New Architectures and Disruptive Technologies for Future Wireless Networks

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Current vs. Future WN architectures

- Future with respect to:
  - Research, Testbeds, Field trials, or Commercial applications?
  - ‘Do we really need these technologies?’
‘Problems at the network layer’

- Will any of the future commercial WN have network layer?

- Is there any commercial application where multi-hop wireless communication was really beneficial and better than any single-hop alternative?
Current Wireless Networks ??

- **Single hop networks**
  - Cellular networks
  - Satellite networks
  - commercial

- **Multi-hop self-organized networks**
  - Conference, battlefield, rescue
  - Peer to peer networks

- **Ad hoc networks**
  - Field trials, 2-3 hops
Hybrid ad hoc wireless networks ??

- Sensor networks
- Cellular multi-hop networks
- **Mesh/rooftop network**: wireless fast Internet access
- Vehicular Networks
Mesh/rooftop networks

- Commercial ??
- I installed wireless terrestrial Internet access in 2007, replacing single-hop satellite access
- But it was only possible via single-hop direct link, by increasing signal strength over tree leaves; 2-hop line-of-sight access impossible
One hop sensor network: Patient monitoring
Traditional wireless sensor networks

Field trials, multi-hop is a bottleneck, energy hole around sink
Research: Future technologies

- Hybrid sensor and ad hoc networks
Mobile Sensor Network
Mobile Sensor Networks Reality

- Network can be very sparse
- Seals can meet in clusters but then they meet rarely at sea
- Multi-hop communication again questionable
Vehicular Networks

Current commercial solutions based on Road Side Units = infrastructure = single-hop
RFID readers and sensor networks

Readers are *single-hop*;
tag could be attached to sensors and be even mobile.
Delay Tolerant Networks?

- Appear multi-hop viable
- But require a priori knowledge of all node movements
SensorFlock: Flying sensors

- An Airborne Wireless Sensor Network of Micro-Air Vehicles
- Univ. Colorado at Boulder, *Field trials, 2007*
Wireless sensor and actor networks = SANET

**Actors**: can act on sensors and environments, higher energy and computation, may be mobile
Applied SANET?

Daniel Steingart, Wireless Industrial Technologies, USA, 2007:

Sensors measure temperature in aluminum production
(one-hop communication to sink)
Human (-actuator) adjust energy supply to keep temperature stable

Equipment as actuators:
Light and sound signals, augmented reality
(firefighting applications) single-hop
One-hop wireless links only?

- Korber, Wattar, School,
- Star topology
- Base station (BS) is master, several nodes (SAM = sensor actuator modules) are each directly linked to BS, on separate channels
- Argues that this topology is needed for reliable industrial applications
Networked robots/actuators
Robot deploys sensors: Snake-like coverage

Chang et al. IEEE WCNC 2007

Robot moves within area in snake-like order and drops sensors at vertices of hexagonal tiling
Network layer issues

- **SANET models**: what is mobile, acting range etc.
- Generating sensor and actuator networks
- Coordinated movement of actors/robots
  - Move to establish (bi)connectivity while serving sensors
- **Movement for energy optimal routing**
  - Actors move to improve quality of sensor reporting (video)
- **Anycasting**: send report from sensor to any actor
- **Multicasting**: from sensor to fixed set of actors
Network layer continuing

- **Sensor relocation**: mobile actors/sensors move to replace failed monitoring sensors
- **Moving to collect sensor readings**
  - Design routes for actors to optimize energy/mobility and collect reports periodically (e.g. TSP tour)
- **Actor coordination**
  - Which actor should act?
- **Coordination for location service**
  - How sensors maintain position information about the nearest actor, and how actors help sensors in providing their position information
The ‘Father’ of wireless communication

Nikola Tesla
1856-1943

- The Serbian-American inventor,
- electrical engineer,
- scientist
- www.teslasociety.com