SUNSET

Sustainable Social Network Services for Transport
www.sunset-project.eu

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The SUNSET project

SUNSET (http://www.sunset-project.eu) is a three-year research & development project part of the European Commission's Seventh Framework programme Smart Cities & Sustainability under DG Connect (http://ec.europa.eu/dgs/connect/en/content/smart-cities). SUNSET started in February 2011 and has ended February 2014.

SUNSET develops and evaluates a set of innovative services that use Smartphone technology, social networks and incentives to encourage people to travel more sustainably in urban environments. The project's objective is to increase personal mobility and at the same time reduce congestion, increase safety, and protect the environment.

The SUNSET project uses a human-centred approach to achieve its objectives stimulating people to change their individual travelling behaviour. To influence behaviour, we developed and exploited a Smartphone application named tripzoom featuring challenges and rewards to move smarter. Moreover, we tailor and personalise these incentives by means of automatically measuring actual travel behaviour of the Smartphone user.. This is a personalised, multimodal coaching approach to traffic and mobility management, based on rewarding good behaviour.

SUNSET is an initiative of a consortium of nine public and private partners from four different European countries with a total budget of 4.1 million euro. SUNSET combines technical with social research creating new services for sustainable travel and evaluation of these services in real life settings of the cities Enschede (NL), Gothenburg (SE) and Leeds (UK).

Summary

SUNSET has driven its adoption of and contribution to relevant standards from its application requirements and its system deployment. For SUNSET, the application requirements cover ITS use focussing primarily on passenger rather than vehicle drivers. SUNSET system requirements tend to cover aspects of ITS that are outside the current ITS standards and the current analysis of ITS standards gaps, e.g., by ITU-T, multimodal travel (walk, cycle, bus, metro, car, etc.), includes safety other than non-vehicle safety and eco-friendly indicators of multi-modal travel.
SUNSET also supports high-level, societal ITS cooperation that is currently outside the ITS standards initiatives. This includes incentivising targeted use of transport to enhance eco-friendly travel and travel safety by transport authorities. It also includes social propagation via social networks and, encouragement, fostering and acknowledgement of good and bad travel behaviour, such as eco-friendly travel.

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V0.6	29.01.2014	Addition of sustainable travel content
V0.9	30.01.2014	Comment on SUNSET system use of standards added
V0.8	30.01.2014	Final edits Task and Work-Package Leader review
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List of Abbreviations

The acronyms used in this document are listed as follows.

Acronym	Full Name
3G (GSM)	3rd Generation GSM (Global System for Mobile Communication)
3GPP	3rd Generation Partnership Project
6LowPAN	Low-power wireless personal area networks over IPv6
ARIB	Association of Radio Industries and Businesses - Ask ...
ATIS	Alliance for Telecommunications Industry Solutions
AVI	Automatic Vehicle Identification
AVI/AEI	Automatic Vehicle and Equipment Registration
CALM	Communications Access for Land Mobiles
CCSA	China Communications Standards Association
CEN	European Committee for standardization
CITS	Collaboration on ITS Communication Standards
ETC	Electronic toll collection
ETSI	European Telecommunications Standards Institute
FCD	Floating Car Data
FVD	Floating Vehicle Data
GHG	Green House Gas
GNSS	Global Navigation Satellite Systems e.g., GPS
GPS	Global Position System (that is It is maintained by the United States government)
GSM	Global System for Mobile Communication
HHI/ PPI	Human-to-Human Interaction that is electronically mediated / or People-to-People
HMI	Human-Machine-Interaction
HTTP	Hypertext Transfer Protocol
IEEE	Institute of Electrical and Electronics Engineers
IoT	Internet of Things
ISO	International Standards Organization
ITS	Intelligent Transport System
ITS-SU	ITS station unit
ITU	International Telecommunication Union
ITU-T	ITU Telecommunication Standardization Sector
LCA	Life Cycle Assessment
LDM	Local Dynamic Map
LowPAN	Low-power wireless personal area networks
M2M	Machine to Machine
NFC	Near Field Communication
ORM	Object-Relational Mapping
REST	Representational State Transfer
RFID	Radio Frequency IDentification
SES	Single European Sky
TC	Technical Committee
TCP	Transmission Control Protocol
TR	Technical Report
TTA	Telecommunications Technology Association
TTC	*Telecommunication Technology Committee* (of Japan)
TTI	Traffic & travel Information

URI	Universal Resource Identifier
V2I	Vehicle to Infrastructure
V2P or V2H	Vehicle to People or – to people
V2V	Vehicle to Vehicle
VMS	Variable Message Signs
WAVE	Wireless Access for the Vehicular Environment
WiFi	is used in general English as a synonym for "WLAN" Wireless Local Area Network based upon the IEEE 802.11 standards.
WiMAX	Worldwide Interoperability for Microwave Access
WG	Working Group

1. Introduction

1.1 Scope of SUNSET

The primary focus of SUNSET is a subdomain of the Intelligent Transportation System (ITS) domain, to monitor travellers' mobility, and then to promote value-added smart transport services based upon this. There are two key methods to monitor travellers' mobility and these are based upon opportunistic and participatory sensing, SUNSET supports both of these. According to Poslad, 2009 [1], there are three designs to enable ubiquitous system applications such as smart transport these are smart (mobile) devices, smart environments (with embedded smart devices) and smart interaction between these that includes crowd-sensing. SUNSET focuses on sensing via smart (mobile) devices and smart interaction between multiple (users') smart devices.

SUNSET does not focus on smart environments (of smart devices) because the use of such smart environments tends to encompass closed, managed, vertical ITSs for V2I (Vehicle-to-Infrastructure), V2V (Vehicle-to Vehicle) and V2P (vehicle-to-People) applications. Typically, smart environment devices to enable V2I road traffic monitoring and management applications include traffic light signals, video traffic cameras and AVI/AEI, Automatic Vehicle and Equipment Registration, cameras that are situated at a limited number of fixed points on major routes. Note that ITS vehicles may sometimes be focused on ground-based vehicles, motorised road vehicles; may include non-motorised, human-powered mobility such as bicycles, and may even include walking.

In contrast, SUNSET focuses rather more on general M2M (Machine-to-Machine) and HMI (Human-Machine-Interaction) based upon smart mobile devices such as mobile phones. SUNSET uses so called Floating Car Data (FCD), also known as floating cellular data, as a general ITS traffic monitoring method, e.g., to determine the traffic speed of cars on the road network. It is based on the collection of localization data, speed and direction of travel and time information from mobile phones in vehicles that are being driven, and which can also be tracked. A more general case of FCD is FVD or Floating Vehicle Data, where the speed and direction of travel can be for vehicles other than cars, including bicycles. FVD can be used to support an alternative to smart environment type V2I and V2V based that is based on mass market mobile devices such as smart phones rather than on specialised embedded vehicle and 'street furniture' devices, see Section 3.6.

