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Connectivity needs and recommendations for deployment of Vehicle and Road Automation

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Executive Summary

Automated driving as an extension of current ADAS systems can increase safety, efficiency and traffic flow in the road transport network. These benefits can be further enhanced if connectivity is also considered. Connectivity can extend the electronic horizon and the environment perception of on-board-sensors which have physical limitations. It can also work during harsh weather conditions (e.g. snow, fog, heavy rain) where some sensors are malfunctioning or providing significant errors. Automated driving could leverage on the recent advances in telecommunication technologies (e.g. ITS G5, 4G/LTE/5G).

In this deliverable the challenges and needs of connectivity with regard to road transport automation are highlighted. The main challenges are to ensure interoperable, resilient, reliable and ubiquitous connectivity, to develop or adapt communication protocols for connected and automated driving, to investigate security and privacy aspects.

For the fast deployment of connectivity and especially in combination with automation in road transport there are several conditions that need to be satisfied, such as demonstration in real-life conditions of different applications and functions that assess the feasibility and the readiness level of the technology, standardization and interoperability of connectivity devices and agreement on the message sets needed for automated driving applications, liability and compatibility with existing legislation.

Moreover, the methodology and the tools used to get the feedback from the relevant stakeholders are included, with the main means for collecting information and discussion being the call 10 cluster projects and the VRA and iMobility forum physical and virtual meetings.

The deliverable concludes with the consolidation on the discussions on connectivity and its role in automated driving and although there are different opinions the prevailing one is that convergence of connectivity and automation will maximize the benefits in terms of safety, efficiency, comfort and environmental impact.

1 Introduction

1.1 Purpose of Document

The objective of this deliverable is to report the activities of the newly created WP3.4 of VRA on connectivity needs and recommendations for deployment of Vehicle and Road Automation.

This deliverable intends to gather the activities performed in the field of connectivity on road automation, using as a basis key projects and experts in the area in Europe and beyond, and provide recommendations and a common approach for the next steps in connectivity 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 connectivity 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 connectivity needs and recommendations
- Section 5: Highlights the consolidation of the discussion topics concerning connectivity that had taken place by the time of writing this deliverable
- Annexes: Support the previous sections by listing the relevant 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.*

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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 Connectivity challenges and needs in the deployment of vehicle and road automation

2.1 Connectivity challenges

In the last decade Cooperative ITS (C-ITS) systems have been in the forefront of European and worldwide research as the next generation of ITS, overcoming the limitations and the barriers of classical sensor based ADAS solutions (e.g. limited sensor range and occlusion, sensors' accuracy and reliability, significant costs involved etc.). The benefits from using C-ITS in their full potential are anticipated to be significant and will improve road safety, reduce congestion and overall optimize the efficiency of today's transport networks.

Despite the efforts and the associated benefits the take-up of C-ITS is really slow and for that reason recently European Commission, and more specifically DG MOVE, has established a "Platform for the deployment of C-ITS in the EU" consisting of several experts in the field and organised into 11 different WPs[1].

Those challenges that connectivity faces towards its actual deployment, both in the short term and the long term in road transport, are becoming even greater when we add the nature of automated driving in this framework, where safety and real-time reaction are key aspects.

A list of key connectivity challenges considering also the automation aspect, extracted from the iMobility Forum Automation Working Group discussion groups, can be found below:

- Interoperability of V2X equipment especially when driving between countries
- V2X communication protocols: updates needed for automated driving
- Ubiquitous connectivity / seamless use of different communication technologies
- Reliable and resilient communication considering harsh environments (e.g. truck platooning in tunnels) to ensure functional safety and a minimum quality of service
- Cyber-security to make automobiles tamper-proof in attacks from hackers
- Data privacy and data ownership (use of enormous amount of data respecting privacy concerns and at the same time ensuring a minimum quality of service)
- Mass market adoption of V2X communication in accordance with spectrum availability (study the effects at different penetration levels incl. extremely high and extremely low penetration level of V2X equipment)
- Rapid evolution of communication systems especially cellular technologies (3G → 4G → 5G)

[1] http://ec.europa.eu/transport/themes/its/news/doc/c-its-platform-deployment/draft-work-programme.pdf

2.2 Connectivity needs

For the fast deployment of connectivity and especially in combination with automation in road transport there are several conditions that need to be satisfied.

