Texas Department of Transportation

M E M O R A N D U M

TO: Distribution **DATE:** April 15, 1997

FROM: Judy B. Skeen, P.E. Judy B Skeen, P.E

SUBJECT: *Strategic Plan for Information Resources*

Enclosed is a copy of TxDOT's *Strategic Plan for Information Resources*, as approved by the Department of Information Resources (DIR) earlier this month. This plan is prepared to ensure that TxDOT's business mission and vision will be achieved through the most effective use of information resources.

The plan supports the department's *Strategic Plan* and the *State Strategic Plan for Information Resources Management* published by DIR. This plan was developed based on DIR guidelines; in addition, supplemental information is included to incorporate strategic objectives of the Retooling TxDOT Program as they relate to strategic objectives of Information Resources Management.

Other sources of input to the plan included:

- *Vision Texas: The Statewide Planning Elements for Texas State Government*
- *Business Information and Systems Plan*
- Information Services Business Process Retooling Reports (from Phases 1-3)
- *Biennial Operating Plan*

Please let me know if you have questions and/or comments related to the enclosed plan.

Distribution:
Management Team
Directors of Administration
Division Administrative Managers
Information Resource Administrators
Retooling Implementation Managers

Texas Department of Transportation

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December 20, 1996

Ms. Carolyn Purcell
Executive Director
Department of Information Resources
300 West 15th Street, Suite 1300
Austin, Texas 78701

Dear Ms. Purcell:

Enclosed is the Texas Department of Transportation's (TxDOT's) *Strategic Plan for Information Resources* for 1997-1998. It supports the department's *Strategic Plan* (1997-2001) and the *State Strategic Plan for Information Resources Management* published by the Department of Information Resources (DIR). Based on DIR guidelines, this plan is prepared to ensure that TxDOT's business mission and vision will be achieved through the most effective use of information resources.

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TABLE OF CONTENTS
Strategic Plan for Information Resources

Appendices

●●●●●●●●●●●●●●●

Executive Summary

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This is the Texas Department of Transportation's (TxDOT's) *Strategic Plan for Information Resources* for 1997-1998. It supports the department's *Strategic Plan* (1997-2001) and the *State Strategic Plan for Information Resources Management* published by the Department of Information Resources (DIR) in November 1995. Based on DIR guidelines, this plan is prepared to ensure that TxDOT's business mission and vision will be achieved through the most effective use of information resources.

The visions, missions, and philosophies of the State of Texas, the Department of Information Resources, and the Texas Department of Transportation include:

Statewide Vision, Mission, and Philosophy:

In *Vision Texas: The Statewide Planning Elements for Texas State Government* (April, 1996) the Governor and the Legislative Budget Board developed the following vision, mission, and philosophy which serve as a foundation for the strategic planning process:

Vision: Together we can make Texas a beacon state. A state where our laws encourage jobs and justice. A state that frees our greatest resource--our people--to achieve their highest potential. A state where our children receive an excellent education so they have skills to compete in the next century. A state where people feel safe in their communities, and all people know the consequences of committing a crime are swift, sure and outweigh any potential reward. And a state where each citizen accepts responsibility for his or her behavior. We envision a state where it continues to be true that what Texans can dream Texans can do.

Mission: The mission of Texas state government is to support and promote individual and community efforts to achieve and sustain social and economic prosperity.

Philosophy: State government will be ethical, accountable, and dedicated to the public being served. State government will operate efficiently and spend the public's money wisely.

State *Strategic Plan for Information Resources Management*: Vision, Mission, and Philosophy:

Vision: Texas state government will empower its citizens through direct and easy access to the specific information and services they need, allowing them to fulfill their needs and express their opinions directly, wherever they are, any time of day.

Convenient access to information and communications systems will challenge government to meet citizens' needs in new ways. Interactive services and multimedia two-way communications will be available to every man, woman, and child through diverse systems installed in homes, offices, and public places throughout Texas. Texans of all educational levels, special needs, economic status, and ethnicities will have access to these technologies and find them helpful and easy to use.

Texas state government will focus on the needs of its citizens. It will display leadership in using information resources effectively and efficiently. It will work proactively to affect national policies and industry practices in the development and use of information technology toward that end.

The state will rely on the private sector to deliver data and services to the public, stepping in to deliver directly to the citizenry only those services and data that are essential or required by law.

Texans will have a government that:

- applies innovative technology to perform its business functions and deliver appropriate services.
- facilitates citizen access across local, county, tribal, state, and federal government; assuring integrated, seamless access to needed information and services.

The state will develop and begin to deploy an architecture for the delivery of information and services to the citizenry. This architecture will contain an index to state information and services, including those that are not provided electronically. A well-defined set of security, data, and service interchange standards will ensure that anyone can access state data or services provided electronically. The figure above shows a diagram of this architecture.
The State of Texas will use information technology in a way that:

- complements commonly available user interface services (such as the

Internet, CompuServe, and cable television) to deliver state services and information while ensuring that the under-served and disadvantaged are not disenfranchised.

- selectively provides required information and services directly to specific citizens, as determined by the ongoing process of prioritization and selection of state services and service levels.
- makes state services and data available electronically in a uniform manner, which appropriately recovers the cost of making the data and services available while protecting the privacy of individuals and enterprises, and assuring the authenticity of information.
- assures open access to the common external interface for state information services, with no exclusive arrangements with commercial service providers.

Mission: To enable effective government operations and provision of public services for the people of Texas through appropriate, cost-effective, coordinated, innovative, and useful application of information resources within and among the various agencies and branches of government.

Philosophy: These guiding principles permeate the goals and objectives articulated in this (the State's) plan.

- Citizens are the ultimate reason for government and its services.
- Government must always be accountable to the citizens of the state.
- A commitment to efficient and effective public service underlies every activity of state government.
- The right to privacy is basic to democratic government.
- Information should be collected once and used many times.
- The free exchange of information is fundamental to democratic government.
- Technology is a facilitator and enabler of superior public service, not an end in itself.

TxDOT's Vision, Mission, and Philosophy:

Vision: To be a progressive state transportation agency recognized and respected by the citizens of Texas:

- Providing comfortable, safe, durable, cost-effective, environmentally sensitive, and aesthetically appealing transportation systems that work together

- Ensuring a desirable workplace which creates a diverse team of all kinds of people and professions
- Using efficient and cost-effective work methods that encourage innovation and creativity
- Promoting a higher quality of life through partnerships with the citizens of Texas and all branches of government by being receptive, responsible and cooperative.

Mission: To work cooperatively to provide safe, effective, and efficient movement of people and goods.

Philosophy: Through a diverse and well-trained workforce, we will be open, ethical, responsive, accountable and dedicated to the external and internal customers we serve.

TxDOT's Information Resources (IR) Mission and Vision:

IR Mission: To enable the department to provide effective operations and continuously improve through the timely application, implementation and support of well-developed information resources.

IR Vision: We envision providing our customers, the people of Texas and our employees, information resource capabilities that promote cost-effective and efficient information sharing and provide information that is relevant, accurate, timely and easily available.

IR CRITICAL SUCCESS FACTORS

Critical success factors are those operating characteristics which must be an integral part of all activities of an organization. Through a series of interviews with Information Systems Division (ISD) management, IR management, and the Deputy Executive Director of Administrative Services, the following areas were identified as critical to the success of information services delivery at TxDOT.

Efficiency: Improving the application development life cycle, improving the speed and efficiency of the procurement process and improving the accuracy and efficiency of the project planning process are examples of management efficiency issues. Overall efficiency within the department has been identified as a major factor in the future success of the department.

Education: The rapidly decreasing life cycle of new technologies combined with the department's desire to identify and implement emerging technologies will require improvement in the delivery of staff and user technology training. It will be critical for management, IS staff and employees to be willing to accept and learn new technologies as they become available.

Products: For IS to be successful, timely delivery of quality products will be critical. To improve the quality of IS products and services, they must meet business requirements and respond to business needs while the need still exists. Examining all alternatives available for product delivery, such as package solutions, should become part of the standard product delivery strategy.

People: The retention of qualified IS professionals, and their career development, will be critical to the future success of the department. Managing staff turnover, increasing career opportunities and providing a challenging work environment will be crucial to retaining staff.

Communication: An important aspect of each critical success factor is communication. IS management recognizes that improving communications between users, management and IS staff is a key element in delivering IS services. Communication includes informing all interested parties when decisions are made regarding projects and technology direction.

Responsibility: Increasing the accountability among the various parties involved in managing IS service delivery and the recipients of IS services will be critical to long-term success. This includes establishing common priorities among management, users and IS. In addition, the correct parties must take responsibility for projects from inception to completion.

Research: Continual research and evaluation of new technology based on legitimate business needs will be necessary in order to efficiently take advantage of new technologies where appropriate.

Environment: Creation of a computing environment which promotes cross platform migration, uniformity in the development environment, and establishment of a comprehensive technology infrastructure will be necessary. Controlling the proliferation of new technology and tools will be an important aspect of creating an improved computing environment.

IR GOALS AND OBJECTIVES

TxDOT's IR goals and objectives support statewide IR goals and objectives as well as the agency's goals and objectives. TxDOT's IR goals and objectives are summarized below, with more detailed information about strategies, action items, and related Biennial Operating Plan projects presented in Chapter 2.

TxDOT's IR Goals:

IR Goal #1: Establish and maintain an information services environment which will support department business processes.

IR Goal #2: Improve the efficiency and effectiveness of department operations through the use of enabling information systems and technologies.

IR Goal #3: Provide state-of-the-art registration and titling capabilities.

IR Goal #4: Maximize the effectiveness and efficiency of the transportation network by actively managing traffic in real-time.

TxDOT's IR Objectives:

IR Objective #1: Ensure that the department's business needs are supported by a flexible, reliable, cost-effective, integrated, and standards-based information technology architecture and infrastructure.

IR Objective #2: Establish ongoing information services processes to promote better communication department-wide and provide the ability to easily share information resources, decrease project risk, and reduce maintenance and support costs.

IR Objective #3: Develop a process to manage and provide consultation services for vendor relation management and contract preparation and management.

IR Objective #4: Minimize redundant data and improve the department's ability to integrate systems, databases, and data definitions.

IR Objective #5: Provide for the development, implementation, and maintenance of a comprehensive contingency plan which will ensure TxDOT's ability to recover its information resources in the event of a major disaster or business interruption.

IR Objective #6: Provide appropriate security and authentication for information maintained and communicated by the department.

IR Objective #7: Improve the efficiency and effectiveness of the department's business processes through the innovative use of technology.

IR Objective #8: Ensure department information resources remain operational into the year 2000.

IR Objective #9: Provide a mechanism that will allow the department to manage the entire procurement cycle of commodities and services.

IR Objective #10: Improve the efficiency and effectiveness of the Supplies, Materials, and Equipment (SME) business processes through the innovative use of technology.

IR Objective #11: Improve the efficiency and effectiveness of the Fiscal Services business processes through the innovative use of technology.

IR Objective #12: Improve the efficiency and effectiveness of the Business Management and Direction and Leadership business processes through the innovative use of technology.

IR Objective #13: Improve the efficiency and effectiveness of the Real Property business processes through the innovative use of technology.

IR Objective #14: Improve the efficiency and effectiveness of the Contract Services business processes through the innovative use of technology.

IR Objective #15: Improve the efficiency and effectiveness of the Plan Transportation Systems business processes through the innovative use of technology.

IR Objective #16: Improve the efficiency and effectiveness of the Right of Way business processes through the innovative use of technology.

IR Objective #17: Improve the efficiency and effectiveness of the Design Transportation Systems, Deliver Transportation Systems, and the Maintain and Operate Transportation Systems business processes through the innovative use of technology.

IR Objective #18: Automate the preparation, pre-qualification, proposal distribution, newspaper advertisement, letting, contract process and payment procedure for all maintenance contracts in each district office, the Construction and Maintenance Division, the General Services Division, the Budget and Finance Division, and the Design Division.

IR Objective #19: Improve the efficiency and effectiveness of the Regulate Transportation Systems business processes through the innovative use of technology.

IR Objective #20: Improve the department's ability to administer the provision of the motor vehicle registration and titling statutes.

IR Objective #21: Continue to improve the department's ability to administer the provisions of the motor vehicle registration and titling statutes.

IR Objective #22: Provide an automated system to facilitate the management of the approximately 34,000 on-state system and 14,000 off-state system bridges in an overall Bridge Management System.

IR Objective #23: Develop an automated database which contains pavement layer (cross section) and work history information for all TxDOT maintained highways.

IR Objective #24: Continue to improve the performance and reliability of existing data collection equipment through the application of automation enhancement technologies.

IR Objective #25: Develop and build traffic management systems.

IR Objective #26: Provide an automated database system to support planning efforts and furnish decision support for the Texas Transportation Commission.

IR Objective #27: Streamline the process of locating and evaluating known historical and archeological sites and provide planning tools for early construction project development.

IR Objective #28: Improve the efficiency and effectiveness of the Human Resources business processes through the innovative use of technology.

SUMMARY OF TXDOT'S YEAR 2000 INITIATIVE

As described in the "IR Goals, Objectives, Strategies, and Action Items" section of Chapter 2, TxDOT has identified strategies and action items required to achieve Year 2000 certification. The strategies include:

- Provide guidance and coordination to end user computing departments.
- Ensure that vended IR software and hardware are year 2000 compliant.
- Provide Year 2000 awareness training to all applicable areas.
- Analyze and correct all central IS maintained computer code.

The current impact of the strategy to "Analyze and correct all central IS maintained computer code" is estimated in excess of 38 project "workyears", unadjusted for administrative overhead activities (vacations, sick leave, etc.). Personnel are being redirected from other high-priority projects to ensure Year 2000 certification as defined in DIR Administrative Rule 1 TAC 201.13(e). In addition, the use of contract resources will be needed to ensure the timely completion of the Year 2000 project.

Introduction

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Chapter 1, "Strategic Assessment", presents TxDOT's business environment; business purpose and direction; business needs; statutory requirements; and demographics, economic and fiscal variables. Based on this information, TxDOT's Strategic Plan for Information Resources is business-driven and business-focused. Planning factors and assumptions are also described based on the ongoing work by the Information Services Business Process Retooling teams. Additionally, the vision for the information services (IS) business area, and a high-level description of the changes in the way information services will be provided on an ongoing basis are presented in Chapter 1. The IS vision is also presented below, and projects are underway to achieve the vision by 1998.

The Vision for Information Services

Partnership between information services providers and all other department business areas is the foundation of the vision for the information services business area. Through partnership, IS providers become an integral element of the department's planning and IR project execution activities, affording management the opportunity to identify information technology enablers for business needs. We envision the IS organization in close and constant touch with its customers. IS expenditures, resource allocations, and project design decisions will be driven by business value and customer need.

Teaming of information service providers to furnish timely, reliable, and integrated business solutions is an essential element of the vision. These teams will be appropriately empowered and accountable for the solutions provided to their customers.

Development and continuous improvement of the department-wide technology infrastructure is a primary element of the vision. Through joint efforts, IS providers will research, implement, and integrate technology elements that will be the foundation for multiple business solutions.

We envision an IS organization and IS processes that enable TxDOT to manage and adapt to continuous change and a technology infrastructure (organizational, informational, and technological) that enables TxDOT to deliver what it needs, when it needs it.

The IS vision also includes these key elements:

- Customer problem resolution through a single point of contact
- Development and utilization of department-wide standards for hardware, software, networks, tools and methods
- Continual refinement of data, application, and technology architectures

- Establishment of a Chief Information Officer
- Definition and communication of clear roles and responsibilities
- Department-wide data administration
- Ongoing measurement of IS performance.

Chapter 2, IR Strategic Directions, presents the agency's IR goals, objectives, strategies, and action items, and relates them to the agency's goals, and to the goals and objectives published in the *State Strategic Plan for Information Resources*. References are also included to the department's Biennial Operating Plan to tie specific projects to goals, objectives, and strategies.

The opportunities depicted in this strategic plan are dependent on technology, funding, and resource availabilities. This includes the introduction of new technology and processes which will change the way operations and services are currently provided; radical reconfiguration of hardware/software to optimize and improve cost effectiveness, efficiency, and expand operations; and allocation and distribution of resources for more cost-effective operations. The goals and objectives in this plan significantly change the way the department does business, especially in the area of information services. These goals and objectives, and the associated strategies, will be a major challenge for the Department and until these strategies can be executed, the department cannot take full advantage of existing information resources or address any additional information resource opportunities. It is important to note that a project is underway as part of the IS BPR Program to develop new IR planning, prioritization, and staffing processes to most effectively meet the challenges ahead.

In **Chapter 3, Information Services (IS) Business Model**, the evolving business model for the information services business area is presented. This business model is being developed as part of the Information Services Business Process Retooling Program. As business needs change, the IS business model will evolve, and as part of the Information Services Business Process Retooling (IS BPR) Program, a primary objective is to design an IS business model that can easily and quickly adapt to ongoing changes in business requirements.

Chapter 4, Information Technology Architecture and Infrastructure, provides an overview of the technical architecture, infrastructure, and related projects underway that will ensure a stable enterprise IT infrastructure to support the business needs of the department. In addition to the IS BPR Program, TxDOT currently has five other major retooling efforts underway, and the enterprise IT infrastructure must be in place by 1998 to support the needs identified in those other business areas of the department. The other Retooling Programs are:

- Human Resources
- Fiscal Services
- Supplies, Materials, and Equipment
- Real Property (specifically, Right of Way)

- Plan Transportation Systems

Chapter 5, Supplemental Planning Information for DIR, presents information on the following topics:

- Organization and Personnel
- IR Policies and Practices
- IT Infrastructure & Configuration
- Data & Major Applications

The Appendices provide additional background information on the department and the Retooling TxDOT Program, as well as a copy of the current IT Core Technology Architecture and Network Diagrams.

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Section A
Business Direction and Needs

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OVERVIEW:

TxDOT's business environment is described in the following section. The description covers the department's organizational structure; business purpose and direction; business needs; statutory requirements; and demographics, economic and fiscal variables.

ORGANIZATION STRUCTURE:

Overview:

TxDOT's organizational structure and key personnel are described in this section. The current organizational structure is depicted in Appendix 1.

Organization Units:

Texas Transportation Commission:

TxDOT is governed by the three-member Texas Transportation Commission and an Executive Director selected by the commission. The commission members, serving six-year overlapping terms, are appointed by the Governor with the advice and consent of the Texas Senate. The Governor designates the Commissioner of Transportation.

Motor Vehicle Board:

The Motor Vehicle Board, formerly the Texas Motor Vehicle Commission, consists of six members appointed by the Governor. Board members serve six-year terms, are independent from the Texas Transportation Commission, and must have no affiliation with any business that manufactures, distributes or sells new motor vehicles.

Executive Director:

TxDOT's Executive Director oversees 25 district offices, 20 functional divisions, and nine special offices. The Executive Director's duties include establishing departmental direction and priorities, establishing policies and procedures, and interacting with the public, other government agencies, and the legislature.

The Executive Director is appointed by and reports to the Texas Transportation Commission.

Senior Management Team:

The Senior Management Team (SMT) oversees the seven organizational functions of the department. The team includes the Executive Director, Deputy Executive Director for Transportation Planning and Development, Deputy Executive Director for Administrative Services, Assistant Executive Director for Field Operations, Assistant Executive Director for Multimodal Transportation, Assistant Executive Director for Human Resources Management, Assistant Executive Director for Motorist Services and Director of Staff Services.

District Offices:

District area, maintenance, and headquarters offices provide direct delivery of transportation products and services. Each district, managed by a District Engineer, is responsible for the design, location, construction and maintenance of its area transportation systems. Varying climate and soil and differing needs of local populations make decentralization of department operations necessary.

District Engineers are also responsible for district support operations, including planning, human resources, public affairs, training, automation support, budget, and fleet maintenance. District Engineers report to the Executive Director.

Management Team:

The Management team includes the Senior Management Team, District Engineers, Division Directors and Directors of Special Offices as outlined in the following functional areas.

Transportation Planning & Development Function:

The Deputy Executive Director for Transportation Planning and Development oversees the International Relations Office, and the Transportation Planning and Programming, Environmental Affairs, Right of Way and Design divisions. Functional activities include development of statewide short range and long range transportation programs with respect to project programming, transportation planning, environmental issues, international relations, roadway, bridge and landscape design, and right of way issues. The five offices and divisions which make up the Transportation Planning and Development function are:

International Relations Office:

The International Relations Office (IRO) serves as focal point for federal, state and local governments, the public, businesses and groups regarding TxDOT international activities. This includes being contact and coordinator for international transportation planning organizations.

The International Relations Office is the protocol office and liaison with the Governor's Office for international activities. The IRO director chairs the TxDOT Standing Committee on Border Affairs, which consists of border-area District Engineers and Division Directors whose activities include some international element. The director also represents TxDOT on the Joint Working Committee for U.S.-Mexico Binational Transportation Planning. Most of the office's activities are focused on Mexico. However, there are also North American Free Trade Agreement (NAFTA) related activities involving Canada. Because IRO coordinates foreign transportation officials' visits to TxDOT, its contacts range worldwide.

Transportation Planning and Programming Division:

The Transportation Planning and Programming Division administers the *Texas Transportation Plan*, the Statewide Transportation Improvement Program, the metropolitan planning organization process, the Unified Transportation Plan and the federal Highway Performance Monitoring System. The division is also responsible for urban transportation studies, road designation, road inventory, bridge and railroad crossing inventory, reference marker locations, road life data, mapping and map distribution, traffic volume analysis, traffic forecasting, travel demand modeling, vehicle weight and classification studies and speed and origin-destination studies.

Environmental Affairs Division:

The Environmental Affairs Division coordinates and oversees all department environmental activities. The division serves as the environmental liaison with state and federal resource agencies, environmental and special-interest groups, and the public. It is responsible for hazardous materials, the Transportation Enhancement Program, and the Congestion, Mitigation and Air Quality Program.

Right of Way Division:

The Right of Way Division manages the acquisition of transportation right of way and other lands necessary for TxDOT operations. The division also disposes of surplus real property, controls signs along roads and highways outside cities, and controls outdoor advertising and junkyards along interstates and primary highways, and administers the Road Utility District and Texas Transportation Corporation Acts, leasing of right of way and mineral rights on TxDOT land and the Relocation Assistance Program. The division also provides coordination for eminent domain proceedings with the state attorney general and administers the adjustment and relocation of utilities on right of way acquisition projects.

Design Division:

The Design Division guides transportation construction projects through preliminary engineering phases. These services include geometric design, pavement design and management, bridge design and management, landscape design, project plan review and processing, standard construction specifications, and hydrology and hydraulics engineering. The division inventories, inspects and appraises the state's 48,000 bridges and administers bridge replacement and rehabilitation programs. The division evaluates and reports on pavement conditions on the 77,000 centerline miles of roadway on the state-maintained system. The division serves as liaison with the Federal Highway Administration on preliminary engineering matters. The division coordinates the monthly and annual construction letting schedule of about $1.6 billion.

Field Operations Function:

The Assistant Executive Director for Field Operations directs all field operations including statewide construction, maintenance, traffic operations, materials and tests functions, and research and technology transfer.

The four offices and divisions which make up the Field Operations function are:

Research and Technology Transfer Office:

The Research and Technology Transfer Office administers the Cooperative Highway Research Program, the Technology Transfer System and other department research and technology transfer activities.

Construction and Maintenance Division:

The Construction and Maintenance Division administers all TxDOT construction and maintenance contracts. The division provides consultation to the districts on the management and administration of these projects from pre-letting phase to final acceptance; and is also responsible for the construction oversight program's overall effectiveness in complying with TxDOT and FHWA requirements. The division administers and oversees statewide maintenance and emergency maintenance operations. The division is responsible for bridge construction and maintenance activities, ferryboat operations, the vegetation management program and the State Use program.

Materials and Tests Division:

The Materials and Tests Division provides quality control of materials used in transportation construction and maintenance, advice for the selection and use of materials, and field consulting on problems with materials. The division administers contracts with commercial laboratories and provides technical training, core drilling, equipment calibration and general support for district laboratories. It also participates in organizations that develop national specifications.

Traffic Operations Division:

The Traffic Operations Division is responsible for the engineering design of traffic control devices, illumination systems and radio operations, safety and traffic operations, and the maintenance and analysis of TxDOT accident records. The division directs the effort of automated traffic management system implementation; oversees Intelligent Transportation System (ITS) projects and the Texas Traffic Safety Program; coordinates traffic safety campaigns; and administers railroad signals and state highway crossing repair programs.

Multimodal Transportation Function:

The Assistant Executive Director for Multimodal Transportation directs all multimodal transportation functions, including gulf intracoastal waterways, abandoned rail, bicycle and pedestrian coordination, aviation and public transportation services. In addition, the director serves as liaison to the Texas Turnpike Authority and the Texas High Speed Rail Authority.

The three offices and divisions which make up the Multimodal Transportation function are:

Multimodal Operations Office:

The Multimodal Operations Office is responsible for project planning, policy development, and operations pertaining to water transportation, freight and passenger rail, bicycles and pedestrians. The office develops and oversees implementation of mode-specific system plans, and serves as TxDOT's liaison with port authorities and other multimodal entities (exclusive of transit and aviation). Multimodal Operations is also responsible for activities associated with TxDOT's role as the state's non-federal sponsor of the Gulf Intracoastal Waterway. The Bicycle Rules Advisory Committee is appointed by the Texas Transportation Commission to advise the commission on bicycle-related issues and rules.

Aviation Division:

The Aviation Division is responsible for promoting, maintaining and protecting an air transportation infrastructure for general aviation airports. This infrastructure provides for the safe and efficient airborne movement of people, goods and services within Texas and access to the global air network. The division acts as agent for each political subdivision in the state for the purpose of applying for, receiving, and disbursing federal and state funds to general aviation airports. The division conducts long-range aviation facilities planning, coordinates the development of a statewide system of airports and also programs available state and federal financial assistance to communities and conducts airport inspections to ensure safety, serviceability and grant compliance. The division executes and manages all airport project funding in accordance with local, state and federal law, and provides specialized aviation training, publications, and videos for the public. The Texas Transportation Commission appoints six people to the Aviation Advisory Committee to advise the commission and the department on aviation matters.

Public Transportation Division:

The Public Transportation Division is charged with fostering and promoting public transportation in Texas. The division prepares and updates a statewide master plan for public transportation. It administers the State Public Transportation Fund and administers programs for the transportation of elderly and disabled individuals, rural transportation programs, and public transportation programs for small urban areas in partnership with the Federal Transit Administration. The division sponsors and monitors research and development in public transportation, and provides technical assistance, training, and planning support to the transit industry and metropolitan planning organizations. The Governor, Lieutenant Governor, and Speaker of the House each appoint two people to serve on the Public Transportation Advisory Committee. The committee advises the department and the Texas Transportation Commission on public transportation matters.

Administrative Services Function:

The Deputy Executive Director for Administrative Services directs all administrative support operations including financial management, information systems, general services, and business opportunities. In addition, the director serves as the agency's Chief Information Officer and oversees the Retooling TxDOT effort.

The four offices and divisions which make up the Administrative Services function are:

Business Opportunity Programs Office:

The Business Opportunity Programs Office oversees the Disadvantaged Business Enterprise program and the Historically Underutilized Business program.

Budget and Finance Division:

The Budget and Finance Division is responsible for TxDOT's accounting, forecasting, budgeting, payment for all goods and services, and processing of all receipts and revenues. The division also analyzes and reports the financial effects of proposed legislation on TxDOT.

General Services Division:

The General Services Division purchases equipment, materials, services, and supplies. The division manages TxDOT's equipment fleet and preventive maintenance programs, maintains regional warehouses in Athens, Post, and Seguin and oversees the department's recycling program. At Camp Hubbard in Austin, the division operates repair shops and a warehouse. The division provides management maintenance and security for TxDOT headquarters and other division and special office buildings. General Services manages the electronic publishing center, records depository, microfilm operation, records management program, surplus property disposal, the Alternative Fuels Program, printing and reproduction, and contract review and processing.

Information Systems Division:

The Information Systems Division manages the department's automation operations, including the central computer system. The division provides an extensive, automated statewide management system, decentralized engineering design operations, an automated vehicle title and registration system, photogrammetry, and telecommunications system management. In addition, the Division Director also serves as the department's Information Resources Manager and oversees information resources strategic planning and biennial operating planning activities.

Human Resources Management Function:

The Assistant Executive Director for Human Resources Management directs the Human Resources, Civil Rights, Occupational Safety, and Training, Quality and Development Divisions.

The four divisions which make up the Human Resources Management function are:

Human Resources Division:

The Human Resources Division coordinates the department's recruitment program, conducts long-range human resources analysis, administers affirmative action and training programs, coordinates personnel benefits and employee-assistance programs, and maintains the functional classification system for the department.

Civil Rights Division:

The Civil Rights Division investigates internal and external discrimination and nondiscrimination complaints. The division also helps all organizational units comply with equal opportunity policies and procedures.

Occupational Safety Division:

The Occupational Safety Division is responsible for the department's self-insured workers compensation insurance program, the employees safety program, aspects of hazardous materials involvement that affect employee safety and health, the resolution of tort claims against the department, and liability insurance for claims that arise from the use of motor-driven vehicles and road-building equipment.

Training, Quality and Development Division:

The Training, Quality and Development Division identifies key organizational learning needs, integrates organizational strategies and supports the achievement of organizational goals. The division manages the overall coordination and administration of training activities in the department including continuous improvement, partnering, employee functional training and professional development.

Motorist Services Function:

The Assistant Executive Director for Motorist Services directs TxDOT's motorist services, including vehicle title and registration, motor vehicle administration, travel and information, and the central permit functions. In addition, the director oversees the operations of the Automobile Theft Prevention Authority.

Automobile Theft Prevention Authority:

The Texas Automobile Theft Prevention Authority, established by legislation in 1991, consists of a six-member board appointed by the Governor to reduce the vehicle theft rate in Texas. The authority's activities are funded by a fee which is assessed annually through automobile insurance companies.

The four divisions which make up the Motorist Services function are:

Motor Carrier Division:

The Motor Carrier Division provides services for issuing oversize/overweight permits, 72/144 hour permits, and one trip registration; registering commercial motor carriers; providing services for motor carrier insurance filings; vehicle storage facility licensing; issuing operating registrations to international motor carriers; filing performance bonds for transportation brokers; complaint resolution between household goods carriers and their customers; and assessing administrative penalties for violations of motor carrier laws and department rules. Efforts are coordinated with the Department of Public Safety regarding federal motor carrier safety provisions.

Vehicle Titles and Registration Division:

The Vehicle Titles and Registration Division registers vehicles, issues certificates of title and collects fees using 254 county tax assessor-collectors as agents. It administers more than 60 categories of license plates and processes about four million title applications each year.

Motor Vehicle Division:

The Motor Vehicle Division regulates the vehicle industry in Texas and licenses new motor vehicle dealers, lessors, lease facilitators, manufacturers, distributors and converters. The division enforces provisions of the Texas Motor Vehicle Commission Code and the Lemon Law and is responsible for the regulation, administration and enforcement of the Texas Dealer Law (Art. 6686). The Motor Vehicle Board consists of six members appointed by the Governor. Board members serve six-year terms, are independent of the Texas Transportation Commission, and must have no affiliation with any business that manufactures, distributes, or sells new motor vehicles.

Travel and Information Division:

The Travel and Information Division oversees the official state tourist information program and manages the department's anti-litter programs. The division also publishes Texas' Official Travel Map, the *Texas State Travel Guide* and *Texas Highways*, the state's official travel magazine, as well as other travel information. It operates 12 travel information centers, including one within the Capitol Complex in Austin. In addition, the division also provides audiovisual support for the department.

Staff Services Function:

The Director of Staff Services directs all management services, legislative affairs, public information, and general counsel functions. In addition, the director oversees the activities of the Appeals Office. The Appeals Office conducts appeal hearings for complaint investigation determinations and for employee complaints arising from adverse personnel actions such as probation, suspension with or without pay, involuntary demotions, involuntary transfers, or terminations.

The four offices which make up the Staff Services function are:

Management Services Office:

The Management Services Office coordinates TxDOT's strategic plan; provides demographic, economic and statistical analyses, and develops performance measures. In addition, the office coordinates activities related to commission meetings.

Legislative Affairs Office:

The Legislative Affairs Office monitors state and federal legislation including coordination of comments on rules in the federal and Texas registers. The office also serves as liaison to congressional delegations and the state legislature, provides policy analysis and review, and prepares policy and communications manuals.

Public Information Office:

The Public Information Office is responsible for the department's internal and external communications, including news media relations, community outreach, and the employee newsletter, *Transportation News*.

General Counsel Office:

The General Counsel Office facilitates proposed legislation, provides legal support to statutory advisory committees, serves as department executor for Title 43 of the Texas Administrative Code, serves as liaison with the Texas Secretary of State and the Texas Attorney General's Office, and provides legal advice on policies, procedures, rules, open meetings, commission agenda, open records, and personnel issues.

BUSINESS PURPOSE AND DIRECTION:

Statewide Vision, Mission, Philosophy, Functional Goals and Benchmarks:

In *Vision Texas: The Statewide Planning Elements for Texas State Government* (April, 1996) the Governor and the Legislative Budget Board developed the following vision, mission, philosophy, functional goals, and benchmarks for the department to serve as a foundation for the strategic planning process:

***Vision*:**
Together we can make Texas a beacon state. A state where our laws encourage jobs and justice. A state that frees our greatest resource--our people--to achieve their

highest potential. A state where our children receive an excellent education so they have skills to compete in the next century. A state where people feel safe in their communities, and all people know the consequences of committing a crime are swift, sure and outweigh any potential reward. And a state where each citizen accepts responsibility for his or her behavior. We envision a state where it continues to be true that what Texans can dream Texans can do.

***Mission*:**
The mission of Texas state government is to support and promote individual and community efforts to achieve and sustain social and economic prosperity.

***Philosophy*:**
State government will be ethical, accountable, and dedicated to the public being served. State government will operate efficiently and spend the public's money wisely.

Economic Development Priority Goal:
To foster economic opportunity, job generation, and capital formation by providing quality business services, preparing the workforce for productive employment, and supporting infrastructure development.
Benchmark
- Highway system quality rating

Natural Resources Priority Goal:
To conserve the state's environment through prudent stewardship of the state's natural resources.
Benchmarks
- Percent of Texans living in areas meeting or exceeding air quality standards
- Tonnage reduction in priority air pollutants in counties not meeting air quality standards.

General Government Priority Goal:
To support effective and efficient state government operations.
Benchmark
- Ratio of federal dollars received to federal tax dollars paid

Regulatory Priority Goal:
To ensure that communities are served by high quality professionals and businesses by setting clear standards, maintaining compliance, and seeking market-based solutions.

Benchmarking:

Benchmarking has been defined as "the process of comparing processes and products against the best that can be found" [William Lareau, American Samurai, p. 128]. TxDOT is a member of a number of national transportation-related organizations such as the Transportation Research Board and the American Association of State Highway and Transportation Officials, as well as discipline-related organizations such as the American Society of Civil Engineers, and the American Management Association, to name just two. These organizations furnish extensive benchmarking opportunities through meetings, publications, and E-mail networks. These avenues are routinely and extensively used for mutual problem solving and identifying best practices, which are the essence of benchmarking. For example, Retooling TxDOT evaluated right of way acquisition processes by benchmarking against four other states and one private company.

Performance measures are periodically reviewed by management and revised if necessary to better reflect efficiency and effectiveness of department operations. New statistical methods such as data envelopment analysis are evaluated for their utility to the department. Cost benchmarking is conducted and is reflected in the Preliminary Engineering Efficiency Report. Information from other state agencies and Departments of Transportation was used by the Optimum Department Staffing Task Force in assessing staff allocations.

TxDOT's Current Business Plans and Strategies:

Vision:

To be a progressive state transportation agency recognized and respected by the citizens of Texas:

- Providing comfortable, safe, durable, cost-effective, environmentally sensitive, and aesthetically appealing transportation systems that work together
- Ensuring a desirable workplace which creates a diverse team of all kinds of people and professions
- Using efficient and cost-effective work methods that encourage innovation and creativity
- Promoting a higher quality of life through partnerships with the citizens of Texas and all branches of government by being receptive, responsible and cooperative.

Mission:
To work cooperatively to provide safe, effective, and efficient movement of people and goods.

Philosophy:
Through a diverse and well-trained workforce, we will be open, ethical, responsive, accountable and dedicated to the external and internal customers we serve.

BUSINESS NEEDS:

Overview:

To assess business process effectiveness and provide a context for the information resource requirements, the strategic environment surrounding TxDOT will be discussed, as well as the economics of the department. Issues and opportunities identified by the Management Team which face TxDOT will also be described.

External/Internal Assessment:

Scope and Evolution of the Texas Department of Transportation (TxDOT):

TxDOT employees are committed to quality performance and results. When the Texas Department of Transportation was created in 1991, it merged responsibilities of two agencies and brought highways, aviation, and public transportation under one roof. Although highways play a prominent role in its transportation efforts, TxDOT is exploring options and opportunities that include all other modes of transportation. TxDOT must consider many factors and modes of transportation as the department strives to make Texas more livable and economically sound. From the research the department conducts with state-supported colleges and universities to its involvement in environmental matters, TxDOT realizes that it is responsible for and contributes significantly to the overall well-being of Texans and others who travel Texas.

TxDOT provides the people of Texas with a state highway system, operates two ferry systems, assists general aviation and public transportation through a variety of services and programs, and serves as the local sponsor for the Gulf Intracoastal Waterway. It also promotes the use of bicycles as a means of transportation.

Transportation responsibilities include planning, designing and managing highway construction projects; maintaining highways and roadsides; managing traffic and improving traffic safety; controlling outdoor advertising and junkyards along highways; inspecting and replacing bridges both on and off the state system; and working with railroads to improve the safety of railroad crossings.

Pilots, businesses, and communities dependent upon general aviation airports are served by TxDOT through planning, inspection, financial assistance, and technical and engineering services. TxDOT helps small-city, rural, and specialized transit operators (such as those serving the elderly and people with disabilities) through research, planning, and financial assistance. TxDOT is in the process of starting the Routine Airport Maintenance Program where airports receive the same maintenance work that is done on the highways. TxDOT coordinates with economic and environmental interests in planning for, maintaining, preserving, and improving the Texas portion of the Gulf Intracoastal Waterway, thereby serving its transportation users.

Travelers are served through travel information centers, rest and picnic areas, travel literature, maps, and a toll-free travel hotline offering information on emergency road conditions as well as personalized travel counseling. *Texas Highways* magazine, the official travel magazine of the state, provides monthly articles and suggestions regarding travel. The growing Texas tourism industry benefits from the department's distribution of the magazine, other travel literature, and counseling services provided to tourists and potential visitors to the state.

The department issues oversize and overweight permits to trucks using the state highway system. TxDOT also registers Texas vehicles, issues certificates of title, and collects fees through the 254 county tax assessor-collectors. The department enforces the Texas Motor Vehicle Commission Code, licenses new and used-vehicle dealerships and leasing companies, and enforces the Lemon Law. Three new regulatory responsibilities added in 1995 are trucking regulation, salvage dealer regulation, and vehicle storage facility regulation.

To fulfill these varied responsibilities to its customers, TxDOT employees plan extensively with both governments and private organizations, including Mexico and neighboring states. The department is building upon existing partnerships and forming new ones. Of particular note is the development of the *Texas Transportation Plan*, which addresses the total transportation picture in Texas: air, rail, highway, transit, bicycle, pedestrian, water, pipeline, and telecommunications, involving both the public and private sectors. TxDOT is striving to improve connections between the different modes of transportation. The department will also evaluate and help preserve corridors that support the most economical and practical flow of people and goods.

STATUTORY LIMITATIONS AND REQUIREMENTS:

State Provisions:

The Texas Constitution dedicates for public road purposes revenue in the form of motor-fuels taxes and vehicle registration fees, which provide the foundation for department operations. Various statutes regulate the department's operations and spending authority relating to highway construction, maintenance and operations; public transportation funding; traffic safety services; aviation funding and services; support for the Gulf Intracoastal Waterway; and other transportation-related services and programs.

The department's legislative appropriation includes specific requirements for transfers of funds. State law emphasizes the use of private contractors and professional services, including disadvantaged business enterprises and historically underutilized businesses. In addition, the department must consider the impact of increased trade resulting from the North American Free Trade Agreement in planning the state's transportation network.

The 72nd Texas Legislature in 1991 directed the Sunset Advisory Commission to review the feasibility of consolidating the Texas Turnpike Authority (TTA) with TxDOT. Texas voters adopted a constitutional amendment in November 1991 that authorizes TxDOT to expend highway funds for TTA toll projects, provided that all funds are repaid from toll revenues. This amendment removed a constitutional impediment to the possible merger of the two transportation agencies in 1997. In addition, the National Highway System Designation Act of 1995 authorizes the use of federal funds for up to 80% of the cost of toll projects.

Federal Provisions:

TxDOT uses federal funds to construct and rehabilitate highways and bridges; to provide public transportation to the elderly and people with disabilities, to assist rural transit and municipal transit systems in cities under 200,000 population; to promote traffic safety efforts throughout the state; to assist localities in establishing and maintaining general aviation airports; and to accomplish many other tasks that help provide safe and efficient transportation systems for the citizens of Texas.

The department must comply with various federal statutes, and federal transportation funds can be withheld (or projects may not be approved) for non-compliance. These standards include the Clean Water Act; the Endangered Species Act; the National Environmental Policy Act; safety-belt laws; commercial vehicle length, size, and weight limits; outdoor advertising and junkyard controls; the zero tolerance provisions; driver's license suspension for drug offenders; commercial vehicle driver license requirements; and certification of metropolitan planning organizations.

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) gives local governments enhanced roles in planning for and spending federal funds for transportation in cities with populations greater than 50,000. Cities with populations of more than 200,000 decide transportation investments for their respective areas in cooperation with TxDOT.

DEMOGRAPHIC/ECONOMIC VARIABLES:

Several major trends set the stage for future Texas transportation needs.

Expanding Population:

The Texas population is steadily increasing. By 2001, the population will be about 21 million, up from an estimated 19.4 million in 1997. The population is also aging. Texas' population greater than 65 years old is 10.3 percent and will be 13 percent by 2015. Both the volume and age of drivers will increasingly affect transportation design and services.

Growing Travel Demand:

Texas population is also growing more urban. About 82 percent of the population lives in the state's 25 urbanized areas. Almost 56 percent of the miles driven each day are on the 20 percent of the state road miles located in urban areas. The vehicle miles traveled are growing at an even faster rate than population, reflecting a more transportation-intensive state.

Competitive Economy:

An intensive economic competition among states and nations exists that effects the scope and quality of transportation. Transportation is a vital component of the Texas economy. State Comptroller data shows that in 1995, an estimated $56.6 billion was spent on transportation of goods, services, and people. This represents 11.4 percent of the Texas gross state product.

Increasing International Trade:

International trade is an important factor in the Texas economy. U.S. trade with Canada and Mexico reached record levels in 1994, jumping 17 percent to $348 billion. This trade is producing an increasing demand on Texas' transportation facilities. Approximately 75 percent of the United States-Mexico trade passes through Texas. These goods travel to all of continental United States and Canada; and Texas is bearing the burden of the impact on the transportation infrastructure.

Declining Air Quality:

Texas has four areas that do not meet federal standards for quality air. According to the Environmental Protection Agency these areas are Houston, Beaumont, Dallas-Fort Worth, and El Paso. Austin, San Antonio, Victoria, Corpus Christi, and Tyler are bordering on non-attainment status for air quality. Clean air will continue to be a major factor in planning transportation options.

Thriving Tourism:

Tourism is Texas' third largest industry and is expected to continue as a major factor in the Texas economy. The quality of transportation is a catalyst for the tourist industry. Texas already is the second most popular destination for U.S. tourists. Tourism is a $24.5 billion industry in the state of Texas and supports 435,000 jobs.

FISCAL ASPECTS:

Forecasted revenues for 1985 to 2001 do not account for the effects of inflation. Automobile fuel efficiency increases are expected to offset increases in driving, producing essentially no increase in revenues through 2001.

Ninety-five percent of TxDOT's revenue is derived from the following three major sources. Fuel consumption is not expected to change substantially over the next five-year span.

- Almost one-half (48 percent) of TxDOT's revenue is derived from the state's motor fuel tax. The motor fuel tax is one of the largest sources of tax revenue for the state, second only to the sales tax. Most fuel tax revenue derives from the 20 cent per gallon state gasoline tax and from diesel and special fuels taxes, of which the department receives about 75 percent (the school fund receives 25 percent).

- Federal reimbursements provide 29 percent of the department's revenue.

- Vehicle registration (license) fees comprise 18 percent of TxDOT's revenue.

- Other revenue (5 percent) includes reimbursements from cities and counties, sales tax on lubricants, title fees, interest and other sources.

Major department expenditures for 1995 programs include construction and maintenance program expenditures averaging 79 percent of all expenditures for this period. Uncertain further effects on expenditures for construction and maintenance programs are expected for fiscal years 1997 through 2001 because of the proposed National Highway System and full implementation of ISTEA.

Funding Requirements:

TxDOT is committed to delivering maximum transportation value to Texans and visitors to Texas. The department has embarked on major efficiency-enhancing initiatives in the areas of automation, organizational reengineering, staffing optimization, and continuous improvement. All of these will help increase the ability of the department to deliver a higher level of service for the taxpayer's dollar. In addition, TxDOT is working actively to use partnering and other innovative financing methods such as toll roads to leverage the transportation buying-power of revenues collected.

However, there are also external forces which act to diminish the department's level-of-service including unfunded federal mandates, inflation, and growth in transportation demand. Unfunded mandates divert resources from direct transportation uses. Highway cost inflation reduces the transportation buying-power of tax revenues just as general inflation decreases the buying-power of the consumer's dollar. Finally, increasing demand for transportation due to increasing population and economic development places further pressure on what the tax dollar can continue to provide in terms of safety, system preservation, and mobility.

Texas' transportation needs for all modes (as estimated by a Transportation Needs Project) are best described in terms of level of service scenarios with their associated costs. The dollar amounts are 10-year annualized needs that reflect a 3.66 percent inflation rate over the 1997-2006 period. These scenarios are:

Scenario One, "Losing Ground": With current funding sources, an average of $3.9 billion per year, adjusted for inflation, there will be a general deterioration of the transportation system resulting in meeting only 33 percent of identified transportation needs.

Scenario Two, "Holding the Line": If funding is increased to an average of $5.7 billion per year, adjusted for inflation, the present level of service will be maintained, meeting 48 percent of identified transportation needs.

Scenario Three, "Gaining Ground": If funding is increased to an average of $8.4 billion per year, adjusted for inflation, the agency's internal staffing will maximize its potential for management of contracted services and the transportation system will attain 72 percent of identified transportation needs.

Scenario Four, "Meeting Optimal Needs": Meeting all reasonable transportation needs of the state and economy by expanding programs to an average of $11.8 billion per year, adjusted for inflation.

Effects of time and expenditures on the cumulative level-of-service provided by the Texas transportation systems; highways and bridges, public transit, aviation, and the Gulf Intracoastal Waterway are increasing. “Holding the Line” shows that today the systems are in fairly good condition but that rehabilitation or reinvestment will be critical to avoid serious deterioration of the infrastructure investment. “Gaining Ground” and “Meeting Optimal Needs” show progressively improved system levels of service as expenditures are increased.

In Scenario One, overall system condition will deteriorate from “good minus” down to a “marginal” level by FY 2006. In Scenario Two, “Holding The Line”, the system will remain at “good minus”. For Scenario Three, “Gaining Ground”, the system will improve, reaching a “superior” level over that time period. In Scenario Four, “Meeting Optimal Needs”, the system overall will attain an “excellent” level of service.

Many business issues, opportunities and recommendations have been submitted to the Retooling project team by TxDOT employees throughout the state by way of the Retooling TxDOT Issues and Opportunities Form. This form has been made available to employees throughout TxDOT for submitting their ideas concerning needed business improvements. The Retooling project team in turn has presented the issues and the employees' recommendations to the Senior Management Team for consideration. Many of the recommendations have been submitted to the appropriate TxDOT office for handling while many will be used for analysis during upcoming business process retooling efforts. The retooling team is currently working with personnel responsible for TxDOT's Employee Incentive Program to integrate the two processes by which employees can submit their ideas.

Section B
Planning Factors and Assumptions

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OVERVIEW:

TxDOT's Business Information and Systems Plan (BISP), published in September 1994, laid the foundation and direction for improving the business environment at TxDOT through the evaluation of business processes and the implementation of improvement projects. The Information Services (IS) business area was selected as the first to be evaluated since it plays an integral part in all TxDOT business. A core team of department IS professionals and consultants formed a partnership to assess the IS business area in January 1995 as part of the overall "Retooling TxDOT" Program. This assessment validated, at a more detailed level, the internal and external assessments included in the BISP. The original internal and external assessments from the BISP are included in Appendix 3 as reference information.

The major findings in the more detailed assessment of the IS business area completed in April 1995 were included in the IS Retooling *Phase 1: The Change Imperative* Report. These findings included:

- Little or no internal communication with IS staffs causes delays, uncertainty, lack of confidence, and poor customer support.
  - Technology direction poorly defined - no central technology architecture plan
  - Projects' scopes and impacts not defined
  - Application enhancements poorly documented.

- Poor project implementation planning effects loss of productivity, increased expense, and user frustration.
  - New technologies not considered
  - New applications designed on old technologies
  - Hardware /software upgrades are inconsistent and lack uniformity.

- Lack of "department" perspective results in poor utilization of resources and low productivity.
  - Allocation and management of resources too restrictive to meet changing needs
  - No uniform procedure for research of new technology / product selection.

- Customer needs are often overshadowed by the tendency to control at the division level.

Recommendations resulting from Phase 2 of the Information Services Retooling Project were published in the *Phase 2: Vision Statements and Process Improvement Recommendations* Report in June 1995. Excerpts from the executive summary of that report follow.

The objectives of this phase (Phase 2) were to strengthen the change imperative developed during Phase 1, develop a new vision for each of the processes included in the current TxDOT IS business model, and build a business case for each process improvement recommendation that resulted from the new process visions.

In this document we set forth a vision of retooled information services processes at TxDOT. Five visioning teams developed vision statements for the processes included in the current information services business model.

OVERVIEW OF THE VISION

Partnership between information services providers and all other department business areas is the foundation of our vision. Through partnership, IS providers become an integral element of the department's planning and IR project execution activities, affording management the opportunity to identify information technology enablers for business needs. We envision the IS organization in close and constant touch with its customers. IS expenditures, resource allocations, and project design decisions will be driven by business value and customer need.

Teaming of information service providers to furnish timely, reliable, and integrated business solutions is an essential element of the vision. These teams will be properly empowered and accountable for the solutions provided to their customers.

Development and continuous improvement of the department-wide technology infrastructure is a primary element of the vision. Through joint efforts, IS providers will research, implement, and integrate technology elements that will be the foundation for multiple business solutions.

We envision an IS organization and IS processes that enable TxDOT to manage and adapt to continuous change and a technology infrastructure (organizational, informational, and technological) that enables TxDOT to deliver what it needs, when it needs it.

The IS vision also includes these key elements:

- Customer problem resolution through a single point of contact
- Development and utilization of department-wide standards for hardware, software, networks, tools and methods
- Continual refinement of data, application, and technology architectures
- Establishment of a Chief Information Officer
- Definition and communication of clear roles and responsibilities
- Department-wide data administration
- Ongoing measurement of IS performance.

PROCESS IMPROVEMENT RECOMMENDATIONS

Eighteen process improvement recommendations were developed based on this vision to enable the department to realize the goals of the Information Services vision and as a result, fulfill a number of the department's strategic IS objectives. These recommendations represent the high level building blocks that must be put in place in order to achieve the vision of the new IS business area. They were developed by combining specific ideas generated by visioning participants with key elements of over 50 innovative practices employed by numerous other public and private sector organizations.

1. Build a process to integrate IS planning and budgeting.
2. Build a process to define and continuously enhance data, application, and technology architecture.
3. Build a process to develop, implement, market, and maintain integrated IR policies, standards, and procedures.
4. Establish, implement, maintain, and scale methodologies for IS planning, product selection, application development and maintenance, and project implementation.
5. Build a process to research, evaluate, select, develop, and deliver new technologies.
6. Provide customers with timely and efficient application and data access across all technical platforms.
7. Build a process to optimize computing capabilities and to determine electronic storage capacity requirements.
8. Develop a department-wide data administration process.
9. Provide appropriate tools for the development and maintenance of applications.
10. Develop a process for continuous review and evaluation of data and application functionality.
11. Build and enable single points of contact for end user and service provider problem resolution.
12. Build a capability to identify IS-related training needs, design curricula, and deliver training for end users.
13. Build information systems to enable the management of the department's information resources.
14. Redesign the IS organization to be aligned with new IS processes.
15. Build a project management process for the execution of IS technology and application projects.
16. Build a process for ongoing IS staff development.
17. Build a quality assurance process that is integrated with all IS processes.
18. Develop a process for IS-related vendor relations, procurements, and contract management.

(Given the incremental nature of the change associated with recommendations 6, 7, and 10, we recommend designating these recommendations as Continuous Improvement projects following implementation of the technology infrastructure. Accordingly, we do not recommend carrying recommendations 6, 7, and 10 above into Phase 3.)

CHANGE MANAGEMENT

While individual process improvement recommendations alone may not imply dramatic organizational change, the implementation of all the recommendations will represent a fundamental shift in the way information services are organized, managed, and delivered at TxDOT. The magnitude of this change carries with it the need to manage the effects of change effectively. The objective of change management is to give the TxDOT organization the direction, capability, and flexibility necessary to make the change occur so that the organization achieves and sustains its target levels of performance.

The following "change levers" are activities or interventions that will need to be used together in a concerted change management program to manage the effects of change on affected stakeholders.

Preparation and Leadership — Establishing IS management's approach to and responsibility for leading the organization through the change. Specifically, TxDOT will need to identify and develop champions to explain the rationale for change and effectively communicate the need for the change to the broader organization when called upon.

Communication and Enrollment — Developing effective strategies to create understanding, belief, and commitment around the new organizational vision and the need for change. This includes the involvement of informal leaders and influential resistors to lay a strong foundation for change. The change initiatives will need to be communicated to the Information Systems Division and IS staff at divisions, districts and special offices. In addition, workshops will need to be conducted to present a draft of the conceptual process redesigns to stakeholders so that they can confirm and refine the project definitions.

Organization and Job Design — Translating retooled processes into organizational structures that are aligned with required roles, responsibilities, capabilities, and behaviors. A separate process improvement recommendation has been devoted to this specific topic. This effort will need to be closely coordinated with the HR BPR (Human Resources Business Process Retooling) project.

Skills Development and Ongoing Learning — Identifying and developing needed skills and competencies to support the new organizational structure, processes, and job roles. This will include general awareness sessions and training sessions to enhance knowledge, understanding, and skills needed to perform redesigned processes and utilize new technology enablers.

Work Force Transition — Providing appropriate processes and programs (such as recruitment and relocation) to ensure a smooth transition to the new organization. Champions will need to work with stakeholders to discuss the change initiatives and their related impacts on personnel. Other avenues of assistance, such as the Employee Assistance Program (EAP) will need to be enrolled to assist in dealing with the significant changes in job situations.

Performance Management — Developing recognition and reward systems that are congruent with the desired behaviors needed to support the transformed organization. This process will be needed to ensure that organizational and process change is focused on results, and that performance improvements are measured, tracked, and achieved.

PARADIGM SHIFTS

The following table highlights the major intended changes in the way information services will be provided on an ongoing basis. These changes are underway and planned for completion in 1997-1998.

Ref	Old Way	New Way
1	• Current IS orientation is "what do we need and when do we need it?"	• Future IS orientation is, "What do we need to put in place to enable us to deliver what we need, when we need it?"
2	• There is no common, integrated technology architecture. • There are isolated pockets of access to limited information. • There are multiple platforms and operating systems with minimal integration.	• A common, integrated technology architecture ensures universal access to and presentation of information in a seamless, open environment.
3	• Gaps and overlaps in support staffs result in customer confusion regarding whom to call for support. • The customer support function lacks uniformity, accessibility, and continuity.	• A single point of contact exists for each customer to locate and obtain full service support.
4	• Customers do not understand technology and IS staffs do not understand business needs.	• Effective partnerships between business areas and IS lead to the development of effective solutions of business needs.

Ref	Old Way	New Way
5	• Non-integrated department-wide IS executive management responsibilities result in duplication of effort, conflicting direction, and unnecessary delays.	• A Chief Information Officer has responsibility for all aspects of the information services business area.
6	• IR standards are fragmented and ineffectively communicated to stakeholders. • IR standards are difficult to upgrade, maintain, and disseminate.	• Information resource standards are integral elements of the technology architecture. • Standards are accepted by users as a path to consistency and compatibility of information, and as a way to promote information sharing.
7	• There is no department-wide process to address research, development, and delivery of enabling technologies or new product selection.	• The evaluation, selection, implementation, and promotion of new technologies is an organized, proactive IS business process.
8	• Custom, in-house developed, automated solutions are the primary method for obtaining new business applications.	• Packaged, outsourced, insourced, public domain, and non-automated solutions are routinely evaluated as alternatives to custom development.

PERFORMANCE MEASURES

In addition to creating new processes and outputs, a primary objective of the IS Retooling Program is to develop a quality program that integrates quality in all information services processes. One aspect of such a quality program is the identification, development, and implementation of performance measurements. By establishing performance targets and measuring actual activity against those targets, IS and retooling management will be able to measure the improvements that result from this retooling effort. Measuring performance also enables continuous improvement by highlighting barriers that prevent a process from achieving its target.

The first step in establishing a performance measurement program is to identify performance metrics and targets for the information services business area. This activity has been completed and the results are reflected in the following table. The "Current Assessment" was made in the Phase 3 report of the IS BPR Program (Published in October 1995). The "Target" column indicates the target performance measures to be achieved during 1997-1998.

Performance Measure	Current Assessment	Target
1. User satisfaction	Moderate (2.8)	High (4 - 5)
2. Existence of data, application, and technology architectures	Technology architecture does not exist; BISP data and application architectures are not maintained.	A single, integrated IT Architecture exists. Process in place to continuously administer the architectures.
3. Percentage of obsolete equipment (equipment that does not meet current TxDOT standard)	40% (estimate)	0 - 10%
4. Time to develop an enterprise application	2 - 5 years (average)	6 - 12 months
5. Application functional quality, as measured by users	Moderate (3)	High (4.5 - 5)
6. Application technical quality, as measured by IS professionals	Moderate (3)	High (4.5 - 5)
7. Data integrity	Moderate (3)	High (4.5 - 5)
8. ISD response time to district/division/ special office customer support requests	varies (1 day to 3 weeks)	Does not exceed one day.

Significant achievements have already occurred in developing an enterprise Information Technology (IT) architecture, planning replacement of obsolete equipment, and speeding up the application development cycle. In the area of application development, LBMS' Process Engineer is being implemented as TxDOT's enterprise systems development life cycle methodology. Several pilot projects are underway to utilize the tool, specifically using the rapid application development (RAD) approach. Two prototype applications have been developed using a similar methodology.

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Section A
IR Goals, Objectives, Strategies, and Action Items

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INTRODUCTION

Based on the guidelines provided by the Department of Information Resources (DIR), this section provides the IR Goals, Objectives, Strategies, and Action Items for the department. These items are tied to the TxDOT *Strategic Plan for 1997-2001* and the *State Strategic Plan for Information Resources Management*, published in November 1995 by DIR. TxDOT's IR Mission and Vision are presented, followed by critical success factors for IR. The IR Goals, Objectives, Strategies, and Action Items are then presented.

The following definitions were extracted from the DIR guidelines for preparation of this section of TxDOT's *Strategic Plan for Information Resources*:

IR Goals generally support the ends toward which agencies direct their efforts. A goal addresses issues by stating policy intention. Goals are both qualitative and quantifiable, but are not quantified. In a strategic planning system, goals are ranked for priority. Goals stretch and challenge an agency, but they are realistic and achievable.

IR Objectives are clear targets for specific action. More detailed than goals, objectives have shorter time frames and state quantity. An objective is achievable, measurable, and sets direction for strategies. Measures should be defined in terms of strategic outcomes or outputs. A single goal may be subdivided into multiple objectives.

Strategies are methods to achieve goals and objectives. Formulated from goals and objectives, a strategy is the means for transforming inputs into outputs and ultimately, into outcomes with the best use of resources. A strategy reflects budgetary and other resource considerations.

Action Items should be associated with particular strategies and identify specific tasks. Action Items break strategies into manageable parts for coordinated implementation of goals and objectives. Expected completion dates are shown for Action Items, based on calendar years.

The DIR guidelines also specify the numbering system that is used in this section. IR Goals, Objectives, Strategies, and Action Items may support multiple agency goals and are uniquely numbered. Strategies and Action Items in the *Strategic Plan for Information Resources* are also directly related to the Biennial Operating Plan projects and activities.

IR MISSION

To enable the department to provide effective operations and continuously improve through the timely application, implementation and support of well-developed information resources.

IR VISION STATEMENT

We envision providing our customers, the people of Texas and our employees, information resource capabilities that promote cost-effective and efficient information sharing and provide information that is relevant, accurate, timely and easily available.

IR CRITICAL SUCCESS FACTORS

Critical success factors are those operating characteristics which must be an integral part of all activities of an organization. Through a series of interviews with Information Systems Division (ISD) management, IR management, and the Deputy Executive Director of Administrative Services, the following areas were identified as critical to the success of information services (IS) delivery at TxDOT.

> ***Efficiency:*** Improving the application development life cycle, improving the speed and efficiency of the procurement process and improving the accuracy and efficiency of the project planning process are examples of management efficiency issues. Overall efficiency within the department has been identified as a major factor in the future success of the department.
>
> ***Education:*** The rapidly decreasing life cycle of new technologies combined with the department's desire to identify and implement emerging technologies will require improvement in the delivery of staff and user technology training. It will be critical for management, IS staff and employees to be willing to accept and learn new technologies as they become available.
>
> ***Products:*** For IS to be successful, timely delivery of quality products will be critical. To improve the quality of IS products and services, they must meet business requirements and respond to business needs while the need still exists. Examining all alternatives available for product delivery, such as package solutions, should become part of the standard product delivery strategy.
>
> ***People:*** The retention of qualified IS professionals, and their career development, will be critical to the future success of the department. Managing staff turnover, increasing career opportunities and providing a challenging work environment will be crucial to retaining staff.

Communication: An important aspect of each critical success factor is communication. IS management recognizes that improving communications between users, management and IS staff is a key element in delivering IS services. Communication includes informing all interested parties when decisions are made regarding projects and technology direction.

Responsibility: Increasing the accountability among the various parties involved in managing IS service delivery and the recipients of IS services will be critical to long-term success. This includes establishing common priorities among management, users and IS. In addition, the correct parties must take responsibility for projects from inception to completion.

Research: Continual research and evaluation of new technology based on legitimate business needs will be necessary in order to efficiently take advantage of new technologies where appropriate.

Environment: Creation of a computing environment which promotes cross platform migration, uniformity in the development environment, and establishment of a comprehensive technology infrastructure will be necessary. Controlling the proliferation of new technology and tools will be an important aspect of creating an improved computing environment.

IR GOALS, OBJECTIVES, STRATEGIES, and ACTION ITEMS:

Agency Goal #1
To provide the State of Texas with transportation services and systems that:

- ***work together;***
- ***are safe, comfortable, durable, and affordable;***
- ***are environmentally sensitive; and***
- ***support economic and social prosperity.***

Agency Goal #2
To achieve the highest level of external and internal customer satisfaction (external customers include the general public, private businesses, transportation users and government entities; internal customers include all TxDOT employees).

Agency Goal #3
To ensure equitable involvement by historically underutilized businesses (HUBs) to provide goods and services to the department.

IR GOAL #1
Establish and maintain an information services environment which will support department business processes.

IR Objective #1
Ensure that the department's business needs are supported by a flexible, reliable, cost-effective, integrated, and standards-based information technology architecture and infrastructure (Core Infrastructure Technology project in Biennial Operating Plan).

IR Strategy #1
Implement and maintain a core technology architecture and infrastructure which will support the development of business applications.

IR Action Item #1
Complete initial Core Technology training in 1997.

IR Action Item #2
Complete the implementation of the technology infrastructure to support Version 2.0 of the Core Technology Architecture in 1997.

IR Action Item #3
Complete and distribute Version 3.0 of the Core Technology Architecture to

add/modify sections on telephony, email, groupware, voice mail, internet, intranet, system management software, and reliability and fault tolerance in 1997.

IR Action Item #4
Plan and implement the technology infrastructure to support Version 3.0 of the Core Technology Architecture in 1997-1998.

IR Action Item #5
Modify and enhance the Office Systems, Engineering/CADD/GIS, Field Data Collection, Application, and Data Architectures to utilize the new technologies defined by Version 3.0 of the Core Technology Architecture in 1997-1999.

Note: The following G&E projects in the Biennial Operating Plan will be coordinated with the technology infrastructure implementation in 1997-1999: Engineering Workstations for Highway Design (SAT), PCs for Maintenance Offices (SAT), Hardware for District Lab (SAT), Add Equipment for Training Room (SJT), District Headquarters Controller Upgrades, Area Offices Controller Upgrades, District 3745 Upgrades, Maintenance Office Controller Upgrades, ISD Controller Upgrades, and Maintenance Office LANS (ABL).

IR Strategy #2
Establish technology direction, standards, and polices for implementation of office systems technologies to ensure compatibility and integration with other technologies.

IR Action Item #6
Complete the document management pilot report in 1997.

IR Action Item #7
Distribute the initial release of the document management component of the office systems architecture in 1997.

IR Action Item #8
Develop a document management implementation strategy in 1997.

IR Action Item #9
Implement engineering document pilot projects in 1997.

IR Action Item #10
Modify the document management architecture and implementation strategy to include engineering document technology in 1997-1998.

IR Action Item #11
Complete the group services component of the office systems architecture (electronic document interchange, electronic forms, imaging, and workflow) in 1997.

IR Action Item #12
Develop an implementation and integration strategy for group services technologies in 1997-1998.

Note: The following G&E projects in the Biennial Operating Plan will be coordinated with the Office Systems Architecture in 1997-1999: Electronic Document Management System (CRP), Document Management System for Purchasing (GSD), Document Imaging System (VTR), Title Imaging Interface, Central Files (Scanning) (ABL), and Design Imaging (ABL).

IR Strategy #3
Establish technology direction, standards, and policies for implementation of engineering, GIS, and CADD technologies to ensure compatibility and integration with other technologies.

IR Action Item #13
Complete initial GIS/GPS and CADD architectures in 1997.

IR Action Item #14
Complete Microstation 95 implementation in 1997.

IR Action Item #15
Implement GIS and GPS pilot projects in 1997.

IR Action Item #16
Develop GIS/GPS implementation strategy in 1997.

IR Action Item #17
Implement GIS basemaps and data infrastructure in 1997-1999.

IR Action Item #18
Upgrade Regional Reference Point Stations on an ongoing basis (RRP project in G&E in Biennial Operating Plan).

IR Action Item #19
Upgrade hardware and software for post processing GPS surveys on an ongoing

basis (Survey Software, Survey Receivers, and Survey PCs projects in G&E in Biennial Operating Plan).

IR Action Item #20
Implement GPS hardware/software infrastructure for real time positioning in 1997-1999 (Real Time Positioning project in G&E in Biennial Operating Plan).

IR Action Item #21
Provide ground control for the Texas Orthoimagery Program (TOP), in 1997-1999, which is sponsored by the interagency GIS Planning Council.

IR Strategy #4
Establish technology direction, standards, and policies for field data collection to ensure compatibility and integration with other technologies.

IR Action Item #22
Develop/distribute a field data collection architecture in 1997.

IR Strategy #5
Define the framework, standards, and tools for application development and maintenance to lead to more rapid application development and maintenance, and quicker response to changing business needs.

IR Action Item #23
Complete the application development architecture and process design in 1997.

IR Action Item #24
Complete an application development (process) implementation strategy in 1997.

IR Action Item #25
Conduct training for new framework/standards/tools in 1997-1998.

IR Action Item #26
Complete pilot development projects using rapid application development methodology and new tools in 1997 and 1998.

IR Strategy #6
Acquire and implement the technology environment for information services staffs to enable IS staffs to most effectively perform their jobs.

IR Action Item #27
Complete technology upgrades for IS staffs in 1997.

IR Strategy #7
Provide personal productivity tool training for end users and IS professionals to improve productivity and reduce down time and wasted efforts.

IR Action Item #28
Complete initial training on core tool set for end users and IS professionals in 1997.

IR Strategy #8
Establish a process to continuously research innovative technology solutions.

IR Action Item #29
Design and implement the technology research process in 1997.

IR Strategy #9
Establish a process to evaluate, select, and integrate new technology products and solutions to provide for optimal integration of new products in the existing technology infrastructure.

IR Action Item #30
Design and implement the technology evaluation, selection, and integration process in 1997.

IR Strategy #10
Provide telemanagement, voice processing, and video-conferencing capabilities to support business needs through improvements to the voice telecommunications infrastructure [Telecommunications (TELECOMM) project in Biennial Operating Plan].

IR Action Item #31
To more accurately reflect operating costs, itemize the billing for user unique telecommunications services by business unit in 1997.

IR Action Item #32
Implement an electronic directory accessible via the LAN in 1997-1998.

IR Action Item #33
In support of routine telephone requirements for the Austin area business units,

implement an electronic work order/service order request form that is accessible via the LAN in 1997.

IR Action Item #34
Network individual voice processing systems located throughout TxDOT in 1997-1998.

IR Action Item #35
Install initial videoconferencing sites at various TxDOT locations in 1997.

IR Action Item #36
Evaluate and expand (with additional sites as applicable) the TxDOT videoconferencing network to support a majority of TxDOT locations in 1997-1999.

Note: The following G&E projects in the Biennial Operating Plan will be coordinated with the TELECOMM project in 1997: Telephone Install Pellicanno Maintenance Office, Telephone Install Hondo Pass Area Office, District Upgrade Telephone System (ELP), Add VTR Regional Office (SJT), and District Upgrade For Telecomm (ELP).

IR Objective #2
Establish ongoing information services processes to promote better communication department-wide and provide the ability to easily share information resources, decrease project risk, and reduce maintenance and support costs.

IR Strategy #11
Select and implement systems development life cycle methodology(ies) and a project management tool for enterprise, business area, workgroup, and employee computing to provide consistency in methods of IS project planning, scheduling, development, and implementation.

IR Action Item #37
Complete methodology implementation and training in 1997.

IR Strategy #12
Develop a quality program that integrates quality in all information services to ensure, on an overall basis, that information services processes produce reliable, timely, fully-tested products and services.

IR Action Item #38

Complete quality program design and implementation in 1997.

IR Strategy #13

Establish a process that increases responsiveness to users' IS support needs, increasing overall IS staff and customer satisfaction and productivity through the development of a customer support center.

IR Action Item #39

Complete implementation of help desk software in 1997.

IR Action Item #40

Complete implementation of customer support procedures in 1997.

IR Strategy #14

Establish an ongoing training process that will ensure a timely and consistent level of IS-related training throughout TxDOT.

IR Action Item #41

Establish the ongoing IS-related training process in 1997.

IR Strategy #15

Develop a process and a communication mechanism for implementing information services policies, standards, and procedures to ensure integrated and relevant information services policies, standards, and procedures; optimize use of information resources; and reduce overall maintenance and support costs.

IR Action Item #42

Design and implement the IS policies, standards, and procedures process and the related communication mechanism in 1997.

IR Strategy #16

Develop a process to manage applications to ensure that the department's application portfolio reflects changing business needs.

IR Action Item #43

Design and implement the application management process in 1997.

IR Strategy #17
Establish a process to integrate and continuously enhance and upgrade the Enterprise IT architecture to minimize redundant and fragmented efforts in maintaining the IT architecture and infrastructure.

IR Action Item #44
Design and implement the process to enhance and integrate the Enterprise IT architecture in 1997.

IR Strategy #9
Establish a process to evaluate, select, and integrate new technology products and solutions to provide for optimal integration of new products in the existing technology infrastructure.

IR Action Item #30
Design and implement the technology evaluation, selection, and integration process in 1997.

IR Strategy #18
Establish a process that provides information resource budget accountability at the business unit and enables the preparation of comprehensive, business driven IR plans.

IR Action Item #45
Complete implementation of the new IR budgeting process in 1997.

IR Strategy #19
Establish a process for the creation and periodic review of IS career paths and staff development to increase the breadth of IS staff technical skills, increase staff's business perspectives, diversify staff responsibilities, decrease staff turnover, and improve morale.

IR Action Item #46
In conjunction with the Human Resources Retooling program, develop the process for IS staff development in 1997.

IR Strategy #20
Coordinate all organization redesign elements, develop and refine transition strategies and tactics, execute a change management program, and support management's implementation of organizational changes resulting from each business improvement project of the IS Retooling program.

IR Action Item #47
Complete strategies and recommendations for IS organizational redesign in 1997.

IR Strategy #21
Plan and design a management information system for information resources to enable IS management to make more informed decisions regarding information resource management.

IR Action Item #48
Complete application and implement statewide in 1997.

IR Strategy #22
Establish a process to define, review, and communicate the department's IS outsourcing strategy to promote more effective partnering with vendors and provide easier access to potential outsourcing solutions.

IR Action Item #49
Define and implement a process to identify IS outsourcing opportunities and manage related contracts in 1997.

IR Objective #3
Develop a process to manage and provide consultation services for vendor relation management and contract preparation and management.

IR Strategy #23
Educate IS staffs on proper vendor relations and ethics to reduce the risk of improper/unethical vendor-employee behavior, reduce liability, and ensure compliance with state contract laws.

IR Action Item #50
Deliver vendor ethics training materials to IS staffs in 1997.

IR Strategy #24
Establish the process to provide department IS staffs consultation and assistance to promote better vendor relations, more effective vendor partnerships and improved vendor management.

IR Action Item #49
Define and implement a process to identify IS outsourcing opportunities and manage related contracts in 1997.

IR Objective #4
Minimize redundant data and improve the department's ability to integrate systems, databases, and data definitions.

IR Strategy #25
Develop an enterprise data management process to ensure the management of data as a strategic business asset, and provide for improved data integrity, data access, and data sharing.

IR Action Item #51
Complete implementation of the enterprise data program in 1997.

IR Objective #5
Provide for the development, implementation, and maintenance of a comprehensive contingency plan which will ensure TxDOT's ability to recover its information resources in the event of a major disaster or business interruption.

IR Strategy #26
Design and implement a sufficient set of procedures for responding to a disaster of any size to the department's information resources.

IR Action Item #52
Review TxDOT's Contingency Plan for Information Resources (including IR Business Resumption) as new technologies are implemented on an ongoing basis.

IR Action Item #53
Test disaster recovery procedures on an annual basis.

IR Objective #6
Provide appropriate security and authentication for information maintained and communicated by the department (Project in Baseline in Biennial Operating Plan).

IR Strategy #27
Continue to design and implement a sufficient set of procedures for securing the department's information resources.

IR Action Item #54
Continue to enhance security rules as required by new software releases (ongoing).

IR Strategy #28
Continue to provide security awareness training to the business users of information resources.

IR Action Item #55
Revise training as necessary based upon input from the business users (on-going).

IR GOAL #2
Improve the efficiency and effectiveness of department operations through the use of enabling information systems and technologies.

IR Objective #7
Improve the efficiency and effectiveness of the department's business processes through the innovative use of technology.

IR Strategy #29
Develop and/or implement new information systems and technologies to enable improvements in business processes.

IR Action Item #56
Continue ongoing development and enhancement of the department's Executive Information System (EIS Project in G&E in Biennial Operating Plan).

IR Action Item #57
Enhance and maintain the legacy systems as required to support business changes on an ongoing basis (Projects in Baseline and G&E in Biennial Operating Plan including MMIS Enhancement and USPS).

IR Action Item #58
Continue to upgrade the mainframe CPU and DASD as required to meet business needs on an ongoing basis [Mainframe Upgrade (CPU) and Disk Drive and Controller Upgrade (DASD) projects in Biennial Operating Plan].

IR Action Item #59
Digitize all prior year department minute orders in 1997 (Minute Order Imaging Startup Library project in G&E in Biennial Operating Plan).

IR Action Item #60
Digitize the Research and Technology Transfer reports to enable LAN and Internet document transfer in 1997-1999 (Digitize RTT Library project in G&E

in Biennial Operating Plan).

IR Action Item #61
Convert the Research and Technology Transfer database to a higher-level, Windows based protocol in 1997 (Convert RTT Library project in G&E in Biennial Operating Plan).

IR Action Item #62
Continue to assist in office relocations as required [TxDOT Relocations (RELOCATION) project and District Relocation in G&E in the Biennial Operating Plan].

IR Strategy #30
Participate in information systems development with other government entities, federal, state, and local; and the public and private sectors.

IR Action Item #63
Participate in joint application development with the American Association of State Highway and Transportation Officials (AASHTO) on an ongoing basis.

IR Action Item #64
Participate in the development of a construction management system (SiteManager) with AASHTO in 1997-1998.

Note: Other action steps for additional sharing opportunities are identified in specific strategies for the business area (i.e., Traffic Accident Record System and Environmental Atlas database).

IR Strategy #31
Promote improved levels of service and increased efficiency through the continued use of the Transportation Research program.

IR Action Item #65
Review research proposals pertaining to technology and ensure compliance with Information Technology Architecture on an ongoing basis.

IR Objective #8
Ensure department information resources remain operational into the year 2000 [Year 2000 Conversion (YR 2000) project in Biennial Operating Plan].

IR Strategy #32
Provide guidance and coordination to end user computing departments.

IR Action Item #66
Provide guidance in the procedures and processes for software portfolio assessment on an ongoing basis.

IR Action Item #67
Provide guidance in the development of plans to resolve year 2000 exposures on an ongoing basis.

IR Action Item #68
Provide guidance in the development of standards and conversion approaches on an ongoing basis.

IR Action Item #69
Provide guidance to enable end users to inventory their software portfolio on an ongoing basis.

IR Action Item #70
Provide guidance to enable end users to make their software portfolio year 2000 compliant on an ongoing basis.

IR Action Item #71
Provide guidance to enable end users to test their year 2000 software changes on an ongoing basis.

IR Action Item #72
Provide guidance to enable end users to determine if their hardware is year 2000 compliant and recommend alternatives for obtaining compliance on an ongoing basis.

IR Action Item #73
Provide guidance for monitoring and tracking year 2000 progress on an ongoing basis.

IR Strategy #33
Ensure that vended IR software and hardware are year 2000 compliant.

IR Action Item #74
Inventory all vended software (mainframe and PC platforms) on an ongoing basis.

IR Action Item #75
Test all computer hardware (mainframe and PC platforms) in 1997 and ongoing.

IR Action Item #76
Obtain written certification from each software and hardware vendor documenting that their product is year 2000 compliant or a date when the product will be year 2000 compliant in 1997 and ongoing.

IR Action Item #77
Develop and implement a contingency plan for vended software and hardware that will not be made year 2000 compliant before 1999 on an ongoing basis.

IR Action Item #78
Test all vended software (mainframe and PC platforms) by 1998 and ongoing.

IR Action Item #79
Monitor and track the progress of non-compliant vended software and hardware through 2000.

IR Strategy #34
Provide Year 2000 awareness training to all applicable areas.

IR Action Item #80
Ensure end users and the Management Team have received sufficient information to make them aware of the problems associated with the year 2000 date change on an ongoing basis.

IR Strategy #35
Analyze and correct all central IS maintained computer code.

IR Action Item #81
Procure automated tools for enterprise assessment in 1997.

IR Action Item #82
Develop plans to resolve year 2000 exposures in 1997.

IR Action Item #83
Develop standards and conversion approaches in 1997.

IR Action Item #84
Inventory software portfolio in 1997.

IR Action Item #85
Develop impact analysis (classification of exposures) in 1997.

IR Action Item #86
Reformat year-date notations beginning in 1997.

IR Action Item #87
Complete unit, integration, and system testing in 1998.

IR Action Item #88
Implement converted applications in 1998.

IR Objective #9
Provide a mechanism that will allow the department to manage the entire procurement cycle of commodities and services.

Strategy #36
Provide the capability to control, process, and to electronically record user requests from districts, divisions, and special offices through the General Services Division and, when necessary, to the General Services Commission.

IR Action Item #89
Complete statewide implementation of the Automated Purchasing System in 1998 [Automated Purchasing System (APS) in the Biennial Operating Plan].

IR Action Item #90
Complete an analysis of the purchasing business processes and associated emerging technologies through the Supplies, Materials, and Equipment Retooling effort in 1997.

IR Action Item #91
Identify improvement projects based on the Supplies, Materials, and Equipment Retooling project in 1997.

IR Objective #10
Improve the efficiency and effectiveness of the Supplies, Materials, and Equipment (SME) business processes through the innovative use of technology.

IR Strategy #37
Identify enabling technology for the Supplies, Materials, and Equipment business processes through the Retooling program.

IR Action Item #92
Analyze and determine the most feasible use of technology for the SME business processes in 1997-1998.

IR Action Item #93
Complete a feasibility study and identify improvement projects in 1997.

Note: The following G&E projects in the Biennial Operating plan will be coordinated with this effort in 1997-1999: Automated Mail System (GSD), Document Management System for Purchasing (GSD), and Work Order System (GSD).

IR Objective #11
Improve the efficiency and effectiveness of the Fiscal Services business processes through the innovative use of technology.

IR Strategy #38
Identify enabling technology for the Fiscal Services business processes through the Retooling program.

IR Action Item #94
Analyze and determine the most feasible use of technology for the Fiscal Services business processes in 1997 and 1998.

IR Action Item #95
Complete a feasibility study and identify improvement projects in 1997.

IR Objective #12
Improve the efficiency and effectiveness of the Business Management and Direction and Leadership business processes through the innovative use of technology.

IR Strategy #39
Identify enabling technology for the Business Management and Direction and Leadership business processes through the Retooling program.

IR Action Item #96
Analyze and determine the most feasible use of technology for the Business Management and Direction and Leadership business processes in 1997-1999.

IR Action Item #97
Complete a feasibility study and identify improvement projects in 1997-1999.

IR Objective #13
Improve the efficiency and effectiveness of the Real Property business processes through the innovative use of technology.

IR Strategy #40
Identify enabling technology for the Real Property business processes through the Retooling program.

IR Action Item #98
Analyze and determine the most feasible use of technology for the Real Property business processes in 1997-1999.

IR Action Item #99
Complete a feasibility study and identify improvement projects in 1997-1999.

IR Objective #14
Improve the efficiency and effectiveness of the Contract Services business processes through the innovative use of technology.

IR Strategy #41
Identify enabling technology for the Contract Services business processes through the Retooling program.

IR Action Item #100
Analyze and determine the most feasible use of technology for the Contract Services business processes in 1997-1999.

IR Action Item #101
Complete a feasibility study and identify improvement projects in 1997-1999.

Agency Goal #1 (Objective 1.1 To develop, operate and maintain in an environmentally sensitive manner an efficient and effective transportation system and provide services which facilitate the movement of people and goods.)

To provide the State of Texas with transportation services and systems that:

- ***work together;***
- ***are safe, comfortable, durable, and affordable;***
- ***are environmentally sensitive; and***
- ***support economic and social prosperity.***

Agency Goal #2 (Objective 2.1 To maximize the quality and improve the delivery of products and services provided by TxDOT.)

To achieve the highest level of external and internal customer satisfaction (External customers include the general public, private businesses, transportation users and government entities; internal customers include all TxDOT employees).

IR GOAL #2
Improve the efficiency and effectiveness of department operations through the use of enabling information systems and technologies.

IR Objective #15
Improve the efficiency and effectiveness of the Plan Transportation Systems business processes through the innovative use of technology.

IR Strategy #42
Identify enabling technology for the Plan Transportation Systems business processes through the Retooling program.

IR Action Item #102
Analyze and determine the most feasible use of technology for the Plan Transportation Systems business processes in 1997 (Plan BPR Feasibility Study in G&E in Biennial Operating Plan).

IR Action Item #103
Complete a feasibility study and identify improvement projects in 1997 (Plan BPR Application in G&E in Biennial Operating Plan).

IR Strategy #43
Provide timely and accurate model data to support the development of accurate traffic

models for both the attainment and non-attainment areas through the Travel Demand Modeling project.

IR Action Item #104
Implement the associated information systems, software, and hardware through a phased approach by 1999 [Travel Demand Modeling (TDM) project in Project in Biennial Operating Plan].

IR Strategy #44
Ensure that the Traffic Analysis and Reporting System supports TxDOT management systems, Travel Demand Modeling, Corridor Analysis, and outside entities by providing traffic information that is accurate, consistent and timely [Statewide Traffic Analysis and Reporting System (STARS) project in Biennial Operating Plan].

IR Action Item #105
Determine and document needs in conjunction with an Interagency Contract in 1996-1997.

IR Action Item #106
Identify and develop alternatives and select alternative in 1997.

IR Action Item #107
Develop new Traffic Analysis and Reporting System, integration, analysis and reporting programs in 1997.

IR Action Item #108
Procure automation equipment to support the complete rewrite of the programs developed by a consultant in 1997.

IR Action Item #109
Procure software (as recommended by the Information Systems Division) and hardware to support rural pilot project in Odessa in 1997.

IR Action Item #110
Pilot project in rural district (Odessa) in 1998.

IR Action Item #111
Procure video logging survey data and hardware/software for urban district pilot project (Houston) both on- and off-system in 1998.

IR Action Item #112
Pilot project in urban district (Houston) in 1999.

IR Action Item #113
Begin statewide implementation in 2000.

IR Strategy #45
Ensure integration of existing and future databases including the current mapping graphics files and develop and implement a system using a universal key which handles on- and off-system data (TxNET project in the Biennial Operating Plan).

IR Action Item #114
Complete the feasibility study, in conjunction with the Plan Transportation System Retooling project, and obtain approval in 1997.

IR Objective #16
Improve the efficiency and effectiveness of the Right of Way business processes through the innovative use of technology.

IR Strategy #46
Develop and implement the Right of Way Information System (ROWIS) based upon the improved processes identified in the Retooling program (ROW Information System Project in G&E in Biennial Operating Plan).

IR Action Item #115
Implement ROWIS Stage I statewide in 1997.

IR Action Item #116
Implement ROWIS Stage II statewide in 1997.

IR Objective #17
Improve the efficiency and effectiveness of the Design Transportation Systems, Deliver Transportation Systems, and the Maintain and Operate Transportation Systems business processes through the innovative use of technology.

IR Strategy #47
Identify enabling technology for the Design Transportation Systems, Deliver Transportation Systems, and the Maintain and Operate Transportation Systems business processes through the Retooling program.

IR Action Item #117
Analyze and determine the most feasible use of technology for the Design Transportation Systems, Deliver Transportation Systems, and the Maintain and Operate Transportation Systems business processes in 1997-1999.

IR Action Item #118
Complete a feasibility study and identify improvement projects in 1997-1999.

IR Objective #7
Improve the efficiency and effectiveness of the department's business processes through the innovative use of technology.

IR Strategy #29
Develop and/or implement new information systems and technologies to enable improvements in business processes.

IR Action Item #119
Develop a prototype to utilize Intelligent Transportation Systems (ITS) and GIS to expedite border clearance procedures, including pre-clearance, for freight and passengers in 1997-1998.

IR Objective #18
Automate the preparation, pre-qualification, proposal distribution, newspaper advertisement, letting, contract process and payment procedure for all maintenance contracts in each district office, the Construction and Maintenance Division, the General Services Division, the Budget and Finance Division, and the Design Division.

IR Strategy #48
Automate inspecting work performed, monthly payment, default and closeout of maintenance contracts, and newspaper advertising [Construction and Maintenance Contract System (CMCS) project in the Biennial Operating Plan].

IR Action Item #120
Implement Stage IV of CMCS in 1997.

IR Action Item #121
Implement State V of CMCS in 1998.

IR Objective #7
Improve the efficiency and effectiveness of the department's business processes through the innovative use of technology.

IR Strategy #29
Develop and/or implement new information systems and technologies to enable improvements in business processes.

IR Action Item #122
Develop the Texas Airport Data System (TADS) to provide automated resources for retrieving and processing of airport development and maintenance related information in 1997 (Texas Airport Data System project in G&E in Biennial Operating Plan).

IR Action Item #123
Enhance the business processes of the Motor Carrier Division through enhancements to the Central Permit System and provide for automated permit routing in 1999 [CPSII Phoenix (MCD), Imaging Expansion (MCD), and Permit Automated Routing System projects in G&E in Biennial Operating Plan].

IR Objective #19
Improve the efficiency and effectiveness of the Regulate Transportation Systems business processes through the innovative use of technology.

IR Strategy #49
Identify enabling technology for the Regulate Transportation Systems business processes through the Retooling program.

IR Action Item #124
Analyze and determine the most feasible use of technology for the Regulate Transportation Systems business processes in 1997-1999.

IR Action Item #125
Complete a feasibility study and identify improvement projects in 1997-1999.

IR GOAL #3
Provide state-of-the-art registration and titling capabilities.

IR Objective #20
Improve the department's ability to administer the provision of the motor vehicle registration and titling statutes.

IR Strategy #50
Implement the Registration and Titling System [Registration and Title System (RTS) project in the Biennial Operating Plan].

IR Action Item #126
Complete statewide implementation of the Registration and Titling System in 1997.

IR Objective #21
Continue to improve the department's ability to administer the provisions of the motor vehicle registration and titling statutes.

IR Strategy #51
Determine information systems and technology enhancement needs for the Registration and Titling and Special Plate processes.

IR Action Item #127
Analyze needs and obtain approvals in 1997 [Includes the following VTR projects in G&E in Biennial Operating Plan: Document Imaging System (VTR), FY96 Uniformity IFTA/IRP (VTR), Legislative Mandates (VTR), Vehicle Title Information Exchange (VTR), Special Plates System (VTR), Bar Code Titles (VTR), Bar Code Inventory Management (VTR),Registration and Title A-List Production Maintenance, Registration and Title A-List Infrastructure Computers, NIC Integration/Replacement (VTR), TNRCC Transaction Interface, Other External Users Transaction Interface, RTS Installations (VTR), Paperless Title, Subcontractor Scanning (VTR), Title Imaging Interface, RTS Legislative Compliance (VTR), and RTS Customer Service Enhancement].

Agency Goal #1 (Objective 1.1 To develop, operate and maintain in an environmentally sensitive manner an efficient and effective transportation system and provide services which facilitate the movement of people and goods.)

To provide the State of Texas with transportation services and systems that:

- ***work together;***
- ***are safe, comfortable, durable, and affordable;***
- ***are environmentally sensitive; and***
- ***support economic and social prosperity***

IR GOAL #2
Improve the efficiency and effectiveness of department operations through the use of enabling information systems and technologies.

IR Objective #22
Provide an automated system to facilitate the management of the approximately 34,000 on-state system and 14,000 off-state system bridges in an overall Bridge Management System [Bridge Management Information System (BMIS) project in the Biennial Operating Plan].

IR Strategy #52
Re-evaluate the project scope (Project is currently on hold pending scope re-evaluation).

IR Action #128
Determine user requirements and develop recommendations in 1997.

IR Objective #23
Develop an automated database which contains pavement layer (cross section) and work history information for all TxDOT maintained highways [Road Life Redevelopment Project (RLS) in the Biennial Operating Plan; currently on hold].

IR Objective #24
Continue to improve the performance and reliability of existing data collection equipment through the application of automation enhancement technologies.

IR Strategy #53
Continue to evaluate data collection needs and technology for pavement and traffic data collection [Automated Pavement Data Collection Equipment (PAVE DATA) and Automated Collection of Traffic Data (TRAFFIC DATA) projects in the Biennial Operating Plan].

IR Objective #7
Improve the efficiency and effectiveness of the department's business processes through the innovative use of technology.

IR Strategy #29
Develop and/or implement new information systems and technologies to enable improvements in business processes.

IR Action Item #129
Acquire project resource/contract management tools and adequate hardware for Construction Project Management (ongoing) (Construction Project Management Tools project in Biennial Operating Plan).

IR Action Item #130
Determine the feasibility and legal implication of implementing electronic bidding for construction contracts in 1997-1999.

IR Action Item #131
Expand the utilization of mechanized accelerated pavement testing through the use of the Texas Mobile Load Simulator in 1997-2000 (Texas Mobile Load Simulator (TxMLS) project in Biennial Operating Plan).

IR GOAL #4
Maximize the effectiveness and efficiency of the transportation network by actively managing traffic in real-time.

IR Objective #25
Develop and build traffic management systems [Traffic Management (TRAFFIC) project in Biennial Operating Plan].

IR Strategy #54
Continue implementation of traffic management systems in Texas.

IR Action Item #132
Continue implementation, operation, and maintenance of traffic management systems in Austin, Dallas, El Paso, Fort Worth, Houston, Laredo, Pharr, and San Antonio in 1998.

IR Action Item #133
Identify and begin development and implementation of traffic management systems in other locations in Texas in 1998.

IR Strategy #55

Investigate the use of state-owned rights-of-way as corridors to transmit information via fiber-optic cables and other advanced telecommunications technologies.

IR Action Item #134

Determine feasibility and legal authority in 1997.

Agency Goal #1 (Objective 1.2 To improve public safety and security on transportation systems.)

To provide the State of Texas with transportation services and systems that:

- ***work together;***
- ***are safe, comfortable, durable, and affordable;***
- ***are environmentally sensitive; and***
- ***support economic and social prosperity***

IR GOAL #2
Improve the efficiency and effectiveness of department operations through the use of enabling information systems and technologies.

