MIAMI VALLEY ITS

Early Deployment Plan

Recommended System Architecture And Technologies Working Paper

August 1997

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1.0 INTRODUCTION

Architecture, as it pertains to Intelligent Transportation Systems (ITS), refers to the technical blueprint by which integrated systems are designed, built, and deployed. Typically, an architecture is comprised of three major components: the processing system, the communications, and a data architecture. The architecture is the strategy, not the applications or services built within that architecture. It defines "what" components and systems must talk to each other but not necessarily, "how" they communicate. These "how" decisions are typically defined on the project or process level.

The United States Department of Transportation has invested considerable effort in developing the ITS Architecture, an architectural framework for ITS deployment nationwide. The goal behind this effort was to establish commonalities among States and regions planning ITS deployment so the "system" as a whole can make better and smarter use of the existing infrastructure in meeting the transportation demands of the 21st Century.

For ITS deployment in the Miami Valley, some architectural components are already in place. Whether by design or not, agencies and organizations around the Miami Valley region have deployed systems that will become a part (either in part or in their entirety) of the overall ITS deployment in the region. The challenge facing those involved in guiding ITS deployment in the area is to implement an architecture that is flexible enough to respond to changing needs and technologies but robust enough to handle the volume of data and information that must be processed and distributed throughout the region.

This system architecture paper will discuss proposed architectures for the four "infrastructure oriented" program areas defined by the project team and presented in the Strategic Deployment Plan (August 1997). As explained in the Strategic Deployment Plan, the other two program areas are process oriented and therefore do not require system architecture. This report will concentrate on defining a combination of the physical and logical architecture of specific projects in the four program areas to define their interfaces and communication criteria. The four program areas, which will be discussed in this paper, are:

1. Program Area 1: Freeway/Incident Management Systems
2. Program Area 2: Advanced Traffic Signal Control Systems
3. Program Area 3: Public Transportation Systems
4. Program Area 4: Multimodal Traveler Information Systems

A brief overview of these program areas and the projects that fall under them is discussed below. The freeway/incident management system program focuses on projects to develop an integrated freeway management system. Capabilities typically include monitoring traffic conditions on the freeway system, identifying recurring and non recurring congestion, implementing appropriate control and management strategies, and providing critical information to travelers through dissemination methods like changeable message signs. This program area also focuses on incident management activities like detection, verification, response, and clearance. Some critical components of this program area are the implementation of service patrols, expansion of detection systems, and expansion of the closed-circuit television (CCTV) coverage area.

Program Area 2, advanced traffic signal control systems, focuses on projects to improve traffic signals and provide local jurisdictions the ability to communicate, via a local traffic signal control location, with their coordinated traffic signal systems. This project is divided into three phases and includes the capability to perform maintenance and malfunction monitoring, updating timing plans remotely, and implementation of traffic responsive signal control strategies. Specific improvements vary by location but examples of some improvements include updating controllers (from mechanical to microprocessor controlled), upgrading the level of coordination among signals currently coordinated, implementing or upgrading vehicle detection systems, etc. This program area also includes projects in implementing ITS applications for Highway/Railroad Intersection and crossings. Though this user service is new to the national ITS plan, planning for the future in the Early Deployment Plan is necessary.

Program Area 3, public transportation systems, focuses on projects to improve the management and operation of public transit and to promote transit ridership in the Miami Valley area by providing efficient, reliable, and flexible transit systems. This program area involves projects for the Miami Valley Regional Transit authority (MVRTA), Springfield City Area Transit (SCAT), Miami County Transit, and the City of Piqua transit agency. Technologies and improvements for these agencies include automatic vehicle location, schedule adherence monitoring, on-board electronic fare and data collection, electronic station displays, and on-board annunciators. All the projects are designed for fixed route service buses, fixed-route deviation buses, paratransit, and demand responsive services.

Program Area 4, multimodal traveler information systems focuses on dissemination of traveler information to users through various ITS technologies which are cost-effective, simple to use and will provide accurate and real-time information. It focuses on a central data server which processes data collected from traffic services and transit agencies and disseminates that information to specific Independent Service Providers (ISP's). Technologies include media reports, automated telephone advisory systems, navigation devices, an Internet home page, etc. Types of traveler information include real-time speeds, incidents, construction, weather, route guidance, yellow page, and critical transit information.

2.0 CURRENT CONDITIONS

Currently, there is very little ITS architecture in place in the Miami Valley Area. The majority of existing architecture is related to traffic signal coordination and operation. While there are multiple closed-loop and open-loop signal coordination systems throughout the area, these are not coordinated on a broad, regional basis nor are they necessarily coordinated across jurisdictional boundaries.

There is some capability for freeway reporting of accidents, incidents and congestion for the media and radio, but this is mostly through commercially available systems from private companies. There are no publically supported, region-wide traffic management and reporting systems in place today.

As discussed earlier, there are four separate transit systems operating within the Miami Valley Area. All systems are planning to either maintain or increase their existing levels of service. MVRTA is beginning construction of a new six-hub system to improve their levels of service and move away from a single-hub operating system. However, there is very little, if any, ITS infrastructure installed in any of the four systems. MVRTA does make use of computer-aided dispatch.

Local television and radio stations provide some traffic information during the morning and evening rush hours but that is the extent of the traveler information provided in the Miami Valley Area. Some Internet sites have been established that provide local information and some routing (driving) instruction capabilities but there are no sites that provide any real-time traffic/congestion information.

3.0 COMMUNICATION PROFILES

One of the most important components of an architecture is the communications infrastructure. The type of communication methods and technologies selected must support the collection and dissemination of transportation information throughout the Miami Valley Area. This architecture report will identify candidate communication technologies that are applicable for the various program areas but will not recommend specific types of communications for a specific interface.

Each program area can be successfully implemented with a variety of communications methodologies. The type of communication ultimately selected will depend on many factors such as existing communication infrastructure, resources available, data communication requirements, and the long-range plan for the systems involved. In order to simplify the multitude of communications options available for each program area, "profiles" have been identified that represent the type of communications and data transmission requirements necessary in each program area rather than a particular communication medium. These profiles (A, B, and C) vary depending on the amount of data (which could be voice, video, or electronic data) that must be transmitted (volume) and how often this transmission takes place (frequency).

The profiles defined below are followed as a standard for the program architecture diagrams and are represented by a specific design/line.

3.1 Profile A

- Low volume data
- Manual data
- Updates only when required

Systems using this profile of communications typically do not have large amounts of data to transfer. The data to be transferred typically is not available electronically and most data is manually processed through hardcopy, voice, facsimile, or pager networks. Typical sources of this information would be transit agencies that have static schedules or special event information. Some examples of communication technologies that fall under this category are briefly described below.

1. Cellular Network

The cellular service can be used to receive and transmit data using the existing cellular network for both voice and data. This method is useful for small amounts of data but it is susceptible to varying quality and dead spots. Examples of using this communications are to change messages remotely to variable message signs and highway advisory radio, or provide communications capabilities for in-vehicle navigation devices for receiving real-time traffic information and mayday functionality.

2. Area Radio Networks

These radio systems broadcast signals to an area and are used by many government agencies for general voice communications. For a typical area radio network, one frequency pair is allocated for an application, meaning all application transmitters must share the same transmit and receive channels. Therefore, for voice communications, all receivers tune to the same broadcast and the users only respond to messages directed to them.

3. Pager Networks

Specific traffic information may be distributed on a pager network. Small amounts of data can be sent through an existing pager network and can be received by users who have a paid subscription to the paging service. This technology is susceptible to dead spots in coverage and is thus recommended only for short bursts of information maybe twice a day.

3.2 Profile B

- Electronic data
- Low and high volumes of data
- Static and dynamic data
- Updated regularly, but not real-time

Systems using this profile of communications typically have large amounts of data to transfer that are available electronically. The data is not updated frequently and could be either static or dynamic in nature. The frequency of data received and transmitted using these profile ranges from one update daily to more than one update (usually if updates occur during peak morning and evening hours). A transit agency would be a typical source of this type of information where they have their route schedules in an electronic format that can be transmitted to a central data server. While not static, this transit information is not frequently updated and thus does not require a real-time communications link to the central data server. This profile could also be used to disseminate information out to changeable message signs, highway advisory radio, and electronic station signs. Some examples of communication technologies that fall under this category are briefly described below.

1. Analog Phone Lines

This uses the voice grade telephone line provided by a telephone company that is suitable for low volume data, updated regularly but not real-time. This method is susceptible to noise and is not suitable for transmitting video images. A typical application using analog phone lines for data communications is to transmit data to a host computer from remote data collection devices (such as radar detectors, or slow scan cameras).

2. Digital Modem Lines

This service is a special subscription to a telephone company and provides cleaner, faster data transfer than an analog line. This service can be combined with commercially available ISDN lines with 64 KBPS data transfer rates to achieve an even faster rate. This method is suitable for large volumes of data and has been used in many cities as a reliable method of communication for transportation purposes.

3. Twisted Pair Wire

This type of communication provides reliable serial data in point-to-point or point-to-multipoint services. The data transfer rate of twisted pair wire is very similar to an analog line except for the fact that it is immune to the noise. Due to its limited transmission range, twisted pair wire is used to connect multiple data collection devices to a local controller in the field, or to connect a computer with peripherals in the same facility. The moderate data transfer rate and reliable transmission scheme has made twisted pair wire a popular choice for connecting end devices in a communication network.

4. Packet Radio Network

This is a wireless communication method, which formats digital data into small packets and transmits them via radio spectrum. Its relatively low data transfer rate has limited application for large amounts of voice and data, but it is a proven technology for communications between a base and multiple mobile units. Some examples of applications include communication media for hand held devices, in-vehicle navigation devices, and emergency vehicles.

3.3 Profile C

- Low and high volume data
- Continuous update of information – real-time
- Primarily dynamic information

Systems using this profile typically have large amounts of data that is available by electronic media and/or is updated frequently or almost continuously. Typically, the data is dynamic, supplemented by some static information. The frequency of data received and transmitted in this category is in real-time. While this may not constitute a continuous open communication link between two systems, it is necessary that this profile support frequent updating (ranging from updates every five minutes to near continuous, real-time updates) of the information. Sources of such information include real-time incident detection, speed data, CCTV images, and video detection systems. Types of dissemination techniques using this type of communications are traveler information services like the Internet, Cable TV, in-vehicle navigation devices, and planning organizations like Emergency Management, Incident Rescue Operations, etc. Some examples of communication technologies that fall under this category are briefly described below.

1. **Fiber Optics**

   This technology provides extraordinary data transfer speed and a longer transmission range. This relatively new cabling technology provides data rates of up to 2.5 Gbps and can transmit data in the form of light waves. This technology is proven and has been used in many cities as the main communication backbone for ITS deployment. Its capabilities of transferring data, voice, and video at high speeds, high volumes and in real-time makes it a viable solution for any ITS deployment planning.

2. **Coaxial Cable**

   Cable television stations commonly use this communications method to provide services to subscribers. The coaxial cable has wide bandwidth to transmit multi channel video, voice, and data and has been widely adopted to provide permanent communications between two fixed facilities.

3. **FM Subcarrier**

   This communication technology transmits data in one direction only. It uses the commercial FM broadcast and sends information at higher frequencies in a cost-effective manner. This method is very useful for continuous updates of real-time traffic and transit information. This is useful for applications that receive constant dumps of information like navigation devices, emergency vehicles, changeable message signs, etc.

4. **Digital Systems**

   Apart from the regular service that telephone companies offer, a new type of service called the digital service which is referred to as the T-l circuit is also available. This type of circuit can operate at speeds of 1.544 Mbps. The T-l circuits have the capability of digitally transmitting video signals, and can carry 24 digital voice channels or combinations of voice and data. The T-l technology has been improved to provide a series of higher speed digital circuits classified as digital services DS2 and DS3. The DS2 can operate up to 6.3 Mbps and the DS3 can operate up to 43.3 Mbps and provide up to 672 digital voice channels. This type of communications is useful for applications like the Internet or a central data server, which need speed and multiple data channels to receive and disseminate information.

4.0 PROPOSED ARCHITECTURE

The structure of the architecture refers to the underlying concept of where the data is stored, where the “processing” of this data is accomplished, and lastly where and how the data gets disseminated to end users.

