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VRA NETWORKING IN AUTOMATION

Support action for Vehicle and Road Automation network

Digital Infrastructure for deployment of Vehicle and Road Automation: needs and recommendations

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Executive Summary

This deliverable reports the activities of VRA WP3.6 on the topic of Digital Infrastructure.

The motivations of Digital Infrastructure are mainly related to:

- The need of a digital representation of the road infrastructure along with the investment needed on the physical road infrastructure
- The need of cooperation from the vehicles and the infrastructure operators to collect, update and correct eventual changes made on the physical infrastructure

The main challenges related to Digital Infrastructure are highlighted in Chapter 2 and they include aspects related to HD maps (accurate data/position, update frequency, diverse situations, and cost), data integration, questions of reliability and levels of automated driving, lliability, roles of static and dynamic data and issues related to privacy, security and risk of terrorism attacks.

VRA WP3.6 networking activities supported the discussion on Digital Infrastructures contributing to several meetings in the first and second period of VRA project.

They include meetings and Workshops in conjunction with the iMobility Forum and in the framework of the EU US JPN Automation in Road Transportation Working Group.

This deliverable is a preliminary draft which will be finalised in the VRA third period (by the end of 2016).

1 Introduction

1.1 Purpose of Document

The objective of this deliverable is to report the activities of the newly created WP3.6 of VRA on digital infrastructure needs and recommendations for deployment of Vehicle and Road Automation.

This deliverable intends to gather the information on the activities performed in the field of digital infrastructure on road automation, using as a basis key projects and experts in the area in Europe and beyond. It also aims at providing recommendations and a common approach for the next steps in digital infrastructure for deployment of automation in road transport.

1.2 Intended Audience

This document is written mainly targeting the following audience:

- European Commission
- Project partners and associated partners

1.3 Structure of Document

The deliverable consists of the following sections:

- Section 1: Introduction including deliverable objectives, intended audience and relation to the VRA Support Action
- Section 2: Outlines the relevant digital infrastructure challenges and needs for actual deployment of automation in road networks
- Section 3: Defines the different tools and methodologies used to involve the relevant stakeholders
- Section 4: Summarizes the different networking activities regarding digital infrastructure needs and recommendations
- Section 5: Highlights the consolidation of the discussion topics concerning digital infrastructure that had taken place by the time of writing this deliverable
- Annexes: Support the previous sections by providing relevant material on the networking events organized through VRA

1.4 VRA contractual references (common section)

VRA, Vehicle and Road Automation, is a Support Action submitted for the call FP7-ICT-2013-10. It stands for *Vehicle and Road Automation Network.*

The Grant Agreement number is 610737 and project duration is 42 months, effective from 01 July 2013 until 31 December 2016. It is a contract with the European Commission (EC), Directorate General Communications Networks, Content & Technology (DG CONNECT).

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1.5 Project Objectives (common section)

In the field of vehicle and road automation, VRA's main objectives are:

- To maintain an active network of experts and stakeholders
- To contribute to international collaboration
- To identify deployment needs
- To promote research and deployment initiatives

In practice, VRA will:

- Organise or support international meetings together with similar initiatives in US and JPN. (WP2.1)
- Support the iMobility Forum Automation WG and extend its role as a reference group for European activities on the topic eventually formulating common positions, especially at European level (WP2.2)
- Aggregate information on existing research or deployment activities in a shared wiki (WP2.3)
- Describe valid business models and deployment paths & scenarios and investigate the broad socio-economic implications of automation for the future societies (WP3.1)
- Clarify, report and setup a plan of actions on legal, liability, insurance and regulatory issues in different member states (WP3.2)
- Monitor and steer standardisation, compliance and certification for vehicle and road automation (WP3.3)
- Contribute to the discussion on relevant topics for the deployment of Vehicle and Road Automation: Connectivity (WP3.4), Human Factors (WP3.5), Digital Infrastructure (WP3.6), Evaluation of Benefits (WP3.7) and Decision and Control Algorithms (WP3.8).

2 Digital Infrastructure challenges and needs in the deployment of vehicle and road automation

2.1 Definition of Digital Infrastructure

The following definition summaries the concept of Digital Infrastructure: “static and dynamic digital representation of the physical world with which the automated vehicle will interact to operate. This includes sourcing, processing and information”.

The motivations of a Digital Infrastructure are mainly related to:

- The need of a digital representation of the road infrastructure along with the investment needed on the physical road infrastructure
- The need of cooperation from the vehicles and the infrastructure operators to collect, update and correct eventual changes made on the physical infrastructure

The roles of the Digital Infrastructure for Automation should include the following aspects (from a static to a dynamic representation information):

- Provide accurate map data (e.g. HD Maps)
- Provide apriori knowledge along the road (Electronic Horizon)
- Enable high relative position accuracy (landmarks)
- Reproduce human like driving (driving patterns)
- Allow or not automated functions on specific roads (e.g. managed lanes)
- Notify the vehicle about situations ahead that may require human attention or even intervention (L4→L3→L2…)
- Provide dynamic information around the vehicle (LDM)

2.2 Digital Infrastructure challenges

The following main challenges have been identified during the discussion in VRA WP3.6:

- HD maps: Accurate data/position, update frequency, diverse situations, cost
    - Need for more precise data with complete accuracy/accurate positions
    - Different driving situations
    - Levels of automated driving
    - Collaboration between public and private sector
    - Separation of static and dynamic data
- How to best realize data integration

  - Sensor data and maps
  - One stop interface
- Question of reliability and levels of automated driving
- Liability
  - Roles of carmakers, map makers, and governments
- Roles of static and dynamic data
  - Different conditions and scenarios
  - Sensor data at under 300 meters
  - Speed of updating types of data (dynamic, quasi dynamic, quasi static, static)
  - Infrastructure and coordinates for positions of pedestrians, etc. and liability
  - Separating dynamic data and maps, and different uses
- Privacy
  - Question of how to send information
  - Updating software
- Security and risk of terrorism attacks

2.3 Digital Infrastructure needs

For the fast deployment of digital infrastructure, especially in combination with automation in road, needs have been identified in relation to the following aspects: accurate data/position, data integration, reliability and supported levels of automated driving, liability, roles of static and dynamic data, privacy, roles for national governments, standards (e.g. interface standard), maps updates.

2.4 Stakeholders tree (common section)

The stakeholders to be taken into account in vehicle and road automation can be divided into four big categories: technology providers (e.g. OEMs, suppliers, research and consulting), service providers (e.g. highway operators, assurance companies), decision makers (e.g. local and national authorities, certification bodies) and final consumers (e.g. drivers associations). Following the distinction of roles for VRA, the stakeholder groups are illustrated in Figure 1. The four sides of the rectangle represent these four roles.

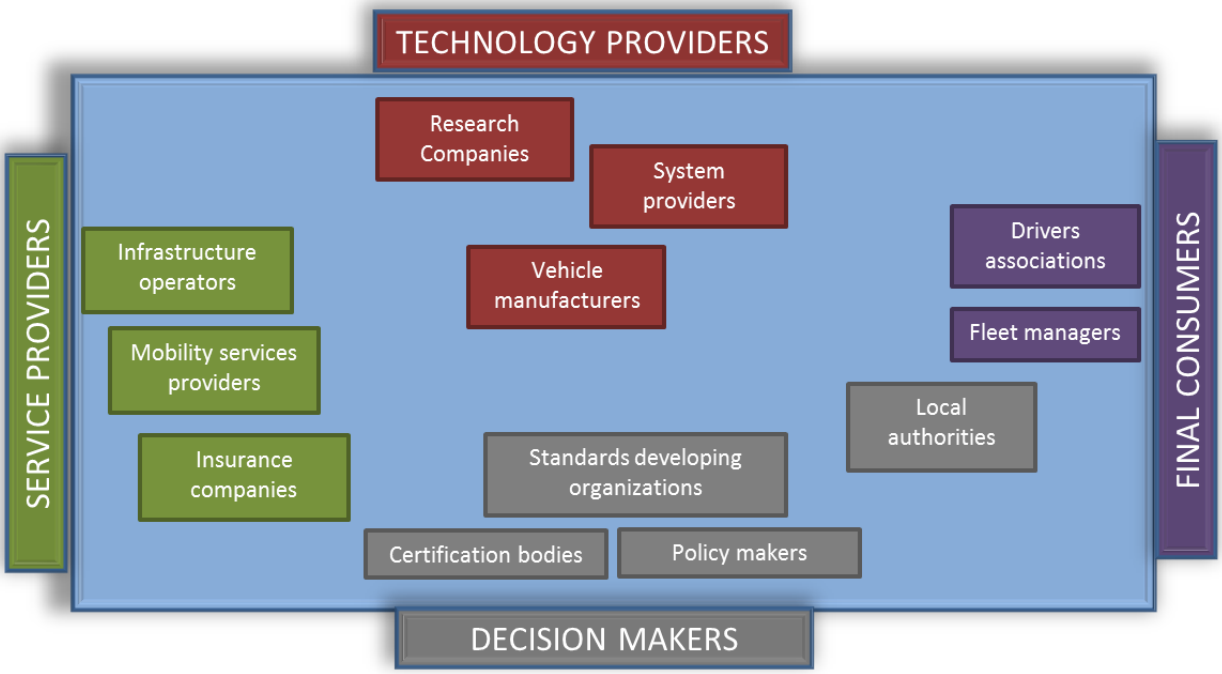

Figure 1: Illustration of stakeholder groups and their role vehicle and road automation

This general overview is customized in Table 1, in which the stakeholders are analysed indicating main function and also key aspects on digital infrastructure that are affecting them. This is important to focus the discussions depending on the group of stakeholders that VRA is addressing at each moment.

