Innovation Action H2020-ICT-2018

5G-CARMEN - Connected and Automated Road Mobility in the European uNion

Cross-ICT18 Project Webinar

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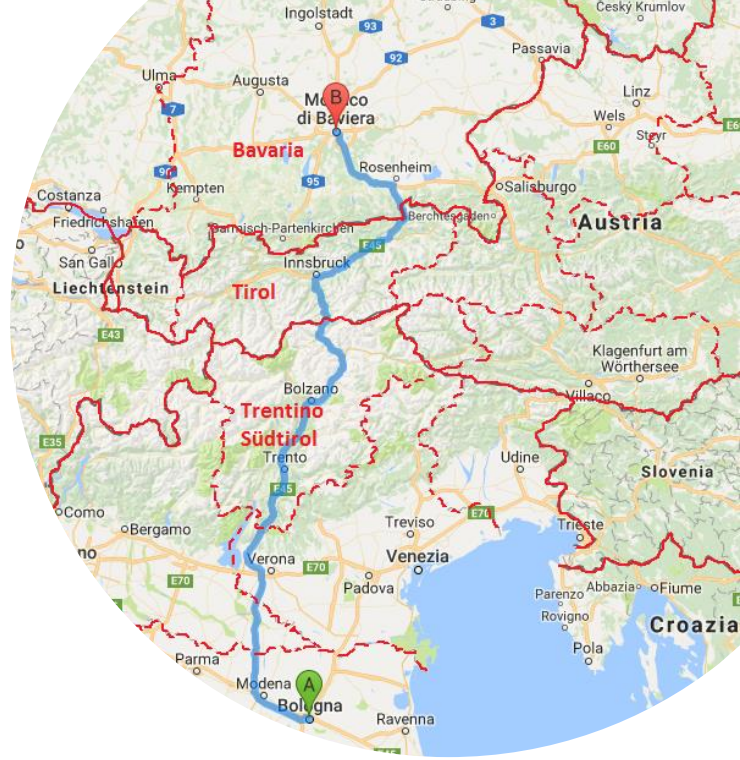
Project Overview
The Bologna-Munich Corridor



- Corridor total length: ~600 km across 3 countries (DE, AT, IT)
- 3 Telcos, 3 Vendors, 2 Automotive OEMs, 2 Road Operator
- 15+ SMEs and Academia
- Single-country trials in 2020, cross-country trials in 2021
- Focus on
  - 5G and MEC as Enablers for CCAM and Automated Driving
  - Federated multi-domain Service Orchestration platform
  - Cellular Network at country border
- Decision to use the Live Network (no 5G Core yet)

