5GMOBIX

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

D4.2
Report on the methodology and pilot site protocol

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Control sheet

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ABBREVIATIONS

Abbreviation	Definition
ADAS	Advanced Driver Assistance Systems
APP	Application
CBC	Cross Border Corridor
CCAM	Cooperative, Connected and Automated Mobility
DPIA	Data Protection Impact Assessment
DSDA	Dual Sim Dual Active
EC	European Commission
EDM	Edge Dynamic Map
EPC	Evolved Packet Core
GDPR	General Data Protection Regulation
GRX	GPRS Roaming eXchange
HD	High Definition
HO	Handover
ITS	Intelligent Transport System
KPI	Key Performance Indicator
LBO	Local Breakout
ML	Machine Learning
OBU	On-Board-Units
PLMN	Public Land Mobile Network
PU	Public
RSI	Road Side Infrastructure
TCU	Telematic Control Unit
TMT	Technical Management Team
ToC	Table of Content

TS	Trial Site
UCC	Use Case Category
UE	User Equipment
US	User Story
VPN	Virtual Private Network
VRU	Vulnerable Road Users
WP	Work Package
X-border	Cross-border

EXECUTIVE SUMMARY

This document entitled "D4.2: Report on the methodology and pilot site protocol" presents the work performed within T4.1 in cooperation with all the 5G-MOBIX Cross-Border Corridors (CBC) and Trial Sites (TS) in T4.2 to T4.9.

D4.2 provides the information on the planning of the trialling activities to be performed during the trials phase of 5G-MOBIX project beginning in 2021. The global and common methodology defined in D4.1 [1] has been adapted and specified by each TS and CBC according to the top-down approach that has been adopted in WP4 and specified in D4.1 [1].. The activities to be trialled presented in D4.2 are based on the specifications of the UCCs and USs described in WP2 deliverable D2.1 [2]. Besides, the progress of the trialling phase depends on the progress made in the development and deployment activities carried out in WP3 and described in WP3 deliverables D3.2 [3] to D3.5 [4] [5] [6].

The detailed planning presented in this document takes into account the 9-month project extension which was decided in April 2020 for the consortium. This extension has set the beginning of the trials phase to January 2021. The plans presented in this deliverable are based on the estimation made by the CBCs and Trial sites leaders at M28 (February 2021), to be as accurate as possible in their execution and to reflect the possible delays induced by the COVID-19 pandemic. At this moment, the COVID-19 situation and the different lockdown measures taken in some countries involved in 5G-MOBIX should not affect the trialling plans defined in this document.

The document is structured with 4 main sections. Section 1 describes D4.2 purpose and intended audience. Section 2 gives updates on the implementation of the methodology described in D4.1 and its specifications at local sites level during the preparation of the trials phase. This section also gives some updates concerning the general methodology, its tools, and its adaptation by the local sites.

Section 3 describes the preparation of the trials at the ES-PT and GR-TR CBCs by giving an overview of the different 5G technologies that will be trialled, the different contributions expected from the TSs during the CBCs trials and the progress made to prepare for the trials. Then in section 4, each TS has a sub section in which is described their trials and the previous cited activities for each one of them. Finally, the document is concluded by a summary of the main elements of the deliverable.

1. INTRODUCTION

1.1. 5G-MOBIX concept and approach

5G-MOBIX aims to showcase the added value of 5G technology for advanced Cooperative, Connected and Automated Mobility (CCAM) use cases and validate the viability of the technology to bring automated driving to the next level of vehicle automation (SAE L4 and above). To do this, 5G-MOBIX will demonstrate the potential of different 5G features on real European roads and highways and create and use sustainable business models to develop 5G corridors. 5G-MOBIX will also utilize and upgrade existing key assets (infrastructure, vehicles, components) and the smooth operation and co-existence of 5G within a heterogeneous environment comprised of multiple incumbent technologies such as ITS-G5 and C-V2X.

5G-MOBIX will execute CCAM trials along cross-border (x-border) and urban corridors using 5G core technological innovations to qualify the 5G infrastructure and evaluate its benefits in the CCAM context. The Project will also define deployment scenarios and identify and respond to standardisation and spectrum gaps.

5G-MOBIX will first define critical scenarios needing advanced connectivity provided by 5G, and the required features to enable some advanced CCAM use cases. The matching of these advanced CCAM use cases and the expected benefits of 5G will be tested during trials on 5G corridors in different EU countries as well as in Turkey, China and Korea.

The trials will also allow 5G-MOBIX to conduct evaluations and impact assessments and to define business impacts and cost/benefit analysis. As a result of these evaluations and international consultations with the public and industry stakeholders, 5G-MOBIX will identify new business opportunities for the 5G enabled CCAM and propose recommendations and options for its deployment.

Through its findings on technical requirements and operational conditions 5G-MOBIX is expected to actively contribute to standardisation and spectrum allocation activities.

1.2. Purpose of the deliverable

The present document, D4.2 "*Report on the methodology and pilot site protocol* ", is delivered as part of WP4 and will be provided by all site and cross-border corridors leaders using the generic trial plans developed within T4.1 of WP4 and detailed in Deliverable D4.1 "*Report on the Corridor and Trial Sites Plans*" [1]. This deliverable gives the vision on the current preparation of the trials at each TS and CBC and plans the coming trials activities, foreseen to start in early 2021 until early 2022.

In WP4, the first step is to ensure the readiness of both CBCs and TSs to carry out the trialling phase which has been done by defining the specifications of the organization, installation, and overall preparation of the CBCs and TSs. In addition, all kinds of characteristics of the CBCs and contributions from local trial sites have

been considered, from the 5G network and vehicles to the road and digital infrastructures, but also the participants and the data collection process. As WP3 is responsible for delivering a fully prepared site to WP4, a checklist has been prepared in the context of WP4 activities which is to serve as the main tool for the control and inspection of the preparations and implementations at 5G-MOBIX CBCs and TSs.

The generic methodology described in D4.1 [1] has been adapted and specified by each TS and CBC depending on their specificities and now gathers several monitoring elements such as a general checklist, trials plans, planning of activities and other documents and tools that have been prepared in T4.1 and filled in by each TS and CBC in order to monitor their progress before and during the execution of the trials activities.

The aim of this whole methodological process adapted to each local site is to come up with detailed plans for the operations at each site presented in this document, while keeping the expected impacts that are targeted from the trialling activities in mind.

1.3. Intended audience

The deliverable D4.2 is a public document (PU) and it is addressed to any interested reader, hence it will be used publicly to inform all interested parties about 5G-MOBIX trialling activities. However, knowing the progress of the trials activities is relevant for WP5 Evaluation and WP6 on Exploitation partners, and for WP3 partners, dealing with the deployment of the different system components.

2. COMMON METHODOLOGY

This section gives an overview on how the CBCs and TSs have adapted their trials based on the general methodology of the trial activities described in D4.1. [1]

2.1. Adaptation of General methodology to Local sites

General methodology and timeline

Within Task 4.1 of WP4, the overall methodology to be adopted by the TSs and the CBCs during trials and their preparation was defined.

Figure 1 below gives an overview of the methodology that will be applied during 5G-MOBIX trials and which is described in D4.1 [1].

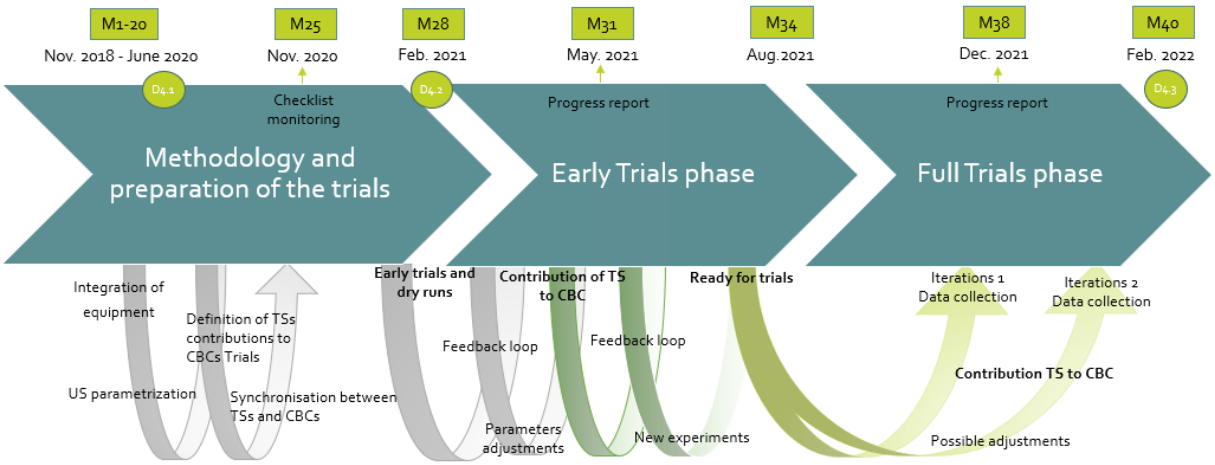

Figure 1 Implementation of WP4 Trial's Methodology (figure abstracted from D4.1)

Currently at M28 (February 2021), the "Preparation of the trials" phase is almost over, and the Early Trials Phase is starting with the first local trials and dry runs. As the trialling methodology follows an agile-like approach, multiple iterations of trials are foreseen. This means that if adjustments are needed, they will be made to the components until the results are successful and mature enough to launch the full trials phase, during which the data collection will be performed (from M34 to M40).

The end of preparation of trials phase is running in parallel with the last tasks of WP3 Deployment and Integration. During this preparation phase, the different 5G equipment, vehicles and roadside infrastructures are being deployed, integrated, and tested to make them ready for the trialling phase. The final US parametrization are also being finalised. Despite the end of main WP3 tasks, once the early trials phase begins, it is foreseen that the WP3 task leaders continue to offer support to the trialling activities.

Concerning the collaboration with WP5 leaders and tasks leaders, discussions have been initiated concerning the data collection and the iterations to be scheduled in order to collect the required KPIs. A detailed document named "*5G-MOBIX- Test cases Evaluation scenario*" was created in WP5 and used by both WP5 and WP4. It has helped the TSs and CBCs leader to estimate as accurately as possible the number of hours they will need to perform during their trials (on open roads, on closed roads, at the border or locally), and how many iterations would be possible to trialled given the time needed. From these inputs, WP4 and WP5 had to align on a feasible number of iterations to be performed during the trials with the main goal of ensuring proper data collection.

Regarding WP4's needs, these exercises allowed the TSs and CBCs leader to calculate the timing needed to perform all their trialling activities (based on the number of iterations agreed with WP5) and to start concretely scheduling when the trialling activities and iterations will be done.

Thus, WP4 "Trials" is at the cross section between the technical activities developed by WP3 (reported in Deliverables D3.2 to D3.5) and WP5 and regular discussions are still ongoing to ensure good communication and alignment between our respective activities.

Trial preparation and validation

Checklist components and monitoring:

The checklist verifies the readiness of the trial's components for the beginning of the trials phase. This has been an ongoing activity ongoing during M25- November 2020. The different aspects of this checklist can be found in each CBC and TS sections ("*Preparation of the trials: Components deployment progress*"). This checklist is a monitoring tool at the service of WP4 coordination activities.

Trial plans

The Trial plan is an additional tool used by the CBCs and TSs to prepare their trials. CBCs and TSs adapted it to define their actual and specific plans (in relation with WP3 and WP5 needs). Following the alignment and coordination discussions with WP5 leaders and tasks leaders, the *Trial plan template* focuses on scheduling their different trials sessions, allowing T4.1 to keep track of what takes place, where and when during the actual trials.

2.2. Cross-border corridors trials and cross-border issues addressed during trials

As CBCs bring a challenging environment, different issues for connected and automated mobility will be addressed to ensure a timely, continuous, and seamless operation of CCAM applications. To this end, the trials activities of the project will show the impact of the proposed solutions to the identified issues when

evaluated at specific 5G corridors. The four cross-border issues categories identified within WP4 activities during the first period of the project are:

- Telecommunications issues
- Regulation issues
- Application issues
- Data & security issues

Both CBCs and TSs will address cross-borders Issues defined by the project and implement different solutions which have also been identified (D6.1 [7] will elaborate more on the different solutions that will be tested during the trials). Some cross-border issues and their implemented solutions will be brought by TSs to CBCs trials, showing their complementarity with CBCs: these cross-borders issues tackled by the TSs at the CBCs trials enable the evaluation of a much wider range of solutions, because additional solutions are tested for the same cross-border issues.

2.3. General planning and scheduled iterations

An important activity led by T4.1 in relation with T4.2 to T4.9 was to set up a detailed planning of all iterations to have an overview of the trials activities that would be as complete as possible.

In order to have a full picture of the activities performed during the trials and also to be better organised in terms of logistics (for instance if roads need to be blocked and authorizations deliver from authorities, or if a TS is bringing contribution), the timeplan includes different type of trialling activities:

- 5G technologies that will be trialled
- Final testing and preparation of trialling activities (in relation to WP3 activities)
- Local trials (including local trials to remotely test the contributions to CBCs)
- Trials at the borders:
    - On open roads (including TSs contributions to CBCs)
    - On closed roads (including TSs contributions to CBCs)

These trialling activities are divided by UCC and user stories specific or agnostic test cases and includes the 5G elements that are tested for each CCAM UC/US.

- Contribution of TSs to CBCs

During the preparation of trials phase, the contributions of TSs to CBCs' trials have been identified. Trial sites will contribute to the CBCs' trials by transferring concrete hardware or software platforms. These contributions developed by the Trial sites are being integrated to the CBCs' infrastructures allowing the trials to address deeper the CBCs trials and X-border issues. Mainly, during the Early Trials phase, the contribution will be tested whether locally and remotely by the local sites. Then these contributions will be concretely

performed during the x-border trials. Thus, the planning of the contributions is aligned between the CBCs' trials and the TSs.

- Demos

A complete version of this planning can be found in the annexes (Section 7). Otherwise, the planning for each site and corridor will be found in their respective sections.

3. CROSS-BORDER CORRIDORS PREPARATION OF TRIALS

The following section presents an overview of the preparation of trials phase at the ES-PT CBC and at the GR-TR CBC at M27, right before the beginning of the Early Trials phase. This section provides overviews on the trials (including the implemented User Stories, the different TSs contributions to CBCs trials and the CBCs issues addressed), describes the preparation of trials progress and finally gives a detailed planning of the trials at the CBCs starting from 2021, as aligned with WP4 general timeline. The inputs of the contributing TSs also appear in the planning below but may be subject to modifications later, depending on the synchronisation discussions between CBCs and TSs considering several factors like Covid-19 pandemic impacts, travel restrictions updates, road availability, etc.

3.1. Spain-Portugal (ES-PT) cross-border corridor

3.1.1. Overview of the trials activities

3.1.1.1. *Overview of the UC/USs that will be tested*

The different user stories that will be tested in the ES-PT CBC are presented in Table 1 according to the different UC.

Table 1 Overview of the user stories – ES-PT CBC

UCC Name	US Id	US Description
Advanced Driving	LaneMerge (1.1)	Complex manoeuvres in cross-border settings: lane merge for automated vehicles
	Overtaking (1.1)	Complex manoeuvres in cross-border settings: automated overtaking
	AutShut (1.5)	Automated shuttle: VRU cooperation
Extended Sensors	HDMaps (3.1)	Complex manoeuvres in cross-border settings: HDMaps
	PublicTransport (3.1)	Public transport, HD media services and video surveillance
Remote Driving	BCrossing (4.1)	Automated shuttle RD across borders: remote control
Vehicle QoS Support	PublicTransport (5.1)	Public transport, HD media services and video surveillance

3.1.1.2. *Overview of the 5G features and technologies tested at ES-PT CBC*

The following Table 2 lists all the 5G features and technologies that will be used by the ES-PT CBC during their trials to implement the different CCAM use cases.

Table 2 5G features/technologies/solutions tested at ES-PT CBC

5G technology/ solution/feature	Description	Related Use case	Related agnostic test case
Seamless cross border (S1) handover with evolved packet core	Home routed roaming vs local breakout roaming Considerations: Different variations are possible with this topic, e.g.: - Home routed roaming - Local breakout roaming - Different coverage conditions (with and without large overlap)	LaneMerge Overtaking AutShut HDMaps (vehicle and bus) PublicTransport BCrossing	TCA-GEN-33_InterPLMN_HO_HR_TCP_DL TCA-GEN-33_InterPLMN_HO_HR_TCP_UL TCA-GEN-34_InterPLMN_HO_LBO_TCP_DL TCA-GEN-34_InterPLMN_HO_LBO_TCP_UL
Session and Service Continuity (SSC) mode 2 or 3	Only when stand alone is available	LaneMerge Overtaking AutShut HDMaps (vehicle and bus) PublicTransport BCrossing	TCA-GEN-12_TCP_DL_No Load TCA-GEN-13_TCP_UL_No Load
Service continuity with multiple edges and an ePC	Service continuity is going to be supported between the edges that are deployed in each side of CB.	LaneMerge Overtaking AutShut HDMaps (vehicle and bus) PublicTransport BCrossing	TCA-ES-PT-01 TCA-ES-PT-02 TCA-ES-PT-04
Local breakout Roaming with ePC	Testing the LBO roaming solution it is possible to measure the interruption time when the user changes from the home network to the visited network and compare it with the HR results	LBO or HR (Option Selectioned): LaneMerge Overtaking AutShut HDMaps (vehicle and bus) PublicTransport BCrossing	TCA-ES-PT-01 TCA-ES-PT-04 TCA-GEN-34_InterPLMN_HO_LBO_TCP_DL TCA-GEN-34_InterPLMN_HO_LBO_TCP_UL
Home routed roaming with ePC	By testing the HR solution, it is possible to measure the increment of the latency when the user is moving away of the border and compare it with the LBO results	LBO or HR (Option Selectioned): LaneMerge Overtaking AutShut HDMaps (vehicle and bus) PublicTransport BCrossing	TCA-ES-PT-02 TCA-ES-PT-04 TCA-GEN-33_InterPLMN_HO_HR_TCP_DL TCA-GEN-33_InterPLMN_HO_HR_TCP_UL
Local breakout roaming with 5G Core	Only when SA become available (PT)	LBO or HR (Option Selectioned): LaneMerge Overtaking AutShut PublicTransport BCrossing	TCA-ES-PT-01 TCA-ES-PT-04

Home routed roaming with 5G Core	Only when SA become available (PT)	LBO or HR (Option Selectioned): LaneMerge Overtaking AutShut PublicTransport BCrossing	TCA-ES-PT-02 TCA-ES-PT-04
Edge computing	The edge solution is based in Openstack virtualization and is directly interfacing a distributed 5G core installation. This allows having UGW interfaces and radio interfaces directly connected to the MEC. Several virtualization instances are deployed in both MEC instances in Spain and Portugal which have a direct interconnection through one of the software defined networks in the OpenVirtualSwitch managed interconnections. The Edge is prepared for handling home routed and local breakout scenarios. A specific VPN Server is hosted in the MEC so that NAT issues and security issues are minimized. OSM capabilities can also be activated in case additional orchestration features are required at this level. The baremetal OS hosting the system is Ubuntu 18.04 and the microstack setup is based on Rocky Edge version.	LaneMerge Overtaking AutShut HDMaps (vehicle and bus) PublicTransport BCrossing	TCA-ES-PT-04 TCA-GEN-18_PING_No load_MTU size
MEC broker interconnection	Direct physical interconnection between	LaneMerge Overtaking AutShut	TCA-ES-PT-06 TCA-ES-PT-07

	NOS and Telefonica at the border	HDMaps (vehicle and bus) PublicTransport BCrossing	
PLMN direct interconnect as alternative to current GRX based interconnections	Both cores will be connected through a 1Gbps direct fiber interconnection. This connection will support S6a, S8 and S10 core interfaces as well as inter-MEC application connectivity.	LaneMerge Overtaking AutShut HDMaps (vehicle and bus) PublicTransport BCrossing	TCA-ES-PT-06 TCA-ES-PT-07
Data privacy / GDPR mechanisms in place	Appointed data controllers and data Processors, conducted a Data Privacy Impact Assessment (DPIA) and elaborate a consent form for participants in the user acceptance tests.		N/A
Data security mechanisms in place	Network is not implementing any additional security mechanism above 5G 3GPP standards. Security at application level is also being applied: TLS on the broker, security during the HO, VPN for remote driving, SFTP for transferring HDmaps.		N/A

All these 5G technologies will be implemented according to the planning Table 2.

