Welcome to the World of Standards

ETSI

World Class Standards

FACILITIES DCC FOR HETEROGENEOUS V2X SERVICES – INITIAL EVALUATION AND PERSPECTIVES

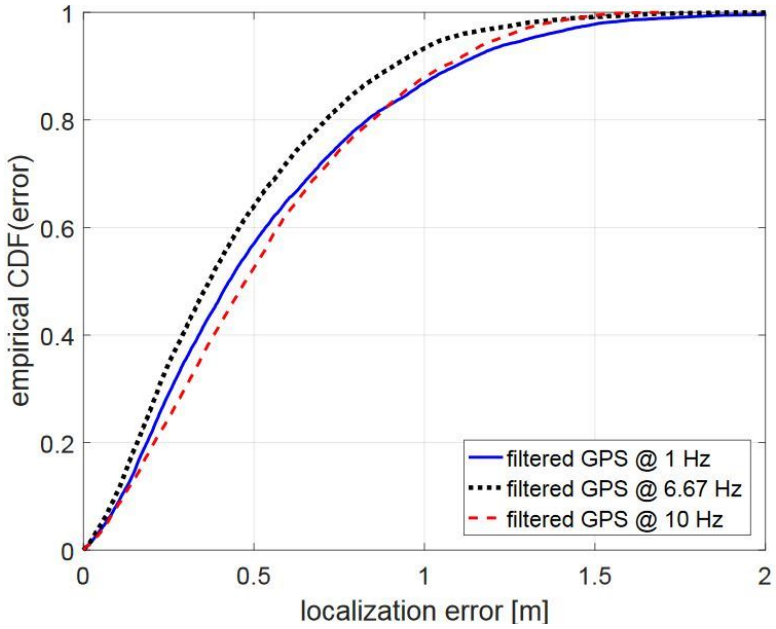
Jérôme Härri, Irfan Khan

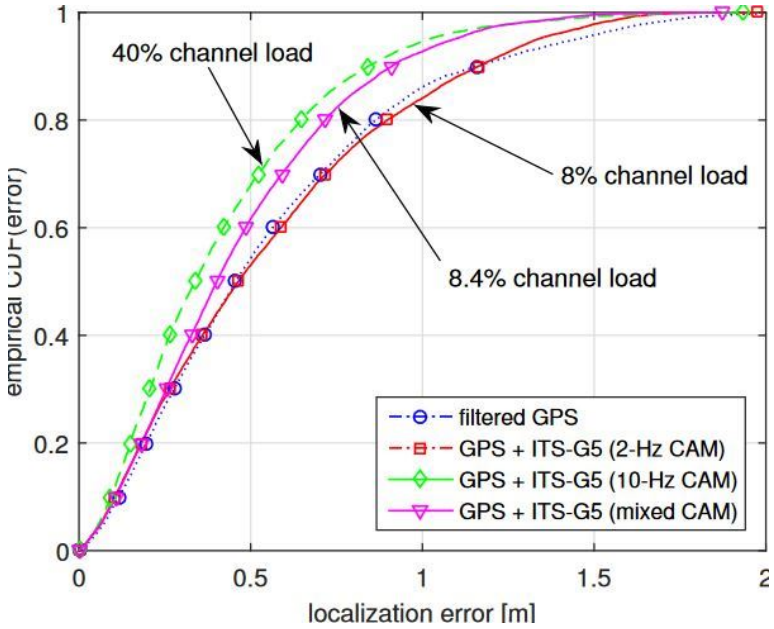
ETSI ITS Workshop Berlin, March 6-8 March 2018