5G PPP

eucar
EUROPEAN COUNCIL FOR AUTOMOTIVE R&D

5GAA
Automotive Association

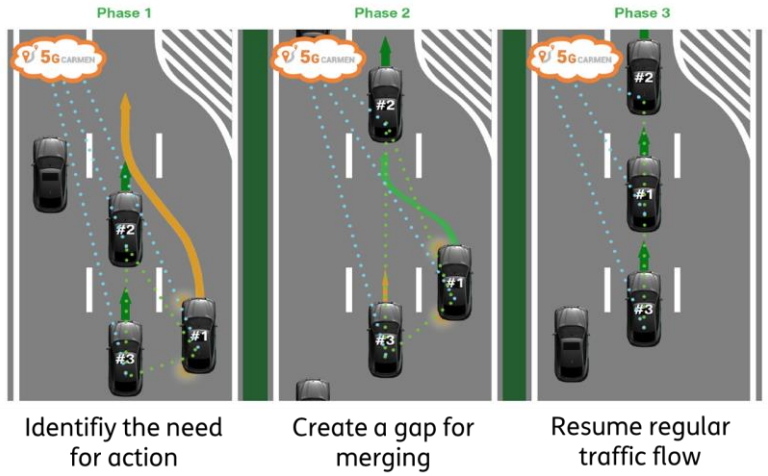
3GPP
A GLOBAL INITIATIVE

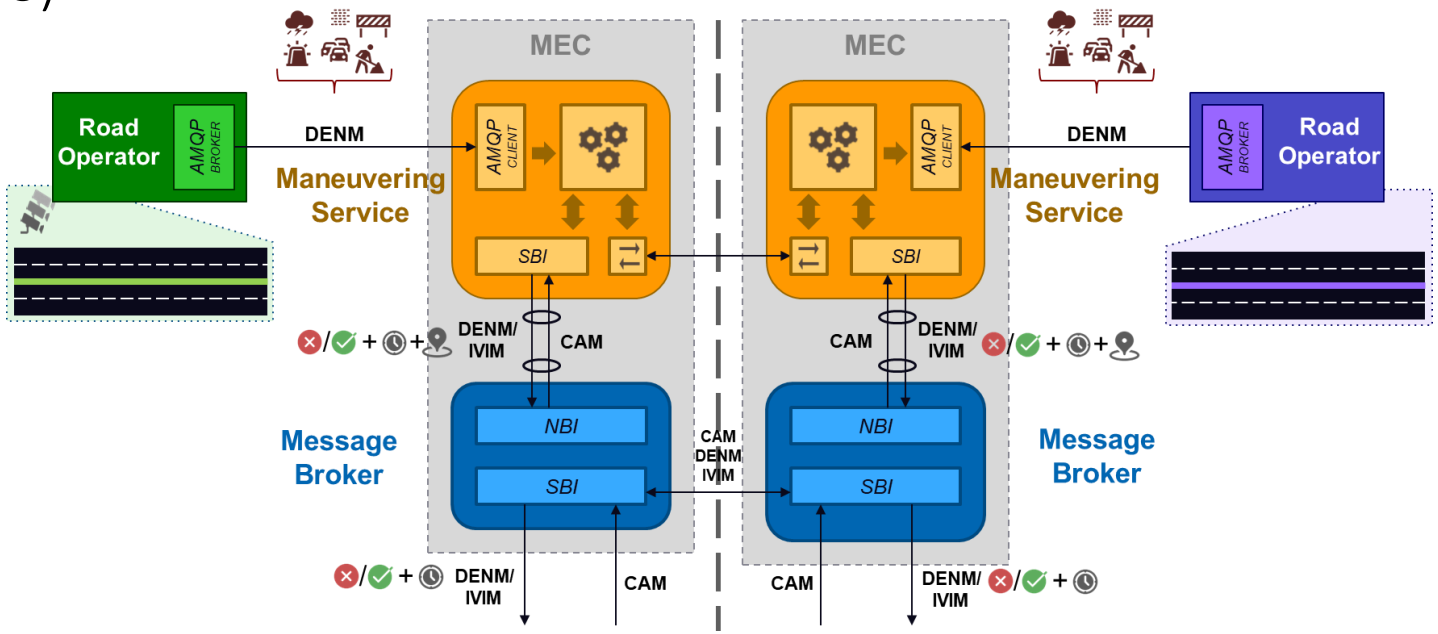
5G CARMEN

Cooperative Maneuvering

V2V (localized) | V2N (MEC-supported)

- Lane Merging operation by exchanging real-time information (IVI, DENM) via
  - **PC5 direct communication** (localized case)
  - Cellular network using **low latency MEC Services** and **cross-border Message Broker** (centralized case)
- Dynamic switching between PC5 and Uu
- AD-Enabler (Precise Positioning, QoS)

