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VDI|VDE|IT

Connected Vehicle (V2X) of Tomorrow

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Audi ERICSSON Qualcomm swarco TECHNISCHE UNIVERSITÄT KAISERSLAUTERN

ConVeX – Connected Vehicle (V2X) of Tomorrow

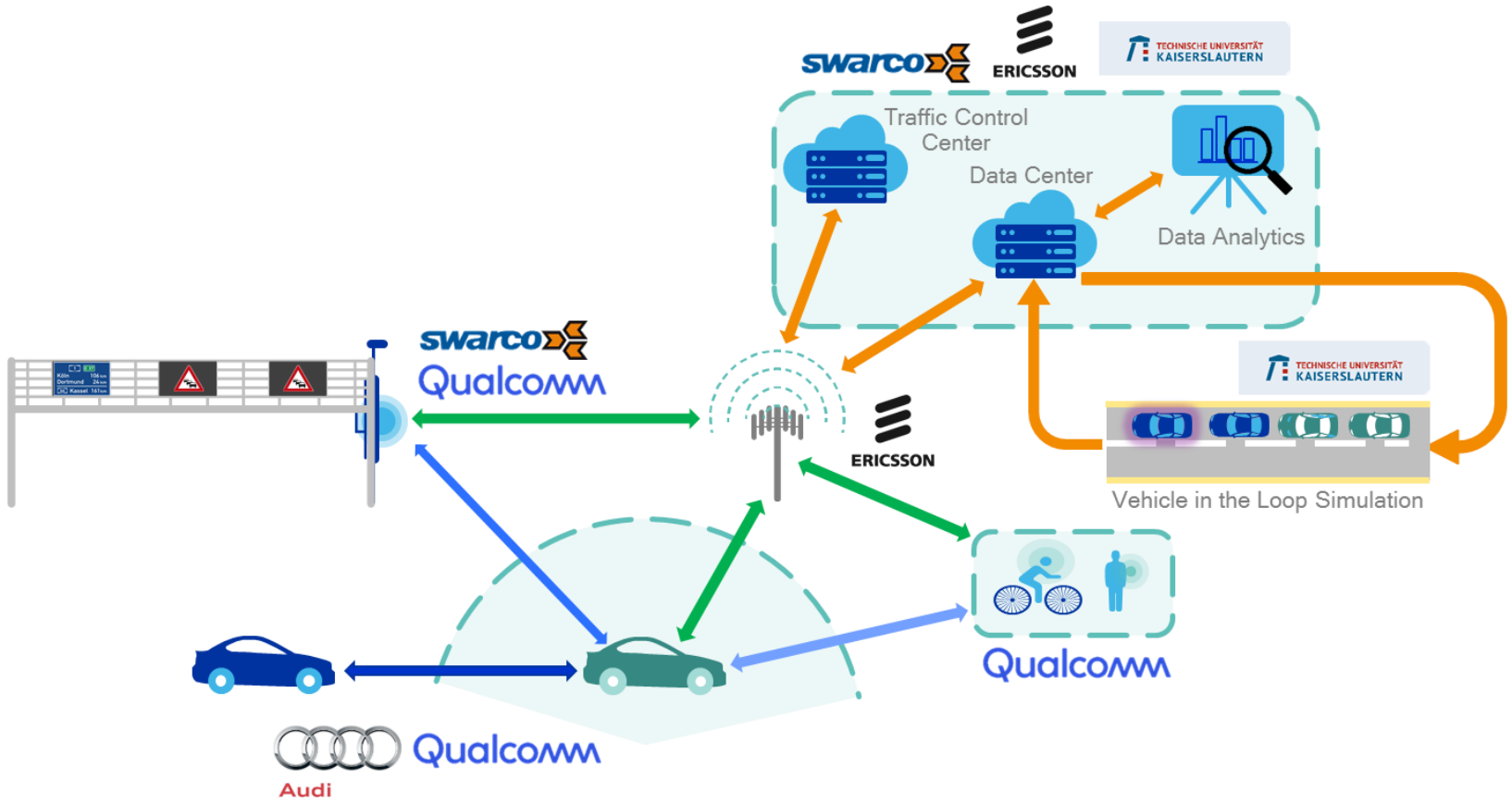
- Funded by: German Ministry of Transportation and Digital Infrastructure (BMVI) in the program "Automated and Connected Driving on Digital Test Fields in Germany"
- Objective: Set-up testbed for first field tests of 3GPP LTE Release 14 Cellular-V2X (C-V2X) and validate performance and feasibility
- Consortium: Qualcomm (lead), Audi, Ericsson, Swarco Traffic Systems, Technical University of Kaiserslautern
- Duration: 1-December-2016 to 30-June-2019

