5GRAIL Mid-Term Conference

Outlook of 5GRAIL developments

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 951725.

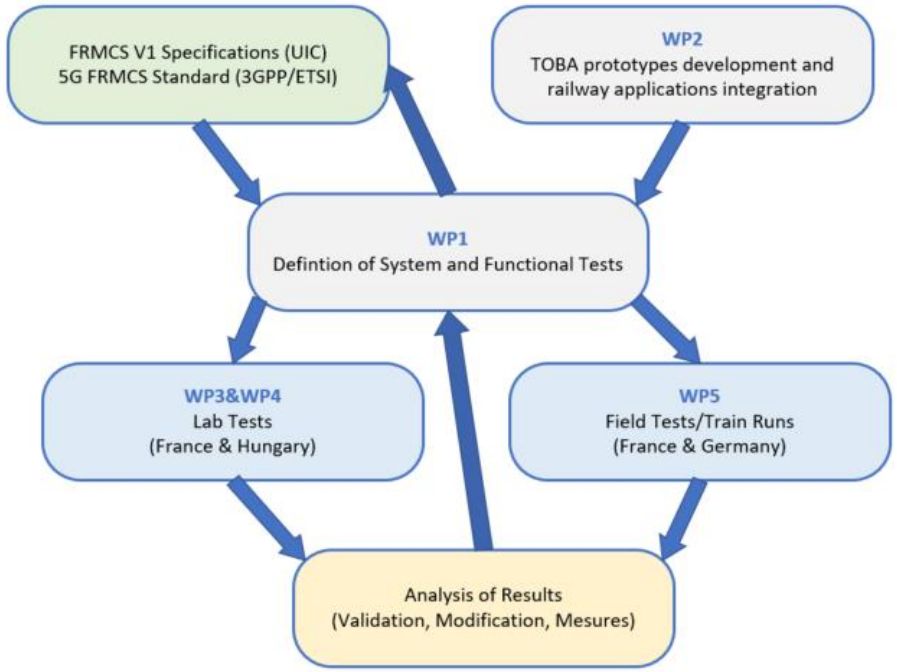
Test cases
FRMCS tests definition, tests results consolidation and specification review

WP1 Leader : Vassiliki Nikolopoulou – UIC

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 951725.

WP1 objectives reminder

- **Definition of functional end-to-end tests** allowing the validation of a selected subset of features of FRMCS V1 Specifications, based on implementation of critical and performance applications protypes using the On-board and trackside protypes over the FRMCS architecture.
- **Analyze and conclude on observations and outcomes during lab activities** of WP3 (Nokia – Hungary) and WP4 (Kontron-France) **and field activities** WP5 (DB-Germany, SNCF-France) in order to evaluate On-board and application protypes provided by WP2, based on the relevant 5G and MCX standards.
- **Contribute to the preparation of a performance measurements methodology**, based on WP5 field activities, to apply on further 5G FRMCS operational deployment
- **Identify technical constraints related to implementation issues** to potentially amend or modify FRMCS V1 Specifications



5G Rail

ALSTOM · mobility by nature · — France
CAF — Spain
DB NETZE — Germany
DTU — Denmark
Infraestruturas de Portugal — Portugal
kontron S&T Group — Germany
NOKIA — Finland
ÖBB INFRA — Austria
SBB CFF FFS — Switzerland
SIEMENS — Germany
SNCF RÉSEAU — France
TELESTE — Finland
THALES Building a future we can all trust — France
uic INTERNATIONAL UNION OF RAILWAYS — Association
unife — Association
Université Gustave Eiffel — France

Grant agreement
No 951725

5G and MCx features, use cases, test cases

Note: X: mandatory, O: optional, TBD: field limitations

Voice applications	WP3 Lab Nokia Hungary	WP4 Lab Kontron France	WP5 Field DB	WP5 Field SNCF
On-train outgoing voice communication from the train driver towards the controller(s) of the train	X	O	X	
On-train incoming voice communication from the controller towards a train driver	X	O	X	
Multi-Train voice communication for drivers including ground user(s)	X	O	TBD	
Railway Emergency Communication (voice and data application)	X	O	X	
Data applications				
Automatic Train Protection communication	X	X	X	X
Automatic Train Operation communication (limited to GoA2 ATO)		X		X
TCMS (**T**rain **C**ontrol and **M**anagement **S**ystem) : ❑ On-Train Telemetry communications ❑ On-Train remote Equipment control	X		X	
Non-critical real time video	X		X	
Transfer of CCTV archives	X		X	
PIS (**P**assenger **I**nformation **S**ystem)		X		
Remote control of engines		O		X

Advanced 5G features:

- ❑ 5G SA Core
- ❑ 5G QoS characteristics and optimized signalling relevant for mission-critical communications
- ❑ 5G unicast IP based PDU (Protocol Data Unit) session
- ❑ 5G User Equipment supporting 5G NR bands relevant for FRMCS (RMR bands)

MCx services:

- ❑ Mission Critical Push-to-Talk (MCPTT) Service
- ❑ Mission Critical Data (MCData) Service
- ❑ Functional alias
- ❑ Multi-talker control
- ❑ Mission Critical Services/GSM-R Interworking
- ❑ Mission Critical Services Systems interconnections for emulation of cross-border use cases.

WP1 activities

Achievements

- Elaboration of the Test plan (D1.1) with more **than 114 test cases** for labs of WP3 and WP4
- Validation of OBapp/TSapp compatibility for loose coupled applications (ATP (ETCS), ATO, TCMS, PIS) and tight coupled (voice)
- Preliminary REC R17 test case description
- Cross-border scenarios for TCMS, ATP (ETCS)
- Bearer flex feature validation using CCTV, ATP (ETCS), ATO applications
- Introduction of application KPIs to compare performances between perfect and degraded conditions
- QoS negotiation included in the test case description
- Mapping of the test case description to the network and radio set-up configuration *(cf. example in slide 5)*
- Agreed list of field test cases in WP5-DB&SNCF

Next steps

- Finalization of the Test Plan with:
  - ✓ Description of field test cases
  - ✓ Cross-border 5G to 5G voice test cases
  - ✓ Enhancement of REC R17 description
  - ✓ Detailed descriptions of the HO and degraded conditions set-up in the relevant test cases
  - ✓ Cybersecurity
- Prepare next deliverables with observations from labs and fields tests

7.2.1 Test case n° Voice_001: Registration of a functional identity related to the user

7.2.1.1 Purpose

The purpose of this test is to demonstrate that an FRMCS User can register a functional identity (train running number and function code) on the FRMCS system. Once the registration is completed the FRMCS User can be reached by its FRMCS functional identity.

58

5GRail

Grant agreement No 951725

7.2.1.2 Description of initial state/configuration

1. The Cab Radio A equipment type is recognised by the FRMCS system. This is handled by a predefined configuration file embedded within the Voice application software.
2. FRMCS User A is logged in into the FRMCS system. The user credentials (username and password) are predefined in a configuration file within the Voice application software.
3. The Cab Radio A is powered on, and the Idle screen is displayed on the GDCP.
4. The FRMCS User A has not been previously registered to a functional identity.
5. An FRMCS handheld device or another FRMCS subscriber registered on the same network is available.

7.2.1.3 Test procedure

Step	Action	Expected result(s)	Compliance with selected requirements
1	FRMCS User A registers its functional identity by navigating to Menu – Reg/De-reg... – Register	The train number field is displayed on the GDCP of the Cab Radio A with a Country Code pre-populated	**[FU- 7100 v0.5.0]** : 8.3.5.3, **[FU-7120-v0.5.0]** : 11.3.2.3.7, 11.3.2.3.8, **TR22.889-V16.6.0** [R-9.3.3-001]
2	FRMCS User A presses the Accept button	The train running number field is displayed on the GDCP of the Cab Radio A	
3	FRMCS User A enters the train running number and presses the Accept button	The function codes list is displayed on the GDCP of the Cab Radio A	**[FU- 7100 v0.5.0]** : 8.3.4.1,
4	Select the Lead Driver function from the list of the function codes	Registration request is sent to the FRMCS system Registration progress is displayed on the GDCP of the Cab Radio A	**[FU- 7100 v0.5.0]** : 8.3.4.1, 8.3.5.2, **[MG-7900-v2.0.0]** :64.3.3.1, 64.3.3.2
5	FRMCS system accepts the registration request	Registration status is displayed on the GDCP of the Cab Radio A (e.g., train running number appears on the display)	**[FU-7120-v0.5.0]**: 11.3.2.3.9

5GRail

WP3 lab

Site Information - Nokia Skypark

Nokia Budapest Address

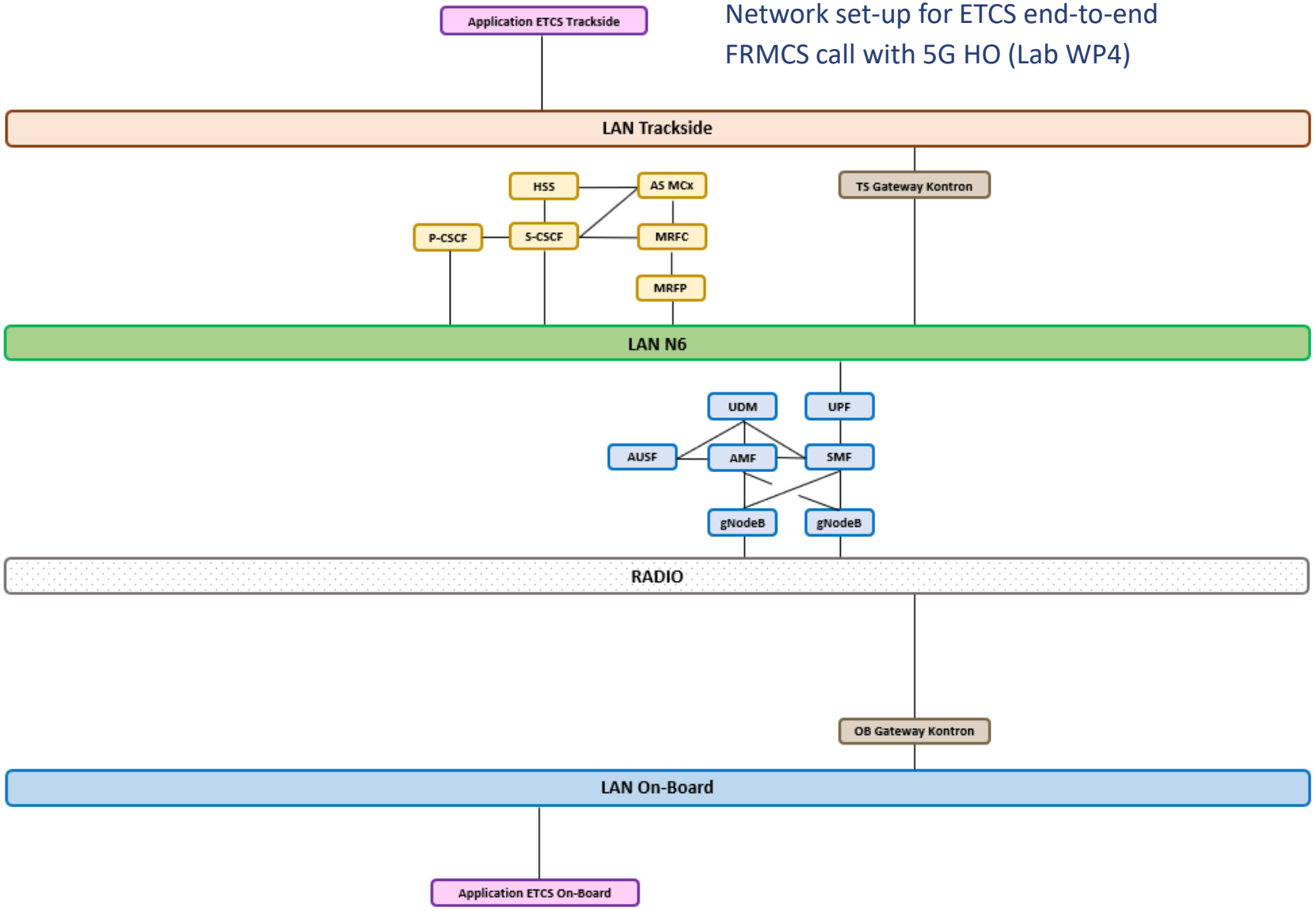
Bókay Janos utca 36-42

Bókay János utca 36, Budapest, Budapest 1083, Magyarország

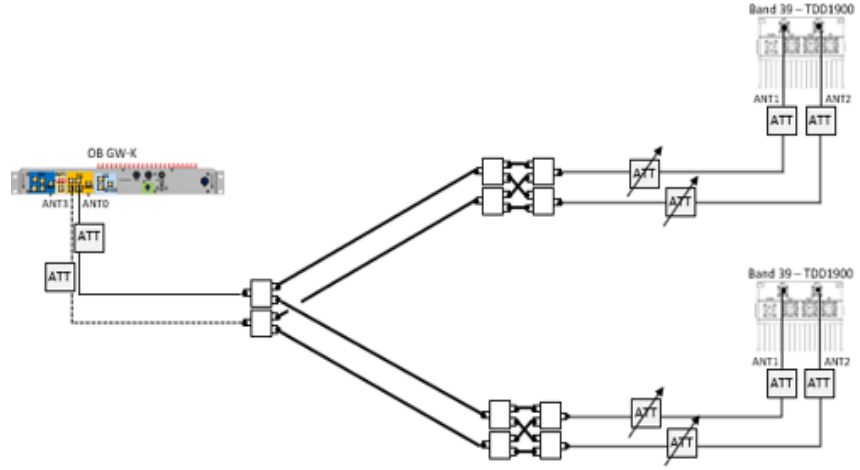
WP4 lab

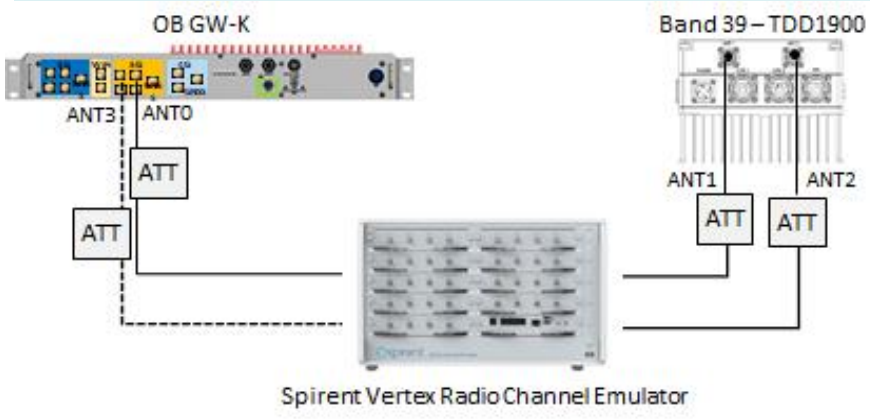
Kontron Transportation France

Network set-up for ETCS end-to-end FRMCS call with 5G HO (Lab WP4)



Radio set-up FRMCS call with 5G HO





Radio set - up FRMCS call in degraded conditions

Thank you for your kind attention

Validation of ETCS, Voice, TCMS and CCTV/Video within TOBA Laboratory tests in Budapest/Hungary/Nokia

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 951725.

