The combination of advanced ICT and more precise positioning provided by satellite systems will drive the development of new service solutions that are based e.g. on real-time location, actual kilometres driven, object or user identification and electronic transactions. The greatest challenges facing developers of ITS services are the lack of working business models, the ambiguity and complexity of value networks, fixed standard practices through regulation or long history, as well as a lack of risk-allowing approaches that should be facilitated. The market is looking for open implementation solutions based on true user needs. The objective of the PASTORI project is to take the first step to meet the aforementioned challenges. The project will deliver the necessary functional specifications and business models, drawing from concrete pilot services and proof-of-concepts, including e.g. safety and emergency services, insurance and taxation, and services based on mobility pricing.

Kicked off in the spring of 2009, the Finnish PASTORI project (1) develops services and business models that exploit advanced technology. These new services are to be based on solid user needs and application of advanced technologies. Positioning and location-based services are in the core of the project. Successful future products will be based on open solutions, and interesting service packages will be put together for customers. The multi-actor modular concept to be developed in PASTORI could be something for the global marketplace.

The technology for services based on positioning is already here at hand. It includes satellite positioning, digital map data and mobile devices among others. However, apart from navigation services, many prospective services are still missing. The combination of advanced ICT and more precise positioning, provided by the European satellite positioning system EGNOS that will later on evolve into Galileo and different other positioning methods which
help GNSS systems in tunnels, urban canyons and indoors, will drive the development of service solutions that are based on e.g. real-time location identification, actual kilometres driven, object or user identification and electronic transactions.

Technological advances can also pose problems. Much of the effort in recent years has concentrated on technological development leaving the user in the background. Users’ needs and their fears of erosion of privacy have not necessarily been addressed properly. However, business cannot be created without paying customers. Hence service development should always be done in close co-operation with the users and not only in technical laboratories and cleanrooms.

The greatest challenges facing developers of ITS services are the lack of working business models, the ambiguity and complexity of value networks, fixed standard practices through regulation or long history (leading to risk aversion), as well as a lack of risk-favouring approaches that should be facilitated. The market is looking for open implementation solutions based on true user needs. This is the foundation for profitable local as well as larger-scale global business ventures.

PASTORI project relies on the ITS Action Plan (2), the EC ITS directive (3) and the lead initiatives associated with them, including eCall. PASTORI aims to support the ITS Action Plan as well as the national implementation of the Finnish ITS Strategy (4).

**OBJECTIVES**

The objective of the PASTORI project is to meet the aforementioned challenges – or at least take a measurable step forward. The conventional objectives to improve traffic safety, reduce congestion and environmental problems, and increase the profitability of associated businesses are always present. The project focuses specifically on intelligent payment applications and the pan-European eCall and TPS-eCall (Third Party Service) systems as these are part of the service platform upon which other public and commercial services can be built on.

The project will deliver:

- the necessary functional specifications, business models, legal and institutional frameworks and open service architectures for the key services
- pilot services, such as safety and emergency services (such as tracking of stolen vehicles, alerts on approaching trains, accident positioning)
- models and proofs-of-concept for insurances and taxation based on actual kilometres driven, and services based on mobility pricing.
IMPLEMENTATION AND METHODS

The project entity will be implemented from spring 2009 to spring 2011. The project has been divided into the work packages described below (Figure 1). The results of PASTORI will be exploited immediately in other projects, such as SUNTIO, which are run in parallel with the aim of producing the specifications and framework for the pilot (proof-of-concept).

Figure 1. The implementation of the project entity and connections between the entities.

The first phase of PASTORI consisted of literature reviews that focused on painting a basic picture of user needs, implementations and business models of existing services as well as lessons learned from already implemented pilots regarding the multi-service platform and its key services. The service framework that consists of the application potential of satellite-based positioning, standardisation, legislative issues and political goals for the multi-service platform was examined as well. Questions related to user needs, the service framework and business models have been more thoroughly examined by interviewing experts, organizing workshops with the stakeholders and by co-operating with different universities and taking part in European projects.

The architecture descriptions utilise the national Finnish ITS architecture TelemArk and the Evaserve meta-tool for evaluation and development of information services (5, 6) taking into
account existing EU-level architectures. The functional architecture descriptions of the examined case services (e.g. eCall) describe the different actors and their responsibilities as well as the connections between them.

The examination of different business models and the definition of functional requirements are mostly based on the results of the previous work packages (benchmarking existing services, lessons learned, user needs, standardisation and the service framework and functional architectures). The evaluation and development of the business models will utilize material e.g. from Osterwalder (7), Heikkilä et al. (8), Evaserve meta-tool and ROADIDEA project (9).