In the National ITS Architecture, there are two architecture types described, the logical and the physical. The logical architecture presents a functional view of the ITS user services. It defines the functions or process specifications that are required to perform ITS user services and the information or data flows that need to be exchanged between these functions. The physical architecture partitions the functions defined by the logical architecture into “systems” and lower level “subsystems”, based on the functional similarity of the process specifications and the location where the functions are ‘performed. For the Miami Valley EDP, the architecture has not been defined through user services, but through program areas and specific projects. Due to this distinction, the architecture that is described below for each program area is a combination of the logical and physical type.

It is evident from the architecture diagrams that a distributed architecture is proposed for the Miami Valley Area. A distributed architecture relies heavily on local storing and processing of data and then communicating that data between systems using the various communications means discussed above. In this form of architecture, each site receives separate data inputs, then processes the data into the appropriate information content and stores it for retrieval. Each user (or data terminal) makes a request of the “system” for information. The type of information requested will determine which “server” or processor will respond to the request. Although there is a disadvantage of the data not being resident in a single “location,” for easier maintenance, consistency and standardization of data format, one advantage of this form is that the users of the data and information need not establish a communications link to a central facility. Using a distributed architecture allows new systems to be “plugged in” to the existing infrastructure as they come on line. This is a good approach for the Miami Valley Area since there is no single regional traffic management facility. However, there is a proposal in the multimodal traveler information systems program area for a “central data server” which acts as a central repository for all traffic information, processing, and dissemination.

The following will describe the architecture for proposed projects that fall under each program area. Note that certain projects in this program area do not need or have an architecture defined and thus the architecture diagram will address only those projects, which have a defined architecture.

4.1 PROGRAM AREA 1: FREEWAY/INCIDENT MANAGEMENT SYSTEMS

As discussed earlier, this program area consists of projects that aim to help public and private organizations to maintain safe freeway conditions, monitor the freeway to quickly identify incidents, and implement responses to enhance public safety and minimize adverse traffic conditions. The projects for which the architecture will be discussed are:

4.1.1 Regional Cellular Hotline Incident Reporting System

This project consists of implementing a regional cellular hotline traffic reporting system, which will allow en-route motorists with cellular, phones to report traffic incidents and related information to a central coordinating facility. The coordinating facility will take the appropriate actions relative to involving law enforcement, emergency response, and freeway/incident management control facilities.

4.1.2 Implement CCTV Cameras

This project consists of installing closed circuit television (CCTV) cameras at select locations (details of locations are available in the Strategic Deployment Plan). The cameras will have the capability to pan, tilt, zoom, and will be controlled at a remote site where operators can monitor them for incident detection and verification.

4.1.3 Install Changeable Message Signs (CMS)

This project will consist of installing CMS's just prior to major diverge locations and key radial routes into the Dayton and Springfield areas and the freeway system. The messages can be sent from a central monitoring facility such as a freeway traffic management center or they can be updated remotely using cellular communications and a laptop computer. Messages will include both planned and unplanned events.

4.1.4 Install Highway Advisory Radio (HAR)

This project consists of installing highway advisory radio in the Miami Valley area to provide en-route motorists with real-time traffic information. Traffic information is broadcast over a dedicated radio frequency and can be updated during peak hours and special events.

4.1.5 Ramp Meter Implementation

This project would consist of the installation of ramp meters at select locations (details of locations are available in the Strategic Deployment Plan). The ramp meters will either be on-line with a central processing facility or pre-timed. The ramp meters will be operational during peak AM and PM weekday periods.

4.1 .1.1 Architecture

Figure 4.1 describes the high-level architecture, which depicts the functional components, and the major data flows of the projects described above. Data sources of non-automatic incident detection include telephone notification from the public through the cellular hotline, and observation of an operator viewing surveillance camera monitors. Data source for automatic incident detection is traffic surveillance data through speed sensors, which provide traffic flow disruption data. All this data gets collected into a local control center where data fusion occurs.

The control center processes the incident data and verifies the information through police reports and anecdotal reports, before an incident is flagged as confirmed. This information is sent to specific centers like the emergency management center that dispatches emergency response services. The congestion caused due to the incident can be evaluated through traffic control measures and the ramp metering device would then control the traffic entering the specific segment of freeway.

Once the incident and congestion report is verified travelers can receive information through changeable message signs, which will display appropriate "real-time message" and through Highway Advisory Radio which would report the same information. The figure represents an example of a typical freeway and incident management systems and some of its components that were described above. Interfaces between subsystems are identified according to the three communication profiles (A, B, C) described in section 3.0.

FREEWAY AND INCIDENT MANAGEMENT
HIGH LEVEL ARCHITECTURE: A TYPICAL FREEWAY SYSTEM

MIAMI VALLEY ITS
EARLY DEPLOYMENT PLAN

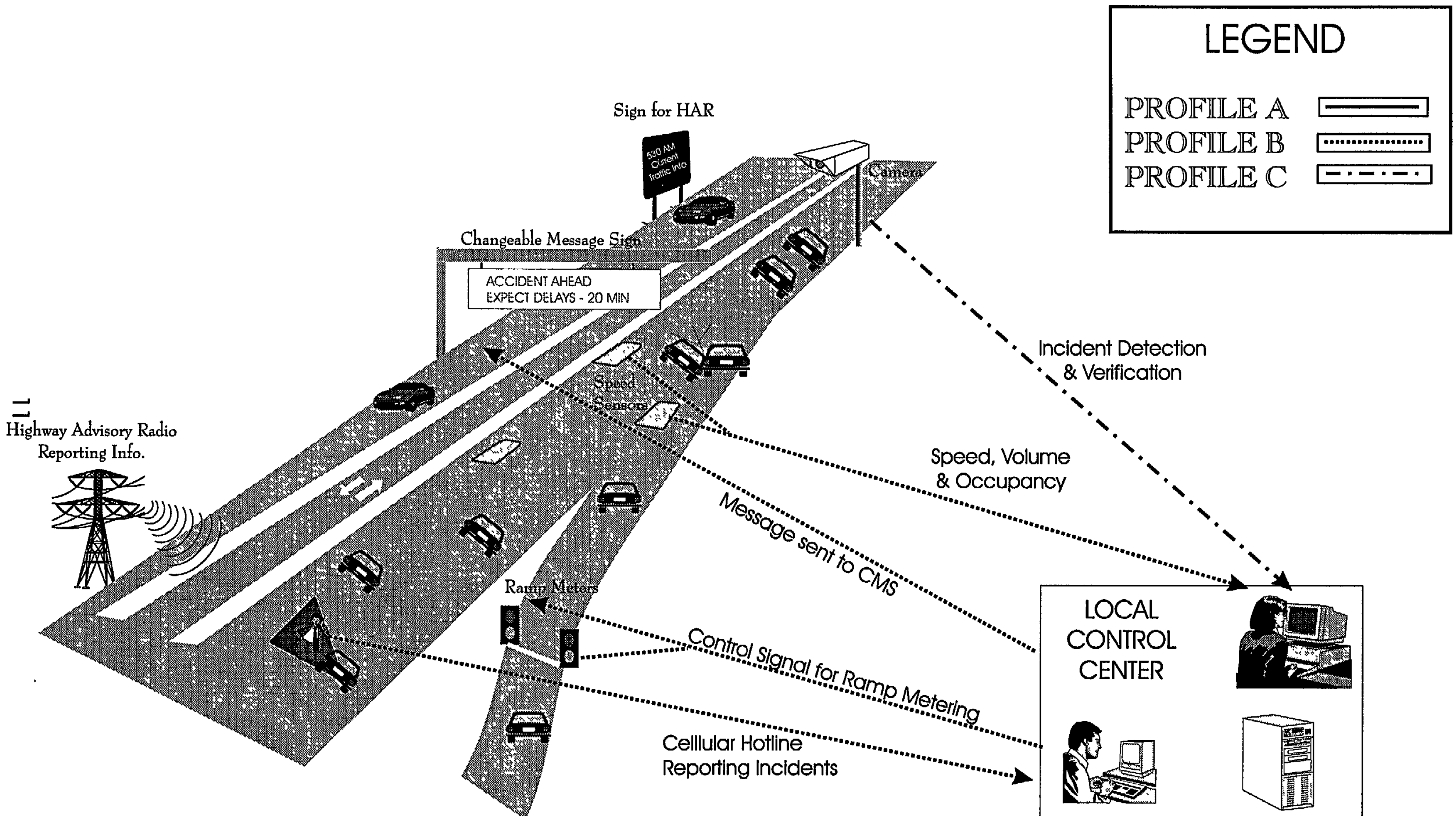


Figure 4.1: Freeway/Incident Management Systems

4.2 PROGRAM AREA 2: ADVANCED TRAFFIC SIGNAL CONTROL

As discussed earlier, this program area consists of projects that manage the movement of traffic on streets and highways by dynamically optimizing traffic control measures from a local control center based on current traffic conditions. It also includes projects to deploy ITS strategies at Highway-Rail intersection priority crossings. The projects for which the architecture will be discussed are:

4.2.1 Coordinated Traffic Signa System Improvements

This project will consist of implementing improvements to traffic signals by upgrading controllers, replacing loops with other detection technologies, coordinating signals which are currently operating independently, and implementing communication systems between the coordinated signal systems and local control locations. This project will be done in four phases based on locations identified by local traffic engineers, from the immediate time frame (years l-2), to the short term time period (year 3-5) to the mid-term (year 6-10), and the long term (year 1 l-20).

4.2.1 .1 Architecture

Figure 4.2.1 describes the high level architecture, which depicts the functional components, and the major data flows of the project described above. The traffic control system can be thought of as an intelligent system that is continuously monitoring, analyzing, and optimizing traffic on streets, and major arterials. The brain of the traffic control system resides in a local center or a group of local centers based on location and types of intersections. Once data from loop detectors, or anecdotal traffic information is collected, the traffic control center performs traffic flow analysis, pattern recognition, control parameter optimization, and uses algorithms to optimize the parameters for each traffic signal or a group of them. This control mechanism is then transmitted to the signals directly or to a control center in the field. This system can dynamically optimize the parameters of traffic control devices based on current conditions. Interfaces between subsystems are identified according to the three communication profiles (A, B, C) described in section 3.0.