WP3 Leader: Michael Kloecker - Head of Solution Management Rail
Nokia Solutions and Networks
mailto: Michael.Kloecker@nokia.com

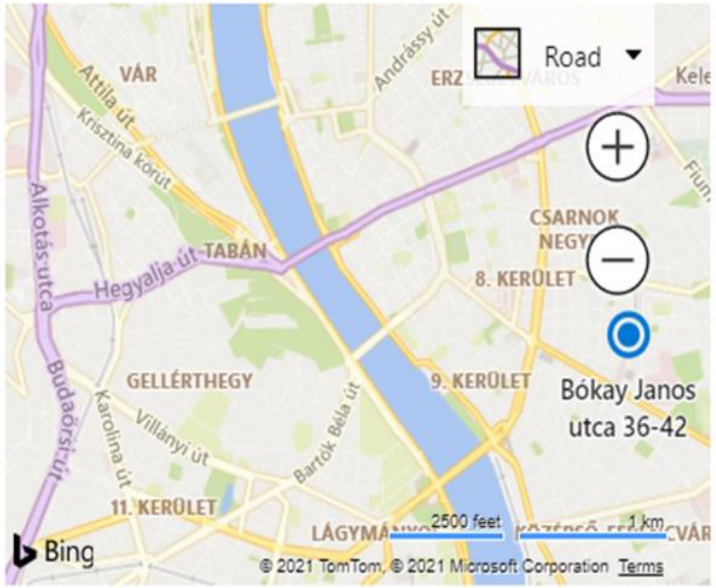
WP3 Lab – Hungary

Site Information - Nokia Skypark

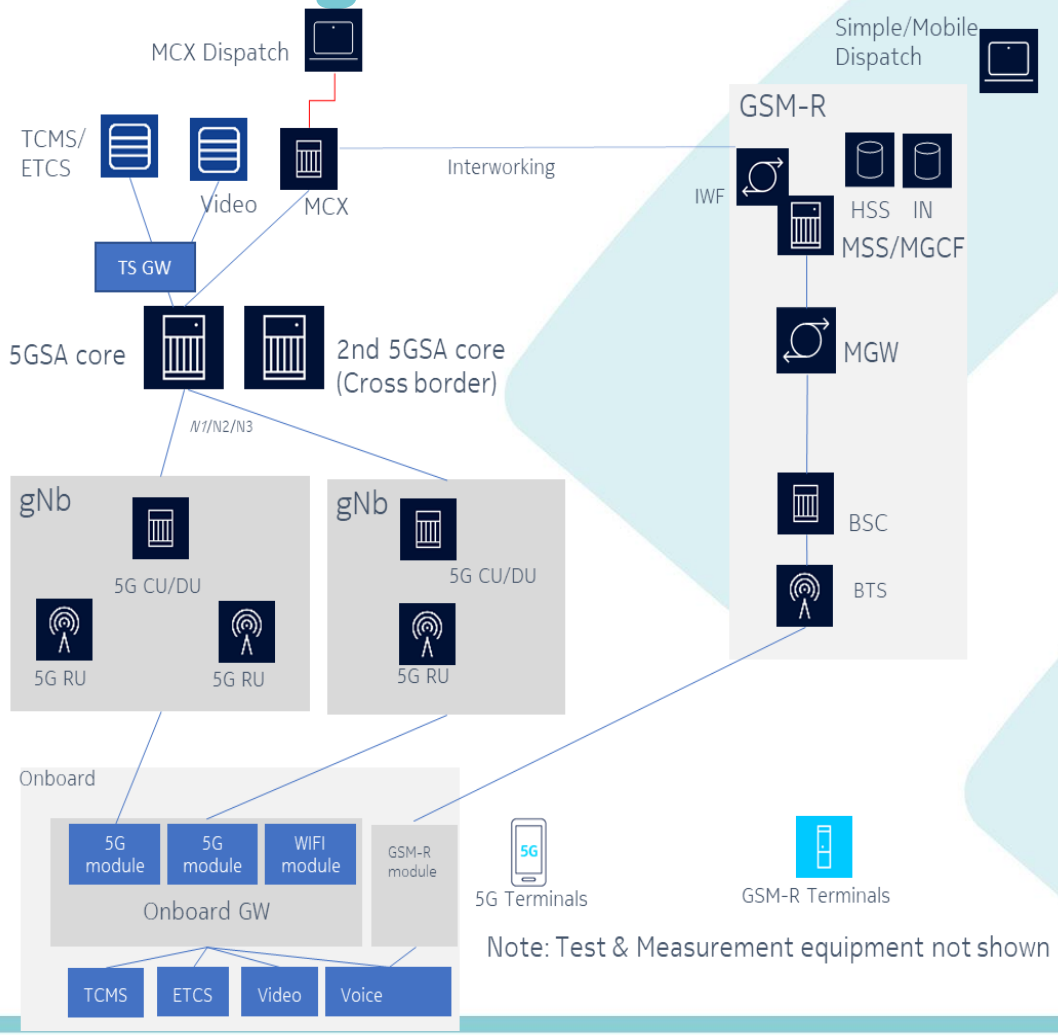
Nokia Budapest Address

Bókay Janos utca 36-42

Bókay János utca 36, Budapest, Budapest 1083, Magyarország



Lab Configuration Overview



- Fully integrated 5G core, radio, MCX, OB/TS Gateway and voice, video, data application
- 5G SA core and radio (second 5G SA core for border crossing
- MCX with Dispatch and GIS platform
- Application server on trackside
- Onboard GW with integration of CAB Radio, ETCS/TCMS (simulated) and Video application & Camera
- GSM-R integration for interworking and border cross
- Monitoring, Fading Emulator and Attenuator equipment
- COTS Smartphones for group call use cases

Grant agreement
No 951725

WP 3 – Multiple Tests – Multiple Partner Integration

- Testcases: Voice, ETCS/TCMS, Video

Application	Partner
Voice / CAB Radio	Siemens
TCMS/ETCS	CAF
Video	Teleste
OB/TS GW	Kontron
Infrastructure	
5G Core, Radio, MCX Server, Dispatcher, GSM-R	Nokia

Railway Emergency incl. GSM-R Interworking	**Train to/from Dispatcher**
ETCS	**TCMS: Remote Control / Telemetry/Cross Border**
CCTV – Transfer of files / Bearer Flexibility	**Real Time Video Streaming**

Lab Configuration Overview HW infrastructure

NOKIA

MCX Dispatch and OAM

Dispatch, OAM GUI

GIS GUI

Lab Cloud based installation

MCX + Location /
GIS (Geographic Information System)
+ SIP core

5G SA Core
(UPF, SMF, AMF,AUSF, UDM)

5G Radio
(Nokia Airscale BBU & RRH

5G Terminals

Tools
- Attenuator/Speed emulator
- Performance Monitoring
- Traffic Load

SIEMENS

Cab Radio

TELESTE

Video Camera and Servers

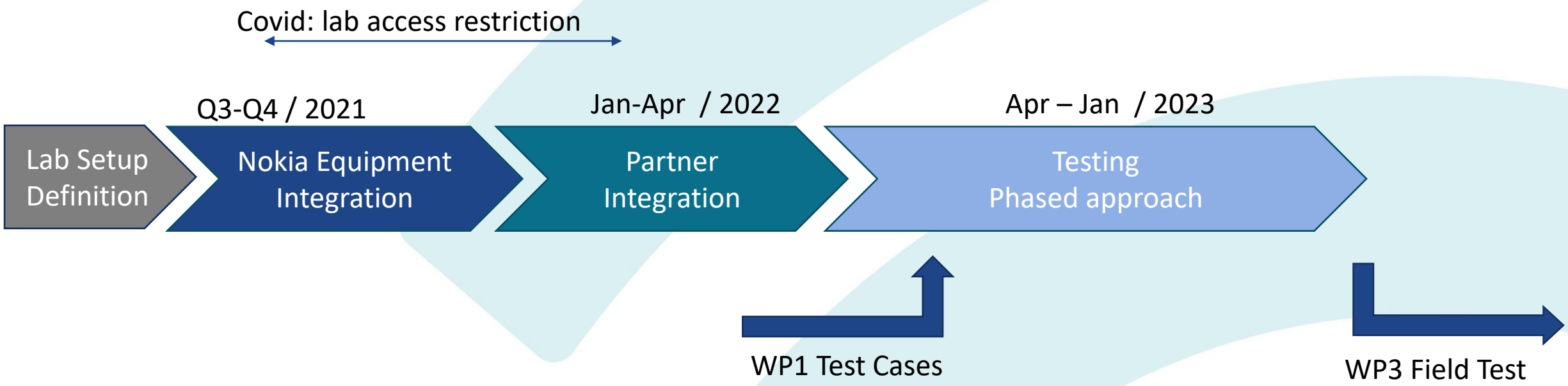
CAF

Onboard and Trackside

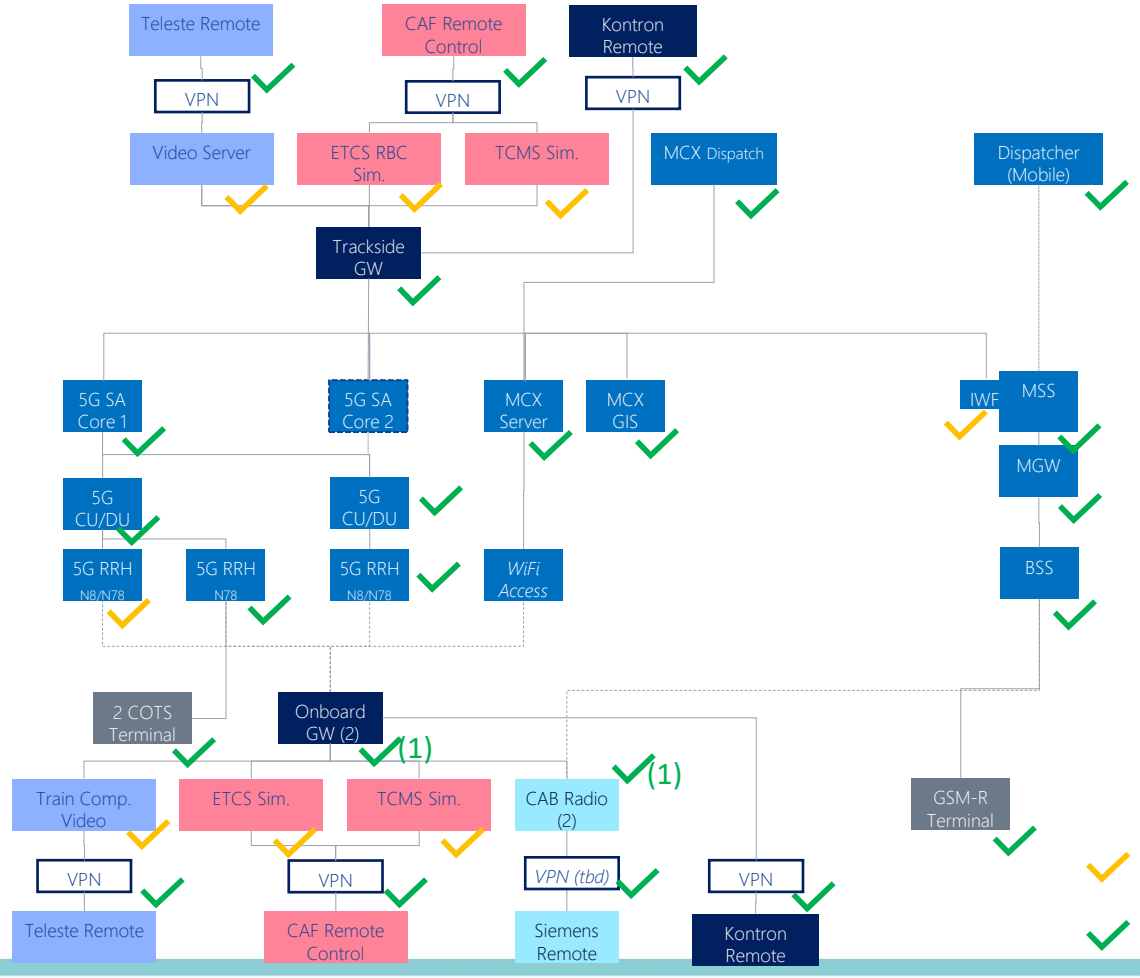
kontron
S&T Group

Gateways

Timeline


Covid: lab access restriction
Q3-Q4 / 2021
Jan-Apr / 2022
Apr – Jan / 2023
Lab Setup Definition
Nokia Equipment Integration
Partner Integration
Testing Phased approach
WP1 Test Cases
WP3 Field Test

Lab Configuration Overview and infrastructure Installation & Integration status



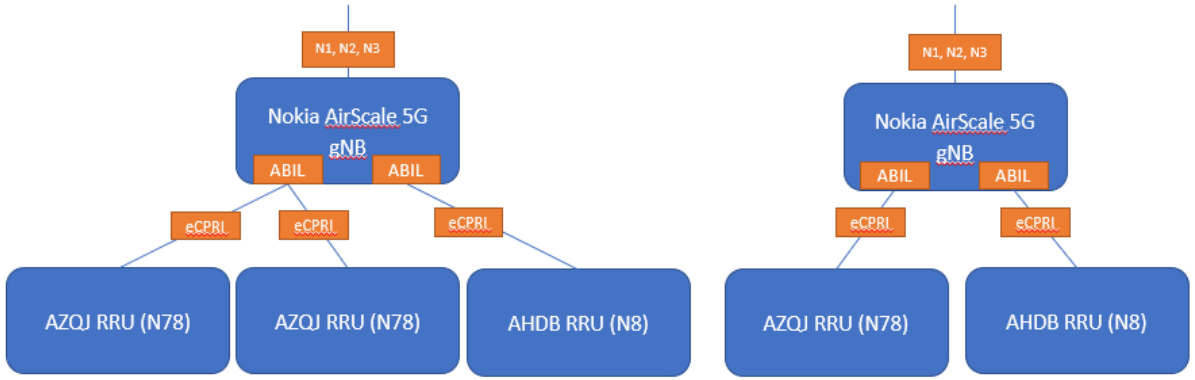
- Installed
- Integrated

- Installation & Integration was mainly done Q4 2021 (Nokia equipment) and Q1 2022 (partner equipment)
- Main reason was the strict access restriction at Nokia Lab due to COVID-19 in end 2021/ begin 2022
- Time was spend in setup remote connectivity to all partner to allow for maintenance and even remote test supervision and execution.
- Some closing activities are still ongoing before testing phase starts

- Achievements until today
  - Setup of all Remote Access
  - First Data call using Thales Modem
  - Smartphone connectivity for MCX Voice

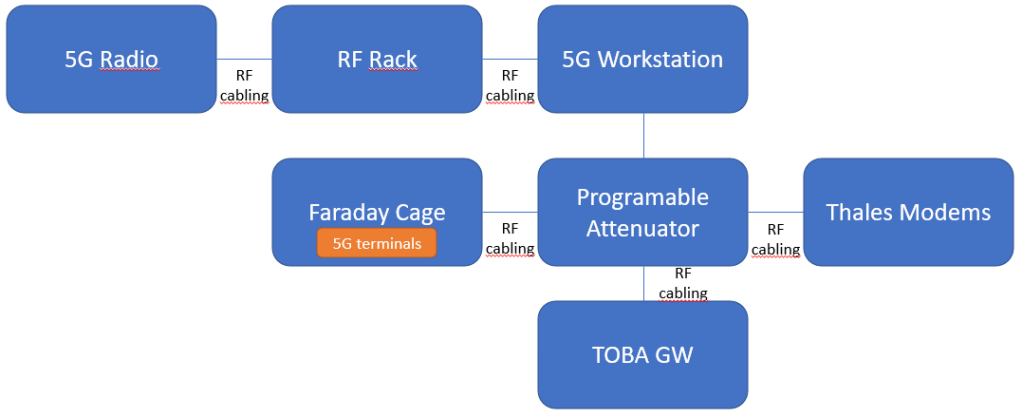
▪ Kontron OM Server not shown

WP3 Radio and RF equipment



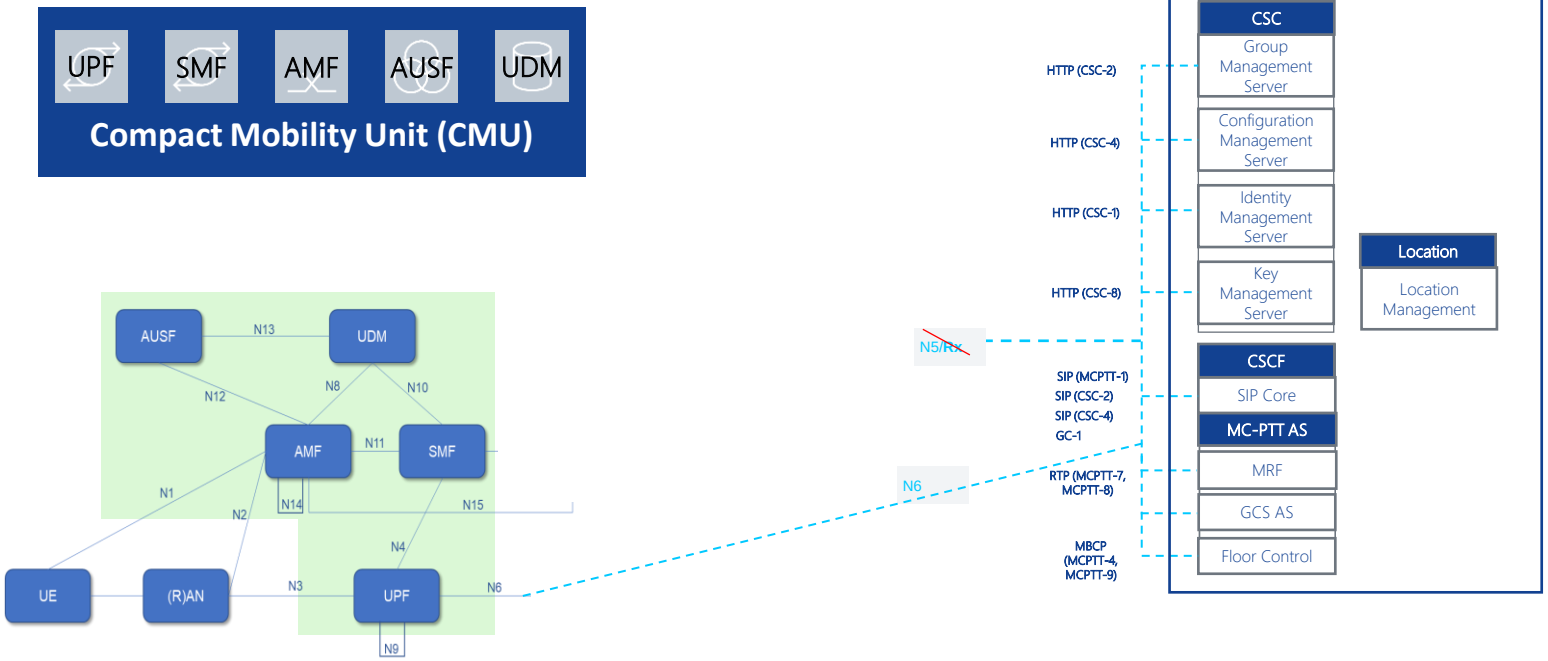
- Spectrum
- N8 band, 900 MHz FDD (UL: 880 – 915 MHz, DL: 925 – 960 MHz)
- N78 band, 3300 – 3800 MHz TDD

