DIGI RAIL

Finland´s road to FRMCS

Conference of Communication and Security System on the Railway

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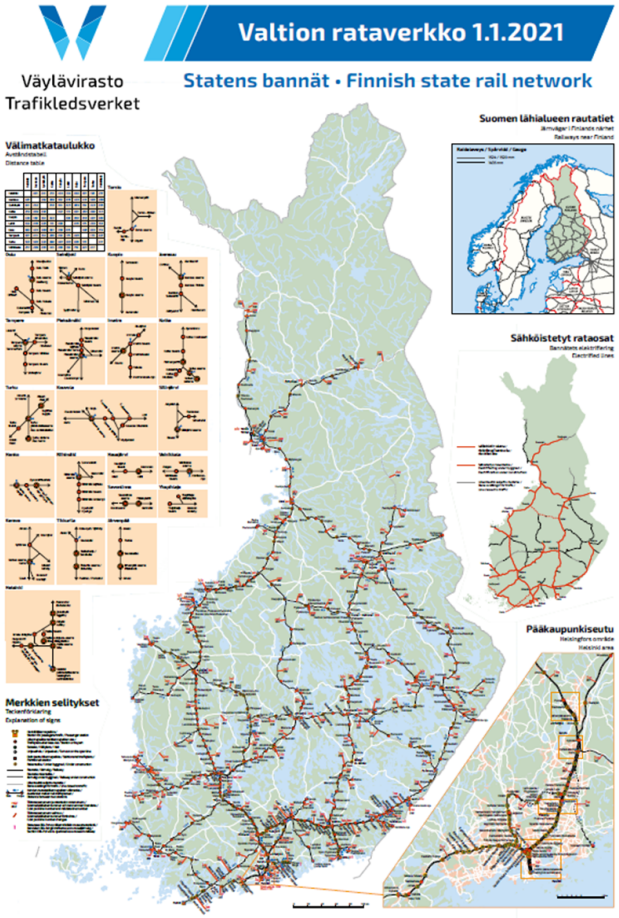
The Finnish Mobile Landscape

- The GRM-R frequencies are freed up, but not in active use, as the railway is using a Tetra-network (nationwide ”blue-light” –network) for voice communication based on a derogation.
- 3 Mobile Operators with nationwide coverage, Elisa Oyj (FIN), Telia Oyj (SWE) and DNA Oyj (NOR)
- Finland is a sparely populated country (only 18 persons per km2), thus the rural broadband strategy has been based on low band mobile coverage
- Low band licence terms contain stipulations on road and railroad coverage, no KPI´s defined though Traficom (NSA) checks the railroad coverage regularly, although only by calculations
- Nationwide 5G is being implemented on the 700 MHz (replacing 3G) and 3.5 GHz bands
- The “Blue-light” Tetra-network will be replaced with a SLA with one operator and based on 4G/LTE

The challenge



ITEM	SUBSET-093 REQUIREMENT	DIGIRAIL TARGETS (FRMCS Draft SRS values)
Packet Service Setup Attach Delay PDP Context Activation	≤ 35 s (99%) ≤ 5 s (99%) ≤ 3 s (99%)	Altogether ≤ 10 s (99,9%)
Transaction Transfer Delay OBU Originated 100 octets	≤ 2.6 s (99%)	≤ 500 ms (roundtrip) (99,9%)
Transaction Transfer Delay RBC Originated 320 octets	≤ 3.0 s (99%)	≤ 500 ms (roundtrip) (99,9%)
ETCS-DNS Lookup Delay	≤ 3 s (99%)	≤ 500 ms (roundtrip) (99,9%)
HTTP Request/Response	Not defined	≤ 1 s (roundtrip)(99,9%)
IP Traffic Jitter (DNS, TCP, POS, MA)	Not defined	≤ 20 ms
Packet Loss	Not defined	≤ 1%

