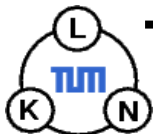# Car-to-Car Communication

Stephan Eichler, Christoph Schroth, Jörg Eberspächer
<s.eichler@tum.de>

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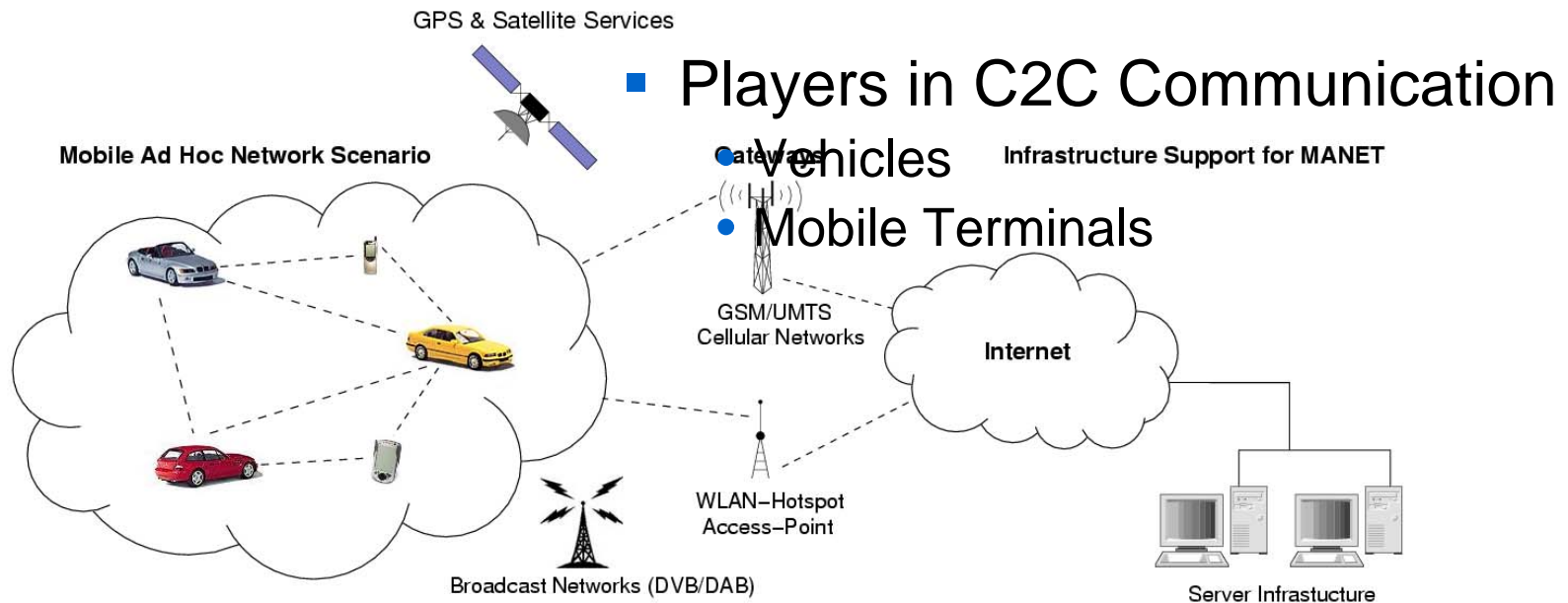Lehrstuhl für Kommunikationsnetze
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Outline

- **Motivation**

- **Technologies and Service Types**

- **Research Challenges**

- **Selected Research Results**
  - GST Telematics Platform
  - Efficient Message Dissemination for C2CC
  - Hybrid Simulation
  - Security – the real challenge

