ERTMS 2024 Conference

23-25 April 2024

Valenciennes, France

#ERTMS2024

EUROPEAN UNION AGENCY FOR RAILWAYS

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ERA

WS 8: How to succesfully introduce FRMCS on EU network and the vehicles?

Migration Strategies and Challenges

Objectives and purpose of this WS

Focus on FRMCS migration and deployment: identify challenges and possible solutions.
Topics for discussion (Examples)

STRATEGIC

- Why / when?
  - Which lines and which applications are we targeting first? (Conditions, key issues, challenges)
  - Migration steps
  - Cost factors
  - Bottlenecks, risks.
  - Link migration with ETCS and other enhancements
  - Coordinated approach or case by case approach? National coordination and/or European Coordination? What kind of coordination do we need?

TECHNICAL

- How?
  - Impact of FRMCS deployment for already existing OB and for TS system, specially signaling. Coordinate migrations.
  - TS practical arrangements for fast deployment: Which frequencies? What about the use of MNOs? How to prepare infrastructure upfront?.
  - OB practical arrangements for deployment: antennas, cabling, OB architectures, dual-mode, VA arrangements, etc.
  - How can solutions help to ease and fasten deployment?

Workshop Organisation

Total duration: 1 h 30’

- 5 minutes Introduction by moderators.
- 30 minutes presentations to set the topics for discussion.
  - 10 minutes IMs: Pipsa Hallner, Achim Vrielink, Ove Skovdahl
  - 10 minutes RUs: Pascal Désaunay, Morten Schlaeger
  - 10 minutes Industry: Alexander Ende, Michael Kloecker, Jorgen Mattison
- 40 minutes of discussion in subgroups
  - Choose your rapporteur and the topics.
  - Discussion.
  - Wrap up of results.
- 15 minutes for conclusions

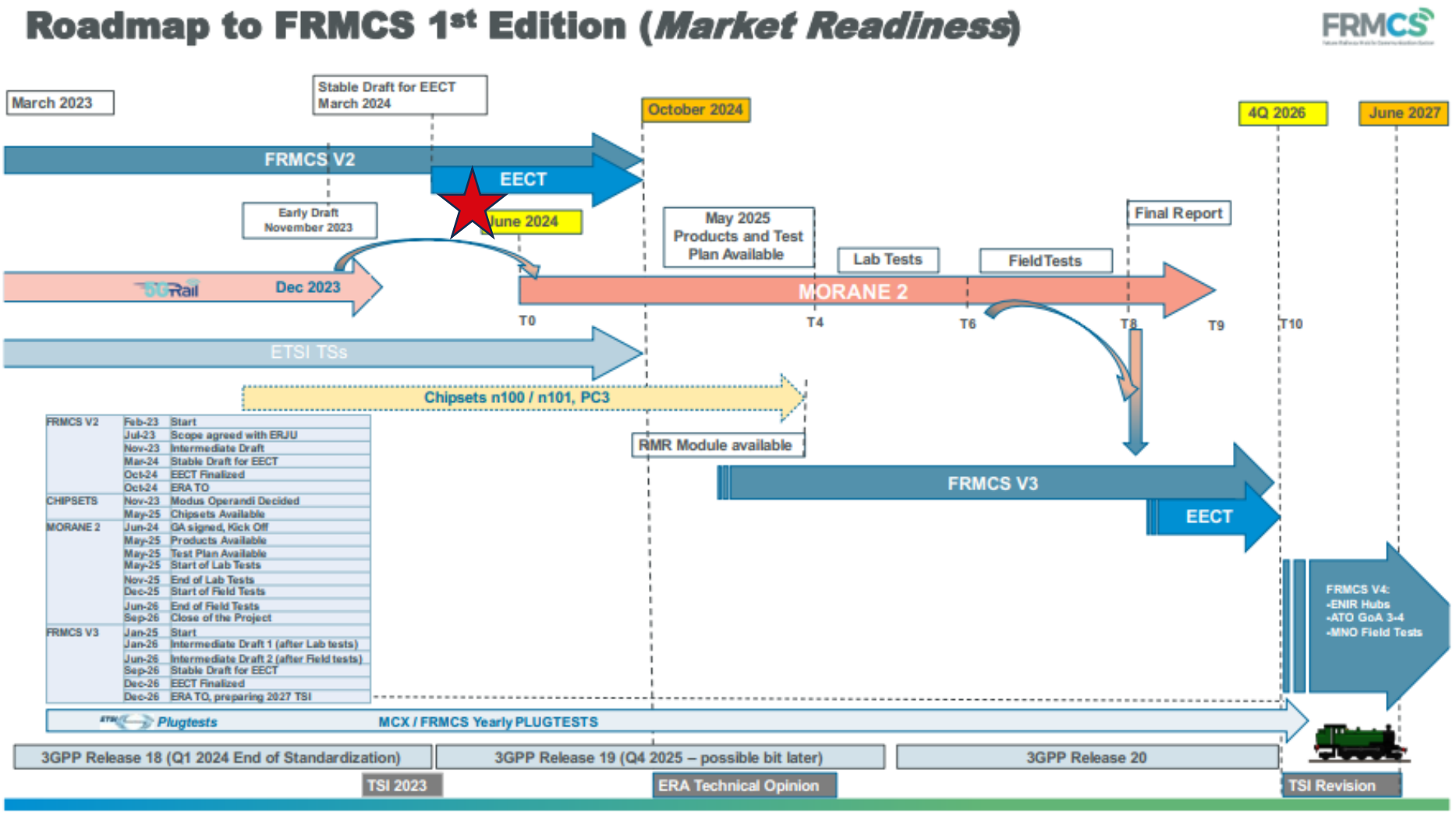
- Market place on the 24th April, 45 minutes.

You need to split in 6 tables!!

OB ST	TRK ST
OB TEC	TRK TEC
OB S/T	TRK S/T

Where do we stand now in FRMCS?

Source: Report on FRMCS V2 and V3 Scope and Planning, ERJU, SP




Thank You!

WS 8: How to succesfully introduce FRMCS on EU network and the vehicles?

