Satellite Application For Emergency handling, Traffic alerts, Road safety and Incident Prevention

**Final Report Summary - SAFETRIP (Satellite application for emergency handling, traffic alerts, road safety and incident prevention)**

SAFETRIP is an integrated project (IP) of 20 partners from 7 European countries, representing partners with a wide range of research and business and interests and expertise, coordinated by the motorway company Sanef of France. The total research effort is about EUR 11.5 million, with funding of EUR 7.9 million by the European Commission (EC) (Directorate-General for Research). SAFETRIP started in October 2009 and was completed in March 2013; its main objective was to improve the use of road transport infrastructures and to optimise the alert chain in case of incidents - this is achieved through an integrated system from data collection to safety service provision.

Satellite-based communication systems for use in homes and cars have been adopted by consumers in many parts of the world. Furthermore, satellite communication can empower intelligent transportation system (ITS) to deploy safety critical services and services of the future, while reaching an unprecedented large number of road users in an eco-friendly and economical way.

The SAFETRIP project aims to build on this success and utilise a new generation of satellite technology to improve the safety, security and environmental sustainability of road transport. While being open and capable of integrating other communication technologies (such as ground networks), SAFETRIP exploits the S-band satellite technology, which is optimised for two-way communication for on-board vehicle units. The S-band communication requires a small antenna making it suitable for the mass market, while existing solutions that use different satellite frequencies demanding larger antennas are less suitable for integration in vehicles or in handheld devices. The first satellite with S-band capacity is the Eutelsat 10A (formerly W2A) satellite, which was launched by Eutelsat in April 2009.

As part of the SAFETRIP project, an open SAFETRIP platform was implemented to host services for improved safety and navigation,
but also entertainment and advertising to vehicle occupants. During the project, a number of existing and new services have been demonstrated, making the best use of the features of this open and flexible platform - in particular using the most appropriate communication technology.

The SAFETRIP platform was designed from ground-up to be an open platform; the consortium developed the full potential of this platform through extensive user requirements and technical research, experimentation and evaluation in field trials. The initial needs of business stakeholders and individuals have been formulated through an extensive user requirements capture exercise over six months - involving drivers, road operators, emergency technicians, operation managers, technologists and the management from road operators, insurance and assistance companies, fleet operators, freight forwarders and coach operators.

The SAFETRIP platform's definition itself is based on key functionalities derived from the user needs; this is to ensure that the platform is able to support the services which in turn address the identified needs.

The SAFETRIP on-board unit (OBU) ('GreenBox') offers an open API that allow third party applications to have access to functionalities of the GreenBox. In addition, a set of enabling services including voice over Internet protocol (VoIP), digital video broadcasting - satellite services to handhelds (DVB-SH) and global navigation satellite system (GNSS) localisation for example was setup to provide a backbone for applications. By giving access to the communication infrastructure as well as enabling services, application developers can create new applications and services for the SAFETRIP platform. For instance, it is possible to develop location based services that run on the platform and use the geographical location of the vehicle to retrieve relevant information from the communication link. This has been realised by an external company in the framework of the 2012 ITS World Congress and we believe this is key to the development of innovative services in future.

SAFETRIP integrates innovative satellite technologies and communication features: accurate positioning, digital radio and TV broadcast and two-way data communication in S-band. It is an extraordinary opportunity to develop and demonstrate several safety-oriented applications, which will improve safety to all road users. Complementary terrestrial networks will ensure that vehicles can be always connected in any circumstances.

In addition to safety services, some complementary services have been offered to the passengers of vehicles (cars, coaches), through the DVB-SH technology, that have made their trip more convenient and comfortable: digital radio, mobile television (TV), music and video on demand.

During the six months trial period, set of promising applications dedicated to passenger cars have been tested on the field with real users on French and Spanish motorways, while those for coaches were experimented in the West of France on the Paris to Rouen and Rennes corridor.

Project context and objectives:

SAFETRIP builds on a new satellite technology: the S-band communication (frequency band around 2 GHz), and opens new perspectives in the mobile telecommunications domain. The first European S-band payload has been built on the Eutelsat10A satellite (formerly known as W2A) that was launched by Eutelsat in April 2009.

This S-band payload is optimised for multimedia content delivery and two-way data communication services via small omnidirectional antennas on mobile units. Its advantages include full coverage across Europe, multicast data transmission, quick and easy deployment, and energy efficiency thanks to its energy provided by solar panels.

Based on this innovative technological foreground, the SAFETRIP consortium chose to develop the full potential of this platform through extensive user requirements and technical research, experimentation and evaluation in field trials.

Moreover, drivers recognise that a comfortable and stress-free travel is a safer travel; this is why a wide range of additional services will be offered to the passengers of vehicles (cars, coaches), through the DVB-SH technology, that will make their trip more convenient and comfortable:

- digital radio;
- mobile TV;
Satellite communication is very convenient for services that require broadcast (one-to-many) type of communication. With the solar powered satellite, it is possible to have a quick deployment and offer coverage over a large area to all users in an environmental friendly manner - unlike most terrestrial networks. In isolated regions with little to no infrastructure or in extreme conditions when terrestrial networks have been destroyed, the satellite telecommunication with S-band represents a unique solution for surveillance and rescue teams. It guarantees a standalone and fully secure communications network everywhere and in all weather conditions via small and virtually ubiquitous mobile terminals.

With more and more vehicle being equipped with networked OBU's, they will also become permanently connected to the service centres as mobile nodes of the network. This may work with traditional third-fourth-generation (3G / 4G) networks for connection-based services. The SAFETRIP platform will provide a brand new low-cost message-based return link with S-band, paving the way to a real spread of a wide spectrum of services where vehicles can truly represent invaluable sources of information for transport management, authorities as well as civil protection and surveillance services.

