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5G-HEART OVERVIEW

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5G PPP Automotive WG

21 September 2020

5G HEALTH AQUACULTURE AND TRANSPORT VALIDATION TRIALS

Outline

- 5G-HEART overview
- Transport use cases
- Transport trial facilities
- Core use case scenarios
- Summary

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- **5G-HEART**: 5G HEalth AquaculturRe and Transport validation trials.
- **Call:** H2020-ICT-2018-3.
- **Topic**: ICT-19-2019 - Advanced 5G validation trials across multiple vertical industries.
- **Period**: 01/06/2019 to 31/05/2022.
  - ✓ A recent 6-month extension (COVID-19).

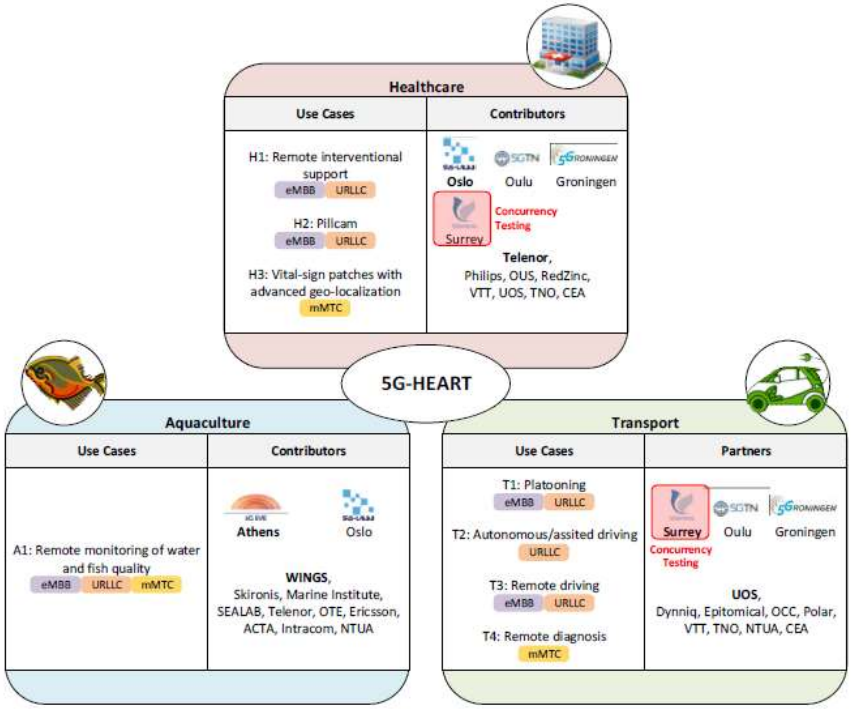

Figure 1 5G-HEART Ecosystem

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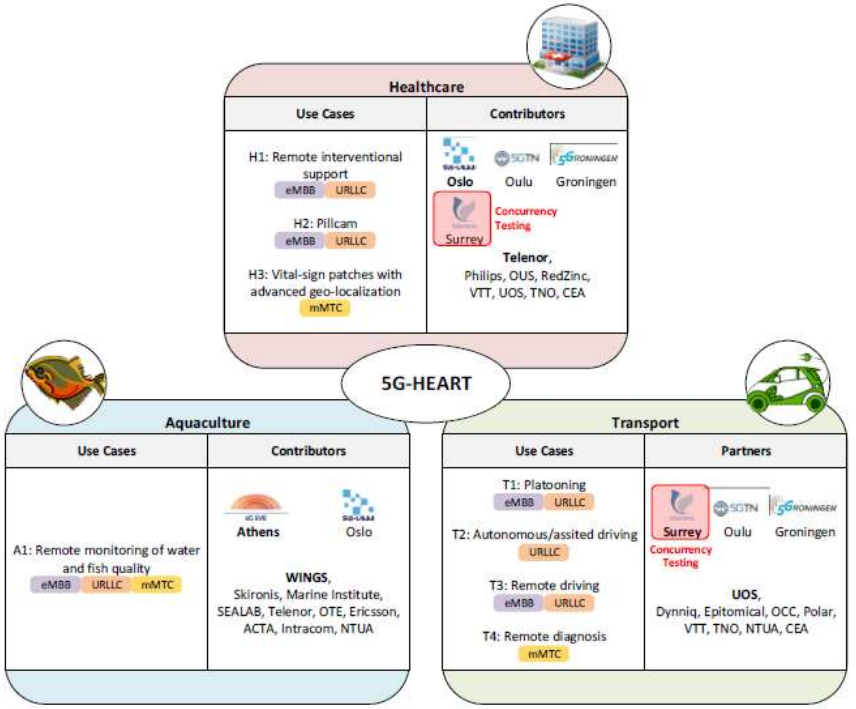

