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ITS in the digital society

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ABSTRACT
Uniform for cars, smartphones, Road Side Units and Traffic Management Centers European Cooperative ITS (C-ITS) Architecture model opens the road to integrated design of mobility management systems where pedestrians and cars play an active role in shaping the traffic conditions and dedicated radio frequencies enable them to solve most of the ongoing cases. The new business models involve equally car makers, drivers, passengers, road and railway operators, financial sector (lease, insurance providers, banks), municipalities and governmental road and transport agencies, telecoms, ICT 800 pounds gorillas as well as startups in cooperative design, enhancement, delivery and consumption of mobility services. Will we manage to leverage the global experience, enrich European C-ITS output and avoid being marginalized as pure consumers on new services market?

KEYWORDS: C-ITS, automatic land vehicle, MaaS, ECIM, sensor fusion, machine learning,

1. Introduction

From 2010 to 2014 fatalities on Roads of Europe decreased by 18%, but between 2013 and 2014 it dropped only by 1%. Data from Japan: there are 16 mln cars registered in Tokyo with its 35,6 mln inhabitants (the numbers and proportions similar to Poland as a country) and although the fatalities fell 4 times from 1970 to 2014 but they still account for 4000 – again the statistics comparable to these of Poland [12]. One can draw from the above data the conclusion that the up to now applied methods of improvement: better infrastructure, more rigid law and its execution, better education of drivers all have met its limits.

From the beginning of the century ITS started its new development in which, from today's perspective, one can discern three phases: first one enclosed between 2000 and 2009 was the time of R&D as well as testbeds of technologies and solutions aiming at radical change of the two rudimentary principles of traffic management systems in accordance with which the vehicles and pedestrians were passive objects surveilled by detectors installed inside or around road infrastructure and the system itself was hierarchically designed with traffic management center and local controllers as layers. The first phase was concluded by the launch of the well-known M/ 453 Mandate [11]. The second phase (2010-2015) comprised further technology improvements, elaborating of standardization documents in response to the Mandate, eg. the works of CEN, ETSI IEEE, ISO and SAE specifying BSMD (Bounded Secured Managed Domain) model for C-ITS-Station architecture - ISO 21217, ETSI EN 302 665 [10], Field Operational Tests of early solutions in the scale of thousands of vehicles and road kilometers EXECUTED as Living Labs: SCOOP@F with its 5 sites in France, other in Spain and Portugal, NL-DE-AT C-ITS Corridor, NordicWay and eventual choice of three domains of transport and mobility technology and models development: Cooperative ITS (known also as connected vehicles or V2X paradigm), Autonomous Land Vehicle and Mobility as a Service – the last on as a generalization of multimodal transport.

- C-ITS Corridor Austria – Germany – The Netherlands, from 2015
- French corridor pilot project Paris – Strasbourg, from 2015
- Corridor project in Sweden, estimated 2016-17
- Corridor project in Poland, estimated 2016-17
- Corridor project in Portugal, estimated 2016-17
- City projects in accordance with the EC supported COMPASS4D project: Bordeaux, FR; Copenhagen, DN; Eindhoven, NL; Newcastle, UK; Thessaloniki, HE; Verona, IT; Vigo, ES
- City projects under consideration within the POLIS organization (source: [16])

As an and of the second phase one can admit the date of publication of the report [9] (21st of January 2016), which confirms that Europe accelerates the move towards new transportation and mobility model, and the years 2016-2018 (the third symbolic phase) will see the last preparations od massive V2X deployments on public roads leading eventually to better traffic where cars mill move with much of situational awareness, in a coordinated way, safely, effectively and environmentally friendly.

The participants of 22nd ITS World Congress, Bordeaux, France, 5–9 October 2015 were actively debating during these days questioning the chances and addressing the factors determining further development and geo-deployment of technological and business innovations. That's why the closer analysis of the directions and pace of new mobility practices expansion will be structured following for fundamental questions: Why, and what for do we need changes (Chapter 1). What are the key enablers for these changes (Chapter 2). How will the governments, markets, communities and individuals proceed in introducing them (Chapter 3) in particular what about legal challenges and what changes are being considered. Who, which actors and in which (new) roles would engage to carry out the changes (Chapter 4). Finally in Chapter 5 we try to condense the answers to the four questions and formulate several most important (in authors' opinion) recommendations for local conditions.

1.1. What for implement C-ITS?

The needs and expected benefits, what bothers us in present state of transportation and what we would like to change? The list of problems starts with car crashes and their victims, congestion, pollution, daily troubles like: why am I so dependent on transport means be it waiting on a bus stop or the challenge of parking my own car. As a pedestrians or cyclists we wish more city space be available for us. I'd prefer not bearing the costs of my car while I'm not using it.

The costs "are here to stay", but at least in business, we are trying to minimalize and even avoid spendings which are not directly connected to benefits, accepting those which we bear in proportion and synchronously to the value. Examples: unwanted costs the initial investment (car's price), insurance in current model) vs more willingly accepted like fuel for the next trip, or tolls

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What is changing? The life style of millenaires: forced by structural debts they are facing should they stick to traditional model of dwelling, travelling and consuming they leverage alternatives brought by internet communities they belong to. Being immersed in the realm of information makes one prone to optimization of virtually every decision and rejection of any value-void activity or engagement. What attracts? More space to live and decide, eg. car as a former exemplification of freedom is being replaced by (affordable) mobility on demand. Let us analyze the potential of C-ITS, ALV and MaaS in key aspects/ criteria.