The SAFETRIP architecture is now fully designed. It is not only innovative but it will also have an impact on the ITS community. To summarise, SAFETRIP has two main objectives:

- to demonstrate the use of S-band satellite in ITS applications; and
- to propose a simple platform that allows application developers to reach an audience of millions of cars with a minimal development effort.

S-band Satellite in ITS applications

The use of a satellite in the ITS domain is not new, global positioning system (GPS) has been existing for years. But the innovation of SAFETRIP is that it is not only dealing with geolocalisation but mainly with telecommunications. While a GPS device is only able to receive a signal from satellites, SAFETRIP devices are also able to send signals and establish a bi-directional link via satellite or, in other words, to use the satellite as a new communication channel. This innovation is possible thanks to favourable breakthroughs in the telecommunications domain. The most important factor was the decision of the EC to grant a new frequency band named S-band for access to mobile satellite services. Following this decision, Eutelsat launched the W2A satellite which embeds the first S-band payload in Europe.

Subsequently, partners such as FhG, DLR, Indra, and MBI started to develop the technology and to define standards. The SAFETRIP project is not only developing the technology, it aims to demonstrate that applications can benefit from S-band technology. Three kinds of communication services are available to applications on the SAFETRIP platform:

- Broadcast services: providing one-to-many data transmission (typically audio / video streams, but also data services) based on the DVB-SH standard with the Low Latency extension option.
- Messaging services: offering bidirectional datagram transmission, based both on the DVB-SH and the novel E-SSA access technique.
- Connection-oriented services: providing bi-directional IP connectivity, based on quasi-synchronous code division multiple access (CDMA) technologies. The main advantage to use S-band communications in a vehicle is the benefit of a full European coverage, without white zones.

This feature is mandatory if an efficient emergency call system is to be provided to all European citizens. But there are other advantages linked to the satellite communications architecture itself. One of them is the ability to broadcast data to a large amount of users quickly and efficiently. In fact, using satellite communications, one can send information one time and have it received by all the terminals listening to the same satellite. This feature is interesting to broadcast information typically sent through radio channels or even to update over the air the maps embedded in navigation devices.

On the other hand, S-band communication has some drawbacks, the main one being the limited bandwidth. A satellite covering the whole of Europe is not comparable to universal mobile telecommunications system (UMTS) networks which are based on millions of cells. This is why SAFETRIP proposes to combine satellite and terrestrial communications in order to benefit of the most appropriate communication channel for a given ITS application.
A simple platform to develop applications

SAFETRIP also offers an open platform to ease application development. The SAFETRIP middleware is a software running both on-board of the vehicle and on-server, providing an abstraction layer to the services and making the SAFETRIP platform capable of:

(a) hiding the complexity of the available communication networks;
(b) providing a unified application programming interface (API) allowing the application to access hardware features such as geolocalisation, vehicle's data.

The name of the middleware is service enabling platform (SEP) for the modules running centrally and SEL for the on-board middleware. The SEP is thus software that allows the services to be independent of the type of the communication channel between the OBUs and the service centres. These two objectives, if they are fulfilled, would allow to reach other important goals such as the improvement of road safety in Europe.

SAFETRIP for ITS applications

SAFETRIP project general objective is to provide an integrated system platform that will allow any third party company to develop applications for the road market. The three communication services of SAFETRIP (broadcast, messaging, bi-directional) associated to the positioning and authentication, authorisation and accounting (AAA) functionalities, are suitable to provide solutions in many domains, amongst others the public sector, insurance, fleet management, entertainment.

Some of these applications have been developed for the SAFETRIP proof-of-concept as part of the project activities. It is the case for the emergency call improved with the use of video, the car tracking, location-based services, the reception of satellite live TV/radio and others.

SAFETRIP constitutes a valuable tool to provide new solutions in all these domains, and certainly to others that are not yet identified. The platform may be used in different manners:

(a) to port existing solutions to make use of the satellite communication and increased coverage;
(b) to improve existing solutions to fully benefits from the platform features and advantages of an open platform;
(c) to create new solutions by exploiting the innovative platform functionalities.

The OBU of SAFETRIP

During the SAFETRIP project, the reference architecture for the OBU has been specified, providing the necessary guidelines to terminal manufacturers on the minimum set of communication channels and functionalities required to convey SAFETRIP services to the user. The SAFETRIP OBU comprises at least the following elements:

(a) S-band communications terminal;
(b) satellite positioning (GNSS) receiver;
(c) 3G / 4G modem providing access to mobile network infrastructure;
(d) gateway to the car infrastructure (e.g. CAN bus);
(e) computing resources to host the SEL and the applications;
(f) human-machine interface (HMI) to allow the user to interact with the OBU.

All the different physical transmission channels, be it GNSS, satellite communication, or AGN, communicate with the SEL to the applications running on the OBU. Thus, the applications are agnostic to the actual hardware architecture of the SAFETRIP OBU as long as it has all the connectivity required by the SEL middleware to successfully run the enabling services.

It is worthwhile to note that the OBU that is used for the demonstrator is a non-engineered device. As bidirectional S-band technology is still very innovative, demonstration OBU will concentrate on functional integration rather than on miniaturisation of the terminal.

The optimisation of the form factor is out of the scope of the project, and is left to interested terminal manufacturers for a later stage.
ITS applications on SAFETRIP

During the project activities, starting from the collection of requirements with the Stakeholders, some key applications have been identified and selected in several domains for implementation as proof-of-concept.

Infotainment

The media and entertainment applications, called Infotainment as including also informative services, are based on satellite broadcasting. Contents are received on the OBU and accessed / fruited via a tablet through WiFi.

Weather forecast

The weather forecast provides the forecast for the next days in thousands of cities. All the data is broadcasted to all the vehicles and regularly updated via satellite.

