

Next Generation Heterogeneous Wireless CyberSystems to Support the Emerging SmartGrid

project update: 12/1/2011

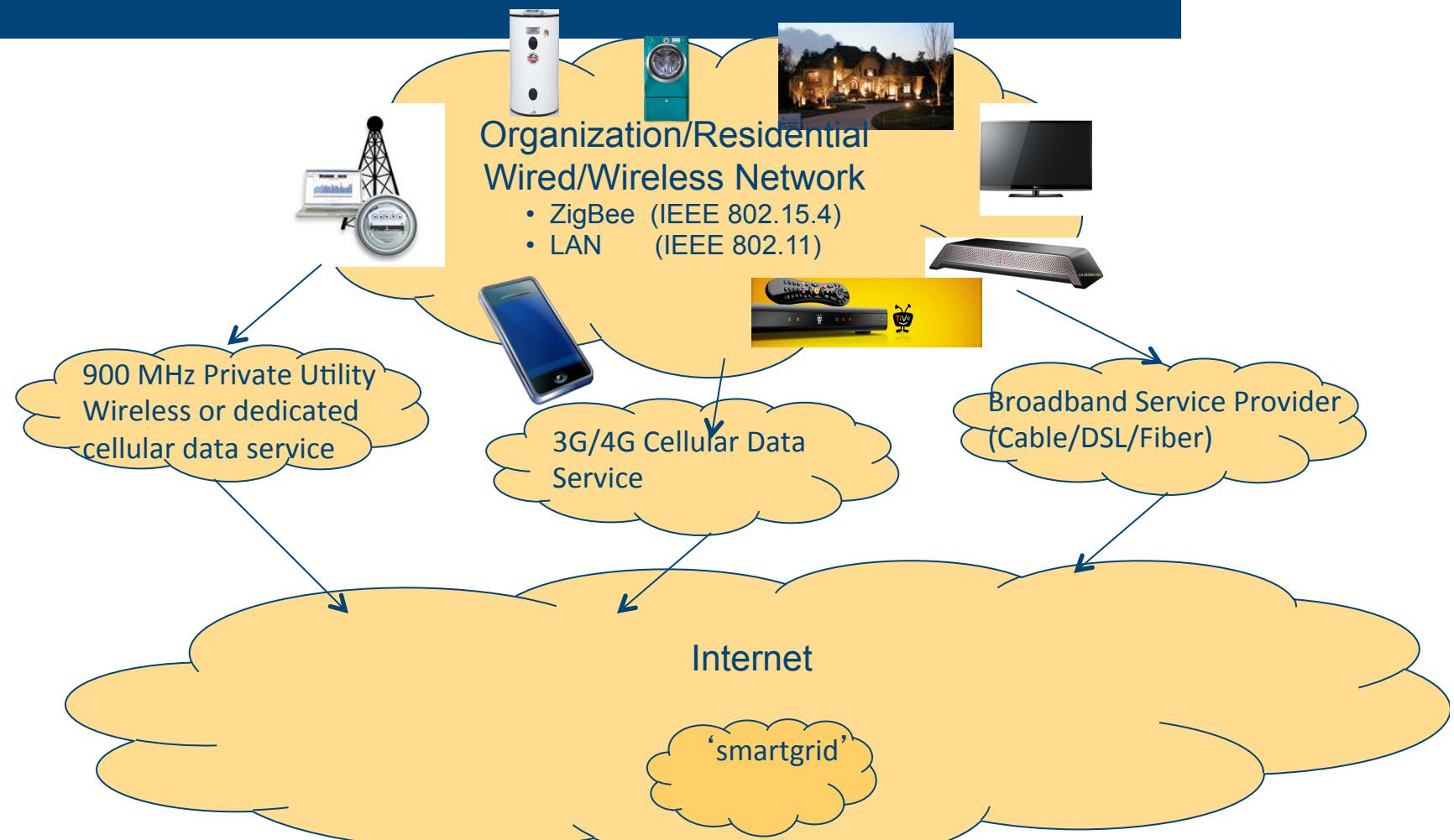
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Overview

- Background
- Introduce the Smartgrid
- Problems of Interest
- Extensions of our current research projects
- Defining the idea

