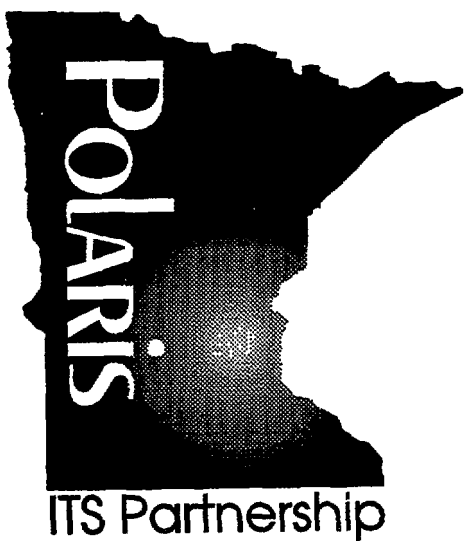
Minnesota Department of Transportation Agreement Number: 73807P

Minnesota Intelligent Transportation Systems

ITS System Specification



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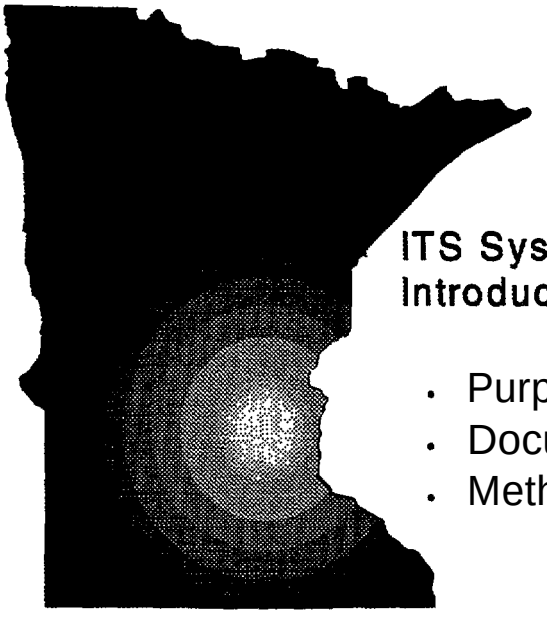

ITS System Specification
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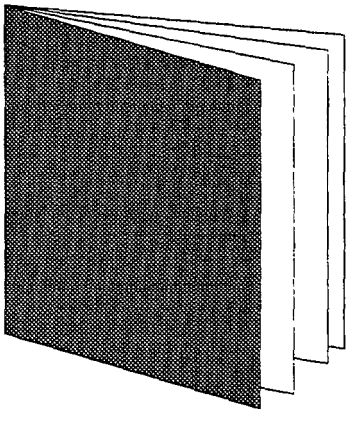
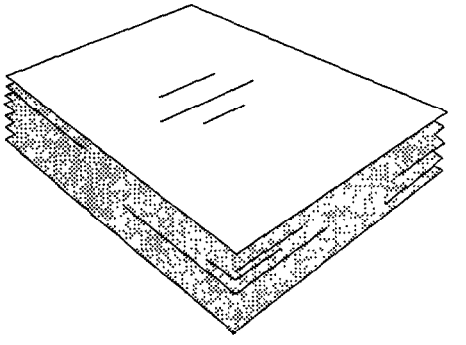




1 Introduction

The objective of the Polaris Project is to define an Intelligent Transportation Systems (ITS) architecture for the state of Minnesota. An architecture is a framework that defines how multiple ITS Components interrelate and contribute to the overall ITS objectives and requirements. Minnesota ITS Components include things like Freeway Traffic Management Center, Regional ITS Management Center, Emergency Vehicle, Freeway Roadside Equipment, etc.

The Polaris architecture provides multiple benefits including a) definition and optimization of the location of system functions, b) identification of critical interfaces, c) illustration of how associated systems can be integrated to share resources and information, and d) identifying where opportunities exist to establish standards for communications and physical components so that interoperability can be maintained as the system evolves to incorporate new capabilities and technologies.

The Minnesota Statewide ITS Architecture incorporates National ITS Architecture requirements with the prioritized wants and needs of the state's transportation users and stakeholders, as well as the Minnesota As-Isinfrastructure. The following project deliverables document the information collected and the resulting architecture for the Polaris Project:

Minnesota Traveler Wants and Needs - documents the transportation wants and needs information collected from Minnesota residents during 10 end user sessions held across the state.

Minnesota Transportation Agency Wants and Needs - documents the wants and needs information collected from Minnesota stakeholder institutions during 7 institutional sessions held across the state.

ITS Architecture Wants and Needs Analysis - uses the information from the ***Minnesota Traveler and Transportation Agency Wants and Needs*** documents to establish and prioritize ITS service requirements.

Statewide ITS As-Is Agency Reports for Minnesota - documents information about existing transportation systems that establish ***the starting*** point for the ***ITS Architecture Implementation Plan*** and physical architecture trade-offs.

ITS System Specification - identifies the functions, interfaces and requirements associated with the Minnesota ITS User Services and Components. Sources of requirements include the ITS National Architecture user services, end-user and institutional wants and needs, and as-is infrastructure constraints.

ITS Component Specification - identifies the physical interface and requirements allocation for each Minnesota ITS component.

ITS Architecture Implementation Plan (future document) - describes the recommended ITS deployment strategy for future state initiatives (e.g., Orion Project).

1.1 Purpose

The Minnesota Statewide ITS architecture was developed to help the various Minnesota transportation related agencies participate as a whole in deploying futuretransportation systems. The goals associated with this architecture include:

- Deliver a system that meets end-user and institutional needs
- Deploy projects efficiently by reducing duplication of effort among agencies
- Provide compatibility with transportation equipment and hardware that is used nationwide

To achieve these goals, the Minnesota Statewide ITS architecture was developed in such a manner that it:

- Incorporates what the traveler and institutional representatives stated they wanted and needed. .
- Documents the system level requirements that transportation system development engineers and public/private agency representatives can use to define new projects.
- Defines the component level requirements and interface baseline that serves as a basis for evaluation and control of system design changes.
- Provides requirements traceability to enable the transportation system engineer to accurately assess the impact of system enhancements and new technology, before deciding to implement a change.

1.1.1 Scope

This System Specification defines a requirements baseline for a Minnesota ITS Architecture and can apply to all new ITS infrastructure, products, and equipment packages to be deployed across Minnesota.

1.2 Document Organization

This system specification documents the Polaris Architecture from the perspective of functional, physical, and requirements views.

The main body of the system specification describes the functional and physical architecture views for the Minnesota service categories. The functional views describe the-functions and subfunctions performed by the service, and graphically shows how the services and functions interface with other services and functions. Sample scenarios are included to describe how key service functions operate. The physical view describes how the service functions are allocated to the various physical components, and shows how the components interface with each other.

Appendix A describes the As-Is and physical architecture candidates that were evaluated and includes the supporting information used in selecting an architecture for the service. Appendices B, C, and D provide detailed text information about service requirements, service function inputs and outputs, and service physical interfaces.

1.2.1 Applicable Documents

1.2.1.1 Government Publications

> "Intelligent Vehicle-Highway System (IVHS) Phase II User Service Requirements" DTFH61-95C-00038 Attachment 6, July 4, 1994

1.2.1.2 Other References

> ITS Architecture - Physical Architecture, June 1995, LFS/Rockwell
> ITS Architecture - Mission Definition, June 1995, LFS/Rockwell
> ITS Architecture Browsing Site - www.rockwell.com/~jblarson/homepage.html
> Minnesota Guidestar Strategic Plan, June 1994, Minnesota Guidestar

1.3 Methodology

This System Specification documents the ITS architecture and requirements baseline for the state of Minnesota that resulted from the following process:

1. Requirements were extracted from the Intelligent Vehicle-Highway System (IVHS) Phase II User Service Requirements, *the Minnesota Traveler* and *Transportation Agency Wants and Needs* documents, and the Minnesota Guidestar Strategic Plan. To maximize the benefit of this task for Minnesota, requirements were extracted from the 21 highest priority IVHS user service groups listed in Table I below. This activity produced a set of requirements were sometimes redundant across multiple IVHS User Service groups, and were written at different levels of detail.

2. The extracted requirements were then grouped into 11 Minnesota Service categories to reduce requirements redundancy and to make the ITS architecture easier for Minnesota transportation agency users to understand and apply. A functional architecture with data flows for each of the 11 services was then synthesized from these requirements. The Minnesota services did not include any Commercial Vehicle Operations (CVO) services because Minnesota is using Commercial Vehicle Information Systems and Networks (CVISN) for their CVO architecture. Minnesota services also did not include Travel Demand Management at this time.

3. A set of top-level testable system requirements was generated from the extracted requirements to quantify what each of the high priority services should do. Traceability to the original requirement sources was captured to support future maintenance of the architecture.

4. A physical architecture was developed to explain the architectural interfaces and requirements to public and private sector individuals that will be implementing the architecture. The physical architecture is described for components that are tangible real world entities. These components include Centers (e.g.; Freeway Traffic Management Center, Traffic Signal Centers, Dispatch Center), Inter-jurisdictional Systems that operate across multiple agencies, Roadside Equipment (e.g.; Freeway Roadside Equipment, Toll Collection Roadside Equipment, Parking Management Roadside Equipment), Vehicles (e.g.; Basic Vehicle, Transit Vehicle, Emergency Vehicle) and User Interface Equipment (e.g.; telephone, computer, pager, kiosk).

   Physical Architecture development for each service began by analyzing the Minnesota ITS As-Is Baseline information in conjunction with the testable service requirements to show how multiple Minnesota components could interact with each other to meet the service requirements. An As-Is physical architecture and several physical architectural candidates for each of the high priority Minnesota ITS Services were developed as a part of this activity.

5. The physical architectures were reviewed with working teams that represented the various agencies that are involved in tbe architecture. Advantages and disadvantages for each architectural candidate as well as evaluation criteria were collected from the working teams. A trade-off analysis was performed on the architecture candidates to select the best physical architecture for the service.

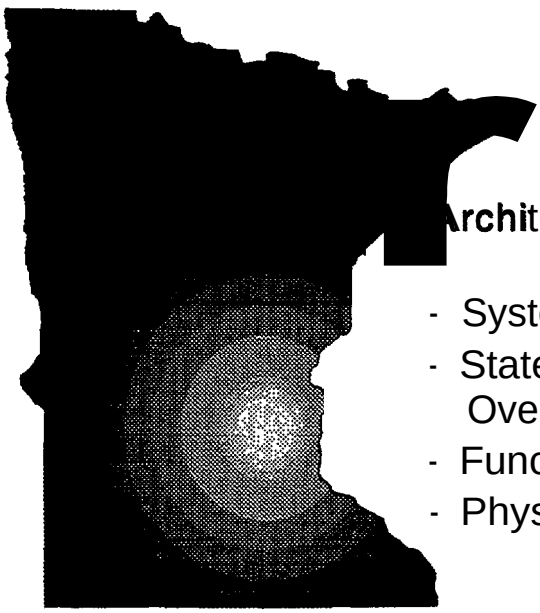
6. System requirements and data flows were then allocated to the components based on the selected physical architecture for each service. The result of this activity documented the component interfaces and requirements needed to implement the Minnesota ITS architecture.

Table I. User Service Mapping

IVHS User Service	Associated Minnesota User Services
Pre-Trip Travel Information	▸ Ride Matching and Reservation Travel Conditions Information ▸ Trip Planning and Directions ▸ Traveler Services Information
En-Route Driver Information	▸ Travel Conditions Information ▸ Trip Planning and Directions
Route Guidance	▸ Travel Conditions Information ▸ Trip Planning and Directions
Ride Matching and Reservation	▸ Account Management ▸ Ride Matching and Reservation
Traveler Services Information	▸ Traveler Services Information
Traffic Control	▸ Traffic Control
Incident Management	▸ Incident Management ▸ Traffic Control ▸ Travel Conditions Information
Travel Demand Management	▸ (future service)
Public Transportation Management	▸ Account Management ▸ Incident Management ▸ Maintenance ▸ Public Travel Security ▸ Public Transit Fleet Management ▸ Trip Planning and Directions
En-Route Transit Information	▸ Travel Conditions Information ▸ Public Transit Fleet Management ▸ Trip Planning and Directions
Personalized Public Transit	▸ Account Management ▸ Ride Matching and Reservation ▸ Public Transit Fleet Management
Public Travel Security	▸ Account Management ▸ Incident Management ▸ Public Travel Security ▸ Public Transit Fleet Management

IVHS User Service	Associated Minnesota User Services
Electronic Payment Services	> Account Management > Public Travel Security > Ride Matching and Reservation > Public Transit Fleet Management
Commercial Vehicle Electronic Clearance	> Commercial Vehicle Information Systems and Networks > Account Management
Automated Roadside Safety Inspection	> Commercial Vehicle Information Systems and Networks
On-Board Safety Monitoring	> Commercial Vehicle Information Systems and Networks
Commercial Vehicle Administrative Processes	> Commercial Vehicle Information Systems and Networks > Account Management
Hazardous Material Incident Response	> Commercial Vehicle Information Systems and Networks > Incident Management
Commercial Fleet Management	> Commercial Vehicle Information Systems and Networks
Emergency Notification and Personal Security	> Incident Management
Emergency Vehicle Management	> Incident Management > Traffic Control > Travel Conditions Information > Trip Planning and Directions

2 Architecture Overview



Architecture Overview:

- System Boundary
- Statewide Architectural Overview
- Functional Architectural View
- Physical Architecture View

2 Architecture Overview

An ITS Architecture is a framework that describes "what" ITS features are needed and "how" they are implemented. The functional view of the architecture captures "what" is needed by describing the relationships between Minnesota services, and the requirements associated with each service. The physical view of the architecture captures "how" multiple Minnesota components cooperate to provide the ITS features identified in the functional architecture.

Functional and service interface diagrams along with summary text are used to describe functional architecture in the body of this system specification. Detailed functional requirements and interfaces are listed by Minnesota service in the system specification appendices.

A physical interface diagram and summary text is used to describe the target physical architecture in the body of this system specification. Detailed interfaces associated with the physical interface diagram are listed by service in a system specification appendix. The detailed functional requirements and interfaces that were allocated to each component, are listed by component in an appendix to the component specification.

2.1 System Boundary

Figure 1, System Context Diagram, shows a top level view of how the Minnesota ITS services and components interface with the external environment. The dotted line represents the system boundary for the lTS services and components that are contained within Polaris, and the smaller boxes represent major external system interfaces.

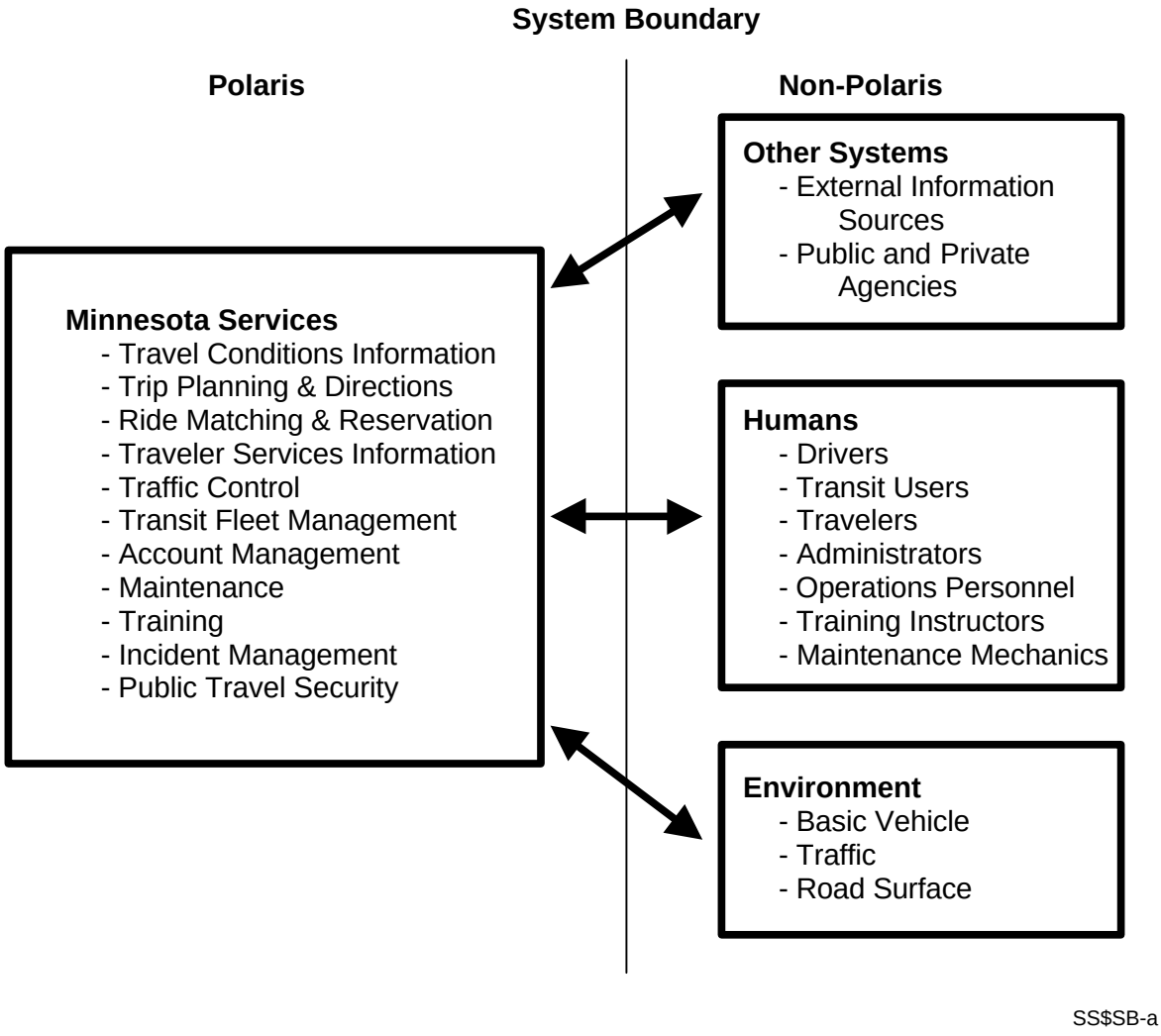


Figure 1. System Context Diagram

2.2 Statewide Architectural Overview

The Minnesota ITS Architecture consists of 11 services and over 50 components. Each Minnesota ITS service is characterized by a set of testable system requirements that are organized into functional and subfunctional groupings, and data flows between services and functions. Each Minnesota ITS component is characterized by the service requirements that were allocated to the component, and the service data flows that were allocated to the component.

2.3 Functional Architectural View

The Minnesota ITS Functional Architecture consists of a set of 11 integrated services that define "what" the ITS architecture does. Each of these services is described below:

Travel Conditions Information (TCI) provides current and/or forecast (future) travel conditions for a specific area or along a specific single mode or multi-modal route. Travel conditions information includes traffic speeds and congestion levels, weather, road surface conditions, accidents, construction, planned events, transit conditions, and parking lot status. The effects these conditions have on travel are also reported, including delay times, reduced speeds, dangers/hazards, road/ramp closures, detours, parking availability, and expected duration of the conditions (start time and end time). Travel conditions information can be tailored to a user's needs through use of a profile. Travel conditions information is provided to travelers prior to their trip, or en route, through a variety of devices.

Trip Planning and Directions (TPD) provides the ability to build the optimum single or multi modal route, directions or trip itinerary based on a mix of user-specified criteria such as origin/destination, travel mode(s), departure time, arrival time, trip duration, preferred route type, cost, etc. Trip Planning and Directions supports "what if' route planning based on different criteria combinations. This service recommends alternate routes/route segments based on user criteria or travel conditions changes. Detour routes are determined for public transit agencies by this service in order to keep transit vehicles on schedule.

The Trip Planning and Directions Service also provides the ability to get step-by-step directions, in text and/or map form, for any route or user-specified destination. Optionally, this service provides automated location, and guidance through a set of directions. This service can assemble tailored trip itineraries which include a route highlighted on a map, directions, schedule and date information (if required), information about destination point(s) and information about points of interest along a route.

Ride Matching and Reservations (RMR) provides riders with information about rideshare options (such as express bus, car pool, vanpool, paratransit or other specialized service), based on user-specified criteria (such as date/time of pick-up/drop-off, origin, destination, and specific restrictions and preferences). This service provides real-time matching of rider needs with

services available from providers, and it provides riders with the capability to reserve rides in advance or in real-time when additional capacity is available.

Traveler Services Information (TSI) provides travelers with access to "yellow pages" information such as restaurants, lodging, vehicle services, tourist sights, shopping and special events. Users can request and receive traveler services information that is tailored to their specific request, their preferences (such as price, provider, cuisine, etc.) and/or a location perspective (such as nearest to my current location, at this exit, along my route, at my destination, etc.). This service also provides the traveler with the capability to make reservations or purchase tickets. The Traveler Services Information service can interact with the Trip Planning and Directions service to provide users with routes, directions and/or a trip itinerary that is based on the traveler services that were requested.

Traffic Control (TC) provides the capabilities to optimize traffic movement on freeways, highways, and arterials throughout jurisdictions and multi-jurisdictional areas. This service provides for coordinated traffic flow via pre-planned traffic control plans. Signal timing and message signing are adaptable baaed on control plans and real-time traffic conditions feedback.

Public Transit Fleet Management (TFM) monitors real-time schedule adherence of public transit vehicles, and provides assistance in getting transit vehicles back on schedule when schedule deviations occur. This service also develops transit routes and schedules, dispatches vehicles, allocates drivers to vehicles and routes, provides real-time guidance directions to drivers of transit vehicles when needed, and monitors vehicle systems.

Account Management (AM) provides the capability for users to maintain travel services account information including personal profiles. It also establishes fees for transportation services and tracks billing and payments for services used.

Maintenance (MNT) compares vehicle mileage and other vehicle condition data with preventative maintenance schedules to develop a prioritized list of maintenance tasks. Personnel availability and skill levels are then compared to the prioritized and unscheduled (i.e. vehicle breakdown) maintenance tasks to a) assign mechanics to vehicle maintenance tasks, and b) request vehicles be assigned to a maintenance garage. Vehicle maintenance and condition history information is maintained to assist the mechanic in performing maintenance tasks.

Training (TNG) provides a capability to educate both transportation service provider personnel and public users of transportation services. For transportation service provider personnel, Training compares personnel training records with periodic training and certification requirements to develop a prioritized list of training tasks. Personnel availability is then compared to the prioritized list of training tasks and course availability information to assign personnel to courses. Personnel training and certification history information is maintained to plan future training activity, and to assist various regulatory agencies by providing easy access to credential information.

Incident Management (IM) provides the capability to detect and acknowledge reported incidents and travel emergencies. This service provides for coordinated multi-jurisdictional incident response via preplanned action plans and procedures. Emergency resources (vehicles, personnel and equipment) are assigned based on incident response needs and available resources. This service also provides for real-time monitoring, recording and reporting of incident information and response status.

Public Travel Security/Enforcement (PTSE) provides for the planning and implementation of public travel security policies, plans and procedures such as the establishment of secure areas for public transit riders and the monitoring of public areas for security incidents. The establishment and enforcement of regulations for HOV lanes, railroad crossings and construction work zones, are also provided. Violations records are kept and statistics are analyzed to determine any needed updates to security policies, plans or procedures.

2.4 Physical Architectural View

The Minnesota ITS Physical Architecture consists of multiple integrated components that define "how" the ITS functional service architecture is implemented. Each of these components is described in the following table:

Component/Group Name	**Examples**
Account Management Provider(s)	Service Billing Company(s)
Basic Vehicle	Personnel Vehicle (w/ tag for parking and/or tolls)
Broadcast Information Provider(s)	AM/PM Radio Stations (KSTP) TV Stations (WCCO) Metro Traffic Cable Companies, Paging Companies
Centralized Control Signal Center(s)	St. Paul DPW Minneapolis DPW
Centralized Roadside Equipment	Traffic Signals, Loop Detectors, Surveillance Cameras Local Intersection Controller Signal Priority/Pre-emption Equipment Portable Workzone System Portable Traffic Management System Railroad Crossing Detectors Changeable Message Signs, Variable Message Signs
Centralized/Decentralized Roadside Equipment (Group)	Centralized Roadside Equipment Decentralized Roadside Equipment

Component/Group Name	Examples
Communication (Group)	External Data Distribution Network Internal Data Distribution Network Security Firewall System
Decentralized Control Signal Center(s)	Hennepin County DPW MnDOT Metro Division -- Oakdale
Decentralized Roadside Equipment	Traffic Signals, Loop Detectors, Surveillance Cameras Master Intersection Controller Local Intersection Controller Signal Priority/Pre-emption Equipment Portable Workzone System Portable Traffic Management System Changeable Message Signs, Variable Message Signs
Demand Responsive Transit Center(s)	Metro Mobility, Metro Mobility Contracted Operators, Plymouth Dial-A-Ride, ZIPS (Rochester), STRIDE (Duluth), Specialized Service Program (St. Cloud)
Dispatch Center (Group)	Centralized Control Signal Centers Decentralized Control Signal Centers Division of Emergency Management Center Emergency Vehicle (command center) External Information Sources (event promoters) Incident Dispatch Center(s) Inter-Jurisdictional IM System Regional ITS Management Center State Patrol Dispatch Center
Division of Emergency Management Center	Dept. Of Public Safety -- Division of Emergency Management Office, Division of Emergency Management Mobile Center
Emergency Vehicle	State Patrol Vehicle, City/County/Transit Police Vehicle Ambulance, Fire Truck, Tow Truck Highway Helper, HAZMAT Vehicle Transit Supervisor Vehicle Emergency Mobile Communication Vehicles

Component/Group Name	Examples
External Information Source(s)	Event Promoters (e.g. sporting event promoters, concert promoters, circus promoters, convention promoters, etc.) National Weather Service, Kavoris 3M, General Mills Map Providers, Department of Motor Vehicles Drug and Alcohol Test Lab, Personnel Systems Privately run RWIS Travel Agencies, Tourist Agencies, Travel Guide Producers Chamber of Commerce, State/County Department of Parks and Recreation, Historical Societies Airlines, Rental Car Companies
External Data Distribution Network	TV Stations, Cable Providers, Microwave Companies, SATCOM Companies, AM/FM Radio Stations, FM Subcarrier Radio Companies, Internet Providers, Phone Companies, Private Dispatch Radios
Financial Institution(s)	Bank, Credit Union
Freeway Roadside Equipment	Ramp Meters, Loop Detectors, Surveillance Cameras Traffic Radio Signs Changeable Message Signs (CMS) Variable Message Signs (VMS) Portable Workzone System Portable Traffic Management System
Freeway Traffic Management Center	Metro Area TMC (includes KBEM)
Incident Dispatch Center(s)	Towing, Medical, Fire, City/County/Transit Police, HAZMAT, Private Security, Public Safety
Information Provider(s)	Connect Company, Taxi Companies, Delivery Service Auto Clubs (e.g., AAA), Travel Agencies
Information Provider Roadside Equipment	Surveillance Cameras
Inter- Jurisdictional Incident Management System	Highway Helper Automatic Vehicle Location System
Inter-Jurisdictional Traffic System	Integrated Corridor Traffic Management System (ICTM)
Inter-Jurisdictional Transit System	(future)

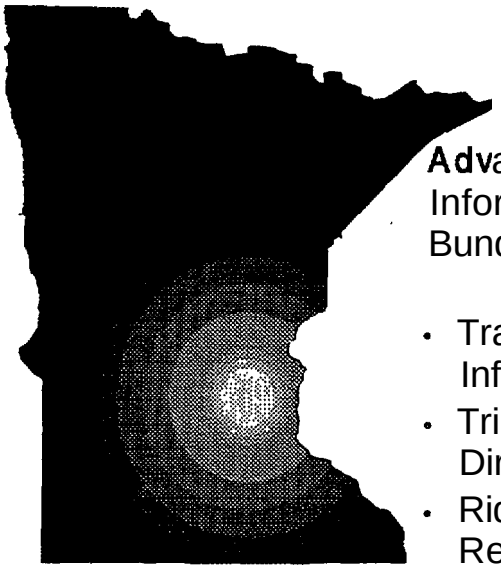
Component/Group Name	Examples
Internal Data Distribution Network	MnDOT Metro Area Intranet Phone System Public Dispatch Radio (voice/data)
Maintenance Garage	State Patrol Maintenance Garage MnDOT Maintenance Garage
Maintenance Vehicle	Snow Plow, Salt/Sand Truck Road Repair Truck
Maintenance Dispatch Center	Waters Edge (MnDOT Metro Region) Other Regional Maintenance Dispatch Centers
Management Center (Group)	Division of Emergency Management Center Freeway Traffic Management Center Inter-Jurisdictional Incident Management System Inter-Jurisdictional Transit System Parking Management Center(s) Regional ITS Management Center Regional ITS Management System Road Weather Information Center Toll Authority Center(s) Transit Maintenance Garage Truck Center
Mayday Service Provider(s)	Mayday Service Company(s)
Other Public Agencies	State/County Economic Development Agencies Social Services Agencies
Other Transit Management Center(s)	Southwest Transit, Minnesota Valley Transit Plymouth Metrolink School Bus Fleet Companies
Parking Management Center(s)	City of Minneapolis Transportation City of St. Paul DPW Privately owned and operated parking facilities
Parking Management Roadside Equipment	Parking Fee Collection Systems Parking Ramp Occupancy Signs AVI System Parking Lot Gates/Counters CMS/VMS Signs, Television Monitors
Payment Instrument	Cash, Smart Cash, Smart Card, Credit Card, Debit Card Subscription Tag/Pass, Token

Component/Group Name	Examples
Probe Vehicle	Personnel Vehicle, Bus
Regional ITS Management Center	MnDOT's next generation TMC (i.e. Shared Facility that includes Traffic Control, incident Management, Transit, Regional ITS Management Systems and Inter-Jurisdictional Systems)
Regional ITS Management System (Location: TBD)	Data Server System Managers
Rideshare Center	Minnesota Rideshare for Twin Cities, St.Cloud, Duluth, etc.
Road Maintenance Roadside Equipment	Portable Changeable Message Signs (CMS) Portable Variable Message Signs (VMS) Traffic Control Signing, Arrow Boards and Barricades
Road Weather Information Center	Publicly run Road Weather Information Center
Road Weather Roadside Equipment	Road Surface Sensors (RWIS) Weather Sensors (RWIS)
Roadside Equipment (Group)	Centralized Roadside Equipment Decentralized Roadside Equipment Freeway Roadside Equipment Information Provider Roadside Equipment Parking Management Roadside Equipment Road Maintenance Roadside Equipment Road Weather Roadside Equipment Security Roadside Equipment Toll Collection Roadside Equipment Transit Route Equipment
Security Firewall System	Firewall
Service Provider (Group)	Account Management Provider(s) Broadcast Information Provider(s) Financial Institution(s) InformationProvider(s) Mayday Service Provider(s) Tailored Traveler Information Provider(s) Transit Service Provider(s)
State Patrol Dispatch Center	Waters Edge (Metro Region) State Patrol Dispatch Center Other Regional State Patrol Dispatch Centers Mobile Command/Communication Center

Component/Group Name	Examples
Tailored Traveler Information Provider(s)	Travel Conditions Data Collection, Data Processing and Data Distribution Systems Traveler Information Center Taxi Service, UPS, FedEx
Toll Authority Center(s)	(future) Note: May consist of either government owned, privately owned or both types of facilities.
Toll Collection Roadside Equipment	Toll Collection Devices Toll Booths, Toll Tag Readers
Traffic Signal Center (Group)	Centralized Control Signal Center(s) Decentralized Control Signal Center(s) Inter-Jurisdictional Traffic System
Training Center	State Patrol Training, Emergency Response Training, Vehicle and Equipment Training, Fire Training
Transit Information Distribution Equipment	Telephone, Variable Message Signs Annunciators, In-Vehicle Devices, Kiosks
Transit Maintenance Garage	MCTO Garages (5 total)
Transit Management Center (Group)	Demand Responsive Transit Center(s) Regional ITS Management Center Other Transit Management Center(s) Transit Service Provider(s)
Transit Route Equipment	Fare Collection Devices Fare Card/Token Dispensers Automatic Passenger Counting System
Transit Service Provider(s)	Paratransit Operators, Taxi Service, DARTS, HSI
Transit Vehicle	Bus, Jitney, Taxi, Car Pool, Van Pool
Truck Center	Waters Edge (MnDOT Metro Region Truck Center) Other Regional Truck Centers
User In terface (Group)	Payment Instrument Transit Information Distribution Equipment User Interface Equipment
User Interface Equipment	Phone/Cellular Phone (Touch-Tone) Fax, AM/FM Radio, Television Personal Computer, Kiosk, Pager, Mayday Devices Portable and In-Vehicle Route Guidance and Navigation Equipment

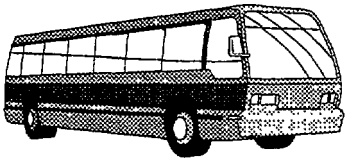
Component/Group Name	Examples
Vehicle (Group)	Basic Vehicle Emergency Vehicle Maintenance Vehicle Probe Vehicle Transit Vehicle

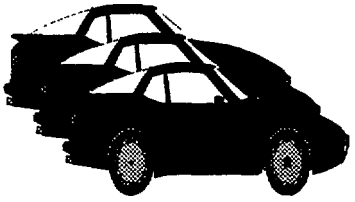
3 Advanced Traveler Infomation Services



Advanced Traveler Information Service Bundle:

- Travel Conditions Information
- Trip Planning and Directions
- Ride Matching and Reservations
- Traveler Services Inform ation





3 Advanced Traveler Information Services

3.1 Travel Conditions Information

Travel Conditions Information (TCI) provides current and/or forecast (future) travel conditions for a specific area or along a specific single mode or multi-modal route. Travel conditions information includes traffic speeds and congestion levels, weather, road surface conditions, accidents, construction, planned events, transit conditions, and parking lot status. The effects these conditions have on travel are also reported, including delay times, reduced speeds, dangers/hazards, road/ramp closures, detours, parking availability, and expected duration of the conditions (start time and end time). Travel conditions information can be tailored to a user's needs through use of a profile. Travel conditions information is provided to travelers prior to their trip, or en route, through a variety of devices.

3.1.1 Service Goals/Objectives

The following service goals and objectives help guide the migration to a **Travel Conditions Information** service architecture that is consistent with the Minnesota Traveler Wants and Needs and the Minnesota Agency Wants and Needs research results.

- Provide current, planned and forecast travel conditions information most desired by travelers and public agencies for freeways and major arterials throughout the Twin Cities region and other regions throughout the state of Minnesota.

- Provide travel conditions information that will help travelers choose the best route and/or best transportation mode to minimize their travel time.

- Support input of travel conditions information from a variety of sources/devices while improving information consistency and quality.

- Provide travel conditions information to travelers and public agencies whenever and wherever needed through a variety of devices.

- Support the performance required by Public Agencies and Travelers for a travel conditions information service (e.g.; accurate, current, consistent among agencies/travelers, delivered in time to choose alternatives, specific to route of travel or area of jurisdiction, sufficient for resource deployment/decisions).

3.1.2 Functional Architecture

Travel Conditions Information consists of the following functions and subfunctions as shown in Figure 2, Travel Conditions Information Service - Functional Architecture:

- Manage Travel Conditions Data
  - Sense Travel Conditions Data
  - Collect Travel Conditions Source Data
  - Determine Basic Travel Conditions and Travel Effects
- Manage Travel Conditions Information
  - Determine Tailored Travel Conditions
  - Determine Tailored Travel Effects
  - Distribute Travel Conditions Information

A summary description of each function and subfunction is provided in the following subsections. The requirements that characterize each subfunction are located in Appendix B. Appendix B is a separate report generated from a Microsoft Access relational database. Title of the Microsoft Access Report that supports Appendix B is: ***Requirements by Service - Function -Subfunction.***

Travel Conditions Information interfaces with the following services as shown in Figure 3, Travel Conditions Information - Service Interface Diagram:

- Account Management
- Incident Management
- Public Transit Fleet Management
- Traffic Control
- Trip Planning and Directions Service
- Other
  - Devices
  - External Information Sources
  - Human (Le., Drivers, Transit Users)
  - Parking Management Centers
  - Public Agencies

In Figure 2 and Figure 3, the arrows between the functions and services represent information data flows. Appendix C, ***Data Flows by Function for*** ITS ***Services,*** defines the input and output data flows for each service and the service's functions. Appendix C is a separate report generated by Microsoft Access.

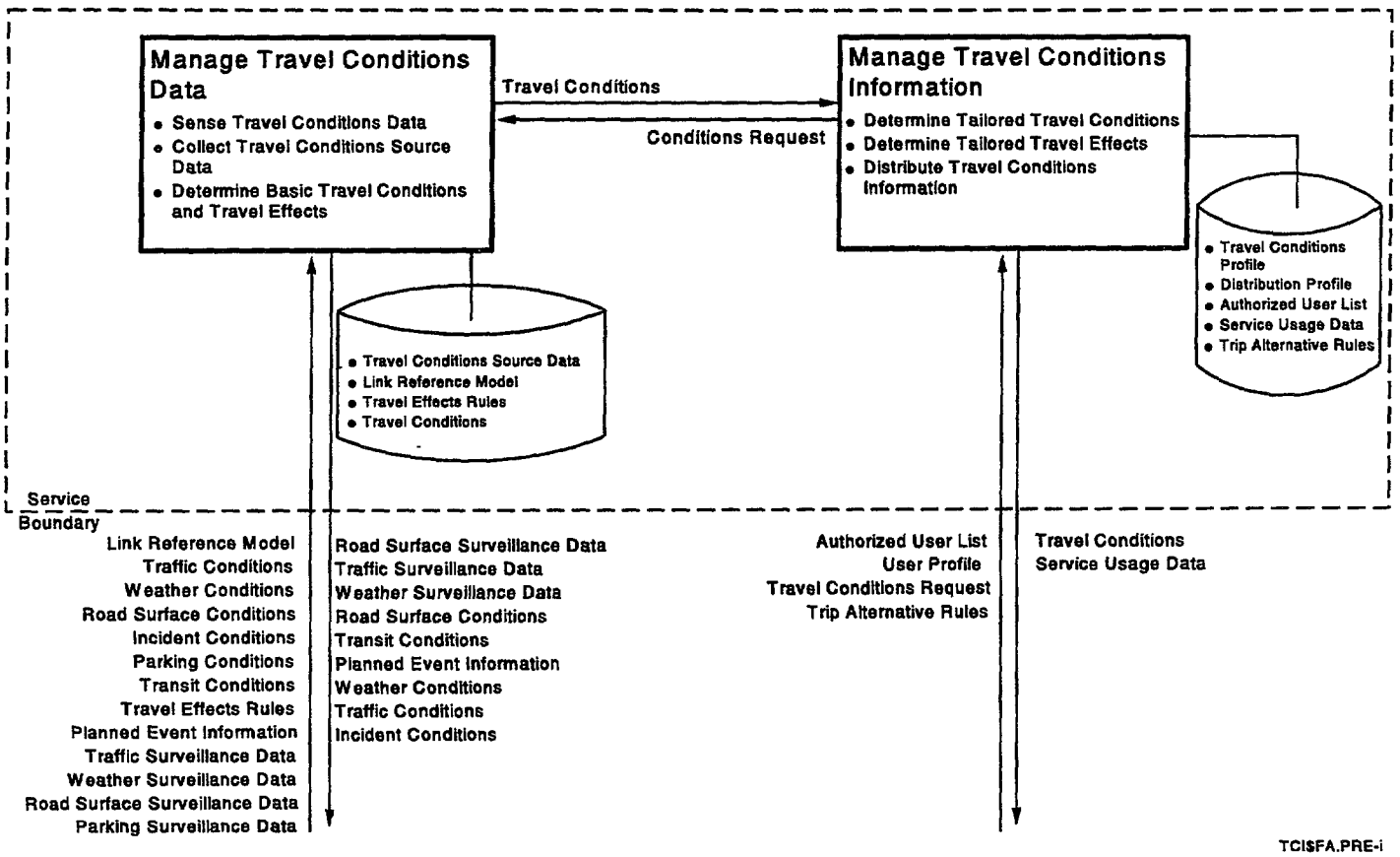


Figure 2. Travel Conditions Information - Functional Architecture

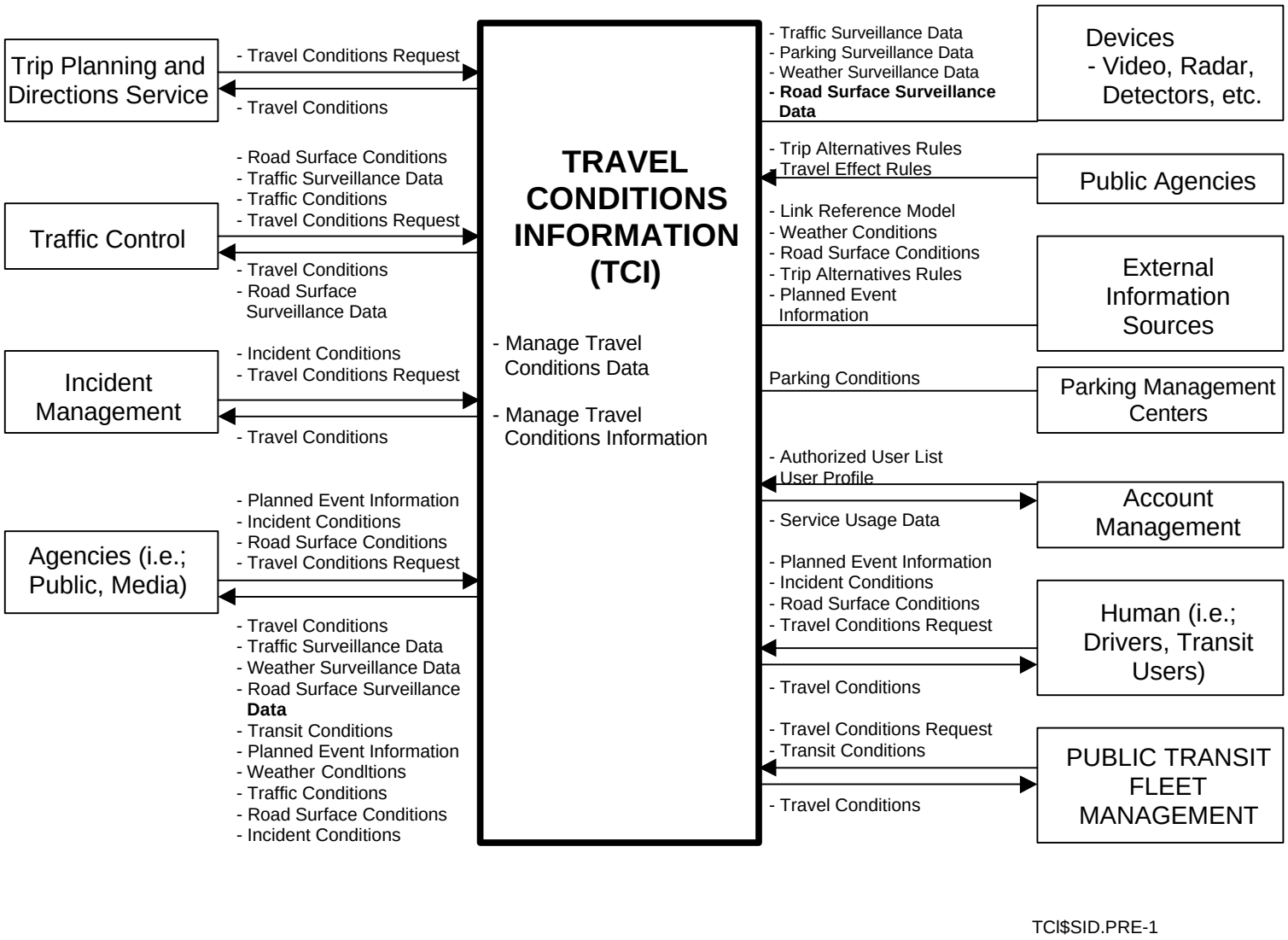


Figure 3. Travel Conditions Information - Service Interface Diagram

3.1.2.1 Manage Travel Conditions Data (MTCD)

The Manage Travel Conditions Data (MTCD) function accepts and stores all travel conditions data from various sources, and maps the travel conditions data to the transportation network model that includes roadway segments, rail segments, bus route segments, bicycle path segments and waterway segments. The impact of travel conditions on travel in a given segment, such as delay in travel time for that segment and segment closures, is also determined. The Manage Travel Conditions Data function consists of the following subfunctions:

- **Sense Travel Conditions Data (STD)** interacts with the physical environment to detect traffic, weather and road surface conditions.