Live TV and radio

A bouquet of TV and radio channels is transmitted live through the S-band, and passengers in the car can access it during their trip with their personal / portable devices (smartphone, tablets); the output can also be integrated in the A/V system of the vehicle, with speakers and integrated screens in the head-rest. The DVB-SH standard is defined for broadcasting in mobility conditions and is suitable for high-speed (as on highways).

Multimedia datacast

As a complement to the live TV and radio channels, passengers can also access to the Multimedia Datacast contents. These are multimedia (audio, video, webpages, ...) files that are pushed to the OBU via datacast, and locally stored for offline utilisation.

SAFETRIP info explorer

The SAFETRIP info explorer is also based on the datacast and GPS / positioning services. Points of interest (POI) are pushed to the OBU and displayed through a graphical and map-based visualisation. The user can browse what's new around his / her position: incoming music and sport events, as well as the attractive offers for shops and restaurants along the journey.

Safety applications

SAFETRIP proposes a set of applications aiming at improving the road safety.

Emergency call

The SAFETRIP emergency call system implementation makes use of bidirectional communication for the voice and messaging for sending a minimum set of data (S-MSD) including the identifier of the vehicle, the position and time, and other relevant information for the operator.

The emergency call is triggered manually by pushing a button reachable by all the passengers in the vehicle, or automatically in case of crash detection. The S-MSD is sent to the operator and in parallel the voice communication is established between the vehicle and the operator. In case of need, the operator may access in real-time the images coming from the camera installed in the vehicle.

Road safety alerts (RSAs)

The potential of the broadcasting, with the satellite coverage enabling to reach the vehicles also in remote areas where the terrestrial infrastructure is not available, can be used as well for safety related applications. It is the case of the Road operators that wants to provide information on the traffic flow or weather conditions to the drivers, as for the variable message sign (VMS).

RSAs
The RSAs are broadcast to the vehicles, stored on the OBU for the time of validity and displayed on the screen to the driver when the vehicle is approaching the concerned area. During the SAFETRIP trials, the alerts from the sanef highway network were injected in the SAFETRIP system.

Collaborative road alerts (CRAs)

A similar use of the SAFETRIP platform for sharing alerts can be used based on a collaborative approach. With the CRA application, the messages can be generated by the vehicle being part of a community of users, to warn on the presence of a danger on a specific location. The application makes use of the messaging service and of the GNSS / positioning of the vehicle. Messages are sent to the service centre and then broadcasted back to all the users of the community.

Patrol with eyes

Patrol with eyes provides satellite / UMTS communications between road maintenance vehicles and the motorway control centre and offers the following services in an integrated package: voice calls (VoIP and PSTN), video transmission, sensor data transmission (temperature and humidity), messaging. The goal of this application is to demonstrate the possibilities of two-way satellite IP connectivity with the SAFETRIP platform, and transparent multi-network access.

The experimentations

One of the central activities in SAFETRIP is the field trial phase, during which the system and applications are experimented in real conditions and with real users, and data is collected - manually and automatically - for further assessment.

The experimentations took place from September 2012 to March 2013 on three different locations and test-beds.

Phase 1 took place in Paris, France, where European citizens were invited to test in a scenario-based mode the SAFETRIP system and its applications addressing both drivers and passengers of the car. Each session had duration of two hours, and the participants accompanied by two experimenters, had the opportunity to discover and comment the emergency call with video, the road alerts, the Infotainment applications.

Phase 2 addressed the patrollers of ACESA, the Spanish road operator managing the highways around Barcelona. During four months, two maintenance vehicles were equipped with the SAFETRIP system to provide a bi-directional communication with the control centre; in particular, the patrol with eyes application allowed to transmit in real time the images from the webcam installed on the vehicles to the operators in the service centre, together with sensor data as humidity and temperature.

Phase 3 addressed passengers travelling on the coach line Paris / Rouen / Rennes operated by Eurolines. Initially, the equipped coach should travel on the Paris / Brussels / Amsterdam corridor, but this was changed by Eurolines for operational and safety reasons. The SAFETRIP OBU installed on board of the coach provided real-time tracking of the vehicle, access to the emergency call and road alerts, and the infotainment services to passengers.

Automatic data collection is performed during the three phases: logs from the system for assessment of the communication link performances and data related to the applications.

Manual data collection complements the information with questionnaires filled in by participants, observations from SAFETRIP experimenters on the field, interviews and audio and video recordings.

A few figures concerning the experimentation:

- six months of field trials;
- eight vehicles equipped;
- more than 130 participants involved (50 % professional / 50 % non-professional);
- more than 10 000 km travelled;
- more than 5 million of data collected automatically.
All this material has been crossly-analysed to assess the perception of usability of the system and the applications by the users, in terms of efficiency, effectiveness and satisfaction, for both private and professional usage according to the concerned phase. The assessment included also safety, security and environment aspects.

Project results:

The SAFETRIP project aims to develop an open platform and demonstrate its benefits through a number of complete end-to-end ready-to-deploy services - improving road safety, mobility and environment protection for passenger vehicles. The proposed services are primarily targeted to address the needs of EU citizens travelling by road - i.e. drivers and passengers of cars and coaches.

The main outcome of the project is an open platform using the S-band technology as the foundation of its communication infrastructure, exploiting the potential of this new spectrum resource to provide low cost channel for broadcasting data to millions of vehicles and managing short messages transmitted from those vehicles. The communication infrastructure will also provide bidirectional channel supporting traditional services based on voice and VPN access.

The SAFETRIP platform is composed of on board items aggregated into an OBU, central items (hub, network control centre) and distributed items (SEP). A smart middleware, software running both on board and centrally, provides an abstraction layer to the services, making the SAFETRIP platform:

(a) capable of integrating alternative communication technologies such as 3G and others;
(b) really open to the integration of third party services.

