Deployment Enablers and roll-out studies

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5GMOBIX

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Deployment Enablers

Ensure the project maximises its impact and takes a detailed look on technical, cooperation, business, standardization and policy/regulatory recommendations

Our work at a glance

- **Provide recommendations and deployment options for the proposed technologies**
  - Challenges/Recommendations for deployment and roll-out
  - Focuses on technical issues
  - Provided a micro (project-specific) and macro (ecosystem-specific) view of challenges and recommendations
  - Provided prioritisation of recommendations based on utility, cost and ranking of the criticality of the challenges (performed through stakeholder inputs)
- **Foster the adoption of innovative business models for 5G-enabled CCAM**
  - Explain value chain created by the *project user stories
  - Provide tentative business plans
  - Provide customer exploration maps

Our work at a glance

- **Contribute to the relevant standardisation bodies and spectrum allocation bodies**
  - Monitor partner inputs to standardisation bodies
  - Explore standardisation gaps
  - Explore issues of spectrum availability and capacity
- **Provide recommendations to policy makers for the adoption of 5G-MOBIX solutions**
  - Explore regulatory and policy ecosystem
  - Explore cooperation issues among stakeholders
  - Provide challenges and recommendations across the value chain
- **Deployment study & ICT-18 Deployment Metastudy**
  - Additional activities mandated by the EC
- **Various dissemination and exploitation activities**

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Overview

Initial recommendations

73 Recommendations:

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

GOLD (macro) recommendations (15)

Example: Prioritisation of x-border issues and recommendations

			GR-TR				ES-PT			
ID	X-border Issue Title	Considered solutions	U	C	F	IMPACT	U	C	F	IMPACT
XBI_1.1	NSA Roaming interruption	1) Inter-PLMN HO using extra interface between the 2 PLMN + Release with redirect	4,3	2,9	1,5	5	4,	2,6	1,5	4
XBI_1.2		2) Single modem with application to steer connectivity	4,0	2,5	1,6	4	3,	4,0	0,8	2
XBI_1.3		3) Multi-modem / multi-SIM implementation	3,7	2,8	1,3	4	4,	3,2	1,3	3
XBI_2	SA Roaming interruption	1) Requirements and proposed architecture for inter-PLMN handover with SA networks	4,3	2,9	1,5	5	4,	2,7	1,6	4
XBI_3.1	Inter-PLMN interconnection latency	1) Considering the low latency possible with a direct connection (theoretical lower limit).	4,1	2,4	1,7	5	3,	2,2	1,6	2
XBI_3.2		2) Comparing impact when using a shared connection (not optimized for latency, e.g., Internet based), giving a worst-case scenario	2,3	2	1,1	2	2,	1,4	1,8	2
XBI_4.1	Low coverage Areas	1) Satellite connectivity	3,6	3,2	1,1	4	4,	3,1	1,3	4
XBI_4.2		2) Multi-modem / multi-sim	3,7	2,8	1,3	4	3,	3,2	1,2	4

NOTE. Corridor Impact:

Score	Definition
1	Has not impact
2	Has little impact, brings awareness to a specific gap
3	Has average Impact - somewhat limits an existing gap
4	It has the potential to simplify CAM deployment
5	Has great Impact - will greatly help 5G for CAM deployment plan

