

Introduction to Vehicular Networks

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Intro to Vehicular Networks

Outline

- ◆ Motivation
- ◆ Common Terms
- ◆ Applications
- ◆ Current Efforts
- ◆ Network Issues
- ◆ Security Issues



From EPFL research group

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Motivation



From trekearth.com

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Common Terms

- ◆ Intelligent transportation systems (ITS)
- ◆ Inter-vehicular communication (IVC)
- ◆ Mobile ad-hoc network (MANET)
- ◆ Vehicular ad-hoc network (VANET)
- ◆ Vehicle-to-vehicle (V2V) communication
- ◆ Vehicle-to-infrastructure (V2I) communication

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Categories of Applications

- ◆ Informative / Warning Systems
 - » traffic information
 - » weather warnings
- ◆ Longitudinal Control
 - » collision avoidance/warning
 - » “look-through” obstructions to avoid accidents
 - » platooning
- ◆ Co-operative Assistance Systems
 - » intersections
 - » highway entrances

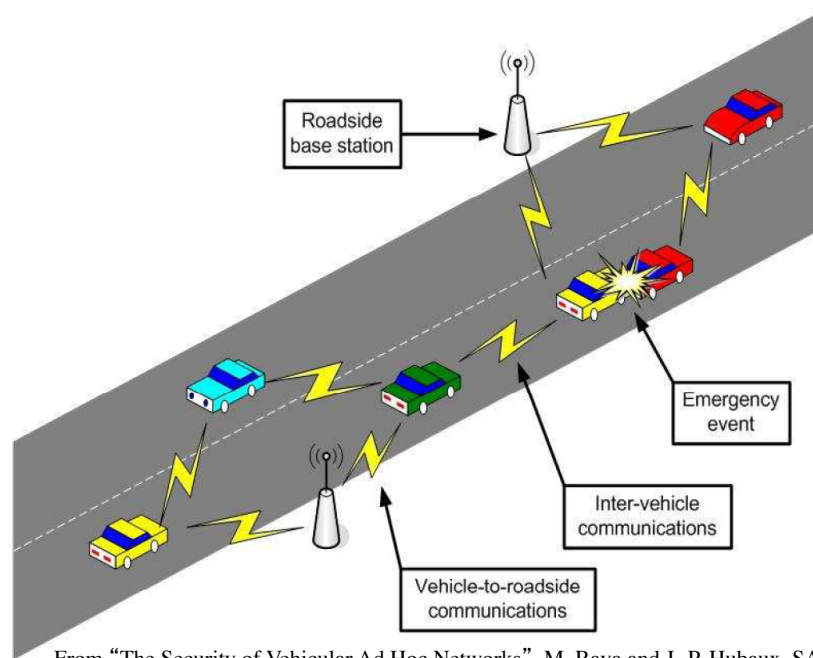
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Approaches

- ◆ V2V only (zero infrastructure, purely ad-hoc)
 - » require no outside infrastructure or roadside devices
 - » vehicles communicate with each other to determine traffic situation
 - » *how many vehicles need to use the system to get high quality information?*
 - » *what kind of attacks on the system are possible?*
- ◆ V2V and V2I
 - » requires some outside infrastructure, often in the form of roadside devices
 - » infrastructure can provide aggregation/processing, encryption key distribution, access to larger network
 - » *how many roadside devices are needed?*

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V2V / V2I Architecture



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Current Efforts

Government / Industry Supported

- ◆ Japan
 - » VICS - www.vics.or.jp/english/
- ◆ Europe
 - » Car2Car Consortium - www.car-2-car.org
 - » CarTALK 2000 - www.cartalk2000.net
 - » FleetNet - www.et2.tu-harburg.de/fleetnet/english
- ◆ US
 - » PATH - www.path.berkeley.edu
 - » Federal Highway Administration's Vehicle Infrastructure Integration (VII) - www.its.dot.gov/vii/

