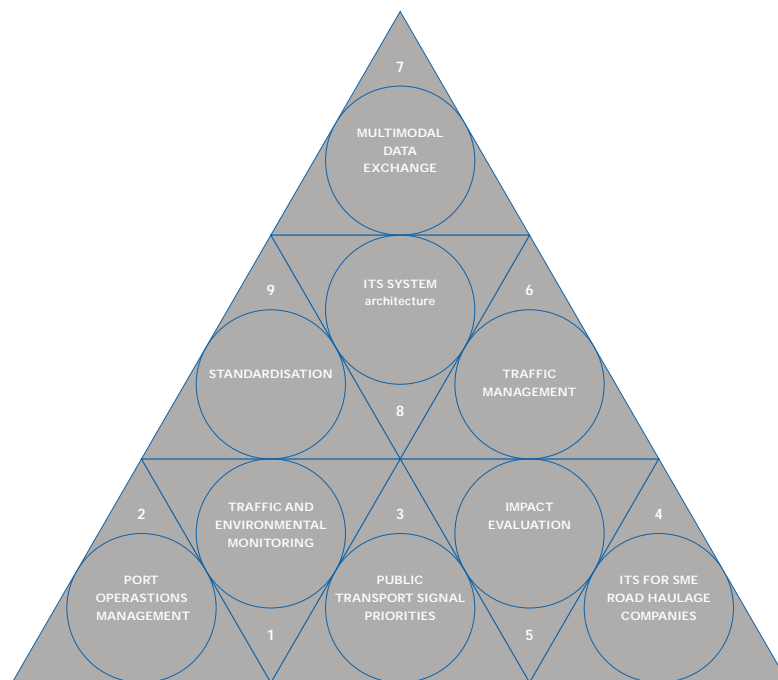




TETRA
FINNISH R&D PROGRAMME
ON ITS INFRASTRUCTURES 1998-2000

FINAL REPORT



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In Finland, the population and vehicle volumes do not offer very good possibilities for the private sector to build up ITS services on their own. The role of the public sector in Finland is to actively invest in the provision of optimal platforms for the private sector to develop ITS products, systems and services while ensuring the benefits from these systems and services to society.

The Ministry of Transport and Communications initiated the three-year (1998 - 2001) national programme, called TETRA, for the development of ITS infrastructures. The programme aimed at promoting the production of interoperable ITS systems covering all transport modes by developing the required basic ITS infrastructure and information systems. The objective of the programme was also to promote national expertise and industrial innovation in the area. The results of the programme are collected to this report and to a separate CD-ROM.

Reports, articles, and papers written at TETRA-program are listed at the end of this rapport. The programme was funded by the Ministry of Transport and Communications and specific transport mode central administrations linked to it, the National Technology Agency (TEKES) and the Finnish municipalities implementing ITS systems. The total costs of the programme were estimated at FIM 75 million or EURO 12.5 million. Co-ordination with European actions was ensured via the Euro-regional VIKING project supported by the TEN-T funding of the European Commission.

The programme was divided into nine programme or priority areas with their own objectives. The results of these areas are presented in the following pages. The responsibilities for reaching the programme and priority area objectives were delegated to the programme area steering committees and their chairmen.

The management committee of the TETRA programme was chaired by Permanent Secretary **Juhani Korpela** from the Ministry of Transport and Communications. The other members of the management committee were **Lassi Hilksa, Petri Jalasto, Anu Lamberg** (1998-1999), **Martti Mäkelä** (2000-2001), **Matti Roine** (2000-2001) and **Marjukka Saarijärvi** (1998-2000) from the Ministry; **Aulis Nironen** from the Finnish Road Administration; **Ossi Niemimuukko** from the Finnish Rail Administration; **Heikki Muttilainen** from the Finnish Maritime Administration, **Jarkko Varjo** (1998-2000) and **Matti Koskivaara** (2000-2001) from the Finnish Civil Aviation Administration; **Mikko Melasniemi** from the Confederation of Finnish Industry and Employers; **Anne Hernejoja** from Helsinki Metropolitan Area Council; **Marja Erola** (1998-2000) and **Matti Evola** (2000-2001) from the National Technology Agency; **Susan Linko** from the Academy of Finland; **Sisko Kangas** (1998-2000) and **Hannele Luukkainen** (2000-2001) from Liikenneliitto; and **Hannu Hakala** from Nokia. The programme co-ordinator was **Risto Kulmala** from VTT Building and Transport assisted by **Jukka Lähesmaa, Anna Schirokoff, Outi Kettunen, Pekka Kulmala** and **Juuso Kummala**.

Much progress took place in the infrastructures and services of ITS during TETRA's three years of operation, but the public sector has still to invest in this domain for its further development. The Ministry has initiated as a follow-up to TETRA a programme named **FITS** (Finnish R&D Programme on ITS Infrastructure and Services) 2001-2004.

Director Matti Roine

BUILDING BLOCKS OF ITS

USERS	> Companies	> Authorities	> Persons
TERMINALS	> Fixed	> In-vehicle	> Portable
ITS SERVICES	> Travel	> Tourism	> Logistics
INFORMATION INFRASTRUCTURES	> Monitoring	> Information systems	> Architecture
TECHNOLOGIES	> Communications	> Positioning	> Identification
			> Operating systems

PROGRAMME RESULTS

TETRA was assessed by an independent, international evaluation team in 2000. The evaluators found the programme structure, decision-making process, the "umbrella" model of operation, the project selection processes and reporting procedures to be appropriate and successful. Flaws were observed in the information dissemination between individual projects and the marketing of results to private sector actors. The evaluators estimated that the programme would fulfil well its primary objectives of building up information infrastructures and national expertise.

TETRA has successfully fulfilled its specific objectives related to carrying out the planned research and development tasks. In 2001, the achievements are mostly various specifications and planning documents as well as the increased co-operation and convergence of the ITS actors. Many plans and pilots were set up concerning the required information infrastructures and services, but comprehensive deployment of these did not take place. Many major obstacles to service provision still remain partly untackled. For example, public transport timetable and route information of different actors is not compatible, traffic monitoring is not comprehensive, and the new traffic information library and interfaces have not been widely adopted. The specifications and pilots have, nevertheless, enabled deployment of a number of systems to commence, such as **DIGIROAD** and the **Passenger Transport Information programme** of the Ministry of Transport and Communications.

The final conclusion on the achievements of the programme can be drawn after some years. Today, it is impossible to predict the future number and type of ITS services that will utilise the information infrastructures developed in the programme. It is quite certain that the LK-tieto, **Port@Net** and especially DIGIROAD systems will be widely utilised in different services. The follow-up programme, FITS, aims to systematically promote the development of ITS services.

The table below presents a summary of the programme achievements by programme area.

PROGRAMME AREA	TETRA			R&D CONTINUED	DEPLOYMENT
	1998-2000			FITS 2001-	2001-
1 > Traffic and environmental condition monitoring	●	●	-	●	●
2 > Port operations management	●	●	●	●	●
> Maritime transport information system Port@Net	●	●	●	-	●
3 > Intelligent signal priorities for public transport	●	●	●	●	●
4 > ITS for SME road haulage companies	●	●	-	-	●
5 > Evaluation of the impacts and economic feasibility	●	●	●	●	●
6 > Traffic management systems	●	●	●	-	●
7 > Multimodal transport information system	●	●	●	●	●
> Digital road and street data DIGIROAD	●	●	-	-	●
8 > ITS system architecture	●	-	●	●	-
9 > Co-ordination of standardisation activities	●	-	●	●	-

Specifications
Deployment
Services

SYMBOLS AND COLOURS

- > Deployed / Deployment or take-up ongoing
- > Piloted / Piloting is ongoing
- > Services not relevant to programme area

Scope

The area included projects to develop new data collection methods and the collection of some new monitoring information types. The emphasis was on the real-time monitoring of traffic and road weather conditions. The methods dealt with probe vehicles, image processing, and air quality monitoring as well as new communication technologies and software. Among the participants involved were the Ministry of Transport and Communications, Central office and Southeast Finland regional office of the Finnish Road Administration (Finnra), Helsinki University of Technology, the Finnish Meteorological Institute, Helsinki Metropolitan Area Council, and the City of Tampere.

