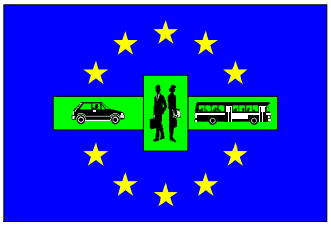

European ITS Framework Architecture

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List of European ITS User Needs

D2.02 - Issue 1

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Executive Summary

- This document describes the process of collecting, categorising and endorsing the List of European ITS User Needs which form the basis of the European ITS Architecture Framework.

- An initial set of User Needs was created from a variety of sources, including European ITS projects in the Third and Fourth Frameworks, national initiatives, the US ITS National Architecture and the ISO TICS Fundamental Services. These have been reviewed extensively by the KAREN Permanent Consultative Group, which consists of many ITS stakeholders from most European countries. As a result of the many comments that have been received the current set of User Needs has been produced.

- The List of European ITS User Needs have been organised into ten main groups. Group 1 contains the general User Needs, i.e. the properties needed by the Framework Architecture itself, and the quality requirements needed by a given ITS. Groups 2-10 contain the User Needs that have been identified for road-based ITS in Europe, and the interfaces to other modes of transport.

- The Groups have been sub-divided into a total of 32 services that correspond to the Transport Information and Control Systems (TICS) services produced by ISO/TC204/WG1.

- Seven categories of user have been identified, and each User Need is allocated to one, or more, of these categories.

Scope

- The List of ITS European User Needs have been written at a high level in order to cover all the requirements of European road transport telematics, and the interfaces to other modes, until 2010. Its primary purpose is to form the basis of the European ITS Framework Architecture.

- The List of European ITS User Needs (or a subset of it) may be used as a reference by national architecture initiatives to build up their own national reference list of User Needs. These initiatives may produce more detail by expanding on selected entries of the European list.

- The List of European ITS User Needs can be used as a check list for those developing a system architecture that is compliant with the European ITS Framework Architecture in order to gain confidence that they have considered the most relevant needs when specifying their system.

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1. Introduction

1.1. Objective

This document is one of the Deliverables that are being produced by the KAREN Project as part of its work to define a European ITS Framework Architecture. It describes the work performed during Work Package 2 within the Project to produce a set of European ITS User Needs. These User Needs will be used as the starting point for the development of the actual Framework Architecture by Work Package 3 (WP3).

1.2. Scope

- The List of ITS European User Needs have been written at a high level in order to cover all the requirements of European road transport telematics, and the interfaces to other modes, until 2010. Its primary purpose is to form the basis of the European ITS Framework Architecture.

- The List of European ITS User Needs (or a subset of it) may be used as a reference by national architecture initiatives to build up their own national reference list of User Needs. These initiatives may produce more detail by expanding on selected entries of the European list.

- The List of European ITS User Needs can be used as a check list for those developing a system architecture that is compliant with the European ITS Framework Architecture in order to gain confidence that they have considered the most relevant needs when specifying their system.

1.3. Document Structure

The document provides a short background to this work, followed by a brief description of the KAREN Project itself, and its relation to other work that is going on throughout the rest of the world. The methodology used to collect the User Needs is then described, as well as the process used to get endorsement from other members of the transport telematics community. The User Needs themselves are then presented, and the structure of their layout explained. Finally there is an analysis of some significant features of the List of European User Needs.

1.4. Abbreviations

Not including names of countries, companies, organisations, or the projects in Table A and Table B.

COMETA	COMmercial vehicle Electronic and Telematic Architecture
DRIVE	Dedicated Road Infrastructure for Vehicle safety in Europe

FFM	Freight and Fleet Management
GERDIEN	General European Road Data and Information Exchange Network
HOV	High Occupancy Vehicle
HUD	Head Up Display
IT	Information Technology
ITE	Integrated Transport Environment
ITS	Intelligent Transport Systems
KAREN	Keystone Architecture Required for European Networks
P+R	Park and Ride
PCG	Permanent Consultative Group
PT	Public Transport
SATIN	System Architecture and Traffic control Integration
TCC	Traffic Control Centre
TIC	Traffic Information Centre
QUARTET	QUadrilateral Advanced Research on Telematics for Environment and Transport
QUARTEX	QUARTet Extension
RAID	Risk Analysis for ITS Deployment
TARDIS	Traffic and Roads- DRIVE Integrated Systems
TICS	Transport Information and Control Systems
VRU	Vulnerable Road Users
UML	Unified Modelling Language

2. Introduction to the KAREN Project

2.1. Background

2.1.1. The Need for a European Framework Architecture

During the last decade, Europe has gained a significant early lead in the development and deployment of telematics technologies in transport applications. The pace at which this progress has been achieved is impressive and appears to be a direct result of a clear focus on the development of well-defined 'building blocks' such as driver information, traffic control, route guidance or public transport information systems.

System engineering has also focused along similar lines, with the development of disparate architectures which represent thorough system engineering approaches to specific and focused applications areas. In some cases, wider system architectures encompassing multiple applications have been developed, although they have been designed to meet local requirements at city and/or regional level rather than European.

Europe is now faced with the challenge of integrating these 'building blocks' into a pan-European system architecture that would offer some degree of consistency and synergy across applications. The need for progress and efficiency is great and confronts Europe with a huge challenge. How can the wide-scale deployment of **Transport Telematics Systems,** now called **Intelligent Transport Systems** or **ITS,** in Europe be stimulated and co-ordinated?

The implementation of ITS has to yield benefits to the public sector and end-users, as well as to private industry and the service sector. Another important consideration is the competitiveness of the European ITS industry, both at home and in other parts of the world.

One way to meet these challenges is to require all stakeholders to adhere to an agreed European Framework. This Framework must accommodate national plans and support the various efforts in research, standardisation, deployment and investment. It must also provide a migration plan which incorporates and builds upon existing 'legacy' systems.

2.1.2. Historical Background

The basis for an Integrated Transport Environment (ITE) concept was laid down in the EC Framework II DRIVE I project TARDIS (V1018) and was further developed by a number of projects during the EC Framework III DRIVE II Programme.

Whilst both of these programmes were oriented towards the road mode of transport, a number of fundamental activities were undertaken which are also applicable to the other modes now being considered in the EC Framework IV Telematics for Transport programme. An ITE can be considered to be made up of a number of different application areas, and the design of the ITE must enable these different areas to exchange information in a common format, to update

their strategies, and to perform co-ordinated control actions on the traffic network. The reasons for doing this are:

- To provide a consistent and up-to-date picture of the traffic and transport network state;
- To control the network state around a common reference optimum using collective control actions (e.g. traffic signals, VMS);
- To disseminate relevant and non-conflicting information to users, operators and authorities.

The common reference optimum referred to above will be dictated by local transport management policies. It will therefore vary at least from country to another, and possibly between regions within a country.

2.1.2.1. The SATIN Task Force

During DRIVE II the SATIN Task Force was inaugurated on 31 January 1994 in order to extend the work that had begun within the forum of Topic Group 10, which was the system architecture group set up as part of the EC concertation activities during the DRIVE II programme. The work included the following items:

- Recommendation of a methodology suitable for the preparation of transport telematic architectures, including assessment (optimisation) criteria and safety analysis;
- Proposal of a system architecture for the road ITE that would include all transport telematic services.

The work undertaken by SATIN was limited in time, and therefore in scope, taking contributions from a large number of DRIVE II projects. Its goal was to try and form a consensus on the methodological issues by identifying the good architecture practices developed during the DRIVE II programme [SATIN].

In parallel with the collection and synthesis of results, SATIN also developed a methodology to support the development of transport telematic system architectures [CORD D004-PT6].

2.1.2.2. QUARTEX

QUARTEX was an extension of the DRIVE II projects QUARTET (V2018) and GERDIEN (V2044) whose aim was to provide guidelines for the practical assessment of road ITE architectures. This work produced:

- A methodology for the assessment of architectures [QUARTET D53].
- A software based tool for the analysis of architectures [QUARTET D54].

2.1.2.3. CONVERGE-SA

The EC Framework IV Telematics for Transport project CONVERGE-SA (TR1101) built on the work of both SATIN and QUARTEX and produced:

- Guidelines for the development and assessment of system architectures [CONVERGE 1998];

- A system architecture analysis tool [Franco 1997].

2.2. Project Details

2.2.1. Introduction

The KAREN (Keystone Architecture Required for European Networks) Project has created a minimum stable framework necessary for the deployment of working and workable ITS within the European Union until at least 2010. It is the European ITS system architecture effort, requested by the High Level Group on road transport telematics, approved by the European Council of Ministers and funded by DGXIII as part of the 4th Framework Programme. The project began on 1st April 1998, and aimed to deliver an agreed, and promoted, Transport Telematics Framework Architecture which will:

- Define the necessary elements for an open market of ITS products throughout Europe, and the rest of the world, for European ITS industry;
- Be the basis for building consensus on issues that still prevent wide-spread deployment of ITS in Europe, and hence permit all categories of user to purchase cost effective ITS products that will work in the same way throughout Europe;
- Provide a bridge between the ITS community and those creating the current and future technologies that may be used by ITS;
- Be a guide for public investments on the basic infrastructure necessary for the deployment of the ITS services;
- Support the identification of areas where new research and demonstrations are needed.

The KAREN Project has produced the following principal outputs [KAREN]:

- A consolidated List of European ITS User Needs (this document);
- A European ITS Architecture Framework (documents D3.x);
- Recommendations for the deployment of the Framework Architecture (documents D4.x).

2.2.2. The European ITS Framework Architecture

The European ITS Framework Architecture must accommodate national plans and support the various efforts in research, standardisation, deployment and investment. It must also provide a migration plan which incorporates and builds upon existing ‘legacy’ systems. (For a discussion as to what is meant by a Framework Architecture see Appendix Appendix A).

A common Framework provides specifications that enable:

- Compatibility of information delivered to end-users through different media;
- Compatibility of equipment with infrastructures, thus enabling seamless travel across Europe;

- A basis for regional, national and European authorities to produce master plans and recommendations to facilitate ITS deployment;
- An open market for services and equipment where compatible sub-systems are offered (no more ad-hoc solutions);
- Economies of scale in equipment manufacture permitting competitive prices and cheaper investments when compatibility is guaranteed;
- A known market place into which producers can supply products with reduced financial risk.