- **Collect Travel Conditions Source Data (CTC)** gathers and stores traffic, regional weather, road surface, incident (accidents, breakdowns, etc.), planned event (construction, special events, etc.), parking and transit conditions information from multiple sources, including public agencies, external information sources, etc. Multiple input formats are supported including voice, fax, video and digital. The information is converted into a standard format.

- **Determine Basic Travel Conditions and Travel Effects (BTC)** maps the travel conditions source data and effects to the transportation network model (e.g.; freeways, arterials, etc.). Information is logged for use by both public and private agencies.

3.1.2.2 Manage Travel Conditions Information (MTCI)

The Manage Travel Conditions Information (MTCI) function tailors travel conditions and travel effects to criteria defined in a user's travel conditions profile. It determines which users are affected by the current travel conditions and can provide automatic notification to the user (if the user chooses that option) of travel conditions and the potential impact on the user's trip. Users also have the ability to directly request travel conditions information. The Manage Travel Conditions Information function consists of the following subfunctions:

- **Determine Tailored Travel Conditions (TTC)** tailors travel conditions to criteria defined in a user's travel conditions profile. Users affected by current travel conditions are determined and automatically notified (if they choose that option) when conditions will impact their travel. Recommendations about trip alternatives that minimize the effect of travel conditions will be made available to users as an option.

- **Determine Tailored Travel Effects (TTE)** determines the effects of travel conditions on a user's trip plans.

- **Distribute Travel Conditions Information (DTC)** provides users with the ability to request and receive travel conditions via a variety of devices (e.g.; phone, road signs, computer, fax, cable TV). An option to specify the order of user notification is provided.

3.1.3 Sample Operational Scenarios

The scenarios in Figure 4, Figure 5, Figure 6, Figure 7, Figure 8, Figure 9, and Figure 10 show how the Travel Conditions Information Service detects, processes and delivers both basic and tailored travel conditions information. Both types of travel conditions information have two scenarios associated with them. The first scenario is "event driven," meaning that the scenario is started by the occurrence of an event such as a traffic accident or a snow storm. The second scenario is "request driven," meaning that it is started by a user making a request for travel conditions via some device (e.g.; phone, fax, computer, etc.).

Each scenario begins at the top of the figure with either the occurrence of an event or a request for travel conditions coming from a user. The rectangular boxes indicate major tasks (and functions) that are performed during the scenario. The lines and arrows connecting the rectangular task boxes indicate the flow of control from one box, or task, to the next. Data elements labeled on these lines indicate the data flowing between the boxes. This data will be used by the next task. The storage disc icons on the left of the task boxes (with lines and arrows leading to the task box) indicate stored data that is used by the task. The rectangular boxes connected to these storage discs indicate the task that generated this data. The storage disc icons on the right of the task boxes indicate data that is generated and stored by that task.

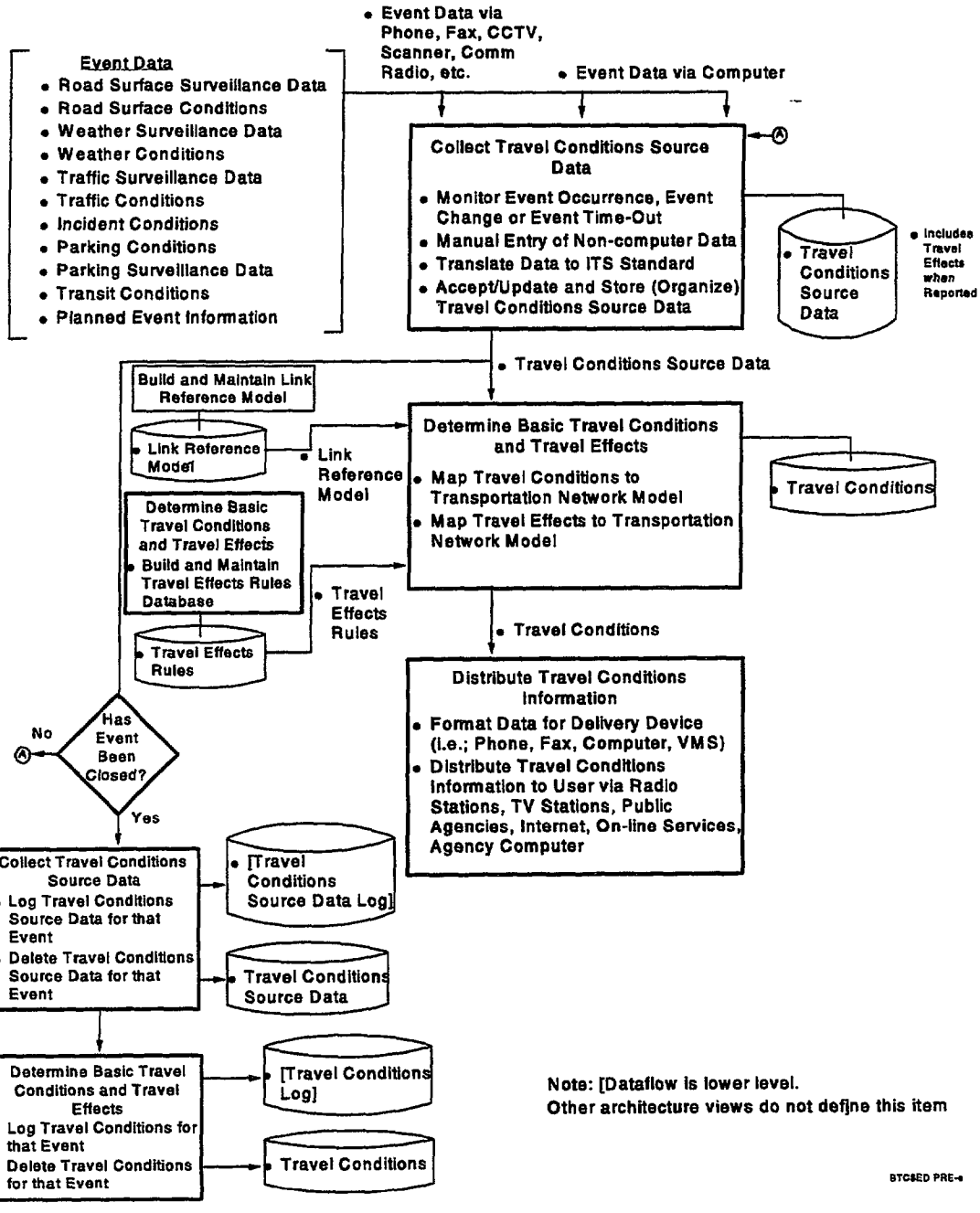


Figure 4. Travel Conditions Information Scenario - Distribute Basic Travel Conditions (Event Driven)

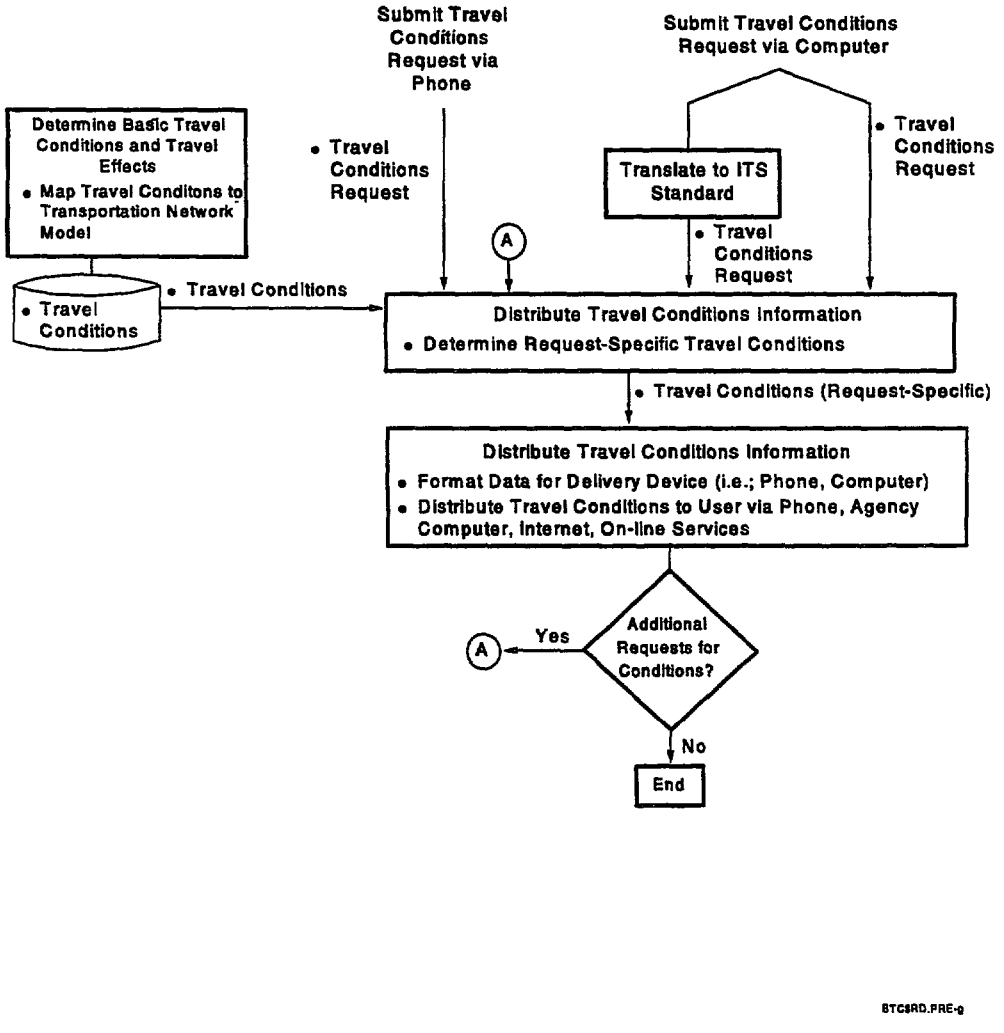


Figure 5. Travel Conditions Information Scenario - Distribute Basic Travel Conditions (Request Driven)

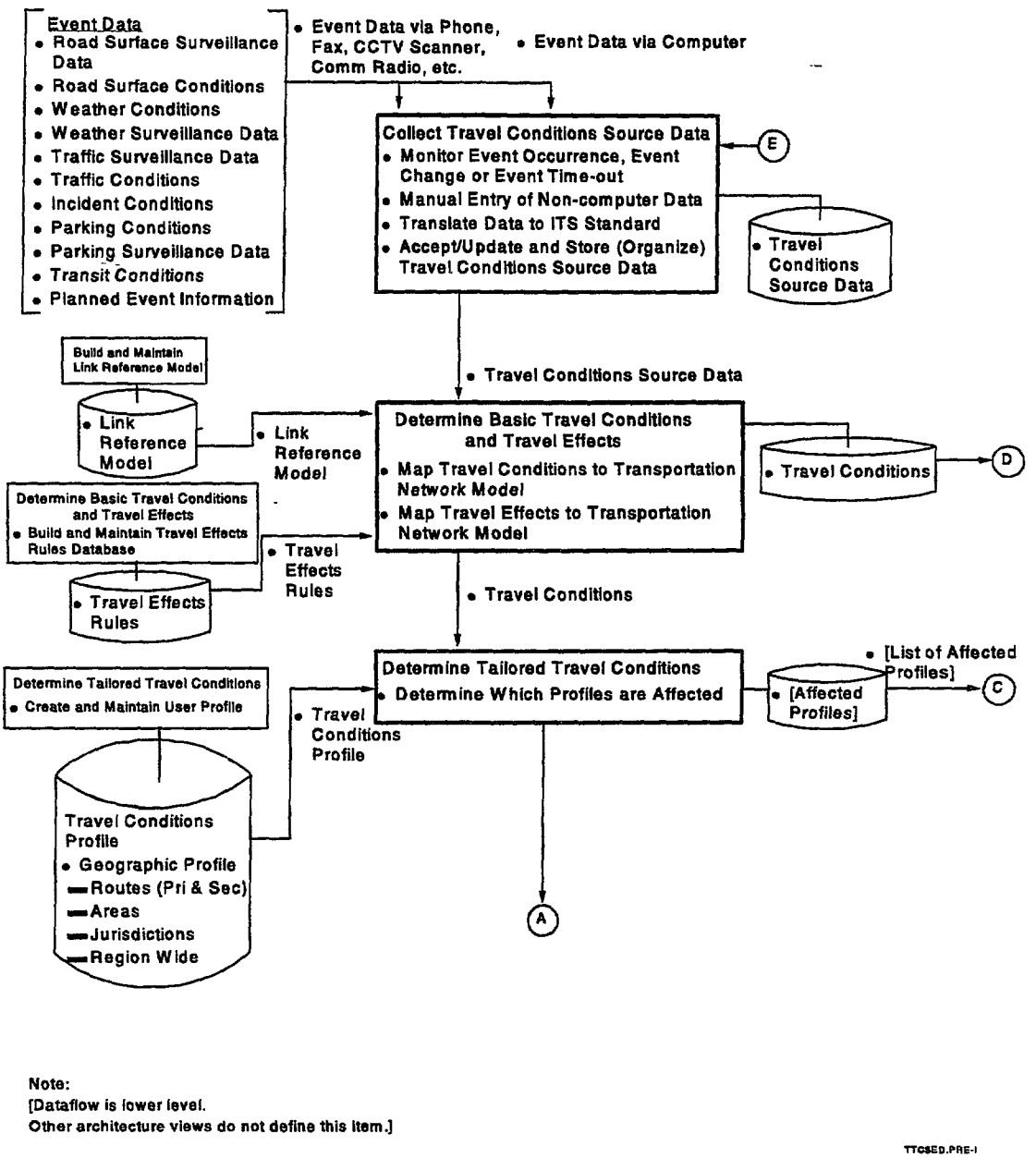


Figure 6. Travel Conditions Information Scenario - Distribute Tailored Travel Conditions (Event Driven)

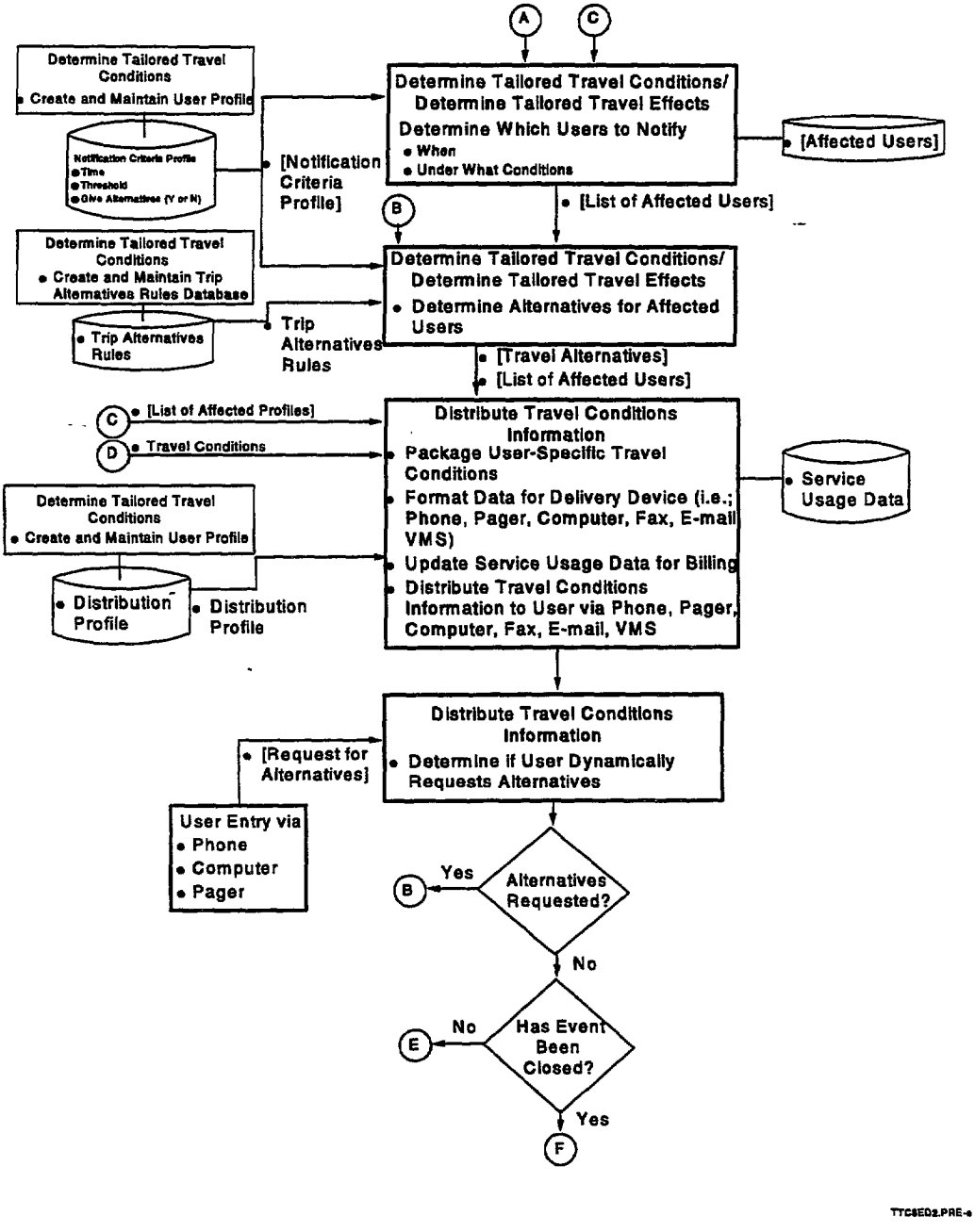
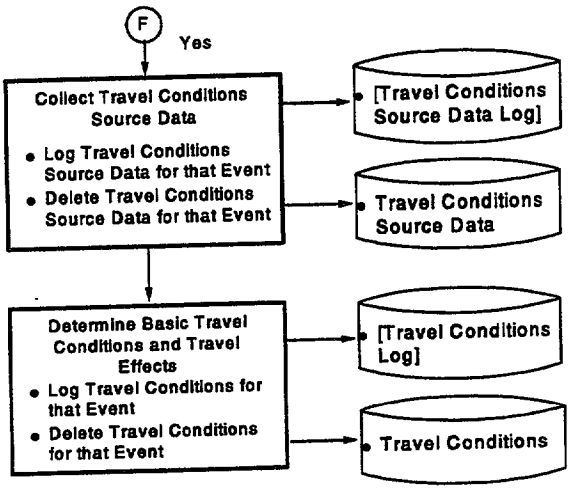
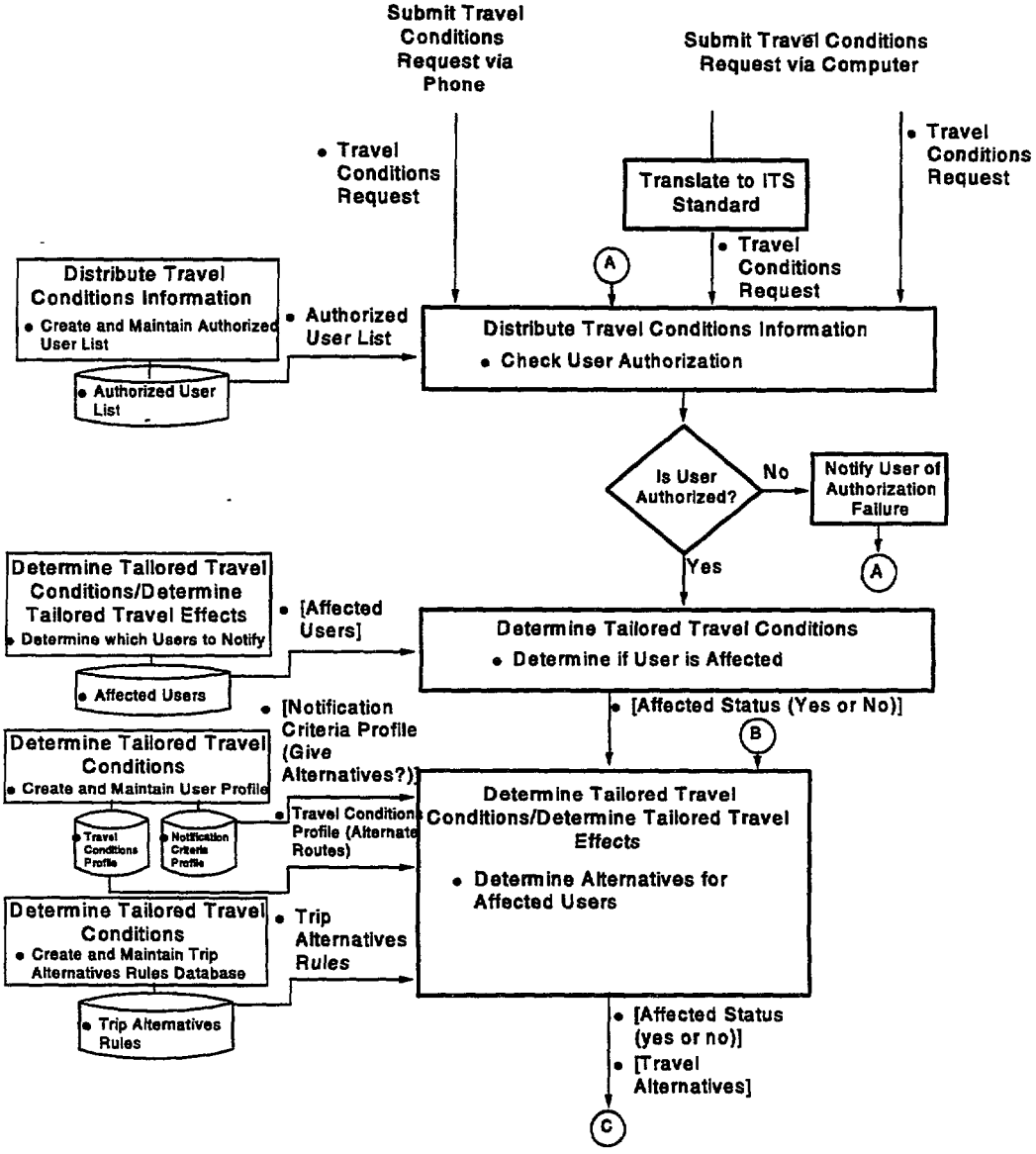


Figure 7. Travel Conditions Information Scenario - Distribute Tailored Travel Conditions (Event Driven) (Cont)



TTCSEDS.PRE-c

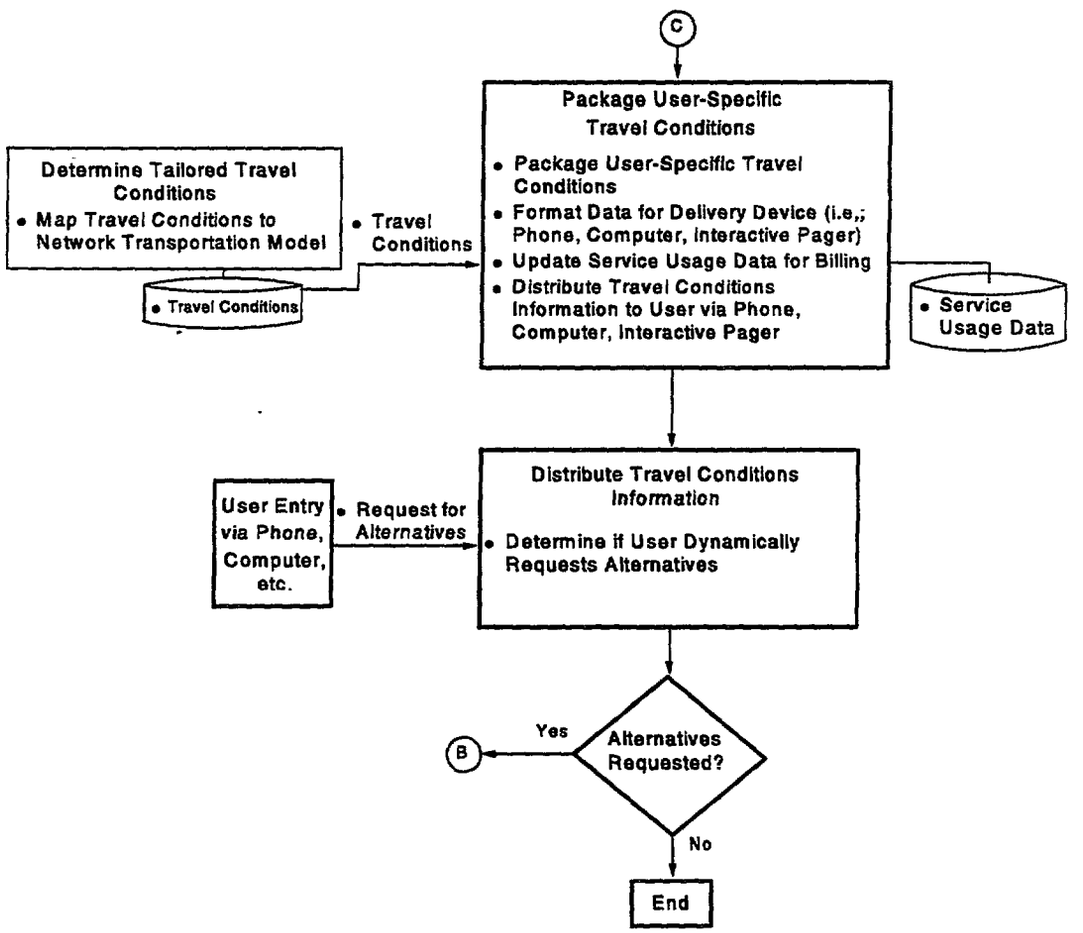
Figure 8. Travel Conditions Information Scenario - Distribute Tailored Travel Conditions (Event Driven) (Cont)



Note:
[Dataflow is lower level.
Other architecture views do not define this item.]

TTGSRD PRE-d

Figure 9. Travel Conditions Information Scenario - Distribute Tailored Travel Conditions (Request Driven)



TTC$RD2 PRE-I

Figure 10. Travel Conditions Information Scenario - Distribute Tailored Travel Conditions (Request Driven) (Cont)

3.1.4 Physical Architecture

The architecture shown in Figure 11, Travel Conditions Information - Physical Architecture, shows how the various Minnesota lTS components are interconnected to provide the Travel Conditions Information Service. Arrows between the components are labeled with tags for identifying the input data flows to a component. Appendix D, *Physical Architecture Component Interfaces,* associates each tag with the corresponding component input data flows.

In this architecture, the public agencies share information as peers where appropriate, and utilize a Regional ITS Management System for sharing information with other government agencies and with privately-owned information provider companies. Each agency collects, verifies, and distributes information for its own operational purposes, as well as sharing its information and utilizing information collected by others. As the operational and political environment develops, it is envisioned that the Regional ITS Management System could be located at the Regional ITS Management Center that replaces many of the individual public agency centers shown in the figure.

The public agencies-in this figure (e.g.; Freeway Traffic Management Center, Centralized Signal Centers, Decentralized Signal Centers, Transit Management Centers, Maintenance Dispatch Centers, Road Weather Information Center, State Patrol Dispatch Center, Truck Center, Parking Management Center) share travel conditions information as peers via interfaces that are defined according to a coordinated set of standards, policies and procedures. In addition, the public agencies share their travel conditions information with a Regional ITS Management System. The Regional ITS Management System then filters the travel conditions information and passes it to Information Provider companies in the private sector (e.g.; Tailored Traveler Inforrnation Providers, Information Providers, Broadcast Information Providers). If desired, the Regional ITS Management System can also be utilized for sharing information between public agencies. The Regional ITS Management System also serves as a centralized management point where all public-private agency interfaces are defined and maintained.

The Security Firewall System provides a secure firewall for two-way data exchange between government owned/leased and privately owned networks, and also supports routing of travel conditions information between public agencies and private Information Provider companies. T'he Information Providers receive the comprehensive, region wide travel conditions information, tailor it and distribute it to their service users.

The numbers, inside each box in the figure, identify the Travel Conditions Information Service Functional Architecture subfunctions that have been allocated to that box. The code for the numbers is defined as follows:

1. Sense Travel Conditions Data (STD)
2. Collect Travel Conditions Source Data (CTC)
3. Determine Basic Travel Conditions and Travel Effects (BTC)
4. Determine Tailored Travel Conditions (TTC)
5. Distribute Travel Conditions Information (DTC)
6. Determine Tailored Travel Effects (TTE)

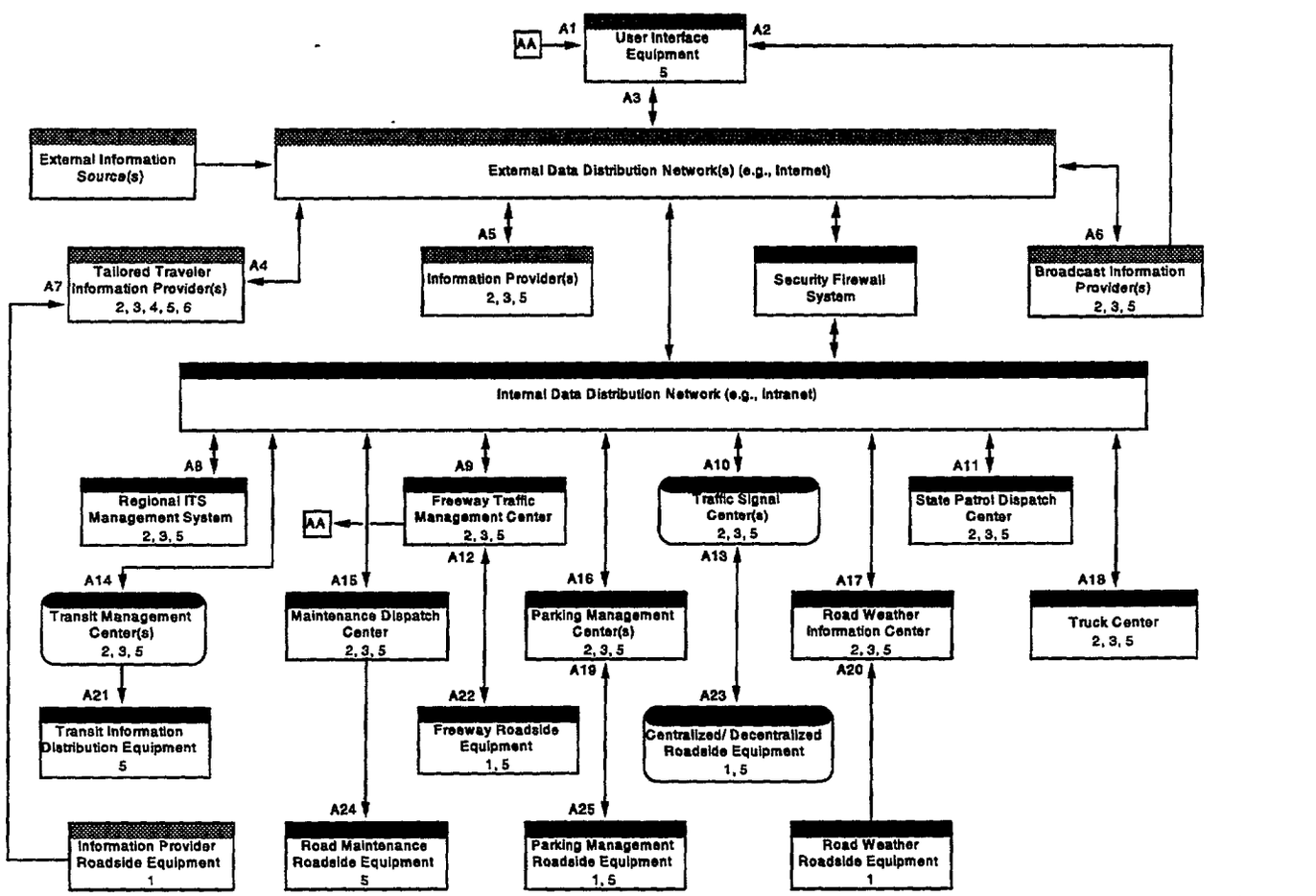


Figure 11. Travel Conditions Information - Physical Architecture

32 Trip Planning and Directions

Trip Planning and Directions (TPD) provides the ability to build the optimum single or multi modal route, directions or trip itinerary based on a mix of user-specified criteria such as origin/destination, travel mode(s), departure time, arrival time, trip duration, preferred route type, cost, etc. Trip Planning and Directions supports "what if' route planning based on different criteria combinations. This service recommends alternate routes/route segments based on user criteria or travel conditions changes. Detour routes are determined for public transit agencies by this service in order to keep transit vehicles on schedule.

The Trip Planning and Directions Service also provides the ability to get step-by-step directions, in text and/or map form, for any route or user-specified destination. Optionally, this service provides automated location, and guidance through a set of directions. This service can assemble tailored trip itineraries which include a route highlighted on a map, directions, schedule and date information (if required), information about destination point(s) and information about points of interest along a route.

32.1 Service Goals/Objectives/Performance Measurements

The following service goals and objectives help guide the migration to a **Trip Planning and Directions** service architecture that is consistent with the Minnesota Traveler Wants and Needs and the Minnesota Agency Wants and Needs research results.

- Provide travelers with a best route plan based on user-specified parameters and, when requested, factors in travel conditions information.

- Provide clear, step-by-step directions for a user to get from an origin point to a specified destination point.

- Provide travelers with information about transportation mode alternatives they have when traveling from their origin to their destination. Also provide travelers with information on how to use various public transportation modes.

- Provide regional coordination in collecting, processing, and presenting trip planning information.

3.2.2 Functional Architecture

Trip Planning and Directions consists of the following functions as shown in Figure 12, Trip Planning and Directions Service - Functional Architecture:

- Manage Trip Planning and Directions Data
  - Determine Route
  - Compute Directions
- Manage Tailored Trip Plans and Directions
  - Build Trip Itinerary
  - Distribute Trip Plans and Directions

A summarydescription of each function and subfunction is provided in the following subsections. The requirements that characterize each subfunction are located in Appendix B. Appendix B is a separate report generated from a Microsoft Access relational database. Title of the Microsoft Access Report that supports Appendix B is: ***Requirements by Service - Function - Subfunction.***

Trip Planning and Directions interfaces with the following services as shown in Figure 13, Trip Planning and Directions Service - Service Interface Diagram:

- Account Management
- Public Transit Fleet Management
- Ride Matching and Reservations
- Travel Conditions Information
- Traveler Services Information
- Other
  - External Information Sources
  - Human (i.e.; Drivers, Transit Users)
  - Parking Management Centers

In Figure 12 and Figure 13, the arrows between tbe functions and services represent information data flows. Appendix *C, **Data Flows by Function for ITS Services,*** defines the input and output data flows for each service and the service's functions. Appendix C is a separate report generated by Microsoft Access.

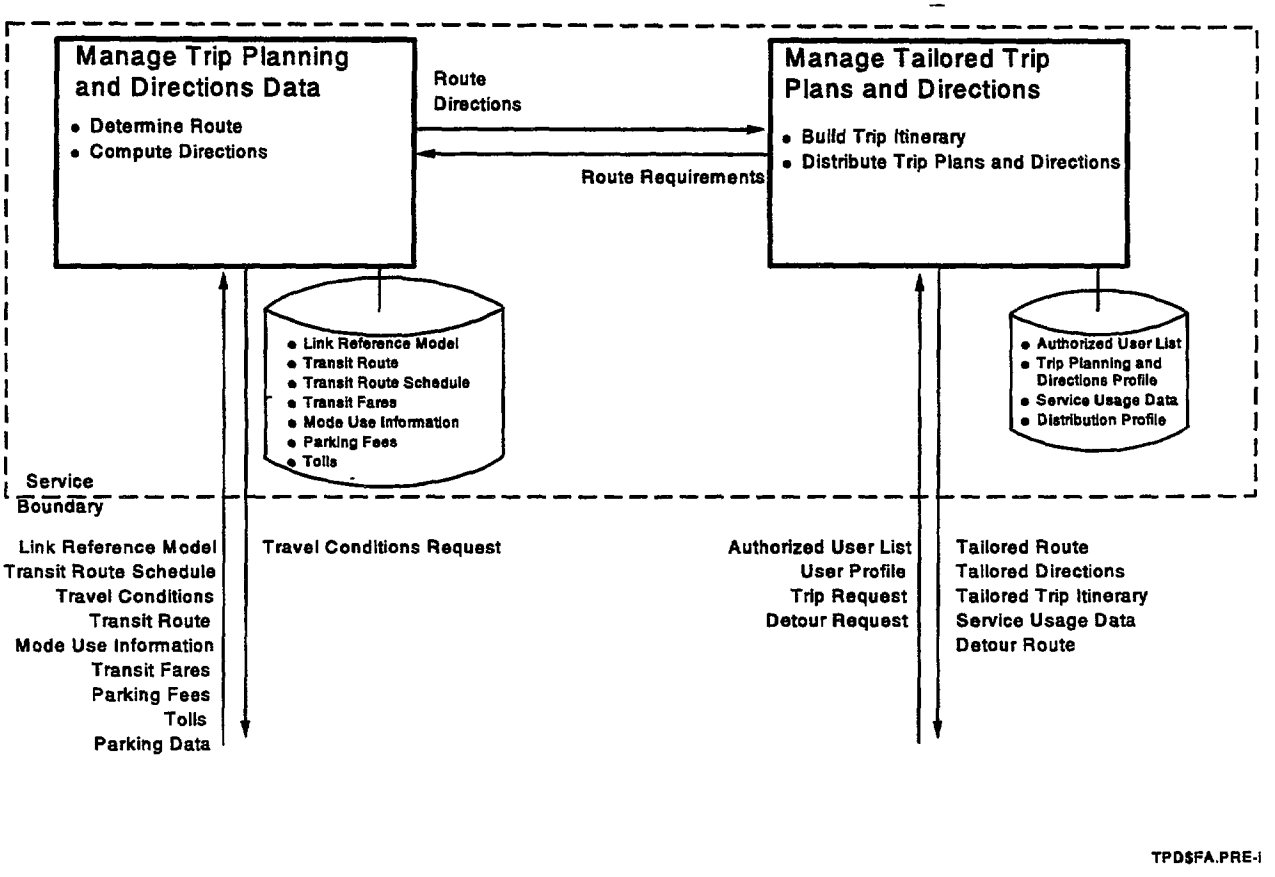


Figure 12. Trip Planning and Directions - Functional Architecture

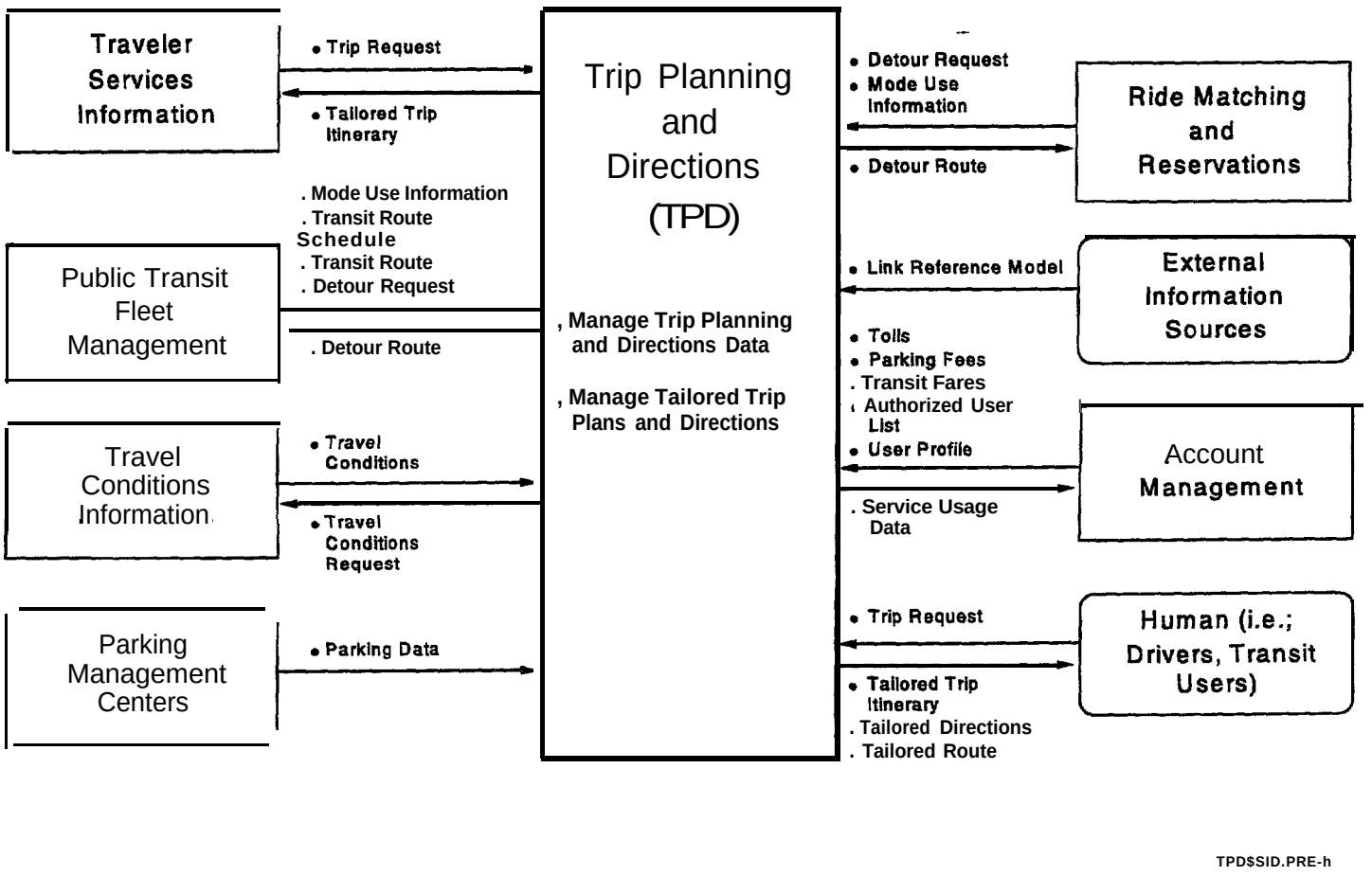


Figure 13. Trip Planning and Directions - Service Interface Diagram

3.2.2.1 Manage Trip Planning and Directions Data (MTPD)

The Manage Trip Planning and Directions Data (MTPD) function accepts and stores all geographic points of reference relative to roadway segments, rail segments, bus route segments, bicycle path segments and waterway segments. Routes are determined and, if requested, directions are computed based on the user's requirements and preferences. The Manage Trip Planning and Directions Data function consists of the following subfunctions:

- **Determine Route (DR)** stores all geographic points of reference for the transportation network model (e.g.; roadways, bus routes, etc.), and calculates the best path or detour route between origin and destination point(s) using user-specified parameters and travel conditions information (if required). Routes can be based on a single mode or multiple modes.

- **Compute Directions (CD)** provides step by step instructions for a user to get from an origin point to a destination point.

3.2.2.2 Manage Tailored Trip Plans and Directions (MTTP)

The Manage Tailored Trip Plans and Directions (MTTP) function receives requests for trip plans, routes, and/or directions, and verifies that the users are authorized to use this service. The specific request being made is determined and an appropriate request for information from other functions or services is sent. The requested information is then received and packaged. User-specified information is formatted for the designated user devices, and then transmitted to the user device. Service usage data is also provided to the Account Management service to support billing. The Manage Tailored Trip Plans and Directions function consists of the following subfunctions:

- **Build Trip Itinerary (BTI)** assembles and packages all information about a user-specified trip, including route highlighted on a map, directions text, schedule and date information (if needed), information about destination point(s) and information about points of interest along the route.

- **Distribute Trip Plans and Directions (DTPD)** provides users with the ability to request and receive routes, transit schedules, directions and trip itineraries via a variety of devices (e.g.; telephone, computer, fax, e-mail, m-vehicle devices).

