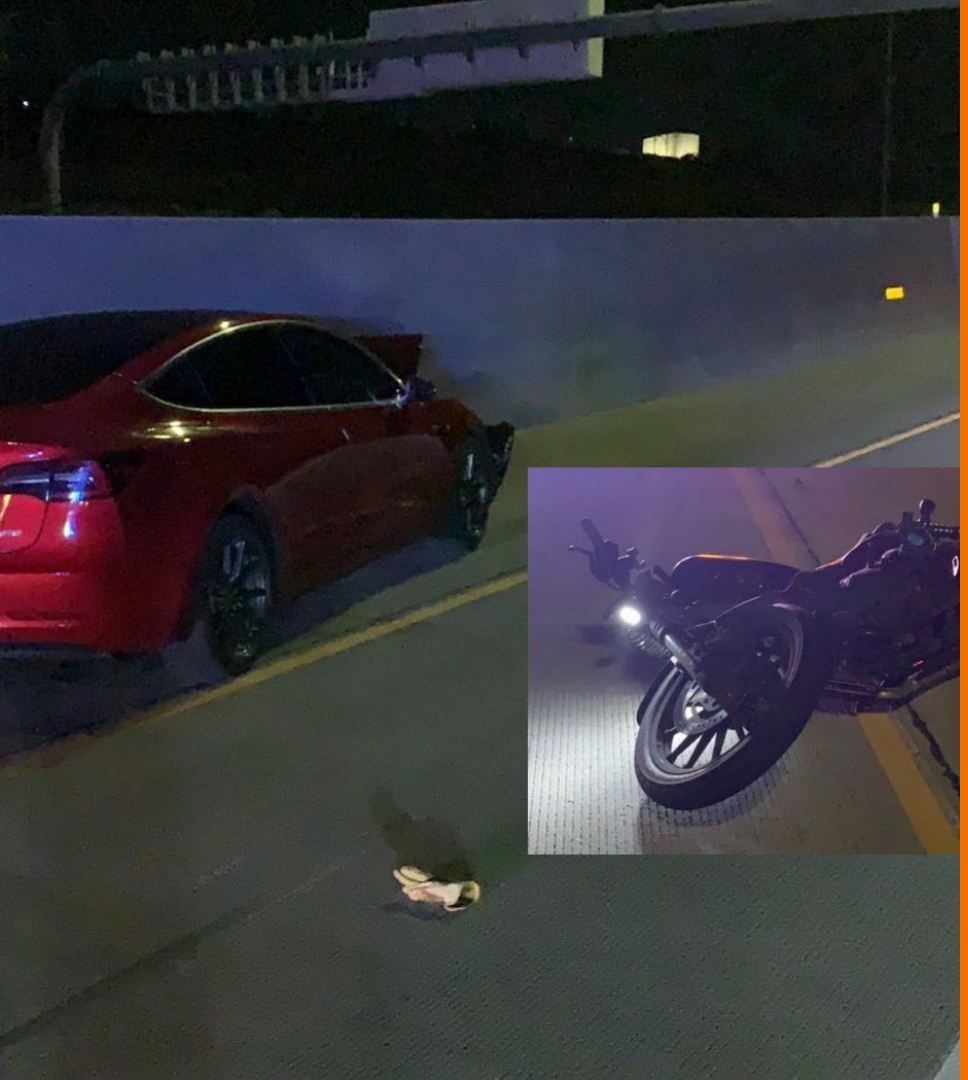
Providing PTW rider safer riding – Cooperative Collision warning & Cooperative Safe Overtake

03.10.2022

This work was conducted in the context of the Celtic-Next 5G-SAFE-Plus project, partially funded by Business Finland



Research justification for Connected Motorcycle (CoMC) Platform

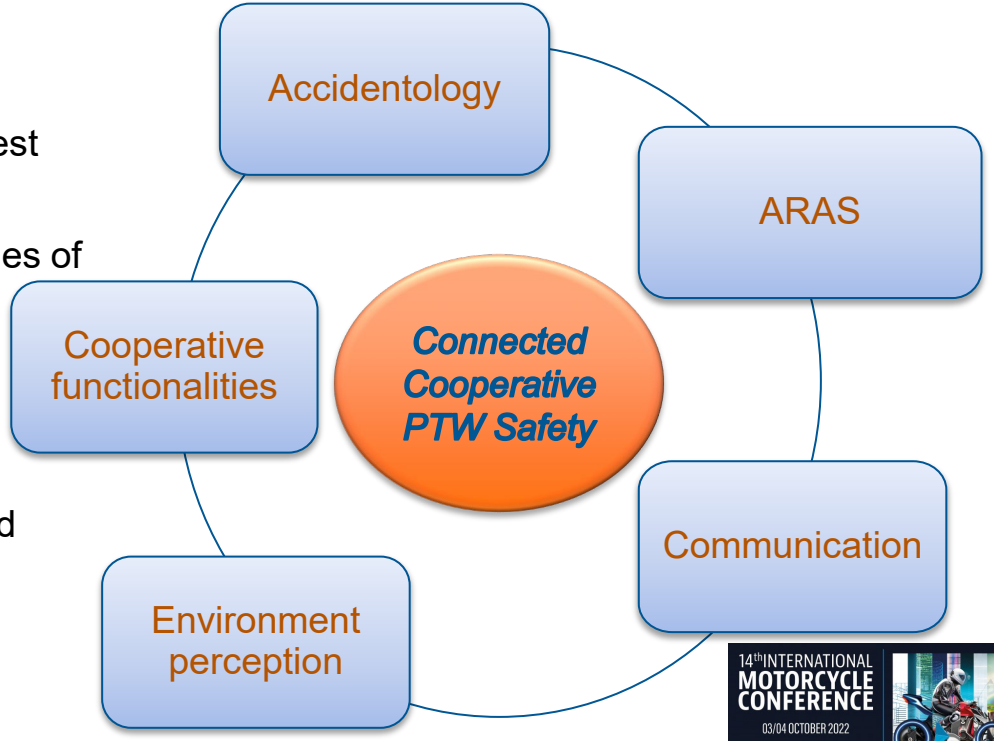
Connected Cooperative PTW Research – Why to continue