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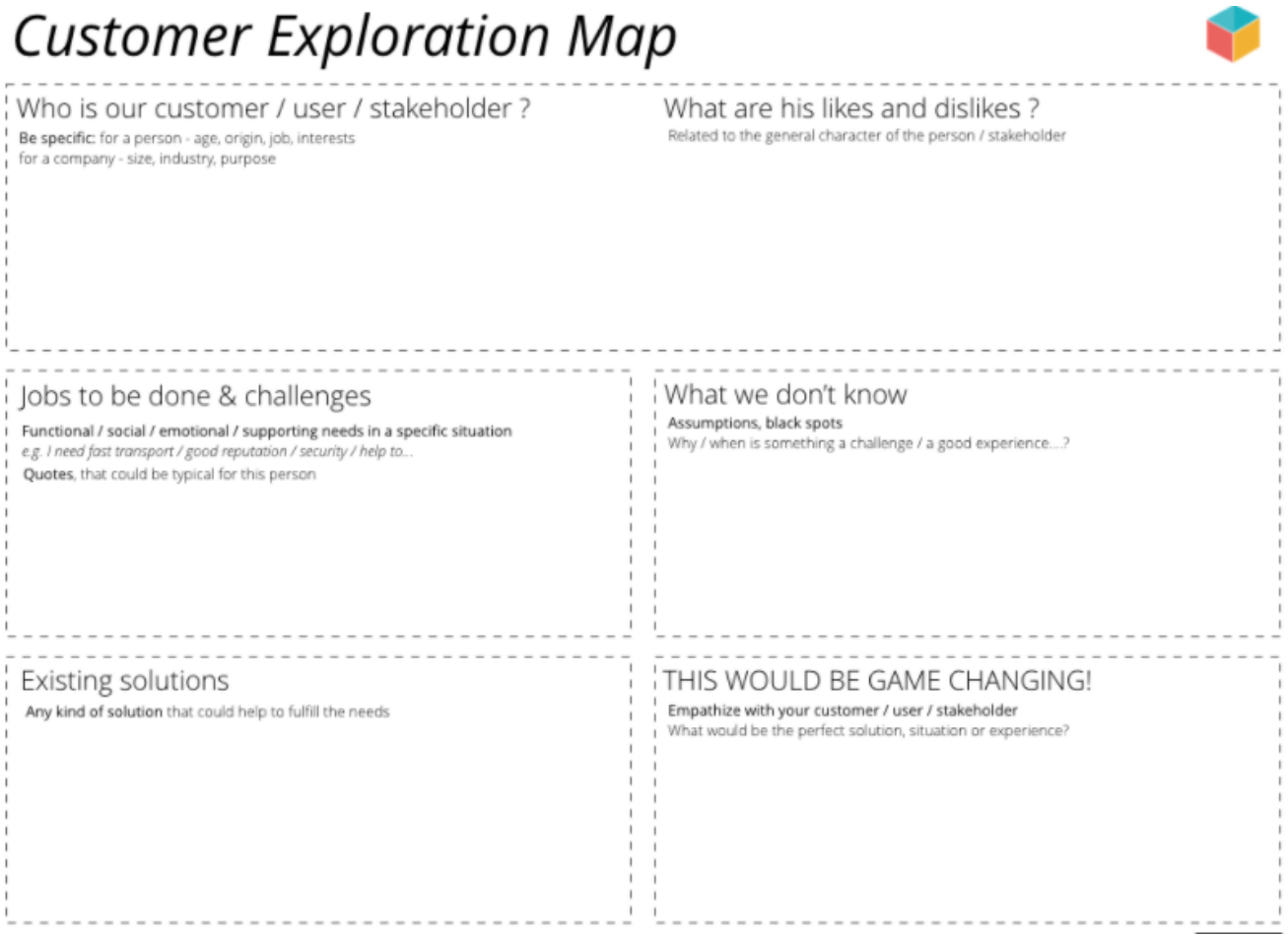
Analytical tools

- **Customer Exploration Map**
  - With the help of this tool, we will be able to see interactions among stakeholders, compare existing and new proposed solutions, what customers like and dislikes etc..
  - Value chain representation & Business Model Canvas to understand the stakeholder ecosystem and business models arising from our user stories



Standardisation gaps and spectrum issues

Standardization Gaps	
Integration of satellite access in 5G	Ubiquitous 5G coverage can be enabled by integration of non-terrestrial communication capability.
Seamless cross-border roaming in 5G	A tight integration and exchange of information between the bordering MNOs is required.
IPv6-based 5G for Connected & Automated Mobility	Migration to IPv6 will be required with the proliferating number of connected devices. How will CAM be affected?
Dynamic Service Discovery and Placement in C-V2X Slice for CAM	A service discovery method is explored for establishment of C-V2X slices.
ETSI ITS Services	Advanced Driving use case design and performance should be investigated with 5G connectivity.
ETSI MEC	The requirements from the ETSI MEC architecture should be revisited for cross-border settings.

Policy recommendations

The recommendation section of D6.8 provides 18 selected key roles recommendations for policy makers and 19 for regulatory authorities. For the presentation purpose 3 recommendations from each section were selected.