	2021										2022		
	March	April	May	June	July	August	September	October	November	December	January	February	March
5G Features	29	30	31	32	33	34	35	36	37	38	39	40	41
ES-PT CBC	Early Trials								Full trials				
Seamless cross border (S1) handover with evolved packet core													
2 or 3													
Service continuity with multiple edges and an ePC	When SA available												
Local Breakout Roaming with ePC													
Home Routed Roaming with ePC													
Local Breakout Roaming with 5G Core	When SA available												
Home Routed Roaming with 5G Core	When SA available												
Edge computing													
MEC broker interconnection													
PLMN direct interconnect as alternative to current GRX based interconnections													
Data Privacy / GDPR mechanisms in place													
Data Security mechanisms in place													
DEMO				EU CNC									Final Demo

Figure 2 5G features planning at ES-PT CBC

3.1.1.3. *Trial Sites contribution to ES-PT cross-border corridor*

- FR and FI contributions to ES-PT CBC, UCC agnostic

Multi PLMN solution: FR and FI will provide two different solutions of seamless handover using dual-SIM OBUs in multi-PLMN scenario (5G to 5G, 4G to 5G, 5G to 4G).

Description of FR TS solution: FR TS will use an intelligent router solution, connected to its OBU, which allows the UE to keep multi-SIM connections with PLMNs ensuring continuity with the application end-point (in the cloud or in the MEC). Based on continuous monitoring of the available networks (4G, 5G) and their quality, the intelligent router selects and connects to two PLMNs. Specifically, the first 5G interface will stay connected to the available PLMN while the second one will be in monitoring mode, scanning for secondary connection, and when it sees a secondary stable connection, it will connect the second interface to the secondary PLMN. The router has a connection bonding and QoS control functionalities, ensuring zero handover delay, guaranteeing QoS of the end-to-end flow. At the reception, a software module, so-called aggregator, aggregates data transmitted over the different PLMNs and provides the aggregated data to the target application.

Agnostic tests will be carried out to evaluate the performances of the contributions. In this scheme, the connected vehicle will be equipped with a 5G OBU and intelligent router. The vehicle will communicate with a destination node (e.g., ITS centre) in the cloud, where the aggregator module, which provides flow aggregation and error correction functionalities.

At the CBC, the FR TS dual-stack OBU, the intelligent router will be integrated in the FR TS connected vehicle, and the proposed seamless handover solution be tested under the CBC multi-PLMN scenario and compared against the ES-PT single-SIM solution.

Description of FI-TS solution: FI contribution consists of a multi-SIM OBU tested in FI in SA and NSA modes. In the CBC, the contribution will be tested in NSA mode. In the CBC, both the FI contribution will be tested on top of FR vehicle. The contributions will help to service continuity (V2X) and availability via redundancy.

Transferable assets:

- FI TS: Multi-SIM OBU in NSA mode (hardware).
- FR TS: Multi-SIM OBU, intelligent router, and aggregator module (hardware, software)

Planning:
Ready:

- FR: multi-SIM OBU, intelligent router, and aggregator, tested under a 4G to 4G scenario.
- Joint planning with FR TS and ES-PT for testing of multi-SIM solutions in ES-PT CBC.
- FI: multi-SIM OBU operating in NSA mode, tested in February 2021.

Pending (FI):

- Shipment, deployment and testing in ES-PT CBC (byM32).

Pending (FR):

- Testing of FR TS solution under 5G to 5G scenarios (M29)
- Shipment, deployment and testing in ES-PT CBC (byM35).

- FR contribution, UCC specific

5G connected vehicle for benchmarking and inter-operability tests: FR TS is bringing a connected vehicle to the ES-PT corridor to interoperate with the other "local" vehicles. Targeting the user stories developed in the ES-PT corridor: US1 of Advanced Driving category (Complex manoeuvres in cross-border settings) we test inter-operability between the FR TS vehicle and ES-PT vehicles/network. Different communication flows will be tested during these benchmarks including CAMs and CPMs.
The testing of this contribution will be executed during the advanced driving use case of the ES-PT CBC. The goal is to check the interoperability of the vehicle by receiving ITS messages from "local vehicles" and also sending messages to them.

Transferrable asset:

- Connected vehicle (5G OBU)

Planning:
For both FR contributions, the first local trials are set in April during the Early trials phase. Then the FR TS will bring the transferrable assets during the ES-PT CBC trials at the border, set in June or in October 2021 depending on EUCNC 2021 conference time organisation.

- FI Contribution, UCC specific

DNS-based service discovery system: The contribution consists of a set of protocols for registration, coordination, and migration of edge services.
In FI, this will be deployed in the 5GC with single- and multi-SIM OBUs. In the CBC, this will be adapted to the CBC network deployment and tested with a multi-SIM OBU configurated to operate in single-SIM mode. In FI, this will be tested on top of FI vehicle. In the CBC, this will be tested on top of ALSA connected bus. In both cases, tests are planned to be open road. These protocols will help to test dynamicity (CBC protocols are static), interoperability (ES and PT networks are different; ES is a commercial network, PT is an experimental network), simplicity (to deploy services), and scalability (to deploy MEC).

Transferrable assets:

- Edge service protocols (software).

Planning:
Ready:

- Understanding of CBC architectures.
- Target CBC US.
- Contribution value.
- Sequence diagrams.
- Test case type.
- Needs from CBC.
- Trials timeline.

Pending:

- KPIs definition (M29).
- Remote verification plan (M29).
- Remote measurement plan (M29).
- Integration work (M31-M32).

- NL Contribution, US specific **(Overtaking)**

Extend the Cooperative Collision Avoidance (CoCA) user story in NL to support overtaking user story in ES-PT: Key difference in the overtaking user story executed at ES-PT with the contribution from NL is at the decision-making point. In the NL's contributed scenario, the decision to change the lane for overtaking is taken by the App running in the MEC, whereas in ES-PT implementation it is taken by the vehicle itself. The vehicle-based decision making of the ES-PT Overtaking scenario will be compared with the edge-based decision making from the NL-trial utilizing transferred components such as MCS app and OBUs. Agreement on using the existing edge infrastructure components such as MQTT brokers, and Geomessaging servers, rather than deploying NL's version of those was made. Additionally, agreements on a common data logging formats and KPIs for evaluation have been made. Discussion on application-level logging is progressing.
Additionally, comparison of the 5G functionalities of ES-PT with NL trials set-ups is planned since NL has SA core networks already implemented that could guide in setting the configurations and parameters for ES-PT's SA core roll-out.

The objectives of this contribution are:

- Benchmark the outcomes of in-vehicle decision-making approach versus the infrastructure decision-making approach
- Compare 5G functionalities of ES-PT (in NSA-NSA mode and two MECS) with NL trials set-ups such as NSA - SA and SA-SA networks

Transferrable assets:

- MCS app and OBUs

Planning:
Local testing will be performed remotely at the NL local site in February and April 2021. Then another session of testing will take place in the Spanish Local site in May and before going on the Full trials at the border in September 2021.

- DE contribution, UCC agnostic

Provide vehicles with Valeo Peiker's 5G TCU, MECs, RSUs, and applications to ES-PT corridor to **realize "EDM-enabled extended sensors with surround view generation" user story in an actual cross-border corridor.**
The main objectives of the contribution are:

  - Test the developments done in the DE TS regarding the surround view generation, the EDM, and the eRSU in a real cross-border deployment.
  - Test the feasibility of DE TS approach in a new scenario with different speed and traffic conditions. The speed of the UEs impact on communication performance as well as on the required reaction time and latency, and this can be assessed in a real cross-border corridor like the one of ES-PT, where you can drive at higher speeds than in the urban scenario of Berlin.

  - Exploration of the interoperability of RSU and ROI-based discovery service, EDM systems, MEC Broker interconnection in different countries (recommendations for inter-country deployments).
  - Contribute to ES-PT with an EDM and a surround view generation application which could be used to increase awareness in the ES-PT user stories as well as to challenge the network with additional CAM features.

Transferrable assets:
  - EDM Application
  - Surround view application
  - Mobile eRSU platform
  - 2 test vehicles
  - 2 Valeo Peiker 5G TCUs

Planning:
DE contribution will have multiple sessions of remote tests between April and July, before being trialled on the ES-PT CBC's open roads in September 2021 and in January 2022.

3.1.2. Preparation of the trials: Components deployment progress

The following section gives an update of the preparation of trials activities (authorizations delivery). Then this section is followed by an update on 5G Network architecture, Road side and cloud infrastructure,

Automated and connected vehicles, which served as a checklist on trials preparation to ensure the full readiness of the components needed to perform the trials.

3.1.2.1. *Authorizations*

In relation to the application for authorizations it is necessary to take into account that it is a long and laborious process that can take many months to obtain. In the case of the ES-PT CBC, numerous authorizations have been processed, among which are:

- Road authorizations:

Progress*: Ready*
Both at local level and at the cross-border to proceed with road closures to execute specific tests. It should be highlighted:

  - More complexity in the processing of authorizations by the Spanish side, having to obtain the approval of "*Ministerio de Fomento*"("Ministry of Development")
  - The great difficulty of closing a high traffic international bridge, which entails a great associated logistic complexity by the road operators.

- Authorizations related to 5G frequency:

Progress: Ready
In the ES-PT CBC there are two different situations. While in Spain no special authorization had to be requested, the Portuguese network has provisional authorizations that are being updated.

  - Telefónica in Spain, which will only install 5G NSA and will deploy it through its commercial network, so no special authorizations have been required for the 5G MOBIX.
  - NOS in Portugal: In relation to the frequency authorization, until the 5G spectrum allocation process is completed by Portuguese regulator ANACOM, the 5G-MOBIX project will be installed on a test network that will be completely segregated from the commercial network. NOS has a provisional authorization that ANACOM is regularly updating.

- Authorizations to proceed with the installation of the RSI:

Progress: Ready (Except for the permissions to fly the drone, which must be requested one month in advance).
In this case, the ES-PT CBC has different cases depending on the location where the road infrastructure is going to be installed.

  - Cases in which the radars are going to be integrated into the network infrastructure: the PT radar in the New Bridge.
  - Cases in which a road operator is involved and directly allows the installation: the radar in A28.

- Cases in which no authorization is required because the system will be completely provisional and will not hinder traffic. This is the case of the pedestrian detection system in Old Bridge (ES Site).
- The cases where authorizations must be requested some time in advance once the test dates are near: drone impact assessment.
- Finally, cases where it was necessary to obtain authorization from a third part, as it was the case with Spanish radars.

- Authorizations by the affected city councils:

Status: Agreement with the authorities, pending completion of procedures 1 month before the trials
Meetings have been held with the municipalities affected by the tests (Tui and Valença). From these meetings, information has been obtained regarding the appropriate way to proceed in order to carry out these tests in a safe framework. This includes:

- Advance notice in order to be able to make a good communication of the cut to the citizens.
- Advance notice in order to have the cooperation of the police to divert the traffic.
- Advance notice in order to manage the appropriate fencing of the test area, preventing pedestrians from accessing it (in the case of the Old Bridge).
- Sending of informative mail to other affected entities.

3.1.2.2. *5G network*

Table 3 5G network architecture at the ES-PT CBC

Component	Description	Notes	Development/deployment progress
MNOs	Telefonica and NOS		
Deployed architecture	NSA	SA will be deployed if possible, according to the commercial roadmap of Telefonica at ES side. SA will be deployed in PT side after deploying, testing and verifying the NSA functionalities.	NSA deployed in ES. NSA deployment in progress in PT.
Base station	eNB/gNB	gNB for 5G technology eNB for anchoring	

Radio frequency	Band n78 (3600-3800 MHz)	4G anchor on 1800 MHz and 2600 MHz	
Sites	7 5G sites	4 sites from Telefonica (Spain) 3 sites from NOS (Portugal)	Telefonica sites already deployed and running.
Number of cells/site	8 cells	In total the ES-PT CBC counts on 8 cells. 4 of them are located on the border (2 in each side), and the remaining ones are located in the local sites: 2 in ES side, and 2 in PT side.	

3.1.2.3. *Road side and cloud infrastructures*

Table 4 Road side and cloud infrastructure at ES-PT CBC

Component	Description	Notes	Development/deployment progress
MECs	2 MEC nodes	1 MEC node on the PT side (Riba d'Ave) 1 MEC node on the ES side (Vigo)	Both MECs installed. Spanish MEC already deployed. Portuguese MEC deployment in progress.
Cloud	2 ITS Center applications	1 ITS Center in Spain 1 ITS Center in Portugal	ITS Centre deployed in ES.ITS Centre under development in PT.
RSUs (PC5/ITS-G5)	5 RSU with cellular 5G connectivity	2 RSUs on the ES side (supplied by CTAG) 3 RSUs on the PT side, supplied by Valeo (OBU Vulcano-5G)	All RSUs developed, tested, and deployed.
Lidars	None		
Cameras	None		
Radars	4 traffic radars for vehicle detection and classification	2 traffic radars in ES side (supplied by CTAG) 2 traffic radars in PT side (supplied by IT)	All Traffic Radars developed, tested, and deployed.
Pedestrian detector	2 pedestrian detector systems	1 pedestrian detector system based on image processing (supplied by CTAG) 1 pedestrian detector system based on radar (supplied by SIEMENS)	Pedestrian detector developed, deployed, and tested in ES. Pedestrian detector under development in PT.
Smartphone app	1 Smartphone VRU App	Smartphone App for connected VRU	Communication part is deployed, CAM and DENM. Improvements on the interface and warnings.

Collision detection system for VRU	1 MEC application for Collision Detection for VRU	1 Application to detect Collisions between VRU and vehicles	Proft of concept developed. MEC application under development.

3.1.2.4. *Automated and connected vehicles*

Table 5 Automated and connected vehicles at the ES-PT CBC

Component	Description	Notes	Development/deployment progress
Number of vehicles, type	3x C4 Picasso 2nd gen 1x VW Golf Mk7 TDI 1x CTAG Autonomous Shuttle 1 ALSA BUS	Legacy vehicles equipped with sensors and systems to be autonomous.	All vehicles equipped with sensors and devices. Every component is integrated.
OBU	5G Qualcomm Chip RM 500Q		Integrated.
Cameras	• ALSA BUS: IDS, front and lateral 60º 60m (car), 40 m (ped.) • CTAG Autonomous Shuttle: IDS, Front and lateral, 60°, 60m (car), 40 m (ped.) • C4 Picasso: Mobileye, Windshield, 30º, 60m (car), 40 m (ped.) • VW Golf: Mobileye, Windshield, 30º, 150m (car), 40 m (ped.)		Integrated.
Lidars	• ALSA BUS: 2D LIDAR SIK, Front and lateral, 180ºHFV, 0º VFV, range:10m. 3D Velodyne, roof, 360 ºHFV, 30º VFV, Range (6-100m) • CTAG Shuttle:		Integrated.

	2D LIDAR SIK, Front and lateral, 180ºHFV, 0º VFV, range:10m. 3D Velodyne, roof, 360 ºHFV, 30º VFV, Range (6-100m) • C4 Picasso: 2D LIDAR Valeo ScaLa, Front and rear bumper, 145ºHFV, 3,2º VFV (4 layers), range:200m. 3D Velodyne, roof, 360 ºHFV, 30º VFV, Range (6-100m) • VW Golf: 2D LIDAR Valeo ScaLa, Front and rear bumper, 145ºHFV, 3,2º VFV (4 layers), range:200m. 3D Velodyne, roof, 360 ºHFV, 30º VFV, Range (6 100m)		
GPS	• ALSA BUS: Trimble Trunk • CTAG Autonomous Shuttle: Trimble Trunk • C4 Picasso: Trimble Trunk • VW Golf: Trimble Trunk		Integrated.

3.1.2.5. *Interoperability between ES-PT CBC and TSs*

For the benefice of the trials and of the TSs contribution to CBC, WP4 monitors and ensure that the interoperability between the CBC and the TSs is effective.

At the ES-PT CBC, for enabling the interoperability between the trial sites' systems and the local ones at the cross-border, some measures have been applied:

The use of standardized V2X messages in order to ensure interoperability between external and local vehicles:

- ETSI CAM 1.4.1 (U.u)

- ETSI DENM 1.3.1 (U.u)
- ETSI CPM 2.1.1 (U.u)

The share of Geoserver services to trial sites, by allowing them to access currently available topics, or creating new ones for them.
The use of a standardized MEC architecture, which enables the deployment of new applications from trial sites in the MEC.

Table 6 Messages that will be used by TS in the ES-PT CBC.

TS	Messages	Description
FI	-	Not defined
FR	CAM CPM	Cooperative Awareness Messages used to report the position and velocity of the vehicle. Collective Perception Messages used to report the position and the type of objects detected sensors
NL	CAM MCM	Cooperative Awareness Messages used to report the position and velocity of the vehicle. Manoeuvre Coordination Message for manoeuvre with the support of the infrastructures
DE	CAM	Cooperative Awareness Messages used to report the position and velocity of the vehicle

The security is implemented in the MQTT broker level. There are two MQTT brokers available with three different protocols (Table 6 & Table 7). The brokers are under development and can be changed until the beginning of the trials. The security strategy is still in discussion.

Table 7 Broker configurations implemented in the ES-PT CBC

UR	Port	Protocol	Security
broker.es.av.it.pt	1883	MQTT	Unencrypted
broker.es.av.it.pt	8883	MQTT	Encrypted [ssl://es.av.it.pt:8883]: - Username: pt-broker - Password: ByTvvr
broker.es.av.it.pt	8884	MQTT	Encrypted with client certificate required (Mandatory): - Username: pt-broker - Password: ByTvvr
testitscenter.siscoga4cad.com	21883	MQTT	Encrypted (tls) with client certificate required (Mandatory): - Username: 5gmobix - Password: lmCpT13a

3.1.3. Detailed planning

The planning of trials was determined by the conditions proposed by the road operators who ensure the safety and welfare of citizens. It is important to emphasize that all the locations where trials will be carried out are roads with a large traffic of vehicles. The "New International Bridge" between Tui and Valença has high daily truck and vehicle traffic making its closure a logistical challenge for operators in both countries.

In order to maximize the tests to be performed during the cutting periods and to facilitate the transit of vehicles as much as possible, the following instructions have been followed:

- 72 hour cutting periods.
- Try to focus the trials on which roadblocks are required in the summer months to take advantage, as far as possible, of the months with a high number of hours of sunlight.
- Avoid roadblocks in the months of July and August due to the increase in traffic during the summer vacations.

In addition, it is necessary to justify the reason why roadblocks for New Bridge have been reserved for the month of June 2021 and duplicated in the months of October/November.

This is due to the current uncertainty caused by the COVID-19 pandemic: if the COVID-19 restrictions allow the organization of the EUCNC in Porto, the June testing session will be postponed to proceed with the 5G-MOBIX Project demonstration preparation by the CBC ES-PT. In this way, the test sessions foreseen in the New Bridge in the planning below (and the corresponding TS contributions) appear twice in June and again in October 2021. Finally, it should be noted that agnostic test cases will be performed in series and even in parallel with specific test cases, since they do not require roadblocks. These tests will be planned once the installation of the 5G network on the Portuguese side has been completed.

