HUAWEI

PUBLIC CONSULTATION PAPER
WIRELESS LOCAL AREA NETWORK (WLAN)
IN THE 6 GHz FREQUENCY BAND

APPENDIX 5

[5]FWCC Supports APCO's 6 GHz Petition for Stay,
https://ecfsapi.fcc.gov/file/106040035611332/01432982.PDF

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Unlicensed Use of the 6 GHz Band	)	ET Docket No. 18-295
	)	
Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz	)	GN Docket No. 17-183

FWCC FILING IN SUPPORT OF
PETITION FOR STAY OF APCO INTERNATIONAL

The Fixed Wireless Communications Coalition (FWCC),[1] by counsel and pursuant to Sections 1.41, 1.45, and 1.429(k) of the Commission's rules, respectfully submits this pleading in support of the Petition for Stay of APCO International (Stay Request) filed in the captioned docket on May 28, 2020.[2]

I. INTRODUCTION

Incumbent licensed users in the 6 GHz band include vital public safety and critical infrastructure users. If the Commission fails to address the concerns raised in APCO International's (APCO) Petition for Reconsideration,[3] licensed 6 GHz users will be at risk of

[1] The FWCC is a coalition of companies, associations, and individuals actively involved in the fixed services—*i.e.*, terrestrial fixed microwave communications. Our membership includes manufacturers of microwave equipment, fixed microwave engineering firms, licensees of terrestrial fixed microwave systems and their associations, and communications service providers and their associations. The membership also includes railroads, public utilities, petroleum and pipeline entities, public safety agencies, backhaul providers, and/or their respective associations, communications carriers, and telecommunications attorneys and engineers. Our members build, install, and use both licensed and unlicensed fixed wireless systems. For more information, see www.fwcc.us.

[2] *In re Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Petition for Stay of APCO International, ET Docket No. 18-295 and GN Docket No. 17-183 (filed May 28, 2020).

[3] *In re Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Petition for Reconsideration, ET Docket No. 18-295 and GN Docket No. 17-183 (filed May 28, 2020) (Petition for Reconsideration).

harmful interference that could have catastrophic consequences, including the injury or death of first responders and members of the communities they serve. Harmful interference in the 6 GHz band could also cause substantial economic, environmental, and public safety damage by disrupting any of the critical infrastructure industries that rely on 6 GHz links to monitor and control oil and gas pipelines, electric and water utilities, railroads, and other systems necessary to the safety and economy of the nation.

Given the gravity of the risk if harmful interference occurs in the 6 GHz band and because APCO's Stay Request clearly meets the four prong test for grant of a stay established by the Commission's rules and precedent, the Commission should grant APCO's Stay Request.

II. BACKGROUND

The Commission's 6 GHz Order opens the 6 GHz band to unlicensed use, including uncontrolled, unlicensed use for so-called low-power indoor only devices.[4] On May 28, 2020, APCO filed a Petition for Reconsideration of the 6 GHz Order. The Petition for Reconsideration argues that the 6 GHz Order improperly fails to consider the impacts of unlicensed devices on public safety, does not implement measures needed to protect public safety licensees from harmful interference, provides no mechanism for remediating harmful interference to public safety licensees, and introduces unlicensed use into a public safety band in a manner that renders the resolution of harmful interference impractical and potentially impossible.[5]

Along with its Petition for Reconsideration, APCO filed a Stay Request on May 28, 2020 asking the Commission to stay the effect of the 6 GHz Order pending resolution of APCO's

[4] *In re Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Report and Order and Further Notice of Proposed Rulemaking, ET Docket No. 18-295 and GN Docket No. 17-183 (Rel. April 24, 2020) (6 GHz Order).
[5] *See generally* APCO Petition for Reconsideration.

Petition for Reconsideration. The Stay Request clearly demonstrates that APCO is likely to prevail on the merits of its Petition for Reconsideration, will suffer irreparable harm absent grant of the stay, other parties will not be harmed by grant of the stay, and the public interest favors grant of the stay. Because the FWCC agrees that the Commission should stay the effect of the 6 GHz Order until it makes a decision on APCO's Petition for Reconsideration (and any other petitions for reconsideration filed in the proceeding), the FWCC is submitting this filing in support of APCO's Stay Request.

III. DISCUSSION

Section 1.429(k) of the Commission's rules permits a party to request a stay of the rules pending a petition for reconsideration.[6] "To qualify for the extraordinary remedy of a stay, Petitioners must show that: (1) they are likely to prevail on the merits of their appeal […], (2) they will suffer irreparable harm absent the grant of preliminary relief, (3) other parties will not be harmed if the stay is granted, and (4) the public interest would favor grant of the stay."[7] APCO's Stay Request is precisely type of situation that warrants such an extraordinary remedy.

a. APCO Is Likely to Prevail on the Merits of its Petition for Reconsideration

The Commission's failure to consider the impact of unlicensed device use on public safety in the 6 GHz Order clearly demonstrates that APCO is likely to prevail on the merits of its Petition for Reconsideration. Just last year, the DC Circuit reconfirmed that protecting public safety is a statutorily mandated factor the Commission must consider and that failing to do so

[6] 47 C.F.R. § 1.429(k).
[7] *In re Rural Call Completion*, Third Report and Order and Order, 33 FCC Rcd 8400, 8417 (2018) (citing *Washington Metro Area Transit Comm'n v. Holiday Tours, Inc.*, 559 F.2d 841, 843 (DC Cir. 1977); *Virginia Petroleum Jobbers Ass'n v. Federal Power Comm'n*, 259 F.2d 921, 925 (DC Cir. 1958)).

during a rulemaking "renders its decision arbitrary and capricious."[8] As APCO's Stay Request points out, the 6 GHz Order never considers the public safety impact of permitting unlicensed devices into the 6 GHz band, other than to acknowledge that public safety users are among the licensed incumbents in the band.[9] The FWCC agrees with APCO's analysis in its Petition for Reconsideration and Stay Request. And that analysis inescapably leads to the conclusion that APCO will prevail on the merits of its Petition for Reconsideration.

The remaining substantive arguments in APCO's Petition for Reconsideration further illustrate the 6 GHz Order's failure to consider public safety and underscore the likelihood that APCO will prevail on the merits of its argument. As APCO notes, the 6 GHz Order permits a massive number of unlicensed devices without technical measures to ensure those devices operate without causing harmful interference to existing incumbent licensees. The AFC, as contemplated by the 6 GHz Order, is insufficient to protect licensed incumbents, including public safety users.[10] The 6 GHz Order also allows the deployment of low-power indoor devices without the use of AFC control. The only protection against harmful interference by these devices is a "low probability" of an uncontrolled device being in a position to cause harmful

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[8] *Mozilla Corp. v. FCC*, 940 F.3d 1, 60 (DC Cir. 2019) (citing *Motor Veh. Mfrs, Ass'n v. State Farm Ins.*, 463 U.S. 29, 43 (1983); *see also Nuvio Corp. v. FCC*, 473 F.3d 302, 307 (DC Cir. 2006) (holding that the Commission is statutorily required to consider public safety considerations); *Public Citizen v. Federal Motor Carrier Safety Admin.*, 374 F.3d 1209, 1216 (finding statutorily mandated considerations definitionally important aspects of any issue before an administrative agency); *Lindeen v. SEC*, 825 F.3d 646, 657 (DC Cir. 2016) (A rule is arbitrary and capricious if an agency fail[s] to consider … a factor the agency must consider under its organic statute.") (internal quotes omitted)).

[9] *See* Stay Request at 3-4; *see also* Petition for Reconsideration at 4 ("Yet, other than acknowledging that incumbent use includes public safety communications, the Order ignores public safety's reliance on the 6 GHz band for mission critical communications and the potential for interference to result in irreparable harm to the public's and first responders' safety. The Order even neglects to acknowledge the impact of interference to public safety as part of the cost/benefit analysis.").