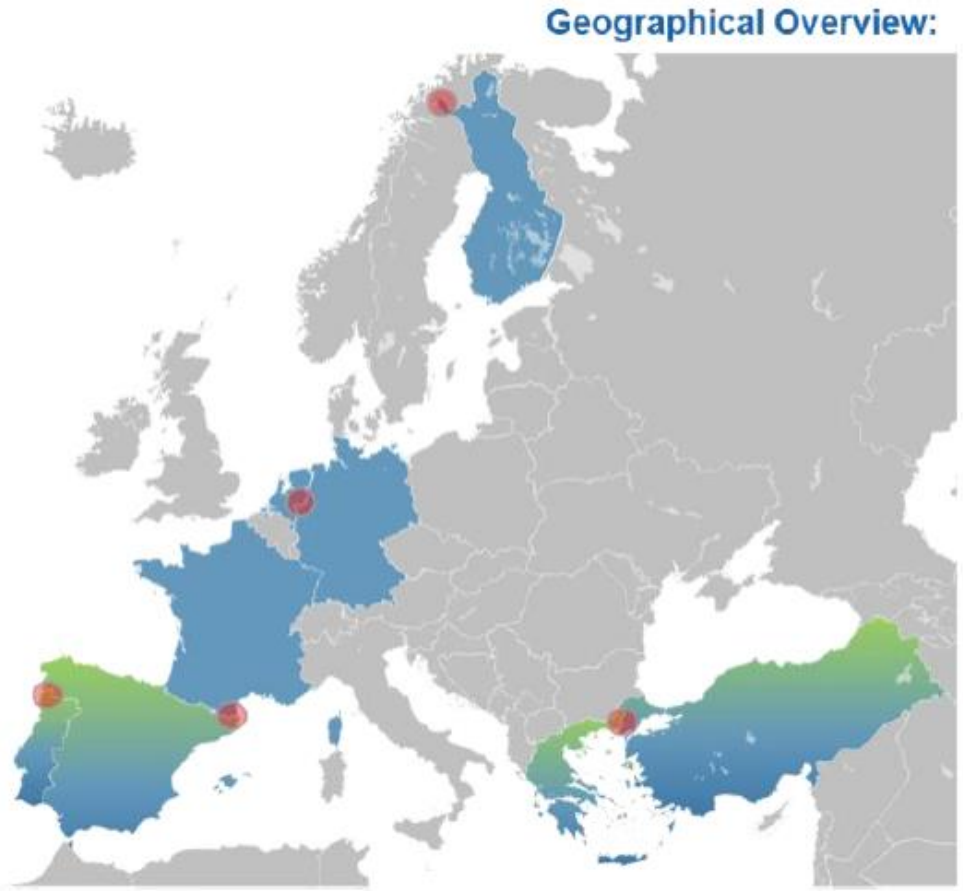
Selected recommendations for regulatory authorities			Selected recommendations for policy makers
Vehicle certification/Type approval. Vehicles that rely on V2N and V2V communications should be subject to some level of certification for the whole vehicle, not just the modem component or the OBU.	Target area: CAM Timeline: Long term	Target area: 5G Timeline: Medium term	For CAM services, policy makers have to ensure that MNOs provide consisted coverage along relevant routes.
Coverage cannot be guaranteed 100%, thus mechanisms should be designed so that autonomous vehicles (different levels of autonomy Regulators 69 may have different requirements) are capable of safely coping with coverage loss or signal degradation.	Target area: 5G Timeline: Long term	Target area: 5G Timeline: Medium term	There is a need to increase 5G coverage in the motorways and other roads where there is no coverage. Policy makers need to play a relevant role to improve the situation. In any case, the networks deployed need also to be commercially viable.
5G is still in its early phases but LTE is mature. The recommendation is to foster the deployment of 5G networks.	Target area: 5G Timeline: Short term	Target area: CAM MNOs, Authorities 68 Timeline: Short term	Prioritization towards the most relevant use cases, including the definition of the corresponding architectures and validation methods.