The first one is to develop, test and demonstrate in real-life conditions different applications and functions that assess the feasibility and the readiness level of this technology. This is carried out through several initiatives worldwide. For example in Europe we have the FP7 call 10 cluster projects (mainly AutoNet2030, i-GAME, AdaptIVe) working on different aspects of connectivity in automated diving and in the US the Safety Pilot in Ann Arbor[2] for Connected Vehicles involving currently more than 3000 vehicles.

At the same time standardization and interoperability of connectivity devices and agreement on the message set needed for automated driving applications are also essential. Already in the different FP7 call 10 projects the need for extension of the CAM messages for the need of automated driving is already identified and communicated to the relevant working group (WG1) of ETSI standardization organization. Cyber-security standards for V2X are also very important for the deployment of connected automated driving.

C-ITS go hand in hand with an increase in vehicle automation, meaning that there is an increase in the functions carried out by the vehicle and not by the driver. This issue has important implications both on the attribution of liability and compatibility with existing legislation. So there is a clear need for a common European framework on liability ensuring at the same time that this is compatible with existing legislation (the Vienna Convention).

Additional issues that need to be tackled before the wide deployment of connectivity are spectrum usage issues (slight differences in Europe and US), the need for a common framework for testing and validation (similar to FESTA methodology) and the creation of new business models taking into account future technologies.

Most of the above mentioned issues are also handled in different groups of VRA such as “standardization and certification” and “regulatory needs”. There is a close link of “Connectivity” group with these in order to have a harmonized outcome in the end.

2.3 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.

[2] http://safetypilot.umtri.umich.edu/

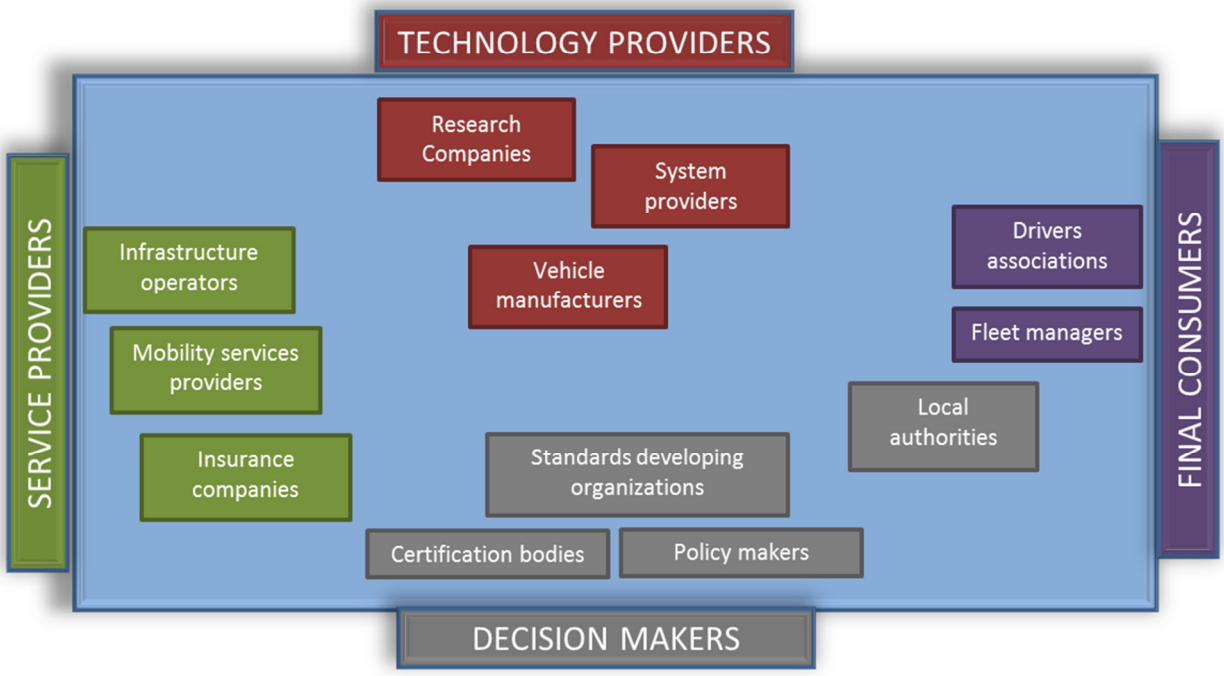

Figure 1: Illustration of stakeholder groups and their role vehicle and road automation

