5G-MOBIX German Trial Site Results and Lessons learnt on 5G for CAM

5G for CCAM solutions
Dual-modem/dual-SIM solution

Sebastian Peters, Technische Universität Berlin
DE TS Webinar, June 22nd 2022

5GMOBIX

5G for CCAM solutions

- Dual-modem/dual-SIM solution (10 min) - TUB Sebastian Peters

- Adaptive QoS solution (10 min) - VICOM Angel Martin

5GMOBIX

Dual-modem/dual-SIM solution
Overall Concept

- A custom solution to utilize multiple mobile networks has been developed in the DE TS based on dual-modem/dual-SIM

- The overall concept is based on **implementing a location-based switch** of the mobile network from one operator to another

  - At specific location X: Perform a switch to another operator as outcome of a decision making component of a prediction function that exploits crowdsourced coverage maps

  - An "In-advance coverage-hole notification" facilitates the **proactive creation of a new session** over another available mobile network with 5G coverage to minimize mobility interruption time


5G coverage hole

5GMOBIX
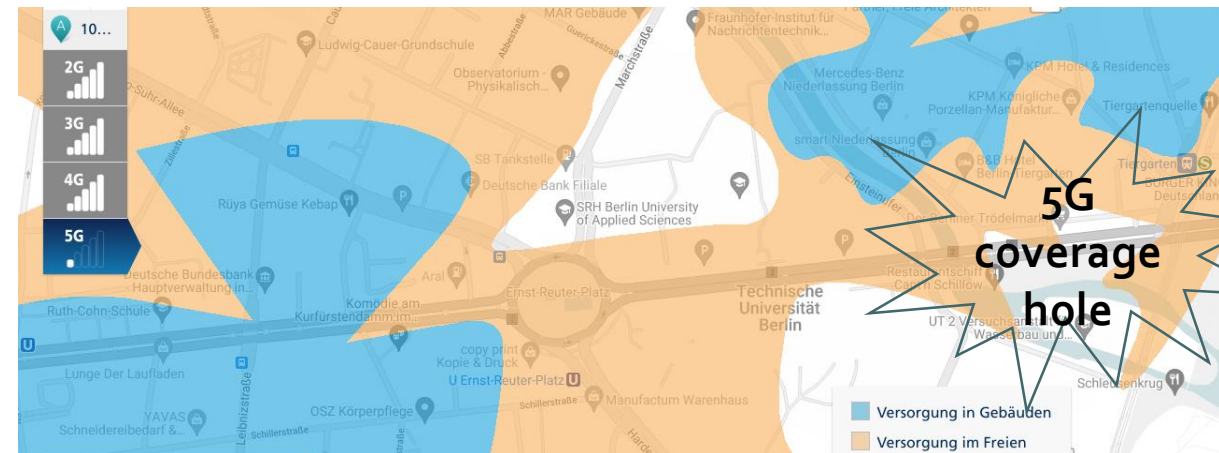
Dual-modem/dual-SIM solution
Scenario

Vulcano 2.0 TCU

- 2 commercial 5G NSA networks for testing the solution
  - Virtual border at 5G coverage hole to simulate cross-border scenario
  - Each modem has its own MQTT application client associated using the respective mobile network
  - When the location X is reached by the vehicle the application establishes connection via other modem's MQTT client.

Quectel RM500Q

- Utilized Hardware
  - 1 x 5G Modem with DT SIM (Vulcano 2.0 TCU)
  - 1 x 5G Modem with O2 SIM (Quectel RM500Q)
  - 1 x Cohda Wireless MK6c
  - 1 x Neousys Nuvo-8108GC as On-Board Unit

Cohda Wireless MK6c

5GMOBIX
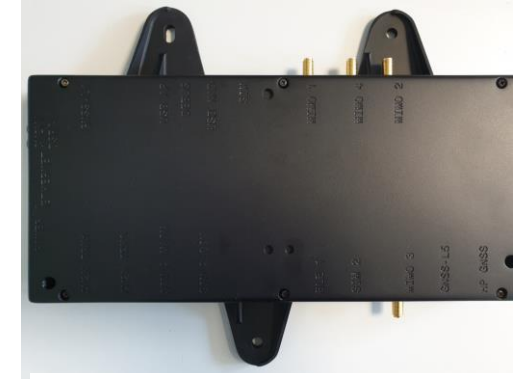
Dual-modem/dual-SIM solution
Technical Realization

- Python Application utilizing GPS of Cohda box
  - A received location-based trigger causes the change of MNO by calling the Linux network manager command-line client:
    - deactivateO2 = 'nmcli con down \'o2\''
    - activateDT = 'nmcli con up \'DT\''
  - Two potential ways of exploiting the coverage map:
    - Query database for full route ahead and store switching locations locally
    - Subscribe for "In-advance coverage-hole notification"

