Workshop on Deployment Methodology of 5G for CAM on Cross-Border Corridors

T6.1. Technical Enablers from 5G-MOBIX Cross Border Corridors and Trial Sites

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5GMOBIX

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Content

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.

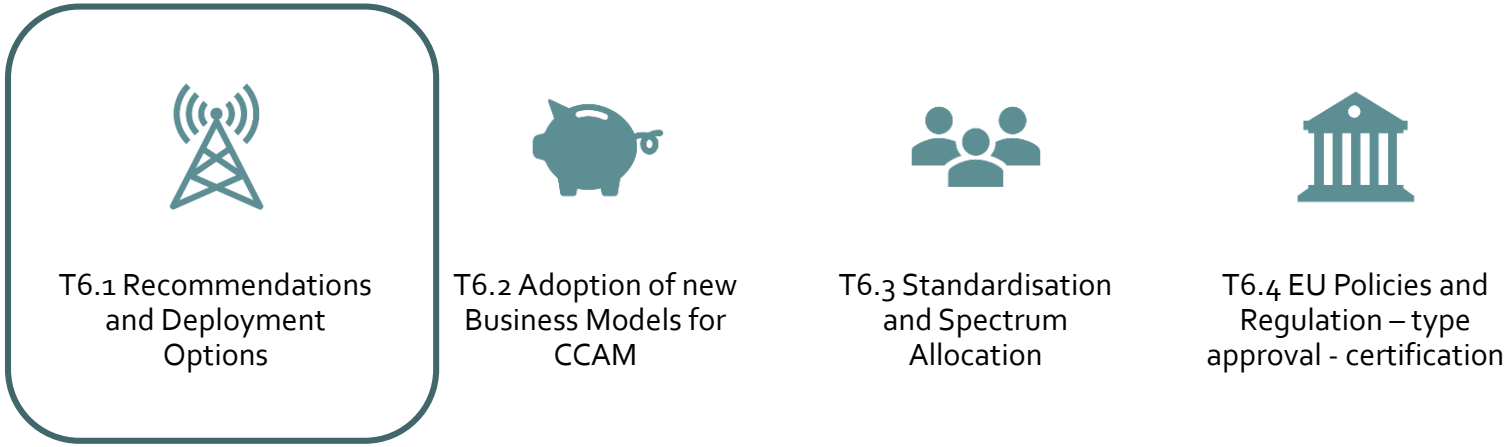


Figure 1: Task breakdown.

2. Task 6.1 Objectives & Main activities

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

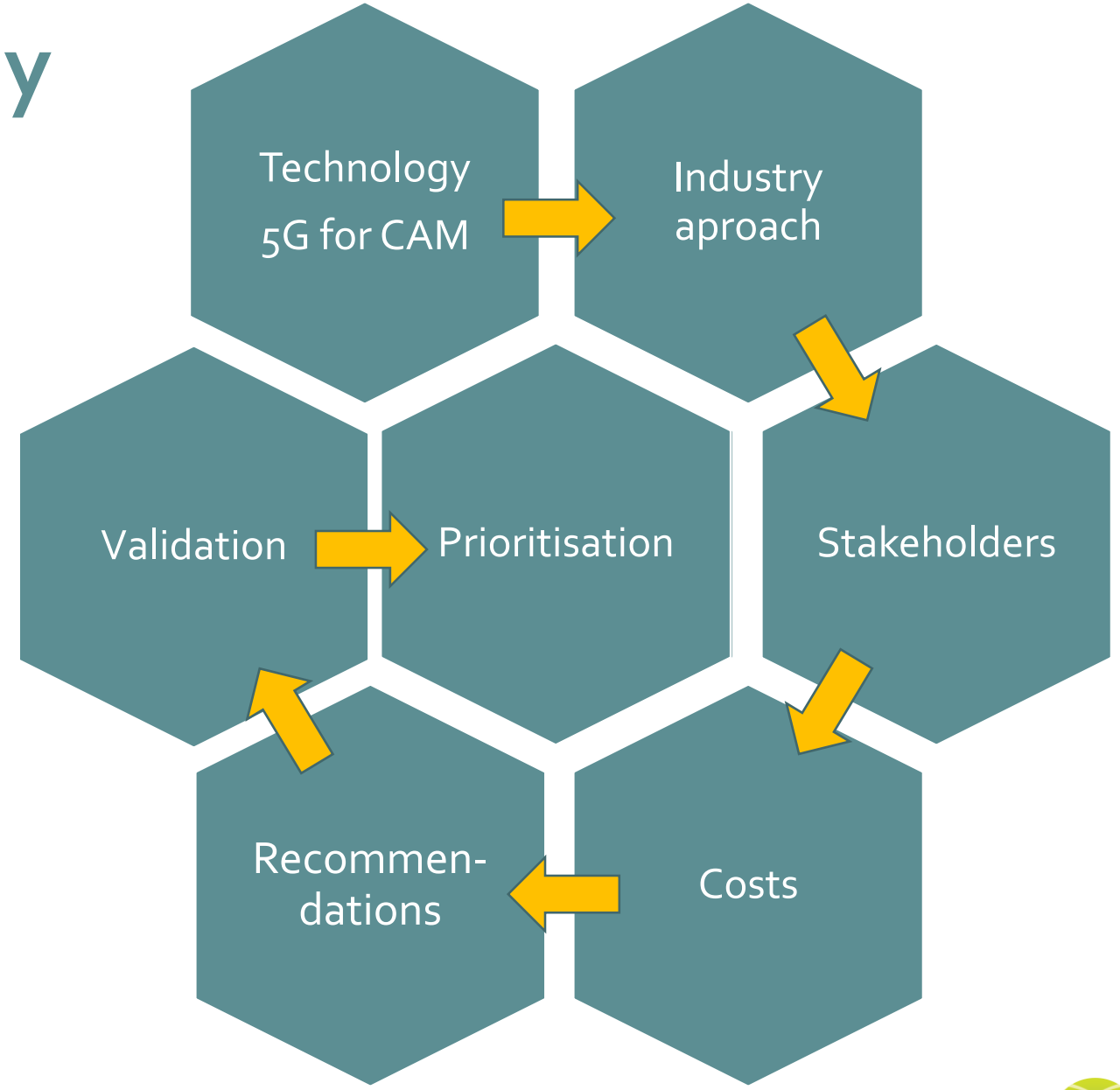
- ***Objectives***
  - To demonstrate at a high scale ***how 5G telecommunication infrastructures can be applied to the transport sector*** and contribute to the ***taking to market of concrete services and products*** that are successfully applied to the project use cases – incorporating solutions from external third parties, thus maximizing socio-economic impact beyond the Project.

  - The specific objective of task T6.1 is to contribute to ***the creation of a multiplier effect on project results*** by implementing a two-sided ***recommendation and deployment strategy*** called '***from local-to-project-to-global***'.

2. Task 6.1 Objectives & Main activities

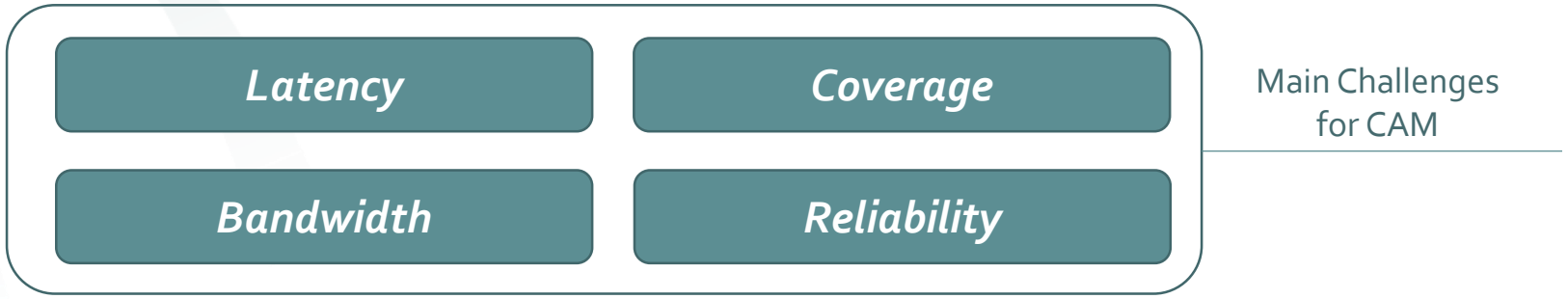
- Main Activities:
  - ***'From local to project':***
    - 1) Identify ***successful innovations in the transport sector at local level***.
    - 2) Promote the ***integration of successful innovations coming from external stakeholders into one of the project use cases offering them a large-scale pan-EU 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.