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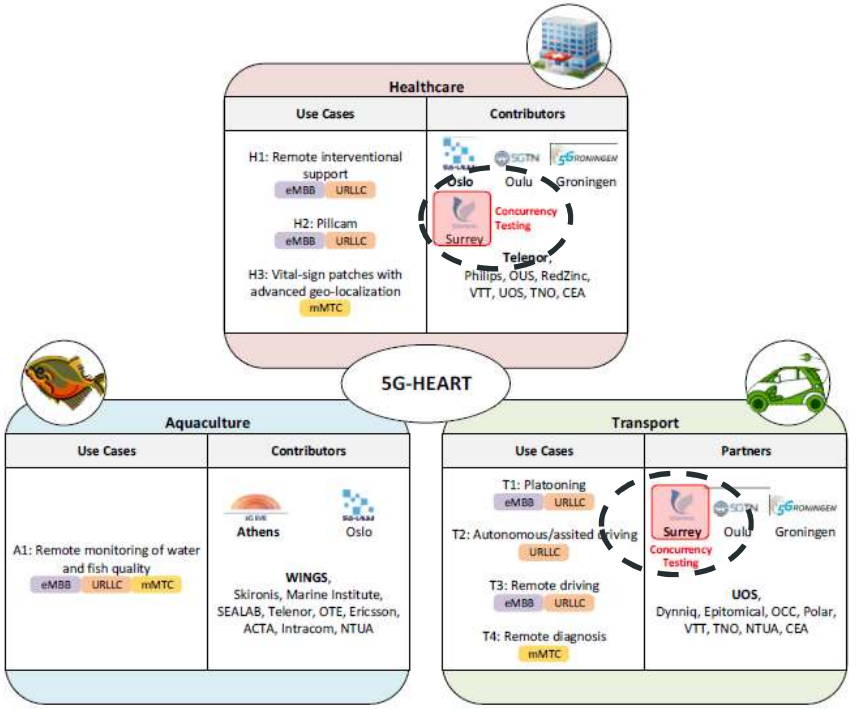

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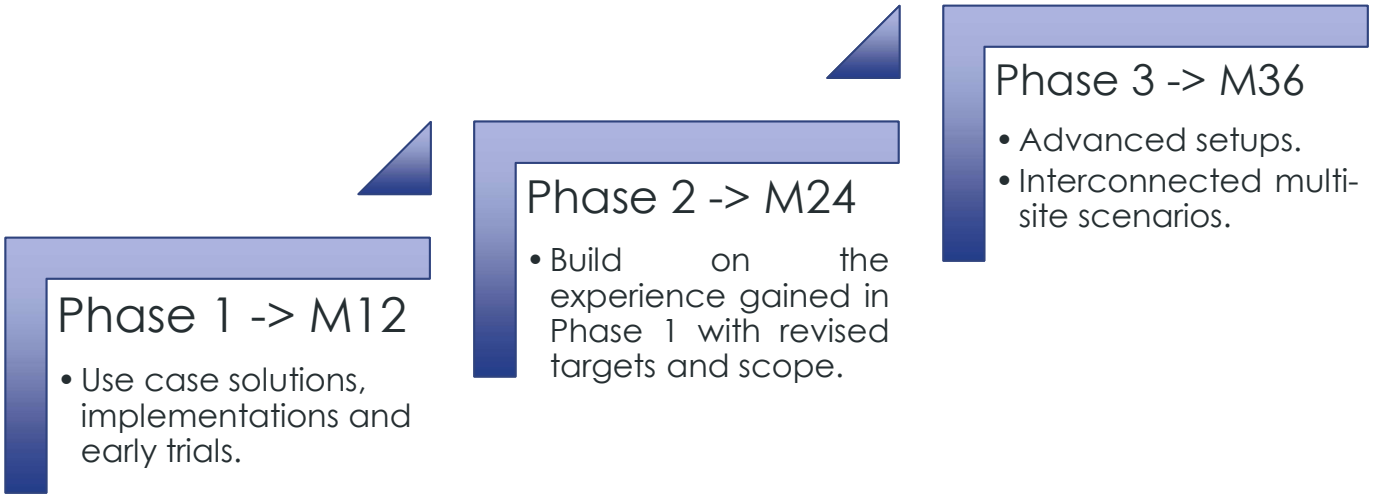
5G-HEART overview, phased trial approach