Migration Strategies and Challenges

Pipsa Hallner

Leader - Strategic Telecom development
Trafikverket - Bransch

Achim Vrielink

Head of Telecom Platform Development
DB InfraGO AG

Ove Skovdahl

Special Advisor, Coordinator of International Affairs
Norwegian Railway Directorate

Railway

11,000 km of track

525 stations

11,000 switches and crossings

4,100 bridges

165 tunnels

Ferry

40 ferry routes

82 ferry berths

Road

98,500 km State roads

16,500 bridges

20 tunnels

2,000 road safety cameras

800 weather stations

ICT

13 200 km fiber

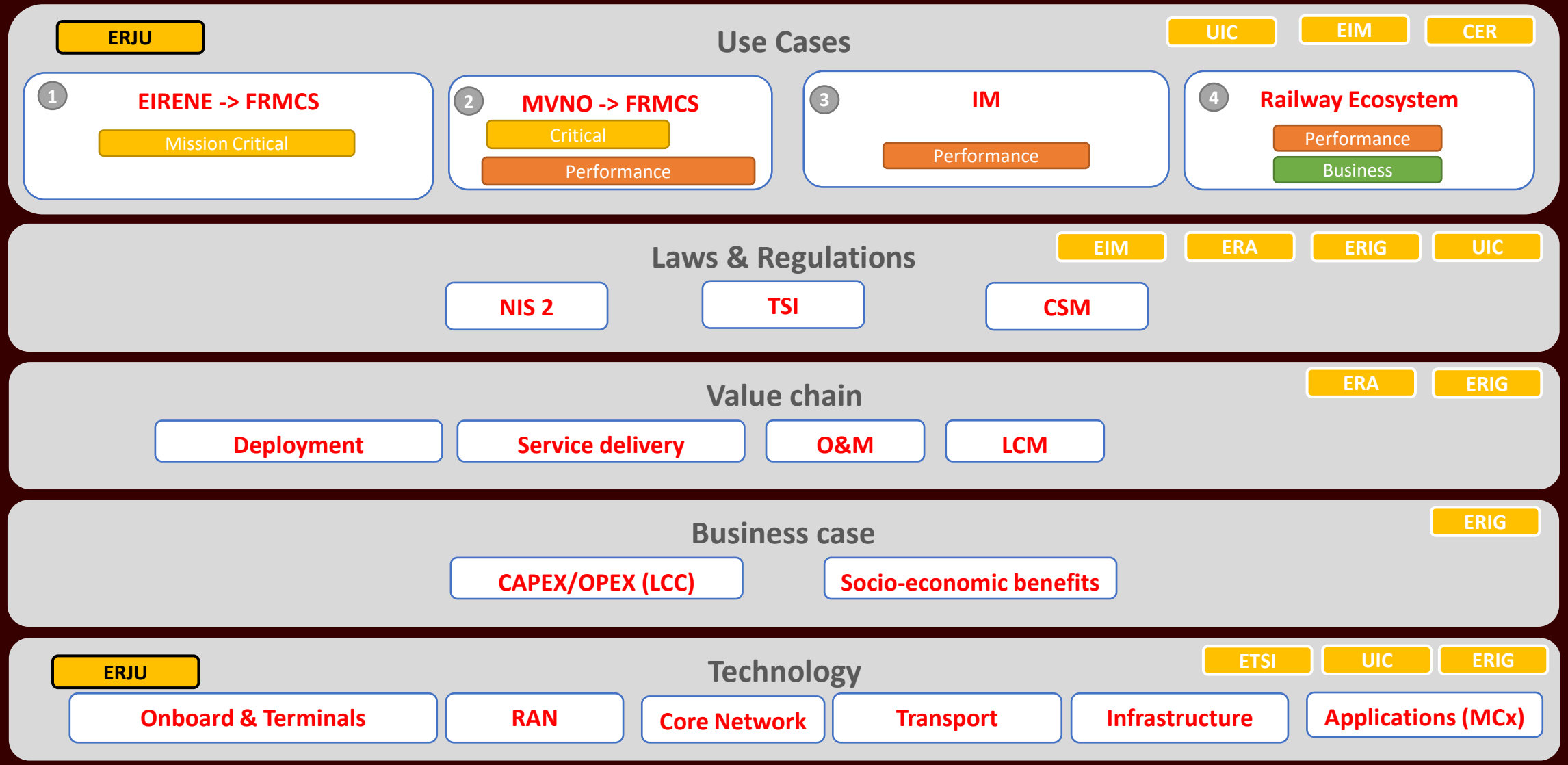
20 000 km Copper cable

1500 Sites

5000 M2M connections

8000 GSM-R users

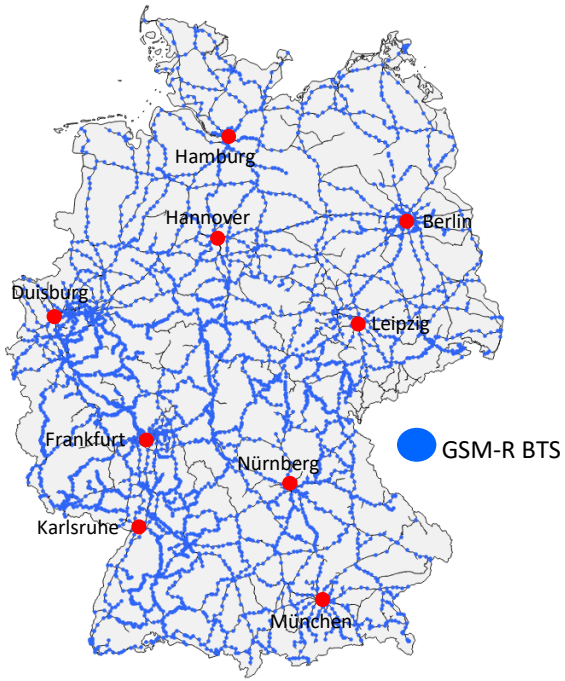
The Scope

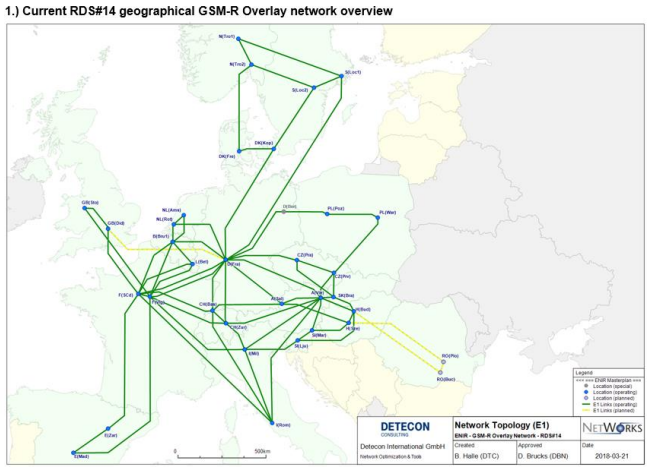

ERJU
Use Cases
UIC
EIM
CER
1
EIRENE -> FRMCS
Mission Critical
2
MVNO -> FRMCS
Critical
Performance
3
IM
Performance
4
Railway Ecosystem
Performance
Business
Laws & Regulations
EIM
ERA
ERIG
UIC
NIS 2
TSI
CSM
Value chain
ERA
ERIG
Deployment
Service delivery
O&M
LCM
Business case
ERIG
CAPEX/OPEX (LCC)
Socio-economic benefits
ERJU
Technology
ETSI
UIC
ERIG
Onboard & Terminals
RAN
Core Network
Transport
Infrastructure
Applications (MCx)

