Alstom LTE/5G/FRMCS experience

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Trafikverket event - May 2025

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2. Enabling FRMCS
   - Way from LTE-5G towards FRMCS
   - Securing FRMCS via 5G-Rail
   - Consolidating FRMCS via MORANE2
3. FRMCS Product Offer

01

FRMCS enabler for Digitalization

FRMCS enabler for Rail Operation & Digitalization

1

Improved Rail Operation

2

Enhanced maintenance for train & infrastructure

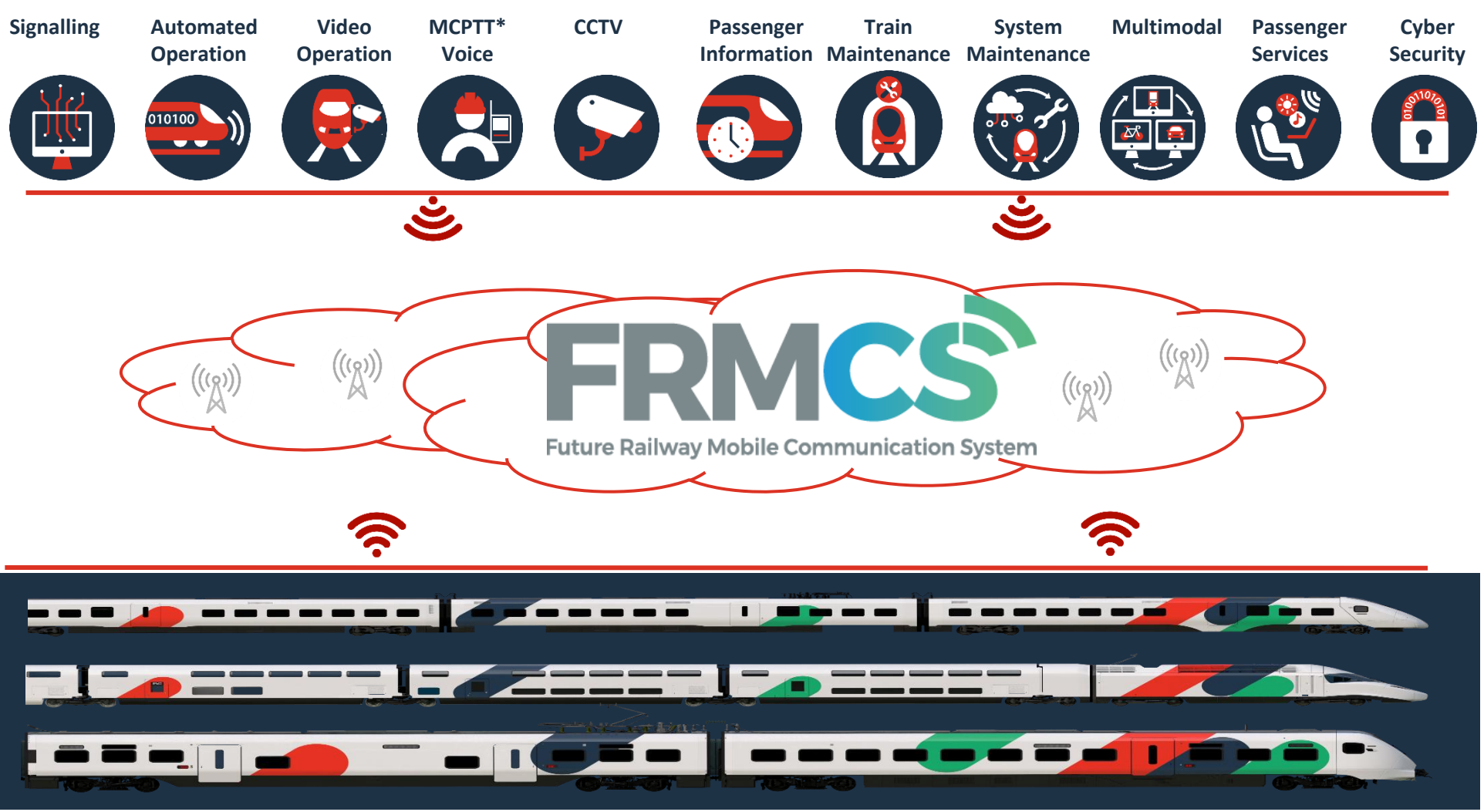
3

Extended Passenger Experience

4

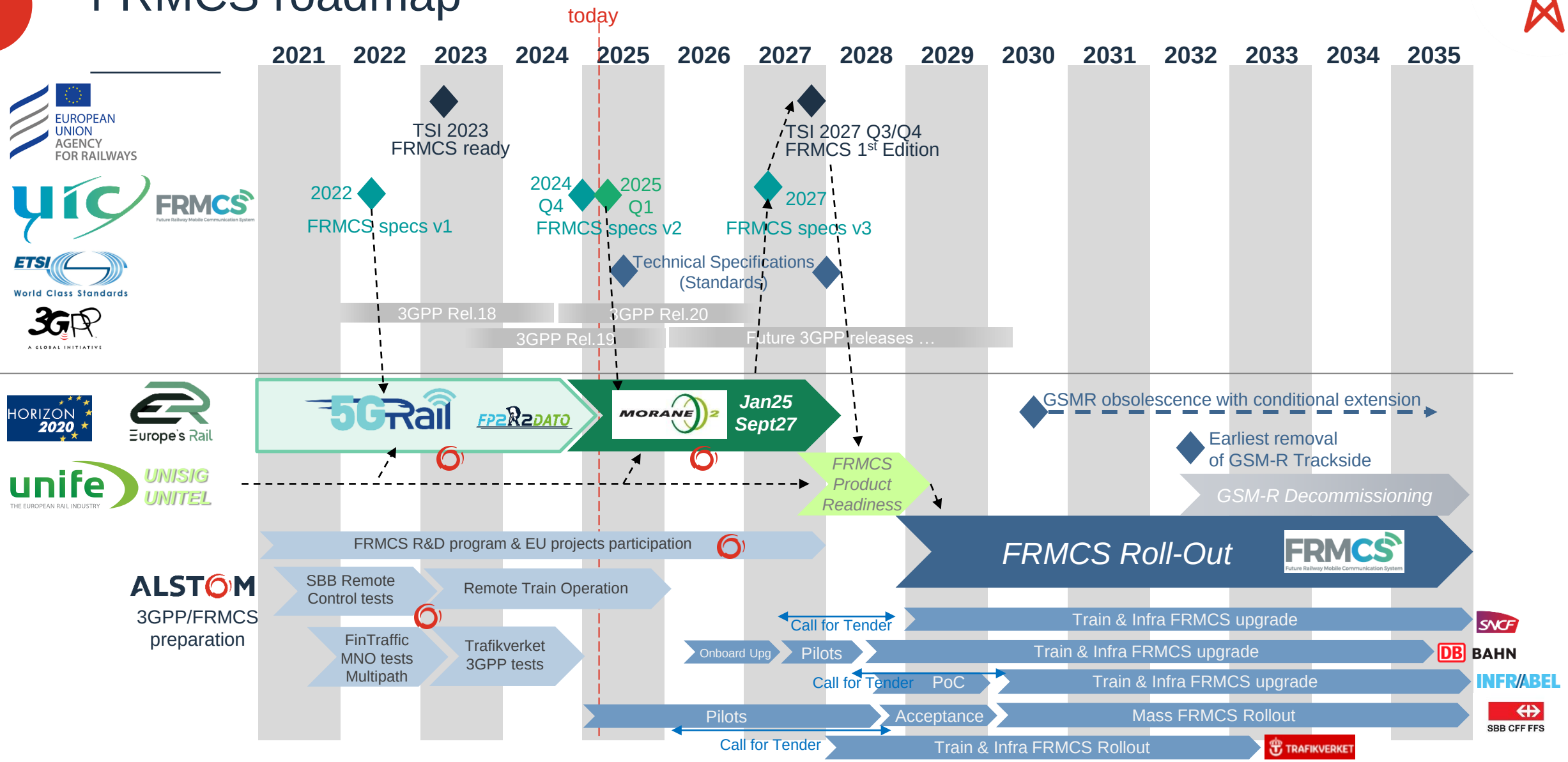
Framework for:

- **Interoperability & Cross-border**
- **Radio bearer flexibility**
- **Multi-services support with QoS**
- **Cost efficiency**
- **Security and Safety**



