CAR 2 CAR COM/ARCH

Facilities DCC

2017/11/29

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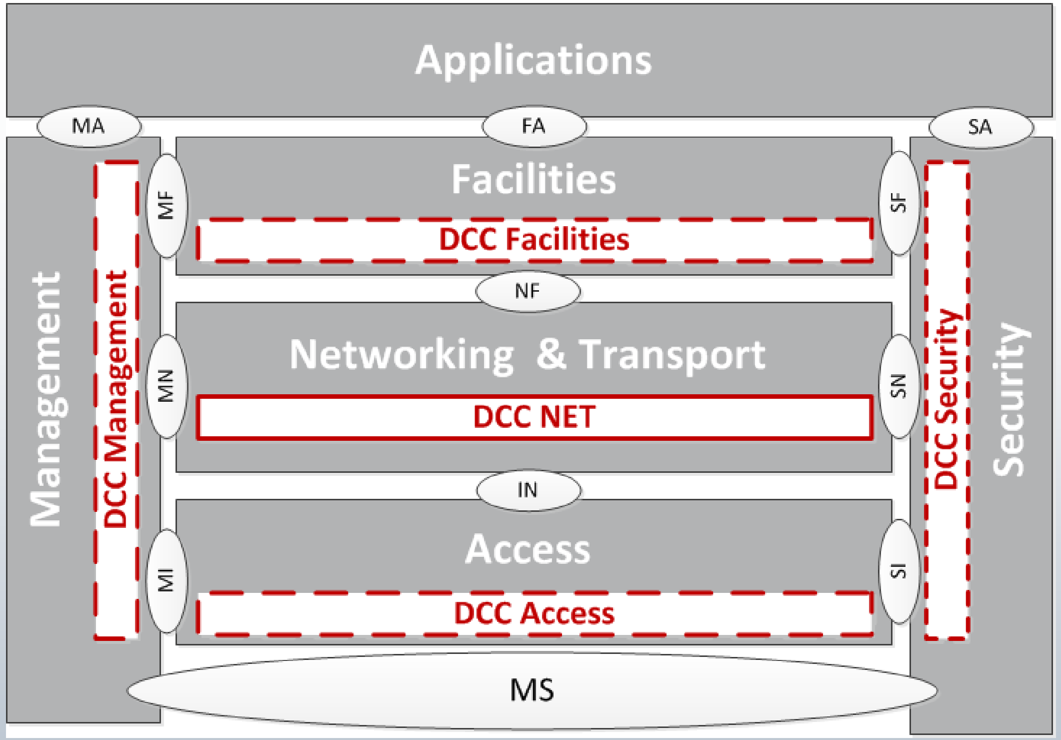
DCC Architecture at ETSI

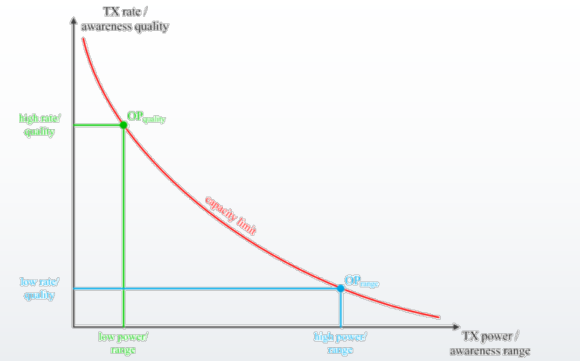
- The Wireless Vehicular Radio Channel has limited resource
  - WiFi is only best effort
  - In Ad-hoc (OCB): requires coordinated access