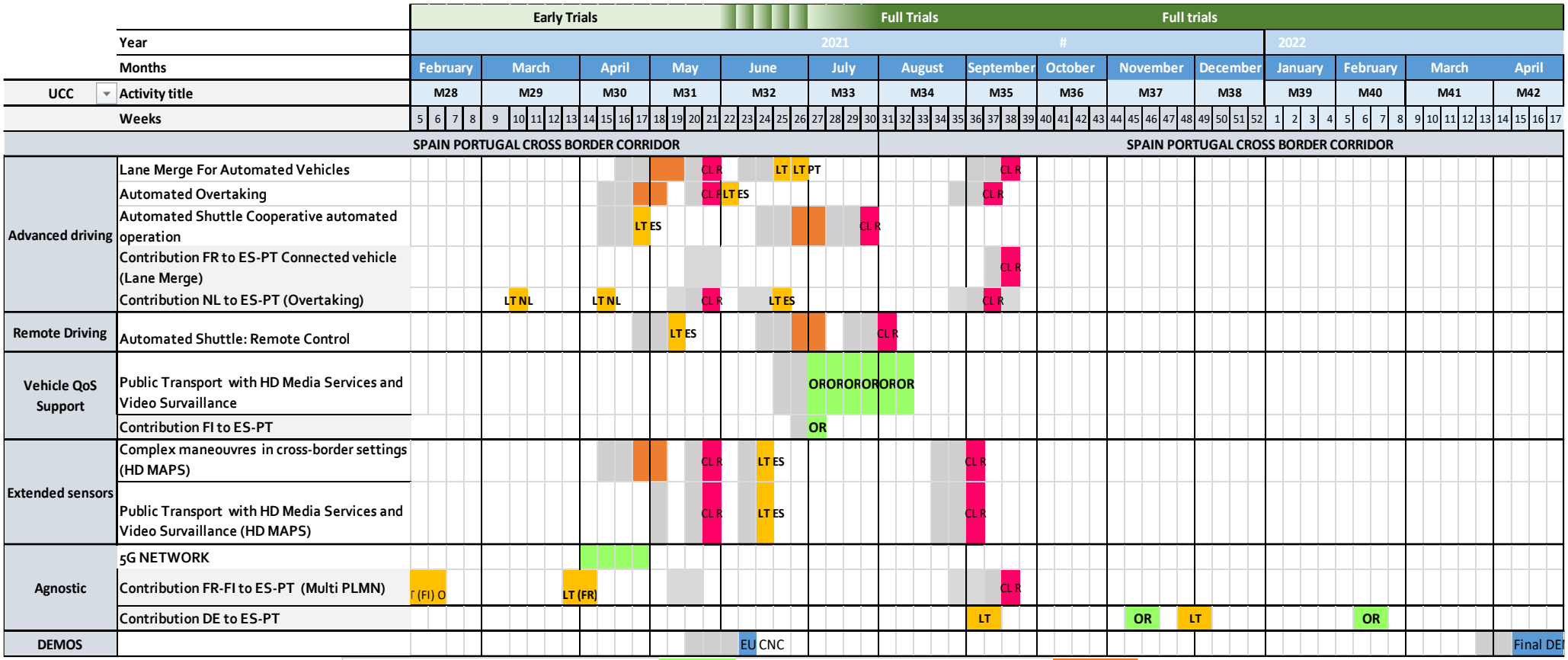

Figure 3 Trial planning - ES-PT CBC

3.2. Greece-Turkey (GR-TR) cross-border corridor

3.2.1. Overview of the trials activities

3.2.1.1. *Overview of the UCC/USs that will be tested*

The different USs that will be tested at the GR-TR CBC are presented in the following table according to the different UCCs.

Table 8 Overview of the user stories – GR-TR CBC

UCC Name	US ID	US Description
Vehicles platooning	Platooning (2.1)	Two or more vehicles move in a convoy ("platoon") with seemingly virtual strings attached between each other. The leading vehicle is driven by a human driver in the GR-TR case, but the followers use the messages transmitted by the leader over either the direct communication links (V2V) or the 5G network (V2N2V), along with the other automated driving functionality that exists in the vehicles, to adjust their manoeuvres.
	See-What-I-See (2.1)	The road view of one of the vehicles as captured by a high quality camera is shared with the others in the form of a video stream. In this scenario, it is the leader truck of the platoon that transmits the video to the followers, but the see-what-I-see functionality is independent of whether the vehicles are in a platoon mode or not. Thus, the see-what-I-see operation can continue even when the platoon is dissolved at the customs area for further checks.
Extended sensors	Assisted border crossing (3.2)	By extending and making use of the sensor data on the vehicle and the other road users, a safe and zero-touch border-crossing is aimed for a hard border like the one that separates GR and TR. The vehicles will be checked/monitored remotely by the authority applications, and will be provided clearance if no threat is detected. In an adverse situation, the vehicle will not be allowed to pass, and may even be automatically stopped by the application on the edge.
	Truck routing in customs area (3.2)	The customs zone on the TR side may require vehicles to go through X-ray checks, which significantly increases the border passing time for drivers, who also need to submit papers and get administrative approvals before continuing to the GR customs zone. In order to perform these two tasks in parallel, the driver leaves the vehicle at the entrance of the customs area to complete paper checks for himself, the other possible passengers on the vehicle, the cargo and the vehicle while the vehicle is autonomously driven by a remote application at the cloud to the X-ray building.

The user stories that are going to be tested at the GR-TR corridor fall under two different use case categories of "Vehicles Platooning" and "Extended Sensors" as in Table 8. Whereas in D2.1 [2]"*5G-enabled CCAM use cases specifications V2.0*" includes only two user stories for GR-TR, under the current setting the activities that will be performed for one of the original user stories, namely "Platooning with see-what-I-see functionality", are divided into three parts based on the separate applications developed for each of these parts, and the vastly varying characteristics that should be exhibited in terms of vehicle manoeuvres and network functionalities during the trialling phase.

3.2.1.2. *Overview of the 5G features and technologies tested at GR-TR CBC*

The following Table 9 lists all the 5G features and technologies that will be used by the GR-TR CBC during their trials to implement the different CCAM Use cases.

Table 9 Overview of the 5G features and technologies tested at GR-TR CBC

5G technology/ solution/ feature	Solution/technology description	Related Use case
Seamless cross border (S1) handover with 5G EPC	Seamless handover for the 5G NSA architecture translates to these two conditions on the radio and core network sides, respectively: a smooth transition of radio coverage from one operator to the other and the home routed (HR) roaming. Thus, alternative coverage conditions will be assessed with the HR roaming scenario.	See-what-I-see, assisted border crossing
Network slicing	Slicing concepts: Current slicing concepts are not related to QoS differentiation or traffic separation. Mainly used to route traffic based on specific use cases (Enterprise, IOT) or implement shared network concepts. See also D2.2 [8] Page 30. • PLMN ID based: Applicable when two PLMN share the same RAN, though use separate cores networks each one owning a unique PLMN ID. Home PLMN configured on SIM. Only1 x Slice per UE supported. • APN Based: Used to direct the traffic to different domains selecting a PGW which serves the specific domain. Is mainly a PGW selection method, not a traffic separation or QoS related. Not all UEs support more than one APN (simultaneous active). Must be supported by terminal OS to select the relevant outgoing IP interface. • DÉCOR: Applicable when two PLMNs share the same RAN, through different core network domains (different MME/SGW/PGW Chains). Each core network domain serves specific type of users differentiated by a UE usage type (subscription). Only 1x Slice per UE supported. • eDECOR: Similar as above, though selection is based on DCN-ID configured on the UE. Only x 1 Slice per UE supported. • 5GC slicing: N/A There is also the possibility to have geographically separated slices which are only available in a certain geographical area. (Abstract from D2.2 ([8])) This is the concept followed also in accordance with the EDGE computing commented in Row "EDGE". Via the distributed EPC architecture, QoS concepts shall be supported E2E to be able to get appropriate handling. 4G/NSA QoS differentiation is obtained by defining QCIs. Our analysis shows it is not possible to demonstrate network slicing with the 5G NSA architecture, and only one UE/service or core network or PLMN being active at a time.	N/A

	The 5G SA core is required for a better demonstration of the network slicing functionality.	
Local breakout roaming with EPC	LBO with session release and redirect. "Release with Redirect" and "S1 Handover" procedure on RAN and the S10 reference points will be defined. The UE and RAN will also be configured with information about neighbouring PLMNs also called equivalent PLMNs. The two main concepts to be implemented on MME to support a smooth steer of the UE into selecting a visitor PLMN network at cell selection and cell reselection to be configured are (Equivalent PLMN, Static IMSI PGW selection)	Platooning See-what-I-see Assisted border crossing
Home routed roaming with EPC	HR with session release and redirect. The S10: Reference point between MMEs for MME relocation and MME to MME information transfer will be configured. This reference point can be used intra-PLMN or inter-PLMN (e.g. in the case of Inter-PLMN HO). HR deployment shall be configured, neighbouring PLMNs (roaming partner) shall be further configured as Equivalent PLMNs (ePLMN) on MME.	Platooning, See-what-I-see, assisted border crossing
Edge computing	The relevant deployment variants of deploying the Packet Core in an EDGE scenario are discussed in the document: https://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp24_MEC_deployment_in_4G_5G_FINAL.pdf [9] • Bump in the wire: MEC platform installation point ranges in locations between the base station itself and the mobile core network. • Distributed EPC : the MEC host logically includes all or part of the 3GPP Evolved Packet Core (EPC) components, as specified in the 4G system architecture in ETSI TS 123.401, and the MEC data plane sits on the SGi interface. • Distributed S/PGW: Only SGW and PGW entities are deployed at the edge site, whereas the control plane functions such as the Mobility Management Entity (MME) and HSS are located at the operator's core site. • Distributed SGW with Local Breakout (SGW-LBO): Co-locate MEC hosts with the SGW. The provided Ericsson solution for 5G-MOBIX, is the Distributed EPC Architecture. The advantage is that session management is not impacted in contradiction to proprietary bump in the wire, even for inter-MEC handover since the standard 3GPP procedures are used to keep the original PGW as anchor. This assures session continuity. Application level mobility is achieved by reassigning the IP address to the user or enforcing a breakout policy into the target SGW. Charging and lawful interception are supported natively by the solution. Can of course handle different types of traffic e.g. in the Enterprise MBB case it can provide Best Effort, Interactive, Streaming etc services, For which related QoS mechanisms (QCIs) need to be supported E2E (UEs, Network, IP NW, Application). Though the above deployment architecture concern mainly the data plane deployment, mobility management of sessions, network QoS, charging, regulatory. EDGE computing is a wider term including also use case/industry specific aspects e.g. ITS infrastructure in V2X context.	AssBCrossing

	Finally, since there are no unique definitions of the terms for the concepts of near and far edges, service providers can define their own approach based on various criteria not strictly related to distance. See the following articles: https://www.thetech.in/2019/06/far-edge-vs-near-edge-in-edge-computing.html https://www.eejournal.com/article/what-the-faq-is-the-edge-vs-the-far-edge/ https://www.rcrwireless.com/20200515/telco-cloud/the-right-edge-for-the-right-application AssBCrossing A double instance implementation of the Assisted Border Crossing application will be implemented at the TR and the GR edge (on top of the single instance implementation). During the double instance implementation various mechanisms in the OBU and the WINGS platform will be tested for improved functionality. These mechanisms are: • Application function detecting imminent border crossing & service interruption • Upon imminent HO detection OBU is instructed to go to reduced operation mode during service interruption (service degradation) • Application state transfer is initiated among the edge instances • OBU is informed about the IP address of the new instance and the IP pool to be assigned to the OBU after border crossing	
inter-PLMN connectivity using the Internet (i.e., using the public IPX interconnection points of each country - towards the Internet)	Both MNOs' core networks will be interconnected via the Internet (use of routable addresses) when the direct interconnection is not available. This connection will support S6a, S8 and S10 core interfaces.	Platooning, See-what-I-see, assisted border crossing
inter-PLMN connectivity using a leased line	Both MNOs' core networks will be connected through a 1Gbps direct interconnection (leased line via OTEGlobe, wholesale carrier). This connection will support S6a, S8 and S10 core interfaces. The direct interconnection reduces the number of intermediate hops allowing GR-TR CBC to achieve target KPIs (i.e. in terms of latency). The direct interconnection will be available for six months in total (2 periods of 3 months duration).	Platooning, See-what-I-see, assisted border crossing
Evaluation of ML for predictive HO and APP state transfer	The WINGS platform includes NL mechanisms for detecting imminent HO and potential interruption (based on OBU reported GPS coordinates and proximity to customs agents). Pro-active actions take place to prepare the application for the service interruption and state transfer to a different application instance (data transfer among edge instances, degradation of application capabilities during service interruption, expect pool of IPs, etc.)	AssBCrossing

Data privacy / GDPR mechanisms in place	INTRA Streamhandler (anonymisation of data streams on the fly based on geolocation) WINGS User login & authentication applied at an application level. E2E application message encryption applied between the OBU, the RSU and the Platform.	AssBCrossing (3.2)

All these 5G technologies will be implemented according to the planning presented below in Figure 4.

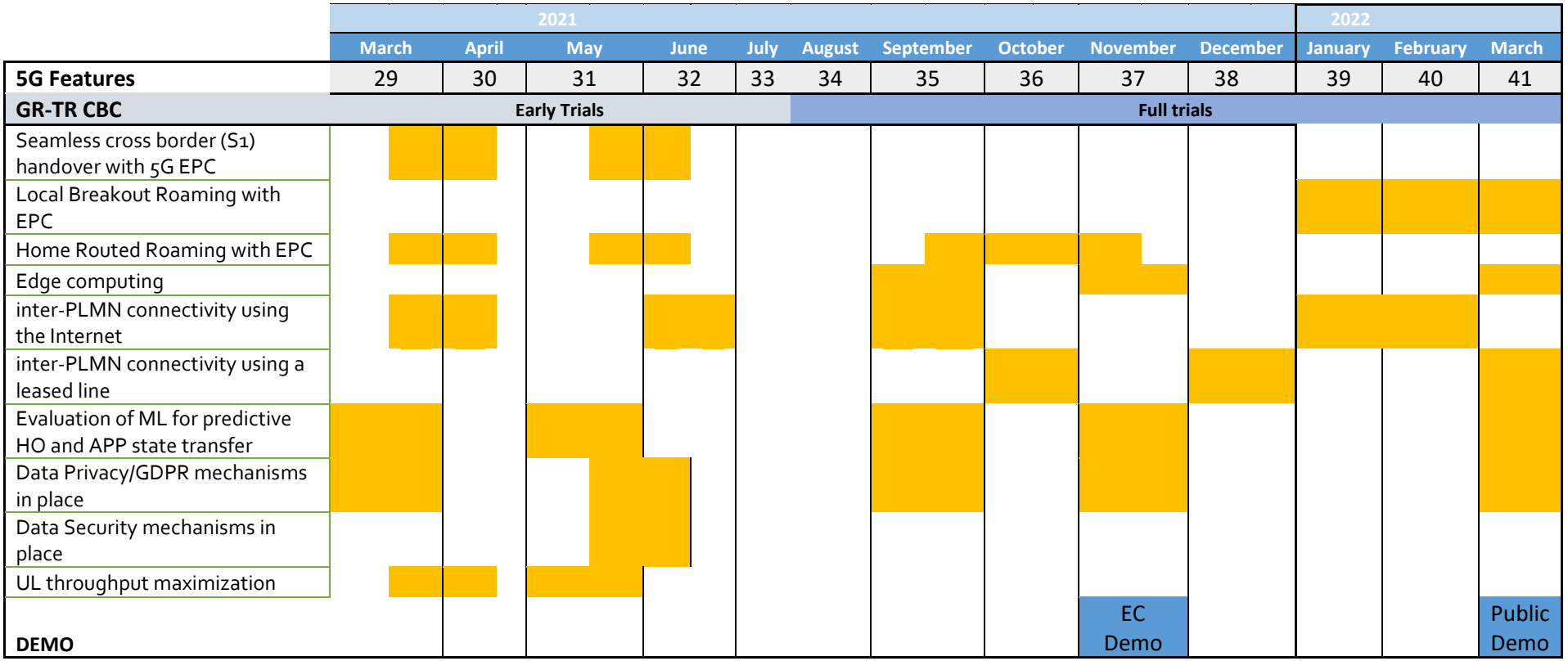

Figure 4 5G features planning at GR-TR CBC

3.2.1.3. *Trial sites contribution to GR-TR cross-border corridor*

The Finnish trial site will contribute to the see-what-I-see user story, which will initially be tested at the Ford Otosan plant (Eskişehir/Turkey) before the actual trials at the İpsala-Kipoi border.

- FI TS contribution to US See-What-I-See user story

LEVIS video streaming solution: GR-TR CBC will directly employ the video streaming service (LEVIS) the Finnish trial site develops in the see-what-I-see application as demonstrated in Figure 5.

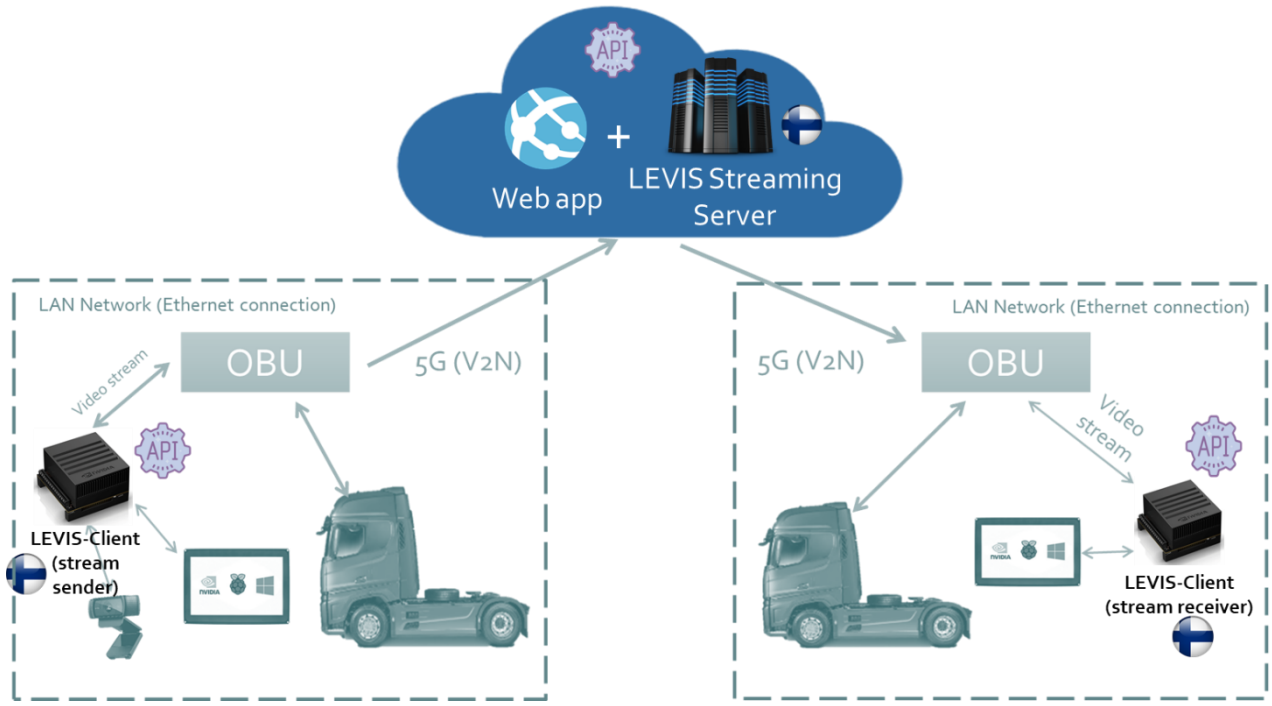

Figure 5 FI Contribution to GR-TR CBC's trials

- The contribution consists of a server for live video streaming under handover (LEVIS).
- In FI, this will be texted with multi-SIM OBUs. In the CBC, this will be tested with a single-SIM OBU.
- In FI, this will be tested on top of FI vehicle under open road. In the CBC, this will be tested on top of FORD-OTOSAN truck.
- These protocols will help to test continuity (video stream after handover/roaming).

Transferrable assets:

- LEVIS server (software and hardware).

Planning:
Ready:

- LEVIS client devices.
- LEVIS server.
- Web application interface developed and tested.

Pending:

- Deployment and integration in GR-TR servers (by M28).
- Tests and trials in GR-TR CBC as part of SWIS user story (various periods in M30-M42).

3.2.2. Preparation of the trials: Components deployment progress

The following section gives an update of the preparation of trials activities (authorizations delivery). Then this section is followed by an update on 5G network architecture, Road side and cloud infrastructure, automated and connected vehicles, which serve as a checklist on trials preparation to ensure the full readiness of the components needed to perform the trials.

3.2.2.1. *Authorizations*

- Road authorizations

Progress: Partially ready

The trial will be performed at the Ipsala-Kipoi border, which involves the parts of the highways on both the Turkish and Greek sides that leads to and leaves the border region, respectively, as well as the customs zones of Turkish and Greek authorities.

The TR and GR customs agencies have granted authorization to perform the tests within the customs zone. They are not responsible and cannot provide any kind of permit for the highway/national roads beyond the customs site (where they have jurisdiction), but they are willing to collaborate and allow our trials within the customs area, which they have control over.

