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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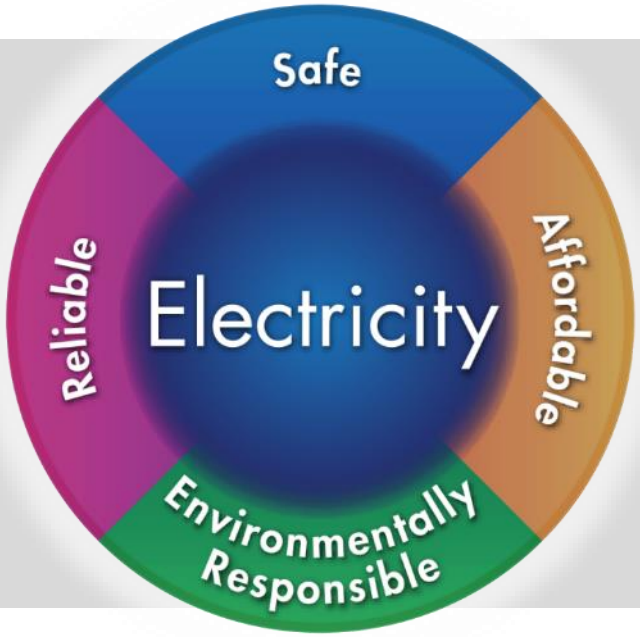
Agenda

- 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

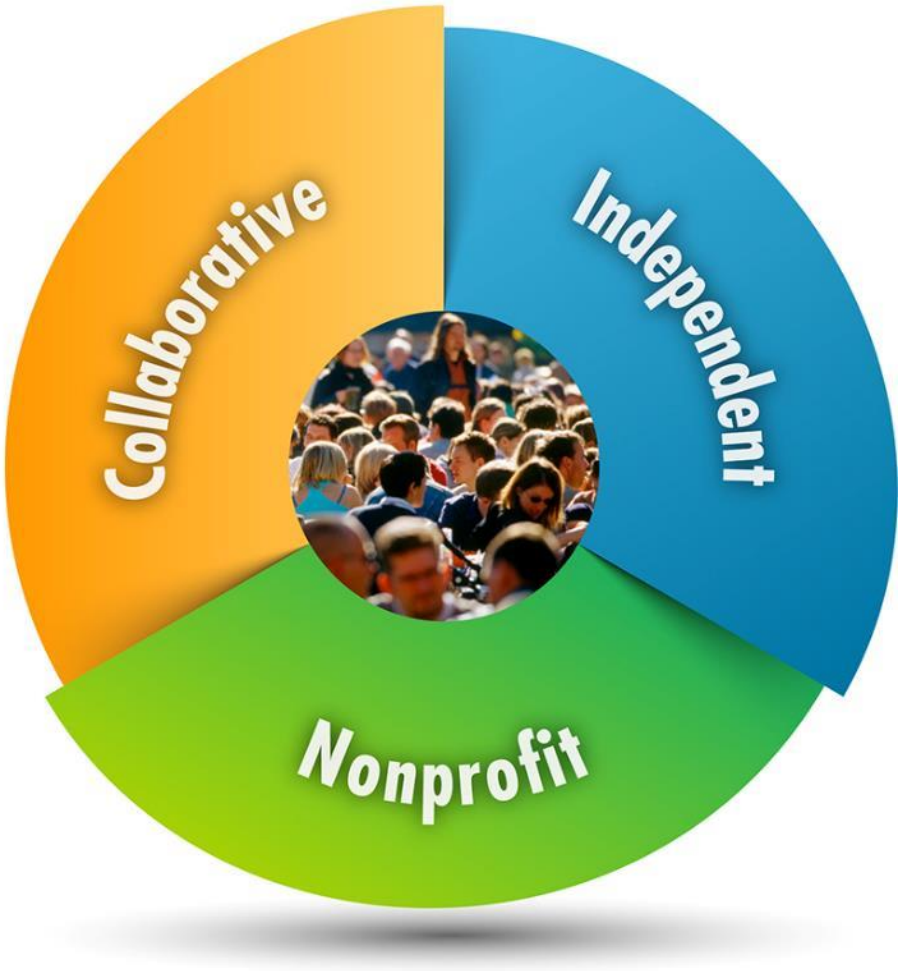
Spectrum Implications for Security of Supply and Grid Resilience

