5G for cooperative & connected automated MOBIility on X-border corridors

5GTNF Results and Demo Seminar

Edward Mutafungwa, Aalto University

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5GMOBIX

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

Background and motivation of 5G-MOBIX

Higher Levels of Vehicle Automation with 5G

SAE automation levels

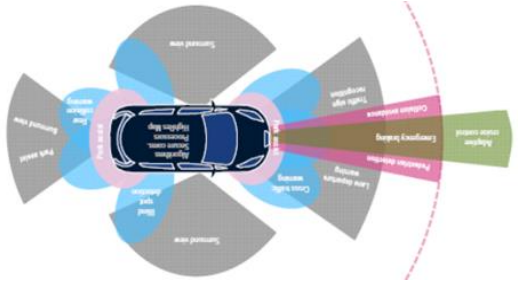
ADAS+ - **Partial automation**
Driver supervises the ADS

Conditinal automation
Driver "out of the loop" but need to take control on request by the ADS

High/Full automation
Driver out of the loop & no need to take control – can be driverless

L2 → L3 → L4/L5

In-vehicle sensors and ADS



Higher environment perception using connected sensors and computing outside the vehicle

Qualcomm

eMTC uRLLC eMBB

ADS: Automated Driving System
SAE: Society of Automotive Engineers

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5G-MOBIX Background

European Commission | **5G Cross-border Corridors for Connected and Automated Mobility**

- A 3-year project (11/2018-10/2021) funded within H2020 framework (ICT-18 call)
- 5G-MOBIX evaluates **automotive use cases** leveraging **5G technologies** with a **specific focus on cross-border areas**
- **Cross-border environment** presents a **number of challenging issues** for 5G use cases with L4/L5 vehicles
  - Run cross-border experimental trials to test and validate potential solutions

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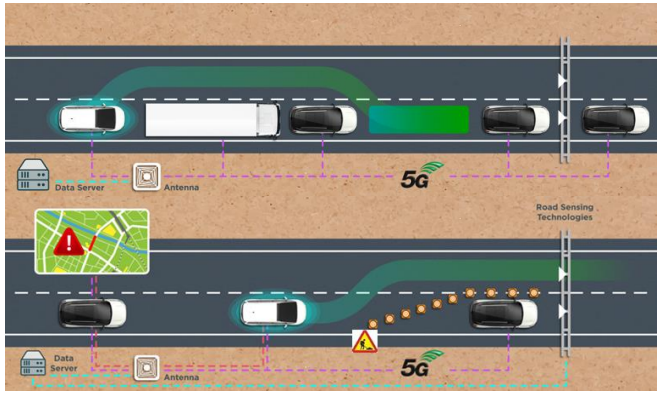
5G-MOBIX – Two cross-border corridors (CBCs)

Spain - Portugal

Use cases

- Private Automated vehicles (SC1: Lane merge, SC2: Automated overtaking, SC3: HD MAPS)
- Public transport
- EV automated shuttle vehicles (SC1: Automated operation. SC2: Remote control.)

Porto – Vigo is a Pan-European X-Border 5G corridor for Connected and Automated Mobility

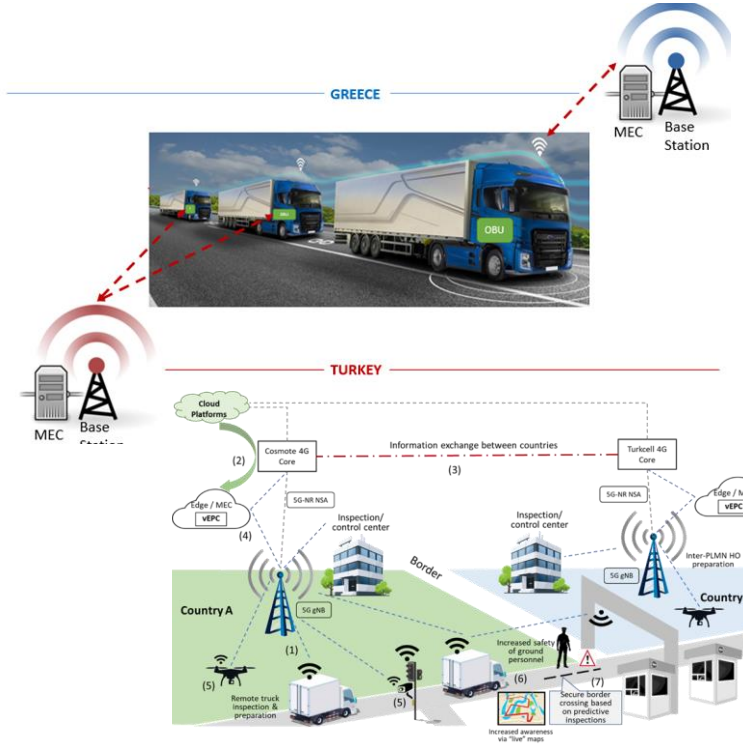


Greece - Turkey

Use cases

- Truck Platooning with "see what I see"
- Assisted Truck border crossing

Kipoi – Ipsala site is a main entry point into EU territory for cargo, with heavy customs operations



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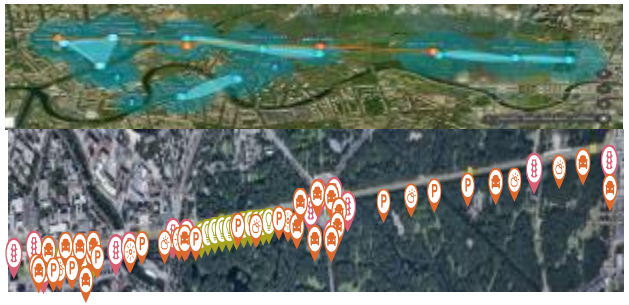
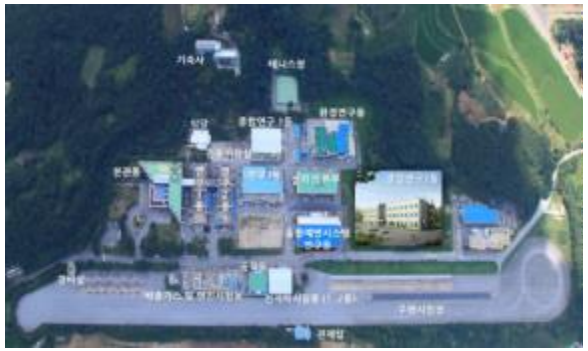
5G-MOBIX – Six Local Trial Sites (TS)