5G-MOBIX Deployment Study

Geographical scope

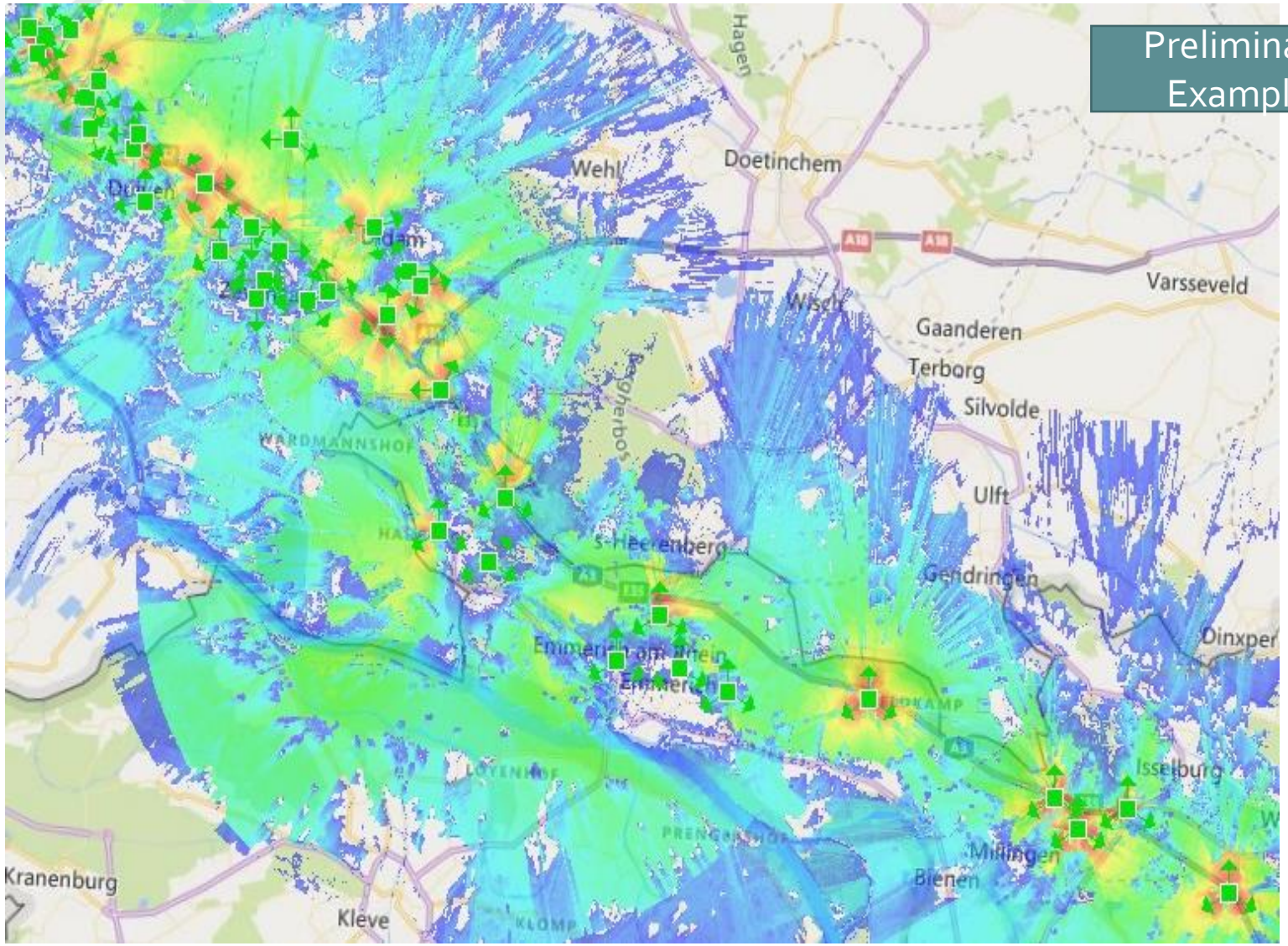
~40km section (20km on each side of the border) of each of the following five CBCs was assessed as part of this study.

- **ES-PT:** Tui/Valenca(Vigo–Porto)
- **GR-TR:** Kipoi/Ipsala(Alexandroupoli–Kesan)
- **DE-NL:** Veldhuizen(Emmerich–Arnhem)
- **FI-NO:** Kilpisjärvi(Skibotn–Muonio)
- **ES-FR:** LePerthus(Figueres–Perpignan)

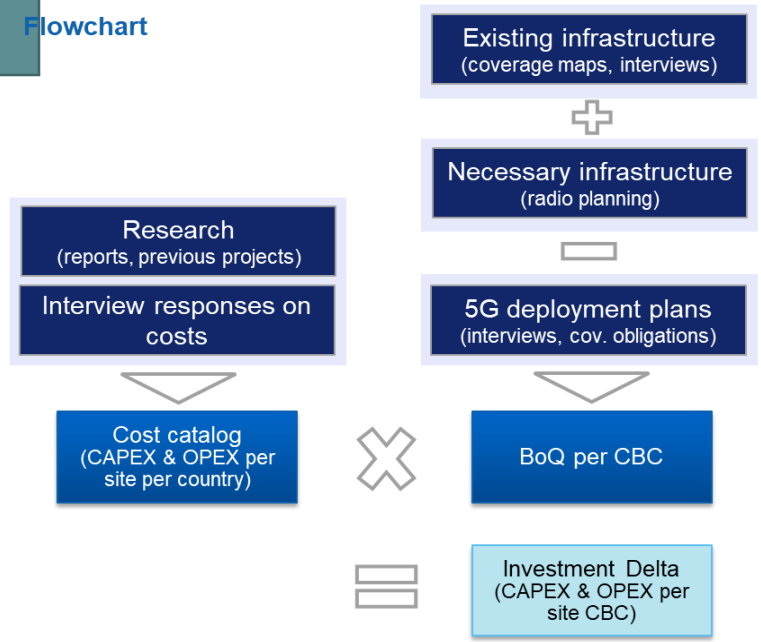


- Mandated at the initiative of the European Commission
- Scope: Estimate the investment "delta" to provide adequate 5G coverage and capacity on Cross-border Corridors, serving the needs of advanced CAM
- Undertaken by DETECON Consulting on behalf of 5G-MOBIX after a public RFQ process