This general overview is customized in Table 1, in which the stakeholders are analysed indicating main function and also key aspects on connectivity 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	Connectivity aspects
Policy makers and legislative bodies	Produce regulations and ensures compliance	• The deployment of connectivity brings an important number of legal questions regarding liability, privacy or road traffic legislation • Data use and ownership (privacy issues)
Vehicle manufacturers	Manufacture and sell vehicles with a level of automation	• Connectivity and needed equipment affect vehicle manufacturing procedures • Tamper-proof cars are a must for OEMs and their customers
System providers	Offer VRA related systems and applications for vehicles and infrastructures	• V2X equipment (both for vehicles and for roadside units) following standards to ensure interoperability
Research companies	Provide new paradigms and application solutions. Part of the technology providers chain	• Identify gaps in existing wireless technologies for the needs of automated driving • Provide secure and reliable communication mechanisms

		• Data analytics for road transport automation
Service providers	Make business providing services based on vehicle and road automation	• Enhanced services exploiting communication technologies
Infrastructure operators	Explode roads and highways. Is a potential service provider	• Support the installation of roadside units for extending the palette of automation applications exploiting communication
Final consumers	Buyers of VRA technology (drivers, fleet owners, local authorities, ...)	• Provide list of their needs and services useful for them while driving enabled by connectivity
Certification bodies	Homologation of vehicles, equipment and drivers for automation	• Certify relevant V2X equipment
Insurance companies	Provide Insurance for automated vehicles. Safe mobility and responsibilities	• Find liability and insurance schemes in case of accidents caused by connectivity malfunctions
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	• Provide new standards or upgrade existing ones to safeguard interoperability between different connectivity vendors and products • Standardization of connected automated vehicles

3 Methodology description for connectivity

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 connectivity 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 connectivity 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 connectivity and its role in automation on road transport; however these were focused on the technical challenges/aspects and were organized under the framework of the Automation WG of the iMobility Forum. Officially there was no specific activity on connectivity within the context of VRA and it was initiated during the last amendment of the VRA DoW to better organize the work on deployment and market perspective of connected 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 connectivity 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 connectivity and automation in transport. The same is valid for other important conferences, such as TRB which gathers all the relevant experts in the field and provides useful feedback through targeted break-out sessions. An indicative example of such a break-out session for V2X connectivity can be found here:

http://2013.vehicleautomation.org/program/breakouts/information-architecture-and-communication

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 connectivity is the iMobility Forum and especially Automation WG which involves key stakeholders in the field to exchange ideas and identify the current trends in connectivity and automation.

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

The main R&D projects that are used as a basis for the work in VRA are the so called call 10 cluster projects, namely AutoNet2030, AdaptIVe, iGAME and COMPANION together with CityMobil2.

The most relevant ones for the work carried out in the connectivity group are AutoNet2030, iGAME and AdaptIVe.

AutoNet2030

AutoNet2030 intends to demonstrate how the combination of cooperative wireless communications and on-board sensors will make cooperative automated driving and interaction between automated and manually driven vehicles more efficient and reliable. Towards this direction the consortium of AutoNet2030 is working closely with standardization bodies, such as ETSI, to extend existing standards or propose new ones to support advanced automated driving use cases such as cooperative lane change, cooperative sensing, driving in a convoy and coordinated intersection control. More details will follow in the next chapter. The website of this project is http://www.autonet2030.eu/.

AdaptIVe

AdaptIVe develops various automated driving functions for daily traffic by dynamically adapting the level of automation to situation and driver status. Further, the project addresses legal issues that might impact successful market introduction. In AdaptIVe during the kick-off meeting a horizontal task force on V2X connectivity aspects has been proposed and established the next few months. The focus of this task force is to identify and cover in a harmonized way the connectivity needs of all the different SPs and demonstrator vehicles. More details about the work carried out in AdaptIVe regarding connectivity will follow in the next chapter. The website of this project is http://adaptive-ip.eu/.

i-GAME

The objective of i-GAME is to develop generic, fault-tolerant, and resilient technologies for automated driving and supporting cooperative applications, focusing on the supervisory control level. To do this the project will arrange the second Grand Cooperative Driving Challenge, namely GCDC 2016, which aims at speeding up real-life implementation and interoperability of wireless communication based automated driving. More details about the work of interest for connectivity performed in i-GAME will follow in the next chapter. The website of this project is http://www.gcdc.net/i-game.