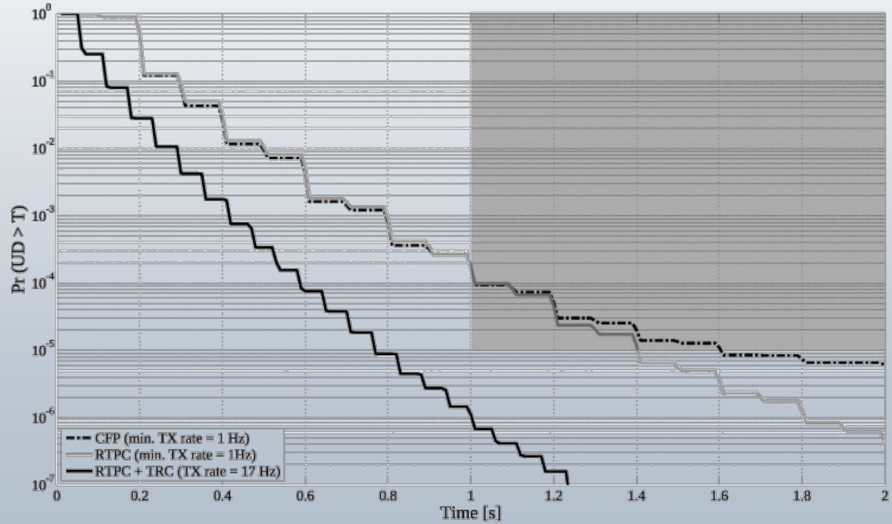
- DCC controls the load with various mechanisms
  - Adjust Tx Rate – DCC FAC
  - Adjust Tx Power – DCC NET
  - Adjust Modulation (MCS) – DCC FAC
  - Adjust Sensing Threshold – DCC ACC
  - Offloading on different channels – DCC MGMT

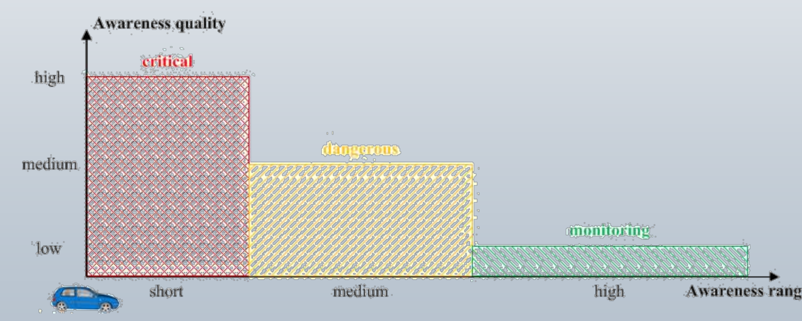


DCC Architecture at ETSI

- 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)



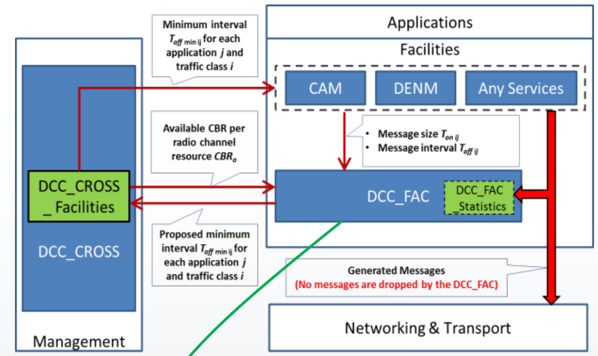


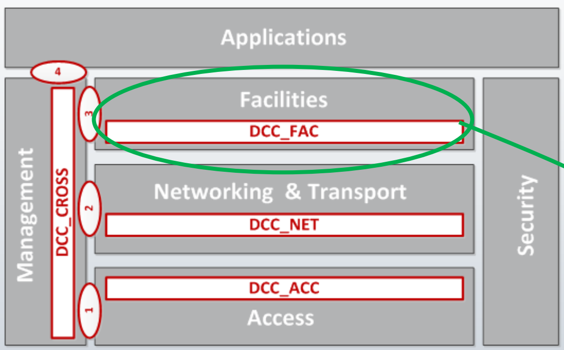


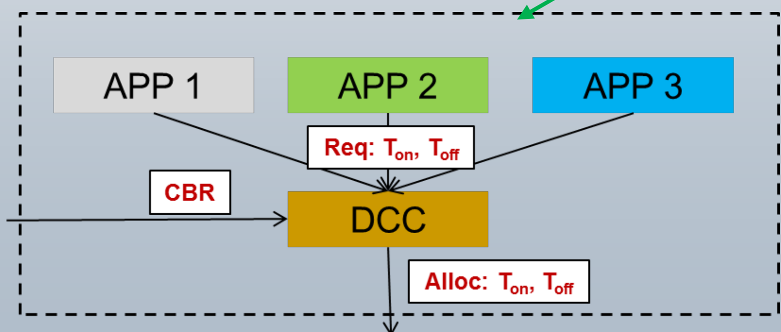
Bernhard Kloiber, Jérôme Härri, Thomas Strang, Stefan Sand, Cristina Rico Garcìa, "**Random Transmit Power Control for DSRC and its Application to Cooperative Safety**", IEEE Transaction of Dependable and Secured Communication, 2015

