# TELEcommunication and InforMATICS Technologies Serving the Greek Freeway Users

K. E. Evangelidis[1], P. I. Papaioannou[1] and T. H. Kaskalis[2]

[1] Department of Civil Engineering, Aristotle University
[2] Department of Nursery, Aristotle University
54124 Thessaloniki, Greece

**Abstract.** Intelligent Transport Systems (ITS), also known as Transport Telematics, combine Telecommunication and Informatics Technologies with the aim to provide a safe and efficient operation of a Transportation System. This paper suggests an approach for planning, and designing Telematics applications for the Greek Freeway Network, by integrating the local experience from such developments and the existing framework of the American ITS Architecture. In this initial approach the two basic thematic areas of Traffic and Incident Management are covered. The Methodological Approach consists of: a) the Identification of System Users and subsequently of their needs, called User Services, b) the transformation of User Services into User Service Requirements, c) the determination of the Processes that form the Logical Architecture and d) the determination of the Data Flows through these Processes along with Mechanisms and Control/Constraints affecting the transformation of Data within Processes.

## 1 Scope

This case study paper aims to contribute to the general framework of an Intelligent Transport System (ITS) development, serving the Users of the Greek Freeways. Such a System is considered of paramount importance, since it provides a safer and more efficient operation of a Road Network, saving time, money and most important, human lives.

Based on the US ITS Architecture, but combined with the prevailing Greek conditions, this approach provides the conceptual data model by determining basic elements of the Logical Architecture such as the Processes and the Data Flows, which will in turn form the guidelines for an applicable deployment of Telematics Systems in Greek Freeways.

The Physical Architecture and the selection of the respective Equipment Packages, necessary to implement Telematics Services, are out of the scope of this paper.

## 2 Methodological Approach

The following steps were taken in order to achieve the above scope:

1. Brief description of Telematics System Architecture key concepts

2. Identification of System Users and subsequently of their Needs, called User Services, relevant to System Use
3. Transformation of User Services into a detailed list of Functional Statements which form the User Service Requirements
4. Determination of the exact processes (functions or activities) forming the Logical Architecture and guiding the development of the functional requirements of the ITS, Telematics System
5. Determination of Data flows through Processes along with Mechanisms and Controls/Constraints affecting the transformation of Data within the Processes

From the above, steps 1,3 and 4 are extracted after a sedulous review of the American National ITS Architecture, that is a generic framework for ITS deployment. The rest are formulated to fit Greek conditions and particularities pertaining to issues such as specific problems, Greek mentality, climatic and terrain morphology characteristics, road network characteristics, legal and institutional issues, policies, established local management information systems and databases etc.

## 3 Key Concepts

*Intelligent Transportation Systems (ITS)*, also known as *Transport Telematics*, arise from the integration of Telecommunications and Informatics technologies. They are also associated with a broad range of diverse technologies applied to and integrated with transportation facilities and services to save lives, time and money, and reduce environmental impacts. The typical services provided by the deployment of an ITS can be divided into functional areas such as *Advanced Traffic Management Systems (ATMS)*, *Advanced Traveller Information Systems (ATIS)*, *Commercial Vehicle Operations (CVO)*, *Emergency Management (EM)* and *Advanced Public Transport Systems (APTS)*.

An *ITS Architecture* is a framework for planning, developing and deploying ITS, providing also a technological growth path.

As any other System, Transport Telematics serves the needs of its *Users*. A User might be the public (drivers, passengers, travellers in general) or System Operator or a Stakeholder.

*User Services* document what Transport Telematics should do from the User's perspective.

A specific *Functional Statement* of what must be done to support the ITS User Services composes a *User Service Requirement*.

The User Service Requirements can serve as a requirement baseline to guide to the System's *Logical Architecture*. The Logical Architecture defines what has to be done to support the ITS User Services and is represented by levels of *Processes* that perform ITS functions and the *Information* or *Data Flows* that are shared between these Processes.

Various *Mechanisms* and *Controls/Constraints* strongly related to local conditions affect the Processes at all levels of the Logical Architecture.