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55 partners from 10 countries

5G-MOBIX use cases and addressed cross-border issues categorisation

5G-MOBIX Use Case Categorisation

- Use case categorisation essential in 5G-MOBIX to **enhance synergy between CBCs and TSs** experimenting on common automotive use cases

5G-MOBIX Use Case Categories	Brief description
Advanced driving	Vehicles (and/or RSU) in proximity **share driving intentions and local sensor data obtained,** thus allowing **vehicles to coordinate their trajectories or maneuvers**.
Vehicles platooning	Enables the vehicles to **dynamically form a group** travelling together.
Extended sensors	**Exchange of raw or processed data gathered through local sensors or live video data** among vehicles, RSUs, devices of pedestrians and V2X application servers.
Remote driving	A **human driver or a V2X application is able to remotely operate** an autonomous vehicle.
Vehicle QoS Support	A **V2X application is timely notified of expected or estimated change of QoS** before actual change occurs and/or mobile network able to **modify the QoS in line with V2X application's QoS needs**.

3GPP TS 22.186 (2018-12). Enhancement of 3GPP support for V2X scenarios; Stage 1

QoS: Quality of Service
RSU: Roadside Unit
V2X: Vehicle to Everything

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5G-MOBIX work on Cross-border issues

- Cross-border operation is the focus of 5G-MOBIX
- Addressed cross-border issues in four main categories
  - Telecommunication Issues
  - Application issues
  - Security and data privacy issues
  - Regulatory issues
- Distinct solutions to be applied and tested at the different cross-border corridors (CBCs) and local trial sites (TSs)

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5G-MOBIX CBCs / TSs – Linking User Stories

- Focus on cross-border operation at the two CBC
  - Spain-Portugal (ES-PT)
  - Greece-Turkey (GR-TR)
- Local TS (e.g. FI) have been selected to ***contribute and enable*** the CBC trials (providing SW, components, alternatives, etc.)
- Extended evaluations requiring more 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		Extended sensors enabling complex manoeuvres	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 over mmW	Tethering via Vehicle over mmW

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

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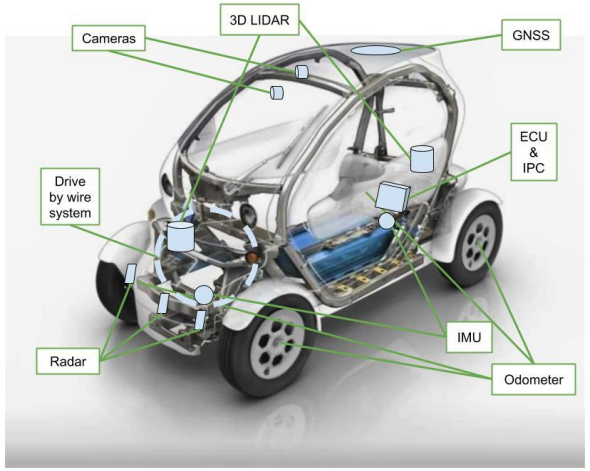
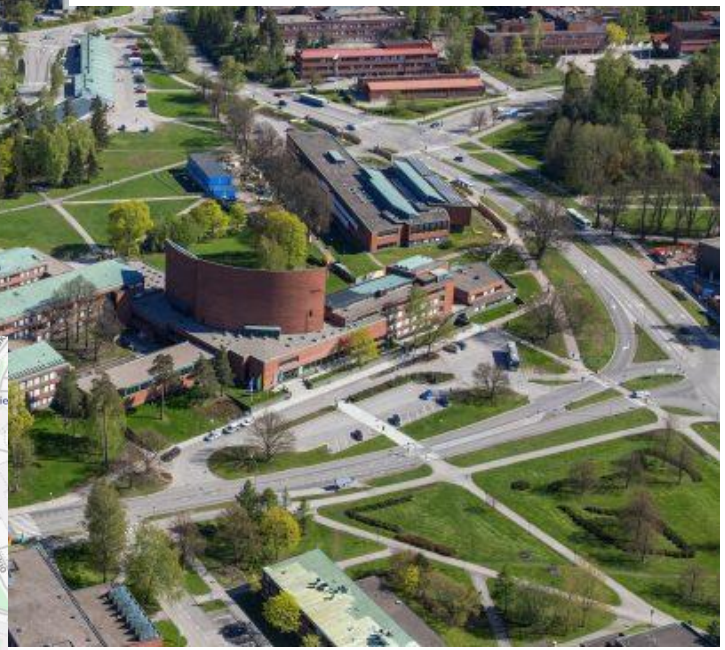
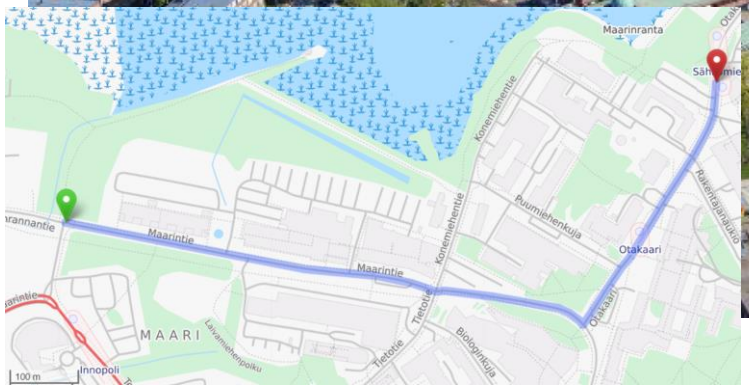
More details on FI trial site

