Politecnico di Torino

Dipartimento di Elettronica e Telecomunicazioni (DET)

Telecommunication Networks Group
Research Activities
on Wireless Networks

TNG
TELECOMMUNICATION NETWORKS GROUP

PEOPLE WORKING ON WIRELESS NETWORKS

- Carla-Fabiana Chiasserini
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- Francesco Malandrino
- Marco Ricca
- Massimo Reineri
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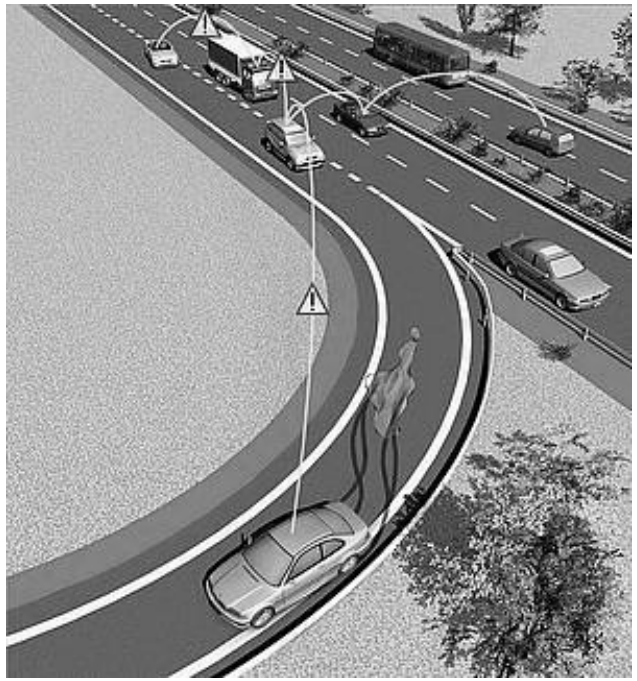
INTERNATIONAL COLLABORATIONS

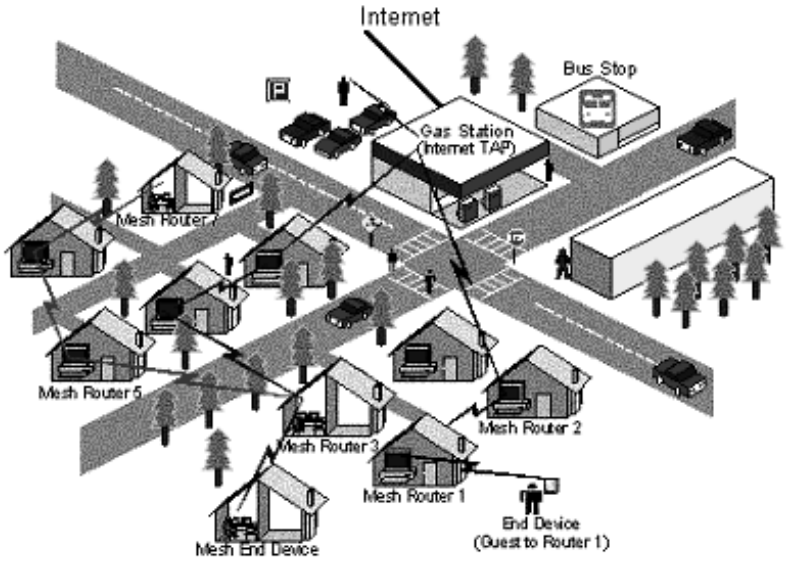
- University of Innsbruck, Austria (Prof. Dressler)
- University of Vienna, Austria (Prof. Hummel)
- KTH, Sweden (Prof. Karlsson)
- University of California Los Angeles, USA (Prof. Gerla)
- INSA Lyon, INRIA, France (Dr. Fiore)
- Universidad Politecnica de Catalunia (UPC), Spain (Prof. Barcelo)
- Qatar University, Qatar University Wireless Innovations Center (QUWIC), (Prof. Filali)
- Telefonica I+D (Dr. Papagiannaki)
- Technicolor (Dr. Lundgren)