The open SAFETRIP platform is designed to host services that primarily improve safety and provide assistance for navigation. It is however capable to host entertainment and advertising services too. During the project, a number of such services will be implemented and demonstrated. By design, the platform is open and flexible - capable of using alternative communication technologies (such as 3G, 4G) and integrates with existing and new ITS services.

An innovative communication infrastructure for continuous connectivity

The SAFETRIP system uses both satellite communications and AGNs in a fully interoperable and integrated approach. This combination has a number of unique features that, together with the intrinsic safety and security characteristics of the satellite-based approach, make it the most suitable telecommunication technology for transport systems.

The SAFETRIP communication infrastructure aims at providing three kinds of services:

(a) Broadcast services exploit the global coverage provided by satellite communication to deliver the same data to all the users. The DVB-SH standard has been adopted for these services, with some modifications (DVB-SH-LL) for the provision of real-time contents with low-latency.
(b) Bidirectional messaging services provide interactivity between the vehicles / terminals and the system (similar to SMS). They are based on S-MIM / S-band mobile interactive multimedia (ETSI TS 102 721) standard that has been especially designed for satellite communications requiring little power on the user equipment side.
(c) Bidirectional connection-oriented services support voice and video communications. In this case, quasi-synchronous CDMA technologies are used, ensuring adequate capacity and dynamic resource allocation.

Satellite communication is very convenient for services that require broadcast (one-to-many) type of communication. With the solar powered satellite, it is possible to have a quick deployment and offer coverage over a large area to all users in an environmental friendly manner - unlike most terrestrial networks. In isolated regions with little to no infrastructure or in extreme conditions when terrestrial networks have been destroyed, the satellite telecommunication with S-band represents a unique solution for surveillance and rescue teams. It guarantees a standalone and fully secure communications network everywhere and in all weather conditions via small and virtually ubiquitous mobile terminals.

With more and more vehicle being equipped with networked OBUs, they will also become permanently connected to the service centres as mobile nodes of the network. This may work with traditional 3G / 4G networks for connection-based services. The SAFETRIP platform will provide a brand new low-cost message based return link with S-band, paving the way to a real spread of a wide spectrum
of services where vehicles can truly represent invaluable sources of information for transport management, authorities as well as civil protection and surveillance services.

The SAFETRIP middleware simplifying integration of new applications

The unique concept of SAFETRIP is about an OBU integrated with a smart middleware harmonising the communication channels that have different interface and behaviour. The SEP is thus software that allows the services to be independent of the type of the communication channel between the OBUs and the service centres.

The SEP connects to the existing service providers (ESP) and the value added service providers (VASP), providing a virtual communication channel over S-band satellite or over alternative ground networks (AGNs). AGNs are typically GPRS, UMTS or high-speed downlink packet access (HSDPA) or WiFi. In the OBU, the SEL works as a mediator between the client applications and the SAFETRIP network. The SEL exposes a set of standardised interfaces to the available services (VoIP, authentication, authorisation, accounting, positioning, messaging, routing and more) to the applications running on the OBU. The SEL communicates with the SAFETRIP network via S-band or AGNs. Alternatively, the SEL can also interface with IEEE 802.11p based car-to-car (C2C) modems to rebroadcast or relay messages to/from other cars located nearby.

To understand better: The name of the middleware is SEP for the modules running centrally and SEL for the on board middleware. However, in the SAFETRIP documentation, the SEP / SEL middleware is often referred to as SEP for simplicity.

A family of OBU offering a large range of functionalities

During the SAFETRIP project, the reference architecture for the OBU has been specified, providing the necessary guidelines to terminal manufacturers on the minimum set of communication channels and functionalities required to convey SAFETRIP services to the user. The SAFETRIP OBU comprises at least the following elements:

- S-band communications terminal;
- satellite positioning (GNSS) receiver;
- 3G / 4G modem providing access to mobile network infrastructure;
- Gateway to the car infrastructure (e.g. CAN bus);
- Computing resources to host the service enabling layer (SEL) and the applications;
- HMI to allow the user to interact with the OBU;
- C2C modem.

All the different physical transmission channels, be it GNSS, satellite communication, or AGN, communicate with the SEL to the applications running on the OBU. Thus, the applications are agnostic to the actual hardware architecture of the SAFETRIP OBU as long as it has all the connectivity required by the SEL middleware to successfully run the enabling services. It is worthwhile to note that the OBU that will be used for the demonstrator is a non-engineered device. As bidirectional S-band technology is still very innovative, demonstration OBU will concentrate on functional integration rather than on miniaturisation of the terminal. The optimisation of the form factor is out of the scope of the project, and is left to interested terminal manufacturers for a later stage.

The demonstrator to experiment new services

The SAFETRIP platform is designed to host external services developed using a simple software development kit. Thanks to the SEP, the complexity of the SAFETRIP platform will be hidden to the service developers and the adaptation of existing services will be facilitated. Some of the SAFETRIP platform advantages include:

(a) the ESP deals with the SAFETRIP service provider only for what concerns telecommunication infrastructure;
(b) the ESP can choose its terminal manufacturer, as long as the device is SAFETRIP compatible;
(c) the ESP has the assurance to use the best telecommunication infrastructure depending on its customer location.

The SAFETRIP platform will allow the service providers focus on their core business which is to deliver a service to a vehicle and its occupants. The service provider will be able to install its application on any compatible OBU - a terminal sharing between several services - and will even be supported by the SAFETRIP service provider, allowing the creation of a SAFETRIP community. This approach
will be demonstrated integrating and testing on field a number of real services developed or adapted by project partners working on the ITS sector.

Implementation of the SAFETRIP system

One of the objectives of SAFETRIP is to deploy an integrated ITS system and to assess its impact on the European road transport users.

