# Workshop
# Challenges and recommendations to 5G for CAM deployment in Cross-border scenarios

## T6.1. Challenges in 5G for CAM cross border deployments

Irene Saco
David Fidalgo
14th June 2021

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# 1. Objectives

**DEPLOYMENT ENABLERS**

5G-MOBIX dedicates Work Package 6 "Deployment Enablers" to the analysis of deployment enablers for large scale 5G deployments across major transport corridors

**WHAT IS OUR OBJECTIVE?**

The fundamental objective is to ensure the project reaches the highest level of impact on real deployment, business, standardization, regulation and policy making, during and after its lifetime. WP6 plans to contribute to policy making with a set of recommendations to improve uptake of 5G/CCAM.

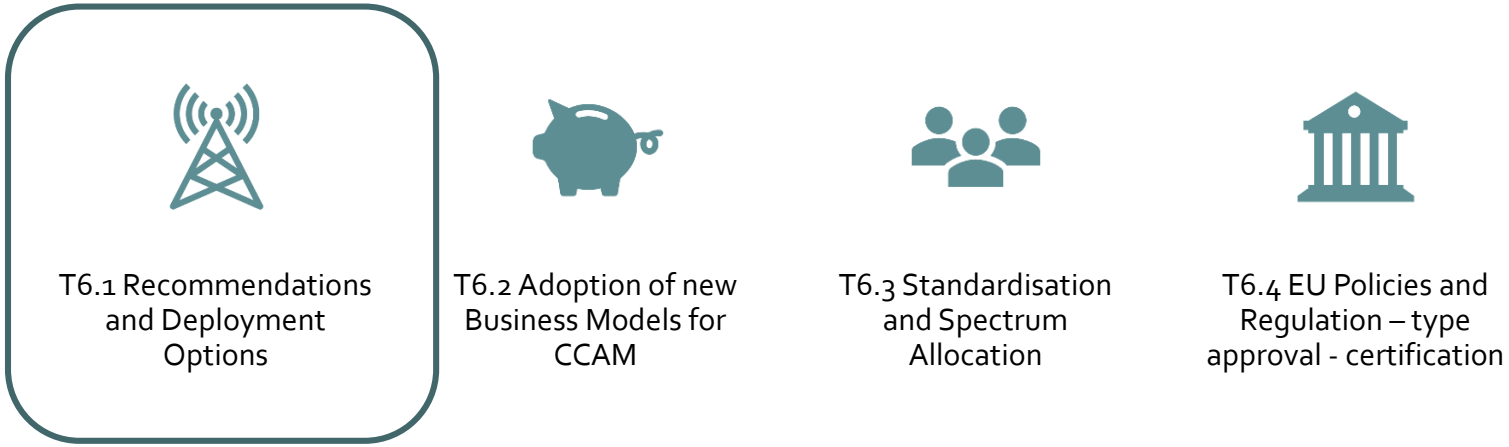


**Figure 1: Task breakdown.**

# 2. Task 6.1 Objectives & Main activities

- ***T6.1 Recommendations and deployment options***

- ***Objectives***
  - To demonstrate at a high scale ***how 5G telecommunication infrastructures can be applied to the transport sector.***
  - Contribute to the ***taking to market of concrete services and products.***
  - To contribute to ***the creation of a multiplier effect on project results*** by implementing ***recommendation and deployment strategy***.



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# 2. Task 6.1 Objectives & Main activities

- ***Main Activities:***
  - ***'From local to project':***
    - 1) Identify ***successful innovations in the transport sector at local level***.
    - 2) Promote the ***integration of successful innovations coming from external stakeholders into one of the project use cases offering them a large-scale pan-EU showcase*** that will contribute to facilitate its take-up and introduction into the market
  - ***'From project to global': support the market take-up of concrete innovations and services demonstrated in the project use cases*** both to innovation coming from external stakeholders and innovation brought by project partners. This support will be implemented by the establishment of tri-lateral agreements among:
    - ***1) Innovators.***
    - ***2) Technology adopters/ customers.***
    - ***3) Private investors.***
  - Provide ***recommendations*** and ***deployment options*** for post-project replication partners as crystallisation points for taking up project results.

