5G-MOBIX

Project Overview & Key Achievements

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5GPPP TB eWorkshop, May 26th, 2020

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 825496

Layout

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  - Cross-Border Corridors
  - Use cases
  - Vehicles
- Key Achievements
  - 5G Architecture
  - Cross-Border Challenges
  - Deployment & Integration methodology/planning
  - KPI definition (Technical, Business, User Acceptance)
- Roadmap (+ Covid-19 impact)

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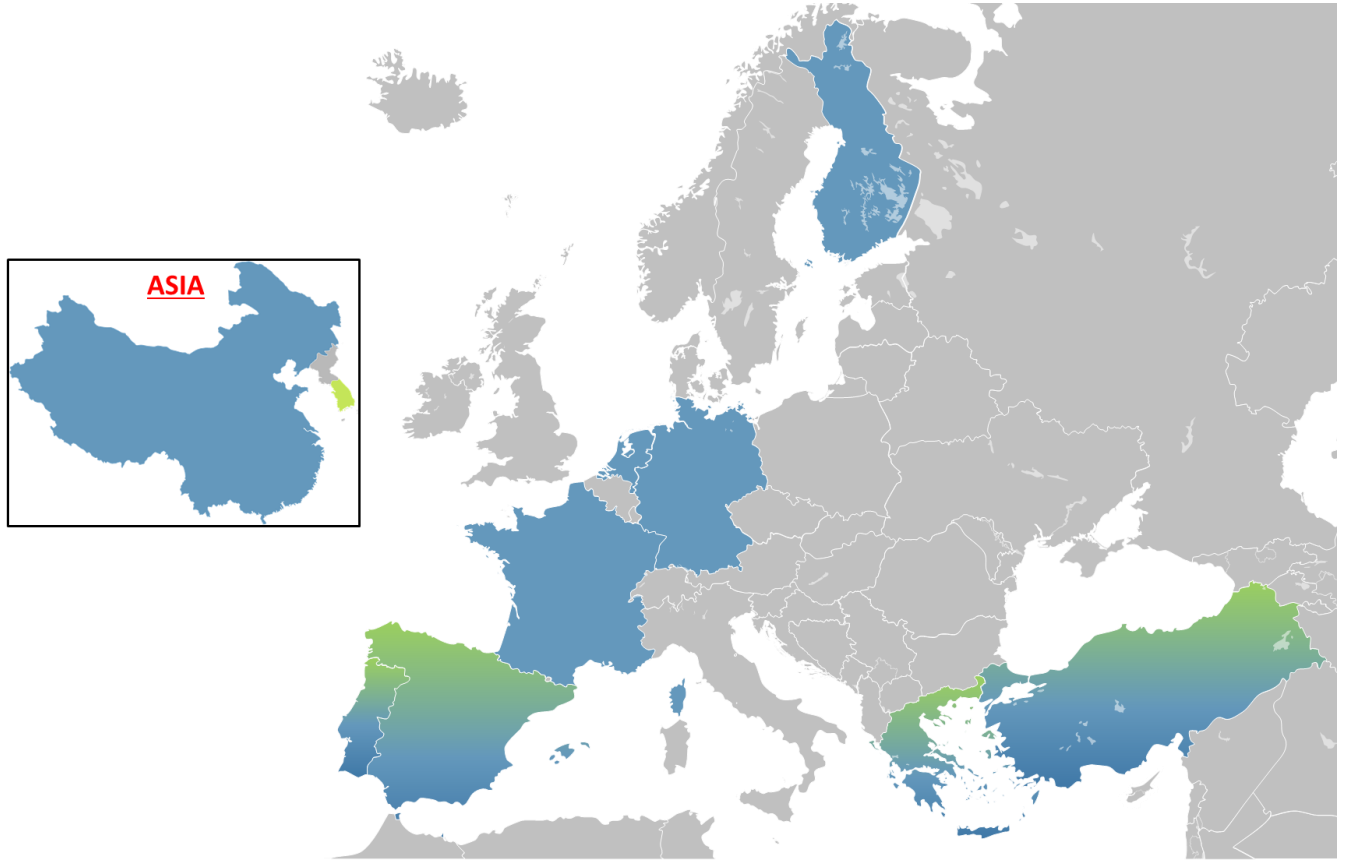
Overview of 5G-MOBIX CBCs / TSs

- ***2*** Cross-Border Corridors (CBC)
- ***4*** complementary European Trial Sites (TS)
- ***2*** complementary Asian Trial Sites (TS)
- ***5*** Use case categories based on 3GPP TS 22.186, focusing on x-border operation
- ***24*** SAE L4 automated vehicles
- ***30*** 5G gNBs
- ***NSA*** Architecture (potential for evolving to ***SA***)



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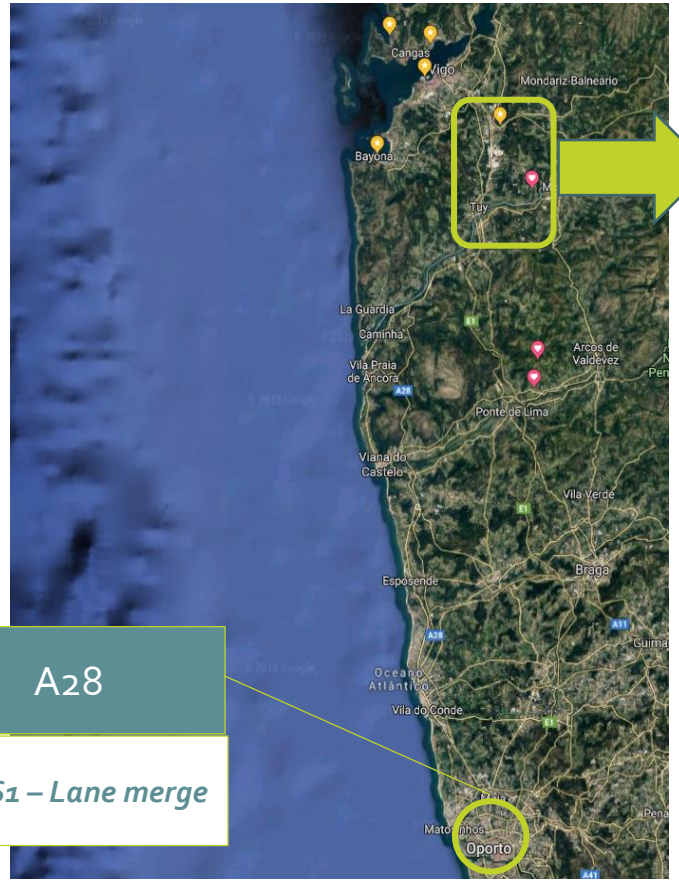
Cross-Border Corridors

ES-PT CBC Overview. Location

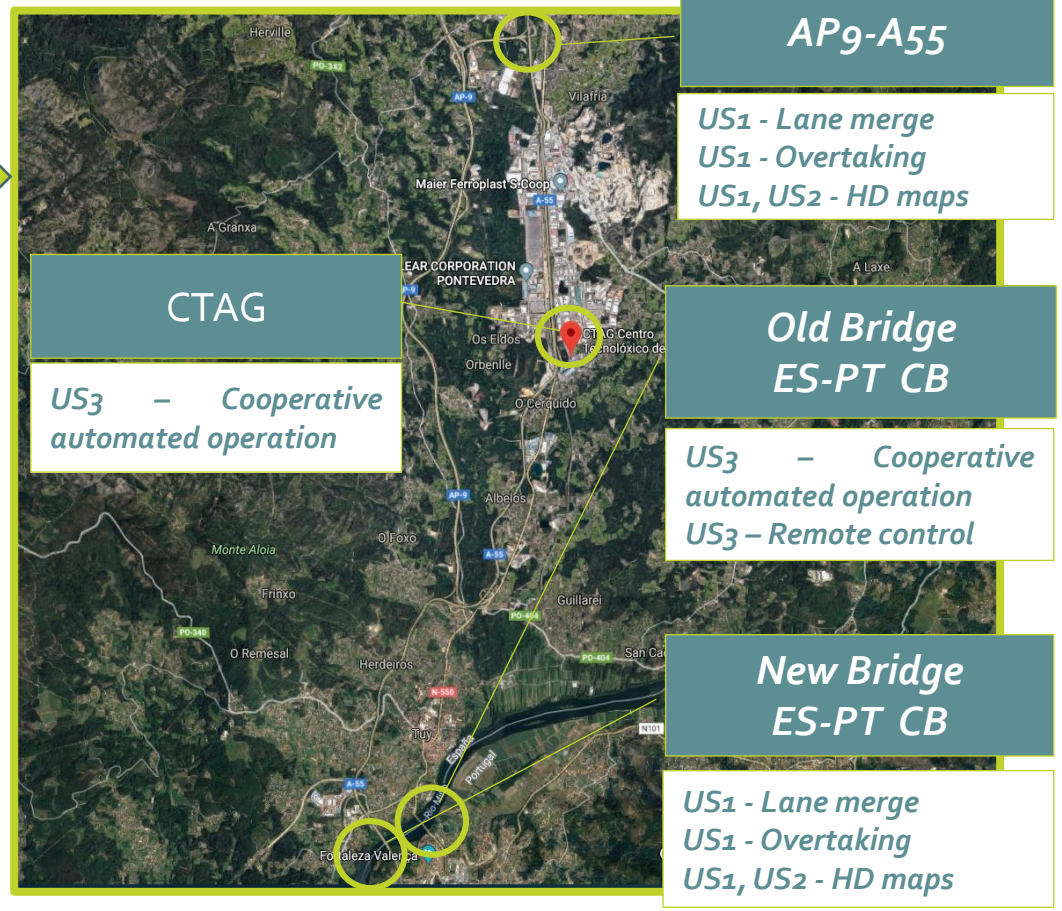
Whole ES-PT corridor Vigo-Porto

- *US2 – 4k bus monitoring*
- *US2 – Multimedia service for passengers*



A28

- *US1 – Lane merge*



AP9-A55

US1 - Lane merge
US1 - Overtaking
US1, US2 - HD maps

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US3 – Cooperative automated operation

Old Bridge ES-PT CB

US3 – Cooperative automated operation
US3 – Remote control

New Bridge ES-PT CB

US1 - Lane merge
US1 - Overtaking
US1, US2 - HD maps

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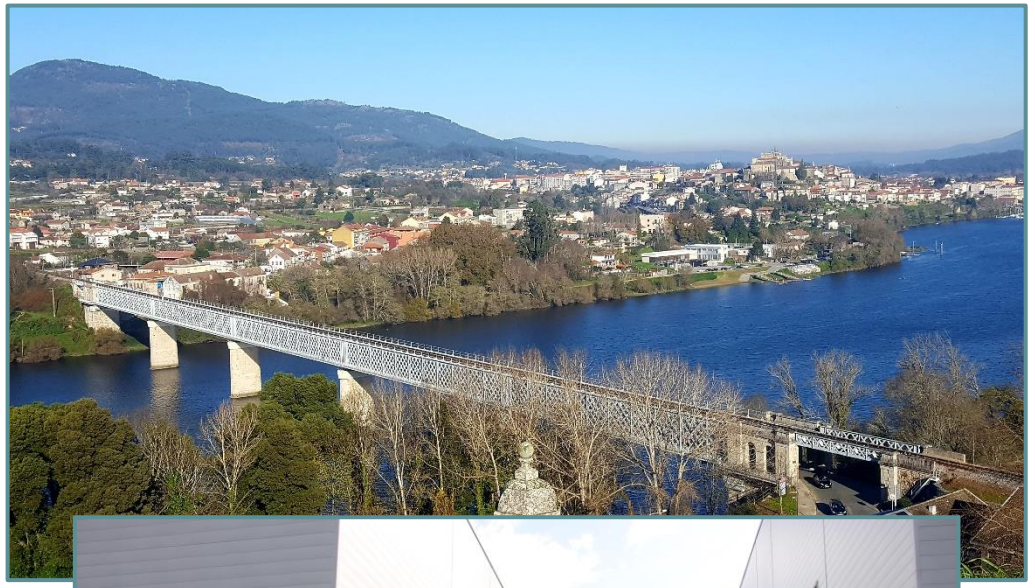
Spain-Portugal Cross-Border Corridor.

