Description of trial objectives, demo story board, test environment and setup

Webinar on the results and insights from the 5G-MOBIX Finland Trial Site
16 June 2022, 14:00 – 15:00 CET

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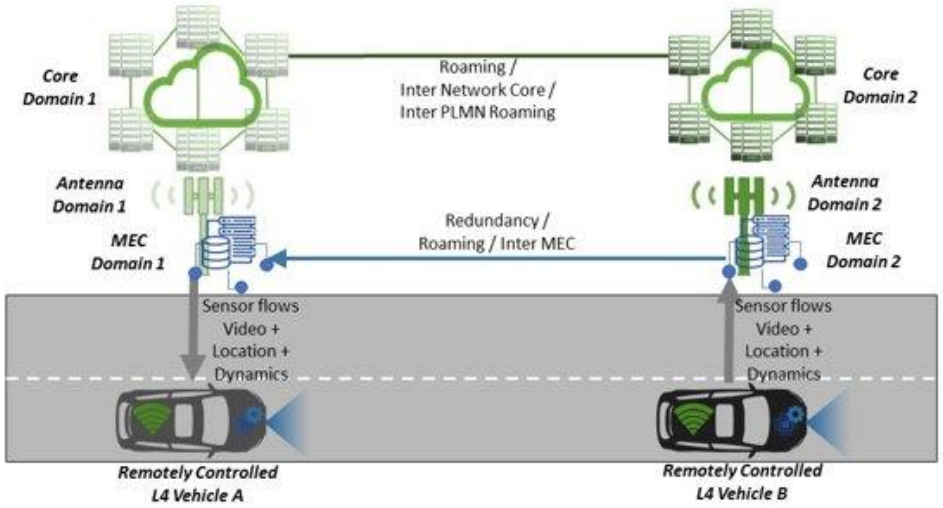
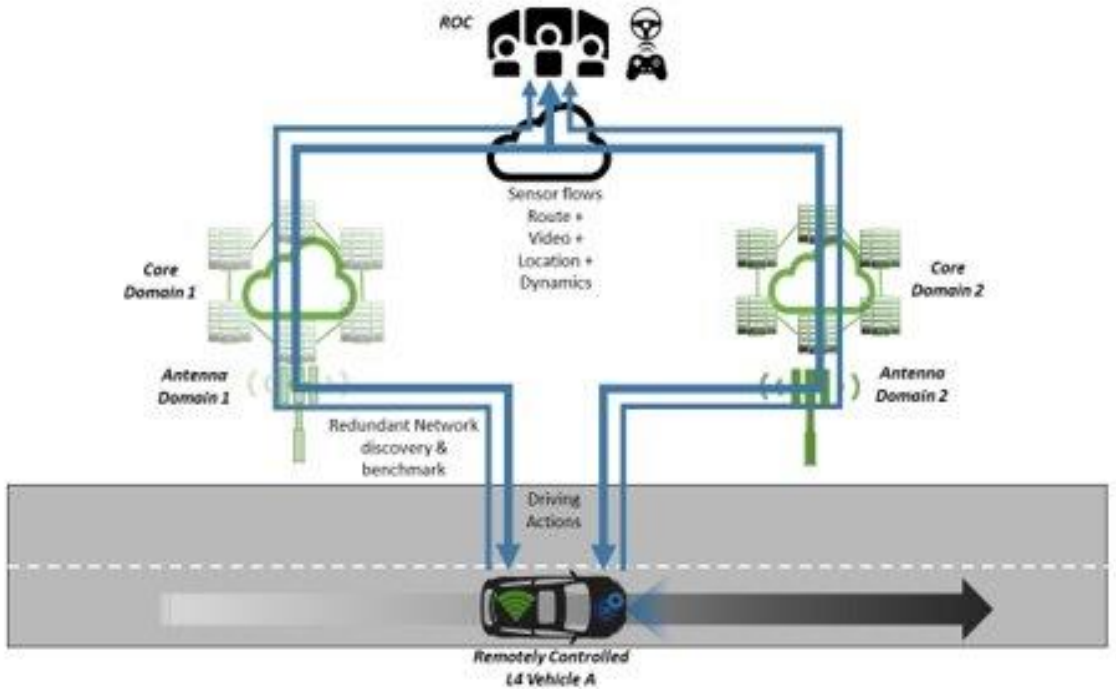
Finland trial site (FI-TS) user stories



