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5GCroCo

Dr. Dirk Hetzer Deutsche Telekom AG / T-Systems International IEEE 5G Virtual Summit for Connected and Automated Mobility (CAM)



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Outline

• 5GCroCo Overview

• Use Case 1: Tele-operated Driving (ToD)

 Use Case 2: High Definition Map Generation and Distribution for Autonomous Driving (HD Mapping)

• Use Case 3: Anticipated Cooperative Collision Avoidance (ACCA)

OBUSINESS Potentials & Cost and Benefits Analysis

• Summary



Project Overview

Validation of 5G technologies for cross-border Cooperative, Connected and Automated Mobility (CCAM)





Facts and Figures





39%

 Coordinated by CTTC, Barcelona, Spain

- 24 partners from 7 European Countries
- O Total project budget ≈ 17M€ (EC Contribution ≈ 13M€)
- Project duration: 44 Months (Nov 2018 – June 2022)



European Stakeholders Involved

- 3 Leading telco equipment vendors
- 3 Mobile Network Operators of the 3 corridor countries
- 3 Road Traffic Authorities of the 3 corridor countries
- 4 Automotive Original Equipment Manufacturers (OEMs)
- 1 Automotive 1-tier supplier
- SMEs and Academia
- Explicit support from governments of France, Germany and Luxembourg



Technical 5G Solutions for CCAM

 Cross-border/-MNO handover
 5G New Radio
 Guality of Service (QoS) (-)• End-to-end with Dedicated Bearers^{*)} • QoS prediction • Mobile Edge Computing/Cloud (MEC) • Alternative/complement to public Internet hosting • 3GPP network service/session continuity Inter-MEC communication across borders / MNOs¹⁾ Management and Orchestration & SDN^{2)*)} • Single country /-MNO MANO Cross-border/-MNO • Precise positioning *) Incl. Network Slicing 1) MNO: Mobile Network Operator

2) SDN: Software Defined Networking



Large-scale Tests & Trials

Two Rounds of Tests & Trials

Germany-Luxembourg Corridor (D-L)



France-Germany Corridor (F-D) -122 dBm 50 dBn **Border** Stiring-Wendel **Cité Bruch** Marine Behren-les Forbach



Teleoperated Driving - ToD



ToD Tests in Renningen using 4G





- Determine planned route and timestamps per location
- ✓ Check that valid predictions are always available
- ✓ Request a prediction with all required information
- Provide to the application received predictions with timestamps

- ✓ Collect Network Data/Statistics
- ✓ Process Data
- ✓Train Prediction Model
- ✓ Receive Prediction Request
- ✓ Provide Prediction Response



HD Mapping **High Definition Maps Generation and Distribution for Autonomous Driving**

Permanently updated (crowd sourcing) and e.g. used for:

Optimal route selection

• Updating route in hazardous situations



HD Mapping Test & Trials D-L Corridor US1 Streaming the HD Map to the Vehicle Results

Trial	Re	sult [Mbit/s]	± 40.	_					
5G MEC		37.6 ± <mark>1.2</mark>	nd 40 dy 35	_	I	1 +16 5%			♠
5G Pub. Inet. 32		32.3 ± <mark>1.5</mark>					+84 3%	6	
4G MEC		20.3 ± <mark>0.8</mark>	t/s]				-04.57	0	+81.4%
4G Pub. Inet. 17		17.8 ± <mark>0.8</mark>	idM]				↓ ,	1170/	
Downloading 6.7 MByte large HD map tiles			Mean Dov 12 12 12 10						
Param.	Peak Spec. Eff.	Gain	verage						
4G DL	4.6 [bis/s]/Hz	. 1070/	Ϋ́Ο		5G MEC	5G Pub. Inet.	4G MEC	4G Pub. Inet.	
5G DL	9.6 [bis/s]/Hz	+107%							



ACCA Anticipated Cooperative Collision Avoidance

Anticipate dangerous events, more than "Hazard Warning"
Facilitate smoother and more homogeneous vehicle reaction





ACCA Tests & Trials D-L Corridor Initial Results

Scenario	Mean App. Level Delay [ms]
RSA MEC	18.8
PSA MEC	Experiment failed ¹⁾
RSA Pub. Inet.	44.4
PSA Pub. Inet.	141414

 Experiment was done but something went wrong, and we got no results.
 No time to repeat before D4.2 deadline





Business Potentials and Cost & Benefit Analysis



5GCroCo Ecosystem



5GCroCo

ToD Synergies Stakeholders



Summary

- Selected use cases will need big variance in requirements for 5G networks (bandwidth up/down, E-2-E latency)
- 5G can support MEC with local breakout routing without service interruption in cross-border scenarios ("make-before-break")
- Trials in 2020/2021 show how automotive application can be used seamless during change of operator / country



Thank you!

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