- The Spanish-Portuguese corridor connects the cities of Vigo and Porto (250 Km,) and use next roads/highways:
  - ***Spain:***
    - City of Vigo (4 Km).
    - A55 (10 Km).
    - AP9 (5 Km).
  - ***Portugal:***
    - A3 (5 Km).
    - N13 (1km).
    - A28 (7 Km) near the Porto Airport and Boat Passenger Terminal.
  - ***Cross-Border:***
    - Located in the border of the north of Portugal with Spain.
    - Established by the Minho/ Miño river, disposing of two bridges providing the road infrastructure serving trucks, cars and pedestrians.
    - International trade as well as large passenger commuting flows are of great importance and provide ideal conditions for the execution of diversified trials to showcase the advantages offered by the 5G connectivity to CCAM use cases.



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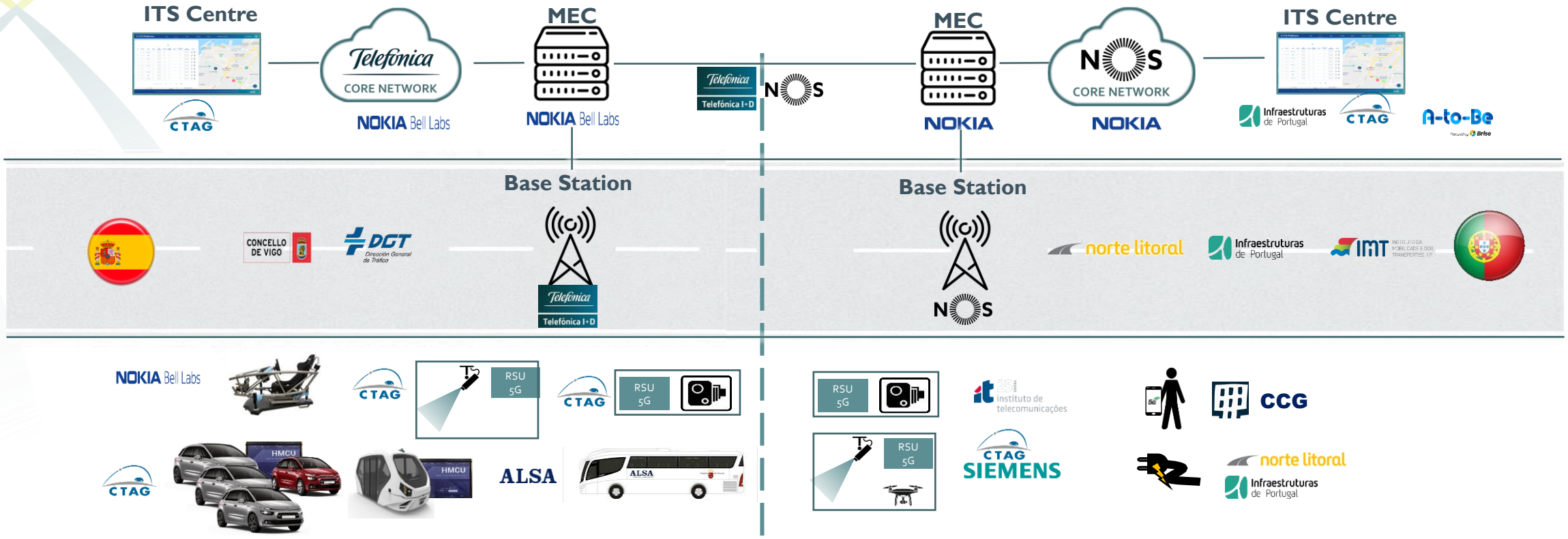
ES-PT CBC Overview. Stakeholders



Evaluation

CTAG · DEKRA · NOKIA · NOKIA Bell Labs · OTIS · Universidad de Murcia · CCG · ISEL · Infraestruturas de Portugal · SIEMENS

Deployment Enablers

DGT · NOKIA · NOKIA Bell Labs · ISEL · Concello de Vigo · CTAG · norte litoral · CCG · AEVAC · Politécnica · NOS

Dissemination

NOKIA Bell Labs · NOKIA · instituto de telecomunicações · SIEMENS · CCG · DEKRA · Universidad de Murcia · Concello de Vigo · DGT · CTAG · AEVAC

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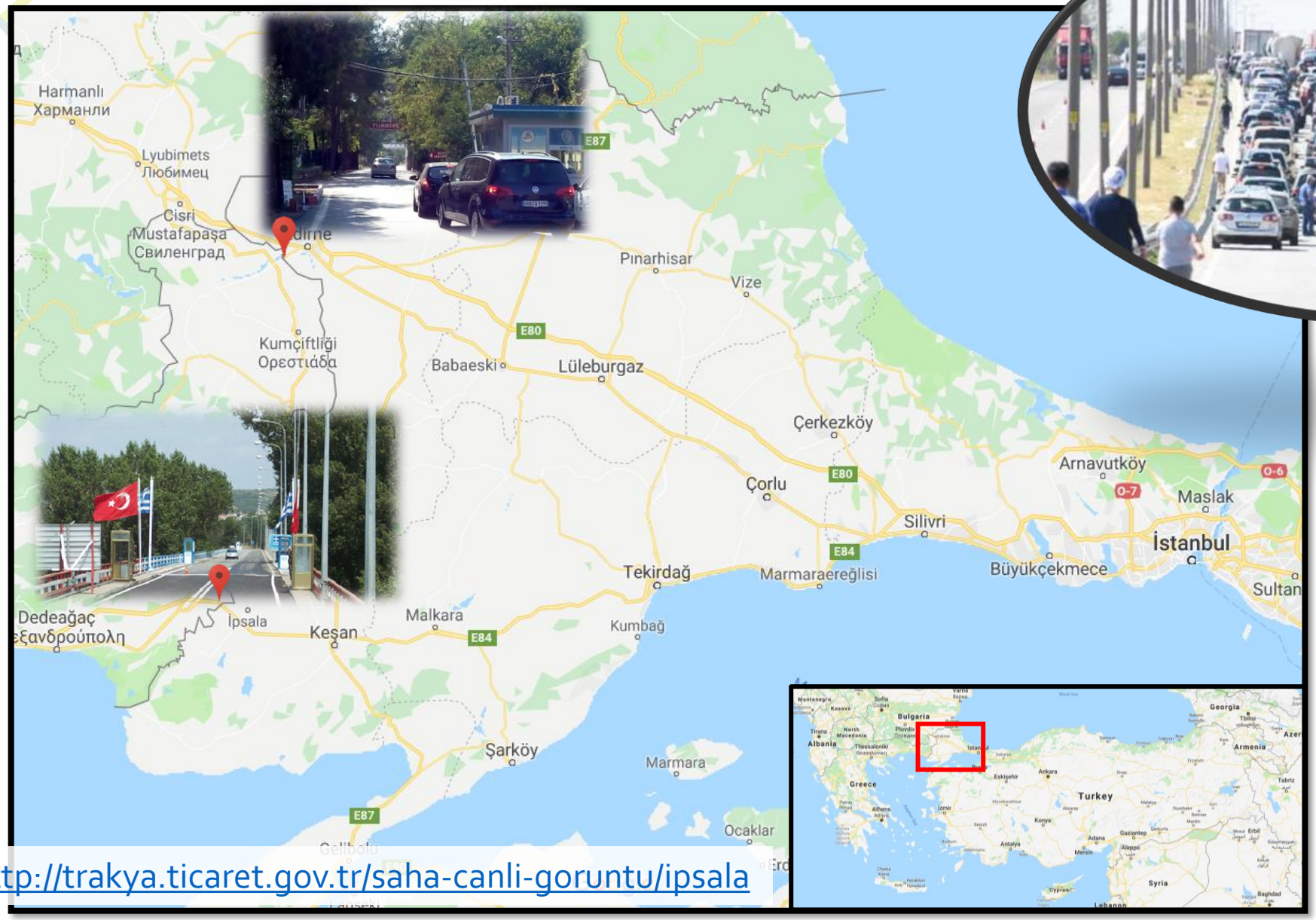
Greece-Turkey Border