- **Extended sensors** with redundant edge processing
  - MEC discovery and migration
  - Video crowdsourcing and HD maps application



- **Remote driving** in a redundant network environment
  - Selection or aggregation of links from multiple 5G networks

Focus of this webinar

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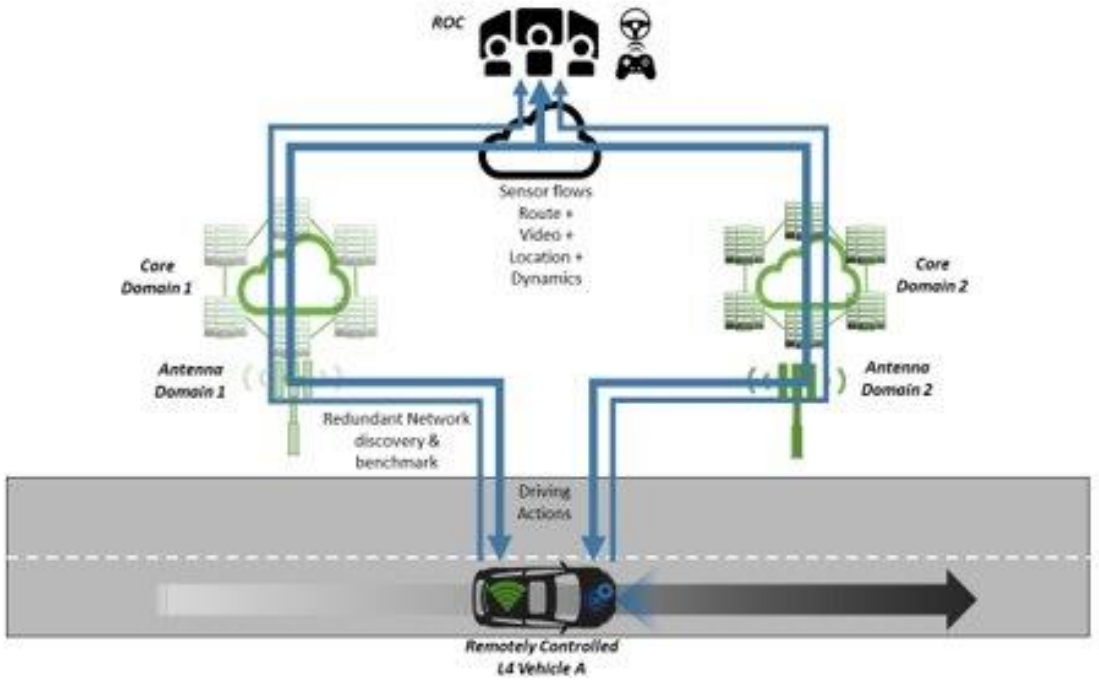
Remote driving user story: Challenges and considered solutions

- **Data exchange between autonomous vehicle and Remote Operations Centre (ROC)**
  - Requires continuous, reliable and high-capacity vehicle-to-network connectivity (V2N)
- **Session and service continuity challenge in 5G networks**
  - Within national borders → limited or discontinuous 5G coverage, coverage holes, handover failures, network congestion
  - At cross-border areas → interruptions during roaming procedures
- **FI-TS evaluates solutions for V2N service continuity in a multi-network (multi-PLMN) environment using multi-SIM onboard unit (OBU)**