- International news
  - Non-equipped PTWs run over by ADAS-equipped cars
  - PTWs not properly detected and identified by ADAS
- European tests
  - RDV (the *Netherlands Vehicle Authority*) Study(* on modern cars' ACC and motorcycle recognition
  - ACC does not correctly recognise PTW → imminent danger for PTW crashes
  - VTT findings in European and national ITS research
- European research
  - PTWs not deep enough involved in the European public ITS cooperative driving domain
  - Lack of push? Lack of pull? Lack of tech? Lack of business?

(* Adaptive Cruise Control & Motorcycle Recognition, E.A. Westerband, VRT-TTV-PB-Testcentrum Lelystad, RDV, 2018

Circle for Life – Five Building blocks for Connected Cooperative PTW Safety

- Accidentology
  - To find those accident types where CC-PTW Safety impact would be greatest
- ARAS
  - First to deploy, to enhance the capabilities of current/future rider assistance
- Communication
  - To enable exchange of V2X messages
- Environment perception
  - To understand the events, situations and conditions in PTW vicinity and ahead
- Cooperative functionalities
  - To enable warning, advise, assist



Backbone for CoMC – based on VTT CoMC Functional architecture

Extra-vehicular knowledge

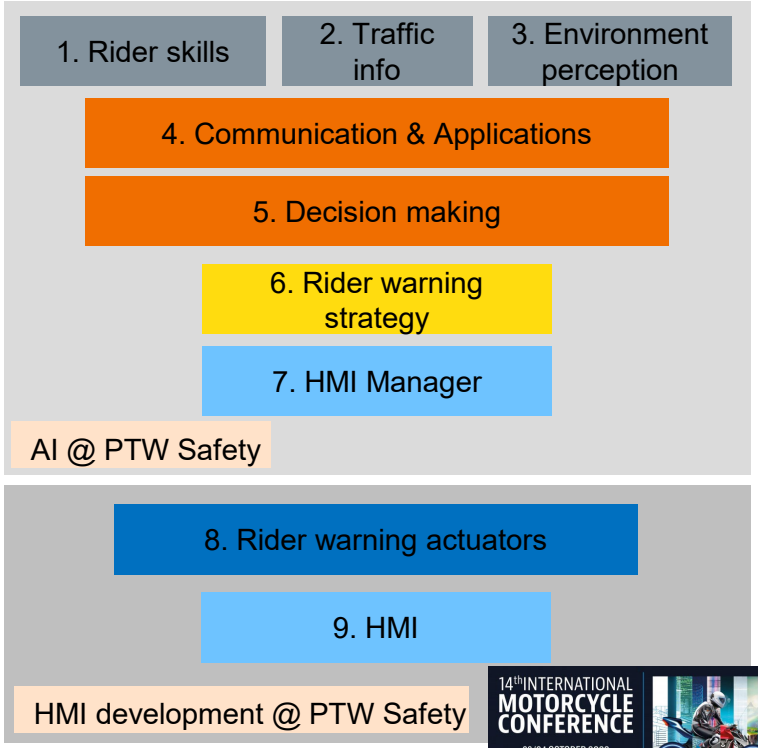
1. Rider skills (personal)
2. Traffic information (OV in vicinity, external, available)
3. Environment perception (external, obtainable)