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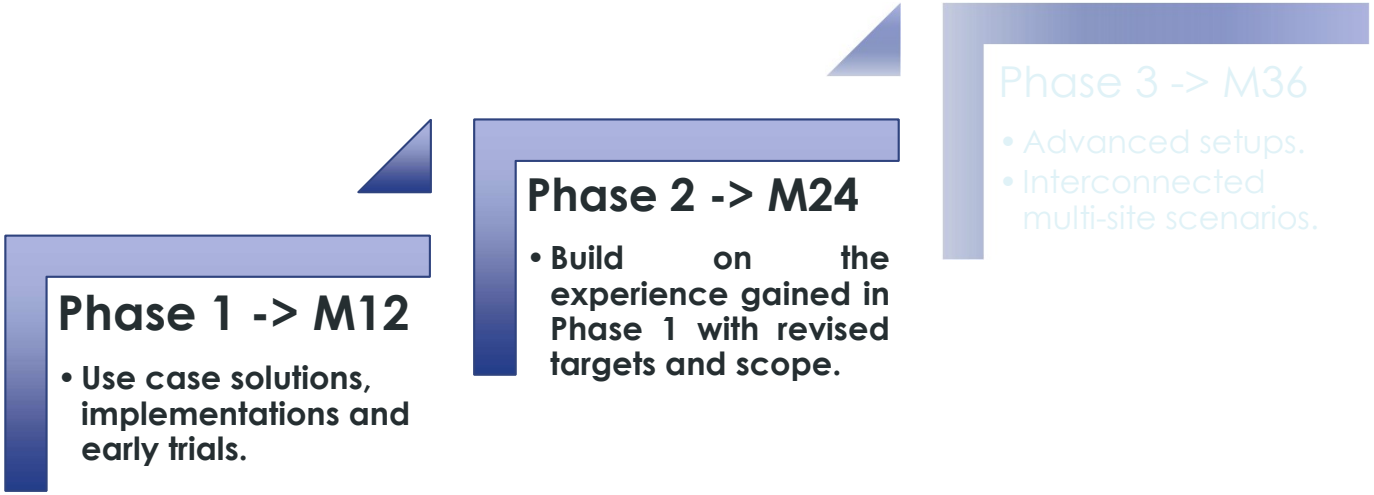

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Transport use cases – T1 platooning

- Vehicles move like a train with virtual strings attached between vehicles.
- Reduces the distance between vehicles, overall fuel consumption and number of needed drivers.
  - ✓T1S1&T1S2: High bandwidth in-vehicle situational awareness and see-through for platooning.
  - ✓T1S3: Dynamic channel management for traffic progression.
  - ✓Location: Surrey
  - ✓**eMBB and URLLC requirements.**

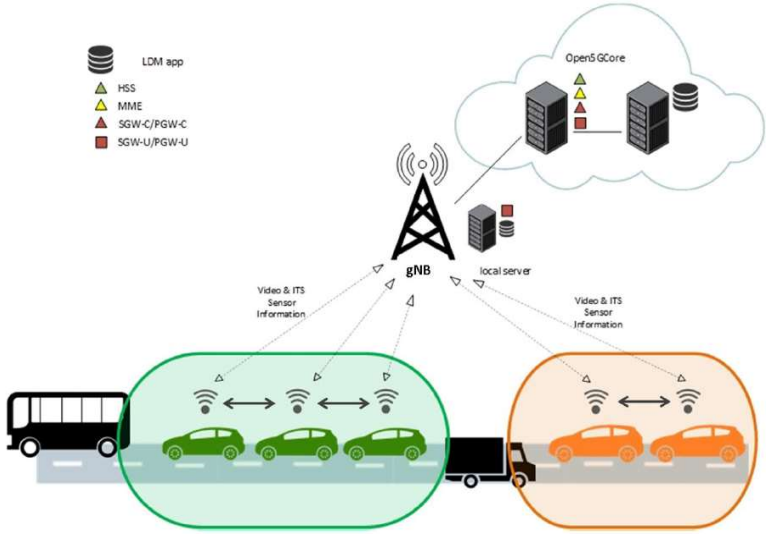

Figure 2 See-through for platooning

Transport use cases – T2 autonomous/assisted driving

- Combine sensor data and communication capabilities to support driving modes.
  - ✓ T2S1&T2S2: Smart junctions and network assisted & cooperative collision avoidance (CoCA)
  - ✓ T2S3: QoS for advanced driving
  - ✓ T2S4: Human tachograph
  - ✓ Locations: Oulu, Groningen and Surrey
  - ✓ **URLLC requirement.**