- CU/DU based on Nokia Airscale
- Flexible connection of RRH
- Shielding and Programmable Attenuator (Handover Emulation)
- Fading simulator (degraded, high speed condition



Grant agreement
No 951725

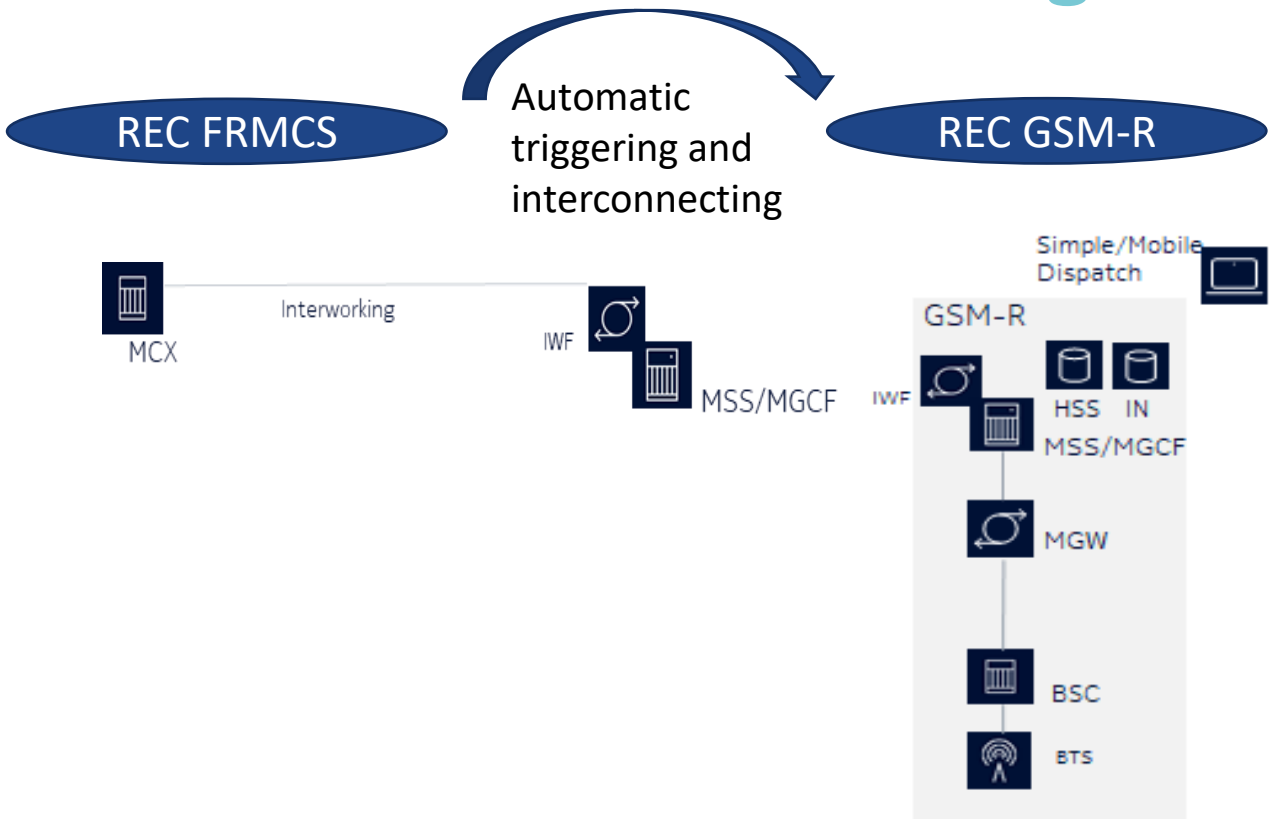
WP3 5G Core and MCX



- Fully integrated 5G SA core
- PCF emulation by QoS filtering rules
- HP server (redundant)

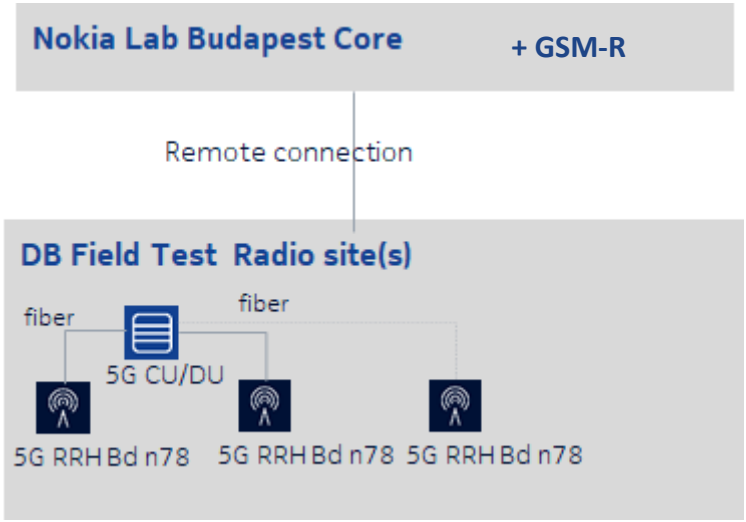
- MCX Server, Dispatcher and GIS/Graphical interface
- Cloud and Bare Metal

MCX – GSM-R Interworking



- Interworking Use case / pre standard
- Establishment of FRMCS Railway Emergency Call triggers automatically GSM-R REC setup
- Configuration for example at border
- Moving from GSM-R to FRMCS as a Border Crossing Scenario
- IWF integrated in Nokia MSS/MSC

Support WP5

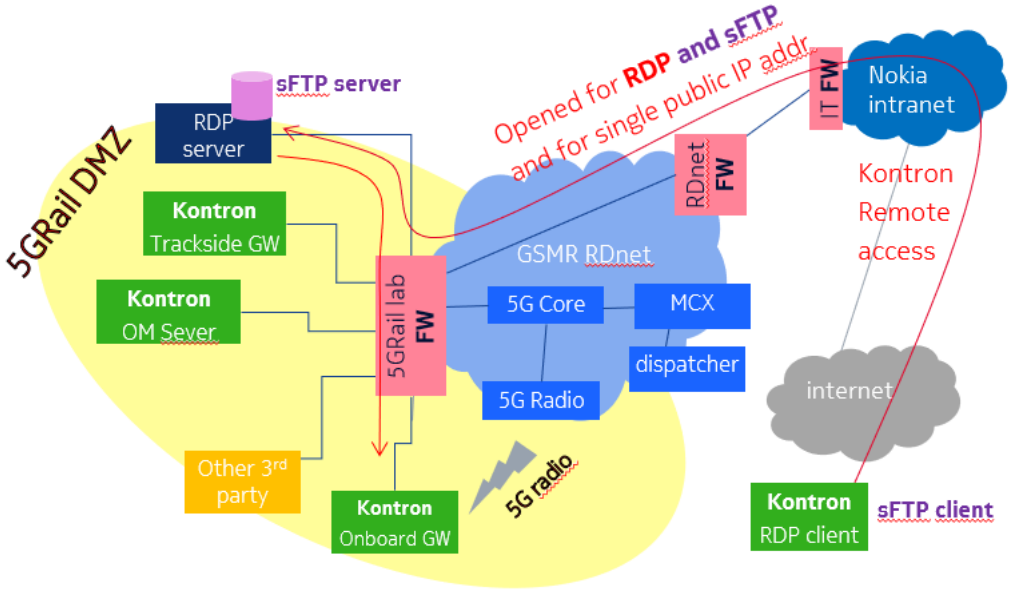


- Remote connection from Core Network to Radio Sites at German Field
- Selected testcases

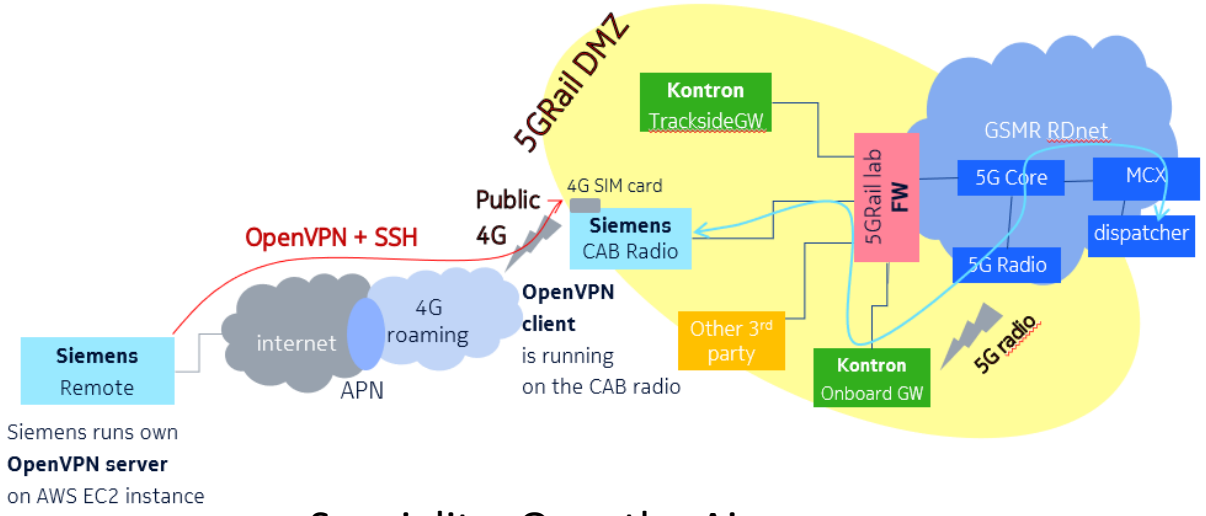
Managing COVID-19

Remote Access for all partners for maintenance and test support (I)

Kontron



Siemens

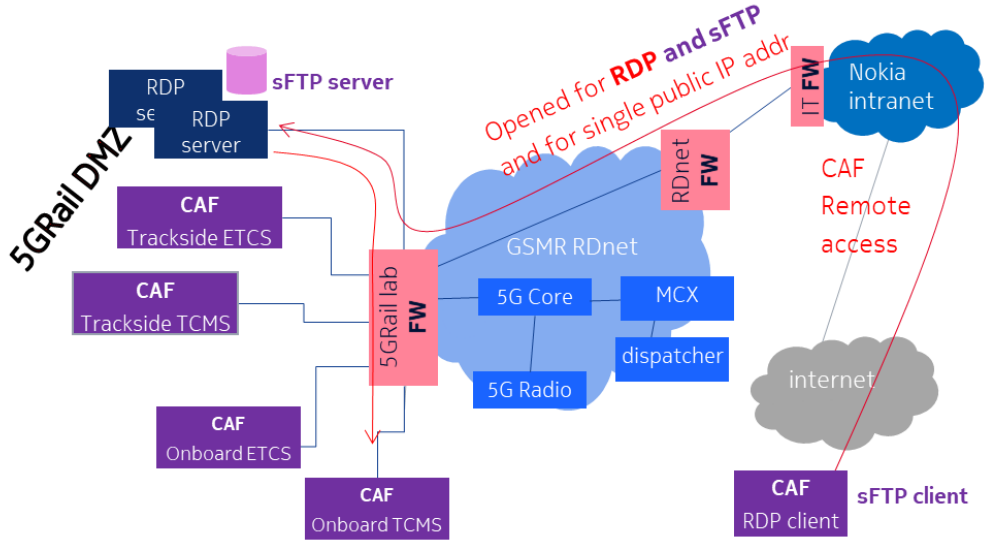


Speciality: Over the Air access

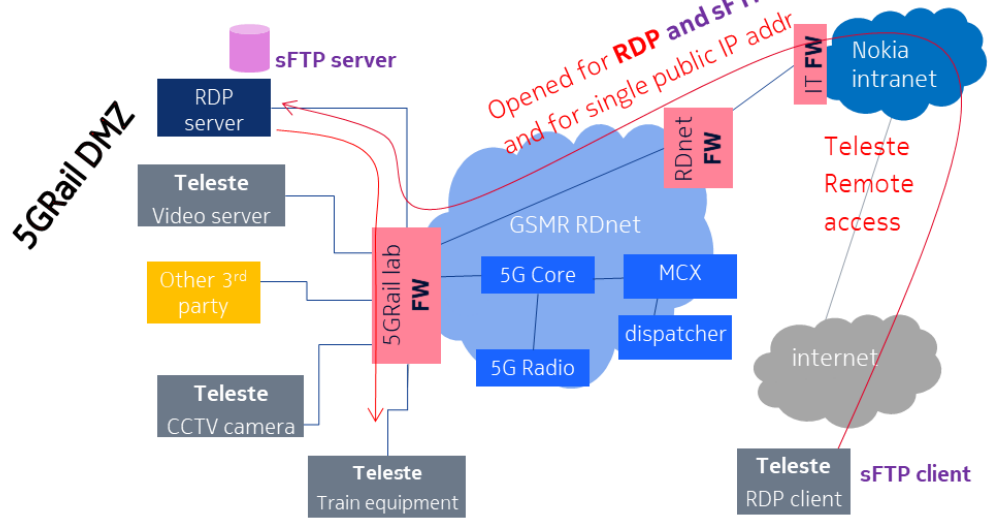
Managing COVID-19

Remote Access for all partners for maintenance and test support (II)