[10] Petition for Reconsideration at 5-7.

interference, but with an anticipated one billion devices, low probably events become a certainty.[11] APCO's Petition for Reconsideration rightly recognizes that the 6 GHz Order "did not include sufficient measures to ensure low power access points are restricted to indoor operation,"[12] and the 6 GHz Order fails to include other measures to ensure low-power devices do not cause harmful interference. Finally, the Petition for Reconsideration shows that the 6 GHz Order offers insufficient mechanisms for detecting and resolving the inevitable harmful interference that unlicensed devices will cause in the 6 GHz band.[13] Where an unlicensed device is controlled by the AFC, the 6 GHz Order does not specify procedures for reporting or promptly addressing the interference caused by an unlicensed device.[14] Of even greater concern to incumbent licensees, however, is the fact that low-power indoor devices will be entirely uncontrolled. As a result, interference caused by these devices, which the Commission acknowledges will occur, will require licensees to engage in an expensive and time consuming search for the interfering device, which a licensee may never find.[15]

Taken together, the FWCC believes these flaws in the 6 GHz Order exceed the Commission's authority to authorize unlicensed devices. That is especially true with respect to public safety users of the 6 GHz band because the Commission has a statutory responsibility to evaluate these issues as they relate to public safety. Therefore, the Petition for Reconsideration is likely to succeed on its merits, and the Stay Request satisfies the first prong of the four part test.

[11] Petition for Reconsideration at 12 ("It is insufficient to rest on assumptions that interference will occur with relative infrequency.").
[12] *Id.* at 2.
[13] *Id.* at 10.
[14] *Id.*
[15] *Id.*

b. Licensed 6 GHz Incumbents, Including APCO's Members, Will Suffer Irreparable Harm in the Absence of a Stay

Having identified a litany of interference risks the 6 GHz Order fails to address, particularly with respect to public safety users, APCO's Stay Request also demonstrates that its members will suffer irreparable harm absent a stay. "'[W]henever public safety is involved, lives are at stake,' and the potential harms 'during a public safety emergency are irreparable.'"[16] Setting aside interference remediation, any interference event might cause loss of life, damage to property, or place first responders and the communities they serve in harm's way.

Moreover, permitting the 6 GHz Order to go into effect will introduce devices into the band that cannot be subsequently removed or eliminated. In particular, once the Commission rings the bell for uncontrolled, unlicensed devices in the 6 GHz band, it will never be able to reconsider that decision with respect to already deployed devices. Even if harmful interference from unlicensed devices is rare and never causes a catastrophic public safety emergency, interference will occur and will be difficult or impossible to remediate. As noted above, the particular environment of the microwave bands and characteristics of unlicensed devices are such that incumbent licensees are not able to pinpoint the location or identity of unlicensed devices that are the sources of harmful interference. Therefore, incumbent licensees, including public safety licensees, will suffer irreparable harm if the 6 GHz Order goes into effect before procedures are adopted to resolve harmful interference caused by unlicensed 6 GHz devices.

The critical nature of the services relying on 6 GHz microwave links means any harmful interference will cause irreparable harm. Microwave communications serve a wide variety of vital needs that cannot be replicated by other communications systems. Public safety users do not have an alternative to the 6 GHz band, and other licensed incumbents depend on the band's

[16] Stay Request at 6 (citing *Mozilla*, 940 F.3d at 62).

unique characteristics, including for communications to remote areas unserved by wired networks. Telecommunications providers and public safety agencies also rely on the high reliability of and ease of restoring service to microwave communications to help bring communications systems back online quickly after natural disasters, helping ensure the safety of the communities impacted by the disaster.

c. Other Parties Will Not Be Harmed by the Issuance of a Stay

Delaying the effect of the 6 GHz Order will not harm other parties. As APCO notes, grant of its Stay Request will merely "mean maintaining the status quo that has been in place for several decades, and the Order was not intended to end an existing harm."[17] Unlicensed devices may currently access a wide range of bands, including a substantial amount of spectrum in the near adjacent 5 GHz band, and the record does not demonstrate a critical need for unlicensed devices that will go unsatisfied in the near term as a result of delaying access to the 6 GHz band.

d. The Public Interest Favors the Grant of a Stay

Given the potential harm to public safety—the threat to life and property—the public interest compels staying the 6 GHz Order until the Petition for Reconsideration is addressed and the Commission has fulfilled its legal obligations. There is no rational public policy basis for rapidly moving forward with the introduction of new unlicensed devices given the existing ability of such devices to access spectrum in other bands and the lack of any critical needs documented by the unlicensed device manufacturers. Moreover, where the risks of a misstep are so consequential, the public interest favors a measured response and re-evaluation as real word experience is accrued, rather than drastic, irreversible measures.

[17] Stay Request at 8 (citing 6 GHz Order at ¶ 2).

e. The 6 GHz Order's Invitation for Parties to Conduct Testing Weighs in Favor of Staying the Order Pending the Outcome of the Testing

The 6 GHz Order envisions the creation of a multi-stakeholder group to consider both standard-power and indoor low-power operating concerns, which "could provide valuable insights into complex coexistence issues and provide a forum for the industry to work cooperatively towards efficient technical and operational solutions."[18] It goes on to encourage the multi-stakeholder group to "work cooperatively to develop and test devices to aid in the goal of developing processes for introducing and operating devices across the 6 GHz band."[19] Thus, the Commission acknowledge both the complex coexistence issues caused by and the benefits of testing prior to the deployment of unlicensed devices in the 6 GHz band.

Oddly, however, the Commission does not require testing prior to the deployment of unlicensed devices. Its rational for doing so is not that testing is unnecessary; rather, it is that the Commission expects "that it will take some time before devices can be designed, manufactured and made available to consumers." Unfortunately, the Commission's expectation is flatly wrong. Manufacturers began the design and manufacture process for 6 GHz devices prior to the 6 GHz Order in anticipation of the Commission's decision, which it telegraphed well in advance. Therefore, uncontrolled, unlicensed devices may begin being deployed as soon as July 27, and the FWCC anticipates that uncontrolled, unlicensed devices will be available to consumers by the end of Q3 2020 at the latest, in time for the holiday shopping season. Moreover, by failing to mandate testing, the 6 GHz Order eliminates any incentive for RLAN proponents to engage in testing prior to deployment of their devices, and the FWCC is not aware of any multi-stakeholder group that is attempting to test indoor low-power devices prior to their deployment.

[18] 6 GHz Order at ¶ 174.
[19] *Id.* at ¶ 177.

In the absence of collaborative industry-wide testing of indoor devices, several FWCC members have begun real-world testing of their own. As the Commission anticipated, this is proving to be a difficult process because the FWCC's members currently lack access to 6 GHz unlicensed devices. Nonetheless, the initial results of this real-world testing are alarming.[20] For example, in bench testing using 5.8 GHz test devices, testing showed measurable performance degradation even with 33 dB attenuation of the interfering signal. The test showed degradation to RSL, SNR, and fade margin, all of which resulted in output power maxed for the link and a downshift in modulation.[21] At 18 dB attenuation, the impact was even more pronounced.[22] While these are preliminary results, the tests demonstrate that, even with significantly low levels of interference, a point-to-point microwave link is forced to use its signal processing resources to compensate for interference.[23] This reduces a link's capability to address actual fading and other naturally occurring impairments, which ultimately is reflected in a reduction of the link availability.[24] So far, the tests conducted have been based on TDD signals consistent with Wi-Fi interferers. However, the FWCC would note that the 6 GHz Order does not preclude the use of

[20] The FWCC recognizes that the Commission typically does not consider evidence not previously presented to the Commission. *See* 47 C.F.R. § 1.429(b). However, the Commission has the discretion to consider new evidence if it determines that consideration is in the public interest. *See* 47 C.F.R. § 1.429(b)(3); *see also In re TerreStar Corporation Request for Temporary Waiver of Substantial Service Requirements for 1.4 GHz Licenses*, Order on Reconsideration, WT Docket No. 16-290, DA 20-391 at ¶¶ 23-24 (Rel. April 30, 2020) (exercising discretion to permit late-filed supplement to a Petition for Reconsideration pursuant to Section 1.106(c) of the Rules, which is analogues to Section 1.429(b)). Moreover, the FWCC could not have previously tested 6 GHz low-power indoor devices, which the 6 GHz Order invites parties to do prior to deployment of the devices, because low-power indoor devices have not been made available by device manufacturers. *See* 47 C.F.R. § 1.429(b)(2).
[21] *See* Attachment A at 9.
[22] *Id.* at 10.
[23] *Id.* at 11.
[24] *Id.*

FDD technology that would effectively eliminate the interference protection the 6 GHz Order assumes based on activity factor.