In-vehicle deployment of dual modem / dual SIM solution

5GMOBIX

Dual-modem/dual-SIM solution

Coverage Map Approach

Coverage Map Database

	id	signalStrength	networkProvider	cellId	frequency	gpsNmea	
1	6	-122	Telekom	102	6200	$GPGGA,092855.809,5230.756,N,01319.317,E,1,12,1.0,0.0,M,,0.0,M,,63	$GPGSA,A,...
2	7	-96	Telekom	199	6700	$GPGGA,092855.809,5230.397,N,01320.028,E,1,12,1.0,0.0,M,,0.0,M,,6F	$GPGSA,A,...
3	8	-141	Telekom	107	6500	$GPGGA,092855.809,5230.707,N,01318.635,E,1,12,1.0,0.0,M,,0.0,M,,63	$GPGSA,A,...
4	9	-104	Telekom	105	7000	$GPGGA,092855.809,5230.689,N,01318.316,E,1,12,1.0,0.0,M,,0.0,M,,60	$GPGSA,A,...
5	10	-35	Telekom	154	6400	$GPGGA,092855.809,5230.654,N,01317.781,E,1,12,1.0,0.0,M,,0.0,M,,65	$GPGSA,A,...
6	11	-96	Telekom	119	6000	$GPGGA,092855.809,5230.604,N,01316.986,E,1,12,1.0,0.0,M,,0.0,M,,68	$GPGSA,A,...
7	12	-108	Telekom	186	6500	$GPGGA,092855.809,5230.557,N,01316.359,E,1,12,1.0,0.0,M,,0.0,M,,65	$GPGSA,A,...
8	13	-77	Telekom	102	6300	$GPGGA,092855.809,5230.756,N,01319.317,E,1,12,1.0,0.0,M,,0.0,M,,63	$GPGSA,A,...
9	14	-91	Telekom	199	6800	$GPGGA,092855.809,5230.397,N,01320.028,E,1,12,1.0,0.0,M,,0.0,M,,6F	$GPGSA,A,...
10	15	-110	Telekom	107	6600	$GPGGA,092855.809,5230.707,N,01318.635,E,1,12,1.0,0.0,M,,0.0,M,,63	$GPGSA,A,...
11	16	-134	Telekom	105	6800	$GPGGA,092855.809,5230.689,N,01318.316,E,1,12,1.0,0.0,M,,0.0,M,,60	$GPGSA,A,...
12	17	-82	Telekom	154	7000	$GPGGA,092855.809,5230.654,N,01317.781,E,1,12,1.0,0.0,M,,0.0,M,,65	$GPGSA,A,...
13	18	-36	Telekom	119	6400	$GPGGA,092855.809,5230.604,N,01316.986,E,1,12,1.0,0.0,M,,0.0,M,,68	$GPGSA,A,...
14	19	-59	Telekom	186	6100	$GPGGA,092855.809,5230.557,N,01316.359,E,1,12,1.0,0.0,M,,0.0,M,,65	$GPGSA,A,...
15	20	-145	O2	102	6200	$GPGGA,092855.809,5230.756,N,01319.317,E,1,12,1.0,0.0,M,,0.0,M,,63	$GPGSA,A,...
16	21	-48	O2	199	6000	$GPGGA,092855.809,5230.397,N,01320.028,E,1,12,1.0,0.0,M,,0.0,M,,6F	$GPGSA,A,...
17	22	-148	O2	107	6600	$GPGGA,092855.809,5230.707,N,01318.635,E,1,12,1.0,0.0,M,,0.0,M,,63	$GPGSA,A,...