CAF



Teleste



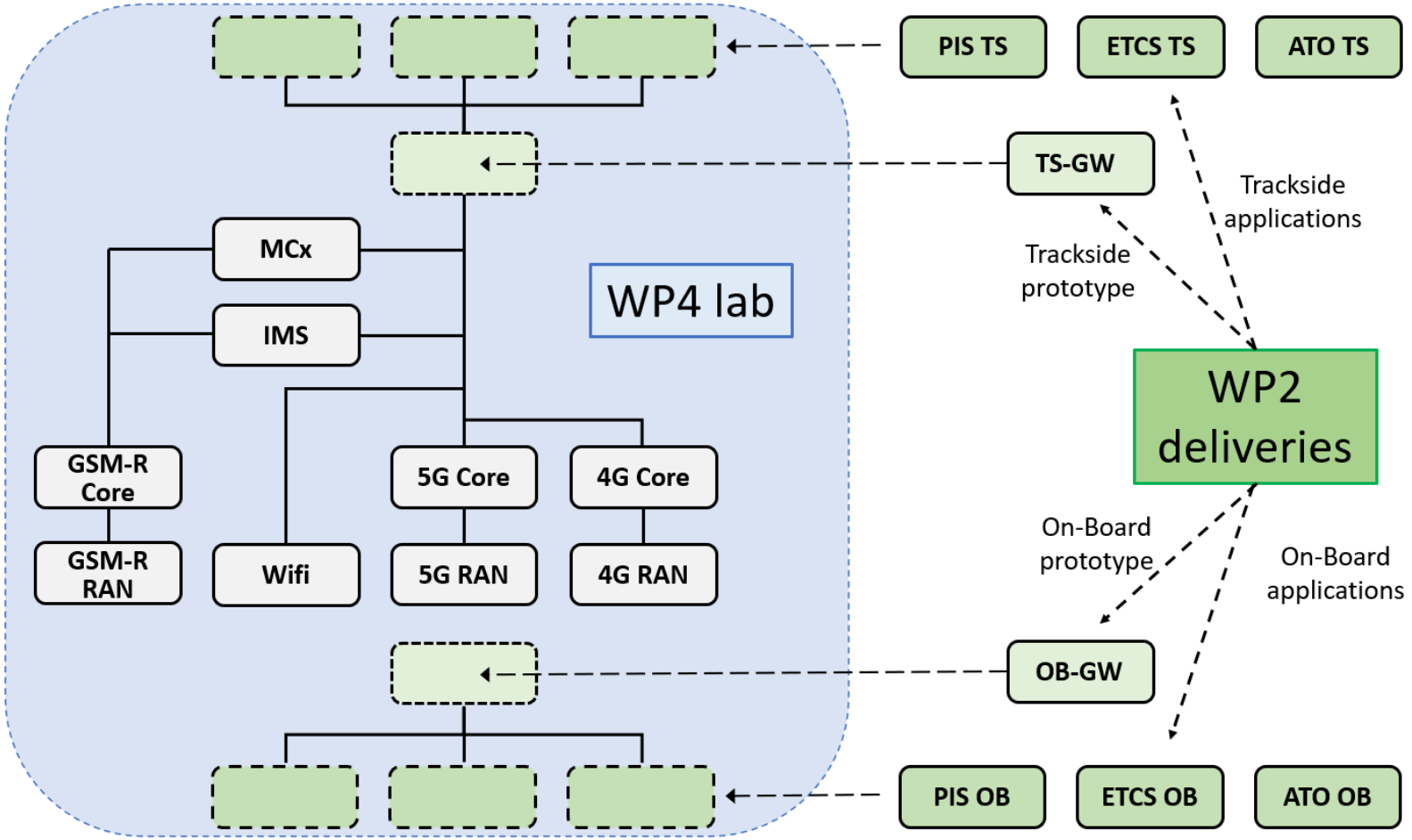

5GRail

5GRail Lab Tests Status

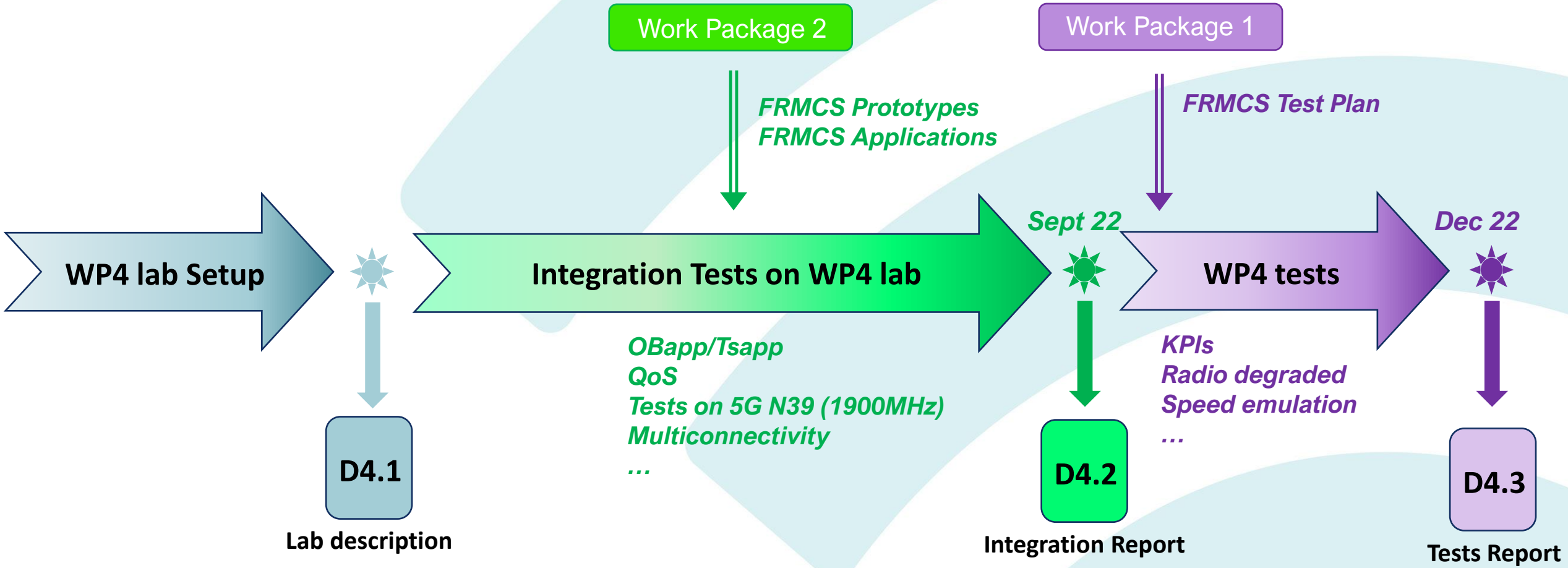
WP4 Leader: Sébastien TARDIF - Kontron Transport

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 951725.

WP4 integration activities for WP2 drops



WP4 activities overview



WP4 outcomes

- WP4 will provide **test results** and associated measurements in D4.3
- **Test data to be given to WP1 for analysis** in D1.2 and D1.3 deliveries
- WP4 activities are also a **preparation for WP5 activities in France**
- Part of WP4 **infrastructure will be reused** in WP5

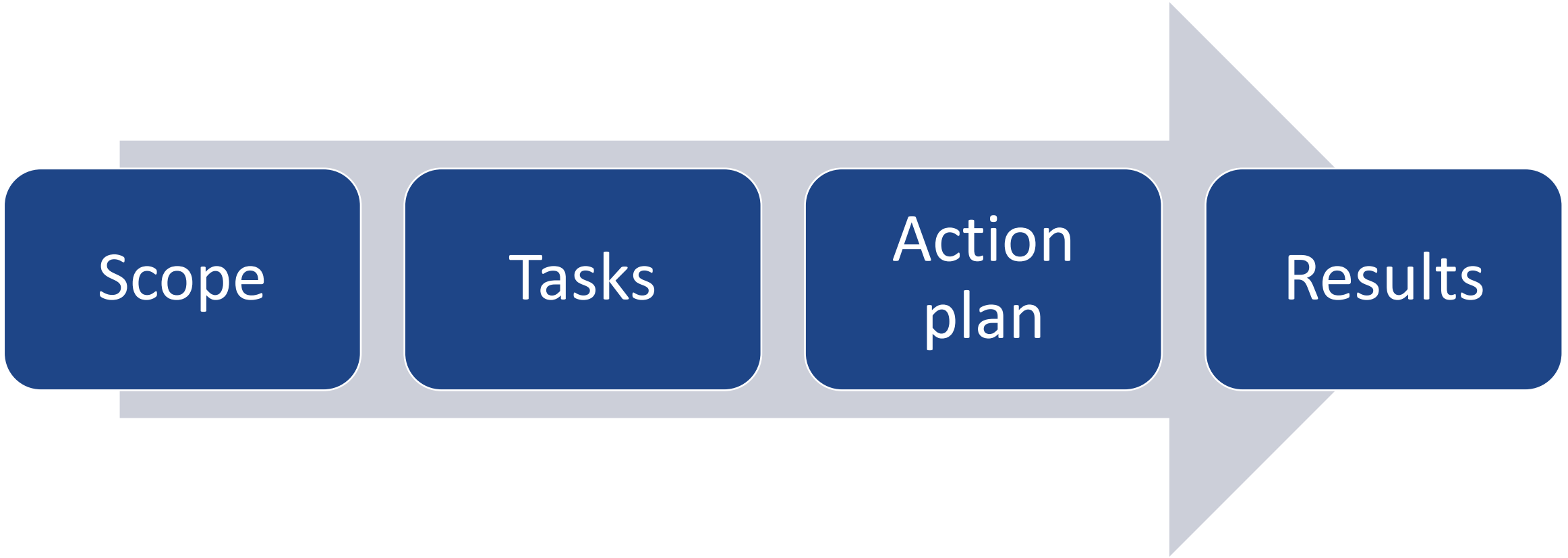

5GRail

Field Implementation and Evaluation

WP5 Leader: Guillaume Jornod, DB Netz AG
WP5 co-Leader: Nazih Salhab, SNCF-Réseau

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 951725.

Agenda



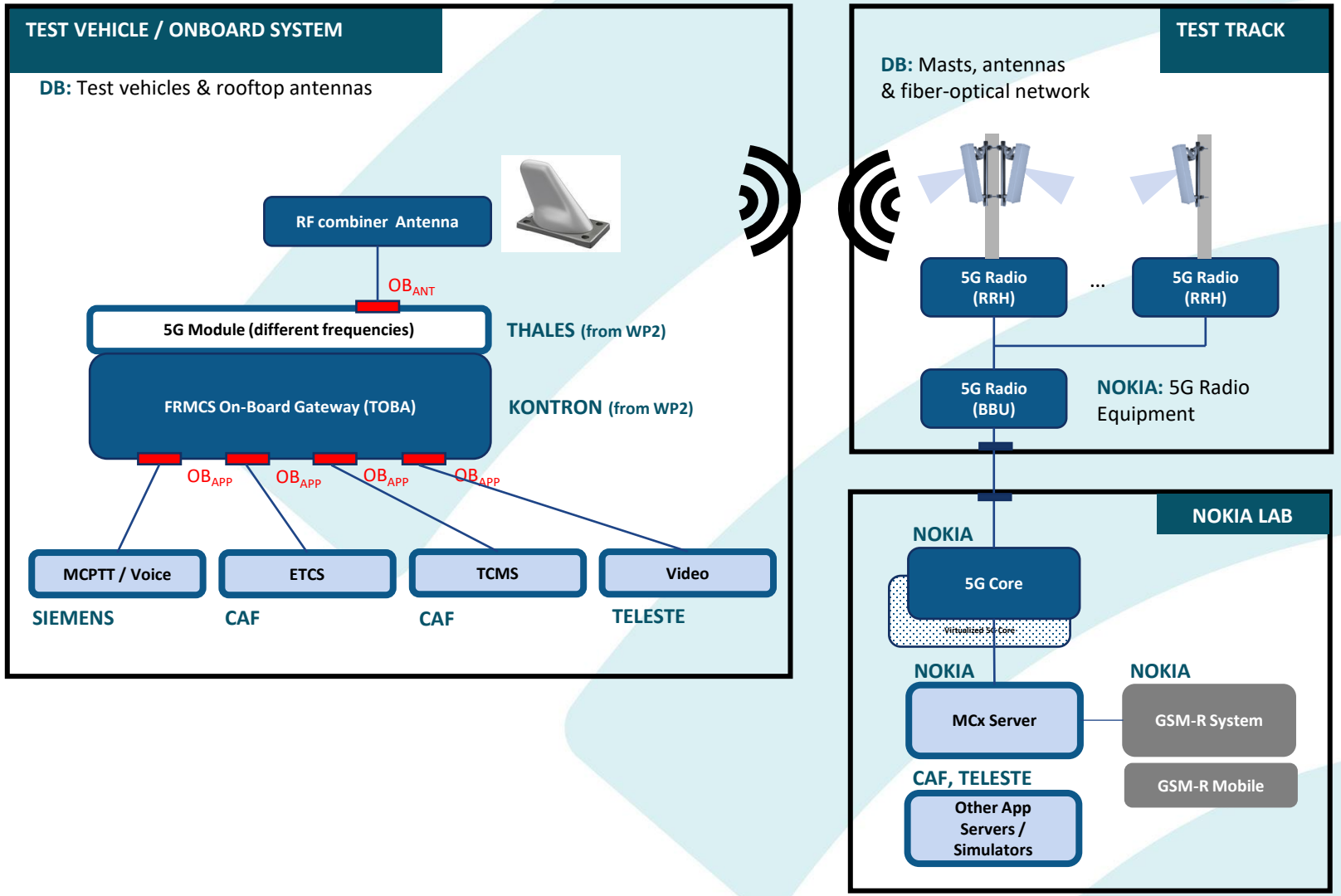
WP5 Test Arrangement in Germany

Scope

Tasks

Action plan

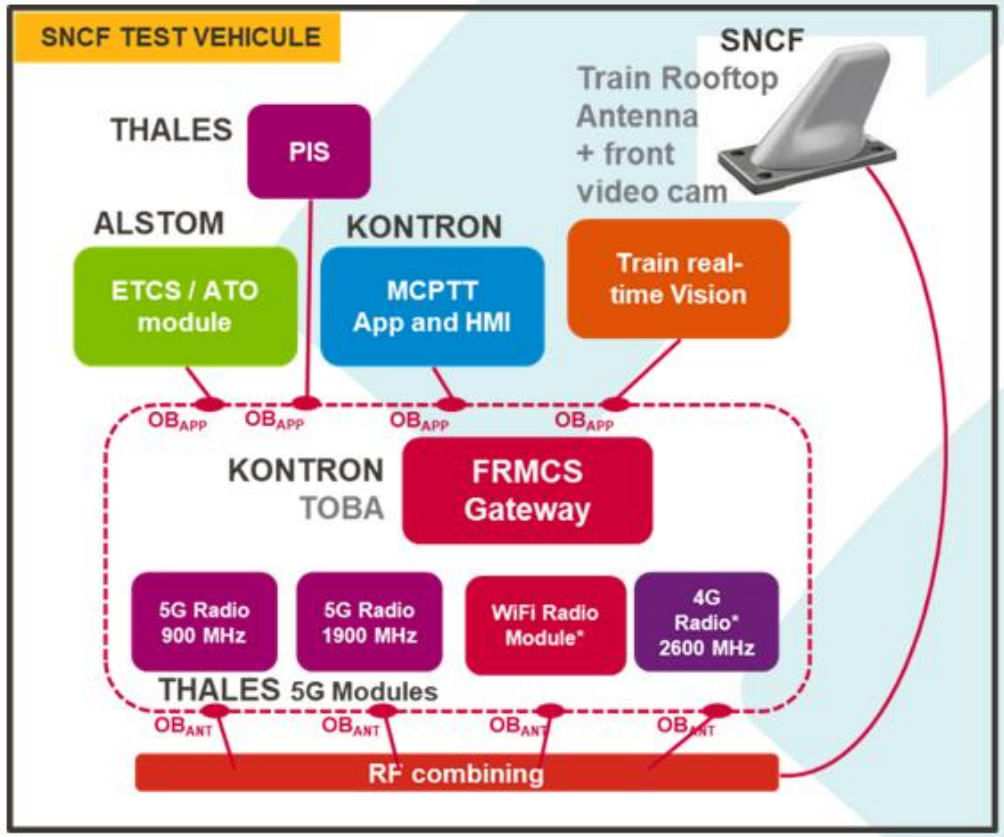
Results

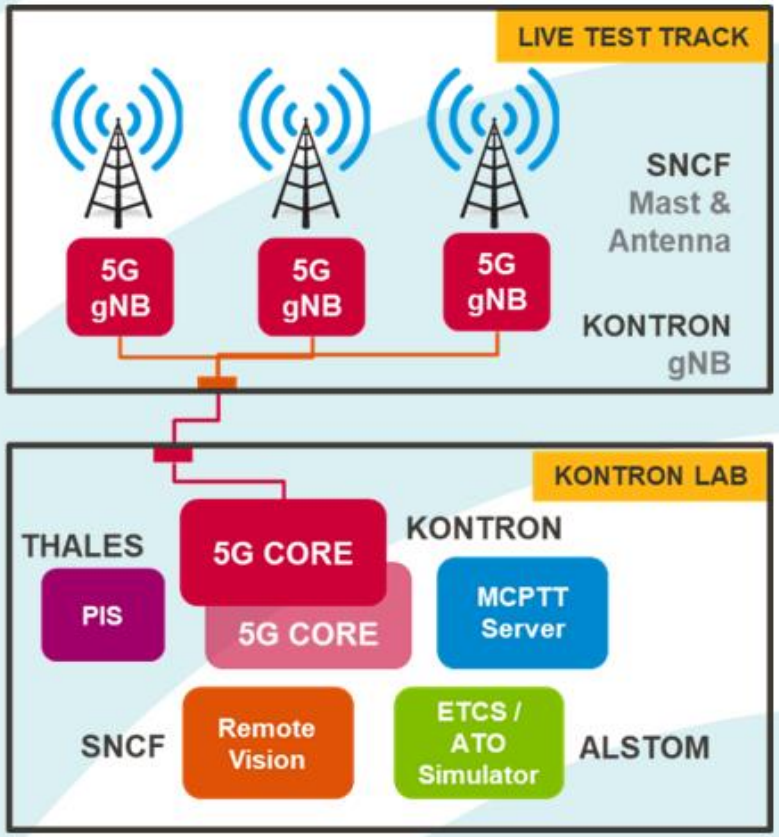


Grant agreement
No 951725

WP5 Test Arrangement in France

WP5 Test Arrangement in France (SNCF-R)