The 6 GHz Order shows that the Commission is aware of the complexity of introducing unlicensed devices into the 6 GHz band and the benefits of testing those devices before deployment.[25] That the Commission would move forward despite this understanding is likely arbitrary and capricious, but more importantly, it is unnecessarily risky for vital public safety and critical infrastructure industries that rely on 6 GHz microwave links. Testing can be completed relatively quickly if the various stakeholders to this proceeding work together. Therefore, the Commission should stay the effectiveness of the 6 GHz Order because a brief stay is necessary to give industry time to complete essential testing and give the Commission time to review APCO's Petition for Reconsideration along with any other timely filed petitions for reconsideration.

IV. CONCLUSION

In light of the foregoing, the Commission should immediately grant APCO's Stay Request and stay the effect of the 6 GHz Order pending its consideration of APCO's Petition for Reconsideration.

Respectfully submitted,

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June 4, 2020

[25] 6 GHz Order at ¶¶ 175-177.

Attachment A

FAS WiFi Testing Summary
Laboratory Testing Observations and Conclusions
(May 27th, 2020)

1 General Description.

The FAS expert system is designed to use a number of rules to determine if interference is happening in any of the radio links registered for monitoring in the application. As part of the overall design and implementation efforts, Aviat has conducted a number of laboratory tests that were intended to determine the effects of different types of interferer signals in point to point microwave links. These tests allowed not only for the better understanding of how the performance parameters of the radio link were being affected in the presence of interference but also to the creation, validation and refinement of the rules that were implemented in the FAS expert system. As we understand more about the impact interferers can cause to the radio links the expert system rules will be refined and new rules will be added. This will be part of the overall expert system learning and evolution.

The built-in rules of the expert system use several performance parameters to be able to uniquely identify interference from other radio link impairments. In essence, the main signature of interference consists of a strong received signal level (RSL) accompanied by one or more degraded performance indicators, like SNR, BER, ES/SES or Alarms in the link. These considerations not only allow the expert system to detect interference but to classify it in up to 5 levels of severity:

1. Link disrupting interference – when the radio link is lost due to interference.
2. Error generating interference – when the radio link is taking errors due to interference.
3. Performance affecting interference A – when the radio link is being stressed due to interference, causing modulation changes, power adjustments and/or link availability reduction but not to the point of causing errors. This type of interference usually goes un-noticed.
4. Performance affecting interference B – In this case the radio link is degraded due to the interference, but such interference may be too low to trigger any compensation action, or the compensation mechanisms are not enabled. To determine if and how much degradation exists in this case, we will use a more sensitive set of parameters based on the U-BER. The U-BER will tell us how hard the Forward Error Correction decoder is working to clean the received signal. This type of interference usually goes un-noticed.
5. No interference or neglectable interference level.

The expert system will apply a number of rules to determine which type of interference is being detected or if this detected instance may be considered a false positive (un-confirmed interference):

- Persistence, false positives (unconfirmed) and bursty/steady interferers – validates duration of interference thus enabling determination of false positives, short single interference bursts, burst interferers that are constantly affecting the radio link, or steady interferers.
- Multipath – validates if the type of interference should be considered multipath or confirm that it is due to an external interferer.

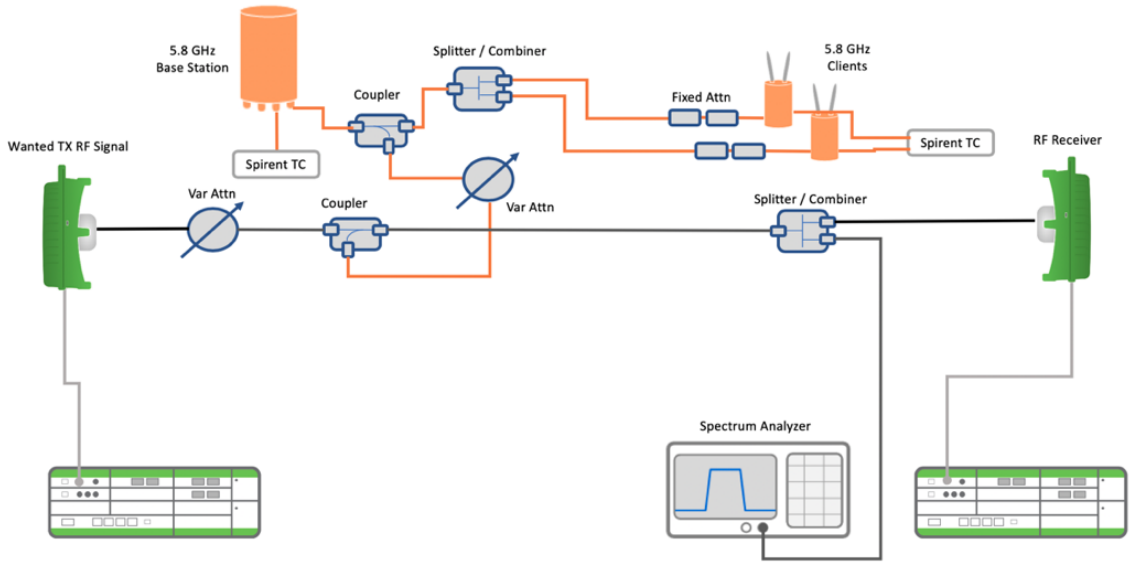
- Symmetry – validates if the same degradation pattern is happening in both directions of the radio link. If this is the case, interference is unlikely as it is usually not symmetric in nature.
- Historical reference and regular/irregular behavior – validates against the historical database reference for the link under analysis if the interference pattern is happening at regular intervals or if it is showing an irregular behavior.

The purpose of this document is to describe the laboratory tests executed to understand, create, validate and refine the rules designed and implemented in the expert system. We will focus specifically in the WiFi interference tests as those are the most critical at this point in time due to the imminent opening by the FCC of the 6 GHz frequency band to WiFi and other unlicensed uses. While we have conducted numerous WiFi interferer tests in our labs, we will only present in this document one of the most representative sets capturing the different interference levels and the effects that they create in the PTP microwave link.

1.1 WiFi Interference Laboratory Setup

The experiments in the laboratory for the specific test set that will be described in this document were conducted using two INUs loaded with RAC 60/6X connected to ODU 600s operating in the 5.8 GHz band. The RACs and ODUs were configured to operate using a 30 MHz channel, with ACM and ATPC enabled and using a center frequency of 5.745 GHz in one direction and 5.829 GHz in the opposite direction (84 MHz T0-R spacing). This part of the setup represents the PTP microwave radio link (wanted signal).

For the interferer we used a Mimosa A5C access point with 2 clients. The access point was configured to operate using a single sector with center frequency at 5.745 GHz and enabled to use 80 MHz of bandwidth and a maximum Tx power of 1 Watt. The two clients are connected to the base station using a splitter/combiner and 20 dB fixed attenuation pads.