Measurement Representation

Coverage Mapper Architecture

In-vehicle deployment

5G MOBIX
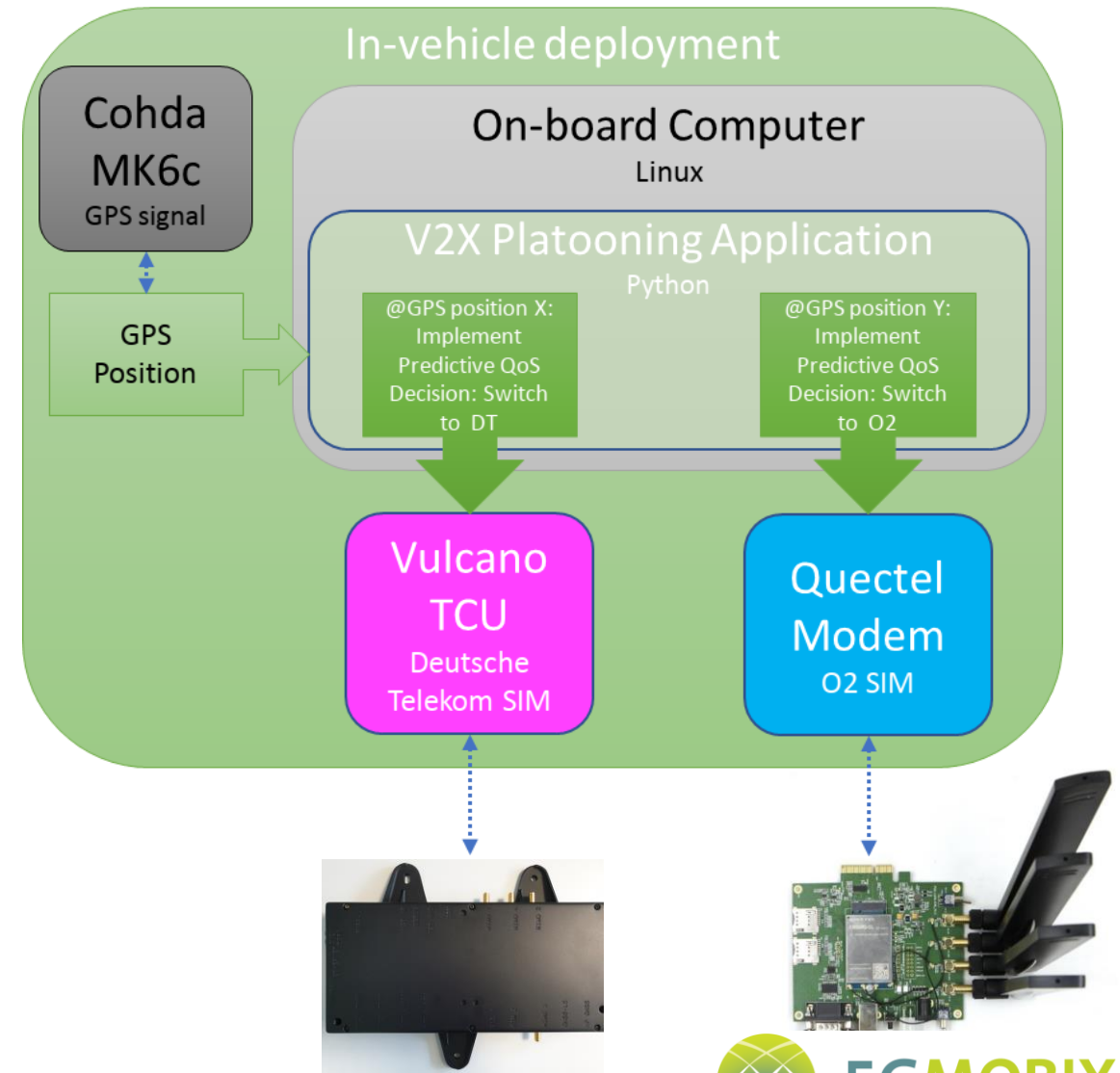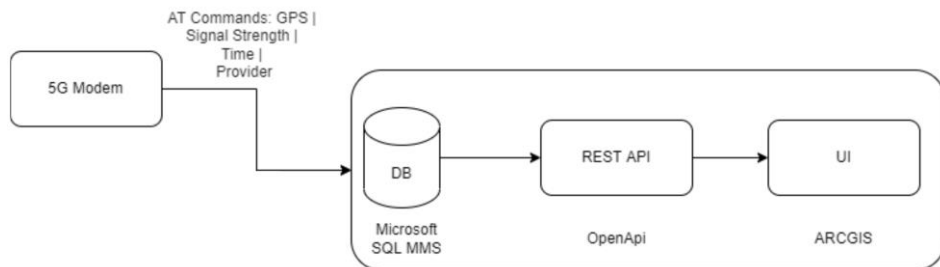
Dual-modem/dual-SIM solution
Conclusions

- True Dual-SIM Dual-Active functionality in 5G modems will supersede our dual-modem concept, eSIM functionality will enable replacement of conventional SIMs -> Predictive QoS approaches will see a deeper integration on the vehicle V2X application side

- The DE TS trials of the custom multi-SIM solution have shown the viability of utilizing the GPS position to implement mobile network switching decisions for V2X applications that can tolerate reconnections

  - In contrast to EDM service more complex stateful-applications require the appropriate handling on the respective network and application layers before breaking the connection

5G MOBIX

Thank you

5GMOBIX

www.5g-mobix.com