HIGHTS
High precision positioning for Cooperative-ITS

EURECOM
Sophia Antipolis

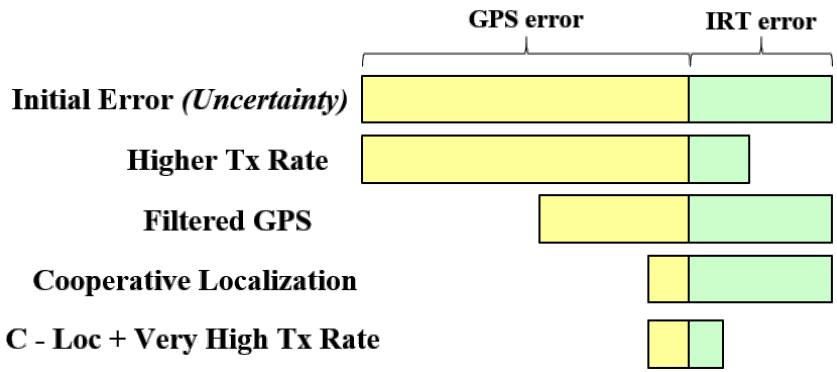
Rethinking Awareness for Day 2

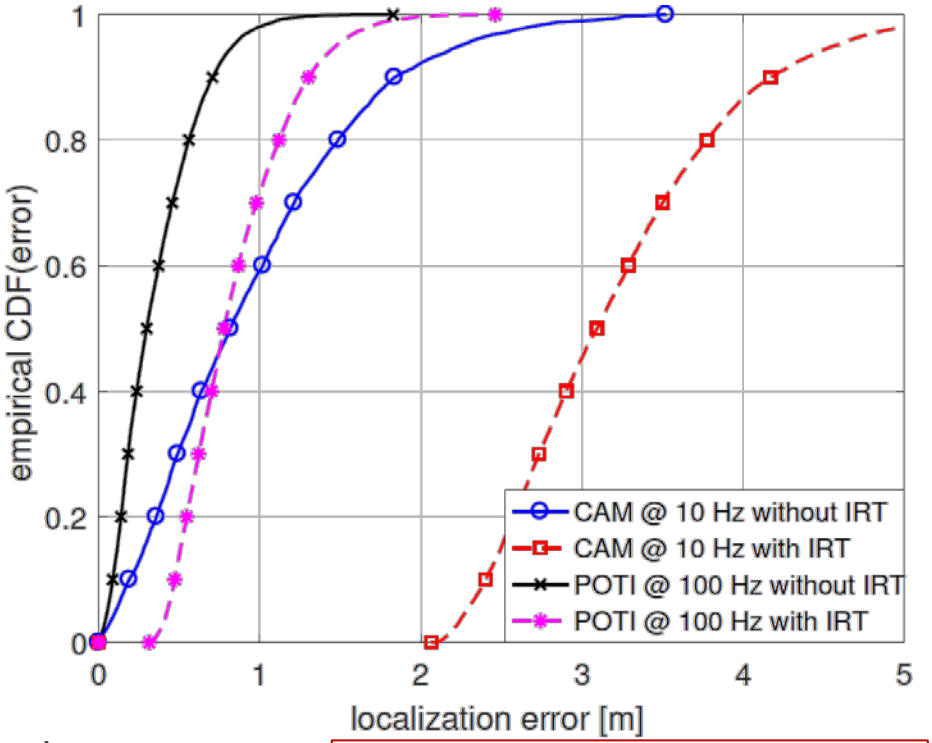




- Correlated GPS data leads to useless CAM GPS and channel load
- On the usefulness of CAMs for high precision positioning…

Rethinking Awareness for Day 2

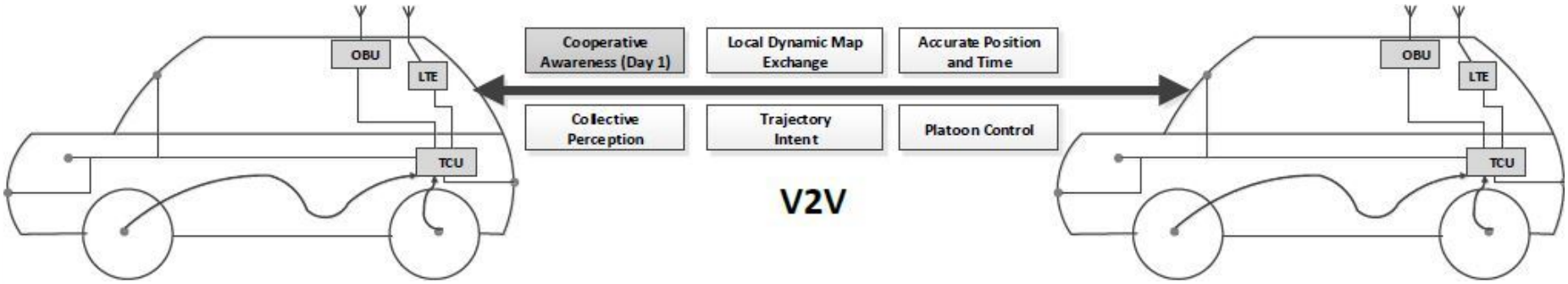




- Median Errors:
  - 10 Hz CAM (only localization error): 0.82 m
  - 10 Hz CAM (localization error + IRT): 3.1 m
  - 100 Hz PAM (only localization error): 0.3 m
  - 100 Hz PAM (localization error + IRT): 0.78 m

Irfan Khan, Gia-Minh Hoang, Jérôme Härri, **Rethinking Cooperative Awareness for Future V2X Safety-Critical Applications**, IEEE Vehicular Networking Conference (VNC), Turin, 2017.