* Mission Critical Push-To-Talk

FRMCS roadmap



02

Enabling FRMCS

Enabling FRMCS …

Success story for FRMCS relies on key fundamentals:

a) Provide optimized 3GPP infrastructure
   - Significant experience deploying LTE/5G provide confidence for 3GPP broadband infrastructure

b) Validate the key principles of FRMCS interfaces
   - 5G-RAIL and R2DATO prototypes and interfaces (v1 specs) implementations have been validated

c) Consolidate all FRMCS features implementation and ensure operation migration
   - MORANE2 Onboard & Trackside Gateways delivery to validate the v2 specifications

FRMCS introduction is being prepared since several years

a) Provide optimized 3GPP infrastructure : LTE/5G experience

2014 2016 2018 2020 2022 2024 2026

Metro : Multiservice over LTE

Systu

Metro/Railways : Adaptable Communication System over LTE/5G

Shift2Rail

Railways services in shared 5G network

5G VICTORI

Railways FRMCS 5G Prototypes FRMCS Spec v1

5GRail

Europe's Rail

R2DATO

Railways FRMCS 5G Protos FRMCS Spec V1+

MORANE 2

Railways FRMCS 5G pre-products FRMCS Spec V2

LTE private

First metro CBTC signalling over LTE (commercial service)

As of today, 15 CBTC lines over LTE in commercial service

LTE private

First Railway ETCS signalling (+MCPTT +Video) over LTE (commercial service)

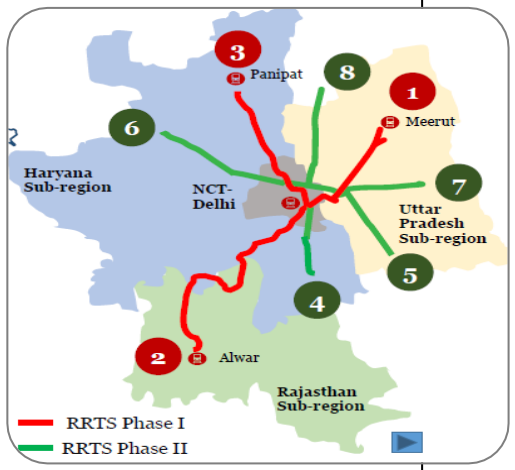
5G private / public / hybrid

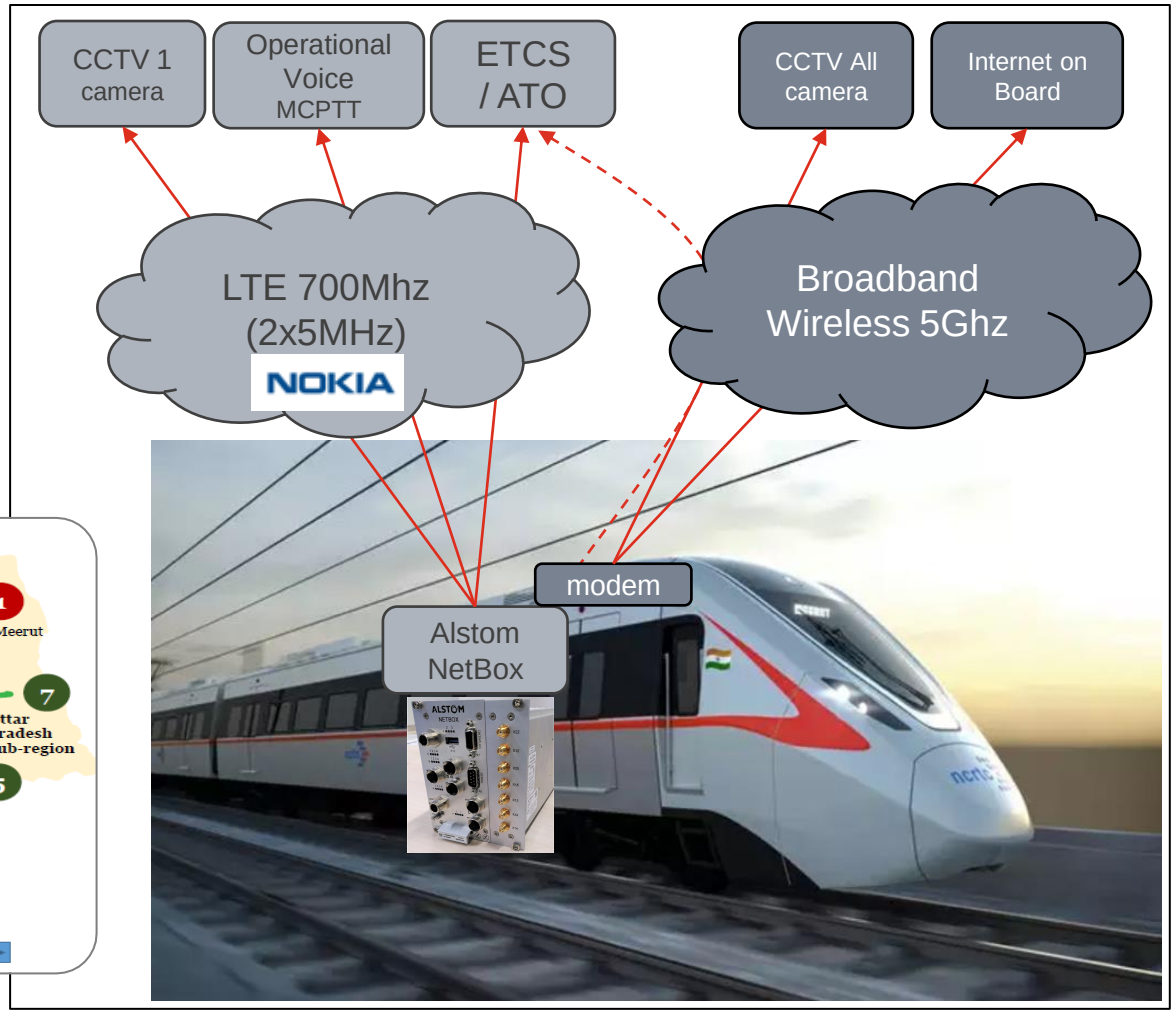
- **First metro CBTC signalling (+MCPTT +Video) over private 5G (under deployment)**
- **Railways & Metro 5G ongoing offers**

