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December 16, 2015

VIA ELECTRONIC FILING

Marlene H. Dortch, Secretary
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20228

Re: IB Docket No. 13-213, RM-11685

Dear Ms. Dortch,

On December 15, 2015, I met with Edward Smith, Legal Advisor to Chairman Wheeler, with regard to the above proceeding. We discussed the risks vs. reward of approving TLPS, and spent a good part of the meeting discussing the implications of new test data[1] in the attached presentation.

Given the risks involved with Globalstar's TLPS proposal, I believe the Commission should consider a simple question:

> *If a person relying on a Bluetooth Low Energy Hearing Aid walks into an airport terminal, will that device continue to operate in the presence of TLPS?*

Advocates of TLPS should be able to cite evidence in the record that supports their position[2].

Respectfully Submitted,

Greg Gerst
Gerst Capital, LLC

cc: Edward Smith
Johanna Thomas
Louis Peraertz
Erin McGrath
Brendan Carr
Julius Knapp
Bruce Romano
Rashmi Doshi

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[1] Slides 9-12 present new results from tests conducted by Frontline Test Equipment (www.fte.com). These tests were conducted at no cost to Gerst Capital. FTE could conduct a comprehensive set of tests to assess the impact of TLPS on Bluetooth and/or Bluetooth Low Energy devices. This would require: a) access to TLPS-enabled equipment, and b) a commercial agreement including compensation for testing time and labor.

[2] Similar questions can be asked for other Bluetooth and Bluetooth Low Energy devices across a variety of real-world environments. A BLE Hearing Aid is important because it is a relatively new category of device, and due to the fact that voice data is more susceptible to packet loss, latency, and jitter impairments (vs. data-only, or unidirectional audio).

Globalstar's TLPS Proposal: Risks vs. Rewards

Presented to Edward Smith, Legal Advisor to Chairman Wheeler

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AGENDA

1) **Risks and Rewards of TLPS**

2) **TLPS Introduces new source of Co-Channel and Adjacent-Channel Interference for existing Bluetooth & Bluetooth Low Energy Devices**

   - **The single quantitative test of TLPS' impact on BT/BLE demonstrated the packet error rate of a BLE Hearing Aid doubled in the presence of TLPS.**
   - **Preliminary tests conducted by Frontline Test Equipment (FTE) illustrate the risk of adding TLPS in a congested 2.4GHz Wi-Fi environment.**
   - **The record fails to provide sufficient technical information for the Commission to determine how TLPS will impact BT/BLE devices in the real-world. The limited information available to date clearly show further testing and investigation is required.**

3) **Conclusion**

Paragraph 1 of the NPRM asks for a record to determine the risks vs. rewards of Globalstar's TLPS:

1. By this *Notice of Proposed Rulemaking* (*Notice*), the Commission proposes modified rules for the operation of the Ancillary Terrestrial Component (ATC)[1] of the single Mobile-Satellite Service (MSS) system operating in the Big LEO S band.[2] The proposed changes would allow Globalstar, Inc. (Globalstar) to deploy a low power broadband network. Under the proposals in this *Notice*, Globalstar would be able to provide low-power ATC using its licensed spectrum at 2483.5-2495 MHz under certain limited technical criteria, and with the same equipment would be able to utilize spectrum in the adjacent 2473-2483.5 MHz band pursuant to the applicable technical rules for unlicensed operations in that band. For all the reasons stated herein, we believe that Globalstar's proposal to deploy broadband access equipment should be further examined and a record developed to determine whether this proposal has the potential to enable more efficient use of Globalstar's S-band spectrum and spectrum in the adjacent band. This action could ***potentially increase the amount of spectrum available for broadband access in the United States***. At the same time, significant concerns have been raised about ***potential detrimental impacts on unlicensed devices***. We **seek comment on the costs and benefits of the proposed approach**, and on changes to our rules which may facilitate such deployment and minimize any negative impacts.[1]

Reward: Increase the amount of spectrum available for broadband access in the United States

VS.

Risk: Detrimental Impact on existing unlicensed devices & services

[1]*See "NOTICE OF PROPOSED RULEMAKING", FCC 13-147, Released on November 1, 2013.*

REWARD: 3.6% increase in currently available Wi-Fi Spectrum

	2.4GHz Band	5GHz Band	Total
Non-Overlapping 20MHz Wi-Fi Channels	3	25	28
w/TLPS	4	25	29
Change:	33.3%		3.6%

Stating the benefits of TLPS solely in terms of 2.4 GHz ignores:

- **Most Wi-Fi devices are now "dual-band", supporting both 2.4GHz & 5GHz frequency bands[2].**
- **At least one recent study shows 5GHz Wi-Fi channels are under-utilized[3].**
- **In congested areas where TLPS purportedly offers the most benefit, 5GHz Wi-Fi channels are an increasingly attractive, risk-free alternative to the 2.4GHz band. In congested Wi-Fi deployments, the shorter range of 5GHz can be an advantage (due to shorter frequency reuse distance).**

[2] http://www.fiercewireless.com/tech/press-releases/5-ghz-wi-fi-now-mainstream .

[3] See ACRP Report 127 titled "A Guidebook for Mitigating Wi-Fi Interference at Airports". A webinar based on this report was conducted on November 5, 2015 and can be accessed at http://www.trb.org/ElectronicSessions/Blurbs/173178.aspx. Also see final slide of Appendix for one real-world snapshot of 5GHz Wi-Fi utilization in an airport setting.

RISK #1: TLPS will interfere with Bluetooth and Bluetooth Low Energy devices in congested environments

- **According to Bluetooth SIG, 3 billion Bluetooth devices shipped in 2014 alone[4].**
- **Currently, the frequency range above Wi-Fi Channel 11 acts as a safe haven for Bluetooth traffic in congested Wi-Fi environments[5].**
- **TLPS will interfere with this safe haven, possibly rendering BT and/or BLE devices unusable.**
- **Bluetooth and Bluetooth Low Energy devices are confined to the 2.4GHz band, unlike Wi-Fi users who have the option of using 5GHz.**

[4]Bluetooth SIG 2014 Annual Report: https://www.bluetooth.org/en-us/Members/Annual-Report/2014-Annual-Report/default.aspx

[5]See Attachment to Letter from Gerst Capital, LLC to Marlene H. Dortch, Secretary, FCC, IB Docket 13-213 (July 28, 2015), "Open Technical Issues Regarding Globalstar's TLPS Proposal", Slide 4. Adding a 4th "non-overlapping" Wi-Fi channel requires 1/6/11/14, and would decrease the number of available BT/BLE channels, regardless of whether Channels 12&13 are allowed or not.

RISK #2: Today's most attractive 2.4GHz Wi-Fi channel will suffer the most adjacent channel interference

5GHz is underutilized with plenty of remaining capacity

Channel 11 is most utilized Wi-Fi Channel[6,7]

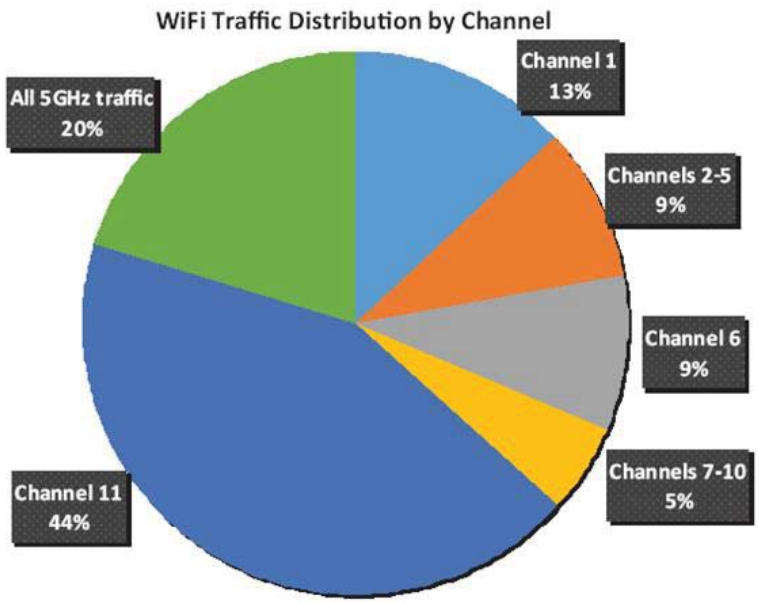

Figure 3. Traffic distribution among WiFi channels.

[6]See ACRP Report 127 titled "A Guidebook for Mitigating Wi-Fi Interference at Airports". A webinar based on this report was conducted on November 5, 2015 and can be accessed at http://www.trb.org/ElectronicSessions/Blurbs/173178.aspx.

[7]The record shows increased ACI-induced errors from TLPS on Channel 11 due to narrower channel spacing (22MHz vs. 25MHz channels spacing between 1&6 and 6&11). With TLPS, Channel 11 goes from the most attractive to least attractive Wi-Fi channel.