ADVANCED TRAFFIC CONTROL SYSTEMS
HIGH LEVEL ARCHITECTURE

MIAMI VALLEY ITS EARLY DEPLOYMENT PLAN

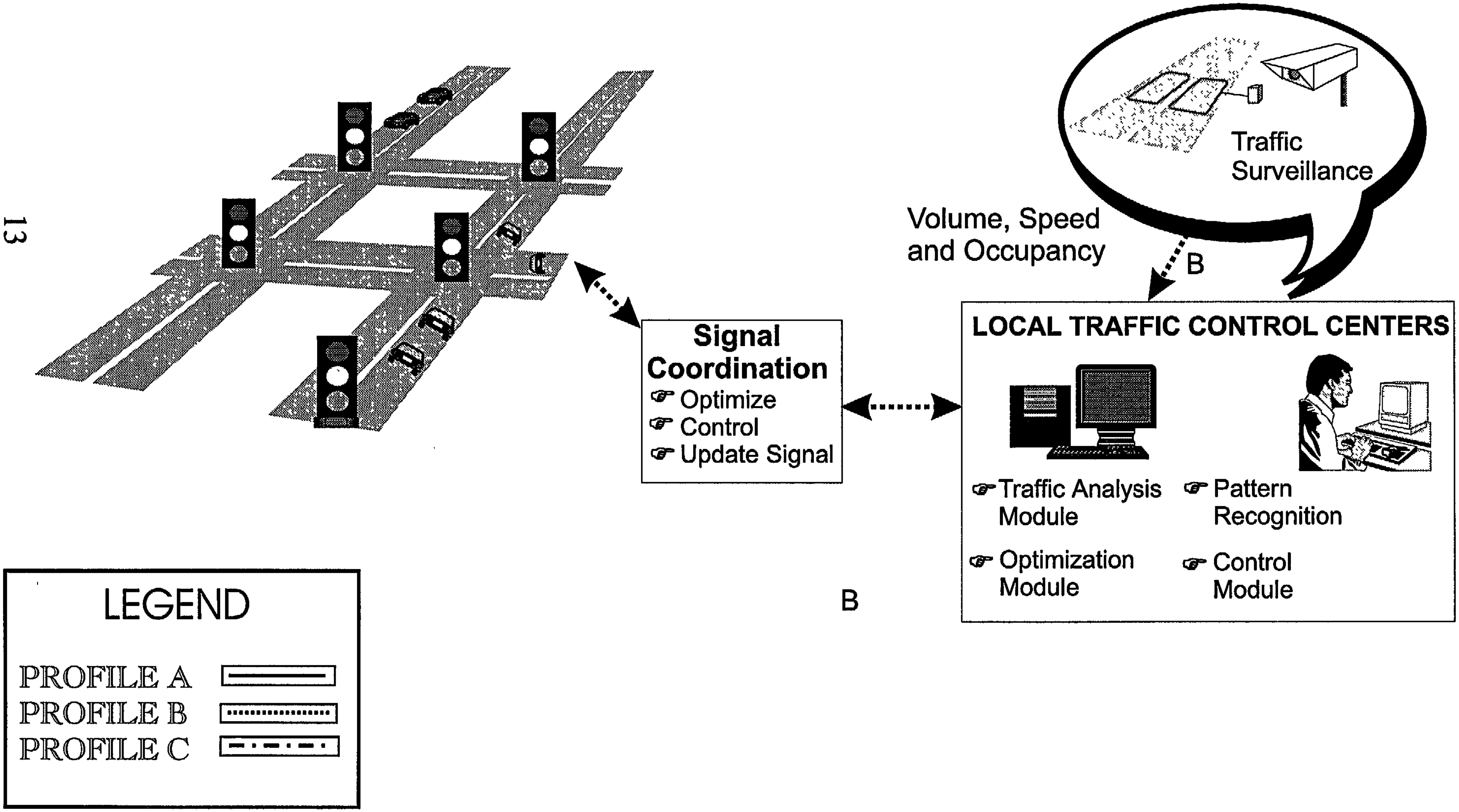


Figure 4.2.1: Advanced Traffic Signal Control Systems

4.2.2 Deploy ITS Strategies at Identified Highway Rail Intersections (HRI)

This project will implement recommended ITS strategies to improve safety at high-risk highway-rail intersections. Possible types of ITS devices/systems include changeable message signs, in-vehicle motorist advisory, automated stopping of trains, and advisories and alarms to train crews of HRI warning device status.

4.2.2.1 Architecture

Figure 4.2.2 describes the high-level architecture, which depicts the functional components, and the major data flows of the projects described above. The architecture defines ITS devices for both standard speed rail (SSR) which applies to traditional rail operations under 79 mph, and for high-speed rail (HSR) which applies to rail operations above 79 mph. Data from both HSR and SSR include train position, arrival times, and train conditions at the intersection. This data is collected at a local train control center, which processes and analyzes the data. The train control center uses the data and fuses it with additional data about the intersection. The control center is responsible for sending out information in the form of advisories and alarms to the train crews of any highway intrusions and the status of the intersection.

Information from the train control center is disseminated to an operations center which has the capability of transmitting messages through roadside variable message signs, in-vehicle motorist advisories, and assisting with the automated stopping of trains. Interfaces between subsystems are identified according to the three communication profiles (A, B, C) described in section 3.0.

High-Level Architecture:
Highway-Rail Intersection (HRI)

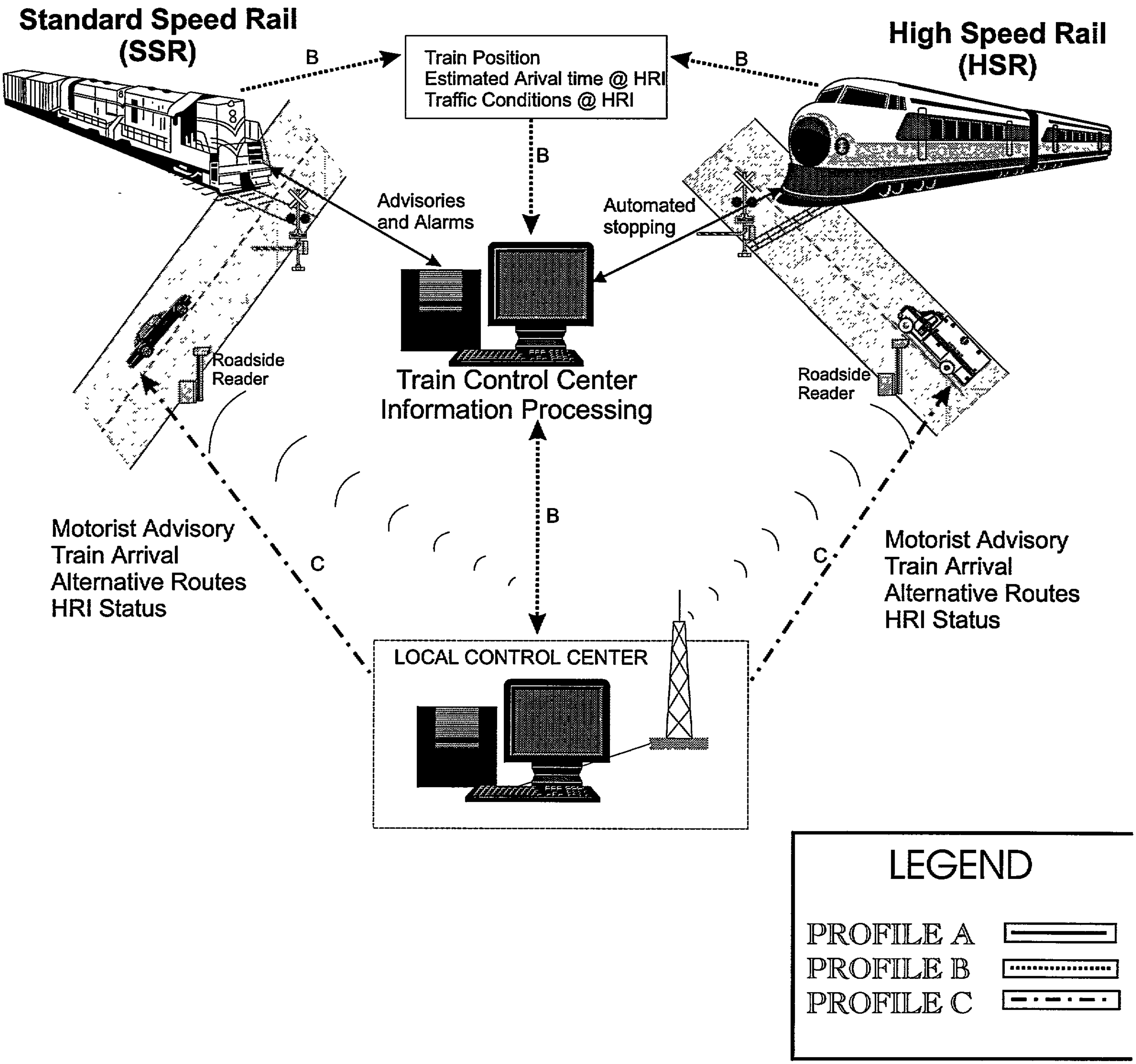


Figure 4.2.2: ITS Strategies at Identified HRI

4.3 PROGRAM AREA 3: PUBLIC TRANSPORTATION SYSTEMS

As discussed earlier, this program area consists of projects that apply ITS technologies to enhance the operations, planning, and management of transit systems in the Miami valley area. There are four transit systems in the area: the Miami Valley Regional Transit Authority (MVRTA), the Springfield City Area Transit (SCAT), the City of Piqua, and Miami County. The projects for which the architecture will be discussed are:

4.3.1 Automatic Vehicle Location Systems (AVL) and Schedule Adherence Monitoring

This project provides MVRTA and SCAT the capability to identify, in real-time, the location of each transit vehicle and to determine the status of each vehicle relative to its schedule. The fundamental AVL and schedule adherence monitoring system make possible a wide range of activities which will benefit transit operators in terms of improved efficiency and improved service reliability. This system will be implemented for:

- MVRTA's fixed-route, fixed-route deviation, paratransit, and demand-responsive services
- SCAT's fixed-route, paratransit, and demand-responsive services.

4.3.2 Automated On-Board Fare and Data Collection

This project implements a system to automatically collect the number of passengers alighting and departing, vehicle run time and vehicle mileage data on MVRTA and SCAT fixed route buses via on-board sensors which will store information to be downloaded periodically at the transit operations center. This information is useful for planning and reporting and will contribute to transit operational efficiencies. Electronic fare collection equipment on these buses adds the capability of collecting fare through fare cards, smart-card technology, and automated reader technologies.

4.3.3 Traveler Information

This project implements a means to disseminate transit status information to the traveling public by using changeable or "active" electronic station displays at major MVRTA and SCAT transfer locations/stations. A second dissemination method is through on-board, automatic voice synthesized annunciators and visual signage, to announce/display transit stops, the bus' ultimate destination and transfer/connection information. These projects provide the users with real-time transit information to make better decisions through deployment of ITS technology.

4.3.1 Architecture

Figure 4.3 describes the high-level architecture, which depicts the functional components, and the major data flows of the projects described above for MVRTA and SCAT. Data from the AVL system include vehicle position, which is collected through a GPS system on the bus. Data on vehicle mileage, vehicle run time, ridership, and passenger count is collected through on-board sensors. The last source of data collection involves automated reader technologies to collect electronic fares.

Data processing occurs in the transit operations center that collects data from the AVL system and automatically calculates vehicle schedule adherence and alerts transit staff about buses that are either ahead or behind schedule. The vehicle mileage, and passenger count data are downloaded periodically at the operations center and this information allows the transit system, to maintain a database in analysis to improve the service.

The transit operations center also communicates with information dissemination mechanisms like the electronic signs at transfer stations and buses, and through on-board annunciators. The operations center dispatches information on bus arrival times and essential transfer stops and this is displayed to travelers through the methods described above. The figure represents the various processes of data collection, data processing and the information dissemination flows described above. Interfaces between subsystems are identified according to the three communication profiles (A, B, C) described in section 3.0.

