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September 22, 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 September 18th and 21st, 2015, I met individually with:

Johanna Thomas – Legal Advisor to Commissioner Rosenworcel (9/18)
Erin McGrath – Legal Advisor (Wireless, Public Safety, and International) to Commissioner O'Rielly (9/18)
Brendan Carr – Legal Advisor (Wireless, Public Safety, and International) to Commissioner Pai (9/18)
Louis Peraertz – Sr. Legal Advisor (Wireless, International, & Public Safety) to Commissioner Clyburn (9/21)

When meetings were being scheduled last month, the intent was to provide an overview of the technical issues discussed during my July 27th, 2015 meeting with engineers from the International Bureau and Office of Engineering and Technology[1]. After Globalstar's September 10th, 2015 filing, I added an agenda item providing an analysis of their latest demonstrations.[2] With that in mind, we discussed the attached slides covering the following areas:

1. Review of claims from the recent TLPS "deployment" conducted by Globalstar's consultants:

The review of the TLPS "deployment" focused on two distinct areas: A) Globalstar's continued unwillingness to conduct quantitative testing of the effects TLPS will have on Bluetooth and Bluetooth Low Energy devices, and B) Analysis of their throughput demonstration results that raise more questions than they answer.

A) As summarized in slide 3 of the attached presentation, the single quantitative test of TLPS's impact on Bluetooth (specifically BLE) was conducted over six months ago by Bluetooth SIG , not Globalstar, and showed the device's packet error rate doubled in the presence of TLPS. Slides 4-7 provide a sampling of technical concerns raised by other parties that, among other things, concludes "there is insufficient technical data in the record" to approve TLPS. Common sense implies Globalstar would take action to address the concerns surrounding Bluetooth<>TLPS interference, yet they continue to avoid conducting even the most basic quantitative tests.

According to Globalstar, the "Roberson and Associates report further demonstrates that there are no interference or compatibility issues ….with TLPS and Bluetooth operations[3]…". However, a search on the word "Bluetooth" in the September 10th filing reveals <u>Globalstar's consultant conducted NO QUANTITATIVE TESTS</u>. The consultant repeats phrases like "user perceivable"[4] and "was/were observed"[5,6] without providing a single quantitative data point.

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[1] See Letter from Gerst Capital, LLC to Marlene H. Dortch, FCC Secretary, IB Docket 13-213 (July 28, 2015).
[2] See Letter & Attachments from Barbee Ponder, Globalstar, Inc., to Marlene H. Dortch, FCC Secretary, IB Docket No. 13-213 (September 10, 2015).
[3] Ibid., Letter, Page 3 of 5
[4] Ibid., Attachment "Declaration of Kenneth J. Zdunek, Ph.D.", Paragraph 18
[5] Ibid., Attachment "Declaration of Kenneth J. Zdunek, Ph.D.", Paragraph 21
[6] Ibid., Attachment "TLPS Deployment and Summary Measurements, Roberson and Associates, LLC", Slide 17

Further, one would assume that, given the level of concern expressed about this particular issue, Globalstar's consultant would have conducted demonstrations (perhaps even tests?) that lasted more than "20-30 minutes" over a period of two days[7].

B) *Unlike the Bluetooth-related demonstrations, Globalstar's consultant does provide quantitative information allowing them to legitimately claim "users experienced increased aggregate throughput in excess of 90%" when following their "Steps to Measure Capacity Gain with TLPS"[8]. However, a close inspection of their methodology and data raises far more questions than it answers.*

Does Globalstar or their consultant really believe it is somehow remarkable that halving the number of users on any given Wi-Fi Channel will result in the remaining users' data rates nearly doubling? In Roberson's contrived scenario, the only surprising thing is that every user's data rate on every channel didn't more than double.

As detailed on Slide 9 of the attached, a quantitative analysis of Roberson's "Downlink Average Throughput Per Device" [9] data raises a series of basic questions about how this demonstration was configured, and what was driving the results. Of particular interest is the comparison of aggregate average channel throughput across the different channels and different steps of the demonstration.[10] While it was well under 50% of the non-MIMO 802.11n capacity[11] for Channels 1, 6, and 11 for each of the "Steps to Measure Capacity Gain with TLPS", it was well over 100% on TLPS for "Step 3". Even with the limited information provided in Roberson's report, this fact proves that MIMO clients (those with multiple transmit/receive chains like the iPad) were used on the TLPS channel. The key question is whether an identical mix of MIMO vs. non-MIMO clients were used on Channels 1, 6, and 11. If the mix of clients across the different channels wasn't consistent, then this was not an "apples-to-apples" test, and the results are meaningless. Unfortunately, this is among the many crucial details omitted by Globalstar's consultant.

