



- <u>Urban loT</u> -The Path Toward the Smart City

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Urban IoT



Urban IoT and Smart City

Information acquisition and processing system to enable "interactions" in the city

- Interconnection between "smart" services and infrastructures
- Interconnection between citizens and technology
- City-wide information generation
- City-wide information processing



2

Current Approach

Centralized Architecture

Many heterogeneous streams of data (e.g., video, air quality, traffic, positioning) flowing to central processing centers

Will likely overload:

- Wireless edge of the network
- Processing centers

and create additional issues:

- Coexistence with "traditional" traffic
- Energy consumption (sensors and mobile)













Multi-Scale Computation

- In-device computing
- Local Cloud (fog computing)
- Edge computing
- Cloud services

(Coexisting) Multi-Scale Communications

- Device-to-Device
- Wireless Edge (LTE, Wi-Fi)
- Infrastructure





More Efficient

• Cross-System Sensor Selection (Less traffic, less energy,...)

More Effective

 Processing-Oriented and Self-Adaptive Communications

Faster Reaction

- In-Device and Edge computing
 - = smaller latency



Crowd Monitoring, Event Detection and Tracking video, biometric, city-wide sensors







Architecture

- Interconnects computational and network resources
- Interconnects Heterogeneous Networks and Systems

The local problem: Body Area Networks

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Activity detection - body area networks



- Sensor transmission rate selection
- Battery constraints
- Packet loss
- Maximize accuracy



The local problem: Body Area Networks





Consumer-Driven DR

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Modeling, prediction and Control in Smart Buildings



Cyber-Physical System

- Human Component!
- Loads
- Batteries, generation
- Information Acquisition
- Computation
- Communications

Information Acquisition



Activity Detection from Informative Appliances (Entertainment System)





Consumer-Driven DR

Modeling and Predicting Human Activity (to control plug loads)



Consumer-Driven DR

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Hierarchical model - from human to appliances to observation



Prediction-based activation of heavy load appliances





Large-Scale: Smart-City Testbed





- Emulated network resources (real-world communications)
- Multi-scale computational resources
- Software Defined Radio connected to edge processing to introduce joint communication-processing intelligence



Develop and test:

Hierarchical Information Compression/Selection

- Select most informative sensors given present objectives/state (e.g., smart cameras vs positioning/biometric to detect "events" in the city)
- Compress information across sensorial system
- Create feedback loops from larger scales computational resources

Hierarchical Communications

- Content-based protocols
- Effective coexistence technologies (Cloud-RAN, D2D underlay to LTE, etc)

Resilient Algorithms

- Algorithms resilient to packet loss (information loss)
- Flexible algorithms capable of adapting to time-varying information input

Preliminary Results



Content-based Interference Management in real-time video processing systems









Thank you!

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