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BENEFITS AND EXPERIENCES OF ‘ADDING’ 5G TO A SMART JUNCTION

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5G HEALTH AQUACULTURE AND TRANSPORT VALIDATION TRIALS

Outline

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1.

Smart Junctions use case

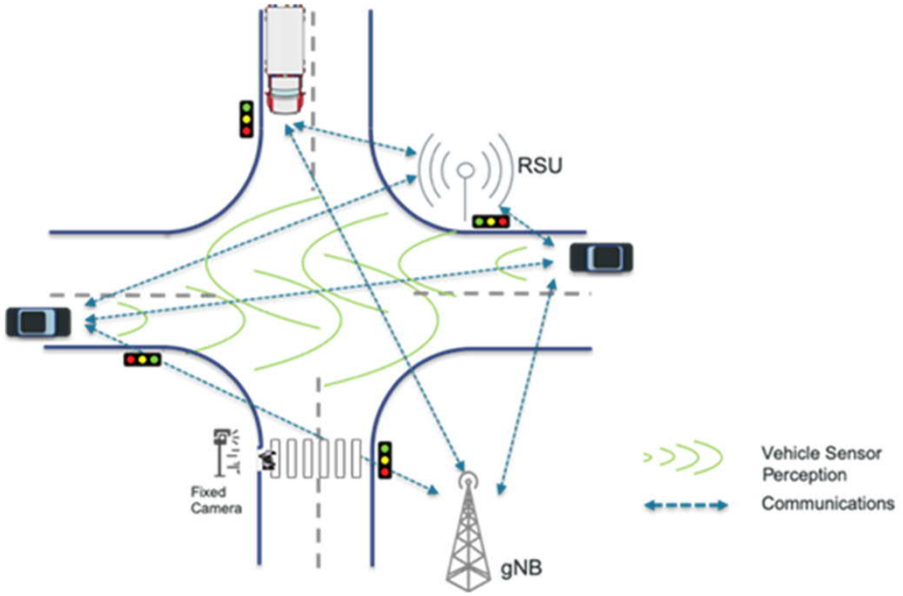
Description

Situation: A high percentage of all traffic accidents occur at intersections

Intersections contain high density of vehicles and vulnerable road users (e.g. cyclists and pedestrians).

Goal: provide network assisted safety information to road users and vehicles

- Preventing traffic accidents
- Assisting Cooperative automated driving



Motivation

Transport vertical: Smart Junctions

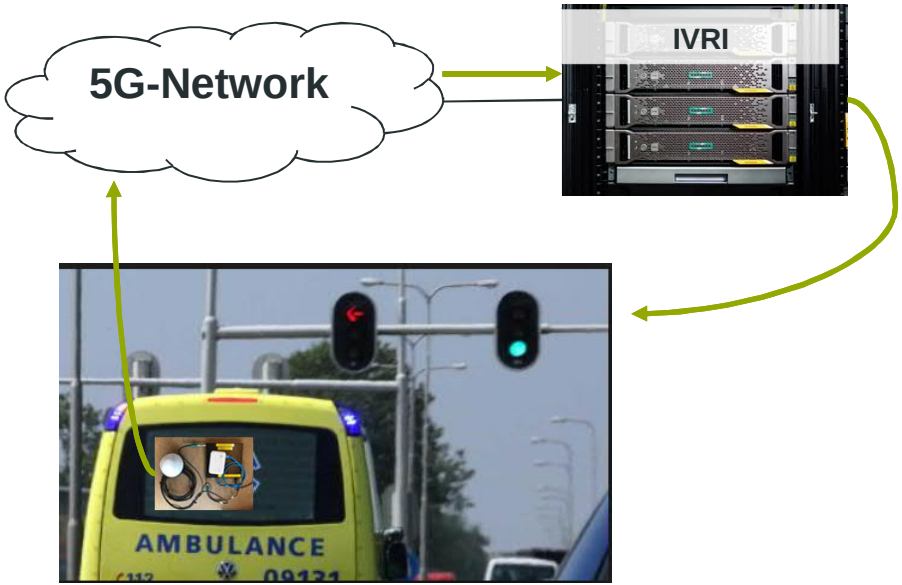
Goal: Real-time traffic prioritisation and traffic awareness for ambulance