**MULTI-SERVICE MODEL**

*Requirements and description*

There is a huge amount of different services and service systems in use today. Very often this results in expensive and inefficient services that are difficult to use and that are incompatible with each other. Emerging user needs are hard to fulfil at reasonable cost. PASTORI multi-service model (Figure 2) builds on the utilization of location information in different services and applications using a common service platform in order to provide services that fulfil user needs in a more efficient manner. Basic features and requirements of the multi-service model are:

- a wide array of services that are modular and modifiable (enabling service bundling based on user needs)
- ensuring information security and privacy as well as fulfilling other legislative requirements
- open and transparent architecture solutions and interfaces
- the use of harmonized solutions and reliable technology
- utilization of existing components and solutions
- independence of the technology used
- terminal-independence

The central issue in realizing the multi-actor multi-service model is to improve the processes and co-operation models in the service network to correspond with the requirements listed above while at the same time taking into account the issues of data ownership and service liability. It is also important that the technology used can be replaced as new developments arise and the standardisation process proceeds so that services can be provided more efficiently and new applications can be integrated into the common service platform.
Figure 2. The fundamental idea of the open and modular PASTORI multi-service model.

Basic needs behind any location-based service are location (“Where am I?”), available services (“What is nearby?”, “Can I get quick help in case of an emergency?”), time (“Are the services open now?”, “Is the heavy rain about to start just now?”), route guiding and information (“What is the best route to the service?”, Can I use public transport?”).

The components of any location-based service are:

- Device to access the information needed (e.g. PDA, mobile phone, laptop, navigation unit in car, tolling OBU, vehicle platform)
- Positioning component (e.g. network positioning, GNSS, odometer, DSRC, tachograph)
- Communication network which transfers the service requests and data between the user’s device and the service provider
- Service and application providers (e.g. calculation of position, navigation, searching objects and points-of-interest, information services, alerts and emergency services, pay as you drive (PAYD) insurances, road tolls)
- Data and content providers (e.g. digital maps, address databases, point-of-interest lists and traffic information)
In addition to these components there are other important elements such as the user interface (its availability, accessibility and usability must be good in demanding situations), visualisation of information, usable and beneficial information and available technology.

Services can be either pull services or push services. For example the information about routes, car parks and points-of-interest can be provided by pull services whereas alerts, emergency services and the paying of road tolls require the use of push services. The pulled or pushed data can be either real-time (alerts, emergency services) or historical (PAYD insurances and road tolls).

The pilots in Finland are concentrating on testing the business models for LBS services with the whole LBS service chain: device manufactures, service and application providers and data and content providers. Pilots are proof-of-concepts for both real-time and historical driving log book LBS services for companies, government and directly to end-users. The tested services are e.g. mobile work management, driving log books, PAYD insurances, travel chain payment (payment of parking, public transport tickets, road tolls etc.), different vehicle tax payment experiments, and the Finnish eCall service. One key issue to be tested in pilots is technical performance: the quality and accuracy of network positioning compared to GPS location, development needs for the user interface, and sorting out contractual and service processing problems.

The Finnish Transport Safety Agency (TraFi) (10) is responsible for regulating and supervising the transport system, actively improving its safety and promoting environmentally friendly traffic. The Agency’s goal is to raise the safety and environmental standards of the Finnish transport system to the highest international level. One of the PASTORI pilots is done in close co-operation with TraFi in order to demonstrate vehicle taxing and access to vehicle database. The target fleet for the pilot is a few hundred vehicles for the year 2011. The pilot is supposed to form a basis for the future real-life solution.

Benefits of the multi-service model
Main benefits of the multi-service model come from creating a common platform that makes it easier to offer services (service provider) and to order them (end-user) thus saving money and resources. The public sector does not have to invest into separate services (e.g. road tolls and safety-related services), and the service sector has a platform upon which they can integrate different services. On the other hand, end-users will have easy access to a great variety of services at modest cost. The multi-service model is estimated to provide at least the following advantages in its ideal form.