The Measurement Setup

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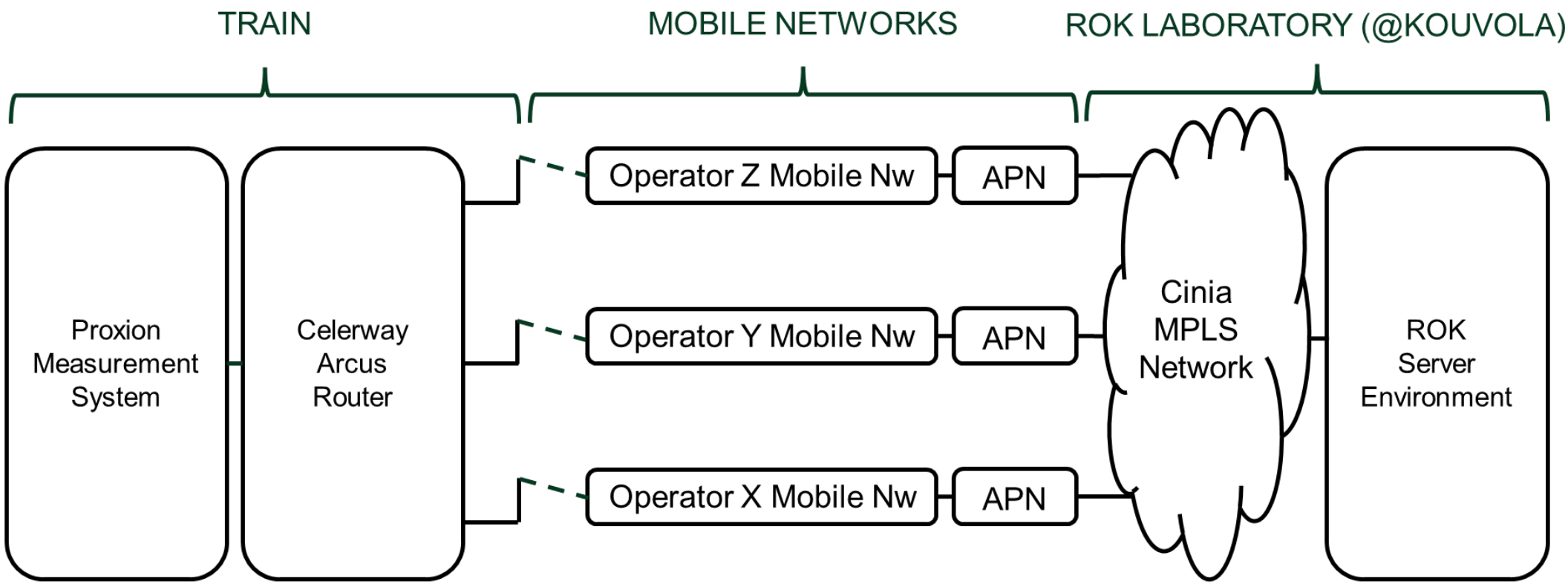