3. Methodology



3.1 Technology

- **Requirements of 5G for CAM:** The 5G Automotive Association (5GAA) published a table with the requirements of 5G for the different cases of use of CCAM/functionalities (some of them yet under discussion).
- Diversity of Use Cases related to CCAM makes it difficult to present general requirements.



- 5G networks seem to be the best networking option due to the following reasons:
  - ***5G networks are fully virtualized***, so these networks can be very flexible with many different services and requirements and can take advantage the concept of network slicing to provide different kinds of services of CAM with different requirements.
  - ***Applications*** can be installed in ***any operator network***.
  - The new radio bands allocated for 5G network mobile operators are providing ***a lot of capacity that can be used by the CCAM applications.***

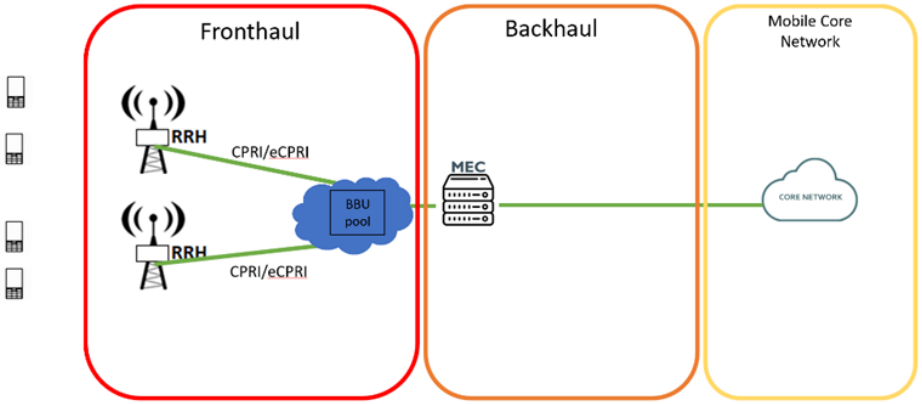
UCC Id	UCC Name	Trial Site	US Id
AdDr	Advanced Driving	ES-PT	LaneMerge
		ES-PT	Overtaking
		FR	AssInfrastructure
		NL	CCA
		CN	CloudAssisted
		ES-PT	CoopAutom
Plat	Vehicles Platooning	GR-TR	SeeWhatISee
		GR-TR	5GPlat
		DE	AsseRSU
		CN	AssCloud
ExSe	Extended Sensors	ES-PT	HDMapsVehicle
		ES-PT	HDMapsPublicTransport
		GR-TR	AssBCrossing
		GR-TR	TruckRouting
		DE	EDM
		FI	EdgeProcessing
		NL	CPM
ReDr	Remote Driving	ES-PT	RCCrossing
		FI	RedundantNE
		NL	5GPositioning
		CN	DataOwnership
		KR	mmWave
QoS	Vehicle QoS Support	ES-PT	MediaPublicTransport
		KR	Tethering

3.1 Technology

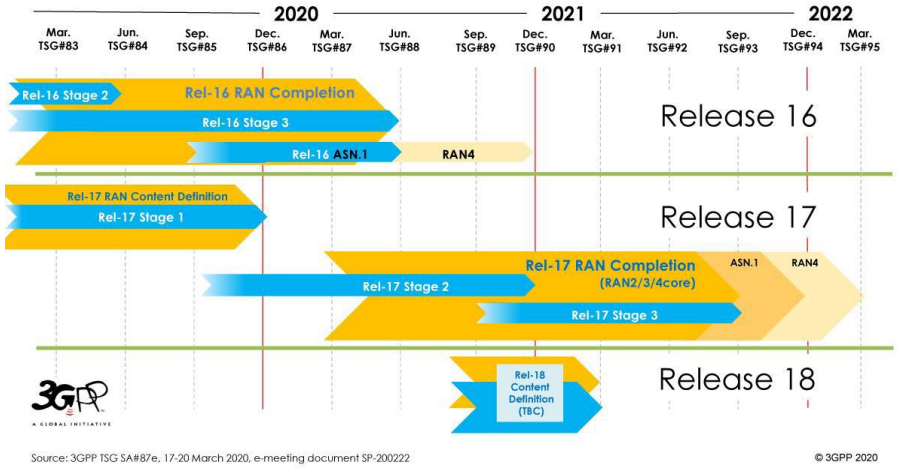
- In practical terms, the telecommunications infrastructure for the 5G CAM corridor's interconnection rely on the following dimensions:
  - **Envisioned Scenarios:** critical to dimension the project deployment and targeted deployment cost.

Minimum scenario	*Classic scenario*	*Breaking scenario*	*Future proof scenario*

  - **Technology Readiness:** availability of the technology in the border countries and deployment readiness. The current 5G systems, both 5G Core and 5G radio (New Radio, NR) and the User Equipments (UEs), which are being commercially deployed, are based on the 3GPP Release 15 (Rel-15) standard.



- RAN (Radio Access Network)
- MEC (Multi-access Edge Computing)
- 5G Core



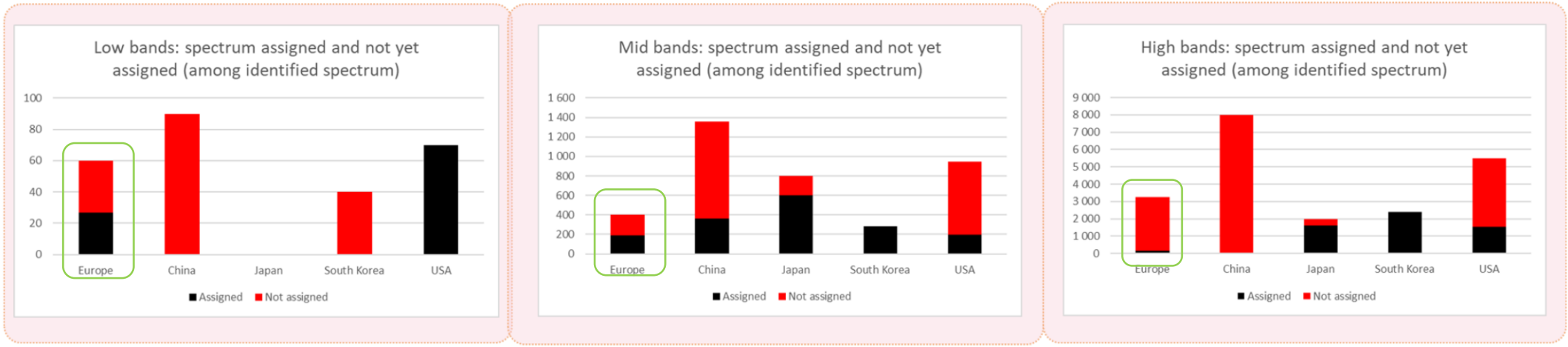
3.1. Technology

- **Frequency Availability:** available spectrum in the different countries and impact on massive services deployment.
  - Each spectrum band presents properties which provide different opportunities to balance between throughput, coverage, quality, and latency, as well as reliability and spectral efficiency. The frequency availability for the different operators in different countries could not be synchronized, and the border areas may need specific modems compatibility in case special frequency allocations are required. The allocation of bands to telecommunication operators may also be critical, or even, the radio sites sharing that could be regulated in different regions.

T6.3

International scoreboard (December 2020).