Table 1. Stakeholder tree identification and description

Stakeholder	Function	Digital Infrastructure aspects
Policy makers and legislative bodies	Produce regulations and ensures compliance	• Cost benefit analysis for PA • Clear definition of the role of the public and private sectors (governance, role and responsibility, regulations, etc…) • ownership (privacy issues)
Vehicle manufacturers	Manufacture and sell vehicles with a level of automation	• Requirements of the DI • applications using accurate mapping and precise localization

System providers	Offer VRA related systems and applications for vehicles and infrastructures	• cloud-based spatial data infrastructure for highly automated driving
Research companies	Provide new paradigms and application solutions. Part of the technology providers chain	• Identify requirements (precise/lane-level positioning, human-like behaviour, landmarks, etc) • definition of requirements for digital infrastructure (content and quality)
Service providers	Make business providing services based on vehicle and road automation	-
Infrastructure operators	Management of roads and highways.	-
Certification bodies	Homologation of vehicles, equipment and drivers for automation	• Certification & Minimum standardisation of map representation
Insurance companies	Provide Insurance for automated vehicles. Safe mobility and responsibilities	• Tort liability standards for automated vehicle
Standards Developing Organizations	Primary activities in developing, coordinating, promulgating, revising, amending, reissuing, interpreting, or otherwise producing technical standards that are intended to address the needs of some relatively wide base of affected adopters	• Needed for reliability and keeping a good level of safety • Standardisations of map contents for automation • Standardize interfaces with Cloud

3 Methodology description for Digital Infrastructure

3.1 Tools for stakeholders engagement

The main tools for stakeholders' engagement which are already used in VRA and will continue to feed the discussions, regarding not only digital infrastructure but overall VRA activities, are briefly highlighted below.

Inside each one of the following paragraphs apart from the way the respective tool contributes to this deliverable, a short status of how digital infrastructure subgroup is using or intends to use this tool is also highlighted.

3.1.1 *Meetings and teleconferences*

The most common and widely used way to engage the relevant experts in the field is through the organization of meetings and teleconferences. Meetings and phone conferences were organized the last couple of years for digital infrastructure was organized under the framework of the Automation WG of the iMobility Forum. The discussion on Digital Infrastructure has been carried out in the context of WP3.1 during the first part of the project and a specific WP was added in the last amendment of the VRA DoW to better organize the work on needs and recommendations for digital infrastructure in automation.

3.1.2 *Congresses and forums*

ITS Congresses, both World and European, are a very good opportunity to exchange ideas and perspectives on the issue of Digital Infrastructure, especially in the context of automation. In the last couple of years a significant trend is noted in the conference programmes, which are enriched with several (technical, special and executive) sessions regarding digital infrastructure and automation in transport. The same is valid for other important conferences, such as TRB (e.g. AVS2015[1] and SIP-ADUS[2]) which gathers all the relevant experts in the field and provides useful feedback through targeted break-out sessions.

In addition to congresses forums play a significant role as facilitators of similar discussions and stakeholders' gatherings. The most important one for the work on digital infrastructure is the iMobility Forum and especially Automation WG which involves key stakeholders in the field to exchange ideas and identify the current trends in digital infrastructure and automation.

[1] http://www.automatedvehiclessymposium.org/home

[2] http://www.its-jp.org/english/files/2015/04/SIP_Worlshop2015_leaflets_e_20150326.pdf

Finally, the activity of the EU-funded project Big Data Europe[3] http://www.big-data-europe.eu/ is monitored and information exchange is supported thanks to the participation of ERTICO-ITS Europe to the project.

3.1.3 *Link activities with on-going R&D projects*

WP3.6 is currently monitoring the activity of recently launched project under the call "MG-3.5a-2014 - Cooperative ITS for safe, congestion-free and sustainable mobility". Research and Innovation Action proposals in this call address the development of one or several of the following domains:

- Open in-vehicle platform architecture for provision of real-time ITS services and mechanisms to provide seamless connectivity, interoperability and secure flow of information across stakeholders, including convergence of Dedicated Short-Range Communication (DSRC) and 4th generation mobile communication technologies.
- Improved positioning technology, building on innovative features of European GNSS systems, with standard interfaces to serve different ITS applications and new concepts for flexible charging based on guaranteed positioning.
- Highly accurate, dynamic maps for transport applications, leveraging technologies based on advanced GNSS and cloud computing.

Currently, the project HIGHTS "High Precision positioning for cooperative-ITS"[4] has been identified as relevant in this call for the activity of VRA WP3.6 and more interaction is planned in 2016.

3.1.4 *Link activities with task forces or interest groups*

As mentioned above, in the context of the Trilateral Automation the main task forces and groups that digital infrastructure has established already a good link are the following:

- US Department of Transportation. US DoT has developed a research program on automation[5] and it is actively involved in the Trilateral EU-US-JPN Automation in Road Transportation Working Group. Proposal for quality insured data collection have been formulated.
- SIP-ADUS[6]. It is a cross-ministerial Innovation Promotion Program (SIP) aiming to realize innovation through promoting R&D at all stages by enhancing cross-ministerial

[3] http://www.big-data-europe.eu/

[4] http://hights.eu/

[5] http://www.its.dot.gov/automated_vehicle/index.htm

[6] http://www.sip-adus.jp/

cooperation. The Working Group on the Next Generation of Urban Transportation WG.

- Japan Digital Road Map Association. The Japan Digital Road Map Association (DRM) was established in 1988 and led the world in standardizing a digital road map database. DRM has greatly expanded the content of this reliable, integrated national database, based on uniform specifications which are open to the public. DRM is working on several projects including the development and spread of the new DRM Standard Format 21, which provides a versatile and expandable database. Additional information can be found on the official DRM website[7].

3.1.5 *Webinars*

The organisation of webinars is another very important tool for gathering relevant stakeholders, inform them about specific activities and at the same time gather feedback from them (through polls and raised questions).

3.1.6 *Implementation plan*

To facilitate the follow up of the different discussions and events in which VRA CSA supported the objectives described in Task 3.6 on Digital Infrastructure, as well as in the activities performed in the discussion group of the AWG, Table 2 has been introduced. This table also includes a description of the events, a short summary, any particular result to be explained and if there is an ANNEX with the most relevant working documents used (a detailed reports on previous meetings is reported in Chapter 4). Table 2 includes the initiatives of VRA in period 1 (in the context of WP3.1 activities) and in period 2 (WP3.6)

Table 2: Meetings, teleconferences and congresses with active contribution to VRA Task 3.6 (P1 and P2)

Events/Topics	*Date*	*Description*	*Summary and objectives*	*Annex*
Automation WG	24 Jan 2014	Open discussion on the topic of Digital Infrastructure	• Break out session on Digital Infrastructure	**1**

[7] http://www.drm.jp/english/drm/introduction/aisatu.html

Automation WG Conference Call	02 April 2014	Discussion on the status and on the activities of the Digital Infrastructure sub-Working group	• Progress of the sub-groups • 2015 R&D issues	-
VRA Meeting	07 May 2014	Update on the current status of the initiatives	• Discussion on the status of the activities in US and in Japan	-
Trilateral WG Automation in Road Transport (Antwerp)	08 May 2014	Presentation of the Digital Infrastructure WG (HERE and ERTICO)	• Digital Infrastructure • Definition, Aim & Vision • Role of Maps and Data needs • Limitations • Quality • Research needs for 2014 & 2015 • Project proposal • Detroit Special Session	-
Automation Vehicle Symposium - Transport Research Board (SF)	13-18 July 2014	Road Infrastructure Needs for Connected-Automated Vehicles	Breakout session aiming to identifying: • Identify challenges and opportunities where potential infrastructure changes and innovations are needed • Discuss research needs and next steps to prepare infrastructure to be supportive of and compatible with connected-automated vehicles	-
International Task Force on Vehicle and Highway Automation (ITFVHA)	06 Sept 2014	Update on the current status of the initiatives on Digital Infrastructure	• Tri-lateral Working Group on Automation in Road Transportation: an update presented on behalf of the Working Group	-

ITS World Congress (Detroit)	07 Sept 2014	Special Interest Session on Digital Infrastructure	• Digital Infrastructure Sub-Working Group • An advanced digital road map database in ITS evolution (Japan DRM) • Automated Driving Cloud (HERE) • Maps and Data: a State DoT and Michigan DoT Perspective	-
VRA – iMobility Forum Automation WG (EC Recommendations)	17 Sept 2014	Discussion for providing recommendations to the EC	• Discussion on the relevant research topics and elaboration of recommendations • Finalisation and publication of the recommendations • Link with ERTRAC	
Trilateral WG Automation in Road Transport (Tokyo)	19 Nov 2014	This meeting theme 'Digital Infrastructure' included the following presentations: (1) Digital Map (2) ADASIS (3) Proposed Concept of Operation	• Dynamic Map was presented as a good example of the Digital Infrastructure (Jun Shibata): ・ technologies and their positioning-accuracy technology; ・ positioning accuracy enhancement activities; TC204 WG3 scope and stand; • 'ADASIS'[8] was presented (Maxime Flament): 'data border line' between the field for common and for the private competitiveness; understanding of the interface is needed in order to provide required data for connected vehicles or automated vehicles. • "Proposed Concept of Operation" was presented by Carl Andersen: data requirements; static data and dynamic data; data ownership.	-