The GR agency further mentions that as for the most part there is only one traffic lane, so the trials would have to take place in low traffic hours/days (they offer Mondays & Tuesday 05.00 – 07.00 as an example), where the regular traffic would not be impacted too much.

ICCS is in contact with the relevant ministries and agencies to secure trialling licenses for the roads beyond the customs site on the Greek side whereas in Turkey, Ford Otosan has the right to perform tests on the highway leading to the customs area.

- Authorizations related to the 5G frequencies

Progress: Ready

- GREECE: Since there is a commercial 5G service in Greece beginning with 2021, Cosmote will switch to those bands that are commercially available while using the 5G test network already deployed. The effects of this are being analysed in order to ensure that no interference is caused to the commercial services on the GR side.
- TURKEY: Turkcell has acquired 5G test licenses for Ford Otosan plant and Ipsala border area. It is effective until the end of 2020, but once the first license is granted, the next step is to renew it at the beginning of each year, which has been done in January 2021. Also, the regulatory body in Turkey is on the advisory board of 5G-MOBIX, which makes it easier to get/renew the license for Turkcell.

- Authorizations to proceed with the installation of the Road Side Infrastructure (RSI)

Progress: Ready

Among all four user stories, "truck routing" and "assisted border crossing" are the ones that require roadside infrastructure installation. The GR and TR customs areas will host the RSI equipment as allowed by the agencies.

3.2.2.2. *5G network*

Table 10 5G network architecture at GR-TR CBC

Component	Description	Notes	Development/deployment progress
MNOs	Cosmote (GR), Turkcell (TR)	Radio access network and core network equipment is provided by Ericsson GR and Ericsson TR to Cosmote and Turkcell, respectively.	All equipment and software have been delivered to the MNOs, and work is in progress with the configurations.
Deployment architecture	NSA	Based on the SCC Mode 3 and NSSAI network slicing readiness timeline, a two- phased approach was proposed to fit into the 5G-MOBIX project timeline. Due to project budgetary constraints, it is decided not to deploy 5GSA network and continue with the 5GNSA deployment.	The NSA architecture is chosen at the beginning of the project because of the availability of commercial-grade equipment from Ericsson. In the January-February 2020 period, an assessment was made to explore the options to start with the SA architecture or migrate to SA at a second stage, but these options were not deemed economically and practically feasible. Especially, the migration is not a simple task, since the NSA and SA 5G cores exhibit

			substantially different paradigms, where the SA core is cloud-native by design, rendering it impossible to re-use the deployed hardware.
Base station	4 gNBs (1 in Greece, 3 in Turkey)	There is also a local site at the premises of Ford Otosan in Eskişehir, where 1 gNB is deployed to be used in the initial development/ testing activities.	All five base stations are deployed (including the one in Eskişehir).
Radio frequency	2600 MHz (B7),3.5 GHz (n78) - Covering the 3300-3800 MHz band	The gNBs will use the 3.5 GHz band while the anchor LTE cells for the NSA architecture will be operating at 2600 MHz. To be specific, 100 MHz of non-overlapping spectrum will be used in the 3600-3800 MHz range on both sides of the corridor.	The 5G test license is granted in Turkey for Turkcell – a commercial license is not expected over the time frame of the project. However, Cosmote will be using its commercial license beginning with 2021.
Sites	3 in Turkey 1 in Greece	Three of these sites are on the Turkish side of the border, and one site is in Greece. An additional local site is required for the tests at the Ford plant.	All of the site installations are completed.
Cells	5 cells in Turkey 1 cell in Greece	One cell is on the Greek side. In line with the current architecture for the LTE network, two of the Turkish sites have two sectors per cell, and the third one is equipped with one omnidirectional cell. Thus, there are five cells in total at the Turkish side. Again, another cell is located at the Ford Otosan plant.	Ready for testing

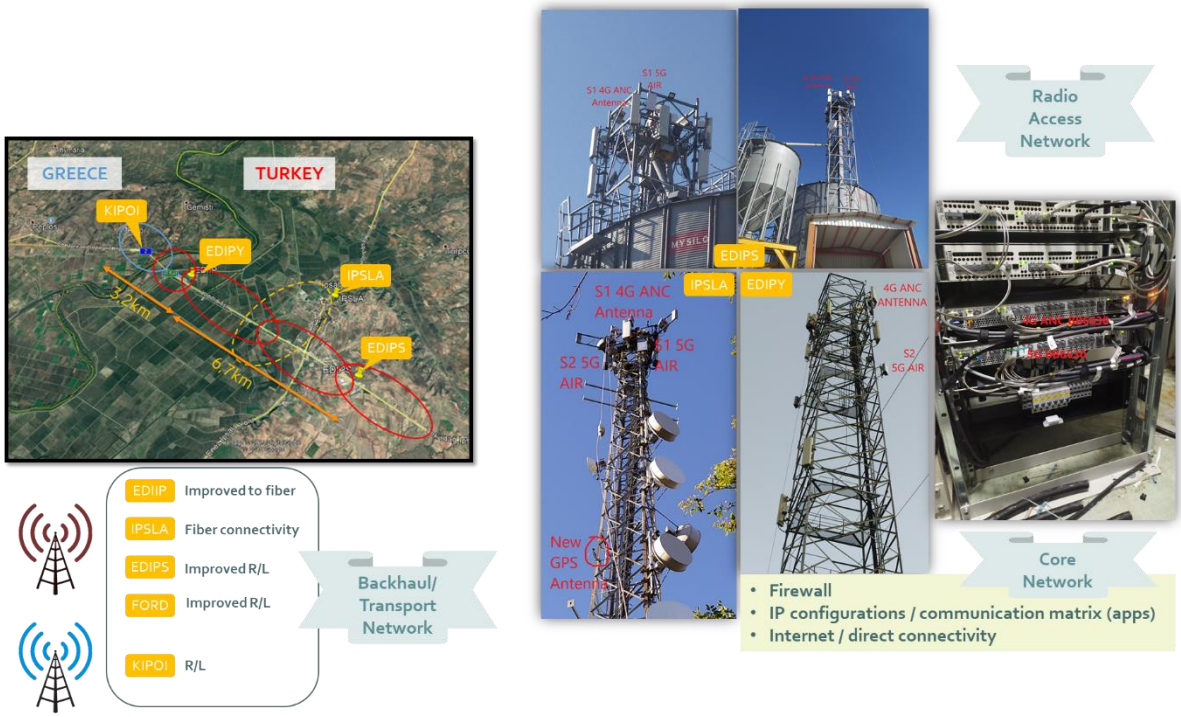

Figure 6 Preparing the 5G network of the GR-TR corridor for the trials

3.2.2.3. *Road side and cloud infrastructure*

Table 11 Road side and cloud infrastructure at GR-TR CBC

Component	Description	Notes	Development/deployment progress
MEC application	2 x 3 Edge computing servers (3 in GR and 3 in TR)	Not necessarily following the ETSI MEC architecture, three user stories require MEC / edge applications: Platooning, see-what-I-see and assisted border crossing. These will be hosted at the edge sites of Turkcell and Cosmote.	The initial versions of the applications are ready for verification / integration.
Cloud infrastructure / application	2 Cloud environments / applications WINGS (Athens), TÜBİTAK (Istanbul)	Different environments / applications for the different user stories.	The cloud infrastructures are in place (Athens and Istanbul). The applications have their initial version ready for further testing of the user stories: WINGS – assisted border crossing and TÜBİTAK-truck routing.

RSUs / IMEC (4G, 5G, C-V2X PC5, GPS)	3 RSUs 1. C-V2X PC5 Cohda MK6c 2. 5G provided by Valeo (under discussions) 3. 4G Mikrotik wAP LTE kit GPS receiver Navilock NL-8012U	Provided by IMEC. GPS for timing synchronization (in ms level) is needed for evaluation. 4G modem is only used for remote configuration.	3 RSUs have been assembled with all the communication modules and GPS and have been shipped to Ford. Expected delivery any time soon.
Road Side infrastructure / WINGS	1 RSU (WINGS) Quectel RM500Q 5G chipset Embeded smart traffic light and HD camera MX-106 servo motor	The Road Side Unit (RSU) is designed to capture and send real time image frames for the licence plate recognition, and control the border bar and the traffic light. As a computation platform, the raspberry pi 3 is used , and has built in Wi-Fi, 4G and 5G connectivity. Power supply is provided form AC voltage.	The WINGS RSU is ready and has been successfully connected to the Ericsson 5G testbed at Cosmote facilities in Athens. Initial tests have been performed to measure the performance and E2E functionality has been achieved.
Lidars	2, Velodyne Lidar VLS 128	Needed for the truck routing user story inside the TR customs area.	Equipment is ready to be assembled on the IMEC RSUs once they arrive in Turkey.

3.2.2.4. *Automated and connected vehicles*

Table 12 Automated and connected vehicles at GR-TR CBC

Component	Description	Notes	Development/deployment progress
Number of vehicles, type	2 vehicles, both 4x2 N3 type trucks.	Provided by Ford Otosan.	One vehicle is ready and fully equipped with the required sensors and ECUs. The second one is planned to be ready until the end of February 2021, which needs a steering wheel controller ECU. Procurement of this part was delayed due to COVID-19.

OBU / IMEC	2 OBUs 4. C-V2X PC5 Cohda MK6c 5. 5G-Modem provided by Quectel 6. 4G Mikrotik wAP LTE kit GPS receiver Navilock NL-8012U	Provided by IMEC. GPS for timing synchronization (in ms level) is needed for evaluation. 4G modem is only used for remote configuration	2 OBUs have been assembled with all the communication modules and GPS and have been delivered to Ford Otosan, Istanbul. From there, they are immediately handed over to Turkcell for 5G connectivity tests. Upon successful completion of the 5G connectivity testing, one of the OBUs was used in the initial 5G network testing at Ipsala (TR border). The next step is to perform the Ford Otosan ECU integration of the OBUs.
OBU / WINGS	1 OBUs - Quectel RM500Q 5G chipset embeded CO_2, proximity, NFC, vibration, luminosity, GNSS sensors Embedded	The On Board Unit (OBU) is designed to collect and send real time vehicle information and receive autonomous driving directives. As a computation platform, the raspberry pi 3 is used with a SIM7600 modem attached, providing 2G (GPRS)/3G/4G connectivity. 5G connecitivy is provided by the Quectel chipset, while WIFi connectivity is also available. Power supply is provided form the connected vehicle's battery, through the On-Board Diagnostics (OBD) port connection. There is a capability for secondary power supply from AC voltage (220 V).	The WINGS OBU is ready and fully functional. It has been successfully connected to the Ericsson 5G testbed at Cosmote facilities in Athens, and initial tests have been performed, collecting basic performance KPIs. E2E functionality has been achieved through interconnection with the WINGS cloud platform and RSU. The final pending test is to check the interconnectivity of the WINGS OBU with the IMEC OBU and Ford Otosan truck controllers.
Cameras	2 cameras per vehicle. Mobileye 6 Series and Knorr Bremse Ford Specific Camera	These cameras are distinct from the ones used in the see-what-I-see user story. They will aid the vehicle in perceiving the environment and making automated decisions for manoeuvre.	Cameras are ready and one vehicle is equipped with all cameras. The second one is waiting for the steering wheel ECU. This ECU assembly requires vehicle cabin tilt. Thus, we need to wait until this ECU is assembled.

Lidars	N/A	LIDARs will be located at the border crossing zone, instead of the vehicle.	No Lidar on the vehicle.

3.2.3. Detailed planning

The GR-TR partners are using the first months of 2021 to have all components ready for end-to-end testing. The initial testing of the user stories will be carried out at the Ford Otosan plant, where there is a closed track and 5G connectivity, for the period March-April 2020. The next two months will be devoted to the open road tests, which will help the corridor get prepared for the demo agreed to take place in November 2021. Based on the upgrades from the trials, further trialling will be carried out in October-November 2021 for two of the user stories. A final set of tralling is planned for the other two in during the first quarter of 2022. The rest of the timeline will be saved for upgrades and improvements.

The rationale for grouping platooning and see-what-I-see together is that these two user stories both require two vehicles while the assisted border crossing and truck routing can each share one vehicle for testing and trialling.

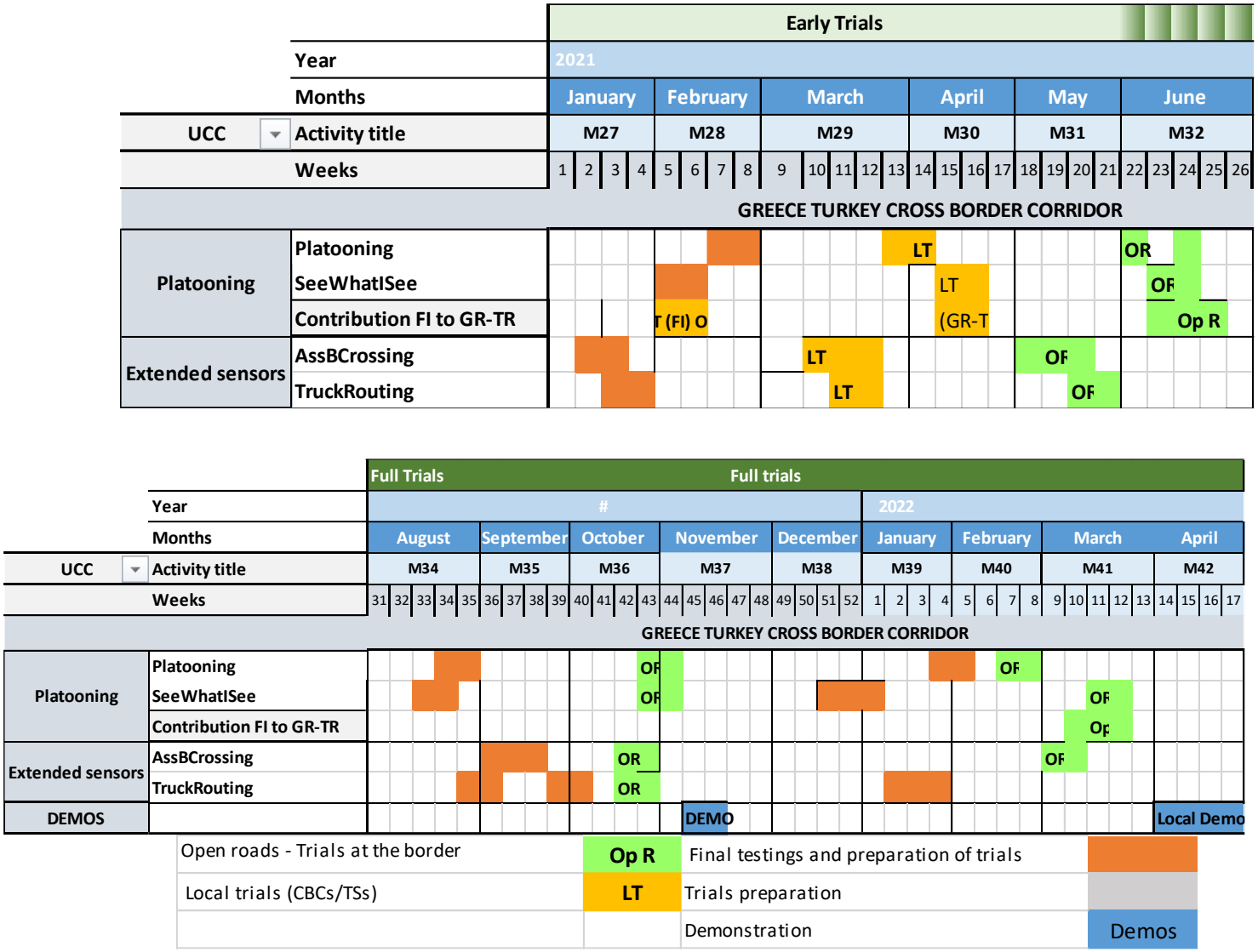

Figure 7 Use case specific trials planning - GR-TR CBC – Early trials from January 2021 to June 2021 (top) - Full trials from August 2021 to April 2022 (bottom)

4. TRIAL SITES PREPARATION OF TRIALS

The following section presents an overview of the preparation of the trials at the trial sites at M26. As for the previous section, the next ones provide complete overviews on the trials (including the User Stories implemented and the CBCs issues addressed) as well as a description of the preparation of trials progress. Detailed plans are also provided in the following sections for each TS detailing their trials activities from 2021 and aligned with WP4 general timeline.

4.1. Netherlands (NL) Trial Site

4.1.1. Overview of the trials activities

4.1.1.1. *Overview of the UC/USs*

Table 13 Users stories implemented at NL TS

UCC Name	US Id	US Description
Advanced Driving	CCA (1.3)	Cooperative collision avoidance using MCM
Extended Sensors	CPM (3.5)	Extended sensors with CPM messages
Remote Driving	5GPositioning (4.3)	Remote driving using 5G positioning

The Cooperative Collision Avoidance (CCA) (see Figure 8) user story uses MCM messages to negotiate between connected and automated vehicles which are on a collision course. The MCM messages can contain both a desired trajectory, which the vehicle prefers to take, as well as the planned trajectory, which is a collision-free trajectory. Two different scenarios are tested: a scenario with an MCS (Maneuver coordination Service) application in the MEC, which provides advices to the vehicles, as well as a scenario without application in the MEC, in which the vehicles negotiate between each other. In the evaluation the vehicles will be connected to different networks: the TUE vehicle to the KPN 5G-network and the VTT vehicle to the TNO 5G-network.

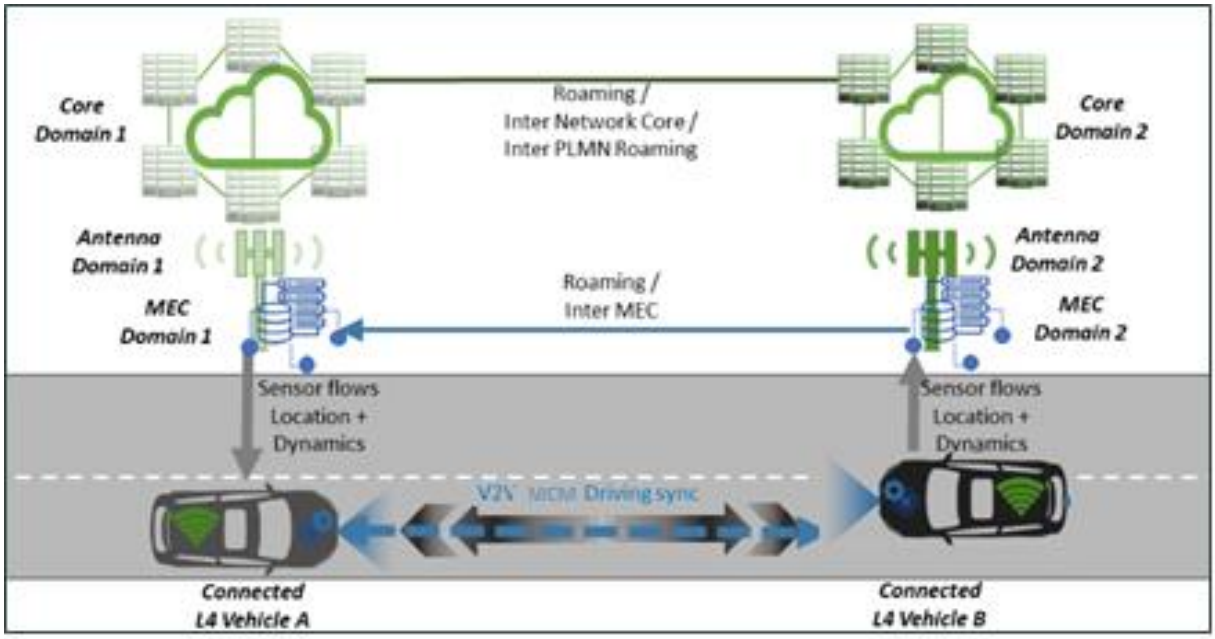

Figure 8 US cooperative collision avoidance using MCM

The user story Extended sensors with CPM messages focuses on enhancing the environmental perception of vehicles by enabling the real-time data exchange between vehicles and RSU using Collective Perception Messages (see Figure 9). The user story involves both KPN 5G-SA network and TNO 5G-SA network. To evaluate the user story, a cooperative lane merging scenario at the on-ramp to a motorway is considered as shown in the Figure 9 Extended sensors with CPM messages. Traffic information obtained from the roadside cameras is available in the CPM messages. CAM messages from connected vehicles will additionally be used and exchanged.