Day 2 Messages..more than CAM

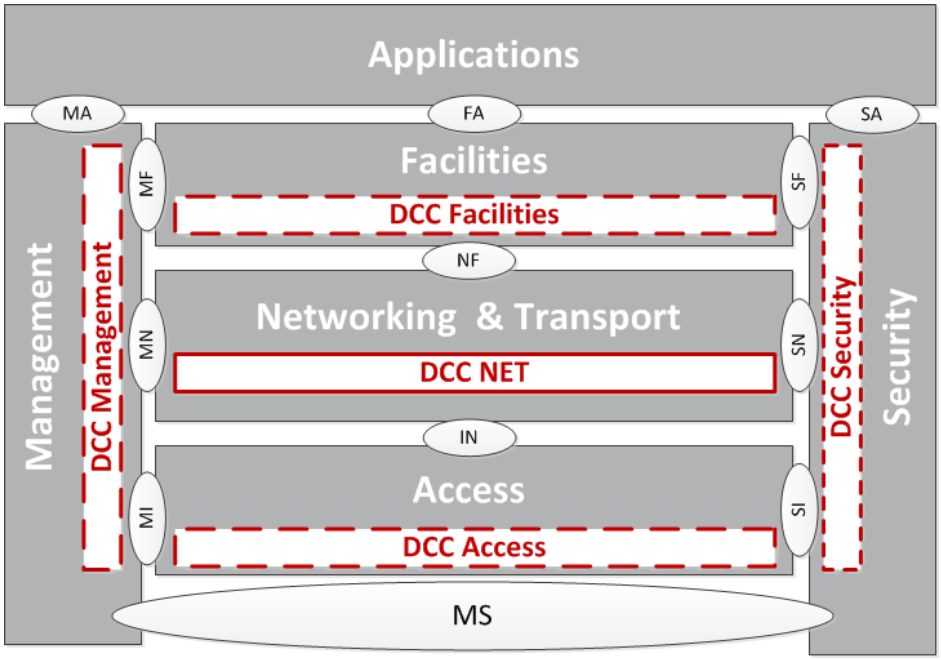


- **Day 2 Messages**:
  - CAM (different sizes, different rates) – trajectory, type, GPS position 1-10Hz
  - CPM – sensor information - 2-5 Hz
  - POTI – position and time (10Hz, e.g.)
  - LDM – dynamic map content exchange – 1Hz (e.g)
  - PAM – Precise Positioning Message - 100Hz
  - ….

Enhancing DCC – DCC Architecture at ETSI

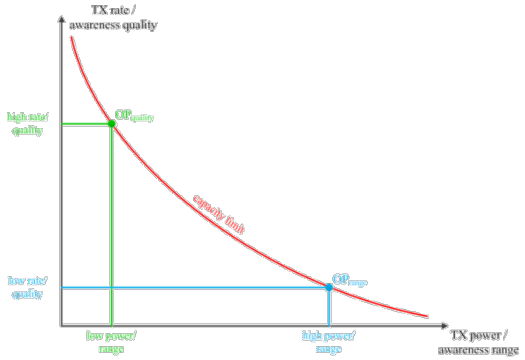
- The Wireless Vehicular Radio Channel has limited resource
  - WiFi is only best effort
  - In Ad-hoc (OCB): requires coordinated access