Alstom has already a significant experience in Rail over LTE and builds the solution towards 5G & FRMCS

a) Provide optimized 3GPP infrastructure : India NCRTC Delhi-Meerut project - Signaling and operational services over private LTE

- First time ETCS/ATO over LTE, instead of GSM-R, as a preliminary step towards FRMCS
- First time multi-services over LTE on the Mainline segment (Signaling, MCPTT, Video)
- Dedicated private single overlapping LTE network to support critical applications
- Dedicated private wireless broadband network for non-critical
- **Commercial Service in Oct 2023**





India NCRTC railway project under deployment based on LTE paves the way towards FRMCS/5G

b) Validate the key principles of FRMCS interfaces: 5G-RAIL project

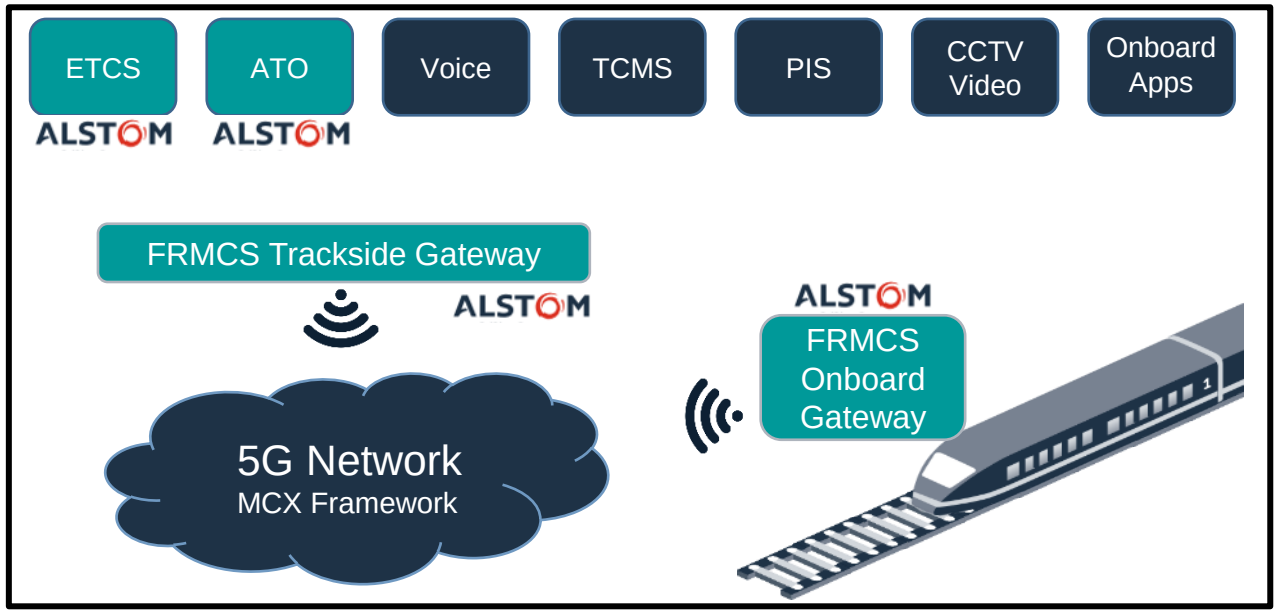
5G-RAIL project (2020-2023) delivery status:

- Alstom deliverables: ETCS, ATO, Onboard & Trackside Gateways
- OB_{APP} & TS_{APP} standard interfaces
- Tight coupling, Loose coupling, Flat-IP interfaces
- MCX framework integration

Alstom NetBox Onboard Gateway

Alstom Radio Module (USB_IP interface)

Alstom Trackside Gateway



5G-Rail project : First FRMCS ETCS / ATO / Onboard & Trackside Gateways prototypes

c) Consolidate all FRMCS features implementation :

MORANE 2

5 FIELDS TESTS:

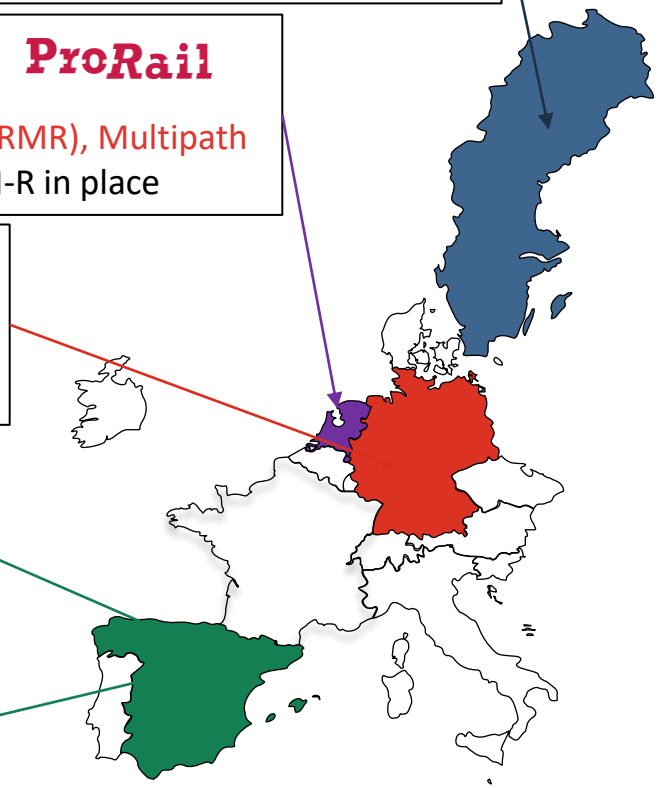
Operational Line Sweden (Katrineholm – Aby)
- ready-for vendor equipment 2024
- Focus: 1900 MHz RMR
- length: ~40 km, speed: 180 km/h, operational GSM-R in place

Operational Line Netherlands (Arnhem – Emmerich)
- ready-for vendor equipment Q4 2025
- Focus: Hybrid MNO-FRMCS Interfacing (1900 MHz RMR), Multipath
- length: ~35 km, speed: 160 km/h, operational GSM-R in place

Pilot Line Germany (Digital Rail Testbed Erzgebirge)
- ready-for vendor equipment Q3 2025
- Focus: 1900 MHz RMR, GSM-R/FRMCS Interworking, Cross-Border Interop.
- length: ~12 km, speed: 50-80 km/h, no operational but GSM-R test network

Operational Line Spain (north Spain, Leon - Guardo)
- ready-for vendor equipment Q3 2025
- Focus: 900 MHz RMR, (1900 Mhz if needed)
- length: ~30 km, speed: max. 80 km/h, no operational GSM-R

High Speed Line Spain
- ready-for vendor equipment Q3 2025
- Focus: 900 MHz RMR, (1900 Mhz if needed)



3 LAB TESTS:

- NOKIA 5G lab
- ERICSSON 5G lab
- kontron 5G lab

Alstom will provide FRMCS Onboard & Trackside Gateways (2/3 lab + 4/5 field)