Location & key stakeholders

- Espoo Otaniemi
- Local 4G/5G test network
- 1.2 km of road (Otakaari & Maarintie)







Key Role	Partner	Contribution
SITE LEADER	A?	Local test environment
OEM	sensible4	L4 vehicles
Automotive vendor	INSTITUT VEDECOM	5G OBUs

Other Stakeholders		Contribution
MNO (1)	Telia	Operator perspectives
Road authority (2)	TRAFICOM	Road and frequency regulator Perspectives from Nordic Way and Aurora corridors

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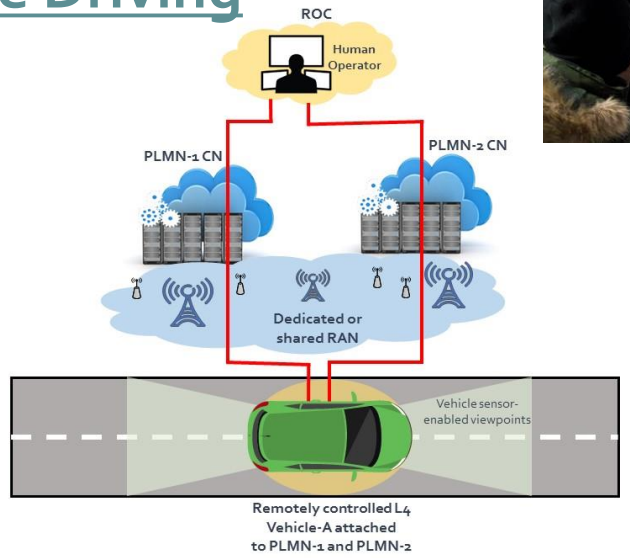
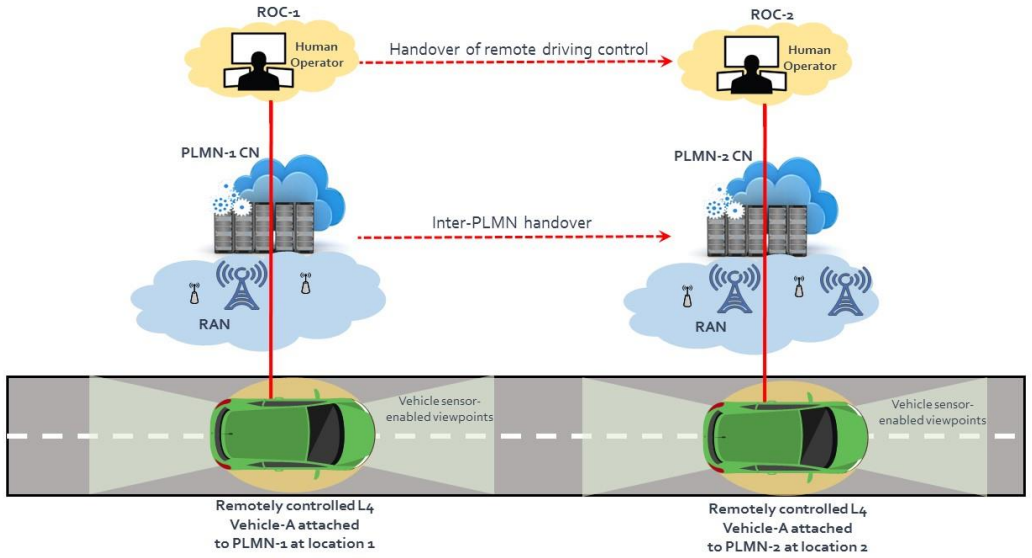
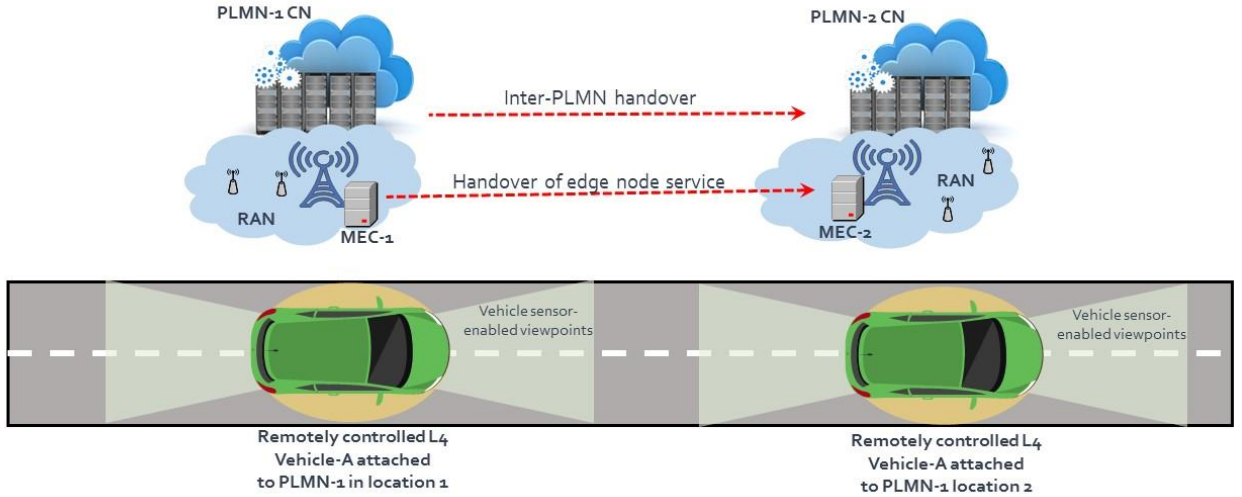
FI Trial Site User Stories (Use Cases)