IR Objective #26
Provide an automated database system to support planning efforts and furnish decision support for the Texas Transportation Commission.

IR Strategy #56
Maintain access to the Local Area Network Safety Evaluation Report (LANSER) system for all essential users. (This system will need to be maintained from now until a replacement system is developed and a minimum of 3 years of historical data is available through the new system, approximately 2002.)

IR Action Item #135
The operational location system for traffic accidents will be reviewed in 1997 to determine the most effective way to locate traffic accidents for current and future systems [Local Area Network Safety Evaluation Report (LANSER) project in Biennial Operating Plan].

IR Action Item #136
Replace LANSER and other existing traffic accident analysis programs with the new Crash Records Development System (CRIS) that is being jointly developed with DPS in calendar year 1998-1999.

Agency Goal #1 (Objective 1.3 To protect and enhance the environment in transportation activities.)

To provide the State of Texas with transportation services and systems that:

- ***work together;***
- ***are safe, comfortable, durable, and affordable;***
- ***are environmentally sensitive; and***
- ***support economic and social prosperity***

IR GOAL #2
Improve the efficiency and effectiveness of department operations through the use of enabling information systems and technologies.

IR Objective #27
Streamline the process of locating and evaluating known historical and archeological sites and provide planning tools for early construction project development [Texas Historical Sites Atlas (ATLAS) project in Biennial Operating Plan].

IR Strategy #57
Provide the funding to the Texas Historical Commission for the development of a computerized database of historic and archeological sites within the State of Texas.

IR Action Item #137
Administer the project to ensure department needs are met through 1997.

IR Objective #7
Improve the efficiency and effectiveness of the department's business processes through the innovative use of technology.

IR Strategy #29
Develop and/or implement new information systems and technologies to enable improvements in business processes.

IR Action Item #138
Develop a GIS prototype for testing and utilizing hardware and software for environmental planning, research, and development to provide districts with relevant and timely information and feedback in 1997-1999 [GIS Prototype (ENV) project in G&E in Biennial Operating Plan].

Agency Goal #2 (Objective 2.1 To maximize the quality and improve the delivery of products and services provided by TxDOT and Objective 2.2 To effectively communicate TxDOT's responsibilities and performance.)

To achieve the highest level of external and internal customer satisfaction (External customers include the general public, private businesses, transportation users and government entities; internal customers include all TxDOT employees.)

IR GOAL #2
Improve the efficiency and effectiveness of department operations through the use of enabling information systems and technologies.

IR Objective #7
Improve the efficiency and effectiveness of the department's business processes through the innovative use of technology.

IR Strategy #29
Develop and/or implement new information systems and technologies to enable improvements in business processes.

IR Action Item #139
Standardize the department's electronic transfer to the Comptroller to perform payroll calculations through the Statewide Payroll Project in 1998 (Statewide Payroll project in G&E in Biennial Operating Plan).

IR Action Item #140
Continue the development of the department's internet web site to provide internal and external information (ongoing).

IR Action Item #141
Continue the expansion of E-mail access via internet to the business users as needed (ongoing).

IR Action Item #142
Develop a new client server application to manage the Adopt-a-Highway program for the State in 1997 (Adopt-A-Highway project in G&E in Biennial Operating Plan).

IR Objective #28
Improve the efficiency and effectiveness of the Human Resources business processes through the innovative use of technology.

IR Strategy #58
Identify enabling technology for the Human Resources processes through the Retooling program.

IR Action Item #143
Analyze and determine the most feasible use of technology for the HR business processes in 1997 (HR BPR Feasibility Study project currently in G&E in Biennial Operating Plan).

IR Action Item #144
Complete a feasibility study and identify improvement projects in 1997 (HR BPR Application project currently in G&E in Biennial Operating Plan).

State Strategic Plan for Information Resources

Goal 1: ***Texas state government will integrate government services by developing, implementing, and maintaining a statewide information resources infrastructure.***

Objective A: Provide access to the coordinated, interoperable communications infrastructure to support state computer and videoconferencing needs.

Objective B: Develop and assist organizations that coordinate and facilitate sharing of information.

Objective C: Share a common electronic mail exchange infrastructure that ensures all agencies can be reached by electronic mail.

Objective D: Provide a standard electronic index to all information and services, even those that are not provided electronically.

Objective E: Establish inventories, definitions, and identified custodians for all data elements in state databases.

Goal 2: ***Texas will adopt and apply information resources standards and guidelines.***

Objective A: Ensure interoperability and connectivity between and among state and private information resource facilities.

Objective B: Ensure the privacy of citizens as required by law.

Objective C: Provide appropriate security and authentication for information and services maintained and communicated by the state.

Goal 3: ***Texas government will enable sharing and interoperability of services through common frameworks and processes.***

Objective A: Harmonize and improve information resources planning within and between entities at all levels of government.

Objective B: Standardize information systems development and implementation.

Objective C: Foster exemplary management of information resource projects.

Goal 4: ***Texas state government's acquisition, use, and management of information***

technology will be driven by the recognition and understanding of user needs.

Objective A: Provide equitable access to state-provided information and services at times and locations citizens select, taking into account special needs and social, economic, and ethnic considerations.

Objective B: Ensure the availability of simple, comprehensive user interfaces to state-provided information and services.

Objective C: Ensure electronic availability for all state documents, data, and services from a variety of sources as allowable by law.

Objective D: Effect continuous availability and business recovery of the state's mission-critical information resource capabilities.

The following chart provides a cross-reference between TxDOT's IR Strategies and the statewide IR Goals and Objectives as defined above (refer to pages 34-35).

TxDOT's IR Strategy #	State Strategic Plan for Information Resources Management - Goals/Objectives														
	1/A	1/B	1/C	1/D	1/E	2/A	2/B	2/C	3/A	3/B	3/C	4/A	4/B	4/C	4/D
1	x		x			x									
2	x			x		x								x	
3	x					x								x	
4	x					x									
5						x				x	x	x	x		
6	x									x					
7													x		
8	x														
9	x														
10	x					x									
11									x	x	x				
12									x		x				
13											x	x			
14												x	x		
15				x	x	x	x	x			x		x	x	x
16	x				x							x			
17	x					x			x	x	x				
18									x						
19											x				
20									x		x				
21				x					x				x	x	
22									x		x				
23											x				
24											x				
25		x		x	x						x			x	
26															x
27								x							x
28		x	x											x	
29												x			
30		x				x			x		x	x			
31		x													
32											x				x
33															x
34															x
35															x
36												x			
37												x	x		
38												x	x		
39												x	x		

TxDOT's IR Strategy #	State Strategic Plan for Information Resources Management - Goals/Objectives														
	1/A	1/B	1/C	1/D	1/E	2/A	2/B	2/C	3/A	3/B	3/C	4/A	4/B	4/C	4/D
40												x	x		
41												x	x		
42												x	x		
43					x							x			
44												x			
45				x	x							x		x	
46												x	x		
47												x	x		
48												x			
49												x	x		
50						x						x	x	x	
51						x						x			
52												x		x	
53												x			
54	x	x				x						x	x		
55	x														
56		x										x			
57		x										x			
58												x	x		

The following provides the TxDOT IR Objectives by the applicable organizational function.

Transportation Planning and Development

IR Objective #7:	Improve the efficiency and effectiveness of the department's business processes through the innovative use of technology.
IR Objective #8:	Ensure department information resources remain operational into the year 2000.
IR Objective #12:	Improve the efficiency and effectiveness of the Business Management and Direction and Leadership business processes through the innovative use of technology.
IR Objective #13:	Improve the efficiency and effectiveness of the Real Property business processes through the innovative use of technology.
IR Objective #15:	Improve the efficiency and effectiveness of the Plan Transportation Systems business processes through the innovative use of technology.
IR Objective #16:	Improve the efficiency and effectiveness of the Right of Way business processes through the innovative use of technology.
IR Objective #17:	Improve the efficiency and effectiveness of the Design Transportation Systems, Deliver Transportation Systems, and the Maintain and Operate Transportation Systems business processes through the innovative use of technology.
IR Objective #22:	Provide an automated system to facilitate the management of the approximately 34,000 on-state system and 14,000 off-state system bridges in an overall Bridge Management System.
IR Objective #23:	Develop an automated database which contains pavement layer (cross section) and work history information for all TxDOT maintained highways.
IR Objective #24:	Continue to improve the performance and reliability of existing data collection equipment through the application of automation enhancement technologies.
IR Objective #27:	Streamline the process of locating and evaluating known historical and archeological sites and provide planning tools for early construction project development.

Field Operations

IR Objective #7:	Improve the efficiency and effectiveness of the department's business processes through the innovative use of technology.
IR Objective #8:	Ensure department information resources remain operational into the year 2000.
IR Objective #12:	Improve the efficiency and effectiveness of the Business Management and Direction and Leadership business processes through the innovative use of technology.
IR Objective #14:	Improve the efficiency and effectiveness of the Contract Services business processes through the innovative use of technology.
IR Objective #17:	Improve the efficiency and effectiveness of the Design Transportation Systems, Deliver Transportation Systems, and the Maintain and Operate Transportation Systems business processes through the innovative use of technology.
IR Objective #18:	Automate the preparation, pre-qualification, proposal distribution, newspaper advertisement, letting, contract process and payment procedure for all maintenance contracts in each district office, the Construction and Maintenance Division, the General Services Division, the Budget and Finance Division, and the Design Division.
IR Objective #24:	Continue to improve the performance and reliability of existing data collection equipment through the application of automation enhancement technologies.
IR Objective #25:	Develop and build traffic management systems.
IR Objective #26:	Provide an automated database system to support planning efforts and furnish decision support for the Texas Transportation Commission.

Multimodal Transportation

IR Objective #7:	Improve the efficiency and effectiveness of the department's business processes through the innovative use of technology.
IR Objective #8:	Ensure department information resources remain operational into the year 2000.
IR Objective #12:	Improve the efficiency and effectiveness of the Business Management and Direction and Leadership business processes through the innovative use of technology.
IR Objective #17:	Improve the efficiency and effectiveness of the Design Transportation Systems, Deliver Transportation Systems, and

the Maintain and Operate Transportation Systems business processes through the innovative use of technology.

Administrative Services

IR Objective #1:	Ensure that the department's business needs are supported by a flexible, reliable, cost-effective, integrated, and standards-based information technology architecture and infrastructure.
IR Objective #2:	Establish ongoing information services processes to promote better communication department-wide and provide the ability to easily share information resources, decrease project risk, and reduce maintenance and support costs.
IR Objective #3:	Develop a process to manage and provide consultation services for vendor relation management and contract preparation and management.
IR Objective #4:	Minimize redundant data and improve the department's ability to integrate systems, databases, and data definitions.
IR Objective #5:	Provide for the development, implementation, and maintenance of a comprehensive contingency plan which will ensure TxDOT's ability to recover its information resources in the event of a major disaster or business interruption.
IR Objective #6:	Provide appropriate security and authentication for information maintained and communicated by the department.
IR Objective #7:	Improve the efficiency and effectiveness of the department's business processes through the innovative use of technology.
IR Objective #8:	Ensure department information resources remain operational into the year 2000.
IR Objective #9:	Provide a mechanism that will allow the department to manage the entire procurement cycle of commodities and services.
IR Objective #10:	Improve the efficiency and effectiveness of the Supplies, Materials, and Equipment (SME) business processes through the innovative use of technology.
IR Objective #11:	Improve the efficiency and effectiveness of the Fiscal Services business processes through the innovative use of technology.
IR Objective #12:	Improve the efficiency and effectiveness of the Business Management and Direction and Leadership business processes through the innovative use of technology.
IR Objective #13:	Improve the efficiency and effectiveness of the Real Property

	business processes through the innovative use of technology.
IR Objective #14:	Improve the efficiency and effectiveness of the Contract Services business processes through the innovative use of technology.

Human Resources Management

IR Objective #7:	Improve the efficiency and effectiveness of the department's business processes through the innovative use of technology.
IR Objective #8:	Ensure department information resources remain operational into the year 2000.
IR Objective #12:	Improve the efficiency and effectiveness of the Business Management and Direction and Leadership business processes through the innovative use of technology.
IR Objective #28:	Improve the efficiency and effectiveness of the Human Resources business processes through the innovative use of technology.

Motorist Services

IR Objective #7:	Improve the efficiency and effectiveness of the department's business processes through the innovative use of technology.
IR Objective #8:	Ensure department information resources remain operational into the year 2000.
IR Objective #12:	Improve the efficiency and effectiveness of the Business Management and Direction and Leadership business processes through the innovative use of technology.
IR Objective #19:	Improve the efficiency and effectiveness of the Regulate Transportation Systems business processes through the innovative use of technology.
IR Objective #20:	Improve the department's ability to administer the provision of the motor vehicle registration and titling statutes.
IR Objective #21:	Continue to improve the department's ability to administer the provisions of the motor vehicle registration and titling statutes.

Staff Services

IR Objective #7:	Improve the efficiency and effectiveness of the department's business processes through the innovative use of technology.
IR Objective #8:	Ensure department information resources remain operational

into the year 2000.

IR Objective #12: Improve the efficiency and effectiveness of the Business Management and Direction and Leadership business processes through the innovative use of technology.

Section B
Additional IR Opportunities

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The opportunities depicted in this strategic plan are dependent on technology, funding, and resource availabilities. In conjunction with the Retooling TxDOT Program, this includes the introduction of new technology and processes which will change the way operations and services are currently provided; radical reconfiguration of hardware/software to optimize and improve cost effectiveness, efficiency, and expand operations; and allocation and distribution of resources for more cost-effective operations. The goals and objectives in this plan significantly change the way the department does business, especially in the area of information services. These goals, objectives, and strategies, will be a major challenge for the Department and until the strategies can be executed, the department cannot take full advantage of existing information resources or address any additional information resource opportunities.

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Chapter 3

Information Services Business Model

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Introduction

The purpose of this chapter is to present the Information Services (IS) business model, including the major processes, subprocesses, inputs, outputs, and related projects at this time. As business needs change, the IS business model will evolve. In fact, as part of the Information Services Business Process Retooling (IS BPR) Program, a primary objective is to design an IS business model that can easily and quickly adapt to ongoing changes in business requirements.

Background

An IS business model was derived in early stages of the IS BPR Program; however, the model is continuously being refined as part of the IS BPR Program. Although the major processes defined in the IS BPR Phase 3 Report, *Initial Design and Implementation Strategy*, have not changed, the complexity of the IS business area is reflected by additional subprocesses presented in this new model. The IS business model presented in this chapter supersedes the IS business model presented in the IS BPR Phase 3 Report.

It is important to note that the IS business model is not intended to reflect any proposed organizational structure. It is focused on the processes, subprocesses, inputs, and outputs, regardless of organizational structure. The "Related Projects" section is not a part of the business model; however, it is included to cross reference existing and planned IS projects that are needed to fully implement the new IS business model.

A common project to all processes is the "Development of an IS Quality Program" to ensure that all IS processes have defined performance metrics, and that the process for measuring performance is implemented with any redesigned IS process. Another project common to all processes is the "Development of Information Services Policies, Standards, and Procedures Process". This project will define the process for developing and communicating policies, standards, and procedures for TxDOT's IS business processes.

Redesigned Information Services Business Model

The business model depicts the major processes, inputs, and outputs within the information services business area. The definition and subprocesses are listed on the following pages.

Establish IS Plans and Budgets

- Develop/Maintain Strategic Plan for Information Resources
- Develop/Maintain IS Business Model
- Prepare/Maintain Biennial Operating Plan
- Define Priorities for Information Services
- Develop/Maintain Outsourcing and Asset Management Strategies
- Develop IS Project Plans/Budgets
- Develop IS Resource Plans
- Budget/Monitor IS Expenditures
- Monitor Performance based on Plans
- Develop/Maintain Related IS Policies, Standards, Procedures, and Methodologies

Develop and Maintain the Enterprise IT Architecture

- Research Information Technology and Services
- Evaluate and Select Hardware and Software
- Procure Information Resources for Research and Development
- Maintain Enterprise Information Technology Architecture
    - Core Technology Architecture
    - Office Systems Architecture
    - Engineering/CADD/GIS Architecture
    - Field Data Collection Architecture
    - Application Development Architecture
    - Application Architecture
    - Data Architecture
- Monitor Compliance to IT Architecture
- Plan/Manage IT Architecture Projects
- Plan/Manage Enterprise Data Program
- Develop/Maintain Related IS Policies, Standards, Procedures, and Methodologies

Manage the Information Technology Infrastructure

- Plan/Manage Mainframe Operations
- Plan/Manage Wide Area Network
- Plan/Manage LANs, Servers, and Desktops
- Plan/Manage Infrastructure Implementation Projects
- Define Infrastructure Integration Requirements
- Develop/Maintain Infrastructure Implementation Strategy
- Procure Technology Infrastructure Components
- Plan/Manage Information Security and IR Interruption Risk
- Provide Database Systems Management
- Plan/Manage Data Distribution and Data Migration Projects
- Plan/Manage Voice Telecommunications
- Provide Infrastructure Training and Technical Support
- Monitor Operational Performance
- Develop Related IS Policies, Standards, Procedures, and Methodologies

Provide Customer Services
- Provide Customer Problem Resolution
- Provide IS Consulting Services
- Identify IS Training Needs
- Develop and Maintain Curricula
- Train IS Users
- Maintain Knowledge Base
- Monitor Service Level
- Develop Related IS Policies, Standards, Procedures, and Methodologies

Develop and Maintain Applications
- Document Requirements
- Identify/Analyze Alternatives
- Develop and Maintain Software
- Develop Interfaces with New and Existing Applications
- Evaluate/Select/Procure Application Development Hardware and Software
- Deploy Applications/Systems
- Evaluate Applications/Systems Usage and Functionality
- Plan/Manage Application Development/Maintenance Projects
- Develop Related IS Policies, Standards, Procedures, and Methodologies
- Maintain Application Inventories

Manage IS Human Resources
- Define Career Paths and Career Development Plans
- Identify and Provide Training for IS Professionals
- Maintain Skills Inventory
- Deploy IS Staff Resources
- Monitor IS Staff Performance
- Procure Contract Services
- Manage Service Contracts
- Develop Related IS Policies, Standards, Procedures, and Methodologies

Process:	**Establish IS Plans and Budgets.**

Subprocesses:

- Develop/Maintain Strategic Plan for Information Resources
- Develop/Maintain IS Business Model
- Prepare Biennial Operating Plan
- Define Priorities for Information Services
- Develop/Maintain Outsourcing and Asset Management Strategies
- Develop IS Project Plans/Budgets
- Develop IS Resource Plans
- Budget/Monitor IS Expenditures
- Monitor Performance based on Plans
- Develop/Maintain Related IS Policies, Standards, Procedures, and Methodologies

Inputs:

- TxDOT's Strategic Plan
- Biennial Report on Information Resources Management (DIR)
- IS Business Model
- Biennial Operating Plan
- Legislation and Mandates
- Project Requests
- Enterprise IT Architecture
- DIR Statewide Strategic Plan
- Information Technology and Services Research (Best Practices)
- AASHTO Directions
- Planning and Budgeting Tools

Outputs:

- TxDOT's Strategic Plan for IR
- IS Business Model
- Biennial Operating Plan
- IS Prioritization List
- Outsourcing and Asset Management Strategies
- IS Project Plans
- IS Resource Plans
- IS Budgets
- Legislative Appropriations Request
- IS Policies, Standards, Procedures, and Methodologies

Related Projects:

- Develop an IS Planning and Budgeting Process
- Design and Implement an Information Services Management Information System
- Develop an IS Outsourcing Strategy and Contract Management Process
- Develop a Project Prioritization and Staffing Process
- Develop an IS Quality Program
- Develop an IS Policies, Standards, and Procedures Process

Purpose:	**Develop and Maintain the Enterprise IT Architecture.**

Subprocesses:

- Research Information Technology and Services
- Evaluate and Select Hardware and Software
- Procure Information Resources for Research and Development
- Maintain Enterprise Information Technology Architecture
  - Core Technology Architecture
  - Office Systems Architecture
  - Engineering/CADD/GIS Architecture
  - Field Data Collection Architecture
  - Application Development Architecture
  - Application Architecture
  - Data Architecture
- Monitor Compliance to IT Architecture
- Plan/Manage IT Architecture Projects
- Plan/Manage Enterprise Data Program
- Develop/Maintain Related IS Policies, Standards, Procedures, and Methodologies

Inputs:

- Business Needs and User Requirements
- IS Plans and Budgets
- Current Hardware and Software Inventories
- Existing and Available Technologies
- Implementation Performance Measures

Outputs:

- Enterprise IT Architectures
- Enterprise Data Model
- Hardware/Software Configurations
- Product Evaluations and Selection Recommendations
- Impact and Risk Assessments
- IS Policies, Standards, Procedures, and Methodologies

Related Projects:

- Develop the Core Technology Architecture
- Develop the Office Systems Architecture
- Develop the Engineering/CADD/GIS Architecture
- Develop the Field Data Collection Architecture
- Develop the Application Development Architecture
- Develop the Application Architecture
- Develop the Data Architecture
- Develop an Enterprise Data Program
- Develop a Process to Continuously Enhance and Integrate the Enterprise IT Architecture
- Develop a Process for Continuous Research of Innovative Technology Solutions
- Develop a Process for Technology Evaluation, Selection, and Integration
- Develop an IS Quality Program
- Develop an IS Policies, Standards, and Procedures Process

Purpose:	**Manage the Information Technology Infrastructure.**

Subprocesses:

- Plan/Manage Mainframe Operations
- Plan/Manage Wide Area Network
- Plan/Manage LANs, Servers, and Desktops
- Plan/Manage Infrastructure Implementation Projects
- Define Infrastructure Integration Requirements
- Develop/Maintain Infrastructure Implementation Strategy
- Procure Technology Infrastructure Components
- Plan/Manage Information Security and IR Interruption Risk
- Provide Database Systems Management
- Plan/Manage Data Distribution and Data Migration Projects
- Plan/Manage Voice Telecommunications
- Provide Infrastructure Training and Technical Support
- Monitor Operational Performance
- Develop Related IS Policies, Standards, Procedures, and Methodologies

Inputs:

- Enterprise IT Architecture
- Requests for Information Technology
- Reference Material
- Implementation Plans
- Utilization Information
- Capacity Plans
- User Access Requests
- User Profiles
- Support Requests
- Hardware and Software Inventories

Outputs:

- Operational Systems and Technologies:
  - Mainframe
  - Wide Area Network
  - LANs, Servers, and Desktops
  - Databases
  - Voice Telecommunications
- Infrastructure Implementation Strategy
- Contingency Plan and Disaster Recovery Implementation Plan
- Upgrades
- Access/Update Authorizations
- IS Policies, Standards, Procedures, and Methodologies

Related Projects:
• Develop the Core Technology Architecture • Develop the Office Systems Architecture • Develop the Engineering/CADD/GIS Architecture • Develop the Field Data Collection Architecture • Develop the Application Development Architecture • Develop the Application Architecture • Develop the Data Architecture • Develop an Enterprise Data Program • Develop a Process to Continuously Enhance and Integrate the Enterprise IT Architecture • Develop a Process for Continuous Research of Innovative Technology Solutions • Develop a Process for Technology Evaluation, Selection, and Integration • Develop an IS Quality Program • Develop an IS Policies, Standards, and Procedures Process

Purpose:	**Provide Customer Services.**

Subprocesses:

- Provide Customer Problem Resolution
- Provide IS Consulting Services
- Identify IS Training Needs
- Develop and Maintain Curricula
- Train IS Users
- Maintain Knowledge Base
- Monitor Service Level
- Develop Related IS Policies, Standards, Procedures, and Methodologies

Inputs:

- User Questions and Problems
- User Requests for Services
- Enterprise IT Architecture
- Enterprise Data Model
- Hardware/Software Inventories
- Product Reference Material
- Training Course Information
- Knowledge Base

Outputs:

- Problem Resolutions (on-site and phone support)
- Consulting Services
- IS Training Curricula and Programs
- IS Training Catalog
- Knowledge Base
- Service Level Agreements/Performance Information
- IS Policies, Standards, Procedures, and Methodologies

Related Projects:

- Develop a Customer Support Center
- Provide Personal Productivity Training to IS End Users and Professionals
- Establish a Process to Identify IS Training Needs and Develop Curricula
- Develop an IS Quality Program
- Develop an IS Policies, Standards, and Procedures Process

Purpose:	Develop and Maintain Applications.

Subprocesses:

- Document Requirements
- Identify/Analyze Alternatives
- Develop and Maintain Software
- Develop Interfaces with New and Existing Applications
- Evaluate/Select/Procure Application Development Hardware and Software
- Deploy Applications/Systems
- Evaluate Applications/Systems Usage and Functionality
- Plan/Manage Application Development/Maintenance Projects
- Develop Related IS Policies, Standards, Procedures, and Methodologies
- Maintain Application Inventories

Inputs:

- Business Needs (through Information Resource Requests)
- User Requirements
- IS Policies, Standards, and Procedures
- Application Development Methodology
- Enterprise IT Architecture
- Enterprise Data Model
- Existing Data, Applications, and Technology
- Legislation and Mandates

Outputs:

- Applications/Information Systems
- Feasibility Studies and Cost-Benefit Analyses
- Impact Analyses
- Hardware/Software Evaluations
- User Manuals
- Technical and Support Documentation
- Application Inventory
- Support and Training Requirements
- IS Policies, Standards, Procedures, and Methodologies

Related Projects:

- Develop the Core Technology Architecture
- Develop the Application Development Architecture
- Develop the Application Architecture
- Develop the Data Architecture
- Develop an Enterprise Data Program
- Develop an IS Quality Program
- Develop an IS Policies, Standards, and Procedures Process

Purpose:	**Manage IS Human Resources.**

Subprocesses:

- Define Career Paths and Career Development Plans
- Identify and Provide Training for IS Professionals
- Maintain Skills Inventory
- Deploy IS Staff Resources
- Monitor IS Staff Performance
- Procure Contract Services
- Manage Service Contracts
- Develop Related IS Policies, Standards, Procedures, and Methodologies

Inputs:

- Biennial Operating Plan
- IS Project Plans
- Employee Input
- Skills Inventory
- Training Catalogs
- Industry Best Practices
- Outsourcing Strategy
- Performance Plans

Outputs:

- IS Career Plans
- Training Plans/Training for IS Staff
- Skills Inventory
- IS Staffing Plan
- Performance Evaluations
- IS Contract for Services
- IS Standards, Policies, Procedures, and Methodologies

Related Projects:

- Provide Personal Productivity Training to IS End Users and Professionals
- Establish a Process to Identify IS Training Needs and Develop Curricula
- Develop an IS Quality Program
- Develop an IS Policies, Standards, and Procedures Process

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Information Technology Architecture and Infrastructure

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OVERVIEW:

The Enterprise Information Technology (IT) Architecture provides the framework, principles, guidelines, minimum standards, specifications, policies, and procedures to direct the process of designing, acquiring, constructing, modifying, maintaining, and interfacing technologies, data, applications, and other information resources required to support TxDOT's business needs. The IT Architecture is designed to be manageable, consistent, comprehensive, scalable, supportable, and easily integrated. Through continuous improvement, it is constantly aligned with TxDOT's business strategies and priorities. It is composed of the following component architectures:

- Core Technology Architecture
- Office Systems Architecture
- Engineering/CADD/GIS Architecture
- Application Development Architecture
- Application Architecture
- Field Data Collection Architecture
- Data Architecture.

The third release of the Core Technology Architecture (Version 3) will be completed in 1997 and the initial release of the other component architectures will be also completed in 1997. An infrastructure implementation project to support Version 3.0 of the architecture will begin in 1997 and be completed in 1998.

Core Technology Architecture

The Core Technology Architecture is the foundation component of the Enterprise IT Architecture. It defines the strategic direction for networking, telecommunications, operating systems, workstations, servers, mainframes, printers, plotters, database management systems, general purpose workstation software, groupware, enterprise system management, and reliability and fault tolerance. The Core Technology Architecture defines the guiding principles that will create the framework from which the technology infrastructure can be implemented. The current version of the Core Technology Architecture (Version 2.0) is included in Appendix 4. The topics addressed in Version 2.0 include:

- Enterprise Network Architecture
- Operating Systems
- Relational Database Management System (RDBMS)

- Hardware Architecture
- Remote/Dial-in/Dial-out
- Office Suites
- Groupware
- Enterprise System Management
- Reliability & Fault Tolerance

Version 3.0 of the Core Technology Architecture, which will be completed in 1997, represents TxDOT's strategic direction for the technology infrastructure in 1997-1998. Version 3.0 will include major upgrades that address significant gaps in the current architecture. The proposed table of contents for Version 3.0 is included at the end of this chapter.

Core Technology Infrastructure

The Core Technology Infrastructure is the result of the physical implementation of the technologies identified in the Core Technology Architecture. The infrastructure consists of the specific components that make up the local area network (LAN), wide area network (WAN), hardware, operating systems, printers, and relational database management system (RDBMS). The infrastructure is defined based on the recommendations of the architecture. Currently TxDOT is in the process of implementing the essential components of the technology infrastructure that comply with Version 2.0 of the Core Technology Architecture and should be completed in 1997. An infrastructure implementation project to support Version 3.0 of the architecture will begin in 1997 and be completed in 1998.

Office Systems Architecture

The Office Systems Architecture provides the framework, principles, guidelines, minimum standards, specifications, and policies/procedures to direct the process of acquiring, constructing and enhancing applications that capture, store, access, and manage documents and related information. This architecture extends the Core Technology Architecture and utilizes the basic components of the core technology infrastructure. It is also being developed in conjunction with the Engineering/CADD/GIS Architecture to ensure that vector and raster engineering drawings, plan sheets, maps, orthophotography, and digital photo logs are addressed. Document creation is primarily addressed by the Core Technology, Engineering/CADD/GIS, and Application Development Architectures. Elements of the Office Systems Architecture include:

- Document management services such as storage and management, information retrieval, access and security.
- Group services such as electronic document interchange, electronic forms, imaging, and workflow

Several pilot projects are ongoing and the initial architecture for document management will be completed in 1997. Group services will be addressed in 1998.

Engineering/CADD/GIS Architecture

This architecture provides the framework, principles, guidelines, minimum standards and specifications, and policies/procedures to direct the process of acquiring, constructing, and enhancing TxDOT's engineering applications. This architecture extends the Core Technology Architecture and utilizes the basic components of the core technology infrastructure. Elements of the Engineering/CADD/GIS Architecture include:

- Computer-Aided Design and Drafting (CADD) Software
- Geographic Information Systems (GIS)
- Global Positioning System (GPS) and Photogrammetry technology support for GIS
- Video Logging and digital photography support for GIS and CADD
- Large format plotters, scanners, and printers
- Spatial data extensions to the data architecture
- Workstation configurations for engineering, CADD, mapping, GIS, and surveying applications.

The Engineering/CADD/GIS Architecture will define the required technologies to extend the Document Management Architecture to include vector and raster engineering drawings, plan sheets, maps, orthophotography, and digital photo logs. The initial version of this architecture will be completed in 1997.

Field Data Collection Architecture

The field data collection architecture provides the framework, principles, guidelines, minimum standards, specifications, and policies/procedures to direct the process of acquiring, constructing, and enhancing TxDOT's field data collection technologies such as bar coding/scanning, digital video, pen-based computing, wireless hand-held devices, GPS, and other emerging technologies. The architecture defines the standard for field data and how it interfaces with the technology infrastructure. The initial version of this architecture will be completed in 1997.

Application Development Architecture

The Application Development Architecture provides the framework, principles, guidelines, standards, specifications, policies, and procedures for application development and maintenance. This architecture extends the Core Technology Architecture for application development and utilizes the basic components of the core technology infrastructure. The architecture, which will be completed in 1997, will include the following:

- Application development and maintenance policies, procedures, and guidelines
- Programming language standards
- Graphical user interface standards (GUI)
- Quality assurance and quality control process
- Configuration management process
- Enterprise application development strategy
- Modularity and code reuse strategy
- Object oriented technologies strategy
- Disposition, migration, and integration strategy for legacy systems
- Guidelines for determining appropriate platforms and tools for application development projects
- Application development skills, training, and support requirements
- Software development tools for enterprise, workgroup, and employee applications (including I-CASE tools)
- Workgroup application development tools
- Intranet/Internet development and document publishing tools
- End-user reporting, forms, and decision support tools
- Model management tools (process and data modeling tools for enterprise and workgroup applications)
- Testing and debugging tools
- Configuration management tools
- Software installation and distribution tools
- Help authoring tools
- Developer workstation configurations (hardware and software).

Application Architecture

The Application Architecture identifies the application systems needed to support the business needs and data requirements of the department. It is a model of all applications (existing and future) required to support the actions of the business, with an emphasis on sharing information resources. The initial version of this architecture will be completed in 1997.

Data Architecture

The strategic direction for TxDOT's data resources is defined in the Data Architecture and Enterprise Data Program. The Data Architecture is the conceptual description of the data that must be collected and maintained to support the statewide data requirements of TxDOT's business areas. In order to improve the management of the department's data and implement an infrastructure to address current data issues, TxDOT will create an enterprise data model as a component of the Enterprise Data Program.

The Enterprise Data Program will enable TxDOT to achieve its mission by optimizing the value of its data assets, and will ensure sound management practices through partnerships with a variety of data stakeholders throughout, and external to, the department.

The objectives documented below illustrate "what" the Enterprise Data Program must accomplish in order to effectively manage data assets while satisfying stakeholder demands. The Program must:

- provide a data environment that promotes better business communication and decision making for both internal and external stakeholders,
- improve the quality, accuracy, and integrity of data,
- promote the sharing of data across organizational boundaries,
- develop a data architecture to support the development of applications responsive to changing business needs,
- minimize the cost of gathering, processing, maintaining, and accessing data,
- establish authority, responsibility, and accountability for data management activities throughout the department,
- emphasize the integration of data with business activities,
- ensure a global perspective of data, and
- move TxDOT from an unarchitected (legacy) data environment to an architected (target) data environment.

The strategies documented below represent "how" the Enterprise Data Program will accomplish its objectives. This list is expected to be dynamic, and it will undoubtedly evolve to meet TxDOT's future data management requirements. The Program must:

- implement accountability for the information resource through the Information Resource Council (IRC), a management team responsible for setting information resource strategic direction and policy, assigning enterprise data to business unit "stewards", and resolving a variety of global data-related issues,
- manage and promote an Enterprise Repository to support data management objectives,
- organize, maintain, and promote an Enterprise Glossary of standardized TxDOT business terms,
- organize, maintain, and promote an Enterprise Data Dictionary,
- develop, maintain, and promote contextual, conceptual, and logical models of data,
- build and maintain physical models and databases,
- organize and maintain database distribution and migration techniques,
- support the protection of enterprise data by managing the risk to the data from accidental or unauthorized access, disclosure, damage, and loss, while promoting the sharing and accessibility of the data,
- define and implement the training and education necessary for effective data

management, and
- actively participate in strategic systems planning efforts.

TxDOT is currently in the initial phases of implementing the Enterprise Data Program and the associated data architecture. The program, with an initial data architecture, will be implemented in 1997.

Information Technology Architecture and Infrastructure Processes

To ensure that the Information Technology Architecture and Infrastructure are continuously enhanced and upgraded to support the business needs of the department, a series of processes are being defined.

- Information Technology Architecture integration and upgrade process
- Innovative technology research process
- Technology selection, evaluation, and integration process
- Infrastructure project implementation process
- Application administration process
- Enterprise Data Program management
- Application development
- Package application implementation process

Information Resource Information System

TxDOT is currently developing an Information Resources Information System (IRIS) to support the information services business area. IRIS will contain a decision support segment (DSS) that provides information services managers with access to information that is critical for planning, implementing, and managing information resources. IRIS will benefit the management of IT architectures and infrastructure by:

- Improving tracking and monitoring of information resources
- Improving tracking and monitoring of architecture and infrastructure projects
- Providing access to personnel skills and availability to assist in forming teams for architecture and infrastructure projects
- Providing access to performance metrics and best practices from previous projects
- Simplifying the procurement of hardware and software that complies with the IT Architecture
- Monitoring non-compliance with the IT Architecture
- Providing accurate, consistent, and readily available information services asset information. An accurate inventory of existing information resources will:
    - Assist in user and technical support

- Improve the accuracy of budget and planning for upgrades, replacements and maintenance contracts
- Assist in planning and implementing of infrastructure projects.

Proposed Table of Contents -Version 3 Core Technology Architecture

Proposed Table of Contents -Version 3 (continued)

Proposed Table of Contents -Version 3 (continued)

Proposed Table of Contents -Version 3 (continued)

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Proposed Table of Contents -Version 3 (continued)

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Section A
Organization and Personnel

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OVERVIEW:

Refer to Chapter 1, Section A for a description of the Texas Department of Transportation's organization. An organizational chart is provided in Appendix 1.

Reviewing the current Information Services (IS) organization and management approach enables TxDOT to begin migration development for a new approach. In order to develop an IS structure which will meet the requirements of TxDOT, the IS organization structure and related roles and responsibilities were reviewed during the initial phases of the Information Services Business Process Retooling project. In addition, several business improvement projects that are currently underway have the potential to affect future roles and responsibilities in these areas.

IS ORGANIZATION AND MANAGEMENT:

Responsibility for the department's information resources is distributed among three organizations:

- Deputy Executive Director of Administrative Services, designated as the Chief Information Officer
- Information Systems Division (ISD)
- District/division/special office Information Resource Administration (IRA) sections

The roles and responsibilities of each organization are described below.

Deputy Executive Director of Administrative Services:

The Deputy Executive Director of Administrative Services is designated as the department's Chief Information Officer, responsible for overseeing the strategic information technology direction, as recommended by the Information Services Business Process Retooling (Reengineering) project. The Information Systems Division reports directly to the Chief Information Officer.

Information Systems Division:

The Director of the Information Systems Division is the department's designated Information Resource Manager. The Information Resource Manager is responsible for the development of information resource strategic directions. The Information Systems Division supports the strategic directions for information resources through the development of plans, policies, and procedures and the associated implementation. Information resource directions relevant to Traffic Management are implemented by the Traffic Operations Division.

The Information Systems Division (ISD) develops policies and procedures for the implementation and support of technology in all functions of the department. ISD also ensures that the department's information resources are secured from unauthorized access and abuse and coordinates telecommunications services statewide. The major organizations of the division are:

- Operating Systems and Telecommunications
- Information Resource Planning, Security and Quality Assurance
- Administrative Support
- Systems Coordination and User Support
- Engineering and Survey Systems
- Business Systems Development and Support
- Executive Information Management.

The Operating Systems and Telecommunications section is responsible for the development and support of the department's operating systems, wide-area network and voice telecommunications. This section also operates the central computer and provides capacity planning and management of the computer resources.

The Information Resource Planning, Security and Quality Assurance section compiles, maintains, and monitors the department's Biennial Operating Plan (BOP) for Information Resources and the department's Contingency Plan. This section also provides automated information security and integrity, and quality assurance.

The Administrative Support section provides internal support for ISD personnel. Support services include human resources, procurement, fiscal services, graphics, and information systems support.

The Systems Coordination and User Support section provides support for all automation users. Support is provided for engineering applications and graphics, management information systems, and microcomputer development. This section is also responsible for the development and support of the department's local area networks.

The Engineering and Survey Systems section coordinates all engineering/surveying related functions, including engineering research, development, and administration, GPS/Satellite technology, and photogrammetry.

The Business Systems Development and Support section develops and maintains business, transportation, and registration and title applications. The data administration, database management, methodology support, and development support functions are also performed in this section.

The Executive Information Management section develops, implements, maintains, and supports the department's Executive Information System decision support system as well as the TxDOT internet presence on the web server.

District/Division/Special Office Information Resource Administration:

There is an Information Resource Administrator in every district and division to act as a direct liaison between the district/division and the Information Systems Division. The Special Offices are supported by support resources from ISD. The following is a brief list of Information Resource Administrator responsibilities:

- Ensures effective allocation and utilization of hardware and software resources
- Recommends, develops, and implements district/division policies and procedures regarding information resources
- Provides support to mainframe, PC, and graphics end users
- Provides informal training for a variety of information resource systems
- Performs local-area network (LAN) administration
- Ensures compliance with data security policies.

In a typical IS staff, the Information Resource Administrator is assisted by a security administrator, microcomputer advisor, graphics coordinator, and programming and support personnel.

IS SKILLSET ASSESSMENT:

Given the department's success in information resources, particularly its proficiency at mainframe application development and support, it is obvious that ISD possesses a wide range of development, maintenance, telecommunication, database, and support skills. However, as the department shifts away from the mainframe platform and implements new technologies, different skillsets will be required. In 1994, a Skillset Survey was used to assess the current and optimal level of information technology skills expected to be predominant over the next few years. This assessment addressed only the skills of the ISD personnel and is based on responses from ISD staff.

Overall, there is a gap between current and optimal level for every skillset category, indicating the need and desire to improve all IS skills. Although there is room for improvement, the current skill level was evaluated to be close to the optimal level for the following skills:

- PC Support
- LAN/WAN Support
- Methodology Support
- End-user Support - applications.

Since the following methods and technologies have not been fully implemented at ISD, there is a large discrepancy between the existing and desired skill level for these skillsets:

- Rapid Application Development
- Distributed Processing Design
- Object Oriented Programming
- Client/Server Design/Development
- Platform/Systems Integration
- Relational Database Design
- GIS
- Document Management.

These skills will be critical for the implementation of new technologies and the development of more functional, easier-to-use applications. The Information Services Business Process Retooling project will identify a process for future skillset analysis and further address on-going training needs in order to enable IS personnel to change from the current development environment.

District/Division/Special Office Skillsets:

Having the skillsets required to implement and support the future technology direction of the department will be the key to success. The department will need to invest time and resources in developing an equity in the skillsets of the districts/divisions/special offices and providing the appropriate infrastructure necessary to support the strategies set forth in this document.

FUTURE DIRECTION:

Information Services Model:

The Information Services Business Process Retooling program is currently working on the future direction of the department-wide IS organization. This direction is based on a three-tiered structure which provides for flexible management of TxDOT's information resources and decentralization of key activities to provide the maximum ability to meet specialized needs. This model does not focus on who is responsible for any given computing service, but rather what type of computing service is involved. Figure 5.A-1 displays the components of the information services model.

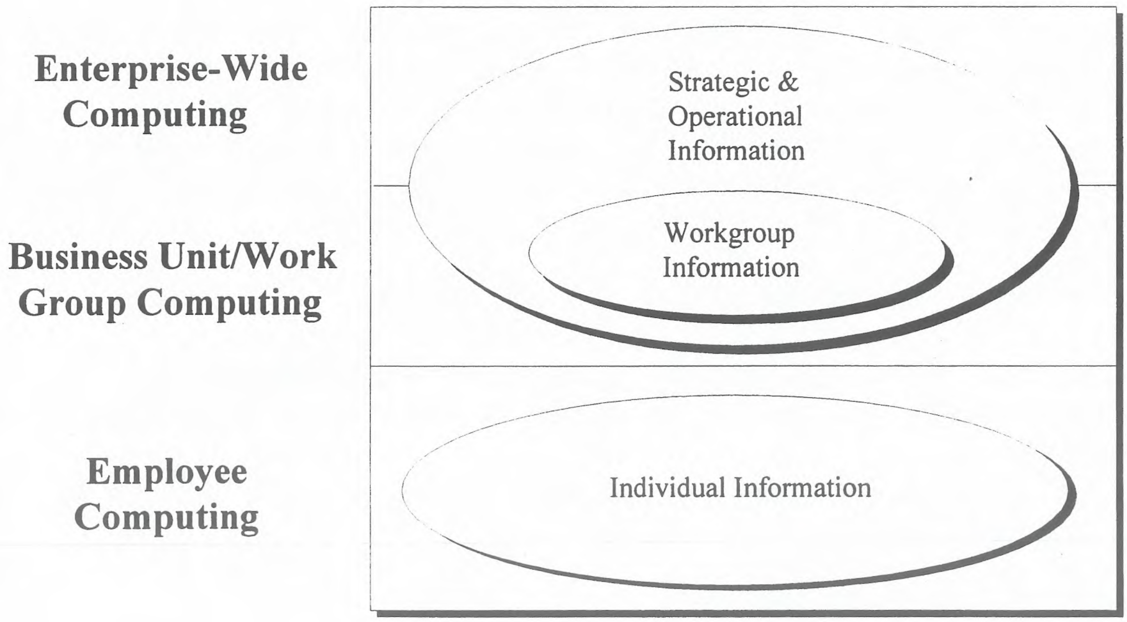

Figure 5.A-1: Information Services Model

All computing services are classified into three categories: enterprise-wide computing, business unit/work group computing and employee computing. Enterprise-wide computing spans across business units and includes a large number of diverse users. These services are usually mission critical in nature, require complex business logic and are provided by the Information Systems Division. Business unit/work group computing applies to a given business unit and includes operational and/or work group information. These services can be provided by the business unit/work group or by the Information Systems Division, or both. Employee computing applies to a specific individual or a small number of individuals.

Although this type of service or application can be shared with others, there is no need to share the information processed. These services are provided by the individual users.

Under this model, all enterprise-wide and business unit/work group computing services must be business driven and architecturally (e.g., data, application, technology) consistent. Any service or application to be developed must be compared to the business model and the enterprise information technology (IT) architecture to ensure that the direction set forth in the BISP is being followed. Key attributes of these services include the following:

- Flexibility - services must be portable, parameter-based, and open
- Longevity - services must be maintainable, tool-based, and methods-driven
- Quality - services must be results driven and end-user friendly
- Rapid Delivery - services must be delivered fast and efficiently

Employee computing services, on the other hand, will not be required to be business model or architecture driven, although development must be business driven to ensure data is not stored exclusively for luxury. Provided the necessary criteria are met in defining a employee application, all obstacles should be removed to encourage the rapid delivery of employee application systems. This will provide greater flexibility and fewer restrictions which the user will need to be concerned with during the development of a new service.

Key attributes of employee computing services include the following:

- Unique Needs - services must meet the specific functionality of the user
- Limited Constraints - red tape must be removed from the process to support rapid development
- Support - consultation/assistance from ISD should be available where feasible to the user to facilitate development and support.

Centralized vs. Decentralized Functions:

To support this model, some IR functions once centralized will need to be decentralized to provide more effective and efficient end-user support.

Centralized IR Functions:

- Architecture Development and Maintenance
- Methodology Maintenance
- Enterprise Data Management
- IR Consultation/Help Desk
- Hardware Procurement for Enterprise-Wide Support

- Enterprise-Wide Application Development
- Contribution to Work Group Application Development
- Technology Implementation Planning/Coordination

Decentralized IR Functions:

- Query Generation
- Work Group Application Development
- Employee Application Development
- Procurement of Employee and Work Group Related Devices
- Procurement of Employee and Work Group Related Applications
- Implementation of Technology

Major IS Restructuring Elements:

Two major elements of the restructuring of IS should include the increased emphasis of an Enterprise Data Management Program and the establishment of an Enabling Center.

Increased emphasis on data management will help ensure that the department's information is treated as a strategic asset. Data management should focus on the development and maintenance of the Data Architecture and Enterprise Data Model, and support of the use of these data models in application development.

The Enabling Center concept needs to be explored to provide the best possible information resource support to the end user. This center should provide educational programs, consulting, help desk support, IR standards development, and quality assurance.

This center should be a cornerstone in creating a level of trust between the IS organization and the end-user community, providing an increased level of support to facilitate the rapid delivery of applications. It is important to note that these services should be designed to provide only as much assistance as needed by the end user, rather than another control mechanism in the delivery and use of information services. The benefits of such a service can only be realized with appropriate staffing and associated resources. Negative impact will result if the level of support is not adequate to meet the needs of the users.

IMPACT OF FUTURE DIRECTION:

The impact of this direction will be significant. The IS organization will become flexible and business driven and will provide an increased level of service and support to the end-user community. Additional benefits of this direction include:

- Renewed trust in the IS organization
- Business-driven solutions
- Increased end-user ownership
- Data managed as a strategic business asset
- Foundation for implementing the necessary technology infrastructure
- Increased equity in district/division/special office skillsets due to training and support
- Integration of applications
- Increased ability to deliver user support services
- IS organization technology objectives supported (e.g., technology leadership position, increased ad-hoc end-user access, etc.)
- Allows ISD to focus in implementation of strategic and mission critical information issues.

Establishing the new IS organization will not be without challenges. These challenges include:

- Greater need for development and adherence to standards
- Higher degree of coordination required among application developers
- Increased funding required to train and support new structure
- Acquiring and retaining necessary skillsets
- Changing IS culture
- Additional personnel resources.

These changes will not come without a cost. To implement an Enterprise Data Management and an Enabling Center concept, decentralize some functions once managed by ISD, and implement the skillset migration, there will have to be increased IR funding and a significant redeployment of resources, at least in the short run. As these changes are implemented through the Information Services Business Process Retooling Project, and IS moves along the learning curve, efficiencies will be achieved and costs will start to come down again. Until then, it will be imperative to invest in this new model to ensure complete success.

Section B
IR Policies and Practices-Introduction

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This section summarizes TxDOT's current policies and practices that support information resources management. Additionally, as part of the Information Services Business Process Retooling program, new (or revised) information services policies, standards, guidelines, and procedures are being developed for implementation during 1997-1998.

A project is underway to develop the process to identify, integrate, communicate, and maintain IS policies, standards, guidelines, and procedures. As part of this project, a "standards clearinghouse" will be established to work with "sponsors" of standards from other IS processes, ensuring consistency and integration of IS standards throughout the department. This clearinghouse will coordinate the development and maintenance of the repository for IS policies, standards, guidelines, and procedures so that TxDOT personnel have online access to the most up-to-date information.

Once established, this new process will alleviate duplication of effort and enable maximum effectiveness in providing IS customers with timely, quality services. It will also enable the decentralization of information services through effectively-communicated policies, standards, guidelines, and procedures. The communication of standards is a key element to be defined by this project. The use of technology enablers to electronically communicate standards is critical to promote compliance and to recognize the projected benefits of a standards clearinghouse.

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Section B.1
IR Prioritization Process

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The following summarizes the Department's current method for setting IR priorities. Additional details and procedures are provided in the Department's Information Resources Manual. As part of the Information Services Retooling program, this process will be reviewed to determine what redesign will be required to facilitate ongoing prioritization needs for information resources.

The Department's Information Resource Council (IRC) consists of the Department's Senior Management Team, a District Engineer selected by the Executive Director and the Director of the Information Systems Division. This committee is chaired by the Deputy Executive Director of Administrative Services, TxDOT's Chief Information Officer (CIO). The IRC meets quarterly or at the call of the chairperson.

The IRC:

- sets information resource strategic direction and policy
- allocates TxDOT fiscal resources for information resources
- allocates TxDOT programming resources for application development
- sets information system priorities if the work is estimated at more than 60 project days or represents a scope change to an active IRC project
- reviews status and other requested reports on information systems development.

The following outlines the types of requests and information provided to the IRC. A priority list is published quarterly by the IRC.

There are two major processes for handling Information Resource Requests (IRRs):

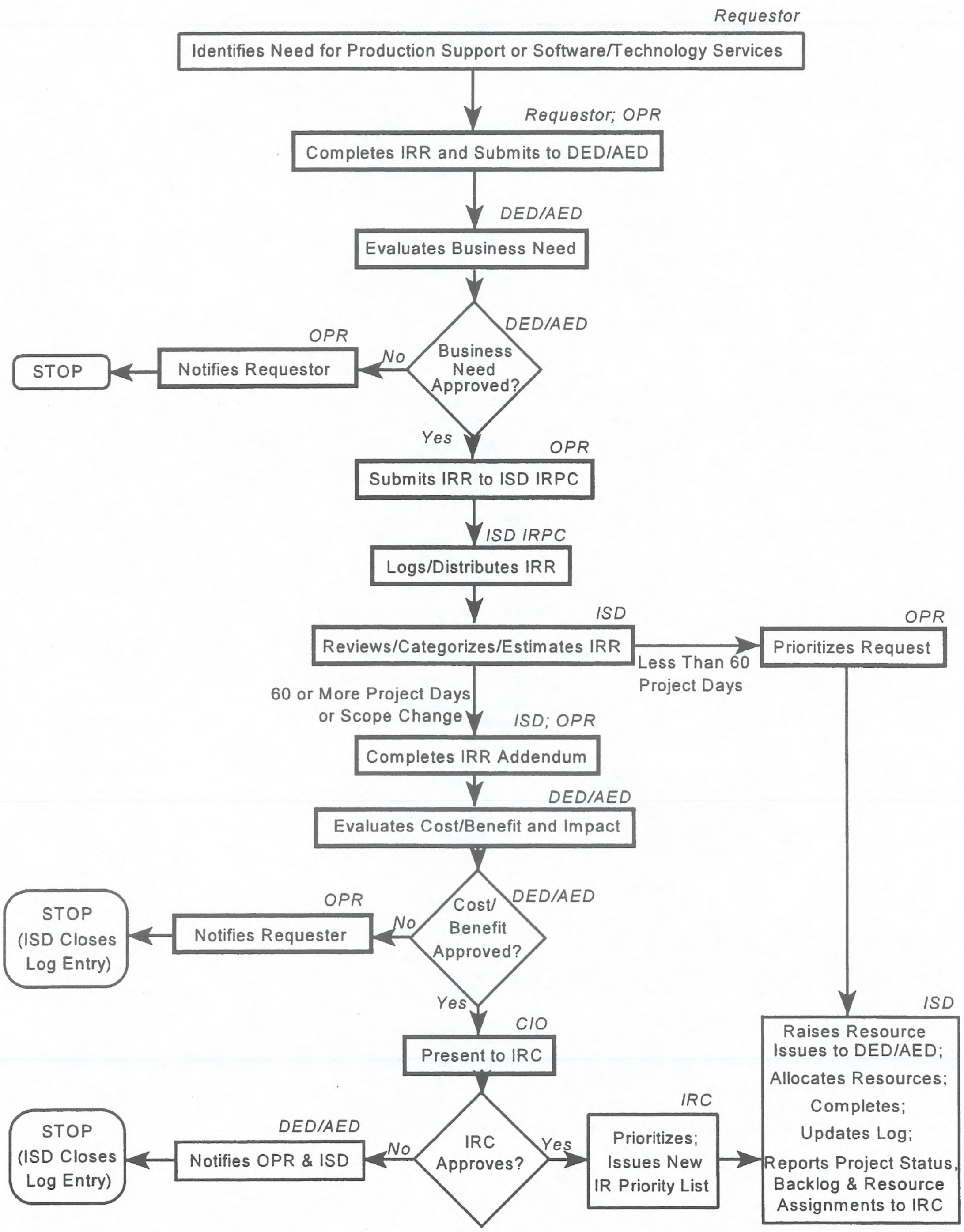
- The *Production Support or Software/Technology Services Process* addresses:

    - *Production Support Services* - An application maintained by ISD is not functioning correctly (includes processing errors and controlled data changes).

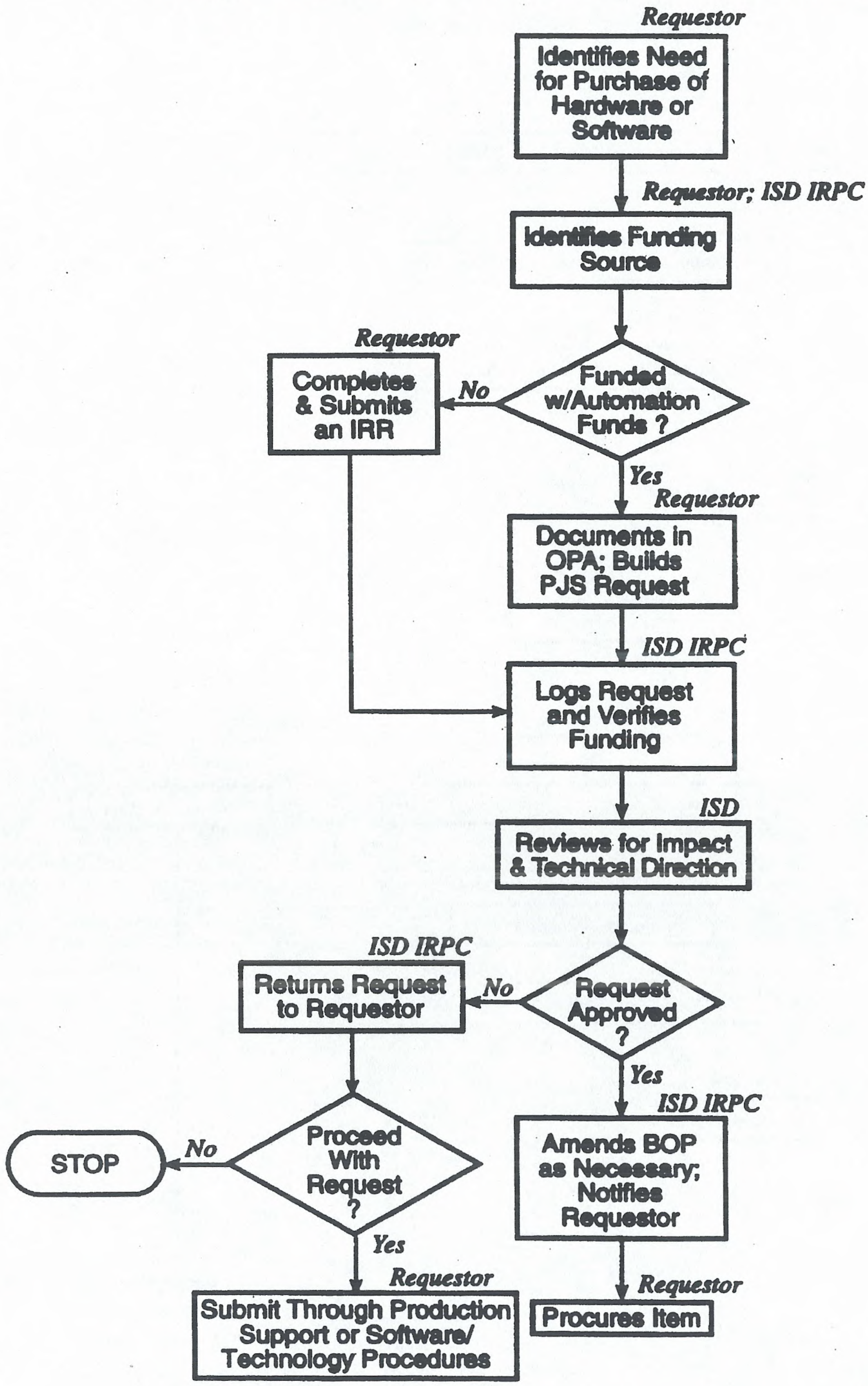
    - *Software/Technology Services* - A need is identified for a new application, an enhancement to an existing application, or technology or contract services. If a critical production support need arises and time does not allow for the outlined approvals without interruption to critical department operations, the Office of Primary Responsibility (OPR), in coordination with ISD, may certify the need as an emergency. The emergency will be handled by ISD and will be reported periodically to the appropriate Deputy Executive Director (DED) or Assistant Executive Director (AED).

- The *Technical Review Services Process* addresses requests for hardware and software procurements.

Requests for Production Support or Software Technology Services



REQUESTS FOR TECHNICAL REVIEW SERVICES



Key Information Required on Information Resource Requests:

Project Description:
This is a comprehensive narrative for a new project or enhancement/scope change to an existing project. Supporting data is appended, if applicable, to indicate the current and proposed system of hardware, supporting software and applications. If a Biennial Operating Plan (BOP) already exists for the project, the Project Description is modified, as necessary.

Statement of Need:
The statement addresses the deficiencies with the current system, capacities or functionality, the problem to be solved and any other reasons/mandates to justify the project or enhancement/scope change. Provides quantitative and qualitative workload measures, where applicable. Expected achievements and quantitative performance factor improvements are also included, as appropriate. If a BOP exists for the project, the Statement of Need is modified, as necessary. Business needs are tied to the TxDOT Strategic Plan. Related critical success factors are identified. If mandated by law, legislation is cited.

Benefits:
Benefits are identified that will result from completing this project. This includes both tangible and intangible benefits that justify the resource commitment required to complete the work. Defines the period of time to which the benefits apply. If a BOP exists for the project, the Benefits section is modified as necessary.

Estimate:
ISD completes an estimate when the business need has been approved by the DED/AED. All requests must be approved and signed by the District Engineer, Division Director or Special Office Director.

Business Need Approved by DED/AED:
The Deputy Executive Director or the Assistant Executive Director over the Office of Primary Responsibility (OPR) of the application must approve and sign any Software/ Technology Services Request. This approval indicates agreement with the business need and authorizes ISD to provide an estimate of the work. This signature constitutes approval of the IRR if the work estimate is less than 60 project days. If the work estimate is 60 or more project days, the DED/AED must certify a Software/Technology Services Request as cost-beneficial prior to submission to the IRC.

Key Information Required on Addendums for Information Resource Requests

Organizational Impact:
Items are described that will (or may) impact the organization. The organizational areas are

identified that will be impacted during development and after implementation. Anticipated maintenance costs and support staff requirements are identified. Expected changes to policies and/or procedures are identified. In addition, the impact to TxDOT if the system is not developed is defined. If a Biennial Operating Plan (BOP) exists for the project, the Organizational Impact is modified as necessary.

Analysis of Alternative Strategies:
Provides as much information as feasible on alternative solutions. Includes any information on hardware and software implementation alternatives. This might include information about the feasibility of outsourcing the development or purchasing (and possibly modifying) a packaged solution. If a BOP exists for the project, the Analysis of Alternatives is modified as necessary.

Planning Factors:
(Assumptions, Dependencies, Constraints, Issues)
Includes any factors and assumptions utilized in preparing the project schedules or estimates. Describes any dependencies which might impact the project's success. Such items might include equipment delivery, contract negotiations, etc. Describes actual or potential constraints, such as processing capacity, personnel availability, impact to other Information Systems efforts, and budget/procurement constraints.

Benefit/Cost Summary:
Includes more detailed information related to total cost of the project and projected benefits.

Section B.2
Staff Training and Continuing Education

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As part of the Information Services Business Process Retooling program, several projects are underway to address existing and ongoing IS training and continuing education requirements.

One of the projects is currently implementing computer-based training courseware statewide for both IS professionals and end users. When fully implemented in 1997, IS professionals will have access to a library of fifty courses on productivity tools used, or planned for use, at TxDOT.

Another project is underway to develop a process to identify and respond to the emerging IS training needs of the Department. This process will identify the IS training needs of end users and IS professionals. This process will also design, develop, market, and assure delivery of training programs to address the training needs identified. Ongoing IS training of end users and IS professionals is vital to the effective use of technology as an enabler of the core business of the Department. Performance measures will be established to measure the success of this critical new process.

A third project will establish a career path and staff development framework that promotes the professional development and retention of TxDOT information services professionals. Career pathing is the charting of an individual's career through the organization. Career pathing ensures that individuals obtain job-related experience in various areas to support both their needs and the requirements of the organization. The organization benefits from individuals who have received specific training, development, and experience, and are therefore prepared to assume more senior positions. In the future, the information services business area organization will be largely project-focused while incorporating cross functional teams. This shift in organizational orientation carries with it the need to develop new career paths and staff development approaches. Also impacting staff development is the introduction of new technology that requires many new job functions to be documented. Business analysis, as well as technical skills development will be promoted by this new framework. This new career path and staff development framework will promote significant employee participation and responsibility for selecting equally viable alternate career paths and development opportunities. Career pathing models will be accompanied by clearly defined and communicated personal performance expectations and performance measurement criteria so that advancement decisions can be made objectively.

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Section B.3
Operating Systems Standards

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TxDOT's Core Technology Architecture defines the framework, principles, guidelines, standards, specifications, polices, and procedures for networking, telecommunications, operating systems, workstations, servers, mainframes, printers, plotters, database management systems, general purpose workstation software, groupware, enterprise system management, and reliability and fault tolerance. The current version of the Core Technology Architecture (Version 2.0) is included in Appendix 4. The Operating Systems section of the architecture defines the recommended operating systems for workstations, servers, and mainframes. The requirements for non-compliance with the Core Technology Architecture are defined in the Introduction.

The Information Systems Division (ISD) is responsible for evaluating and recommending all standard operating systems used on TxDOT's information resource hardware and for maintaining a catalogue of items approved for procurement. Any non-standard operating systems must be approved by ISD and added to the TxDOT Procurement Justification System catalogue before it can purchased. The Information Services Business Process Retooling (IS BPR) Program is currently developing new processes to improve the methods used for evaluating and selecting technology solutions, upgrading the Core Technology Architecture, maintaining the catalogue of approved items, monitoring architecture compliance, and developing and communicating IS standards. These new processes will be completed in 1997.

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Section B.4
Interagency Data Communications

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The formal policies and guidelines which govern Interagency Data Communications at TxDOT are found in Texas Administrative Code:

Title 43. TRANSPORTATION
Part I. TEXAS DEPARTMENT OF TRANSPORTATION
Chapter 3. PUBLIC INFORMATION
Subchapter B. ACCESS TO OFFICIAL RECORDS
§ 3.14 Electronic Access to Department Records

(a) Electronic on-line delivery systems. The department will provide certain information via the Internet through a departmental World Wide Web Site (http://www.dot.state.tx.us). Information concerning doing business with the department, news about the department, tourism and travel information, public transportation information, and other transportation-related information will be provided through this web site. Public information requests or other requests will not be accepted via Internet.

(b) Electronic access to vehicle title and registration information.

(1) The department maintains files of motor vehicle registration, title, and vehicle ownership information and will make such information available electronically as required by Transportation Code, § 502.008.

(2) The department may provide information contained in vehicle registration and title records to an individual or business under the terms of a written service agreement for each electronic access terminal.

(c) Electronic access by other governmental agencies. The department will provide electronic access to its records for use by other governmental agencies under the terms of a written agreement and payment of the fees indicated in § 3.13 of this title (relating to Cost of Copies of Official Records). Law enforcement agencies are exempt from these fees. A request for social security number information must be accompanied by a statement citing the requestor's authority to obtain such information.

Source: The provisions of this § 3.14 adopted to be effective September 26, 1996, 21 TexReg 8955.

Section F of TxDOT's Strategic Plan for Information Resources outlines a number of the agencies TxDOT communicates with electronically, including types of data and information shared. It should also be noted that TxDOT has a number of ongoing initiatives to facilitate the sharing of information with other agencies and the public. For example, the Information Systems Division (ISD), cooperating with other organizations, has established a TxDOT presence on the Internet World Wide Web. This electronic presence will improve citizen and government access to TxDOT information and services, directly supporting our goal to achieve the highest level of external and internal customer satisfaction. Additionally, TxDOT and the Federal Highway Administration (FHWA) participate on an interagency team to assess and implement opportunities to share electronic information.

Section B.5
Information Security

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The TxDOT Information Security program was established to develop and implement department-wide information security. It provides security policies, standards, procedures and guidelines for TxDOT Information Resources as well as a security awareness training program. Data security classification at the application level has been established.

- In accordance with TAC 201.13(b) section 4, TxDOT has formally designated an information resources security function within the Information Systems Division (ISD). In 1986 TxDOT began investigating establishment of the information resources security function within the department. In March of 1990, DIR approved funds for a consultant to do detailed analysis and a plan for implementing a full-blown Information Security Program (ISP). TxDOT formally established an Information Security Plan in January, 1991.

- TAC 201.13(b) section 5 requires all agencies conduct a comprehensive risk analysis of all information systems and related resources on a periodic basis. The entire process will be fully documented and identify the degree of risk acceptance (i.e. the security exposure remaining after implementation of recommended protective measures). The deadline for the standards relating to risk management to be implemented was September 1, 1994.

  In September of 1986, Price Waterhouse conducted a risk analysis of TxDOT's information systems. Their report identified the need for the establishment of an information security function. A Business Impact Analysis was conducted during the initial disaster recovery planning initiative. Both the State Auditor's Office and DIR agreed that this was an adequate first step towards a comprehensive risk management program.

  In late 1995, TxDOT's Information Services Business Process Retooling (IS BPR) project began looking at the department's data management and administration function. The Information Security Section is partnering with the Data Management Business Improvement Project to develop a new risk analysis methodology that will be used throughout the life of the data to insure that controls are at the data level to facilitate sameness of security rules and processing across platforms. Data classification methodology(ies) and associated security controls will be redefined.

- In accordance with TAC 201.13(b) section 6, TxDOT has adopted several personnel practices to complement the implementation and maintenance of the ISP. In December of

1992 TxDOT published an information security manual outlining employee responsibilities, and policies and procedures for requesting information resource access changes. Employee security agreements were distributed to provide written acknowledgment that they had received, read, and understood the security policies and procedures. Signing this agreement is now standard policy for all new hires. A comprehensive information resources security awareness program was developed and implemented in early 1993. In addition, a statewide video-teleconference on information security requirements at TxDOT was held for all employees. This video conference was taped and made available to security administrators (SAs) throughout TxDOT for use in ongoing security awareness. Other elements of the security awareness program included distribution of security-related posters, videos, brochures, and quick reference materials. The TAC target date of September 1, 1993, was achieved.

The Computer Security Institute selected TxDOT's ISP as the Best Information Security Program of 1993. TxDOT is currently working to re-write its information security manual to make it more user friendly, enhance its use as a reference tool, and to identify changes in security from the implementation of new information systems and the enhancement of existing systems.

- In accordance with TAC 201.13(b) section 8, September 1, 1996 was the deadline for all security controls identified in the risk analysis to be in place. Specific components of this implementation included access controls, user authentication, data integrity controls, audit trails, periodic internal audits, and the documentation and investigation of security breaches.

  By August of 1992 all TxDOT mainframe users were assigned individual userids for increased accountability. Passwords were established for every mainframe user; these passwords must be changed on a periodic basis. CA-Top Secret (the mainframe security software at TxDOT) controls have been in place since December 28, 1993, except for batch processing. We are currently implementing batch processing to FAIL mode. Critical system resources identified in earlier risk analysis activities have already been secured to FAIL mode.

  All changes to the master security file are logged and a report is generated daily to maintain historical accounting data for all security changes, violations, and possible security breeches. TxDOT's internal audit staff , as well as the State Auditor's Office conducts periodic reviews at least annually.

TxDOT has complied with all mandatory requirements of TAC 201.13(b) to date. A list of the contents from the Information Security Volume of the Information Resources Manual is included in the next few pages.

INFORMATION SECURITY VOLUME CONTENTS:

District, Division and Special Office LAN Manager
District, Division or Special Office Internal Review Staff
District, Division or Special Office MES Coordinator
User's Supervisor
Users

APPENDIX A - PASSWORD STANDARDS GUIDE
APPENDIX B - PROPRIETARY SOFTWARE/APPLICATION ACCESS
APPENDIX C - TxDOT DEVELOPED APPLICATIONS
GLOSSARY

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Section B.6
Disaster Recovery

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The TxDOT Contingency Plan for Information Resources entails restoring the ISD Central Site Data Center, within 72 hours, at a hot site location provided by SunGard Recovery Services. SunGard was the successful vendor in the 1993 statewide bid for Contingency Planning Services, sponsored by the Department of Information Resources. As a result of the statewide contract, TxDOT has an interagency contract with DIR for SunGard to provide hot site services to TxDOT. TxDOT also has an interagency contract with DIR to use the Disaster Recovery Operations Center (DROC). The DROC is a cold site defined as a facility equipped with a raised floor and all environmentals required to house a mainframe in a relatively short period of time. Renewal of the interagency contract is reviewed annually with DIR for hot site services as well as DROC usage.

Restoration of the TxDOT mainframe and SNA network has been exercised (tested) three times. In addition, two desk top exercises have been conducted for the ISD Management Team to familiarize them with their roles and responsibilities. Exercises will continue on an annual basis in compliance with TAC 201.13b. Development, implementation, maintenance and testing of the ISD Contingency Plan is the responsibility of ISD as understood within TAC 201.15b.

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Section B.7
Use of Computing Resources

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TxDOT policy defines the structure, distribution of responsibilities, and levels of accountability for every Management Team level organizational unit within the department to prevent redundant efforts and voids in user support coverage. Integrated planning, budgeting, and resource allocation and acquisition systems ensure that adequate funding is available to TxDOT and that each Management Team level unit receives its approved share of resources in a timely manner.

To further maximize the productivity of all information resources, policies and practices specifying limitations on usage have been established. This has proven necessary to compensate for lapses in accountability until the organizational culture fully embraces the concept of empowerment and accountability.

The department's prohibition on divulging sensitive information and information protected from release under the Public Information Act requires supervisory approval for release and subjects violators to personal and criminal liability. Policy permits only brief personal telephone calls and requires the utilization of TEX-AN for long distance calling with only three exceptions under which employees are not personally liable for excess costs.

Employees may only use computer equipment for non-state business when applying for another position within the department, preparing a department requested resume for an awards nomination, and using a microcomputer under specific conditions when participating in the educational assistance program.

Due to the unusual potential for misuse, home and satellite work center based telecommuting are well defined and regulated by department policy. The stringent approval process and close monitoring requirements ensure that both employee and supervisor accept the appropriate levels of responsibility in establishing and maintaining productivity.

As a new TxDOT tool, electronic mail (e-mail) also requires close scrutiny. Guidelines have been established to emphasize compliance with state law and to minimize the impact of e-mail on communications circuits and electronic storage devices. Restrictions are placed on personal use, broadcast messages, customized mail screens, and the archiving of old messages.

In addition to compliance with state regulations on the personal use of telecommunications equipment, TxDOT bills users for personal cellular telephone calls and prescribes voice mail approvals, implementation, and etiquette. Business need, live voice back up, and message content are the primary focus of department policy.

Client/server computing created the need to control Information Systems Division server disk storage practices and may lead to statewide guidelines. The restrictions include eliminating duplicate files, archiving e-mail files on servers, backing up hard drive data to servers, retaining out of date and unneeded files, and storing more than 10 megabytes of data per user.

Section B.8
Use of Contract Services and Consultants

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Currently, TxDOT utilizes contract services and consultants to supplement its information services personnel in performing their normal job duties and new projects and to totally outsource selective IS functions or projects. Decisions to utilize external resources are normally driven by lack of personnel with a specific skill, lack of available qualified personnel, the immediate need to initiate or complete a project or task, or the desire to take advantage of economies of scale (e.g., contracting with a vendor to provide contingency operations for the Information Systems Division (ISD), as well as other customers; allowing ISD to pay only a part of what it would cost to maintain a backup facility exclusively for ISD). Examples of contracted functions are included below:

- Installation, configuration, implementation, and troubleshooting of local area networks, servers, microcomputers, and software
- User support for hardware and software
- System analysis, design, and programming
- IS training
- Retooling and process redesign
- Benchmarking
- Project management
- Contingency planning

Assistance in obtaining contracted services or consultants is provided by TxDOTs' General Services Division (GSD) and the Department of Information Resources (DIR). GSD and DIR assist in acquiring services through catalog purchase procedures and purchase of services. Using the catalog purchase procedures there can be negotiations with the vendors on the General Services Commission Qualified Information Systems Vendor list. There are no negotiations with the vendors using the purchase of service procedures since these procedures generally use the formal bid process.

In conjunction with the Information Services Business Process Retooling (IS BPR) Program, business improvement projects have been defined to design and implement new processes for outsourcing IS services and for preparing and managing IS contracts. The objective of each of these projects is provided below:

- Outsourcing strategy: The objective of this business improvement project is to develop the information services outsourcing strategy and design a process and a continuing capability to evaluate and identify candidates for outsourcing. The process will incorporate maximum flexibility and control to meet the changing business needs of TxDOT.

- Contract preparation and management: The objective of this business improvement project is to develop and establish the process for consultation services to TxDOT information services employees and vendors regarding vendor relations, management, and ethics. The process will establish an ongoing source of consultation and assistance for both the vendor community and TxDOT in the acquisition and management of contracted vendor services, while incorporating flexibility to meet the changing service needs of the department.

Both processes will be completed in 1997.

Section B.9
Use of CASE and Methodology

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CASE Tools

Currently TxDOT has limited utilization of Computer-Aided Software Engineering (CASE) tools; however, the Information Services Business Process Retooling Program (IS BPR) is in the process of developing an Application Development Architecture and associated development processes that will include tools and strategies for CASE tools. This architecture and process will provide the framework, principles, guidelines, standards, specifications, policies, and procedures for application development and maintenance. The architecure and process, which will be completed in 1997, will include the following:

- Application development and maintenance policies, procedures, and guidelines
- Programming language standards
- Graphical user interface standards (GUI)
- Quality assurance and quality control process
- Configuration management process
- Enterprise application development strategy
- Modularity and code reuse strategy
- Object oriented technologies strategy
- Disposition, migration, and integration strategy for legacy systems
- Guidelines for determining appropriate platforms and tools for application development projects
- Application development skills, training, and support requirements
- Software development tools for enterprise, workgroup, and employee applications (including I-CASE tools)
- Workgroup application development tools
- Intranet/Internet development and document publishing tools
- End-user reporting, forms, and decision support tools
- Model management tools (process and data modeling tools for enterprise and workgroup applications)
- Testing and debugging tools
- Configuration management tools
- Software installation and distribution tools
- Help authoring tools
- Developer workstation configurations (hardware and software)

Methodology

1. Current Methodology

The Project Development Guide (or PDG) that is currently being used as the system development life cycle methodology at TxDOT was developed in 1993 by an internal task force to replace the SPECTRUM methodology and the Project Leader Guide that had been used previously by IS developers. In addition to identifying the Phases, Subphases, and Tasks that make up the application development process, the PDG also includes Subphase Overviews, descriptions of Roles and Responsibilities, Checklists for ensuring completion of activities, Deliverable Requirements and sample deliverables, Quality Review Requirements, Information Security Requirements, and Information Planning and Coordination Requirements.

The PDG life cycle follows a "waterfall" approach, with Phases including Systems Definition, Systems Design, and Systems Implementation. It may be scaled to maintenance projects, small development projects, and large development projects. The PDG also includes decision points for Funding Review and Approval, Quality Review, and Design Freezes. Specific roles are defined for the Project Manager, the Project Sponsor, the User Coordinator, the Quality Review Board, and the Steering Committee (an optional role).

The Guide is paper-based and stored in binders – one binder for the Guide itself, and a second binder for the "Samples" Repository. Its use has been supported by a Project Consultant within the Information System Division's Development Support Branch. Since its implementation, updates to the PDG have been made on approximately a quarterly basis. Some specific updates include use of facilitated Planning Workshops, procedures for submitting Information Resource Requests, procedures for handling Project Change Requests, and some updates to Deliverable Requirements.

2. Goals of new methodology tool - LBMS/Process Engineer

As part of the Information Services Business Process Retooling (IS BPR) program, TxDOT is implementing LBMS/Process Engineer as its new system development life cycle methodology and process management tool for enterprise and workgroup application development and enhancement. At present, three development projects and two technology planning projects are piloting the use of the process management toolset (includes Process Engineer and Microsoft Project software). The three pilot development projects (Right of Way Information System, Texas Airport Data System, and the Information Resources Information System) will pilot methodologies for Rapid Application and Client/Server Development.

Although TxDOT has been using a structured methodology for many years, there are several shortcomings of our existing methodology (the Project Development Guide) that the department would like to overcome by implementing Process Engineer.

a. Access/Usability
Process Engineer is an electronic-based methodology tool that will be much more readily accessible to developers both within the Information Systems Division and within the rest of the department. It will also provide for more flexible use, since methodology "templates" can be tailored to meet the needs of each specific project.

b. More Support for Project Management
Process Engineer also provides more extensive, and on-line, support for such project management functions as project planning, project scheduling, project estimating, resource assignment, project progress tracking and reporting, issue resolution, and project change control. The Process Engineer library contains tips, techniques and guidelines to assist project managers in performing these critical functions.

c. Flexibility for New Development Processes
The Process Engineer library comes with a set of templates for a variety of development processes, including Client/Server, Rapid Delivery, PowerProcess (C/S tailored to PowerBuilder), Incremental, Classic (Waterfall), Maintenance, and Package Selection. The vendor can provide updates to the library templates with future releases, and the vendor's ProcessWare partners can provide additional process templates for more specific efforts such as Year2000 projects.

d. Continual Improvement of the Development Processes
A component of Process Engineer is Process Management. Through the Process Management tool, process templates, techniques, roles, and deliverables may be modified based on feedback from the project teams using Process Engineer. In this way, components of the Process Engineer library can be continuously enhanced using a structured means of process improvement. The improved processes are then readily available to all future project teams using the on-line library.

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Section B.10
Geographic Information Systems (GIS)

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Currently TxDOT has no published information resource standards for Geographic Information Systems (GIS) and GIS is not widely used within the agency. Although there has been limited use of this technology to date, GIS has been defined as an essential technology to support the retooling of TxDOT's business areas. To meet this requirement, TxDOT's Information Services Business Process Retooling (IS BPR) Program is currently in the process of developing a Geographic Information Systems (GIS) technology architecture. This architecture will provide the framework, principles, guidelines, standards, specifications, policies, and procedures for acquiring, constructing, and enhancing GIS applications. The architecture will include the use of complementing technologies such as Global Positioning Systems (GPS) and Video Logging. Additionally, a separate architecture will be developed for Computer-Aided Design and Drafting (CADD). The GIS/GPS and CADD Architectures will both be completed and published in 1997 and will be components of TxDOT's Information Technology Architecture.

TxDOT is a participating member of the Texas GIS Planning Council and will integrate all applicable state GIS standards into the TxDOT GIS/GPS Architecture. Additionally, TxDOT is participating in the Planning Council's Texas Orthoimagery Program (TOP) and the Strategic Mapping Initiative (StratMap). TxDOT is collecting the ground control for the TOP rectification process and will in return receive a copy of the final product. Both initiatives should benefit TxDOT's future GIS basemap efforts while ensuring compatibility with other agencies.

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Section B.11
Software Development Quality Assurance and Risk Management

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The current software quality assurance function of TxDOT's Information Systems Division is comprised of activities including change control, special reporting, performance measurements, and trend analysis. The Quality Assurance Branch provides and manages a repository for all source code, documentation deliverables, and any other text document of record.

Change control concentrates on the integrity of program modules, both source and executable, moved from test status to production status. A program module qualifies for production status only after a rigorous audit by the QA branch. First and foremost a customer service organization, the Quality Assurance Branch maintains a delicate balance between its obligations as the only group authorized to move program modules to production status, and the practical need to initiate these moves in a timely manner.

The Quality Assurance Branch publishes a quarterly User Survey Report, summarizing information provided on user survey forms for Information Resource Requests (related to software development/maintenance) following project completion. Additionally, performance measurement and trend analysis reports for Quality Assurance processing of submitted Library Service Requests are developed by this branch.

As part of the Information Services Business Process Retooling program, several projects are underway to address software development quality assurance and risk management requirements.

First, a project has been identified to establish an information services quality program. This project will establish a management process to ensure quality in all information services processes. The quality program will be integrated with TxDOT's Department-wide quality initiative(s) to ensure consistency in quality measures and reporting, as well as alignment with TxDOT's and the State's strategic plans. The central IS quality program will coordinate and consult on quality requirements, measurements, and reporting so that IS management will have timely, relevant, integrated information. The quality program will ensure that each IS process provides measures of individual, team, and process performance.

As part of the Application Development Architecture project, in conjunction with the Methodology Implementation project, performance measures for software development will be identified and implemented to track software development progress. The objectives of this project are to:

- Define the architecture for application development and maintenance. The Application

Development Architecture provides the framework, principles, guidelines, minimum standards/specifications, and policies/procedures for application development and maintenance.
- Select a core set of development tools as defined by the Application Development Architecture.

The Application Development Architecture project team is also in the process of identifying required skills, training needs, and support requirements. Benefits of this project will be:

- Predefined IT architectures and IS standards enable decentralization of application development.
- Predefined IT architectures and IS standards lead to more rapid application development and maintenance, and quicker response to changing business needs.
- Standardization on fewer tools will reduce training and support costs.

In addition, the department is currently piloting the use of LBMS' Process Engineer methodology and planning a statewide implementation for enterprise and workgroup computing.

Effective use of the methodology and an integrated project management tool will:

- Ensure customers' requirements are met
- Provide a proactive assessment of project deliverables (methodology group works with teams to identify and scope deliverables)
- Reduce application maintenance and support costs
- Reduce duplication of effort (project teams aren't reinventing the wheel in determining what deliverables to produce and what actions to take)
- Reduce risk of IS project failure
- Promote timely and "smooth" project implementations; ensure milestones are met
- Provide consistency in methods of IS project planning, scheduling, and implementation for various IS project types, and promote better communication Department-wide
- Provide the ability to quickly build cross-functional teams
- Ensure new and enhanced applications are subjected to stringent stress and quality testing
- Optimize use of information resources
- Promote the ability to comply with State Quality Assurance Team requirements.

It is important to note that the methodologies provide for Software Risk Management plans and activities as well as post-implementation reviews.

Section B.12
User Acceptance

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TxDOT's existing system development life cycle methodology (The Project Development Guide) includes activities for user acceptance. The methodology includes the development and execution of a User Acceptance Plan as part of the System Test subphase of the life cycle. The User Acceptance Plan documents checklists and testing plans to ensure that all aspects of the system have been appropriately addressed, to the satisfaction of the users. This includes meeting functional user requirements, providing adequate training in the use of the system, and providing adequate system documentation in the form of User Manuals and other user procedures, as appropriate.

The User Acceptance Test is conducted according to the test objectives and expected results documented in a User Acceptance Test Plan and the results are recorded on test progress logs. User acceptance of the system is secured in writing through a review and comparison of the test results and through agreement on completion of the items on the checklists that were developed as part of the User Acceptance Plan.

At the end of this System Test subphase, the users are asked to accept the system (in light of any deferred Information Resource Requests). The project team will not continue with system implementation until all issues are resolved and the users have accepted the system. If the users do not accept the system, the Quality Review Board, comprised on business and technical subject-matter experts, must determine how remaining issues will be resolved. Change management procedures may be necessary if the situation "deadlocks"; in this case, planning workshops may be held to re-estimate the project.

Another aspect of ensuring User Acceptance is the inclusion of the final subphase in the system development life cycle - Monitor and Wrap-Up. Once the system is in production, the project team is given the responsibility of monitoring its performance during the initial production period. During this "warranty" period (which is an amount of time that is agreed upon between the users and the IS organization), any flaws detected in the system are corrected. Any enhancements to the system which are identified are documented on Information Resource Requests for later resolution in the maintenance process. Upon completion of the warranty period, project documentation is transferred to permanent storage and the system is turned over to the appropriate maintenance team.

As part of the Information Services Business Process Retooling (IS BPR) program, TxDOT is implementing LBMS/Process Engineer as its new system development life cycle methodology and process management tool for enterprise and workgroup application development and enhancement. The new methodology will ensure proactive user involvement and will include activities for user acceptance.

Specific activities are defined in the steps for Acceptance Testing and for Monitor and Support. The objective of the Acceptance Testing step is to ensure that the application meets both the business needs for which it was developed and acceptance criteria defined by the business users and the IS organization. The Acceptance Testing activities involve end users in the evaluation of system functionality, evaluate the effectiveness of system documentation and user procedures, and test the training program with a pilot group of users involved in the Acceptance Test.

The objective of the Monitor and Support step is to monitor the live running of the system in a way that evaluates the functionality and performance of the system, captures any required user enhancements to the system that can be fed into the maintenance cycle, and optimizes the technical and working environments.

Process Engineer is currently being piloted on three development projects. A phased implementation of Process Engineer for new development and maintenance projects will begin in 1997.

Section C
Methodology for Information Resources Planning

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This section describes the methodology and steps used to develop and implement TxDOT's Strategic Plan for Information Resources (IR).

Agency Strategic Plan
TxDOT prepares an agency strategic plan on June 1 of even years. The agency strategic plan defines TxDOT's vision, mission, and philosophy; an external/internal assessment; and TxDOT's goals, objectives, and strategies for a five year period. Additionally, TxDOT has developed the Texas Transportation Plan which is a twenty-year document covering plans by both TxDOT and other transportation stakeholders in the state. The Texas Transportation Plan was developed in compliance with federal mandates that require each state to develop a transportation plan for all areas of the state that considers all modes of transportation. State mandates specifically require TxDOT to develop a statewide transportation plan containing all modes of transportation.

State Strategic Plan for Information Resources Management
The Department of Information Resources (DIR) prepares a State Strategic Plan for Information Resources Management on November 1 of odd years. The State Strategic Plan for Information Resources Management defines similar information as TxDOT's agency plan including the goals and objectives that describe both the general direction and specific ways that information and technologies will be used to achieve the vision for Information Resources in Texas government.

TxDOT's Strategic Plan for Information Resources
TxDOT prepares its Strategic Plan for Information Resources by January 1 of odd years. The goals and objectives of the TxDOT Strategic Plan, the State Strategic Plan, and the Texas Transportation Plan drive the goals, objectives, strategies, and action items of the TxDOT Strategic Plan for Information Resources. Each IR goal, objective, strategy, and action item must directly relate to projects that have been previously identified in the Biennial Operating Plan (BOP) or projects that support a goal and objective from the Agency Strategic Plan. The TxDOT Strategic Plan for Information Resources is reviewed and approved by the Executive Director or designee.

TxDOT's Information Resource Operating Plan and Budget
Each business unit (district, division, or special office) must submit an Information Resource Operating Plan and Budget to the Information Systems Division (ISD) by April 1 of even years. An update to these plans is submitted by April 1 of odd years. ISD is also required to submit an IR Operating Plan and Budget for central infrastructure and development projects and for internal

IR operations projects. Each business unit involves all levels of management, including review and approval by the district, division, or special office director, in defining IR projects and expenditures for the current year and the next two bienniums. All projected expenditures are documented as Baseline Operations, Growth and Expansion, and Projects over Threshold and must support the goals and objectives of the State Strategic Plan for Information Resources Management and TxDOT's Strategic Plan for Information Resources.

The Information Systems Division evaluates the business units' IR Operating Plans and Budgets and:

- Ensures technical compatibility with the Enterprise IT Architecture and Infrastructure
- Reviews for completeness of the needs and benefits
- Reviews cost-effectiveness of the implementation of information resources technologies to meet the department's mission
- Reviews for consistency with General Appropriations action and other legislation
- Reviews for consistency with State and TxDOT Strategic Plan for Information Resources
- Reviews for completeness with respect to published instructions
- Reviews for relevance to the department's organizational and operational goals
- Reviews qualitative and quantifiable project justification.

Projects Over Threshold

Each project over threshold identified in the business unit's IR Operating Plan and Budget must be submitted to the functionally aligned Senior Management Team (SMT) member for approval. The appropriate SMT member approves or disapproves projects over threshold based on business need.

TxDOT's Biennial Operating Plan

The Information Systems Division (ISD) consolidates or amends the existing business unit information resource plans and budgets into a consolidated Biennial Operating Plan for submission to the Department of Information Resources (DIR) based on DIR guidelines.

Legislative Appropriations Request

The Information Systems Division (ISD) develops the Legislative Appropriations Request (LAR) Capital Equipment Portion for Information Resources in conjunction with the Budget and Finance Division (BUD) based on the consolidated Biennial Operating Plan. ISD provides the IR portion of the LAR to BUD by June of even years. The IR funding request is subsequently adjusted by the department's Senior Management in the submission of the LAR, the Legislative Budget Board and the Governor's Budget and Planning Office through their budget recommendations, and ultimately the Texas Legislature in their appropriated spending authority to TxDOT.

Implementation of Approved Operating Plan
After operating funding is approved by Senior Management, each business unit implements the projects and activities in its IR Operating Plan. Projects requiring the development or procurement of a new application, enhancement to an existing application, technology services, contract services, or hardware/software procurement require approval by Senior Management and TxDOT's Information Resources Council (IRC) prior to beginning implementation and expenditure of funds. The IRC's major purpose is to prioritize IR projects for implementation. Refer to Chapter 5, Section B.1 for a detailed discussion of the IRC and the IR Prioritization Process.

The following table summarizes the work steps used to develop and implement TxDOT's Strategic Plan for Information Resources (IR).

Step	This business unit or person ...	Does This ...
1	Executive Director or Designee	TxDOT prepares an agency strategic plan on June 1 of even years.
2	Department of Information Resources (DIR)	The Department of Information Resources (DIR) prepares a State Strategic Plan for Information Resources Management on November 1 of odd years.
3	Executive Director or Designee	TxDOT prepares its Strategic Plan for Information Resources by January 1 of odd years. The goals and objectives of the TxDOT Agency Strategic Plan, the State Strategic Plan, and the Texas Transportation Plan drive the goals, objectives, strategies, and action items of the TxDOT Strategic Plan for Information Resources.
4	District, Division, or Special Office	Develops draft Information Resource Operating Plan and Budget for the business unit and submits to the Information Systems Division (ISD). All projected IR expenditures are documented as Baseline Operations, Growth and Expansion, and Projects Over Threshold.
5	Information Systems Division (ISD)	Reviews and recommends actions to the business unit to ensure architectural compatibility, completeness, cost-effectiveness, consistency with legislation and with the state's and the department's strategic plans for information resources, and adequate project justification.