2.3. Relationship with other Architecture activities

2.3.1. International Activities

There are two other principal architecture activities from which information is readily available, namely the US National ITS Architecture and the work being done by ISO/TC204/WG1; though work is also going on elsewhere, e.g. Japan, Korea, and Australia. Both the US National Architecture and the ISO/TC204/WG1 Reference Architecture begin with a 'green field' and do not consider any existing systems or equipment. Although they were supposed to be reasonably comprehensive, the US User Service Requirements are now recognised as being not totally applicable outside the USA. The 32 Transport Information and Control System (TICS) Fundamental Services produced by ISO/TC204/WG1 have been based mainly on the US User Service Requirements and, as a result, they tend to be oriented towards US problems and desires.

The US National ITS Architecture uses a Function Oriented (sometimes called Process Oriented) approach and contains Functional, (Information), Physical and Communications Architectures at varying levels of detail [ITS America]. ISO/TC204/WG1 have taken the US National ITS Architecture and re-written it using an Object-Oriented approach with UML to produce a proposal for a Reference Architecture for TICS [ISO TC204 WG1 Pt2]. During 1998 it was recognised by the US, European and Japanese representatives that the work needed to be improved with regard to its consistency and readability. These and other comments were submitted to WG1 in November 1998, the European ones being submitted through ISO/TC204/WG1/SG7 which is responsible for representing European interests in this area. The comments have resulted in the production of a revised and improved version. A new work item was also proposed, the "bridge building function", which would also describe the TICS architecture using a Function Oriented approach.

2.3.2. RAID

This is a study on system architecture performed as part the EC 4th Framework Programme from January 1998 until March 1999 by a sub-set of the KAREN consortium. The objective of RAID was to identify the obstacles that might prevent the successful deployment of ITS within the EU, and to recommend possible solutions for overcoming them.

The risks that were considered are those that may hinder, or prevent, the implementation of:

- The European ITS Framework Architecture in general;
- Any particular ITS.

All areas of ITS were considered, using the knowledge and expertise of both the members of the team, and the extensive group of external organisations established by the KAREN Project. Although not a specific objective, the output of the RAID project serves as supplementary background information to the work of the KAREN Project. The RAID report that describes the principal risks, and their suggested mitigation strategies, is included on the CD-ROM produced by the KAREN Project.

2.3.3. COMETA

The COMETA project (TR4005) is running concurrently with KAREN and has the objective of developing an open architecture for on-board systems in commercial vehicles. In particular COMETA is defining and designing modular associations of a wide range of on-board functions to support professional transport operations by road, and efficient interfaces with a global transport telematics system. Examples of components considered for the on-board systems include devices for on-board data capturing and data processing, driving assistance, tools for on-board remote diagnostics, mechanisms for data exchange within the vehicle and with the different actors involved in the transport chain, the digital tachograph, devices for electronic tolling etc. COMETA and KAREN have some members in common, and there is active liaison and co-operation between them. A practical consequence of this liaison and co-operation is that the Architectures are compatible.

2.4. The List of European ITS User Needs

For a common European Framework to succeed, it must build on the experience available in Europe and on the work done by the many national and European initiatives. It must also stay at a level of abstraction which is high enough to avoid constraints on the design and implementation plans that will be developed by each country or region. Thus the aim of the KAREN Project has been to define the core elements of this Framework so that it can be taken by relevant actors and turned into reality. The Framework includes:

- A List of European User Needs for ITS;
- A set of architectures that describe the different elements and interactions necessary to satisfy those User Needs;
- Recommendations for standards and best practices that should be used during implementation.

The first phase of the KAREN Project has therefore been to collect and categorise the User Needs for European ITS. It has been important to ensure that not only are they the real European User Needs, i.e. based on actual investigations performed in previous work, but also that they are seen to be so. This document describes the result of performing these tasks, namely the establishment of a List of European User Needs and their endorsement.

3. Methodology for Collecting the User Needs

3.1. Introduction

In order to ensure that the European ITS Framework Architecture will satisfy the needs of the potential users of transport telematics, it is necessary to identify all the possible users. The CONVERGE Guidelines [CONVERGE 1998] identified four main categories of user who will be affected by, or have an effect on, the final system implementation. They are those who Want IT, those who Make IT, those who Use IT and those who Rule IT. For ITS they can be identified as follows:

- **Want IT** - These users want the system to solve (or diminish) traffic problems, or to provide travel information services to the public, e.g. city authorities, motorway operators, public transport operators, freight and fleet operators, police, etc.
- **Make IT** - Component suppliers will deliver hardware and software components for the system. System integrators will combine the components into complete systems, e.g. system integrators, vehicle manufacturers, telecommunication operators, service providers, etc.
- **Use IT** - There are two categories of this class of user: primary and secondary. The primary users will benefit from the output of the systems, e.g. commuters, business users, leisure users, travellers with special needs, etc. The secondary users will control the system and provide the main input, e.g. traffic control operators and emergency services.
- **Rule IT** - The local and national authorities have the responsibility for issuing the regulations on how to implement and use the systems. The international authorities may also issue regulations, as well as standards and recommendations for international inter-operability. E.g. government ministries (transport, finance, etc.), European Union bodies, etc.

Since KAREN is working at a very high level of abstraction it is possible to group many of the sub-categories of user together. The resulting set of users identified in the List of European User Needs is as follows:

- *Private Consumers - Travellers*: Commuters, travellers on business or at leisure, domestic travellers, tourists, etc. who will make use of ITS.
- *Commercial Consumers - Freight and Transport Industry*: Companies that transport commercial goods, or provide public passenger transport, and who will make use of ITS.
- *Companies providing/using ITS*: Information Providers, Airports, etc. that will provide their customers with information produced by ITS as part of their overall service.
- *Local Authorities*: City or District Authorities that plan and manage the transport needs in their area, and that issue regulations concerning ITS on the local, district or state level.

- *High Level Ministries*: National or Federal Authorities that plan and manage the transport needs for the nation or state, and that issue regulations concerning ITS at that level.
- *Exploitation Level - Operators applying the ITS*: Companies that will provide services, normally chargeable, based on the use of ITS.
- *Industry Level - Companies developing and producing ITS*: All industrial companies concerned with the development, production and sale of ITS.

3.1.1. The Relation between User Needs and System Requirements

User Needs emanate from the users and are entirely user oriented. Meanwhile system requirements are a series of formal statements that describe the features of the system that will be necessary to satisfy the User Needs. Thus, in theory, all the system requirements can be traced back to one, or more, User Needs. In practice this can only happen if both the User Needs and the System Requirements are complete, and they have been originally specified in this hierarchical manner. The KAREN Project team obtained its User Needs and system requirements from many disparate sources, which were not consistent in how they handled this issue. Thus one source's User Need would be another source's high level system requirement, some sources did not even write their high-level specifications using such titles. **Thus, in order to avoid confusion, a decision was taken not to make a distinction between User Needs and System Requirements in the final list**.

A summary of the distinction between User Needs, System Characteristics, System Requirements and System Specification can be found in Appendix Appendix A.

3.2. Sources

In order to ensure that the List of European ITS User Needs does indeed reflect reality, the initial set was collected from existing documents and the partners' knowledge of existing systems. Whilst most of the sources originated in Europe it was found both necessary and useful to collect data from the USA, as well as from other organisations, to fill in certain gaps. Information was therefore collected from:

- European Commission funded projects and activities - those for which information was available, see Table A;
- Nationally funded projects - material from all European Union Member States, Switzerland and the USA, covering descriptions of existing systems, national system architecture plans, feasibility studies, etc., see Table B;
- Material from the CEN and ISO standardisation bodies;
- Other initiatives such as ERTICO Committees or user associations;
- Comments from the Permanent Consultative Group (see Section 3.3).

The KAREN partners would like to thank all those who answered queries about their projects and supplied information.

Table A - European Commission Funded Projects and Activities Review by KAREN

Sources Funded by the European Commission		
ADEPT II/CONCERT	FORCE	SAVE
AC-Assist	HANNIBAL	SCRIPT
AUSIAS	ICARE	SITE
CAPITALS	IN_RESPONSE	SURFF
CARPLUS	INFOPOLIS	TABASCO
CHAUFFEUR	INFOTEN	TELTEN
COREM	MULTITRACK/TRACAR	TILEMATT
COSMOS	PROMISE	TITAN
DACCORD	QUARTET-PLUS	UDC
Digital tachograph project	SAMPO	VADE MECUM
EDEN	SAMOVAR	VASCO
ENTERPRICE	SATIN	VIKING
EUROSCOPE		

Table B - National Projects Reviewed by KAREN

Country	Strategy Paper / Project / System
Finland	Traffic management system
France	MIGRAZUR, PALOMAR
Germany	Strategy paper on Telematics for Transport (German DoT), Procurement conditions for Traffic Control Systems (TLS), Concept for the implementation of RDS-TMC (TeKoVWD), Projects Bayerninfo, DELFI, MOTIV, and Traffic Controller Munich New Fair (üStR)
Netherlands	GERDIEN, AVB (Architecture for Motorway traffic management)
Spain	Traffic management system
Sweden	TRISS, MCS systems
Switzerland	SNIR
UK	UTMC, EVSC, RTCC, ROMANSE
USA	NAHSC, US Architecture

The data was gathered according to a strict set of rules that was written down and distributed to all those undertaking the work. These rules specified, for each User Need, the data that had to be collected and the manner in which the User Needs should be described. Initially all User Needs were collected even if they were thought to be duplicates; this was to avoid any possibility of some accidental omissions.

Once all the User Needs had been collated into a single spreadsheet a review was undertaken in order to identify ambiguities and repetitions, and, occasionally combine two or more User Needs. At this stage it was decided to remove all duplicate User Needs, though this decision was later changed (See Section 4.3.3.1). Finally the User Needs were arranged in a logical order.

3.3. The Consultative Process

The sources given in Section 3.2 represent a good cross-section of all the road transport telematics work that has been carried out within the EU. However, it was always recognised by the KAREN Project that this exercise on its own would not produce a definitive List of European ITS User Needs, and certainly not one that would be generally accepted within the European ITS community. It was therefore necessary to consult with experts outside of the Project.

The KAREN Project organised a Permanent Consultative Group (PCG) of experts made up of representatives of all categories of user from around the EU. Each member of the PCG was sent a copy of the first draft of the User Needs (see Section 3.2) and invited to a Workshop that was held in Brussels on 16th September 1998 (see Table C). The first draft was presented at this Workshop and a number of comments were received at that time. The delegates were also invited to send in written comments during the following three weeks. The 8 man Wise Men Group of independent experts advising KAREN also convened on 16th September and submitted their comments.