Remote Driving





Extended sensors



ROC: Remote Operations Centre

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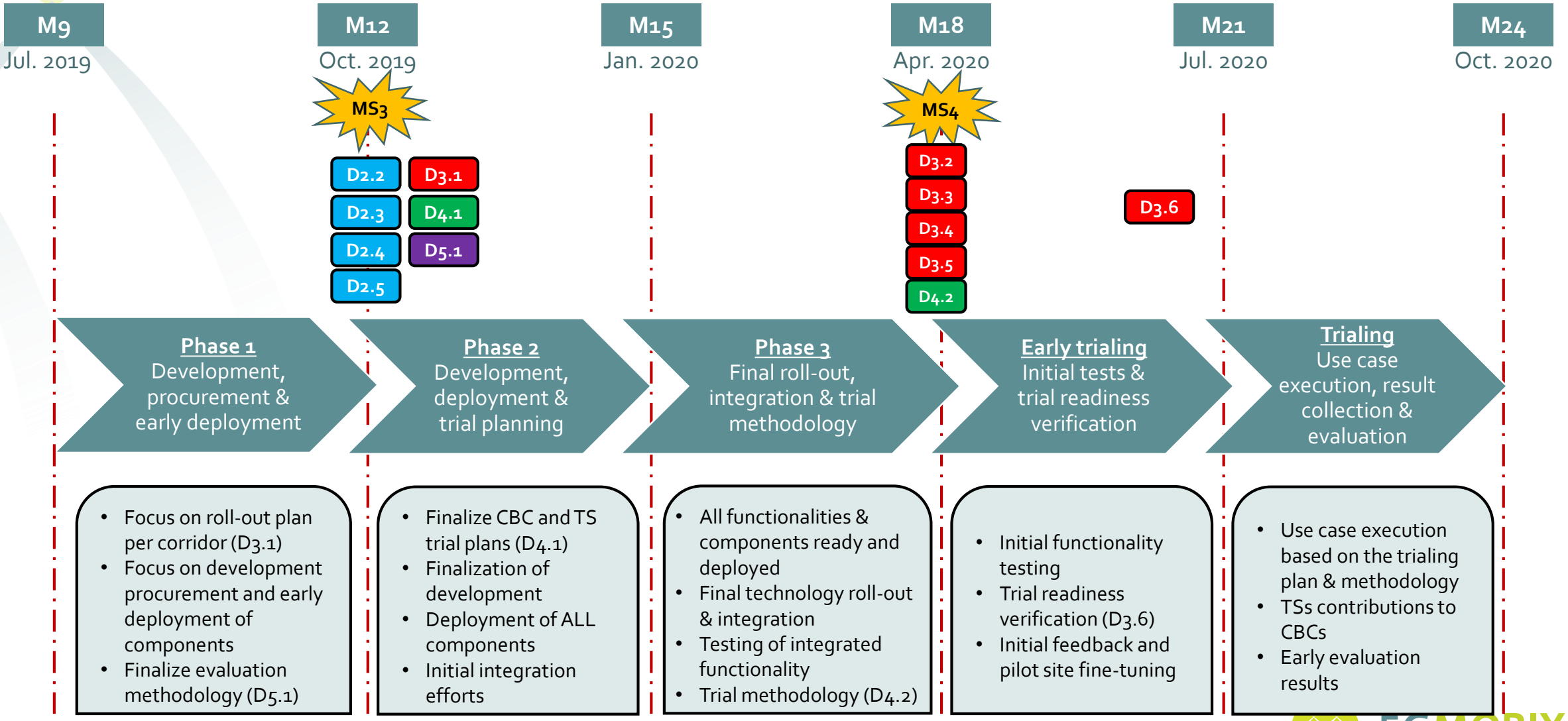
5G-MOBIX Technical Roadmap until M24

Trials from Q2 or Q3 2020 (also in FI site)



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For Further Info

- Welcome to our small stand at this event

- Or contact by email:
  - Edward Mutafungwa edward.Mutafungwa@aalto.fi
  - Giancarlo Pastor Figueroa giancarlo.pastor@aalto.fi