VEHICULAR NETWORKS

1. Architectures and protocols for Vehicular networks
   + V2V
   + V2I
2. Goals:
   + Safety
   + Infotainment
   + Content distribution
   + Remote monitoring



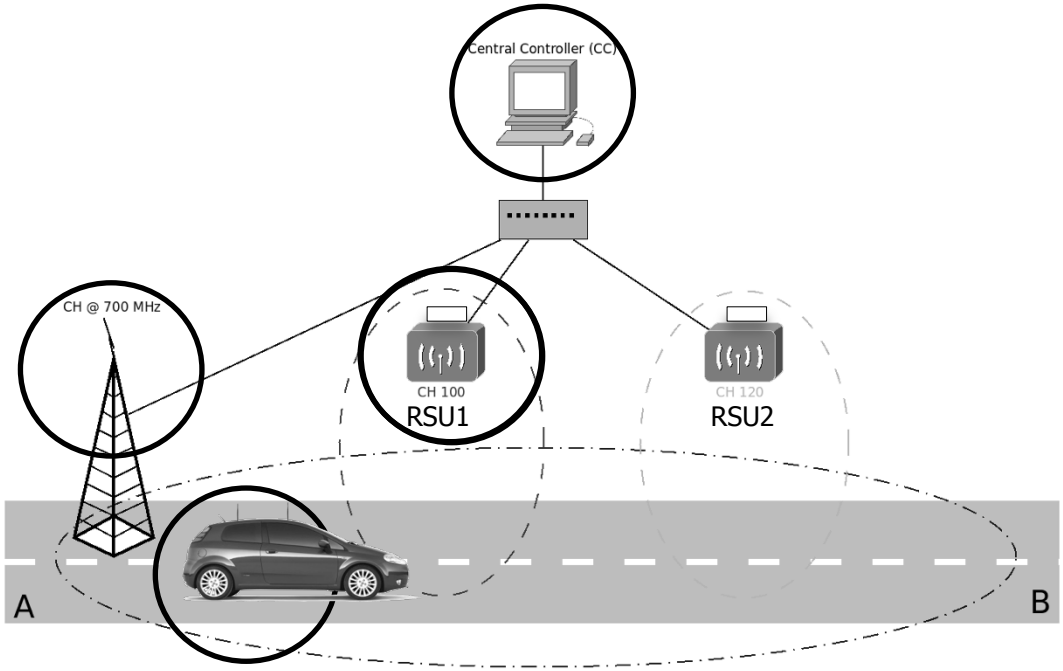
MESH NETWORKS



- Routing protocols and channel assignment
- Testbed comparison of existing solutions
- Mobility support