PUBLIC TRANSPORTATION SYSTEMS
HIGH LEVEL ARCHITECTURE: PROJECTS INVOLVING MVRTA AND SCAT

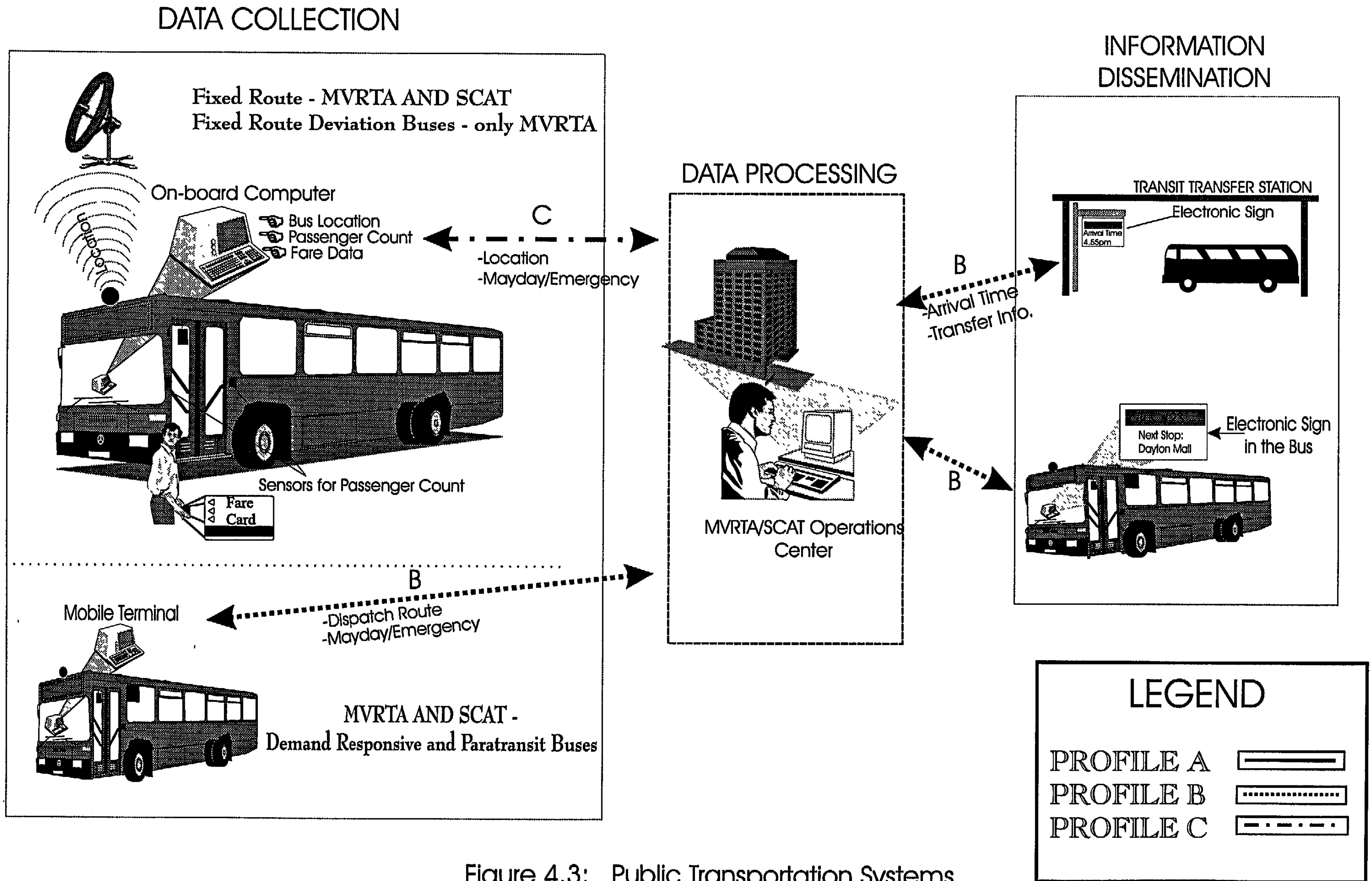


Figure 4.3: Public Transportation Systems

4.4 PROGRAM AREA 4: MULTIMODAL TRAVELER INFORMATION SYSTEMS

As discussed earlier, this program area consists of projects that use ITS devices and technologies to disseminate travel and transit information to travelers and end users to assist them in making better travel decisions. Types of traveler information can range from speed, incidents, construction, and maintenance information to more details on route guidance, weather-related information, and other modes of travel information. The projects discussed below assist users for both pre-trip travel information and en-route driver information. The projects for which the architecture will be discussed are:

4.4.1 Central Data Server

This project will provide a centralized data repository for collecting traffic and travel data, storing and processing that data, and distributing the "information" out to dissemination devices such as cable television, kiosks, the Internet, pagers, etc., in the Miami Valley region. This system will be designed in an open environment so that future expansion of the data collection infrastructure or addition of more dissemination devices in the area can easily be incorporated into the existing system.

4.4.1 .1 ARCHITECTURE

Figure 4.4.1 describes the high-level architecture, which depicts the functional components, and the major data flows of the central data server (CDS). For the traveler information projects that follow this description, the central data server is the data source and the "brains" of the overall traveler information system. The data collection includes a variety of sources on the left side of the figure. These include traffic data, transit data from all the agencies in the area, traffic signal control data, pavement and weather sensor data, and general data on wide area travel, special events, and yellow pages.

The ideal location of the CDS for Miami Valley is in a local operations center, which already exists and performs some type of traffic operations as represented in the figure. This would assist in the transfer of traffic and incident related data in an efficient and quick manner. The CDS fuses all this data and formats it in a meaningful manner to disseminate to the technologies in the right side of the figure. These technologies are discussed in detail with individual architecture figures following. Interfaces between subsystems are identified according to the three communication profiles (A, B, C) described in section 3.0.

MULTIMODAL TRAVELER INFORMATION SYSTEMS
HIGH LEVEL ARCHITECTURE: CENTRAL DATA SERVER

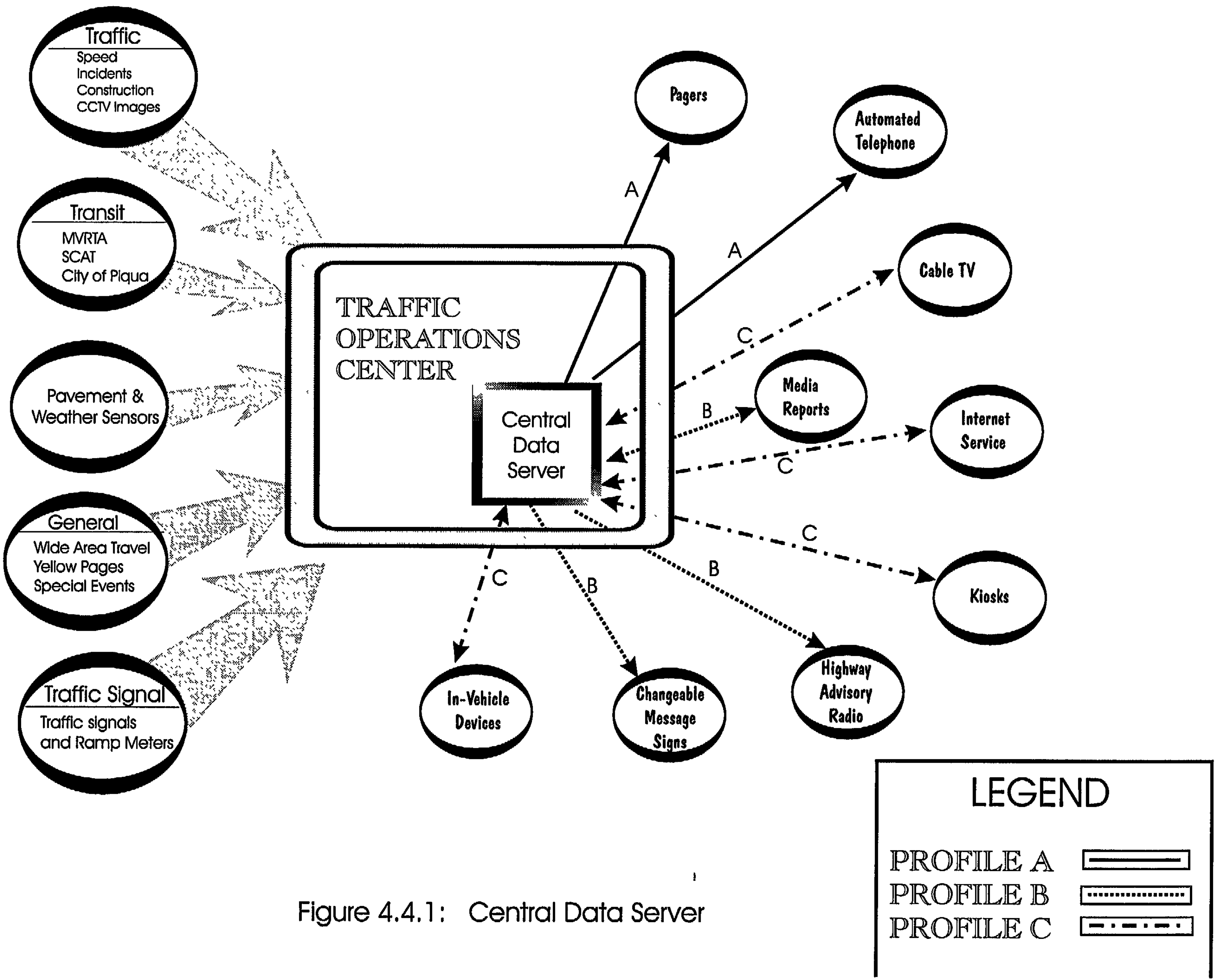


Figure 4.4.1: Central Data Server

4.4.2 Traveler Information Dissemination

4.4.2.1 Media Reports

This project provides a consistent means of disseminating real-time traveler information to the local radio and TV stations in the Miami Valley Area to benefit daily commuters and provide them with up to date information.

4.4.2.1.1 ARCHITECTURE

Figure 4.4.2.1 describes the high-level architecture, which depicts the functional components, and the major data flows of traveler information dissemination through media reports. The data source identified in the left side of the figure is the central data server. Information is sent in a specified format to area media and radio stations at specific intervals during peak hours. Types of information sent from the CDS include speed, travel time, incidents, construction, maintenance, etc. Interfaces between subsystems are identified according to the three communication profiles (A, B, C) described in section 3.0.

4.4.2.2 Automated Telephone System

This project implements an automated telephone system to provide traveler information to the Miami Valley area with both landline and cellular telephones. This system will provide travelers with up to the minute, route specific and on-demand information from anywhere, via the telephone. By using pre-recorded, up-to-date traffic reports provided by operators or using computerized text-to-speech software (audiotext systems), users can make a phone call and through a series of menu choices, receive traffic and travel information for the areas of interest.

4.4.2.2. I ARCHITECTURE

Figure 4.4.2.2 describes the system architecture, which depicts the functional components, and the major data flows of traveler information dissemination through an automated telephone system. The data source identified in the left side of the figure is the central data server. Data from the central server is processed using specialized software and recorded to an automated system which users can access through regular telephone lines or through cellular lines.

The automated telephone system can also have cross-connects, which are shown in the right side of the figure. These are agencies/information sources, which can be connected through the system, and users can access additional information through a series of menus. Types of cross-connects sources include transit agencies, emergency services, airport information, etc. Types of information users can receive over the phone include speed, travel time, incidents, construction, maintenance, etc. Interfaces between subsystems are identified according to the three communication profiles (A, B, C) described in section 3.0.

4.4.2.3 Cable TV

This project will provide traveler information to the public in their homes through a dedicated traveler information cable TV channel. While similar in content to information currently available from radio and television stations, this system has the capability to provide viewers with traffic information 24 hours a day. Information provided by the travel channel would include traffic congestion, travel speeds, accidents, construction and maintenance activities, and other special event information.

4.4.2.3.1 ARCHITECTURE

Figure 4.4.2.3 describes the high-level architecture, which depicts the functional components, and the major data flows of traveler information dissemination through a Cable TV system. Data sources shown in the left side of the figure include the central data server for all traffic data and video/CCTV data from the field. This data is sent to a cable TV programming system, which compiles the data and develops a programming cycle that includes the traffic information in the form of maps and text.

The cable TV programming is disseminated through head-end servers acting as a transfer medium to send the program from the source to the users at home. Types of information provided on a travel channel include speed, incident, construction, emergency broadcast, etc. Interfaces between subsystems are identified according to the three communication profiles (A, B, C) described in section 3.0.