[8] http://adasis.org/

ADASIS WG2 core group	June 2015	Presentation of the new ADASISv3 (for automation)	• Presentation of the new ADASISv3 including mainly:
			  ○ extended architecture with multiple provider and clients update,
			  ○ deletion and feedback mechanism,
			  ○ extended road lane model	

Automated Vehicle Symposium (Ann Arbor) 2015	21 Jul 2015	Plenary Session Presentation	• Role in the development of the Digital Transportation Infrastructure (HERE)	-
Trilateral WG Automation in Road Transport (Ann Arbor)	23-24 Jul 2015	Presentation of several initiatives on Digital Infrastructure	• Survey Results: Digital Geospatial Infrastructure for Cooperative and Automated Vehicles (Noblis) • Some comments on Digital Infrastructure/Dynamic Maps (Japan Digital Road Map Association)	-
IMobility Forum Plenary (Brussels)	21 Oct 2015	Presentation on the topic of Digital Infrastructure	• Presentation from HERE: “Building the Digital Infrastructure” (first introduction of the DTI and sensori)	-
Trilateral WG Automation in Road Transport (Tokyo) in conjunction with the 2nd SIP-adus Workshop	30-31 Oct 2015	Presentation of the status of the initiatives on Digital Infrastructure	• Digital Infrastructure SWG Report • VRA presentation: Definition of Digital Infrastructure (EU) and motivation and Role of Digital Infrastructure • HERE presentation	**2**

4 Report of the networking activities

4.1 Building a network for discussion groups and current status

VRA together with iMobility Forum Automation WG is providing the pool of experts in the field needed for this discussion. In the framework of WP3.6, ERTICO and IFSSTAR, in collaboration with several associated partners (e.g. HERE), are responsible for collecting the results of those discussions and reflecting them in this first version and upcoming versions of the present deliverable.

4.2 Report of the relevant activities on Digital Infrastructure

4.2.1 iMobility Working Group Automation in Road Transport (24/01/2014)

A Round table on Digital Infrastructure has been organised on the topic in Digital Infrastructure. The following points of discussion were considered:

- How to build and maintain maps at low costs
- How to ensure quality? (Importance of certification, Understand where a given degree of automation is possible/allowed, Standardisation of the map representation)
- Role of the maps? What is the role of the maps and where are the maps needed for automation?
- What map data? (the more automation the more mandatory will it be to provide data; Not clear yet: what is the magnitude of the data needed for the use cases; Information derived from human drivers for human-like automation)
- Maps for positioning (Digital infrastructure should be used for accurate positioning)
- Use cases (Highway pilot: classic traffic information, weather information, construction sites – Intersection: accurate maps of everything – Platooning: good representation of curves, roundabout, priority rules and traffic lights).
- Can maps be used as a fall back in degraded situations?

4.2.2 Automation WG Conference Call (02/04/2014)

During the Conference Call the following main points were discussed:

- Based on AWG DI discussion, focus on precise localisation and highly accurate maps for V2X and Automation
- Objective: guarantee sub-lane positioning accuracy below 1m 99% of the time in dynamic road environment

The following R&D issues for 2014 were debated:

- Define cloud-based spatial data infrastructure for highly automated driving
    - State requirements for precise positioning
    - Standardise map content needed for automation
    - Standardise interface with cloud
- Demonstrate applications using accurate mapping and precise localisation
    - Show differences with and without precise positioning
- Demonstrate a “automated” map data feedback loop

The following R&D issues for 2015 were debated:

- Create a Digital Infrastructure framework between public authorities and map providers including
    - Governance
    - Role and responsibilities
    - Roadmap towards a digital infrastructure
    - Regulations
- Investigate impact/benefits of shift of investments between roadside furniture (post signs) and digital infrastructure.
    - What does it cost for PA to get involved / not to get involved in the DI
- Demonstrate LDM-based applications such as intelligent intersections

Criteria for evaluation projects:

- Future projects should plan on using a digital infrastructure/maps giving an accurate electronic horizon
- Future projects should consider the use of accurate maps with extra features to improve their positioning
- Future projects should consider the “volatility” of the GNSS signal and increase robustness of positioning engine.
- Future projects should contribute to definition of requirements for digital infrastructure (content and quality).

4.2.3 *VRA Meeting (07/05/2014)*

Maxime Flament (ERTICO) and Stephane Dreher (HERE) discussed the activity of the Digital Infrastructure sub-group.

The following points were discussed:

<u>Vision</u>

- The digital infrastructure must be reliable and clear governance must be in place for data sourcing, processing and maintenance
- Any future change in the infrastructure can have a impact on safety and will need to be carefully planned and communicated/shared.
- The digital infrastructure will need to be maintained, requiring a close cooperation between the Public Authorities and road operator managing the physical infrastructure, the service and map provider bringing the information to the user and finally the vehicle using the infrastructure
- The update mechanism will most likely strongly rely on input from the vehicle sensors. Data acquired by the vehicles will need to be communicated to the data aggregators in a harmonized way.

Possible subtopics: Governance, Role and responsibilities, Roadmap towards a digital infrastructure, Smart cities, Standardised representations, Content types, Transport modes, Guarantee Quality, Privacy, Regulations, Collection, Minimum requirements

Role of maps:

- Maps used as central point to collect information for decision (LDM)
- Map information used as additional sensor (Electronic Horizon)
- Map information as an essential part to support positioning
    - Highly accurate Maps
    - Landmarks
- Freshness vs. Availability
    - Role of Cloud computing with streaming of maps ahead on the route

4.2.4 *Trilateral ART WG (Antwerp) (08/05/2014)*

Status of the U.S. Digital Infrastructure (by Carl K. Andersen, FHWA, US DOT)

In his presentation Carl Andersen (US DOT) presents the Transportation Related Organization: U.S. Office of Management and Budget (OMB), Federal Geographic Data Committee (FGDC), U.S. Department of Transportation, Geospatial Transportation Mapping association (GTMA).

Then, he illustrates the Circular A-16 “Coordination of Geographic Information and Related Spatial Data Activities” where spatial data refer to information about places or geography, and has traditionally been shown on maps.

This Circular describes the effective and economical use and management of spatial data assets in the digital environment for the benefit of the government and the nation. The Circular affirms and describes the National Spatial Data Infrastructure (NSDI) as the

technology, policies, standards, human resources, and related activities necessary to acquire, process, distribute, use, maintain, and preserve spatial data.

Carl then mentions the National Spatial Data Infrastructure Strategic Plan: 2014 – 2016, which sets priorities and describes the actions the FGDC community will take to develop and maintain the Nation's critical geospatial infrastructure and the National Geospatial Data Asset Management Plan which implements a systematic and efficient portfolio management process that supports and optimizes investments in Federal geospatial assets.

Finally, the Highway Safety Improvement Program (HSIP) is presented with some recommendations and the next actions.

After the presentation, there is a short discussion among the participants.

Regarding spatial data availability, it is mentioned that the State of Utah offers this kind of data for free. The State wants to share available information with companies, such as Here and Tom-Tom. Data have been collected with public money and are now fully open to be used as baseline.

One of the risks in data collection is related to the choice of data format: the risk is that using a specific format, information cannot be shared and there should be some flexibility on this point.

For the European side, some of the participants refer to the ADASIS (Advancing map-enhanced driver assistance systems) forum which is very active.

The ADASIS Forum was launched by ERTICO in order to address the interface specifications necessary for the information exchange of Advanced Driver Assistance Systems (ADAS), mainly with the objective to define an open standardised data model and structure to represent map data in the vicinity of the vehicle position (i.e. the ADAS Horizon) and to define open standardised API(s) to enable ADAS applications to access the electronic horizon and position-related data of the vehicle.

There is a specific workgroup which will address the requirement for automated drivers and there will be a meeting next week. ADASIS is not involving only representatives from Europe but worldwide.

It is highlighted that there should be tools and methods to test the map to work with different applications. The reference should be more the industry.

In ADASIS the collaboration with industry is considered as a main focus. ADASIS for the moment is representing all the industry partners involved. Requirements for applications could be translated in requirements for map. The specification of ADASIS will be open to the public: the interested stakeholders can register and access the information.

Stephane Dreher (Here, a Nokia business) mentions the activity of the Navigation Data Standards (NDS - http://www.nds-association.org/): it is a closed association and it is not supposed to share information.

Also the transport networks can offer specified data infrastructure for common services.

One of the relevant points is related to the quality and updateness for connectivity and automation applications. The maintenance and updateness of data can be considered a level that could be added to the INSPIRE directive.

The INSPIRE Directive in May 2007 established an infrastructure for spatial information in Europe to support Community environmental policies, and policies or activities which may have an impact on the environment.