03

FRMCS Product offer

MAINLINE: From GSM-R to Future Railway Mobile Communication System (FRMCS)

Today's ecosystem

RBC Signalling

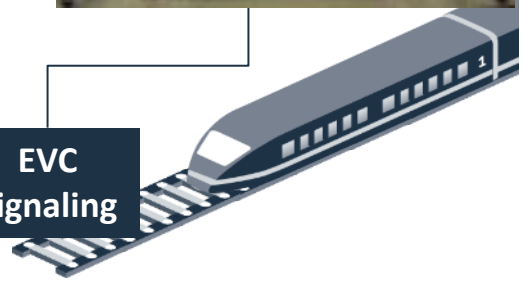
Network Transmission Gateway (NTG)

GPRS

GSM-R

EDOR (ETCS Data Only Radio) & Voice Cab-Radio

EVC Signaling



Tomorrow's ecosystem

FRMCS Trackside Gateway

Public / Private telecom networks

GSM-R · WiFi · 5G · LTE

FRMCS on-board Gateway

Critical

ETCS, ATO, Op Voice, …

Operational

Video, CCTV, maintenance,

Passengers

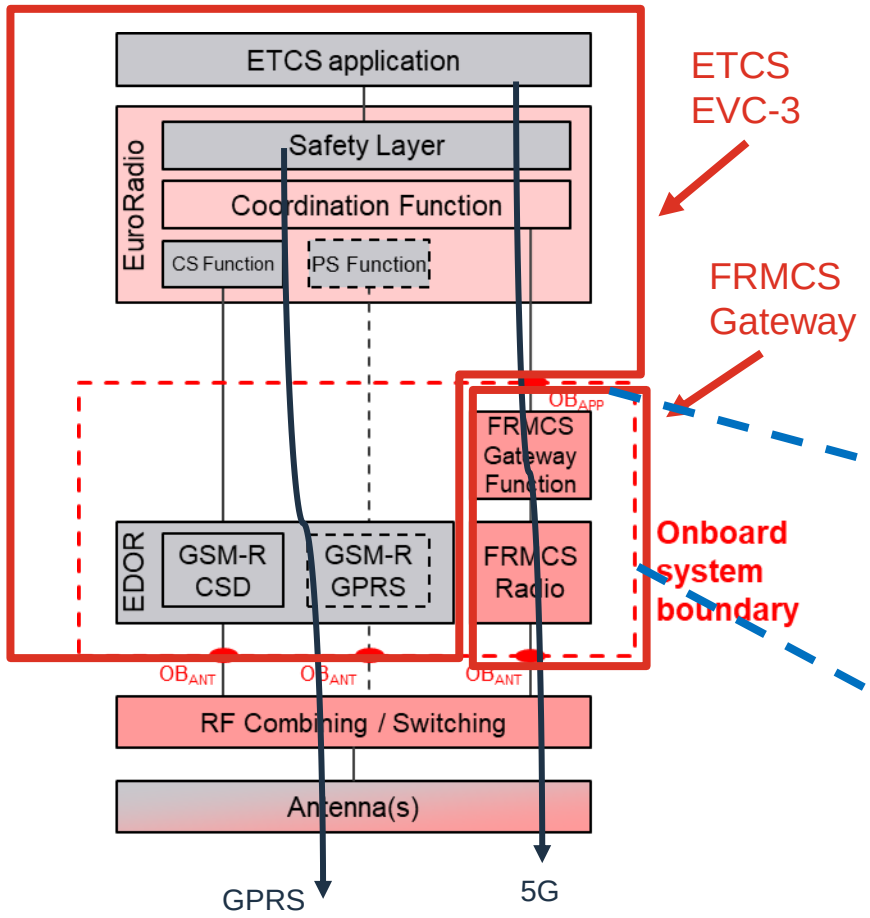
Wifi on Board

Installation of the FRMCS component beside GSM-R:

- **3U format : standalone or fitting in 3U rack**
- **Independent Power Supply**
- **Remote radio concept**

FRMCS Onboard/Trackside Gateways installation based on TSI2027 (specs v3). Hardware expected stable (except modem change for further 3GPP releases). Only software upgrade expected in the future

ETCS & FRMCS Gateway architecture (ERA TOBA* option3)