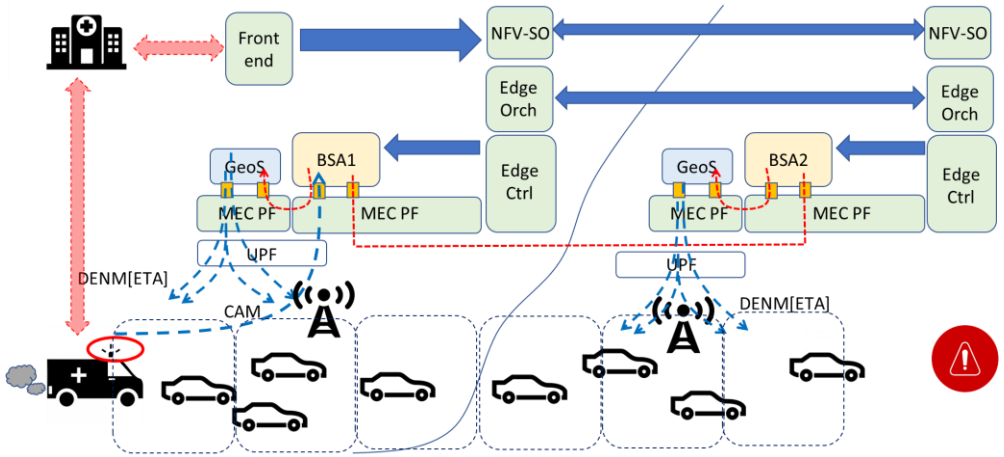


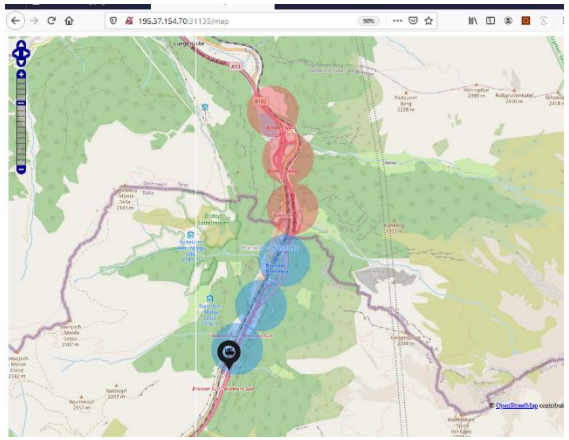


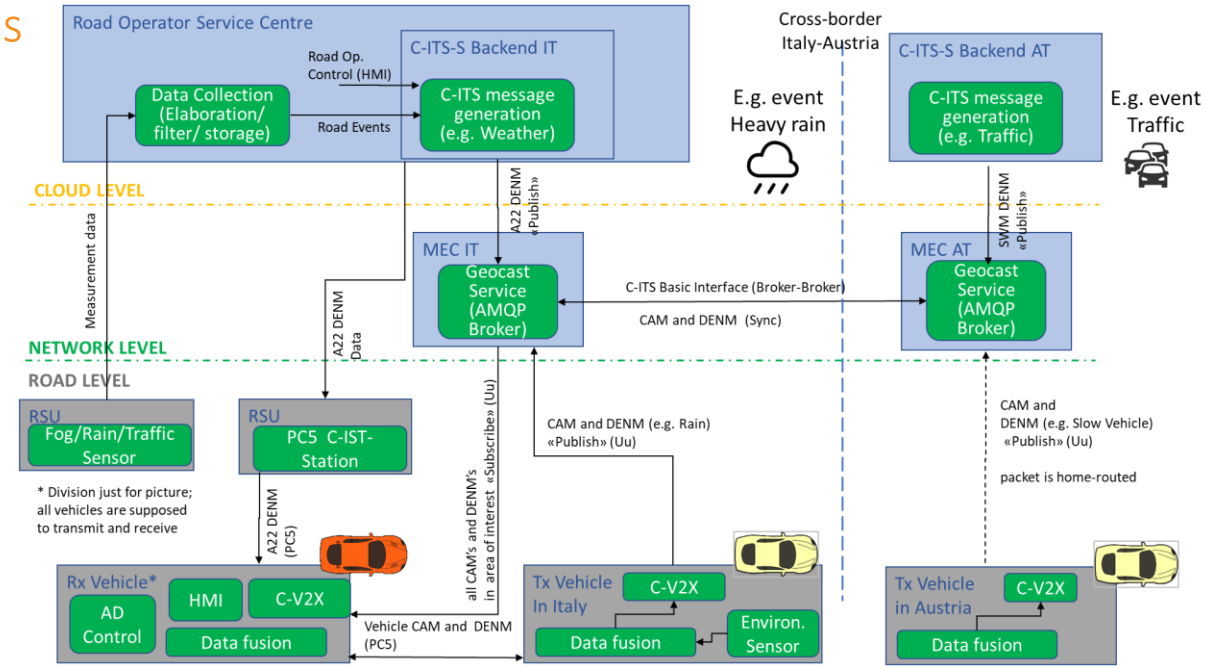
Situation Awareness

Sensors and State Sharing | Back-Situation Awareness

- Communication of safety-relevant information (e.g. hazards, emergency vehicles) via **PC5 and Uu**
- **Cross-border V2X Message dissemination**
- **Federated CCAM platform** for dynamic Service instantiation and orchestration