Transport Network ITS Spatial Data Deployment Platform (TN-ITS) association works on the top of INSPIRE data, aiming at the exchange of ITS-related spatial data between public road authorities as data providers, and map makers and other parties as data users. The TN-ITS works on top of the INSPIRE data and the principle could be similar.

The Directive 2010/40/EU was adopted on 7 July 2010 to accelerate the deployment of these innovative transport technologies across Europe. This Directive is an important instrument for the coordinated implementation of ITS in Europe. Even if it doesn't oblige the Member States to act, it is powerful in obliging Member State to follow certain rules: if they want to provide a service, they need to do it in a certain way.

Carl K. Andersen (US DOT) notes that currently there are available maps with a different level of quality and that the challenge is how to improve the level in the future.

Maarten Oonk (TNO) thinks that the creation of maps should follow a more structured approach starting from a clear identification of the objective and, then, one of the relevant issues is related to the maintenance of the available information.

Regarding the maintenance of the available information, Maxime Flament (ERTICO – ITS Europe) highlights that there are mainly 2 different viewpoints:

- The public authority should provide the information, but the point of view of industry is that this is not the most feasible option.
- The information should be taken from vehicles.

Digital Infrastructure presentation (by Stephane Dreher, HERE)

In his presentation Stephane Dreher (HERE) illustrates the following points:

- Digital Infrastructure Definition, Aim & Vision
- Role of Maps and Data needs
- Limitations
- Quality
- Research needs for 2014 & 2015
- Halo-Maps Project proposal
- Detroit Special Session

Some of the participants mention the difference between the Google approach to use the car for data collection and the possibilities to rely on other initiatives for having information on fundamental road features.

Adriano Alessandrini (University of Rome) thinks that a special effort should focus on the standardisation of data maintenance: the point is that there should be some reliable data that has not to come from crowd data. Adriano notes that, for instance, in CityMobil2 where the lane indication is used to identify the location and this process can fail. One of the problems in the deployment of the CityMobil2 automated system was to keep the lane clean.

T'Siobbel Stephen (Tom Tom maps) reminds that Tom Tom has an agreement to collect speed limit. They perform several travels and the operational complexity is very high, but this way of working adds a more frequent possibility of updating.

Carl Andersen (US DOT) reports that, considering the differences in data availability and available infrastructure, it would be very interesting to certify some roads for automated vehicles. For instance, this would allow reducing the level of automation in case the road we are currently using does not support certain application. If the lane is not certified for a specific level of automation, there is the possibility to switch to another level of automation.

Maxime Flament (ERTICO – ITS Europe) highlights the importance of having a feedback loop operating efficiently. For instance, if a tree currently used as point of reference has been cut and, after a certain number of times the unavailability of this object is reported by vehicles, this element cannot be considered as a reference anymore. Adriano Alessandrini (University of Rome) notes that this consideration works if there are a lot of elements that can be used for identifying your position.

Carl Andersen (US DOT) mentions that there is the need of a standard message that should be used for a lot of map makers. He mentions the Geospatial Transportation Mapping Association (GTMA) which seeks to improve decision makers' ability to create a safer, environmentally sound and efficient transportation infrastructure through the use of state-of-the-art mapping technologies. The activity of GTMA are mainly focused on the USA and supported by industry.

Some authorities could be actively involved and the plan is to foster the activity in the different member states. The activity developed in the Digital Infrastructure working group could help the identification of very specific needs and anticipate them in order to gain support from the authorities.

Plan for Digital Infrastructure (preliminary discussion)

After a short break with the active members of the Digital Infrastructure group Maxime (ERTICO – ITS Europe) reports some of the main points that will be used for a more detail discussion on Digital Infrastructure:

- Motivating Digital Infrastructure
- Definition or understanding of use cases: this could motivate for a line of funding in the USA

- Governance
- Connected standards: SPAT, GID, (MAP)
- List of benefits: why road operators should invest in these road infrastructure.

Carl Anderson (US DOT) remembers that different use cases have been discussed:

- indoor parking;
- highway performance management in relation to the problem of congestion
- Asset management;
- Post-crash analysis;

The different uses of Digital Infrastructure should be discussed referring, for instance, to safety or mobility. One important aspect is also related to the certification process: it would be important to have one harmonised process.

The participants agree on the benefits of having a national requirement for certification: the idea of a single certification process is the best and, if Digital Infrastructure is described in a good way, this process will be easily followed.

Another mentioned topic is the use of managed lane. This concept is more common in USA, but it could be introduced more deeply also in Europe: the use of intelligent sensors can provide a large amount of information in case of problems.

Topic of collaborations

During the meeting held in Antwerp, the following topics of collaboration have been discussed:

- Develop a process for the development of the DI concept in the respective regions
- Explore and define the Use Cases relevant to DI
    - Define the Concept of operations (ConOps)
    - Identify performance requirements for the DI
    - Illustrate Impact and benefits with concrete examples
- Identify the relevant standards
    - List and identify the links to the Cooperative Systems standards (GID-MAP and SPAT)
    - Make a link to the ADASIS and NDS
- Synchronise with planned or foreseen activities (eg. HALO-MAPS)
- Mapping of the relevant activities (Policy, Research, Awareness, Market deployment)
    - ITS, INSPIRE Directives…
    - EU: TN-ITS, ADASIS, NDS
    - CAMP
- Identify Needs for certification of the system i.e the vehicle + the road? Of the DI?

- DI will help to evaluate the ability of the infrastructure to support automated operation

How to accomplish this

- US plan
  - Internalise within FHWA and US DOT implying funding support. (July 2014)
  - Present to FGDC committee (August 2014)
  - Propose a New WG within the FGDC (September 2014)
  - Plan B: obtain funding through the automated vehicles programme
- EU Plan
  - Request endorsement of the DI activity by ADASIS Forum (July 2014)
  - Inform US DoT about ADASIS work (July 2014)
  - Confirm HALO-MAPS as a working platform. (First results: June 2014, confirmation: Nov 2014)
  - If not, lower level of activity, resubmit with refinements from the DI group and delay one year.
  - Contribute to iMF Automation WG discussions on the recommendations for WP2016-2017 (before Sept 2014)

4.2.5 *Transport Research Board (13-18/07/2014)*

A breakout session on Road Infrastructure needs for connected-automated vehicles was organised. The focus of this Session was to explore how transportation infrastructure interacts with and supports connected-automated vehicles. The goals were:

- Identify challenges and opportunities where potential infrastructure changes and innovations are needed
- Discuss research needs and next steps to prepare infrastructure to be supportive of and compatible with connected-automated vehicles

The results for the Digital Infrastructure session can be summarised in the following main points:

- States are collecting digital data to generate roadway base maps
- Opportunity to share data with digital mapping and automated vehicle developers
- Could all states provide a common base level map as a starting point for high precision maps?
- Varying data format and collection standards by State
- Requirements for building maps for automated vehicles are unknown by States

- Need and discussion between developers and states if leveraging maps would be useful for deployment of AVs

The identified next steps have been identified below:

- Hold workshops at the national and state level to gather requirements from developers of automated vehicles
- Assess impacts of requirements on digital infrastructure data collection and maintenance of physical infrastructure
- Develop recommendations and guidance to share across all states to accelerate deployment of automated vehicles

4.2.6 *International Task Force on Vehicle and Highway Automation - ITFVHA (13-18/07/2014)*

An update of the Tri-Lateral Working Group on Automation in Road Transportation has been presented.

The following priorities on Digital Infrastructure have been discussed:

- Identify Use Cases
    - ex: urban driving, highway driving
- Develop Concepts of Operation
- Identify Performance Requirements
    - including evaluating the ability of the infrastructure to support automated operation
- Identify Relevant Standards
- Link to on-going Activity
- Paper being developed to flesh out approach

4.2.7 *ITS World Congress (Detroit) (07/09/2015)*

A Special Interest Session on the topic of Digital Infrastructure has been proposed by VRA and the following presentations were given:

- Maps and Data: A State DOT Perspective (by Kirk Steudle, P.E.)
- An advanced digital road map database in ITS evolution (by Takeshi Doihara & Jun Shibata - Japan Digital Road Map Association)
- WG Automation in Road Transport (Digital Infrastructure Subgroup) (by Maxime Flament)

- Automated Driving Cloud (by Stephan Dreher, HERE)

4.2.8 *Recommendations for the EC (H2020 2016-2017 Call) (17/09/2014)*

During the VRA-iMobility Forum Automation Working Group meeting held in Brussels (17/09/2014) the main relevant research topics and some recommendations to the European Commission for the H2020 – 2016-2017 Call.