Other relevant projects, especially the ones currently funded through the first call of EU Horizon 2020 framework programme, will be identified and investigated in due time and in case this is feasible further links will be established.

3.1.4 *Link activities with task forces or interest groups*

As mentioned above the main task forces and groups that connectivity has established already a good link are the following:

- iMobility Forum Automation WG: V2X connectivity sub-group
- AdaptIVe: task force on V2X connectivity

At this point it should be mentioned that connectivity is one of the areas that are of interest for the trilateral cooperation between EU, US and Japan but it has not been addressed properly yet since the focus was mainly on other areas such as digital infrastructure. This is anticipated to change in the next months and the feedback received from this international activity will be a very useful input for the work carried out in this task.

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). In the area of connectivity and automation one VRA webinar was organized so far by TNO on 26th of March 2015 (more details in chapter 4 of this deliverable). The current list of VRA webinars (six in total in the time of writing this deliverable) can be found here: http://vra-net.eu/library/

3.2 Implementation plan

To facilitate the follow up of the different discussions and events in which VRA CSA supported the objectives described in Task 3.4 on connectivity, as well as in the activities performed in the V2X connectivity discussion group of the AWG, Table 2 has been introduced. This table also includes a description of the event, a short summary, any particular result to be explained and if there is an ANNEX with the different working documents used.

Table 2: Meetings, teleconferences and congresses with active contribution to VRA Task 3.4

Events/Topics	*Date*	*Description*	*Summary and objectives*	*Annex*
AWG Meeting	17 Sept 2014	EC Recommendations	• Discussion and description of recommendations to be provided to the EC for future H2020 calls (WP 2016-2017)	1
AWG Meeting	2 Dec 2014	Harmonization and complementarity of inputs from sub-working groups and contribution from European Projects	• Presentation on the status of the V2X sub-group and suggestions for next steps that leaded to the Whitepaper	-
AWG Meeting	28 Apr 2015	White paper of the Automation WG Planning of the activities of each sub-working group	• First draft on the iMobility Forum AWG whitepaper	-
VRA – AWG Meeting	1 Jul 2015	White paper on Automation and VRA	• Discuss mainly about the iMobility Forum AWG whitepaper	-

		Deliverables Planning of the activities of each sub-working group		
VRA – AWG Meeting	23-24 Sep 2015	White paper on Automation Planning of trilateral activities and ITS Bordeaux VRA Deliverables	• Discussion on the iMF whitepaper adding key messages and recommendations for collaboration	-

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 VRA, ICCS, Tecnalia and TNO 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 Current status of the discussions

As already mentioned in the beginning of this document this task, namely 3.4, is newly established in VRA so the discussions so far were driven from the relevant sub-group in the iMobility Forum AWG and were technically oriented. The role of this task here in VRA is mainly to identify needs and provide recommendations for early deployment and market penetration of the relevant technology.

4.3 Main outcomes of the work done

The main results of the discussions and the ongoing work regarding connectivity are summarized in the following sections and are actually related to the work carried out so far in the EU call 10 cluster projects, the recommendations provided to the EC for the 2016-2017 work programme and a dedicated VRA webinar.

4.3.1 *EU co-funded projects*

AutoNet2030

AutoNet2030 intends to demonstrate how the combination of cooperative wireless communications and on board sensors technologies will make cooperative automated driving and interaction between automated and manually driven vehicles more efficient and reliable.

In the first phase of the project, a list of automated driving control use cases and the related requirements were listed. Based on these use cases and requirements, the AutoNet2030 functional architecture was developed which is decomposing the complex on-board unit of a cooperative (automated) vehicle, road-side unit and a central unit in well-defined building blocks and interfaces.

The main outcome of AutoNet2030 which is interesting for the connectivity task in VRA is the public deliverable D3.2 “Specifications for the enhancement to existing LDM and cooperative communication protocol standards“[3]. This deliverable is the final output of Work Package 3 “System design” which specifies the enhancements of European C-ITS standards and identifies new protocols and technical features to support the advanced automated driving use cases defined in AutoNet2030 such as cooperative lane change, cooperative sensing, driving in a convoy and coordinated intersection control.