Furthermore, Globalstar dramatically overstates the incremental increase in Wi-Fi capacity of adding TLPS by ignoring the 24 5GHz Channels freely available today. As illustrated on Slide 10 of the attached, adding TLPS to a congested 2.4GHz-only Wi-Fi network adds 33% to the average throughput per client. A network deployment would achieve an identical capacity increase by adding a single (free!) 20MHz 5GHz Channel, a 300% (= [(9+3)/3] – 1) improvement using the nine highest power 5GHz Channels, and 800% (= [(24+3)/3] – 1) using all 24 20MHz 5GHz Channels. Most importantly, adding TLPS creates NEW INTERFERENCE which negatively impacts Bluetooth Low Energy and Wi-Fi Channel 11(per Slides 3 and 15 of attached) while adding FREE 5GHzWi-Fi Channels presents zero additional interference/risk to Bluetooth, Bluetooth Low Energy, or other 2.4GHz Wi-Fi services.

While the meetings with the Commissioners' advisors covered these and other issues at a high-level, we agreed technical details must be addressed by engineers in the OET and IB. Ideally, the OET and IB would request that Globalstar submit additional information to the proceeding so that interested parties would have the necessary level of detail to assess the legitimacy of Globalstar's latest claims.

2. Controlled testing shows increased Wi-Fi Channel 11 interference due to TLPS:

In this section, I gave an overview of the Wi-Fi Channel 11<>TLPS adjacent channel interference tests, and emphasized:

- *This is an example of the type of precisely controlled tests conducted by wireless equipment manufacturers (employing test equipment used by virtually every Wi-Fi chip, access point, and smartphone supplier) BEFORE attempting to release a product/system to the public.*

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[7] Ibid., Attachment "TLPS Deployment and Summary Measurements, Roberson and Associates, LLC", Slide 17.
[8] Ibid., Attachment "TLPS Deployment and Summary Measurements, Roberson and Associates, LLC", Slide 8.
[9] Ibid., Attachment "TLPS Deployment and Summary Measurements, Roberson and Associates, LLC", Slide 9.
[10] Though Roberson demonstration report never explicitly says how throughput is measured, as it would in a proper test report, we can assume it is "TCP Throughput".
[11] If either device (AP or Client) uses a single antenna, the channel's maximum "PHY-Layer" capacity is 67MBps while the "TCP-Layer" capacity is always something less (typically ~50MBps depending on traffic mix).

- *As expected, the "apples-to-apples" testing showed the impact of TLPS on the adjacent non-overlapping channel (Ch11) is worse than that of "normal" non-overlapping Wi-Fi Channels, due to the narrower spacing (22MHz vs. 25MHz).*

- *The nature of errors exposed by the test equipment highlights the need for additional investigation and testing regarding this specific risk. None of the demonstrations conducted by Globalstar or their consultant use equipment that would expose the type of issues identified by Ixia's test equipment.*

3. **Access Point (AP) <u>hardware used in Globalstar's March demonstrations and subsequently tested by the OET is NOT THE SAME as commercially available hardware with the identical FCC ID number</u>. Specifically, the coexistence filters used in commercial Ruckus hardware were removed from the APs used in the March demonstrations and tested by the OET. The fact it was necessary to remove these passive, non-programmable components in order to support TLPS has wide-ranging implications:**

   Unfortunately, wording in the OET's Emissions Report implies Ruckus' "TLPS-enabled" and commercial hardware are identical[12]. As detailed in my July 27th presentation to OET & IB engineers[13], and summarized on slides 18-19 of the attached, comparative analysis of public information proves this is not the case.

   The implications of Globalstar requiring Ruckus to remove coexistence filters from the "TLPS-enabled" hardware actually has little to do with APs themselves. Virtually every popular LTE-enabled smartphone produced in the past 3-4 years employs the same coexistence filter technology used by Ruckus in the commercial version of their APs[14]. As detailed on slides 23, 27, 28, 31, 32, and 33 of the attached, the fact the Commission can no longer assume all "client devices can be modified by over-the-air software upgrades"[15] has a variety of serious implications that have yet to be addressed in the proceeding record.