The following relevant research topics have been identified:

Short term

- Define cloud-based spatial data infrastructure for highly automated driving
- Identify requirements (precise/lane-level positioning, human-like behaviour, landmarks, etc)
- Study standardisations of map contents for automation
- Standardise interfaces with Cloud
- Demonstrate applications using accurate mapping and precise localisation
- Show differences with and without precise positioning
- Demonstrate an “automated” map data feedback loop
- Demonstrate LDM-based applications such as intelligent intersections

Long term

- Create a Digital Infrastructure framework between public authorities and map providers including
- Governance
- Role and responsibilities
- Roadmap towards a digital infrastructure
- Regulations
- Investigate impact/benefits of shift of investments between roadside furniture (post signs) and digital infrastructure.
- Communication infrastructure and content
- What does it cost for PA to get involved / not to get involved in the DI

Cross-cutting to be taken into account

- Privacy
- Security
- Product and/or Tort Liability

The following main conclusion has been drafted. Future projects should focus on:

- Plan on using a digital infrastructure/maps giving an accurate electronic horizon

- Consider the use of accurate maps with extra features to improve their positioning
- Consider the "volatility" of the GNSS signals (GPS, Galileo, GLONAS, etc) and increase robustness of positioning engine using fully the capacity of the vehicle sensors (including maps)
- Contribute to definition of requirements for digital infrastructure (content and quality)
    - Minimum quality requirements

The targeted outcome of the Digital Infrastructure research should resolve the following issues:

- How detailed should be the DI
- Cost benefit analysis for PA
- Clear definition of the role of the public and private sectors (Cooperation between PA/road operators) and service providers
    - Tort liability standards for automated vehicle
- Data needs (minimum requirements) & Role of the maps
- Open data: common ground for competitive collaboration
- Ensure quality: Certification & Minimum standardisation of map representation: Feedback loop?
- Safety guarantee: soft failure/fail safe scenarios
- Privacy: who owns the data

4.2.9 *Trilateral US-EU-JP Automation in Road Transportation Working Group (Tokyo) (19/10/2014)*

This meeting theme 'Digital Infrastructure' included the following presentations:

- Digital Map
- ADASIS
- Proposed Concept of Operation

"Digital Map" was presented as a good example of the Digital Infrastructure (Jun Shibata). Questions, discussion and comment are:

- Technologies and their positioning-accuracy technology was used only for test vehicles. GNSS does not provide the required accuracy for lane positioning. GPS, GLONASS, and camera were discussed.
- A reflection problem exists with GPS in metropolitan environment (Japan rep)
- Positioning accuracy enhancement activities - research is underway. DRM is quintessentially provided as infrastructure for a whole nation. The term 'sidewalk' in geometric feature includes all regarding road side features (Japan rep)

- TC204 WG3 scope and stand –the current status to deal with emerging features was explained and discussed. WG3 currently does not include emerging features in location reference (Japan rep)
- European map maker status explained –map makers are reluctant to link with standardization due to issues including patent cost or market demand (EU rep)
- What is expected for auto makers - information sharing through cooperation (US rep)
- Some information from the SIP presentations was provided in this group meeting. The status quo of information sharing between the public and private (auto maker and map providers) in three regions was discussed, and on-going competitiveness in business field was noted.
- What the public can contribute for map creation and what the public can do through the cooperation with private industry was discussed
-

"ADASIS" was presented (Maxime Flament). Questions, discussion and comments are:

- An issue in Europe is 'data border line' between the field for common and for the private competitiveness. The field for cooperation needs to be identified (EU rep)
- Understanding of the interface is needed in order to provide required data for connected vehicles or automated vehicles. The ADASIS interface and V2I use case helps to identify what data the public should provide to the map makers (US rep)
- Since map maintenance cost is very high, a flexible operation concept which can cover three regional differences in Digital Map Infrastructure is needed (US rep)
- When information provided to the ERTICO members is transferred to the non-members, compliance to the stipulated specifications is required, which is posted on Internet (EU rep)
- The first application implemented was for commercial vehicles, due to potential market scale (EU rep)

"Proposed Concept of Operation" was presented (Carl Andersen):

- Data requirements become significant as migration progresses from manual to automated vehicle operation, requiring locally provided data to the data provided at network level (US rep)
- "Table 4 Rough Mapping of Application Areas to digital Map Data element", which illustrates data elements and applications relations to indicate fundamental and conceptual direction, is moving forward. Any comments or feedback is needed on this (US rep)
- Static data and dynamic data can provide images in advance. Before actual driving, those images allow drivers to prepare for the upcoming situation. Tactical or strategic driving becomes possible with those images (US and EU reps)

- In order to provide flexible supports for those data use in three regions, taking leadership by this group was recommended (US rep)
- As for a start toward this end, data ownership should be identified in our three regions and need of cooperation for flexible supports is highlighted (US rep)

4.2.10 *Automated Vehicle Symposium (Ann Arbor) 2015*

During the Plenary session, Mr. Ogi Redzic, gave a presentation on the role in the development of the Digital Transportation Infrastructure.

He presented the following topics:

- the HD Live Map (Cloud based mapping assets). The HD Map layer is the world's most precise set of mapping assets enabling precise positioning for lateral & longitudinal vehicle control on the road surface
    - 3D Spline-based Surface Model
    - ADAS attributes (height, slope, etc)
    - Localization objects for positioning

  Providing public test track data in US, Europe and Japan and have a planned roll-out for a full-featured HD Live Map product supporting vehicle automation.
- How the HD Live Map is built. The world's most robust data collection and processing practices. Massive investment in collection technology and field deployment with a fleet of over 300 vehicles globally. Combination of highly precise LiDAR collection technologies fused with OEM vehicle sensor data to create the most precise representation of reality
- HD Live Map (Real-time data processing). Live Roads is a data aggregation and delivery layer providing real-time awareness, beyond the range of vehicle sensors - allowing insight into:
    - congestion
    - accidents
    - slippery road conditions
    - variable message signs

  Today HERE collects billions of probe points per day to generate real-time traffic conditions
- HD Live Map (Advanced data analytics). The Humanized Driving layer uses historical probe data to determine speed profiles, with high spatial granularity (10 meters). Test speed profiles by comparing with "ground truth" collected by HERE drivers all over the world. Clear agreement between median speeds and ground truth.
- Sensor Ingestion Interface Specification: The goal is to drive this specification to simplify the housekeeping between sensor data suppliers, the cloud and sensor data consumers (vehicles).

4.2.11 *Trilateral ART WG (Ann Arbor) (23-24/07/2015)*

Survey Results: Digital Geospatial Infrastructure for Cooperative and Automated Vehicles (Noblis)

Michael McGurrin and James Moore (Noblis) presented the results of a survey on Digital Geospatial Infrastructure for Cooperative and Automated Vehicles.

There are broad open questions regarding the geospatial information needs for connected and automated vehicles, the appropriate roles for public and private sector entities, and what work the trilateral WG should undertake

A stakeholder survey was conducted to:

- Begin to identify needs and issues associated with the use of geospatial and geospatial related data for cooperative (also known as connected) and automated vehicle applications.
- Collect stakeholder input concerning the appropriate roles of the national and regional public agencies and the private sector
- Begin to identify possible synergies between public and private sector needs.

It was web-based survey utilized and stakeholders included representatives from:

- Digital map providers
- Traffic information providers
- Automobile manufacturers
- Automobile industry suppliers
- Other commercial entities conducing cooperative and/or automated vehicle research
- National departments or ministries of transportation
- Other national level departments
- Sub-national public sector transportation entities, such as state, county or provincial DOTs
- Other sub-national public sector entities, e.g., state geospatial offices
- Universities and other non-profit research centers
- Telecommunications service providers

57 respondents were registered and the main points are summarised below

- Stakeholder survey provides useful insights on general needs and direction; however:
    - Survey was not in any way a scientific representative sample
    - The more detailed the question, the fewer responses
- Consensus among respondents:
    - There are roles for national governments
    - Significant work is needed on standards
    - Some sort of common, shared basemap / data set is desirable

- Next steps:
    - More detailed survey results will be made available in some form at a later date
    - Follow-up telephone interviews are planned for a subset of survey respondents (details TBD)
    - Survey has useful information to be mined as more specific questions and issues arise

Some comments on Digital Infrastructure/Dynamic Maps (DLR)

Digital Infrastructure (DI):

- Complex system to provide digital representation of road infrastructure
- To create, manage, and update Dynamic Maps (DMs)

Dynamic Maps (DMs):

- Digital road environment to support:
    - Connected/automated vehicles
    - Advanced road management
    - Advanced traffic management

Stepwise Implementation of DI

- Use-case identification
    - connected/automated vehicles
    - advanced road management
    - advanced traffic management
- System architecture development
- Prototype development
- Model deployment
- Standardization

Key roles for national governments:

- To create:
    - Dynamic Map Center (shared data, open platform, under public-private partnership)
    - Business model (boundary between cooperation and competition)
- To promote:
    - Data circulation (standard format, location referencing)
    - Electronic availability of public sector information (CAD data of large-scale completion map of road construction, Traffic signs and regulations, Integration of vehicles into DI/DMs as probe)
- To ensure:

- Data reliability (screening, certification)
- Data accessibility: rule-making (fee, obligation, ownership, copyright,…)

- To facilitate:
  - R&D (Prototype development, Model deployment)
  - Standardization (static information, dynamic information, data format for communication, location referencing)

Key roles for private sector

- Cooperative creation of Dynamic Map Center (e.g. private finance initiative)
- Cooperative data sharing (e.g. probe information)
- To seek business opportunities and embark on new undertaking
- Technical participation in R&D
- Technical lead in Standardization

Full Set of WG3 Work Items (Figure 2)