Step	This business unit or person ...	Does This ...
6	District, Division, or Special Office	Incorporates or negotiates with ISD on proposed recommendations.
7	District, Division, or Special Office	Reviews IR Operating Plan and Budget after ISD recommendations and determines if Projects Over Threshold exist. The IR Operating Plan and Budget is organized by project under these categories: "Baseline Operations", "Growth and Expansion" (G&E), and "Projects Over Threshold". • Projects Over Threshold are submitted to the appropriate Senior Management Team Member for approval (Step 8). • If no Projects Over Threshold exist, the business unit may prepare a formal submission of the IR Operating Plan and Budget (Step 9).
8	Appropriate Senior Management Team Member	Approves (or disapproves as applicable) Projects Over Threshold based on "business need".
9	District, Division, or Special Office	Prepares formal submission of the business unit IR Operating Plan and Budget (including Projects Over Threshold) and determines if funding issues are being raised. • Yes (funding issue) - If this is a biennium budget request or if funding is not available for project(s) within the plan, forwards to the Budget and Finance Division for review and action. • No - Submits to Information Systems Division.
10	Budget and Finance Division	Reviews submitted business unit IR Operating Budget and • Takes appropriate action if it is a biennium budget request or • Advises of impact on existing budget if this is an amendment to existing information resource plans and budgets.
11	Appropriate Senior Management Team Member	Approves or disapproves funding request based on business needs.

Step	This business unit or person ...	Does This ...
12	Information Systems Division	• Consolidates or amends existing business unit IR Operating Plans and Budgets into a consolidated Biennial Operating Plan for submission to the Department of Information Resources. • Develops the Legislative Appropriations Request Capital Equipment Portion for Information Resources in conjunction with the Budget and Finance Division.
13	Executive Director or Designee	Reviews and approves IR Operating Plans and Budgets as consolidated into the department's Biennial Operating Plan in accordance with the Information Resources Management Act and subsequent governing legislation.
14	Information Systems Division (The Director of ISD is also TxDOT's Information Resource Manager)	Submits approved amendments to the department's Biennial Operating Plan to the Department of Information Resources.
15	District, Division, or Special Office	Implements approved Information Resource Operating Plans and Budgets. Projects requiring the development or procurement of a new application, enhancement to an existing application, technology services, contract services, or hardware/software procurement require approval by Senior Management and the Information Resources Council (IRC) prior to beginning implementation (Steps 16-19).
16	District, Division, or Special Office & Office of Primary Responsibility (OPR)	Develops an Information Resource Request (IRR) for individual projects for software development/procurement, application enhancement, technology services, contract services, or hardware/software procurement. If the project is not in the existing BOP, then the business unit must submit an amendment.
17	Appropriate Senior Management Team Member	Evaluates the IRR to assess the business need for the project and approves or denies. If approved, the IRR is forwarded to the Information Systems Division for evaluation of resource requirements.

Step	This business unit or person ...	Does This ...
18	Information Resource Council (IRC)	Approves or denies the request. If approved, the project is then prioritized among existing projects.
19	District, Division, or Special Office with ISD necessary support.	Implements IR projects approved by the IRC.

Note: Refer to Chapter 5, Section B.1 (IR Prioritization Process) for additional details about the Information Resource Request (IRR) and the Information Resources Council (IRC).

Section D
Configuration

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Current Environment

The engine of the Department's host computing environment is an IBM 9021-962 mainframe, capable of operating at approximately 310 million instructions per second. Supporting this computer are approximately 750 gigabytes of direct access storage from various manufacturers (Amdahl, Hitachi, and IBM), a 5,000 cartridge Memorex/Telex automatic tape library, eight independent tape drives (six from IBM and two from STC), and five high speed printers (two 4,000 lines per minute IBM impact printers and three 90 pages per minute Xerox laser printers).

The software running on this host computer is dependent upon OS/390 (which includes MVS, CICS, VTAM, and TCP/IP). Adabas, ROSCOE, and Top Secret are other essential products. Natural, Software AG's fourth generation language, is the basis for most of the application systems which have been developed by TxDOT.

The mainframe computer operates around the clock. During normal working hours there is an emphasis on providing rapid response to the users of the various online production systems (typically 3270-based inquiries or updates, but client-server traffic as well). Off-peak periods are more focused on batch jobs, such as the update and maintenance of database files, the transferring of files and reports across the network, and the backing up of the system.

In addition, to the central mainframe system, local area networks are installed in twenty-five (25) district office sites and in five (5) Austin headquarter's campuses. District installations include a server and associated software. Headquarters campus server installations are shared by the various resident divisions and special offices in each campus. TxDOT presently has total of 71 Novell servers and 30 NT servers located throughout the department.

TxDOT's local area networks (LANs) consist of the following major hardware and software components:

- Intel based 486 and Pentium servers with 64/128MB of RAM and 2 to 8 gigabytes of disk storage
- Fiber cable connection between campus buildings
- Intelligent wiring hubs in each building
- Category five building wiring
- IPX , TCP/IP, and SNA communications protocols
- Novell 4.1 and Microsoft NT 3.51 operating systems

- Novell GroupWise email and scheduling software

Microcomputer workstations attach to the LANs and consist of the following hardware and software components:

- Intel based 486 and Pentium workstations with 4/8/16/32 MB of RAM and 200MB to 1.2GB of disk storage
- DOS 6.2 and Windows 3.1 operating systems
- WordPerfect word processing software
- Lotus 123 spreadsheet
- DBase or Clipper (dBase compiler) database software

Planned Changes

TxDOT's Core Technology Architecture defines the strategic direction for networking, telecommunications, operating systems, workstations, servers, mainframes, printers, plotters, database management systems, general purpose workstation software, groupware, enterprise system management, and reliability and fault tolerance. The Core Technology Architecture and the associated technology infrastructure is the foundation for providing all Information Services and for developing business applications. The current version of the Core Technology Architecture (Version 2.0) is included in Appendix 4. Currently TxDOT is in the process of implementing the essential components of the technology infrastructure that comply with this architecture. The following changes in the hardware/software operating environment will result from this implementation in 1997 and 1998.

- Implementation of TCP/IP as the single communications protocol for TxDOT interoffice communications
- The implementation of local area networks in TxDOT's 111 area offices and 30 division field offices
- Upgrading microcomputer workstations and servers to meet the architecture
- Workstations -Pentium 133 or above, 32MB of RAM, 1.2GB of disk storage
- Servers- Pentium Pro, 128MB of RAM, 8.4GB RAID level 5 disk storage
- Implementation of NT server-based client/server applications
- Replacement of non-intelligent 3270 terminals with microcomputer workstations
- Replacement of Windows 3.1 with Windows NT and Windows '95 as microcomputer workstation operating systems
- Implementation of Microsoft Office suite of products as standard end user productivity tools
    - Wordprocessing - MS Word for Windows '95
    - Spreadsheet - MS Excel for Windows '95

- Presentation Graphics - PowerPoint for Windows '95
- Personal productivity database - Access Windows '95

- Implementation of Sybase SQL database for enterprise client/server applications
- Implementation of Sybase SQL Anywhere database for workgroup client/server applications
- Implementation of Citrix dial-in servers for LAN access by TxDOT's 250 maintenance offices

The following are diagrams of TxDOT's core information architecture components for districts, divisions and special offices:

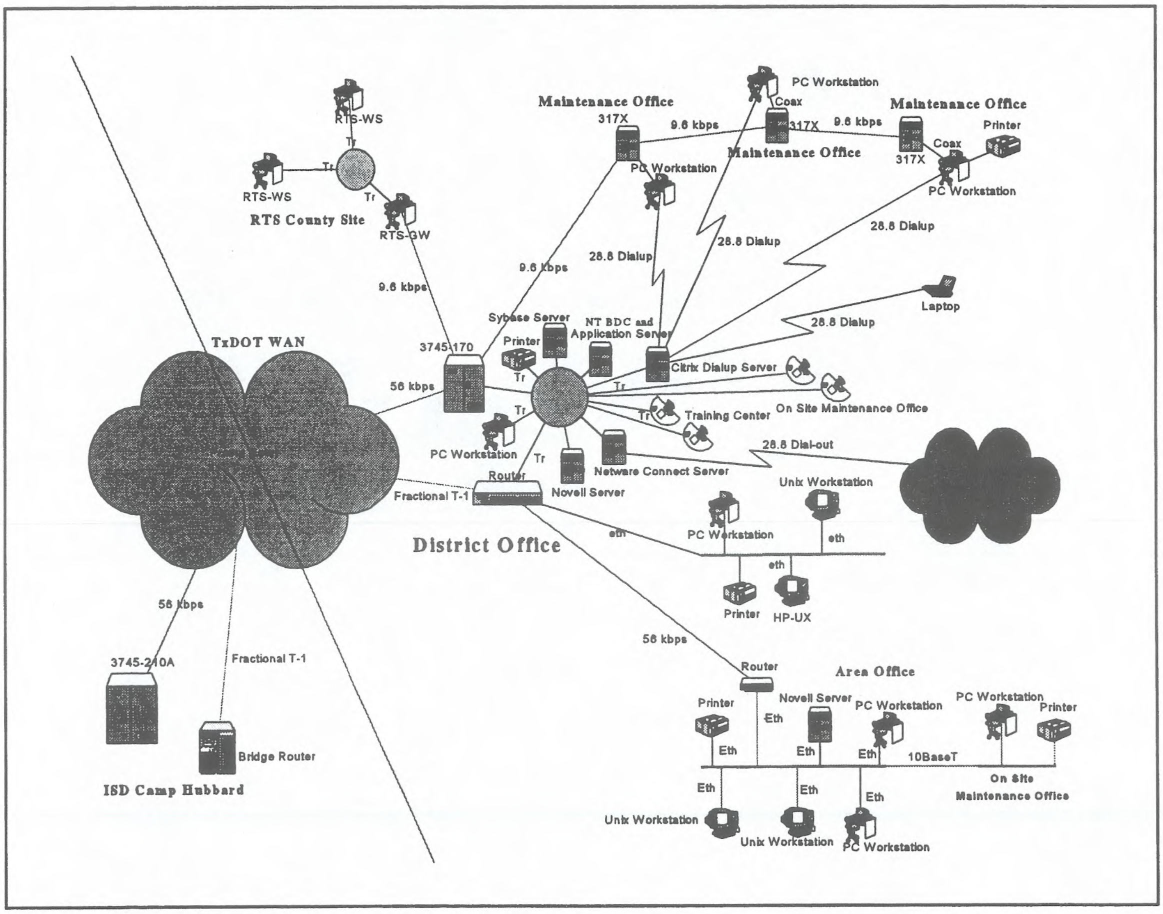

Figure 5.D.1 - District Architecture Components

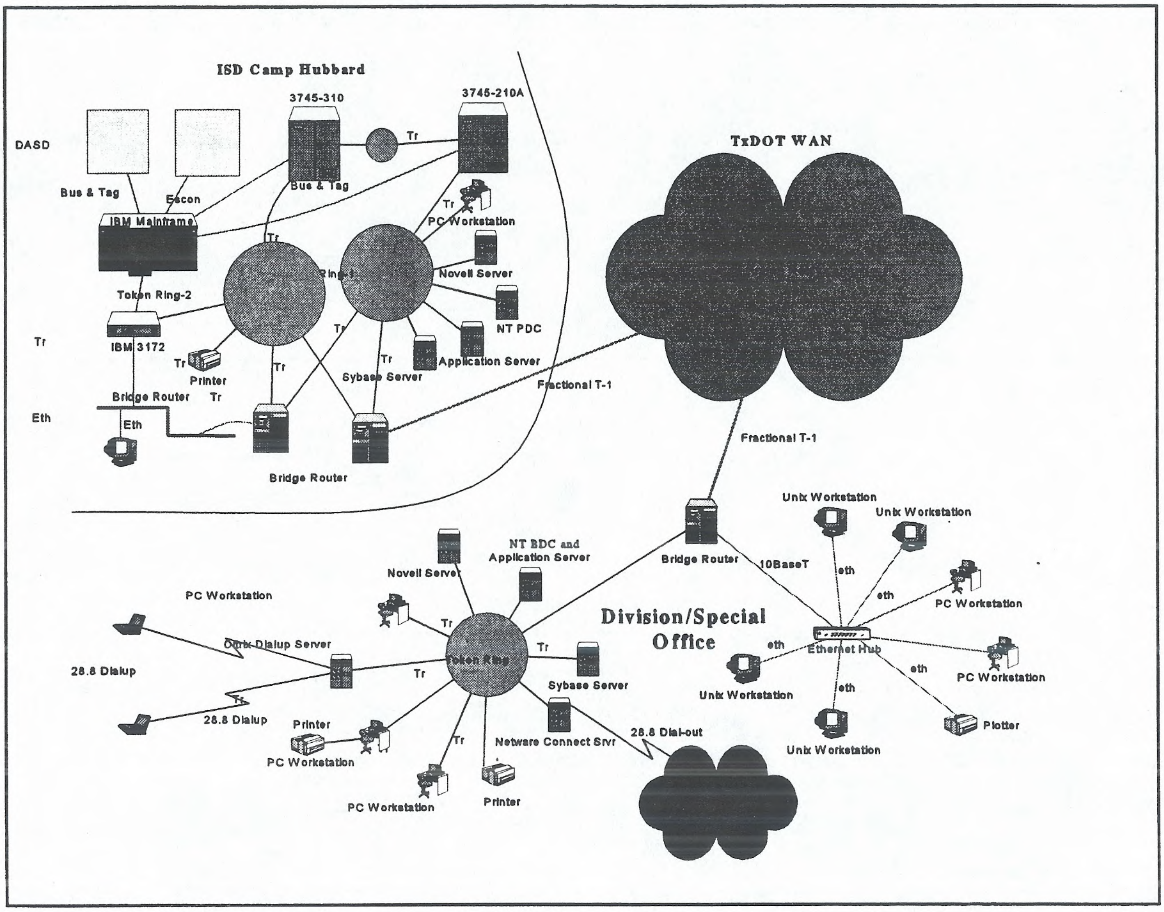

Figure 5.D.2 - Division/Special Office Architecture Components

Section E
Telecommunications Infrastructure

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Current Environment

The TxDOT wide area network is currently comprised of five 1.544 Mbps (T-1) data circuits connecting the Austin, Dallas, Ft. Worth, Houston and San Antonio District Offices. The remaining twenty districts are connected via both frame relay data circuits using 512 kbps (CIR) Committed Information Rate and 56 kbps data circuits.

Each District headquarters office is comprised of an IBM 3745 front end processor supporting 3270 SNA control units, an OS/2 token ring LAN and an IBM 6611 multi-protocol router supporting both Novell Netware (token-ring) and Ethernet (10baseT) local area networks, utilizing TCP/IP and IPX protocols.

The District Area Engineer Offices are in the implementation phase of the extension of the Ethernet local area network project. These offices will be connected with both frame relay 64 kbps clear channel and 56 kbps data circuits using an IBM 2210 multi-protocol router connected to their host districts IBM 6611 multi-protocol router, that establishes a connection back to the central site in Austin. The District Maintenance offices are supported with 9.6 kbps multi-point data circuits supporting 3270 SNA terminals connected to their host districts IBM 3745 which is connected to the IBM 3745 at the central site in Austin.

Another large portion of the wide area network supports the Registration and Title System located in the 254 County Tax Assessor-Collector offices throughout Texas. This network is comprised of 9.6 kbps multi-point data circuits and 19.2 kbps point to point data circuits connecting the OS/2 token-ring LAN in these offices to their host districts IBM 3745 connected back to the IBM 3745 at the central site in Austin.

The Austin metropolitan wide area network is comprised of seven 1.544 Mbps (T-1) data circuits that interconnect 150 Riverside, 105 Riverside, Training Center, Main Office, Anson Jones, Camp Hubbard Building 1 and Camp Hubbard Building 6, in a completely redundant high capacity backbone infrastructure. TxDOT's network diagrams are included in Appendix 5.

Planned Changes

As previously defined, TxDOT's Core Technology Architecture defines the strategic direction for networking, telecommunications, operating systems, workstations, servers, mainframes, printers, plotters, database management systems, general purpose workstation software, groupware, enterprise system management, and reliability and fault tolerance. Currently TxDOT is in the process of implementing the essential components of the technology infrastructure that comply with this architecture. Changes in the telecommunications environment resulting from this implementation in 1997-1998 are included in "Planned Changes" as described in Section D, Configuration.

Section F
Interagency Network Participation

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For more than twenty years, the mainframe computer at TxDOT has communicated with its counterpart at the Department of Public Safety (DPS), providing timely and accurate motor vehicle registration information in support of the demanding requirements of law enforcement. With advances in technology, TxDOT's circuit to the DPS has evolved into a sophisticated program-to-program link over separate SNA networks (SNI). This technology is also used in communication with tax offices in Bexar, Tarrant, and Dallas Counties. The Federal Highway Administration (FHWA) uses this technology for GroupWise email communication with TxDOT personnel and for access to business information through ROSCOE. Additionally, TxDOT uses this technology to connect to the American Association of Highways and Transportation Officials (AASHTO) bulletin boards and to send email to AASHTO and other Departments of Transportation through the Advantis network gateway.

With the implementation of the Registration and Title System (RTS), TxDOT has established a direct link to PCs in almost every county tax office in Texas. In this system the mainframe functions as a database server to these distributed computers.

Another mechanism by which TxDOT communicates with other agencies is through a communication link to the Comptroller's office as a conduit to other agencies. In this way TxDOT provides access to its mainframe computing system to the University of Texas at Austin, the Texas Department of Insurance, the Employees Retirement System, the Legislative Council, the Secretary of State, Texas A&M University, the Texas State Treasury, the Railroad Commission, Texas Parks and Wildlife, and the Attorney General. The link to Texas Parks and Wildlife is particularly noteworthy because it allows county tax offices to use the facilities of both TxDOT and the Comptroller to access the Texas Parks and Wildlife computer system. The county tax offices access boat registration data residing on the Texas Parks and Wildlife computer system utilizing the interagency communication link and the RTS link to TxDOT's mainframe.

The Internet provides additional opportunities for information sharing. TxDOT's Internet Web pages are dynamic, well-organized, and popular. TxDOT's download site of GIS data has proven to be an economical way to distribute large data files. FTP will probably be used to support the Texas Natural Resource Conservation Commission's emission testing project. TN3270 allows the Internet to be used for traditional CRT-to-mainframe transactions (an evaluation pilot test with the Department of Human Services is currently underway). It should also be noted that approximately 3,000 businesses and organizations query TxDOT's motor vehicle database via ordinary dial-up telephone connections.

The following steps are being taken to increase TxDOT's ability to share data with other agencies:

- Encryption technology is being examined for its potential to eliminate concerns associated with sending sensitive data across the Internet.
- The capacity of the gateway connecting the mainframe to the TCP/IP network will be increased.

Section G
Database(s)

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This section contains four subsections which describe the department's database environment, its logical databases, how information is shared among applications, and external information sharing efforts underway at TxDOT:

Database Environment

ADABAS Description
The primary database management system is ADABAS from Software AG. ADABAS resides on the central mainframe and is accessed batch and on-line through CICS, using COBOL, Natural2, SAS, and SQL.

Production ADABAS is physically segmented as follows:

PROD-DATA-BASE (Database number 215) on 12 3390T disk packs
This contains the majority of MIS databases.
PRD2-DATA-BASE (Database number 141) on 10 3390T disk packs
This contains the RTS database only.
PRD3-DATA-BASE (Database number 216) on 5 3390T disk packs
This contains databases for PMIS and TRM.

Additional information on logical databases, file names, and sharing information can be found in this section under "Logical Database Description".

VSAM and Sequential Files Description
VSAM and sequential files (tape and disk) are used to process large quantities of data or for history purposes. VSAM and sequential files are also prevalent as the primary database technology in older business applications.

Engineering applications process flat (sequential) files stored on the user's workstation. Additional information on logical files, current disk use, and sharing information can be found in this section.

PC files Description
The majority of applications written by the district and division automation staffs are PC-based, using primarily dBASE files.

RTS currently uses Database Manager databases on 450 servers with 1785 (eventually

2000) 486 PCs throughout the state. The databases will be migrated to DB2/2.

RDBMS Description
The Relational Database Management System (RDBMS) selected for future database development is SYBASE.

Logical Database Description

* Local refers to files stored on a user workstation

Database Name	**Entity Types/Description**	**DBMS/(DBMS MB) non-DBMS MB/ Batch or On-line**
ABUT Abutment Detail	Abutment Breakback Pier Wingwall Bearing Pad	Local Graphics/
ACR Accumulative Count Recorders	Traffic Volume Counts	Sequential/ 175 MB/ Batch
APPS Automated Plan Preparation System	Plan Profile	Local Graphics/
APS Automated Purchasing System	Purchase Orders Requisitions Vendor Performance Purchase Quantities Pricing Lead Time	ADABAS PROD/ (885 MB) 1064 MB/ On-line + Batch
ARMS Automation Resource Management System	Hardware and Software Items Configurations	ADABAS PROD/ (8 MB) 206 MB/ Batch + On-line

Database Name	Entity Types/Description	DBMS/(DBMS MB) non-DBMS MB/ Batch or On-line
ARRS Automated Receiving Report System	Reports	ADABAS PROD/ (9 MB)/ Batch
ATR Automated Traffic Recorders	Continuous Traffic Seasonal Variations	VSAM + Sequential/ 226 MB/ Batch
BAMS Bid Analysis Management System	Bidders Item Cost	SAS/ 1775 MB/ Batch & On-line
BDG Bridge Inventory, Inspection and Appraisal	On System and Off System Structures: Roadway Traffic Inspections	VSAM + Sequential/ 698 MB/ Batch
BFAST Bridge Foundation and Soil Test	Project Log Test Lab Test Foundation Foundation Strength Soil Strength	Local Graphics/
BPS Bid Proposal System	Construction Bid and Informational Proposals: Vendor Requests Printing/Distribution	ADABAS PROD/ (6 MB) 23 MB/ Batch + On-line
BUD Budget	Program Activity Account Budget Preparation 'Cash' Budget Monitoring Activity	ADABAS PROD/ (4 MB) 9657 MB/ Batch + On-line
CAP18 Bent Cap Analysis	Bridge Bent Cap	Local Graphics/

Database Name	Entity Types/Description	DBMS/(DBMS MB) non-DBMS MB/ Batch or On-line
CBS Contractor Bidding System	Construction and Maintenance Contractor Data: General Prequalified Financial	ADABAS PROD/ (7 MB) 0 MB/ Batch + On-line
CIS Contract Information System	Construction Contracts: Bid Items Materials Quantities Prices Work Placed Material Tests Contractor Payments	ADABAS PROD + Seq./ (536 MB) 2562 MB/ Batch + On-line
CMCS Construction/Maintenance Contract System	Maintenance Contracts: Contractors	ADABAS PROD/ (1 MB)/ On-line + Batch
CPS Central Permits System	Oversize/Overweight Permits Tolerance Permits	VSAM/ 5832 MB/ On-line + Batch
CSI City Street Inventory	City Street Mileage Surface Type City Population	VSAM + Sequential/ 0 MB/ Batch
CTS Contract Tracking	Contractor Project County Change Documents	VSAM/ 0 MB/ On-line + Batch
CULV Culvert Detail	Culvert	Local Graphics
DCIS Design and Construction Information System	Project Planning Bid Information Contract Award	ADABAS PROD/ (314 MB) 1594 MB/ On-line + Batch

Database Name	Entity Types/Description	DBMS/(DBMS MB) non-DBMS MB/ Batch or On-line
DRC Drivers Record Check	Employee Driver Record	Sequential// Batch
EOS Equipment Operations System	Major Equipment Repair Orders Part Issues	ADABAS PROD/ (313 MB) 32 MB/ Batch + On-line
FAMS Funds Allocation and Monitoring	Apportionment (funds) Project	ADABAS PROD/ (6 MB)/ On-line + Batch
FIMS Financial Information Management	Accounts Payable Buildings and Land Capitol Equipment Clearing Expenditures Cash Revenue Construction Payroll and Misc Deductions Encumbrances Fund Equity General Ledger Bank Retainage Liabilities Project Maintenance Public Transportation Accounts receivable Research Expenditures Routine Maintenance Vouchers Payable Warehouse Stock	ADABAS PROD + VSAM + Sequential/ (1,541 MB) 18,126 MB/ On-line + Batch
GPS Geodesy, Photo, & Surveying	Geodetic Position	PC/ Batch

Database Name	Entity Types/Description	DBMS/(DBMS MB) non-DBMS MB/ Batch or On-line
HCR Highway Condition Report	Road Conditions Central Permits Weather Wildflower Sites	ADABAS PROD/ (7 MB)/ On-line + Batch
HPMS Highway Performance Monitoring System	Highway System Inventory	Sequential/ 569 MB/ Batch
HRIS Human Resources Information	Employee Insurance Vacation/Sick Leave Payroll Deductions	ADABAS PROD/ (71 MB) 3429 MB/ On-line + Batch
IGRDS Interactive Graphics Roadway Design	Coordinate Geometry Horizontal and Vertical Alignment	Local Graphics
IRP International Registration Plan	Vehicle International registration Fee	VSAM/ 1511 MB/ On-line + Batch
JAT Job Applicant Tracking	Job Vacancy Applicant Referrals	ADABAS PROD + VSAM/ (15 MB) 509 MB/ Batch + On-line
MCC Manual Classification Count	Vehicle Classification	Sequential/ 259 MB/ Batch
MCD Motor Carrier Division		SYBASE// Batch + On-line
MCS Material Control	Material Test Results Producers/Vendors	ADABAS PROD/ (367 MB) 20 MB/ Batch + On-line

Database Name	Entity Types/Description	DBMS/(DBMS MB) non-DBMS MB/ Batch or On-line
MES Minor Equipment	Minor Equipment Inventory Minor Equipment Requisitions	ADABAS PROD/ (41 MB) 7 MB/ Batch + On-line
MICS MICS Management Support System	Automation Equipment Utilization	Sequential/ 14,794 MB/
MMIS Maintenance Management Information	Roadway Maintenance	ADABAS PROD/ (581 MB) 1514 MB Batch + On-line
MPE Milepoint Equivalency	Control-Section Changes Milepoint Changes	VSAM + Sequential/ 2 MB/ Batch
MSMS Material and Supply Mgmt	Material and Supply Inventory: Received Issued Pass-Thru Stock Levels Locations Asset Value	ADABAS PROD/ (414 MB) 1607 MB/ On-line + Batch
NCS Natural Control	User Application Function	ADABAS PROD/ (6 MB)/ On-line + Batch
OPA Operations Plan for Automation	Automation Project Objectives Needs	ADABAS PROD/ (10 MB) 1 MB/ On-line + Batch

Database Name	Entity Types/Description	DBMS/(DBMS MB) non-DBMS MB/ Batch or On-line
PAY Payroll	Employee Pay Deductions	ADABAS PROD + VSAM + Sequential/ 1071 MB/ Batch
PDL Program Documentation Log	Programs	VSAM// Batch
PJS Planning and Justification	Automation Catalogue Automation Requests Inventory	ADABAS PROD/ (131 MB) 88 MB/ On-line + Batch
PMIS Pavement Management	Roadway Inventory Conditions Project Planning Performance	ADABAS PRD3/ (1,894 MB) 1480 MB/ On-line + Batch
PADT Post Average Daily Traffic	Map Traffic Count	Local Graphics
PPE Milepoint/Reference Marker Equivalency	Location Reference	Sequential/ 10 MB/ Batch
PSTRS14 Prestressed Concrete Beam Design and Analysis	Span Beam	Local Graphics
RDS Roadway Design	Roadway Coordinate Geometry Bridge Geometry Terrain Design	Local Graphics

Database Name	Entity Types/Description	DBMS/(DBMS MB) non-DBMS MB/ Batch or On-line
RGN Registrar/N	Employee (student) Class Class Registration training	Sequential PC/ 43 MB/ Batch
RIA Road Inventory	Roadway Traffic Design	Sequential/ 0 MB/ Batch
RLSE Road Life System Data Entry	Highway Construction Job Material Pavement Layer Money Spent	VSAM/ 148 MB On-line
ROWIS Right-of-Way Information System	Real Property	SYBASE// Online + Batch
RRA Registration Report Audit	County Registration Reports County Payments County Inventory	ADABAS PROD/ (65 MB)/ On-line + Batch
RRX Railroad Grade Crossing	Railroad Crossings Trains	VSAM + Sequential/ 12 MB/ Batch
RTS Registration and Title	Registrations Titles	ADABAS PRD2 + PC/ (15,964 MB) 47,787 MB/ On-line + Batch
SES Single Entry Screen	Transaction	ADABAS PROD/ (1,334 MB) 26 MB/ On-line + Batch
SIGNSZ Interstate Sign Sizing	Interstate Highway Sign	Local Graphics

Database Name	Entity Types/Description	DBMS/(DBMS MB) non-DBMS MB/ Batch or On-line
SKD Skid Test Program	Skid Numbers	VSAM + Sequential// Batch
SLD Salary and Labor Distribution	Time Sheet Repair Order Worked	ADABAS PROD/ (156 MB) 0 MB/ Batch + On-line
SMS Subcontractor Monitoring	Minority-owned Business Small Business	ADABAS PROD/ (38 MB) 185 MB/ On-line + Batch
SPC Special License Plates	Special Plate registration Dealer Plate	VSAM/ 988 MB/ On-line + Batch
STAMINA Noise Barrier Cost Reduction	Noise Barrier	Local Graphics
SWS Statewide Safety Improvements	Federally Funded Safety Projects	VSAM/ 252 MB/ Batch
TAF Traffic Assignment and Forecasting	Trip Distributions Current Urban Traffic Future Urban Traffic	Sequential/ 49 MB/ Batch
THM Texas Highways Magazine System	Subscriptions	VSAM// On-line + Batch
THYSYS Texas Hydraulic	Surface Runoff Channel Flow Hydraulic Structures Storm Sewer Networks Pump Stations	Local Graphics

Database Name	Entity Types/Description	DBMS/(DBMS MB) non-DBMS MB/ Batch or On-line
TLG Traffic Log	Traffic Design	Sequential/ 56 MB/ Batch
TRA Traffic Accident Report	On System Accidents Off System Accidents	VSAM + Sequential/ 1 MB
TRFSGN Traffic Control Signing Options	Traffic Signs	Local Graphics
TRIMS Texas Roadway Inventory Mapping	County Maps District Maps	Local Graphics
TRM Texas Reference Marker	Reference Marker	ADABAS PRD3/ (259 MB) 1538 MB/ Batch
TSS Top Secret	Security Authorizations	Sequential/ 752 MB/ Batch
TVL Travel Literature	Travel Literature	VSAM/ 159 MB/ On-line + Batch
TXTOM Texas Truck Offtrack Modeling	Curve Vehicle	Local Graphics
USF Universal Specifications File	Bid Item Specifications Material Specifications	ADABAS PROD/ (7 MB)/ Batch + On-line
UVD Universal Vendor Description	Vendors	ADABAS PROD/ (21 MB) 12 MB/ Batch + On-line

Database Name	Entity Types/Description	DBMS/(DBMS MB) non-DBMS MB/ Batch or On-line
VPS Vendor Payment	Vendors Vouchers Payments	ADABAS PROD/ (407 MB) 1646 MB/ On-line + Batch
WIM Weight In Motion	Truck Weight	Sequential/ 63 MB/ Batch

Section H
Major Applications

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APPLICATION INVENTORY

Major applications are described in this section (acronyms are listed with each application).

ABUT Abutment Detail
Detailed Description:
ABUT is an Automated Plan Preparation System (APPS) subsystem that creates sheet details for bridge abutments (subsystem of APPS).

ACR Accumulative Count Recorders System
Software: COBOL, FORTRAN
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
ACR collects and analyzes 24-hour traffic data to provide traffic-volume counts necessary for the publication of traffic maps, travel trends, and truck traffic-flow maps. The data is used for the forecasting of future traffic volumes, pavement design, and for special studies as requested. This information is furnished to the Federal Highway Administration (FHWA), Districts, other state agencies, and the public, as requested.

ADOPT Adopt-A-Highway System
Detailed Description:
ADOPT tracks highway assignments for organizations that volunteer to keep highways clean of litter for the Adopt-A-Highway program .

APPS Automated Plan Preparation System
Software: FORTRAN, C, User Cmd. Language (UCM), MicroStation Development Language (MDL)
Hardware: Engineering workstations
Location: Distributed Statewide
Batch/On-line Status: On-line
Detailed Description:
APPS automates plan sheet drafting functions via computer-aided design and drafting (CADD) technology. This is one of the largest automated engineering

systems ever developed by TxDOT. This system assists the engineer, designer, and draftsman with graphic-aided software to reduce plan preparation time and standardize numerous plan sheets and procedures. The software developed by this project will operate on all engineering workstations that are in use by TxDOT. The system will utilize a project data base to store and retrieve various existing and proposed features in a Master Design File to produce details, bill of materials, summaries, and other needed documents. This project will be approached in phases. Phase I - Plan Profile is currently in production.

Subsystems include: Abutment Detail (ABUT), Culvert Detail System (CULV), Plan View System (PLANV), and Span Detail System (SPAN).

APS Automated Purchasing System
Software:
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: On-line/Batch
Detailed Description:
APS allows districts and divisions to electronically transfer requisition and purchase order related documents and purchasing status information. APS will record transactions related to requisitions and purchase orders for the Material and Supply Management System (MSMS), Equipment Operating System (EOS), Minor Equipment System (MES) and service items. APS will route the items to the appropriate purchaser for action. Word processing and electronic mail capabilities will be used to create and route specifications, memorandums, and letters through districts, divisions, and the State Purchasing Commission. The American Software Purchasing and Materials Management Software will process purchase requests, requisitions and purchase orders at the district and division levels. Open market and contract requisition and purchase order information will be transmitted electronically between the Department and the State Purchasing Commission. Reports and on-line inquiry will show the status of requisitions and purchase orders. Historical and status data on vendor performance, purchase quantities, pricing, and lead time will be kept. Interfaces with MSMS, EOS, MES and FIMS will be created. Appropriate manual intervention points and security will be included so that the system fully supports the Department's routine decision making.

ARMS Automation Resource Management System
Detailed Description:
ARMS provides standardized management information about hardware and software resources at a workstation level.

ARRS Automated Receiving Report System
Detailed Description:
ARRS allows users to generate Equipment Operations (EOS) and Minor Equipment System (MES) receiving reports with a minimum of effort. ARRS may also be used to inquire into EOS and MES items previously received.

ATR Automated Traffic Recorders System
Software: COBOL, FORTRAN
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
ATR collects continuous traffic data using permanent, automated counters and the data is retrieved by an automated polling system. The data is used to determine the seasonal variations in traffic patterns. Those variations become factors which may be applied to the accumulative count recorders (ACR: Traffic Counts). It is analyzed for the publication of traffic maps, for forecasting of future traffic volumes, pavement design, and for special studies as requested. This information is furnished to the Federal Highway Administration (FHWA), Districts, other state agencies, and the public, as requested.

B30 Continuous Beam Analysis - B30 System
Detailed Description:
B30 performs a complete analysis of a 'continuous' beam, which is a beam that crosses multiple bent caps, rather than just a single span.

BAMS Bid Analysis Management System
Software: SAS, Natural
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch/On-line
Detailed Description:
BAMS provides a detailed analysis of item costs. This analysis can be used to provide relationships between bidders to detect collusion and as a basis for cost estimation. This is a proprietary system licensed from AASHTO and maintained by Infotech. This system interfaces with DCIS and CIS.

HCI is a portion of the Bid Analysis Management System. HCI is maintained by Infotech. It calculates the cost index of Bid items used in the letting of highway construction contracts. This data is used by the Districts for forecasting and budgetary purposes.

BDG Bridge Inventory, Inspection and Appraisal System (BDG or BRINSAP)
Software: COBOL
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
The BRINSAP file consists of all pertinent data concerning the 'On' and 'Off' system structures within the state. This includes roadway structure characteristics, traffic data, inspection data, and ratings.This database supports the Federal Highway Administration's requirements for reporting bridge inspection and appraisal data.

BEN Benefits System
Software: COBOL
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
BEN produces employee reports identifying benefits received or accrued. The benefits statement shows medical benefits, survivor's benefits, retirement benefits, and the 'hidden' paycheck. This system creates a benefits statement for each TxDOT employee.

BFAST Bridge Foundation and Soil Test Program
Software: MicroStation Basic
Hardware: PC
Location: Statewide
Batch/On-line Status: On-line
Detailed Description:
BFAST is a soil analysis and bridge foundation design aid. It can be used solely for soil analysis, or it can do soil analysis combined with bridge foundation analysis and design. BFAST allows input of field boring log and laboratory soil test data to help design piling and drilled shafts of various selected sizes for the input ranges of design loads.

BPS Bid Proposal System
Software: COBOL, Natural
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: On-line
Detailed Description:
BPS is an information system for the production and distribution of highway

construction bid proposals. This system produces a master copy of each bid proposal for a letting and stores the document on DOTS. The system is used to keep track of all requests for bid and informational proposals. The system allows for the demand printing of proposals based on requests. The system allows for revisions to be made and the automatic distribution of the revisions once it is complete.

BUD Budget Monitoring System
Software: Natural, COBOL
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch/On-line
Detailed Description:
BUD is a streamlined budget creation process for the preparation of the Legislative Appropriations Request (LAR) at the district and division level. The Budget Monitoring system allows for reconciliation of expenditures and cash disbursements. This system receives information from other MIS subsystems and organizes this data by activity and account to produce the annual budget and provide monitoring during the biennium.

CAP18 Bent Cap Analysis Program
Detailed Description:
The CAP18 program performs analysis for flexural design of bridge bent caps. This program is specialized for beam columns and uses the AASHTO lane loading rules.

CAiCE Computer Aided Civil Engineering and Surveying
Detailed Description:
CAiCE provides coordinate geometry and digital terrain modeling features and can be used to edit, reduce, and process survey data.

CBS Contractor Bidding System
Software: COBOL
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch/On-line
Detailed Description:
This system automates the process of qualifying contractors wanting to do business with TxDOT and maintains contractor information before and after the qualification process.

CCIS Consultant Certification Information System (under development)

Detailed Description:
CCIS automates the process of pre-certification of engineers, architects, and other associated firms that apply for consultant work with the department.

CES CICS Editor System (under development)
Detailed Description:
CES is an online editor for CICS which emulates the ROSCOE editor.

CIS Contract Information System
Software: COBOL, Natural
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch/On-line
Detailed Description:
CIS provides the means for divisions, districts, and residencies to update, receive reports, monitor progress, and authorize payment on contracts from the time the contract is let until the work is complete. This system receives information on construction projects from the districts and produces automated vouchers. It also provides information for Federal aid billings and construction ledgers.

CMCS Construction/ Maintenance Contract System
Software: Natural
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: On-line/Batch
Detailed Description:
CMCS is a standardized method to process and manage the department's maintenance contracts. It automates the preparation, pre-qualification, letting, and payment procedures for all maintenance contracts.

CMS Construction Management System (under development)
Detailed Description:
CMS will eventually replace the Contract Information System (CIS).

COSB1 Cantilever Overhead Sign Bridge
Detailed Description:
COSB1 is a program specifically designed for cantilevered bridge analysis. It includes analysis for column, base plate, and anchor bolts.

CPP Career Planning Profile System
Detailed Description:

CPP keeps a profile for each employee consisting of data such as education, licenses, training, skills, work experience, etc. (subsystem of HRIS).

CPS Central Permits System
Software: Natural, Clipper, COBOL, C
Hardware: IBM Mainframe, PC DOS, Novell network
Location: Central
Batch/On-line Status: On-line
Detailed Description:
CPS provides a centralized, automated process for issuing oversize/overweight and House Bill 2060 (tolerance) permits. It provides for access to permit data for law enforcement through the Department of Public Safety. In addition, the system provides accounting reports related to the issuance of permits.

CRIS Crash Records Information System (under development)
Detailed Description:
CRIS will provide a more streamlined and automated process to collect and disseminate crash information for the Department of Public Safety and the Texas Department of Transportation.

CSI City Street Inventory System
Software: COBOL
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
CSI is an inventory of the city street mileage by surface type for cities of population of 5,000 and over.

CTS Contract Tracking System
Software: COBOL
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
CTS provides the means to track correspondence on contracts from the time a contract is let until the work is complete.

CULV Culvert Detail System
Detailed Description:
CULV is an Automated Plan Preparation System (APPS) subsystem that aids in the

production of culvert detail drawing sheets for standard or custom jobs (subsystem of APPS).

CULV5 Concrete Box Culvert Analysis System
Detailed Description:
The CULV5 system performs analysis for box type culvert design. This system replaces its predecessor, CULV3.

DCIS Design and Construction Information System
Software: COBOL, Natural
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch/On-line
Detailed Description:
DCIS is used for preliminary engineering on construction projects. It gives engineers detailed information to manage design activities of highway facilities, produce project estimates, and plan letting schedules.

DOTS Data on Terminal System
Software: COBOL
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
DOTS is a report storage system, allowing reports to be stored and printed when needed.

DRC Drivers Record Check System
Software: COBOL
Hardware: IBM Mainframe
Location: Central & DPS
Batch/On-line Status: Batch
Detailed Description:
DRC allows the districts and divisions to obtain driving record reports from the Department of Public Safety for specified employees.

EOS Equipment Operations System
Software: COBOL, Natural
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch/On-Line

Detailed Description:
EOS maintains an inventory and expense record for all TxDOT's major highway equipment and distributes total cost to the accounts and projects on which the equipment is used. Reports from EOS are also used for property management.

EVM Environmental System
Detailed Description:
EVM performs analysis of the environmental impact from actual and projected traffic flows. This is necessary to minimize harmful effects caused by air and noise pollution.

FAMS Funds Allocation and Monitoring System
Software: Natural
Hardware: IBM Mainframe, PC
Location: Central
Batch/On-line Status: On-line/Batch
Detailed Description:
FAMS records and keeps track of federal and state apportionments made to TxDOT for construction, traffic safety, transportation, and aviation projects.

FIMS Financial Information Management System
Software: COBOL, Natural, Mark IV
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch/On-line
Detailed Description:
FIMS records all of TxDOT's accounting events. It is the basis for all official departmental financial information. It also sends data to other subsystems when that information is needed to update related files.

FTE Full Time Equivalent System
Detailed Description:
FTE provides support for tracking, budgeting and planning of personnel to perform work.

GEOPAK Roadway Design and Drafting System (vendor-supplied)
Detailed Description:
GEOPAK is a comprehensive, interactive software package for use in the design and production of plans for civil engineering projects.

GPS Geodesy, Photo and Surveying System

Software: Trimvec, Nadcon, Geoid
Hardware: PC, IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
GPS calculates the geodetic position to state plane coordination conversion, and vice versa. This system is capable of measuring precise time, calculating the height of a specific point, and navigating is possible given to latitude and longitude. This information is easily accessible to Divisions, Districts and other state agencies.

HCR Highway Condition Report
Software: Natural
Hardware: IBM Mainframe
Location: Central, Statewide access
Batch/On-line Status: Online/Batch
Detailed Description:
HCR accepts input from district offices describing each abnormal road condition deemed to be significant to travelers. HCR provides printed reports and on-line queries for TxDOT employees who give information to travelers either by telephone or in person at the Travel Information Centers. The system also accepts input from the districts concerning temporary restrictions on vehicle permits in essentially the same format. This information is provided to the Central Permit Office in report or query format.

HPMS Highway Performance Monitoring System
Software: COBOL, FORTRAN
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
HPMS is a Federal Highway Administration System used to determine statewide rehabilitation, reconstruction, and construction requirements for the department.

HRIS Human Resources Information System
Software: Natural, COBOL
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: On-line/Batch
Detailed Description:
HRIS is an inquiry/update system for Human Resources information. The update subsystem consists of four steps: on-line data entry, batch edits, HRIS creates, and

updates. This system provides inquiry and update to the HRMS-master file and the personnel-profile file. The Human Resources information includes personnel data, insurance, vacation/sick leave, and payroll deductions. This system also provides the Comptroller with HRIS records via tape. The Human Resources Division (HRD) and the Budget and Finance Division (BUD) are co-offices of primary responsibility (OPR's). Subsystems (or related systems) include: Career Planning Profile System (CPP), Group Insurance System (INS), Job Applicant Tracking System (JAT), Personnel System (PER), and Vacation/Sick Leave System (VSL). (These systems are also known collectively as the Human Resources Management System (HRMS).)

IGIDS Interactive Graphics Intersection Design System (under development)
Detailed Description:
IGIDS provides for graphical intersection design, including signal analysis and truck off-tracking movements.

IGRDS Interactive Graphics Roadway Design System
Software: FORTRAN, Intergraph User Cmd. Language (UCM), C
Hardware: Workstation
Location: Distributed Statewide
Batch/On-line Status: On-line
Detailed Description:
IGRDS is designed specifically for highway applications that rely heavily on reference to horizontal and vertical alignments and geometry referenced to these alignments by stationing. This is presently an AASHTO maintained product. TxDOT maintains an enhanced version. This product is being phased out over a multi-year period for an orderly transition to GEOPAK.

INS Group Insurance System
Software: COBOL, Mark IV
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
INS updates employees insurance coverage consisting of Health, Life, AD&D, Disability and Dependent Life coverage. It also updates TexFlex information for premium conversion, health care and dependent care.

IRIS Information Resource Information System (under development)
Detailed Description:
IRIS will replace the Automation Resource Management System (ARMS).

IRP International Registration Plan System
Software: COBOL, CICS Command Level
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
IRP is a program for licensing commercial vehicles (trucks, trailers, and busses) engaged in Interstate operations among member jurisdiction (U.S. states and provinces of Canada). Section 4008 of the Motor Carrier Act of 1991 pertains to states which participate in the International Registration Plan (IRP). Texas residents operating into IRP jurisdictions must pay proportional registration fees based on mileage, under the IRP. This is accomplished by filing through the Vehicles Titles and Registration Division (VTR) of the Texas Department of Transportation (TxDOT). The IRP automated system provides cabcards for each vehicle, which upon payment of apportioned fees due, the applicant will receive along with a license plate that will identify the applicant as properly registered in each of the IRP jurisdictions.

The IRP system also features automated deposit, transmittal and recap reports for disbursement of proportional fees to the jurisdictions, as well as an automated audit process.

JAT Job Applicant Tracking System
Detailed Description:
JAT tracks applicants for department job openings and Job Vacancy notices statewide. Initial screening is done to determine if employee meets minimum requirements for the job (subsystem of HRIS).

LANSER Local Area Network Safety Evaluation and Reporting System
Detailed Description:
LANSER is used for analysis of statewide traffic collision data. It provides roadway, bridge, and railroad crossing data for engineering purposes, plus city and county demographic data.

LET Letting System
LET records and tabulates the low bidders for highway construction contracts.
Software: COBOL
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: On-line
Detailed Description:

LET is used to record and tabulate the low bidders for highway construction contracts.

MCC Manual Classification Count System
Detailed Description:
MCC does analysis of vehicle classification data. Data is collected at approximately 1200 sites across the state, and consists of counts of thirteen classes of vehicles for each hour of the 24- or 48-hour observation period.

MCS Material Control System
Software: COBOL, Natural
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: On-line
Detailed Description:
MCS formalizes test results of all materials submitted to the Materials and Tests Division (MTD) for quality testing and makes those results available on-line to all interested parties.

MDC Master Data Controller
Software: Assembler
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
MDC coordinates the database update processes of the MIS systems (e.g., FIMS, EOS, MES, SLD, etc.) The MDC allows systems to share data in a coordinated manner. It also provides error recovery for transaction processing.

MES Minor Equipment System
Software: COBOL, Natural
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch/On-line
Detailed Description:
MES provides information about all aspects of minor equipment from requisition, receipt, assignment, payment, transfer, and retirement. Minor equipment is defined as any non-consumable implement, tool, or device. This system is similar to EOS in that it maintains an inventory of equipment, but MES deals only with minor equipment owned by TxDOT.

MICS MICS Management Support System
Detailed Description:
MICS provides management reporting, financial management, capacity management, technology management and service management using System Management Facility (SMF) performance records.

MMIS Maintenance Management Information System
Software: Natural
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: On-line/Batch
Detailed Description:
MMIS provides statistics on roadway maintenance. It provides simplified data recording, input and retrieval, produces data on workload and operational planning efforts, and provides a tool to analyze maintenance activities, improving production and efficiency.

MPE Milepoint Equivalency System
Detailed Description:
MPE provides automated update of county-control-section-milepoints in any data set that is tied to this reference base.

MSMS Material and Supply Management System
Software: COBOL, Natural, SAS
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch/On-line
Detailed Description:
MSMS supports inventory management and purchasing of stock, parts, and supplies. MSMS includes inventory and accounting of all items purchased and used by the districts and maintenance section warehouses. It includes inventory management, forecasting, and purchasing.

MVD Dealer License System
Detailed Description:
The MVD Dealer License System maintains data pertinent to motor vehicle dealer licensing.

NCS Natural Control System
Software:
Hardware: IBM Mainframe

Location: Central
Batch/On-line Status: Batch/On-line
Detailed Description:
NCS controls access to the department's NATURAL and ADABAS resources.

OPA Operations Plan for Automation
Software: Natural
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: On-line
Detailed Description:
OPA is a planning tool used to define automation projects in the districts/divisions. The OPA is divided into two main areas: 1) Objectives and Factors, which outline the needs of the District/Division, and 2) Projects, which are plans to satisfy these needs.
The OPA system standardizes the format and content of the OPA document, facilitates reporting of automation projects, and verifies that the Planning and Justification System (PJS) requests support the OPA.

OSB6 Overhead Sign Bridge Analysis Program
Detailed Description:
OSB6 is a program designed for overhead sign bridge analysis.

PADT Post Average Daily Traffic System
Detailed Description:
Using an existing map file created from Texas Road Inventory Mapping System (TRIMS), the PADT program is used to create a station map on which it places (posts) labels that show average daily traffic counts.

PAY Payroll System
Software: COBOL, Natural
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch/On-line
Detailed Description:
PAY creates TxDOT's payroll and the tapes, reports, and error messages that are needed to process, monitor, and audit payroll.

PCACOL PC Column
Detailed Description:
PCACOL is a Windows-based program that designs and analyzes reinforced

concrete columns. The program allows the use of any arbitrary cross section as well as the analysis of slender columns.

PCDS Projected Cash Disbursement System

PDL Program Documentation Log
Detailed Description:
PDL maintains documentation of the resources required by TxDOT computer systems.

PER Personnel System
Detailed Description:
PER tracks personnel information on each employee. Data includes personnel codes, work location, salary group and class, and longevity (subsystem of HRIS).

PJS Planning and Justification System
Software: Natural
Hardware: IBM Mainframe
Location: Central Computer - Statewide application
Batch/On-line Status: Batch/On-line
Detailed Description:
PJS ensures the cost effective procurement of automation hardware and software.

PLANV Plan View System
Detailed Description:
PLANV is an Automated Plan Preparation System (APPS) subsystem which subdivides a roadway into a series of production plan sheet drawings at specified scales with complete annotation (subsystem of APPS).

PMIS Pavement Management Information System
Software: Natural, SAS, RPF, Visual Basic
Hardware: IBM Mainframe, PC
Location: Central, Statewide access
Batch/On-line Status: Batch/On-line
Detailed Description:
PMIS automates highway network-level activities of the Department's overall pavement management system and addresses pavement-related functions including planning, rehabilitation, reconstruction, and major maintenance of the state's pavements.

PPE Milepoint/ Reference Marker Equivalency System

Detailed Description:
PPE implements a department-wide single location reference key and establishes responsibilities for continued monitoring, support, and coordination.

PSTRS14 Prestressed Concrete Beam Design/Analysis System
Detailed Description:
The PSTRS14 program performs calculations for the design or analysis of simple span beams of pretensioned, prestressed concrete for use in highway and railroad bridges.

RDS Roadway Design System
Software: FORTRAN
Hardware: IBM Mainframe, workstation
Location: Statewide/Central
Batch/On-line Status: Batch
Detailed Description:
RDS is an integrated program of over 400 computer processes developed to aid engineers in the design of highways and bridges. It utilizes a project database to store terrain, design, and geometry information for a design project. This is presently an AASHTO maintained product. TxDOT maintains an enhanced version.

RGN Registrar/N System
Software: Natural
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: On-line/Batch
Detailed Description:
RGN is a computer-based training, record keeping, and scheduling system that handles the daily activities of class and student record storage and maintenance, class registration processing, logistics management, training correspondence, and training management reporting.

RIA Road Inventory System
Detailed Description:
RIA contains roadway characteristics, and traffic and design data for designated under maintenance state highway system and federal-aid system, country roads, functional classified city streets, and interstate highway frontage roads.

RIS Roadway Information System
Software: COBOL

Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
RIS consists of eight individual "core" application areas. RIS is a combination of coordinated data files containing roadway characteristics, structure descriptions, traffic counts, railroad grade crossing inventory, and traffic accidents. Also, there is one file that contains a history of changes in roadway location data (milepoints) and one that equates milepoints to mileposts.

RLSE Road Life System Data Entry
Software: Natural2
Hardware: IBM mainframe
Location: Central
Batch/On-line Status: On-line
Detailed Description:
RLSE is a warehouse of information about highway construction jobs. Type of work, location, money spent, layer thickness and width, and materials used are among the information stored.

This system is intended to be replaced by a PC-based Road Life System at an undetermined date. Data stored in this system will be converted for use in the new system when it is developed. The Pavements Section of the Design Division is the current OPR/data steward for this system.

ROW Right-of-Way Records System
Detailed Description:
ROW allows the display of information to monitor the Right-of-Way parcel acquisition process.

ROWIS Right-of-Way Information System (under development)
Detailed Description:
ROWIS is a client/server application that manages the information needed for acquiring all real estate necessary for the operation, construction, and maintenance of the transportation system.

RRA Registration Report Audit System
Software: Natural2
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch/On-line

Detailed Description:
The RRA System is an on-line, interactive system for the reporting of vehicle registrations, by counties, to the state. RRA provides the recording and auditing of registration reports (Form 158), payments made by counties for these reports, and maintenance of county inventories of registration items.

RRX Railroad Grade Crossing System
Software: COBOL
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
The RRX file contains information on each crossing on the state highway system, city streets and county roads. There is one record for each crossing location. The data consists of location, railroad company, number of trains, number of tracks, train speed, average daily traffic, type of protection at the crossings, etc. The file is updated on a quarterly basis and contains both "on" and "off" system data on a single master file.

RTS Registration and Title System
Software: COBOL, Natural, SQL, C, Applications Manager
Hardware: IBM Mainframe, PC
Location: Central/Distributed Statewide
Batch/On-line Status: Batch/On-line
Detailed Description:
RTS is a point-of-sale system to be used by the state's 254 county tax assessor-collector offices for the registration and titling of motor vehicles. RTS provides rapid update of motor vehicle database records (24-36 hours following county processing), and the ability to comply with statutory title issuance requirements (5 days following transaction receipt by VTR). Current vehicle record information will be of particular benefit to law enforcement. Vehicle sales tax data will be collected as part of title transaction processing and furnished on computer tapes to the Texas Comptroller of Public Accounts. In addition, department revenue/budget forecasting will be strengthened by the prompt and accurate accounting data provided by the new system.

SDMS Survey Data Management System
Detailed Description:
SDMA is an AASHTOWare product that runs on DOS-based surveying data collectors, allowing for the systematic collection and storage of survey data.

SES　Single Entry Screen System
Software: Natural, COBOL
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
SES provides input of Salary and Labor Distribution (SLD), Material and Supply Management System (MSMS), Equipment Operations System (EOS), and Maintenance Management Information System (MMIS) information to be entered into a single entry point for maintenance section users. It also provides an automated time report.

SIGNAL　Traffic Signal Pole Assemblies Program
Detailed Description:
SIGNAL is a program designed for traffic signal assembly analysis.

SIGNSZ　Interstate Sign Sizing Program
Detailed Description:
SIGNSZ sizes and locates copy on interstate highway sign panels, producing both graphics and a report of sign dimensions and materials.

SKD　Skid Test System
Software: COBOL, FORTRAN
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
SKD stores skid data collected from skid trucks throughout the state highway system. It is used by Highway Design Engineers to assist with roadway decision making when building or rehabilitating highways. Skid numbers are one of the variables that can be used by highway engineers to determine the frictional performance of existing seal coat pavements after a specific service period and to prioritize plans for rehabilitation. Otherwise, they can be used during the design stage to select the type and quality of aggregates that will maintain the desired frictional performance within a desired time span.

SLD　Salary and Labor Distribution System
Software: COBOL, Natural
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch/On-line

Detailed Description:
SLD is responsible for assimilating and reconciling employee time sheet records and Equipment Operating System (EOS) repair order work records.

SMS Subcontractor Monitoring System
Software: COBOL, Natural
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch/On-line
Detailed Description:
SMS provides on-line monitoring and batch reporting capabilities for state and federal construction projects. This system ensures accuracy of information supplied to FHWA, Texas Economic Development Commission (TEDC), State Highway Commission, the media, and others concerning TxDOT's use of Minority-owned Businesses and Small Businesses. It also provides monitoring of all subcontracting by prime construction contractors performing work for TxDOT. This ensures continued funding of Federal Aid projects.

SPAN Span Detail System
Detailed Description:
SPAN is an Automated Plan Preparation System (APPS) subsystem that produces span detail drawing sheets, with complete annotation, for prestressed concrete bridges (subsystem of APPS).

SPC Special License Plates System
Software: COBOL, Assembly, CICS Command Level
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
SPC maintains data pertinent to the issuance, renewal and inquiry of Special license plates issued in accordance with the registration laws enacted by the Texas legislature. This system allows for a faster and more timely method of issuing, invoicing, manufacturing and renewing these special plates and provides for the appropriate notification to be sent to the owner of these special plates on a timely basis.

STAAD-III/ISDS Structural Analysis and Design - Integrated Structural Design Systems
Detailed Description:
STAAD-III/ISDS is used for the design and analysis of structural systems. It is used primarily for its 2-D finite-element modeling capabilities. STAAD has an

automatic mesh generator to allow complex shapes to be modeled with ease.

STAMINA Noise Barrier Cost Reduction Program
Detailed Description:
In conjunction with the OPTIMA program, STAMINA constitutes a system for traffic noise prediction modeling. The STAMINA program is used to predict and abate highway traffic noise.

SWS Statewide Safety Improvements System (Title II)
Software: Natural, COBOL
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
SWS provides a cost/benefit analysis of federally funded safety projects, both before and after construction. SWS (Title II) enables TxDOT to manage projects which use Federal funds disbursed under the Title II act by the FHWA. Projects are intended to provide traffic safety improvements to highways. This system monitors such things as whether accident rates were reduced after a signal light was installed.

TACS Tables and Characteristics System
Software: COBOL, Natural
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
TACS stores table information that is used by numerous applications throughout the department.

TADS Texas Airport Data System (under development)
Detailed Description:
TADS is a client/server application that is used to store information on airport locations, facilities, and inspections. It is also used to track projects for the state's Capital Improvement Plan (CIP).

TAF Traffic Assignment and Forecasting System
Detailed Description:
TAF, which includes the Texas Trip Distribution package and the Large Network package, is designed to perform trip distributions and assign current and future traffic to a large transportation network in urban areas.

TexIS TxDOT's Executive Information System
Software: SAS, Natural, Commander, One-Up V1.4, Interactive Financial Planning System (IFPS), Windows
Hardware: PC, IBM Mainframe, Networked
Location: Central (Administration only)
Batch/On-line Status: On-line/Batch
Detailed Description:
TExIS equips the TxDOT Executive Management with a tool which reinforces the goals of the organization and monitors progress towards the accomplishment of those goals. Information contained in the system assists in strengthening the department's decision-making capacity while enhancing resource management, thus providing information necessary to react in a timely, accurate fashion to inquiries received from State Legislators, Transportation Commissioners, other agencies and the public sector.

Application areas already addressed by the system include: Legislative tracking, Roadway information, civil rights/affirmative action, automated organizational charts, and work force composition.

THM Texas Highways Magazine System
Software: Omni (proprietary), C
Hardware: DEC VAX
Location: Travel and Information Division
Batch/On-line Status: On-line/Batch
Detailed Description:
THM maintains the subscriptions for the official State travel magazine "TEXAS HIGHWAYS". This system provides mailings, renewals, billings, gift cards, address changes, nightly updates, donor/recipient relations, and presorting.

THYSYS Texas Hydraulic System
Software: C, Visual C, Visual Basic
Hardware: PC
Location: Distributed Statewide/Central
Batch/On-line Status: On-line
Detailed Description:
THYSYS performs hydraulic calculations used in highway hydraulic design and analysis.

TLG Traffic Log System
Detailed Description:
TLG is a file of current, historical, and 20-year traffic design data. Data is

assimilated to produce design data such as KIPS, ATHWLD, 20-year projection for the AADT, etc.

TRA Traffic Accident Report System
Software: RPF, COBOL, FORTRAN
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
TRA contains all "on" and "off" system accidents and is a coordinated effort between the Department of Public Safety (DPS) and TxDOT. DPS collects the data from various sources such as DPS investigating officers, city and county law enforcement agencies, and individuals filing reports. DPS codes the location using control-section, milepoint, and the RI-1 map.

TxDOT receives the data from the Department of Public Safety (DPS) and updates roadway characteristics and traffic. The file is made available to the TxDOT Divisions and Districts, and State and Federal agencies. The accident file is updated on a monthly cycle and an end-of-year tape is produced with a cut-off date of December 31st.

TRFSGN Traffic Control Signing Options
Software: FORTRAN, Intergraph User Cmd. Language (UCM)
Hardware: DOS,
Location: Distributed Statewide
Batch/On-line Status: On-line
Detailed Description:
TRFSGN is a MicroStation traffic sign tutorial application that provides a MicroStation user with the ability to create various sign layouts using sign cell libraries accessed through screen tutorials.

TRIMS Texas Roadway Inventory Mapping System
Software: FORTRAN, User Cmd.
Hardware: Workstation
Location: Available statewide, primarily central
Batch/On-line Status: On-line
Detailed Description:
TRIMS provides the tools necessary to digitize county and city maps.

TRM Texas Reference Marker System
Software: Natural, C++

Hardware: IBM Mainframe, PC
Location: Central, Statewide access
Batch/On-line Status: On-line/Batch
Detailed Description:
TRM implements a single location reference key statewide and continued monitoring and coordination of roadway inventory data.

TSI Traffic Signalization/Illumination System
Detailed Description:
TSI programs account for the bulk of the data processing for traffic signalization and traffic progression analysis. The programs are heavily used, particularly in the major urban areas of the state, to maintain an efficient and safe flow of traffic on and along major roadways.

TSS Top Secret System
Detailed Description:
TSS provides access control and security for mainframe data and applications.

TVL Travel Literature System
Detailed Description:
TVL tracks distribution of travel literature.

TXTOM Texas Truck Offtrack Modeling System
Detailed Description:
TXTOM is a computer model that simulates the offtracking characteristics of a truck (or any vehicle combination) negotiating a simple circular curve. Over time, this will be replaced by IGIDS.

USF Universal Specifications File System
Software: COBOL, Natural
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
USF provides a defined center of information for all construction specifications and details of the materials referenced in these specifications.

USF was designed as an ADABAS file to provide a defined center of information concerning all bid items, materials and material groups. The USF is available as a service to any system, Division, or District that requires its information. The USF is now accessed by the Materials Control System (MCS), Contract Information

System (CIS), Design and Construction Information System (DCIS) and the letting and post-letting system.

UVD Universal Vendor Description System
Software: COBOL
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
UVD is used to store and retrieve information on vendors and contractors.

VPS Vendor Payment System
Software: Natural/COBOL
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch/On-line
Detailed Description:
VPS provides inquiry into the voucher/vendor information of the Financial Information Management System (FIMS). This system tracks vendor activity from invoicing to voucher payment.

VSL Vacation/Sick Leave System
Detailed Description:
VSL is used to update vacation, sick leave, other leave, and compensatory time for Department employees (subsystem of HRIS).

WIM Weight In Motion System
Software: COBOL
Hardware: IBM Mainframe
Location: Central
Batch/On-line Status: Batch
Detailed Description:
WIM is used to collect truck-weight data at various sites throughout the state for development of the 18-KIP equivalency file and the Federal Highway Administration's (FHWA) Highway Performance Monitoring System (HPMS). The stations weigh trucks in motion and collect data on one lane at a time. In the future, FHWA will require data to be collected across multiple lanes.

The automated weighing of trucks in motion provides input to the Traffic Log (TLOG) where the 18-KIPS are calculated. This along with the traffic counts (ACR, ATR, and MCC) and other related data are input and adjusted by the Traffic

Log System (TLG) and are passed to the RI-2 file.

APPLICATIONS BY BUSINESS AREA

Determine and Analyze Transportation Needs

ACR	Accumulative Count Recorders System
ATR	Automated Traffic Recorders System
BDG	Bridge Inventory, Inspection and Appraisal
CSI	City Street Inventory System
EVM	Environmental System
HPMS	Highway Performance Monitoring System
MCC	Manual Classification Count System
MPE	Milepoint Equivalency System
PMIS	Pavement Management Information System
PADT	Post Average Daily Traffic
PPE	Milepoint/ Reference Marker Equivalency System
RIA	Road Inventory
RIS	Roadway Information System
RRX	Railroad Grade Crossing System
SKD	Skid Test Program
TAF	Traffic Assignment and Forecasting System
TLG	Traffic Log System
TRA	Traffic Accident Report System
TRIMS	Texas Roadway Inventory Mapping System
TRM	Texas Reference Marker
WIM	Weight In Motion System

Plan Transportation Systems

DCIS	Design and Construction Information System
EVM	Environmental System
FAMS	Funds Allocation and Monitoring System
HPMS	Highway Performance Monitoring System
PMIS	Pavement Management Information System
STAMINA	Noise Barrier Cost Reduction Program
SWS	Statewide Safety Improvements System (Title II)
TAF	Traffic Assignment Forecast

Design Transportation Systems

ABUT	Abutment Detail
APPS	Automated Plan Preparation System
B30	Continuous Beam Analysis - B30 System
BFAST	Bridge Foundation and Soil Test Program
BPS	Bid Proposal System

CaiCE	Computer Aided Civil Engineering and Surveying
CAP18	Bent Cap Analysis Program
COSB1	Cantilever Overhead Sign Bridge
CULV	Culvert Detail System
CULV5	Concrete Box Culvert Analysis System
DCIS	Design and Construction Information System
GEOPAK	Roadway Design and Drafting System (vendor-supplied)
GPS	Geodesy, Photo, and Surveying System
IGIDS	Interactive Graphics Intersection Design System (under development)
IGRDS	Interactive Graphics Roadway Design System
OSB6	Overhead Sign Bridge Analysis Program
PCACOL	PC Column
PLANV	Plan View System
PSTRS14	Prestressed Concrete Beam Design/Analysis System
RDS	Roadway Design System
SDMS	Survey Data Management System
SIGNAL	Traffic Signal Pole Assemblies Program
SIGNSZ	Interstate Sign Sizing Program
SPAN	Span Detail System
STAAD-III/ISDS	Structural Analysis and Design - Integrated Structural Design System
THYSYS	Texas Hydraulic System
TRFSGN	Traffic Control Signing Options
TXTOM	Texas Truck Offtrack Modeling System
USF	Universal Specifications File System

Deliver Transportation Systems

CIS	Contract Information System
FIMS	Financial Information Management System
MCS	Material Control System
MMIS	Maintenance Management Information System
SMS	Subcontractor Monitoring System

Maintain and Operate Transportation Systems

HCR	Highway Condition Report
MMIS	Maintenance Management Information System
SES	Single Entry Screen System
SWS	Statewide Safety Improvements System (Title II)

Regulate Transportation Systems

CPS	Central Permits System
IRP	International Registration Plan System
RRA	Registration Report Audit System
RTS	Registration and Title System
SPC	Special License Plates System

Fiscal Services

APS	Automated Purchasing System
ARRS	Automated Receiving Report System
BUD	Budget Monitoring System
CIS	Contract Information System
CMCS	Construction/ Maintenance Contract System
CPS	Central Permit System
FAMS	Funds Allocation and Monitoring System
FIMS	Financial Information Management System
IRP	International Registration Plan System
MSMS	Material and Supply Management System
PAY	Payroll System
RTS	Registration and Title System
SLD	Salary and Labor Distribution
THM	Texas Highways Magazine System
VPS	Vendor Payment System

Contracted Services

BAMS	Bid Analysis Management System
BPS	Bid Proposal System
CBS	Contractor Bidding System
CIS	Contract Information System
CMCS	Construction and Maintenance Contract System
CTS	Contract Tracking System
FIMS	Financial Information Management System
LET	Letting

Human Resources

BEN	Benefits System
CPP	Career Planning Profile System
DRC	Drivers Record Check System
HRIS	Human Resources Information System
INS	Group Insurance System
JAT	Job Applicant Tracking System
PER	Personnel System
RGN	Registrar/N System
VSL	Vacation/Sick Leave System

Information Resources

DOTS	Data on Terminal System
MDC	Master Data Controller
NCS	Natural Control System
OPA	Operations Plan for Automation
PDL	Program Documentation Log
PJS	Planning and Justification System
TACS	Tables and Characteristics System
TSS	Top Secret System

Real Property Management

ROW	Right of Way Records
ROWIS	Right of Way Information System

Equipment, Materials and Supplies Management

APS	Automated Purchasing System
ARMS	Automation Resource Management System
EOS	Equipment Operations System
MES	Minor Equipment System
MSMS	Material and Supply Management System
PJS	Planning and Justification System
SES	Single Entry Screen
UVD	Universal Vendor Descriptions

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Appendix 1

TxDOT Organization Chart

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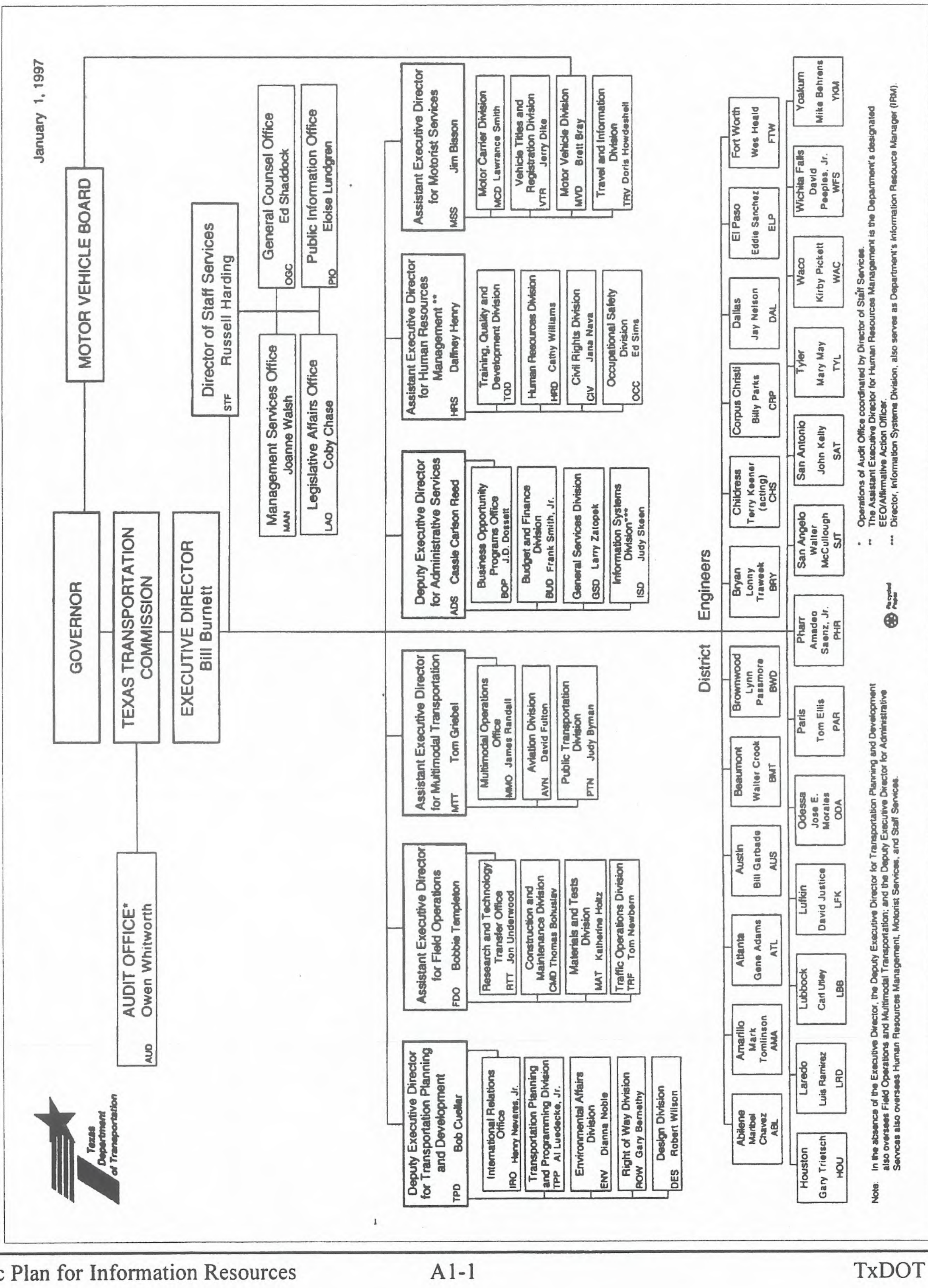

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Appendix 2

The TxDOT Business Model

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OVERVIEW:

The TxDOT business model is described by processes that depict what the department does. *Business areas* group processes by related products and services delivered to TxDOT customers. *Functional areas* in turn group business areas into larger categories of related products and services. Most organizations (including TxDOT) have processes and activities that fall into three categories or *functional areas*:

Management: related to direction for the entire organization

Operations: related to the product or service life cycle

Business Services: necessary activities to support management and operations

Figure A2.1 below represents the fourteen business areas that form the TxDOT business model within the previously described functional areas. Each functional area will be presented with the accompanying business areas and processes in the following discussion.

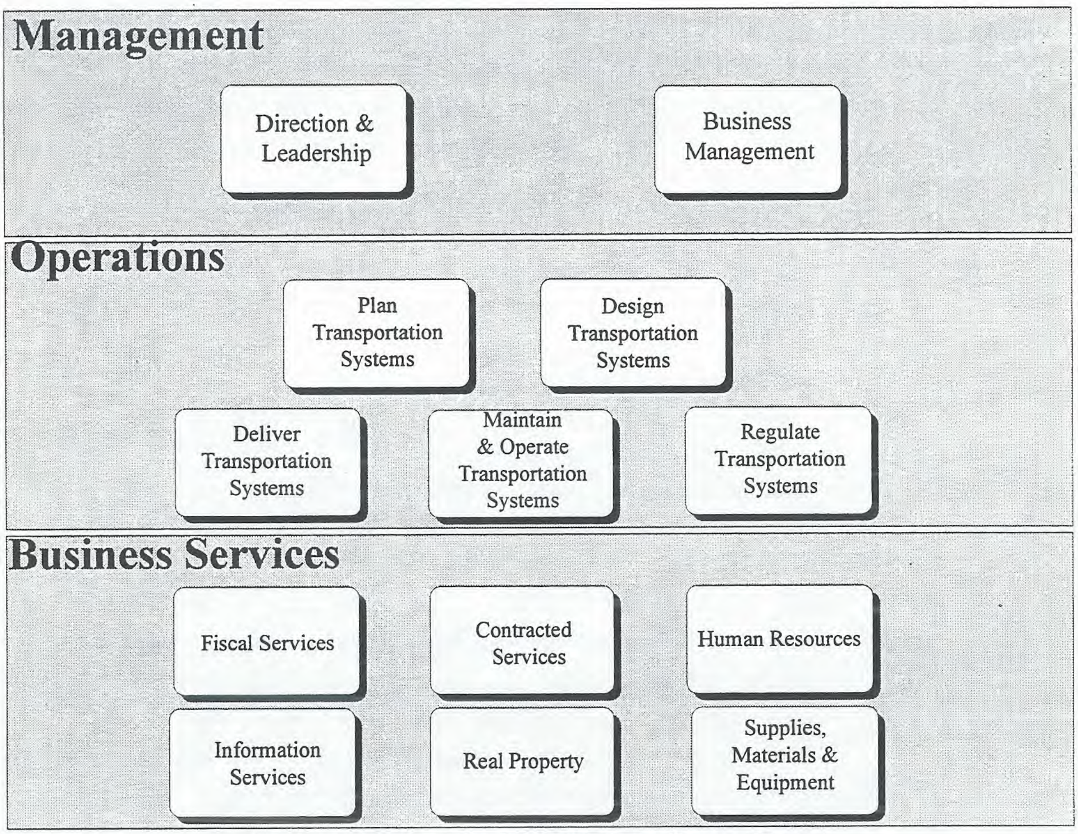

Figure A2.1 - The TxDOT Business Model

Closer observation of the business model indicates that each business area involves multiple organizational units. No one process or activity belongs exclusively to only one part of the organization. To deliver products and services to TxDOT customers, everyone in the organization must contribute. The model represents "what" must happen, not "who" performs the processes or "how" they are performed.

For example, maintenance office activities are described in the following business areas: Plan Transportation Systems, Deliver Transportation Systems, Maintain and Operate Transportation Systems and Regulate Transportation Systems. Maintenance office participation can also be observed in other business areas, including those in the Management and Business Services functional areas. This concept is important because it demonstrates the model as a working picture of the services provided by the department, not the organizational chart.

MANAGEMENT FUNCTIONAL AREA:

It is important to realize the distinction between the management functional area and the management of the organization. Management *for the organization* establishes hierarchy ("chain of command"). The management *functional area* encompasses the processes necessary to provide direction for other business areas and processes within the model. Direction, guidance and coordination for and evaluation of the organization as a whole are the result of processes within this functional area.

Two business areas have been defined, Direction and Leadership and Business Management. The functional area, business areas and processes were developed based on workshop results for the Operations and Business Services functional areas. It is anticipated that the business areas will be refined through further analysis because these areas were defined without the benefit of workshops. The management functional area with two business areas is represented in Figure A2.2 below.

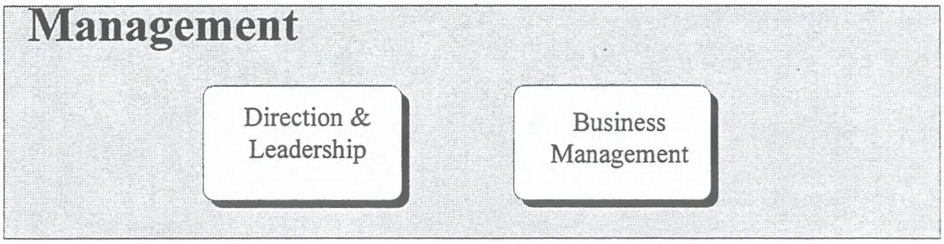

Figure A2.2 - Management Functional Area

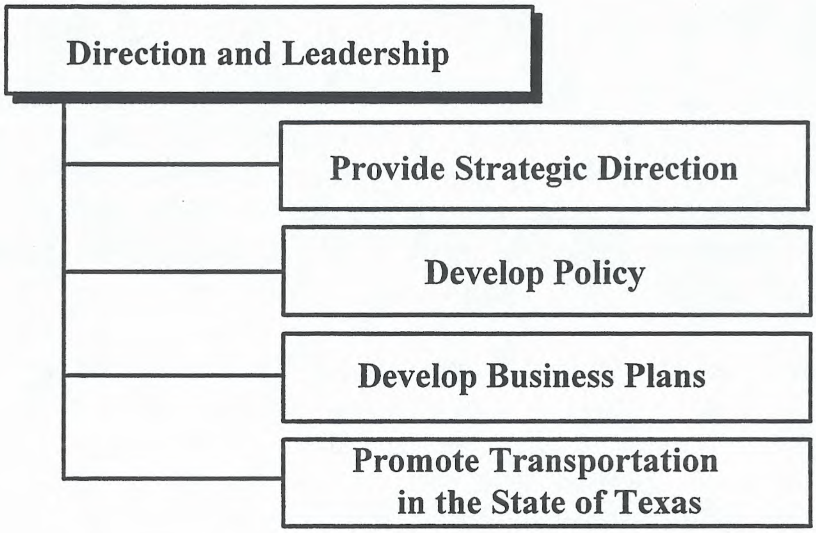

Figure A2.3 - Processes within the "Direction and Leadership" Business Area

Direction & Leadership: Establishes the strategic direction for the department and its operations and includes producing business plans to achieve this direction (see Figure A2.3).

It is important to remember that all segments of the organization, not just upper management, are responsible for carrying out activities within this business area. This business area is composed of four processes.

> ***Provide Strategic Direction:*** Sets the future direction, mission and goals for the department and establishes strategies for achieving them.
>
> ***Develop Policy:*** Provides for internal leadership by establishing mandates which department offices are to follow when conducting their business.
>
> ***Develop Business Plans:*** Produces operating plans that enable the department to reach its strategic mission, goals and objectives.
>
> ***Promote Transportation in the State of Texas:*** Provides a proactive look at marketing the different products and services available to individuals and businesses using the transportation systems to move either people or goods.

Note that business plans include resource plans (financial, personnel, equipment and information and systems plans), communications plans, marketing plans, etc. These plans are tactical in nature, as opposed to the strategic plan.

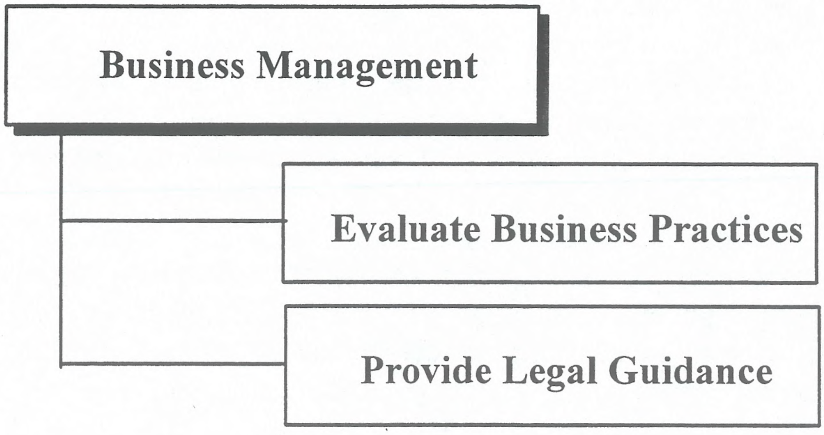

Figure A2.4 - Processes within the "Business Management" Business Area

<u>**Business Management:**</u> Oversees department operations by reviewing, evaluating and recommending actions to improve the way the department does business (see Figure A2.4).

The effectiveness and performance monitoring of the business plans would be carried out within this business area. Two processes make up this business area:

> *Evaluate Business Practices:* Evaluates the way the department conducts business and recommends business improvements or courses of action to ensure compliance with policies and legislation.
>
> *Provide Legal Guidance:* Provides for legal advice when performing department responsibilities and operations.

OPERATIONS FUNCTIONAL AREA:

The product or service life cycle is often described in business models by an operations functional area. The business areas and processes described within the operations functional area are those which plan, develop, produce and maintain the products and services unique to TxDOT.

Within TxDOT, most organization units perform activities in more than one business area. In contrast, no one organization unit is singularly responsible for a particular business area. The processes and activities within the business model include the actions performed by department personnel or by external entities with oversight by department personnel.

Note that "transportation systems" is a common term to all five business areas. All modes of transportation are included in this term. Another assumption throughout the model is that actions reflected in the model comprehensively address the delivery of all TxDOT products and services. In some areas, such as public transportation and aviation, TxDOT's role is not as direct in the delivery of services. TxDOT is, however, responsible to assure that the services are delivered, so the model has been customized to accommodate those roles. The operations functional area with five business areas is represented in Figure A2.5 below.

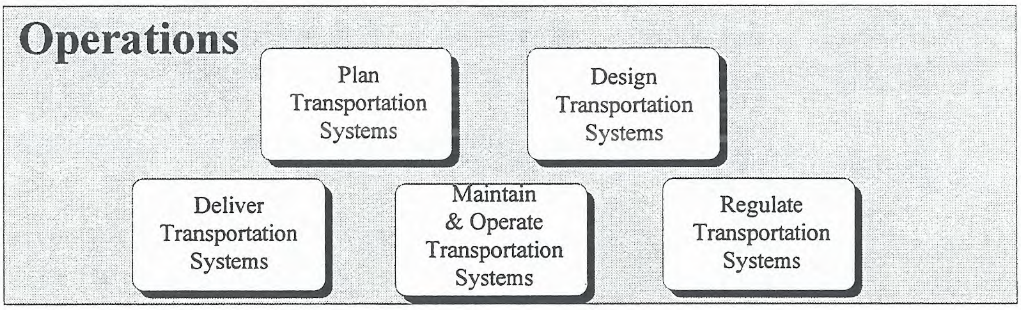

Figure A2.5 - Operations Functional Area

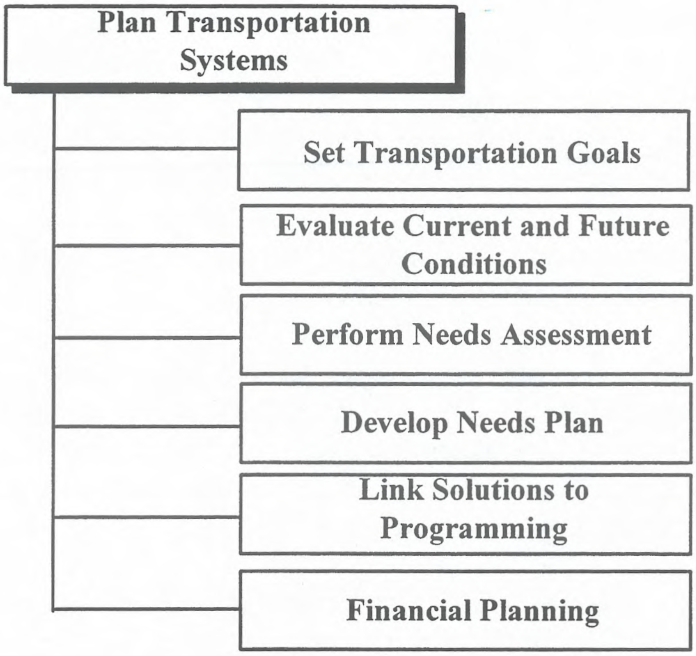

Figure A2.6 - Processes within the "Plan Transportation Systems" Business Area

<u>**Plan Transportation Systems:**</u> Addresses transportation needs by identifying, prioritizing and scheduling transportation solutions/projects (see Figure A2.6).

This business area begins with transportation needs and results in funded projects. The planning approach outlined in this business area addresses needs based upon a statewide transportation plan, including statewide goals. The plan should drive the funding and scheduling of projects for all transportation systems. The processes within this business area are iterative and dependent on other processes within the model. Iterations through the processes may be driven by factors such as changing needs, mandates, revised project circumstances, etc.

A solution may consist of one or many projects. The projects may be mode specific or incorporate the use of more than one mode to meet the identified need. This planning approach emphasizes the use of multiple modes to move people and goods in the most feasible and effective manner. Planning is currently done by mode with very little integration. Life cycle planning for systems is also essential. The planning is not only for initial implementation of a transportation solution but the preservation and continued operation of the solution as well. Long-term costs of preservation are not always considered with current project alternative and solution selection.

Set Transportation Goals: Establishes, reviews, and revises the overall policy goals and strategies for the Texas transportation system. These policy goals and strategies are also used for agency strategic planning. Consistent goals are established for individual modes and corridors. Performance measures are developed that enable the planning process to assess progress towards or away from the transportation system goals. Financial goals and strategies are developed and revised as needed to help obtain the transportation goals. Stakeholders and the public are involved throughout the process to ensure transportation providers and users participate in the development of transportation system goals and strategies.

Evaluate Current and Future Conditions: Current and projected conditions of the existing transportation system are determined and documented. Future system conditions are forecasted and determined using methods and tools for the different elements of the transportation system. As part of this process current and future transportation revenues are determined and forecasted.

Perform Needs Assessment: Identifies transportation needs by considering transportation goals, performance measures, and current and future conditions of the defined transportation system by using standard methods for identifying and measuring transportation system deficiencies from which needs will be derived.

Develop Needs Plan: Develop and document planned solutions to meet identified transportation system needs. These solutions provide strategies, actions, improvements, and potential programs and projects that will be implemented to meet transportation system goals.

Link Solutions to Programming: Provides a smooth flow of programs and projects from long-range planning to short-range implementation. Develops programs and projects from the transportation needs plan. Broad goal-related categories (e.g. mobility, maintenance, safety, intermodal, modal, etc.) and funding requirements are identified in the needs plan.

Financial Planning: Occurs as part of and concurrent with other processes. Improves the integration of continuous statewide transportation planning and programming processes with its financial element. Encourages the development of new and innovative funding methods and maximizes existing funding sources. Funding is directly linked to planning, transportation needs, and meeting transportation system goals and performance measures. Funding requirements for all modes of transportation are more effectively addressed. Balanced funding goals are identified and prioritized for broad transportation goal-related categories to maintain the effectiveness of the transportation system.

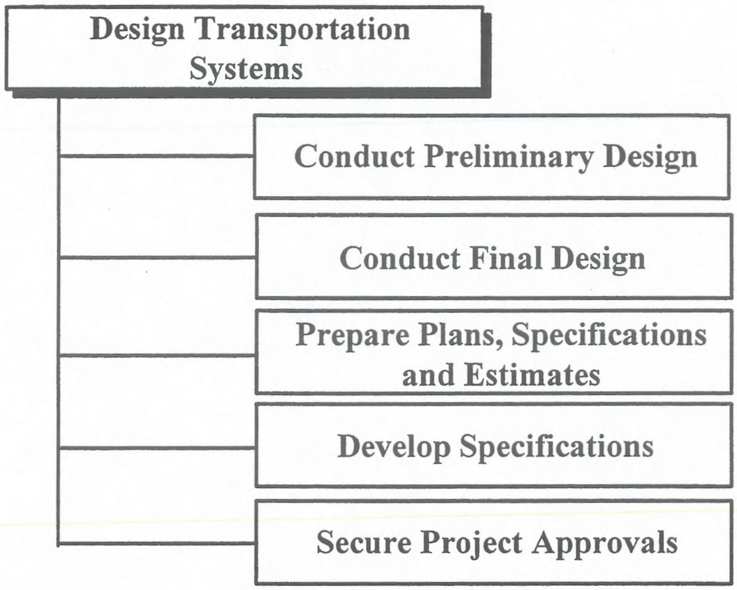

Figure A2.7 - Processes within the "Design Transportation Systems" Business Area

Design Transportation Systems: Transforms solutions from a conceptual framework to a fully designed project with detailed plans and specifications (see Figure A2.7).

The plans and specifications are developed for all transportation systems and facilities that serve TxDOT's external customers (roadways, right-of-way maintenance, transit facilities and services, aviation facilities, landscape, rest areas, travel information centers, etc.) Activities within the processes include providing oversight for external entities delivering design projects (e.g., transit authorities and consultants). The five processes are defined as follows:

> ***Conduct Preliminary Design:*** Refines the project scope and initiates the design of the project.
>
> ***Conduct Final Design:*** Performs primary design functions, including design and quantity calculations, developing details and selecting applicable specifications.
>
> ***Prepare Plans, Specifications and Estimates:*** Compiles the project details into a published form, ready for proposal preparation and contract development.

Develop Specifications: Develops project specifications and makes them available for project designers. Identifies needed utility adjustments.

Secure Project Approvals: Provides appropriate coordination with external entities for effective communication and approvals.

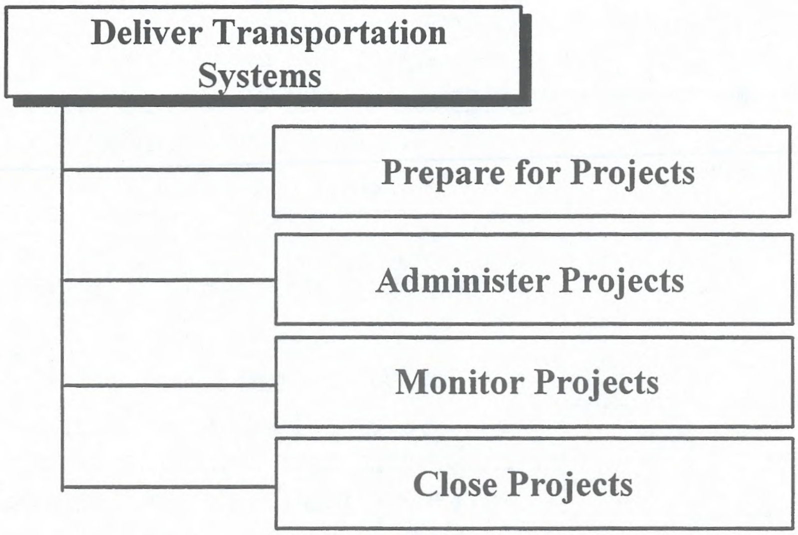

Figure A2.8 - Processes within the "Design Transportation Systems" Business Area

<u>Deliver Transportation Systems:</u> Transforms a fully designed project with detailed plans and specifications to a delivered product (construction projects, maintenance projects, transit facilities and services, landscape projects, traffic control systems projects, airport facilities, etc.). The "Deliver Transportation Systems" business area is depicted in Figure A2.8 above.

The activities in this business area are directed toward project management and includes quality assurance of delivered products. The business area also provides oversight for projects administered by external partners. Processes include:

> ***Prepare for Projects:*** Prepares project personnel to manage and inspect a project.
>
> ***Administer Projects:*** Performs project management, material testing and contract compliance functions to achieve quality assurance.
>
> ***Monitor Projects:*** Performs project inspection and record keeping to provide quality control.
>
> ***Close Projects:*** Performs the final acceptance of a completed project.