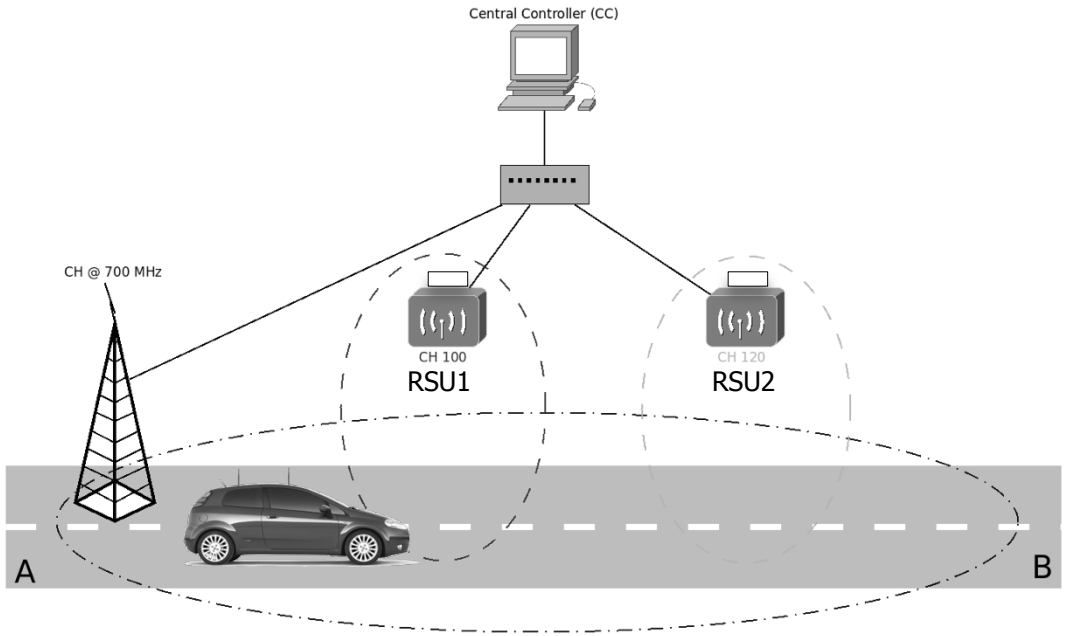
RESEARCH ACTIVITIES
VEHICULAR NETWORKS WITH INFRASTRUCTURE SUPPORT

- Infrastructure
  - + Central Controller (CC)
  - + Roadside Units (RSU)
  - + Long-Range Unit (LRU)
  - + Vehicle On-Board Units (OBU)



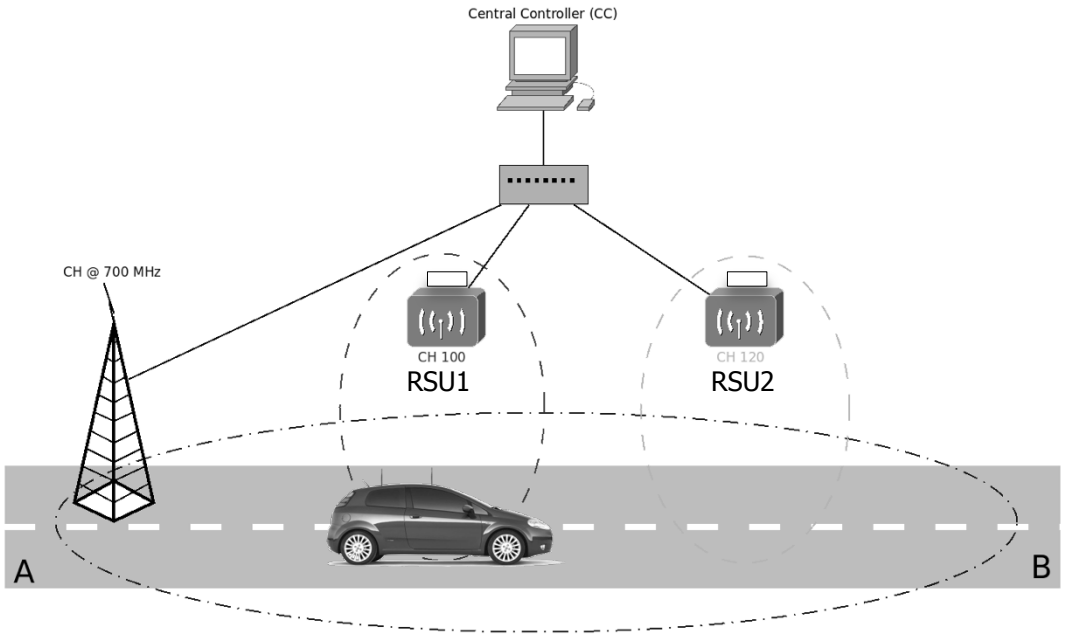
RESEARCH ACTIVITIES
VEHICULAR NETWORKS WITH INFRASTRUCTURE SUPPORT

- Vehicle notifies CC over 700 MHz link:
  - own position
  - content requests
- CC fetches requested content and dispatches it to nearest RSU
- Vehicle associates to RSU and downloads as much as possible



RESEARCH ACTIVITIES
VEHICULAR NETWORKS WITH INFRASTRUCTURE SUPPORT

- When moving out of RSU coverage, the download stops
- RSU reports the outcome of the download
- If incomplete, the CC schedules the download to continue at next RSU
- Remaining file is dispatched to the next RSU



