Hungary
96-756B
Vol. 3

HUNGARIAN INTELLIGENT ROAD INFORMATION SYSTEM (IRIS) TECHNICAL DEVELOPMENT AGENCY (TDA) PROJECT

PRELIMINARY DESIGN REPORT

GRANTEE:
Directorate for Road Management
and Coordination
Republic of Hungary

June 1997

CONTRACTOR:
Wilbur Smith Associates
PO Box 92
Columbia, SC 29202-0092
USA
CEO: Mr. Robert A. Hubbard

This report was funded by the U.S. Trade and Development Agency (TDA), an export promotion agency of the United States Government. The opinions, findings, conclusions, or recommendations expressed in this document are those of the author(s) and do not necessarily represent the official position or policies of TDA.

MAILING ADDRESS: Room 309, SA-16, Washington, DC 20523-1602
DELIVERY ADDRESS: 1621 North Kent Street, Suite 309, Arlington, VA 22209
PHONE: (703) 875-4357 **FAX:** (703) 875-4009

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF EXHIBITS

Republic of Hungary - Major Road Corridors

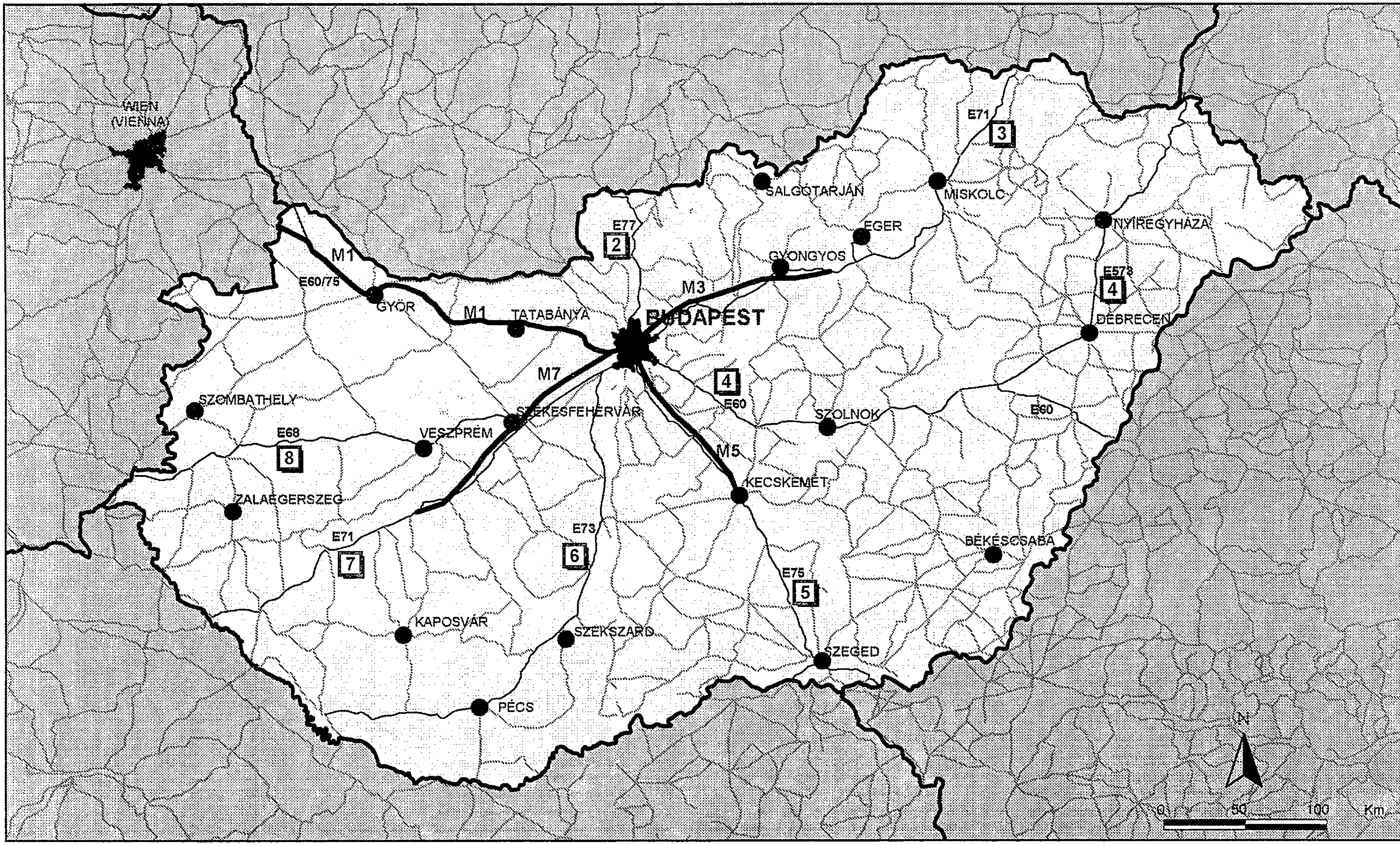


Exhibit 2-1

IRIS - HUNGARY

TDA

IKIR - MAGYARORSZAG

IRIS TDA Project

Wilbur Smith Associates

SECTION 1
INTRODUCTION

Section 1
INTRODUCTION

1.1 BACKGROUND

The Intelligent Road Information System (IKIR) project was initiated by the Hungarian UKIG in late 1996. The purpose of IKIR will be to provide a system that supports and coordinates roadway operations and traveler information activities being carried out by the various roadway transportation agencies in Hungary. The IKIR project design is being performed by a Project Team led by Wilbur Smith Associates under a grant from the United States Trade and Development Agency.

This document describes the preliminary design of the IKIR. This preliminary design involves a high-level definition of the system goals and objectives, a concept of operation, and resultant system requirements. A functional definition is performed through development of a logical architecture which describes functions and data flows, assigned to specific information sources and providers.
The physical architecture is derived from the system functions, and describes the physical elements and framework (functional components and communications system) which will be needed to develop the system, as well as where operational software will reside. This physical architecture and the resultant technology assessment will serve as a basis for development of the detailed IKIR design and procurement documents.

1.2 REPORT STRUCTURE

The IKIR Preliminary Design Report is structured as follows:

Section 1: Introduction. The purpose of the Preliminary Design Report is summarized and the report's structure is described.

Section 2: System Context. The existing conditions and current transportation activities in Hungary are summarized, with emphasis on the current means of gathering and disseminating travel information, as well as providing congestion and incident management on motorway facilities.

Section 3: System Concept and Requirements. Agency goals for IKIR, system objectives, and the system operations concept are defined. From this will come the development of high-level system requirements, including operational and performance requirements.

Section 4: Functional Definition of IKIR. This section includes the definition of system functions and data flows required to support the IKIR requirements, also known as the logical architecture.

Section 5: Preliminary Design. Defines the physical elements of the system which will carry out the system functions and exchange data. This is called the physical architecture, and may involve multiple alternatives depending upon the communications scheme that is chosen. Performance and operational criteria along with relative cost will be assessed in identifying the appropriate technologies to be deployed for IKIR. Incorporation of existing Hungarian transportation information and operations elements into IKIR is also addressed.

Section 6: Deployment. The phasing of deployment for the IKIR system will be identified, based on expected funding and availability of various technologies in Hungary. Also evaluated will be alternative means of system deployment and contracting.

1.3 GLOSSARY OF TERMS

A number of abbreviations are used in the Preliminary Design Report. These abbreviations are listed below.

AKKT	-	County Road Directorate
AKMI	-	Road Directorate Department of Technical Services
ATM	-	Asynchronous Transfer Mode
AVL	-	Automatic Vehicle Location
CCTV	-	Closed Circuit Television
CVO	-	Commercial Vehicle Operations
DFD	-	Data Flow Diagrams
EMS	-	Emergency Medical Services
FOVINFORM	-	City of Budapest Road Information Service
IKIR	-	Intelligens Közúti Információs Rendszer (The Intelligent Road Information System)
ITS	-	Intelligent Transportation System
SONET	-	
UKIG	-	Road Directorate Department of Planning
UTINFORM	-	Ministry Road Information Service
VMS	-	Variable Message Sign
WIM	-	Weigh-in-motion

IRIS - HUNGARY

TDA

IKIR - MAGYARORSZAG

IRIS TDA Project
Wilbur Smith Associates

SECTION 2
SYSTEM CONTEXT

Section 2
SYSTEM CONTEXT

2.1 INTRODUCTION

This section presents an overview of the Hungarian road transportation system, with particular emphasis on existing procedures to collect and disseminate travel information to the motoring public. The existing structure of transportation agencies involved in roadway operations and maintenance is also described.

The objective of this section is to provide the necessary background to the description of the preliminary system design contained in the remainder of this report. This background information is provided under the following major headings:

- The Hungarian Transportation System
- Existing Road Transportation Agencies
- Overview of the IKIR Concept
- IKIR Participants
- IKIR Implementation Issues
- Operational Challenges

Annex A includes an overview of Hungarian road funding.

2.2 THE HUNGARIAN TRANSPORTATION SYSTEM

2.2.1 Geographic Setting

Hungary is located geographically and politically in the center of Europe. Although it remains a distinct entity due to its language and locale, Hungary has very strong ties to Western Europe, particularly to Austria and Germany. Hungary also has close relationships with neighboring countries formerly under the Russian sphere of influence, including Slovakia, Ukrainia, Croatia, Serbia, Slovenia and Rumania. With a very strong likelihood of joining the European Community as well as the North Atlantic Treaty Organization (NATO), Hungary will gain in importance as a crossroads for travel and commerce across both Eastern and Western Europe.

Geographically, Hungary is largely a plain edged by the Carpathian Mountains, the major physical barriers being the Danube and Tisza Rivers. The Danube, roughly dividing Hungary east and west, historically has connected Central Europe to the Black Sea. Now it is connected to the North Sea through canals on the Rhine River. The Tisza meanders across Eastern Hungary and often causes considerable flooding. The Nine Arch Bridge across the Tisza floodplain is an important and historic transportation facility.

2.2.2 Rail, Water and Air Modes of Transportation

The IKIR project primarily concerns road transportation, however, there may be some opportunities to incorporate travel information relating to other modes of transportation, such as rail, water and air.

The domestic transportation of people and goods within the country is relatively easy due to the flat terrain. Two major trans-Europe corridors pass through Hungary – one connects Western Europe to the Orient (Vienna to Beijing), while another connects the ports of the Adriatic Sea to Ukrainia and Russia.

The rail network is electrified and is predominantly oriented to passenger transportation rather than freight. Generally, the distances between cities in Hungary are short enough that freight movements on highways are more convenient and efficient.

On the other hand, the Danube handles a growing amount of freight traffic, with additional port facilities being planned for the Budapest area. Scheduled passenger services between Budapest and Vienna operate from April to November utilizing hydrofoils.

Air service is provided through Ferihegy International Airport southeast of Budapest, serving cities throughout Europe and Asia, as well as North America. No regional air service within Hungary is currently available. Ferihegy boasts two terminals and is accessible by highway, as well as by bus connections to metropolitan rail services in Budapest.

2.2.3 Roadway Network

The existing highway system in Hungary, illustrated in Exhibit 2-1, is largely a radial system focused upon Budapest. Historically, the major circumferential routes were located well outside Budapest. Since the end of World War II, these circumferential routes largely fall outside the Hungarian borders.

There are eight corridors radiating from Budapest, with the highway routes historically numbered clockwise from 1 to 8. The highway system connects all the major cities in Hungary with two-lane paved highways. As additional development and traffic growth has occurred, these two-lane routes are becoming inadequate to handle the additional traffic.

Increased capacity has been proposed through implementation of limited-access "Motorways" parallel to the historical radial corridors, along with a number of circumferential highways connecting eastern and western Hungary between Budapest and the southern border.

The motorway system has been partially implemented. These motorways consist of four-lane divided highways (two lanes in each direction) with right hand shoulders which permit parking of disabled vehicles) that are grade-separated from other highways and railroads. In the Budapest area, these routes can be expanded to six-lane motorways (three lanes in each direction) to handle the heavier urban area traffic.

2.2.4 Motorway Operations

The Hungarian motorway system has a radial pattern with Budapest as its hub. A combination of eight motorway and highway corridors have been established. These are the M1 motorway (to Austria in the northwest), the H2 Highway to Slovakia in the north, the M3-H3 corridor to Ukraine in the east, the H4 highway through the southeast of Hungary, the M5 motorway south to Romania and Yugoslavia, the H6 highway south along the Danube River, the M7-H7 corridor southwest past Lake Balaton on to Croatia, and the eighth corridor is H8 westward towards Graz in Austria.

The motorway system is organized in a radial pattern similar to the traditional highways in Hungary, focused upon Budapest. Eight Motorway corridors have been designated, M1 (to the northwest) clockwise to M8 (to the west), along with M0, an inner ring motorway around Budapest. To date, only M1 has been completed to the border (in this case, the border with Austria).

The Hungarian government has toll concession agreements for the M1 Motorway, 45 km of toll operations, the M5 with 80 km of toll operations, the M3 introduction of toll operations and M7 tenders for toll operation now in development. The M0 is expected to continue operating without tolls. The M1, M3, and M5 are planned to operate as toll motorways throughout their length. The Government, by Cabinet Decree No. 2119/97 (V.14) has decided to operate all motorways as toll concessions.

Importantly, the Motorway system, regardless of the presence of tolls, will be operated under a common operational plan serving the domestic and international transit traffic through Hungary. This is an important stipulation since it will facilitate the implementation of a national IKIR program. It would thus require all concession agreements to incorporate elements of IKIR as recommended for the Motorway network.

2.2.5 Issues Relating to Motorway Operations

A number of issues impact operations of the Motorway network, along with other parts of the highway network. The Motorway speed limit is 120 km/h. However, motorway traffic includes older vehicles that have difficulty maintaining that speed and vehicles traveling at speeds of 180 to 200 km/h. The extreme differential in travel speeds and the frequent passing that occurs increases the hazards of motorway travel and results in more serious injury accidents.

Also of interest is the presence of overweight vehicles on the roadway network. Hungary permits these vehicles on the system by charging the operators a modest permit fee for overweight axle loads and excess total weight. These fees are collected at the border stations located at international entry points.

High volumes on the highway network are found along four key corridors, plus the MO Connector:

- The M1 corridor from Budapest to Gyór
- M3 corridors northeast of Budapest to Gyongyos
- M5 corridors southeast of Budapest connecting with Highway 5 at ~~to~~ Kecskemet
- The M7 corridor between Budapest and Lake Balaton (summer)
- The M0 partial motorway south of Budapest connecting M1 to M5

Preceding page blank

Lower volumes are found in the eastern portion of Hungary. Volumes in southern Hungary, near the Serbian border, fluctuate depending upon the embargoes or restrictions currently in place due to the civil unrest within Serbia.

Congestion that reduces travel speeds is found recurrently along the M0 motorway and along M7 between Budapest and Lake Balaton during the summer holiday season.

The planned highway system is designed to eliminate existing capacity constraints. Plans include completing the eight radial motorways from Budapest to the borders, completing M0 around Budapest, and providing two additional circumferential highways across the central and southern tiers of Hungary. As discussed above, limitations in funding had constrained the Cabinet has decreed the expansion of motorways using toll concessions.

2.2.6 Recommended IKIR Road Network

The IKIR program will address traveler information needs on all motorways and major highways in Hungary, along with congested conditions in specific locations. However, for the purpose of planning IKIR implementation, it is important to identify specific high priority corridors for early deployment. These locations will encompass higher traffic volume routes, in particular those routes representing the Hungarian portion of the major Trans-European Corridors (TEN-T). These include:

- E60 (Austria to Rumania via Budapest) via M1, M0 and Highway 4 (future M4)
- E71 (Croatia to eastern Slovakia via Budapest) via M7, M0 and M3
- E75 (Austria to Yugoslavia via Budapest) via M1, M0 and M5

Four major highway corridors (and the M0 motorway) serve the transit traffic passing through Hungary en route to other destinations in Western, Central and Eastern Europe. These will be the highest priority corridors:

- M1 corridor (E60/E75), including Highways M1, M15, 10, 15 and 85
- M3 corridor (E71), including Highways M3, 3, 32, 33, 34, 35, 36
- M5 corridor (E75), including Highways M5, 50, 51, 52, 44, 441
- M7 corridor (E71), including Highways M7, 7, 8, 70, 811, 71, 74, 75, 63
- M0 ring road around Budapest

Other main highway corridors to be implemented in the next level of priority will include:

- Highway 4 corridor (E60), including Highways 4, 441, 442, 46, 42
- Highway 6 corridor (E73), including Highways 6, 61, 66, 55, 56, 57
- Highway 8 corridor (E66), including Highways 8, 80, 71, 75, 84.

Cross-country corridors located south and west of Budapest include:

- Highway 61-52-44-47 (Nagykanizsa, Dunafoldvar, Keckemet, Bekecsaba, to Debrecen)
- Highway 84-71 (Sopron to Lake Balaton)

The cross-country corridors provide east-west routes passing south of Budapest which roughly parallel future motorways in southern Hungary. Other future IKIR corridors include Highway 1 and Highway 2 north of Budapest. These two corridors currently do not have significant congestion.

It should be noted that the definition of the IKIR road network includes local roads which both parallel and intersect the motorway network. The IKIR road network also defines the network for which the IKIR can give routing information across Hungary. Requests for routing between two major cities in Hungary or between borders and cities within Hungary will be made on the basis of those roads within the IKIR road network.

2.3 EXISTING ROAD TRANSPORTATION AGENCIES

2.3.1 Ministry of Transport, Communications and Water Management

The agency responsible for road transport throughout Hungary is the Ministry of Transport, Communications and Water Management. This Ministry has the responsibility for the development of the road transport program and is directed by the Minister who is a member of the Hungarian Cabinet. In the Ministry the road transportation program is lead by the Director of Road Transport. The Minister, Mr. Hóvólgyí, is directly responsible for the development of road transportation within Hungary. This includes the state-owned non-profit companies and toll concessions. Under the road directorate of the Ministry, there are several agencies and companies responsible for the operation and management of the road network, (state-owned non-profit County Road Companies) and the State Motorway Company and together with the individual toll concessions.

2.3.1.1 Ministry Policy

Within the Ministry of Communications, Transport and Water Management there are distinct areas of technical expertise where Ministry staff set the policy to be followed at the national and county level. The Ministry has the responsibility to set policy to cover all the operations and maintenance needs of the State Motorway Company and the 19 county road directorates. The Ministry does not have operational staff and is not directly responsible for day-to-day operations of any of the highway network. The policy set by the Ministry serves to unify the request for operational and maintenance needs in a fashion that satisfies the competitive demands of individual operating agencies to acquire equipment in their system. The Ministry has the responsibility to set policies that would coordinate the individual development aspects of all the private companies active within the Ministry and provides a technical review of those developments and the applicability of individual projects towards the national road transport standards.

2.3.1.2 National Standards

For the Ministry to sustain a national policy in the management of the road transportation system, it is becoming increasingly important to establish through electronic communication and coordination among the state-owned non-profit companies, and toll concessions a set of technical standards that may be uniformly applied throughout Hungary, and including county road areas. Several important electronic communication standards need to be established for the IKIR.

Motorway Communication Standards - The first is the development of a motorway communications system. This standard would apply to all new motorways, tollway operations, and retrofitting of older motorways. The concept would be to expand a communication backbone system along the motorway network to provide several ducts to carry fiber optic bundles along the motorway. These standards would allow for equipment stations at one kilometer spacing along the motorway in the most heavily traveled sections to a five kilometer spacing in the less highly traveled areas away from Budapest. This same fiber optic network communication system would surplant the present emergency phone system along the roadside.

Standard Interface Unit - It would be desirable for the Ministry to establish in coordination with the operating companies, a national standard for an interface unit to connect all traffic management equipment to the motorway communication system. Such an interface units would be based on rugged microprocessor systems that would allow multiple devices to be attached to the roadway communications system. These interfaces would allow connection to the communications network of existing IKIR-type equipment in use in Hungary:

- traffic loop detectors;
- traffic detectors;
- variable message signs;
- CCTV camera control;
- weather stations; and
- weigh-in-motion detectors.

Establishing interface unit standards it would allow the State Motorway Company and all the county road directorates to utilize the same equipment and to buy this equipment in large enough quantities that they can achieve a significant price saving. The software to be provided by the manufacturer should be guaranteed as operationally safe to relieve the Ministry of any liability. Each county district could use the same software that has been tried and tested throughout Hungary. In this way, the software would offer the county road directorates some reassurance in court that this equipment is reliable, well tested and safe in operations on the Hungarian roads.

2.3.2 County Road Directorates

Each of the 19 counties in Hungary is administered through a state-owned non-profit company responsible for the operation and maintenance of road transportation within their county. These county road directorates perform most of their responsibilities under a contractual arrangement with UKIG in which the road fund is used to contract maintenance and operational services with each county. These agencies have good technical skills and experience in performing the operational maintenance requirements of the counties. As part of their contractual relations with UKIG, they provide traffic management information from each county directly to UTINFORM.

2.3.3 The State Motorway Company

This state-owned non-profit company is organized to operate and maintain those motorways that are free of tolls. This group has the technical staff and responsibility to operate these motorways. The State Motorway Company is centered in Budapest and has its operational responsibilities distributed among the motorway control center and maintenance operation centers along M0, M1 and M7.

2.3.3.1 The MARABU Project

In 1995 the State Motorway Company had tender documents prepared to introduce a motorway control system known as MARABU, for implementation along M0 and interacting with the major highways entering the city of Budapest. The development of the MARABU system was supported by the City of Budapest who would provide the complimentary traffic management on the major arterials. The original concept of MARABU was to effectively direct traffic off the M0 motorway onto the least crowded access roads into Budapest. The system included variable message signs and separate lane use control. The MARABU development plan also included a fully developed motorway control center on Cspel Island adjacent to the M0 motorway. The MARABU system was not been implemented because the tender costs exceeded the available budget.

2.3.4 The AKMI

The AKMI is a state-owned non-profit company that contracts to provide technical services to the UKIG. The AKMI operates separate departments, such as the DATABANK, to provide specialized technical services. Three technical services include:

- traffic count program and weigh-in-motion;
- border crossing operations;
- DATABANK; and
- UTINFORM a road information service within the road directorate of the Ministry.

AKMI is now organized on the same level a the UKIG operation. UKIG who administers the road fund can commission AKMI to provide technical services on specific projects. AKMI offers its technical services to other groups responsible for the maintenance and operations of the road network in Hungary. The technical program developed by AKMI is also monitored by and follows the policies established by the Ministry.

AKMI does not have operational and maintenance responsibility for the road network itself. It is primarily responsible for special functions and services offered to the operating agencies. AKMI has to compete with other firms since the county road directorates have the option to solicit proposals for technical service from AKMI and to seek similar services from outside private companies in Europe or in Hungary.

2.3.4.1 Border Crossing Stations

As noted above, AKMI is responsible for the operation of the border crossings. These stations survey trucks entering and leaving the country to establish the weight of vehicles and, in appropriate cases, set charges for permits for oversized or overweight vehicles. The individual border crossing stations identify trucks by total and individual axle weight and license plate number. These data are routed to Budapest on a regular basis, usually daily.

An oversized or overweight truck is charged a premium for travel in Hungary and is given a route map that select routes which are deemed safe for the axle loading. At present trucks are the only vehicles counted. Border crossing functions may be expanded to include automobile counting and automation of the permit process. This would allow distribution of the axle loading and license plate numbers to the operating agencies in the counties and within the police force.

2.3.5 The National Weather Institute

The National Weather Institute (OMI) in Hungary now provides weather forecasts throughout the country. These forecasts are based on three major radar weather stations maintained and operated by the Institute weather satellites and numerous field weather stations. These national weather forecasting programs show in pictorial form the prevailing weather conditions and the expected path of those weather patterns across the country.

Within the Ministry and road directorates there is increasing interest in expanding coverage of weather from the broad national picture to a detailed weather station and ice detection system in each county. This micro weather system would provide detailed weather parameters at selected locations within the counties. Introduction of the IKIR program would preserve the integrity of the national weather service, but would expand the graphical display of detailed information at specific sites located throughout the county and these added stations could meet OMI standards to expand their database.

2.3.6 Integration of Existing Systems

In recent years, Hungary has introduced a number of advanced ITS services that have operated continuously and need to expand as road transportation increases throughout Hungary. The IKIR goal is to coordinate these ongoing functions towards the common objectives of improved road management, through better use of the national road resources, and closer coordination among active operating agencies through ready access to realtime operating data. By such efforts, IKIR can provide critical operating support to achieve safer traffic operations, improved mobility, and more timely information on ways to avoid traffic delays and hazardous road conditions. IKIR offers an opportunity to decrease the per unit price of data collection by automating these programs.

The road transportation administrative community is very stable, well established and has earned an excellent reputation. The Ministry of Transport, Communication and Water Management is the leader with strong support from 19 state-owned non-profit County Road Management and Operations Companies, the State Motorway Company, the Toll Concessions and the AKMI. The ministry is continuously updating its own organization to better respond to changing public demands and technology advances. IKIR will contribute to improved road management through the better deployment of limited road department staff and equipment resouces to achieve higher utilization of these resouces to best satisfy increasing traffic demands throughout Hungary and transit traffic in eastern Europe.

IKIR will also provide summary data to the DATABANK to enhance the quality and quantity of traffic data available. IKIR will collect traffic data by connecting existing count stations and WIMs to the IKIR Center. The realtime data will be summarized and will be accessible to the DATABANK. This automated data collection reduce the data collection costs to the DATABANK department of AKMI.

UTINFORM will have access to the realtime weather and traffic data from the counties and the motorways. In times of severe weather conditions, IKIR will provide realtime road data at critical road and bridge sites, this will assist faster and better prioritized equipment and people dispatch to those sites. UTINFORM has a well established program to receive daily reports from the state-owned non-profit road management and operations companies.

IKIR could become the initiative through which Hungary can coordinate the Eastern European Expansion of the European Union ITS Expansion. There are several well established Euro-Regional Projects already underway. The projects include CENTRICO (Central Europe), SERTI (Southern Europe), VIKING (Scandinavia) and CORVETTE (Alpine Area). A summary of these projects is provided in Annex A.

The CORVETTE project has its eastern edge at the Austro-Hungarian border and IKIR plans providing a data exchange facility at either the border crossing at Heygessalom or the County center at Gyór subject to final agreement with CORVETTE.

Hungary also shares borders with Sovakia, Ukraine, Romania, Yugoslavia, Croatia and Slovenia all of these countries will be negotiating to enter the European Union or share major east European truck traffic routes across Europe. Through working level groups, it is planned to coordinate needed European TACIS and PHARE funding for ITS projects in this Eastern European, Euro-Region. IKIR is a focus for EU coordination and a working level opportunity for bilateral and regional ITS expansion and coordination.

2.4 OVERVIEW OF THE IKIR CONCEPT

The state-owned non-profit companies involved in road transportation in Hungary will be discussed in more detail later in this section. First, however, it is necessary to provide a brief overview of the IKIR concept and its rational.

2.4.1 A Balanced Approach

The development of the road transportation system in Hungary requires that the integrity of the roadway itself be maintained at the highest level, while at the same time the network operates at the highest levels of safety and efficiency. The development of the pavement management program by UKIG provides an ongoing program to maintain the structural integrity of the roadway and to provide a smooth, safe, black top surface along the motorway. As the road fund monies are spent to maintain the quality of the Hungarian Motorway Network, there is the competing challenge of increased truck traffic, with heavy loads, contributing to hazardous conditions. Once the integrity of the motorway pavement is established, either through initial design or through various upgrading procedures, the motorway needs to be operated in a balanced fashion. For the Ministry advisors and decisionmakers, there are competing claims to invest more in construction or more in traffic management. Embedded in the IKIR concept is the need to fund both the structural integrity of the roadway and effective traffic management.

2.4.1.1 Expanding Motorway Capacity

While traffic continues to grow in Hungary and could increase rapidly within several years, it is important to continue to provide adequate capacity on the motorways by completing the half motorway sections and in some cases, expanding the four-lane motorways to six or even eight lanes around the Budapest area. The application of IKIR concepts to old roadway designs with major capacity limitations cannot on its own assure successful road operations. The Hungarian network needs an expansion in roadway capacity at key sites, accompanied by a major investment in traffic management to assure success in achieving the potential improvements provided by the new motorways.

2.4.1.2 Benefits of Incident Management

As an example of the benefits of traffic management on motorways, the capacity of a two-lane roadway (one direction) is reduced by more than one-half whenever an incident blocks one lane of traffic. Thus, the initial investment in two lanes can only be effective if traffic flow is sustained along the two lanes without incidents blocking a lane. Failure to detect and remove these incidents promptly is equivalent to destroying one lane of the motorway.

2.4.2 IKIR's Four Point Program

As a result of discussions with UKIG staff, the roundtable discussion in April, 1997 and the technical presentation at the Academy of Transport Science in May, 1997, a four point IKIR program was These four categories reflect the goals of the system operators and the need to integrate IKIR conceived. administratively within the UKIG administrative structure. It is important to stress that the IKIR program itself is not to become an administrative bureaucracy, but still work cooperatively within the Ministry and the state-owned non-profit and toll concession companies to accomplish its goals and objectives. The IKIR program consists of four operational components:

- the IKIR real time information system;
- the motorway control and monitoring system;
- county road management; and
- coordination of existing ITS activities.

IKIR collates consistent data on road operations and informs travelers of the up to date traffic conditions alon their route.

2.4.2.1 Real-Time Information

The IKIR information system would collect real time data throughout the Hungarian road network and provide that information to the operating agencies and to the road users through information kiosks computer terminals and radio broadcasts.

2.4.2.2 Motorway Traffic Control and Monitoring

The motorway control system would be centered on the higher volume motorway sections around Budapest and the non-toll road sections of M1, M7 and M0. This system would be an expansion over the originally planned MARABU and would include many of the features of the MARABU system.

2.4.2.3 County Road Management

The county road companies would operate as both a provider of real-time information to the IKIR and also a user of that data to carry out their own operational management programs. There are 11 counties close to or within two major European corridors crossing Hungary. These nine counties are candidates included in the first phase of IKIR with the remaining counties being added as the-IKIR expands throughout Hungary.

2.4.2.4 Coordination of Existing ITS Activities

The coordination function of IKIR allow coordination of many of the AKMI programs which are already under development and have been initiated. Coordination with the toll concessions would hinge very heavily on the growth of traffic on the toll roads and the development of Hungarian standards for communications on motorways and field equipment interfaces to the communcations system as discussed in Section 2.3.1.2.

2.4.2.5 The Critical Role of Agency Coordination

Agency coordination is a particularly important function in Hungary. The redevelopment of the road directorate program created state-owned non-profit companies to carry out specified functions of the road operation and maintenance plan. In so doing, each company has carefully crafted a program to develop its own area of expertise and responsibility. As a result of this active program, each of these companies has tended to develop and refine their own ITS related functions.In AKMI, there are several functions that relate directly to IKIR, namely border crossings, traffic count programs, and weigh-in-motion programs. At the county level, each county road directorate is responsible for performing specified operational and maintenance requirements by UKIG and to furnish to UTINFORM data on daily operations of the system. It is the role of IKIR to provide additional electronic communications, computer analysis, and computer software to the data gathering capabilities of these ongoing ITS-related functions.

The IKIR program would support these ongoing functions at no direct cost to the agency involved. Agencies would provide information they already collect to IKIR. In return they would have access to data provided by other participating agencies and organizations. One of the key tasks of IKIR is to develop a national system, capable of expansion and evolution that can serve both the county roads, motorway systems, and the toll roads. In this way, an effective, coordinated operational policy can be achieved throughout the road network in Hungary.

2.5 IKIR PARTICIPANTS

Hungary is in a unique position of having pioneered many of the concepts at the heart of the IKIR program. Over the years it has developed a well educated, computer literate, well trained technical staff experienced in managing and operating the national road system. It is because of this basic reserve of skills and experience that Hungary is able to offer the first national ITS program that can be expanded throughout the country with the assurance that staff are available to oversee this development. This does not mean that there are no staffing needs. As the system is implemented there will be a need for training programs in the counties and central government on the operation of the IKIR.

As indicated above in the summary of IKIR concepts, a wide range of agencies and organizations will participate and benefit from the IKIR program, including:

- national agencies;
- county road directorates;
- the State Motorway Company;
- toll concessions;
- police
- emergency medical services
- emergency towing services
- border crossings;
- City of Budapest; and
- trucking companies and motor clubs.

Based on interviews with many of thee organizations, a summary is presented below of each organization and its potential role in this IKIR program.

2.5.1 National Agencies

The primary national agencies involved in operating the IKIR program will be the Ministry of Transport, Communications and Water Management, the resources of the Weather Institute and the private companies managed by these agencies to provide the specialty services in the technical areas of IKIR.

2.5.1.1 The Ministry

Critical to the success of IKIR will be the Ministry's role in setting the national ITS policy for traffic engineering and coordination of electronic communications. The need for the Ministry to set standards has already been highlighted earlier in Section 2.3.1.2.

2.5.1.2 UTINFORM

The UTINFORM program now performs many of the information services that are included in IKIR. IKIR will build on the UTINFORM program, extend its real-time database and provide more direct access to more travel related data than has been possible to date. In addition, IKIR will expand data distribution to the private sector, including radio and television broadcast media, and encourage other private firms and private interests to fully utilize real-time travel information. In return, IKIR will support Ministry goals through improved electronic communications, computers and software to fully coordinate and expand the ongoing IKIR functions used by private companies. In this way, it is planned that cost sharing of electronic communications, joint use of computers and software, can greatly expand the capabilities of the road management team and effect a major cost savings over the development of separate and independent PC developed subsystems.

The UTINFORM service receives traffic and weather data several times a day from the state-owned non-profit companies. These services are contracted for and paid for by the UKIG. In addition, this reported information is broadcast on a regular schedule as part of the news on Hungarian AM radio. These same traffic reports, generated in the UTINFORM radio studio, are also offered as a subscriber paid service by Westel as one of their available radiophone information services.

The Hungarian Government has received tender offers for a National FM Radio Frequency franchise. Associated with this frequency are multiple subchannels allocated for RDS-TMC usage. The successful franchise will be allowed 90 days in which to exercise its option to implement a RDS-TMC plan on the National FM frequency subchannels. Failure by the successful tenderer to exercise this option could lead to awarding the RDS-TMC service to others. Questions of RDS-TMC coordination with UTINFORM may be addressed after the awarding of the National FM Frequency tender.

2.5.2 County Road Directorates (AKKHT)

As the traffic grows in the counties, there has been a growing interest among the County Road Directorate to perform, under their own direction, traffic management programs that address the problems of the county. These traffic management issues center around two conditions, the icing and snow problems of winter and the traffic accident and incident problems. The IKIR provides counties the opportunity to gain the real-time traffic information that they have lacked to date and an opportunity to expand their own traffic management capabilities to respond to critical weather and accident conditions. The IKIR given them them the opportunity to coordinate diversion in two or more contiguous countries

2.5.2.1 Improved Management Information

In addition, IKIR will provide improved management information to quantify how well county roads are operating. As a private company it is important for a county road directorate to be able to inform its customers of how well the road network is working and to alert them to any problem in the area. IKIR will help the counties to do this. By improving traffic management capabilities IKIR will help counties achieve a better balance between pavement management functions (their traditional role) and traffic operations activities (incident response, traveler information services, etc.).

2.5.2.2 County Support for IKIR

In general and with very limited exceptions, all of the directorates were interested in the IKIR concept and were anxious to see how IKIR could assist their operation. At the same time, in fairness to them, they were skeptical that the IKIR system, although highly desirable from their viewpoint, would achieve the full implementation that the interview team promoted. The support from the directorates was qualified only in the sense that they were apprehensive about the level of funding that would become available for IKIR. They clearly saw the need for more real time data in their districts and if that were to become available, they could readily see the improvements in traffic management that could be accomplished in each district.

2.5.2.3 IKIR Services to Counties

In discussing IKIR operations with the counties, it was made clear that the intention of IKIR was to provide services to the counties, not to become a bureaucratic entity in and of itself but to offer services that were now lacking within the counties and between counties to provide them access to the IKIR real time information base, to assist them in monitoring weather conditions at critical points within the county, and to implement control using radio or other wireless communications for the monitoring of traffic signals, the monitoring of ice on bridges, the monitoring of weather stations and the use of AVL to monitor their patrol vehicles and to automatically provide travel time information on the major highway elements of the IKIR network.

To provide these services to the individual county directorates and to meet their expanded needs in monitoring and control, it is anticipated that IKIR would provide additional work stations, graphic wall displays, color printers, and radio equipment in each of the existing county operation centers. In keeping with IKIR's policy of assisting the project management in each directorate, it would be left to the directors themselves to balance the number of weather stations, ice detection stations, and variable message sign controls that they would like to introduce in their county.

2.5.2.4 AVL Equipped Patrol Vehicles

The only added requirement that IKIR would have on the counties would be a cooperative arrangement whereby patrol vehicles would traverse critical links in the IKIR network and that through the use of AVL travel time on those roadway sections would be automatically entered into the IKIR data bank to provide real-time travel time along those roadways. The patrol vehicles would only need to turn on the AVL equipment and to use its built in radio phone transmission to report their position along the roadway and the system itself would record the travel time and compute average speeds.

2.5.2.5 County Priorities

In discussions with the counties, the following are the major items or features that they are most interested in:

- expanded weather detection stations;
- additional ice condition measurement stations on bridges and critical road sections;
- warning signs for icy conditions at critical locations; and
- route diversion capabilities for incident management.

In terms of equipment, the county's biggest deficiency is the data transmission capability of their two way radio systems. This radio system uses audio tones to signal traffic and status information from the field. However, in order to complete a transmission effectively, they have to curtail voice transmissions and allow the audio tone to be used separately from any voice communications. Any enhancement in the data transmission on the radio system would include digital signaling, error detection and error correction, so that they can greatly enhance the accuracy and efficiency of their radio system. This would allow them to use the system more extensively throughout the county. Parallel to this development will be certain features of the IKIR system which may encourage data transmission for variable message sign control and traffic signal monitoring using the radio phone network rather than a dedicated two-way radio system.

In summary, the counties were extremely supportive of the IKIR program. They were most cooperative and courteous on our visits. Their only hope is that IKIR can really be implemented soon and that its implementation will include sufficient features and scope that it can make an immediate contribution to the traffic management in the road directorates. It is the purpose of the preliminary design to try to meet those legitimate goals and to reinforce the active support shown by the road directorates and their staff.

2.5.3 The State Motorway Company

As discussed earlier in this section, this is a state-owned nonprofit company responsible for the operation and maintenance of all motorways which are free of tolls. In this role, the State Motorway Company is potentially a major participant in the IKIR program. The Company would have access to real-time travel data provided by IKIR, which would assist them in daily traffic management activities and in responding to traffic congestion caused by incidents or accidents on the motorway. In return for access to real-time data, the State Motorway Company would be a valuable source of data for IKIR.

2.5.4 Toll Concessions

The Hungarian government, by Cabinet Decree is committed to expand the motorway through toll concession agreements. There are three separate groups for the M1, M5 and M3 motorways and more toll concessions are planned.

2.5.4.1 The M1 Tollway

The M1 concession connects Gyor and the Austrian border. The section is 45 kilometers long and charges a basic toll fee of 1,500 fornt for each passenger car. The truck tolls are higher, rising to 5,000 fornt for the largest vehicles. The toll concessionaire widened the motorway to the national motorway standards and has a continuing contract to operate the toll facility. This contract includes toll revenue management, roadway maintenance and operational response to incidents on the motorway, this included answering the emergency phones located at 2 kilometer intervals along the tollway.

Highway 10 - In this M1 corridor, there is a parallel facility connecting to the frontier. This roadway, Highway 10, carries approximately 50 percent of the M1 corridor traffic. When leaving Hungary and approaching the Austrian border, trucks on the M1 tollway are required to exit and connect to a local road which goes directly to the Austrian customs point. This road is also used by trucks that has utilized Highway 10. Both sets of vehicles use the same customs and immigration control points on the Austrian border. Because this is the busiest border crossing in, trucks can experience significant delays at the border. The concessionaire has no responsibility in controlling this border traffic. However, when there are delays of several hours in processing vehicles at the Austrian border any potential travel time advantage on the 45 kilometer tollway is lost. This encourages traffic to avoid the toll and use the local road instead of paying the toll premium.

The toll company does not weigh trucks using the M1 toll road. They have limited facilities, consisting of a single count station, and a variable message sign on the tollway close to the Austrian border. The variable message signs, the emergency telephones and the emergency response along the M1 tollway are handled from an operational center near the middle of the tollway at a point adjacent to the M1 toll barrier.

Toll Collection Configuration - The toll system on M1 is based on barrier tolls at the mid-point of the motorway and additional toll collection points at either the entrance or exit ramps along the tollway. There are a total of seven interchanges along the toll section. At present, the toll concession is quite satisfied with its ability to monitor toll collection and effectively collect tolls without causing traffic delays. In addition, the traffic volumes have not grown to a large extent and the traffic ADT in this section of the tollway is around 6,600 vehicles per day.

Public Reaction to the M1 Tollway - Development of the toll road was accomplished by widening the old M1 motorway. Users of the original M1 motorway were confronted with a change in operational policy that added a toll for the last 43 kilometers. Some of the public reaction to the tollways in this area is centered on the fact that the old motorway was replaced by a tollway system and that users of the M1 roadway are now obliged to pay the toll or to use the parallel highway. There has been heavy use of this parallel highway by the domestic Hungarian truck traffic. The presence of a large number of trucks on the local road has caused local resentment by some of the small communities along the local road. The combination of new tolls on the M1 motorway and the re-routing of traffic from the M1 onto the local roads has caused some vocal resentment against the toll company and the Ministry.

To date the market share of traffic in the corridor that uses the toll road is less than 50%. The financial requirements for operating the toll road has lead the toll operating company to announce its intention to increase the toll on this section. The over 30 forint per kilometer summertime toll on this section is high when compared to both the average working wage in Hungary and the average European motorway tolls.

2.5.4.2 The M5 Tollway

The M5 motorway, which connects the outskirts of Budapest southeast to the City of Kecskemet is toll motorway that has a parallel local road, Highway 50, along its entire length. The travel times on Highway 50 are much longer than on the motorway. As a result Highway 50 is becoming so busy that it is vulnerable to incidents delays along its length. These incidents cause delays on Highway 50 and results in higher accident rate.

The tolls on the M5 are set at a lower toll rate than that used for M1. For the 80 kilometer M5 tollway, the toll is about 1,000 forint (summertime). The M5 operating company is satisfied with the safe operation of the tollway and the response to the emergency phone system and incident problems. At present, corridor traffic divides evenly between M5 and Highway 50.

Truck Driver Preferences - Again, as on the M1, many of the local Hungarian trucks prefer to use the parallel Highway 50 and avoid paying a toll for motorway use. This action is a result of driver choice in route selection. If drivers uses the parallel highway they will save the tolls, which they may keep.

