CS 795/895
Vehicular Networks

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

Intro to Vehicular Networks
Motivation

From trekearth.com

Intro to Vehicular Networks
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

Intro to Vehicular Networks
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

Intro to Vehicular Networks
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?*

Intro to Vehicular Networks
V2V / V2I Architecture

From "The Security of Vehicular Ad Hoc Networks", M. Raya and J.-P. Hubaux, SASN 2005
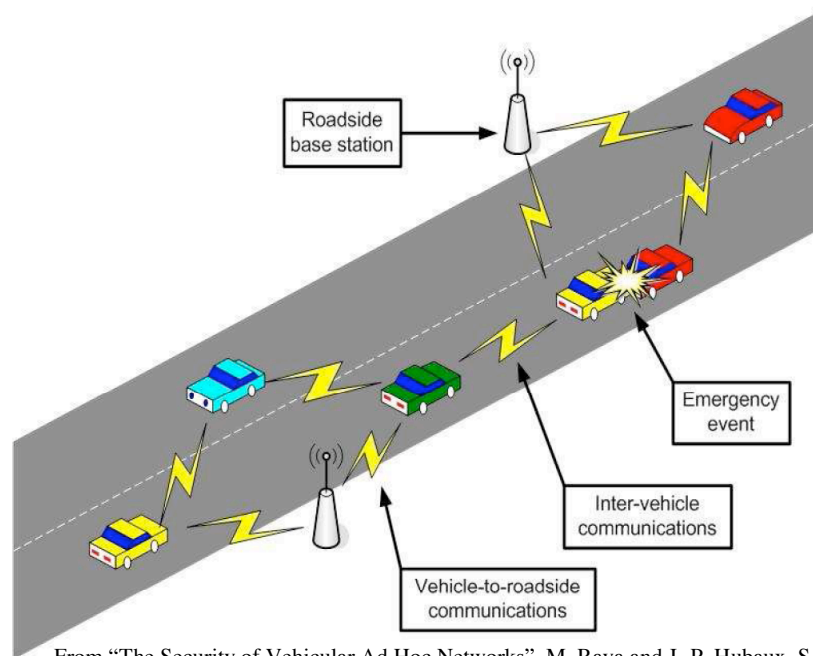
Current Efforts
Government / Industry Supported

◆ 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/

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

Intro to Vehicular Networks
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

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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?*

Intro to Vehicular Networks
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