WP5 Tasks
In both fields (French and German)

Scope

Tasks

Action plan

Results

T5.1. Test Site & Field Trial Preparations

- **Train runs** and test **sessions**
- Preparing **Trackside** (TS) infrastructure for 5G/FRMCS field test sites
- **Installing** and **commissioning** of FRMCS equipment

T5.2. FRMCS Functional & Performance Testing

- Organizing and executing functional and performance test sessions **according to the field test strategy defined in WP1**

T5.3. Cross-border Scenario Testing

- Organizing and executing border-crossing test **sessions inline with the field test strategy**

WP5 Planned Syncs & Work Streams (within Task 5.1)

Scope

Tasks

Action plan

Results

WP5

WP5.1 WS#1 Test Verification [WP5-WP1]	**WP5.1 WS#2** DE Network [WP5-WP3]	**WP5.1 WS#3** DE Applications [WP5-WP3]	**WP5.1 WS#4** FR Network [WP5-WP4]	**WP5.1 WS#5** FR Applications [WP5-WP4]

WP5.1 Workstreams	Scope	Involvement	Start	Deadline
#1 Test Verification	Test plan review, Assumptions Review (WP3,WP4)	DB, SNCF + partners on demand	01/2022	05/2022
#2 DE Network	Field Architecture + Implementation Specifics (e.g. frequencies, VPN/IP plans, SIM cards & MNCs)	DB, Nokia, tbd: Kontron (TS GW)	01/2022	Q4 2022
#3 DE Applications	Integration of Application Devices/Servers in Field, OAM	DB, Nokia, Siemens, CAF, Teleste	Dep. on D1.1 v2, WP3	
#4 FR Network	Field Architecture + Implementation Specifics (e.g. frequencies, VPN/IP plans, SIM cards & MNCs)	SNCF, Kontron + DB	01/2022	Q4 2022
#5 FR Applications	Integration of Application Devices/Servers in Field, OAM	SNCF, Kontron, Alstom tbd: Thales (PIS)	03/2022	

Envisioned Test Sites in Germany

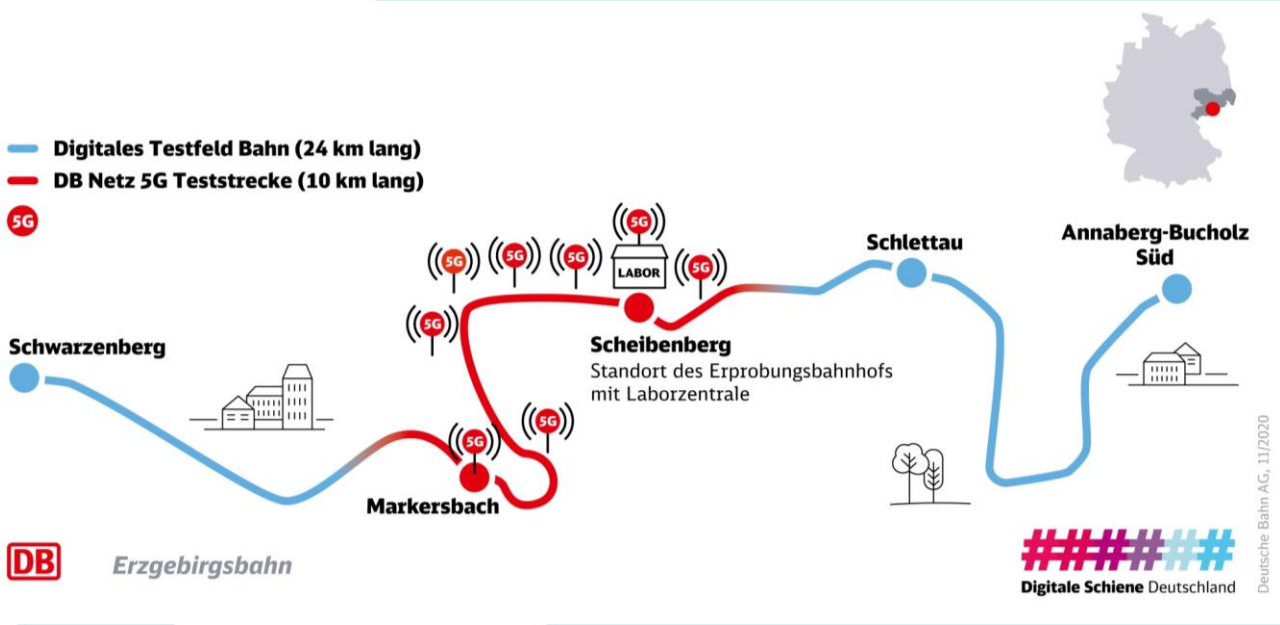
Scope

Tasks

Action plan

Results

- **Track Location:**
  - Line for experimental trials within *Digitales Testfeld Bahn* (Erzgebirge), allows 50-80 km/h
- **5GRail Spectrum:**
  - Industrial Private Network Spectrum 3.7-3.8 GHz (5G band n78), divided in two times 20Mhz with 10MHz guard band
- **Basic Infrastructure:**
  - Container/masts to host antennas and RRUs; Server Room (Scheibenberg) to host 5G CU/DU; Fiber-optical network along the track
- **Work started Jan. 2022:**
  - Preparation of test track
  - Realization IP/VPN concept to connect to 5G Core in Nokia lab
  - Realization 5G RAN field concept with Nokia (min. 3 gNBs)
  - Selection of test train for onboard equipment integration



Envisioned Test Sites in France

- **Track Location:**
  - Commercial line in Vigneux sur Seine, Ile de France
  - approx. 7 km length
- **5GRail Spectrum:**
  - Future FRMCS Spectrum 1.9 GHz (5G band n39)
- **Basic Infrastructure:**
  - Masts to host antennas, RRUs; 5G CU/DU and 5GC
  - Dark fiber fronthaul
- **Ongoing Work:**
  - Preparation of test infrastructure
  - Preparation for 5G RAN & Core with Kontron (3 gNBs)
  - Realization of backhaul to duplicated 5G Core
  - Onboard equipment integration on rolling stock
  - Realization of one 4G site (1 eNB) for inter-RAT test

Grant agreement
No 951725

Envisioned Bearer flexibility scenarios in France

MULTI-CONNECTIVITY FIELD TESTS

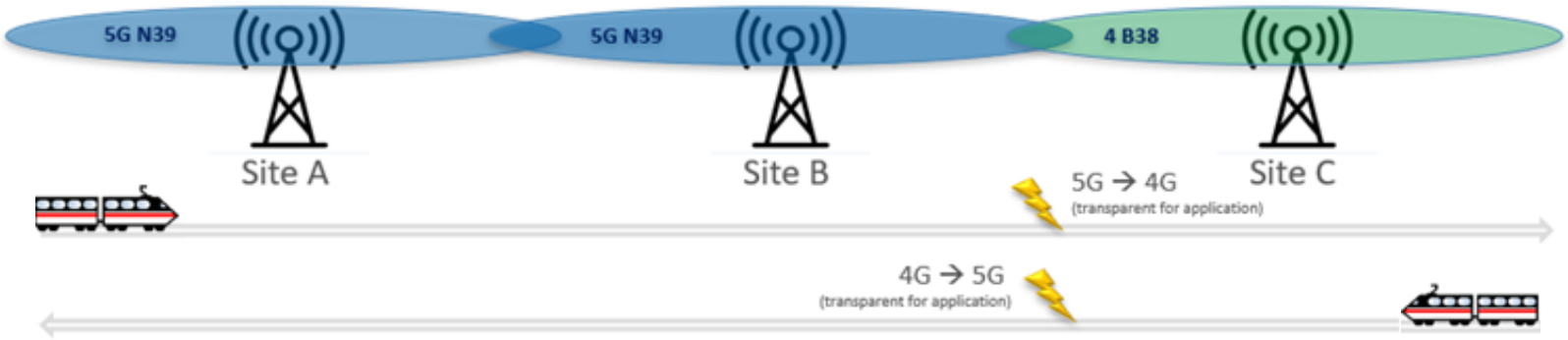
Scope

Tasks

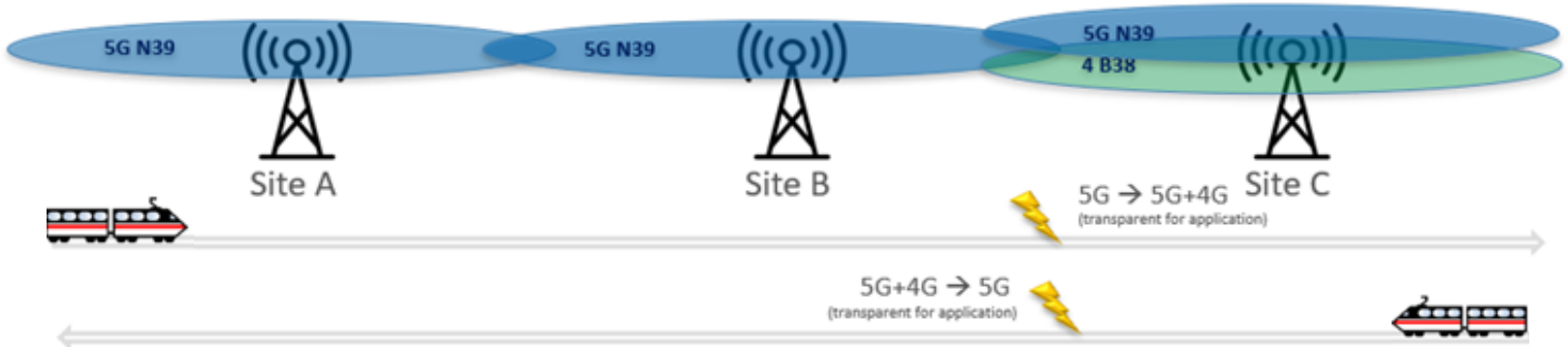
Action plan

Results

Scenario #1
Redundancy use case



Scenario #2
Aggregation use case



Grant agreement
No 951725

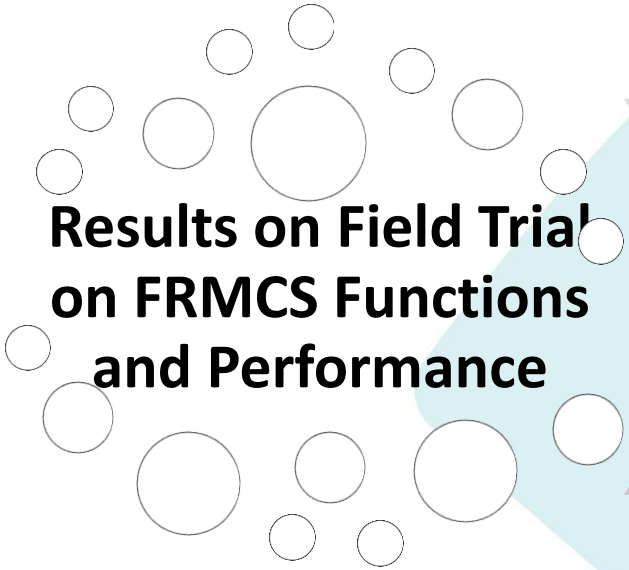
WP5 Deliverables

Scope

Tasks

Action plan

Results



Results on Field Trial on FRMCS Functions and Performance

Comprehensive description of test performed and results

Results on Field Trial for Cross-border Scenario

Comprehensive description of test performed, and results

Conclusion Report on 5G FRMCS Field Trials

interpretation of the 2 field outcomes to highlight of key findings for the future

Thank you for your attention!

Rail and Road communication systems coexistence

WP6 Leader : Marion BERBINEAU – UNI. EIFFEL

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 951725.

WP6 objectives

Evaluation of the **coexistence of rail and road automotive communication use cases** by evaluating the possible synergies allowed by the Future Railway Mobile Communication System between both vertical industries based on a situation implying common use cases

Partners: Uni. Eiffel, DTU, UIC, IP, CAF-ID

What means Rail and Road coexistence scenarios?

- Civil-engineering
- Telecommunication (radio access and core nework)
- Communication services

Illustration of possible existing scenarios

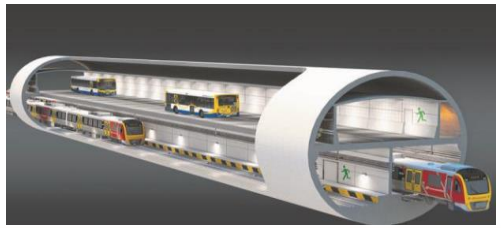
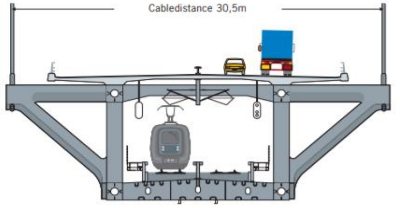
- Tracks parallel to roads