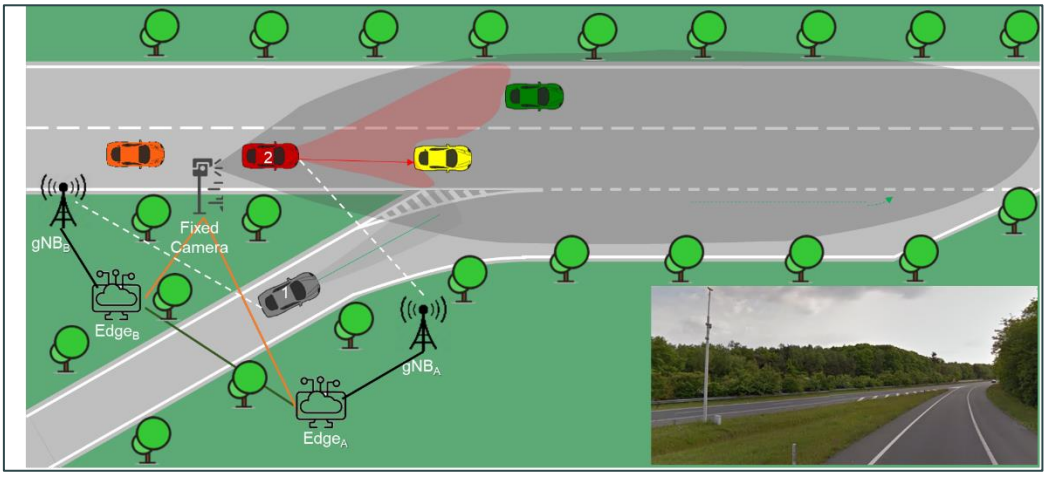

Figure 9 Extended sensors with CPM messages

The user story Remote Driving – 5GPositioning focuses on testing different modalities of localization in a degradation of sensors, using mmwave localization as one of the options (next to GPS, odometry, visual

odometry etc.), facilitated by the TU/e SA- network. Additionally, the user story focuses on using two remote stations (one at TU/e location, one at Siemens' office location) integrating a virtual environment for development and virtual remote control via the KPN 5G-SA network. Multiple remote drivers with consoles connected to different MECs taking over control of the vehicle (see Figure 11).

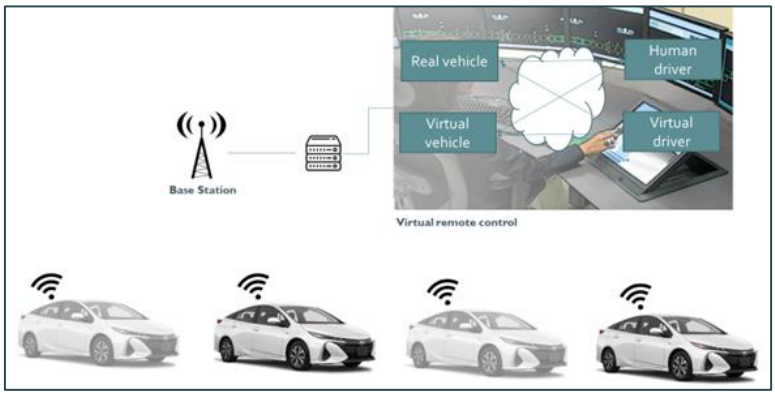

Figure 10 Remote driving using 5G positioning

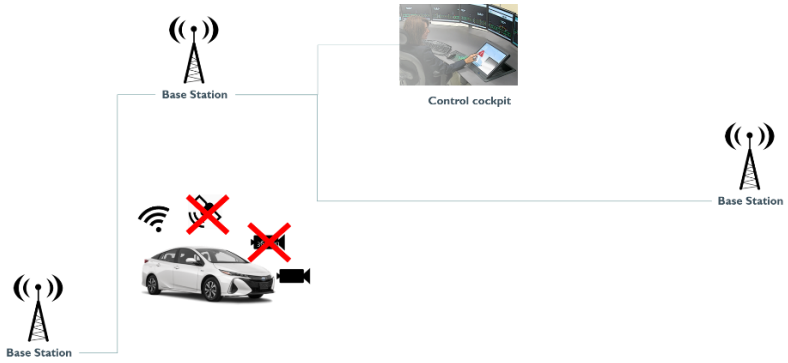

Figure 11 Multiple remote stations and vehicle over virtual control

4.1.1.2. *Overview of the 5G features and technologies tested by the NL TS*

Table 14 lists all the 5G features and technologies that will be used by the NL TS.

Table 14 Overview of the 5G features and technologies tested by the NL TS

5G technology/ solution/ features	Solution/technology description	Related Use case	Related agnostic test case
Seamless cross border handover with 5GC	Setup SA roaming between two networks, test out different technologies to lower the disconnect timeout.	Remote driving	TC23-Gen - TC25-Gen
Local breakout roaming with 5G core	Simple remote driving setup with local breakout to remote driving station	Remote driving	TCA-GEN-33_InterPLMN_HO_LBO
Network slicing	Setup different slices. Generate load in one slices and measure impact on CCAM traffic in other slice.	Remote driving	TCA-NL-01

QoS sustainability while roaming and during inter-PLMN HO	Setup static slicing on both networks with comparable slicing parameters.	Remote driving	TCA-NL-03
Location services using mmWave 5G NR	Using 5G technology for vehicle positioning	Remote driving	none
Edge computing	Application for providing advice using MCM (Manoeuvre Coordination Message) to CAVs.	Advanced driving	none
Session and Service Continuity (SSC) mode 2 or 3	Two edges in one network. An application function directs the UE to connect to a new edge before disconnecting from the old edge.	Extended sensors	TCA-NL-04
MEC broker interconnection	Exchange messages between MECs of different operators between two message brokers	Extended sensors	TCA-NL-05
Radio slicing	Slicing to give support for prioritization (QoS) of user-plane traffic based on slice id (NSSAI). Multi-PDU sessions will be supported to allow for multiple user-plane datastreams and dynamic switching between edge (LBO) and core user-plane routing	Extended sensors	TCA-NL-01
Multi operator slicing	Multiple PDU-sessions from the UE's perspective will be used to facilitate handovers between SA-SA networks (to emulate roaming, while waiting for the standards), so the UE will be able to maintain a connection to two different PLMNs at the same time to facilitate a smooth handover. With this implementation, slice handover (slice continuation) will be verified and tested	Extended sensors	TCA-NL-03

NL Trial site contribution of non x-border elements to the overall vision of 5G deployments:

- The use of MCM and CPM is extended, providing a more comprehensive view on the potential of using these methods for CCAM.
- Exploitation of 5G-mmWave technology and 5G-network positioning services for high level automated driving service

All these 5G technologies will be implemented according to the planning presented below in Figure 12.

	2021										2022		
	March	April	May	June	July	August	September	October	November	December	January	February	March
5G Features	29	30	31	32	33	34	35	36	37	38	39	40	41
NL TS	Early Trials					Full trials							
Seamless cross border handover with 5GC													
Local Breakout Roaming with 5G Core													
Network Slicing													
QoS sustainability while roaming and during inter-PLMN HO													
Location services using mmWave 5G NR													
Edge computing		Local	CBC		CBC		CBC						
Session and Service Continuity (SSC) mode 2 or 3													
MEC broker interconnection													
Radio slicing													
Multi operator slicing													
DEMO													

Figure 12 5G features planning - NL TS

4.1.2. Preparation of the trials: Components deployment progress

4.1.2.1. *Authorizations*

The following section gives an update of the preparation of trials activities (authorizations delivery).

Table 15 Authorizations delivery progress

Authorizations	Progress	Comments
Roads	Remote Driving – Ready Remote Driving – 5GPositioning – in development CCA – Ready CPM (ExSe)– Not applicable	Remote driving and CCA will be trailed at parking lot along the A270 highway. CPM is executed with a connected vehicle and no authorization is needed. Remote Driving – 5GPostitioning will be trailed on TU/e campus and TU/e network
5G frequencies	Ready	KPN and TNO – valid until October 2021, TUE until June 2021

4.1.2.2. *5G network*

Table 16 5G network architecture at the NL TS

Component	Description	Notes	Development/deployment progress
MNOs	KPN, TNO and TU/e	Commercial network from KPN and research network from TNO and TU/e	KPN: Rollout on schedule TNO: 5G SA GnB available TU/e: mm-Wave network scheduled in > Q3, 2021
Deployment architecture	NSA initially, SA as upgrade (already available)	TNO only SA, KPN NSA and SA	
Base station	gNB	KPN: 2 gNBs & 6eNBs TNO: 1 gNBs TUE: 2-3 gNBs	
Radio frequency	KPN network: 3,5GHz NR + shared RAN LTE NW NR700(+NR1800/NR2100) TNO network: 100 Mhz in		

	3,5GHz band for NR TU/e network: 27GHz NR		
Sites	KPN: 2 for 5G and 6 for LTE TNO: 1 for 5G TU/e: 2-3 sites		
Number of cells/site	KPN: 3 for NR700, NR3500 is limited to three cells in total TNO: 1 TU/e: 1	TNO: 2 sectors on the one site	

4.1.2.3. *Road side and could infrastructure*

Table 17 Road side and cloud infrastructure at the NL TS

Component	Description	Notes	Development/deployment progress
MECs	2	KPN and TNO	Ready
Cloud	2 or 3 cloud systems with integration to 2 MECs		Ready
RSUs (PC5/ITS-G5)	None		
Lidars	N/A		
Cameras	>50 road-side fixed and dome cameras	For extended sensors a subset of these cameras will be used	Ready
Radar	N/A		

4.1.2.4. *Automated and connected Vehicles*

Table 18 Automated and connected vehicles at the NL TS

Component	Description	Development/deployment progress

Number of vehicles, type	4 TU/e - AIIM: Toyota Prius PHV SISSBV: Toyota Prius VTT: VW Touareg TNO: A connected non automated vehicle	Vehicles (Siemens, TNO, TU/e - AIIM, VTT) are all available
OBU	4 (1 per vehicle)	Confirmation of 5G chipset for roaming and slicing delayed mm-wave OBU still in development VTT provides OBUs existing of laptop, GNSS receiver and 5G router for the CoCa tests, in order to be able to test CoCa data flows, as travel restrictions due to COVID-19 restrict travel of VTT to the trial site. These OBUs will also be used in the ES-PT trial site.
Cameras	TU/e: 4, Sekonix SISSBV: 4, Sekonix Camera VTT:1, Stereo camera	Ready
Lidars	TU/e: 5, 1x3D LiDAR and 4xVelodyne LIDAR SISSBV: 1, Velodyne VTT: 1, 3D LiDAR	Ready
Radars	SISSBV: 1, Prius VTT: 1, Conti SRR 208	Ready
GPS	TU/e: 1,RTK-GPS SISSBV: 2, 1xOXTS, 1xU-Blox F9 VTT: 1, ublox RTK-GPS	Ready

4.1.2.5. *Interoperability TS/CBC*

The NL-Trial's MCM developments (used in CCA US) is transferred to ES-PT to support the Overtaking scenario in ES-PT. The Manoeuvre Coordination Service deployed in the CBC Edge receives CAM messages from the CBC vehicles and MCM messages from the NL-OBUs ensuring interoperability of the messages.

4.1.3. Detailed planning

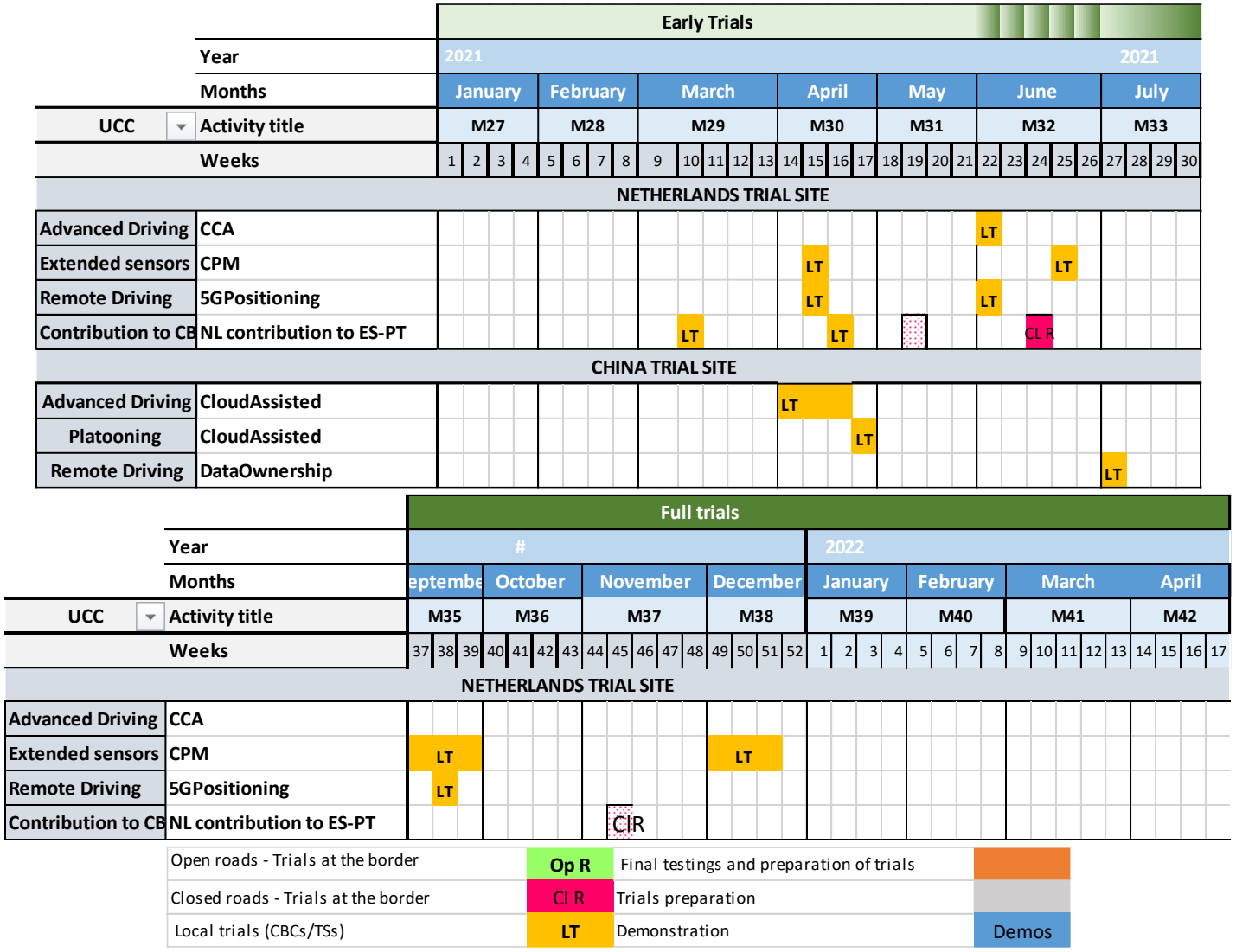

Figure 13 Use case specific trial planning – NL TS – Early trials February to June 2021 (top)- Full trials from July 2021 to April 2022 (bottom)

4.2. French (FR) Trial Site

4.2.1. Overview of the trials activities

4.2.1.1. *Overview of the UC/USs*

Table 19 User story implemented by FR TS

UCC Name	US Id	US Description
Advanced Driving	AssInfrastructure (1.2)	Infrastructure-assisted advanced driving

The FR TS is implementing infrastructure-assisted advanced driving in hybrid traffic user story. In this user story, the infrastructure (MEC/Cloud) assists the AVs to avoid collision in hybrid traffic and respect road regulation while crossing the border.

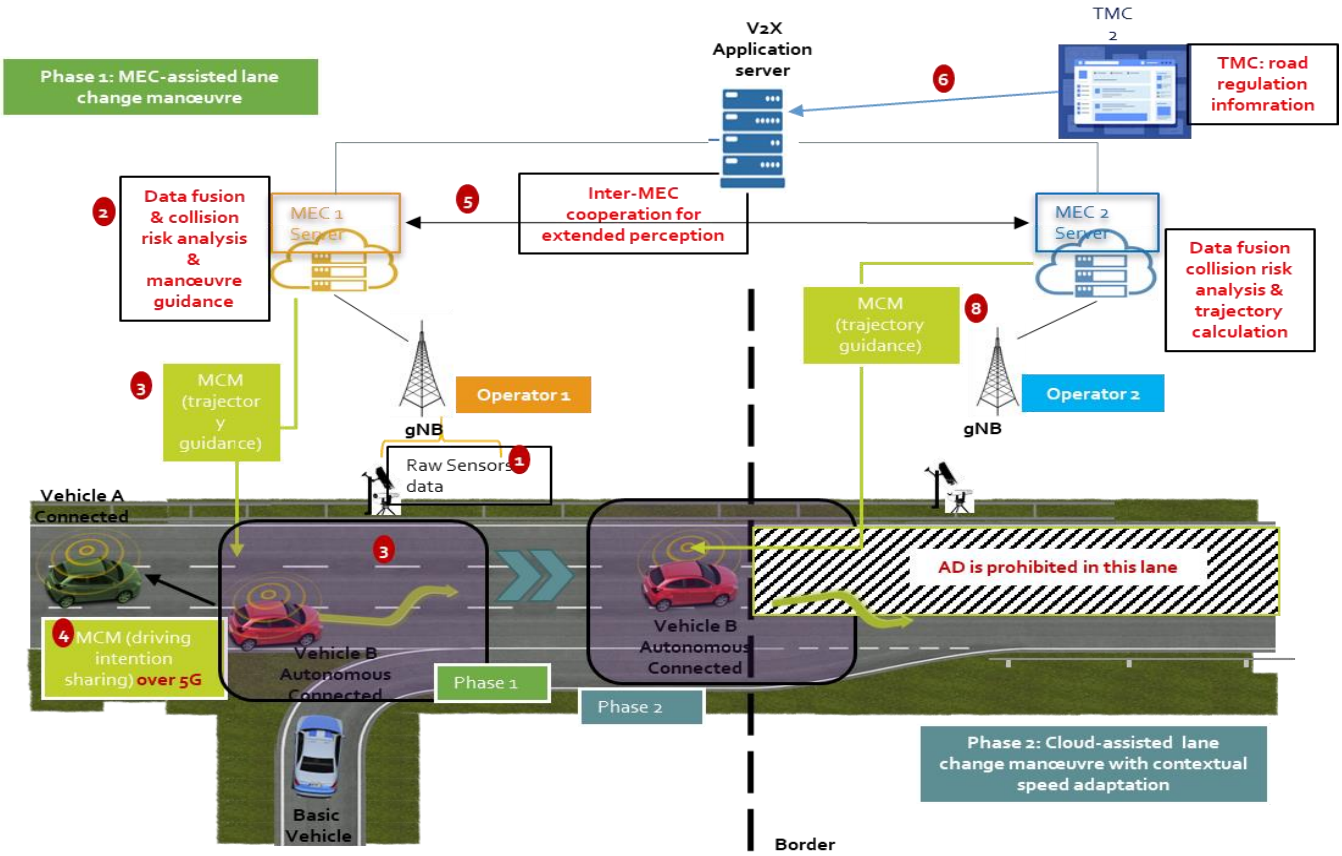

Figure 14 FR TS infrastructure assisted advanced driving in hybrid traffic

4.2.1.2. *Overview of the 5G features and technologies tested by FR TS*

Table 20 lists all the 5G features and technologies that will be used by the FR TS.