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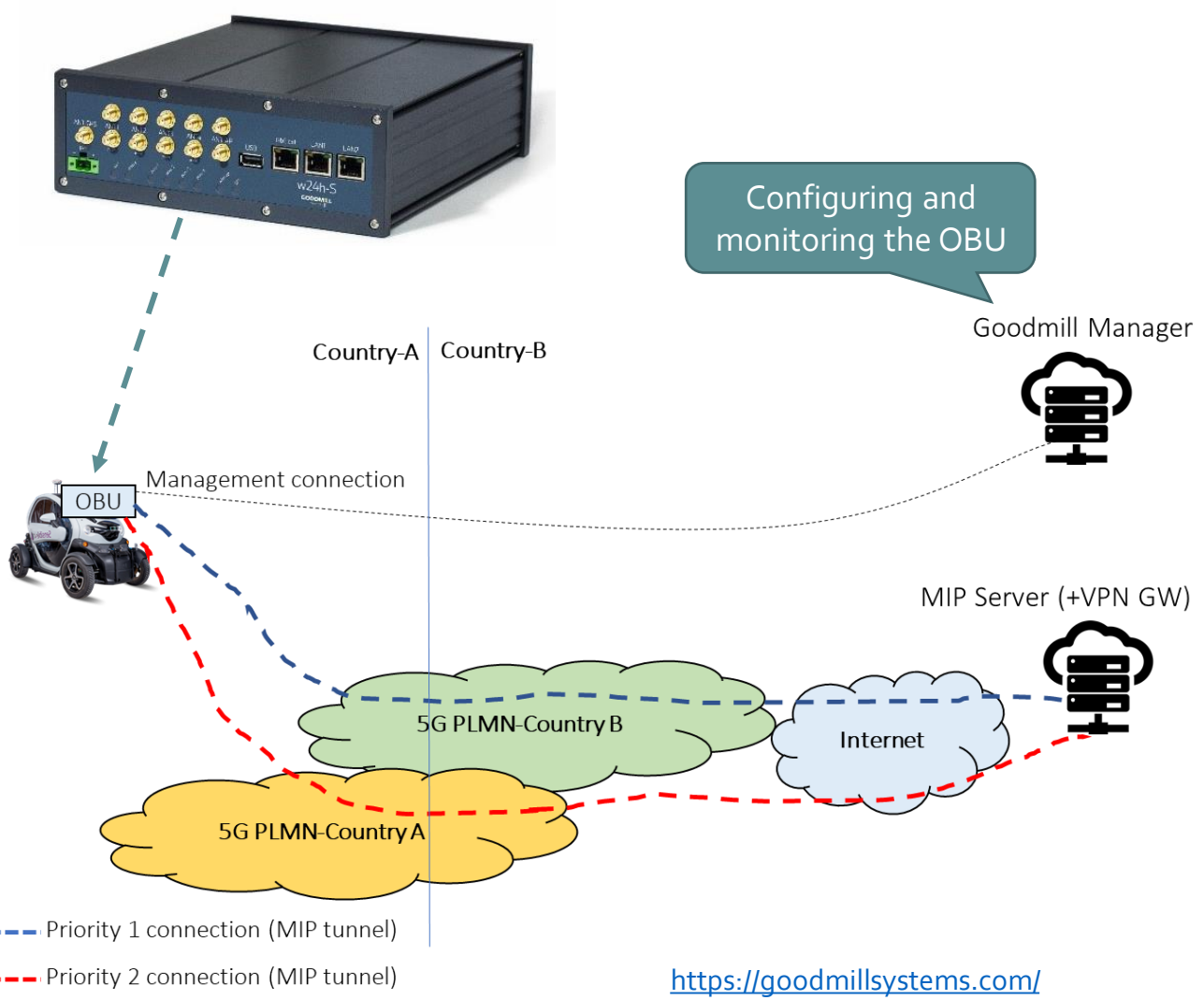
Multi-SIM OBU Solution

FI-TS Multi-SIM OBU Solution (1)

- Solution for service continuity in multi-PLMN environment
  - Vendor: Goodmill Systems
  - Used for critical communications scenarios
- Multi-SIM OBU solution based on Mobile IP tunneling (MIP)
  - MIP GW server terminates MIP and VPN tunnels coming from OBU
  - **Link selection** → OBU continuosly monitors different connections and selects best one
    - Criteria based on signal strength, latency, RAT priority etc.
  - **Link aggregation** → OBU simultaneously utilises multiple connections



https://goodmillsystems.com/

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FI-TS Multi-SIM OBU Solution (2)