   Globalstar has yet to publically admit their claim every client device will support TLPS "as long as it is enabled through a software or firmware push"[16] is incorrect. The OET Emissions Report's sentence stating that AP hardware tested and used in Globalstar's demonstrations "contained modular transmitters approved under Sections 15.247...of the Commission's rules" lends credence to Globalstar's erroneous claim. By implying Ruckus' TLPS hardware is identical to its commercial hardware (and understanding their commercial hardware with the identical FCC ID contains coexistence filters), a reader of the OET Emissions Report could logically conclude coexistence filters present no problems for TLPS operations. Current wording may inadvertently minimize an issue that is specifically addressed in the NPRM, and warrants further exploration in this proceeding.

4. **Globalstar's March demonstration was not configured at maximum power. Had it been, data from the OET's Emissions Report shows that interference to Wi-Fi Channel 11 and Bluetooth would have been materially higher. This previously unreported issue was just one of many ways Globalstar's March demonstration did not represent "real-world" conditions:**

   The attached slide 21 provides a summary of the issue that was discussed in detail during the July 27th meeting.[17] In meetings where we had time to review this material, I encouraged the Commissioners' advisors to explore the relevance of this issue with OET and IB engineers, and ask whether a 6dB higher noise level would be material in a demonstration of a Wi-Fi and/or Bluetooth wireless system.

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[12] See report TR 15-1002, "ELECTROMAGNETIC EMISSIONS CHARACTERIZATION OF SAMPLES USED AT TLPS DEMONSTRATION", prepared by the FCC OET, Section 1.1 "Executive Summary", Page 8 (May 7, 2015)

[13] See Attachment to Letter from Gerst Capital, LLC to Marlene H. Dortch, FCC Secretary, IB Docket 13-213 titled "Open Technical Issues Regarding Globalstar's TLPS Proposal", Slides 17-20 (July 28, 2015).

[14] See "Attachment #1" to Letter from Gerst Capital, LLC to Marlene H. Dortch, FCC Secretary, IB Docket 13-213 titled "*Even If Approved, Globalstar's TLPS Will Underperform Free Wi-Fi On (Tens Of) Millions of Existing Devices*", Page 4 (March 10, 2015). The "Side Note" describes the fact that at least one coexistence filter Avago markets for AP devices is identical to a filter marketed for smartphones/clients. This was confirmed by Avago.

[15] See "NPRM To Enable Terrestrial Broadband Network in Licensed MSS Spectrum", IB Docket 13-213, Paragraph 47 on Page 19 (November 1, 2013).

[16] Quote attributed to Jay Monroe, CEO of Globalstar, Inc. during the "Q1 2013 Earnings Call" conducted on May 21, 2013.

[17] See Attachment to Letter from Gerst Capital, LLC to Marlene H. Dortch, FCC Secretary, IB Docket 13-213 titled "Open Technical Issues Regarding Globalstar's TLPS Proposal", Slides 22-26 (July 28, 2015).

5. Response to NPRM:

During the course of each meeting, I highlighted the fact that all technical issues raised in the July 27th meeting are specifically addressed in at least one section of the NPRM. Slides 23-33 of the attached include responses to relevant paragraphs of the NPRM, with notation added to highlight the technical area of concern.

As a participant in this proceeding, it was encouraging to see that the Commissioners' advisors are well aware of the important technical issues surrounding the TLPS proposal. It is readily apparent these staff members will have conducted the diligence necessary to ask the hard questions that will face the Commission if/when a recommendation finally makes it "up to the 8th floor". Here are a couple suggestions for simple starter questions:

> ***"Why does Globalstar continue to avoid conducting quantitative tests that could support their claims that TLPS does not impair Bluetooth and Bluetooth Low Energy devices?"***
>
> ***"If Globalstar was provided with software enabling TLPS demonstrations with an iPhone released over five years ago, why didn't they have Apple provide software that enables TLPS demonstrations on modern versions such as the iPhone 6 or 6S? What about other modern, popular LTE-enabled devices?"***

If forced to make a decision based only on information available today, I believe the Commission should terminate this proceeding. If the Commission requires further analysis and/or test data before making a decision, I believe the OET and/or IB should publish updated guidance allowing interested parties to efficiently focus their efforts on providing such information.