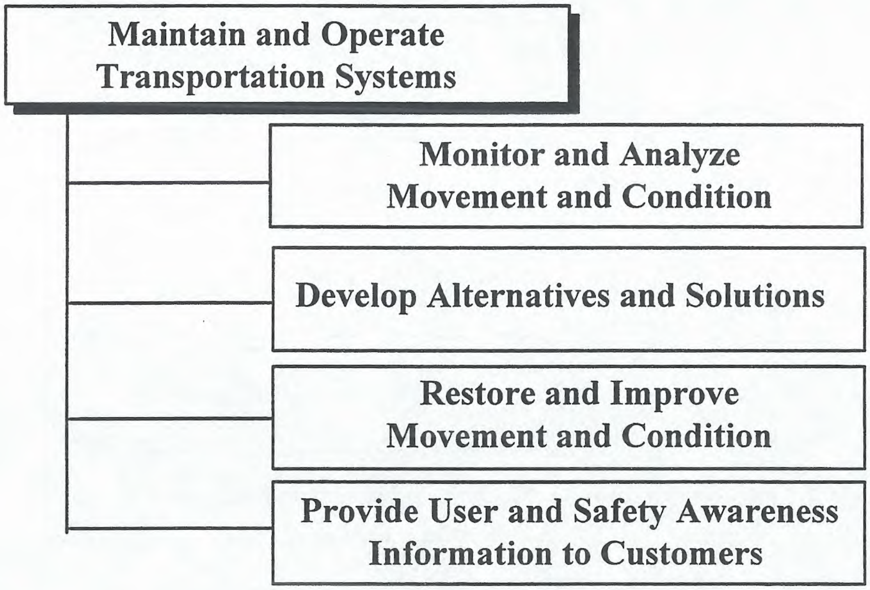

Figure A2.9 - Processes within the "Maintain and Operate Transportation Systems" Business Area

<u>Maintain and Operate Transportation Systems:</u> Keeps people and goods moving safely and efficiently on all modes of transportation networks (see Figure A2.9).

Some processes in this business area duplicate terms in the Plan Transportation Systems business area. The distinction lies within the continual and time responsive manner in which these activities are performed. The Plan Transportation Systems business area results in funded projects to address statewide transportation needs. The Maintain and Operate Transportation Systems business area results in the most effective <u>continual</u> operation and preservation of the transportation system. The activities performed within this business area are performed on a daily basis with a focus on responsiveness, safety and prevention of disruptions to movement and deterioration of the transportation systems. An effective transportation system operates best when users are properly informed. Having excellent facilities can be wasted if users do not know how to effectively and safely use the system. Processes include:

> ***Monitor and Analyze Movement and Condition:*** Continually observes, detects and determines causes of disruptions to flow and deterioration of the system.
>
> ***Develop Alternatives and Solutions:*** Identifies and develops solutions and courses of action to address disruption and deterioration.

Restore and Improve Movement and Condition: Preserves or restores system flow and condition to an acceptable level of service.

Provide User and Safety Awareness Information to Customers: Provides customers with educational and navigational information to effectively and safely utilize transportation systems.

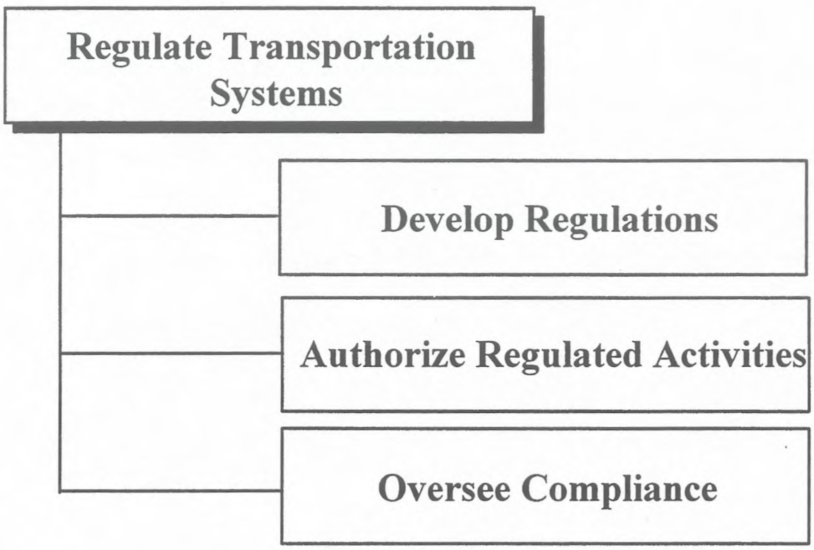

Figure A2.10 - Processes within the "Regulate Transportation Systems" Business Area

<u>Regulate Transportation Systems:</u> Enforces compliance with regulations relating to the use of the transportation systems and state owned right-of-way by issuing licenses or permits, or as specified by law (see Figure A2.10).

This business area concentrates on regulating the use of the transportation system only after the system is in place. It includes regulating the use of the right-of-way; registering and titling vehicles; licensing motor vehicle dealers, manufacturers, distributors and converters; issuing oversize/overweight permits, utility and driveway permits; regulating outdoor advertising signs and junkyards; and regulating the construction of tall towers near general aviation airports. TxDOT has limited enforcement powers in these areas except in licensing motor vehicle dealers, manufacturers and converters.

Where authorized, the department is responsible for developing the regulations for others to follow, authorizing the regulated activity and overseeing compliance. The department performs these regulatory activities for various reasons including the safety of the public; consumer protection; to protect and preserve the transportation system; to protect the environment; and to be in compliance with state and federal laws.

Processes include:

Develop Regulations: Develops regulations for an area that the department is responsible or in response to federal or state laws and rules that give the department the authority to govern a particular activity.

Authorize Regulated Activities: Accepts applications and any related fees or bonds, reviews the application and either grants or denies the authorization (e.g., license or permit).

Oversee Compliance: Ensures that authorized individuals, companies or other entities comply with regulations established by the department. Includes subsequent renewal or cancellation of the authorization.

BUSINESS SERVICES FUNCTIONAL AREA:

Business services are those processes that are not directly associated with the product life cycle or the management processes described by the other two functional areas, but are necessary to support both. The six business areas do not directly deliver TxDOT products and services to external customers. The operations and management functional areas could not deliver products and services, however, without the support of processes and activities within the business services functional area. The activities and processes within these business areas may be performed in any and all department offices including maintenance and area offices, district offices, divisions and special offices. The business services functional area with six business areas is represented in Figure A2.11 below.

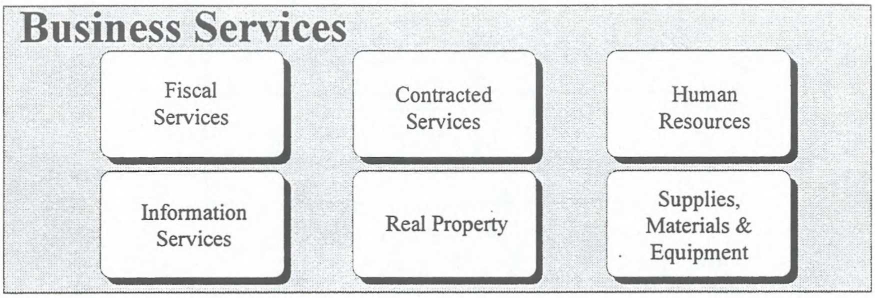

Figure A2.11 - Business Services Functional Area

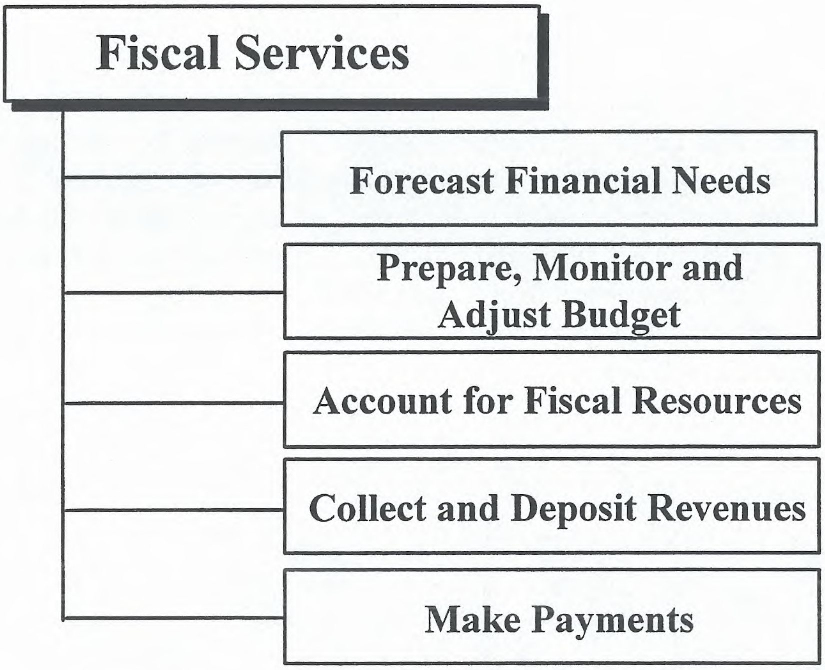

Figure A2.12 - Processes within the "Fiscal Services" Business Area

Fiscal Services: Determines financial needs and manages the department's financial resources (see Figure A2.12). Processes include:

Forecast Financial Needs: Identifies all trends, impacts, constraints and other factors that will affect the department's future financial needs and effectively quantifies those needs.

Prepare, Monitor and Adjust Budget: Provides for the allocation of money to be spent towards planned expenditures necessary for the department to perform according to plans. Also provides for monitoring and adjusting the allocation of money between budget cycles to ensure the department continues to perform according to plans.

Account for Fiscal Resources: Tracks and analyzes the department's use of taxpayers' dollars in order to facilitate decision-making and ensure fiscal accountability includes financial accounting, internal control procedures and financial reporting.

Collect and Deposit Revenues: Collects and deposits all financial resources owed or entitled to the department.

Make Payments: Pays and records expenditures owed or obligated by the department to other entities and to employees.

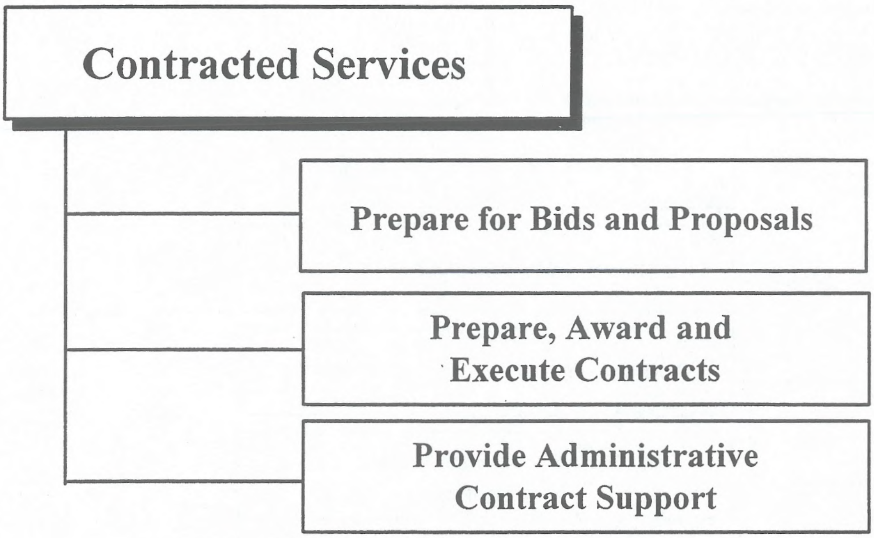

Figure A2.13 - Processes within the "Contracted Services" Business Area

<u>Contracted Services:</u> Guides and supports the various department functions responsible for project management and oversight of contracted services (see Figure A2.13). Processes include:

Prepare for Bids and Proposals: Prepares final bid proposals and requests for proposal, notifies potential candidates of project availability and ensures candidates are qualified to perform proposed projects.

Prepare, Award and Execute Contracts: Determines the most qualified candidate based on submitted bids and proposals, prepares and awards the contract and ensures that all contract requirements are met before work begins.

Provide Administrative Contract Support: Advises, recommends and assists project and contract managers with responsibilities related to contract administration (e.g., contract revisions, subcontractor approvals, claims resolution).

Figure A2.14 - Processes within the "Human Resources" Business Area

__Human Resources:__ Addresses the department's needs by effectively hiring, managing and supporting human resources (see Figure A2.14). Processes include:

> ***Plan for Workforce Needs :*** Forecasts, analyzes and allocates workforce needs for the department. Workforce needs include: managing legislative issues; analyzing diversity; managing human resource information; and developing and managing human resource policies and procedures.
>
> ***Provide Employment Opportunities:*** Recruits, screens, selects and tracks qualified individuals to meet the department's workforce needs including coordination of special programs.
>
> ***Manage Training and Development:*** Assesses and manages workforce developmental needs and curriculum effectiveness including training registration, scheduling and career development.
>
> ***Administer Compensation and Benefits:*** Coordinates and ensures benefit availability to all employees by providing communication, education and benefit administration. Administers payroll.

Oversee Employee Relations: Manages, coordinates and tracks employee information, performance and satisfaction including the complaints and appeals process, awards, separation, and work and family programs.

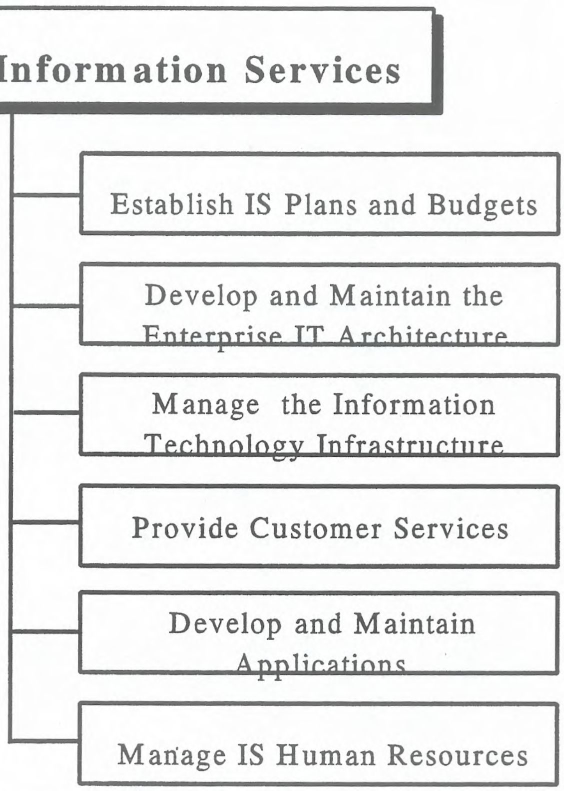

Figure A2.15 - Processes within the "Information Services" Business Area

<u>**Information Services:**</u> Enables and supports TxDOT's effective use of information as a business resource including services for communicating information (see Figure A2.15). Processes include:

Establish IS Plans and Budgets: Defines strategic and operational planning for information resources to support business information needs. Defines the IR budgeting process and identifies priorities within the Information Services business area. This process also includes monitoring of budgets and plans.

Develop and Maintain the Enterprise IT Architecture: Includes subprocesses to research, evaluate, and procure Information Technology and Services in support of the Enterprise IT Architecture. Designs and manages IS data, application and technology architectures to support the current business needs and anticipated future business direction. The Enterprise IT Architecture includes Core Technology, Office Systems, Engineering/CADD/GIS, Application, Field Data Collection, and Data Architectures. The Enterprise Data Program is also managed as part of this overall IS process.

Manage the Information Technology Infrastructure: Includes subprocesses to plan and manage mainframe operations, the wide-area network, the local-area networks, servers, and desktops. Infrastructure implementation and integration strategies are defined technology procurements are made to support the infrastructure. Other components in this area are telecommunications management, database systems management, and monitoring operational performance. Information security and IR Interruption Risk is managed as part of this overall IS process.

Provide Customer Services: Provides support and training services to information services users as well as IS professionals. This includes problem resolution and consulting services in many IS processes such as methodology and IS project management.

Develop and Maintain Applications: Designs, builds, selects and delivers applications and manages development projects. Maintains and enhances application functionality and technical quality.

Manage IS Human Resources: Defines career paths and career development plans for IS professionals, identifies and provides training and maintains skills inventory. Staff performance will also be evaluated.

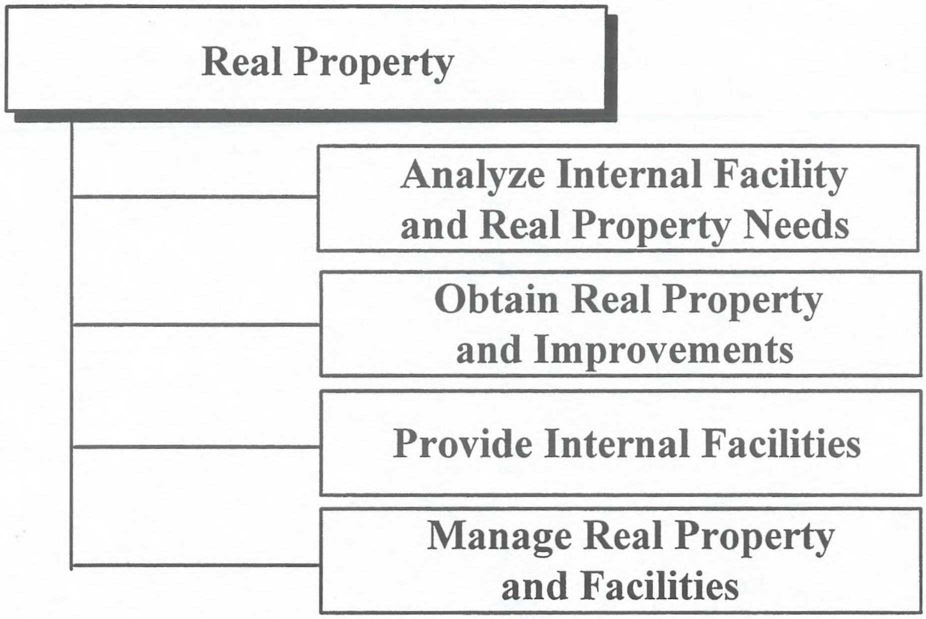

Figure A2.16 - Processes within the "Real Property" Business Area

<u>Real Property:</u> Acquires, manages and disposes of buildings and/or land for the transportation system and for the department's employees and assets (see Figure A2.16). Processes include:

Analyze Internal Facility and Real Property Needs: Identifies and analyzes land and building needs for effectively housing and supporting the employees and property of the department. (Note: Real property needs for the transportation system are identified in "Design Transportation Systems.")

Obtain Real Property and Improvements: Acquires land and improvements to serve the transportation system or to house TxDOT employees and property. Included in this process are the following right-of-way acquisition subprocesses: appraisal, negotiation, eminent domain, relocation, property management and utility adjustments.

Provide Internal Facilities: Develops plans and specifications for construction or renovation of facilities for department employees and property. Includes overseeing the construction, remodeling or demolition of facilities.

Manage Real Property and Facilities (internal & transportation system): Maintains, protects and manages land and improvements that house department employees and property. Includes real estate activities and transactions related to transportation system parcels and managing land and facilities leased by the department to serve the public and the department's internal needs.

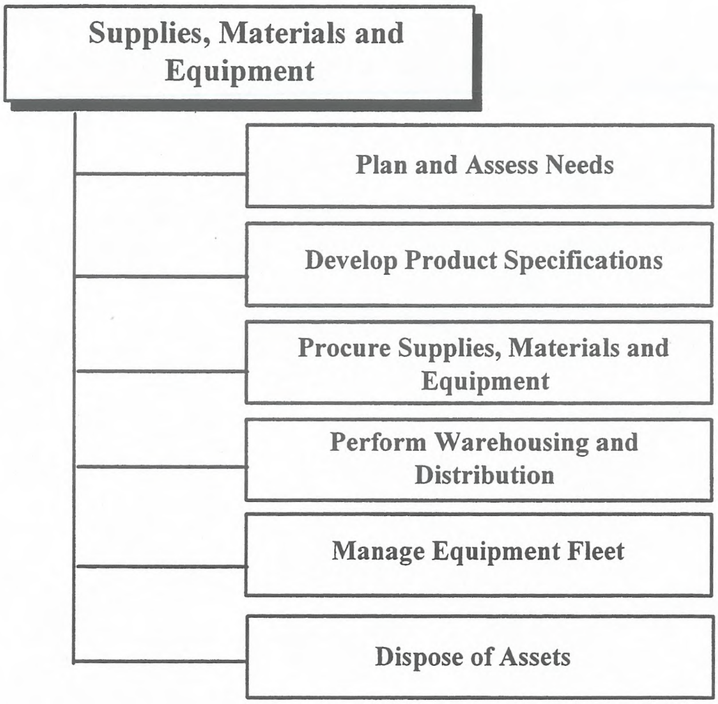

Figure A2.17 - Processes within the "Supplies, Materials and Equipment" Business Area

<u>Supplies, Materials and Equipment:</u> Analyzes needs, procures, manages and disposes of supplies, materials and equipment (see Figure A2.17). Processes include:

> *Plan and Assess Needs:* Assesses and evaluates the supply, materials and equipment needs and plans for procurement of items at the right time and in the most cost effective and efficient manner.
>
> *Develop Product Specifications:* Assesses product availability in the marketplace to fulfill department needs and evaluates products for specific requirements.
>
> *Procure Supplies, Materials and Equipment:* Acquires supplies, materials and equipment for day-to-day operations of the department.
>
> *Perform Warehousing and Distribution:* Stores, tracks and moves supplies, materials and equipment to satisfy customer needs in a timely manner.

Manage Equipment Fleet: Maintains, tracks and repairs the department's equipment fleet.

Dispose of Assets: Disposes of excess, surplus and scrap property by transferring, trading, donating, selling or destroying items that are no longer needed.

Appendix 3

Internal and External Assessments

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This appendix contains three subsections which describe the internal and external assessments performed as part of TxDOT's Business Information and Systems Plan published in September 1994. The three sections are included here as originally published in the 1994 document (except for references to figures or other sections of the Strategic Plan for Information Resources).

- ♦ INTERNAL ASSESSMENT
- ♦ EXTERNAL ASSESSMENT
- ♦ SERVICE AREAS FOR EXTERNAL ASSESSMENT

Section A: Internal Assessment

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OVERVIEW:

The objective of the Internal Assessment is to inventory and evaluate the business functionality and technical quality of current information systems, including applications, data, and technology, and to evaluate the history of spending for information resources. These evaluations are input into the development of the Information Resources, described in Chapter IV (of the 1994 BISP).

Application, database and technology evaluations were conducted through interviews and surveys with project leaders, offices of primary responsibility (OPR), management representatives, technical staff and users throughout the department. The business and engineering applications were evaluated for platform, programming language, age, functional quality and technical foundation. The database evaluation included a review of the data environment and database management systems. The technology assessment describes the existing hardware and software platforms used throughout the department.

This section also includes a summary of the overall level of user satisfaction with IS services. This assessment is based on a survey distributed to a sampling of users, representing all business areas of the department.

Finally, this section provides a historical perspective on TxDOT's IS expenditures. The IS budget has been analyzed to identify trends in technology, staff and training spending.

EVALUATIONS:

Application Evaluation:

There are 106 existing applications supported by the Information Systems Division (ISD). Brief descriptions of these applications appear in Appendix 2 (of the 1994 BISP). Organizationally, these applications are divided into two sections: Business and Engineering. The business applications include the Financial Information Management System, Design and Construction Tracking, Transportation and Motor Vehicle applications, and other Management Information Systems. Engineering applications are primarily graphical applications used to design and analyze highway and bridge structures. Automated Plan Preparation and Roadway Design System are large applications supported by the Engineering section.

The general characteristics of these applications are described below. This summary is based on survey responses from end users and the ISD project leaders.

Business Area Support: Figure A3.1 represents the distribution of ISD applications among the department's business areas. Refer to Section H of this plan for a listing of the applications for each business area.

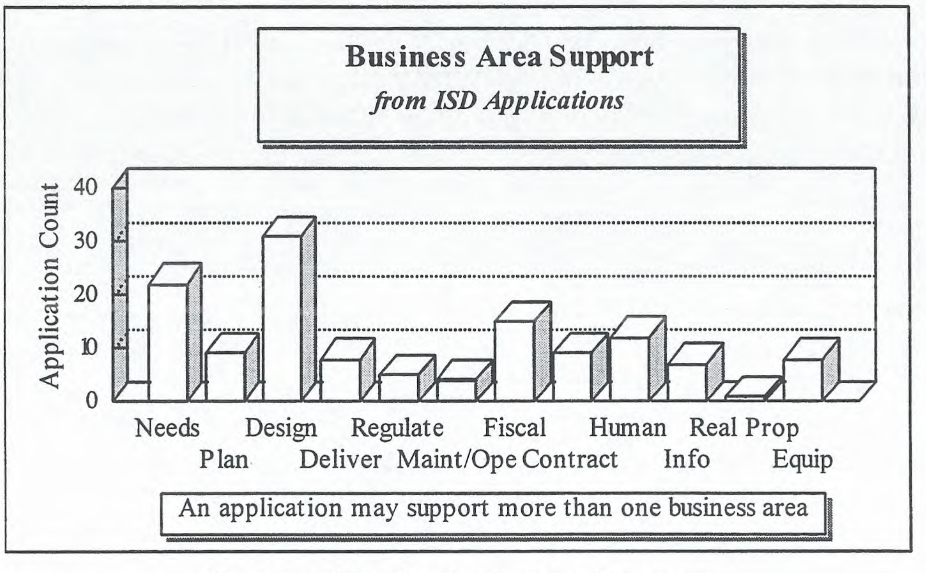

Figure A3.1 - Business Area Support

More than 60 percent of the ISD applications support the business areas of "Determine and Analyze Transportation Needs," "Design Transportation Systems," and "Fiscal Services." "Maintain and Operate Transportation Systems" and "Real Property" are the business areas least supported by ISD applications.

Platform: The Department of Transportation uses the mainframe platform for the majority of its processing. As depicted in Figure A3.2, 74 percent of the centrally supported applications are processed exclusively on a mainframe platform, 14 percent are PC-based, and 12 percent exist on both the mainframe and PC platform.

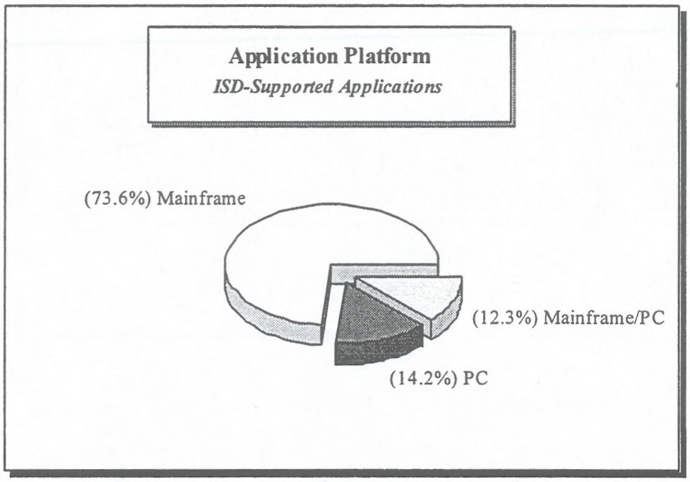

Figure A3.2 - Application Platform

The department trend, however, is towards increased development of PC applications. Of the 24 applications implemented since 1991, 17 are PC-based or incorporate PC processing for some procedures. As new development takes place on non-mainframe platforms, the need to interface with existing applications and/or enterprise data will continue to force application developers to utilize a mainframe platform for some processing and/or data access.

Processing Mode: Figure A3.3 illustrates the extent of online and batch processing for both update and inquiry processes.

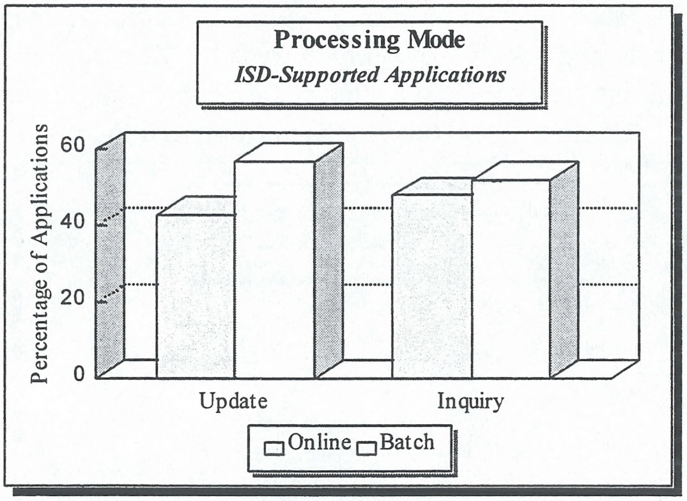

Figure A3.3 - Processing Mode

More than 50 percent of the applications process in batch mode. A critical factor in the batch environment is the Master Data Controller (MDC), which controls update, interface, and error recovery processing for twelve MIS applications.

The implications of a predominantly batch environment include:

- Increased technical and user support to submit jobs and monitor results
- Limited window of processing time
- Difficult to use applications
- Reduced productivity due to prolonged turn-around time

The transition towards graphical user interface (GUI) applications is quicker and smoother for applications already using online processing. Because more than 50 percent of the ISD applications operate in batch mode, this transition will require extensive planning and coordination.

Programming Languages: The predominant programming languages are COBOL, FORTRAN, and Natural. The Roscoe Programming Facility (RPF) is also used to provide a user front-end for batch job submission. The use of these programming languages is consistent with the high percentage of mainframe applications. The usage of programming languages is represented in Figure A3.4.

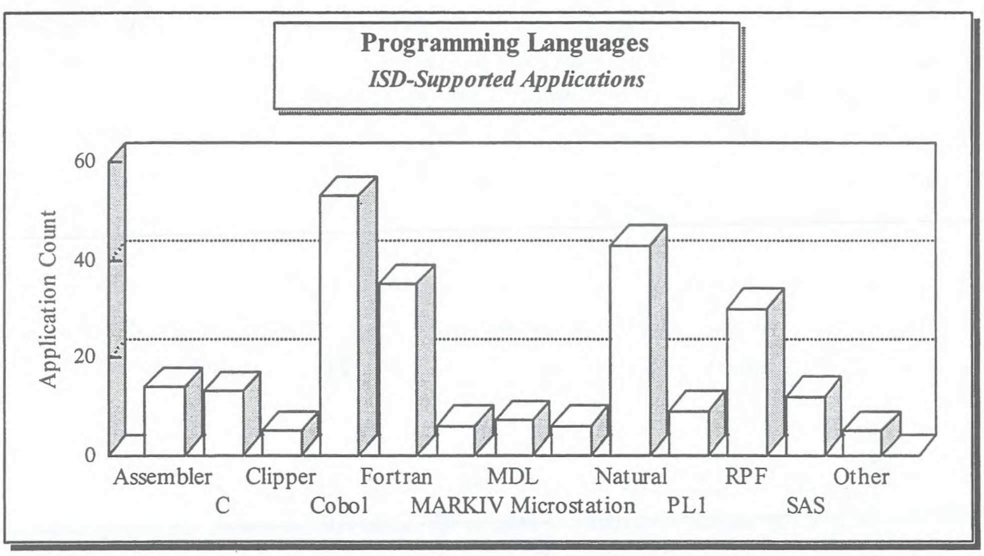

Figure A3.4 - Programming Languages

Twenty-six percent of the applications are written in programming languages considered to be obsolete (Assembler, Mark IV, and PL1). The maintenance of these applications will be increasingly difficult as the availability of programmers skilled in these languages diminishes.

Proprietary Application Software: Only 10 percent of the department's applications use proprietary application software for some or all processing. Factors contributing to the low utilization of packaged software include:

- Unavailability of proprietary solutions, due to unique requirements of transportation business areas
- Long procurement process
- Historical problems with maintenance contracts and/or package customization
- Platform and integration problems
- Requirement to share data with other applications

Interfaces: The department's applications are highly interfaced and depend on data generated by other applications. Eighty percent of the applications interface with other applications by:

- Reading data from another application,
- Updating another application,
- Passing transactions to an application, and
- Sharing processes.

This level of interface makes it difficult to enhance or modify applications. Modifications to one application can have a snowball effect on other applications, resulting in long maintenance cycles and complicated programs. The single application/single database development strategy perpetuates application interfaces. When each application has its own database (or set of files), interfaces to update duplicate data in other databases are required.

Most of these interfaces occur among the business applications. There is virtually no automated communication between the business and engineering applications. Although there is data to be shared among these applications, interfaces have not been developed because:

- The systems operate on separate non-integrated platforms,
- Each development section is organizationally isolated,
- The systems use different database management technologies, and
- Original application design did not include the need for integration with other systems.

Age: Many of the department's first automated systems are still used today. Fifteen percent of the production applications have existed for over 20 years. The age of the ISD applications is graphically represented in Figure A3.5.

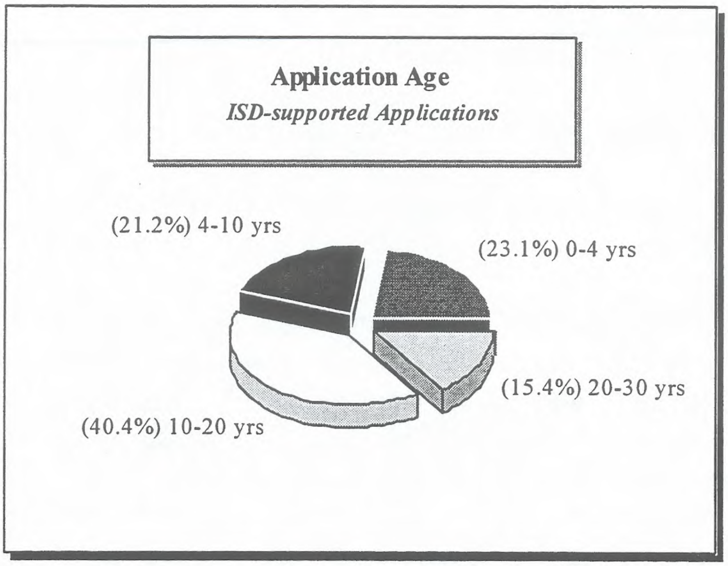

Figure A3.5 - Application Age

Most of these older applications have been modified to prolong their useful life. However, the age of these applications suggests that the applications are unstructured, difficult to maintain and use old technology. These conclusions are supported by the technical quality review (refer to the "Technical Quality" section for more information on the technical evaluation of these applications)

Functional Quality: The functional quality of the ISD applications was evaluated by the Office of Primary Responsibility (OPR) for each application and a sampling of end users. Applications were evaluated in the following five areas:

- Overall satisfaction
- Functionality
- Integration with other applications
- Useability
- Support

Overall satisfaction was rated as moderately satisfactory for the functionality, integration and useability of these applications. On a scale from 1 (unsatisfactory) to 5 (excellent), ISD applications were rated as 3 (satisfactory) in each of the above categories. In order to analyze these results in more detail, the functional scores were grouped by business area.

Clearly, some business areas are better supported than others. The business areas with the highest functionally-rated applications are:

- Regulate Transportation Systems,
- Fiscal Services, and
- Equipment, Materials and Supplies.

The business areas with the lowest rated applications are:

- Determine and Analyze Transportation Needs, and
- Plan Transportation Systems.

Some of the department's oldest applications are used to collect data in the Needs business area. The changing demands of this business area, which includes ISTEA mandates, and the antiquated data-input procedures for these applications are probable explanations for the low ratings. The low functionality rating in the Plan business area reflects the lack of solid decision-support modeling tools.

ISD application Functionality is only partially satisfying the users' business needs. Users are satisfied that the applications process correctly, but much functionality is missing from the applications. This is evidenced by the large number of local applications developed to fill the gaps left by ISD applications.

A common complaint is that applications need to have better Integration with other applications. Too often, users are having to re-enter data in two applications. A number of applications are considered to be incomplete because they do not link to a related application or use data owned by another application.

Many users have requested improvements in the Useability of applications by including graphical user interfaces (GUI). As users become more familiar with PC applications, they are asking for the same type of presentation from the mainframe applications. The useability of an application is also determined by data access and the availability of reports. Users are asking for more flexibility in the way in which data is presented.

Several users have been complimentary of the ISD Support provided by the project leaders and programmers. However, many are dissatisfied with the prioritization process and long wait-period before enhancements can be made to an application. This delay often forces users to use the application differently than it was designed, perpetuates data integrity problems, and hinders the user's ability to conduct business.

The training and documentation support for these applications is often inadequate.

Training is usually provided as new applications are implemented, but few applications offer on-going training. Additionally, users do not always know which applications are available, or what the applications are capable of doing.

Technical Quality: Technical quality of the ISD applications was evaluated on the following four criteria:

- Performance
- Ease of Maintenance
- Technical Foundation
- Quality of Design

The ISD project leaders were asked to evaluate each application. The following figures summarize the results.

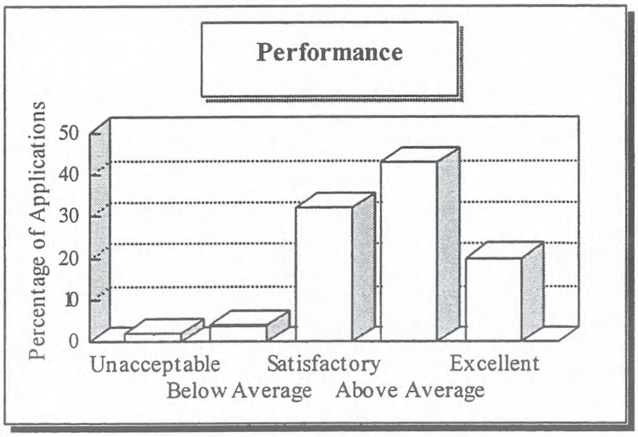

Figure A3.6 - Performance

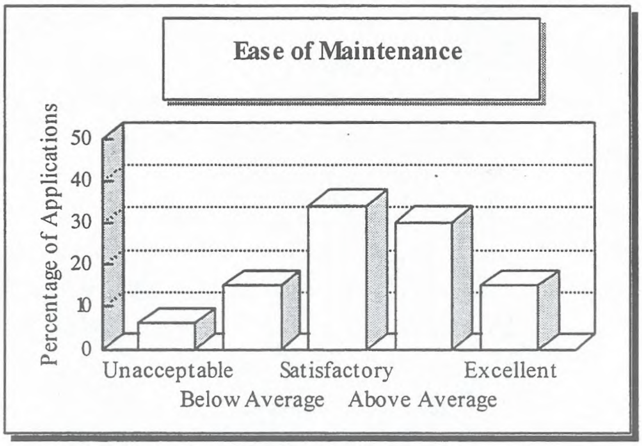

Figure A3.7 - Ease of Maintenance

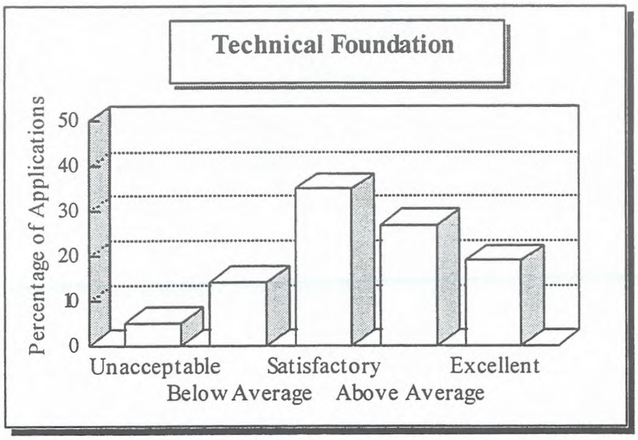

Figure A3.8 - Technical Foundation

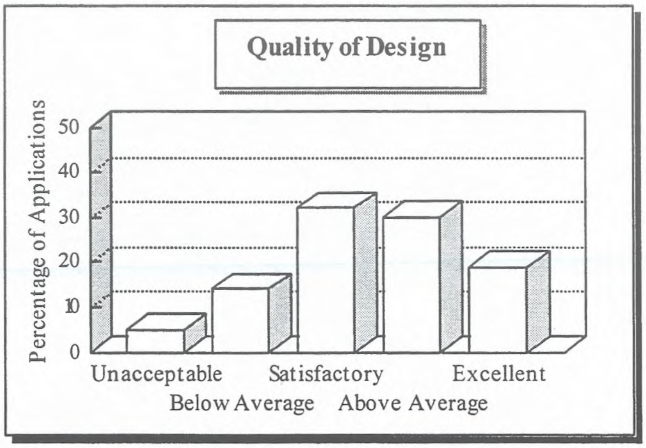

Figure A3.9 - Quality of Design

The Performance rating considers the rate of abnormal terminations, the amount of resources consumed, and the processing time for the application. The high ratings in this category are an indicator of the department's competence with mainframe processing. Ninety-four percent of the applications perform at or above satisfactory levels.

Ease of Maintenance considers the degree to which structured programming is used, the modularity of the design, the languages used, the age of the system, previous modifications and adherence to department standards. Twenty-one percent of the applications are difficult to maintain. Additional factors contributing to difficult maintenance include:

- Programmer turnover
- Lack of technical documentation
- Number of interfaces to other applications

Often, a maintenance change to a single program may be a relatively simple task. However, given the level of integration between programs and applications, most maintenance efforts require changes to multiple programs. This "domino effect" accounts for the lengthy time required to complete a maintenance request.

The Technical Foundation rating considers whether the application uses procedures, methods, techniques, equipment, and/or languages which are obsolete or which will soon become obsolete. The technical foundation is satisfactory (or better) for 81 percent of the ISD applications. However, only 46 percent of the applications have an excellent or above-average technical foundation. This is indicative of the widespread use of batch, mainframe processing.

The Quality of Design rating measures the overall technical design of the application. Eighty-one percent of the ISD applications have at least a satisfactory technical design.

Overall, 23 percent of the applications have an unacceptable or below-average technical rating. These applications may be candidates for replacement or technical modifications. Conversely, only 15 percent of the applications were evaluated as technically excellent. This suggests that functional modifications to the majority of the applications will be cumbersome and time-consuming.

Locally-Developed Applications: More than 250 applications have been developed by local automation staffs and end users, as identified through survey responses from the automation administrators. Most of these applications are used to support the following business areas:

- Design Transportation Systems
- Deliver Transportation Systems
- Maintain and Operate Transportation Systems
- Fiscal Services
- Human Resources

Figure A3.10 illustrates the distribution of locally developed applications among the department's business areas.

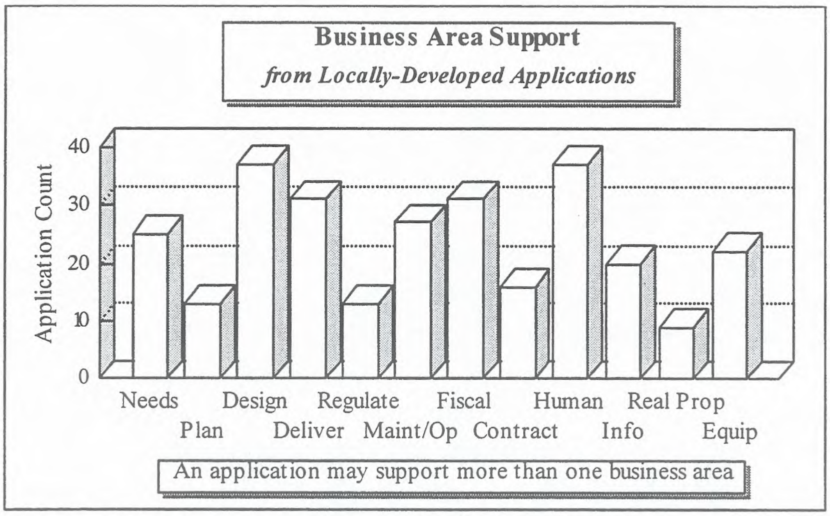

Figure A3.10 - Business Area Support

The following factors have caused this surge in locally-developed applications:

- Long wait time and cumbersome prioritization process for ISD applications
- Dissatisfaction with statewide applications
- Demand for easy-to-use GUI applications
- Emergence of fourth-generation programming languages
- Skilled non-ISD programmers
- Ability to dedicate resources and prioritize needs locally

Over 75 percent of the locally-developed applications are PC-based. This suggests that the district and division automation staffs have a skilled and experienced group of PC programmers. This will become an important resource for the migration towards GUI applications.

There are several inherent issues with the development of local applications, including:

- Inconsistent procedures
- Duplication of effort
- Lack of enterprise data
- Duplication of data
- Support

When ISD fails to meet user needs, users turn to other sources for application development, including local automation staffs, contract services and other users. The local automation staffs and end users have proven that they are capable of providing the necessary automation tools for their users.

Database Evaluation:

Data Profile: Currently, the data environment at TxDOT is characterized by:

- Complexity,
- Centralized data administration,
- Traditional database technologies, and
- A lack of an enterprise-wide data model.

The data environment is made up of numerous hardware platforms, including mainframe, midrange, personal computer and workstation. In addition, data is stored in many types of databases, such as ADABAS, flat files, VSAM and dBase. As new tools and databases are introduced, the old tools and databases are not replaced, which creates increasingly complex data support requirements.

Currently, the Data Administrator (DA) provides support for ISD business applications only. No support is provided for the districts and other divisions or for engineering applications. Data administration activities are limited to ADABAS databases only and support is limited or non-existent for VSAM and flat file databases. No cross-application data models have been created, although the computer-aided system engineering (CASE) tool Excelerator is available. The use of relational databases is limited.

The databases supported by the ISD applications are listed in Section G of the Strategic Plan for Information Resources. The entity type(s) of each database are also listed. This summary is based on information provided by the ISD Data Analysts.

These databases are application databases rather than subject databases. Almost every application has its own unique set of files, and some of the data definitions and integrity rules are embedded in the application. Data describing the same entity type is sometimes scattered among several databases.

Database Technology: Figure A3.11 illustrates the use of database technologies by the ISD applications.

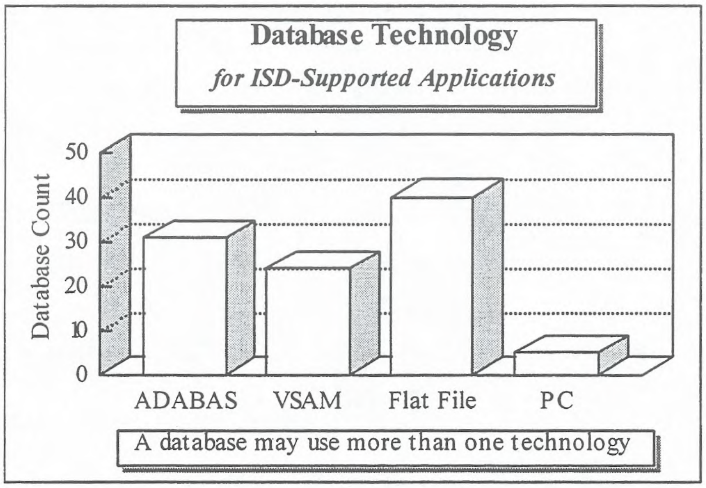

Figure A3.11 - Database Technology

The department's primary database management system is ADABAS. ADABAS is the principal Data Base Management System (DBMS) for more than 50 percent of the department's business applications. VSAM and sequential files are sometimes used in conjunction with ADABAS to process large quantities of data or for history purposes. VSAM and sequential files are also prevalent as the primary database technology in older business applications.

The engineering applications process flat (sequential) files stored on the user's workstation. There is very little centralization of these files.

The majority of the applications written by the district and division automation staffs are PC-based, using dBASE files.

Technical Quality: The technical quality of the centralized databases were evaluated on the following criteria:

- Quality of design
- Ease of access

- Ease of maintenance

The following figures summarize the results. The ratings for ADABAS databases were summarized independently of the VSAM and flat files, in order to analyze the impact of database management technology.

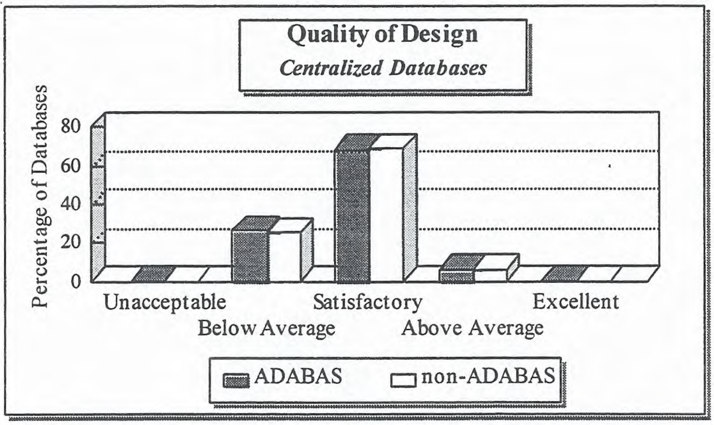

Figure A3.12 - Quality of Design

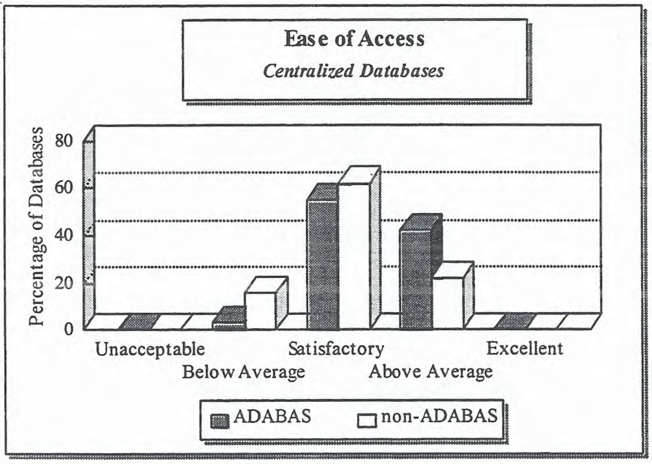

Figure A3.13 - Ease of Access

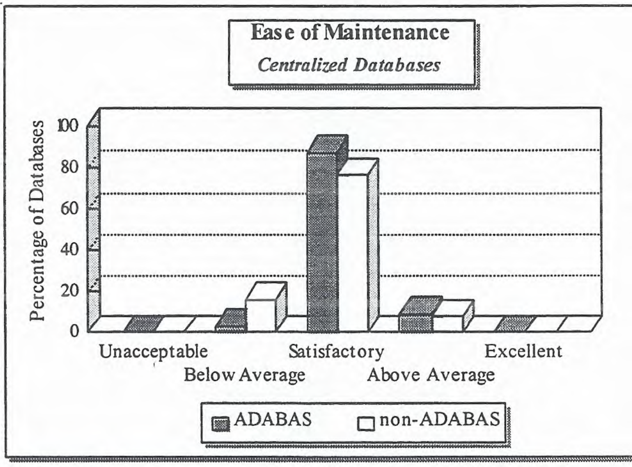

Figure A3.14 - Ease of Maintenance

Quality of Design considers the logical design of the database, the degree of normalization, redundancy and flexibility. Only 6 percent of the databases have an above-average design. This inadequacy of database design can also degrade application and program design, increasing maintenance problems (see Figure A3.12).

Ease of Access rates the ability to access the data within the database. Consideration was given to the primary and secondary access keys, the record sequence query and report writer facilities. The ADABAS databases are significantly easier to access than the VSAM and flat files, but only 42 percent of the ADABAS databases were rated as above-average. This rating is supported by the user's complaints about the unavailability of data and complexity of ad-hoc reporting programs (see Figure A3.13).

Ease of Maintenance rates how easily changes can be made to the database structure. Almost all of the databases were rated as satisfactory as illustrated in Figure A3.14. Database structures must be easily modifiable to allow applications to respond to the business needs of the users.

The database architecture is the foundation for application development. In order to improve the quality of the department's applications, the database architecture must first be improved.

Technology Evaluation:

Desktop Hardware: CRTs, general-purpose microcomputers, graphics microcomputers and engineering workstations have been categorized as desktop hardware; this equipment is used directly by the department's employees. The CRTs are located primarily in the districts and can be used only to establish connections to the mainframe. The general purpose microcomputers (PCs) are used for PC and mainframe administrative applications. The graphics microcomputers and engineering workstations offer graphics support for highway and bridge design and map base generation. The inventory counts for desktop hardware are depicted in Figure A3.15. The 2,200 machines for the Registration and Title System (RTS) are not included in these counts.

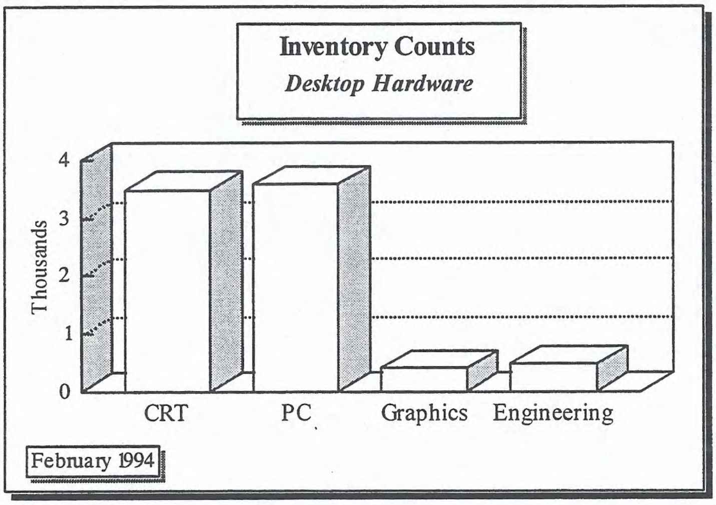

Figure A3.15 - Inventory Counts

Figure A3.16 illustrates the breakdown of the microcomputer inventory by processor type. The current microcomputer standard is a 486/33 machine. Only 20 percent of the department's current inventory meets that standard. The Information System Division (ISD) plans to upgrade all equipment to a 486 processor by the end of FY 1995, dependent on the availability of funds.

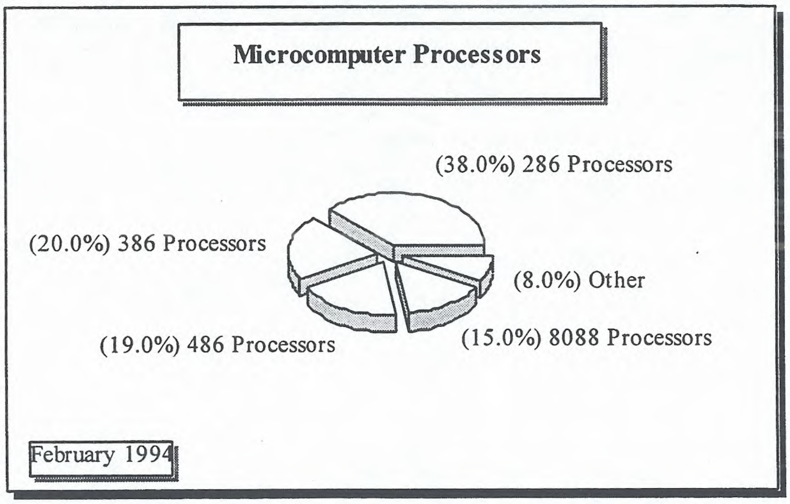

Figure A3.16 - Microcomputer Processors

There are approximately 8,000 automation users in the department who need a CRT, general purpose microcomputer, graphics microcomputer or engineering workstation to do their job. In the districts, the ratio of users to microcomputers is 2.2 (2.2 users per microcomputer, including engineering workstations). The microcomputer inventory is much more concentrated in the divisions and special offices, as evidenced by the 1.3 "saturation" level. Figure A3.17 and Figure A3.18 illustrate the gap between users and microcomputers in the districts and divisions.

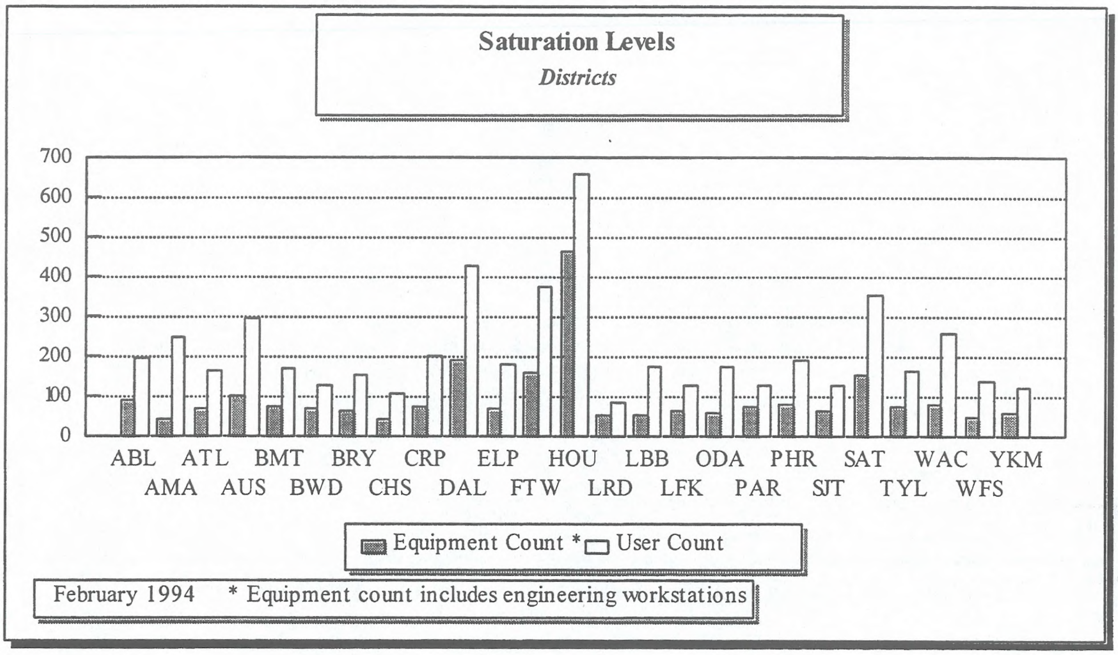

Figure A3.17 - Saturation Levels (Districts)

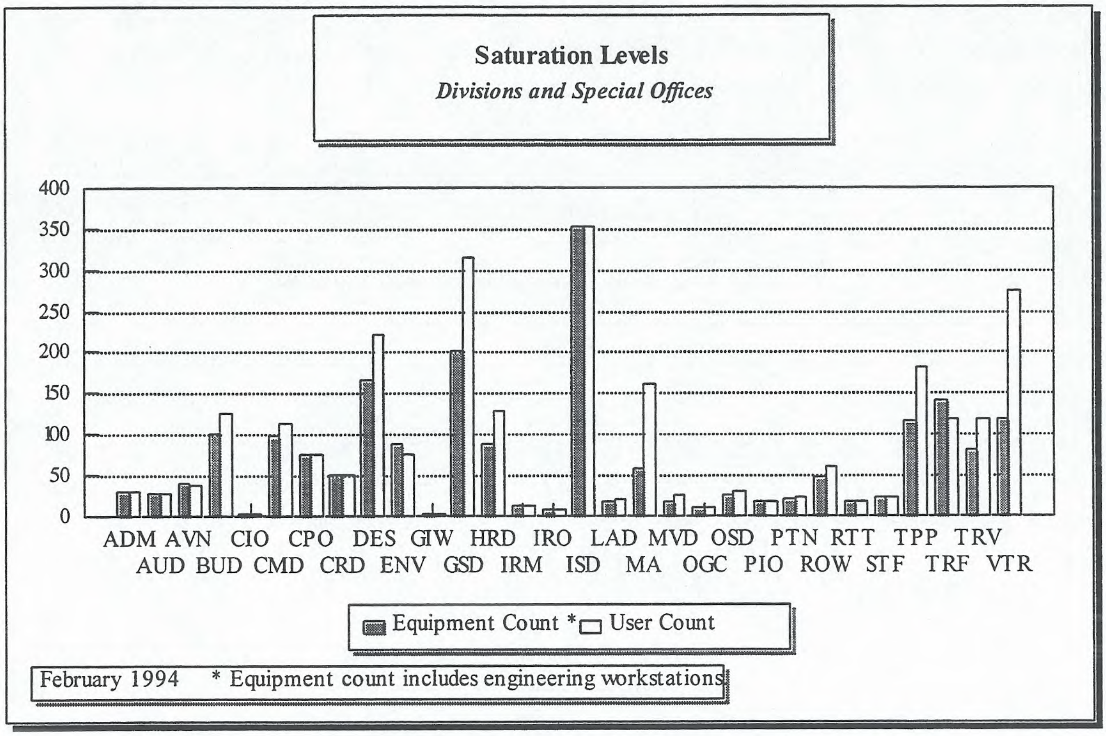

Figure A3.18 - Saturation Levels (Divisions and Special Offices)

Given current funding allocation levels, the Automation Advisory Committee (a group of peer-elected Automation Administrators who formulate recommendations to IS management) estimates that it will take three or four years to reach total saturation.

The lack of high-level processors for every automation user will severely affect the department's:

- Transition to a distributed processing environment,
- Development of easy-to-use Graphical User Interface (GUI) applications,
- Networking capabilities,
- Office automation, and
- Productivity.

Microcomputer Operating Systems Software: The distribution of microcomputer operating systems software is illustrated in Figure A3.19.

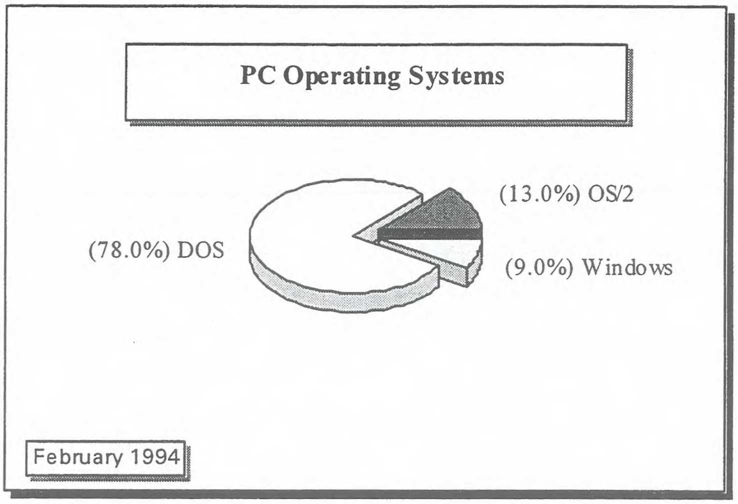

Figure A3.19 - PC Operating System

The DOS machines will need to be upgraded to Windows or OS/2 to support Graphical User Interface (GUI) applications and multi-tasking. This upgrade will impact over 3,000 users, increasing the need for operating system support and training.

Mainframe Hardware: The Austin Central Site has three mainframe processors:

- Amdahl 5995-3550M
- VAX 11/785
- Intergraph 350

The Amdahl 5995-3550M is the main processor which stores and executes all TxDOT administrative applications. It has 96 parallel channels and 16 escon channels, 384 megabytes of main memory, 384 megabytes of expanded memory and is supported by 320 gigabytes of disk storage. This processor is the focal point of a statewide communications network supported by 25 remote and two local IBM 3745 communication processors serving over 8,000 department users, the Department of Public Safety, the Federal Highway Administration and other state agencies.

The Central Site VAX mainframe is a graphics-oriented processor that supports the mapping and engineering sections of the Design Division, the Transportation Planning and Programming Division, and the engineering sections of the Information Systems Division. The VAX 11/785 has 16 megabytes of memory.

The Intergraph 350 and VAX 11/785 are part of an ETHERNET Wide Area Network composed of thirty-eight local area networks connected by Intergraph routers.

Mainframe Software: The operating system employed on the Amdahl (CPU) is the MVS/Enterprise Systems Architecture (MVS/ESA) which contains the MVS/System Product (MVS/SP) and MVS/Data Facility Product (MVS/DFP). The operating system provides system control, data handling and access, application development services, and system expansion capabilities. Also used in this system are Computer Associates/TOP SECRET for the protection of information resources, Software AG/ADABAS for the storage of data, IBM/CICS for the enabling of the development of network accessible applications, and Computer Associates/ROSCOE for data entry and job submission. The VAX system is controlled by the Digital Equipment Corporation Virtual Memory System (VMS).

USER SATISFACTION SUMMARY:

Overview:

A user satisfaction survey was created and distributed to a sampling of users which represented all business areas of the department in order to ascertain the overall level of satisfaction with IS services. The survey also solicited comments regarding each of the areas surveyed. As Figure A3.20 indicates, the level of satisfaction in all categories was moderate at best.

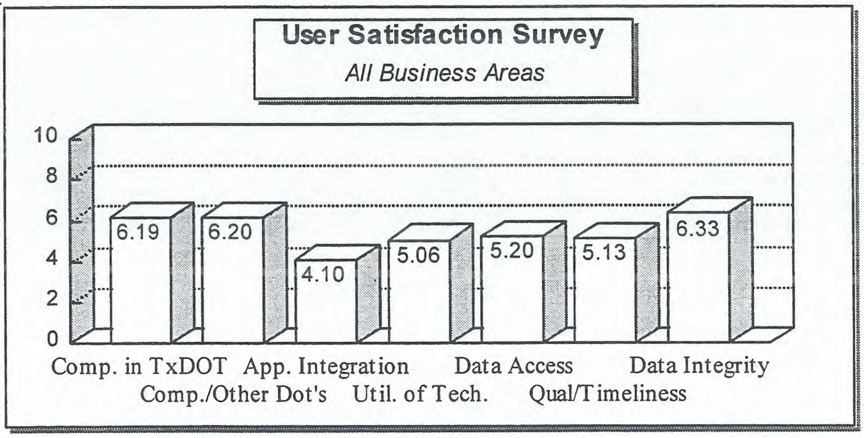

Figure A3.20 - User Satisfaction Survey

Questions:

The following seven questions were asked of users representing a wide range of districts and divisions within the department.

"Degree of Computerization Within the department" asked users to indicate the level at which processes that could be automated were automated within TxDOT.

"Degree of Computerization Relative to Other DOTs as a Whole" asked users to indicate how the level of computerization within TxDOT compared to their experience or understanding of computerization at other transportation departments.

"Level of Application Integration" asked users to indicate how well related applications work together.

"Utilization of Technology" addressed how well the technology the department has deployed is used.

"Access to Data" asked users to indicate how accessible the data they need is actually available to them.

"Quality and Timeliness" asked users to rate the overall quality and timeliness of information services provided to them.

"Integrity of Data" asked users to evaluate how the accuracy of the data available to them.

Results:

Several of the questions on the survey addressed the access, integrity and redundancy. On a scale of 1-10, with 10 meaning highly satisfied, Data Access received a score of 5.2 and Data Integrity received 6.33. Data redundancy was cited as a common problem.

Several questions addressed technology and its use within TxDOT. The overall response indicated that users did not believe that technology was efficiently used and cited a lack of training as one cause of the underutilization.

The level of application integration received the lowest score on the survey, 4.1 out of a possible 10. Legacy systems, which are not integrated, and system planning, not done from a "global" perspective, were cited as reasons which may explain the low score.
The survey did point out that users believe TxDOT has achieved the same overall level of computerization as other transportation departments.

INFORMATION SYSTEMS SPENDING HISTORY:

In order to understand how the Information Systems (IS) organization has historically spent funds, this analysis identifies and documents historical IS spending levels and trends, and describes how and where the resources have been spent.

Background:

The Information Resources Act of 1991 changed the way the department's operating plan is developed. Information resources by definition are procedures, equipment and software that are designed, built, operated and maintained to collect, record, process, store, retrieve, display and transmit information, including associated personnel. Information resource expenditures that were previously reported outside the IS operating plan (e.g. traffic and radio equipment) are now included in the Biennial Operating Plan (BOP). Expenditures for radio and traffic management equipment were not considered in this analysis because they do not allow equitable comparison to industry figures. The historical IS expenditures used in this document are derived from the BOP with the following exclusions:

- All costs related to Research Projects, Private Branch Exchange, Key Systems, Traffic Data, Traffic Management, Lanser, Pave Data, Texas Mobile Load Simulator and Radio; and
- All cost related to Photogrammetry, Satellite Surveying, Aerial Photography, Field Salaries, Graphics Services, Process Controls and Equipment for use in the field.

Total Expenditures:

In fiscal year 1993, 1.9 percent of the total TxDOT expenditures was budgeted for information resources. This percentage increased to 2.3 percent for fiscal year 1994. TxDOT's ratio of total IS spending to total agency spending is less than the government organization ratio (4.3 percent) and slightly higher than the rail and bus transportation ratio (2.1 percent). Figure A3.21 illustrates TxDOT's IS spending to total agency spending ratio.

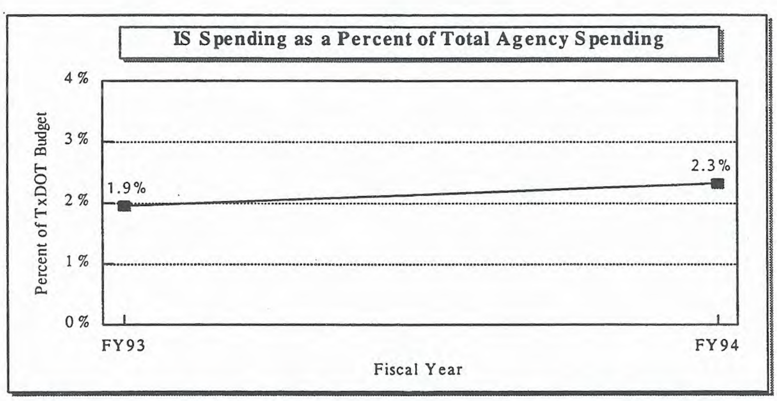

Figure A3.21 - IS Spending as a Percent of Total Agency Spending

The TxDOT IS budget increased from $55.9 million in fiscal year 1993 to $73.4 million in fiscal year 1994, which resulted in a 31.3 percent growth rate. This increase is mostly due to an increase in expenditures in hardware/software maintenance and services.

Technology Expenditures:

Component	1993 (bud.)	1994 (est.)
Staff Salaries and Fringes	42.2%	35.5%
Services	8.8%	14.8%
Maintenance	24.1%	38.7%
Planned Procurements	21.5%	8.5%
Operating Supplies	0.6%	0.3%
Other	2.8%	2.1%

Figure A3.22 - TxDOT IS Budget by Category (1993 - 1994)

Figure A3.22 indicates TxDOT IS spending by category for fiscal years 1993-1994. Staff salaries, maintenance and planned procurements occupy the largest percentages of the total IS budget. Maintenance and service expenditures increase from fiscal year 1993 to 1994 while staff salaries and planned procurements decrease from fiscal year 1993 to 1994.

IS Staff Expenditures:

TxDOT IS staff has decreased from fiscal year 1993 to 1994. Figure A3.23 illustrates the percent of the TxDOT IS budget allocated to staff salaries. Although this component of the budget decreased in fiscal year 1994, it still occupies approximately 35.5 percent of the IS budget. This decrease is due to the loss of personnel to retirements and job turnover.

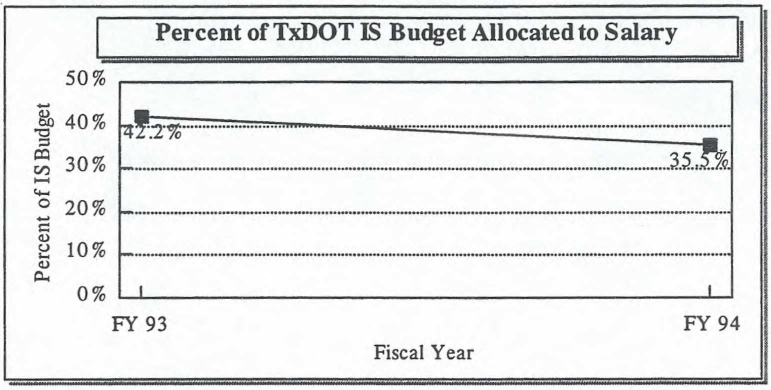

Figure A3.23 - Percent of TxDOT IS Budget Allocated to Salary

A Gartner Group survey indicates that IS managers are allocating personnel to those activities most directly linked to end-user needs and to fulfilling the organization's current and future information technology requirements. The survey also indicates that the functions that will benefit from staff increases over the next two years are development, database administration, education and training, help desks, end-user computing and research and development.

Education and Training Expenditures:

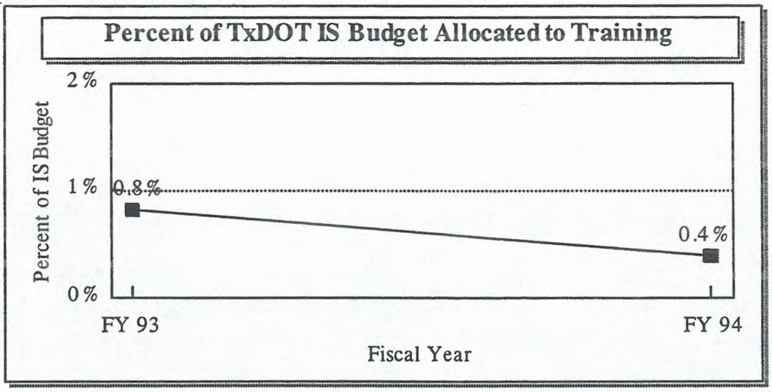

Figure A3.24 - Percent of TxDOT IS Budget Allocated to Training

Figure A3.24 illustrates the spending trends for TxDOT's training expenditures. These percentages do not include travel for training. These training percentages are approximately one-half or less of the budgets spent by other government organizations. This is partially due to education and training costs which are not reflected in the IS budget because districts and divisions allocate expenditures for IS training from their own operating budgets. Gartner Group research suggests that to develop and maintain the increasingly complex networked environments unfolding in most IS organizations, the typical organization will need to increase its spending on education and training twofold to fourfold just to reach the minimum level of proficiency necessary to support these environments.

Section B: External Assessment

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OVERVIEW:

This section provides an external perspective on the quality of TxDOT's information systems support relative to that of other transportation departments and significant information system trends which may impact TxDOT in the future.

Seven DOTs, including TxDOT, were surveyed to determine their effectiveness and efficiency at deploying IS strategies. The external DOTs surveyed are considered to be peers of TxDOT and thought to be leaders in business process reengineering and the utilization of technology as an enabler of change.

In addition, general and industry-specific trends were identified which may impact the way TxDOT conducts business. Identified trends will assist in the identification of the data, application, technology and organization migration approaches.

EXTERNAL DOT ASSESSMENT:

Overview:

Information Services Divisions from seven transportation departments were surveyed, including the Texas Department of Transportation (TxDOT), to gain an external perspective on TxDOT's quality of information systems support. The seven DOTs surveyed included Florida, Michigan, Minnesota, Oregon, Pennsylvania, Wisconsin and Texas.

The 16-page survey was divided into the following five sections:

- **Common Measures** - measured the general size of each DOT so that all respondents could be compared on an equal level. Size was measured in several different ways including number of employees, lane miles, services offered and total budget.

- **Application Portfolio Assessment** - evaluated the extent of computerization and the nature and quality of the applications planned and in place.

- **Data Portfolio Assessment** - evaluated the nature of the data systems, tools and standards planned and in place.
- **Technology Assessment** - evaluated the nature and extent of information technology employed, as well as future technology directions and strategies.

- **Resource Strategies Assessment** - evaluated the level of investment in information systems technology and the major components of that investment.

To determine the deployment levels of the application, data, technology and resource strategies for each DOT, a weighted scoring system was developed. A series of attributes was identified for each strategy, and scores were established for each possible answer. A weight factor was then assigned to each attribute based on its importance to the strategy. The strategy's deployment level was determined based on the score and the assigned weight of each attribute.

Although a significant amount of data was collected and analyzed, the following assessment highlights the major findings.

DOTs Surveyed:

The transportation departments selected to participate in this survey are considered to be peers of Texas and leaders in providing transportation services. In terms of total number of employees, Texas, at 15,000 employees, outnumbered Florida by 5,000, including 8,000 information system (IS) users vs. Florida's 5,000. Total operating budgets seemed to split logically into two tiers. Florida, Texas and Wisconsin fell within the top tier at $3 billion and Michigan, Minnesota, Oregon and Pennsylvania fell within the second tier at approximately $1.5 billion.

It is important to note that neither the Michigan DOT nor the Minnesota DOT offer motorist services. Otherwise, all of the other DOTs offer a full range of services including aviation, public transportation, permits, travel information and the operation of waterways, roads and roadside facilities.

Application Strategies:

The following attributes were considered in evaluating application strategies:

- Extent of automation
- Use of modern application development tools
- Percent time spent on maintenance vs. application development
- Extent of integration
- Average number of years required to develop new applications

- Current backlog
- Percent of applications which process transactions on-line (vs. batch)
- Percent of packaged software applications (vs. custom programmed applications)
- Average age of applications

This section was divided into four areas to more specifically assess the condition of the application portfolio of each key business service area. Business service areas included Transportation Planning and Development, Field Operations, Administrative Services and Motorist Services. A more detailed description of these business service areas is listed in Appendix 3.

Results: Overall, it appears that Texas falls in the middle of its peers when examining the ratio of applications executed on a mainframe versus a personal computer (PC). However, Figure A3.25 below indicates that Texas has the highest level of automation of any of the DOTs surveyed.

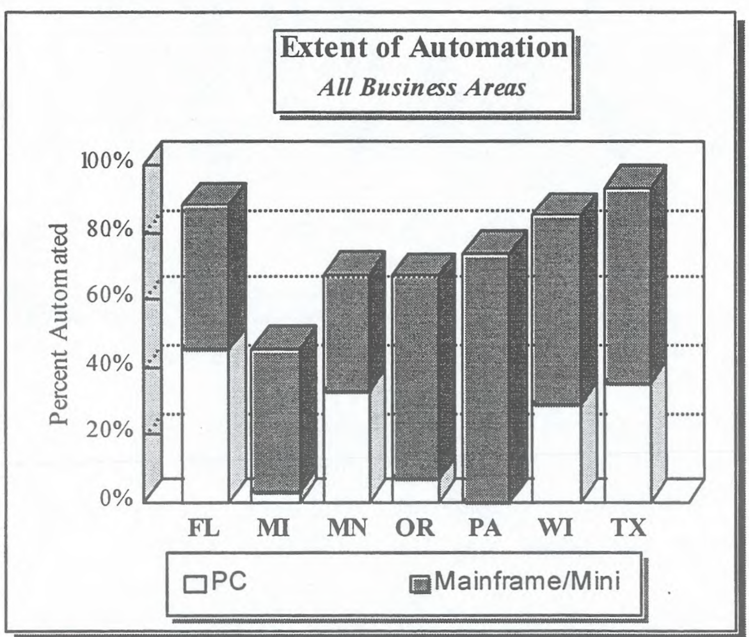


Figure A3.25 - Extent of Automation

The results also indicate that the use of package applications within the industry as a whole may be very low (20 percent). In fact, only Texas and Wisconsin are utilizing package applications for Motorists Services and Administrative Services, respectively. In addition, it appears that newer application technologies and development tools have had a relatively minor effect on the industry's aging legacy systems, as the average age of existing applications is currently over nine years.

With regard to application development time and development backlog, the results of the survey indicate that Texas is behind its peers in both categories, requiring an average of four years to develop an application system while maintaining a development backlog of more than four years (see Figure A3.26). It is important to note that although Michigan's backlog is equally high, they have just implemented rapid application development (RAD), which has already driven the average development time to under a year and is expected to drive their backlog down as well.

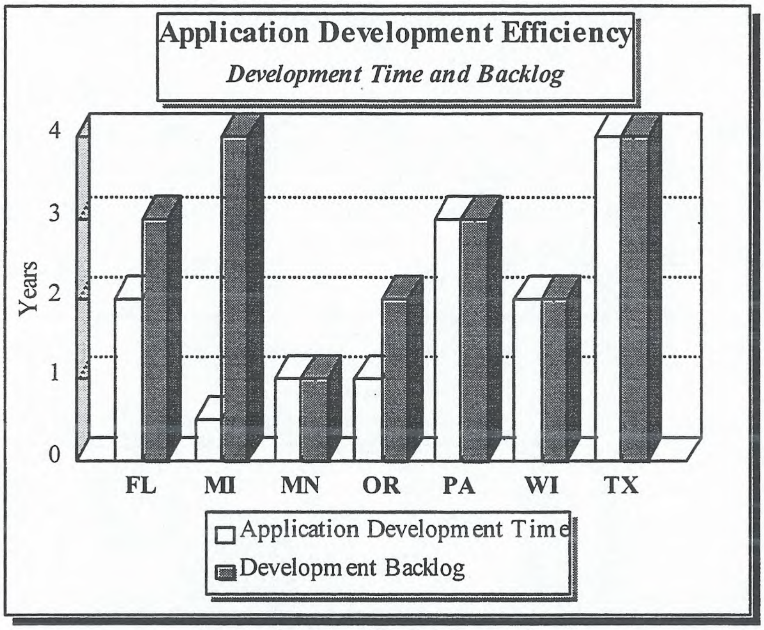


Figure A3.26 - Application Development Efficiency

Based on the attributes described above, it appears that Florida, Wisconsin and Texas are the most effective at deploying application strategies (see Figure A3.27). This is mainly due to the high level of automation and integration of applications and the utilization of modern technology such as on-line and package systems.

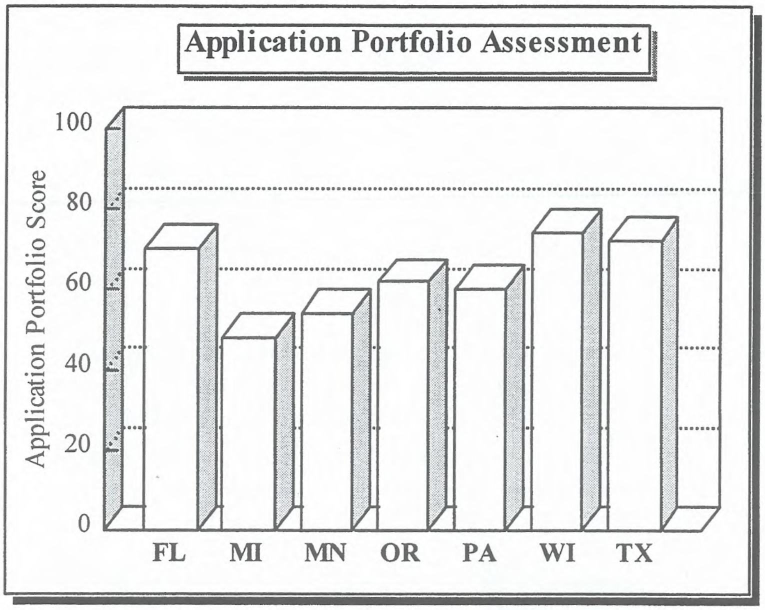


Figure A3.27 - Application Portfolio Assessmnt

Application Development Issues and Opportunities: Recurring themes emerged among IS administrators when asked to identify key issues and opportunities. Most prominent was the concern over the effects of ISTEA and the high volume of modifications to current application systems which will be necessary to meet the new legislation requirements.

Other commonly noted issues include implementing metrication and geographic information systems (GIS), migrating applications from mainframe technology to client/server, and decentralizing responsibility for specific applications to users while the IS department remains focused on department-wide systems.

Data Strategies:

The following attributes were considered in evaluating data strategies:

- Data managed as an asset
- Use of data modeling & development tools
- Employment of a database administrator
- Employment of a data administrator
- Extent of database integration
- Extent of database centralization

Results: It appears from the survey that data is not being managed as an asset, as almost half of the respondents have neither an enterprise data model nor utilize any type of automated data modeling tool. Texas has not utilized an enterprise data model in the past but is currently testing the functionality of the Information Engineering Facility (IEF) CASE tool, which includes data modeling and model management capabilities. In addition, even though all DOTs have formal database administrators, only half utilize a formal data administrator. Texas, however, has both but not at an enterprise level.

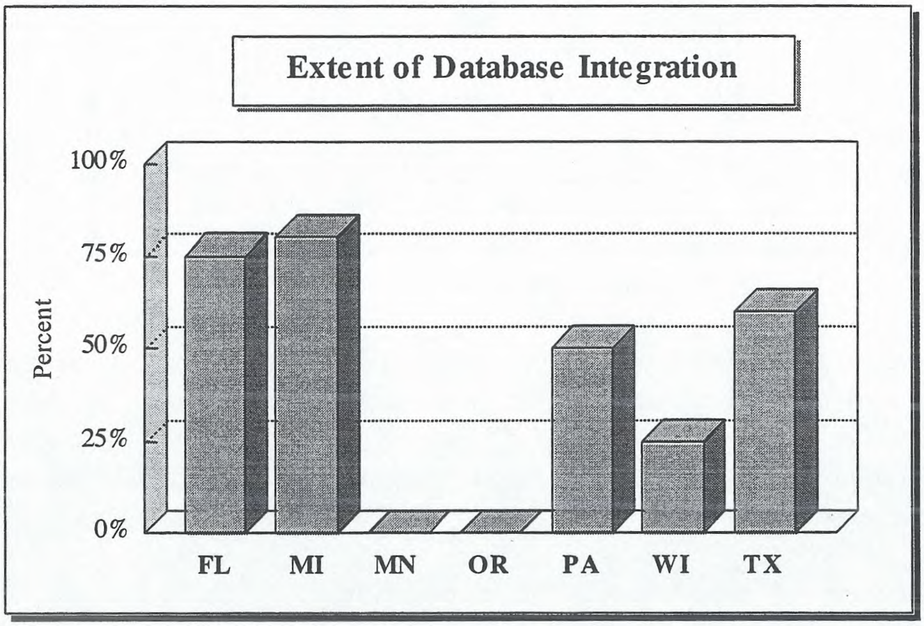


Figure A3.28 - Extent of Database Integration

As indicated from Figure A3.28 above, there are large variations in the perceived level of database integration between the respondents. Generally, Texas appears to be in the upper tier of departments providing integration among databases.

Overall, there seems to be a wide dispersion of effectiveness in the deployment of data strategies. As Figure A3.29 indicates, Texas ranks in the middle of its peers, having moderately integrated databases and utilizing modern data management tools, but leaves room for improvement due to the lack of an enterprise data model.

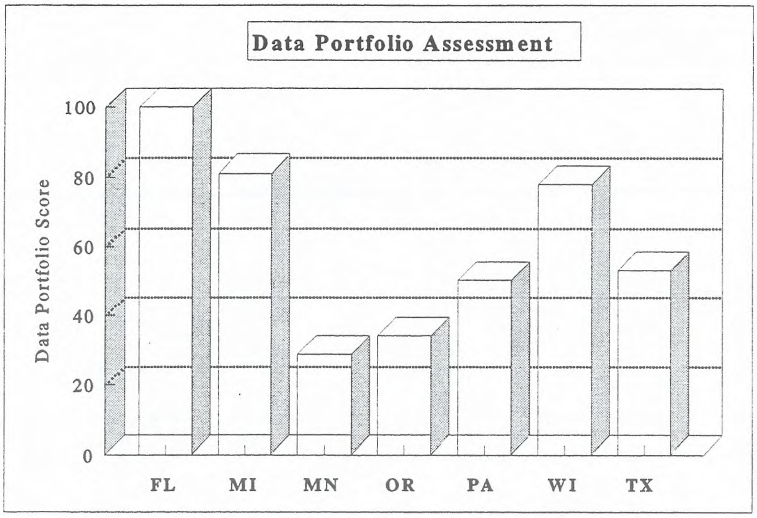


Figure A3.29 - Data Portfolio Assessment

Data Strategy Deployment Issues and Opportunities: Several issues were provided by the respondents with regard to the deployment of data strategies. Most commonly noted were the challenge of selecting adequate database software for a client/server environment and migrating existing databases from a centralized mainframe environment to a distributed environment.

Technology Strategies:

The following attributes were considered in evaluating technology strategies:

- Utilization of personal computers (PCs)
- Satisfaction with current technology
- Utilization of advanced technology
- Standardization or "openness" of hardware platforms

Results: As indicated by Figure A3.30 and Figure A3.31 on the following page, there has been tremendous growth in the use of microcomputer technology over the last several years. Texas has increased the utilization of PCs by 170 percent over the last four years, ranking above the average DOT rate of 150 percent. In addition, almost every DOT now has approximately one IS user per PC. These two facts indicate a significant trend toward decentralization of computing power to the user's desktop.

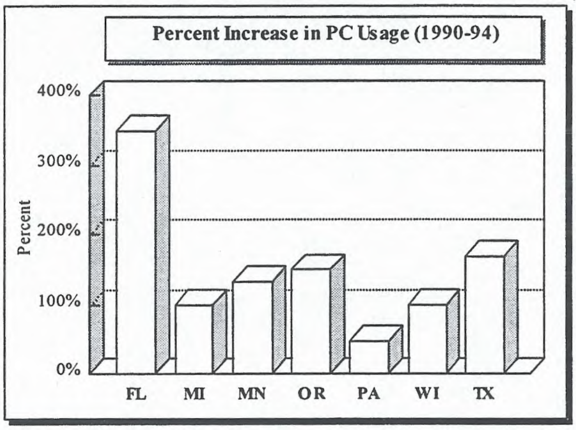


Figure A3.30 - Percent Increase PC Usage (1990-94)

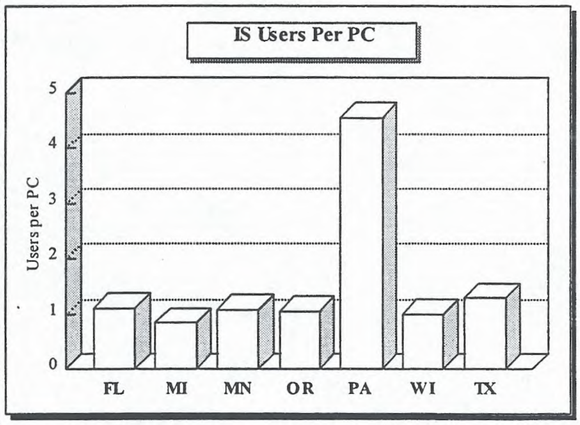


Figure A3.31 - IS Users Per PC

With respect to the level of satisfaction with the technology currently in place, almost every DOT indicated only a moderate level of satisfaction. This may be attributed to lower funding levels and a rapidly changing technology environment, resulting in IS never being able to fulfill its requirements.

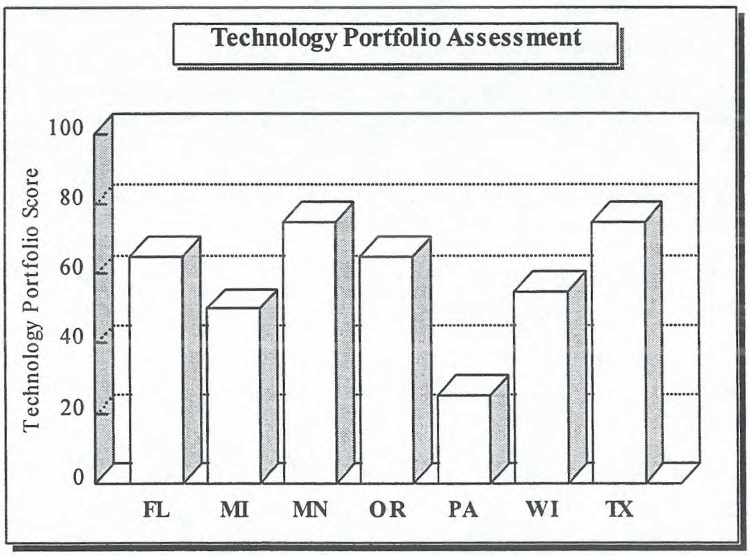


Figure A3.32 - Technology Portfolio Assessment

Overall, Texas and Minnesota appear to be the most effective at deploying technology strategies as indicated in Figure A3.32. Texas achieved a high score due to its extensive use of PCs and advanced technologies (e.g., GIS, bar coding, voice response, etc.), which appears to be consistent with the increased funding for hardware over the last several years.

Technology Strategy Deployment Issues and Opportunities: The following issues were identified by the respondents as challenges to the deployment of technology strategies:

- Technology is changing at a rapid pace, causing uncertainty and delays in the decision to procure and implement these technologies
- It is increasingly difficult to recruit and retain personnel trained in advanced technologies
- Conflict exists between technology standardization to minimize support efforts and non-standardization of technology to maximize user satisfaction and productivity

Resource Strategies:

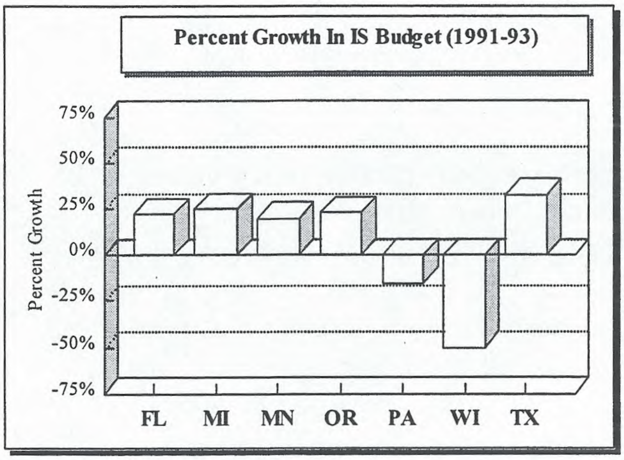
The following attributes were considered in evaluating resource strategies:

- Managerial experience
- IS budget as a percent of DOT budget
- IS personnel turnover
- User satisfaction with IS support
- Non-IS personnel performing IS functions
- Strategic planning policies
- Growth in IS budget

Results: The survey shows that Texas and Oregon have the least managerial experience within their IS departments, with managers having an average of approximately seven years of experience. All other DOTs have IS managers with experience ranging from 10-20 years.