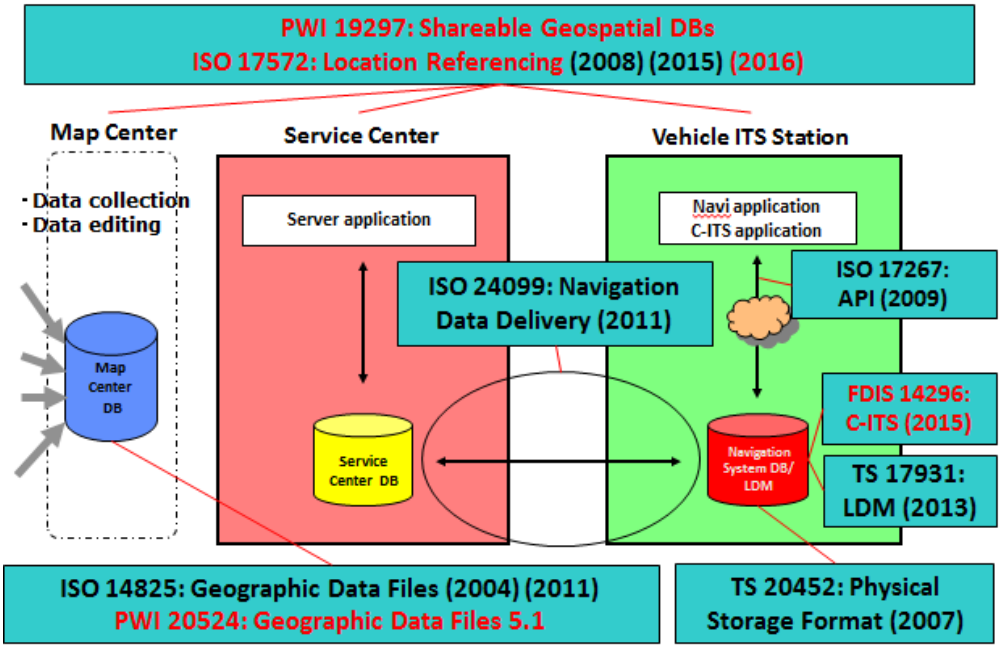

Figure 2: Full Set of WG3 Work Items

Vehicle Sensor Data Cloud Ingestion Interface Specification

HERE presented the Vehicle Sensor Data Cloud Ingestion Interface Specification.

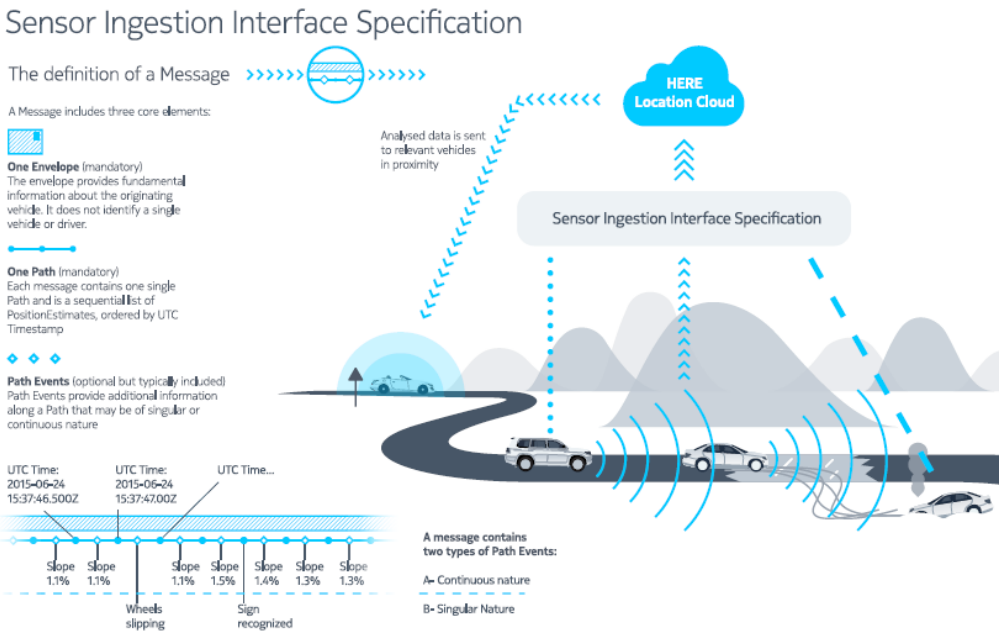

Figure 3: HERE Sensor Ingestion Interface Specification

4.2.12 *iMobility Forum Plenary (Brussels) (21/10/2015)*

Building the Digital Infrastructure (by Ahmed Nasr, HERE)

The main points discussed are the following:

- Challenges of modern mobility
  - Fragmented mobility ecosystem
  - Scalability: ultra-mobile world requires solutions that are both global and local
  - New approaches around connectivity
  - Dynamic and seamless experiences for consumers
- Benefit of connected environments (Data from ecoMove project 2010)
  - Being able to use SPaT data for routing can increase fuel economy by 24%.
  - 22% of all wasted fuel is caused by inefficient deceleration.
  - Congestion is responsible for 15% of the used fuel while traveling.
- HERE Digital Transportation Infrastructure
  - Market first, effective and cost efficient approach connecting all participants in transportation on one platform connecting physical and digital world
- Finnish Transportation Agency pilot
  - World's first end-to-end deployment of car to car to traffic management centre based on 4G/LTE
  - Supports EU C-ITS directive

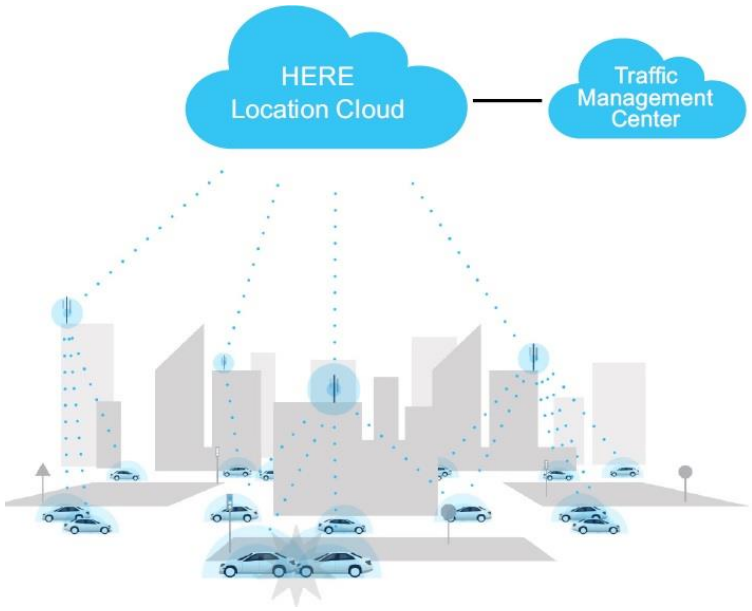

Figure 4: HERE proposed concept

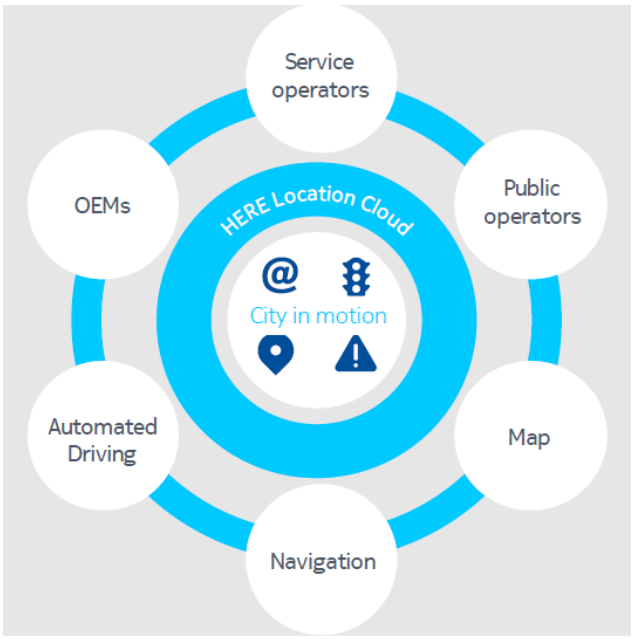

Figure 5: HERE orchestrates the ecosystem for mobility

4.2.13 *Trilateral ART WG (Tokyo) (30-31/10/2015) in conjunction with the 2nd SIP-adus Workshop*

Several speakers participated to the discussion on Dynamic maps:

- Dr. Maxime Flament, ERTICO-ITS Europe, Belgium
- Ms. Elizabeth Machek, U.S. Department of Transportation, USA
- Mr. Russell Shields, Ygomi LLC USA
- Mr. Ryota Shirato, SIP-adus, Nissan, Japan
- Ms. Mako Matsumoto, HERE,USA
- Dr. Hiroshi Koyama, Mitsubishi Electronics Corporation, Japan
- Mr. Harald Kraaij, Cadastre, land Registry & Mapping Agency, Netherlands

The moderator proposed the following concept of Dynamic Map: Idea of Dynamic Map (DM) is based on integration of multiple Local Dynamic Maps (LDMs) at Central ITS Station or DM Centre. While LDM was invented for C-ITS, DM will support Automated Driving Systems in addition to C-ITS and advanced road/traffic management systems with lane-level accuracy, 3D features including Lidar (Laser Imaging Detection and Ranging) data, vehicle-sensor data, probe data, …