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Thank you

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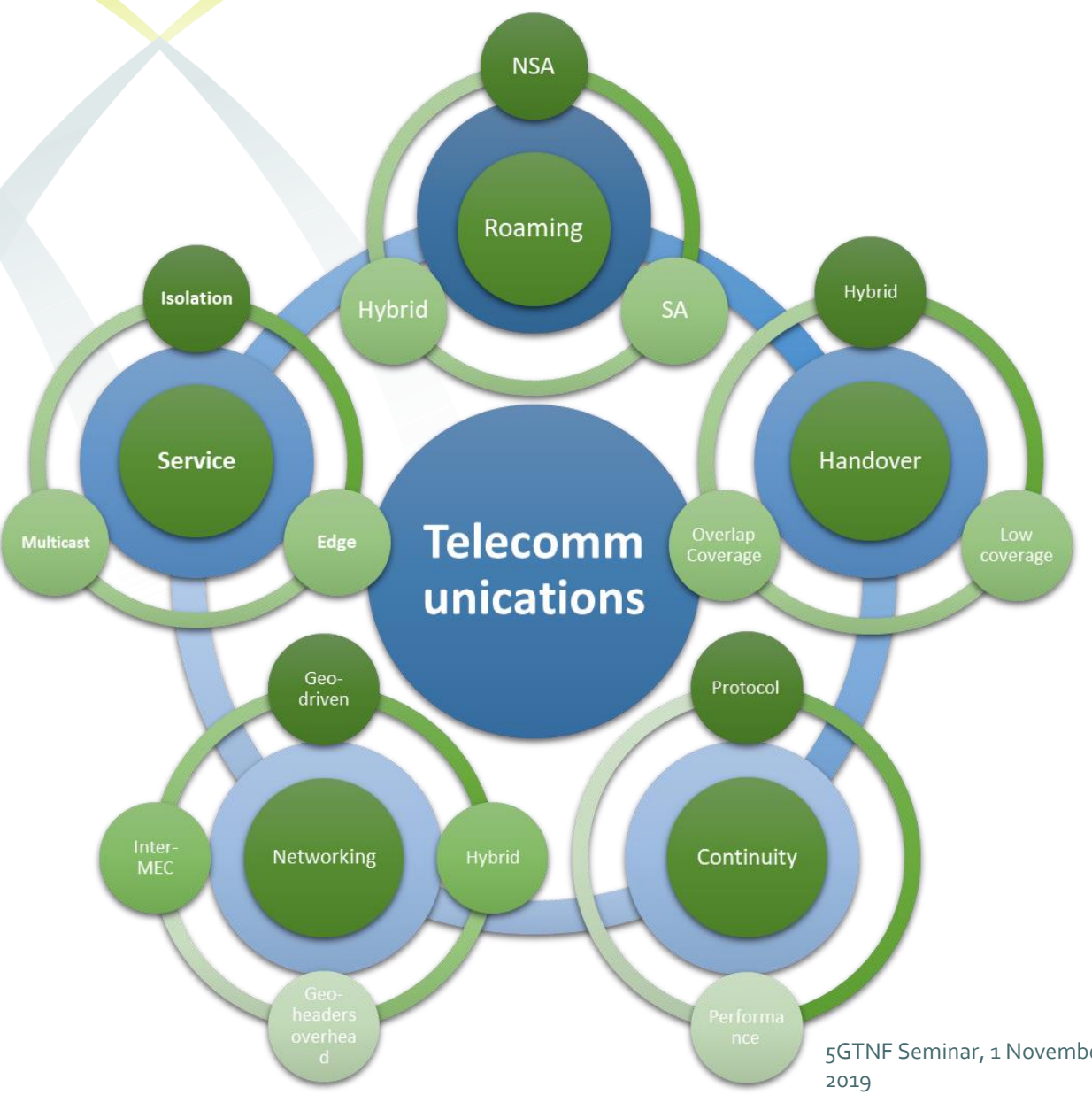
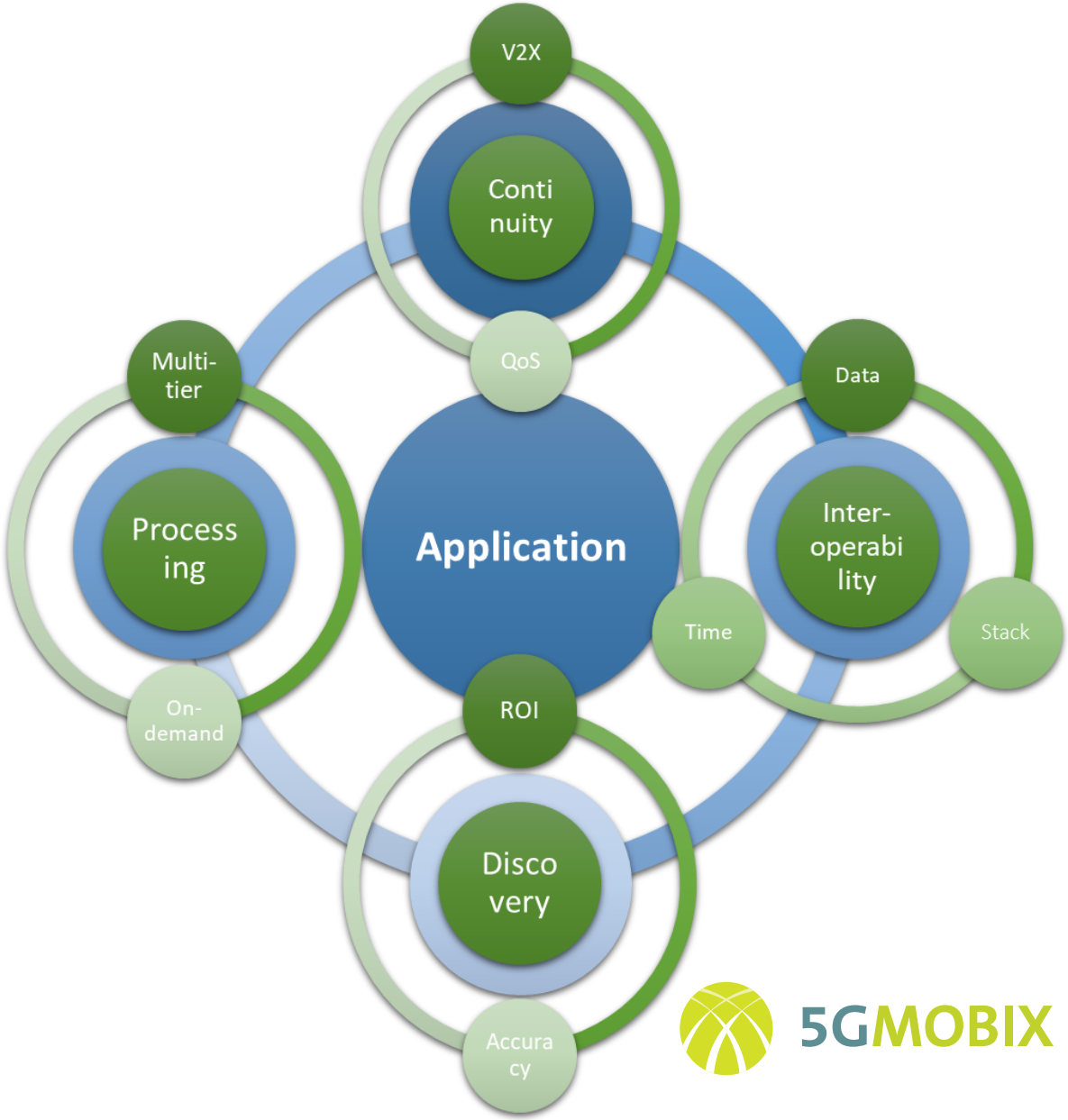
www.5g-mobix.com