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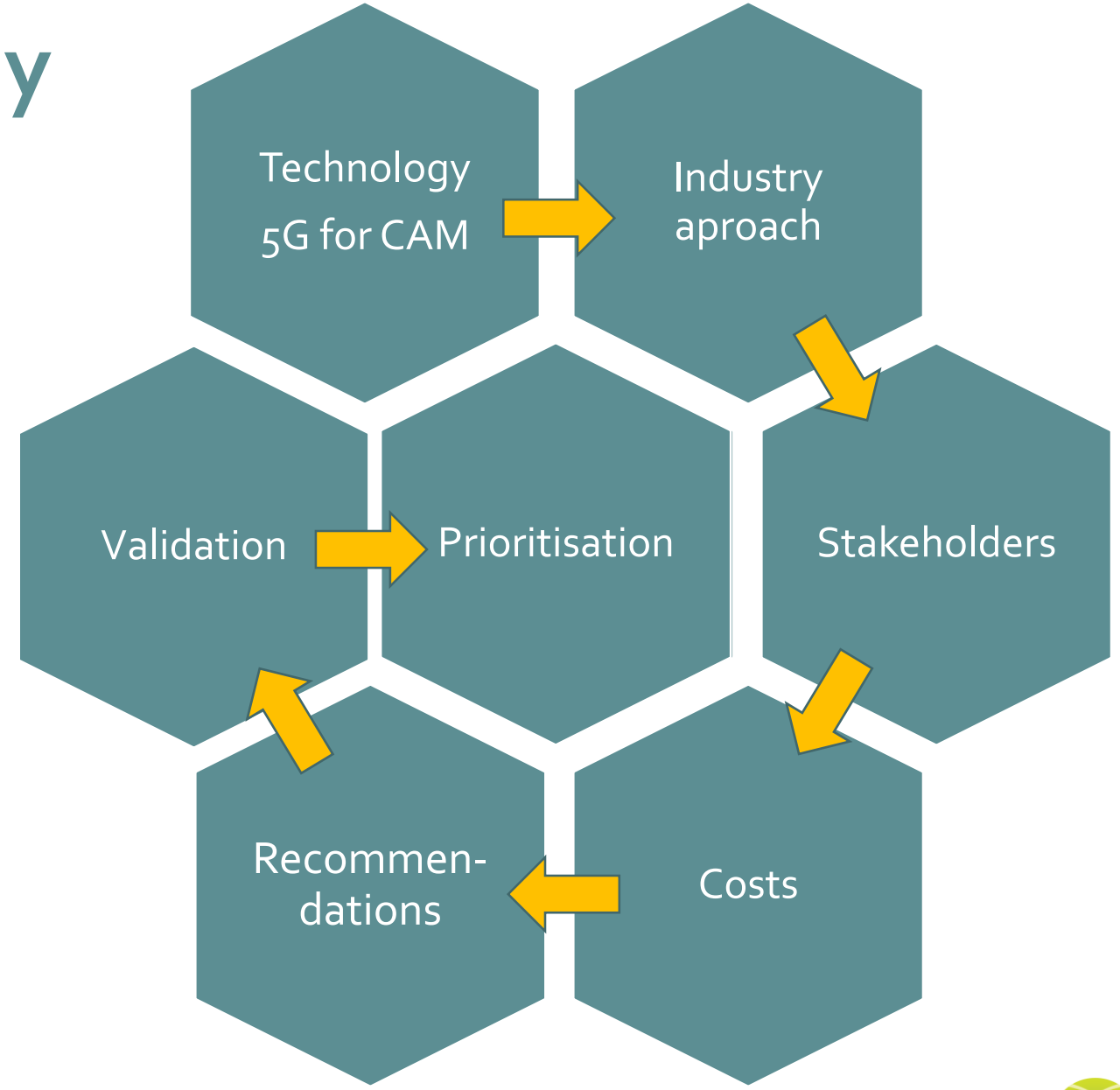
# 3. Methodology

# General challenges for 5G for CAM

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14th June 2021

# 4. General challenges for 5G for CAM

### DEPLOYMENT

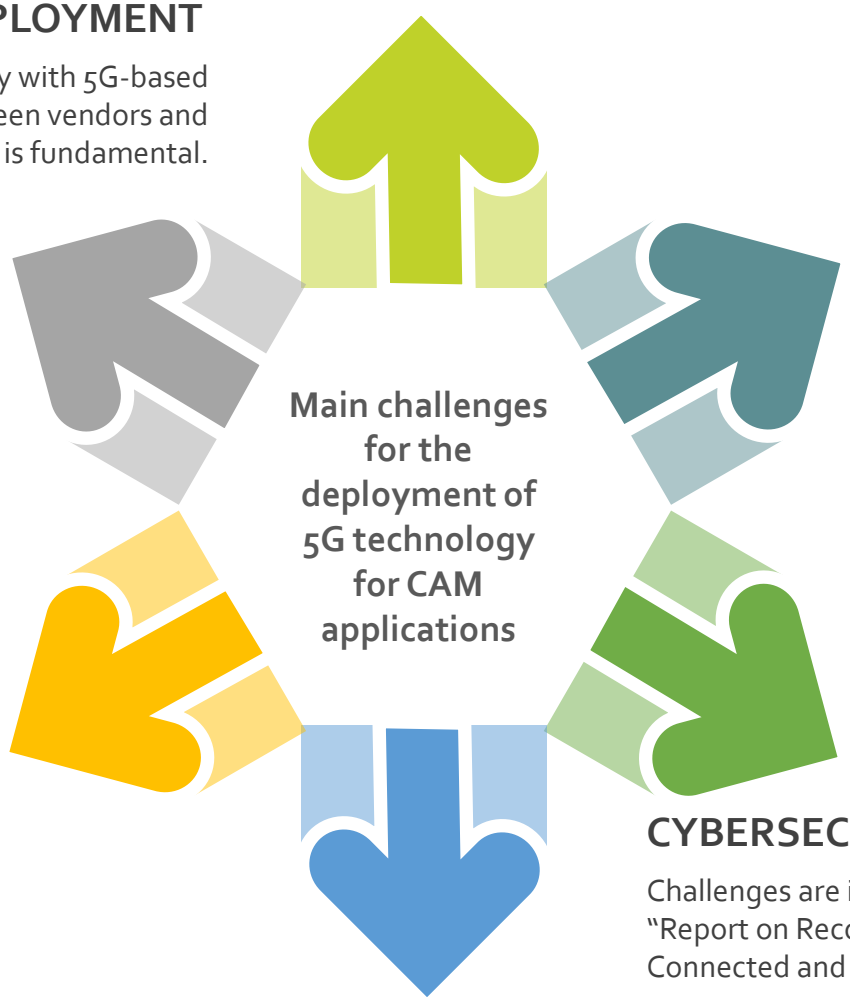
Implementation of new technology with 5G-based architecture. The cooperation between vendors and operators is fundamental.

### ROAD

5G technology can play an important role here by connecting people and vehicles on the move with road infrastructure and road operators.

### AUTOMOTIVE INDUSTRY & CAM

5G can offer the industry new and improved services that also reduce production costs.




### DATA

Analyse the information and data generated by sensors and applications under two key aspects: Data Quality-Validity and Property and Management.

### APP & INTEROPERABILITY

As part of the core automated driving functions the applications must be reliable and robust so the infrastructure must be designed for all possible combinations and also be interoperable.

### CYBERSECURITY

Challenges are identified according to to the ENISA "Report on Recommendations for the Security of Connected and Automated Mobility".