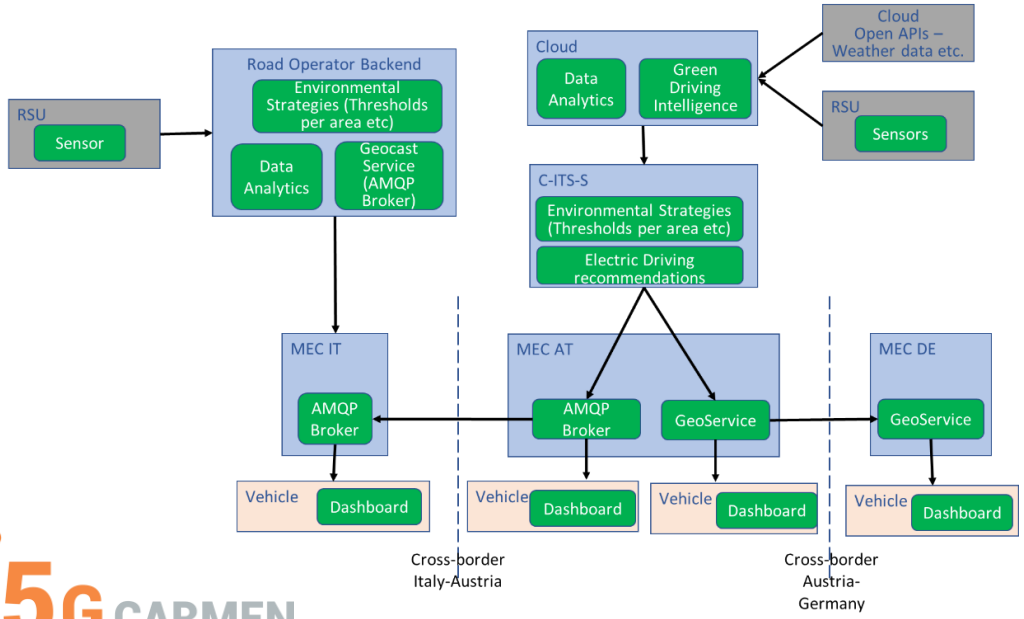


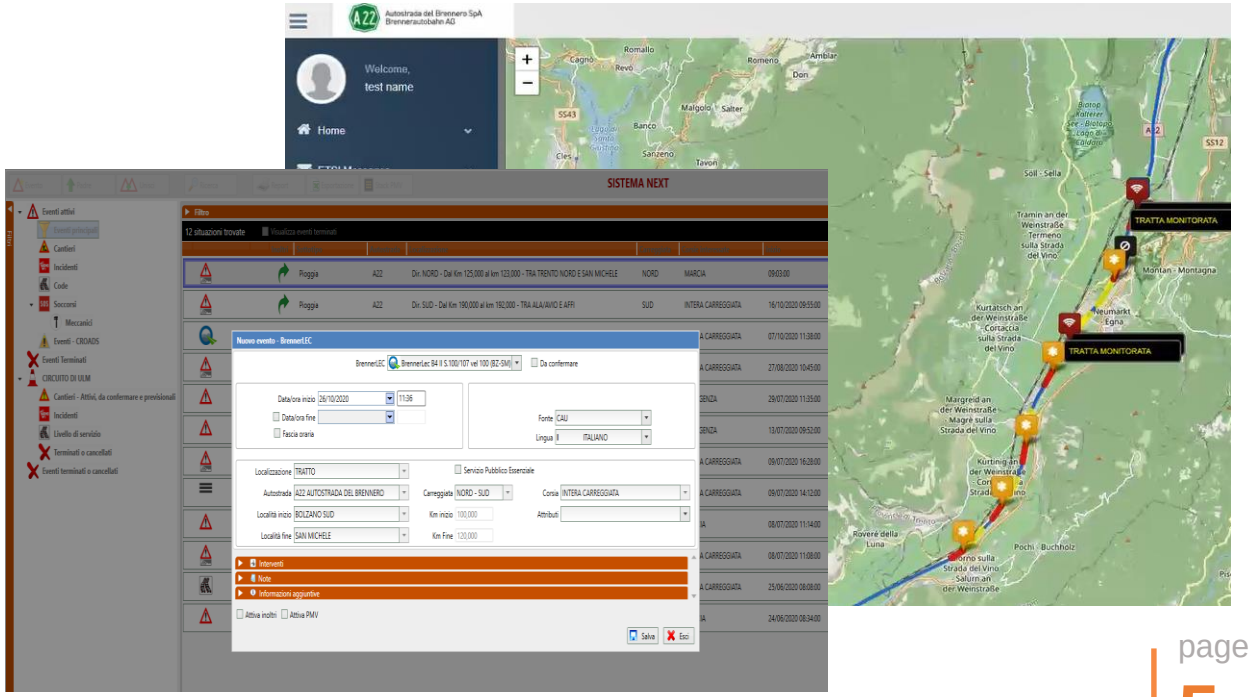


Green Driving

Electric Zones | Speed Advisory

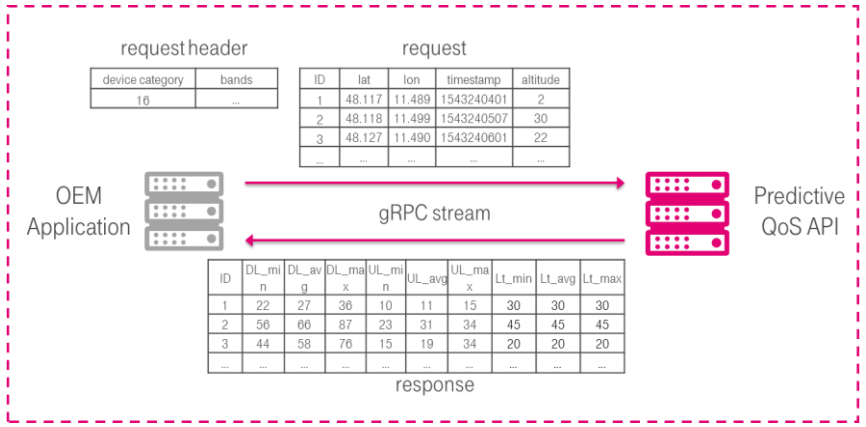
- Analysis of air quality measurements from environmental sensors inside RSUs
- Road Operator Backends apply “Environmental Strategies” and disseminate IVI **messages cross-border** to the vehicles which are close to the respective areas
- Indication of Speed Limits and/or to change to electric mode (hybrid vehicles)
- Automatic adoption by vehicles