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

5G-MOBIX Cross-border issues - Overview





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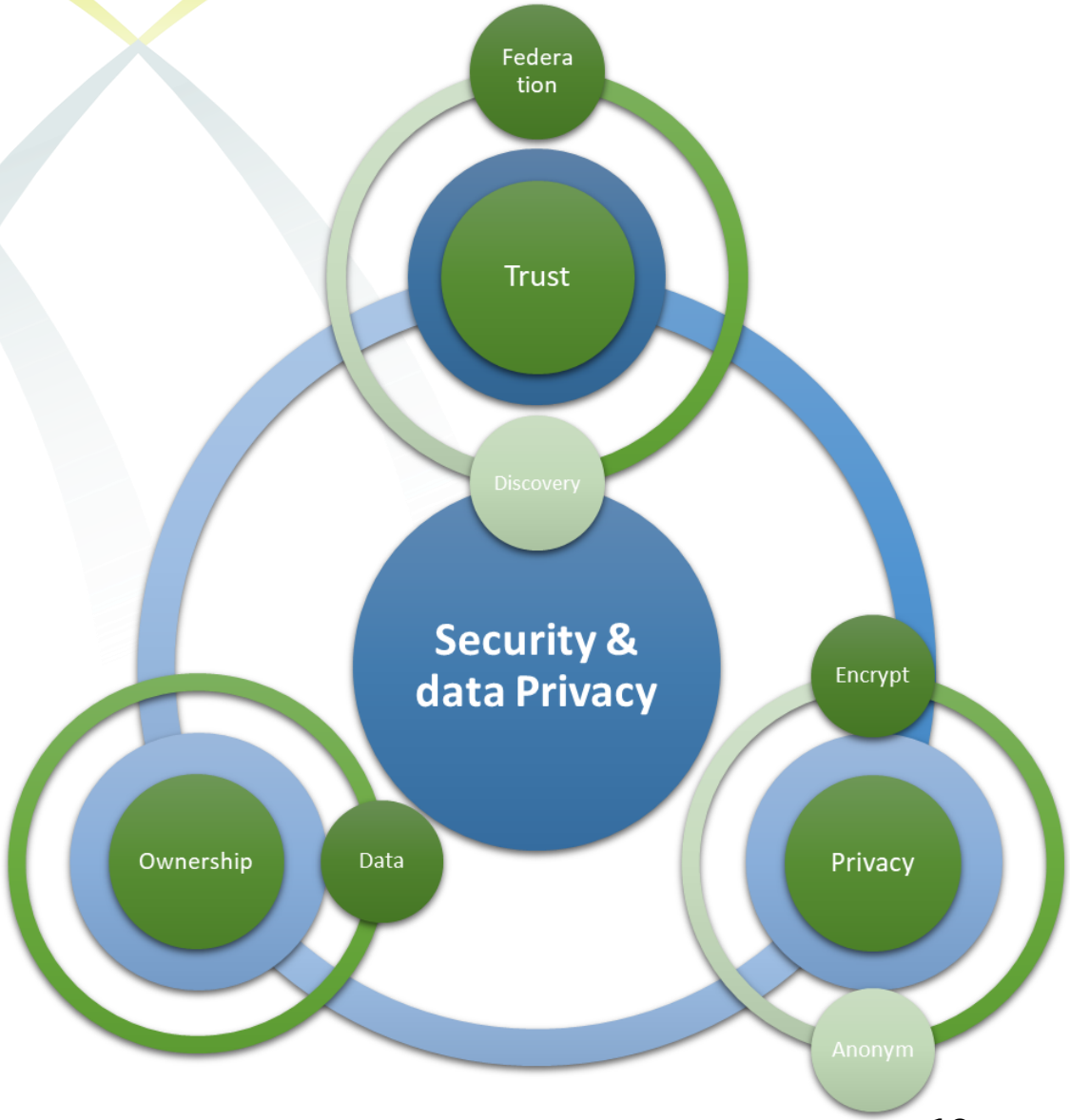
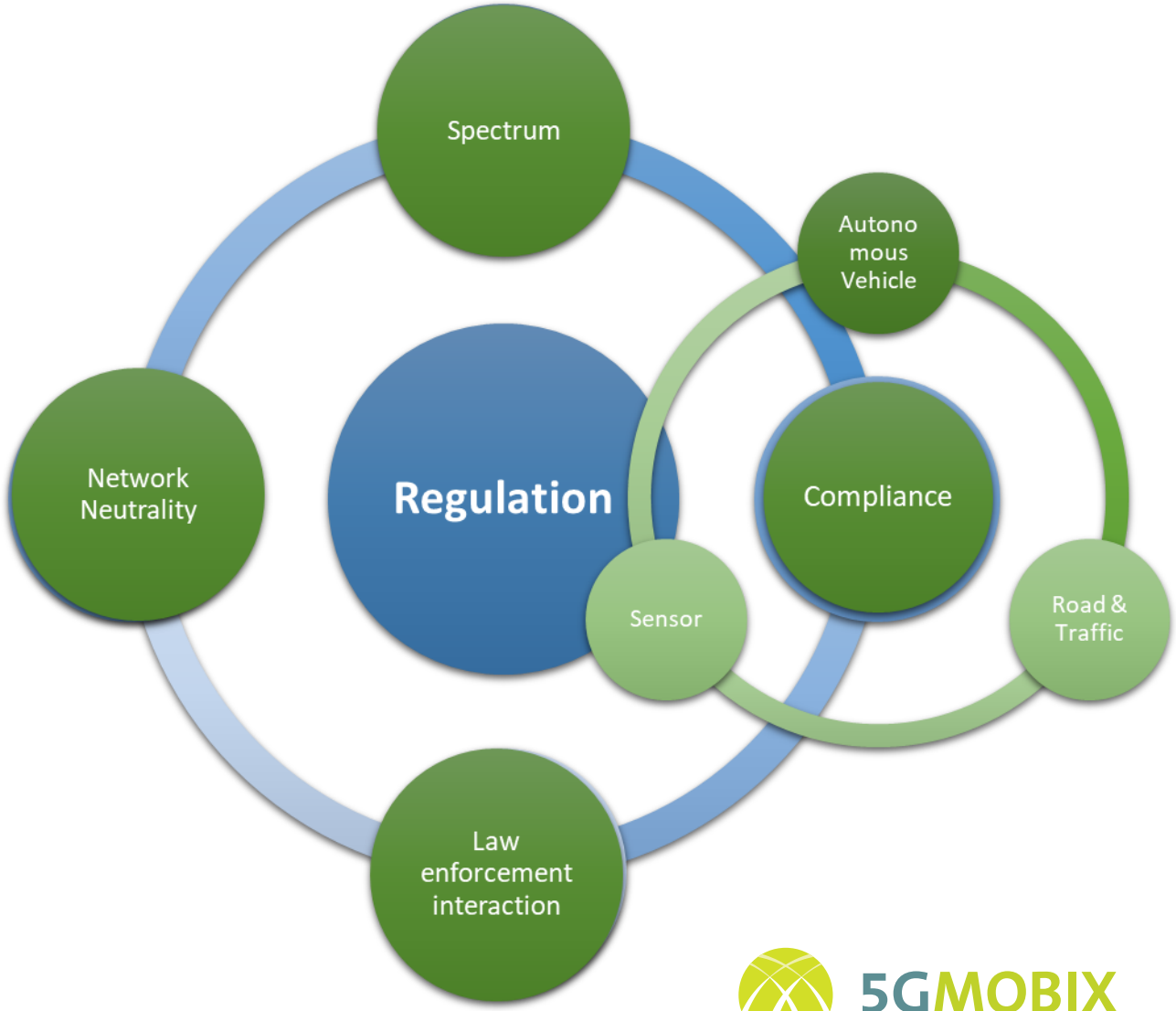
5G-MOBIX Cross-border issues – Overview