State of the art: Traffic pioritisation using ITS-G5 and LTE communication

Enhancement: Test capability of 5G NR and Cellular-V2X for better use case support

Requirements: High data rate (downlink), low latency and high reliability, high mobility, guaranteed coverage

Key 5G enabler: eMBB (downlink), URLLC



Combining Transport & Healthcare verticals

Healthcare vertical: Paramedic support

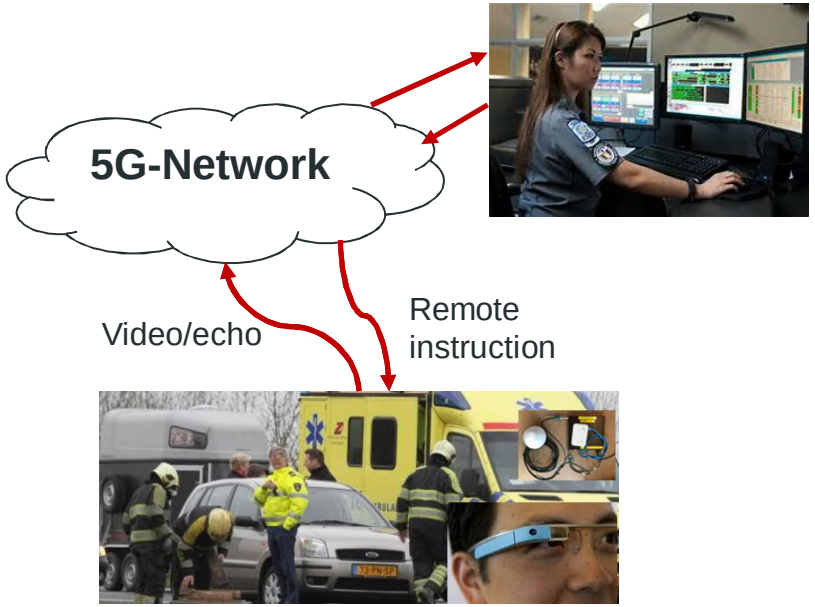
Goal: Remote real-time video delivery for effective situational assessment

State of the art: hospital involvement only via telephone with ambulance personnel at the scene

Enhancement: adding high-quality audio-video link with moving ambulance.

Requirements: high data rate (uplink), low latency and high reliability, high mobility, guaranteed coverage

Key 5G enabler: eMBB (uplink), URLLC



Challenges

Supporting the Smart Junctions use case already poses challenges to the network.

Final goal: supporting to combined trial with the Transport use case ”Smart Junctions” and the Healthcare use case “Paramedic support”.

Supporting simultaneously both time critical use cases, which both need

- high bandwith (eMBB) and
- low latency (URLLC),

on the same 5G network , poses an even bigger challenge.

Especially considering that these will most certainly not be the only services on the network.

2. 5GRONINGEN Trial site

Overview

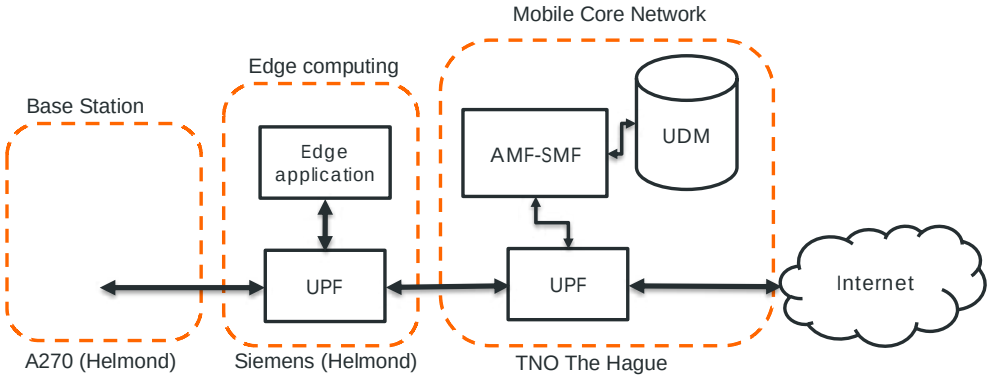
Hi5 is TNO's own 5G mobile network, offering