Pursuant to Section 1.1206(b)(2) of the Commission's rules, an electronic copy of this letter and attachments are being filed for inclusion in the above-referenced dockets.

Respectfully Submitted,

Greg Gerst
Gerst Capital, LLC

cc: Johanna Thomas
Erin McGrath
Brendan Carr
Louis Peraertz
Jessica Almond
Ruth Milkman
Gigi Sohn
Mindel De La Torre
Jose Albuquerque
Roger Sherman
John Leibovitz
Bruce Romano
Mark Settle
Rashmi Doshi
William Hurst
Troy Tanner

Open Technical Issues Regarding Globalstar's TLPS Proposal

Presented to Staff Members of:

Commissioner Clyburn

Commissioner Rosenworcel

Commissioner Pai

Commissioner O'Rielly

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AGENDA

1) **Review of Globalstar's September 10, 2015 Filing**
   - Globalstar STILL provides no objective, quantitative test results regarding TLPS impact on Bluetooth and Bluetooth Low Energy
   - Throughput demonstrations effectively meaningless given level of information provided

2) **Controlled Testing Shows Increased Wi-Fi Ch.11 Interference from TLPS**

3) **Co-existence Filter Removal from Ruckus AP Raises Red Flags**
   - Publicly available data clearly shows hardware used in March Demo & OET emissions tests was modified
   - Globalstar's prior claims that all Wi-Fi devices can be enabled for TLPS with a "firmware upgrade" are incorrect

4) **Power level used in March Demonstration presented ~6dB lower interference to WiFi Ch. 11 than a Maximum Power real-world scenario**

5) **Gerst Capital Response to NPRM**

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[1]

Simple, Repeatable Test Procedure

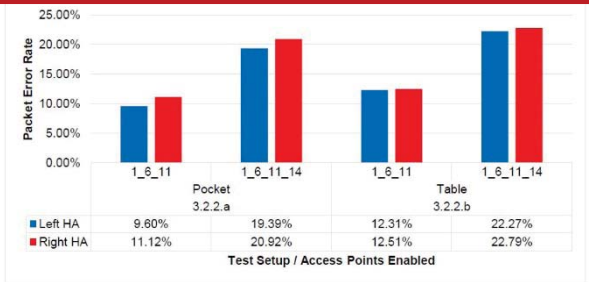
a. One HA pair is worn on the ears of a human subject and an iPhone is placed in a pants pocket. An audio stream is initiated on the iPhone using the music player. The human subject walks about the room for 300 seconds while audio packet statistics are recorded by the iPhone. Upon completion, the audio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

[1]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.

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

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

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

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

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)*

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

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

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)*

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

In response to technical concerns over a lack of testing, Globalstar's consultant produces yet another "demonstration"[9]

Demonstration of Bluetooth and TLPS Coexistence

Roberson and Associates, LLC
Technology and Management Consultants

- Loaded Channels 1, 6, 11 and 14 with 6 to 8 client devices each generating continuous uplink and downlink traffic through 2-way video Skype calls
- Demonstrated operation of several Bluetooth (BT) and Bluetooth Low Energy (BLE) devices (a BT speaker, BT and BLE mice and a BLE wrist-worn heart monitor) in the presence of Channel 1, 6, 11 and 14 activity
- The devices generating background traffic on Channels 1, 6 and 11 were between 10 and 20 feet away from the BT/BLE device table
- The access points for Channels 1, 6 and 11 were located approximately 30 to 40 feet from the table
- The Channel 14 access point was approximately 10 feet away
- Demonstrations occurred on August 11 and 18, 2015, and lasted 20-30 minutes
- Tests were observed by Roberson engineers and third parties

Typo?

Total of ~1 Hour dedicated to TLPS<>BT/BLE interference "demonstrations" since March 2015

No quantitative results for key metrics such as packet error rates, latency, & jitter

Word Count from "DECLARATION OF KENNETH J. ZDUNEK, Ph.D."