## 4 Current Status on International ITS Architectures and Greek Transport Telematics Applications

An ITS Architecture serves as an information source and provides institutional packages to coordinate deployment effort by public and private organisations. In this respect, various national initiatives are either currently taking place or are under development in the international ITS community [1]. A brief summary providing these development activities in Europe, Canada and the United States is as follows:

In *Europe*, for almost a decade, numerous efforts have been spent in programs for research and development on Intelligent Transport Services and in particular on Road Transport Telematics (RTT). However, a Telematics architecture for the European framework has not been developed, and only consolidated guidelines for the development and assessment of intelligent transport system architectures have been published as a result of the CONVERGE project in early 1998. As a concerted effort to comparable developments in the U.S. and Japan, the European Commission initiated the Keystone Architecture Required for European Network (KAREN) Project in April 1998. The objective of KAREN is to build a minimum stable framework necessary for the deployment of working and workable ITS within the European Union until at least 2010 [2]. The *US* ITS Architecture provides a common framework for planning, defining, and integrating intelligent transportation systems. It is a mature product that reflects the contributions of a broad cross-section of the ITS community (transportation practitioners, systems engineers, system developers, technology specialists, consultants, etc.) over a five year period [3]. The *Canadian* ITS Architecture which was recently released, is based on the respective American one but it includes further developments specific to the Canadian institutional and operating environment [4].

With the recognition that the National ITS Architecture developed in the United States is currently the most comprehensive and well-known architecture for ITS, it is recommended to be adopted for use in developing the initial system architecture for Telematics systems on Greek Freeways. In any case, it should be noted that the lists of user services, market and equipment packages are neither exhaustive nor final. They serve as living database, which will be subject to continuous revisions and updates based on changing user requirements and emerging technologies. In addition, the development of an architecture would be an iterative process with more functionalities and more agencies / stakeholders getting involved over time.

Regarding implementations related to Transport Telematics in Greece, few of them can be mentioned almost all working independently of an ITS architectural framework:

Egnatia Motorway with a length of 680 km crossing 4 regions of Greece, traversing mountainous terrain in its western section of Epirus, (where critical bridged and tunnelled links combined with difficult weather conditions, offer significant operations and maintenance challenges), can be considered as the proper representative of the Greek Freeways Class, as regards ITS Applications. A Master Plan for the deployment of "Telematics Applications for Traffic Management and Toll Collection" has been accomplished for Egnatia Odos A.E. in 2000. This study was based mainly on the US ITS Architecture treating the whole road as one System. The Implementation of a Telematics Pilot Project in the Kavala By-Pass is now under way [1].

Other individually implemented ITS applications in Greece such as those deployed in Attiki Odos or in the immerged tunnel connecting Preveza and Aktio, as already stated are not based on an ITS architectural framework.

## 5 System Users, Users Needs and User Services Identified for the Greek Freeways

The possible Users of an ITS System with regard to the usage of the Greek Freeways and with respect to the current legal and institutional framework are:

- Drivers and travellers
- Operation and Maintenance Agencies
- Public or Private Sector

The role and responsibilities of each User category and the objectives related to these responsibilities define the User Needs. Subsequently, the appropriate User Services that will meet the requirements of User Needs are identified.

Version 3.0 of the US National ITS Architecture released in December 1999, defines 31 User Services grouped into seven broader development areas.

The Canadian ITS Architecture released in October 2000, is fully based on the respective US Architecture and defines 35 User Services which are grouped into eight user service bundles and are sub-divided into 90 User Subservices.

Work Package 2 of the KAREN European Project includes a User Needs Database released in April 1999, containing 10 major groups and 32 User Needs group categories. Instead of user Services a Set of Architectures, which describe the different elements and interactions necessary to satisfy those User Needs is provided.

Table 1 provides a summary of User Services along with a potential implementation time frame and a preliminary categorisation to core and non-core services relative to the Telematics System for traffic management and toll collection on Egnatia Motorway. Since Egnatia Motorway is the proper representative of the Greek Freeways Class, regarding ITS Development, the above User Services can be considered as representative to the Greek Highway User Services.

## 6 Functional Statements Providing Greek User Services

The concept of User Services allows the identification of high-level services in addressing the specific needs of the Users. The functions required to accomplish each User Service form what is called Functional Statements, also defined as User Service Requirements. These requirements can be used as a departure point for the development of project functional requirements and system specifications.

