Wireless Sensor Networks (WSN) for Distributed Solar Energy in Smart Grids

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Outline

Background and Motivation

Smart Grid

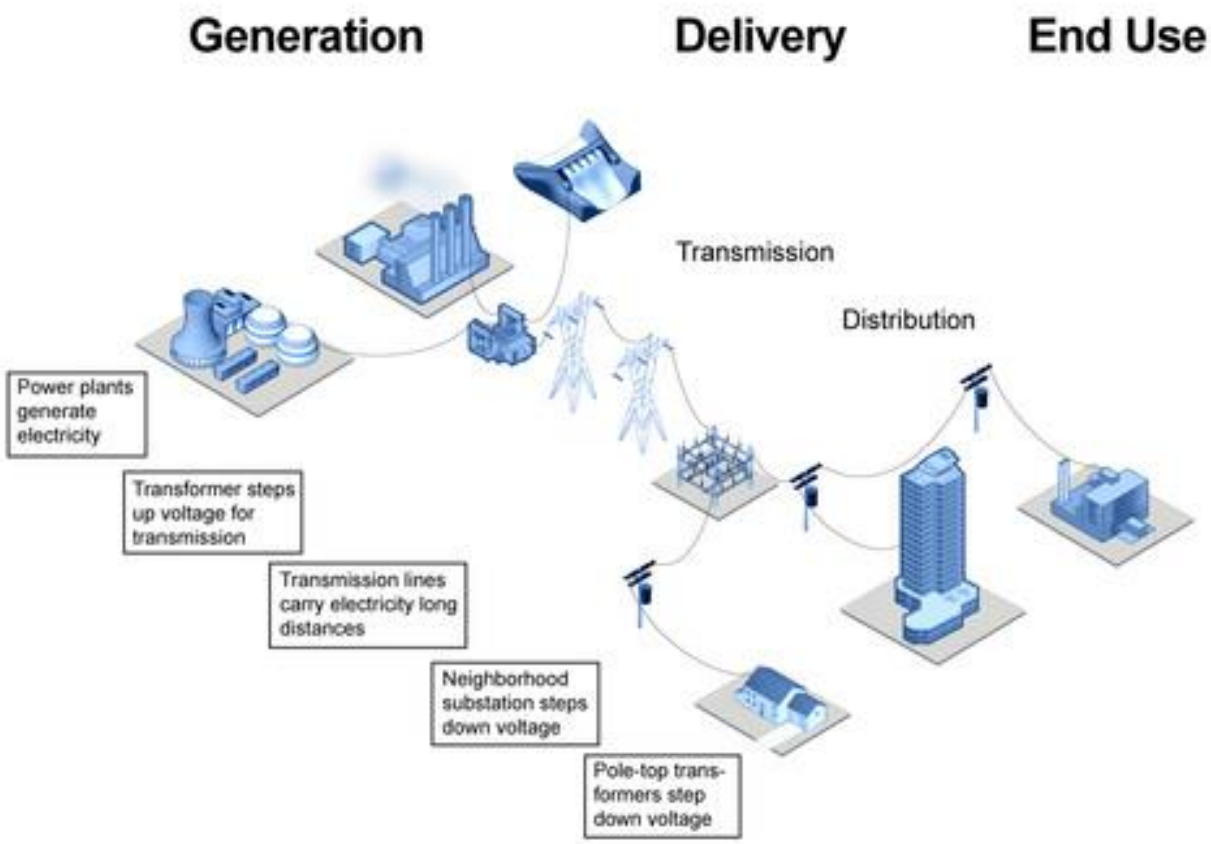
Challenges and Opportunities

Wireless Sensor Networks (WSN)