The nationwide GSM-R network of DB InfraGO on more than 30.300 km of lines has to be migrated to FRMCS

Today more than 90% of the DB InfraGo railway lines are using GSM-R

- GSM-R fulfills the current rail operations requirements concerning voice and data for ETCS according to international standards
- International **GSM-R roaming** between **19 European railways** allows Europe-wide communications between trains and controllers, shunting teams, maintenance staff etc.
- **National roaming** with Telekom and **interconnection** with Telekom/Vodafone allows use of public networks as backup solution etc., communication to public networks and to the DB internal business voice network (VoIP)
- In Germany more than **30.300 km of lines** are equipped with GSM-R
- Around **4000 GSM-R base stations** are currently in operation
- Around **3.300 controller workplaces** are equipped with wireline dispatcher terminals
- Around **30.000 Cab Radios/EDORs** and around **77.000 Handhelds** are in use





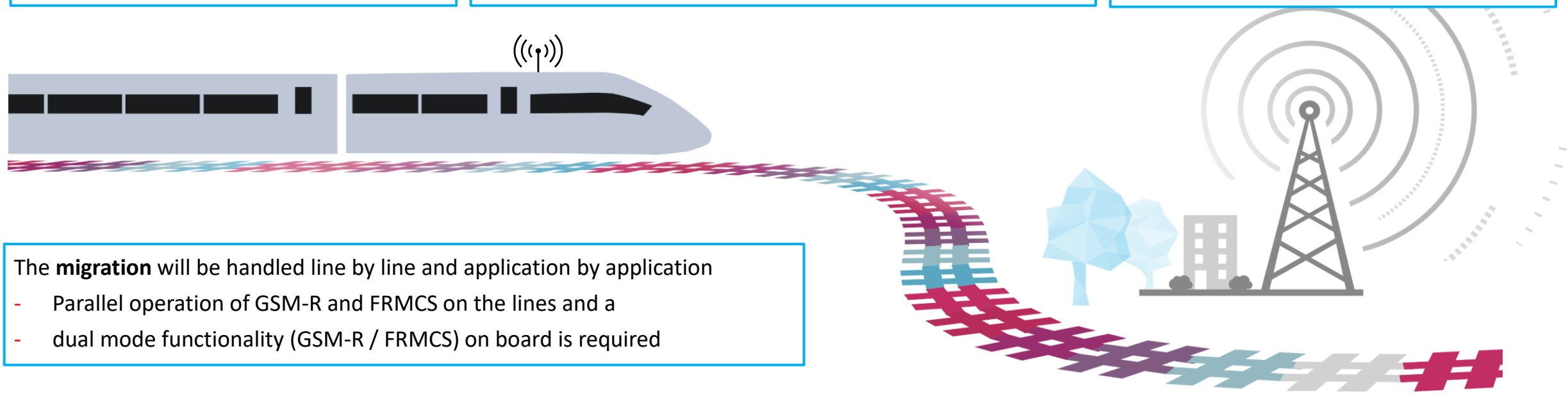
Parallel operation of GSM-R and FRMCS allows “smooth” introduction of FRMCS, but needs to be limited

GSM-R technology will not be supported by industry after 2035!

FRMCS **frequencies** : EC / CEPT 2021 ✓

“**Legal anchor**” 5G for FRMCS : TSI in force 09/2023 ✓

FRMCS is necessary as connectivity basis for future digital railway!



The **migration** will be handled line by line and application by application

- Parallel operation of GSM-R and FRMCS on the lines and a
- dual mode functionality (GSM-R / FRMCS) on board is required

The **benefits** of FRMCS and digital railway operation shall be made **available** to rail operation and train operators **as soon as possible**

The **cost** of parallel operation of two networks shall be **reduced** line by line **as early as possible**

Stepwise introduction of FRMCS into railway operation incorporates migration aspects from demanding to complex scenarios

Rollout all lines
- Regular rollout process
- Line by line migration to FRMCS

6 „Big Hub“ with international traffic in GSM-R
- **Introduce first ATO applications** (GoA 2) on FRMCS
- Interworking / national roaming with **public network**(s)

5 Border crossing line with GSM-R
- **International roaming and interworking** with other European network operators / railways
- International operational procedures for FRMCS users and for network operation

4 Long distance line with GSM-R
- **Higher traffic load**, more train operators and more trains / engines involved
- **High speed** aspects in live operation

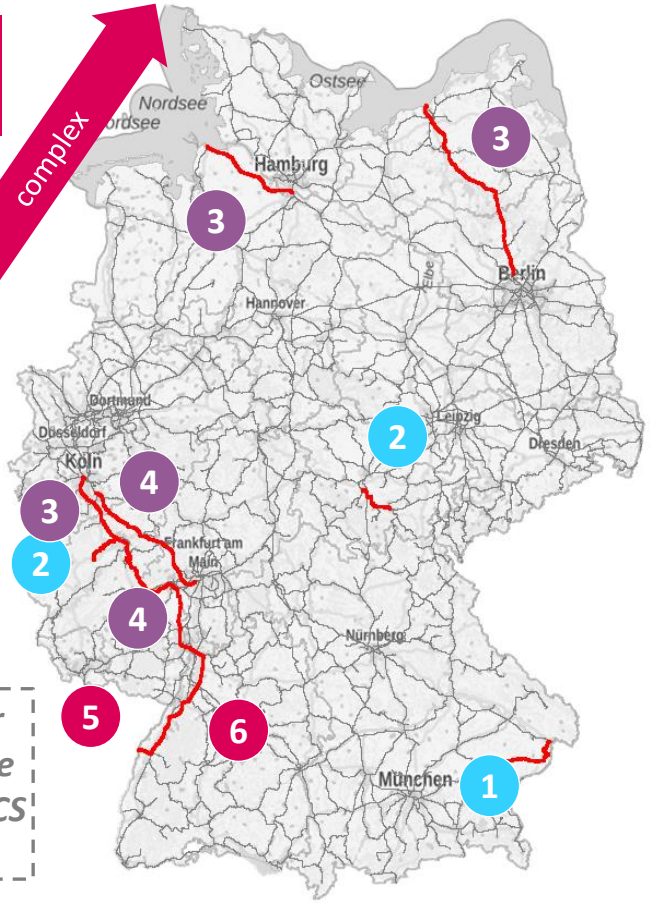
3 Regional line with GSM-R
- **Interworking functions GSM-R / FRMCS**
- Processes for railway operation for users with GSM-R and FRMCS in parallel