Test/tests/tested:	**1**
Demonstration/ demonstrations/ demonstrated:	**10**

Results of Demonstration of Bluetooth and TLPS Coexistence

Roberson and Associates, LLC
Technology and Management Consultants

- For the BT speaker demonstration, the speaker was moved 10 to 20 feet away from the laptop, with no interruption or gaps in the music
- For the BLE heart monitor demonstration, the test engineer wearing the watch moved between 10 and 20 feet away from the smartphone with no interruption of the continuous measurement of the heart rate
- For the wireless mice test, the mice were used to control the music player on the laptop and open and close browser windows with no interruption or delay observed in their operation

In the six months since the March 2015 demonstration, Globalstar has provided no Objective, Quantitative Test Results to assess the impact of TLPS on Bluetooth and/or Bluetooth Low Energy Devices

[9] *See Attachments to Letter from Barbee Ponder, General Counsel & Vice President, Globalstar, Inc. to Marlene H. Dortch, Secretary, FCC, IB Docket 13-213 (September 10, 2015)*

PUTTING CLAIMS OF DRAMATIC THROUGHPUT IMPROVEMENTS IN CONTEXT

Among other things, Globalstar's "deployment"[10] demonstrates…

Step 1 *Step 2* *Step 3*

(4 + 4 + 4) = (3 + 3 + 3) + 3 = (2 + 2 + 2) + 6 = 12 ***[think of ch1/6/11 inside the ( )'s]***

Steps to Measure Capacity Gain with TLPS

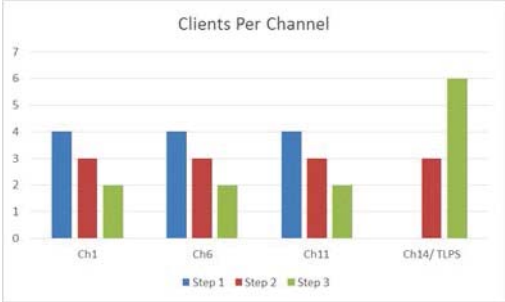
Roberson and Associates, LLC Technology and Management Consultants

This measurement procedure assesses aggregate network throughput with the addition of Channel 14 to the network and measures the throughput gain by all users

Step 1 1. Establish the baseline: determine average downlink throughput per device when 12 clients are on Channels 1, 6 and 11 (no TLPS in use)

Step 2 2. Determine average downlink throughput per device when 3 clients are moved to Channel 14 and 9 remain on 1, 6 and 11 (3 per channel)
   - Determine the gain in average device throughput for:
     - Channels 1, 6 and 11 devices
     - Channel 14 devices
     - All devices on network

Step 3 3. Repeat Step 2 with 6 devices on Channels 1, 6 and 11 (2 per channel) and 6 on Channel 14



Average Throughput / Client (MBps)	Ch1	Ch6	Ch11	Ch14/ TLPS	Wgt Avg Through-put/ Client	Increase vs. Step 1	Aggr. Avg. Channel Through-put of Ch 1/6/11	Aggr. Avg. Channel Through-put of Ch14/TLPS
Step 1 (Ch 1/6/11= 4 Clients, TLPS=0 Clients)	5.7	5.7	5.7		5.7		22.8	
Step 2 (Ch 1/6/11=3 Clients, TLPS =3 Clients)	6.3	6.3	6.3	16.1	8.75	53.5%	18.9	48.3
Step 3 (Ch 1/6/11=2 Clients, TLPS = 6 Clients)	10.9	10.9	10.9	11.2	11.05	93.9%	21.8	67.2

Basic Questions (see cells highlighted in yellow):

1. **Step 1: Why is aggregate average channel (1/6/11) throughput < 50% of maximum possible? Is this due to other clients on channels 1/6/11, noise environment, or limited traffic generation per client?**
2. **Step 2: With every channel allegedly supporting the same number of clients, why is the aggregate average channel throughput of Ch14/TLPS close to 100% of maximum (for non-MIMO) while Channels 1/6/11 are < 50%?**
3. **Step 3: How does Ch14/TLPS have an aggregate average channel rate > 100% channel capacity (assuming TCP-Level throughput measurements, 6 times 11.2MBps = 67MBps, or about 134% of a non-MIMO 802.11n channel)? Implies MIMO in use on Ch14 but not Ch1/6/11 which would not be an "apples-to-apples" comparison.**
4. **Step 3 vs. Step 1: The # of clients/channel is cut in half, so why is the aggregate avg. throughput of Ch1/6/11 in Step 3 less than that of Step 1?**
5. **Step 3 vs. Step 1: All else equal, if the number of clients on Ch1/6/11 are cut in half (4->2), we should expect the average throughput/client to at least double (possibly higher with less contention on the channel). Why does the average throughput only increase by ~91%?**