RESEARCH ACTIVITIES
VEHICULAR NETWORKS WITH INFRASTRUCTURE SUPPORT

- Val di Viù testbed
- RSU:
  - + 5GHz directional antenna
  - + 700MHz directional antenna

In collaboration with CSP: IEEE Journal on Selected Topics in Communications (JSAC), IEEE WCNC 2012

RESEARCH ACTIVITIES
VEHICULAR NETWORKS WITH INFRASTRUCTURE SUPPORT

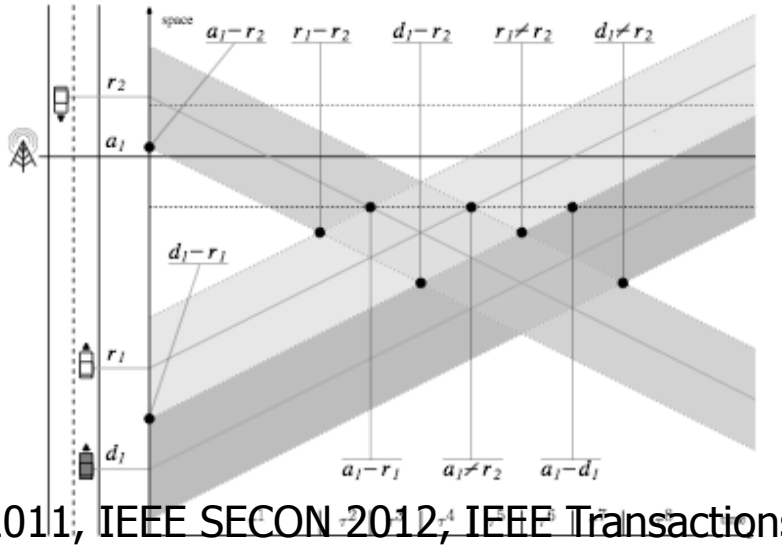
- Val di Viù testbed
- Vehicle:
  - 5GHz Omni antenna
  - 700MHz Omni antenna
  - GPS device

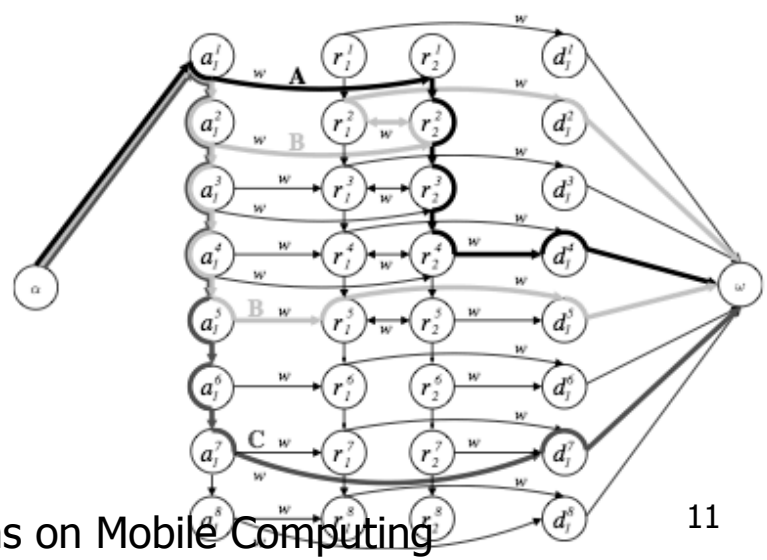
In collaboration with CSP: IEEE Journal on Selected Topics in Communications (JSAC), IEEE WCNC 2012

RESEARCH ACTIVITIES

VEHICULAR NETWORKS WITH INFRASTRUCTURE SUPPORT

- We model the system dynamics over time as a time-expanded **graph, a**nd solve a **max-flow** problem
- **Input**: road layout, mobility trace, RSU candidate locations, number of RSUs to deploy
- Control **variables**: RSUs to enable, traffic (flow) on I2V and V2V links
- **Output**: RSUs to deploy





RESEARCH ACTIVITIES
VEHICULAR NETWORKS WITH INFRASTRUCTURE SUPPORT

- Additional directions, ongoing work:
  - Exploiting parked vehicles to act as supplementary RSU
  - Game theory – Concurrent operators deploy RSUs on predefined set of locations
  - Auction theory – Operators bid for RSU locations (or bundles of them)