3.2.3 Sample Operational Scenarios

The scenarios in Figure 14, Figure 15 and Figure 16 show how the Trip Planning and Directions Service determines routes, computes directions and packages the information into a trip itinerary, based on user requests. The first scenario shows how the Trip Planning and Directions Service would be offered by a tailored traveler information provider company. Users submit requests for routes, directions and/or trip itineraries and receive information that is tailored to their specific request and to their preferences (via a user profile). This scenario can accommodate either a single mode, or multiple modes of travel, during the course of a trip. The second scenario focuses on how the Trip Planning and Directions Service would be offered by a transit organization. Users submit requests for routes, directions and trip itineraries and receive information that is tailored to their specific request. This scenario accommodates users of the transit system.

Each scenario begins at the top of the figure with a trip request coming from a user. The rectangular boxes indicate major tasks (and functions) that are performed during the scenario. The lines and arrows connecting the rectangular task boxes indicate the flow of control from one box, or task, to the next. Data elements labeled on these lines indicate the data flowing between the boxes. This data will be used by the next task. The storage disc icons on the left of the task boxes (with lines and arrows leading to the task box) indicate stored data that is used by the task. The rectangular boxes connected to these storage discs indicate the task that generated this data. The storage disc icons on the right of the task boxes indicate data that is generated and stored by that task.

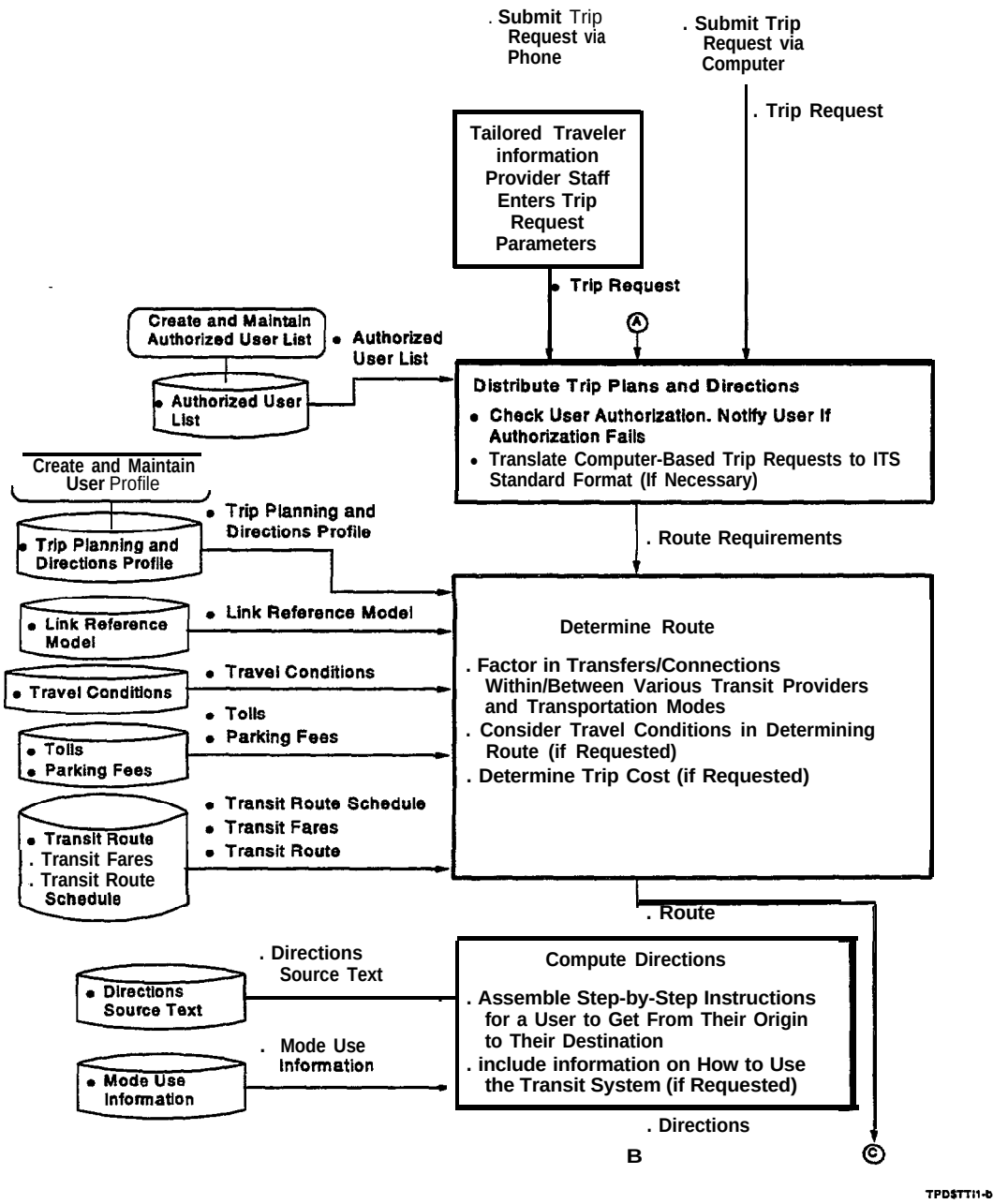


Figure 14. Trip Planning and Directions - Tailored Traveler Information Provider; Single or Muliple Mode(s)

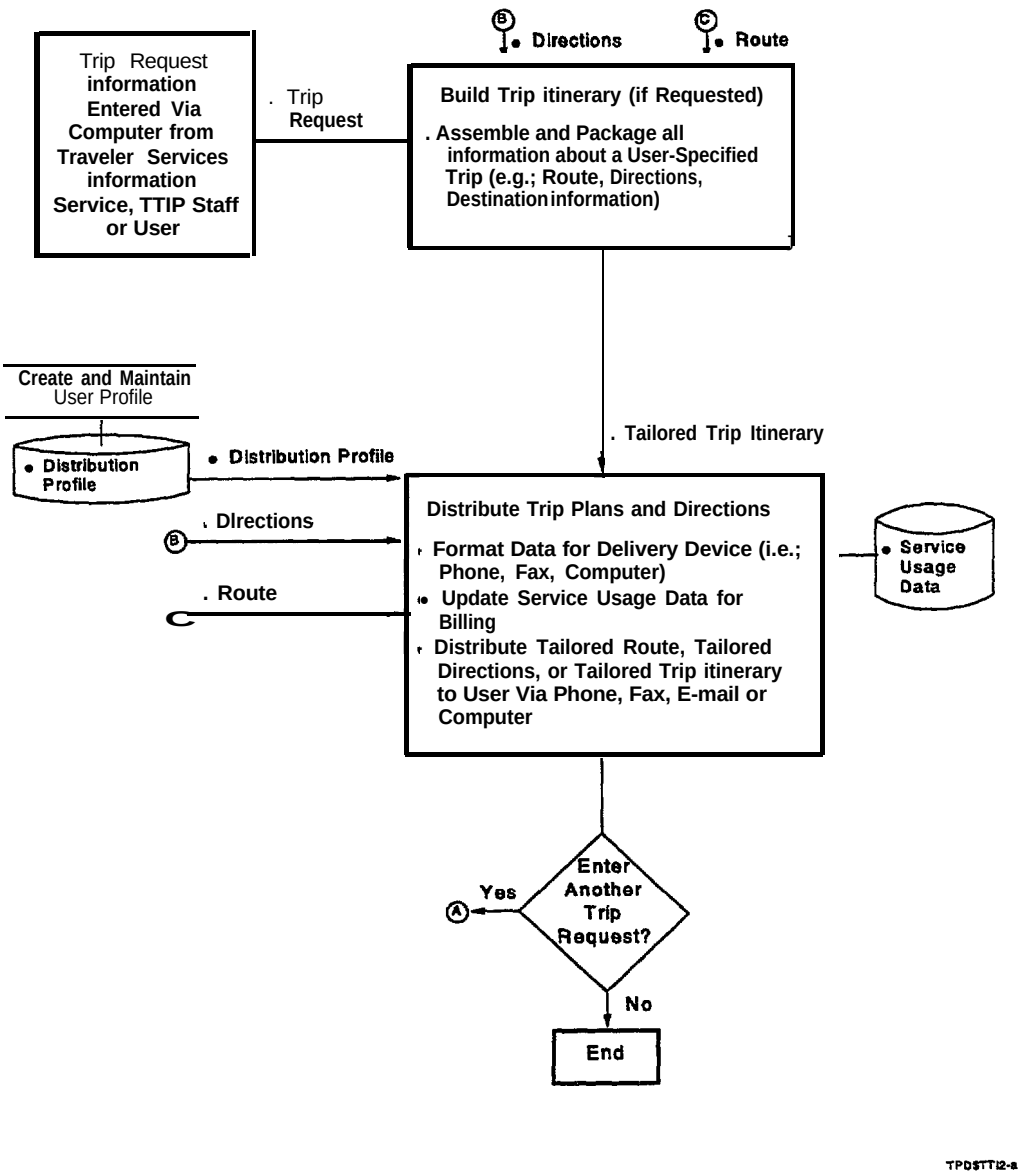


Figure 15. Trip Planning and Directions - Tailored Traveler Information Provider; Single or Multiple Mode(s) (Cont)

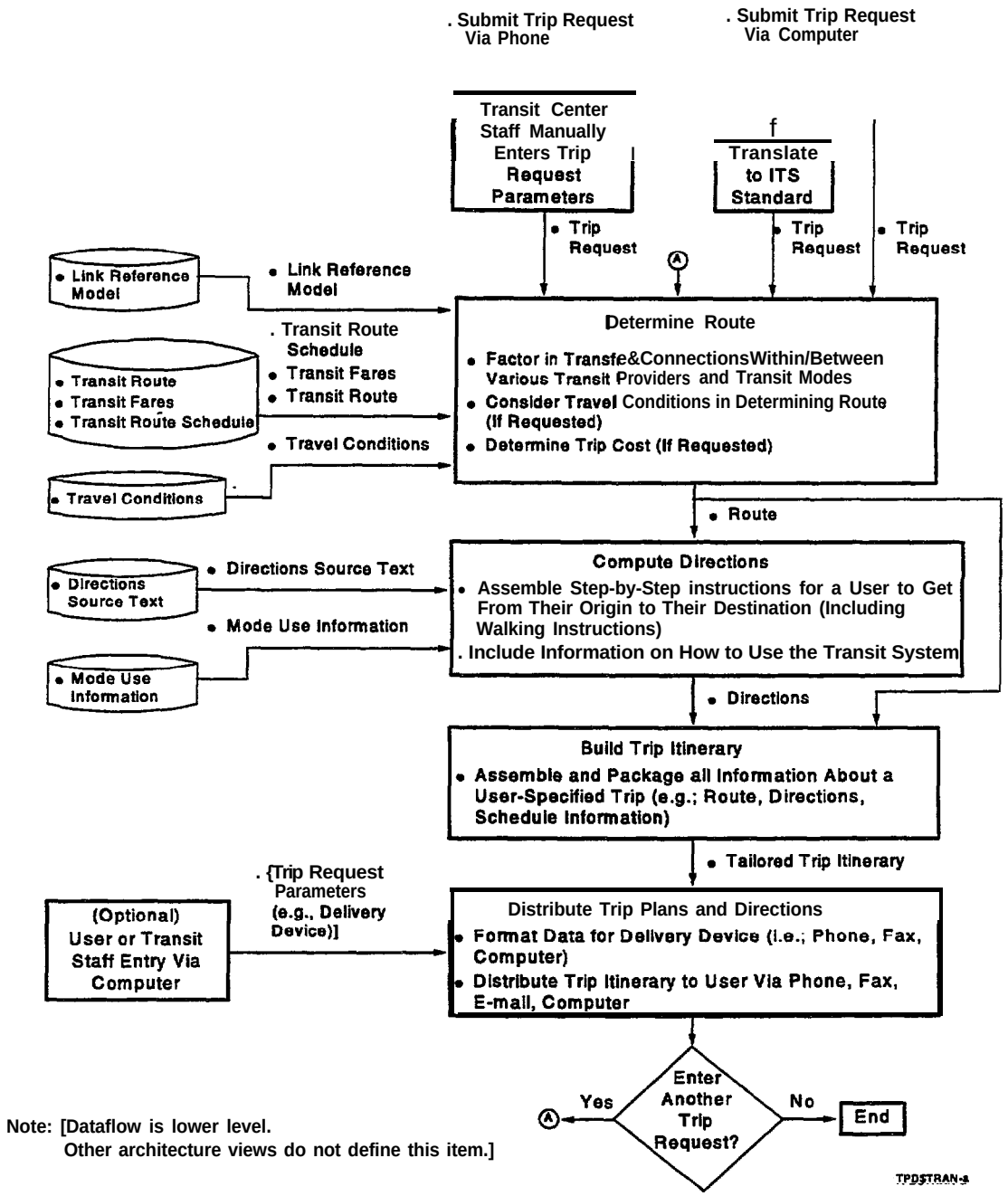


Figure 16. Trip Planning and Directions - Transit Management Center; Transit Scenario Only

3.2.4 Physical Architecture

The architecture shown in Figure 17, Trip Planning and Directions - Physical Architecture, shows how the various Minnesota ITS components are interconnected to provide the Trip Planning and Directions Service. Arrows between the components are labeled with tags for identifying the input data flows to a component. Appendix D, *Physical Architecture Component Interfaces*, associates each tag with the corresponding component input data flows.

In this architecture, the public agencies share information as peers where appropriate, and utilize a Regional ITS Management System for sharing information with other government agencies and with privately-owned information provider companies. As the operational and political environment develops, it is envisioned that the Regional ITS Management System could be located at the Regional ITS Management Center that replaces many of the individual public agency centers shown in the figure. Each transit agency provides transit route and directions information to users of its own transit services, and shares access to an Inter-Jurisdictional Transit System that can be used to provide transit route and directions information to users who require the services of multiple transit agencies to complete their trip.

The public agencies in this figure (e.g.; Regional ITS Management Center, Other Transit Management Center(s) and Demand Responsive Transit Center(s)) calculate the best transit route and directions between origin and destination points for transit users, and calculate detour routes for their transit drivers. Each agency shares transit route, schedule and fare information with each other via interfaces that are defined according to a coordinated set of standards, policies and procedures. Each agency also maintains its own transit route, schedule and fare information. In addition, the public transit agencies share their transit route, schedule and fare information with a Regional ITS Management System. Parking Management Center(s) and Toll Authority Center(s) share parking fee and roadway toll information with the Regional ITS Management System.

The Regional ITS Management System passes on the transit, parking fee and roadway toll information to Information Provider companies in the private sector (e.g.; Tailored Traveler Information Providers and Information Providers). It also maintains comprehensive transit route and schedule information that both public agencies and Information Provider companies can use for data recovery, and serves as a centralized management point where all public-private agency interfaces are defined and maintained.

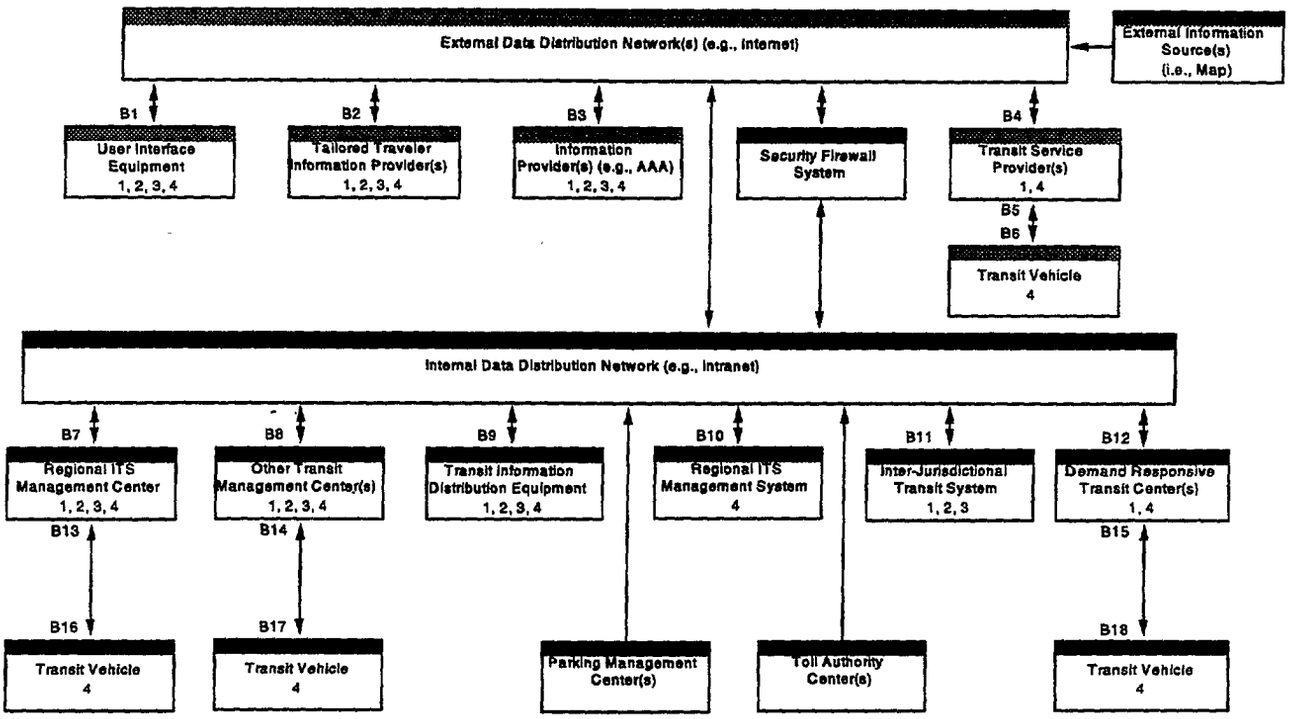
The Inter-jurisdictional Transit System is used by all the public transit agencies to calculate transit routes and directions for transit users that require the use of more than one transit agency's services to complete their trip.

The Security Firewall System provides a secure firewall for two-way data exchange between government owned/leased and privately owned networks, and also supports routing of information between public agencies and private Information Provider companies. The Information Provider companies calculate the best single or multiple mode route and directions for all travelers (not just transit users).

The User Interface Equipment can provide a range of capabilities depending on the type of equipment. It can consist of a computer that can perform route and directions calculations, connecting to the network only for updates to the trip planning and directions source information and/or the latest travel conditions information, or it can be a telephone that only allows users to request directions or trip itineraries, with the actual route and directions calculations taking place on systems located elsewhere in the network.

The numbers, inside each box in the figure, identify the Trip Planning and Directions Service Functional Architecture subfunctions that have been allocated to that box. The code for the numbers is defined as follows:

1. Determine Route (DR)
2. Compute Directions (CD)
3. Build Trip Itinerary (BTI)
4. Distribute Trip Plans and Directions (DTPD)



TPD$PHYS-a

Figure 17. Trip Planning and Directions - Physical Architecture

3.3 Ride Matching and Reservations

Ride Matching and Reservations (RMR) provides riders with information about rideshare options (such as express bus, car pool, vanpool, paratransit or other specialized service), based on user-specified criteria (such as date/time of pick-up/drop-off, origin, destination, and specific restrictions and preferences). This service provides real-time matching of rider needs with services available from providers, and it provides riders with the capability to reserve rides in advance or in real-time when additional capacity is available.

3.3.1 Service Goals/Objectives/Performance Measurements

The following service goals and objectives help guide the migration to a Ride **Matching & Reservations Service** architecture that is consistent with the Minnesota Traveler Wants and Needs and the Minnesota Agency Wants and Needs research results.

- Provide travelers with a shared ride based on their specified input criteria
- Provide travelers with a safe and secure environment
- Optimize routing and travel times for vehicles
- Optimize efficient use of transit vehicles, facilities and personnel through the measurement of passenger demand and real-time vehicle location, identification, performance and schedule adherence. Analyze planned-versus-actual data to continually improve application of transit system assets to meet customer needs.
- Provide an on-demand system that is flexible and adaptable to change
- Provide for automatic scheduling of a demand responsive system to reduce reservation time
- Enhance transit system to accept requests for real-time ridematching
- Integrate paratransit, public transit and private taxi services.
- Measure the environmental benefits of increased transit usage and technological advances
- Collect and manage current information on riders and transportation providers

3.3.2 Functional Architecture

Ride Matching and Reservations consists of the following functions as shown in Figure 18, Ride Matching and Reservations Service - Functional Architecture:

- Manage Rideshare Requests
  - Manage Rider Requests
  - Distribute Rideshare Information
- Manage Rideshare Offers
  - Manage Rideshare Offers
  - Match Rider with Provider
  - Plan Rideshare Routes
  - Distribute Transit Service Provider Information
  - Plan Rideshare Operating Procedures
- Manage Demand Responsive Operations
  - Manage Rideshare Service Usage Data
  - Manage Rideshare Schedule Adherence
  - Provide Demand Responsive Service

A summary description of each function and subfunction is provided in the following subsections. The requirements that characterize each subfunction are located in Appendix B. Appendix B is a separate report generated from a Microsoft Access relational database. Title of the Microsoft Access Report that supports Appendix B is: *Requirements by Service - Function - Subfunction.*

Ride Matching and Reservations interfaces with the following services as shown in Figure 19, Ride Matching and Reservations - Service Interface Diagram:

- Account Management
- Incident Management
- Maintenance
- Public Transit Fleet Management
- Training
- Travel Conditions Information
- Trip Planning and Directions
- Other
  - Devices (i.e., Video, Detectors)
  - External Information Sources (i.e., Transit Service Provider)
  - Human (i.e., Travelers, Transit Drivers)

In Figure 18 and Figure 19, the arrows between the functions and services represent information data flows. Appendix *C, Data Flows by Function for ITS Services*, defines the input and output data flows for each service and the service's functions. Appendix C is a separate report generated by Microsoft Access.

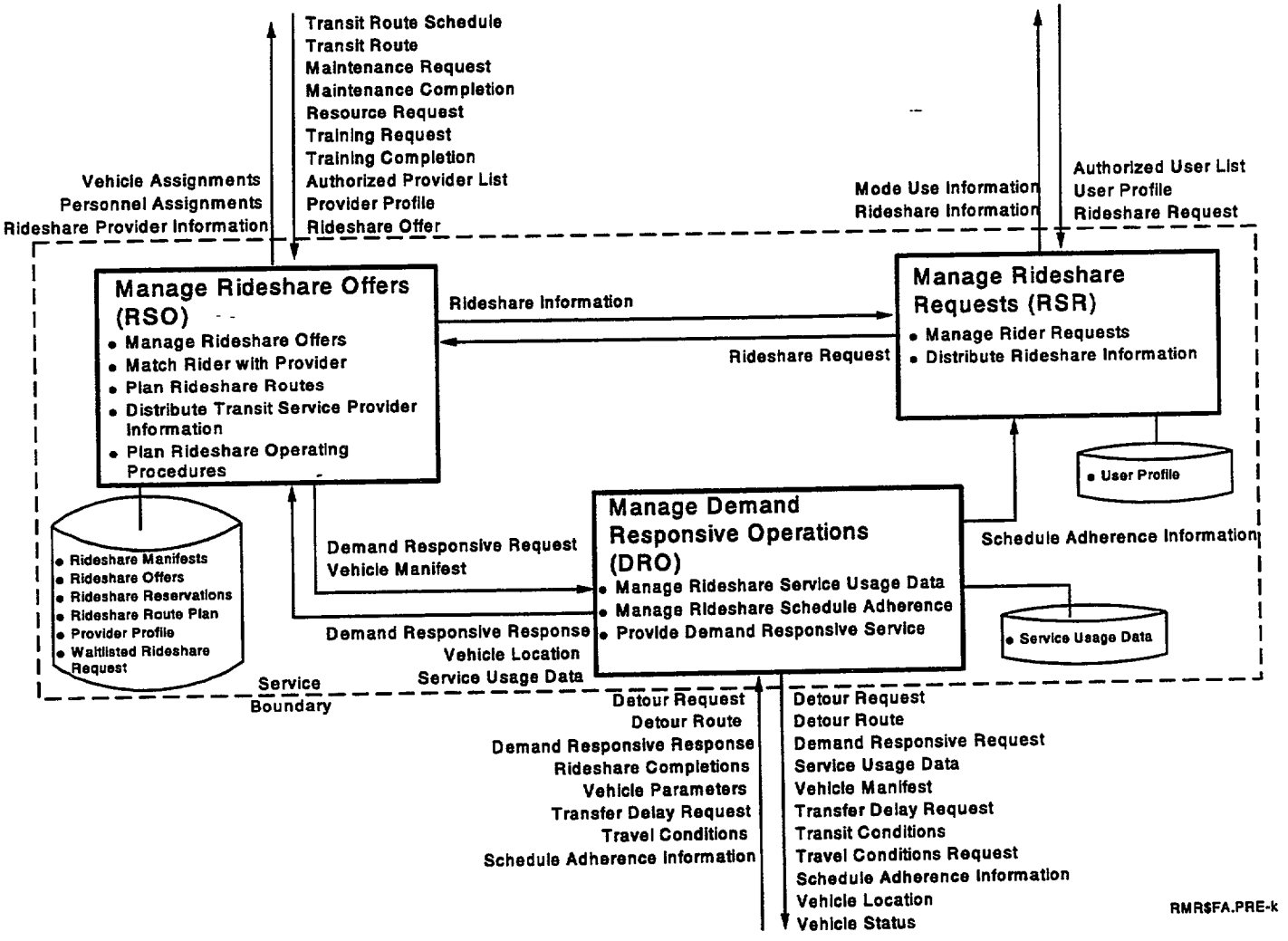


Figure 18. Ride Matching and Reservation - Functional Architecture

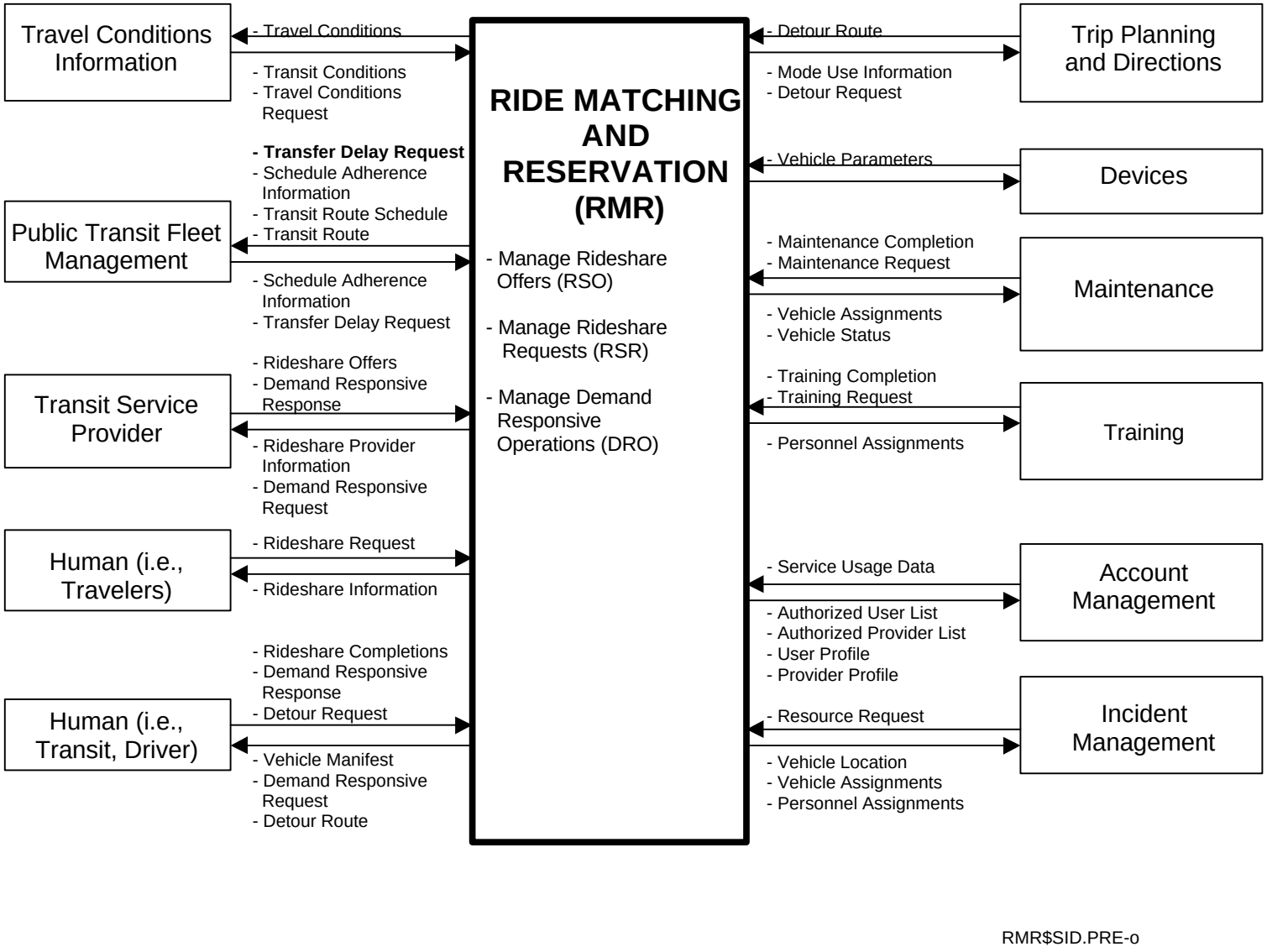


Figure 19. Ride Matching and Reservation - Service Interface Diagram

3.3.2.1 Manage Rideshare Requests (RSR)

The Manage Rideshare Requests (RSR) function provides an interface with authorized transit users that allows the user to specify trip requests and review information about available rideshare options. A reservation is made when the transit user accepts one of the available rideshare options. Imminent arrival notification, and general information about the rideshare program and rideshare providers is also provided to the transit user. Manage Rideshare Requests consists of the following subfunctions:

- **Manage Rider Requests (RRQ)** provides an interface with the transit user that allows the user to specify a trip request and review information about available rideshare options. This subfunction maintains a list of users that are authorized to use ride matching and reservation, and prevents access by unauthorized users. A reservation is made for the transit user when the user accepts one of the available rideshare options.

- **Distribute Rideshare Information (DRI)** provides the transit user with updated information about a rideshare request, imminent arrival notification, and general information about the rideshare program and rideshare providers.

3.3.2.2 Manage Rideshare Offers (RSO)

The Manage Rideshare Offers (RSO) function collects and maintains authorized rideshare provider trip offers for use in matching providers with riders. This function matches future day ride requests with planned vehicle routes, and matches real-time demand responsive ride requests with vehicle position and planned vehicle routes. When a match is found between provider and rider, a seat reservation is made with the provider. Individual daily route plans are developed and maintained for up to 30 days in advance of the day that the plan is actually executed. This function also generates reports and vehicle manifests that are needed to support rideshare provider operations. Manage Rideshare Offers consists of the following subfunctions:

- **Manage Rideshare Offers (RSO)** provides an interface with the rideshare provider that allows the provider to offer rides, reserve seats, and enter provider profile information. This subfunction maintains the list of authorized rideshare providers and collects and maintains rideshare provider trip offers and provider profile information for use in matching providers with riders.

- **Match Rider with Provider (MRP)** matches future day ride requests with planned vehicle routes, and matches real-time demand responsive ride requests with vehicle position and planned vehicle routes. When a match is found between provider and rider, a seat reservation is made with the provider. This subfunction also balances the assignment of ride&are vehicles and personnel to support rideshare operations, vehicle maintenance, and driver training.

- **Plan Rideshare Routes (PRR)** develops optimum route plans for random-route operations. Individual daily route plans are developed and maintained for up to 30 days in advance of the day that the plan is actually executed.

- **Distribute Transit Service Provider Information (DTSPI)** generates reports and vehicle manifests that are needed to support rideshare provider operations.

- **Plan Rideshare Operating Procedures (PRO) analyzes** passenger usage and other data obtained during daily rideshare operations in order to evaluate and continuously improve rideshare operating procedures and rideshare use instructions.

3.3.2.3 Manage Demand Responsive Operations (DRO)

The Manage Demand Responsive Operations (DRO) function coordinates real-time rideshare requests with available vehicles to support demand responsive operations. This function gathers vehicle location information from rideshare vehicles for schedule adherence tracking and demand responsive dispatch. This function also gathers passenger usage data for computing fares, and for planning future routes and schedules. The Manage Demand Responsive Operations function consists of the following subfunctions.

- **Manage Rideshare Service Usage Data (RSU)** gathers passenger usage data for use in fare payment computation and billing, and for planning future routes and schedules.

- **Manage Rideshare Schedule Adherence (RSA)** gathers vehicle location information from rideshare vehicles for schedule adherence tracking and demand responsive dispatch. This subfunction compares planned to actual vehicle location in order to determine how well the vehicle is adhering to the planned route schedule. When a vehicle gets significantly behind schedule, this subfunction assists the dispatcher and/or vehicle driver in regaining schedule adherence along the route. This subfunction also coordinates planned passenger transfer operations.

- **Provide Demand Responsive Service (DRS)** coordinates real-time rideshare requests with vehicle drivers to support demand responsive operations.

3.3.3 Sample Operational Scenarios

The scenarios in Figure 20 and Figure 21 show how the Ride Matching and Reservation Service a) collects rider requests and provider rideshare offers, b) generates a rideshare route plan, and c) matches rider requests with provider offers. The first scenario starts when a rider requests a shared ride and ends when either a seat is reserved or when the request is waitlisted. The second scenario describes how trips are removed from the waitlist by re-optimizing the rideshare route plan. This scenario is both "event driven," meaning that it is started when a provider submits a rideshare offer, and "batch driven," meaning that rideshare route plans are generated on a time cyclical basis (generally during off-shift hours because of resource intensive processing).

Each scenario begins at the top left of the figure. The rectangular boxes indicate major tasks (and functions) that are performed during the scenario. The lines and arrows connecting the rectangular task boxes indicate the flow of control from one task to the next. Data elements labeled on these lines indicate the data flowing between the tasks. The storage disc icons indicate data that is either stored or used by the task

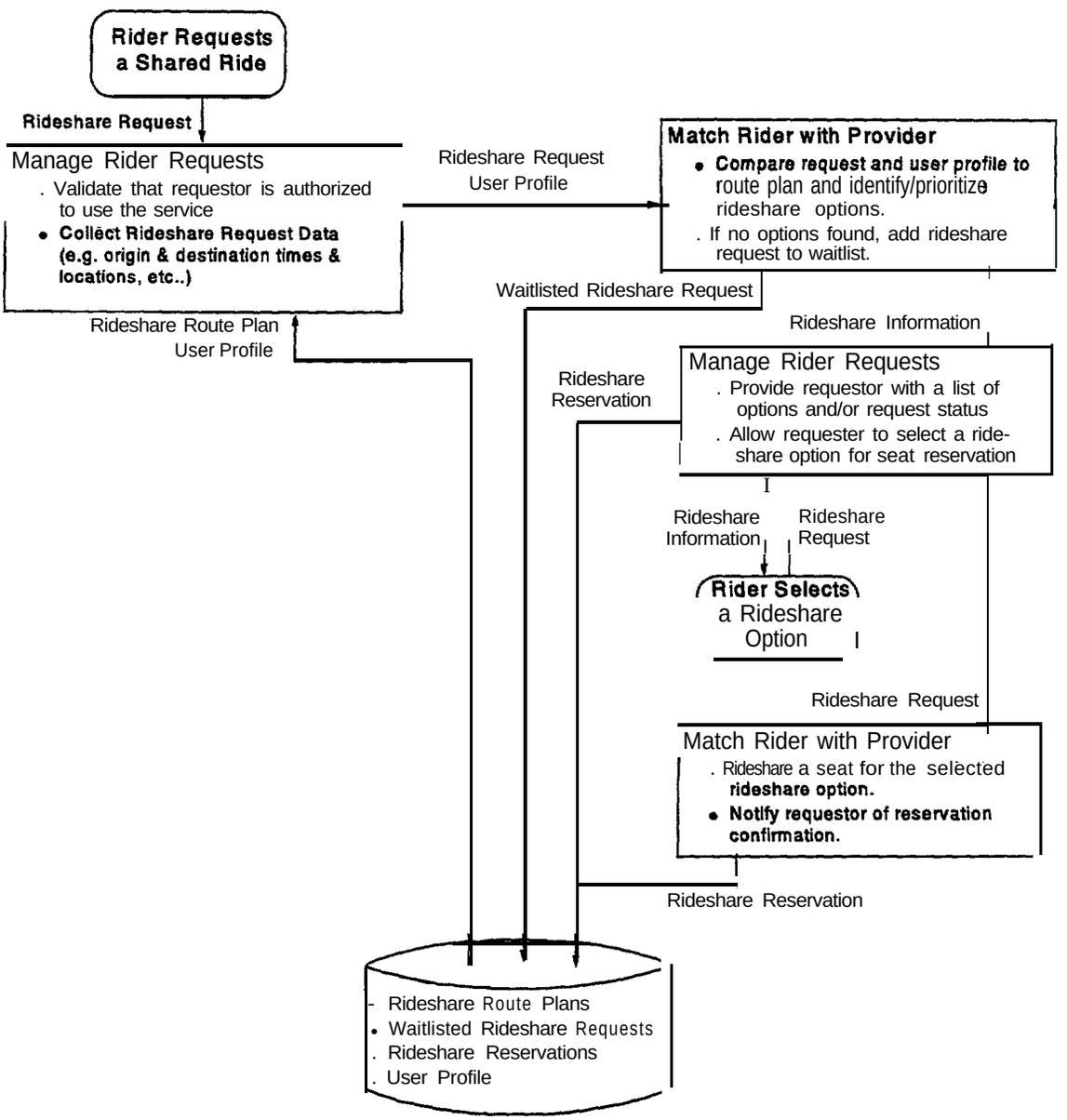


Figure 20. Ride Matching and Reservations Scenario - Reserve a Ridesharing Trip on a Future Date

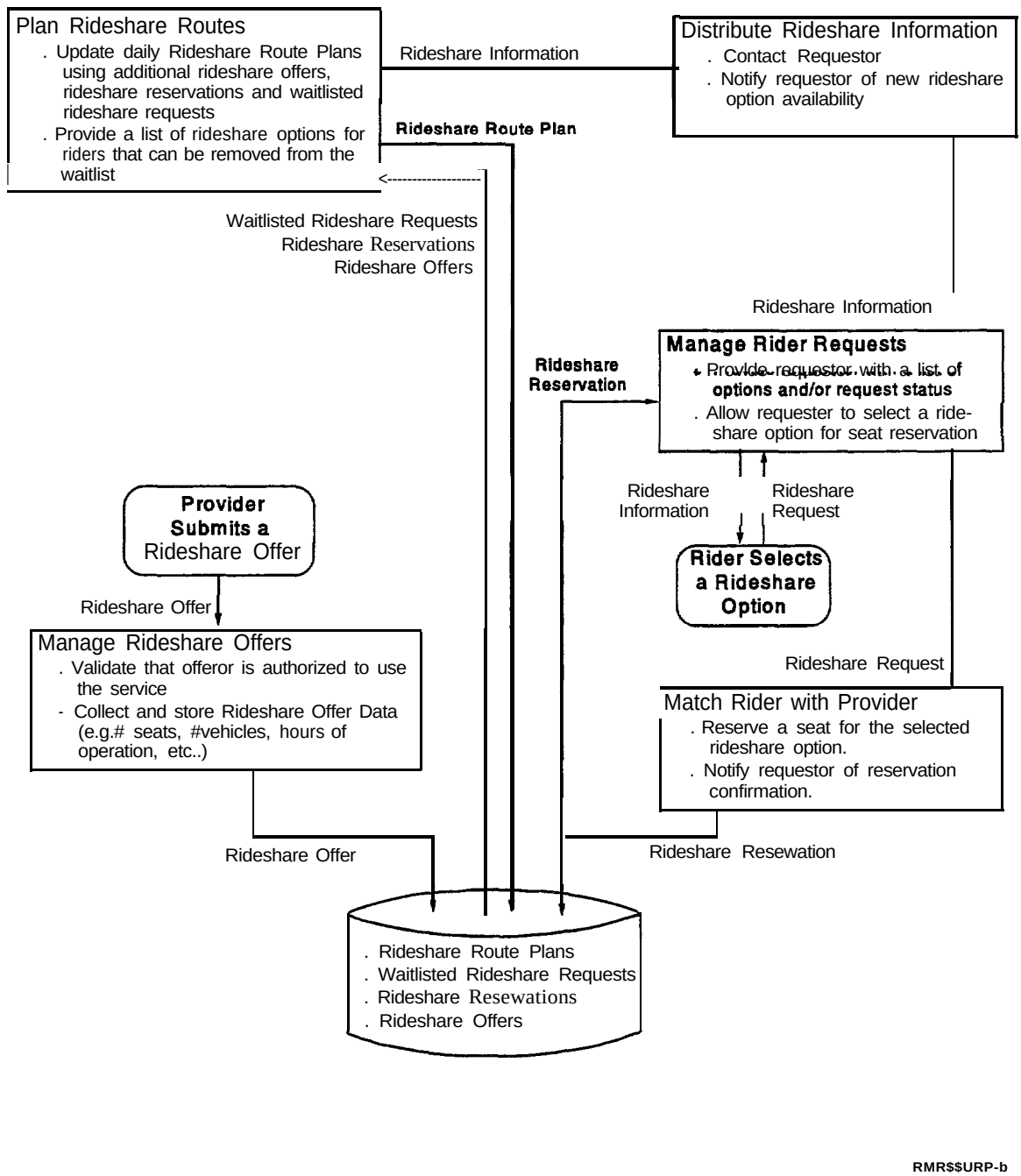


Figure 2 1. Ride Matching and Reservations Scenario - Update Rideshare Route Plan

3.3.4 Physical Architecture

Ride Matching and Reservations functionality is physically implemented as shown in Figure 22, Ride Matching and Reservations - Physical Architecture. The architecture illustrated in this figure shows how the various Minnesota ITS components are interconnected to provide the Ride Matching and Reservations Service. Arrows between the components are labeled with tags for identifying the input data flows to a component. Appendix D, *Physical Architecture Component Interfaces,* associates each tagwith the corresponding component input data flows.

The public management centers in this figure (i.e.; Regional ITS Management Center, Rideshare Center, Demand Responsive Transit Centers) manage the overall daily operations and off-line planning and analysis required to ensure smooth, predictable rideshare operations. This management includes collection of information from the rideshare vehicle fleet, collection of rider requests, development of rideshare routes and schedules, assignment of riders to rideshare providers, communications with rider user interface equipment, and distributes rideshare data to the rest of the Intelligent Transportation System.

The concept behind the Regional ITS Management Center is to consolidate as many of the transit and rideshare management functions, central data repository and data management as possible. The presence of the Rideshare Center and Demand Responsive Transit Centers components on the figure acknowledges the organizational reality that some Management Center functions will most likely not be combined due to fiscal and other existing constraints.

The Inter-jurisdictional Transit System is provided to facilitate and manage the many anticipated rider transfers that will be performed across rideshare agencies and jurisdictions. The privately owned Transit Service Providers provide on-demand and supportive transit service beyond that provided by the metro transit authority. The User Interface Equipment represents the many and varied ways (i.e. telephone, FAX, E-mail, modem) in which a rider can contact the rideshare authorities to make reservations. The Security Firewall System provides a secure firewall for two-way data exchange between government owned/leased and privately owned networks, and also supports routing of transit fleet information between public agencies and private information provider companies.