- Development and implementation of novel 5G concepts (within the core network and the radio interface).
- Deploy & experiment with new services (e.g., AR/VR, smart factories, automotive services, IoT, etc.).
- Enables independent research and open innovation in Mobile Networks.

… all within a controlled and flexible environment.

Location Helmond

- TNO base station
  - LTE FDD @ 1875 MHz with a bandwidth of 5 MHz
  - 5G SA @ 3650 MHz with a bandwidth of 100MHz
- Used to test 5G automotive applications in 5G-HEART and 5G-MOBIX projects,
  - e.g. (truck) platooning, self driving cars, smart junctions and other intelligent transport systems use cases.
- Deployed TNO's own edge computing implementation (MEC) to reduce latency further.
- Focus on 5G Low latency applications



Logical architecture

3. Proposed solution

Conducted trials - Goals

The aim of the conducted trials was to set the baseline of the current SotA (Rel-14 LTE) performance with regards to this Smart Junctions use case.

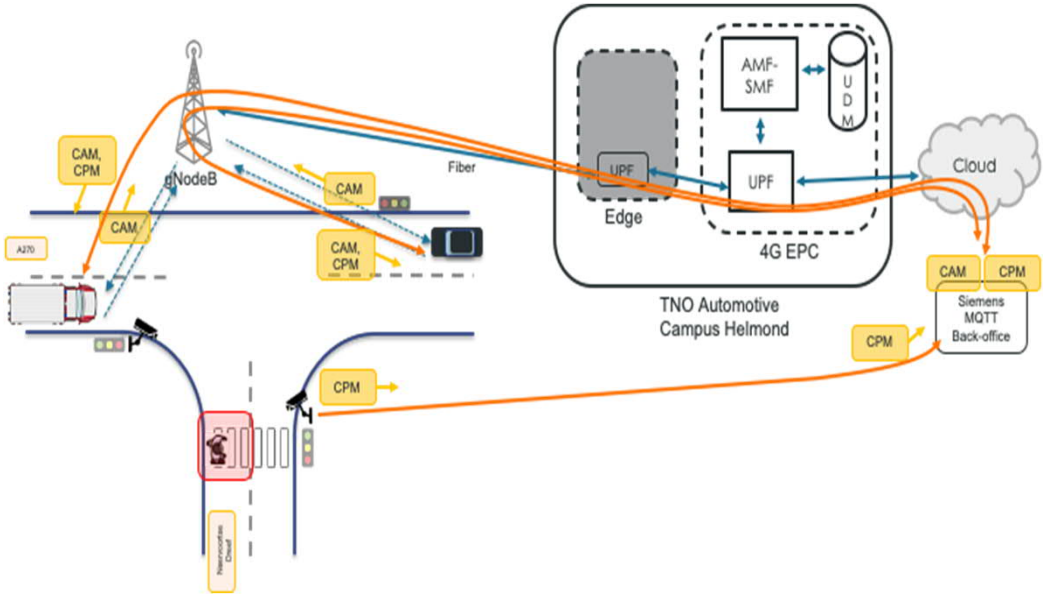
To do so, we used a Camera system for real-time object detection.

- System placed along the A270 Smart Highway and Smart Junction.
- Object detections are included within ETSI Collective Perception Messages (CPM)
- Provided via the network to the vehicles.