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

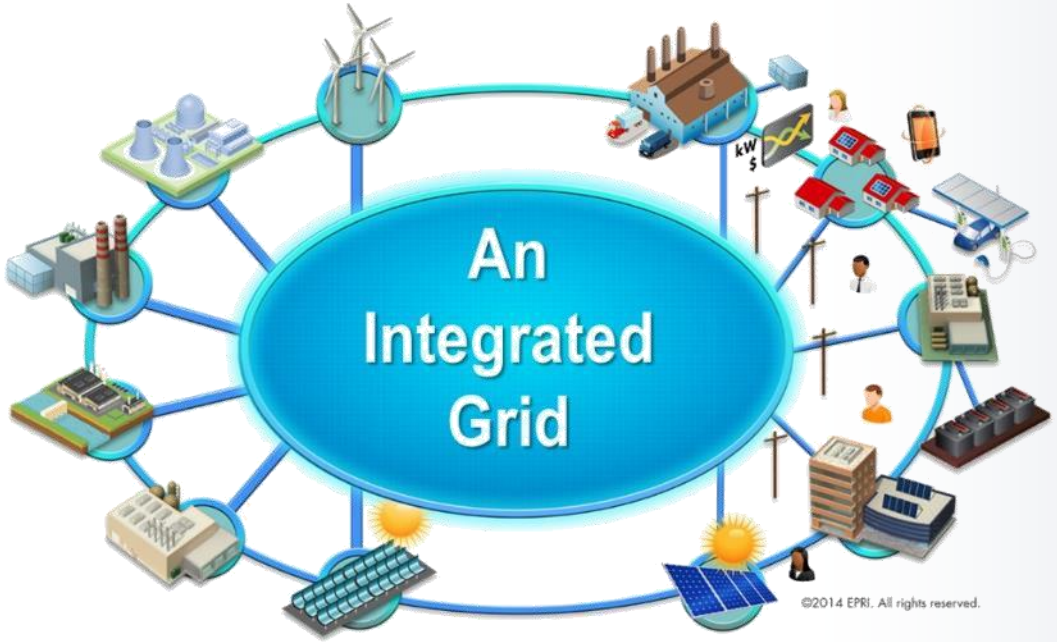
Our Members…

- 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



Integration of:

Electricity, Telecommunications, and Customer Local Energy Platforms

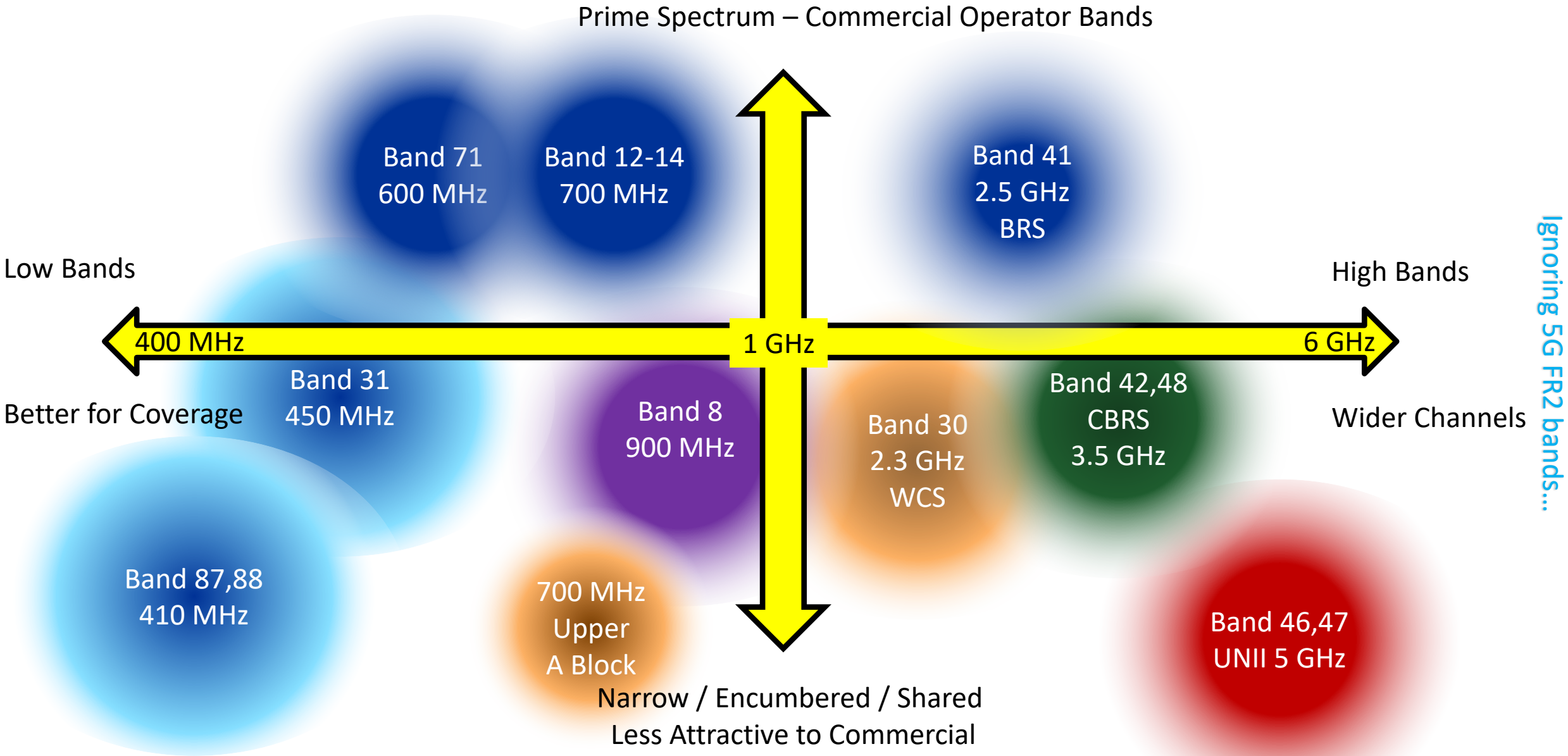
Why are utilities choosing private LTE over commercial?