Traffic Operations - At present, the M5 concession is satisfied with its financial controls and collection techniques. Because of low volumes, the full concession has had little difficulty in maintaining incident free operations along the motorway. The M5 has its own operations center, which is responsible for monitoring toll collection operations. The center also coordinates closely with the police to implement an effective police response to accidents on the motorway.

The M5 toll concession has considered more instrumentation for traffic counts and truck weighing on the toll road, but so far has delayed any major investment in such systems. They have, however, with the cooperation of the University of Budapest evaluated and reviewed some possible design packages for traffic management on the M5 tollway. So far, the traffic volumes have remained relatively low on the tollway and the operating personnel do not see an immediate need to introduce a traffic management system. They are currently content to monitor toll collection and management procedures, maintain the facility to the highest level, and wait for growth in traffic before introducing traffic management responses for possible incidents along M5.

2.5.4.3 The M3 Tollway

The M3 motorway, while awarded to a Hungarian state-owned non-profit concession company, has not yet implemented its toll collection system on M3, however, there is a toll collection and traffic management plan funded under a contract between the M3 Concessionaire and the University of Budapest. The toll concessionaire is not anxious to spend more money on the tollway itself for traffic management. It has already installed along its length an extra duct which could carry fiber optic communications. A VMW study (MAESTRO) has been completed. The implementation awaits a final decision by the toll concession company.

The concessionaires in general, see the need for traffic management, particularly since they charge a toll to offer premium travel services in Hungary. At present, the lower tollway traffic volumes have not caused significant incident delays along these motorways. Once incident delays grow the local agencies will have to address some of the resulting capacity constraints and redirect some of the traffic to other areas.

2.5.4.4 Toll Concessions Summary

Initially, the IKIR would operate parallel to the toll concessions but would provide the tollways communication access to the IKIR real-time data. This operation could change once a national communications standard for motorways is established. At that time it is foreseen that there would be a fiber optic connection between and along all the motorways in Hungary. This would provide full monitoring of the tollways and the sharing of that data through the IKIR real-time center for all users and operators of the highway system.

The tollways currently perform limited traffic monitoring. The initial operations are confined to the toll collection and operational management aspects and the security system to handle toll fees. The toll concessions do monitor the emergency phones on those roadways. The expansion of the emergency phone system may be more cost effective using radio phones with special limit call-in capabilities, in lieu of the present emergency phones and the required cabling of those phones. It is not proposed to replace the existing emergency telephone cable system with radio phones.

Toll concessions have a strong management directive to efficiently collect the tolls and to operate the toll roads at the best level of service possible. Because of the controversy amongst groups as to the correct level of tolls, the concessions are having to reconcile their present toll structure against the lower than hoped for market share of corridor traffic. The concessions themselves are very interested and have expressed positive feelings about providing communications along the motorway. The introduction of such standards would involve negotiations with the toll companies to implement and cost share those standards, so that a complete operational system for the motorways can be introduced in the major corridors of Hungary.

2.5.5 Border Crossings

The border crossings operate the trucks scales at the border and issue permits. This group also generates the permit fees based on the overweight status of the vehicle and the distance of travel on the Hungarian Road Network. The potential coordinating role for IKIR with the border crossings is at two levels. The first would simply be providing communications between the border crossings and the county centers, then onto the capital area. These communications links would offer an alternative to the present dial-up telephone service used by the border stations to transmit their daily data to their offices in Budapest. The second role would be expanded detection facilities at the border crossing to provide more real-time traffic data on passenger cars and trucks entering Hungary.

IKIR also offers the opportunity to supplement the scales at the border with the use of weigh-in-motion detection units and with loops to county automobile traffic. This would allow monitoring of the effectiveness of the weigh-in-motion program and its relative accuracy. The IKIR would offer electronic communications, not only on a daily basis between the border and Budapest, but it would also allow for real-time data collection from the border to the IKIR center and the capital. In this fashion, once a truck permit is issued to a carrier, this information can be immediately entered in the IKIR and the information on weight, routing, and the license plate number will be accessible to police and county centers throughout Hungary. The police see this as an opportunity to improve and make full use of overweight traffic data by the individual police patrols in each of the county areas. At present, the police often need to pull over an oversized or overweight vehicle and call in for a portable weighing system. The Police favor this even though the truck is required to carry its overweight permit.

The interviews and discussions with AKMI on the operation of their border crossings reflected a satisfaction with manual procedures, and revealed a keen interest in methods to improve and smooth out the details of those operations. At present, the reading of license plates is straining because of the relative position of the truck to scales and the crossing guard operations. The position of the border crossing operator is such that they do not always get a clear head on view of the license plate as the truck approaches and once the truck reaches the scale, the border crossing operator no longer has a view of that license plate.

The staffing of the border crossings is now well established and they have found that they can recruit good operators, particularly when using them on 24-hour shifts. This is made possible by the fact that the border crossing operator works in conjunction with the police of the neighboring country. This cooperation between adjacent operators assures that each one can look after the interests of the other and can assure full attention to their operation at all times. Additional traffic detection and the use of TV cameras to read license plates would assist AKMI in not only its regular border crossing operations, but may assist when they are called upon to conduct or contribute to origin and destination surveys. This additional instrumentation and its real-time data collection will also allow AKMI to conduct further detailed studies on patterns of various vehicle types entering and leaving Hungary. The interview team visited several border crossings with Mr. Bozan and he was generous in offering his ideas and information to the team. It is hoped that incorporating new detection technologies and the use of television cameras will assist the IKIR real-time database, while at the same time helping to improve border crossing operations.

2.5.6 City of Budapest

The City of Budapest through its traffic operations groups is struggling with the demands of traffic operations within the city. It realizes that traffic is growing and that the capacity of the street system in Budapest is limited. It is also concerned that when a problem develops within the city such as construction work or incidents and accidents, that the motorway system feeding traffic to Budapest should be moderated so that it would relieve some of the congestion problems and not add to them. Following this philosophy the City of Budapest agreed to participate with the State Motorway Company in the development of the MARABU control system, mentioned previously. The original MARABU design included a dynamic parking system; this is not included in IKIR.

The City expressed an interest that IKIR would provide motorway data, television surveillance and diversion plans which would be directly accessible to the City in their control center. In this mode of operations, motorway data would be made available to the Budapest Traffic Operations Center and it would be up to them to implement a traffic program to distribute traffic with the least congestion in the Budapest area. Similarly, through communications links provided by IKIR the City would be able to send messages to the motorway operations center to advise, in a prioritized fashion, of those exit ramps from the motorway into the city that offer the most direct and least congested route to various sections of the City.

2.5.6.1 City/Motorway Linkage

In the discussion, it was pointed out that from the motorway operations point of view it would be desirable to direct travelers to Budapest to specific areas within the city. As part of their ongoing traffic management plan the City is reviewing the possible identification of key activity centers within the city to which traffic could be directed from the motorway. As part of the original MARABU plan it was hoped to provide direction to parking lots within the city for major events and to guide traffic to those lots with sufficient capacity to handle the entering traffic. The City of Budapest is developing its own traffic control plans and is expanding on its equipment base. At this time, the interaction between IKIR and the city's traffic operations would be limited to a communication link from the city traffic center to the state motorway operations center to indicate the preferred entrances to the city from the motorway. Later developments could envisioned coordination of some traffic control signals or variable message signs at the ramp terminals on the entering roads to the City of Budapest.

2.5.6.2 Autonomous Operation

Regardless of the plan, each agency, the State Motorway Company and the City of Budapest would retain full autonomy over the operation and the control of traffic devices in their area. In summary, the communications between the two facilities will allow the City of Budapest to receive current information on traffic operations on the motorway, including its ability to monitor individual cameras along the motorway and to use that data in making their own control decisions for the city. Once they have selected their best operational controls they then would have the option to communicate them to the motorway control center so that if the opportunity arises the motorway control center through its own variable message signs could more effectively direct motorway traffic to various point within the City of Budapest.

The IKIR system would foster the concept of the MARABU system, would provide communications to exchange data but it would not infringe on the autonomous operation of the Budapest traffic control system. Similarly, the State Motorway Company will have its responsibility to operate the motorway system at its safest and most efficient levels and having achieved that, it would then be able to review its potential to adjust traffic into the City by various routes in a fashion that best suites the City's control plan.

2.5.7 Trucking Companies and Other Organizations

Trucking companies, the motor club and others offering technical or professional services related to the IKIR were also visited. The issue of the market share of tollways in the major corridors is strongly influenced by the concerns about truck traffic using or remaining on the old highways and not using the congestion free tollways away from local community traffic.

2.5.7.1 Trucking Companies

The major trucking company in Hungary is Hungarocamion. This company has been very competitive in providing transport services within Hungary and also in the transeuropean traffic market. They have a well developed program and offer first class service for road transport in Europe. They are also geared to meet the anticipated growth in travel demand. They recognize that there could be a major increase in transport demand once the economy and stability in the Ukraine and Russia and the Caucuses has reached equilibrium. They would like to have access to real-time data and they would be willing to provide information to the IKIR system on some of their travel performances.

GPS Radio Phone Equipped Vehicles - The Hungarocamion company has over 1,000 vehicles that are traveling on the Hungarian Motorway System and has 250 of these vehicles already equipped with a GPS/AVL vehicle locating system connected to a radio phone transmitter/receiver. They anticipate increasing the number of GPS/AVL radio phone equipped vehicles as business develops and they are able to invest more in their equipment. This approach is identical to the one proposed by IKIR for vehicles, police and road directorate vehicles in the counties.

Trucking Company Dispatcher - From an operational point of view, the trucking companies like to route their communications through their dispatcher. While they can collect information from each vehicle, they would take advantage of the IKIR system if an information terminal were made available to them at the dispatch center. The dispatcher would interrogate the IKIR for a status report in any area within Hungary. Also, if and when the truckers report problems on their route they can convey their information to the dispatcher and that dispatcher would have the opportunity to communicate those problems to the IKIR network.

From a practical point of view the truck companies prefer coordinating interaction with IKIR through their own dispatcher. This is a method they are comfortable with and they would feel that they have control over dissemination of their information which in some cases could be perceived as of competitive value to other trucking companies.

Vehicle Probes - The trucking industry offers a major contribution to IKIR in the fact that it can provide a large source of probes to establish real time travel time throughout the system. In return for this service, the IKIR system would offer real time information, particularly under bad weather conditions or other adverse conditions through the dispatcher of the transport company so that the trucks can avoid unexpectedly delay or circumvent potential road hazard that would jeopardize the safety of their cargo.

2.5.7.2 Motor Clubs

In a complimentary fashion, the Hungarian Automobile Club offers services to their own members along the motorways and other highways and will extend an offer to join the motor club to anyone else needing services.

Yellow Angel Patrol Vehicles - The Hungarian Motor Club has developed, and is justly proud of, their yellow angel patrol vehicles. These are small vans that patrol the motorways and highways and offer services to stranded motorists. Their first priority is to meet the needs of the Hungarian Motor Club members and motor club members throughout Europe who are traveling in Hungary. The yellow angels provide a similar function to the highway patrols in each of the road directorates. They are geared to help the public to provide immediate service and if necessary to call on larger facilities as the need arises. The yellow angels would be pleased to expand or to increase their service to meet the IKIR needs for incident response on both the motorways and the main highways.

Cost Sharing - However, as a cost item, any expansion in that service would need some cost sharing with the IKIR. One private contribution would be a cost sharing plan in which the yellow angels could offer their service to members and nonmembers on the motorway system and that where the yellow angels are providing patrol services they could be reimbursed by IKIR at the same rate as for a highway patrol vehicle within a county company. In addition, the motor club would welcome the opportunity to have access to IKIR real-time data. The yellow angels themselves would also provide information to both the motor club groups and to the IKIR real-time file database. In this way there would be some cynogism to encourage the use of the yellow angels to provide real-time data on traffic operating conditions.

The motor club is clearly designed to provide special services to its members and it develops its income through those members contributions so that sharing data with IKIR would enhance the service they provide, but it would not be as simple to expand their yellow angel patrol utilizing the membership contribution and for that reason they would seek some cost sharing arrangement with UKIG in the expansion of the IKIR system.

2.5.7.3 Communication Companies

Clearly, the IKIR system depends heavily on the provision of electronic communications. The IKIR study team met with three companies that provide communication services. Both the Pannon GSM radio phone company and the Westel Company have indicated that they have separate microwave facilities that could provide the interconnect service between the road directorates and the IKIR center. This would be accomplished by their separate microwave networks that are now used to interconnect their radio phone system. The service available is in terms of E1 channels and subchannels. Service would be multiplexed on E1 channels/subchannels to join county centers together.

In addition to these two radio phone systems, there is another company, the Hungaria Antenna Company, which previously was responsible for the transmission of radio and television broadcast signals. They too, either through their own resources or with connections to satellite systems, would like the opportunity to offer services between the county road directorates and the capital area IKIR center.

Rapid Implementation - It is recognized that for the rapid implementation of IKIR, it would be practical to utilize these services and that competitive quotations could be solicited from them in the tender documents. It is also recognized that in the future, once the motorway communication system standards are developed, that they could either contribute in the installation of those system or that private owned systems would replace the need for these leased services offered by these companies. These communication companies offer basic E-1 service of 2 megabits per second on their microwave system or similar service using the satellite links.

Available Radio Phone Capacity - The climate is favorable for including these companies in the IKIR program because, at present, there is capacity available from these companies to meet the IKIR system needs and they are encouraged by the potential expanded use of radio phones throughout the IKIR system. Each of these communication companies offer special services, particularly with respect to the radio phone system and there are many situations including AVL, that lend themselves to the expanded use of radio phones in the IKIR. It is expected that the use of radio phones will be encouraged and will be made a viable option in the tender documents for IKIR.

2.5.7.4 Radio Stations

UTINFORM presently disseminates information throughout Hungary through the use of telephone lines and their coordination with the radio stations in Budapest that broadcast on a national level. This is an important and ongoing program. In fact, UTINFORM would like to expand its broadcast capabilities so that it can disseminate locally relevant information in real-time at any sector in Hungary. There has been a large increase in the number of FM radio stations now coming into service throughout Hungary. Each county is now confronted with the possibility of working with several local FM radio stations to disseminate traffic information. This is particularly important when an unusual event occurs, a major accident, severe weather conditions or other unexpected conditions that chronically affects the local area.

In the same way that the counties are enthusiastic in joining UKIG in the operation of the IKIR system, the public sector and commercial services similarly see a major opportunity for them to be participants in the IKIR program. It is the intent of the IKIR design to take advantages of those resources and to incorporate them in the IKIR program.

2.6 IKIR IMPLEMENTATION ISSUES

In developing a preliminary design for the IKIR, attention has been given to implementing a system which will not only provide benefits initially but which will provide a solid foundation for growth and expansion in the future. A number of issues relating to IKIR implementation are discussed below under the following headings:

- Geographic distribution of IKIR elements
- Minimum Critical Phase 1 IKIR Implementation
- Planned Expansion of IKIR
- Sustainable IKIR Operations
- International Coordination
- Private Industry Cooperation
- Training and Implementation Supervision
- Coordination with the DATABANK

2.6.1 Geographic Distribution of IKIR Elements

The IKIR will require phased implementation to reflect funding constraints. The motorway system is expected to be covered in the initial phase of the IKIR. The toll concessions will operate in their own autonomous mode, coordinating traffic operations wherever possible with the neighboring motorways, and the State Motorway Company will direct the operations of traffic management on the remaining motorway system. The Phase 1 implementation anticipates at least 11 counties to be included in the county operations centers. These counties lie along both of the major corridors across Hungary and include several adjacent sections that provide continuity to the border.

2.6.1.1 State Motorway Company

The State Motorway Company will implement its own control system on the motorways and develop a standard package that can be applied to the adjacent motorways when the traffic volumes reach critical levels. These volumes are to be about 1,100 vehicles per hour per lane in the peak period. This represents the critical volume at which incidents may cause major congestion problems.

2.6.1.2 Toll Concessions

The toll concessions are planning their own implementation of control, but it is hoped that a standard can be developed to coordinate the deployment of variable message and lane control. The VMS are to be used at decision points along the motorway where traffic has the choice of changing between motorways or of leaving the motorway. The lane use signals will be used on high volume sections where a lane blockage or incident activity could require warnings of congestion ahead and of the potential of low speeds in specific lanes of the motorway. This is an expansion of the original MARABU concept and would be tailored to be compatible with the national standard to be adopted by the toll roads and the motorways to provide a rationale coordinated traffic management program on all the motorways in Hungary.

2.6.1.3 County Road Directorates

The county road directorates will have the communications ability to work with numerous data gathering stations within the county. It is proposed that IKIR be the assisting agency providing communications and that the road directorates themselves decide on the type and the number of detection devices they would like.

At present, there is a diverse viewpoint on the number of measuring devices needed in each county. This is appropriate and it should be left to the county to make those decisions. Options in the county should include the number of micro weather stations, the number of ice detection locations on bridges, the monitoring of critical sections of roadway or bridges within the county, and the measurement of real-time traffic data for both truck weights and for traffic counting.

Each road company director will make his own decision on which of these elements are necessary for the improved management of his area. He will be looking at improvements in terms of the services offered by the county directorate to the motoring public and will include the management response to incidents, accidents, weather or any other conditions that seriously impacts traffic operations in the counties.

2.6.2 Minimum Critical Phase 1 IKIR Implementation

In order to facilitate improved management and operations by each of the counties it is proposed that the initial first phase of the IKIR concentrate on assuring good communications between each of the collection areas and the data centers. This means that Phase 1 should include electronic communications between the state motorway and county operating centers and the IKIR center. Phase 1 must include all of these connections to operate the system efficiently and to include electronic transfers of data gathered by data collection stations located within the county.

The next critical area would be the upgrading of each of the operational centers in each county to include an enlarged work station capability, AVL communication, and radio control for the monitoring and control of data stations within the county.

In addition, Phase 1 of IKIR must include the software to allow all of these systems to work together and interface with the applications programs that each agency may develop. The software will be developed such that IKIR provides the main operating system, while the operating agencies, at the county and the state motorway level, will develop their application programs to run on the IKIR system.

2.6.3 Planned Expansion of IKIR

The ultimate goal of IKIR is to provide a national system throughout Hungary. In order to do this IKIR must expand its communications network to connect all of the 19 county districts to the IKIR center in the capital area. In the second phase of IKIR deployment there will be expansion of the backbone communication system. Within each of the districts there will be expanded use of the radio control or other wireless devices to monitor and collect data and exercise traffic management control in each county.

When the national standards for motorway communications are established, it is anticipated that there will be a fiber optic network on all the motorways in Hungary to support the long-term development of IKIR. In the transition from leased communications to user owned fiber opportunities of cost sharing will be given to the private industry to share use of the communication conduits and even allowing the installation of separate fiber bundles along the roadway.

IKIR would also expand the UTINFORM function of broadcasting and disseminating information throughout Hungary. Initially, information kiosks and information centers will be developed along the main motorway corridors. This will be expanded in the future to include other corridors and will follow each of the motorways when they are fully developed.

The rate of expansion above the critical initial phase 1 will be governed by public acceptance, private involvement and available international funding. IKIR expansion will be conditioned also on the progress of the road development fund. More funding dedicated to the road fund will speed up the process significantly.

2.6.4 Sustainable IKIR Operations

The initial funding for IKIR will provide the computer software and electronic communications which will be the primary resources of the IKIR system. These will be complimented by the state motorway operations for traffic management along the motorways near to Budapest. In order to sustain its operation, two things are required:

- a staff of well trained people must be brought together to operate the IKIR; and
- involvement of private industries must be encouraged to speed up the full development of IKIR and assure its widespread utilization.

To sustain the program, it is necessary to develop and train the staff, set up the funding and administrative organization to sustain the operation or maintenance of IKIR, and to provide semi-annual evaluations of the impacts of IKIR. The IKIR is not designed for a large central staff and many of these evaluations and performance functions will be performed by the individual groups such as the motorway company and the county seats. Their information will be coordinated in the capital area through UKIG or another designated body.

2.6.5 International Coordination

Implementation of IKIR will allow close cooperation with neighboring countries. In the foreseeable future the primary coordination of ITS related projects would be with Austria and extensions through Austria to Switzerland and Germany. There are numerous projects underway in Europe, many of which are on relatively short sections of the national networks. There is, however, a plan to connect the Austrian system with IKIR and it is proposed to identify specific interfaces between IKIR and its neighbors and to develop a European system that shows continuity between countries. This will be done in a way that will encourage European funding of multinational ITS projects. The base provided by IKIR should encourage neighboring countries to join in the operation and expansion of IKIR. The "EU" TROPIL project is aimed at standardization of VMS symboles and legends.

2.6.6 Private Industry Cooperation

Private industry is anxious to market its goods and to sells its services throughout Hungary. For some industries their involvement with IKIR could assist them in developing other services that are related to IKIR, but that are best performed by the private sector. Some of these private interests include assisting trucking companies to improve their operations, their fleet management, and their knowledge of traffic operations. Private enterprises may participate in IKIR because they can then access real-time data, provide some value at its services and market these services to other trucking companies. In a similar fashion, the IKIR information may be used in Budapest and marketed through the UTINFORM program. In other areas of Hungary the radio stations may similarly take the IKIR database, provide added value services and include this information in their national broadcast networks.

Similarly, IKIR offers an opportunity for cost sharing or resource sharing of the fiber optic network. Development of this network would be coordinated within other functions of the Ministry and with private contributors. As the AKMI companies expand in their operations, IKIR can provide critical communications resources to help them in their expansion and to share real time data with them.

2.6.7 Training

The results of this project will provide tender documents for the design of the first phase of the IKIR. While this documentation is sent out for tender, it is important to develop a training program and an implementation supervisory program to successfully operate IKIR and supervise its installation. IKIR is designed as a service function and the training would be such that it would allow operators and individuals from different companies to join in the initial expansion of IKIR. It is not planned to have a major administrative staff for IKIR. Operational staff will need training for such entities as the State Motorway Company and in the future, the toll concessions who will need to expand their operational staff.

2.6.8 Implementation Supervision

The departments will have to screen and prequalify potential responders and will also have to assist the UKIG in reviewing the tenders made for their completeness and responsiveness to the tender documents. Once UKIG has awarded a contract. it would be desirable right from the beginning of the award to retain a supervisory staff that can oversee the implementation of IKIR. This staff would be small and be of a temporary nature that would assist the key operating groups within UKIG and AKMI to implement the IKIR.

In particular, the supervisory staff would be responsible for overseeing the development, installation and testing of all the IKIR elements. This service, combined with the training, would allow the individual companies to operate and maintain the IKIR in a similar fashion to the present relationship and contractual agreements developed between UKIG and the independent companies.

2.7 OPERATIONAL CHALLENGES

The discussions, interviews and plans for the IKIR have brought together many ideas and highlighted the strengths of the outstanding technical staff and computer literacy of agency personnel. They have also illustrated some of the shortcomings, the lack of funding and constraints on contributing more effectively to the IKIR program. These issues are also influenced by the ongoing discussions within the Ministry and the public regarding the expansion of the motorway system, and the distribution of traffic between local roads and the tollways.

From these different viewpoints, we have attempted to list several keys items that need to be addressed by the Ministry. These issues are listed in no particular order and are not prioritized. Also they may or may not be influenced by the development of IKIR, but they are challenges that have come to light in the development of the preliminary design.

2.7.1 Motorway Network

The Hungarian Ministry of Transport, Communications and Water Management has announced in press releases that it's long-term plan is to complete the motorway system in two major corridors. These are the extension of the M5 motorway corridor down to the southern border with Romania and Yugoslavia and the extension of M3 from Gyongyos east to the border with the Ukraine. The final alignment for the extension of M3 has yet to be decided.

The Ministry will give highest priority to these corridors but, plans to complete the ring road around Budapest ~~and~~ it has not committed to widening M0 in the near future. As a result of this programming the motorway network will not be completed soon. Because of the radial road system which has developed in Hungary, a lot of transfer traffic between motorways necessarily uses the M0 connection. This traffic conflicts with through traffic from the other motorways trying to connect across the city and north to highway 2.

A lot of traffic, recognizing that the ring road is incomplete, traverses the city of Budapest, resulting in the unpopular need for trucks to use the city roads, in the peak period. The city introduced truck routes to try to minimize this demand. However, there will be a sustained truck traffic demand to use city streets in Budapest, until the circumferential ring road is completed.

2.7.2 Toll Pricing

At present in Hungary toll pricing is set by the toll concessionaires themselves. They essentially establish the pricing for each of the individual toll roads. This toll pricing is governed by the financial requirements to pay off the initial funding loans for the construction of the motorways. At present the toll pricing is relatively high and the tollways do not attract their market share of traffic, particularly commercial traffic. A more uniform toll structure is called for by Cabinet Decree (No. 2119/97 (V.14)).

The price mechanism of trucking in Hungary allows many trucks to use the local roads at extra travel time, even though they may save travel time using the toll roads. The present system rewards the drivers for not paying tolls. The establishment of tolls is a complex matter and it is particularly difficult to establish tolls simply on a small section of roadway such as the M1 section on 45 kilometers to the border with Austria. A two-fold approach should be considered:

- evaluate and decide on how to develop and complete the motorway network particularly, including the critical ring road around Budapest; and
- review of toll pricing on a national basis, incorporating the long-term motorway network plan and a national toll pricing strategy into a Ministry of Transport policy.

The Ministry is well aware of this issue and is planning to go beyond its own staff in gaining advice and a listing of options so that the government may select and develop a national toll pricing strategy and a revised national policy on expansion of the toll road system.

2.7.3 Truck Permits

In Hungary, as in other European countries, overloaded trucks are permitted to traverse the country provided that they pay an additional fee for this overload. When a truck crosses a border into Hungary and is weighed and an overweight on axle load or total load is established, a fee is charged based on the weight of the truck and the total travel expected between the border crossing and the truck's destination within Hungary. The cost of the permit is based on charges established some years ago. Fees have not been adjusted and are not regularly adjusted for inflation. On average, inflation in Hungary runs at 20 percent or more, so the permits to truckers represent a very low cost. It is to their advantage to load the trucks as heavily as they can and pay the very modest fees.

The IKIR would be a valuable source of information on the need to revise the permit charges based on their impact on traffic and on pavement conditions. It would also contribute to appropriate routing that the permit allows the trucker through Hungary. At present all overloaded trucks are given a permit and routing to traverse Hungary which excludes the use of tollways. The toll roads from their point of view are not anxious to attract overloaded vehicles onto their system for the regular tolls, since they neither have the scales to measure the weight nor the agreement for them to charge additional tolls for overweight trucks. Their position is that they would only consider allowing overweight trucks on toll sections if AKMI and the Ministry would share any of the permit revenue collected at the border.

2.7.4 Accident Reporting

In most of the districts of the individual counties, there are many occasions when the road directorate itself does not receive prompt notification of accidents. The police are responsible for accident reporting and would normally notify the road directorate if their services are needed. In general, the police do not report directly to the road directorate for routine accident occurrences. The police usually document accidents in two forms. They prepare a brief accident report which is distributed through their dispatcher within the police system. At a later date they prepare a more detailed documentation of the accident, including the drivers, the vehicles and possible causes. These reports are filed at a later date and sent to Budapest.

The accident reporting system updates its data monthly sometimes accidents are reported in detail later than the monthly update. The challenge is to get reports of accidents into the system promptly so that the information is available both at the national IKIR level and at the county road directorate level. In fact, the goal of the county road directorates is to get real-time reports on accidents and incidents that may cause congestion on the county roads. When the detailed accident reports are received possibly six months later, if there is a noted deficiency in the design of the roadway, then the counties must respond to that notice and investigate the situation and report on any deficiencies.
One additional problem in this process is the accuracy of locating an accident, particularly as it relates to roadway geometrics. The officer reporting the accident usually gets the information on the basis of kilometer markers. Consistent with the IKIR concept, it is proposed that police utilize vehicles equipped with a combination of GPS location and radio phone communications to automatically and accurately report the location of vehicles involved in accidents. When the police officer using these devices reports an accident in the field his position will be established usually within less than 10 meters. If this were to prove inadequate, the resolution can be improved to three meters or less. The challenge is to work closely with the police, to support them with vehicle locating devices and to allow them to identify the exact location of accidents, report them as they occur and also to add incident reporting into the routine police patrols. The MARABU project provided in-vehicle terminals equipment.

2.7.5 Emergency Medical Services

There is a critical situation that develops on the outlying roads in Hungary when a major accident occurs in which they are serious personal injuries. In such cases it is difficult to organize prompt medical response to those incidents. The challenge for IKIR and particularly for the county administration is to coordinate local medical services to respond to these accidents and also to advise the medical centers through the IKIR, or other direct communication, that a major accident has occurred with injuries and that the medical services are needed promptly. At the moment, this service of coordination is performed by the police, but the potential exists for IKIR to enhance this communication and assure the prompt response of emergency medical services to seriously injured motorists on the highway.

2.7.6 Motorway Incident Response

The State Motorway Company will be exercising motorway control and monitoring on the major roadways around Budapest. The monitoring system will provide automatic incident detection for events occurring on the roadway. The motorway company, in coordination with the police department, needs to develop an effective response plan so that the required services are provided for incidents along the roadway.

The primary responsibility for many of the incidents would be with the police. However, the challenge is to provide close coordination, shared communications, and information to the police department when incidents occur. When the opportunity arises, the police should locate an officer in the state motorway control center, in a separate office, so that they would have access to visual information through CCTV and to traffic data through the detectors. From their position in this control center, the police could closely coordinate the response services of the motorway company and of the police department.

IRIS - HUNGARY

TDA

IKIR - MAGYARORSZAG

IRIS TDA Project

Wilbur Smith Associates

SECTION 3
SYSTEM CONCEPT
AND REQUIREMENTS

Section 3
SYSTEM CONCEPT AND REQUIREMENTS

3.1 GOALS AND OBJECTIVES

The IKIR has the primary goal of coordinating the development of an expanded Intelligent Road Transportation System in Hungary. This system would improve the safety and efficiency of operations on the national road network. IKIR would build upon existing programs already in place in Hungary and would provide a leadership role in the development of a European system based on multiple national programs. These multi-faceted goals are expressed in terms of the follow IKIR objectives.

- Provide real-time data on traffic operations in Hungary for road users and managers.
- Coordinate IKIR related functions within the Road Directorate of the Ministry of Transport, Communications, and Water Transportation.
- Encourage private partnership to accelerate funding for IKIR.
- Improve traffic safety and operating efficiency for road transport users in Hungary.
- Develop a nationwide system compatible with expansion of Intelligent Road Transportation in Europe.
- Provide the electronic communications, computers and software to accomplish these goals and objectives.
- Integrate existing ITS systems.

Specific measures of performance for IKIR include:

1. Real-time data collected in time to be effective in making travel decisions under prevailing traffic conditions.
2. Communication to allow timely access to real-time data by road users and managers.
3. Incident management: early incident detection (less than 5 minutes); prompt service response (within 15 minutes); and road clearance (within 30 minutes) - these are average values.
4. Delay reduction by advising road users of the site of congestion and the potential of alternative road routes.
5. Reduced accidents caused by congestion on the motorways and primary highways.
6. Reduced full consumption, air pollutants, and operating costs.
7. Increased private expenditures and services related to IKIR-based services.
8. Better management information and more efficient work performance in the Counties.

IKIR emphasizes support and coordination services to many of the ongoing IKIR functions in the Road Directorate. It is designed to operate with a limited staff and to supplement the resources of other agencies and companies responsible for operating Hungary's road transportation system.

3.2 OPERATIONAL CONCEPT

IKIR can be thought of as having three distinct operational processes:

- Information
- Decisions

- Responses.

The process will generate actions that pertain to the following four operational components:

- Real-time information
- Motorway traffic control and monitoring
- County road management
- Coordination of existing transportation activities

IKIR will integrate transportation information for real-time traffic flow, truck operations, incident and construction information, and weather and road conditions. The information will be shared between the operational components listed above, as well as information and public safety agencies. IKIR will be used for a variety of activities, including:

- Management of congestion on motorways
- Incident management on motorways and highways
- Route guidance
- Traveler advisories

Varying conditions exist on the IKIR Road Network at any given time. The following are representative examples of such conditions:

- Recurring congestion. This refers to delay conditions which occur on a daily or otherwise regular basis at specific times, and generally is associated with commuter traffic between workplaces and residences. This most often occurs due to the inability of the road network to handle peak travel demand beyond its physical capacity.

- Incidents and nonrecurring congestion. Incidents are unscheduled events which may involve a disabled vehicle, accident or other activity which results in a blockage of some portion of the road or causes a significant distraction from travel. Non-recurring congestion occurs when this unscheduled event results in traffic demand exceeding the remaining physical capacity of the road or when the unscheduled event requires a reduction in speeds to ensure the safety of police, emergency or other rescue actions.
- Seasonal Congestion. This type of congestion occurs along routes leading to summer vacation areas, including Lake Balaton, during certain summer time periods. The M7 motorway and connecting highways are particularly impacted.

- Snow or icing conditions. These conditions require the appropriate snowplow and salting activities on the roadway network. Information on the status of roads (i.e., whether or not they are clear) is of importance from a safety standpoint, as well as a means of reducing travel time.

The IKIR process is illustrated in Exhibit 3-1, and is portrayed as a continuous loop, where information is continuously updated based on the changing travel conditions. This updated information results in continuous traffic control and route guidance activities (or no activities if none are required), as well as the continuous output of traveler information.

3.2.1 Information

The quality of roadway information received from a variety of sources will be critical to the success of the IKIR. The types of information required to address the conditions described above are illustrated in Exhibit 3-2. The types of information include:

- Traffic Flow Measurements
- Visual Monitoring and Verification
- Identification of Overweight Trucks and Hazardous Materials Carriers
- Location, Type and Magnitude of Accidents and Resulting Lane Blockages
- Location, Type and Magnitude of Road Work and Resulting Lane Blockages
- Location of Special Event and Route Restrictions / Detours
- Weather and Road Conditions

Exhibit 3-3 identifies the sources of the above information, including existing information elements in place throughout Hungary, as well as potential future elements. Such sources include:

Existing sources

- existing traffic sensors (count stations)
- toll plazas (mainline and ramp)
- border crossings
- weigh-in-motion stations
- County Road directorate Operations Centers
- County Road Directorate Patrol Services
- Radiophone call-ins to Motorway and County Operations Centers
- Call Box call-ins to Motorway Operations Centers
- Police call-in and verification of incident and traffic conditions
- Motorway Operations Centers
- Existing information services, including UTINFORM (national) and FOVINFORM (Budapest)
- Weather stations (National weather service, motorway, County)

New activities

- Operator monitoring of closed-circuit television cameras
- Traffic flow measurement sensors
- Traveling "vehicle probes" providing travel time information between two points on specific routes

In summary, much of the information for the IKIR will be gathered from current services and equipment, with additional elements implemented where appropriate to collect the needed data.

Exhibit 3-1

IKIR Process

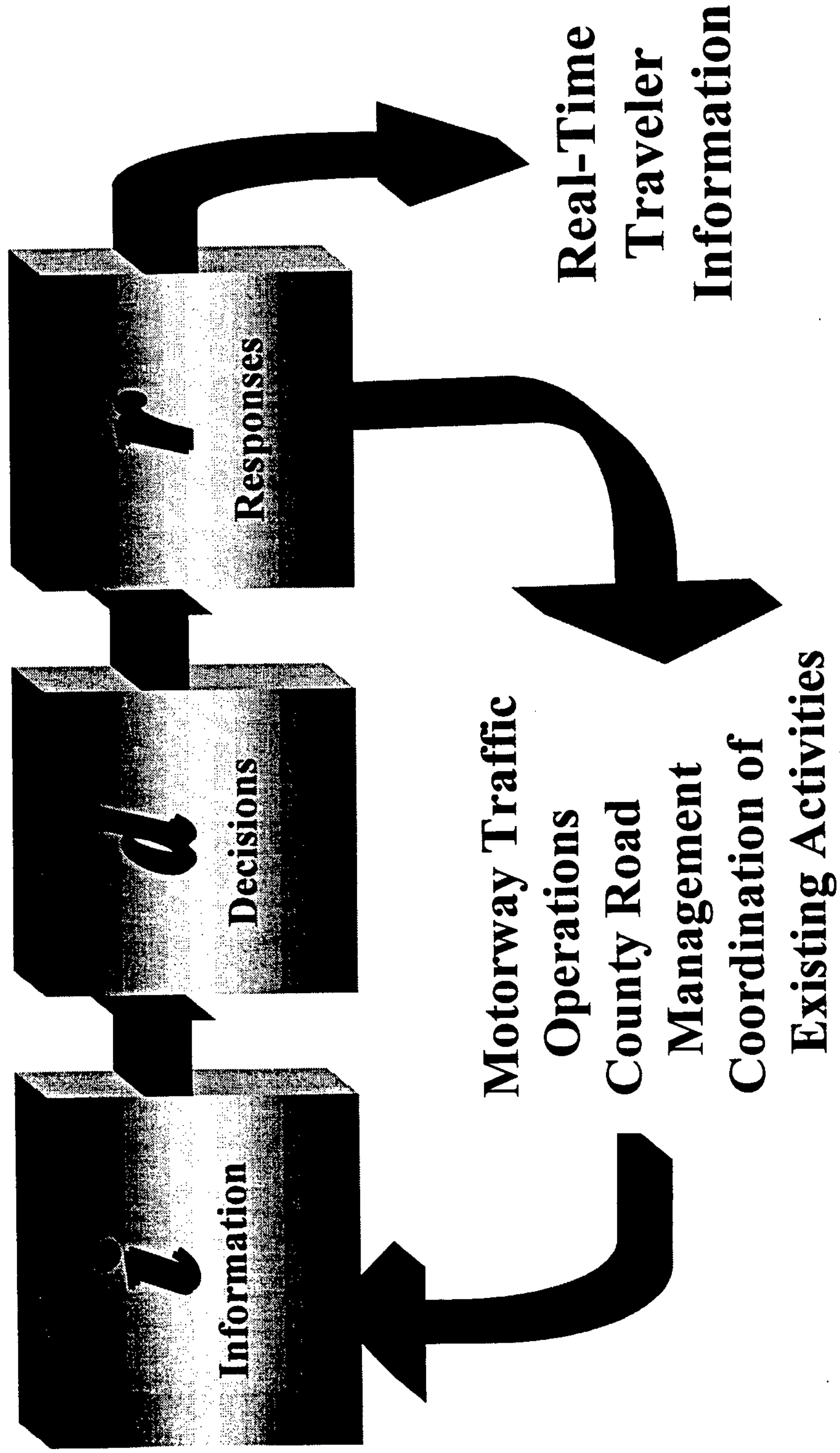


Exhibit 3-2
Data To Be Collected for Representative Travel Conditions

	Representative Travel Conditions			
Data To Be Collected	**Recurring Congestion**	**Incidents, and Non-Recurring Congestion**	**Seasonal Congestion**	**Snow or Icing Conditions**
Traffic Flow Measurements	[shaded]	[shaded]	[shaded]	
Visual Monitoring and Verification		[shaded]		
Identification of Overweight Trucks, Hazardous Materials Carriers		[shaded]		
Location, Type, Magnitude of Accident		[shaded]		
Lane Blockages Due to Accident		[shaded]		
Location, Type, Magnitude of Road Work		[shaded]		
Lane Blockages Due to Road Work		[shaded]		
Location, Type of Special Event		[shaded]		
Route Closures/Restrictions Due to Special Event		[shaded]		
Weather Conditions				[shaded]
Road Conditions				[shaded]

Exhibit 3-3
Available Information Sources

Data To Be Collected	Existing Sources: Existing Traffic Sensors	Toll Plazas	Border Crossings	Weigh-in Motion Stations	County Ops Centers	County Patrols	Radio-phone Call-ins	Emergency Phone Call-ins
Traffic Flow Measurements	■	■						
Visual Monitoring and Verification								
Identification of Overweight Trucks, Hazardous Materials Carriers			■	■				
Location, Type, Magnitude of Accident						■	■	■
Land Blockages Due to Accident						■	■	■
Location, Type, Magnitude of Road Work								
Lane Blockage Due to Road Work								
Location, Type of Special Event								
Route Closures/Restrictions Due to Special Event								
Weather Conditions					■			
Road Conditions					■	■		

Data To Be Collected	Existing Sources: Police Call-ins/ Verifications	Motorway Operations Staff	UTINFORM and FOVINFORM	Weather Stations	Candidate New Activities: Monitoring of CCTV	Traffic Flow Sensors (real-time)	Vehicle Probes
Traffic Flow Measurements						■	■
Visual Monitoring and Verification					■		
Identification of Overweight Trucks, Hazardous Materials Carriers							
Location, Type, Magnitude of Accident	■				■		
Land Blockages Due to Accident	■				■		
Location, Type, Magnitude of Road Work		■			■		
Lane Blockage Due to Road Work		■			■		
Location, Type of Special Event		■	■				
Route Closures/Restrictions Due to Special Event		■	■				
Weather Conditions				■	■		
Road Conditions		■		■	■		

3.2.2 Decisions

Decision-making activities will require coordination of information between various operations centers. Existing facilities include the following:

- Motorway maintenance yards (M0, M1, M3, M5, M7)
- County road directorate centers
- UTINFORM (State travel information)
- FOVINFORM (Budapest area travel information)
- Toll road operations facilities (concessions)

Coordination by IKIR will be achieved through a separate "IKIR data center" which coordinates all the information received from the Motorway and County agencies, and presents it in a manner that facilitates decision-making.

Appropriate decisions will be made based upon the information received, using an appropriate set of pre-planned strategies defined by each of the responsible agencies.

The premise of traffic management actions (decisions) based on real-time conditions requires a minimum performance level in terms of data retrieval. From the operation of traffic management systems on motorways and similar facilities throughout the world, it has been found that traffic flow data needs to be received at a minimum one-minute interval. This is particularly true for Motorway traffic control, which needs to remain timely and reflective of current conditions. Traveler information should not be as sensitive to minute-by-minute fluctuations, since it is more important for the traveler to assess prevailing conditions over a longer period, such as the next one to two hours.

The nature of traffic control and incident management is that non-recurrent traffic conditions need to be addressed at all times. Heavy levels of recurrent congestion also require monitoring. Therefore, it is recommended that certain components of IKIR be managed 24 hours a day, particularly in more congested areas. However, certain elements, including traveler information, should be obtainable from KIRI automatically without operator interface – particularly since there would likely be numerous inquiries for real-time information simultaneously. Such inquiries would be both from travelers and other agencies.

The ability to make decisions will depend upon real-time information being available at each center. The ability to implement specific actions will be facilitated through the use of single-operator or multiple-operator capabilities using graphical workstations. These types of workstations permit the operator to view current conditions while at the same time addressing these conditions using one or more tools, as discussed below in "Responses".

