Emerging Research Challenges in the Era of IOT

Jie Wu

Temple University

IoT for Emergency Response

Infrastructure

• Erdogan used FaceTime to reach out during military coup in Turkey (July 2016)

Burak Kara via Getty Images

Infrastructureless

• 4 millions people without power for two weeks in South Florida (Nov. 2005)

Evolution of Smart-Phone Based
Emergency Communications Network
(NSF project)

Theoretical Foundations

Approximate Computing

- Energy- and accuracy-aware
- Online vs. offline
- Local vs. global algorithms

Local Algorithms

- Local interactions with global properties
- Minimizing state information
- Adaptive to changes
- Implicit coordination

What can be efficiently and locally computed?

Virtual backbone
coverage & connectivity

- Marking process: A node is marked if it has two unconnected neighbors
- Good performance for geometric graphs
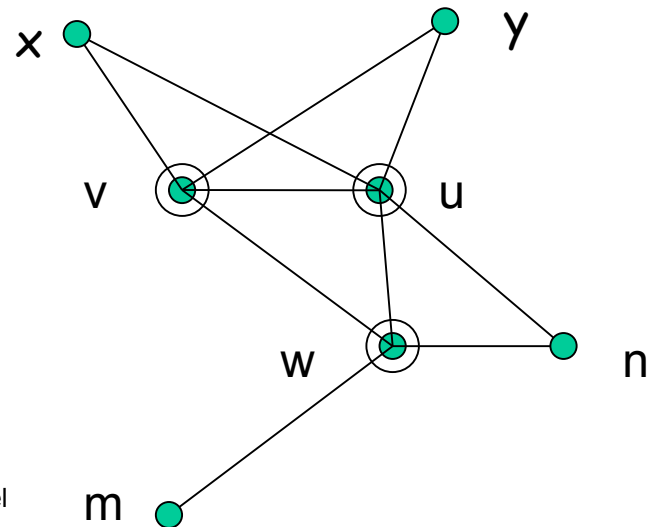
Human-in-the-loop: Crowdsensing

- Crowdsourcing: crowdsensing
  - Security, privacy, and trust

- Things: Smarter Than You Think

- Who is smarter
  - Human, things, or combination?

- 1997 (Chess)
  - Kasparov vs. Deep Blue
- 1998
  - Kasparov vs. Topalov: 4:0
  - Kasparov + machine vs.
    Topalov + machine: 3:3
- 2005 (freestyle tournament)
  - Grand-master (>2,500)
  - Machine (Hydra)
  - Grand-master + machine
  - Amateurs (>1,500) + machine *
- 2016 (Go game)
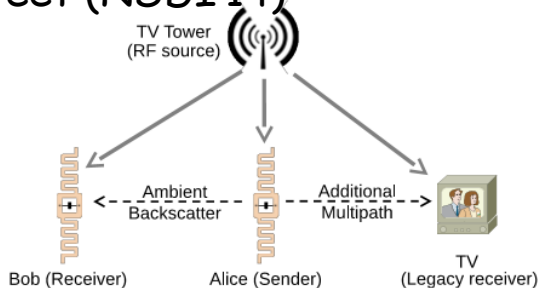 - AlphaGo vs. Lee Sedol: 4:1

Energy-Related Technology
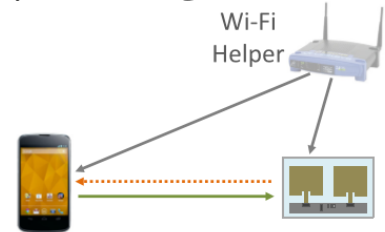
Wireless Energy Transfer & Battery Free Devices
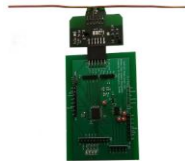
Energy from RFID reader

Achieving average accuracy of 97% for distances of up to 2.5 feet (outdoor) and 1.5 feet (NSDI'14)
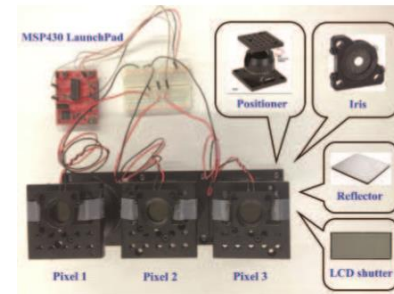

Energy from Wi-Fi signal

Achieving rates of 1 kbps and ranges of up to 2.1 meters (SIGCOMM'15)

Energy from TV tower

Achieving rates of 1 kbps over distances of 2.5 feet and 1.5 feet (SIGCOMM'13)

Energy from visible light

600 bps is achieved at 2 meters (airXiv'16)

Applications in US Ignite for Smart City

- Safety surveillance system on campus police

Key features

- Use 3D cameras (e.g. Kinect) for monitoring

- Supercluster backend for video surveillance

- QoS-based rate adaptation

- Secure data transmission and data sharing

Adjust video quality   Adjust wireless quality

On-board processing   Remote processing
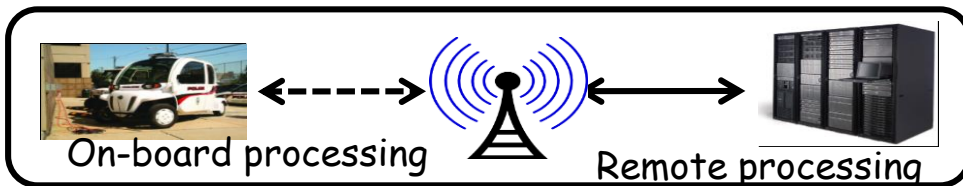
Mobility-Enhanced Public Safety Surveillance System using 3D Cameras and High Speed Broadband Networks (NSF project)

ICCCN'16 IoT Panel

Advanced Wireless Research Initiative

Exciting news

- $400M: next seven years
- FCC Spectrum Frontier: open up spectrum bands
- 21 companies

Applications

- Environmental sensing
- Telemedicine
- Autonomous vehicles
- Immersive communications
- ...

Future

- 200B connected devices globally by 2020
- 1000x improvements

Technologies

- mmWave
- Dynamic spectrum sharing
- Network virtualization (SDN)
- Mobility-at-scale
- ...