SUNSET also seeks to leverage HHI, Human-to-Human,-Interaction mediated by communication technology, in relation to ITS, where for example, social networking can be used to promote more informed TTI (traffic and Travel Information).

The SUNSET system, tripzoom, focuses on the use of people as mobile sensors, opportunistic sensing, through leveraging the mass use of smart mobile phones that accompany people where ever they move. Smart phones with their inbuilt inertial sensors such as accelerometers and transceiver type network sensors such as GPS can be used for mobility sensing including location sensing.

The SUNSET system enables its core applications to profile the mobility of urban commuters primarily, offering value added services such as:

- Enabling individuals to profile their own travel via opportunistic mobile phone sensing, e.g., carbon footprints and energy efficiency, travel safety, thus informing individual travellers so that they can decide to shift their mobility behaviour.
- Offering travel incentives to promote shifts in mobility behaviour to promote low-carbon, energy-efficient, safer travel
- Facilitating the use of social interaction (HHI) to promote shifts in mobility behaviour to promote low-carbon, energy-efficient travel
- Supporting in-situ traveller experience sampling to get more finely grained input (participatory sensing).

Thus SUNSET's activities cover these main aspects of ITS: MMI based upon so called floating vehicle data. , HMI, road-safety, personal well-being and eco-travel.

1.2 Goals

The goals of this deliverable are to report the main outcomes of the SUNSET T8.3 standards activity:

- This activity will maintain an overview of the ongoing relevant activities
- It will coordinate contributions in the targeted standardisation bodies and forums
- SUNSET will seek to actively contribute to standardisation bodies and forums.

1.3 Approach

SUNSET has only a small resourced activity towards standardisation. The main focus of the approach is to review the range of ITS standards from a range of ITS bodies and to analyse their relevance to SUNSET.

1.4 Document Structure

The remainder of this document is structured as follows. The next chapter, 2, gives an overview of ITS standards activities, it describes the ITS communities that are active, the ITS standardisation challenges and gives an overview of ITS standards activities. The following chapter 3 discusses in more detail the specific standards activities that are relevant to SUNSET. Chapter 4 presents the conclusions.

2. Overview of ITS Standards Activities

2.1 ITS Standardisation Drivers and Challenges

There are many standards fora active in the area of ITS. To date there are already a huge number of V2I protocols based upon standardisation of environment devices embedded in vehicles and in the vehicle infrastructure.

Vehicle and infrastructure data availability and access to such data by third-parties to promote value-add services is challenging because the vehicle operators and transport infrastructure operators are often private companies, use proprietary encodings and data structures to represent their ITS data, and hence require complex ,individual data agreements to allow access. Multiple data from multiple V2I and V2V sources may be incompatible in order to support integrated services.

The trend to deploy more advanced ITS is symptomatic of a wider trend called the Internet of Things or IoT. The addition of many additional types of devices and their interaction will open new security breaches so as to spark new malicious actions. Security, safety and privacy management for the IoT remains a core challenge [2], e.g., Road safety based upon V2V communication between cars introduces stringent technical and legal problems.

2.2 The ITS Communities that are Active

Currently, the main big interest groups in ITS standards can be grouped as follows:

1. Road operators and city authorities who provide the I part of V2I services
2. Vehicle manufactures who promote V2I and V2V services
3. (Cellular)Network operators that provide the communication systems to enable v2I and V2V.

In terms of the activity of these different groups, the first two groups are the most active but network operators are more silent mode (partly because they work on competing technologies in the area of IoT and the related field of Machine-to-Machine or M2M communication [3].

Note that other key stake-holders such as transport regulators, authorities, service providers and transport service customers are not in general represented in such technical ITS standards. An example of a forum for transport authorities is perhaps EUROCITIES. EUROCITIES is a political platform for major European cities. Founded in 1986, it networks the local governments of over 130 of Europe's largest cities and 40 partner cities. Between them they govern some 130 million citizens across 35 countries. Through its forums and working groups, it formulates policy positions on key issues affecting cities such as sustainable urban transport. EUROCITIES as an example of a transport authority forum type stakeholder that does not seem to participate in ITS standards fora.

2.3 ITS Standards Activities

There are multiple standards bodies that are active in ITS standardisation. These are as follows.

- European Committee for standardization (CEN)
  - CEN TC 278 WG18 on co-operative systems
- International Standards Organization (ISO)
  - ISO TC204 WG16 on co-operative systems