Safety: bringing to zero the number of fatalities or seriously injured, bringing down number of crashes caused by road defects, obstacles, animals; protecting vulnerable road users (VRU) – disabled, seniors, minors, cyclists; avoiding accidents near road works, railway crossings; following drivers' fatigue, distraction, blocking of privileged vehicles. Reducing damages resulting from (natural) disasters, mass events, stealing and devastations - more generally improving safety in public space in every case where the right information passed in time allows for (partially) automated prediction, diagnosis and intervention support. Basic set, as well as possible bundles of appropriate message exchanging scenarios serving the above cases are easily imaginable and to some extend already, standardized implemented and tested.

The effectiveness, efficiency and reliability of transport begins where the trip/ shipment can be avoided with the "business" objective achieved (home office, tele-diagnostics, 3/4D printing). In prevailing number of all remaining cases we'd like to economize on time, hence keeping as few trip's modal segments as possible and waiting time between them the shortest. This goal interferes however with that of cost, or our readiness to sacrifice for the good of environment. On the level of the segment we would like to transfer rapidly and seamless but the optimization should be done for the overall concurrent work. So, one part of the answer on the What for C-ITS, ALV, MaaS? question is: to leverage new data capturing and information exchange technics to supply to people's and machines' decisive and actuating processes the most complete traffic picture possible allowing them to be part of multitude of distributed, collaborative processes aiming at high transport efficiency accompanied with low social and environmental costs.

There is a trend for vehicle use within Europe that can be described as ‚private vehicle abuse' where cars with single occupancy are used for journeys of less than 3 Km accounting for 50% of all car journeys in urban environments, 98% of the time the car is parked occupying space on the road. 60% of the space in the Swedish cities is devoted to infrastructure, 25% to roads. The goals of OptiCities project are to: save 1.5M T CO2, increase public space by 3.6M sqm; an achieve a move of 6% use towards public or soft transport methods.

The expected shift from individual cars towards public transport will happen if the latter becomes attractive in several ways: should be faster than the car alternative, cheaper, comfortable enough etc. But the decisive attributes in that respect: dependability/ assuredness and flexibility/ reachability in terms of time and space (last mile) coverage if to be achieved at reasonable costs (which means that the solution should reuse existing assets and apply car pooling/ car sharing schemes) entail comprehensive dynamic and precise information to relay on when navigating the two parties (passenger and transport) to the meeting point. Such a level of informative services offers the connected vehicle paradigm with the Local Dynamic Map (see later) and wireless communication with every data source and addressee. High reliability of all the assets is a natural consequence of the Extended Car concept where real time exploitation data are gathered and analyzed by manufacturers to alert the user in case of breakdown predicted.

Energy/ resource efficiency, low environmental impact: is to be achieved when individuals are confronted on the consequence of their decisions directly (with precise, quantitative information in their trip planners) or through the cumulated cost of mobility services. On the level of carriers and operators fine granularity data on the on-going demand (O-D) and present as well as predicted traffic allows for two types of intervention: influencing individuals in their choices and optimal disposition of resources. The landform data fused with traffic conditions will be leveraged by algorithms deciding on fuel consumption in engines and specifically in those with energy recovery feature.

Travelling comfort: physical and mental fatigue monitoring, reacting on early symptoms, and finally reduction, educating and entertaining those who can be distracted without compromising their safety – infotainment. Social integration and inclusion as a side effect of car sharing: before we share an asset we exchange information, we meet people on a regular basis, spend time with them, start talking …

Transport and mobility sectors can almost immediately leverage data created and exchanged dynamically to resolve safety, traffic management and transportation efficiency problems in much more comprehensive way than up to now, but on the way they are also able to create deep and reach information resources, transform them in a kind of knowledge network, connect the latter with global knowledge network and help resolve general social and economic issues. On top of benefits described above, hosting ICT in the traditional domain of telematics can help create new markets of services addressing informational needs of mobility and traffic management. While tackling the How? and Who? questions in following chapters we will give several examples of these services nevertheless we would like to stress already here that the data driven mobility will be the source of generally applicable scientific and technical solutions for instance in the field of Human – Machine interaction.

1.2. What are the key enablers of the change?

The answer conveying some details on components and solutions as well as structures and tools assuring interoperability of the former ones to pave the way to first chapter's vision of safe, effective and efficient mobility brought back to the human scale and enriching our lives was divided into layers treating separately: The technology, The architecture, applications and economic/ social models. The ubiquity of technology determines effective design and deployment of applications and solutions but tackling the integration issues is fruitless without standardization at least in the domains of data exchange and software portability between executing platforms (various nomadic devices, On Board Units). But only after the take up of the new services and solutions to apply them in our daily routines: leveraging situational awareness in the choice of transport mode, co-creation of that awareness through granting information on planned trips, offering one's own transport resources (sharing cars), collecting and discounting but also cleverly delaying gratification due for safe and socially aware driving/ parking and on the other hand after new services creation, composing them into processes delivering added value and further bundling them into entire business models capable to sustain through multidirectional benefits and synergies will be the mobility model radically changed.