- Tracks crossing roads

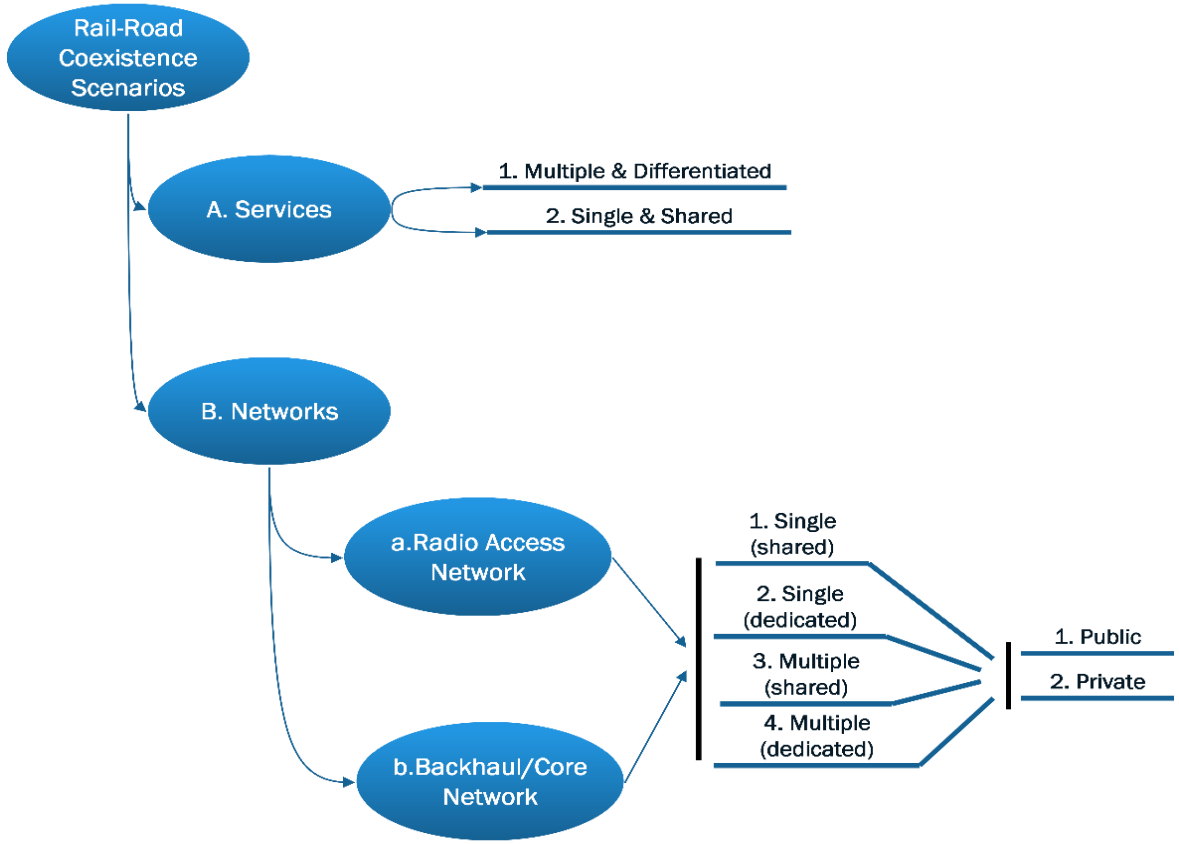


- Tunnels, bridges

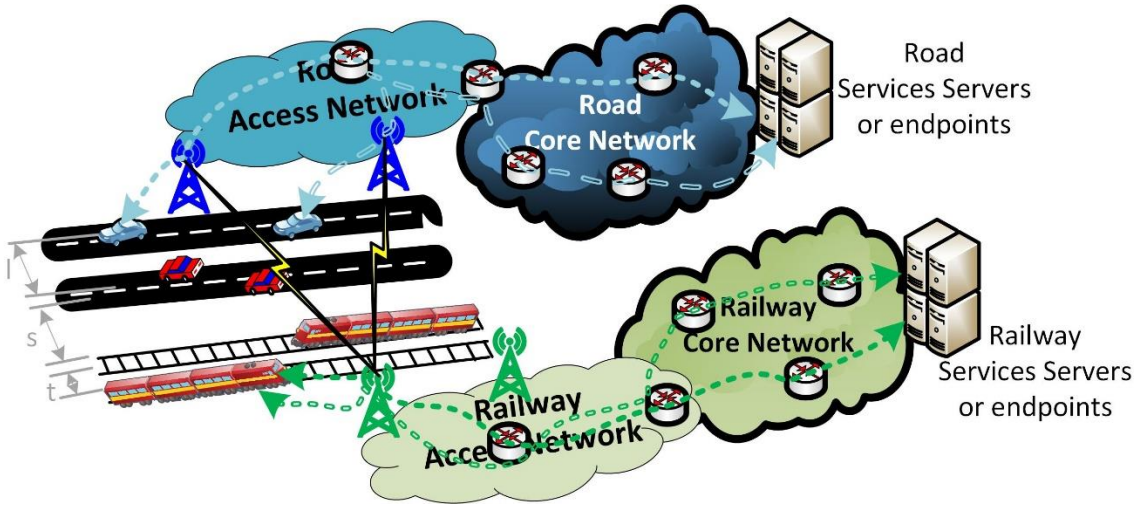
- Autonomous vehicles

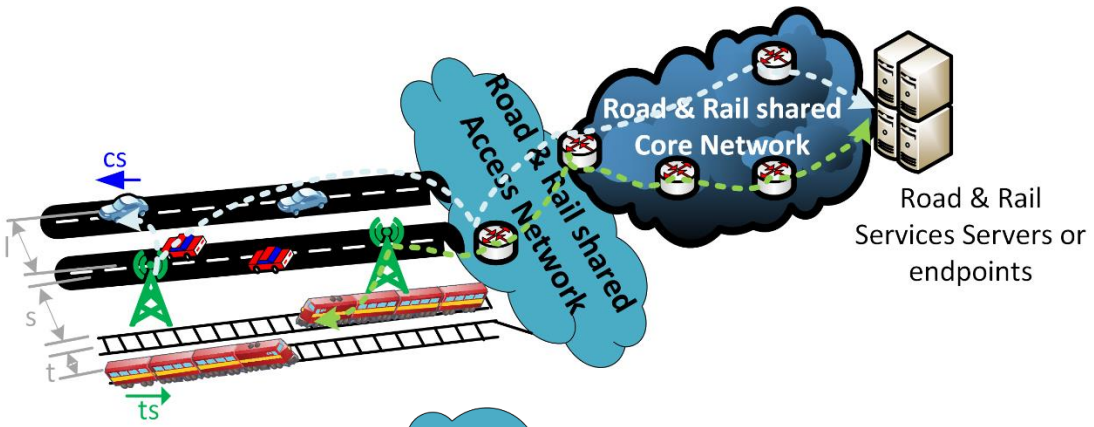
Methodology for scenarios identification

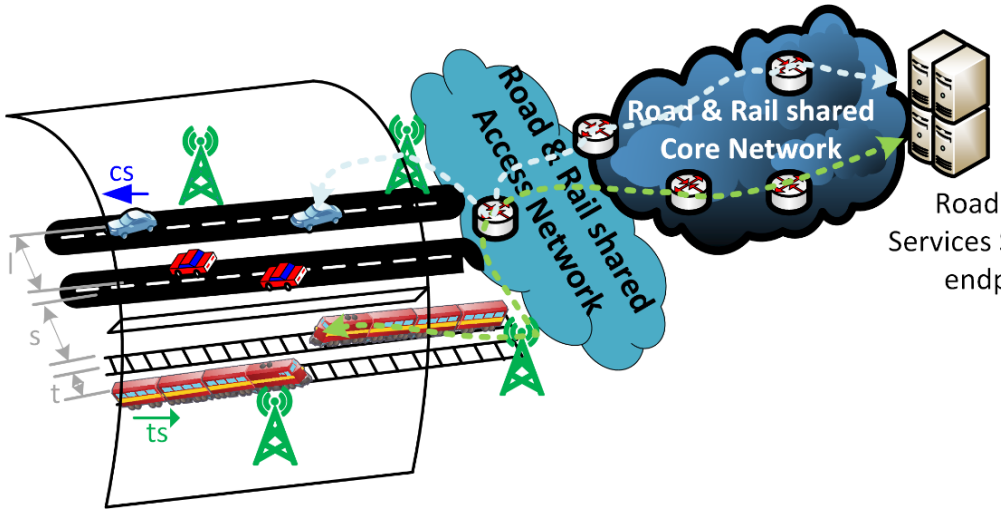


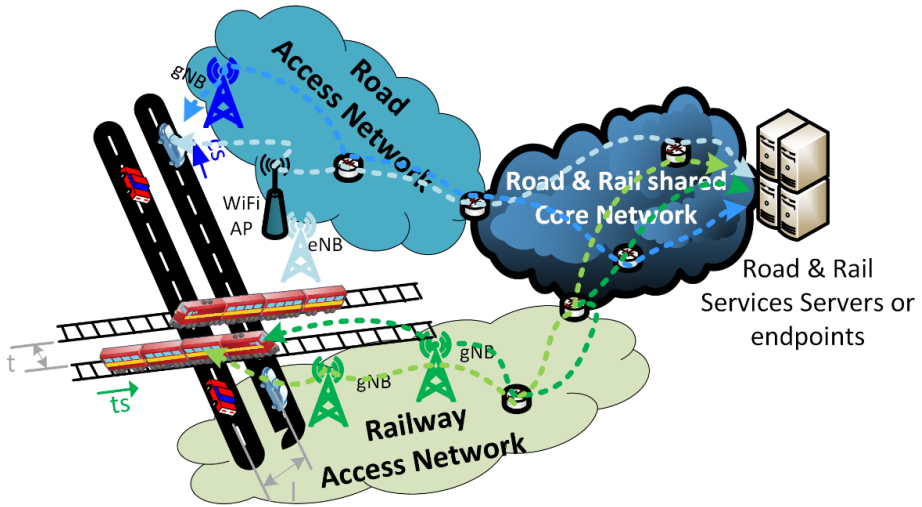
- The amount of Radio Access Technologies (RATs) and associated Radio Access Networks (RANs)
- Differentiating if these RANs as public or private
- The amount of core networks and the fact that these networks are public or private

Examples


Road
Access Network
Road
Core Network
Road
Services Servers
or endpoints
Railway
Core Network
Railway
Access Network
Railway
Services Servers
or endpoints


Road & Rail shared
Core Network
Road & Rail
Access Network
Road & Rail
Services Servers or
endpoints
cs
l
s
t
ts


Road & Rail shared
Core Network
Road & Rail shared
Access Network
Road & Rail
Services Servers or
endpoints
cs
l
s
t
ts


gNB
Road
Access Network
WiFi
AP
eNB
Road & Rail shared
Core Network
Road & Rail
Services Servers or
endpoints
gNB
gNB
gNB
Railway
Access Network
t
ts
l

Some starting hypothesis for preliminary research works on going

- Railway operators will deploy private 5G edge networks and they will not rely on public 5G networks for safety functions
- These private networks could be shared by different operators (trains, tramways)
- Railway operators will probably consider 5G public network for non safety applications (adaptable communication system in FRMCS will allow to consider several RATs)
- Public 5G networks are expected to support other types of demanding applications, in particular applications for automated and connected vehicles on the road

Objective of the first on-going research works

Propose an effective system to ensure:

1) **coexistence of services** dedicated to both trains and tramways in the private edge 5G network
2) **safe migration of rail services to the public edge 5G network to guarantee coexistence with road services**

This implies:

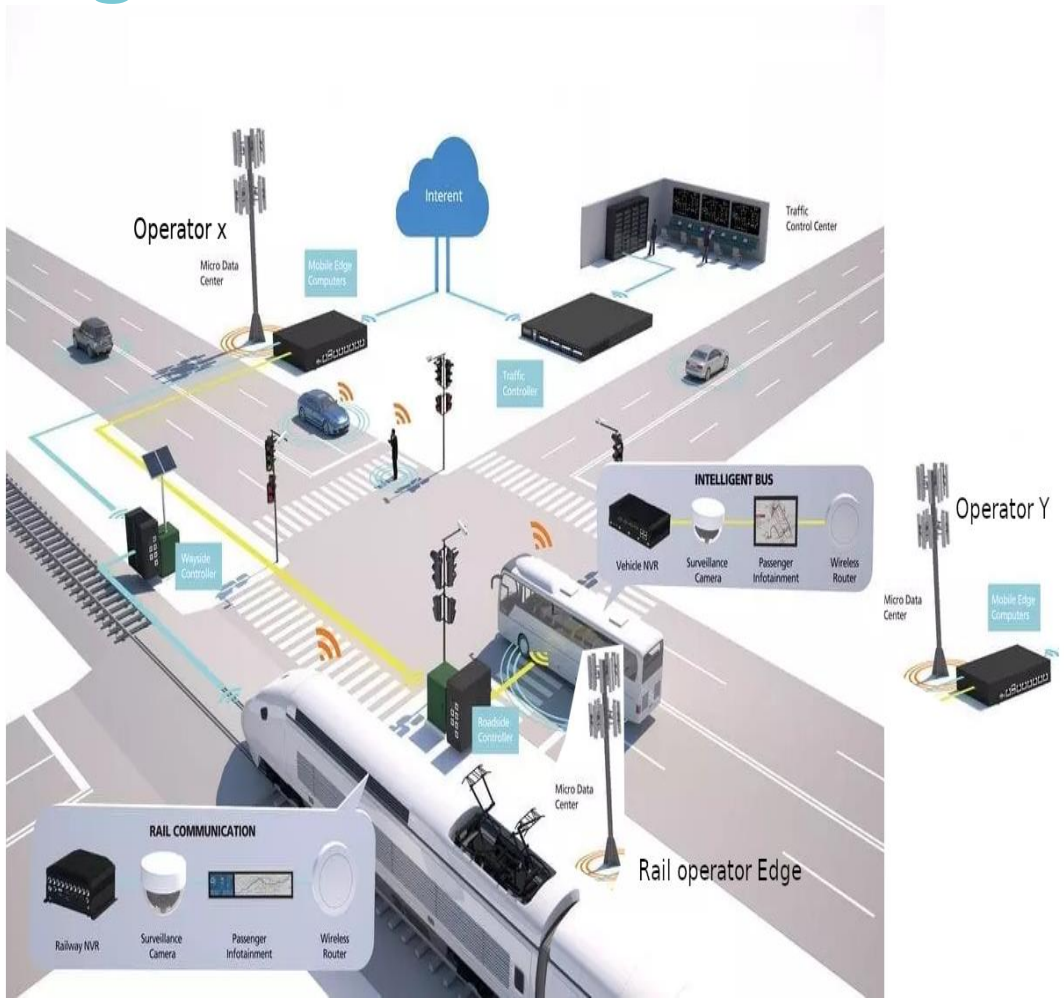
a) **the development of an emulation/simulation environment** reproducing such an architecture
b) **the definition of innovative solutions for edge services management** (see related work in the next slide)

Positioning of the works

- ✓ Dynamic V2X services placement in Edge computing infrastructure
  - A. Moubayed, A. Shami, P. Heidari, A. Larabi, et R. Brunner, Cost-optimal V2X Service Placement in Distributed Cloud/Edge Environment, in *2020 16th International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob)(50308)*, Thessaloniki, Greece, oct. 2020, p. 1-6. doi: 10.1109/WiMob50308.2020.9253437.
  - X. He, H. Lu, M. Du, Y. Mao, et K. Wang, « QoE-Based Task Offloading With Deep Reinforcement Learning in Edge-Enabled Internet of Vehicles », *IEEE Trans. Intell. Transport. Syst.*, vol. 22, nº 4, p. 2252-2261, avr. 2021, doi: 10.1109/TITS.2020.3016002.
- ✓ The positioning of edge services intended for the railway environment has never been considered even though it implies specific constraints (mobility, type of services, etc.)
- ✓ The positioning of edge services in a multi-operator environment has never been addressed and involves specific constraints (agreements, service migration, etc.)

➔ **New solutions need to be proposed !**

Targeted architecture



Deployment of an architecture allowing:

1. to model trains and cars and their mobility
2. to model the private/public 5G communication network associated with these vehicles
3. to model the edge services used by these vehicles (both road and rail services)
4. to manage the migration of services between networks

Tools used for the implementation

1. **Mobility: SUMO** an open source, highly portable, microscopic and continuous traffic simulation that can be used both for railway and roadway mobility simulation. It also allows to reproduce situations such as level crossings.

2. **Network communication** : **Mininet-Wifi** is a tool widely used for emulating wireless networks with adaptable parameters (bandwidth, latency, packet loss, etc.). It also allows to simulate two networks in parallel and thus to reproduce public and private networks. In this part, we should consider in the future the use of **Open Air Interface 5G,** which would allow us to couple simulation and emulation of networks.

3. **Services:** We consider the use of tools allowing to model traffic (i.e., information exchange) and thus to reproduce a realistic network load level, such as **Iperf.**

4. **Services Management :** For service migration, we consider a realistic cloud architecture using the **Containernet, Vim-emu and 5g-tango tools (from H2020 Sonata project).** This would allow us to reproduce the migration of **virtual machines (Docker) representing train/v2x services**, and thus to realistically evaluate the overhead associated with this management.

Future steps

- Complete the setting up of the environment
- Implement some realistic scenarios of coexistence between cars and trains
- Implement efficient mechanisms to dynamically manage the migration of services between telecommunication operators
- Demonstrate the benefits of these approaches
- First results expected at Autumn 2022

Conclusion

- List of coexistence context and the methodology proposed to define the most demanding scenarios from a telecommunication point of view.

- The work to build the simulations/emulations environment is on going. An integration week is planned beginning of June with a virtual workshop of the WP6.


5GRail

5GRAIL Project

5GRAIL Mid-Term CONFERENCE, Brussels, 12 of April 2022

Dan Mandoc, UIC, Head of FRMCS

12 April 2022

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 951725.