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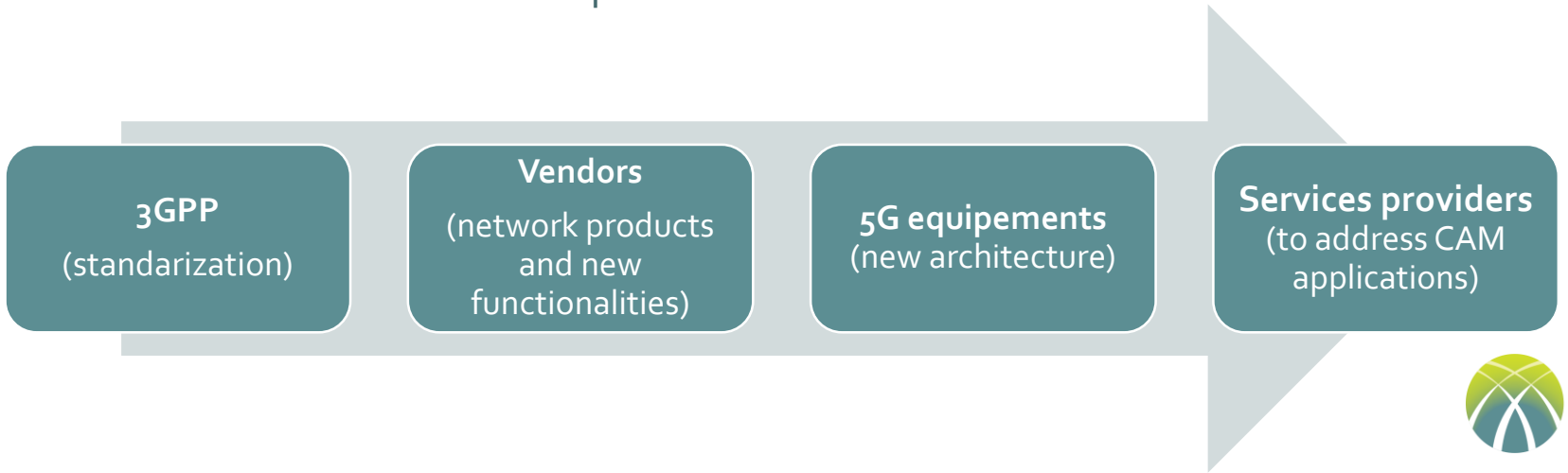
# 4. General challenges for 5G for CAM

- ***DEPLOYMENT***
- ***<u>Implementation of a new mobile communications technology</u>***
  - The deployment of a novel network architecture.
    - New 5G equipment availability depends on vendors and their ability to manufacture the elements that comply with this new architecture.
    - In order to develop new network products and add new functionalities vendors depend on the maturity of standardisation by 3GPP.
  - The evolution of the technology and the availability of new deployments are critical in user cases such as CAM.
  - The cooperation between vendors and operators is fundamental.

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# 4. General challenges for 5G for CAM

- ***DEPLOYMENT***
- ***<u>Some considerations must be provided in these new networks</u>***

**1** **Dimensioning each element for 5G speeds.**

An end-to-end evolution plan is needed.

Much of the network must be pushed to the edge using cloud technology.

**2** **Distributed cloud-based architecture.**

**3** **Security.**

Into every element of the network and embedded in every step of network operation.

To handle the complexity of many different CAM use cases.

**4** **A new end-to-end, cloud-native and secure 5G.**



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# 4. General challenges for 5G for CAM

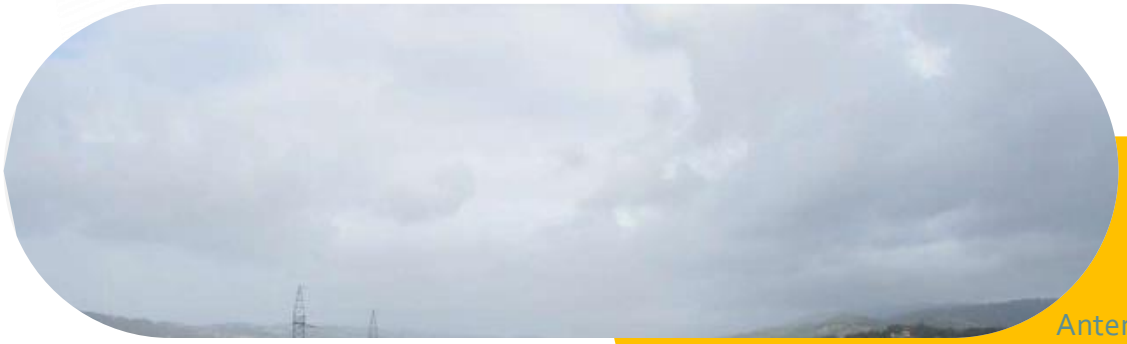
- ***DEPLOYMENT***

Preliminary CBC field tests on Spanish side on February 2020 to identify **issues in the 5G networks.**

Improve the performance of the network

**Small radio power in the border and regions without 5G coverage in testing areas**

The antenna locations and each 5G site must be located in an optimal scenario.
The best possible radio link configuration is necessary.



Equipements quality

**The use of the best possible automotive communications equipements**

Antennas, modem selection for OBU adoption and communication equipements should guarantee the coverage and will provide reliable services dependent on vehicle data collection and exchange.

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# 4. General challenges for 5G for CAM

- ***DATA***
- ***<u>Information and data generated by CAM sensors and applications will be analysed under two key aspects</u>***
  - Data Quality-Validity:
    - It is associated to many issues such: data sensor quality, calibration, health, ASIL, error probability or trustworthiness.
    - Data must ensure robustness, constancy, and reliability, providing credibility. **¡It is a critical safety issue if data quality-validity is not met!.**
  - Property & Management:
    - It deals with different identified barriers, such as the access to the data economy. It is built on two key pillars: **transparency** and **fair competition** and focuses on economic aspects of the re-use of information.
    - For CAM use cases and to actors involving AI, such as autonomous vehicles European framework guidelines should be considered such as: GDPR, Commission's Ethics Guidelines for Trustworthy Artificial Intelligence (AI) , Open Data Directive (Directive (EU) 2019/1024 …

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# 4. General challenges for 5G for CAM

- ***APP & INTEROPERABILITY***
- ***<u>These applications are part of an infrastructure connecting in-vehicle apps, backend apps, road-side units and much more.</u>***
  - A failure in one of the elements may never lead to a safety critical situation.
  - It is needed to design an infrastructure for all possible combinations and create it also interoperable.