- FRMCS Gateway TOBA* Option3 (selected by ERA/UNIFE/UIC) :
  - Minimize modification in EVC (only Coordination function)
  - FRMCS Gateway independent from GSM-R EDOR**
  - Switch from/to GSM-R & FRMCS done by EVC (new Coordination Function) upon trigger from balise
- FRMCS Gateway in addition to existing EVC/EDOR

- FRMCS Onboard Gateway (Alstom NetBox):
  - Prototype available (v1 specs / 5G-Rail)
  - Prototype ongoing (v2 specs / MORANE2)
  - Serial product for 2028 (v3 specs / Rollout)

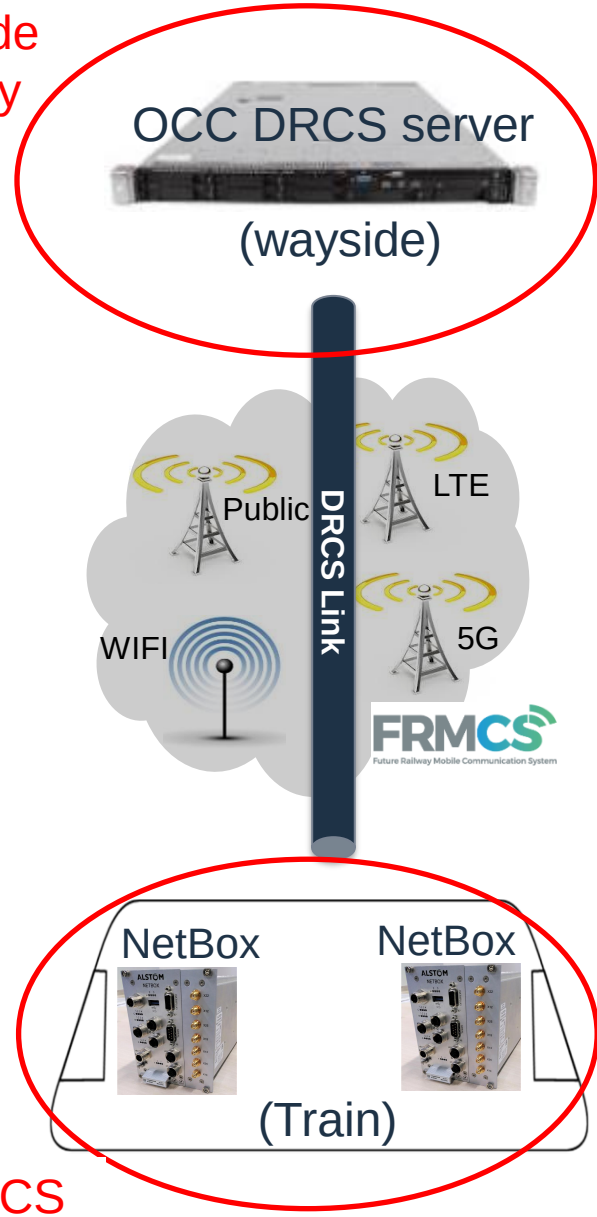
- Extended-size NetBox or Airbox (both 3U format) for “remote-radio” concept requested by Railways
- RMR modems (900/1900MHz) at 31dBm
- Optional MNO*** modem for hybrid connection

- FRMCS Trackside Gateway (Alstom DRCS)

* Telecom On Board Architecture **ETCS Data Only Radio ***Mobile Network Operator

NETBOX / DRCS (Data Radio Communication System)