- 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

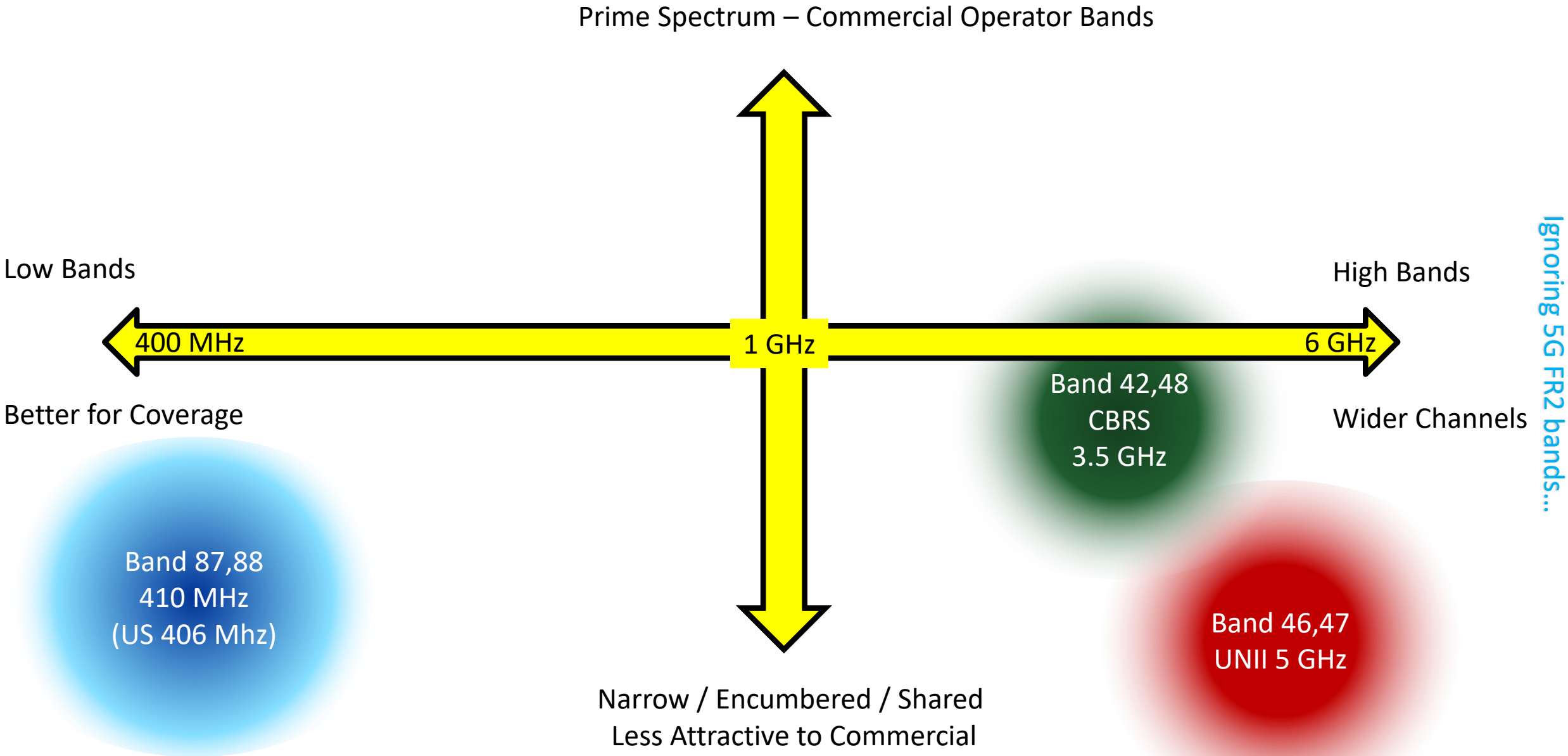
Challenges for Private LTE

- 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



Private LTE/5G Spectrum Space (shared)

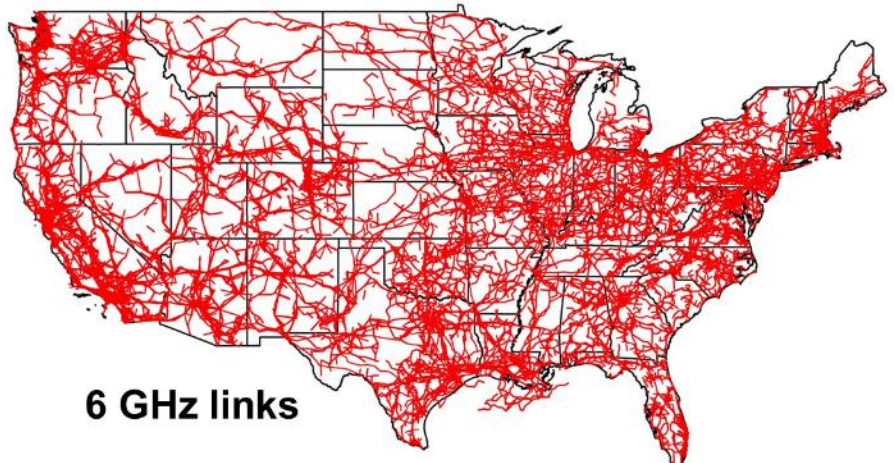


Unlicensed Use of the 6 GHz Band - FCC R&O / FNPRM

- 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

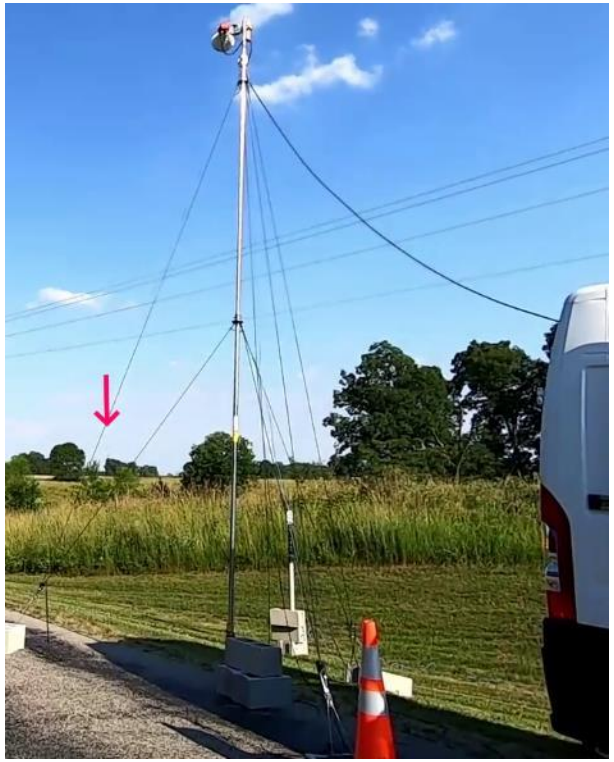
- Licensed 6 GHz links are used for utility critical wide area networks.
- Design reliability 99.999% (5 minutes outage per year) or 99.9999% (31 seconds outage per year)