Existing sites in DE-NL, 5G NR 3500 MHz TDD radio coverage simulation

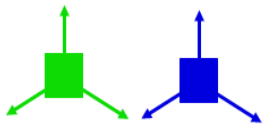


Flowchart



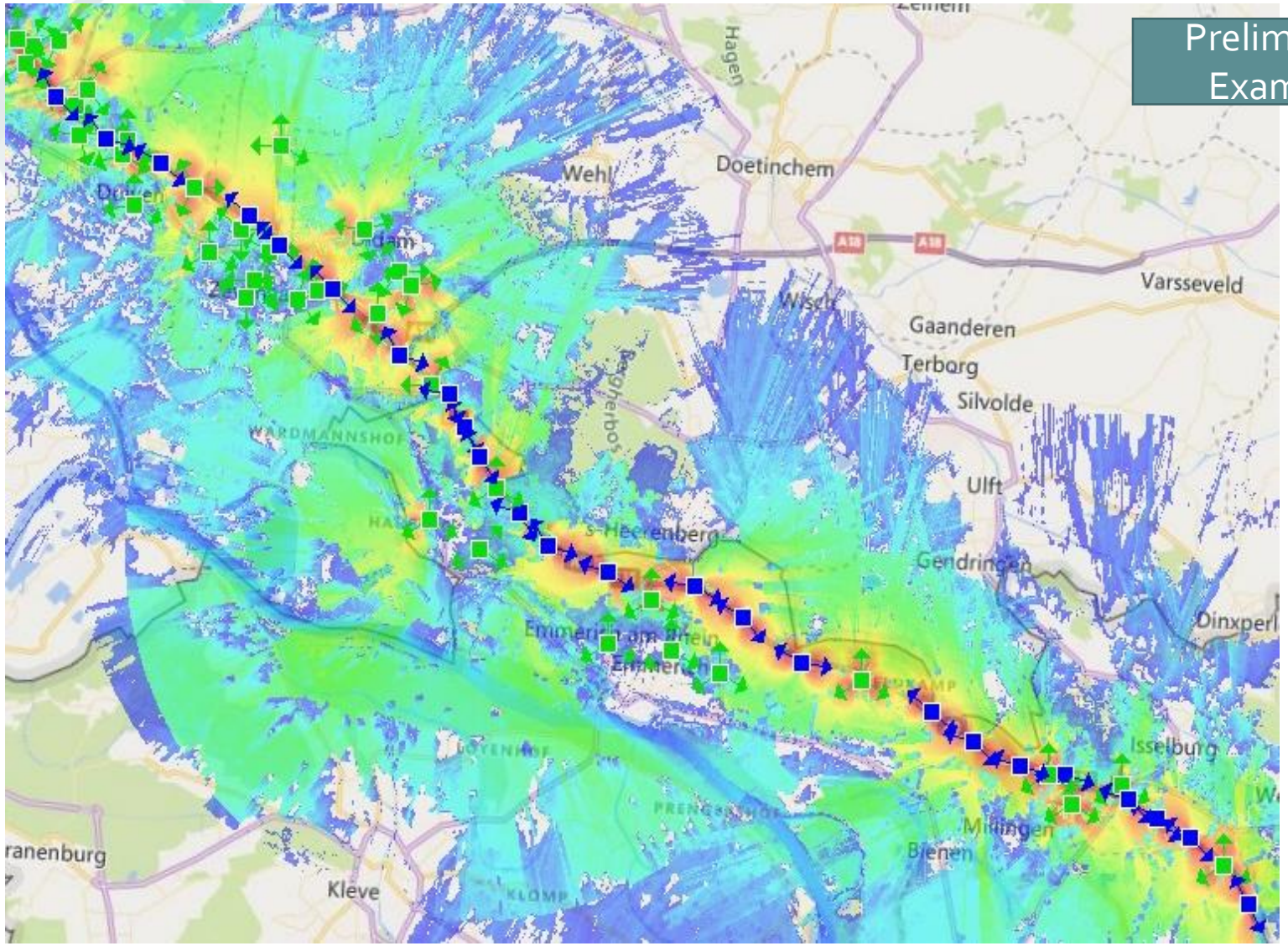
LEGEND

Existing site New site



RSRP	Interpretation	Color code
- 60 dBm	Excellent	Brown orange
- 72 dBm	Very good	Orange
- 90 dBm	Good	Green
-111 dBm	Low	Light-blue
122 dBm	Poor	Dark blue

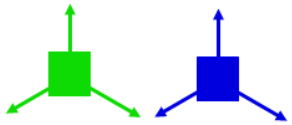
Existing and new sites in DE-NL, 5G NR 3500 MHz TDD radio coverage simulation