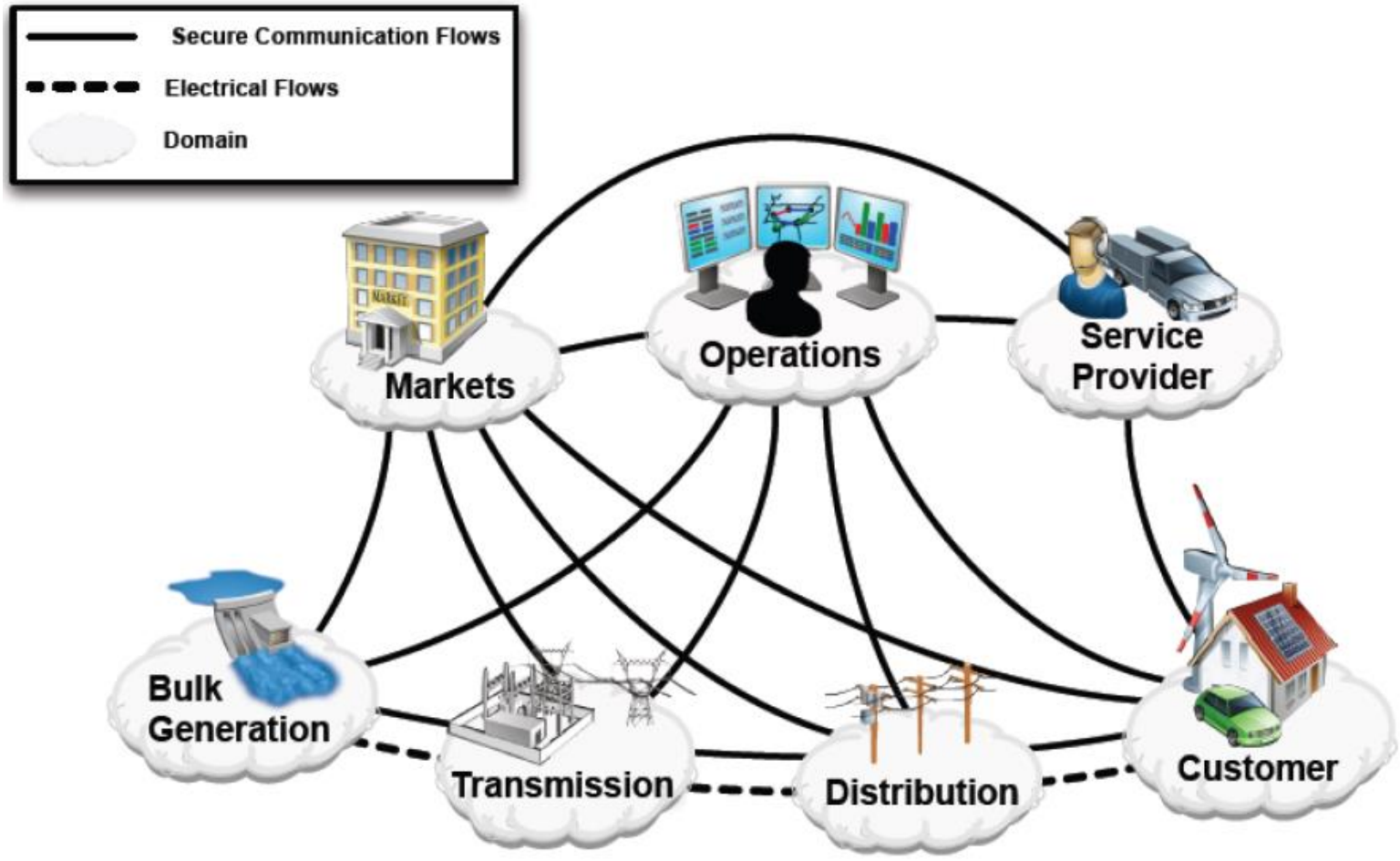
WSN and Smart Grid

Future Work

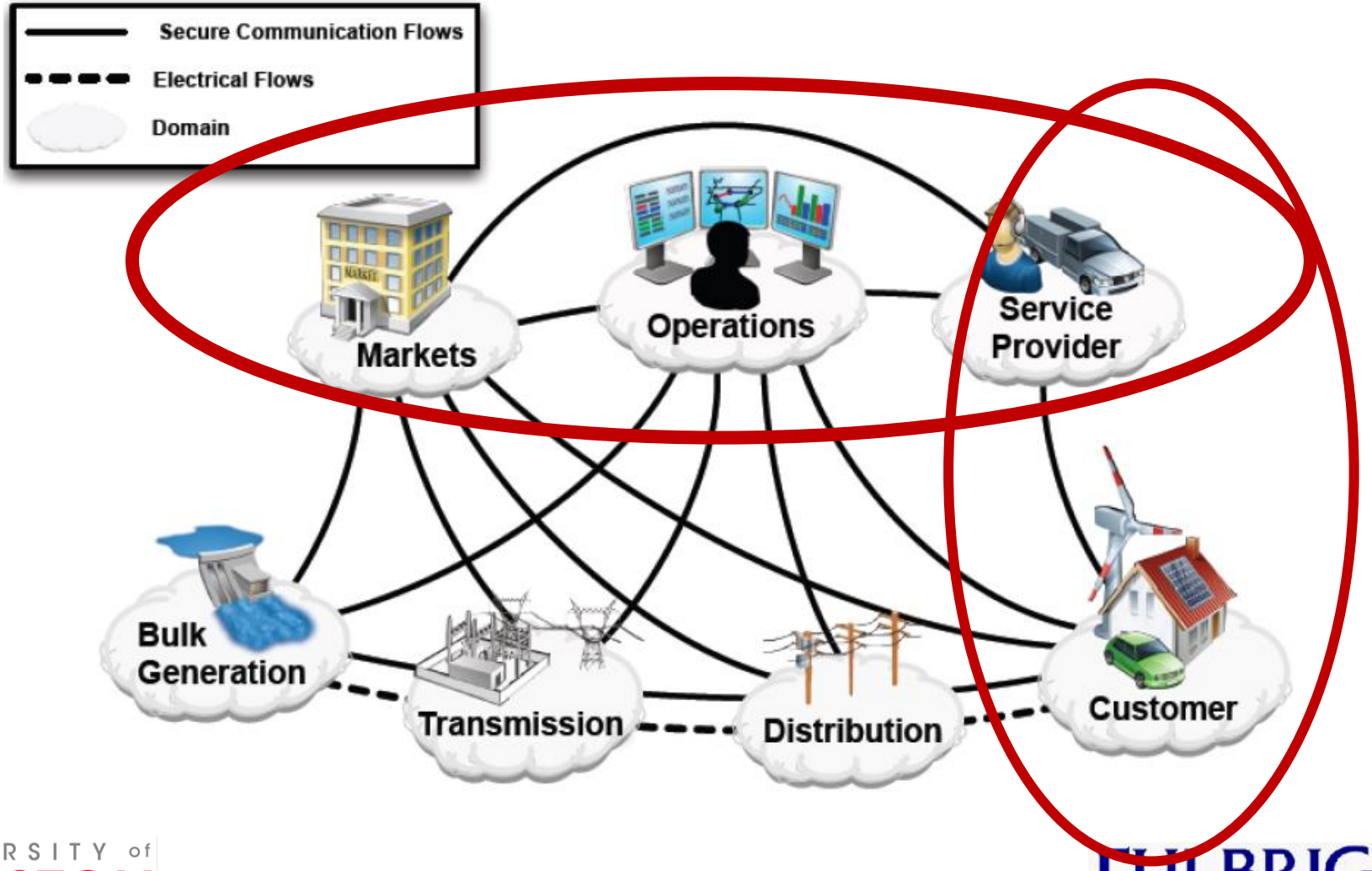
Background and Motivations



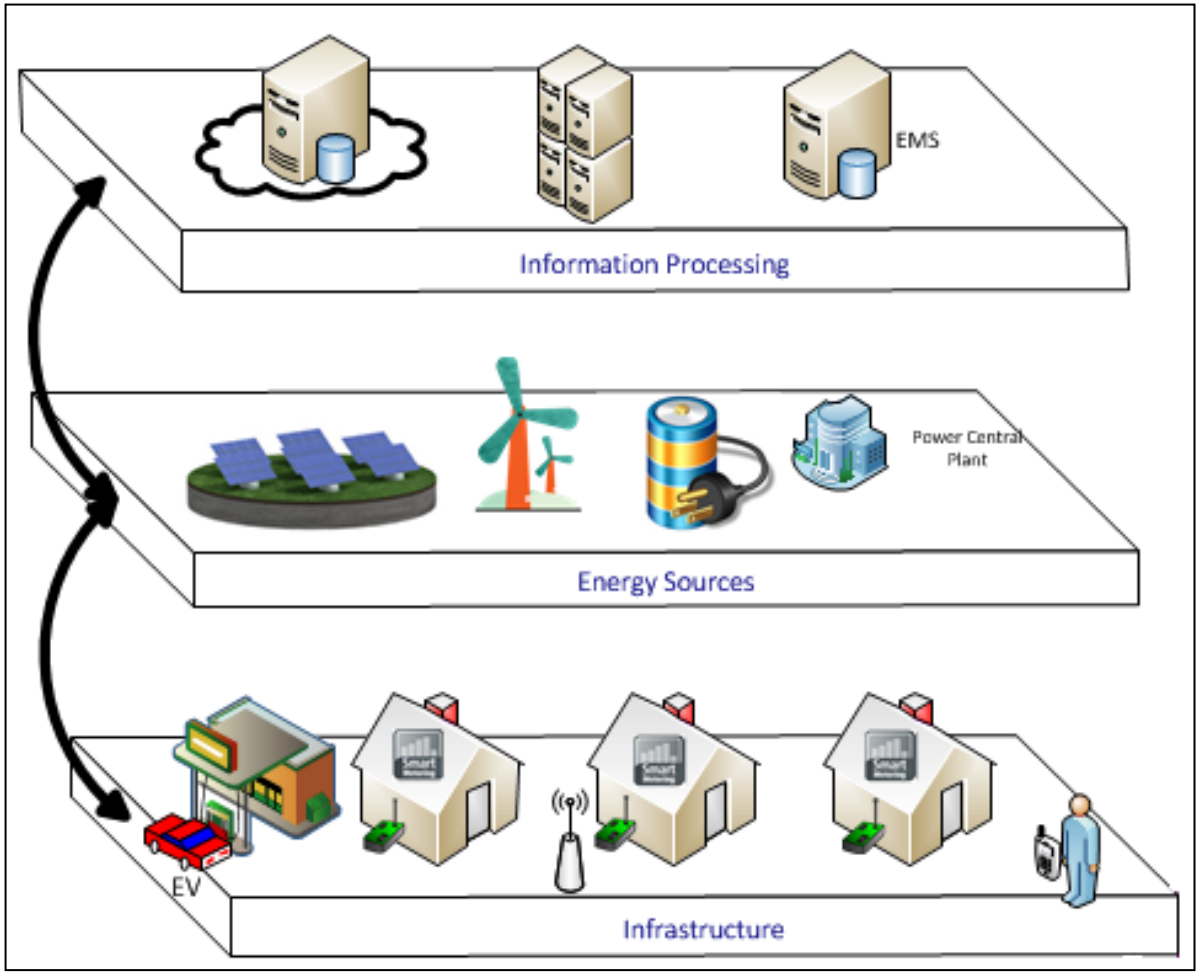
What is Smart Grid



Actors Involved



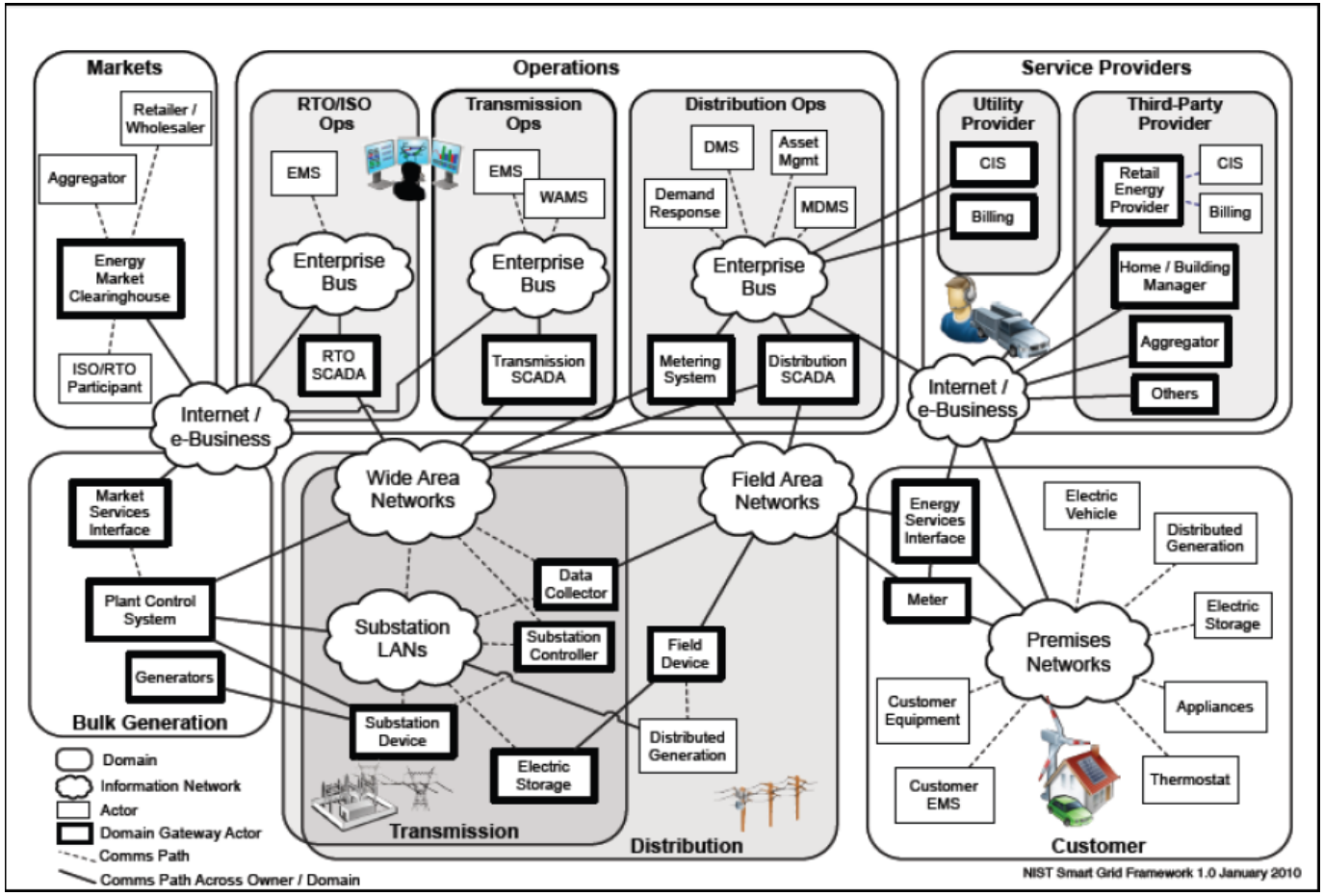
Layered View



Who's Involved

- DOE (Regulatory and funding)
  - Electricity Advisory Committee(EAC)
  - DOE Smart Grid Task Force
- NIST: National Institute of Standard and Technologies (standard development)
- National Science Foundation (NSF), DoD, etc.
- National Labs
- IEEE (standard development)
- Non government research centers (University, Private organizations, etc.)