AGENDA

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- The single quantitative test of TLPS' impact on BT/BLE demonstrated the packet error rate of a BLE Hearing Aid doubled in the presence of TLPS.
- Preliminary tests conducted by Frontline Test Equipment (FTE) illustrate the risk of adding TLPS in a congested 2.4GHz Wi-Fi environment.
- The record fails to provide sufficient technical information for the Commission to determine how TLPS will impact BT/BLE devices in the real-world. The limited information available to date clearly argues for further testing/investigation.

3) Conclusion

SINGLE QUANTITATIVE BT/BLE<>TLPS INTERFERENCE TEST TO DATE

The Bluetooth SIG Test Report quantitatively showed Bluetooth Low Energy Packet Error Rate doubled when TLPS was enabled[8]

Simple, Repeatable Test Procedure

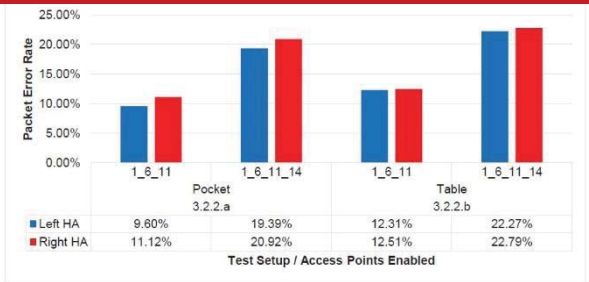
a. One HA pair is worn on the ears of a human subject and an iPhone is placed in a pants pocket. An audio stream is initiated on the iPhone using the music player. The human subject walks about the room for 300 seconds while audio packet statistics are recorded by the iPhone. Upon completion, the audio packet statistics are downloaded from the iPhone.

b. One HA pair is worn on the ears of a human subject and an iPhone is placed on a table. An audio stream is initiated on the iPhone using the music player. The human subject walks about the room for 300 seconds while audio packet statistics are recorded by the iPhone. An Ellisys protocol analyzer [2] is simultaneously recording all Bluetooth traffic at this time. Upon completion, the audio packet statistics are downloaded from the iPhone and the Ellisys air trace is saved.

Quantitative Results Collected for a Key Performance Metric

Setup	HA Side	Enabled Access Points	Total Samples	Missing Samples	Missed Packet Total	Total Packets Sent
3.2.2.a	Left	1_6_11	40144	614	4198	**43728**
3.2.2.a	Right	1_6_11	40147	752	4928	**44323**
3.2.2.a	Left	1_6_11_14	40150	1289	9348	**48209**
3.2.2.a	Right	1_6_11_14	40153	1610	10199	**48742**
3.2.2.b	Left	1_6_11	40143	980	5496	**44659**
3.2.2.b	Right	1_6_11	40143	808	5622	**44957**
3.2.2.b	Left	1_6_11_14	40147	2098	10901	**48950**
3.2.2.b	Right	1_6_11_14	40143	2232	11193	**49104**

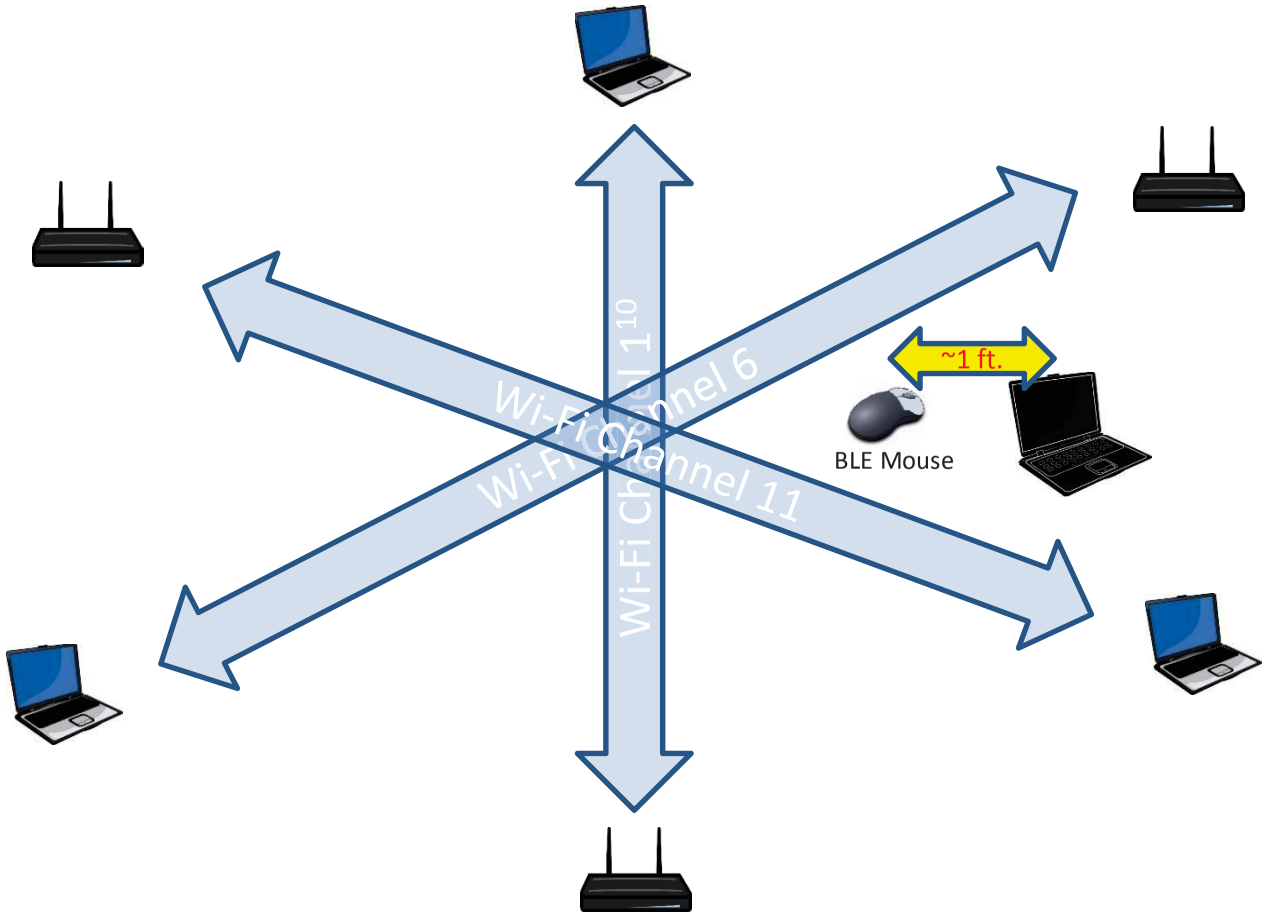
Unambiguous Results Show Negative Impact of TLPS



Leading to concerns by parties across multiple industries… (see Appendix)

[8]See Attachment to Letter from Mark Powell, Executive Director, Bluetooth SIG, Inc. filed to the FCC's IB Docket 13-213 (March 20, 2015) "TLPS and Bluetooth Demonstrations FCC Technology Center – March 6, 2015", Section 2.1.2 on Pages 4&5.

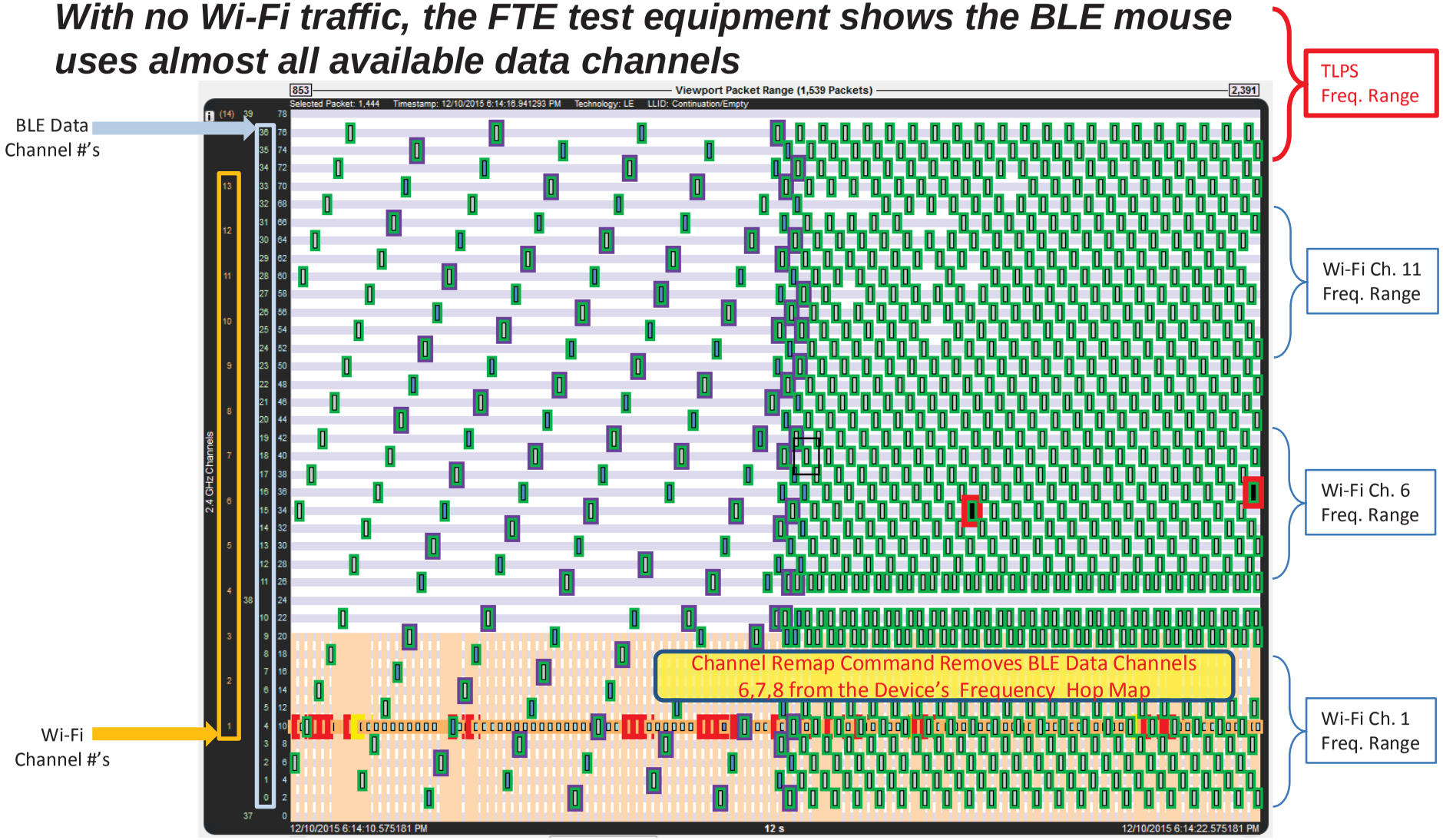
Frontline Test Equipment[9] (FTE) recently conducted a simple test to demonstrate the impact a congested Wi-Fi environment can have on a Bluetooth Low Energy Device