Technology. The data domain describing real objects, their behavior and mutual relationships comprise: the position expressed in geographical coordinates, altitude, relative to marking points in the road infrastructure, to other road users or other relevant objects taking into account their categories (truck, pedestrian, obstacle) and orientation, the time stamps, distances, velocities, accelerations, masses, temperatures, humidity, precipitation and it's hardening state, visibility, line of sight, air transparency and it's composition, light conditions, the pavement category and state, driver's reactivity etc. In measurement/ capturing of most of the above categories, from last several years on we have noticed significant progress thanks to the still improving precision of satellite (Global Navigation Satellite System augmented by European Geostationary Navigation Overlay Service) optic, laser, kinetic and inertial technics. Application of numerical methods: image analysis and recognition, sensor data fusion using Kalman/ particle filters, and more generally statistical data analysis for precision enhancement many of technological barriers were overcome (under decimeter moving objects positioning, high quality object classification) on the road to automated (ALV) and connected (C-ITS) cars. What eventually decide and ultimately ascertain the maturity of the technology at hand to contribute to our connected cars vision is radical decrease of it's cost to the level allowing for ubiquitous installation in nomadic devices or lower segment cars.

Elon Musk, the founder of Tesla motors and SpaceX, announced on 16 January 2015 that he is beginning a new project that will launch hundreds of communication satellites into orbit. On 21st of December he successfully launched a spatial vehicle delivering a cluster of low orbit telecommunication satelites and the booster landed undamagged to be furthe reused. It becomes quite viable to bring down the cost of such a mission to the level of 5-7 mln USD and consequently his plan to install some 4000 low orbit satellites.

In the case of satellite technology an expected breakthrough is related to accomplishment of Galileo and GLONASS programs but also those of Google and SpaceX, which in spite of being primarily aimed on Internet delivery to every corner of Earth can as well once and for all resolve the geo-localization issues. Smartphones and satellite system are commonly perceived as telecommunication technology artefacts but in our V2X realm they act as devices measuring wide range of parameters mentioned at the beginning of this section. For communication purposes wireless technologies (GPS, G3, LTE, millimeter WAVE) and hybrid use of them can be leveraged for building systems of message exchange between cars equipped with native hardware (OBUs), individuals wielding nomadic devices, road side units and traffic management centers. Such a system will extensively benefit from specialized protocols: Wreless Access in Vehicular Environments (WAVE) and Vehicular Ad hoc NETworking (VANET) to dynamically set up temporary local networks with topologies corresponding to traffic situation at hand, with security and privacy ascertained through higher network layers. The next technology after sensors, sensor fusion and wireless telecommunication artefacts enabling the design, development and deployment of C-ITS systems, ALVs and new mobility services is ICT, and more specifically Open Data, Big Data and Machine Learning, Service Oriented Architecture implementation, process management suites of tools and proved through numerous implementations of massive customer management applications electronic payments, master data management. Classification, diagnostic and predictive statistical algorithms reposing on traffic data streams and historic dbs belong to the larger set of tools for designing situational awareness platforms.

Collective Awareness Platforms for Sustainability and Social Innovation … to harness the collaborative power of ICT networks (networks of people, of knowledge, of sensors) to create collective and individual awareness about the multiple sustainability threats … at social, environmental and political levels. The resulting collective intelligence will lead to better informed decision-making processes and empower citizens, through participation and interaction, to adopt more sustainable individual and collective behaviours and lifestyles. The challenge includes the deployment at larger scales of digital social platforms for multidisciplinary groups developing innovative solutions to societal challenges.Similar to CAPS could be the platform enabling in-depth insight into the details of current situation, it's roots and possible evolving scenarios on local/temporal (instant traffic task resolution) as well as broader scale (demand – supply balance). That knowledge to be elaborated based on data collected by networks of people and things and then enriched to diagnostic/ predictive models through networks of knowledge and macine learning.

The next set of technics from the ICT toolset invading the territory of IoT and consequently ITS comprise distributed databases retaining encrypted chains of records (block chains, side chains, Bitcoins) serving as persistence layer of traffic events, infrastructure or vehicle exploitation and tolling data. The last tech block in the general sequence: data capture -> transmission -> processing -> informative service delivery, commonly known as Human Machine Interface (HMI) and in particular visualization technologies. The progress in this domain is widely visible: large touchscreens and Head Up Displays (HUD) in middle and higher car segments, so it can be concluded the if only the right message could be delivered to on board units or at least to by cellular networks then the costly Variable Message Signs prove to be unnecessary or redundant. Let us close his short overview mentioning the cloud technology and it's exemplary use by European Cloud Marketplace for Intelligent Mobility (ECIM)uses to develop and maintain the so called open platform of intelligent services for mobility [17].

Architecture and Standards. The notion of (system, software) Architecture in ICT matured along with growing complexity of solutions being designed and maintained. Folks started to leverage the rules of software decomposition into smaller pieces: components and interface and delegate development jobs to independent teams avoiding the necessity to consult the implementation details. It was no use to repeat fragments of code "doing the same" in many places of the overall program – universally applicable services were created. Equally important was the possibility of porting the software on various hardware/ operating systems. All these circumstances are valid in the case of C-ITS: software complexity, designating of utility functions (security, communication services) concurrent and independent development in various software houses and startups, at least four platforms: OBU, RSU, nomadic and TMC. The by ETSI (EN 18750) and ISO (21217:2014) recommended BSMD use as a building block for homogenous design of C-ITS Station architecture for the four aforementioned stations is shown at Picture 1. Also, indicated by the arrows from left to right, you can follow one selected expansion path of the C-ITS-S ending with Local Dynamic Map with its four layers. Various LDM implementations must fit in the Model in that sense that they should follow the structures and interfaces imposed by the specification of facility layer.