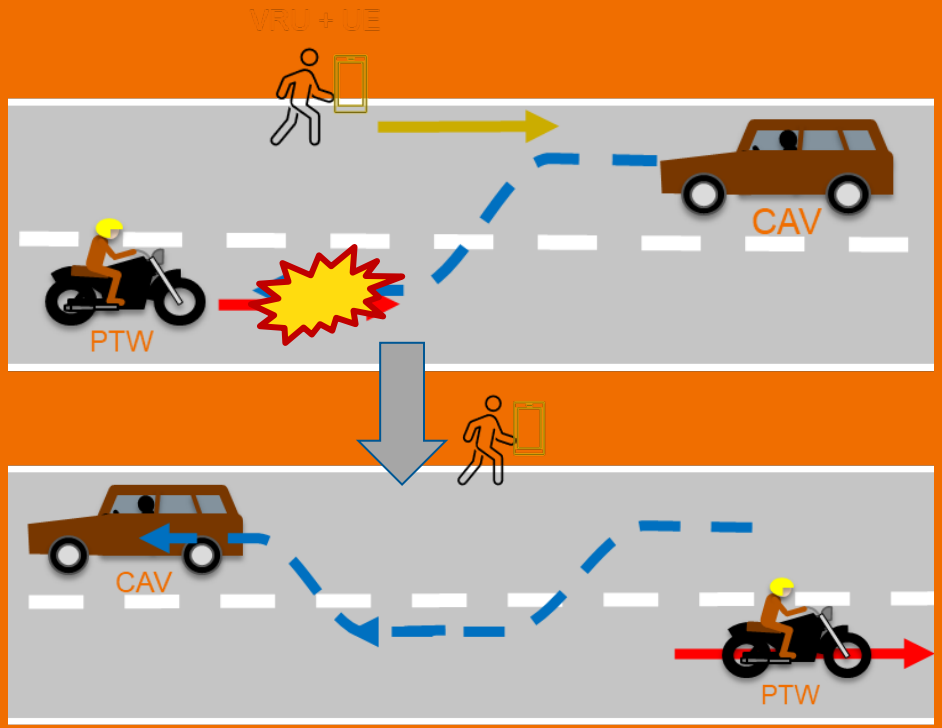
AI Software

4. Communications & Applications
5. Decision making
6. Rider Warning Strategy
7. HMI Manager module

HMI for Advice & Assist

8. Rider Warning actuators
9. HMI modules

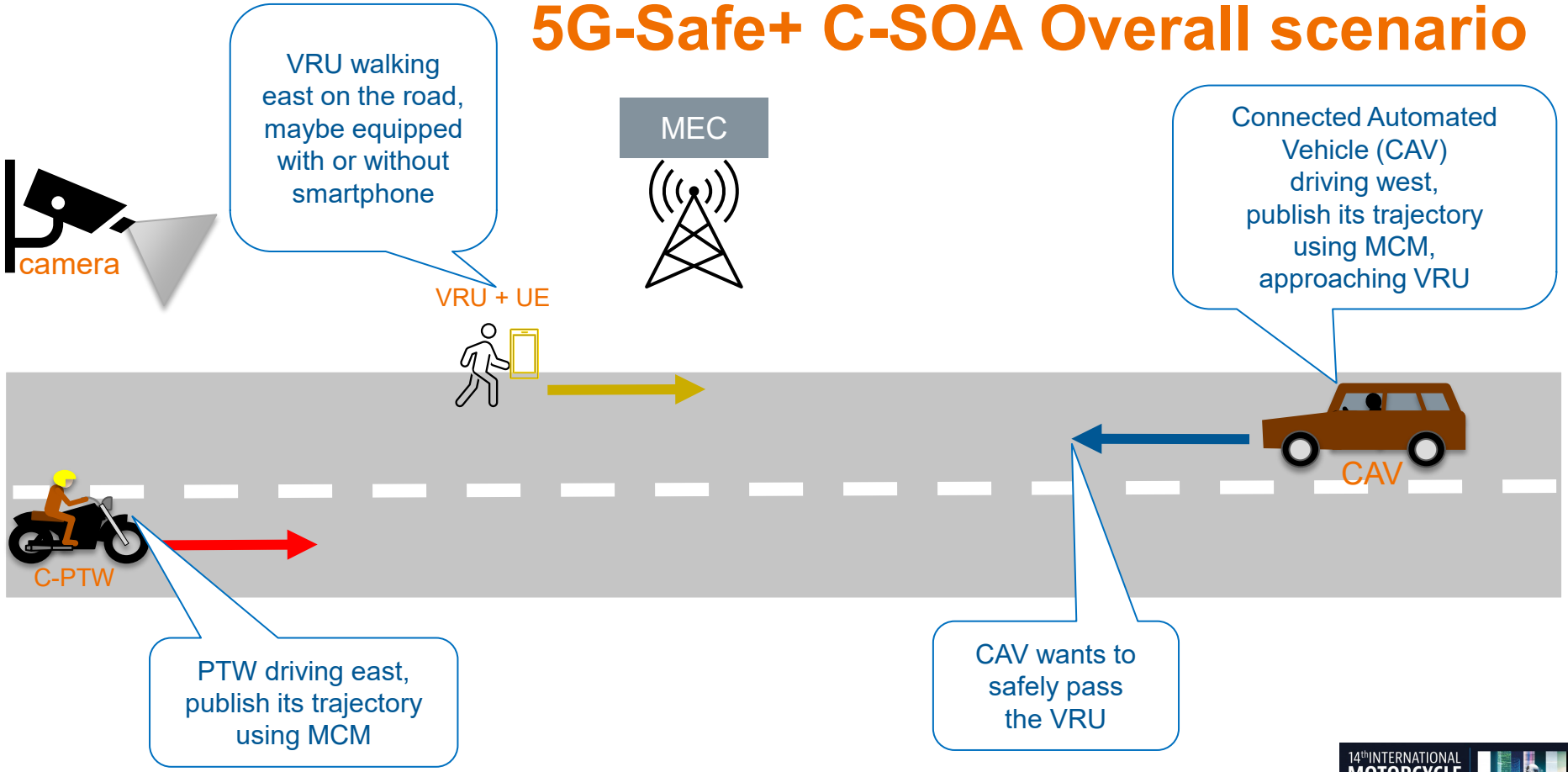




Connected Automated Vehicle (CAV) evades pedestrian to avoid collision
→
Cooperative Safe Overtake Assist (C-SOA) saves all