Technical development

The development phase was split into five concurrent activities: the implementation of satellite messaging capability, bidirectional satellite communication, the main OBU hardware platforms, the middleware and the C2C communication component.

Virtualisation techniques were used to enable concurrent development of software and the underlying hardware platform to take place at geographically dispersed sites. Early field-tests took place even before the end of the development phase within the activities dealing with satellite technology to ensure that the communication link was working properly. Several joint lab-sessions were initiated to ensure a common understanding of critical interfaces between partner contributions before handing over to the integration phase.

The integration

The first part of the integration phase was carried out in a laboratory controlled environment at DLR premises near Munich. During this phase, no radiofrequency (RF) equipment was used. This allowed the work to focus solely on the integration of the SAFETRIP applications with the middleware and the hardware components of the OBU. In the second part of the integration phase, the system was tested in an outdoor environment along with the satellite radio link. The OBU moved from the lab setting into a test vehicle so as to carry out field tests with RF components (antennas, satellite, hub) and monitor the behaviour of the applications when used under real conditions.

The driver HMI mounted on the dashboard provided access to the navigation application and all driver related SAFETRIP services. The passenger services could be accessed through a Tablet PC connected to the OBU through WiFi. Intensive tests were performed with the test vehicle around DLR premises to ensure most typical usage scenarios and pitfalls (like no or low satellite visibility) were covered to finalise the SAFETRIP system tuning.

Overall, we travelled more than 2860 km with the OBU within the implementation and integration phase to validate the SAFETRIP system behaviour!

Trial preparation

During the field trials, end users had the opportunity to use demonstrator services running on the SAFETRIP platform in both real (naturalistic) and orchestrated (scenarios) conditions. These field trials aim to demonstrate and evaluate the strength of the platform by testing it at multiple geographical locations across Europe, with different types of vehicles and end users.

In order to make this ambitious objective manageable, the trials were organised into three main phases.

Phase 1: European citizens (mainly from Paris) were invited to use the services in a car, accompanied by experimenters from UCL, Eutelsat and Sanef. To maintain a consistent trial condition, a fixed route was chosen to run a scenario during which the participants used services such as the emergency call, collaborative road alerts and Live TV. Each trial session consisted of two parts. During the first leg of the journey, the participant drove the SAFETRIP car and used the services intended for the driver; while in the second leg of the journey, the services targeting the passengers could be experienced from the front passenger seat. For end-to-end services, we tried our best to engage all concerned parties along the service chain. For instance, for the emergency call service, professional emergency operators on the IMA platform handled all the calls triggered by participants during the scenarios.

Phase 2: Patrollers and control centre operators, working for the Spanish road operator Acesa, used the SAFETRIP system as part of their daily activities over several weeks on the motorway AP7. On few occasions, they were accompanied by experimenters from UCL and FUB. The key interest in this phase is to assess the potential of the platform in enriching the interaction between the control centre
operators and the patrollers on the field with a view to promote road safety.

Phase 3: Eurolines, a coach operator headquartered in Paris, used the SAFETRIP system on coach along commercial routes. Similar to phase 2, coach drivers were asked to use the services as part of their daily activities, occasionally accompanied by experimentalists from UCL and FUB. Passengers were invited to use the infotainment services like live TV, Multimedia datacast (multimedia files carousel frequently updated like video on demand) and Info Explorer (portal offering travel-related information) through WiFi from their personal devices (tablets, smartphones and laptops). Initial plans also should include the collaboration with AFT-IFTIM - a major training organisation in transport and logistics in France - during this phase. Unfortunately, this part of the trial had to be cancelled because it was not possible to undertake it within the project time schedule.

By end of December, over 40 end-users have used the SAFETRIP services and this number increased significantly once phase 3 was completed. Thanks to this intensive use, we could analyse a large body of experimental data. The data from the trials comprised of qualitative data (from interviews, questionnaires, video recordings and observations) and quantitative data (from the system and application logs).

An important task lies ahead for the assessment team led by UCL to transform this data into an exploitable form - not to mention the practical aspects of transcribing and translating recordings in French and Spanish. The analysis presents itself under the banner of usability, commercial aspects, safety, security and environment.

In addition to the field trials, several smaller studies were conducted to enrich the insights into these aspects. For instance, a comprehensive study was conducted with telematics companies and car manufacturer to understand how SAFETRIP can fit into their ecosystem. A driving simulator has been setup within a fully immersive virtual reality system to study finer usability aspects. The results and insights were compiled in the corresponding assessment deliverables and were presented as well to participants during the project final conference in February 2013.

Dissemination

During the 42 months of the project, the SAFETRIP consortium has largely participated to conferences and publications to disseminate the concept of this innovative platform and its advantages and features.

Two public events were organised by the consortium: the initial workshop in collaboration with NEARCTIS (November 2011) to discuss with experts on relevant topics during the early phases of the project and the final conference (February 2013) hosted by the French Ministry of Transports to present the achievements of the project.

As a whole, the project has been presented to more than 40 conferences and events all around the world, out of which the participations concerned up to 30 papers published in relative proceedings. Additionally, the project got five articles published in magazines specialised in ITS and scientific topics. The list of papers and publications is on the project website.

The first public SAFETRIP demonstration took place in May 2012 at the S-band Workshop organised by the European Space Agency (ESA-ESTEC). Then in October 2013 SAFETRIP exhibited at on the EC stand and was part of the demonstrations at the ITS World Congress in Vienna where live demonstration tours were offered to the participants. The ITS WC demo was also the occasion to collaborate with an external service provider, WonderSys, whose turn-key solution for fleet management named WonderFleet was adapted to run on the SAFETRIP platform.