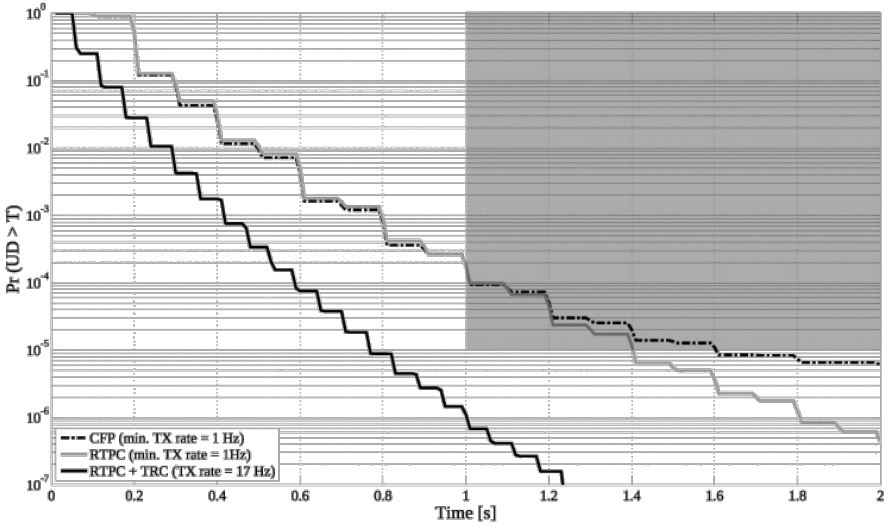
- DCC controls the load with various mechanisms
  - Adjust Tx Rate – DCC FAC
  - Adjust Tx Power – DCC NET
  - Adjust Modulation (MCS) – DCC FAC
  - Adjust Sensing Threshold – DCC ACC
  - Offloading on different channels – DCC MGMT

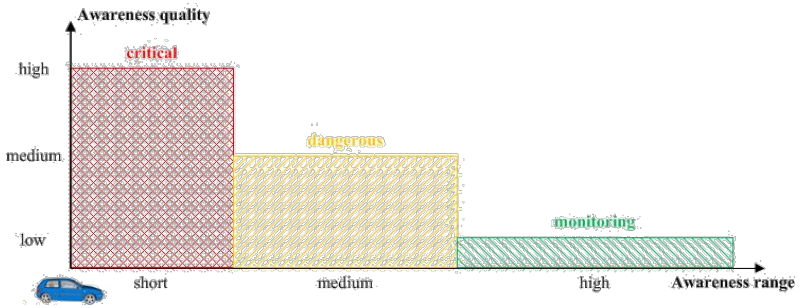


DCC Strategies Architecture at ETSI

- Strategy: Decentralized Congestion Control
  - Adjust Tx parameters to maintain the channel load in an operational limit
  - Based on cooperation between vehicles
  - Mostly adaptation of Tx power and Tx Rate (flow control)



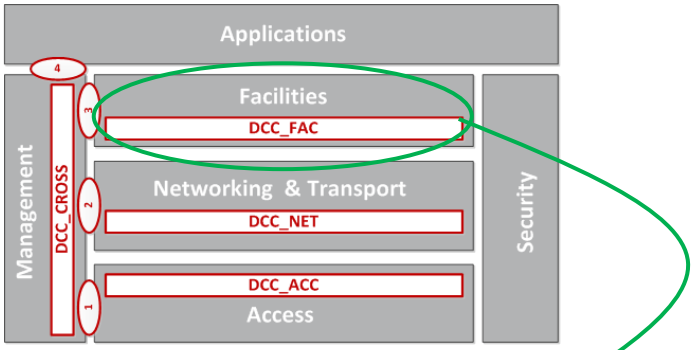


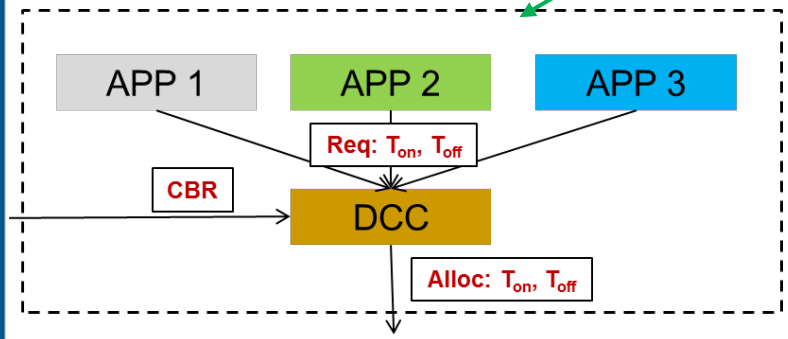


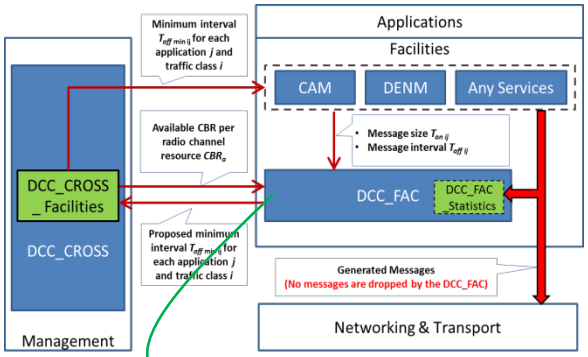
Bernhard Kloiber, Jérôme Härri, Thomas Strang, Stefan Sand, Cristina Rico Garcìa, "**Random Transmit Power Control for DSRC and its Application to Cooperative Safety**", IEEE Transaction of Dependable and Secured Communication, 2015