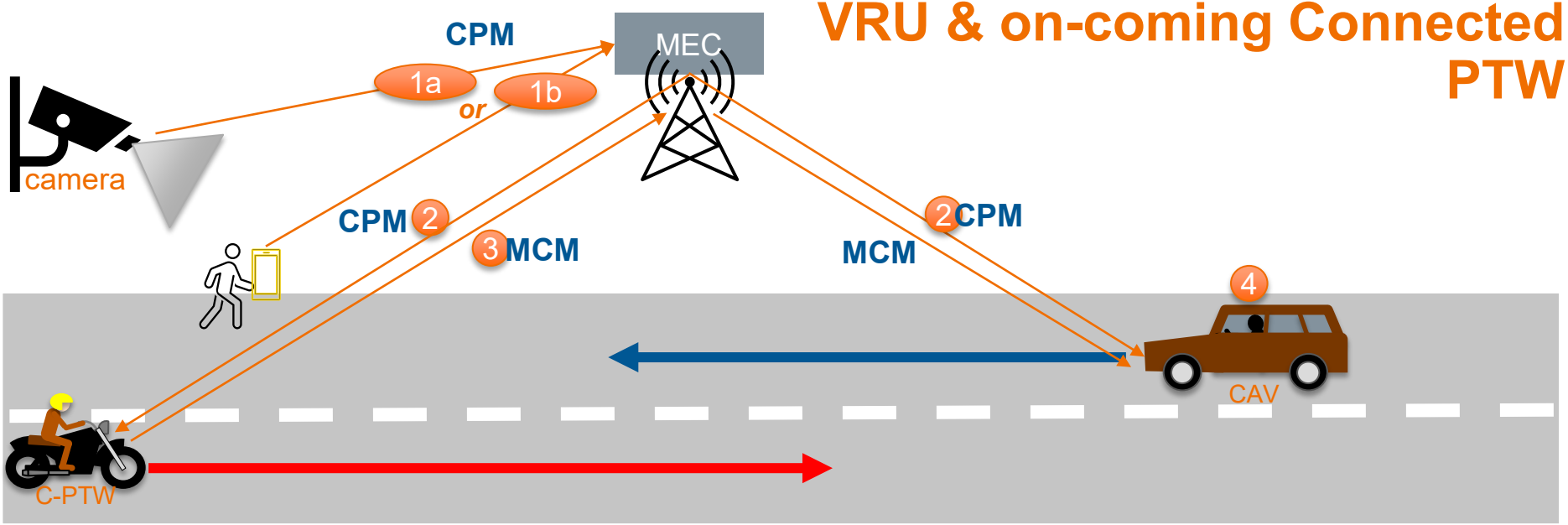
This work was conducted in the context of the Celtic-Next 5G-SAFE-Plus project, partially funded by Business Finland

5G-Safe+ C-SOA Overall scenario



This work was conducted in the context of the Celtic-Next 5G-SAFE-Plus project, partially funded by Business Finland

Time = t1: CAV – detection of VRU & on-coming Connected PTW



1: 1a: RSU (camera+lidar) detects & transmits the VRU and their position ***OR***

1b: Pedestrian smartphone app transmits position using CPM

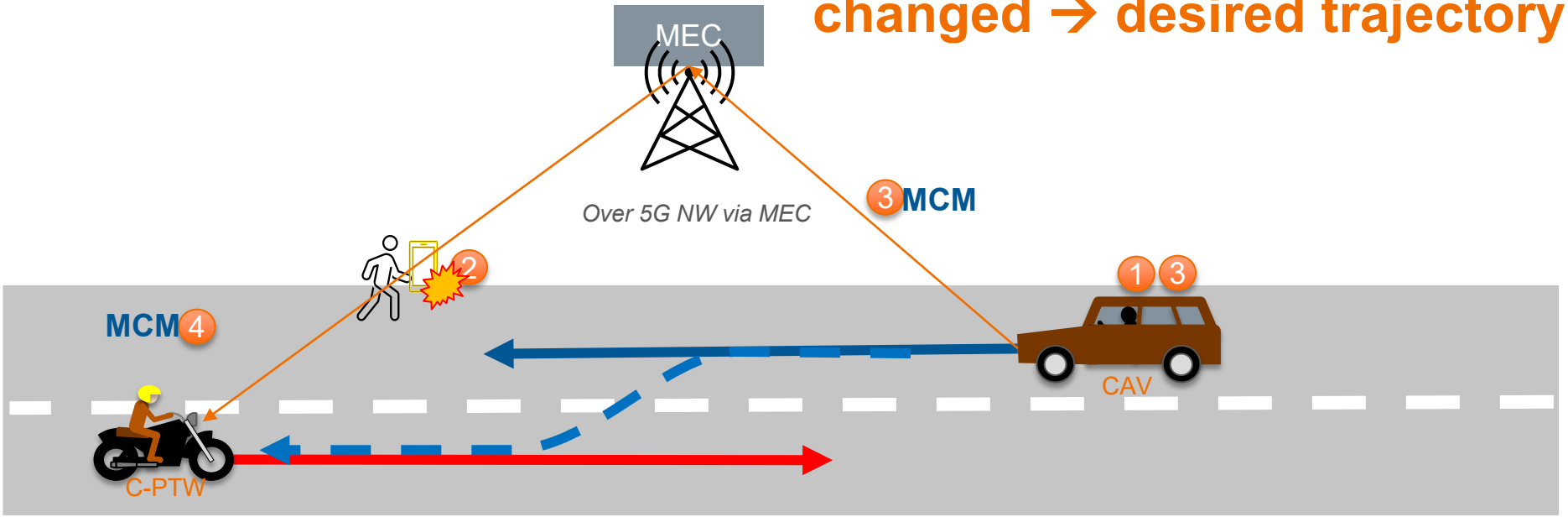
2: CPM Messages are routed through the MEC on 5G network and received by CAV and PTW

