SATCOM AS PART OF THE OPERATIONAL IMPLEMENTATION OF ITS APPLICATIONS–THE SISTER PROJECT

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Introduction

Many studies and demonstration projects have investigated applications, which use GALILEO-like positioning services for road applications. A number of successful demonstration projects having been completed it is time to address the issue how satellite communication can play a role in the context of road transport applications.
The majority of ITS applications require one or two way communication to function effectively, or indeed at all. Technical demonstrations have been made using terrestrial communications services, typically GSM and GPRS. However, it is recognized in many scenarios that mobile telephony will not provide on its own the Quality of Service or the economics to satisfy customers, particularly for applications requiring multi-casts or broadcast services. Additionally, lack of communications coverage, particularly in less developed regions, peripheral and rural areas will constrain the effectiveness of many applications. In particular advanced Real Time Kinematics (RTK) GPS applications will rely on continuous communications, which can only be achieved by the integration of a range of communications technologies. In many of these applications, satellite communications, whilst not replacing the need for terrestrial services, can complement them and lead to a superior overall solution.
The Satcoms in Support of Transport on European Roads project (SISTER) promotes the integration of satellite and terrestrial communications with GALILEO to enable mass-market take-up by road transport applications. The project is supported by the European Commission under the 6th frame programme for Research and Development. It is lead by Avanti Communications (UK) with the support of a team of industrial and academic partners covering all aspects of the value chain for ITS services, from R&D through to space infrastructure and communications delivery.
Major projects objectives are the assessment of satellite communication applicability in specific road transport applications and services, the development of an integrated satcom transceiver prototype and the demonstration, through a number of proofs of concepts, of the role of the satellite (telecommunication services and navigation technology) in enabling road transport applications in Europe.

Analytical stream

Project first activity has been the analysis of 4 groups of road transport applications:

Regulation driven: Road User Charging (RUC) and Digital Tachograph.
Mass-market safety applications: eCall, Speed Alert and ADAS applications
Mass-market non-safety: Dynamic Personal Navigation (including Traffic Management and Control and Floating Vehicle Data), Pay per Use Insurance, Theft detection and recovery, Remote Vehicle Diagnostic, Digital Maps Updating.
Commercial Applications: Fleet Management and Hazardous Goods Monitoring

The analysis has been conducted on:

- the *technical aspects* of the applications in order to identify the requirements in terms of communication and positioning. In particular for the communication requirements the focus was on the possible current applications limitations, which can be relieved by the satellite communication technology;
- the *value chains*, to be able to already identify the major players, drivers/barriers of the applications, which will be further investigated in the business development;
- the *legislation framework*

The project has then consolidated the requirements and categorised the SISTER applications in 4 groups, based on their communication requirements: navigation services, safety and security services, fleet management services and Road User Charging services. A market forecast up to 2020 has been analysed based on three different scenarios: 1) market stimulated scenario; 2) technology driven scenario and regulation dominated scenario. This analytical activity allowed the project to identify which are the ITS road applications more suitable to a satellite and terrestrial communication integration , considered their communication requirements, their market forecast and their expectations in terms of technology development and new features. Based on the analytical stream results the SISTER proofs of concepts have been defined. This paper focuses on a high level description of the SISTER demonstrations.

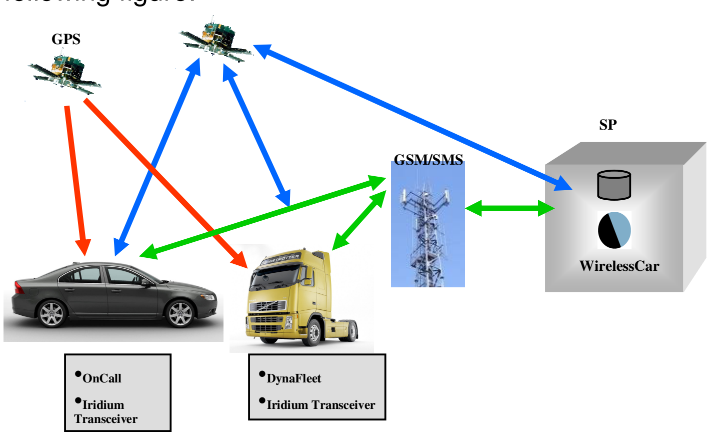
SISTER Proofs of concepts

eCall Proof of concept

The main focus of the eCall trial is:

1. To demonstrate that the in-vehicle emergency calls (eCall) service related to the accident data transmission is able to operate also in remote area with weak or no GSM signal using the satellite communication
2. To analyse how the SISTER eCall architecture performs in terms of end-to-end timing and successful delivery of the incident data to the Service Provider
3. To compare the performance of the eCall data transmission service using the two different communication technologies: GSM/GPRS and the SISTER satellite communication solution.