In this approach the User Services primarily selected to structure the ITS for Greek Freeways, are Traffic Control and Incident Management User Services. The following provide the decomposition of the selected User Services in a number of Functional Statements. The analysis is based on the US ITS Architecture [3].

| *USER SERVICE & IMPLEMENTATION TIME FRAME* | *Core Service* | *Non-core Service* |
|---|---|---|
| Short to Medium Term | | |
| 1. Traffic Control | • | |
| 2. Incident Management | • | |
| 3. Electronic Toll Payment Service | • | |
| 4. Assessment of Pavement and Weather Conditions* | • | |
| 5. Hazardous Materials Incident Response | • | |
| 6. Emergency Vehicle Management | • | |
| 7. Emergency Notification and Personal Security | • | |
| 8. Archived Data Management | • | |
| 9. Infrastructure Management and Maintenance* | | • |
| 10. Commercial Vehicle Electronic Clearance | • | |
| Medium to Long Term | | |
| 11. Traveller Information Services | | • |
| 12. Travel Demand Management | • | |
| 13. Transportation Planning | | • |
| 14. En-route Public Transport Information | | • |
| 15. Public Transport Management | | • |
| 16. Emissions Data Collection | | • |
| 17. Enforcing/Policing Traffic Regulations* | | • |
| 18. Customs and Immigration Inspection and Clearance | | • |
| 19. Commercial Vehicle Administrative Processes | | • |
| 20. Commercial Fleet Management | | • |
| 21. Assessment of Environmental Conditions* | | • |

* New User Service specific to Egnatia Odos

**Table 1.** Identified User Services for Greek Highways - Time Frame and Preliminary Categorisation [1]

### 6.1 Traffic Control

Traffic Control provides the capability to efficiently manage the movement of traffic on streets and highways. Four functions are provided:

- Traffic Flow Optimisation
- Traffic Surveillance
- Control Function, and
- Provide Information

The transformation of Traffic Control User Service functions to Functional Statements is given in Table 2.

### 6.2 Incident Management

Incident Management will identify incidents, formulate response actions, and support initiation and ongoing coordination of those response actions. Six major functions are provided which are:

| *Traffic Control shall include a Flow Optimise function (capability to optimize traffic flow)* |
|---|
| • The Flow Optimise function shall employ control strategies that seek to maximize traffic-movement efficiency. |
| – Traffic-movement control shall manage movement of traffic on streets. |
| – Traffic-movement control shall manage movement of traffic on highways. |
| – Traffic-movement control shall include the goal of minimizing delay times. |
| – Traffic-movement control shall include the goal of minimizing energy use. |
| – Traffic-movement control shall include the goal of minimizing air quality impacts due to traffic. |
| • The Flow Optimise function shall include a Wide Area optimisation capability, to include several jurisdictions. |
| – Wide area optimisation shall integrate the control of network signal systems with the control of freeways. |
| – Wide area optimisation shall include features that provide preferential treatment for transit vehicles. |
| – Wide area optimisation shall include features that provide preferential treatment for HOV. |
| • Flow optimise shall be implemented in a manner that seeks to optimise traffic movement over a large geographic area. |
| • Flow optimise shall include a Control function that is responsive to both the current demand as well as the expected demand. |
| – Control shall include the capability to facilitate the dissipation of traffic congestion |
| • Flow Optimise shall provide the capability to predict travel patterns. |
| • The Control Function shall include the use of data acquired from traffic surveillance as feedback to the control strategies. |
| • Driver/traveller behaviour and expectancies. |
| *Traffic Control shall include a Traffic Surveillance function.* |
| • Traffic Surveillance shall include a Vehicle Detection function with the capability of accurately detecting vehicles in a real-time fashion. |
| – Vehicle Detection shall include the capability to determine High Occupancy Vehicles. |
| • Traffic Surveillance shall include a Data Collect function to provide the capability to collect data that are needed for determining traffic flow and prediction. |
| – Data Collect shall provide the capability to quickly feedback traffic data to the control processes. |
| • Traffic Surveillance shall include an area wide surveillance capability to include several jurisdictions. |
| – The area wide surveillance shall gather speed and flow information. |
| – The area wide surveillance shall cover a large number of roadway segments. |
| • Traffic Control shall provide the capability to acquire detailed traffic measurements at specific locations. |
| – Traffic Surveillance shall include a Data Process function to process the traffic data which are acquired. |
| • The wide area surveillance shall acquire sufficient data to provide the system with the knowledge of the existing conditions. |
| – Data Process shall combine and process traffic data from multiple sources and times in order to improve the accuracy of the view of the current traffic condition. |
| – Data Process shall process traffic data to generate near term predictions of traffic conditions. |