- **Conclusion**

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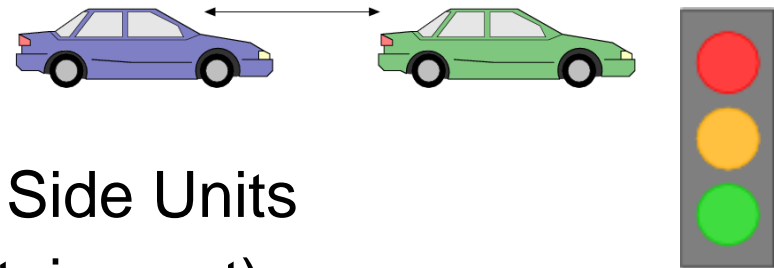
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Motivation for C2C Communication

- **Reduce road fatalities with active safety**
- Use communication for new services
  - Up-to-date traffic information
  - Active & adaptive navigation services
  - Infotainment

C2C + Car-to-environment!

- Players in C2C Communication
  - Vehicles
  - Mobile Terminals

GPS & Satellite Services

Mobile Ad Hoc Network Scenario

Gateway

Infrastructure Support for MANET

GSM/UMTS
Cellular Networks

Internet

WLAN–Hotspot
Access–Point

Broadcast Networks (DVB/DAB)

Server Infrastucture

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Rich Choice of Technologies and Services

- **Wireless Access Technologies**
  - IEEE 802.11 WLAN
  - Dedicated Short Range Communication (DSRC)
  - GPRS/UMTS
  - Down the line: IEEE 802.11p (C2C Comm.)

- **Service Types**
  - Inter-vehicle Services
  - Services provided by Road Side Units
  - Portal-based Services (Infotainment)

- **Besides technology:**

  Definition of a **business case!**

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Possible Services for C2C Networks

- ## Car-to-Car Services

  - Exchange of traffic information
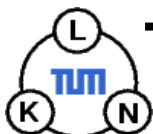 - Exchange of weather or road conditions

- ## Car-to-Infrastructure Services

  - Active road side infrastructure
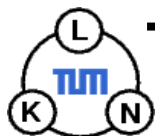 - Road Side Units (RSU) as information points

- ## Portal-based Services

  - Use of a Telematics platform
  - Services like „Pay-as-you-drive" insurance
  - Fleet management
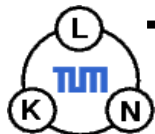 - Internet access in the vehicle

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Research Challenges for C2C

- **Protocols and Wireless Access**
  - Scalability: Shared Medium $\Rightarrow$ limited resources & capacity
  - Robust and reliable communication even at high speeds
  - Efficient data dissemination schemes for large networks (>> 100 nodes)

- **Integration and Definition of Security and Privacy**
  - Realization of efficient trust environments (PKI)
  - Reliability of nodes, routes, and messages
  - Sufficient anonymity for mobile nodes

- **Quality of Service and Realtime Communication**
  - Depending on Service class and application
  - Key issue: low latency (e.g. for collision warning)