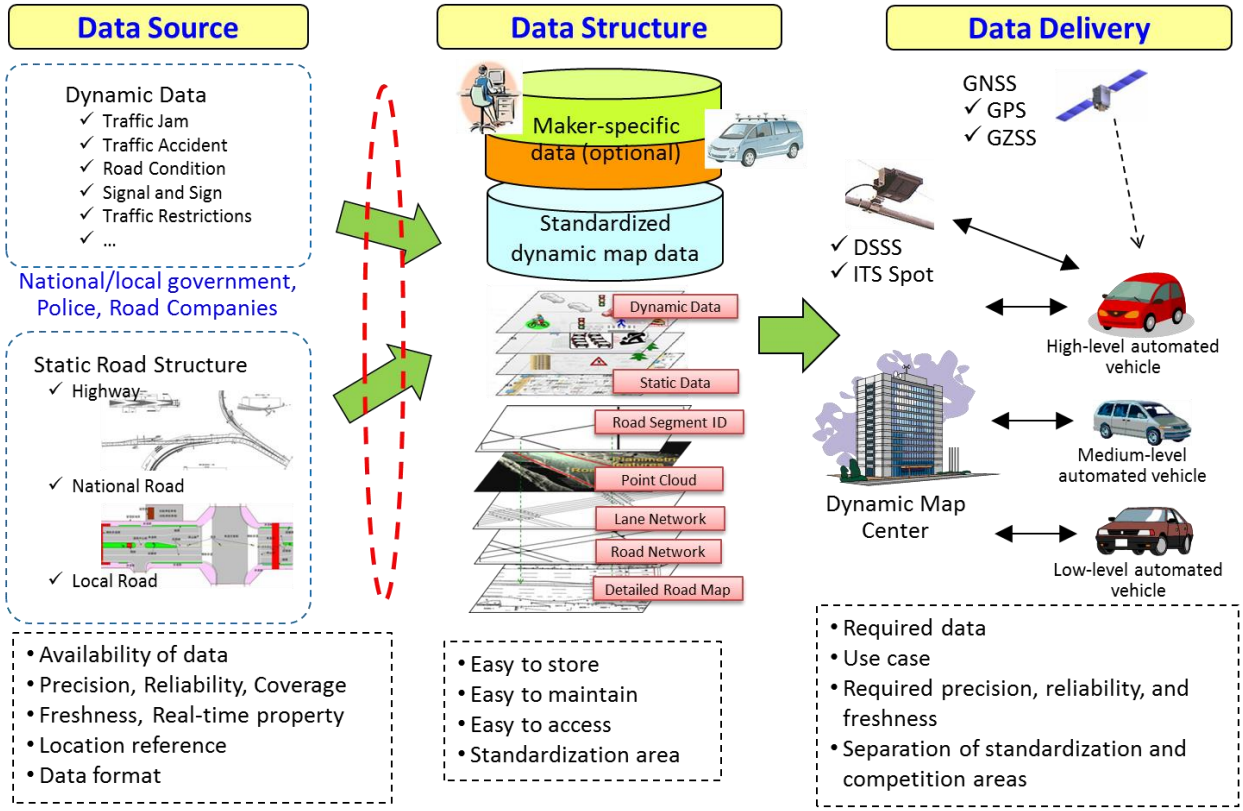

Figure 6: Example of Dynamic Map Centre

Maxime Flament discussed the following points:

- A self-learning, highly accurate living map enables the safest and most comfortable Highly Automated Driving

- The location cloud big data, sensor ingestion algorithms, real time software and services power the most intelligent car sensor
- HERE HD Live Map is currently being used in 10 HAD OEM projects

Ryota Shirato illustrated the Dynamic Map Development in SIP-Adus (Figure 7).

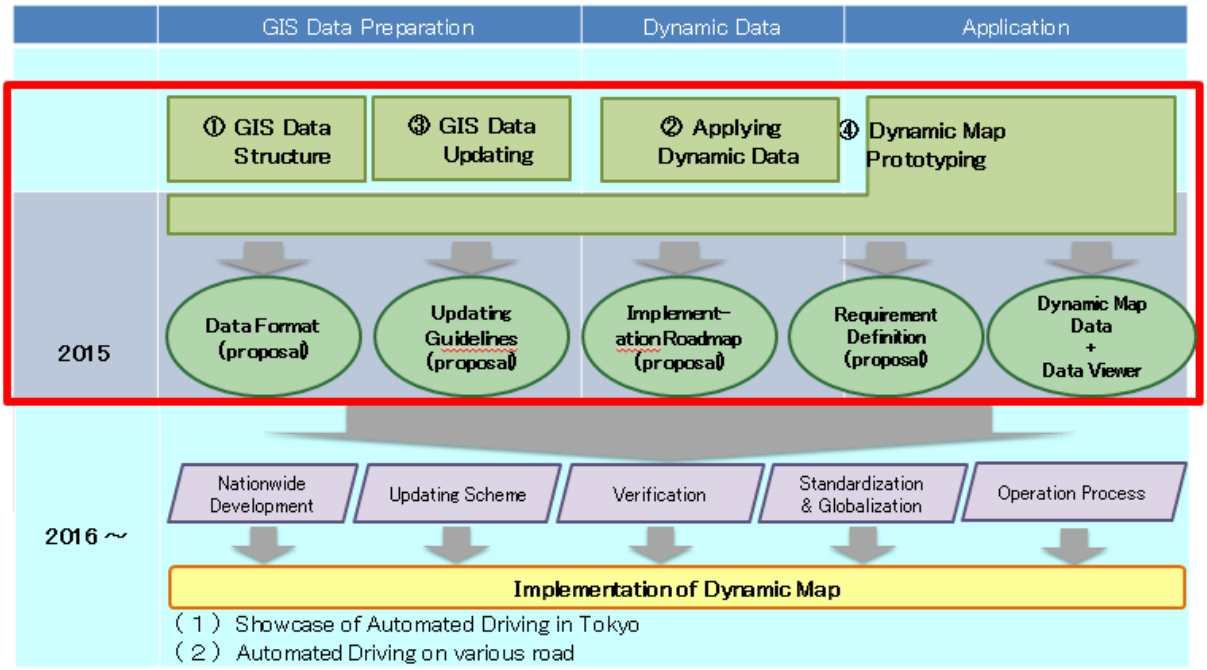

Figure 7: Dynamic Map Development in SIP-Adus

Mako Matsumoto on the advent of Highly Automated Driving focused on the following points:

- HERE HD Live Map is ready in H2 2015 – first enabling connected ADAS use case
- HERE HD Live Map Client is ready in H2 2015 and supports HD Live Map product
- Continued innovation in Intelligent Car, introducing to the industry a sensor ingestion specification to support Automated Driving

Hiroshi Koyama presented a summary of the activity plan of Dynamic Map Study for SIP-adus:

- This year, the consortium is dedicated to study of “Dynamic Map Data Structure”, “Dynamic Map Data Updating” and “Applying Dynamic Data”. Based on the study, “Dynamic Map Prototyping“ is planed
- For this activity, concept of “Common 3D Digital Map” is also introduced
- The consortium would like to propose adoption of the implemented “Dynamic Map” to showcase of Automated Driving in Tokyo and also Automated Driving on various environments

Harald Kraaij discussed the following points:

- What geo-data are needed?
  - Does the base map consist of static and dynamic data?
  - What data should be ready in advance?
  - Should all base map data be 'open'?
- What interface standards are needed?
  - For data formats, exchange, and transmission
- How can base map data be kept up to date?
  - Permanent changes, such as new roads or roadway alignments
  - Temporary changes such as work zones

A **breakout session** on the topic has been organised during the SIP-adus Workshop to discuss mainly the following points:

- How to get HD map information
- Dynamic and static data integration
- Safety and privacy issues

The main challenges have been identified:

- Accurate data/position, update frequency, diverse situations, cost
- How to best realize data integration
- Question of reliability and levels of automated driving
- Liability
- Roles of static and dynamic data
- Privacy
- Security and risks of terrorism and attacks

Finally the future initiatives have been discussed:

- Getting information and improving accuracy, cost, etc.
- Realizing appropriate integration of static and dynamic data
- Taking responsibility for information reliability and liability
- Judging the correct uses of dynamic data and dynamic maps
- Tackling security and preventing attacks

4.3 EU co-funded projects

High precision positioning for cooperative ITS applications (HIGHTS)

This project addresses the problem of providing sufficiently accurate position information for many important applications and in certain challenging but common environments (e.g., urban canyons and tunnels). The project combines traditional satellite systems with an innovative use of on-board sensing and infrastructure-based wireless communication technologies (e.g., Wi-Fi, ITS-G5, UWB tracking, Zigbee, Bluetooth, LTE...) to produce advanced, highly-accurate positioning technologies for C-ITS.