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Current Efforts

V2V Approaches

- ◆ Mobile Computing Lab / Osaka University
 - » www-higashi.ist.osaka-u.ac.jp/research/inter-vehicle-ad-hoc-communication-protocol2.html
- ◆ e-Road Project / Rutgers
 - » discolab.rutgers.edu/traffic/
- ◆ SOTIS / Technical University of Hamburg-Harburg
 - » Self-Organizing Traffic Information System
 - » www.et2.tu-harburg.de/Mitarbeiter/Wischhof/sotis/sotis.htm
- ◆ CarNet / MIT
 - » SIGOPS 2000

Current Efforts

V2I/V2V Approaches

- ◆ Chisalita / Linkoping University / Sweden
 - » focused on collision avoidance/warning
 - » peer-to-peer approach
 - » vehicles and roadside infrastructure are all peers
- ◆ Rubinet Group / UC-Davis
 - » VGrid - vehicular-based computing grid
 - » fixed roadside sensors, in-vehicle sensors, Central Coordination Center, changeable message signs
 - » example application: lane merging
 - » www.ece.ucdavis.edu/rubinet/vmesh.html

Current Efforts

V2I/V2V Approaches

- ◆ Ott / University of Bremen / Germany
 - » Drive-thru Internet
 - » only V2I (roadside Internet access points)
 - » study of limitations of connectivity

- ◆ Sampigethaya / UW and University of Tokyo
 - » CARAVAN
 - » group navigation
 - » techniques for avoiding tracking of vehicles (privacy)
 - » roadside infrastructure for access to location server

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Network Issues

- ◆ Radio
 - » DSRC in US
 - ❖ 75 MHz spectrum
 - ❖ 5.9 GHz band (5.850 to 5.925 GHz)
 - ❖ 802.11-based technology

- ◆ MAC/PHY
 - » WLAN (802.11) vs. 3G (CDMA)

- ◆ Network
 - » routing protocols
 - ❖ take advantage of GPS/road topology
 - » broadcast
 - ❖ flooding algorithms

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Security/Privacy Issues - Challenges

- ◆ Authentication vs. Privacy
 - » want to bind each driver to a single identity
- ◆ Availability
 - » only 50-60% of vehicle's neighbors will receive a broadcast message (based on evaluation of DSRC)
- ◆ Low Tolerance for Error
 - » especially in collision avoidance/warning systems
- ◆ Mobility
 - » each vehicle has a constantly shifting set of neighbors
- ◆ Key Distribution
 - » when/where to install keys? how many to install? who is certification authority?

Bryan Parno and Adrian Perrig. Challenges in Securing Vehicular Networks, HotNets 2005.

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Security/Privacy Issues - Adversaries

- ◆ Greedy Drivers
 - » convince neighbors that congestion is ahead to clear roads
- ◆ Snoops
 - » driver profiling, tracking
- ◆ Pranksters
 - » hack things “just for fun”
- ◆ Industrial Insiders
 - » if mechanics are in charge of uploading software, they can load malicious programs
- ◆ Malicious Attackers
 - » terrorists, criminals with specific targets in mind

Bryan Parno and Adrian Perrig. Challenges in Securing Vehicular Networks, HotNets 2005.

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Security/Privacy Issues - Attacks

- ◆ Denial of Service (DoS)
 - » overwhelm a vehicle's resources or jam communication channels
 - » *malicious attacker*
- ◆ Message Suppression
 - » selectively drop packets, suppress congestion alerts
 - » *prankster*
- ◆ Fabrication
 - » broadcast false information into network
 - » *greedy driver*
- ◆ Alteration
 - » alter existing data, replaying earlier transmissions, disrupt voting mechanisms
 - » *malicious attacker*

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Future Topics

- ◆ Data Dissemination / Aggregation
- ◆ Security / Privacy
- ◆ Simulators
- ◆ Automatic Incident Detection
- ◆ LISA (ODU's approach)
- ◆ Evacuation Issues
- ◆ Driver Distraction

- ◆ *Others?*

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