- **„Open" Platforms**
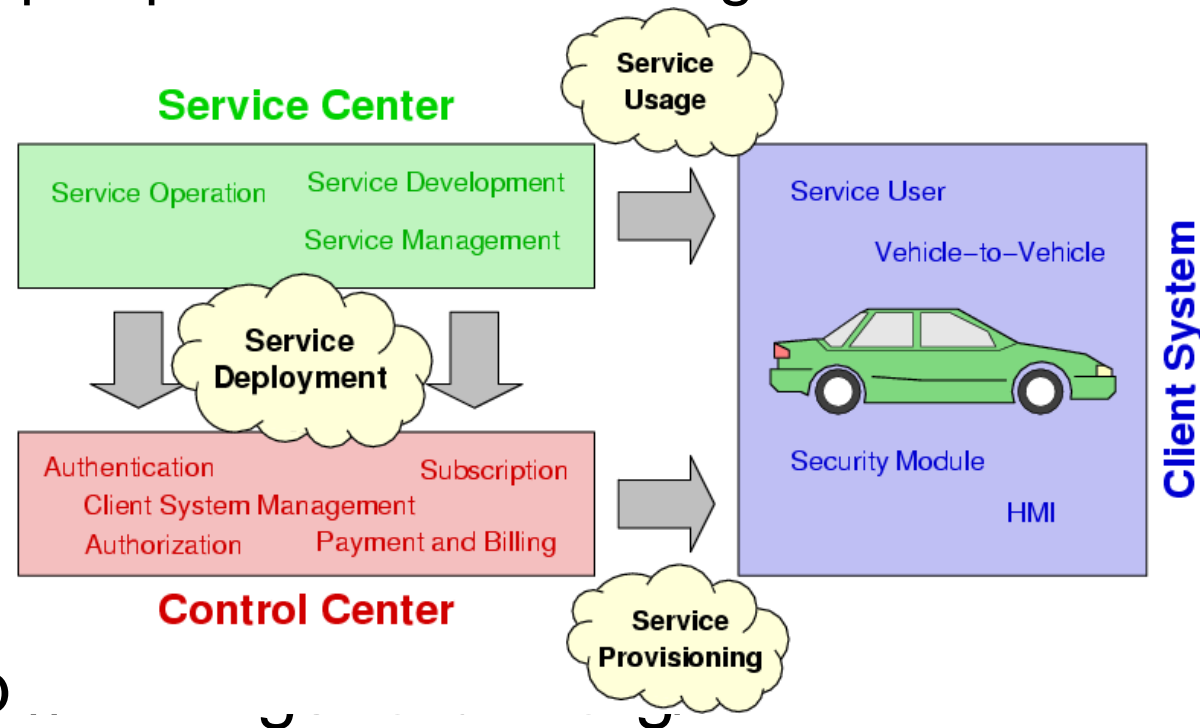
- **Realistic Simulation Systems**

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Overview of Selected Research Results

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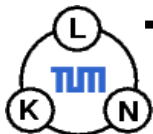S. Eichler
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The GST Telematics Service Platform

- **GST: Global System for Telematics**
- **Vision:** Standard for Vehicular Telematics Platforms
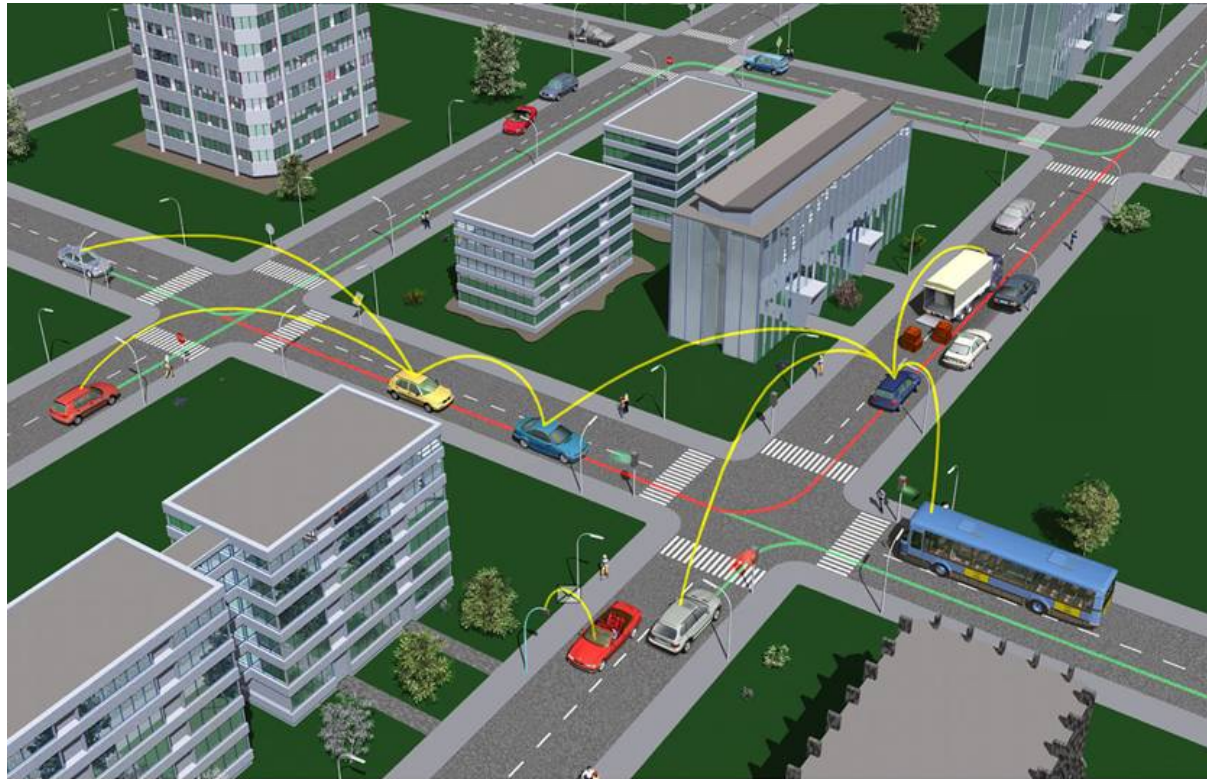 - Open platform with reconfigurable services