- FI-TS implementation has 2 5G modems and 2 SIM slots
- Sierra EM9191 modems
  - NSA (SA upgrade mid 2021)
  - Bands: LTE and 5G sub-6GHz (including n78 band used in FI-TS)
  - Chipset: Qualcomm Snapdragon X55
  - Form factor: M.2 3052
- Up to 4 SIMs could be fit but with smaller form factor modems

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OBU Deployment in Vehicle

SENSIBLE4 "AVA"
SAE L4 vehicle
Road legal
Mixed traffic
Up to 40km/h
Various automated driving features

Rooftop antenna placement (2 antennas per modem/SIM)

OBU deployed in rear, connected to PCs (vehicle, KPI tool etc.)

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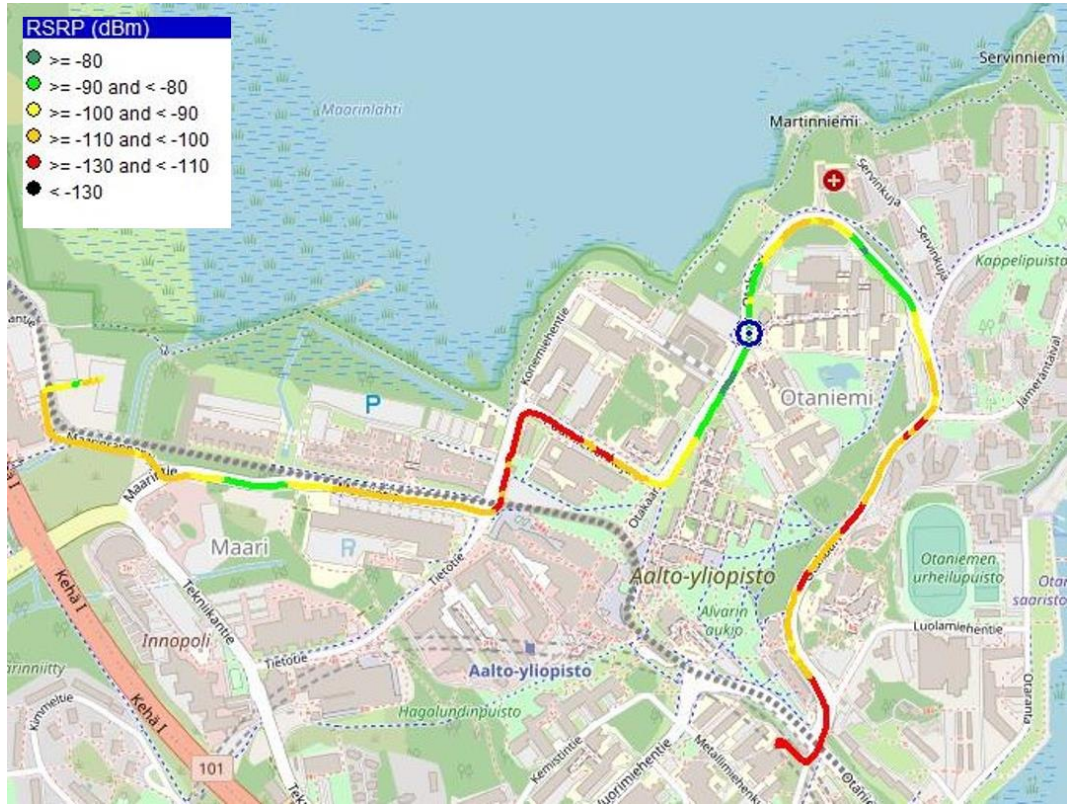
Background on test setup and test cases

Multi-PLMNs used in remote driving trials (1)

- Multi-PLMN environment created with two commercial networks with overlapping coverage in Espoo Otaniemi area

FI-MNO-05

(Commercial 5G NSA, 2.6/3.5 GHz)



FI-MNO-05

(Commercial 5G NSA, 2.6/3.5 GHz)