(A PROPERLY FORMULATED & EXECUTED TEST PLAN WOULD ANSWER THESE AND OTHER QUESTIONS)

[10] *See Attachments to Letter from Barbee Ponder, General Counsel & Vice President, Globalstar, Inc. to Marlene H. Dortch, Secretary, FCC, IB Docket 13-213 (September 10, 2015)*

PUTTING CLAIMS OF DRAMATIC THROUGHPUT IMPROVEMENTS IN CONTEXT

Using Globalstar's "deployment"[11] reasoning, let's analyze the impact of adding freely available 5GHz Wi-Fi channels..with some real-world assumptions.

Assumptions:

1. **In a dense Wi-Fi environment, it is not uncommon to configure deployments with a target of ~20 clients per 802.11n channel.**
2. **Start with a "congested" Wi-Fi environment where the client density is two times the target (40 clients/802.11n channel).**
3. **The primary goal is to "offload" clients from Wi-Fi channels 1, 6, and 11, getting their client density to the target of 20, and below if possible.**
4. **Initially, new Wi-Fi channels (such as TLPS and 5GHz) will be loaded with the target client density (20), though this will be decreased if the number of channels allows.**
5. **Assume each 20MHz 802.11n channel has a TCP-level capacity of 50Mbps.**

	2.4GHz				UNII-1				UNII-3					
Clients/Channel	Ch1	Ch6	Ch11	Ch14/ TLPS	Ch 36	Ch40	Ch 44	Ch 48	Ch 149	Ch 153	Ch 157	Ch 161	Ch 165	Total Clients
No OffLoad	40	40	40											120
Offload to TLPS/Ch14	33	33	34	20										120
Offload to One 5GHz Channel	33	33	34		20									120
Offload to Two 5GHz Channels	26	27	27		20	20								120
Offload to Three 5GHz Channels	20	20	20		20	20	20							120
Offload to Four 5GHz Channels	13	13	14		20	20	20	20						120
Offload to Five 5GHz Channels	6	7	7		20	20	20	20	20					120
Offload to Six 5GHz Channels	1	2	2		19	19	19	19	19	20				120
Offload to Seven 5GHz Channels	1	1	1		16	16	16	16	16	17	20			120
Offload to Nine 5GHz Channels	1	1	1		13	13	13	13	13	13	13	13	13	120

	2.4GHz				UNII-1				UNII-3						
Throughput/Client (50MBps Ch. Capacity)	Ch1	Ch6	Ch11	Ch14/ TLPS	Ch 36	Ch40	Ch 44	Ch 48	Ch 149	Ch 153	Ch 157	Ch 161	Ch 165	Wgt Avg Through-put per Client	% Increase vs No Offload
No OffLoad	1.3	1.3	1.3											1.3	
Offload to TLPS/Ch14	1.5	1.5	1.5	2.5										1.7	33%
Offload to One 5GHz Channel	1.5	1.5	1.5		2.5									1.7	33%
Offload to Two 5GHz Channels	1.9	1.9	1.9		2.5	2.5								2.1	67%
Offload to Three 5GHz Channels	2.5	2.5	2.5		2.5	2.5	2.5							2.5	100%
Offload to Four 5GHz Channels	3.8	3.8	3.6		2.5	2.5	2.5	2.5						2.9	133%
Offload to Five 5GHz Channels	8.3	7.1	7.1		2.5	2.5	2.5	2.5	2.5					3.3	167%
Offload to Six 5GHz Channels	50.0	25.0	25.0		2.6	2.6	2.6	2.6	2.6	2.5				3.8	200%
Offload to Seven 5GHz Channels	50.0	50.0	50.0		3.1	3.1	3.1	3.1	3.1	2.9	2.5			4.2	233%
Offload to Nine 5GHz Channels	50.0	50.0	50.0		3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	5.0	300%