Achievements

Server software for road weather and traffic data.

The application collects data from road weather stations, road weather CCTV cameras, and automatic traffic-monitoring stations to traffic centres. The application may also be used in controlling variable message and speed limit signs.

Development of a mobile monitoring station.

Instruments in the prototype measure the air temperature, relative humidity, road surface temperature, and friction in addition to the location of the vehicle with exact time information. The speed of the vehicle is used in estimating the traffic flow status. The system starts up automatically at vehicle start-up, and collects and transmits data independently of the driver's actions. Data are transmitted in almost real time via GSM to the road weather information system of Finnra, where the information is positioned in a map along with other road weather data. Video images from a camera in the vehicle are also sent along with the other information items to Finnra's traffic centres.

Road weather and traffic CCTV cameras.

The work phases included the determination of the functional specifications of CCTV cameras, and testing of various camera systems for the selection of a CCTV camera server for Finnra.

Monitoring for traffic management systems.

The state of the art of automatic traffic control and information systems was investigated as a literature survey. Specific studies looked into the short-term forecasting of traffic volume and speed.

Air quality monitoring.

A pre-study investigated the usability and uses of air quality information in traffic management, and proposed a tentative operational model for the use of air quality information in traffic management.

INFORMATION

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Scope

The objective was to develop the tracking and tracing systems for goods transport, systems integrating the goods units and their associated data, and the real-time management of the information (location, time, batch, load, transport, unit, transport condition, damages, etc.) at ports. The management of the terminal, land transport, port and sea transport phases of port operations was developed within a number of pilot trials. In addition to the Ministry of Transport and Communications, the Finnish Maritime Administration, the Confederation of Finnish Industry and Employers, the National Technology Agency, the National Board of Customs, VR Group, and several companies participated in the area.

Achievements

Automatic tracking and tracing was studied in two projects. TRACKIDEF studied **automatic identification of goods transport units** (container, wagon, trailer, etc.) based on RFID (Radio Frequency Identification). Eight different systems for container identification were tested in the laboratory, and two for train wagon identification in a port environment. The interfaces and links to transport planning and management systems as well as customer services were specified (data content, format, communications technology).

The Hanko port automatic transport unit identification project piloted an **automatic identification and status monitoring process**. The video image based system was installed at the new gate to the port. The access control system identifies the vehicles and transport units, and opens the gate automatically for vehicles with access, which is enabled according to the information management systems.

The study on **stowage planning of ro-ro ships** recommended the further utilisation of stowage planning data. The study identified the notifications of the consignee about the accurate unloading time, monitoring of cargo objects, and pinpointing the exact location of IMO cargoes in the ship as the most important development targets in the near future. The results can be utilised in the further development and planning of the details and the technical solution of the system towards an application.

INFORMATION

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Port@Net

The Maritime transport information system **Port@Net** provides reliable real-time information on vessels, their location and cargo. The safety, efficiency and economics of maritime transport are improved as a result.

Port@Net covers port operations as well as the functions and services related to vessel traffic guidance and control, piloting, and icebreaking. Information on the vessels and their movements can be utilised by all relevant actors (traffic managers, customs, pilots, icebreakers, stevedoring companies, haulage companies and transport operators). The information system also covers hazardous goods transports by vessels.

The systems aim for a "paperless" port, where one arrival or departure report once given is sufficient. The Internet-based solution interacts with other systems by XML.

As an additional feature to Port@Net, the national guidelines for applying **electronic manifest information** were produced. The manifest is the cargo list for the goods transport units of a vessel between the origin and destination ports. The information contents of the manifest have been harmonised to reflect the demands of the customs authorities.

The **Intermodal Portal** project is developing a generic portal solution in order to standardise and transfer data flows between ports and their interest groups either as EDI or XML messages or via the www interface. The project is a part of the 5th R&D Framework Programme of the EU. The portal is developed on top of the Port@Net system. This enables data exchange between different Baltic sea ports.

INFORMATION

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Scope

The cities and other actors involved in the TETRA-BUS area developed in co-operation applications related to signal control and especially public transport priorities at signals. Continuous exchange of information concerning the experiences and results between the various projects included in the area was a central part of the area operations.

Achievements

Short-range radio communications function well as a means for detecting buses and trams in telematics systems for public transport. The radio modem in the approaching vehicle transmits a low-power signal message directly to the local signal control device. The system is reliable and accurate enough for public transport signal priorities.

Long loop detectors for buses, are well-suited for use in small and medium-sized towns. Their detection accuracy is sufficient, and their costs are much smaller than those employing radio communications, which require heavy initial investments.

Tampere was the first city in Finland to make use of the SPOT **area-wide signal control** system including signal priorities for public transport. In SPOT, signal control is based on modelling the state of current traffic and minimising stops and delays. SPOT did not fulfil all expectations. This may be because of the inefficiencies in operation caused by the lack of effective development and monitoring systems. A probable cause is also the Finnish tradition of strong prioritisation of major road traffic in signals. This has meant that signal control optimisation for all road users and flows does not necessarily improve the conditions for vehicles on the major road.

There are very promising indications of the potential of **fuzzy signal control** for public transport priorities. For the time being, the use of fuzzy control suffers to some extent from the deficiencies in the basic functions of signal control. Because of this, it is still difficult to quantify the benefits of incorporating fuzzy logic into public transport priorities in comparison to the priorities in conventional signal control. Fuzzy logic should be applied in area-wide signal control in order for fuzzy logic to have any larger significance in Finnish signal control.

The planning of public transport priorities requires a lot of effort and resources with current signal devices. The new up-to-date **guidelines for planning public transport priorities** "LIVASU2000" clarifies the design-related concepts, harmonises the planning methods, and reduces the efforts and time needed for planning.

INFORMATION

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Scope

The development and take-up of telematics in road haulage companies requires information technology expertise, which the small road haulage companies do not have. The **KANTELE** action attempted to promote the use of telematics in small and medium-sized road haulage companies with the help of public-sector funding. The co-operative action involved the Ministry of Transport and Communications, the National Technology Agency, the Finnish Trucking Association, and Tampere University of Technology.

Achievements

The action started with a study on the types of telematics applications that would be the most beneficial for small and medium-sized road haulage companies, and at the same time offer the possibility of being taken up by the companies. Two priority applications were identified: **electronic transport log book**, and **transport operations monitoring system**. Functional specifications were made on these applications with the help of structured analysis. In addition, the need for authority interfaces was investigated.

Pilot Internet applications were set up for the electronic transport log book and the transport operations monitoring system as well as the **transport exchange**.

The specifications can be used by all actors free of charge; and they will hopefully be utilised by the actors involved, software developers, and road haulage companies. Recommendations were also given for further actions in order to promote the deployment of telematics in road haulage companies.

INFORMATION

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Scope

The objective of the programme area was to harmonise the methods for the evaluation of ITS projects and to enable their comparison to other transport projects. Another objective was to accumulate knowledge of the impacts and economic feasibility of ITS projects and systems with the help of independent evaluation studies. The area steering group involved the Ministry of Transport and Communications, the Finnish Road Administration, the Finnish Rail Administration, Helsinki Metropolitan Area Council, the City of Helsinki, Tampere University of Technology and VTT.