5G SPECTRUM



Source: 5G Observatory (IDATE Digiworld)

3.1 Technology

- **Agreements between telecommunication operators**: required to implement an efficient and global solution for the automotive market.

  - Two approaches for implementing the sharing of mobile infrastructures: passive and active sharing.
    - ***In passive sharing***, the equipment shared between different mobile operators is limited to the passive network elements such as radio masts, power supplies, cabinets, towers, security alarms, etc.
    - ***Active sharing*** extends the list of shared equipment to include the transport infrastructure (fiber, cables, etc.), baseband processing resources, and potentially the radio spectrum.

  - Cost savings benefits (network operators):
    - ***Passive sharing*** can save up to 16%-35% CAPEX and 16%-35% OPEX.
    - ***Active sharing excluding spectrum*** can save about 33%-35% of CAPEX and 25%-33% of OPEX.
    - ***Active sharing including spectrum*** can save up to 33%-45% of CAPEX and 30%-33% of OPEX.

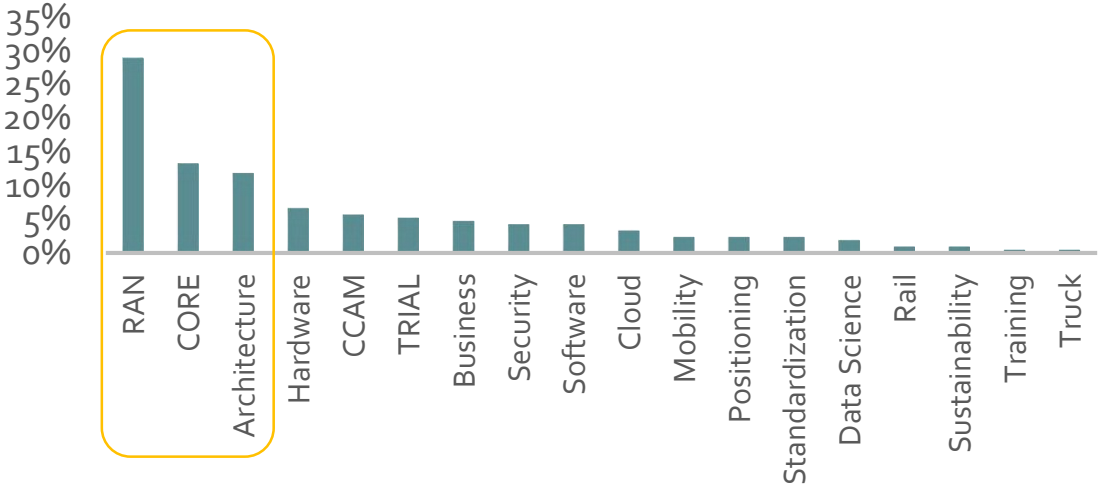
  - In addition to the previous benefits, other advantages can be associated to Network sharing:
    - ***Environmental benefits:*** reduces energy consumption.
    - ***Customer experience:*** Improvements of quality of the services, better coverage, higher data speed.

3.2 Industry Approach

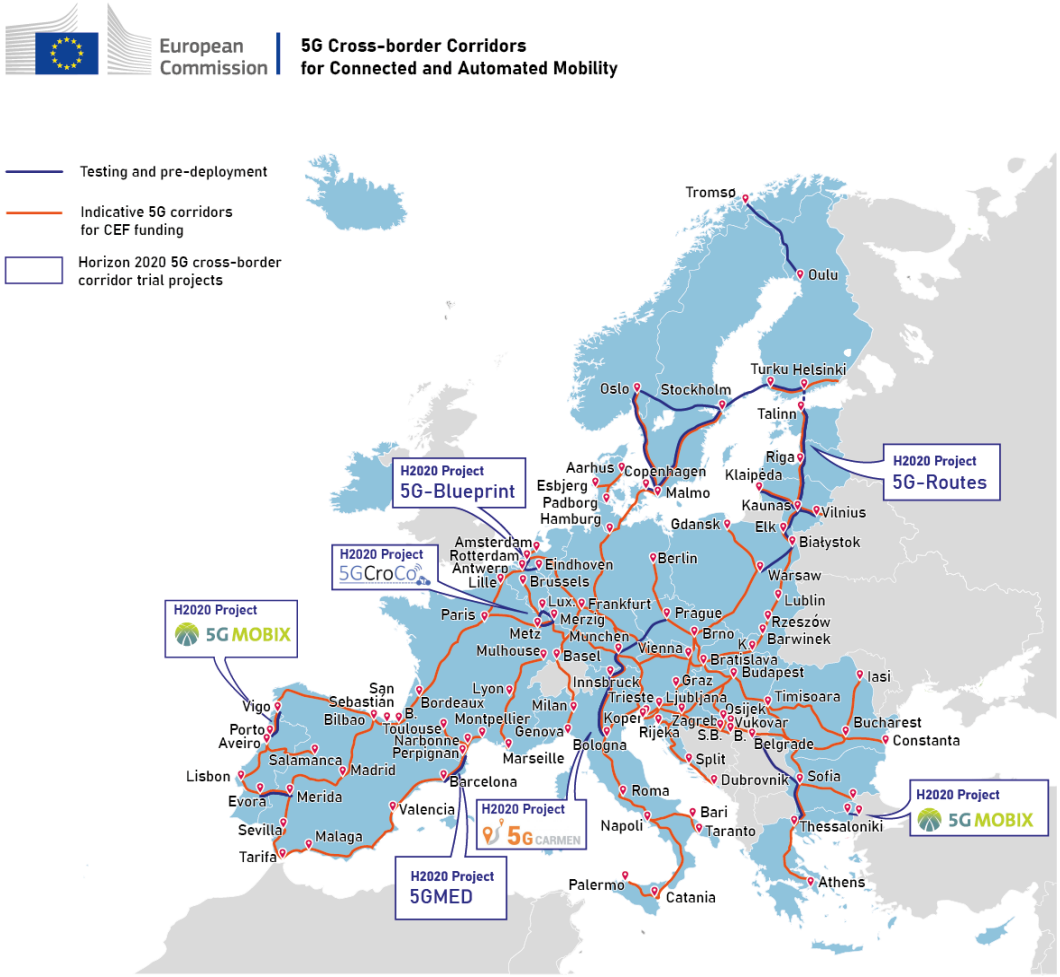
3.2 Industry Approach. Projects, fairs and congress

EU current key projects on 5G and CAM.

Project	Country
SCOTT	Austria
5G-DRIVE	Germany
5G-CROCO	Spain
5G-CARMEN	Italy
5G-MOBIX	Belgium
CARAMEL	Spain
SHOW	Belgium
5G Routes	Estonia
5G MED	Spain
5G Blue Print	-



European's 5G projects and topics related investments. Source: CORDIS.