For road users and businesses:
- all needed services are available in the car and anywhere else from a single window
• early warnings about traffic disturbances
• fluent moving from one place to the next
• on-line safety and emergency services
• on-line maintenance services
• up-to-date multimodal traffic information
• improved style of driving makes moving more efficient
• specific services for professional drivers
• customer agreement ensures privacy

For the society:
• public services on a common platform are more cost-efficient
• investments will serve a wider customer and consumer base
• improvement of traffic safety
• less congestion and more efficient transport networks
• helps the fulfilment of climate goals
• creation of new services and new jobs

Issues to be studied and solved
To achieve the full functioning multi-service platform there are still a number of issues to be studied and solved. Main challenges lie in creating the service value chain or value network with all relevant actors included (especially for cross-border services), in need for innovations for cost and revenue distribution and in tackling the possible threats and fears related to privacy. The following questions must be answered:

• Who owns the data flowing in from cars and users? Has the driver (“creator” of the data unit) any role there?
• How to leverage the data and turn it into cash flow? And who are the stakeholders for doing it?
• How to solve the “big brother” issue: trust, security, liability and privacy?
  Segmenting the data for different uses: anonymous Floating Car Data vs. highly protected personalised data?
• What are the key services that the public really wants? How to guarantee the ~100 % functioning of regulated public services side by side with less demanding commercial services?
• Quantitative and qualitative market analyses to find out about user needs, willingness to pay, investor needs, service operator needs? Socio-economic studies are required to answer the issues of motives behind and objectives of the services.
• How will the certification system be organised for a multi-service model?
• What are the optimal roles between public bodies and commercial actors?
• What should be the strategy for communicating and marketing the services to the public?
FIRST RESULTS AND LESSONS LEARNED

The following results are preliminary. The final results will be ready in the spring of 2011 after the pilot projects have been finished and their lessons have been learned.

Review of standards and legislation and service benchmarking in Europe

The standardising organisations and committees guiding transport-related services in Europe are: committee CEN/TC 278, CEN, CENELEC and ETSI. Already in the 1990s the European Commission identified five priority areas needing specific action to be taken in order to facilitate the implementation of Road Transport and Traffic Telematics (RTTT) in Europe. The areas were: RDS-TMC (Radio Data System - Traffic Message Channel), Electronic Fee Collection (EFC), Traffic Data Exchange, Human-Machine Interface and System Architecture. So far only the information system RDS-TMC has been the only real European-wide roaming service.

The regulation efforts of localised in-vehicle services have been concentrating on digital tachographs, harmonised EFC, eCall (Automated Emergency Call system) and tracking and tracing of dangerous goods in EU. In 2006 the Digital Tachograph (a system for ensuring the security of recording the driver’s duty periods) was made obligatory for new heavy goods vehicles (HGVs). Now the introduction of a European Electronic Toll Service (EETS) will start a new era in harmonised telematics services. Mounted OEM services require type-approval. Applications for tracking and tracing people need to take into account existing privacy and individual rights regulations. The tracking possibilities of mobile devices are controlled and regulated (only the police or emergency services have access to the mobile phone location in case of emergency). Opening a vehicle’s black box is usually prohibited; only on request from judiciary. All these laws affect retrofitted location-based and personal navigation services as well. There are still many open issues and gray areas which can rapidly change the business cases of location-based services if and when new regulation is introduced to the field.

eCall

eCall is one of the key services in European Commission’s ITS Action Plan. eCall promotes a pan-European in-vehicle emergency call service that builds on a location-enhanced single European Emergency Number (E112). eCall service activities include the introduction of a single common phone number, multi-lingual response by intelligent routing of calls, and the introduction of automatic, GPS-assisted delivery of emergency messages and manual and automatic triggers. (11)
The eCall product is optimised to trigger an emergency call when a set of standardised sensors in the vehicle reach a threshold value. To avoid false alarms, at least two sensors have to be triggered. In the case of a manually generated eCall, a double-check mechanism is in place to avoid unintended eCalls. A verification of the eCall via voice link is possible. The eCall sends a Minimum Set of Data (MSD) to the Public Service Answering Point (PSAP). The mandatory MSD includes

- a time stamp
- precise location including the direction of driving
- vehicle identification
- identification of service provider
- eCall qualifier (a minimum requirement is an indication stating if the eCall has been manually or automatically initiated).

For retrofitted devices there does not exist a standardised method for sensing a collision or other incident that should trigger eCall.

Experts say that the implementation of eCall across Europe is not likely in the short term. Many stakeholders are complaining that the European Commission started the eCall initiative and is driving it on a political level without a good business case. Regulations require that the car industry will implement eCall in new vehicles by 2014. The hard part is to demand the PSAPs to implement the receiving systems on their own or to have TPS-eCall services up and running. Many EU member states have formally agreed to the initiative, but the implementation of the relevant practices has not yet been planned.