2 Regional line with analogue radio
- **First DB InfraGO lines** with more trains from **different train operators** and common operational rules
- Optimize processes for planning, construction, operation of FRMCS network elements and for railway operation

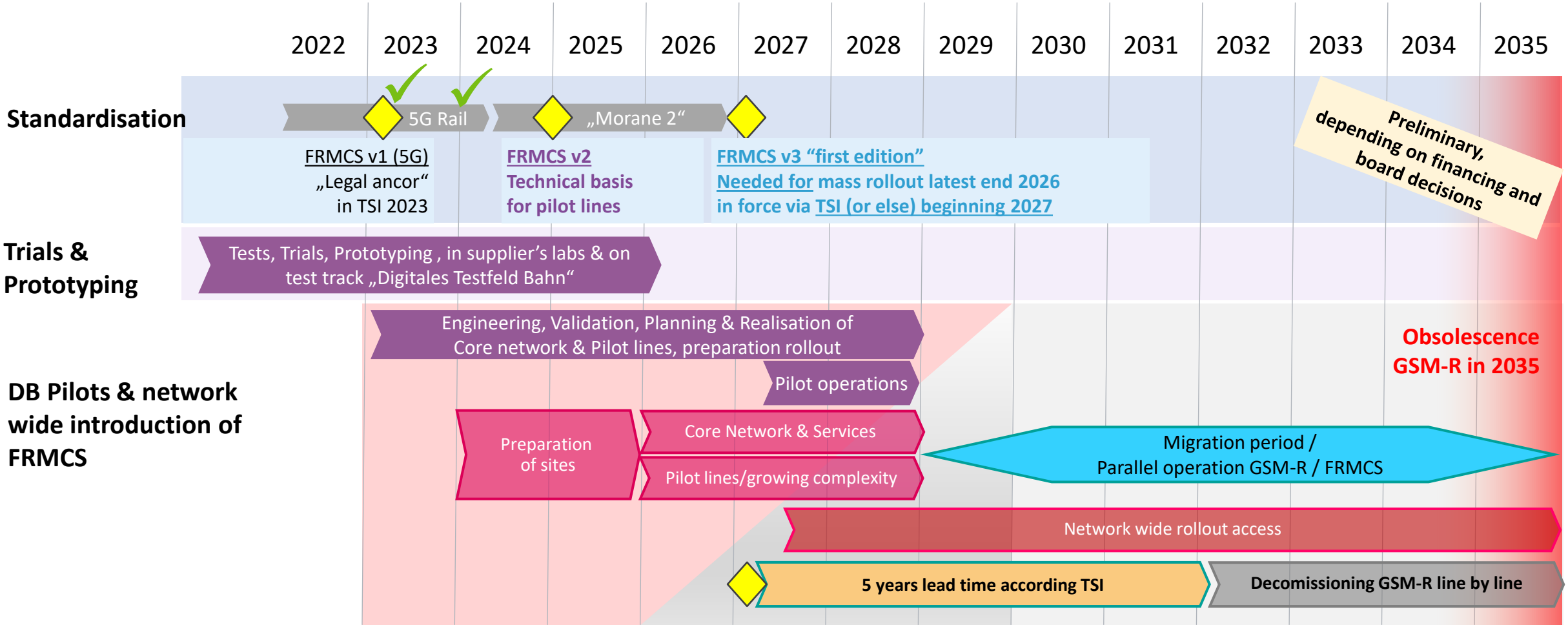
1 Analogue „Island“
- **First trails in railway operation** “independent solution”
- Infrastructure, trains & railway operation in “one hand”
- Limited number of trains/engines

demanding → complicated → complex

Candidates for pilot lines, to be verified in FRMCS project



FRMCS introduction in Phase 1 till 2028 is very demanding, but only seven years remain for network wide rollout in Phase 2