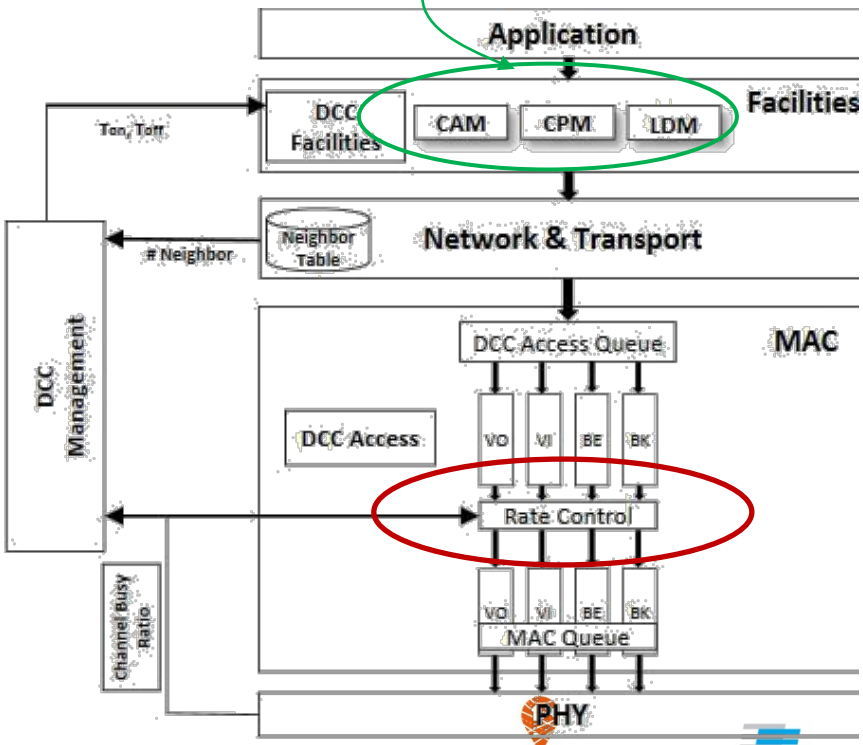
Facilities DCC Architecture

- Facilities-layer DCC – TS 103 141
  - Objective: provide fair ‘channel access time’ to all message
    - Potentially irrespective to the technology or channel