The numbers inside each component box identify the Ride Matching and Reservations Service subfunctions that have been allocated to each component. The code for these numbers is as follows:

1. Manage Rider Requests (RRQ)
2. Distribute Rideshare Information (PRI)
3. Manage Rideshare Offers (RSO)
4. Match Rider with Provider (MRP)
5. Plan Rideshare Routes (PRR)
6. Distribute Transit Service Provider Information (DTSP)
7. Manage Rideshare Service Usage Data (RSU)
8. Manage Rideshare Schedule Adherence (RSA)
9. Provide Demand Responsive Services (DRS)
10. Plan Rideshare Operating Procedures

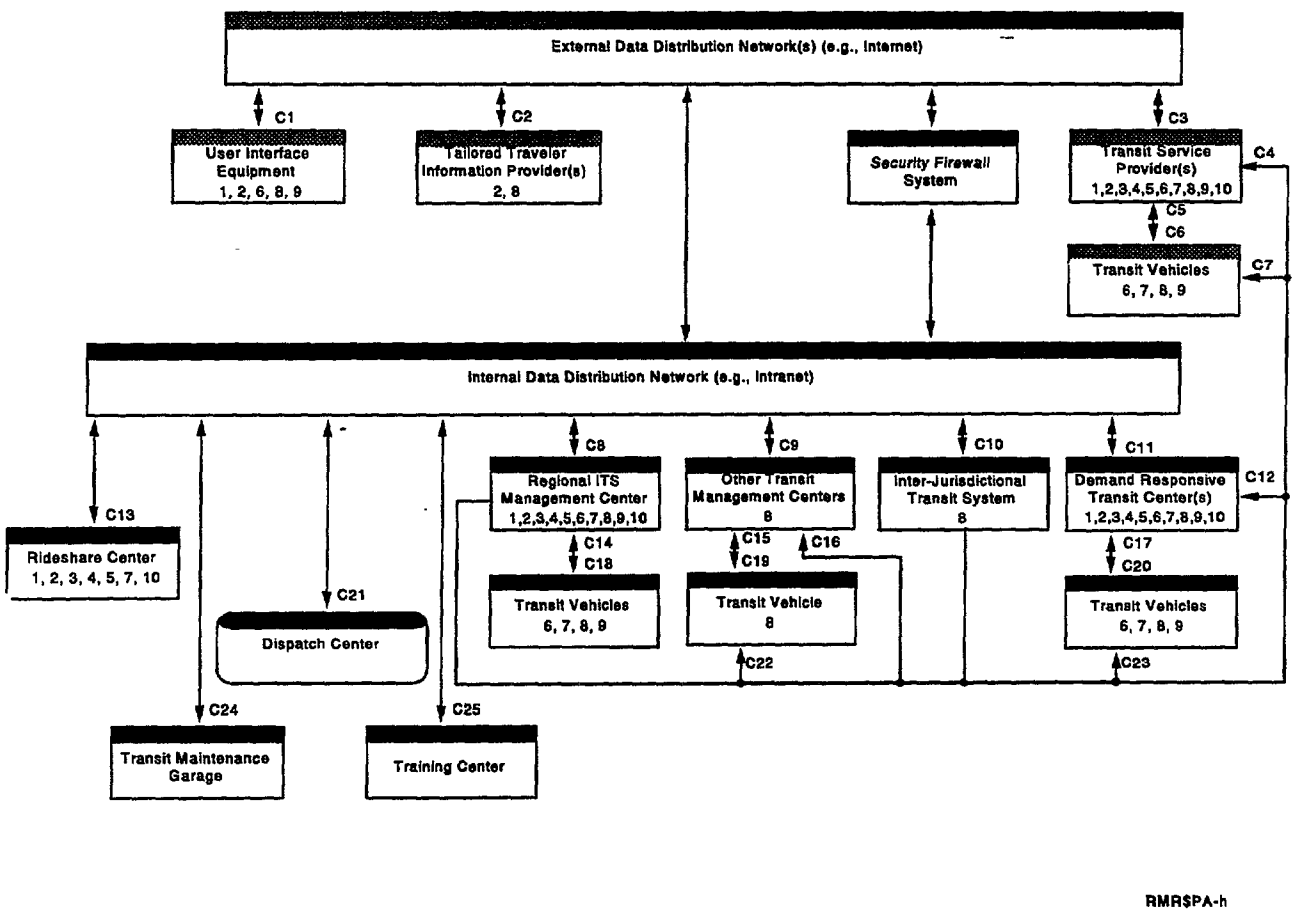


Figure 22. Ride Matching and Reservations - Physical Architecture

3.4 Traveler Services Information

Traveler Services Information (TSI) provides travelers with access to "yellow pages" information such as restaurants, lodging, vehicle services, tourist sights, shopping and special events. Users can request and receive traveler services information that is tailored to their specific request, their preferences (such as price, provider, cuisine, etc.) and/or a location perspective (such as nearest to my current location, at this exit, along my route, at my destination, etc.). This service also provides the traveler with the capability to make reservations or purchase tickets. The Traveler Services Information service can interact with the Trip Planning and Directions service to provide users with routes, directions and/or a trip itinerary that is based on the traveler services that were requested.

3.4.1 Service Goals and Objectives

The following service goals and objectives help guide the migration to a **Traveler Services Information** service architecture that is consistent with the Minnesota Traveler Wants and Needs and the Minnesota Agency Wants and Needs research results.

- Provide access to comprehensive yellow pages information about restaurants, lodging/camping, recreational areas, vehicle services, emergency medical facilities, tourist sights, special events, entertainment, shopping, airlines and rental vehicles.

- Provide an interface to the Trip Planning and Directions Service so that travelers can easily obtain directions to their selected traveler services item.

- Provide the ability for travelers to make reservations and/or purchase tickets electronically.

- Provide traveler services information to travelers whenever and wherever needed through a variety of devices.

- Provide regional coordination in collecting, processing and presenting traveler services information.

3.4.2 Functional Architecture

Traveler Services Information consists of the following functions as shown in Figure 23, Traveler Services Information Service - Functional Architecture:

- Manage Traveler Services Data
  - Collect Traveler Services Source Data
  - Manage Basic Traveler Services Information
- Manage Tailored Traveler Services Information
  - Determine Tailored Traveler Services Information
  - Make Reservations
  - Distribute Traveler Services Information

A summary description of each function and subfunction is provided in the following subsections. The requirements that characterize each subfunction are located in Appendix B. Appendix B is a separate report generated from a Microsoft Access relational database. Title of the Microsoft Access Report that supports Appendix B is: *Requirements by Service - Function -Subfunction.*

Traveler Services Information interfaces with the following services as shown in Figure 24, Traveler Services Information - Service Interface Diagram:

- Account Management
- Public Transit Fleet Management
- Trip Planning and Directions
- Other
  - External Information Sources
  - Human (i.e.; Drivers, Transit Users)
  - Parking Management Centers

In Figure 23 and Figure 24, the arrows between the functions and services represent information data flows. Appendix C, *Data Flows by Function for ITS Services,* defines the input and output data flows for each service and the service's functions. Appendix C is a separate report generated by Microsoft Access.

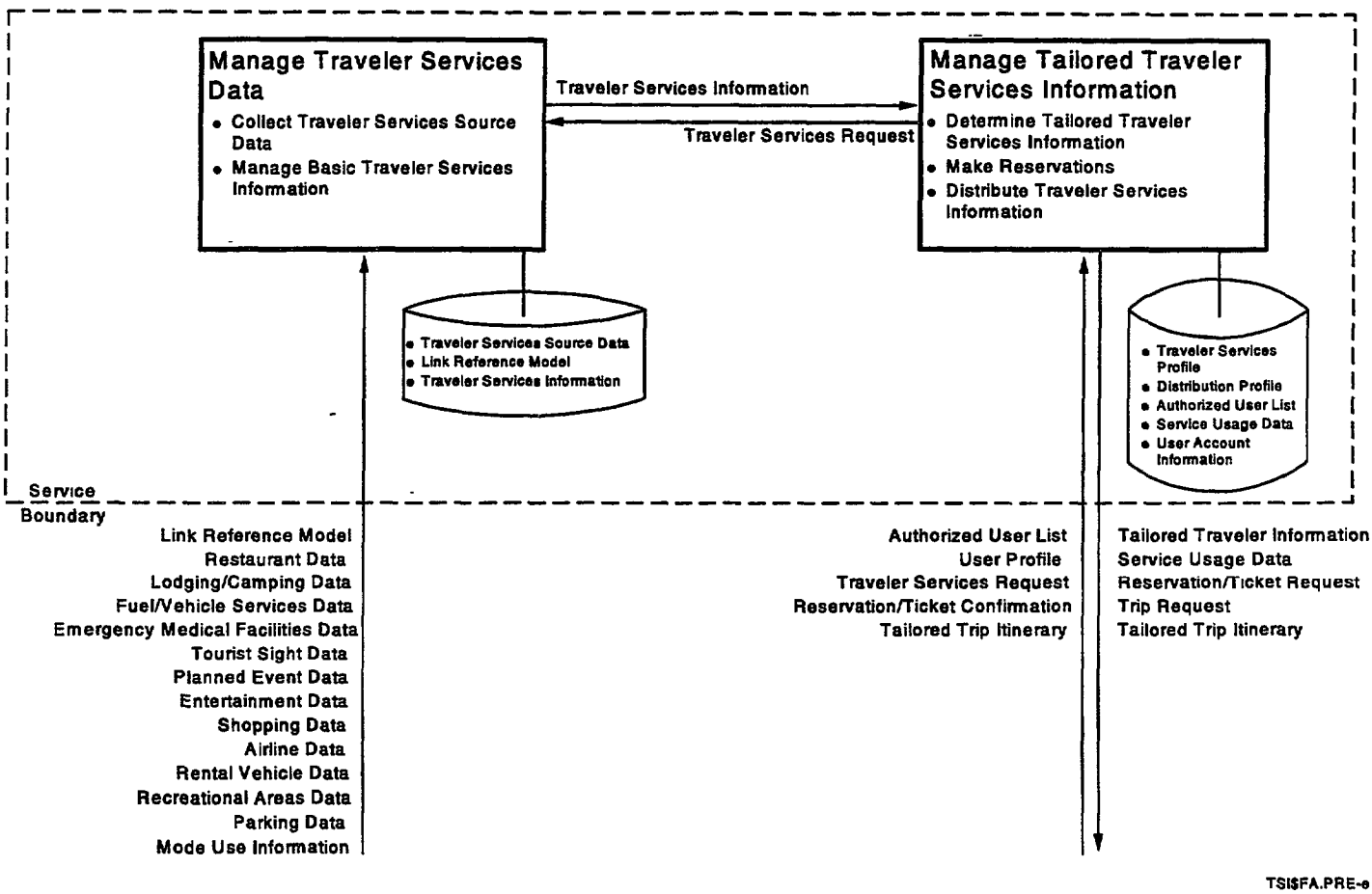
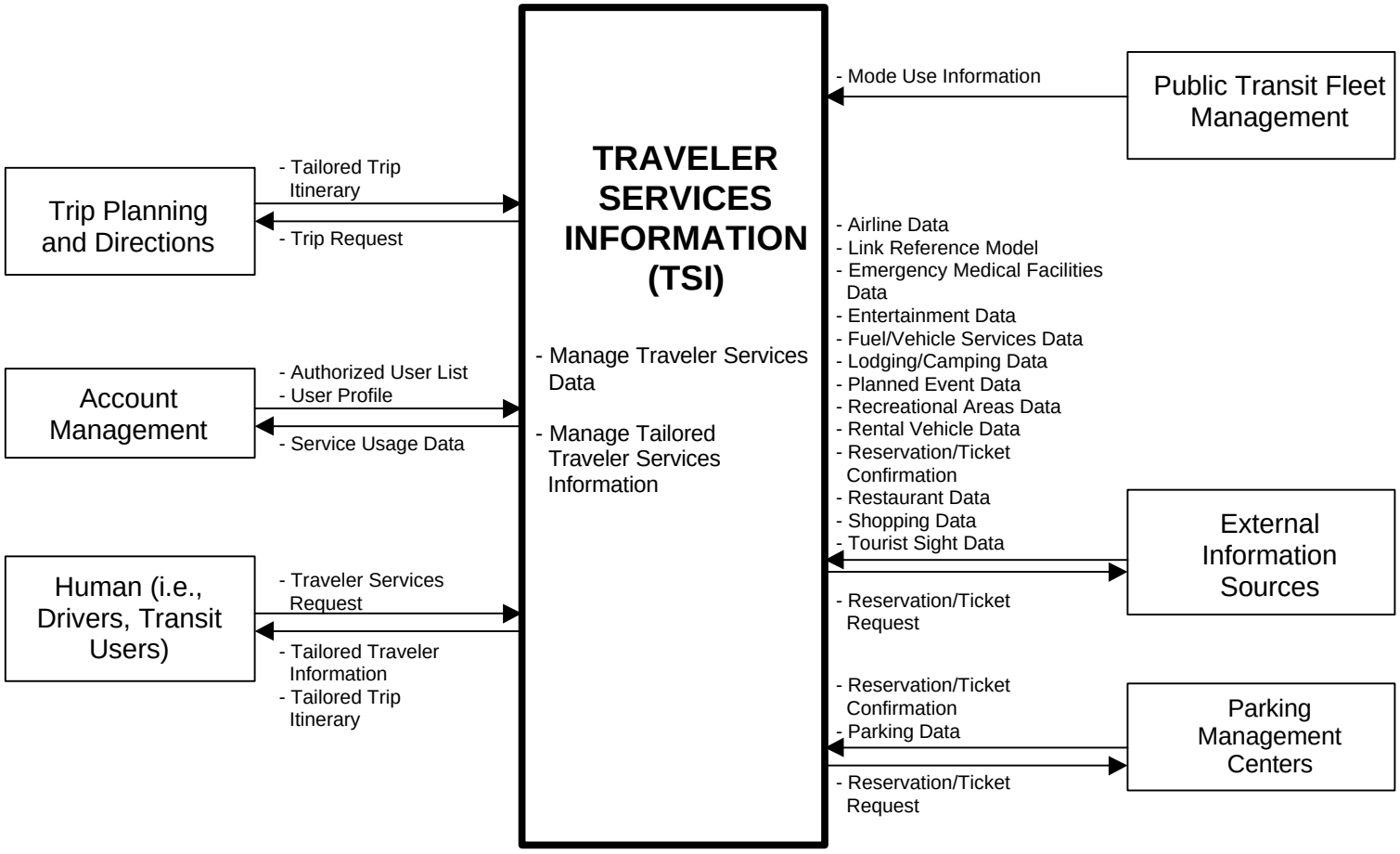


Figure 23. Travel Services Information - Functional Architecture



TSI$SID.PRE-g

Figure 24. Traveler Services Information - Service Interface Diagram

3.4.2.1 Manage Traveler Services Data (MTSD)

The Manage Traveler Services Data (MTSD) function accepts and stores all traveler services data from various sources, and references the traveler services data to specific geographic points of reference, such as roadway segments, rail segments, bus route segments, bicycle path segments and waterway segments. The Manage Traveler Services Data function consists of the following subfunctions:

- **Collect Traveler Services Source Data (CTS)** gathers and stores information about restaurants, lodging, vehicle services, emergency medical facilities, tourist sights, planned events, recreational areas, entertainment, shopping, airlines and rental car companies. Key attributes of each traveler service facility, service, or event, such as name, address, type, phone number, etc., are stored. Multiple input formats are supported including voice, fax and digital.

- **Manage Basic Traveler Services Information (BTS)** maps the traveler services source data to the transportation network model (e.g.; roadways, bus routes, etc.)

3.4.2.2 Manage Tailored Traveler Services Information (MTTS)

The Manage Tailored Traveler Services Information (MTTS) function receives requests for traveler services and verifies that the users are authorized for this service. Traveler services are tailored according to users' traveler services profiles and the information in their specific traveler services request. Optionally, users can make airline, lodging, dining, entertainment, parking and/or rental vehicle reservations via this service. Users can also purchase tickets for events, such as shows, concerts or sports via this service. Tailored traveler services information is formatted for the designated user devices, and transmitted to the user. Service usage data is also provided to the Account Management service to support billing. The Manage Tailored Traveler Services function consists of the following subfunctions:

- **Determine Tailored Traveler Services Information (DTTS)** determines requested traveler services information based on parameters specified in the request and criteria contained in a user profile.

- **Make Reservations (MR)** allows a user to make reservations or purchase tickets for travel, dining, entertainment and/or parking. Multiple devices are supported including phone, computer, fax and e-mail.

- **Distribute Traveler Services Information (DTSI)** provides users with the ability to request and receive traveler services information via a variety of devices including phone, fax, computer, e-mail and m-vehicle devices.

3.4.3 Sample Operational Scenarios

The scenarios in Figure 25, Figure 26, Figure 27 and Figure 28 show how the Traveler Services Information service collects, stores and distributes information about restaurants, hotels, special events, tourist sights, gas stations and other information that would be of interest to users (both visitors to, and residents of, a given area). The first scenario shows how the Traveler Services Information service collects the information about traveler services and references it to the transportation network model. This serves as the base information for all requests. The second scenario shows how users request and receive traveler services information that is tailored to their specific request and to their preferences (via a user profile). This scenario also shows how users can make reservations for travel, dining, entertainment and/or parking using this service. In addition, this scenario shows how the Traveler Services Information service interacts with the Trip Planning and Directions service to provide the user with directions and/or a trip itinerary based on the traveler services information that was requested.

Each scenario begins at the top of the figure. The rectangular boxes indicate major tasks (and functions) that are performed during the scenario. The lines and arrows connecting the rectangular task boxes indicate the flow of control from one box, or task, to the next. Data elements labeled on these lines indicate the data flowing between the boxes. This data will be used by the next task. The storage disc icons on the left of the task boxes (with lines and arrows leading to the task box) indicate stored data that is used by the task. The rectangular boxes connected to these storage discs indicate the task that generated this data. The storage disc icons on the right of the task boxes indicate data that is generated and stored by that task. The dotted rectangular boxes indicate a major task(s) that is performed by another service.

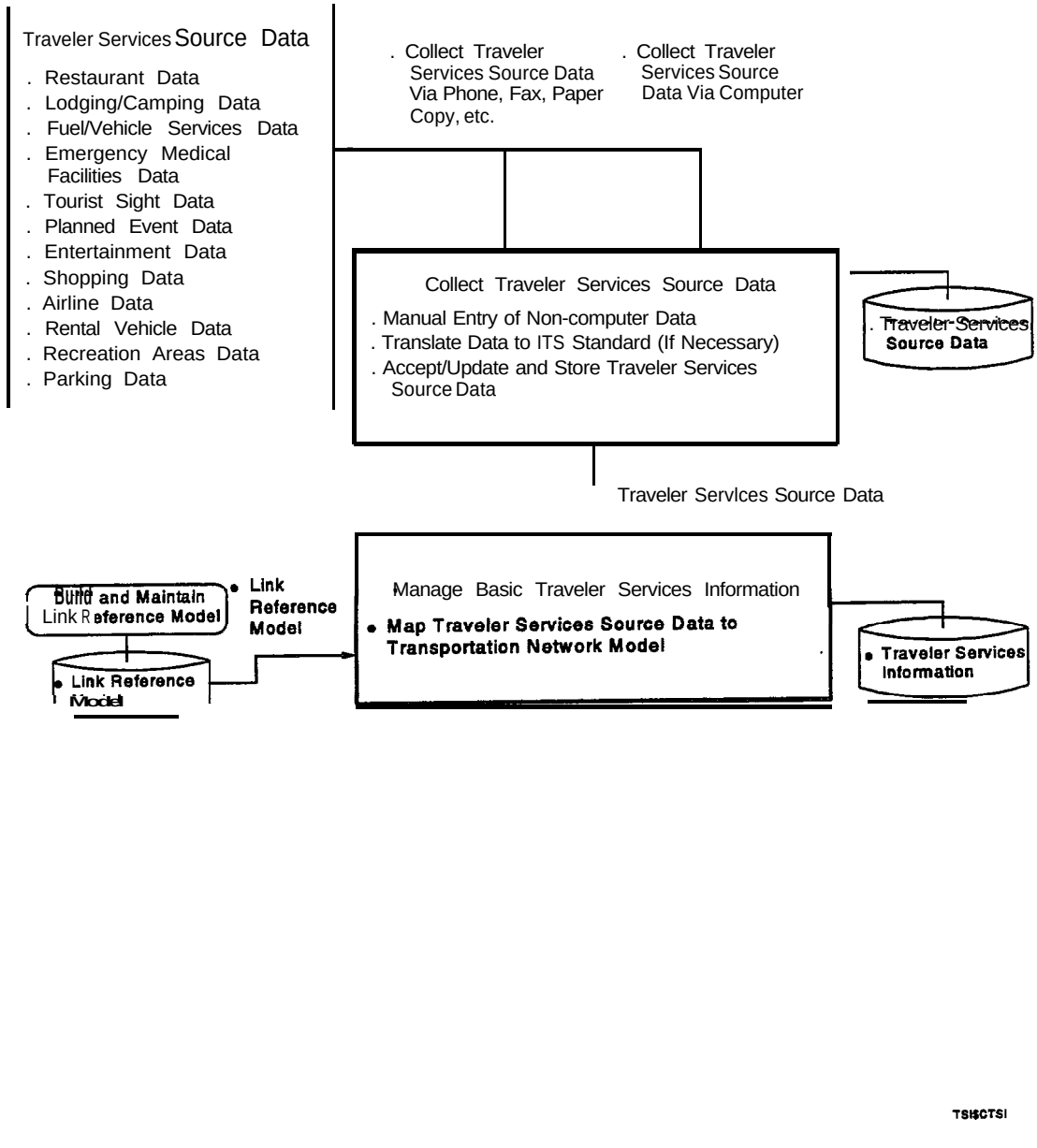


Figure 25. Traveler Services Information - Collect and Store Traveler Services Information

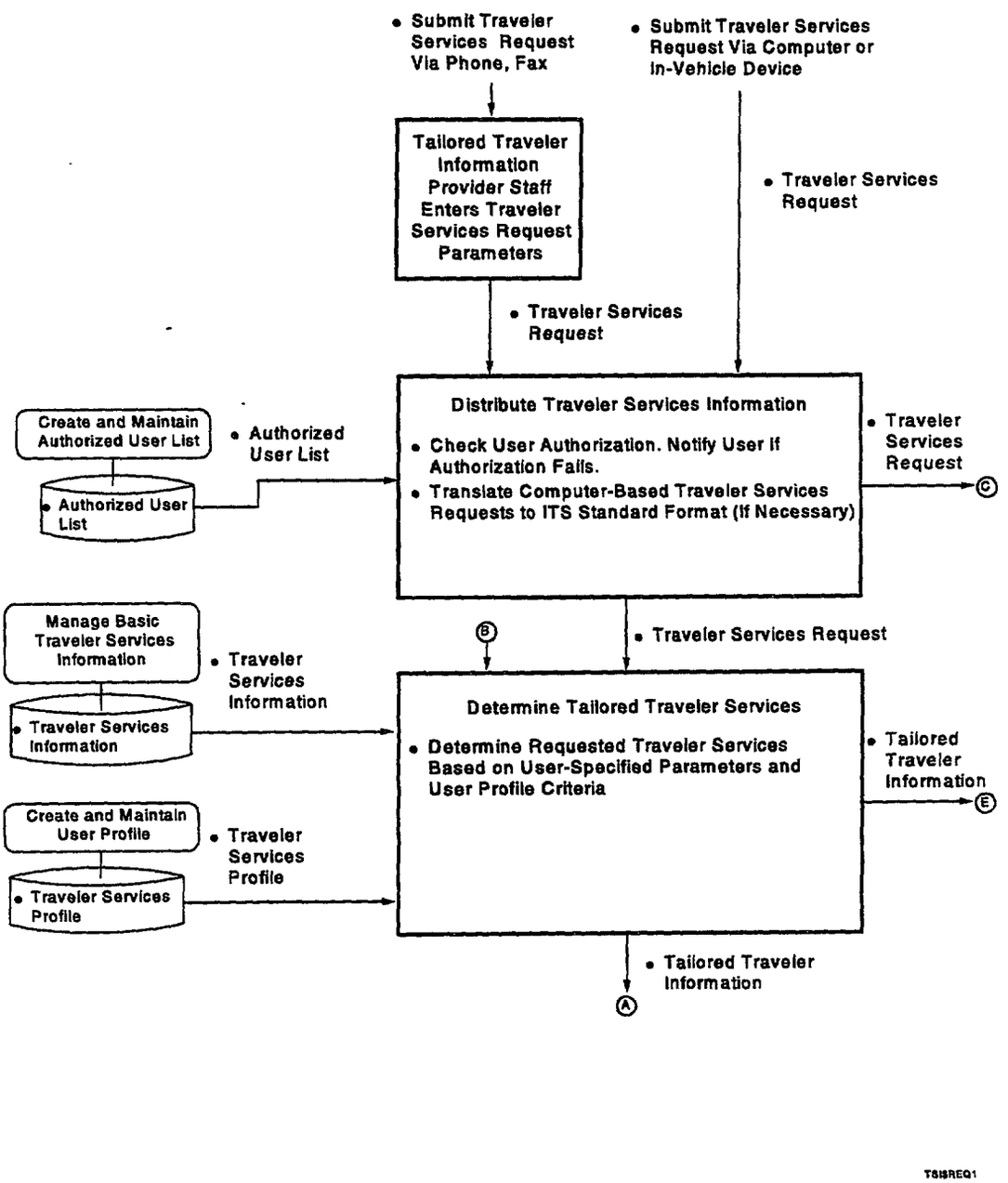


Figure 26. Traveler Services Information - Process Traveler Services Information Request

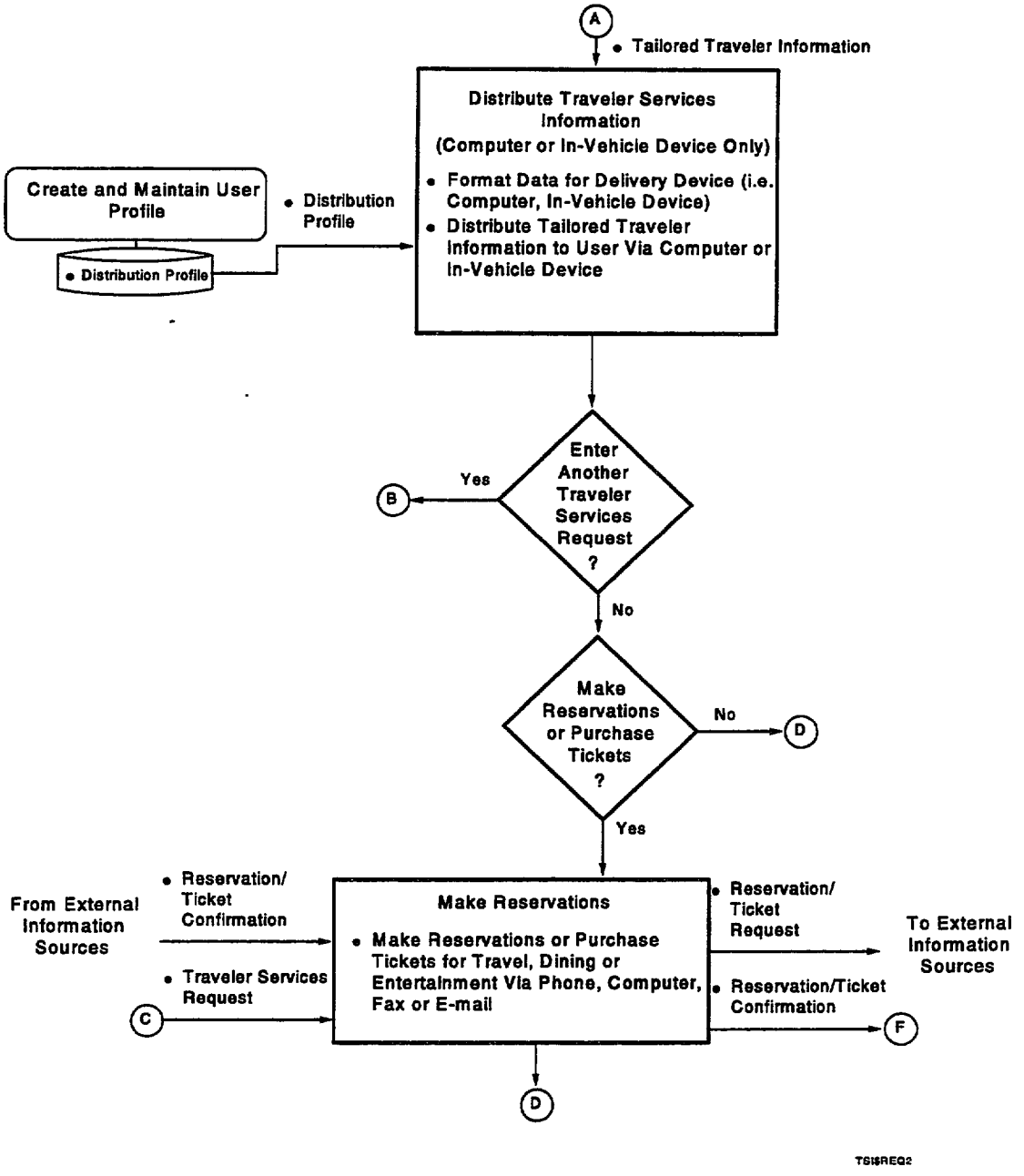


Figure 27. Traveler Services Information - Process Traveler Services Information Request (Cont)

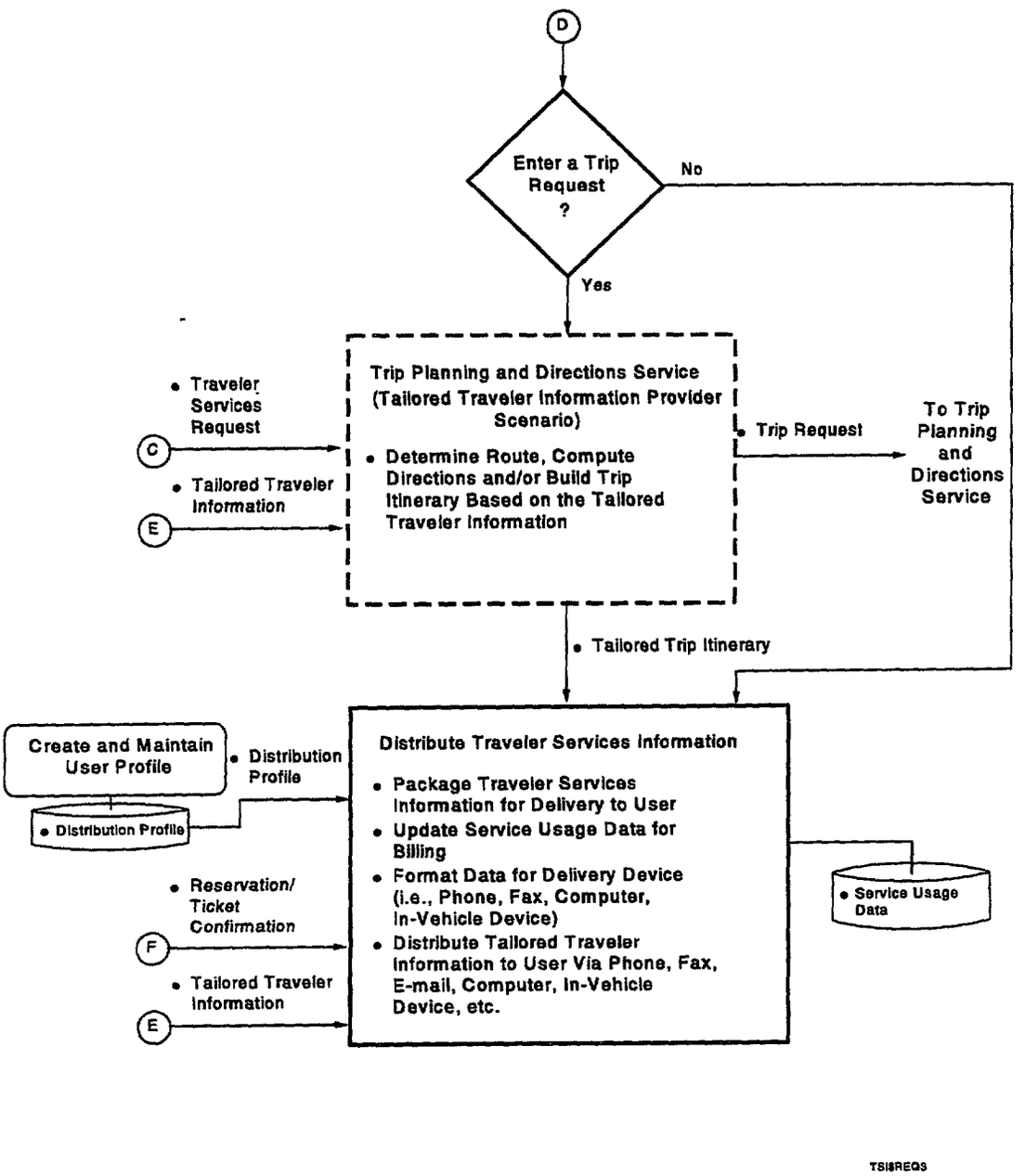


Figure 28. Traveler Services Information - Process Traveler Services Information Request (Cont)

3.4.4 Physical Architecture

The architecture shown in Figure 29, Traveler Services Information - Physical Architecture, shows how the various Minnesota ITS components are interconnected to provide the Traveler Services Information Service. Arrows between the components are labeled with tags for identifying the input data flows to a component. Appendix D, *Physical Architecture Component Interfaces*, associates each tag with the corresponding component input data flows.

In this architecture, the public agencies utilize a Regional ITS Management System for sharing information, such as parking facilities or how to use the transit system, with privately-owned information provider companies. Information provider companies use this information when providing traveler services information to their customers. As the operational and political environment develops, it is envisioned that the Regional ITS Management System could be located at the Regional ITS Management Center.

The public agencies in this figure (e.g., Regional ITS Management Center, Other Transit Management Center(s) and Parking Management Center(s)) send public traveler services source data, such as parking facility information (e.g., location, rates, etc.) and transit mode use information to the Regional ITS Management System. The Parking Management Center(s) will also be responsible for accepting reservations for parking (if this function is implemented at some time in the future).

The Regional ITS Management System passes on the public traveler services source data to Information Provider companies in the private sector (e.g.; Tailored Traveler Information Providers). It also maintains a parking facility and transit mode use information database that both public agencies and Information Provider companies can use for data recovery, and serves as a centralized management point where all public-private agency interfaces are defined and maintained.

The Security Firewall System provides a secure firewall for two-way data exchange between government owned/leased and privately owned networks, and also supports routing of information between public agencies and private Information Provider companies. The External Information Source(s) provide travel conditions source data, such as restaurant, hotel, tourist sight, vehicle services, etc., to the Information Provider companies and process requests for reservations or ticket purchases.

The User Interface Equipment can provide a range of capabilities depending on the type of equipment. It can consist of a computer that can directly process traveler services information requests, connecting to the network only for updates to the source information and/or to make a reservation or ticket purchase, or it can be a telephone that only allows users to request traveler services information, with the actual processing of the request taking place on systems located elsewhere in the network. The Transit Information Distribution Equipment would consist of a kiosk type computer and would be used to give travelers (mainly transit users) traveler services information about restaurants, tourist sights, shopping, etc., near that transit location.

The numbers, inside each box in the figure, identify the Traveler Services Information Service Functional Architecture subfunctions that have been allocated to that box. The code for the numbers is defined as follows:

1. Collect Traveler Services Source Data (CTS)
2. Manage Basic Traveler Services Information (BTS)
3. Determine Tailored Traveler Services (DTTS)
4. Make Reservations (MR)
5. Distribute Traveler Services Information (DTSI)

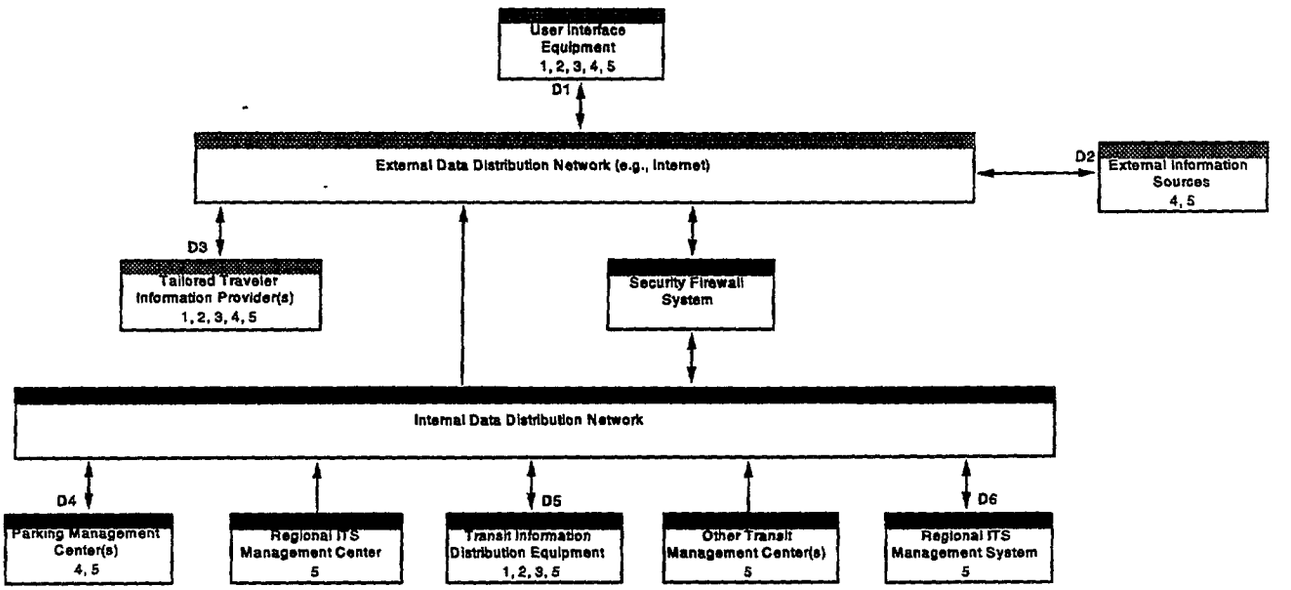
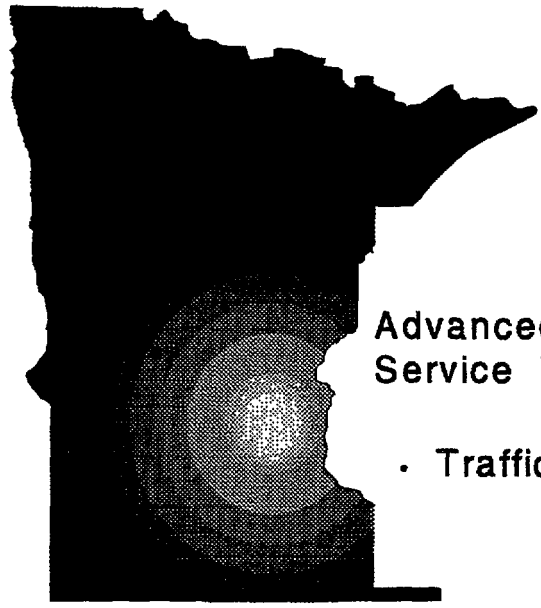


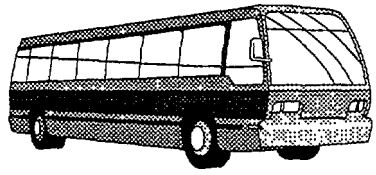
Figure 29. Traveler Services Information - Physical Architecture

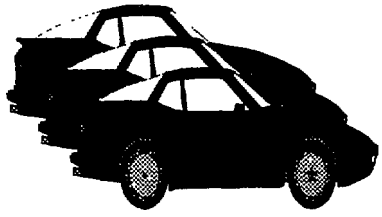
4 Advanced Traffic Management



Advanced Traffic Management **Service Bundle:**

- **Traffic** Control





4 Advanced Traffic Management

4.1 Traffic Control

Traffic Control(TC) provides the capabilities to optimize traffic movement on freeways, highways, and arterials throughout jurisdictions and multi-jurisdictional areas. This service provides for coordinated traffic flow via pre-planned traffic control plans. Signal timing and message signing are adaptable based on control plans and real-time traffic conditions feedback.

4.1.1 Service Goals/Objectives

This section contains the service goals and objectives needed to manage the migration to a **Traffic Control** architecture that is consistent with the Minnesota Traveler Wants and Needs and the Minnesota Agency Wants and Needs research results.

- Provide traffic control to minimize stops and delays based on input from detectors and/or available travel conditions information (accidents, special events, construction, detours, etc.)

- Provide information to travelers on route alternatives with optimized traffic control (e.g., switched to faster timing plan, HOV lane available, etc.)

- Provide traffic control pre-emption services for authorized vehicles.

- Provide “seamless” control across jurisdictional boundaries.

4.1.2 Functional Architecture

Traffic Control consists of the following functions as shown in Figure 30, Traffic Control Service - Functional Architecture:

- Plan Traffic Control Strategies
  - Manage Traffic Control Requirements
  - Manage Traffic Control Strategies/Plans
- Manage Signal Network Operations
  - Control Signal Modes
  - Implement/Adapt Signal Timing Plans
  - Manage Signal Resources
- Manage Sign Network Operations
  - Control Sign Modes
  - Implement/Adapt Signing Control Plans
  - Manage Signing Resources
- Monitor Traffic Conditions
  - Sense Traffic Surveillance Data
  - Collect Traffic Surveillance Data
  - Determine Traffic Conditions
  - Distribute Traffic Conditions

A summary description of each function and subfunction is provided in the following subsections. The requirements that characterize each subfunction are located in Appendix B. Appendix B is a separate report generated from a Microsoft Access relational database. Title of the Microsoft Access Report that supports Appendix B is: ***Requirements by Service - Function - Subfunction.***

Traffic Control interfaces with the following services as shown in Figure 3 1, Traffic Conditions - Service Interface Diagram:

- Incident Management
- Public Transit Fleet Management
- Travel Conditions Information
- Other
  - Devices (i.e., Video, Detectors)
  - External Information Sources
  - Human (i.e., Drivers, Traffic Operations Personnel)

In Figure 30 and Figure 3 1, the arrows between the functions and services represent information data flows. Appendix *C, Data Flows by Function for ITS Services,* defines the input and output data flows for each service and the service's functions. Appendix C is a separate report generated by Microsoft Access.