LIVE http://trakya.ticaret.gov.tr/saha-canli-goruntu/ipsala

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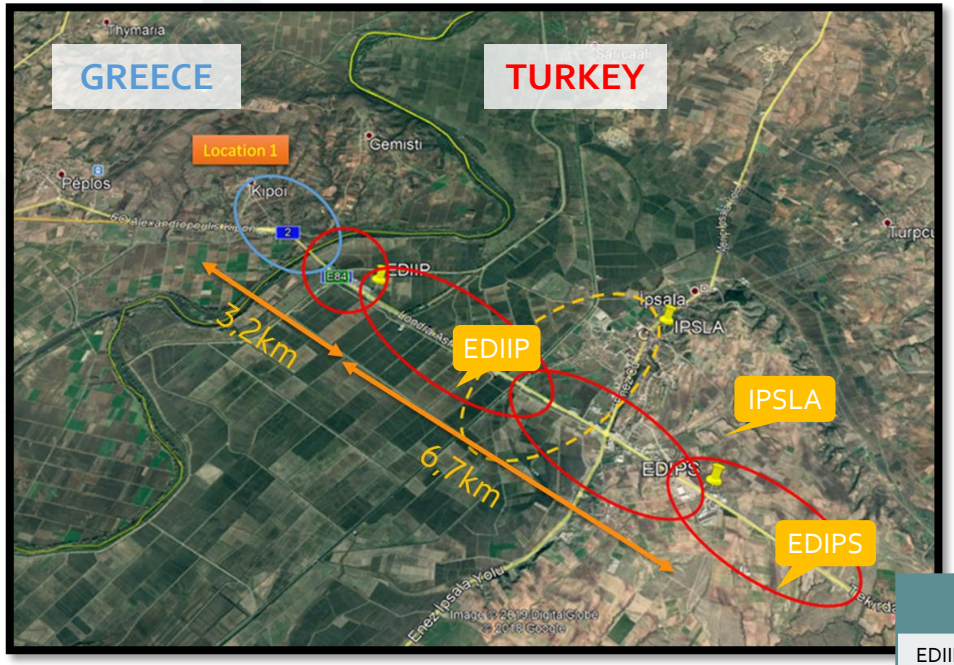
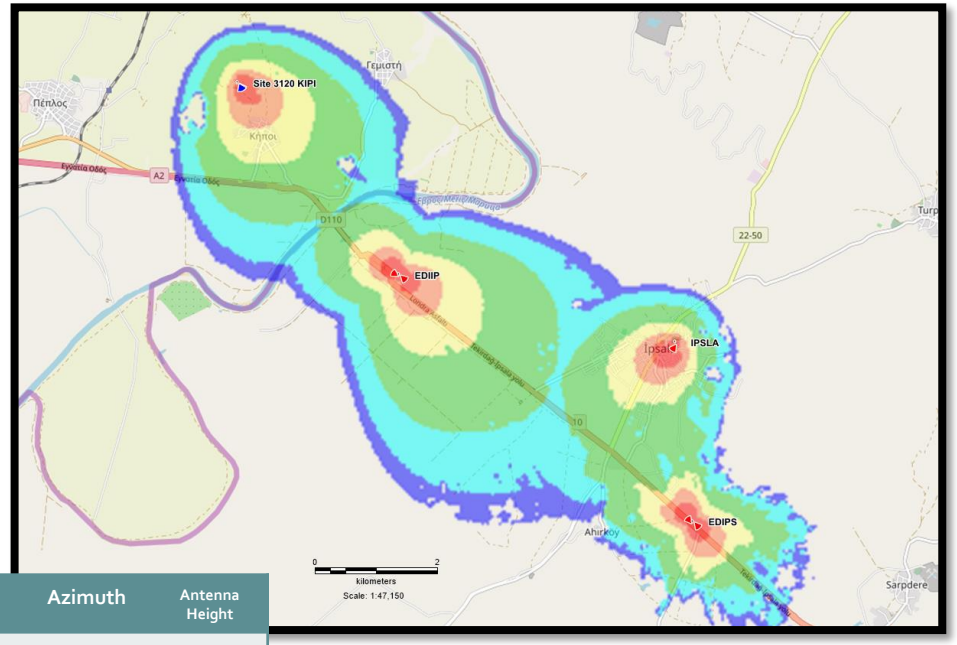
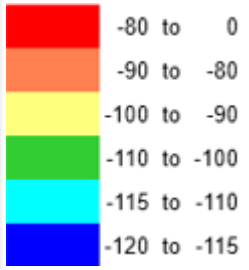
Cross-border Trial Location

Ipsala (TR) – Kipoi (GR)



	Sector	Azimuth	Antenna Height
EDIIP	1	135°	30m
	2	300°	30m
EDIPS	1	140°	15m
	2	320°	15m
IPSLA	1	215°	40m





NR n78
100MHz

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Key Stakeholders

Partner	Role
FORD OTOSAN	Truck Manufacturer
imec	C-V2X Technology Developer
TURKCELL TEKNOLOJİ	MNO, Network and Frequency Provider
COSMOTE	MNO, Network and Frequency Provider
INTRASOFT INTERNATIONAL	Technology Integrator & Software Developer
WINGS ICT SOLUTIONS	Software Tools Developer & IoT, AI Expert
ERICSSON GR	5G Technology Provider
ERICSSON TR	5G Technology Provider
ICCS	CCAM / 5G Experts & KPI Evaluation Experts
TÜBİTAK BİLGEM	Research institute
Hellenic Ministry of Infrastructure and Transport (GR)	
Ministry of Digital Policy, Telecommunications and Media (GR)	
Turkish Ministry of Transport and Infrastructure (TR)	

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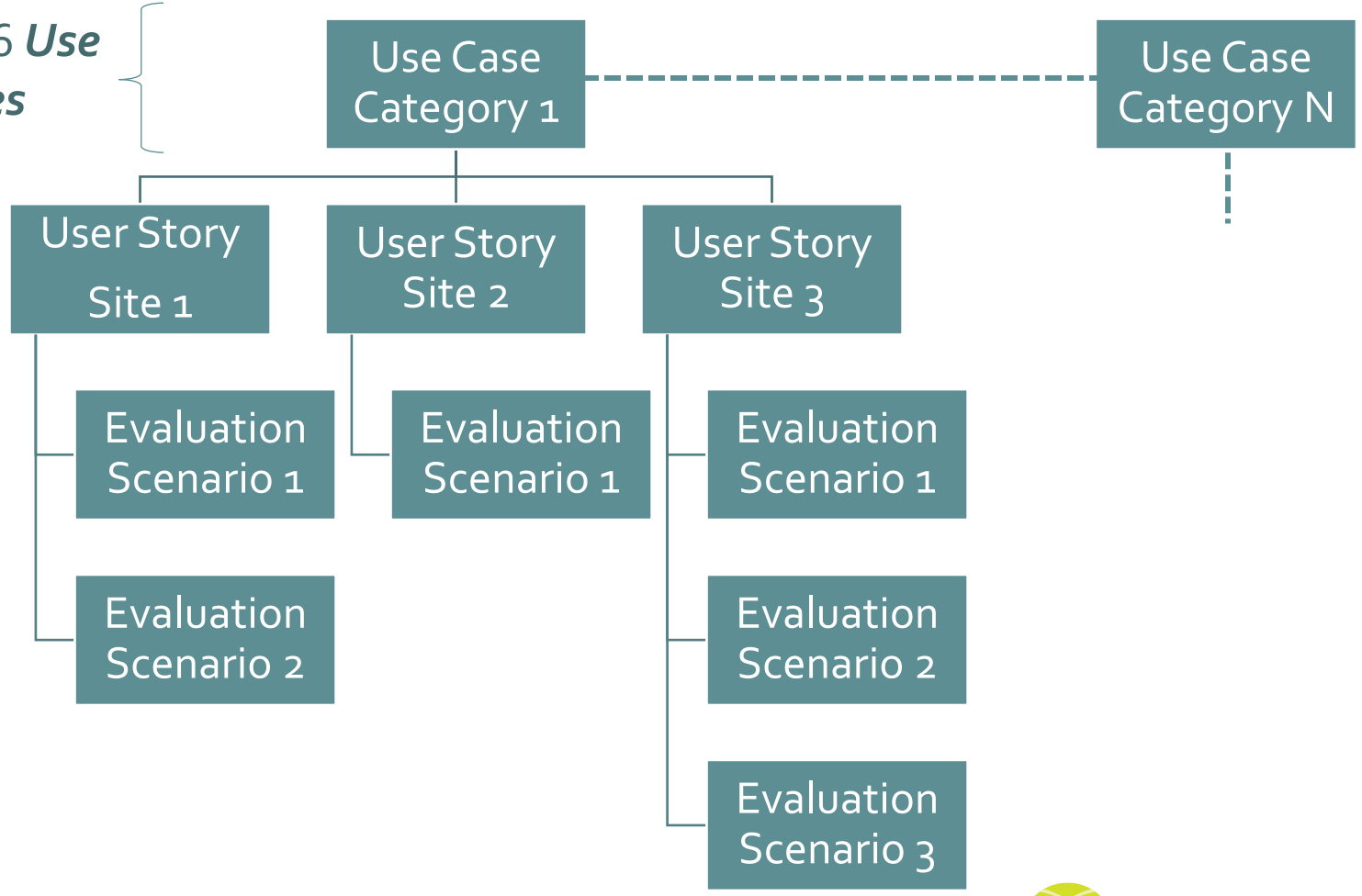
5G-MOBIX Use Cases

5G-MOBIX Use Case Taxonomy

3GPP TS 22.186 ***Use Case Categories***

Each 5G-MOBIX trial site may contribute one ***User Story*** for given ***Use Case Category***

Each ***User Story*** must address at least one cross-border issue and have a corresponding ***evaluation scenario*** for a solution to the issue



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5G-MOBIX UCC/US overview & TS contributions

- Different architecture / technology may be used at different sites evaluating their performance
- Focus on cross-border operation at the two CBC
  - Spain-Portugal (ES-PT)
  - Greece-Turkey (GR-TR)
- Local TS have been selected to ***contribute and enable*** the CBC trials (providing SW, components, alternatives, etc.)
- Extended evaluations requiring controlled environments also performed at the TS

Trial site	Advanced Driving	Vehicles Platooning	Extended Sensors	Remote Driving	Vehicle QoS Support
ES-PT	Complex manoeuvres in cross-border settings			Automated shuttle remote driving across borders	Public transport with HD media services and video surveillance
GR-TR		Platooning with "see what I see" functionality in cross-border settings	Extended sensors for assisted border-crossing		
DE		eRSU-assisted platooning	EDM-enabled extended sensors with surround view generation		
FI			Extended sensors with redundant Edge processing	Remote driving in a redundant network environment	
FR	Infrastructure-assisted advanced driving				QoS adaptation for Security Check in hybrid V2X environment
NL	Cooperative Collision Avoidance		Extended sensors with CPM messages	Remote driving using 5G positioning	
CN	Cloud-assisted advanced driving	Cloud-assisted platooning		Remote driving with data ownership focus	
KR				Remote driving using mmWave communication	Tethering via Vehicle using mmWave communication