[9]*For more information, visit http://www.fte.com/company/aboutus.aspx .*

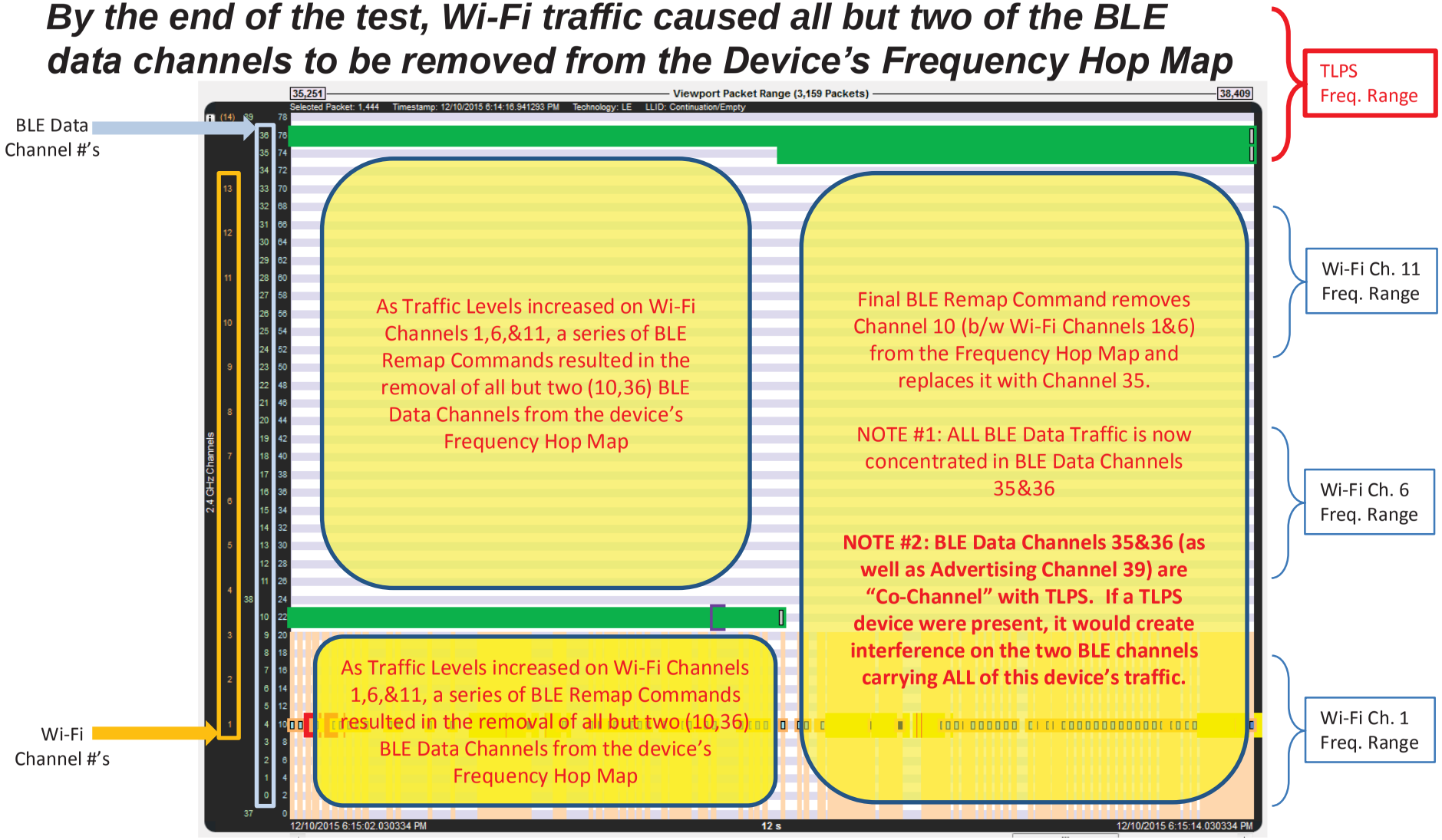
[10]*Measurement from client on Wi-Fi channel 1 shows power levels consistent with those of at least one real-world RF environment measured at an airport terminal (see Appendix) .*

With no Wi-Fi traffic, the FTE test equipment shows the BLE mouse uses almost all available data channels



Vertical Axis: Frequency/BLE Channel Map/BT Channel Map/Wi-Fi Channel Map
Horizontal Axis: Time/Packet Counter

By the end of the test, Wi-Fi traffic caused all but two of the BLE data channels to be removed from the Device's Frequency Hop Map



Vertical Axis: Frequency/BLE Channel Map/BT Channel Map/Wi-Fi Channel Map
Horizontal Axis: Time/Packet Counter

Output from FTE Software detailing two 4-second traces from the beginning and end of the test:

Minimal WiFi Traffic
Selected Duration: 0:00:03.990078

BLE Data Channel	Packets w/ No Error	Packets w/ CRC Error	Channel Available
0	15	0	Yes
1	14	0	Yes
2	15	0	Yes
3	15	0	Yes
4	15	0	Yes
5	15	0	Yes
6	0	0	No
7	0	0	No
8	0	0	No
9	29	0	Yes
10	29	0	Yes
11	29	0	Yes
12	14	0	Yes
13	15	0	Yes
14	14	0	Yes
15	13	1	Yes
16	14	0	Yes
17	14	0	Yes
18	15	0	Yes
19	14	0	Yes
20	15	0	Yes
21	15	0	Yes
22	16	0	Yes
23	14	0	Yes
24	15	0	Yes
25	13	0	Yes
26	15	0	Yes
27	14	0	Yes
28	12	0	Yes
29	15	0	Yes
30	14	0	Yes
31	13	0	Yes
32	14	0	Yes
33	14	0	Yes
34	14	0	Yes
35	15	0	Yes
36	14	0	Yes
Total	**531**	**1**	**34 Yes 3 No**
	>99%	<1%	92% Yes 8% No

WiFi Traffic on Channels 1, 6, and 11
Selected Duration: 0:00:03.997541

BLE Data Channel	Packets w/ No Error	Packets w/ CRC Error	Channel Available
0	0	0	No
1	0	0	No
2	0	0	No
3	0	0	No
4	0	0	No
5	0	0	No
6	0	0	No
7	0	0	No
8	0	0	No
9	0	0	No
10	0	0	No
11	0	0	No
12	0	0	No
13	0	0	No
14	0	0	No
15	0	0	No
16	0	0	No
17	0	0	No
18	0	0	No
19	0	0	No
20	0	0	No
21	0	0	No
22	0	0	No
23	0	0	No
24	0	0	No
25	0	0	No
26	0	0	No
27	0	0	No
28	0	0	No
29	0	0	No
30	0	0	No
31	0	0	No
32	0	0	No
33	0	0	No
34	0	0	No
35	276	0	Yes
36	263	0	Yes
Total	**539**	**0**	**2 Yes 35 No**
	100%	0%	5% Yes 95% No

<u>Minimal Wi-Fi traffic</u>: BLE Packets transmitted across 34 of 37 possible data channels

<u>Wi-Fi traffic on Channels 1/6/11</u>: Approximately same number of packets now transmitted on only 2 of 37 possible data channels. TLPS will impair these channels.