Table 20 Overview of the 5G features and technologies to be tested by FR TS

5G technology/ solution/feature	Solution/technology description	Related Use case	Related agnostic test case	Considerations or comments
Multi SIM (DSDA)	FR TS will use an intelligent router solution, connected to its OBU, which allows the UE to keep multi-SIM connections with PLMNs ensuring continuity and communication quality between the application endpoints. it performs link aggregation and load balancing across different PLMN connections and use these connections in a combined manner	Infrastructure assisted advanced driving	TCA-FR-01, TCA-FR-02, TCA-FR-03, TCA-FR-04, TCA-FR-05, TCA-FR-06, TCA-FR-07, TCA-FR-09	Both sims are from different PLMN's
Predictive QoS	FR TS solution is based on a Network-based QoS prediction technique that enables to predict the link quality with the AV path and then can notify the vehicle of anticipated automated maneuver	Infrastructure assisted advanced driving	TCA-FR-01, TCA-FR-02, TCA-FR-03, TCA-FR-04, TCA-FR-05, TCA-FR-06, TCA-FR-07, TCA-FR-08,TCA-FR-09, TCA-FR-10, TCA-FR-11	The mobile network gives warning of possible performance degradation. The application and/or human operator can take preventive measures.
Satellite using NTN-based NG-RAN	FR TS OBU will have access to both terrestrial and non-terrestrial radio bearers through an intelligent routing device. The use of satellite bearer for critical traffic is carried out whenever the terrestrial 5GNR is unable to satisfy the connectivity requirement (e.g., due to unavailability, signal degradation, etc). Satellite connectivity is attained by using the LEO land-mobile Thales MissionLink terminal. The selection of the terminal is based on its capabilities to provide LEO satellite services and thus achieving the minimum possible latency among all satellite communication alternatives.	Infrastructure assisted advanced driving	TCA-FR-08	LEO satellite terminals are used to enable high reliability and resilience
Edge computing	FR TS will use edge computing to host the necessary intelligence modules (data fusion, risk analysis) in order to enable advanced driving maneuvers for AVs. In addition, FR TS will deploy scalable and open ETSI MEC platform under different schemes (shared MECs, , 2 MECs , cloud MEC). In addition, FR TS will work on MEC service continuity and load balancing between different MECs	Infrastructure assisted advanced driving	TCA-FR-10, TCA-FR-11	For edge computing multiple technologies come together: Application Function running at the edge providing services - Platform offering resources to applications available via an orchestration service

5G NR mmWave for V2X (UU) connectivity	A mmwave experimental network will be deployed at Satory site during 2021. FR TS se case to be trialled using this network with adapted OBUs. KPIs to be compared with results of NSA KPIs at TEQMO	Infrastructure assisted advanced driving	TCA-FR-02, TCA-FR-03, TCA-FR-04, TCA-FR-07, TCA-FR-09	

FR TS contribution of non x-border elements to the overall vision of 5G deployments

- Connection bounding, load balancing, QoS control in 5G and hybrid networks for CCAM applications Integration of LEO satellite communication in 5G to support CCAM applications (5G Rel 16, Rel 17)
- Test and evaluation of different MEC deployment solutions
- Demonstration CCAM service continuity in multi-PLMNs scenarios

All these 5G technologies will be implemented according to the planning presented below in Figure 15.

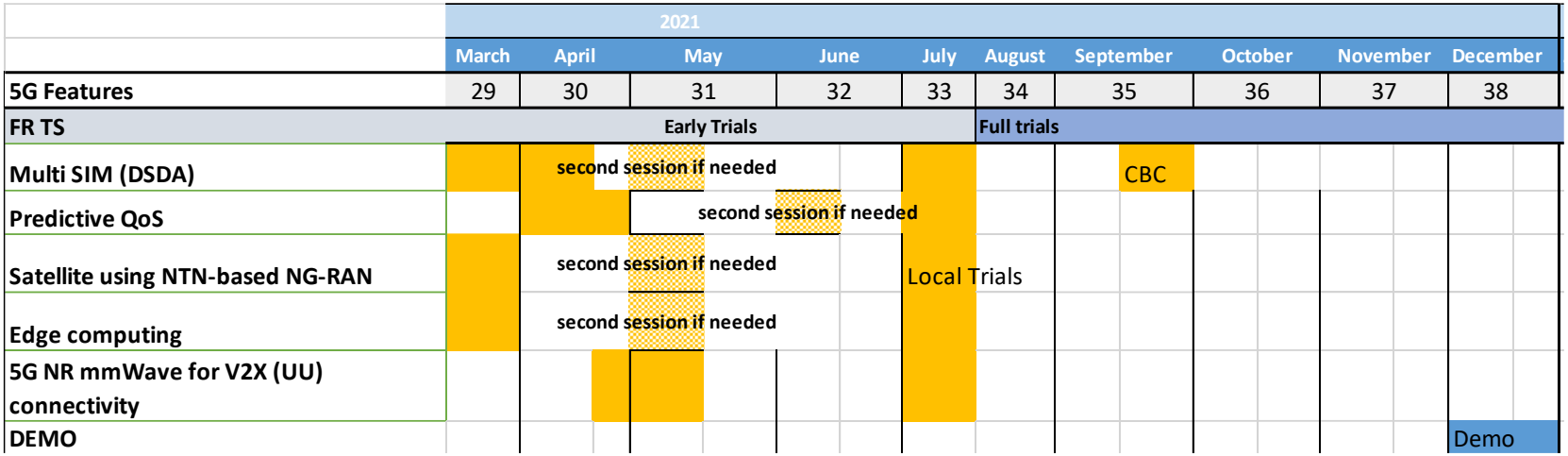

Figure 15 5G features planning - FR TS

4.2.2. Preparation of the trials: Components deployment progress

The following section gives an update of the preparation of trials activities (authorizations delivery).

4.2.2.1. *Authorizations*

Table 21 Authorizations delivery progress

Authorizations	Progress	Comments
Roads	Ready	Since FR TS trial sites (Satory and TEQMO) are closed, there is no need to acquire authorization
5G frequencies	Ready	Orange: 90 MHz at 3,755GHz Bouygues: 80 MHz at 3,530 GHz VEDECOM: 70 MHz at 2,6GHz VEDECOM 200 MHz at 26GHz

4.2.2.2. *5G network*

The 5G networks used for FR TS trialling activities are deployed in both TEQMO and Satory sites. At TEQMO, 5G 3x NSA option is deployed by both Orange & Bouygues, and they are functioning. At Satory, a mmWave 5G network is under installation (to be ready by the end of January 2021) with objective of installing 5G SA and other advanced features.

Table 22 5G network architecture at the FR TS

Component	Description	Notes	Development/deployment progress
MNOs	3 MNOs (Bouygues, Orange,and TDF)	Bouygues network: a commercial CN with experimental RAN Orange and TDF: experimental networks	5G Orange and Bouygues networks are Ready TDF network is under installation (to be ready by the end of March 2021)
Deployment architecture	NSA option 3	Orange & Bouygues TDF networks it to be upgraded to SA (possible plan of installation by the end of 2021)	Ready Ongoing (March 2021)
Base station	1 gNB/eNB Bouygues	-	Ready

	1gNB/eNB Orange 1 gNB/eNB TDF		Ready Ongoing
Radio frequency	TEQMO: User plane: 3.5 GHz Control plane: 700MHz Satory Control plane: 2.6 Ghz Data plane: 26 Ghz	Orange: 90 MHz at 3,755GHz Bouygues: 80 MHz at 3,530 GHz TDF: 200 MHz at 26GHz	Ready
Sites	1 site per network	-	-
Number of cells/site	3 cells per site	-	-

4.2.2.3. *Road side and cloud infrastructure*

FR TS user story is based on the intelligence at the infrastructure side to guide the AV during its maneuver. For that purpose, several MEC and cloud entities are deployed to enable the different functionalities. In the table below, we describe the different element of the FR TS infrastructures.

Table 23 Road side and cloud infrastructure at the FR TS

Component	Description	Notes	Development/deployment progress
MECs	2 ETSI MECS 2 Operator-owned MECs	1 MEC for Orange, 1 cloud vMEC for Bouygues, 2 MECs for TDF	2 ETSI MECs are ready 1 TDF MEC is under development
Cloud	1 Cloud by CATAPULT	One cloud to be used during trials	
RSUs (PC5/ITS-G5)	N/A	N/A	N/A
Lidars	2 lidars	2 Lidar Quanergy M8	ready
Cameras	3 cameras	2 AXIS M5525-E 1 AXIS M3058-PLVE	ready

Radar	N/A	N/A	N/A

4.2.2.4. *Automated and connected Vehicles*

Table 24 Automated and connected vehicles at the FR TS

Component	Description	Notes	Development/deployment progress
Number of vehicles, type	3 vehicles (Renault Zoe and C4)	Level 4 self-driving mode prototype 5G connected vehicle Basic vehicle	5G autonomous is ready 5G connected vehicle is ready Basic vehicle is ready
OBU	2 x 5G OBUs 3 x 5G OBU	5G OBU made by VEDECOM. VALEO is providing all the packaging for the 5G chipset	VEDECOM 5G OBUs are ready VALEO OBU were received in December 2020, and currently tested
Cameras	2 stereo cameras for Renault Zoe	Front and back	ready
Lidars	5 lidar for Renault Zoe	Velodyne	ready
GPS	1 Geoflex GNSS for each vehicle	RTK GPS receiver	ready

4.2.2.5. *Interoperability TS/CBC*

In order to ensure the interoperability of the 5G FR connected vehicle during its tests at the ES-PT CBC, FR TS and ES-PT CBC have conducted several discussions and coordinate their development effort to use the same ITS message (CAM, CPM) as illustrated by the following table:

Table 25: FR TS & ES-PT CBC ITS message interoperability

CBC/TS	CAM	CPM
ES-PT CBC /FR TS	1.4.1	2.1.1 (TR 103 562)

In addition, several discussions have tackled the cyber-security measures to be used during trials. To goal is to ensure that both sites can communicate using the same cyber-security techniques. As such, for V2X message exchange, both sites coordinate on the use of a password-based authentication to access V2X

gateway and the access rights for particular V2X contents/types. Discussions/harmonisations with ES-PT are ongoing.

4.2.3. Detailed planning

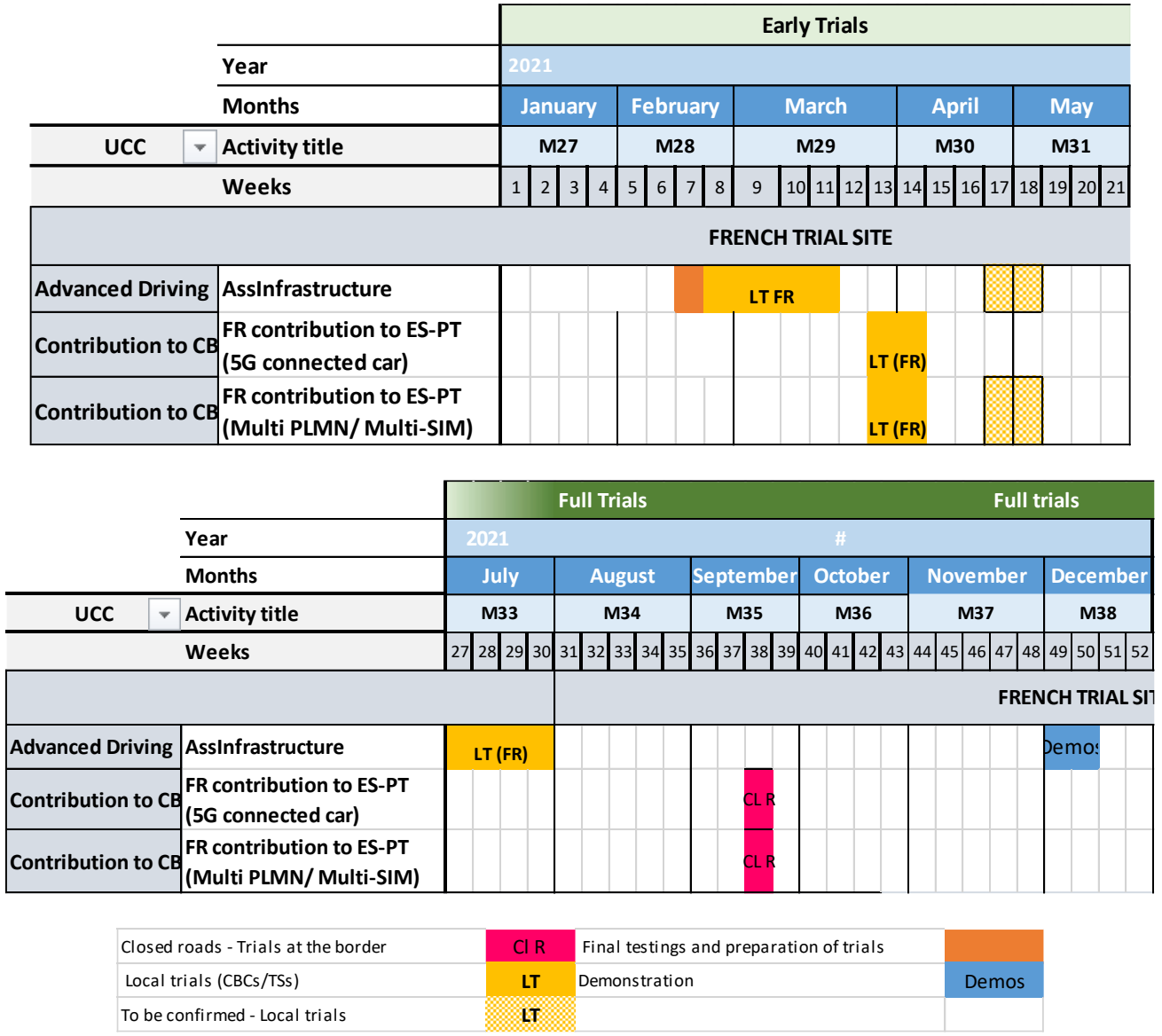

Figure 16 Use case specific trials Planning – FR TS early trials from February to May 2021 (top) – Full trials from July to December 2021 (bottom)

4.3. German (DE) Trial Site

4.3.1. Overview of the trials activities

4.3.1.1. *Overview of the UC/USs*

Table 26 User stories implemented by DE TS

UCC Name	US Id	US Description
Vehicles Platooning	AsseRSU (2.2)	eRSU-assisted platooning
Extended Sensors	EDM (3.3)	EDM-enabled ES with surround view generation

The DE TS implements two user stories, one on extended sensors and one on platooning. Both user stories make use of the Edge Dynamic Map (EDM) service provided from the digitized roadside infrastructure. In the platooning user story, the EDM service aids a platoon driving along the DE TS (in emulated platooning mode, i.e. without actuation) by broadcasting relevant information perceived from the current traffic situation. In the extended sensors user story, the EDM service provides the vehicles with vehicle discovery functionality and live information, enabling among other sensory data also the transmission of HD video among road users.

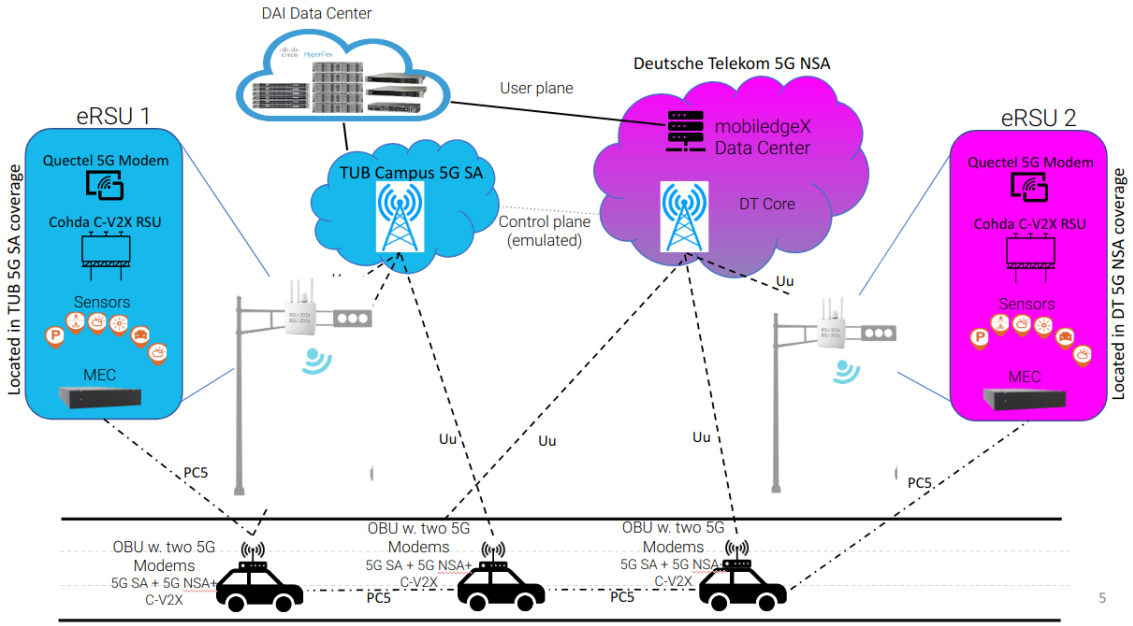

Figure 17 DE TS environment for the trialling of the two user stories

4.3.1.2. *Overview of the 5G features and technologies tested by DE TS*

The following Table 27 lists all the 5G features and technologies that will be used by the DE TS.

Table 27 5G features and technologies tested by DE TS

5G technology/ solution/ feature	Solution/technology description	Related Use case	Related agnostic test case	Considerations
Multi SIM (DSDA)	Multi-PLMN solution with multi-SIM , multi-modem approach using one link at the time (to be upgraded with single modem approach after OBU hardware support for all required 5G bands / dual active is available)	Extended Sensors Surroundview	TCA-DE-06	The two SIMs are from different PLMNs
Edge computing	DE TS uses both near edge and far edge computing: near edge computing is on mobiledgeX (Deutsche Telekom Cloudlet located in Berlin) to host the MEC Broker and application server functionality for the ES surroundview use case, far edge computing is deployed by TUB on roadside infrastructure with OpenShift-based orchestration of applications for EDM service (for platooning use case)	eRSU-assisted Platooning & Extended Sensors Surroundview	TCA-DE-05	- Local breakout in the mobile network (e.g. through CUPS for ePC or a local UPF for 5GC) - Platform offering resources to applications available via an orchestration service - A discovery mechanism to connect to the optimal service in the network - Inter-MEC connectivity
MEC broker interconnection	MEC Broker with discovery service deployed in two network domains.	Extended Sensors Surroundview	TCA-DE-05	- MEC infrastructure in MNO domain, micro-datacenter at DAI infrastructure
National roaming with seamless handovers	DE TS provides two C-V2X Service Areas located in two different 5G networks and infrastructures. The national roaming in this solution focuses on inter-domain mobility aspects for the Surroundview Use Case, the interconnection of core networks is emulated.	Extended Sensors Surroundview	TCA-DE-03 TCA-DE-06	- NSA/SA to NSA/SA network reselection with UE directed handovers
PC5 / Uu hybrid networking	eRSU assistance provided to platoon leader via PC5 or Uu interface	eRSU-assisted Platooning	TCA-DE-02 TCA-DE-04	- This involves PC5 sidelink communication directly from roadside infrastructure vs. providing the EDM service via Uu interface.

DE TS contribution of non x-border elements to the overall vision of 5G deployments

- Evaluation benchmarking using a different testing environment (urban vs highway (ES-PT) for EDM Service
- Use of different sensor and 5G hardware characteristics (Valeo camera setup and Valeo Peiker's Vulcano TCU vs ES-PT setup)

All these 5G technologies will be implemented according to the planning presented below in Figure 18.

	2021									
	March	April	May	June	July	August	September	October	November	December
5G Features	29	30	31	32	33	34	35	36	37	38
DE TS	Early Trials					Full trials				
Multi SIM										
Edge computing										
MEC broker interconnection										
National roaming with seamless handovers										
PC5 / Uu hybrid networking										
DEMO					Demo					

Figure 18 5G features planning - DE TS

4.3.2. Preparation of the trials: Components deployment progress

The following section gives an update of the preparation of trials activities (authorizations delivery).

4.3.2.1. *Authorizations*

The DE TS performs its trials on public, urban roads which provide the environment for the trials. No specific road authorizations had to be obtained for the use cases, as the trials will take place in the normal traffic flow and no roads will be closed to the public. Regarding the 5G network frequency authorization, a research deployment at TUB campus had already pursued the authorization for a 5G campus network on 3.7 to 3.8GHz from outside of the 5G-MOBIX project. A currently on-going activity is the application at Bundesnetzagentur for the deployment of two PC5 units at the roadside of Str. des 17. Juni, where the trialling will take place.

