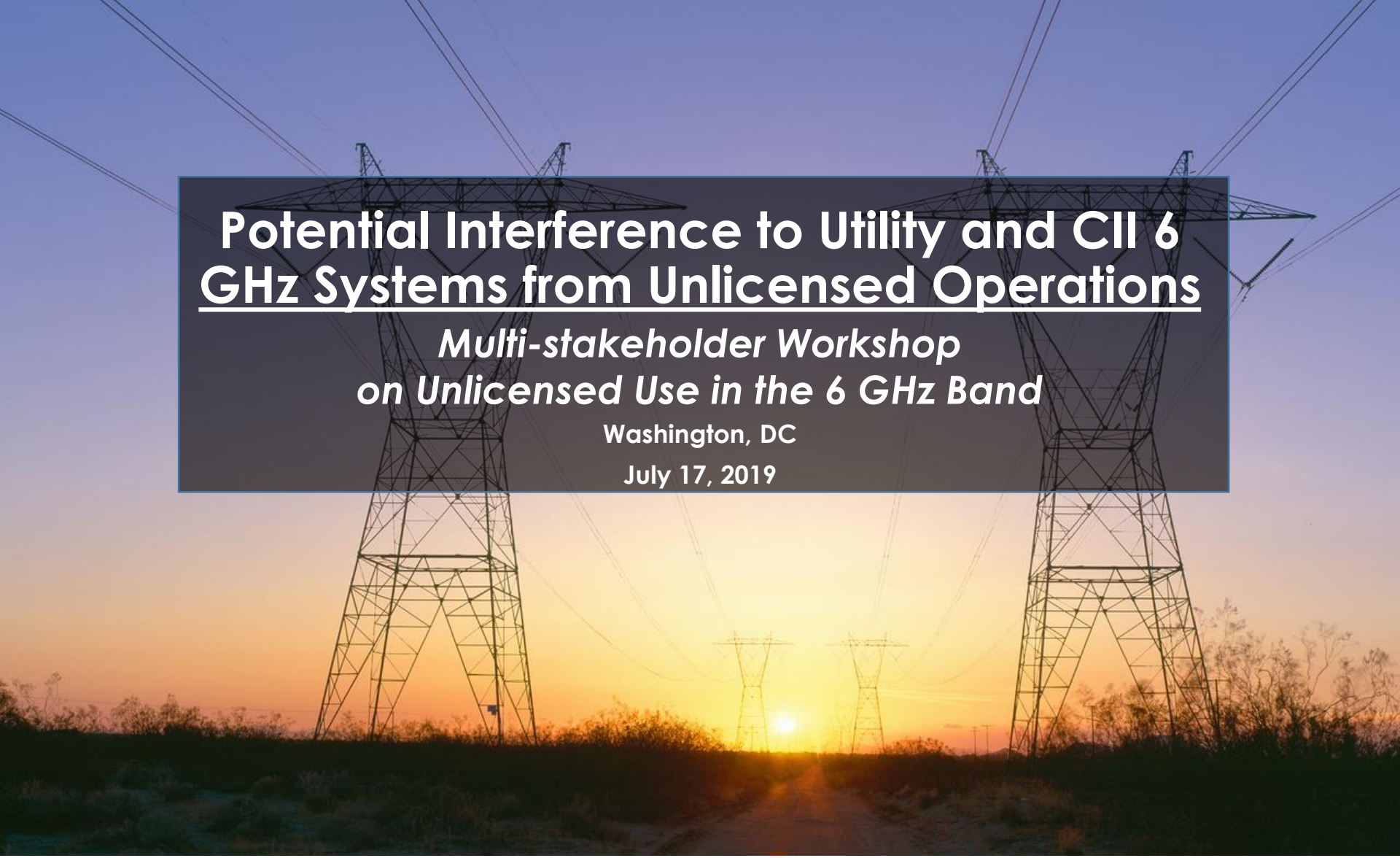


Potential Interference to Utility and CII 6 GHz Systems from Unlicensed Operations

Multi-stakeholder Workshop on Unlicensed Use in the 6 GHz Band

Washington, DC

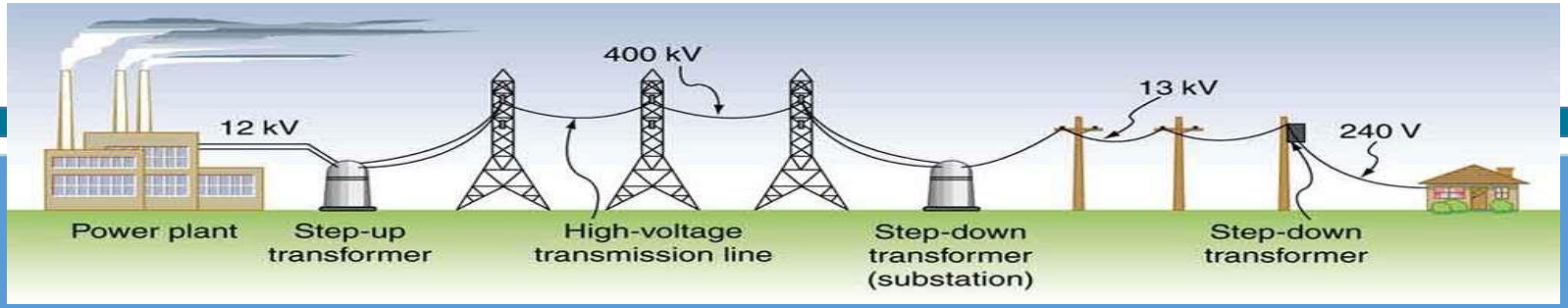
July 17, 2019

Utilities Technology Council™

utc.org

Utility Grid Operations

- Electric utilities operate three functional systems
  - Generation
  - Transmission – 69KV-765KV
  - Distribution – 120/240V (customer) – 4KV-46KV (feeders)
- The power within the grid must constantly be maintained in balance, i.e. generation=consumption
- A complex telecommunications ecosystem enables monitoring and controlling power equilibrium within the grid