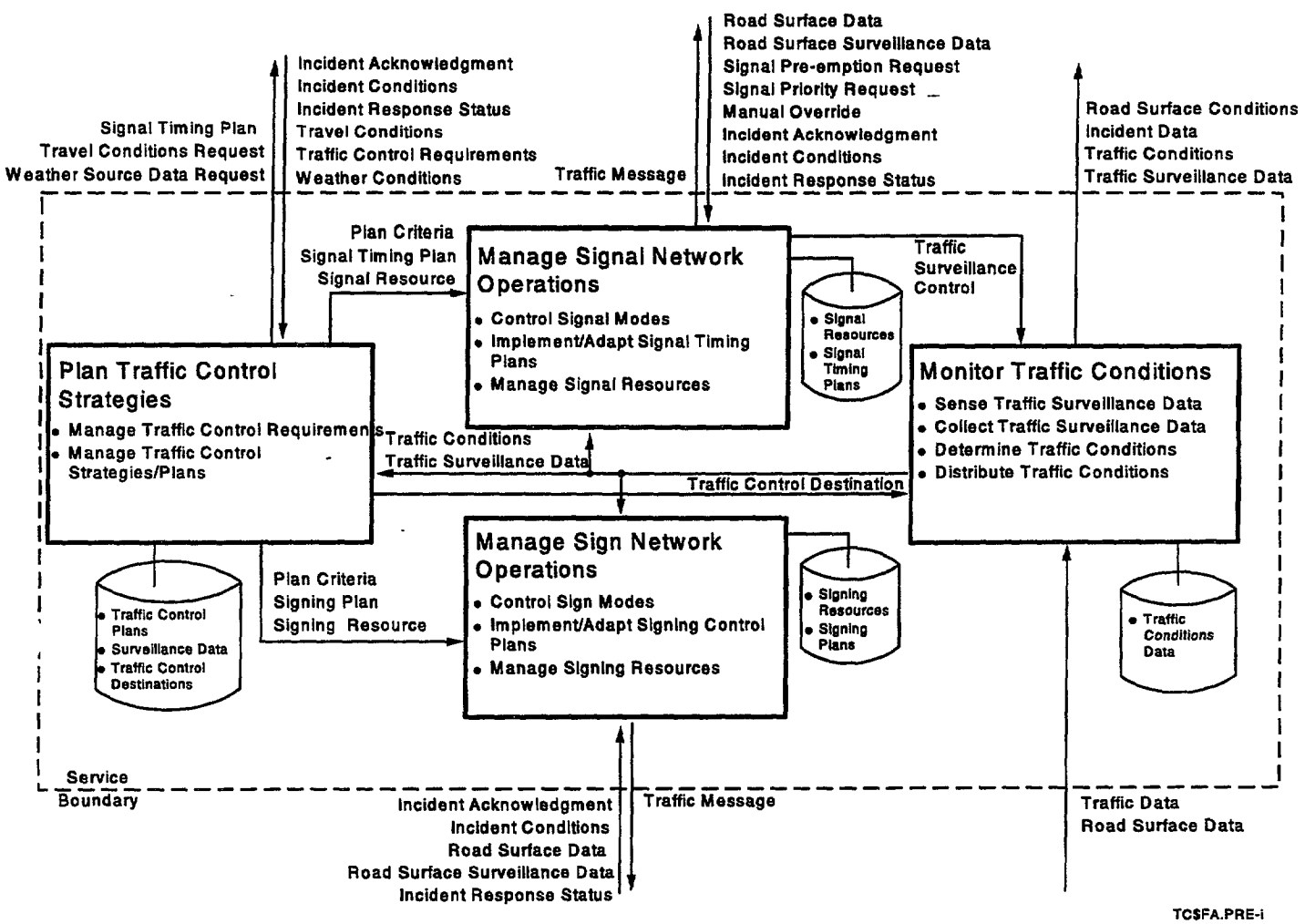


Figure 30. Traffic Control - Functional Architecture

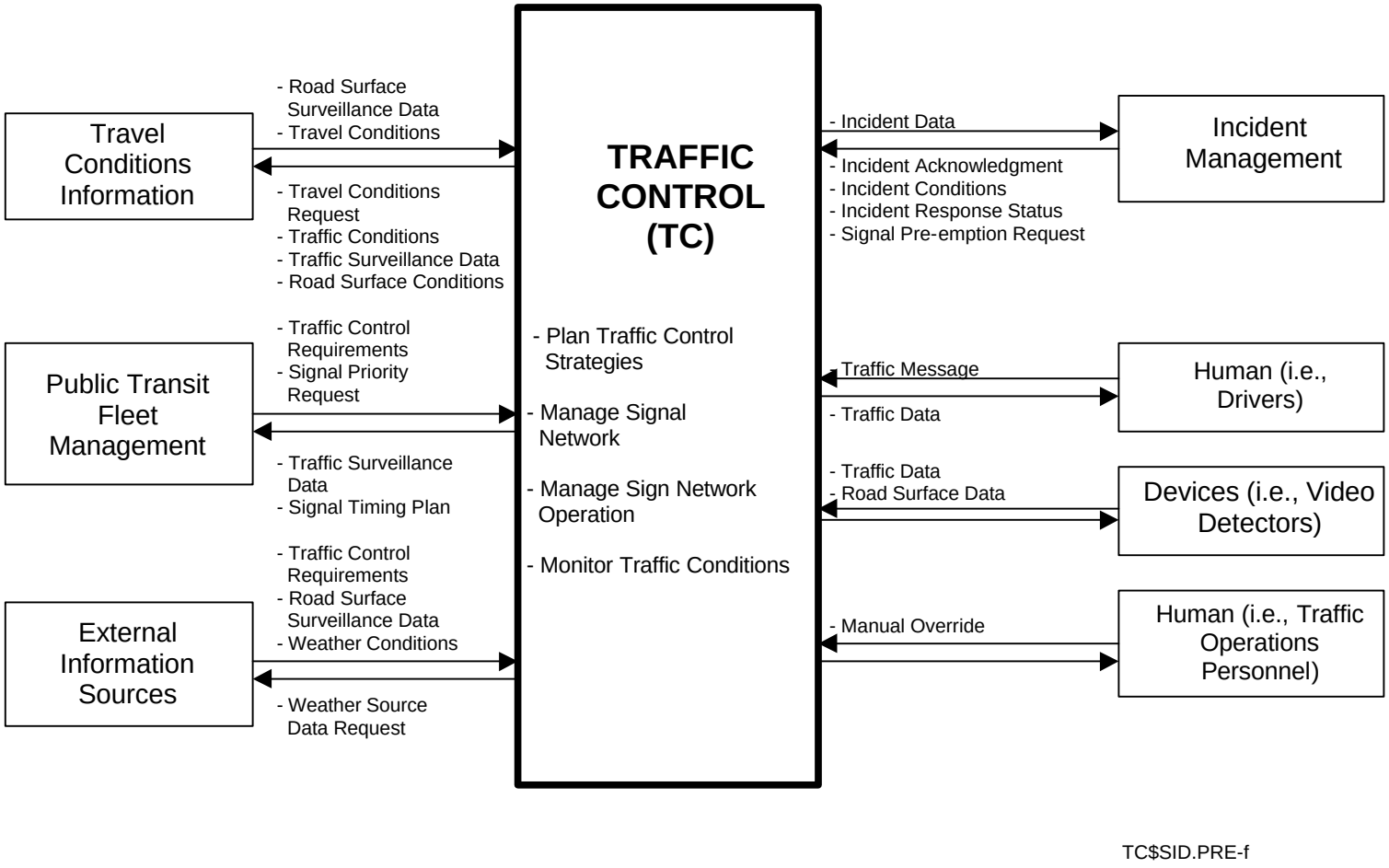


Figure 31. Traffic Control - Service Interface Diagram

4.1.2.1 Plan Traffic Control Strategies (PTC)

The Plan Traffic Control Strategies (PTC) function is responsible for the creation and maintenance of traffic control plans. Control plans are developed and updated based on traffic control requirements, available traffic control resources, and traffic volume/occupancy data. Control plans can be defined for a single intersection or transportation link (e.g., a freeway ramp meter or street intersection), a series of intersections along an arterial, or an entire signal network across large geographical areas and multiple jurisdictions. Available traffic management resources including equipment, personnel and funding are allocated in a manner that best meets the traffic control requirements. The Plan Traffic Control Strategies function consists of the following subfunctions:

- **Manage Traffic Control Requirements (TCRQ)** collects and maintains traffic control requirements from various sources such as travelers' needs, private agency needs, and public agency needs.

- **Manage Traffic Control Strategies/Plans (TCP)** analyzes traffic requirements and historical traffic performance data. The analysis is used in developing traffic control strategies for optimum flow and incident response across a wide area and cross jurisdictions. This subfunction provides measures of effectiveness to support continuous improvement in traffic control.

4.1.2.2 Manage Signal Network Operations (MSN)

The **Manage Signal Network Operations (MSN)** function is responsible for implementing signal timing plans across the signal network, adapting signal timing plans to address real-time traffic situations, and managing allocated signal network resources. The Manage Signal Network Operations function consists of the following subfunctions:

- **Control Signal Modes (CSM)** provides the capability to select multiple operational signaling modes and supports signal pre-emption for emergency vehicle operations and railroad crossings and signal priority for transit vehicle operations.

- **Implement/Adapt Signal Timing Plans (STP)** a) provides arterial/freeway signal resource control, b) dynamically implements/adapts signal timing/control plans to support the desired traffic control strategies under varying traffic and incident conditions, and c) supports real-time selection/modification of signal timing/control plans across wide area/multiple jurisdictions.

- **Manage Signal Resources (MSR)** a) allocates signaling operations responsibilities among agencies, b) allocates signal equipment maintenance responsibilities among agencies, c) operates and maintains signals per agency agreements, and d) provides for shared operations across jurisdictions.

4.1.2.3 Manage Sign Network Operations (MSO)

The Manage Sign Network Operations (MSO) function is responsible for implementing signing plans across the sign network, adapting signing plans to address real-time traffic situations, and managing allocated sign network resources. The Manage Sign Network Operations function consists of the following subfunctions:

- **Control Sign Modes (CSM)** provides the capability to select multiple operational signing modes such as automatic or manual override.

- **Implement/Adapt Signing Control Plans (SIP)** a) provides arterial/freeway signing control, b) dynamically implements/adapts signing devices to support the desired traffic control strategies under varying traffic and incident conditions, and c) supports real-time selection/ modification of signing plans and messaging across wide area/multiple jurisdictions.

- **Manage Signing Resources (MSIR)** a) allocates signing operations responsibilities among agencies, b) allocates signing equipment maintenance responsibilities among agencies, c) operates and maintains signs per agency agreements, and d) provides for shared signing operations across jurisdictions.

4.1.2.4 Monitor Traffic Conditions (MTC)

The Monitor Traffic Conditions (MTC) function is responsible for sensing and collecting traffic surveillance data from roadside sensors and other available sources, and determining current traffic characteristics and conditions. This information is used to modify traffic control plans, and dynamically adapt signal and sign controls to meet current traffic management requirements. The Monitor Traffic Conditions function consists of the following subfunctions:

- **Sense Traffic Surveillance Data (STD)** detects and transmits traffic parameters information along roadways such as volume, occupancy, density, and speed.

- **Collect Traffic Surveillance Data (CTD)** processes and stores traffic parameters information transmitted from multiple detectors.

- **Determine Traffic Conditions (DETC)** determine geo-referenced traffic conditions using sensed traffic surveillance data such as average traffic speeds, and congestion levels.

- **Distribute Traffic Conditions (DITC)** distributes traffic related data to other public and private agencies in support of other ITS services.

4.1.3 Sample Operational Scenarios

The scenarios in Figure 32 and Figure 33 show how the Traffic Control Service detects, processes and distributes traffic control information.

Each scenario begins at the top of the figure with either the occurrence of an event or a request for some type of traffic control related data. The rectangular boxes indicate traffic control service sub-functions that are performed during the scenario. The lines and arrows connecting the rectangular subfunction boxes indicate the flow of control from one box, or subfunction, to the next. Data elements labeled on these lines indicate the data flowing between the boxes. This data will be used by the next sub-function. If there are multiple boxes labeled with the same sub-function, then the tasks within the boxes are different but still are part of the same overall sub-function. The storage disc icons beside the subfunction boxes (with lines and arrows leading to or from the subfunction box) indicate stored data or generated data that is used by the task.

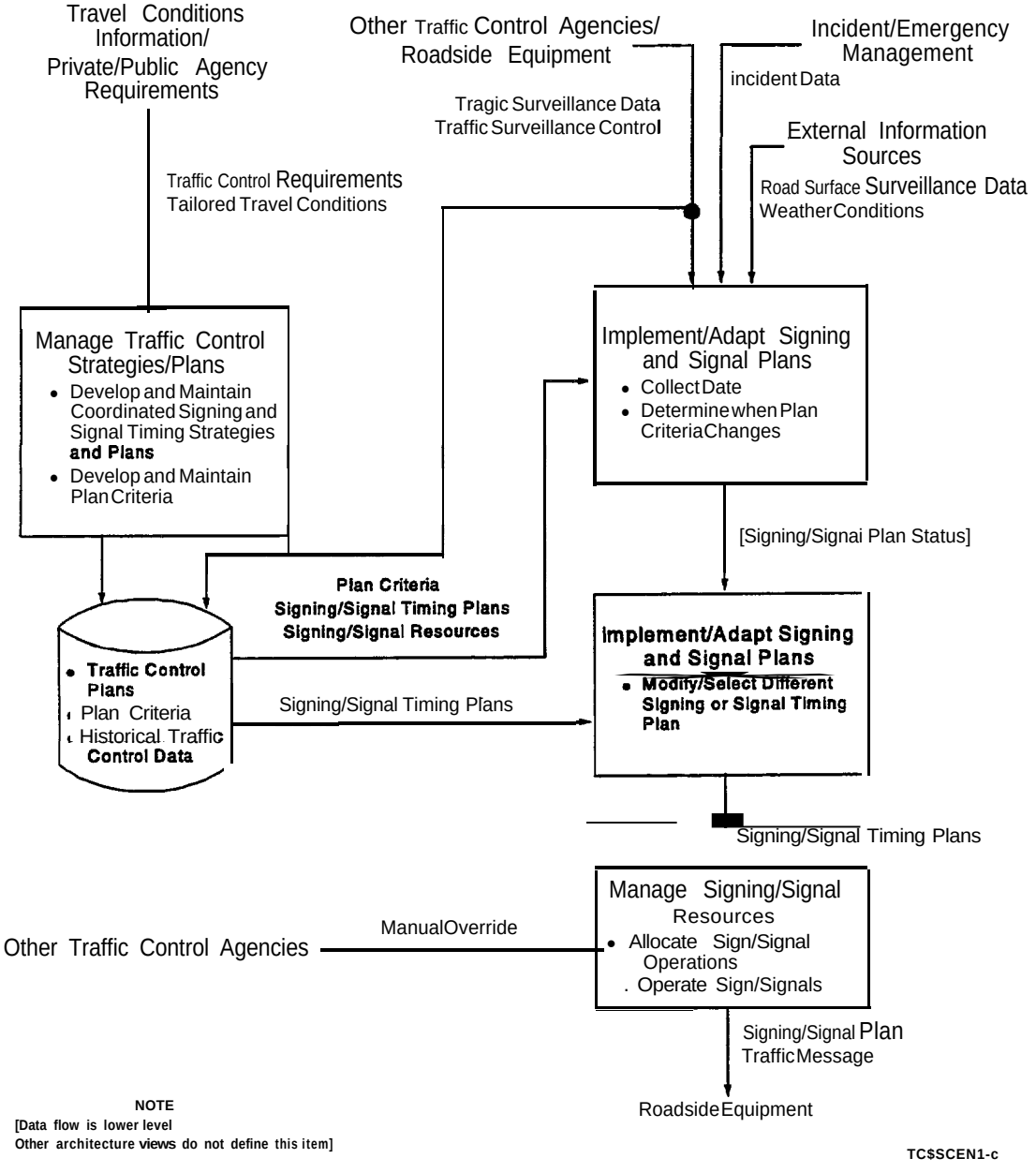


Figure 32. Traffic Control Scenario - Plan and Manage Sign/Signal Network Operations

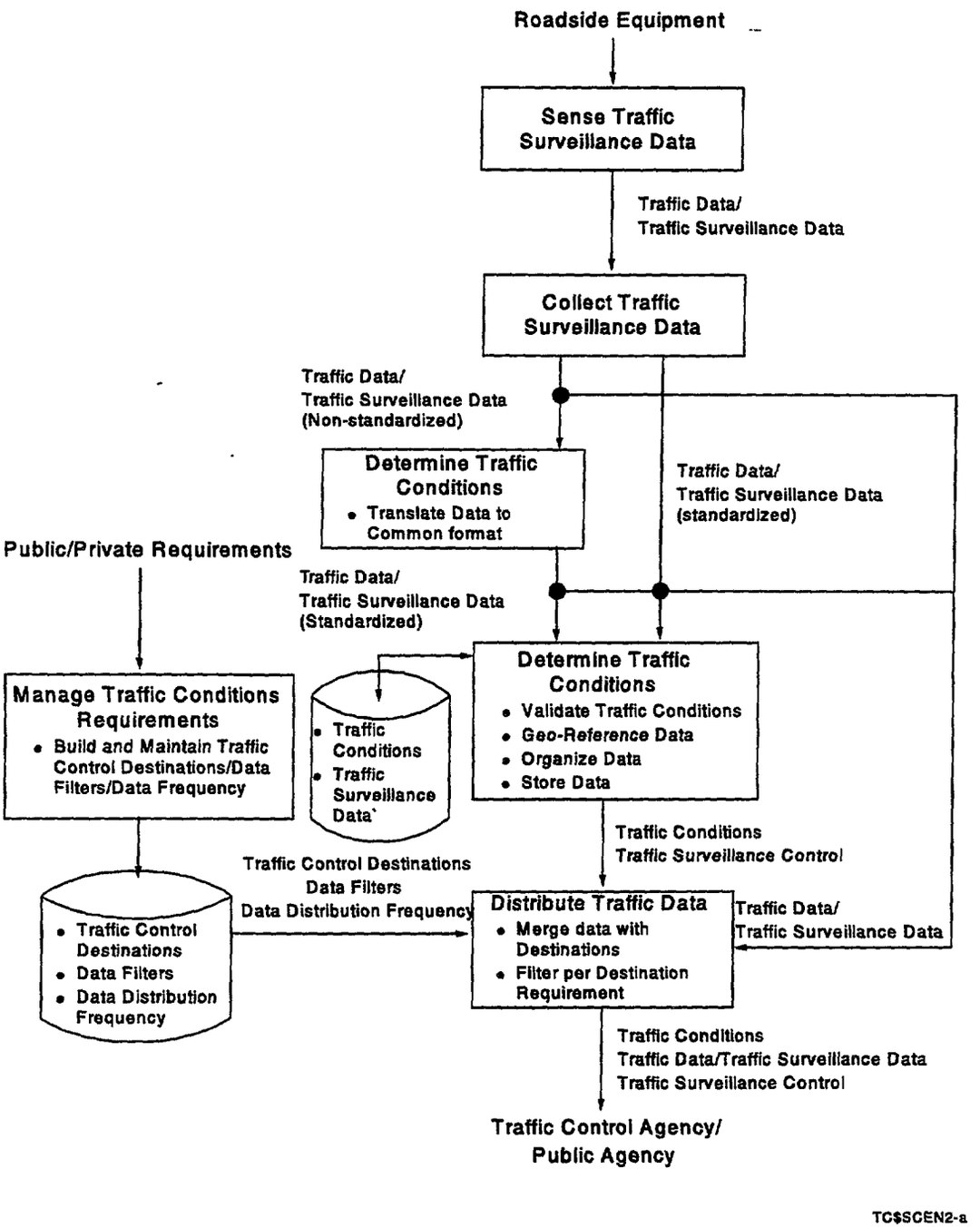


Figure 33. Traffic Control Scenario - Distribute Traffic Control Data

4.1.4 Physical Architecture

The architecture shown in Figure 34, Traffic Control - Physical Architecture , shows how the various Minnesota ITS components are interconnected to provide the Traffic Control Service. Arrows between the components are labeled with tags for identifying the input data flows to a component. Appendix D, *Physical Architecture Component Interfaces*, associates each tag with the corresponding component input data flows.

In this architecture, the public agencies coordinate traffic control among themselves through sharing of information as peers with other agencies. Each agency retains control of its own traffic signals and signs, and there is no centralized repository of the shared data. However, an Inter-Jurisdictional Traffic System (or multiple such systems) allows for one system to control the traffic signals and/or signs of multiple agencies where such centralized control is desired. As the operational and political environment develops, it is envisioned that an Inter-Jurisdictional Traffic System could evolve into a Regional ITS Management Center, replacing many of the individual centers shown in the figure.

The public Traffic Control agencies that manage traffic in this figure (e.g.; Centralized Signal Centers, Decentralized Signal Centers, Freeway Traffic Management Center and Maintenance Dispatch Center) share traffic control data using predetermined interfaces that are defined according to each agency's policies and inter-agency working agreements. Each Traffic Control agency maintains their own view of data (either locally collected and/or collected from other Traffic Control Agencies) that satisfies their own specific operational needs. The architecture permits each Traffic Control Agency to receive traffic control data from other traffic agencies and to distribute traffic control data to a subset of public agencies in a predefined geographic area. The Traffic Control Physical Architecture does not change the function or interconnections for the family of roadside equipment components from the current deployed environment.

Other public agencies, such as State Patrol and Incident Management Centers, co-ordinate with the Traffic Agencies on signal pre-emption plans, traffic control requirements, traffic conditions data to support their emergency vehicle operations. The Security Firewall System provides a security firewall for two-way data exchange between government owned/leased and private data networks.

The numbers, inside each box in the figure, identify the Traffic Control Functional Architecture subfunctions that have been allocated to that box. The code is defined as follows:

1. Manage Traffic Control Requirements (TCRQ)
2. Manage Traffic Control Strategies/Plans (TCP)
3. Manage Signal Resources (MSR)
4. Control Signal Modes (CSM)
5. Implement/Adapt Signal Timing Plans (STP)
6. Manage Signing Resources (MSIR)
7. Control Sign Modes (CSIM)
8. Implement/Adapt Signing Control Plans (SIP)

9. Collect Traffic Surveillance Data (CTD)
10. Determine Traffic Conditions (DETC)
11. Distribute Traffic Conditions (DITC)
12. Sense Traffic Surveillance Data (STD)

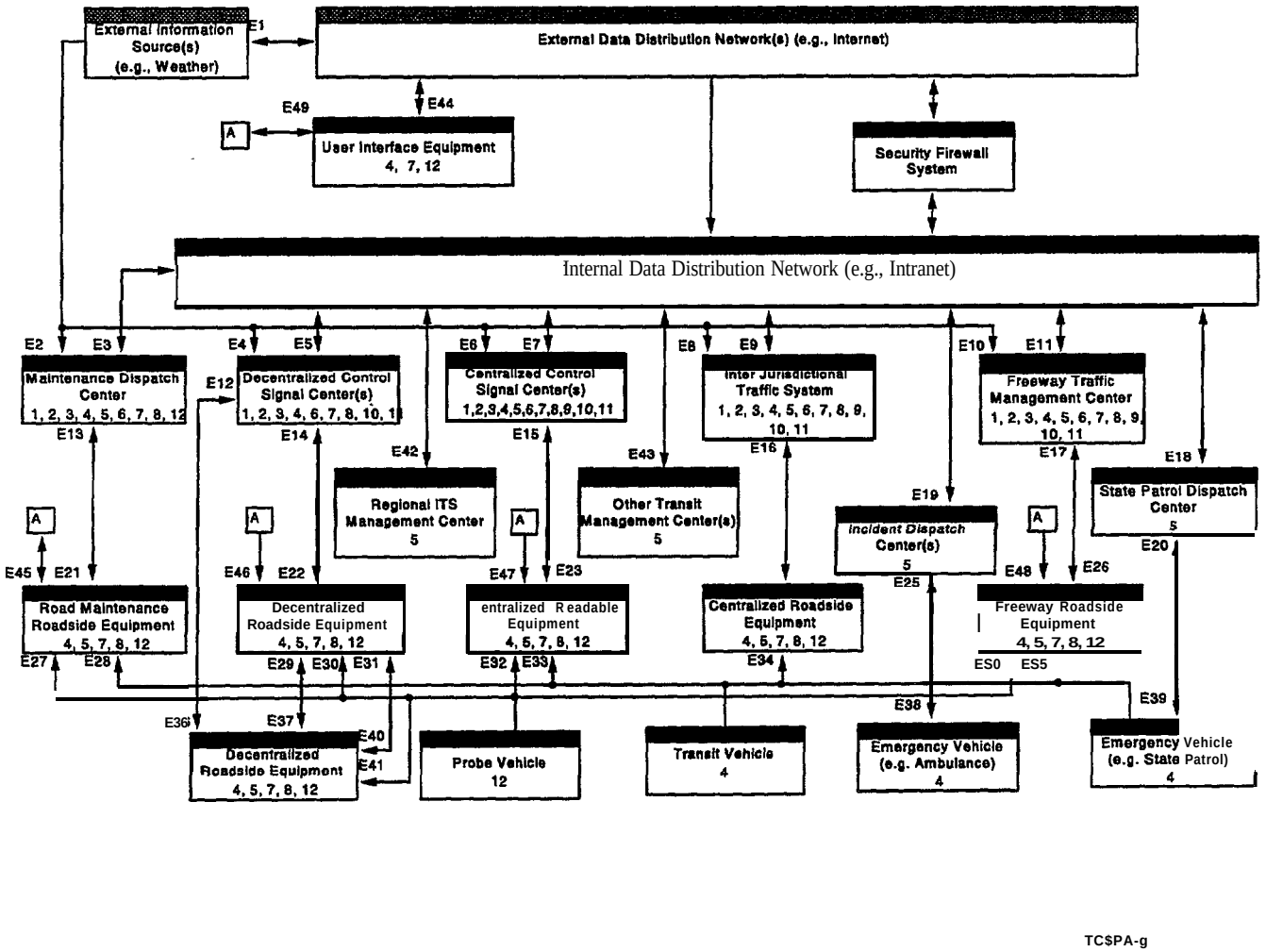
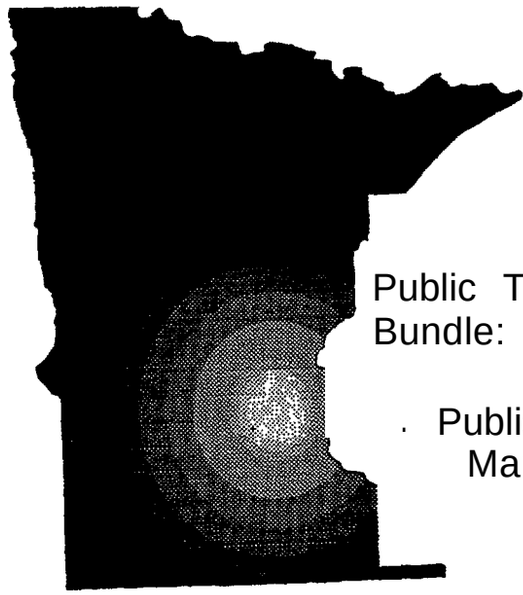


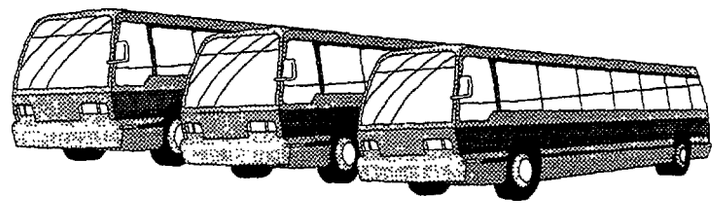
Figure 34. Traffic Control - Physical Architecture

5 Public Transportation



Public Transportation Service Bundle:

- Public Transit Fleet Management



5 Public Transportation

5.1 Public Transit Fleet Management

Public Transit Fleet Management (TFM) monitors real-time schedule adherence of public transit vehicles, and provides assistance in getting transit vehicles back en schedule when schedule deviations occur. This service also develops transit routes and schedules, dispatches vehicles, allocates drivers to vehicles and routes, provides real-time guidance directions to drivers of transit vehicles when needed, and monitors vehicle systems.

5.1.1 Service Goals/Objectives/Performance Measurements

The following service goals and objectives help guide the migration to a **Public Transit Fleet Management Service** architecture that is consistent with the Minnesota Traveler Wants and Needs and the Minnesota Agency Wants and Needs research results.

- Provide route alternatives to avoid delays caused by congestion, accidents, and road conditions and road construction
- Provide a safe, secure and least stressful environment for travelers on transit vehicles and at transit stations
- Optimize travel times for transit vehicles
- Provide real-time, accurate transit information to travelers, including but not limited to clear and timely directions, information on alternative mode choices, route planning based on specified input criteria, and real-time transit information for inter-modal transfers
- Optimize efficient use of transit vehicles, facilities and personnel through the measurement of passenger demand and real-time vehicle location, identification, performance and schedule adherence. Analyze planned-versus-actual data to continually improve application of transit system assets to meet customer needs.
- Provide an operational transit system that is flexible and adaptable to change
- Integrate all transit modes technologically, with emphasis on communications and, where required, apply relevant “Smart bus” and other technologies
- Measure the environmental benefits of increased transit usage and technological advances

5.1.2 Functional Architecture

Public Transit Fleet Management consists of the following functions and subfunctions as described in Section 5.1.2, Functional Architecture:

- Plan Fleet Operations
  - Plan Fixed / Flexible Routes, Trips and Runs
  - Schedule Trip Times
  - Plan Fleet Operating Procedures
- Manage Fleet Operations
  - Manage Transit Assignments
  - Track Resource Operational Status
  - Manage Route Changes
  - Manage Schedule Adherence
  - Manage Passenger Usage Data
  - Manage Passenger Transfers

A summary description of each function and subfunction is provided in the following subsections. The requirements that characterize each subfunction are located in Appendix B. Appendix B is a separate report generated from a Microsoft Access relational database. Title of the Microsoft Access Report that supports Appendix B is: *Requirements by Service - Function - Subfunction.*

Public Transit Fleet Management interfaces with the following services as described in Section 5.1.2, Service Interface Diagram:

- Account Management
- Incident Management
- Maintenance
- Ride Matching and Reservations
- Traffic Control
- Training
- Trip Planning and Directions
- Travel Conditions Information
- Traveler Services Information
- Other
  - Devices
  - External Information Sources
  - Human (i.e., Transit Drivers)

In Figure 30 and Figure 3 1, the arrows between the functions and services represent information data flows. Appendix *C, Data Flows by Function for ITS Services,* defines the input and output data flows for each service and the service's functions. Appendix C is a separate report generated by Microsoft Access.

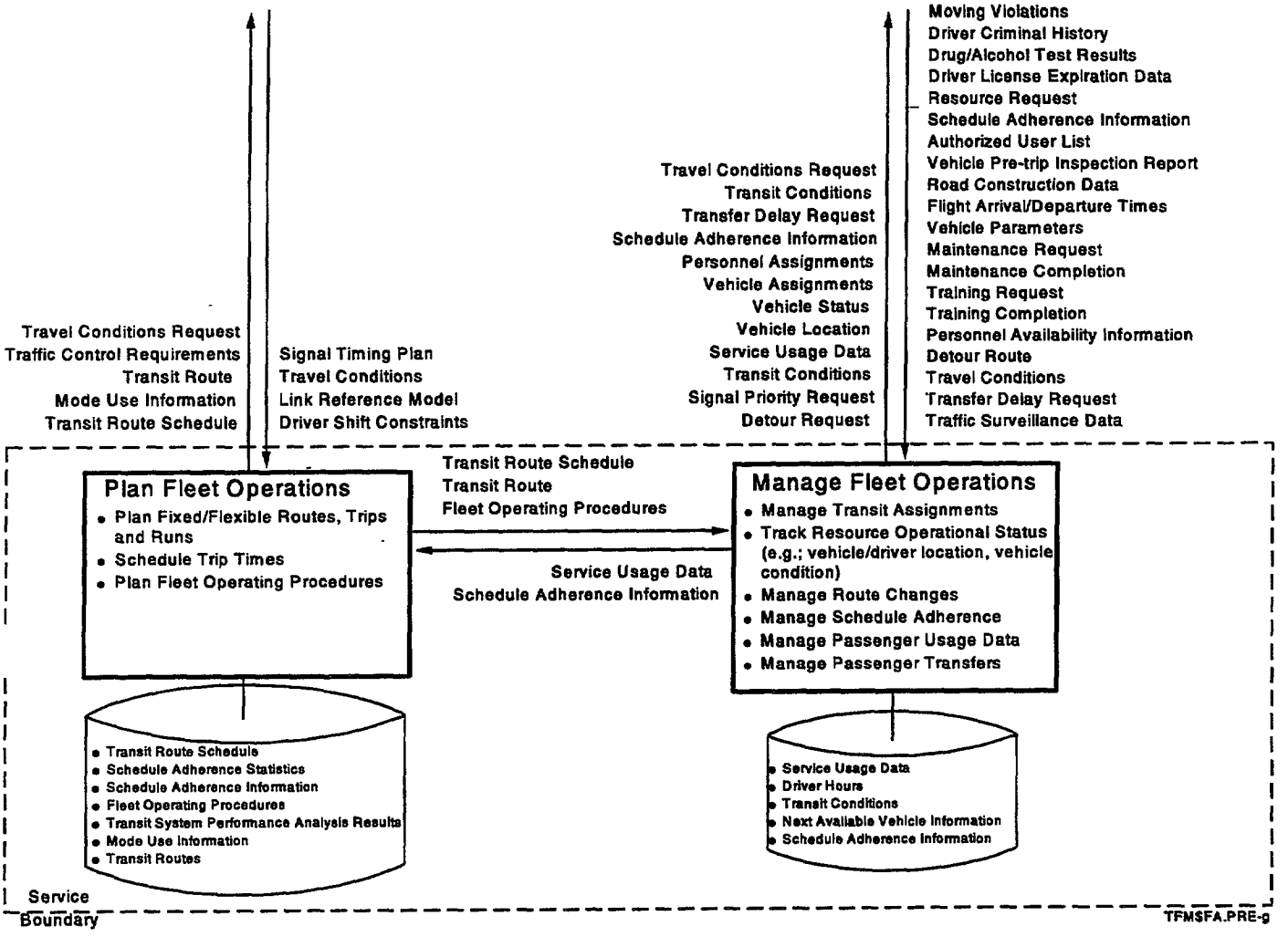


Figure 35. Public Transit Fleet Management - Functional Architecture

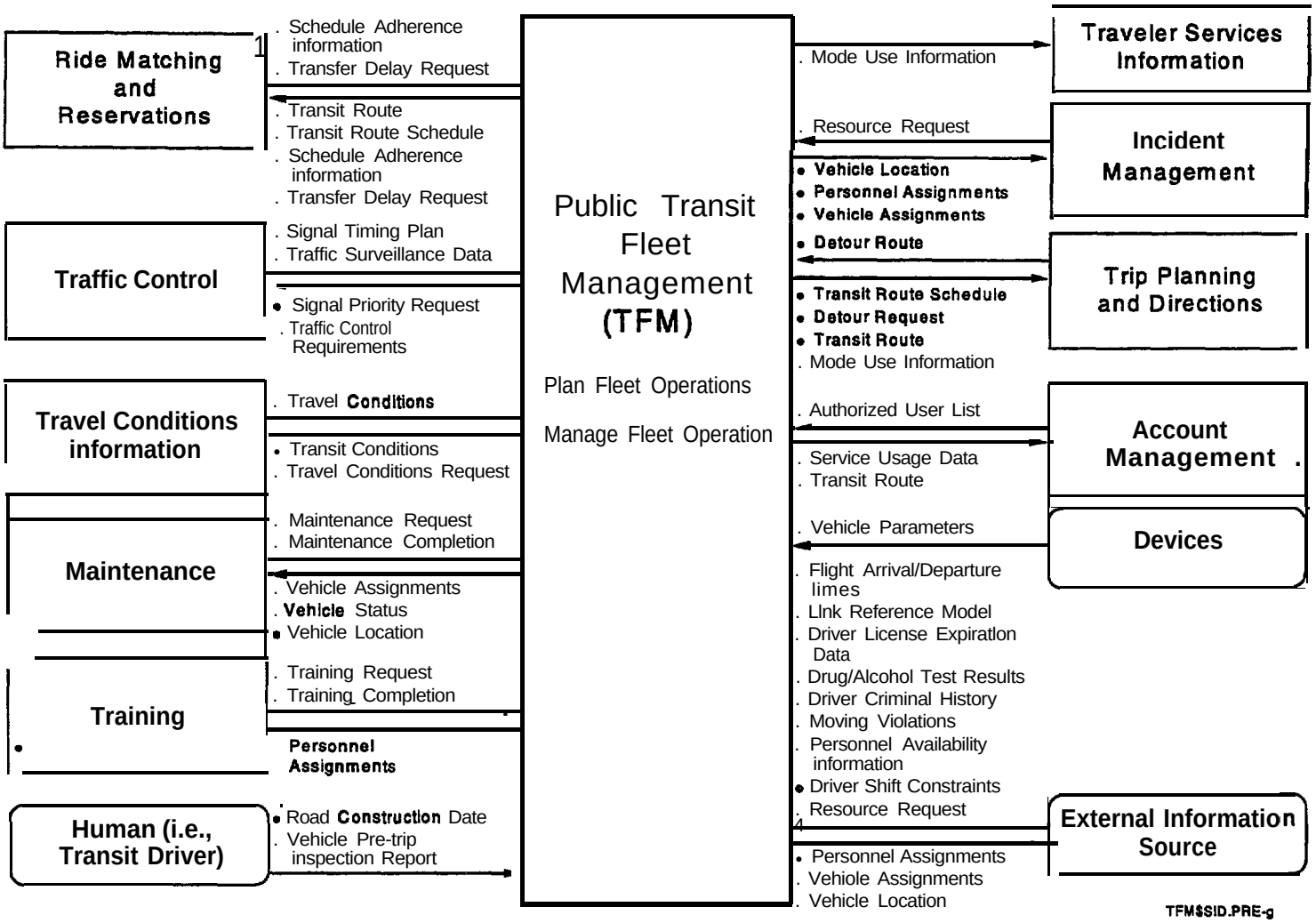


Figure 36. Public Transit Fleet Management - Service Interface Diagram

5.1.2.1 Plan Fleet Operations (PFO)

The Plan Fleet Operations (PFO) function develops and maintains the layout of routes, trips, blocks and runs for the fleet. Both fixed and flexible routing structures are supported by this function. Scheduling is performed to develop a route schedule that minimizes trip time while insuring that the vehicle can reliably meet the schedule. Fleet performance information is collected and analyzed and the routes, schedules and operating procedures are updated to continually improve the performance of the fleet. Plan Fleet Operations consists of the following subfunctions:

- **Plan Fixed/Flexible Routes, Trips and Runs (PFR)** assists transit planners in development and update of transit routes, trips, blocks and runs. Both fixed and flexible route structures are supported. (Note: a flexible route consists of a set of mandatory transit stop locations with multiple optional stops between mandatory stops.)

- **Schedule Trip Times (STT)** assists the scheduler in generating transit schedules for use in transit operations, and for distribution to the public via hardcopy and information service providers.

- **Plan Fleet Operating Procedures (POP)** provides analysis and simulation support to the transit planner to enable optimization of transit system performance. A database for maintaining operational procedures is also provided by this subfunction.

5.1.2.2 Manage Fleet Operations (MFO)

The Manage Fleet Operations (MFO) function coordinates the assignment of transit vehicles and drivers to routes and runs, tracks fleet vehicle location and condition, manages adherence to the transit schedule, and tracks passenger transit usage. Manage Fleet Operations consists of the following subfunctions:

- **Manage Transit Assignments (MTA)** balances the assignment of transit vehicles and drivers to support fleet operations, maintenance, training and incident response.

- **Track Resource Operational Status (TRS)** gathers information about fleet vehicles and drivers for use in tracking vehicle location, schedule adherence and driver fatigue, and for planning preventative maintenance activity.

- **Manage Passenger Usage Data (MPU)** gathers passenger usage data for use in fare payment computation and billing, and for planning future routes and schedules.

- **Manage Schedule Adherence (MSA)** compares actual vehicle location to the planned location to determine how well the vehicle is adhering to the route schedule. When a vehicle gets significantly behind schedule, this subfunction assists the fleet dispatcher and/or vehicle driver in regaining schedule adherence along the route.

- **Manage Route Changes (MRC)** coordinates real-time route changes to support demand responsive and flexible route operations, and to assist in schedule adherence by re-routing vehicles around congestion and incidents.

- **Manage Passenger Transfers (MPT)** coordinates passenger transfers between modes and within the same mode of transportation.

5.1.3 Sample Operational Scenarios

The scenarios in Figure 37 and Figure 38 show how the Public Transit Fleet Management Service a) manages real-time schedule adherence against the published transit schedule, and b) performs off-line adjustments to transit schedules to balance schedule adherence with other factors to optimize overall transit performance. The first scenario operates continuously by a) monitoring vehicle locations and traffic conditions, b) determining when a transit vehicle is late, off the planned route, or in jeopardy of being late due to traffic conditions, c) implementing corrective action procedures to either regain schedule adherence or to avoid a delay, and d) collecting and storing schedule adherence data for off-line analysis and optimization of the schedule. The second scenario describes the periodic planning activity associated with optimizing the schedule.

Each scenario begins at the top left of the figure. The rectangular boxes indicate major tasks (and functions) that are performed during the scenario. The lines and arrows connecting the rectangular task boxes indicate the flow of control from one task to the next. Data elements labeled on these lines indicate the data flowing between the tasks. The storage disc icons indicate data that is either stored or used by the task.

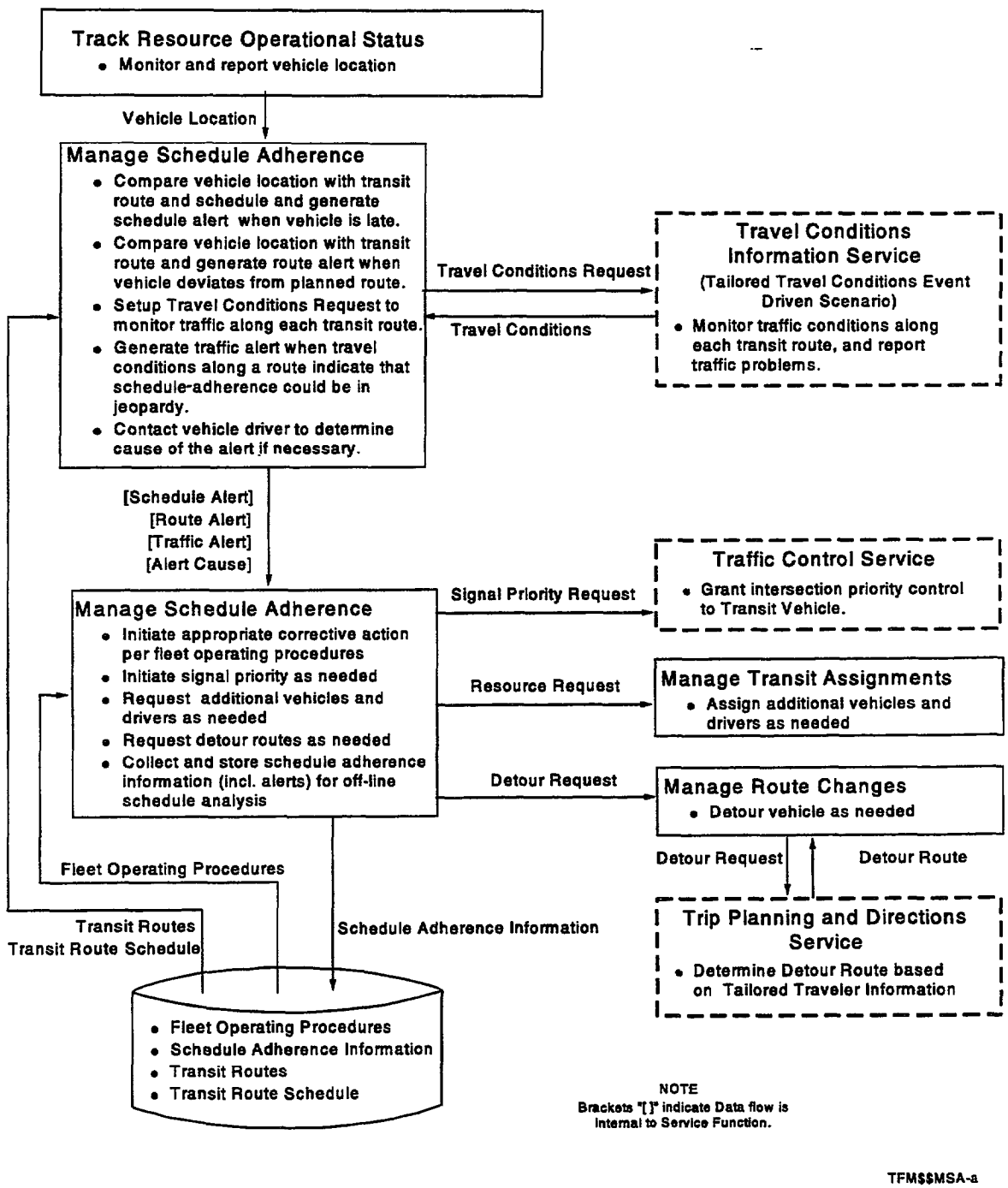
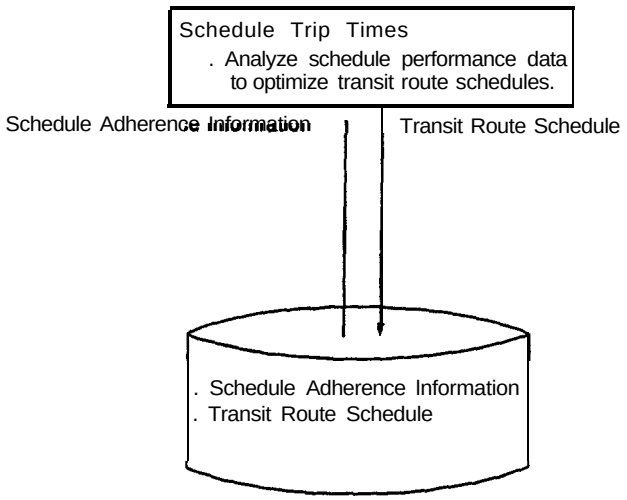


Figure 37. Public Transit Fleet Management Scenario - Manage Transit Schedule Adherence



TFM$$STT-a

Figure 38. Public Transit Fleet Management Scenario - Transit Schedule Planning

5.1.4 Physical Architecture

Public Transit Fleet Management functionality is physically implemented as shown in Figure 39, Public Transit Fleet Management - Physical Architecture. The architecture illustrated in this figure shows how the various Minnesota ITS components are interconnected to provide the Public Transit Fleet Management Service. Arrows between the components are labeled with tags for identifying the input data flows to a component. Appendix D, *Physical Architecture Component Interfaces*, associates each tag with the corresponding component input data flows.

The public Management Centers in this figure (Regional ITS Management Center, Other Transit Management Centers, Demand Responsive Transit Centers) manage the overall daily operations and off-line planning and analysis required to ensure smooth, predictable transit operations. This management includes collection of transit information from the transit vehicle fleet, collection of flexible route rider requests from transit stops, development of transit routes and schedules, coordination with the transit maintenance garages for vehicle maintenance activities, and distribution of transit data to the rest of the Intelligent Transportation System.