Qualcomm Audi ERICSSON swarco Technische Universität Kaiserslautern Bundesministerium für Verkehr und digitale Infrastruktur

Project Goals

- Demonstrate benefits of using a unified C-V2X connectivity platform, as defined by 3GPP (Release 14):
  - V2V/V2I/V2P direct communications (PC5, aka LTE-sidelink)
  - 4G/5G-based vehicle-to-network (V2N) communication
  - ETSI-ITS upper layer stacks
  - Comparative study of LTE-sidelink versus ETSI ITS-G5 technology
- Showcase C-V2X range, reliability and latency advantage for real-time V2X communications
- Highlight new use cases that help support traffic flow optimization, improve safety and pave the path to automated driving
- Evaluate radio communications, performance and user experience under real traffic conditions
- Use trial results to inform regulators, provide important inputs to standardization and shape a path for further development and future evolution of cellular V2X technology
  - Including a transition towards 5G New Radio (NR)

High Level Network Architecture



PC5

V2V: Vehicle-to-Vehicle

V2I: Vehicle-to-Infrastructure (i.e., to RSU)

V2P: Vehicle-to-Pedestrian

Uu

V2N: Vehicle-to-Network

Other (Backhaul) Links

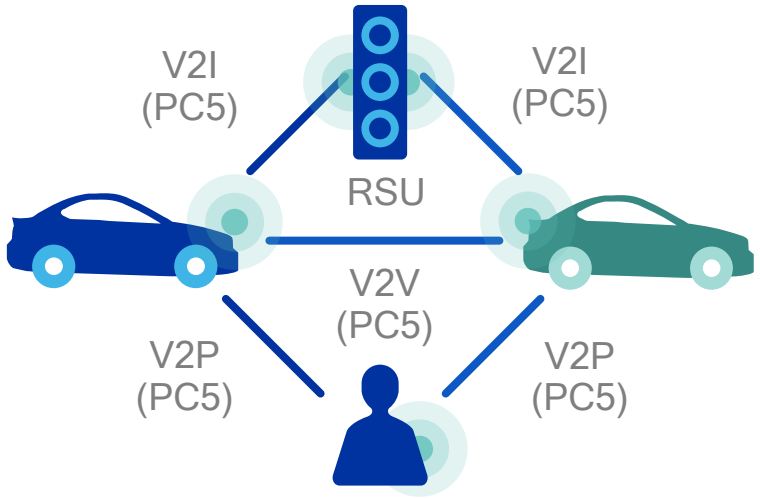
C-V2X Defines Two Complementary Transmission Modes

Direct Communications

V2V, V2I, and V2P on “PC5” Interface,
can operate in ITS bands (e.g., ITS 5.9 GHz)
independent of cellular network

PC5 interface

e.g., location, speed

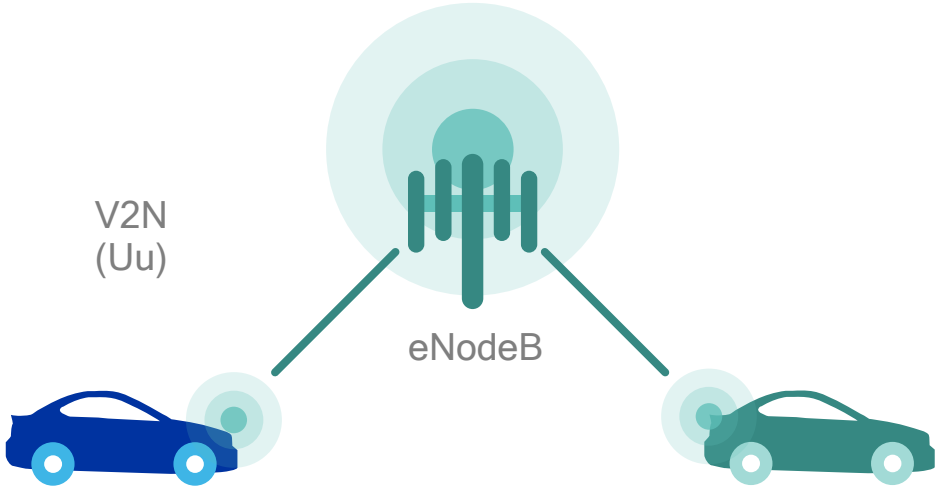


Network Communications

V2N on “Uu” interface operates in traditional
mobile broadband licensed spectrum

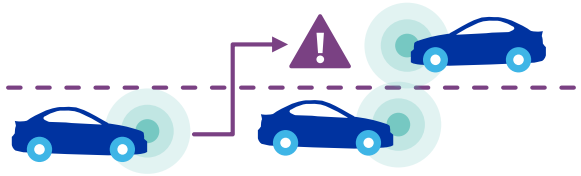
Uu interface

e.g., accident 2 kilometer ahead



Example Use Cases

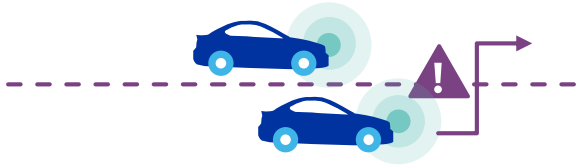
Emergency Electronic Brake Light
& Forward Collision Warning