Tutorials

As part of the transferability of the project knowledge, four tutorials have been developed; their objective is to communicate the SAFETRIP concept, technology, and research methods and results to young researchers, professionals and non-technical managers.

The tutorials are available for browsing on the project website and cover the following thematic:

(1) Current and emerging needs: designed to enable interested parties to understand current and emerging needs in the area of safety, security and environmental impact of intercity travel in cars, commercial vehicles, and passenger coaches.

(2) Using the SAFETRIP technology: with an introduction to developers of ITS services on how to make use of the strength of the open
platform.

(3) User interaction design: sharing guidelines and results of preliminary study about UI and interaction design for applications for vehicle occupants.

(4) Privacy, personal data management and legal issues: presenting the identified issues around privacy and personal data for road operators, passenger transport operators, private citizens and emergency services.

Potential impact:

Final major achievements

Successful rollout of the demonstration phase

Different sort of trials were carried out with the aim to provide the best possible evaluation of our system by maximising its use by testers:

(a) scenario based trials;
(b) naturalistic trials with restricted set of actors;
(c) naturalistic trials with real end users.

Provision of a fully integrated system

(a) first automotive system capable of communicating using S-band satellite technology;
(b) two technologies available: broadcast and messaging and Bi-directional system;
(c) compliant with our mid-term review objective;
(d) five units delivered.

Integration of SAFETRIP with existing applications

All possible cases were addressed during the project:

(a) integration with existing applications from project partners;
(b) development of applications designed to take advantages of SAFETRIP strengths;
(c) integration of an application provided by an external partner.

This showed the high efficiency of the SAFETRIP architecture.

Socio-economic assessment of the demonstration:

(a) completion of the assessment plan;
(b) iterative adaptation to trials;
(c) supplementary studies - business potential and scientific;
(d) creation of assessment toolkit;
(e) design and implementation of driving simulator;
(f) mix of safety and infotainment applications.

Safety and security assessment of the demonstration:

(a) appropriate response time (emergency call);
(b) clear impact on safety (speed reduction, relevant alerts);
(c) communication reliability and positioning accuracy;
(d) security: no invasion of privacy;
(e) environmental aspects: fuel savings; congestion avoidance, incident detection.

Commercial and business deployment:

(a) the work to be done to deliver a commercial product has been measured;
(b) reference architecture is ready and proven with prototypes running and integration with external applications proved;
(c) clear customer demand (traffic information provision and Satellite radio broadcasting);
(d) competitive business model for satellite radio and datacast services.

Potential impacts

Business ecosystem

Cooperative systems are ITS systems based on vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I, I2V) and infrastructure-to-infrastructure (I2I) communications for the exchange of information.

Cooperative systems have the potential to further increase the benefits of ITS services and applications. Cooperative ITS is a subset of the overall ITS that communicates and shares information between ITS stations to give advice or facilitate actions with the objective of improving safety, sustainability, efficiency and comfort beyond the scope of stand-alone systems.

SAFETRIP is a key enabler of cooperative ITS. It will open a new and evolving collaborative space, enabling new dialogues to take place between entities from the same or from different ecosystems.

Each business ecosystem is an interconnected and evolving network of organisations, technologies, products and infrastructures built around a shared vision and common foundations, and of value to some customers, who are themselves members of the ecosystem. Members of such an interactive and interdependent economic community also include suppliers of related goods and services, customers of customers, competitors, government agencies and other stakeholders.

Our analysis has revealed that the automotive telematics market is still in its infancy and we have identified a number of new players entering it in force (e.g. manufacturers of portable and nomadic devices). Opportunities abound, but the competitive forces must be fully understood to avoid costly mistakes. For instance, it is becoming difficult to sell premium services when there are so many free content and applications available on smartphones.

Based on a deep analysis of the SAFETRIP business ecosystem, including an examination of key roles, macro-environmental trends and competitive landscape, we have built different business models, which show how we can win (More details are included in deliverable D2.4.2 'Role model and business analysis').

After assessment, we have found that these business models are sound, but not without weaknesses and risks. For instance, we have not yet succeeded in partnering with an automaker or with a tier 1 automotive supplier. On the other hand, the fruitful collaboration with potential future customers like Wondersys is very encouraging. Indeed the SAFETRIP platform is very promising for actors who need narrowband communication like PAYD service providers or fleet management service providers such as Wondersys.

Next steps

The competitiveness of satellite communications in the provision of certain services has been demonstrated. It has been shown that Satellite broadcast and messaging can allow significant savings in communication costs.

The use of SAFETRIP as a hybrid network enabler has been highlighted. It has been shown that the use of a hybrid network is perhaps not the cheapest choice but that the price difference is rather low compared to the technical advantages it brings such as the pan-European coverage capabilities. Finally, it is important to highlight the advantages to be derived from all available networks in order to provide the best service quality. Even though the use of SAFETRIP as a hybrid network platform is not the least expensive choice, the technical advantages for coverage capabilities must be considered. The different typologies of services offered by SAFETRIP are well deployed on the market on technologies which are considered mature both in terms of technology and pricing.

The next steps regarding the potential future use of the project results include:

(a) miniaturise the SAFETRIP OBU;
(b) contact new partners / customers:
(i) car manufacturers and service providers;
(ii) refine the business analysis;
(iii) industrialise the system with a set of killer applications: strong implication from a customer is needed.

Live radio and datacast services therefore seem to be good candidates to enable SAFETRIP take off.

It is important to keep in mind that the SAFETRIP business model shall be based on a central service:

(a) to enhance the OBU penetration;
(b) to ease the deployment of side services.

Advanced road safety management is a complex and rapidly evolving field, but it is of crucial importance for the future of our societies. SAFETRIP can contribute positively to it, and even succeed in it, through the benefits it provides to its customers and partners, and the value it creates for all stakeholders, including the community at large.