The interferer system is connected to the wanted signal via a vane continuous variable attenuator which allows us to control how much interference is injected to the PTP microwave radio link.

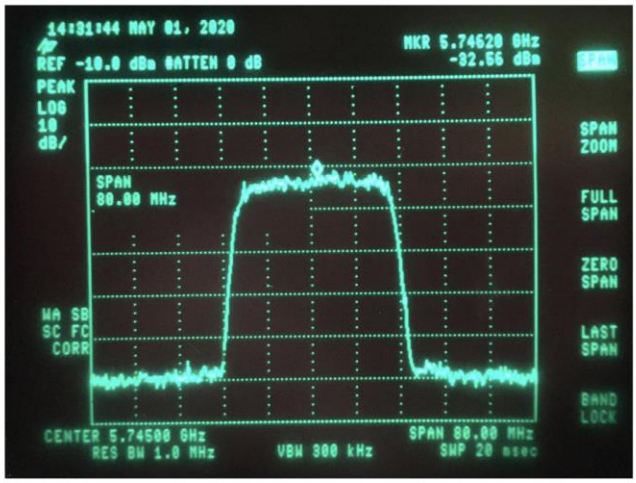
The PTP microwave radio link is also connected through a vane continuous variable attenuator that allows us to control how much wanted signal we want to have in the system. We can create in this way the effect of longer paths or introduce fading conditions to the link.

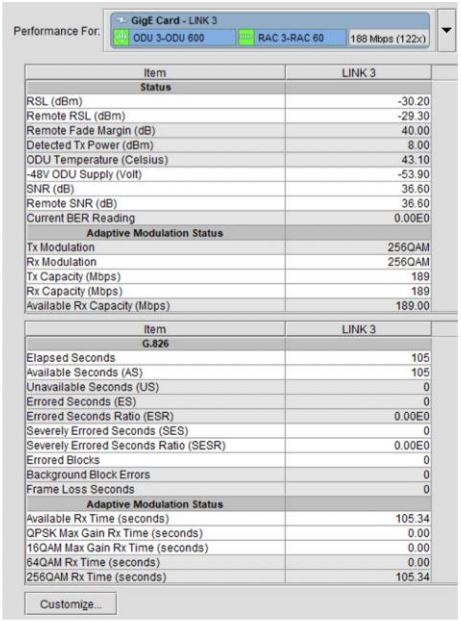
2 Laboratory Testing

The set of tests presented in this section of the document will cover WiFi interference applied to the radio link at different strength levels. This will allow us to show the different effects that a single interferer may have in a PTP microwave radio link. It will also allow us to demonstrate how applying the expert system rules will yield to the interference detection at the different levels. Independent captures of the wanted signal, a link fading sequence and the isolated interferer signal are presented as reference and baseline that will be used to contrast against the interference effects presented.

2.1 Wanted Signal

In this section, we show a spectrum analyzer screen capture of the wanted signal without interference together with its corresponding Portal screen showing the link performance. As can be seen the link is running error free at the maximum configured modulation and with a very healthy RSL -30.2 dBm and a very healthy SNR 36.6 dB.

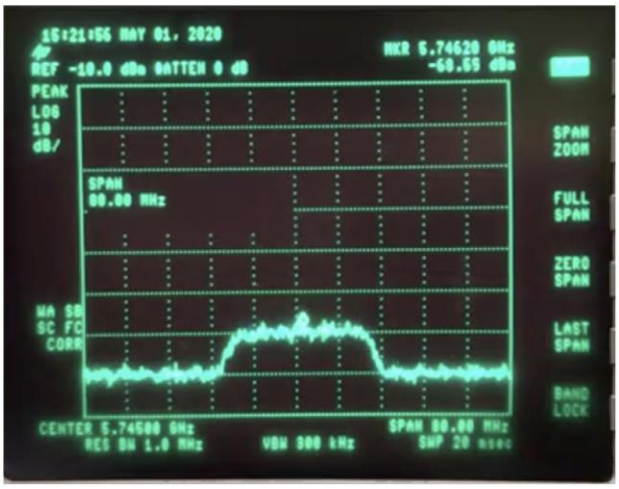




As indicated above, the wanted signal is presented here as a reference or baseline to be used to compare with the different effects caused by fading and interference.

2.2 Fading

An example of fading is presented in this section to show how the different performance parameters of the radio link are affected when fading is taking place. Similarly to interference, fading can cause the radio link to drop, to take errors or to change modulation and output power. However, the key performance parameters like RSL and SNR move together and in the same direction. The rules to determine if fading is taking place in the radio link have also been incorporated as part of the FAS expert system as we consider that it is important to differentiate among the two conditions.



Performance For: GigE Card - LINK 3 | ODU 3-ODU 600 | RAC 3-RAC 60 | 188 Mbps (122x)

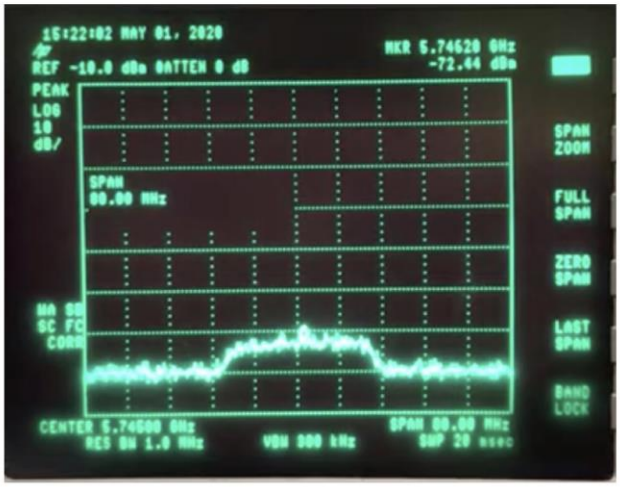
Item	LINK 3
Status	
RSL (dBm)	-67.80
Remote RSL (dBm)	-66.80
Remote Fade Margin (dB)	8.20
Detected Tx Power (dBm)	18.50
ODU Temperature (Celsius)	44.10
-48V ODU Supply (Volt)	-53.80
SNR (dB)	26.70
Remote SNR (dB)	27.00
Current BER Reading	0.00E0
Adaptive Modulation Status	
Tx Modulation	64QAM
Rx Modulation	64QAM
Tx Capacity (Mbps)	138
Rx Capacity (Mbps)	138
Available Rx Capacity (Mbps)	189.00

Item	LINK 3
G.826	
Elapsed Seconds	430
Available Seconds (AS)	430
Unavailable Seconds (US)	0
Errored Seconds (ES)	0
Errored Seconds Ratio (ESR)	0.00E0
Severely Errored Seconds (SES)	0
Severely Errored Seconds Ratio (SESR)	0.00E0
Errored Blocks	0
Background Block Errors	0
Frame Loss Seconds	0
Adaptive Modulation Status	
Available Rx Time (seconds)	430.47
QPSK Max Gain Rx Time (seconds)	0.00
16QAM Max Gain Rx Time (seconds)	0.00
64QAM Rx Time (seconds)	114.39
256QAM Rx Time (seconds)	316.08

Customize...

In the spectrum analyzer screen capture above we are observing the shape and amplitude of the PTP microwave radio link signal after it has been faded (using the wanted signal attenuator) to a point where a modulation downshift (256 QAM Max Throughput to 64 QAM Max Throughput) has taken place. The signal was attenuated as indicated in the Portal performance capture in the right from -30.2 dBm RSL to -67.80 dBm RSL. The SNR moved in harmony with the RSL dropping from 36.6 dB to 26.70 dB. It should also be observed that the Tx Power has reached its maximum point at 18.5 dBm and the fade margin is below 10 dB which caused the link to downshift in modulation. No errored seconds (ES) nor severely errored seconds (SES) have been observed as Adaptive modulation and power control actions are expected to be hitless.