**Cooperative operation of the application.**

Information exchange between app, traffic participants and traffic centres.
Taking action on possible network inefficiencies.

**Interoperability operation of the application**

Collaboration between traffic participants, road-side infrastructure and traffic centers. Data interoperability is key for this.

**Interaction between applications and networks**

**Standardization across countries and OEM's**

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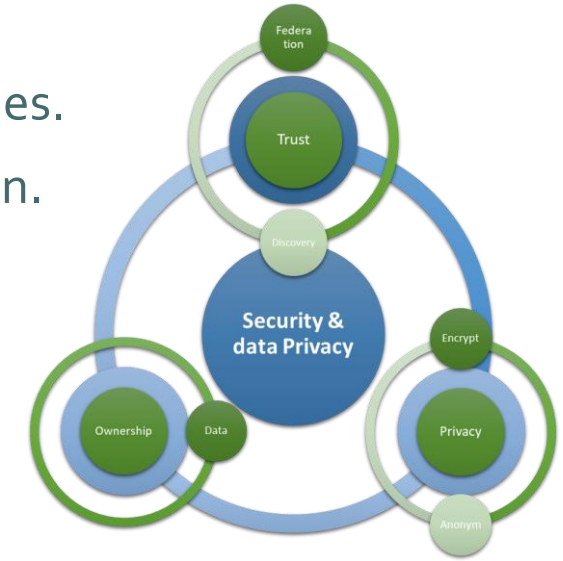
# 4. General challenges for 5G for CAM

- ***CYBERSECURITY***
- ***<u>According to the ENISA "Report on Recommendations for the Security of Connected and Automated Mobility", seven cybersecurity challenges were identified.</u>***




- Governance and cybersecurity integration into corporate activities.
- Lack of top management support and cybersecurity prioritization.
- Technical complexity in the CAM ecosystem.
- Technical constraints for implementation of security into CAM.
- Fragmented regulatory environment.
- Lack of expertise and skilled resources for CAM cybersecurity.
- Lack of information sharing and coordination on security issues among the CAM actors.

# 4. General challenges for 5G for CAM

- ***AUTOMOTIVE INDUSTRY & CAM***
- ***5G in the automotive industry as a booster for developments and efficiencies.***

**Send sensor data to edge or cloud**
With 5G applications, it will be possible to send sensor data from the vehicle or infrastructure to edge or cloud centres and to gain insight into these centres.

**Cloud data to autonomous vehicles**
This type of service will allow the optimisation of the sensors included in the vehicles, thus allowing for reductions in the production costs of the vehicles.

**New services**
OEMs will be able to provide novel enhanced services to their customers with the help of the 5G.



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# 4. General challenges for 5G for CAM

- *ROAD*
- ***The main operational objectives of Road Operators are:***
  - To **improve road safety** on the road network.
  - **Optimise traffic flow** on the arterial and motorway networks.
  - **Manage incidents**, reducing delays and adverse effects of incidents and congestion, weather, road works, special events, emergencies, and disaster situations.
  - **Effectively manage maintenance and construction work** to minimize its impact on safety and congestion.
  - Provide the traveller with **timely and accurate information**.

- ***Main issues:***
  - Spectrum
  - Standarization
  - Coverage
  - Implementation cost
  - Security and privacy

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# Cross Border challenges for 5G for CAM

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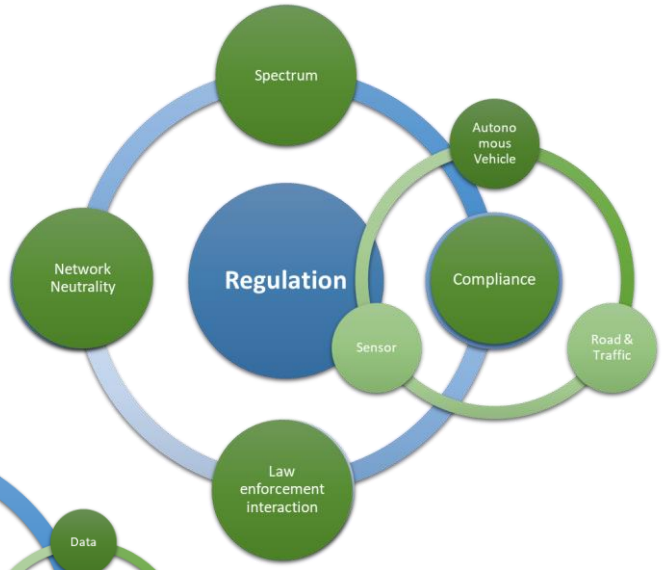
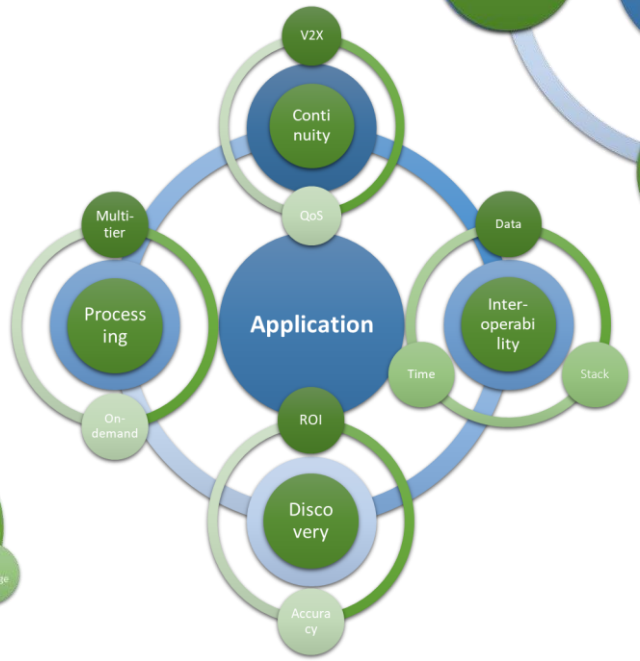
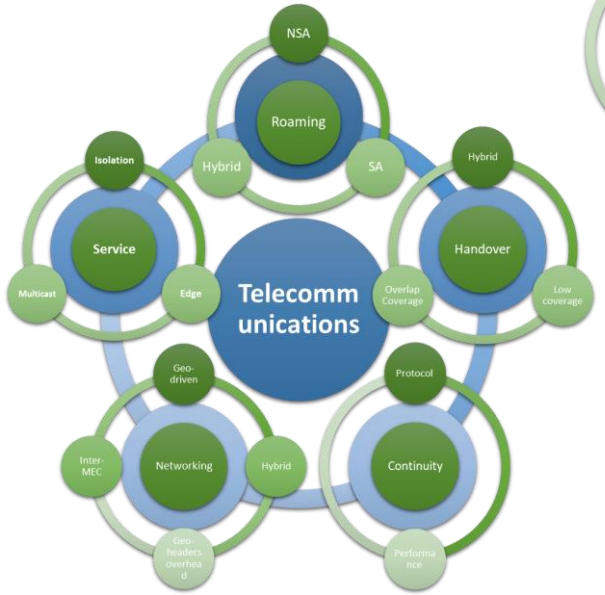
14th June 2021