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3) Conclusion

CONCLUSION

- **As use of 5GHz Wi-Fi grows, the benefit of TLPS becomes less important.**
- **Wi-Fi users have an alternative frequency band (5GHz) that presents no incremental risk to existing services. BT/BLE users have no alternative to the 2.4GHz band.**
- **The single *quantitative* BLE<>TLPS coexistence test in the proceeding record proves TLPS has a negative effect on a BLE Hearing Aid.**
- **Preliminary testing conducted by FTE illustrates how Wi-Fi traffic affects a BLE device's operation and foreshadows problems if TLPS were added.**
- **Qualitative tests of the type conducted by Globalstar would fail to recognize the impact Wi-Fi traffic has on BLE device operations.**

Other Issues:

- **Despite Globalstar's demonstrations, quantitative tests showed TLPS' effect on Channel 11 is worse than ACI-induced effects between current non-overlapping Wi-Fi channels (1&6,6&11) due to narrower channel spacing (22MHz between 11&TLPS vs. 25MHz between 1/6 and 6/11).**

  At minimum, illustrates the need for further testing.

- **The removal of the coexistence filter from the TLPS Access Point (& limiting TLPS client devices to those without modern coexistence filters) refutes Globalstar's claims of a "firmware only" upgrade for all devices.**

  The full implications of this fact have not been explored in the record.

APPENDIX

SINGLE QUANTITATIVE BT/BLE<>TLPS INTERFERENCE TEST TO DATE

Demonstrations ≠ tests. Multiple parties have repeatedly expressed concerns over lack of testing.

Etymotic Research[2]

…there is **not sufficient technical specificity** to allow a thorough analysis of the system's impact on other users of the band…

…We **observe with grave concern Globalstar's representations about lack of impact to audio quality**. Assessing the psychoacoustic impact of interference is a specialized topic. The impact of interference on people with normal hearing is different from that on people with hearing loss...

…The similarity in name between Bluetooth and Bluetooth LE perhaps implies that their characteristics are similar. In fact, particularly for this issue, the interference vulnerability is very different for these two categories of devices. Both are widely used and should be evaluated separately...

Hearing Industries Association[3]

…**When Wi-Fi Channels 1, 6, and 11 are congested, the 2473-2483.5 MHz band is necessary for Bluetooth operation** – as Bluetooth SIG notes, this **is a "safe haven" for Bluetooth devices**. The same is true for ALDs, that use other low power unlicensed technologies on the 2.4 GHz band…

…The **"testing" and data presented to the FCC by Globalstar to date has been very limited** and controlled, and HIA does not find that they adequately evaluate the range of scenarios or the potential impact of Globalstar's proposed TLPS operations on unlicensed users. Further peer review of the testing done to date, and testing that better reflects real-world conditions is needed to adequately understand the risks of Globalstar's proposal and explore what mitigations might minimize any negative impacts…

…**with the Globalstar proposal, the risks are not well understood** and the technical work to minimize interference has not been done…HIA asks the Commission to strongly encourage more involvement by neutral and collaborative forums rather than by individual stakeholders…

[2]*See Letter from Mead Killion, CTO & Founder of Etymotic Research, Inc. to Marlene H. Dortch, Secretary,FCC, IB Docket 13-213 (July 24, 2015)*
[3]*See Letter from Laura A. Stefani, Counsel for The Hearing Industries Association to Marlene H. Dortch, Secretary, FCC, IB Docket 13-213 (July 13, 2015), pg 3.*

SINGLE QUANTITATIVE BT/BLE<>TLPS INTERFERENCE TEST TO DATE

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Entertainment Software Association[4]

…ESA's analysis of the reports following the recent TLPS demonstration strongly suggests that Globalstar's proposal presents a substantial and unacceptable risk of interference to Wi-Fi and Bluetooth. **The Bluetooth hearing and demonstration conducted by the Bluetooth Special Interest Group ("SIG") causes particular concern**. Consistent with the anticipated theoretical impact on Bluetooth, the Bluetooth SIG's **results demonstrate a doubling of the packet error rate** on a Bluetooth link with fully 20 percent of Bluetooth packets lost to interference. This degree of interference significantly impacts the performance of video game controllers currently on the market – **it would noticeably increase input latency**, and significantly degrade consumers' gaming experiences.

Even worse, these **alarming results were the result of testing in the presence of a lightly loaded TLPS system operating at significantly reduced power**...Globalstar TLPS base station operated at only 200mW, and was loaded with only a single 3.75 Mbps stream….

…**Data loss and transmission latency represent significant challenges** for both of these technologies. Even a **small amount of additional latency or "lag" on either the Wi-Fi or Bluetooth link will diminish the consumer's gaming experience** and will lead to significant frustration. GlobalStar's proposed TLPS service threatens to interfere with these inks and thus increase latency…….

…The technical record, including **Globalstar's demonstration results, does not provide the Commission with an adequate basis for adopting the rule changes** sought by Globalstar…

…the 10 MHz at the top of the 2.4 GHz unlicensed band – the **frequencies that Globastar has petitioned to occupy – is the only portion of that band that is reliably free from interference** for the tens of millions of game consoles owned by consumers across the country...

…There is a real possibility that interference from TLPS could force console manufacturers to redesign their wireless controllers to operate in different bands, using different wireless protocols…

…**The technical record fails to provide the Commission with an adequate basis for adopting the rule changes Globalstar seeks**. To the contrary, the evidence presently in the record suggests that the proposed TLPS service, if built, would cause significant public harm to the Wi-Fi and Bluetooth technologies that virtually every American consumer relies upon…

[4]See Letter from Michael Warnecke, Chief Counsel, Technology Policy, Entertainment Software Association to Marlene H. Dortch, Secretary, FCC, IB Docket 13-213 (April 20, 2015)

SINGLE QUANTITATIVE BT/BLE<>TLPS INTERFERENCE TEST TO DATE

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Microsoft[5,6]

…our concerns about the **lack of technical information needed to support an authorization of Globalstar's Terrestrial Low Power Service (TLPS)** deployment, since the operation of TLPS in Wi-Fi Channel 14 at locations where there is a high density of Wi-Fi deployments **has the potential to cause *latency, jitter*** and other harms to real-time, two-way online services and untold millions of devices, from gaming consoles to hearing aids, that rely on 2.4 GHz Wi-Fi and Bluetooth technology for their everyday use…

…We explained that in densely populated environments – such as multi-unit dwellings (apartment buildings, condominiums, college dorms), mixed use developments, and generally where lots of people congregate – if all three independent Wi-Fi channels are concurrently in operation and the magnitude of the data traffic is such that the medium is saturated, **the potential for adverse consequences such as *latency, jitter, and packet loss as a result of the interference from TLPS* are real, significant, and have not yet been tested**…

…TLPS operations are potentially very problematic for Bluetooth and Bluetooth-like devices that adaptively hop to open Bluetooth channels across the unlicensed 2.4 GHz spectrum band. Currently, **when all three independent Wi-Fi channels are in use, the bulk of the available Bluetooth channels are above Wi-Fi Channel 11** and in the guard band protecting Globalstar's Mobile Satellite Service. Based on what little could be gleaned from the documentation regarding the demonstrations at the FCC's TEC, it appears that **even if TLPS operates at low duty cycles, operations relying on these upper Bluetooth channels will at best be noticeably impaired and most likely will fail**….

…American households with gaming consoles could be adversely affected by TLPS interference into the 2.4 GHz band – **one reason testing is required**…testing of TLPS service and equipment must address these various use cases – indoor and outdoor, one-way and two-way, enterprise and consumer, urban and rural – and at the operating parameters proposed in the Commission's NPRM**…because there is insufficient technical data in the record** and the recent TEC demonstration did not effectively address the various use cases, the FCC should not go forward based on this record to authorize Globalstar to deploy TLPS.

…**Microsoft did not itself comment in this proceeding up until this point because it had hoped that Globalstar would have conducted rigorous system-level testing** of indoor and outdoor real-world TLPS use cases at the Commission's proposed operating parameters. Such rigorous system-level testing could have allayed concerns regarding the potential impacts of TLPS operations…and could have demonstrated Globalstar's capacity and willingness to address any technical issue that might arise from such a service…**the record has shown that Globalstar has chosen not to take such actions…**

…The recent **uncontrolled and limited demonstrations** of TLPS at the FCC's Technology Experience Center (TEC) **did not produce data that the FCC can rely upon to approve the new service, and, if anything, raised more red flags**…

[5] *See Letter from Paula Boyd (Director, Government & Regulatory Affairs) & Michael Daum (Technology Policy Strategist, Regulatory Affairs) of Microsoft to Marlene H. Dortch, Secretary, FCC, IB Docket 13-213 (May 29, 2015)*

[6] *See Letter from Gerard Waldron, Counsel to Microsoft Corporation to Marlene H. Dortch, Secretary, FCC, IB Docket 13-213 (June 18, 2015)*

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Microsoft[7,8]

…Contrary to Globalstar's assertion, **actual controlled testing of the potential impacts of TLPS deployment** at the Commission's proposed power levels and permitted out-of-band-emissions for some key deployment scenarios **is required if the FCC is to make sound policy**…

…it is important to understand how TLPS under different load factors in high-density deployments might impact the real-time, two-way video quality of service. For these products, packet throughput is not the only relevant parameter. ***Packet latency, jitter, and error rate very much affect the mobile consumer's experience*. The TEC demonstration offers little insight in this regard**…

…**Microsoft has concluded that the Globalstar demonstration was just that – a limited and controlled demonstration of TLPS that produced some interesting tidbits of data – *but nothing that the Commission should consider as a substitute for rigorous testing***….