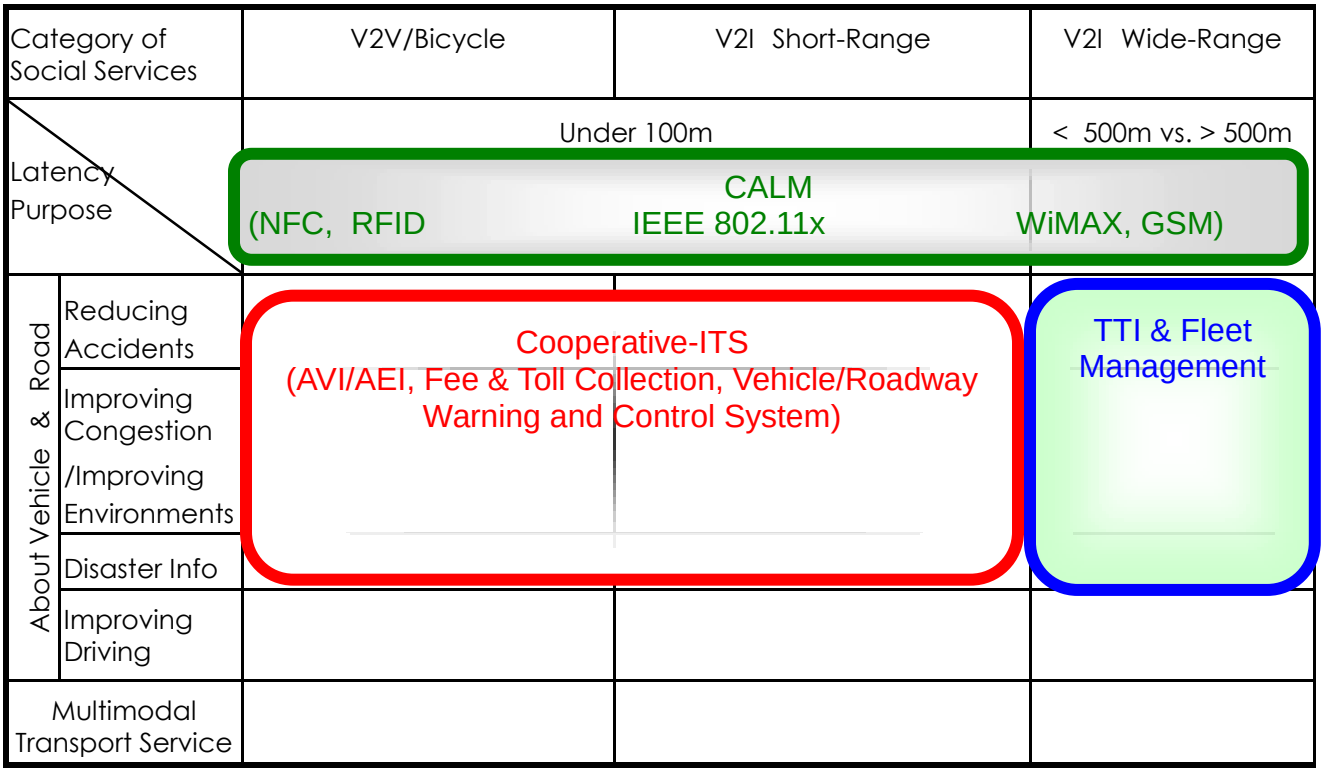
    - Joint activity of ISO TC204 WG18 and CEN TC278 WG16
- European Telecommunications Standards Institute (ETSI)
    - ETSI TC on ITS
    - ETSI TC on M2M
- ITU Telecommunication Standardisation Sector (ITU-T)
    - Collaboration on ITS Communication Standards (CITS) is one of the three sectors (divisions or units) of the ITU; it coordinates standards for telecommunications
- Institute of Electrical and Electronics Engineers (IEEE)
    - IEEE 802.11p: WAVE - Wireless Access for the Vehicular Environment
    - IEEE WiMAX
- Internet Engineering Task Force (IETF)
    - 6LowPAN
- GSM 3G
    - 3rd Generation Partnership Project unites [ARIB, ATIS, CCSA, ETSI, TTA, TTC] telecommunications standard development organizations

3. Standardisation Bodies Activities that are Relevant to SUNSET

In order to better understand how ITS standards apply to SUNSET, we assess the current standards (Table 1) and the gap analysis (Finally (blue box), in improving congestion reduction long range oriented standardisation efforts in Fleet management could be of interest and relevance to SUNSET.

Table 2).

Table 1: SUNSET Analysis of ITS standards according and how they fit the ITU-T [4] UTS Gap Analysis

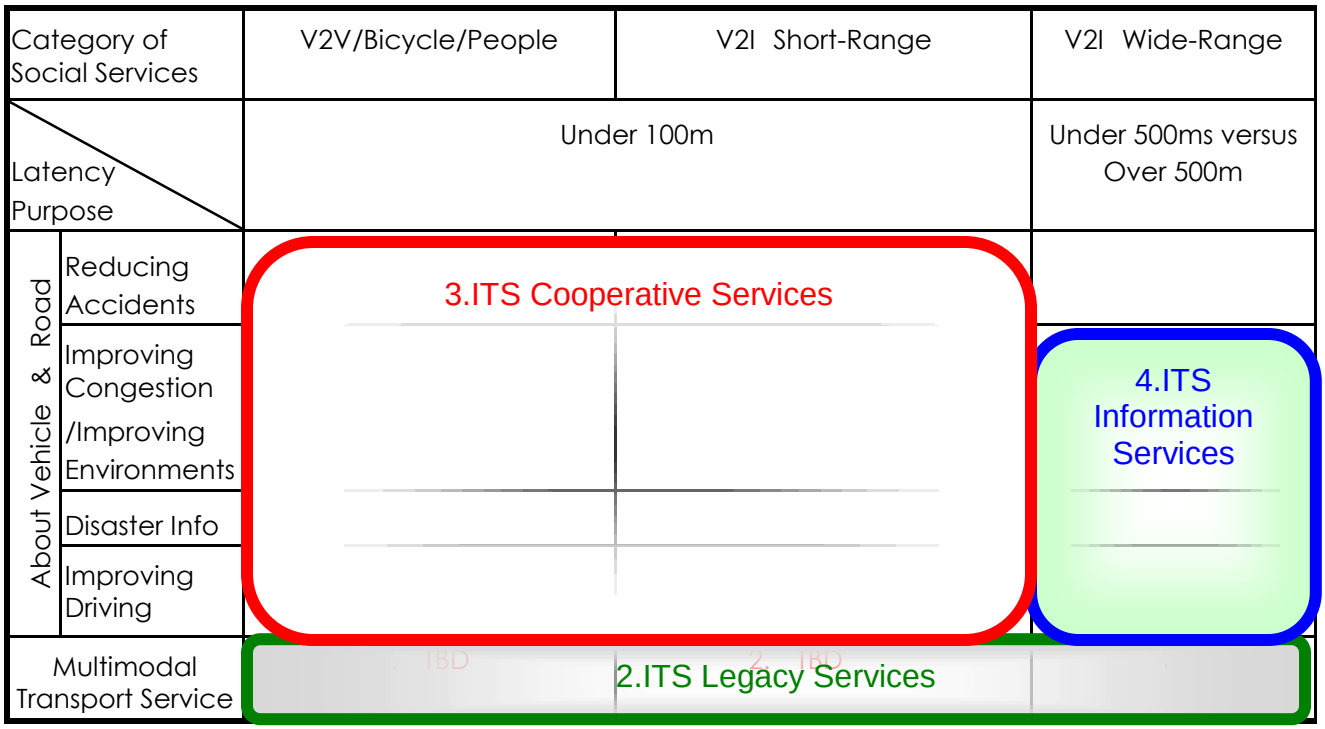


With respect to Table 1, we see three areas of relevant ITS standards to the SUNSET work.
First of all (green box) standards apply either to wide range communication like GSM and WiMAX and on the shorter range WiFi and NFC standards. With respect to the SUNSET work related i-Beacon technology[1] is of interest as a possible Near Field Communication (NFC) competitor. The iBeacon works on Bluetooth Low Energy (BLE), also known as Bluetooth Smart. BLE can also be found on Bluetooth 4.0 devices that support dual mode. One potential application is a location-aware, context-aware, pervasive small wireless sensor beacon that could pinpoint users' location in e.g. a store, but also e.g. in a vehicle like a bus or train.