**EETS**

EU Directive 2004/52/EC on the interoperability of electronic fee collection systems harmonises road user charging by limiting the technologies to GNSS-based positioning and GSM mobile communications; the DSRC system that has been widely used is still a possible technology after heavy pressure from current toll chargers. The harmonisation will take place with the implementation of the European Electronic Toll Service (EETS) after a heavy standardisation process (12).

EETS will be available for heavy goods vehicles in 2012 and for private cars a few years later. The EETS Application Guide gives details of duties, obligations and rights of road user charging stakeholders. EETS will be complementary to any national or local toll system. EETS provider makes contracts with local system owners and sees that the toll collected does not exceed the original. The EETS service will be beneficial for carriers that drive through many different EFC systems because they need only one end-user device, contract and payment. The EETS providers take care of laborious contract bidding with all 300 European toll chargers and provide the end-user with a common OBU. The tough challenge apart from
concluding the agreements is to be able to cover all tolling systems within 24 months.

The Application Guide says about other services apart from EFC that “EETS Provider may choose to offer additional value-added services to further enhance its service offer. The fact that the EETS on-board equipment features other technologies and services than strictly required by EETS shall not lead to a toll charger’s discrimination of the users and EETS Provider concerned. The EETS Provider has the ultimate responsibility of the functionalities and services offered by the OBE in addition to EETS. The OBE design shall ensure that the additional functionalities and services bear no impact on the overall EETS performance and correctness.” This is also the case concerning eCall: value-added services can co-exist with public ones but the services must be guaranteed to work independent of each other.

Interoperability of EFC systems will probably develop into widely integrated and country-to-country roaming ITS systems similar to what has happened in telecommunications. The user demand there is clear and the market drives the development. Although the number of paying EFC end-users, such as foreign trade carriers and tourists travelling with their cars, are lower than travelling mobile phone users. It is also evident that the most time-consuming interoperability issues to solve are not technical problems but procedural and contractual complexities. From the carriers’ point of view road toll payment should be compensated by cross-border services such as electronic customs clearance, cross-border slot management and safe parking.

**EWSP**

EC’s ITS Action Plan has initiated research efforts for the European-Wide Service Platform (EWSP) which is considered to be an enabler of the mobility of the future, a combination of vehicle-related services that would serve the traveller throughout Europe. This development is connected to driver assisting co-operative systems, automated driving, mobile broadband access, communication protocols (including IPv6) and overall connectivity. In this scenario personal information and infotainment are seamlessly available anywhere at anytime.

European-Wide Service Platform (EWSP) is supposed to fulfil the expectations and needs of all travellers in Europe, wherever they are geographically, whatever terminal they have access to, and whatever transport mode they are using. The service deployment of the EWSP will consist of subsystems like service development, service offerings, service discovery and operations as well as of authorisation / authentication, subscription / identification, payment / billing / charging and CRM in order to have full independence of existing service concepts of today. The business model of EWSP will be a web-based service model. The FP7 integrated project EURIDICE and another integrated project CVIS are developing the same concept for a variety of mobility services.
In the near future, Internet will be available in cars with all its possibilities to communicate, inform and entertain. The development in mobile communication in cars will take place as has already happened with PCs and phones. Cars will become a part of the same integrated communication and control systems as devices in offices, homes and summer cottages. Information and content can be synchronised between different devices. The role that software plays in cars will keep growing, and content and ways of controlling and communicating will be harmonised between vehicle systems and other office, home-based and entertainment systems.

The retrofitted vehicle device industry, car industry and service production sector are now experiencing a big shift. New stakeholders are coming into the market, and old roles are being transformed. Device manufacturers such as TomTom and Continental are becoming service providers, and new liaisons and co-operative service chains are being built with the automobile industry. The same business liaison development is taking place between mobile phone producers, telecommunication operators and the car industry. Mobile communication industry offers new traffic- and transport-related services via mobile phones which are either stand-alone or communicate with vehicle OEM platforms. Service integration will bring new interesting services into the market, and the opportunities seem almost endless so one can justifiably say that only the sky is the limit for potential new business ideas.

**Functional architectures**

A system architecture, as it relates to information systems, is a formal description of a system’s structure and its functionalities. It describes the different parts of the system, the relationships between the parts and the general principles guiding the design and planning of the system. A system architecture often contains descriptions of a varying level of detail: The working of a specific component can be depicted as well as some specific logically uniform parts of the system. A general representation of the system architecture is also included.

Figure 3 describes the general architecture of the kind of multi-service platform that is being envisioned in PASTORI. The fundamental idea of the model is to acquire location information as to the whereabouts of end-users and transfer this information via the internet to a location database. This location information is then available to service providers through contracts that they make with the end-users who subscribe to their services. The service providers can then utilize the information and create useful and valuable content and deliver it to the users’ terminal of choice (e.g. a vehicle’s information system, a personal navigation device or a smartphone).