3: PTW publish its trajectory using MCM

4: The detection data coming from different sources is fused in the vehicles or in the MEC and published

This work was conducted in the context of the Celtic-Next 5G-SAFE-Plus project, partially funded by Business Finland

Time = t2: CAV planed trajectory changed → desired trajectory



1: CAV intent to pass VRU

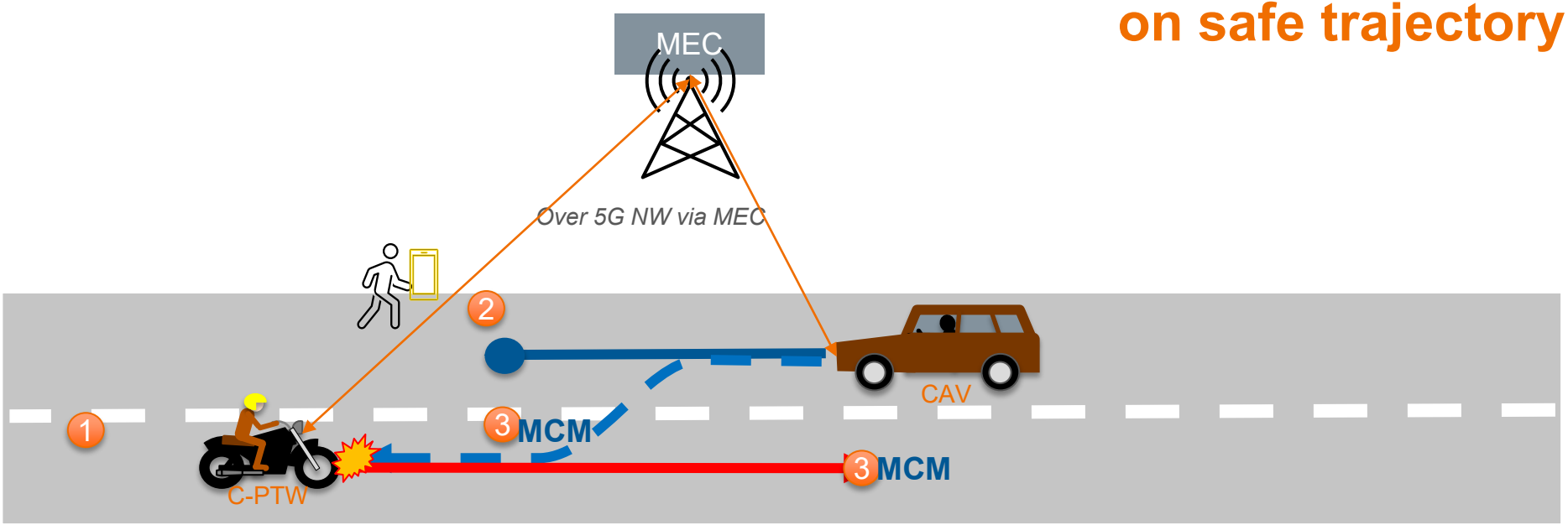
2: CAV detects potential collision with pedestrian

3: CAV calculates both planned trajectory (fixed line, to stop) and new desired trajectory (dashed line, to avoid pedestrian), and publishes new MCM

4: PTW receives CAV's MCM and is warned of VRU presence and CAV desired trajectory

This work was conducted in the context of the Celtic-Next 5G-SAFE-Plus project, partially funded by Business Finland