- Presentation Layer: Contains all the User Interfaces and Visualization Modules
- Services Layer: Exposes APIs as web services, defining resources/ methods and message structures
- Business Layer: Encapsulates all the business logic, as well as core domain entities of the system.
- It implements all system's workflows and offers a simplified API (system façade) to the top layers
- Data Layer: Consists of all Data Access Objects as well as external service consumers. It is the broker to all the persistence storage and external data.
- Cross-Cutting Layer: contains a set of features security and communication collaborating with all layers of the platform.

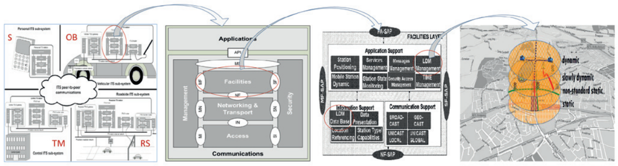
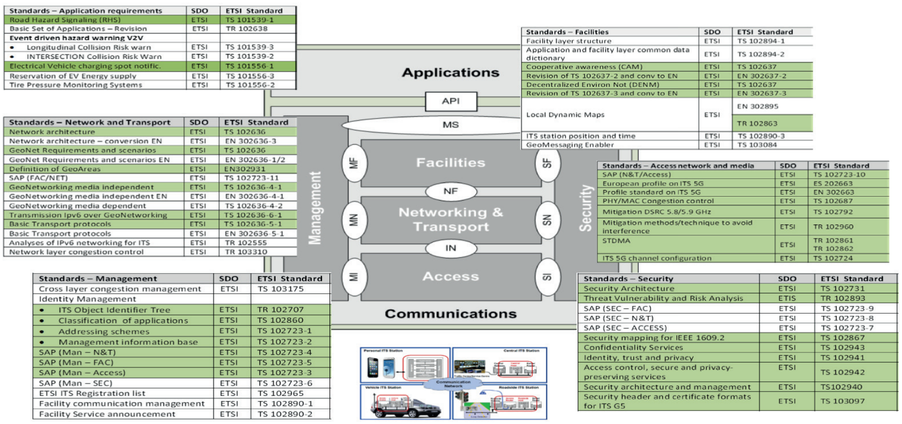


Fig. 1. C-ITS-S architecture [own study]

The working groups inside several international standardization organizations started continue their efforts from the date of the launch of the M/ 453 Mandate [11]. Picture 2 presents some of the specifications for C-ITS- architecture in various stages of elaboration. The connected vehicles messages and use cases are gathered in two other specs: CAM and DENM [9]. [12] designates several of them for building the so called Day 1 and Day 1, 5 C-ITS services planned for deployment on European roads starting from 2019, In [10] you can find the complete list of standard organizations' works and deliverables as the response to M/ 453.



Hazardous location notifications:
Slow or stationary vehicle(s) & Traffic ahead warning
Road works warning
Weather conditions
Emergency brake light
Emergency vehicle approaching
Other hazardous notifications
Signage applications:
In-vehicle signage
In-vehicle speed limits
Signal violation / Intersection Safety
Traffic signal priority request by designated vehicles
Green Light Optimal Speed Advisory
Probe vehicle data
Shockwave Damping

Fig. 2. Standardization around BSMD framework for C-ITS-S and list of Day 1 services [own study]

Services and applications. The central assumption behind communicating vehicles meaning that we are capable to leverage the distributed traffic component: vehicles, pedestrians, road infrastructure for local (a car and its surroundings, an intersection) and city/ region-wide management which translates into capturing, exchanging and processing a comprehensive set of dynamically generated data will open the perspective to share and reuse the data by new service generations supporting, beyond traffic, to support: planning and management of transportation resources, city space and resources, individual mobility management, business processes of tourism, recreation, energy, finance sectors or daily operations of security guards and social security among many others. The specific applications will be supported by overall C-ITS architecture and its interfaces conforming to specific requirements in respect of data sampling frequency, security, speed of transmission and granularity. The following examples of applications illustrate the span of the requirements: from (under) ms real-time through on-line mode adequate to man-machine interactions to batch processing of historic data.

In line with the growth of information gathered in terms of categories and volume the uniform policy and mechanisms of data retention, guard, sharing and deleting will impose. The proliferation of applications will necessitate to coordinate service interaction with external means. Structuring the development processes like sharing services' interfaces for design of their interactions, new services composition from the existing ones, and ready to use applications advertising, use control and billing. The C-ITS architecture provides for these requirements specifying their scope, position relative to other components (in the Facilities, Management and Security Layers) an interface. Some of the auxiliary processes will be implemented in the cloud (see the example of ECIM).