Achievements

The area commenced with the development of **Guidelines for evaluation of ITS projects**. The guidelines present a systematic method for allocating the impacts, to identify the most essential impacts and to assess the importance of the impacts in relation to transport policy objectives. The benefits of ITS projects should be measured by their contribution to these transport policy objectives. The evaluation methodology is compatible with that of conventional transport investments. Hence, ITS projects can be assessed as an alternative to conventional projects.

The guidelines also present a methodology for evaluating logistics projects. The benefits of logistics projects will appear in the profits of companies. A method for estimating the changes in the profits and capital return rate is presented in the guidelines. The guidelines can be applied in both ex-ante as well as ex-post evaluations.

The **assessment of the profitability of ITS projects** was investigated in detail for later development of evaluation methodology. The study analysed the differences between ITS and conventional transport investments, and concluded that the benefit-to-cost ratio as estimated nowadays is inappropriate for the sole instrument of comparison between projects. The study proposed a number of possible ways to improve the evaluation procedures taking into account the different nature of ITS and conventional transport investments and the option values of ITS projects.

The guidelines were applied in evaluating the following ITS projects:

- > **Project 423: Passenger information and signal priorities for public transport lines 4 and 23 in Helsinki**
- > **Lane control system at Kallavesi bridges in Kuopio (long-term effects)**
- > **www-service of the regional public transport information centre in northern Savo**
- > **Weather-related speed control system on a single carriageway section of the E 18**
- > **Queue warning system on Länsiväylä**
- > **Scheduling and routing service integrating train and bus timetables**

The evaluations produced information of the technical performance of the systems, user acceptance, impacts of the systems, and in some cases information about the economic feasibility of the systems and services. For example, the benefit-to-cost ratio of project 423 was estimated to be 3.3. The practical application of the guidelines in these evaluations indicated their usefulness but also the needs for some improvements.

INFORMATION

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Scope

The area concentrated on the development of the operations, information management systems, and co-operation at traffic centres and especially at Finnra's traffic management and information centres. The developments in the police and rescue domains of the Ministry of Internal Affairs were included for the part of co-operation between the emergency centres and traffic centres. The area also included the road traffic related traffic management systems at Helsinki-Vantaa Airport funded by the Civil Aviation Administration. In all, the area was oriented towards road traffic.

Achievements

The first phase of the **information management system for the traffic centre operator** (LK-tieto) was developed and taken into use. The foundations for the information management system and its operator interface were laid by the **functional analysis of traffic centres**.

A pre-study on the **principles for selection and traffic control of alternative routes on the main road network** developed traffic centre operations and especially incident management procedures. The planning and route guidance for alternative routes should be developed by identifying and agreeing on the tasks of the actors involved as well as through improved data exchange facilities between transport modes.

The development of an **action plan and model of operations for ITS in the Tampere region** resulted in a number of ITS implementations as a co-operation between Finnra, the City of Tampere, and transport operators.

The **ground transport management at Helsinki-Vantaa Airport** was improved by developing the management systems for parking, bus transport and taxis.

In addition to the concrete system developments and specifications, a major achievement of the area was the increased awareness of the objectives and systems of the various actors as well as the agreement on the areas and targets of co-operation. New needs and possibilities for co-operation were identified especially in the domain of data exchange.

INFORMATION

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Scope

The long-term objective was to develop an information exchange system covering all modes to be used by the transport sector actors and service providers as a platform for comprehensive, reliable, real-time, and easily accessible services catering to user requirements. The area began with a scoping study followed by projects, in which different actors developed parts of the total system. In this way, single projects could proceed unhindered while fulfilling interoperability requirements.

Achievements

The development of **KALKATI, the information exchange system covering all transport modes**, commenced with a feasibility study defining the basic properties of the system and identifying the tasks in its development. The study concluded that KALKATI has to be built on a digital transport network database.

The parts of KALKATI and data exchange between actors were developed and tested in seven pilots:

- > ITS for the Tampere region
- > Data exchange between Finnra, the police and regional emergency centres
- > Passenger information system in bus transport
- > Integrated scheduling and routing service for bus and train transport
- > Regional public transport information centre
- > Helsinki centre public transport passenger information system
- > Integrated road traffic and lighting management system

A separate study on **agreement on ITS service provision** investigated institutional and economic issues such as information ownership, maintenance, liability, quality assurance, and pricing. The study also identified contractual issues and models for their settlement. The study presented a checklist of items to be considered in actor co-operation, and proposed a set of basic rules for multi-actor traffic information exchange and ITS service provision.

Harmonised interfaces for traffic information exchange were specified for public transport passenger information and road traffic information. These specifications were made in co-operation with the relevant actors by utilising their existing information systems, and the available standards and pre-standards. The specifications resulted in the **Traffic information library KALKATI.net** available on the Internet, which contains the specifications with many additional tools. The web site presents the harmonised interfaces, information types and specifications and data models as well as enabling the user to view and download message interface descriptions. Users can also utilise the service by downloading ready-made Java scripts in order to build up information exchange systems of their own.

INFORMATION

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DIGIROAD - Digital road and street network information system

DIGIROAD will include the information of the location, geometry and other properties of the whole Finnish road and street network. The system will also include tools for information exchange, management and update. Companies, authorities and municipalities can utilise the system in the development of ITS systems and services for passenger and goods transport.

DIGIROAD will be operational by the end of 2003. Before this, wide data collection activities have to be carried out, the information updating mechanism has to be set up, and the information system has to be planned and deployed.

The development of DIGIROAD within the TETRA programme consisted of a **pre-study**, **pilot system** covering six municipalities, and the **implementation plan**. The implementation plan is built upon the results of the pre-study and the pilot. The plan describes the current view of the system, and acts as a basis for the more detailed planning of the system.

The pilot tested the functions and feasibility of the DIGIROAD system. The pilot especially studied the collection of data from different source systems and combined these data into a database following the DIGIROAD specifications. The pilot also enabled assessment of the technical procedures and costs of the total national system. In addition, the pilot produced information of the quality (correctness, location accuracy) of the available databases.

The municipality task force discussed the **role of municipalities in DIGIROAD**. The task force produced a recommendation for the actions of the municipalities in the DIGIROAD data collection and update processes, and principles for co-operation between the municipalities and the DIGIROAD organisation.

The Finnish Road Administration (Finnra) is responsible for implementing and maintaining DIGIROAD. According to the implementation plan, Finnra is supported by an operations management consultant and the companies responsible for the planning, implementing and updating of the system. Finnra collects and maintains the information content of the system together with the National Land Survey of Finland, the municipalities, forest and other organisations.

A separate project DIGISTOP developed a **public transport stop database**. The system contains an information system for collecting, managing, and maintaining the information of about 20 000 most important stops specified in existing timetables. The database includes the location co-ordinates and information of the features of the stop in digital form. The system can be immediately utilised by the national transport licence system VALLU.

INFORMATION

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Scope

The objective of the programme area was to create prerequisites for interoperable multimodal and mode-specific ITS services by developing an open national system architecture for ITS. The system architecture should describe the environment in which the ITS systems and services operate. The open system architecture creates the basic prerequisites for data interoperability, data exchange, the integration of systems and services, and standardisation and other harmonisation actions. The system architecture can be utilised in planning new services as it describes the different elements and actors in the service provision process. The system architecture was developed as an interactive process involving all major actors in the passenger transport domain.

Achievements

The **national system architecture for ITS TelemArk**, describes 11 passenger transport telematics functions as processes.