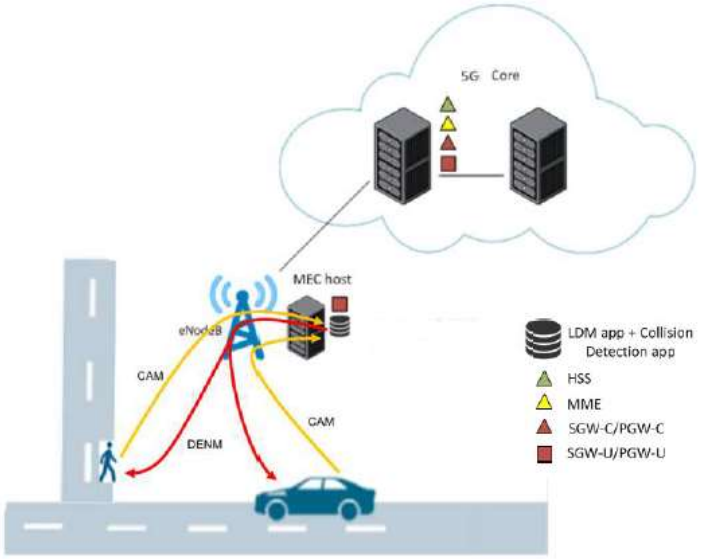

Figure 3 Network-assisted collision warning

Transport use cases – T3 support for remote driving

- Remote driving is a concept in which a vehicle is controlled remotely by either a human operator or cloud computing.
  - ✓ Efficient road construction (control of multiple autonomous vehicles from a single human operator) e.g., snow plowing.
  - ✓ Cost-feasible step towards purely automated driving.
  - ✓ Location: Surrey
  - ✓ **eMBB and URLLC requirements.**

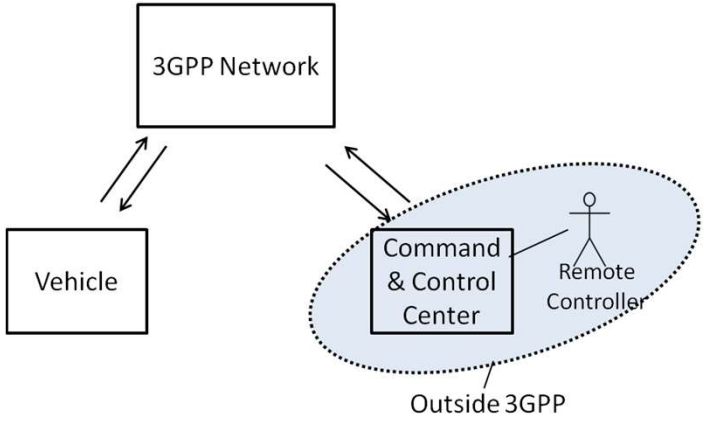

Figure 4 Remote Driving

Transport use cases – T4 vehicle data services

- The network collects actionable information from the relevant entities (e.g., vehicles and road users) to provide various services.
  - ✓ T4S1: Vehicle prognostics.
  - ✓ T4S2: Over-The-Air (OTA) updates
  - ✓ T4S3: Smart traffic corridors
  - ✓ T4S4: Location based advertising
  - ✓ T4S5: End-to-End (E2E) slicing
  - ✓ T4S6: Vehicle sourced HD mapping
  - ✓ T4S7: Environmental services
  - ✓ Locations: Surrey and Oulu
  - ✓ **mMTC requirement**.

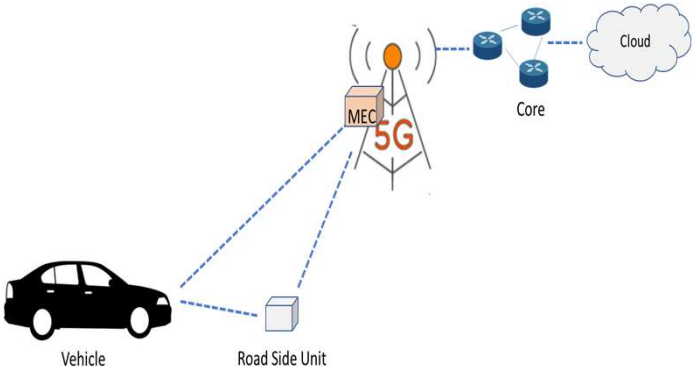

Figure 5 Indicative architecture for vehicle data services

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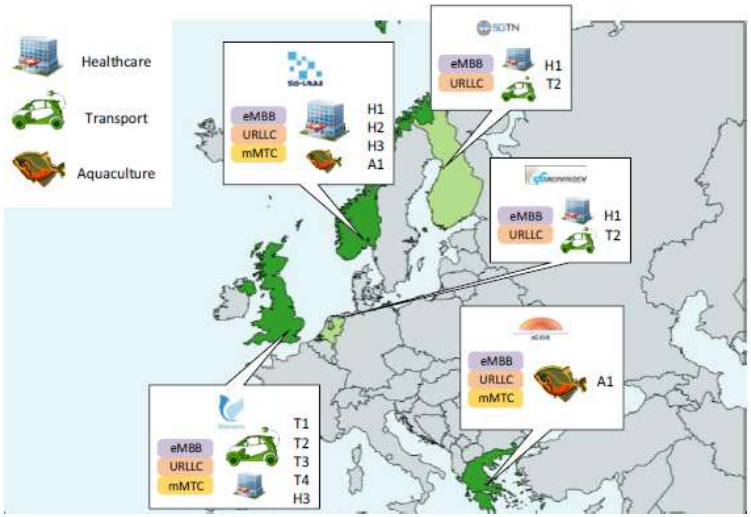
Transport trial facilities

- The main Transport trial facility is ICT-17 5GENESIS (Surrey, UK).
  - ✓ Employs the best of evolving NFV and SDN implementations and features.
  - ✓ Testbed covers the main campus of the University of Surrey (area of around 4 km^2).