Social and Business Models. The technology is only one factor determining the growth and sustainability of new mobility models reposing on C-ITS and MaaS paradigms; it is necessary to overcome barriers and to open new horizons. The boost will come from business: new features for next generations of cars, the idea of Extended car: what we drive is only a piece of hardware,

• congestion warning	• road works warning	• broken car on the road side warning
• emergency vehicle approaching	• weather info and warnings	• electronic brake
• slow moving vehicle	• crash ahead/ nearby warning	• general obstacle warning
• approaching motorcycle/ motorcycle ahead	• speed limit (in car display)	• speed advisory (GLOSA, GLODTA)
• traffic info	• transparent (pay as you drive) insurance	• car manufacturer/ dealer services
• Point of Interest info	• fleet management	• transparent leasing
• Dynamic complex mobility surveys	• flexible transport calling	• flexible transport car dislocation
• journey planners	• MaaS services registry/ repository	• special services for VRU [9]
• car pooling	• car sharing	• enterprise mobility policy
• tolling (roads, city entrance)	• platooning	• driver reaction's monitoring (eg. drowsiness)
• passing/ line changing assistance	• parking available (in road, off road)	• trip continuation
• Infotainment	• enhanced reality (for passengers)	• transport resources management
• passenger ahead warning	• cyclist warning	• left turn assistant

the value rests in data, new markets, new marketing/ resource allocation tools (historic data driven assessment), process optimization, Time to Market shortening and it will come from peoples' acceptance of the new services but also readiness for contribution: mental change (forgetting the tradition of owing the car), readiness to share information anonymized if required, bartered for a gadget – if it happens („dashcam to give away in exchange for its data", Andy Rubin, Android co-founder). The empathy for the environment, compliance to social behavior, the habits acquired through participation in cooperative processes. The today's applied informatics is ubiquitous on the customer side but also development: 4,5 millions coding for IOT in 2015 and forecasted 10 millions In 2020 (source: Vision Mobile 2015). In that meaning ICT brings to mobility the potential and dynamics of Internet, and as a consequence the comprehension of the need and value of information sharing while being a part of communities expanding around sharing of things, recuperation of space for cities, improving air quality, fighting with noise, proper and faire time use, looking for deeper sense in tourism etc. the new mobility paradigm will grow in the process of interweaving od the networks of devices (IOT), people (Internet communities) and knowledge - CAPS[13], being from one side the source of ongoing situational awareness and problem detection, their causes and possible effects and on the other side making up the frame to look for solutions and collaboration platform. – Fig. 3.

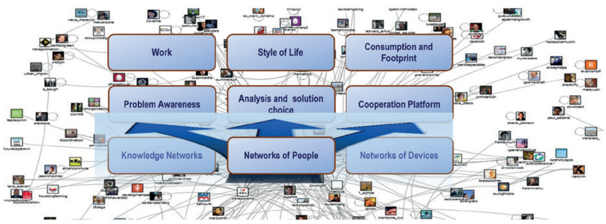


Fig. 3. Digital Society: networks of devices, networks of people, networks of knowledge [own study]

Mobility will be eventually influenced by the deconstruction of social relations, economy and politics caused by processes commonly coined digitalization, but rooted much deeper than the metaphor of technical hue would suggest.

- (transportation) from opposing the mass and individual transport to the continnum spread between the exhtrema (networks of devices, knowledge, people)
- (energy, food, appareil, consumer goods) from standardized offer designed for mass production and marketing (eg. food technology) aiming at highest profit possible to diversified, locally rooted, co created by communities in recycling schemes or prosumerism (networks of devices, people)
- (social communication, culture, marketing) from unidirectional broadcasting to multistakeholder creation, sharing and discovery of information (networks of devices, knowledge, people)
- (education, family, proffesional milieu, city planning) from rigid, hierarchical or strictly functional structures towards compact organizations and architectures supported by multirateral exchange of information (networks of knowledge, people)
- (minimum subsistence level, social insurance) from relying totally on individual resources or dependency on a state policy in assuring one's well being, social position, and ultimately the pension towards community inclusion and support e(networks of knowledge, people)
- (decision-making with general consequences) from non-transparent, representative systems based on political parties and electoral hypocrisy to liquid democracy where the decision processes and artifacts are conform to the nature of problems to decide on and the outreach to achieve. (networks of knowledge, people)

The maturity of sensor technology including IMU, GNSS/ EGNOS positioning, optic/ radar/ lidar, communication and data processing, the advancements in standardization of C-ITS architecture, message sets etc, business models and social ecosystems evolution, and last but not least the potential of growing engagement of individuals and communities in creation, sharing and leveraging the new categories of data and information as well as applications being built around them; the interactions of networked devices, knowledge and people are the reasons to elaborate real plans of wide C-ITS implementations and launch them in years to come (2019-20). To maintain and develop the communicating vehicles paradigm the incentives and sustainability patterns at business and communities' levels will be needed. From whom and how to assemble the vital construction will be discussed in the next chapters.

1.3. How to implement and deploy

To come to radically improved (1) Safety (2) effectiveness, and reliability (3) resource efficiency (4) traveler general experience at the same time forging priority for public/ multimodal and the so called "soft transport means" (on foot, by bicycle) are the main objectives of the first C-ITS deployments [9], [12]. These deployments, led as Living Labs are confined in selected road network segments, involve up front fixed number of cars and are limited in terms of information and functionality. After the assessment of their results the verified corrected/ improved solution will be functionally enriched, expanded and replicated geographically and opened to larger groups of subjects in various roles: road users, vehicle types, service providers etc. The question how to plan, or more warily, which planning policy to adopt should be projected onto three dimensions, that of the method, time and space. The last dimension being heavily dependent on topography, urban development and administrative structure we leave for local analysis, the time, following [12] we confine in 15 years perspective and divide in it 5 years long periods, …We first characterize the method dimension and then its further split in five threads: scope of data gathered and information/ knowledge derived from the data, services and applications, legal intervention (caveats, incentives, obstacles), economic drivers and social response.