The process descriptions present the actors using and providing the processes and their elements as well as the connections between the various elements of the process. Illustrative distribution maps describe the most important parts of the processes in terms of information system components and functions.

The **architecture development plan** identifies the current deficiencies in the ITS processes in Finland, and recommends a development plan to overcome the most crucial deficiencies. The development plan can also be used to guide various actors into utilising the system architecture in their activities.

The system architecture and its use were promoted via many congress papers, articles, workshops and a large seminar.

11 passenger transport telematics functions as processes:

- > **information about public transport**
- > **information to drivers**
- > **park and ride**
- > **demand-responsive public transport and travel brokering**
- > **access control**
- > **payment (private and public transport)**
- > **traffic control**
- > **hazardous goods transport management**
- > **incident management, private transport**
- > **incident management, public transport**
- > **traffic enforcement**

INFORMATION

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Scope

The objective of the programme area was to increase the expertise and understanding of ITS system architecture and standardisation in Finland. The area involved the Ministry of Transport and Communications, the Finnish Road Administration, Helsinki Metropolitan Area Council, the Finnish Civil Aviation Administration, the Finnish Rail Administration, the Telecommunications Administration Centre, VR Group, Matkahuolto, the Finnish Trucking Association, the City of Helsinki, Traficon Ltd and VTT.

Achievements

The full impacts and benefits from ITS can only be achieved by using open and modular systems and system components. Hence, national and European ITS systems and applications should be compatible with the commonly agreed system architectures and technical standards.

The programme area monitored the international progress in its domain, analysed the existing information and disseminated it widely via the **T9 Internet site**. The Internet site contains descriptions of the main actors in international standardisation and harmonisation activities, and the standards in existence and in preparation. The site has links to the existing standards and pre-standards. The programme area maintained close contacts to the KAREN action aimed at developing the common European ITS framework architecture.

A separate study was carried out to identify the international standards, pre-standards or similar harmonisation instruments linked to the national ITS system architecture. The study makes it easy for service providers to consider the standards with which they should comply.

Another study dealt with the participation in the international standardisation activities linked to ITS. This study described the current state of standardisation and recommended a number of actions to be carried out by Finnish actors. The study also identified the most important standardisation objects and requirements from the Finnish point of view.

INFORMATION

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BIBLIOGRAPHY

- > Hilska L., Kulmala R. (1999). ITS implementation strategies - the Finnish approach. ITS in Europe '99. Amsterdam, 14 - 17 June 1999. (CD-ROM). Brussels: ITS Congress Association.
- > Jalasto P., Kulmala R. (2000). Building up ITS Infrastructure as a Public Sector Programme - Does it work? From Vision to Reality. Proceedings of the 7th World Congress on Intelligent Transport Systems. Turin, Italy, (CD-ROM). Brussels: ITS Congress Association.
- > Kulmala R. (1998). Liikennetelematiikan perusrakenteiden kehittäminen. (Development of the basic transport telematics infrastructure.) Rakennusinsinööripäivät 1998. Espoo, 14.10.1998. Helsinki: Suomen Rakennusinsinöörien Liitto RIL. pg. 87 - 94.
- > Kulmala R. (1998). TETRA - Liikennetelematiikan rakenteiden tutkimus- ja kehittämisohjelma. (TETRA - Research and Development Programme on Transport Telematics Infrastructures.) Tie ja Liikenne 1998 Esitelmät. Suomen Tieyhdistys. pg. C1 - C6.
- > Kulmala R. (1999). TETRA - Liikenteen telematiikan rakenteiden tutkimus- ja kehittämisohjelma. (TETRA - Research and Development Programme on Transport Telematics Infrastructures.) Tiennäyttäjät Vol. 8, (1999) No: 1, pg. 23 - 24.
- > Kulmala R. (1999). Tieliikenteen telematiikan nykytila ja kehitysnäkymät Suomessa ja muissa EU-maissa. (Current state and future scenarios for road transport telematics in Finland and other EU-countries.) Telemattiset liikenteen ohjausratkaisut/Oulu.TELIO-seminaari. Oulu, 6.9.1999. Oulun tiepiiri. 6 pg.
- > Kulmala R. (2000). Liikennetelematiikan rakenteiden T&K -ohjelma TETRA. (R&D Programme on Transport Telematics Infrastructures TETRA.) e-business, informaatioteknologia ja kuljetusvälineet, Helsinki 18.10.2000. KULTEK (Suomen kuljetusvälineiteollisuuden kehitysohjelma 1999-2001, Yleinen teollisuusliitto ja Tekes). pg. 39- 41.
- > Kulmala R., Hilska L. (2000) TETRA on jo loppusuoralla, pääseekö se maaliin? (TETRA is on the home stretch, but will it make it?) Väylät & Liikenne 2000 Esitelmät. Suomen Tieyhdistys. pg. 257 - 260.
- > Kulmala R., Jalasto P. (1999). Building up ITS infrastructure - the Finnish approach. Proceedings of the 6th World Congress on Intelligent Transport Systems. Toronto, Canada. (CD-ROM). Brussels: ITS Congress Association.
- > Kulmala R., Jalasto P. (1999). Liikennetelematiikan rakenteiden T&K -ohjelma. (R&D Programme on Transport Telematics Infrastructures.) Liikenne. Vol. 17 No: 2, 7 - 9.
- > Kulmala R., Lähesmaa J., Hyppönen R., Roine M., Oinas J., Appel K., Ristola T. (1997). TETRA - Liikenteen telematiikan rakenteiden tutkimus- ja kehittämisohjelma 1997 - 2000. Ohjelman kuvaus. (TETRA - Research and Development Programme on Transport Telematics Infrastructures 1997 - 2000. Programme description.) Liikenneministeriön mietintöjä ja muistioita: B 41/1997. Helsinki: Liikenneministeriö. 25 pg. + app.

Programme area 1

- > Innamaa S. (1999). Automaattiset liikenteen ohjaus- ja liikenneinformaatiojärjestelmät. (Automatic Traffic Control and Information Systems.) Tielaitoksen selvityksiä 28/1999. Helsinki: Tielaitos. 136 pg.
- > Innamaa S. (2000). Liikennetilanteen lyhyen aikavälin ennustaminen MLP-neuroverkolla. (Short-term prediction of traffic situation using MLP-neural networks.) Väylät ja Liikenne 2000 Esitelmät. Suomen tieyhdistys. pg. 533-539.
- > Innamaa S. (2000). Short-term prediction of traffic situation using MLP-neural networks. From Vision to Reality. Proceedings of the 7th World Congress on Intelligent Transport Systems. Turin, Italy, (CD-ROM). Brussels: ITS Congress Association.
- > Innamaa S., Pursula M. (2000). Liikennemäärän ja nopeuden lyhyen aikavälin ennustaminen. (Short-Term Prediction of Flow and Speed.) Tielaitoksen selvityksiä 54/2000. Helsinki: Tielaitos. 101 pg. + app. 3 pg.