With respect to turnover within the IS department, rates varied widely between the respondents, with Florida incurring an average of 15 percent turnover per year down to 2 percent per year for Wisconsin. Texas falls in the middle of its peers with a turnover rate of 8 percent.

As indicated by Figure A3.33 on the following page, most IS budgets grew approximately 25 percent between 1991-93 (12.5 percent annually), including Texas, which is well above the industry average of 4 percent (*Industry Service,* Gartner Group, July 14, 1993). It is important to note, however, that Wisconsin's IS budget was cut in half over the same period.



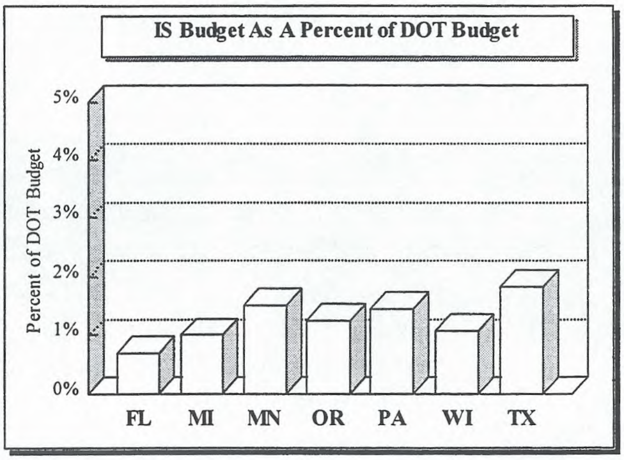


Figure A3.33 - Percent Growth In IS Budget **Figure A3.34 - IS Budget as a Percent of DOT**

In addition, it appears that most of the respondents IS budgets, except Texas's, have been averaging 1 percent to 1.5 percent of the total DOT budget. As Figure 2.37 indicates, Texas's IS budget is almost 1.8 percent of the total budget. Although IS budgets have been growing at a rapid pace, the ratio of IS budget to total operating budget for every respondent still lags behind the government average of 4.3 percent (*Industry Service,* GartnerGroup, July 14, 1993).

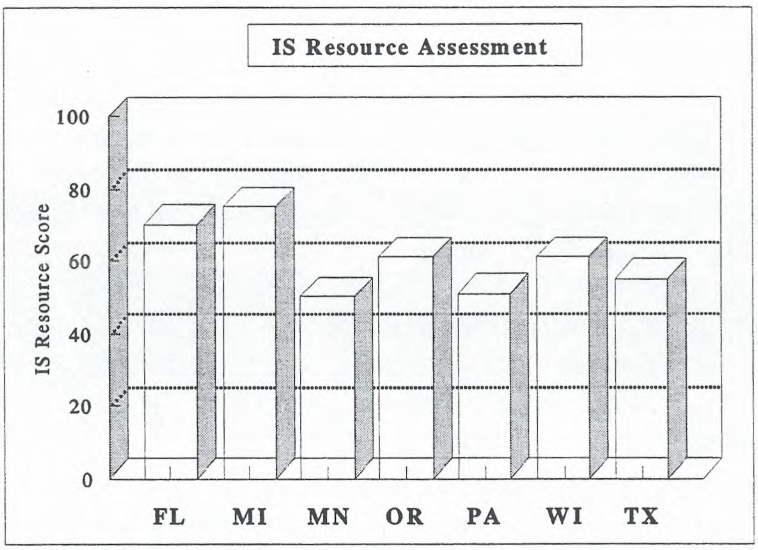


Figure A3.35 - IS Resource Assessment

Based on the attributes discussed in Figure A3.35, Texas appears to be in the bottom tier of its peers overall. Although Texas is experiencing strong growth in its IS budget, the lower resource score is due to the low level of satisfaction with IS support.

Resource Strategy Deployment Issues and Opportunities: Several issues were identified by the respondents as challenges to executing IS resource strategies, including:

- Budget limitations prohibit or limit DOT's ability to hire and retain the necessary skillsets
- Turnover of experienced personnel is high due to large salary discrepancies between the public and private sector
- Headcount is fixed and expected to be downsized - DOTs are increasingly resorting to contract staff and temporaries to overcome workload variances

Conclusion:

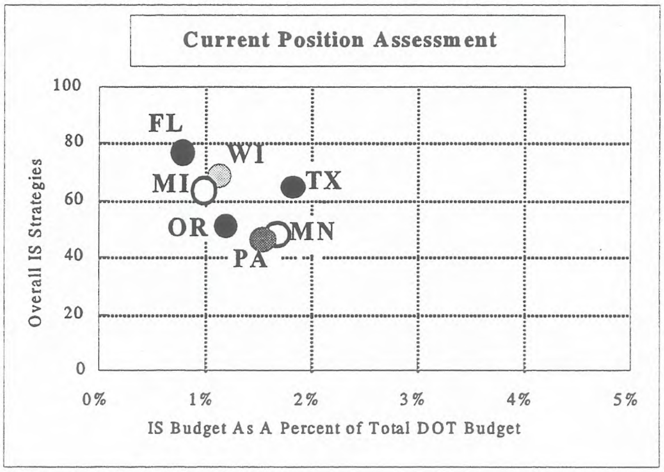


Figure A3.36 - Current Position Assessment

When considering the four areas of the evaluation (application, data, technology, IS resources) in total, Texas's "performance" ranks slightly above average as depicted in Figure A3.36. Texas seems highly effective in deploying the application and technology components, due to the higher level of automation and application integration; widespread use of PCs; and use of advanced technologies. Texas seems less effective, however, in managing the data and IS resource components, highlighted by the lack of an enterprise data model and the low level of satisfaction with both the current technology being utilized and the overall level of IS support.

It is important to note that although Texas ranked in the middle of its peers in deployment *effectiveness*, its IS budget, as a percent of the total operating budget, is approximately 50 percent higher than that of its peers. This may indicate that Texas is less *efficient* in delivering service to its customers.

INFORMATION SYSTEMS TRENDS:

Overview:

The Texas Department of Transportation faces many challenges in the deployment of information systems resources which effectively provide the support required to meet business objectives. The need for faster application development and an increasing need to share data between business areas is highlighted by the expanding backlog of application systems required by the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and metrication conversions. These demands also come at a time when workloads are on the rise and the size and complexity of projects continues to grow.

Advancements in information technology and computing power have been increased by a factor of 10 every three years over the past decade. By the increases in processing speed and storage capacity and in the reduction of physical component size, these advancements are evident. In addition, several trends are changing the way Information Systems Departments are doing business, such as the decentralization of technology and constantly decreasing application development life cycles.

The effect of these advancements has been significant to business in general, but has been particularly high to departments of transportation where there is a heavy reliance on information technology. As a result, information technology is becoming an increasingly critical component in achieving the goals of the department. Refer to Appendix 3 for bibliography covering IS trends.

General Industry Trends:

An analysis of industry literature reveals business enterprises are employing new technologies to reduce the time required to develop applications and to support the changing needs of the agency or company. Among these trends are new application development tools and methods, growing IS budgets due to increased business requirements and decentralization through downsizing with client/server technology.

> ***Increasing IS Budgets:*** Research of large U.S. based enterprises reveals that IS budgets are averaging 5.5 percent of revenues in 1994 and are expected to increase to 8.3 percent by 1998. In addition, businesses which are undergoing business process reengineering (BPR) and decentralization resulting in downsizing and migration to client/server, are experiencing a shift in the component expenses of their IS budgets.
>
> Spending growth for centralized IS is down to 2 percent while spending for decentralized IS support is growing at a rate of 14 percent. The cost to decentralize

support is the fastest growing component of the IS budget, increasing at a rate of 26 percent. This is followed by spending for outsourced IS services, which was 12 percent in 1991, and is expected to be 18 percent by 1994.

Another interesting note is that, by 1998, it is estimated that 90 percent of new applications will require a mixture of skillsets not prevalent in today's application development organizations. This will have a significant impact on the TxDOT training budget for IS professional and support personnel.

Based on an analysis of companies committed to reengineering their organizations, TxDOT could experience significant IS budget growth to implement business process reengineering.

Decentralization: The trend toward decentralization is evolving through the migration of enterprise critical IS applications, data and support from a centralized mainframe environment to a decentralized environment. Driving this trend is the increasing availability of affordable computing power, speed, storage, connectivity and development tools. This trend is also being driven by users who see IS as too autonomous, too expensive, and out of touch with user needs.

It is estimated that by 1998, at least 60 percent of new applications will be built under the direction and control of business units. Centralized IS is expected to shift its role from sole application developer to facilitator and provider of infrastructure, architecture, specialty skills, technical support, training and enterprise data management.

Client/Server (C/S) Migration And Downsizing: In the simplest terms, downsizing by migrating from mainframe-based applications and data to microcomputer-based client/server applications is the movement of applications from a mainframe to a network of PCs where data and applications are distributed among the clients and the server. The trend to migrate application development and data is being driven by a two primary forces. First, client/server applications collectively have the potential to deliver more computing power and flexibility than a mainframe can alone. Additionally, capital outlays for client/server hardware and software and contract maintenance can be one-third to one-fifth mainframe costs for comparable performance.

Development tools for client/server applications are less complex and generally contain more features than tools available for mainframe application development. This factor alone has spawned a proliferation of applications development in organizations that have decentralized and moved the responsibility for business applications into business areas. This trend fosters an increasing need to institute uniform enterprise wide architectures and methods, a distributed applications development support infrastructure, and new organizational roles and responsibilities.

Computer Aided Systems Engineering (CASE): While computerized automation of business processes has evolved over the last 30 years, only in the past five to seven years have computerized tools and methodologies evolved to facilitate the development of new systems.

Computer Aided Software Engineering (CASE) products are tools that provide automated graphics and analysis support for computer systems developers. These tools exist for virtually every phase of the systems development life cycle. The implementation of CASE technology offers data processing professionals a complete diagramming, analysis and reporting system to help automate the production of information systems.

It is expected that by 1998, at least 85 percent of applications development organizations will achieve portability and interoperability through ported proprietary fourth-generation languages (4GLs), cross-platform application generators, and CASE-driven generators, rather than through "open systems" standards. CASE tools affect application development in the following ways:

- Planning - Provide the capabilities to formally document and report business functions, organizational entities, critical success factors, applications and the relationships which can be defined among this data.

- Design Aids - Support capturing and documentation of system functional requirements, functional process descriptions, data descriptions, screen/report layouts and facilitate prototyping. These utilities will assist the development teams in communicating the functional specifications of an application early in the development cycle.

- Analysis Tools - Provide substantial analytical approaches to ensure the development of highly structured application designs.

- Database Tools - Provide a set of comprehensive facilities which support the design, development, prototyping and tuning of an integrated database management system.

- Programmer Productivity Aids - Automate the generation of computer program code.

- Testing - Provide a series of programs designed to supplement, enhance, audit and document the programming and systems test phases of a project.

- Documentation - Provide a comprehensive set of utilities which automate the documentation of the entire system.

DOT Specific Trends:

TxDOT has widespread geographical responsibilities and is accountable to customers ranging from the general public to the state Legislature. As access to additional data sources and telecommunications becomes increasingly important to TxDOT's customers, the need to assemble and quickly deliver the accurate business information they desire will become critical to satisfying their needs. The following technology solutions are examples of advanced information technology which may help meet these needs.

Document Management/Imaging Systems: Document management systems are composed of four fundamental ingredients: Workflow software, Scanning, Optical Character Recognition and Full Text Storage and Retrieval.

Workflow software: As a concept, work-flow is the sequence of activities that are performed in accordance with business processes. The latest versions of workflow software are highly intuitive, object-oriented programs which allow users to assign tasks to a series of work events, and trigger additional events based on the action taken by the worker. Workflow software tools enable employees to focus on the work, while the software takes care of the process.

Scanning: The second system ingredient allows workers to share images instead of paper documents and enables the same piece of information to be processed simultaneously rather than serially. Image files, however, contain no alphabetic or numeric information that applications can recognize.

Optical Character Recognition (OCR) Technology: Converts the information in an image to any format an application requires.

Full Text Storage and Retrieval: The rate that the above technologies can acquire and store information can create an information overload without *Full Text Storage and Retrieval* technology. This technology allows any document to be retrieved within seconds, no matter where it resides in the system.

Together, the document management/imaging processing technologies that compile a document management system can be a "technology enabler" which supports business process reengineering. This technology can be used to build and maintain a central inventory of official documents and provide timely information that is consistent and accurate to employees and TxDOT customers alike. Existing TxDOT documents, as well as those of customers can be incorporated into a digital inventory and the business work flow with little or no key entry. The strategic benefits of an effective document management system include improved access to cross-functional data and a significant reduction in labor and communications costs.

Electronic Data Interchange (EDI): Electronic Data Interchange (EDI) is the electronic transfer of information from one system to another in a format understood by both systems. EDI allows for the rapid transfer of information and reduces paperwork, processing time and the number of errors associated with key entry. EDI brings a significant advantage to any enterprise where information timing and accuracy is a critical asset.

Three primary issues have generally slowed the implementation of EDI in state government and particularly at TxDOT:

- It is difficult to get approval for the implementation of a technology solution to a business problem which has little or no known statewide benefit. One reason for this difficulty is the significant backlog of prioritized projects which do address statewide needs.

- It is difficult to rationalize the payback time for this type of investment in the absence of well-documented statewide needs.

- State agencies lack the procurement flexibility that is inherent in private industry. Companies, often by virtue of long-standing contractual agreements, can persuade vendor and contractual partners to implement EDI.

Although TxDOT faces these challenges, the use of its distributed inventory of microcomputer technology and potential partnerships with other government agencies, utility companies and businesses which depend on TxDOT to provide services offers a unique opportunity to realize the benefits offered by EDI. Examples of relationships which require mail or personal visits and may benefit from EDI include utility and access permits, map sales, public hearing documentation, environmental impact studies and Texas Highways subscriptions.

Geographical Information Systems (GIS) And Global Positioning Systems (GPS): Geographical Information Systems (GIS) are becoming increasingly critical for application developers and users who need a Graphical User Interface (GUI) for applications which deal with location sensitive information. GIS applications and Global Positioning Systems (GPS) which use satellites to acquire topographical data, combined with the much greater speed and storage capacity of today's equipment, promise a significant reduction in the cost of three-dimensional geographical data.

GPS technology, which now provides five-meter accuracy at highway speeds, can reduce the costs of capturing bulk geographical data which is fundamental to GIS applications and system components. Another GIS enabling technology is dynamic segmentation. Dynamic segmentation provides the tools to analyze segments of an entire transportation network by database queries on two or more geographical attributes. These attributes may include combinations of land use, parcel data, transportation system class, jurisdictional boundaries, environmental zones, traffic data and other information which describes the associated topography.

GIS technology is being pursued in several state DOTs to integrate individual pavement evaluation systems, safety, traffic management systems, and statistical data regarding the locations of accidents, speed limits, maintenance locations, and transportation facilities into a single Transportation Management System.

Using GIS to integrate geographical coordinates with engineering and business data can streamline the analysis of event "causes" and event "affects." The ease with which planners can view GIS topographical features in color can reduce the time for planning and increase its value. GIS visualizations of data also enable planners to see trends and identify problems much earlier.

Intelligent Transportation System (ITS): ITS is composed of a number of technologies, including information processing, communications, control and electronics. Joining these technologies to our transportation system can save lives, time and money by improving safety, reducing congestion, enhancing mobility, minimizing environmental impact, saving energy and promoting economic productivity.

First-generation ITS systems generally:

- Collect and transmit dynamic information on traffic conditions and transit schedules for travelers, whether they are at home, in the office or en route.

- Expand the capacity of highways by reducing the number of traffic incidents, clearing them more quickly when they occur, rerouting traffic around them, and automatically collecting tolls.

- Improve the productivity of commercial, transit and public safety fleets by using automated tracking and dispatch systems that dynamically reroute vehicles to accommodate changes in customer needs.

- Help drivers in reaching a desired destination with navigation systems enhanced with pathfinding or route guidance.

Planned research and development promises even more advanced products and services such as collision avoidance systems, in-vehicle display of road and congestion information including curves, speed limits and construction projects. Research projects underway include guidance systems to automatically provide direction to shortest or quickest routes; enhanced vision systems to improve safety during darkness or dusty conditions; and systems that automatically weigh trucks and identify them as they pass state and international borders.

Section C: Service Areas for External Assessment

●●●●●●●●●●●●●●

The Application Strategies section of the external assessment was divided into four areas to more specifically assess the condition of each key business service area. Pre-defined business service areas were developed in an effort to standardize responses between participants and were not intended to be the same as the Business Areas outlined in the "Business Direction and Needs" section. The following functions were listed under each business service area to provide guidance on the type of activities that should be considered during completion of the questionnaire:

Transportation Planning and Development:
- Research and Technology Transfer
- Transportation Planning and Programming
- Environmental Affairs
- Right of Way
- Design

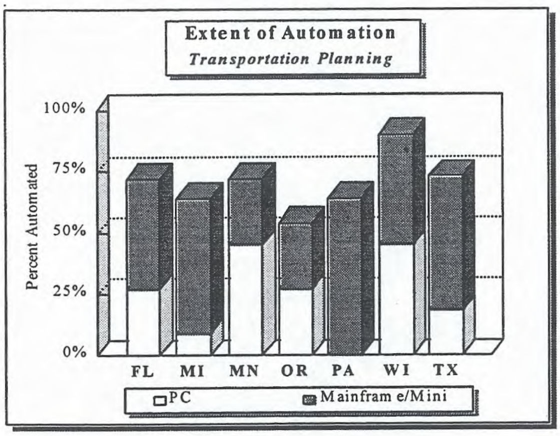
Field Operations
- Construction and Maintenance
- Materials and Tests
- Traffic Operations

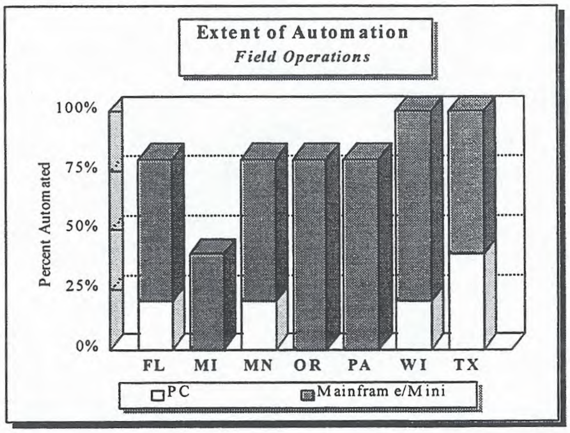
Administrative Services

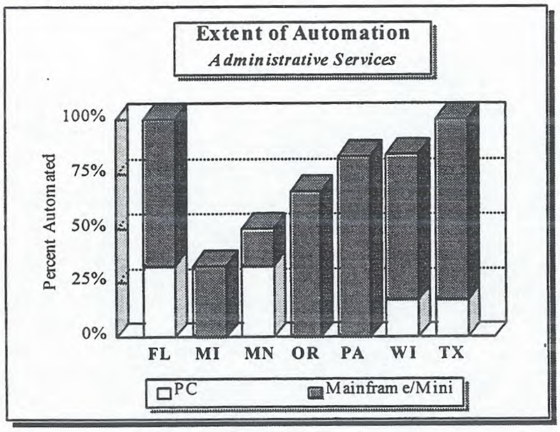
- Budget and Finance
- Human Resources
- General Services
- Information Systems

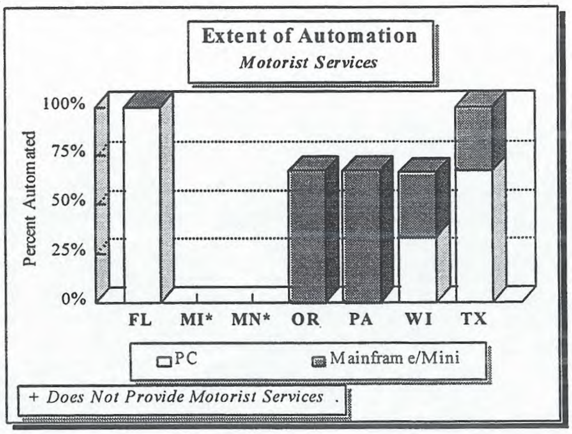
Motorist Services
- Central Permit Administration
- Vehicle Titles and Registration
- Motor Vehicle Division
- Travel and Information Services

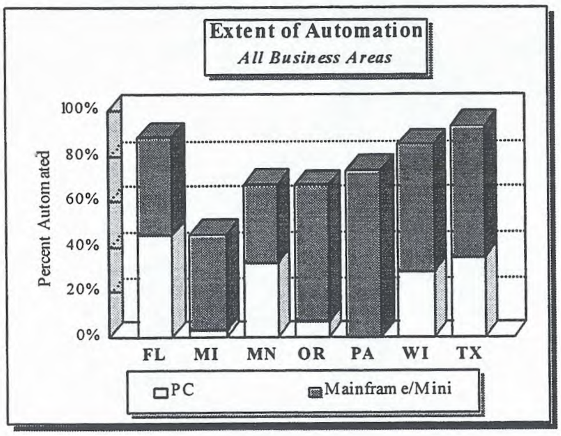
Application Strategies: The following charts display the extent of automation within each business area. Figures were derived from question 1, pages 3-7 of the External DOT Survey.



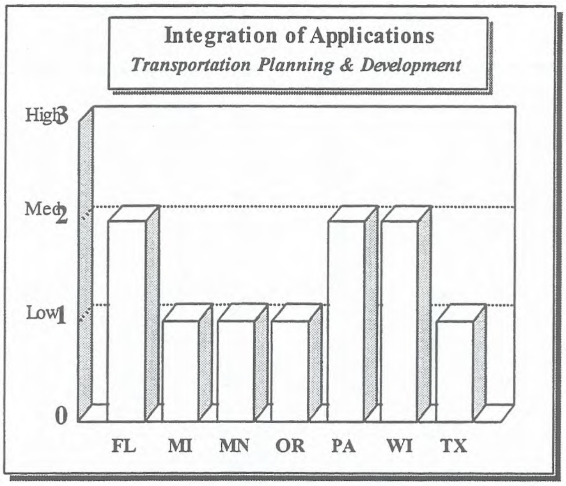


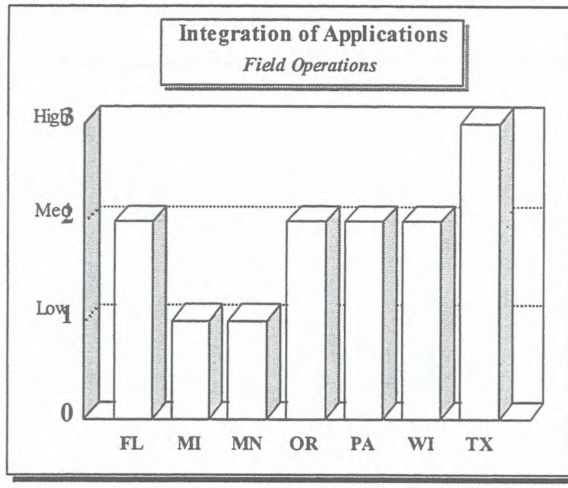


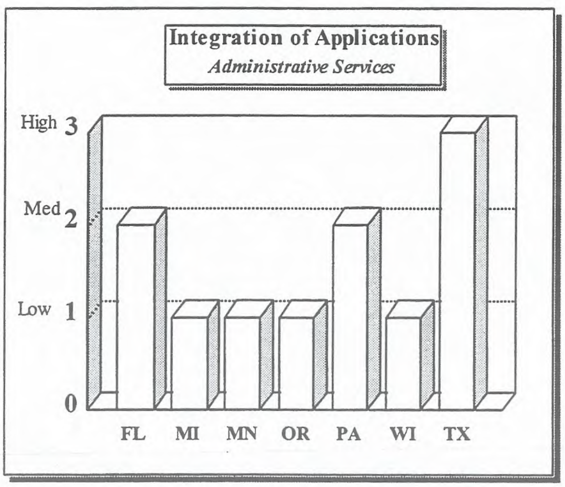


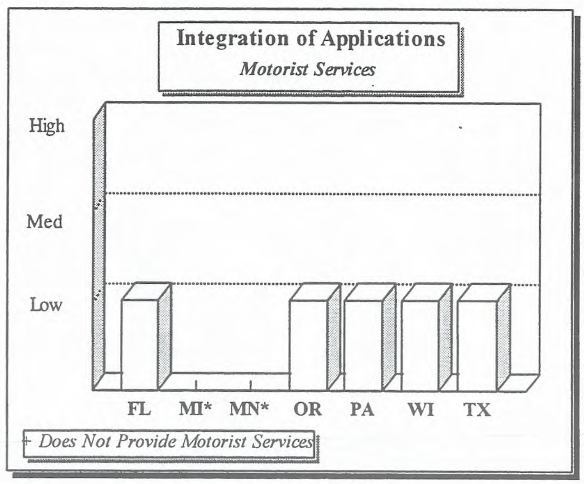


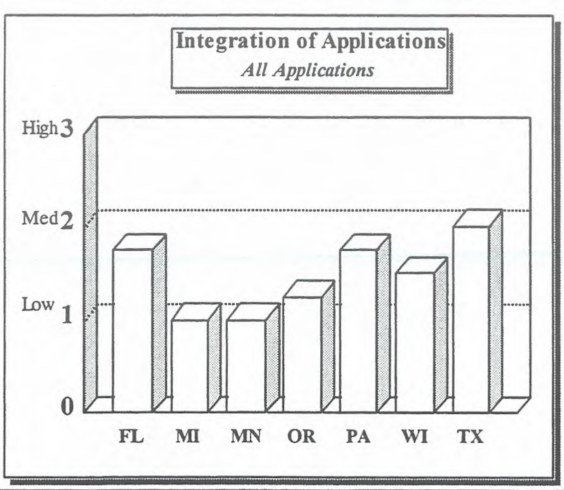
Application Strategies: The following charts display the extent of integration between applications within each business area. Figures were derived from question 1, pages 3-7 of the External DOT Survey.



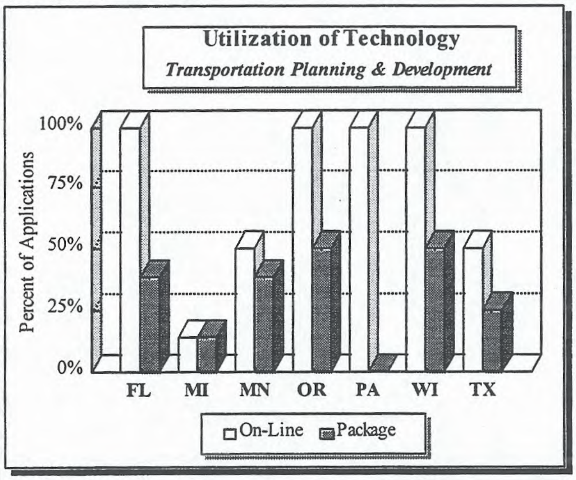


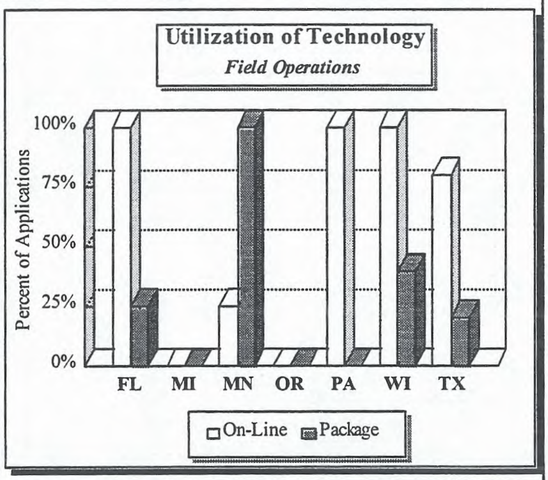


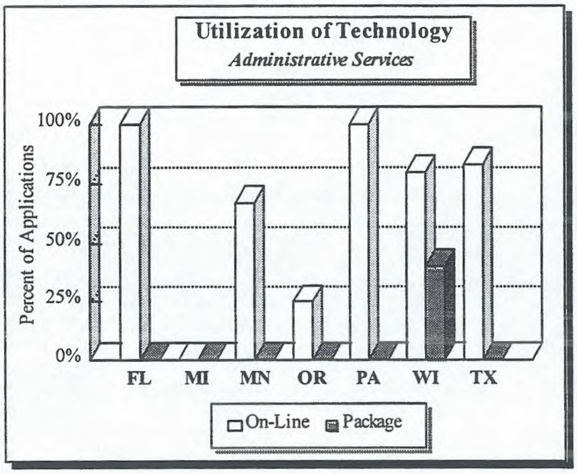


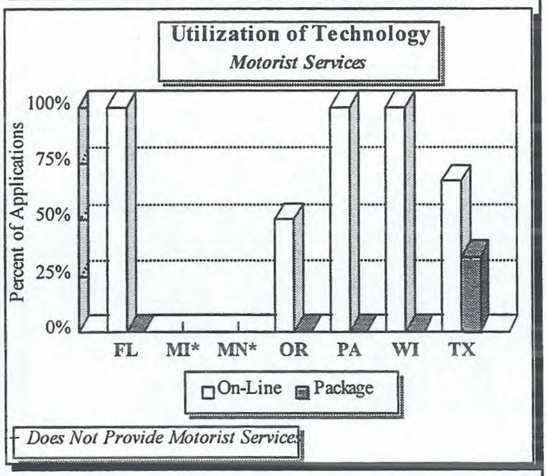


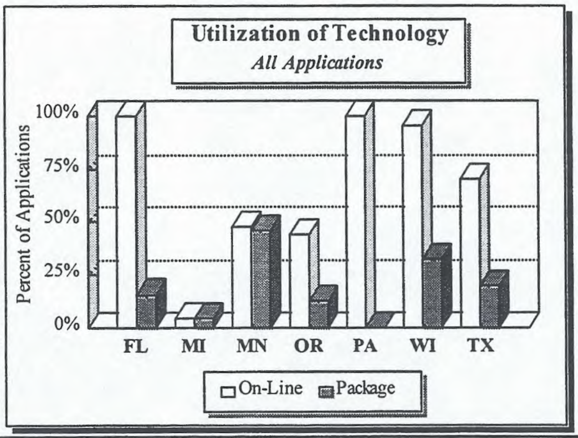
Application Strategies: The following charts display the utilization of technology within each business area through the use of on-line systems and package applications. Figures were derived from question 1, pages 3-7 of the External DOT Survey.



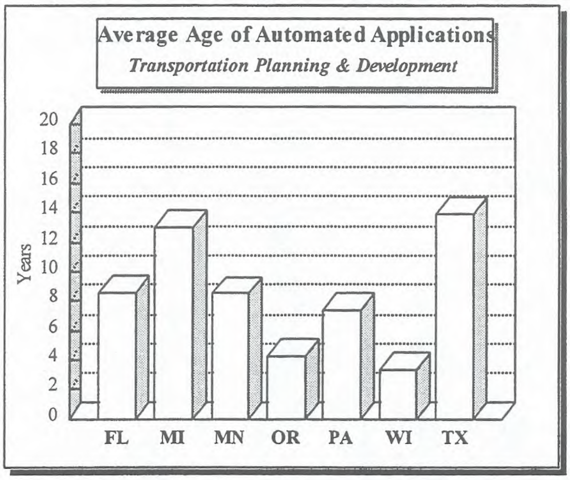


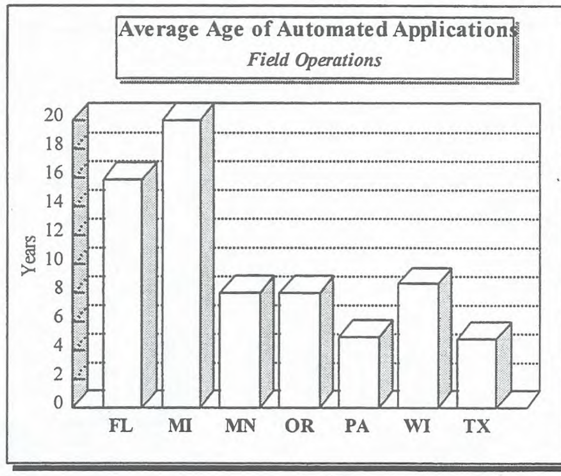


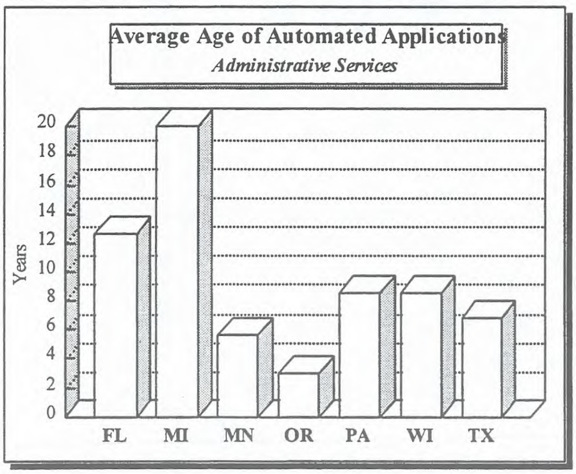


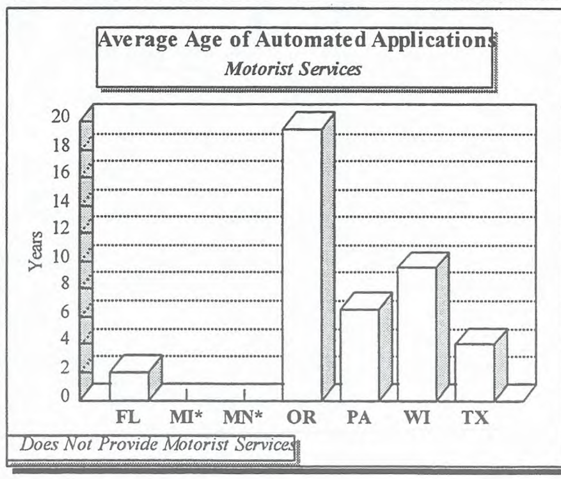


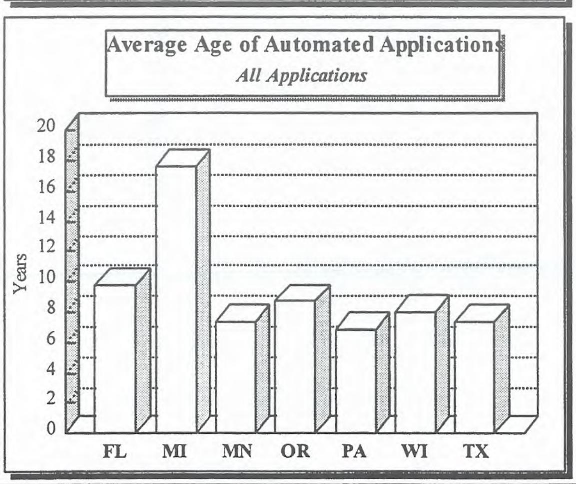
Application Strategies: The following charts display the average age of applications within each business area. Figures were derived from question 1, pages 3-7 of the External DOT Survey.



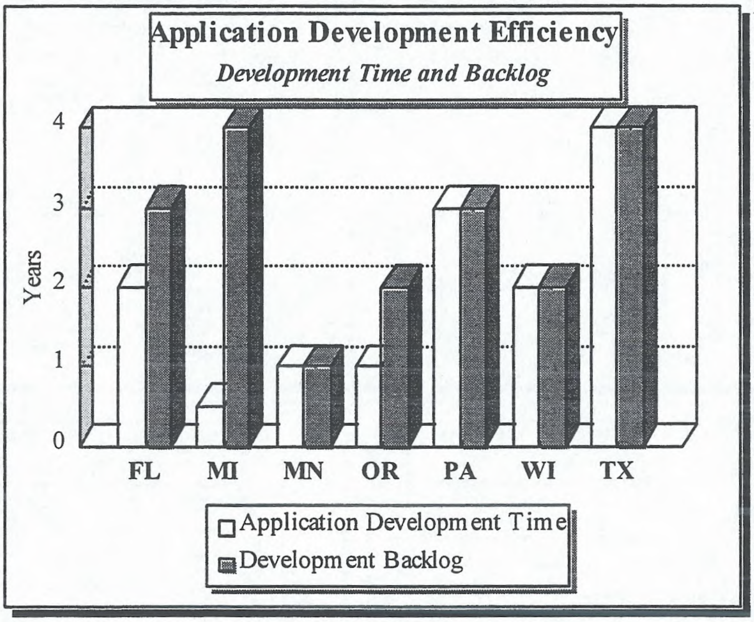


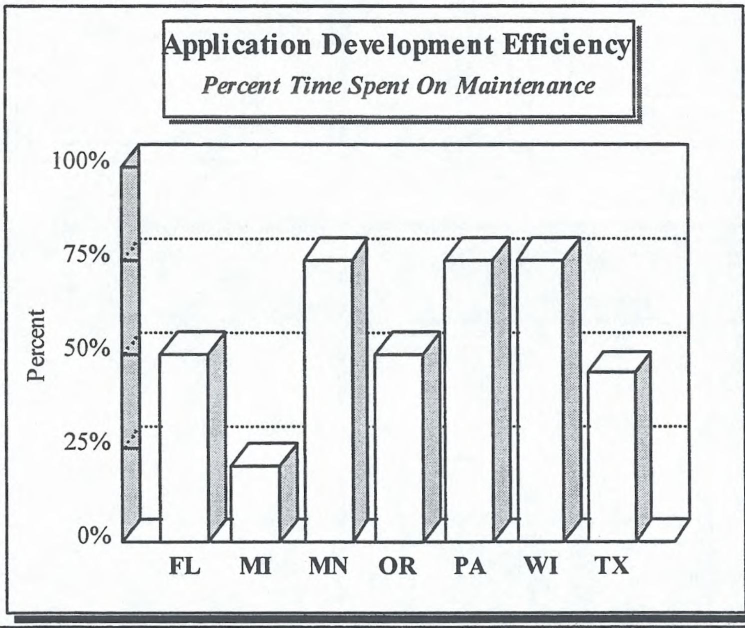




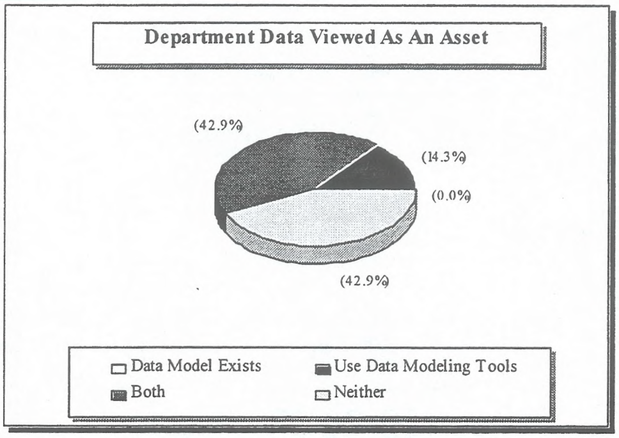


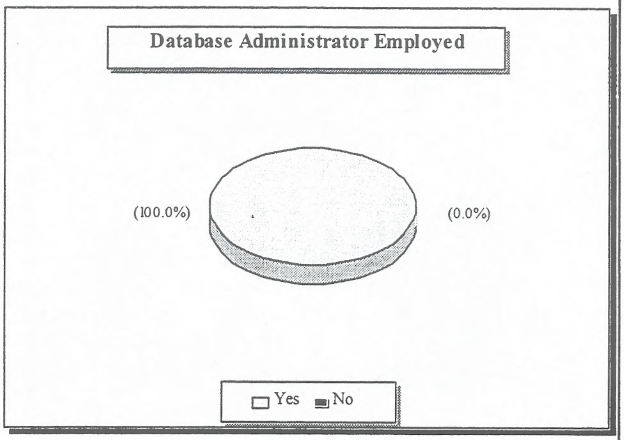
Application Strategies: The following charts display the application development efficiency of each DOT. Attributes included application development time, development backlog, and percent time spent on maintenance of existing applications. Figures were derived from questions 5-7, page 8 of the External DOT Survey.

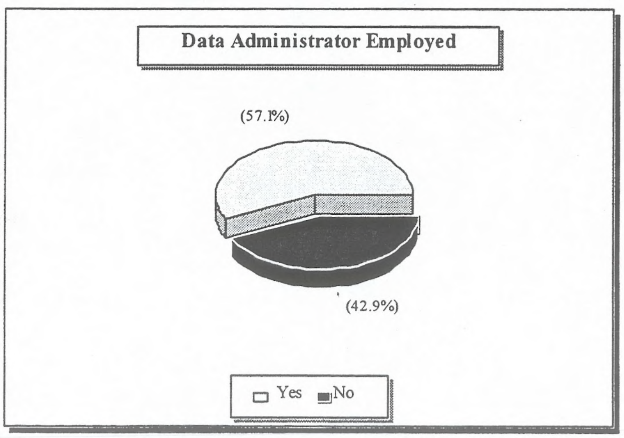




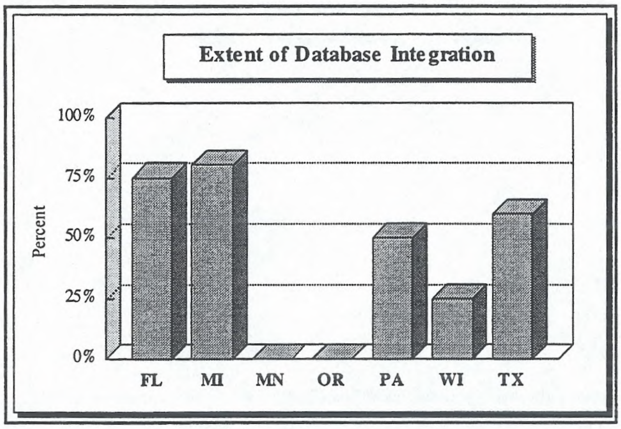
Data Strategies: The following charts display the treatment of department data as an asset and the employment of data and database administrators. Figures were derived from questions 1, 2 and 3 on page 10 of the External DOT Survey.

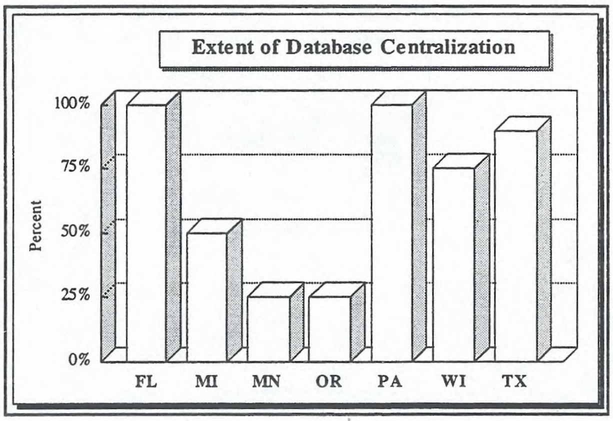


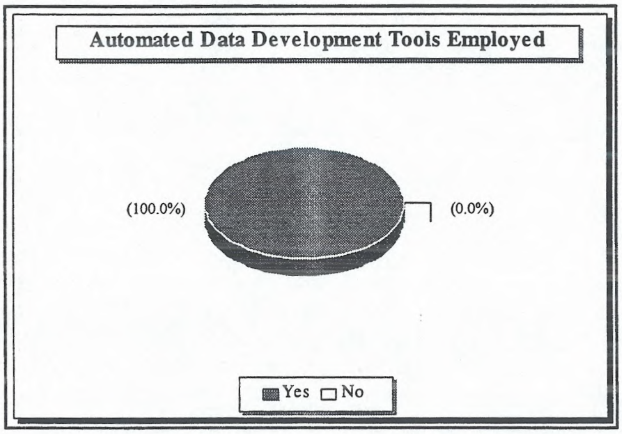




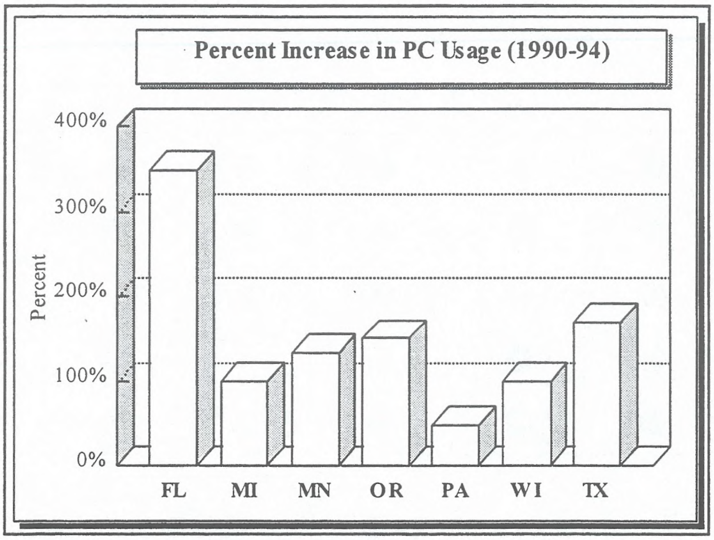
Data Strategies: The following charts display the extent of database integration and centralization and the use of automated data development tools. Figures were derived from questions 6, 7 on page 10 and question 10 on page 11 of the External DOT Survey.

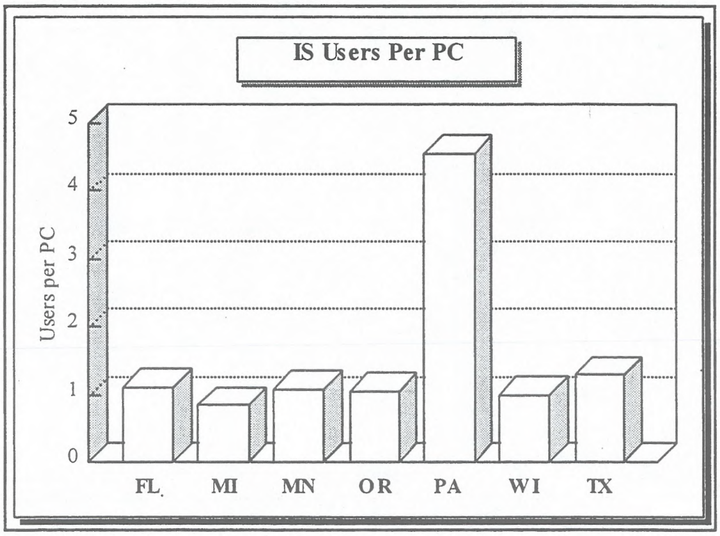






Technology Strategies: The following charts display the growth and deployment of microcomputer technology within each DOT. Figures were derived from questions 4, 8 on page 12 of the External DOT Survey.





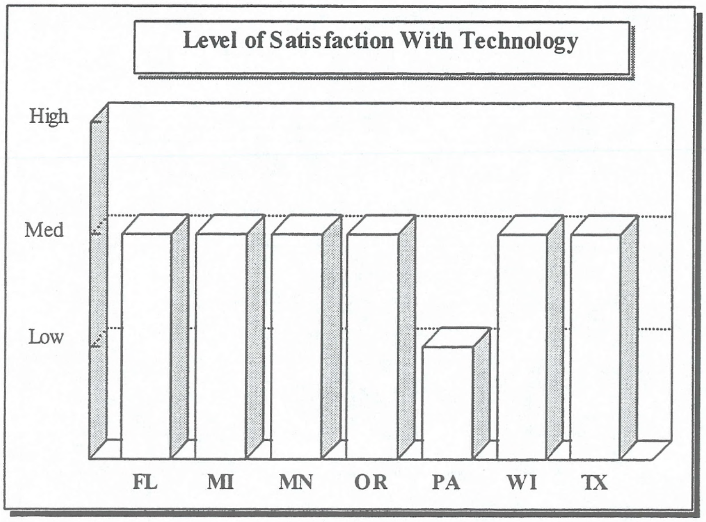
Technology Strategies: The following charts display the platforms and advanced technologies utilized by each DOT and the level of satisfaction with the technology currently in place. Figures were derived from question 9 on page 13 and question 3 on page 12 of the External DOT Survey.

Hardware Platforms

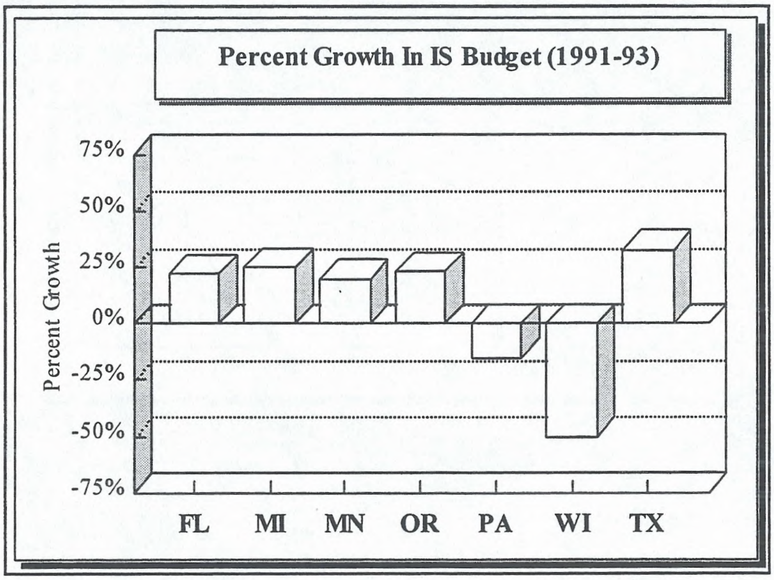
	FL	MI	MN	OR	PA	WI	TX
PC	●	●	●	●	●	●	●
LAN	●	●	●	●	●	●	●
WAN	●	●	●	●			●
Minicomputer	●	●	●		●		●
Mainframe	●	●	●	●	●	●	●

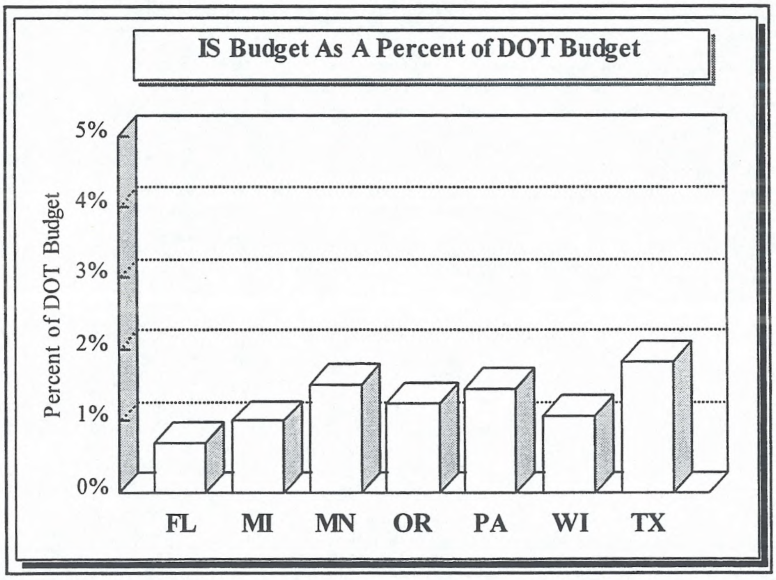
Advanced Technologies

	FL	MI	MN	OR	PA	WI	TX
Fiber Optics	●	●	●	●	●	●	●
Bar Coding	●						●
Doc. Mgmt./Imaging			●			●	●
GIS	●	●	●	●	●	●	●
Voice Response				●	●	●	●
Neural Networks							
Expert Systems			●			●	
Hand Held Devices	●	●	●	●		●	●

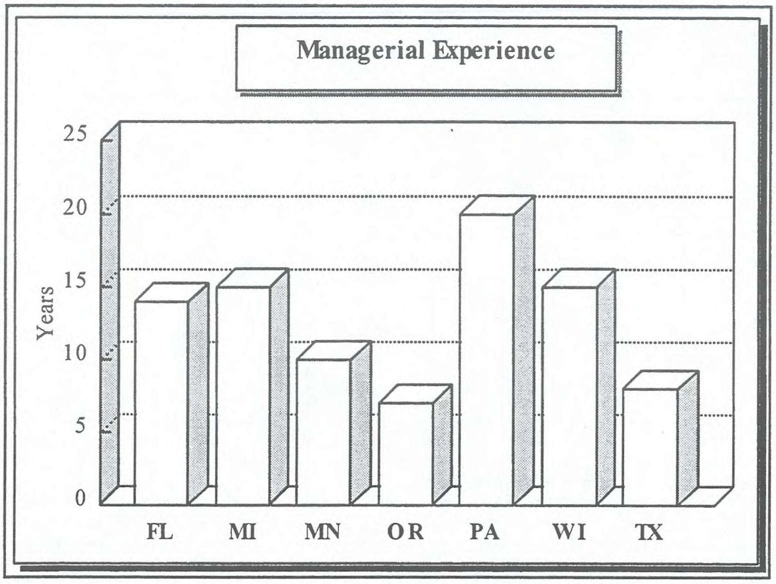

Level of Satisfaction With Technology
High
Med
Low
FL
MI
MN
OR
PA
WI
TX

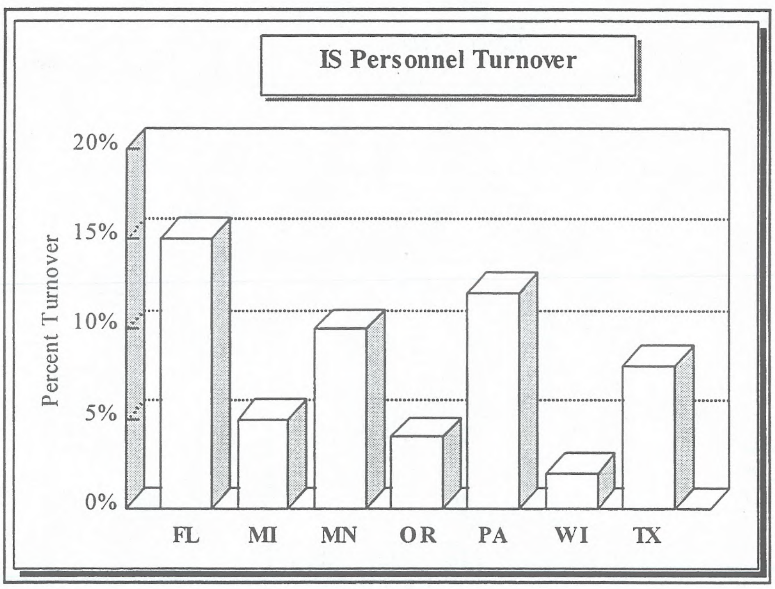
Resource Strategies: The following charts display the growth in IS budgets over the last three years and the current level of IS funds as a percent of the total DOT budget. Figures were derived from questions 1, 2 on page 14 of the External DOT Survey.





Resource Strategies: The following charts display the level of managerial experience within the IS department and the level of turnover experienced on an annual basis. Figures were derived from questions 5 and 6, page 15 of the External DOT Survey.





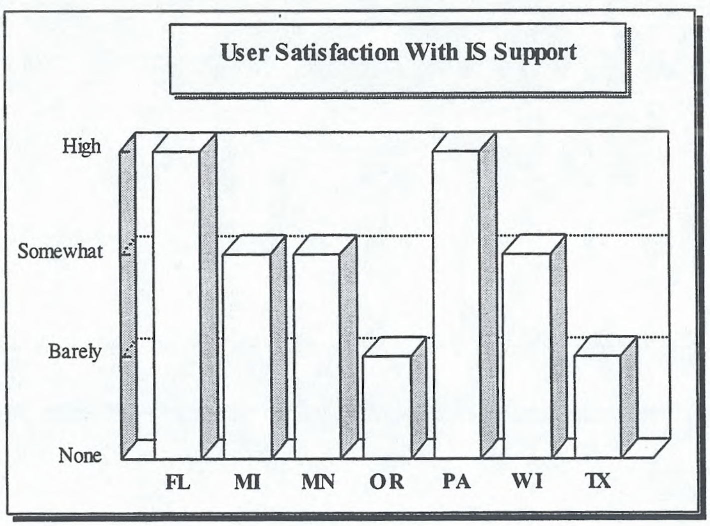
Resource Strategies: The following charts display IS activities performed by non-IS personnel, the importance of IS strategic planning, and the overall user satisfaction with IS support. Figures were derived from question 9 on page 15, and questions 12, 13, 14 and 15 on page 16 and of the External DOT Survey.

IS Activities Performed by Non-IS Personnel

	FL	MI	MN	OR	PA	WI	TX
Programming	●		●	●	●	●	●
Software Installation	●		●	●	●	●	●
Hardware Installation	●		●	●	●	●	●
Hardware Maintenance	●		●				●
LAN Administration	●		●	●	●	●	●

Organizational Importance of IS Planning

	FL	MI	MN	OR	PA	WI	TX
Existing IS Strategic Plan		●	●	●	●	●	●
IS Strategic Plan Tied to Business Plan	●	●		●	●	●	●
Level of Organization Which Sets IS Direction	Executive Committee	CIO	Management Committee	Resource Allocation Committee	Deputy Secretary	Division Councils	Executive



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Appendix 4

Core Technology Architecture

Version 2

Texas Department of Transportation

December 1996

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TABLE OF CONTENTS

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INTRODUCTION

The Core Technology Architecture: A Living Document

The Core Technology Architecture document is a living document and is meant to be updated periodically. This document is known as Version 2 of the Core Technology Architecture. Future versions should be produced periodically (for example, every 6 months) to incorporate changes in the technology and business requirements.

What is the Core Technology Architecture?

The core technology architecture of TxDOT is a key ingredient to providing information quickly and effectively to people. The desire is to have an enterprise-wide technology architecture that supports the data and applications architectures while being consistent, manageable, non-redundant, comprehensive, and easily integrated. The user group requiring information is no longer just individuals within TxDOT. Individuals and organizations outside of TxDOT need access to transportation related information located throughout TxDOT. The technical architecture provides the base upon which applications are built that support these needs.

An architecture is a blueprint rather than a facility. It is often compared to the city plan that lays out major highways, sets zoning ordinances, and defines locations and utilities. It does not describe the details of houses, though it may impose standards of size, construction, and safety.[1] The architecture is not intended to limit the solutions or creativity of the individuals involved with the business enterprise. The purpose of the architecture is to provide guidelines that promote and facilitate the integration of systems and development of an infrastructure that is consistent, manageable, scaleable, and easily integrated.

Within the Information Technology profession, two terms, architecture and infrastructure, are used interchangeably; however, each has a very different meaning. For this reason, clarifying these terms initially should reduce the potential for any misunderstanding.

Architecture

Architecture defines the guiding principles that will create the framework from which the infrastructure can be defined. It is the general direction that the operating systems, hardware, and networks will take.

Architecture refers to the logical view of the data, processes, applications, technology, and standards required to support the business from an information and technology perspective. The architecture also defines the standards, policies, and procedures for implementing an environment. Architecture is a framework that provides a logical view of the information and technology required to support the business. Architecture addresses the structure and interconnection between information processing and technology as well as the logical information and technology architecture required to support business systems.

[1] "Shaping The Future - Business Design Through Information Technology" - Peter G.W. Keen, 1991, p.200

Infrastructure

Infrastructure defines the specific components that make up the local area network (LAN), wide area network (WAN), hardware, operating systems, printers, and relational database management system (RDBMS). The infrastructure is defined based on the recommendations of the architecture. The architecture provides guiding principles; whereas, the infrastructure defines the specific components that are required.

Recommendations Leading to the Core Technology Architecture

The following recommendations were made in the IS BPR report "Phase 2: Vision Statements and Process Improvement Recommendations" (page 62):

> *Information technology architecture is a series of principles, guidelines, or rules used by an organization to direct the process of acquiring, building, modifying, and interfacing with IT resources throughout the enterprise. These resources can include equipment, software, communications protocols, application development methodologies, database systems, modeling tools, IT organizational structures, and more. The benefit of an integrated architecture is a more efficient business providing greater service to the end user and promoting a greater sense of collaboration that will contribute to the best use of available resources.*

The following recommendations were made:

- Provide an integrated, scaleable, and supportable technology architecture
- Coordinate solutions and information flows for technology architecture development
- Include appropriate controls and access for enterprise, business area, workgroup, and employee computing
- Ensure effective development, maintenance, and integration of the data, application, and technology architectures
- Involve stakeholders throughout the Department in definition and evolution of the technology architecture
- Include a "configuration management" process by which existing data, applications, and technology components can be managed and migrated toward the defined architecture.

Scope of the Core Technology Architecture

The Core Technology Architecture is the basic foundation for all the IS processes and TxDOT business functions. It is on the critical path to enable future Information Systems Division retooling projects.

The focus of the Core Technology Architecture is to provide TxDOT with an enterprise-wide blue-print for the future technical architecture. The Core Technology Architecture is one that allows Business Improvement Project (BIP) teams to develop applications to support the reengineered TxDOT.

The topics addressed in Version 2 of the Core Technology Architecture include:

- Enterprise Network Architecture
- Operating Systems
- Relational Database Management System (RDBMS)
- Hardware Architecture
- Remote/Dial-in/Dial-out
- Office Suites
- Groupware
- Enterprise System Management
- Reliability & Fault Tolerance

The following projects have not been included in the scope of this document:

- Intelligent Transportation Systems (ITS) projects, including transportation management centers, freeway traffic management systems, high occupancy vehicle lane traffic management systems, arterial traffic management systems, closed loop traffic systems, and ITS and traffic management related research and development projects. This includes ITS projects that are under operation, being installed, and planned for the future. ITS may be included in future versions of this document.
- Registration and Title System (RTS) that is being rolled-out statewide (some drawings include reference to RTS to indicate how RTS integrates with the Core Technology Architecture).

Requirements for Non-Compliance with the Core Technology Architecture

The following conditions must be met to justify non-compliance with the Core Technology Architecture:

- A strong business case must be made for not following the architecture when developing or implementing a new application. It must be shown that the application being developed or purchased cannot be logically, technically, and economically developed or implemented using the architecture.
- All exceptions to the architecture must be approved by the Information Resource Council. In addition, if a system is chosen that has not been identified in the architecture, all costs associated with the implementation and support of the system will be borne by the requesting District/Division/Special Office.
- An existing system cannot be economically converted to the architecture. In this case, attempts should be made to develop future enhancements to existing systems utilizing the architecture.

ENTERPRISE NETWORK ARCHITECTURE

Strategy

The enterprise network architecture is the foundation of the overall architecture. All other components rely upon the availability and capabilities of the network.

The enterprise network architecture is summarized as follows:

Transmission Control Protocol / Internet Protocol (TCP/IP)

In order to address the needs of future client/server and intranet technologies, the present multi-protocol topology of the TxDOT wide area and local area networks should be consolidated into a single TCP/IP protocol.

Ethernet Topology

Ethernet is recommended as the media of choice for local area connectivity for all new sites. Present locations at Division/Special and District Offices will continue to use both Token Ring and Ethernet with eventual conversion to Ethernet when feasible. All new installations at District, Division/Special and Area Offices should be based on Ethernet.

Network Extension

The TxDOT WAN/LAN TCP/IP network should be extended to all offices. T1 or fractional T1 circuits should connect all Divisions and Districts. Connections from Districts to Area Offices should be 56 kbps. Smaller sites should attach to the network with 28.8 kbps dial-up connections to Divisions or Districts.

Redundancy in Network

The existing wide area network should be reconfigured to provide redundant connectivity where possible. This will provide a more robust fault-tolerant network which is required for a successful implementation of client/server and intranet technologies.

3270 Terminal Replacement

All existing 3270 dumb terminals should be eliminated and replaced with PC workstations supporting 3270 emulation. This replacement strategy will provide a platform for client/server and office product support on every PC workstation.

Other LAN Protocols

LAN protocols such as Internet Packet Exchange (IPX), NetBIOS Extended User Interface (NETBEUI), Xerox Network System (XNS) and AppleTalk are not recommended for future development and expansion. System Network Architecture (SNA) should continue to be supported for legacy applications but should not be used for future application development.

Figure 1 is the Enterprise Summary Diagram representing the overall TxDOT LAN/WAN strategy graphically.

Conceptual Diagram of the Enterprise Network.

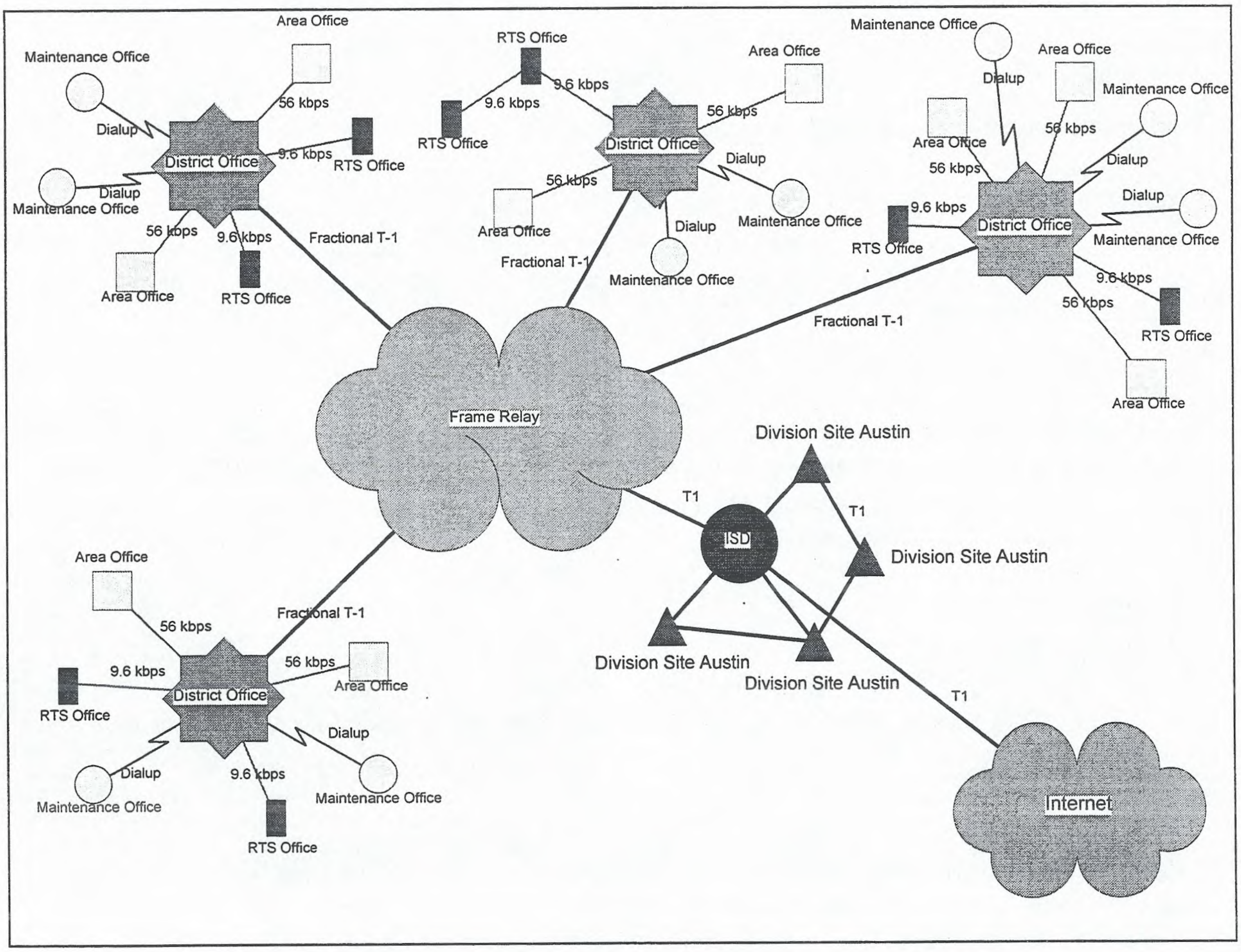

Figure 1 - Conceptual Diagram of the Enterprise Network

<u>Major Components</u>

- ISD Division Office
- Division/Special Offices
- District Offices
- Area Offices
- Maintenance Offices
- RTS Offices

Components of the Network Architecture

Figure 2 presents the network architecture at a level more detailed than the conceptual network architecture diagram depicted in Figure 1. It represents the type of components and topology that make up the overall network.

Summary of the Network Architecture Components.

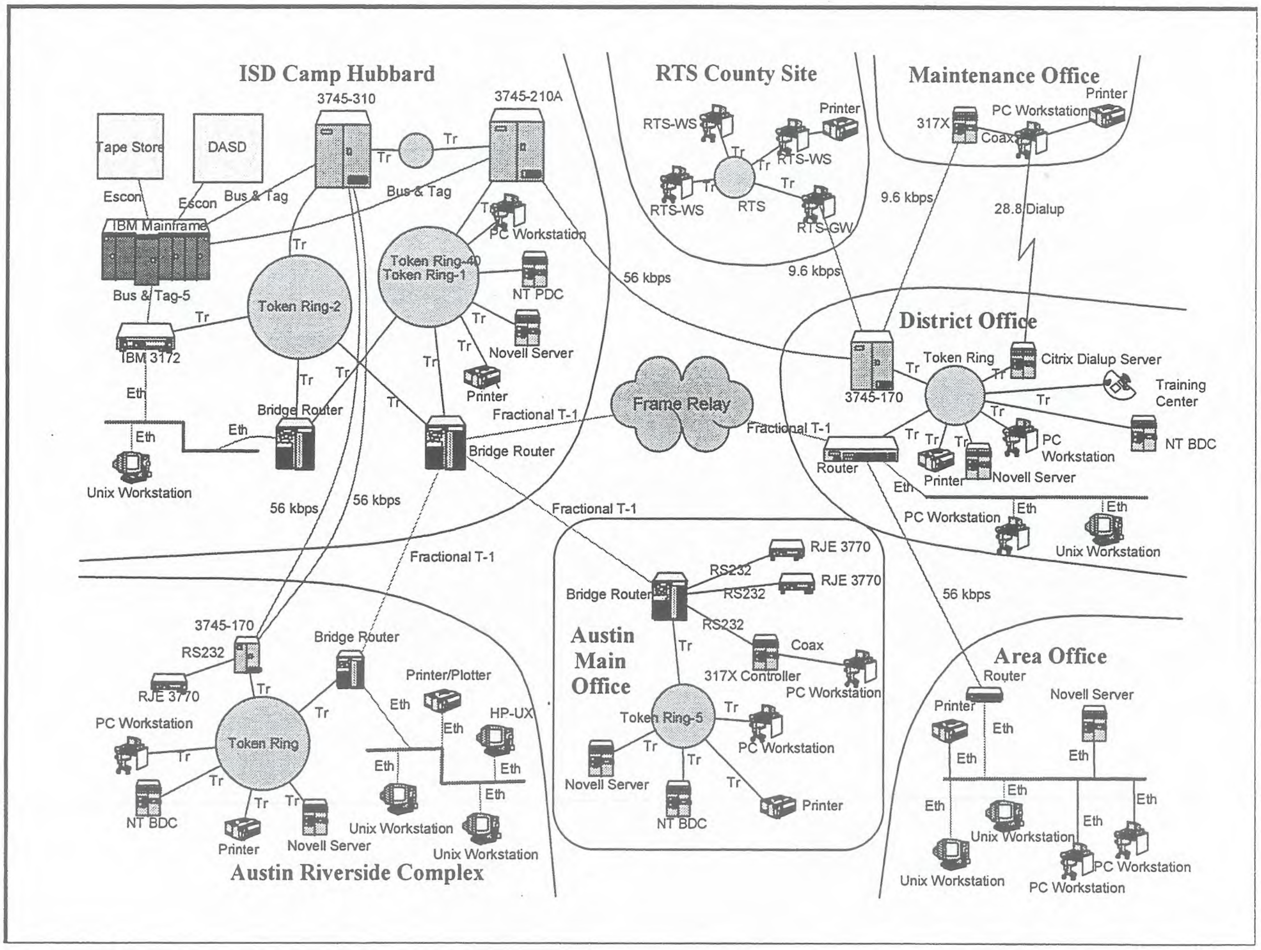

Figure 2 - Summary of the Network Architecture Components

Major Concepts of the Network Architecture

- Division/Special Offices in the Austin area will be interconnected with redundant T1 links providing support for SNA, TCP/IP and IPX protocols.
- A frame relay network will be used to connect T1 links from ISD in Austin to District Offices.
- District Offices will use the same frame relay network to connect to their adjacent Area Offices with 56 kbps circuits.
- Citrix server will support dial-in connectivity from laptops and remote Maintenance Offices.
- Dial-out from District Offices will be through NetWare Connect server.

District Architecture Components

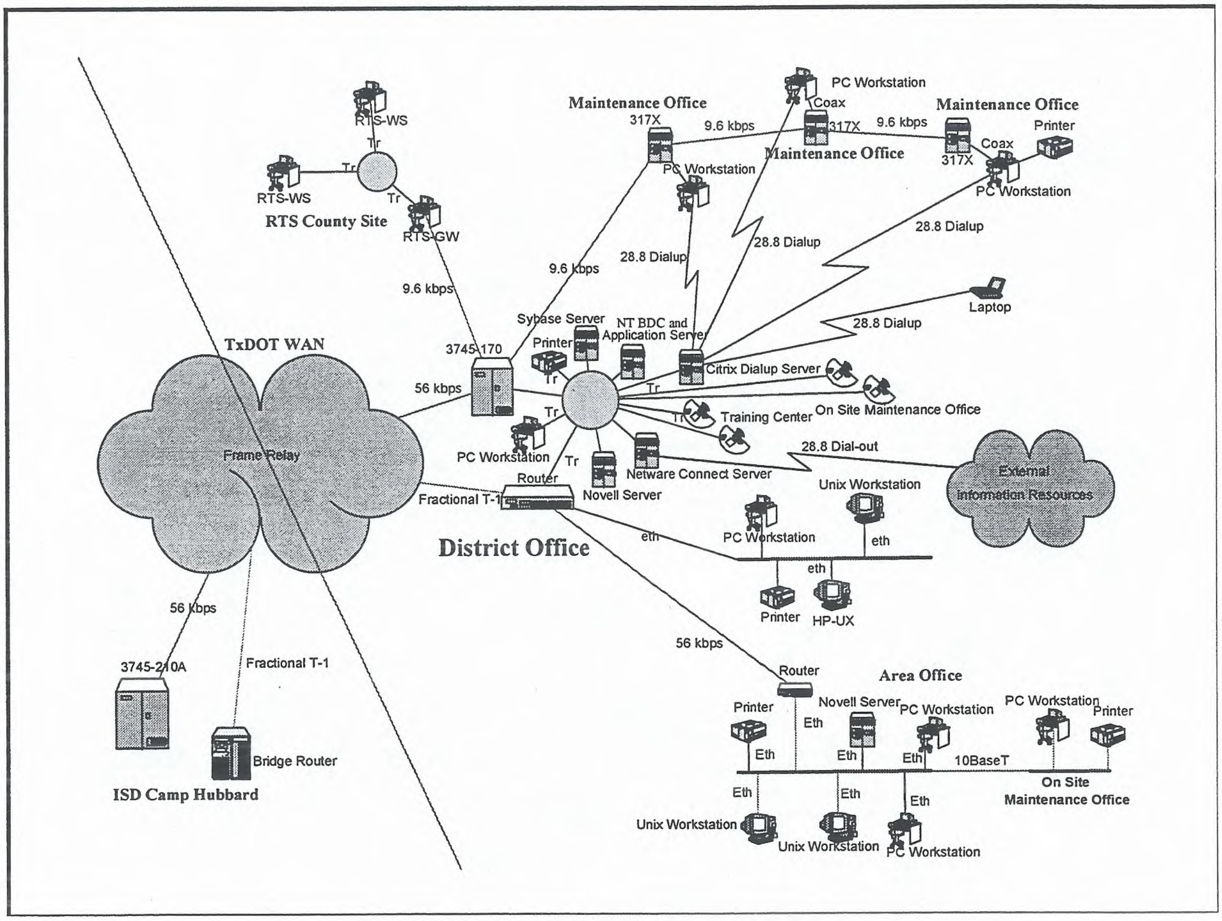

Figure 3 - District Architecture Components

Major Components of District Office Architecture

- Area Offices connected through routers to District Office network.
- Both Token Ring and Ethernet topology will remain in place.
- On-site Maintenance Offices connected to District LAN.
- Citrix server will support dial-in connectivity from laptops and remote Maintenance Offices.
- Dial-out from District Offices will be through NetWare Connect server.

Division/Special Office Architecture Components

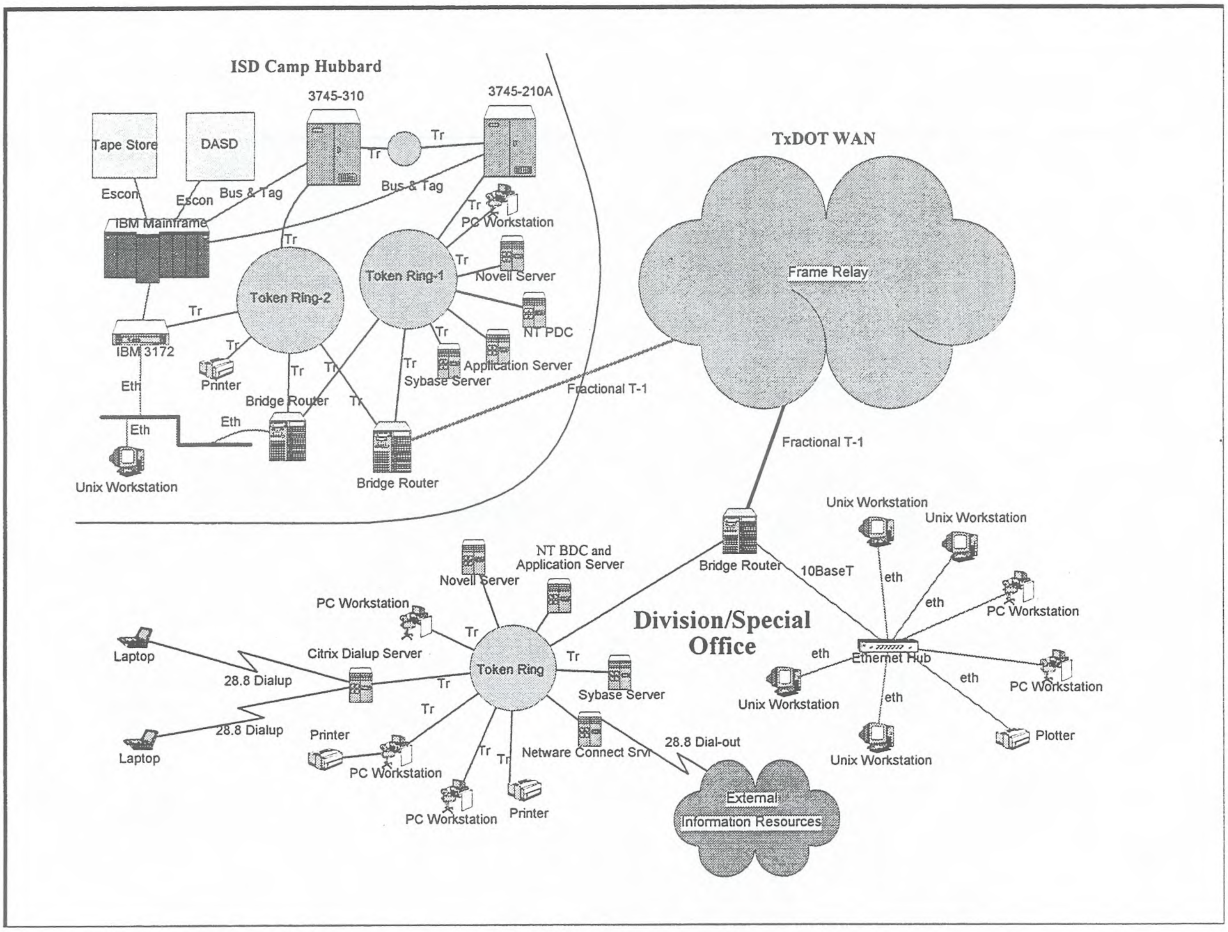

Figure 4 - Division/Special Office Architecture Components

Major Components of Division/Special Office Architecture

- Divisions/Special Offices will be connected through a router to other Divisions/Special Offices and District Offices.
- Both Token Ring and Ethernet topology will remain in place.
- Citrix Server will support dial-in connectivity from laptops and other remote users, where a business case exists.
- Dial-out from Divisions/Special Offices will be through NetWare Connect server.

Area Office Architecture Components

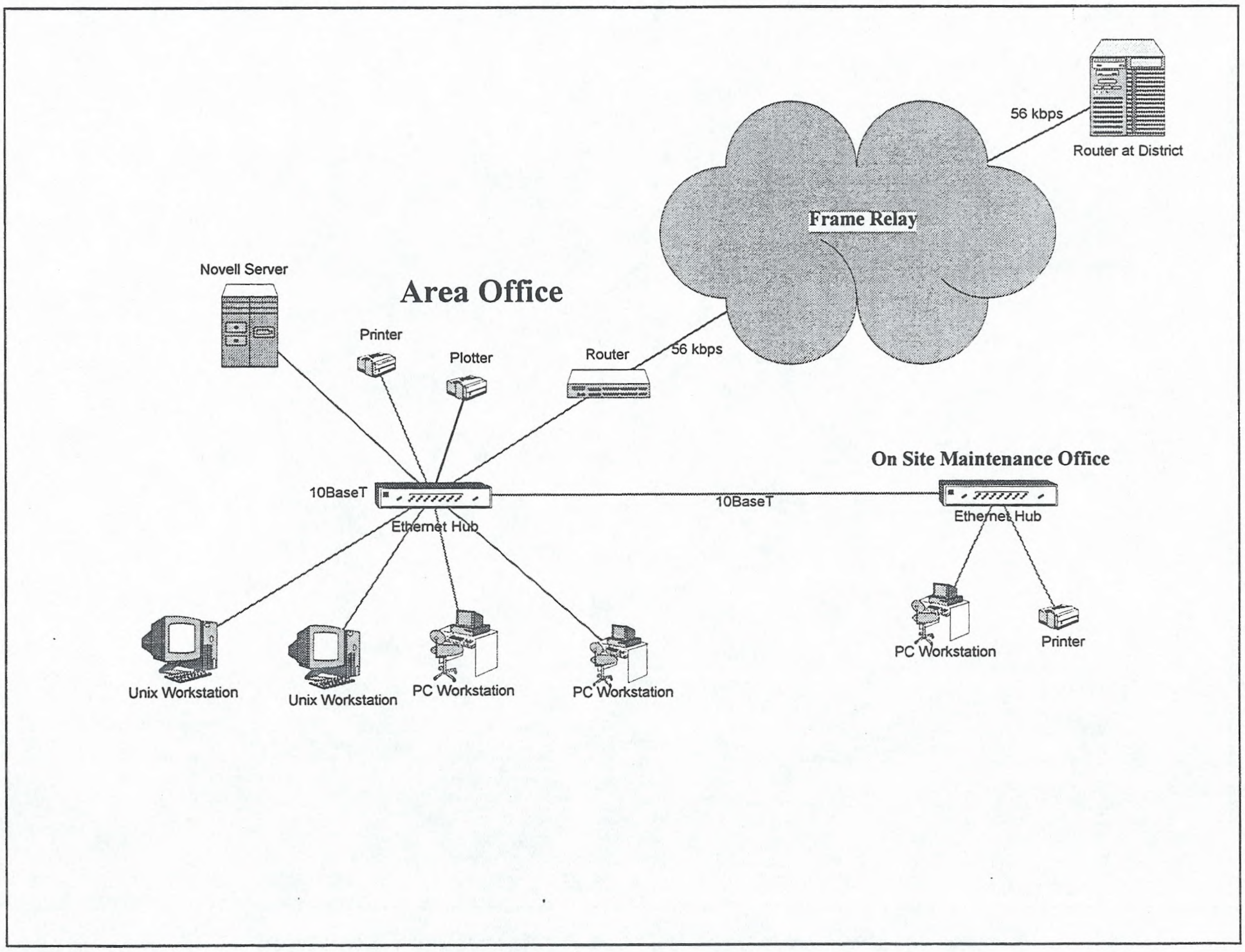

Figure 5 - Area Office Architecture Components

Major Components of Area Office Architecture

- Ethernet topology utilizing 10-Base-T hubs.
- 56 kbps connection to adjacent District Office.
- Network attached workstations, printers and NetWare file server.
- On-site Maintenance Offices will be attached to Area Office LAN.

Maintenance Office Architecture Components

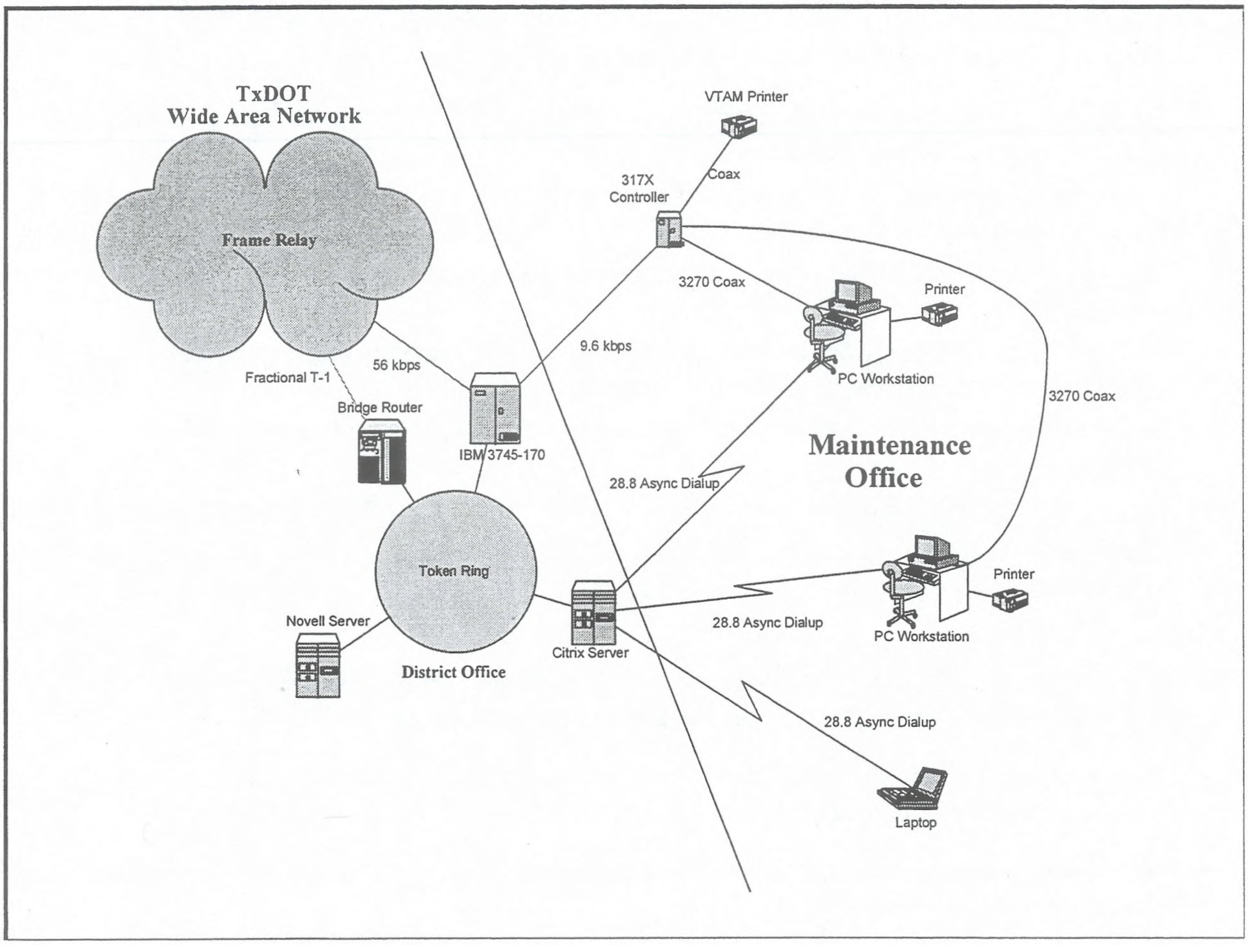

Figure 6 - Maintenance Office Architecture Components

Major Components of Maintenance Office Architecture

- Dial-in connectivity for GroupWise and new applications to Area Offices
- Maintenance Offices located on-site at District Offices and Area Offices will be an extension of the network at those sites.

The overall dial-up connectivity will be detailed further in the remote/dial-in/dial-out section of this document.

Benefits of Enterprise Network Architecture Strategy

Selecting TCP/IP as the protocol of choice for the TxDOT enterprise-wide network has many advantages over the present multi-protocol environment. Some of these advantages include:

- Simplification of network configurations for all devices on the TxDOT network with only one protocol stack to define and maintain.
- Enhanced troubleshooting due to reduced training requirements (only one protocol to learn) and fewer required diagnostic tools.
- Less resource utilization and fewer network devices. Workstations and routers use less memory when supporting only one protocol.
- More efficient use of network bandwidth can be achieved because a single protocol can be optimized more effectively than multiple protocols.
- Easier communication to outside agencies because TCP/IP has become the "de facto" communications protocol.
- Many existing applications, i.e. web servers, use TCP/IP as their communications protocol.
- Client/server applications development is simplified with only one communications protocol API.
- TCP/IP required for all new network installations by DIR.

There are several reasons for choosing Ethernet over Token Ring or other local area network media access protocols. Some of the reasons for the selection of Ethernet are as follows:

- Ethernet simplifies the consolidation of engineering and business hardware and software communications components.
- New developments in Ethernet technology have enhanced its performance and capabilities, i.e. switching and 100 Mbps bandwidth.
- Ethernet is the predominant media choice in TCP/IP based networks. This results in more vendor support and lower hardware prices than competing LAN media protocols such as Token Ring.

Extension of the LAN/WAN TCP/IP network to all TxDOT offices will mean that capabilities such as Novell file and print services, e-mail, and 3270 connectivity will be available to all personnel requiring these services. Furthermore, the expansion of the LAN/WAN network to all levels of the TxDOT infrastructure is necessary to successfully implement future client/server statewide applications.

Emerging Technologies

The adoption of the network strategies listed above will be a dynamic process. It is already evident that newer technologies are being developed that offer advantages to future TxDOT network design. Some examples include:

ATM (Asynchronous Transfer Mode)

ATM is a very high speed (155 Mbps) connection oriented replacement for Ethernet and Token Ring. It offers the promise of high speed predictable communication in multimedia environments.

High Speed Switching

Another new technology already starting to be used as a replacement for network routers and bridges in some networks is the high speed switch. This device, if used properly, can greatly increase the performance of LAN networks reducing congestion and improving throughput.

The TxDOT Network will continue to evolve into a more open and serviceable platform to meet future TxDOT business requirements.

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OPERATING SYSTEMS

Strategy

TxDOT's strategy for PC workstation and laptop operating systems is aimed at providing a consistent graphical user interface (GUI) for the end user, and a high level 32-bit capability with preemptive multitasking and multithreading application use and development. The operating systems should provide compatibility with existing 16-bit applications. Local area network (LAN) connectivity is to be included as an integral part of the operating system.

TxDOT's strategy for network server operating systems is aimed at providing a high level of connectivity throughout the Department. The LAN operating systems are scaleable across a variety of computing platforms. The LAN operating systems support a wide variety of hardware and software configurations. In addition, they provide consistent software application development platforms.

The following operating systems are recommended for future application development:

- Windows NT Workstation
- Windows NT Server
- Windows 95
- Novell NetWare
- UNIX
- OpenEdition MVS.

The following factors were considered when recommending operating systems for the new architecture:

- Potential viability of the vendor and the product in the near future
- Stability of the product
- Support for 16-bit and 32-bit applications
- Third party application support
- Product market share for operating systems
- Training/support requirements.

Workstation Operating System Architecture

LAN-attached PC workstations

Windows NT Workstation and Windows 95 have been selected as the operating systems for all LAN-attached PC workstations. Windows NT Workstation and Windows 95 are 32-bit multitasking operating systems that provide excellent compatibility with existing 16-bit Windows applications and newer 32-bit applications.

The goal for the Department is for all LAN-attached PC workstations to run the Windows NT Workstation operating system. However, the current PC workstation inventory includes units that are incapable of satisfactorily running Windows NT Workstation because of slow processor speeds, disk space, and/or limited memory. For this reason, Windows 95 should be used on PC workstations that would be incapable of running Windows NT Workstation satisfactorily. Recommended use of Windows NT Workstation and Windows 95 is described below and in the section "Determining Which PC Workstation Operating System to Use" on page 17.

The strategy of using Windows NT and Windows 95 agrees with the Meta Group recommendation, "Windows NT Workstation should be considered the strategic desktop, with Windows 95 a tactical step on the road to an NT-based desktop environment."

Windows NT Workstation

Windows NT Workstation is recommended as the operating system for all LAN-attached PC workstations with Pentium-level and above processors and as the optional operating system for PC workstations utilizing 486 processors with speeds equal to or greater than 66 MHz with 32 MB of memory.

Windows NT Workstation provides a high level of workstation security, memory protection, broad network protocol support and should be used for the development of and use with mission critical applications. The latest version of Windows NT Workstation (version 4.0) has the Windows 95 shell interface and will provide TxDOT with a single user interface for all microcomputer platforms in the future. The built-in TCP/IP stack allows Windows NT Workstation to attach to TxDOT's IP network.