Conceptual Reference Model



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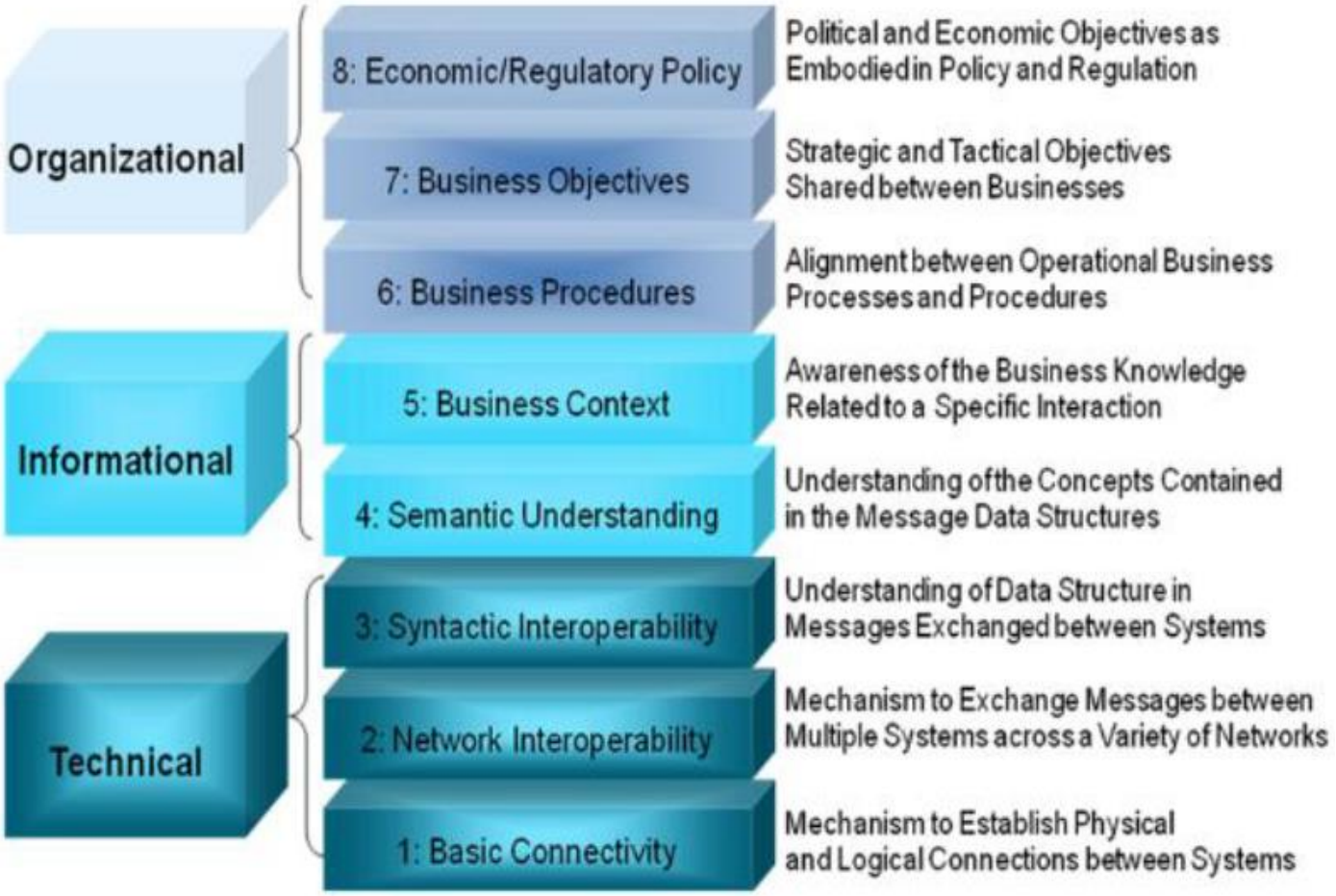
Layers of Interoperability



Challenges and Opportunities Segment

Smart Grid Infrastructure

- Power systems electronics
- Inverters,
- Electric flow controllers Concentrators
- Power Monitoring & Protection
- Renewable Energy
- HV Circuit Breaker
- Grid Stability

Smart Meters

- Electricity meter
- Gas meter
- Water meter
- Demand Response

Smart Homes and Buildings

- Energy Efficiency
- Smart Thermostats
- Smart Appliances
- Demand response
- Electric vehicle
- Distributed Energy Resource (DER)

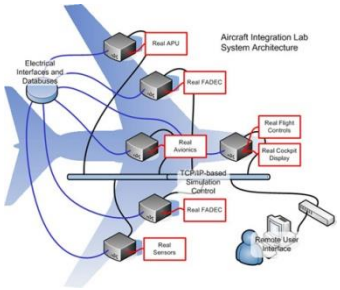
Challenges and Opportunities

- Power systems electronics: Smart energy systems and technologies, inverters, electric flow controllers, etc.
- Infrastructure: distributed generation, fault detection, localization, and remediation
- Energy Management
- Mechanical
- Civil and Architecture
- Networking
- Business: Socio-economic drivers and incentive

Challenges and Opportunities: IT

- Data analytics
- Network communications and protocols
- Optimization of energy consumption in buildings
- Demand Management via Home Area Network
- Integration of renewable energy
- Middleware development
- Smart phone integration
- Modeling
- Plug-In Electric Vehicle

NSF view: Cyber Physical System



With Intelligence

*Adapted From Dr. Yuan presentation

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NSF Challenge

- **How can we design, build and verify reliable, predictable, safe and secure cyber-physical systems upon which people can - and will - bet their lives?**