APN = Access Point Name
MPLS = Multi-Protocol Label Switching

The Measurement Vehicle EMMA

Measurement System & monitoring in action

EMMA (Ttr151) maximum speed is 120 km/h

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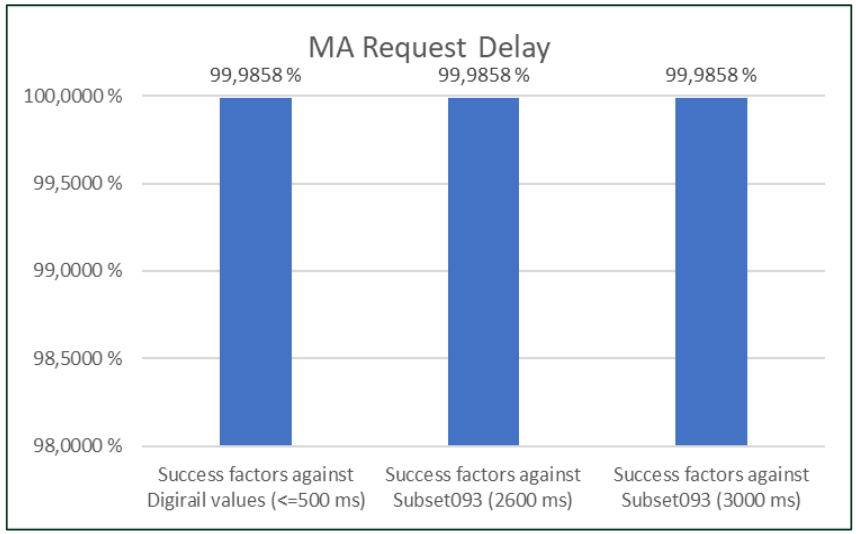
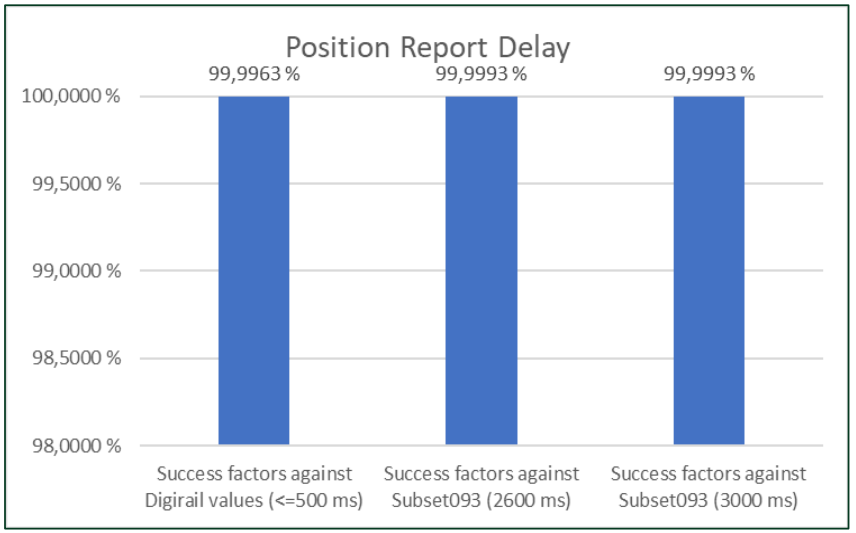
The Measurement Results