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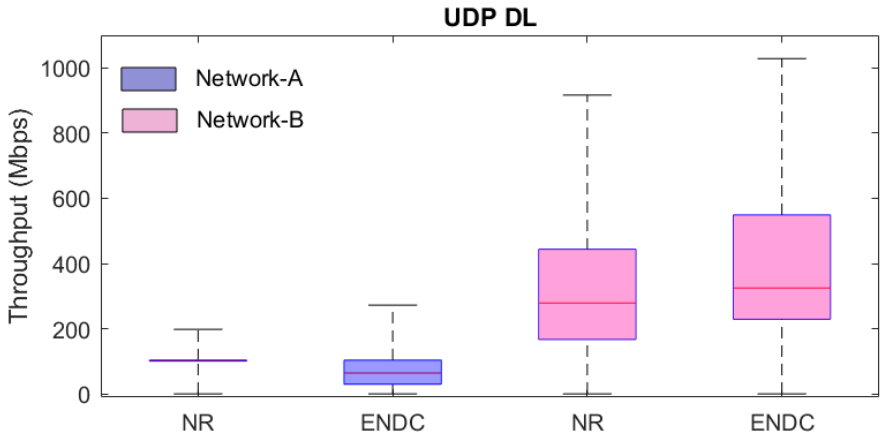
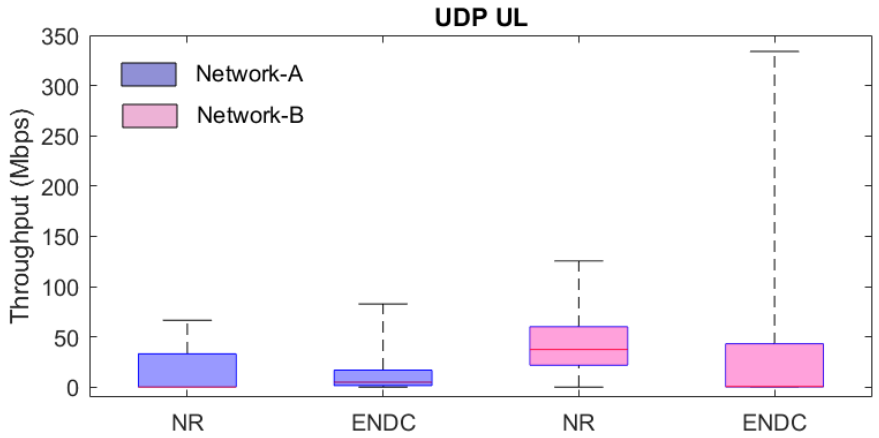
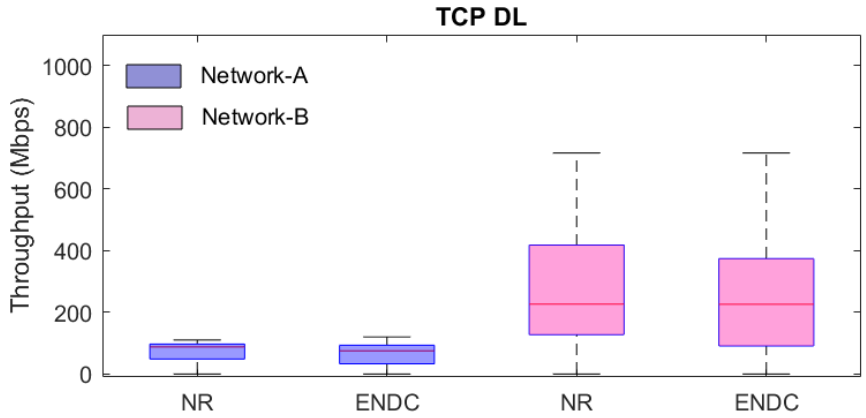
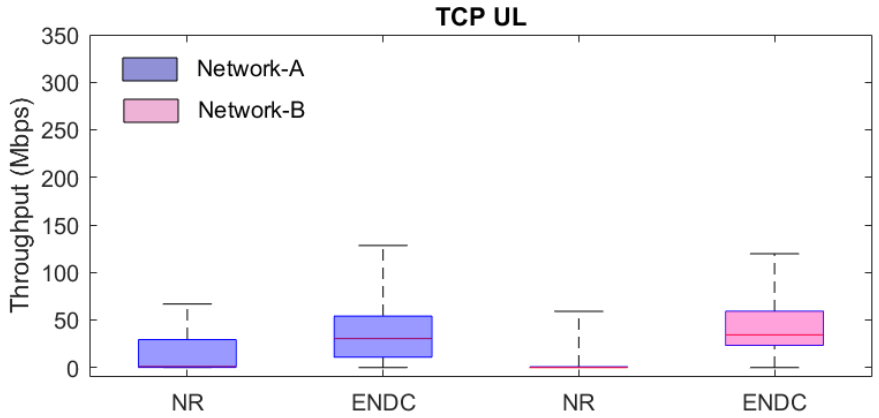
Multi-PLMNs used in remote driving trials (2)