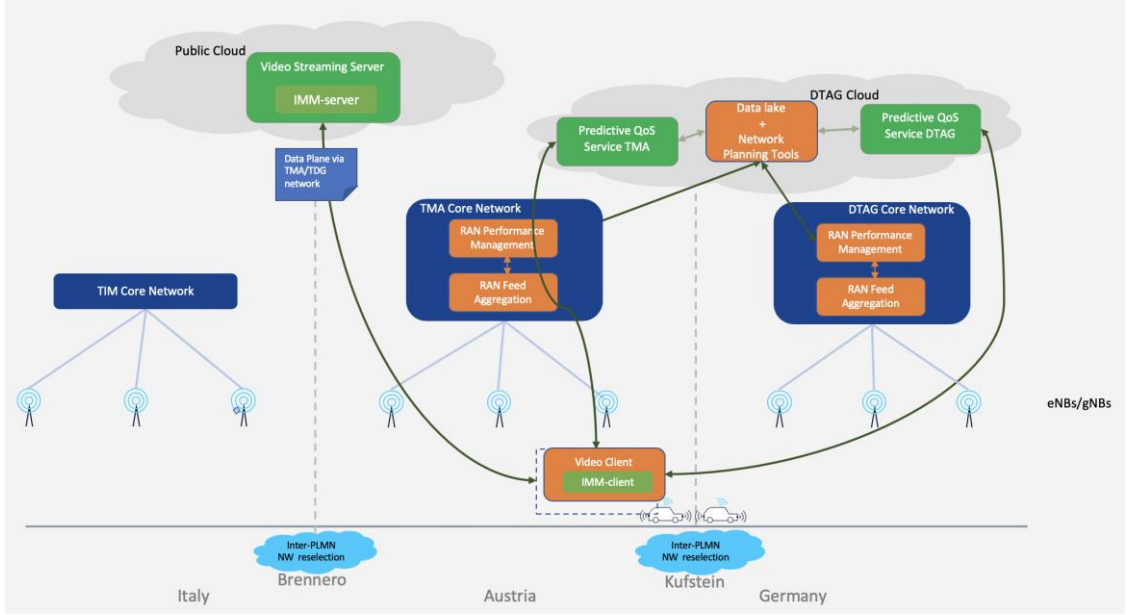




Video Streaming

- Proactive adaptation of Multimedia/Entertainment content to minimize Service interruptions or low data-rate conditions
- Predictive **Quality of Service** (QoS) as network capacity indicator
- **Network Reselection Acceleration** via secure **inter-MNO RAN data exchange**
- **Local Breakout** in Austria