…The Commission adopted its Notice of Proposed Rulemaking for IB Docket No. 13-213 in November 2013 with the publication in the Federal Register in February 2014 with the hope that Globalstar could find a way to put to rest fears of consumers and businesses that have grown the rely on unlicensed spectrum in the 2.4GHz band. If this outcome was possible, **one would expect, at this point in the proceeding, there would be some consensus forming among stakeholders based on data such that the disagreements would be limited to a handful of issues. But here, *due to the limited data collected and the significant risks involved, many of the open questions are fundamental*.**

[7] *See Letter from Paula Boyd (Director, Government & Regulatory Affairs) & Michael Daum (Technology Policy Strategist, Regulatory Affairs) of Microsoft to Marlene H. Dortch, Secretary, FCC, IB Docket 13-213 (May 29, 2015)*

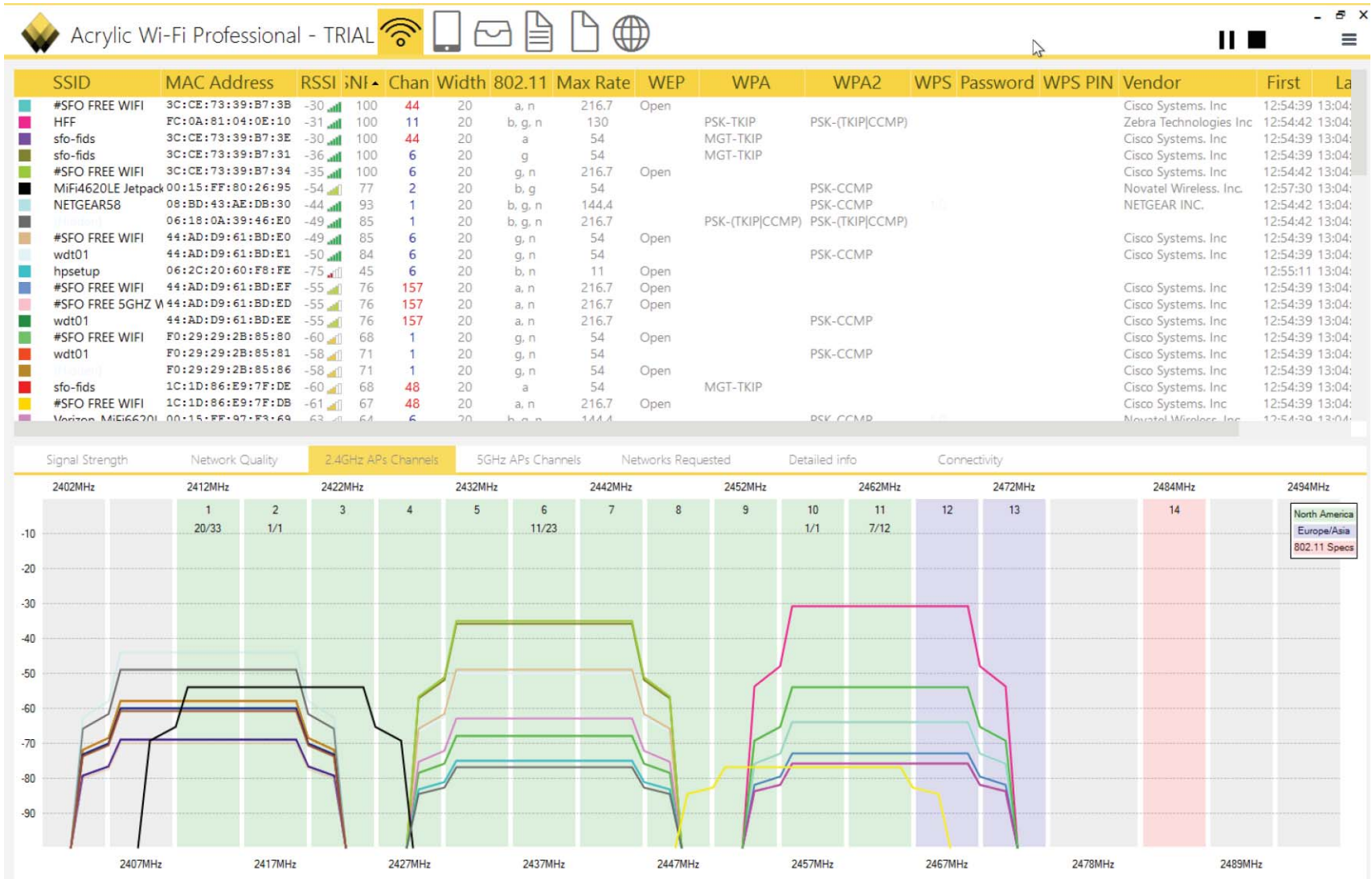
[8] *See Letter from Gerard Waldron, Counsel to Microsoft Corporation to Marlene H. Dortch, Secretary, FCC, IB Docket 13-213 (June 18, 2015)*