Source: FWCC

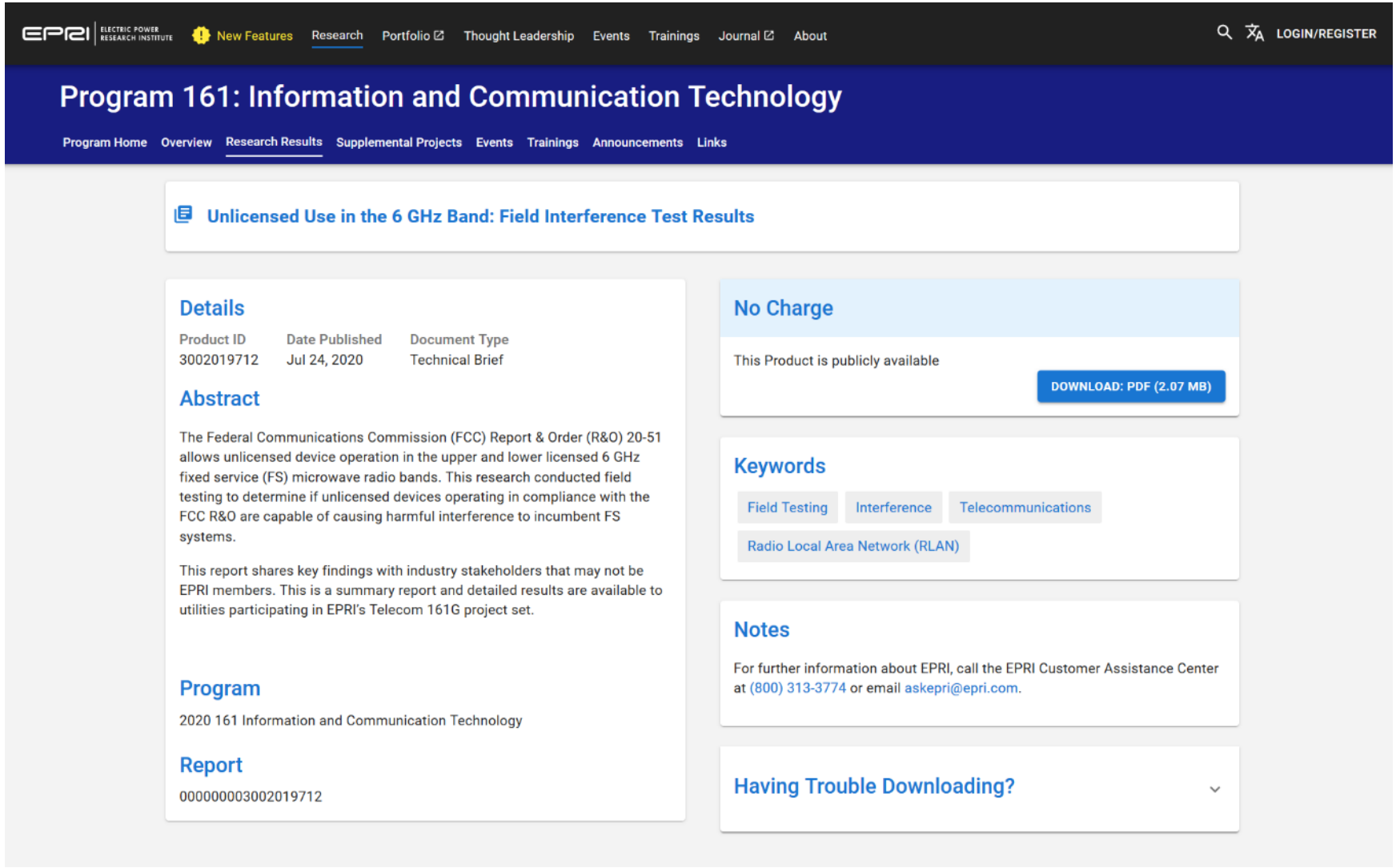
Unlicensed Use of the 6 GHz Band - Testing