- http

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GST: Project Details & Status

- **Integrated EU project (FP6)**
- **Consortium with 49 companies**
  - **OEMs:** BMW, DaimlerCrysler, Fiat, Ford, Renault, Volvo
  - Project Management: ERTICO
- **Vision/Goal: Open environment $\Rightarrow$ generate a de facto standard**
- **Status: Reference Implementation and Evaluation**
- **http://www.gstforum.org/**

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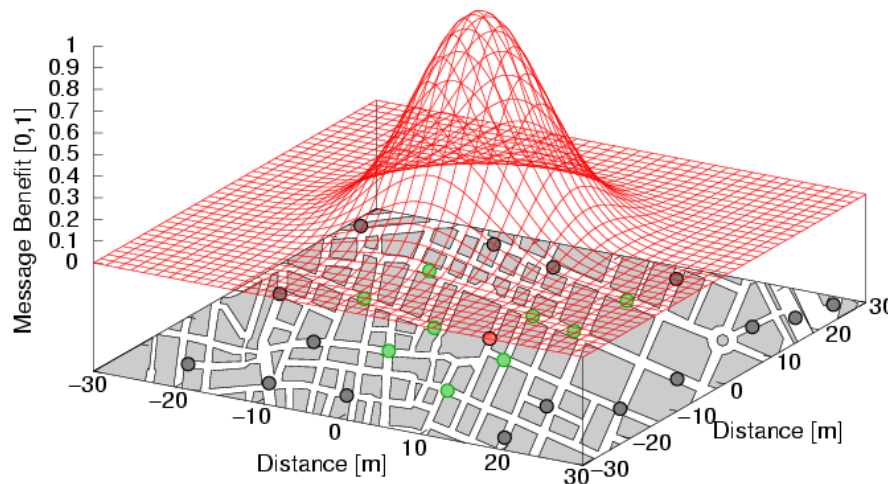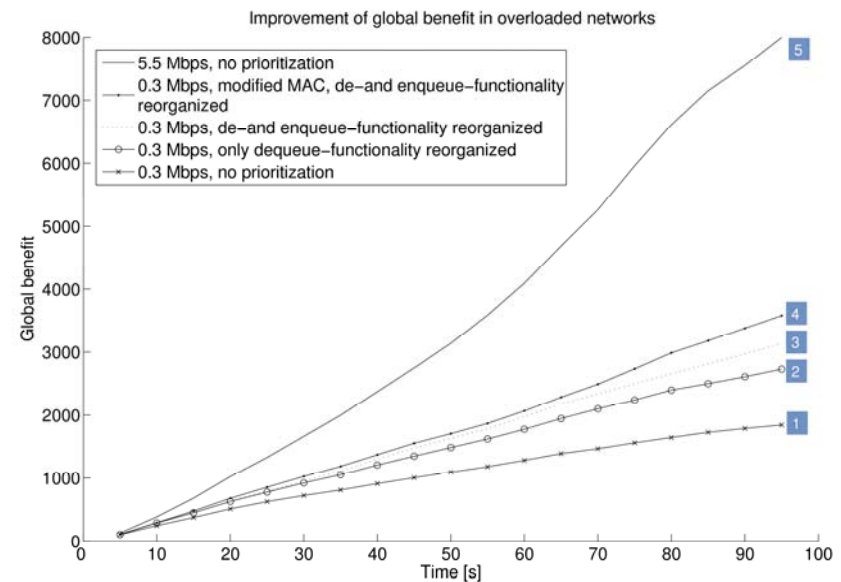
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C2C Message Dissemination