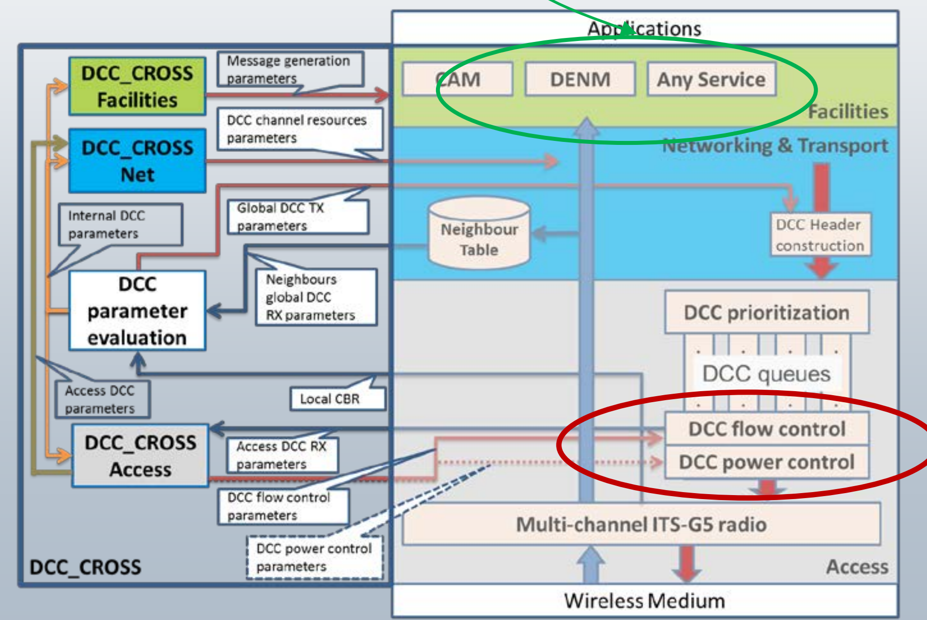
Facilities DCC Architecture

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









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:
  - $T_{off\,\min\,ij} = \overline{T_{on\,ij}} \times \frac{1-ACR_{ij}}{ACR_{ij}}$