Table C - Organisations Currently Involved in the KAREN Consultation Activities

Members of the Permanent Consultative Group participating in KAREN Workshop 1		
AFT-TNT	Flemish DoT	SNRA (Swedish DoT)
Autostrada	Highways Agency	Portel Servicios Telematicos
BMV	ITF Intertraffic	Swiss Federal Highways Office
Computer Management Group	Mairie de Paris	Syndicat des Transports Parisiens
Danish DoT	MISRA	TDF - France Telecom
DSCR (French DoT)	NavTech	Traficon Ltd *(for Finnish DoT)*
Dutch DoT	Nokia	UK DoT (DETR)
ETICAI	Polis	Walloon DoT
Eurolum	Robert Bosch	Welsh Office *(for ITS Focus)*

Over 30 sets of comments were received and collated for use during the revision process, a total of over 40 pages. Each User Need was then reviewed in the light of these comments, and normally re-worded according to a standard format (see Appendix Appendix C). In addition, as a result of a number of requests, the entire list was then reorganised into a set of groups that was more representative of the European situation than the TICS Fundamental Services produced by ISO [ISO TC204 WG1 Pt1] that had been used for the first version. The new version is described in the next section.

3.4. The Revision Process

Between the publication of Version 3 of the database of User Needs and the end of the KAREN Project further comments were received from sources such as the TELSCAN Project (transport needs of elderly and disabled users) and the UK UTMC Programme, as well as from within the Project team. It was therefore decided that a final revision of this document, together with Version 4 of the database, should be produced at the end of the project. The database file contains a complete list of the all the changes that have been made in the rows immediately following the last User Need, though they are not printed out in Appendix Appendix F.

4. The List of European ITS User Needs

4.1. Introduction

This Chapter describes the structure and contents of the European List if ITS User Needs that have been produced by the KAREN Project. These are provided as an Appendix to this document and are on the European ITS Framework Architecture CD-ROM.

4.2. Contents of a European User Need

The List of European ITS User Needs has been organised using an Excel spreadsheet. The information on each User Need takes up one row. A brief explanation of each column is given in Table D, which is expanded in the following sections.

Table D - Description of a User Need Entry

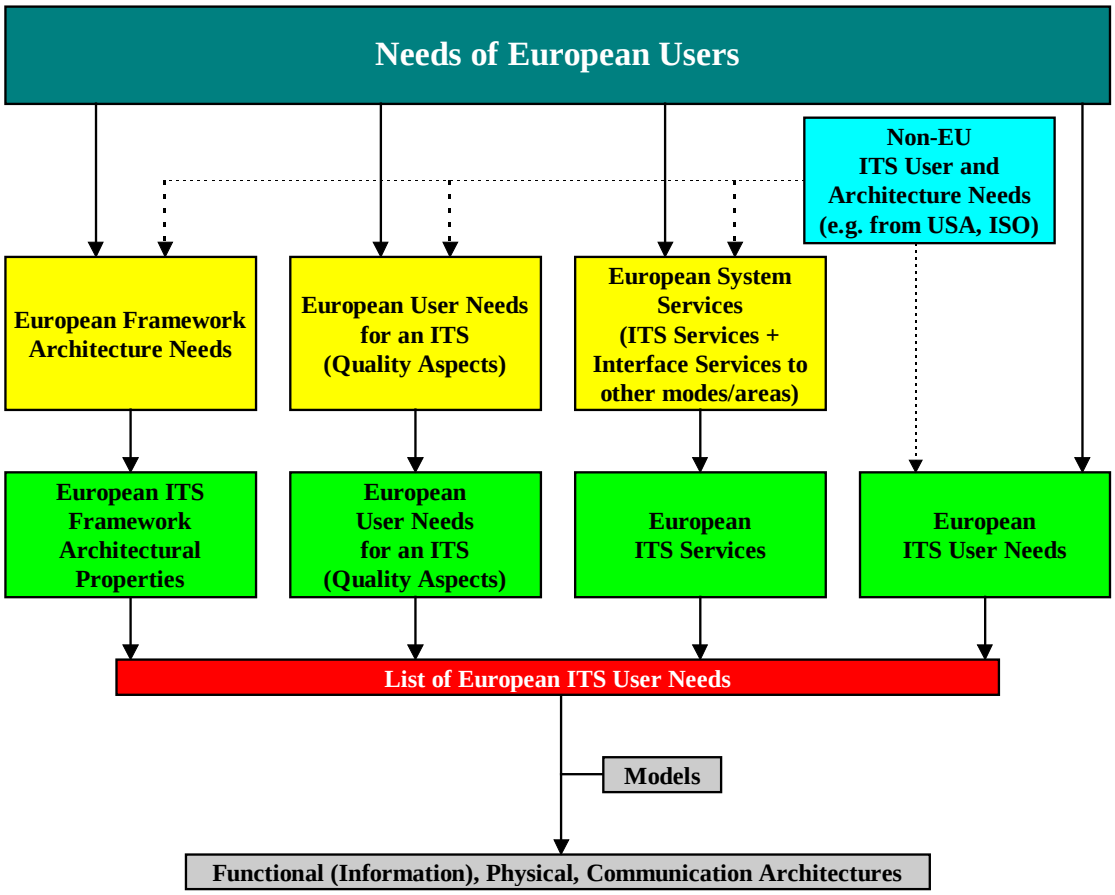
Title	Explanation
Allocation and Reference Number (see also Section 4.3.3.2)	Each User Need has a unique reference number "N.M.P.Q", except for the General Group (N = 1) which uses "N.P.Q", as follows: • N - Identifies the main group. The nine groups of high-level services, and the General Group are described below. • M - The service within the main group. These correspond to the TICS Fundamental Services produced by ISO. • P - A related set of User Needs within the high-level service. • Q - The unique number of the User Need within this set.
Description	Each User Need has been written in a precise manner so that its meaning is clear. Thus "The system shall do X" implies that the feature X is mandatory, whilst the "The system shall be able to do Y", or "The system shall enable Y" implies that the feature Y is optional.
Users	Each column contains a "y" (for "yes"), if the entry is applicable to that category of user (see Section 3.1)
Repeats	On occasions the same User Need appears in more than one group or service, when his happens this column contains the reference to the primary entry of this User Need.

4.3. Structure of the List of European User Needs

4.3.1. Introduction

An analysis of the totality of possible User Needs shows that there is more than one type, and more than one way of presenting them. The KAREN Project has built the European ITS Framework Architecture upon all relevant earlier work. Figure 1 shows that the final List of European ITS User Needs is made up of information from a variety or sources, and that they cover different aspects of both the Framework Architecture itself, and any ITS solutions implemented from the Architecture.

Figure 1 - Provenance of the KAREN Framework Architecture



4.3.2. General Group

4.3.2.1. Introduction

There are two main types of General User Need. The first covers the properties needed by the Framework Architecture itself, and the second covers the quality requirements needed by a given ITS. These contents of these two types are described in the following two sections.

4.3.2.2. Framework Architectural Properties

These define the properties of the Framework Architecture itself, of which the main features are:

- The Framework Architecture shall be presented in a structured manner, allowing the reader to perceive the overall context through reference models and a glossary. Specific details should be given from functional, information, physical and communication perspectives;
- Those ITS which require large investments in infrastructure will have very long life-times, the Framework Architecture shall therefore be technology independent, thus permitting future technology evolution;
- Being European in scope, the Framework Architecture shall not be tied to a specific organisational or legal structure;
- In order to encourage the market, the Framework Architecture shall facilitate the creation of modular systems, with services coming from many providers, and equipment coming from many manufacturers.
- There are many existing, or legacy, systems in operation and the Framework Architecture shall, where possible, describe migration paths that can be followed to become compliant.

4.3.2.3. User Needs for an ITS (Quality Requirements)

These are the general performance, quality requirements, and constraints - the “ilities” - common to a subset or all ITS implementations and that are valid regardless of the service considered:

- Data Exchange - compatibility of information format, equipment and infrastructure;
- Adaptability - the capability to conform to the changing patterns of User Needs;
- Constraints - the rules and regulations to which the systems will have to conform;
- Continuity - the capability to maintain a service in time and space;
- Cost/Benefit - the avoidance of unnecessary expenditure;
- Expandability - the capability to add equipment and functions;
- Maintainability - the capability to be maintained, repaired, modified or enhanced with minimum disturbance;
- Quality of Data Content - the information should be fit for its purpose;
- Robustness - the capability to operate satisfactorily under all expected conditions;
- Safety - the capability to not cause harm to persons or the environment;
- Security - the capability to protect the system and data from external attack or interference;
- User Friendliness - be simple and efficient to use.

4.3.3. System Services

4.3.3.1. KAREN Groups

The List of European User Needs in Appendix Appendix F have been categorised into ten major groups. These groups were chosen after the consultative process (see Section 3.3), and are whilst they closely related to the top level structure of the Functional Architecture [KAREN 1999], they do not correspond exactly. This is due to the need to provide a List that will also meet the additional objectives (see Section 1.2) in a readable manner. The ten groups are as follows:

- General - See Section 4.3.2.
- Infrastructure Planning and Maintenance - This group contains the activities associated with long term planning, modelling and reporting as well as the maintenance of the infrastructure;
- Law Enforcement - This group contains the activities associated with the enforcement of traffic laws and regulations, and the collection of evidence;
- Financial Transactions - This group contains the activities associated with the payment for traffic or travel services, and includes the manner of the transaction, its enforcement, and the sharing of revenues;
- Emergency Services - This group contains 'May Day' and stolen vehicle management, the prioritising of emergency vehicles, and hazardous goods incident management;
- Travel Information and Guidance- This group contains all the activities concerned with the handling of pre-trip and on-trip information, including modal choice and change, and route guidance;
- Traffic, Incidents and Demand Management - This group contains the activities associated with traffic control, incident management and demand management, including monitoring, planning, flow control, exceptions management, speed management, lane and parking management, High Occupancy Vehicle (HOV) management, road pricing and access control, and Vulnerable Road Users (VRU) facilities;
- Intelligent Vehicle Systems - This group contains the functions found within a vehicle, including vision enhancement, longitudinal and lateral collision avoidance, lane keeping, platooning, speed control, driver alertness, 'May Day' initiation, etc.;
- Freight and Fleet Management - This group contains all the activities associated with FFM, including statutory data collection and reporting, orders and document management, planning, scheduling monitoring, reporting and operations management, vehicle and cargo safety, and management of the inter-modal interface;
- Public Transport Management - This group contains the activities associated with public transport (PT), demand responsive PT, shared PT, on-trip PT information and traveller security. It includes management, scheduling, monitoring, information handling, communications and PT priority.