3.2.3 Responses

The agency decisions above result in the use of various tools which implement traveler information, route guidance, motorway control, and incident response strategies. The natures of these types of strategies are summarized below and related to the representative conditions discussed above. Exhibit 3-4 illustrates the various operational situations and the type of information that may be required for each.

Exhibit 3-4
RESPONSE DEVELOPMENT

	Representative Travel Conditions			
IKIR Functional Area	**Recurring Congestion**	**Incidents, Events Non-Recurring Congestion**	**Seasonal Congestion**	**Snow or Icing Conditions**
Real-Time Information	•Congestion advisory	•Warn of incident, event, congestion, lane closures •Advise on alternative routes	•Congestion advisory	•Warn of weather, surface conditions •Advise on alternate routes
Motorway Control	•Warn of con-gestion •reduce speeds in ad-vance of con gestion	•Warn of lane closure •Reduce speeds, •Reroute traffic out of closed lanes	•Warn of congestion •Reduce speeds in advance of congestion	•Reduce speeds •Reroute traffic •Route traffic out of hazardous lanes
County Road Management		•Warn of incident, event, congestion, lane closures •Advise on alternative routes	•Congestion advisory	•Warn of conditions •Reroute traffic •Reduce speeds
Coordination with Existing Activities		•Dispatch emergency vehicles •Dispatch maintenance vehicles		•Dispatch maintenance vehicles

3.2.3.1 Real-Time Information

Traveler information may range from pre-trip travel planning information to en-route advisory information. The information disseminated to the traveler may include one or more of the following:

- Motorway congestion warning
- Incident alert
- Road work advisory
- Route guidance for problem avoidance
- Weather conditions and road hazards
- Rerouting information due to special events

Route guidance involves providing pre-trip and en-route information on the best routes. Such information may be based on real-time conditions (congestion, incidents increasing travel time on specific routes), as well as historical data (minimum travel distance, scenic routings, toll road alternates). Pre-trip data may be distributed via broadcast media, over dial-up phone services such as UTINFORM, or over the Internet. En-route guidance is provided along a route that has congestion or incident conditions that may increase travel time. Variable message signs and roadside radio would provide visual and audio means of providing route guidance information. These include:

- Minimum travel time routings
- Minimum travel distance routings
- Tourist routings
- Incident avoidance routings

3.2.3.2 Motorway Control

Motorway control includes actions that will reduce traffic flow turbulence and unpredictability upstream of, and in the vicinity of, congestion, road work or incidents. These would include advisory speed limits, lane use signals and, in the future, ramp metering signals on motorway entrance ramps. "Toll gate metering" (use of minimum time intervals between passage of vehicles through meters) is another potential future technique. In either of the above examples, metering reduces delays and accidents that occur when multiple vehicles attempt to enter a busy Motorway.

Motorway control strategies under different operational situations include:

- Lane use control
- Speed control
- Road work alert
- Congestion warning
- Future ramp control

3.3 DEFINITION OF REQUIREMENTS

The system functional requirements of the IKIR have been defined. These requirements are listed in detail in Annex B.

System functional requirements have been defined for each of the four operational components. Requirements have been further grouped in sixteen major categories as follows:

- Real-time Information
  - 1.0 IKIR shall provide traveler information to all motorists and operations agencies, including roadway operations, planning and data collection agencies, private businesses and service providers.
  - 2.0 IKIR shall provide route guidance information.
  - 3.0 IKIR shall develop route guidance strategies in response to real-time conditions.

- Motorway Traffic Control and Monitoring
  - 4.0 The system shall gather traffic flow data from Motorways.
  - 5.0 IKIR shall collect Weather and Road Conditions Information.
  - 6.0 IKIR shall permit the logging of Incident Information and confirmation of reported incidents on the Motorways.

7.0 IKIR shall permit the logging and current road work on the Motorways along with dissemination of road work information.
8.0 IKIR shall permit the Motorway operator to implement routing strategies in coordination with the appropriate Counties.
9.0 IKIR shall be capable of implementing Traffic Control strategies on Motorways
10.0 IKIR shall provide Motorway Control (lane and speed control plus future ramp control) and Driver Advisory Displays on urban or congested Motorway sections.

- County Road Management

11.0 The system shall gather traffic flow data from highways within each County.
12.0 IKIR shall collect Weather and Road Conditions Information
13.0 IKIR shall permit the logging of Incident Information and confirmation of reported incidents on highways.
14.0 IKIR shall permit the logging of scheduled and current road work within each County along with dissemination of road work information.
15.0 IKIR shall permit County agencies to implement routing strategies in conjunction with the Motorway Company.

- Coordination with Existing Transportation Activities.

16.0 The system shall gather Truck Data for tracking purposes as well as for transportation planning. These data will be shared with the private companies such as Hungarocamion.

IRIS - HUNGARY

TDA

IKIR - MAGYARORSZAG

IRIS TDA Project
Wilbur Smith Associates

SECTION 4
FUNCTIONAL DESCRIPTION OF IKIR

Section 4
FUNCTIONAL DESCRIPTION OF IKIR

4.1 INTRODUCTION

This section presents an overall system architecture for the IKIR based on the requirements presented in Section 3 and Annex B. This architecture is developed using a structured system engineering process.

The process consists of the following steps:

Definition of system context, including definition of all existing systems and agencies external to, but interacting, with the new IKIR processes.

Definition of system functions and data flows, based upon the requirements in Section 3. The functions are decomposed into more detailed subfunctions. This multi-layered functional description is known as a logical architecture.

Allocation of logical functions to subsystems which service specific agencies or types of functions. The allocation results in development of a high-level block diagram representing a physical architecture. It is this architecture, defining IKIR subsystems and communications interfaces, that serves as the basis for assessment of alternative technical and communications elements which can carry out the required functionality of IKIR.

4.2 ASSUMPTIONS

Several key assumptions were made in developing the Data Flow Diagrams (DFDs) and the preliminary IKIR system architecture. These include:

1. IKIR provides traffic management functions principally in the urban area around Budapest. Elsewhere in Hungary, traffic management is limited and the function becomes one of surveillance, data collection and traveler information dissemination. Some routing around incident locations is performed by County centers.

2. Commercial vehicle operations functionality is limited to Weight-in-Motion (WIM) and border crossing credential checking via manual methods. Data collected by these facilities is available to Police. Tracking of commercial vehicles is shown as an option which will not be reflected in the detailed design.

3. Although much of the functionality of UTINFORM is incorporated into IKIR, an external interface to UTINFORM is shown.

4. Emergency services support is limited only to call-boxes on Motorway sections only. Coordination of emergency services is considered outside the scope of IKIR.

5. IKIR does not support RDS functionality although roadside broadcast functions are shown as a future option. In lieu of roadside broadcast to vehicles, IKIR provide call-in services for pre-trip planning.

6. Motorway Toll Sections are external to IKIR. Toll Service Providers interface with IKIR to provide toll road surveillance information. IKIR may provide advisory messages through the interface for display at toll road locations.

7. Yellow page information is assumed to be internally managed by IKIR and provided through the IKIR kiosks.

8. IKIR's primary focus is on passenger traffic with limited functions provided for commercial vehicle management. NO SUPPORT is provided for public or multi-modal transportation options although interfaces can be provided to disseminate this type of information.

9. Direct travel time data collection is not supported by IKIR. Travel time estimates on urban Motorway sections can be made based on traffic data collection. On other roads travel times are not dynamically determined. Future options such as vehicle classification and tag processing are not considered to be realistic for the near term; they are shown as options on the DFDs.

10. There are institutional reasons for maintaining the existing transportation management organizations comprising Motorway Company and County directorates and the associated responsibilities

Based on the above assumptions and the information collected during the initial data collection activities, the IKIR functional requirements have been captured in a set of Data Flow Diagrams and process and external interface definitions, as discussed below.

4.3 SYSTEM CONTEXT

4.3.1 System Context Overview

This Section identifies the users and sources of data relative to the IKIR system. Exhibit 4-1 describes all the "external" IKIR users and sources in a graphical fashion.

4.3.2. External Entity Definitions

The external IKIR users and sources, identified in terms of name, and definition are described below. Acronyms are kept to a minimum, with the exception of AKKT, referring to County Road Directorate, and AKMI, referring to the nationwide traffic planning database.

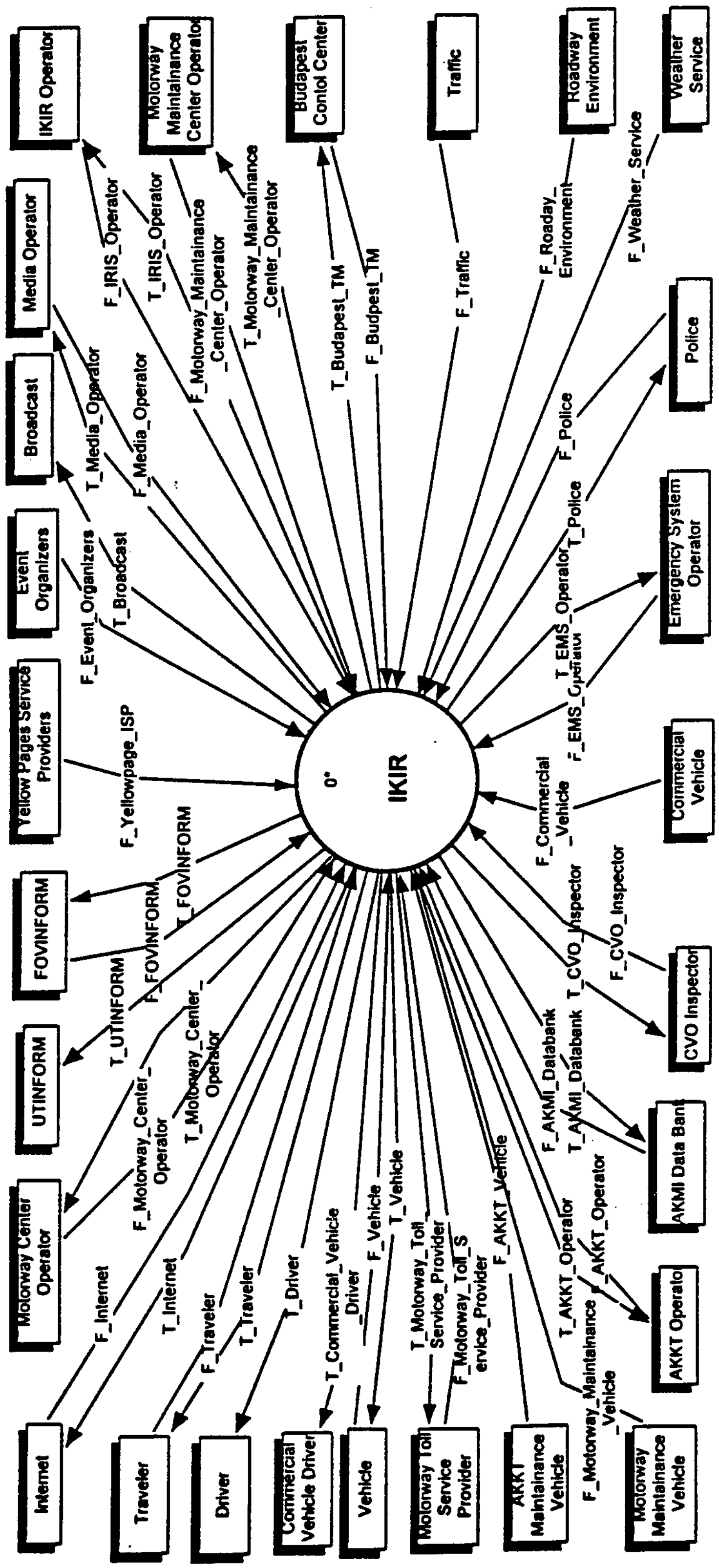


Exhibit 4-1
IKIR Context Diagram

AKKT Operator
NAME AKKTOperator
DEFINITION This human entity represents the operator of the IKIR components at the 19 AKKT sites. AKKT functions include road construction and maintenance. Through these sites IKIR obtains data related to road conditions, etc. These sites may also function as collection points for IKIR surveillance data.

AKKT Maintenance Vehicle
NAME AKKTMaintainanceVehicle
DEFINITION This entity corresponds to a maintenance vehicle associated with the AKKT County directorate.

AKMI Data Bank
NAME AKMIDataBank
DEFINITION The AKMI Databank is a database system used to store various planning data on Hungarian roads. IKIR surveillance data is provided to the AKMI Databank.

Budapest Control Center
NAME Budapest Control Center
DEFINITION This entity represents the system interface to the Traffic Control Center of the City of Budapest which can potentially exchange information with the IKIR Motorway Center.

Commercial Vehicle
NAME CommercialVehicle
DEFINITION This entity corresponds to a commercial vehicle along with the special aspects of large commercial vehicles and vehicles designed to carry cargo. This classification applies to vehicles ranging from small panel trucks to multi-axle tractor trailers.

Commercial Vehicle Driver
NAME CommercialVehicleDriver
DEFINITION This is a human entity representing the driver of a commercial vehicle who may receive messages from IKIR via roadside signs, etc. IKIR DOES NOT ASSUME ANY CVO IN-VEHICLE CAPABILITIES.

Commercial Vehicle Operations Inspector
NAME CVOInspector
DEFINITION This is a human entity which represents the operator at the border crossings and the en-route WIM stations who may perform the roadside inspections, weighting, and checking of credentials either manually or through automated means.

Commercial Vehicle Operations Administrator
NAME CVO_Administrator
DEFINITION This is the human entity which is responsible for the administration of credentials of CV operators and which uses and analyzes the CVO data which is collected by IKIR

Driver
NAME Driver
DEFINITION This is the human entity representing a traveler in a vehicle who receives visual and audio information from IKIR roadside devices.

Emergency System Operator
NAME EmergencySystemOperator
DEFINITION This entity includes dispatchers who manage an emergency fleet (police, fire, ambulance).

Event Organizers
NAME EventOrganizers
DEFINITION This entity represents external special event sponsors that have knowledge of events that may impact travel on roadways. Events may include sporting events, parades, etc.

FOVINFORM
NAME FOVINFORM
DEFINITION This external entity is the FOVINFORM center which may provide information to or receive information from IKIR. FOVINFORM is a facility currently used to deliver broadcast information to travelers in Budapest via TV and radio stations.

RDS Broadcast
NAME Future RDS Broadcast
DEFINITION This entity corresponds to a external broadcast station which will transmit IKIR information directly to vehicles using RDS-TMC technology.

Internet
NAME Internet
DEFINITION This entity represents the "generic" internet interface through which IKIR can provide on-demand information to travelers as part of pre-trip planning.

IKIR Operator
NAME IKIROperator
DEFINITION This human entity represents the operator at the IKIR center responsible for the overall management of data collection and dissemination of the IKIR system.

Media Operator
NAME MediaOperator
DEFINITION Human entity from which IKIR may collect traffic flow information, incident information, special event information or any other travel impacting events. The operator may be a TV/radio broadcaster, traffic reporting service operator, private citizen or any other person external to IKIR.

Motorway Center Operator
NAME MotorwayCenterOperator
DEFINITION This human entity is the operator at the Hungarian Motorway Center responsible for the traffic management on all motorways.

Motorway Maintenance Center Operator
NAME MotorwayMaintainanceCenterOperator
DEFINITION This human entity is the operator at the one of the Hungarian Motorway Centers (M1, M3, M5, M7) responsible for the operation and maintenance of the motorways.

Motorway Maintenance Vehicle
NAME MotorwayMaintainanceVehicle
DEFINITION This entity corresponds to a maintenance vehicle associated with the Motorway Maintainance Center.

Police
NAME Police
DEFINITION This entity represents the "generic" police organization responsible for tracking commercial vehicles which either carry hazardous materials or which are not in compliance. It is not clear at this time whether a special interface will be required.

Roadway Environment
NAME RoadwayEnvironment
DEFINITION This entity represents the operational setting in which IKIR operates. It represents weather effects. Environmental conditions may be monitored by IKIR so that travelers are informed and control strategies can reflect adverse conditions in a timely fashion.

Toll Service Provider
NAME TollServiceProvider
DEFINITION This entity represents a system. Toll Service Providers are the concessionaire organizations responsible for operating and maintaining the various motorway toll road sections.

Traffic
NAME Traffic
DEFINITION This is an environmental entity which represents the collective body of vehicles that travel on the highway network. Traffic depicts the vehicle population from which traffic flow surveillance information is collected to which traffic control indicators are applied.

Traveler
NAME Traveler
DEFINITION This represents the individual who uses transportation services. A Traveler is considered distinct from a driver of a vehicle.

UTINFORM
NAME UTINFORM
DEFINITION This entity is the UTINFORM center which may receive information from IKIR. UTINFORM is a facility currently used to deliver nationwide broadcast information to travelers via TV and radio stations.

Vehicle
NAME Vehicle
DEFINITION The physical movement and orientation of the vehicle which may be monitored and measured to support some forms of vehicle determination.
Weather Institute
NAME WeatherService
DEFINITION An external source of current and forecasted weather conditions. This externally derived weather data is integrated with internal IKIR weather information.

4.4 LOGICAL ARCHITECTURE

Based on the external entity definitions above and requirements presented in Section 3, a logical architecture (defining data flows and system functions) has been developed. The architecture consists of a series of Data Flow Diagrams (DFDs) which graphically represent the system functions.

The DFDs also illustrate the various subfunctions which carry out these top-level functions. They are organized as follows:

DFD 0 = Top-level diagram
DFD *a* = Second-level diagram presenting subfunctions of Function *a*
DFD *a.b* = Diagram presenting subfunctions of Function *a*, Subfunction *b*

Data flow diagrams have been prepared for the following levels and system processes:

0 - IKIR Top-level diagram
1 - Manage traffic
- 1.1 - Provide motorway traffic surveillance
- 1.2 - Manage urban motorway incidents
- 1.3 - Provide motorway device control
- 1.4 - Provide AKKT road network surveillance
- 1.5 - Provide AKKT device control

2 - Manage Commercial Vehicles
- 2.1 - Provide Commercial vehicle roadside facilities
- 2.2 - Administer commercial vehicles

3 - Support Emergency Services
4 - Provide driver and traveler services
- 4.3 - Collect IKIR Surveillance Data
- 4.4 - Provide Information Services
- 4.5 - Provide Route Guidance

The IKIR top-level data flow diagram is illustrated in Exhibit 4-2.

All of the above DFD's are illustrated in Annex C together with the process definitions. These definitions describe the purpose of each function / subfunction and the actions carried out.

4.5 TOP-LEVEL PHYSICAL SYSTEM FRAMEWORK

The following presents a preliminary top-level architecture of the IKIR system based on the information gathered to date. The purpose of the physical architecture is to identify the framework by which the agencies will work with each other, as well as how the different areas of system components (control centers, roadside, vehicle and personal remote access) would work.

A preliminary physical architecture is defined as shown in Exhibit 4-3, Physical Architecture Diagram. The IKIR logical architecture is obtained by allocating the DFD processes described in the previous section to systems and subsystems as shown in Exhibit 4-4, and the corresponding Functional Process Allocation presented in Exhibit 4-5.

4.6 SYSTEM AND SUBSYSTEM DESCRIPTIONS

Each of the systems/subsystems shown in Exhibit 4-4 is allocated to a physical IKIR elements as described in the following paragraphs.

4.6.1 IKIR System Elements

IKIR Data Processing and Communication Center - The IKIR Center houses all the computing facilities necessary to support the functions data processing and communication functions associated with collecting and disseminating the advisory and routing data on the IKIR Network. Interfaces are provided with all motorway and AKKT centers as well as the Motorway Center. Automated interfaces are also provided for obtaining weather forecast information. The Center also includes the various display facilities to display the network-wide surveillance data to the IKIR operator.

IKIR Kiosks - IKIR kiosks are located at various locations throughout Hungary: border crossings, roadside rest stops on Motorways and other highways, Urban centers in Budapest and other cities. Kiosks are used to disseminate IKIR traffic, weather, routing, and other tourist data. Traffic and weather information is downloaded to the kiosks at regular intervals from the IKIR Center.

4.6.2 Motorway Systems (M0, M1, M3, M5, M7)

Motorway Control Center - The Motorway Center houses all the computing and communication facilities used to manage the traffic on the M0, M1, M3, M5 and M7 non-toll motorway sections in Hungary. The control center is a fully equipped traffic management center including video display capabilities and operator

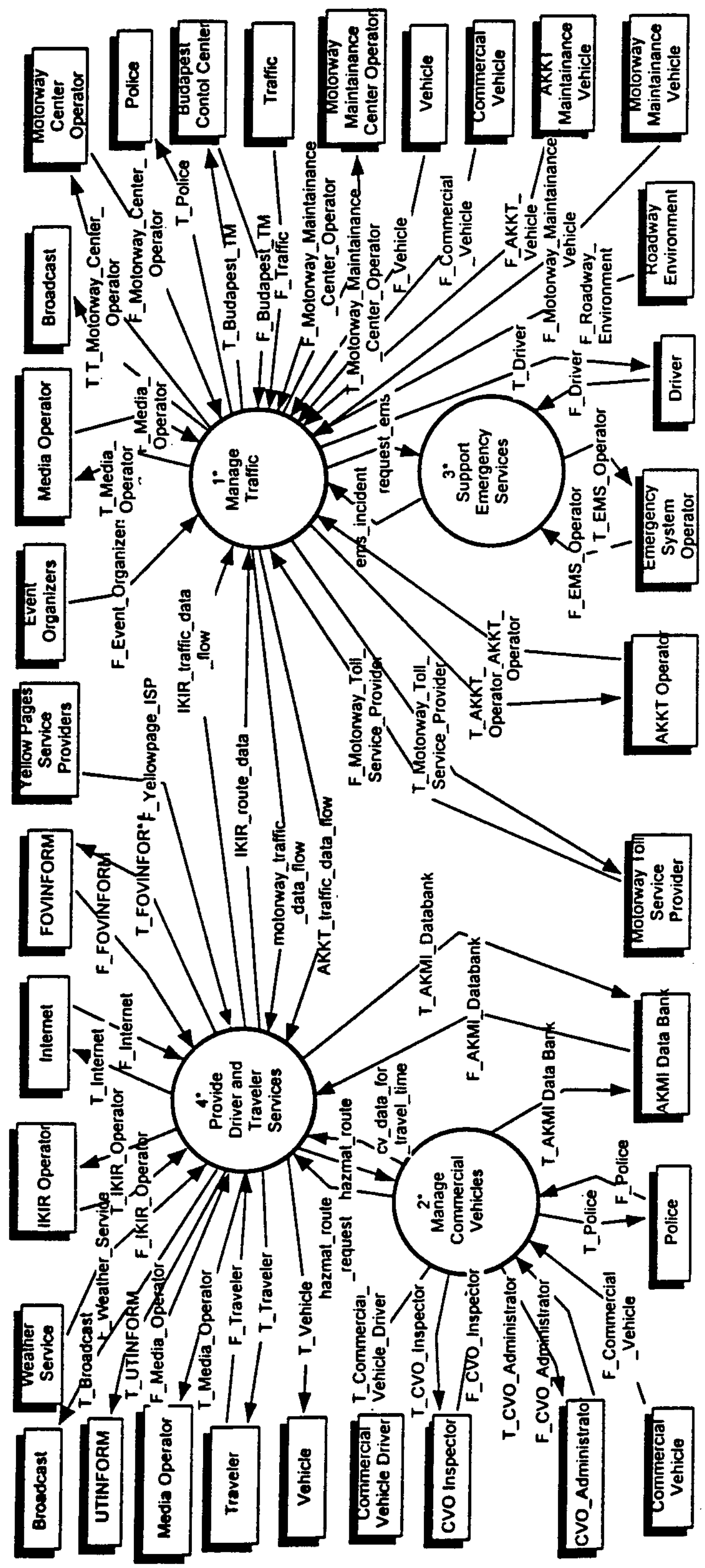


Exhibit 4-2

IKIR Top-level Data Flow Diagram

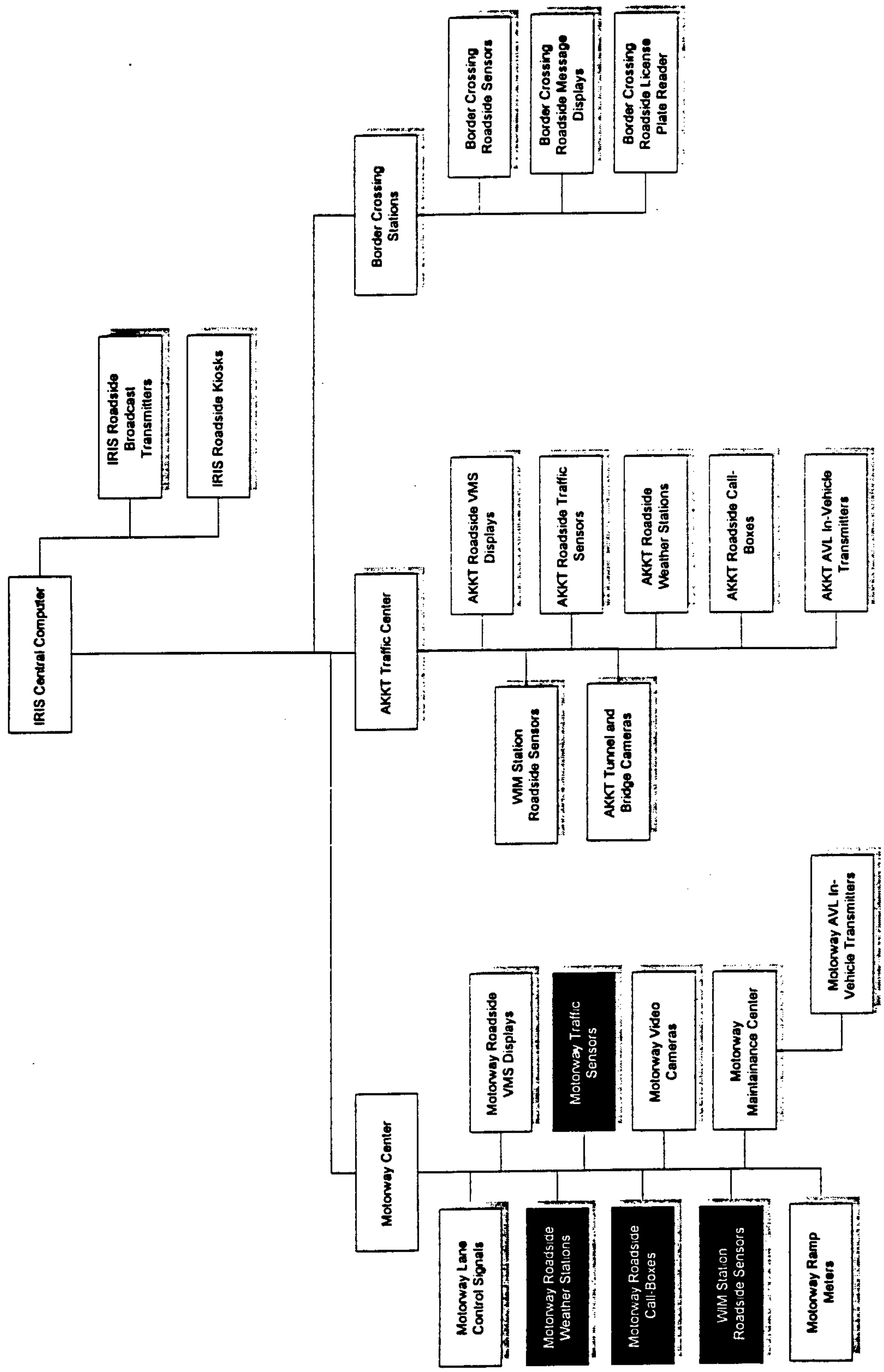


Exhibit 4-3
IKIR Preliminary Physical Architecture Diagram

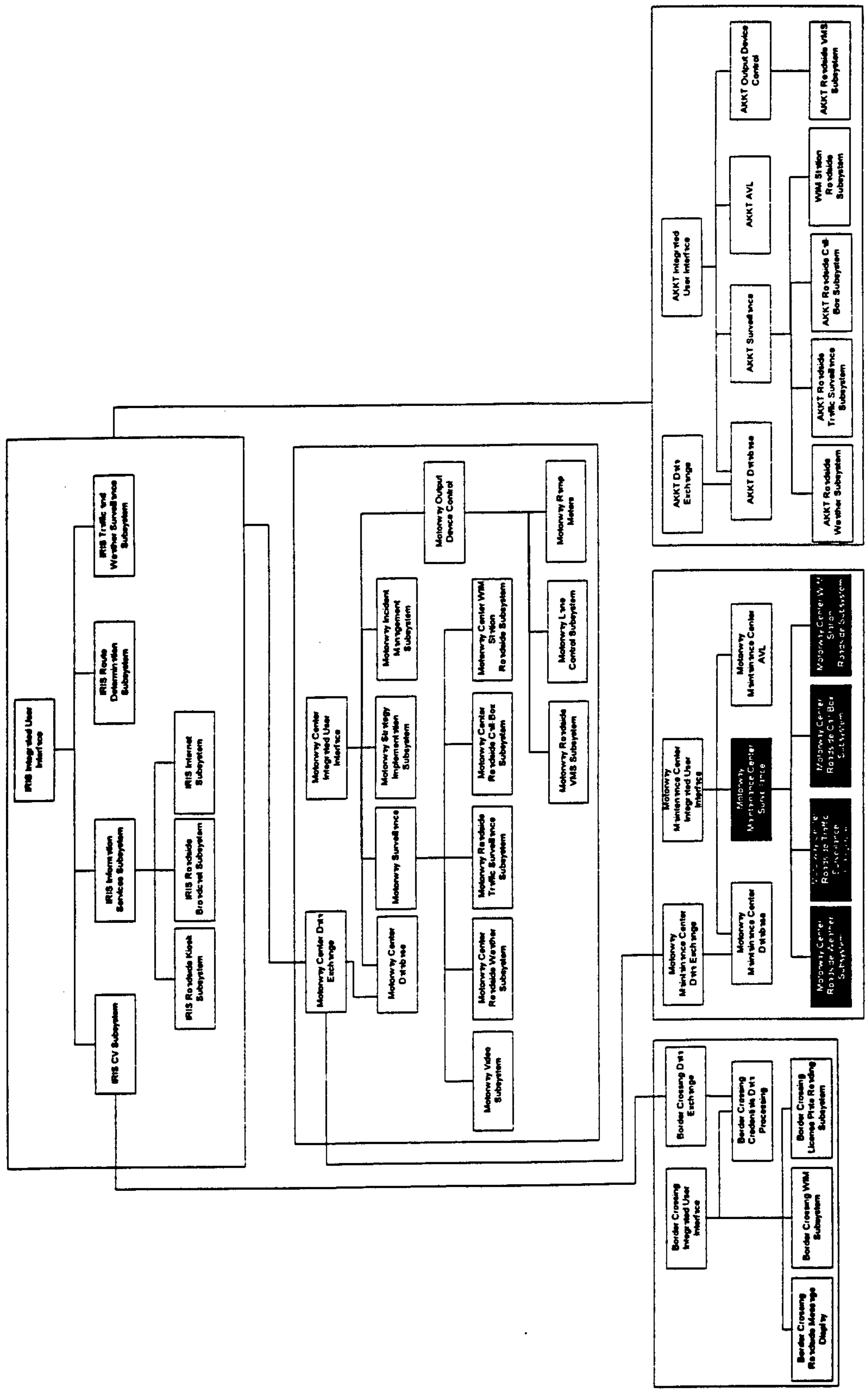


Exhibit 4-4

IKIR System/Subsystem Diagram

Exhibit 4-5 - Functional Process Allocation Table

	Center System		Center Subsystem	DFD Process		Field Subsystem	DFD Process
1	IKIR	1.1	IKIR Integrated User Interface	4.4.4, 4.3.3			
		1.2	Traffic & Weather Surveillance	4.3.1, 4.3.2			
		1.3	Route Determination	4.5			
		1.4	Commercial Vehicle	2.2.5			
		1.5	Information Services	4.4.2	1.5.1	IKIR Kiosks	4.1
		1.5.2	Call-in Travel Info	4.4.6			
		1.5.3	Internet	4.4.5			
2	MOTORWAY CENTER	2.1	Motorway Center Integrated User Interface	1.2.1, 1.1.5			
		2.2	Motorway Incident Management	1.2, 3.1			
		2.3	Motorway Strategy Implementation	1.3.1, 1.3.2, 1.3.3, 1.3.7			
		2.4	Motorway Surveillance	1.1.1, 1.1.2,1.1.7	2.4.1	Motorway Video	1.1.1
					2.4.2	Motorway Roadside Weather	1.1.1
					2.4.3	Motorway Traffic Surveillance	1.1.1
					2.4.4	Motorway Call-Boxes	3.2
					2.4.5	Motorway WIM Stations	1.1.4
		2.5	Motorway Center Database				
		2.6	Motorway Center Data Exchange	1.1.6			
		2.7	Motorway Output Device Control	1.3.4, 1.3.6	2.7.1	Motorway Roadside VMS	1.3.5
					2.7.2	Motorway Lane Control	1.3.5
3	MOTORWAY MAINT-ENANCE CENTER	3.1	Motorway Maintenance Center Integrated User Interface	1.1.9, 3.1			
		3.2	Motorway Maintenance Center Database				
		3.3	Motorway Maintenance Center Data Exchange	1.1.11			
	Motorway Maintainance Center	3.4	Motorway Maintenance Center AVL	1.1.8, 1.1.10	3.4.1	Motorway Maintenance Center Vehicles	NA
		3.5	Motorway Maintenance Center Surveillance	1.1.1, 1.1.2,1.1.7	3.5.1	Roadside Weather	1.1.1
					3.5.2	Roadside Traffic Surveillance	1.1.1

Exhibit 4-5 - Functional Process Allocation Table

	Center System		Center Subsystem	DFD Process		Field Subsystem	DFD Process
					3.5.3	Call-boxes	3.2
					3.5.4	WIM Stations	1.1.4
4	AKKT CENTER	4.1	AKKT Integrated User Interface	1.4.6, 1.5.7, 3.1			
		4.2	AKKT Center Database				
		4.3	AKKT Data Exchange	1.4.7			
		4.4	AKKT Surveillance	1.4.1, 1.4.2, 1.4.3	4.4.1	Roadside Weather	1.4.1
					4.4.2	Roadside Traffic Surveillance	1.4.1
					4.4.4	WIM Stations	1.4.5
		4.5	AKKT Strategy Implementation	1.5.1, 1.5.2, 1.5.6, 1.5.7			
	AKKT Maintainance Center	4.6	AKKT AVL	1.4.3			
		4.7	AKKT Output Device Control	1.5.3, 1.5.5	4.7.1	Roadside VMS	1.5.4
5	BORDER CROSSING	5.1	Border Crossing User Interface	2.1.3			
					5.1.1	Border Crossing Roadside Message Display	2.1.2
					5.1.2	WIM	2.1.1
		5.2	Border Crossing Credential Data Processing	2.1.7, 2.1.4			
6	AKMI BORDER CROSSING DATA CENTER	6.1	AKMI Border Crossing Data Center User Interface	2.2.3			
		6.2	AKMI Border Crossing Central Database	2.2			
		6.3	AKMI Border Crossing Data Center Data Exchange	2.2.1, 2.2.2, 2.2.4			

workstations. The scope of control within the Budapest urban area includes VMS displays and lane control signals. Strategies are computed automatically and incidents detected by the software. Operator intervention is permitted in all functions. Communication interfaces with the Budapest Traffic Management Center (city of Budapest) are provided to exchange traffic and incident data. Automatic interfaces are also provided with the IKIR Center for providing and receiving surveillance and guidance information. Outside the urban area, the level of surveillance is significantly reduced to the level associated with rural highways.

Roadside VMS Display Units - Several VMS display stations are provided on the urban motorway sections and some isolated rural locations. These are controlled by the Motorway Center, with messages being automatically generated based on current and predicted conditions. Information content includes traffic conditions (e.g. incident ahead, expect delay of x minutes), roadway safety advisories (e.g. icy road ahead) and routing information (e.g. Alternate route to ......) Operator interface permits overriding message content. ***Traffic Detector Stations*** - Traffic detection stations are located on urban motorway sections to detect incidents and collect traffic flow information. Detection stations are spaced at a distance which provides the detection rate specified by the requirements (e.g. 0.5 km spacing). A detection stations comprises loops on every lane of the road in both directions with a connection to a roadside computer for data processing and communications. In each lane, the detector configuration supports all traffic parameter data collection (e.g. speed, volume, occupancy). Outside the urban area, detection stations are located primarily for the purpose of collecting traffic planning data.

Roadside Video Camera Stations - Roadside Video Camera Stations are located on motorway sections within the urban area at distances necessary to provide sufficient coverage for incident verification. Camera control is at the Motorway Control Center with capabilities to zoom, pan and tilt. Camera outputs are transmitted to the control center for display on the panel displays. Camera output can be routed (split) from the Control Center to the Police upon demand.

Motorway Lane Control Signal Stations - At various motorway locations within the urban area, lane control stations are located. Each station consists of overhead lane control signals and a roadside computer for processing and communications with the motorway center. Lane control signal indicators include lane usage and speed controls. The control indicators are computed at the motorway center on an area-wide basis and sent to the field computer for implementation.

Motorway Call-Boxes - Emergency call-boxes are located at various motorway locations both within and outside the Budapest urban area. Call boxes are located at 1-2 km spacing at the shoulder of the roadway. Call-box emergency calls are processed at either the motorway central facility or the motorway maintenance center, depending on the final communication architecture.

Motorway WIM Stations - WIM data collection stations are located at various motorway locations. Each station consists of a pavement WIM sensor and a roadside computer for processing and communications with the motorway center. Depending on the communication architecture, WIM data can be routed to the motorway center via a motorway maintenance center communication hub. A future option exists for adding vehicle classification processing at the local station for use in commercial vehicle tracking or the computation of travel time. If this option is selected, the local computer requires the added software for classification.

Motorway Roadside Weather/environmental Data Collection Stations - Roadside weather and environmental data collection stations are located at various motorway locations. Each station consists of the roadside weather collection devices, the in-pavement sensors (Optional) and the roadside computer for processing and communications with the motorway center. Routing of the data can be via a communication hub at the motorway maintenance center. If a VMS safety advisory capability exists in the vicinity, a direct connection to the local weather computer can be made for determining and controlling the display.

Motorway Maintenance Centers - Depending on the IKIR communication architecture, motorway maintenance centers (depots) on M1, M7 and other motorways may serve as communication hubs to route other traffic and weather data from field computers to the central motorway center. As shown in the Architecture Diagram, certain data collection and processing functions on motorways, can be distributed between the central motorway facility and the motorway maintenance centers. Maintainance Centers also are provided with AVL functions which are independent of and do not interface with other IKIR systems.

Motorway Maintenance Vehicle AVL Subsystem - Several motorway maintenance vehicles are equipped with AVL equipment through which vehicle location data can be transmitted to the motorway maintenance center for display.

4.6.3 County (AKKT) Systems

AKKT Control Center - Each AKKT Center houses all the computing and communication facilities used to manage the traffic on the highways within its jurisdiction. The control center is a partially equipped traffic management center including operator workstations and video display capabilities for those AKKT's whose responsibility includes the monitoring of key bridges. Strategies for local diversion based on reported accidents and weather conditions are computed automatically and control implemented either directly or by cooperation with the motorway control center. Operator intervention is permitted in all functions. Communication interfaces with the motorway control center are provided to implement joint strategies. Automatic interfaces are also provided with the IKIR Center for providing and receiving surveillance and guidance information. WIM data from in-road sensors is also collected and forwarded to IKIR for further processing. AKKT Centers include traffic signal monitoring software. However, the signal equipment itself is not considered within the IKIR scope and is not shown in the architecture diagrams.

Roadside VMS Display Units - VMS display stations may be provided on congested highways or other key points in the highway network. These are controlled by the operator at the AKKT center with messages being automatically or manually generated based on current and predicted conditions. Information content includes traffic conditions (e.g. incident ahead), roadway safety advisories (e.g. icy road ahead) and routing information (e.g. Alternate route to ......) ." VMS displays may also be directly connected to roadside weather stations in which case the message content is determined by the roadside computer.

Traffic Detector Stations - Traffic detection stations are located on rural highway sections primarily to collect traffic flow information for planning purposes. Surveillance data can be used by AKKT software to identify congested conditions. However, the density of surveillance is not sufficient for automatic incident detection. A detection stations comprises loops on every lane of the road in both directions with a connection to a roadside computer for data processing and communications. In each lane, the detector configuration supports all traffic parameter data collection (e.g. speed, volume, occupancy).

Roadside Video Camera Stations - Roadside Video Camera Stations are located at key bridges. Camera control is at the AKKT Control Center with capabilities to zoom, pan and tilt. Camera outputs are transmitted to the control center for display on the panel displays.

AKKT Highway WIM Stations - WIM data collection stations are located at various highway locations. Each station consists of a pavement WIM sensor and a roadside computer for processing and communications with the motorway center. WIM data is routed to the AKKT center for further processing and forwarding to the IKIR commercial vehicle system. An option also exists for adding vehicle classification processing at the local station for use in commercial vehicle tracking or the computation of travel time. If this option is selected, the local computer requires the added software for classification.

AKKT Roadside Weather/environmental Data Collection Stations - Roadside weather and environmental data collection stations are located at various highway locations. Each station consists of the roadside weather collection devices, the in-pavement sensors (Optional) and the roadside computer for processing and communications with the AKKT center. If a VMS safety advisory capability exists in the vicinity, a direct connection to the local weather computer can be made for determining and controlling the display.

AKKT Maintenance Vehicle AVL Subsystem - Several AKKT maintenance vehicles are equipped with AVL equipment through which vehicle location data can be transmitted to the AKKT maintainance depots for vehicle location display. Various other functions associated with the AVL equipment are external to the IKIR scope.

4.6.4 Border Crossing Systems

Central Border Crossing Data Center - The Central Border Crossing Data Center is located in Budapest and is managed by AKMI. The existing center houses all the computing and communication facilities used to manage the collection and dissemination of commercial vehicle credential and permit data from the border crossings in Hungary. The existing center will be upgraded to provide a communication interface with IKIR and to support the IKIR real-time data collection requirements for permit data.

Border Crossing Station - Each existing Border Crossing Station houses all the computing and communication facilities used to manage the collection of commercial vehicle credential and permit data and transmission to the Central Border Crossing Data Center in Budapest. Each processed vehicle constitutes an entry in the database which includes: vehicle registration, license plate number, weight, owner, credentials, permit, etc. The Border Crossing computers and software require an upgrade to comply with the IKIR real-time data collection requirements.

Border Crossing VMS Display Units - VMS displays can be located in the vicinity of the WIM sensors to alert commercial vehicle drivers and to provided informational messages. These displays are under the direct control of the operator at the Border Crossing Station.