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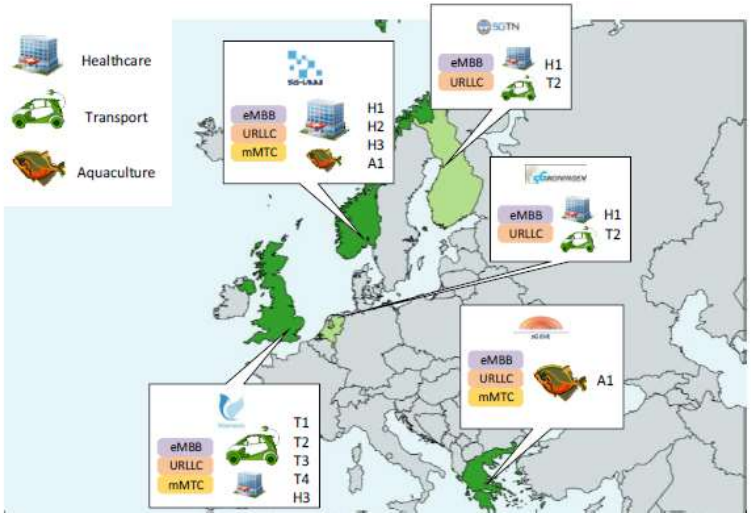
- Supporting trial facilities
  - ✓ 5GTN in Oulu, Finland.
  - ✓ 5Groningen in the Netherlands.



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- Trials will start with local tests and evolve towards interconnected multi-site scenarios.

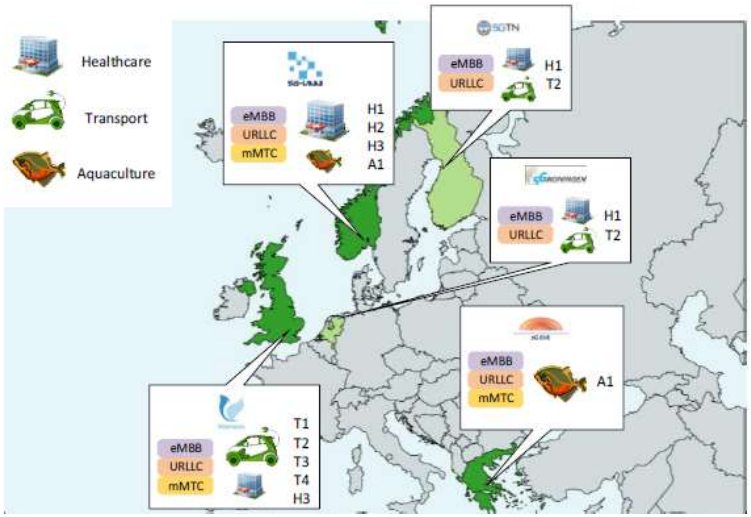

Figure 6 Transport trial facilities

Transport trial facilities, research vehicles

- Provided by Technical University Chemnitz (TUC)
  - ✓ Multitude of sensors to understand the situation inside and outside the car.
  - ✓ Remote collaboration for by-design integrability of our components into the vehicles.
  - ✓ Transport workshop at TUC premises scheduled 10/2020.

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Figure 6. TUC CARAI 3 research vehicle

Model: BMW i3 – Electric Vehicle

SAE automation level: Level 4

Autonomous Features: Remote Driving

Sensors Installed:

- GPS
- Camera
- V2X (ITS G5, 5G based V2X UE will be installed during the course of the project with help of UOS)
- Ability to access CAN data
- Ability to control actuators
- Inertial measurement unit (IMU)
- Human-machine interface (HMI) Screen

Figure 7. TUC CARAI 1 research vehicle

Model: VW Touran

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- Synergies with other projects with car manufacturers on-board
  - ✓ Through the 5G PPP Automotive working group (WG)

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T2S1&T2S2: smart junctions and network assisted & cooperative collision avoidance (CoCa)

- Trial track
  - ✓ Provide time-critical safety information at intersections/junctions.
  - ✓ Improve the overall traffic flow in various situations e.g., create a green light wave or give priority to certain types of vehicles.