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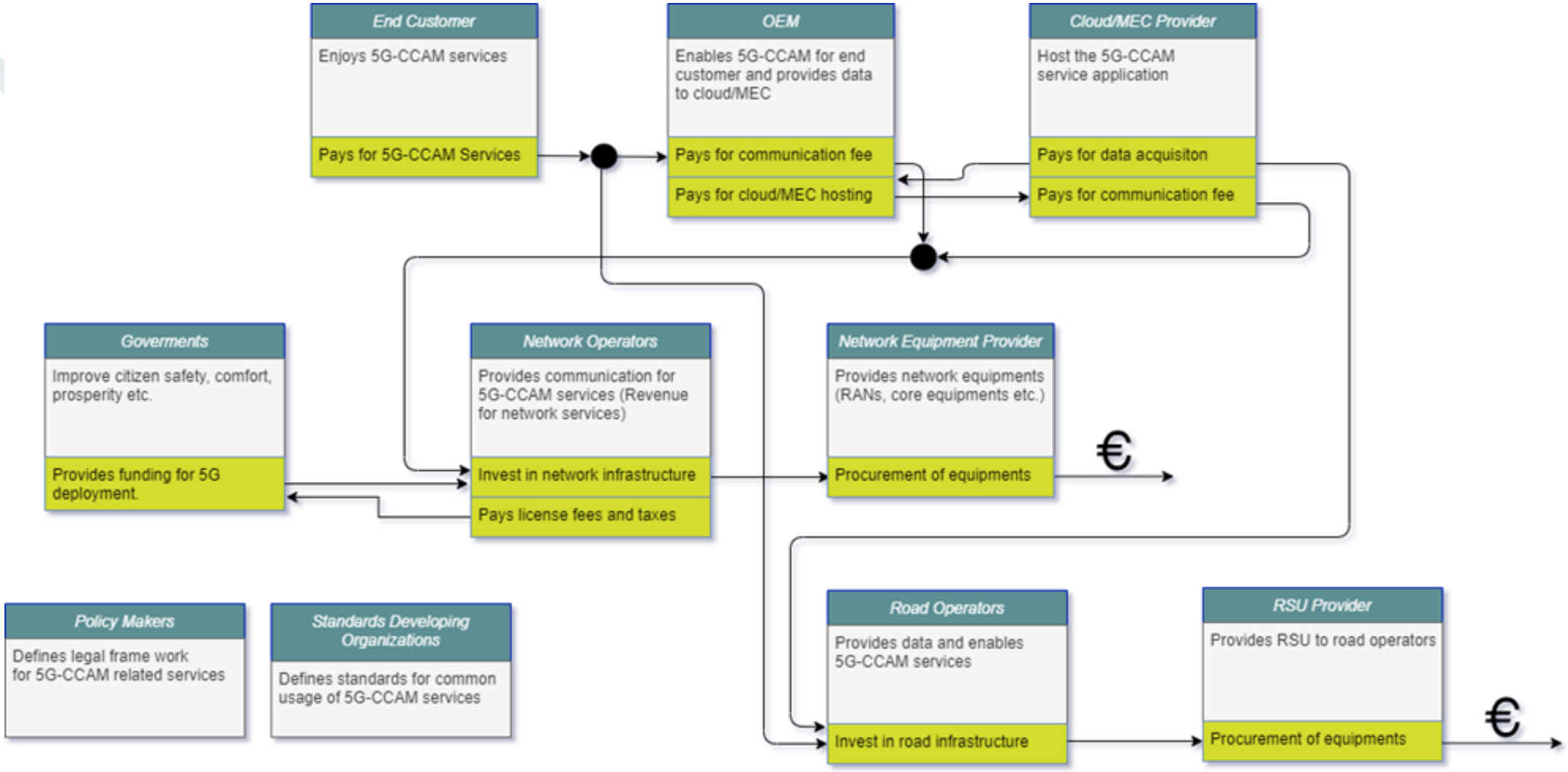
3.3 Stakeholders



3.4 Costs of Deployment of 5G for CAM

	Telecommunication related costs	Explanation
CAPEX	Antennas / Feeder	Antennas are mounted on towers and usually require to have nearly uniform patterns in the horizontal plane with shaping in the vertical plane to conserve power. It includes RF front end cost also.
	Transport from Antenna Site	Fibre network to transfer data from antenna to core or MEC etc.
	Network Core Equipment	Core equipment that includes.
	Permits	Permit fees to deploy base station on a specific area.
	Site Civil Works	Civil works to deploy a base station for the first time.
	Labour	Workforces to meet new requirements or maintain connection (software engineers, field engineers etc.).
	Cabinets	A range of enclosures designed for installation of telecommunications equipment inside customers premises. Designed for installation inside telephone exchanges to house standard telecommunication equipment and r mesh doors.
	Spectrum	
	Bare Met	
OPEX	Antenna	
	Antenna	applicable).
	Edge cloud cabinet rent & utilities	Costs of edge cloud cabinet rent & utilities.
	Edge cloud operating overhead cost	Costs of Edge cloud operation.
	Edge cloud transport	Costs of Edge cloud transport.
	Edge cloud RAN equipment licensing	Licensing costs.
	Insurances	Cost of insurances.
	Energy costs	kWh necessary * €/kWhe.

Telecommunication related costs

	CLOUD	Explanation
CAPEX	Server to deploy Cloud applications (ITS CENTER)	kWh consumed annually
	Server to applicati	
	Broker-M	
OPEX	Cloud Fe	
	Operatin	
	Maintenance	Periodic maintenance costs
	Insurances	Required insurances

Cloud related Costs

	Automotive OEM Related Cost	Explanation
CAPEX	Sensors	Costs related to all the sensors that need to be installed in the vehicle: cameras, Radars, LIDAR, etc.
	Vehicle architecture modification costs	Costs required for the integration of the previous sensor in the vehicle (body modifications, supports, etc.).
	Modem	5G Modem necessary for the OBU.
	Infotainment	
	Processing E Units	r Autonomous
	Labour	
	Homologatio	
OPEX	SW Updates	Periodic software update costs.
	Communications fees	Terrestrial & non terrestrial communications fees (sim card & sat fees).
	HD Map Service Fees and Maintenance Fees	Periodic maintenance fees for the high-definition mapping service.
	Insurances	Required insurances

Automotive OEM related Costs

	Road Operators Related Cost	Explanation
CAPEX	Toll Gates	Toll gate costs
	Labour	Cost (Hours) required for full integration road.
	Modem (RSU)	5G Modem Costs for each RSU
	Transport from Equipment	Fibre optic costs
	Sensors (CCTV, Radar etc.)	Road Infrastructure costs
	Site Civil Wo	
	Permits and	
OPEX	Operation ar work (Hours)	ysical problems on
	Operating ov	
	Rental costs	Monthly Rental costs for deployment site, e.g. from city authority for a lantern / other public or private installation site on building or roadside
	Electricity fees for site + KWhe consumed	Annual expenditure on electricity consumption.
	Telecommunication costs	Monthly telecommunication costs per site in case of Fixed Wireless Access: 5G contract including sufficient Data plan for uplink / downlink traffic
	Insurances	Required insurances

Road Operator related Costs

3.4 Costs of Deployment of 5G for CAM

5GPPP Phase 1

	Economic Data	Link:
Flex5Gware	NO	• Web: https://flex5gware.eu/
5G Norma	YES	• Web: https://5g-ppp.eu/5g-norma/ • Economic: http://www.it.uc3m.es/wnl/5gnorma/pdf/5g_norma_d2-2.pdf • http://www.it.uc3m.es/wnl/5gnorma/pdf/5g_norma_d2-3.pdf
METIS II	YES	• Web: https://metis-ii.5g-ppp.eu/ • Economic data: https://metis-ii.5g-ppp.eu/wp-content/uploads/deliverables/METIS-II_D1.1_v1.0.pdf
EURO 5G	NO	• Web: https://5g-ppp.eu/euro-5G/
5G-XHAUL	YES	• Web: https://www.5g-xhaul-project.eu/ • Economic data: https://www.5g-xhaul-project.eu/download/5G-XHaul_D6_4.pdf
5G ENSURE	NO	• Web: http://www.5gensure.eu/
CHARISMA	YES	• Web: http://www.charisma5g.eu/ • Economic data: http://www.charisma5g.eu/wp-content/uploads/2015/08/CHARISMA-D5.6-v21.0.pdf
SESAME	NOT PUBLIC	• Web: https://www.sesame-h2020-5g-ppp.eu/Default.aspx • Economic data: https://www.sesame-h2020-5g-ppp.eu/Portals/0/Deliverables/SESAME_Deliverable%208.7_v1.2_Final%20-%20Abstract.pdf?ver=2018-11-12-120625-417
SELFNET	NO	• Web: https://selfnet-5g.eu/
COGNET	NO	• Web: http://www.cognet.5g-ppp.eu/
VIRTUWIND	NO	• Web: http://www.virtuwind.eu/
5GEX	NO	• Web: http://www.5gex.eu/
FANTASTIC	NO	• Web: http://fantastic5g.com/
COHERENT	YES	• Web: http://www.ict-coherent.eu/ • Economic data: http://www.ict-coherent.eu/coherent/wp-content/uploads/2018/05/COHERENT_D7_4_v1.pdf
SONATA	NO	• Web: https://project.sonata-nfv.eu/
SUPERFLUIDITY	NO	• Web: http://superfluidity.eu/
5G-CROSSHAUL	NO	• Web: http://5g-crosshaul.eu/
MmMAGIC	YES	• Web: https://5g-mmmagic.eu/ • Economic data: https://bscw.5g-mmmagic.eu/pub/bscw.cgi/d213978/mmMAGIC_D1.4.pdf
Speed5G	NO	• Web: https://speed-5g.eu/