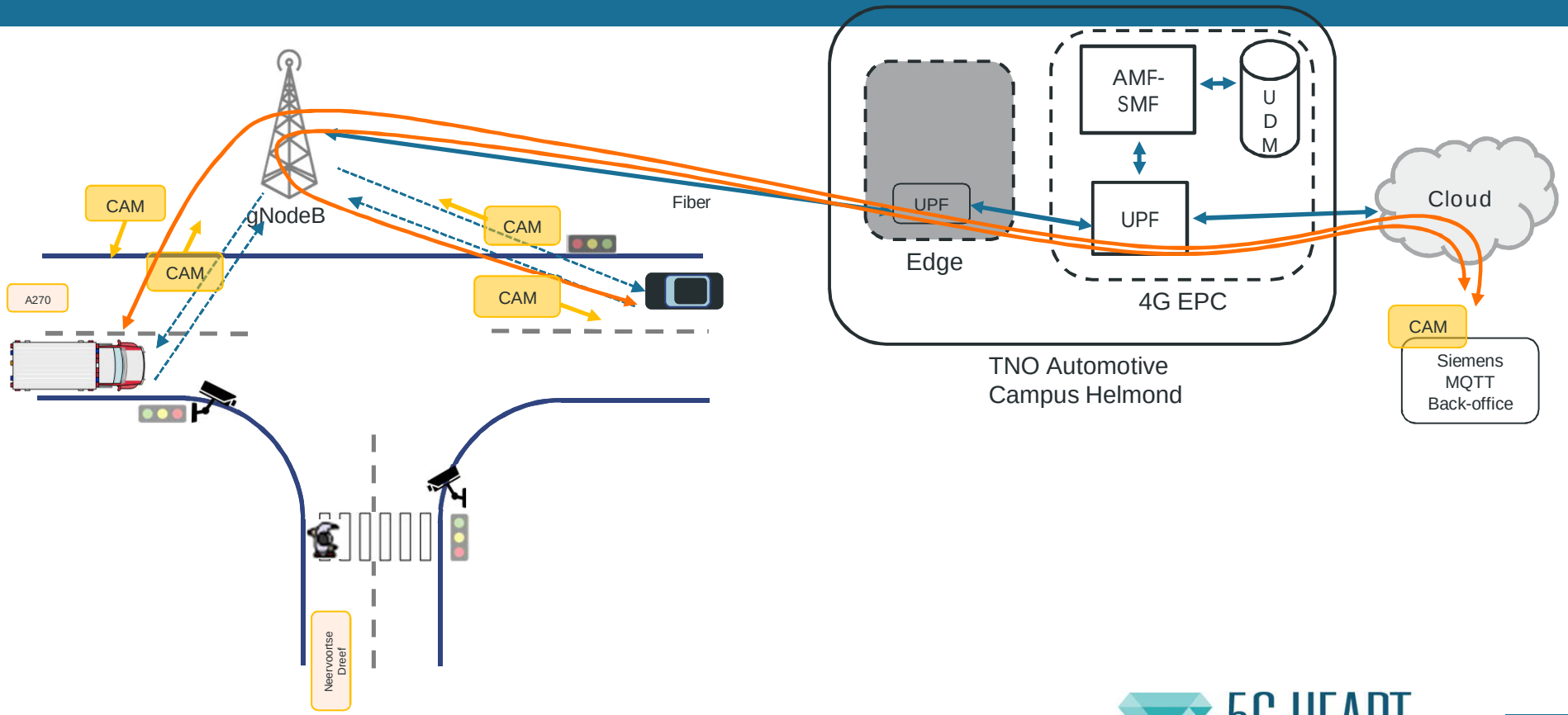
Conducted trials - architecture

The network architecture contained:

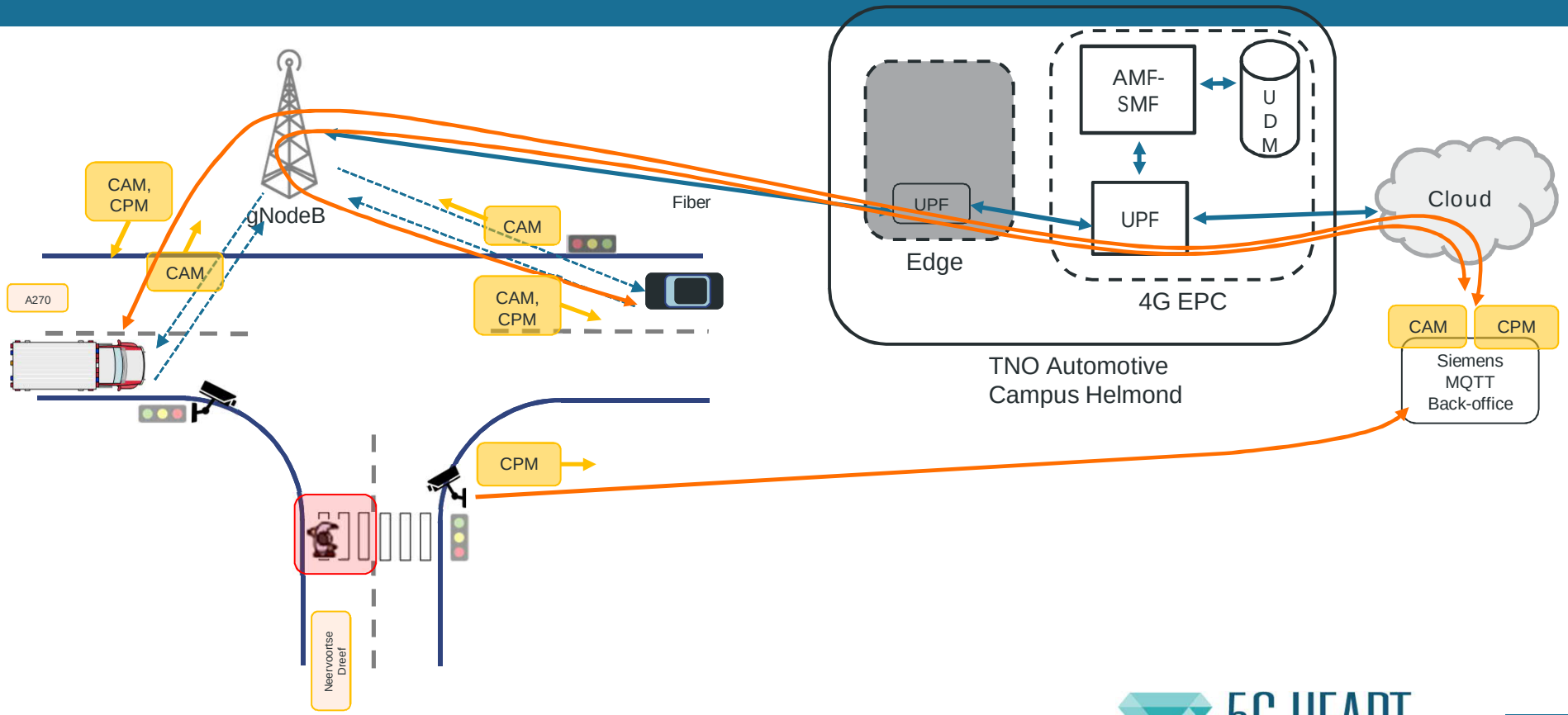
- One OBU configured for both LTE-Uu and LTE-V2X
- TNO LTE eNodeB:
  - Running LTE FDD @ 1875 MHz with a bandwidth of 5 MHz.
- TNO LTE EPC Core network
- IP based security camera's with object detection, e.g. vehicle and vulnerable road user tracking.
- Back-office cloud server running an MQTT broker, hosting the object detections



Conducted trials - ETSI CPM architecture



Conducted trials - ETSI CPM architecture



Conducted trials - results

Key target KPIs

The conducted trials set the baseline of the current SotA (Rel-14 LTE) performance with regards to this use case.

