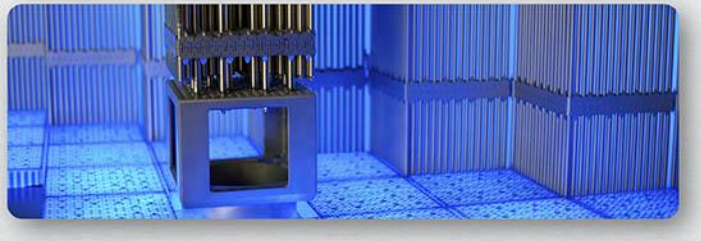



ELECTRIC POWER RESEARCH INSTITUTE

Wireless Field Area Network Spectrum Assessment

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Smart Grid Informational Webcast
February 22, 2011

Outline

- Context and Motivation
- Definitions and Assumptions
- Methodology
- Findings
- Discussion

Context and Motivation

- Utilities have limited access to licensed radio spectrum
  - No national coordination, niche markets for spectrum & equipment
  - Need is understood, some initiatives are being pursued, but the process may be long and arduous

- Reliance on unlicensed spectrum is potentially risky
  - Experience shows congestion is inevitable, can be overwhelming
  - Methods for interference tolerance are specific to a standard
    - Not generally the intent or reality in unlicensed bands (ISM: 915 MHz, 2.45 GHz)
    - Development of standards, products, certification/conformity, and the institution of cooperative behavior all takes time, effort

Context and Motivation

- EPRI's programmatic approach
  - TU #1022421 launches a series of planned Technical Updates
  - A systematic basis for Smart Grid Communications Planning
  - To enable & inform custom and collaborative SG Comms projects
    - One under way, one in approval process, others in development
    - Preparing an Industry-wide Technology Demonstration Project focused on High Reliability Field Area Networks (HR-FAN)

- Important distinction and notice!
  - *Within* EPRI mission and scope: research, analyze, and publish information on the technical and economic impacts of actual or potential spectrum allocations
  - *Not within* EPRI mission or scope: advocating or promoting any policy choices or recommendations regarding spectrum allocation

Definitions and Assumptions

- Field Area Network (FAN): "broadband wireless network providing essentially ubiquitous regional coverage"
  - Broadband: using 4G cellular (WiMAX, LTE) technology to provide coverage for current and future (+10 yrs) utility applications
  - Essentially ubiquitous: coverage in well-defined urban/suburban and rural environments and population densities (morphologies)
  - Security: robust application- and medium access layer (MAC)-level encryption and device authentication; "government grade" security
  - Reliability: 99.99% available (<2hrs/yr unplanned outage) including disruptions (e.g. storms) in outdoor urban/suburban areas; may be somewhat less indoors or in rural areas
  - Latency: end-to-end <1second worst case (can be up to 10x faster)

Definitions and Assumptions

- Morphologies used in the study
  - "Urban Model"
    - Based on a large, multi-county metropolitan area
    - Total population of roughly 4.8 million
    - Land area ~6500 km^2 including 442 km^2 dense urban (33,690 persons per km^2)
  - "Rural Model"
    - Based on one largely rural state, excluding cities and towns of more than 5,000 population and counties with population densities below 0.2 persons per km^2
    - Total population 1,428,000; avg density 6.64 persons per km^2
    - Land area of roughly 215,000 km^2

Definitions and Assumptions

- Data throughput based on OpenSG Network System Requirements, v4.0 (but with increased message size to allow for security)
- Models today's substation and feeder-based SCADA and AMI data, as well as growth in these traffic classes over 10 years
- All assumptions re: data flows, position of devices (meters), RF power levels, antenna configuration and gain, indoor and outdoor coverage, etc. are explicitly documented
- Summary

Timeframe	Condition	Throughput Including Smart Meter Communications		Throughput Without Smart Meter Communications	
		Downlink	Uplink	Downlink	Uplink
Present	Normal	0.49 Mbyte/hr	0.49 Mbyte/hr	0.42 Mbyte/hr	0.42 Mbyte/hr
	Disaster	1.27 Mbyte/hr	1.27 Mbyte/hr	1.26 Mbyte/hr	1.26 Mbyte/hr
10 Years	Normal	16.61 Mbyte/hr	16.61 Mbyte/hr	9.24 Mbyte/hr	9.24 Mbyte/hr
	Disaster	28.46 Mbyte/hr	28.46 Mbyte/hr	27.72 Mbyte/hr	27.72 Mbyte/hr

Methodology

- Model deployment of 4G technology on three bands
  - Unlicensed ISM bands (2.45 GHz, 915 MHz)
  - Licensed band, dedicated FAN (1800 MHz, 30 MHz ttl)
  - Licensed band, shared FAN (700 MHz, 22 MHz ttl)
- Use Extended HATA model for path loss and typical forward and reverse (UL/DL) power levels
- Make clear and explicit all aspects of 4G technology used in modeling (channel size; number of subchannels, assignable blocks, and subcarriers; path loss calculations; cell size and overlap; SNR; spectrum efficiency; etc.)
- Use data and models to estimate number of base stations and associated cost (CAPEX) of deploying a FAN

Findings

- General finding:
  - Wireless FANs will be coverage not capacity bound
  - Additional AMI traffic, growth over 10 years have minimal impact
- FAN on unlicensed spectrum seems impractical today
  - Limited power levels means thousands of base stations or APs
  - Operational complexity and cost seem prohibitive
- FAN on dedicated 1800 MHz spectrum
  - Requires 227 base stations, cost ~$72M
  - Urban/sub: 136 BS, $44M; Rural: 91 BS, $28M
- FAN on shared 700 MHz spectrum
  - Requires 149 base stations, cost ~$48M
  - Urban/sub: 73 BS, $24M; Rural: 76 BS, $24M

Discussion

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