Border Crossing WIM Sensor Station - WIM sensors are located at the border crossing approaches. The sensors are directly connected to the computer at the border crossing station. WIM sensors may be upgraded in the future to include classification capabilities which can be used for tracking overweight and other commercial vehicles carrying hazardous materials.

Border Crossing Camera - At several Border Crossing stations, the visibility of the operator is hindered by the physical structure. IKIR enhancements will include a video camera at those stations at which visibility is restricted.

IRIS - HUNGARY

TDA

IKIR - MAGYARORSZAG

IRIS TDA Project
Wilbur Smith Associates

SECTION 5
PRELIMINARY DESIGN

Section 5
PRELIMINARY DESIGN

5.1 IKIR SUBSYSTEM FUNCTIONALITY

This section provides an overview of various technologies to be considered for the physical architecture subsystems developed in Section 4 and following the system engineering process referenced in Section 4.

As the technologies being recommended or discussed in this section are, by and large, proven technologies, i.e., they have been used elsewhere in the world for the same applications, the focus in this section is on the requirements for communications connections. The deployment section (Section 6) will discuss phasing of communications to address both cost constraints and time to deploy.

A brief overview of central and field processing is presented. As there is a strong interest in deployment of "off-the-shelf" components, specific hardware and network configuration alternatives are not addressed in detail, except where necessary to identify use of specific standards for interfaces and protocols. However, certain salient characteristics of central and field configurations will be discussed as the basis for further activities in the Detailed Design.

As there are a number of similar functions inherent in the IKIR components, for the sake of brevity, specific subsystems have been grouped according to functional characteristics in Exhibit 5-1.

In the "Purpose" column, each component is identified as to its primary purpose in the IKIR. It indicates that Traffic Monitoring, and Video Monitoring components primarily gather information; On- and Off-Motorway Information components primarily disseminate information; Ramp Meter and Traffic Signal Control components generally do both; and the Emergency Motorist Service and Weather Information components provide external information that effects the traffic in a very direct way.

5.2 CENTRAL INFORMATION PROCESSING

In addition to the functional activities listed in Exhibit 5-1, there needs to be a consideration of information processing requirements. These need to be addressed at the IKIR Center, Motorway Control Center, AKKT Control Centers, and Border Crossing Centers. Each of these centers is defined to work with specific field elements and to exchange field data as discussed in Section 4.

We have addressed these requirements in more detail in Section 5.7 (IKIR Communications); however, a number of points need to be addressed:

- Each of the centers will require development of Integrated User Interfaces that permit an operator to control all of the various center components.
- Depending on the various functions associated with each Center, there will likely need to be multiple computers performing concurrent processing in order to operate the system in a reliable, timely manner.

- Configurations will be housed in existing buildings or facilities. Detailed design activities will identify specific room configurations along with, for AKKT centers, a standard layout and configuration for computers and consoles.

Exhibit 5-1
IKIR SUBSYSTEMS

IKIR Subsystem	Activity	Characteristics	Component Elements	Purpose
• Motorway Traffic Detection Station • AKKT Traffic Detection Station • Motorway WIM • AKKT WIM	Traffic Monitoring	Monitors real-time traffic data	• In-ground vehicle detectors • Above ground vehicle detectors • WIMS • Classifiers • Automatic Vehicle Identification devices • Video Image Processing	Information (traffic flow)
• Motorway Video • AKKT Video	Video Monitoring	Verify Incident; assess severity and conditions	• Cameras • Monitors • Transmission devices	Information (traffic conditions)
• Ramp Metering Station	Ramp Metering and Intersection Control	Controls demand at motorway ramps and intelligent intersections	• Traffic signals • Vehicle detection • Controllers	Information and Response
• Roadside Radio • Motorway VMS	On-Motorway traffic information	Provides motorist with current motorway conditions	• Variable Message Signs • Highway Advisory Radio • In-vehicle devices	Response (Information dissemination)
• Roadside Radio • AKKT VMS	Off-Motorway traffic information	Provides motorist with trip planning information	• Kiosks • In-vehicle devices • Internet • Public Media	Response (Information dissemination)
• IKIR Center	Support of Private Information Services	Provide motorist value added services and current traffic information	• In-vehicle devices • Private media (radio, TV) • In-home devices	Response (Information dissemination)
• Motorway Center • Motorway Call - Boxes • AKKT Center	Emergency Motorist Services	Monitors and responds to motorist emergencies	• Emergency call boxes • Cellular (radio) phones	Information (external)
• Motorway Center • Motorway Weather Stations • AKKT Center • AKKT Weather Stations	Motorway and Highway Weather Information	Provide weather condition information to motorists	• Remote weather sensing equipment	Information (external)

The configuration of the system may be implemented in different ways. It is best from the standpoint of cost and flexibility that the IKIR Detailed Design present a detailed functional description that permits various competitive alternatives to be addressed. However, at the minimum, the following characteristics will need to be incorporated into IKIR Centers subsystems:

- Use of "off-the-shelf" hardware and system software, such as Windows interfaces and Windows-compatible display software. It is expected that Windows NT would be the system most likely to support interface functions, as it is a 32-bit operating system, fully-multi-tasking and fully network-compatible. UNIX systems may be used for system functions as well, particularly for systems requiring substantial processing activities. Thus, user interface computers should be Intel Pentium or Pentium Pro-based systems while processing computers may be Pentium or Pentium Pro-based systems on UNIX-based workstations.

- Networking of multiple computers is done through local area networking. Although a number of systems utilize proprietary off-the-shelf network software and hardware such as Novell networks, compatibility with the Internet and ability to share information among users such as electronic mail requires the use of TCP/IP (transmission control protocol / Internet protocol) –based networks. These are linked through a configuration known as Ethernet, which permits multiple users to share and transmit data simultaneously. Ethernet may be configured using coaxial cable, fiber optics, or thin-wire communications. The configuration used will be addressed in the Detailed Design, but may be flexible depending on the competitive configurations proposed in response to the Detailed Design.

5.3 FIELD INFORMATION PROCESSING

From the communications assessment presented later in this Section, specific interfaces are defined in terms of communication and processing needs. There are a limited number of EU communications standards adopted for ITS. Those requirements set out for Data Exchanges and the RDS-TMC broadcasts will be required in teh IKIR Detailed Design Report (DDR). A major concern is use of interface standards and protocols that are consistent with emerging European standards. It is also crucial that some standardization be implemented for roadside processors for the IKIR, in order that costs for installation, as well as operations and maintenance, can be better managed.

Co-location of specific components (variable message sign and traffic detector stations, for example) can reduce the costs associated with Center-to-field communications as well.

It is recommended that the Detailed Design tasks identify a standard field cabinet configuration for IKIR field elements, along with a standard roadside processor configuration. This is done in many jurisdictions through use of a series of non-proprietary hardware standards. These include:

- Model 170 controller standards that provide a standard microprocessor, operating system and memory scheme along with standard connections to peripheral equipment. The controller can be tailored to do specific functions, including control of traffic signals, ramp meters, weigh-in-motion, traffic detection processing, weather sensor monitoring etc. The means to do this is through programming of a standard Programmable Read-Only Memory (PROM) module.

- Standard modem specifications and detector specifications that identify the physical, electronic and mounting configuration of the equipment.

- Implementation of a standard 48.26 cm (19 inch)-wide rack configuration within a standard environmental enclosure, similar to that for indoor computer and communications racks.

Although there may be a number of alternative processors for specific IKIR functions, it is recommended that these processors adhere to specifications to be identified in the Detailed Design that standardize various hardware configurations. This will facilitate maintenance of the system and assure that multiple vendors would be able to supply specific field hardware, including detectors, weather sensors, weigh-in-motion processing units and variable message sign controllers.

5.4 TRAFFIC MONITORING

Traffic monitoring is the means for the System to gather information about activity on the roadway. Traffic flow parameters, such as volume, occupancy, speed, and queue length are measured or calculated from data obtained from field devices. Vehicle stops, delay, and other measures of congestion, and incidents are inferred from this data. Used with processing capability available in the field or remotely, vehicle characteristics are derived from this data. The predominant technologies used by today's systems for traffic monitoring are discussed below.

5.4.1 Vehicle Detection

Traditionally, vehicle detecting sensors are designed to recognize the presence of a moving or stopped vehicle or the passage of a vehicle. When coupled to another device with intelligence, such as an intersection controller or integral microprocessor, detectors are used to derive volume, speed, lane occupancy, and queue length; to classify vehicles by size, weight, number of axles, etc.; and to infer congestion, incidents, stops, and delays.

Detector types range from mechanical type pressure (treadle) detectors to those that sense changes in energy such as magnetic, magnetometer, sonic, radar, inductive loop, microwave, and infrared detectors.

Physical damage often caused by roadwork milling operations, utility trenching requirements and harsh weather effects on road surfaces, often renders inductive loops useless. In response, efforts have focused on improving loop installation techniques and manufacturing processes to produce more robust loops (i.e., pre-formed loops). In addition, other technologies that don't require installing sensors in the roadway were developed and used. Among these are acoustic, infrared, microwave and optical devices collectively referred to as "non-pavement invasive" detectors.

Video cameras have been used for roadway and intersection surveillance for many years. Recent advances in video based detection technologies have renewed interest in machine vision and thrust it into contention as a traffic detector. These devises are attractive for several reasons. For example, the video detector goes beyond simply emulating the loop. These units offer wide area detection along with vehicle classification and counting, and can be used to determine vehicle headway, occupancy and queue length. Since a camera is used as the source of the image, this technology has the potential to provide video for surveillance as well.

There are several manufacturers presently marketing machine vision technology for traffic detection. They vary principally in the way in which they do the image processing. These include techniques referred to as "tripline", and "tracking based" systems. These manufacturers advertise that their devices provide complete loop emulation functionality, equivalent or better life-cycle cost, and enhanced presence and count accuracy when compared to inductive loops. Because of the relative small number of user sites, there is not a lot of documented evidence to back up these claims. However, because of their versatility and rapid technological advances, the prospects are good, that these devices will provide a viable alternative to the inductive loop detector.

Exhibit 5-2 lists some of the commonly used technologies, and the advantages and disadvantages of each. The induction loop detector has been the default standard in the traffic industry for many years because of its simplicity, low comparative cost, versatility and wide use.

The IKIR has no particular requirements which necessitate the use of a different form of detection. Therefore, all detection requirements in the initial system for data collection associated with traffic control and monitoring, or planning purposes will be satisfied by using inductive loops. Mainline loops are to be employed in groups (detector stations) at regular spacing (1.0 km) intervals along the Motorway, across all lanes to collect sufficient data for incident detection. The detector stations are to be connected to roadside processors for data processing and transmission to the Motorway Control Center, or an AKKT center.

5.5 VIDEO MONITORING

Video monitoring technology plays a vital role in support of advanced transportation management systems. Monitoring cameras are typically used for the detection of malfunctions and/or congestion problems along motorways and at critical roadway crossings. This information is used by traffic operators to verify incidents, to implement incident clearance strategies, to make control adjustments to improve traffic flow, to verify changes, to manage queue lengths, and to provide information to the public.

Camera placements, lens configurations, and operator guidelines combine to help ensure the operation and utilization of the cameras for the purpose of improving traffic flow.

The system should include provisions for video recording, for the occasional recording of a roadway for data collection, after which the data should be summarized and the video tape erased or archived. However, the recording of video images must be considered as an Institutional issue. The regular recording of video images can lead to excessive demands on the part of system staff, as tapes might be subpoena for collision cases or requested for police criminal investigations.

Another institutional issue involves which agencies will have actual control of the camera positioning. Video feeds to other agencies, including the Police and Fire Departments and cable television channels, should be considered carefully, with only authorized staff able to aim and switch the video cameras and signals.

When placing a camera, the camera should be readily accessible for maintenance, secure from external influences (including wind, vibration, and vandalism), and effective in coverage. To fulfill these requirements, several factors are taken into account -- the characteristics of each of the camera sites, the mounting height, adjacent street lighting, the design of the camera supports, and the location of the field control equipment.

The field-located camera control equipment includes those devices essential to the operation of the camera assembly, generally including a regulated power supply, a control unit that drives the camera functions, and a fiber-optic transceiver to receive the camera commands and to transmit the video signals on the communication system. This equipment would normally be housed in the same cabinet as the local traffic monitoring equipment, unless the camera site is so removed from such equipment that a separate control site is required.

Exhibit 5-2
VEHICLE DETECTION TECHNOLOGY OPTIONS

Detector Technology	Advantages	Disadvantages
Loop	• excellent presence detection • can measure all traffic parameters • relatively easy to install • measures small vehicles	• installed in the roadway • requires closing down roadway for installation and repair
Magnetometer	• relatively easy to install • reliable • located under roadway and not subject to damage	• requires closing down roadway for installing • prone to double count • poorly defined detection zone
Pressure	• well defined detection zone • rugged construction • reliable • detects regardless of vehicle speed	• poor count accuracy • does not measure presence • traffic disruption during installation
Radar/Microwave	• generally does not require closing roadway to install • non roadway or pavement invasive	• requires FCC license to operate (in USA) • antenna alignment required
Sonic (active)	• generally does not require closing roadway to install • non roadway or pavement invasive • useful at locations with unstable pavement	• poor occupancy and speed accuracy • difficult to calibrate for single lane coverage • sensitive to temperature variations
Video Image Processing	• provides wide area detection • provides traffic information beyond capability of spot detectors	• relatively expensive especially for simple applications • prone to errors due to shadows, occlusion and background lighting

5.5.1 Camera Design Requirements

Video cameras used for traffic monitoring must be designed to provide the image quality necessary for an operator to discern the status of an incident or traffic conditions, with the capability to aim at and zoom in on specific sections of the roadway, all while accommodating the rigors of the outside environment.

There are a number of features to be considered when designing for a camera installation -- the type of camera enclosure to be utilized, the various characteristics of the camera and lens assemblies, and the requirements for the pan and tilt mechanism. The following paragraphs address these requirements, leading toward a recommendation for the design requirements for the cameras to be utilized in the IKIR.

5.5.1.1 Camera Enclosure

The use of a camera enclosure is required to provide protection for the camera from a variety of environmental conditions, as well as to provide security for the camera installation. Two basic camera housings are available -- the box-type and the dome-type. The box-type (or environmental) housing encloses the camera electronics, CCD array, and the zoom lens, and mounts on an external pan / tilt unit. A viewing window for the camera is included at one end of the enclosure. The enclosure may be in the shape of a cylinder or a rectangular cross section box. A cylindrical housing with the lens integrated with the enclosure usually provides a superior optical performance and reduced wind loading as compared to a rectangular housing, and is recommended for traffic monitoring.

The dome-type enclosure houses the pan / tilt unit as well as the camera. This construction has the advantage of providing overall protection for both the pan / tilt unit and the camera, and also makes the camera installation and positioning more discrete to the passer-by. The design is very convenient for maintenance purposes, as the lower hemisphere of the dome can be easily removed to provide full access to all the internal components. However, there are a few disadvantages -- the dome enclosure, having a larger exposed surface, can shake under heavy wind conditions; the curved dome adds some optical distortion and possibly light loss; and, in some designs, visibility is reduced by sheeting action during rain. A shield against heavy rain and strong sunshine, and a rugged, stable mounting support, is recommended for this type of enclosure.

For traffic monitoring cameras, sealed and pressurized enclosures are preferred, to completely protect the camera unit from moisture, airborne contaminants and pollutants, condensation, dust, fungus, and so on. Dome enclosures typically do not allow the pressurization of the enclosure, but do provide a reasonable seal against most pollutants. A temperature sensor, with appropriate alarm reporting and a camera heater is recommended because of the Hungarian climate.

5.5.1.2 Camera Characteristics

There are a number of parameters relating to camera performance that should be selected to fit the need and environment. Several criteria must be considered, such as the following:

Signal to Noise Ratio - The minimum Signal to Noise Ratio (SNR) is measured at the monitor output in the control center for a picture generated by the camera installation furthest from the control center. It is cumulative, starting from the camera, through the transmission system and the switching system. Typically, it should be no less than 40 dB in order to receive a decent picture. The higher the SNR, the better the picture quality. The use of fiber optic cable will provide for the optimal transmission of the images back to the central site.

Camera Sensitivity - The sensitivity is the minimum scene illumination necessary to achieve a picture. With Automatic Gain Control (AGC) off, a color camera should achieve full video at 6.5 lux faceplate illumination. With an adequate SNR, picture quality can be improved through the use of AGC circuitry which compensates for low light levels. With AGC on, a color camera could provide a usable picture (80% of full video with AGC on) with only 0.55 lux faceplate illumination.

Low Lux Color Cameras - Low lux color cameras are recommended to provide the operator with more detail of the surrounding roadway conditions during night time surveillance.

Resolution - The picture resolution is defined by the number of lines (both horizontal and vertical) that makes up each video frame. The higher the resolution, the higher the costs for the camera and the control center equipment. In addition, the required bandwidth for the video signal transmission also increases with higher resolution. Resolution is measured at both the center of the picture and at the edges.

Pick-Up Device - The pick-up device is the part of the camera that converts incoming light to electrical signals. This device is the eye of the camera, and its characteristics govern the picture quality provided by the camera; i.e., the picture size, light sensitivity, and resolution.

The most common type of pick-up devices are of a solid-state design, which have been developed and refined over the past several years. Within solid-state technology, two different types of pick-up devices are available: the Charged Couple Device (CCD) and the Metallic Oxide Semiconductor (MOS) device. CCD technology produces a superior image and is used exclusively for monitoring camera applications.

There are two basic designs used in CCD pick-up devices -- frame transfer field technology and in-line transfer. The advantages and disadvantages of these two designs are summarized below:

Frame Transfer Field Technology

- Good for sunset and infrared applications
- Problem with staring/streaking
- Problem with overload of pixel storage resulting in vertical smear and bloom (solved by shutter)

In-Line Transfer

- Minimize staring/streaking
- Good light overload characteristics
- Good temperature versus noise characteristics
- Has reasonable sensitivity with use of Microlens
- Use of mosaic grid supports greater than 450-line resolution

For monitoring cameras, the most common CCD image sensor sizes are 1/3" to 2/3". Normally, the larger sensor sizes provide a higher sensitivity. However, with the application of Digital Signal Processing technology, a 1/3" CCD camera can provide a smaller size lens, better resolution, and higher sensitivity. As a result, it has become more and more popular. CCD image sensors of 1/4" format are also becoming more common.

5.5.1.3 Lens Characteristics

The lens serves to diverge and focus the light reflected from an object onto the pickup element, thus forming an image of that object. The height and width of the image is determined by the focal length of the lens. There are two basic types of lenses: fixed focal length lenses and motorized variable focal length (zoom) lenses. A fixed focal length lens provides one field of view. It is useful for viewing an area with a limited view. A motorized zoom lens provides the ability of the lens to physically alter its field of view from wide angle to a narrow band.

The range of focal length required in a zoom lens is a function of the distance from the camera to the objects in the desired viewing area, the size of object to be viewed, and depth of field needed for user evaluation.

For CCD cameras, zoom lenses are available in magnification ranges from 2:1 to 15:1. Usually, the higher the magnification range, the greater the range of zoom adjustment, and the greater the distortion factor. Thus, a zoom lens should be selected at the minimum ratio needed to accommodate incident detection confirmation in each section of the roadway.

5.5.1.4 Pan and Tilt Mechanisms

In order to implement a proper surveillance system that will be able to provide traffic monitoring over a wide area, and to verify and determine the nature of an incident, cameras with zoom lenses and pan / tilt capability are desired.

Pan / tilt units are motorized devices designed to direct the camera lens toward a target of interest. Most pan / tilt units provide a horizontal travel range of 0 to 355 degrees at a rate ranging from ½ to 125 per second. Vertical travel (tilt) is typically ±90 degrees from horizontal at a rate ranging from ½ to 60 per second.

Pan / tilt mechanisms are available with pre-set positioning. This allows the operator to select camera positions in advance and to move the camera to a pre-determined position upon command. Pre-sets are often used in motorway monitoring systems to assist in the incident confirmation process by automatically pointing the nearest camera in the direction of a detected incident.

5.5.2 Summary of Camera Design Requirements

The video cameras for the IKIR should be configured within a dome enclosure or standard environmental enclosure, based upon the camera's surrounding terrain and environment. Dome enclosures that provide for easy access to the cameras, for maintenance purposes, with a design that protects against rain and sunshine hitting the optical portion of the dome, are recommended. Where the terrain would require the camera to aim above the horizontal level, because of camera placement, an environmental enclosure should be used.

Cameras for use in the system should be color cameras designed for use in low level lighting conditions, as would be found on the more rural Hungarian roadways. Typically, the cameras should provide for a horizontal resolution of 460 lines and a vertical resolution of 350 lines. A camera utilizing Digital Signal Processing technology and a 1/3 inch Charged Couple Device (CCD) sensor should provide the level of sensitivity and resolution required for this project, while minimizing the demands on the lens. The camera's Signal-to-Noise ratio, with the AGC turned off, should be greater than 48 dB.

For motorway surveillance a zoom lens within the ratio range of 2:1 to 15:1 should be utilized and for intersection monitoring the ratio range should be 2:1 to 8:1.

Pan / tilt mechanisms for the cameras must be designed for the type of camera enclosure; while the speed of camera positioning is not critical, the mechanism should provide for the smooth relocation of the camera between aiming locations. The pan / tilt mechanism should be provided with pre-set positioning, to allow the interface with the incident detection and camera positioning portion of the system.

5.6 VARIABLE MESSAGE SIGNS

Variable message sign technologies will be used for two types of signage within IKIR:

- VMS located alongside motorway and highway sections, and at border crossing stations; and
- Lane control stations providing overhead lane control signals and speed indications on critical sections of motorway.

To fulfill their purpose of communicating information to the roadway user, variable message signs must meet the following functional requirements:

- Conspicuity;
- Legibility;
- Comprehensibility; and
- Credibility.

Conspicuity (target value) describes the ability of the VMS to appear prominent in the visual environment and capture attention. Legibility defines the ability of the VMS message to be perceived and understood through its words and/or symbols. It is often recorded as a threshold value at which the message becomes "legible" to the motorist. Once read, the message must be processed by the motorist. The relative ease with which the message is understood by the motorist is the measure of the sign's comprehensibility.

Credibility refers to the quality of the message being portrayed on the VMS in terms of the information reliability, accuracy, and currency. Obviously, if the VMS were to lack credibility in the eyes of the motorists, it would not serve its function. A commitment is necessary on the part of the operating agency to display messages only when the agency is certain of traffic conditions and when the message display can serve a useful and understandable function.

5.6.1 VMS Types

The most flexible of the VMSs use a matrix format upon which characters and symbols are formed by showing appropriate patterns of the matrix elements (bulbs, disks, pixels, etc.). Matrix VMSs are designed in the following three formats:

- One or more lines composed of individual character modules;
- One or more lines with continuous matrix lines; and
- Full matrix display.

For the first type, each character matrix module is typically formed by 35 elements arranged 5 wide by 7 high (5x7). Each line of a continuous matrix line VMS is formed by evenly spaced elements that are typically 7 high and extend across to an upper limit dictated by the required number of characters one desires to display on the line. A full matrix display is one in which the elements are spaced equally to form a full matrix. The full matrix display is the most flexible because it allows an agency to display symbolic messages and messages with different character sizes.

VMSs can be conveniently classified into three categories, namely:

- Light-reflecting,
- Light-emitting, and
- Hybrid.

5.6.2 Light-Reflecting VMSs

Light-reflecting VMSs (e.g., reflective disk, rotating drum) reflect light from some external light source such as external sign lights, vehicle headlights, or the sun. The more common types of light-reflecting VMSs range from the rotating drum sign with a limited number of messages to the reflective disk matrix sign with infinite message capability. One distinct characteristic of light-reflecting VMSs is that, with the exception of external and internal lighting requirements and requirements for environmental controls (e.g., fans, heaters, etc.), power is required only when a message is changed.

There are three principal types of reflective disk VMSs:

- Circular disks,
- Rectangular disks, and
- Dimensional square disks.

5.6.2.1 Reflective (Circular) Disk VMS

The viewing face of a circular reflective disk VMS (sometimes referred to as "flip disk") is formed by an array of permanently magnetized, pivoted 2-inch diameter circular-shaped indicators inset in a dark background surface. Messages are displayed by electro-magnetically rotating appropriate disks to reveal a reflectorized yellow side. The reflective disk can be used in modular character matrix, continuous line matrix, or full matrix signs.

The circular reflective disk VMS was extremely popular in the mid-1970s and early 1980s when agencies became sensitive to energy conservation. Energy requirements are relatively low for the reflective disk sign compared to light-emitting technologies; however, because of the low target value and legibility distances of the reflective disk sign, the current trend in highway applications is toward greater use of VMSs with light-emitting technologies.

Experience has shown that the legibility of reflective disk signs can be quite good during daytime conditions when the sun is in front of the sign. However, when the light levels are low during most of the day and at night, the signs are difficult to read. External or internal illumination is required for nighttime and low ambient conditions. Because the disks are recessed, the sun and external lamps can cause shadows which cover portions of the legend. As discussed later, several transportation agencies are now retrofitting existing reflective disk signs with light-emitting hybrid technology in order to improve conspicuity and legibility.

5.6.2.2 Reflective Disk (Rectangular VMS)

The rectangular reflective disk VMS is very similar in operation to the circular disk. However, the viewing face is formed by an array of permanently magnetized, rectangular disks measuring about 1-5/8 inches wide by 2-1/2 inches high. Each disk swings like a door 180 degrees on a vertical hinge. When the "door" is open, it shows a yellow side and exposes a yellow wall behind it. When it closes, it shows black for both the flipper door and the wall. The rectangular disk can be used in modular character matrix, continuous line matrix, or full matrix signs.

5.6.2.3 Reflective Disk (Three-Dimensional Square Cube) VMS

The viewing face of a three-dimensional square cube VMS is formed by either a continuous line matrix or full matrix array of 2-1/2-inch square elements that rotate to display a side that is either fluorescent yellow (on), or a side that is flat black. The elements have sloping sides and are "3-dimensional," thus providing some depth to the message element. These signs are often referred to as using “glow-cube” technology.

5.6.2.4 Rotating Drum VMS

The rotating drum sign continues to be popular with several transportation agencies, particularly in the northern regions, because of its low initial cost, good reliability, ease of maintainability, low maintenance cost, good legibility, and the ability to incorporate highway route markers into the message. The signs come equipped with 3-, 4- or 6-sided drums.

The major limitations of rotating drum signs are the lack of message flexibility and the fixed number of messages available to the operator. The operator may remotely select which of the 4 or 6 messages will be displayed, but cannot revise message content. Rotating drum messages may be replaced by maintenance personnel when necessary.

5.6.3 Light-Emitting VMSs

Light-emitting VMSs generate their own light on or behind the viewing surface. These sign types require power at all times when a message is displayed in comparison to light-reflecting VMSs that require power only when a message is being changed. Both types of signs require power for environmental equipment (fans, heaters, etc.). Light-emitting VMSs are either modular character matrix, line matrix, or full matrix. The most common types of light-emitting signs are listed below.

- Bulb (incandescent) matrix;
- Fiberoptic matrix; and
- Light-emitting diode (LED) matrix.

Bulb matrix, sometimes referred to as "lamp matrix", is one of the oldest types of light-emitting VMS used for highway applications. In recent years, advances in technology in the United States have resulted in an increased popularity of fiberoptic and LED signs and in hybrid signs--fiberoptic enhanced reflective disk and LED enhanced reflective disk signs.

Light-emitting VMSs have been shown to have better conspicuity and longer legibility distances than reflective disk VMSs under most environmental conditions.

5.6.3.1 Bulb Matrix VMS

The major advantages of the bulb matrix VMS are: 1) very high visibility under all environmental conditions; 2) provides a very good cone of legibility compared to other types of light-emitting technologies; and 3) parts interchange can be facilitated. The major negative attribute is the cost of both power consumption and maintenance (including high frequency of bulb replacement).

5.6.3.2 Fiberoptic VMS

Fiberoptic VMSs are either fixed grid or matrix with shutters. Light radiating from an internal point source (halogen lamp) is directed to the sign's viewing face through a bundle of optically polished glass fibers. For a fixed grid sign, the points of light (pixels) are arranged to form the specific message(s) (words, numbers, and/or symbols) on the sign face. Thus a fixed number of messages are available.

In contrast, the fiberoptic matrix with shutters VMS is capable of displaying a large number of user designed messages and thus provides greater flexibility in message selection. Rather than forming specific fixed messages, the fiberoptic fibers direct light to form individual pixels on the sign face. The primary halogen lamp, contained in a lamp harness with two lamps, is continuously illuminated and feeds two fiber optic harnesses of over 100 glass fiber bundles each. Two fiber optic bundles illuminate each pixel in the matrix. Each pixel with two fiberoptic dots has a corresponding shutter that rotates to either permit light from the halogen lamps to pass through the fibers or to block the light, thus forming the message. The secondary lamp is used when extra brightness is needed or as a backup lamp in case of failure of the primary lamp. A fiberoptic sign with three lines and 18 characters per line would require 36 lamps at 50 watts each, compared to a comparable bulb matrix sign which would require 1890 lamps at 25 watts each.

The fixed grid fiberoptic sign is not generally used for freeway traffic management in the United States (except for lane control signals). Reference to fiberoptic VMSs in subsequent paragraphs imply fiberoptic with shutters.

Several transportation agencies have purchased fiberoptic VMSs in recent years. The major positive attributes of the fiberoptic VMS are good conspicuity (target value) and good legibility. The major weakness is the narrower cone of legibility (viewing angle) compared to bulb matrix and light-reflecting VMSs.

5.6.3.3 Light-Emitting Diode (LED) VMS

The viewing face of an LED VMS is formed in a manner similar to the bulb matrix sign, with the exception that each lighted element is a cluster of LED lamps (20 to 64) rather than a single incandescent bulb. The characteristics of the early standard LED lamps were inadequate for highway applications because of their low visibility. The development of super bright LEDs has spurred interest in LED VMS technology in recent years. Initially, a combination of red and green LEDs had to be used to simulate the required yellow (amber) color for the legend. Unfortunately, the color tended toward orange, rather than yellow. High-intensity yellow (amber) LEDs have corrected this problem and have been successfully deployed since 1993.

Experience to date indicates that the LED VMS provides good conspicuity (target value) and legibility distances during daytime and nighttime lighting conditions. Comparable to the fiberoptic VMS, the LED sign suffers from lower cone of legibility. In addition, the power consumption appears to be unexpectedly high because fan ventilation is required to dissipate heat produced by the LEDs.

5.6.4 Hybrid VMSs

Hybrid signs combine two VMS technologies to produce displays that combine the better qualities of both. To circumvent the deficiencies of the reflective disk VMS relative to poor conspicuity and legibility distances, manufacturers have integrated fiber optic or LED with circular reflective disk matrix technologies. The basic operations depend on the established principles of the reflective disk sign technology which is supplemented with fiber optics or LEDs.

5.6.4.1 Fiber Optic Enhanced Reflective Disk VMS

In the case of a fiber optic enhanced reflective disk VMS, a single fiber optic light dot is located behind each reflective disk and radiates through small holes in the disk. The fiber optic dot shows when the disk is in the "on" position. The pixels in use, therefore, show both the reflective disk and the fiber optic light.

5.6.4.2 LED Enhanced Reflective Disk VMS

The LED enhanced reflective disk VMS is designed similar to the fiber optic enhanced reflective disk sign, except that LEDs are used as the light source.

5.6.5 Display Technology Recommendations

The positive and negative attributes of the most-commonly used VMS types are summarized in Exhibit 5-3. Recommendations relating to variable message signs for the IKIR are as follows:

- Light emitting technology (LED or fiber optics) shall be utilized.
- For motorway VMS, the nature of messages requires the use of three text lines, in combination with a white/red symbol. Symbols would indicate road work, accident, slippery road or road closure.
- For highway VMS two line signs would be used, in combination with symbols. Similar VMS would be used at border crossing stations.
- Lane control signals would be mounted at 2-5 km intervals along M0 motorway and on approaching M1, M5 and M7 sections within 5 km of M0, with displays of lane use (red X = closed, green up arrow = open, green up/left arrow = merge left, green up/right = merge right) and speed in each lane displayed. These signals would operate in a similar manner to displays in other parts of Europe (Germany, Netherlands, UK). Final configuration to be determined in detailed design.

5.7 IKIR COMMUNICATIONS

5.7.1 General

Communications often is the most critical and expensive element of a complex system. The communications subsystem functions as the means to transfer information among system components. Information flows from a transmitter to a receiver over a transmission path called a link or channel. This transmission path is provided by a communications medium, and may be a physical connection (copper wire, coaxial cable or fiber optic cable) or an air path (microwave, cellular, single channel or spread spectrum radio).

Exhibit 5-3
ATTRIBUTES OF VMS TYPES

VMS Type	Positive Attributes	Negative Attributes
Reflective Disk Matrix (Circular)	• Low energy consumption. • Reliable performance. • Good visibility under high ambient conditions • Relatively low cost.	• Low legibility at night, under backlit conditions, and under washout (glare) conditions. • Low target value. • Reflective disks fade.
Rotating Drum	• Reliable operation regardless of weather conditions. • Good visibility. • Low initial cost. • Low maintenance cost. • Interstate shields and other highway route markers can be displayed.	• Limited number of messages.
Bulb Matrix	• Very good target value. • Very good legibility distance under all environmental conditions. • Good cone vision. • Interchangeability of parts.	• Relatively high cost of power consumption. • Relatively high maintenance (bulb replacements).
Fiber optic Matrix	• Good target value. • Very good legibility distance under all environmental conditions.	• Narrow cone of vision.
Light-Emitting Diode (LED) Matrix	• Good target value. • Very good legibility distance for daytime and nighttime lighting conditions.	• Light output decreases at very high temperatures. • Narrow cone of vision.
Fiber optic Enhanced Reflective Disk Matrix	• Good target value. • Good legibility distance. • Good visibility in all directions. • Good reliability.	
LED Enhanced Reflective Disk Matrix	• Good target value. • Good legibility distance.	

The IKIR roadway management and information system requires that:

- real time commands necessary to execute control, and information requests are communicated to the remote field or roadside equipment,
- information equipment including modes, status, and measurement data are transmitted to traffic operation centers from the field, and
- roadway conditions, such as travel time, incidents, weather, etc. are provided to the motorist.

Data and control signals flow between the field and the several Traffic Centers operated by the Motorway, AKKT and the Border Crossing Stations. In addition, the System requires a variety of inter-communication of information between the IKIR data center, motorway maintenance centers, Toll Operations centers, the AKKT control centers, and the UTINFORM and FOVINFORM.

In the subsequent sections, alternative communications system architectures and technology options will be described and related to the system requirements.

5.7.2 System Communications Issues and Requirements

The IKIR embodies a variety of information handling requirements, each placing different and unique demands on the communications system. Two issues that impact the design of the IKIR communications system need consideration.

The first is the use of Standards. The IKIR communications system infrastructure will be constructed over a number of years. Because of the fast pace of technology advancement, it will use different equipment models from different manufacturers that must work with the old installed equipment. This requirement for interchangeability and interoperability dictates the adherence to international standards for hardware and software interfaces, and transmission protocols. For the case where published and accepted standards do not exist, de-facto standards should be considered and where appropriate used.

The second issue deals with the decision to use, when appropriate, existing available communications technology, and services, whether private or public. However, since it is generally acknowledged that technology and available services for information transfer are rapidly changing, consideration shall be given to those technologies and services that may not be available yet, but are based on international standards and scheduled for deployment. Those could be integrated into the system during the course of completing the system implementation.

As a result of the forgoing, the IKIR preliminary design is based on employing a communications infrastructure that allows for both public and private networking solutions, adequate supply of vendors for equipment, common interworking between vendor's equipment and a clear specification requirement for interfacing field devices and/or end terminals. A communications system based on open standards will protect the equipment investment and facilitate easier evolution to future technologies and standards, such as Asynchronous Transfer Mode (ATM), a multimedia protocol suite under development, designed to carry data, voice and video over a common signal format.

Geographical distances for the IKIR application, along the Motorway system, are typical of metropolitan or wide area networks (both public and private). Key transmission standards are embodied in the Electrical Digital Hierarchy and Synchronous Optical Network (SONET) Standards, and the Synchronous Digital Hierarchy (SDH) international standard produced by the ITV. Added standards are prepared by ESRI.

IKIR functional requirements are detailed in Section 3 of this report. The requirements were analyzed and a preliminary system architecture synthesized in Section 4. The resultant architecture identified the physical subsystems required to satisfy the functional requirements.

The data flow rates form the basis for the selection of the media, technology and architecture options for the IKIR communications infrastructure. The following paragraphs will review these requirements and discuss the options.

5.7.3 Data Requirements

System architectures and field equipment have increasingly become influenced by the improved capability for storing and processing data in the field. This has led to a greater distribution of control of the system. The degree of distribution of processing and control governs the communications architectures more than any other factor. This in turn dictates the choices regarding polling schemes, the repetition interval for communication and transmission data rates. Currently most systems use either short-term communications intervals (typically once or twice per second) or long-term intervals (on the order of 10 seconds to 1 minute). Obviously these differing architectures have an effect on the data rates and protocols and to some extent the medium to be used.

Variable message signs, trail blazer signs, traffic detector stations, lane control signals, ramp metering controllers, traffic signal controllers and weather monitoring equipment all have information transmissions, dealing with control commands, some kind of data retrieval and equipment monitoring. Generally, they can all be classified as low data rate devices. Baud rates of
1200 to 9600 are more than sufficient to communicate with the kinds of field equipment being considered for the IKIR, apart from CCTV cameras discussed below. Information to and from traveler kiosks or in-vehicle motorist guidance and information devices also present relatively low data rate requirements and also place little burden on the communications subsystem design.

5.7.4 Video Requirements

Closed Circuit TV (CCTV) is an integral part of the long term IKIR design, to provide such functions as roadway monitoring, incident verification, vehicle detection, vehicle classification, and license plate reading. The requirements for communication of video signals differ significantly from data communication requirements. These systems require greater bandwidths and higher data rates if transmitted digitally. The European television system uses the PAL standard which is regularly included in CCTV equipment with the NTSC North American Standard.

CCTV camera systems include the means for controlling the camera operation and setting by remotely commanding it to pan, tilt or zoom and controlling the iris setting, etc. from the control center. This control requires a set of control signals to each camera location. The data rate required for this control is comparatively low. A single 9600 baud transmission channel can provide simultaneous and concurrent control for up to 16 cameras.

5.7.5 Voice Requirements

Voice linkages are required to several field subsystem devices, including :

- Major equipment field location maintenance telephones
- Roadside broadcast transmitters, and
- Motorway and Highway Roadway emergency call boxes.

Each voice channel uses a 64 Kbps channel which is a fraction of the E1 (2.04 Mbps) channel. Use of the radio phones is sufficient to provide voice communications between maintenance crews at different field locations or the operations/control center.

A separate 64 Kbps channel is provided for each remote roadside broadcast transmitter.

The Motorway emergency call-box system communications uses a multipair copper cable. If the emergency call operators remain at the local centers and the existing emergency phones should be left intact.

5.7.6 Communications Network Architecture, Transport Media and Technology Options

5.7.6.1 Network Architecture

As for most large scale and complex intelligent information systems, IKIR requires a versatile and robust network to transport information between many geographical locations with diverse applications. Central to such an application is a communication architecture that can support data, voice and video transmission over relatively long distances, subject to a phased implementation and deployment plan.

Traffic management system communications architectures are generally defined as central, distributed or a combination, which are sometimes referred to as hybrid. Central architecture is the simplest since it assumes no changes in data rates or communications protocol between field devices and control center. This architecture is appropriate for small numbers of field devices and/or video channels.

A Distributed architecture provides for changes in data rates between the control center and field devices. Low speed data, to and from the field devices, are concentrated onto high speed channels (trunks) for longer transmission links between the field and the control center. This type architecture is appropriate where geometric considerations, and/or heavy communications requirements (i.e., video) make the use of high speed channels economical by reducing the number of long cable runs.

Many present day communications networks use multiple data rates distributed from a high data rate channel referred to as a backbone. For these applications, the high data rate backbone connects a series of hubs or nodes located in the field. The hubs contain equipment that converts the high data rate channel into a larger number of lower data rate distribution channels. This type of architecture will be the design basis for the IKIR communications network.

Data from the field devices is multiplexed at the node and placed on a high speed transmission link to the motorway operations center. The high speed link can be provided by point-to-point, hubbing, linear drop or ring network configurations. A ring is proposed for the motorway system based on the following reasoning:

- Fiber optic cable interconnect is recommended to be installed along all new motorway construction to be undertaken over the course of the phased IKIR deployment, and this offers the opportunity to specify a SONET/ATM based system; and

- Rings are the first choice for robust communications design because of their ability to provide a self-healing network, while minimizing the network optical equipment.

The motorway center to IKIR link will be provided in one of the following ways:

1) If the IKIR center is co-located with the motorway center, the interconnect between the two will be networked within the center;
2) If they are separate facilities, and the fiber cable extends to the operations center, then they both will have nodes on the fiber cable; or

3) If the operations center is remote from the IKIR center the trunk between them will be provided by microwave circuits leased from the communications service provider.

For the AKKT centers, there are fewer choices. First, there are no planned major construction undertakings planned that would provide the opportunity to install a new fiber cable infrastructure throughout the counties. Second, unlike the equipment installed on the motorways, field devices are scattered about the counties. This coupled with topological features in the more rural areas reduce the opportunities for multiplexing and trunking. For the county systems then, the communications network for connecting field devices to each AKKT center will make use of several alternate media -- leased telephone circuits, county owned twisted pair, and radio -- as appropriate and where available. The media selection for each application will be made during the detailed design phase for the project.

A point-to-point link will be provided to connect each of the AKKT centers with the IKIR center. The trunks to the IKIR center from the AKKT operations centers will be provided by telephone or microwave T1 circuits leased from a private service provider. The major reason for this is the long distance between centers, and therefore, the lack of an IKIR owned communication link, and conversely, the availability of alternative (private) service providers.

The communications links from the IKIR center to the kiosks, roadside broadcast transmitter sites, boarder crossing stations and other external users will be provided by leased telephone or microwave circuits, as appropriate.

5.7.6.2 Media Options

As noted, it is anticipated that the IKIR will install fiber cable to provide for CCTV video communications with the motorway operations center control facility. The use of fiber is ideal for video transmission. The advantages of fiber optics over copper twisted pair and coaxial cable are well documented. Fiber optic cable has the capacity for handling large amounts of data at high data rates for long distances without requiring amplification. High immunity to electromagnetic or radio frequency interference and damage from lightning strikes are important attributes. In addition, with advances made in splicing techniques, and because it is smaller, lighter and more flexible than copper, it is easier to work with. Finally, the cost of fiber has been decreasing, so that presently it is cost competitive with copper to install.