This would be considered normal behavior in a link that is being affected by rain fade and where the link is using its signal processing resources to compensate for the fading condition.



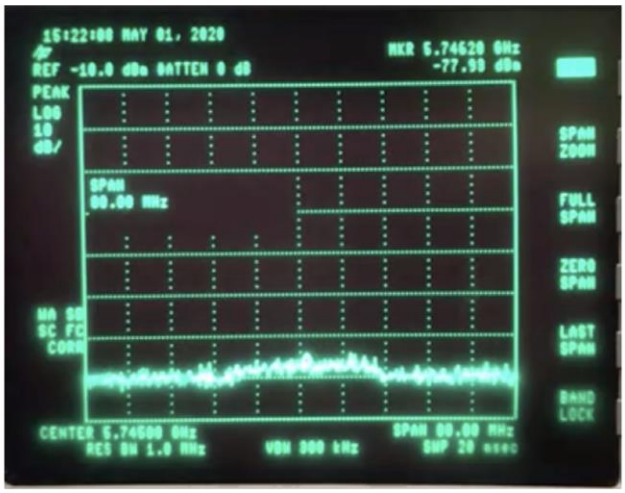
Performance For: GigE Card - LINK 3 | ODU 3-ODU 600 | RAC 3-RAC 60 | 188 Mbps (122x)

Item	LINK 3
Status	
RSL (dBm)	-70.00
Remote RSL (dBm)	-68.80
Remote Fade Margin (dB)	13.20
Detected Tx Power (dBm)	18.50
ODU Temperature (Celsius)	46.00
-48V ODU Supply (Volt)	-53.80
SNR (dB)	24.80
Remote SNR (dB)	25.00
Current BER Reading	0.00E0
Adaptive Modulation Status	
Tx Modulation	16QAM Max Gain
Rx Modulation	16QAM Max Gain
Tx Capacity (Mbps)	78
Rx Capacity (Mbps)	78
Available Rx Capacity (Mbps)	188.90

Item	LINK 3
G.826	
Elapsed Seconds	2,639
Available Seconds (AS)	2,639
Unavailable Seconds (US)	0
Errored Seconds (ES)	0
Errored Seconds Ratio (ESR)	0.00E0
Severely Errored Seconds (SES)	0
Severely Errored Seconds Ratio (SESR)	0.00E0
Errored Blocks	0
Background Block Errors	0
Frame Loss Seconds	0
Adaptive Modulation Status	
Available Rx Time (seconds)	2,640.33
QPSK Max Gain Rx Time (seconds)	0.00
16QAM Max Gain Rx Time (seconds)	2,156.93
64QAM Rx Time (seconds)	167.32
256QAM Rx Time (seconds)	316.08

Customize...

Similarly to the transition to 64 QAM, in the spectrum analyzer screen capture above we are observing the shape and amplitude of the PTP microwave radio link signal after it has been faded further (using the wanted signal attenuator) to a point where an additional modulation downshift (64 QAM Max Throughput to 16 QAM Max Gain) has taken place. The signal was attenuated as indicated in the Portal performance capture in the right from -67.80 dBm RSL to -70.00 dBm RSL. The SNR moved in harmony with the RSL dropping from 26.7 dB to 24.80 dB. Again, no errored seconds (ES) nor severely errored seconds (SES) have been observed.



Performance For: GigE Card - LINK 3 | ODU 3-ODU 600 | RAC 3-RAC 60 | 188 Mbps (122x)

Item	LINK 3
Status	
RSL (dBm)	-78.20
Remote RSL (dBm)	-77.50
Remote Fade Margin (dB)	10.90
Detected Tx Power (dBm)	18.40
ODU Temperature (Celsius)	46.40
-48V ODU Supply (Volt)	-53.80
SNR (dB)	16.80
Remote SNR (dB)	16.70
Current BER Reading	0.00E0
Adaptive Modulation Status	
Tx Modulation	QPSK Max Gain
Rx Modulation	QPSK Max Gain
Tx Capacity (Mbps)	38
Rx Capacity (Mbps)	38
Available Rx Capacity (Mbps)	188.90

Item	LINK 3
G.826	
Elapsed Seconds	2,749
Available Seconds (AS)	2,749
Unavailable Seconds (US)	0
Errored Seconds (ES)	0
Errored Seconds Ratio (ESR)	0.00E0
Severely Errored Seconds (SES)	0
Severely Errored Seconds Ratio (SESR)	0.00E0
Errored Blocks	0
Background Block Errors	0
Frame Loss Seconds	0
Adaptive Modulation Status	
Available Rx Time (seconds)	2,748.91
QPSK Max Gain Rx Time (seconds)	70.55
16QAM Max Gain Rx Time (seconds)	2,194.95
64QAM Rx Time (seconds)	167.32
256QAM Rx Time (seconds)	316.08

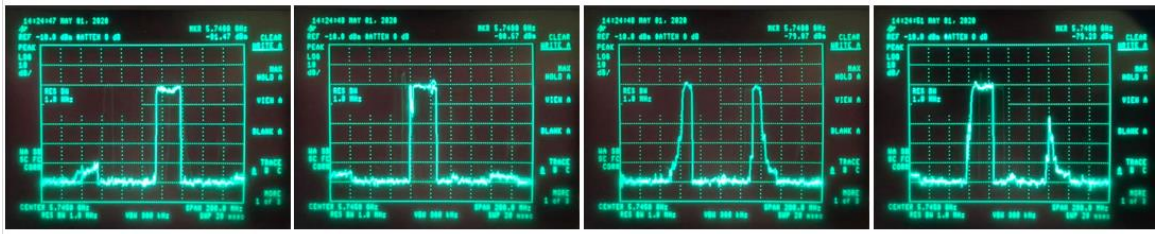
Customize...

In the final image of this section we show in the spectrum analyzer screen capture above the shape and amplitude of the PTP microwave radio link signal after it has been faded further (using the wanted signal attenuator) to a point where an additional modulation downshift (16 QAM Max

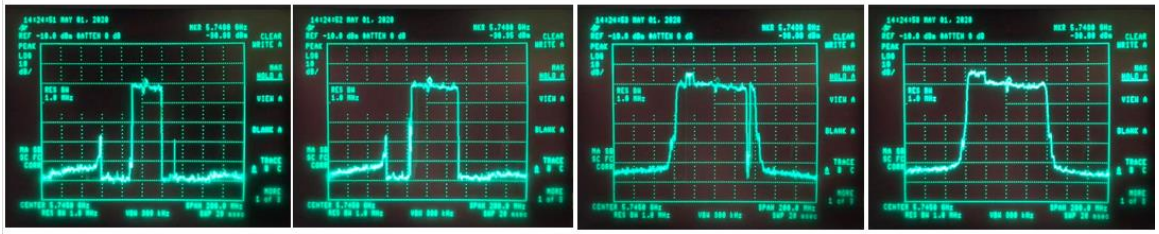
Gain to QPSK Max Gain) has taken place. The signal was attenuated as indicated in the Portal performance capture in the right from -70.00 dBm RSL to -78.20 dBm RSL. The SNR moved in harmony with the RSL dropping from 24.8 dB to 16.80 dB. Again, no errored seconds (ES) nor severely errored seconds (SES) have been observed.

2.3 Interferer Signal

This section presents the isolated interferer signal in a number of spectrum analyzer snapshots. For the images in the top row, the spectrum analyzer is free running and the pictures show the different areas of spectrum the base stations is using to communicate with the clients. The total span in these images is 200 MHz.