5GPPP Phase 2

	Economic Data	Link:
5g ESSENCE	NO	• Web: https://www.5g-essence-h2020.eu/Default.aspx
5g CAR	YES	• Web: https://5gcar.eu/ • Economic data: ○ https://5gcar.eu/wp-content/uploads/2019/03/5GCAR_D2.2_v2.0.pdf ○ https://5gcar.eu/wp-content/uploads/2019/08/5GCAR_D2.3_v1.1.pdf ○ https://5g-ppp.eu/wp-content/uploads/2018/02/5G-PPP-Automotive-WG-White-Paper_Feb.2018.pdf
5G CITY	YES	• Web: https://www.5gcity.eu/ • Economic data: https://zenodo.org/record/3757733#.XoYzePZuJKe
5G MEDIA	NO	• Web: http://www.5gmedia.eu/
5G-MONARCH	YES	• Web: https://5g-monarch.eu/ • Economic data: https://5g-monarch.eu/wp-content/uploads/2019/07/5G-MoNArch_761445_D6.3_Verification_and_validation_final_report_v1.0.pdf
5GPHOS	NO	• Web: http://www.5g-phos.eu/
5G-PICTURE	YES	• Web: https://www.5g-picture-project.eu/ • Economic data: https://www.5g-picture-project.eu/download/5g-picture_D2.3.pdf
5GTANTO	NO	• Web: https://www.5gtango.eu/
5GTRANSFORMER	YES	• Web: http://5g-transformer.eu/ • Economic data: http://5g-transformer.eu/wp-content/uploads/2019/11/D1.4_5G-TRANSFORMER_final_system_design_and_Techno-Economic_analysis.pdf
5GXCAST	NO	• Web: http://5g-xcast.eu/
5GBLUE SPACE	NO	• Web: https://bluespace-5gppp.squarespace.com/
IoRL	NO	• Web: https://iorl.5g-ppp.eu/
MATILDA	NO	• Web: https://www.matilda-5g.eu/
METRO X HAUL	NOT PUBLIC	• Web: https://metro-haul.eu/
NG PAAS	NO	• Web: http://ngpaas.eu/
NRG5	NOT PUBLIC	• Web: http://www.nrg5.eu/
ONE5G	YES	• Web: https://one5g.eu/ • Economic data: D2.3.: https://one5g.eu/documents/
SAT5G	YES	• Web: https://www.sat5g-project.eu/ • Economic data: https://www.sat5g-project.eu/wp-content/uploads/2019/04/761413_Deliverable_8_Business-Modelling-and-Techno-economic-Analysis-of-Satellite-eMBB.pdf
SLICENET	NOT PUBLIC	• Web: https://slicenet.eu/
GLOBAL5G	NO	• Web: https://5g-ppp.eu/global5g-org/

5GPPP Phase 3

	Economic Data	Link:
5G EVE	NO	• Web: https://www.5g-eve.eu
5G VINNI	YES	• Web: https://www.5g-vinni.eu/ • Economic data: https://zenodo.org/record/3345665#.XoZirDVS_bo
5GENESIS	NO	• Web: https://5genesis.eu/
5G CROCO	NOT PUBLIC	• Web: https://5gcroco.eu/
5GCARMEN	NO	• Web: https://5gcarmen.eu/
5G SOLUTIONS	YES	• Web: https://www.5gsolutionsproject.eu/ • Economic data: https://www.5gsolutionsproject.eu/wp-content/uploads/2020/03/D8.1A-Market-assessment-technology-monitoring-v1.0_v1.1_NURO.pdf
5G TOURS	NO	• Web: http://5gtours.eu/
5G DRONES	NO	• Web: https://5gdrones.eu/
5G HEART	NO	• Web: https://5gheart.org/
5G GROWTH	NO	• Web: http://5growth.eu/
5G SMART	NO	• Web: https://5gsmart.eu/
5GVICTORI	NO	• Web: https://www.5g-victori-project.eu/
FULL5G	NO	• Web: N/A.
ARIADNE	NO	• Web: https://www.ict-ariadne.eu/
5GCLARITY	NO	• Web: https://www.5gclarity.com/
5G COMPLETE	NO	• Web: N/A.
INSPIRE-5GPLUS	NO	• Web: https://www.inspire-5gplus.eu/
LOCUS	NO	• Web: https://www.locus-project.eu/
MONB5G	NO	• Web: -N/A.
TERAWAY	NO	• Web: https://ict-teraway.eu/
5GZORRO	NO	• Web: https://www.5gzorro.eu/5gzorro/
5G-DRIVE	NO	• Web: https://5g-drive.eu/
PRIMO-5G	NO	• Web: https://primo-5g.eu/

3.4 Costs of Deployment of 5G for CAM

Telecom Related Cost	Project	5G Norma.	Metis II.	Charisma.	5G CAR	5G City	5G Monarch	5G Picture
CAPEX	Antennas / Feeder	• Antennas: From £250 (Small cell) to 7200 (Macrocell) • Feeder, install, test and commission costs per site: From £ 700 to £4400 • RF front end: From part of integrated active equipment to £24k (for 3 sectors).	• 11000€: 5G outdoor small cell including all related cost (integrated antenna, router, security gateway, site related costs, backhauling (a mixer of optical fibre and Microwave)). • 5000€: 5G indoor hotspot small cell including all related cost (integrated antenna, router, Security gateway, inch, site related costs, backhauling (a mixer of optical fibre and Microwave)). • 20000€: mm Wave 5G outdoor cell on existing small cell site. • 8000€: mm Wave 5G indoor cell on existing small cell site-	• 4.000€:Small Cell. • 40.000€: Macro Cell.	• 5G Site:(CAPEX (40K€)) • Digital Infrastructure (CAPEX): 35K€/km • Fibre (CAPEX): 100k€/km • OPEX: 17,5k€/km/year • Inter-site-distance (ISD): 1 km	• Investment costs: • 45%- Server • 25% - Small Cells • 13% GPUS • 6% - Switches • 3% - Micro servers • 2%- Air conditioning • 2% - Racks • 1% - UPS • 1%- Cables		• Total yearly CAPEX (Power?) 4297179 €/y
	Transport From Antenna Site		• 4.000 €: A new backhaul link for outdoor small cell.					
	Network Core Equipment						• 48% (servers)	
	Permits							
	Site Civil Works	• £ 46,200: Macrocell (3 sectors) • £ 46,200: Small cell (2 sector small cell) • £ 4,800: Picocell (1 sector mm Wave small cell)		• 15000€: Small Cell Site: civil works, connection to utilities, etc. • 10000€: Macro Cell Site: upgrades needed to host the new equipment.				
	Labour							
	Cabinets						• 5%	
	Spectrum costs		• 12.000 €: Adding an additional frequency (non mm Wave) band to an installed 5G macro base station.					
	Bare Metal							
	Edge cloud CAPEX	• Fixed costs for initial set up pf an installation at edge cloud site: 10,100 £. • Costs include power supply distribution boards, sockets, lighting, enclosure, overhead racking and cabling. • Fixed costs to set up a cabinet/rack at the edge cloud site: 21,400 £ • Includes power distribution, Air Conditioning set-up, space set-up, AC distribution and cabinet. • Fixed costs per server 6,500 £ (Maximum of 16 servers per cabinet. • Assumes 35% discount. This is equivalent to just under £490/installed core (for a fully equipped cabinet))						
	Base station (*)		• (*) 55000 €: 5G macro base station on an existing site, including 5G BS, embedded SW, installation, new MIMO antennas and infrastructure adaptation.					