# 5. Cross Border Challenges

- ***CROSS BORDER ISSUES***
- ***Identification***
  - (XBI_n) → Total of 11 issues identificated. From XBI_1 to XBI_11
- ***Classification categories***
  - Telecommunication
  - Application
  - Regulatory
- ***X-border Issue Title***



# 5. Cross Border Challenges

- ***CROSS BORDER ISSUES:*** ***Telecomunication issues.***

| ID | Category | X-border Issue Title | X-border Issue definition |
|---|---|---|---|
| XBI_1 | Telecommunication | NSA Roaming interruption | Loss of connections when crossing borders, which is aggravated by roaming steering. |
| XBI_2 | | SA Roaming interruption | Currently Roaming for SA networks has only been defined for basic roaming. No handover is specified and the equivalent of the S10 interface for ePC (N14) has not been referenced as a roaming interface. |
| XBI_3 | | Inter-PLMN interconnection latency | Currently, operators interconnect over a GRX network unsuitable for app CAM. It is designed for high continuity and throughput at the expense of low latency (many times higher due to rerouting traffic to distant nodes). |
| XBI_4 | | Low coverage Areas | In the current border areas, coverage is very low due to the sparse population on the border, which does not provide incentives to increase coverage. In addition, the same frequencies are used on both sides of the border. Operators have to try to limit interference. |
| XBI_5 | | Session & Service Continuity | High probability of changing the IP when redirecting the user's equipment to a new data network, as current networks do not allow identifying the location from which the equipment is connected, causing continuity or latency problems.<br>A handover event can imply the change of network address with impact on running UDP/TCP communications and service disconnection. |
| XBI_6 | | Data routing | When roaming, normally the data traffic will be routed to the home network and connect to the data network at home. Crossing the border from home-PLMN to a visited-PLMN will then lead to higher latencies. |

# 5. Cross Border Challenges

## CROSS BORDER ISSUES: Telecomunication & Application issues.

| ID | Category | X-border Issue Title | X-border Issue definition |
|---|---|---|---|
| XBI_7 | Telecommunication and application | Insufficient Accuracy of GPS Positioning | Global Navigation Satellite Systems (GNSS) positioning cannot meet the stringent CAM requirements i.e., down to 20-30 cm accuracy.<br>GNSS also lack a refresh rate high enough to be used in safety critical applications. |

## CROSS BORDER ISSUES: Application issues.

| ID | Category | X-border Issue Title | X-border Issue definition |
|---|---|---|---|
| XBI_8 | Application | Dynamic QoS Continuity | A sudden drop in the network connection quality may happen when the vehicles move from one MNO to the other in a cross-border area. |
| XBI_9 | | Data and Protocol Stack Interoperability | Inconsistent data schemes and protocols hinder the exchange of information and the overall communication between vehicles from different providers, different network domains, infrastructure systems or federated services. |



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# 5. Cross Border Challenges

- ***CROSS BORDER ISSUES:*** ***Application issues.***

| ID | Category | X-border Issue Title | X-border Issue definition |
|---|---|---|---|
| XBI_10 | Regulatory | Geo-Constrained Information Dissemination | A geo-restricted information dissemination scheme should be designed to disseminate relevant CAM data to the appropriate vehicles so that no unnecessary or relevant information is exchanged at the border. |
| XBI_11 | | Law enforcement interaction | Dedicated communication procedures and protocols will need to be in place to ensure that authorities can communicate with vehicles, even if they originate from a different country being generally served by a foreign network provider |



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# Recommendations Prioritization