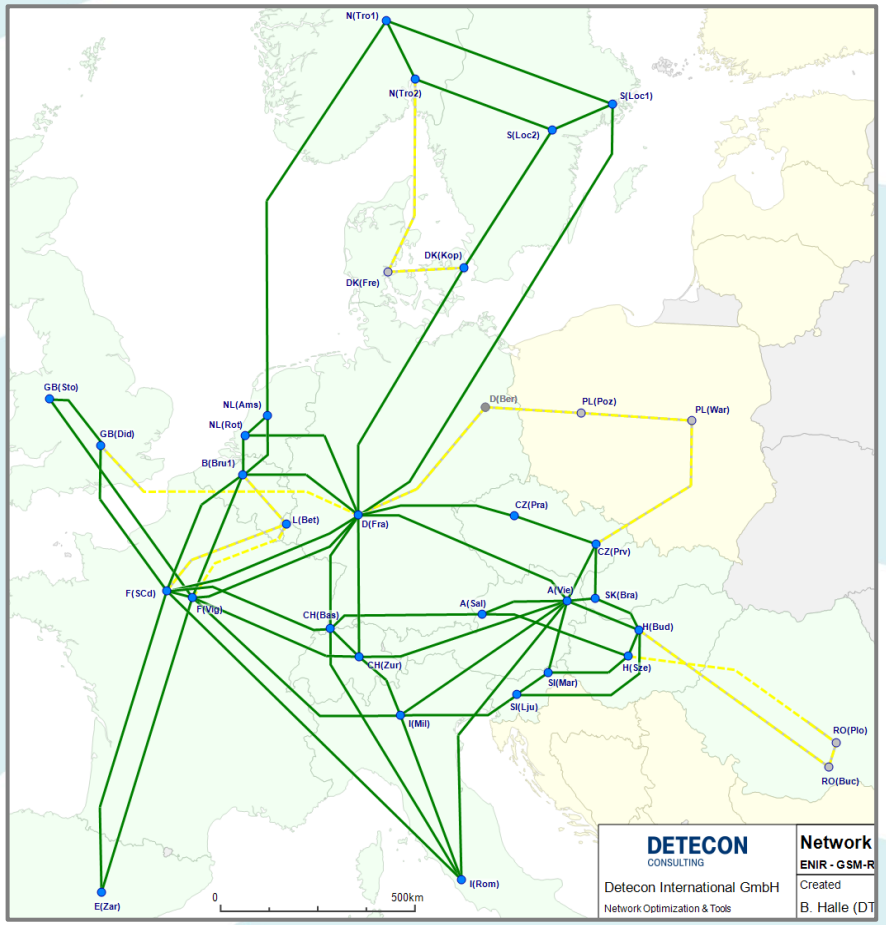
TODAY IS GSM-R...

The railways currently use the GSM-R system for operational communication. Designed 20+ years ago and completely border-crossing interoperable, GSM-R is deployed on more than 130,000 kilometers of track in Europe - and 210,000 kilometers worldwide.

GSM-R is a key component of the European Railway Traffic Management System ERTMS. The system supports the train driver to signaller voice applications including the Railways Emergency Call (considered to be the best method to avoid a train accident when all the other system has failed) and ETCS (European Train Control System). 4 MHz dedicated frequency band is allocated for GSM-R in Europe.

In Europe, 17 European Railways are interconnected via the ''ENIR'' (European Network Integration for Railways) network.

With a limited data capability, GSM-R is supporting also other railway applications, e.g. track side phones, passenger information screens on platform, etc.



Grant agreement
No 951725

...TOMORROW WILL BE FRMCS

Future Railway Mobile Communication System

The Future Radio Mobile Communication System (FRMCS) is the Railways response for two elements of strategic importance for the future of the railways.

Firstly, GSM-R is a 2G system, where manufacturers have announced that GSM-R equipment is due to reach the end of its life (around 2030) and will be supported until around 2035. Without a suitable and timely replacement, this will heavily impact the train system in Europe.

Secondly, this is also a significant opportunity, which is to enable and support the Railways Digitalization - the need to transmit, receive and use increasing volumes of data, which is at the very heart of sustainable transport.

Improving the telecom service quality, the potential offered by the Internet of Things, smart maintenance, wireless connectivity, driverless trains... railways need a suitable radio system to enable these ever-increasing communication flows in an efficient way.

FRMCS

Future Railway Mobile Communication System

-3GPP 5G
-DEDICATED FREQUENCIES IN 1900 AND 900 MHZ

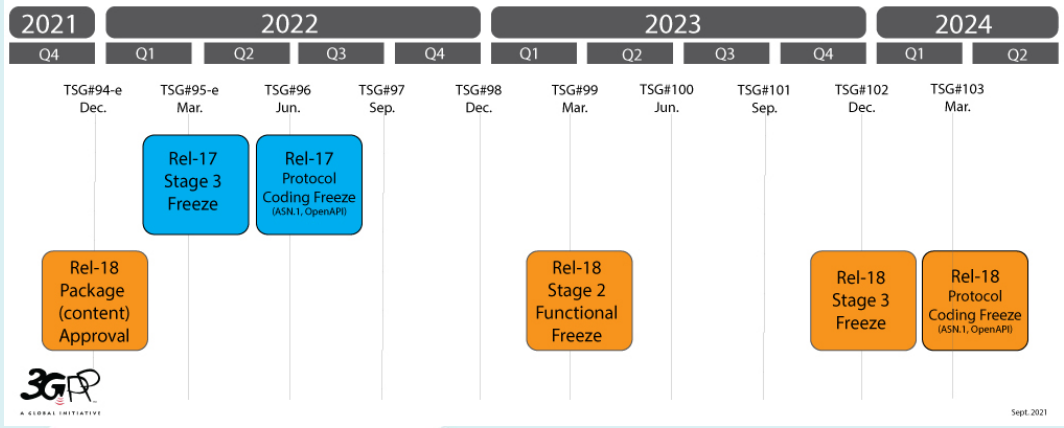
-COEXISTENCE WITH GSM-R
-SUPPORT ERTMS – VOICE, ETCS AND ATO
-BORDER CROSSING INTEROPERABLE

-ENHANCE RAIL TRAFFIC & PERFORMANCE
-ENHANCE SAFETY
-SUPPORTS TCMS
-ENABLE DIGITALISATION

Grant agreement
No 951725

FRMCS will be based on 5G MCX

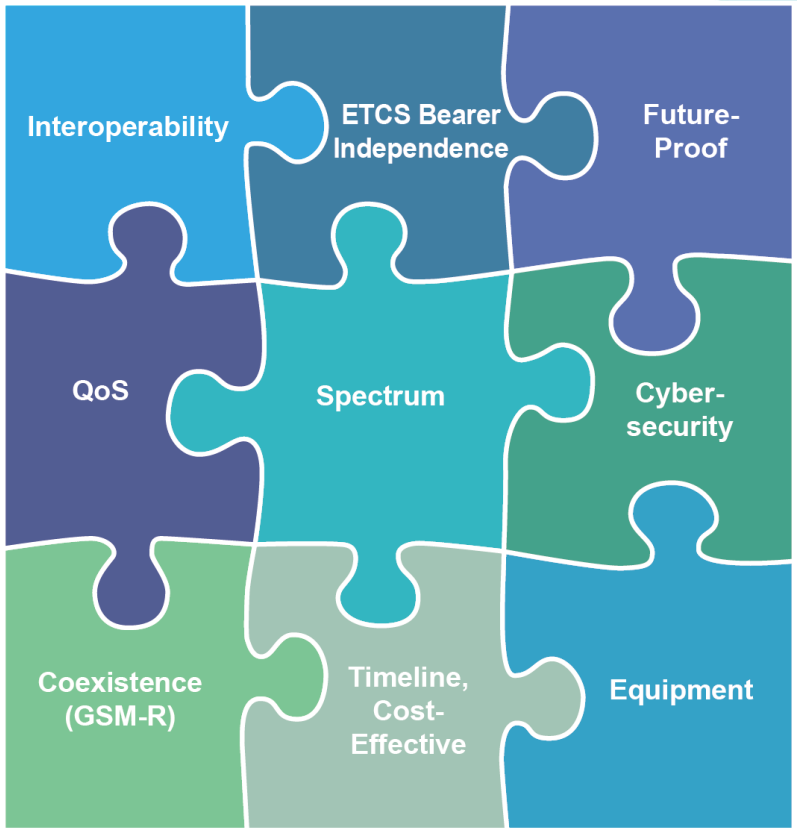
- The FRMCS 1st Edition, planned to be available for implementors second half of 2025, will be a 5G system , including the Mission Critical (MCX) work frame, all based on 3GPP R17 and R18.
- We are working to ensure that the necessary 3GPP MCX (Mission Critical) services that are needed to meet the operational expectation - as per the embedded list, are included in these two releases.
- The FRMCS system will continue to evolve with more services in R19 and beyond.



URS Ref.	Application	Use	Type	applications to be considered for the migration phase
5.1	On-train outgoing voice communication from the train driver towards the controller(s) of the train	Critical	Comms	Y
5.2	On-train incoming voice communication from the controller towards a train driver	Critical	Comms	y
5.3	Multi-Train voice communication for drivers including ground user(s)	Critical	Comms	y
5.4	Banking voice communication	Critical	Comms	y
5.5	Trackside Maintenance Voice communication	Critical	Comms	y
5.7	Public emergency call	Critical	Comms	Y
5.8	Ground to ground voice communication	Critical	Comms	Y
5.9	Automatic Train Protection communication	Critical	Comms	Y
5.10	Automatic Train Operation communication	Critical	Comms	Y
5.11	Data communication for Possession Management	Critical	Comms	Y
5.12	Trackside Maintenance Warning System communication	Critical	Comms	Y
5.13	Remote control of Engines	Critical	Comms	Y
5.14	Monitoring and control of critical infrastructure	Critical	Comms	Y
5.15	Railway Emergency Communication	Critical	Comms	Y
5.16	On-train safety device to ground communication	Critical	Comms	Y
5.19	Voice recording and access	Critical	Comms	Y
5.20	Data recording and Access	Critical	Comms	Y

URS Ref.	Application	Use	Type	applications to be considered for the migration phase
10.1	Billing information	Business	Support	Y
5.24	On-train outgoing voice communication from train staff towards a ground user	Critical	Comms	Y
5.25	On-train incoming voice communication from a ground user towards train staff	Critical	Comms	Y
5.27	Critical real time video	Critical	Comms	Y
5.27	Critical real time video in case of ATO GoA3/GoA4 operation	Critical	Comms	Y
8.1	Assured voice communication	Critical	Support	Y
8.2	Multi user talker control	Critical	Support	Y
8.3	Role management and presence	Critical	Support	Y
8.4	Location services	Critical	Support	Y
8.5	Authorisation of communication	Critical	Support	Y
8.7	Authorisation of application	Critical	Support	Y
8.8	QoS class negotiation	Critical	Support	Y
8.9	Safety application key management communication	Critical	Support	Y
8.10	Assured data communication	Critical	Support	Y
8.11	Inviting-a-user messaging	Critical	Comms	Y
8.12	Arbitration	Critical	Comms	Y

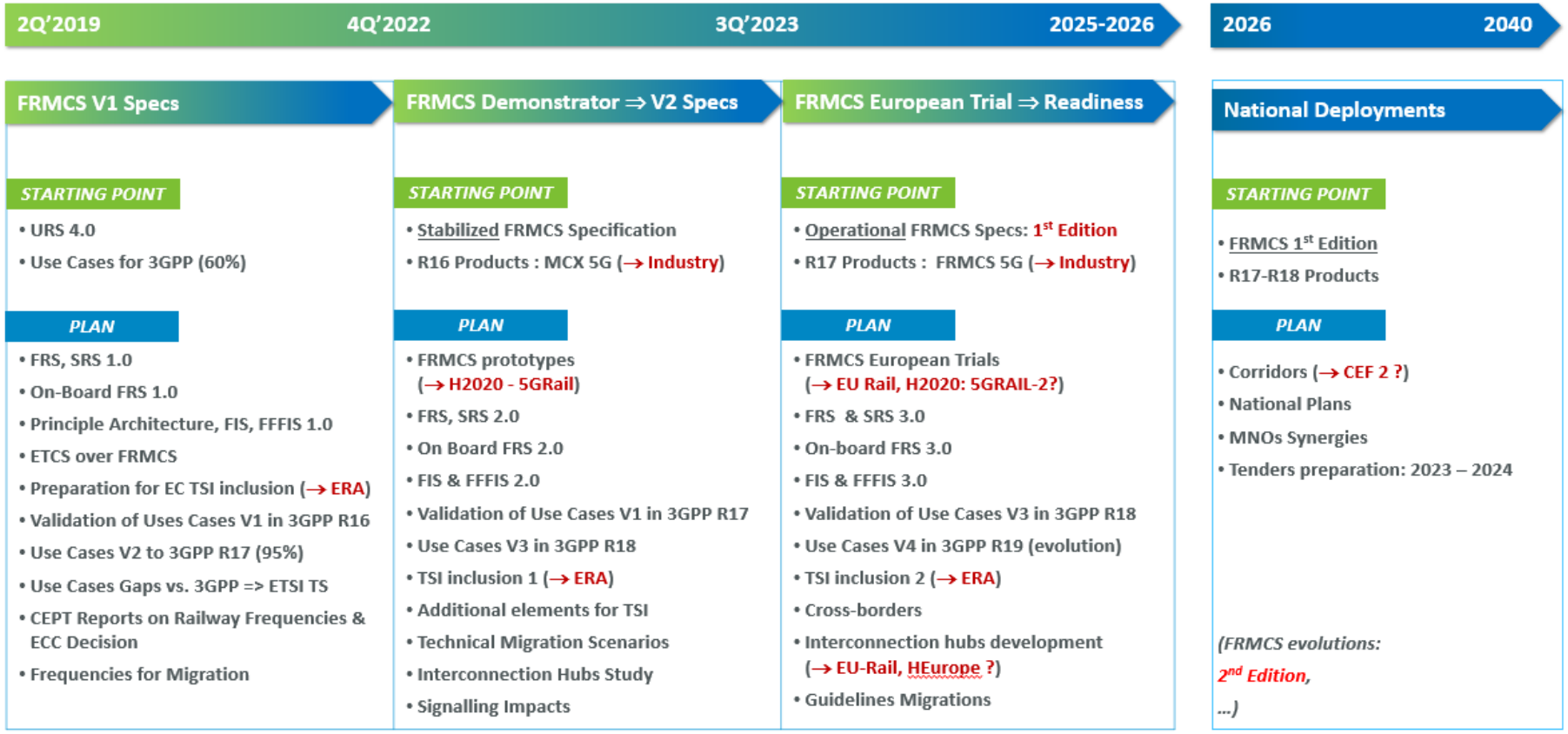
FRMCS CHALLENGES – considered within 5GRail



FRMCS challenges are considered within 5GRail:

- **Radio modules in the FRMCS 1900 MHz frequency range;**
- **ETCS and ATO signalling systems demonstrators;**
- **Railway Emergency Call demonstrator;**
- **Cross Border scenarios;**
- **Interworking with GSM-R;**
- **Quality of Service Scenarios;**
- **Train Performance applications;**

Strategic Plan for FRMCS market introduction in Europe



Our goal is to make available together with partner Industry and Authorities a FRMCS 1st Edition to Railways, based on 5G, 3GPP R17 MCX products, for starting the National Deployments.

To reach that we have put in place and following the embedded plan.

A crucial step of this plan is building and testing the FRMCS Demonstrators, especially the On-Board FRMCS.