Telecom Related Cost	Project	5G Norma.	Metis II.	Charisma.	5G CAR	5G City	5G Monarch	5G Picture
OPEX	Antenna Maintenance Visits	• Macrocell: 10% of Active Equipment / 10% of the RF front end cost. • Small Cell: 25% of Active Equipment • Picocell 25% of Active Equipment	• 10% Operation & maintenance, including SW licenses (10% of CAPEX)	• 800€/month [Small cell site: Monthly rent and utilities cost] • 4000€/month [Macro cell site: Monthly rent and utilities cost]				
	Antenna site rental	• From 1K£ (picocell, small cell) to 20K£ (Macrocell)	• 800 € (Average macro site rental per year)					
	Site updates		• 3000€: Upgrade 5G outdoor small cell to 2 bands including all related costs. • 2000€: Upgrade 5G indoor small cell to 2 bands including all related cost)			• Running costs: 29% - Installations 29% - Employees 14% - Maintenance 10% - Venue Rental 9% - Network Operation 8% - electricity 2% - Billing license		• OPEX energy 39172 €/y • OPEX others 249068 €/y
	Edge cloud cabinet rent & utilities	• Server (nominal) cost 10,000 £ • Transport: 1150 £ • Standing charges / edge cloud: 6,300 £ • Site rent and utilities/cabinet: 6,600 £			•		• 18%	
	Edge cloud operating overhead cost						• 7%	
	Edge cloud transport						• 1%: Site transmisión.	
	Edge cloud RAN equipment licensing						• 22%: Licensing and maintenance.	
	Insurances							
	Energy costs		• 600 € (Annual macro site energy cost, 5G part)					

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3.4 Costs of Deployment of 5G for CAM

Deployment costs and assumptions for 5G V2X Deployment			MINIMUM 5G Scenario 1 Mbps guaranteed bitrate in Highly traffic period	CLASSIS 5G Scenario 2 Mbps guaranteed bitrate in Highly traffic period	BREAKING 5G Scenario 30 Mbps Average guaranteed bitrate Normal Conditions	FUTURE PROOF 5G Scenario 100 Mbps Average guaranteed bitrate Normal Conditions
Deployment costs	5G site (CAPEX)	64.000 € per site	90.000€			
	Civil works (CAPEX)	20.500 € per site	17.000€/km (*3)	24.000€/km (*3)	70.000€/km (*3)	181.000€/km (*3)
	Fibre backhaul (CAPEX)	23.000 € per site	12.000€/km (*2)	12.000€/km (*2)	19.000€/km (*2)	19.000€/km (*2)
	Network operation (OPEX)	10 % of CAPEX	N/A	N/A	N/A	N/A
	Site lease (OPEX)	5.700 € per site	N/A	N/A	N/A	N/A
Area and capacity demand	Inter-site-distance (ISD)	1 km	≈4km	≈3km	≈1km	≈0,4km
	Number of vehicles	50.000 Vehicles/100km/day	N/A	N/A	N/A	N/A
Deployment rate	Connectivity costs for CAM	0,5 € per 100 km	N/A	N/A	N/A	N/A
	Network deployment rate	55 % for year 1 for coverage	N/A	N/A	N/A	N/A
		5 % for year 2 to 10 for capacity	N/A	N/A	N/A	N/A
	Fibre deployment rate	80% year 1	N/A	N/A	N/A	N/A
		20 % year 2	N/A	N/A	N/A	N/A
	Yearly penetration rate	10 % from year 1 to 10	N/A	N/A	N/A	N/A
Costs evolution	CAPEX yearly price evolution	-3 % from year 1 to 10	N/A	N/A	N/A	N/A
	OPEX yearly price evolution	3% from year 1 to 10	N/A	N/A	N/A	N/A

RSU Costs

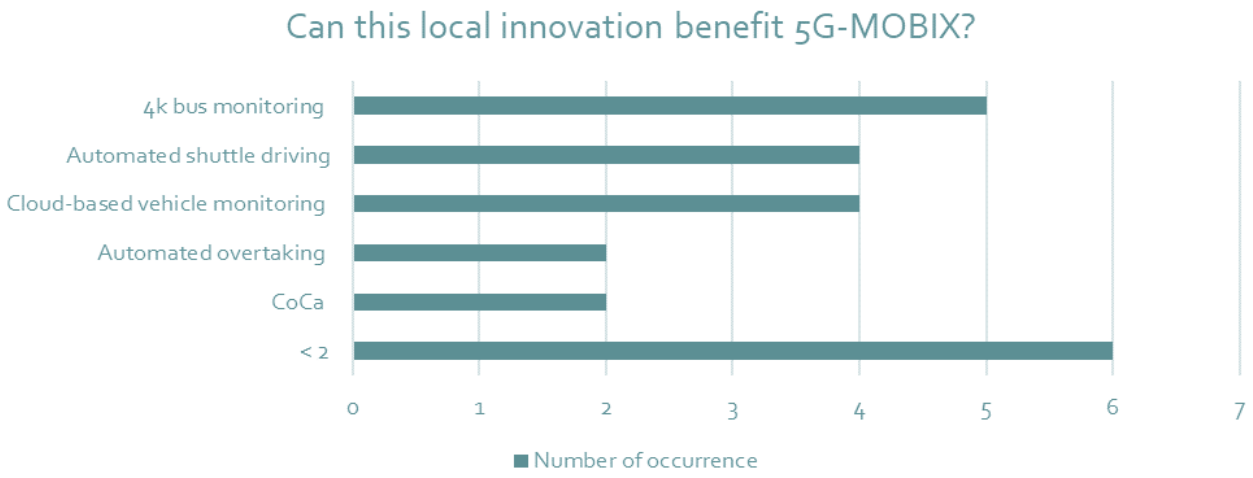
CAPEX Cost element	Cost per device (EUR)	MINIMUM 5G Scenario	CLASSIS 5G Scenario	BREAKING 5G Scenario	FUTURE PROOF 5G Scenario
Hardware	3500	5 k€		20k€	
Installation	1000				
Design & planning	2700 (60% of hardware and installation costs)				
Interdistance	[300m-1km]	3 km		2 km	
Total CAPEX	7200	5000	5000	20000	20000
OPEX Cost element	Yearly cost per device (EUR)	N/A	N/A	N/A	N/A
Power	20	N/A	N/A	N/A	N/A
Maintenance	225	N/A	N/A	N/A	N/A
Security	40	N/A	N/A	N/A	N/A
Annualized replacement cost (over ten years)	250	N/A	N/A	N/A	N/A
Total OPEX	735	N/A	N/A	N/A	N/A

Sources:

- **5GPPP, "5G PPP Automotive Working Group «Business Feasibility Study for 5G V2X Deployment» pp. 7, version 2.," February 2019.**
- **"5G for Cooperative Connected and Automated Mobility.," in *9th ETSI ITS Workshop.* , Berlin, 7 March 2018.**
- **5GAA, "CITS Vehicle to infrastructure Services: how C-V2X technology completely changers the cost equation for road operators. White Paper.".**

4. From "Local to Project"

- ***Step 1:*** Identification of successful innovations (self-assessment). Preliminary list of successful innovations in the transport sector at local level.
  - 43 entries



- ***Step 2:*** Identification of successful innovations (extended assessment → Next Steps).
  - Scoring and integration of successful innovations into one of the project's use-cases.