The Smartgrid



Smartgrid Complicates the CyberInfrastructure

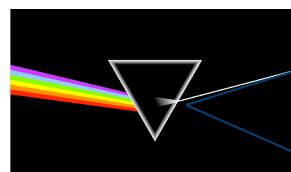
- Organizations/Residential homes will have a cyberinfrastructure.....
 - Computing platforms
 - Entertainment devices
 - Communications devices
 - Security devices
 - Devices that can be monitored and controlled via the network
 - Sensing devices
- There has been tremendous debate over the architecture of the emerging smartgrid. A crucial issue is the debate on the best choice of connectivity from the organization/home to the smartgrid cloud
 - Zigbee versus 802.11 devices
 - 900 Mhz licensed spectrum dedicated for private utility wireless networks, 2G/3G/4G cellular data service, broadband Internet access service
- As the Smartgrid evolves we anticipate the following:
 - There will likely not be a universal set of standards (at all layers from the PHY to the application) for many years. The resulting cyberinfrastructure will likely be a diverse set of networks that must work together
 - The complexity of the heterogeneous network will be high – beyond the home user. We fear this is yet another technology that will increase the digital divide.
 - The bandwidth requirements of the smartgrid end point will increase much faster than expected.

Problem Definition

- **The areas of concern**
 - Cybersecurity
 - Managing resources for critical applications with products and networking technology that is “consumer grade”.
 - Complexity management
- **This set of problems exists in every business/organization that plans to join the ‘smartgrid’.** To focus the project we consider the home environment

Problem Definition and Scope

- The areas of concern
 - Managing resources for critical applications with products and networking technology that is “consumer grade”
 - Complexity management
 - Cybersecurity
- This set of problems exists in every business/organization that plans to join the ‘smartgrid’. However, to help provide focus, we limit the scope of the project to focus just on the home (residential/small/home office) environment.



Focus on Residential, small business, home office environment

Focus on methods to manage resources in these future heterogeneous wireless network

Project Idea

- Trends clearly show wireless devices are becoming more capable, more power efficient. Our device model is described as follows:
 - Some devices will have static radio communications capability- there is no way to change or vary the access technology. We anticipate the number of this type of device will drop over the next decade
 - Emerging devices will be multi-modal. They can be configured (dynamically) to support different types of radio access technologies.
 - While battery technology will improve, the requirements imposed on the devices will continue to make battery power a limiting factor in the capabilities of the home smartgrid
- Rather than have devices communicate over different wireless networks, we propose a system that allows the multiple, independent wireless systems to work together to form a single unified wireless network.

Project Idea

- With this idea and motivation, the research problems addressed by the proposal are :
 - Defining an appropriate wireless architecture that supports a heterogeneous wireless system
 - Develop methods by which the system manages the wireless spectrum that is available in a manner that blends policy, fairness, and system efficiency while taking into account power management and application performance requirements.

Project Description

- Develop the foundations to study the problem through a combination of lab benchmarking studies and simulation modeling.
- Research objectives:
 - Provide guidelines for the amount of broadband access (wired and wireless) bandwidth might be required.
 - Explore the sensitivity of the home network to intrusions caused by intentional and unintentional denial-of-service.
 - Intentional DoS occurs when an ‘infected’ computer within the network can cause portions of the home network to not work
 - Unintentional DoS occurs when a device (such as a netflix-enabled wireless device) consumes 100% of the bandwidth.

Project Milestones

- **Task 1: Literature survey:** the starting point is to do a thorough academic literature survey to determine where the issues and possible future paths for the smartgrid.
- **Task 2: Industry/deployment survey:** We need an understanding of what the capabilities are of smartgrid systems being deployed now as well as what we can expect to see deployed over the next 5 years. This task includes connecting this project with smartgrid activities within IBM.
- **Task 3:** We will develop a system architecture and design a simulation model that captures the basic components of the system. We will use the open source ns2 simulation tool.
- **Task 4:** Baseline the basic system
- **Task 5:** Resource allocation algorithm design and evaluation
- **Task 6:** Document the project, deliver all code and data to our IBM sponsors, develop one or more academic papers and submit for publication at top level conferences and journals.