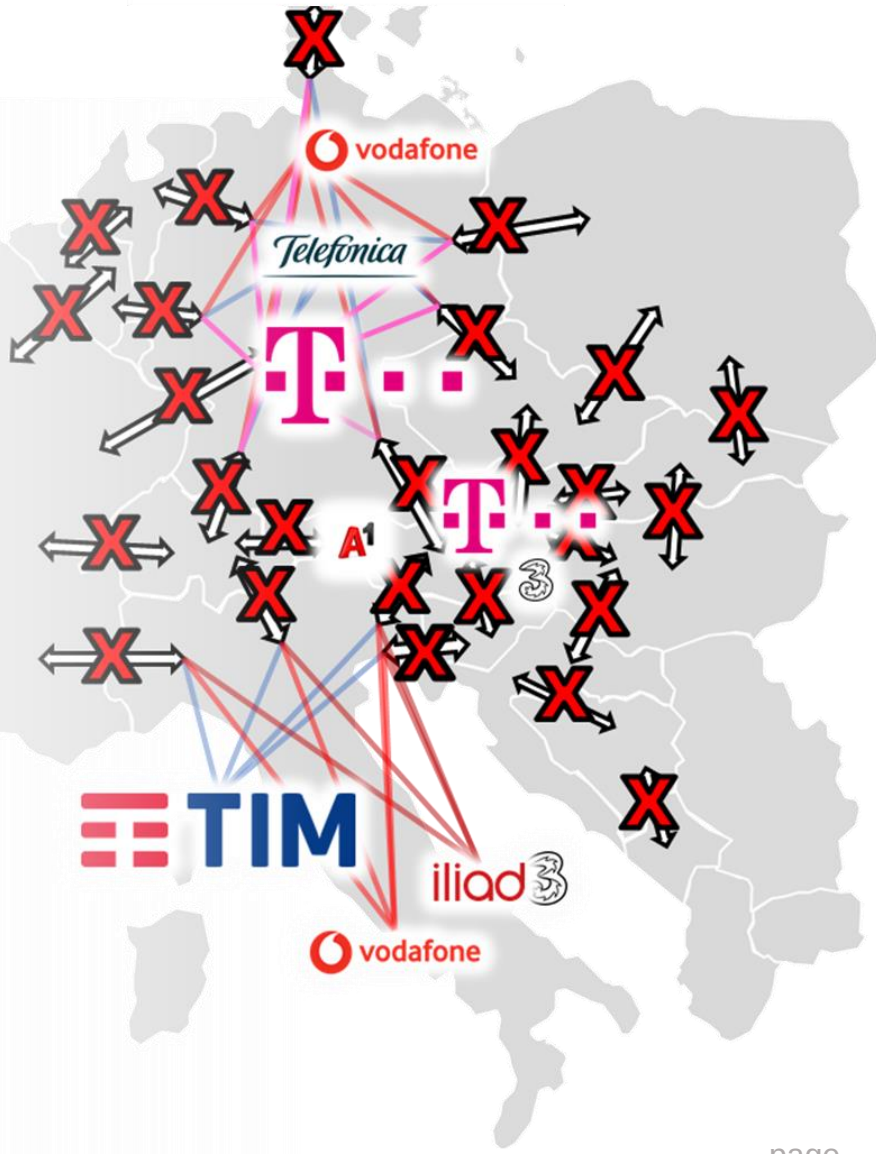




Cellular networks at country borders

Same situation all over Europe

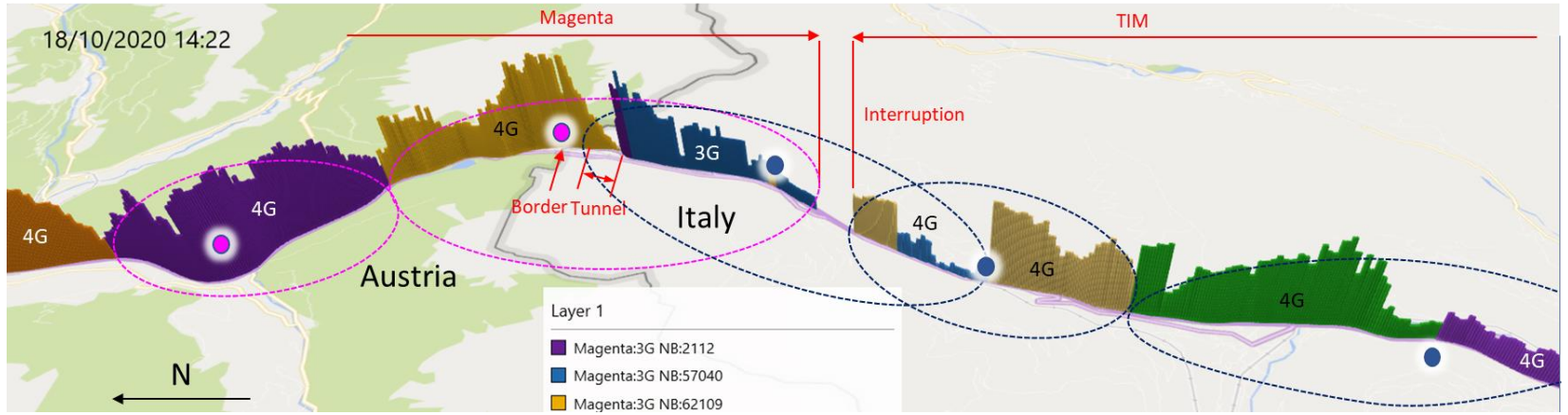
- Not all inter-MNO Core Network interfaces implemented in Live Networks (**EU: >200 MNOs**)
- Cellular coverage and network management is related to **national territory and legislation**
  - Foreign territory is not supposed to be covered with a cellular network from a domestic MNO
  - **National Federal Network Agencies** control and supervise spectrum usage (only nationally)
  - Coverage at borders is handled with suppleness
- Cellular network configuration data is not/scarcely shared with foreign MNOs (**MNOs focus on individual alignments**, e.g. roaming)