Watcher (5G-MOBIX partner)	Name (if applicable)	Type (Project, patent, product, etc.)	Location (country)	Purpose (what are the key interests and benefits of innovation?)	Can this local innovation benefit 5G-MOBIX?	Can 5G-MOBIX solutions benefit this local innovation?
INTRA	-	Policy	Germany	Germany opens the way to industrial partners for private 5G licenses https://5gobservatory.eu/german-authorities-opened-process-for-private-5g-licences/		
INTRA	-	Trial	Denmark	Telia, Nokia and Telenor complete first 5G MOCN deployment illustrating how infrastructure sharing can be used https://www.telecomtv.com/content/5g/nordic-telcos-get-together-on-5g-with-mocn-trial-37922/		
CTAG	1st 5G cross border data connection	Demo	Spain	Optimization of multimedia content download under roaming context	Yes, 4K bus monitorin g	
CTAG	5G Andalucía Pilot	Project	Spain	Optimization of multin process in Malaga bus https://www.piloto5ga		
CTAG	5G Connected Ambulance	Project	Spain	Remote medical suppo by in real time HD vide https://5gbarcelona.or conectada-5g/		
CTAG	5G Connected Car, SEAT	Project	Spain	Driving safety and effic providing info on VRU information. https://5gbarcelona.or conectado-5g/		
CTAG	5G Galicia Pilot	Project	Spain	Driving safety improve existing traffic events a entering and weather exiting. https://piloto5ggalicia		
CTAG	5G Technological Cities, Telefonica	Project	Spain	Multimedia download context (shuttle) https://www.saladepr prensa/np_primera_lla		
FRAUN	5G-AUTOSAT	Project	Germany	Using 5G-New Radio d different automotive u autonomous driving, v https://www.dlr-innos projekte/5g-autosat/		
VTT	5G-DRIVE	project	Finland, China	C-ITS messages over P https://5g-drive.eu/		
LIST	5G-EMIT	Project	Luxembourg	EMF monitoring platfo deployment initiatives		
CCG	Anpeb	Public	CCG, University of Minho	To evaluate VRU (pede crosswalks.		

UCC Id	UCC Name	Trial Site	US Id
AdDr	Advanced Driving	ES-PT	LaneMerge
		ES-PT	Overtaking
		FR	AssInfrastructure
		NL	CCA
		CN	CloudAssisted
		ES-PT	CoopAutom
Plat	Vehicles Platooning	GR-TR	SeeWhatISee
		GR-TR	5GPlat
		DE	AsseRSU
		CN	AssCloud
ExSe	Extended Sensors	ES-PT	HDMapsVehicle
		ES-PT	HDMapsPublicTransport
		GR-TR	AssBCrossing
		GR-TR	TruckRouting
		DE	EDM
		FI	EdgeProcessing
		NL	CPM
ReDr	Remote Driving	ES-PT	RCCrossing
		FI	RedundantNE
		NL	5GPositioning
		CN	DataOwnership
		KR	mmWave
QoS	Vehicle QoS Support	ES-PT	MediaPublicTransport
		KR	Tethering

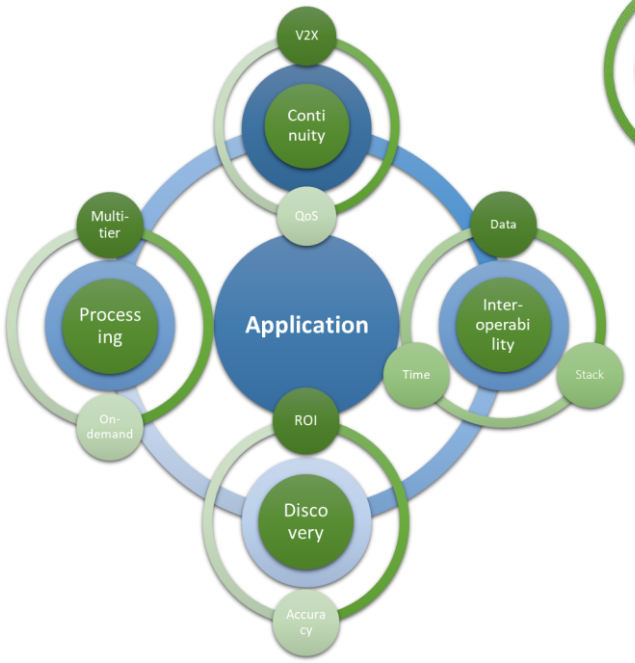
5. From "Project to Global"

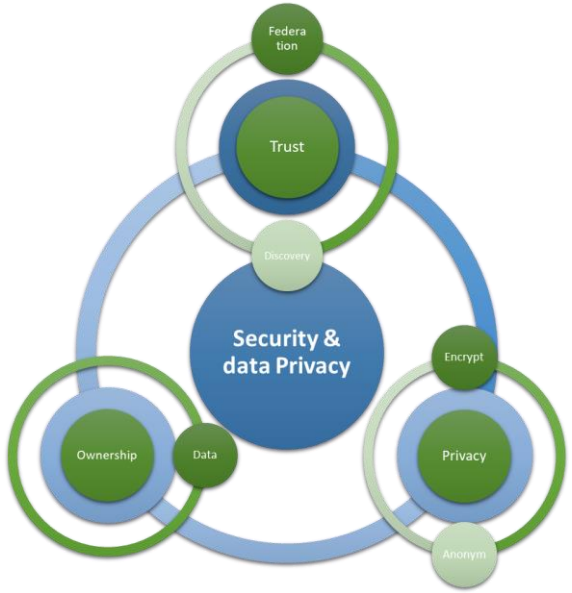
- Step 1: establishment of tri-lateral agreements → Preliminary list of agreements will be presented in **D6.5 in M44**.

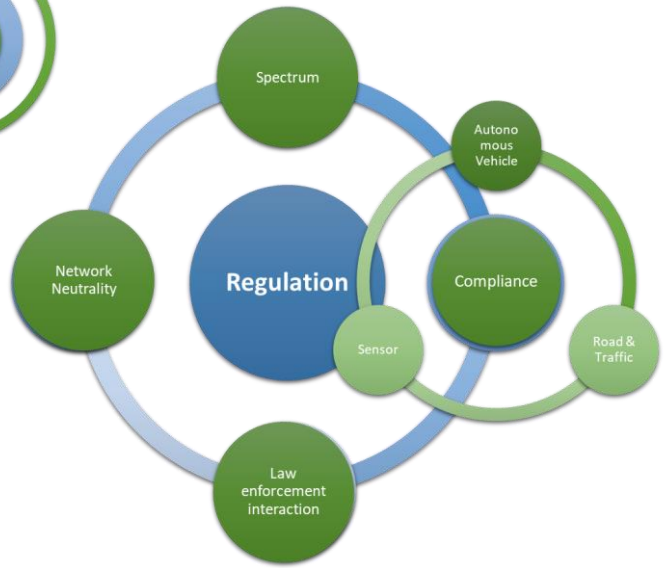
- Step 2: provide recommendations and deployment options for opening the door to post-project extensions and replications

5. From "Project to Global"

Challenges. CB Issues







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5. From "Project to Global"