The key target KPIs for Phase 1 are:

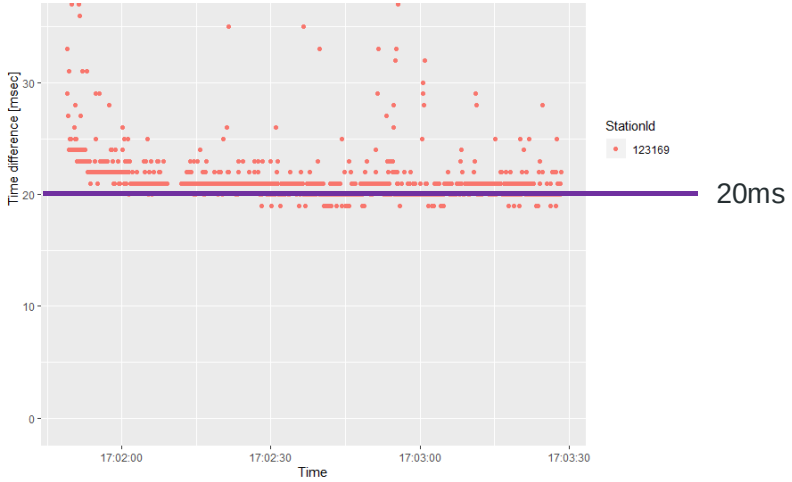
- Throughput (DL and UL)
- Peak data rate / Message rate
- E2E latency

Test tools

The measurement and testing tools utilised:

- Software probes for network performance measurements, e.g. Ping, IPerf2, IPerf3
- CPM application for application layer E2E latency
- Automatic logging analysis platform

Results



Tool	From	To	Result
Ping	UE	Cloud	RTT: 36ms
iPerf	UE	Cloud	Upload: 8.49 Mbits/s
iPerf	Cloud	UE	Download: 10.5 Mbits/s

Ongoing trials - Goals

The aim of the next trials is to show the potential benefits of 5G URLLC and eMBB by adding 5G NR and a 5G Core with Edge Computing and Slicing support.

The previously conducted measurements will be re-conducted on the 5G network and will compare the 5G network performance versus the earlier baseline (i.e., 4G) results.

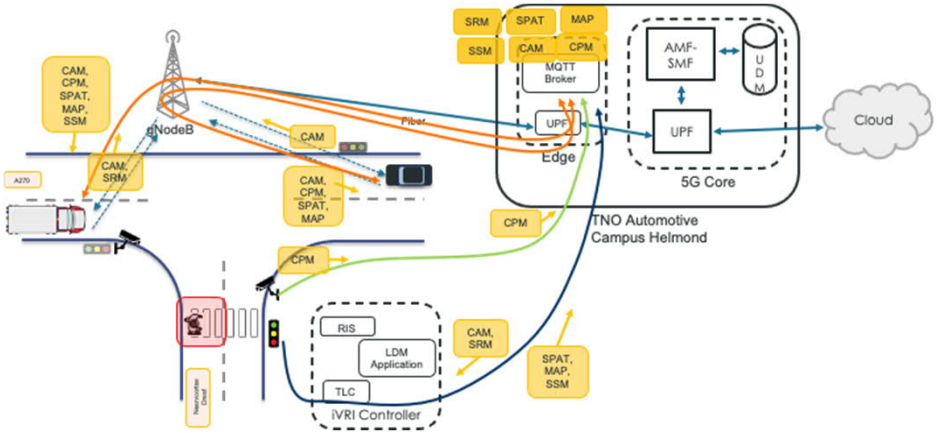
This will be done for the ETSI CPM based application, and extended with an additionally connected Traffic Light Controller and its corresponding application.