% Increase in Ch 1/6/11 Throughput/Client	Ch1	Ch6	Ch11
No OffLoad			
Offload to TLPS/Ch14	21%	21%	18%
Offload to One 5GHz Channel	21%	21%	18%
Offload to Two 5GHz Channels	54%	48%	48%
Offload to Three 5GHz Channels	100%	100%	100%
Offload to Four 5GHz Channels	208%	208%	186%
Offload to Five 5GHz Channels	567%	471%	471%
Offload to Six 5GHz Channels	3900%	1900%	1900%
Offload to Seven 5GHz Channels	3900%	3900%	3900%
Offload to Nine 5GHz Channels	3900%	3900%	3900%

- ***Impact of adding TLPS identical to adding a single 5GHz channel***
- ***Benefit of adding multiple 5GHz channels has far greater impact than TLPS***
- ***Usage of 5GHz channels poses ZERO risk to Bluetooth/BLE & existing 2.4GHz Wi-Fi***
- ***5GHz channels are FREE. Will TLPS be free?***

[11] See Attachments to Letter from Barbee Ponder, General Counsel & Vice President, Globalstar, Inc. to Marlene H. Dortch, Secretary, FCC, IB Docket 13-213 (September 10, 2015)

Demonstrations conducted by Globalstar's consultant shows:

1) **They have yet to conduct quantitative testing of the impact TLPS will have Bluetooth & Bluetooth Low Energy Devices**
   - **Globalstar continues to ignore technically-consistent concerns from organizations spanning a variety of industries. Regarding requests for tests, as Microsoft said, "they have chosen not to take such actions."**

2) **Their claims of dramatic throughput improvements are based on demonstrations that are, without additional information, effectively meaningless. Analysis of Roberson's demonstration results raise more questions than they answer**
   - **Even with unrealistically low client/AP density, aggregate channel throughput is < 50% of maximum 802.11n non-MIMO capacity. No information provided to explain why (intentionally limited via traffic generation software? Other users not part of demo? Low RSSI?)**
   - **For scenario with identical client/AP density, aggregate channel throughput for channels 1/6/11 was < 50% of TLPS channel. No information provided on RSSI for clients on each channel to objectively determine the reason for dramatic difference. For example, if TLPS clients were closer to AP than those for other channels, then TLPS capacity would obviously be higher, but this would not be a legitimate comparison**
   - **Was there a mix of MIMO and non-MIMO clients? If so, how were they allocated across channels? In one scenario, the aggregate channel throughput on TLPS was greater than the maximum possible 802.11n channel capacity assuming all non-MIMO clients. Were MIMO clients assigned to the TLPS channel while non-MIMO clients were assigned to the other channels? If so, this would not be a legitimate comparison**

3) **Their throughput benefit claims, while demonstrating not much more than simple math, are overstated due to their exclusion of freely available 5GHz channels. Using the scenario on the prior slide (which uses Roberson's methodology to "measure capacity gain"), compare the impact of adding TLPS vs. incrementally adding freely available 5GHz channels:**
   - Adding TLPS = Adding One 5GHz channel => weighted average client throughput ↑ 33%, and the Ch. 1/6/11 throughput/client ↑ 21%
   - Add Two 5 GHz channels => weighted average channel throughput ↑ 67%, and the Ch. 1/6/11 throughput/client ↑ 48-54%
   - Add Four 5 GHz channels => weighted average channel throughput ↑ 133%, and the Ch. 1/6/11 throughput/client ↑ 186-208%
   - Add Nine 5 GHz channels => weighted average channel throughput ↑ 300%, and the Ch. 1/6/11 throughput/client ↑ 3900% (only 1 client/AP here)
   - **THERE ARE *OVER TWENTY 5GHz CHANNELS AVAILABLE TODAY, NONE OF WHICH PRESENT ANY RISK TO EXISTING SERVICES LIKE BLUETOOTH, BLUETOOTH LOW ENERGY, OR 2.4GHz WI-FI***

AGENDA

1) Review of Globalstar's September 10, 2015 Filing

- Globalstar STILL provides no objective, quantitative test results regarding TLPS impact on Bluetooth and Bluetooth Low Energy
- Throughput demonstrations effectively meaningless given level of information provided

2) Controlled Testing Shows Increased Wi-Fi Ch.11 Interference from TLPS

3) Co-existence Filter Removal from Ruckus AP Raises Red Flags

- Publicly available data clearly shows hardware used in March Demo & OET emissions tests was modified
- Globalstar's prior claims that all Wi-Fi devices can be enabled for TLPS with a "firmware upgrade" are incorrect