99,9858%



Total Samples	14043
Jitter (ms)	10,71
Average Delay (ms)	90,64

99,9963%

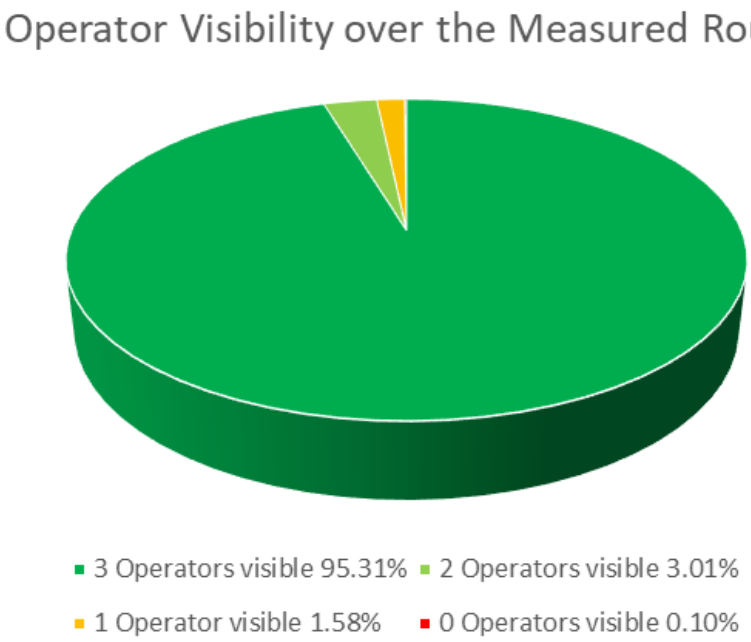


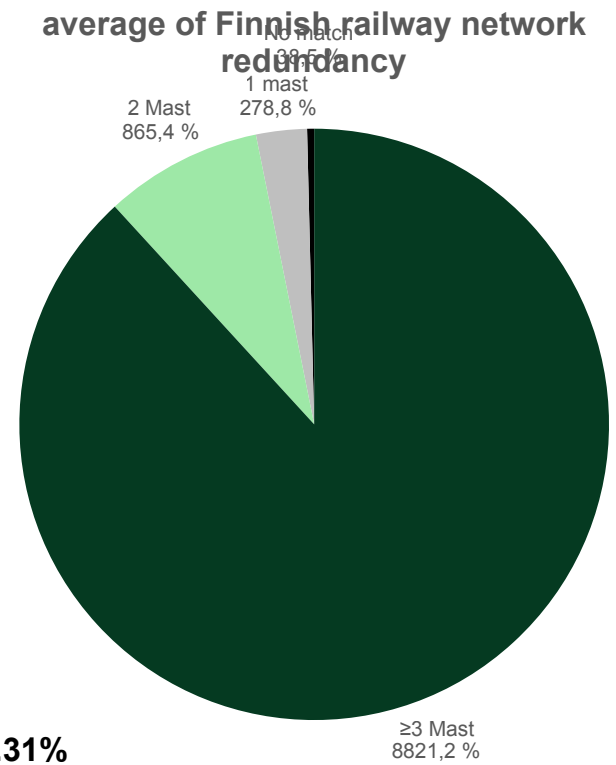
Total Samples	133352
Jitter (ms)	7,76
Average Delay (ms)	67,06

The secret ingredient

- The multichannel router was using ”packet duplication”, ie. the same signal was simultaneously sent through all three networks and the one first to arrive was used.
- This way you always use the best connection available
- Using ”packet duplication” you can turn three semi-good networks into one excellent one.
- We strongly recommend that ”packet duplication” should be part of the upcoming FRMCS V2 specifications.

How reliable is this setup?