[1] iBeacon is the Apple Trademark for an indoor positioning system that Apple Inc. calls "a new class of low-powered, low-cost transmitters that can notify nearby iOS 7 devices of their presence.

Secondly (red box) Cooperative ITS relates to the SUNSET work especially where integration between road-side or in-car sensor networks with Smartphone technology is in scope.
Finally (blue box), in improving congestion reduction long range oriented standardisation efforts in Fleet management could be of interest and relevance to SUNSET.

Table 2: Gap analysis of ITS standards according to the ITU-T [4]



The Gap analysis according to the ITU-T of Table 2 mainly impacts SUNSET in the areas of ITS legacy Services (green box) and ITS Information Services (Blue box). In the sections below related ITS active Standardisation Working Groups are briefly revisited.

3.1 CEN/TC278 and ISO/TC 204

The CEN TC278 ITS active WGS as of July 2013 [5] were:

- WG1: Electronic Fee Collection
- WG 2: Freight, Logistics and Comm. Vehicle Operations
- WG 3: Public Transport
- WG 4: Traffic and Travel Information, e.g., using road-side VMS (Variable Message Signs)
- WG 8: Road Traffic Data
- WG 9: DSRC dormant
- WG 10: Human-Machine Interfacing
- WG: 12: AVI/AEI
- WG 13: Architecture and Terminology
- WG 14: Recovery of stolen vehicles (UK)
- WG 15: eSafety / eCall
- WG 16: Co-operative ITS

The scope of ISO/TC 204 is the Standardisation of information, communication and control systems in the field of urban and rural surface transportation. This includes intermodal and multimodal aspects, e.g., traveller information, traffic management, public transport, commercial transport, freight vehicle telematics, Transport Protocol Expert Group (TPEG) data-streams, emergency services and commercial services in the intelligent transport systems (ITS) field [6]. In-vehicle transport information and control systems are excluded from ISO/TC 204 as these are dealt with a separate TC, ISO / TC 22.

The ISO/TC 204 ITS active WGS, as of July 2013 [5], were:

- WG1: Architecture
- WG3: Database Technology
- WG4: Automatic Vehicle Identification / Automatic Equipment Identification (AVI/AEI)
- WG5: Fee and Toll Collection
- WG7: General Fleet Management and Commercial/Freight Operations
- WG9: Integrated Transport Information, Management and Control
- WG10: Traveller Information Systems
- WG14: Vehicle/Roadway Warning and Control Systems
- WG16: CALM
- WG18: Cooperative ITS

There are about one hundred and seventy-five ISO/TC 204 standards, including updates. These cover a broad range of ITS activities including toll charging, autonomous systems and safety. There is an individual cost of about 70 euros to access each ISO standard.

CEN/TC278	ISO/TC204
WG13: Architecture	WG1: Architecture
	WG3: Database Technology
WG12: Automatic Vehicle Identification / Automatic Equipment Identification (AVI/AEI)	WG4: Automatic Vehicle Identification / Automatic Equipment Identification (AVI/AEI)
WG1: Electronic Fee Collection	WG5: Fee and Toll Collection
	WG7: General Fleet Management and Commercial/Freight Operations
WG8: Road Data	WG9: Integrated Transport Information, Management and Control
WG4: TTI	WG10: Traveller Information Systems
	WG14: Vehicle/Roadway Warning and Control Systems
	WG16: CALM
WG16: Cooperative ITS	WG18: Cooperative ITS

Table 3: Collaboration CEN/TC278 and ISO/TC 204 [5]

There is a collaboration and overlap between CEN and ISO in terms of ITS standards, see Table 3.

The ISO/TC 204 standard areas relevant to SUNSET include:

- Personal ITS stations (ITS-S) are split into a ITS-S router and connected ITS-S hosts, either or both that can be located in a hand-held device)
- Localisation but the main focus is on for use with autonomous vehicles rather with human controlled ones
- Mobile devices(ISO/TR 10992:2011)
- Local Dynamic Maps (ISO/WD TR 17424)

N.B. There is no public access to the ISO ITS standard documents in order to analyse its use in SUNSET without paying ISO an access fee for each standard.

3.1.1 ISO/TR 10992 (Mobile Devices)

ISO/TR 10992:2011 specifies the use of multimedia and telematics nomadic devices for PT and automotive world to support ITS service provision and multimedia use:

- Passenger information,
- Automotive information
- Driver advisory and warning systems
- Entertainment system interfaces to ITS service providers and motor vehicle communication networks.

3.1.2 ISO/TR 17424, TS 18750, (Local Dynamic Maps)

SUNSET uses an open-source initiative openstreetmap (http://www.openstreetmap) to display map information to users of the SUNSET system. It could use other standards to enhance the content in these maps to make them more temporally and/or spatially situated. ISO/TS 17931:2013 provides the map-related functional requirements, data model (logical data model/logical data organization), and data elements for Local Dynamic Map for those applications of Cooperative ITS that require information derived from map databases. An LDM (Local Dynamic Map) is a key element for cooperative ITS used to store location-stamped and time-stamped information in an ITS-SU in support of sharing of data between applications. This LDM standard will support all kinds of data dictionaries (existing ones and new ones) and ITS message sets.

3.2 ETSI Activities and Standardisation

3.2.1 ITS

ETSI supports various transportation domains with standardisation activities that are carried out by key industry players and therefore reflect true market demand. Standardisation for road transport focuses on wireless communications for Cooperative ITS, with a priority on the safety of life through the reduction of road fatalities and injuries, traffic efficiency with reduction of transport time, economic consequences, and polluting emissions.

ITS add information and communications technology to transport infrastructures and to all types of vehicles in an effort to improve their safety, reliability, efficiency and quality. They also help to optimize transportation times and fuel consumption, thus providing greener, safer and more economical transportation. Road transport, railways, aviation and maritime services will benefit greatly from the deployment of ITS, whilst end-users will experience customized services. Connected vehicles will improve electronic toll collection and navigation systems, e.g. through real-time maps that take account the current traffic situation derived from the Co-operative ITS. Knowledge of exact geographical locations is important to all these services, so the standardization of Global Navigation Satellite Systems (GNSS) such as GPS and Galileo also plays

a vital role. Furthermore, the combination of communications and services can lead to smart handling such as the eFreight and the Single European Sky (SES) initiatives.