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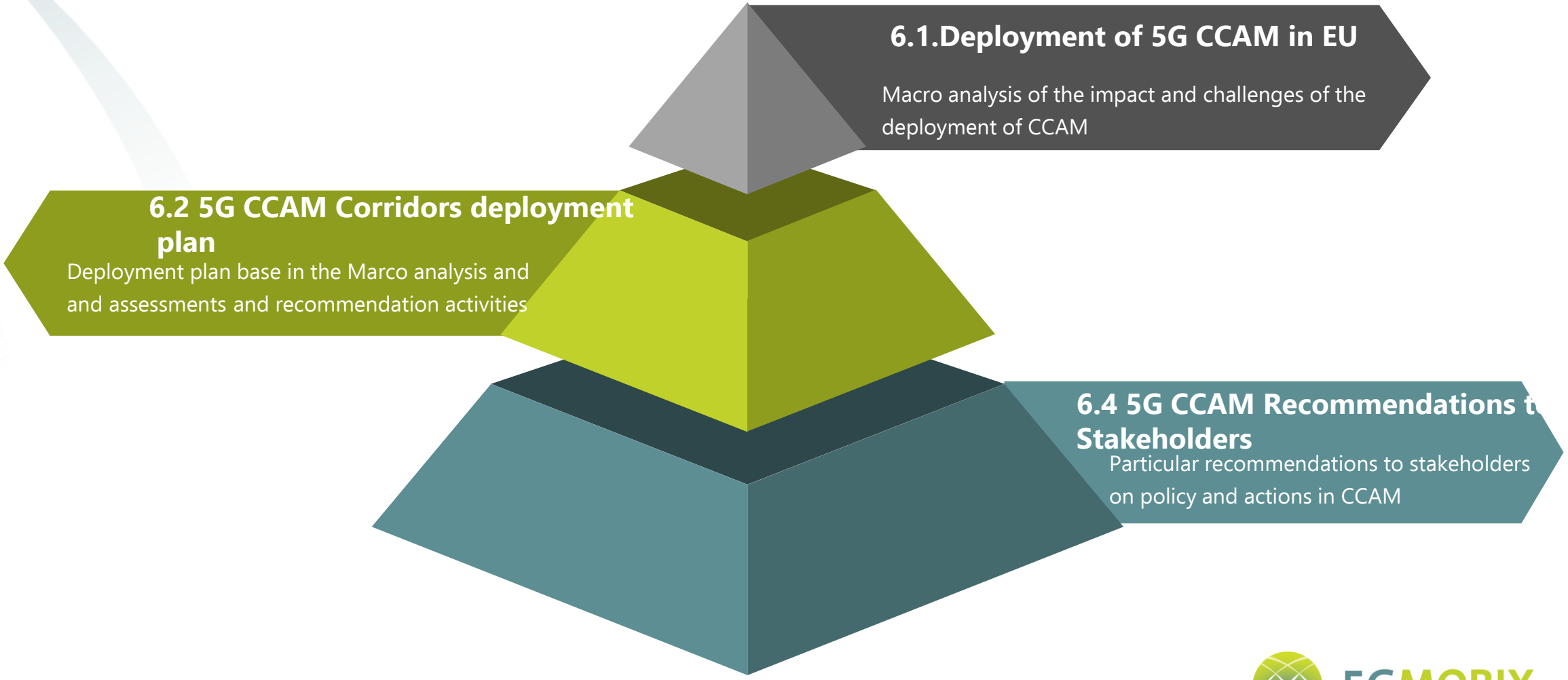
14th June 2021

# Recommendations Review Approach

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# Objectives

- Categorization of the issues
- Analyse the issues against the difference stakeholders and industry standards & practices
- Develop the golden recommendation containing the inputs for WP6.1, WP6.2 and WP6.4
- Evaluation Criteria ( Usability vs Lifecycle cost )
- Prioritization of 13 golden recommendations

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# Evaluation Criteria

## STAKEHOLDERS

- Impact in the major stakeholders of the project * WP6.4) : Road infrastructure, Network Operators, MVNOs, Automotive OEMs, Local and National governments and EU.

## IMPACT IN EU

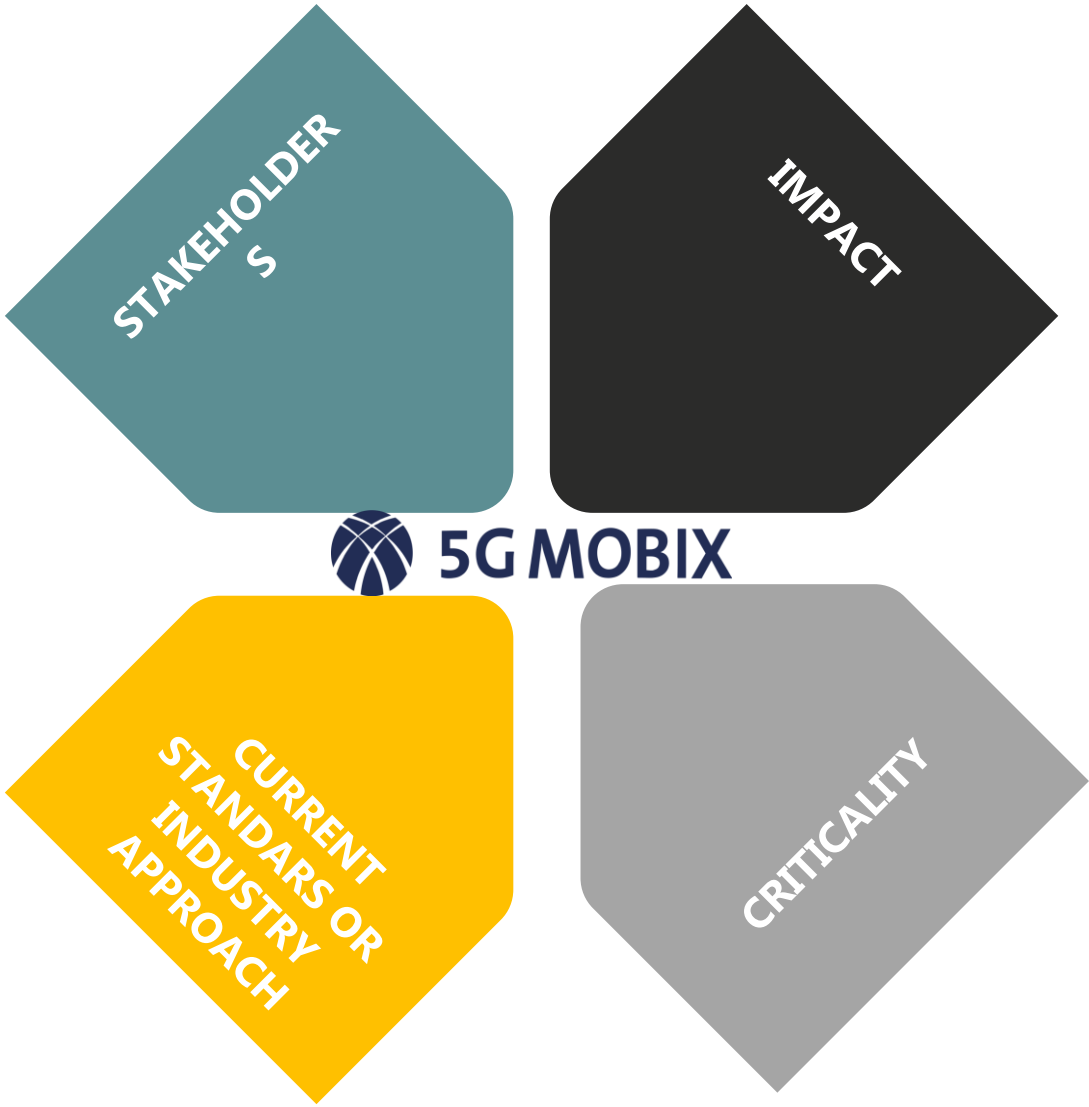
- We would evaluate the impact in four areas Technical , Deployment, competitive value and business value