Wi-Fi Interferer Alone – Payload 100 Mbps



Wi-Fi Interferer Alone – No Payload. MaxHold

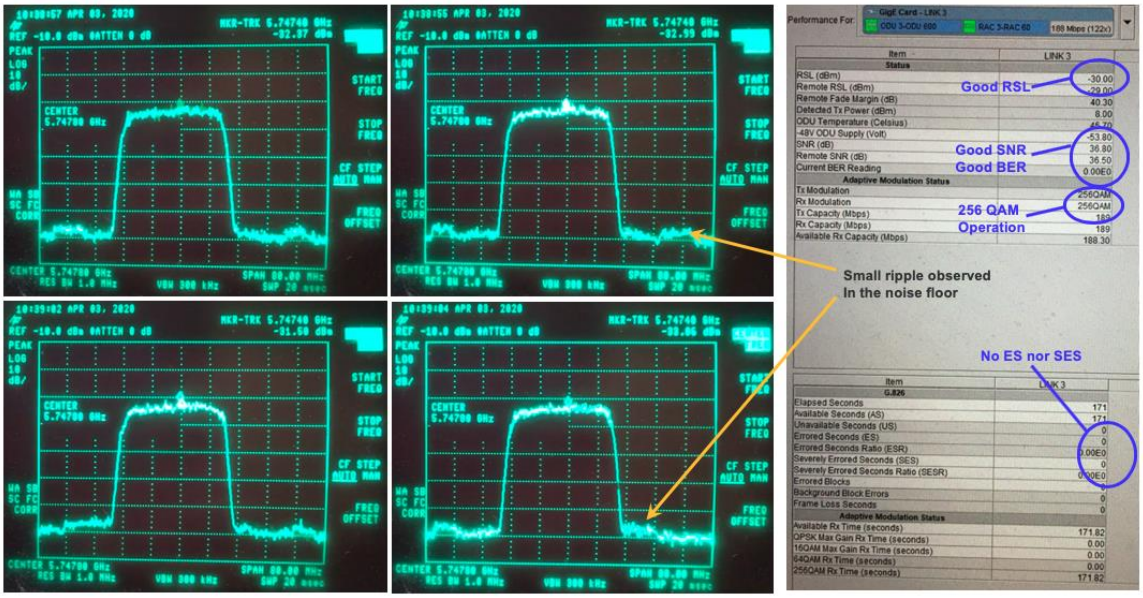
For the images in the bottom row, the spectrum analyzer is in Max-Hold where the spectrum analyzer keeps track of the maximum energy levels across the whole span. The right most image shows the total spectrum used by the base station and clients (TDD) slightly wider than the intended 80 MHz total bandwidth.

It is important to notice that while the total bandwidth being utilized by the base station is 80 MHz, the whole bandwidth is not all used at once. The base stations and the clients working in a TDD (Time Division Duplexing) fashion will use subchannels to convey payload, control and management across. The base station will coordinate how long will the downstream burst would be (from base station to client) and which subchannel will be utilized. It will also allocate the subchannel to be utilized and the upstream burst duration for each client. Due to the subchannel use shifting over time and the bursty nature of TDD communication the interference will sometimes be completely immersed in the wanted signal (co-channel), sometimes it could be adjacent to the wanted signal (adjacent channel) and sometimes it could be in between (part co-channel and part adjacent channel)

2.4 Interference Tests

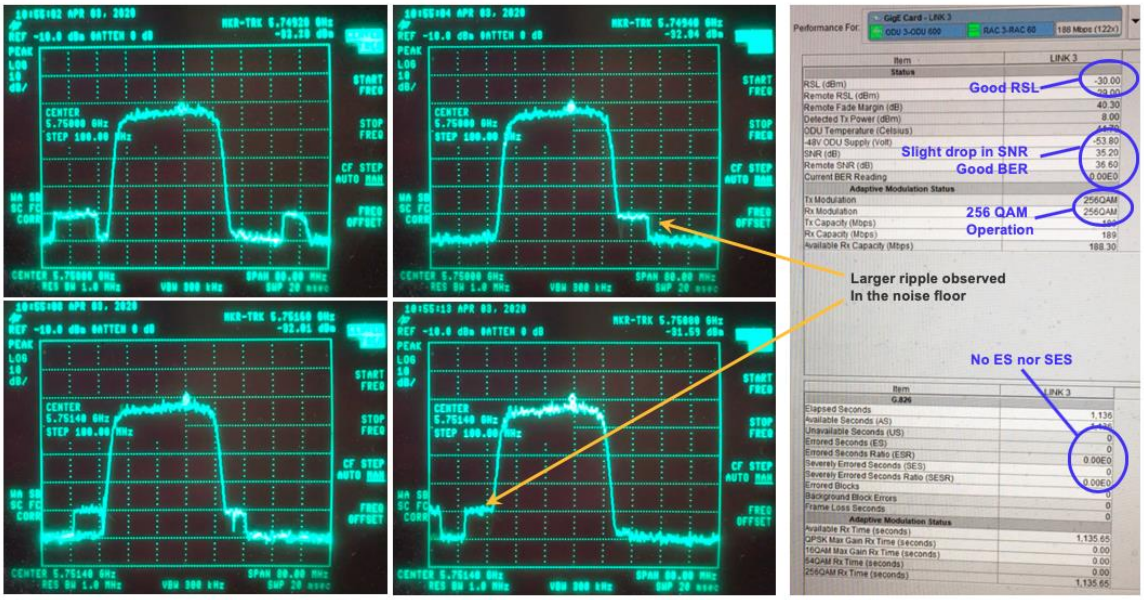
The WiFi interference tests that we have conducted in the laboratory have been numerous and with varying configurations. It will take a significant amount of time to present the details of all of them in the form of a technical paper. That is why we chose to present one of the most representative sets and explain in detail the effects that have been observed when applying the interference at different strength levels. We will point out the key parameters that are being taken

into account by the rules of the expert system and will ultimately show spectrum analyzer screen captures that clearly display the interference together with the wanted signal.



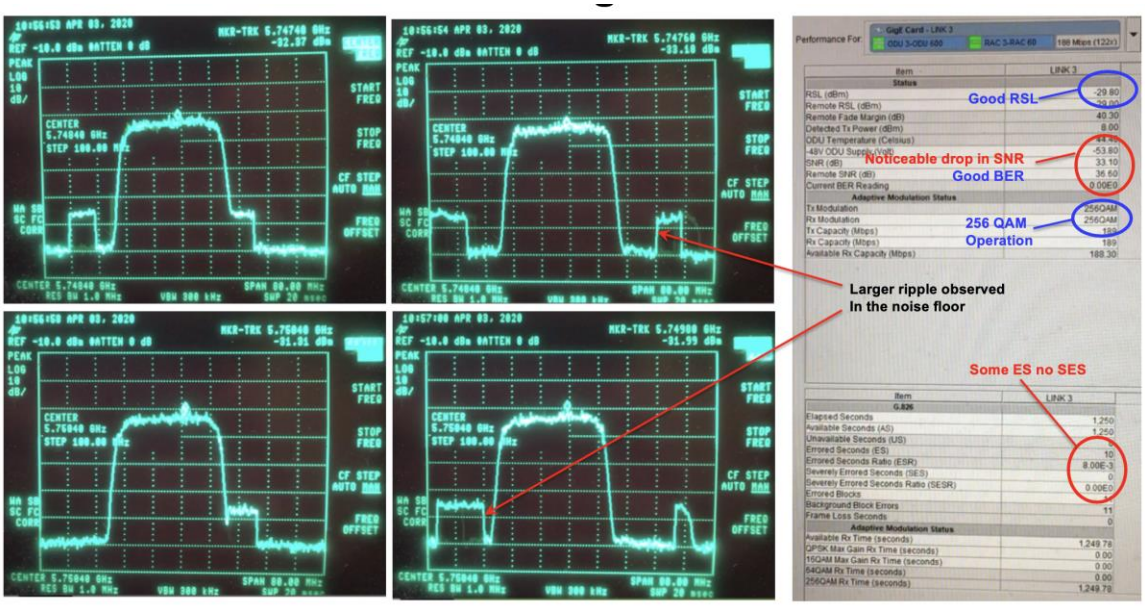
In the spectrum analyzer set of screen captures above we can observe the shape and amplitude of the PTP microwave radio link (wanted signal) together with a very small ripple disturbance that can be observed in the noise floor. That noise ripple represents the interferer signal that in this case has been injected into the main signal across a 50 dB attenuation using the vane continuous variable attenuator described in section 1.1 above.