Utility Telecommunications

- Utilities maintain a highly reliable and available telecommunications network to manage the grid
  - Utilities require pervasive network coverage across their service territory
  - Backbone transport services are typically a combination of fiber optics and point-to-point microwave systems
    - Backbone systems aggregate traffic and services across the grid – creates a large telecom fault domain if interrupted
    - Fiber – very expensive ~$100k per mile
    - Pt-to-Pt microwave ~$50-$100k per path
    - Path distance can be up to 40+ miles, avg 20 miles
    - Utilities may have 100's of microwave hops, ranging from 20%-80% of backbone mileage for a given utility
    - Microwave is used in urban, suburban, and rural areas

Critical Utility Applications

- Among the many applications within the utility portfolio, two critical applications stand out that are required to ensure grid stability and reliability
  - Teleprotection – monitoring the health of transmission lines between substations
    - Require millisecond response time to clear faults
    - Five 9's of availability
    - Failure to function would result in significant equipment damage, i.e. substation transformer fires or worse
  - SCADA Telemetry – monitoring power flow across the grid
    - Requires real-time reporting of critical power related parameters from grid infrastructure across the territory
    - Enables control of transmission & distribution switchgear to maintain grid equilibrium

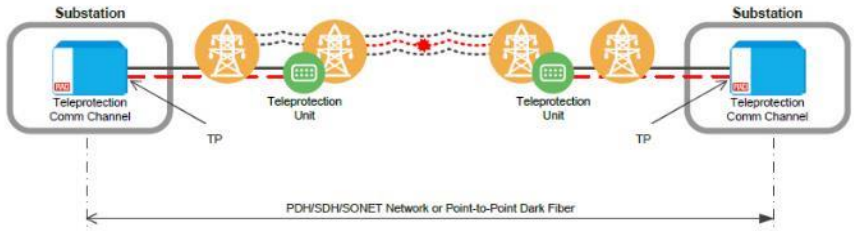


Figure 1. Teleprotection Connectivity with Ultra-Low End-to-End Delay

Microwave Design Considerations

- Microwave paths are an integral component of utility network backbone
  - Paths exist as single spurs or built in a protected ring configuration
  - Path design is a complex calculation to ensure worst case fade budget
  - Rule of thumb path budget is 40db
- Many factors contribute to link budget based on clear line-of-sight including Fresnel Zone
  - Free space path loss – function of distance
  - Rain/Snow fade
  - Atmospheric absorption
  - Line-of-sight obstacles – terrain
  - Foliage clutter
  - Multipath fade – ground reflection
- Introduction of yet another interference factor may render the link unavailable under certain circumstances
  - Increase in noise floor caused by external interference could consume available fade budget
  - Digital microwave system are either on or off, no reduction in capacity if fade margin is depleted (unlike analog)
  - Near impossible to track down the interfering device

Loss of Signal Impact

- In the event of signal loss
  - Network traffic stops
  - Operations personnel lose visibility and control functions for portions of the grid being serviced by the affected path
  - Transmission lines may have to be removed from service if no backup communications are available
  - In the event a backup path exists, network routing must re-converge to align to backup path – up to two minutes of outage time
  - If signal is restored during this time the radios will synchronize and network routing must again re-converge – up to two more minutes
  - Oscillating interference, could render the network down hard

- Utilities and other critical infrastructure industries (CII) rely on the 6 GHz band for a variety of mission critical communications.
- The 6 GHz band is uniquely suited to support utility and CII communications needs and there is a lack of reasonable alternatives.
- Many utilities and CII relocated microwave systems to the 6 GHz band after the 2 GHz band was reallocated.

- Utilities and CII require ultra-high reliability and exceptionally low latency for these communications systems.
- Potential interference from unlicensed operations must be prevented from occurring.
- Remedying interference after the fact will not be sufficient.
- The probability of interference and the magnitude of the risk is unacceptably high

- Concerns:
  - Interference from outdoor operations
    - AFC is untested and lacks transparency to allow utilities and CII to mitigate and resolve interference that occurs.
    - AFC is predicated on modelling that may not account for real-world environment or actual microwave operations.
  - Interference from indoor operations
    - Overestimated attenuation
    - Uncontrolled operations
    - Unknown locations
    - Improper installation
    - Nothing prevents devices from being taken outdoors

- Remaining issues:
  - Enforcement mechanisms in the event of interference
  - Security concerns about AFC
  - Inaccuracies in underlying data
  - Centralized or decentralized AFC
  - Performance requirements for AFC
  - Independent testing and certification of AFC
  - Adjacent channel interference
  - Incremental deployment of unlicensed systems to limit the potential for interference

Discussion

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