[3] http://www.autonet2030.eu/wp-content/uploads/2015/02/D3.2-Specifications-cooperative-communication-protocol-standards-draft-for-approval.pdf

The communication architecture considered for the AutoNet2030 project is based on the C-ITS communication architecture, as defined by ETSI in the European Standard ETSI EN 302 665[4]. Figure 2 provides a graphical representation of the communication components in the AutoNet2030 architecture and their distribution into layers. A color coding has been used to differentiate between new and updated communication components within the scope of AutoNet2030 (red) and existing components in the C-ITS communication architecture which will be reused without substantial modifications (blue).

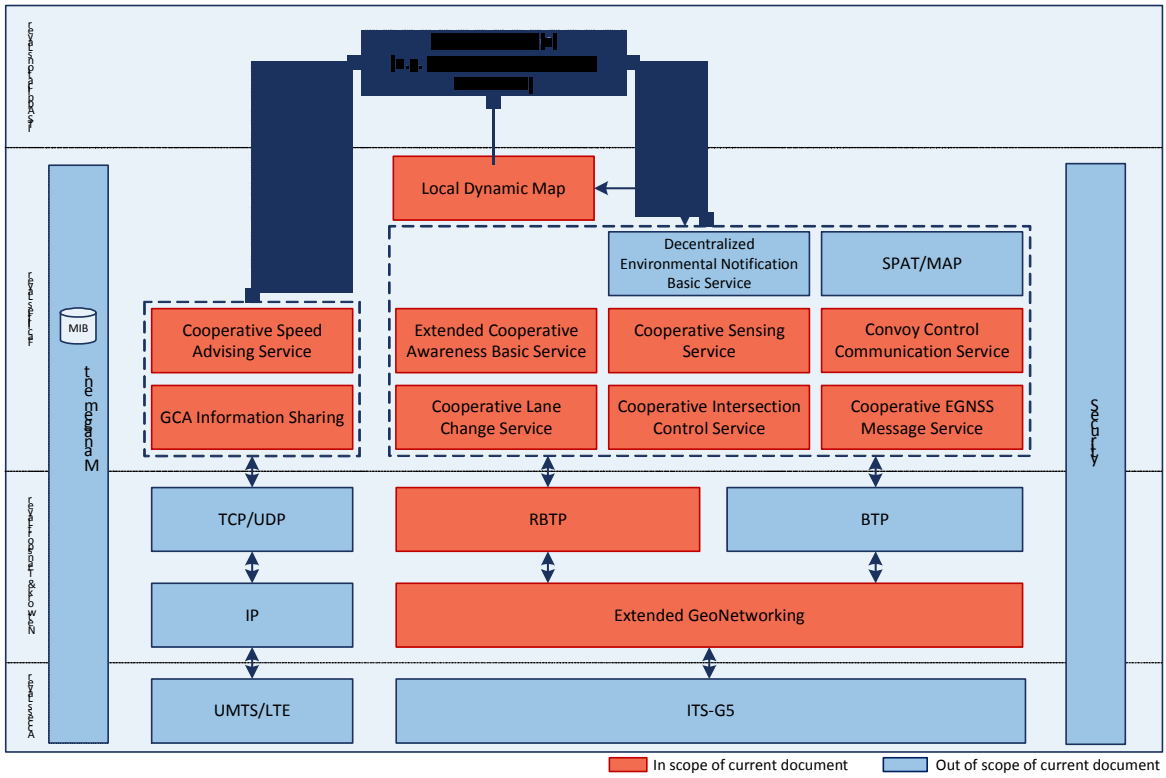

Figure 2: AutoNet2030 Communication Architecture

This work is already communicated to the relevant ETSI working group (WG1) through consortium partners actively contributing to ETSI. The main standardization proposal of interest for connectivity is the extension of the Cooperative Awareness Messaging (CAM) for automated driving support which was jointly proposed by AutoNet2030 and AdaptIVe projects. This proposal included the following main points:

- Increase CAM transmission frequency to 10Hz for high awareness
- Dual-channel transmission on CCH and SCH (SCH6?).
- Introduce two new containers:
  - *automatedVehicleHighFrequencyContainer* as subset of *basicVehicleHighFrequencyContainer* to limit the CAM size
  - *automatedVehicleLowFrequencyContainer* with new fields

[4] http://www.etsi.org/deliver/etsi_en/302600_302699/302665/01.01.01_60/en_302665v010101p.pdf

More details about the standardization activities in AutoNet2030 can be found in D3.2, while more information on the project itself can be found here: http://www.autonet2030.eu/.