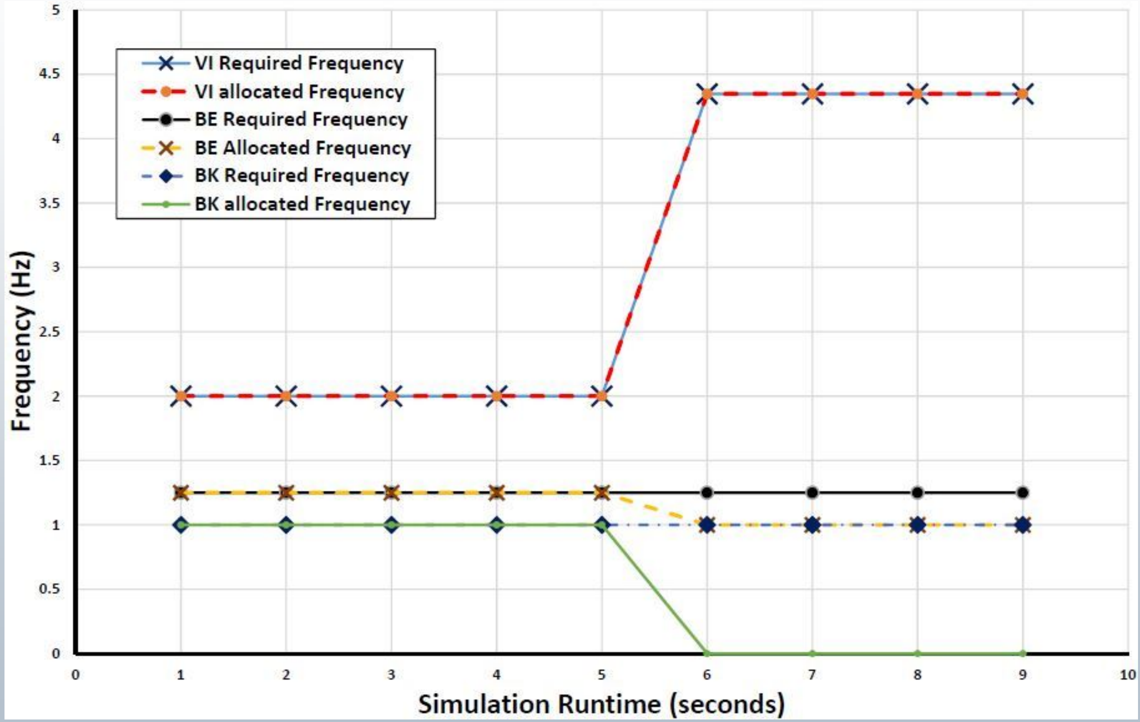
Facilities DCC – Performance Evaluation

- Facilities-layer DCC Baseline

- Simulator:
  - iTETRIS-ns3.20
  - C-ITS/Geonet stack
  - ETSI & CAR2CAR DCC

- T_{on} = 1ms

- Tx Rate Request:
  - AC-VI – 2Hz
  - AC-BE – 1.25 Hz
  - AC-BK – 1Hz



Facilities DCC – Performance Evaluation

- Facilities-layer DCC – Impact of the Gatekeeper (CAR2CAR)

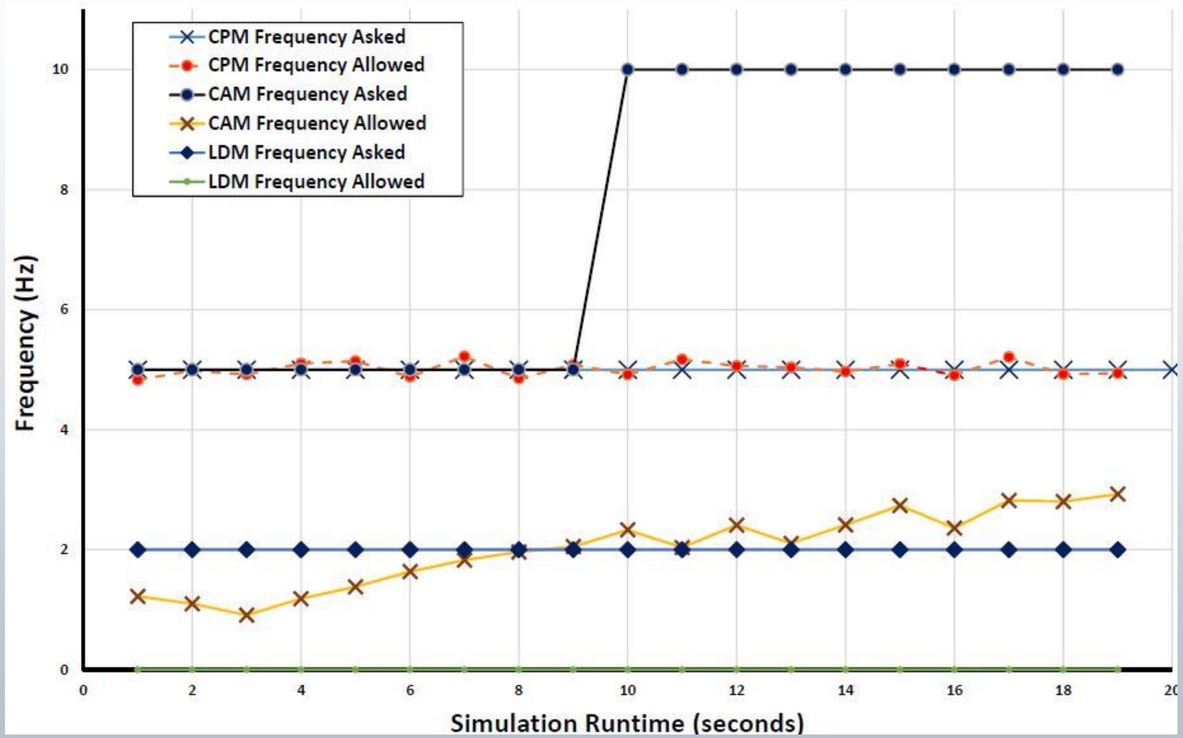
- Simulator:
  - iTETRIS-ns3.20
  - C-ITS/Geonet stack
  - ETSI & CAR2CAR DCC