The concept behind-the Regional ITS Management Center is to consolidate as many of the Regional ITS Management Systems, Inter-jurisdictional Transit Systems, transit management functions, central data repository and data management functions as possible. The presence of the Other Transit Management Centers and Demand Responsive Transit Centers acknowledges the organizational reality that some Management Center functions will most likely not be combined due to fiscal and other existing constraints. The Transit Maintenance Garages monitor vehicle condition information, request vehicles for preventative maintenance service, perform vehicle maintenance activities and are the focal point for daily vehicle, driver and route assignments.

The privately owned Transit Service Providers provide on-demand and supportive transit service beyond that provided by the metro transit authority. The Security Firewall System provides a secure firewall for two-way data exchange between government owned/leased and privately owned networks, and also supports routing of transit fleet information between public agencies and private information provider companies.

The numbers inside each component box identify the Public Transit Fleet Management Service subfunctions that have been allocated to each component. The code for these numbers is as follows:

1. Plan Fixed/Flexible Routes, Trips and Runs (PFR)
2. Schedule Trip Times (STT)
3. Plan Fleet Operating Procedures (POP)
4. Manage Transit Assignments (MTA)
5. Track Resource Operational Status (TRS)
6. Manage Route Changes (MRC)
7. Manage Schedule Adherence (MSA)
8. Manage Passenger Usage Data (MPU)
9. Manage Passenger Transfers (MPT)

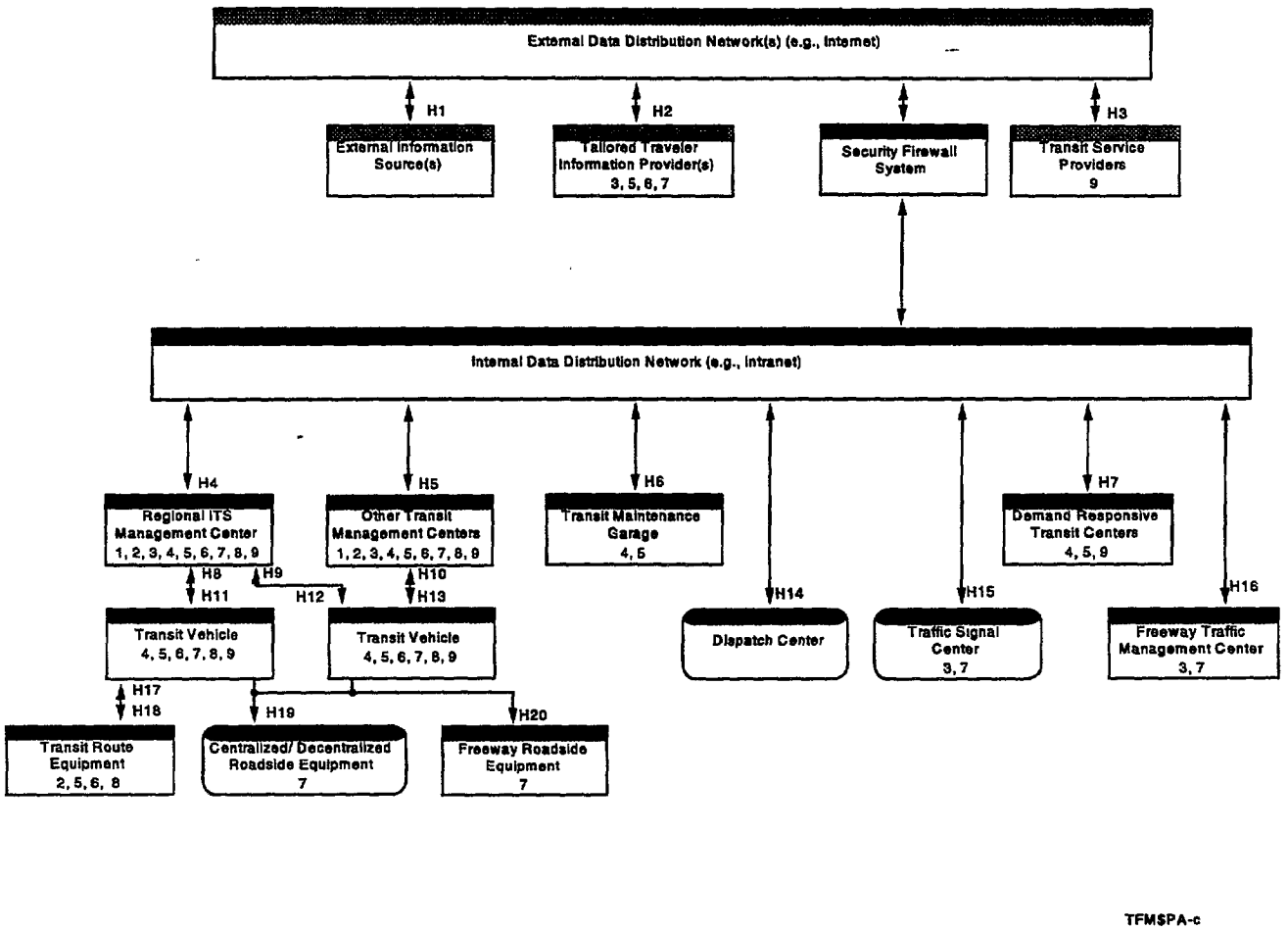
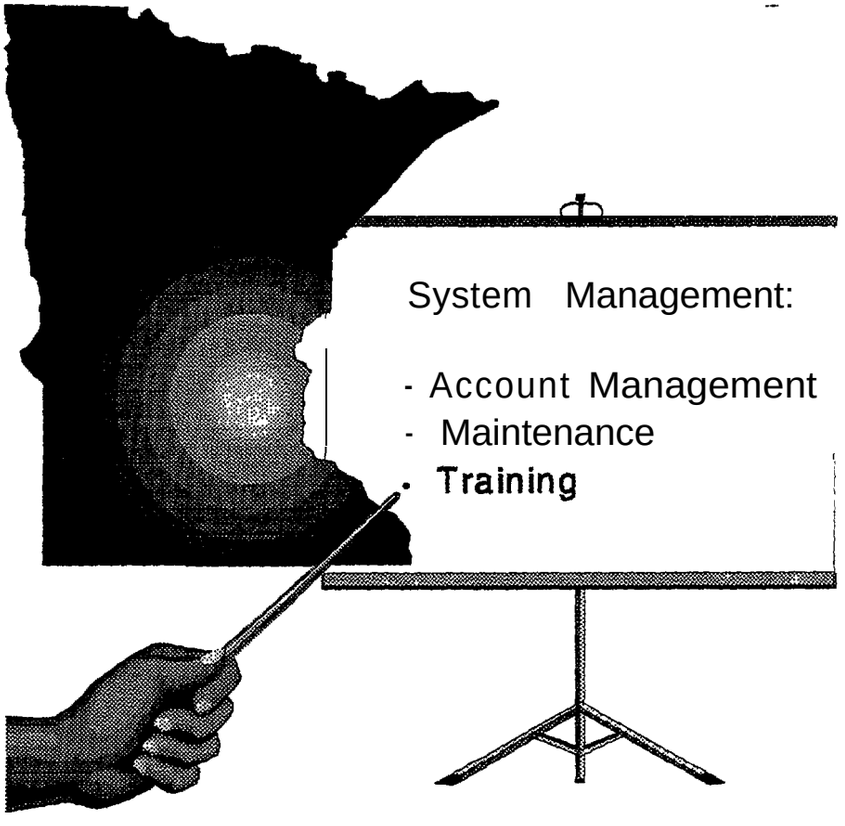


Figure 39. Public Transit Fleet Management - Physical Architecture

6 System Management



6 Spstem Management

6.1 Account Management

Account Management (AM) provides the capability for users to maintain travel services account information including personal profiles. It also establishes fees&or transportation services and tracks billing and payments for services used.

6.1.1 Service Goals and Objectives

The following service goals and objectives help guide the migration to an **Account Management** service architecture that is consistent with the Minnesota Traveler Wants and Needs and the Minnesota Agency Wants and Needs research results.

- Provide the capability for maintaining travel services account information including personal profiles.
- Enable travelers to pay for various transportation services, such as parking, tolls and transit fares, using a single medium (e.g., a credit card or smart card)
- Reduce the necessity for travelers and public agencies to handle money.
- Develop pricing strategies for transportation services that encourage use of certain transportation modes or use of certain routes.

6.1.2 Functional Architecture

Account Management consists of the following functions and subfunctions as shown in Figure 40, Account Management Service - Functional Architecture:

- Manage Service Price Structures
  - Manage Pricing Requirements
  - Manage Pricing Strategies
  - Manage Service Pricing Structures
- Manage User Service Accounts
  - Administer User Accounts
  - Manage Service Usage Data
  - Manage Service Billing/Payments

A summary description of each function and subfunction is provided in the following subsections. The requirements that characterize each subfunction are located in Appendix B. Appendix B is a separate report generated from a Microsoft Access relational database. Title of the Microsoft Access Report that supports Appendix B is***: Requirements by Service - Function - Subfunction.***

Account Management interfaces with the following services as shown in Figure 4 1, Account Management Service - Service Interface Diagram:

- Incident Management
- Public Transit Fleet Management
- Ride Matching and Reservations
- Travel Conditions Information Service
- Traveler Services Information Service
- Trip- Planning and Direction Service
- Other
  - Devices (i.e.; Payment Collection Equipment)
  - External Information Sources
  - Financial Institutions
  - Human (i.e.; Travelers, Administrators, Transit Service Providers)
  - Public Agencies

In Figure 40 and Figure 4 1, the arrows between the functions and services represent information data flows. Appendix ***C, Data Flows by Function for ITS Services,*** defines the input and output data flows for each service and the service's functions. Appendix C is a separate report generated by Microsoft Access.

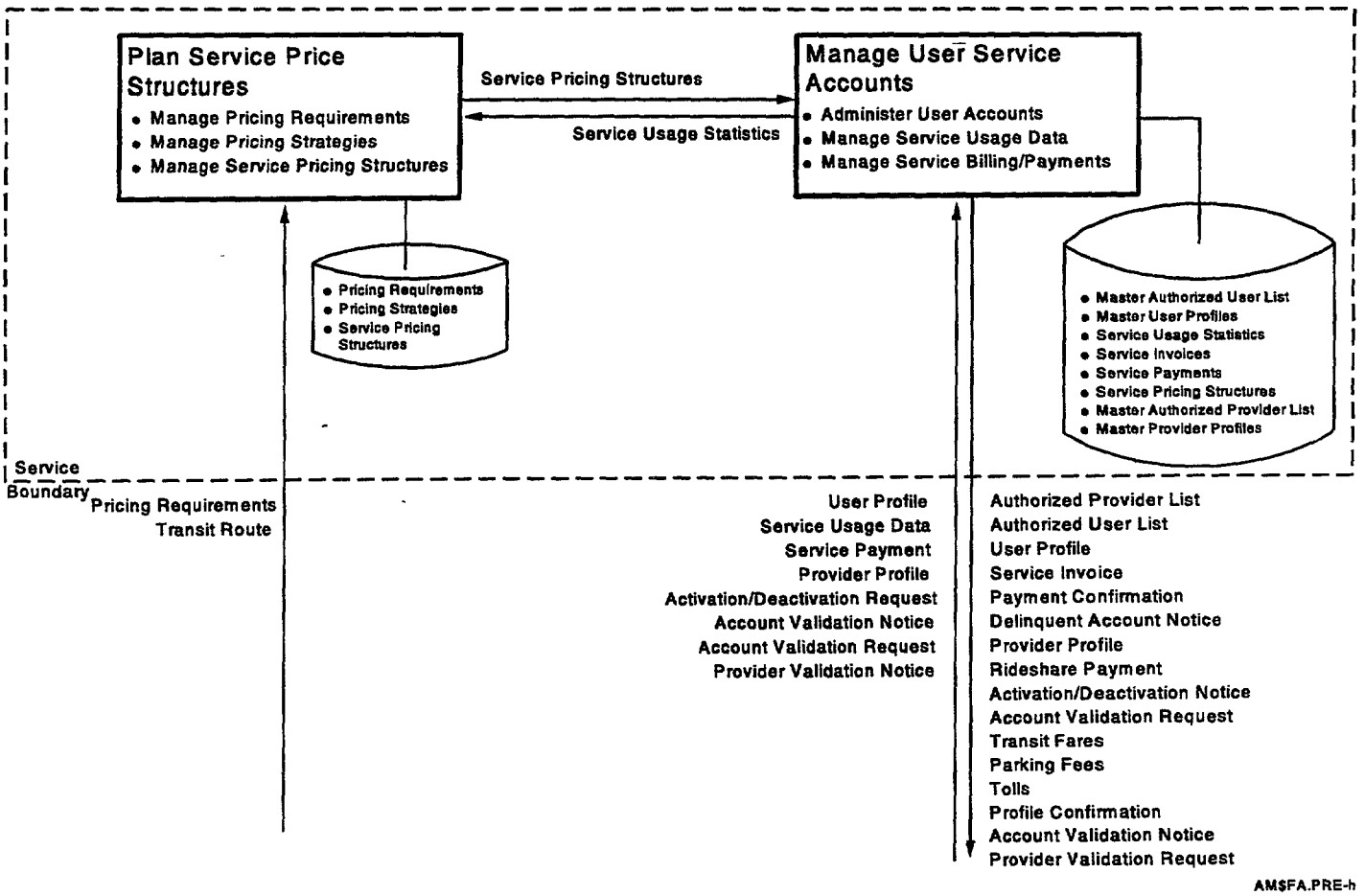


Figure 40. Account Management - Functional Architecture

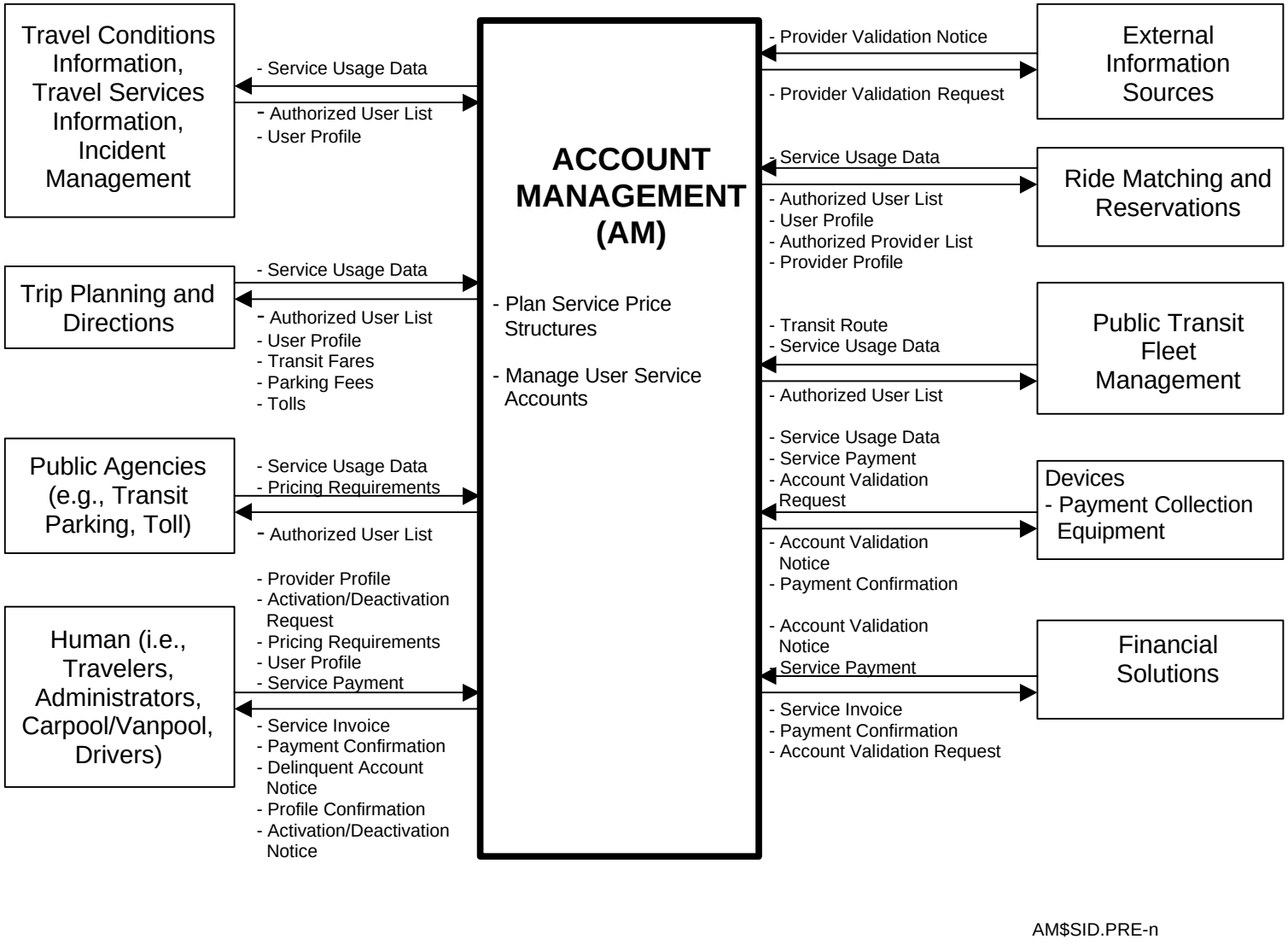


Figure 41. Account Management - Service Interface Diagram

6.1.2.1 Plan Service Price Structures (PSPS)

The Plan Service Price Structures (PSPS) function is responsible for the creation and maintenance of pricing strategies and pricing structures for the Advanced Traveler Information Services (ATIS), and transportation system charges such as public transit fares, parking fees and roadway tolls. Pricing requirements and service usage statistics are formulated and pricing structures are developed based on analysis of the requirements and usage statistics. The Plan Service Price Structures function consists of the following subfunctions:

- **Manage Pricing Requirements (MPR)** collects pricing requirements for transportation services, such as traveler information services, public transit, parking and tolls. Requirements are collected from a variety of sources including travelers, public agencies and private companies.

- **Manage Pricing Strategies (MPS)** analyzes service usage statistics, collected from the various transportation services, and pricing requirements. Pricing strategies, that optimize use of the transportation services, are developed.

- **Manage Service Pricing Structures (MSPS)** establishes prices, rates, fares and tolls for transportation services based on pricing strategies and pricing requirements.

6.1.2.2 Manage User Service Accounts (MUSA)

The Manage User Service Accounts (MUSA) function is responsible for the creation and maintenance of user accounts and profiles for the Advanced Traveler Information Services (ATIS). Service usage data is collected for the ATIS services and from public transit, parking and toll roadway providers, and user charges are calculated. User payments are tracked and user accounts are credited accordingly. The Manage User Service Accounts function consists of the following subfunctions:

- **Administer User Accounts (AUA)** creates and maintains user accounts used for the billing of transportation services, user profiles used by the Advanced Traveler Information Services (ATIS) and Mayday Service and provider profiles used for tracking information about service providers in the Ride Matching and Reservations Service.

- **Manage Service Usage Data (MSU)** collects service usage data from transportation services such as Advanced Traveler Information Services (ATIS), Mayday Services, public transit, parking and roadway tolls. This service usage data is used in calculating charges for transportation services. Service usage statistics are calculated from this data and used in developing pricing strategies.

  Manage Service Billing/Payments (SBP) calculates charges for transportation services based on service usage data. Users are invoiced and payments are tracked to users' accounts. Delinquent accounts are detected and reported.

6.1.3 Sample Operational Scenarios

The scenarios in Figure 42, Figure 43, Figure 44, Figure 45, Figure 46, Figure 47, Figure 48, Figure 49 and Figure 50 show how the Account Management service manages user profile information and manages the billing and payment for transportation services such as traveler information, transit, parking and tolls. The first set of scenarios show how new customers are registered for traveler information services (creating a profile), how user profile information is updated, how user profiles can be activated or deactivated and how user-profiles and accounts are deleted from the system. The second set of scenarios show how customers are billed for transportation services and how payments are tracked

Each scenario begins at the top of the figure. The rectangular boxes indicate major tasks (and functions) that are performed during the scenario. The lines and arrows connecting the rectangular task boxes indicate the flow of control from one box, or task, to the next. Data elements labeled on these lines indicate the data flowing between the boxes. This data will be used by the next task. The storage disc icons on the left of the task boxes (with lines and arrows leading to the task box) indicate stored data that is used by the task. The rectangular boxes connected to these storage discs indicate the task that generated this data. The storage disc icons on the right of the task boxes indicate data that is generated and stored by that task.

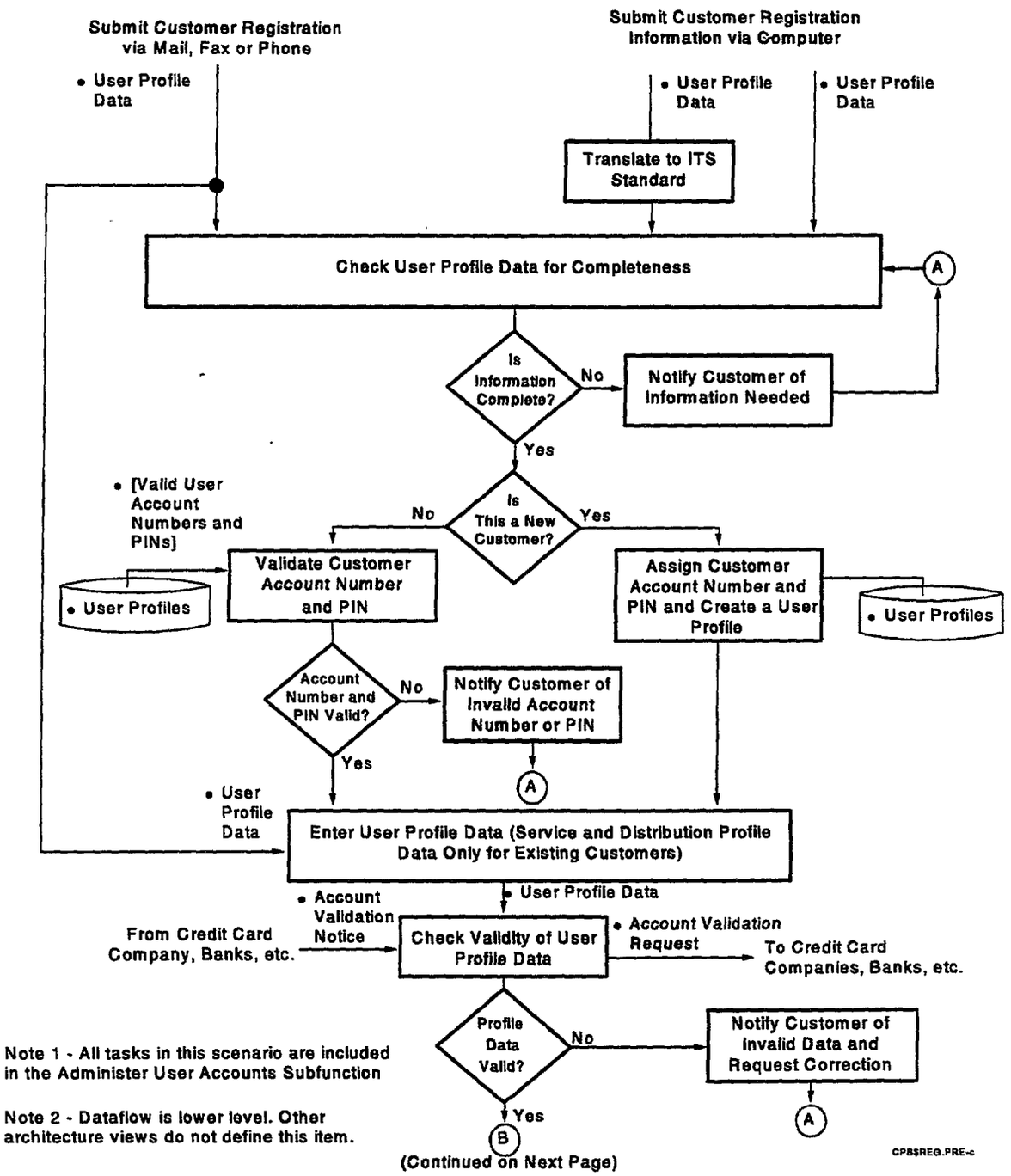


Figure 42. Account Management Scenario - Register a New Customer for Traveler Information

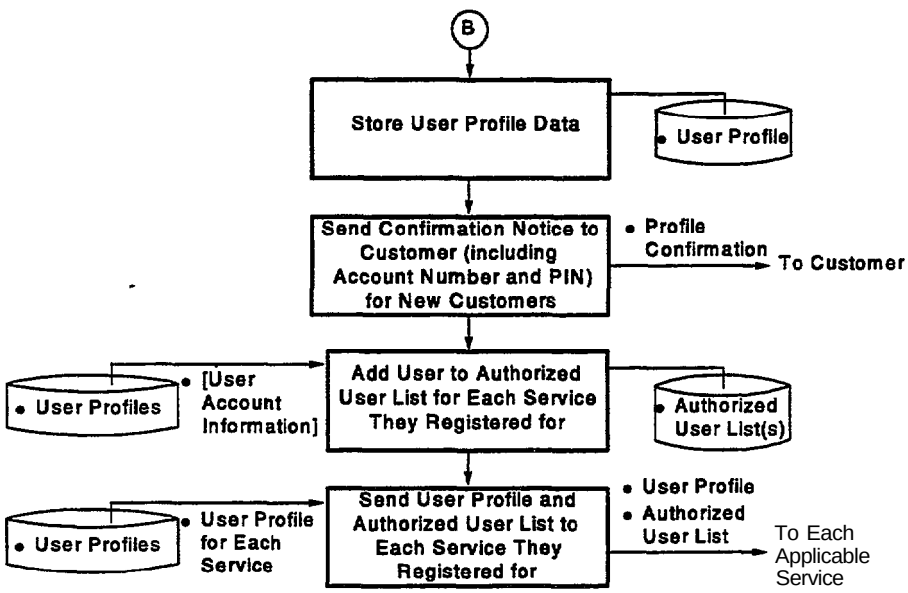


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Figure 43. Account Management Scenario - Register a New Customer for Traveler Information (Cont)

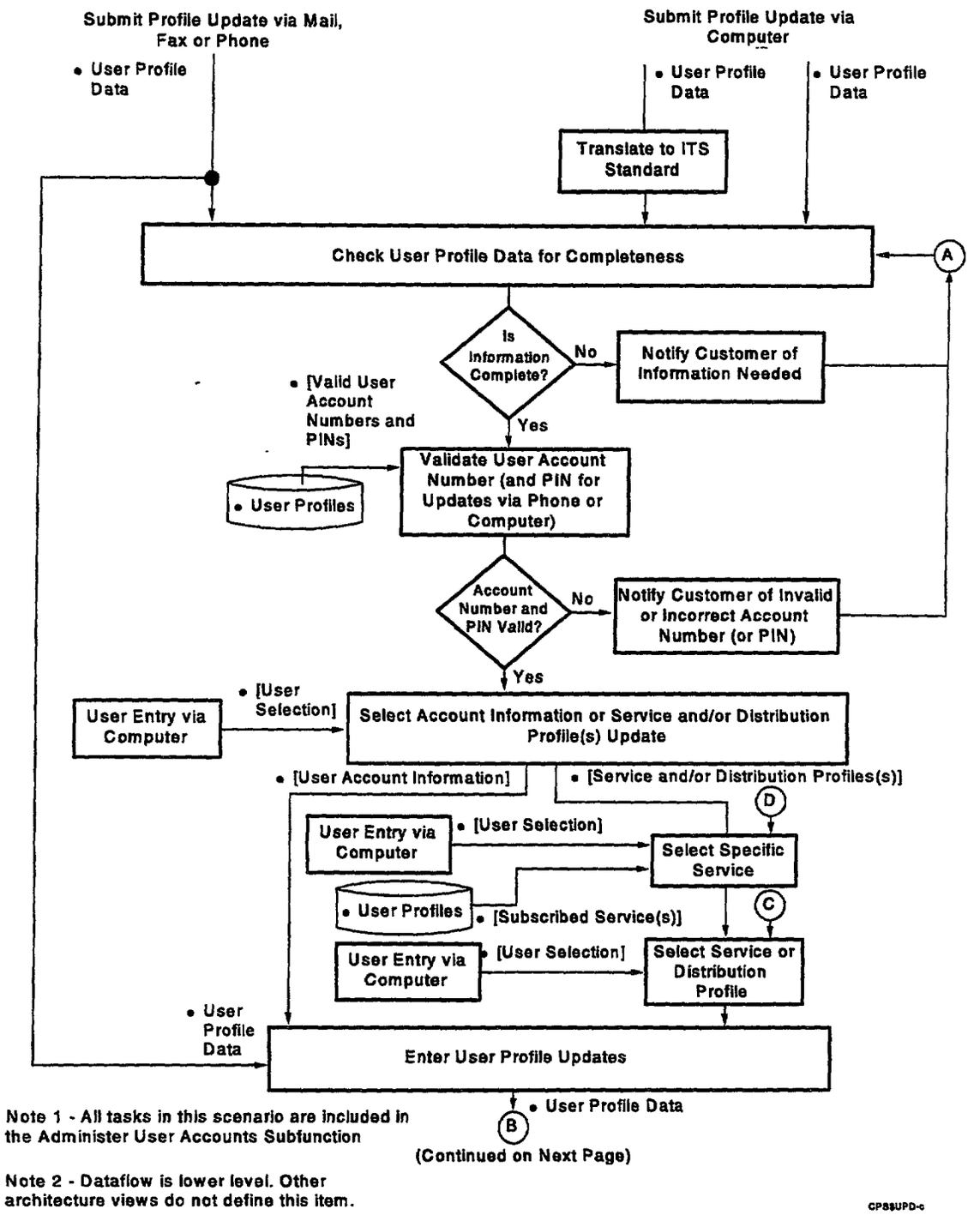


Figure 44. Account Management Scenario - Update User Profile Information

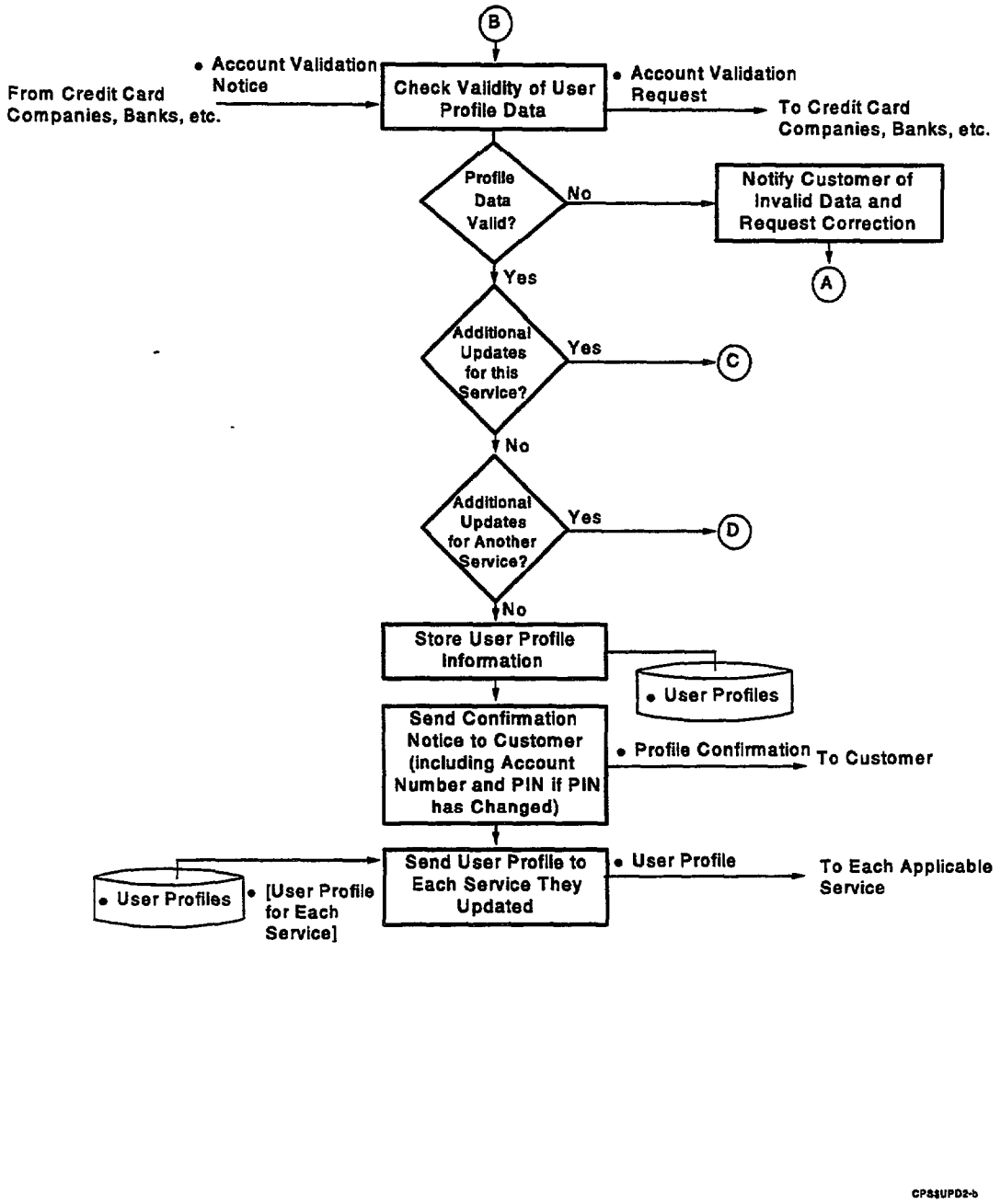
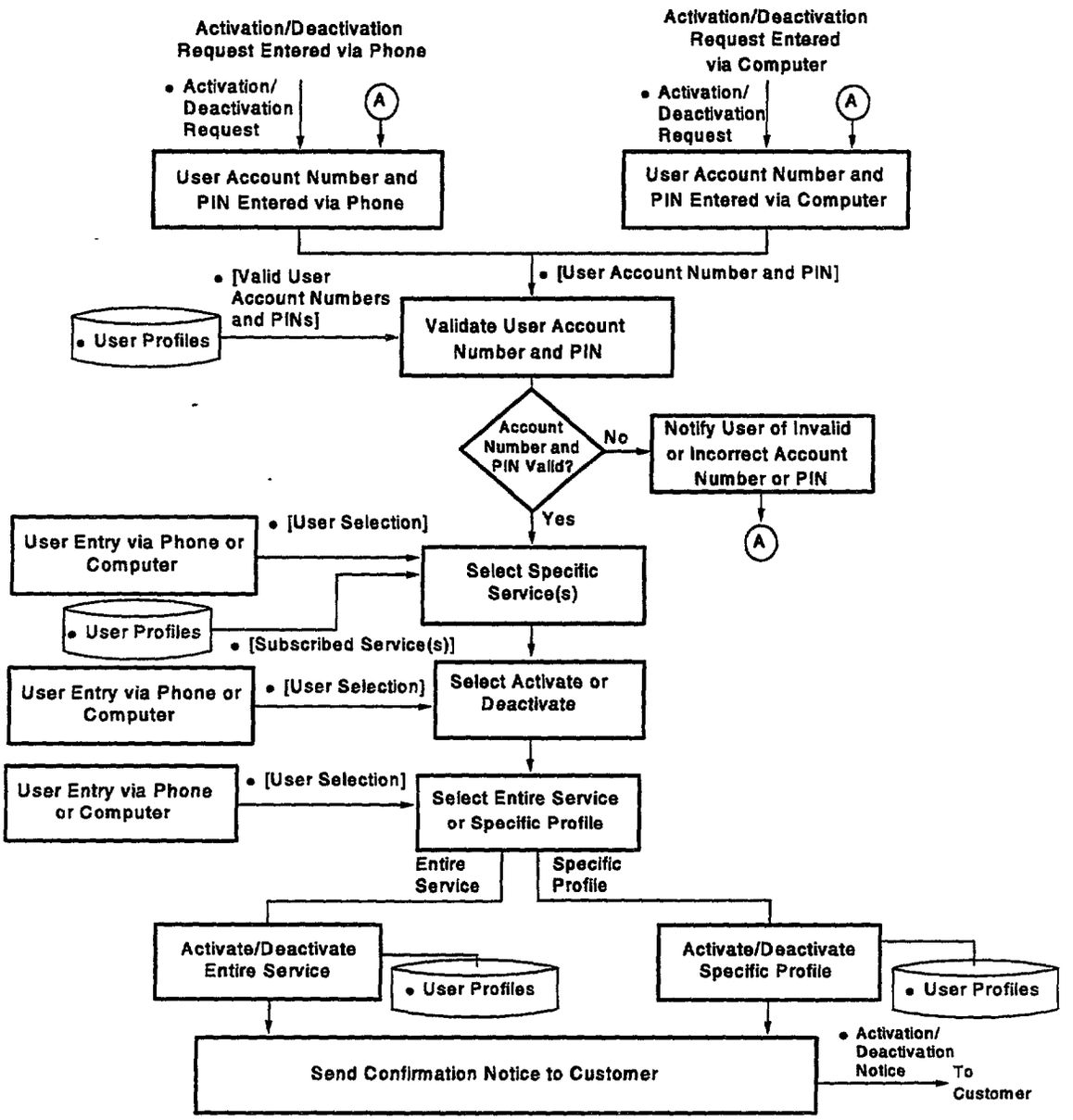


Figure 45. Account Management Scenario - Update User Profile Information (Cont)



Note 1 - All tasks in this scenario are included in the Administer User Accounts Subfunction

Note 2 - Dataflow is lower level. Other architecture views do not define this item.

CPSSACT-b

Figure 46. Account Management Scenario - Activate/Deactivate a Service or Profile

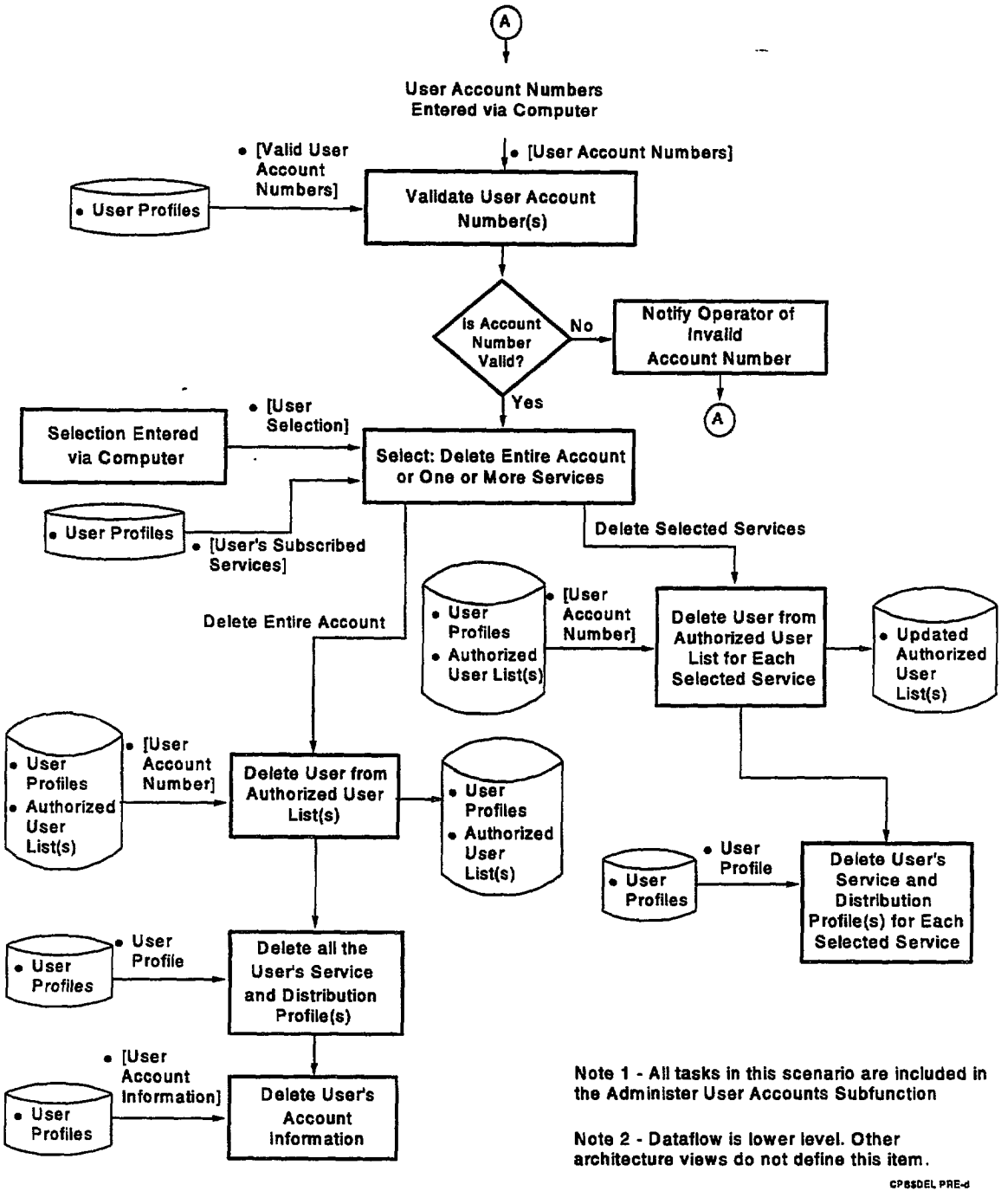
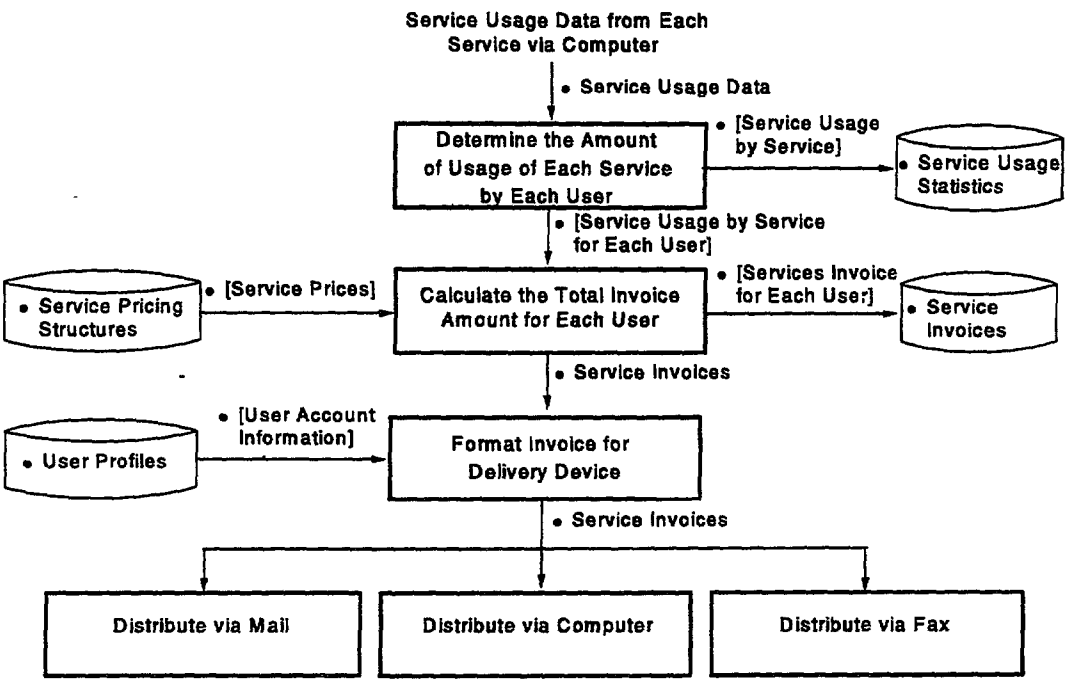


Figure 47. Account Management Scenario - Delete User Access to One or More Services



Note 1 - All tasks in this scenario are included in the Manage Service Billing and Payments Subfunction.

Note 2 - Dataflow is lower level. Other architecture views do not define this item.