## CRITICALITY

- Base in the industry deployment of 5G how time critical is this recommendations to remain competitive

## LIFECYCLE COST & ROI

- Cost of Acquisition and Utilization of the recommendation and the potential ROI bas ein the current market

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# Validation process

- After the categorization we select 6 areas
- All the issues were validated following interviews with stakeholders and industry standards

| 5G Architecture | 5G Network | Legal & Standards | Stakeholder collaboration | Road Infrastructure | Business Models |
|---|---|---|---|---|---|
| Series of Interviews with industry experts in the deployment of the technology | 5GAA 5G PPP | ISO ITU IEEE SAE | Series of Interviews with experts in international projects | Series of Interviews with experts in road Infrastructure | Series of Interviews with industry experts in the deployment of the technology |

- The output were 13 golden recommendation containing the Marco level recommendations at European Level and the Micro recommendation at CBC level.

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# Lifecycle Cost & Utility Score

## *Utilisation Score*

| | | | UTILITY SCORE (Higher is better) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Minimal | Low | Average | High | Critical | | | |
| | | Scoring System | 1 | 2 | 3 | 4 | 5 | WEIGHTS | SCORE | WEIGHTED SCORE CALCULATION |
| 1 | Impact | Has user value | Has no user value | Has little value, brings awareness to a specific gap | Has average value - somewhat limits an existing gap | It has the potential to simplify CCAM adoption | Has great user value - will greatly help adoption of 5G for CCAM | 0,17 | 3 | 0,50 |
| 2 | Impact | Has business value (for Europe?) | Has no business value | Has little value, brings awareness to a specific gap | Has average value - somewhat limits an existing gap | It has the potential to increase investment or the creation of new products and services, or mitigate known gaps | Has great business value this recommendation can improve investment in 5G for CCAM and will help create new products/services/business models, or solve known gaps | 0,17 | 5 | 0,83 |
| 3 | Impact | Has technical value | Has no technical value | Has little value, brings awareness to a specific gap | Has average value - somewhat limits an existing gap | It has the potential to mitigate or circumvent a technical gap | Has great technical value - this recommendation bridges a significant technical gap | 0,17 | 4 | 0,67 |
| 4 | Impact | Has operational value | Has no operational value | Has little value, brings awareness to a specific gap | Has average value - somewhat limits an existing gap | It has the potential to improve operational procedures | Has great value in terms of improving operational procedures - it can bring multiple operational benefits | 0,17 | 4 | 0,67 |
| 5 | Impact | Has standardisation value | Has no standardisation value, does not utilise or validate an existing standard | Has little value, brings awareness to a specific gap | Has average value - somewhat limits an existing gap | it has the potential to drive standardisation efforts or support an existing standard | Solves a significant standardisation gap or is based on existing well known, industry accepted standard | 0,17 | 5 | 0,83 |
| 6 | Criticality | This recommendation is time critical | not time critical | 2021-2035 | 2021-2030 | 2021-2025 | Recommendation is time critical and should be applied within 2021-2023 | 0,17 | 5 | 0,83 |
| | | | | | | | SUM SHOULD BE EQUAL TO 1 | 1 | TOTAL SCORE | 4,33 |

## *Lifecycle Score*

Just put an "x", ONLY one 'x' per row (lower is better)

| | | Very Low | Low | Medium | High | Very High | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lifecycle Cost factor | 1 | 2 | 3 | 4 | 5 | ANSWERS | WEIGHTS | WEIGHT* SCORE | |
| Acquisition | Cost to research | | | x | | | 3 | 0,1 | 0,3 | |
| | Cost to develop | | | | x | | 4 | 0,2 | 0,8 | |
| | Cost to deploy | | | | x | | 4 | 0,1 | 0,4 | |
| | Cost to integrate | | | | x | | 4 | 0,1 | 0,4 | |
| Utilisation | Cost to operate | | | x | | | 3 | 0,1 | 0,3 | |
| | Cost to train | | | x | | | 3 | 0,2 | 0,6 | |
| | Cost to maintain | | | | x | | 4 | 0,1 | 0,4 | |
| | Cost to dispose | x | | | | | 1 | 0,1 | 0,1 | |
| | | | | | | | SUM OF WEIGHTS should be 1 | 1 | 3,3 | Cost Score |

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# Golden Recommendations ( Macro Level) Recommendations Prioritization


