NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

6 GHz Communication Network Extent of Condition White Paper

Purpose

The NERC 6GHZ Task Force (6GHZTF) scope document includes deliverables to perform the following:

- Identify penetration of owners and operators relying on 6 GHz to support reliability of the bulk power system (BPS)
- Develop suggested recommendations related to impact assessment to effectively assess communication disruption risks in operations of the BPS

The white paper presented here details conditions related to this deliverable and identifies reliability risks associated with 6 GHz communication interference.

Background

FCC Actions

In April 2020, the Federal Communications Commission (FCC) issued a report and order that partially opened the 6 GHz band of radio spectrum to unlicensed users. In addition, there is a pending notice of further proposed rulemaking with the FCC to fully open the 6 GHz band to unlicensed use and cause additional harmful interference to proliferate in this radio spectrum band.

In 2020, a consortium of electric industry associations published a report on the impact of proposed Wi-Fi operations on microwave links at 6 GHz. The 6 GHz band of the radio spectrum is widely used by a broad array of industries responsible for critical infrastructure, such as electric, natural gas and water utilities, railroads, and wireless carriers as well as by public safety and law enforcement officials. These industries rely on the 6 GHz band to operate their equipment, and this band is the main source of primary communications for voice and data and back-up communications in-many cases during emergencies and disasters. The report identifies impacts to electric power operations. Additional follow-on work by the Electric Power Research Institute (EPRI) and various affected stakeholders have shown—through testing—impacts on their critical electric infrastructure communications due to increased congestion and interference on the 6 GHz wireless communication band. As adoption of the new technology increases, the risk to BPS operations may and likely will increase.

Prior to the FCC ruling, the 6 GHz licensees had exclusive use of the assigned frequency and the concern for communication interference was minimum/non-existent and more easily identified due to licensing requirements.

NERC Survey Results

Through the 6GHZTF, NERC conducted a voluntary survey of BPS owners and operators as its first attempt to assess penetration of 6 GHz usage and assess the extent of condition that will impact the BPS.[1]

The following is a summary of the responses to the survey:

- It is predominantly used for supervisory control and data acquisition (SCADA), relay protection, and various means of voice communication between control centers (including nuclear), radio, and corporate communication.
- The vast majority of 6 GHz users employ it for both primary and backup communication.
- Respondents who identified 6 GHz as critical to BPS also had a high number (greater than 75) of 6 GHz paths in use.
- The majority of respondents had not performed any impact assessments in relation to the FCC ruling.
- The majority of respondents had not performed any testing to identify interference.
- The majority of respondents had some type of mitigation plan in place.

Communication Interference

In general terms (regardless of communication medium), communication interference for the electric utility industry would have the characteristics described in **Table 1**.

Table 1: Communication Interferences

Function	Impacts of Communication Interference
Voice	Delay in (or loss of) clear, concise communication among operating personnel (includes field personnel)
SCADA: Data	Poor data quality or loss of data (monitoring)
SCADA: Control	Control timeouts, possible delay in operator action, inability to send control commands
Relay Protection	Faulty operations due to poor data quality/loss of communication

A visual of communication interference is a television with rabbit ear antenna; the picture appears with static until the antennae are appropriately adjusted. Communication interference is often intermittent and may occur at inopportune times. Given the functions that could be impacted by harmful interference and the characteristics or likelihood for interference to occur at inopportune times, there is a higher likelihood of increased reliability risk. Furthermore, given that it is unlicensed users that will be the source of the harmful interference, it will be difficult for BPS owners and operators to identify sources to quickly remedy.

[1] https://www.nerc.com/comm/RSTC/AgendaHighlightsandMinutes/Presentations_RSTC_Meeting_June_9_2022_POSTING.pdf

What is the Reliability Risk?
The 2021 ERO Reliability Risk Priorities Report identifies four risk profiles:[2]

- Risk Profile #1 Grid Transformation
- Risk Profile #2 Extreme Events
- Risk Profile #3 Security Risks
- Risk Profile #4 Critical Infrastructure Interdependencies

While each profile references communication, Profile 3 and Profile 4 are the most relevant to communication interference.

Risk Profile #3 Security Risks

Statement of Risk
Operational security is an essential element of a highly reliable BPS. Cyber and physical security are interdependent aspects as exploitation of either cyber or physical security vulnerabilities could be used to compromise the other dimension. Resultant impacts could cause asset damage, functionality loss, or limit the situational awareness needed to reliably operate or promptly restore the BPS.