Time = t3: PTW continues on safe trajectory



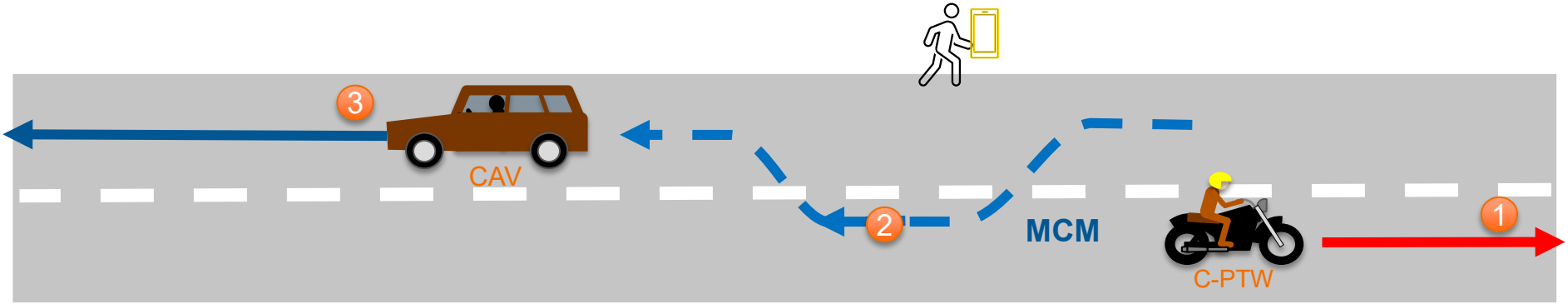
1: PTW continues on its trajectory

2: CAV moves according to the planned trajectory and brakes before the VRU allowing PTW safe riding

3: When PTW has passed (detected from MCM messages sent by PTW), the CAV overtakes the VRU

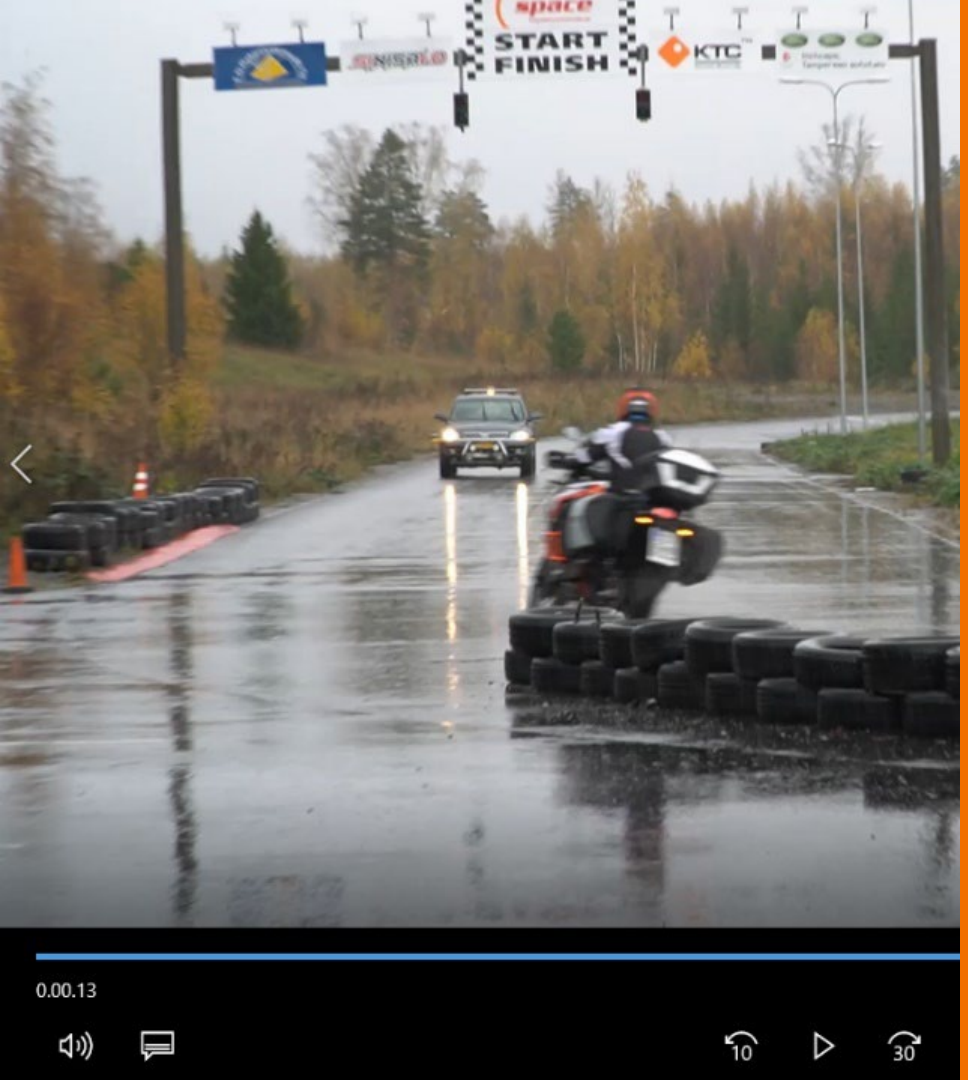
This work was conducted in the context of the Celtic-Next 5G-SAFE-Plus project, partially funded by Business Finland