Within each of these groups there are a number of services. These are the TICS Fundamental Services produced by ISO [ISO TC204 WG1 Pt1] (see Section 4.3.3.2) and a table of cross

references between the ISO Fundamental Services numbers and the KAREN Groups numbers can be found in Appendix Appendix D. An attempt has also been made to make the set of User Needs within each service complete, and in order to do this it has been found necessary to duplicate certain User Needs on occasions. Where this has happened there is a cross-reference in the 'Repeats' column.

The TICS Fundamental Services have been further sub-divided into related sets of User Needs, where this is relevant.

The full List of European ITS User Needs, organised in the above manner, can be found in Appendix Appendix F.

4.3.3.2. TICS Fundamental Services Produced by ISO

[ISO TC204 WG1 Pt1] has proposed a set of 32 Transport Information and Control Systems (TICS) Fundamental Services with which to categorise the User Needs (see Appendix Appendix D). This was the basis upon which the first draft of the User Needs were organised, though it was found necessary to introduce Service 0 to cater for the general features (see Section 4.3.2). For those who still wish to use this structure the List of European User Needs have been reorganised in this manner, complete with ISO reference numbers (see Appendix Appendix G). A table of cross references between the TICS Fundamental Services numbers and the KAREN Groups numbers can also be found in Appendix Appendix D.

The Excel spreadsheet containing the User Needs actually includes both sets of numbers (and the numbering system used in the first draft) the 'column hide/unhide' feature being used to swap between the two versions, which can then be sorted as appropriate.

4.3.3.3. Relationship between KAREN Groups and TICS Fundamental Services

At the beginning of this task it was felt that since ISO/TC204/WG1 had recently produced a proposed standard list of TICS Fundamental Services [ISO TC204 WG1 Pt1], it did not make sense to structure the User Needs in any other way. However, use of this list did not prove to be as easy as expected for the following reasons:

- The TICS list of Fundamental Services seems to be based mainly on the experience and needs of the USA. Some Services were of little relevance to the EU, with "32. Intelligent Junctions and Links" having no entries at all (see Section 5.1).
- The TICS Fundamental Services are not all specified at the same level of abstraction. Some, such as "Traffic Control", are at a high level, whilst others, such as "Lateral Collision Avoidance" are at a lower level and, indeed can be considered to be part of another service, in this case "Automated Vehicle Operation".
- It is well known that FFM operates in a very different manner within the EU than it does in the USA, and most of the corresponding TICS Fundamental Services have few entries.
- Many members of the PCG (see Section 3.3) did not like the resulting structure, and requested that it be changed.

It is for these reasons that the decision was taken to reorganise the List of European User Needs into its current form (see Section 4.3.3.1), though the links with the TICS Fundamental Services have been maintained in the second level services within each top level group. The ability to order the users needs according to the TICS Fundamental Services has also been maintained for those who want or need it (see Section 4.3.3.2)

4.4. Properties of the User Needs

Often a User Need is considered to be an unstructured statement of an unsatisfied desire which will be honed into system requirements and system specifications at a later stage [CONVERGE 1998]. However, for the KAREN Project the List of European ITS User Needs are the starting point for the Framework Architecture and consequently they need to have many of the properties usually associated with system requirements and system specifications, namely:

- Unambiguous - it must be absolutely clear from the description what it is that is being said. Thus, for example, whenever the word 'information' is used it must be obvious from the context what should be contained within that information, otherwise examples should be given.
- Testable - since they form the basis of the Framework Architecture, they must be written in a manner such that it is possible to check that each User Need is represented in some manner in the Framework Architecture.
- Traceable - it must be possible to trace the manifestation of a User Need in the Framework Architecture in both directions.
- Singular - multiple User Needs should be split into singular User Needs wherever possible. This is of particular importance for optional features to ensure that they do become truly optional and, where applicable, independent of each other.
- Unique - each User Need must have a unique identifier such that it is easy to find in the full list.
- Allocated - each User Need must be allocated to at least one category of user, otherwise it is not a User Need.

In order to satisfy these properties, each User Need has been written in a specific manner:

Example 1 - The system shall provide travellers with recommended routes to specified destinations (Route Guidance and Navigation 6.4.0.1)

Example 2 - The system shall be able to modify its navigation instructions if an incorrect turn is made (6.4.0.4)

Example 3 - The system shall enable the use of portable equipment to provide route guidance (6.4.2.4)

Each normal User Need, i.e. those not in Group 1 (see Section 4.3), begins with the words "The system shall". In this case "the system" refers to the final system being deployed, and not directly to the Framework Architecture. Strictly speaking the words "The Framework

Architecture shall require all systems developed from it to" should have been used, but it was felt that "The system shall" was easier to read and to understand.

When the words "be able to" or "enable" are ***not*** present, as in Example 1, the KAREN Project felt that all systems that provide this service must satisfy this User Need, i.e. the feature is fundamental to this service.

When the words "be able to" or "enable" ***are*** present, as in Examples 2 and 3, then this User Need will be supported by the Framework Architecture, but a given instance of the service may not satisfy it, i.e. the feature is optional for a developer.

4.5. Using the List of European ITS User Needs

Readers of the User Needs should ensure that they don't try to extract more information than is intended. A User Need is a high level statement of something that is desired, i.e. a statement of the problem to be solved, and not a low level specification on exactly how it should be done or designed. Thus a User Needs is not a statement about the solution. Indeed all the User Needs have been written in a technology independent manner to provide maximum flexibility for system designers.

Although the User Needs have been grouped into logical sections, readers are strongly recommended to study the entire list whenever they are planning a real system, in case some relevant User Needs have been categorised elsewhere. Similar User Needs do exist in different groups to aid readability, and they have been cross-referenced in the "Repeats" column. It must also be remembered that Group 1 applies to all systems, and that Groups 2-5 provide specialist support to the other Groups, and thus they should always be read in conjunction with them.

Although no terms have been defined, examples are often provided in order to point the reader in a particular direction. When examples are given they usually in the form of an open list, since it is not the task of these User Needs to define all the details precisely. Since the User Needs have formed the basis of the Functional Architecture [KAREN D3.1], it is possible to refer to that document (using the trace tables in the Overview Document [KAREN D3.6]) in order to clarify their interpretation.

Where a generic term is used, e.g. "vehicle", then the User Needs applies to all. On the occasions when a User Need applies to a sub-set, then the term is qualified, e.g. "emergency vehicle".

It should be noted that Group 9, Freight and Fleet Operations, only covers those activities that take place outside of the freight vehicle, though not exclusively. A parallel project, COMETA, has undertaken a similar task for in-freight-vehicle activities, and those readers interested in this area should also study their results [COMETA 2000].

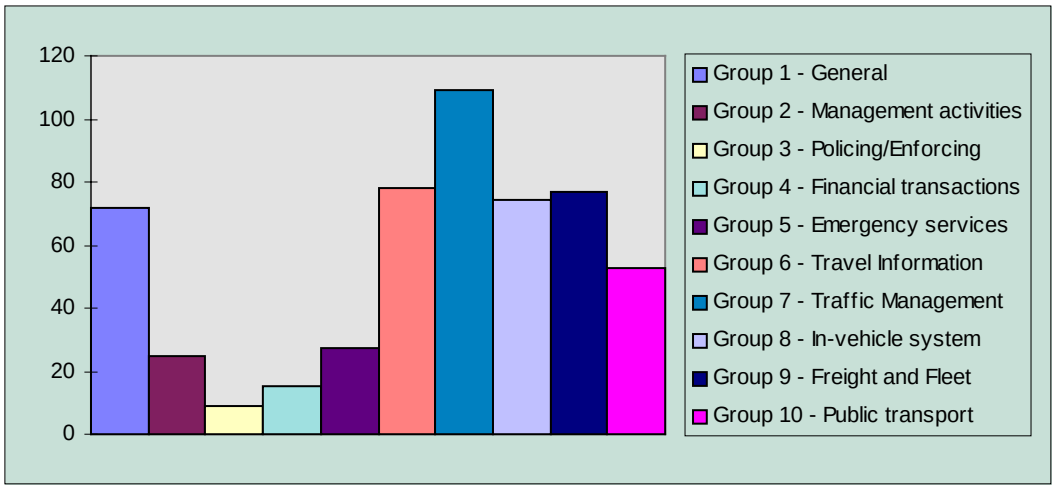
Some of the User Needs make reference to certain generic problems which have been studied in other projects. Appendix Appendix F contains an annotated bibliography of documents and books that may be of use to the developers of an ITS.

5. Analysis of the User Needs

5.1. Statistical Analysis

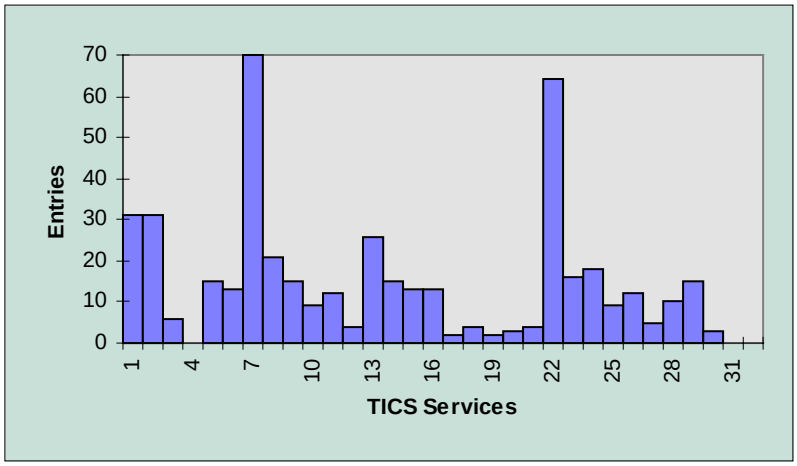
Version 4 of the List of European User Needs contains a total of 539 entries. These are split between the general group (Group 1), and the nine main groups of services (Groups 2-10) as shown in Figure 2. It should be noted that although some of the Groups 2-5 only have few entries, they will be called upon by one or more of Groups 6-10. Thus, with an eye on the creation of the Framework Architecture itself, it was decided to keep these groups separate.