FRMCS Trackside Gateway



- NETBOX / DRCS = onboard/trackside gateways between telecom & rail domains

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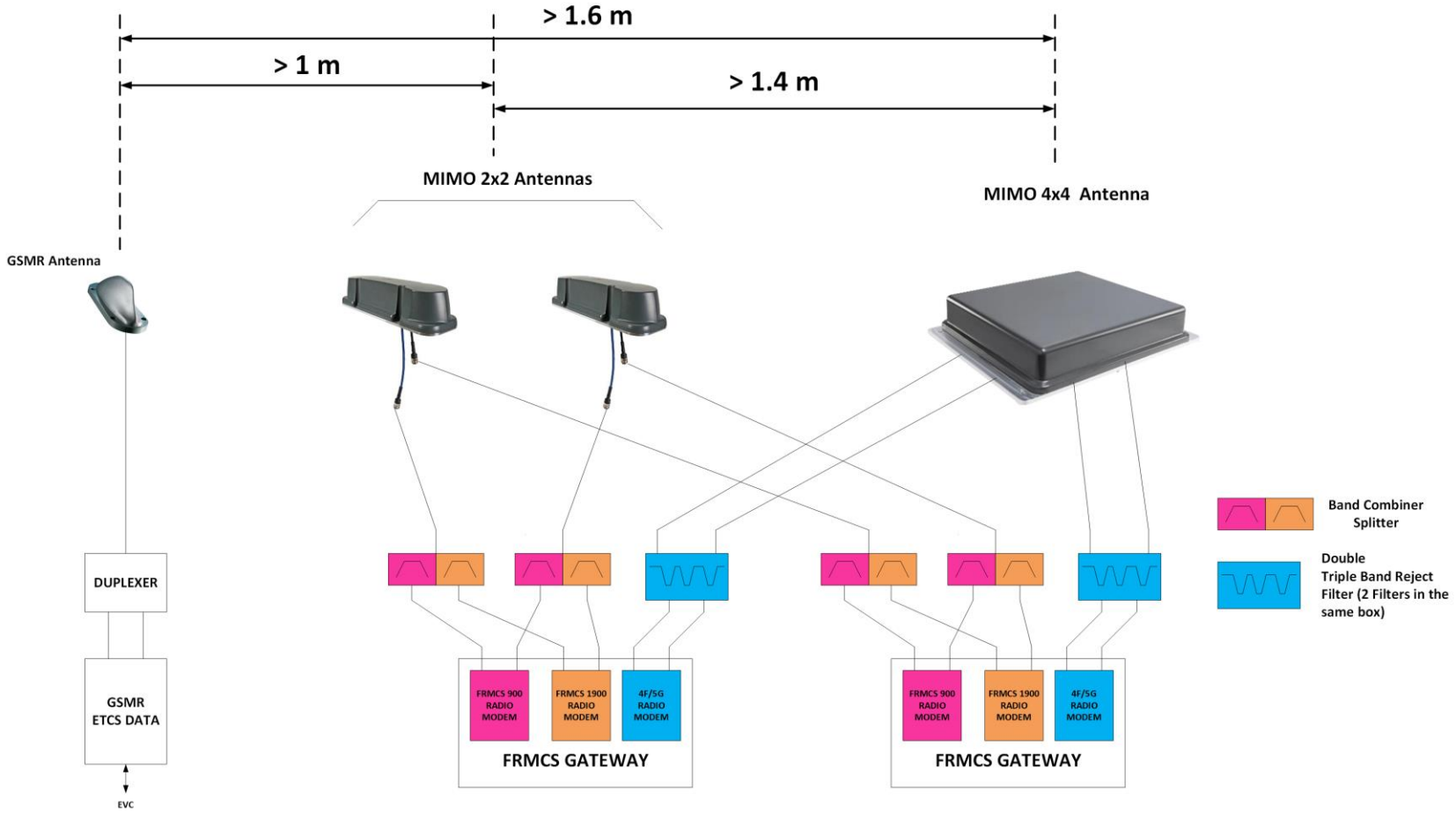
Train-to-Ground communication mgt			Routing	Tunnelling		Application hosting
Linux						
Ethernet	Serial	GPS	modem 1	modem 2	modem 3	24/110V

- NETBOX / DRCS is a communication system providing transparent data tunneling & routing between train and ground
- Solution agnostic to applications: signaling, video-surveillance, remote status, maintenance data, media content, real time information (video, audio, PIS…)
- Solution agnostic to wireless technologies, compliant to private and/or public networks, providing aggregation or roaming between the wireless networks
- Load Balancing between radio links / best radio link / multilink aggregation

FRMCS Onboard Gateway

Example of system & antenna installation for GSM-R / FRMCS (RMR/MNO)



Need isolation from/to GSM-R and FRMCS (both RMR and MNO)

04

Take Away

Take Away

- Alstom involvement:
  - Signaling over LTE/5G already for 10 years for Urban & Mainline segments
  - Multi-services ETCS/MCPTT/CCTV over LTE private in commercial service since Oct 2023
  - FRMCS prototypes delivery to projects: 5G-RAIL, R2DATO, MORANE2

- Alstom already implementing the v2 specs (2025) and will implement v3 specs (2027) for product market availability from 2028+

Alstom strongly involved in the LTE/5G/FRMCS implementation and ready to support Swedish rail & train deployment

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