4.3.2.2. *5G network*

Table 28 5G network architecture at the DE TS

Component	Description	Notes	Development/deployment progress
MNOs	Deutsche Telekom / TUB (campus)	Deutsche Telekom provides its commercial network to DE TS, TUB campus gNB is a research deployment with experimental core.	Both networks are deployed, installations finished. Tests with SA are on-going and expected to be successfully completed by end of Q4 2020.
Deployment architecture	NSA / SA	Telekom 5G network operates in NSA mode, TUB in SA mode.	Both architectures are deployed and operational, SA experimental core is being tested.
Base station	gNB	Telekom NSA BS: Multiple gNBs available in the TS area TUB gNB: one SA gNB available.	Connection to NSA gNB confirmed. Connection to SA gNB is being tested
Radio frequency	Telekom: 2.1GHz 3.6 GHz TUB:3.7GHz	TE800,900,1800MHz as anchoring frequency (2.1 GHz) LTE1800 MHz as anchoring frequency (3.6 GHz)	Deutsche Telekom is actively extending its 5G coverage in the vicinity of the DE TS, with several more 3.6GHz sites coming end of 2020 / during 2021. The areas where no 3.6GHz coverage is

			available has 2.1GHz coverage (n1 band)
Sites	>10 (Telekom), 1 (TUB)	N/A	Given the dense urban environment Deutsche Telekom has a large number of sites in the vicinity of the DE TS. TUB campus deployment currently has 1 site.
Number of cells/site	2		

4.3.2.3. *Road side and cloud infrastructure*

Table 29 Road side and cloud infrastructure at the DE TS

Component	Description	Notes	Development/deployment progress
MECs	9 (eRSU)	Provide the computational power for the object detection for EDM service	MECs are deployed and in operation
Cloud	1	Management & Orchestration	OpenShift-based deployment is finalized and in operation
RSUs (PC5/ITS-G5)	9 (PC5 and ITS-G5)	For now two RSUs will be extended with PC5, some more might be added if the coverage in the testing period proves to be insufficient.	The deployment of the PC5 units can be performed once the authorization from Bundesnetzagentur is available, expected in early Q1 2021
Lidars	0		
Cameras	18	In total 15 HD cameras are utilized for the object detection for EDM service	The HD cameras are deployed and in operation. A future upgrade is planned to test the impact of ADAS camera sensors on the delay of the object detection. First tests of the ADAS camera are currently in progress, with a potential deployment in Q1 2021

Other	10x (traffic sensors)	Traffic analysis, road condition, weather, environmental sensors,	Sensors are deployed and in operation.

4.3.2.4. *Automated and connected vehicles*

Table 30 Automated and connected vehicles at the DE TS

Component	Description	Notes	Development/deployment progress
Number of vehicles, type	1x TUB (VW Tiguan), 2x Valeo (VW Passat B8), 1x Vicom (Toyota Prius)	The vehicles are enhanced to meet SAE-L4 requirements.	Upgrade of the TUB vehicle to L4 to be completed in Q1 2021
OBU	4x 5G Valeo-Peiker TCU	Valeo-Peiker TCU is based on Quectel chipset which is not yet 5G SA-capable and requires a second chipset for 5G SA connectivity.	Delivery of Valeo-Peiker OBUs is delayed. Adding secondary modem is an on-going activity at Valeo-Peiker, requires some engineering activity.
Cameras	5-9	Mono & Stereo	Mounted and in operation.
Lidars	1-7	Ibeo Scala B3, Velodyne HDL-32, VALEO SCALA	Mounted and in operation.
GPS	OXTS xNAV550 DGPS, GNSS uBlox-EVK M8T, iMar	N/A	Mounted and in operation.

4.3.2.5. *Interoperability TS/CBC*

Integration with the MQTT broker of ES-PT is planned.

4.3.3. Detailed planning

		Early Trials																				
	Year	2021																				
	Months	March					April				May				June					July		
UCC	Activity title	M29					M30				M31				M32					M33		
	Weeks	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
GERMAN TRIAL SITE																							
Platooning	AsseRSU					LT							LT							Demos			
Extended sensors	EDM					LT							LT							Demos			
Contribution to CB	DE contribution to ES-PT																						

		Full trials																								
	Year	2021																		2022						
	Months	September				October				November					December					January				February		
UCC	Activity title	M35				M36				M37					M38					M39				M40		
	Weeks	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	1	2	3	4	5	6	7	8
GERMAN TRIAL SITE																										
Platooning	AsseRSU													LT												
Extended sensors	EDM																									
Contribution to CBC	DE contribution to ES-PT	LT									OR			LT											OR	

Open roads - Trials at the border	Op R
Local trials (CBCs/TSs)	LT
Demonstration	Demos

Figure 19 Use case specific Trials planning - DE TS – Early trials from March 2021 to July 2021 (top) – Full trials from September 2021 to February 2022 (bottom)

4.4. Finland (FI) Trial Site

4.4.1. Overview of the trials activities

4.4.1.1. *Overview of the UC/USs*

The FI TS will implement 2 users stories during their trials, one on extended sensors and one in remote driving.

Table 31 User stories implemented by FI TS

UCC Name	US Id	US Description
Extended Sensors	EdgeProcessing (3.4)	Extended sensors with redundant Edge processing
Remote Driving	RedundantNE (4.2)	Remote driving in a redundant network environment

4.4.1.2. *Overview of the 5G features and technologies tested by FI TS*

The following Table 32 lists all the 5G features and technologies that will be used by the FI TS.

Table 32 Overview of the 5G features and technologies tested at FI TS

5G technology/ solution/ feature	Solution/technology description	Related Use case	Related agnostic test case
Multi SIM	Multi-PLMN solution with multi-SIM 5G NSA router or OBU, initially in NSA mode and with SA upgrade planned end of Q2 2021. The multi-SIM OBU uses mobile IP tunnelling while selecting 5G one connection (out of two) at the time. Alternatively, next upgrade of multi-SIM OBU would enable use both connections simultaneously (link aggregation or bonding mode). Independently of national roaming agreements, automated vehicles can seamlessly switch networks depending on given marginal service metrics or utilise both networks at same time. The added value is guaranteed availability of connectivity thus increased safety. Considerations: SIMs are from different PLMNs	Remote driving Extended sensors	TCA-FI-01 TCA-FI-02 TCA-GEN-12_TCP_DL_No Load TCA-GEN-13_TCP_UL_No Load TCA-GEN-14_TCP_DL_Loaded TCA-GEN-15_TCP_UL_Loaded TCA-GEN-18_PING_No load_MTU size TCA-GEN-36_DL_Reliability TCA-GEN-37_UL_Reliability
Edge computing	Edge computing in the 5GC. Under the above and below scenarios, offloaded computing tasks from automated vehicles can seamlessly migrate over multiple edge servers (locally) deployed in the 5GC, e.g., cooperative generation of HD 3D mapping. The added value is guaranteed availability of computing thus increased autonomy and safety Consideration: Discovery mechanism to connect to the optimal service in the network	Extended sensors	TCA-GEN-12_TCP_DL_No Load TCA-GEN-13_TCP_UL_No Load TCA-GEN-14_TCP_DL_Loaded TCA-GEN-15_TCP_UL_Loaded TCA-GEN-18_PING_No load_MTU size

National roaming	5G roaming in SA mode (between interconnected 5GCs) and implemented based on the 5G SA roaming Local Breakout (LBO) architecture [1]. Under national roaming agreements, automated vehicles can seamlessly switch networks depending on given marginal service metrics. The added value is guaranteed availability of connectivity thus increased safety. Consideration : Current upgrade of 5G NR base stations to SA mode done, but pending upgrade of devices (NSA to SA modem upgrade in OBU or router).	Remote driving	TCA-GEN-34_InterPLMN_HO_LBO_TCP_DL TCA-GEN-34_InterPLMN_HO_LBO_TCP_UL TCA-GEN-34_InterPLMN_HO_LBO_UDP_DL TCA-GEN-34_InterPLMN_HO_LBO_UDP_UL
Local breakout for UPF	One of the virtualised 5GC in FI TS leverages flexibility of the 5G SBA, with the UPF deployed locally close to test route, whereas, the control plane NFs deployed in a remote cloud (1500 km away). The objective is to demonstrate the latency reduction with this UPF local breakout. The added value of the reduced latency is to meet the stringent requirements of delay-sensitive CCAM applications even when operator utilises a distant 5GC (in central office).	Remote driving	TCA-GEN-18_PING_No load_MTU size
Network slicing	Network slice implemented using APNs in 5G SA mode. At time of UE registration, the UE needs to inform the SMF which APN to use and the SMF will assign a UPF to the UE according to the UE's request (e.g. throughput requirement). To that end, gNBs in SA mode will be configured with two slices, where the AMF will check with the NSSF to confirm eligibility of UE to use particular slice.	Remote driving Extended sensors	TCA-GEN-12_TCP_DL_No Load TCA-GEN-13_TCP_UL_No Load TCA-GEN-14_TCP_DL_Loaded TCA-GEN-15_TCP_UL_Loaded TCA-GEN-18_PING_No load_MTU size

<u>FI TS contribution of non x-border elements to the overall vision of 5G deployments</u>

- Evaluate interoperability and dynamicity of MEC service protocols and their impact on application continuity.
- Evaluate impact of multi-SIM solutions on service continuity in areas with overlapping coverage of two PLMNs.

All these 5G technologies will be implemented according to the planning presented below in Figure 20.

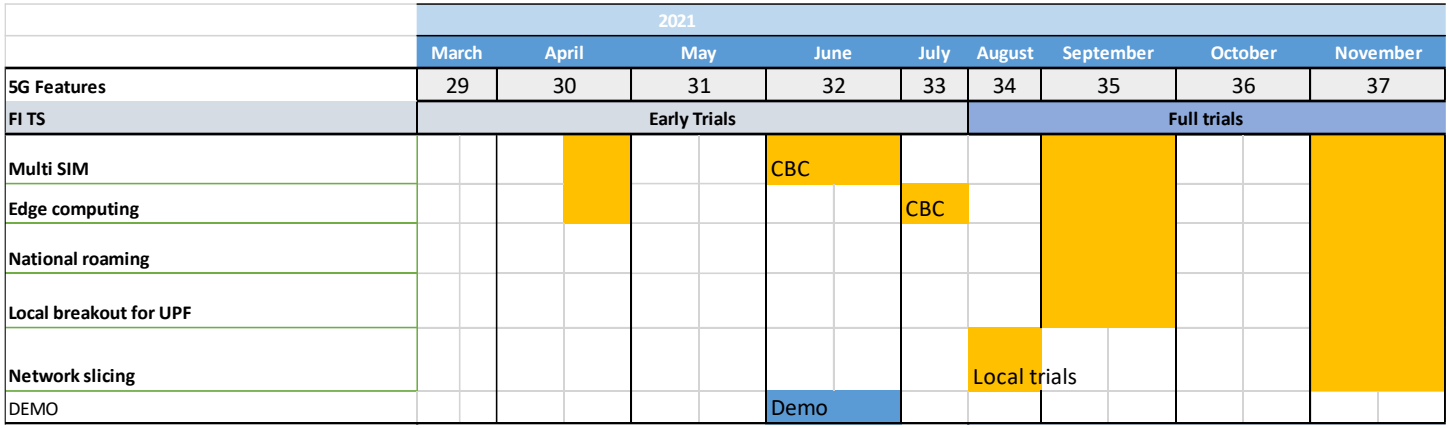

Figure 20 5G features planning - FI TS

Important: The trialing timeline above includes 4 early or full trials (of 1-2 days duration each). However, the inclusion of the automated vehicle in each trial will be evaluated based on the upgrades of the network.

4.4.2. Preparation of the trials: Components deployment progress

Developments and deployment are following the planned timeline. At M26, almost all components are ready and in the integrating phase. Details can be found in the tables below.

4.4.2.1. *Authorizations*

Table 33 Authorizations delivery progress

Authorizations	Progress	Comments
Roads	Ready	SENSIBLE4 (vehicle provider) has all authorizations in place to drive in open roads.
5G frequencies	Ready	AALTO (network provider) has all the frequency permissions in place, both 4G and 5G bands, and 10 PLMNs (2 to be used).

4.4.2.2. *5G network*

Table 34 5G network architecture at the FI TS

Component	Description	Notes	Development/deployment progress
MNOs	AALTO	AALTO holds multiple spectrum licenses (700 MHz, 2600 MHz and 3500 MHz bands), produces own SIM cards and possesses up to 10 PLMN IDs.	Ready
Deployment architecture	NSA & SA	Both sites can switch from NSA and SA.	For SA, OBUs (modems) have been upgraded
Base station	2 gNBs	Also eNBs available for NSA.	Both deployed, configured and tested
Radio frequency	Band n78 (TD 3500)		Ready
Sites	2	1 site available, 1 pending	1st site ready, 2nd site installation ongoing (completion in February 2021).
Number of cells/site	2	Configuration of 2nd site is ongoing.	To be completed in February 2021.

4.4.2.3. *Road side and cloud infrastructure*

Table 35 Road side and cloud infrastructure at the FI TS

Component	Description	Notes	Development/deployment progress
MECs	2 Nokia		Both deployed, configured and tested. Ready.
Cloud	1	AALTO Data Centre	GDPR complaint. Ready
Lidars	1	For extended sensor user story, USS3.3.	Ready
Cameras	1	For both user stories, USS3.3 and USS4.2.	Ready

4.4.2.4. *Automated and connected vehicles*

Table 36 Automated and connected vehicles at the FI TS

Component	Description	Notes	Development/deployment progress
Number of vehicles, type	1 Renault Twizy	Road legal in Finland.	Ready. Fully equipped and tested in open roads in Finland.
OBU	2 5G OBUs (1 per user story)	AALTO is developing multi-SIM OBU based on Quectel modems (upgraded to SA). In addition, another local partner will provide 2 multi-SIM routers (to be upgraded to SA in Q1 of 2021).	Quectel's modem firmware upgrade is complete. Second option will be available December 2020. Upgrades to SA are expected for 2021.
Cameras	1	Vehicle with 2 colour cameras	Installed and ready. Additional 360 camera system available as option. Thermal camera is an optional addition that can be implemented.
Lidars	1	Two 3D LIDARs	Installed and ready
Radars	3	Short and medium range radars in vehicle	Installed and ready. It may not be used in the user stories

GPS	1	Vehicle with GNSS RTK	Installed and ready. It may not be used in the user stories

4.4.2.5. *Interoperability TS/CBC*

Concerning the interoperability between the FI TS and the CBCs, all solutions are 3GPP-complaint and use common operating spectrum bands with CBCs.

4.4.3. Detailed planning

FI TS will test locally in the first quart of 2021. The contribution to GR-TR CBC's trials is specific, thus the FI TS contribution planning is synchronised with the GR-TR trials sessions in 2021 and 2022. Same applies for the FI contributions to ES-PT CBC, the plans are aligned with the trials at the borders.

Important: The trialling timeline below includes 4 early or full trials (of 1-2 days duration each). However, the inclusion of the automated vehicle in each trial will be evaluated based on the upgrades of the network.

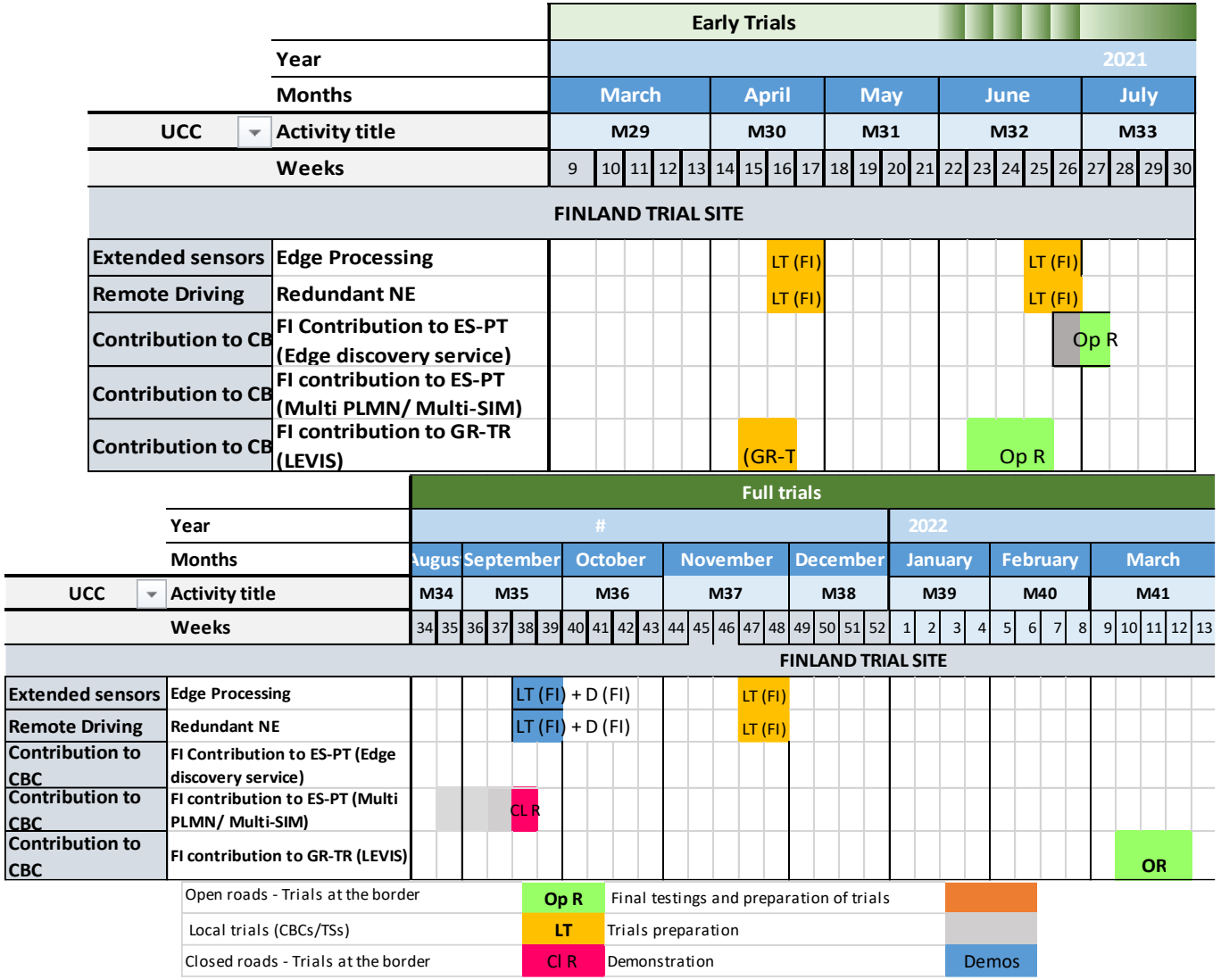

Figure 21 Use case specific Trials planning -FI TS – Early trials from February to July 2021 (top) – Full trials from September 2021 to March 2022 (bottom)

4.5. China (CN) Trial Site

4.5.1. Overview of the UCC/USs and of the 5G features and technologies tested

Table 37 User stories implemented by CN TS

UCC Name	US Id	US Description
Advanced Driving	CloudAssisted (1.4)	Cloud-assisted advanced driving
Vehicles Platooning	AssCloud (2.3)	Cloud-assisted platooning
Remote Driving	DataOwnership (4.4)	Remote driving with data ownership focus

The following Table 38 lists all the 5G features and technologies that will be used by the CN TS.

Table 38 Overview of the 5G features and technologies tested by CN TS

5G technology/ solution/ feature	Solution/technology description	Related Use case
Multi SIM (DSDA)	Both sims are from different PLMN's (China Mobile and Unicom)	Remote Driving
Edge computing	Platooning running at the edge providing services Cloud-edge-vehicle collaboration mechanism	Platooning Advanced Driving
5G NR mmWave for V2X (UU) connectivity	5G NR for UU from China Mobile	Platooning Advanced Driving

All these 5G technologies will be implemented according to the planning presented below in Figure 22.

							2022
	July	August	September	October	November	December	January
5G Features	33	34	35	36	37	38	39
CN TS	Early Trials	Full trials					
Multi SIM (DSDA	Local					Local	
Edge computing			Local			Local	
5G NR mmWave for V2X (UU) connectivity		Local				Local	
DEMO						Demo	

Figure 22 5G features planning - CN TS

4.5.2. Preparation of the trials: Components deployment progress

The following section gives an update of the preparation of trials activities (authorizations delivery), and where the TSs are at concerning their components deployment and integration progress. The tables included in this section are an overview of the Checklist material that was created during WP4 activities.