The use of fiber optics cable, if available throughout the IKIR system coverage area, offers additional opportunities to use it as the communications plant for the entire urban motorway system, as well as, the infrastructure to connect the future additional CCTV cameras, incident detection sensors, VMS equipment and Highway Advisory Radio (HAR) installed on the urban motorway system. However, since the deployment of the IKIR will be staged (over an undefined time), and much of the system will be in locations where no fiber is or will ever be installed, options and alternatives to fiber will be considered.

5.7.6.3 Land Line Options

Digital lines can be leased from the local exchange carriers (LEC). Digital private line service can be leased providing for duplex transmission of digital signals at synchronous speeds up to 56 Kbps. The LEC can also make available higher capacity digital channels such as E1 (2.048 Mbps). These transmission facilities can transmit coded video from field cameras to the central control center, although not without a reduction in video quality at the low rates.

Integrated Services Digital Network (ISDN), an internationally standardized, narrow band service, also is provided by local exchange carriers. A single ISDN line can carry both video and control data transmission.

5.7.6.4 Wireless Options

There are two wireless options that have the bandwidth required to support both data and video -- terrestrial microwave and spread spectrum radio. Both are proven technologies and both make use of commercial-off-the-shelf equipment.

Terrestrial microwave links are used primarily in point-to-point applications. Microwave signals radiate along a line-of-sight path between transmitter and receiver antennae. Microwave radio uses simplex transmission (one direction per link) so transmission in both directions at the same time requires a frequency pair. Microwave frequencies are regulated by governmental authorities. A major attribute of a microwave radio link is the ability to transmit broadband analog video. The predominant drawbacks are related to the line-of-sight and point-to-point characteristics that would require the use of repeaters and multiplexer equipment in this system design. Leasing circuits from privately owned microwave operators with spare capacity is an option that will be addressed in the detailed design.

Spread Spectrum Radio (SSR) technology is enjoying wide use in the commercial and industrial marketplace. Spread spectrum refers to the technology that spreads the bandwidth of a signal over a wide range of frequencies at the transmitter. At the receiver the signal is compressed to the original frequency range. The key to the process is that the receiver knows in advance exactly the technique used by the transmitter. Spread spectrum does not require facility licenses for use in several frequency bands but is constrained on the effective radiated power output. Although the equipment is not restricted to point-to-point communication, it is primarily a line-of-sight radio. Also, because of this and power output restrictions, the useful range is generally one to six miles, depending on the application and area topology. Commercially available equipment currently supports data rates of 200 Kbps, or more, capable of satisfying requirements for supporting coded video transmission of reasonable quality.

The primary advantages of SSR are in its installation flexibility, noise resistance, and relative low equipment cost and will be considered for use in the rural areas for use with field devices.

5.8 IKIR Control Center Communication

All system communication links into and out of the IKIR Data Processing and Communications Center shall be implemented with connections made through private telecommunications service providers. The general form of the service shall be point-to-point, E-1, or fractional E-1 utilizing in place microwave facilities.

5.8.1 Scope of Work

The contractor shall provide a communication system design for the IKIR Control Center using a leased telecommunications service to provide the communication linkages required for supporting the exchange of information and data with Centers and Facilities specified elsewhere in these specifications. This design shall adhere to all applicable European Telecommunications Standards Institute (ESTI) and International Consultative Committee on Telegraph and Telephone (CCITT) standards. The contractor shall specify, supply and install all items that are required to support the leased service in order to provide a complete and operational communication system for the IKIR Control Center. The Control Center Communication System shall be furnished complete, installed, tested, and operational when connected with associated equipment.

Following award of contract, the Contractor shall make site visits to verify and complete engineering design including the following as a minimum:

- The Contractor shall verify the following:
  - Data characteristics,
  - Required data rates and bandwidth,
  - Desired quality, and
  - Operational aspects of the system (e.g., dedicated/switched service, polling frequencies, full / half-duplex, etc.),

- The Contractor shall clearly define the following information:
  - Characteristics of the leased channels and equipment restrictions. These include:
    Data rates,
    Transmission characteristics and quality,
    Frequency allocations, and
    Any limitations (e.g., maximum number of multi point drops on a channel, dial-up times, etc.).
  - Estimated time to provide service.
  - Location of the nearest access point to the provider's cable,
  - Rules regarding leased circuit terminations at the central facility, including any equipment, which IRIS must furnish.
  - Complete understanding of the tariff agreement
  - Firm quotation of costs - both one-time charges and monthly fees.
  - Pending rate increase requests, if any, and an estimate of expected increases in leasing rates.
  - Maintenance responsibilities of the provider and of IRIS.

- The Contractor shall prepare and furnish submittals in accordance with the time schedules specified in the Contract. Preliminary and final designs submitted by the Contractor shall contain, as a minimum, block diagrams, installation details, device location drawings, concept descriptions, function descriptions, specific product brochures and explanations of equipment interactions.

- Perform tests to show the System is properly installed and that it meets the specifications and applicable codes and standards.

- The Contractor shall train personnel who will be responsible for operating and maintaining the IRIS Control Central Communication System.

5.8.2 Equipment Requirements

E-1 Multiplexer

An E-1 Mux shall interface the dedicated E-1 service from Motorway Control Center. Compressed video signals from the Motorway system transported by the E-1 service, shall be decompressed by Codec equipment at the IKIR Center, and routed to the specified display monitors though the video switch, as required.

Video switch
[Refer to the description of the Motorway central video switch]

Communication Service Unit / Data Service Unit (CSU/DSU)
Typical specification

Modems
Typical specification

Codec
Typical specification

5.9 MOTORWAY FIBER OPTIC COMMUNICATION SYSTEM

The Contractor shall be responsible for the design and provision of a complete Fiber Optic Communication System. As a requirement of contract award the Contractor shall take full responsibility for the design and installation of said Fiber Optic Communication System. The function of the Fiber Optic Communication System is to transport various data, voice and video communication protocols throughout the Urban Motorway system. This voice, data, and video communications system shall include a Synchronous Optical Network (SONET) based data/voice fiber optic backbone and a video image transmission backbone.

5.9.1 Work Scope

The following summary of work is a general description of the work to be included in this project. It does not necessarily include every item of work. The contractor shall provide a fiber optic backbone system, using equipment that meets or exceeds applicable European Telecommunications Standards Institute (ESTI) and International Consultative Committee on Telegraph and Telephone (CCITT) standards. The contractor shall supply and install items that meet or exceed the specified requirements herein. The Fiber Optic Communication System shall be furnished complete, installed, tested, and operational when connected with associated equipment.

Following award of contract, the Contractor shall make site visits to verify and complete engineering design. This shall include verification of sizes and routing detail of the conduit system.

The Contractor shall prepare and furnish submittals in accordance with the time schedules specified in the Contract. Preliminary and final designs submitted by the Contractor shall contain, as a minimum, block diagrams, installation details, device location drawings, concept descriptions, function descriptions, specific product brochures and explanations of equipment interactions.

The Contractor shall verify that equipment and devices furnished are adequate for the intended purpose. The Contractor shall perform a layout check to ensure that adequate access is available for construction, installation and maintenance of equipment and devices furnished.

The Contractor should perform tests to show the Fiber Optic Communication System is properly installed and that it meets the specifications and applicable codes.

The Contractor shall train personnel who will be responsible for operating and maintaining the Fiber Optic Communication System.

5.9.2 Data and Voice Backbone

The data and voice backbone subsystem shall, as a minimum, be capable of the following:

- Provide a self-healing fiber optic backbone network, capable of operating with sufficient individual nodes to accommodate the various data and voice interfaces and protocols that may be connected to the backbone. The backbone shall be capable of creating a dual counter rotating ring network utilizing only one pair of fiber cables when configured as a physical ring. Each ring may be routed on each side of the motorway to provide geographic path redundancy.

- Provide a high speed, high bandwidth, fiber optic backbone system conforming to SONET and Synchronous Digital Hierarchy (SDH) standards with an OC-3 optical transmission rate.

- Provide diagnostic capability from any one of the nodes on the backbone that allows the user to monitor all of the nodes on the backbone. A backbone network manager computer, located at the Motorway Control Center, shall support the Simple Network Management Protocol(SNMP) and interface with the Motorway main computer system to provide the operators with critical status and alarm information regarding the performance of the backbone.

- Provide as a minimum, multi-drop interface capability for RS232, RS422, RS485 and Voice. Data communications circuits from each node to its respective field devices, such as traffic detectors, weather stations, variable message signs camera control and various other device controllers as specified herein, shall be accomplished via single-mode fiber optic links. This may be accomplished through the use of field distribution hubs connected to backbone nodes via fiber optic cable operating, as a minimum, at DS-1 data speeds. The distance between nodes shall not be limited because of a particular interface type or protocol being used.

- Provide the capability for Ethernet and Token Ring connectivity with broadcast technology on the network ring. Broadcast technology provides a function that allows multiple interfaces of the same type to share the same bandwidth on the fiber optic network.

Operational Requirements - The design of the system shall include all of the equipment necessary to create a fiber optic backbone capable of transporting various interface types and protocols from node to node on the backbone, and between nodes and field devices on the distribution trunks. The speed of the aggregate signal on the fiber optic backbone shall be 155.52 Mb/s minimum. The fiber optic system shall be capable of providing the following interface types as a minimum requirement: RS232 (point to point and multi-drop); RS422 / RS485 (point to point and multi-drop); Voice (telephone ring down, PBX to Telephone, 4 wire with E & M signaling, 2 Wire multi-drop for intercom system interface); E1 (point to point interface); Ethernet (broadcast interface) and Token Ring (16 Mb/s and 4 Mb/s). The interconnections between the high speed backbone and the various field equipment may be provided for with distribution hubs co-located with the Sonnet node or located in the field in an outstation (refer to xxx for cabinet specifications). The hub equipment shall provide for the data speed and protocol interface conversions and signal multiplexing to transport multiple protocols to and from the high-speed backbone.

The system shall provide diagnostic capability that allows the user to observe the health of the optical interface of the entire network from one diagnostic station at any node in the system. The diagnostic system shall also provide visual and/or audible signals if an alarm occurs on the communications network.

Equipment Requirements - The fiber optic communication system shall consist of, but not limited to, components similar to those listed below:

- The fiber optic interface modules provided shall meet the following typical requirements: they shall have the capability to interface to single mode and multi-mode fiber optic cable; they shall be available with 850nm LED, 1300 nm LED and 1300 nm Laser optical components; and they shall generate the aggregate signal that is used on the fiber optic backbone.

- Line interface modules that are inserted into the backbone nodes or distribution hubs typically shall provide native interface to the network for various interface types specified herein. These modules shall provide interface for any standard low level protocol that is commonly used with the particular interface being employed. Modules shall be available with, but not limited to, the following interfaces capabilities: RS232 / RS422 (Synchronous and Asynchronous); RS485; V.35; Voice (2-wire telephone; 4-wire telephone) Ethernet and Token Ring.

- Video switcher and controller are specified elsewhere herein with the monitor camera equipment [Refer to the description of the Motorway central video switcher and controller].

- All equipment shall be capable of meeting the mechanical, electrical and environmental requirements of NEMA (TS2-1992) standards or the equivalent, applicable EU requirements.

5.9.3 Video Image Transmission Backbone

A video backbone shall provide the means of transporting video image signals from video cameras mounted along the Motorway to video monitors located at the Motorway control Center. Video signals from roadside cameras shall be transmitted via radial, single mode, fiber optic links to communication hubs located at the Motorway Maintenance Centers as specified on the Contract Plans. Each camera location will be equipped with a dual output optical video transmitter. Each video signal received at a node shall be inputted to a video multiplexer. The video signals shall be combined in a video multiplexer and transmitted across a redundant, singlemode, fiber optic backbone to video demultiplexers located at the Motorway Control Center. The video network shall use the same physical fiber optic cable as the voice/data network, however it will use separate fibers within the cable. The high-speed backbone fiber will be used only for fiber routing of the video. The geographical ring layout of the high-speed backbone shall be used to provide diverse routing for each video multiplexer where possible. Sending the optical video signals from each multiplexer via two geographically diverse paths shall provide redundancy. At the Control Center each optical path shall be connected to a video receiver unit that shall compare the two signals and select the strongest to be demultiplexed. The signal shall then be demultiplexed to baseband video, and put into the video switch in the Control Center and be distributed to the various monitors in the Center.

Equipment Requirements - The camera monitoring system communication shall consist of, but not limited to, components similar to those listed below:

- Video multiplexing may be accomplished using either digital or analog techniques. The equipment shall meet all applicable EU electrical, mechanical and environmental standards and specification.

- Video communications equipment shall provide for bi-directional flow of data over a single fiber optic fiber. The video image and camera feedback signals shall be transmitted from the field transceiver to the node multiplexer; camera control signals shall be transmitted from the node to the field transceiver.

- The field located fiber optic video and data transceivers shall convert a standard PAL CCTV signal and bi-directional data (PTZ) signal into a frequency modulated (FM) or pulse frequency modulated (PFM) light for transmission over a single mode optical fiber for distances of up to 60 km. The emitter of the transceivers shall be a laser diode; edge-emitting LEDs are not acceptable. The transceivers shall be provided with diagnostic LEDs and loop-back capabilities for monitoring system performance. Field located transceivers shall be either rack mounted or wall mounted as best indicated to interface with the outstation cabinet located camera control equipment.

- Control Central site multiplexer equipment shall be housed in a 19-inch EIA rack mounted chassis, or EU equivalent. Each chassis shall include a rack power supply suitably rated and protected by fusing for the electrical requirements of the transceivers. The chassis shall be mounted in an attractively designed 19-inch EIA rack cabinet designed to accommodate a minimum of eight chases. A door with Plexiglas viewing panel shall be included. All fiber optic and electrical cables shall be routed to and from the rear of the rack cabinet. A power strip shall be installed at the bottom of the cabinet to provide power to the chassis. A minimum of eight outlets shall be provided. All chassis shall be designed so that any failure in any chassis shall not short-circuit the power supply or affect the performance or operation of any other module in that chassis or within the cabinet.

5.9.4 Network Management / Diagnostics

The fiber optic communication system shall provide a facility that allows the user to manage and monitor the fiber optic backbone system. The diagnostic system shall be capable of monitoring the entire network from any one node. The diagnostic system shall consist of an interface to the node from an external computer. The Contractor shall provide diagnostic software that will operate on any IBM PC or compatible with a 486, or better, processor and supports SMNP. This software shall interface to the network via a special module, or via the fiber optic interface module, and provide the user with screens that allow the user to determine that the fiber optic backbone is operational at all nodes on both of the dual counter rotating, if applicable.

5.10 COUNTY ROAD DIRECTORATE COMMUNICATIONS SYSTEM

All communication links into and out of the County Road Directorate Operations Centers shall be implemented with connections leased through private telecommunications service providers. The general form of the service shall be point-to-point fractional E-1, and Digital Multiple Access Subscriber System (DRMASS) service.

5.10.1 Scope of Work

The contractor shall provide a communication system design for the County Road Directorate Operations Centers using leased telecommunications service to provide communication linkages required to support the exchange of information and data with IKIR Control Center and field locations specified elsewhere in these specifications. This design shall adhere to all applicable European Telecommunications Standards Institute (ESTI) and International Consultative Committee on Telegraph and Telephone (CCITT) standards. The contractor shall specify, supply and install all items that are required to support the leased service in order to provide a complete and operational communication system for the County Road Directorate Operations Centers. The communication system shall be furnished complete, installed, tested, and operational when connected with associated equipment.

Communication Link to the IRIS Control Center - The requirements for this link is covered in IKIR Control Center Communication discussion.

Communication link to Field Devices - Communications to field device outstations shall be provided by leased DRMASS. A typical configuration of a digital cordless telephone system is shown on page 5-28.

Following award of contract, the Contractor shall make site visits to verify and complete engineering design including the following as a minimum:

- The Contractor shall verify the following:
  - Data characteristics,
  - Data rates and bandwidth required,
  - Desired quality,
  - Operational aspects of the system (e.g., dedicated/dial-up communications, full/half-duplex, etc.), and
  - Field locations (e.g., outstation cabinets) included in the system.

- The Contractor shall clearly define and understand the following information:
  - Characteristics of the leased channels and equipment restrictions. These include:
    Data rates,
    Transmission characteristics and quality, and
    Any limitations (e.g., maximum number of multipoint drops on a channel; dial-up times, etc.).
  - Capability of the provider to furnish service to the field locations and capability for expansion.
  - Estimated time to provide service.
  - Location of the nearest access point to the provider's connection from each field cabinet, and the division of work between the provider and user in connecting to this point. Determine who shall provide conduit or other facilities from the termination point into the cabinet.

- Rules regarding leased circuit terminations at the field cabinets, and any special requirements for isolating the provider's lines from controller equipment. Rules regarding leased circuit terminations at the central facility, including any equipment, which the contractor must furnish.
- Complete understanding of the tariff agreement.
- Firm quotation of costs - both one-time charges and monthly fees.
- Pending rate increase requests, if any, and an estimate of expected increases in leasing rates.
- Maintenance responsibilities of the provider and of the Counties.

- The Contractor shall prepare and furnish submittal data in accordance with the time schedules specified in the Contract. Preliminary and final designs submitted by the Contractor shall contain, as a minimum, block diagrams, installation details, device location drawings, concept descriptions, function descriptions, specific product brochures and explanations of equipment interactions

- The Contractor shall perform tests to show the system is properly installed and that it meets the specifications and applicable codes and standards.

- The Contractor shall train personnel who will be responsible for operating and maintaining the IKIR Control Central Communication System.

5.10.2 Equipment Requirements

Wireless communications equipment shall consist of the following transmission equipment:

- Communication Service Unit / Data Service Unit (CSU/DSU)
- Hayes compatible data modem (9600 bps minimum)
- Subscriber Terminal (Interface to DRMASS)

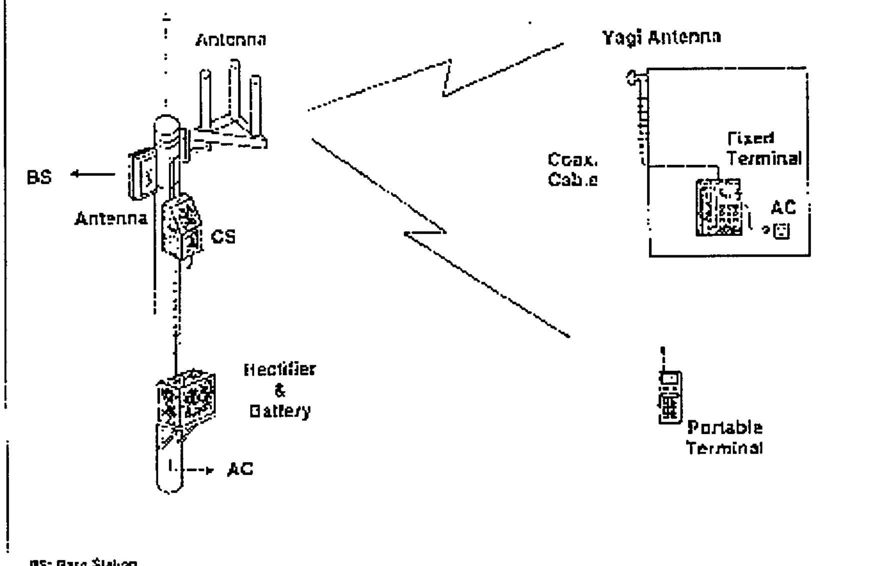


Exhibit xxx - Typical Configuration of Digital Cordless Telephone System (DCTS)

IRIS - HUNGARY

TDA

IKIR - MAGYARORSZAG

IRIS TDA Project
Wilbur Smith Associates

SECTION 6
DEPLOYMENT

Section 6
DEPLOYMENT

6.1 PHASED IMPLEMENTATION

The deployment of the IKIR will be accomplished in a manner which facilitates early implementation of the following functional components:

- Real-time exchange and dissemination of real-time traffic and incident information

- Motorway Traffic Monitoring and Control (M0, M1, M7)

- County Road Management

- Coordination with existing traffic management, information and planning functions

The implementation of IKIR will require an extensive amount of communications. Realistically, an initial deployment of the elements above in a timely fashion will involve two distinct levels of implementation. These will be based on the following:

- Initial implementation of wireless communications for communication to counties and deployment of fiber optic communications on urban motorway sections (Phase 1)

- Deployment of fiber optic trunk services along all motorways (Phase 2)

The Phase 1 and 2 deployments are described in the remainder of this Section. Deployment is discussed in terms of the four main functional components of IKIR:

- real-time information;
- motorway control and monitoring;
- county road management; and
- coordination of existing transportation activities.

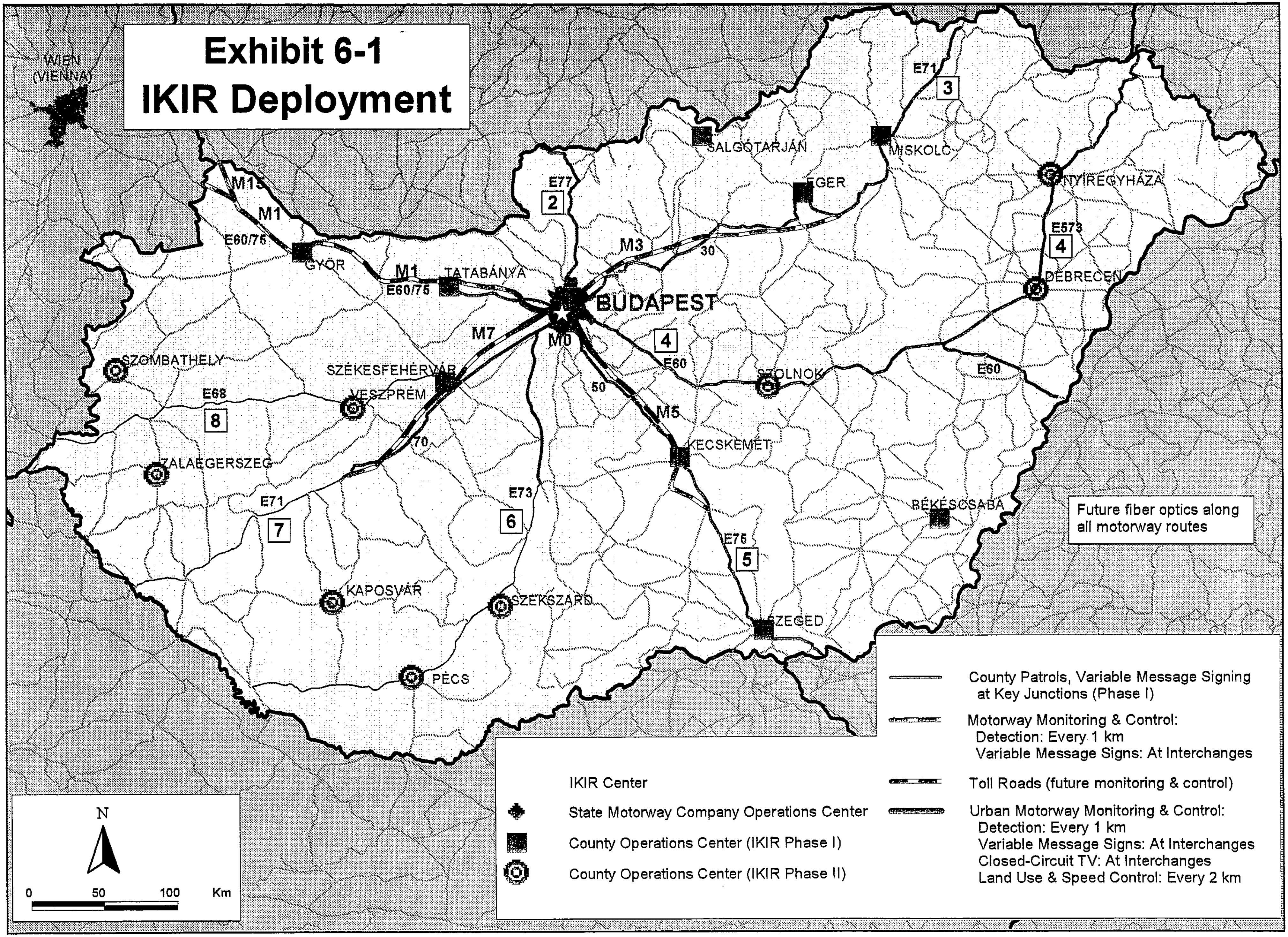
IKIR deployment is illustrated on the map in Exhibit 6-1.

6.2 REAL-TIME INFORMATION

6.2.1 IKIR Data Processing and Communication Center

Description: The IKIR Center will include processing and display capabilities to collect and disseminate traffic and weather information obtained from the motorways and counties. It will include all facilities to disseminate information to the World Wide Web (Internet), to kiosks, to UTINFORM and FOVINFORM, the media and third-party information providers, and to roadside radio facilities. It will permit automated data access for motorway and county operational purposes.

Exhibit 6-1
IKIR Deployment



Location: Budapest region (may be co-located with Motorway Control Center.
Communications: *Phase 1* - Dedicated E-1 links to Motorway Control Center and County Control Centers; dedicated analog phone links to roadside radio transmitters (estimated 100 total, located in 11 counties incorporated into IKIR). Dial-up analog phone lines to be provided to kiosks. Dedicated phone lines to UTINFORM, FOVINFORM, third-party providers, Border Crossings and Police will be provided; police line may be dedicated E-1 should they desire to receive video data.

Phase 2 - Fiber optics links to Motorway Control Center (unless co-located), selected County Centers and Roadside Radio locations, E-1 links to other County Centers and Roadside Radio Locations. Dial-up phone lines to kiosks will remain, except when located near fiber optics trunk; in those cases, kiosks may be tied into fiber optics system.. Ultimate deployment will be configured as Wide-Area Network.

6.2.2 IKIR Roadside Broadcast Transmitters

Description: AM or FM-frequency radio broadcast transmitters will be in the vicinity of all "IKIR intelligent intersections," locations where route decisions are made along either Motorways or highways. Broadcasts are made in three (3) languages: Hungarian, German and English. The information content consists of traffic data, weather data, and routing data, which will be customized to the location.

Locations: 100 radio transmitters will be provided at locations to be determined during detailed design based upon the above criteria.

Communications: *Phase 1 and Phase 2* - Dedicated phone line to Motorway Control Center; information to traveler through standard AM or FM radio frequencies.

6.2.3 IKIR Kiosks

Description: IKIR kiosks will be located at various locations throughout Hungary: border crossings, roadside rest stops on motorways and other highways, urban trip centers in Budapest and other cities. Kiosks are used to disseminate IKIR traffic, weather, routing, and other tourist data. Traffic and weather information will be downloaded to the kiosks at five minute intervals from the IKIR Center.

Locations: To be determined in detailed design; total quantity will be based upon available funding.

Communications: *Phase 1 and Phase 2* - Dedicated phone line to IKIR Center, dial-up as needed for upload of user inputs, IKIR download of real-time data and user-requested information.

6.3 MOTORWAY CONTROL AND MONITORING

6.3.1 Motorway Control Center

Description: The Motorway Control Center will house traffic management software and hardware for motorway lane control stations and Variable Message Sign (VMS) displays, along with control and monitoring capability for Roadside Video Cameras, and monitoring and analysis software for Traffic

Detector Stations. It will also provide facilities for data collection and monitoring of Weigh-in-Motion stations for sharing with the IKIR Center. Facilities for sharing traffic data and current VMS displays and control schemes with IKIR will be provided. The Control Center will also control future Ramp Metering systems.

The multiple control systems and monitoring capabilities will be operable from integrated user interfaces on graphical workstations. Response to calls from motorway-based emergency phones (existing) will be provided at the center. Strategies related to specific traffic flow and incident information and lane closures will be stored in the system and selectable either automatically or by the operator. Exchange of traffic and incident data will be possible with the Budapest Traffic Management Center (city of Budapest).

Location: In Budapest area, convenient to motorways (may be co-located with IKIR Center).

Communications: *Phase 1* - Dial-up phone lines or microwave links to be provided to Motorway Lane Control Stations, Variable Message Sign Displays, Traffic Data Stations and Weigh-In-Motion Stations on motorways. Dedicated digital phone links (E-1) or microwave links will be connected to video cameras; these links will include appropriate video digitization equipment permitting near-full-motion video to be displayed. Emergency phone services will be rerouted from current locations at motorway maintenance centers to Motorway Control Center.

Phase 2 - Installation of fiber optics from Control Center to above locations, utilizing existing and new conduit, will be done along all motorways; this may be done in a staged manner for specific areas of the motorway, based on funding, current projects, and new roadway installations.

6.3.2 Roadside Variable Message Sign (VMS) Display Units

Description: Motorway VMSs will be controlled by the Motorway Control Center, with messages being either automatically or operator-generated based on current and predicted conditions. Information content will include traffic conditions (e.g. incident ahead, expect delay of *x* minutes), roadway safety advisories (e.g. icy road ahead) and routing information (e.g. Alternate route to ......). Operator interface will permit overriding pre-programmed or automatically-generated message content. VMS displays will utilize fiber optic or LED displays, utilizing a combination of white or amber message displays (up to three lines) and white and red symbols to augment text displays. These symbols will include road work, accident, slippery road, road closure symbols.

Locations: VMS will be located at 2 km intervals along M0; VMS will be located on M1, M5 and M7 2 km in advance of the M0 junctions (both directions). VMS will also be installed on M7 westbound 2 km from the first exit to Lake Balaton.

Communications: *Phase 1*- Provide dedicated phone lines or microwave links to Motorway Control Center from each sign. Information received by the VMS controllers will include message selection and removal commands along with diagnostic commands. Information transmitted by the VMS controllers will include current message displayed and information on current pixels not operational.

Phase 2 - Connect VMSs to fiber optics links as they are installed along motorways.

6.3.3 Traffic Detector Stations

Description: Traffic detection stations are located on urban motorway sections to detect incidents and collect traffic flow information. The detection stations will comprise two inductive loops mounted 2 meters apart in each lane of the road in both directions (utilizing a "speed trap" configuration), connected to a microprocessor on the roadside that will store data for up to one hour and disseminate collected data at one-second or longer intervals to the Motorway Control Center. In each lane, the detector configuration supports all traffic parameter data collection (e.g. speed, volume, occupancy). Under Phase 2, Detector Stations will support Ramp Metering operations at motorway entrance ramps. At selected locations, Weigh-in-Motion detection will be incorporated into Traffic Detection Stations.

Locations: In Phase 1 detector stations will be installed at 1 km or shorter intervals on all motorways (except toll roads), with detector loops installed on entrance and exit ramps in addition to the motorway lane detection. In Phase 2, detector stations will be installed on toll road facilities.

Communications: *Phase 1*- Each detector station microprocessor will be linked to the Motorway Control Center via a dedicated phone line or microwave link. Detector stations will receive operational parameters and diagnostic commands from the motorway center and will transmit current volume, occupancy and speed data.

Phase 2 - Detector stations will be connected to fiber optics communications as they are installed on each motorway.

6.3.4 Roadside Video Camera Stations

Description: Roadside Video Camera Stations will provide the ability for motorway operators to verify incidents and lane blockages along with congested conditions. Camera control at the Motorway Control Center will permit pan, tilt, iris open/close and zoom functions for each camera. Camera outputs are transmitted to the control center for display on the panel displays. Camera output will be routable (split) from the Control Center to the Police upon demand. Cameras are to view approximately ½ km of roadways on all sides of the camera; this typically requires cameras to be mounted on a stiffened steel pole at a height of approximately 14 meters.

Location: *Phase 1* - Cameras will be mounted at strategic interchanges and congestion points along the M0 motorway, with spacing of approximately 1 km.

Phase 2 - Cameras will be mounted at strategic locations along the M1 and M7 motorways, near high-accident and high-congestion locations, as well as along the M1, M3 and M5 toll roads and future motorways.

Communications: Cameras will transmit video images and current camera status information to the Motorway Control Center and to other secondary users, including police. Cameras will receive pan, tilt and zoom commands along with iris open/close commands from the Motorway Control Center or from secondary users when the motorway center operator is not monitoring the cameras. Leased E-1 communications will be used between the centers and cameras, with fiber optics used as the cables are installed along motorways.

6.3.5 Motorway Lane Control Signal Stations

Description: Lane control stations provide overhead lane control signals and speed indications, connected to a roadside computer for processing and communications with the Motorway Control Center. Lane use indications display one of the following symbols: open lane (up arrow), closed lane (red X), merge to the left (arrow up and left), and merge to the right (arrow up and right). These are augmented by speed indications. Control indications are based on stored incident and congestion response plans, modified as appropriate by the motorway operator, and sent to the lane control station for implementation.

Locations: Deploy at 250 meter intervals along M0 motorway and on approaching M1, M5 and M7 sections within 5 km of M0. During Phase 2 additional lane control stations will be deployed on other congested sections of motorways.

Communications: *Phase 1* - Utilize dedicated phone lines or microwave to connect Lane Control Stations to Motorway Control Center. Data sent to Lane Control Station includes display commands for lane control and speed. It is updated on a one-minute basis. Data sent to Motorway Control Center shows current display status, as well as any failure alarms and information identifying burned-out pixels.

6.3.6 Motorway Emergency Phones (Call-Boxes)

Description: IKIR will utilize existing emergency call-boxes located at various motorway locations both within and outside the Budapest urban area. Emergency call-boxes are located at 1-2 km spacing on the shoulder of the roadway. Call-box emergency calls will be processed at the Motorway Control Center rather than the motorway maintenance center as is existing. Under phase 2, new emergency phones may be considered for locations not currently served. These phones would utilize radiophone (cellular) technology in combination with self-sustaining solar power.

Locations: Use existing emergency call-box locations during Phase 1. In Phase 2 for locations without emergency phone coverage, or where existing phones need to be replaced for maintenance reasons, use new technology emergency phones at 1- 2 km spacings.

Communications: *Phase 1* - Use existing dial-up phone lines.

Phase 2 - Utilize radiophone (cellular GSM) technology. Communications consists of two-way voice communication. Radiophone technology will permit digital transmission of physical phone location data without requiring traveler to state the phone identification number or location.

6.3.7 Motorway WIM Stations

Description: Weigh-in-Motion (WIM) data collection stations will be co-located with selected traffic detector stations. Each station consists of a pavement WIM sensor (Piezoelectric) set between the loops in each lane (there will be 2 meters longitudinal spacing between loops in the same lane for speed and classification measurement). These sensors will communicate with a roadside computer for processing and communications with the Motorway Control Center and ultimately, using the communications network, IKIR and the police department.

Location: WIM sensors will be located on M0, beyond each junction with another motorway, for example, sensors will be located on westbound M0 west of M5 and M7, and on eastbound M0 east of M1 and M7. Additional sensor stations have been designed and installed, but without a roadside computer to collect and disseminate information. New WIM field computers (possibly co-located with traffic detection stations) are to be deployed where WIM existing sensors are installed but not connected.

Communications: WIM sensors will share the traffic detection station communications system, with weight information being sent from the station to the Motorway Control Center. Future two-way communications will be provided depending on automatic vehicle identification technology selected for receiving vehicle information.

6.3.8 Motorway Roadside Weather/Environmental Data Collection Stations

Description: Existing roadside weather and environmental data sensors will be incorporated with new sensors at weather/environmental data collection stations at various motorway locations. Each station consists of the roadside weather collection devices, the in-pavement sensors for icing and the roadside computer for processing and communications with the motorway center. Routing of the data would be via a communication hub at the motorway maintenance center. Information would be sent to the Motorway Control Center for dissemination via VMS, as well as through the IKIR Center.

Location: *Phase 1* - At or near existing weather sensor locations.

Phase 2 - Additional stations to be identified and deployed.

Communications: Dedicated phone line or microwave link to Motorway Maintenance Centers. Data to stations consists of operational parameters and diagnostic commands. Data to maintenance centers includes sensor status, sensor type, and sensor reading.

6.3.9 Motorway Ramp-meter Stations (Phase 2)

Description: Ramp-meter stations would be installed during Phase 2 IKIR deployment. Ramp meter stations are located on motorway entrance ramps. Each station comprises loop detectors at the stop line (two before, one after) and the start of the ramp (also known as a queue detector), a tri-color ramp signal and local controller for communications with the Motorway Control Center. Metering would occur during periods where motorway speeds are irregular and below the speed limit (beginning stages of congestion). Area-wide ramp-metering is performed at the motorway center, with control parameters sent to the local ramp meter station for implementation. Local metering is a default option during periods of localized congestion and construction. Traffic detector stations upstream and downstream of the ramp meter are connected to the ramp meter for local metering. In this case the ramp-meter controller serves the dual purpose of a traffic detector station computer in relaying traffic data to the Motorway Control Center.

Location: *Phase 2 only* - At entrance ramps to M0 and approaching motorways (M1, M5, M7) to approximately 5 km before M0.

Communications: *Phase 2 only* - Sent to the ramp metering station will be upstream and downstream traffic flow information, desired meter rate, meter enable / disable command. Sent to the Motorway Control Center will be current detector flow information on ramp, current meter status, and current meter rate. Communications may be via dial-up phone line, microwave link or fiber optics along motorway (when installed).

6.3.10 Motorway Maintenance Centers

Description: Motorway maintenance centers (depots) on M1, M7 and other motorways currently exist and serve as dispatch centers for maintenance vehicles and snow plows as well as response locations for emergency call box call-ins. For IKIR, the maintenance centers, in addition to current vehicle dispatch functions, will be able to track locations of patrol and snow plow, vehicles utilizing Automatic Vehicle Location (AVL) systems. These would permit collection and assessment of vehicle location coordinates for travel time data using AVL software at the center. Other functions associated with the AVL subsystem are external to the IKIR scope. Under the Phase 2 fiber optics communications scheme, motorway maintenance centers may also serve as communication hubs to route other traffic and weather data from the weather stations to the Motorway Control Center. IKIR will also permit maintenance yards to access current traffic flow condition information being brought back to the control center.

Locations: Existing centers along M0, M1, M5, M7.

Communications: *Phase 1* - Dedicated phone lines for data exchange with Motorway Control Center. If video is desired, lines would consist of digital E-1 connections. Communications to the maintenance center from AVL-equipped vehicle would use radio communications utilizing GPS coordinates as well as voice channels. Communications to vehicles would involve both voice channels and transmission to mobile data terminals of key information, advisories and requests. Call-box transmission would be funneled directly to Motorway Control Center.

Phase 2 - Fiber optics would be used for control center-maintenance center communications; these would be trunk links. Secondary links from the maintenance center to weather stations might continue to use either dedicated land-line phone services or radiophone data transmission depending on location. AVL would continue to be wireless.

6.3.11 Motorway Maintenance Vehicle AVL Subsystem

Description: Motorway maintenance vehicles are to be equipped with AVL equipment through which vehicle location data can be transmitted to the motorway maintenance center for further processing and generation of travel time estimates. Other functions associated with the AVL equipment are external to the IKIR scope, but would benefit management and operation of maintenance services for the motorway company.

Location: On motorway patrol and maintenance vehicles.

Communications: Two-way shortwave or radiophone communications using transmission of GPS coordinates to maintenance center. System may also include mobile data terminals for exchange of text messages between maintenance center and vehicle.

6.4 COUNTY ROAD MANAGEMENT

6.4.1 AKKT Control Center

Description: Each AKKT control center houses all the computing and communication facilities used to manage the traffic on the highways within the county. The control center is a fully equipped traffic management center, including operator workstations and video display capabilities as needed in counties where monitoring of key bridges and tunnels is required.

Strategies for local traffic diversion based on reported accidents and weather conditions are stored in the local workstations as operations plans and can either be selected automatically or by the AKKT operator in conjunction with specific conditions. Coordinated strategies may be implemented in cooperation with the Motorway Control Center. Operator intervention is permitted in all functions.

Communication interfaces with the IKIR center and Motorway Control Center will be required to implement joint operations strategies as well as to provide IKIR with county highway information and receive from IKIR motorway traffic flow and control status. The AKKT Control Centers will also include AVL software to compute travel time estimates based on location data received from AVL-equipped maintenance vehicles. WIM data from in-road sensors (on highways) is also collected and forwarded to IKIR for further processing. AKKT Control Centers include traffic signal monitoring software. However, the signal equipment itself is not considered within the IKIR scope.

Locations: In Phase 1 eleven existing county (AKKT) operations centers will be incorporated (Gyor, Tatabanya, Pest, Szekesfehervar, Kaposvar, Kecskemet, Szeged, Bekescsaba, Eger, Miskolc and Salgortarjan). During Phase 2 the remaining county centers will be incorporated.

Communications: *Phase 1* - Dedicated E-1 links between IKIR center and county control centers; dedicated analog phone links to roadside devices, including VMS and intersection traffic signals. E-1 links to video cameras located near bridges or key locations will be identified. Utilize radio for AVL communications. Information sent to IKIR will include link travel time, weather and incident information, along with status and display of VMS. Information to AKKT center from IKIR will include motorway traffic flow, incident, and VMS/lane control display data where relevant to the specific county. AKKT center will also send control commands to VMS and video cameras and receive VMS and traffic signal display status plus images from video cameras.

Phase 2 - When installed, utilize fiber optics link to IKIR center plus motorway control center depending on routing and installation of fiber. Continue utilizing leased or wireless communications except where communications (fiber or copper) is being deployed for other activities, e.g., traffic signal system operations.

6.4.2 Roadside VMS Display Units

Description: VMS display stations will be provided at key points in the highway network, particularly in the vicinity of the 100 proposed intelligent intersections to be identified in the detailed design. These VMS's will be controlled by the operator at the AKKT center with messages being automatically or manually generated based on current and predicted conditions. Information content will include traffic conditions (e.g. incident ahead, expect delay of *x* minutes), roadway safety advisories (e.g. icy road ahead) and routing information (e.g. Alternate route to ......). The operator interface will permit overriding pre-programmed or automatically-generated message content. VMS displays will utilize fiber optic or LED displays, utilizing a combination of white or amber message displays (up to two lines) and white and red symbols to augment text displays. These symbols will include road work, accident, slippery road, road closure symbols.

Locations: VMS will be located on two to four approaches at up to 100 intelligent intersections, located at decision points near a motorway or bridge crossing.

Communications: Provide dedicated phone lines or microwave links to appropriate AKKT Control Center from each sign. Information received by the VMS controllers will include message selection and removal commands along with diagnostic commands. Information transmitted by the VMS controllers will include current message displayed and information on current pixels not operational.

6.4.3 Traffic Detector Stations

Detection: Traffic detection stations will be located on rural highway sections primarily to collect traffic flow information on roadways connecting with intelligent intersections for route monitoring and for planning purposes. Existing loops used for traffic counting purposes may also be incorporated. Surveillance data will be used by the AKKT Control Center to identify congested conditions. However, the density of surveillance is not sufficient for automatic incident detection. A detection station comprises loops on every lane of the road in both directions with a connection to a roadside microprocessor unit for data processing and communications. In each lane, the detector configuration supports all traffic parameter data collection, for example, speed, volume, occupancy etc.