Windows 95

Windows 95 is recommended as the operating system for all LAN-attached PC workstations utilizing 486 processors with speeds less than or equal to 50 MHz. Also, Windows 95 is recommended for use with 486/66 and faster 486 PC workstations with less than 32 MB of memory.

Windows 95 has lower hardware requirements (for processor, disk space, and memory), greater compatability with older PC workstations, and greater support for device drivers than Windows NT Workstation, and provides easier installation. Windows NT Workstation is more robust, has greater application protection, has better multitasking, and has better security.[2]

[2] "Windows 95 or Windows NT on the Desktop?" Gartner Group PC Research Notes P-230-1188 & P-230-1189, 5/31/95

Laptops and non-LAN-attached PC workstations

Windows 95 has been selected as the operating system for laptops and non-LAN-attached PC workstations. Windows 95 provides compatibility with existing 16-bit Windows 3.1 applications and is capable of running the next generation of 32-bit Windows applications. Windows 95 requires less memory (RAM) than Windows NT Workstation, has lower processor requirements than NT Workstation, supports dial-in better than NT Workstation, and has "plug and play" device detection that is especially useful when installing and removing adapter cards in laptop computers. Windows 95 also comes with a built-in TCP/IP stack which allows the computer to attach to TxDOT's IP network.

Determining Which PC Workstation Operating System To Use

The operating systems that should be used for PC workstations are summarized in the following table.

PC Workstation	Processor	Operating System	Recommended RAM
LAN-attached PC Workstation	Pentium and above	Windows NT Workstation	32 MB
	486/66 and faster 486's	*Recommended:* Windows 95	16 MB
		Optional: Windows NT Workstation	32 MB
	486/50 and below	Windows 95	16 MB
Non-LAN-attached PC Workstation (dial-in)		Windows 95	16 MB
Laptop		Windows 95	16 MB

Table 1 - PC Workstation Operating Systems Selection Guidelines

Server Operating Systems

General Print and File Servers

Novell NetWare version 4.1 (and subsequent versions) has been selected as TxDOT's print and file server operating system for local area networks. Novell NetWare 4.1 is an enterprise LAN operating system and provides for enterprise-wide management and support through the use of NetWare directory services (NDS). New additions to the Novell network will allow printing of documents using the Novell print queue, regardless of source. GroupWise, TxDOT's department-wide e-mail and scheduling software is also internally linked to the Novell NDS for enterprise-wide administration. This decision also leverages TxDOT's considerable existing investment in Novell throughout the Department.

Application and Database Servers

Windows NT Server

Windows NT Server has been selected as TxDOT's application and database server operating system. Windows NT Server offers preemptive 32-bit multitasking with multithreading and support for multi-processor servers. In addition, Windows NT Server supports multiple protocols and has C-2 certifiable security and also supports attachment to existing TxDOT Novell networks.

UNIX

UNIX should be considered as an application server platform for those applications, which by design specifications or transaction volumes, are considered too large for Windows NT Server to handle effectively. To leverage TxDOT's expertise with HP-UX, it is recommended that this version of UNIX be considered first for this category of application or database support.

CLIX , Intergraph Corporation's implementation of the UNIX operating system, should continue to be used with existing Intergraph engineering workstations and with print and plot servers. No further development is recommended utilizing CLIX.

HP-UX should continue to be used on existing Hewlett Packard UNIX workstations. Continued development using HP-UX on existing workstations is recommended to support existing engineering systems.

MVS

MVS will continue to be the mainframe operating system for TxDOT's IBM mainframe. It is further recommended that TxDOT migrate to OpenEdition MVS on the mainframe as soon as practical.

Server Operating System Summary

The operating systems selected for servers are summarized in the following table.

Operating Systems Selection Guidelines	
Print/File Server	• Novell NetWare 4.1
Application Server	• Windows NT Server • UNIX (High transaction volumes/Intergraph CADD) • MVS/ESA (Mainframe)
Database Server	• Windows NT Server • UNIX (High transaction volumes) • MVS/ESA (Mainframe)

Table 2 - Server Operating Systems Selection Guidelines

Other Operating Systems Considered

The other operating system strategies that were considered are listed below:

- Remaining with Windows 3.1 and 3.11
- Migrating to OS/2
- Migrating to UNIX for clients

Remaining with Windows 3.1 and 3.11

Remaining with Windows 3.1 and 3.11 would not allow the Department to take advantage of the computing resources available with 32-bit processors. It would define all applications development to a slower 16-bit applications arena. In addition, Windows 3.1 and 3.11 are not multitasking operating systems and would further hamper the development of robust applications for the Department. While the vast majority of off-the-shelf programs available today are 16-bit, these application programs are rapidly being converted to 32-bit applications to take advantage of newer processor architecture and operating systems such as Windows NT Workstation and Windows 95.

Migrating to OS/2

Migrating to OS/2 was considered. It is a 32-bit multitasking, multithreading operating system with multiple protocol support. OS/2's market share is nine million copies according to IBM. While this is a large number, it represents only about a six (6) percent market share and is small in comparison to the 80 to 90 million copies of Windows in use today. The Gartner Group recommends that organizations with OS/2 should cap their OS/2 investment and where applications have been developed in OS/2, further development with OS/2 should not be considered. Gartner also projects OS/2 as only a niche player in the PC workstation operating systems arena.

Migrating to UNIX for Clients

UNIX is a robust, multitasking operating system with approximately 12 to 15 percent of the operating system market when all platforms are considered. There are many varieties of UNIX to choose from and that presents problems with program compatibility and its complexity leads to the need for higher levels of support. In addition, there are few PC workstation applications written specifically for UNIX. The Gartner Group does not expect that the market share of UNIX will exceed its current position in the market.

Benefits of Operating System Strategy

The selected operating systems architecture supports the following TxDOT business objectives:

- Facilitates TxDOT's migration to a distributed computing environment by providing consistent development operating systems across hardware platforms.
- Enhances software application developer's ability to execute rapid application development projects with homogeneous/interoperative operating systems.
- Standardized operating systems will lead to reduced administration, support, and training costs.
- More effective delivery of central support services and enhanced end user satisfaction with the central support services

Emerging Technologies

Emerging operating system technologies that should be considered in the future include:

- 64-bit operating systems - The current development of 32-bit operating systems is the result of the design of 32-bit processor architecture. The next generation of 64-bit microcomputer processors are in the design and testing stage now. It will not be uncommon by the year 2000 to have a 64-bit PC workstation processor. Operating systems must be developed to handle these newer and larger capacity processors.
- Symmetrical multiprocessing (SMP) for large numbers of processors (massively parallel computers) - SMP is the combining of several physical processors to make a large logical processor capable of handling multiple operations. The benefit of this technology is to take relatively inexpensive (when compared to a mainframe) processors, link them together logically with the operating system and perform larger tasks. Operating systems must be able to take advantage of this technology.
- Internet browser interfaces - The Internet is projected to become the main medium of information transmittal by the year 2000. Browsers will give the user a "universal interface" to this world of information. Operating systems must provide mechanisms to aid in the seamless transmittal of information.
- Management of large capacity storage devices - It will become increasing important that operating systems be able to handle very large storage devices. Storage capacity technology is on an exponential development curve with larger and large capacity devices and a decreased physical size. Operating systems must be able to support these devices.
- Multimedia effects on OS efficiency - Multimedia operations such as teleconferencing, computer based training and distance learning will require additional bandwidth in our telecommunications networks. Operating systems must be able to manage the incoming data streams in an efficient manner.
- Object Oriented Operating Systems - Traditional operating systems link lines of written code as applications are developed. Object oriented operating systems allow the linking of objects. The objects contain coded operations for particular operations. This will aid in the rapid development of information systems.
- Interoperability/Compatibility between PC workstation OS and LAN OS - To decrease the amount of support necessary for the integration of PC workstation operating systems and LAN operating systems, it will become increasingly important that both types of operating systems communicate with a minimum of interface overhead. The development of appropriate drivers for PC workstations is a critical element in the interoperability between the two types of operating systems.

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RELATIONAL DATABASE MANAGEMENT SYSTEM (RDBMS)

Strategy

In order to address the database needs of future application development, a relational database management system should be used for enterprise and workgroup applications in development and production environments.

Enterprise applications are applications that span multiple business areas and multiple Districts, Divisions, or Special Offices.

Workgroup applications are applications that meet the District, Division, or Special Office needs and can be provided by the business area.

The following products are recommended for use as application databases:

- Sybase SQL Server for the development of enterprise wide and workgroup applications
- Sybase SQL Anywhere for PC workstation applications that have the potential of expanding beyond a single workstation and for small workgroup applications
- Microsoft Access for individual workstation database use
- ADABAS C (ADABAS) for application development requiring the mainframe and for maintenance of existing applications. (While ADABAS C is not a true relational database, it does support the relational model.)

The products listed above are the databases recommended for future applications development. However, applications currently exist that will require the continued use of databases that are not recommended for future application development.

RDBMS Research and Recommendation

In December 1994, a project team was formed to formally evaluate Relational Database Management Systems (RDBMS) and to recommend an RDBMS for future applications at TxDOT. The project team compiled detailed requirements and published a Request For Information (RFI). Through an extensive RFI evaluation process, the team recommended the selection of the Sybase solution for new application development and the continued use of ADABAS on the mainframe.

Selecting a Database for New Applications

The RDBMS products that are recommended are best used for different types of applications. The criteria listed in Table 3 should be considered when making database selection decisions for application development, modification, and maintenance.

Database Alternatives	When to Use
Sybase SQL Server	• Enterprise or workgroup application development • Decision Support Systems (DSS) • Online Transaction Processing (OLTP) • Number of users > 40 • Database size is > 2 gigabytes • SMP environment, up to 30 CPU's
Sybase SQL Anywhere	• Workgroup applications • Decision Support Systems (DSS) • PC workstation applications with potential for being shared among a workgroup • Number of users ≤ 40 • Database size is ≤ 2 gigabytes • Applications with the potential of expanding above size and use limits
Microsoft Access	• PC workstation applications for a single user with no data sharing
ADABAS C	• Support of legacy applications • OLTP systems with minimal adhoc access and extremely large amounts of data • If required by a proprietary package that meets TxDOT business needs
VSAM	• Support of legacy applications
SAS	• Support of legacy applications
Other PC Workstation Databases	• Support of legacy applications

Table 3 - Detailed Database Selection Criteria for New Applications

Different databases have specific strengths. Table 4 indicates which database should be used in most cases for the development of specific application types.

Application Type	Database Options for Application Development			
	Sybase SQL Server	Sybase SQL Anywhere	Microsoft Access	Software AG ADABAS
Enterprise	X			X
Workgroup	X	X		
Workstation/Single user		X	X	
Laptop/Single user		X	X	

Table 4 - Database Selection Guidelines by Application Type

Enterprise/Workgroup Server Database Environment

Sybase SQL Server is the recommended RDBMS for the development of new enterprise-wide and workgroup applications. Many configuration issues and complementary products must be considered before developing an application.

Configuration Issues Related to Sybase SQL Server

Sybase SQL Server has many features which present configuration issues when designing applications. The following features should be considered when making decisions about application development utilizing Sybase SQL Server:

Operating System Options

As noted in the Operating System section of the architecture, Windows NT is the recommended operating system for application development. In cases where database volumes cannot be supported by Windows NT, UNIX is the recommended operating system. Sybase SQL Server runs native on both Windows NT and UNIX. Also, Sybase SQL Server runs native on other operating systems in use such as OS/2 and NetWare.

Replication Capabilities

The replication feature copies data/tables from one primary location to other database locations. The goal of replication is to move data as close to the client as possible. Replicated data tables are read-only copies of the primary data source. Replicated stored procedures can be used to asynchronously update primary data from a remote site.

The Replication Server (the Sybase product that supports replication) forms the foundation for data distribution. The following points should be considered when making a decision to utilize the replication functionality:

- High Availability of Data: Data distribution through the architecture of Replication Server reduces the exposure of business operations to computer system component failures.
- Consistent Information Delivery: Replication Server delivers information while maintaining the transactional integrity of the data.
- High Performance: Replication Server does not burden the original source of the data to be replicated, uses the network efficiently through intelligent routes, and allows each site to optimize local access to replicated data.
- Centralized Administration: Replication Server includes a systems management tool which allows administrators to monitor and manage components of the replication system individually, or in a collection.
- Heterogeneous Data Source Access: Replication Server combined with other Sybase technology allows customers to replicate data to and from non-Sybase data sources.

Figure 7 represents the use of the Replication Server in an application with a central database and databases located in Districts that receive updated data from the central database.

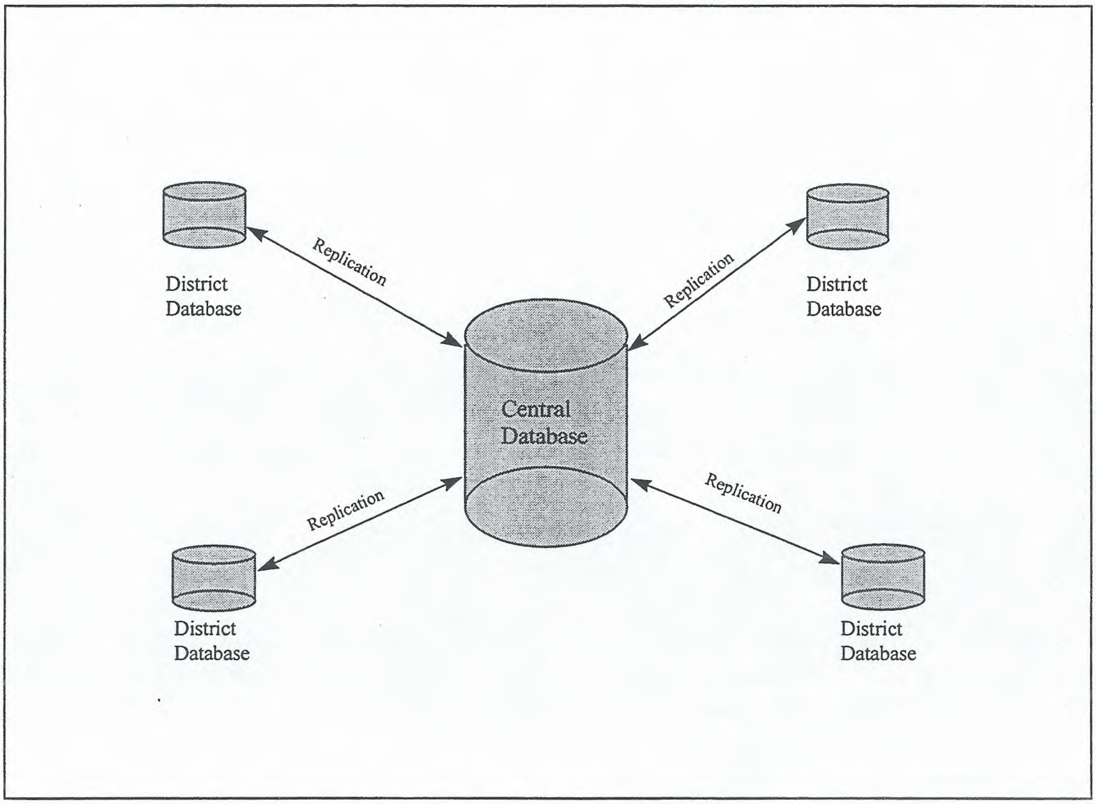

Figure 7 - Database at Districts with Shared Information Replicated To and From the Central Database

This model replicates (copies) the primary data located in each District database to the central database and the primary data in the central database to each District database. Each District has the same database layout which contains the individual District's data and statewide code tables. The central database maintains and stores the common data such as statewide codes and replicates those to the District whenever they change.

Remote Administration

Changes to database software can occur at three levels: software changes/installations, database structural changes, and database table changes. The software products to support these types of changes are in the process of being evaluated or reviewed. These products are described as follows:

- Microsoft's BackOffice Systems Management Server (SMS) - This product provides a feature to maintain a centralized database of software and hardware inventory of each server and workstation. It also allows the installer to remotely manage the Server or Workstation to make required changes.

- Sybase's Enterprise SQL Server Manager (ESSM) - This product provides the capability to proliferate changes to a database on all the Sybase Servers automatically. It also allows the setting of standards through default or validation policies and enforce naming conventions. Currently, ESSM exists for UNIX servers and is expected to be released for Windows NT servers in the third quarter of 1996.
- Sybase's SQL Server Manager (SSM) and DB Artisan from Embarcadero Technologies can accomplish routine database maintenance locally or remotely, one database at a time. Both products have some definite strengths and can be used remotely on a WAN or telephone line. TxDOT currently has both products.
- Windows NT Server Manager in the Windows NT toolkit allows the starting and stopping of the SQL server for maintenance purposes. The Windows NT Command Scheduler provides the capability to schedule backups and to check databases at scheduled intervals with the use of batch files.

ANSI-SQL and SQL Based Tools Supported

ANSI-SQL provides a standard way to access data stored in relational databases. Sybase SQL Server supports the use of ANSI-SQL and SQL based tools. These tools should make it easier for Districts, Divisions, and Special Offices to retrieve data as needed. Databases can be located centrally, at the Districts or as needed, making Districts less susceptible to central downtime, network downtime or slow response due to networking difficulties.

Complementary Products to Sybase SQL Server

Table 5 is a list of products which can be used with Sybase SQL Server for new enterprise-wide and workgroup application development and support.

Sybase Products	Possible Use with Sybase SQL Server
Enterprise Connect	
• Open Client	Open Client is used on the workstation to connect to Open Server where SQL Server is installed. It is a client API that enables third-party programs to access Sybase SQL Server and it supports standard APIs including Embedded SQL and Open Database Connectivity (ODBC). The interfaces are published allowing developers to build products on these interfaces. This product can be installed on a workstation or a server.
• Open Server	Open Server is the counterpart to Open Client which allows any data source or computer service to respond to client requests and behave as though it were an intelligent server. This product is installed on the server.
SQL Server Manager	SQL Server Manager, used by the database system manager, to administer and manage local and remote SQL Servers, storage resources, database and segments, database schema, and user access privileges. It is also used for SQL Server configuration tuning.

Sybase Products	Possible Use with Sybase SQL Server
SQL Server Monitor	SQL Server Monitor, used by the database system manager, is a graphical performance monitoring tool which provides access to real-time statistics from multiple SQL Servers. These statistics include information needed to tune and maintain good performance on a server. The SQL Monitor Client component is an Open Client application which provides a graphical user interface to the statistics gathered by the SQL Monitor Server.
Backup Server	Backup Server is a standard component of the SQL Server. It is a utility for backing up and restoring local and remote data. Backup services are accessible from the SQL Server Manager products component.
Embedded SQL Pre-compiler for C or COBOL	Embedded SQL Pre-compiler allows an application programmer to use embedded ANSI SQL compliant statements in a host language (C or COBOL) program.
Replication Server	Replication Server coordinates the data replication activities for the local data servers and exchanges data with Replication Servers at other sites. The server system tables hold information needed to accomplish the copying of data as defined to other locations in the organization.
Log Transfer Manager (LTM)	The Log Transfer Manager detects modifications made to primary data and submits them to the replication server so they can be distributed to other sites. Every database where primary data is stored requires an LTM.
Replication Server Manager	Replication Server Manager is used by the database system manager to define the data and location replication requirements for specific data to be replicated, and for monitoring the Replication Server environments.
Sybooks and AnswerBase	Sybooks and AnswerBase products provide online documentation for the Sybase products.
DB Artisan by Embarcadero Technologies	DB Artisan is used by the database system manager to administer and manage local and remote SQL Servers, storage resources, database and segments, database schema, and user access privileges. It is also used for SQL Server configuration tuning.

Table 5 - Sybase Complementary Products That Could Be Used At TxDOT

Example of Sybase SQL Server and Complementary Pro4ducts

Figure 8 is an example of how Sybase SQL Server and complementary products could be deployed for a new application.

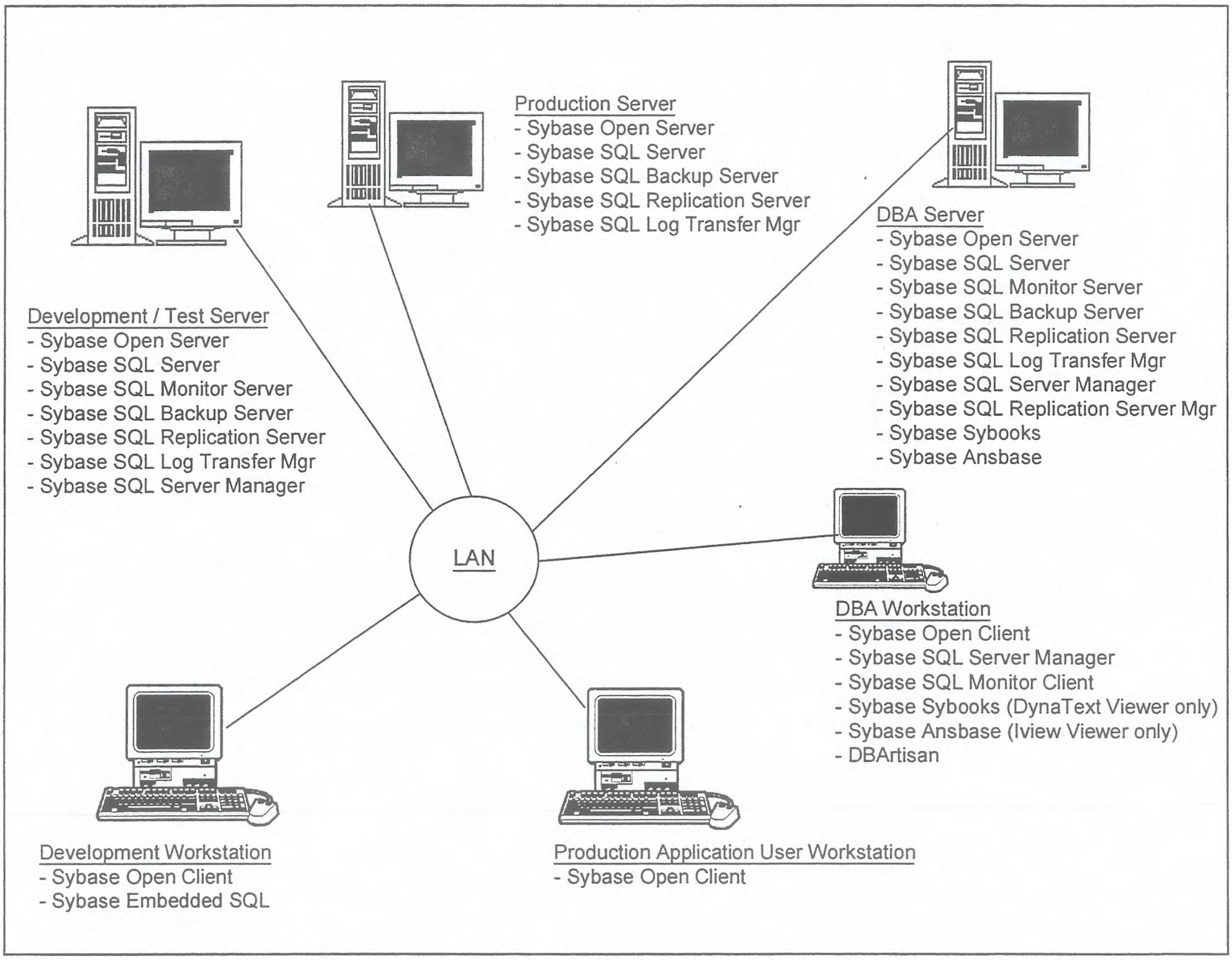

Figure 8 - Example of How Sybase Products Could be Installed

PC Workstation/Laptop and Small Workgroup Database Environment

PC workstation/laptop databases are defined as those which reside on a user PC workstation or laptop and are typically only accessed by one user. Small workgroup databases are those which reside on PC workstations or small servers and are typically accessed by multiple users. Two products are recommended for these environments: Microsoft Access and Sybase SQL Anywhere. Because each database environment has different requirements, the databases should be used according to the following guidelines:

- SQL Anywhere is the recommended database for workgroup applications that require a database to be located on a workstation or laptop. SQL Anywhere is recommended for small workgroup applications requiring multi-user access.
- Microsoft Access is the recommended database for standalone PC workstation applications. Access is a flexible, easy-to-use PC workstation database that is included in the recommended office product suite.

Sybase SQL Anywhere

SQL Anywhere is a multi-user RDBMS server that can be run on a network server or high-end PC. It has relational data-integrity and network-based client/server structured query language (SQL) access. SQL Anywhere was originally marketed as Watcom SQL by Powersoft and was acquired by Sybase with the purchase of Powersoft.

SQL Anywhere is recommended for developing applications that will be used by a single user or workgroup and require the features of a large enterprise-wide application, such as triggers and stored procedures, cascading updates and deletes, and built-in referential and entity integrity. SQL Anywhere supports full transaction processing with automatic data recovery. The product uses the Open Database Connectivity (ODBC) standard as its functional application programming interface (API).

All of the code developed to access Sybase SQL Anywhere can be migrated to access Sybase SQL Server databases if needed.

With SQL Remote, SQL Anywhere provides replication of data between databases in different offices connected only occasionally, for example by a periodic dial-up link or by e-mail. This allows replication of databases between several offices or between SQL Anywhere and Sybase. Changes made on a remote computer, such as a laptop, can be submitted for replication to a consolidated database on a local area network and updates of data in the consolidated database can be replicated to the remote computers.

SQL Anywhere can be used by developers without the need to interact with central DBAs for database creation and modifications.

Figure 9 demonstrates how Sybase SQL Anywhere fits into a client/server environment.

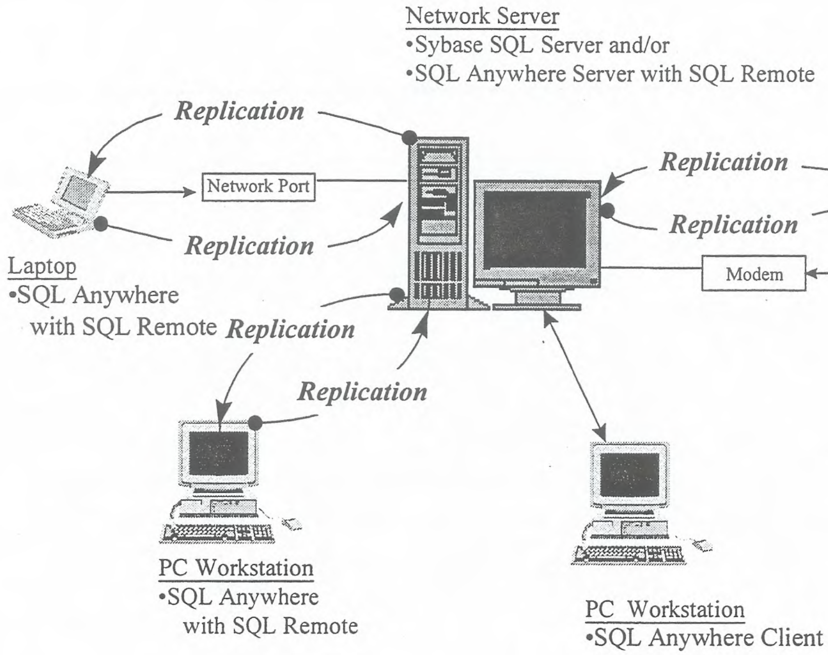

Figure 9 - How Sybase SQL Anywhere fits into a Client/Server Environment

Microsoft Access

Microsoft Access is the recommended database for a single user with no data sharing.

It is recommended for the following reasons:

- Integration with Microsoft Office Suite - With a suite of products on the PC workstation, users are able to easily share and move information between products in the suite. This capability to move data to the most appropriate product for further handling the immediate task provides the user the best use of his/her time and the tools available.
- Ease of use - Microsoft Access is an easy to use database for novice users and experienced developers. It shares a common user interface consistent with the other Microsoft Office applications.
- Powerful development environment - Microsoft Access is a relational database accessed with ANSI-SQL.
- Data Integration - Microsoft Access using ODBC links MSAccess data, Sybase SQL Server data and SQL Anywhere data together for user manipulation and reporting.

Mainframe Database Environment

The current mainframe database environment is comprised of the primary DBMS, ADABAS, as well as VSAM and SAS datasets. Although their role has been reduced in the Core Technology Architecture, they are included in order to provide continued support of legacy applications and when business needs dictate their use.

ADABAS C

ADABAS C (ADABAS) was procured by TxDOT from Software AG (SAG) in 1976. Continuing to use ADABAS for legacy applications and for the specific applications that it handles best should continue to benefit TxDOT. TxDOT has a massive amount of data and applications residing in ADABAS. Over time, as business needs arise and new client/server applications are developed, data may be moved from ADABAS to the Sybase databases.

ADABAS will continue to be available to support legacy applications. Also included will be routine maintenance and minor modifications/enhancements to existing applications.

As defined by user needs and system design, there may be instances in the future when ADABAS will be the database of choice. The ADABAS environment is very stable. It provides excellent performance (response time) with excellent support and knowledge base at TxDOT. ADABAS securely handles high data volumes and high transaction loads very well. Any development that requires an interface to other ADABAS applications may require the use of ADABAS.

VSAM

Future development using VSAM is not recommended unless strong business reasons can be presented to support the development.

VSAM will continue to be available for support of legacy applications and also for purchase of proprietary software that require the use of VSAM datasets.

SAS

Future development using SAS is not recommended unless strong business reasons can be presented to support the development.

SAS datasets will continue to be available for support of legacy applications. SAS datasets may be chosen for new development only if:

- The proposed application is primarily processing statistical information, and
- The application development cannot be completed in a more timely manner, and
- The Sybase RDBMS cannot provide a more robust solution.

Gateway Products

Description of Gateway Products

Gateway products are used to integrate all major data sources to create seamless environments of data access.

The key to the interoperability of gateway products is transparency to the user:

- Vendor - seamless integration between vendor products
- Data location - user does not have to keep track of where the data resides to access it
- Data access language - SQL provides the consistent language interface
- Administration - support personnel have one tool to administer the gateway products for a variety of data sources.

For example, the products allow users and developers to not worry about the location and name of the databases containing the information they seek. The result is that the user can access the data utilizing consistent screens/access mechanisms. A user could ask to retrieve certain data and get the desired results without knowing whether the data is stored on ADABAS, VSAM or a Sybase SQL Server on any platform.

Concepts of Gateway Products

Gateway products provide the following functionality:

- Facilitate users' access to non-relational data sources, such as ADABAS and VSAM, through PC-based application development and query/reporting software. They allow for read, write and update capabilities, and the ability to join relational and non-relational mainframe data.
- Enable access to multiple data sources without knowing the details of each piece of data. They maintain a global catalog of enterprise data, containing the location of data, differences in naming conventions and data types.
- Provide full SQL transparency; translate standard SQL into the target database dialects, identify the distributed data tables, retrieve the needed data, and join it as though it were stored within a single database running on one hardware platform.
- Allow mainframe transactions to access and update LAN-based RDBMS data and execute stored procedures.
- Allow connection to the LAN-based clients and servers on the network without modifying the existing LAN environment or applications.
- Allow support of mainframe security systems and map user IDs and passwords as required to access a specific data source.

Benefits of Gateway products

Benefits of Gateway products include:

- Leverage existing investments by supporting legacy data
- Provide a migration path to new systems and applications; legacy data can remain on the mainframe with new application data in the Sybase SQL Server database
- Leverage existing investments by integrating the mainframe into an advanced client/server environment

Gateway Product Integration

Figure 10 represents how gateway products could be incorporated into the overall database and application architecture.

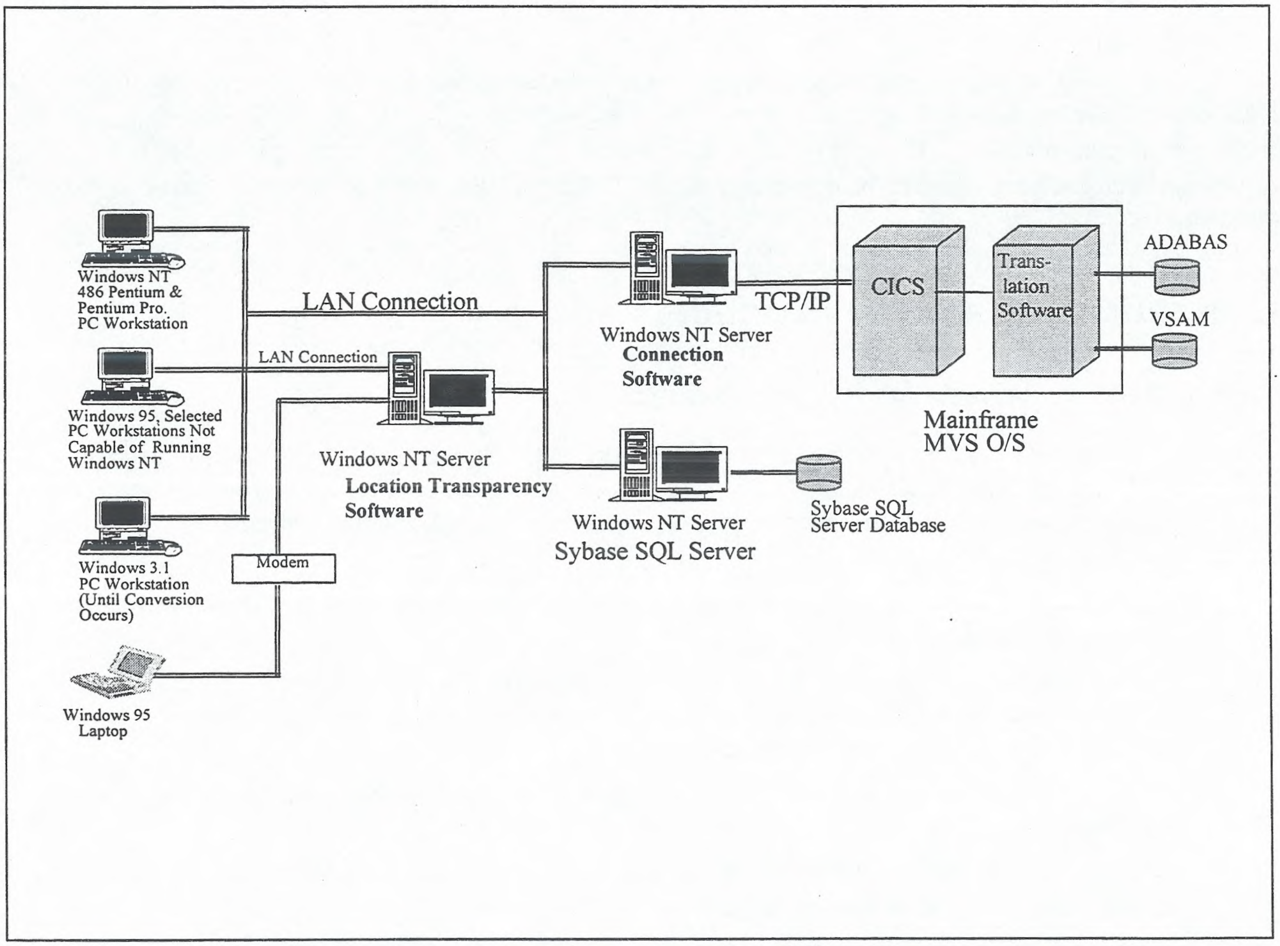

Figure 10 - How Gateway Products Can Be Integrated Into a Database and Application Architecture

Benefits of RDBMS Strategy

Selection of an RDBMS as the choice for the TxDOT database has advantages over other types of databases. Some of these advantages include:

- Support for a distributed database environment
- Operates on multiple hardware and operating systems/platforms
- Portable across platforms with consistent RDBMS characteristics
- Scaleable as required by growing data and applications
- Allows the use of a wide range of application development tools, query tools, and compatible third-party applications and software packages.

Emerging Technologies

The adoption of the database strategies should be implemented through the development of new applications. It is evident that databases will continue to grow and additional features and enhancements will be provided.

RDBMS Use With Internet & Intranet Technologies

Future versions of Sybase are expected to include enhanced database and middleware products to provide security, directory services and interfaces that support safe use of the Internet and intranets for business applications. These features will allow customer service applications through the Internet and intranets.

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HARDWARE ARCHITECTURE

Strategy

TxDOT's hardware strategy for workstations, laptops, and servers is to standardize on a single processor architecture. TxDOT's hardware strategy for printers, scanners and copiers (connected to a workstation, server, or network) is to standardize on Windows NT compatible devices. Connection to the network will be standard for PC workstations, servers and shared devices. TxDOT will standardize on a limited number of hardware vendors. The goal of this strategy is to strive for the greatest investment protection and lowest overall cost of ownership while providing an adequate platform for future development.

Strategy for the Mainframe

The mainframe platform should remain in place to support present legacy applications and future applications that may operate more efficiently on the mainframe than in other environments. Applications requiring high volume batch processing, high volume transaction processing facilities such as provided by CICS, or ready access to legacy data may be candidates for residing on the mainframe platform.

Future requirements for increased capacity on the mainframe can be addressed by the implementation of Parallel Sysplex and the use of CMOS-based technology. These enhancements have the potential of increasing capacity and reliability while reducing operating cost

Strategy for PC Workstation, Laptop, and Server Processors

Intel-processor based 80x86 personal computers will be the primary processor architecture for laptops as well as workstations and servers. This is the predominant processor architecture in use today in the public and private sector, has the widest range of software available, and is the best supported processor architecture available.

Strategy for PC Workstations

PC workstations should be Intel-based microcomputers that connect to either the LAN or WAN. All systems will be capable of being tied into the network, either by a network interface card (NIC) or by dial-in.

PC workstations are stratified into three levels of utility: low, middle (mid), and high. The purposes for which they are used fall into the following categories:

- General productivity applications such as e-mail and mainframe access
- Front ends to future client/server applications
- Applications such as CADD
- Desktop publishing
- Document management
- Software development
- End user support

There are three classes of workstations:

- *Low* - meets the needs of a large portion of users
- *Mid* - meets the needs of a smaller number of users according to business needs
- *High* - used where performance is most critical

Items common to all machines should include:

- PC workstations should have a CD-ROM drive to aid software installation, document distribution, and support.
- PC workstations should be Desktop Management Interface (DMI) compliant to aid in remote management.
- PC workstations should have a network interface, either integrated or network interface card (NIC).
- Monitors should be .28mm dot pitch or better and should be capable of non-interlaced operation at maximum resolution.

Optional PC workstation features include:

- PC workstations may have business sound (headphones output only) to facilitate Computer Telephony Integration (CTI), Computer Based Training (CBT), Video Conferencing, and other emerging technologies.
- Systems may be dual-processor capable, purchased initially with a single processor installed so that they can be upgraded to dual processors to extend the lifespan.
- Systems may also have dual processors initially.

Intel 80486-based machines currently in use in the Districts, Divisions/Special Offices, and Area Offices should be migrated to other locations, such as the Maintenance Offices where non-programmable 3270 terminals are currently being used for mainframe access. All new microcomputers procured should be part of the hardware model shown in Table 5. These microcomputers should be deployed appropriately considering the user's needs and the hardware's capabilities.

	PC Workstation		
Configuration	**Low**	**Mid**	**High**
Processor	Single 133 MHz Pentium OR Dual 133 MHz Pentium, one installed, upgradeable to two	Dual 90-166 MHz Pentium, both installed OR Dual 133-166 MHz Pentium, one installed OR Single 133-166 MHz Pentium	Dual 133-166 MHz Pentium, both installed OR Single 150-200 MHz PentiumPro OR Dual 150-200 MHz PentiumPro, one or two installed
Monitor	One 17"(1280x1024) OR One 21"(1600x1280)	One or two 21"(1600x1280) OR Two 17"(1280x1024)	One or two 20-27" (1600x 1280)
CD ROM	4x minimum	6x minimum	6x minimum
Hard Drive	1-1.6 GB	1-4 GB	1-4 GB OR 4-100 GB RAID array
Memory	32 MB RAM, expandable to 64 MB	64 MB RAM, expandable to 128 MB	128 MB RAM, expandable to at least 256 MB
Business Sound	Optional	Optional	Optional
Network Interface	Either integrated or NIC	Either integrated or NIC	Either integrated or NIC
Approximate Cost	$2,200 - 3,700	$2,900 - 5,800	$5,000 - 15,900

Table 6 - PC Workstation Configuration Guidelines

Uses	PC Workstation		
	Low	Mid	High
General Client	Mainframe access (3270) Application client General administrative work	Multiple applications Inter-application communication Heavy network communications Time-sensitive work	Not recommended
CADD	Occasional use Plan review Measurement Labeling Some Geopak	Full time 2D and 3D drafting Design using GEOPAK Modeling	3D rendering and animation Solids modeling Finite element analysis Advanced design using Geopak
Software Development	Not recommended	General programming GUI development Client/Server development	Working on large local databases/files CADD programming Advanced GUI development Client/Server development
Support	Not recommended	Network Monitoring System Analysis Help desk General user support	Networking analysis Remote management Software delivery

Table 7 - PC Workstation Use Guidelines

The minimum amount of memory in the low end PC workstation is designed to be sufficient for running the following background processes:

- One or more network protocols
- Novell GroupWise Mail
- GroupWise Notify

It should be sufficient to run the following foreground processes:

- One office suite application
- An Internet browser or other application (either custom PowerBuilder/Visual Basic/OLE app, database client, or other application)

Microsoft recommends 16 MB for Windows NT with any protocols loaded and an additional 8 MB for one office suite application. Additional memory is required for the GroupWise background processes. To provide an adequate platform for future development and to run existing applications well, the entry level workstation should have 32 MB RAM.

As a result of industry benchmarking, disk size has been set at a minimum of 1 GB. Disk prices have fallen dramatically, while disk space requirements have increased. The trend is for entry level systems to come configured with 1-2 GB disk drives. This allows the use of larger virtual memory settings which improves performance. The time between system disk upgrades will be increased, extending the system lifespan and preventing the end user disruption caused by a disk upgrade.

Similarly, entry level processors are getting faster and fewer vendors are selling systems configured with the slower and less powerful processors. Few vendors produce PC workstation systems based on the 80486 central processor unit (CPU), which is the predominant CPU currently in use at TxDOT. The cost of systems configured with a Pentium or PentiumPro CPUs produce a price versus processor speed curve similar to Figure 11, which represents data gathered from the July 1996 issue of Computer Shopper Magazine. The systems consisted of the following: CPU unit with 16 MB RAM, 1 GB or 1.2 GB disk drive, 15 inch monitor, and 4x or 6x CD-ROM drive.

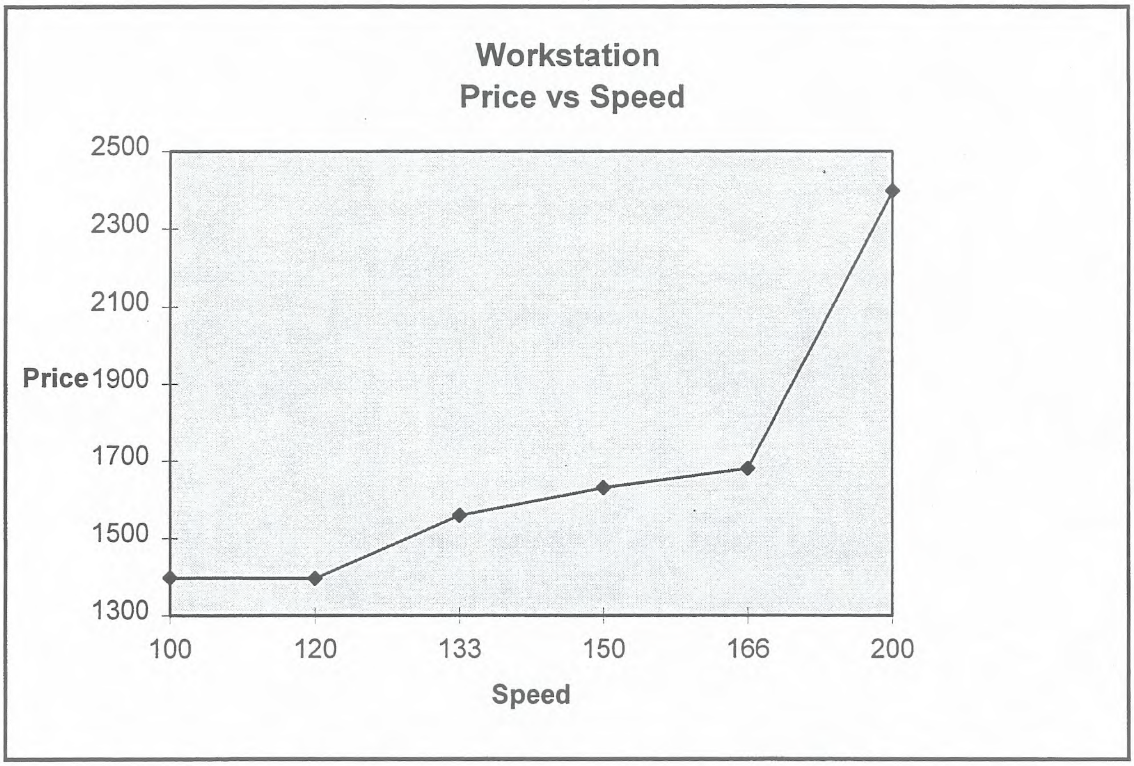

Figure 11 - Workstation System Price Versus System Clock Speed

The lowest price/performance ratio indicates the maximum performance per dollar spent. The 133 MHz through 166 MHz Pentium systems represent the best price/performance ratio as shown in Figure 12, while the ends of the spectrum represent the highest.

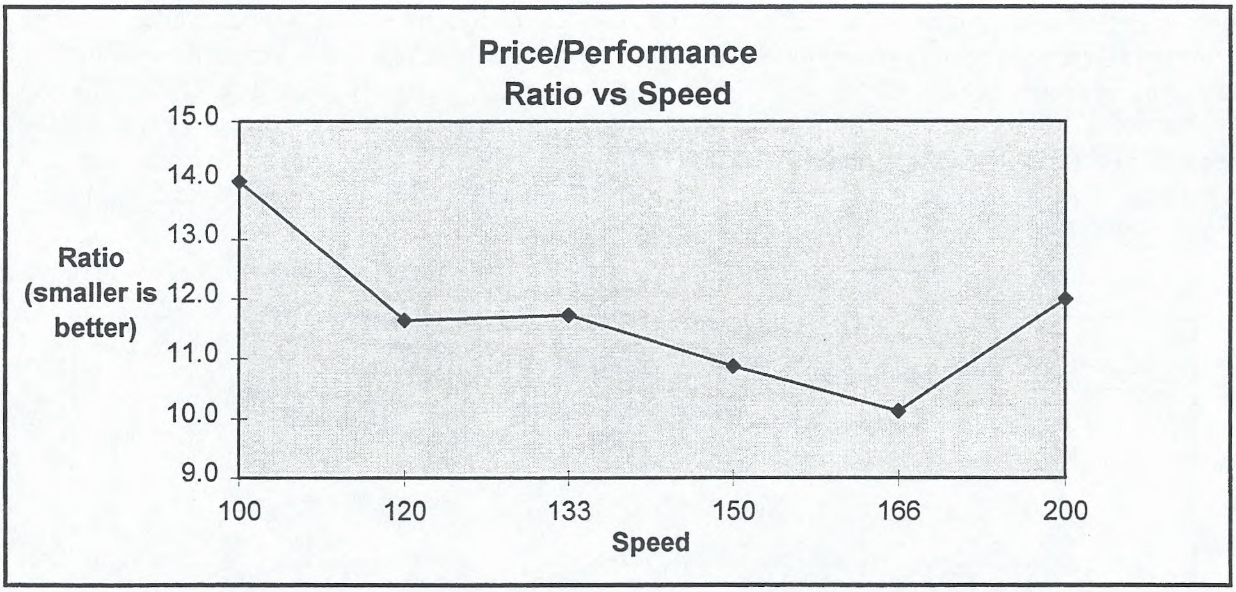

Figure 12 - Price/Performance Ratio Versus System Clock Speed.

The lifespan of the systems determines their annualized cost. Table 7 is an estimate of system lifespan based on industry trends. Figure 13 shows the cost spread over the system lifespan for the systems from Figure 5 and Figure 6. The best return on investment (ROI) comes from the 120 MHz through 166 MHz Pentium systems.

Processor Speed (MHz)	System Lifespan (yrs.)
100	2
120	3
133	3
150	3
166	3
180	4
200	4

Table 8 - Estimated Lifespan for Acceptable Performance of Processors

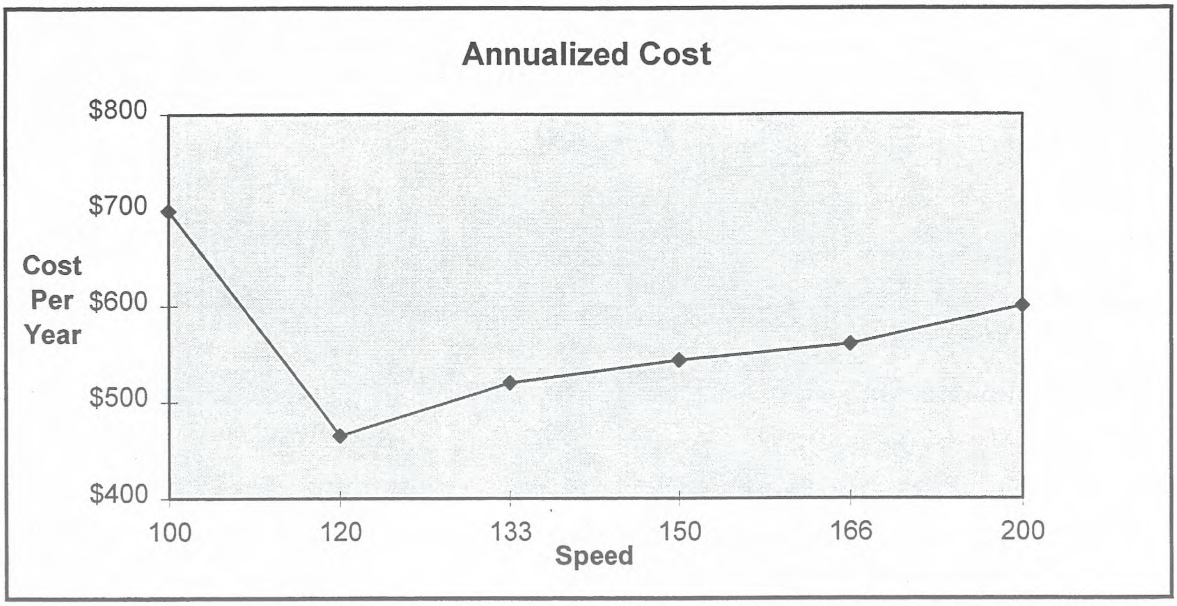

Figure 13 - Estimated Cost Per Year Versus System Clock Speed

Monitors

With the increase in use of graphical user interfaces and multitasking operating systems the 15 inch monitor is no longer appropriate as an entry level display. The minimum size monitor is now recommended to be 17 inches, and 21 inches is recommended for some applications. It is now possible to use dual monitors without special hardware, and both dual 17 inch and dual 21 inch monitors are available as an option to satisfy certain business related requirements.

Strategy for Laptops

The strategy for laptops is to use devices with a minimum processor speed of 75 MHz using a 486/75 DX4 processor. There is a lag in processor development for laptops such that they are always a generation behind PC workstation devices. These devices should meet the following minimum requirements:

- 540 MB
- 16 MB RAM, expandable to 32 MB
- Active or Passive matrix color screen, monochrome optional
- AC converter/battery charger
- 2 type II PCMCIA slots
- Integrated pointing device
- CD-ROM (optional)

User's needs for laptops are more individualized than for workstations. For this reason laptops are not stratified into specific classes of devices. The size of components included should reflect the business application of the device. The benefits of this strategy are:

- Dual use at the office and the remote site
- Remote connectivity
- The interchangeability of PCMCIA cards

PC Workstation and Laptop Acquisition Strategy

The acquisition strategy recommended is to procure similar devices in each class to increase parts interchangeability and to reduce the number of different drivers required.

Mainstream users will use a powerful minimum configuration. This will delay the need for major system upgrades or replacement. Benefits of this strategy are:

- Avoid the operational impact and disruption to end users caused by major mid-life upgrades
- Reduce the frequency and number of re-deployments of existing devices (migration)
- Simplify device migration support by the use of similar devices from a limited number of hardware vendors
- Increase TxDOT's ability to exploit next-generation software environments
- Extend the useful system lifespan

PC Workstation and Laptop Asset Management Strategy

TxDOT will deploy devices where they provide the greatest benefit to the Department. There will be a natural migration of devices; when new devices replace existing ones, the existing devices move to a less demanding situation. A goal of the asset management strategy is to minimize the frequency and number of migrations.

There are several methods to increase system lifespan:

- Initially procuring high capacity entry level systems
- Upgrading the system with more memory or disk capacity
- Replacing the processor or motherboard with a more powerful version
- Installing a second processor in a dual-processor system

The upgrades that cause the least disruption to the IS user and the support staff are the memory and processor upgrades. Intel has standardized the supporting chip sets for multi-processor system boards so that systems purchased initially with a single processor are upgradeable to two processors through a process similar to a memory upgrade. Systems that will benefit most from a processor upgrade are those used in a processor-bound environment such as 3-D Computer Aided Design and Drafting (CADD) or image rendering. Upgrading a dual-processor system from single to dual processors has a low impact on support staff and end users while extending the hardware lifespan at low cost. The system performs 1.7 times higher on industry benchmarks after this type of upgrade.

The initial difference in cost between a dual-processor system with one processor installed and a dual-processor system with both processors installed may be large.

For example:

Two years ago:

Dual-processor 90 MHz Pentium, two processors installed = $4,000

Dual-processor 90 MHz Pentium, one processor installed = $3,000

Today:

Purchase price of a second processor is $180

Cost difference:

Two processors installed at workstation purchase = $4,000

One processor installed at workstation purchase and second processor installed two years later = $3,180

Cost difference = $820

Conclusion:

Purchasing the workstation with one processor installed and then installing a second processor two years later is the less expensive strategy.

Alternative strategies include:

- Buy at the low point of the price-performance curve, then upgrade the disk and memory subsystems when the users' needs require it. This strategy results in significantly lower initial capital costs. However there is considerable impact to support staff.
- Migrate machines from more demanding situations to less demanding ones annually. This can lead to a large operational impact on support staff and greater disruption for end users than the recommended strategy.
- Purchase the machines with the lowest price/performance ratio, regardless of processor type. The strategy of mixing clients with different processor families and architectures leads to parts and software incompatibilities and increased support and training.

All of these strategies are support and labor intensive.

Strategy for Servers

Servers are a strategic component of distributed client/server environments. As such, these devices should have a high degree of reliability and flexibility to ensure the goals of maximum up-time and scalability. The server strategy is geared toward facilitating those goals.

Servers are categorized as either print, file, application, and/or database servers. Hardware options for servers range from standalone dual-processor tower configurations to rack mounted multi-processor configurations. User's needs for servers are more individualized than for workstations. For this reason servers are not stratified into specific classes of devices. The size of components included should reflect the business application of the device.

Listed below are the minimum requirements for servers:

- Pentium based multiple CPU system unit
- 64 MB RAM
- RAID level 5 disk arrays
- 4mm tape backup
- Fault tolerant capabilities
- Rack mounted chassis where cost effective
- Tape carousel where cost effective
- Uninterruptible Power Supply (UPS)

Strategy for Printers, Plotters, and Scanners

Printers

Laser printers are recommended for all TxDOT business applications. Impact printers should continue to be used until they can be economically replaced with laser printer or if the business application has a continued need for this type of printer.

PCL5 is the recommended printer language. This is the predominant printer language in use today and has the widest availability of devices and Windows device drivers. The HPGL2 printer language should be used for engineering output where required due to its increased efficiency. Postscript should remain available as an option.

Listed below are the minimum requirements for laser printers to be used in TxDOT architecture:

- Printer throughput - four (4) to 24 pages per minute
- Minimum Resolution - 300 dots per inch (dpi)
- Paper handling capacity - 500 sheets and up to 11"x17"
- Output - Black and white or color
- Availability of either a Token Ring or Ethernet adapter
- Printer language - PCL 5 compatible.

Plotters

Plotters will primarily be used for the production of engineering drawings. Other applications such as the production of project plans is also anticipated for plotters. An important aspect of the plotter implementation is the eventual elimination for the need of a dedicated plotter server by facilitating direct attachment to the LAN.

Listed below are the minimum requirements for plotters to be used in TxDOT's architecture:

- Resolution - 600 dots per inch (dpi) (black and white), 300 dpi color
- Capacity - A through E size drawings
- Paper handling - both roll and sheet devices
- Availability of either a Token Ring or Ethernet adapter for attachment to the LAN

Scanners

Scanners will be used for a variety of data input tasks ranging from the scanning of business correspondence to engineering drawings. To accommodate this wide range of documents, listed below are general specifications for scanner to be used with this architecture:

- Resolution - 200 to 400 dpi
- Scan speed of three (3) pages per minute (PPM) in color, seven (7) PPM for black and white documents
- Optional page feeder with a capacity of at least 25 pages
- Availability of either a Token Ring or Ethernet adapter for attachment to the LAN

Shared devices are to connect to the network directly whenever possible. This provides the fastest and most flexible method of connecting to a device and allows the use of redundant NetWare or Windows NT servers to provide better device management. Alternatively, printers lacking the capability of direct network attachment can attach to the network with a device called a print server.

Benefits of Hardware Strategy

Benefits of this strategy are:

- Reduced costs associated with end user support, training, maintenance, and deployment
- Reduced duplication of effort
- Reduced disruption to end users
- Increased manageability

Emerging Technologies

The price versus performance curve will continue to change as will the performance needs of users. Industry benchmarking will need to be repeated at some interval to determine the optimal disk size, processor speed and number of processors, as well as the predominant microprocessor architecture. The strategy will be modified so that new devices are procured from the upper middle portion of the performance curve. The specific manufacturers should continue to be chosen from among the top two tiers as defined by the Gartner Group. Trends and technologies that are emerging now should be examined for inclusion in the hardware architecture. These technologies include:

- The Universal Serial Bus (USB) has begun to be incorporated into motherboards and is forecast to replace all existing external connection technology outside SCSI.
- SCSI is evolving from the current SCSI-II into SCSI-III.
- Microsoft is adding clustering capabilities into the NT operating system, which may allow for more powerful servers to be configured from a group of less powerful devices.
- The technology associated with multi-processor machines is changing so that it is becoming easier to produce multi-processor devices inexpensively.
- The cost of Rewriteable Optical storage is dropping rapidly
- 120 MB 3½" floppy drives are beginning to be offered as replacements for existing 1.44 MB 3½" floppies.
- Flat panel displays are getting larger and less expensive
- Wireless connection through infra-red technology may be useful for laptop printing and connectivity.
- There is a need for fast, inexpensive (ink-jet), color 11x17 output, however manufacturers have not begun to offer such a device. Current color 11x17 printers use dye-sublimation or thermal-wax transfer printing methods which result in very high quality but are very slow and expensive. As prices decrease and speeds increase these may become alternatives.
- Wide format copiers (36" wide media) have changed recently such that these devices may also be used as scanners and printers. These devices are extremely expensive, but their print speed is forty times as fast as current devices. These devices may be able to supplement or replace existing wide format scanners.

REMOTE / DIAL-IN / DIAL-OUT

Strategy

District remote dial-in services are needed to provide core functionality for four primary groups of users:

- Maintenance Office users
- Support personnel
- Approved telecommuting personnel
- Remote laptop users at various locations

Remote dial-in must be considered as an option for these groups of users due to the cost comparison of providing dedicated high-speed lines to the Maintenance Offices, as well as the transient nature of support, telecommuting and laptop users. With a remote dial-in strategy, users such as Maintenance Offices will have the ability to connect to the LAN to update files, retrieve mail, check schedules, or synchronize with client/server databases. Support personnel should be able to diagnose and solve problems, without the time delays of traveling to the remote site.

Components

Remote / Dial-in

District dial-in should be provided to enable core client/server applications and connectivity. Dial-in should be accomplished with a minimum 28.8 kbps modem from both non-LAN attached PC workstations and laptops.

Dial-in should be accomplished through a modem server with the capability of servicing multiple, simultaneous communications sessions over multiple incoming lines (Citrix server software on a dedicated server). The modems on the Modem Server will need to be capable of running in a modem pool. A toll-free number is recommended at each dial-in server to facilitate the dial-in process for remote users dialing long distance. Maintenance Offices are expected to dial-in about three to four times a day or as needed for E-mail delivery, scheduling updates, and database synchronization for client/server applications.

Division and Special office dial-in as well as needs for specialized dial-in servers will be evaluated on a business-needs case evaluation. Dial-in servers that are identified as a core requirement will be placed with regards to the campus locations.

Dial-out / Modem Pooling

Dialing out to external resources should be accomplished through the use of a Novell NetWare Connect server utilizing a pool of high-speed modems. Access to the dial-out server should be limited, for security reasons, and granted to users as business needs are identified. Multiple outgoing phone lines and modems would be monitored to ensure that adequate resources are available for both Area Offices and District headquarters personnel to utilize.

Figure 14 depicts the components for the District dial-in/dial-out architecture, and Figure 15 depicts the components for the Division/Special Office dial-in/dial-out architecture.

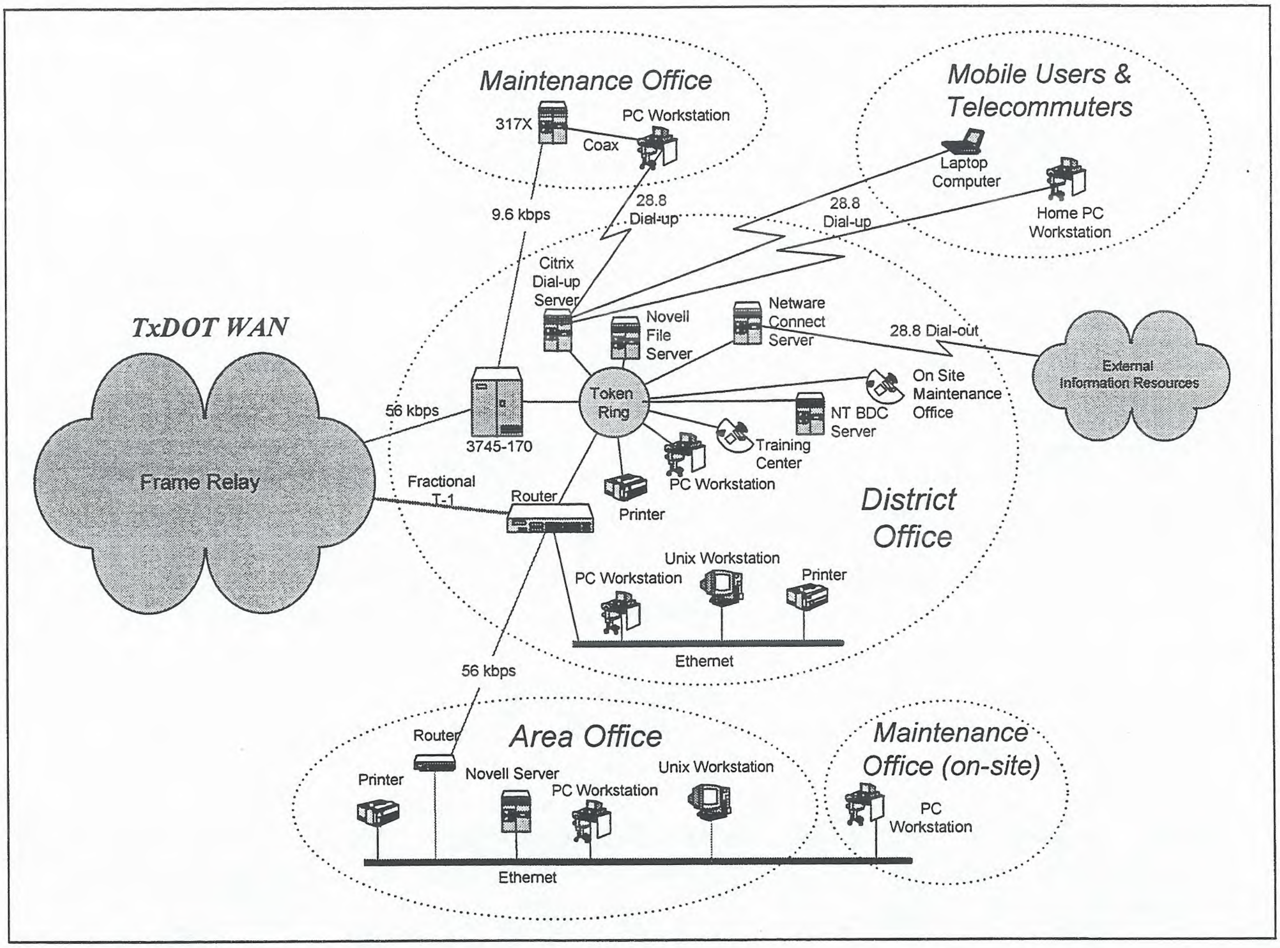

Figure 14 - Dial-In/Dial-Out Architecture Components for a District

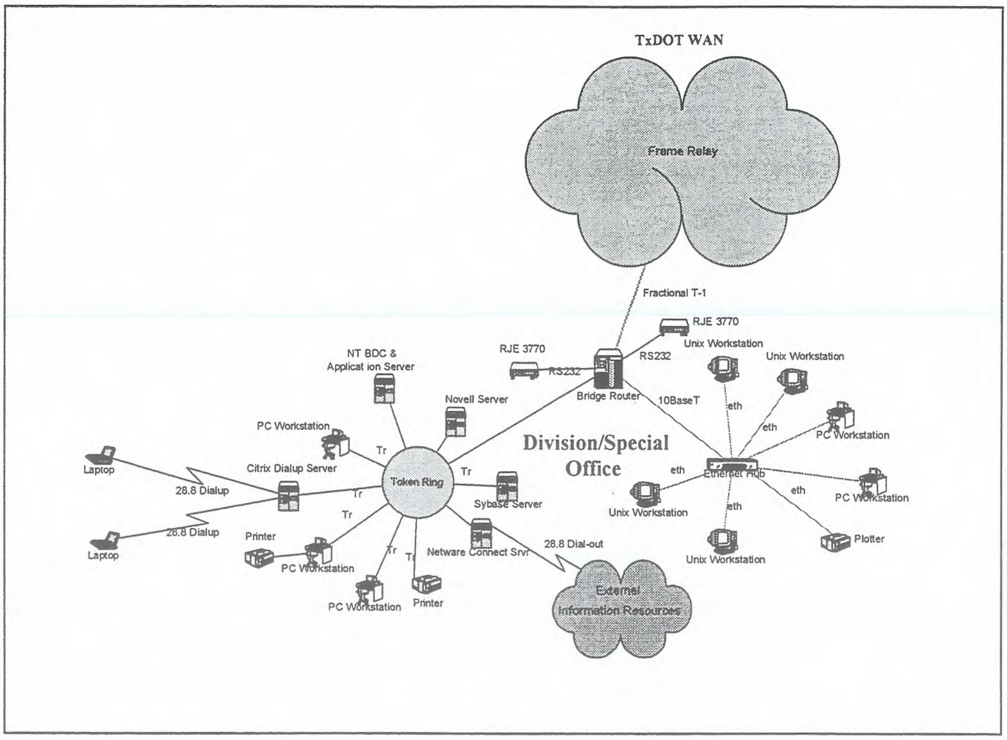

Figure 15 - Dial-in/Dial-out Architecture Components for a Division/Special Office

Alternative Options

Another option, not recommended, is to place remote dial-in servers at the Area Offices instead of the District Offices. This would alleviate the need for the toll-free number, however, long distance charges would still accrue due to the physical locations of some Maintenance Offices and their respective Area Office. This would also require additional equipment and phone lines to be placed and serviced at each Area Office. A dial-in server would still be needed at the District Office site to handle the headquarters personnel or telecommuters who would need dial-in access for their job duties.

Benefits of Remote/Dial-in/Dial-out Strategy

The selected architecture benefits TxDOT business objectives in the following ways:

Enables remote access to applications

TxDOT will be able to develop and use client/server applications in which data synchronization is handled by transferring database changes as necessary without the high cost of direct connections. Users in remote locations will still be able to take advantages of groupware products, such as scheduling, e-mail, the Internet, intranets, and client/server applications.

Supports approved TxDOT Telecommuters

Gartner Group states that there is an 80% probability that 80% of enterprises will be running corporate telecommuting programs for home and mobile workers by 1999. Gartner also believes that employee and corporate productivity/effectiveness will increase, employee retention will increase, and there will be a reduction in office and parking spaces.[3] This strategy will provide an infrastructure that will enable TxDOT to take advantage of telecommuting opportunities as they arise.

Increases High-Speed Modem Availability to More Users

All users requiring modems would have access to high-speed modems. The modem relationship to users will be many-to-many instead of the current one-to-one relationship. Another advantage would be the ability to consolidate the number of modems to one physical area, while maintaining the ability for users to dial-out to resources which exist outside of the Department.

Enables Coordination of Upgrades

By centralizing the location of the remote access servers at the District Offices, the Department can capitalize on concentrated efforts to upgrade modems. By concentrating the users access to fewer sites, fewer overall modems are needed (as opposed to each user having his/her own modem. Or even having access servers at the Area Offices). This will enable the Department to upgrade to higher speed modems or new technology as they become cost-effective to implement. Also, upgrades become available immediately to all users, not just a few.

Eases support issues

Having both the dial-in and dial-out servers located at the District Office will also help with problem-solving by utilizing the training and technical expertise of the District automation support staff.

[3] "Implementing a Telecommuting Strategy" (R-826-102) - Gartner Group

Emerging Technologies

Several emerging technologies appear to be viable alternatives for future remote access connections. These include Integrated Services Digital Network (ISDN), Point to Point Protocol (PPP), wireless and cellular networks.

ISDN

"ISDN (Integrated Services Digital Network) is an international telecommunications standard for transmitting voice, video, and data over digital lines running at 64K-bps. ISDN uses circuit-switched bearer channels (B channels) to carry voice and data and uses a separate data channel (D channel) for control signals via a packet-switched network. The ISDN Basic Rate Interface, or BRI, provides two B channels and one 16K-bps D channel (2B+D) for a total of 144K-bps. The ISDN Primary Rate Interface, or PRI, provides 23 B channels and one 64K-bps D channel (23B+D), equivalent to T-1."[4]

PPP

Point-to-Point Protocol (PPP) is a communications protocol that provides dial-up access to the Internet. PPP was developed by the Internet Engineering Task Force (IETF) in 1991 and is more advanced than the earlier SLIP protocol, which is also commonly used for Internet access. PPP can establish and terminate a session, hang up and redial on a low-quality call, and run on any full-duplex link from dial-up to high-speed lines.

PPP encapsulates common network-layer protocols in specialized Network Control Protocol packets; for example, IPCP (IP over PPP) and IPXCP (IPX over PPP). It can be used to replace a network adapter driver, allowing remote users to log on to the network as if they were in-house.

PPP also provides password protection using the Password Authentication Protocol (PAP) and the Challenge Handshake Authentication Protocol (CHAP).[5]

Wireless & Cellular Networks

As the cellular systems become more established and extended throughout the state, and as new technologies are introduced, prices should drop to the point that cellular and wireless dial-in access should become a viable alternative.

As these technologies mature they should be revisited as to their place in the Remote Access / Dial-in / Dial-out strategy of the Department.

[4] "Networking acronyms at a glance" - PC Week, February 19, 1996
[5] Electronic Computer Glossary, The Computer Language Co. Inc.

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OFFICE SUITES

Strategy

Office software suites are software applications grouped together in a single package that generally includes a word processor, spreadsheet, graphics, and database. These products are distinguished by the tight integration between the applications which allows for the sharing of data between applications, common interfaces, and the ability to link objects between the applications.

The recommended office suite is Microsoft Office. Microsoft Office has built-in interoperability between products which facilitates data sharing. Also, Microsoft Office allows users to easily work with existing documents created using WordPerfect and Lotus 123. Users can open most WordPerfect documents using Microsoft Word. Also, most Lotus 123 spreadsheets can be opened and modified with Excel.

Microsoft has an 85% market share of the office application suites, according to the Gartner Group. The large market share should increase the product's chances of viability in the future. The large market share also provides increased support available from more sources, increased third party development and productivity tools, and more job applicants with product experience.

Components

Microsoft Office has the following components:

- Word for word-processing
- Excel for spreadsheets
- PowerPoint for presentation and graphics
- Access (in the Microsoft Office Professional Version) for personal database use

Benefits of Office Suites Strategy

Benefits of this integrated office suite include:

- Interoperability of the office suite components.
- Limited conversion required of existing documents created in WordPerfect or Lotus 123. Most existing documents can be opened with Microsoft Word and Microsoft Excel with no difficulty. Documents can then be saved as Word or Excel documents for future use.
- Data sharing between applications through object linking and embedding (OLE).

Emerging Technologies

Office suite technology that should be included in the future includes:

- Office suites incorporating Internet/intranet browsers
- Microsoft Office 97

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GROUPWARE ARCHITECTURE

NOTE: The information below includes preliminary recommendations for the Groupware Architecture. Further development of the Groupware Architecture section will continue and final recommendations made in a future version of the Core Technology Architecture.

Strategy

Groupware has been coined to describe applications designed to provide electronic support for individuals within groups working together toward a common goal. The term usually refers to applications that are grouped into a single product encompassing e-mail, scheduling, calendaring, file sharing and work-flow.

The TxDOT groupware architecture is composed of GroupWise by Novell. GroupWise by Novell is a workgroup productivity tool that integrates electronic mail, personal calendaring, task management, group scheduling, and workflow routing.

GroupWise features

- E-mail capability
- Personal calendaring
- Group scheduling
- Task Management
- Phone messages

Components of the Groupware Architecture

Figure 2 presents the GroupWise architecture. It represents the type of components and topology that make up the overall GroupWise deployment within TxDOT.

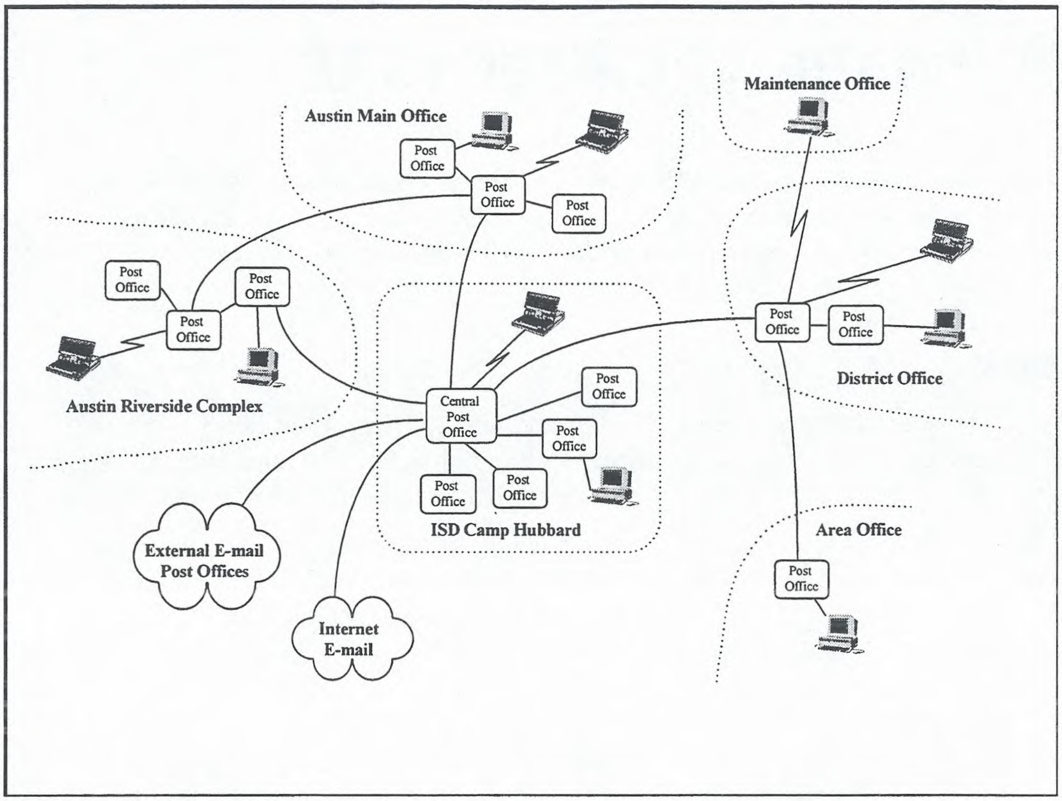

Figure 16 - Summary of the GroupWise Architecture

Major Components of the GroupWise Architecture

- Central Post Office in ISD for clearing messages between Districts, Divisions, and Special Offices
- Post offices at all District sites. Some Districts have multiple post offices depending upon size.
- Post offices located at Area Offices.
- Dial-in for GroupWise from Maintenance Offices, telecommuters, and laptop users utilizing the Citrix server.
- Direct connection between Austin Main Office and Austin Riverside post offices to accommodate high traffic volumes.

Emerging Technologies and Future Considerations

The continued adoption of the groupware strategies listed above will be a dynamic process. It is evident that newer technologies are being developed that offer advantages to TxDOT. Also, some current product offerings should be reconsidered for future architecture releases:

Lotus Notes

Notes is a client/server environment that allows users (or clients) to communicate securely over a local area network or telecommunications link, with a document residing on a shared computer (or server). Notes combines an application development environment, a document database, and a sophisticated messaging system, giving the user the power to create custom applications for improving the quality of business processes in areas like product development, customer service, and client management.

Intranets

An intranet is an internal adaptation of the Internet. Intranets usually reside logically inside a business organization's firewall and the network traffic is not broadcast to or accessible from the Internet.

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ENTERPRISE SYSTEM MANAGEMENT

NOTE: The information below includes preliminary recommendations for the Enterprise System Management Architecture. Further development of the Enterprise System Management section will continue and final recommendations made in a future version of the Core Technology Architecture.

Strategy

The ability to effectively manage TxDOT's Information Technology resources is critical in a distributed environment. An enterprise systems management architecture is a very important piece of the overall management strategy. This solution should be compatible with the other infrastructure decisions made for TxDOT.

Capabilities

An Enterprise System Management application will offer the following capabilities:

Automatic software and hardware inventory

Automatic software and hardware inventory that can detect all devices attached to the network, gather inventory information about both the hardware and software, and place this information into its database. An administrator can query the central database and determine, among other things, a machine's free hard disk space, amount of RAM, or what operating system is running.

Automatic software distribution and installation

Automatic software distribution and installation that allows the system administrator to easily perform unattended software installations, using the extensive inventory information to properly target the machines. Software distribution can start from the Central Site Server down to designated distribution servers and onto the clients. The administrator can setup a push or pull installation with the option of a network shared application or a standalone version.

Configuration

The Enterprise System Management architecture could consist of the following components:

- Central Site Server
- Primary Site Server
- Client software.

Software is distributed from the central or primary site down to the clients. Inventory is passed up to a primary site on up to the central site.

Figure 17 represents the possible architecture of an enterprise system management application at TxDOT.

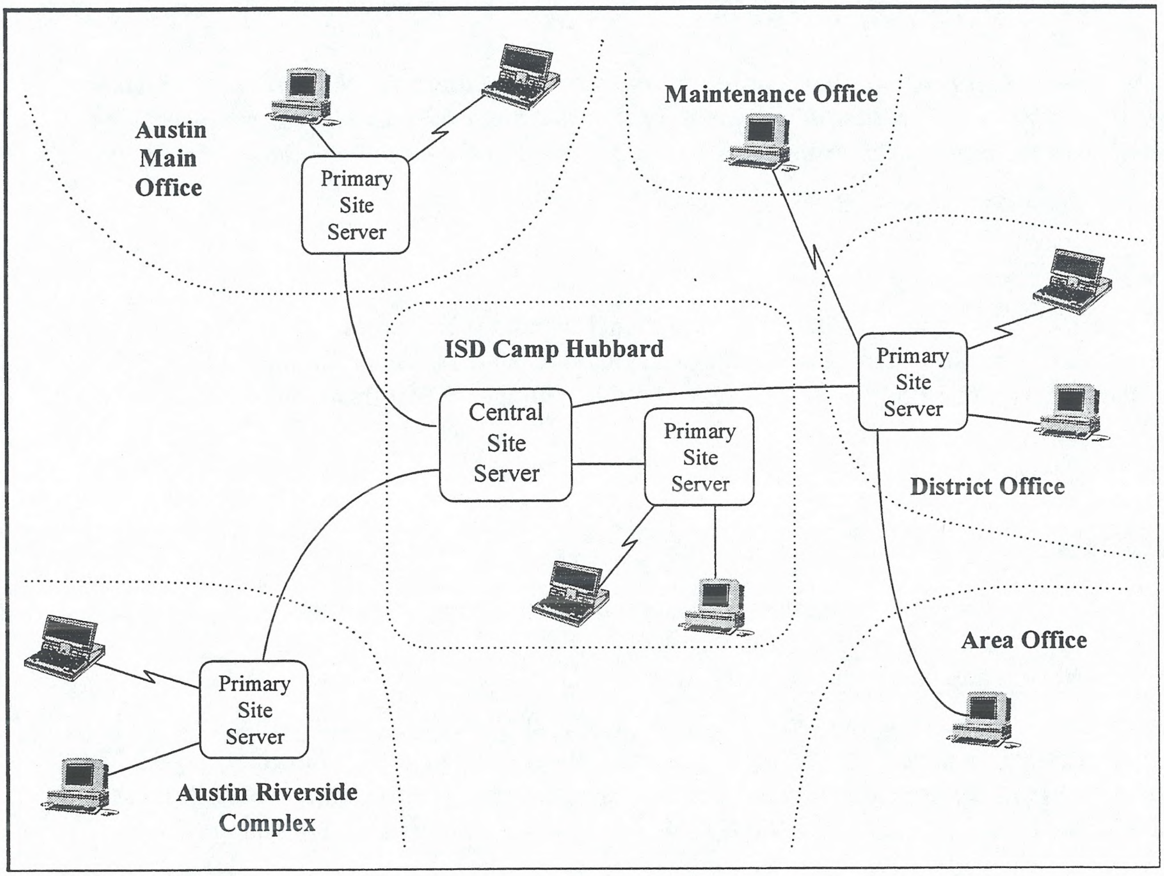

Figure 17 Enterprise System Management Architecture

Figure 18 represents the logical flow of information within enterprise system management application. Software updates and configuration changes will flow down from the site server to the workstations. Inventory information will flow upward from the workstations to the central site server.

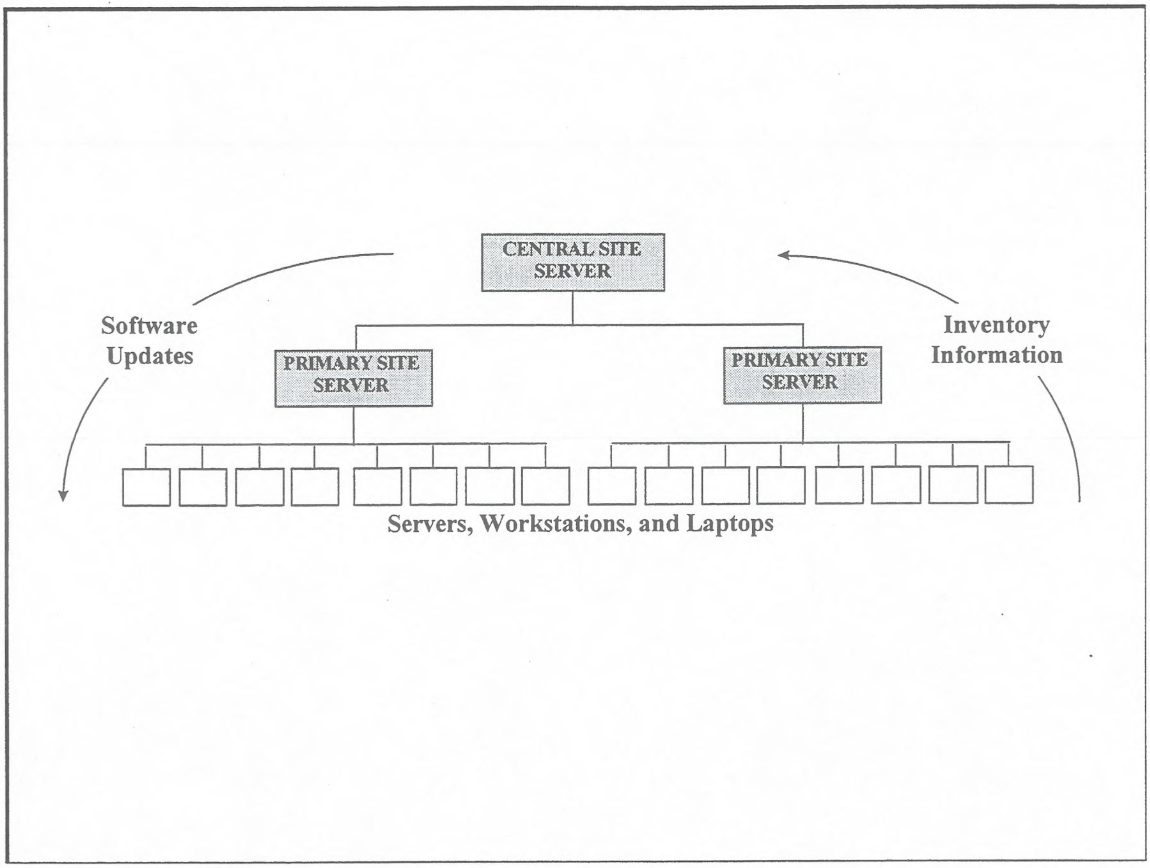

Figure 18 Logical Flow of Information Using An Enterprise System Management Product

Benefits

- Automated hardware and software inventory collection and management is faster, cheaper, and more accurate (compared to manual methods), saving time and money, and making possible more precise business decisions.
- The ability to remotely troubleshoot machines will save both support time and costs.
- Automated software distribution reduces installation and configuration costs (compared to manual methods) and provides greater control over software assets.

Emerging Technologies and Future Consideration

- Microsoft System Management Server
- Novell ManageWise
- Computer Associates Unicenter
- IBM Tivoli
- A+ Enterprise Desktop Manager
- Intranet for Software Distribution

RELIABILITY AND FAULT TOLERANCE

NOTE: The information below includes preliminary recommendations for the Reliability and Fault Tolerance Architecture. Also, some portions have not been detailed; however, preliminary decisions about content have been indicated with section headings. Further development of the Reliability and Fault Tolerance section will continue and final recommendations made in a future version of the Core Technology Architecture.

Strategy

The Reliability & Fault Tolerance Architecture is the basis for ensuring that system availability is maximized and effects of hardware/software problems are minimized. The architecture to ensure reliability of systems within TxDOT is described in the following sections.

The Reliability & Fault Tolerance Architecture is designed to provide the framework to deploy hardware and software that will be incorporated into processes and procedures.

Components of the Reliability & Fault Tolerance Architecture

NetWare File Servers

Placement

All NetWare file servers should be placed in a controlled access environment. Division and special office NetWare file servers supported by ISD should only be accessible to authorized ISD support personnel. NetWare file servers supported by district, division, or special office IS staff should be accessible to authorized IS staff for the district, division, or special office as well as authorized ISD support personnel.

Backup and Off-Site Storage

File server backup and off-site storage guidelines have been added to the Information Resource Manual - Information Security Volume as Chapter 4 - PC and LAN Security.

The software that should be used to complete server backups is Cheyenne Arc Serve.

Server backups should be made with magnetic tape or optical backup units. Also, servers should be able to support unattended backups with direct attachment or remote connection to a backup unit.

NetWare Servers should include a tape or optical backup unit and backup software.

The LAN backup database will be the source of backup information to support LAN administration and data restoration.

Redundancy

Redundant systems on NetWare file servers can be implemented at varying levels of protection.

- Server Duplication: Where applicable NetWare file servers can be mirrored such that two identical server systems are in operation simultaneously. If one server fails the other continues to service its clients without the clients awareness of any problems. In a campus environment file servers can be located in different buildings, further minimizing the effects of a catastrophic event.
- Hard Drive (HD) Duplication: Two levels of HD duplication should be implemented. The first level available is Hard Drive Mirroring or RAID (Redundant Array of Inexpensive Disks) Level 1, where partitions on separate disks are mirrored by the NetWare operating system software. RAID Level 1 is the lowest level of acceptable HD duplication. The second level is RAID Level 5 (Distributed Data Guarding), which utilizes a special RAID Hard Drive Controller, and distributes parity over each drive. RAID Level 5 is tolerant of single-drive failures.

Spare Hardware

The NetWare and NT file server hardware will be the same for all offices. This will allow parts from the NT file servers to be used on the NetWare file servers in case of a hardware failure. The Area Office servers will all be identical for each district and a spare will be kept at the district office.

Uninterruptable Power Supply (UPS)

All NetWare file servers will be plugged into an appropriately sized UPS. The UPS will be able to communicate power outage information to the NetWare file server, so it will shut down in an orderly manner and safe manner.

Recovery Plan

To be defined in a future version

Problem Notification

To be defined in a future version

UNIX Servers

There are currently approximately 40 Intergraph CLIX UNIX Servers in production within TxDOT. The primary function of these servers is to run the Interplot software that has been the cornerstone of TxDOT's plotting strategy for the last 6-7 years. Additionally, these devices often include a significant amount of mass storage that allows each to be the primary file server for CADD. These devices will continue to be represented in these quantities for at least the next year. Most of these devices are at least 4 years old at this time and are approaching the end of their expected life cycle. Investigation of replacement of the functionality provided by these servers with a system that complies with the Core Technology Architecture will be conducted.

Backup Plan

Data on these servers is backed up by the local CADD support specialist daily, weekly and monthly, utilizing a locally attached tape drive or optical drive.

The use of backup software agents which can communicate and retrieve data from servers using TCP/IP would help to integrate these devices into the enterprise backup system. In the long term, it is expected that these devices will be replaced with hardware and software that will be easily integrated into the enterprise architecture.

Off-site storage of backup

The person responsible for backing-up the server should store monthly backup media off-site.

Recovery Plan

The user must first provide the name and date of the file they wish to recover. Local CADD support personnel will most often be able to locate and recover the file and provide it to the user within a few hours.

Recovery of the operating system and other applications on the server can be performed by reloading the system from tapes that are created by ISD and distributed with the workstations. In the future, distribution of the system on WORM or Re-writeable CD-ROM media will be preferred over tape.

Spares

There are currently no formal provisions for maintaining spare components on-site or even at the local level. As the CADD Severs become more mainstream with the use of hardware and software that complies with the Architecture, it will become more practical for local support personnel to relocate equipment and components to critical areas in the event of a failure.

Uninterruptable Power Supply

Currently, most of the CADD Servers are not connected to a UPS.

Notification

There are currently no provisions for automatic notification of system failure. Considering the age of the existing UNIX servers, it is not expected that the hardware or software of these systems will comply with industry standards necessary for automatic notification.

Service Level Goals

Service of the UNIX servers is currently handled on a case by case basis. This service level should be adequate until these devices are replaced.

UNIX Workstations

This section to be defined further in a future version.

There are currently approximately 25 Intergraph CLIX Unix Workstations and approximately 475 HPUX Workstations in production within TxDOT. Both types of devices will continue to be represented in these quantities for at least the next year. It is estimated that these devices may be replaced with PC Workstations at a rate of approximately 40% per year beginning late in FY 1997.

Backup Plan

Currently data on each workstation should be backed up by its primary user daily and weekly utilizing one of the following methods:

Method 1: Backup to a locally attached SCSI tape device.

Method 2: Copy files (using NFS) to another UNIX Workstation or Server where the files will be backed up to tape or optical storage media.

In the future the use of backup software agents should be used as available to automatically backup each workstation as needed to a central mass storage medium. While backup agents for HPUX currently exist and have been briefly tested, there are no known equivalents for the CLIX platform.

Off-site storage of backup

Currently there are no recommendations for storing workstation backups off-site due to the prohibitive cost versus risk of such a strategy. However, files copied to the UNIX Servers within a district or division/special office should be backed up and stored off-site as detailed in the following section.

Recovery Plan

Recovery of lost or corrupt data on an individual workstation can be performed in one of the following ways depending which method was used for the backup:

1. Primary user restores file(s) from tape using locally attached SCSI tape device.
2. Primary user contacts support personnel responsible for server backups and asks them to restore the file(s) from tape or optical. Once files are restored, the user can copy or move the files back to the workstation utilizing NFS or ftp.

Optical storage media is preferred over tape media due to the frequency of file restoration inherent to the CADD environment. Not unlike most other data, many hours can be spent in the development of a CADD file. However, CADD software typically writes information to disk as changes are made and until recently, automatic backup of the file was not provided by the CADD software. Therefore, a single erroneous operation on the file, can require restoration of yesterday's version in order to "undo" the mistake. Needless to say this happens frequently and the additional cost of optical media is viewed as insignificant compared to the cost of retrieving the data from tape.

These methods will continue to be important until the latest version (MicroStation '95) of the CADD software can be fully implemented on all platforms. The automatic backup feature of this software will greatly reduce the frequency of file restorations. Use of technologies such as document management and hierarchical storage management (HSM) will greatly enable the CADD users to effectively manage their data.

Recovery of the operating system and other applications on the workstation can be performed by reloading the system from tapes that are created by ISD and distributed with the workstations. In the future, distribution of the system on WORM or Re-writeable CD-ROM media will be preferred over tape.