- Additional example result from pre-trial drive tests (agnostic) for the two networks (→ note uplink constraints)









NR: New Radio
ENDC: E-UTRAN New Radio – Dual Connectivity

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Remote driving demo storyboard

Remote driving user story storyboard

Step 1) Vehicle sends status messages and LIDAR stream to ROC using FI-MNO-05 and/or FI-MNO-06 from the beginning of the route.

Step 2) Vehicle faces obstacle and requests assistance from ROC and starts to also send video (live stream and pre-recorded) to ROC

Step 3) Remote human operator at ROC accepts new trajectory and vehicle manoeuvres around obstacle

Remote Operations Centre (ROC)

Fleet control server

Video streaming server

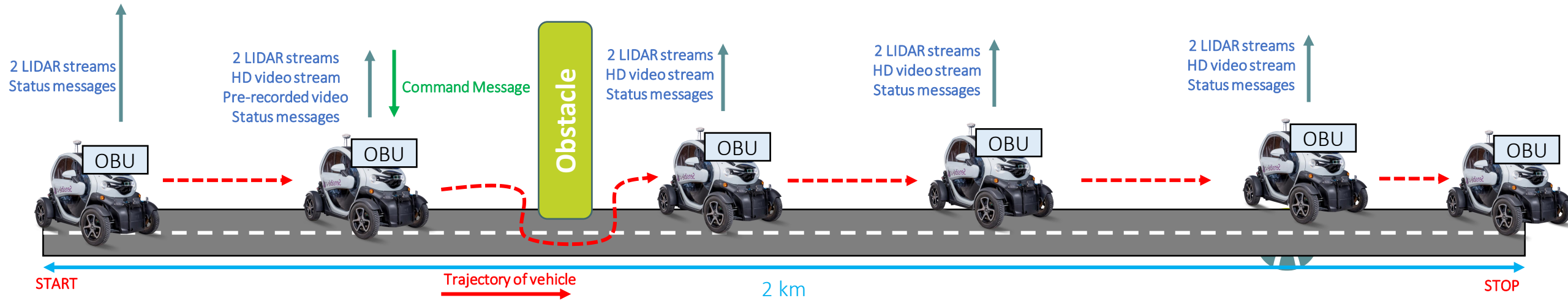
PUBLIC INTERNET

Step 4) vehicle connection to ROC maintained depending on single-SIM or multi-SIM OBU config

Step 5) Vehicle continues sending status message, LIDAR and video stream to ROC and terminates the traffic streams at the end of route