MULTIMODAL TRAVELER INFORMATION SYSTEMS
HIGH LEVEL ARCHITECTURE: MEDIA REPORTS

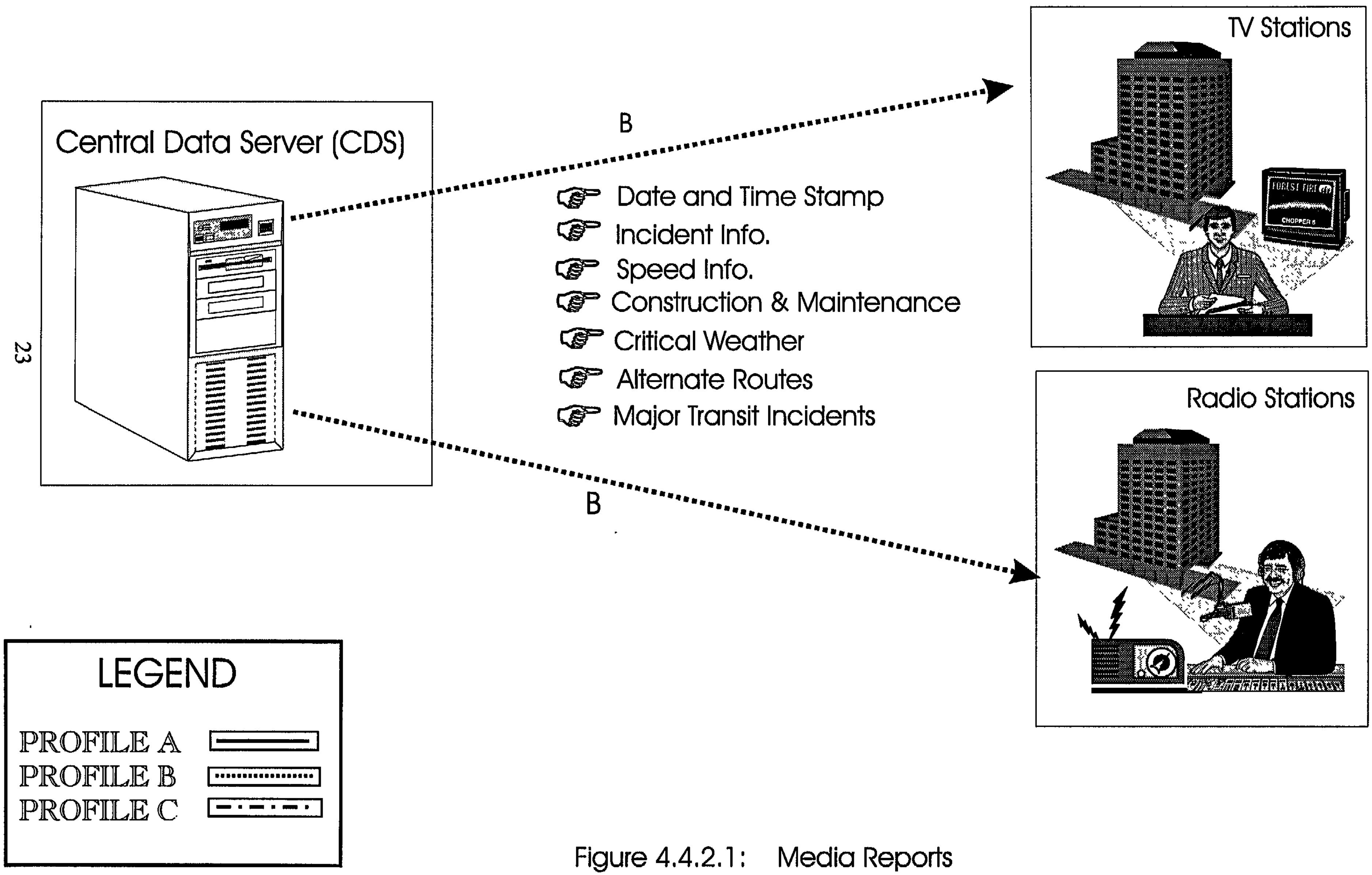
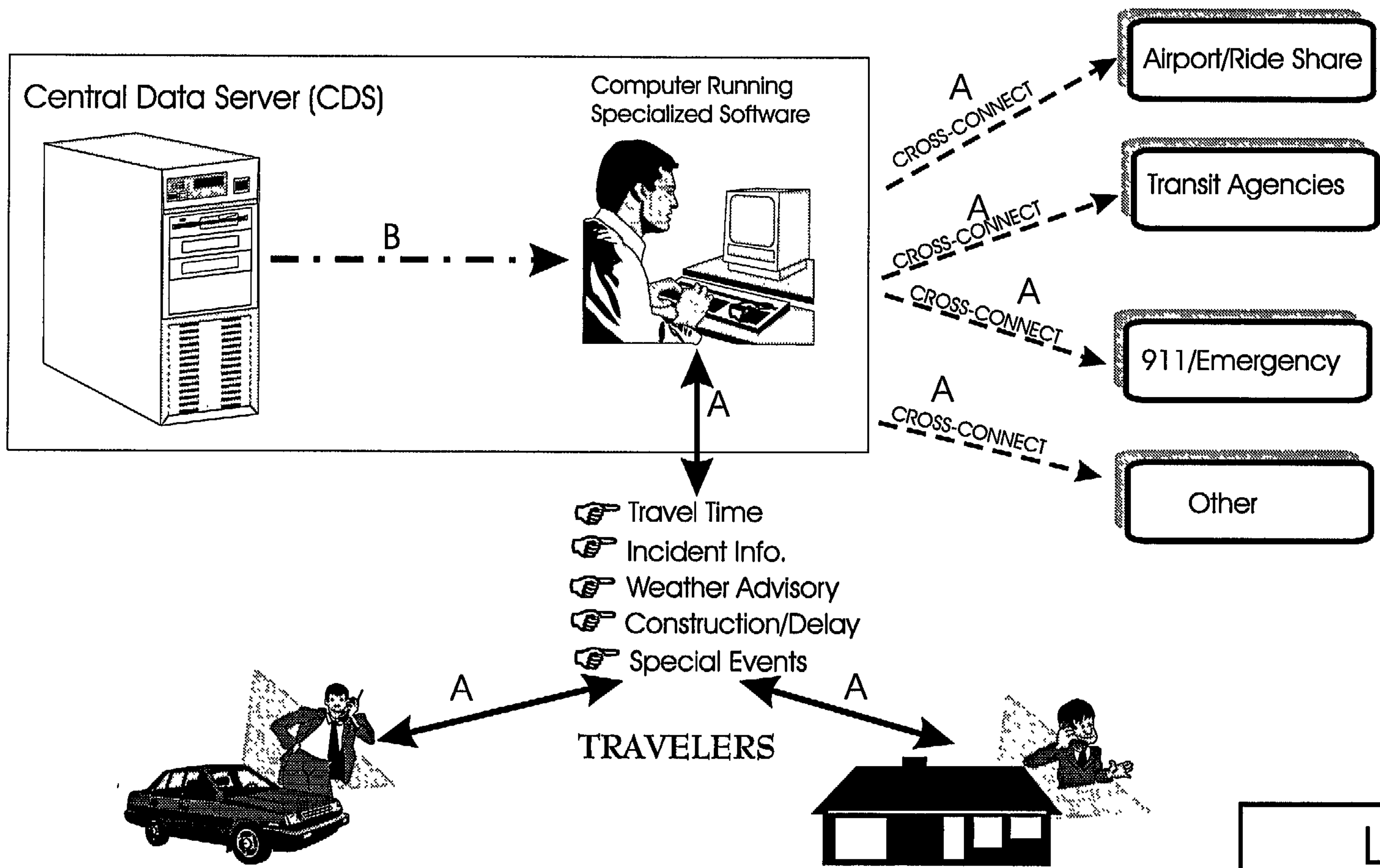


Figure 4.4.2.1: Media Reports

MULTIMODAL TRAVELER INFORMATION SYSTEMS
HIGH LEVEL ARCHITECTURE: AUTOMATED TELEPHONE



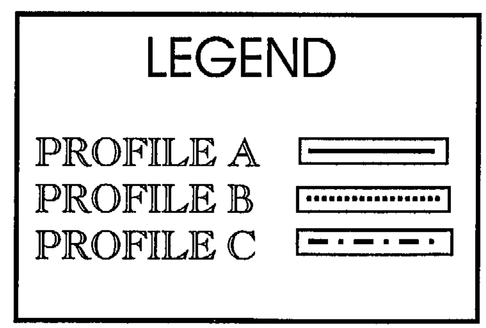
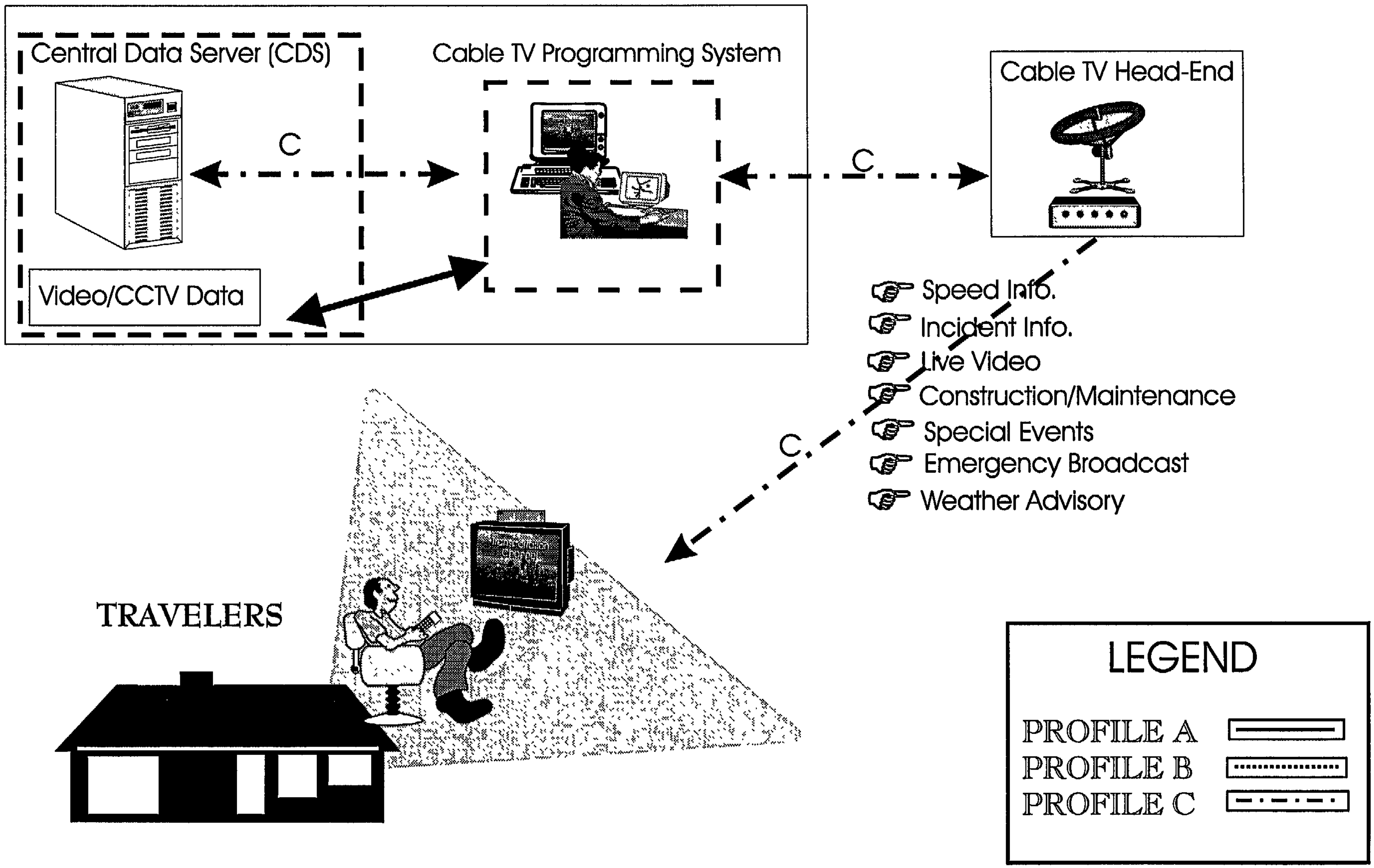


Figure 4.4.2.2: Automated Telephone Systems

MULTIMODAL TRAVELER INFORMATION SYSTEMS
HIGH LEVEL ARCHITECTURE: CABLE TV



Fogure 4.4.2.3: Cable TV

4.4.2.4 Internet

This project will provide residents with real-time traveler information on their computers at home or at work through access to the Internet. The project will take advantage of existing sources of travel related data such as transit schedules and routes, schedule of events, links to other Internet sources of information with data on or related to the Miami Valley region, and information provided by local convention or visitors bureaus.

4.4.2.4. I ARCHITECTURE

Figure 4.4.2.4 describes the high-level architecture, which depicts the functional components, and the major data flows of traveler information dissemination through an Internet home page. Data sources shown in the left side of the figure include the central data server for all traffic data and Video/CCTV data from the field. This data is sent to a web server that compiles the data and develops a web page that includes real-time traffic information in the form of maps and text and static information.

The web page can be accessed by users who have an Internet connection through a commercial Internet provider or though any local provider. Information that users can access is in real-time and updates are continuous. Types of information provided on the web page could include speeds, incidents, transit information, route planning, etc. The web page can also connect to various other home pages called "hotlinks". Users can access additional information on specific modes like wide-area travel, or transit if the specified agencies have a web page already developed. Interfaces between subsystems are identified according to the three communication profiles (A, B, C) described in section 3.0.

4.4.2.5 In-Vehicle Navigation Systems

This project will provide users real-time traveler information through in-vehicle navigation systems installed in personal and commercial vehicles. This project involves the development and dissemination of traveler information to an "off-the-shelf' navigation device, through wireless communications, installed in vehicles in the Miami Valley area.