Diverse group of opposition parties with a variety of concerns

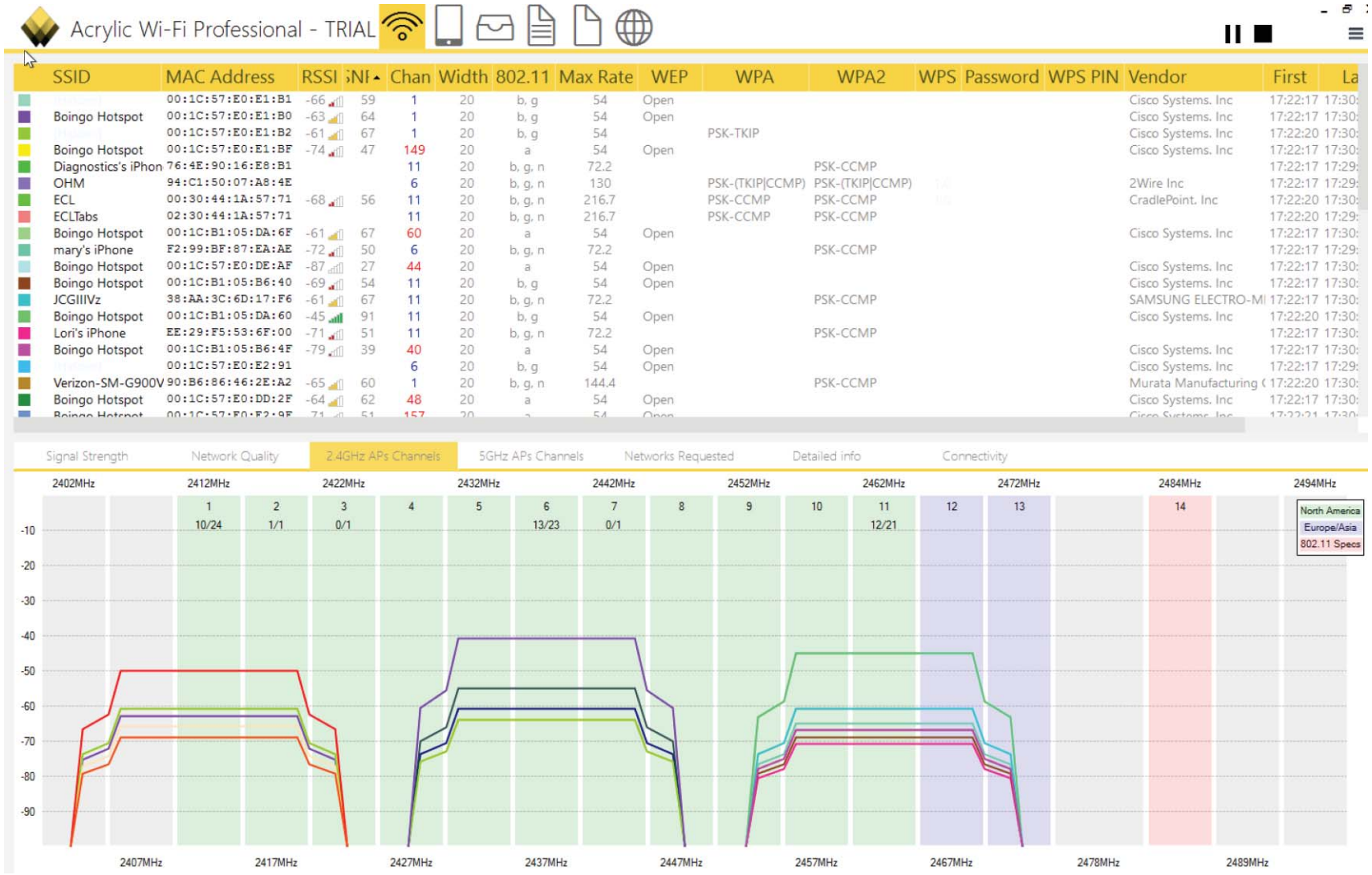
Oppose		
Filer/Participant	**Type**	**Rationale/Position**
ABC Television Network	Corporation	Interference with broadcast auxiliary service frequencies in the 2.5GHz band.
Alarm Industry Communications Committee	Interest Group	Wi-Fi interference, specifically to alarm devices transmitting signals on Wi-Fi Ch 11.
ARRL (the national association for Amateur Radio)	Interest Group	"This plan would thus, for the first time, create a multiple-use, radio frequency environment in which Part 15 unlicensed devices do not have to protect a licensed, allocated radio service from harmful interference. This is untenable as a precedent and it makes the entirety of the Notice proposal likewise untenable."
Bluetooth SIG	Interest Group	Interference with Bluetooth and Bluetooth low energy. Limited testing showed doubling of packet error rate for Bluetooth devices in presence of TLPS. Fairness regarding differentiated rules in the ISM band.
CBS Television Stations	Corporation	Interference with broadcast auxiliary service frequencies in the 2.5GHz band.
Consumer Electronics Association	Interest Group	Globalstar demonstrations "not well-conceived", "not open and transparent" and "serious questions still remain regarding the ability of TLPS to co-exist with existing unlicensed users". Calls for joint testing.
Engineers for the Integrity of Broadcast Auxiliary Services Spectrum (EIBASS)	Interest Group	Interference with licensed Broadcast Auxiliary Services. Concern over credibility of Globalstar's proposed Network Operations Center.
Entertainment Software Association (ESA)	Interest Group	Interference with Bluetooth, (particularly game controllers). Unreliable demonstrations and unanswered questions.
Etymotic Research, Inc.	Corporation	Interference with Bluetooth and Bluetooth Low Energy, specifically to hearing aids. Unworkable NOS proposal.
Google	Corporation	Concerns over interference. Concerns over policy fairness, precedent and allowing benefits to accrue to single corporation.
Hearing Industries Association (HIA)	Interest Group	Interference with unlicensed technologies in the 2.4GHz band including Bluetooth low energy.
Hearing Loss Association of America (HLAA)	Interest Group	Interference with Bluetooth and Bluetooth low energy, specifically in hearing aids.
Meredith Corporation/KPHO Broadcasting Corporation	Corporation	Interference with broadcast auxiliary service frequencies in the 2.5GHz band.
Microsoft	Corporation	Interference with Bluetooth and Wi-Fi. Lack of testing and technical information, unreliable demonstrations and unanswered questions.
National Cable & Telecommunications Association (NCTA)	Interest Group	Wi-Fi interference. Unreliable and unrepresentative demonstrations by Globalstar. CableLabs measurements demonstrate negative impact on Wi-Fi Channel 11 from TLPS.
Society of Broadcast Engineers	Interest Group	Interference to BAS channels A8 and A9 coupled with high noise levels in the 2.5GHz band which make 2.4GHz band important.
Sony Computer Entertainment America	Corporation	Interference with Bluetooth, particularly in game consoles.
Sprint Corporation	Corporation	Meeting OOBE limits and interference above 2496 MHz and protection of Channel BRS-1.
WGN Continental Broadcasting Company, LLC	Corporation	Interference with broadcast auxiliary service frequencies in the 2.5GHz band.
Wi-Fi Alliance	Interest Group	Interference with Wi-Fi and inconclusive demonstrations by Globalstar. Lack of meaningful test results.
Wireless Communications Association International (WCAI)	Interest Group	TLPS will cause harmful interference to BRS and EBS. Globalstar has failed to address unanswered questions about such interference, and meeting OOBE limits at 2495 MHz.
Wireless Internet Service Providers Association (WISPA)	Interest Group	Interference with Wi-Fi. Lack of testing and inadequate demonstrations by Globalstar.