The SISTER eCall trial will take place in the Sweden test bed, as illustrated in the following figure:



The SISTER eCall in-vehicle system will be integrated with satellite communication in order to provide an additional coverage in areas with weak or no GSM signal. Therefore for its accident simulation, the trial will deliberately choose test sites road areas where there is poor or no GSM coverage. During the eCall testing phase 2 test vehicles (one car and one truck) will be travelling in Sweden across various road types during a period of 3 months (60 days). These 2 vehicles will be equipped with two systems, the satellite communication unit as well as with the commercial GSM/SMS based telematics system (Volvo on Call for the car and Dynafleet Online for the truck).

The objective of the trial is the validation of Satcom as a facility for the pan-European eCall services. The performance of the Satcom based data communication in terms of eCall data transfer time, eCall data transfer success and eCall data transfer errors will be compared to the use of terrestrial data communication for critical functions.

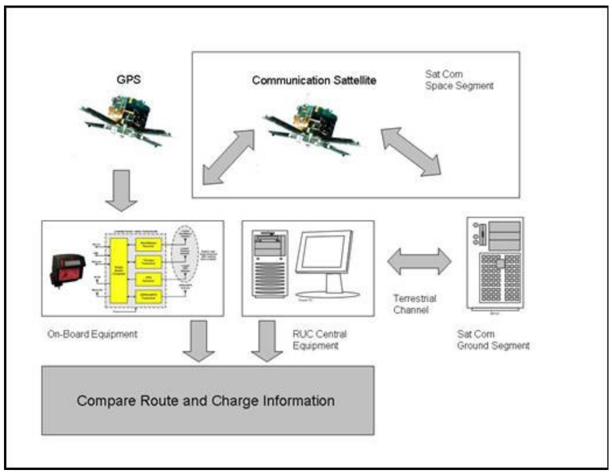
RUC proof of concept

The assumption for the RUC proof of concept is the fact that terrestrial communication networks like GSM or UMTS are not covering the complete road network which is planned to be subject to tolling. Therefore the RUC demonstrator intends to focus on:

1. Evaluate the capabilities of satellite communication links to transmit road charging data, i.e. the data which contains road charging fees or allows calculating road charging fees at a central equipment.
2. Evaluate how road users, travelling on charged roads, can be enforced to ensure that correct charging is executed by means of satellite communication (e.g. polling).
3. Analyse how satellite communications service accessibility and transmission delay affect the reliability and correctness of road user charging.
4. Define which adaptations in transport and service protocols shall be made to smoothly support road user charging via satellite communications.

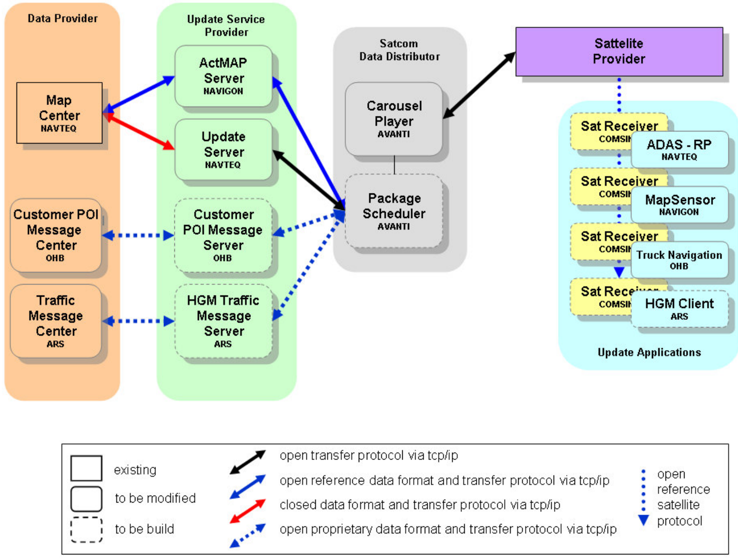
SISTER RUC will take place in Czech Republic using the following architecture:

Testing of satcom for RUC will mainly evaluate if satcom characteristics allow correct charging of the road user. The influence of satcom transmission conditions in the selected test field will be evaluated by means of comparison of routes travelled by the test vehicles and the corresponding information received at the CE side.