- *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.*



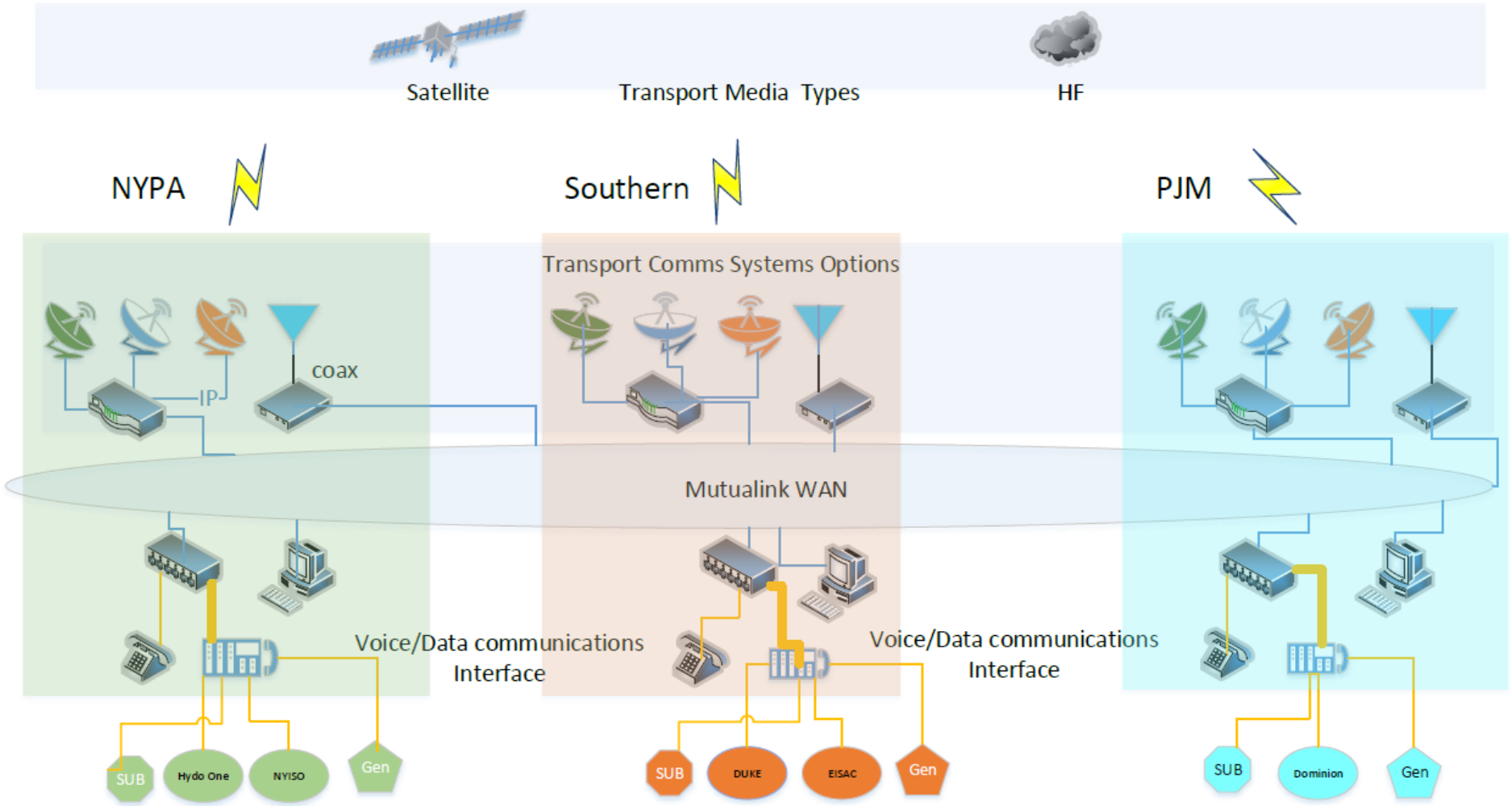
- ***Insights:***
- The FS antenna sidelobes are vulnerable locations for a co-channel interferer. Sidelobes may easily be found experimentally in the field where LOS exists, but antenna sidelobe data is not included in the FCC ULS data from which automatic frequency coordination (AFC) exclusion zones 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