**Table 2.** Transformation of Traffic Control User Service to Functional Statements [3]

| *Traffic Control shall include a Control Function.* |
| --- |
| • The Device Control Function shall include a "real-time" traffic-adaptive control capability.<br>• The real-time traffic-adaptive control portion of the Control Function shall be an area wide control to include several jurisdictions.<br>– The area wide control shall be implemented in an integrated and consistent manner that avoids the issuance of conflicting controls.<br>– The area wide control shall be implemented in a manner that permits the following types of vehicles to have preference over other vehicles being controlled. Transit - High Occupancy Vehicles - Emergency Medical Service Vehicles.<br>• The Device Control Function shall provide the capability to exercise control over those devices utilized for traffic control.<br>– Device Control shall include the capability to control traffic signalisation, including rapid modification of signalisation parameters to respond to traffic requirements.<br>– Device Control shall include the capability to control dynamically traffic signing.<br>– Device Control shall include the capability to control freeway ramp metering.<br>– Device Control shall include the capability to exercise dynamic control over the infrastructure (such as reversible-lanes, turning restrictions, etc.).<br>• Device Control shall communicate control data to the following devices:Traffic signals - Ramp meters - Information signs - HOV lanes - Human operator support.<br>– Traffic Surveillance shall include a Data Process function to process the traffic data which are acquired.<br>• Device Control shall provide the operator with the capability to manually override the system's automatic controls.<br>• Device Control shall provide the operator the capability to adaptively change system response in order to provide a coordinated support of other Traffic Management Controls that are responding to incidents. |
| *The Control Function shall provide traffic control information to other elements of the ITS, including but not limited to the following:*<br>– *In-vehicle navigation.*<br>– *Trip planning.*<br>– *Routing systems.*<br>– *Fleet management systems.* |

**Table 2.** Transformation of Traffic Control User Service to Functional Statements [3] (continued)

- Scheduled Planned Incidents,
- Identify Incidents,
- Formulate response Actions,
- Support Coordinated Implementation of Response Actions,
- Support Initialisation of Response to Actions, and
- Predict Hazardous Conditions.

The transformation of Incident Management User Service functions to Functional Statements is given in Table 3.

## 7 ITS Logical Architecture

The Logical Architecture presents a functional view of the ITS User Services, transforming the Functional Statements determined for the selected ITS User Services in to logical elements. Developing a Logical Architecture, which is independent of institutions and technologies, helps to identify the system functions and information flows,

| *Incident Management shall provide an incident identification function to identify incidents.* |
|---|
| • The incident identification function shall include the capability to identify predicted incidents.<br>– The incident identification function shall use information from the following types of sources, where available, to identify predicted incidents: Traffic flow sensors - Environmental sensors - Public safety sources - Media sources - Weather information sources - Transportation providers - Sponsors of special events - Hazardous condition prediction algorithms.<br>– The incident identification function shall determine at least the following characteristics of each predicted incident: Type.- Extent. - Severity. - Location - Expected duration.<br>– The incident identification function shall determine the expected traffic flow impact of each predicted incident.<br>• The incident identification function shall include the capability to identify existing (both planned and unplanned) incidents.<br>– The incident identification function shall use information from the following types of sources, where available, to identify existing incidents: Traffic flow sensors. - Environmental sensors. - Public safety sources. - Media sources. - Weather information sources. - Transportation providers. - Travellers.<br>– The incident identification function shall determine and continuously monitor at least the following characteristics of each existing incident: Type. - Extent. - Severity.- Location. - Expected duration.<br>– The incident identification function shall determine and continuously monitor the current and expected traffic flow impact of each existing incident. |
| *Incident Management shall provide a response formulation function to formulate appropriate response actions to each identified incident and revise those actions when necessary.* |
| • The response formulation function shall propose and facilitate the appropriate scheduling of those predicted incidents that can be scheduled to minimize incident potential, incident impacts, and/or the resources required for incident management.<br>• The response formulation function shall propose and facilitate the appropriate dispatch of emergency response vehicles to an incident.<br>• The response formulation function shall propose and facilitate the appropriate dispatch of service vehicles to an incident.<br>• The response formulation function shall propose and facilitate the appropriate dissemination of incident related information to travellers and potential travellers.<br>• The response formulation function shall propose and facilitate the appropriate control of traffic signals and other traffic control to reduce the traffic flow impact of an incident. |
| *Incident Management shall include a response implementation function to provide those services needed to implement a coordinated incident response using all appropriate agencies.* |
| • The response implementation function shall provide at least the following decision support capabilities needed to implement coordinated incident response actions by all participating institutions: Response implementation shall allow coordinated selection/determination of the procedures needed for resolution of each incident and provide the procedures to those agencies responding to the incident.<br>• The response implementation function shall provide a link between Incident Management and all other user services necessary to implement incident response actions.<br>• The response implementation function shall provide the capability to disseminate information relating to response status to other agencies and user services. |
| *Incident Management shall provide the capability to predict the time and location of hazardous conditions that may cause an incident.* |