As can be observed from the Portal performance capture in the right part of the image, all performance parameters show normal values; RSL at -30.00 dBm, SNR at 36.8 dB, BER at 0.0, no errored seconds nor severely errored seconds, significant fade margin, output power normal, operating at the maximum configured modulation (256 QAM Max throughput) and no alarms. This type of condition will be classified as no interference/negligible interference after applying the expert system rules.



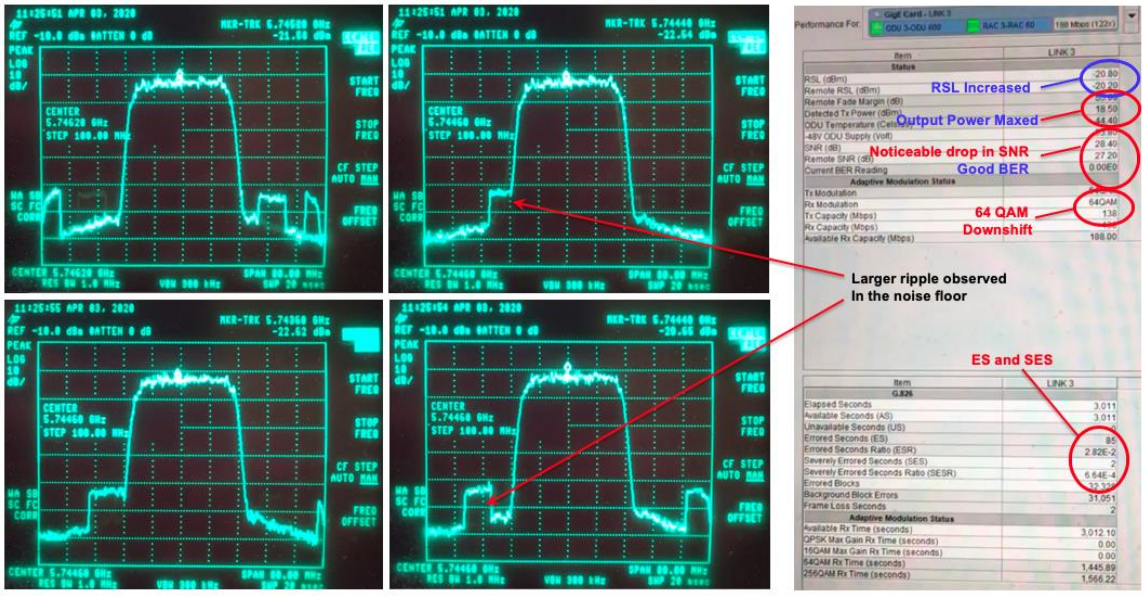
After reducing the interferer attenuation to 40 dB (10 dB stronger interferer), the spectrum analyzer set of screen captures above show a much more noticeable ripple in the noise floor. That noise ripple now shows bars about 10 dBm above the noise floor. Those bars correspond to the communication exchange happening between the base station and the clients. As it can be observed those bars sometimes are in the adjacent channels of the wanted signal and sometimes partially embedded in it. When the interference is completely immersed in the wanted signal (co-channel) the spectrum analyzer will only show the wanted signal as it is continuous and stronger. However, that does not mean that the interferer is not there or not affecting the wanted signal. Unfortunately, the interference is there and affecting the wanted signal to a larger extent than what is does when it shows up in an adjacent channel

As can be observed from the Portal performance capture in the right part of the image, all performance parameters show almost normal values; RSL at -30.00 dBm, SNR at 35.2 dB (a degradation of 1.6 dB), BER at 0.0, no errored seconds nor severely errored seconds, fade margin degradation observed in the far end (not shown), output power normal, operating at the maximum configured modulation (256 QAM Max throughput) and no alarms. In this case, even though it is not shown in the regular performance parameters, we make use of the uncoded BER to calculate if the link is under significant stress. The uncoded BER for this set of conditions indicates that the amount of stress exceeds expectation and therefore the expert system rules will deem interference is present and will classify it at level 4.



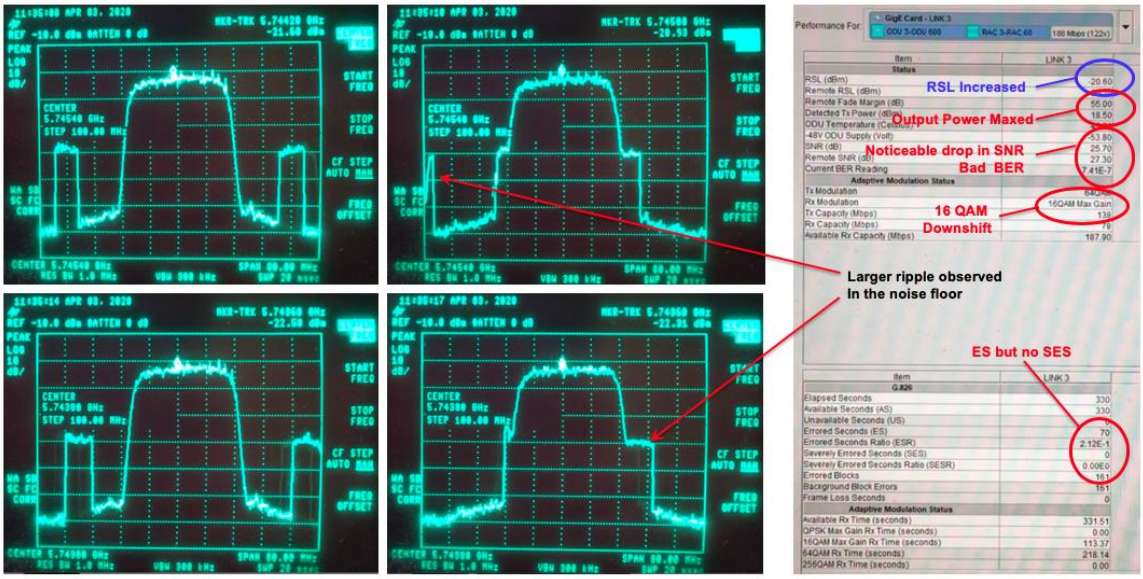
After reducing the interferer attenuation to 35 dB (5 dB stronger interferer from the previous step), the spectrum analyzer set of screen captures above show a larger ripple in the noise floor. That noise ripple now shows bars about 15 dBm above the noise floor. As before, those bars correspond to the communication exchange happening between the base station and the clients.

As can be observed from the Portal performance capture in the right part of the image, now there is noticeable degradation to the performance parameters shown; RSL at -29.80 dBm, SNR at 33.1 dB (a degradation of 3.7 dB), BER at 0.0, errored seconds but no severely errored seconds, further fade margin degradation observed in the far end (not shown), output power normal, operating at the maximum configured modulation (256 QAM Max throughput) and no alarms. In this case, there is enough evidence with the standard performance parameters to assert that interference is present and the expert system will classify it as Level 2 due to the error seconds, otherwise it would have been a Level 3 due to SNR degradation.



