Perspectives on Spectrum and Resilient Communication for the Grid

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ISART: 5G SPECTRUM AND A ZERO-TRUST NETWORK
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Agenda

- About EPRI
- Private LTE and the evolution to private 5G
- Impact of Unlicensed Operation in 6 GHz licensed spectrum
- Black Sky Communication without terrestrial infrastructure
- Extending the Microgrids concept to grid telecom networks
EPRI’s Mission

Advancing *safe*, *reliable*, *affordable* and *environmentally responsible* electricity for society through global collaboration, thought leadership and science & technology innovation.
Three Key Aspects of EPRI

**Independent**
Objective, scientifically based results address reliability, efficiency, affordability, health, safety, and the environment

**Nonprofit**
Chartered to serve the public benefit

**Collaborative**
Bring together scientists, engineers, academic researchers, and industry experts
Our Members...

- 450+ participants in more than 30 countries
- EPRI members generate approximately 90% of the electricity in the United States
- International funding – nearly 25% of EPRI’s research, development, and demonstrations
Drivers for the Utility Field Area Network

Carbon reduction goals require large scale adoption of DER and storage. This must be built on a modernized grid with advanced telecommunications

*The Integrated Grid* combines two rapidly evolving large system infrastructures – Electric Grids and Telecom Networks
Why are utilities choosing private LTE over commercial?

- **Reliability / Availability**
  - Network can be built to utility reliability standards
  - Restoration can be done on utility schedule and priority
  - Network maintenance downtime fully visible and controlled by utility

- **Cyber-security**
  - All parts of network under utility management and ownership

- **Cost**
  - For Investor Owned Utilities (IOUs), capitalized expenses for investment projects are financially preferable over operational expenses
  - In many states, spectrum costs are also treated as capital

- **Lifecycle**
  - Utility life cycle for field devices longer than commercial networks
  - No stranded assets due to operator service discontinuation
Challenges for Private LTE

- Cost and availability of licensed spectrum
  - US allocation model is FCC auction or secondary market
  - Priced per person covered – expensive in dense cities
  - Competing with commercial cellular operators
  - Important to capitalize spectrum investment

- Cost of required infrastructure to provide full coverage
  - Cost challenge increases for the higher frequency band options

- Cost and complexity of deploying and managing the LTE Core
  - Training, skill set, etc.
Private LTE/5G Spectrum Space

Prime Spectrum – Commercial Operator Bands

Low Bands
- Band 71: 600 MHz
- Band 31: 450 MHz
- Band 37,38: 410 MHz

Better for Coverage
- Band 87,88: 410 MHz
- Band 700 MHz Upper A Block

Mid Bands
- Band 12-14: 700 MHz
- Band 8: 900 MHz

Wider Channels
- Band 30: 2.3 GHz WCS
- Band 42,48: 3.5 GHz CBR

High Bands
- Band 41: 2.5 GHz BRS
- Band 46,47: UNII 5 GHz

Ignoring 5G FR2 bands...

Narrow / Encumbered / Shared
Less Attractive to Commercial
Private LTE/5G Spectrum Space (shared)

Prime Spectrum – Commercial Operator Bands

- Low Bands: Better for Coverage
  - Band 87,88
  - 410 MHz
  - (US 406 Mhz)

- High Bands: Wider Channels
  - Band 42,48
  - CBRS
  - 3.5 GHz

- Band 46,47
  - UNII 5 GHz

Narrow / Encumbered / Shared
Less Attractive to Commercial

Ignoring 5G FR2 bands...
Unlicensed Use of the 6 GHz Band - FCC R&O / FNPRM

- **FCC Report and Order 20-51**
  - **Adopted:** April 23, 2020
- **Published in the Federal Register**
  - **Effective date of the order is July 27, 2020**

- Entire band (5925 to 7125 MHz) opened

- Licensed 6 GHz links are used for utility critical wide area networks.

- Design reliability 99.999% (5 minutes outage per year) or 99.9999% (31 seconds outage per year)

Source: FWCC
Unlicensed Use of the 6 GHz Band - Testing

- This research conducted field testing to determine if unlicensed devices operating in compliance with the FCC R&O are capable of causing harmful interference to incumbent FS systems.

- **Insights:**
  - The FS antenna sidelobes are vulnerable locations for a co-channel interferer. Sidelobes may easily be found experimentally in the field where LOS exists, but antenna sidelobe data is not included in the FCC ULS data from which automatic frequency coordination (AFC) exclusion zones will be derived.
  - The effective edge of an exclusion zone may be found experimentally in the field in front of the FS receiver out to several kilometers where LOS exists.
  - The FCC’s proposed Automatic Frequency Coordination (AFC) system is similar in concept to SAS for CBRS spectrum sharing.
Test Results Summary: Public Report

https://www.epri.com/research/programs/062333/results/3002019712
Black Sky Communications Demonstration Design

Transport Media Types
- Satellite
- HF

NYPA
- Transport Comms Systems Options
- Mutualink WAN
- Voice/Data communications Interface

Southern
- Transport Comms Systems Options
- Mutualink WAN
- Voice/Data communications Interface

PJM
- Transport Comms Systems Options
- Mutualink WAN
- Voice/Data communications Interface
Autonomous Microgrid Communications

- **State 1 – Normal**: MicroGrid controlling devices in communication with commercial cellular infrastructure.

- **State 2 – Infrastructure unavailable due to extended power outage**: Grid control devices transition to islanded, autonomous communication. Devices in microgrid-powered island establish peer-to-peer communications (e.g. ProSe / PC5 sidelink).
  - Cyber security is re-configured dynamically.
Closing thought

- Research questions of cyber-security, telecommunications, security of supply, grid resilience and reliability, and emergency communications systems are highly interwoven with wireless spectrum.
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