Ongoing trials - architecture

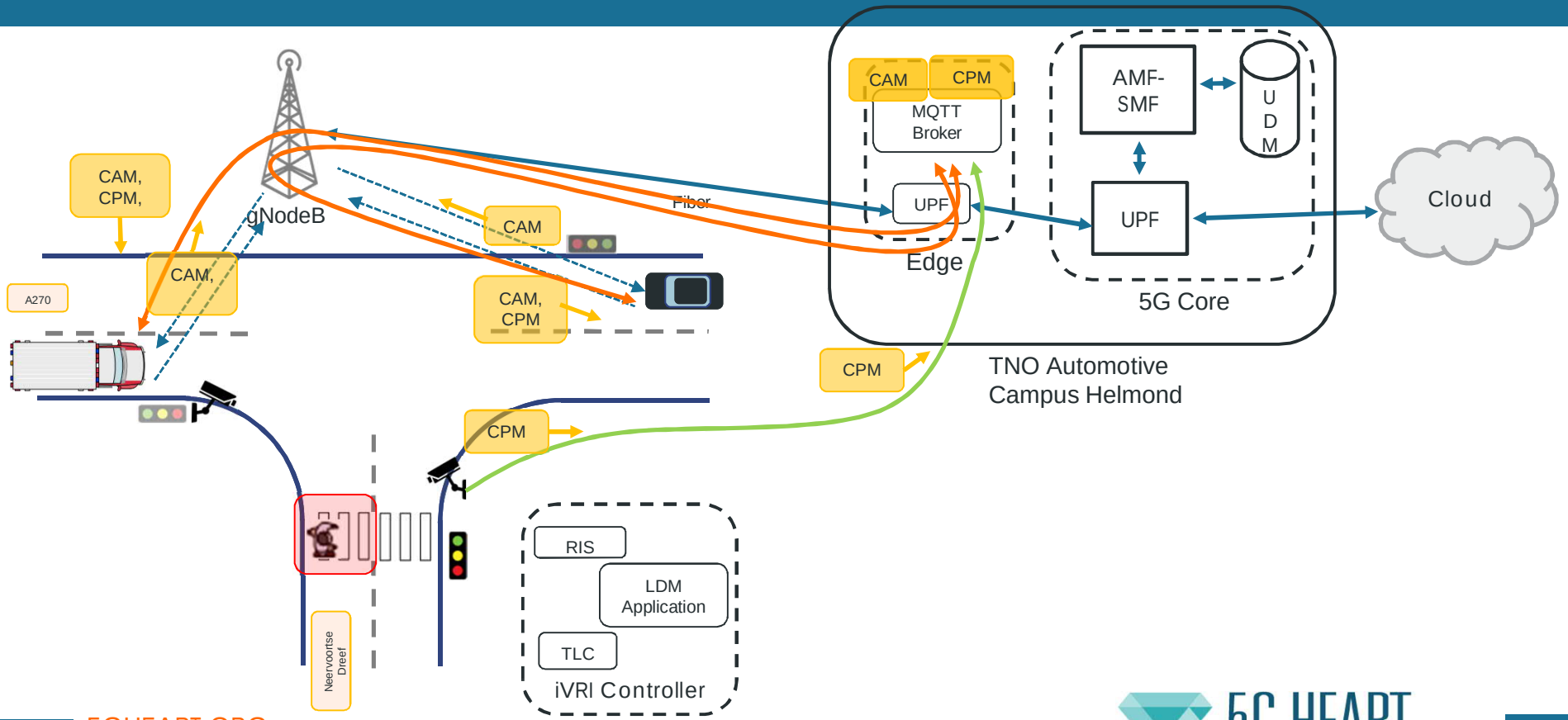
The upgrade trial network contains:

- One OBU configured for both 5G SA and LTE-V2X
- 5G SA gNodeB:
  - Running 5G SA @ 3650 MHz with a bandwidth of 100 MHz.
- 5G Core network

- IP based security camera's with object detection, e.g. vehicle and vulnerable road user tracking.
- Traffic Light Controller providing Traffic Light Status information and support for Priority Request
- Back-office edge server running an MQTT broker, hosting the object detections and Traffic Light Status information.