Wireless Sensor Networks Applications

Emergency Medical Care

Seismic Structure response

Develop in situ observation of species and ecosystem dynamics

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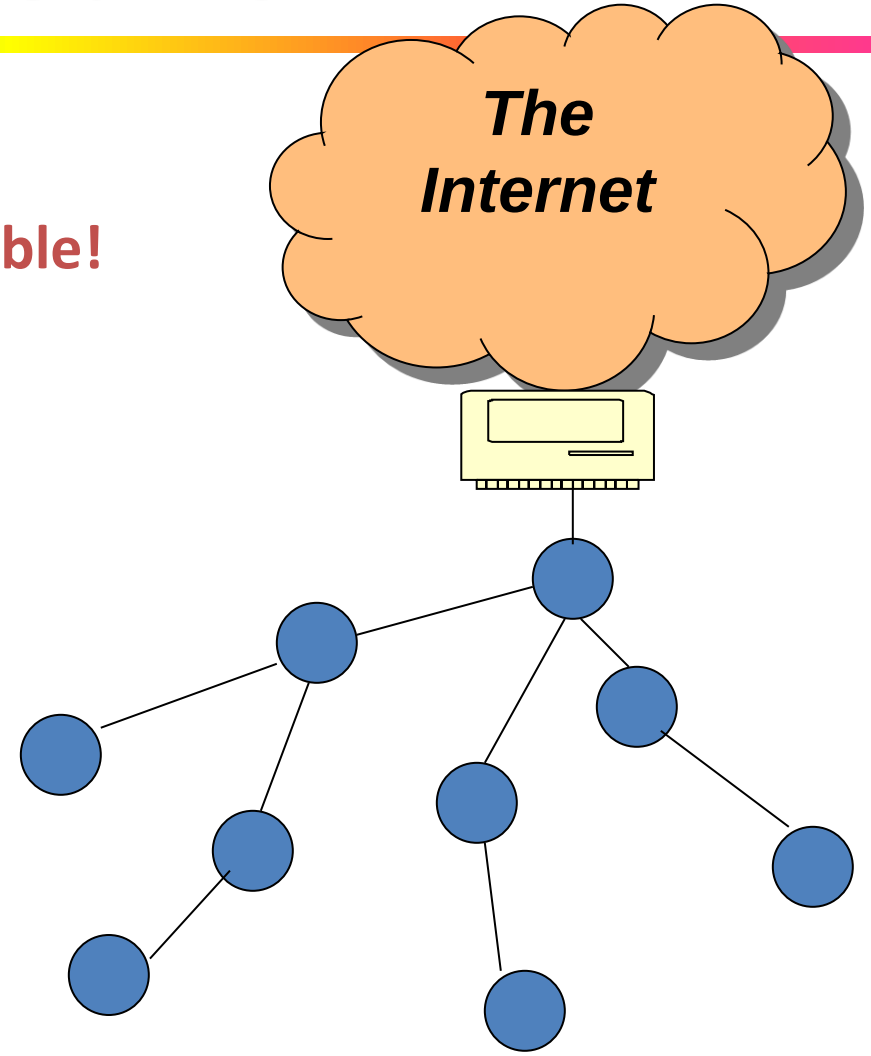
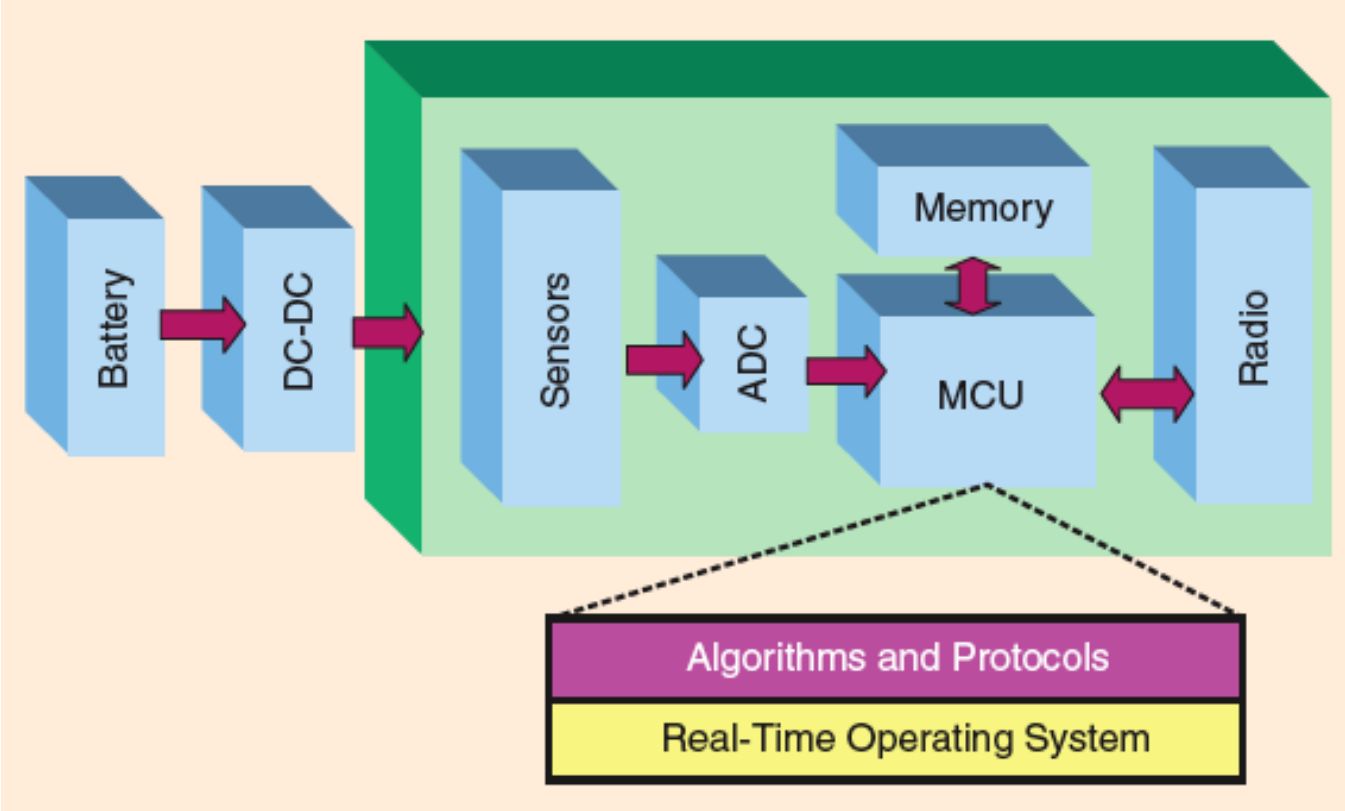
What is a WSN

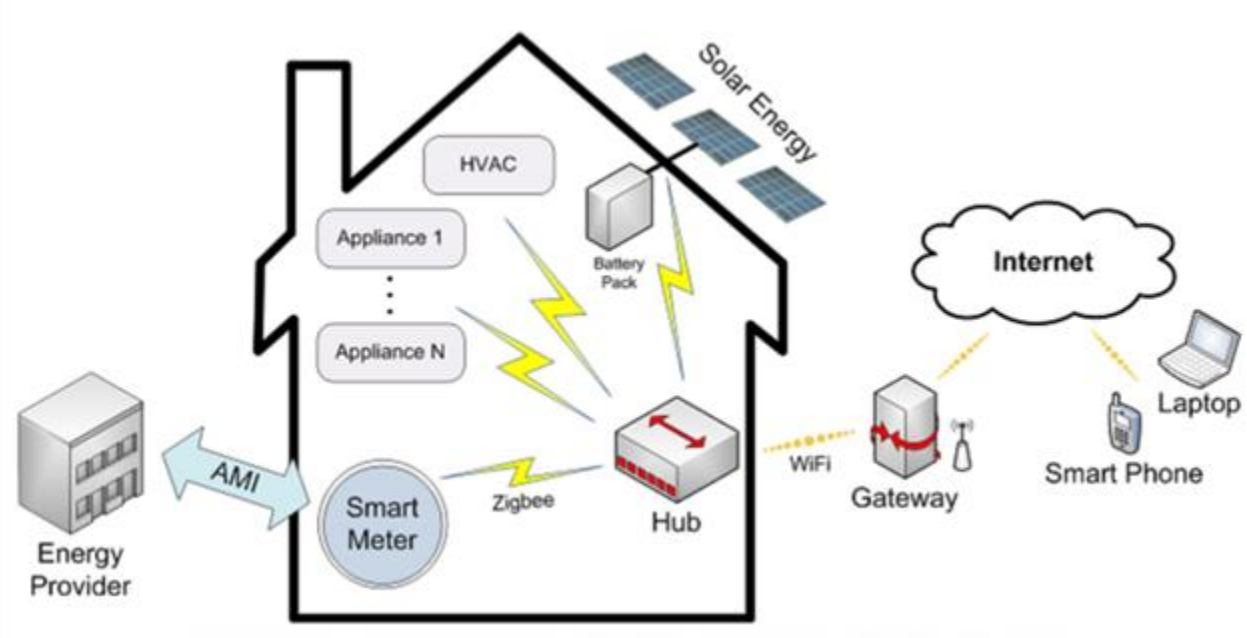
- Each node is **Programmable!**
- Data Collection and dissemination