Time = t4: All entities are on safe trajectories



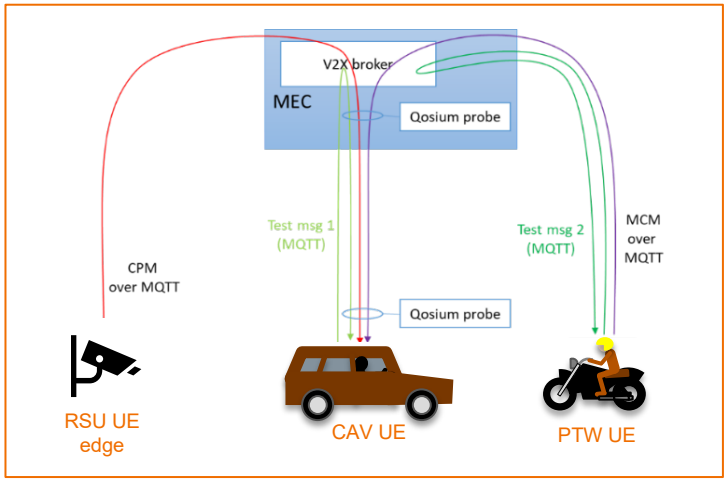
1. PTW continues on its trajectory
2. When PTW has passed (detected by CAV from MCM published by PTW), the CAV overtakes the VRU
3. CAV returns and continues on the desired trajectory

This work was conducted in the context of the Celtic-Next 5G-SAFE-Plus project, partially funded by Business Finland

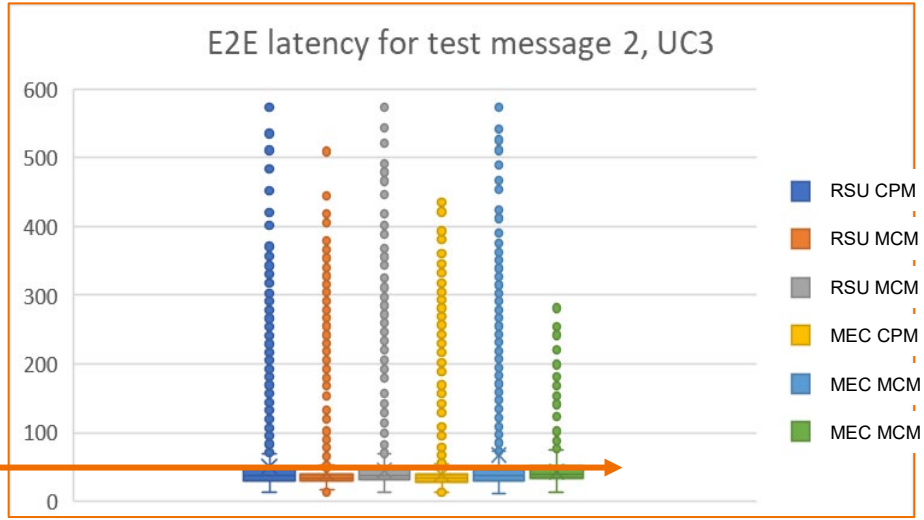


Discussion

RTT Measurement MQTT Test message – 5G NSA



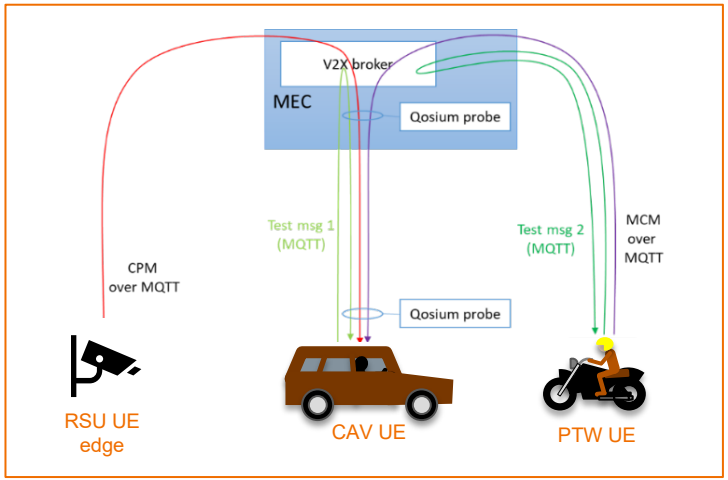
RTT (ms)	Test message 1 (CAV)	Test message 2 (PTW)
average	40.9	**47.7**
median	31	**37**
95% percentile	86	**105**



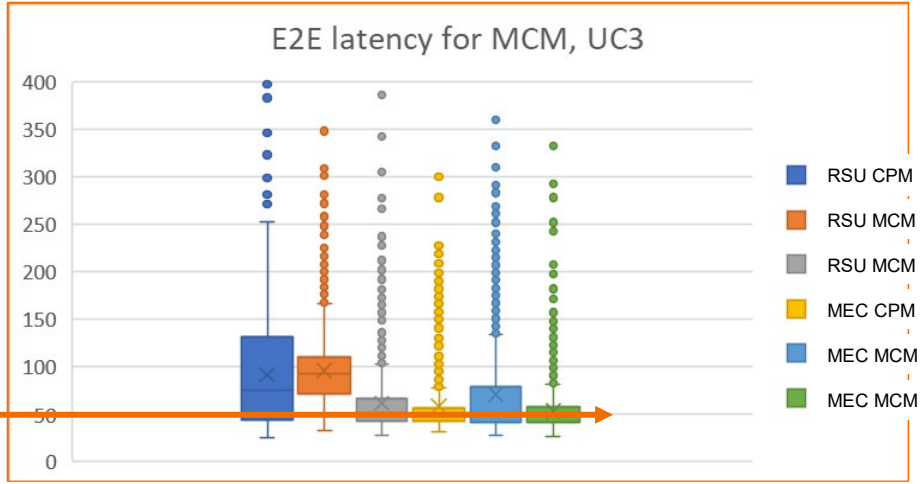
Target:
RTT MQTT Test message @C-PTW
< 50 ms → *Achieved*