AdaptIVe

AdaptIVe targets an ideal interaction between drivers and automated systems by using advanced sensors, cooperative vehicle technologies and integrated strategies. The level of automation dynamically adapts to the situation and driver status.

The joint effort required from different demonstrator vehicles in various subprojects within AdaptIVe regarding connectivity led to the creation of a horizontal V2X task force. The main work of this task force so far was to gather the needs from the different demo vehicles together with the respective functions and propose a harmonized approach for V2X equipment and messages. The work carried out so far is reflected in the different deliverables having to do with system specification and architecture which are not publicly available; however abstracts of that deliverables can be found here: http://adaptive-ip.eu/index.php/deliverables_papers.html.

Moreover, through the common partners between AutoNet2030 and AdaptIVe, namely ICCS and CRF, a joint proposal for CAM extension for the needs of both projects was communicated to ETSI. More details about the ongoing work of the project will be provided in its website http://adaptive-ip.eu/.

i-GAME

i-GAME is a research and demonstration project aiming at speeding up real-life implementation and interoperability of wireless communication based automated driving. Within the framework of the project a challenge will be organized, that is the second Grand Cooperative Driving Challenge (GCDC) which comprises a series of verification and validation workshops, and is rounded off with a final cooperative driving challenge.

Different scenarios will be realized including highway cooperation, intersection cooperation and proper handling of situations involving emergency vehicles. The work carried out so far which is of interest for VRA task 4.3 is reflected in the deliverable "D3.2 Proposal for extended message sets for supervised automated driving". This deliverable includes proposed extensions to CAM and DENM message sets as well as the creation of a new i-GAME message, however this deliverable is currently in a draft version and not yet publicly available.

More details about the ongoing work of the project will be provided in its website http://www.gcdc.net/i-game.

4.3.2 *VRA webinar*

In the area of connectivity and automation one VRA webinar was organized so far by TNO on 26th of March 2015. The title of this webinar was “Cooperative Automation: Activities in the European Project i-GAME” and its general objective was to present a quick overview of the on-going and planned activities in the field of communication (V2X) in the European project i-GAME. All the relevant information about this webinar, the presentations and the relevant video can be found here: http://vra-net.eu/news/vra-webinar-6-cooperative-automation-activities-in-the-european-project-i-game/.

Apart from the above webinar it should be also noted that the issue of connectivity and automated driving was indirectly tackled, due to its interdisciplinary nature, in other webinars

organized so far from VRA. The current list of VRA webinars (six in total in the time of writing this deliverable) can be found here: http://vra-net.eu/library/.

4.3.3 *Recommendations for the EC*

The final version of the connectivity recommendations to the EC which fed the work programme 2016-2017 were discussed during a physical meeting in Brussels on the 17th of September 2014 with several experts and EC representatives (more details can be found in Annex 1). After the finalisation of the dedicated break-out session on V2X connectivity group the following recommendations were extracted (in priority order):

1. Large scale pilots which test the technical maturity and security aspects of V2X in order to assess if the requirements posed by cooperative automated driving and safety critical applications are covered by the current technology and which specific issues should be addressed (e.g. Interoperability, low latency, increased throughput, congestion strategies, data verification and data integrity)
2. Enable reliable and secure communication by seamless and transparent integration of different communication technologies (e.g. 4G / 5G / WiFi / 802.11p) and develop and improve data fusion algorithms to combine V2X information with on-board sensor information
3. Big Data management, analytics and privacy to support V2X connectivity incl. Vehicle-to-cloud communication

4.4 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, organize physical and/or virtual meetings to better facilitate the discussions for connectivity and automated driving and interact in a more active and structured way with the trilateral (EU-US-Japan) workshops and activities.

Partners involved in the connectivity sub-group will try to find additional opportunities, apart from the VRA and iMobility Forum meetings, to discuss the connectivity challenges and needs towards road transport automation. For example, a meeting on this topic is foreseen during the next Grand Cooperative Driving Challenge on 28 - 29 May 2016.

