UNIVERSITEIT GENT

Development of Vehicular Ad Hoc Network Routing Protocols using the Click Modular Router

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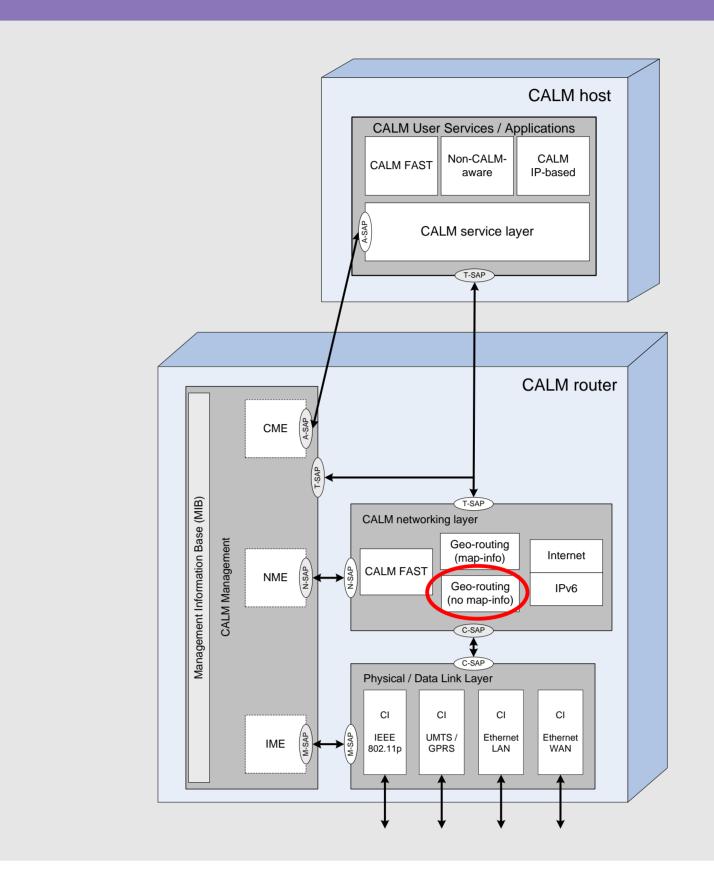## Intelligent Transport Systems

Intelligent Transport Systems (ITS): ICT systems that enable a more efficient and safer traffic through the use of a wide range of diverse technologies.

Cooperative Systems: ITS applications that rely on vehicle-to-vehicle (V2V) and local vehicle-to-infrastructure (V2I) communication to increase the quality of information about the road conditions and other vehicles in their immediate environment.

Applications: e.g. traffic jam detection, obstacle warning, ghost driver alert, slippery surface announcements, emergency vehicle warnings, rerouting of traffic in case of incidents, etcetera.