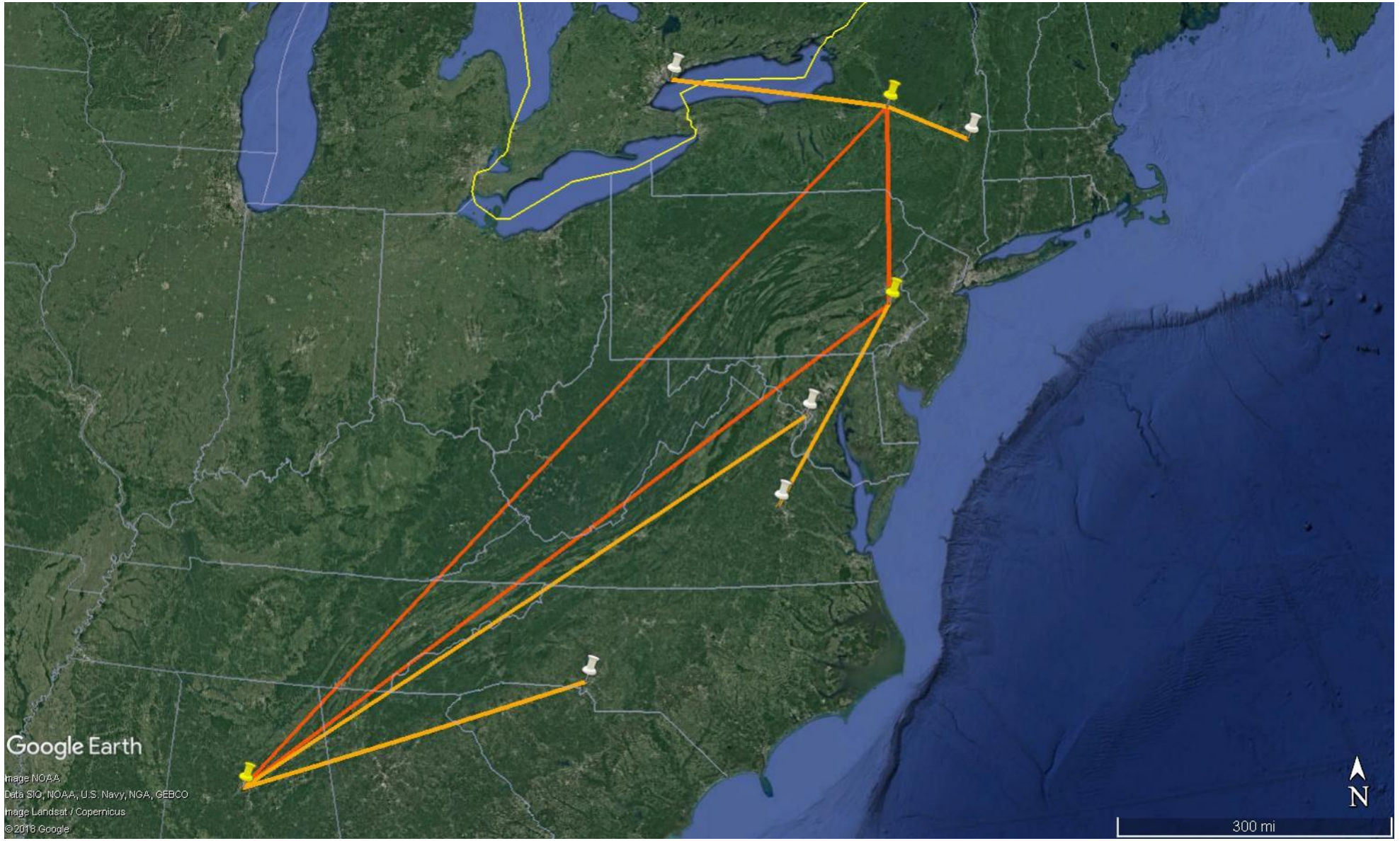


https://www.epri.com/research/programs/062333/results/3002019712

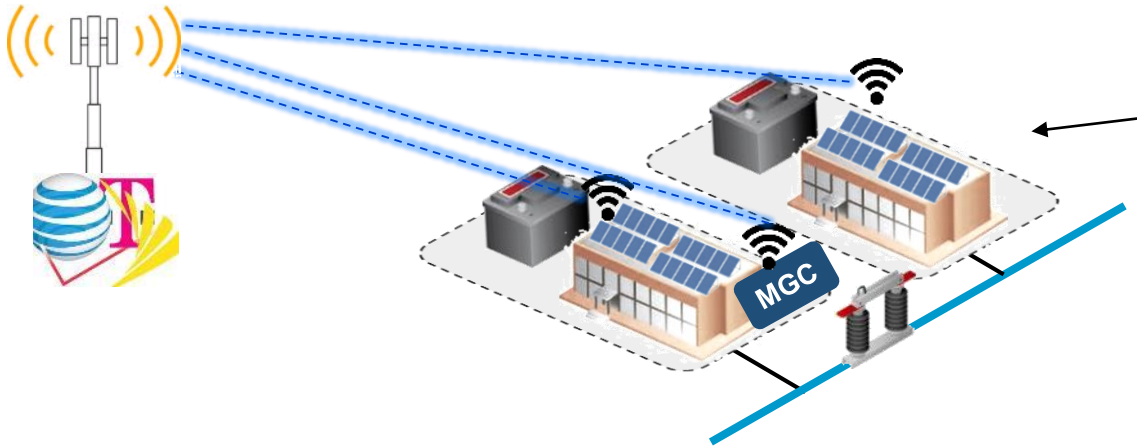
Black Sky Communications Demonstration Design



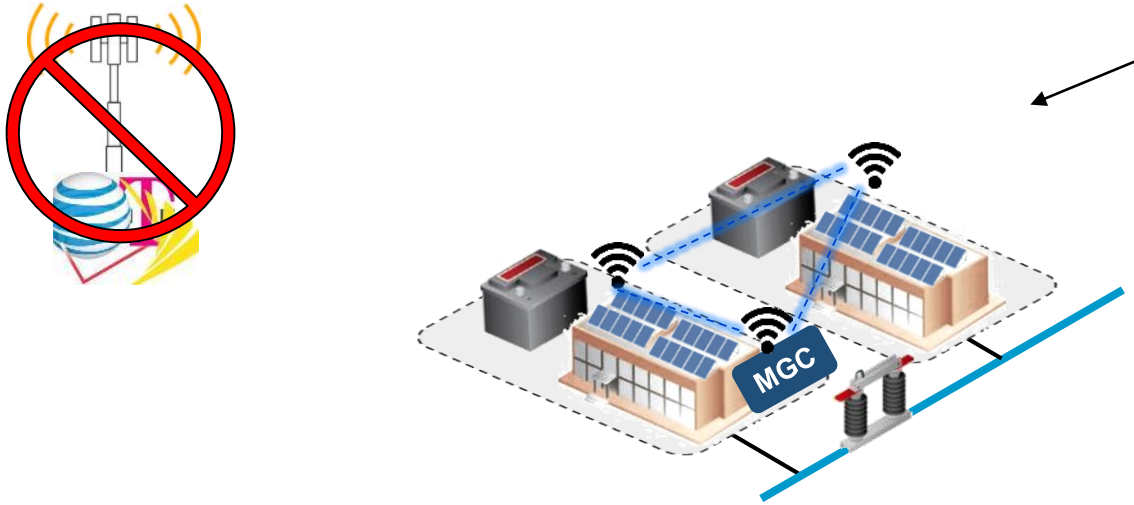
Black Sky Communications Demonstration



Autonomous Microgrid Communications



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



Peer to Peer connections

- 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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