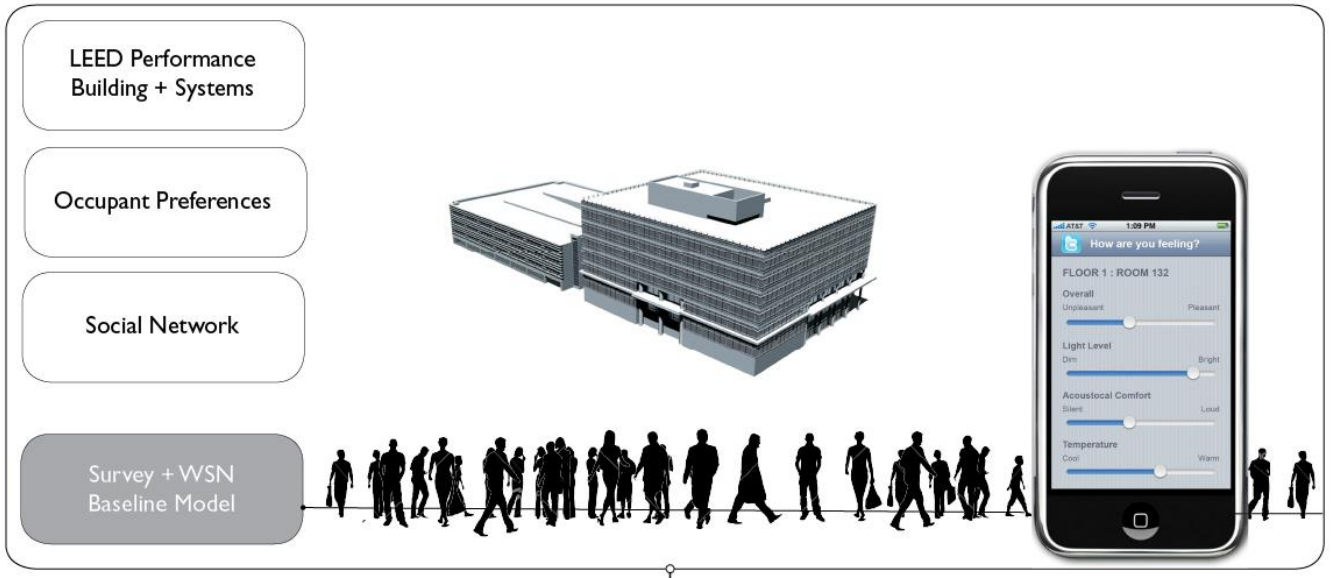
The Node


Battery
DC-DC
Sensors
ADC
Memory
MCU
Radio
Algorithms and Protocols
Real-Time Operating System

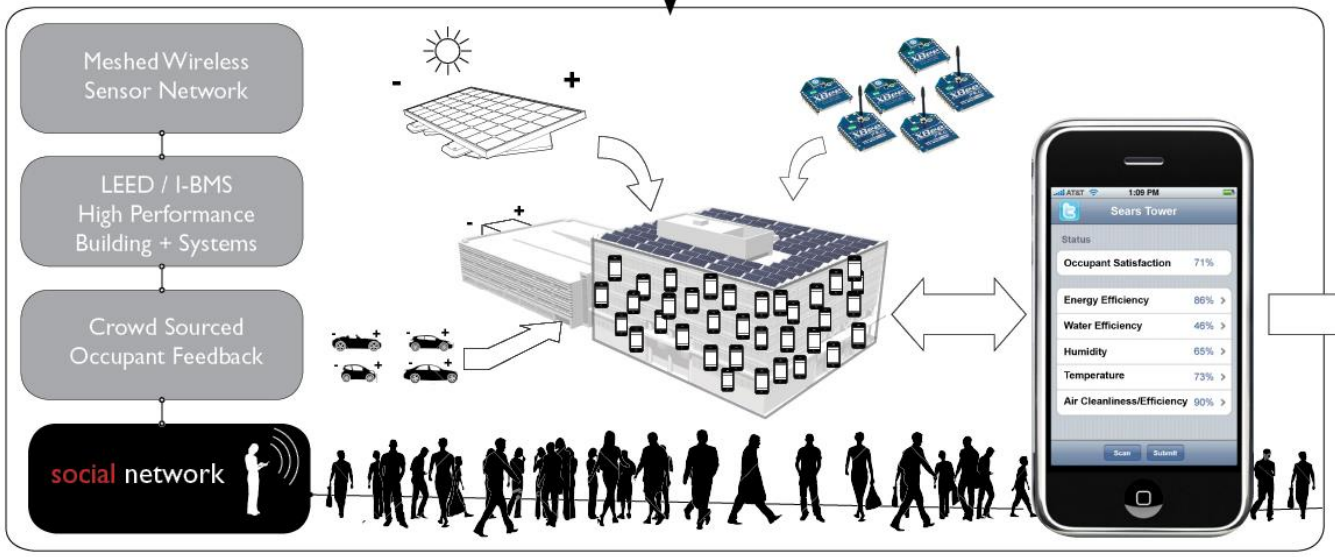
WSN and Smart Grid: Home Scenario



Social and Wireless Sensor Network Driven Intelligent Building Management Systems



4 years



BIM
BUILDING INFORMATION MODEL
- parametric unit material pricing
- platform for design coordination
- platform for construction coordination
- parametric unit material pricing