Real-World Wi-Fi Environment: San Francisco International Airport

2.4GHz Band RF Snapshot Taken at SFO, Gate 26-31 Seating Area

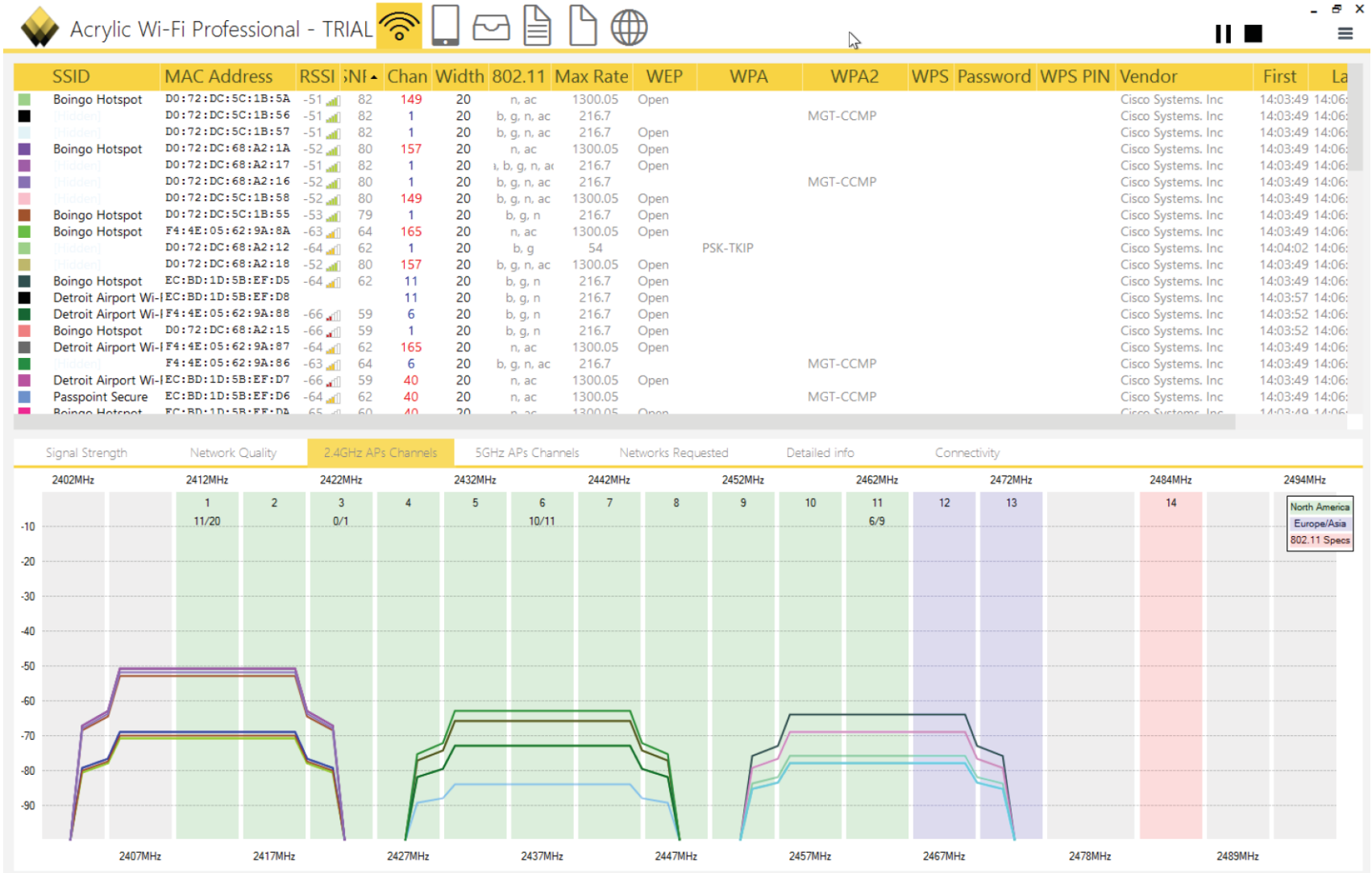


2.4GHz Band RF Snapshot Taken at STL, Gate E18 Seating Area



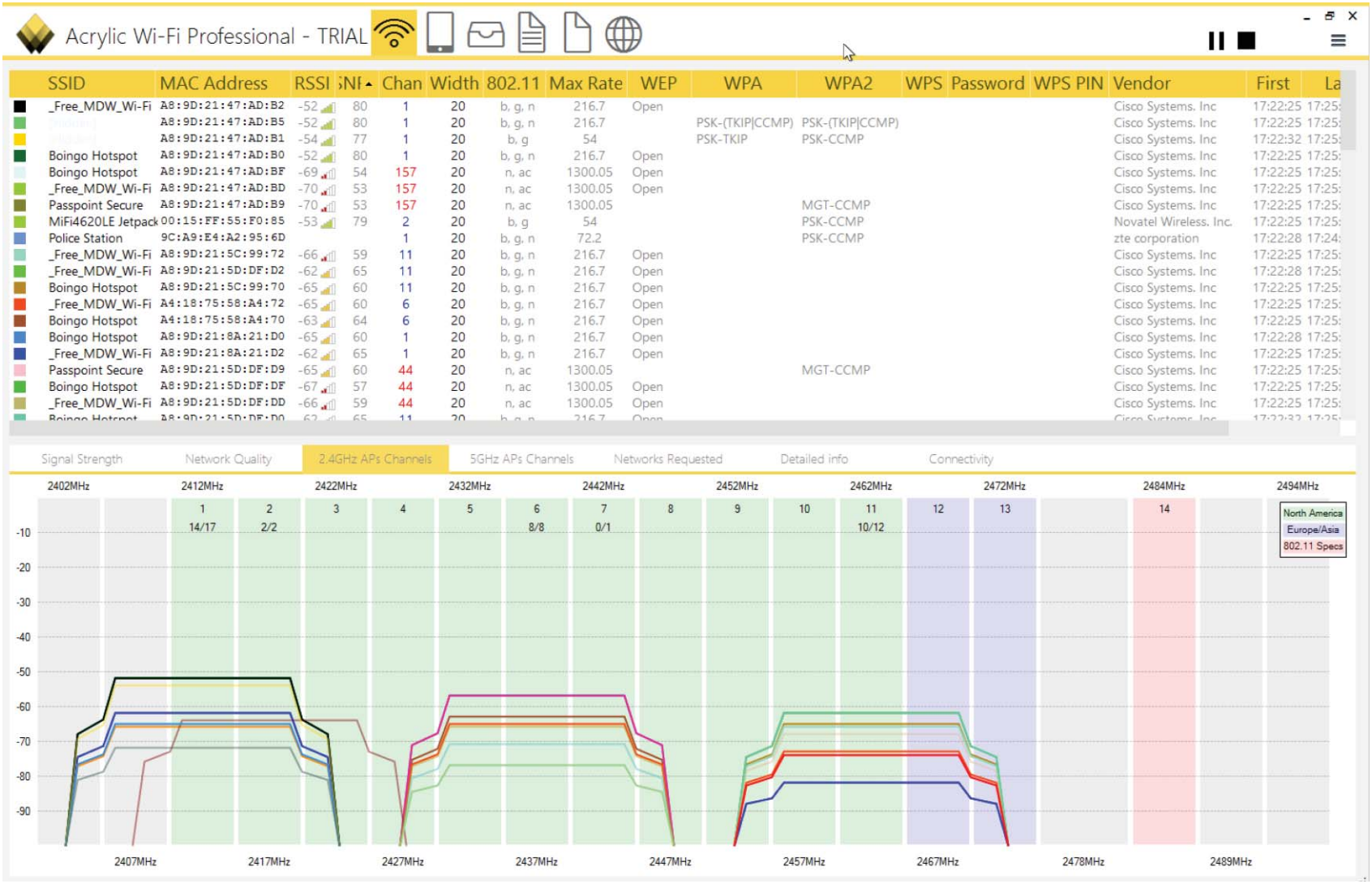
SSID	MAC Address	RSSI	SNI	Chan	Width	802.11	Max Rate	WEP	WPA	WPA2	WPS	Password	WPS PIN	Vendor	First	La
	00:1C:57:E0:E1:B1	-66	59	1	20	b, g	54	Open						Cisco Systems. Inc	17:22:17	17:30:
Boingo Hotspot	00:1C:57:E0:E1:B0	-63	64	1	20	b, g	54	Open						Cisco Systems. Inc	17:22:17	17:30:
	00:1C:57:E0:E1:B2	-61	67	1	20	b, g	54		PSK-TKIP					Cisco Systems. Inc	17:22:20	17:30:
Boingo Hotspot	00:1C:57:E0:E1:BF	-74	47	149	20	a	54	Open						Cisco Systems. Inc	17:22:17	17:30:
Diagnostics's iPhon	76:4E:90:16:E8:B1			11	20	b, g, n	72.2			PSK-CCMP					17:22:17	17:29:
OHM	94:C1:50:07:A8:4E			6	20	b, g, n	130		PSK-(TKIP|CCMP)	PSK-(TKIP|CCMP)				2Wire Inc	17:22:17	17:29:
ECL	00:30:44:1A:57:71	-68	56	11	20	b, g, n	216.7		PSK-CCMP	PSK-CCMP				CradlePoint. Inc	17:22:20	17:30:
ECLTabs	02:30:44:1A:57:71			11	20	b, g, n	216.7		PSK-CCMP	PSK-CCMP					17:22:20	17:29:
Boingo Hotspot	00:1C:B1:05:DA:6F	-61	67	60	20	a	54	Open						Cisco Systems. Inc	17:22:17	17:30:
mary's iPhone	F2:99:BF:87:EA:AE	-72	50	6	20	b, g, n	72.2			PSK-CCMP					17:22:17	17:29:
Boingo Hotspot	00:1C:57:E0:DE:AF	-87	27	44	20	a	54	Open						Cisco Systems. Inc	17:22:17	17:30:
Boingo Hotspot	00:1C:B1:05:B6:40	-69	54	11	20	b, g	54	Open						Cisco Systems. Inc	17:22:17	17:30:
JCGIIIVz	38:AA:3C:6D:17:F6	-61	67	11	20	b, g, n	72.2			PSK-CCMP				SAMSUNG ELECTRO-MI	17:22:17	17:30:
Boingo Hotspot	00:1C:B1:05:DA:60	-45	91	11	20	b, g	54	Open						Cisco Systems. Inc	17:22:20	17:30:
Lori's iPhone	EE:29:F5:53:6F:00	-71	51	11	20	b, g, n	72.2			PSK-CCMP					17:22:17	17:30:
Boingo Hotspot	00:1C:B1:05:B6:4F	-79	39	40	20	a	54	Open						Cisco Systems. Inc	17:22:17	17:30:
	00:1C:57:E0:E2:91			6	20	b, g	54	Open						Cisco Systems. Inc	17:22:17	17:29:
Verizon-SM-G900V	90:B6:86:46:2E:A2	-65	60	1	20	b, g, n	144.4			PSK-CCMP				Murata Manufacturing (	17:22:20	17:30:
Boingo Hotspot	00:1C:57:E0:DD:2F	-64	62	48	20	a	54	Open						Cisco Systems. Inc	17:22:17	17:30:

2.4GHz Band RF Snapshot Taken at DTW, Gate G21 Seating Area



SSID	MAC Address	RSSI	SNR	Chan	Width	802.11	Max Rate	WEP	WPA	WPA2	WPS	Password	WPS PIN	Vendor	First	La
Boingo Hotspot	D0:72:DC:5C:1B:5A	-51	82	149	20	n, ac	1300.05	Open						Cisco Systems. Inc	14:03:49	14:06:
[Hidden]	D0:72:DC:5C:1B:56	-51	82	1	20	b, g, n, ac	216.7			MGT-CCMP				Cisco Systems. Inc	14:03:49	14:06:
[Hidden]	D0:72:DC:5C:1B:57	-51	82	1	20	b, g, n, ac	216.7	Open						Cisco Systems. Inc	14:03:49	14:06:
Boingo Hotspot	D0:72:DC:68:A2:1A	-52	80	157	20	n, ac	1300.05	Open						Cisco Systems. Inc	14:03:49	14:06:
[Hidden]	D0:72:DC:68:A2:17	-51	82	1	20	ı, b, g, n, ac	216.7	Open						Cisco Systems. Inc	14:03:49	14:06:
[Hidden]	D0:72:DC:68:A2:16	-52	80	1	20	b, g, n, ac	216.7			MGT-CCMP				Cisco Systems. Inc	14:03:49	14:06:
[Hidden]	D0:72:DC:5C:1B:58	-52	80	149	20	b, g, n, ac	1300.05	Open						Cisco Systems. Inc	14:03:49	14:06:
Boingo Hotspot	D0:72:DC:5C:1B:55	-53	79	1	20	b, g, n	216.7	Open						Cisco Systems. Inc	14:03:49	14:06:
Boingo Hotspot	F4:4E:05:62:9A:8A	-63	64	165	20	n, ac	1300.05	Open						Cisco Systems. Inc	14:03:49	14:06:
[Hidden]	D0:72:DC:68:A2:12	-64	62	1	20	b, g	54		PSK-TKIP					Cisco Systems. Inc	14:04:02	14:06:
[Hidden]	D0:72:DC:68:A2:18	-52	80	157	20	b, g, n, ac	1300.05	Open						Cisco Systems. Inc	14:03:49	14:06:
Boingo Hotspot	EC:BD:1D:5B:EF:D5	-64	62	11	20	b, g, n	216.7	Open						Cisco Systems. Inc	14:03:49	14:06:
Detroit Airport Wi-I	EC:BD:1D:5B:EF:D8			11	20	b, g, n	216.7	Open						Cisco Systems. Inc	14:03:57	14:06:
Detroit Airport Wi-I	F4:4E:05:62:9A:88	-66	59	6	20	b, g, n	216.7	Open						Cisco Systems. Inc	14:03:52	14:06:
Boingo Hotspot	D0:72:DC:68:A2:15	-66	59	1	20	b, g, n	216.7	Open						Cisco Systems. Inc	14:03:52	14:06:
Detroit Airport Wi-I	F4:4E:05:62:9A:87	-64	62	165	20	n, ac	1300.05	Open						Cisco Systems. Inc	14:03:49	14:06:
[Hidden]	F4:4E:05:62:9A:86	-63	64	6	20	b, g, n, ac	216.7			MGT-CCMP				Cisco Systems. Inc	14:03:49	14:06:
Detroit Airport Wi-I	EC:BD:1D:5B:EF:D7	-66	59	40	20	n, ac	1300.05	Open						Cisco Systems. Inc	14:03:49	14:06:
Passpoint Secure	EC:BD:1D:5B:EF:D6	-64	62	40	20	n, ac	1300.05			MGT-CCMP				Cisco Systems. Inc	14:03:49	14:06:
Boingo Hotspot	EC:BD:1D:5B:EF:DA	-65	60	40	20	n, ac	1300.05	Open						Cisco Systems. Inc	14:03:49	14:06:

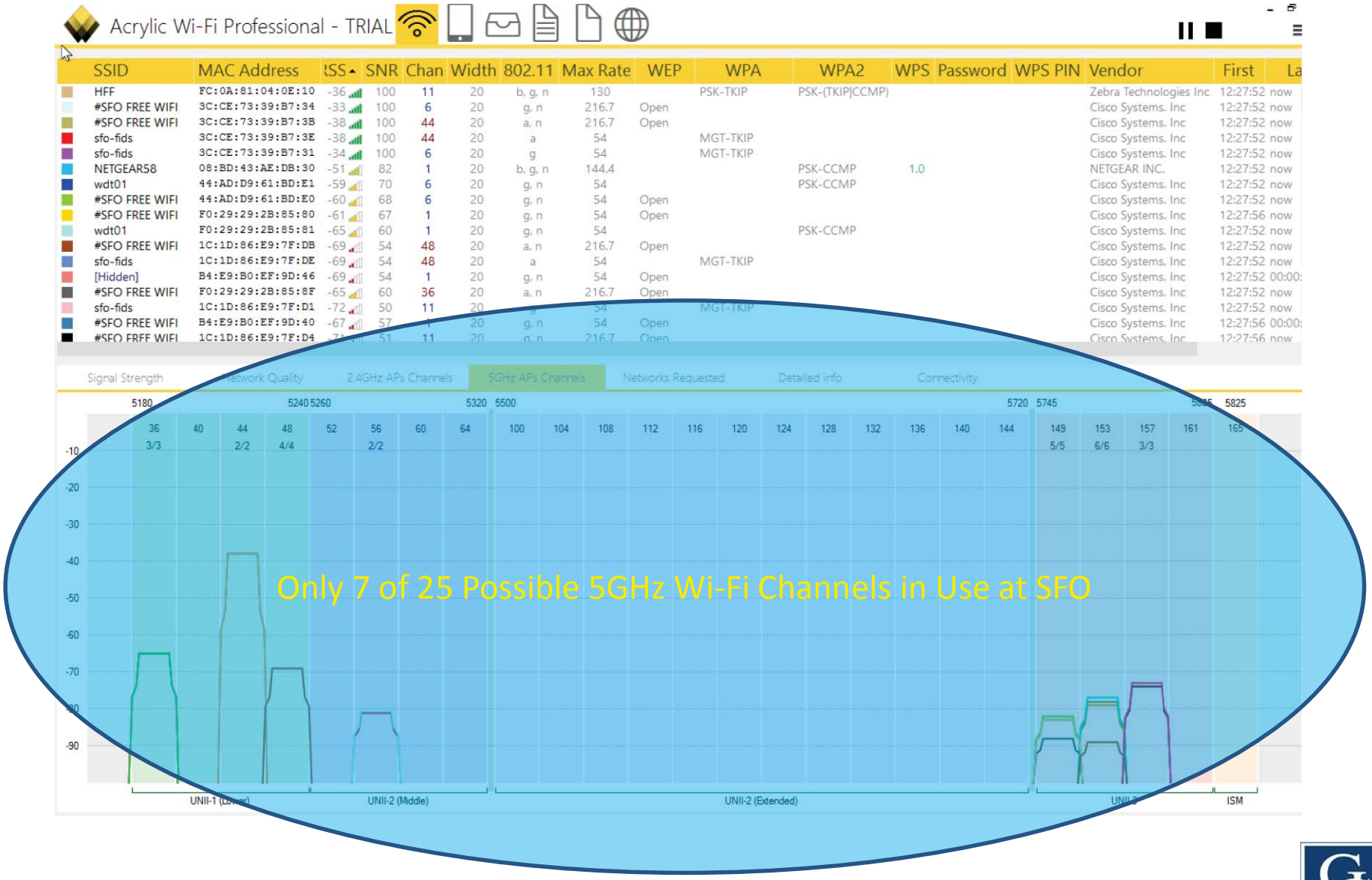
2.4GHz Band RF Snapshot Taken at MDY, Gate B16 Seating Area



SSID	MAC Address	RSSI	SNR	Chan	Width	802.11	Max Rate	WEP	WPA	WPA2	WPS	Password	WPS PIN	Vendor	First	La
_Free_MDW_Wi-Fi	A8:9D:21:47:AD:B2	-52	80	1	20	b, g, n	216.7	Open						Cisco Systems. Inc	17:22:25	17:25:
[illegible]	A8:9D:21:47:AD:B5	-52	80	1	20	b, g, n	216.7		PSK-(TKIP|CCMP)	PSK-(TKIP|CCMP)				Cisco Systems. Inc	17:22:25	17:25:
[illegible]	A8:9D:21:47:AD:B1	-54	77	1	20	b, g	54		PSK-TKIP	PSK-CCMP				Cisco Systems. Inc	17:22:32	17:25:
Boingo Hotspot	A8:9D:21:47:AD:B0	-52	80	1	20	b, g, n	216.7	Open						Cisco Systems. Inc	17:22:25	17:25:
Boingo Hotspot	A8:9D:21:47:AD:BF	-69	54	157	20	n, ac	1300.05	Open						Cisco Systems. Inc	17:22:25	17:25:
_Free_MDW_Wi-Fi	A8:9D:21:47:AD:BD	-70	53	157	20	n, ac	1300.05	Open						Cisco Systems. Inc	17:22:25	17:25:
Passpoint Secure	A8:9D:21:47:AD:B9	-70	53	157	20	n, ac	1300.05			MGT-CCMP				Cisco Systems. Inc	17:22:25	17:25:
MiFi4620LE Jetpack	00:15:FF:55:F0:85	-53	79	2	20	b, g	54			PSK-CCMP				Novatel Wireless. Inc.	17:22:25	17:25:
Police Station	9C:A9:E4:A2:95:6D			1	20	b, g, n	72.2			PSK-CCMP				zte corporation	17:22:28	17:24:
_Free_MDW_Wi-Fi	A8:9D:21:5C:99:72	-66	59	11	20	b, g, n	216.7	Open						Cisco Systems. Inc	17:22:25	17:25:
_Free_MDW_Wi-Fi	A8:9D:21:5D:DF:D2	-62	65	11	20	b, g, n	216.7	Open						Cisco Systems. Inc	17:22:28	17:25:
Boingo Hotspot	A8:9D:21:5C:99:70	-65	60	11	20	b, g, n	216.7	Open						Cisco Systems. Inc	17:22:25	17:25:
_Free_MDW_Wi-Fi	A4:18:75:58:A4:72	-65	60	6	20	b, g, n	216.7	Open						Cisco Systems. Inc	17:22:25	17:25:
Boingo Hotspot	A4:18:75:58:A4:70	-63	64	6	20	b, g, n	216.7	Open						Cisco Systems. Inc	17:22:25	17:25:
Boingo Hotspot	A8:9D:21:8A:21:D0	-65	60	1	20	b, g, n	216.7	Open						Cisco Systems. Inc	17:22:28	17:25:
_Free_MDW_Wi-Fi	A8:9D:21:8A:21:D2	-62	65	1	20	b, g, n	216.7	Open						Cisco Systems. Inc	17:22:25	17:25:
Passpoint Secure	A8:9D:21:5D:DF:D9	-65	60	44	20	n, ac	1300.05			MGT-CCMP				Cisco Systems. Inc	17:22:25	17:25:
Boingo Hotspot	A8:9D:21:5D:DF:DF	-67	57	44	20	n, ac	1300.05	Open						Cisco Systems. Inc	17:22:25	17:25:
_Free_MDW_Wi-Fi	A8:9D:21:5D:DF:DD	-66	59	44	20	n, ac	1300.05	Open						Cisco Systems. Inc	17:22:25	17:25:
Boingo Hotspot	A8:9D:21:5D:DF:D0	-62	65	11	20	b, g, n	216.7	Open						Cisco Systems. Inc	17:22:32	17:25:

Real-World Wi-Fi Environment: San Francisco International Airport

5GHz Band RF Snapshot Taken at SFO, Gate 26-31 Seating Area



Only 7 of 25 Possible 5GHz Wi-Fi Channels in Use at SFO