AMSBILL.PRE-b

Figure 48. Account Management Scenario - Service Billing Scenario

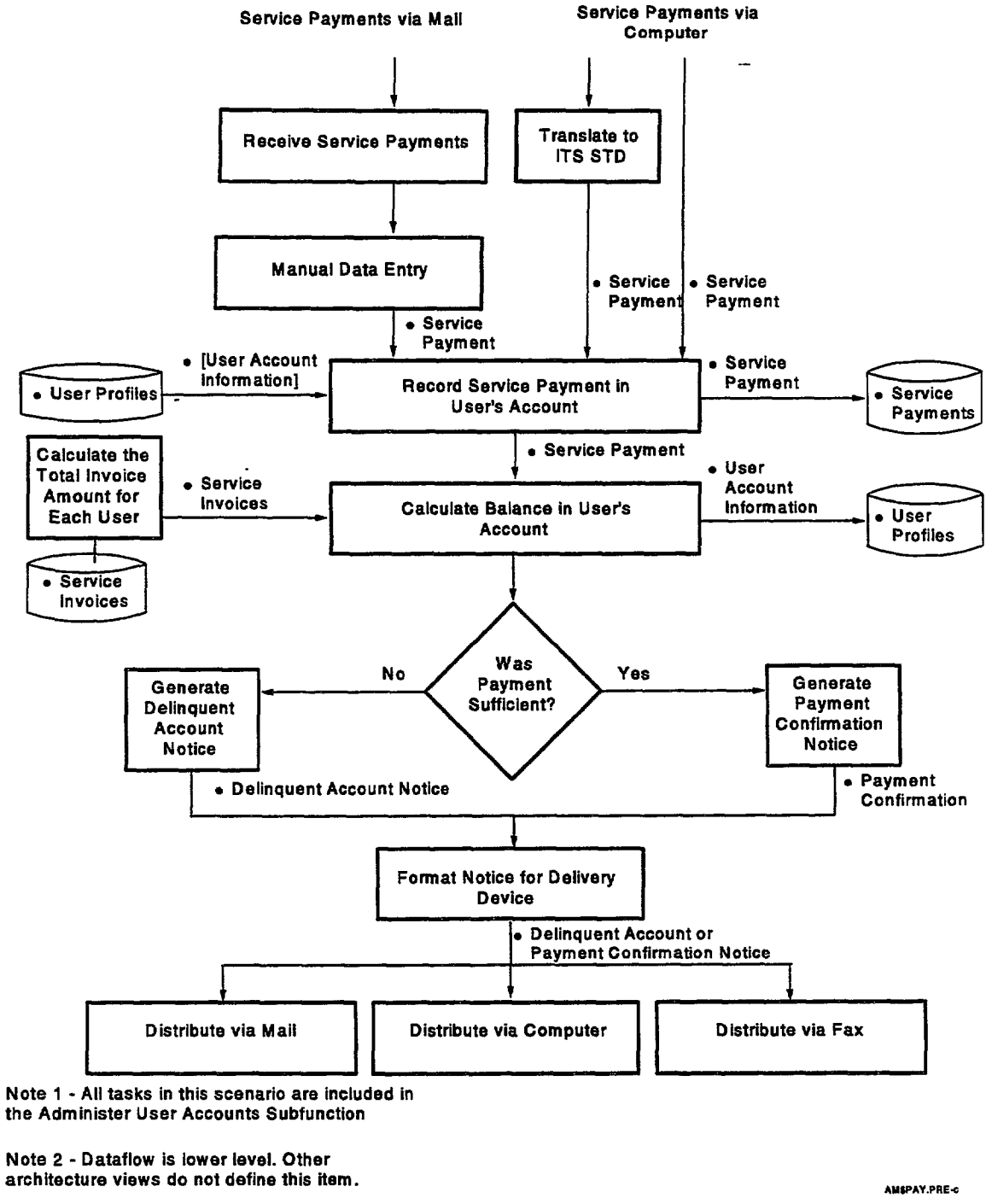


Figure 49. Account Management Scenario - Service Payments Scenario

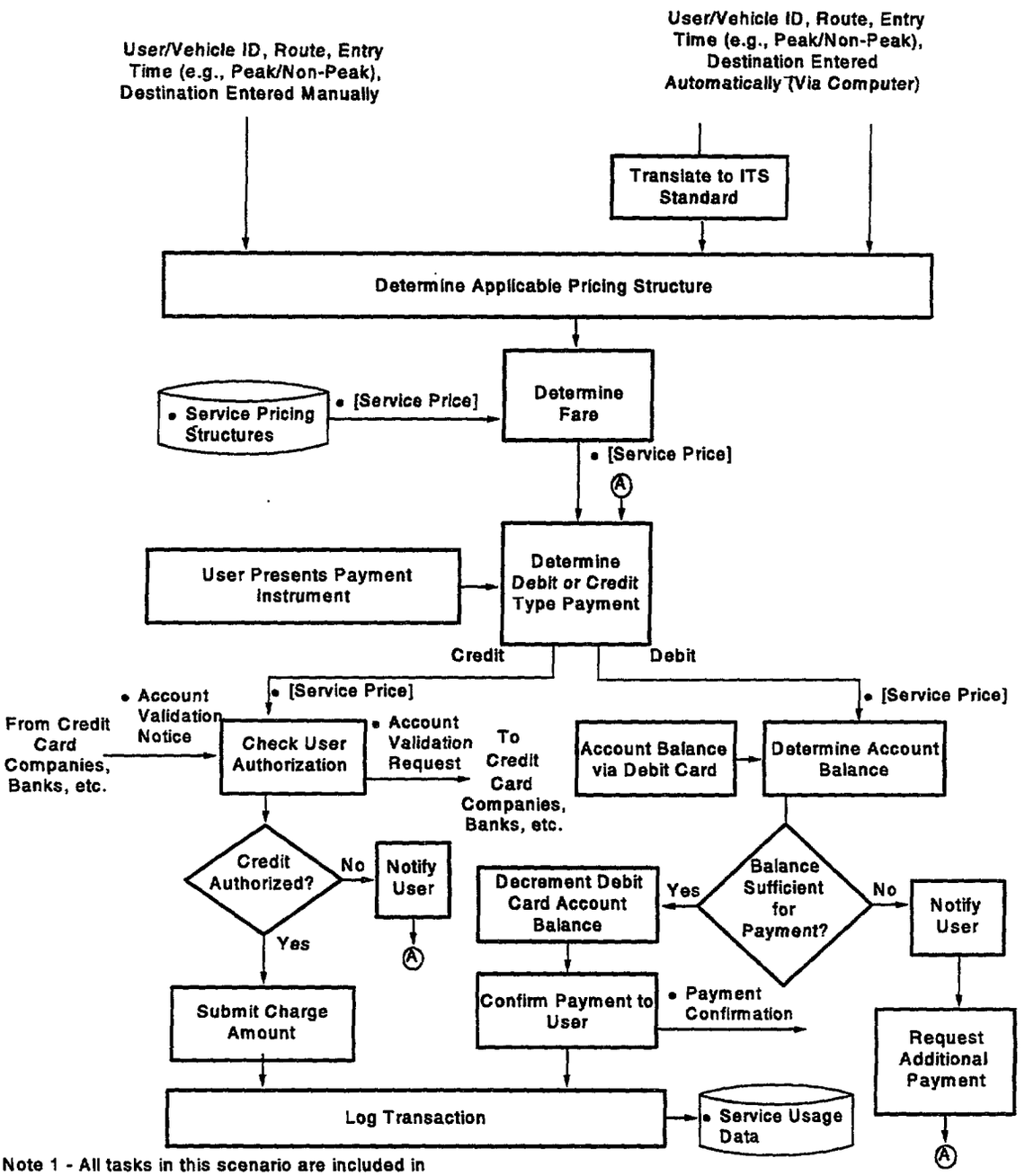


Figure 50. Account Management Scenario -Transaction-Based Billing and Payment

6.1.4 Physical Architecture

The architecture shown in Figure 5 1, Account Management - Physical Architecture, shows how the various Minnesota ITS components are interconnected to provide the Account Management Service. Arrows between the components are labeled with tags for identifying the input data flows to a component. Appendix D, *Physical Architecture Component Interfaces,* associates each tag with the corresponding component input data flows.

The Account Management Service provides several major functions in the Minnesota ITS architecture. Service pricing strategies and service pricing structures are developed for optimum use of transportation services. User profiles are created and maintained for the Advanced Traveler Information and Mayday Services. User accounts are administered for the billing of transportation services. Charges for use of transportation services are calculated, users invoiced and payments tracked by components in this service.

In this architecture, the public agencies establish prices for their services and collect their fees and fares electronically through various methods described below. The private companies also establish prices for their services. In addition, they create and manage the user profile information required by the services they offer (e.g., personal notification of travel conditions on a user's route).

The public agencies in this figure (e.g.; Regional ITS Management Center, Other Transit Management Center(s), Demand Responsive Transit Center(s), Parking Management Center(s) and Toll Authority Center(s)) establish their own pricing strategies and service pricing structures for the transportation services they provide. They maintain user account information and service usage data for the electronic billing and/or payment of transit, parking and roadway toll services. These components interact with Roadside Equipment, Vehicles (equipped with a special electronic payment tag or transmitter) and Payment Instruments (such as debit cards) in the collection of service usage data and electronic payments. They may also interact with Financial Institutions (such as banks) for electronic invoicing and the collection of electronic payments. It should be noted that the Parking Management Center(s) and the Toll Authority Center(s) (and their associated roadside equipment) can be either publicly or privately owned and operated.

The private companies in this figure (e.g.; Tailored Traveler Information Provider(s), Mayday Service Provider(s) and Transit Service Provider(s)) also establish their own pricing strategies and service pricing structures for the transportation services they provide. They maintain user account information and service usage data for electronic billing and/or payment. These components, and the Rideshare Center public component, create and maintain user profiles that are used in the various services they offer, such as Travel Conditions Information, Trip Planning and Directions, Traveler Services Information, Mayday Service and Ride Matching and Reservations. In addition, the Rideshare Center and Transit Service Provider(s) create provider profiles that are used to maintain information about people or companies offering rides as part of the Ride Matching and Reservations Service. All of these private components may interact with Financial Institutions (such as banks) for electronic invoicing and the collection of electronic payments,

The Security Firewall System provides a secure firewall for two-way data exchange between government owned/leased and privately owned networks, and also supports routing of information between public agencies and private companies. The User Interface Equipment provides the means by which users can register for Advanced Traveler Information Services and also the means for them to update profile and account information.

In addition to electronic payments, Financial Institutions also serve as a check point for public agencies and private companies to validate user account information, such as credit card numbers and bank account numbers. External Information Source(s), such as the Department of Motor Vehicles, serve as a check point for public agencies and private companies to validate provider profile information (e.g.; driving record) from people or companies offering rides.

It should be noted that both public agencies and private companies may choose to manage service billing and payments themselves, or they may contract with Account Management Provider companies to perform this service for them.

The numbers, inside each box in the figure, identify the Account Management Service Functional Architecture subfunctions that have been allocated to that box. The code for the numbers is defined as follows:

1. Manage Pricing Requirements (MPR)
2. Manage Pricing Strategies (MPS)
3. Manage Service Pricing Structures (MSPS)
4. Administer User Accounts (AUA)
5. Manage Service Usage Data (MSU)
6. Manage Service Billing and Payments (SBP)

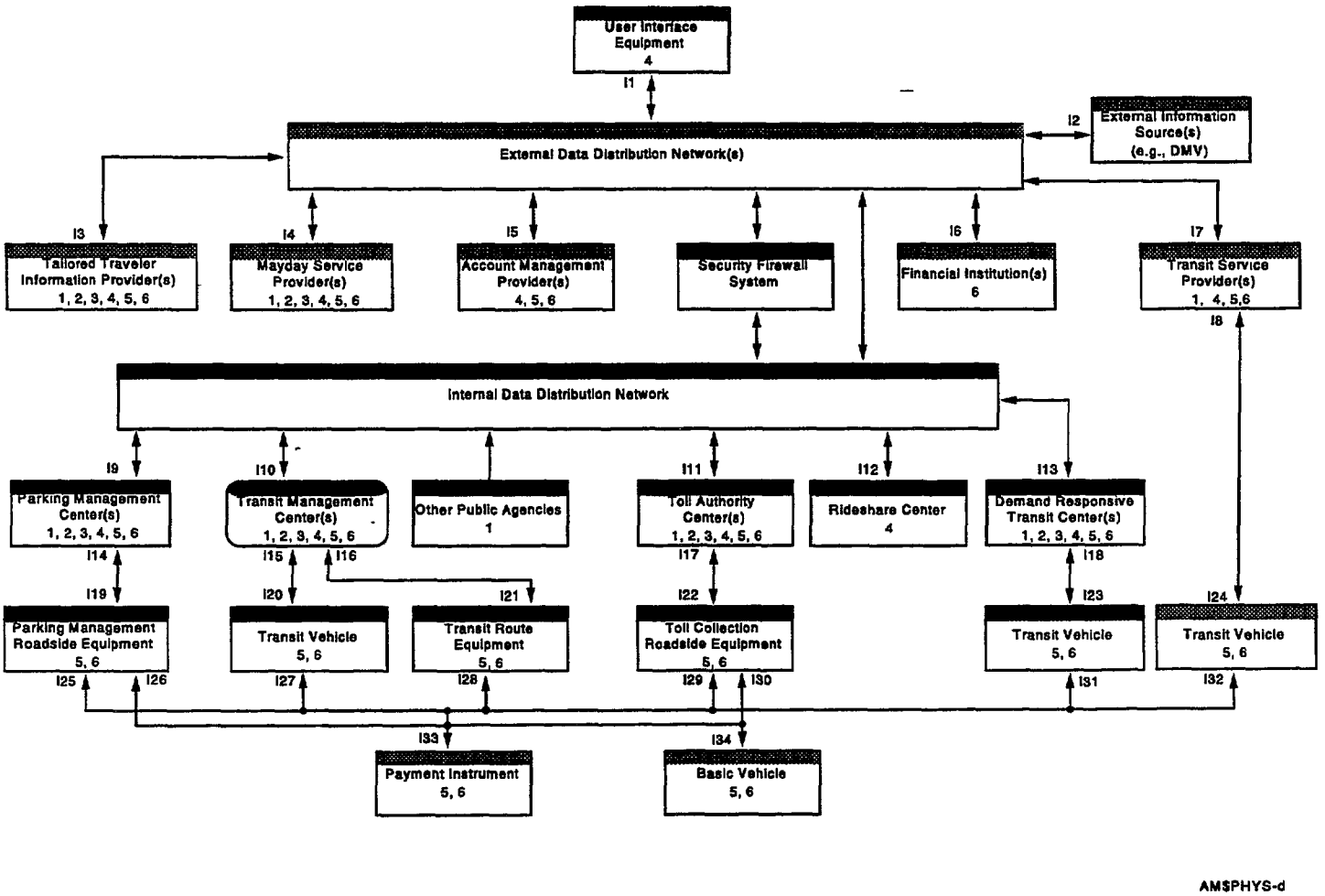


Figure 51. Account Management - Physical Architecture

6.2 Maintenance

Maintenance (MNT) compares vehicle mileage and other vehicle condition data with preventative maintenance schedules to develop a prioritized list of maintenance tasks. Personnel availability and skill levels are then compared to the prioritized and unscheduled (i.e. vehicle breakdown) maintenance tasks to a) assign mechanics to vehicle maintenance tasks, and b) request vehicles be assigned to a maintenance garage. Vehicle maintenance and condition history information is maintained to assist the mechanic in performing maintenance tasks.

6.2.1 Functional Architecture

Maintenance consists of the following functions and sub-functions as shown in Figure 52, Maintenance Service - Functional Architecture:

- Plan Maintenance Activities
  - Manage Maintenance Planning Information
  - Prioritize Maintenance Tasks
  - Generate Maintenance Plan
- Manage Maintenance Activity
  - Perform Maintenance Activity
  - Manage Maintenance Records

A summary description of each function and subfunction is provided in the following subsections. The requirements that characterize each subfunction are located in Appendix B. Appendix B is a separate report generated from a Microsoft Access relational database. Title of the Microsoft Access Report that supports Appendix B is***: Requirements by Service - Function - Subfunction.***

Maintenance interfaces with the following services as shown in Figure 53, Maintenance - Service Interface Diagram:

- Incident Management
- Public Transit Fleet Management
- Ride Matching and Reservations
- Training
- Other
  - External Information Source
  - Human (i.e.; Mechanic, Planner)

In Figure 52 and Figure 53, the arrows between the functions and services represent information data flows. Appendix ***C, Data Flows by Function for ITS Services,*** defines the input and output data flows for each service and the service's functions. Appendix C is a separate report generated by Microsoft Access.

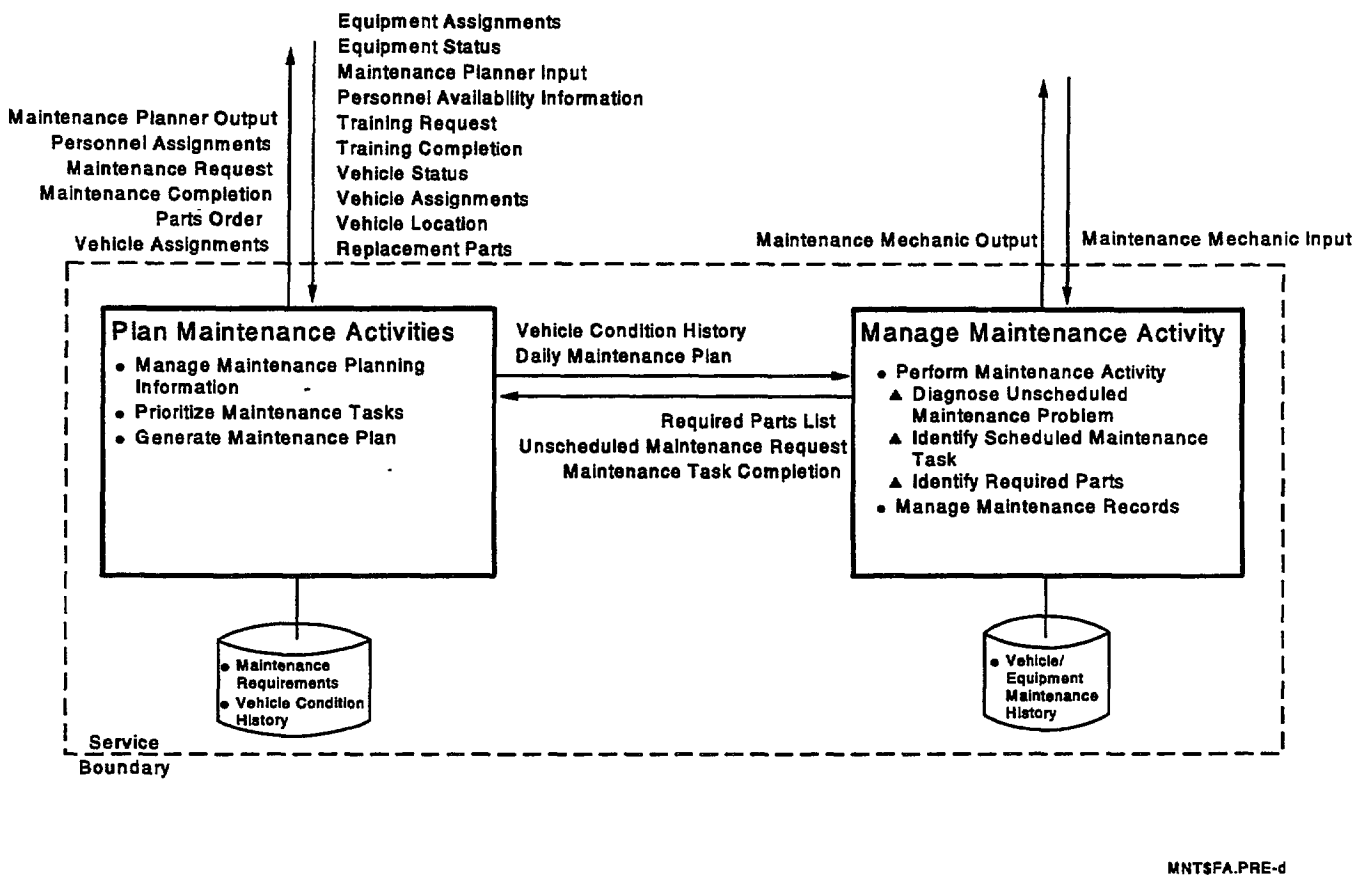


Figure 52. Maintenance - Functional Architecture

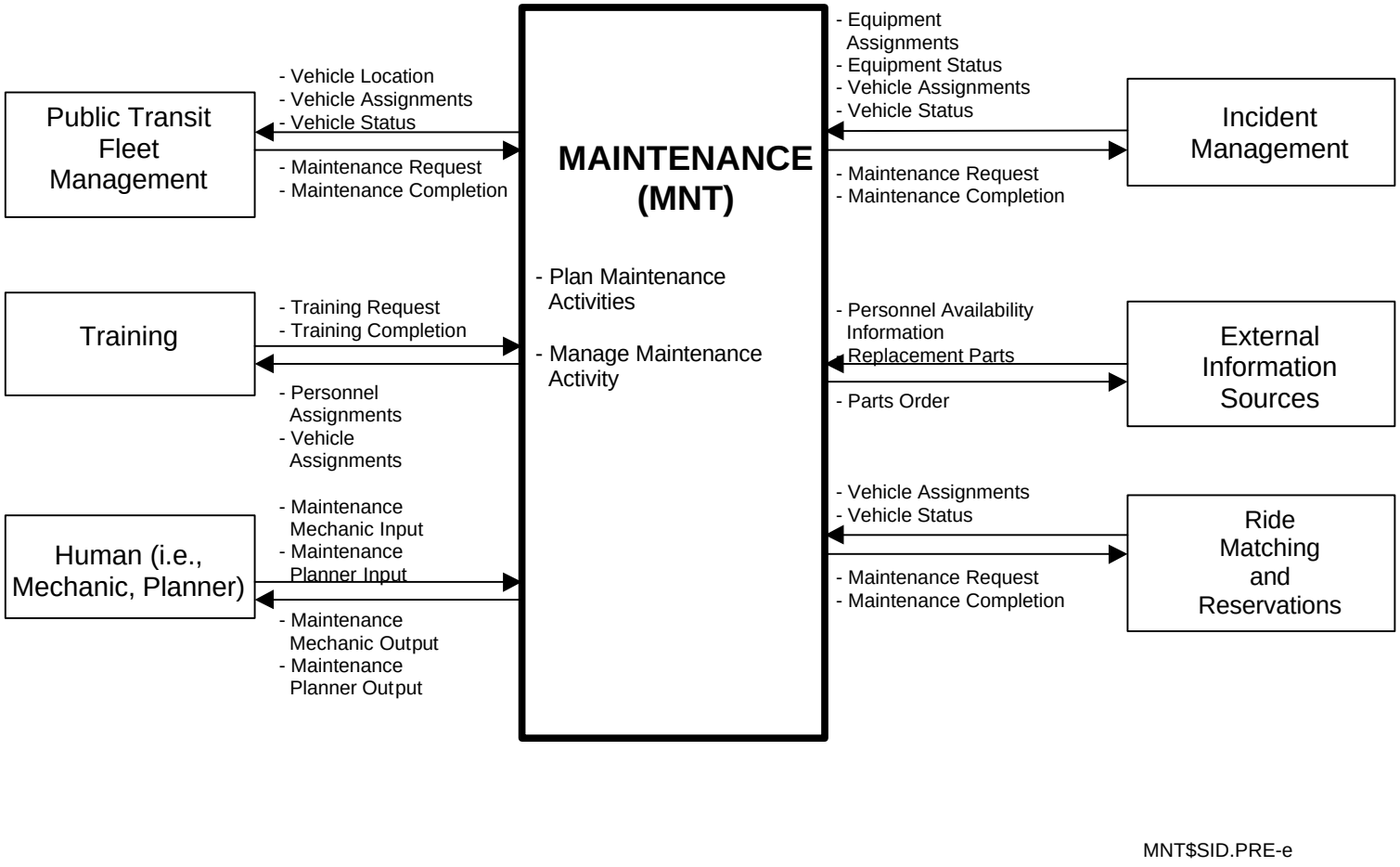


Figure 53. Maintenance - Service Interface Diagram

6.2.1.1 Plan Maintenance Activities (PMA)

The Plan Maintenance Activity (PMA) function maintains a prioritized list of maintenance tasks and assigns the appropriately skilled mechanics to work on the vehicles. Plan Maintenance Activity consists of the following subfunctions:

- **Manage Maintenance Planning Information (MPI)** allows the maintenance operator to enter and store preventative maintenance schedules, maintenance task skill requirements, and maintenance task durations for each model of vehicle. Vehicle mileage is tracked to predict the vehicle maintenance date for each vehicle's next preventative maintenance activity. Vehicle condition history is tracked to support maintenance activities.

- **Prioritize Maintenance Tasks (PMT)** tracks vehicle failures and schedules diagnostic maintenance tasks. This sub-function allows mechanics to schedule additional maintenance tasks that are discovered during preventative maintenance and diagnostic maintenance tasks. A vehicle maintenance priority list is generated for the vehicle fleet in the order of vehicle maintenance date. If a vehicle needs additional parts, a parts order is generated and the maintenance task shall be removed from the vehicle maintenance priority list until replacement-parts have been received.

- **Generate Maintenance Plan (GMP)** examines personnel availability information to determine which mechanics should be available for performing tomorrow's activities. Maintenance plans are generated by matching available mechanics with the necessary skills to vehicles with the highest priority maintenance task. Each mechanic is assigned to a minimum of 8 hours of maintenance tasks per day and the number of vehicles assigned for maintenance is limited to allow enough resources to support normal fleet operations.

6.2.1.2 Manage Maintenance Activity (MMA)

The Manage Maintenance Activity (MMA) function implements the daily maintenance plan, provides vehicle information to assist the mechanic, and provides vehicle maintenance record management. Plan Maintenance Activity consists of the following subfunctions:

- **Perform Maintenance Activity (PM)** assigns mechanics to work on vehicles in accordance with the daily maintenance plan and provides the mechanic with vehicle condition history and vehicle maintenance records as needed. This subfunction also supports scheduling of unscheduled maintenance and ordering of replacment parts.

- **Manage Maintenance Records (MMR)** creates and stores vehicle maintenance records when maintenance activity is complete.

6.2.2 Sample Operational Scenarios

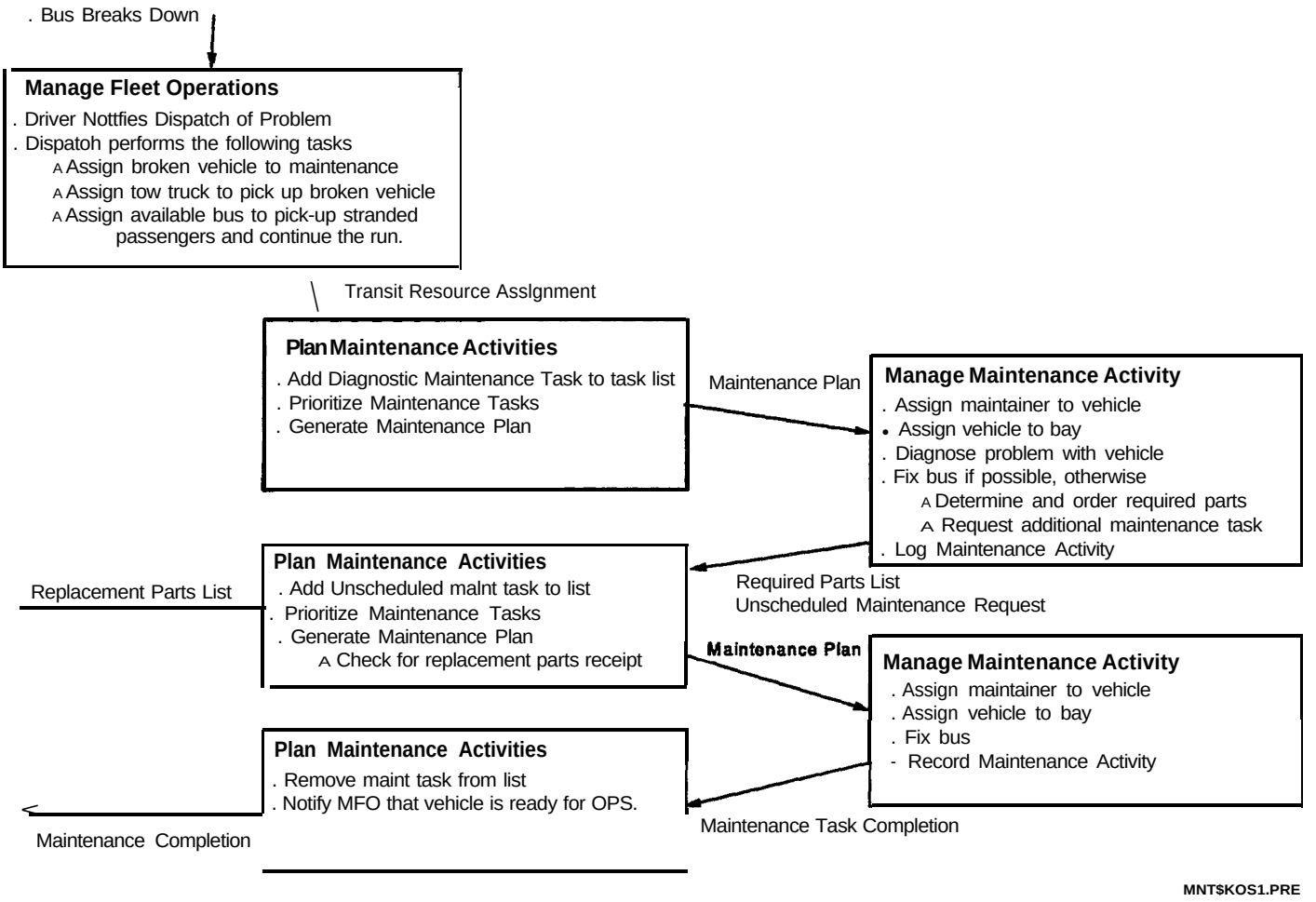


Figure 54. Maintenance - Transit Breakdown Scenario

6.3 Training

Training (TNG) provides a capability to educate both transportation service provider personnel and public users of transportation services. For transportation service provider personnel, Training compares personnel training records with periodic training and certification requirements to develop a prioritized list of training tasks. Personnel availability is then compared to the prioritized list of training tasks and course availability information to assign personnel to courses. Personnel training and certification history information is maintained to plan future training activity, and to assist various regulatory agencies by providing easy access to credential information.

6.3.1 Functional Architecture

Training consists of the following functions and sub-functions as shown in Figure 55, Training Service - Functional Architecture:

- Plan Training Activities
  - Enter Training Schedule
  - Prioritize Training Tasks
  - Generate Training Plan
  - Plan Public Education
- Manage Training Activity
  - Perform Training/Certification Activity
  - Manage Training Records
  - Manage Training Credentials

A summary description of each function and subfunction is provided in the following subsections. The requirements that characterize each subfunction are located in Appendix B. Appendix B is a separate report generated from a Microsoft Access relational database. Title of the Microsoft Access Report that supports Appendix B is: ***Requirements by Service - Function - Subfunction.***

Training interfaces with the following services as shown in Figure 56, Training - Service Interface Diagram:

- Incident Management
- Public Transit Fleet Management
- Ride Matching and Reservation
- Maintenance
- Other
  - External Information Source
  - Human (i.e., Instructor)

In Figure 55 and Figure 56, the arrows between the functions and services represent information data flows. Appendix C, *Data Flows by Function for ITS Services*, defines the input and output data flows for each service and the service's functions. Appendix C is a separate report generated by Microsoft Access.

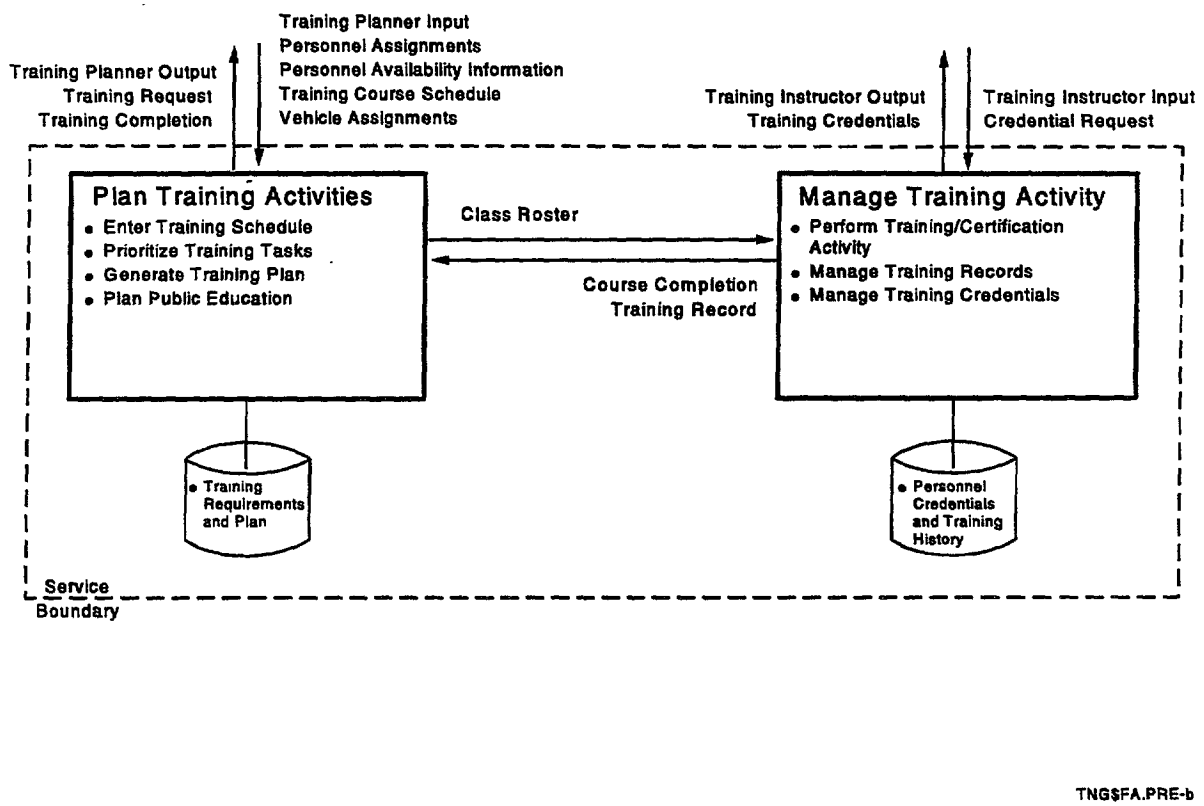


Figure 55. Training - Functional Architecture

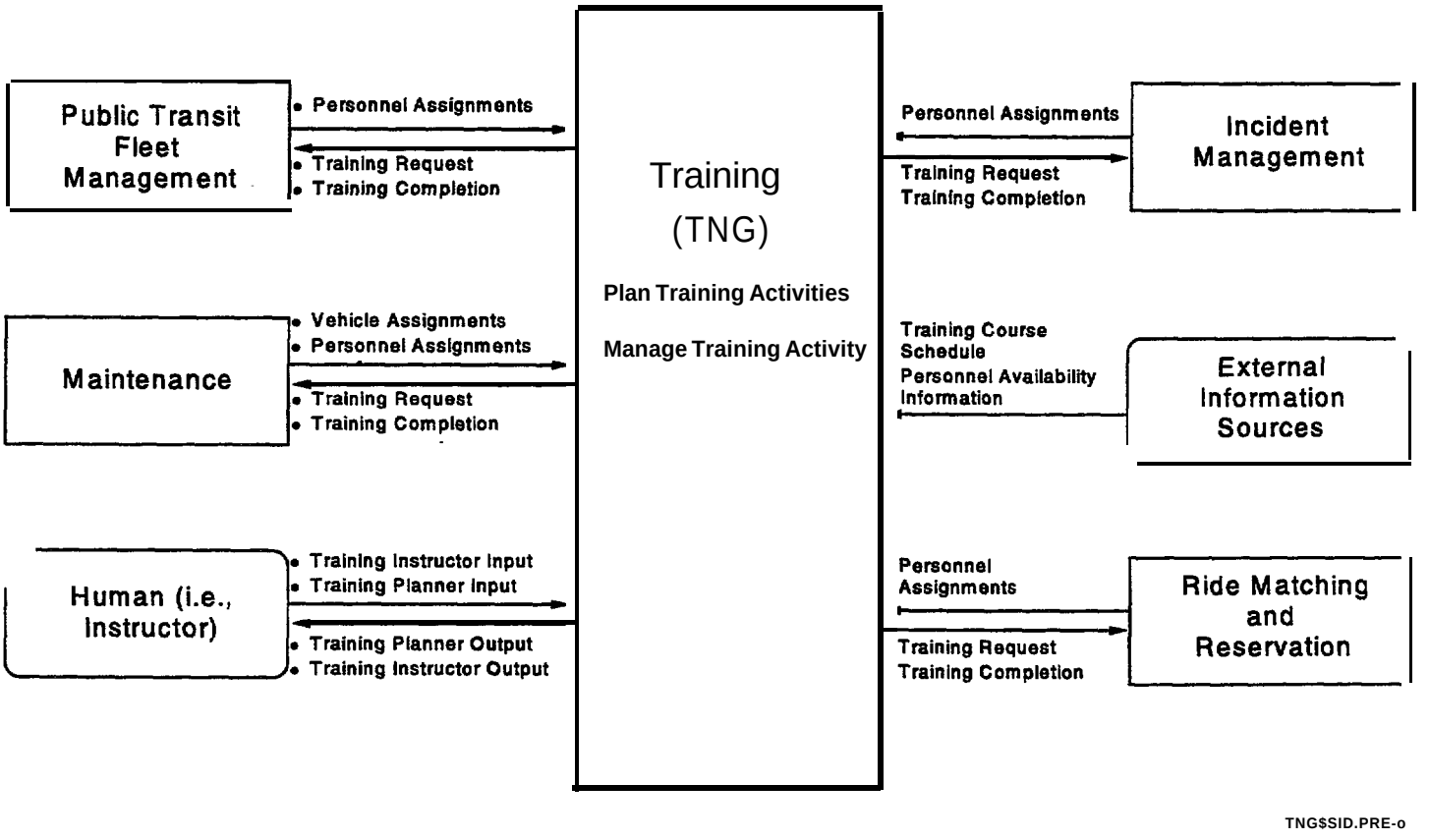


Figure 56. Training - Service Interface Diagram

6.3.1.1 Plan Training Activities (PTA)

The Plan Training Activities (PTA) function reviews training records and training requirements to determine training priorities. This function also reserves student seats in the classes. Plan Training Activities consists of the following subfunctions:

- **Enter Training Schedule (ETS)** allows the training planner to enter and store training requirements for each person, number of training course seats, training course dates, and training course duration. When a training course schedule is received, the training course dates and training course duration shall be automatically updated, and the training planner is notified of the change.

- **Prioritize Training Tasks (PTR)** allows the training planner to prioritize training tasks. The-training expiration dates for each student are determined using the training requirements and the date of the student's latest training record for each required course. A training priority list is generated for all students in the order of training expiration date. Upon receipt of a course completion, a training completion shah be generated.

- **Generate Training Plan (GTP)** allows the training planner to reserve seats in a class for the students with the highest priority need. Upon completion of reserving seats, a training request shall be generated for each student reservation. Personnel availability information is tracked to determine which students are available to attend the class. A final class roster shall be generated for the instructor of the class.

- **Plan Public Education (PPE)** allows the training planner to enter and store public training course dates, number of seats available, and to reserve seats at the public training classes.

6.3.1.2 Manage Training Activity (MTA)

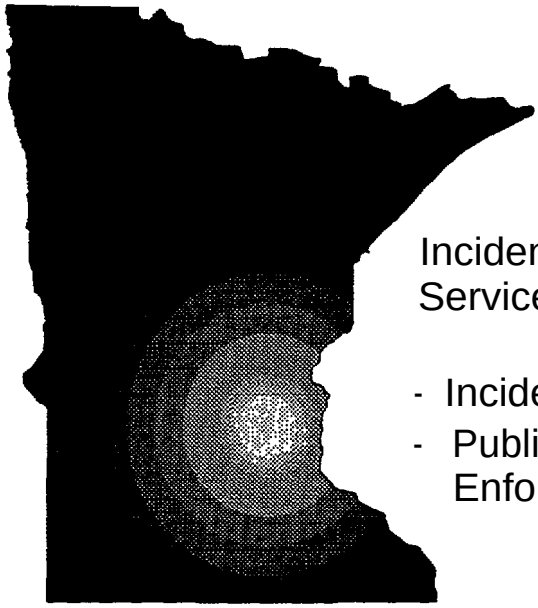
The **Manage Training Activity (MTA)** function provides the instructor with class roster information and allows the instructor to enter grades and/or course completions for each student. This function also provides authorized users with access to training credentials. Manage Training Activity consists of the following subfunctions:

- **Perform Training/Certification Activity (PTC)** supports the instructor by providing a copy of the class roster.

- **Manage Training Records (MTR)** creates and stores training records and/or training credentials for each student as courses are completed.

- **Manage Training Credentials (MTC)** provides authorized access to training credentials. If the requestor is not authorized, system security is notified of a possible security incident.

7 Incident Management



Incident Management Service Bundle:

- Incident Management
- Public Travel Security/ Enforcement

7 Incident Management

7.1 Incident Management

Incident Management (IM) provides the capability to detect and acknowledge reported incidents and travel emergencies. This service provides for coordinated_multi-jurisdictional incident response via preplanned action plans and procedures. Emergency resources (vehicles, personnel and equipment) are assigned based on incident response needs and available resources. This service also provides for real-time monitoring, recording and reporting of incident information and response status.

7.1.1 Service Goals and Objectives

This section contains the service goals and objectives needed to manage the migration to an objective **Incident Management** architecture that is consistent with the Minnesota Traveler Wants and Needs and the Minnesota Agency Wants and Needs research results.

- Coordinate incident management across regional boundaries to ensure efficient and sufficient response
- Use traffic management capabilities to improve response times
- Use onboard or dispatch located route guidance equipment to assist incident response vehicles (e.g., ambulances and tow trucks)
- Provide for the efficient/concise exchange of i&a/interagency incident management information (i.e.; avoid information duplication among agencies, provide only condensed, specific data as needed)

7.1.2 Functional Architecture

Incident Management consists of the following functions and sub-functions as shown in Figure 57, Incident Management Service - Functional Architecture:

- Plan Incident Response
  - Manage Response Requirements
  - Manage Response Plans and Procedures
  - Manage Response Routes
- Manage Incident Response
  - Detect and Acknowledge Incident
  - Manage Mayday Requests
  - Classify and Record Incident
  - Initiate Response Plans, Procedures and Routes
  - Track Response Progress
  - Manage Incident Log
- Manage Incident Resources
  - Manage Incident Resource Assignments
  - Track Incident Resource Status

A summary description of each function and subfunction is provided in the following subsections. The requirements that characterize each subfunction are located in Appendix B. Appendix B is a separate report generated from a Microsoft Access relational database. Title of the Microsoft Access Report that supports Appendix B is: *Requirements by Service - Function - Subfunction.*

Incident Management interfaces with the following services as shown in Figure 58, Incident Management - Service Interface Diagram:

- Account Management
- Maintenance
- Public Transit Fleet Management
- Public Travel Security/Enforcement
- Ride Matching and Reservations
- Traffic Control
- Training
- Travel Conditions Information
  - Other
  - Devices (e.g.; Mayday devices, alarms, sensors, etc.)
  - Human
  - External Information Sources
  - Public Agencies

In Figure 57 and Figure 58, the arrows between the functions and services represent information data flows. Appendix C, *Data Flows by Function for ITS Services*, defines the input and output data flows for each service and the service's functions. Appendix C is a separate report generated by Microsoft Access.