Standardization currently focuses on Co-operative ITS, aviation, electronic fee collection and interoperability of these technologies. There about 20 current ETSI ITS standards [5]. These tend to focus on the use of specialised V2I and V2V systems and applications whereas SUNSET focused more on the use of mobile phone enabled FVD exchange.

3.2.2 M2M

There are two aims of ETSI M2M TC: to develop and maintain an end-to-end overall telecommunication high level architecture for M2M; to identify gaps where existing standards are incomplete and to provide specifications to fill these gaps. For example, while many M2M deployments will make use of short-range or proprietary radio links, cellular-based M2M solutions will be preferred where mobility is required, or where high data volumes or data transfer rates are involved. Cellular-based M2M can also be used to enable V2P and V2I long-range communication. Within the TC, it is organised into the following WGs: Use Cases & Requirements, Architecture & Network Interworking, Protocols & Interfaces and Security Aspects.
The following M2M TR is the most ITS related one, TR 102 898, Machine to Machine communications (M2M); Use cases of Automotive Applications in M2M capable networks [7], [8].

3.3 Collaboration on ITS Communication Standards (CITS)

ITU Telecommunication Standardization Sector (ITU-T) is one of the three sectors (divisions or units) of the ITU. It coordinates standards for telecommunications. The aim of the ITU-T Collaboration on ITS Communication Standards, CITS, [9] is to provide a globally recognized forum for the creation of an internationally accepted, globally harmonized set of ITS communication standards to enable the rapid deployment of fully interoperable ITS communication-related products and services in the global marketplace. Its current work focus [9] is to:

- Perform a study of identified ITS application requirements so that needed communication capabilities and performance can be properly defined.
- Perform a gap analysis and quality assessment of current ITS communications standards and create an action plan to address identified needs.
- Converge, harmonize, and incorporate appropriate published and emerging ITS communication standards into ITU Recommendations.
- Create a complete, coherent and effective package of security frameworks and standards for use within ITS communications.
- Develop standards to govern the interaction of drivers with communication devices brought into vehicles (such as smart phones).
- Investigate regulatory and legislative actions necessary to facilitate the deployment of ITS communication products and services based on the ITS communication standards being developed.
- Review mobility network services and ITS communications for their application as a 'last resort' supplement to other communication systems for emergency and disaster handling.

Table 4: Gap analysis of ITS standards according to the ITU-T [4]. TBD indicates that CITS had identified a gap but had not expanded on the details of the gap yet.

Category of Social Services		V2V/Bicycle	V2I Short-Range	V2I Wide-Range
Latency / Purpose		Under 100m		Under 500ms versus Over 500m
About Vehicle & Road infrastructure	Reducing Accidents	Ad-/multi-hop V2V safety Comms, Warnings for:: Blind spot , Lane change, Do not pass, Emergency brake light, Emergency vehicle, Forward collision, Motorcycle approach, Slow vehicle, Wrong-way driving; Intersection movement assist; Left turn across path / opposite way	Fleet mgt, hazardous material tracking, emergency response , Loading zone mgt, border crossing mgt, Road hazard warning (e.g., road workers, accident) Smart pedestrian crossings, Speed warnings / regulation enforcement / signage reinforcement, Traffic signal violation detection & enforcement	
	Improving Congestion /Improving Environments			Cooperative navigation, Evacuation route info., Fleet mgt, hazardous , material tracking, vehicle monitoring Floating car (probe) data, Loading zone mgt, border crossing mgt
	Disaster Info			Disaster info., "I am alive" message
	Improving Driving		Electronic toll collection (ETC) Traveler information, urban multi-modal information Location-based services / infotainment / insurance / financial services	LBS / infotainment / insurance / financial services; Mgt of electric vehicles & charging spots; Navigation, Person finder, Refugee information; Vehicle diagnostic info. Weather info.
Multimodal Transport Service		TBD (To Be Done) by ITU-T	TBD by ITU-T	TBD by ITU-T

3.4 IEEE ITS Standards

IEEE has standards activities on several aspects of ITS, such as vehicle communications and networking (IEEE 802 series), vehicle to grid interconnectivity (IEEE P2030.1), addressing applications for electric-sourced vehicles and related support infrastructure and also communication for charging (IEEE 1901). In addition, the IEEE 1609 Family of Standards for Wireless Access in Vehicular Environments (WAVE) define an architecture and a complementary, standardized set of services and interfaces that collectively enable secure vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) wireless communications. Together these standards are designed to provide the foundation for a broad range of applications in the transportation environment, including vehicle safety, automated tolling, enhanced navigation and traffic management,

IEEE 802.11p WAVE, Wireless Access for the Vehicular Environment, defines enhancements to 802.11 (the basis of products marketed as Wi-Fi) required to support Intelligent Transportation Systems (ITS) applications that use short-range communications (less than 500m), specifically WAVE [10]. This includes data exchange between high-speed vehicles, such as ambulances and passenger cars, and between the vehicles and the roadside infrastructure in the licensed ITS band of 5.9 GHz (5.85-5.925 GHz). IEEE 1609 is a higher layer standard based on the IEEE 802.11p. IEEE 1609 is a family of standards:

- IEEE Std 1609.3-2010 IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Networking Services
- IEEE Std 1609.3/Cor1-2012] IEEE Std 1609.4-2010 I EEE Standard for Wireless Access in Vehicular Environments (WAVE) - Multi-channel Operation
- IEEE Std 1609.11-201 0 IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Over-the-Air Electronic Payment Data Exchange Protocol for Intelligent Transportation Systems (ITS)
- IEEE Std 1609.12-201 2 IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Identifier Allocations.

WiMAX (Worldwide Interoperability for Microwave Access) is a wireless communications standard designed to provide 30 to 40 megabit per second data rates. The IEEE 802.16 Working Group on Broadband Wireless Access Standards develops standards and recommended practices to support the development and deployment of broadband Wireless Metropolitan Area Networks. IEEE 802.16 is a unit of the IEEE 802 LAN/MAN Standards Committee [11]. In theory, in urban areas, WiMAX can be used as a replaced for GSM. However, WiMAX cannot typically deliver of the order of 50 Mbit/s over long distance of 50 kilometers.