4.4.2.5.1 ARCHITECTURE

Figure 4.4.2.5 describes the system architecture, which depicts the functional components, and the major data flows of traveler information dissemination through in-vehicle navigation systems. Data source shown in the left side of the figure is the central data server. Information is sent in a specified format to in-vehicle navigation devices in user's cars in the Miami Valley. Types of information sent from the CDS include speed, travel time, incidents, construction, maintenance, etc. The navigation device has a GPS device, which locates its position, and this information can be sent to the central data server for emergency mayday functions. The device can also perform inherent functions like route guidance, and yellow pages database information. Interfaces between subsystems are identified according to the three communication profiles (A, B, C) described in section 3.0.

4.4.2.6 Kiosks

This project will provide relevant traveler information to daily commuters, visitors, transit users, pedestrians, and fleet operators through the deployment of state-of-the art touch screen traveler information kiosks. The system will serve as an information link to the traveler, providing real-time maps, incident, congestion, route planning, and transit schedule information. These kiosks can be placed at high mobility areas like airports, hotels, visitor centers, hospitals, and shopping centers.

4.4.2.6.1 ARCHITECTURE

Figure 4.4.2.6 describes the high-level architecture, which depicts the functional components, and the major data flows of traveler information dissemination through kiosks. Data source shown in the left side of the figure is the central data server for all traffic data. This data is sent to a kiosk server that compiles the data and processes it to provide real-time traffic information in the form of maps and text and static information.

The kiosk server send data to kiosks located at major traffic areas like airports, transit stations, and welcome centers. Users can access the information on touch screen kiosks and can have the capability of printing requested information. Types of information provided on the kiosk include speeds, incidents, transit information, route planning, transit information, wide-area travel, etc.

The kiosk server can also connect to various other home pages called “hotlinks”. Users can access additional information on Internet home pages on transit, airports, or visitor information. Interfaces between subsystems are identified according to the three communication profiles (A, B, C) described in section 3.0.