- > Intrinsic Oy (1999). Tieliikenteen telematiikka-EI8 -kokeilualue; Windows NT-keskusajohjelmisto, toiminnallinen määrittely, V2.1.4, 25.02.1999. (Transport Telematics - EI8 Test Area; Windows NT Server Software. Functional specification.)
- > Savolainen J., Myllylä J., Pili-Sihvola Y. (1999). Liikkuva kelin havainnointi - testiraporttien yhteenveto. (Mobile Road Condition Monitoring - Summary of the Test Reports.) Kaakkois-Suomen tiepiirin selvityksiä 5/1999. Kouvola: Tielaitos. 22 pg. + app. 7 pg.
- > Savolainen J., Myllylä J. (1999). Tielaitoksen uusi kelikamerajärjestelmä. (Finnra's New Road Condition Camera System.) Kaakkois-Suomen tiepiirin selvityksiä 6/1999. Kouvola: Tielaitos. 15 pg. + app. 1 pg.
- > Schirokoff A., Hämeikoski K., Laurikka H., Kulmala R., Mäkelä K., Ahonen A., Pulkkinen J. (1999). Ilmanlaatu-tiedon hyödyntäminen liikenteen hallinnassa. (Use of air quality data in traffic management.) Liikenneministeriön julkaisuja 48/1999. Helsinki: Liikenneministeriö. 113 pg. + app. 3 pg.
- > Schirokoff A., Hämeikoski K., Laurikka H., Kulmala R. (2000). Use of air quality data in traffic management. From Vision to Reality. Proceedings of the 7th World Congress on Intelligent Transport Systems. Turin, Italy, (CD-ROM). Brussels: ITS Congress Association.

Programme area 2

- > Aspelin, E. (1999). Manifestin käyttö, käytön esteet ja kehittämistarpeet, Loppuraportti. (Use of Manifest, Obstacles to Use and Development Needs. Final report.) Oy EDI Management Finland Ltd. (Unpublished study 18.6.1999).
- > Bäckström, R. (2000). Port@Net - A national traffic information system for the maritime community. Conference proceedings of the VTS2000 -symposium, 18-21 January 2000. Singapore.
- > EP-Logistics Oy, Liikenneministeriö (1999). Selvitys automaattisen tunnistamisen nykytilasta Suomen satamissa. (EP-Logistics Ltd., Ministry of Transport and Communications (1999). Automatic Identification of Transport Units in Finnish Ports.) (Unpublished study 15.6.1999). 15 pg. + app. 5 pg.
- > Holmberg S., Tikkanen J. (1999). Ro-ro-alusten elektroninen lastaussuunnittelu. (The electronic stowage planning of Ro-Ro-vessels.) Liikenneministeriön mietintöjä ja muistioita B 12/1999. Helsinki: Liikenneministeriö. 58 pg.
- > Permala A., Granqvist J., Scholliers J., Kutila M., Auvinen S., Aspelin E., (2000). TRACKIDEF, Kuljetusyksikön automaattinen tunnistus. (Automated identification of transport units. Research report.) Tutkimusraportti 549. Espoo: VTT Yhdyskuntatekniikka. 75 pg. + app.
- > Permala A., Scholliers J., Granqvist, J. (2000) Automated identification of transport units in complex transport chains, Finnish test results. From Vision to Reality. Proceedings of the 7th World Congress on Intelligent Transport Systems. Turin, Italy, (CD-ROM). Brussels: ITS Congress Association.
- > Scholliers J., Permala A. (2000) Kuljetusyksikön automaattinen tunnistus. (Automated identification of transport units.) Automaatioväylä. Forssa. Suomen Automaatioseura ry, Suomen Mittaus- ja Sääteknillinen Yhdistys ry. Vol. 16 No: 6, 14 - 16.

Programme area 3

- > Bäckström J. (1998). Real-time information about waiting times at bus stops. Proceedings of the 5th World Congress on Intelligent Transport Systems. Seoul, Korea. (CD-ROM). Brussels: ITS Congress Association.
- > Hautala R., Vehmas A., Vehviläinen J. (1999). Espoon ja Länsiväylän joukkoliikenteen matkustajainformaatiojärjestelmän vaikutustutkimus, II-vaihe "Aikana-tutkimus." (Espoo and Länsiväylä Public Transport Passenger Information System Impact Study, Phase II: During-study.) Liikenneministeriön mietintöjä ja muistioita 6/1999. Helsinki: Liikenneministeriö.

> Programme area 1 > Programme area 2 > Programme area 3

- > Helsingin liikenteenohjauskeskus (2001). Helsingin joukkoliikenteen liikennevaloetuedet ja matkustajainformaatio HeLMI. (Helsinki Urban Traffic Control Centre (2001). Helsinki Public Transport Signal Priorities and Passenger Information HeLMI.) (http://www.hel.fi/liikenteenohjaus/helmi/helmi_laajennus.htm) 24.5.2001.
- > Helsingin liikenteenohjauskeskus (2001). Joukkoliikenteen liikennevaloetus-miten se oikein toimii? (Helsinki Urban Traffic Control Centre (2001). Public transport signal priorities - How do they work?) (<http://www.hel.fi/liikenteenohjaus/kysymykset/etuudet/index.htm>) 24.5.2001.
- > Helsingin liikenteenohjauskeskus (2001). Joukkoliikenteen telematiikka. (Helsinki Urban Traffic Control Centre (2001). Public Transport Telematics.) (http://www.hel.fi/liikenteenohjaus/jl_liikennetelematiikka.htm) 24.5.2001.
- > Helsingin liikenteenohjauskeskus (2001). Miten Helsingin liikennevalo-ohjausta tulisi kehittää? (SPOT) (Helsinki Urban Traffic Control Centre (2001). How signal control should be developed in Helsinki? (SPOT)) (<http://www.hel.fi/liikenteenohjaus/kysymykset/spot/index.htm>) 24.5.2001.
- > Kokkinen M., Eloranta T. (2000). Pitkäsilmuksella bussi-ilmaisimena - tekninen selvitys. (Long Inductive Loop as Bus Detector: Technical study.) 19 pg. (study can be found at <http://www.hel.fi/liikenteenohjaus/tetra/julkaisut.htm>) 24.5.2001.
- > Långström L., Sane K. (1998). Testing of different bus detectors for traffic signal priority in Helsinki. (<http://www.hel.fi/ksv/entire/repBusDetectors.htm>) 24.5.2001.
- > Långström L. (1998). Public transport telematics system configuration in the city of Helsinki. (<http://www.hel.fi/ksv/entire/repDetSystem.htm>) 24.5.2001.
- > Långström L. (1999). Implementation of radiobased detection for public transport in Helsinki. (<http://www.hel.fi/ksv/entire/repLowPowerDetection.htm>) 24.5.2001.
- > Mäenpää M. (2000). Sumea valo-ohjaus ja joukkoliikenne-etuudet. Diplomityö. Espoo. Teknillinen korkeakoulu, liikennelaboratorio. (Public Transport Priorities Using Fuzzy Logic. Master's Thesis. Helsinki University of Technology, Laboratory of Transport Engineering)
- > Mäenpää M. ja Hackman J. (2000). Sumealla logiikalla toteutetut joukkoliikenne-etuudet - case Vantaa. (Public Transport Priorities Using Fuzzy Logic - case Vantaa.) Väylät & Liikenne 2000 Esitelmät. Suomen Tieyhdistys. 541-545.
- > Mäenpää M. ja Niittymäki J. (2000). Joukkoliikenteen sumeat liikennevaloetuedet. (Fuzzy Signal Priorities for Public Transport.) Tie ja liikenne 12/2000. 21-23.
- > Niittymäki J., Mäenpää M. (2001). The role of fuzzy logic public transport priority in traffic signal control. Traffic Engineering & Control. January 2001. Vol. 42 No: 1, 22-26.
- > Niittymäki J., Mäenpää M. (2000). Fuzzy public transport priority in traffic signal control. Draft paper for German-Dutch-Finnish seminar on traffic engineering in Bochum.
- > Oinas J. (2000). Joukkoliikenteen liikennevaloetuksiin suunnitteluhje - JOLIVA 2000. (Guidelines for Public Transport Signal Priorities - JOLIVA 2000.) 47 pg. (study can be found at <http://www.hel.fi/liikenteenohjaus/tetra/julkaisut.htm>) 24.5.2001.
- > Sihvola T., Niittymäki J., Väliharju R., Tuupanen (2000). SPOT-Tampere. Adaptiivinen alueellinen valo-ohjausjärjestelmä. (SPOT Tampere - Adaptive Area-wide Signal Control System.) Kuntatekniikka 6/2000.
- > Tampereen kaupunki (1999). Uusi tekniikka matkanteon avuksi. (Tampere City (1999). New Technology to Aid Travel.) Kaavoitusksaus 1999. (<http://www.tampere.fi/ytoteto/aka/kkats99/lisuind.htm#ohjaus>) 24.5.2001.
- > Tampereen kaupunki, Hämeen tiepiiri, Teknillinen korkeakoulu, liikennelaboratorio (2001). Tampereen SPOT, toimivuus-tutkimus. (Tampere City, Häme Road District, Helsinki University of Technology Laboratory of Transportation Engineering (2001). SPOT Tampere. Evaluation of Technical Performance.)

