

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)



Infrastructureless

- 6 millions people without power for two weeks in South Florida (Nov. 2005, hurricane Wilma)



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

Theoretical Foundations: Autonomous IoT

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

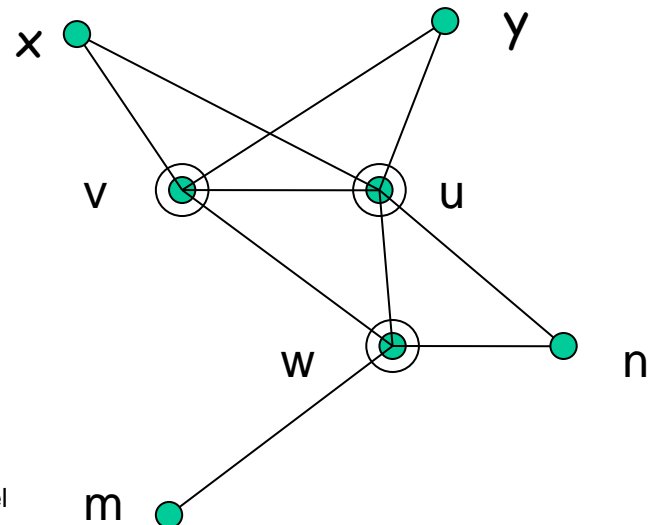
Implicit coordination

What can be efficiently and locally computed?

e.g. 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

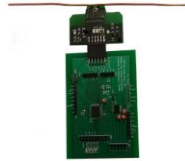
- Crowdsourcing: crowdsensing
 - Security, privacy, and trust
- Things (Intelligent IoT)
 - Smarter Than You Think
- Who is smarter?
 - Human, things, or a combination of both?



- 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

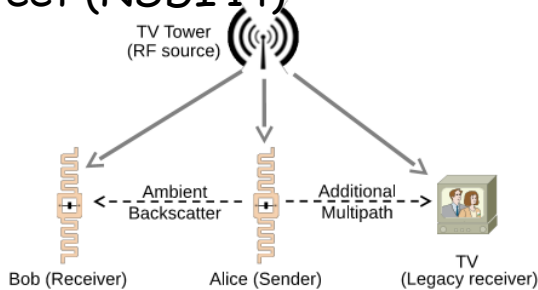
Energy-Related Technology

Wireless Energy Transfer & Battery Free Devices



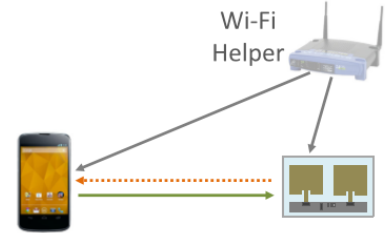
Energy from RFID reader

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



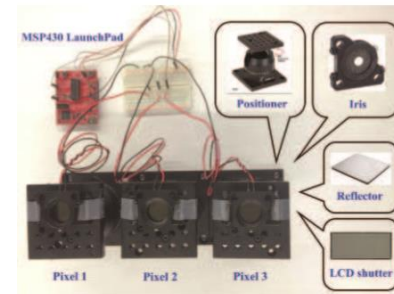
Energy from TV tower

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



Energy from Wi-Fi signal

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



Energy from visible light

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

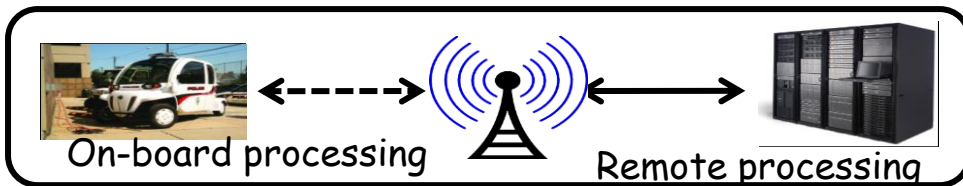
Applications in US Ignite for Smart City

- 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



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

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

• ...



ICCCN'16 IoT Panel

Future

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

Technologies

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