Norwegian Railway Directorate

- Advisor to the Ministry
- Long Term Planning
- Sector Coordination

Bane NOR SF

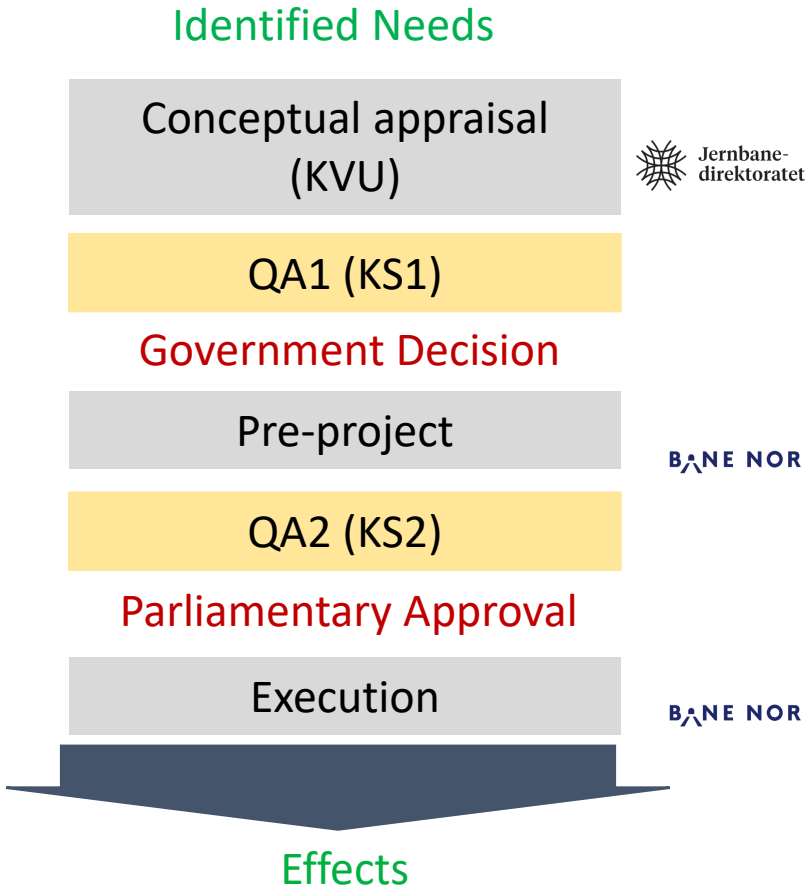
- Infrastructure Manager

Concept Appraisal (KVU) - Involvement and Process

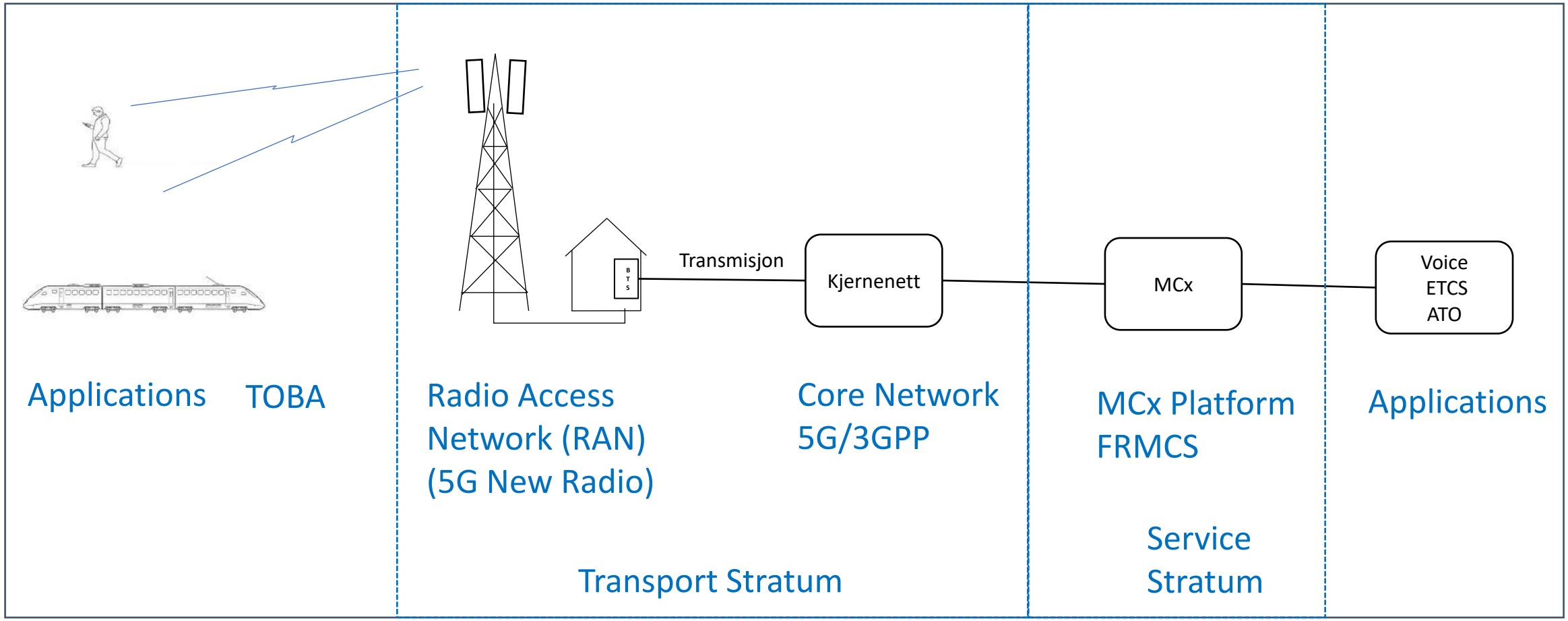
- 2022-24
- Railway Directorate - Lead (1000 mh)
- Bane NOR - Crucial Contributor (4700 mh)
- Consultancy Assistance (2300 mh)
- Broad Sector Involvement/ Workshops
- Cooperation with Railway and Telecom Authorities
- Meetings with other Infra Managers
- Cooperation and RFI with 3 MNOs

Norwegian State Project Model

All Public Expenditures > 1 BNOK (85 M€)



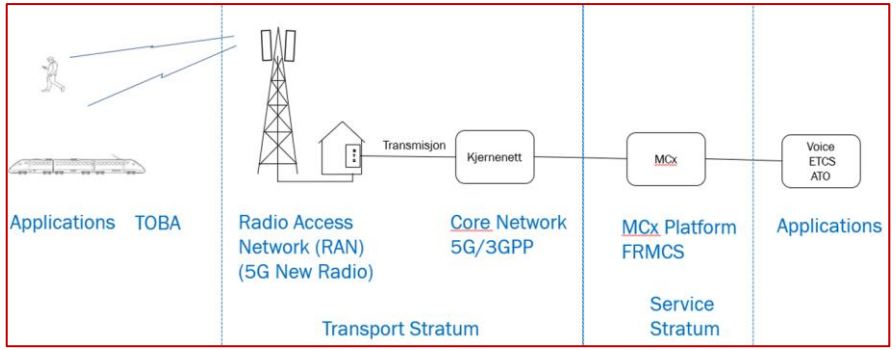
Possibilities - Feasibility - Alternatives



68 Combinations reduced to 6 Alternatives

Analysis and Conclusion

Alt.	MCx	Transport CN+RAN	Freq.	Socio-eco Rank	
				Mon	Non-Mon
1	BN	BN	RMR	3	5
2	BN	MNO	RMR	2	6
3	BN	1 MNO	Comm	**1**	4
4	BN	BN+1 MNO	RMR+Co	**6**	**3**
5	BN	BN+3MNO	RMR+Co	5	2
6	BN	3 MNO	Comm	4	**1**



BN= Bane NOR (Infrastructure Manager)
RMR= Rail Mobile Radio Frequencies (TSI CCS 2023)
Comm.= Commercial frequencies, other than RMR
MNO= Mobile Network operator

Socio-economic Analysis: Ranking based on analysis of monetary and non monetary impacts:

Use of only MNOs and commercial frequencies (alt 3 and 6)

- Give highest socio-economic score
- Ensures fastest/ easiest implementation
- But cannot be recommended due to uncertainty about development of EU legislation