- > Tampereen kaupungin liikennelaitos, Tampereen kaupunki, Hämeen tiepiiri, Liikenneministeriö (1999). PARAS, Tampereen paikallisiikenteen hallintajärjestelmä 2002, Rakennussuunnitelma. (Tampere City Transport Department, Tampere City, Häme Road District, Ministry of Transport and Communications (1999). PARAS - Tampere Local Public Transport Management System 2002. Construction plan.)
- > Vehmas A., Hautala R., Vehviläinen J. (1997). Espoon ja Länsiväylän joukkoliikenteen matkustajainformaatiojärjestelmän vaikutustutkimus, I-vaihe "Ennen-tutkimus." (Espoo and Länsiväylä Public Transport Passenger Information System Impact Study, Phase I: Before-study.) Liikenneministeriön mietintöjä ja muistioita 2/1997. Helsinki: Liikenneministeriö.
- > YTV liikenneosasto (1998). ELMI Espoon ja Länsiväylän matkustajainformaatio, Esitesarja: Järjestelmä - Info - Pysäkit - Infotaulut - Monitorit - Bussilaitteet - Tietoliikenne - Ennen-tutkimus. [Helsinki Metropolitan Area Council, Transport department (1998). ELMI - Espoo and Länsiväylä Passenger Information. Brochure series: System - Info - Stops - Info Signs - Monitors - Bus Equipment - Data Communications - Before-study.] (<http://www.ytv.fi/liikenne/kamp/elmi/elmi.html>). 24.5.2001.
- > YTV liikenneosasto. Parempaa ja monipuolisempaa informaatiota - Länsiväylän matkustajainformaatio. (Helsinki Metropolitan Area Council, Transport department. A better quality and range of information - Länsiväylä passenger information.) (<http://www.ytv.fi/liikenne/kamp/elmi/elmi.html>) 24.5.2001.

Programme area 4

- > Laakso J. (2000). Tavarakuljetusten tietojärjestelmien käyttäjälähtöinen suunnittelu. Lisensiaatintutkimus. Tampere: Tampereen teknillinen korkeakoulu. (The User-oriented Developing of Information Technology for the Goods Transport. Licentiate of Technology Thesis. Tampere University of Technology.)
- > Laakso J., Rauhamäki H. (1999). The Development of Telematics for Small and Medium Sized Trucking Enterprises (KANTELE). Proceedings of the 6th World Congress on Intelligent Transport Systems. Toronto, Canada. (CD-ROM). Brussels: ITS Congress Association.
- > Laakso J., Rauhamäki H. (2000). KANTELE - Pienten ja keskiuurten kuorma-autoyrytysten telematiikan kehittäminen. Tutkimusraportti. (KANTELE - The Development of Telematics for Small and Medium-Sized Trucking Enterprises. Research report.) Liikenneministeriön julkaisuja 4/2000. Helsinki: Liikenneministeriö. 156 pg.
- > Laakso J., Rauhamäki H. (2000). KANTELE - Pienten ja keskiuurten kuorma-autoyrytysten telematiikan kehittäminen. Liiteraportti. Sähköinen ajopäiväkirja. Kuljetustapahtumien seurantaajärjestelmä. (KANTELE - The Development of Telematics for Small and Medium-Sized Trucking Enterprises. Annex report. Electronic vehicle log book. Transport event monitoring system.) Liikenneministeriön julkaisuja 5/2000. Helsinki: Liikenneministeriö. 122 pg.
- > Laakso J., Rauhamäki H. (2000). KANTELE - Pienten ja keskiuurten kuorma-autoyrytysten telematiikan kehittäminen. Pilotihanke. (KANTELE - The Development of Telematics for Small and Medium-Sized Trucking Enterprises. Pilot.) Liikenne- ja viestintäministeriön julkaisuja 51/2000. Helsinki: Liikenneministeriö. 52 pg.

Programme area 5

- > Innamaa S., Vanhanen K., Pursula M. (2000). Länsiväylän automaattisen liikenteenohjausjärjestelmän vaikutukset liikennevirtaan. (Effects of Automatic Traffic Control System of Länsiväylä on Traffic Flow.) Tielaitoksen selvityksiä 53/2000. Helsinki: Tielaitos. 82 pg. + app. 8 pg.
- > Kulmala R. (1999). ITS Evaluations - Finnish Views. ITS Evaluation. Proceedings of the 6th World Congress on Intelligent Transport Systems. Toronto, Canada. (CD-ROM). Brussels: ITS Congress Association.

> Programme area 3 > Programme area 4 > Programme area 5

BIBLIOGRAPHY

- > Kulmala R., Hyppönen R., Lähesmaa J., Manunen O., Oinas J., Pajunen-Muhonen H., Pesonen H., Ristola T. (1998). Liikennetelematiikkahankkeiden arviointiohjeet. Liikenneministeriön julkaisuja 59/1998. Helsinki: Liikenneministeriö. 116 pg. (English version below.)
- > Kulmala R., Hyppönen R., Lähesmaa J., Manunen O., Oinas J., Pajunen-Muhonen H., Pesonen H., Ristola T. (1999). Guidelines for the evaluation of ITS projects. Publication of the Ministry of Transport and Communications: 24/1999 Helsinki: Ministry of Transport and Communications of Finland. 86 pg. + app. 30 pg.
- > Kulmala R., Karhunen M., Miikkulainen T., Linna-Varis H., Korhonen A., Goebel A. (1999). Kallansiltojen kaistaopastuksen vaikutus selvitys 1999. (The impact appraisal of the traffic lane use control system of the Kalla bridges.) Liikenneministeriön mietintöjä ja muistioita B 28/1999. Helsinki: Liikenneministeriö. 56 pg.
- > Kulmala R., Pajunen-Muhonen H. (1999). Guidelines for the evaluation of ITS projects. Nordic Road & Transport Research .Vol. 11 (1999) No: 1, 13 - 15.
- > Kulmala R., Rämä P. (1998). Ohjeet muuttuvien nopeusrajoitusten vaikutusten arvioinnista. (Guidelines for the impact assessment of variable speed limit demonstrations.) Tielaitoksen selvityksiä 41/1998. Helsinki: Tielaitos. 46 pg. + app. 1 pg.
- > Lehtonen M., Anttila V., Koskinen O. H., Kulmala R., Pajunen-Muhonen H., Pesonen H., Rintanen J., Ristola T. (2001). Joukkoliikenteen etuisuudet ja matkustajainformaatio raitiolinjalla 4 ja bussilinjalta 23 - vaikutustutkimus. (Public transport priorities and passenger information on tram line 4 and bus line 23. Impact study.) Draft for publication by the Ministry of Transport and Communications.
- > Leviäkangas P., Lähesmaa J. (1999). Liikennetelematiikkahankkeiden kannattavuuden arviointi. (Profitability Assessment of ITS Projects.) Tiennäyttäjät. Tieliikenteen hallinta. Teemanumero. Helsinki: Tielaitos. Vol. 8 (1999) No: 1, 22 - 24
- > Leviäkangas P., Lähesmaa J. (1999). Profitability comparison between ITS investments and traditional investment in infrastructure. Reports and Memoranda B 24/1999. Helsinki: Ministry of Transport and Communications, 62 pg.
- > Luoma J., Rämä P. (1998). Effects of variable speed limit signs on speed behaviour and recall of signs. Traffic Engineering + Control. Printerhall Limited. London. Vol. 39 (1998) No: 4, 234 - 237
- > Malmivuo M., Pajunen K. (2000). Tehostetun kelinseurantajärjestelmän kokeilu - Tieliikenteen telematiikan E18-kokeilualue. (The experiment of enhanced weather monitoring system - Road traffic telematics experimental area on the E18.) Tielaitoksen selvityksiä: 5/1999. Helsinki: Tielaitos. 64 pg. + app. 59 pg.
- > Rämä P. (1999) Effects of weather-controlled variable speed limits and warning signs on driver behavior. Transportation Research Record (1999) No: 1689, 53 - 59
- > Rämä P. (2000). The effects of weather controlled speed limits on driver behaviour. Hastighed 2000, Faellesnordisk conference om hastighed. Aalborg, 31.10. - 1.11.2000. Rådet for større færdselsikkerhed.
- > Rämä P., Pilli-Sihvola Y. (2000). Keli huomioon ajonopeuksissa. (Road Condition and Driving Speed.) Helsingin Sanomat, No: 12.12.2000, 5.
- > Rämä P., Raitio J., Harjula V., Schirokoff A. Sää- ja keli tietoon perustuvan liikenteenohjausjärjestelmän vaikutukset yksijorataisella osuudella valtatiellä 7 (2000). [Effects of the weather-controlled traffic management system on single-carriageway road section of E18.] Tielaitoksen selvityksiä: 44/1999. Helsinki: Tielaitos. 68 pg. + app. 11 pg.