FI-MNO-05

FI-MNO-06



KPIs of interest and measurement tools

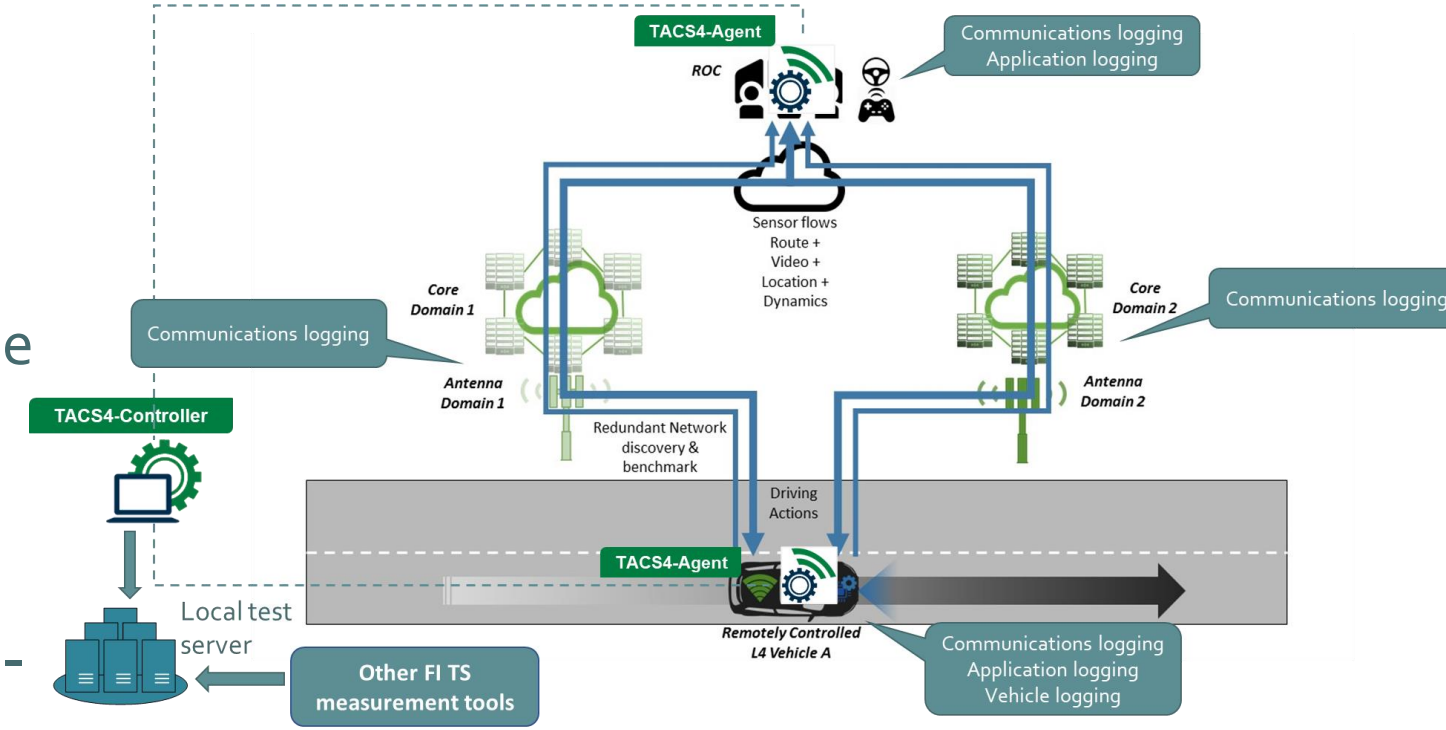
Traffic flows and KPIs

- **Traffic flows analysed**
  - TFT4.2.1-Sensor – LIDAR streams from vehicle to ROC
  - TFT4.2.2-Status – Status messages from vehicle to ROC
  - TFT4.2.3-Video – HD video streams from vehicle to ROC
  - TFT4.2.4-Command – Command messages from ROC to vehicle

- **KPIs of interest for different flows may include:**
  - KPI 1.1 User experienced data rate
  - KPI 1.3 End to end latency
  - KPI 1.6 Reliability (packet loss)
  - KPI 2.3 Mobility interruption time

KPI measurement tools

- DEKRA TACS-4 testing solution
  - Composed of a Controller and as many distributed Agents as needed for the measurements
  - Agents placed anywhere along the path between measurement points
- In-built logging tool in the multi-SIM OBU
  - Logs/KPIs for each modem/SIM
  - Active/inactive, Signal strength, latency, timestamp, RAT used, cell-ID, PLMN-ID etc.



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Conclusions

- This presentation introduced remote driving user story, its connectivity challenges, considered solution and experimental setup

- The next presentation will review the measurement results obtained from the remote driving scenario

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