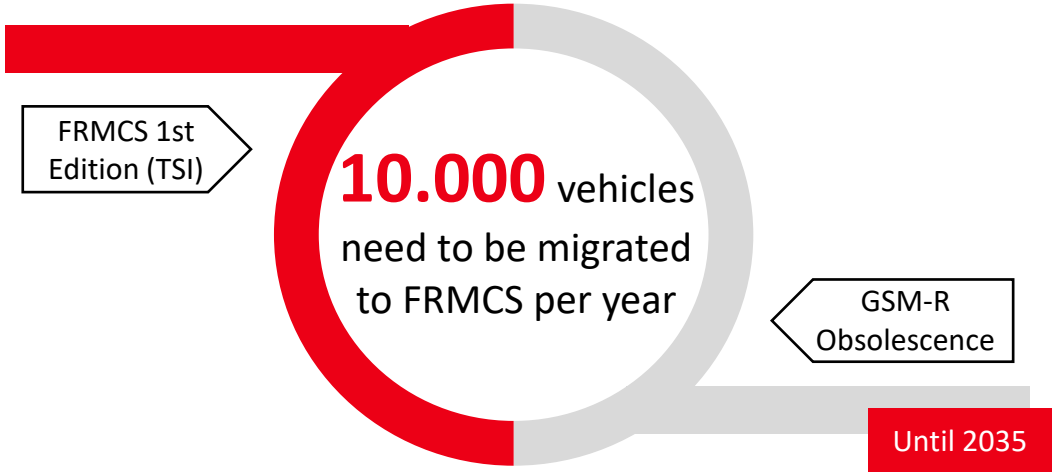
Given that restriction: Alternative 4 is recommended (RMR + MNO redundancy)

Conclusion confirmed by independent Quality Assurance (QA1)


Thank You!

Getting vehicle migration completed by 2035 is a huge challenge, migration preparation has to start now

Situation



Migration time is limited from both sides

1. **FRMCS** product **availability** depends on FRMCS validation project and final specifications. Products might not be available before 2029
2. **GSM-R obsolescence by 2035**, with possibility of first GSM-R phase out by 2032

Challenges

Short time and parallel migration in all European countries resulting in too huge a demand on e.g.

- Workshop capacity
- Engineering capacity
- Authorization capacity

Significant **cost** of migration without financing

Coordination between IM and RUs not clear

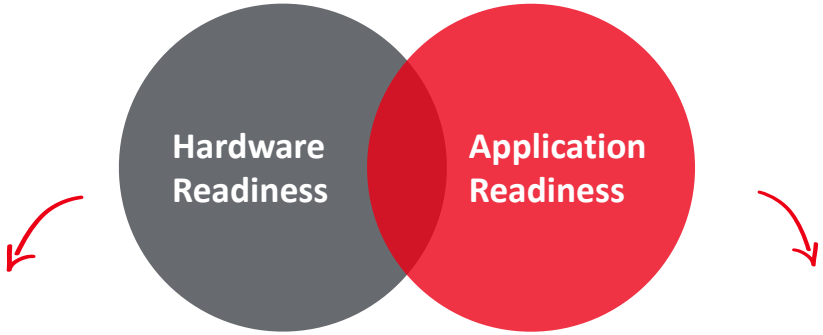
*) Assumed FRMCS product availability. Compliant ETCS products might not be available before 2030

**) Number of vehicles: 65000 - Source: https://www.statista.com/statistics/453306/european-countries-number-of-locomotives-and-railcars/

Improvement of the migration timeline can be achieved by two levers: FRMCS hardware readiness and application readiness

Challenge

Possible solutions



Preparation of vehicles to allow a later FRMCS introduction ideally with a software update only

Applications using FRMCS:

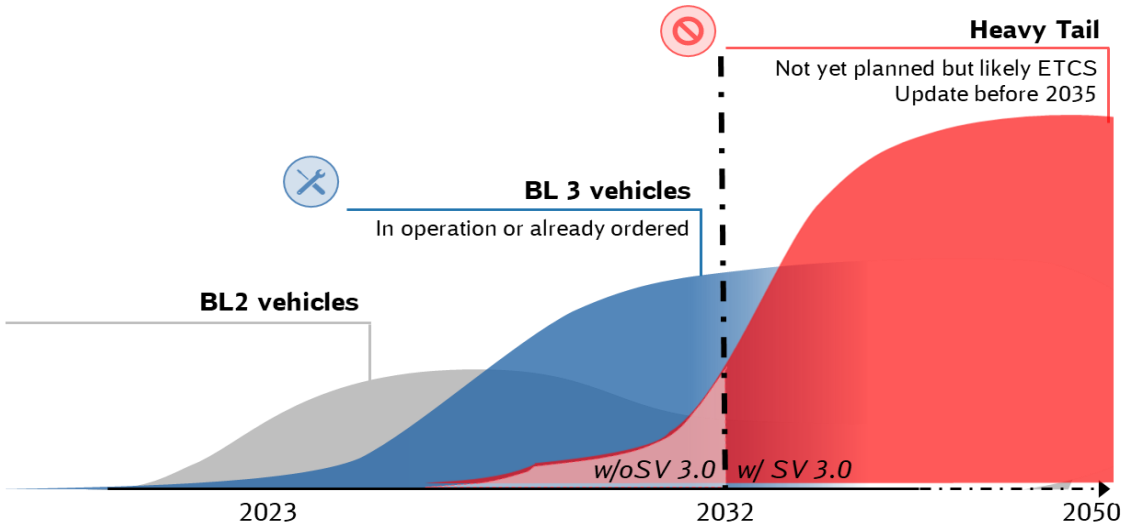
- already FRMCS compatible or
- software update without full new authorization possible

TSI 2023 does not fully contain the detailed technical clarifications, however, this should not hinder hardware preparation of vehicles.

Preparation can include e.g. space for FRMCS Gateway/Modems, cables, antennas.

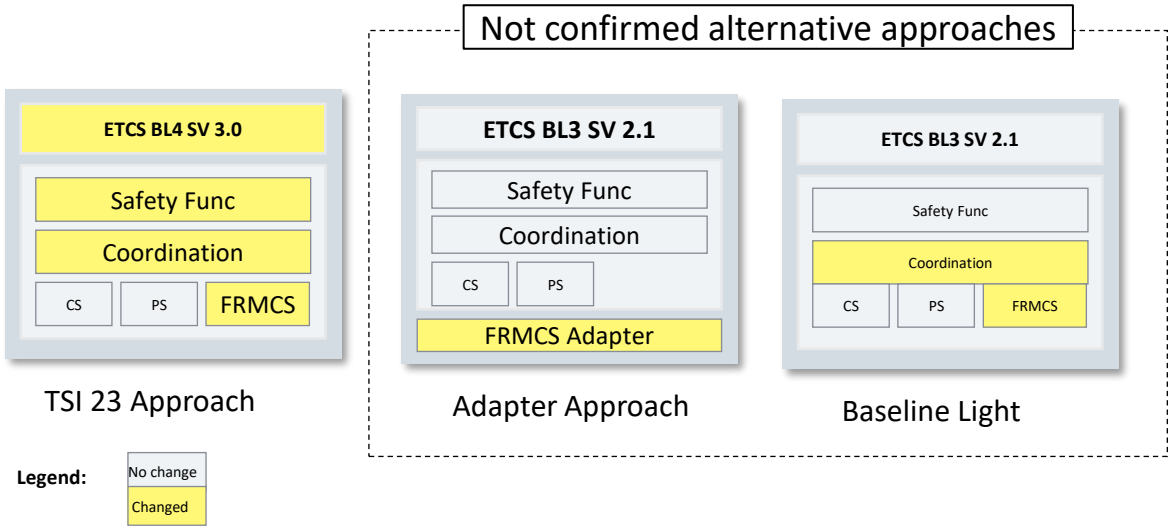
ETCS onboard units with System Version below 3.0 do not support FRMCS. Time and cost challenge to achieve compatibility