Programme area 6

- > Laitinen R., Vehviläinen J., Toivainen M., Ylisiurunen K. (2000). Tampereen seudun liikenteen telematiikan toimintamalli. (Transport Telematics Operational Model for the Tampere Region.) Liikenneministeriön julkaisuja 3/2000. Helsinki: Liikenneministeriö. 55 pg.

- > Noukka M., Vitikka H. (2001). TETRA 6, Liikenteen hallintajärjestelmien kehittäminen, Loppuraportti. (TETRA 6 - The Development of Traffic Management Systems. Final report.) Liikenneministeriön mietintöjä ja muistioita B12/2001. Helsinki: Liikenneministeriö. 30 pg.
- > Tielaitos (1998). Liikennekeskusten toiminnallinen analyysi. (Finnra (1998). Traffic Management Centres of Finnra - Functional requirements and definitions.) Tielaitoksen selvityksiä 50/1998. Helsinki: Tielaitos. 131 pg. + app.
- > Österman T. (1999). Pääteiden varareittien valintaperusteet ja ohjausjärjestelyt: esiselvitys. [Reserve Routes on Finnish Main Roads, Selection and Signing Principles.] Tielaitoksen sisäisiä julkaisuja 7/1999. Helsinki: Tielaitos. 35 pg.

Programme area 7

- > Genimap (2001). DIGIROAD-pilottitietokanta. Pilotoinnin teknisen ympäristön systeemi kuvaus. (draft). (DIGIROAD Pilot Database. System Description of the Technical Environment of the Pilots.)
- > Genimap (2001). DIGIROAD-pilottitietokanta. Pilottien toiminnalliset kuvaukset. (draft). (DIGIROAD Pilot Database. Functional Specifications of Pilots.)
- > Hautala R., Lähesmaa J., Kummala J., Bäckström J., Nurmela M., Vesala T. (2001). Standardien rajapintojen määrittely liikennetietojen välitykseen. (Standard Interfaces for Traffic Information Exchange.) Liikenne- ja viestintäministeriön mietintöjä ja muistioita B 15/2001. Helsinki: Liikenne- ja viestintäministeriö. 39 pg.
- > Helsingin keskustan joukkoliikenteen matkustajien informaatiojärjestelmä. Rakennussuunnitelma. (Public Transport Passenger Information System for Central Helsinki. Construction plan.) HKL 1999.
- > Karpinen A. (1999). Digitaalisten liikenneverkkoja kuvaavien karttojen kansainvälinen kehitys ja standardointi. (unpublished study). (International Development and Standardisation of Digital Road Maps.)
- > Karpinen A. (1999). Johdatus GDF 3.0 -standardiin. (Introduction to the GDF 3.0 Standard.)
- > Lehtonen M., Lähesmaa J. (1999). Multimodal transport information system based on geographical information system for transportation. Proceedings of the 6th World Congress on Intelligent Transport system. Toronto, Canada. (CD-ROM). Brussels: ITS Congress Association.
- > Liikenne- ja viestintäministeriö (2001). Tie- ja katuverkon tietojärjestelmä DIGIROAD. Toteutus suunnitelma. (Ministry of Transport and Communications (2001). Road and street database DIGIROAD. Implementation plan.) Liikenne- ja viestintäministeriön mietintöjä ja muistioita B 16/2001. Helsinki: Liikenneministeriö.
- > Liikenneministeriö (1998). Kaikki liikennemuodot kattava liikenteen tietojärjestelmä - KALKATI. Osaprojekti 1: Järjestelmän perusteiden määrittely. [Ministry of Transport and Communications (1998). Transport Information System for All Modes of Transport, KALKATI. Sub-project 1: Definition of System Basics.] Liikenneministeriön julkaisuja 45/98. Helsinki: Liikenneministeriö. 45 pg. + app. 30 pg.
- > Lähesmaa J. (1998). Liikenteen ja matkailun informaatiojärjestelmien toteutus. (Realisation of traffic and travel information systems.) Liikenneministeriön mietintöjä ja muistioita B 24/1998. Helsinki: Liikenneministeriö. 52 pg.
- > Lähesmaa J. (2001). Kuntien rooli DIGIROAD-järjestelmässä. (draft). (The role of municipalities in the DIGIROAD system.)
- > Lähesmaa J. et al. (2000). Tie- ja katuverkon digitalisointi DIGIROAD. Nykyjärjestelmien kuvaus. (Road and street network digitalisation - DIGIROAD. Description of current systems.)
- > Lähesmaa J., Kummala J. (2001). Sopiminen liikennetelematiikan palveluiden toteuttamisesta. (Agreeing on the Implementation of Transport Telematics Services.) Liikenne- ja viestintäministeriön mietintöjä ja muistioita B 5/2001. Helsinki: Liikenne- ja viestintäministeriö. 78 pg.