CBC: Cross-Border Corridor
TS: (Local) Trial Site

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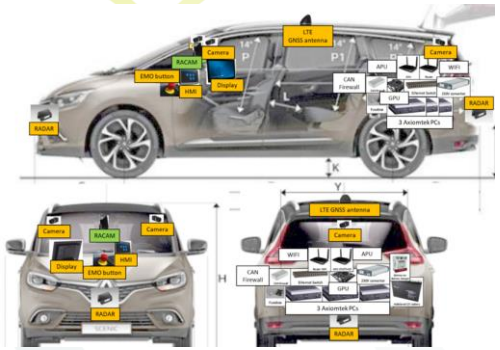
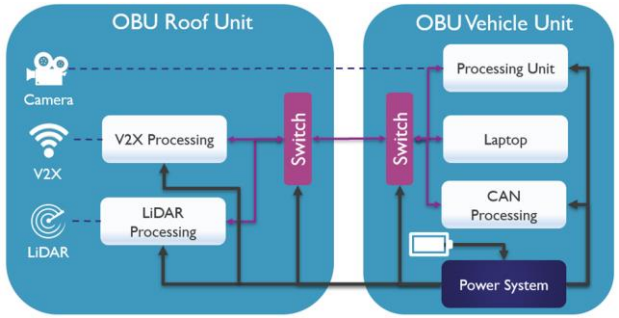
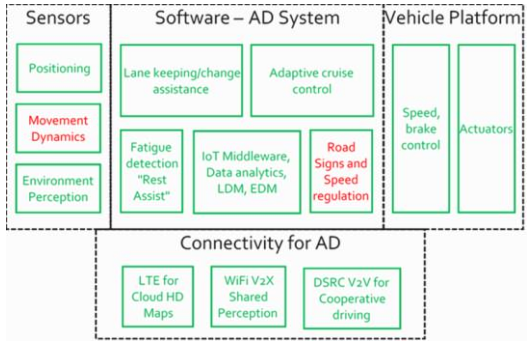
5G-MOBIX Vehicles

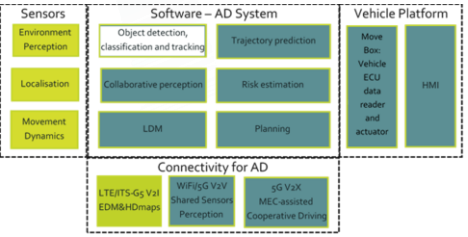
Overview of 5G-MOBIX CBCs / TSs – Vehicles

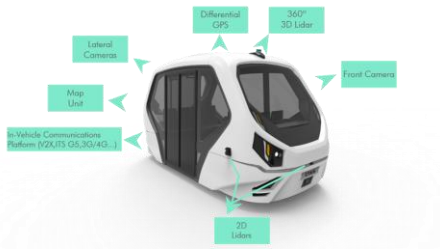


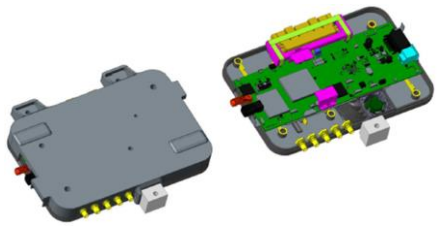


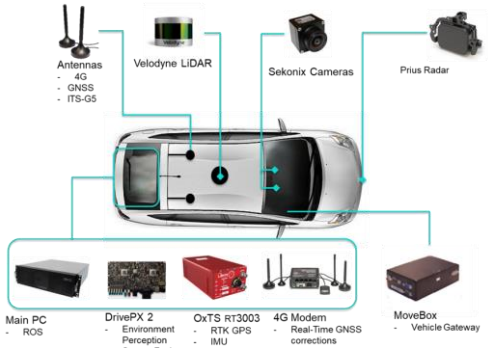


- Large variety of SAE L4 vehicles with a multitude of on-board sensors
- Different functional architecture utilized
- Various OBU versions and functionalities
  - Starting from Rel.14 support and migrating to Rel.15 during the project lifetime
- Supporting different Augmented Automated Driving Functions









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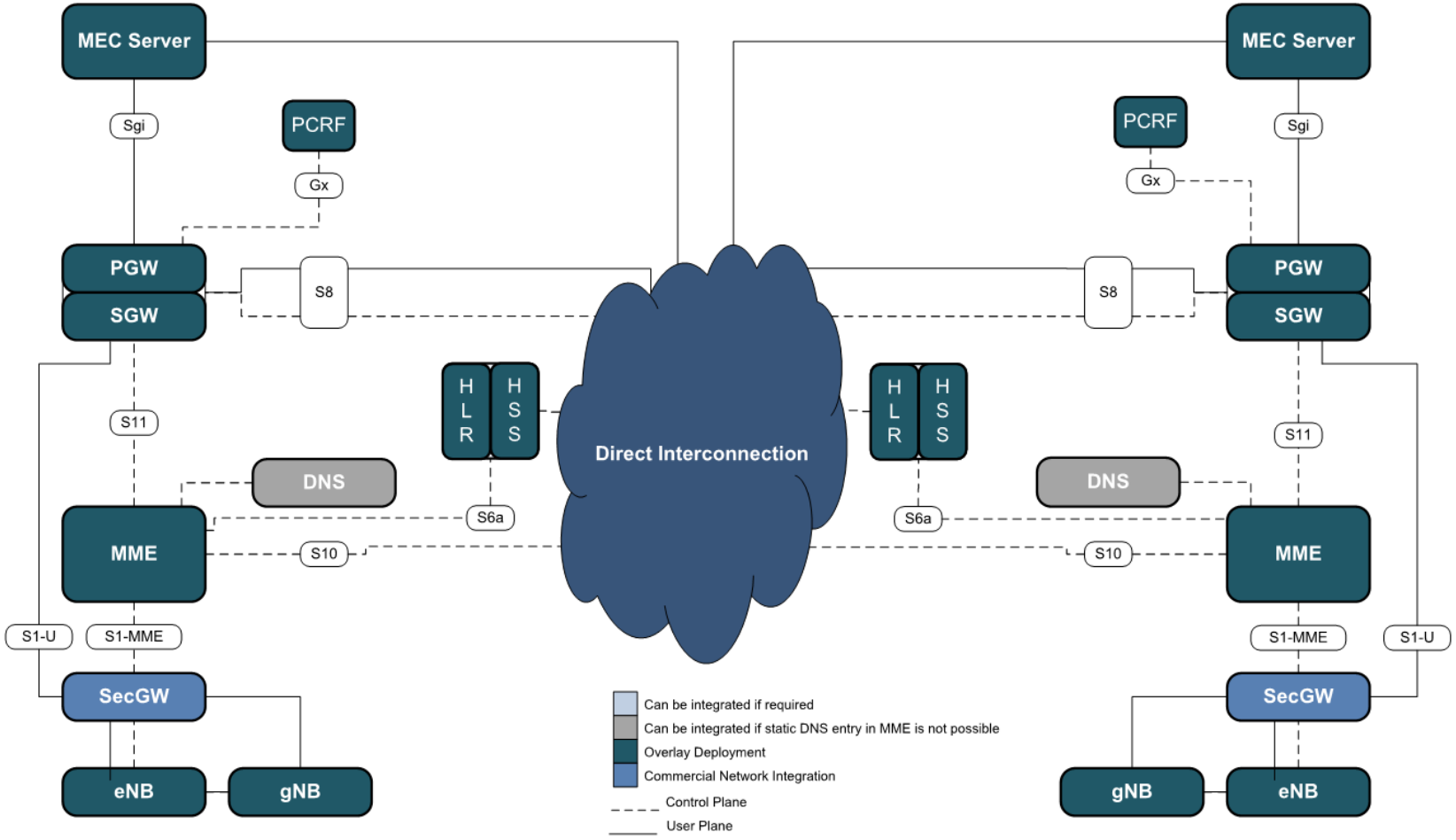
Key Achievements

5G Architecture

Common 5G architecture defined for the CBCs



- Direct interconnection between neighbouring PLMNs
- UP & CP traffic over the direct interconnection
- HR & LBO roaming options available

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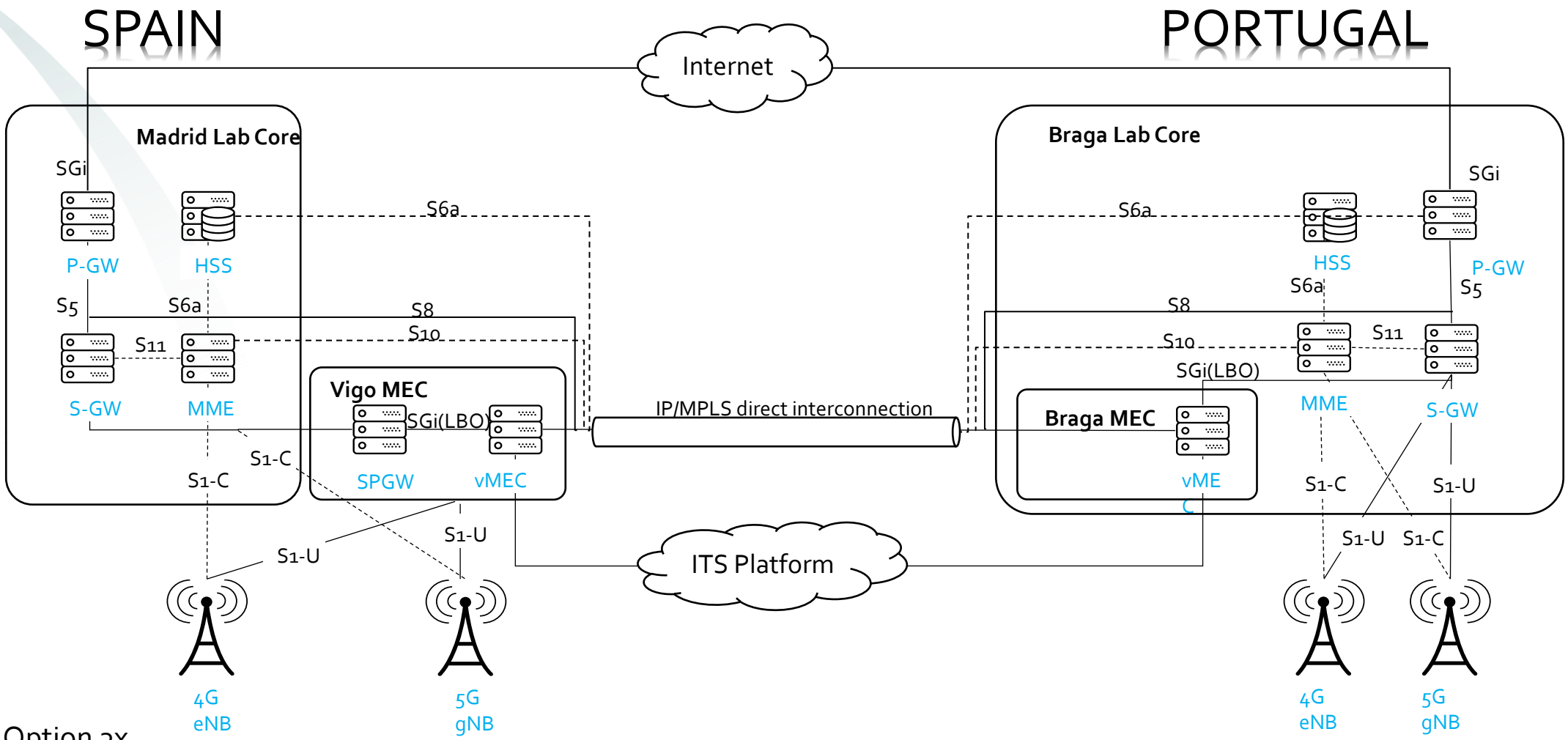
ES-PT 5G Architecture