Initial Recommendations

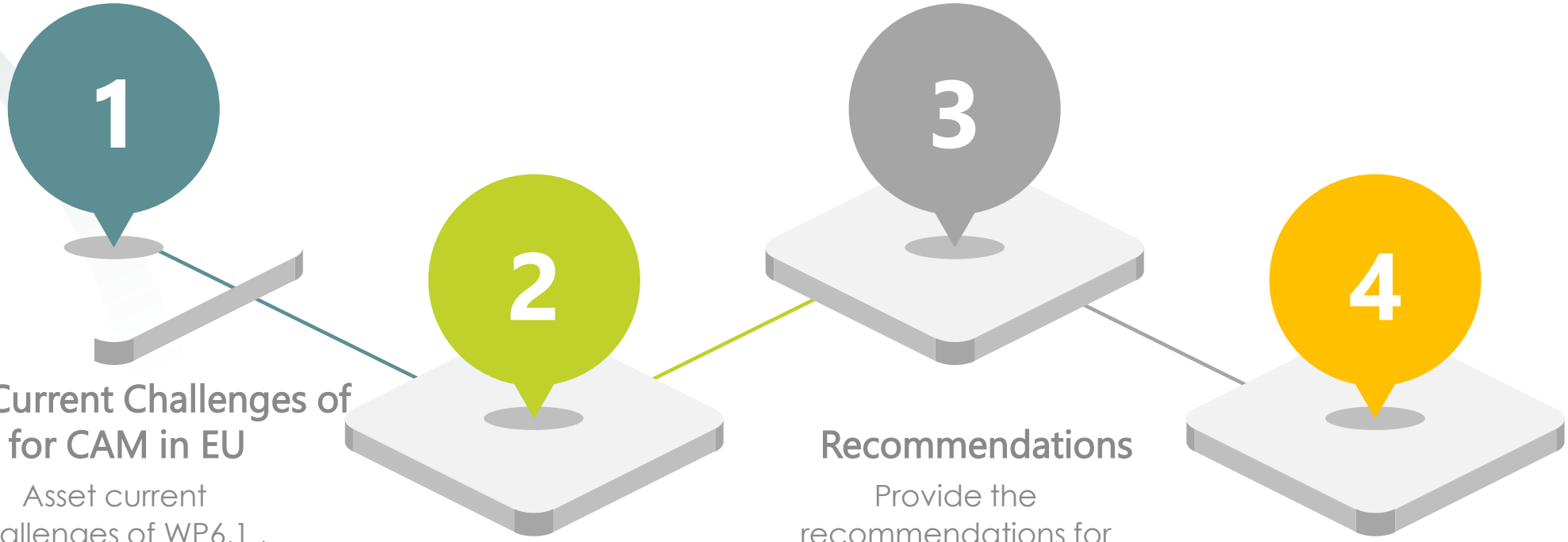
73 Recommendations:

- *Legal*
- *Deployment*
- *Data Quality-Validity*
- *Data Property Management*
- Application and interoperability
- *Fixed On-Board infrastructure*
- *Cybersecurity recommendations*

GOLD recommendations (22 to 25)

5. From "Project to Global"

New Recommendations Approach



Assess Current Challenges of 5G for CAM in EU

Asset current challenges of WP6.1 , WP6.2 & WP6.4 to evaluate the challenges

Define the areas of recommendation

Define the areas of the recommendations and evaluate the challenges base in the current Industry development

Recommendations

Provide the recommendations for the CCAM in EU and the corridors in line with current industry standard and gaps.

Deployment plan

Develop a Deployment plan at Eu level and Corridor level

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5. From "Project to Global"

Assess Current Challenges and define areas of Recommendations

AEVAC has review the challenges from T6.1, T6.2 , T6.4 to assess the issues and categorise to understand the areas of recommendations.
After the review we can conclude that most of the challenges can be group in fours main areas of recommendation.

5G Network	5G Architecture	Legal & Standards	Stakeholder collaboration
Network integration, performance, business models and deployment	Definition: The architecture define by vehicles architecture+ edge + road infrastructure +network integration	All the legislation and Standards that they are currently in the industry and or the gaps in legislations that is not develop yet	Collaboration between the stakeholder define in the project : Road Infrastructure, ICT Sector , Automotive, Governments

5. From "Project to Global"

Recommendations Status

Using this four areas of recommendation AEVAC has review all the challenges /Issues be can conclude :

- All the challenge/issues are 80% common between the T6.1, T6.2 and T6.4
- Base in our estimations we expected to have between 22 to 25 golden recommendations for WP6

	5G Architecture (Vehicles & Network)	Stakeholder Collaboration	Legal & Standars	Network &V2X	Total
WP6 Recommendations	5	5	4	5	19
Expected Recomendations	Base in our estimations we expected to have between 22 to 25 golden				

6. Results expected

Areas	ID	Issue name	Geog. Scope	Short description	Recommendations	Recommendations
5G Architecture Issues	DEP6	Resource migration solutions	ALL	There is a lack of open solution to guarantee the migration of edge resources assigned to vehicles.	Holistic architecture offering edge capabilities across MNOs, countries and network/security domains	Resiliance in the 5G architecure need to be guarentee to enable a minumin of 80% of conectivity coverage to have a secure and safe handover between diference boarders and the vehicule architecture could be have in a secure way to handle the hand over.In order to achieve this the architecture need to be desing following the INCOSE standars of a supersystems, the stakeholders has to be collaborate in the definition of the architecure and thier requrements and design an specific valaidation and verifications process base in the (ISO 26262) standars as well as the recomendations provide in the standards section reglated with Data and Cybersecurtity. Also each systems Vehcikes + edgede _+ digital infrastructure need to be desing to allow then to work independly of each other in the cases that there a failure occur in the systems. So the systems need to work as a whole as well as an individual sotware componets. A tracebility mechanish to understanding the event manage and prioritization woeuld need to be deelop for the the road users , goverments and MVNO to assess the handovers .
5G Architecture Issues	DEP7	Orchestration and allocation of resources in mobile scenarios	ALL	Need for solutions offering orchestration and resource allocation through different computing domains and using locally available network resources in mobile scenarios such as CCAM.	Holistic and/or distributed architecture coping with mobility, security and QoS required in CCAM	
5G Architecture Issues	AI13	KPI measurement synchronization across different components and across neighbouring 5G networks	ALL	Absolute clock synchronization of OBUs, RSUs, 5G network, sensors, etc. for accurately measuring KPIs (e.g. to estimate the E2E latency and break it down to its components the OBUs and the network need to be synchronized. Problem intensifies when communicating across the borders as MNOs may have different synch clocks.	· Common clock reference, such as GPS timing, might be a solution but it is not always possible as low tier/low-cost devices may not be capable for this.	
5G Architecture Issues	AI15	Fallback in case of network outage	ALL	A standard to regulate OBU behaviour is required in case of network outage. In case of network outage, a set of basic rules must be defined to module OBU behaviour, especially when the vehicle interacts with other vehicles. A lack of a fullback rules can lead to critical events between autonomous vehicles.	· Fall-back to 4G or national roaming	
5G Architecture Issues	AI &CCAM5	Dependability requirements of CCAM services	ALL	In order to provide trustworthy operation of connected autonomous vehicles, very high levels of reliability and availability are required both in the 5G network, as well as in the vehicle, road and cloud infrastructure systems. For that purpose, extensive testing needs to be performed, so that it can be guaranteed the provision of continuous and failure-free service provided by 5G applications.	· Fault-prevention and fault-tolerance mechanisms, for instance redundant 5G networks, are typically employed to ensure such high dependability requirements. In order to prove the correct operation of the system, fault-injection procedures may be employed to shorten the testing and verification period.	

7. Next Steps
Validation

The recommendations need to be in line with some of the current activates that the industry is currently working on.
Before start to write the recommendation the AEVAC team has started a initial research and discussion with Industry experts in the in the following areas:

5G Network	5G Architecture	Legal & Standards	Stakeholder collaboration
5GAA Automotive Association	Series of Interviews with industry experts in the deployment of the technology	ISO, ITU, IEEE Advancing Technology for Humanity, SAE International, World Economic Forum, bsi.	Series of Interviews with experts in international projects (USA & China)

7. Next Steps.

Prioritisation. WIP 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

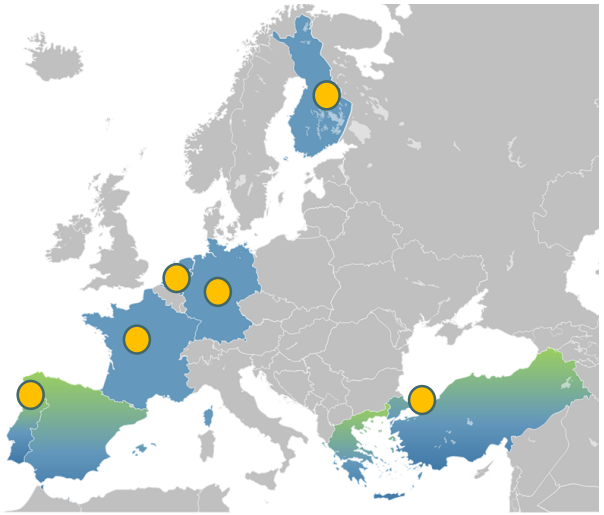
We would evaluate the impact in four areas Technical, Deployment, competitive value and business value

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 in the current market



Thank you

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