Problem Statement



- Today's vehicles are equipped with ETCS On board units with **system version (SV) <3.0 incompatible with FRMCS**
- TSI 23 introduces SV 3.0 as first onboard version supporting FRMCS
- ETCS products with SV 3.0 might **not be available before 2032**
- Number of vehicles with incompatible ETCS version continues to increase

Dependencies & mitigation options



- Product availability depends on FRMCS 1st Edition (FRMCS v3)
- Achieving ETCS/FRMCS for vehicles with ETCS should be significantly **less complex than typical ETCS Upgrades SV 3.0** concerning fitment and new authorization
- Vehicles with new ETCS deployment before SV 3.0 product availability should support FRMCS **with a software update only and without complex reauthorization**

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Workshop #8
How to successfully introduce FRMCS (the successor of GSM-R) on EU network and the vehicles? Migration strategies and challenges

Alexander Ende
UNITEL/Funkwerk
Product Management
Chairman UTG

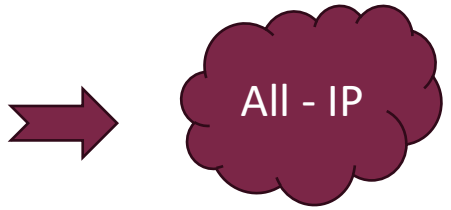
Michael Kloecker
UNITEL/Nokia
Solution Management Railway

Jorgen Mattisson
UNISIG/Alstom
Network System Architect

FRMCS Introduction and Migration for Application(s)

FRMCS INFLUENCE ON ETCS

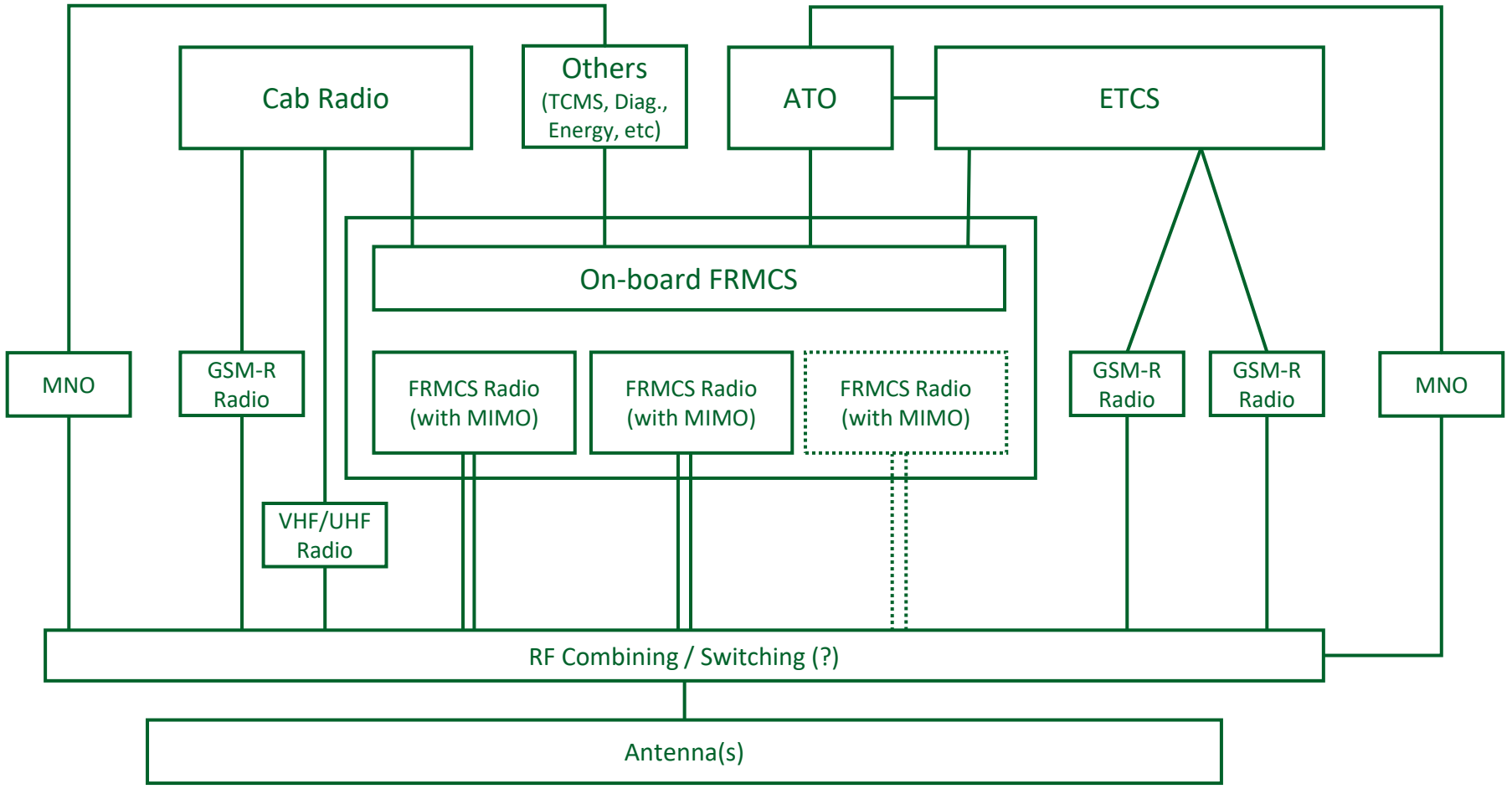
- Communication: Shared resource (FRMCS gateway) replacing dedicated communication
- Interface: Networking interfaces replacing serial/E1 interfaces
- Protocol: Standard IP protocols including improved security



- Application and system changes
  - Selection of communication system => Additional balise data
  - Use of security certificates => Need of public key infrastructure (PKI)
  - Use of shared resource => Loss of direct control of radio