- CPM – 5 Hz 900 byte
- CAM – 5Hz 300 byte
- LDM – 2 Hz 1kByte

- CAM Tx Rate not reached
  - Only 1-2Hz instead of 10Hz

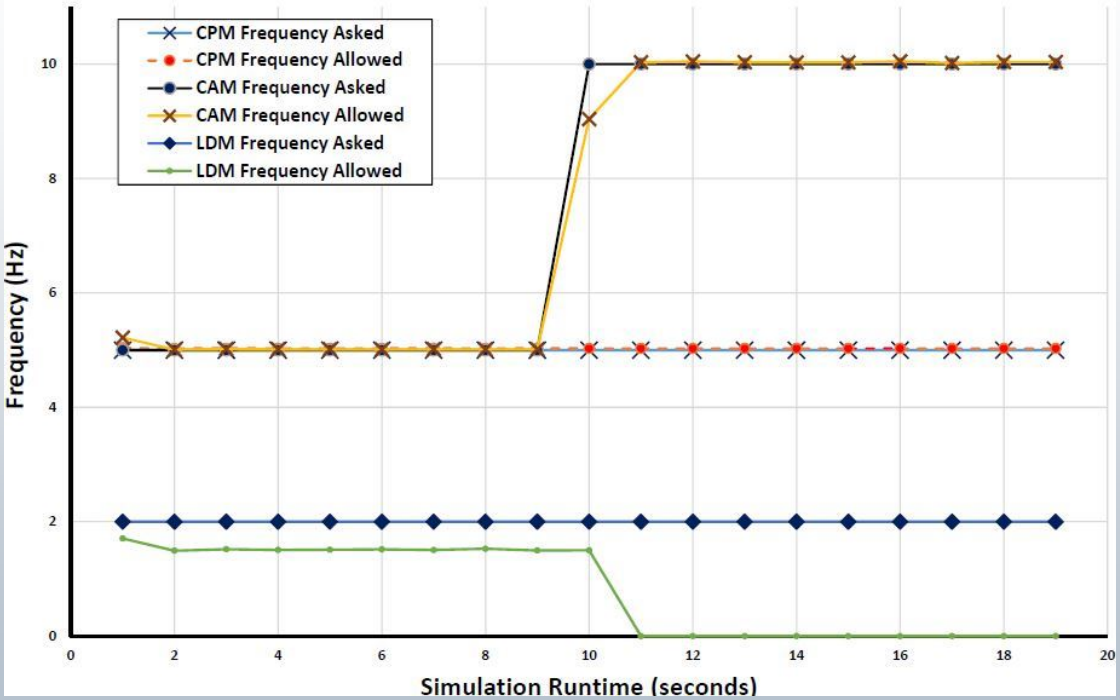
- DCC state between Active 1 and Active 2

- **Average CL: 26%**



Facilities DCC – Performance Evaluation

- Facilities-layer DCC – No Gatekeeper
- Simulator:
  - iTETRIS-ns3.20
  - C-ITS/Geonet stack
  - ETSI & CAR2CAR DCC
- CPM – 5 Hz 900 byte
- CAM – 5Hz 300 byte
- LDM – 2 Hz 1kByte
- CAM Rate increase to 10Hz
  - No LDM drop
- **Average CL: 57 %**



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**:
  - Evaluate the integration between a DCC Facilities and the CAR 2 CAR DCC mechanisms
  - Develop an adaptive mechanism that would guarantee minimum resource between all TC and applications

BACKUP SLIDES

Facilities DCC – Model

TC_i	ACR_i (ACR_{ij})	$T_{off\ ij}$	CR_i ($\overline{CRE_{ij}}$)	$T_{off\ \min ij}$
TC_1	0.005	0.499s	0.002	0.199s
TC_2	0.003	0.799s	0.00125	0.332s
TC_3	0.00175	0.999s	0.001	0.570s

Example of Sufficient Channel Resources ($CBR_a = 0.005, T_{on\ ij} = 0.001s$)

TC_i	ACR_i (ACR_{ij})	$T_{off\ ij}$	CR_i ($\overline{CRE_{ij}}$)	$T_{off\ \min ij}$
TC_1	0.005	0.299s	0.004	0.199s
TC_2	0.001	0.799s	0.00125	0.999s
TC_3	0	0.999s	0.001	∞

Example of Insufficient Channel Resources , TC2 CR 0.004 ($CBR_a = 0.005, T_{on\ ij} = 0.001s$)

Source – ETSI TS 103 141