- Hazard warning & traffic status information
- Dissemination by „smart" broadcast
- Techniques for scalability and QoS needed

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Scalability for Message Dissemination

- **Many parallel information services**

  $\Rightarrow$ Network congestion

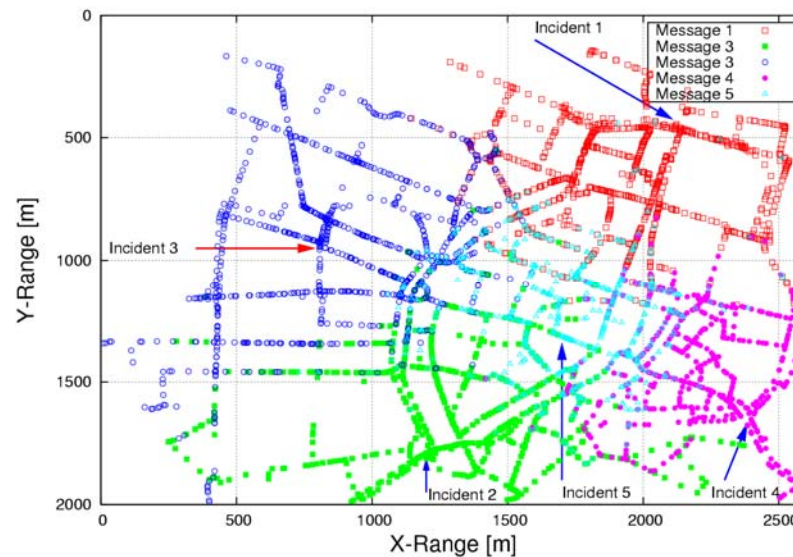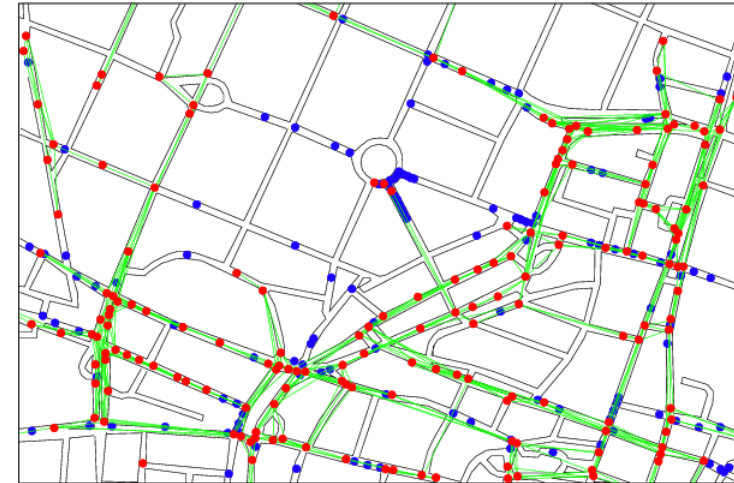- **New approach: Use context information to prioritize messages (benefit maximization)**