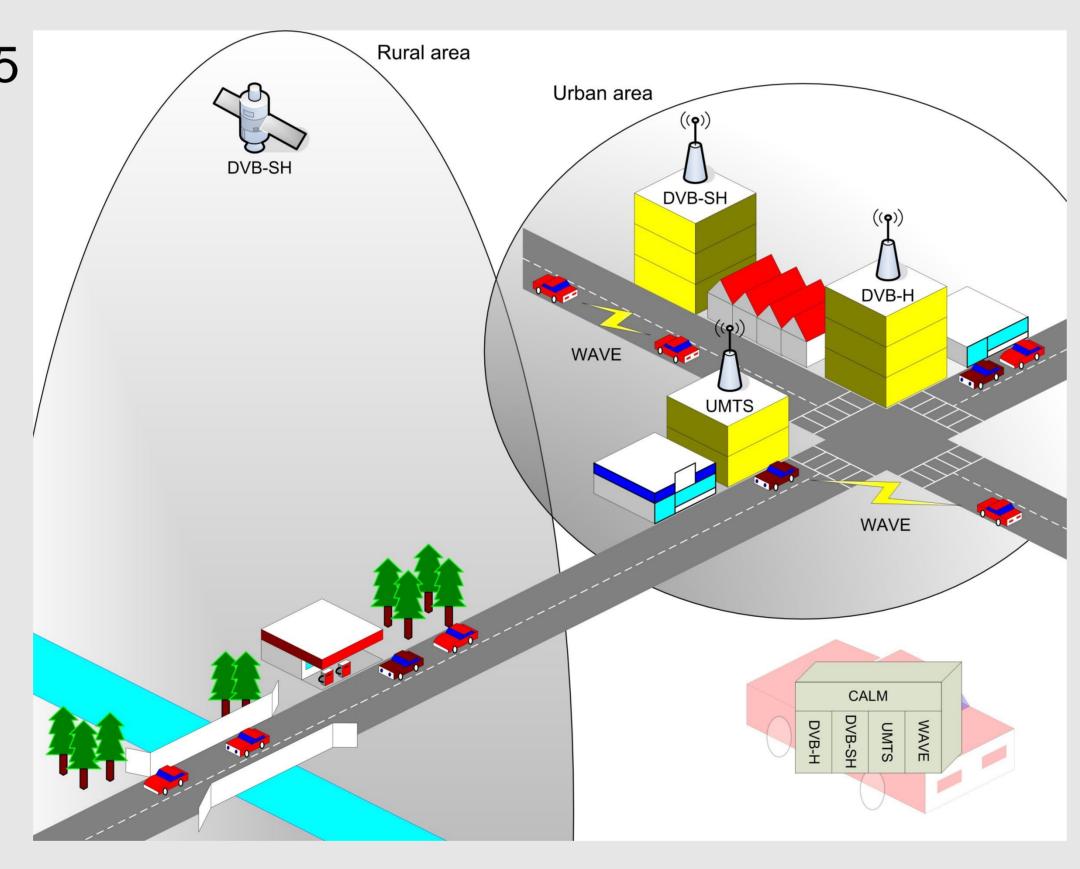**Benefits**: important social relevance, both on the level of the environment, mobility and traffic safety.
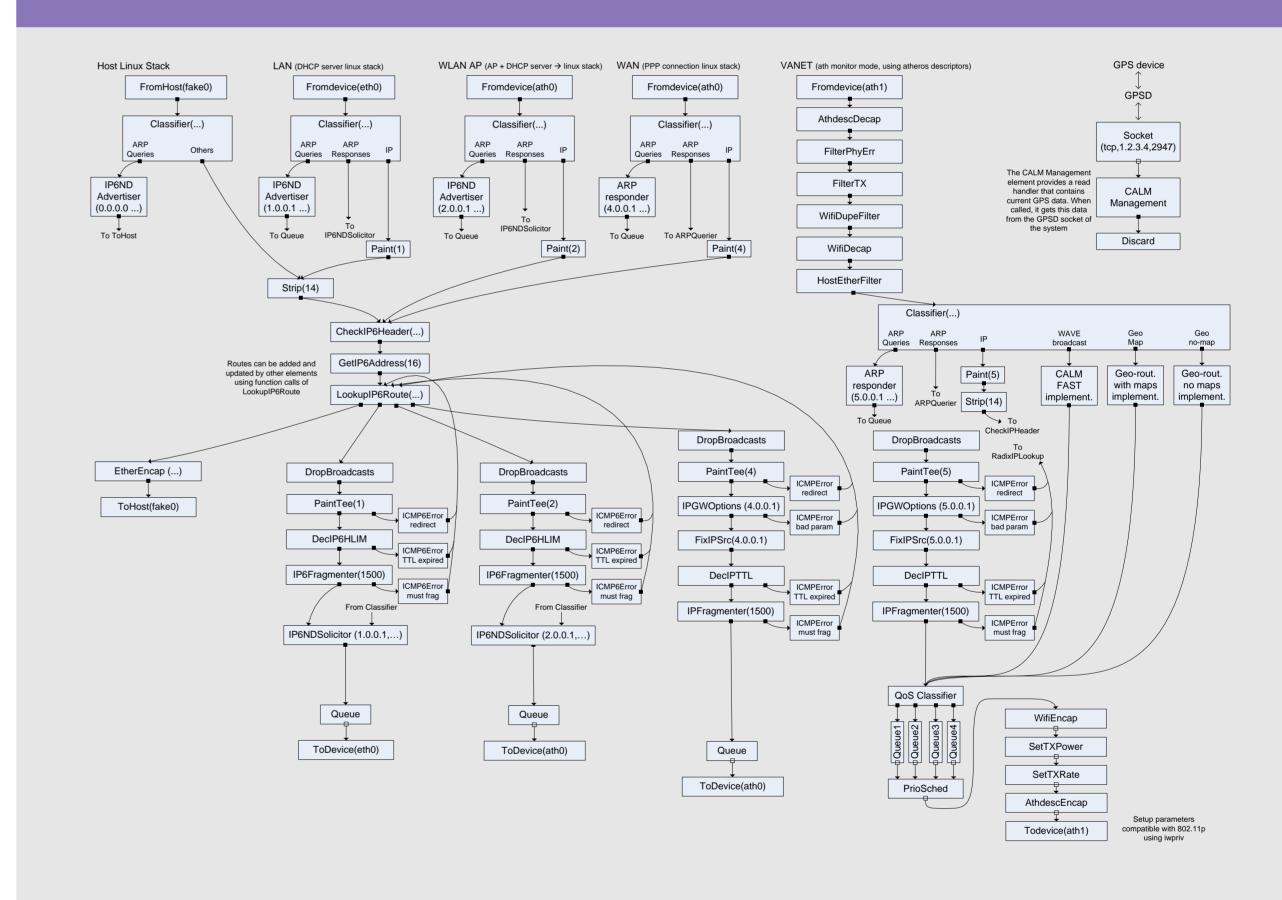
Communication architecture