Spares

There are currently no formal provisions for maintaining spare components on-site or even at the local level. As the CADD Workstation becomes more mainstream with the use of PC hardware and software, it will become more practical for local support personnel to relocate equipment to critical areas in the event of a failure.

Uninterruptable Power Supply

Due to the cost, it is not feasible for workstations to have their own UPS.

Notification

There are currently no provisions for automatic notification of system failure. Considering the age of the existing UNIX workstations, it is not expected that the hardware or software of these systems will comply with industry standards necessary for automatic notification.

Service Level Goals

Service of the UNIX workstations is currently handled on a case by case basis. This service level should be adequate until these devices are replaced with PC workstations.

Local Area Network (LAN)

This section to be defined further in a future version.

For reliability and fault tolerance purposes, the LAN can be defined as the physical transport media and hardware necessary to transport information at the local campus or single building level. This includes Token Ring and Ethernet hubs, fiber optic cable plant, Category 5 (CAT 5) building wiring, patch panels, patch cables, faceplate assemblies and drop cables (from the wall jack to the computer). Devices attached to the LAN via Network Interface Cards such as printers, workstations, and file servers can also be included in this definition, the concern is more with how these devices communicate with the LAN rather than how well they are operating.

Two types of LAN failures usually occur, the first being failures associated with the physical plant or attached devices as defined above and the second being failures caused by the nature of network traffic.

The first type of failure encompasses much territory, some of which is covered elsewhere in this document (NetWare File Servers, Hubs, etc.). Items such as the fiber optic plant, CAT 5 building wiring and patch cables should be installed by qualified technicians and certified appropriately. Rudimentary test equipment has been provided to each district to test the fiber optic and patch cables. This test equipment is NOT adequate for testing the CAT 5 building wiring.

The second type of failure, due to network traffic, is more difficult to prevent or diagnose. The best preventive measures here is good network design and hardware. Future improvements will include Token Ring and Ethernet switches and VLAN's (Virtual LAN's) where appropriate to control network traffic. To help diagnose problems, network management systems running HP OpenView have been provided at each district office, Camp Hubbard, and Riverside, allowing network managers to monitor and diagnose LAN traffic problems. This software communicates with the Token Ring and Ethernet Hubs using RMON (Remote Monitoring) and SNMP (Simple Network Management Protocol).

Wide Area Network (WAN)

This section to be defined further in a future version.

WAN reliability and fault tolerance will be addressed initially by utilizing the Permanent Virtual Circuit (PVC) and Committed Information Rate (CIR) capabilities of Frame Relay.

PVC

PVC's will enable the creation of additional redundant links to the TxDOT WAN. Frame Relay allows for meshed networks. Since each endpoint in a Frame Relay network can have one or more addresses, each user location can be connected to one other location, several locations, or all locations. If every location were connected to every other location, the network would be said to be "fully meshed". Future design of TxDOT's WAN will incorporate a "partially meshed" structure which will allow districts to have more than one WAN connection. This will enhance the reliability of WAN connections by providing an alternate data path if the primary link fails.

CIR

The CIR is the maximum sustained subscriber data throughput rate that the network commits to supporting per permanent virtual circuit (PVC). At a maximum, the CIR is equal to the interface speed of the router. WAN connections will be monitored and if it is determined that the capacity of a particular link is approaching its CIR, steps can be taken quickly to increase the CIR to reduce bandwidth bottlenecks.

Mainframe

This section to be defined further in a future version.

Virus Scanning

This section to be defined further in a future version.

PC Workstations, Intel based Servers, and Laptops

All PC workstations, Intel-based servers, and laptops should be scanned for viruses to prevent loss of information or damage to files. The scan should include all files on the disk drive, including all disk partitions.

The virus scanning software that should be used for PC workstations is McAfee VirusScan. A copy of McAfee VirusScan should be installed on each PC Workstation and laptop with updates and patches applied as made available by McAfee. Also, McAfee should be installed and used on each Intel-based server.

This section will be developed further in a future version.

Additional Topics to be Considered for a Future Version

- PC Workstations
- NT Servers
- Citrix Server Dial-In
- Dial-out
- System Monitoring
- Databases
- Off-site Maintenance Office Dial-In
- Applications
- Groupwise
- HUBs
- Routers
- Laptops
- Virus Scanning for UNIX Workstations, UNIX Servers, and the Mainframe

Emerging Technologies and Future Considerations

- Hierarchical backup for LAN/WAN and PC workstations

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GLOSSARY

7x24 Operations

A term used to describe an entity (usually a computer system or computing facility) that is operable twenty-four hours a day, seven days a week, 365 days a year.

Adapters

Devices that connect systems through circuits or channels which enable them to be compatible.

Application Server

A computing platform whose primary function is to provide application oriented services to users within the business environment.

Architecture

A high-level representation of the data, applications, and technology needed to support the business requirements of the Department. It includes a series of principles, guidelines, or rules used by an organization to direct the process of acquiring, building, modifying, and interfacing with IT resources throughout the enterprise.

Architectural Principles

An architectural principle represents an architectural assumption or foundation that has been documented and around which the technological architecture has been designed and constructed.

Archival

The process of copying data that is maintained on an operational system in real-time to some other type of storage device such as another system or to a data warehouse and is from that point forward used only for "read-only" historical analysis or a similar type of activity.

"As-Is" Assessment

A baseline understanding of strengths, weaknesses, and core competencies of the "as-is" processes and known improvement initiatives is required here. The team must understand enough of the "as-is" process to comprehend current problems and know when something different and improved has been developed during the visioning process. Recognizing the problems of the "as-is" can help ensure they are not represented in the "to be". Briefly, these are processes constructed around the current methods of operation.

Asynchronous Transfer Mode (ATM)

A standard developed for high speed networking, capable of supporting all types of information flow including voice, data, and images.

Bandwidth

The signaling frequency supported by a circuit. It is generally accepted to mean the capacity provided by a particular circuit expressed as a data transfer rate (bits/second). The term is also used to express a requirement for such capacity.

Batch Interface

An interface that is generally used to execute high-volume repetitive tasks during non-peak times as a background process.

BDC

See "NT BDC"

Benchmarking

Performance gaps relative to best-in-class companies provide an approximation of the magnitude of performance improvement possible, thus allowing legitimate targets to be set.

Business Area

A set of logically-related business processes, usually directed towards a common result or set of results (e.g., Determine and Analyze Transportation Needs).

Business Process Reengineering (BPR) / Business Process Retooling

A multidisciplinary approach to implementing fundamental change in the way work is performed across the organization to dramatically improve performance. A field of expertise in which the work processes used to support a business entity are analyzed and modified in order to allow the entity to more efficiently and expeditiously conduct its business activities.

Business Resumption Plan (BRP)

Also known as a Disaster Recovery Plan (DRP), this is a plan that has been developed and tested under simulated conditions before it is actually needed and that will be put into operation after a natural or man-made disaster in order to allow a business entity to resume its operations that were temporarily interrupted by the disaster.

Business Users

Users that utilize components of the technological infrastructure to perform their normal daily work functions.

Cache

A technological architecture component that exists between a computer system's main memory and its disk storage system used to speed up references to data.

CAD/CAM

Computer Aided Design/Computer Aided Manufacture.

Change Imperative

A clear, succinct, high-impact argument establishing the irrefutable requirement for change.

Client

A computing platform component in a client/server architecture that is functioning as the requester of processing services.

Client/Server

A networking architecture through which a PC or workstation (client) requests information from a LAN file server, mini-computer, or mainframe (server). The client supplies the user interface and conducts application processing. The server maintains databases and processes client requests.

Communications Management Information Protocol (CMIP)

A network management protocol developed by the International Standards Organization.

Collapsed Backbone Router

A technology in which a router is used to directly switch LAN traffic from message originator to message addressee thus making the electronic communications process more efficient.

Communications Ring

A LAN or WAN based, electronic communications segment that has been organized along some combination of functional, geographical and/or topological boundary. For example, a particular communications ring may be designed to provide LAN services only for users located within a particular building or to provide access only to those systems that are used for application development.

Computing Platform

This term is used generically to represent a functional combination of computer system hardware, software and all supporting peripherals and services that when employed together deliver computing services to a user or group of users.

Conceptual Design

A stage in the computer system design, specification and development process. In this context, this term refers to the development stage during which the high level requirements, design implications and recommendations are determined and documented. The end result of this activity is known as the architecturally based "Conceptual Design".

Concurrent Users

The group of users within a business processing environment that are requesting processing services from the environment all at the same point in time. The size of this group can be equal to but is generally less than that of the "Total Users" group.

Customer

A person or organization unit who receives an IS service or product.

Digital Audio Tape (DAT) Tape Drive

A hardware device used by system administration staff for backups and restores.

Data Backup

The process of copying data that is stored on a computer system to some sort of secondary storage device so that a full or partial restoration of this data to the system from which it came can be enabled at some future point in time if required.

Data Integrity

A measure of the quality of information. The integrity of data is measured in terms of the following characteristics: accuracy, reliability, timeliness, conciseness, non-redundancy, and consistency. Data integrity has been achieved and can be maintained when the data that is stored on a system is physically and procedurally secure from unauthorized and/or unwanted access, protected from concurrent and/or unauthorized or malicious manipulation, and current and up to date across all locations in which it is maintained.

Database Server

A computing platform whose primarily processing activity is centered around that of database processing.

Detailed Design

This is one stage in the computer system design, specification and development process. In this context, this term refers to the development stage during which the actual implementation design (the how to do with what) is determined and documented. The end result of this activity is known as the architecturally based "Detailed Design".

Dial-up Access

A type of communication between two computer systems in which they communicate with each other via standard telephone lines or through a similar type of medium.

Disaster Recovery Plan (DRP)

Also known as a Business Resumption Plan (BRP), this is a plan that has been developed and tested under simulated conditions before it is actually needed and that will be put into operation after a natural or man-made disaster in order to allow a business entity to resume its operations that were temporarily interrupted by the disaster.

Distributed Data

Data that is located in more than one physical location, usually across two or more servers within a client/server or similar type of architectural configuration.

Distributed Database

A database system that is maintained in more than one physical location within the technological architecture but that is represented to the user community as one logical database instance.

Distributed Processing

Processing that occurs at two or more physical locations within a technological architecture which is dynamic supplied by a variety of different computing platform resources.

Domain

A cohesive collection of hardware and software that is used to implement the specific function of a system such as the Production System.

Electronic Data Interchange (EDI)

A standardized scheme used for exchanging business data between different systems with the aid of defined documents such as invoices, orders, delivery notifications, etc.

Element

A generic term used to refer to a uniquely identifiable component within the Core Technology Architecture whose interpretation is subject to its usage context (e.g. computer system, domain, environment, etc.).

Employee Computing

Any information service, typically application development and report generation, that the end user provides for himself or for a very small number of users. While the IS staffs provide the enabling infrastructure, these employee computing services are not managed by the IS staffs.

Enterprise Computing

Any information service that spans multiple business areas and multiple Districts/Divisions/Special Offices.

Environment

A combination of hardware, software and supporting services that cooperatively function to perform work.

Fail-Over

The term that describes when some element within a technological architecture (usually a computer system) has the ability to safely and reliably compensate for its own operational failure by switching its processing load over to some other similar type of element within the architecture that has not been affected by the failure and that is able to assume the operations of the failed element.

Fiber Distributed Data Interface (FDDI)

A type of network communications medium that is based upon fiber optic technology and which uses light waves as the signal transport mechanism.

Frame Relay

A wide-area communications service that can be used to inter-network most locations found within major world-wide urban areas.

Gap Analysis

An analysis and comparison of the desired information systems components (data, applications, technology) which are not part of the current information systems inventory. The gap analysis defines desired information systems components that are new or replace/enhance existing components.

Graphical User Interface (GUI)

An interface such as that provided by Microsoft's "Windows" operating system that functions to allow a user community to gain access to available processing activities. This interface is usually characterized by resizeable windows, scroll bars, push buttons, etc. and operates in a graphics based, bit-mapped fashion.

Groupware

Applications programs which run on a network and enable groups of co-workers to interact collectively.

Highly-Available, Highly-Reliable

Terms which define a condition in which a technological architecture has been constructed with redundant (or backup) systems, components and/or communication pathways such that it is highly resistant to failure.

HP-UX

Hewlett-Packard's version of the UNIX operating system.

Incremental Backup

A backup in which only the files that have changed since the last backup are copied to and stored on the backup device.

Innovative Practices

The result of a search of how other successful organizations provide information services. This search is expected to uncover new and innovative ways of doing business which can be tailored for the business area under study.

Intranet

An intranet is an internal adaptation of the Internet. Intranets usually reside logically inside a business organization's firewall and the network traffic is not broadcast to or accessible from the Internet.

Legacy System

Typically, an existing system based upon older technologies that is functioning to provide key business related processing for an organization.

Local Area Network (LAN)

A communications topology that is contained within a defined area such as a floor segment, building or campus and can be constructed using technologies such as Ethernet, Token Ring, etc.

Local User

A user that is directly connected to the computer system being used through a LAN or similar type of connection.

Middleware

Software used to facilitate access to systems which would otherwise be incompatible where a client/server environment is being adopted.

Network Addressing

Each item of equipment or logical entity (i.e., an application or a user) connected to a network must have a unique network address to enable it to communicate. A network addressing scheme is usually devised to facilitate the management of network addressing.

Network Bandwidth

A measure of how much data can be sent from one point in a communications network to another during a specified period of time.

Network Topology

The pattern by which individual items of networking equipment are interconnected. Drivers for particular topologies include service level requirements such as availability.

NT BDC

Windows NT Backup Domain Controller

NT PDC

Windows NT Primary Domain Controller

On-Line Transaction Processing (OLTP)

The processing of transactions as they are received. Also called online or realtime systems, master files are updated as soon as transactions are entered at terminals or arrive over communication lines.

On-line Users

Users who are directly interacting with a computer system in real-time.

Open System Interconnection (OSI)

A set of network architecture standards created by the International Standards Organization.

PDC

See "NT PDC"

Peripherals (or Peripheral Devices)

Computer oriented hardware components such as printers, modems, RAID drives, etc.

Policy

A general statement of principle to provide broad guidance in fulfilling the agency's mission and in maintaining an agency work environment conforming to federal and state laws. Policy requires, guides, and restricts present and future decisions and actions of the agency.

Procedure

A detailed description of required or allowable actions to be executed in delivering agency services or in supporting the delivery of services. Procedures establish sequence, timing, coordination, and specify what shall be done and by whom. Procedures translate policies, plans, and programs into action.

Process

A set of subprocesses that take input and create one or more outputs that are of value to the customer.

Protocol

A pre-established standard that is used to communicate between two entities where each entity is able to understand and communicate with the other.

Protocol Stack

Communications functions are generally divided into separate "layers" of protocol, each of which builds on the functions provided by a more basic layer. The combination of these layered protocols is termed a protocol stack.

Redundant Array of Inexpensive Disks (RAID)

A type of data storage mechanism in which large numbers of small and inexpensive hard disks are utilized in combination to provide for data protection, redundancy and recoverability.

Remote Terminal Access

Access to a system by any terminal device which is not directly attached to it via a dedicated connection.

Remote User

A user that is not located at the same place as is the computer system to which communications have been established. Remote communications for this type of user is usually established through dial-up telephone lines.

Scaleable Architecture

A technological infrastructure in which the computing capacity can be increased or decreased (scaled) in both a horizontal and/or vertical direction.

Horizontal scalability occurs when the number of similarly configured machines is increased or decreased within an established architecture.

Vertical scalability occurs when a machine or a number of machines within an established architecture is reconfigured or replaced with machines that have more or less computing horsepower. In this case the number of machines will remain constant.

Server

The component within a client/server architecture that is responsible for satisfying a client component's request.

Serial Line Internet Protocol (SLIP)

An asynchronous Internet communications protocol that is commonly used by mobile computers via dial-up access.

Systems Network Architecture (SNA)

IBM's predominant data communications architecture in mainframe environments.

Simple Network Management Protocol (SNMP)

A network management protocol standard developed to complement the TCP/IP protocol suite.

Standard

A definite rule, principle, or measure established by authority; may be used to measure quality based on specified quantities or values. Examples of IS standards include programming standards, technology configuration standards, and data naming conventions.

Subprocess

A set of activities that are performed continuously and which take input and create one or more outputs that are of value to the customer.

Symmetric Multi-Processing (SMP)

A type of configuration for a multi-processor computer in which all installed CPU's share elements of the system architecture (i.e. memory and I/O buses) and where each CPU in the configuration works in close coordination with all others in the configuration.

System Administration

An activity in which the computer systems resident within a technological architecture are main tained and supported in order to keep them operational and responsive to the user community.

System Architecture

The combination of hardware, software, services, policies and procedures that when taken together function to define a computer system organization and capabilities.

System Interface

A pre-determined and pre-established interface point within a computer systems architecture that is used by one or more other systems for communications between the systems.

Transaction

A transaction is a discrete automated business function which requires interaction between two systems, or a user and a system. An example is updating a customer name and address. A complete transaction may involve several data exchanges.

Transmission Control Protocol / Internet Protocol (TCP/IP)

A communications protocol that is used in both LAN and WAN configurations to communicate between two or more computer systems.

Technical Infrastructure

This term is applied to all hardware, software, peripheral and supporting services that when taken together function to supply data processing capability to a target user community.

Three-Tiered Architecture

A technological hardware and software configuration in which the presentation, application and database components of the architecture are resident on separate and distinct systems within the configuration.

To-Be Processes

Processes constructed around the planned for, future methods of operation.

Total Users

The group of users within a business processing environment that are expected to request processing services from the environment, but not all at the same point in time. The size of this group is generally greater than that of the "Concurrent Users" group but theoretically can be equal to this group.

Transaction Volume

A measure of the number of processing requests that a computer system will receive and respond to within a specified period of time.

Two-Tiered Architecture

A technological hardware and software configuration in which the presentation and application components of the architecture are resident on one system in a two-system configuration and the database component is resident on the other system in the configuration.

Wide-Area Network (WAN)

The component of a communications network that is used to tie together separate and distinct local-area networks by using such services as X.25, Frame Relay, T1 and/or T3 services.

Windows

A graphical based visually oriented operating system marketed by Microsoft that installs on top of DOS (Microsoft's Disk Operating System).

Windows 95

The name of Microsoft's newest release of the Windows operating system.

WinSock

A TCP/IP communications stack that installs on top of the Windows operating system in order to provide the user with TCP/IP communications capability.

Workgroup Computing

Any information service that meets the District, Division, or Special Office needs and can be provided by the business area and/or the Information Systems Division.

Workstation

A generic term for general purpose microcomputers, graphic microcomputers, and UNIX stand-alone engineering computers.

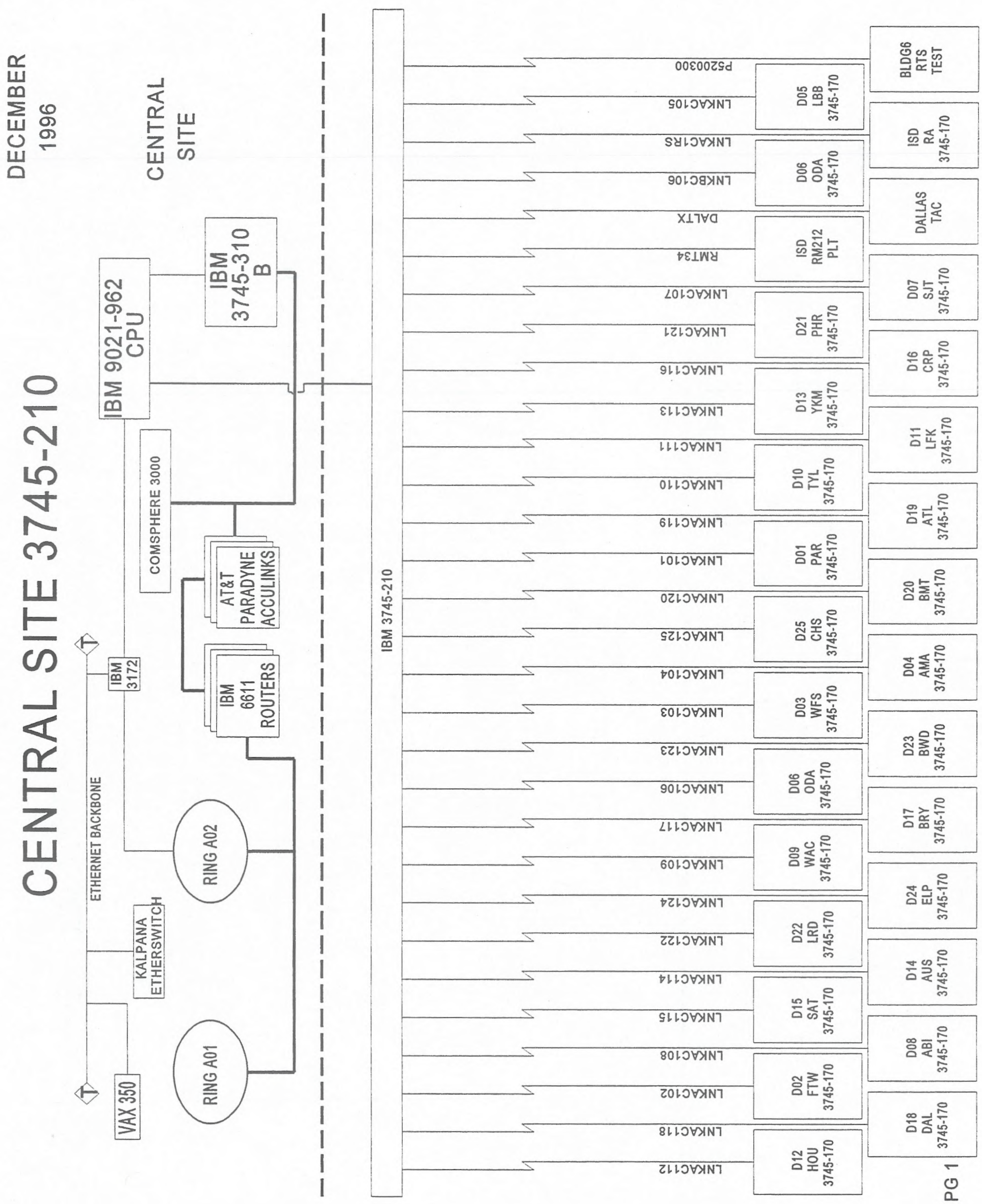
X-Windows

A graphical user interface that is supported within most versions of the UNIX operating system.

X.25

A communications protocol that is employed across wide-area networks.

Appendix 5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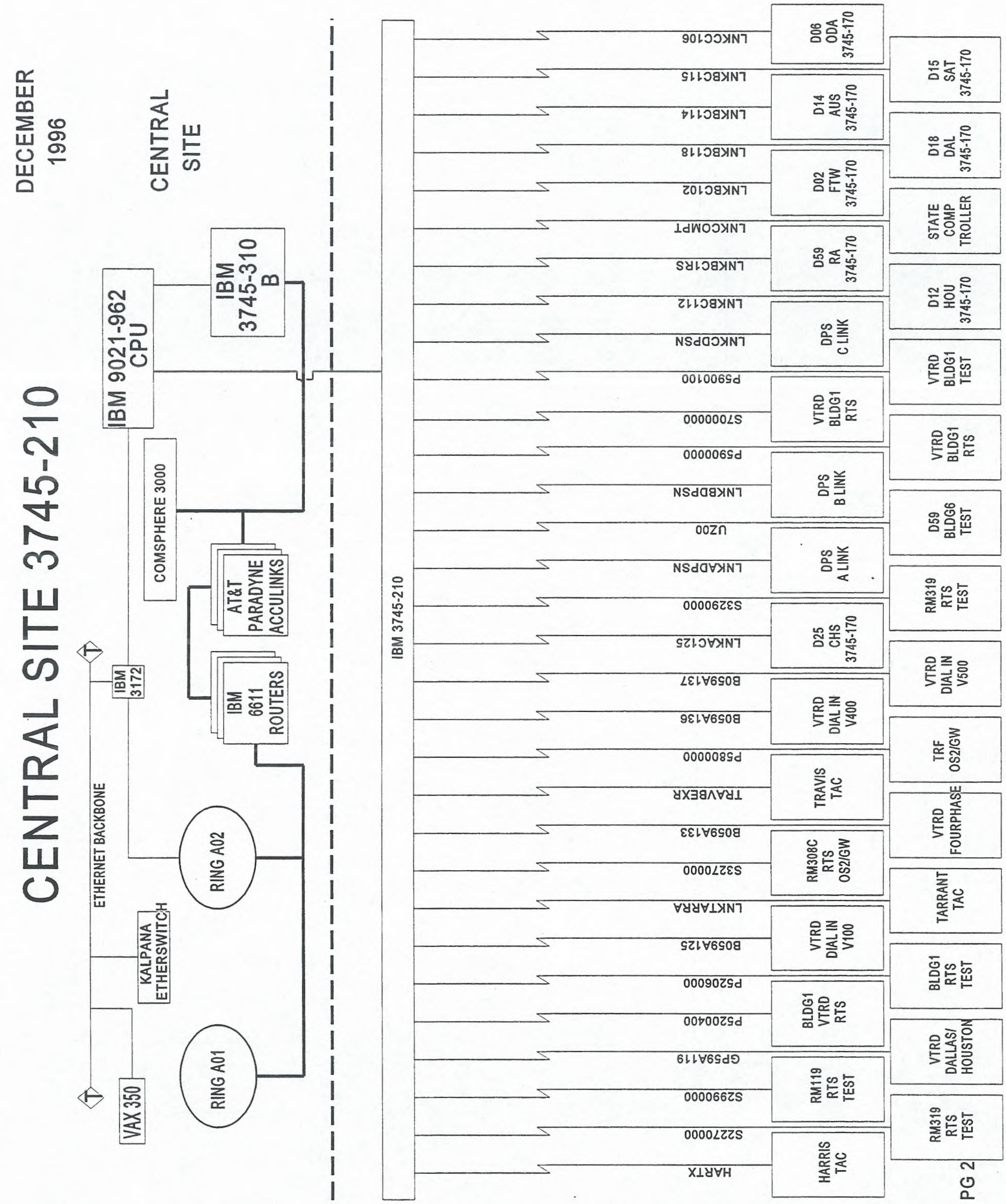
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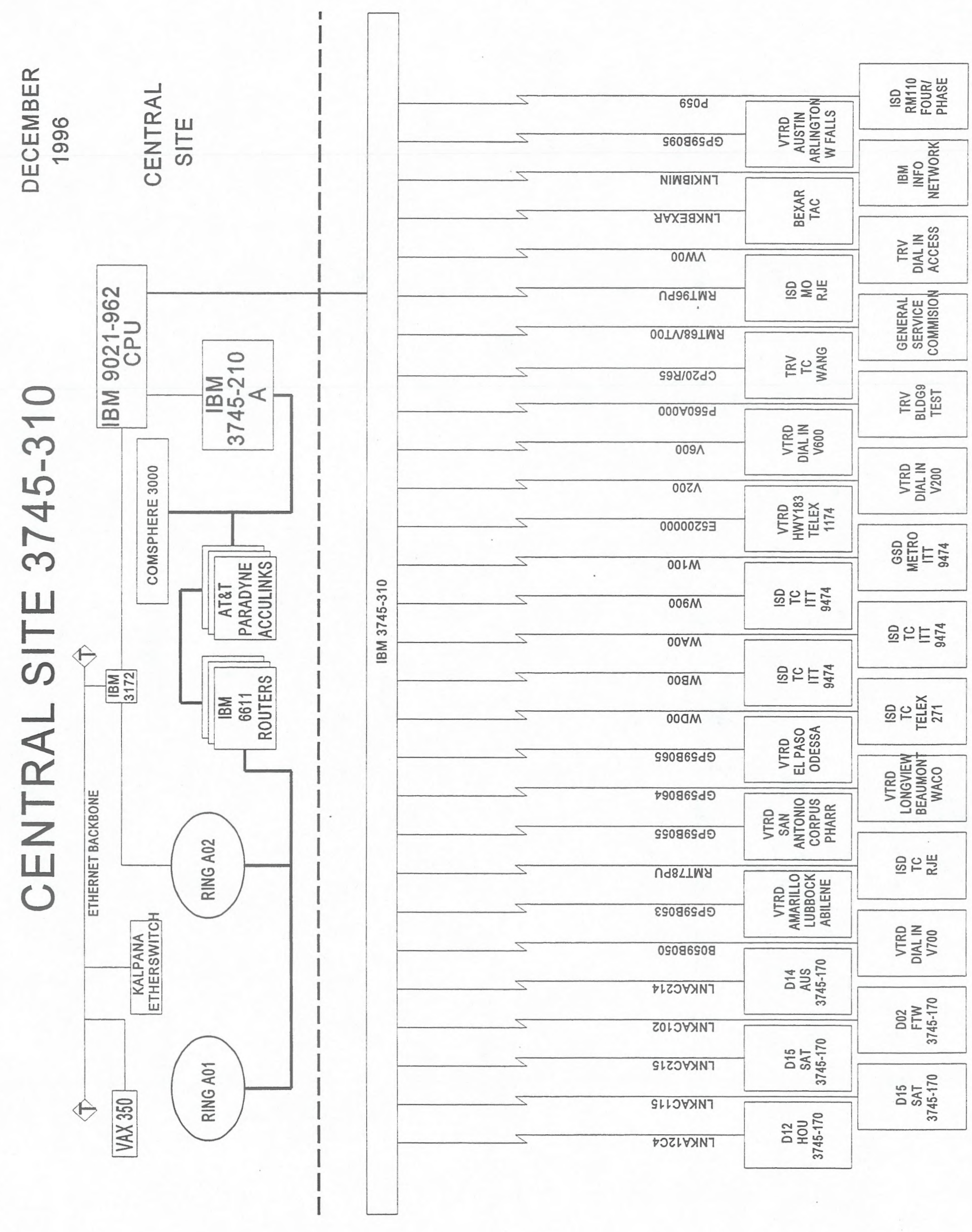
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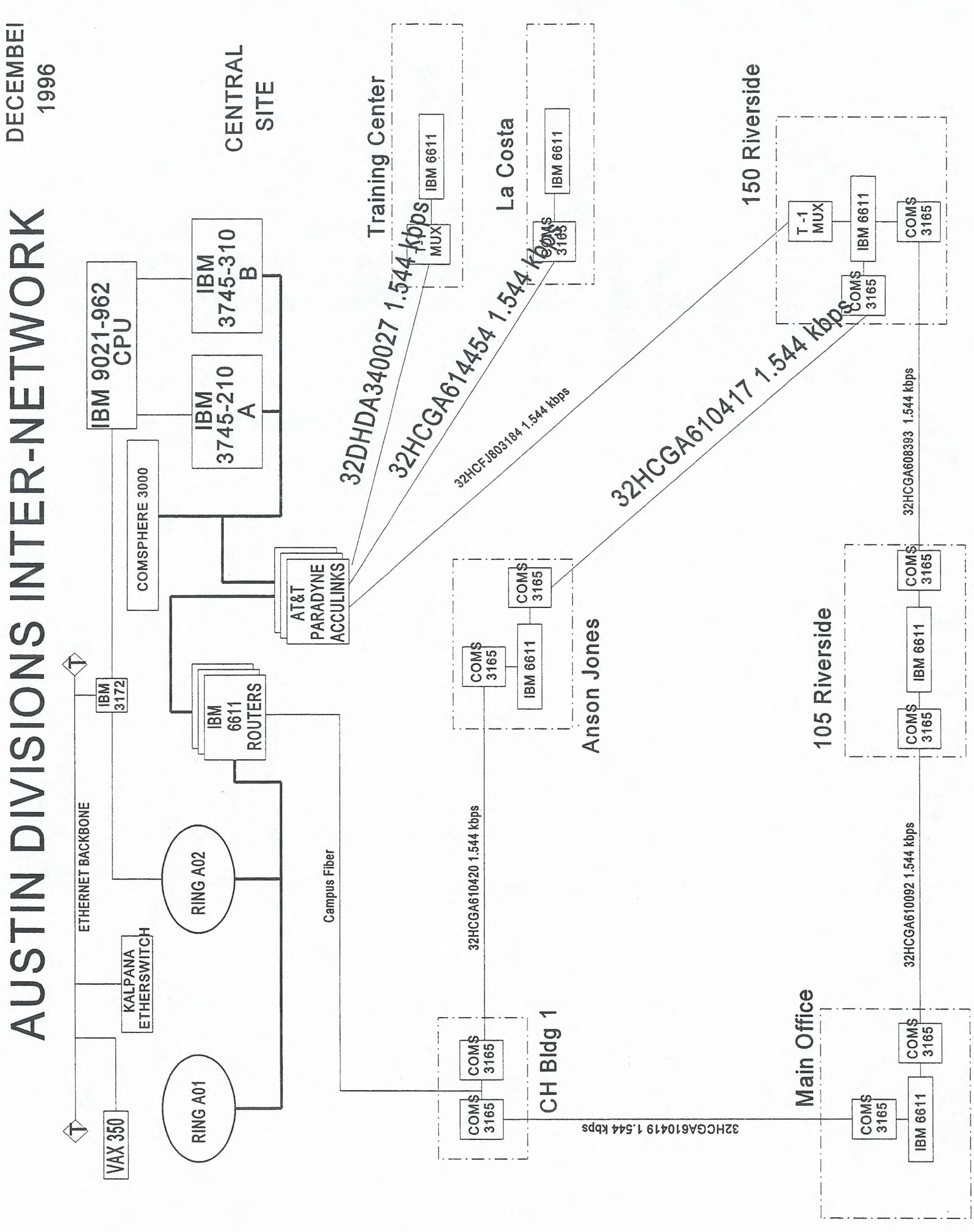
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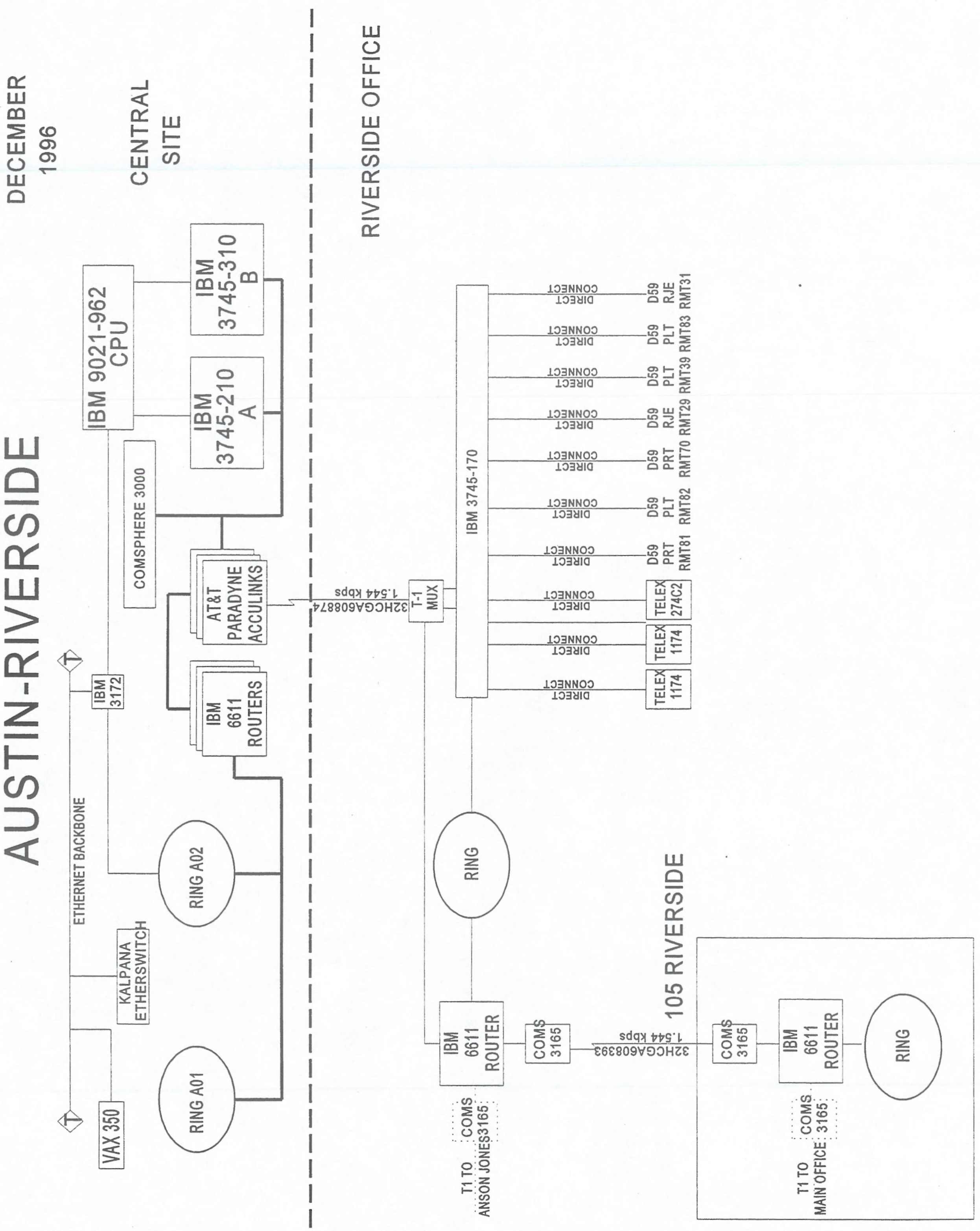
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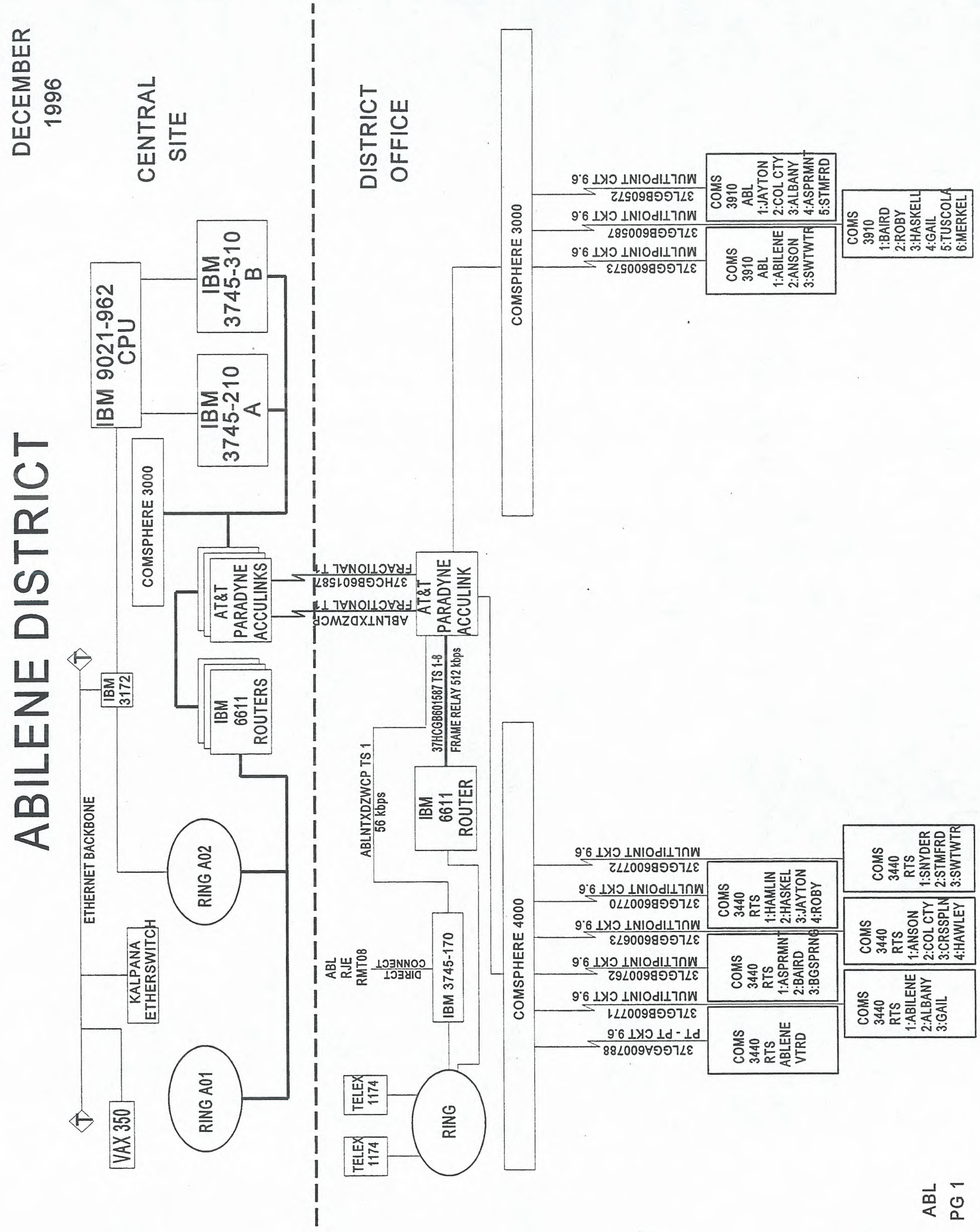
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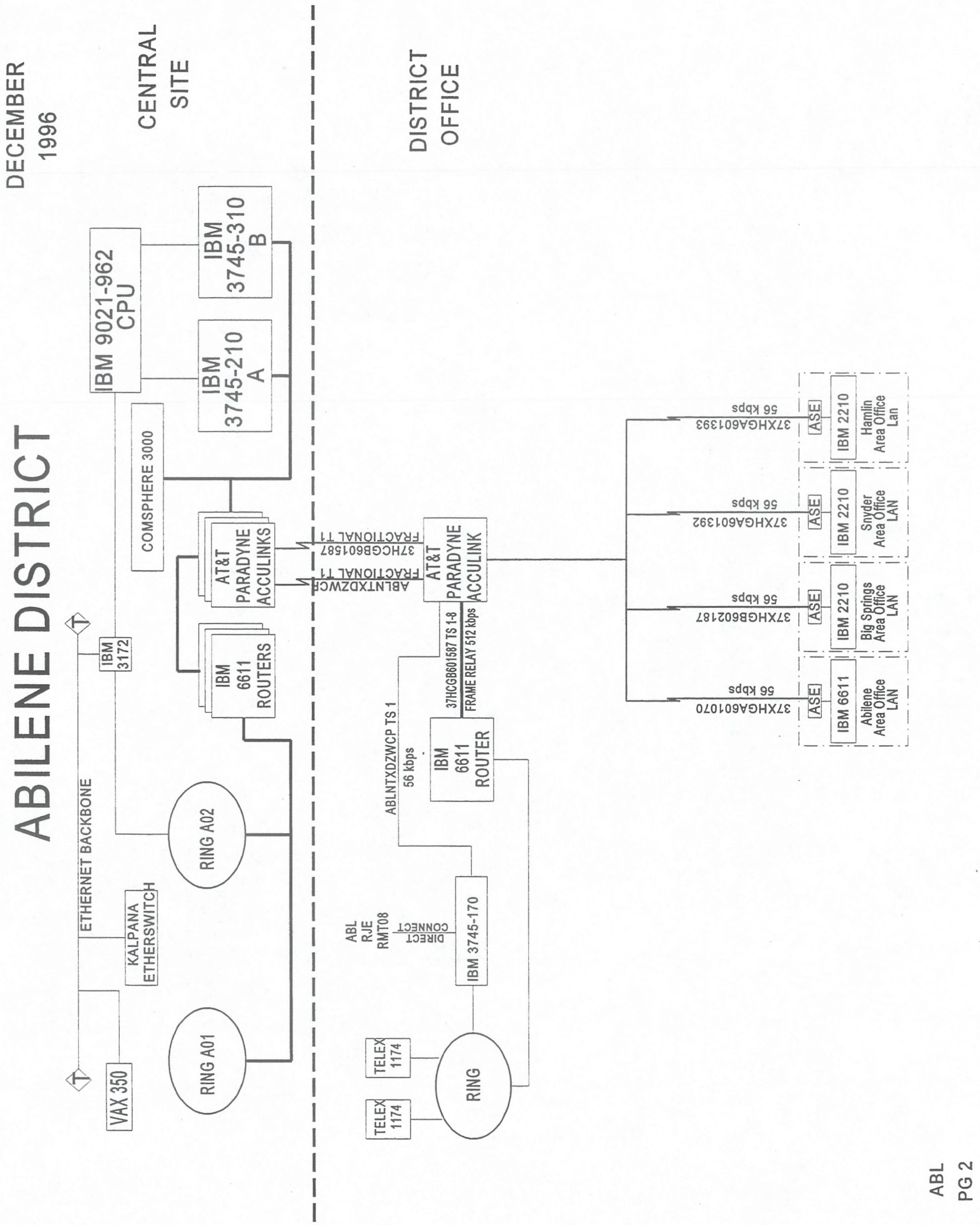

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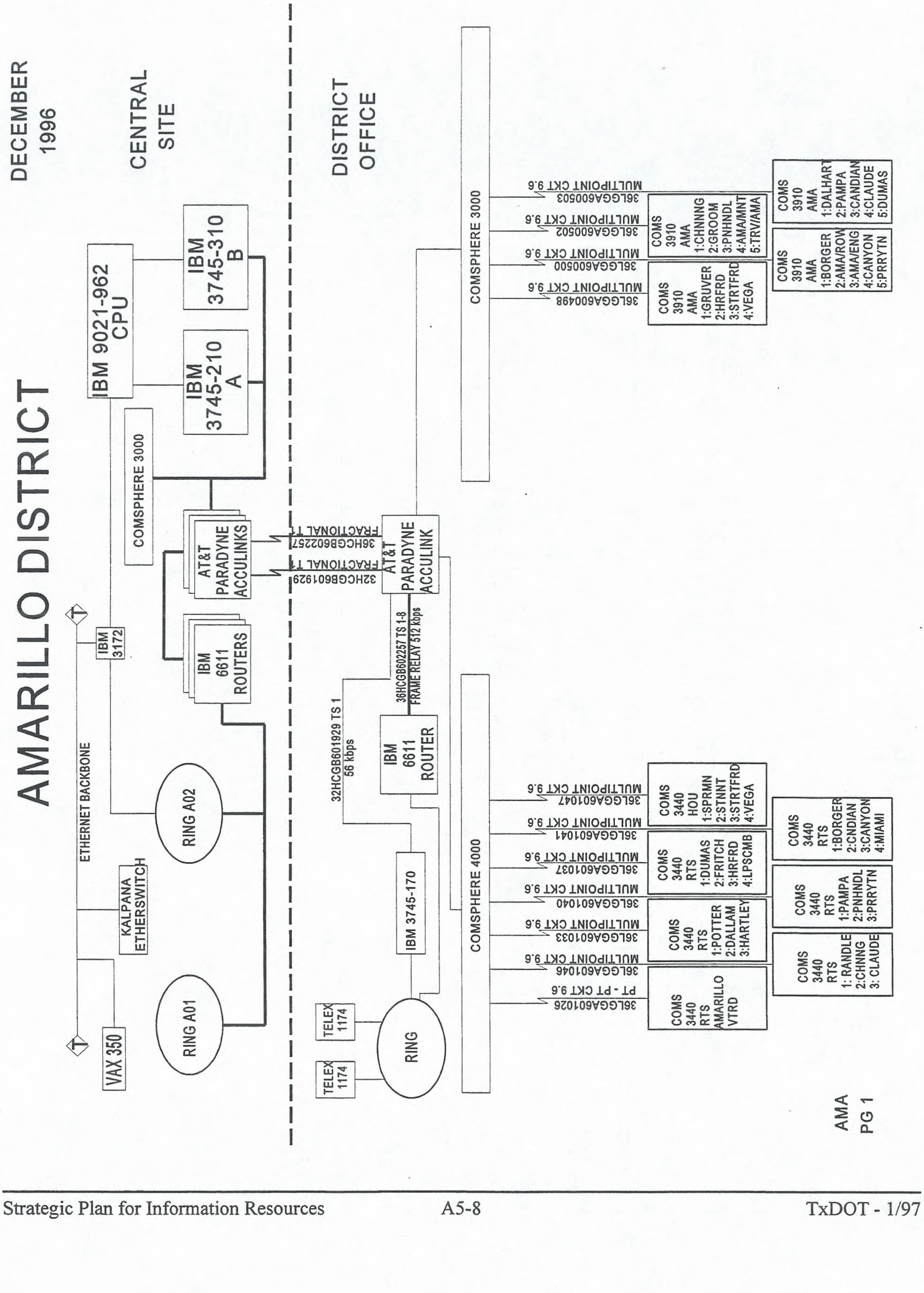
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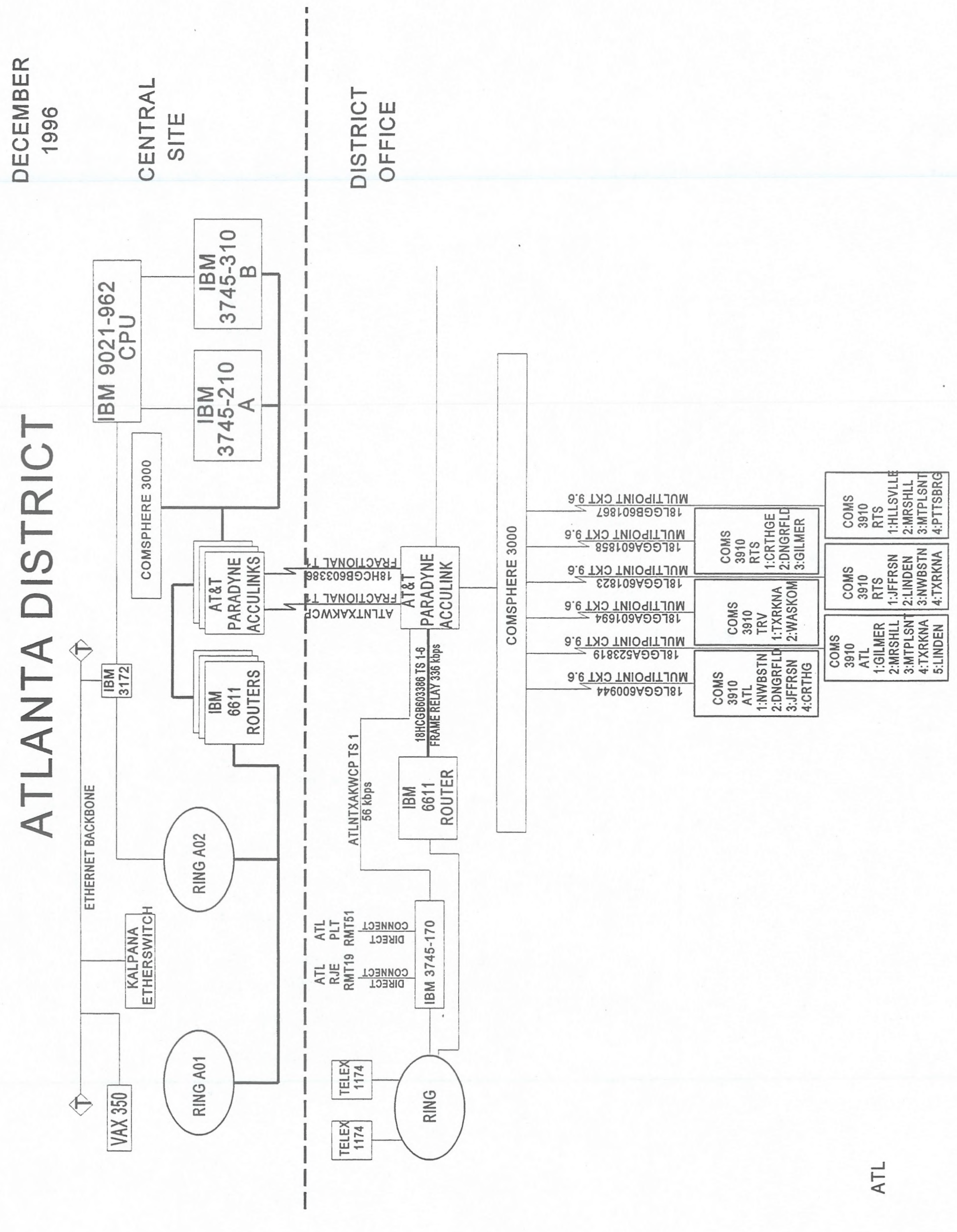
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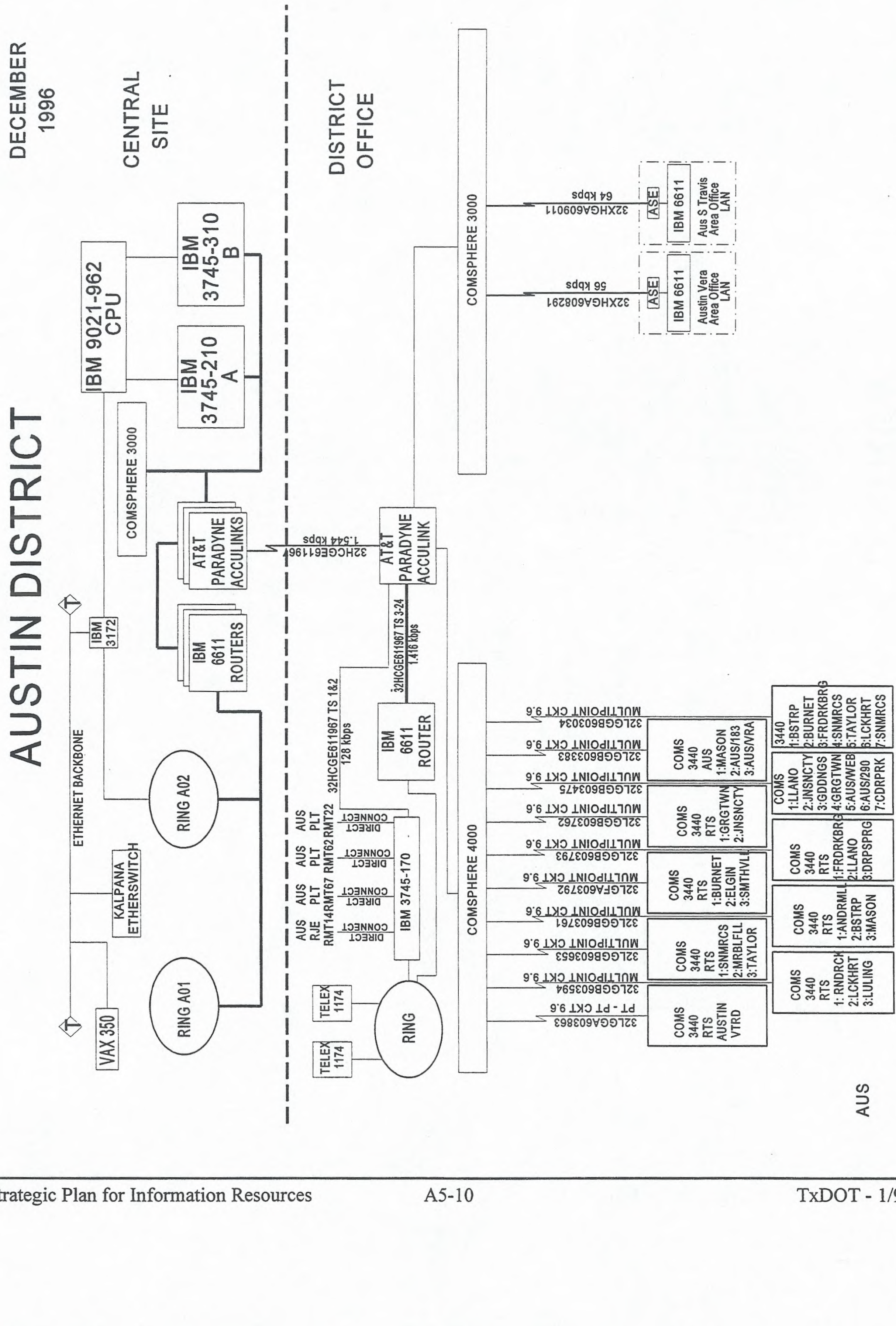
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KALPANA ETHERSWITCH
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COMS 3440 RTS 1:SNMRCS 2:MRBLFLL 3:TAYLOR
COMS 3440 RTS 1:BURNET 2:ELGIN 3:SMTHVLL
COMS 3440 RTS 1:GRGTWN 2:JNSNCTY
COMS 3440 AUS 1:MASON 2:AUS/183 3:AUS/VRA
COMS 3440 RTS 1:RNDRCK 2:LCKHRT 3:LULING
COMS 3440 RTS 1:ANDRMLL 2:BSTRP 3:MASON
COMS 3440 RTS 1:FRDRKBRG 2:LLANO 3:DRPSPRG
COMS 1:LLANO 2:JNSNCTY 3:GDDNGS 4:GRGTWN 5:AUS/WEB 6:AUS/290 7:CDRPRK
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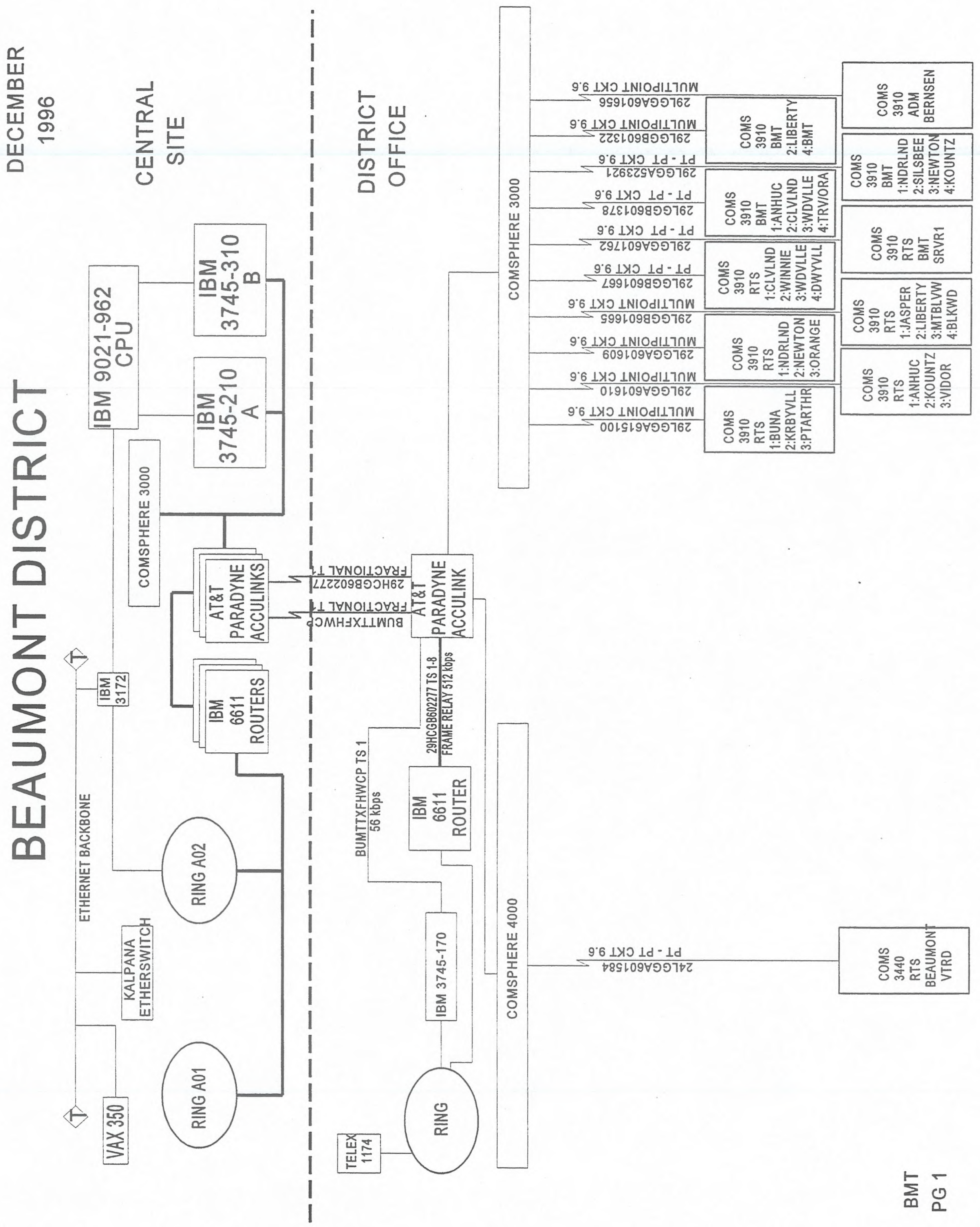
AUS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KALPANA ETHERSWITCH
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COMS 3910 ADM BERNSEN
COMS 3910 BMT 1:ANHUC 2:CLVLND 3:WDVLLE 4:TRV/ORA
COMS 3910 BMT 1:NDRLND 2:SILSBEE 3:NEWTON 4:KOUNTZ
COMS 3910 RTS 1:CLVLND 2:WINNIE 3:WDVLLE 4:DWYVLL
COMS 3910 RTS BMT SRVR1
COMS 3910 RTS 1:NDRLND 2:NEWTON 3:ORANGE
COMS 3910 RTS 1:JASPER 2:LIBERTY 3:MTBLVW 4:BLKWD
COMS 3910 RTS 1:BUNA 2:KRBYVLL 3:PTARTHR
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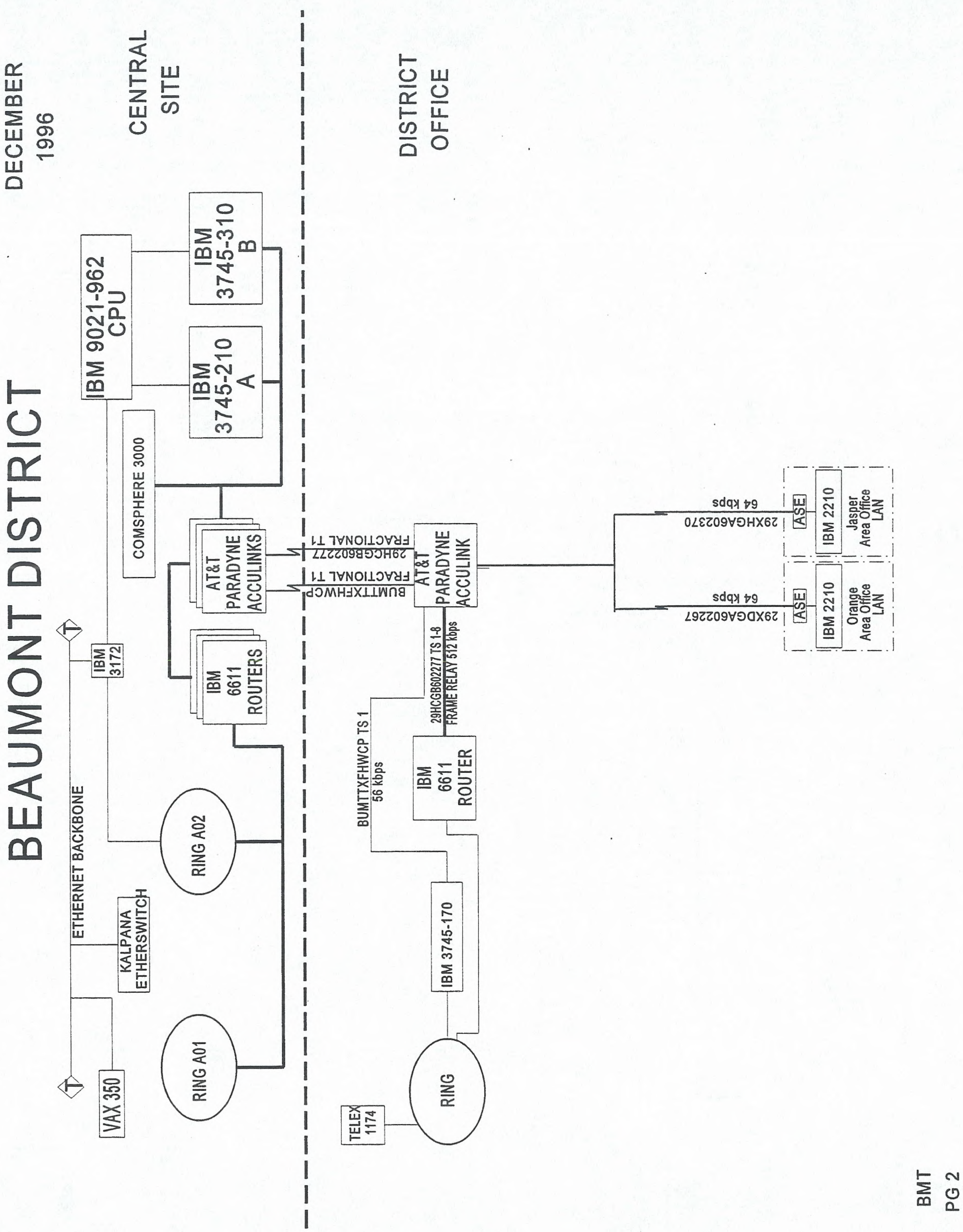
COMS 3440 RTS BEAUMONT VTRD
BMT PG 1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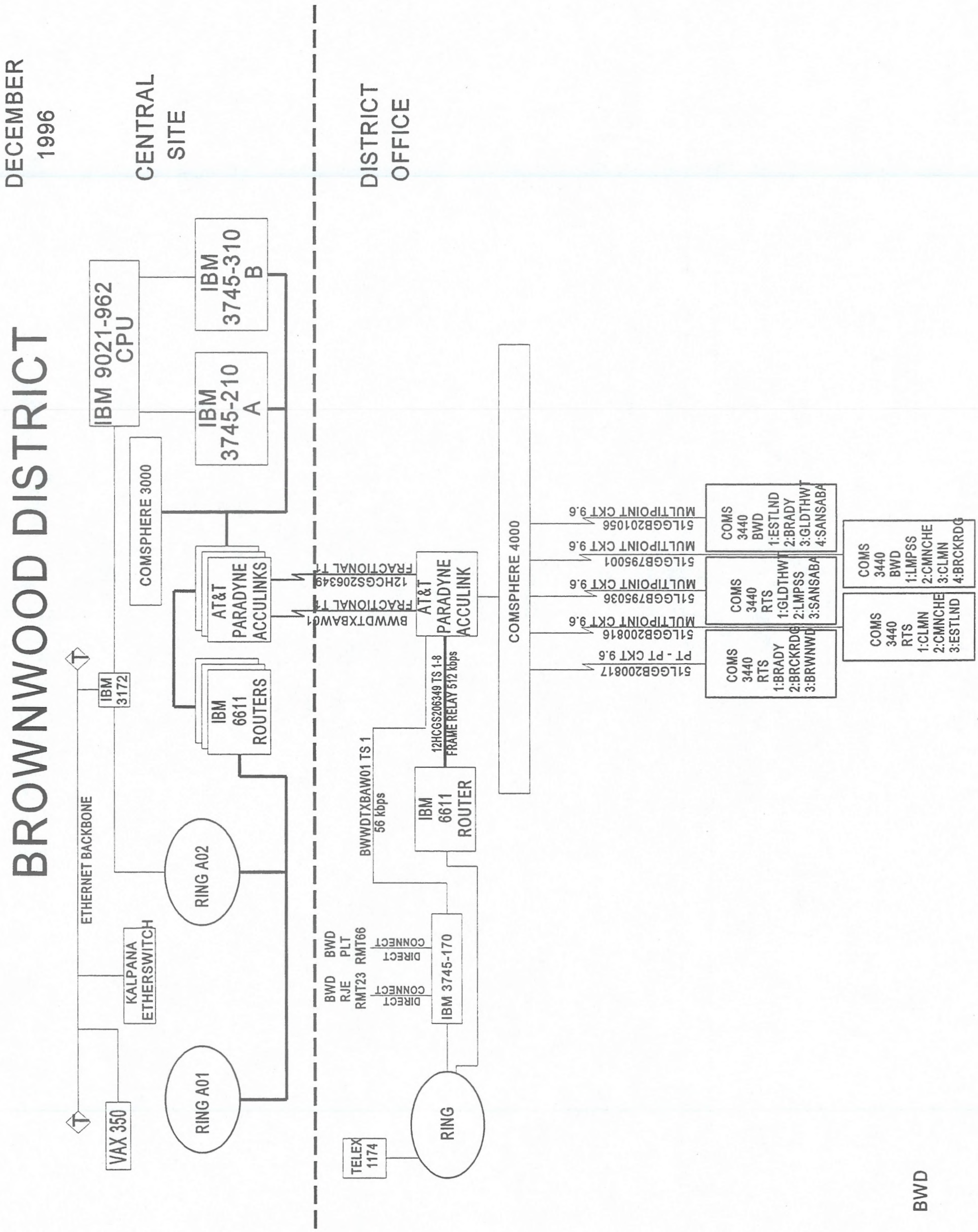
PG 2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ETHERNET BACKBONE
KALPANA ETHERSWITCH
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IBM 6611 ROUTER
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COMS 3440 RTS 1:BRADY 2:BRCKRDG 3:BRWNWD
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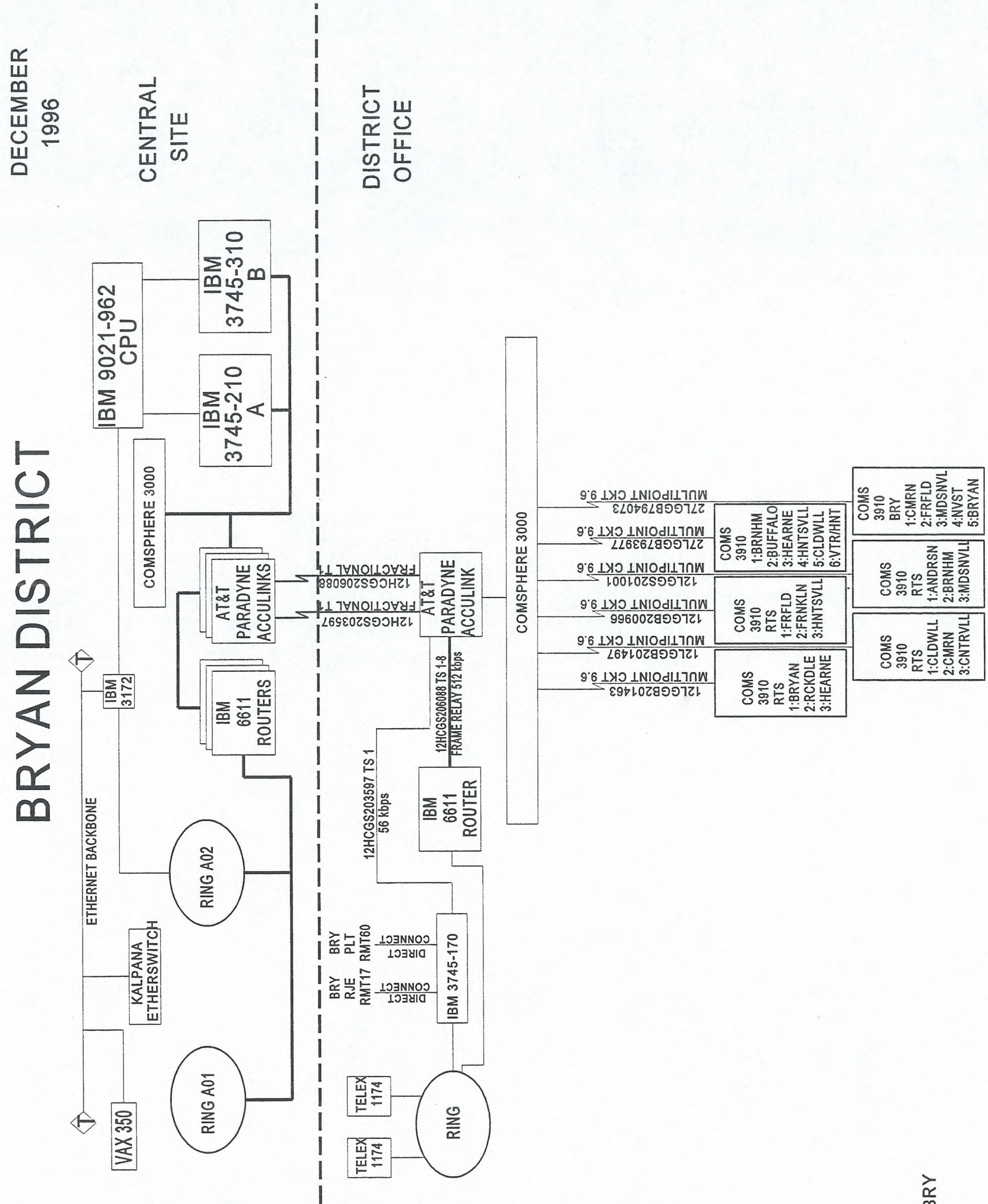
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IBM 3172
ETHERNET BACKBONE
KALPANA ETHERSWITCH
VAX 350
RING A01
RING A02
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COMS 3910 RTS 1:BRYAN 2:RCKDLE 3:HEARNE
COMS 3910 BRY 1:CMRN 2:FRFLD 3:MDSNVL 4:NVST 5:BRYAN
COMS 3910 RTS 1:ANDRSN 2:BRNHM 3:MDSNVLL
COMS 3910 RTS 1:CLDWLL 2:CMRN 3:CNTRVLL
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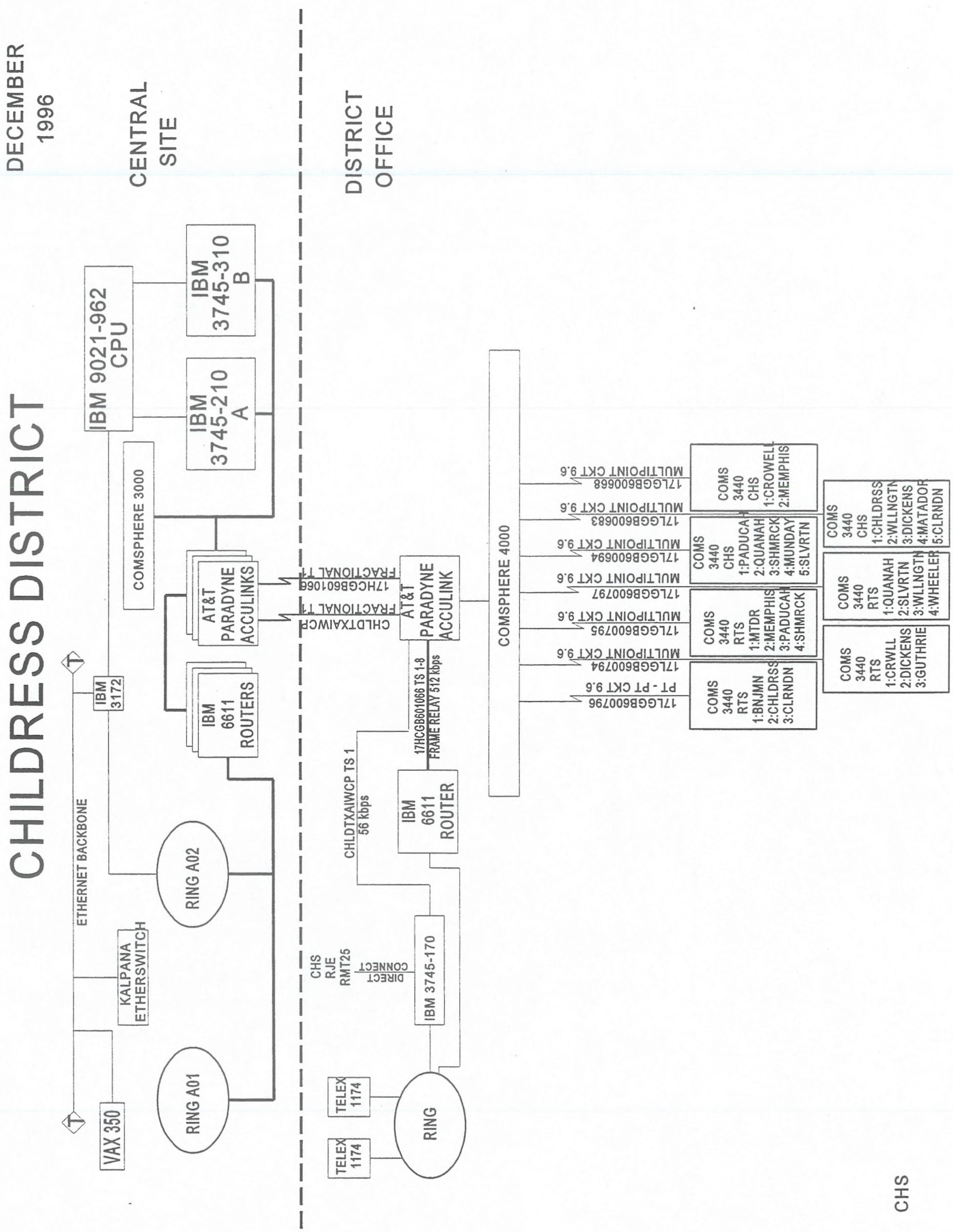
BRY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IBM 6611 ROUTERS
IBM 3172
ETHERNET BACKBONE
KALPANA ETHERSWITCH
VAX 350
RING A01
RING A02
FRACTIONAL T1
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RMT25
DIRECT CONNECT
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COMS 3440 CHS 1:PADUCAH 2:QUANAH 3:SHMRCK 4:MUNDAY 5:SLVRTN
COMS 3440 RTS 1:MTDR 2:MEMPHIS 3:PADUCAH 4:SHMRCK
COMS 3440 RTS 1:BNJMN 2:CHLDRSS 3:CLRNDN
COMS 3440 CHS 1:CHLDRSS 2:WLLNGTN 3:DICKENS 4:MATADOR 5:CLRNDN
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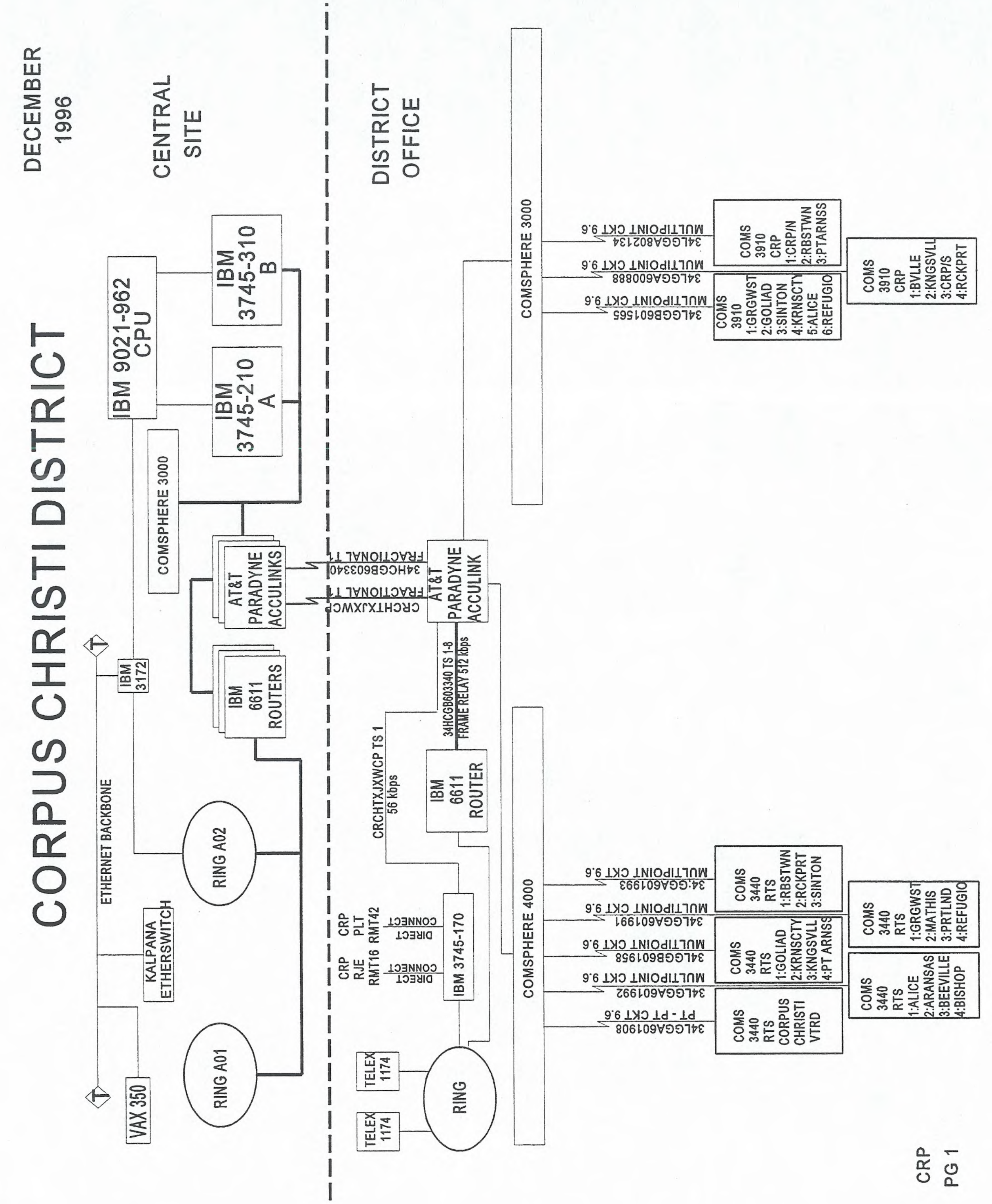
CHS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COMS 3440 RTS 1:GRGWST 2:MATHIS 3:PRTLND 4:REFUGIO
COMS 3440 RTS 1:GOLIAD 2:KRNSCTY 3:KNGSVLL 4:PT ARNSS
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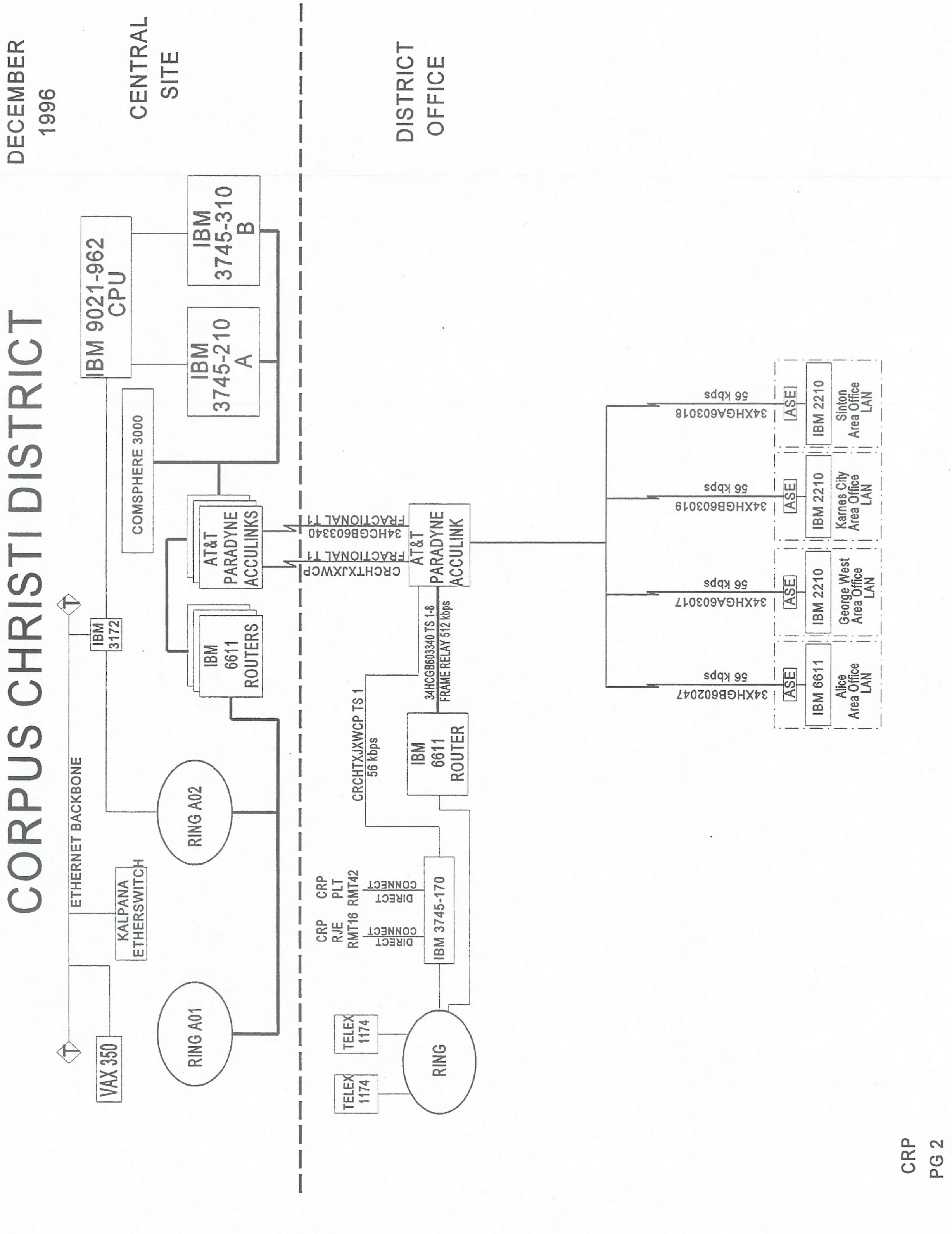
CRP PG 1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KALPANA ETHERSWITCH
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AT&T PARADYNE ACCULINK
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IBM 6611 ROUTER
CRCHTXJXWCP TS 1 56 kbps
IBM 3745-170
DIRECT CONNECT
DIRECT CONNECT
CRP RJE RMT16
CRP PLT RMT42
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Alice Area Office LAN
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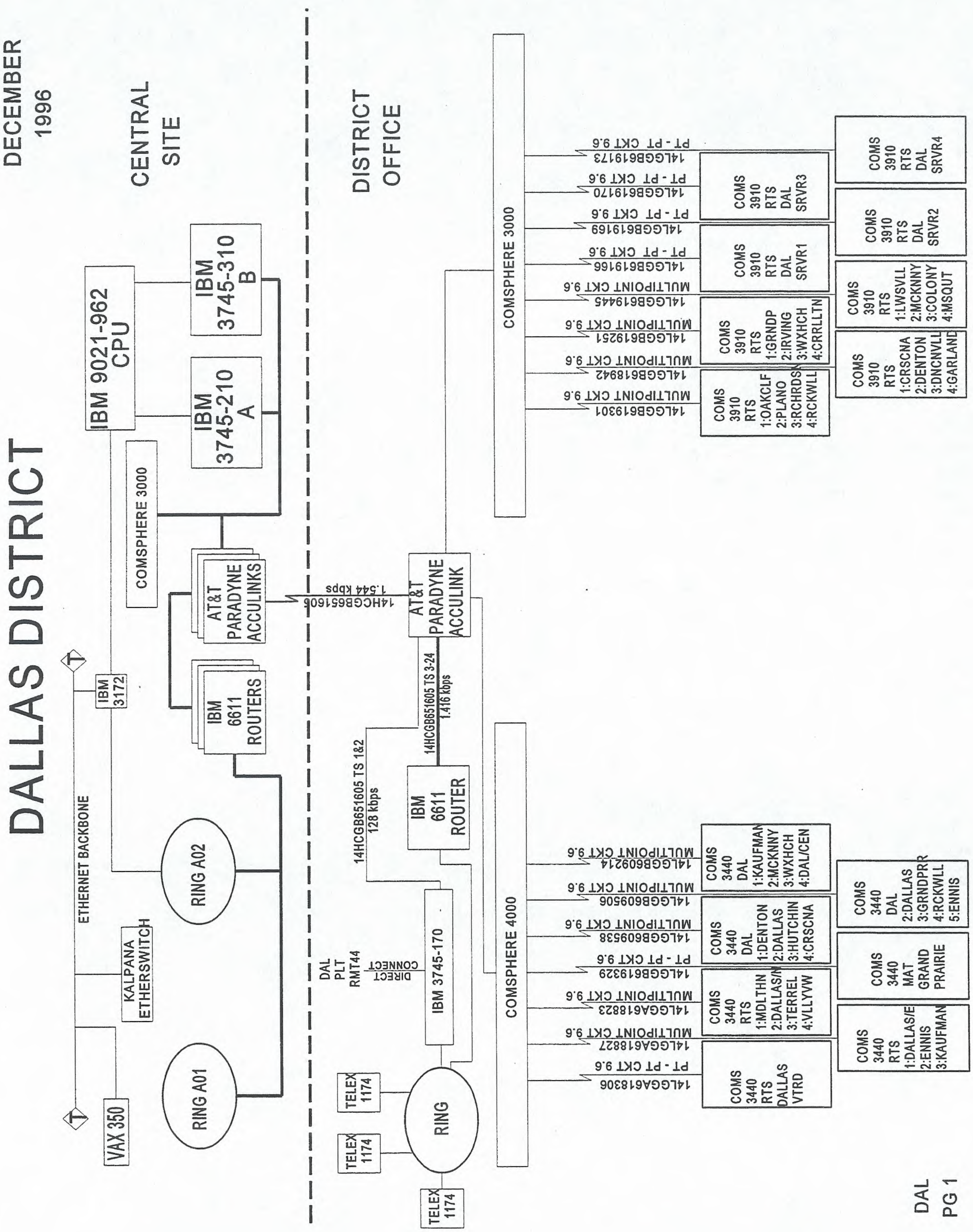
CRP PG 2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AT&T PARADYNE ACCULINKS
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IBM 3172
ETHERNET BACKBONE
KALPANA ETHERSWITCH
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RING A01
RING A02
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COMS 3910 RTS DAL SRVR3
COMS 3910 RTS 1:CRSCNA 2:DENTON 3:DNCNVLL 4:GARLAND
COMS 3910 RTS 1:LWSVLL 2:MCKNNY 3:COLONY 4:MSQUT
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COMS 3440 DAL 1:DENTON 2:DALLAS 3:HUTCHIN 4:CRSCNA
COMS 3440 DAL 1:KAUFMAN 2:MCKNNY 3:WXHCH 4:DAL/CEN
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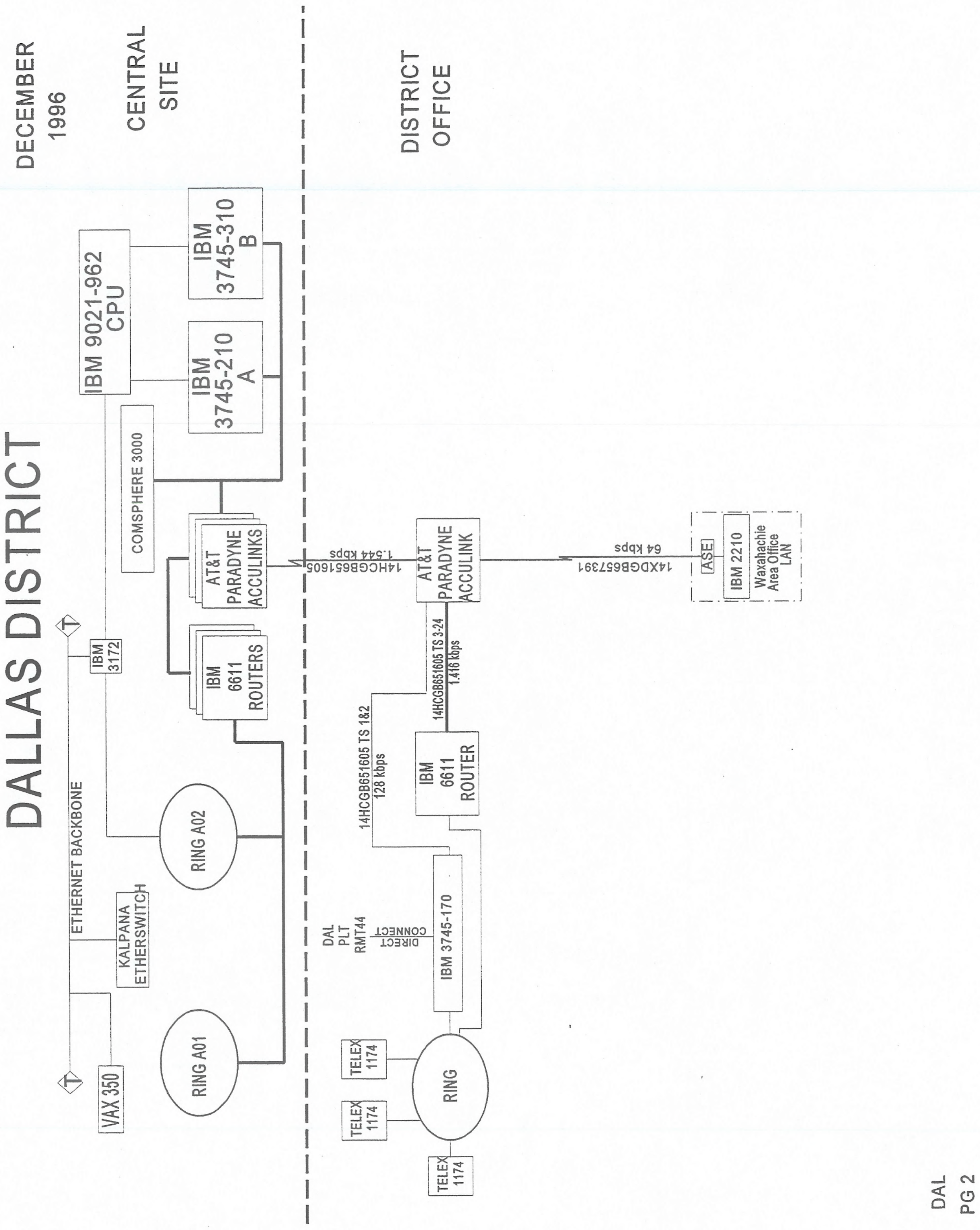
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KALPANA ETHERSWITCH
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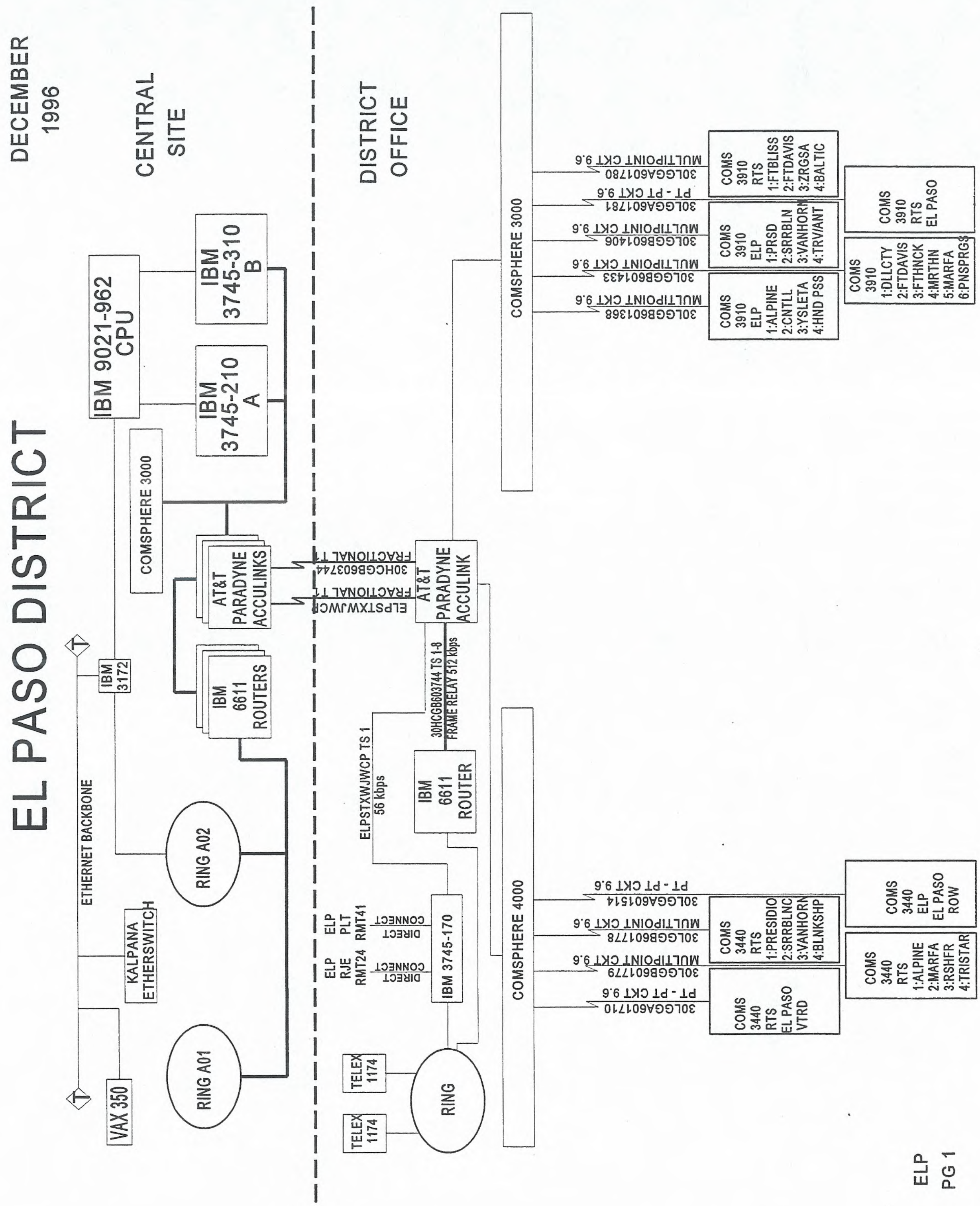