- ≥3 Mast 88.2%
- 2 Mast 8.7 %
- 1 mast 2,8 %
- No match 0,4 %

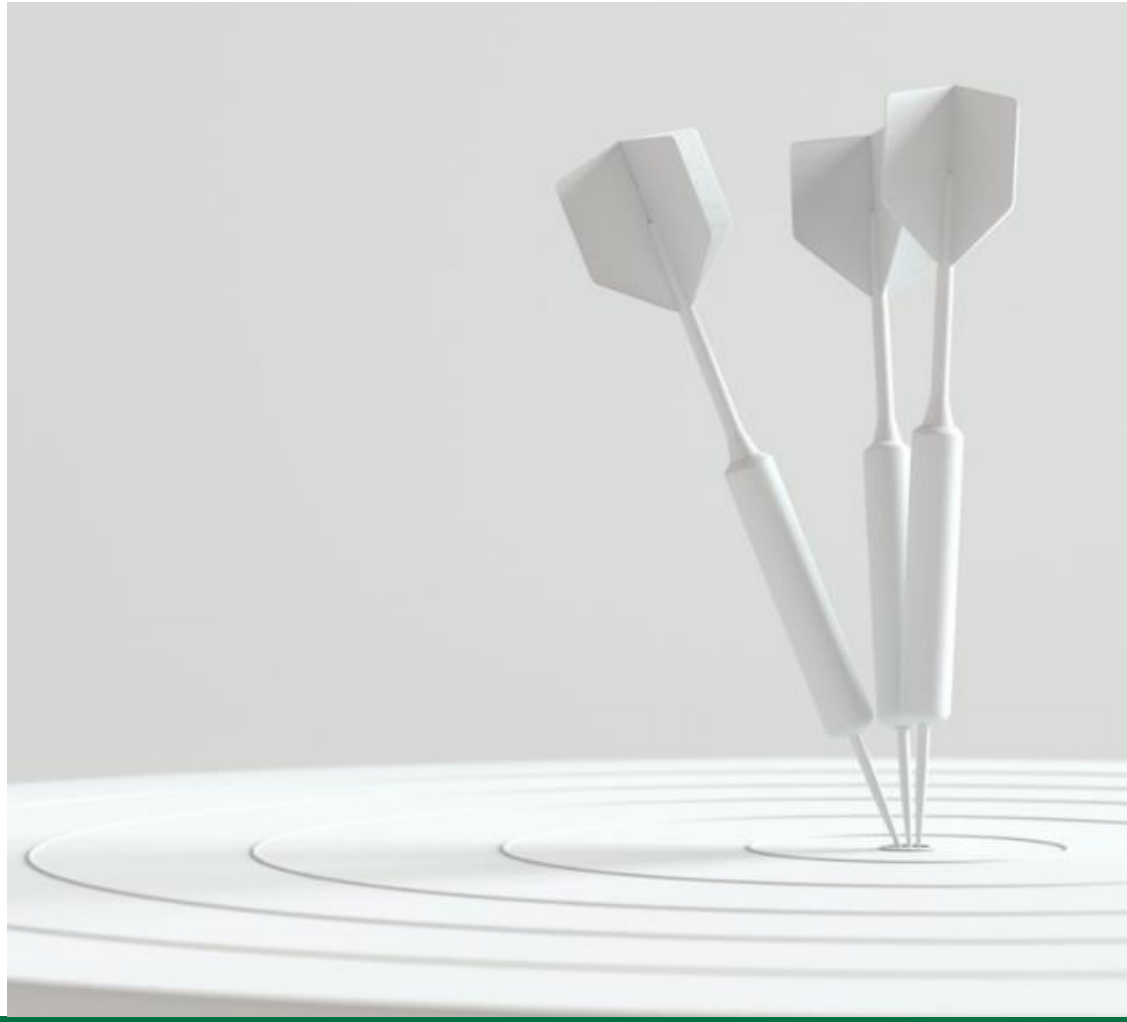
96,9%

All 3 operators visible:

All three operators are visible for communication **95.31%** of the route., at least 2 operators visible **98.32 %**

Conclusions

- The 4G networks in Finland are **well positioned** for ETCS-traffic.
- Finland **will definitely stand by its strategy to utilise them** and continue lobbying for them
- Utilising MNO´s will massively save CAPEX and OPEX as well as speed up the implementation. As a bonus, the next technology change will be in the hands of the MNO´s and not affect us.
- **The pre-FRMCS solution will be nationwide available** by end of **2025**.



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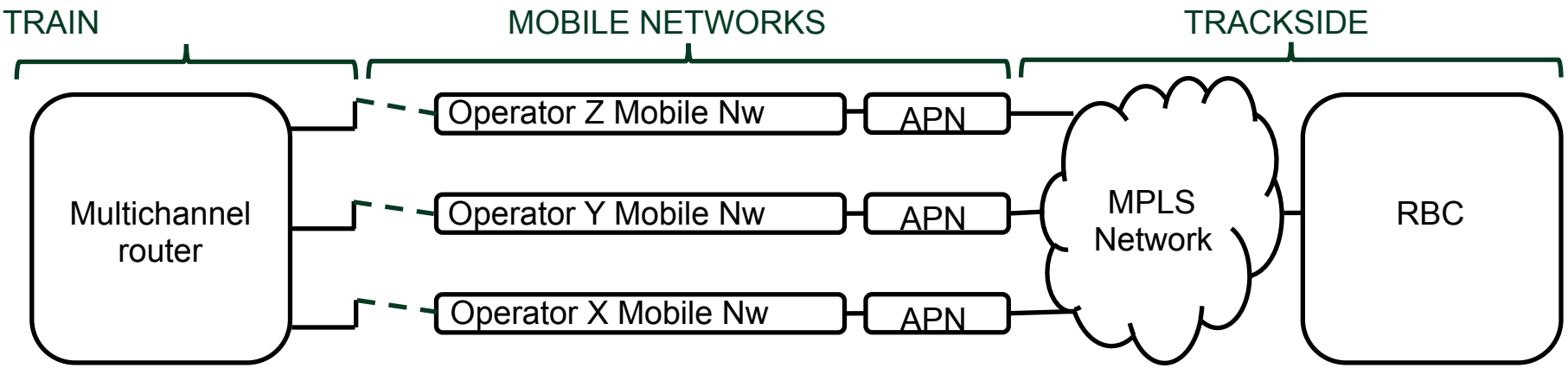
A Two Step Approach

1. **Pre-FRMCS by end of 2025, voice still on ”Blue-Light” Tetra**



2. **Full FRMCS by 2029**

?

Next steps

- Developing the architecture and technical specifications for pre-FRMCS by February 2024
- Live tests of the latest versions of the equipment manufacturers multichannel routers using the pre-FRMCS setup on 4G by end of 2023. (”Mini-Morane”)
- Start of drive tests with real OBU (SV 2.1 with GPRS) on the test track in Kouvola with Celerway router and 3 commercial SIM-cards. Static tests completed successfully.
- Closing the service level agreements with the teleoperators

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