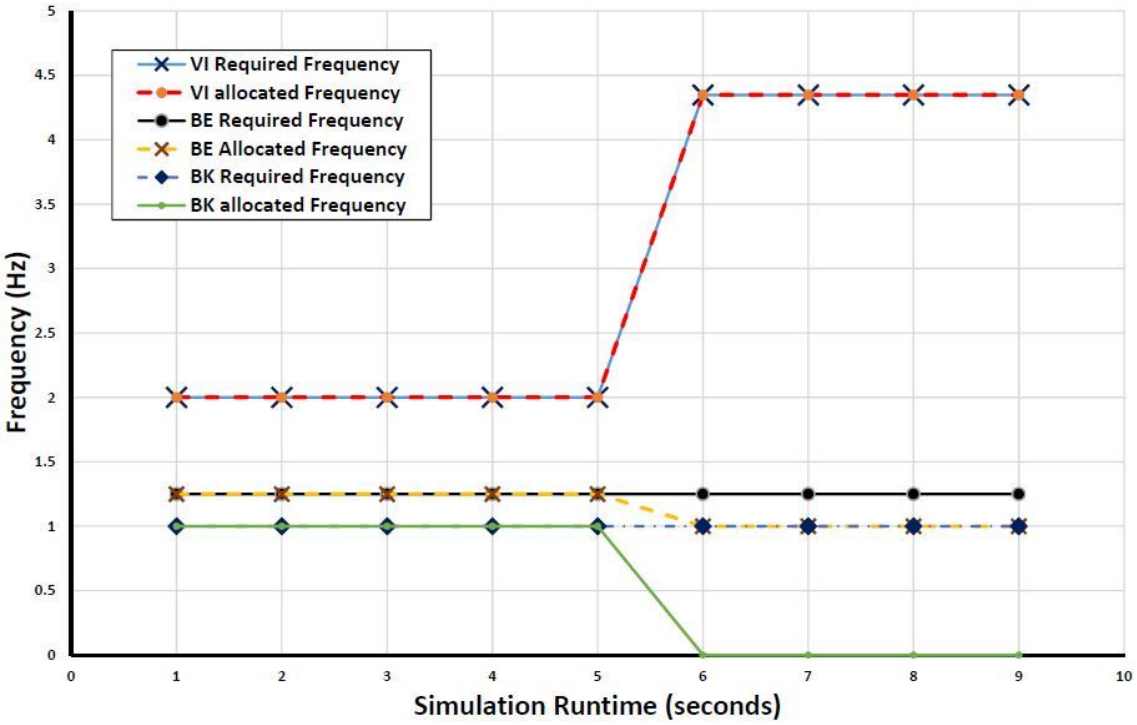


Facilities DCC Model

- For each Application j and Traffic Class i
  - Estimate the average message size $\overline{T_{on\,ij}}$ and message interval $\overline{T_{off\,ij}}$
  - Estimate the average Channel Resource Estimation:
    - $\overline{CRE_{ij}} = \frac{\overline{T_{on\,ij}}}{\overline{T_{on\,ij}}+\overline{T_{off\,ij}}}$
- Calculate the total Channel Resource (CR) for all applications using a TC i
  - $CR_i = \sum_j \overline{CRE_{ij}}$
- Set the Available Channel Resources
  - ACR_0 for traffic class TC_0 to CBR_a
  - ACR_i for traffic class TC_i to $\max(0, ACR_0 - CR_{(i-1)})$.
- Divide channel resources ACR_i between the application *j* and traffic class *i*
  - $ACR_{ij} = \frac{\overline{CRE_{ij}}}{CR_i} \times ACR_i$
- Define the minimum T_{off} for application j and traffic class i:
  - $T_{off\,\min\,ij} = \overline{T_{on\,ij}} \times \frac{1-ACR_{ij}}{ACR_{ij}}$

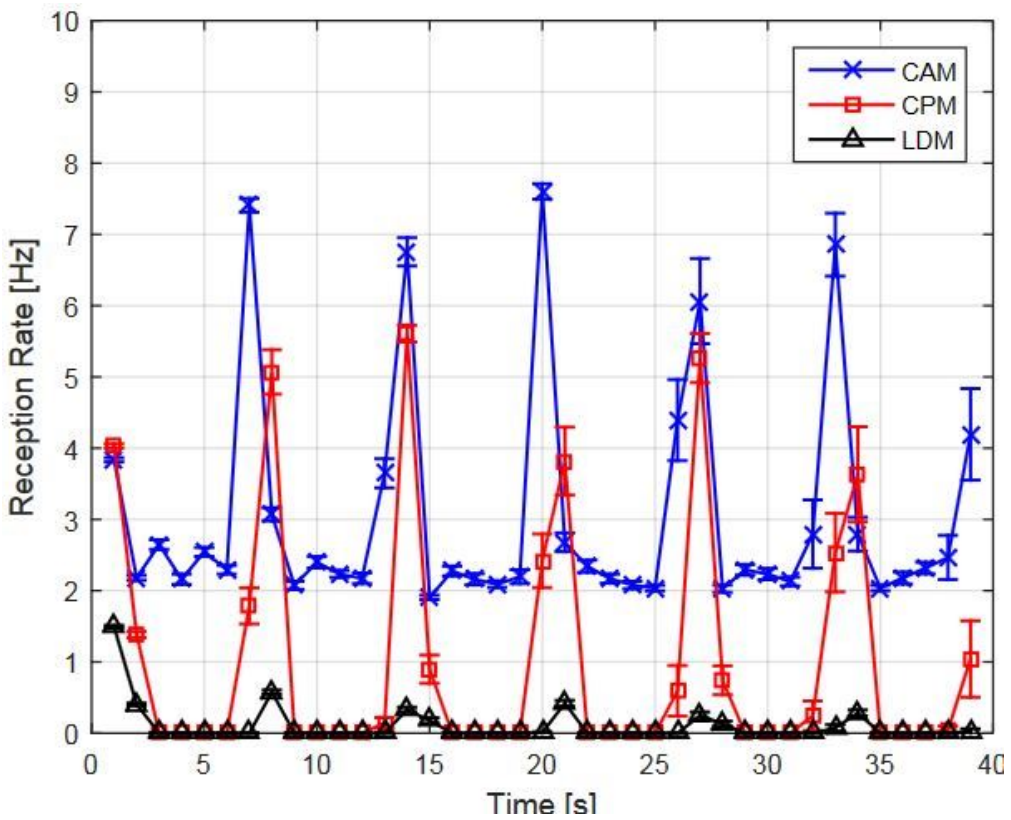
Facilities DCC – Performance Evaluation

- Facilities-layer DCC Baseline
  - Simulator:
    - iTETRIS-ns3.20
    - C-ITS/Geonet stack
    - ETSI & CAR2CAR DCC
  - T_{on} = 1ms (theory)
  - TX Rate Request:
    - AC-VI – 2Hz
    - AC-BE – 1.25 Hz
    - AC-BK – 1Hz