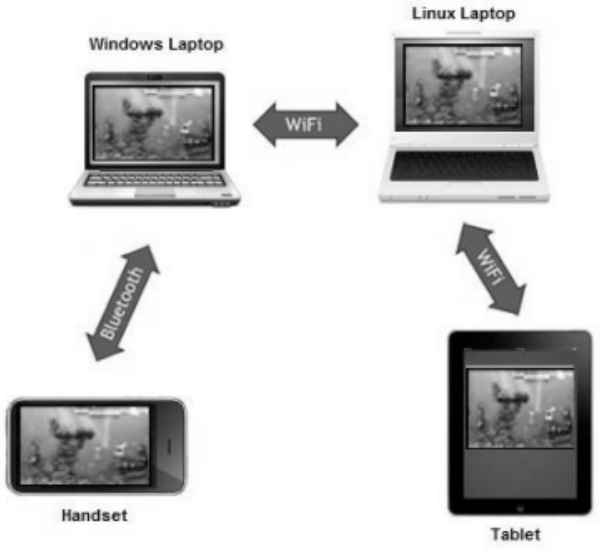
RESEARCH ACTIVITIES
DELAY-TOLERANT NETWORKS

- Nodes frequently partitioned
- Node mobility can be exploited to carry data across the network
  - + "store-carry-forward" communication scheme

- Example of DTN network backbone
  - + Torino GTT public transportation system

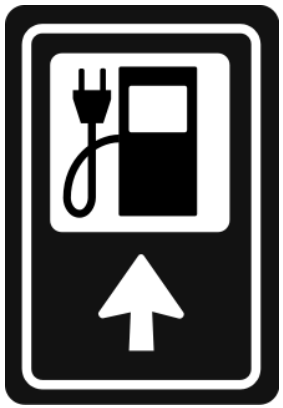
RESEARCH ACTIVITIES
DELAY-TOLERANT NETWORKS

- ad hoc, proximity-based, device-to-device communications
- without the use of an intermediary server
- algorithm design for
  - + resource discovery
  - + opportunistic caching
- testbed implementation
  - + Android terminals
  - + enabled by recent Qualcomm AllJoyn middleware



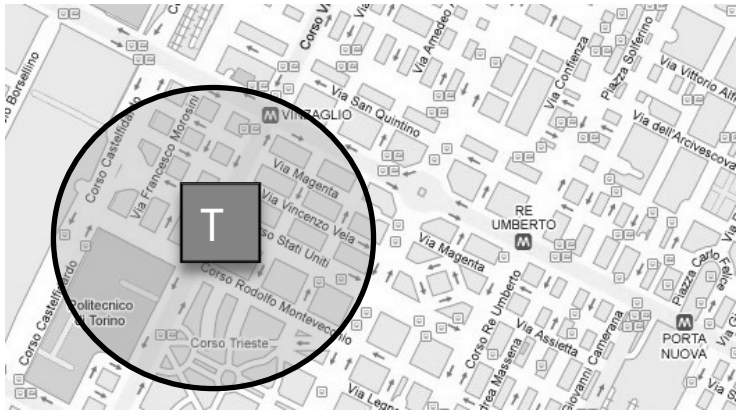
RESEARCH ACTIVITIES
E-VENETS: COOPERATING NETWORKED ELECTRIC VEHICLES

- Support of ICT and ITS for e-vehicles seeking charging stations
- Goals:
  - Protocol design for charging information dissemination
  - Charging stations deployment planning