5G NSA Option 3x
ETSI MEC deployed with distributed SGW with Local Breakout (SGW-LBO)

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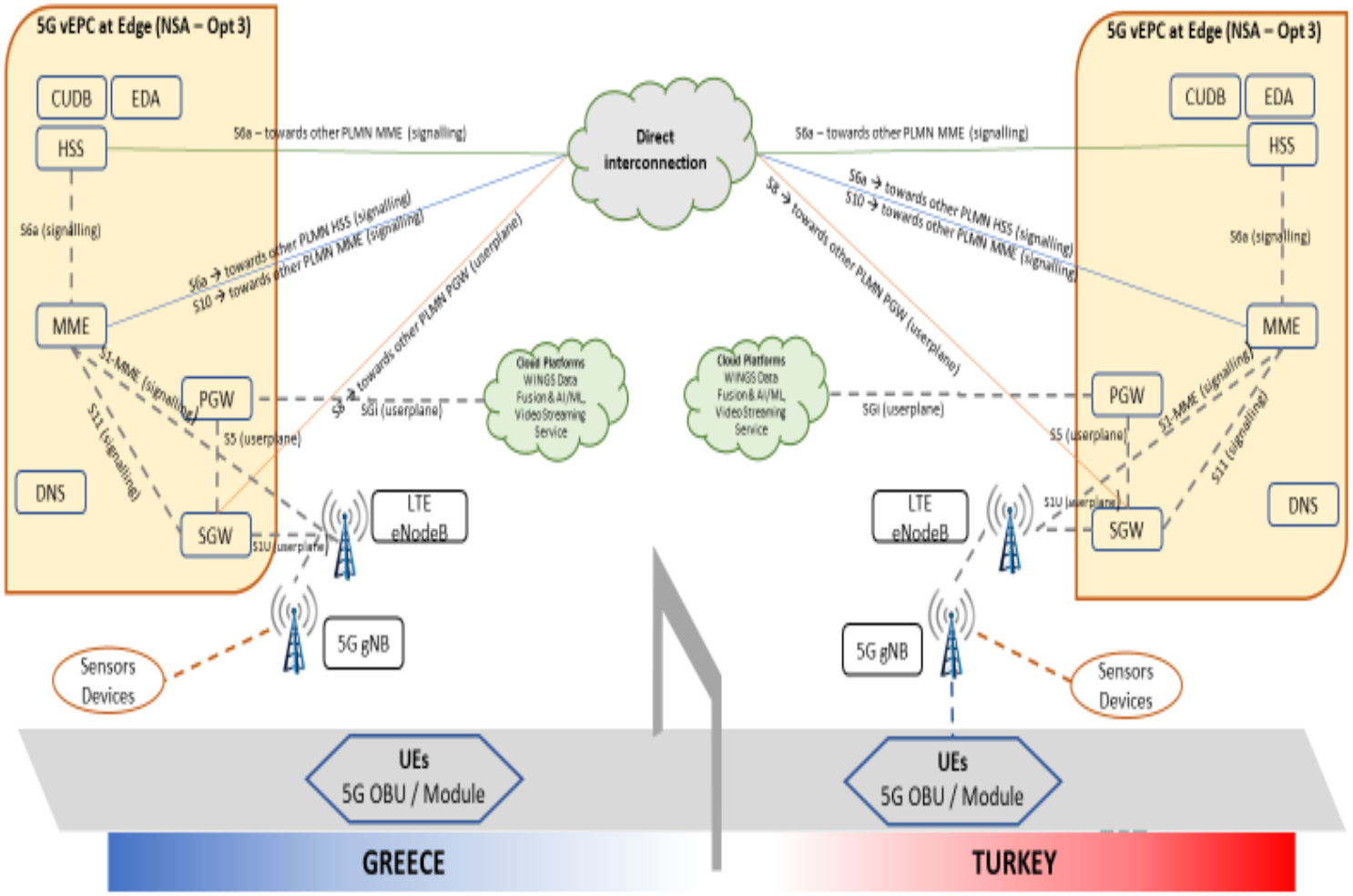
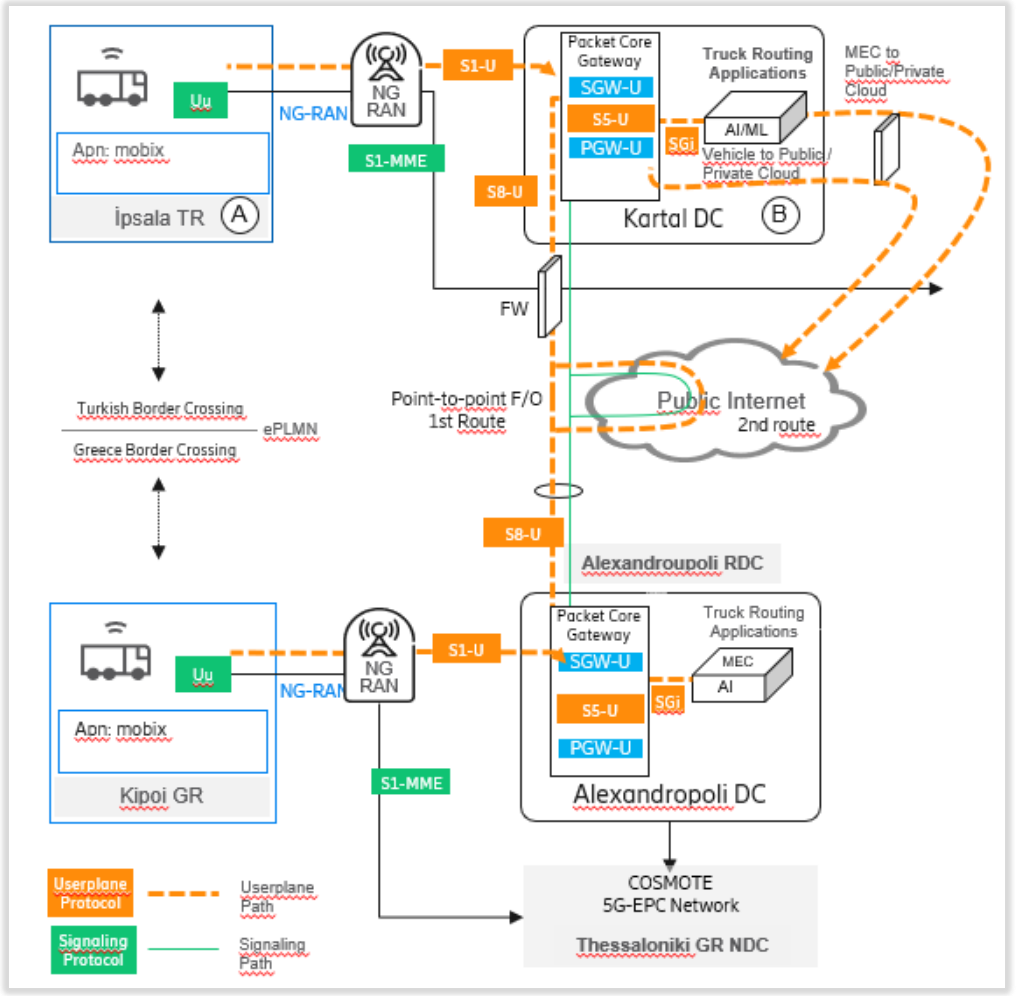
GR-TR 5G Architecture