> Programme area 5 > Programme area 6 > Programme area 7

BIBLIOGRAPHY

- > Sauna-aho J., Suominen T., Karppinen A., Lähesmaa J. (2000). Tie- ja katuverkon digitalisointi nostaa tieliikenteen sekä tien ja kadunpidon hallinnoinnin uudelle tasolle. (Digitalisation of country's road and street network raises road transport and road network management to a new level.) Väylät & Liikenne 2000 Esitelmät. Suomen tieyhdistys. 290-298.
- > Sauna-aho J., Suominen T., Lammi H. (1999) Creation and updating multi-purpose digital databases of road and street networks is a challenge, A case study of Finland. Proceedings of the 6th World Congress on Intelligent Transport Systems. Toronto, Canada. (CD-ROM). Brussels: ITS Congress Association.
- > Sauna-aho J., Suominen T., Lammi H. (2000). Digitalisation of a country's road and street network. experience from the planning phase of the Finnish digiroad project. Proceedings of the 7th World Congress on Intelligent Transport Systems. Turin, Italy. (CD-ROM). Brussels: ITS Congress Association.
- > Sauna-aho J., Tervo M., Karppinen A. (2000). Digitalisation of country's road and street network raises road transport and road network management to a new level. Nordic-Baltic Transport Research Conference, Riga, April 2000.
- > Seudullinen joukkoliikenteen informaatiokeskus. Loppuraportti. (2000). (Regional Public Transport Information Centre. Final Report.)
- > Suominen et al. (1999). Tie- ja katuverkon digitalisointi DIGIROAD. Väylänpidon toimintojen tarpeet osaraportti. (unpublished study). (Road and Street Network Digitalisation - DIGIROAD. Transport Infrastructure Management Function Requirements. Sub-report.)
- > Tielikelaitos (2001). DIGIROAD - pilotin laadunvarmistus. (draft) (Finnish Road Enterprise (2001). DIGIROAD Pilot Quality Assurance.)
- > VTT Yhdyskuntatekniikka (1999). Tie- ja katuverkon digitalisointi DIGIROAD. Liikennetelematiikan toimintojen tarpeet osaraportti. (unpublished study). (VTT Communities and Infrastructure (1999). Road and Street Network Digitalisation - DIGIROAD. Transport Telematics Function Requirements. Sub-report.)

Programme area 8

- > Kiljunen M., Leppänen H., Kauhanen R., Leskinen T., Kotilainen H. (1998). Liikennetelematiikan palveluiden edellytysten kehittäminen. Työsuunnitelma 9.11.1998. Suunnittelukeskus. (Development of Prerequisites for ITS Services. Project plan.)
- > Kulmala R., Lähesmaa J. (1999). TETRA programme - General ITS system architecture. International Road Federation Regional Conference, Lahti IRF Technical Reports. Lahti. 153 - 159.
- > Lehtonen M., Leviäkangas P. (1999). Liikenteen telematiikan kansallinen järjestelmäarkkitehtuuri - TelemArk. (The Finnish National Architecture for Transport Telematics - TelemArk.) Tie ja Liikenne (1999): No 11.
- > Lehtonen M., Leviäkangas P. (1999). Liikenteen telematiikan kansallinen järjestelmäarkkitehtuuri - TelemArk. (The Finnish National Architecture for Transport Telematics - TelemArk.) Kuntalehti 21.-22/1999.
- > Leviäkangas P. (2000). TelemArk - The Finnish national architecture for transport telematics. Proceedings of the 7th World Congress on Intelligent Transport Systems. Turin, Italy. (CD-ROM). Brussels: ITS Congress Association.
- > Leviäkangas P., Lähesmaa J., Lehtonen M., Oinas J., Ristola T., Appel K., Mäkinen P., Ruoti K. (2000). Liikennetelematiikan kansallinen järjestelmäarkkitehtuuri. Tiivistelmäraportti. (The Finnish National Architecture for Transport Telematics. Executive summary report.) Liikenneministeriön mietintöjä ja muistioita B 1/2000. Helsinki: Liikenneministeriö. 22 pg.
- > Leviäkangas P., Lähesmaa J., Lehtonen M., Oinas J., Ristola T., Appel K., Mäkinen P., Ruoti K. (2001). Finnish National Transport telematics System Architecture, Summary. 29 pg. 27 pg. + app. 2 pg. (not published yet).

- > Leviäkangas P., Lähesmaa J., Mäkinen P., Oinas J. (2000). TelemArk - Henkilöliikenteen telematiikan kansallinen järjestelmäarkkitehtuuri. (TelemArk - National System Architecture for Passenger Transport Telematics.) Väylät & Liikenne 2000 Esitelmät. Suomen tieyhdistys. 261-268.
- > Liikennetelematiikan kansallinen järjestelmäarkkitehtuuri. Työpajat arkkitehtuurin käytöstä. Ohjelma. 16.8.2000. (The Finnish National Architecture for Transport Telematics. Workshops on the Use of the Architecture. Programme.)
- > Liikennetelematiikan kansallinen järjestelmäarkkitehtuuri. Työpajat arkkitehtuurin käytöstä. Yhteenveto tuloksista. 12.12.2000. (The Finnish National Architecture for Transport Telematics. Workshops on the Use of the Architecture. Summary of the findings.)
- > Liikennetelematiikan kansallinen järjestelmäarkkitehtuuri. Yhteenveto lausunnoista. 16.8.2000 (The Finnish National Architecture for Transport Telematics. Summary of statements.)
- > Lähesmaa J., Lehtonen M., Oinas J., Ristola T., Appel C., Mäkinen P. (2001). The Finnish National System Architecture for Transport Telematics. The Development Plan. Reports and memoranda of the Ministry of Transport and Communications B 7/2001. Helsinki: Ministry of Transport and Communications. 46 pg. + app. 6 pg.
- > Lähesmaa J., Lehtonen M., Oinas J., Ristola T., Appel K., Mäkinen P. (2000). Liikennetelematiikan kansallinen järjestelmäarkkitehtuuri, Kehittämissuunnitelma. Liikenneministeriön mietintöjä ja muistioita B 2/2000. Helsinki: Liikenneministeriö. 48 pg. + app. 4 pg. (English version above.)
- > Lähesmaa J., Oinas J., Mäkinen P. The Finnish National System Architecture for Transport telematics - TelemArk. ITS System Architecture Seminar 7.12.2000.
- > Mäkinen P., Ruoti K., Lähesmaa J., Lehtonen M., Oinas J., Ristola T., Appel K. (2000). Liikennetelematiikan kansallinen järjestelmäarkkitehtuuri, Arkkitehtuurikuvaus. Liikenneministeriön mietintöjä ja muistioita B 5/2000. Helsinki: Liikenneministeriö. 95 pg. (English version below.)
- > Mäkinen P., Ruoti K., Lähesmaa J., Lehtonen M., Oinas J., Ristola T., Appel K. (2001). Finnish National System Architecture for Transport Telematics, Architecture Description. Reports and memoranda of the Ministry of Transport and Communications B 6/2001. Helsinki: Ministry of Transport and Communications. 76 pg. (not published yet).

Programme area 9:

- > Lähesmaa J., Kummala J., Oinas J., Eloranta T. (2001). Osallistuminen kansainväliseen liikennetelematiikan standardointiin. (Participation in the Drawing up of International Standards for Transport Telematics.) Liikenne- ja viestintäministeriön mietintöjä ja muistioita B4/2001. Helsinki: Liikenne- ja viestintäministeriö. 44 pg.
- > Lähesmaa J., Kummala J., Oinas J., Eloranta T. (2000). Liikennetelematiikan kansallinen järjestelmäarkkitehtuuri. Sovellettavat kansainväliset standardit. (The Finnish National System Architecture for Transport Telematics. Applied International Standards.) Liikenneministeriön mietintöjä ja muistioita B 17/2000. Helsinki: Liikenne- ja viestintäministeriö. 38 pg.
- > TietoEnator Oy. (2000). SOTE, Valtakunnallinen liikuntaesteisten henkilöiden kuljetusten toimikorttipohjainen maksu-järjestelmä. (National Smart Card -based Payment System for Transports for the Disabled.) Liikenneministeriön mietintöjä ja muistioita B13/2000. Helsinki: Liikenneministeriö. 138 pg.
- > <http://www.mintc.fi/www/sivut/suomi/tetra9/index.html>

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