Scientists' efforts to shift the limits of our imagination, Engineers' "mules", proofs of concepts and Living Labs, Managers' corporate drivers, and large roll-outs planning, startups looking for opportunities, readiness of people to consent and engage, political pushes and incentives – here's the mix of real facts, visions, forces and tensions to align and build upon should our new mobility paradigm come true. There are external/ global changes to leverage: OEMs installing sensors and communication modules in their cars as part of the Extended Vehicle and databases to gather the sensor data and incentives for drivers to gain their consent to give the data away. On local level there are business opportunities for SMEs to retrofit the older cars to make them capable to communicate or to offer services fed by vehicle probe data. The method to harmonize, integrate and give momentum to changes in some extent could follow the C-ITS Platform [9] Work Breakdown Structure from where several topics deserve further development on local level: Cost Benefit Analysis, Business Models and Business Cases, Legal Issues, Hybrid Communication, Public Acceptance. Taking or abstaining from seminal decisions, undertaking or postponing critical course of action and consequently invigorating or blocking new mobility deployment in the region will depend on understanding the outreach of knowledge hidden in data and applications, complexity of legal issues, economic potential to trigger and social evolution it appears to be part of. A policy is needed as well as a setup to monitor conditions, recommend and support initiatives and coordinate deployment activities: Living Labs, solutions' integration and extensions. The highest priority and urgency have to be attributed to the harmonization of ongoing and planned investment, the EU C-ITS deployment and leveraging of local assets (infrastructure, implemented systems, budgets, and planned projects). At stake is the money: hundreds of millions Euro at the scale of single region to invest in obsolete (in terms of 2020-2025) infrastructure or prudently to allocate them in tools, platforms and knowledge to capture, process and make use of C-ITS data. What is needed is the regional C-ITS plan development with a strong Cost Benefit Analysis and simulation capabilities. A development board should iteratively issue successive versions of the plan based on the results of several working groups: data and knowledge modelers, service and application landscape analysts, business/ social response sensing bureau and legal/ political recommendation committee. The latter identifies legal and administrative issues prior to elaborate recommendations. Auxiliary services supplying recent info on EU C-ITS Platform's deployment, local investment initiatives, research and business activities, are also indispensable.

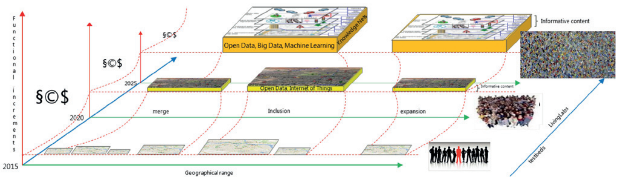


Fig. 4. C-ITS regional deployment dimensions – a vision [own study]

Informations. In sections Technology and Service and Applications we give some examples of data and service categories indicative of the merits of the mobility models supported by C-ITS. The frequency of data acquisition from independent sources, through application of statistical filters, allows to enhance precision of measurements or to calculate the value of another physical quantity. With the wealth of data gathered it is possible to effectively derive Knowledge from the data (Machine Learning) in the form of graphical representations of functions (Artificial Neural Networks for optimization tasks, pattern recognition or fault detection) and distributions. The latter method leads to a large class of the so called Graphical Probabilistic Models (eg, Dynamic Bayes Networks) where statistically weighted causal relationships between events (phenomena) – allow for classification, diagnosis and prediction of events. Multi-stakeholder use and reuse of data/ information/ knowledge will drive and interfere with the other dimensions: Services and Apps, Business, Social and Legal. Stirring the uptake of data enhancement and knowledge generation skills as well as the uptake of the information and knowledge thus generated is crucial for the overall planning of C-ITS coined not without reason as Information on wheels.

Services and Applications. For the purposes of proper management of the services/ apps logistic chains: publication of awaited new services specs, services implementations delivery together with accompanying SLA, services discovery, composition and orchestration around business processes, provisioning and billing - the tools observing XML web services standardization stack should be used and in particular that of services registry and repository like UDDI or ebXML. This is for instance the case of ECIM platform – Section Technology.

Legal. From the regional perspective the most worrying issue is the long investment processes with the lagging procurement phase to that effect that in the typical time span the initially chosen technology happens to be outdated often by force of the innovations invading adjacent markets (eg. smartphones, satellites). The legal setup being only a part of the problem it is nevertheless worth stressing as the Public Procurement evolves and assimilates critics from business and administration. Smart application of the new, overarched by European directives, law can significantly accelerate the process as well as open the door for "late innovations". On the other hand data security and privacy of road users should be backed by the even more restrictive law and consequently encourage the owners of data to share.

Business response. In this perspective we look at various categories of enterprises as data producers/ consumers whose business development perspective, operational processes and consequently market position and profit may be impacted by public and ubiquitous availability of mobility data and services. Sensing their readiness for data/ services uptake, flexibility to change their offer and internal processes and validating them through CBA and simulations is crucial for the assessment of the C-ITS deployment pace. Keeping a record of obstacles, risks and threads they identify allows for better harmonization of business thread with the other four.

Social response. Alike to the previous thread we should sound people's aptitude to share data they produce while planning trips, driving a car or a bicycle and if for some reward or just generously. The dependency of four other axes on that one being obvious we stress the importance of social readiness to give away their data from the angle of the readiness to engage in CAP's based general processes of leveraging sensor, knowledge and people networks for spotting problems and opportunities, and looking for/ negotiating solutions. That "information/ knowledge based readiness to sacrifice" is of paramount importance for further forecasting the future of the new mobility.