- **Existing sites** could be upgraded to 5G: 12 on the German side, 2 on the Netherlands side
- **12 new sites** were added and distributed along the road in order to provide seamless coverage: 8 along the German stretch of the corridor, 4 along the Netherlands stretch of the corridor
- Fleet share estimates, vehicle traffic estimates, CAM requirements

LEGEND

Existing site New site



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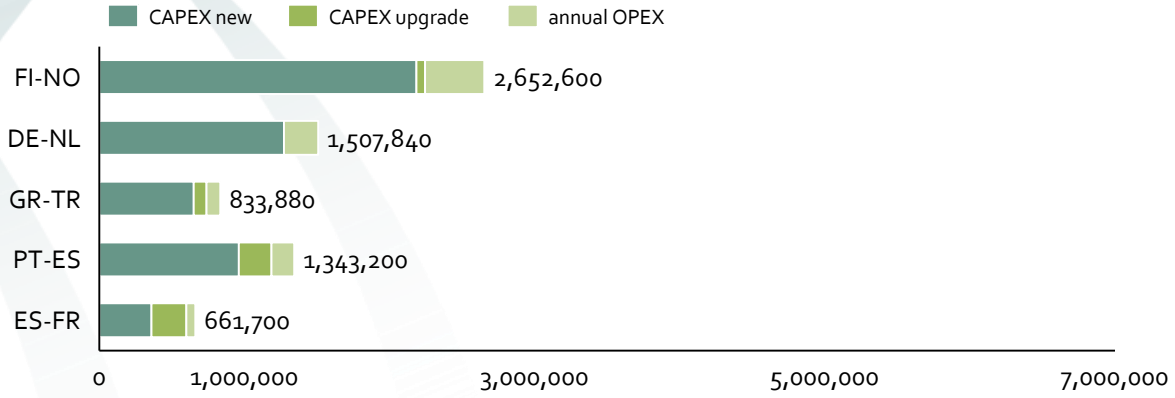
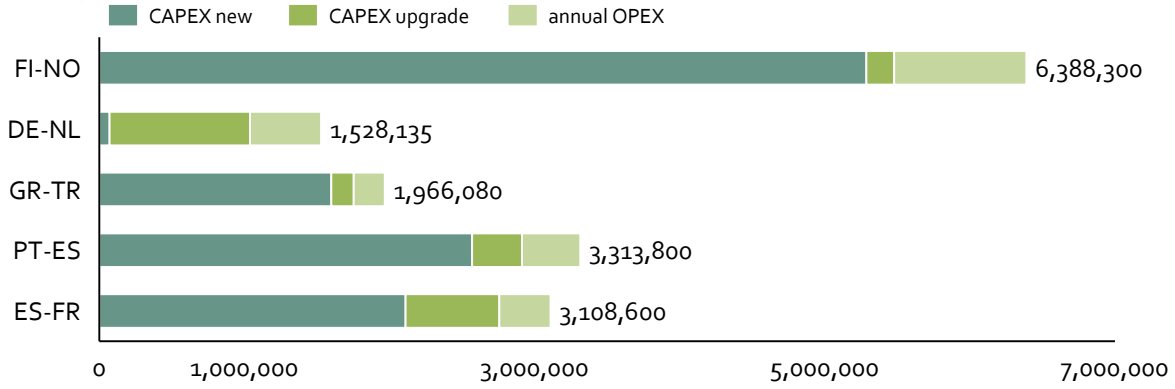
Comparing the costs of 5G-MOBIX shows major corridor cost differences.

Deployment cost for the 700MHz scenario, on all corridor



Deployment cost for the 3.5GHz scenario, on all corridor



- The costs have been compared considering the 2023 deployment scenario
- Each corridor is 40km, approximately 20km on each side
- For each corridor the deployment planned and obligations have been deducted to obtain the investment delta:

$$\Delta = RAN_{required} - (RAN_{planned} + RAN_{existing})$$

- Cost varies drastically between corridors showing the impact of:
  - Existing infrastructure
  - Price differences between countries
  - Geographic surroundings

ICT-18 Deployment Meta-study

Deployment Metastudy Objectives

- The overall objective of the metastudy is to **compare the three underlying studies, consolidate their results, identify methodological and analytical gaps**
- The metastudy reflects the diversity of the three different approaches in order to arrive at a consolidated perspective on 5G deployment and related investment estimates with respect to the CEF2 Digital deployment.
- The study is available online [pdf]
- DETECON was subcontracted by 5G CroCo to perform this task
- The three ICT-18 projects, along with DETECON, organised a panel during EuCNC 2022 and have submitted a paper to IEEE Future Networks 2022 which has been accepted.