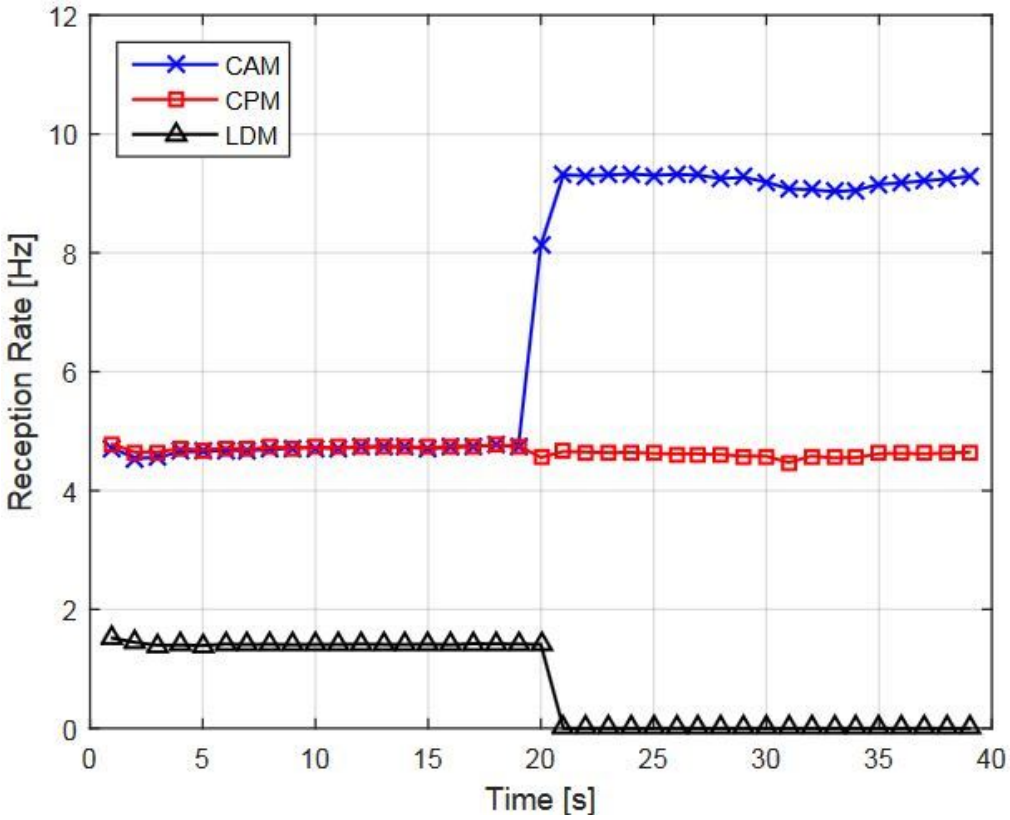
Facilities DCC – Performance Evaluation

- Facilities-layer DCC with Gatekeeper (Access DCC)
  - Simulator:
    - iTETRIS-ns3.20
    - C-ITS/Geonet stack
    - ETSI & CAR2CAR DCC
  - T_{on} = 1ms (theory)
  - TX Rate Request:
    - CAM
      - AC_BE – 5Hz – 10Hz
      - 300 Bytes [0.4ms]
    - CPM
      - AC_BE – 5 Hz
      - 900 Bytes [1.2ms]
    - LDM
      - AC_BK – 1,5 Hz
      - 1000 Bytes [1.3ml]