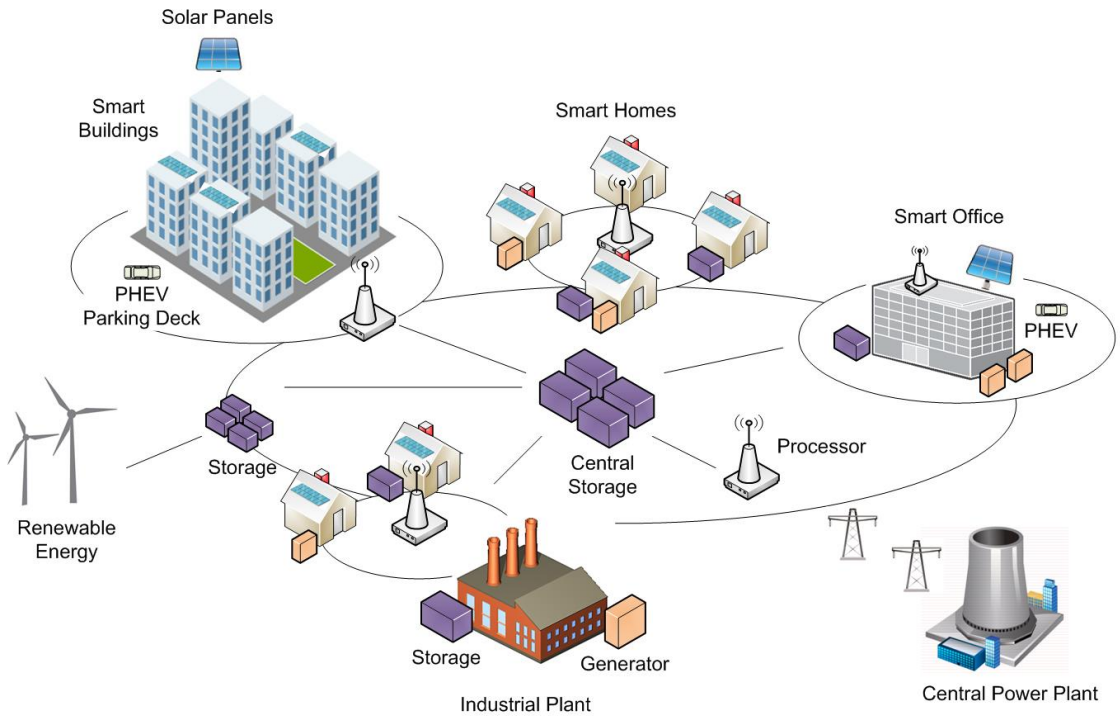
BMS
BUILDING MANAGEMENT SYSTEM
- proprietary control platform
- minimal occupant control
- insufficient control of individual devices, systems, appliances

P-BIM
PARAMETRIC BUILDING INFORMATION MODEL
- parametric coordination of subjective and empirical data throughout the building into BIM model
- traffic and occupancy data for patterning and prediction
- building consumption vs. occupant preference

I-BMS
INTELLIGENT BUILDING MANAGEMENT SYSTEM
- open crowd-source control platform
- occupant input for comfort
- individual patterns & preference settings
- energy model with occupant preferences to maintain efficiency at peak hours

Smart Campus/City

Smart Campus



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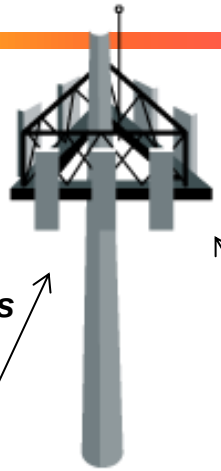
The Provider View

Device Controller
HVAC, Water Heater, Pool Pumps

ZigBee™

Wireless Data



Internet

Meter / Gateway

ZigBee™

Thermostat

Operations Center

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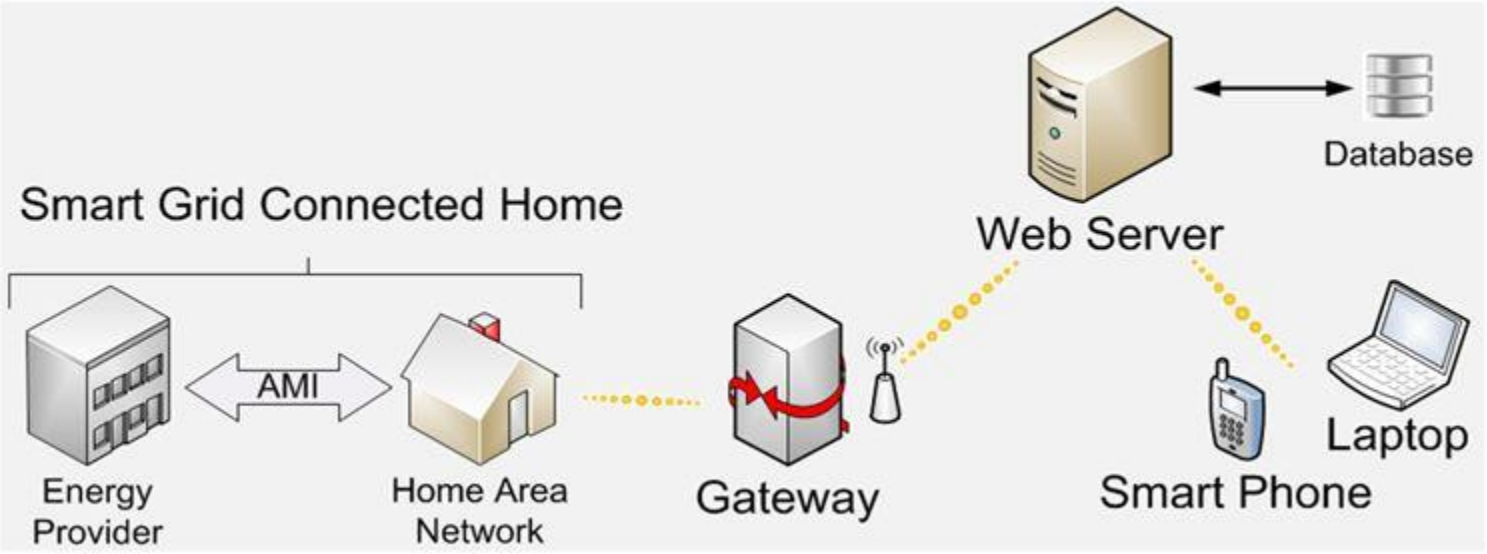
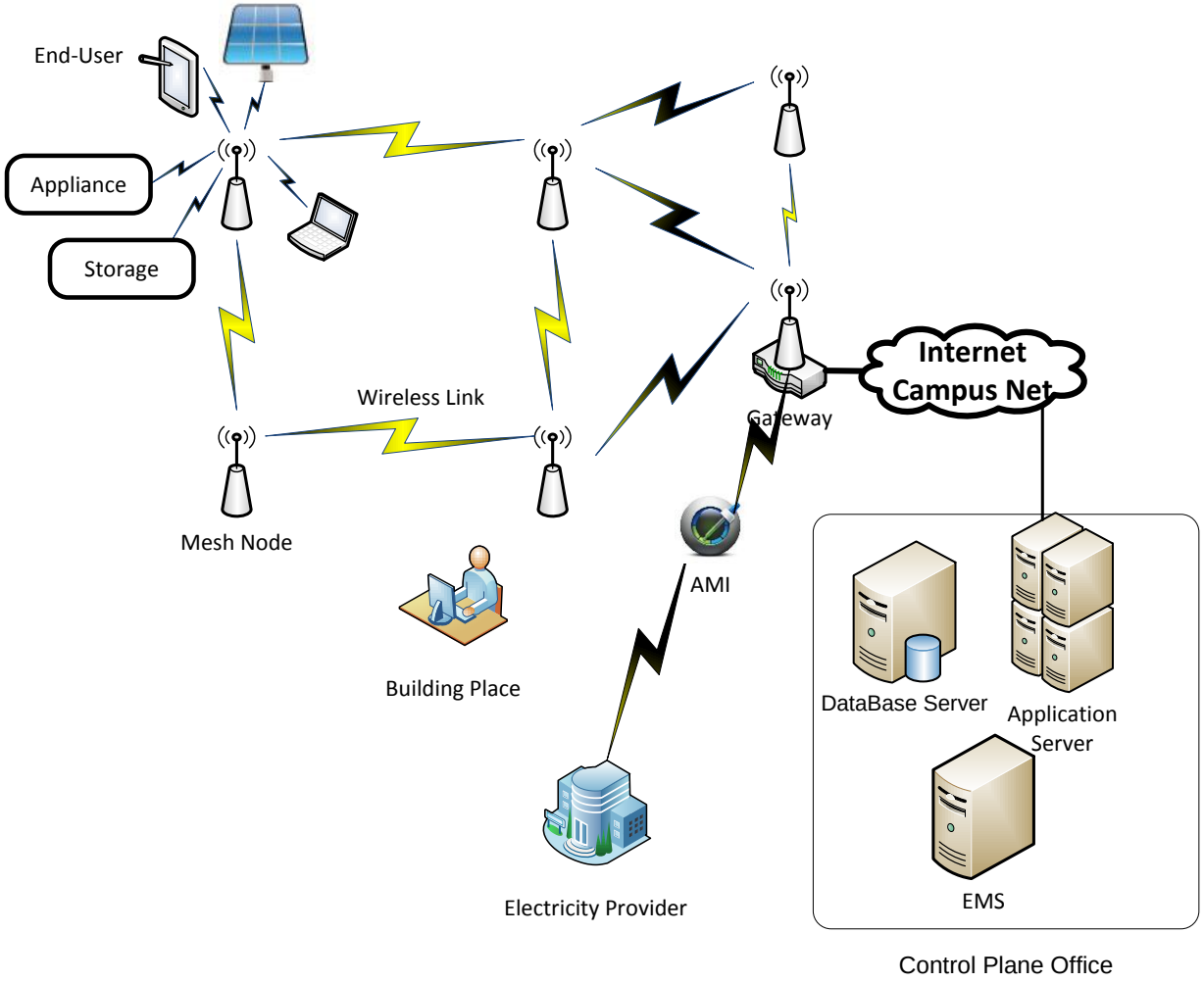
Network Architecture