Combination of three different types of communication technology

- **Dedicated Short Range Communication**
  - CEN DSRC
  - IEEE 802.11p, CALM-M5
  - CALM-IR, CALM-MM
  - IEEE 802.15.4 (ZigBee)
- **Wide Area Network**
  - GSM/GPRS, EDGE
  - UMTS, HSPA, LTE
  - WiMAX, MBWA
- **Digital Broadcast**
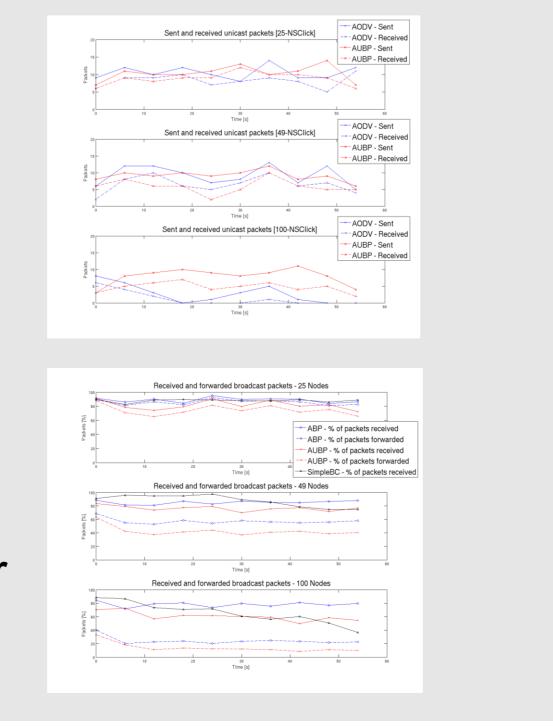 - RDS-TMC
  - DAB
  - DVB-T, DVB-H
  - MBMS

Scalability problem

IEEE 802.11p / CALM-M5
- Low node density → low delay, high reliability
- **High density → higher delay, low reliability**
  - Unacceptable for critical safety applications
  - Due to saturation of the wireless medium
- Possible solutions
  - More efficient VANET routing protocols
  - More efficient VANET broadcast protocols
  - Optimization of QoS mechanisms on MAC layer
  - Cross-layer optimizations

Mobile router architecture

Click implementation

- Focus: IPv6 VANET networking protocols

Developed research environment

SUMO Traffic Simulator — TraNS — NS-2 Network simulator — NSClick — Click Modular Router

ALIX Hardware
Indoor Wireless Testbed
In-vehicle Tests

Simulation

Real life validation