We summarize and complement the chapter as follows: the fifteen years period: starting from 2018/19 will see fast deployment of C-ITS and accompanying changes in mobility models in Europe. The technology is ready and the industry will drive the deployment. The regional level should start aligning its ongoing investment acting on several; levels to catch up with the global change.

1. Data/Information/Knowledge: tapping on CEN, ETSI ISO standards, statistical filters, Big Data, Machine Learning, Knowledge Networks and promoting them among business and communities
2. Servicess and Apps: CEN, ETSI ISO standards as specifications of basic functionality, architecture and interfaces, SOA platforms with its flagship tools: services registries and repositories conforming to UDDI, ebXML, cooperative development.
3. Legal: public-private-people partnership, Pre-commercial Procurement (PCP), Public Procurement of Innovative Solutions (PPI)
4. Business: new business opportunities through uptake of data/ services, bundling them for added value around old and new processes, shared economy like processes included
5. Social: new mobility models, data sharing for C-ITS needs are all special cases of Collective Awareness Platforms for Sustainability and Social Innovation Specific (CAPS).

4. Who will engage?

Five Guiding Principles adopted by C-ITS Platform [10] promote multiple and multi-way use of traffic data under some obvious caveats concerning road user and their employers, privacy and security.

(a) Data provision conditions: Consent

The data subject (owner of the vehicle and/or through the use of the vehicle or nomadic devices) decides if data can be provided and to whom, including the concrete purpose for the use of the data (and hence for the identified service). There is always an opt-out option for end customers and data subjects. This is without prejudice to requirements of regulatory applications

(b) Fair and undistorted competition

Subject to prior consent of the data subject, all service providers should be in an equal, fair, reasonable and non-discriminatory position to offer services to the data subject.

(c) Data privacy and data protection

There is a need for the data subject to have its vehicle and movement data protected for privacy reasons, and in the case of companies, for competition and/or security reasons.

(d) Tamper-proof access and liability

Services making use of in-vehicle data and resources should not endanger the proper safe and secure functioning of the vehicles. In addition, the access to vehicle data and resources shall not impact the liability of vehicle manufacturers regarding the use of the vehicle.

(e) Data economy

With the caveat that data protection provisions or specific technologic prescriptions are respected, standardised access favours interoperability between different applications, notably regulatory key applications, and facilitates the common use of same vehicle data and resources.

The scope and quality of information exceeding by far the today's standards attracts broad range of interested parties: road users and their employers, traffic management, regulators and executing staff responsible for or involved in assuring accessibility, throughput and safety of transportation assets: state and local government, road infrastructure administration, operators, carriers, car rental offices; the industry: car manufacturers with their dealers and service chains; providers of informative services: weather, GPS, advertising; ICT vendors and integrators, telecoms; financial sector: insurers, leas-holder, other services: store chains; tourism, recreation, mass event organizers; restaurants etc. The aforementioned ecosystem will repose on the data/ services access architecture and its usability strongly depends on reconciliation of interests of negotiating parties: car manufacturers and added value providers. The architecture comprises of three key components:, On-board Application Platform, In-vehicle Interface, Data Server Platform and the design foundations for the latter will determine the assurance of equal access to traffic data for OEMs and service providers. The concept of Extended Vehicle pushed forward by car manufacturers represented by ACEA (*Association des Constructeurs Européens d'Automobiles*; English: European Automobile Manufacturers Association), assuming that traffic data categorized along the up-front declared use cases will be maintained and rendered to interested parties based on from OEMs serves is strongly criticized by service providers represented by FIA (*Fédération Internationale de l'Automobile*, English: International Automobile Federation) arguing that this will hamper innovation by independent providers. FIA's proposal consists in decomposing the traffic data into two parts : one in the full disposal of a car manufectur and the other administered by independent party (Shared server). IBM radically modifies the architecture introducing between OEMs' data and service providers what they call B2B Marketplace as an independent layer; Picture 5.

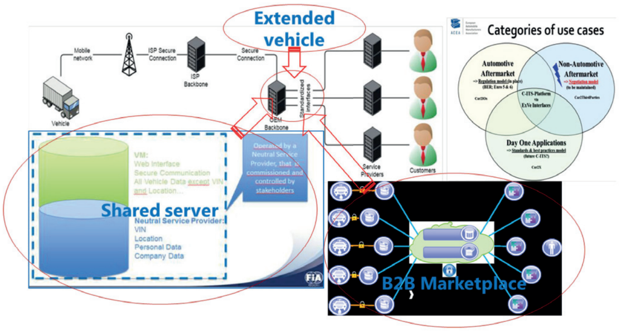


Fig. 5. Implementation concepts for Data Server Platform [own study]

5. Conclusion

In View of the facts mentioned in previous chapters:

- the necessity to change the transportation and mobility models: to minimize and bring to zero the number fatalities on European roads, improve transport efficiency, lessen environmental aspects and invigorate informative services around mobility new markets to ….
- proved capability to apply wireless communication for traffic management tasks and more generally what is coined as the „legitimacy" of the deployment of C-ITS, i.e. the fact that the deployment of C-ITS can be justified and fostered at all levels,
- significant progress in detailing and adopting of the European C-ITS architecture and maturity of standardization processes
- systematic use of ICT methods and tools in the domain of transportation and mobility and in particular data protection and system security and information processing: cryptography, Sensor Fusion, Big Data, Machine Learning, networks of devices, people and knowledge as well as service logistic chains: eg. application of SOA, or B2B Marketplace
- driving C-ITS by car industry, transport operators and carriers, new informative service providers but also financial sector, R&D, non-profit organizations
- launching a number of Field Operational Tests in Europe, US and Japan