Dissemination of the outcomes of the project

Dissemination is essential to collect benefits from the outcomes of the previous activities of design and development. Together with the trials and assessment, demonstrations at public events and communication on SAFETRIP were centric in the last months of the project, with in particular the final conference. Dissemination actions were carried out both within the ITS ecosystem and the satellite ecosystem.

Actions thus included the participation to several events, the maintenance of our existing communication channels (web site, annual newsletter) and the setup of a final conference. New communication materials such as tutorial and a video were created during the second and third periods in order to reach a widest public. The SAFETRIP dissemination report is a strong tool allowing monitoring the achievement of this objective.

All dissemination papers and presentations are available for downloading on the project website.

First project period

The dissemination activities of this first period consisted in the preparation and distribution of informative and promotional materials (the dissemination package) and the production of technical and non-technical papers and the participation to conferences, congresses, workshops and other events.

The D8.1.5 SAFETRIP dissemination plan defined the targets and the objectives of the dissemination of the project, and the way to reach them, mainly through the participation to relevant events.

Such a package is composed of different elements, some of which are already listed as deliverables in the DOW, while others have been added during the early activities.

According to the objectives and targets of the dissemination, the definition of the branding of SAFETRIP was conceived to reflect the mixture between innovation (RandD) and institutional (EU-granted, safety-related) aspects provided by the project. This includes the final logo, the banner used for the poster (D8.1.3) the website (D8.1.2) the brochures (D8.1.6) the template for the presentations, the pop-ups used to dress the events, the newsletters (D8.1.7).

The list of main events to which SAFETRIP participated are listed here after, and are also reported in the D8.1.1 first year report on SAFETRIP dissemination and training.

(1) SAT Expo (4 - 6 February 2010, Rome, Italy): presentation of SAFETRIP during the Second European Conference on S-band Mobile Satellite Services (SAN, EUT) (see http://www.satexpo.it/en/report/ online for further details)
(2) ISI General Assembly (7 - 8 April 2010, Toulouse, France): presentation of SAFETRIP for ISI endorsement procedure (MBI, DLR) (see http://www.isi-initiative.eu.org online for further details)
(3) Forum TV Mobile (7 May 2010, Paris, France): presentation of SAFETRIP in the context of mobile services in S-band (SAN, EUT)
The SAFETRIP project obtained the ISI Endorsement (Certificate dated 20 January 2011). Integrated Satellite Initiative (ISI) is an industry-led action forum designed to bring together all aspects related to satellite communications; it gathers all relevant and interested private and public stakeholders. The ISI endorsement provides to SAFETRIP a vehicle for dissemination and concentration.

The Initial SAFETRIP workshop was organised on 25 - 26 November 2010 in Lyon, France:

- joint workshop in association with NEARCTIS;
- special guest keynote speech from scutm (gsa fp7);
- 5 topics common to SAFETRIP and NEARCTIS;
- 60 participants;
- cardboard and dissemination material produced for the event.

Second project period

Dissemination kit:

During this period 2, the following supports for dissemination have been created / updated by the consortium:

- D8.1.8 SAFETRIP newsletter issue No. 2 was delivered at the beginning of December 2011;
- SAFETRIP in a nutshell 4 pages, A4 format, formatted with the project colours; the document contains the essential information on the SAFETRIP platform and technology.

The official project website was regularly updated with the events where SAFETRIP was presented and new available documents of public dissemination.
Dissemination events:

(a) Insurance Telematics Europe 2011 (4 - 5 May 2011, London, UK)
Presentation of SAFETRIP in the section Expand the scope of insurance telematics (SAN, MAI)

(b) ITS European Congress (6 - 9 June 2011, Lyon, France)
PAPER SAFETRIP - A green architecture for an open ITS platform (SAN, EUT, FHG, IND, MBI, UCL) Technical session TS 05 Alternative communication for ITS and HMI specials 7 June
Paper Cooperative end to end user services in SAFETRIP (SAN, EUT, MBI, UCL, ABE) Technical session TS 05 Alternative communication for ITS and HMI specials 7 June
Participation of SAFETRIP at the special session SS 23 EGNOS and Galileo for intelligent mobility, 8 June 2011
http://2011.itsineurope.com/

(c) SCUTUM Think-Tank Workshop (7 June 2011, Lyon, France)
Presentation of SAFETRIP 7 June (SAN)

(d) 8th European Forum on digital TV (9 - 10 June 2011, Lucca, Italy)
Sponsoring partnership with speech and material distribution (SAN, MBI)
http://www.comunicaredigitale.it/forum-2011

(e) IEEE Forum on Integrated and Sustainable Transportation Systems (FISTS) (29 June to 1 July 2011, Vienna, Austria)
PAPER Getting on the S-band wagon for crossing borders (UCL, SAN, PIAP, EUT)
http://www.ieee-fists.org/

(f) Driver Distraction and Inattention 2011 (DDI 2011) (5 - 7 September 2011, Gothenburg, Sweden) Distribution of SAFETRIP brochures; networking and dissemination (UCL)
http://www.chalmers.se/safer/ddi2011-en/

(g) 2. Fachtagung Infotainment (27 - 28 September 2011, Frankfurt-am-Main, Germany)
Presentation of SAFETRIP dissemination material and OBU along with others (FHG)
http://www.sv-fachveranstaltungen.de/2-fachtagung-infotainment/

(h) ATEC-ITS France - Journée Transports terrestres et Applications spatiales (6 October 2011, Paris, France)
No speech for SAFETRIP, but networking and dissemination (SAN, EUT)

(i) Fourth High-level Conference on European Space Policy (8 - 9 November 2011, Brussels, Belgium)
No speech for SAFETRIP (EUT)
http://www.spaceconference.eu