MULTIMODAL TRAVELER INFORMATION SYSTEMS
HIGH LEVEL ARCHITECTURE: INTERNET

MIAMI VALLEY ITS
EARLY DEPLOYMENT PLAN

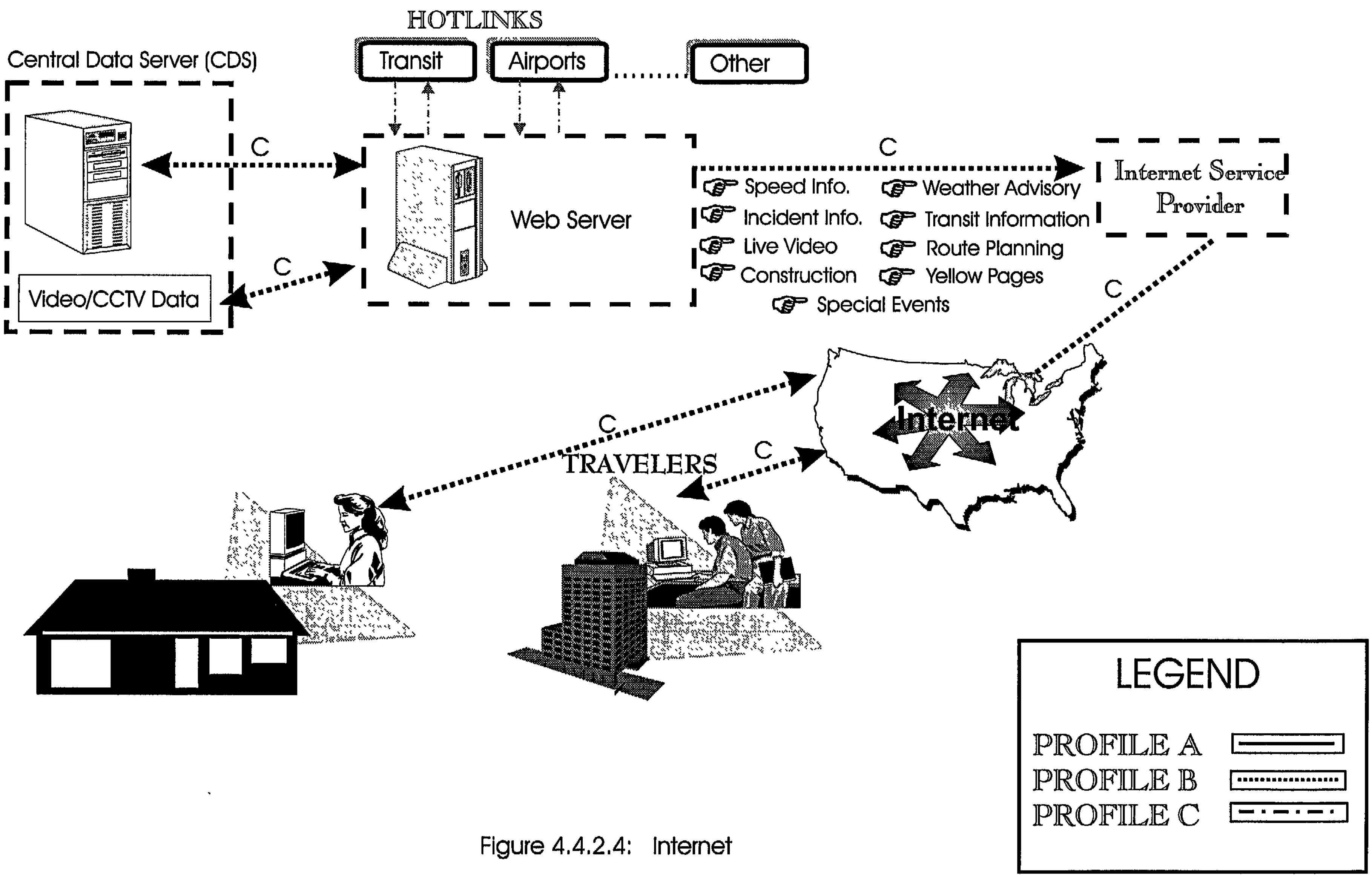


Figure 4.4.2.4: Internet

MULTIMODAL TRAVELER INFORMATION SYSTEMS
HIGH LEVEL ARCHITECTURE: IN-VEHICLE DEVICES

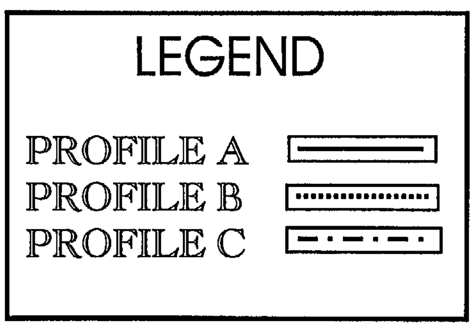


Figure 4.4.2.5: In-Vehicle Navigation Systems

MULTIMODAL TRAVELER INFORMATION SYSTEMS
HIGH LEVEL ARCHITECTURE: KIOSKS

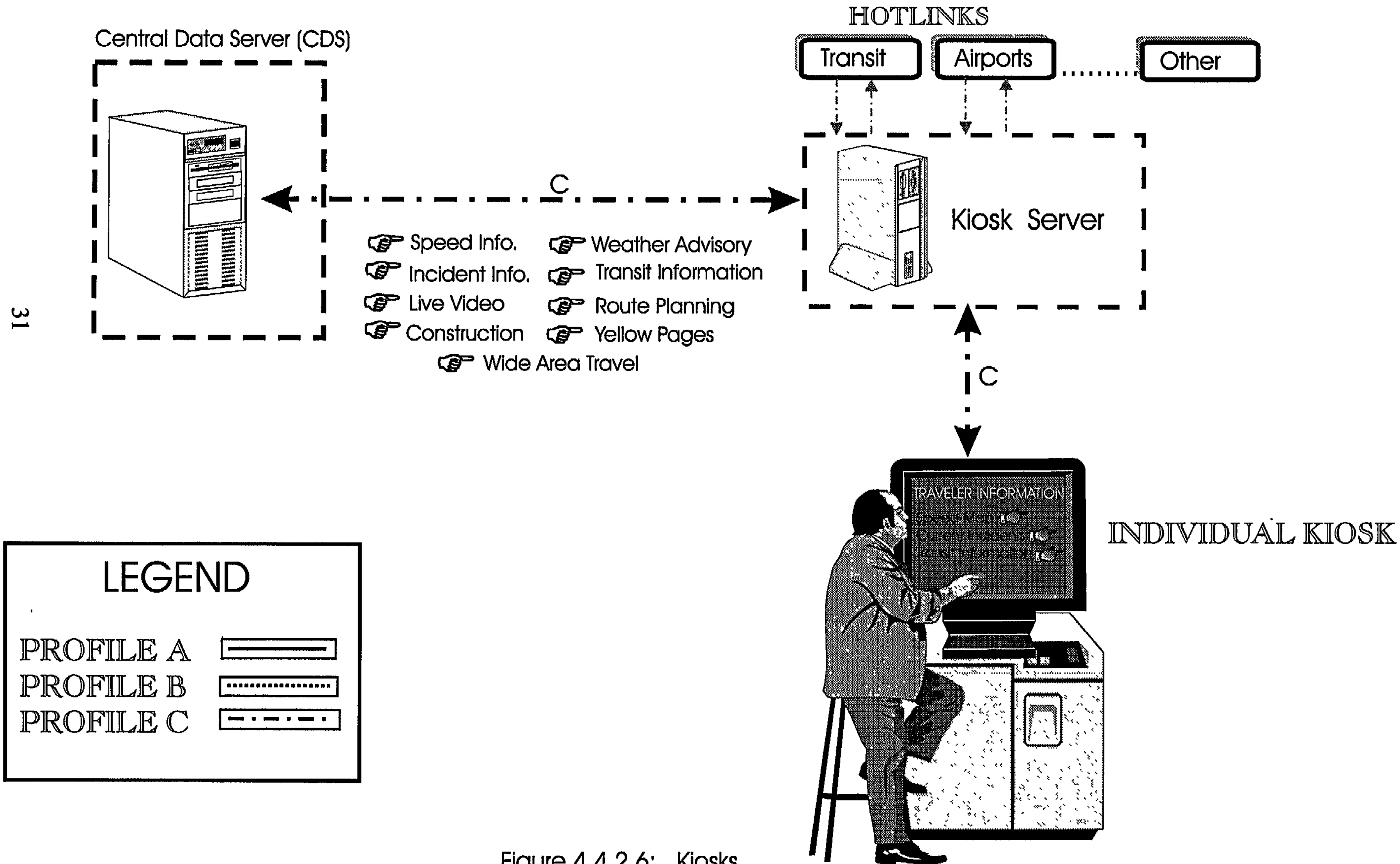


Figure 4.4.2.6: Kiosks

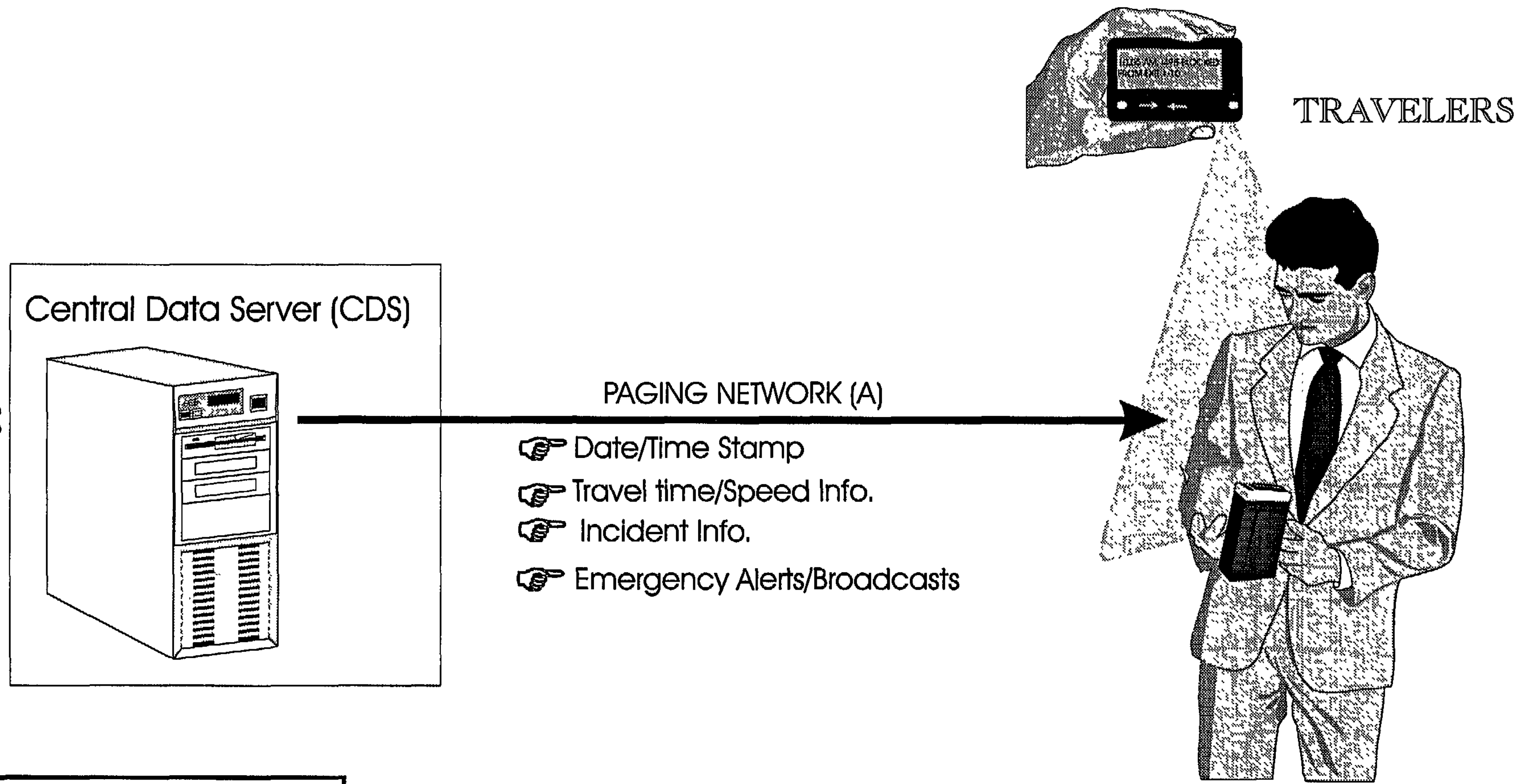
4.4.2.7 Pagers

This project will provide a means of disseminating real-time traveler information to daily commuters through alphanumeric pagers. Traveler information disseminated through this method can reach users throughout the region while they are en-route or before planning a trip. Information collected in a central location will be processed into a specific format based on priority. This data will be sent through a paging service (locally) to subscribers requesting the travel service. The information sent can be broadcast at time intervals or during morning and evening rush hours.

4.4.2.7.1 ARCHITECTURE

Figure 4.4.2.7 describes the high-level architecture, which depicts the functional components, and the major data flows of traveler information dissemination through pagers. The data source identified in the left side of the figure is the central data server. Information is sent in a specified format through a paging network to users with pagers. Information sent is low volume and sent once or twice daily during peak travel times. Types of information sent from the CDS include date and time report, speed on specific freeway, incidents delays, major construction, etc. Interfaces between subsystems are identified according to the three communication profiles (A, B, C) described in section 3.0.

MULTIMODAL TRAVELER INFORMATION SYSTEMS
HIGH LEVEL ARCHITECTURE: PAGERS



LEGEND

PROFILE A
PROFILE B
PROFILE C

Fiogure 4.4.2.7: Pagers

4.4.3 Pavement and Weather Sensors

This project will provide daily commuters with information concerning the state of essential roadways due to weather impacts. This project implements a network of pavement and weather sensing devices throughout the Miami Valley area to provide roadway conditions to Miami Valley travelers. By using state-of-the-art pavement and weather sensing equipment, general or specific pavement conditions such as 'possible icy conditions ahead' or 'pavement temperature 30°F' can be generated. The public can receive this information through a variety of platforms such as Kiosk, the media, cable TV, the Internet or changeable message signs. In addition, roadway maintenance crews can use current and forecasted pavement conditions gathered by this project to effectively clear ice and snow from roadways.

4.4.3.1 ARCHITECTURE

Figure 4.4.3 describes the high-level architecture, which depicts the functional components, and the major data flows of collecting data through pavement and weather sensors and disseminating the information through traveler information methods described above. Data sources shown on the left side of the figure include pavement sensors and weather sensors. Pavement sensors collect data on temperature of roadway, and chemical residue and weather sensors collect data on air temperature, dew point, etc. A remote-processing unit in the field that compiles the data and sends it to a central processing unit (CPU) collects this data. The CPU processes the data received and determines the current road and weather conditions along with location information. This information is sent to the central data server, which passes it along to different dissemination methods described above.

An additional interface shown from the central data server is to the Miami Valley Maintenance Crew (or the authority, which is responsible for maintenance of the roads). Information on pavement and road temperatures can help the crew make better decisions on maintaining the roadways. Interfaces between subsystems are identified according to the three communication profiles (A, B, C) described in section 3.0.

MULTIMODAL TRAVELER INFORMATION SYSTEMS
HIGH LEVEL ARCHITECTURE: PAVEMENT AND WEATHER SENSORS

MIAMI VALLEY ITS
EARLY DEPLOYMENT PLAN

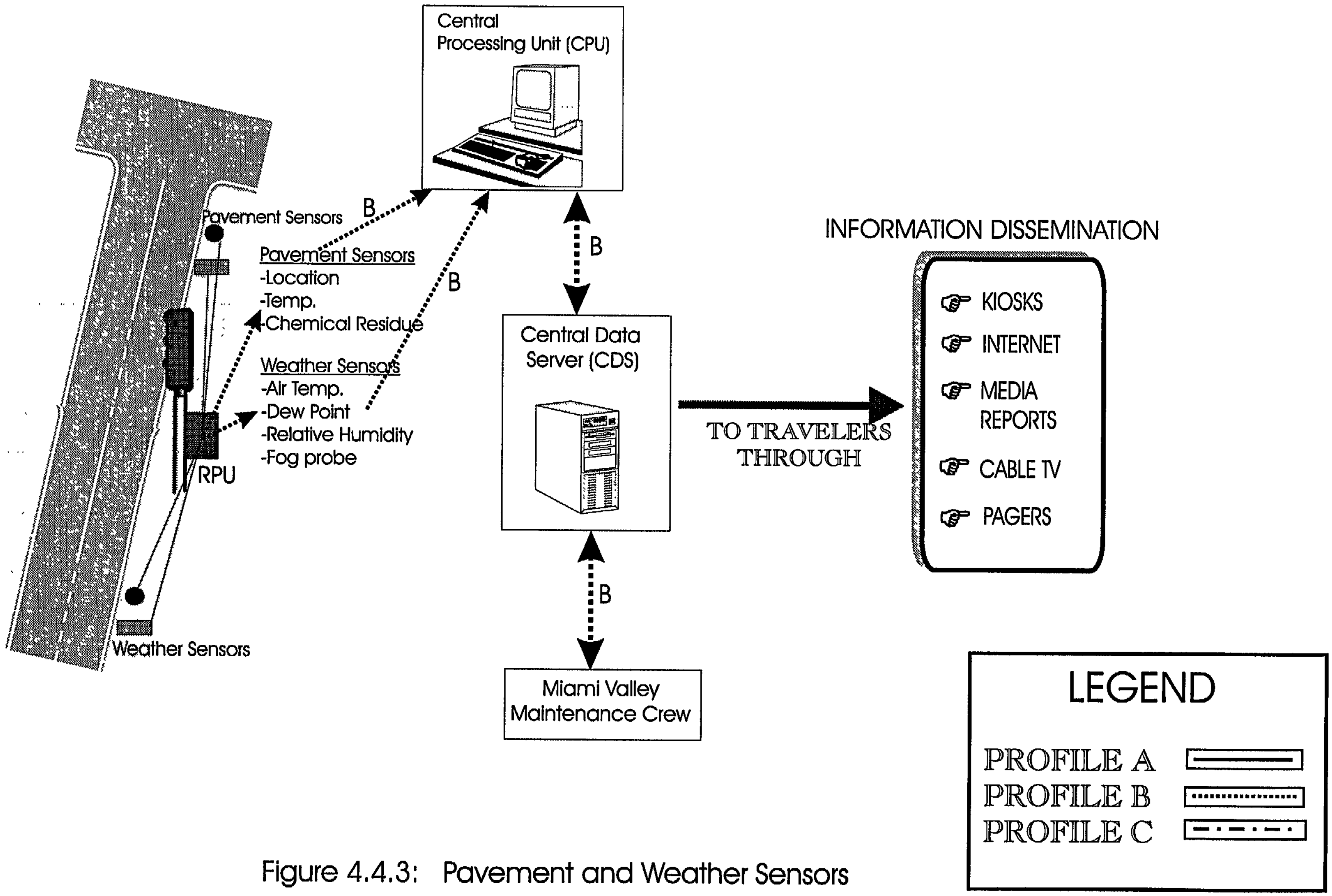


Figure 4.4.3: Pavement and Weather Sensors

5.0 RECOMMENDATIONS

Based on the planning and evaluation process conducted as part of the early deployment plan, the programs and specific projects are recommended for implementation over a time period ranging from the immediate (years l-2) to long-term (years 11-20). The architecture figures below represent projects that are implemented in the Immediate time frame (year l-2), Short term time frame (year 3-5), Mid-Long term time frame (year 6-20) in all program areas.

5.1 Immediate time frame architecture (Figure 5.1)

Projects recommended for implementation in the immediate time frame (years l-2) focus on establishing "early winners." These projects are relatively autonomous systems that can be useful to travelers even if there is not a large, installed base of traffic detection and reporting devices. In later phases, as more traffic data and surveillance systems become available, more data intensive projects are recommended for implementation.

For the Freeway/Incident Management Systems program area, projects recommended for deployment in the immediate time frame include changeable message signs and closed-circuit television surveillance. These systems can provide immediate benefits to agencies responsible for monitoring freeway flow and responding to incidents on the freeway system.

The projects recommended for implementation in the Advanced Traffic Control Systems program are scheduled timing updates, microprocessor controller conversions, and phase 1 of the coordinated traffic signal system improvements.

For Public Transportation Systems program area, the immediate time frame includes projects in the automatic vehicle locations systems for MVRTA buses, automated on-board fare and data collection, and transit traveler information through electronic displays on MVRTA buses.

The five projects recommended for implementation in the Multimodal Traveler Information Systems program area during this time frame include media reports, internet, pagers, automated telephone, and the central data server. The central data server is the most complex of these projects and is implemented in the immediate time frame to establish a foundation on which future projects can be implemented. Without the central data server, many of these systems would not be able to take advantage of traffic information that will be collected. The remaining four projects can be established as automous systems, not necessarily connected into the central data server. Their deployment can parallel the development and deployment of the central data server. While these systems can provide functionality without connection to the central data server, it is highly recommended that this connection be designed into each system so when the central data server comes "on line," each system can take advantage of the extended information that is available.