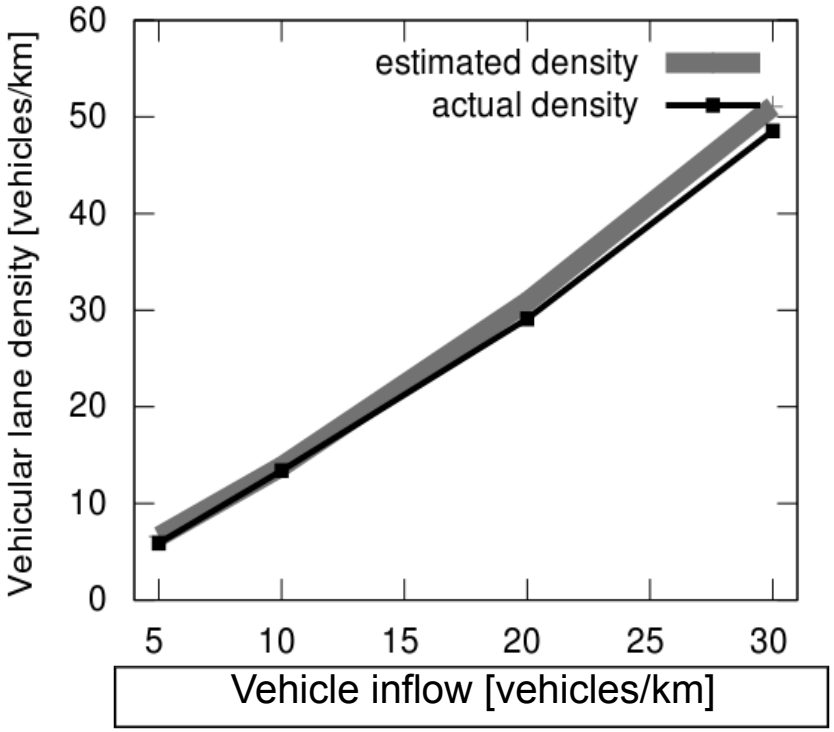
RESEARCH ACTIVITIES
V2V COMMUNICATION FOR TRAFFIC DENSITY ESTIMATION

- Existing systems for the measurement of traffic levels require dedicated infrastructure (e.g. loop detectors, roadside sensors or cameras). Drawbacks: high costs and low flexibility
- MobSampling: a framework for the on-line estimation of vehicle traffic density over localized areas, through V2V communications
- Samplers: Vehicles in the target area that “sample” their surroundings and record statistics on the vehicle density.

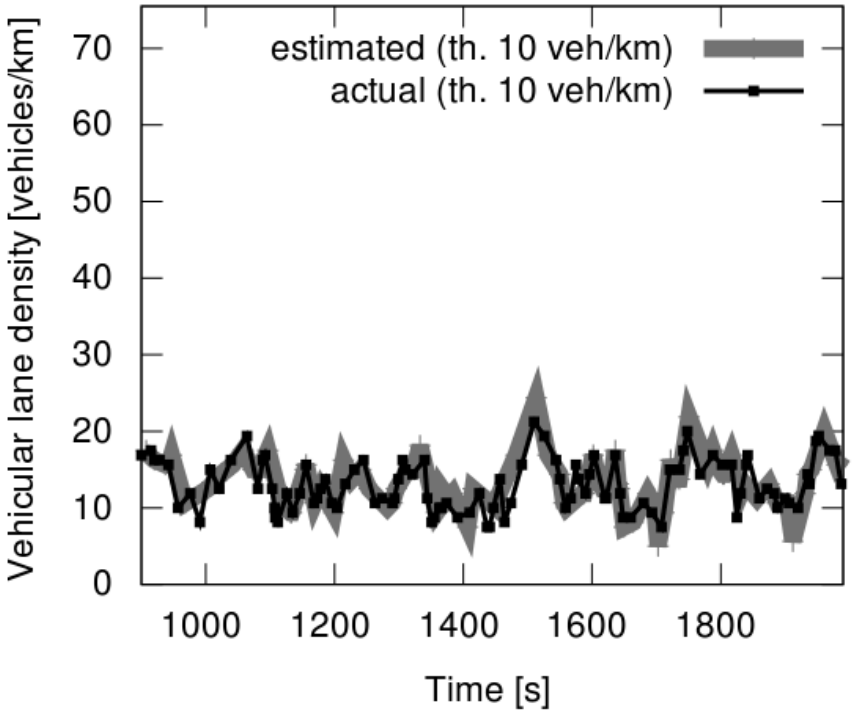


RESEARCH ACTIVITIES
V2V COMMUNICATION FOR TRAFFIC DENSITY ESTIMATION

Urban intersection scenario



(i) Average estimated lane densities over 15 minutes



(ii) Instantaneous (i.e. average frequency 10 s) lane densities; theoretical density: 10 veh/km