3.5 IETF

LoWPANs, low-power wireless personal area networks, e.g., 6LowPAN, Low-power wireless personal area networks over IPv6, play an important role in intelligent transportation systems. Incorporated in roads, vehicles, and traffic signals, they contribute to the improvement of transporting system safety. Through traffic or air-quality monitoring, they increase the possibilities in terms of traffic flow optimization and help reducing road congestion. An example scenario is given in [12] where scattered 6 LoWPAN nodes are included in roads during their construction for motion monitoring. When a car passes over these nodes, the possibility is then given to track the trajectory and velocity of cars for safety purposes.

The lifetime of the LoWPAN Nodes incorporated into roads is expected to be as long as the lifetime of the roads (about 10 years). Multihop communication is possible between LoWPAN Nodes, and the network should be able to cope with the deterioration over time of the node density due to power failures. Sink nodes placed at the side of road are mains- powered, LoWPAN Nodes in the roads run on battery. Power savings schemes might intermittently

disconnect the nodes. A rough estimate of 4 nodes per square meter is needed. Other applications may involve car-to-car communication for increased road safety.

3.6 3G GSM and 3GPP

3GPP standardization, established in December 1998, encompasses Radio, Core Network and Service architecture, is an important enabler to support wide area, over distances greater than 500M, V2I and V2P communications [13]. Note that although the 3G GSM standards are the most ubiquitous digital mobile phone network standards, they are not the only one. The USA and some other countries for example support the CDMA2000 standards but GSM is predominant in Europe.

3G GSM also enables Floating car data (FCD), or in the more general form FVD, is a method to determine the traffic speed on the road network. It is based on the collection of localization data, speed and direction of travel and time information from mobile phones in vehicles that are being driven. FVD can be used to support an alternative to smart environment device type V2I and V2V, one that is based on mass market mobile phones rather than on specialised traffic infrastructure environment devices such as traffic light signals, video traffic cameras and AVI/AEI, Automatic Vehicle and Equipment Registration, cameras.

Floating car data technology provides advantages over fixed infrastructure or environment methods of traffic measurement as it is less expensive than fixed, specialised, traffic sensors or cameras; it offers more coverage (potentially including all locations and streets); it is faster to set up and requires less maintenance; it works in all weather conditions, including heavy rain.

The 3rd Generation Partnership Project unites [ARIB, ATIS, CCSA, ETSI, TTA, TTC] telecommunications standard development organizations and provides their members with a stable environment to produce the highly successful Reports and Specifications that define 3GPP technologies. It consists of four Technical Specification Groups (TSG) in 3GPP are Radio Access Networks (RAN), Service & Systems Aspects (SA), Core Network & Terminals (CT) and GSM EDGE Radio Access Networks (GERAN).

3.7 Eco-Travel & Sustainable Travel Standards

The European standard CEN 16258:2012 Methodology for calculation and declaration of energy consumption and GHG emissions of transport services [14] establishes a common methodology for the calculation and declaration of energy consumption and Green House Gas (GHG) emissions related to any transport service. This standard was developed in parallel with the SUNSET project, and it has been intended that any environmental performance calculations of transport modes shall be made with this standard as the basic method support. The standard specifies general principles, definitions, system boundaries, calculation methods, apportionment rules (allocation) and data recommendations, with the objective to promote standardised, accurate, credible and verifiable declarations, regarding energy consumption and GHG emissions related to any transport service quantified. It also includes examples. Intended users of this standard are especially transport service operators, transport service organisers and Transport service users. This standard is therefore important to make the correct calculations of fuel consumption and GHG emissions from any mode of transport. The standard explains for example how to encompass not only the vehicle, but also the life cycle of the production of the energy or fuel used by the vehicle. For these calculations this CEN standard refers to the international standard for Life Cycle Assessment (LCA), ISO 14040:2006 [15] and ISO 14044:2006 [16].

However, assessing the environmental performance of different urban travel routes and transport modes is not simply a matter of calculation. The SUNSET project has specifically acknowledged this by focusing on detailed geographical measurement, acceleration and speed, as well as real time identification of actual transport mode for each traveling individual. The CEN 16258:2012 standard does not take such detailed measurements and data sources into account. Therefore to correctly calculate real time environmental performance of actual transport modes or to correctly summarize the environmental performance of one person's weekly travel, in comparison to other persons or to the same person another week, further guidance is needed.

The international standard ISO/TS 14033:2012 Quantitative environmental information [17] was developed to guide on how to relate detailed data to general calculation methodologies to achieve specific measurement results.

This ISO/TS 14033 standard provides a generic information system architecture that links measurement, data acquisition, data treatment, calculations and reporting in a clear and consistent way. This supports the overall need to both identify each traveller's environmental performance with a calculation of the overall performance of for example a total urban transport system.

Though these sets of standards have been implicitly referenced throughout the work in the SUNSET project, it may be good to also study the Odette Guidelines for Reporting Freight Greenhouse Gas Emissions [18] which summarizes the combined use of the above described standards in the case of the automotive supply chain, as best practice recommendations.

3.8 Information Security and Privacy

Both Information Security (prevent data breaches and unauthorised access to information) and Privacy (prevent disclosure of sensitive, personal information) are of concern considering SUNSET types of real time systems. As these systems potentially provide substantial information about individual vehicles and individual travelers there are concerns within the general public that the potential privacy invasions resulting from this increased monitoring will create a 'Big Brother' or Panopticon state.

While it is shown that people's views on privacy are very heterogeneous (varying from completely unconcerned, to concerned to the point of paranoia), drawing on research conducted into both general privacy and the privacy concerns associated with ecommerce, it is identified that the most appropriate definition of a privacy impact is where the increased monitoring associated with intelligent transport systems (ITS) restricts the perceived freedom of travel that an individual currently experiences

Privacy concerns associated with ITS fall into six distinct areas: the volume and type of data collected ('Is privacy sensitive data collected?'); errors in the data collected ('Is false personal information generated?'); unauthorised secondary uses of the data collected ('Is personal data re-used for other purposes without user consent?'); inappropriate use of the data collected (again 'Is personal data re-used for other purposes without user consent?'); a lack of awareness about what the data will be used for ('No clear privacy policy in place protecting users'); and a lack of control over who can gain access to the data.
In many European countries, legislative bodies usually define privacy requirements. Data protection supervisors are responsible for implementing and monitoring such privacy requirements in evolving application domains.

ISO:IEC 27001:2013 [19] states that any compliant system will ensure the integrity, availability and confidentiality of any information and data that is held by an organisation so in the case

of any ITS this is important as considerable amounts of the data are personal data from GPS tracking devices for example.