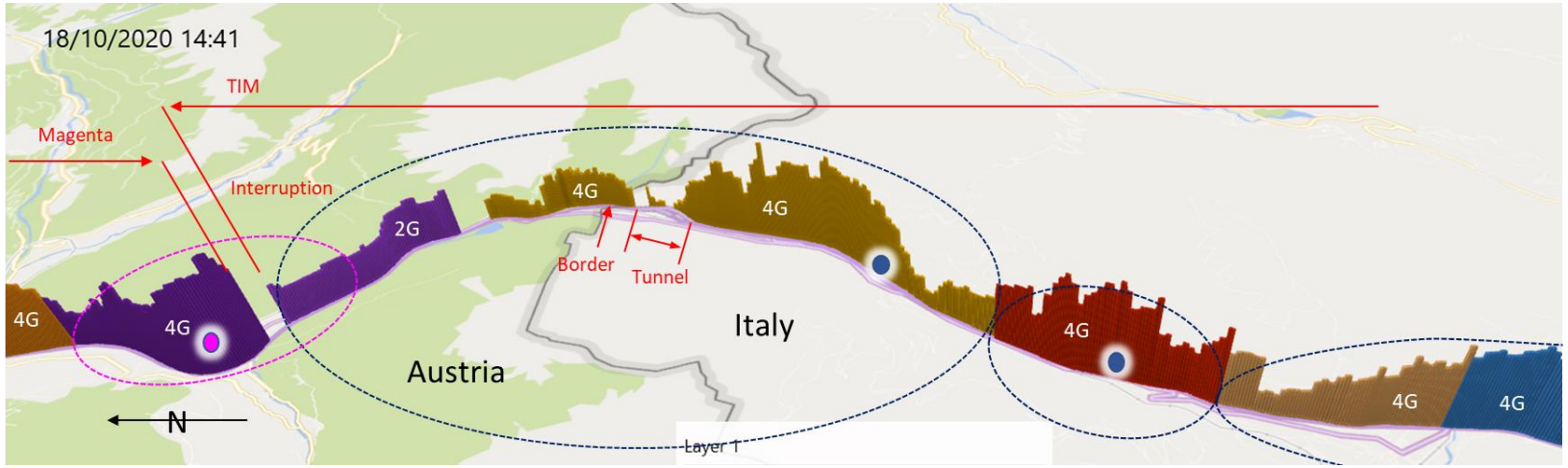
Not all countries shown
Not all MNOs shown

Example: Test Drive Italy <-> Austria

- Austria to Italy (top)
  - Magenta network received 4 km into Italy
  - Interruption of 25 seconds (700m)



- Italy to Austria (bottom)
  - TIM network received 3.7 km into Austria
  - Interruption of 11 seconds (300m)



Displayed bars are received signal strengths from cellular sites
Different colours represent different sites or different technologies (e.g. 3G, 4G)

… approximate site location - Magenta
… approximate site location - TIM
… corresponding coverage of site tower

Cross-border Mobility solutions (1/2)

- Network Reselection (**often inter-RAT**) Acceleration
  - **Exchange RAN data** (used frequencies, cell IDs) of respective border cells
  - Configuration of **Neighbor Relations between foreign cells** and **redirection of UEs to foreign cells**
  - Configuring neighboring **foreign PLMNs as Equivalent PLMN**
- **(European) Inter-MNO radio and spectrum management**
  - Exchange and **align border region radio planning** (avoid interferences, **focus on Mobility**)
  - Adapted, **harmonized European legislation** (and cross-border processes)

Cross-border Mobility solutions (2/2)

- V2X Sidelink (combined with network pQoS)
- **Cross-Border (MEC-based) Message Broker**
  - AMPQ Broker (Quadtree)
  - GeoService (specific Geofences)
- **Federated Orchestration "platform" for 5G-CCAM**
  - Coupling ETSI MEC, NFV, MANO and 5G Systems
  - Ecosystem to include E2E inter-domain Edge Orchestration