4.5.2.1. *Authorizations*

Table 39 Authorizations delivery progress

Authorizations	Progress	Comments
Roads	Ready	SDIA (urban road provider), SDHS (highway provider) have all authorization in place to drive in roads
5G Frequencies	Ready	China Mobile and China Unicom (5G network provider) have all the frequency permissions in place.
Other	Ready	Huawei and ZTE (5G equipment providers) have all the authorizations for commercial use.

4.5.2.2. *5G network*

Table 40 5G network architecture at the CN TS

Component	Description	Notes	Development/deployment progress
MNOs	China UNICOM, China MOBILE	China UNICOM and China MOBILE hold multiple spectrum licenses and produce own SIM cards.	They have provided core network services for this project.
Deployment architecture	SA	SA is still in the experimental stage and will be the final choice for 5G with more technical advantages.	NSA is deployed in the CN TS, and SA will be deployed in the next phase.
Base station	gNB	gNB is available for NSA and SA.	SDIA has already installed three 5G base stations in east zone for remote driving tests. SDHS has installed several 5G base stations for 2k highway.
Radio frequency	3.5GHz for China Unicom and 2.6 GHz or 4.9 GHz for China MOBILE	China Unicom and China MOBILE	5G spectrum allocation was completed in December 2018 in China.
Sites	1 site	Available	The CN site has two parts, which completed 2km highway in the north of Miao Mountain, with three full-width gantry with a spacing of 500 meters and eagle-eye camera.
Number of cells/site	3 gNB	available	The deployed gNBs have been applied to scenarios for testing.

4.5.2.3. *Road side and cloud infrastructure*

Table 41 Road side and cloud infrastructure at the CN TS

Component	Description	Notes	Development/deployment progress
MECs	5+MECs	Available	The deployed MECs have been applied to scenarios for testing.
Cloud	1	Shandong Supercomputing Center	Ready
RSUs (PC5/ITS-G5)	5+RSUs	Cohda	Ready to test
Lidars	5+	For user story UCC1,3,4.	Ready
Cameras	5+	For user story UCC1,3,4	Ready
Radar	5+ Millimeter Wave Radar	Testing speed	Ready for UCC1,3,4

4.5.2.4. *Automated and connected vehicles*

Table 42 Automated and connected vehicles at the CN TS

Component	Description	Notes	Development/deployment progress
Number of vehicles, Type	2+ SDIA vehicle 2+ CNHTC truk	More vehicles will be provided if CN funding is approved	L4 vehicles from SDIA and CNHTC
OBU	4+ ZTE OBU	Also, LTE-V OBU PC5 from Datang group	And OBUs (Uu) from CNHTC
Cameras	4+ Binocular Camera	Or more for requirement	The deployed Cameras have been resided on L4 vehicle.
Lidars	4+	Vehicle with four 3D LIDAR	Have been resided
Radars	4+ millimeter wave radar	Vehicle with four millimetre wave radar	Have been resided
GPS	2+ GNSS	BeiDou or GPS	Have been resided

4.5.3. Detailed planning

CN TS will conduct early trials of the three main use cases (Advanced Driving, Platooning and Remote Driving) in April 2021 and July 2021.

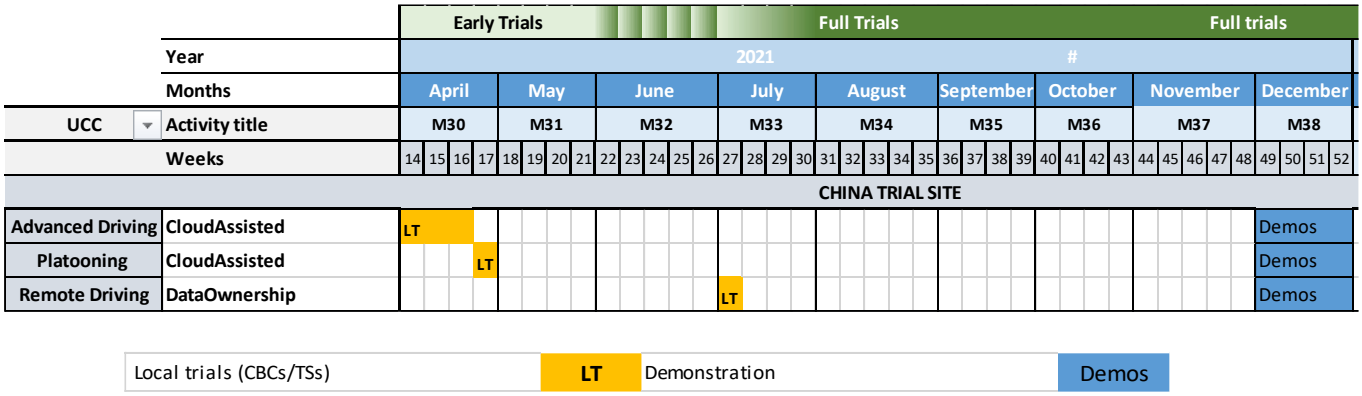

Figure 23 Specific Trial Planning CN TS

4.6. Korean (KR) Trial Site

4.6.1. Overview of the UC/USs and of the 5G features and technologies tested

The KR TS will implement 2 users stories during their trials, one Remote Driving and one vehicle QoS support.

Table 43 User stories implemented by KR TS

UCC Name	US Id	US Description
Remote Driving	mmWave (4.5)	Remote driving using mmWave communication
Vehicle QoS Support	Tethering (5.2)	Tethering via Vehicle using mmWave communication

The following Table 44 lists all the 5G features and technologies that will be used by the KR TS.

Table 44 Overview of the 5G features and technologies tested by KR TS

5G technology/ solution/ feature	Solution/technology description	Related Use case
National roaming with seamless handovers	Support low latency handover within a dedicated 5G trial network	Vehicle QoS Support Remote driving
5G NR mmWave for V2X (UU) connectivity	Support high data rate V2X (Uu) connectivity using mmWave on a high mobility environment (e.g., highway, urban road)	Vehicle QoS Support Remote driving

All these 5G technologies will be implemented according to the planning presented below in Figure 24.

	2021								
	March	April	May	June	July	August	September	October	November
5G Features	29	30	31	32	33	34	35	36	37
KR TS	Early Trials					Full trials			
National roaming with seamless handovers	Local		Local						Local
5G NR mmWave for V2X (UU) connectivity	Local		Local						Local
DEMO									Demo

Figure 24 5G features planning - KR TS

4.6.2. Preparation of the trials: Components deployment progress

4.6.2.1. *Authorizations*

The following section gives an update of the preparation of trials activities (authorizations delivery);

Table 45 Authorizations delivery progress

Authorizations	Progress	Comments
Roads	Ready	KATECH has all authorizations in place to test RCV in urban type proving ground.
5G frequencies	Ready	KATECH has all authorizations in place to test RCV in urban type proving ground

4.6.2.2. *5G network*

Table 46 5G network architecture at the KR TS

Component	Description	Notes	Development/deployment progress
Deployment architecture	SA	Option 2	-
Base station	gNB	3 gNB	Ready to test
Radio frequency	22~23.6GHz	An unlicensed band called Flexible Access Common Spectrum (FACS) is allocated by Korean government. FACS ranges from 22 ~ 23.6 GHz.	Ready to test
Sites	2 sites	1st site in ETRI 2nd site in KATECH	1st site ready to test 2nd site will be ready to test in March 2021

Number of cells/site	1 gNB		Ready to test

4.6.2.3. *Road side and cloud infrastructure*

Table 47 Road side and cloud infrastructure at the KR TS

Component	Description	Notes	Development/deployment progress
Cloud	1	KATECH remote control center	Will be Ready to test in March 2021

4.6.2.4. *Automated and connected vehicles*

Table 48 Automated and connected vehicles at the KR TS

Component	Description	Notes	Development/deployment progress
Number of vehicles, type	1, SUV	Renault	
OBU	mmWAVE	Additional LTE modem	Will be ready to test in Feb. 2021
Cameras	8 Cameras	Front, Rear, Left, Right Front, Rear, Left, Right for around view monitoring	Installed and ready to test
Radars	3	Front radar, 77GHz Left/Right radar , 24GHz	Installed and ready to test
GPS	1 DGPS		Installed and ready to test

4.6.3. Detailed planning

Pre trials at KR TS will take place early February 2021. The full Trials will begin in April 2021. Demonstration (with KR project officer) are set to take place early November 2021.

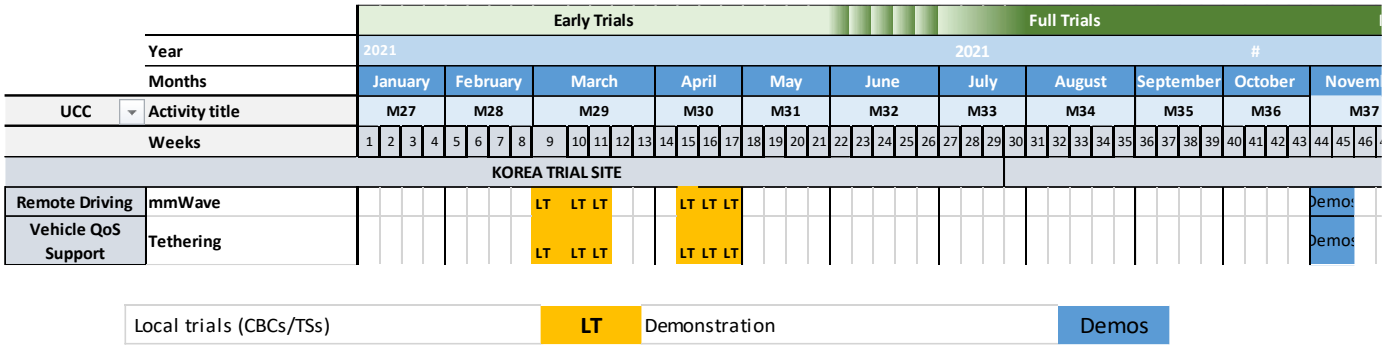

Figure 25 Use case specific Trials planning – KR TS

5. CONCLUSION

After having defined and described the common methodology for the preparation and execution of the trials within WP4 activities and reported in D4.1, the CBCs and TSs specified and adapted this trialling methodology to their site, depending on their needs and specificities. After reminding the methodology process implemented for the 5G-MOBIX trials activities, this deliverable describes how each CBC and TS adapted the general WP4 timeline and presents the detailed activities that will be tested during the trials.

This deliverable presents what will be trialled in 2021, including information on the content of the trialling activities (equipment used, cross-border issues addresses and implanted solutions, the TSs contribution to the CBCs trials etc.), where and when. The preparation of the trials phase is almost over and the next steps of WP4 are now the beginning of the Early trials phase, early 2021, in parallel of the final tasks ongoing on WP3. The Early trials phase followed by the Full trials phase in 2021 will ensure delivering proper results to WP5 and WP6 for data evaluation and consultation's study respectively.

6. REFERENCES

[1] *5G-MOBIX Deliverable D4.1, "Report on the Corridor and Trial Sites plans", Version 2.0, May 2020.*

[2] "5G-MOBIX Deliverable D2.1, "5G-enabled CCAM use cases specifications", April 2019".

[3] *5G-MOBIX Deliverable D3.2, "Report on vehicle development and adaptation for 5G enabled CCAM use cases", December 2020.*

[4] *5G-MOBIX Deliverable D3.3, "Report on the 5G Technologies integration and roll-out", December 2020.*

[5] *5G-MOBIX Deliverable D3.4, "Report on corridor infrastructure development and integration", December 2020.*

[6] *5G-MOBIX Deliverable D3.5, "Report on the evaluation data management methodology and tools", December 2020.*

[7] *5G-MOBIX, Deliverable D6.1, "Plan and preliminary report on the deployment options for 5G technologies for CCAM", May 2021..*

[8] *5G-MOBIX Deliverable D2.2, "5G architecture and technologies for CCAM specifications", October 2019.*

[9] *ETSI White Paper, "MEC Deployments in 4Gs and evolution towards 5G" February 2018. [Online]. Available:https://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp24_MEC_deployment_in_4G_5G_FINAL.pdf [Accessed 19 February 2019].*

[10] *5G-MOBIX Deliverable D5.1, "Evaluation Methodology and Plan" February 2020.*

[11] *5G-MOBIX Deliverable D3.1, "Corridor and Trial Sites Rollout Plan", May 2020.*

[12] *5G-MOBIX Deliverable D2.5, "Initial Evaluation KPIs and Metrics", October 2019.*

[13] *5G-MOBIX Deliverable D1.4, "Data management plan", April 2019.*

7. ANNEXES

7.1. General trial planning per Use cases of all sites

The following figure shows the overall planning by use cases of all the TSs and CBCs and the contribution of each TS to the CBCs. (The details of this figure are presented in more details in each TS and CBC section of this document).

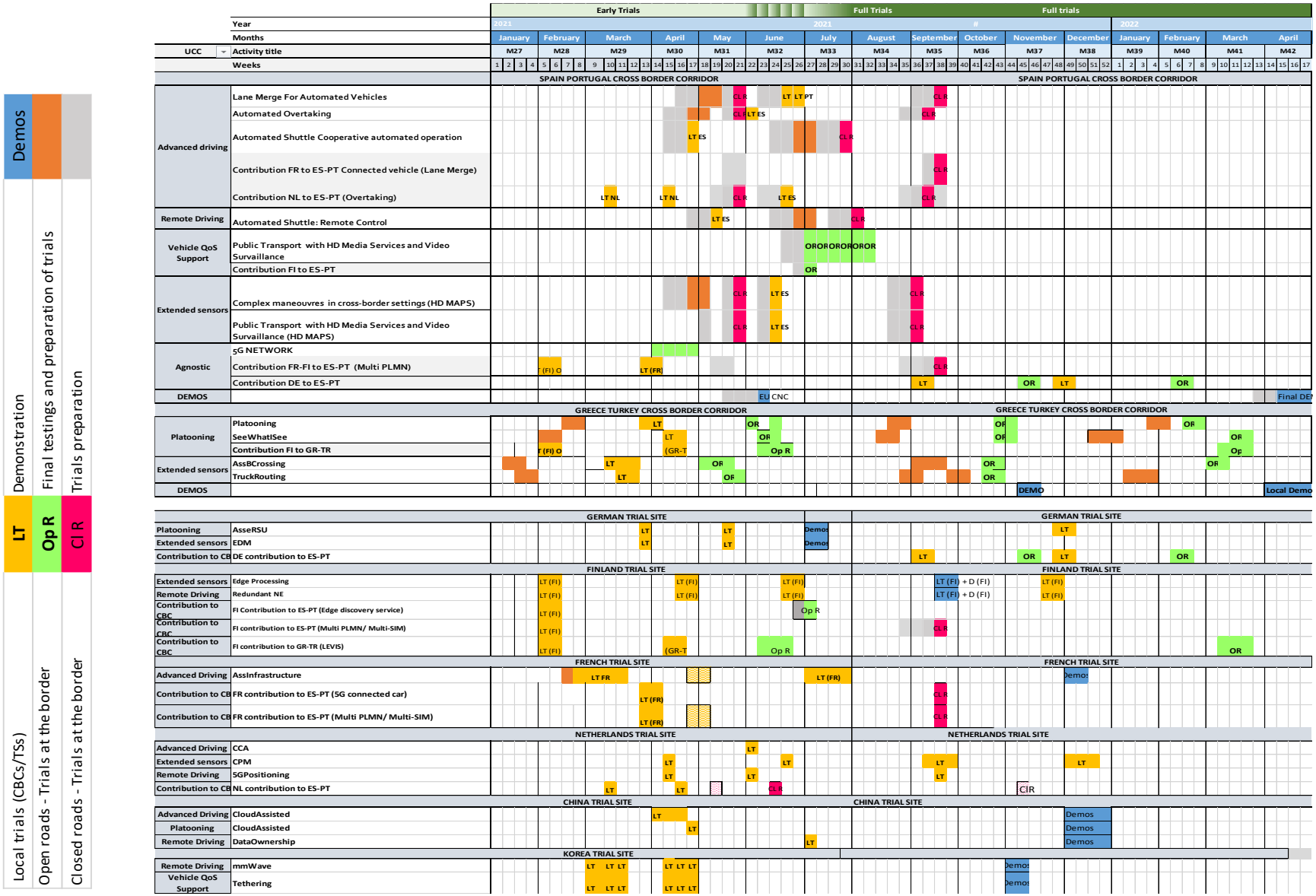

Figure 26 Trials activities Planning from January 2021 to April 2022 – All CBCs and TSs

7.2. General 5G features planning for all CBCs and TSs

The following figure shows the overall planning for all the TSs and CBCs implementing 5G technologies for their trials. (the details of this figure are presented in more details in each TS and CBC section of this document).

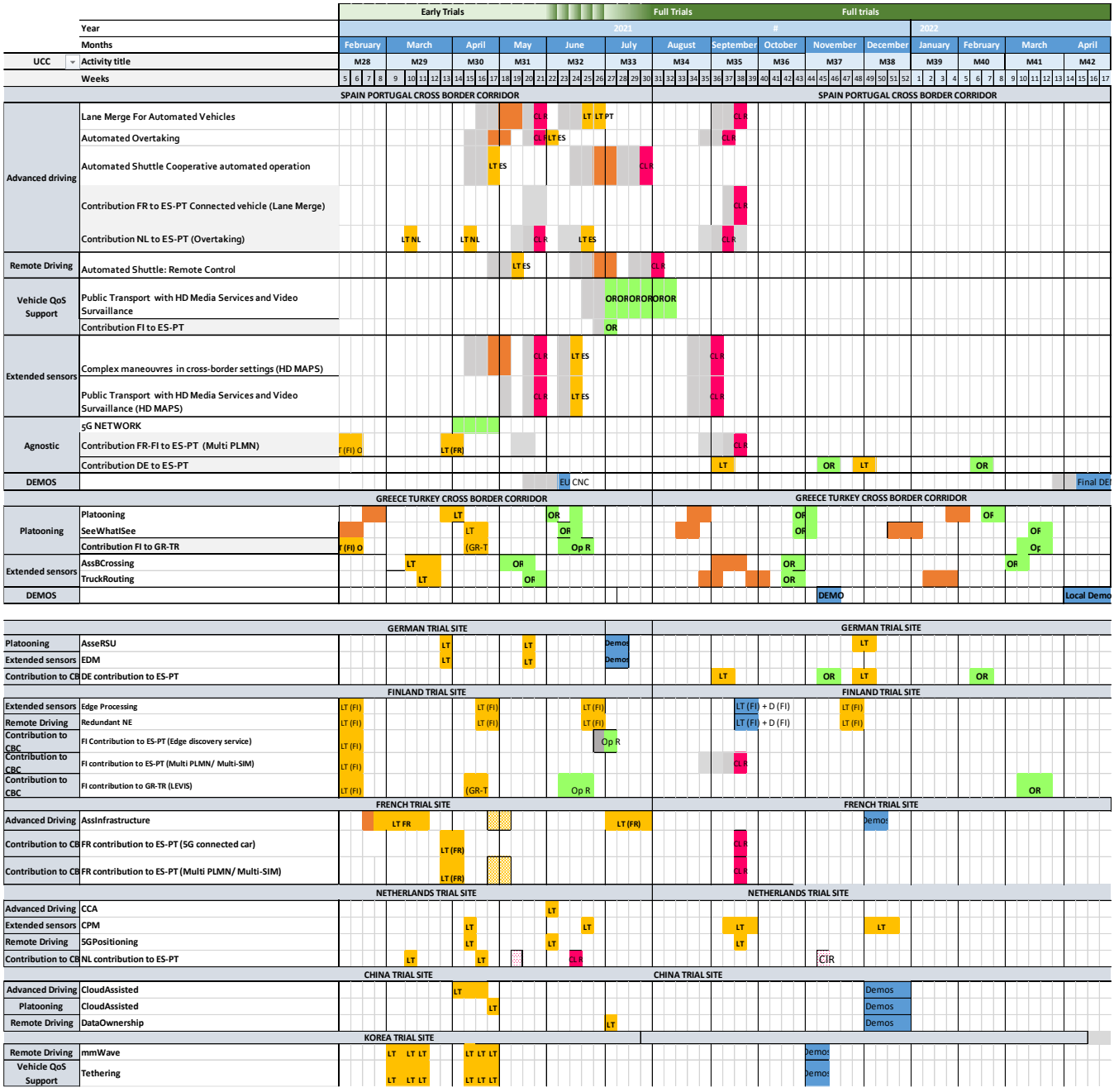

Figure 27 5G Features general planning