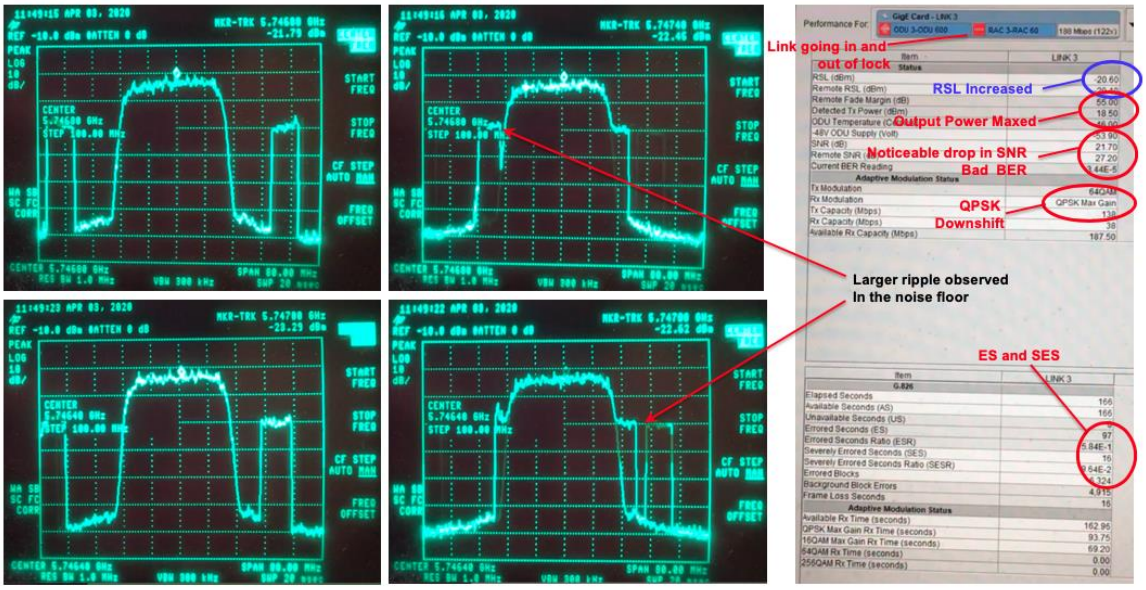
After reducing the interferer attenuation to 33 dB (2 dB stronger interferer from the previous step), the spectrum analyzer set of screen captures above show an even larger ripple in the noise floor. That noise ripple now shows bars about 18 dBm above the noise floor. However, now the shape of the noise floor has changed significantly, and it not only shows the bars but also a significant slope that can be attributed to the larger amount of energy present now introduced by a stronger interferer. As before, the bars correspond to the communication exchange happening between the base station and the clients.

As can be observed from the Portal performance capture in the right part of the image, now there are more performance parameters showing degradation; RSL at -20.80 dBm (increase by about 10 dBm due to the stronger interferer), SNR at 28.4 dB (a degradation of 8.4 dB), BER at 0.0, errored seconds and severely errored seconds, further fade margin degradation observed in the far end (now below the pre-established 10 dB), output power maxed out, downshift in modulation (64 QAM Max throughput) and no alarms. In this case, there is also enough evidence with the standard performance parameters to assert that interference is present and the expert system will classify it as Level 2 due to the error seconds and severely errored seconds.



The spectrum analyzer set of screen captures shown above correspond now to the reduction of the interferer attenuation to 18 dB (14 dB stronger interferer from the previous step). As expected there is an even larger ripple in the noise floor. That noise ripple now shows bars about 30 dBm above the noise floor. The noise floor continues to show not only the interference bars but also a significant slope that can be attributed to the larger amount of energy present now introduced by a stronger interferer. As before, the bars correspond to the communication exchange happening between the base station and the clients.

As can be observed from the Portal performance capture in the right part of the image, now pretty much all performance parameters are showing degradation; RSL at -20.60 dBm (pretty similar to the previous stage), SNR at 25.7 dB (a degradation of 11.1 dB), BER at 7.41 x 10-7, errored seconds but no severely errored seconds, further fade margin degradation observed in the far end (continues below the pre-established 10 dB), output power maxed out, downshift in modulation (16 QAM Max Gain) and BER threshold alarms. In this case, there is also enough evidence with the standard performance parameters to assert that interference is present and the expert system will classify it as Level 2 due to the error seconds and severely errored seconds.



In the final image of this section, the spectrum analyzer set of screen captures shown above correspond now to the reduction of the interferer attenuation to 8 dB (10 dB stronger interferer from the previous step). As expected there is an even larger ripple in the noise floor. That noise ripple now shows bars about 40 dBm above the noise floor. The noise floor continues to show not only the interference bars but also a significant slope that can be attributed to the larger amount of energy present now introduced by a stronger interferer. As before, the bars correspond to the communication exchange happening between the base station and the clients.

As can be observed from the Portal performance capture in the right part of the image, now all performance parameters are showing degradation; RSL at -20.60 dBm (same to the previous stage), SNR at 21.7 dB (a degradation of 15.1 dB), BER at 3.44 x 10-5, errored seconds and severely errored seconds, further fade margin degradation observed in the far end (continues below the pre-established 10 dB), output power maxed out, downshift in modulation (QPSK Max Gain) and Demodulator not locked alarms (radio link going in and out of lock). In this case, there is also enough evidence with the standard performance parameters to assert that interference is present and the expert system will classify it as Level 1 due to the radio link alarms (DNL).

3 Conclusions

1. It is pretty clear from the test set presented that WiFi interference can cause severe damage to PTP microwave links specially when operating co-channel.
2. The TDD nature of WiFi interferers and the subchannel frequency shifting that takes place creates particularly difficult challenges for the PTP microwave link to compensate for. That is why in some cases there may be unexpected bursts of errors or large variations of the SNR levels over a short period of time.
3. We have demonstrated that even with significantly low levels of interference the PTP microwave link is forced to use its signal processing resources to compensate for interference, reducing in this way the link capabilities to address actual fading and other naturally occurring impairments. This ultimately is reflected in a reduction of the link availability.
4. It is expected that interference from multiple sources will aggregate together and have a more harmful effect in the PTP microwave link.

5. We expect that the AFC protection looking solely at the AFC standard power access points will not be sufficient to contain the amount of interference that the PTP microwave links are going to experience. The Standard power clients will also have a significant effect and the accumulation of low power devices will also be problematic.
6. We were able to demonstrate that the FAS expert system will be able to detect interference at 4 different severity levels using the designed and refined set of rules.
7. The rules will have to be augmented and further refined in the future as we learn more about the interference patterns and special conditions that we will encounter. Those rules will be updated to the FAS expert system deployed base and all new installations.

AFFIDAVIT OF
SERGIO LICARDIE

I, Sergio Licardie, declare that:

1. I am a VP of Advanced Technology and Innovation for Aviat Networks, and I designed and personally supervised the testing process referenced below.

2. I have read the attached "FWCC Filing in Support of Petition for Stay of APCO International" (FWCC Filing).

3. As to the technical testing results described in Section III.e. and Attachment A of the FWCC Filing, I attest that the facts and information contained therein are true and accurate to the best of my knowledge and belief.

I, Sergio Licardie, declare under penalty of perjury under the laws of the United States of America that the foregoing is true can correct.

Executed this 4th day of June 2020.

Sergio Licardie

CERTIFICATE OF SERVICE

I, Seth L. Williams, do hereby certify that I have, this 4th day of June, 2020, caused a copy of the foregoing "FWCC FILING IN SUPPORT OF PETITION FOR STAY OF APCO INTERNATIONAL" to be sent by electronic mail to:

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Mark S. Reddish
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reddishm@apcointl.org
Counsel for APCO International

/s/ Seth L. Williams
Seth L. Williams