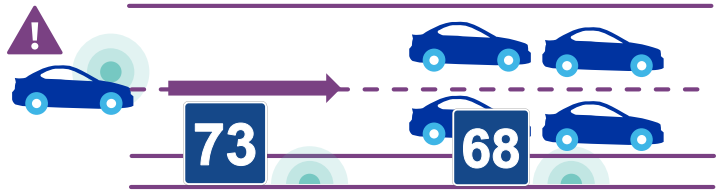
Do Not Pass Warning

Blind
Intersection
Movement
Assistance

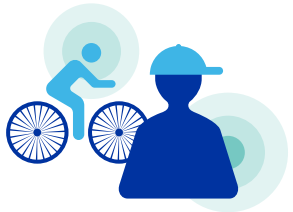
Road Works Warning /
In Vehicle Information



Blind Spot Warning /
Lane Change Warning



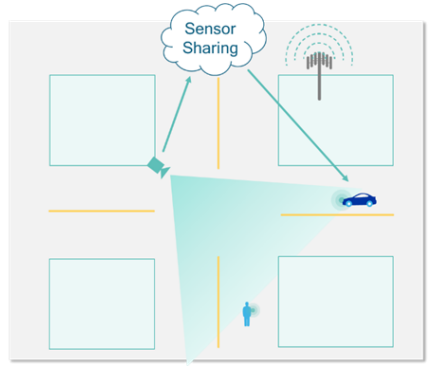
Queue Warning &
Speed Recommendation for
Shock Wave Damping



Vulnerable Road
User (VRU) alerts

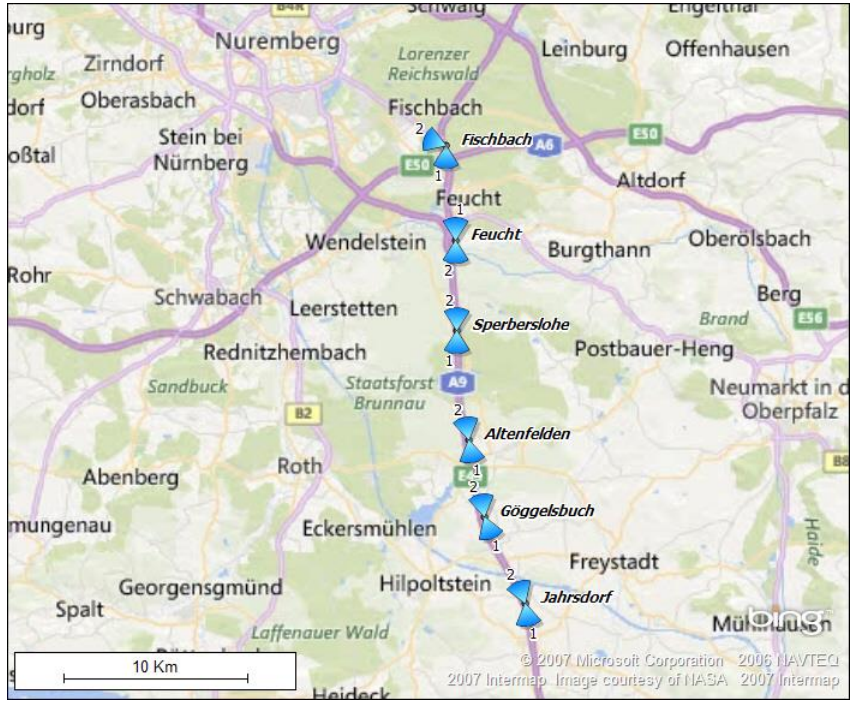
Follow Me (& other direct
communication services)