This work was conducted in the context of the Celtic-Next 5G-SAFE-Plus project, partially funded by Business Finland

MCM E2E Measurements – 5G NSA



E2E MCM (ms)	Overall UC3	First day	Second day
average	**77.25**	89.5	60.9
median	**64**	84	49
95% percentile	**164**	171	150



Target:
MCM E2E latency CAV->C-PTW
< 50 ms → *Not yet fully achieved*

This work was conducted in the context of the Celtic-Next 5G-SAFE-Plus project, partially funded by Business Finland

Non-equipped PTW vs. Connected PTW with Environment Perception

Event:	Non-equipped PTW:	Connected PTW with Perception:
1. Single vehicle accident	1. No assistance	1. Event may be avoided (due perception)
Collision: Ego + OV	**Collision: Ego + OV**	**Collision: Ego + OV:**
2. PTW not visible/detected	2. "*SMIDSY*"	2. Presence published & OV detected
3. Left turning collision	3. "*SMIDSY*"	3. Presence published & OV detected
4. Rear-end collision	4. "*SMIDSY*"	4. Presence published & OV detected
5. Head-on collision	5. "*SMIDSY*"	5. Presence published & OV detected
6. Overtake collision	6. "*SMIDSY*"	6. Presence published & OV detected
7. Intersection collision	7. "*SMIDSY*"	7. Presence published & OV detected
8. Etc.	8. …	8. …

➔ *Connected PTW and Environment perception provide safer riding*

➔ *No more accidents with "SMIDSY" → but less accidents due to "YISY" ☺*

Thank you!

beyond
the obvious

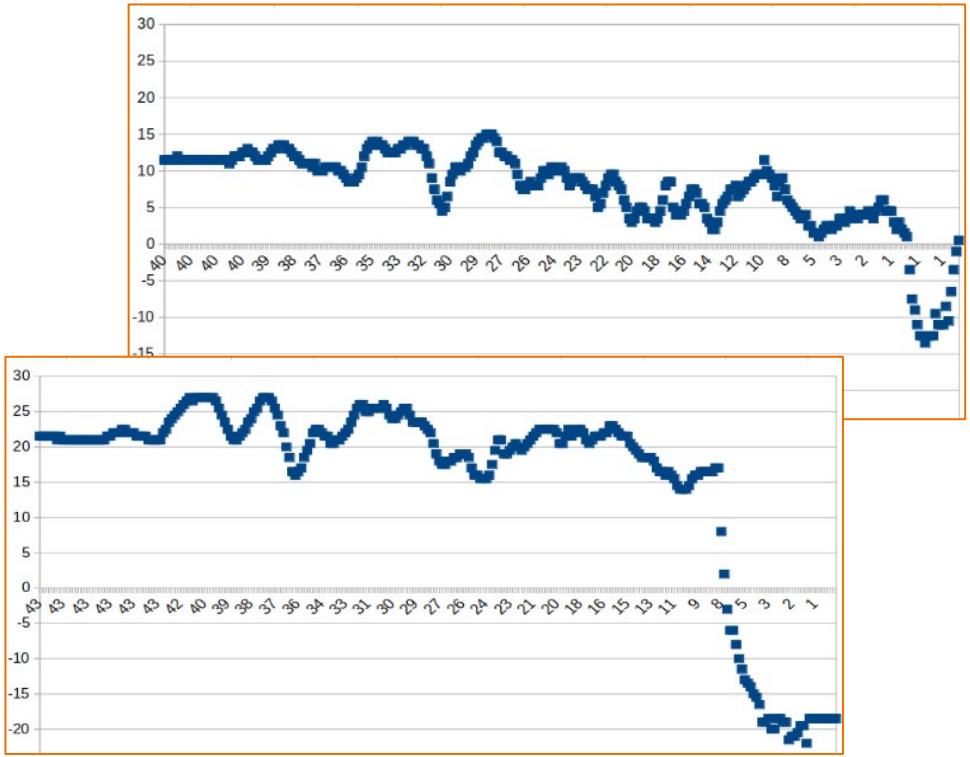
Aki Lumiaho
aki.lumiaho@vtt.fi

@VTTFinland

www.vtt.fi

Simple conspiquity enhancement

- Radar reflectors improve relative detectability 50-100% when in range 30…<50 m
- Reflectors imbeddable in modern frontal design
- BOM minimal → no significant cost penalty on RRP



Prerequisites for Connected Driving

- Vehicles shall be capable to
  - communication
  - publish and receive V2X messages
  - handle the V2X message
  - make necessary decisions
    (to warn/advise/assist) for safer driving/riding
  - environment perception
  - publish their trajectories
- Access to traffic information
  - Traffic status: 3s behind – 30s ahead
- Knowledge of rider skill level (?)
  - One missing aspect (*or is it relevant*?)