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IBM 6611 ROUTERS
IBM 3172
ETHERNET BACKBONE
KALPANA ETHERSWITCH
RING A02
RING A01
VAX 350
T
T
30HCGB603744 FRACTIONAL T1
ELPSTXWJWCR FRACTIONAL T1
AT&T PARADYNE ACCULINK
30HCGB603744 TS 1-8 FRAME RELAY 512 kbps
ELPSTXWJWCP TS 1 56 kbps
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IBM 3745-170
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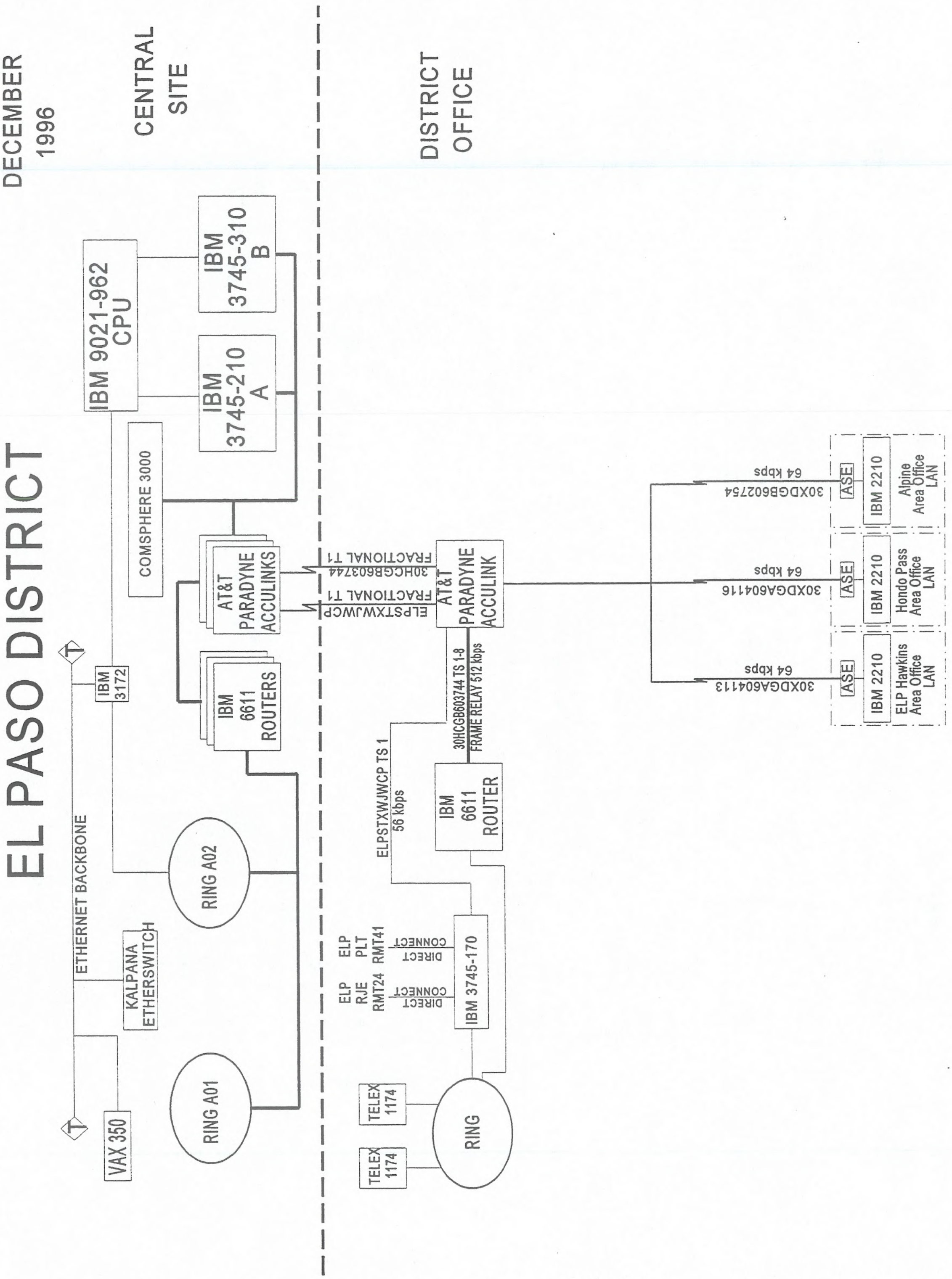
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KALPANA ETHERSWITCH
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Alpine Area Office LAN
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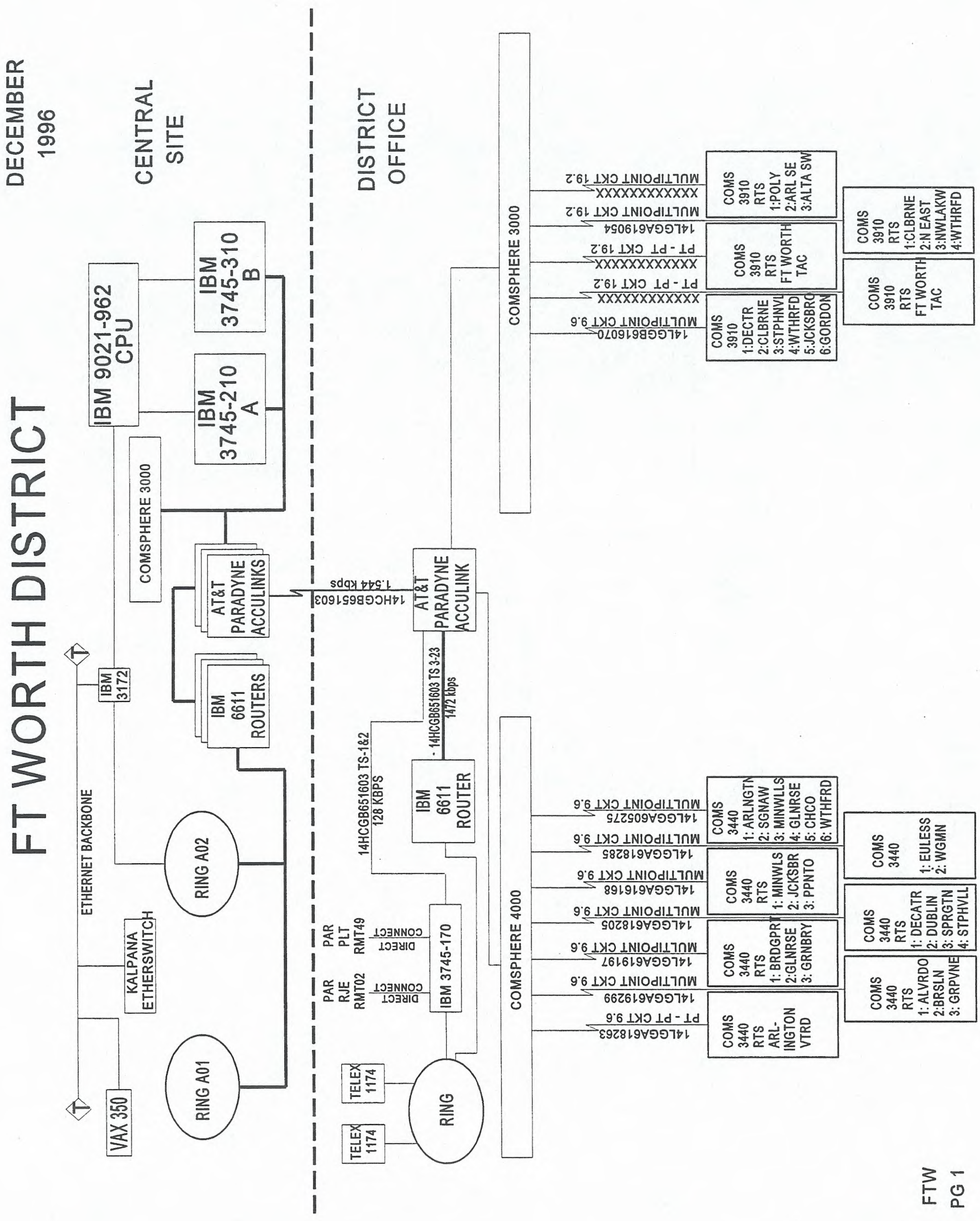
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IBM 6611 ROUTERS
IBM 3172
ETHERNET BACKBONE
KALPANA ETHERSWITCH
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IBM 6611 ROUTER
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PAR PLT RMT49 DIRECT CONNECT
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COMS 3910 RTS FT WORTH TAC
COMS 3910 RTS 1:POLY 2:ARL SE 3:ALTA SW
COMS 3910 RTS FT WORTH TAC
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COMS 3440 RTS ARL-INGTON VTRD
COMS 3440 RTS 1: BRDGPRT 2:GLNRSE 3: GRNBRY
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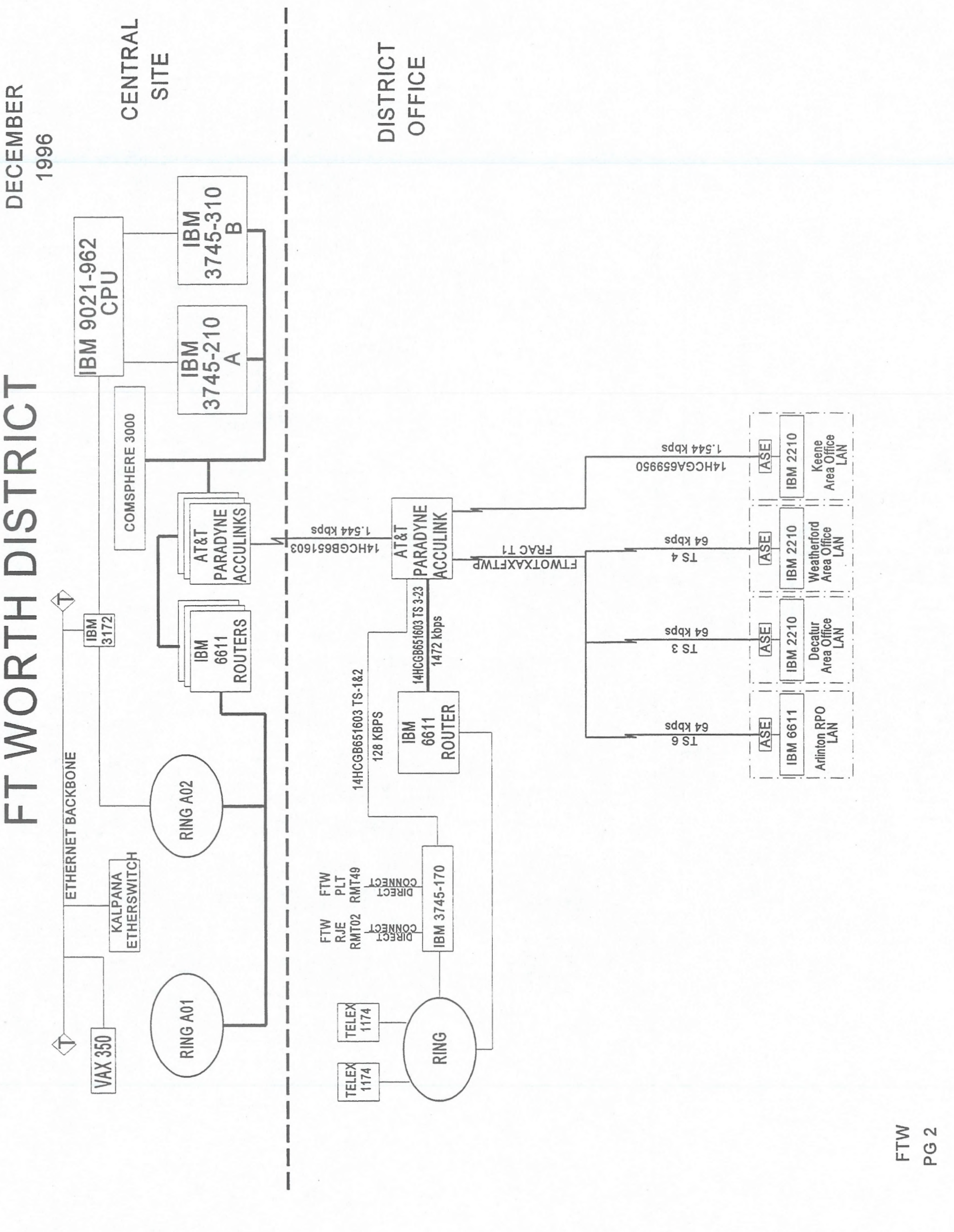
FTW PG 1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IBM 3172
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KALPANA ETHERSWITCH
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RING A02
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FTWOTXAXFTWP
FRAC T1
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1472 kbps
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128 KBPS
IBM 6611 ROUTER
IBM 3745-170
FTW RJE RMT02
DIRECT CONNECT
FTW PLT RMT49
DIRECT CONNECT
RING
TELEX 1174
TELEX 1174
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TS 3
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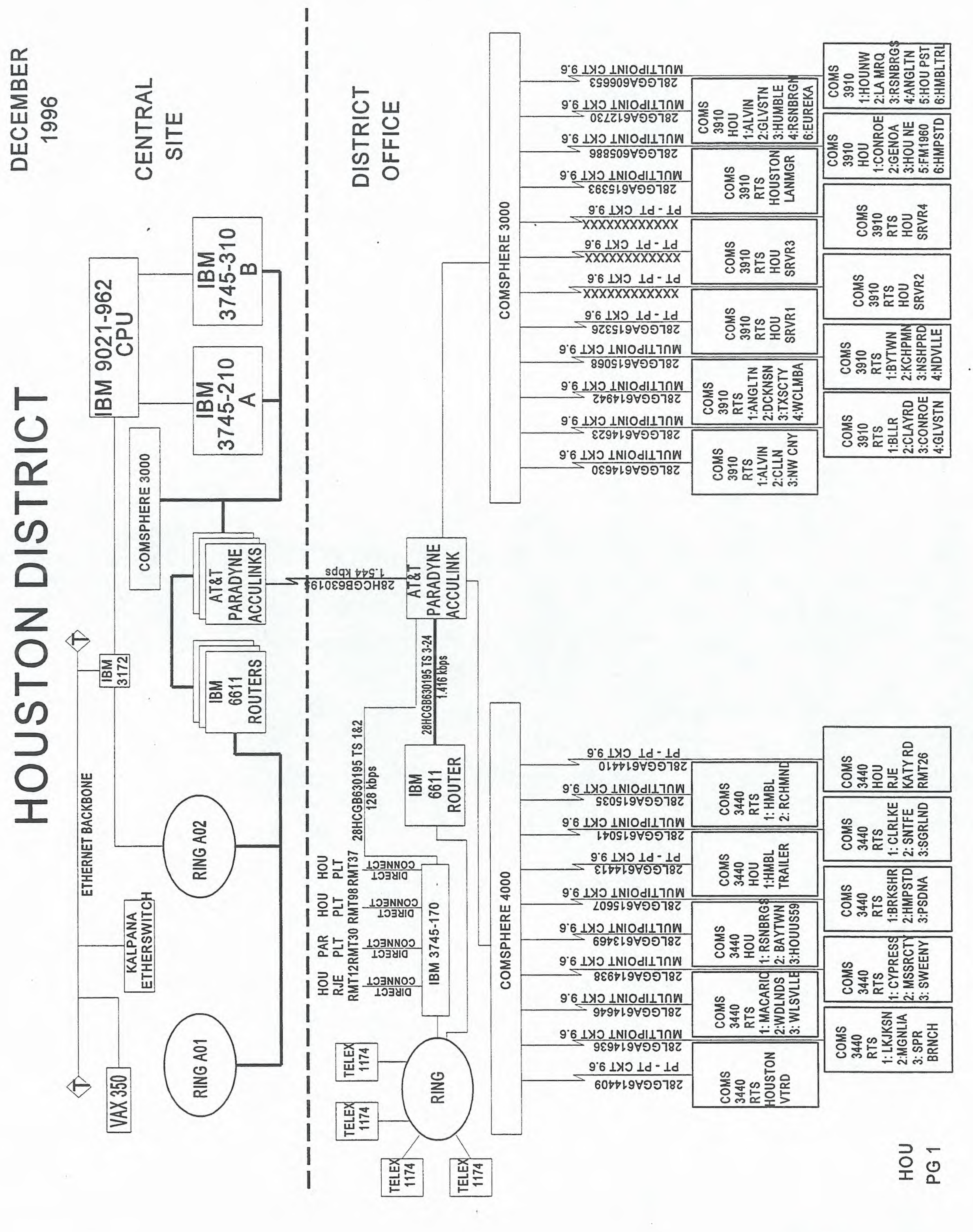
PG 2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KALPANA ETHERSWITCH
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RING A02
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28HCGB630195
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1.416 kbps
IBM 6611 ROUTER
28HCGB630195 TS 1&2
128 kbps
IBM 3745-170
DIRECT CONNECT
RING
TELEX 1174
COMSPHERE 4000
MULTIPOINT CKT 9.6
PT - PT CKT 9.6
COMS 3910 RTS HOU SRVR1
COMS 3910 RTS HOU SRVR2
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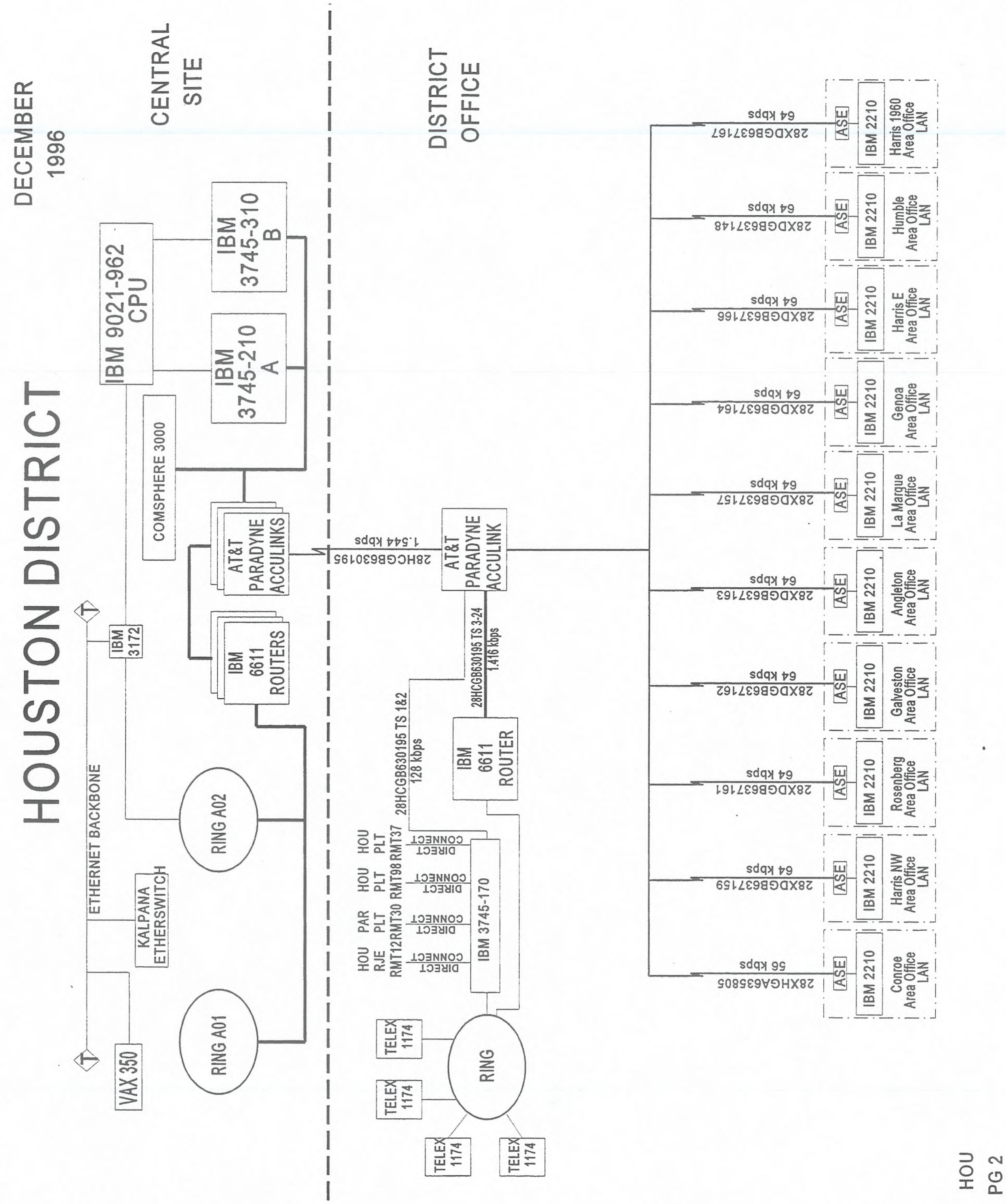
COMS 3440 RTS HOUSTON VTRD
HOU PG 1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PAR PLT RMT30
HOU PLT RMT98
HOU PLT RMT37
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Conroe Area Office LAN
Harris NW Area Office LAN
Rosenberg Area Office LAN
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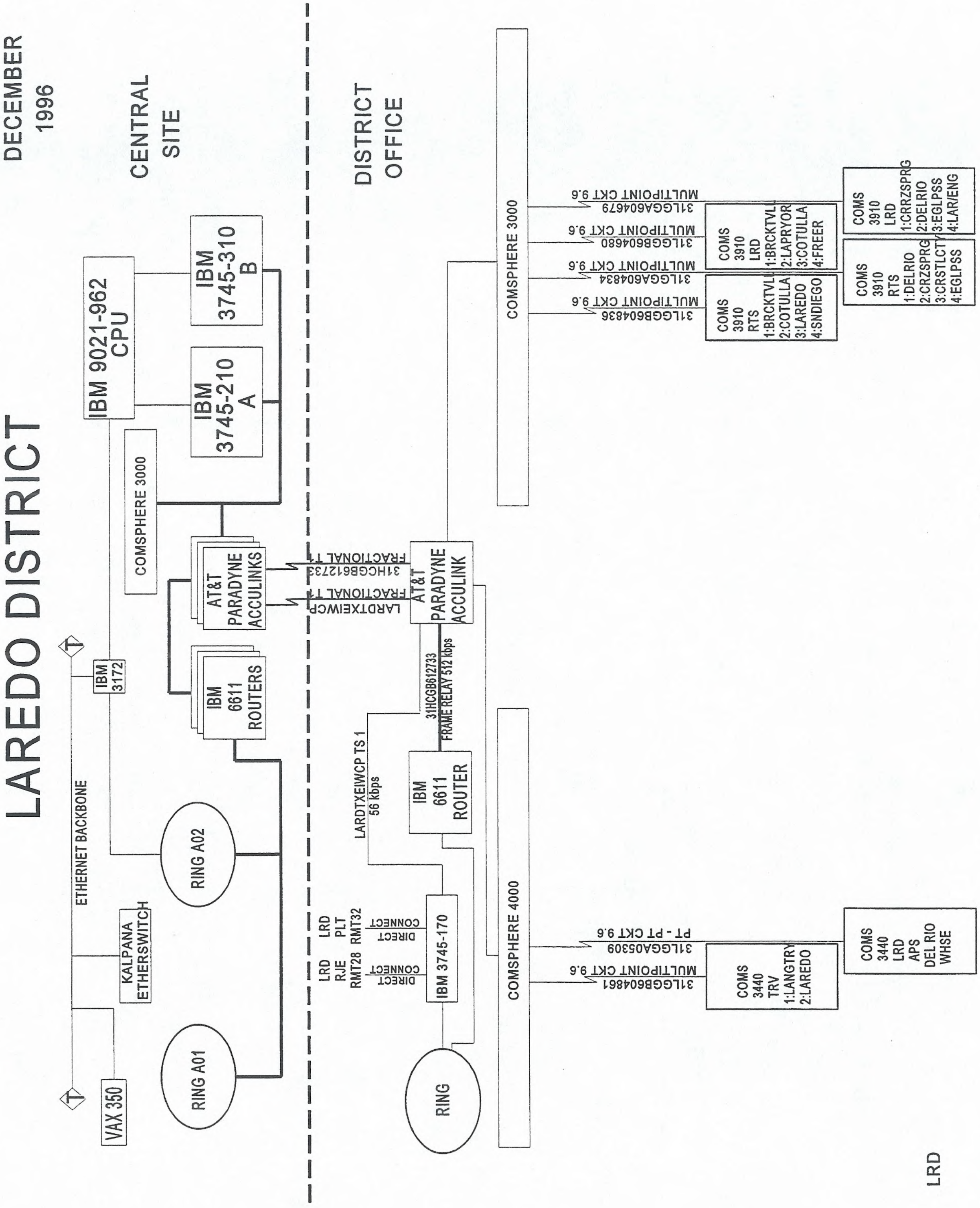
Genoa Area Office LAN
Harris E Area Office LAN
Humble Area Office LAN
Harris 1960 Area Office LAN
HOU PG 2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KALPANA ETHERSWITCH
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LARDTXEIWCP
AT&T PARADYNE ACCULINK
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IBM 3745-170
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LRD PLT RMT32
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DIRECT CONNECT
RING
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COMS 3910 RTS 1:DELRIO 2:CRZSPRG 3:CRSTLCTY 4:EGLPSS
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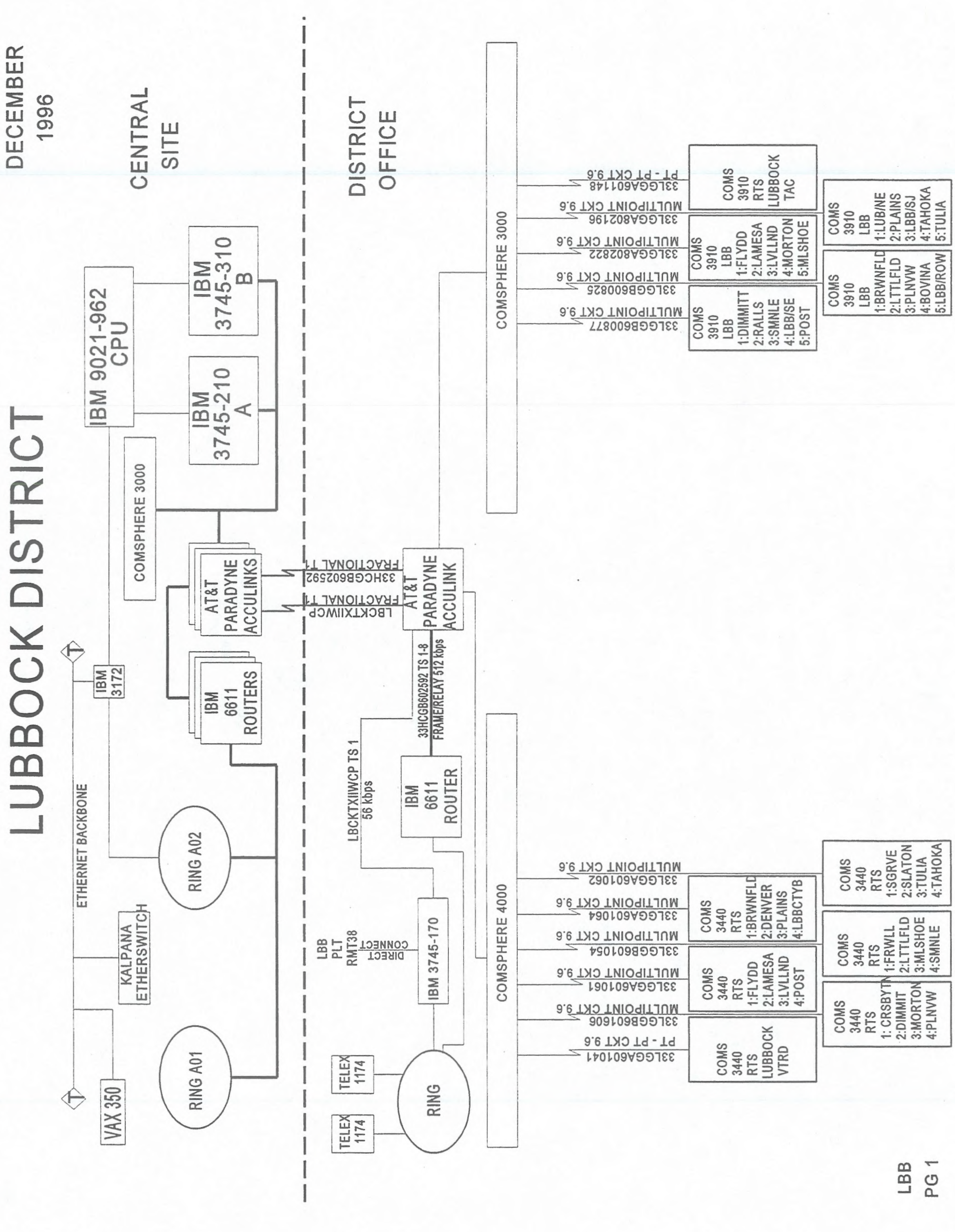
LRD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KALPANA ETHERSWITCH
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RING A02
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FRACTIONAL T1
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COMSPHERE 4000
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COMS 3910 RTS LUBBOCK TAC
COMS 3910 LBB 1:BRWNFLD 2:LTTLFLD 3:PLNVW 4:BOVINA 5:LBB/ROW
COMS 3910 LBB 1:LUB/NE 2:PLAINS 3:LBB/SJ 4:TAHOKA 5:TULIA
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33LGGA601064
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33LGGA601062
MULTIPOINT CKT 9.6
COMS 3440 RTS LUBBOCK VTRD
COMS 3440 RTS 1:FLYDD 2:LAMESA 3:LVLLND 4:POST
COMS 3440 RTS 1:BRWNFLD 2:DENVER 3:PLAINS 4:LBBCTYB
COMS 3440 RTS 1: CRSBYT 2:DIMMIT 3:MORTON 4:PLNVW
COMS 3440 RTS 1:FRWLL 2:LTTLFLD 3:MLSHOE 4:SMNLE
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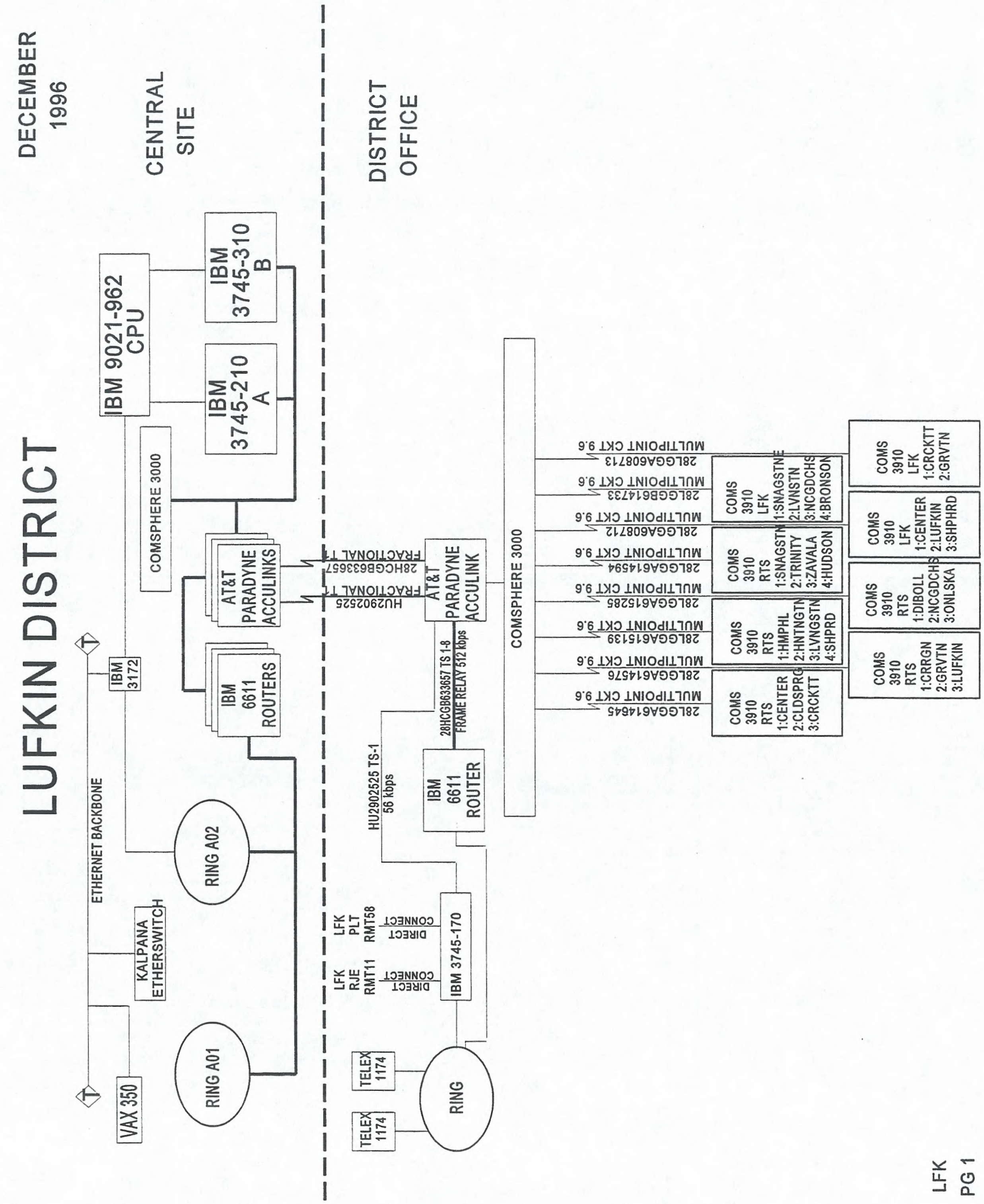
LBB PG 1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ETHERNET BACKBONE
KALPANA ETHERSWITCH
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LFK RJE RMT11
LFK PLT RMT58
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MULTIPOINT CKT 9.6
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COMS 3910 RTS 1:SNAGSTN 2:TRINITY 3:ZAVALA 4:HUDSON
COMS 3910 RTS 1:HMPHL 2:HNTNGTN 3:LVNGSTN 4:SHPRD
COMS 3910 RTS 1:CENTER 2:CLDSPRG 3:CRCKTT
COMS 3910 LFK 1:CRCKTT 2:GRVTN
COMS 3910 LFK 1:CENTER 2:LUFKIN 3:SHPHRD
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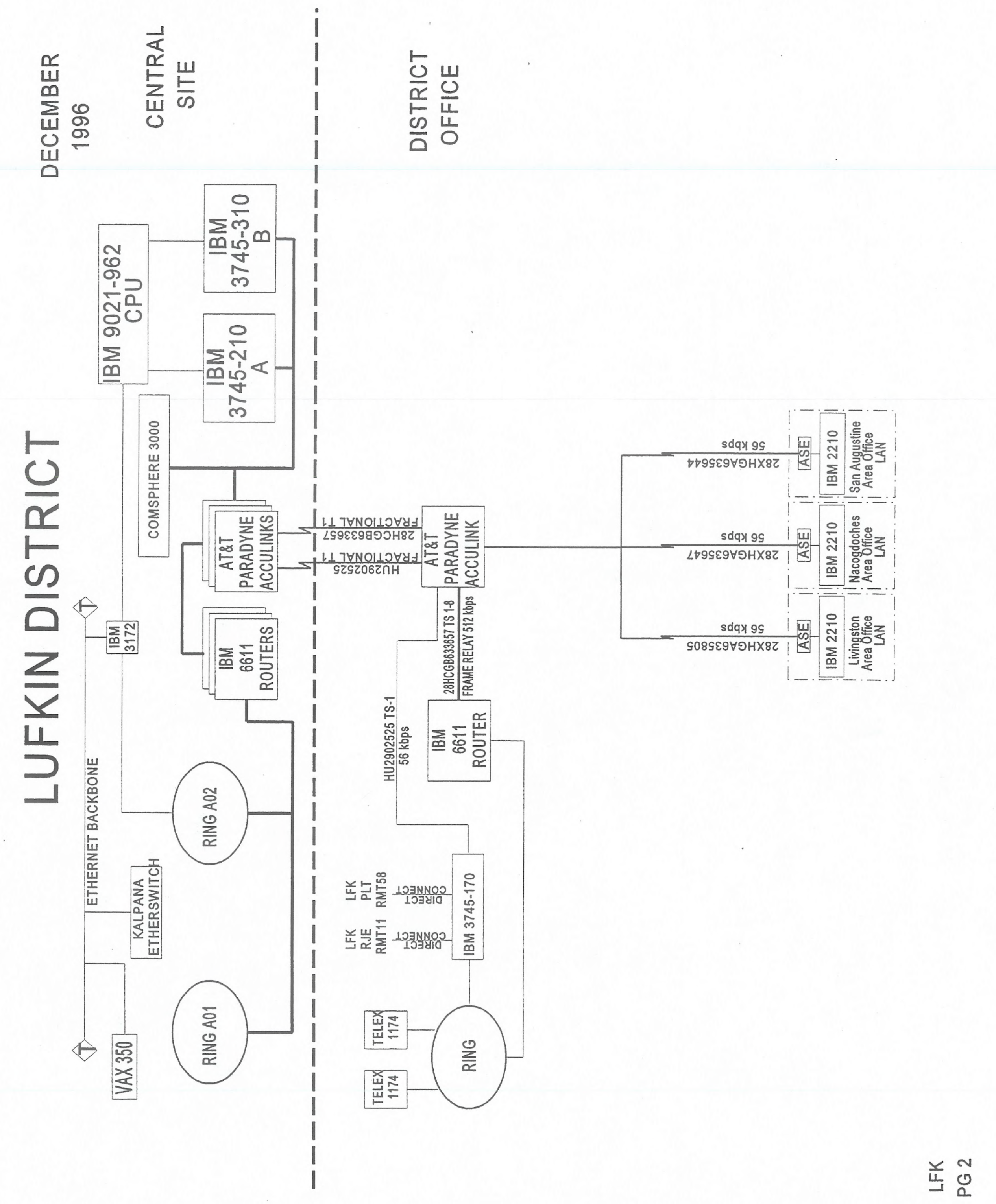
LFK PG 1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KALPANA ETHERSWITCH
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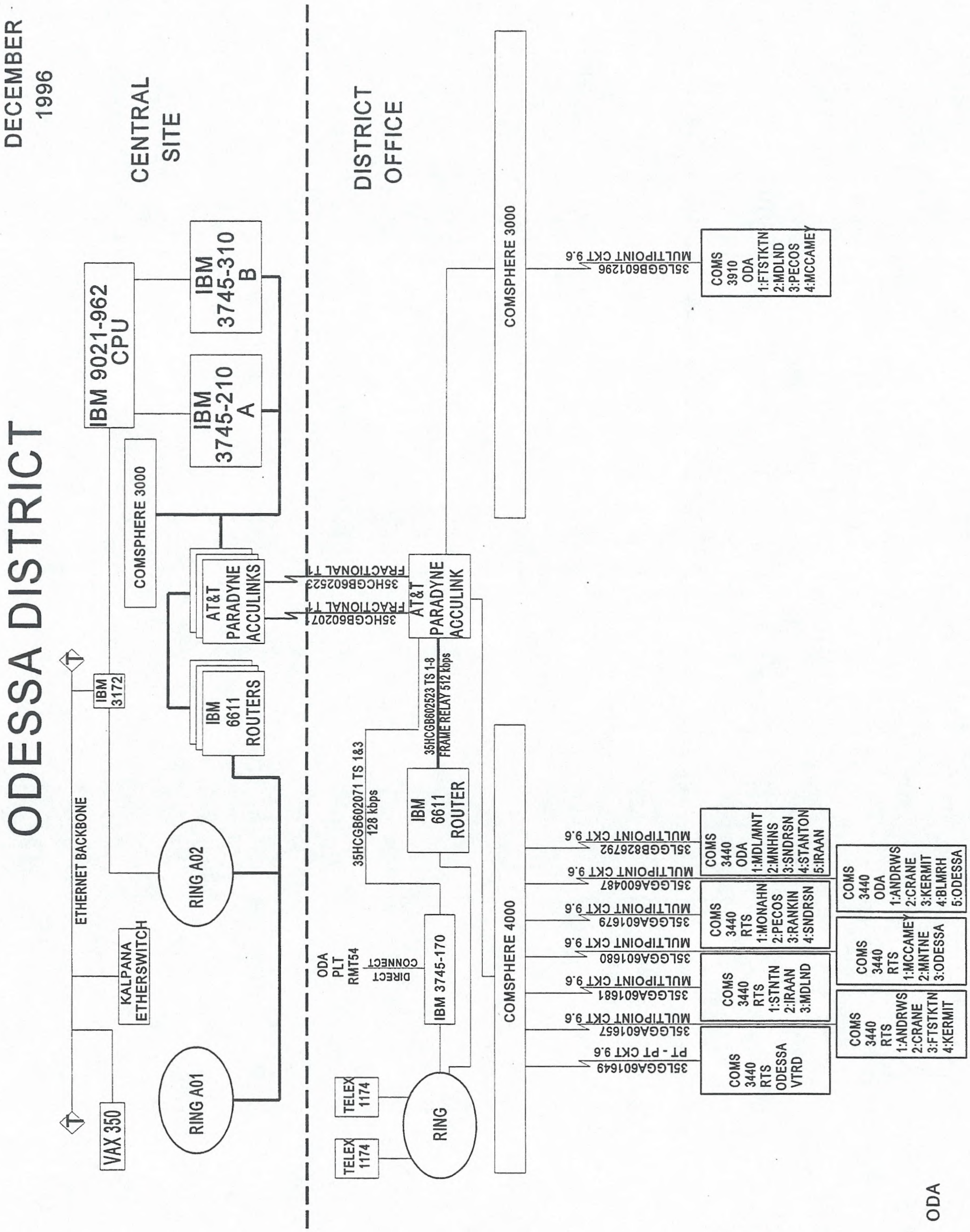
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KALPANA ETHERSWITCH
VAX 350
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RING A02
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35HCGB602071 FRACTIONAL T1
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35HCGB602071 TS 1&3 128 kbps
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ODA PLT RMT54
DIRECT CONNECT
IBM 3745-170
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TELEX 1174
RING
COMSPHERE 3000
COMSPHERE 4000
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COMS 3910 ODA 1:FTSTKTN 2:MDLND 3:PECOS 4:MCCAMEY
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COMS 3440 ODA 1:MDL/MNT 2:MNHNS 3:SNDRSN 4:STANTON 5:IRAAN
COMS 3440 RTS 1:MONAHN 2:PECOS 3:RANKIN 4:SNDRSN
COMS 3440 RTS 1:STNTN 2:IRAAN 3:MDLND
COMS 3440 RTS ODESSA VTRD
COMS 3440 ODA 1:ANDRWS 2:CRANE 3:KERMIT 4:BLMRH 5:ODESSA
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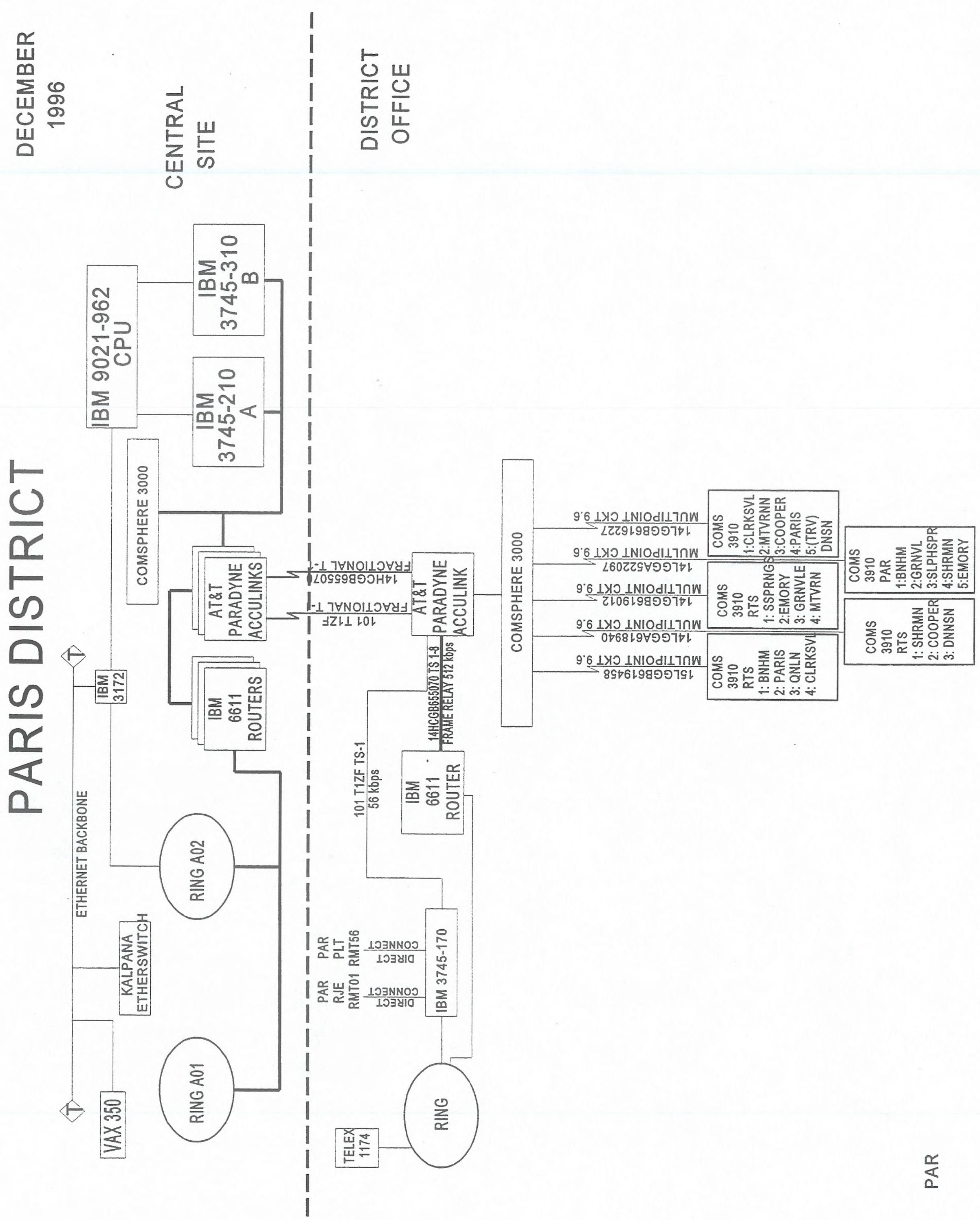
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IBM 3172
ETHERNET BACKBONE
KALPANA ETHERSWITCH
VAX 350
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RING A02
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101 T1ZF FRACTIONAL T-1
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COMS 3910 RTS 1: SSPRNGS 2:EMORY 3: GRNVLE 4: MTVRN
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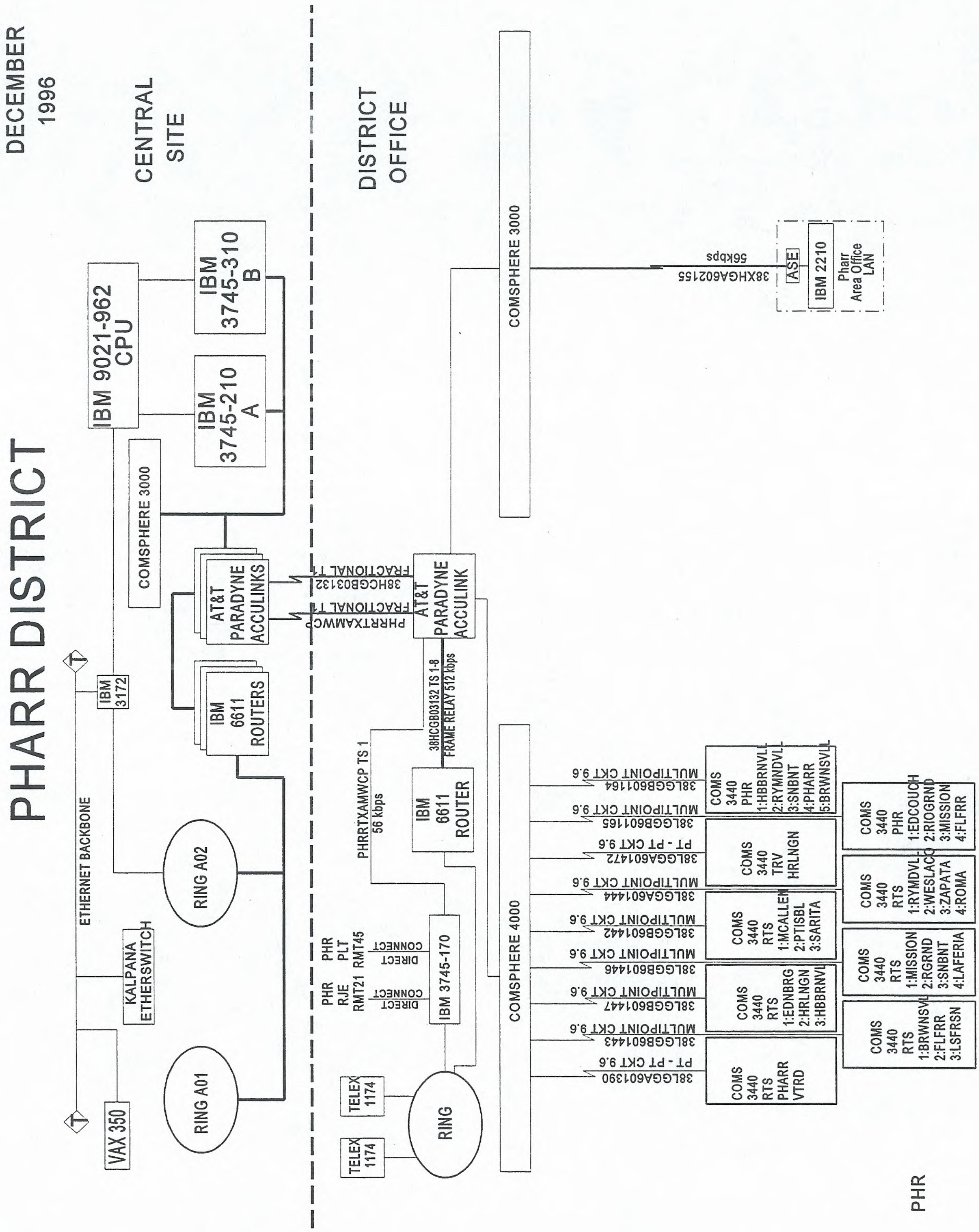
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ETHERNET BACKBONE
KALPANA ETHERSWITCH
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RING A01
VAX 350
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DIRECT CONNECT
DIRECT CONNECT
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COMS 3440 PHR 1:EDCOUCH 2:RIOGRND 3:MISSION 4:FLFRR
COMS 3440 RTS 1:RYMDVL 2:WESLACO 3:ZAPATA 4:ROMA
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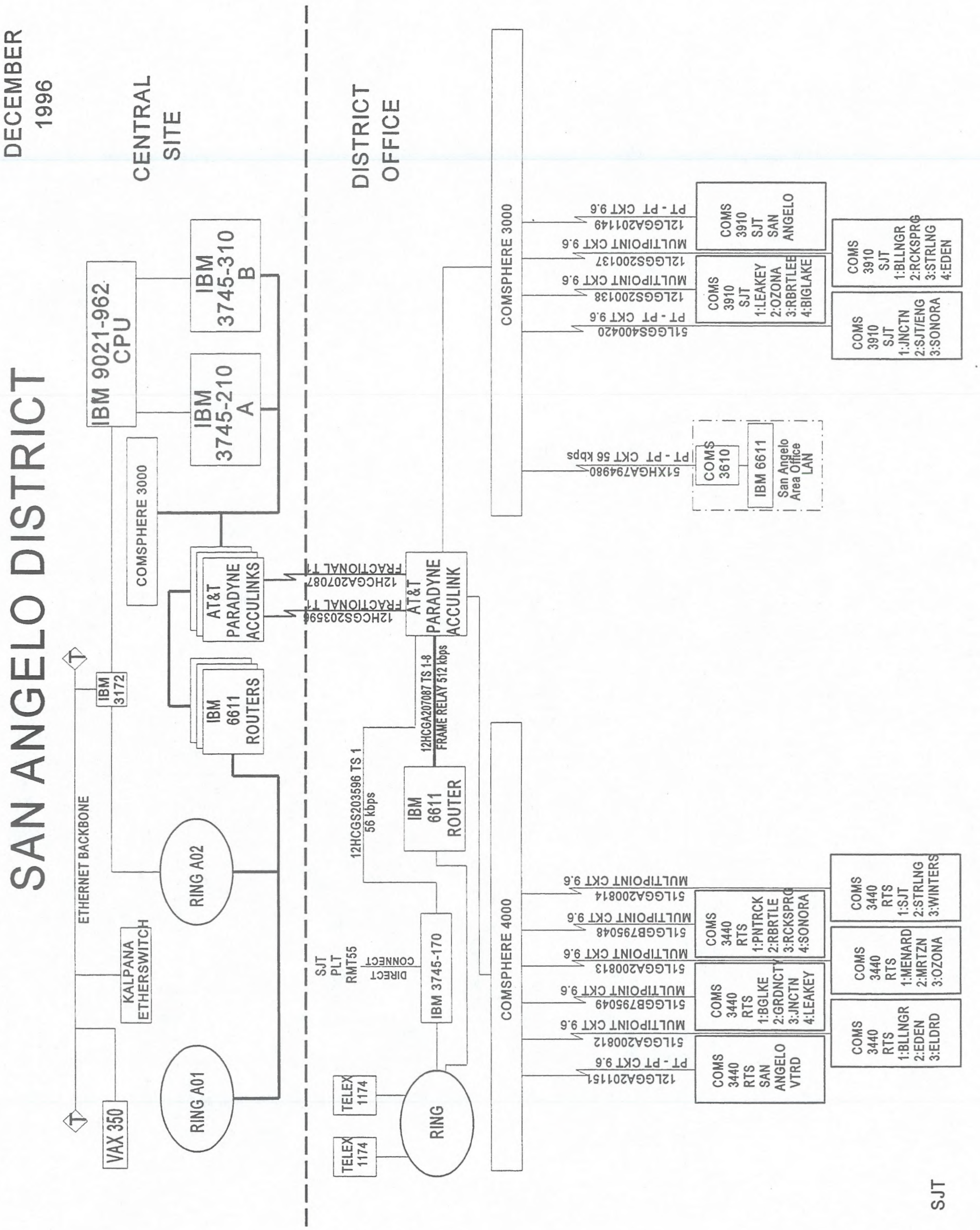
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COMS 3910 SJT 1:LEAKEY 2:OZONA 3:RBRTLEE 4:BIGLAKE
COMS 3910 SJT 1:BLLNGR 2:RCKSPRG 3:STRLNG 4:EDEN
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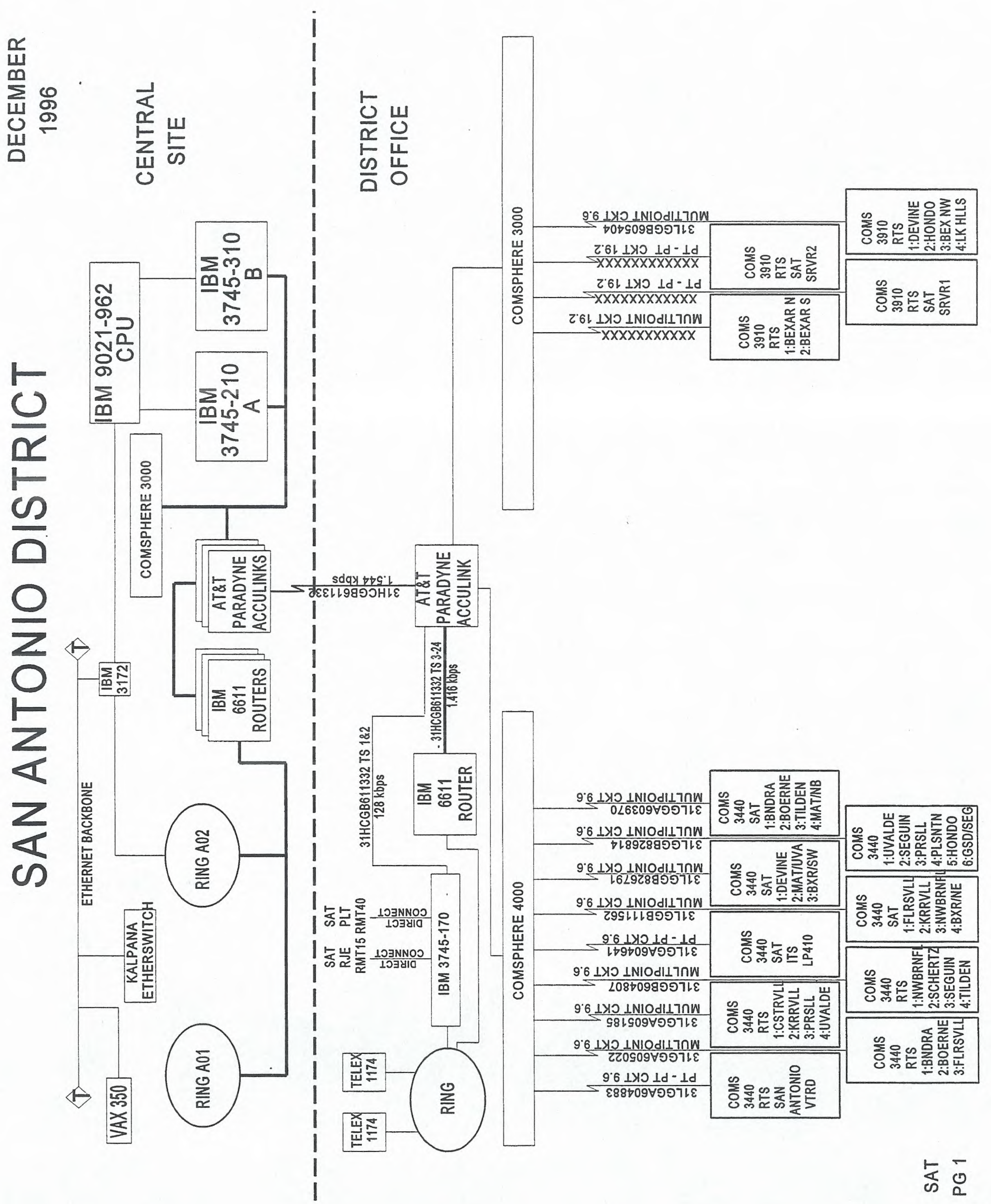
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COMS 3440 RTS SAN ANTONIO VTRD
COMS 3440 RTS 1:CSTRVLL 2:KRRVLL 3:PRSLL 4:UVALDE
COMS 3440 SAT ITS LP410
COMS 3440 SAT 1:DEVINE 2:MAT/UVA 3:BXR/SW
COMS 3440 SAT 1:BNDRA 2:BOERNE 3:TILDEN 4:MAT/NB
COMS 3440 RTS 1:BNDRA 2:BOERNE 3:FLRSVLL
COMS 3440 RTS 1:NWBRNFL 2:SCHERTZ 3:SEGUIN 4:TILDEN
COMS 3440 SAT 1:FLRSVLL 2:KRRVLL 3:NWBRNFL 4:BXR/NE
COMS 3440 1:UVALDE 2:SEGUIN 3:PRSLL 4:PLSNTN 5:HONDO 6:GSD/SEG
COMS 3910 RTS 1:BEXAR N 2:BEXAR S
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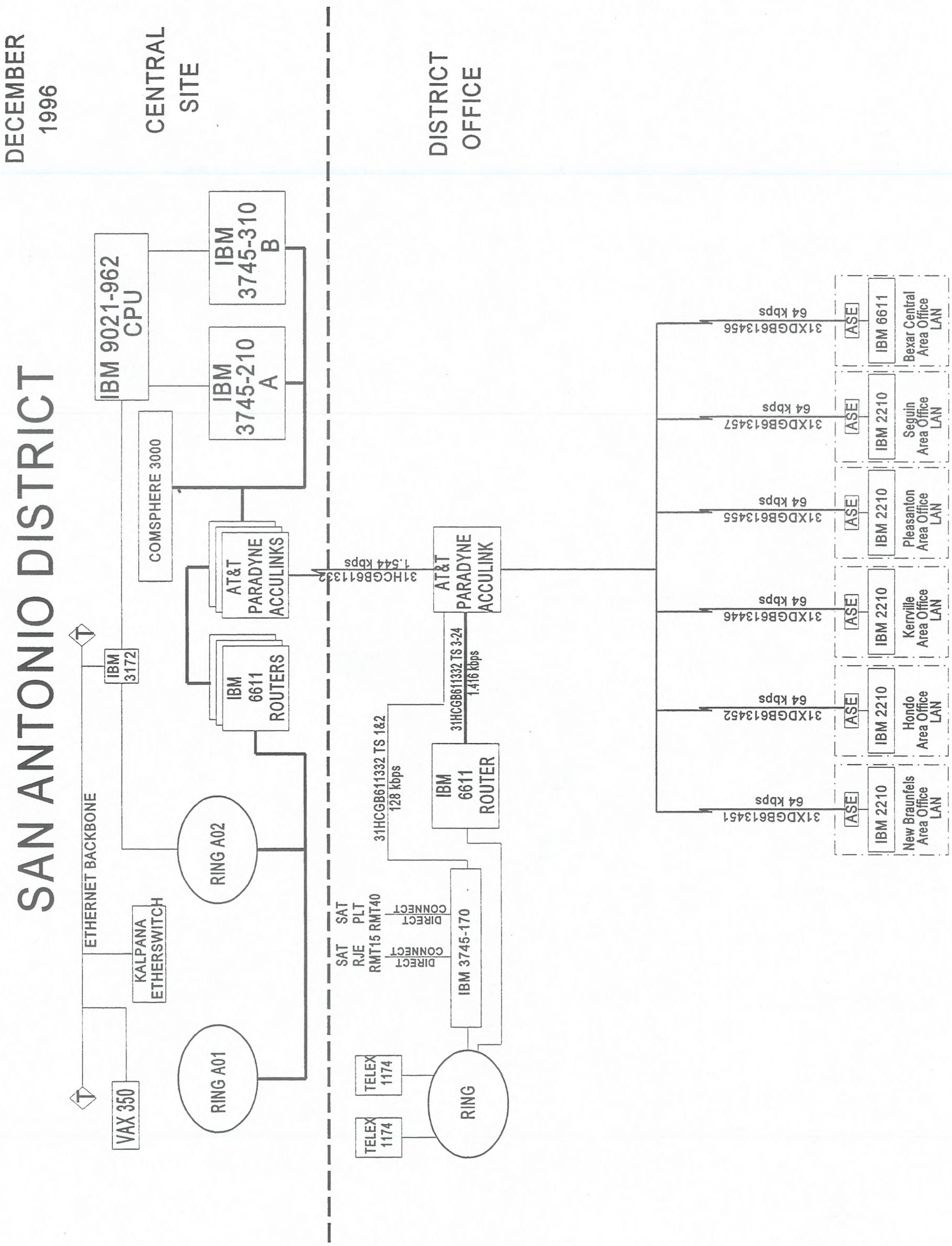
SAT PG 1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IBM 2210
Seguin Area Office LAN
31XDGB613455 64 kbps
ASE
IBM 2210
Pleasanton Area Office LAN
31XDGB613446 64 kbps
ASE
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Kerrville Area Office LAN
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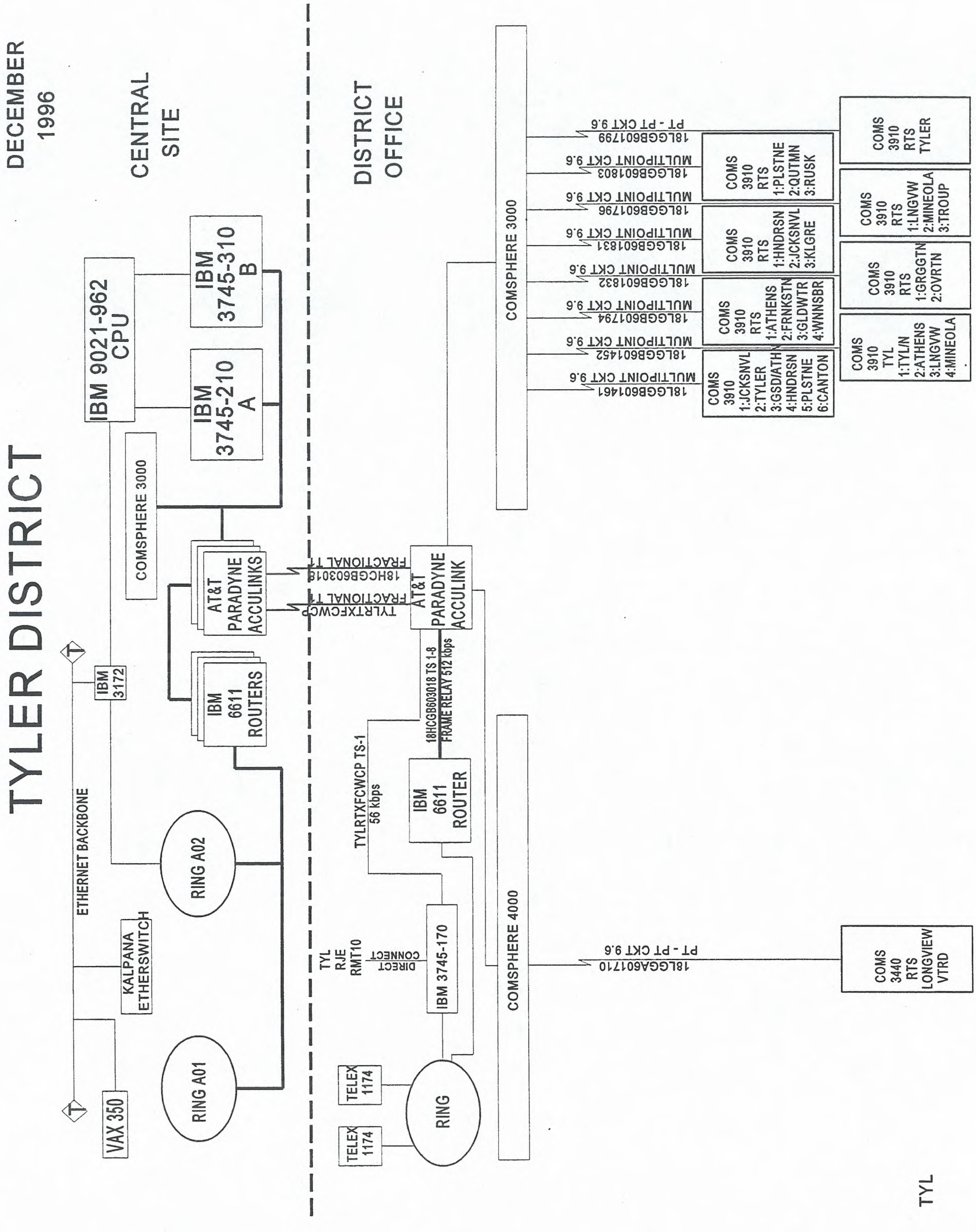
IBM 2210
New Braunfels Area Office LAN
SAT PG 2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DECEMBER 1996
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IBM 9021-962 CPU
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IBM 3745-310 B
COMSPHERE 3000
AT&T PARADYNE ACCULINKS
IBM 6611 ROUTERS
IBM 3172
ETHERNET BACKBONE
KALPANA ETHERSWITCH
VAX 350
RING A01
RING A02
18HCGB603018 FRACTIONAL T1
TYLRTXFCWCP FRACTIONAL T1
AT&T PARADYNE ACCULINK
18HCGB603018 TS 1-8 FRAME RELAY 512 kbps
TYLRTXFCWCP TS-1 56 kbps
IBM 6611 ROUTER
TYL RJE RMT10
DIRECT CONNECT
IBM 3745-170
TELEX 1174
TELEX 1174
RING
COMSPHERE 4000
COMSPHERE 3000
18LGGB601461 MULTIPOINT CKT 9.6
18LGGB601452 MULTIPOINT CKT 9.6
18LGGB601794 MULTIPOINT CKT 9.6
18LGGB601832 MULTIPOINT CKT 9.6
18LGGB601831 MULTIPOINT CKT 9.6
18LGGB601796 MULTIPOINT CKT 9.6
18LGGB601803 MULTIPOINT CKT 9.6
18LGGB601799 PT - PT CKT 9.6
COMS 3910 1:JCKSNVL 2:TYLER 3:GSD/ATH 4:HNDRSN 5:PLSTNE 6:CANTON
COMS 3910 RTS 1:ATHENS 2:FRNKSTN 3:GLDWTR 4:WNNSBR
COMS 3910 RTS 1:HNDRSN 2:JCKSNVL 3:KLGRE
COMS 3910 RTS 1:PLSTNE 2:QUTMN 3:RUSK
COMS 3910 TYL 1:TYL/N 2:ATHENS 3:LNGVW 4:MINEOLA
COMS 3910 RTS 1:GRGGTN 2:OVRTN
COMS 3910 RTS 1:LNGVW 2:MINEOLA 3:TROUP
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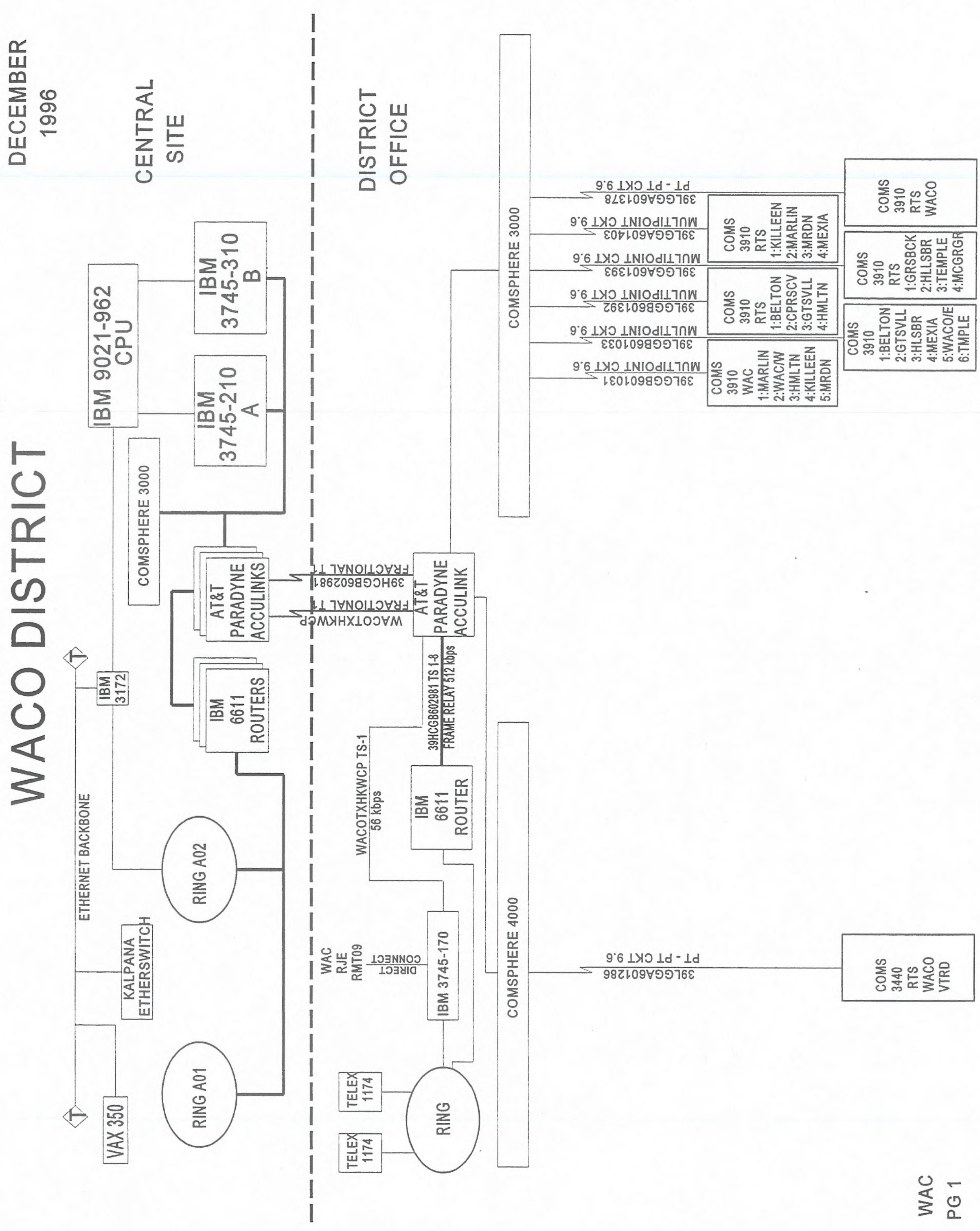
COMS 3440 RTS LONGVIEW VTRD
TYL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AT&T PARADYNE ACCULINKS
IBM 6611 ROUTERS
IBM 3172
ETHERNET BACKBONE
KALPANA ETHERSWITCH
RING A02
RING A01
VAX 350
FRACTIONAL T1
39HCGB602981
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AT&T PARADYNE ACCULINK
39HCGB602981 TS 1-8
FRAME RELAY 512 kbps
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56 kbps
IBM 6611 ROUTER
WAC RJE RMT09
DIRECT CONNECT
IBM 3745-170
TELEX 1174
TELEX 1174
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COMSPHERE 4000
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39LGGB601031
MULTIPOINT CKT 9.6
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PT - PT CKT 9.6
COMS 3910 WAC 1:MARLIN 2:WAC/W 3:HMLTN 4:KILLEEN 5:MRDN
COMS 3910 RTS 1:BELTON 2:CPRSCV 3:GTSVLL 4:HMLTN
COMS 3910 RTS 1:KILLEEN 2:MARLIN 3:MRDN 4:MEXIA
COMS 3910 1:BELTON 2:GTSVLL 3:HLSBR 4:MEXIA 5:WACO/E 6:TMPLE
COMS 3910 RTS 1:GRSBCK 2:HLLSBR 3:TEMPLE 4:MCGRGR
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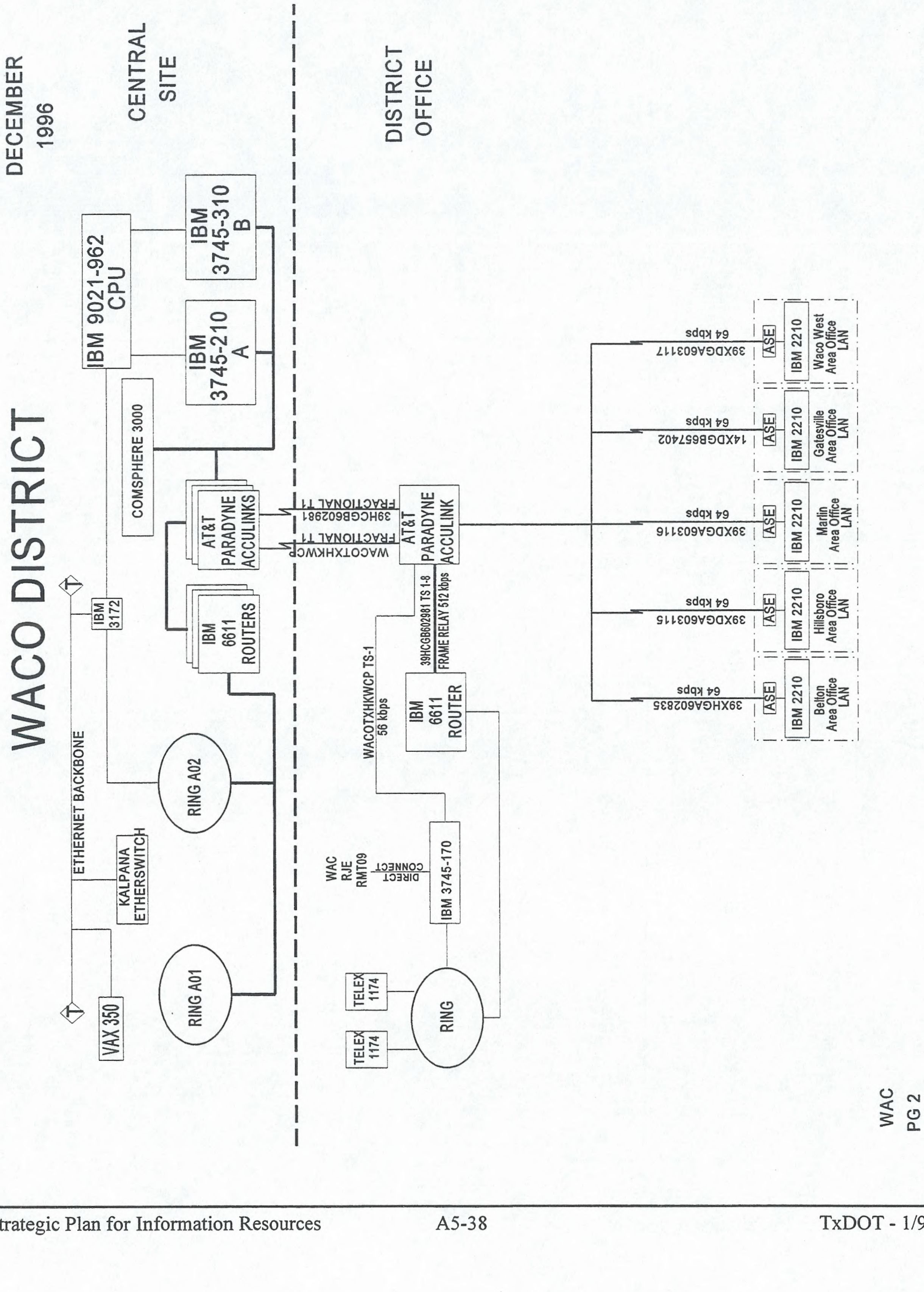
WAC PG 1


WACO DISTRICT
DECEMBER 1996
CENTRAL SITE
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IBM 9021-962 CPU
IBM 3745-210 A
IBM 3745-310 B
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AT&T PARADYNE ACCULINKS
IBM 6611 ROUTERS
IBM 3172
ETHERNET BACKBONE
KALPANA ETHERSWITCH
VAX 350
RING A02
RING A01
FRACTIONAL T1 39HCGB602981
FRACTIONAL T1 WACOTXHKWCP
AT&T PARADYNE ACCULINK
39HCGB602981 TS 1-8 FRAME RELAY 512 kbps
WACOTXHKWCP TS-1 56 kbps
IBM 6611 ROUTER
WAC RJE RMT09
DIRECT CONNECT
IBM 3745-170
TELEX 1174
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RING
39XDGA603117 64 kbps
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ASE
IBM 2210
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Marlin Area Office LAN
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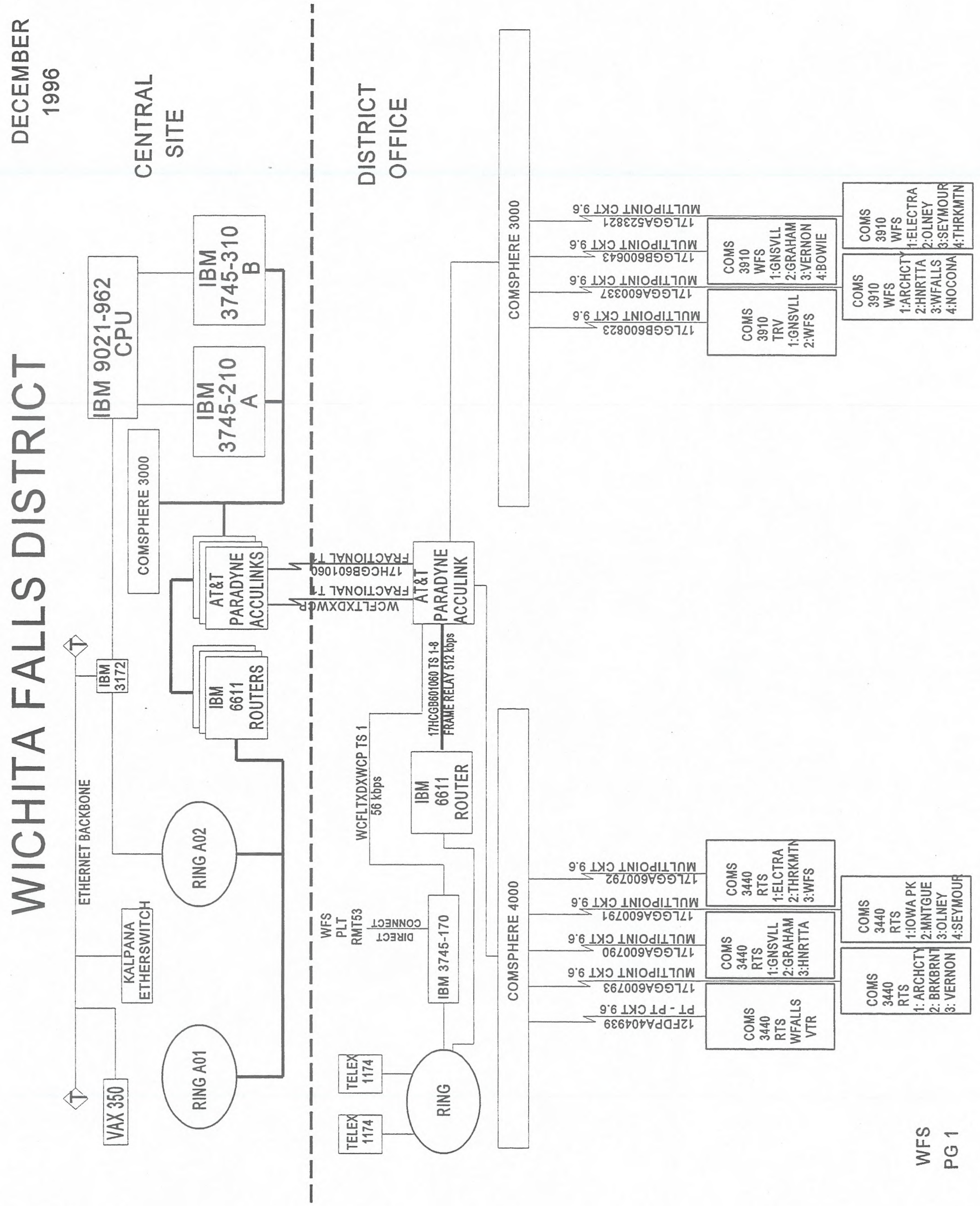
Belton Area Office LAN
WAC PG 2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DECEMBER 1996
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IBM 3745-310 B
COMSPHERE 3000
AT&T PARADYNE ACCULINKS
IBM 6611 ROUTERS
IBM 3172
ETHERNET BACKBONE
KALPANA ETHERSWITCH
VAX 350
RING A01
RING A02
FRACTIONAL T1
17HCGB601060
FRACTIONAL T1
WCFLTXDXWCR
AT&T PARADYNE ACCULINK
17HCGB601060 TS 1-8
FRAME RELAY 512 kbps
WCFLTXDXWCP TS 1
56 kbps
IBM 6611 ROUTER
WFS PLT RMT53
DIRECT CONNECT
IBM 3745-170
TELEX 1174
TELEX 1174
RING
COMSPHERE 3000
COMSPHERE 4000
MULTIPOINT CKT 9.6
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MULTIPOINT CKT 9.6
17LGGB600643
MULTIPOINT CKT 9.6
17LGGA600337
MULTIPOINT CKT 9.6
17LGGB600823
COMS 3910 WFS 1:ELECTRA 2:OLNEY 3:SEYMOUR 4:THRKMTN
COMS 3910 WFS 1:GNSVLL 2:GRAHAM 3:VERNON 4:BOWIE
COMS 3910 WFS 1:ARCHCTY 2:HNRTTA 3:WFALLS 4:NOCONA
COMS 3910 TRV 1:GNSVLL 2:WFS
MULTIPOINT CKT 9.6
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COMS 3440 RTS 1:IOWA PK 2:MNTGUE 3:OLNEY 4:SEYMOUR
COMS 3440 RTS 1:GNSVLL 2:GRAHAM 3:HNRTTA
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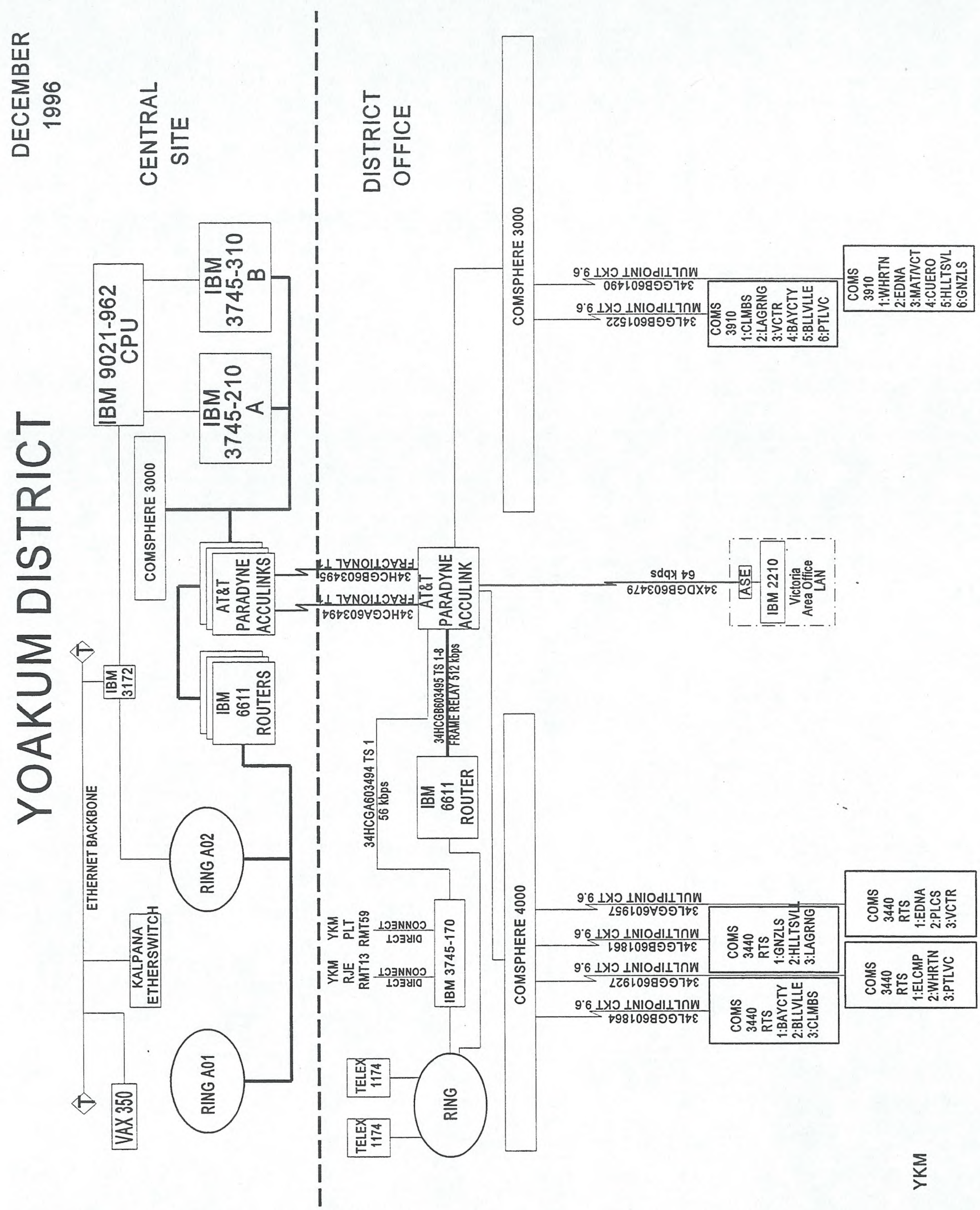
COMS 3440 RTS WFALLS VTR
WFS PG 1


YOAKUM DISTRICT
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CENTRAL SITE
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IBM 3745-310 B
COMSPHERE 3000
AT&T PARADYNE ACCULINKS
IBM 6611 ROUTERS
IBM 3172
ETHERNET BACKBONE
KALPANA ETHERSWITCH
VAX 350
RING A01
RING A02
34HCGA603494 FRACTIONAL T1
34HCGB603495 FRACTIONAL T1
AT&T PARADYNE ACCULINK
34HCGB603495 TS 1-8 FRAME RELAY 512 kbps
34HCGA603494 TS 1 56 kbps
IBM 6611 ROUTER
IBM 3745-170
DIRECT CONNECT
YKM RJE RMT13
YKM PLT RMT59
TELEX 1174
TELEX 1174
RING
34XDGB603479 64 kbps
ASE
IBM 2210
Victoria Area Office LAN
COMSPHERE 3000
34LGGB601522 MULTIPOINT CKT 9.6
34LGGB601490 MULTIPOINT CKT 9.6
COMS 3910 1:CLMBS 2:LAGRNG 3:VCTR 4:BAYCTY 5:BLLVLLE 6:PTLVC
COMS 3910 1:WHRTN 2:EDNA 3:MATVCT 4:CUERO 5:HLLTSVL 6:GNZLS
COMSPHERE 4000
34LGGA601957 MULTIPOINT CKT 9.6
34LGGB601861 MULTIPOINT CKT 9.6
34LGGB601927 MULTIPOINT CKT 9.6
34LGGB601864 MULTIPOINT CKT 9.6
COMS 3440 RTS 1:GNZLS 2:HLLTSVL 3:LAGRNG
COMS 3440 RTS 1:BAYCTY 2:BLLVLLE 3:CLMBS
COMS 3440 RTS 1:EDNA 2:PLCS 3:VCTR
COMS 3440 RTS 1:ELCMP 2:WHRTN 3:PTLVC
YKM