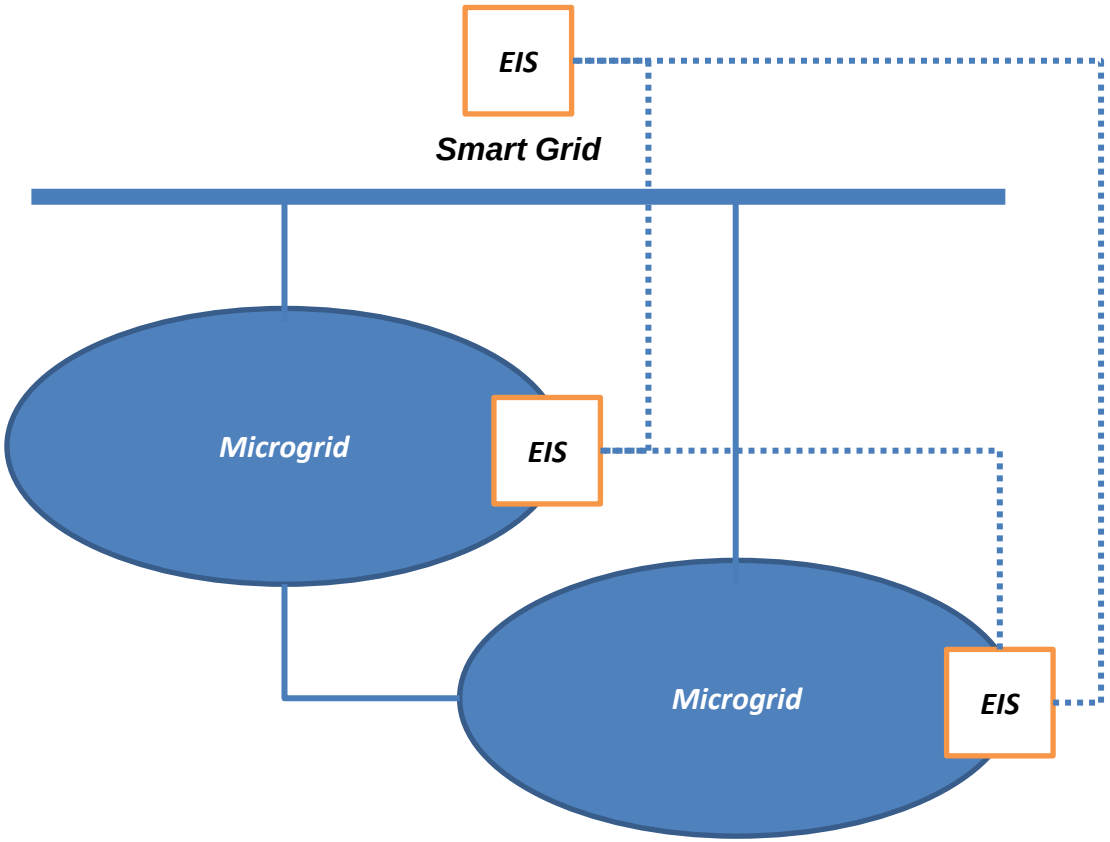


Multi-domain



Where Smart Grid is Heading?

Federating microgrids



Research Question

- How human behavior can be modeled and implemented in the system?
- What “smart” algorithms can be implemented so that the building is autonomous and adapt to the human behavior?
- What methods should we use to verify the functionality of the system?
- Fundamental Problems in term of robustness, reliability and resiliency

Is It a Killer Application?

- Smart Grid may be the killer app for the Internet!

Aknowledgement

I would like to thank

- Fulbright program for funding this Project
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- University of Houston for paying half of the bill and for Seed Funds through GEAR program
- Faculty and students

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Thank You!

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