3.9 Specific ITS Standards Initiatives by SUNSET and Consortium Members

Table 5: SUNSET System Functions and how it Analysis of ITS standards according and how they fit the ITU-T [4] ITS Gap Analysis

Category of Social Services		V2V/Bicycle	V2I Short-Range	V2I Wide-Range	V2P	H2H or P2P
Latency / Purpose		Under 100m		< 500m vs. > 500m	SUNSET .ITS Information Services	
About Vehicle & Road infrastructure	Reducing Accidents					
	Travel safety					
	Improving Congestion /Improving Environments					
	Eco-friendly travel					
	Improving Driving					
	Disaster Info				SUNSET .ITS Information Services	
Multimodal Transport Service						
Road Use Strategies & Policy						

ITS Gap Analysis is summarised in Table 5. SUNSET does not directly support the use of NFC, RFID, 6LowPAN, WiFi and WiMAX, for communications although these could be used. SUNSET relies on the use of GSM 3G mobile phones to enable support for FVD communication. SUNSET is not a member of CEN/ISO and ETSI as these tend to support specialised fixed and vehicle (smart) environment device V2V and V2I communications It did not pay the fees to access CEN/ISO document standards.

The standards activities by SUNSET industrial members are detailed in the following sections. N.B. SUNSET consortium members, Novay, Queen Mary University of London, University of Twente and Leeds University, Viktoria Institute and LocatieNet have no specific activities in ITS standardisation bodies.

3.9.1 NTT Docomo

NTT Docomo is active in 3GPP Release 10 and will include work on Machine Type Communications, which promise to be a major element in Intelligent Transport Systems. This will enable 3GPP type communication to internetwork with local M2M communications [20].

3.9.2 Eco2Win

Eco2Win presented the paper 'individual sustainability performance indicators for urban everyday traveling' at the 7th Ecobalance conference in Japan in November 2012, which describes the vertical information from individual measurements to sustainability performance of an entire urban transport system.

Eco2Win Supervised the Master thesis work 'Sustainable Urban Mobility - Could smartphone apps master the challenge…?', Mia Pantzar, Lund University, 2011. The thesis also gained first student price by Sweco in 2012 [21].

Eco2Win has an accepted paper 'Sustainability and social media based transport schemes to the 8th Ecobalance conference in Japan October, 2014 [22]. This paper describes the mechanisms that may make social media influence a sustainable performance of urban transport systems.

3.10 Standards and Principles Used in the SUNSET Platform

The goal of the SUNSET platform is to offer enriched mobility information, based on raw sensor data from the personal sensor network of travellers, and offers clear added value to the platform applications in the sense that it derives patterns and models from this raw data and exposes these to the applications concerned with visualization or user interaction. All applications are integratedinto the SUNSET platform using state-of-the-art technology and standards

3.10.1 Technology Choices and Standards

All SUNSET interfaces are specified and implemented as REST (Representational State Transfer) services, where all functionality is available from well specified resource URLs according to the API descriptions. All SUNSET APIs have the following characteristics:

- Architectural model: REST
- Message payload: JSON
- Content type: application/json
- Character encoding: UTF-8
- Compression: GZIP
- Protocol: HTTPS via a central proxy
- URL pattern: https://www.tripzoom.eu/api/apiname/resource/parameters
- Security: SSL
- Authentication: oAuth

The SUNSET database is a MySQL database, accessed using ORM (Object-Relational Mapping) implementations such as (N)Hibernate, for Java and C#, in which the majority of the server side components is developed.

3.10.2 Naming Conventions

We define names of classes in UpperCamelCase, instances in lowerCamelCase, and methods in UpperCamelCase.

3.10.3 Internal and External APIs

External APIs (Application Programmer's Interfaces) are named Incentive, Identity, PersonalMobility and Measurement.
Internal APIs, such as the InfraNetwork API, also have a clear service contract

3.10.4 Authorization

Three types of sessions exist: anonymous, user and consent sessions. For consent sessions, there are a number of additional rules:

- If an incoming request does not originate from localhost: reject always. This should not be possible because of the firewall but better safe than sorry.
- If an incoming request does originate from localhost:
  - Without X-Forwarded-For header in the request: accept always and neglect the consent restrictions. This is an internal request from other services on the server.
  - With X-Forwarded-For header in the request: check if the iZone-OAuth-Consent header (a comma separated list) contains *all* consent items that are required for the requested operation. Next, check if the user ID in the request (if any) is the same as the ID in the iZone-OAuth-User header. If this is the case, the request can be accepted.

3.10.4.1 Application Authentication

Application credentials consist of an application identifier and a shared-secret. These credentials are used during the establishment of an OAuth consent session. The platform stores the shared-secret in clear text because it must be used to verify application signatures during OAuth negotiation.

3.10.4.2 Application Authorization

Applications get access to the SUNSET API based on consent given by the user (through the OAuth protocol). All applications may receive consent for all consent groups defined in the SUNSET API, i.e., no restriction apply for which consent groups an application asks permission from the user. The platform must define user interface elements (dialogues) for the authentication and authorization steps during OAuth negotiation (i.e., a login dialogue, and a consent dialogue presenting information about the consent groups for which the application asks consent).

3.10.5 Resources

Important resources in the context of SUNSET are things like location, user, traffic information, infrastructure segments, et cetera. These resources can be created or requested via URI, in a standard way, such that these URIs can act as both the unique ID of the resources and the location where the resource description can be obtained from, .

URI	Meaning
resource/{id}	A resource with ID id
user/{id}	A user with ID id
resource/user/{id}	All resources of user with ID id
location/from/{t0}/to/{t1}	All location measurements in the period from t0 to t1
mobilityprofile/user/{id}/match	All mobility profiles matching the one of user with ID id
trafficinfo/sensor/{id}/prediction/{ts}	A prediction of the traffic information of sensor id over ts seconds

Table 6: URIs (Universal Resource Identifiers) used by SUNSET and their meaning

3.10.6 Units of Measure

Units of Measure are assumed to be standard across the platform, and are not specified in the data model.

- Length (m)
- Speed (m/s)
- Time (s)
- Temperature (C).

3.10.7 System Status and Error codes

The IETF HTTP protocol 4xx class of status code is intended for cases in which the client seems to have erred. Except when responding to a HEAD request, the server should include an entity containing an explanation of the error situation, and whether it is a temporary or permanent condition. These status codes are applicable to any request method. User agents should display any included entity to the user. If the client is sending data, a server implementation using TCP should be careful to ensure that the client acknowledges receipt of the packet(s) containing the response, before the server closes the input connection. If the client continues sending data to the server after the close, the server's TCP stack will send a reset packet to the client, which may erase the client's unacknowledged input buffers before they can be read and interpreted by the HTTP application.