Figure 2 - Number of User Needs per Main Group



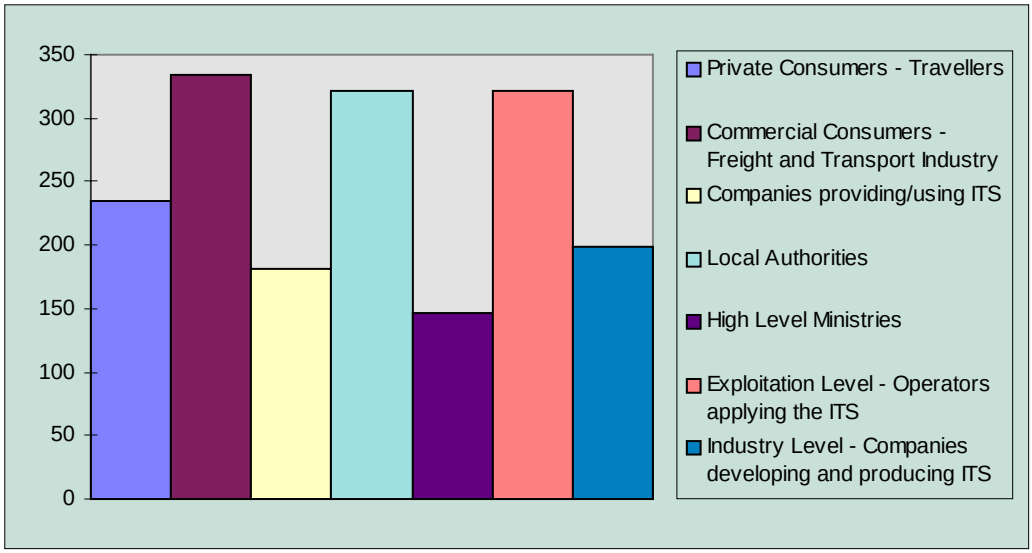
As explained in Section 4.3.3.2 the links with the TICS Fundamental Services have been maintained, and the number of entries for each of the 32 services is shown in Figure 3. It can be seen that some of the services seem to have little relevance for the EU. There are three services with zero entries though two of these were felt to be special cases of other services, with Service 4 (Personal Information Services) being covered by Services 1, 2, 3, and 5, and Service 31 (Safety Enhancements for Vulnerable Road Users) being covered in Service 7. Only the need for Service 32 (Intelligent Junctions and Links) was not found at all.

Figure 3 - Number of User Needs per TICS Fundamental Service



Each User Need is usually only of interest to a sub-set of the possible users, and the number of User Needs for each of the seven user categories is shown in Figure 4.

Figure 4 - Number of User Needs per User Category



5.2. Completeness

The KAREN Project team never intended to create a list of all *possible* User Needs but to capture, at a high level of abstraction, all those that had already been identified as being necessary. Despite having undertaken the work described in Section 3, it is unlikely that every European User Need has been captured; however the enthusiastic and effective way in which the PCG made their comments does provide a high degree of confidence in the result. Certainly, the project team has more than sufficient confidence that Appendix Appendix F provides a suitable basis for the Framework Architecture.

It is inevitable, however, that there will be gaps or omissions, and the List will need to be kept under continual review after the project has finished. Changes will be needed for the following reasons:

- Omissions - A few projects did not supply us with the necessary detailed information. In these circumstances the project team based its entries on the public information that was available.
- Gaps - It is likely that the unpublished needs of certain industries and authorities are not represented. These will only come to light after the List has been placed in the public domain, its existence becomes widely known, and such organisations can make contact with us.
- Level of Abstraction - In order to keep the List to a manageable size, the User Needs have been written at a reasonably high level of abstraction: sometimes this was necessary because the details were not known. The project team recognises that one of the dangers of doing this is that different people will place different interpretations on the descriptions, and thus it may be necessary to re-word, or add additional User Needs, to clarify the situation.

The organisation of the KAREN Groups (see Section 4.3.3.1) was chosen to take account of the need for such changes.

5.3. Interfaces to Other Areas

5.3.1. Introduction

Whilst the European ITS Framework Architecture is targeted at road-based ITS, it does need the support of activities that are outside of its immediate influence, in particular other modes of transport, telecommunications infrastructures, law enforcement agencies and financial clearing houses. This section is an overview of the User Needs which have been collected that relate to these areas, and provides an indication of the requirements for the interfaces that will be necessary for the exchange of data between them in a safe, reliable and fast manner.

5.3.2. Other Modes of Transport

There are a number of User Needs[2] that build up a need for the Framework Architecture to support systems across the various modes of transport that communicate between each other in a coherent and uniform manner, in order to provide information on all transport modes to the traveller. The Framework Architecture must also permit the relevant authorities to influence modal shifts according to their current transport policy. For freight and fleet operations the Framework Architecture must support the modal shift of goods and equipment.

[2] The specific user needs can be found in Appendix Appendix E at reference numbers 1.1.15, 2.1.1.1, 4.1.2.2, 6.1.0.5, 6.1.1.1, 6.1.2.1, 6.2.1.1, 6.2.1.2, 9.5.5.1-5.

5.3.3. Telecommunications Infrastructure

Telecommunications are needed for all kinds of data transfer, and hence are a very important section of the Framework Architecture itself. There are a number of User Needs[3] that build up a need for the Framework Architecture to be able to use telecommunications infrastructures to provide a flexible means of data exchange, especially in the fields of open data protocols and interfaces, and to permit communication with systems not covered by the Framework Architecture. The User Needs also express the need that the Framework Architecture should support the integration of existing and emerging means of communication, as well as complying with the various applicable regulations.

5.3.4. Law Enforcement Agencies

This area is concerned with the activities associated with the enforcement of traffic laws and regulations, and the collection of evidence. There are a number of User Needs[4] that build up the need for the Framework Architecture to support systems that will assist the policing of traffic regulations by providing the relevant authorities with the necessary data that can be used for the legal pursuit of subjects. The User Needs also express the need that the Framework Architecture should support systems that enforce safe behaviour and vehicle priorities without obstructing the flow of normal traffic, if it is not intended so to do.

5.3.5. Financial Clearing Houses

This area is concerned with the payment (both electronic and non-electronic) for travel and traveller services including the transaction, enforcement and the sharing of revenues. There are a number of User Needs[5] that build up the need for the Framework Architecture to support a variety of payment methods, whilst having a minimum impact on the traffic and the driver. The Framework Architecture shall also support systems that exchange information between themselves and the vehicles, whilst supporting the management of variable tariff policies and the sharing of revenues between different service providers. Because of the high level of assurance necessary, the Framework Architecture shall support systems which can guarantee maximum security and privacy, and a minimum failure rate for financial transactions.

[3] The specific user needs can be found in Appendix Appendix E at reference numbers 1.1.13, 1.2.6, 1.4.3, 2.1.1.2, 6.1.3.10 and 6.2.3.4.

[4] The specific user needs can be found in Group 3 in Appendix Appendix E.

[5] The specific user needs can be found in Group 4 in Appendix Appendix E.

6. Conclusions and the Next Steps

The current version of the List of European ITS User Needs has been reviewed by a representative sample of stakeholders in the form of the Permanent Consultative Group, and the Wise Men Group. The List has therefore some authority as being a suitable set of high level User Needs for European Road Transport Telematics until 2010 to form the basis of the Framework Architecture.

The KAREN Project is already aware that the earlier drafts the List of European ITS User Needs (or a subset of it) have been used as a reference by some regional and national architecture initiatives to build up their reference list of User Needs, producing more detail where necessary by expanding on selected entries of the European list. The List can also be used to formulate an EU strategy for the deployment of ITS.

The List of European ITS User Needs can also be a check list for those developing a system architecture compliant with the European Framework, in order to gain confidence that they have considered the most relevant needs when specifying their system.

Finally, the List of European ITS User Needs has been the basis for building up the Framework Architecture. All the elements of the Framework Architecture (Functional Architecture, Communication Architecture, Physical Architecture, etc.) are linked to this list.

The List of European ITS User Needs cannot remain static, and recommendations have been made on how the entire Framework Architecture can be maintained once the project has finished.

7. References

[COMETA 2000]
COMETA, *Commercial Vehicles On-Board Systems Integrated Architecture(s) Specifications, Risks Analysis and Implementation Time Schedules Hypothesis*, Framework IV Transport Telematics Project COMETA (TR4005), Deliverable 6.1, 2000.

[CONVERGE 1998]
Jesty P H et al., *Guidelines for the Development and Assessment of Intelligent Transport System Architectures*, Framework IV Transport Telematics Project CONVERGE (TR1101), Deliverable 2.3, 1998.

[CORD D004-PT6]
Gaillet J-F (Ed.), *Recommended Methodology for Transport Telematics Architectures*, SATIN Task Force, DRIVE II project CORD (V2056), 1994.

[Franco 1997]
Franco G and Jesty P H, *Architecture Analysis Tool Getting Started Manual*, Framework IV Transport Telematic Project CONVERGE (TR1101), Deliverable DSA4.2, 1997.

[ISO TC204 WG1 Pt1]
ISO TC204 WG1, *Transport Information and Control Systems - Reference Model Architecture(s) for the TICS Sector - Part 1: TICS Fundamental Services*, ISO/TR 14813-1, 1998.

[ISO TC204 WG1 Pt2]
ISO TC204 WG1, *Transport Information and Control Systems - Reference Model Architecture(s) for the TICS Sector - Part 2: Core TICS Reference Architecture*, ISO/PDTR 14813-2, 1998.

[ITS America]
The documents can be found at “http://www.odetics.com/itsarch/”.

[KAREN]
See below.

[QUARTET D53]
QUARTET, *Final Methodology for Architecture Assessment*, DRIVE II Project QUARTET (V2018), Deliverable Nº 53, 1995.

[QUARTET D54]
QUARTET, *Operational Tool for the Analysis of Complex Architectures*, DRIVE II Project QUARTET (V2018), Deliverable Nº 54, 1995.

[KAREN]
The following is a list of the public documents produced by the KAREN Project

D2.02, *List of European ITS User Needs* (this document)

D3.6, *European ITS Framework Architecture Overview*

D3.1, *European ITS Functional Architecture*

D3.2, *European ITS Physical Architecture*

D3.3, *European ITS Communications Architecture*

D3.4, *European ITS Cost Benefit Report*

D3.7, *European ITS Models of Intelligent Transport Systems*

D4.1, Framework of Required Standards

D4.2, *Deployment Approach and Scenarios*

Appendix A The European Architecture Framework

It is important to distinguish between the three different rôles of an "Architecture" in the European scenario. They can be defined as follows:

1. At the level nearest the design there is the system architecture which is of fundamental importance when systems are created by integrating two or more sub-systems. The system architecture provides the structure around which a class of systems may be developed. It is the level at which the basis for "Working and Workable Systems" is set up [CONVERGE 1998].