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# 5G Architecture Recommendations

| Number of recommendations | Areas | Final Recommendation |
|---|---|---|
| 1 | 5G Architecture | Resilience in the 5G architecture needs to be guarantee to enable a minimum level of connectivity coverage to ensure a secure and safe handover at different borders, and the vehicle architecture should handle this handover in a secure way. Even if the vehicle follows an architecture definition by standards, such as INCOSE, or ensures safety though SOTIF and ISO 26262, any vehicle functionality reliant on infrastructure to support operation will require security in the form of trusted perception from off-vehicle sources (V2X, GNSS, HD maps), for which currently no standard exists. Vehicle resilience should also consider behaviour for collisions/incidents. It is recommended that a set of standards be developed for incident investigation. Standards for teleoperation are also absent, so recommend instigating a set of standards for I2V support for teleoperation, to enable vehicle developers to understand resilience expectations. Recommend review of China standard GB/T 204-14 telematics service/management as a potential basis. There are some working groups in the IEE and ITU working on potential guidelines to tackle trials, and combine the standards from the difference stakeholders, however standards to provide guidance in the deployment of the 5G architecture in the context of CCAM need to be developed to facilitate collaboration between stakeholders and create a framework to develop, test and scale these deployments. Recommend a standard be formulated for this. |
| 2 | | In the context of 5G architecture Integration there is an urgency to execute a set of integration objectives to support 5G for CCAM applications. How quickly do these objectives need to be achieved (to gain society benefits, to justify investment in 5G or route infrastructures etc.)? A competitive landscape here is not likely to lead to an agreed international solution.<br>These are international (and global) issues. A strong regional proposal may well be compelling on a global stage but the proposal/solution needs to be defined and engineered to have credibility.<br>These issues are more complex than have ever been managed traditionally (international air standards, telecom standards etc.) due to the safety and security implications.<br>European level organizations are required (with agreed authority) to coordinate/invest/provision in these agreements. As importantly such organizations need to be funded to collaborate globally to reach agreement (or identify operational divergence and manage it). Currently there are no minimum capability standards for I2V in support of highly automated vehicles, therefore recommend establish agreed minimum viable infrastructure to support V2X for AV consistently. China activity on GB/T 102-2 Automotive intelligent, networked data structure and transmission format, will provide a potential basis for this standard that should be reviewed. Also an alignment with e.g. GB/T 204-6 to 11 Technical requirements for security equipment and information security to integrate the 5G architecture would be recommended |

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# Business & 5G Network Recommendation

| Number of recommendations | Areas | Final Recommendation |
|---|---|---|
| 7 | **Business Models** | MNOs are making significant investments in antenna and connection equipment, which is often duplicated by different operators. Local authorities are running tendering processes for small cell equipment. 5G bandwidth is being auctioned by governmental authorities to MNOs. Both processes are running very slowly, typically taking 12-18 months.<br>MNOs are making significant investments in antenna and connection equipment, which is often duplicated by different operators. This should be coordinated and accelerated. |
| 8 | **5G Network** | Using legislation to overcome the difference in local rules and to standardise MNOs services. There should be harmonised EU rules & regulations:<br>1. to facilitate the installation of 5G infrastructure, such as small cell or radio apparatus widely.<br>2. to define common service level agreement between MNOs for CCAM applications.<br>Cross-border harmonisation issues may arise in cases of countries that do not implement the ECC/DEC/(15)01 decision on “Harmonised technical conditions for mobile/fixed communications networks (MFCN) in the band 694-790 MHz including a paired frequency arrangement (Frequency Division Duplex 2x30 MHz) and an optional unpaired frequency arrangement (Supplemental |
| 9 | | A specific plan needs to be in place from any member state prior to the spectrum auctions to enable telco operators to make appropriate plans for 5G deployments. A flexible mechanism should be in place to enable leasing of additional frequencies and the additional licensing processes for the development of infrastructure (e.g. antenna placement etc.) should be fast.<br>Encourage a harmonization plan to the members of state focussed on:<br>1. share infrastructure to reduce cost.<br>2. to have a set of commonly defined service level agreement in order to maintain the V2X performance cross regions and boarders. Recommendation 7 is quite link to recommendation 9 so it would be recommended to undertake the work scope in sequence. |

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# Legal & Standards Recommendations

| Number of recommendations | Areas | Final Recommendation |
|---|---|---|
| 11 | Legal & Standards | Recommend digitalisation of all the regional traffic rules. When the vehicle travels between member states, the relevant digital highway code should be available to the vehicle and applied. This is currently missing. Recommend all member states' highway codes are digitised. Also recommend decision if these should be incorporated with ODD activities, or kept separate.<br><br>Recommend development of a standard for teleoperation of CCAM vehicles to avoid any ambiguity about maturity of development or enabling framework. This is currently recognised as a |
| 12 | | Recommend harmonisation of EU rules and regulations to facilitate the widespread installation of integrated 5G infrastructure.<br><br>Recommend the EU 5G EMF limits standard be developed together with the European public health organisations. Public Health organisations typically take the lead on public health matters associated with radiofrequency electromagnetic fields, or radio waves, including in relation to 5G. A typical position is that “The overall exposure [from all mobile network EMFs, including 5G] is expected to remain low relative to guidelines and, as such, there should be no consequences for public health.” A consensus will be needed between all member states' public health |
| 13 | | This class of technical definition is largely being addressed in other forums. The correct choice of an appropriate set of extensible standards and rules still has to be made in the context of the working objectives and safety criteria for the system/infrastructure. The UN Economics and Social council and the World forum for Harmonization of Vehicle Regulations has approved in June 2020 the resolution ( ECE/TRANS/WP.29/2020/79).The two new UN Regulations, adopted by UNECE’s World Forum for Harmonization of Vehicle Regulations, require that measures be implemented across 4 distinct disciplines:<br>1.Managing vehicle cyber risks;<br>2. Securing vehicles by design to mitigate risks along the value chain;<br>3.Detecting and responding to security incidents across vehicle fleet;<br>4. Providing safe and secure software updates and ensuring vehicle safety is not compromised, introducing a legal basis for so-called “Over-the-Air” (O.T.A.) updates to on-board vehicle software.<br>The regulations will apply to passenger cars, vans, trucks and buses. They will enter into force in January 2021.Despite this and having some guidance related to 5G deployment for connected vehicles and data there is still significant work to be done to have a more harmonized set of standards and guidance's on:<br>GDPR: Recommend to develop a standard to ensure all data sharing complies to GDPR, referring to AP-C100-17 Privacy Impact Assessment (PIA) for Cooperative Intelligent Transport System |

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# Thank you

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