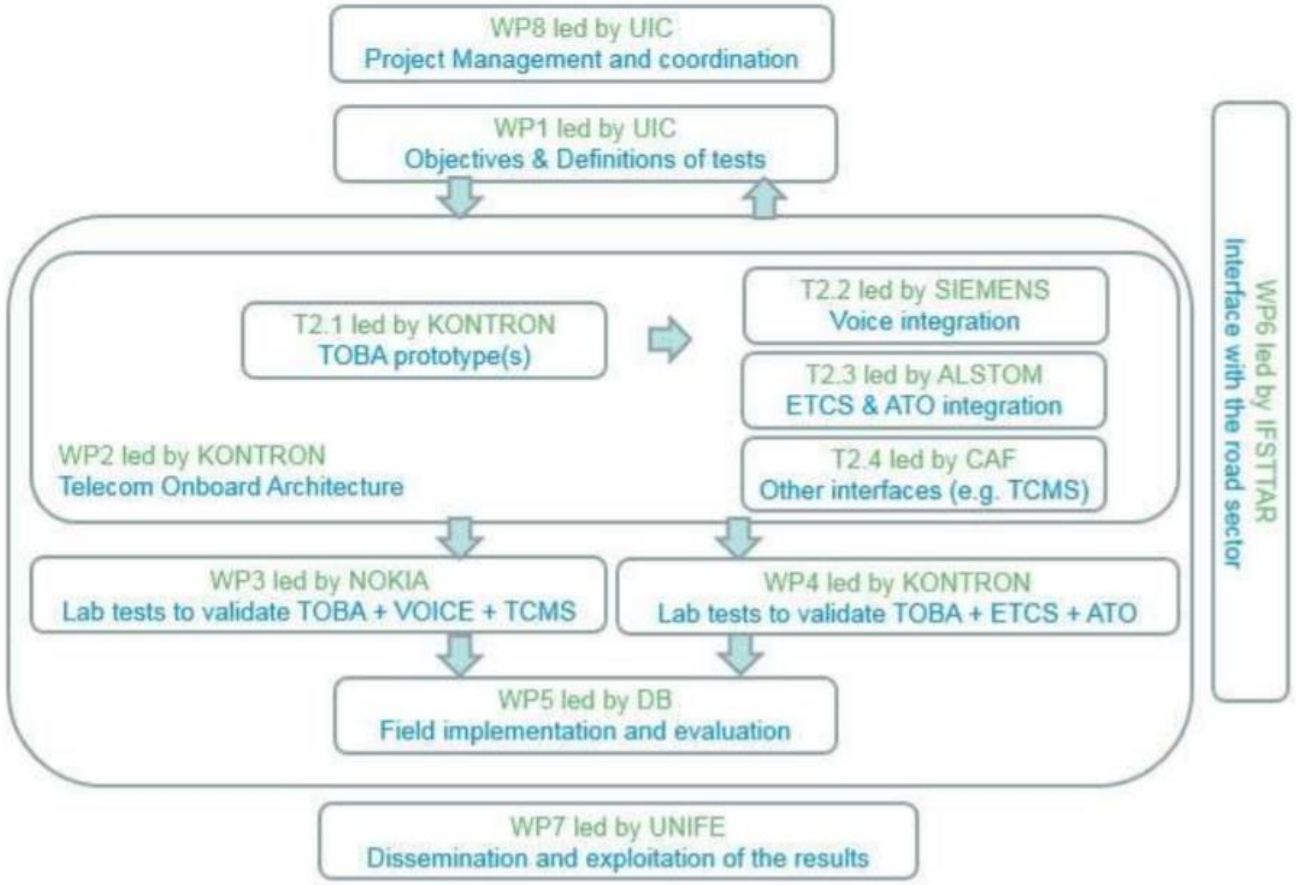
This will be performed through the EU co-funded H2020 ICT-053 5GRAIL project.

Grant agreement
No 951725

5GRAIL - General Information

Project acronym	5GRAIL
Project title	5G for future RAILway mobile communication system
Starting date	01/11/2020
Duration in months	30
Call (part) identifier	H2020-ICT-2019-3
Topic	ICT-53-2020 5G PPP – 5G for Connected and Automated Mobility (CAM)

5GRAIL scope and overall framework



Elaborate FRMCS prototypes based on the FRMCS V1 specifications, including telecom 5G infrastructure - compliant with FRMCS 3GPP specific standardization elements, and the new on-board equipment (FRMCS On-Board Gateway and additionally prototypes of adapted ETCS and ATO elements);

Define the relevant technical and functional tests required to verify the compliance of the prototypes with the FRMCS V1 specification, maximizing the scope of applications to be tested or simulated (particularly operational voice services, ETCS, ATO, TCMS, video and interaction with automotive) and including some measurements of performance;

Execute these tests in lab environment firstly, and then in railway environment with train runs. Consider cross-border conditions; define and emulate coexistence scenarios between railway and roads;

Analyze the outcomes of these tests to loop back on FRMCS V1 specification, to amend or modify those, and then obtain a finalized version of FRMCS V1 specification for sector regulation.

Work Packages and Consortium members

WP Number	WP Title	Lead
WP1	FRMCS tests definition, tests results consolidation and specification review	UIC
WP2	TOBA prototypes development	KONTRON
WP3	Validation of ETCS, Voice, TCMS and CCTV/Video within TOBA – Laboratory tests	NOKIA
WP4	Validation of Data, ETCS, ATO and Cybersecurity within TOBA – Laboratory tests	KONTRON
WP5	Field Implementation and Evaluation	DB Netz
WP6	Rail and Road communication systems coexistence	UNI.EIFFEL
WP7	Dissemination, Communication and Exploitation	UNIFE
WP8	Project Management & Coordination	UIC

1	UIC	France
2	Nokia-DE	Germany
3	KONTRON	Austria
4	Alstom	France
5	DB Netz	Germany
6	SNCF Reseau	France
7	THALES	France
8	SBB	Switzerland
9	UNIFE	Belgium
10	CAF	Spain
11	OBB	Austria
12	SIEMENS	UK
13	IP	Portugal
14	UNIVERSITE GUSTAVE EIFFEL	France
15	TELESTE	Finland
16	DTU	Denmark
17	NOKIA-IT	Italy
18	NOKIA-HU	Hungary

5GRAIL started on 1st of November 2020, for a initial 30 months duration.
Due to delays caused by Covid-19, the project is discussed to be extended with six months, which means to be finalised end October 2023.

5GRAIL is a crucial step for the FRMCS introduction. The project is advancing well, with a very good experts engagement.

Details on the work packages status and plans will presented in next session.

Thank you for your attention

www.5GRail.eu

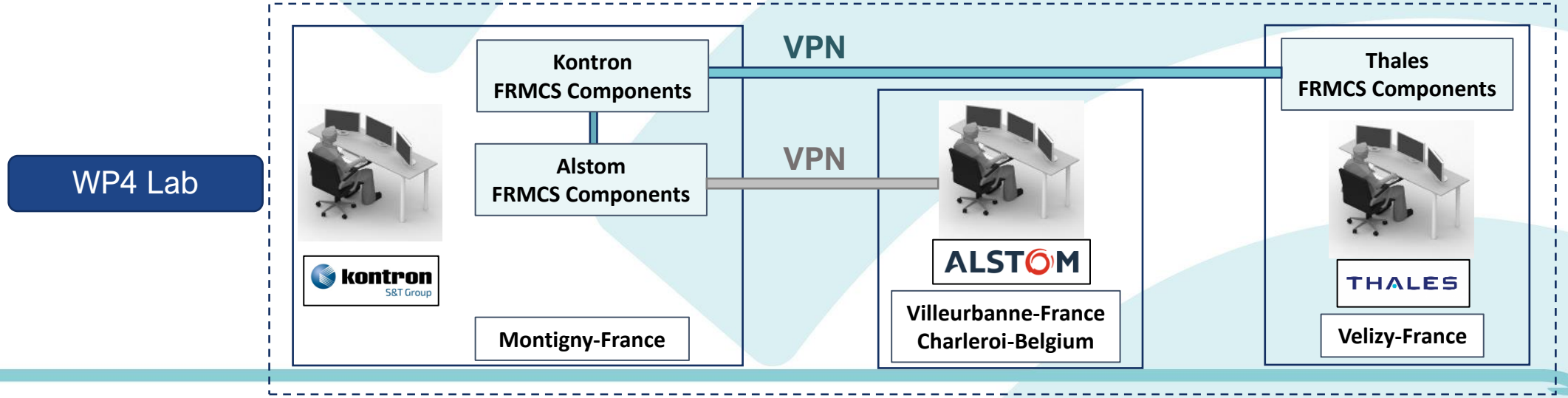
WP4 – 5GRail 2nd Lab Presentation

Sébastien TARDIF Kontron Transport

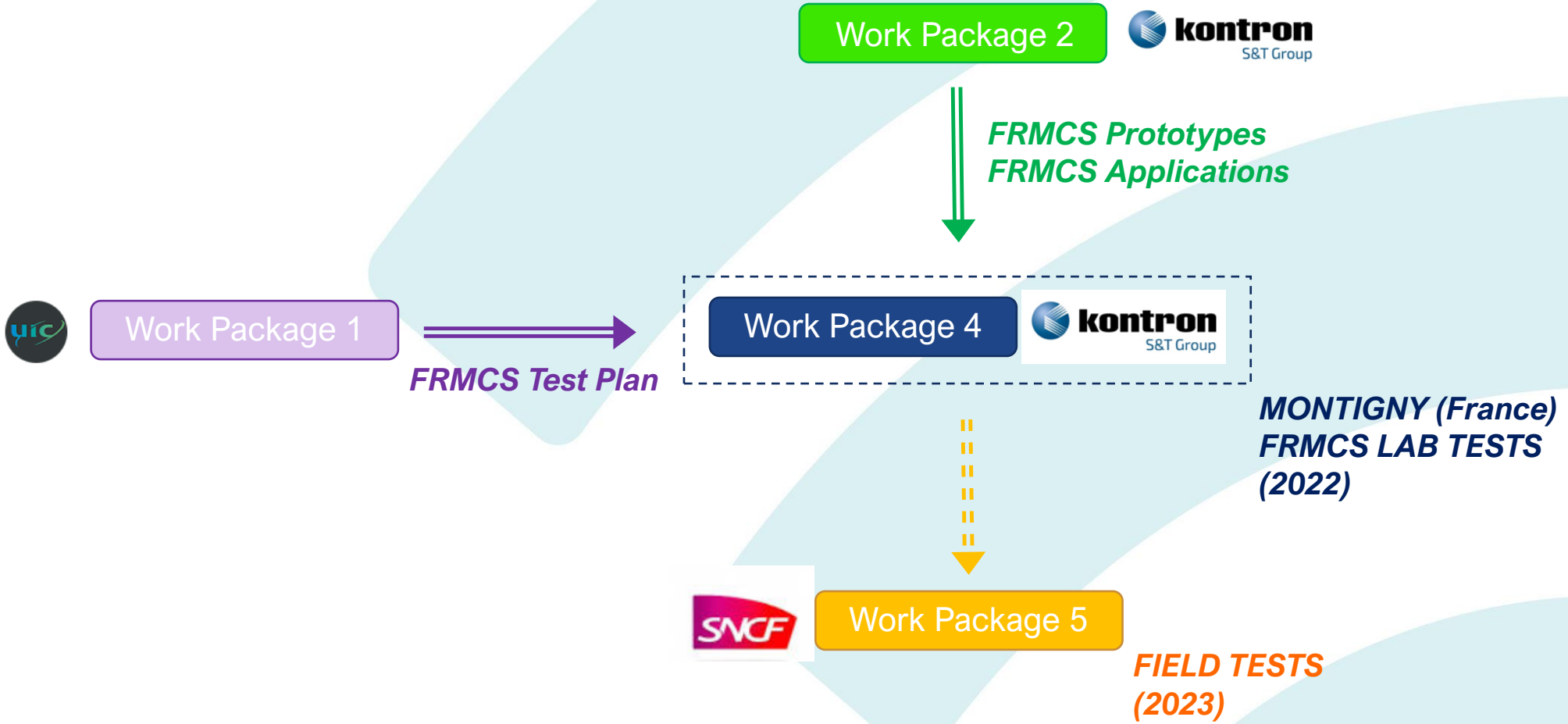
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 951725.

WP4 at a glance…

- WP4 **scope** : Build a 2nd 5GRail lab and Run tests defined by WP1
- WP4 **focus** : FRMCS Data applications (ETCS, ATO, PIS)
- WP4 **members**: *Kontron Transport*, Alstom, Thales, SNCF, UIC, IP
- WP4 **setup** : Lab in Kontron, France / connections with partners



WP4 within 5GRail



WP4 Lab Details

ALSTOM THALES

ETCS ATO PIS *FRMCS Apps (trackside)*

Trackside

FRMCS Gateways

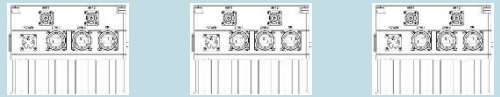
ALSTOM kontron S&T Group

IMS/MCx

FRMCS MCx brick
HP Gen10

5G

Core Network
Kontron ME1210



Kontron Radio Units
900/1900/3700 MHz

4G

Core Network
Kontron ME1210

Kontron Radio Unit
2600 MHz

Wifi

GSM-R

On-Board

TOBA Gateways

ALSTOM kontron S&T Group

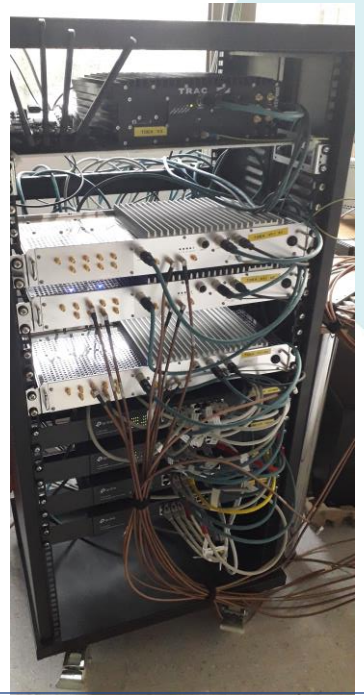
ETCS ATO PIS *FRMCS Apps (on-board)*

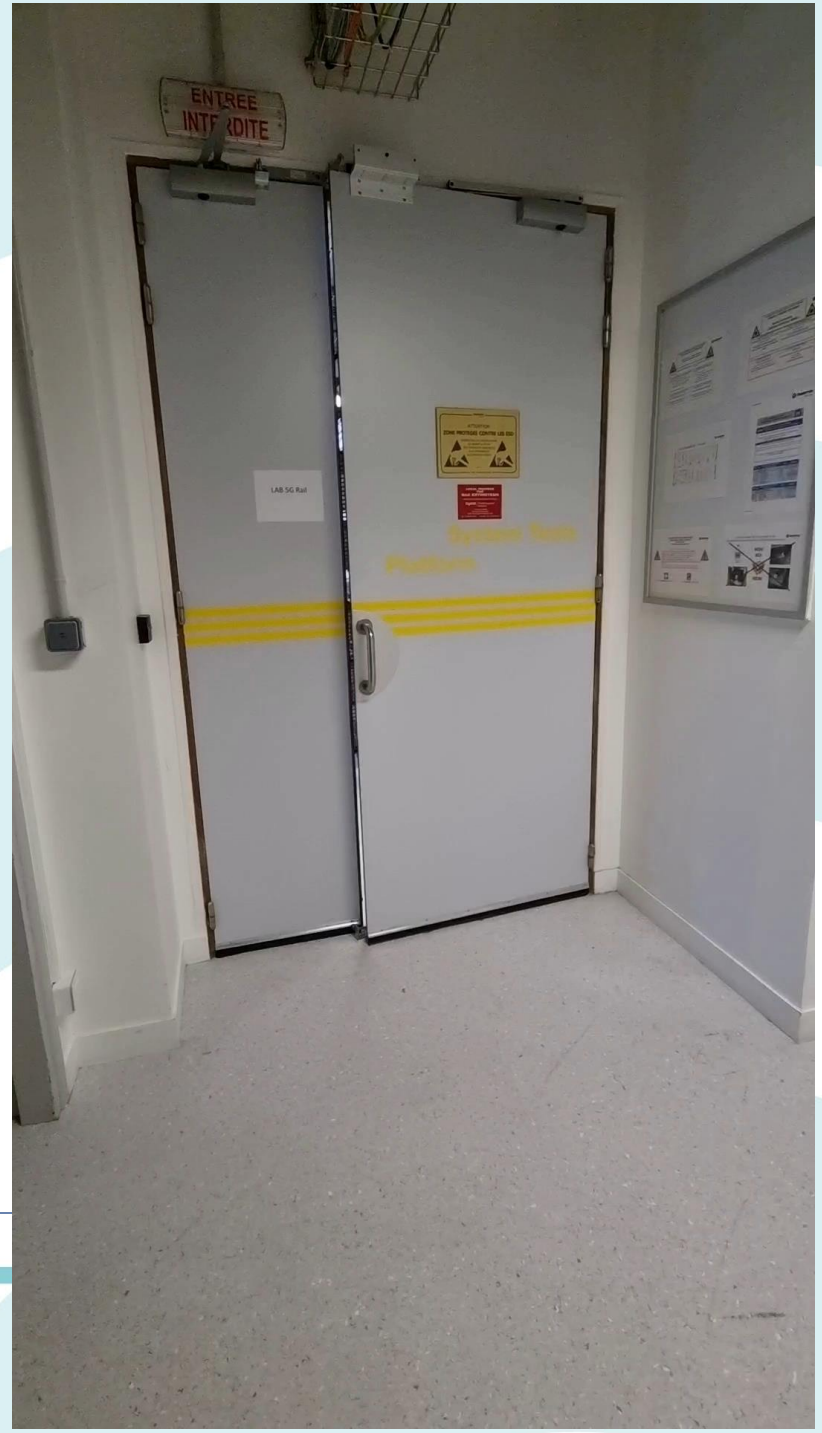
ALSTOM THALES

Grant agreement
No 951725

WP4 virtual Tour

Let’s now have a virtual tour on WP4 setup…





Grant agreement
No 951725


5GRail