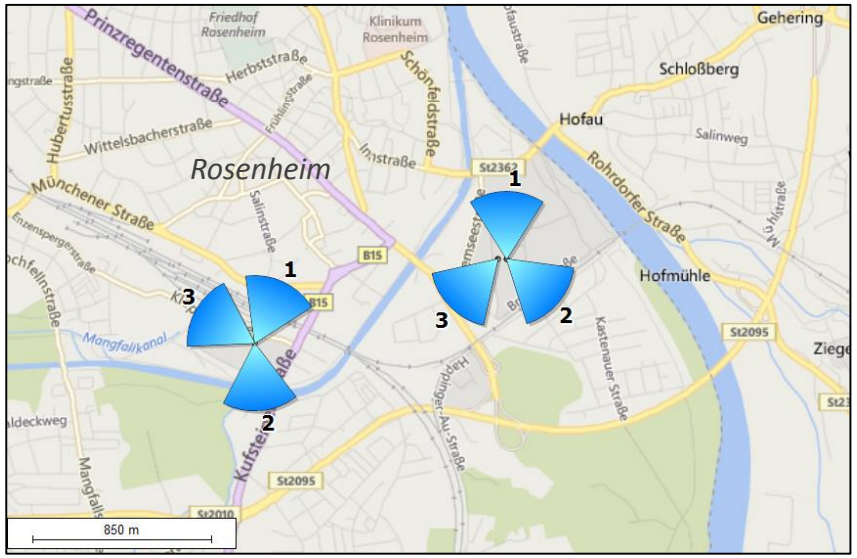
Sensor Sharing
(V2N)



Field Trial Locations

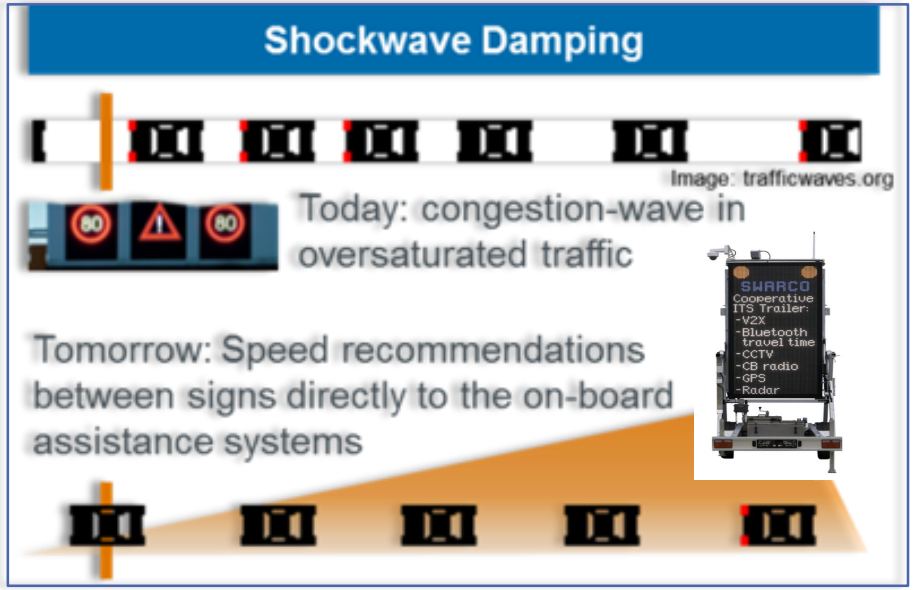
- Ericsson 5G testbed A9
  - 34 km section of the A9 south of Nuremberg
  - 6 base stations with 2 sectors each
- Ericsson 5G testbed Rosenheim
  - Urban and suburban environment
  - 2 base stations with 3 sectors each
- Testbed infrastructure owned and operated by Ericsson
- Supports V2N use cases and data upload via CCard





Example: Shockwaves

- Use Case: Speed Recommendation for Shock Wave Damping
  - Vehicle-to-Infrastructure (V2I)
  - Highways
    - Road blockings
    - Entry & exit ramps
    - Slow moving vehicles
- Approach & Tools
  - Simulation environment (SUMO)
  - Road side units & cars equipped with C-V2X DP boards integrated into (real-time) simulation
- Goal
  - By exclusive or hybrid simulation of real-world car in high traffic scenario proof of avoidance algorithms' functionality



Summary and Outlook

- C-V2X Technology
  - Supports both, today's basic safety and innovative advanced use cases
  - Enhanced communication range, higher reliability, higher vehicle speed
  - Designed to enable continuous evolution to 5G while maintaining backward compatibility
  - Gaining support from automotive and telecom leaders (5G Automotive Association)

- ConVeX Status and Outlook
  - ☑ Preparing steps accomplished (WP1 – use cases, WP2 - architecture, WP3 – C-V2X technology)
  - ➔ Vehicle and RSU integration
  - ➔ Field tests in designated test areas
  - ➔ Use case realization and evaluation (V2V, V2I, V2N)