**Table 3.** Transformation of Incident Management User Service to Functional Statements [3]

and serves to guide development of functional requirements for new systems and improvements.

The following provide the key elements of the ITS Logical Architecture:

- The Processes performing ITS User Services
- The Information that is shared between these Processes

It should be noted that the Processes and Information below, have been yield with regard to Traffic Control and Incident Management User Services identified for the Greek Freeway Users.

### 7.1 Processes Performing ITS User Services

Process is a function or activity identified in the Logical Architecture that is required to support the ITS User Services. Many different Processes must work together and share information to provide a User Service. Processes may be decomposed into more detailed sub-processes forming various levels of Processing [5].

With the "Manage ITS" Process as the starting point, representing the 1st level of Processes, the sub-processes - belonging to the 2nd level of Processes - involved to Traffic Control User Service were identified. The same procedure followed until the 5th level of Processes leading to the generation of Figure 1. Figure 2 represents the same Process classification performing the Incident Management User Service functional requirements.

### 7.2 Data Flows: "data in motion" in ITS

Figures 1 and 2 depict the Processes (functions or activities) performing ITS User Services, classified in various levels of processing. Processes may be connected between each other through data exchanges, called Data Flows. Data Flows represent the information that is transferred between processes in the Logical Architecture showing how data moves through the system. Data flows are aggregated together to form higher-level Architecture Flows in the Physical Architecture. Depending on the level of Process data exchange, Data Flows may flow from Parent Data Flows or may disaggregate to Sub Data Flows.

Table 4 illustrates "data in motion" in the higher level of the major Processes identified for Traffic Control User Service (Figure 2). The US ITS Architecture Data Flows sourcing or sinking to a Process extracted the incoming and outgoing to the Process Data.

## 8 Mechanisms and Controls affecting the Processes

The Processes previously determined in the Logical Architecture of the Telematics Applications for the Greek Freeways are also governed by a number of Controls and Mechanisms that are defined externally.

Controls constrain or dictate under what conditions transformation of Input to Output Data occurs. An indicative control determination includes but is not limited to the following:

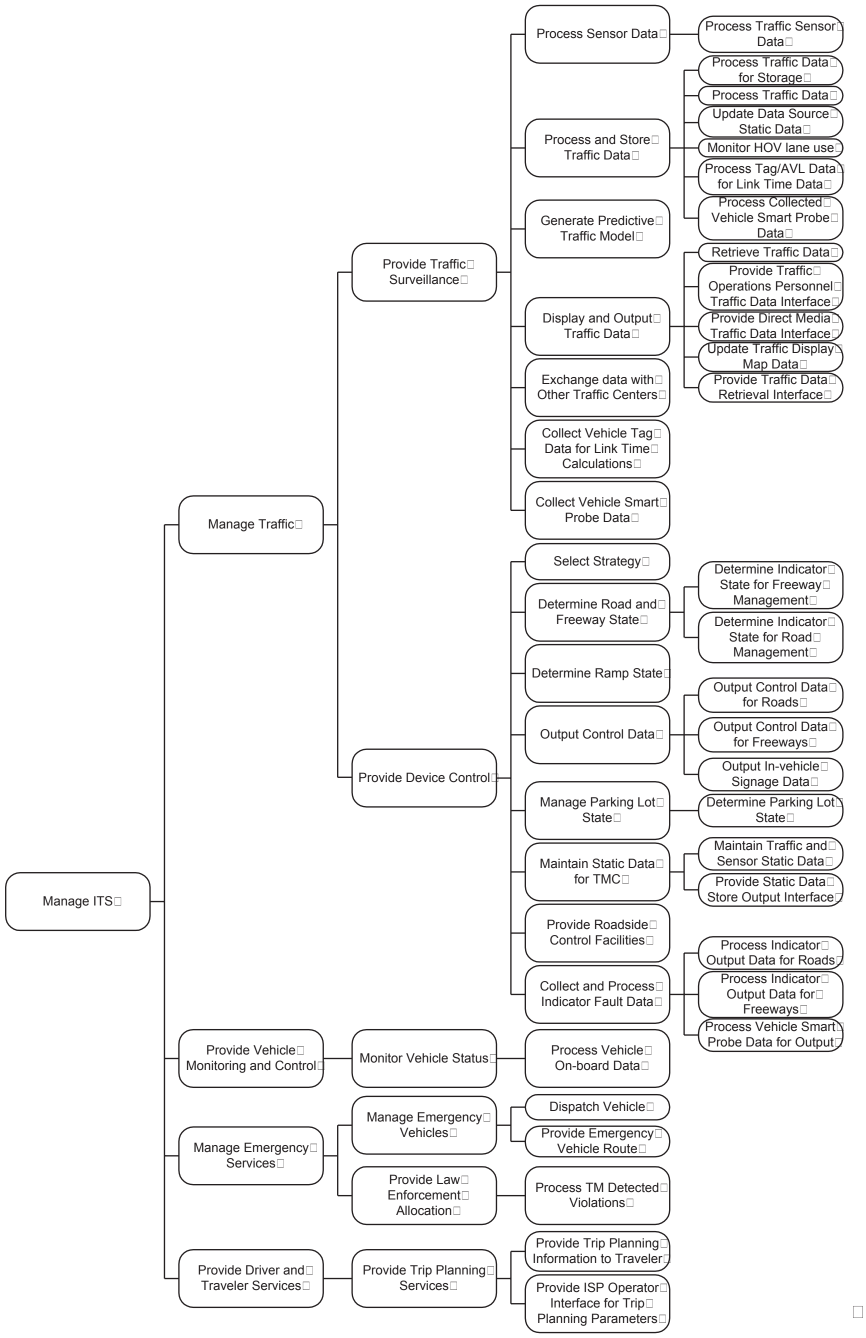


**Fig. 1.** Transformation of Traffic Control User Service Functional Statements to Processes

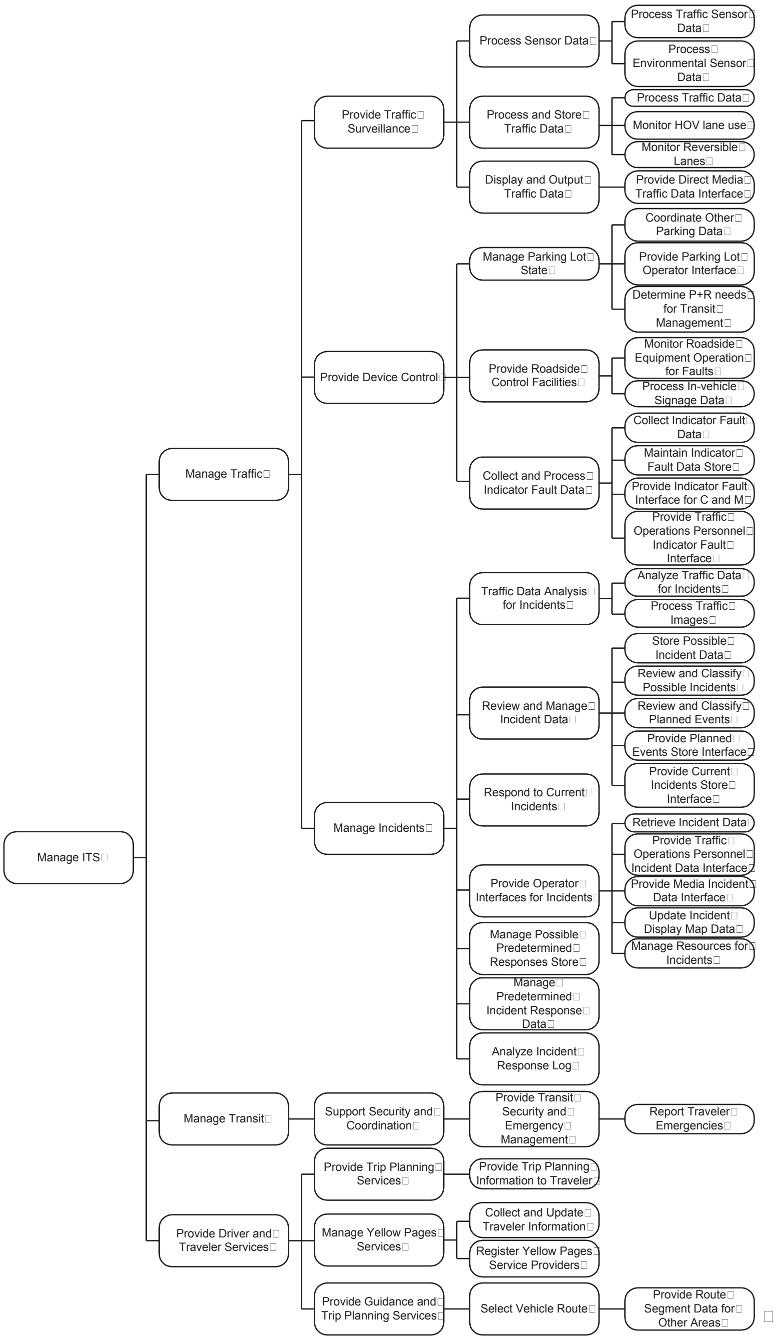


**Fig. 2.** Transformation of Incident Management User Service Functional Statements to Processes

| *INCOMING* | *PROCESS* | *OUTGOING* |
|---|---|---|
| multimodal crossing close duration, time - pedestrian data, images - roadside environment physical conditions - traffic data, images - sensor configuration data | Process Traffic Sensor Data | sensor fault data, status - traffic video image, high occupancy vehicle lane data input - incident analysis data - local sensor data for highways, roads - multimodal crossing sensor data - pedestrian sensor data - sensor data archive input, for reversible lanes |
| current highway network data, incident data, ramp state, network data, road network use - high occupancy vehicle lane data - indicator control storage data for highways, roads - indicator input storage data for highways, roads - link data from automatic vehicle location, tags - planned event data - processed data - selected strategy - sensor output data - vehicle smart probe data for storage - wide area pollution data | Process Traffic Data for Storage | current data - long term data |
| environment, high occupancy vehicles, hri-multimodal crossing - pedestrian - traffic sensor data, static data for sensor processing, traffic video image data | Process Traffic Data | unusual data - traffic surveillance data - strategy data for highways, roads - processed data - ramp data - sensor output data - parking lot input data |
| current, long term, predictive model data - request traffic media, operations data - traffic data demand, deployment, distribution request | Retrieve Traffic Data | traffic data for demand, deployment, distribution, emergency services, signage, transit - retrieved traffic media, operations data - sensor data for distribution - operator log for traffic data - incident video for emergency services |
| traffic data parameter updates, traffic information requests, weather request information from traffic operations personnel - map data for traffic display - operator log for traffic data - retrieved traffic operations data - traffic video image for display - weather service information | Provide Traffic Operations Personnel Traffic Data Interface | environment sensor configuration data - operator log for traffic data - request traffic map display update, operations data - sensor configuration data - traffic data media parameters - to traffic operations personnel traffic control information display, video image output, weather information - weather service information request |
| traffic data request from media - map data for traffic display - retrieved traffic media data - traffic data media parameters | Provide Direct Media Traffic Data Interface | traffic data to media - request traffic media data |