FRMCS Introduction and Migration for Vehicles

ON-BOARD RADIO SYSTEMS FOR TRAIN OPERATION



Next slide

FRMCS based on 5G | Migration Strategies for Trackside

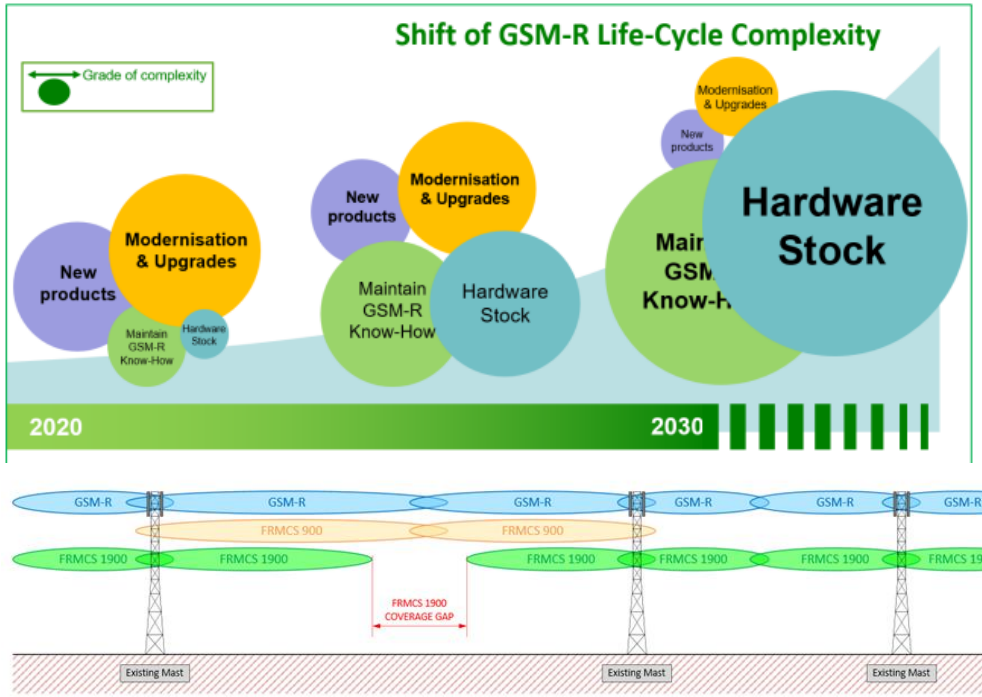
FRMCS MIGRATION CHALLENGES & MITIGATIONS

Migration challenges and strategies

- New technology -> specification, verification, certification
- Long migration period -> increasing effort and cost, GSM-R Lifecycle
- Efficient spectrum use during migration 900 (n100), 1900 (n101) GSM-R spectrum sharing
- Opportunities and challenges for MNO sharing
- Cyber security, market evolution

Measure for fast and smooth FRMCS introduction in time

- Product and specification availability
- Rollout strategies aligned, resources optimized. Faster than TSI ?
- Network Preparation upfront (Sites, Core, Transmission)
- Life Cycle Management, automation, and certification

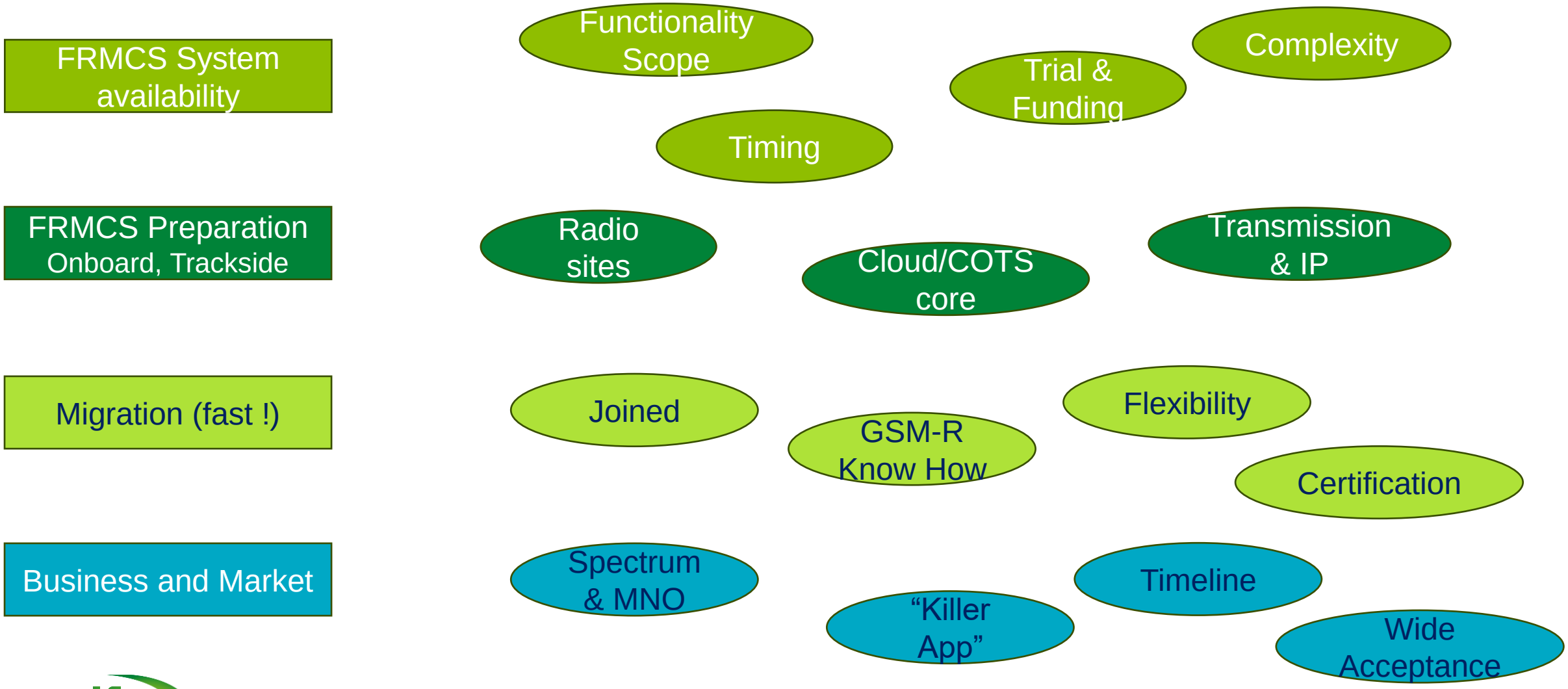


Source: UIC UGFA

Business Case

- Timeline and scope : no uncertainty
- Industry to manage e2e ecos system
- Funding and trial alignment

Food for thoughts….



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