The key issues in the architecture are the interfaces for delivering location information into
the location database and accessing the database. The interface for delivering content on users’ terminals is also essential. The interfaces should use open and standardised ways of representing information in order to create a level playing field for different application and service providers. Access control to the location information must be implemented in order to address privacy issues.

Figure 3. The general architecture of a multi-service platform.

Figure 4 depicts the functional architecture of the automated emergency call service eCall described earlier in the paper. The architecture description follows the guidelines of the Finnish national ITS architecture TelemArk. The different actors are displayed as horizontal bands, and the functions associated with the service are represented by rounded boxes with a description of the function inside. The chronological order of the functions goes from left to right with the arrows representing a transition from one function to the next.

In the case of an accident, the process starts with the activation of the eCall functionality in the vehicle and the transmission of the minimum set of data (MSD) to the emergency response centre (ERC). The ERC saves the MSD and retrieves additional information from the service provider. A voice connection is then opened between the vehicle and the ERC, and the ERC evaluates the severity of the situation and alarms appropriate response units to the location of the accident that is known based on the MSD and network-based location
information provided by the telecommunications operator. The authorities alarmed by the ERC send their acknowledgements and engage in operative action according to their respective roles. After operative action has finished, the event information is stored into the ERC information system for later analysis. Other relevant authorities, media and the accident investigation board are also informed of the event.

**Implementation of the service platform and business models**

In order for the multi-service platform to achieve wider adoption it needs to have a feasible business model to support it. Three different business models (Figure 5) and their benefits and disadvantages are examined in PASTORI.

The first model is an authority-driven one, where all location information acquired from end-users is stored in a centralized location database serving eCall and EETS services and administered by a relevant authority. The service providers can access the location information by negotiating with the authority on the access rights.

The second model relies purely on the market forces by letting end-users act directly with all the different service providers without any co-ordination, co-operation or interference from authorities. In this model, eCall and EETS would be implemented as separate systems by authorities. The third model is a mix of the two other models. It relies on public-private
partnerships in founding, maintaining and administering the location database and methods of providing services to end-users. eCall and EETS could share some of the infrastructure with commercial services thus lowering the bar for new actors to enter the market.

![Figure 5. Three different variants in organising the multi-service model.](image)

**DISCUSSION**

As mentioned previously the mobile communications, nomadic device and automobile industries are all in a big shift from separately developed technology- and device-oriented production towards more co-operative service-oriented production. New services should be built through piloting and strong co-operation with consumers and end-users. The mobile industry is teaching end-users to accustom themselves to buying interesting and useful applications from app stores – the same will be the future of vehicle-related services.

It is an evident waste of resources to separately develop large and expensive systems like obligatory nationwide road tolling or emergency systems side by side with commercial services and to have a number of different devices mounted to the dashboard with separately operated and maintained back-office systems for all the different services. It is becoming clear that now is the time to concentrate all efforts on creating an innovative open multi-service
The multi-service model will not be one specific technical platform that includes all services or a single-service monopoly to serve everybody. More likely it will entail many service providers serving their own customers by using, and sharing when possible, the common elements of location-based systems. The multi-service model is more of a business concept with sophisticated agreements, access control into databases, open interfaces, certification procedures and procurement processes between public authorities and sub-contractors in different countries and communities.

Some lessons learned from the aforementioned service introductions:

- All societal, individual and commercial objectives must be set and defined in the early phases of planning for a service to be successful.
- For harmonised obligatory services the legal and regulatory guidance must help the service development and not hinder it e.g. by taking too much time and being too technical (it should just determine the desired outcome and societal benefits, not specify the technology to produce it).
- If the services are provided by the government they are usually very expensive and stiff due to political and procurement-related procedures.
- If the investment and operational needs and responsibilities of governmental organisations (e.g. PSAP, road authority, tax administration) are unclear, nothing happens.
- Writing standards takes too much time – how to overcome that? Markets have a tendency of making their own standards while waiting.
- There must be real and serious efforts to prevent the emergence of monopolies.
- There must be a shift of focus from technology to business models and assisting user needs – e.g. the complexity of type-approval processes can severely hinder the development of services.
- Specifications must be simple and target-oriented (what is the aim of the service, what benefits are wanted) instead of technically detail-oriented
- Privacy concerns must be taken very seriously and handled delicately.
- The lack of user demand does not help any service.

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