2. Intermediate level architectures are being defined for EU Member States to create the conditions for a market of compatible and modular solutions, and for establishing the implementation of nation-wide inter-operable solutions and services. Two or more systems are inter-operable if they can pass data between each other to their mutual benefit, i.e. to provide harmonious and/or complementary functionality: inter-operability includes the technical, operational and organisational aspects.

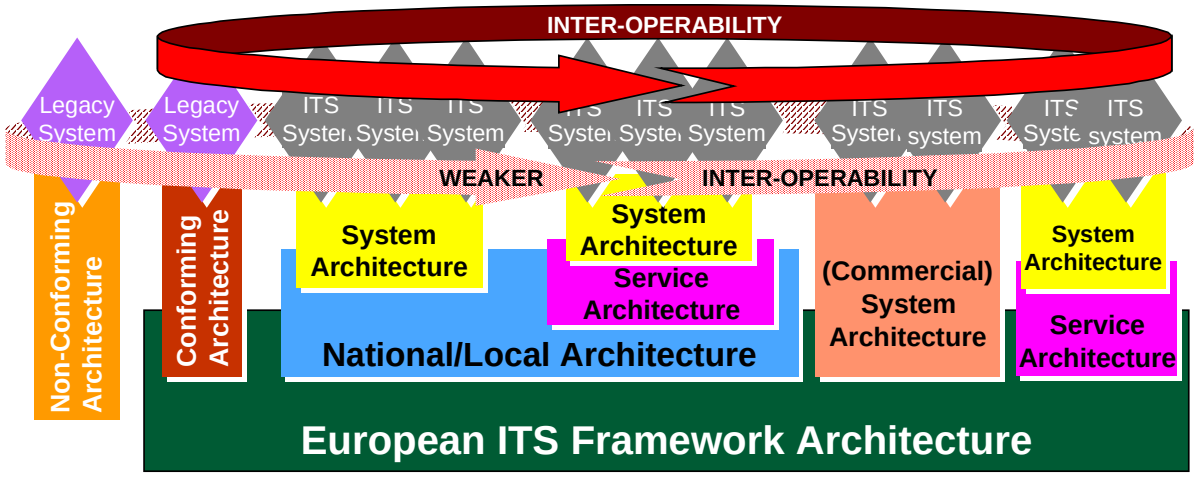
   National architectures are also the tool for guiding national research initiatives, and for providing the reference document for standards and rules to be used for national applications. They also provide the common terminology for specifying systems, and possibly recommend the standards and the interfaces to be used to achieve compatibility at the European level. Other system architectures may also be defined by the private or public sector independently of any national ITS architecture.

3. The European Framework Architecture is at a "level" such that it can be used as a reference by all ITS architects. It is intended to be the foundation for building the other types of architecture. It will enable them to guarantee compliance at the interfaces of other systems so that seamless services can be provided to cross-border travellers, and an open European market of compatible components can be established.

The KAREN Project had the task of creating the key elements of the European Framework Architecture, and whilst it took account of what exists already, it also had to look to the future and the desires expressed in the List of European User Needs, which may not be fully satisfied by existing systems. Thus, whilst the Framework Architecture concentrates on the functionality and other features that are needed to satisfy the User Needs, it does not "re-invent the wheel" if there is an existing solution.

Figure 5 provides an overview of how the various architectures relate to each other. Initially, there will be two main categories of ITS system co-existing:

Figure 5 - Overview of the Relationship Between the Various Architectures



1) Those that will conform fully to the European Framework Architecture. These will be made up of:
   a) New systems that have been designed to conform to the Framework Architecture: they will eventually be in the majority;
   b) Legacy systems that do conform to the European Framework Architecture: some legacy systems will be in this category.

   These systems, by ensuring this conformance, will have completed the first major step towards providing inter-operability with each other.

2) Those legacy systems that do not conform completely to the European Framework Architecture of other ITS. Whilst they may not be fully inter-operable with those systems that do conform, once can expect there to be a useful degree of mutual functionality especially for those system that are not very old.

In order to make legacy systems fully inter-operable with other ITS, there is be a migration strategy to inform their owners on how they can become compliant with the European Framework Architecture [KAREN D4.2]. It should be noted that whilst ‘migration’ is often assumed to mean ‘replace’, in practice it can also mean ‘enhance’ or ‘add to’, which is usually less contentious and expensive!

The European Framework Architecture also has other rôles, such as providing the bridge between the ITS community and those creating other current and future technologies (e.g. in the telecommunications or banking world). It may also be a catalyst for new research.

Appendix B User Needs, System Characteristics, System Requirements, and System Specifications

Between a system concept and a detailed design there are a number of different levels of description that it is possible to give about a system, or a class of systems. They have been given the titles User Needs, System Characteristics, System Requirements and System Specifications [CONVERGE 1998]

User Needs emanate from the users and are entirely user oriented. They will not necessarily be consistent, and are likely to be expressed in plain text, sometimes with informal diagrams. Completeness is measured in terms of the numbers and types of users who have contributed.

System Characteristics are also user oriented and expressed in plain text, sometimes with informal diagrams, and permit the users to embellish the User Needs, which may be lacking in detail. They start from the User Needs and the system concept but as well as receiving contributions from the users, they also bring in the experience of system engineers and system architect(s) who have worked on other systems. It is not necessary for the system characteristics to be entirely consistent, but the most obvious inconsistencies in the User Needs should be removed.

System Requirements are system and implementation oriented, and will use (semi-)formal text and diagrammatic techniques to capture all the requirements (see below); they will not necessarily be easy to read by the users. They should be consistent and traceable back to the system characteristics and/or the User Needs. The primary requirements will come from the User Needs and the System Characteristics, but in addition the system engineers and system architect(s) will add derived requirements to provide the *working* characteristics of the system. Whilst the System Requirements may be used to test the resulting system, many of the detailed implementation issues may not have been decided, i.e. they may be technology independent.

System Specifications are system oriented and represent in detail how the future implementation will work. They represent one of the possible manifestations of the System Requirements, i.e. the detailed design. They are usually only readable by specialists as they should be written in (semi-)formal specification languages and/or diagrams which are rich in semantics and rules for internal consistency, and form the basis for detailed testing. The System Specification forms the input for the operator manual, user documentation, training manual, maintenance manual etc.

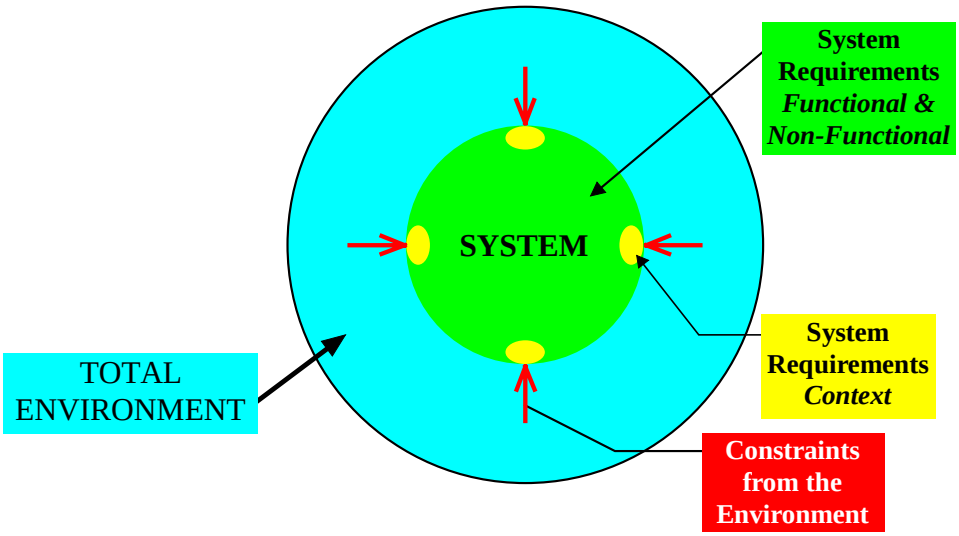
System Requirements

An ITS will always be part of a larger scheme that involves the personal, recreational and commercial activities of the area that it serves, it may also have to co-operate with other (telematic) systems; it therefore cannot be considered in complete isolation from the effects of that environment. Three types of System Requirements have been identified in [CONVERGE 1998] (see Figure 6):

- Functional Requirements - these specify the service(s) that will be expected from the system, and/or the functions needed to provide a working system.
- Non-Functional Requirements - these specify the performance and/or quality attributes of a workable system.
- Context Requirements - these specify the reaction to the constraints imposed by the environment on the introduction of the system. They may be statements on the assumptions that have been made about that environment, or statements as to what is needed for the system to work effectively within the environment.

Thus ITS which perform the same service, i.e. they have the same Functional and Non-Functional Requirements, can be expected to have different Context Requirements if they are to operate in different countries.

Figure 6 - Functional, Non-Functional and Context Requirements



Appendix C Comments from the Permanent Consultative Group

A very large number of detailed comments were received from the PCG, but they can be summarised under four main categories:

- *Additions/corrections* - Most members of the PCG detected some omissions or mistakes. These varied from a missing ‘y’ in a user category to a request for a complete new entry. All these issues were acted upon.
- *Misunderstandings/Clarification* - Version 1 of the List of European User Needs was written in a variety of styles that did not always conform to the strict rules of English grammar, and this may have led to a number of misunderstandings or requests for clarification. As a result almost every single User Need was re-written in a common style, and this should resolve most, if not all, of these problems.
- *Organisation* - It was clear, in particular from the comments received during the Workshop, that many members of the PCG did not like the result of using the 32 TICS Fundamental Services as the primary method of ordering the User Needs. As a result the list was completely reorganised in the manner described in Section 4.
- *Deletions* - A few members of the PCG made comments such as ‘irrelevant’ or ‘to be suppressed’ without any further explanation. In almost all of these cases the view was taken that, since each User Need had originated in previous practical work (see Section 3.2) and thus someone had considered it necessary, then such requests were ignored. It is possible that the person making the comment did not realise that the existence of a User Need in the list does not necessarily mean that it must be implemented (see Section 4.4).