Benefit changing over distance

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Hybrid Network Simulation

- Goals:
  - Investigation of coverage, connectivity and QoS in realistic environments
  - Vehicle movement on real maps
  - Mobility simulator connected with network simulator (CARISMA, SUMO, ns2)
  - C2C services can be evaluated with realistic settings
  - **Key issue**: Scalability for scenarios with 500 nodes and more

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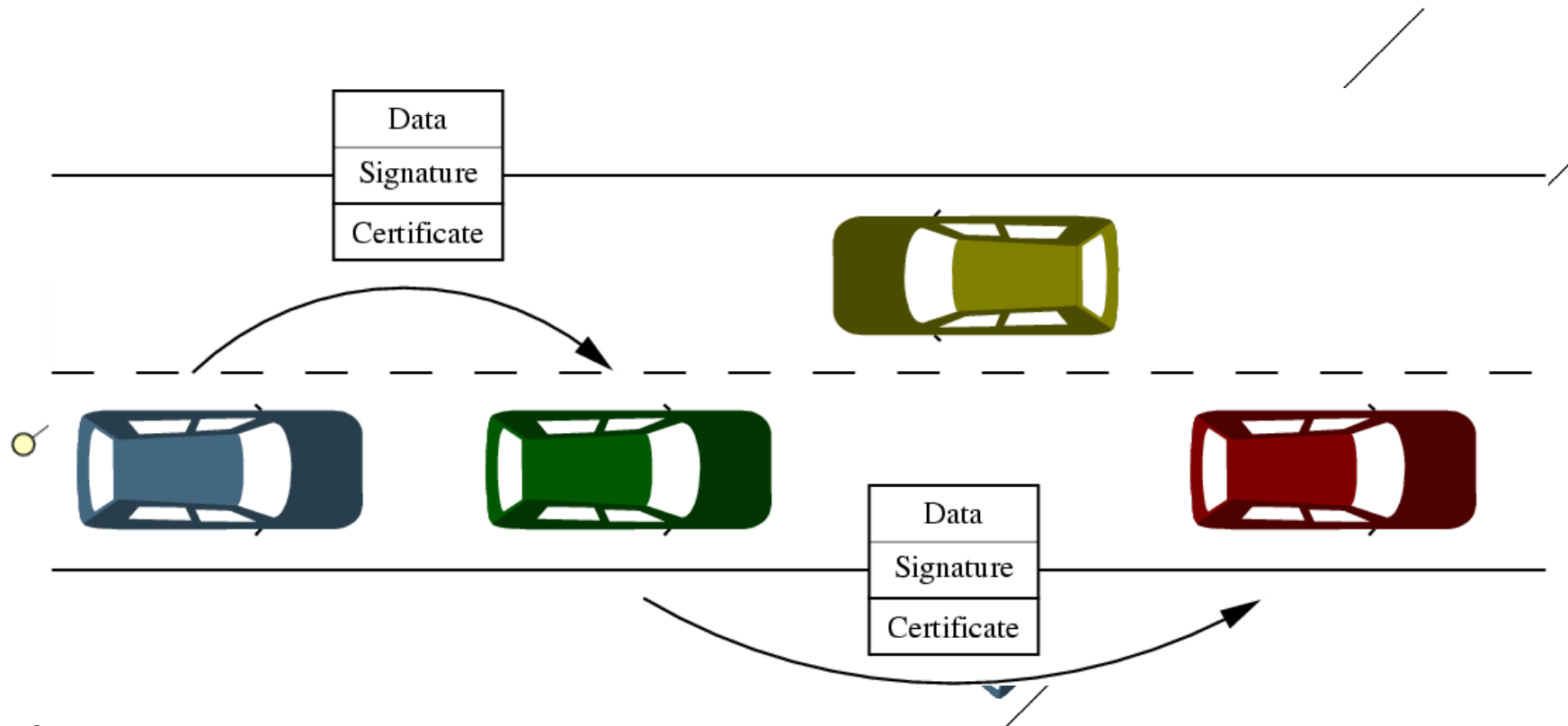
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Highspeed and Low Latency for C2C