- 400 - Bad Request
- 401 - Unauthorized
- 402 - Payment Required
- 403 - Forbidden
- 404 - Not Found
- 405 - Method Not Allowed
- 406 - Not Acceptable
- 407 - Proxy Authentication
- 408 - Request Timeout
- 409 – Conflict

4. Conclusions

There are several different standards that seek to specify ITS standards, not only for operational systems (in terms of ITS specific standards) but also support other phases of the life-cycle of ITS development such as requirements and design (architectures).

In order to assess the scope and focus of ITS standards in general and relate these to SUNSET, there are several different analysis criteria that could be proposed in terms: of the type of ITS interaction, viz, V2I, V2V, V2P, in terms of the type of vehicle (road motorised versus human-powered versus non-road motorised); the distance of the ITS communications, e.g., Under 100M, under 500M or over 500M; in terms of stake-holder such as transport infrastructure operator, vehicle manufacturer or network operator; and finally in terms of ITS system user and application domain requirements.

SUNSET adopts and drives its adoption of ITS standards from its application requirements and its system deployment. For SUNSET, the application requirements cover ITS use focussing primarily on passenger rather than vehicle drivers. SUNSET system requirements tend to cover aspects of ITS that are outside the current ITS standards and the current analysis of ITS standards gaps, e.g., by ITU-T, multimodal travel (walk, cycle, bus, metro, car, etc.), includes safety other than non-vehicle safety and eco-friendly indicators of multi-modal travel. SUNSET also supports high-level, societal ITS cooperation that is currently outside the ITS standards initiatives. This includes incentivising targeted use of transport to enhance eco-friendly travel and travel safety by transport authorities. It also includes social propagation via social networks and, encouragement, fostering and acknowledgement of good and bad travel behaviour, such as eco-friendly travel. SUNSET does not directly support the use of NFC, RFID, 6LowPAN, WiFi and WiMAX, for communications although these could be used. SUNSET relies on the use of GSM 3G mobile phones to enable support for FVD communication.

5. References

[1] Poslad S. Ubiquitous Computing: Smart Devices, Environments and Interaction, Wiley, ISBN-13 9780470035603, 473 pages, 2009. http://www.eecs.qmul.ac.uk/~stefan/ubicom/

[2] Poslad, S, Hamdi M. Abie, H. Adaptive security and privacy management for the internet of things (ASPI 2013), September 2013, UbiComp '13 Adjunct: Proc. of the 2013 ACM Conf. on Pervasive and ubiquitous computing adjunct publication, pp 373-378. ISBN: 978-1-4503-2215-7. DOI: 10.1145/2494091.2499770.

[3] Intelligent Transportation Systems (ITS) Standards Program Webpage. Available from http://its-standards.eu/, accessed 05/12/2013.

[4] ITU-T Meeting June 2013, Report, Geneva. Switzerland. Available from http://www.itu.int/en/ITU-T/extcoop/cits/Pages/meeting-documents.aspx. Retrieved 30/11/2013/

[5] Schade, H-J. CEN/TC278/WG16 and ISO/TC204/WG18 Progress towards ITS Standardization, July 2013. Available from http://www.comesafety.org/fileadmin/user_upload/PDFs/C-ITS_at_CEN_TC278.pdf, ETSI Intelligent Transport Systems Standards. Available from http://www.etsi.org/technologies-clusters/technologies/intelligent-transport. Retrieved 10/10/2013.

[6] ISO Standards catalogue. Standards and projects under the direct responsibility of ISO/TC 204 Secretariat. Available from http://www.iso.org/iso/home/store/catalogue_tc/catalogue_tc_browse.htm?commid=54706. Retrieved 15/09/2013.

[7] ETSI Machine to Machine Standards. Available from http://www.etsi.org/technologies-clusters/technologies/m2m. Retrieved 10/10/2013.

[8] Proceedings of the 4th ETSI M2M Workshop, 5th-7th November 2013, Congress Exhibition Centre, Mandelieu-La Napoule, France. Available from http://www.etsi.org/news-events/events/666-2013-m2mworkshop, Retrieved 05/12/2013.

[9] ITU-T Collaboration on ITS Communication Standards, CITS, Homepage. Available from http://www.itu.int/en/ITU-T/extcoop/cits/Pages/default.aspx. Retrieved 05/12/2013

[10] Jiang D, Delgrossi, L. IEEE 802.11p: Towards an International Standard for Wireless Access in Vehicular Environments, 2010. Available from ftp://ftp.cs.ntust.edu.tw/yhl/mobile12/802.11p-intro.pdf. Retrieved 23/11/2013.

[11] IEEE 802.16 Working Group on Broadband Wireless Access Standards Home page, http://grouper.ieee.org/groups/802/16/. Retrieved 23/11/2013.

[12] Vasseur JP. . Design and Application Spaces for 6LoWPANs, 2010. Available from http://tools.ietf.org/search/draft-ietf-6lowpan-usecases-06, Retrieved 23/11/2013.

[13] 3rd Generation Partnership Project (3GPP) Home page http://www.3gpp.org/. Retrieved 05/12/2013.

[14] CEN 16258:2012 Methodology for calculation and declaration of energy consumption and GHG emissions of transport services

[15] ISO 14040:2006 Environmental management -- Life cycle assessment -- Principles and framework

[16] ISO 14044:2006 Environmental management -- Life cycle assessment -- Requirements and guidelines

[17] ISO/TS 14033:2012 Environmental management -- Quantitative environmental information -- Guidelines and examples, International Standards Organization

[18] Buchanan, J. et al , Odette guidelines for reporting freight greenhouse gas emissions v 1.0, Odette International Logistics General, LG08 Odette, London UK, 2013

[19] ISO information security standard. Available from http://www.iso.org/iso/catalogue_detail?csnumber=54534. Retrieved 07/12/2013
[20] 3GPPI News Article, Available from http://www.3gpp.org/news-events/partners-news/1131-Intelligent-Transport-Systems, Retrieved 05/12/2013
[21] Pantzar, M. Sustainable Urban Mobility. Could smartphone apps master the challenge...? 2011. Msc Thesis, Lunds universitet. Available from http://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=3053393&fileOId=3053401. Retrieved 12/01/2014.
[22] 8th ecobalance conference Homepage, Japan October, 2014. Available from http://ilcaj.sntt.or.jp/EcoBalance2014/. Retrieved 29/01/2014