RESEARCH ACTIVITIES
SECURE NEIGHBOR POSITION DISCOVERY

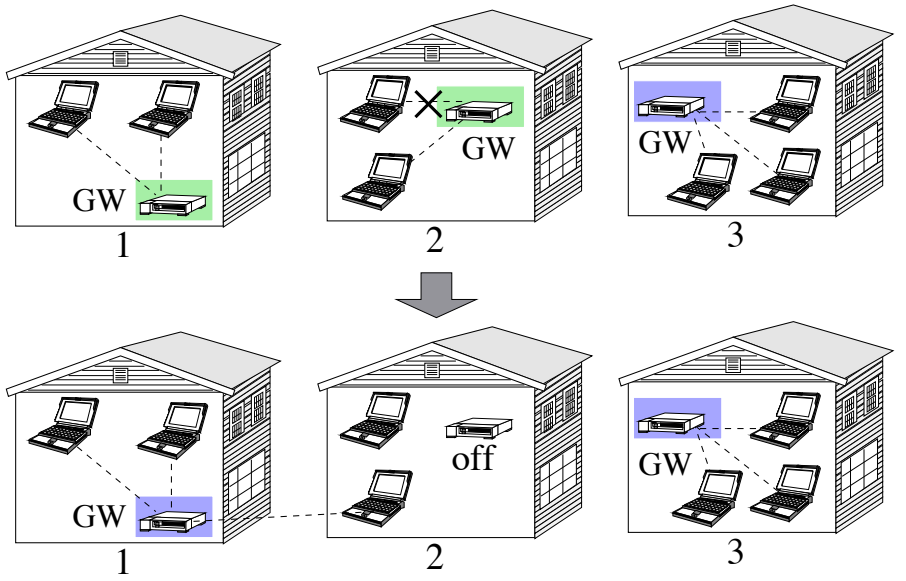
- Goal: to allow any node to discover and verify the position of its communication neighbors
- Why do I need a secure neighbor position?
  - Position-based services: Restrict network access to people in an open area
  - Position-based pricing: Fast-tracking of vehicles
  - Secure service access: Prevent connection hijacking by fake RSUs
- The protocol provides for a message exchange between the initiator (called verifier) and neighboring nodes

RESEARCH ACTIVITIES
SECURE NEIGHBOR POSITION DISCOVERY

- After collecting the information, the verifier exploits a technique based on the message time-of-flight to *verify* the consistency of its neighbor's claims
- To do so, it runs two tests:
  - Direct Symmetry (DS) test: to verify the symmetry between each neighbor's claims and its own info
  - Cross Symmetry (CS) test: to verify reciprocal claims from neighbor pairs
- Constraint: minimize the number of positive/negative falses

RESEARCH ACTIVITIES
HOME WIRELESS GATEWAY ECO-MANAGEMENT

- Self-coordination algorithms for home gateways
- Goals:
  - + Eco-management
  - + Load balancing



IEEE Globecom 2011

RESEARCH ACTIVITIES

HOME WIRELESS GATEWAY ECO-MANAGEMENT

CHALLENGES

1. Assess the impact of a WS relocated from another AP
   - + On WS's own throughput
   - + On the BSS aggregate throughput
2. Take into account the behavior of the wireless channel in presence of
   - + Both elastic (TCP like) and inelastic (UDP) traffic
   - + Different payload size
   - + Channel errors
   - + Adaptive rate

OUR CONTRIBUTIONS

Algorithms that enable the AP to estimate:

1. The achievable throughput for a new station (flow) wishing to associate with the AP
2. The impact on the system performance of admitting the new station (new flow)
3. The bandwidth still available (if any) for inelastic traffic after association
4. Monitor bandwidth availability in real time
5. Admission control in WLANs