Map Updating proof of concept

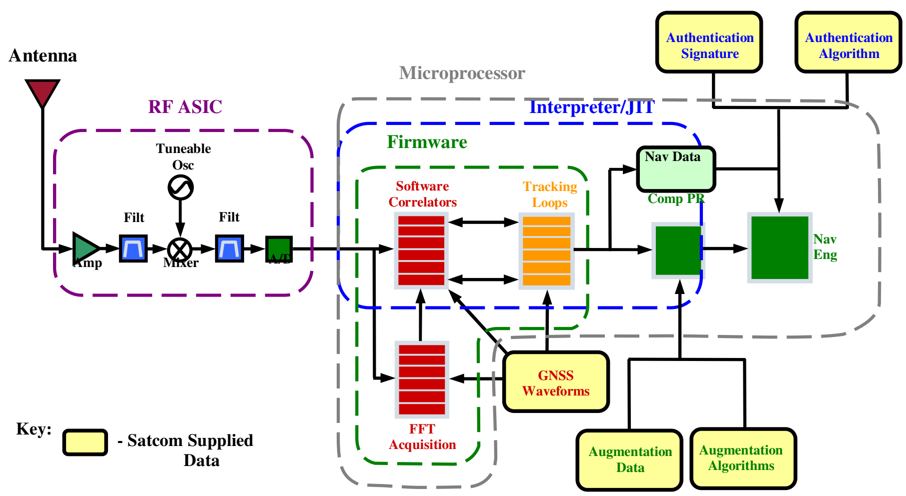
The main objectives of the Map Updating Demonstrations are to investigate if map updates can be distributed to vehicles on the move using a satellite broadcast (one way) approach. Besides broadcasting of map updates additional concepts for satellite broadcasting of map related information like Point-of-Interests (POI) or traffic messages will be developed. One main focus is clear set on the distribution to vehicles on the move. Therefore it is necessary to analyse how the scheduling of the data transmission affects the updating of the digital maps used in vehicles in terms of update coverage and update latency. From the analysis of the signal blockage profiles and the effective percentage of reception time for different environments (e.g. rural and urban areas) conclusions will be identified to evaluate the applicability and needed modifications of the existing ActMAP concept. Expectable results will be advanced update selection strategies for the provision of specific map update information to the satellite broadcast services. Such selection strategies expectably will consider the time of day, relevant map attributes, frequency of road usage etc. For the individual investigated updating scenarios (map updating, POI, traffic messages) different application test environments will be implemented (**Error! Reference source not found.**below).



The Map updating proof of concept will demonstrate the integration of software and hardware tools to build a closed communication chain covering the map update provider, the satellite service provider and the in vehicle application. This will be demonstrated by real world drive and update tests on pre-defined test tracks.

Enhanced Services proof of concept

The Enhanced Services proof of concept shall examine the use of a satcom service to reconfigure the internal architecture and processing of a GNSS (Galileo) receiver. The reconfigurable GNSS software architecture used within the NSL RAZOR receiver is illustrated in the figure below.



The receiver acquires and correlates with the GNSS signals using highly optimised compiled digital signal processing routines. The fundamental signal properties including carrier frequency, pseudorandom primary and secondary sequences, and sub-carrier waveforms are stored in memory for access by the acquisition, correlation and tracking routines. The decoding of navigation data and the application of augmentation data or additional services is conducted in through the use of an interpreter (or just in time compiler). This architecture therefore enables the upgrading of GNSS augmentation or additional services through the broadcast of data and the algorithms (source code) defining how the data is to be used.

The demonstration of the tracking of a new GNSS signal by a GNSS receiver, with no prior knowledge of the signal's structure, will be conducted using a GPS software receiver that will be reconfigured via satcoms to enable the tracking of a test Galileo satellite (GIOVE-A/B).

Conclusions

The selected proofs of concepts are currently defining the tests scenarios, the design and integration of the needed equipment and the pre-test verification plan. The real SISTER demonstrations will start in second quarter of 2009.