Appendix D Cross Reference between TICS Fundamental Services and KAREN Groups

KAREN Groups → ISO TICS Fundamental Services

KAREN Group	TICS Service Nº	Title
1	N/A	**General**
2		**Management Activities**
2.1	6	Transport Planning Support
2.2	11	Infrastructure Maintenance Management
3		**Policing/Enforcing**
3.1	10	Policing/Enforcing Traffic Regulations
4		**Financial Transactions**
4.1	29	Electronic Financial Transactions
5		**Emergency Services**
5.1	26	Emergency Notification and Personal Security
5.2	27	Emergency Vehicle Management
5.3	28	Hazardous Materials & Incident Notification
6		**Travel Information**
6.1	1	Pre-trip Information
6.2	2	On-trip Driver Information
6.3	4	Personal Information Services
6.4	5	Route Guidance and Navigation
7		**Traffic Management**
7.1	7	Traffic Control
7.2	8	Incident Management
7.3	9	Demand Management
7.4	31	Safety Enhancement for Vulnerable Road Users
7.5	32	Intelligent Junctions and Links
8		**In-Vehicle Systems**
8.1	12	Vision Enhancement
8.2	13	Automated Vehicle Operation
8.3	14	Longitudinal Collision Avoidance
8.4	15	Lateral Collision Avoidance
8.5	16	Safety Readiness
8.6	17	Pre-crash Restraint Deployment
9		**Freight and Fleet Operations**
9.1	18	Commercial Vehicle Pre-clearance
9.2	19	Commercial Vehicle Administrative Processes
9.3	20	Automated Roadside Safety Inspection
9.4	21	Commercial Vehicle On-board Safety Monitoring
9.5	22	Commercial Fleet Management
10		**Public Transport**
10.1	23	Public Transport Management

KAREN Group	TICS Service Nº	Title
10.2	24	Demand Responsive Public Transport
10.3	25	Shared Transport Management
10.4	3	On-trip Public Transport Information
10.5	30	Public Travel Security

ISO TICS Fundamental Services → KAREN Groups

TICS Service Nº	KAREN Group	ISO Service Category	Service Name
1	6.1	**Traveller Information**	Pre-trip Information
2	6.2		On-trip Driver Information
3	10.4		On-trip Public Transport Information
4	6.3		Personal Information Services
5	6.4		Route Guidance and Navigation
6	2.1	**Traffic Management**	Transport Planning Support
7	7.1		Traffic Control
8	7.2		Incident Management
9	7.3		Demand Management
10	3.1		Policing/Enforcing Traffic Regulations
11	2.2		Infrastructure Maintenance Management
12	8.1	**Vehicle**	Vision Enhancement
13	8.2		Automated Vehicle Operation
14	8.3		Longitudinal Collision Avoidance
15	8.4		Lateral Collision Avoidance
16	8.5		Safety Readiness
17	8.6		Pre-crash Restraint Deployment
18	9.1	**Commercial Vehicle**	Commercial Vehicle Pre-clearance
19	9.2		Commercial Vehicle Administrative Processes
20	9.3		Automated Roadside Safety Inspection
21	9.4		Commercial Vehicle On-board Safety Monitoring
22	9.5		Commercial Fleet Management
23	10.1	**Public Transport Management**	Public Transport Management
24	10.2		Demand Responsive Public Transport
25	10.3		Shared Transport Management
26	5.1	**Emergency**	Emergency Notification and Personal Security
27	5.2		Emergency Vehicle Management
28	5.3		Hazardous Materials & Incident Notification
29	4.1	**Electronic Payment**	Electronic Financial Transactions
30	10.5	**Safety**	Public Travel Security
31	7.4		Safety Enhancement for Vulnerable Road Users
32	7.5		Intelligent Junctions and Links

Appendix E Annotated Bibliography

The following documents, guidelines and books have been found to be of relevance to the development of ITS. They are listed here because experience has shown that many ITS developers are unaware of their existence. Whilst no-one is expected to read every one, all ITS developers should be aware of the issues associated with each major topic. Where many titles are mentioned, those that are highly recommended have been marked with a "⇨", the others are sometimes supplementary, or alternative, texts in case the main one cannot be found. The list should not be considered complete, especially with respect to the books, as is it always possible that something has been written of which we are unaware.

The list is divided into subject areas, as follows:

- System Planning
  - Process
  - Product
- System Architecture
  - System Behaviour
  - Other ITS Architecture Developments
  - SATIN Documents
- System Specification and Design
- Safety
  - Traffic Safety
  - Functional System Safety
  - Human Machine Interaction
- Security
- Elderly and Disabled
- Standardisation

System Planning

During the early stages of a project is it necessary to get both the process and the product development off to a good start. The following texts provide advice on both of these topics

Process

Burke R, *Project Management - Planning and Control Techniques (3rd Ed)*, Wiley, 1999, ISBN 471-98762-X.

The following book is based on practical experience over many projects and contains sound advice.

Gilb T: *Principles of Software Engineering Management*, Addison-Wesley Longman, 1988, ISBN 0-201-19246-2.

The following book is very much a text book oriented towards young undergraduate students, but the contents are sound.

Hughes R and Cotterell M, *Software Project Management (2nd Ed)*, McGraw-Hill, 1999, ISBN 007-709505-7.

The following book follows one large real project, and then generalises from the experience, it also contains sound advice.

Redmill F: *Software Projects - Evolutionary vs. Big-bang Delivery*, Wiley, 1997, ISBN 0-471-93343-0.

Product

The following document is the latest version of the "CORD Function List".

Gaillet J-F, *A Proposal for a Revised Transport Telematics Functions List*, Deliverable DSA7.2, TR 1101 CONVERGE support project of the Transport sector of the TELEMATICS APPLICATIONS Programme, Fourth Framework Programme (1994-98), 1997, {www.trentel.org→transport}.

The following two documents provide top-level advice on urban ITS.

ITS City Pioneers, *ITS Planning Handbook - Intelligent City Transport*, ERTICO, 1998.

ITS City Pioneers, *ITS Toolbox - Intelligent City Transport*, ERTICO, 1998

System Architecture

The first set of books, and a Guideline, provide an introduction to the subject of system architecture. This list is by no means complete and those who are interested should also consider looking at Journals, e.g. Systems Engineering (published by Wiley), Proceedings of the previous ITS World Congresses, and Trade Magazines, e.g. Traffic Technology International.

Hice G F, *DSI: Distributed Systems Integration*, CAP Gemini Publishing BV, 1991, ISBN 90-71996-27-1.

Hice G F, *MISE: Managing Information Systems Evolution*, CAP Gemini Publishing BV, 1992, ISBN 90-71996-54-9.

⇨Jesty P H et al, *Guidelines for the Development and Assessment of Intelligent Transport System Architectures*, Deliverable DSA2.3, TR 1101 CONVERGE support project of the Transport sector of the TELEMATICS APPLICATIONS Programme, Fourth Framework Programme (1994-98), 1998, {www.trentel.org/transport/deployment/architecture/arch.html}.

⇨Rechtin E, *Systems Architecting: Creating and Building Complex Systems*, Prentice Hall, 1991, ISBN 0-13-880345-5.

Thomé B, *Systems Engineering: Principles and Practice of Computer-based Systems Engineering*, Wiley, 1993, ISBN 0-471-93552-2.

System Behaviour

Systems don't always behave as planned, and the following books and papers provide some warnings for the unwary.

Gall J., *Systemantics: The Underground text of Systems Lore*, The General Systemantics Press, 1986, ISBN 0-9618251-0-3.

Giezen J, Jesty P H and de Bruijn M, *System Architecture: The Control of System Behaviour*, Proceedings of the 3rd World Congress on ITS, 1996.

Hitchins D K, *Putting Systems to Work*, Wiley, 1992, ISBN 0-471-93426-7.

Jesty P H and Giezen J, *System Architecture: Flexibility, Management and Maintenance*, Proceedings of the 3rd World Congress on ITS, 1996.

⇨Leveson N G, *Safeware: System Safety and Computers*, Addison Wesley, 1995, ISBN 0-201-11972-2

⇨Neumann P G, *Computer Related Risks*, Addison Wesley, 1995, ISBN 0-201-55805-X.

Norman D A, *The Design of Everyday Things*, MIT Press, 1998, ISBN 0-262-64037-6 (first published with the title "The Psychology of Everyday Things").

Petroski H, *To Engineer is Human*, St Martins Press, 1982, ISBN 0-312-80680-9.

Wiener L, *Digital Woes: Why We Should Not Depend on Software*, Addison Welsey, 1993.

Other ITS Architecture Developments

There are a number of ITS Architecture initiatives now in existence. If your nation is not mentioned below, and you think that something is happening, then contact your relevant organisation. ISO TC204 is also creating an architecture but, when it is finished, it is likely to be available only via your National Standards Organisation (i.e. BSI, NNI etc.).

ITS America, *The National Architecture for ITS*, {www.odetics.com/itsarch/}.

ITS Australia, {www.itsa.uts.edu.au/architecture.html}

UTMC, *Urban Traffic Management and Control*, Department of the Environment, Transport and the Regions, {www.utmc.org.uk}.

VERTIS, *System Architecture for ITS in Japan*, 1999 {www.vertis.or.jp}.

SATIN Documents

At the end of DRIVE II the SATIN Task Force consolidated the architecture results that had been achieved so far. Most of this work has now been superseded by CONVERGE (see above) and KAREN (this project), but the documents can be found on the CD-ROMs published by the Commission in 1997.

Blonk J, Blachère J and Gaillet J-F, *Review of the DATEX Dictionary, a SATIN contribution to DATEX*, Deliverable N° AC18, SATIN Task Force, V2056 CORD project of the Advanced Transport Telematics (ATT/DRIVE II) sector of the TELEMATICS APPLICATIONS Programme, Third Framework Programme (1991-94), 1995.

Bonora S, *ATT System Architecture Developments: the Automatic Debiting System (ADS) Area*, Deliverable N° AC13-PT1, SATIN Task Force, V2056 CORD project of the Advanced Transport Telematics (ATT/DRIVE II) sector of the TELEMATICS APPLICATIONS Programme, Third Framework Programme (1991-94), 1994.

Both M, *ATT System Architecture Developments: the Freight and Fleet Management and Hazardous Goods Monitoring (FFM and HGM) Areas*, Deliverable N° AC13-PT2, SATIN Task Force, V2056 CORD project of the Advanced Transport Telematics (ATT/DRIVE II) sector of the TELEMATICS APPLICATIONS Programme, Third Framework Programme (1991-94), 1994.