HIGH LEVEL ARCHITECTURE: IMMEDIATE TIME FRAME

MIAMI VALLEY ITS EARLY DEPLOYMENT PLAN

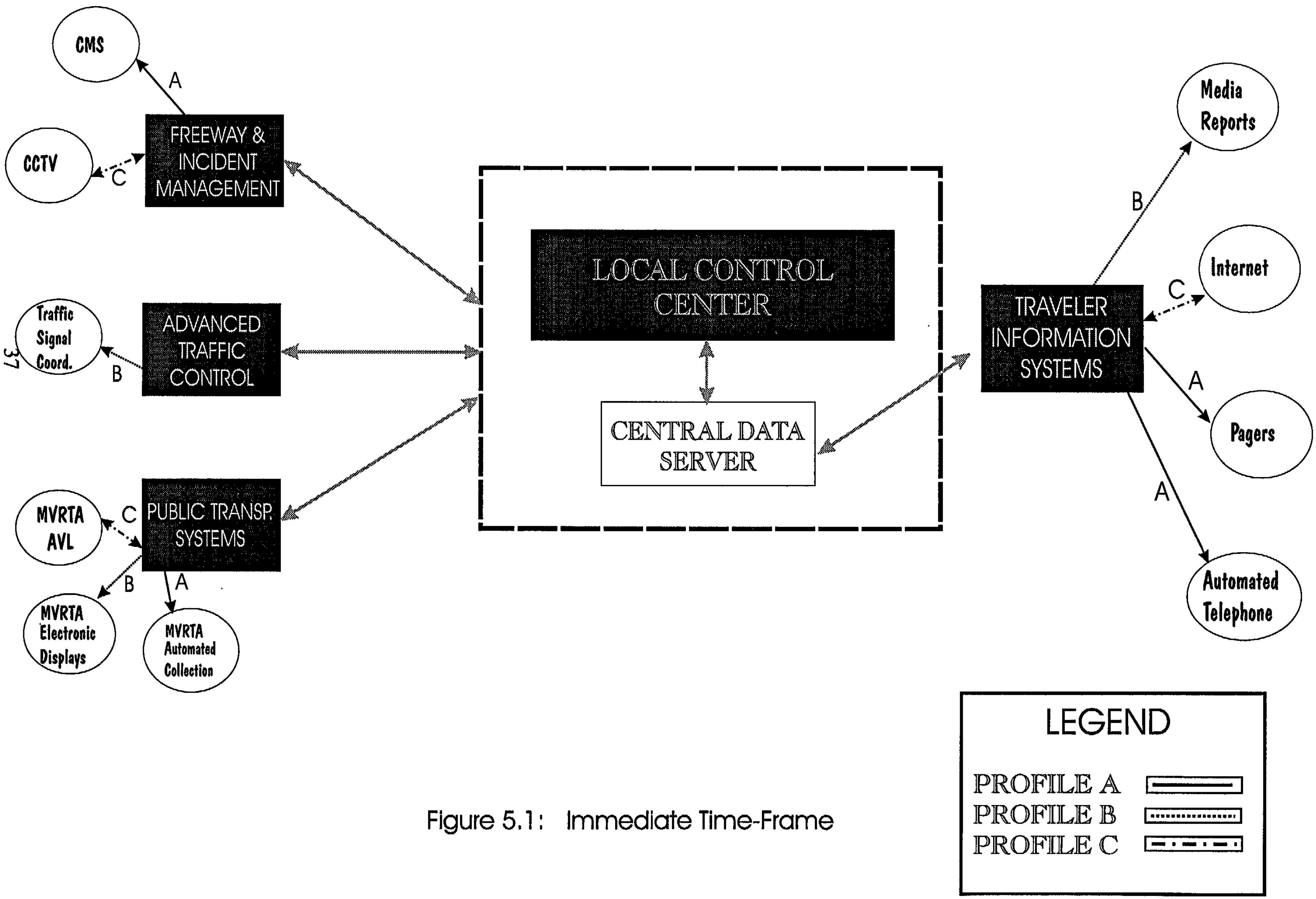


Figure 5.1: Immediate Time-Frame

5.2 *Short term time frame architecture (Figure 5.2)*

Projects recommended for the short term time frame (Years 3-5) typically, though not always, rely more on an established infrastructure and are more complex with respect to the implementation and deployment requirements.

For the Freeway/Incident Management Systems program area, it is recommended that a cellular hotline be established for callers to use from their vehicles to report traffic incidents and other freeway problems as well as gain information regarding current traffic situations. Highway Advisory Radio is the second project in this area to be deployed in the short time frame. This project allows broadcast of traffic and travel related information to all motorists.

Deployment of ITS technologies at highway rail intersections and phase 2 of the coordinated traffic signal system improvements are the projects recommended in the Advanced Traffic Control Systems program area for this time frame.

For the Public Transportation Systems program area, inclusion of on-board annunciators, announcing critical bus stops and major intersections is the project recommended for implementation in the short time frame.

Multimodal Traveler Information Systems program area has three projects recommended for implementation in this time frame. These are a cable television traffic system, traveler information kiosks, and in-vehicle devices. These projects typically rely more heavily on receipt of data and are dependent on the previous development and deployment of the central data server.

Continued updating of the central data server would also be required as additional systems are brought “on-line.”

HIGH LEVEL ARCHITECTURE: SHORT TERM TIME FRAME

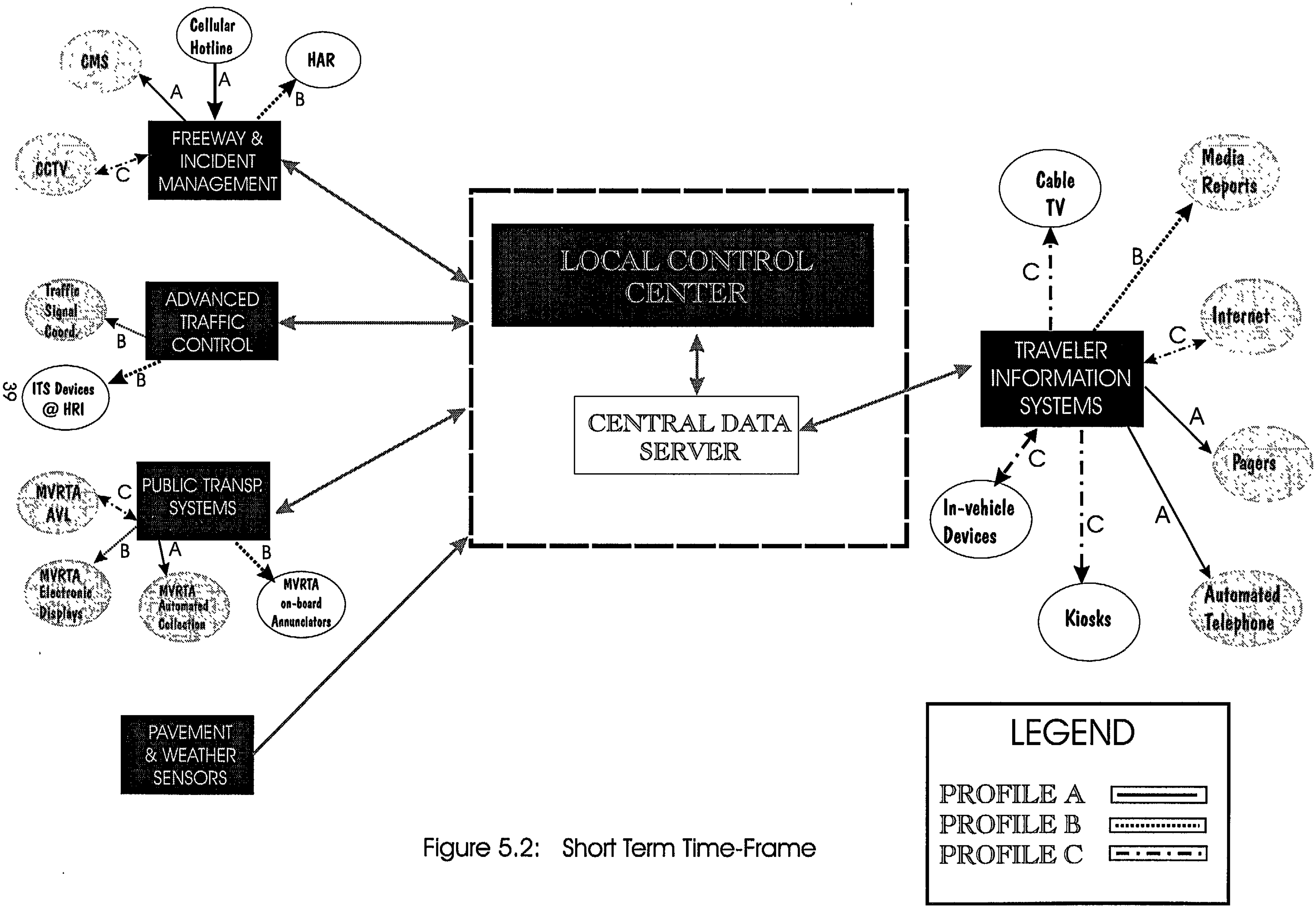


Figure 5.2: Short Term Time-Frame

5.3 Mid-Long term time frame architecture (Figure 5.3)

Projects recommended for implementation in the mid to long term time frame (Years 5-20) are typically heavily dependent on established infrastructure or are recommended based on anticipated growth in the previous 5-10 years that would then make these additional systems a necessity.

Ramp Metering is the only project in the Freeway/Incident Management Systems program area implemented in this area. It was felt that ramp metering was not needed in the immediate or short-term periods and a study would be initiated to determine the feasibility and necessity of ramp metering before any implementation.

In the Advanced Traffic Control Systems program area, projects include phase 3 & 4 of the coordinated traffic signal control system improvements, and ITS Strategies at Highway/Railroad Intersections.

In the Public Transportation Systems program area, projects include implementation of AVL, electronic display, and automated fare collection on SCAT buses.

HIGH LEVEL ARCHITECTURE: MID-LONG TERM TIME FRAME

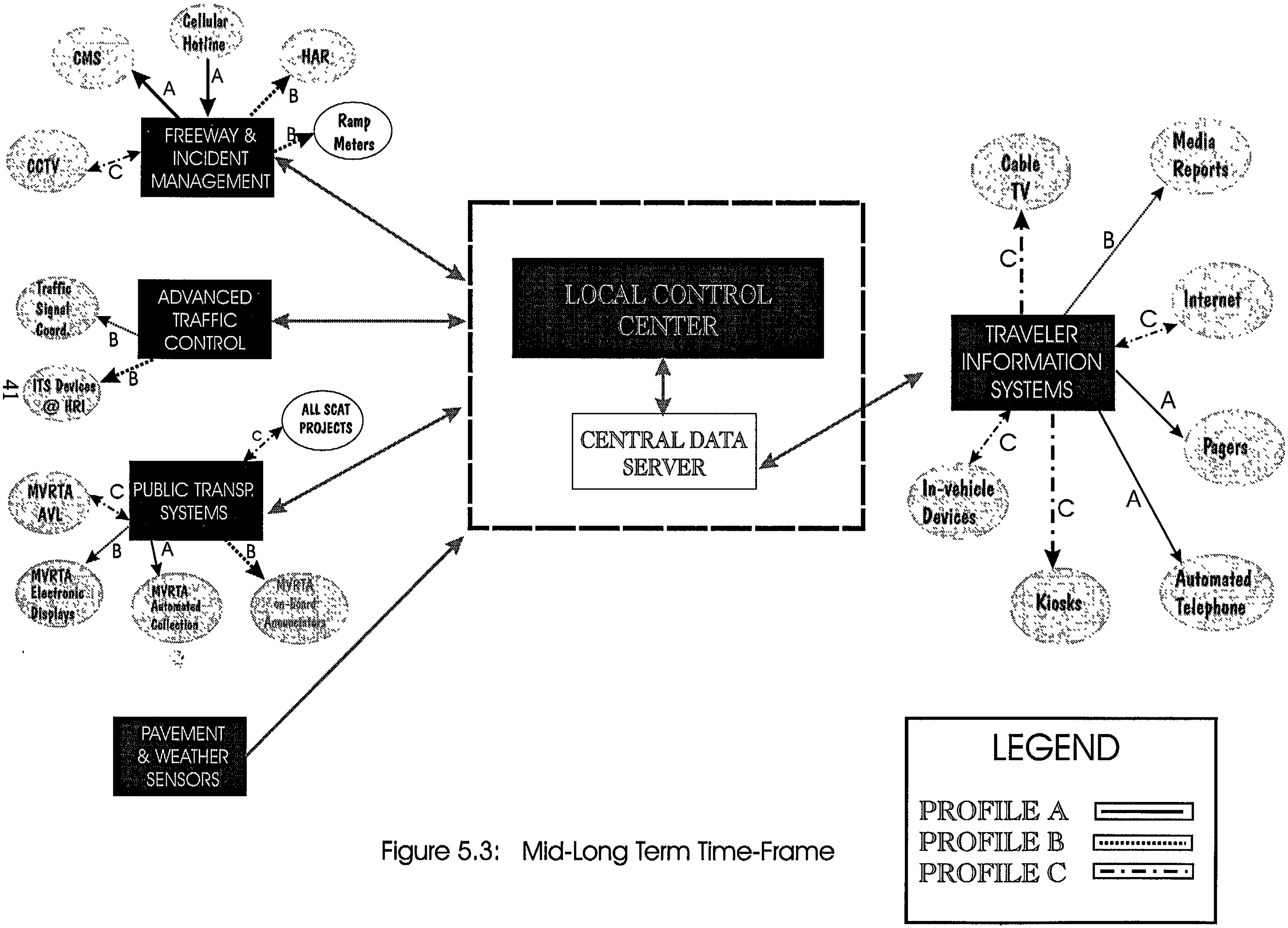


Figure 5.3: Mid-Long Term Time-Frame