Location: On highway approaches to intelligent intersection locations, mounted at least 100 meters from the intersection in each direction along the numbered-highway approaches.

Communication: Dedicated phone line or microwave link to AKKT Control Centers. The detector station will receive configuration and parametric data from AKKT centers, and will send back detector data either real-time or stored for a period of up to one week (for planning purposes).

6.4.4 Roadside Video Camera Stations

Description: Roadside video camera stations are located at key tunnels and bridge crossings. Roadside video camera stations will provide the ability for AKKT operators to verify incidents and lane blockages along with congested conditions. Camera control at the AKKT Control Center will permit pan, tilt, iris open/close and zoom functions for each camera. Camera outputs are transmitted to the control center for display on the panel displays. Camera output will be routable (split) from the

Control Center to the Police upon demand. Cameras are to view approximately ½ km of roadways on all sides of the camera; this typically requires cameras to be mounted on a stiffened steel pole at a height of approximately 14 meters.

Location: *Phase 1* - Cameras will be mounted at either side of highway bridges over the Danube and Tisza Rivers within the eleven counties where AKKT centers will be deployed in Phase 1.

Phase 2 - Cameras will be mounted at either side of highway bridges over the Danube and Tisza Rivers within the eight additional counties where AKKT centers will be deployed in Phase 2.

Communications: Cameras will transmit video images and current camera status information to the AKKT Control Center and to other secondary users, including police. Cameras will receive pan, tilt and zoom commands along with iris open/close commands from the AKKT Control Center or from secondary users when the AKKT center operator is not monitoring the cameras. Leased E-1 communications between the AKKT center and video cameras will be utilized.

6.4.5 AKKT Highway Emergency Phones (Call-Boxes)

Brief Description: IKIR will utilize information from existing emergency phones along with personal radiophones; this will be processed through the AKKT Control Center and the information sent to the IKIR center. No new field installations are proposed.

6.4.6 AKKT Highway Weigh-in-Motion (WIM) Stations

Description: Existing WIM data collection stations are located at various highway locations, but do not currently include permanent roadside processing capability. Each station consists of a pavement WIM sensor (Piezoelectric) and a roadside computer for processing and communications with the motorway center. WIM data is routed to the AKKT center for further processing and forwarding to the IKIR commercial vehicle system. Phase 2 deployment will permit adding vehicle classification processing at the local station for use in commercial vehicle tracking or the computation of travel time. Added classification software will be required at the AKKT center for Phase 2.

Location: In Phase 1 processors will be installed at existing WIM stations along highways in the 11 counties where AKKT centers will be deployed. During Phase 2 processors will be installed at existing WIM stations along highways in the remaining 8 counties where AKKT centers will be deployed. Install new WIM stations where desired in the future.

Communications: Utilize dial-up phone line communications. Weight and classification (Phase 2) information will be sent from the station to the Motorway Control Center.

6.4.7 AKKT Roadside Weather/Environmental Data Collection

Description: Existing roadside weather and environmental data sensors will be incorporated with new sensors at weather/environmental data collection stations at various county locations. Each station consists of the roadside weather collection devices, the in-pavement sensors for icing and the roadside computer for processing and communications with the AKKT Control Center. Data would be sent to the AKKT Control Center for dissemination via VMS as well as through the IKIR center.

Location: *Phase 1* - At or near existing weather sensor locations. Phase 2 additional stations to be identified and deployed.

Communications: Dedicated phone line or microwave link to AKKT centers. Data to stations consists of operational parameters and diagnostic commands. Data to maintenance centers includes sensor status, sensor type, and sensor reading.

6.4.8 AKKT Maintenance / Patrol Vehicle AVL Subsystem

Description: AKKT maintenance and patrol vehicles are to be equipped with AVL equipment through which vehicle location data can be transmitted to the AKKT control center for further processing and generation of travel time estimates. Other functions associated with the AVL equipment are external to the IKIR scope, but would benefit management and operation of maintenance services for the county.

Location: On AKKT patrol and maintenance vehicles.

Communications: Two-way shortwave or radiophone communications using transmission of GPS coordinates to each AKKT center. System may also include mobile data terminals for exchange of text messages between AKKT center and vehicle.

6.5 COORDINATION OF EXISTING TRANSPORTATION ACTIVITIES

6.5.1 Border Crossing Center

Description: Each Border Crossing Center will house computing and communication facilities used to manage the collection and dissemination of commercial vehicle credential and permit data. Operator intervention will be permitted in all functions. The center includes all the software to manage the WIM, VMS and license plate readers at the border crossing. Each processed vehicle constitutes an entry in the database which includes: vehicle registration, license plate number, weight, owner, credentials, permit, etc.

Locations: Installations will be at 16 border crossing sites initially, all border crossings in the future.

Communications: Leased land line phone or microwave communication interfaces with IKIR will be provided to send and receive credential data.

6.5.2 Border Crossing VMS Display Units

Description: VMS displays will be located in the vicinity of the border crossing WIM sensors to alert commercial vehicle drivers to an overweight status and the requirement to stop for permit processing. VMS displays will be under the control of the border crossing operator who may override any automatically determined message (e.g. ALL TRUCKS MUST STOP). VMS may also be used for general traffic in the vicinity of the border crossing, but these displays will be under the control of the appropriate AKKT or motorway control center. VMS displays will utilize fiber optic or LED displays, utilizing a combination of white or amber message displays (up to two lines) and white and red symbols to augment text displays. These symbols will include stop ahead, road work, accident, slippery road, road closure symbols.

Locations: VMS will be located ahead of WIM sensors at 16 selected Border Crossing Centers. Additional VMS will be installed as additional Border Crossing Centers are added to IKIR.

Communications: VMS will be connected to the Border Crossing Center. Information received by the VMS controllers will include message selection and removal commands along with diagnostic commands. Information transmitted by the VMS controllers will include current message displayed and information on current pixels not operational.

6.5.3 Border Crossing WIM/Classification Sensor Station

Description: WIM and other classification sensors will be located at the border crossing approaches. Existing sensors will be used, with processors installed at the roadside, storing and routing information to the Border Crossing Center. Alternatively, the sensors may be directly connected to the computer at the Border Crossing Center. At those crossings where WIM sensors are not used, classification sensors may still be employed under the same general configuration.

Locations: Border crossings with existing WIM sensors but no processing equipment.

Communications: Direct wiring between roadside processor and Border Crossing Center. Alternatively, wireless radio links may be used.

6.5.4 Border Crossing License Plate Reader Units (Phase 2)

Brief Description: An option exists to install license plate readers at the border crossing approaches to automatically read front and back plates for entry to the data record. License plate readers would be particularly useful for completing the record entry for a vehicle which is not overweight and which continues without stopping through the border station check.

IRIS - HUNGARY

TDA

IKIR - MAGYARORSZAG

IRIS TDA Project
Wilbur Smith Associates

ANNEX A

ANNEX A

A.1 DEVELOPMENTAL PRIORITY

After the political changes in 1989-1990, the productivity of the economy fell significantly, and so did the transportion traffic. The Ministry had to react to these changing circumstances and had to prepare a long-term Traffic Policy which determines the main objectives of this complex system.

A.2 THE HUNGARIAN "TRAFFIC POLICY"

The Hungarian "Traffic Policy" was written after widespread professional preparation and discussion.

The Policy assume that by the year 2000:

- development of traffic infrastructure will accelerate, so that it can match the optimal speed of economy, therefore, satisfying EC requirements;
- the society's levels of demand and its structure will gradually grow to match citizen's expectations; and
- ability to carry the traffic load.

This statement implies the fulfillment of transportation's leading role, but also takes reality into account. Its not now a goal to achieve the traffic development level of Western countries.

The policy was prepared in 1993, when:

- 87% of all public transportation (people) occurred on the roads (calculated in passenger km's). For freight transportation, the ratio is 45-46% (calculated in product tonnes-km).
- Road transportation had the highest risk of all. The ratio of accidents on the road to the number of motor vehicles were significantly higher than in countries with the same motor vehicle level. Between 1980 and 1990 the number of people dying in car accidents has doubled. The loss for the economy resulting from these accidents total for more than 50 billion ft.
- In the area of environmental protection, old vehicles are not the only problem, there is the lack of traffic infrastructure, too. (lack of detours, highways, signs, etc.)

The Policy states, that in Western countries traffic infrastructure and services have been developed decades earlier. It also determines that every unit of investment serving traffic development has a 2.5-3 unit worth of effect on the area's private investments. Based on this, transportation industry stands in second place in economy booming effect after telecommunications.

In the long-term, Hungary expects to be accepted as a full member of the European Community. The economic model calculates a 2.8-3.3% annual GDP growth between 1993 and 2005. While in the first period, 1993-1995, there will not be any increase; it is expected to be 3.5-4.0% annually between 1997-2005. Exports are expected to grow 5-6% annually.

Service - export are the most promising areas in foreign trade. Hungary may be a central point based on its geographical location.

The policy states the following four goals, based on the conditions above:

- help European integration;
- help the balanced development of the country;
- protect human life and the environment; and
- help economical development, with effective traffic control.

An important part of the European's integration is the building of the European highway system through Hungary (between Western Europe and the Balkans, and Northern Italy and the Ukraine).

The Policy determines the basic principles for public transportation and the main points of developing the integration of passenger and freight transportation.

In the area of life and environmental protection, it seeks to raise traffic safety and safer transportation of hazardous materials.

Effective traffic control has to contribute to the growth of market economy, to lead to higher competitiveness. Its most cases, this requires modification of the institutional and legal framework to serve market conditions.

The Policy clearly supports the modernization of roadway infrastructure, development of traffic control, improving traffic safety and also, last but not least, the usage of European systems, technics to help achieve European conformity. The development of IRIS would help the succession of all of the above.

A.3 ROAD FUND

The Road Fund was established in 1992 by the Hungarian Parliament. The Fund is a separate government fund for the maintenance and development of the national road system. The Minister of Transport, Communications and Water Issues is in charge of the Fund. The financial transactions of the Fund is managed by a bank chosen in agreement with the Finance Minister.

Resources of the Fund include:

- incomes from gas sales and usage;
- certain part of the vehicle tax;
- several fees, penalties, etc. paid to road operators (e.g., overweight penalty);

- loans, interests on deposits;
- incomes from sales of equipment;
- other incomes and financial support;
- support from the central budget; and
- refund on the AFA (general consumption tax).

In order to preserve the value of incomes above, the rate of gas consumption contribution has to be matched every year to the growth rate of gas consumption tax. It is done in a way so that the own liabilities of the Fund would grow at least the same rate as the consumption tax.

The expenses of the Fund should cover the development, maintenance of the State-owned roads, including bridges, monuments and parts. It also has to finance the:

- interest payments on loans for development and maintenance;
- costs of road control, manager agencies and investment expenses;
- its own expenses;
- all taxes on equipment, asset or service purchases made in connection with road maintenance or development.

The main planned expenses from the Fund between 1996-1999 are as follows:

NAME	1996	1997	1998	1999
Road Service	5,760	6,700	10,000	11,500
Road Maintenance	10,200	18,100	20,300	24,000
Development	10,903	13,485	18,900	16,940
Loan Repayments	13,910	16,020	16,510	16,720
Financial Transactions	13,572	15,150	17,840	19,340
TOTAL	**55,345**	**76,455**	**83,550**	**88,500**

In million ft.

As a summary, the Fund assures a flexible way of doing business. Based on the advice of the road organization, the Minister decides on its usage. This means, that the **Minister, responsible for the success of the Policy, probably supports all projects** which not only adapt the European standards but also help to protect the environment, raise traffic profitability and promote safety.

A.4 BUDGET ALLOCATION

National road maintenance and development is financed by the "Road Fund." The following table shows expenditures by purpose 1990-1995.

NAME	1990	1991	1992	1993	1994	1995
Road Service	2,137	3,392	3,466	4,450	5,355	5,877
Road Maintenance	3,350	2,937	5,283	8,089	12,459	10,058
Development	5,425	5,444	10,682	16,812	24,862	9,029
Credit Payments	--	--	241	2,797	6,180	12,317
Financial Transactions	711	117	1,675	3,309	3,924	6,580
TOTAL	**11,623**	**11,890**	**21,346**	**35,457**	**52,780**	**43,861**

In million forint (ft)

A.5 EXISTING BORROWING AUTHORITY

In the preceding section we have shown that the financial support of the project seems to be insured by the Road Fund, with its continuous, stable value income. The Ministry and other connected organizations are professionally committed to this. Also, many IRIS predecessors are already in operation; they are the future parts of the project.

According to our current knowledge, a loan might not be necessary to finance IRIS. The State will examine the necessity and the possibility of a loan, based on the situation of the Road Fund then, and the connections with other loans. As shown previously, the Road Fund is substantially burdened by the payments of earlier loans. These are loans from IBRD, EBRD, EIB, and from domestic financial institutions. Therefore, the financial and technical schedule of the project is a very key point in the Feasibility Study.

A.6 PROCUREMENT PROCESS

The Parliament created the 1995.XL. Procurement Law in order to shape government expenses. Its most important goal, however, was to improve the visibility and controllability of public monies use, and to keep the procurement competition clean.

The authority of the law includes the certain public companies, such as the County Road Maintenance Company or the State Road Maintenance and Information Company from June 1, 1996. It also covers all purchases in connection with their public activity if the amount exceeds the one determined by the annual budget. It is illegal to separate these purchases to avoid the law.

The law orders that the buyer cannot discriminate among applicants. During the process, foreign-based applicants should be handled according to the principles in international contracts by the Hungarian Republic.

The procurement process can be open by invitation or by negotiation. During the open process anybody interested can make an offer. If the process is invitational, only those can participate invited by the firm asking for offer.

The firm asking for offer can make a summary of all procurements reaching or in excess of the amount determined by the law. This should be made by March 31; its goal is to inform market players. An announcement containing the summary can be issued in a set pattern. It is to be issued in the "Procurement News" (Kozbeszerzesi Ertesito). It can appear in other media only after the issue in the "Procurement News." If a foreign-based firm is allowed to participate, the announcement can be issued in foreign papers, too. In this case, the foreign translation of the summary can also appear in the "Procurement News."

The firm asking for offer can specify the certification of the applicant's financial, economical, and technical suitability; only the way described in the law.

The firm asking for offer can judge the offers conforming the conditions based on:

- the lowest price; or
- the most advantageous one as a whole.

The judging conditions have to be determined in advance. If the firm wants to choose the most advantageous offer, it also has to determine the order of importance of all conditions. These deal with the level of the object, size of the price and its mean and other circumstances.

IRIS - HUNGARY

TDA

IKIR - MAGYARORSZAG

IRIS TDA Project
Wilbur Smith Associates

ANNEX B

Annex B
IKIR Functional Requirements

INTRODUCTION

System functional requirements have been defined for each of the four operational components of IKIR. Requirements have been further grouped in sixteen major categories as follows:

- Real-time Information
  - 1.0 IKIR shall provide traveler information to all motorists and operations agencies, including roadway operations, planning and data collection agencies, private businesses and service providers.
  - 2.0 IKIR shall provide route guidance information.
  - 3.0 IKIR shall develop route guidance strategies in response to real-time conditions.

- Motorway Traffic Control and Monitoring
  - 4.0 The system shall gather traffic flow data from Motorways.
  - 5.0 IKIR shall collect Weather and Road Conditions Information.
  - 6.0 IKIR shall permit the logging of Incident Information and confirmation of reported incidents on the Motorways.
  - 7.0 IKIR shall permit the logging of scheduled and current road work on the Motorways along with dissemination of road work information.
  - 8.0 IKIR shall permit the Motorway operator to implement routing strategies in coordination with the appropriate Counties.
  - 9.0 IKIR shall be capable of implementing Traffic Control strategies on Motorways
  - 10.0 IKIR shall provide Motorway Control (lane and speed control plus future ramp control) and Driver Advisory Displays on urban or congested Motorway sections.

- County Road Management
  - 11.0 The system shall gather traffic flow data from highways within each County.
  - 12.0 IKIR shall collect Weather and Road Conditions Information
  - 13.0 IKIR shall permit the logging of Incident Information and confirmation of reported incidents on highways.
  - 14.0 IKIR shall permit the logging of scheduled and current road work within each County along with dissemination of road work information.
  - 15.0 IKIR shall permit County agencies to implement routing strategies in conjunction with the Motorway Company.

- Coordination with Existing Transportation Activities
  - 16.0 The system shall gather Truck Traffic Data for tracking purposes as well as for transportation planning.

DETAILED FUNCTIONAL REQUIREMENTS

Real-Time Information

1.0 IKIR shall provide traveler information to all motorists and operations agencies, including roadway operations, planning and data collection agencies, private businesses and service providers.

1.1 Dissemination Process

The systems information-providing functions shall consist of the following steps: Data Preprocessing, Information Delivery and Information Display.

1.1.1 Data Preprocessing shall include the updating of agency information as new information is received from the Motorway and County operations facilities.

1.1.1.1 Data Preprocessing shall include the mapping of specific measures of traffic flow, weather, incident and maintenance information onto a geographic representation of the IKIR roadway network on displays and workstation terminals

1.1.1.2 Data Preprocessing shall obtain all the measures defined in 1.1.1.1 from Motorway and County operations facilities

1.1.2 Information Delivery shall provide information to broadcast media, private sector and dedicated interfaces (institutional and privately-developed).

1.1.2.1 Information Delivery shall include providing roadway congestion to broadcast radio and television stations. Content shall be as per requirement 1.2.1.

1.1.2.1.1 The above shall entail reporting and display of traffic flow data and route guidance strategies for radio and television broadcasters.

1.1.2.2 Information Delivery shall include providing geographic traffic flow data, weather information, incident and maintenance information, and route guidance advisories in a standard communications format. Content shall be as per Requirement 1.2.

1.1.2.2.1 This standard format shall be accessible by private vendors who wish to display the data and information as part of their own for-profit services.

1.1.3 Information Display capabilities shall consist of interactive and noninteractive access means.

1.1.3.1 Interactive Information access shall be possible via the Internet and public kiosks.

1.1.3.1.1 Information Displays shall include geographic traffic flow data, weather information, incident and maintenance information onto an Internet World Wide Web site. Data content shall be as per Requirement 9.2 below.

1.1.3.1.2 Information Display shall include public kiosks located strategically along the highway system.

1.1.3.1.2.1 Kiosks shall include real-time congestion information displayed graphically, incident information displayed graphically, and interactively accessed route guidance and travel time data available through a simple, easy-to-use graphical user interface with a minimum of external hardware. Such an interface may involve use of touch-screen navigation techniques.

1.1.3.1.2.2 Kiosks shall be available at rest areas, activity centers, tourist attractions, service stations, airports, and other sites

1.1.3.2 Updated, non-interactive information shall be available via broadcast media, roadside radio, dial-up phone services (including radiophone), services provided by private companies.

1.1.3.2.1 Information stored by IKIR shall be accessible by private companies for dissemination to the public

1.1.3.2.2 Information Display shall include the provision of a display map showing congestion levels on Motorway and highway routes in the Budapest area, displayed on a dedicated public television station, and updated at five minute intervals.

1.2 Information Content

IKIR traveler information shall consist of Pre-Trip Planning, Travel Services and Route Guidance Information.

1.2.1 IKIR shall provide pre-trip planning functions. Pre-trip planning functions shall provide real-time information, traveler services information, and permit the traveler to access travel time information between two selected destinations, along selected route links, and provide "best route" information based on real-time traffic conditions based upon data collected from the field.

1.2.2 Pre-trip planning shall include real-time information

1.2.2.1 Real-time information shall include current incident information

1.2.2.1.1 Real-time information shall include current road work information

1.2.2.1.2 Real-time information shall include agency-designated route alternatives

1.2.2.1.3 Real-time information shall include travel time data on each motorway and highway in the IKIR network

1.2.2.1.4 Real-time information shall include weather data for the country as well as user-selected locations

1.2.2.1.5 Real-time information shall include weather data for neighboring countries

1.2.2.2 Based on user-specified parameters, IKIR shall provide users with a calculated itinerary consisting of selected route and travel time information based on user-input nature of trip.

1.2.2.2.1 Based on user-specified parameters, IKIR shall provide users with real-time travel conditions for the time of inquiry and estimated conditions for estimated time of travel

1.2.2.2.2 Based on user specified parameters, IKIR shall provide users with one or more alternate itineraries in addition to the primary calculated itinerary.

1.2.2.2.3 IKIR shall permit the capability for users to specify a desired destination

1.2.2.2.4 IKIR shall permit the capability for users to specify a planned departure location if not at current location

1.2.2.3 IKIR shall provide the capability for users to access the system from multiple locations along travel routes and at public points of interest

1.2.2.4 IKIR shall provide the capability for users to access the system from their homes

1.2.2.5 IKIR shall provide the capability for users to access the system from their location of work

1.2.3 IKIR shall include a travel service information function.

1.2.3.1 Travel service information shall consist of local area services available to travelers, categorized by region and by type.

1.2.3.1.1 Types of services shall include hotels, restaurants, gas stations, hospitals, points of interest, and entertainment centers.

1.2.3.2 Travel service information shall be accessible by travelers at public locations.

1.2.3.2.1 Travel service information at each public location shall include information on nearest facility(ies) of the types of services identified above.

1.2.3.3 Travel service information shall be accessible by travelers at home.

1.2.3.4 Travel service information shall be accessible by travelers at work.

1.2.3.5 Travel service information shall be accessible by travelers through the same interface as pre-trip information.

1.2.4 IKIR shall provide route guidance information to the traveler.

1.2.4.1 Route guidance information shall include the capability to provide directions to travelers

1.2.4.1.1 Directions to travelers shall be given for user-input destination

1.2.4.1.2 Directions to travelers shall be provided for tourist, truck and fastest routes to the user-input destination.

1.2.4.1.3 Fastest routes shall be computed based upon real-time travel time information and shall show shortest travel path to the user-input destination.

1.2.4.1.4 Directions to travelers shall be provided in the form of text descriptions and map displays

1.2.4.1.5 Directions to travelers shall be made available in hard copy for directions provided at kiosks.

1.2.4.1.5.1 Directions shall be provided in the user's choice of Hungarian, German, or English

2.0 IKIR shall provide route guidance information.

<u>2.1 Contents of Travel Time Information</u>

Travel time information shall consist of historical and real-time data for each roadway link on the IKIR roadway network.

2.1.1 If no real-time travel time information is available for a link, IKIR shall use historical travel time information.

2.1.1.1 Historical information shall be input to system prior to deployment and used as a "default".

2.1.1.2 Historical information shall be replaced by real-time information as per Requirement 1.1.4.

2.2 Calculation of Travel Paths

Real-time travel time calculations shall be utilized in order that the minimum travel time path networks between origins and destinations can be developed.

2.2.1 The system shall support the calculation of routes with the lowest travel times between a given origin and destination.

2.2.1.1 Route calculation shall be done either for agency-developed routing strategies or for user inputs as per requirement 3.0.

3.0 IKIR shall develop route guidance strategies in response to real-time conditions.

3.1 Basis for Development

The system shall calculate strategies based on real-time incident, road work or congestion information.

3.1.1 Route guidance shall take into consideration roadway blockages on specific links.

3.1.2 Route guidance shall take into consideration unusually high travel times based on operator-input parameters.

3.1.3 Route guidance shall utilize the minimum travel time routing necessary through the incident or road work area in order to return the traveler to the route.

3.1.4 Route guidance shall utilize the minimum travel time routing necessary through the incident or road work area in order to reach the user-input destination (for individual interfaces as discussed in Requirement 2.1).

Motorway Traffic Control and Monitoring

4.0 The system shall gather traffic flow data from Motorways.

4.1 Travel Time Data Collection on Motorways

IKIR shall collect travel time data from vehicle probes, either based on manual call-in or from automated vehicle tracking capabilities.

4.1.1 Manual call-ins from County directorate or motorway patrol and police vehicles shall be done at specific checkpoints. Information shall consist of a probe identification and the time of passage.

4.1.1.1 IKIR shall calculate the travel time between the previous location of call-in and the current location in order to calculate current travel time.

4.1.2 Automated vehicle tracking shall consist of readers at intersections and at key motorway interchanges along IKIR routes, which shall be capable of gathering assigned vehicle identification information and applying a time stamp at the specific site.

4.1.2.1 IKIR shall calculate the travel time between the previous reader location and the current location in order to calculate current travel time.

4.1.3 Automatic Vehicle Location services shall be incorporated to provide the above functionality.

4.1.4 The IKIR database shall update current or historical travel time data by incorporating current travel time data for the specific link.

4.1.4.1 IKIR operator shall be capable of selecting an update factor which applies a weight to the current updated information relative to existing information.

4.1.4.1.1 Update factor shall range from 1 (current travel time supplants all previous data) to 0 (current travel time replaces none of the previous data).

4.1.4.1.2 Update factor shall be programmable by the IKIR Operator for individual links or as a default value for the entire system.

4.2 Congestion Data Collection

IKIR shall include a congestion data collection function which permits collection of real-time volume, occupancy, speed and travel time information.

4.2.1 Real-time information shall be updated at one minute intervals for those Motorways covered by Motorway Control.

4.2.2 Real-time information shall be collected for each link under Motorway Control

4.2.3 Real-time information shall be collected between interchanges and on entrance and exit ramps to each link under Motorway Control

4.3 Congestion Determination

The data collection function shall assess whether a link is congested based on user-selected parameters.

4.3.1 User-selected parameters to determine congestion shall include one or more of the following: minimum congested volume (per lane), minimum congested occupancy (percent), congested speed, and magnitude of travel time increase (expressed as a percentage increase of normal travel time)

4.3.2 User-selected parameters shall apply to individual Motorway links as well as for default parameters

5.0 IKIR shall collect Weather and Road Conditions Information

5.1 Weather Stations

The system shall gather information from the National Weather Service and motorway weather stations.

5.1.1 National weather service information shall include temperature, wind and precipitation information from five domestic weather stations.

5.1.2 The system shall gather information from the Motorway weather stations which shall include wind, temperature and precipitation information.

5.2 Road ConditionsIinformation

The IKIR system shall collect information on road icing and visibility conditions.

5.2.1 Road icing and visibility data shall be obtained automatically from icing and fog warning sensors maintained by the Motorway company.

5.2.2 Road icing and visibility data shall be capable of being manually input by the Motorway operator for sharing with other IKIR users and information services.

6.0 IKIR shall permit the logging of Incident Information and confirmation of reported incidents on the Motorways.

6.1 Incident Logging

IKIR shall permit the logging of potential and confirmed incidents for the purposes of information sharing and dissemination.

6.1.1 Incident information shall be logged from the following sources:

- Call-ins from travelers via Motorway call boxes
- Call-ins from Police
- Call-ins from travelers via Radiophone
- Detector threshold alarm

6.1.2 Incident information logging shall be performable by the Motorway operator through a standard IKIR interface

6.1.3 Incident information logging shall include the following characteristics - incident type, severity, location, lanes blocked and expected duration, and whether incident is "potential" or "confirmed"

6.1.3.1 Incident types shall include: accident, stalled vehicle, overturned truck, hazardous materials, pedestrian, and "other".

6.1.3.2 Incident severity inputs shall include : property damage only, injuries, fatalities. Incident location inputs shall include motorway or highway link (route name or number), direction, and directional distance from nearest intersection or junction

6.1.3.3 Incident lane blockage inputs shall include: Right lane, left lane, all lanes, both directions, direction closed, all lanes closed

6.1.3.4 Expected duration shall be logged in hours and minutes.

6.1.3.5 "Other" incident information may be typed in manually by the operator into the standard IKIR interface

6.2 Incident Confirmation

Confirmation of incidents shall be performable by the Motorway operator

6.2.1 Password protection may be used to limit the changes made to a specific incident information listing

6.2.2 The incident response provided (ambulance, fire, police and/or maintenance vehicle) shall be logged for each incident by motorway or County operator

7.0 IKIR shall permit the logging of scheduled and current road work on the Motorways along with dissemination of road work information.

7.1 Road Work Information Logging

Road work information shall be logged from Motorway company information

7.1.1 Road work information logging shall be performable by the Motorway operator through a standard IKIR interface

7.1.2 Road work information logging shall be capable of future logging by voice recognition or from mobile data terminals

7.1.3 Road work information logging shall include the following characteristics - type, location, lanes blocked and expected duration

7.1.3.1 Road work types shall include: Construction, maintenance, bridge repair, landscaping.

7.1.3.2 Road work locations shall include motorway or highway link (name or number) and direction

7.1.3.3 Lane blockage inputs shall include: Right lane, left lane, all lanes, both directions, direction closed, all lanes closed

7.1.3.4 Expected duration shall be logged by day and time of start and scheduled day and time of completion

7.1.4 Changes in road work activities shall be input by the Motorway operator

7.1.5 Password protection may be used to limit the changes made to the road work information listing

7.1.6 The incident response provided (ambulance, fire, police and/or maintenance vehicle) shall be logged for each incident by Motorway operator

7.2 Location of Current Mobile Maintenance Activities

The system shall obtain location data for snow plows and salt trucks from the Motorway Company.

7.2.1 Location data shall be obtained via monitoring of Automatic Vehicle Location systems (Global Positioning System coordinates) or via radio call-in from vehicle operators.

7.2.2 When operators call-in their locations, the Motorway operator shall be able to manually identify the location (link, route number or name and direction) for input into the IKIR database.

7.2.3 Location of the vehicle shall be automatically removed after an operator-defined interval if no update is received.

8.0 IKIR shall permit the Motorway operator to implement routing strategies in coordination with the appropriate Counties.

8.1 Coordinated Routing Plans

IKIR shall permit the Motorway operator to implement specific coordinated routing plans in response to specific conditions, independent of travel time information

8.1.1 IKIR shall utilize preplanned routing strategies implemented in coordination with Motorway Control strategies.

8.1.2 IKIR shall provide stored routing plans to be implemented for specific incidents or road work conditions on specific motorway or highway links.

8.1.3 IKIR shall permit Motorway and County agencies to develop coordinated routing strategies involving both Motorway and highway facilities

8.1.4 For preplanned control strategies, agency-derived travel time strategies shall be able to override normal travel time-derived routing strategies developed for traveler information requests.

9.0 IKIR shall be capable of implementing Traffic Control strategies on Motorways

9.1 Motorway Control Capabilities

IKIR shall provide a Motorway Control capability. Motorway control shall provide Lane Control, Speed Control and Ramp Control. It shall also provide input to Driver Advisory Information functions. These shall be deployed as per Requirement 10.4 in terms of the following functions.

9.1.1 The system shall support lane control, speed control, and en-route congestion and route choice advisories, as well as future ramp metering activities along Motorways and Toll Roads.

9.1.2 Motorway Control shall provide a function to optimize congested traffic flow

9.1.3 Motorway Control shall provide a function to improve traffic flow around incidents

9.1.4 Motorway Control shall be capable of optimizing flow over large areas or on specific roadway links.

9.1.5 Lane control functions shall include the control of lane use signals (open, transition, closed) in advance of lane blockages.

9.1.6 Speed control functions shall include the control of variable speed limit signage, that, in the event of lane blockages or congestion, will display speed reductions to a level that reduces the possibility of rear-end or other area collisions with slow or stopped vehicles in the area of congestion.

9.1.7 En-route information functions shall include Driver Advisory Information (per Requirement 10.4) that implements the route guidance strategies developed by the Motorway and County agencies as discussed above in "Route Guidance" .

9.1.8 En-route information functions shall include messages that warn of incidents ahead or on connecting Motorways and highways.

9.1.9 En-route information functions shall provide route advisory messages consistent with route guidance strategies developed by the Motorway and County agencies as discussed above in "Route Guidance".

9.1.10 The system shall make available traffic flow data (speed, traffic volume, occupancy and travel time) which permits the future development of timing plans associated with ramp metering activities.

10.0 IKIR shall provide Motorway Control (Lane and speed control plus future ramp control) and Driver Advisory Displays on urban or congested Motorway sections.

10.1 Lane Control

IKIR shall support lane control strategies with variable lane signal displays for those links under Motorway Control.

10.1.1 Lane Control shall implement overhead lane signals at regular intervals.

10.1.1.1 Overhead lane signals shall indicate either an open lane (green down arrow), a closed lane (red "X"), or require lane traffic to merge left (arrow pointing to upper left) or merge right (arrow pointing to upper right).

10.1.1.2 Default conditions shall show open lane indications.

10.1.2 Incident and road work locations logged in IKIR database for links under Motorway Control shall cause Lane Control to be implemented as below.

10.1.2.1.1 For lane blockage, lane control signals shall indicate traffic to merge into an unblocked lane beginning a minimum safe merging distance from the incident location.

10.1.2.1.2 For lane blockage, lane control signals shall indicate lane at a minimum safe distance from actual blockage.

10.1.2.1.3 Following lane blockage, lane signals shall show all open lanes except for other blockages located downstream.

10.1.3 Lane Control signals shall be controllable through operational plans incorporating the above requirements for incident situations on each link under Motorway Control

10.1.4 Lane Control signals shall be adjusted at one-minute intervals based on real-time traffic data.

10.2 Speed Control

IKIR shall utilize lane-specific speed control displays for those links under Motorway Control.

10.2.1 Speed control displays shall consist of speed limit indications at regular intervals for each lane.

10.2.2 Speed control shall show speeds reduced below normal at a minimum safe distance from location of congestion

10.2.3 Speed levels shall be reduced to a safe level which reduces chance of rear-end collisions at start of congested queue.

10.2.4 Speed Control signals shall be controllable through operational plans tied to Lane Control plans as well as for simple congestion (e.g., no lanes blocked).

10.2.5 Congestion levels requiring speed control shall be defined based on congestion parameters that are defined by the User.

10.3 Ramp Control

Ramp control shall be implementable in the future by the IKIR system for those links under Motorway Control.

10.3.1 Ramp control shall consist of red/green ramp control signals which permit one vehicle at a time to proceed onto the Motorway.

10.3.2 Interval of vehicle release (length of red time) shall be selectable either by a field control system, by the Motorway operator, or in an automated fashion.

10.3.3 Field ramp control shall consist of queue detection, arrival detection at the signal, passage detection after the signal, and inputs from mainline Motorway detection both upstream and downstream of the entrance ramp merge.

10.3.4 Length of red time between vehicle releases shall be adjustable based on the comparative volume, occupancy, and/or speed levels between upstream and downstream detectors.

10.3.5 For multiple consecutive ramp control locations (consecutive interchanges), future capability shall be provided to analyze consecutive mainline detectors along links under Motorway Control along with queues on entrance ramps under Ramp Control. This shall be referred to as Corridor Ramp Control operation.

10.3.6 For Corridor Ramp Control Operation, Operations Plans shall be implementable for volume, congestion and speed parameters at detectors entering and leaving the corridor as well as intermediate detectors within the corridor and queue detectors on controlled ramps.

10.4 Driver Advisory Messages

IKIR shall provide driver advisory information.

10.4.1 Driver advisory information shall be made available as text messages on variable message signs or as voice messages on roadside radio.

10.4.2 Driver advisory information shall include downstream travel time congestion , accident and road work information

10.4.3 For Motorways with Lane Control and Speed Control operations, driver advisory messages shall be generated to warn drivers of:

10.4.3.1 upcoming incidents logged into IKIR database

10.4.3.2 upcoming Lane Control activities, including identification of lane blocked

10.4.3.3 upcoming Speed Control activities, warning drivers of speed reductions ahead

10.4.4 Lane Control and Speed Control-related data shall have priority over other messages along routes with Motorway Control.

10.4.5 Congestion information shall include advisory queue information at upcoming toll plazas

10.4.6 Driver advisory information shall include downstream alternate route information

10.4.7 Driver advisory information shall include local guidance for tourist and event facilities downstream from driver location

10.4.8 Driver advisory information shall include weather advisory information for current and upcoming conditions.

10.4.8.1 Visibility data shall identify visibility restrictions due to fog or blowing snow

10.4.8.2 Pavement data shall identify the following pavement conditions: wet pavement, snow cover, or road icing

10.4.9 Driver advisory information shall include precautionary information, including:

10.4.9.1 Fasten seat belts

10.4.9.2 Maintain safe distance between vehicle

10.4.9.3 Other locally appropriate information

County Road Management

11.0 The system shall gather traffic flow data from highways within each County.

11.1 Travel Time Data Collection

IKIR shall collect travel time data from vehicle probes, either based on manual call-in or from automated vehicle tracking capabilities.

11.1.1 Manual call-ins from County directorate or motorway patrol and police vehicles shall be done at specific checkpoints. Information shall consist of a probe identification and the time of passage.

11.1.1.1 IKIR shall calculate the travel time between the previous location of call-in and the current location in order to calculate current travel time.

11.1.2 Automated vehicle tracking shall consist of readers at intersections and at key motorway interchanges along IKIR routes, which shall be capable of gathering assigned vehicle identification information and applying a time stamp at the specific site.

11.1.2.1 IKIR shall calculate the travel time between the previous reader location and the current location in order to calculate current travel time.

11.1.2.2 Automatic Vehicle Location services shall be incorporated to provide the above functionality.

11.1.3 The IKIR database shall update current or historical travel time data by incorporating current travel time data for the specific link.

11.1.3.1 IKIR operator shall be capable of selecting an update factor which applies a weight to the current updated information relative to existing information.

11.1.3.1.1 Update factor shall range from 1 (current travel time supplants all previous data) to 0 (current travel time replaces none of the previous data).

11.1.3.1.2 Update factor shall be programmable by the IKIR Operator for individual links or as a default value for the entire system.

12.0 IKIR shall collect Weather and Road Conditions Information

<u>12.1 Weather Stations</u>

The system shall gather information from the National Weather Service, County and motorway weather stations.

12.1.1 National weather service information shall include temperature, wind and precipitation information from five domestic weather stations.

12.1.2 The system shall gather information from County Directorates (AKKM's) which include temperature and moisture (fog conditions) measurements at weather stations along the IKIR roadway corridors.

<u>12.2 Road conditions information</u>

The IKIR system shall collect information on road icing and visibility conditions.

12.2.1 Road icing and visibility data shall be obtained automatically from icing and fog warning sensors maintained by the County.

12.2.2 Road icing and visibility data shall be capable of being manually input by County operators for sharing with other IKIR users and information services.

13.0 IKIR shall permit the logging of Incident Information and confirmation of reported incidents on highways.

13.1 Incident Logging

IKIR shall permit the logging of potential and confirmed incidents for the purposes of information sharing and dissemination.

13.1.1 Incident information shall be logged from the following sources:

13.1.1.1 Call-ins from travelers via radiophone

13.1.1.2 Call-ins from County directorate patrols

13.1.1.3 Call-ins from Police

13.1.2 Incident information logging shall be performable by County operator through a standard IKIR interface

13.1.3 Incident information logging shall include the following characteristics - incident type, severity, location, lanes blocked and expected duration, and whether incident is "potential" or "confirmed"

13.1.3.1 Incident types shall include: accident, stalled vehicle, overturned truck, hazardous materials, pedestrian, and "other".

13.1.3.2 Incident severity inputs shall include : property damage only, injuries, fatalities. Incident location inputs shall include highway link (route name or number), direction, and directional distance from nearest intersection or junction

13.1.3.3 Incident lane blockage inputs shall include: Right lane, left lane, all lanes, both directions, direction closed, all lanes closed

13.1.3.4 Expected duration shall be logged in hours and minutes.

13.1.3.5 "Other" incident information may be typed in manually by the operator into the standard IKIR interface

13.2 Incident Confirmation

Confirmation of incidents shall be performable by motorway, County or IKIR central operator

13.2.1 Password protection may be used to limit the changes made to a specific incident information listing

13.2.2 The incident response provided (ambulance, fire, police and/or maintenance vehicle) shall be logged for each incident by motorway or County operator

14.0 IKIR shall permit the logging of scheduled and current road work within each County along with dissemination of road work information.

14.1 Road Work Information Logging

Road work information shall be logged from the County directorate and other agency sources.

14.1.1 Road work information logging shall be performable by County operator through a standard IKIR interface

14.1.2 Road work information logging shall be capable of future logging by voice recognition or from mobile data terminals

14.1.3 Road work information logging shall include the following characteristics - type, location, lanes blocked and expected duration

14.1.3.1 Road work types shall include: Construction, maintenance, bridge repair, landscaping.

14.1.3.2 Road work locations shall include highway link (name or number) and direction

14.1.3.3 Lane blockage inputs shall include: Right lane, left lane, all lanes, both directions, direction closed, all lanes closed

14.1.3.4 Expected duration shall be logged by day and time of start and scheduled day and time of completion

14.1.4 Changes in road work activities shall be input by the County operator

14.1.5 Password protection may be used to limit the changes made to the road work information listing

14.1.6 The incident response provided (ambulance, fire, police and/or maintenance vehicle) shall be logged for each incident by motorway or County operator

14.2 Location of Current Mobile Maintenance Activities

The system shall obtain location data for snow plows and salt trucks from Counties, Motorway and Toll Road agencies.

14.2.1 Location data shall be obtained via monitoring of Automatic Vehicle Location systems (Global Positioning System coordinates) or via radio call-in from vehicle operators.

14.2.2 When operators call-in their locations, the County operator shall be able to manually identify the location (link, route number or name and direction) for input into the IKIR database.

14.2.3 Location of the vehicle shall be automatically removed after an operator-defined interval if no update is received.

15.0 IKIR shall permit County agencies to implement routing strategies in conjunction with the Motorway Company

15.1 Coordinated Routing Plans

IKIR shall permit the Counties to implement specific coordinated routing plans in response to specific conditions, independent of travel time information

15.1.1 Counties shall coordinate routing strategies, where appropriate, with the Motorway Company

15.1.2 IKIR shall provide stored routing plans to be implemented for specific incidents or road work conditions on specific highway links.

15.1.3 For preplanned control strategies, agency-derived travel time strategies shall be able to override normal travel time-derived routing strategies developed for traveler information requests

15.2 County Traffic Control System

County Traffic Control System capability shall monitor information from County-controlled intersections.

15.2.1 Information shall include bulb failure and conflict monitoring data

15.2.2 Information shall be retrieved for each signal cycle.

15.2.3 IKIR shall be capable of obtaining future data from system detectors located in advance of county-controlled intersections

Coordination with Existing Transportation Activities

16.0 The system shall gather Truck Traffic Data for tracking purposes as well as well as for transportation planning.

16.1 Truck Administrative and Operations Reporting

IKIR shall perform Truck Administrative and Operations Reporting consisting of information-gathering at Border Crossings and Weigh-in-Motion stations, and Vehicle Tracking functions.

16.1.1 Border crossing information shall consist of the following:

16.1.1.1 Origin of truck

16.1.1.2 Whether truck is oversize or overweight

16.1.1.3 Whether hazardous materials are being carried

16.1.1.4 Weight of truck

16.1.1.5 Destination of truck

16.1.1.6 Permit number

16.1.2 Weigh-in-Motion Station information shall consist of the following:

16.1.2.1 Permit number

16.1.2.2 Vehicle weight

16.1.3 Vehicle tracking functions shall permit tracking of vehicle location through both two-way and passive tracking

16.1.3.1 Passive tracking shall include permit number and major information (truck size, hazardous materials yes/no, weight of truck).