5GMOBIX

Comparative Analysis

Comparison Between the Deployment Studies

5GMOBIX

- **700MHz** and **3.5GHz** deployment in **2023** or **2025**
- **Precise radio planning** using the HTZ simulation tool
- **Cost** Δ calculated considering **planned** and **existing** sites

5GCroCo

- **Coverage,** with **IsD of 3km**, and **high throughput,** with **IsD of 1km, 3.xGHz** scenarios
- **Cost** calculation **attributing a percentage of the costs to CAM** (**10%** to **50%** of **CAPEX**)

5G CARMEN

- **Continuous 700MHz** and **3.7GHz** deployment **between 2021 and 2025**
- **Precise radio planning**
- **Costs** calculated per year with **15% planned upgrades** and **revenue** from 5G services

Gap Analysis Between the Studies

Technical Gaps

CAM requirements	Cross-border handover
Cross border handovers	Satellite Comms
Network sharing	MEC

Regulatory Gaps

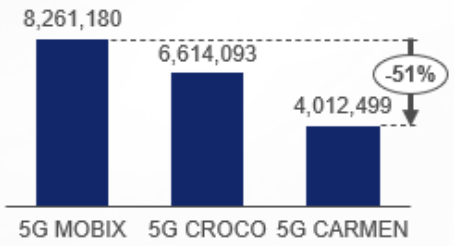
Roll out obligations	Regulatory uncertainty
Environment impact	Cross border data policies
Alignment of the NRAs	Access to RO network

Financial Gaps

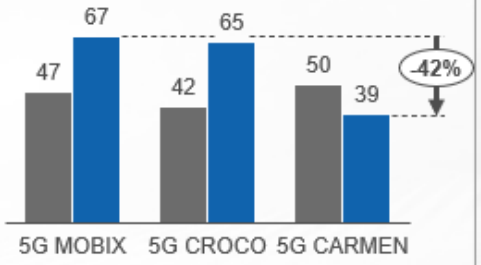
Role of big tech	Price evolution and inflation
Revenue model of CAM	Availability of space on BS
Communal benefits	Role of logistic companies

Cost Comparison Between the Studies

Average costs of the corridors per 100km (high density case*)



Average upgraded (grey) and new (blue) sites per 100km (high density case*)



***High density case**:

- 3.5GHz deployment in **5G MOBIX**
- High throughput case in **5G CROCO**
- Optimistic approach in **5G CARMEN**

Key Findings

- **Costs vary** depending on the **location** and **geographic specificities** of the corridor
- There are **several key steps in estimating** the investment delta that all three studies have in common
- Differences are mainly within the **applied methodology for each step**
- Generally, **estimations of the investment deltas align** among the three studies

1. Defining CAM requirements for each service provided.
2. Specifying the geographical landscape where the deployment will be done.
3. Considering country-wise regulations to estimate time and dependencies for deployment.
4. Considering Country-wise financial aspects to estimate overall cost.
5. Studying CAM penetration in market to calculate road and network traffic demand.
6. Determine what kind of deployment scenario will be undertaken.
7. Radio network planning and capacity planning for the corridor/border area.
8. Calculating the cost Multi-access Edge Computing to support CAM.
9. Cost and delta calculation for the entire planning and deployment process.

Future Framework

- Determine CAM requirements
- Choice of a specific geographical landscape / Choice of a frequently used corridor
- Considering corridor specific regulations / Considering global regulations
- Considering country specific costs / Considering global costs
- CAM service penetration and, road and network traffic estimation
- Deployment scenario and technology
- Radio network planning
- Multi-access Edge Computing deployment and study of impact
- Total cost delta calculation with price elevation and inflation

IsD: Inter-site Distance; RO: Road Operators; BS: Base Station

Several issues and cost drivers remain unclear. They can be grouped into three larger categories: technical, regulatory and financial gaps.

Technical gaps

- Unclear CAM requirements
- Cross-border handovers and network reselection
- Assumption of availability of space on base station site