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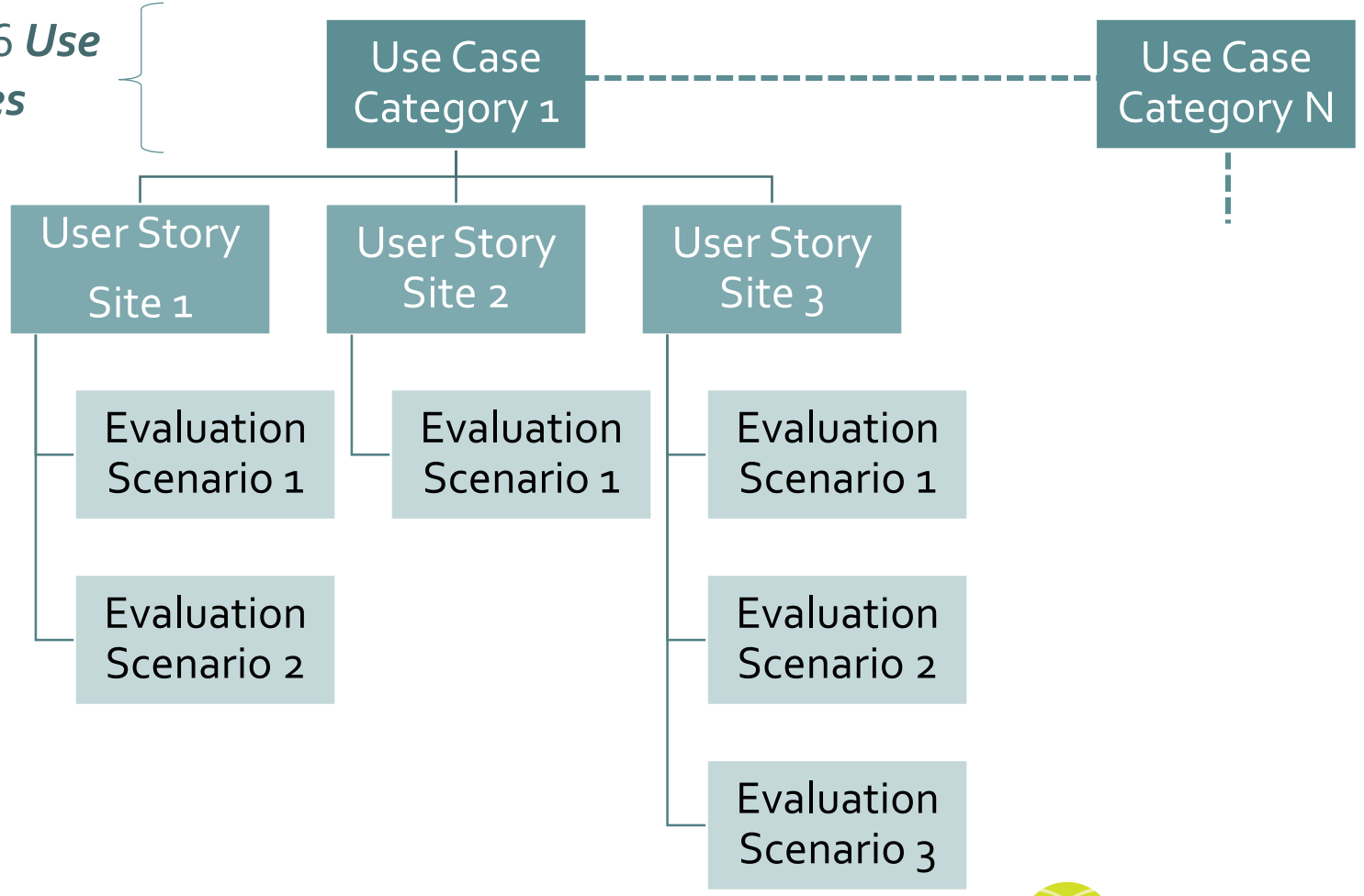
Hierarchy of 5G-MOBIX Trial Activities