**Table 4.** Incoming and Outgoing Data to high-level Traffic Control Processes [3]

| *INCOMING* | *PROCESS* | *OUTGOING* |
|---|---|---|
| current traffic pollution data - incident details from media - sensor data for distribution - traffic data advisory request, for distribution, guidance request, kiosk request, personal request, retrieval parameters, ridesharing request - traveller traffic profile | Provide Traffic Data Retrieval Interface | traffic data retrieval parameters, personal request for archive, kiosk request for archive, for guidance, for kiosks, for personal devices, for ridesharing, distribution request, for advisory output, for broadcast to kiosks, for broadcast to personal devices - information for media |
| coordination data roads to freeways - prediction data - selected highway control strategy - static data for highways - strategy data for highways - transit highway overall priority | Determine Indicator State for Freeway Management | transit highway priority given - current highway network data, state - indicator highway requested state - coordination data freeways to roads |
| dynamic message sign status, updates for roads - highway advisory radio status for roads - indicator input data from roads - indicator road requested state - other control data for roads - parking guidance for dynamic message sign - static data for road control, roads - vehicle pollution message for roads | Output Control Data for Roads | control data for roads - dynamic message sign, highway advisory radio data for roads -indicator control data for roads, monitoring data for roads, storage data for roads, data fault for roads, input state for roads, input storage data for roads- other status for roads - vehicle sign data for roads |
| dynamic message sign status, updates for highways - highway advisory radio status for highways - indicator highway requested state, input data from highways - other control data for highways - parking guidance for dynamic message sign - ramp signal state - static data for highway control, highways - vehicle pollution message for highways | Output Control Data for Freeways | control, dynamic message sign, highway advisory radio data for highways - indicator control, monitoring, storage data for highways - indicator data fault for highways - indicator input state for highways - indicator input storage data for highways - other status for highways - vehicle sign data for highways |
| current incident static data - existing sensor static data - roadway characteristics from traffic operations personnel, static data - static data for traffic control copy | Maintain Traffic and Sensor Static Data | static data for traffic control update, store updated - supply incident static data - link data for guidance, update - new sensor static data - request sensor static data |

**Table 4.** Incoming and Outgoing Data to high-level Traffic Control Processes [3] (continued)

- *Overall Administrative Structure for Highway Monitoring and Control/Policies*: Operations and hence functions at higher levels are strongly affected by the existing Institutional and administrative status in each country. The currents status in Greece imposes controls or changes in the way the various processes or data flows will be accomplished.
- *Management Information System*: The institutional entities included in the Greek Freeway MIS will affect and dictate the information types, level of detail and data format of the data flows in and out of the various Processes
- *Control Centres*: The concept of Control Centres administering the Greek Freeways is under development. The final institutionalisation of Control Centres shall determine the role and activities related to their operation
- *Network Characteristics*: A classification of the Greek Roadway Network, with regard to the Freeway Characteristics (Bridges, Tunnelled sections, Urban, Rural sections etc.) leads to the identification of the major Telematics operations, which in turn control Data flowing.

Mechanisms describe how the functions are accomplished

- *Algorithms*: Input Data used in the various Processes are transformed according to algorithms built in specific software or hardware devices to deliver appropriate form of output data. Furthermore, algorithms are used to trigger specific actions with respect to specific Telematics Applications.
- *Databases*: Data base functionality in terms of storage retrieval and data processing provides the data file system for data transformations and information flow from one process to another.

## 9 Findings and Conclusions

The following findings and conclusions can be briefly extracted:

- The identification of ITS related User Services along typical Greek Freeways as a result of User Needs, relevant to System Use, has been accomplished
- For the short term, Traffic Control and Incident Management have been identified as the mostly required User Services to meet high priority User Requirements.
- The Determination of the exact Processes (functions or activities) performing Functional Statements and the decomposition of these Processes to five levels of processing has been transformed from the US ITS Architecture.
- Determination of Data flows through Processes has been extracted directly from the US ITS Architecture.
- Controls and mechanisms respectively constraining and affecting the Processes have been identified with respect to existing conditions in Greece.
- The establishment of Telematics Systems in Greek Freeways should be considered under the framework of an ITS Architecture. The US ITS Architecture can form a basis for the development of initial system architecture for Telematics systems along Greek Freeways.

## References

1. Needs Assessment, Stage 1 Deliverables, Telematics Applications on Egnatia Odos, DELCAN-DHV in cooperation with TRIAS S.A. Thessaloniki and Planning S.A. Athens. March 1, (2001)
2. European ITS Framework Architecture History, KAREN Project (Keystone Architecture Required for European Networks), First issue, September (2000)
3. The National ITS Architecture, A Framework for Integrated Transportation into the 21st Century, Vers.3.0, Department of Transportation, USA
4. Intelligent Transportation Systems Architecture for Canada.
5. Study of Functionalities in the User Information Domain, Drive Programme, Cassiope Project (V1019), Deliverable 5.1, May (1990)