

# Hybrid Sensor-Vehicular-Networks

in the context of next-generation networking

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## Talk Outline

- **Motivation**
- **Concept**
  - ▶ What are Hybrid Vehicular Sensor Networks?
  - ▶ Different Ways of Information Propagation
- **Proposal of an architecture**
- **Field Tests**
- **Conclusion**

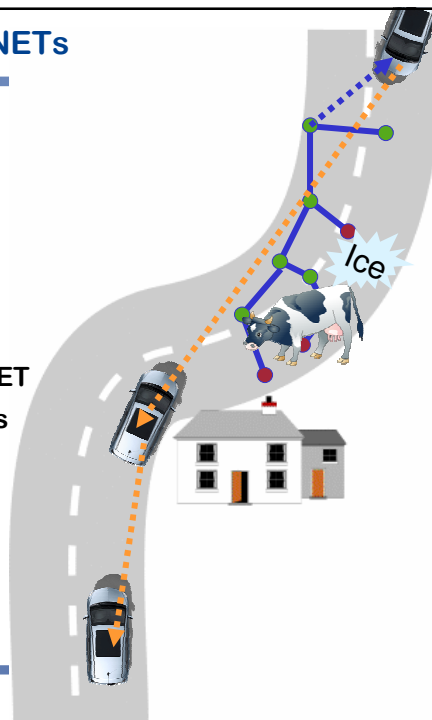
## Motivation

- **Dangerous road event**
  - ▶ Occluded, not visible
  - ▶ Obstacles, Ice, Aquaplaning
- **A car approaches**
- **Accident**
  - ▶ Driver cannot react in time



## Our approach: Hybrid WSN/VANETs

- **Events are detected using a WSN**
  - ▶ Precise
  - ▶ Persistent and stationary
  - ▶ Inside road environment
- **Vehicles retrieve this information**
  - ▶ Directly from WSN
- **Long range propagation using VANET**
- **Idea: Combine VANET/WSN benefits**
  - ▶ WSN: good for event detection
  - ▶ VANET:
    - long range data dissemination
    - Higher bandwidth
    - No energy constraints



## Information flow: Five ways



- 1. Information flow within the Wireless Sensor Network**
  - Task: detect & report events to certain gateway sensor node
- 2. Information transition from WSN to Vehicular Ad-Hoc network**
  - Task: Notify Vehicles of events
- 3. Propagation of Information inside Vehicular Ad-Hoc network**
  - Task: Long-range propagation
- 4. Store data from Vehicular Ad-Hoc Network into Wireless Sensor Network**
  - Task: Preserve information
- 5. "Physical data transport", "data mule"**
  - Task: Exploit node mobility for data dissemination

## Architecture for Hybrid Vehicular Sensor Networks

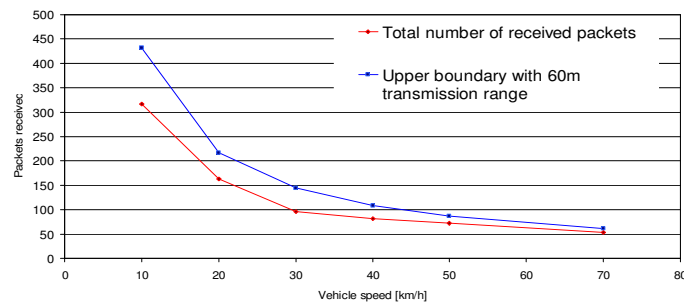
	Task	Architectural Decision
<b>VANET</b>	Long-Range Data Propagation	<b>Geocasting:</b> Forward Data to Area of Interest
<b>WSN/VANET Interface</b>	Gather Information from WSN Store information within WSN	•Dynamic & Probabilistic Gateways •Active Detection of Vehicles •Stored Information: Piggy-Back
<b>Wireless Sensor Network</b>	Event Detection	•Use adequate Sensors •Data aggregation •Spanning Trees for Data-Collection

## A first experiment

- Spanning trees are known to work
- Some work on propagation in VANETs
- Key Question: Transmission from VANET to WSN is time crucial:
  - ▶ Relative speeds up to 250 km/h (about 70m/s)
  - ▶ Range of mote hardware is limited: 50-80m
  - ▶ Vehicles might be in range of gateways for less than a second



## A first experiment: Results

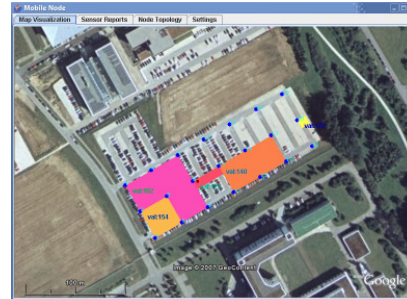


- ▶ Upper (theoretical) boundary: maximum packets that can be received when in range
- ▶ Result limitations:
  - Just one node – if many nodes send, more load on PHY layer
  - Urban scenario not evaluated yet
  - Influence of other cars, reflection, interference

## Field Test

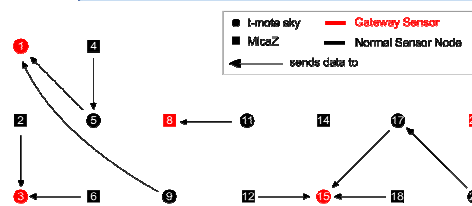
- **Prototype:**

- ▶ 20 t-mote sky as sensor nodes
  - Simulated sensor value
- ▶ Mobile Platform:
  - Java
  - Notebook with attached mote



- **Field Test:**

- ▶ Deployment of 20 motes
- ▶ All ways of information
- ▶ Proof of concept



## Conclusion & Future Work

- **Concept**

- ▶ Hybrid Vehicular Sensor Networks as Traffic Safety Application
- ▶ Different ways of Information Flow

- **Achievements**

- ▶ Proposal of an Architecture
- ▶ Realization within Prototype
- ▶ Investigation of feasibility in two field tests

- **Future Work**

- ▶ Simulation for quantitative evaluation
- ▶ Consider integration of road-side infrastructure within architecture