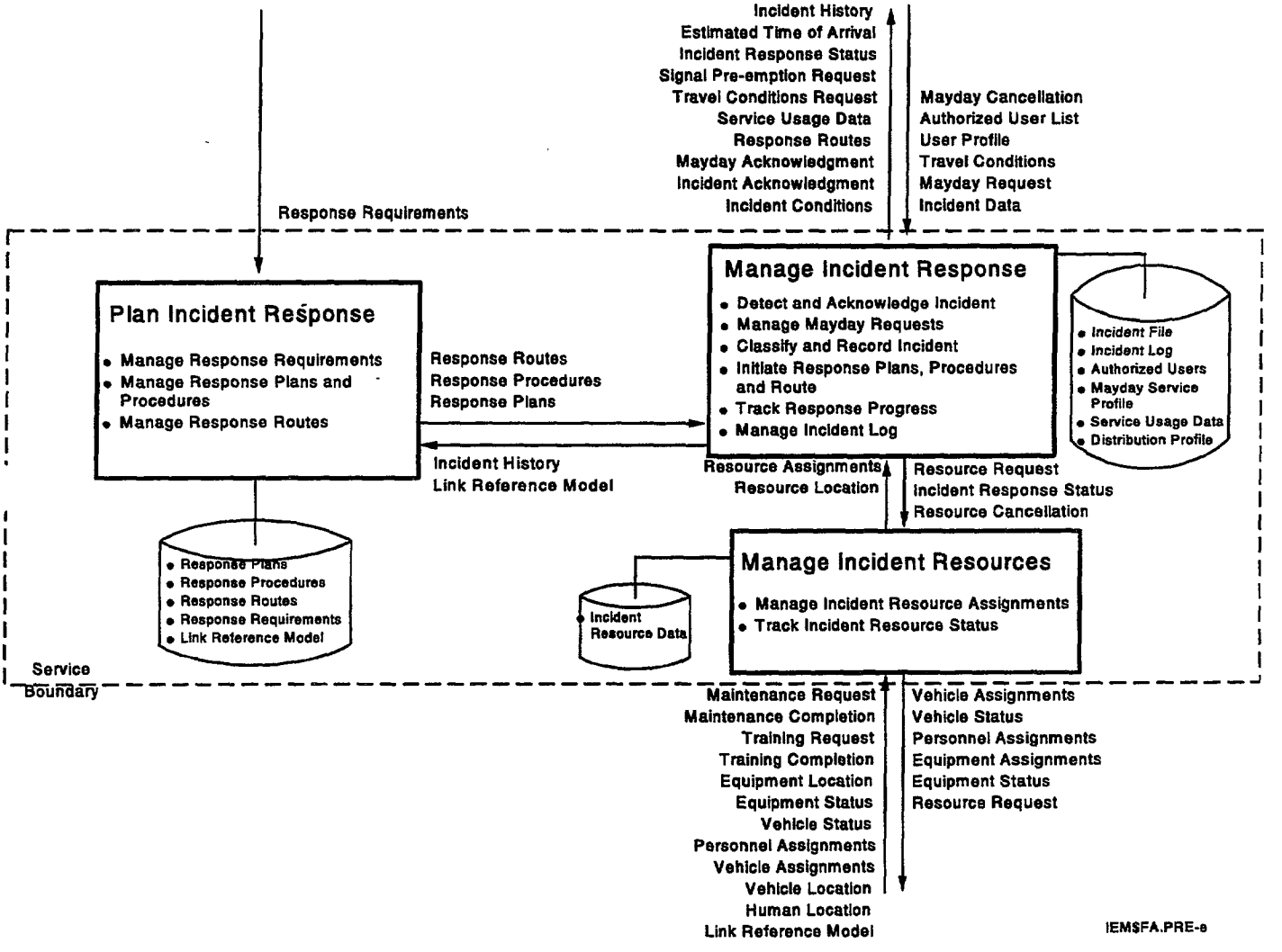


Figure 57. Incident Management - Functional Architecture

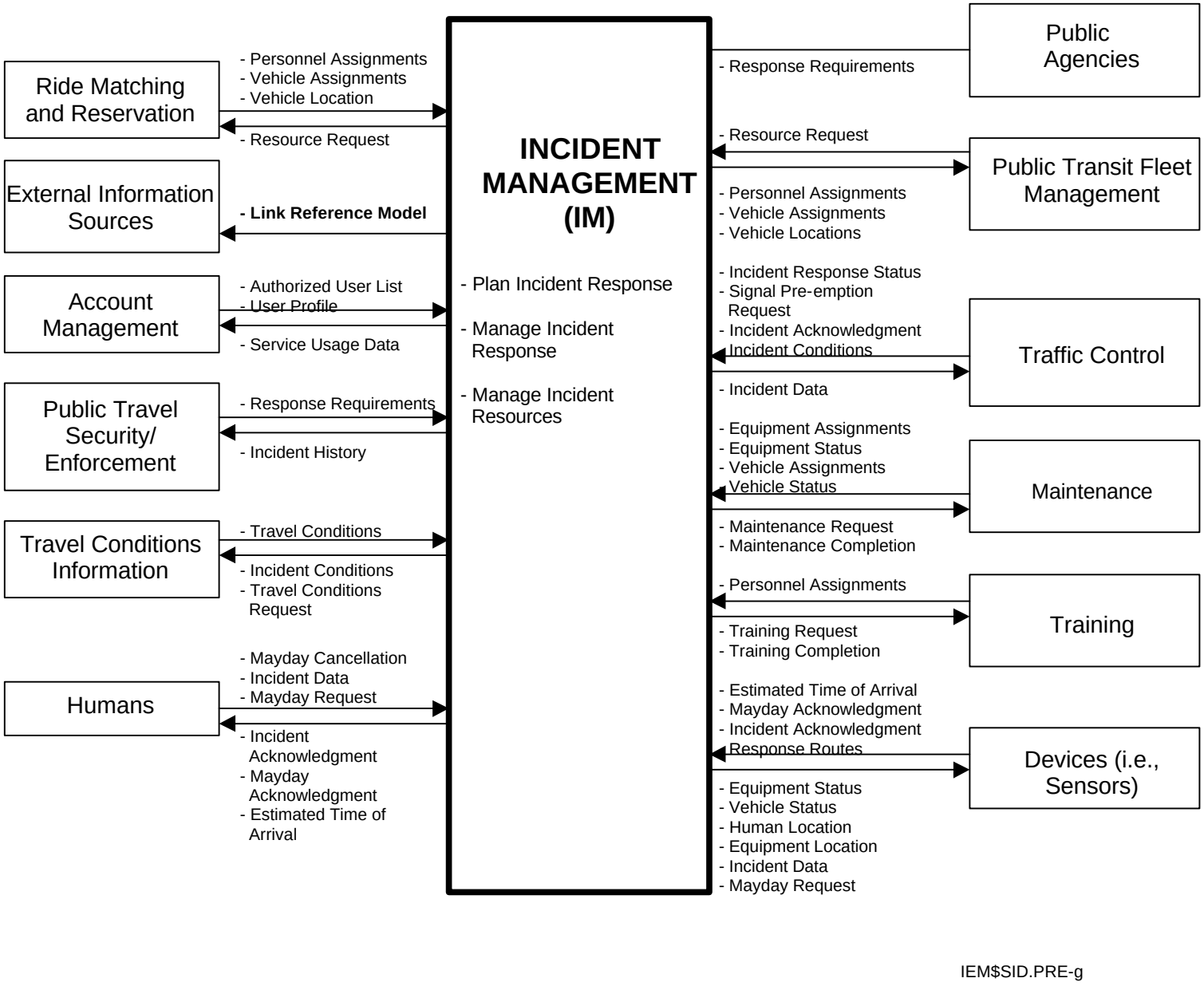


Figure 58. Incident Management - Service Interface Diagram

7.1.2.1 Plan Incident Response (PIR)

The Plan Incident Response (PIR) function is responsible for collecting response requirements which are then analyzed and used to develop response action plans and standard operating procedures. These plans and procedures are kept current and/or updated based on historical incident response performance evaluations and changing requirements. The Plan Incident Response (PIR) function consists of the following subfunctions:

- **Manage Response Requirements (MRR)** is responsible for collecting incident management requirements from public and private agencies, that will be utilized to develop and maintain appropriate response plans, procedures, and routes.

- **Manage Response Plans and Procedures (MRPP)** is reponsible for developing and maintaining response plans and procedures that address incident response requirements and provide for timely, coordinated response involving multiple agencies and jurisdictions. This subfunction also provides measures of effectiveness to support continuous improvement to incident management.

- **Manage Response Routes (MRRO)** is responsible for developing and maintaining incident response routes that minimize travel time required to respond to incidents and emergencies. .

7.1.2.2 Manage Incident Response (MIRP)

The **Manage Incident Response (MIRP)** function is responsible for receiving incident reports, emergency reports, and mayday distress signals that are either manually initiated or automatically initiated. Incidents are classified and incident data is collected and recorded. The appropriate plan, procedure and route for a response is selected based on the initial incident information. Progress of the incident response is tracked, as well as status of additional tasks that need to be performed before the incident can be closed. An incident file is continually updated as additional information is reported and as the response progresses, until the incident is closed. Incident information is shared as appropriate with public agencies, emergency service providers, and traveler information providers. Final reports are generated and distributed as required upon incident closure. The Manage Incident Response (MIRP) function consists of the following subfunctions:

- **Detect and Acknowledge Incidents (DAI)** is responsible for detecting incidents, collecting incident data, and acknowledging reported incidents, locations, and sources using a variety of sensors, surveillance, and communication devices.

- **Manage Mayday Requests (MMR)** is responsible for mayday service requests, acknowledgments, cancellations, and provides mayday service information including user profile and service usage data between authorized users and medical, fire, police, or highway assistance providers.

- **Classify and Record Incidents (CRI)** is responsible for classifying incidents and emergencies according to standard criteria and maintaining an incident log to support incident response.

- **Initiate Response Plans, Procedures, and Routes (IRPPR)** is responsible for utilizing the latest incident data to facilitate selection of the appropriate response plans, procedures, routes, signal pre-emption requests, and requests for resources required to optimally respond to the incident.

- **Track Response Progress (TRP)** is responsible for tracking incident progress and response status, and the status of the assigned resources from the time response plans and procedures are activated until the incident is closed.

- **Manage Incident Log (MIL)** is responsible for ensuring the recording of all data and response status information associated with an incident or emergency from the time response plans and procedures are activated until the incident or emergency is closed. Incident logs contain incident files and incident reports that are generated by the various resources utilized to resolve an incident. Incident information is made available to public agencies and travelers via a variety of devices and services. This function is also responsible for ensuring the protection of incident data from agencies or individuals without a need-to-know.

7.1.2.3 Manage Incident Resources (MIRS)

The Manage Incident Resources (MIRS) function is responsible for tracking/monitoring of the location and status of all emergency personnel, equipment and vehicles, for police, fire, medical assistance and highway assistance resources. Resources are assigned to incidents, training (personnel) and maintenance (vehicles and equipment) by this function. The Manage Incident Resources (MIRS) function consists of the following subfunctions:

- **Manage Incident Resource Assignments (MIRA)** is responsible for coordinating resource assignments (personnel, equipment, and vehicles) from multiple agencies and jurisdictions according to response needs. Resource assignments are tracked to incidents and emergencies, training, maintenance, or out-of-service/off-duty status.

- **Track Incident Resource Status (TIRS)** is responsible for monitoring resource status and tracking resource location. When a resource is found to not be performing as required, this function will output a request for a replacement resource.

7.1.3 Sample Operational Scenarios

The scenario in Figure 59 shows how the Incident Management Service detects and processes planned and unplanned incidents.

The scenario in Figure 60 shows how the Incident Management Service plans for incident response including response plans, response procedures, and response routes.

Each scenario begins at the top of the figure with either the occurrence of an event or a request for some type of incident management related data. The rectangular boxes indicate incident management service sub-functions that are performed during the scenario. The lines and arrows connecting the rectangular subfunction boxes indicate the flow of control from one box, or subfunction, to the next. Data elements labeled on these lines indicate the data flowing between the boxes. This data will be used by the next sub-function. If there are multiple boxes labeled with the same sub-function, then the tasks within the boxes are different but still are part of the same overall sub-function. The storage disc icons beside the subfunction boxes (with lines and arrows leading to or from the subfunction box) indicate stored data or generated data that is used by the task.

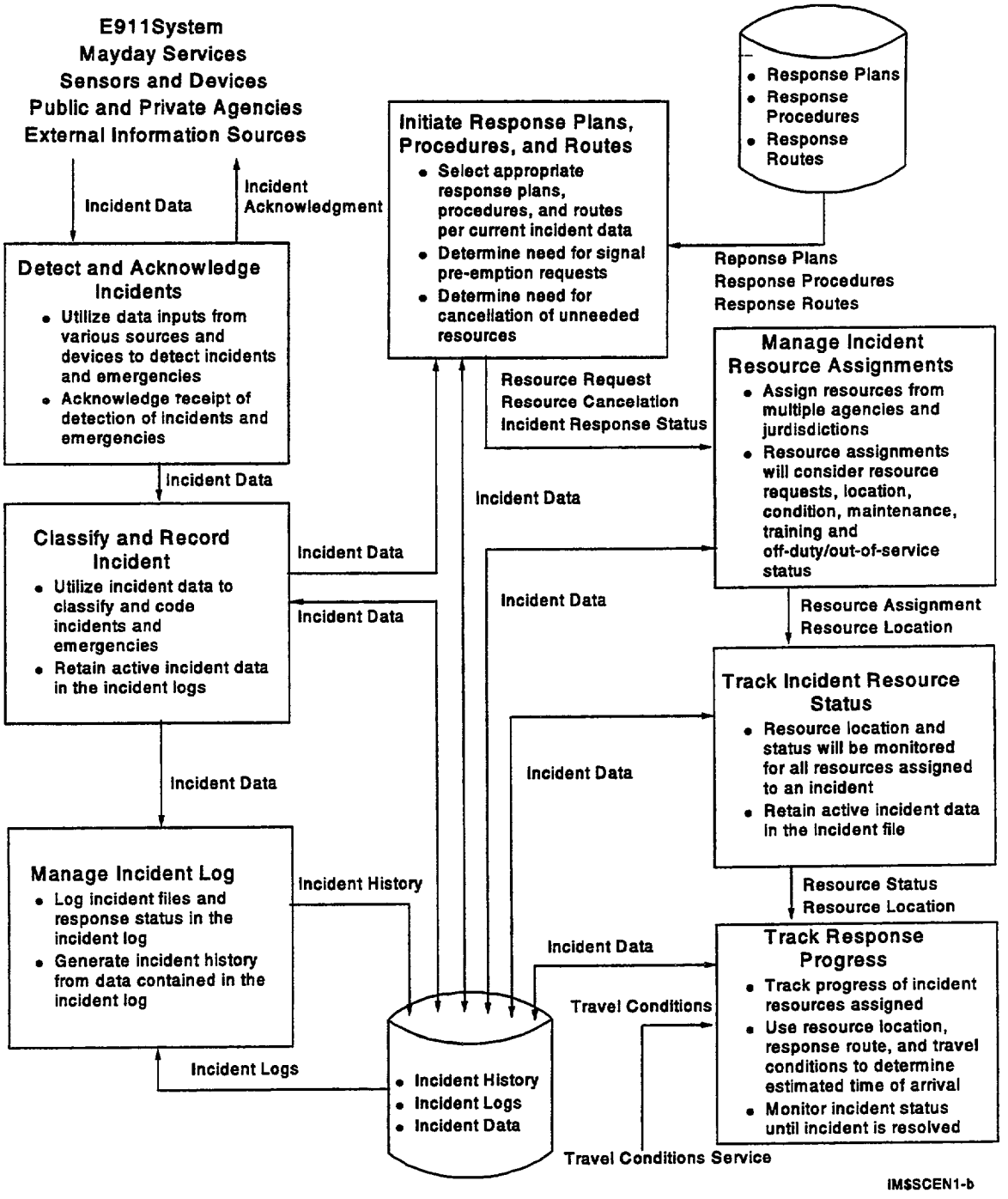


Figure 59. Incident Management (Planned/Unplanned Event)

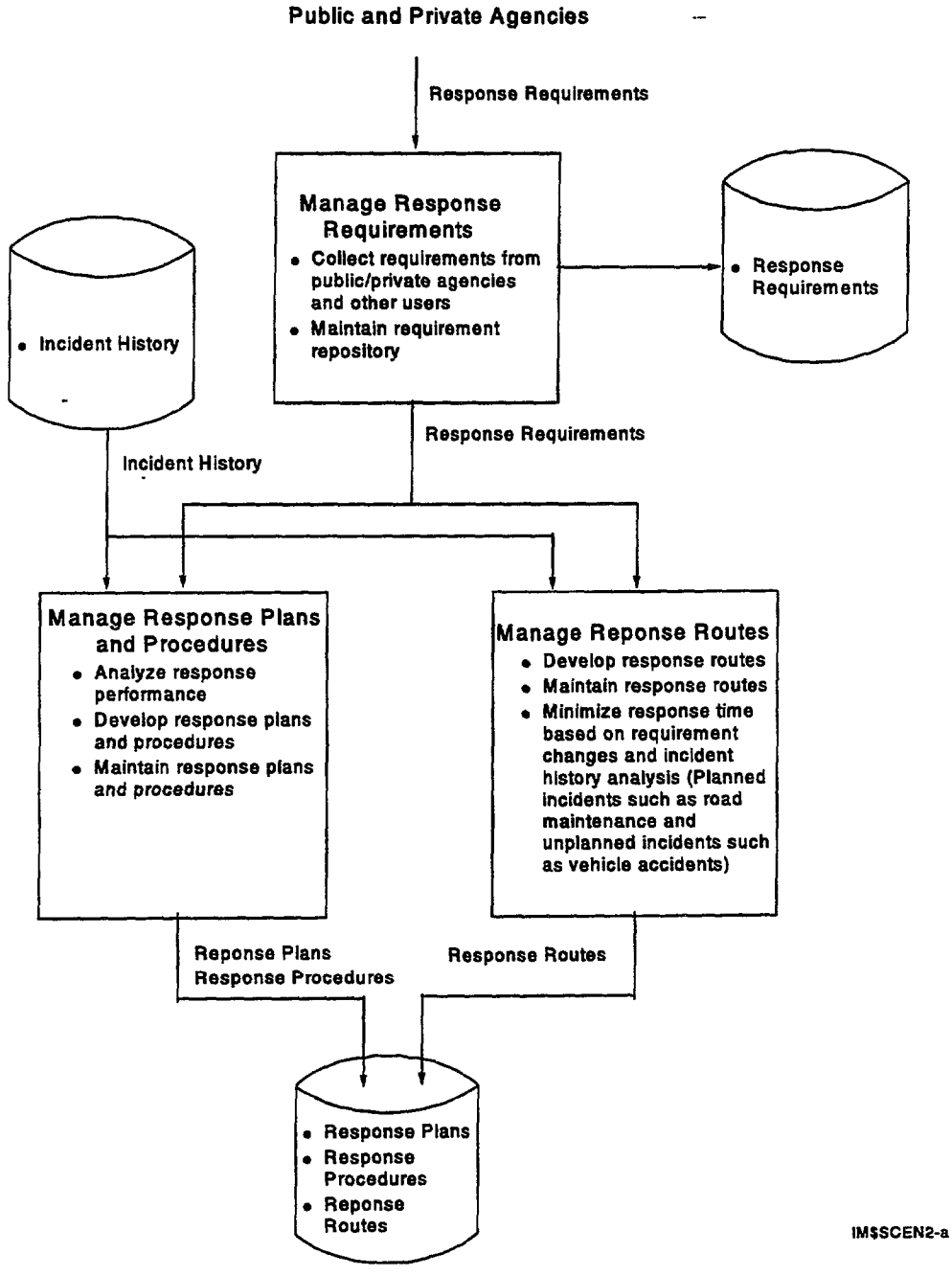


Figure 60. Incident Management (Plan Incident Response)

7.1.4 Physical Architecture

The architecture shown in Figure 6 1, Incident Management - Physical Architecture, shows how the various Minnesota ITS components are interconnected to provide the Incident Management Service. Arrows between the components are labeled with tags for identifying the input data flows to a component. Appendix D, ***Physical Architecture Component Interfaces,*** associates each tag with the corresponding component input data flows.

In this architecture, the public agencies coordinate incident management among themselves through sharing of information as peers with other agencies. A Regional ITS Management System is used for sharing information between agencies and other public or private incident dispatch centers. Each agency dispatches its own vehicles. An Inter-Jurisdictional Incident Management System (or multiple such systems) allows for one system to dispatch the vehicles of multiple agencies where such centralized dispatching is desired. As the operational and political environment develops, it is envisioned that an Inter-Jurisdictional Incident Management System could evolve into a-Regional ITS Management Center that replaces many of the individual centers shown in Figure 61.

The public agencies that manage incidents in this figure (e.g.; Incident Dispatch Centers, State Patrol Dispatch Center, Freeway Traffic Management Center, Maintenance Dispatch Center, etc.) share incident data using predetermined interfaces that are defined according to each agency's policies and inter-agency working agreements. Each agency maintains their own view of data (either locally collected and/or collected from other agencies) that satisfies their own specific operational needs. In addition, the public agencies share their incident information with a Regional ITS Management System that receives and stores incident data from agencies while allowing access to that incident data by other agencies.

The various agencies, such as State Patrol and Incident Management Centers, co-ordinate with the appropriate agencies on signal pre-emption plans, traffic control requirements, resource assignments, etc. to support their operations. Incident data that is shared with private agencies is negotiated with each interface and has to operate in accordance with each Incident Management Agency's policies. The Security Firewall System provides a security firewall for two-way data exchange between government owned/leased and private data networks.

While a hybrid architecture has been selected as the most desirable solution for this service at this time, a transition to the centralized Incident Management Service is easily incorporated into the architecture as funding, resources, and facilities are made available. The centralized system provides opportunities for cost savings in the future as agencies are consolidated for increased efficiencies and thereby reducing manpower requirements required to staff and maintain a Regional ITS Management Center for dispatch of resources required to resolve incidents. The Incident Management Physical Architecture does not change the function or interconnections for the equipment components from the current deployed environment other than incorporating a computer network system to enable the sharing of incident data.

The numbers inside each box, identify the Incident Management Functional Architecture subfunction that have been allocated to that box. The code is defined as follows:

1. Manage Response Requirements (MRR)
2. Manage Response Plans and Procedures (MRPP)
3. Manage Response Routes (MRRO)
4. Detect and Acknowledge Incidents (DAI)
5. Manage Mayday Requests (MMR)
6. Classify and Record Incidents (CRI)
7. Initiate Response Plans, Procedures, and Route (IRPPR)
8. Track Response Progress (TRP)
9. Manage Incident Log (MIL)
10. Manage Incident Resource Assignments (MIRA)
11. Track Incident Resource Status (TIRS)

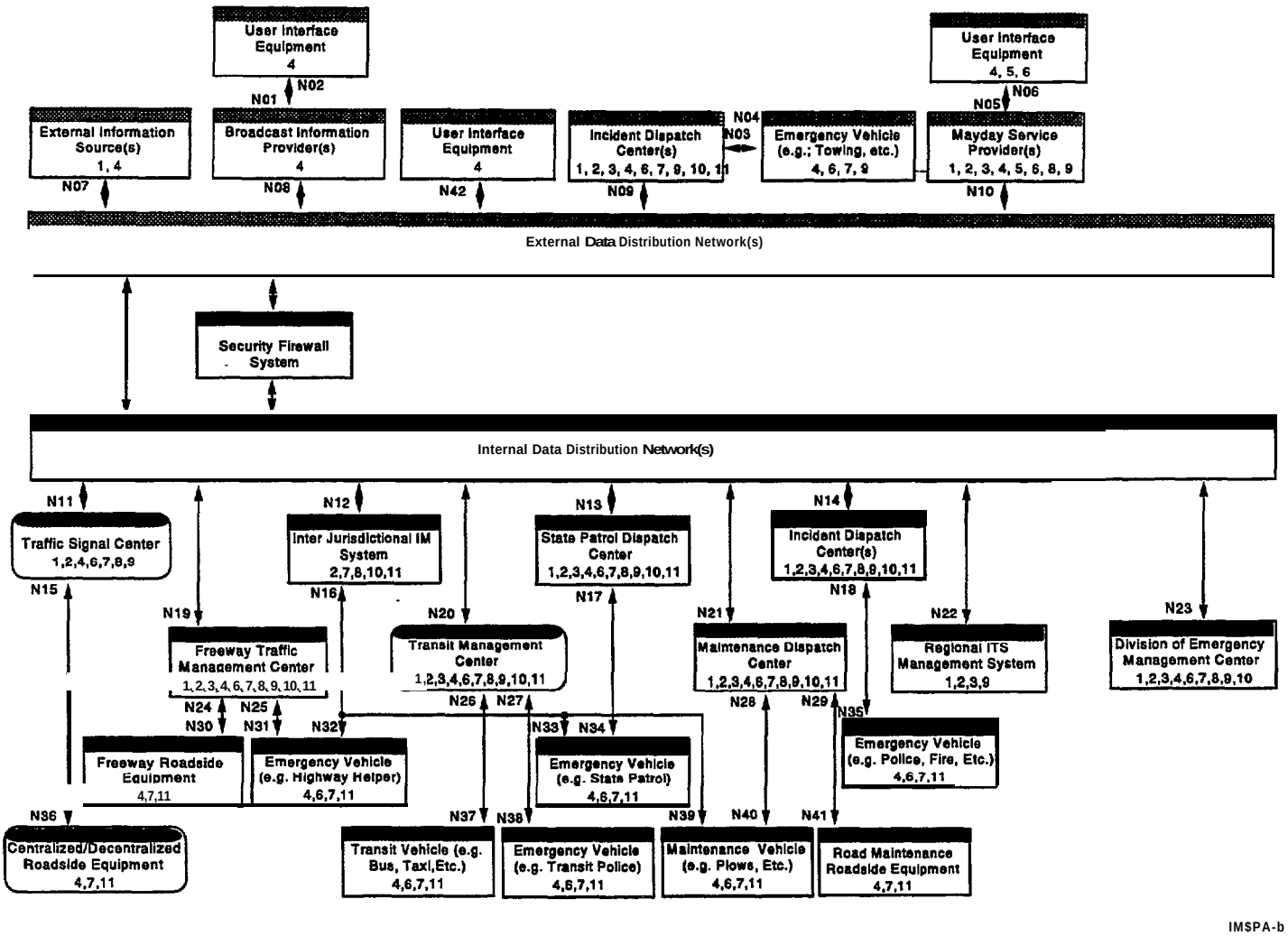


Figure 61. Incident Management - Physical Architecture

7.2 Public Travel Security/Enforcement

Public Travel Security/Enforcement (PTSE) provides for the planning and implementation of public travel security policies, plans and procedures such as the establishment of secure areas for public transit riders and the monitoring of public areas for security incidents. The establishment and enforcement of regulations for HOV lanes, railroad crossings and construction work zones, are also provided. Violations records are kept and statistics are analyzedto determine any needed updates to security policies, plans or procedures.

7.2.1 Functional Architecture

Public Travel Security/Enforcement consists of the following functions and sub-functions as shown in Figure 62, Public Travel Security/Enforcement Service - Functional Architecture:

- Plan Travel Security Enforcement
  - Manage Travel Security/Enforcement Requirements
  - Manage Travel Security Plans and Procedures
  - Manage Enforcement Regulations
- Manage Travel Security/Enforcement
  - Implement Travel Security Policies, Plans and Procedures
  - Enforce Regulations
  - Manage Violations Log

A summary description of each function and subfunction is provided in the following subsections. The requirements that characterize each subfunction are located in Appendix B. Appendix B is a separate report generated from a Microsoft Access relational database. Title of the Microsoft Access Report that supports Appendix B is***: Requirements by Service - Function - Subfunction.***

Public Travel Security/Enforcement interfaces with the following services as shown in Figure 63, Public Travel Security/Enforcement - Service Interface Diagram:

- Incident Management
- Other
  - External Information Sources

In Figure 62 and Figure 63, the arrows between the functions and services represent information data flows. Appendix C, ***Data Flows by Function for ITS Services,*** defines the input and output data flows for each service and the service's functions. Appendix C is a separate report generated by Microsoft Access.

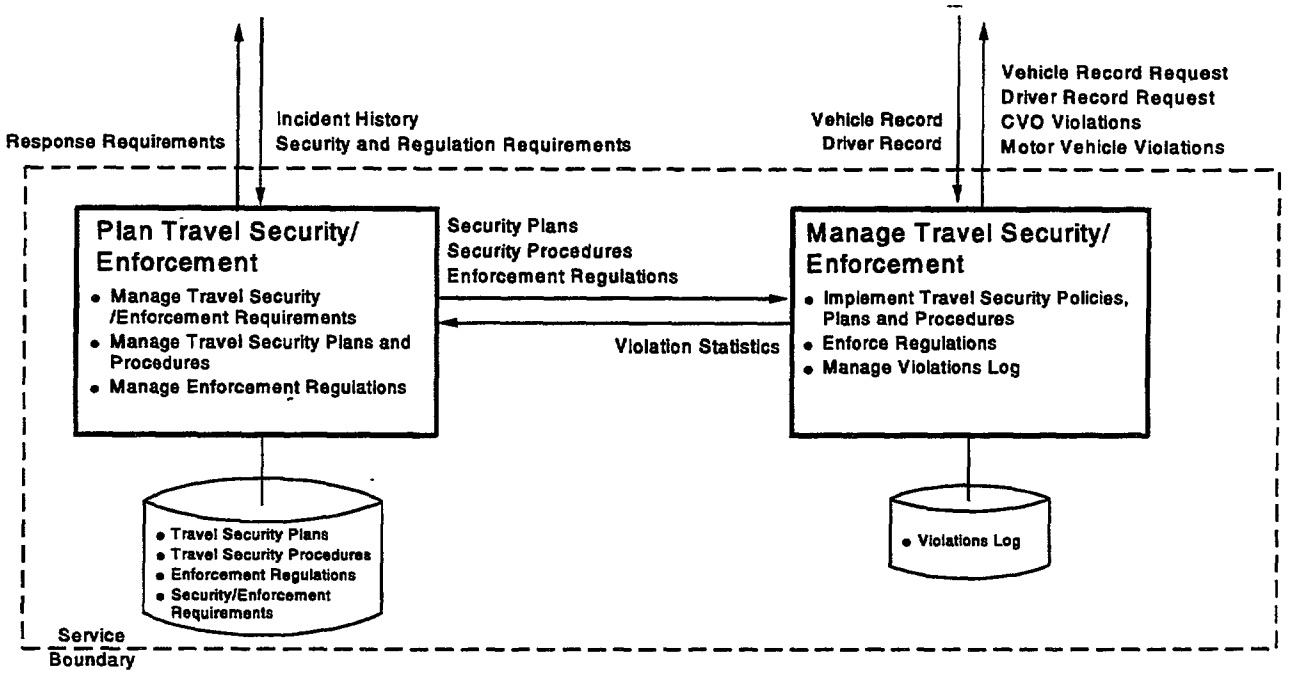


Figure 62. Public Travel Security - Functional Architecture

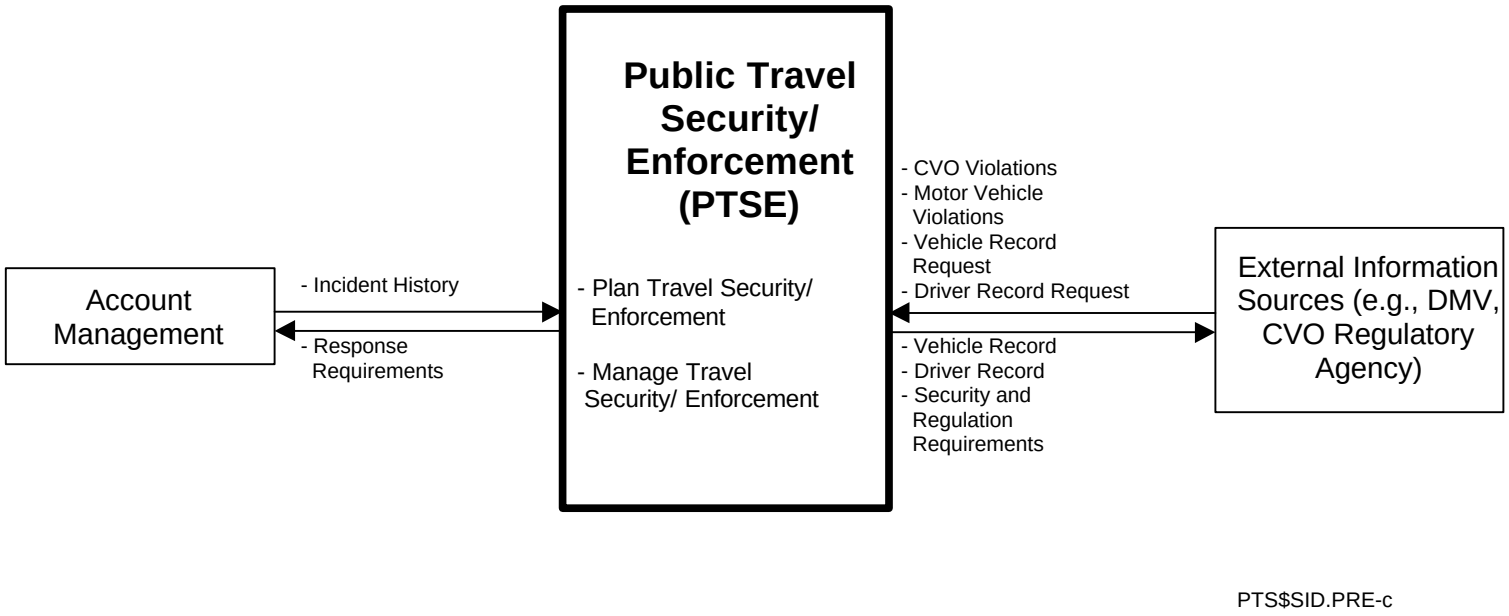


Figure 63. Public Travel Security - Service Interface Diagram

7.2.1.1 Plan Travel Security/Enforcement (PTSE)

The **Plan Travel Security/Enforcement (PTSE)** function is responsible for collecting security/enforcement requirements which are then analyzed and used to develop security plans, security procedures and enforcement regulations. These plans, procedures and regulations are kept current and updated based on historical incident/emergency response performance evaluations and changing requirements. Plan Travel Security/Enforcement consists of the following subfunctions:

- Manage Travel Security/Enforcement Requirements
- Manage Travel Security Plans and Procedures
- Manage Enforcement Regulations

7.2.1.2 Manage Travel Security/Enforcement (MTSE)

The Manage Travel Security/Enforcement (MTSE) function is responsible for the implementation of security plans and procedures, such as the establishment of secure areas for public transit riders, as well as the enforcement of traffic rules and regulations. A log of violations is kept and statistical reports are generated from this log for use in the analysis and updating of security policies, plans, procedures and enforcement regulations. The Manage Travel Security/Enforcement function consists of the following subfunctions:

- Implement Travel Security Policies, Plans, and Procedures
- Enforce Regulations
- Manage Violations Log

8 Acronym Listing

AHS	Automated Highway System
AM	Account Management
AMP	Account Management Provider(s)
APTS	Advanced Public Transportation System
ARSI	Automated Roadside Safety Inspection
ARTS	Advanced Rural Transportation System
ATIS	Advanced Traveler Information System
ATMS	Advanced Traffic Management System
AUA	Administer User Accounts
AVC	Advanced Vehicle Classification
AVI	Automated Vehicle Identification
AVL	Automatic Vehicle Location
AVO	Automated Vehicle Operation
AVSS	Advanced Vehicle Safety System
BIP	Broadcast Information Provider(s)
BTC	Determine Basic Travel Conditions and Travel Effects
BTI	Build Trip Itinerary
BTS	Manage Basic Traveler Services Information
BV	Basic Vehicle
ccsc	Centralized Control Signal Center(s)
CD	Compute Directions
CFM	Commercial Fleet Management
CGR	Communication (Croup)
CMS	Changeable Message Signs
CRD	Pre-Crash Avoidance
CRE	Centralized Roadside Equipment
CRI	Classify and Record Incidents
CSM	Control Signal Modes
CSIM	Control Signing Modes
CTC	Collect Travel Conditions Source Data
CTD	Collect Traffic Surveillance Data
CTS	Collect Traveler Services Source Data
CV	Commercial Vehicle
CVAC	Commercial Vehicle Automated Clearance
CVAP	Commercial Vehicle Administrative Process
CVEC	Commercial Vehicle Electronic Clearance
cvo	Commercial Vehicle Operator
DAI	Detect and Acknowledge Incidents
DCGR	Dispatch Center (Croup)
DCSC	Decentralized Control Signal Center(s)
DEMC	Division of Emergency Mangement Center

DETC	Determine Traffic Conditions
DITC	Distribute Traffic Conditions
DOT	Department of Transportation
DR	Determine Route
DRE	Decentralized Roadside Equipment
DRI	Distribute Rideshare Information
DRO	Manage Demand Responsive Operations
DRS	Provide Demand Responsive Services
DRTC	Demand Responsive Transit Center(s)
DTC	Distribute Travel Conditions Information
DTPD	Distribute Trip Plans and Directions
DTSI	Distribute Traveler Services Information
DTSPI	Distribute Transit Service Provider Information
DTTS	Determine Tailored Traveler Services
EA	Emergency Assistance
EDDN	External Data Distribution Network
EFM	Emergency Fleet Management
EIS	External Information Source(s)
ENPS	Emergency Notification and Personal Security
EP	Electronic Payment
ERDI	En-Route Driver Information
ERTI	En-Route Transit Information
ESGR	External System (Group)
ETC	Electronic Toll Collection
ETM	Emission Testing and Mitigation
ETS	Enter Training Schedule
EV	Emergency Vehicle
EVM	Emergency Vehicle Management
FHWA	Federal Highway Administration
FI	Financial Institution(s)
FRE	Freeway Roadside Equipment
FTA	Federal Transit Administration
FTMC	Freeway Traffic Management Center
GIS	Geographic Information System
GMP	Generate Maintenance Plan
GTP	Generate Training Plan
HAR	Highway Advisory Radio
HAZMAT	Hazardous Materials
HH	Highway Helper
HMIR	Hazardous Material Incident Response
HOV	High Occupancy Vehicle
IC	Commercial Vehicle Inspection/Clearance
ICA	Intersection Collision Avoidance
IDC	Incident Dispatch Center(s)
IDDN	Internal Data Distribution Network

IJMS	Inter-Jurisdictional Incident Management System
IJTR	Inter-Jurisdictional Transit System
IJTS	Inter-Jurisdictional Traffic System
IM	Incident Management
INCA	Intersection Collision Avoidance
IP	Information Provider(s)
IPRS	Information Provider Roadside Equipment
IRPPR	Initiate Response Plans, Procedures, and Routes
ISCP/STP	Implement/Adapt Signing Control Plan
ISTEA	Intermodal Surface Transportation Efficiency Act
ITS	Intelligent Transportation Systems
IVHS	Intelligent Vehicle - Highway Systems
LAC	Lateral Collision Avoidance
LOC	Longitudinal Collision Avoidance
MCGR	Management Center (Group)
MDC	Maintenance Dispatch Center
MFO	Manage Fleet Operations
MFR	Maintain Fleet Resources
MIL	Manage Incident Log
MIRA	Manage Incident Resource Assignments
MIRP	Manage Incident Response
MIRS	Manage Incident Resources
MMA	Manage Maintenance Activity
MMR	Manage Maintenance Records
MMR	Manage Mayday Requests
MNDOT	Minnesota Department of Transportation
MNTG	Maintenance Garage
MPI	Manage Maintenance Planning Information
MPR	Manage Pricing Requirements
MPS	Manage Pricing Strategies
MPT	Manage Passenger Transfers
MPU	Manage Passenger Usage Data
MR	Make Reservations
MRC	Manage Rate Changes
MRP	Match Rider With Provider
MRPP	Manage Response Plans and Procedures
MRR	Manage Response Requirements
MRRO	Manage Response Routes
MSA	Manage Schedule Adherence
MSNEO/MSN	Manage Signal Network Operations
MSNO	Manage Sign Network Operations
MSO	Manage Security Operations
MSP	Mayday Service Provider(s)
MSPS	Manage Service Price Structures
MSR	Manage Signal Resources

MSR/MSIR Manage Signing Resources
MSU Manage Service Usage Data
MTA Manage Transit Assignments
MTA Manage Training Activity
MTC Manage Traffic Conditions
MTC Manage Training Credentials
MTC Monitor Traffic Conditions
MTCD Manage Travel Conditions Data
MTCI Manage Travel Conditions Information
MTCP/TCP Manage Traffic Control Strategies/Plans
MTCR/TCRQ Manage Traffic Control Requirements
MTMC Metro Transit Management Center
MTPD Manage Trip Planning and Directions Data
MTR Manage Training Records
MTSD Manage Traveler Services Data
MTTP Manage Tailored Trip Plans and Directions
MTTS Manage Tailored Traveler Services
MUSA Manage User Service Accounts
MTTP Manage Tailored Trip Plans and Directions
MTTS Manage Tailored Traveler Services
MV Maintenance Vehicle
NMAS Non-Motorized Access & Security
NYSTA New York State Thruway Authority
OPA Other Public Agencies
OSM On-Board Safety Monitoring
OTMC Other Transit Management Center(s)
PCD Personal Communications Device
PCRD Pre-Crash Restraint Deployment
PDA Personal Digital Assistant
PFO Plan Fleet Operations
PFR Plan Fixed/Flexible Routes, Trips, and Runs
PI Payment Instrument
PIR Plan Incident Response
PM Perform Maintenance Activity
PMA Plan Maintenance Activity
PMC Parking Management Center(s)
PMRE Parking Management Roadside Equipment
PMT Prioritize Maintenance Tasks
PMU Personal Messaging Unit
PPT Personalized Public Transit
PRO Plan Rideshare Operating Procedures
PRR Plan Rideshare Routes
POP Plan Fleet Operating Procedures
PPE Plan Public Education
PSDI Plan System Deployment and Implementation

PSO	Plan Security Operations
PTA	Plan Training Activities
PTC	Perform Training/Certification Activity
PTCS	Plan Traffic Control Strategies
PTFM	Public Transportation Fleet Management
PTM	Public Transportation Management
PTMS	Portable Traffic Management System
PTR	Prioritize Training Tasks
PTS	Public Travel Security
PTTI	Pm-Trip Travel Information
PV	Probe Vehicle
RC	Research Center
RE	Regulation and Enforcement
REGR	Roadside Equipment (Group)
RG	Route Guidance
RIMC	Regional Incident Management Center
RIMS	Regional ITS Management System
RITS	Regional ITS Management Center
RMR	Ride Matching and Reservation
RMRE	Road Maintenance Roadside Equipment
RRQ	Manage Rider Requests
RSA	Manage Rideshare Schedule Adherence
RSO	Manage Rideshare Offers
RSR	Manage Rideshare Requests
RTM	Regional Transit Management Center
RTMC	Regional Traffic Management Center
RWIC	Road Weather Information Center
RWIS	Road Weather Information System
RWRE	Road Weather Roadside Equipment
SBP	Manage Service Billing and Payments
SCAN	Surface Condition Analyzer
SFS	Security Firewall System
SIP	Implement/Adapt Signing Plans
SIP	Service Improvement Planning
SOV	Single Occupancy Vehicle
SPDC	State Patrol Dispatch Center
SPGR	Service Provider (Group)
SR	Safety Readiness
SRE	Security Roadside Equipment
STD	Sense Travel Conditions Data
STD	Sensing Traffic Surveillance Data
STP	Implement/Adapt Signal Timing Plan
STT	Schedule Trip Times
TA	Travel Assistance
TAC	Toll Authority Center(s)

TC	Traffic Control
TCI	Travel Conditions Information
TCRE	Toll Collection Roadside Equipment
TDM	Travel Demand Management
TFM	Public Transit Fleet Management
TIDE	Transit Information Distribution Equipment
TIRS	Track Incident Resource Status
TMC	Traffic Management Center
TMG	Transit Maintenance Garage
TMGR	Transit Management Center (Group)
TMS	Traffic Management System
TNGC	Training Center
TOC	Traffic Operations Center
TPD	Trip Planning and Directions
TRB	Transportation Research Board
TRE	Transit Route Equipment
TRKC	Truck Center
TRP	Track Response Progress
TRS	Track Resource Operational Status
TS	Travel Security
TSGR	Traffic Signal Center (Group)
TSI	Traveler Services Information
TSP	Transit Service Provider(s)
TTC	Determine Tailored Travel Conditions
TTE	Determine Tailored Travel Effects
TTI	Transit Traveler Information
TTIP	Tailored Traveler Information Provider(s)
TV	Transit Vehicle
UIE	User Interface Equipment
UIGR	User Interface (Group)
VEC	Vision Enhancement for Crash Avoidance
VGR	Vehicle (Group)
WIM	Weigh In Motion