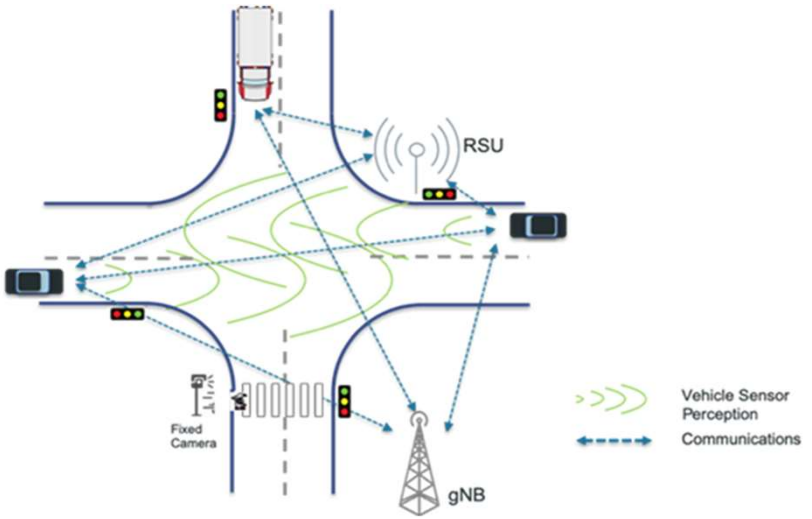

Figure 7 Generic example of T2S1&T2S2

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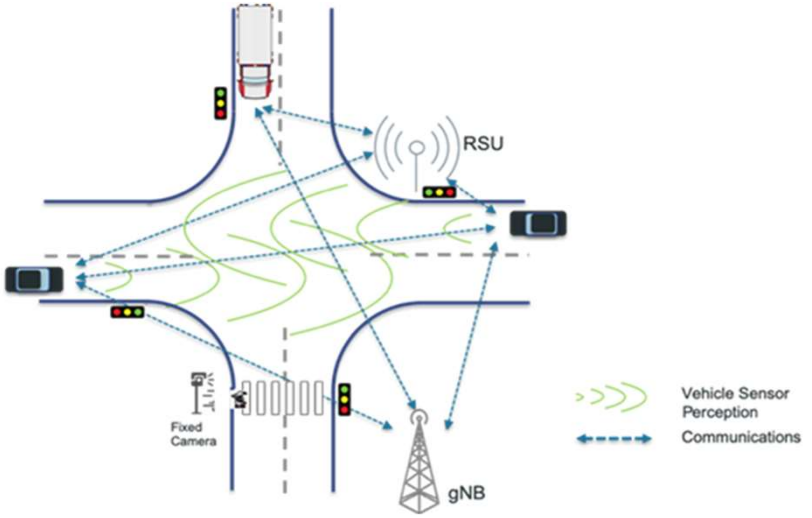
- Simulation track
  - ✓ Impact of V2X connectivity on cooperative collision avoidance system based on occupation maps.
  - Assessment of the scalability of V2X connectivity solutions to complement the trials.



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T2S4: Human tachograph

- Wearables-based human tachograph
  - ✓ Provides direct measurement and assessment of the driver's physiological status.
  - ✓ Monitor the current state of the driver and potential risks from history data (e.g., sleep deprivation and high stress) for proactive measures to improve safety.

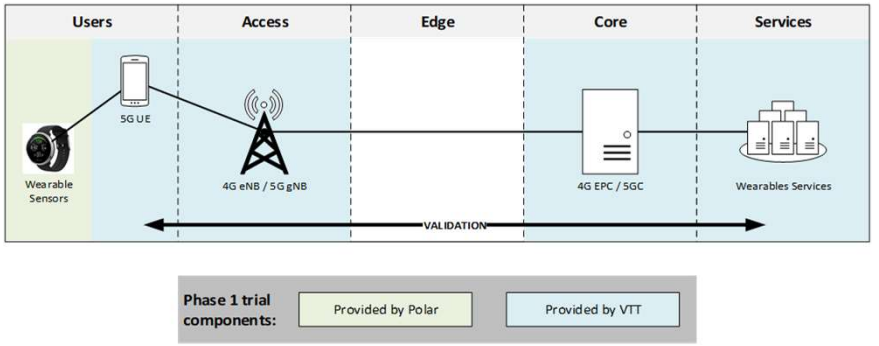

Figure 8 Network architecture for T2S4

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- Initial results
  - ✓ Baseline 4G and initial 5G measurements.
  - ✓ Throughput DL/UL.
  - ✓ End-to-end latency DL/UL.
  - ✓ Reliability.