The results will be integrated into the facilities layer of ETSI C-ITS architecture and will thereby become available for all C-ITS applications, including those targeting the challenging use cases Traffic Safety of Vulnerable Users and Autonomous Driving/platooning. The project will therefore go beyond ego• and infra-structure-based positioning by incorporating them as building blocks to develop an enhanced European-wide positioning service platform based on enhanced Local Dynamic Maps and built on open European standards. Proof-of-concept systems developed in the project will combine infrastructure devices, reference vehicles, communication between road users and offline processing, and will be evaluated under real conditions at TASS' test site in Helmond, with the objective of assessing its capabilities to provide high precision positioning to C-ITS applications. When possible, codes and prototypes will be fully open-source and made available to the larger research community as well as to the automotive industry at the end of the project. All achievements will be published in top-tier events further guaranteeing an open-access to all technical publications produced. The project also aims at a strong commitment to bringing the developed solutions to standardization bodies

Additional information on this project are available on the official project website: http://hights.eu/

4.4 VRA webinar

The topic of Digital Infrastructure has been addressed during the VRA Webinar 3 “Automation @ Helsinki Congress”. In particular, during this Webinar, the presentation provided during the Executive Session (ES04)

The presentations and the recorded video of this Webinar are available on the VRA Website[9]

4.5 Current status of the discussions

The topic of Digital Infrastructure, as illustrated in the previous chapter, has been addressed during several meetings. Currently the main focus of the Working Group is on the support to

9 http://vra-net.eu/news/vra-webinar-3-automation-its-european-congress-main-feedback-and-highlights/

the International activities by supporting the interaction between European and International activities (e.g. Trilateral Working Group on Automation).

4.6 Main outcomes of the work done

The main results of the discussions and the on-going work regarding digital infrastructure are summarized in the following sections and are actually related to the work carried out so far in the:

1) The support to the international cooperation in the Trilateral Automation in Road Transportation (ART) Working Group
2) the recommendations provided to the EC for the 2016-2017 work programme (section 4.2.8)

4.7 Next steps

The focus in the next steps is to be aligned with the work carried out in the iMobility Forum, concerning the preparation of a whitepaper in Automation in Road transport (to be finalised by the end of 2016), organize the consolidation of the discussion group especially taking into account the activities at international levels.

In 2016, VRA WP3.6 mainly plans to:

1) support international and European collaboration on the topic of Digital Infrastructure
2) follow up the activities of EU-funded projects on the topic of Digital Infrastructure
3) consolidate the current content of D3.6.1, delivering the final version (D3.6.2)

5 Consolidation of the discussion on Digital Infrastructure

The discussions on digital infrastructure and its role in automated driving are at their peak both in Europe and worldwide. There is a debate on the role of digital infrastructure in road transport automation. On-going work in this subgroup includes suggestions, key messages and recommendations in terms of the needed collaboration between sectors/stakeholders, which have been briefly highlighted in Chapter 4.

6 Conclusions

This is the first draft deliverable on Digital Infrastructure needs and recommendations for deployment of vehicle and road automation, after the recent restructuring of the work of WP3.

The methodology and tools used so far are highlighted as well as the current activities from the VRA point of view.

A detailed report of the discussion is provided Chapter 4 and a consolidated contribution will be provided in the final version of this Deliverable (D3.6.2).

7 Annexes

7.1.1 *Annex 1 –iMobility Working Group Automation in Road Transport (24/01/2014) – slides summarizing the Breakout session*

Limitations

- Can we rely on the maintenance of the infrastructure and the information on the street?
  - Should we focus on features of the roads that are permanent? Like shape of the road, curb, post signs
  - Should the vehicles build their own maps?

Not needed (out of scope)

- Position of the other vehicles of other road users

Not needed (out of scope)

- Position of the other vehicles of other road users

Highway pilot

- Classic traffic information
  - End queue information
  - Closed lanes
  - Tunnel information
  - Hazardous areas
- Weather information
  - Fog, rain, snow location
- Construction sites
  - Geometry of lanes

Intersection

- Accurate maps of everything
  - Everything painted on the road
  - Topology of the
  - Priority rules

Platooning

- Good representation of the curves, round about, priority rules and traffic lights

7.1.2 *Annex 2 – Trilateral ART WG (Tokyo) (30-31/10/2015) in conjunction with the 2nd SIP-adus Workshop (VRA presentations)*

iMobility Forum WG Automation in Road Transport

Sub-WG on Digital Infrastructure

Maxime Flament, ERTICO
Ahmed Nasr, HERE

Outline

- Introduction to VRA
- Definition of Digital Infrastructure (EU) and motivation
- Role of Digital Infrastructure
- How and who will provide the data

VRA in Short

VRA – Vehicle and Road Automation is a support action funded by the European Union to create a collaboration network of experts and stakeholders working on deployment of automated vehicles and its related infrastructure

COOPERATION

This project is funded by the European Union

Objectives of VRA Support Action

Create an active European network of experts on Vehicle and Road Automation and foster cooperation within the Automation WG

iMobility Forum

EU★US★JAPAN ITS COOPERATION

Contribute to EU-US-JPN trilateral WG on road vehicle automation (EC – US DoT – MLIT)

Deployment paths, Regulatory issues, Testing, Connectivity, Benefits, Maps, Cybersecurity, Human Factors, Decision and Control

Identify deployment needs for Vehicle and Road Automation

VRA-net.eu/wiki

Promote the Research on Vehicle and Road Automation

VRA: Major topics of the Automation WG

Deployment paths (VOLVO)	• Viable business models and deployment paths including socio-economic implications
Regulatory issues (ERTICO)	• Clarify current regulatory and liability issues among European countries
Road Worthiness Testing (IDIADA)	• Identify needs for standardisation, testing, compliance and certification
Connectivity (ICCS)	• Identify additional requirement on C-ITS
Digital infrastructure (HERE - ERTICO)	• Identify role of digital maps for automation
Human factors (DLR-TRL-LEEDS)	• Identify solutions for driver and other road user interactions
Evaluation of benefits (CTL)	• List potential direct and indirect benefits of automation
Controls and decisions (DLR)	• Identify gaps in current control and decision solutions
Reliability and CyberSecurity (→HTG6)	• Clarify reliability concerns and make recommendations

Digital Infrastructure (for Road Transport Automation) (EU)

Definition

Static and dynamic digital representation of the physical world with which the automated vehicle will interact to operate. This includes sourcing, processing and information.

Motivation

- Along with the investment needed on the physical road infrastructure, a "digital representation of the road infrastructure" will be needed.
- Need cooperation from the vehicles and the infrastructure operators to collect, update and correct eventual changes made on the physical infrastructure

Roles of the DI for Automation

Static

Dynamic

- Provide accurate map data (e.g. HD Maps)
- Provide apriori knowledge along the road (Electronic Horizon)
- Enable high relative position accuracy (landmarks)
- Reproduce human like driving (driving patterns)
- Allow or not automated functions on specific roads (e.g. managed lanes)
- Notify the vehicle about situations ahead that may require human attention or even intervention (L4→L3→L2…)
- Provide dynamic information around the vehicle (LDM)

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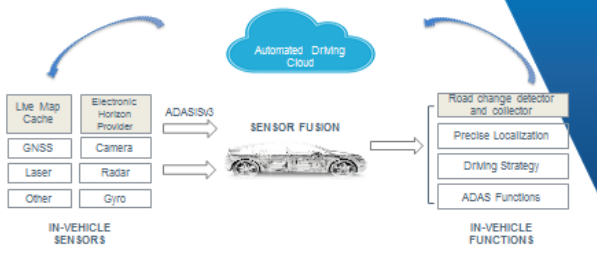
Suppliers to the 2015 BMW X4

HAD sensors overview



Source: HERE, ITS World Congress, 2015

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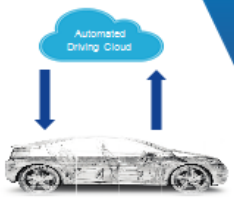
The most intelligent car sensor

A cloud providing **highly accurate live map** is the **most intelligent car sensor** for Highly Automated Driving



Source: HERE, ITS World Congress, 2015

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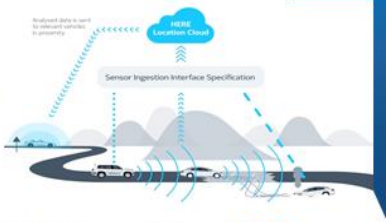
A sensor that learns

A Live Map **learns from humans and from other sensors**

This guarantees the **freshness** and continuous verification of the data

HERE is proposing an open standard for **sensor ingestion interface** (sensorIS)



Source: HERE, ITS World Congress, 2015

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A sensor that extends beyond visible range

A Live Map **sees and anticipates events around** the corners

This significantly improves vehicle **safety and comfort**

It provides near **real time dynamic event information** combined with freshest ADAS data

Source: HERE, ITS World Congress, 2015

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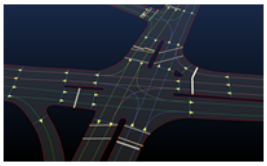
A sensor that provides an accurate reference of the world

A high definition map provides a precise 3D layout of the road and its surroundings

It **removes environment ambiguity and noise**

This allows **accurate positioning and safest vehicle planning and control**



Source: HERE, ITS World Congress, 2015

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Summary

A self learning, highly accurate living map enables the **safest and most comfortable Highly Automated Driving**

The location cloud big data, sensor ingestion algorithms, real time software and services **power the most intelligent car sensor**

HERE HD Live Map is currently being used in **10 HAD OEM projects**

Source: HERE, ITS World Congress, 2015

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Thank you for your attention…

Any questions?

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