16.1.3.1.1 Passive tracking shall permit logging of vehicle path throughout country.

16.1.3.1.2 Information shall be storable on IKIR for a user-selectable period.

16.2 Truck Data Access

16.2.1 The above truck traffic data shall be gathered from permit information obtained at Border Crossings and shall be available for direct access by the Police as necessary in any County.

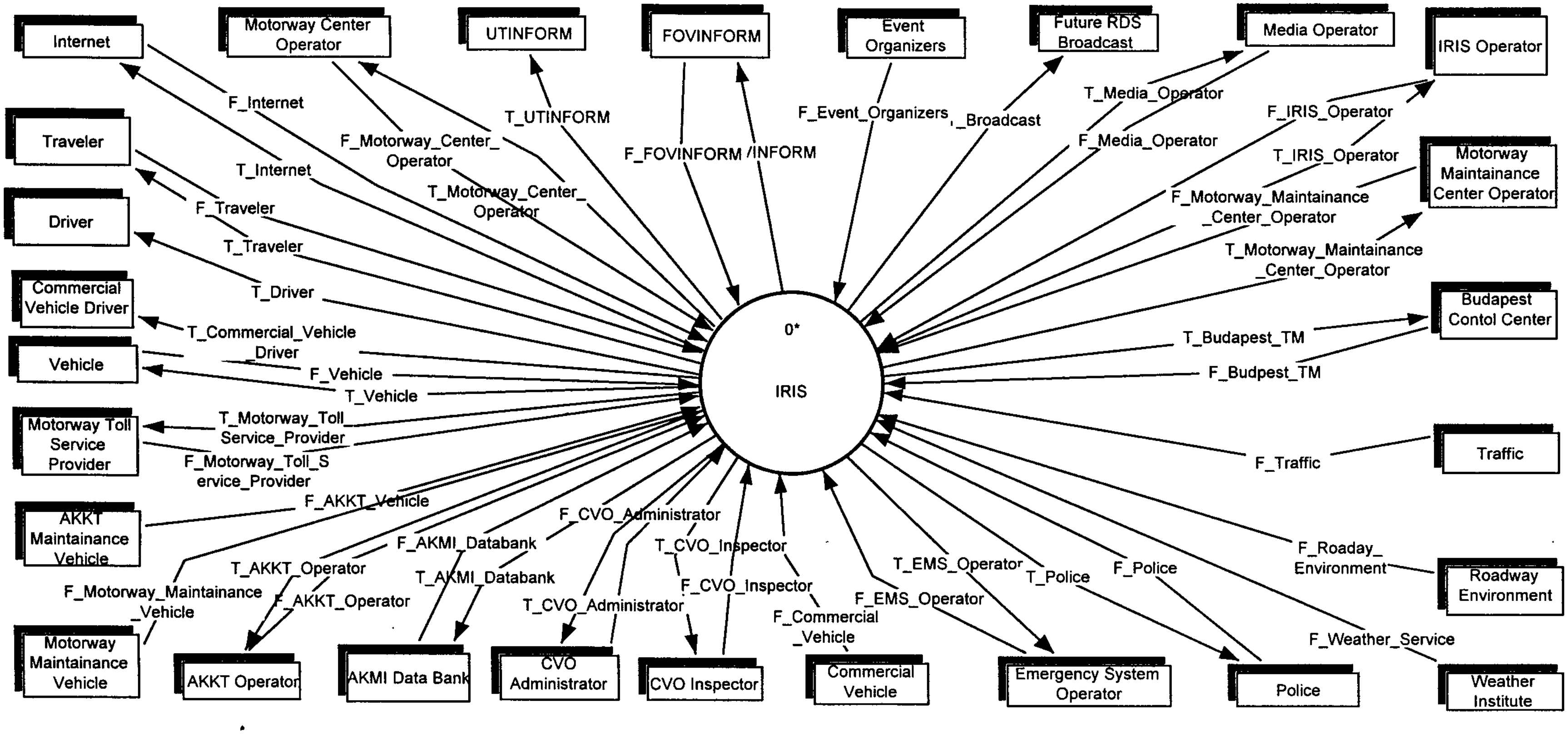
IRIS - HUNGARY

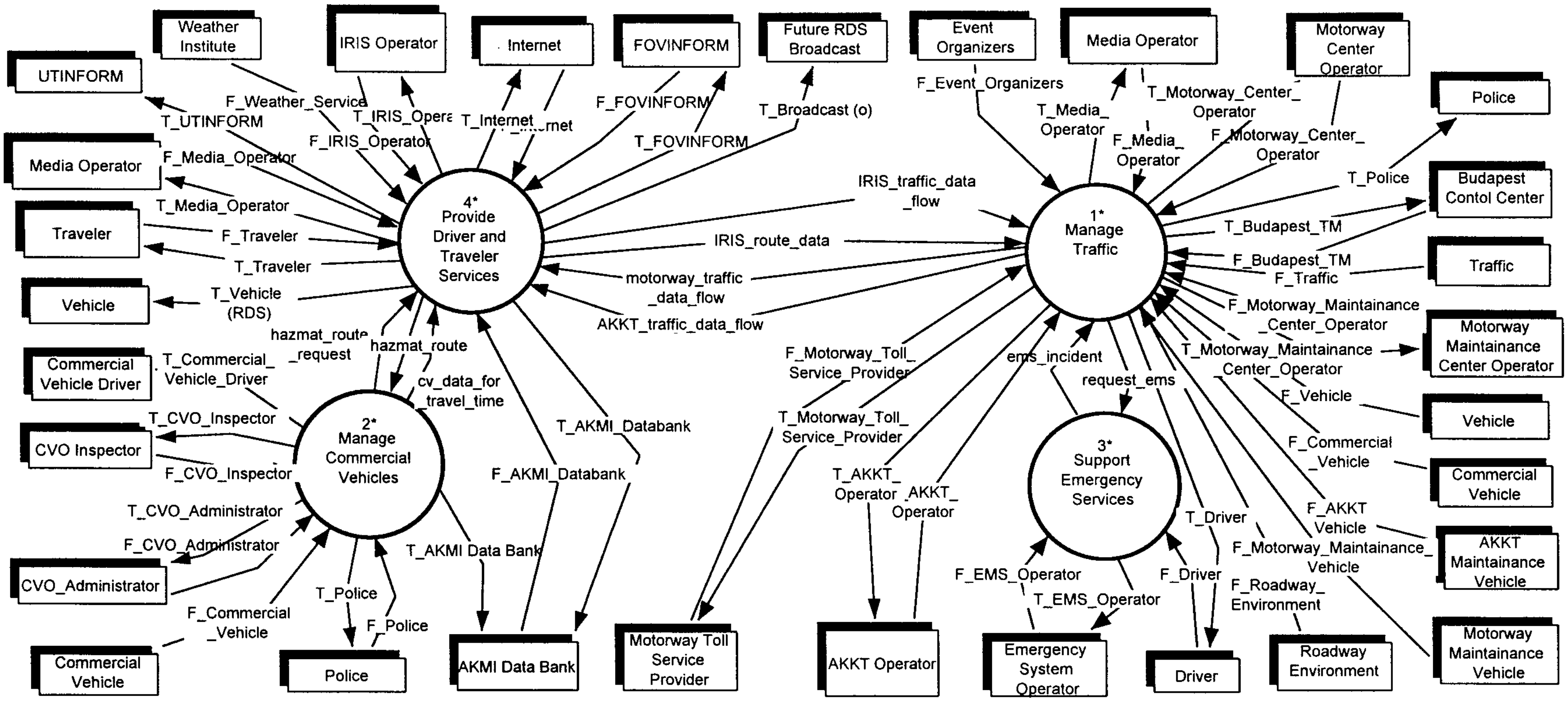
TDA

IKIR - MAGYARORSZAG

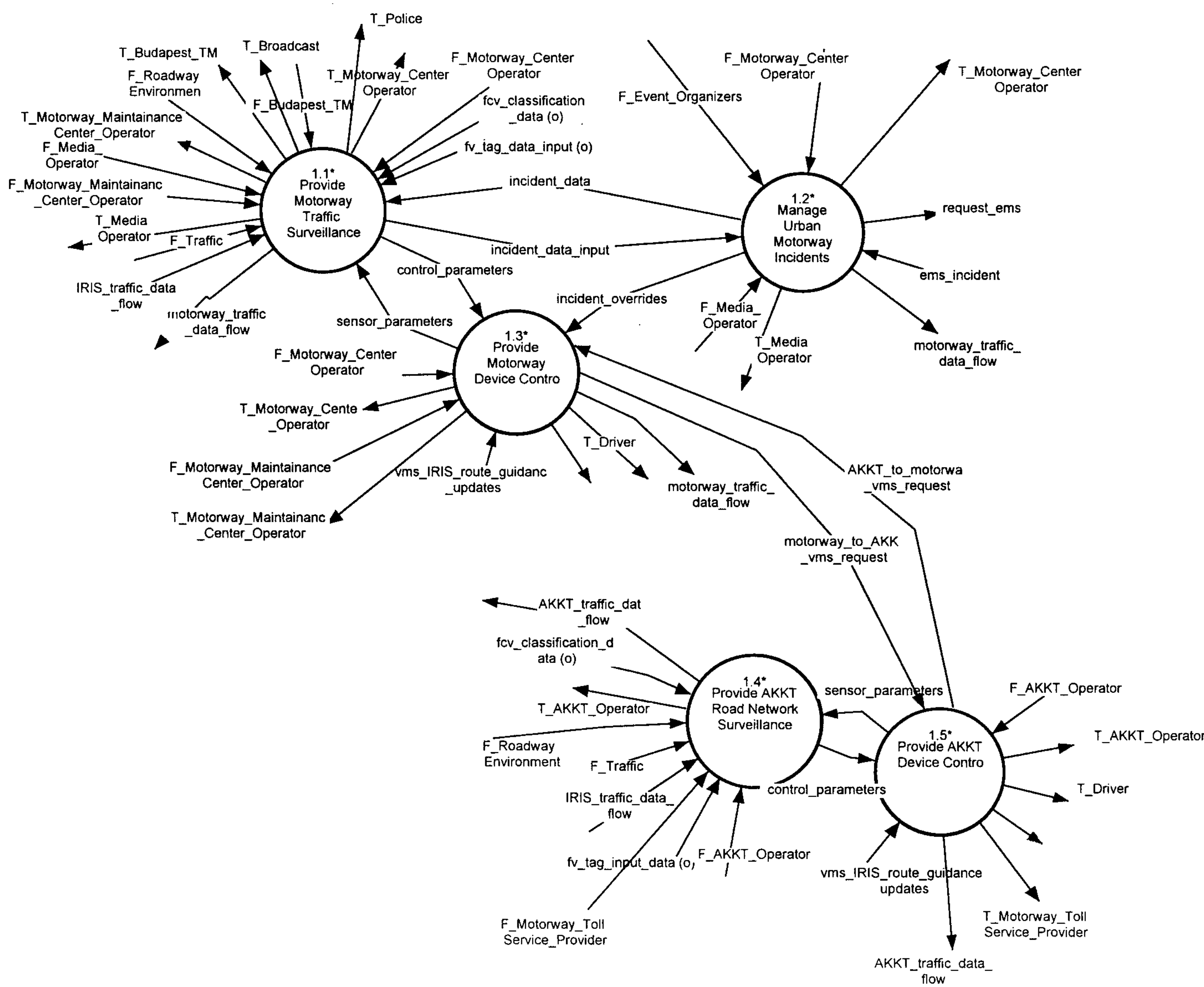
IRIS TDA Project
Wilbur Smith Associates

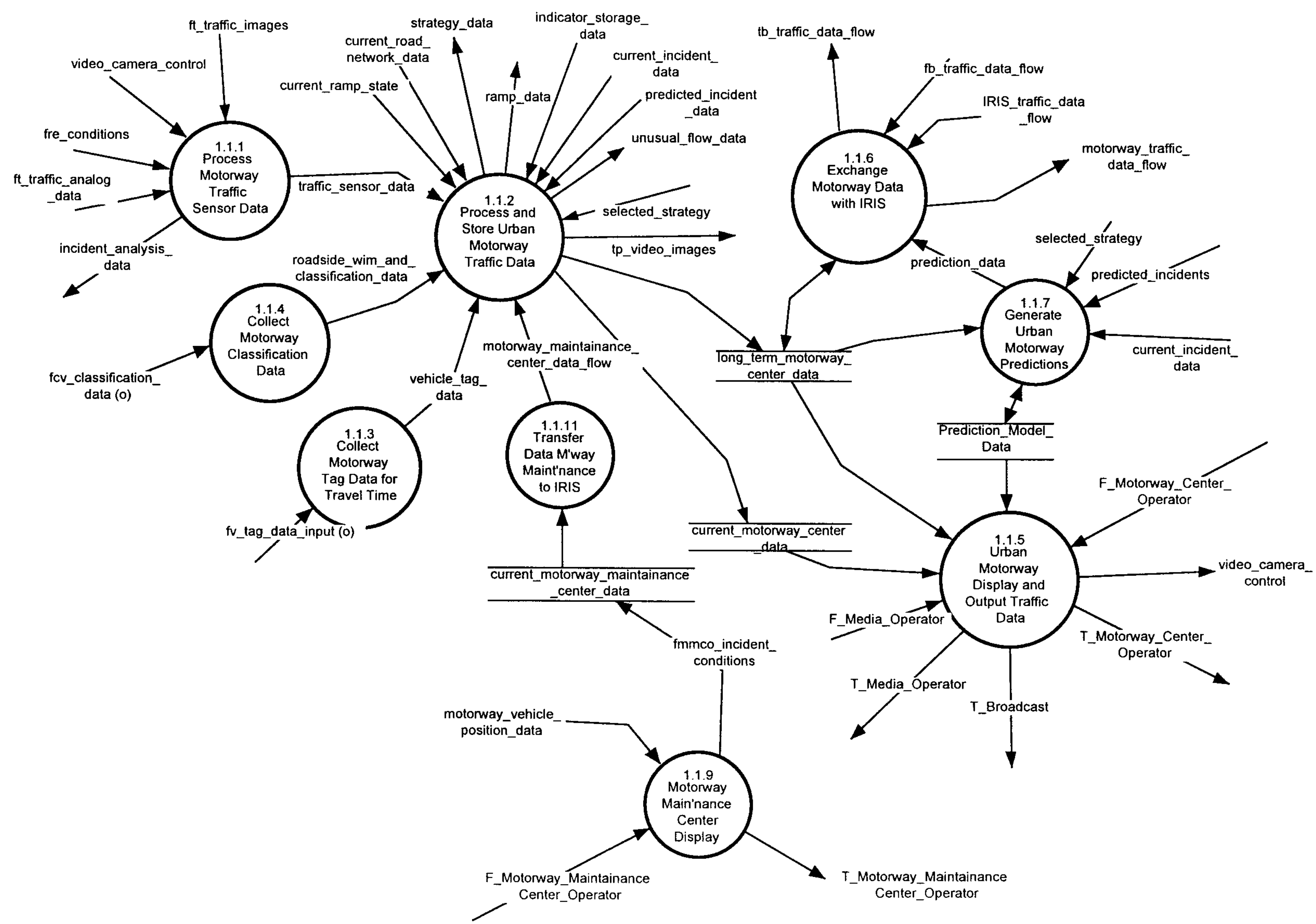
ANNEX C

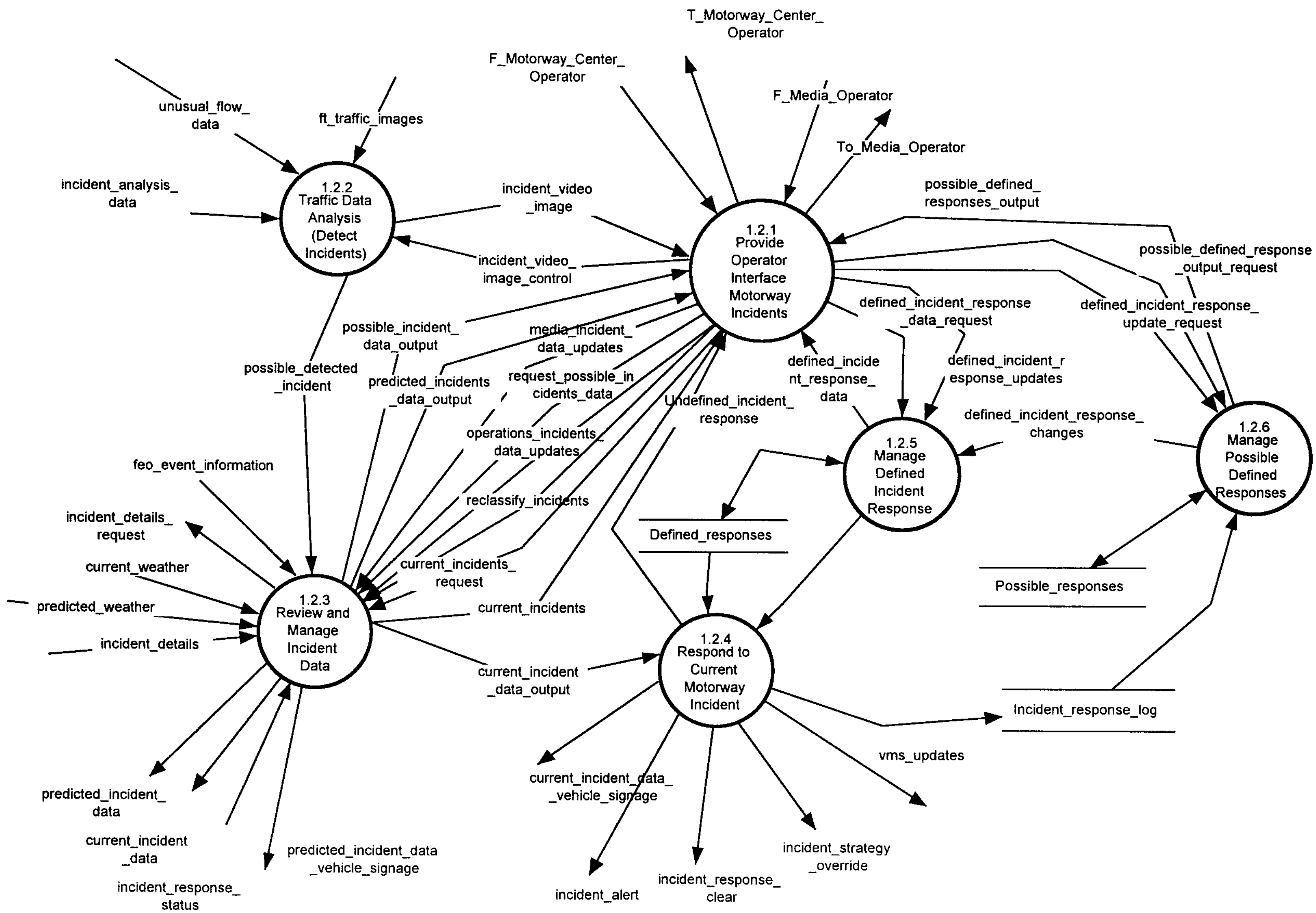

0*
IRIS
Internet
Motorway Center Operator
UTINFORM
FOVINFORM
Event Organizers
Future RDS Broadcast
Media Operator
IRIS Operator
Traveler
Driver
Commercial Vehicle Driver
Vehicle
Motorway Toll Service Provider
AKKT Maintainance Vehicle
Motorway Maintainance Vehicle
AKKT Operator
AKMI Data Bank
CVO Administrator
CVO Inspector
Commercial Vehicle
Emergency System Operator
Police
Weather Institute
Roadway Environment
Traffic
Budapest Contol Center
Motorway Maintainance Center Operator
F_Internet
T_Internet
F_Traveler
T_Traveler
T_Driver
T_Commercial_Vehicle_Driver
F_Vehicle
T_Vehicle
T_Motorway_Toll_Service_Provider
F_Motorway_Toll_Service_Provider
F_AKKT_Vehicle
F_Motorway_Maintainance_Vehicle
T_AKKT_Operator
F_AKKT_Operator
F_AKMI_Databank
T_AKMI_Databank
F_CVO_Administrator
T_CVO_Administrator
T_CVO_Inspector
F_CVO_Inspector
F_Commercial_Vehicle
T_EMS_Operator
F_EMS_Operator
T_Police
F_Police
F_Weather_Service
F_Roaday_Environment
F_Traffic
T_Budapest_TM
F_Budpest_TM
T_Motorway_Maintainance_Center_Operator
F_Motorway_Maintainance_Center_Operator
T_IRIS_Operator
F_IRIS_Operator
T_Media_Operator
F_Media_Operator
_Broadcast
F_Event_Organizers
F_FOVINFORM
/INFORM
T_UTINFORM
F_Motorway_Center_Operator
T_Motorway_Center_Operator

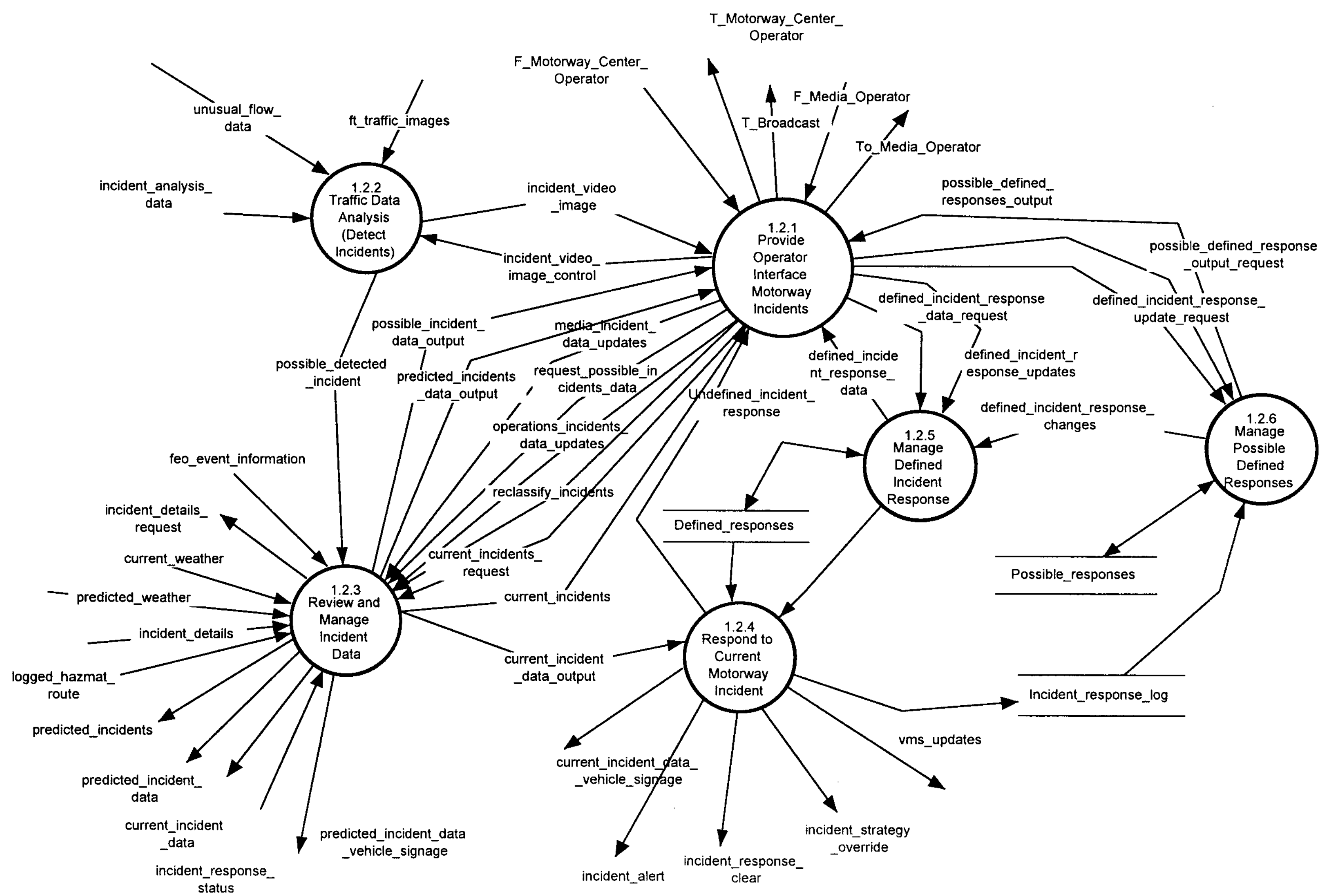


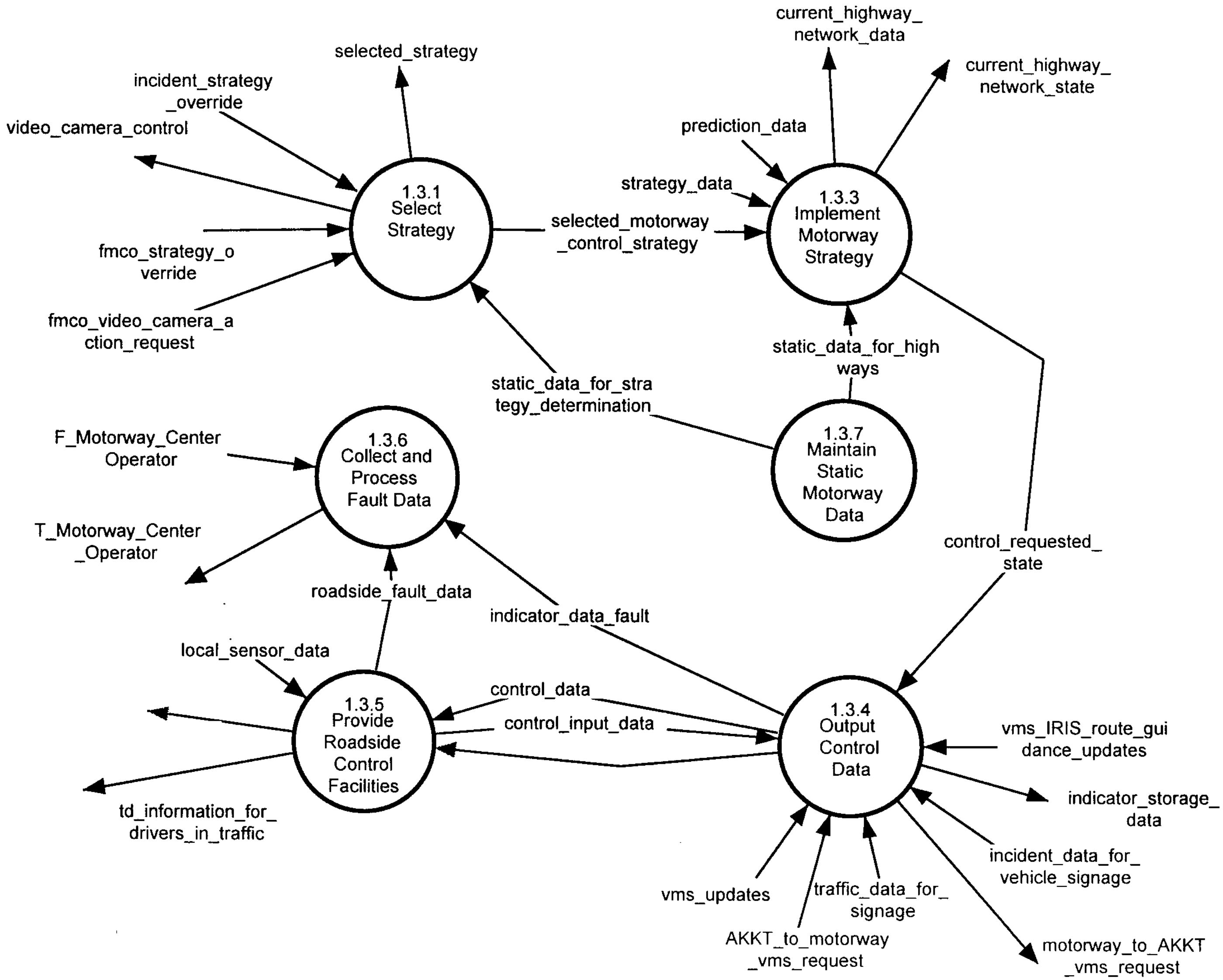
UTINFORM
Weather Institute
IRIS Operator
Internet
FOVINFORM
Future RDS Broadcast
Event Organizers
Media Operator
Motorway Center Operator
Police
Budapest Contol Center
Traffic
Motorway Maintainance Center Operator
Vehicle
Commercial Vehicle
AKKT Maintainance Vehicle
Motorway Maintainance Vehicle
Roadway Environment
Driver
Emergency System Operator
AKKT Operator
Motorway Toll Service Provider
AKMI Data Bank
Police
Commercial Vehicle
CVO_Administrator
CVO Inspector
Commercial Vehicle Driver
Vehicle
Traveler
Media Operator
4* Provide Driver and Traveler Services
2* Manage Commercial Vehicles
1* Manage Traffic
3* Support Emergency Services
F_Weather_Service
T_UTINFORM
F_IRIS_Operator
T_Internet
F_FOVINFORM
T_FOVINFORM
T_Broadcast (o)
F_Media_Operator
T_Media_Operator
F_Traveler
T_Traveler
T_Vehicle (RDS)
hazmat_route _request
hazmat_route
cv_data_for _travel_time
T_Commercial_ Vehicle_Driver
T_CVO_Inspector
F_CVO_Inspector
T_CVO_Administrator
F_CVO_Administrator
F_Commercial _Vehicle
T_Police
F_Police
T_AKMI Data Bank
F_AKMI_Databank
T_AKMI_Databank
IRIS_traffic_data _flow
IRIS_route_data
motorway_traffic _data_flow
AKKT_traffic_data_flow
F_Event_Organizers
T_Media_ Operator
F_Media_ Operator
T_Motorway_Center_ Operator
F_Motorway_Center_ Operator
T_Police
T_Budapest_TM
F_Budapest_TM
F_Traffic
F_Motorway_Maintainance _Center_Operator
T_Motorway_Maintainance Center_Operator
F_Vehicle
F_Commercial _Vehicle
F_AKKT Vehicle
F_Motorway_Maintainance_ Vehicle
F_Roadway_ Environment
T_Driver
F_Driver
request_ems
ems_incident
F_EMS_Operator
T_EMS_Operator
T_AKKT_ Operator
AKKT_ Operator
F_Motorway_Toll_ Service_Provider
T_Motorway_Toll_ Service_Provider

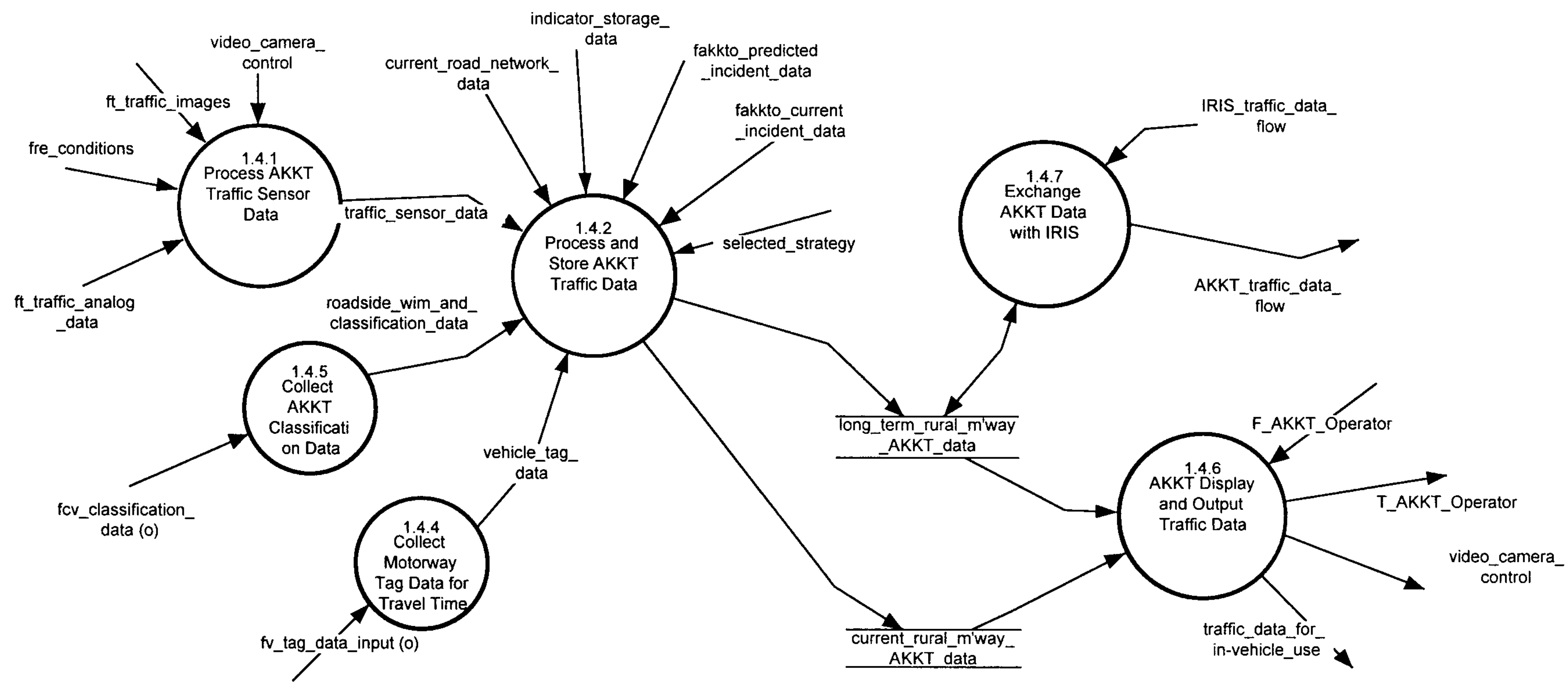

1.1* Provide Motorway Traffic Surveillance
1.2* Manage Urban Motorway Incidents
1.3* Provide Motorway Device Contro
1.4* Provide AKKT Road Network Surveillance
1.5* Provide AKKT Device Contro
T_Police
T_Broadcast
T_Budapest_TM
F_Roadway Environmen
F_Budapest_TM
T_Motorway_Center Operator
F_Motorway_Center Operator
fcv_classification _data (o)
fv_tag_data_input (o)
T_Motorway_Maintainance Center_Operator
F_Media_ Operator
F_Motorway_Maintainanc _Center_Operator
T_Media Operator
F_Traffic
IRIS_traffic_data _flow
motorway_traffic _data_flow
incident_data
incident_data_input
control_parameters
sensor_parameters
incident_overrides
F_Event_Organizers
request_ems
ems_incident
motorway_traffic_ data_flow
T_Motorway_Cente _Operator
F_Motorway_Maintainance Center_Operator
T_Motorway_Maintainanc _Center_Operator
vms_IRIS_route_guidanc _updates
T_Driver
AKKT_to_motorwa _vms_request
motorway_to_AKK _vms_request
AKKT_traffic_dat _flow
fcv_classification_d ata (o)
T_AKKT_Operator
F_Roadway Environment
IRIS_traffic_data_ flow
fv_tag_input_data (o,
F_AKKT_Operator
F_Motorway_Toll Service_Provider
T_Motorway_Toll Service_Provider
vms_IRIS_route_guidance updates
AKKT_traffic_data_ flow

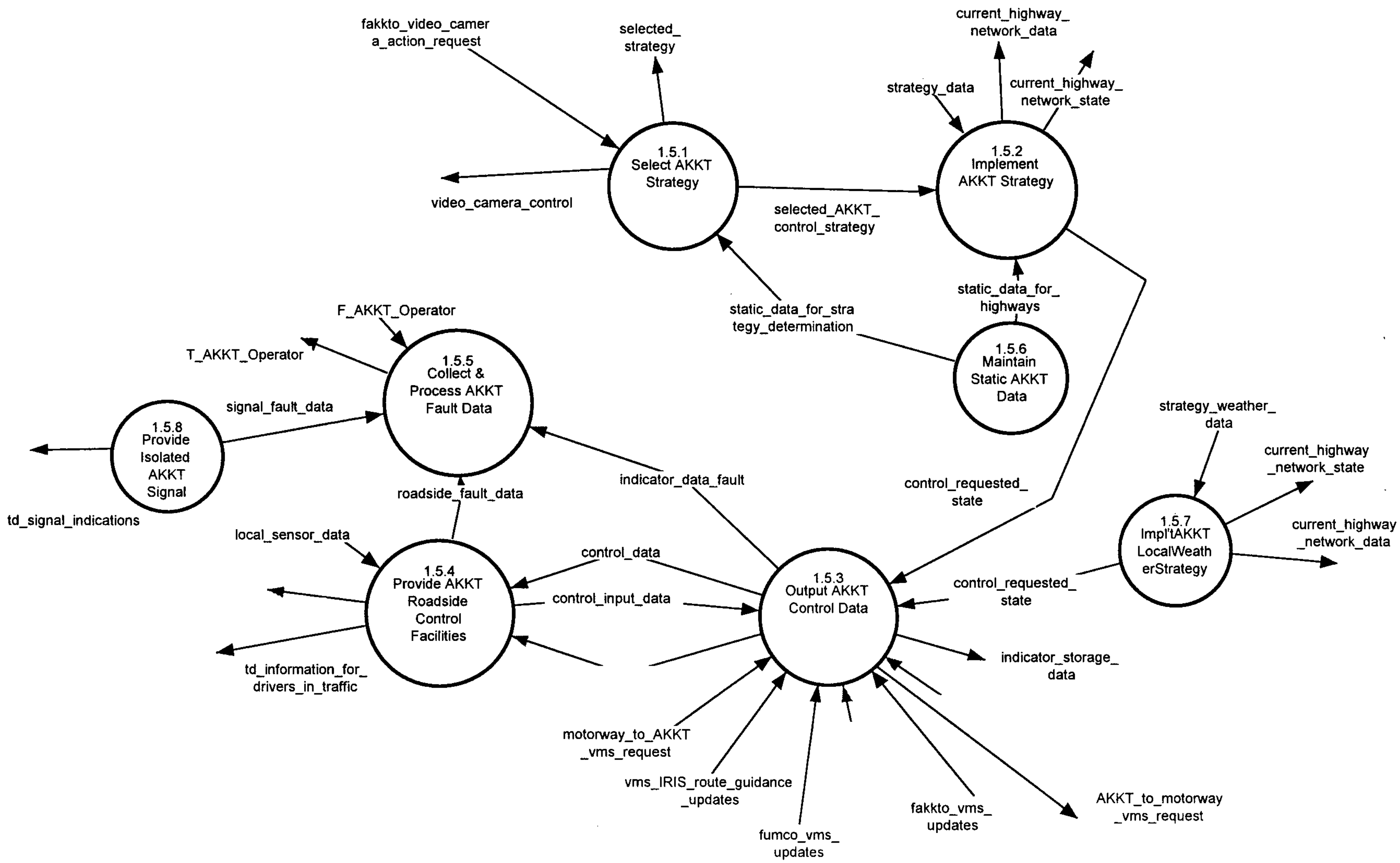

1.1.1 Process Motorway Traffic Sensor Data
1.1.2 Process and Store Urban Motorway Traffic Data
1.1.3 Collect Motorway Tag Data for Travel Time
1.1.4 Collect Motorway Classification Data
1.1.5 Urban Motorway Display and Output Traffic Data
1.1.6 Exchange Motorway Data with IRIS
1.1.7 Generate Urban Motorway Predictions
1.1.9 Motorway Main'nance Center Display
1.1.11 Transfer Data M'way Maint'nance to IRIS
ft_traffic_images
video_camera_control
fre_conditions
ft_traffic_analog_data
incident_analysis_data
traffic_sensor_data
strategy_data
current_road_network_data
current_ramp_state
ramp_data
indicator_storage_data
current_incident_data
predicted_incident_data
unusual_flow_data
selected_strategy
tp_video_images
roadside_wim_and_classification_data
fcv_classification_data (o)
vehicle_tag_data
fv_tag_data_input (o)
motorway_maintainance_center_data_flow
current_motorway_maintainance_center_data
fmmco_incident_conditions
motorway_vehicle_position_data
F_Motorway_Maintainance Center_Operator
T_Motorway_Maintainance Center_Operator
long_term_motorway_center_data
current_motorway_center_data
tb_traffic_data_flow
fb_traffic_data_flow
IRIS_traffic_data_flow
motorway_traffic_data_flow
prediction_data
selected_strategy
predicted_incidents
current_incident_data
Prediction_Model_Data
F_Motorway_Center_Operator
video_camera_control
F_Media_Operator
T_Motorway_Center_Operator
T_Media_Operator
T_Broadcast


T_Motorway_Center_ Operator
F_Motorway_Center_ Operator
F_Media_Operator
To_Media_Operator
unusual_flow_ data
ft_traffic_images
incident_analysis_ data
1.2.2 Traffic Data Analysis (Detect Incidents)
incident_video _image
incident_video_ image_control
1.2.1 Provide Operator Interface Motorway Incidents
possible_defined_ responses_output
possible_defined_response _output_request
defined_incident_response_ update_request
defined_incident_response _data_request
defined_incident_r esponse_updates
defined_incide nt_response_ data
possible_incident_ data_output
media_incident_ data_updates
possible_detected _incident
predicted_incidents _data_output
request_possible_in cidents_data
Undefined_incident_ response
operations_incidents_ data_updates
reclassify_incidents
current_incidents_ request
current_incidents
feo_event_information
incident_details_ request
current_weather
predicted_weather
incident_details
1.2.3 Review and Manage Incident Data
current_incident _data_output
1.2.5 Manage Defined Incident Response
defined_incident_response_ changes
1.2.6 Manage Possible Defined Responses
Defined_responses
Possible_responses
1.2.4 Respond to Current Motorway Incident
Incident_response_log
vms_updates
current_incident_data_ _vehicle_signage
incident_alert
incident_response_ clear
incident_strategy _override
predicted_incident_ data
current_incident _data
incident_response_ status
predicted_incident_data _vehicle_signage