Communication interference from unknown sources can present additional potential for security risk. As stated previously, communication interference could impact SCADA (monitoring and control) and voice communication. Both items are critical to operational security. The challenge with unlicensed 6GHz use is that it will be difficult to identify the specific end user that is causing the interference.

Risk Profile #4 Critical Infrastructure Interdependencies

Statement of Risk
Significant and evolving critical infrastructure sector (e.g., communications, water/wastewater, financial) and subsector (e.g., oil, natural gas) interdependencies are not fully or accurately characterized, resulting in incomplete information about prospective BPS response to disruptions originating from or impacting other sectors or subsectors and resultant reliability and security implications. Furthermore, as there is increasing interdependencies between these critical infrastructures, impacts on one can have a rippling effect on another.

Electric sector reliance on communication paths is a key component that supports the reliability of BPS. The partial opening of the 6 GHz band to unlicensed use will cause harmful interference and increase disruptive communications that could produce unintended consequences by promoting Wi-Fi use and concurrently disrupting reliability of power delivery.

[2] https://www.nerc.com/comm/RISC/Documents/RISC%20ERO%20Priorities%20Report_Final_RISC_Approved_July_8_2021_Board_Submitted_Copy.pdf

The pending proposed rulemaking from the FCC will further open the 6 GHz band and include mobile device outdoor usage. This action increases the complexity of the interference and identification of interference sources in a significant way. The interdependency between the communications and electric sector has been captured in many federal agency meetings, federal hearings, dockets, and federal proposed rulemakings. As proliferation of operational technology (OT) and consumer-use devices continues to grow, the spectrum becomes more constrained and the interdependency between the sectors becomes more critical. Under the Build Back Better Plan, there is substantive funding for expansion of broadband to rural states, tribal nations, and unserved and underserved areas. This increase in broadband use will expand spectrum use significantly and is necessary to support the changing needs; however, the relationship between this issue and the 6 GHz unlicensed use will potentially cause the electric sector to experience potentially harmful interference sooner.

It is important to note that the BPS is a highly integrated system. This reliable operation of the integrated system is dependent on reliable communications. When one portion of the system is under stress (communication interference), it will have an impact on neighboring entities.

The current Wi-Fi spectrums (2.4 GHz and 5 GHz) are congested with too many devices. The result is that some devices may be dropped or have a slow connection. The expansion of 6 GHz for broadband will allow data to be transferred faster than the existing spectrums. While utilities that use 6 GHz may not be seeing interference today, it is very likely to be present in the future. A dropped device or a slow device (SCADA and relay protection) presents a risk for the electricity industry.

The FCC has proposed a process of automated frequency coordination to provide mitigation efforts for harmful interference. While there is substantive work on this concept, it is untested and is not currently effective. The FCC has begun the process for authorizing 6 GHz automated frequency coordinators.

Extent of Condition

A few of the survey respondents indicated that they partnered with industry organizations to conduct interference tests with unlicensed 6 GHz devices. While there are different designs and configurations of communication networks across the BPS owners and operators, the behaviors and characteristics are similar. Consequently, the test results, which confirmed the anticipated interference from unlicensed devices, can be considered applicable to other 6 GHz installations. The majority of respondents indicated some type of mitigation plan was being considered acknowledging the potential impact, likelihood and severity of the spectrum use change. It is important not to underestimate the time and resources needed to fully implement an alternative communication network.

Recommendations

- Entities that use 6 GHz for both primary and backup communications should consider diversifying one of the paths (i.e., consider moving the SCADA primary communication path from 6 GHz to another frequency / band or medium).
- Establish a baseline for the 6 GHz frequency spectrum. A baseline will be critical in establishing and documenting interference.
- Establish a program that routinely checks for frequency interference. The periodicity of the test may vary by area (e.g., urban, suburban, rural) and other factors.
- Consider installing monitoring tools on the microwave links.
- Review reference materials for additional information as needed. They are listed here:
  - The NERC 6GHZTF white paper on establishing 6 GHz communication baseline and interference testing (pending publication).
  - United States Federal Communications Commission, "Unlicensed Use of the 6GHz Band: Expanding Flexible Use in MidBand Spectrum Between 3.7 and 24 GHz. Report and Order/Further Notice of Proposed Rulemaking." 23 April, 2020.[3]
  - EPRI, "EPRI Technical Brief: Unlicensed Use in the 6 GHz Band: Columbus, Georgia Field Interference Test Results."[4]

[3] https://docs.fcc.gov/public/attachments/FCC-20-51A1.pdf
[4] https://www.epri.com/research/programs/062333/results/3002022241