Regulatory gaps

- Roll-out obligations
- Regulatory-legal uncertainty
- Alignment between NRAs

Financial gaps

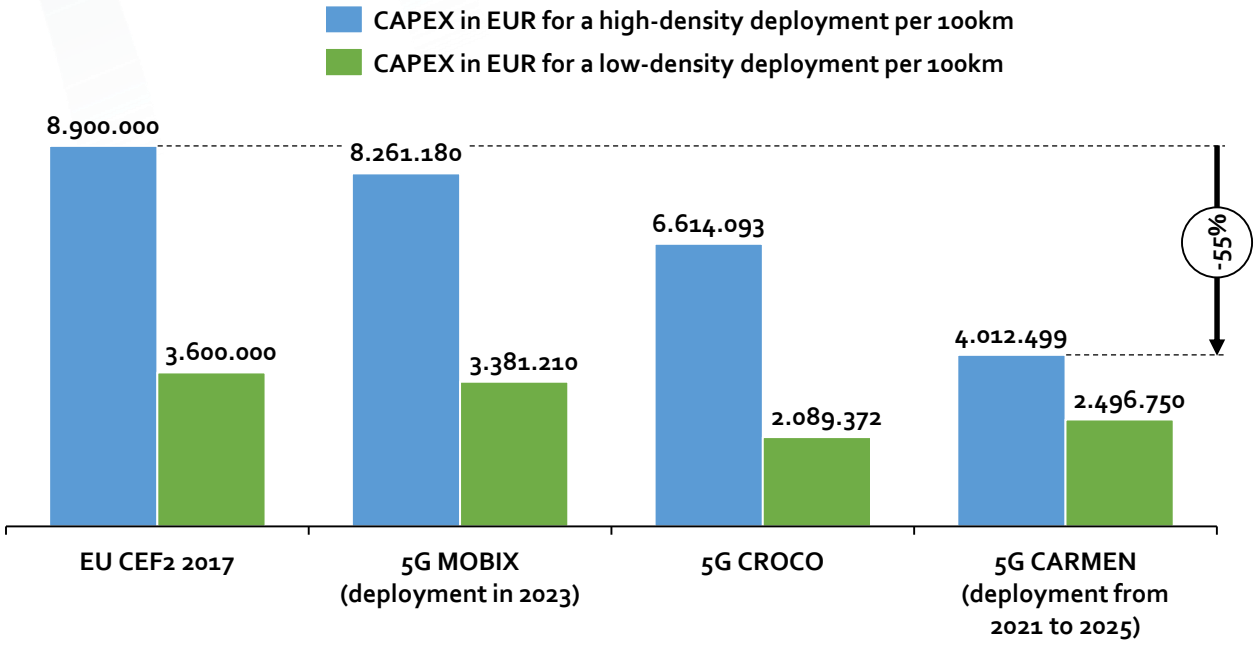
- Revenue models for CAM services
- Potential investment in alternative technologies
- Price Evolution and Inflation

The cost comparison has been made between the average case of the three deployment studies and the EU CEF2 baseline report.

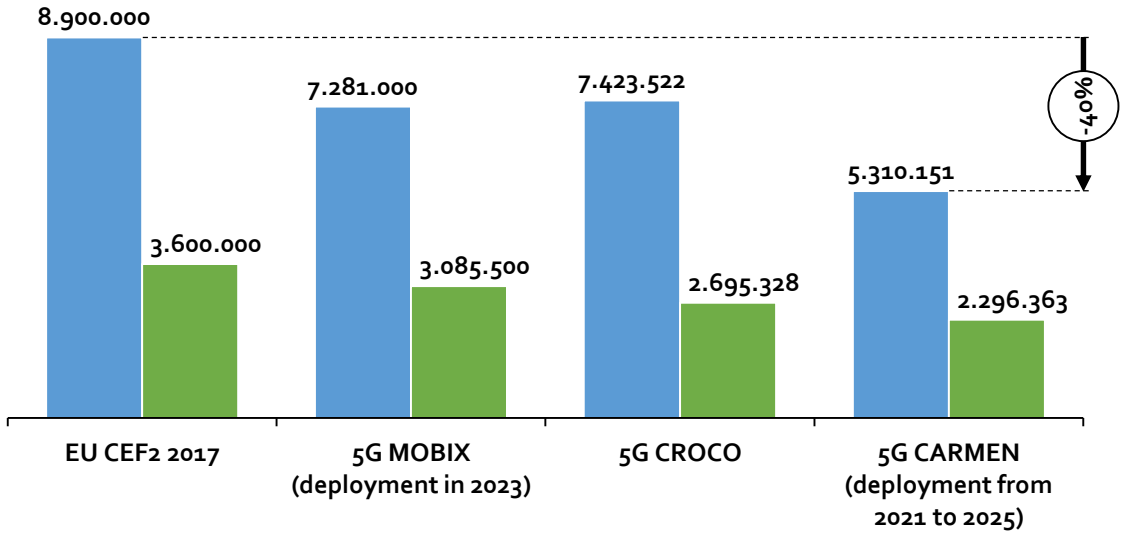
We choose for each of the studies the **average of all corridors or segments** normalized to 100km to compare the results for each density scenario and compare it to the cost per 100km estimated in 2017 by the EU CEF2 report

We choose for each of the studies **a similar geographical corridor or segment** normalized to 100km to compare the results for each density scenario an compare it to the cost per 100km estimated in 2017 by the EU CEF2 report.

Average deployment cost of all corridors per 100km



Average deployment cost for specific corridor per 100km



Thank you

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