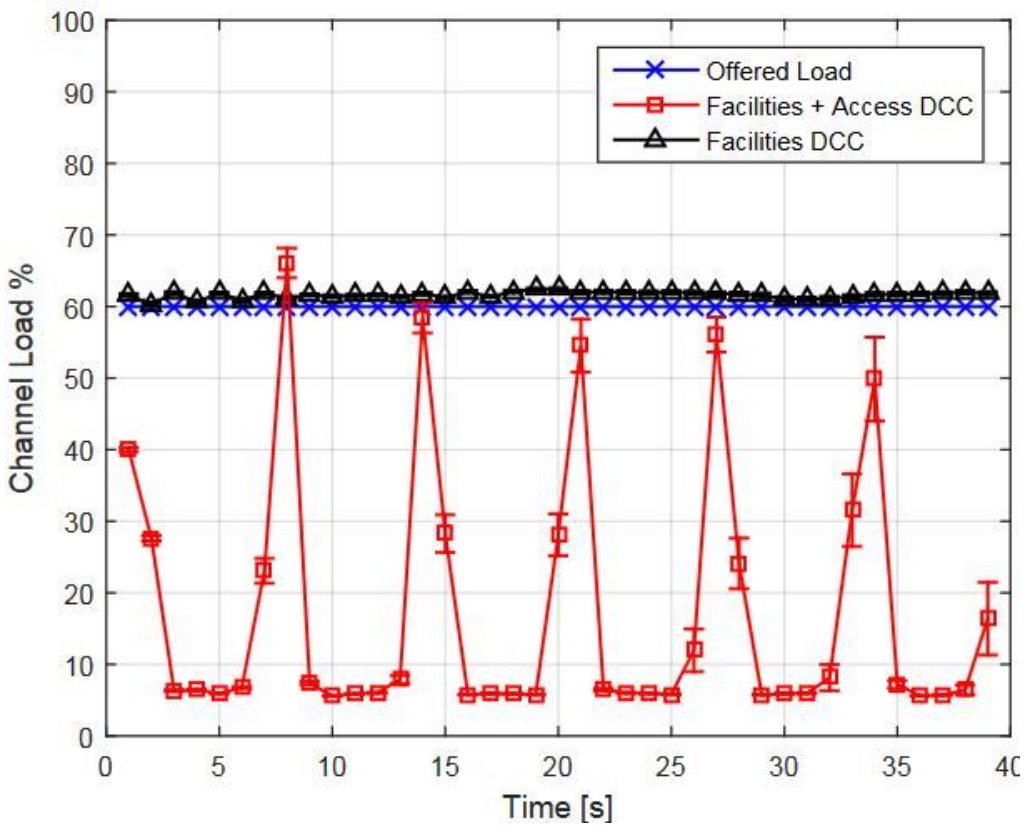
Facilities DCC – Performance Evaluation

- Facilities-layer DCC – No Gatekeeper
  - Simulator:
    - iTETRIS-ns3.20
    - C-ITS/Geonet stack
    - ETSI & CAR2CAR DCC
  - T_{on} = 1ms (theory)
  - TX Rate Request:
    - CAM
      - AC_BE – 5Hz – 10Hz
      - 300 Bytes [0.4ms]
    - CPM
      - AC_BE – 5 Hz
      - 900 Bytes [1.2ms]
    - LDM
      - AC_BK – 1,5 Hz
      - 1000 Bytes [1.3ml]



Facilities DCC – Performance Evaluation

- Facilities-layer DCC – Impact on Channel Load
  - Simulator:
    - iTETRIS-ns3.20
    - C-ITS/Geonet stack
    - ETSI & CAR2CAR DCC
  - T_{on} = 1ms (theory)
  - Channel Load:
    - Offered:
      - 60%
    - Actual mixed DCC:
      - 5% !!
    - Facilities DCC (alone)
      - 60%



Facilities DCC – Discussions

- Facilities-layer DCC is required to regulate traffic for multiple messages and applications
  - Critical for DAY 2 C-ITS
- Facilities-layer DCC needs to be integrated with the DCC_ACC
  - Gatekeeper is counter-productive
  - Best strategy: remove gatekeeper and do traffic flow at Facilities
- Facilities DCC capable to allocate resources for periodic traffic (semi-persistent scheduler)
  - One-shot or event-based allocation is more challenging
  - Might require a mix between semi-persistent and non-persistent schedulers
- Facilities DCC requires application and TC requirements. It is neither attached to a channel nor to a technology:
  - Multi-Channel DCC
  - Multi-Technology DCC
- **Next Steps**:
  - Develop an adaptive mechanism that would guarantee minimum resource between all TC and applications

Contact Details:

Jérôme Härri, Irfan Khan, EURECOM, France

Jerome.Haerri@eurecom

Mohammad-Irfan.Khan@eurecom.fr

http://hights.eu/

HIGHTS

High precision positioning for Cooperative-ITS

Thank you!