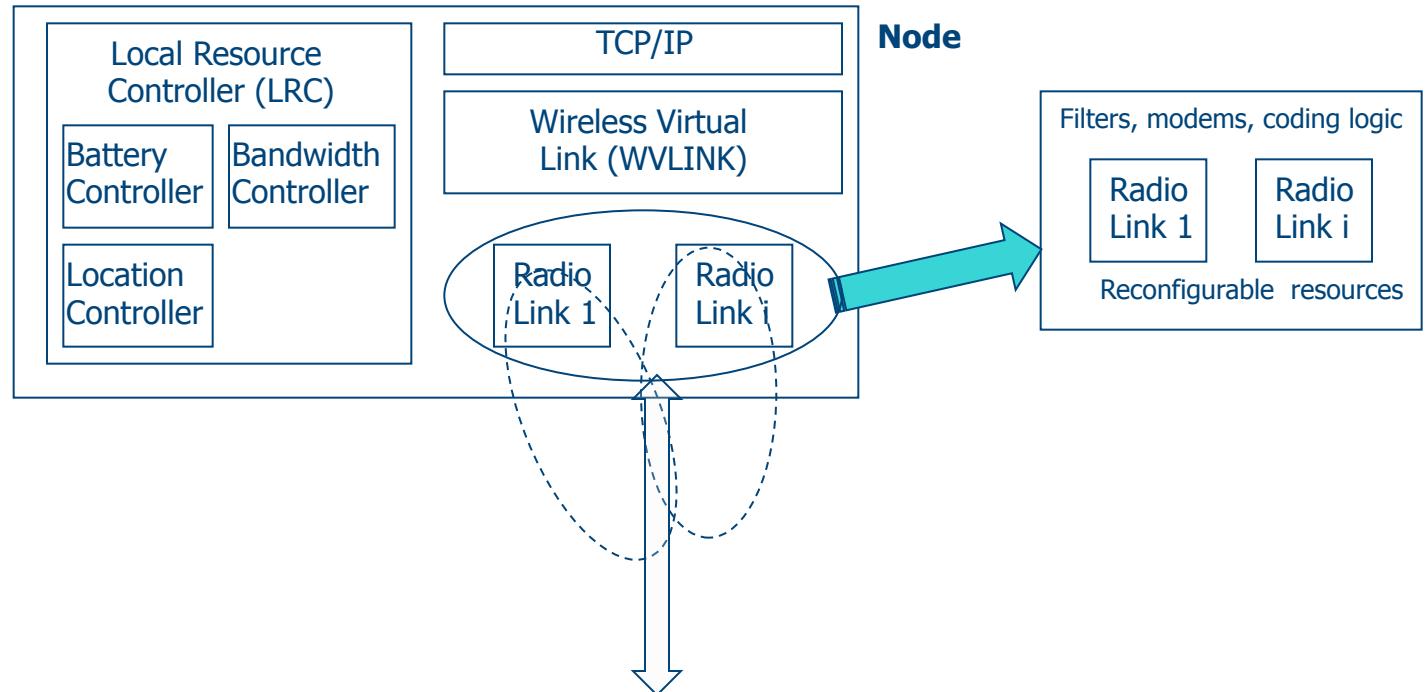
Project Outcomes and Deliverables

- **Outcome 1:** For a residential/home office environment, we will demonstrate issues and limitations of the current approach used to build smartgrid capabilities – that involve separate underlying networks.
- **Outcome 2:** We will propose an innovative new approach for building the ‘cyberinfrastructure’ required to support current and anticipated requirements of the smartgrid.
- **Outcome 3:** We will demonstrate the benefits of the ideas using realistic applications and use cases
- **Deliverables:** Our IBM sponsors will have access to any/all simulation code, all data that is generated, and immediate access to any of the ideas/technology developed through the project (as it will be in the public domain through publications).

Defining/Modeling the ‘Smartgrid’

- **Literature Survey**
 - Lots of research in smartgrids
 - Internet of Things relationship
 - IEEE SmartGrid2010, 2011 (deadline May 6 2012)
- **System Model :**
 - Requirements of the system
 - Device model
 - Application oriented usage model
 - Wireless system model

Device Model



Possible System Model