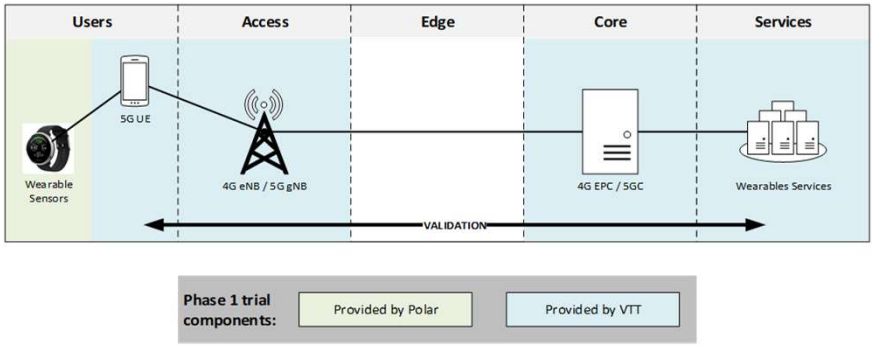

Figure 8 Network architecture for T2S4

T3S1: Tele-operated support (TeSo)

- Use case scenario
  - ✓ Vehicle traveling, bearing HD video cameras and sensors providing instrumentation data.
  - ✓ A remote human operator monitors the vehicle and perform maneuvers.

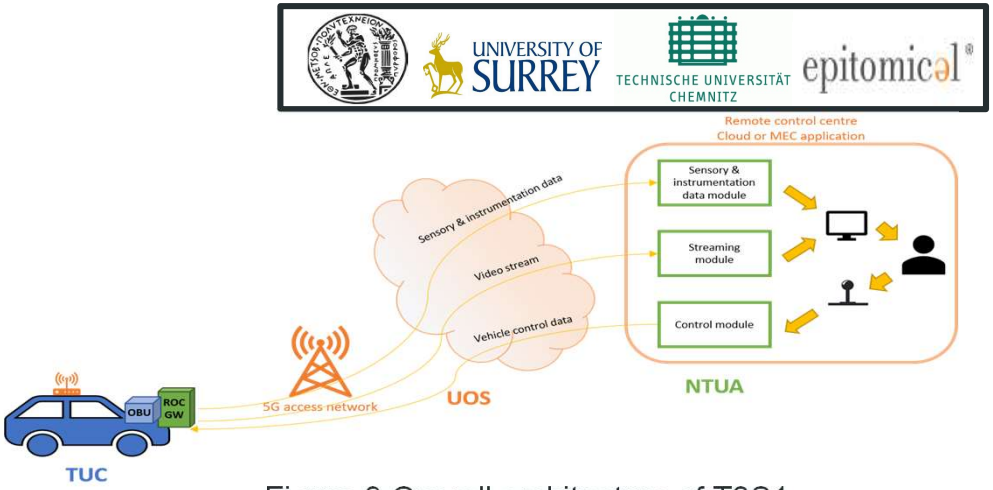

Figure 9 Overall architecture of T3S1

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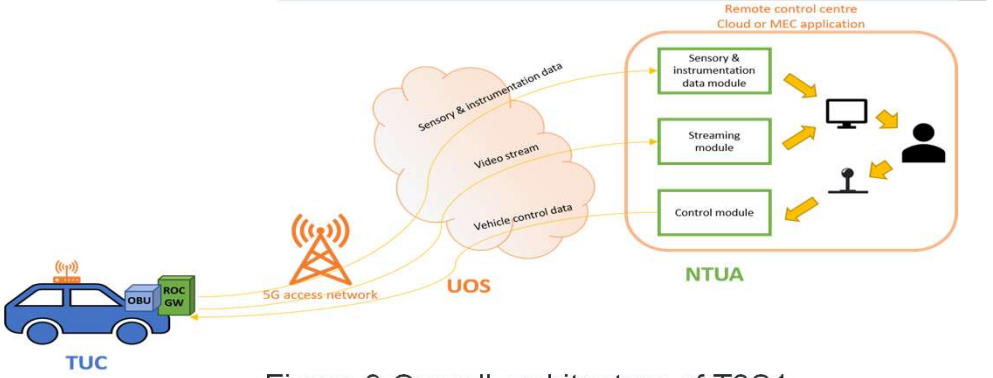


Figure 9 Overall architecture of T3S1

- Hardware components
  - ✓ TUC research vehicles' OBU
  - ✓ ROC gateway
  - ✓ Commercial nodes (5GIC)
  - ✓ Experimental (USRPs)
- Software components
  - ✓ ROC application (i.e., streaming, sensor and remote control)
  - ✓ Vehicle side (i.e., camera, sensor/instrumentation and control)