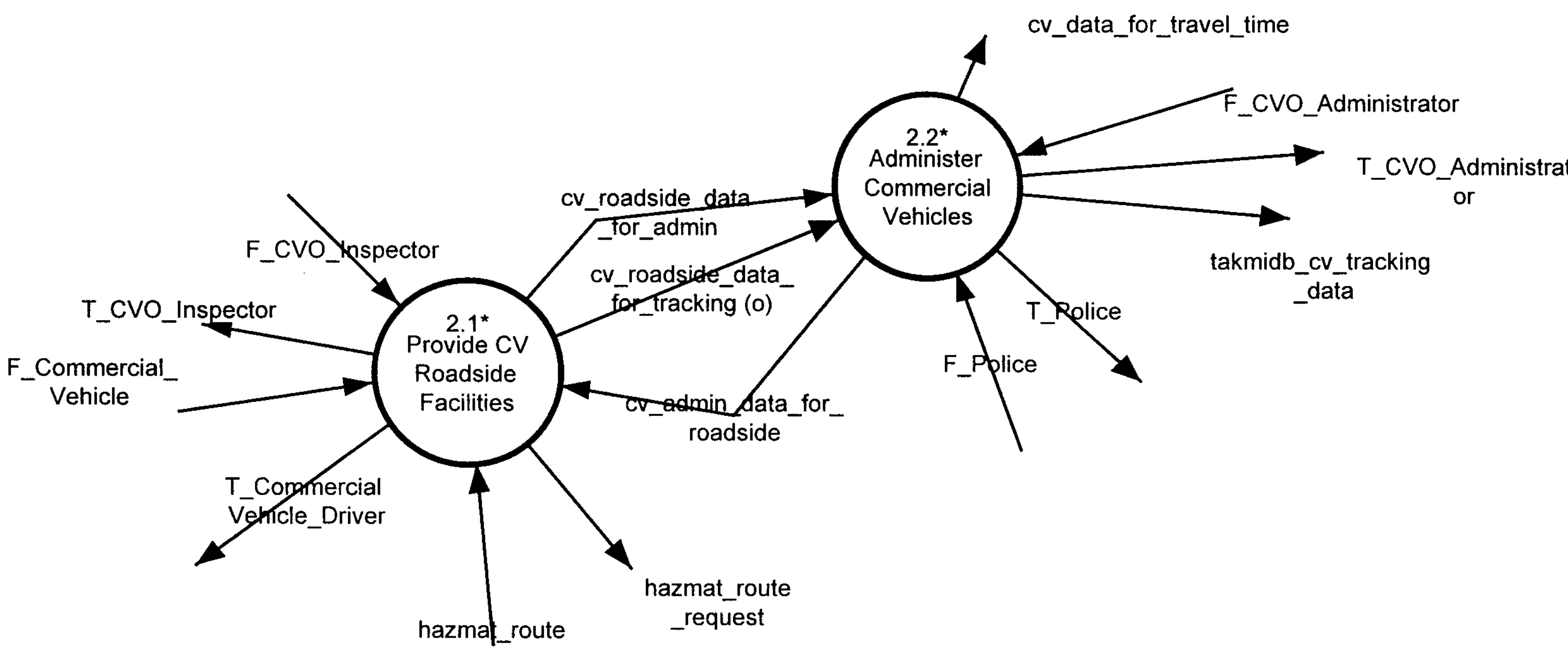

1.2.1 Provide Operator Interface Motorway Incidents
1.2.2 Traffic Data Analysis (Detect Incidents)
1.2.3 Review and Manage Incident Data
1.2.4 Respond to Current Motorway Incident
1.2.5 Manage Defined Incident Response
1.2.6 Manage Possible Defined Responses
T_Motorway_Center_ Operator
F_Motorway_Center_ Operator
T_Broadcast
F_Media_Operator
To_Media_Operator
unusual_flow_ data
ft_traffic_images
incident_analysis_ data
incident_video _image
incident_video_ image_control
possible_defined_ responses_output
possible_defined_response _output_request
defined_incident_response_ update_request
defined_incident_response _data_request
defined_incident_r esponse_updates
defined_incide nt_response_ data
defined_incident_response_ changes
possible_incident_ data_output
media_incident_ data_updates
predicted_incidents _data_output
request_possible_in cidents_data
possible_detected _incident
operations_incidents_ data_updates
Undefined_incident_ response
reclassify_incidents
current_incidents_ request
current_incidents
current_incident _data_output
feo_event_information
incident_details_ request
current_weather
predicted_weather
incident_details
logged_hazmat_ route
predicted_incidents
predicted_incident_ data
current_incident _data
incident_response_ status
predicted_incident_data _vehicle_signage
Defined_responses
Possible_responses
Incident_response_log
vms_updates
current_incident_data_ _vehicle_signage
incident_alert
incident_response_ clear
incident_strategy _override

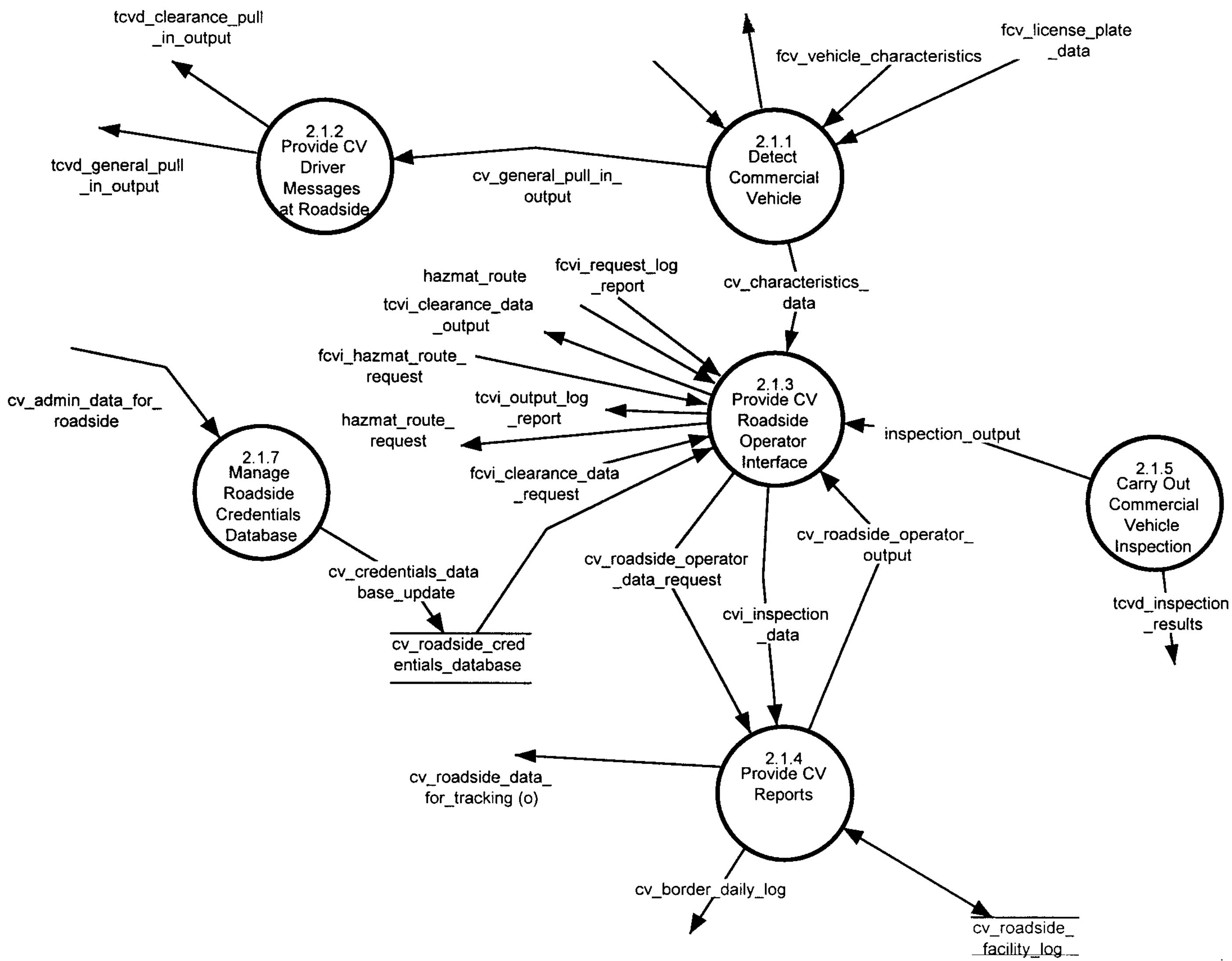

selected_strategy
incident_strategy _override
video_camera_control
fmco_strategy_o verride
fmco_video_camera_a ction_request
1.3.1 Select Strategy
selected_motorway _control_strategy
current_highway_ network_data
current_highway_ network_state
prediction_data
strategy_data
1.3.3 Implement Motorway Strategy
static_data_for_high ways
static_data_for_stra tegy_determination
1.3.7 Maintain Static Motorway Data
F_Motorway_Center Operator
T_Motorway_Center _Operator
1.3.6 Collect and Process Fault Data
roadside_fault_data
indicator_data_fault
control_requested_ state
local_sensor_data
control_data
control_input_data
1.3.5 Provide Roadside Control Facilities
td_information_for_ drivers_in_traffic
1.3.4 Output Control Data
vms_IRIS_route_gui dance_updates
indicator_storage_ data
incident_data_for_ vehicle_signage
vms_updates
traffic_data_for_ signage
AKKT_to_motorway _vms_request
motorway_to_AKKT _vms_request


1.4.1
Process AKKT Traffic Sensor Data
video_camera_control
ft_traffic_images
fre_conditions
ft_traffic_analog_data
traffic_sensor_data
1.4.2
Process and Store AKKT Traffic Data
current_road_network_data
indicator_storage_data
fakkto_predicted_incident_data
fakkto_current_incident_data
selected_strategy
roadside_wim_and_classification_data
1.4.5
Collect AKKT Classification Data
fcv_classification_data (o)
vehicle_tag_data
1.4.4
Collect Motorway Tag Data for Travel Time
fv_tag_data_input (o)
1.4.7
Exchange AKKT Data with IRIS
IRIS_traffic_data_flow
AKKT_traffic_data_flow
long_term_rural_m'way_AKKT_data
current_rural_m'way_AKKT_data
1.4.6
AKKT Display and Output Traffic Data
F_AKKT_Operator
T_AKKT_Operator
video_camera_control
traffic_data_for_in-vehicle_use

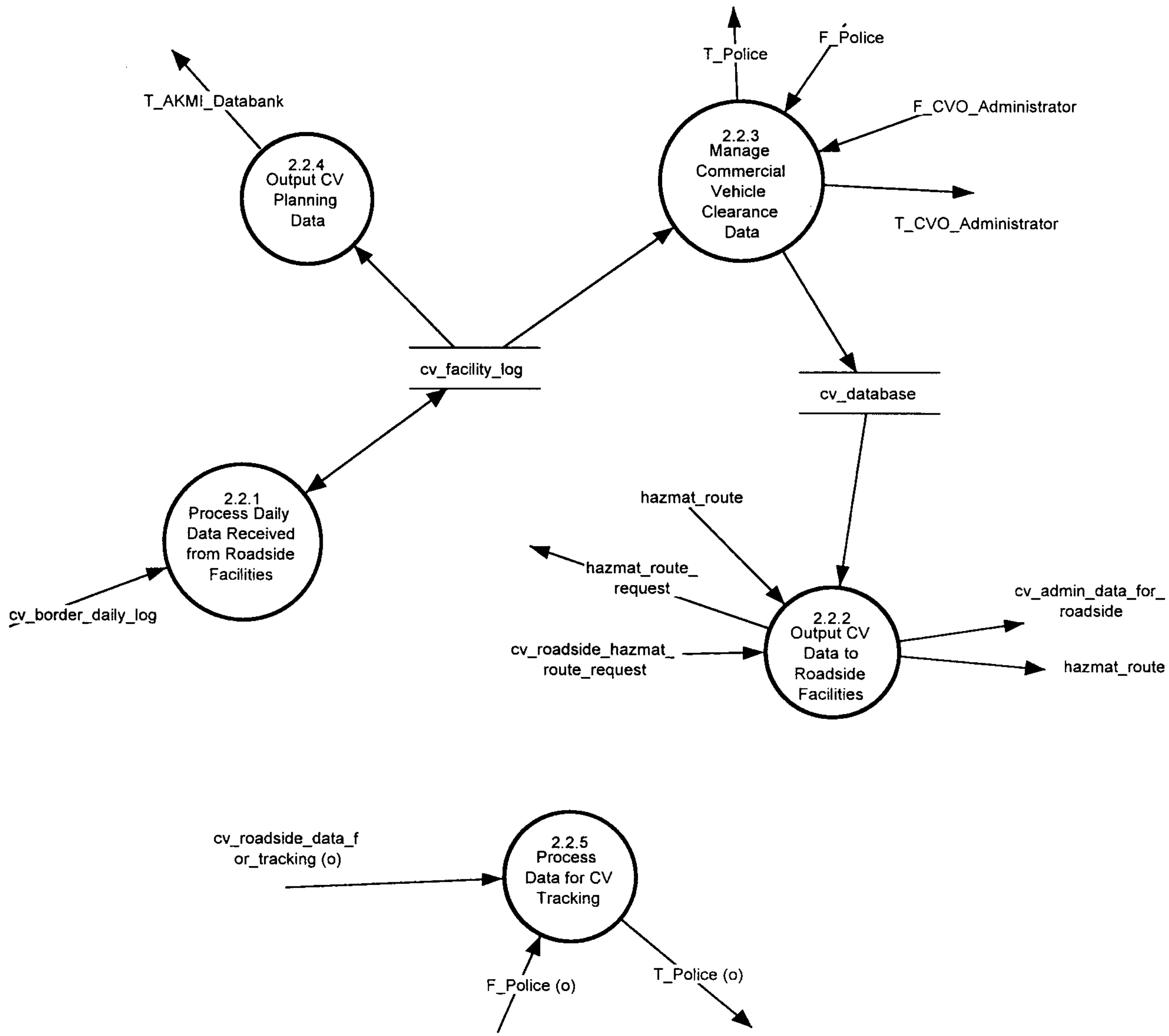


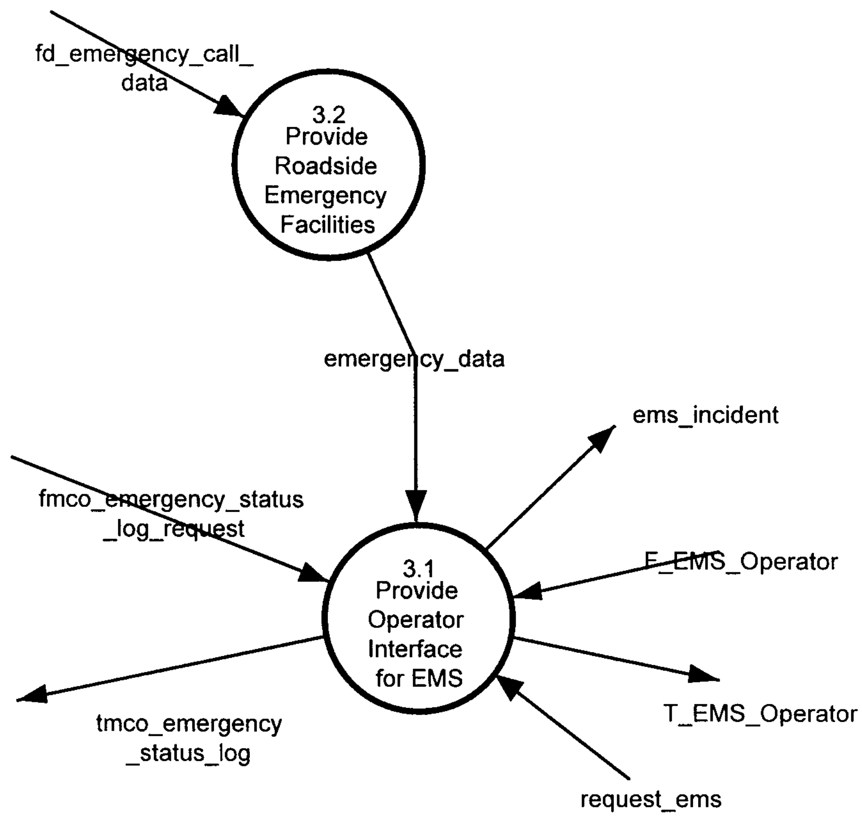
fakkto_video_camer
a_action_request
selected_
strategy
video_camera_control
1.5.1
Select AKKT
Strategy
selected_AKKT_
control_strategy
1.5.2
Implement
AKKT Strategy
strategy_data
current_highway_
network_data
current_highway_
network_state
static_data_for_
highways
static_data_for_stra
tegy_determination
1.5.6
Maintain
Static AKKT
Data
F_AKKT_Operator
T_AKKT_Operator
1.5.5
Collect &
Process AKKT
Fault Data
signal_fault_data
1.5.8
Provide
Isolated
AKKT
Signal
td_signal_indications
roadside_fault_data
indicator_data_fault
control_requested_
state
strategy_weather_
data
current_highway
_network_state
current_highway
_network_data
1.5.7
Impl'tAKKT
LocalWeath
erStrategy
local_sensor_data
1.5.4
Provide AKKT
Roadside
Control
Facilities
control_data
control_input_data
1.5.3
Output AKKT
Control Data
control_requested_
state
indicator_storage_
data
td_information_for_
drivers_in_traffic
motorway_to_AKKT
_vms_request
vms_IRIS_route_guidance
_updates
fumco_vms_
updates
fakkto_vms_
updates
AKKT_to_motorway
_vms_request


2.1*
Provide CV
Roadside
Facilities
2.2*
Administer
Commercial
Vehicles
cv_data_for_travel_time
F_CVO_Administrator
T_CVO_Administrat
or
takmidb_cv_tracking
_data
T_Police
F_Police
cv_roadside_data
_for_admin
cv_roadside_data_
for_tracking (o)
cv_admin_data_for_
roadside
F_CVO_Inspector
T_CVO_Inspector
F_Commercial_
Vehicle
T_Commercial
Vehicle_Driver
hazmat_route
hazmat_route
_request

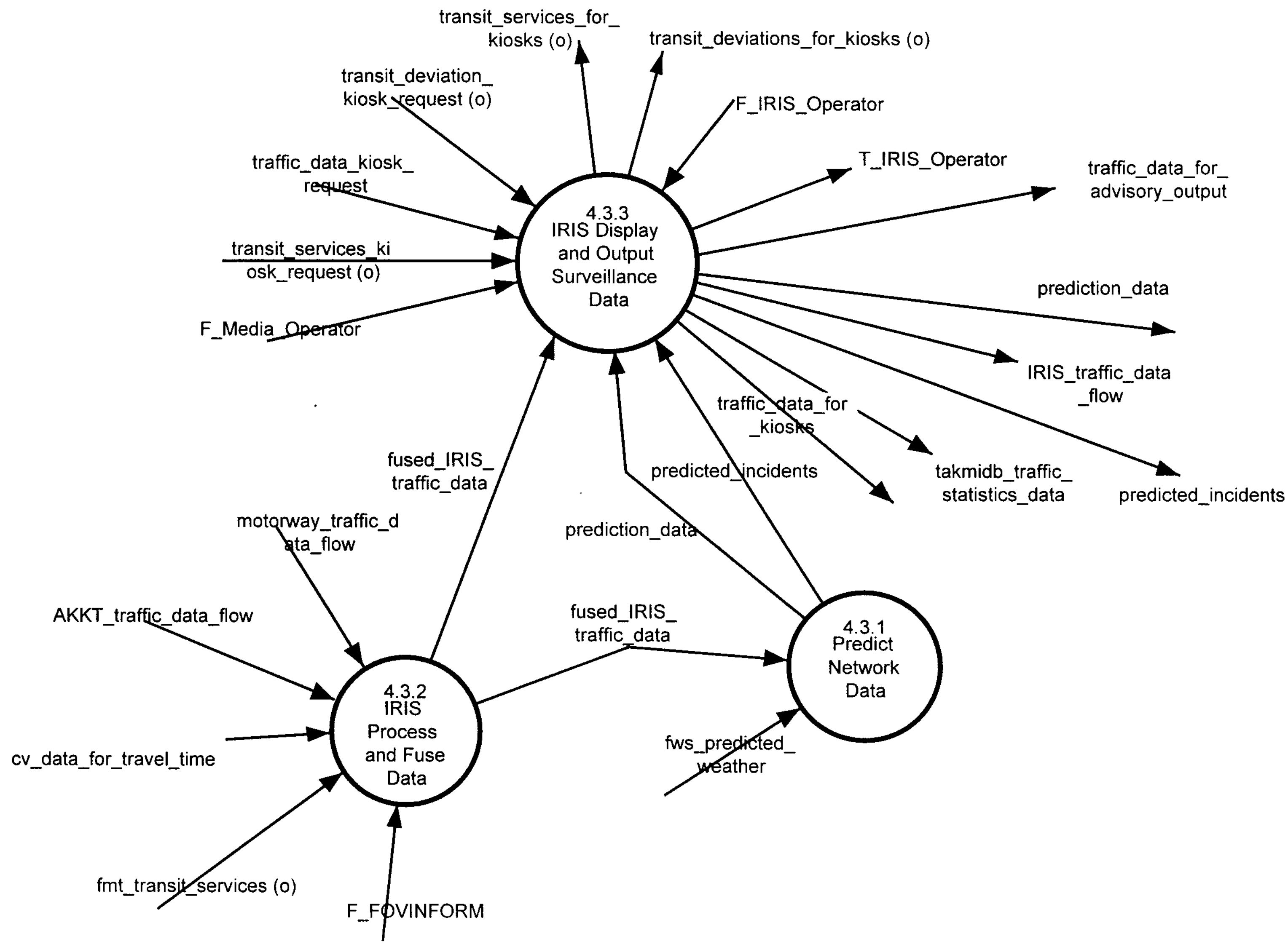


tcvd_clearance_pull
_in_output
tcvd_general_pull
_in_output
2.1.2
Provide CV
Driver
Messages
at Roadside
cv_general_pull_in_
output
fcv_vehicle_characteristics
fcv_license_plate
_data
2.1.1
Detect
Commercial
Vehicle
cv_characteristics_
data
hazmat_route
fcvi_request_log
_report
tcvi_clearance_data
_output
fcvi_hazmat_route_
request
tcvi_output_log
_report
hazmat_route_
request
fcvi_clearance_data
_request
2.1.3
Provide CV
Roadside
Operator
Interface
inspection_output
2.1.5
Carry Out
Commercial
Vehicle
Inspection
tcvd_inspection
_results
cv_admin_data_for_
roadside
2.1.7
Manage
Roadside
Credentials
Database
cv_credentials_data
base_update
cv_roadside_cred
entials_database
cv_roadside_operator
_data_request
cvi_inspection
_data
cv_roadside_operator_
output
2.1.4
Provide CV
Reports
cv_roadside_data_
for_tracking (o)
cv_border_daily_log
cv_roadside_
facility_log

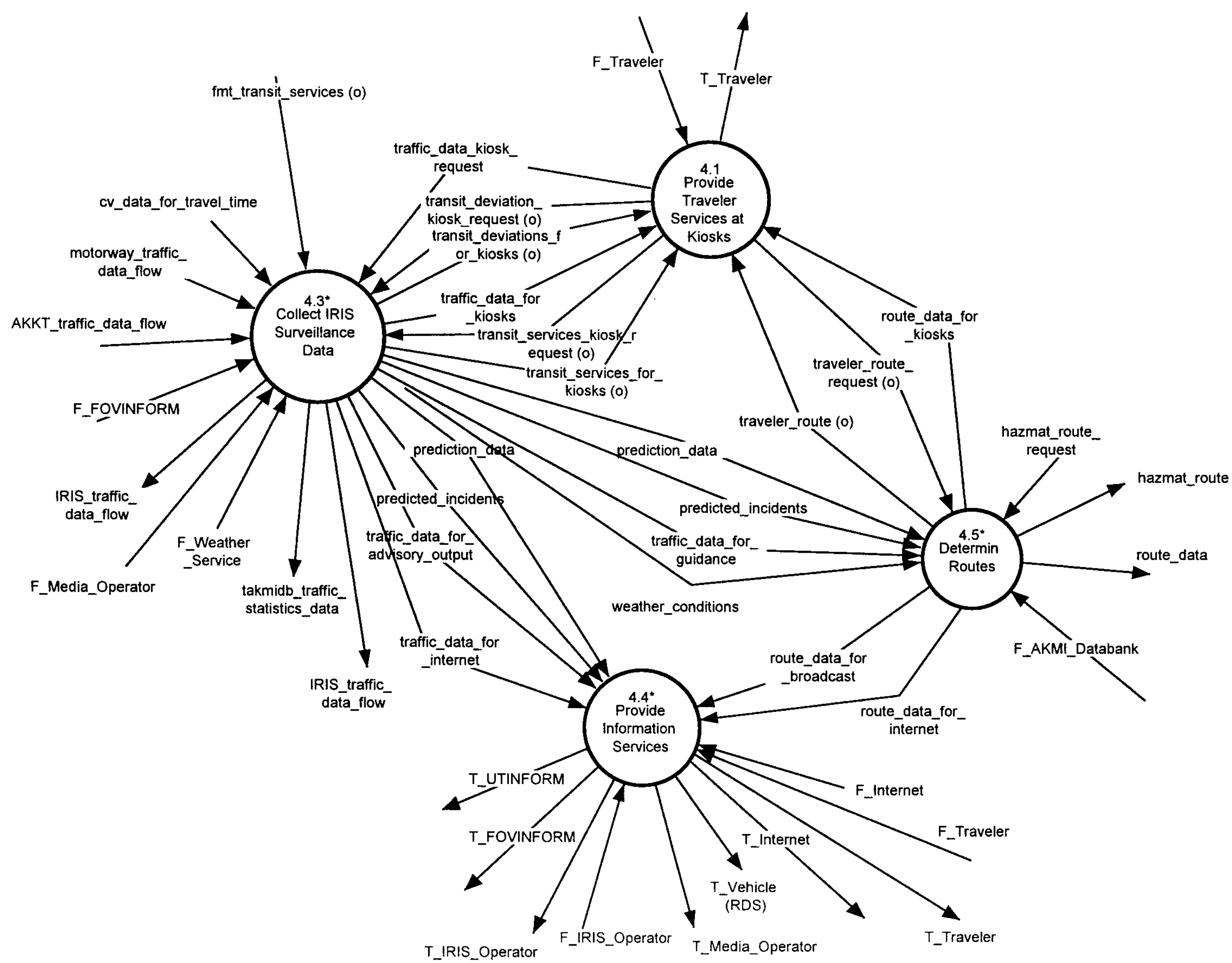

T_AKMI_Databank
2.2.4
Output CV
Planning
Data
T_Police
F_Police
F_CVO_Administrator
2.2.3
Manage
Commercial
Vehicle
Clearance
Data
T_CVO_Administrator
cv_facility_log
cv_database
2.2.1
Process Daily
Data Received
from Roadside
Facilities
cv_border_daily_log
hazmat_route
hazmat_route_
request
cv_roadside_hazmat_
route_request
2.2.2
Output CV
Data to
Roadside
Facilities
cv_admin_data_for_
roadside
hazmat_route
cv_roadside_data_f
or_tracking (o)
2.2.5
Process
Data for CV
Tracking
F_Police (o)
T_Police (o)

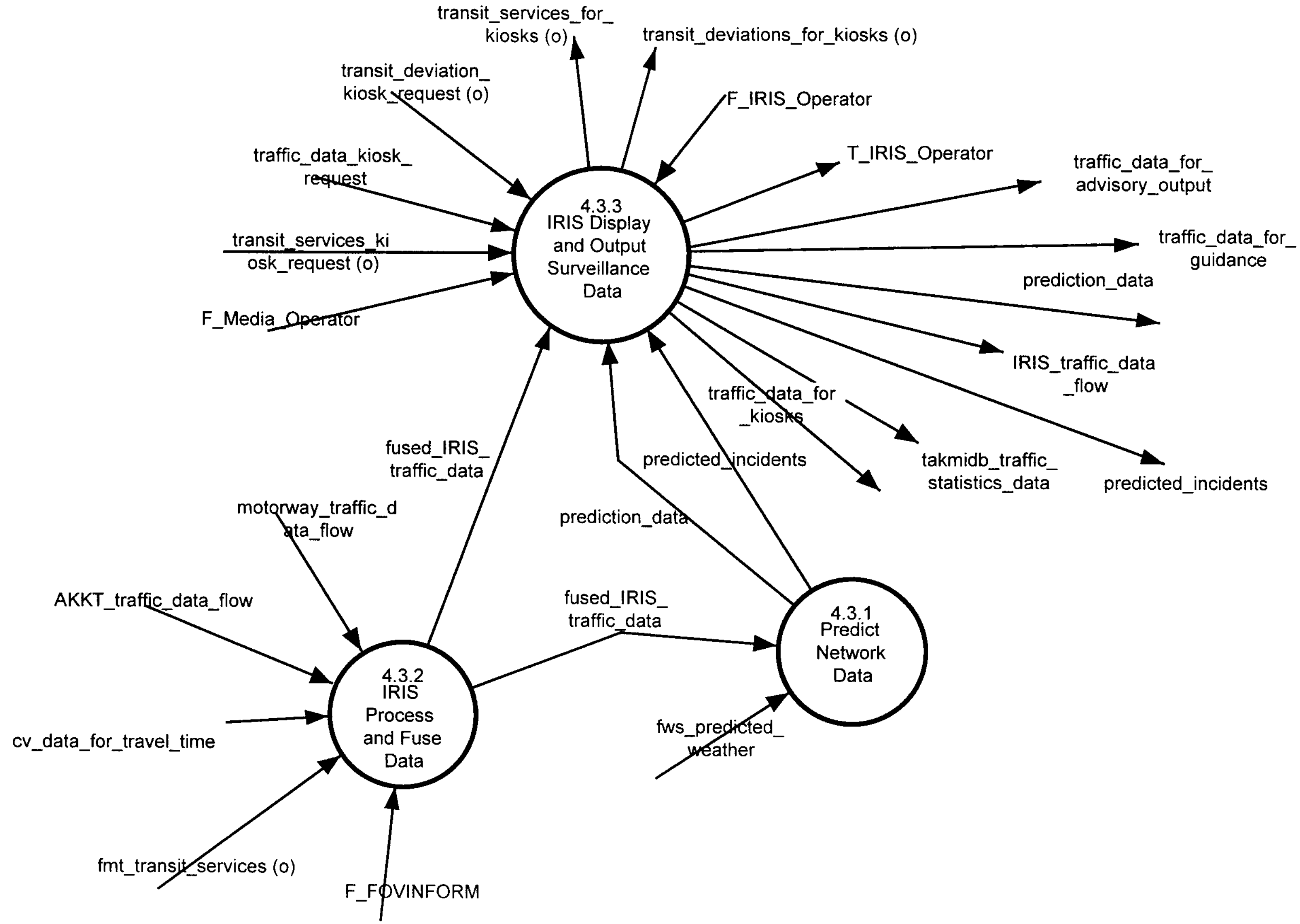


*This diagram shows very limited EMS functions.
No requirements for active management of
emergencies has been identified*

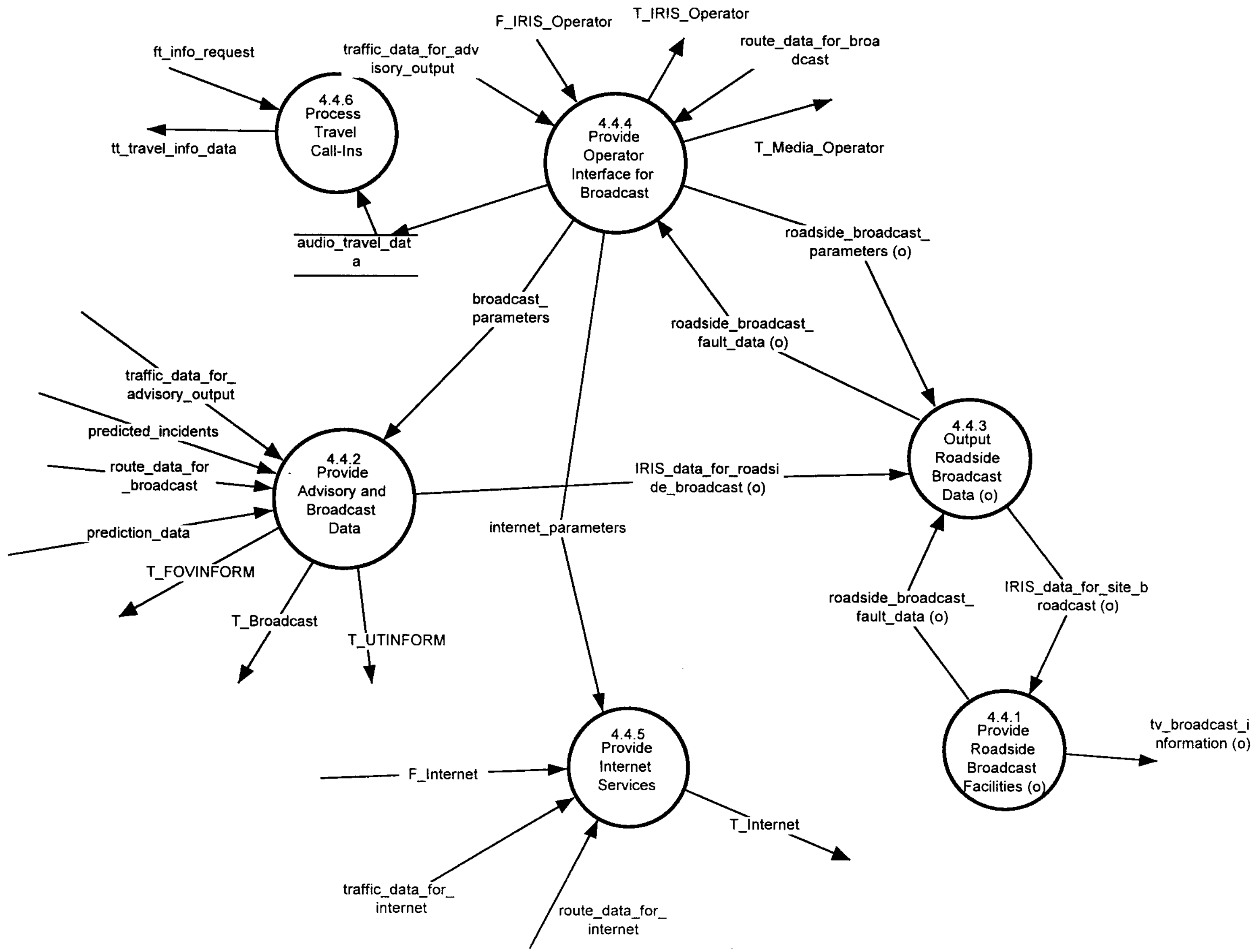


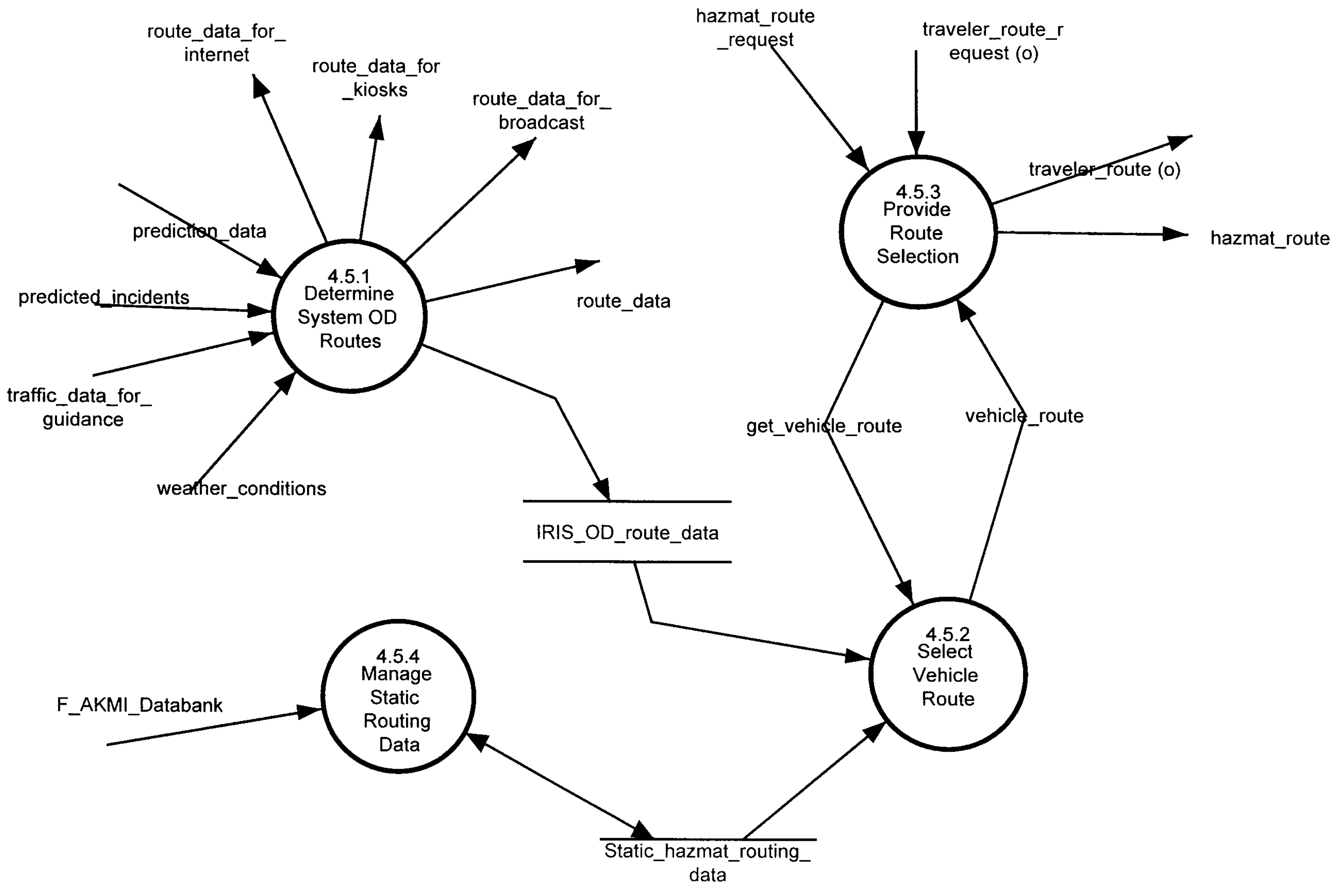
4.3.3
IRIS Display and Output Surveillance Data
4.3.2
IRIS Process and Fuse Data
4.3.1
Predict Network Data
transit_services_for_kiosks (o)
transit_deviations_for_kiosks (o)
F_IRIS_Operator
T_IRIS_Operator
traffic_data_for_advisory_output
prediction_data
IRIS_traffic_data_flow
traffic_data_for_kiosks
takmidb_traffic_statistics_data
predicted_incidents
transit_deviation_kiosk_request (o)
traffic_data_kiosk_request
transit_services_kiosk_request (o)
F_Media_Operator
fused_IRIS_traffic_data
predicted_incidents
prediction_data
motorway_traffic_data_flow
AKKT_traffic_data_flow
cv_data_for_travel_time
fmt_transit_services (o)
F_FOVINFORM
fused_IRIS_traffic_data
fws_predicted_weather


4.1
Provide
Traveler
Services at
Kiosks
4.3*
Collect IRIS
Surveillance
Data
4.4*
Provide
Information
Services
4.5*
Determin
Routes
F_Traveler
T_Traveler
fmt_transit_services (o)
traffic_data_kiosk_
request
cv_data_for_travel_time
transit_deviation_
kiosk_request (o)
transit_deviations_f
or_kiosks (o)
motorway_traffic_
data_flow
traffic_data_for
_kiosks
AKKT_traffic_data_flow
transit_services_kiosk_r
equest (o)
transit_services_for_
kiosks (o)
route_data_for
_kiosks
traveler_route_
request (o)
traveler_route (o)
F_FOVINFORM
IRIS_traffic_
data_flow
F_Weather
_Service
F_Media_Operator
takmidb_traffic_
statistics_data
IRIS_traffic_
data_flow
prediction_data
prediction_data
predicted_incidents
predicted_incidents
traffic_data_for_
advisory_output
traffic_data_for_
guidance
weather_conditions
traffic_data_for
_internet
hazmat_route_
request
hazmat_route
route_data
F_AKMI_Databank
route_data_for
_broadcast
route_data_for_
internet
T_UTINFORM
T_FOVINFORM
F_Internet
F_Traveler
T_Internet
T_Vehicle
(RDS)
T_Traveler
T_IRIS_Operator
F_IRIS_Operator
T_Media_Operator



transit_services_for_
kiosks (o)
transit_deviations_for_kiosks (o)
transit_deviation_
kiosk_request (o)
F_IRIS_Operator
T_IRIS_Operator
traffic_data_kiosk_
request
traffic_data_for_
advisory_output
transit_services_ki
osk_request (o)
4.3.3
IRIS Display
and Output
Surveillance
Data
traffic_data_for_
guidance
prediction_data
F_Media_Operator
IRIS_traffic_data
_flow
traffic_data_for
_kiosks
fused_IRIS_
traffic_data
predicted_incidents
takmidb_traffic_
statistics_data
predicted_incidents
motorway_traffic_d
ata_flow
prediction_data
AKKT_traffic_data_flow
fused_IRIS_
traffic_data
4.3.1
Predict
Network
Data
4.3.2
IRIS
Process
and Fuse
Data
cv_data_for_travel_time
fws_predicted_
weather
fmt_transit_services (o)
F_FOVINFORM


4.4.6
Process
Travel
Call-Ins
ft_info_request
tt_travel_info_data
audio_travel_dat
a
4.4.4
Provide
Operator
Interface for
Broadcast
traffic_data_for_adv
isory_output
F_IRIS_Operator
T_IRIS_Operator
route_data_for_broa
dcast
T_Media_Operator
roadside_broadcast_
parameters (o)
roadside_broadcast_
fault_data (o)
broadcast_
parameters
4.4.2
Provide
Advisory and
Broadcast
Data
traffic_data_for_
advisory_output
predicted_incidents
route_data_for
_broadcast
prediction_data
T_FOVINFORM
T_Broadcast
T_UTINFORM
IRIS_data_for_roadsi
de_broadcast (o)
internet_parameters
4.4.3
Output
Roadside
Broadcast
Data (o)
roadside_broadcast_
fault_data (o)
IRIS_data_for_site_b
roadcast (o)
4.4.1
Provide
Roadside
Broadcast
Facilities (o)
tv_broadcast_i
nformation (o)
4.4.5
Provide
Internet
Services
F_Internet
T_Internet
traffic_data_for_
internet
route_data_for_
internet


route_data_for_
internet
route_data_for
_kiosks
route_data_for_
broadcast
prediction_data
predicted_incidents
traffic_data_for_
guidance
weather_conditions
4.5.1
Determine
System OD
Routes
route_data
IRIS_OD_route_data
hazmat_route
_request
traveler_route_r
equest (o)
4.5.3
Provide
Route
Selection
traveler_route (o)
hazmat_route
get_vehicle_route
vehicle_route
4.5.2
Select
Vehicle
Route
F_AKMI_Databank
4.5.4
Manage
Static
Routing
Data
Static_hazmat_routing_
data