- 5G-MOBIX experimental trial activities inspired by cross-border issues

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 Cross-border issues – Solutions under investigation

- **Advanced Driving** Use case Category **(UCC#1)**
- Multiple identified solutions
- Most promising progressed for evaluation through trialing
- TSs enable the evaluation of a much wider range of solutions
- Additional insights regarding configuration

Category	ID	Issue name	ES-PT	FR	NL	CN
Telecommunications	TR1	NSA Roaming Latency	■			
	TR2	SA Roaming Latency			■	
	TH1	Hybrid Handover Latency		■		
	TC1	Continuity Protocol	■			
	TC2	Performance Continuity			■	
	TN3	Geo Networking Overhead		■		
Application	AC1	V2X Continuity	■	■	■	
	AI1	Data Interoperability	■		■	
	AP1	Real-time Multi-tier Processing		■		
Security & Data Privacy	ST1	Federation Trust	■			
	ST2	Discovery Trust	■	■		
	SP1	Data Privacy		■		
	SO1	Data Ownership				■
Regulation	RC1	Autonomous Vehicle regulation Compliance	■	■		
	RC3	Sensor Compliance			■	
	RN1	Neutrality regulation			■	

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5G-MOBIX CBCs / TSs – Illustrating Synergies

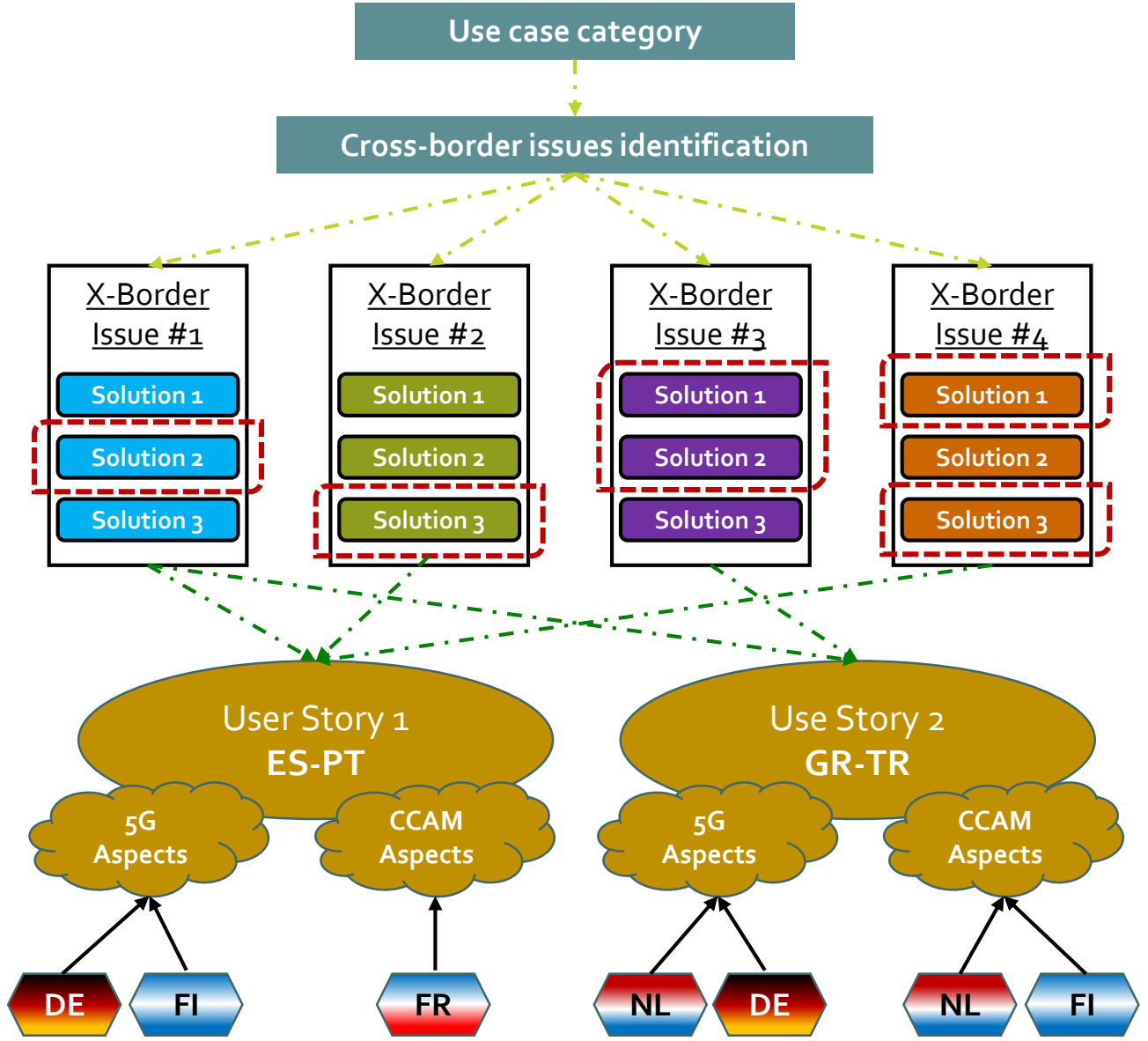
→ Identify the specific x-border issues of this use case category

→ For each cross-border issue identify the potential solutions

→ Test and evaluate the progressed solutions using specific user stories belonging to this use case category

→ Evaluation scenarios on 5G and CCAM aspects

→ Different TSs evaluate specific solutions to cross-border issues



CCAM: Cooperative, Connected and Automated Mobility
ES-PT: Spain-Portugal corridor
DE: Germany trial site
FI: Finland trial site
FR: France trial
GR-TR: Greece-Turkey corridor
NL: Netherland trial site
X-border: Cross-border

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