T4S5: End-to-end (E2E) slicing

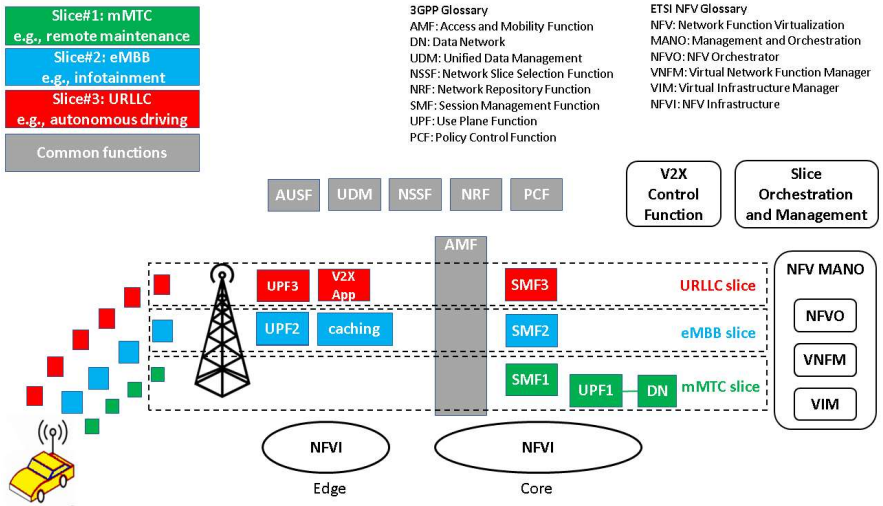
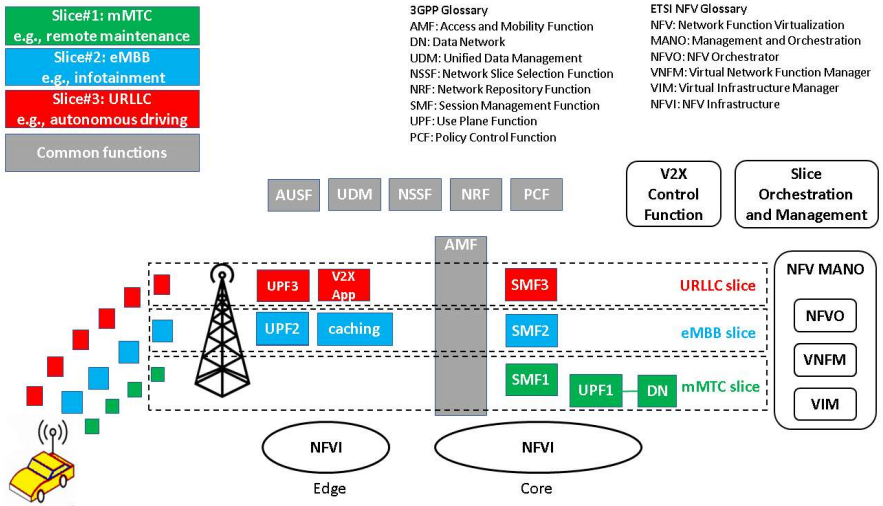


Figure 10 Illustrative architecture for E2E slicing

T4S5: End-to-end (E2E) slicing



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- Interaction with 5GENESIS
  - ✓ User friendly portal
  - ✓ Open API

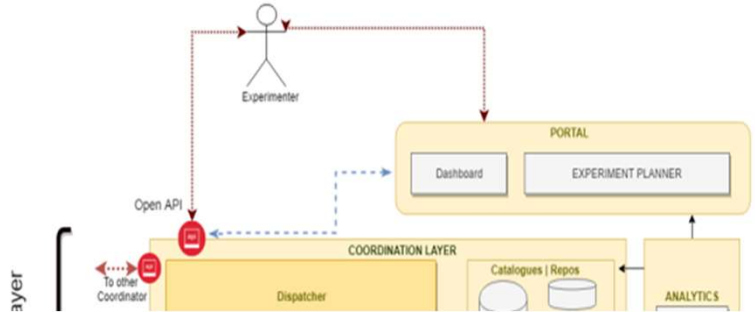

Figure 12 Extract of the 5GENESIS blueprint [1]

[1]5GENESIS, Deliverable D2.2 "Initial overall facility design and specifications" [Online], https://5genesis.eu/wp-content/uploads/2019/12/5GENESIS_D2.2_v1.0.pdf

T4S6: Vehicle sourced HD mapping

- Use case scenario
  - ✓ Autonomous vehicles rely on HD maps.
  - ✓ Crowdsource data through on-board cameras and sensors.
  - ✓ Establish baseline maps and manage subsequent changes.

Figure 13 Indicative architecture for T4S6.

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Figure 13 Indicative architecture for T4S6.

- Hardware components
  - ✓ OBU
  - ✓ HD Camera
  - ✓ GPS
  - ✓ 4G/5G Frontend
  - ✓ Server

- Software components
  - ✓ Client App
  - ✓ Cloud Analytics App
  - ✓ Network Middleware
  - ✓ USB Driver

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  - ✓ Various tests and experiments have been conducted.
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- Ultimate objective is concurrent testing through cross-vertical trials.

THANK YOU
FOR YOUR ATTENTION

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