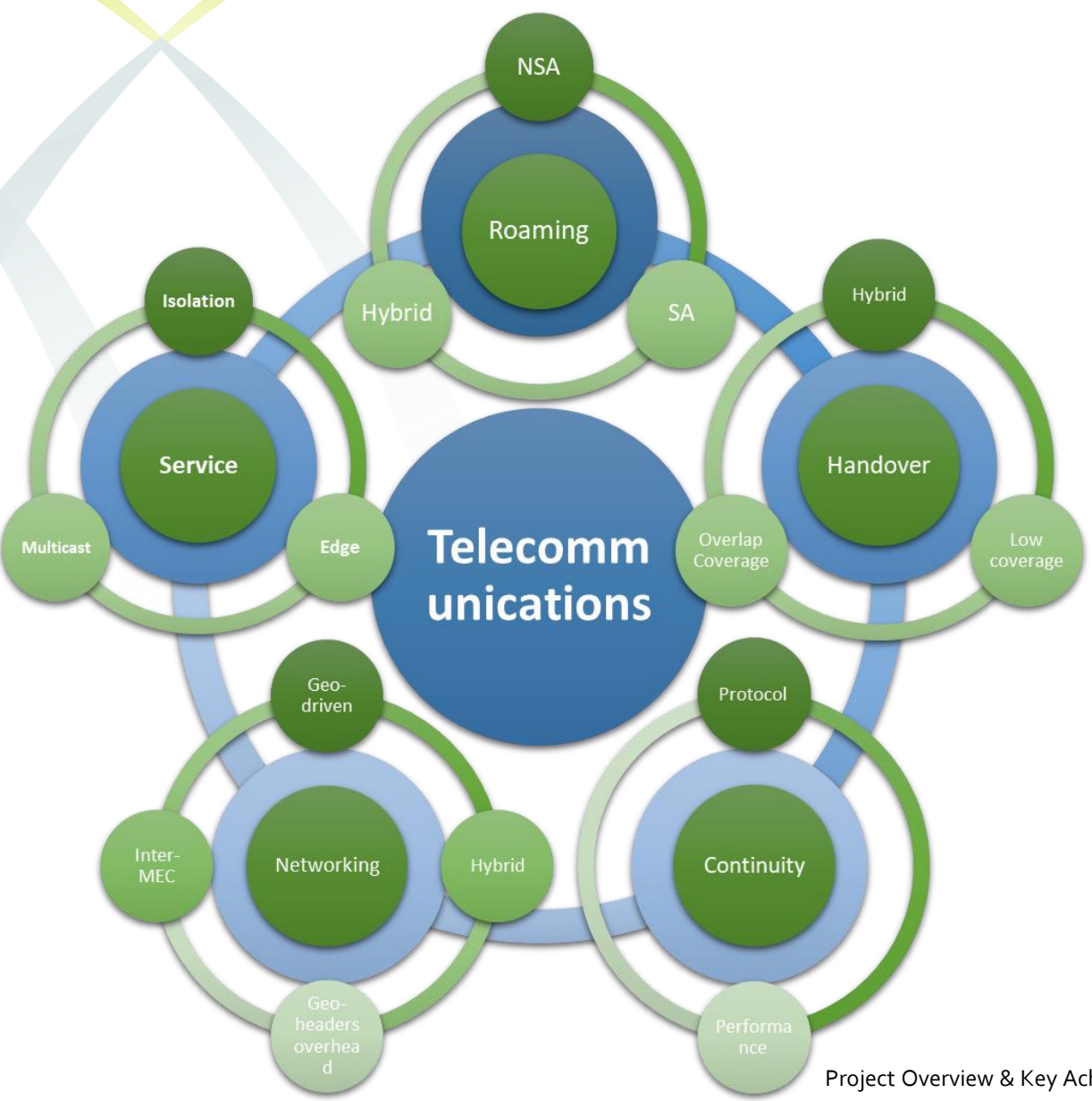


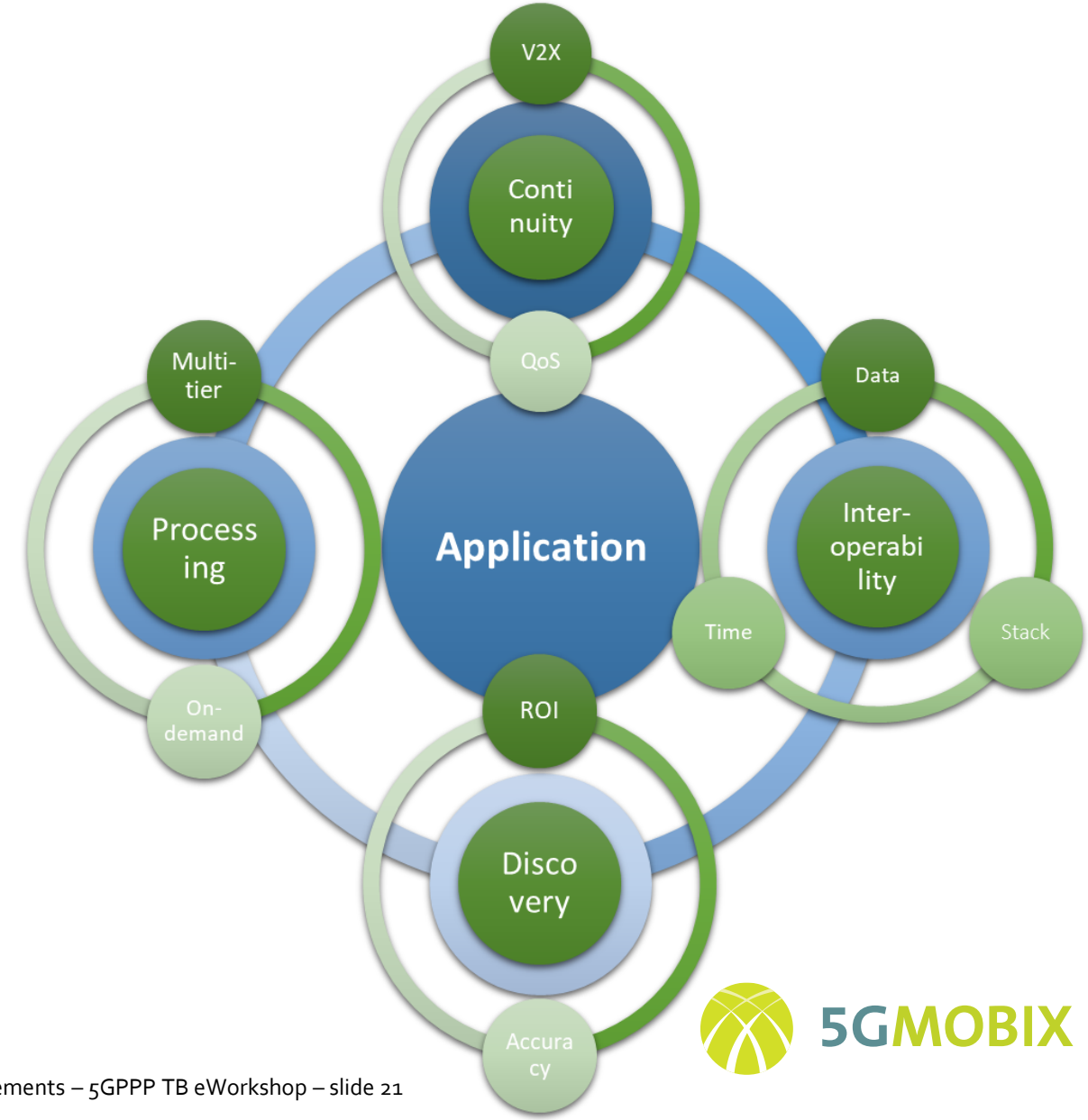


Key Achievements

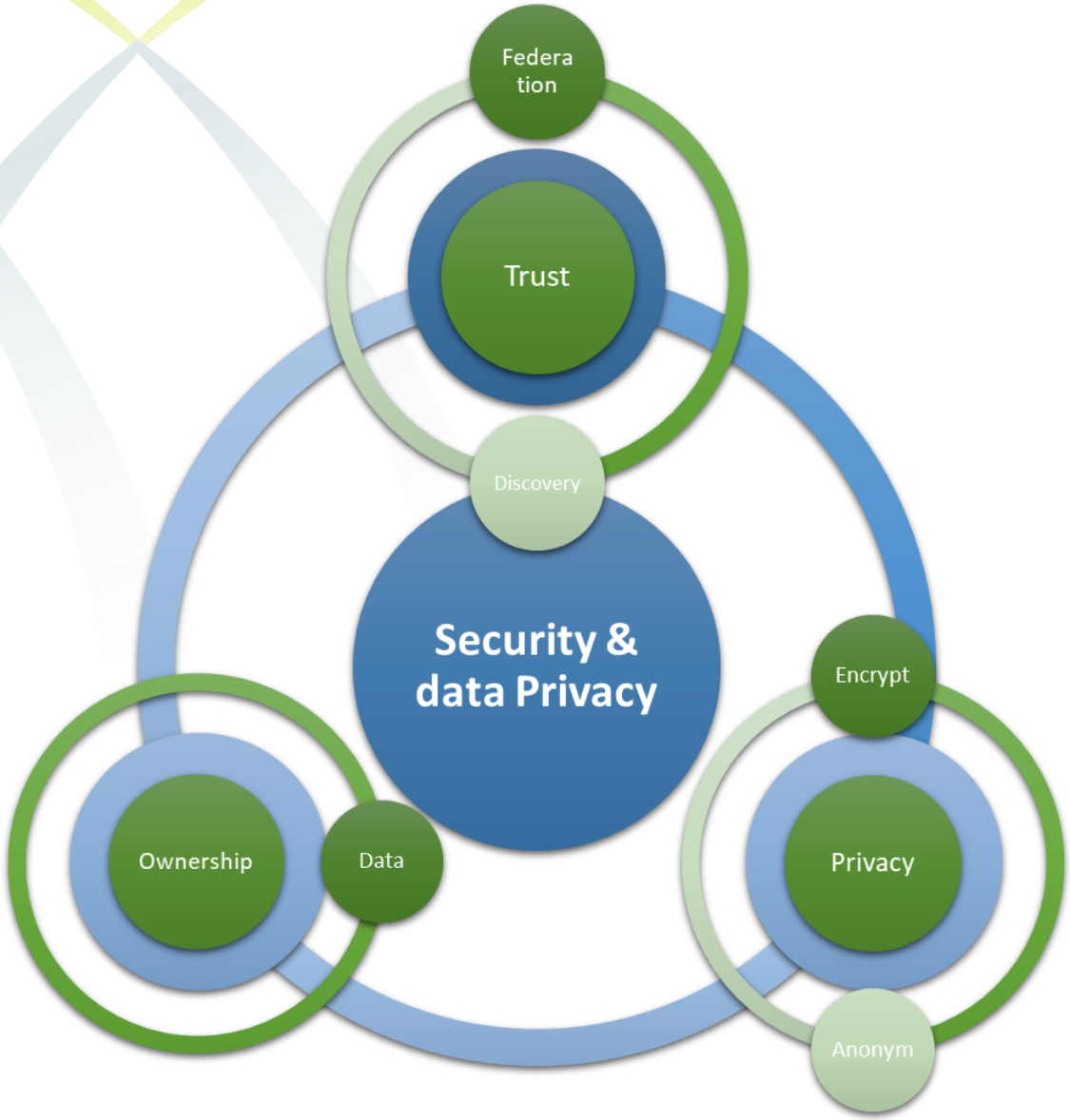
Cross-Border Challenges

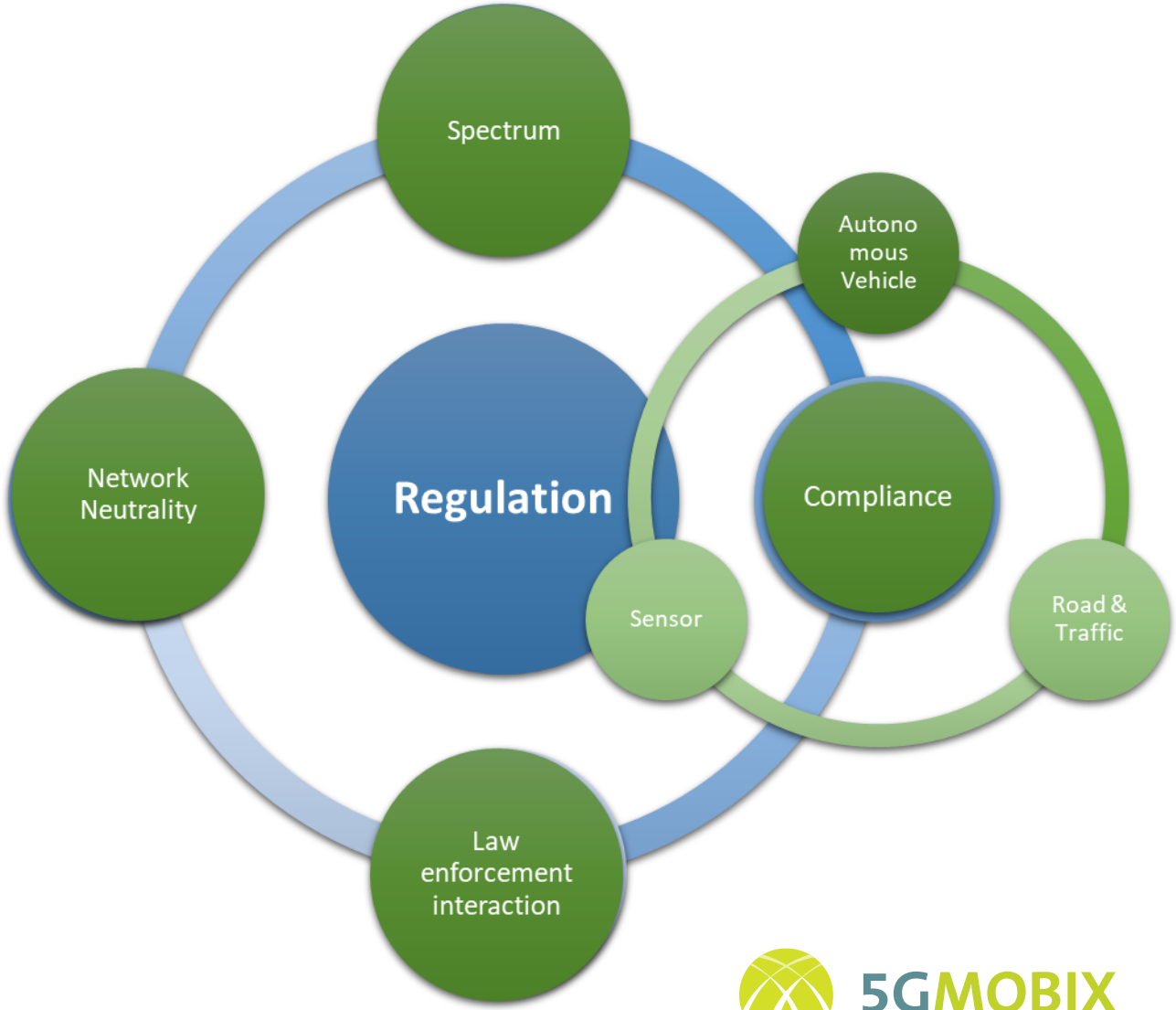
5G-MOBIX Cross-border issues - Overview





5G-MOBIX Cross-border issues – Overview





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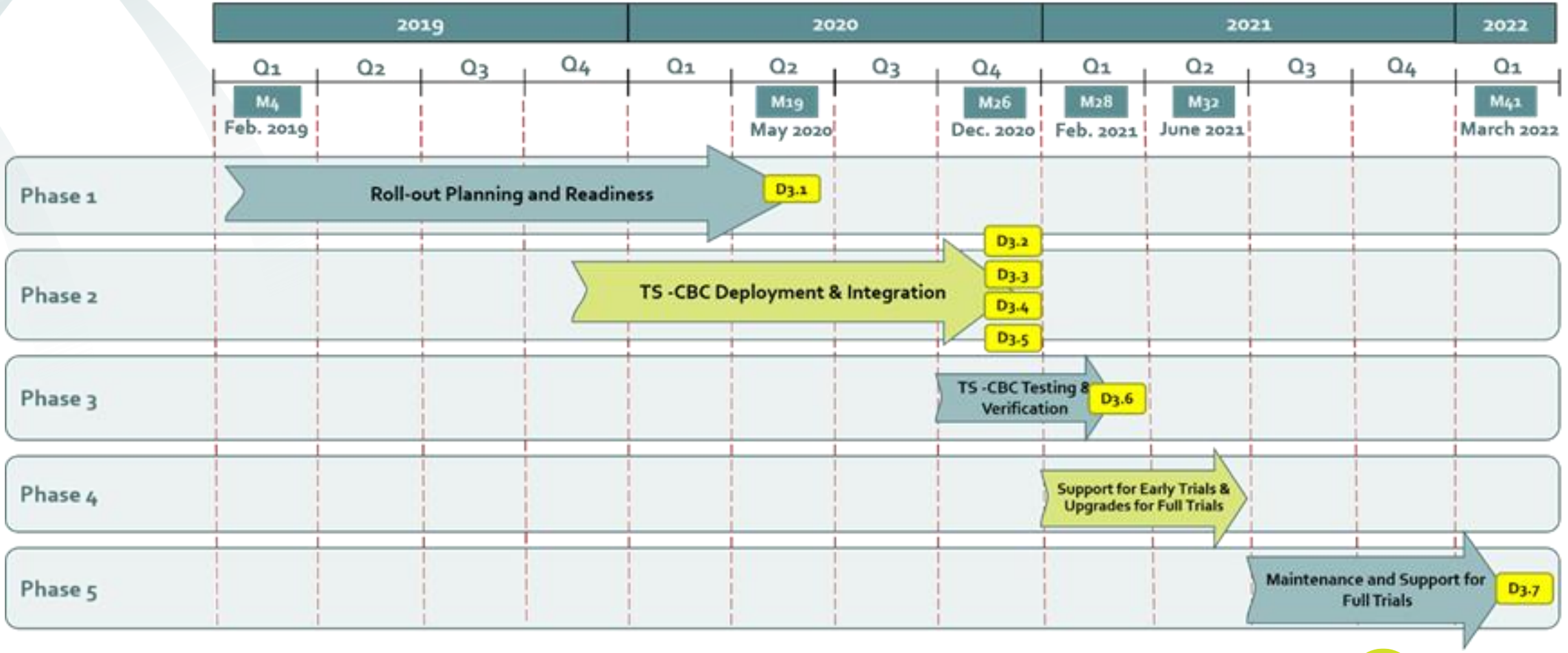
Key Achievements

Deployment & Integration methodology/planning

5-Phase Roll-out plan

- Centralized plan for CBC/TS deployment, integration and verification



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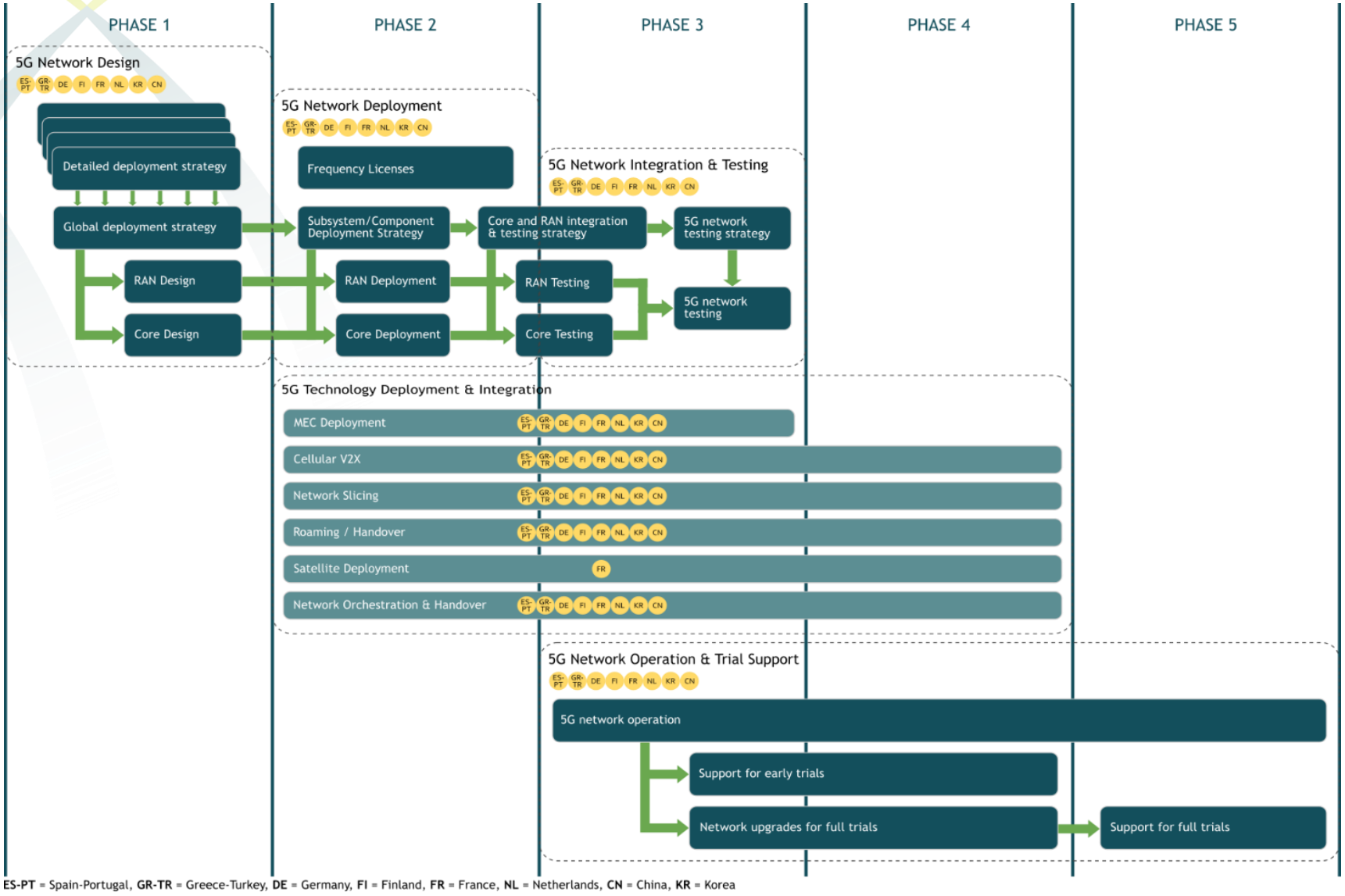
Deployment Methodology



- Individual detailed planning of main tasks following the 5-phase approach, for each major component
  - 5G Network
  - ITS/RSI Infra
  - Vehicles/OBUs
  - Evaluation & Data management infra
  - Integration & Verification
- Individualized actions per CBC/TS
- Common check-points for progress monitoring

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Key Achievements

Evaluation Approach & KPI Definition
(Technical, Business, User Acceptance)

Evaluation Scope and Objectives

Technical evaluation

OBJECTIVE: To comprehensively evaluate the technical performance of technologies and solutions implemented

Impact assessment (QoL/Business impacts – Cost/benefit analysis)

OBJECTIVE: To assess the potential business and societal impacts of the systems and applications demonstrated in the cross-border corridors and trial sites.

User acceptance

OBJECTIVE: To evaluate acceptability and acceptance rates of different kinds of mobility services.