It is well founded, reasonable and requisite to provide for, pick up and apply the aforementioned achievements but also sound-based forecasts of C-ITS, ALV and MaaS expansion, the proliferation and integration of pilots and corridors while planning regional ITS investments to be put into exploitation in the horizons of 2020, 2025, 2030 and particularly to:

- leverage the European C-ITS Architecture and standards
- observe the five guiding principles, Living Labs as Field Operational Tests approach
- plan the functional and geographical development of already implemented systems in a region, especially these based on not intrusive traffic detection and more generally public space monitoring while using video analytics, nomadic devices integration, social networks data analysis where integration platforms were applied capable of sensor fusion, heterogeneous data integration and processing, diagnosis and prediction to build a situational awareness. Further electronic payments and city cards systems development and applications should be included in the planning processes.
- support innovative projects in the domain of Vehicle Probe Data acquisition and processing, especially these aimed at elaboration of effective retrofitting of not equipped cars
- support applications in traffic/ mobility management systems of the most promising technologies from the angle of C-ITS deployments: sensors and Sensor Fusion leveraging nomadic devices, Cooperative Awareness Platforms, Open Data, Big Data and Machine Learning, Block-chain databases, service registries and repositories.
- apply wireless communication, DAB+ based messaging to road users, car (head up) displays/ smartphones to visualize the messages, light autonomous telecommunications and observation masts in implementing TMC to driver communication
- support retrofit approach to make older cars C-ITS (partially) compatible in particular based on smartphones
- support innovative services: to secure the Vulnerable Road Users, integration with services platform (ECIM)
- previous investment protection and assets (infrastructure, applications, licenses) reuse.

Bibliography

[1] SEREDYŃSKI M., KHADRAOUI D., VITI F.: Signal Phase and Timing for Cooperative Public Transport Priority Measures; 22nd ITS World Congress, Bordeaux, France, 5–9 October 2015.

[2] SHIMADA H., et al.: Implementation &Evaluation of Local Dynamic Map in Safety Driving Systems; J. of Transportation Technologies, 5, 102-112, 2015.

[3] Resume of the Project SCOOP@F http://www.predim.org/IMG/pdf/resume_du_projet_scoop_f.pdf [date of access: 12.10.2015].

[4] ETSI TR 102 863 (V1.1.1) Intelligent Transport Systems (ITS): Vehicular Communications; Basic Set of Applications; Local Dynamic Map (LDM) Rationale for and Guidance on Standardization, 2011.

[5] SAFESPOT Integrated Project (2012) http://www.safespot-eu.org/

[6] KARBOWSKI D., SOKOLOV V., ROUSSEAU A.: Vehicle Energy Management Optimisation through Digital Maps and Connectivity; 22nd ITS World Congress, Bordeaux, France, 5–9 October 2015.

[7] SHLADOVER S.E., NOWAKOWSKI C.: Regulatory Challenges for Road Vehicle Automation: Lessons from the California Experience; 22nd ITS World Congress, Bordeaux, France, 5–9 October 2015.

[8] WANG J., et al.: Modified driving safety field theory and its application to collision warning algorithm in complex traffic environments; 22nd ITS World Congress, Bordeaux, 5–9 October 2015.

[9] C-ITS Platform Final report January 2016; http://ec.europa.eu/transport/themes/its/doc/c-its-platform-final-report-january-2016.pdf [date of access: 12.10.2015].
[10] iMobility Support D3.5c, D3.6c and D3.13b – Standardisation Handbook, Standardisation activities and EU-US-Japan missions (Merged deliverables) http://www.imobilitysupport.eu/library/imobility-support-activities/its-deployment-deliverables/standardisation/deliverables-2/2988-d3-5c-d3-6c-and-d3-13b-standardisation-handbook-activities-missions/file [date of access: 12.10.2015].
[11] Standardisation mandate addressed to cen, cenelec and etsi in the field of information and communication technologies to support the interoperability of co-operative systems for intelligent transport in the european community http://www.Etsi.Org/website/document/aboutetsi/ec_mandates/m453%20en.Pdf [date of access: 12.10.2015].
[12] Post-Congress Report; 22nd ITS World Congress, Bordeaux, France, 5–9 October 2015.
[13] DIGITAL AGENDA FOR EUROPE A Europe 2020 Initiative https://ec.europa.eu/digital-agenda/en/collective-awareness [date of access: 12.10.2015].
[14] SHIMADA H., YAMAGUCHI A., TAKADA H.: Kenya Sato; Implementation and Evaluation of Local Dynamic Map in Safety Driving Systems 31March 2015.
[15] PRE-COMMERCIAL PROCUREMENT (PCP) PUBLIC PROCUREMENT OF INNOVATIVE SOLUTIONS (PPI) European Comission http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-e-inproc_en.pdf.
[16] Guide about technologies for future C-ITS services http://www.telematicsvalley.org/assets/Guide-about-technologies-for-future-C-ITS-services-v1-0.pdf [date of access: 12.10.2015].
[17] D3.1 ARCHITECTURE AND IMPLEMENTATION PLAN; European Cloud Marketplace for Intelligent Mobility; http://ecim-iminds.rhcloud.com/wp-content/uploads/2014/03/ECIM-D3.1.pdf [date of access: 12.10.2015].