5 Consolidation of the discussion on connectivity

The discussions on connectivity and its role in automated driving are at their peak both in Europe and worldwide. There is a debate on the role of connectivity in road transport automation and although there are different opinions the prevailing one is that convergence of connectivity and automation will maximize the benefits in terms of safety, efficiency, comfort and environmental impact.

At this point it worth to mention that the work carried out within the connectivity subgroup within the last year was quite successful since most of the recommendations provided to the EC were reflected to the WP2016-2017. Indicative topics that were integrating the recommendation mentioned in section 4.3.3 are MG.6.1, MG6.2 and several ART topics. This shows the importance and acceptance of the worked carried out within this subgroup. In the longer term the target is to set more recommendations to support the EC and relevant stakeholders and guide them towards actual deployment.

Then the discussions were focused on identifying current initiatives with regard to connectivity and automated driving at national level (AutoDrive in UK, DriveMe in Sweden), Europe-wide level (AutoNet2030, AdaptIVe, iGame, ROADART) and worldwide (UMTRI, Ann Arbor pilot) and the identification of current market products that could lead the deployment phase (e.g. Imtech C-ITS platform, Hitachi V2X solutions, Cohda wireless).

In addition, the outcome of the subgroup discussions regarding how connectivity could be deployed in automated driving was that an incremental approach seems to be the most viable option, while the real benefits of connectivity can be visible when we will have significant penetration levels of V2X devices. So scaling up from already available initiatives such as the C-ITS corridor from Rotterdam to Frankfurt through Vienna or starting first in segregated/controlled areas (e.g. segregated lanes, warehouses, airport/port terminals) are potential deployment paths. Moreover, specific and clearly planned business cases will really accelerate deployment. Some suggestions are: platooning, last-mile collective automated transport or freight transport (early adopters), C-ACC, urban intersections, multi-modal solutions connecting transport hubs, collaborative and autonomous parking.

Ongoing work in this subgroup includes suggestions, key messages and recommendations in terms of the needed collaboration between sectors/ stakeholders, which are briefly highlighted below:

- Collaboration between telecom operators (5G) and suppliers of OBUs (G5) is needed to bring value from both technologies; in close cooperation with OEMs to define clear business cases;
- Collaboration of OEMs with public authorities and traffic managers to enhance interactions and communication with the infrastructure (V2I); different to the current approaches focusing mainly on V2V;
- OEMs agreement to be proactive and use V2X equipment on a voluntarily basis (not mandate within EU).

This is the first draft of this deliverable and includes actually an initial approach regarding connectivity challenges and needs for the deployment of automation in road transport. In the next version of this deliverable the material collected will be more mature and could be used for consolidated outcome.

6 Conclusions

This is the first draft deliverable on Connectivity 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.

Future activities and plan are also provided.

7 Annexes

Annex 1 – Workshop WG Automation (EC Recommendations)

Meeting	*Workshop WG Automation (EC Recommendations)*
Location	*Brussels, ERTICO office*
Date	*17 Sept 2014*
Attendants (to the specific V2X break-out session)	
1. Panagiotis Lytrivis, ICCS 2. Tobias Hesse, DLR 3. Stefan Deix, Clepa 4. Dimitrios Axiotis, EC 5. Alain Van Gaever, EC 6. Maria Pia Fanti, ICOOR 7. Simon Godwin, EUCAR 8. Diego Bernardez Moron, CTAG 9. Patrick Pype, NXP 10. Bastiaan Krosse, TNO 11. Jaap Vreeswijk, Imtech 12. Andres Aparicio, IDIADA	
Recommendations from V2X connectivity sub-group	
After the breakout session on V2X connectivity group the following recommendations were extracted (in priority order): 4. Large scale pilots which test the technical maturity and security aspects of V2X in order to assess if the requirements posed by cooperative automated driving and safety critical applications are covered by the current technology and which specific issues should be addressed (e.g. Interoperability, low latency, increased throughput, congestion strategies, data verification and data integrity) 5. Enable reliable and secure communication by seamless and transparent integration of different communication technologies (e.g. 4G / 5G / WiFi / 802.11p) and develop and improve data fusion algorithms to combine V2X information with on-board sensor information 6. Big Data management, analytics and privacy to support V2X connectivity incl. Vehicle-to-cloud communication	