Casimir C and Helcmanocki N, *ATT System Architecture Developments: the Traffic and Travel Information (TTI) Area*, Deliverable N° AC13-PT3, SATIN Task Force, V2056 CORD project of the Advanced Transport Telematics (ATT/DRIVE II) sector of the TELEMATICS APPLICATIONS Programme, Third Framework Programme (1991-94), 1994.

Gaillet J-F (Ed), *Recommended Methodology for Transport Telematic Architectures*, Deliverable N° D004-PT6, SATIN Task Force, V2056 CORD project of the Advanced Transport Telematics (ATT/DRIVE II) sector of the TELEMATICS APPLICATIONS Programme, Third Framework Programme (1991-94), 1995.

Gaillet J-F, *Highlights of Transport Telematics Architecture Concepts and Results*, Deliverable N° AC13-PT9, SATIN Task Force, V2056 CORD project of the Advanced Transport Telematics (ATT/DRIVE II) sector of the TELEMATICS APPLICATIONS Programme, Third Framework Programme (1991-94), 1995.

Giezen J and Blonk J, *ATT System Architecture Developments: the Inter-Urban Traffic Management (IUTM) Area*, Deliverable N° AC13-PT5, SATIN Task Force, V2056 CORD project of the Advanced Transport Telematics (ATT/DRIVE II) sector of the TELEMATICS APPLICATIONS Programme, Third Framework Programme (1991-94), 1994.

Giezen J, Blonk J and Jesty P H, *Reference Models and their use in Architecture Development*, Deliverable N° AC20, SATIN Task Force, V2056 CORD project of the Advanced Transport Telematics (ATT/DRIVE II) sector of the TELEMATICS APPLICATIONS Programme, Third Framework Programme (1991-94), 1995.

Roach H, *ATT System Architecture Developments: the Public Transport Area*, Deliverable N° AC13-PT4, SATIN Task Force, V2056 CORD project of the Advanced Transport Telematics (ATT/DRIVE II) sector of the TELEMATICS APPLICATIONS Programme, Third Framework Programme (1991-94), 1994.

SATIN, *Interfaces Between the IRTE Areas*, Deliverable N° AC13-PT8, SATIN Task Force, V2056 CORD project of the Advanced Transport Telematics (ATT/DRIVE II) sector of the TELEMATICS APPLICATIONS Programme, Third Framework Programme (1991-94), 1995.

SATIN, *Proposals for Urban, Inter-Urban and In Vehicle Architectures*, Deliverable N° AC13-PT7, SATIN Task Force, V2056 CORD project of the Advanced Transport Telematics (ATT/DRIVE II) sector of the TELEMATICS APPLICATIONS Programme, Third Framework Programme (1991-94), 1995.

Wrathall C, *ATT System Architecture Developments: the Urban Traffic Management (UTM) Area*, Deliverable N° AC13-PT6, SATIN Task Force, V2056 CORD project of the Advanced

Transport Telematics (ATT/DRIVE II) sector of the TELEMATICS APPLICATIONS Programme, Third Framework Programme (1991-94), 1994.

Wrathall C, *High Level User Requirements and Quality Factors for a European IRTE*, Deliverable N° D007-PT1, SATIN Task Force, V2056 CORD project of the Advanced Transport Telematics (ATT/DRIVE II) sector of the TELEMATICS APPLICATIONS Programme, Third Framework Programme (1991-94), 1995.

System Specification and Design

Once a development gets underway the system specification must begin, followed by the design. The following books describe various techniques for performing this task. This list is definitely *not* complete!

Crowe M, Beeby R and Gammack J, *Constructing Systems and Information: A Process View*, McGraw Hill, 1996, ISBN 0-07-707962-0.

DeMarco T, *Structured Analysis and System Specification*, Prentice Hall, 1978.

⇨Hatley D J and Pirbhai IA, *Strategies for Real-Time System Specification*, Dorset House, 1987, ISBN 0-932633-11-0.

Newton J and Wahl D C, *Manual for Data Administration*, US Department of Commerce, National Institute of Standards and Technology Special Publication 500-208, 1993 (Available from Superintendent for Documents, US Government Printing Office, Washington, DC 20402, USA)

Priestley M, *Practical Object Oriented Design*, McGraw Hill, ,ISBN 077091760.

⇨Rumbaugh J, Blaha M, Premerlani W, Eddy F and Lorensen W, *Object-Oriented Modelling and Design*, Prentice Hall, 1991, ISBN 0-13-630054-5

⇨Sommerville I, *Software Engineering (5th Ed.)*, Addison-Wesley, 1995, ISBN 0-201-42765-6.

Safety

Most ITS are safety-related to some degree, and so it is important to identify the safety issues and to handle them appropriately. The first document provides an overview of all three areas of safety and how they can affect an ITS deployment. The remaining documents cover each area of safety separately.

UTMC, *Framework for the Development and Assessment of Safety-Related Urban Traffic Management and Control Systems*, Department of the Environment, Transport and the Regions, 2000, {www.utmc.org.uk}

Traffic Safety

Traffic safety is concerned with the overall affect that an ITS may have on the behaviour of drivers, and the resulting effect on the traffic.

Carsten O M J (ed.), *Framework for Prospective Traffic Safety Analysis*, Deliverable Nº 6, V2002 HOPES project of the Advanced Transport Telematics (ATT/DRIVE II) sector of the

TELEMATICS APPLICATIONS Programme, Third Framework Programme (1991-94), Department of Traffic Planning and Engineering, University of Lund, Sweden, 1993.

⇨Draskóczy, M., Carsten. O. and Kulmala, R, *Road Safety Guidelines*, Deliverable B5.2, TR 1103 CODE support project of the Transport sector of the TELEMATICS APPLICATIONS Programme, Fourth Framework Programme (1994-98), 1998, {www.trentel.org→transport}.

VRU-TOO, *Final Report*, V2005 VRU-TOO project of the Advanced Transport Telematics (ATT/DRIVE II) sector of the TELEMATICS APPLICATIONS Programme, Third Framework Programme (1991-94), Working Paper 439, Institute for Transport Studies, University of Leeds, 1995.

Functional System Safety

Functional System Safety is concerned with the assurance that the equipment will always work properly and not produce unexpected, and dangerous, output.

Astruc J-M et al: *Towards the Certification of ATT Systems - System Safety Aspects*, Deliverable N° 8, V2058 PASSPORT project of the Advanced Transport Telematics (ATT/DRIVE II) sector of the TELEMATICS APPLICATIONS Programme, Third Framework Programme (1991-94), 1995.

The following documents describes a technique that has been proved to be particularly effective at identifying safety hazards at the concept phase of a development.

⇨Hobley K M et al: Framework for Prospective System Safety Analysis Volume 1 - Preliminary Safety Analysis, Deliverable N° 9a, V2058 PASSPORT project of the Advanced Transport Telematics (ATT/DRIVE II) sector of the Telematics Applications Programme, Third Framework Programme (1991-94), 1995.

Hobley K M et al: *Framework for Prospective System Safety Analysis Volume 2 - Detailed Safety Analysis*, Deliverable N° 9b, V2058 PASSPORT project of the Advanced Transport Telematics (ATT/DRIVE II) sector of the TELEMATICS APPLICATIONS Programme, Third Framework Programme (1991-94), 1995.

The following Standard is now a “Basic Safety Publication” and all safety-related systems will be expected to conform to its requirements.

IEC 61508, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems*, International Electrotechnical Commission, 1999/2000.

Jesty P H et al, *System Safety Guidelines*, Deliverable D5.4, TR 1103 CODE support project of the Transport sector of the TELEMATICS APPLICATIONS Programme, Fourth Framework Programme (1994-98), 1998, {www.trentel.org→transport}.

Jesty P H et al: *Functional System Safety and EMC*, Deliverable N° 1b, V2064 EMCATT project of the Advanced Transport Telematics (ATT/DRIVE II) sector of the TELEMATICS APPLICATIONS Programme, Third Framework Programme (1991-94), 1995.

⇨MISRA, *Development Guidelines for Vehicle Based Software*, MIRA, Nuneaton, UK, ISBN 0 9524156 0 7, 1994 {www.misra.org.uk}.

Human Machine Interaction

HMI safety is concerned with the way that a traveller, e.g. driver, interacts with an ITS and whether any safety hazards ensure, e.g. through misinterpretation, boredom etc.

⇨Carsten O, Franzén S, Draskóczy M. and Carver E, *Monitoring and Control of Human Implications of New Technology*, Deliverable 11, HINT Project of the TRANSPORT RESEARCH Programme of DG VII, Fourth Framework Programme (1994-98), Institute for Transport Studies, University of Leeds, 1999

EC, *Safe and Efficient In-Vehicle Information and Communication Systems : A European Statement of Principles on Human Machine Interface*, Recommendation of the Commission of the European Communities to the Member States and Industry 1999, {www.trentel.org→transport}.

Security

Some ITS will require their data to be kept secure, e.g. when it contains information about individual travellers, the following documents describe how such system can be shown to be secure.

DG XIII, *Information Technology Security Evaluation Criteria (ITSEC)*, Commission of the European Communities, 1991.

DG XIII, *Information Technology Security Evaluation Manual (ITSEM)*, Commission of the European Communities, 1993.

Elderly and Disabled

ITS will be used by all sections of society, the following guidelines describe how to ensure that the elderly and disabled can use them effectively.

TELSCAN, *The TELSCAN Handbook of Design Guidelines for Usability of Systems by Elderly and Disabled Drivers*, Deliverable D5.2, TR 1108 TELSCAN support project of the Transport sector of the TELEMATICS APPLICATIONS Programme, Fourth Framework Programme (1994-98), 1999, {www.trentel.org→transport}.

Standardisation

These two documents describe the work that was going on in standardisation at the time they were published. They should prove to be a useful introduction to anyone who needs to know more about this aspect.

Gaillet J-F, *CEN/TC 278 Framework Part 1: Description of the Different Working Groups*, ERTICO, 1996.

Hewitt R, *Review of the Use of Standards by the Telematics Application Programme - Transport Sector*, Deliverable D5.3.1, TR 1101 CONVERGE support project of the Transport

sector of the TELEMATICS APPLICATIONS Programme, Fourth Framework Programme (1994-98), 1998, {www.trentel.org→transport}.

Appendix F List of ITS User Needs according to KAREN Groups

Database Version 4

Appendix G List of ITS User Needs according to TICS Fundamental Services

Database Version 4