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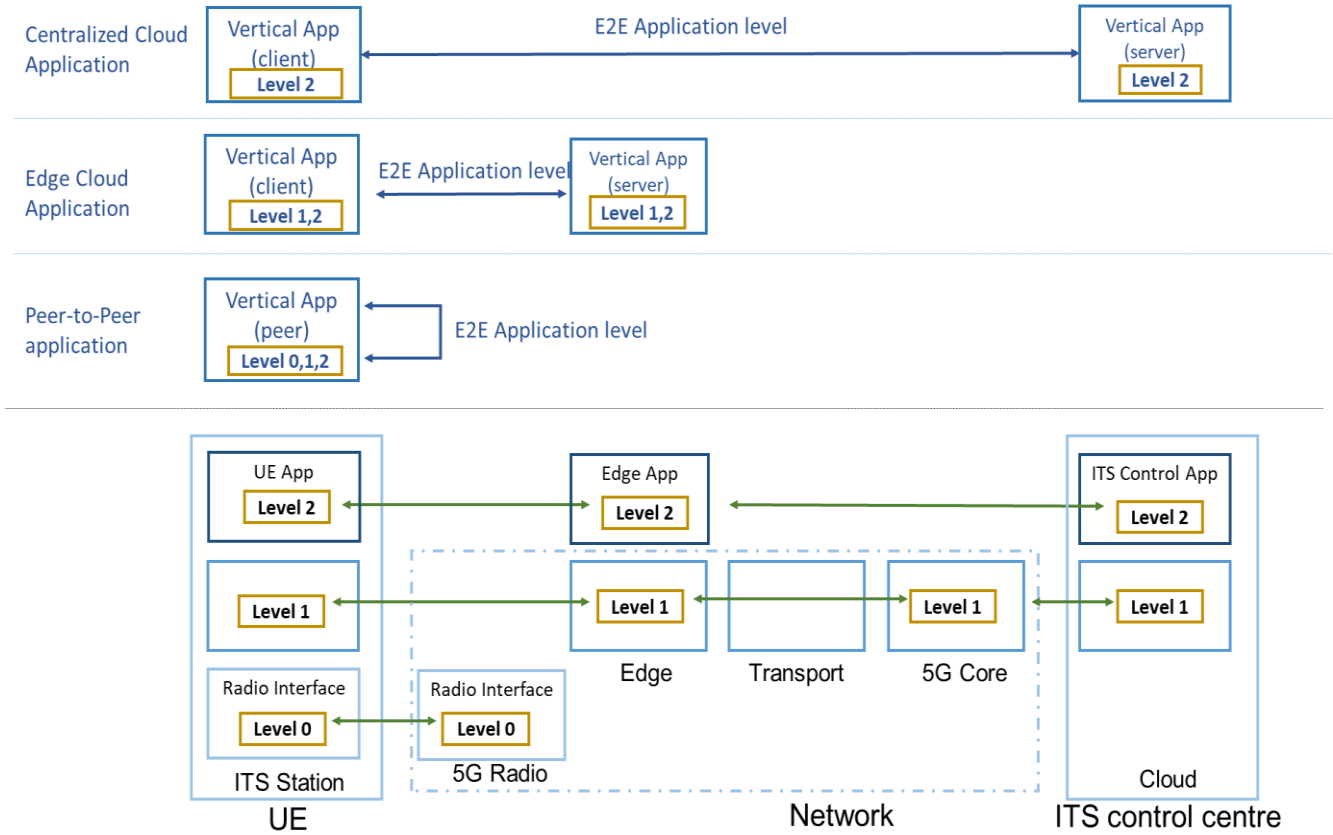
Technical Performance Evaluation

High Level Objectives

- Assess network capabilities – *UCC/US-agnostic*
  - End-to-end / Per network segment
- Assess user perceived performance – *UCC/US-specific*
  - Impact of cross-border mobility on CCAM application-level

Measurements

- Layered
  - Access (e.g., radio parameters)
  - Transport (Network/IP Layer)
  - Application (E2E: *UE-UE*, *UE-Edge*, *UE-Cloud*)
- Per Segment
  - Access – Edge – Transport – Core - Cloud



Data Collection Levels and Network Segments

Technical Performance KPIs

- **General KPIs**
  - *User experienced data rate / Throughput*
  - *End to end Latency*
  - *Control / User plane Latency*
  - *Reliability*
  - *Position Accuracy*
  - *Network Capacity*
  - *Mean Time To Repair*
- **Handover KPIs**
  - *NG-RAN Handover Success Rate*
  - *Application Level Handover Success Rate*
  - *Mobility interruption time*

Taking into account 5G-PPP, 3GPP and 5G-AA KPI frameworks…

	User Story	TE-KPI1.1 User experienced data rate (UL / DL)	TE-KPI1.3 E2E Latency	TE-KPI1.6 Reliability	TE-KPI1.7 Position Accuracy	TE-KPI2.3 Mobility Interruption Time	TE-KPI2.2 Application Level Handover Success Rate?
UCC-1 : Advanced Driving	Complex manoeuvres in cross-border settings	0.2 / 0.2 Mbps	200 ms	99,9%	1 - 5 m	< 10 s	99-100%
	Infrastructure-assisted advanced driving	100 / 50 Mbps	5 - 20 ms	100.00%	0.1 m	< 5 s	N/A
	Cooperative Collision Avoidance	1 /1 Mbps (10-20 Mbps for high resolution raw data DL)	< 10 ms	90-99.99%	0.2 m	< 1s	99-100%
	Cloud-assisted advanced driving	100 / 100 Mbps	20 - 50 ms	90-99.99%	0.2 m	< 10 s	N/A
UCC-2 : Vehicles Platooning	Platooning with "see what I see" functionality in cross-border settings	100 / 50 Mbps	20 ms	99% – 99.999%	0.5 m	< 40 ms	99-100%
	eRSU-assisted platooning	200 / 100 Mbps	40 ms	100.00%	0.2 m	40 ms	N/A
	Cloud assisted platooning	100 / 100 Mbps	20 - 50 ms	90-99.99%	0.2 m	< 10 s	N/A
UCC-3 : Extended Sensors	Extended sensors for assisted border crossing	100 / 200 Mbps	20 - 50 ms	100.00%	0.2 m	50 ms	N/A
	EDM-enabled extended sensors with surround view generation	200 / 100 Mbps	40 ms	100.00%	0.2 m	40 ms	99-100%
	Extended sensors with redundant Edge processing	15 / 15 Mbps	100 ms	99.99%	N/A	10 - 80 ms	99-100%
	Extended sensors with CPM messages	10 / 10 - 20 / 20 Mbps	< 20 ms	90-99.99%	N/A	100 ms	99-100%
UCC-4 : Remote	Automated shuttle remote driving across borders	10 / 1 Mbps	100 - 200 ms	99,9%	1-5 m	< 10 s	N/A

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Impact assessment & User Acceptance metrics

Business

- Customer need
- Costs
- Revenues
- Progress towards commercial deployment

Quality of Life

- Personal mobility
- Traffic efficiency
- Traffic safety
- Environment

User Acceptance

- General Technology Acceptability
  - *Acceptance Intention (statement of interest), Perceived Technology Usefulness, Perceived Technology Ease-of-use, Affinity for Technology Interaction, Acceptability difference between prior and post-contact with technology*
- Trust on the system
- Systems usability
- Error tolerance

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5G-MOBIX Roadmap

Impact on 5G-MOBIX Roadmap

- COVID-19 measures have impacted the project timeline in several ways
  - 5G-chipset delivery
  - 5G-network equipment delivery
  - Ability to work "in the field" for deployment tasks
  - Ability to work in factories/labs for vehicle, RSU, OBU development
  - Ability to perform site visits for measurements, assessments and design
- Additional challenges
  - Change of Project Coordinator
  - Turmoil at GR-TR borders (fugitive crisis)
- A project extension of 9 months has been requested

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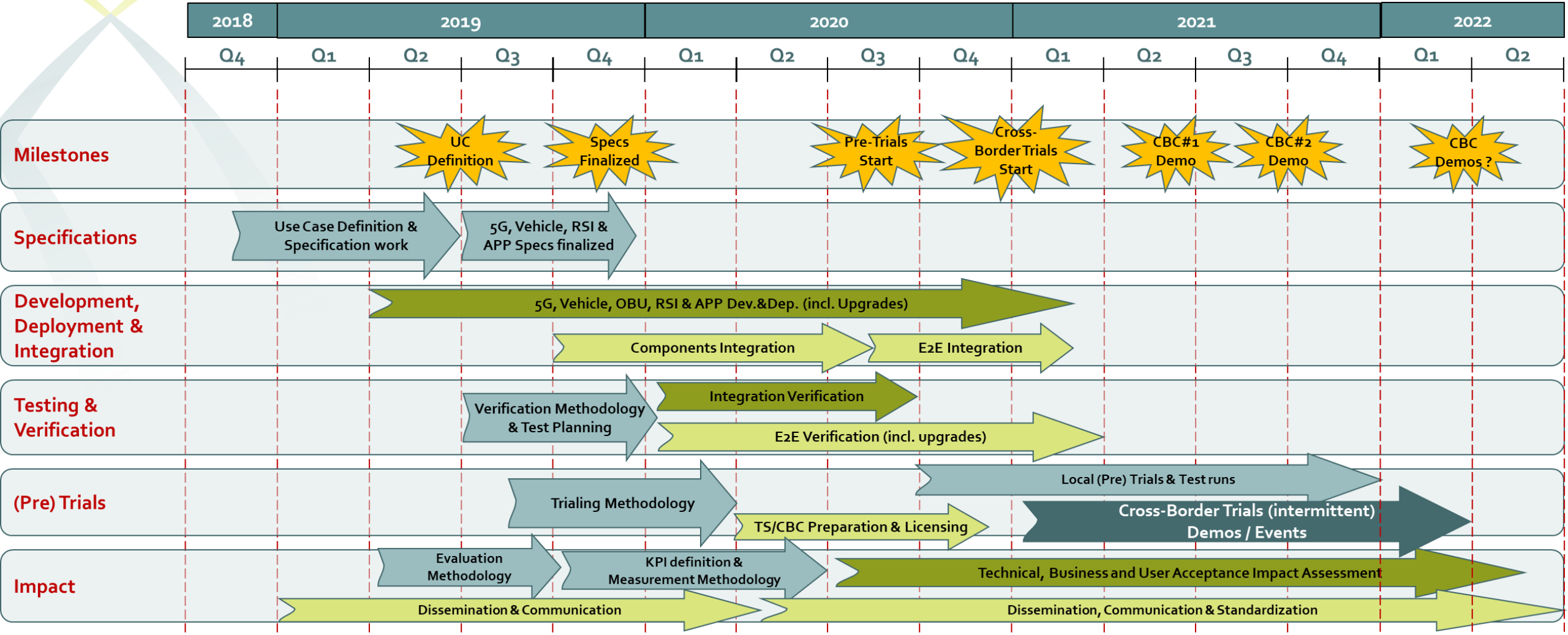
5G-MOBIX updated Roadmap



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Thank you

Questions?

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