(k) EasyWay Fourth Annual Forum Roads for tomorrow including SCUTUM Final Workshop (9 - 11 November 2011, Rome, Italy)
No speech for SAFETRIP but networking and dissemination (MBI, SAN)
http://www.easyway-its.eu/1/

(l) ITN 2011 Infrastructure, Telematics and Navigation (16 - 18 November 2011, Turin, Italy)
Project presentation in the session dedicated to the On-board telematics and car sensor (17 November 2011, 3.00 pm)
Sponsorship of the event, with SAFETRIP logo in the official event material
Interviews on SAFETRIP (MBI)
http://www.itnexpo.it/eng/

(m) Automotive user interfaces and Interactive Vehicular Applications - AutomotiveUI 2011 (29 November - 02 December 2011, Salzburg, Austria)
Paper In-car contextualised search on tablets, A. Beeharee (UCL), A. Vaccaro (MBI) accepted to workshop 4 on Integrating mobile devices into the car ecosystem - Tablets and smartphones as vital part of the car.

(n) CeBit 2012 (6 - 10 March 2012, Hannover, Germany)
Networking and dissemination. SAFETRIP roll-ups, dissemination material and presentation on the benefits of the SAFETRIP architecture at the CeBit Destination ITS booth (FhG).

Third project period

Dissemination kit:

During this period 3, the following supports for dissemination have been created and updated by the consortium:

(a) D8.1.9 SAFETRIP newsletter issue No. 3 was printed in October 2012 and distributed at the ITS WC 2012. It was updated at the end of December to announce the details of the final project conference.
(b) D8.1.4 SAFETRIP video was in use at the ITS WC 2012, on both the EC stand project booth (Hall B) and on the demo launch area (Hall A).

Additional videos presenting some of the applications running on the SAFETRIP platform have been produced in occasion of the final conference and visible all together on the project website.

The official project website was regularly updated with the events were SAFETRIP was presented and new available documents of public dissemination.

Dissemination events:

(a) Transport Research Arena Europe 2012 (23 - 26 April 2012, Athens, Greece):
The three papers submitted for this event were accepted: one of them was presented by S. Grazzini (EUT) in a technical session, while the other two were included in the poster sessions
http://www.traconference.eu/

(b) ESA-ESTEC S-band workshop (14 - 15 May 2012, Noordwijk, the Netherlands):
During this workshop organised by the European Space Agency (ESA), the SAFETRIP project was presented and provided the first live public demonstration of ITS applications using the S-band communication (using the equipped DLR Van)
http://telecom.esa.int/telecom/www/object/index.cfm?fobjectid=31739 online

75th IEEE Vehicular Technology Conference - VTC2012 (6 - 9 May 2012, Yokohama, Japan)
One paper was presented at the event
http://www.ieeevtc.org/vtc2012spring/ oneline

(c) IEEE Intelligent Vehicles Symposium - IV2012 (3 - 7 June 2012, Alcalá de Henares, Spain)
One paper on the integration of Sat and C2C communication was presented at the event
http://www.robosafe.es/iv2012/

(d) International Society for Remote Photogrammetry and Remote Sensing Congress, ISPRS 2012 (25 August - 1 September 2012, Melbourne, Australia)
One paper was presented at the event
http://www.isprs2012.org/

(e) 6th Advanced Satellite Multimedia System Conference, ASMS 2012 (5 - 7 September 2012, Baiona, Spain)
Conference organised by DLR and with the participation of many of the consortium partners; SAFETRIP was present with a dedicated paper but also in many debates and discussions on the concrete applications of the S-band and S-MIM protocol.
http://www.asms2012.org/
(f) ITS World Congress 2012 (22 - 26 October 2012, Vienna, Austria) 
SAFETRIP was present with two papers presented in the technical sessions, with the live demonstration as part of the official demos of the conference, and in the exhibition in the EC stand.
http://2012.itsworldcongress.com/ online

(g) ISI General assembly (14 November 2012, Brussels, Belgium)
As part of the network and endorsed project, the SAFETRIP activities' update was presented to the participants.
http://www.isi-initiative.org/

(i) Oversee Final Event (19 - 20 December 2012, Brussels, Belgium)
SAFETRIP was invited to present the joint technical architecture studied together with oversee as part of their X-fertilisation activity.
http://www.oversee-project.com/ online in News

(j) ATEC ITS France (30 - 31 January 2013, Paris, France)
Two proposal of communication on SAFETRIP have been retained in the official program and were presented, one by SAN, the other by IMA. The first paper presented some results of the experimentation and the second paper a feedback of IMA regarding their involvement as an assistance company.
http://www.atec-itsfrance.net/

(k) SAFETRIP Final Conference (25 February 2013, Paris, France)
Hosted by the French Ministry of Ecology and Sustainable Development in the Grande Arche of La Défense. More than 80 experts from all Europe attended this event, which includes presentations, demonstrations in vehicles and video showing the different implemented applications. All presentations and videos are available on the project website: http://www.SAFETRIP.eu
Project website: http://www.SAFETRIP.eu
Information: contact@SAFETRIP.eu

The project consortium:

Given the focus of the project on an advanced vehicle communication system for transport applications, the consortium has been carefully selected to gather partners from the road, insurance and transport industry with a mid- and long-term perspective along with telecommunication companies, research centres and universities.

The leadership of the project was ensured by Sanef, while Eutelsat was in charge of the technological aspects, ensuring a well-balanced decision process between transportation actors and telecommunications companies.

The consortium is a balance of industrials, SMEs, research institutions and universities, all with specific knowledge and experience relevant to the projects objectives. This leads to a very good complementarity of the consortium in terms of technical expertise and contributions on the one hand and in terms of domain of activity and business on the other hand. Note that the originality of the consortium is to merge companies coming from the transportation industry with partners from the IT domain.