- Needed for collision warning & intersection assistance

- Research for autonomous and cognitive vehicles (SFB/Transregio 28 „**KogniMobil**")
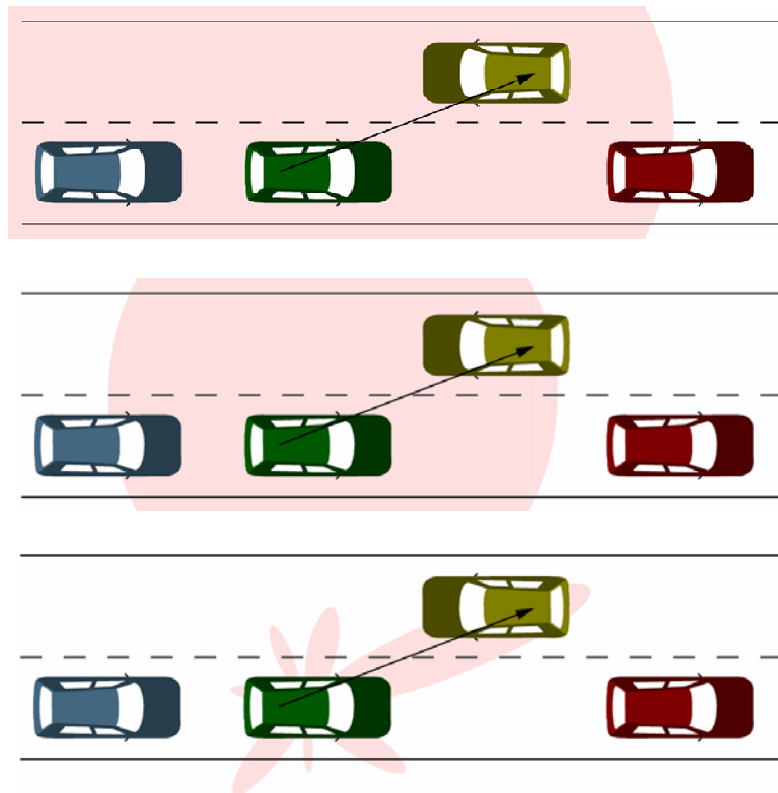
- Conventional Broadcast
  - ➔ Interference
  - ➔ Collisions lead to delays

- Power Control
  - ➔ reduced interference
  - ➔ fewer collisions, higher capacity

- Beamforming concepts
  - ➔ reduced interference
  - ➔ improved connectivity

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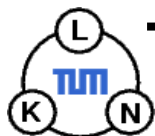
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Security & Trust for C2C Environments

- Trustability of nodes and messages is crucial
- Introduction of Trust with Public-Key Cryptography
- Vehicles use certificates to authenticate

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Challenges for Security Integration

- **Reduction of data overhead necessary!**
  - More efficient protocols with improved scalability
  - Lower delay times
  - ➔ Use of improved schemes (e.g. Elliptic-Curve Cryptography)

- **Security aware data dissemination & routing**
  - Use of efficient **and** secure routing schemes
  - Data dissemination with content verification & authentication

- **Integration of privacy aspects (anonymity)**
  - Limited traceability of vehicles
  - Linking of actions, identities, pseudonyms has to be prevented

- **Intrusion detection and exclusion of compromised nodes**
  - Design of security schemes resistant to internal attackers

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Conclusion and Outlook

- New services will be possible with C2CC

- Rich technology variety, however, basic C2C technology will be similar to WLAN

- Open integrated service platform concepts available (GST)
  - Services need to be developed / invented
  - Integration into existing business processes

- New message dissemination approaches
  - Improving e.g. benefit, capacity, and delay times
  - Make schemes more scalable

- Security concepts available; open issues:
  - Realtime, overhead, privacy
  - Fully operable integrated solutions

C2C Communication will be a key component of future telematics systems

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