Ongoing trials – ETSI CPM architecture



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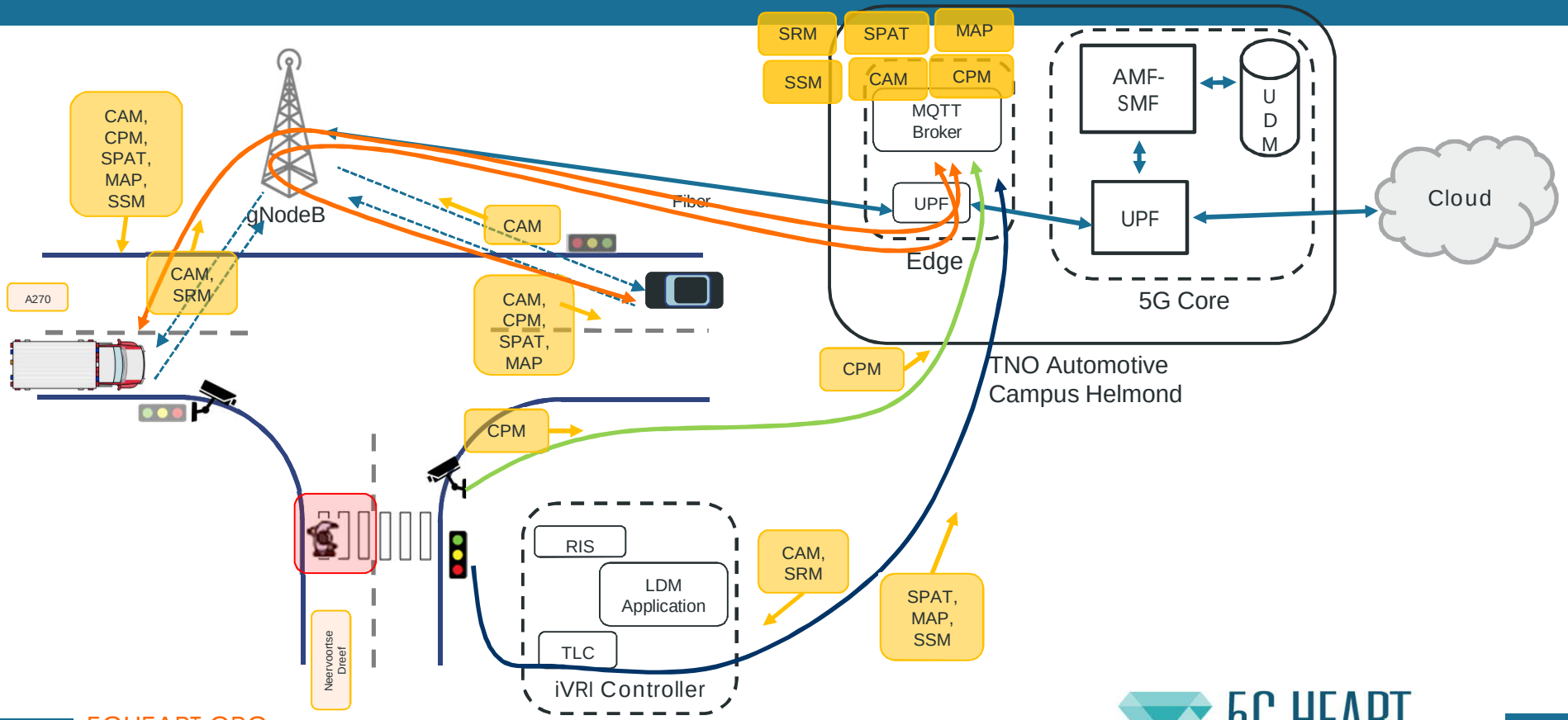
Ongoing trials – ETSI CPM & TLC architecture



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4. Key take-aways

Why we do what we do?

Cross vertical to reflect real-life scenario's

- These kind of use cases pose network requirements only satisfiable by 5G
- More and more network capacity required, merely expanding not the solution
- Needs smarter solutions to guarantee certain services, Transport and Healtcare use cases often not best effort
- Technologies like 5G Slicing makes it possible to provide network capacity guarantee
- Evaluate potential of 5G for these settings

5. Future steps

Future steps

- Now that the network architecture has been upgraded to 5G, we will reconduct Collective Perception Message trials
- Extend trials with Traffic Light Controller application
- Re-evaluate performance now that application architectures have been upgrade to include Edge Computing and Slicing
- Conduct combined trials with Transport and Healtcare, Ambulance use case. Evaluate simultaneous support for:
  - URLLC
  - eMBB (Up- and Downlink)

THANK YOU
FOR YOUR ATTENTION

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