4) Power level used in March Demonstration presented ~6dB lower interference to WiFi Ch. 11 than a Maximum Power real-world scenario

5) Gerst Capital Response to NPRM

IMPORTANT DISCLOSURES REGARDING SLIDES TITLED "WI-FI ADJACENT CHANNEL REJECTION TESTS SHOW INCREASED TLPS INTERFERENCE":

1. **Ixia takes no position in the Globalstar TLPS Proceeding. Ixia provided test tools, expertise on how to use those tools, and supporting hardware. Gerst Capital specified and directed the execution of all tests. Ixia expresses no opinion on the test results, nor the conclusions drawn by Gerst Capital.**

2. **Ixia is willing to work with any interested party to design and conduct testing relevant to the TLPS proposal.**

3. **Neither Gerst Capital nor Ixia compensated the other for any aspect of this testing, including travel, equipment, or personnel. Neither party has an investment in the other, nor do the parties have any financial relationship.**

WI-FI ADJACENT CHANNEL REJECTION TESTS SHOW INCREASED TLPS INTERFERENCE

Using Ixia's IxVeriWave[12] Platform, we conducted controlled testing to begin quantifying the impact of TLPS on Wi-Fi

Objectives

- **<u>Begin to quantify</u> the impact of adjacent channel interference for 22MHz channel spacing (11<>TLPS) vs. 25MHz spacing (1<>6 and 6<>11)**

- **Conduct "apples-to-apples" testing in a precisely controlled environment with simultaneous access to all statistics at the PHY, MAC, and Network layers.**

[12]See Attachments to Letter from Gerst Capital, LLC to Marlene H. Dortch, Secretary, FCC, IB Docket 13-213 (May 19, 2015).

WI-FI ADJACENT CHANNEL REJECTION TESTS SHOW INCREASED TLPS INTERFERENCE

Results Summary and Implications:

Results show that, under precisely-controlled, identical conditions:

1) **ACI-induced errors with 22MHz channel spacing is materially worse than 25MHz**
   - **At the "packet level", 22MHz spacing is ~3dB worse than 25MHz spacing**
   - **"Packet level" results generally consistent with analysis showing ACI/Desired Power ratio of 22MHz vs 25MHz is ~2x (3dB) higher**

2) **Severity of 22MHz packet errors is materially higher than 25MHz. Understanding the full system-level implications (i.e.: impact of different packet error types on different applications, different client hardware, etc.) requires more testing.**
   - **Non-Overlapping Channel Spacing of 25MHz: PER driven by least severe FCS errors. ACI test range *does not encounter most severe "Lost" packets*, and "*Malformed" packets remain under 5% for most of the ACI range***
   - **Wi-Fi Channel 11 <> TLPS Channel Spacing of 22MHz: Minimal FCS errors because of earlier, more severe, sources of packet loss. *Material "Lost" packets at upper ACI Levels*, *"Malformed" exceeds 5% for over 90% of the ACI range***

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FCC REPORT IMPLIES TESTING OF "OFF-THE-SHELF" RUCKUS HARDWARE

The sentence highlighted below gives parties to this proceeding the mistaken impression that Ruckus hardware tested by the OET is identical to commercially available hardware with the same FCC ID[13]. Simple engineering analysis illustrates this is not the case.

Access points use the same coexistence filter technology as those used in virtually every modern LTE-enabled smartphone. Parties to this proceeding should ask themselves why Globalstar STILL has not demonstrated TLPS operation on ANY modern smartphone. Their latest demonstration allegedly used an iPhone 4 which Part 15.247 data shows does not utilize a modern coexistence filter. If Apple can enable TLPS on an iPhone released over 5 years ago, they can certainly enable TLPS on a recent version such as the iPhone 6 and/or 6S.

1.1 Executive Summary

The primary purpose of this testing was to characterize the electromagnetic emissions profile of sample devices that Globalstar, Inc. (Globalstar) used in a recent demonstration of its proposed terrestrial low power service (TLPS) at the FCC Technology Experience Center.[1] The sample devices provided for these tests were manufactured by Ruckus Wireless and contained modular transmitters approved under Sections 15.247 and 15.407 of the Commission's rules.[2] The objective of this testing was to characterize the transmission profile of the devices; there was no intent or effort to perform comprehensive compliance testing.

Table 1 provides a list of the sample devices covered by this test report.

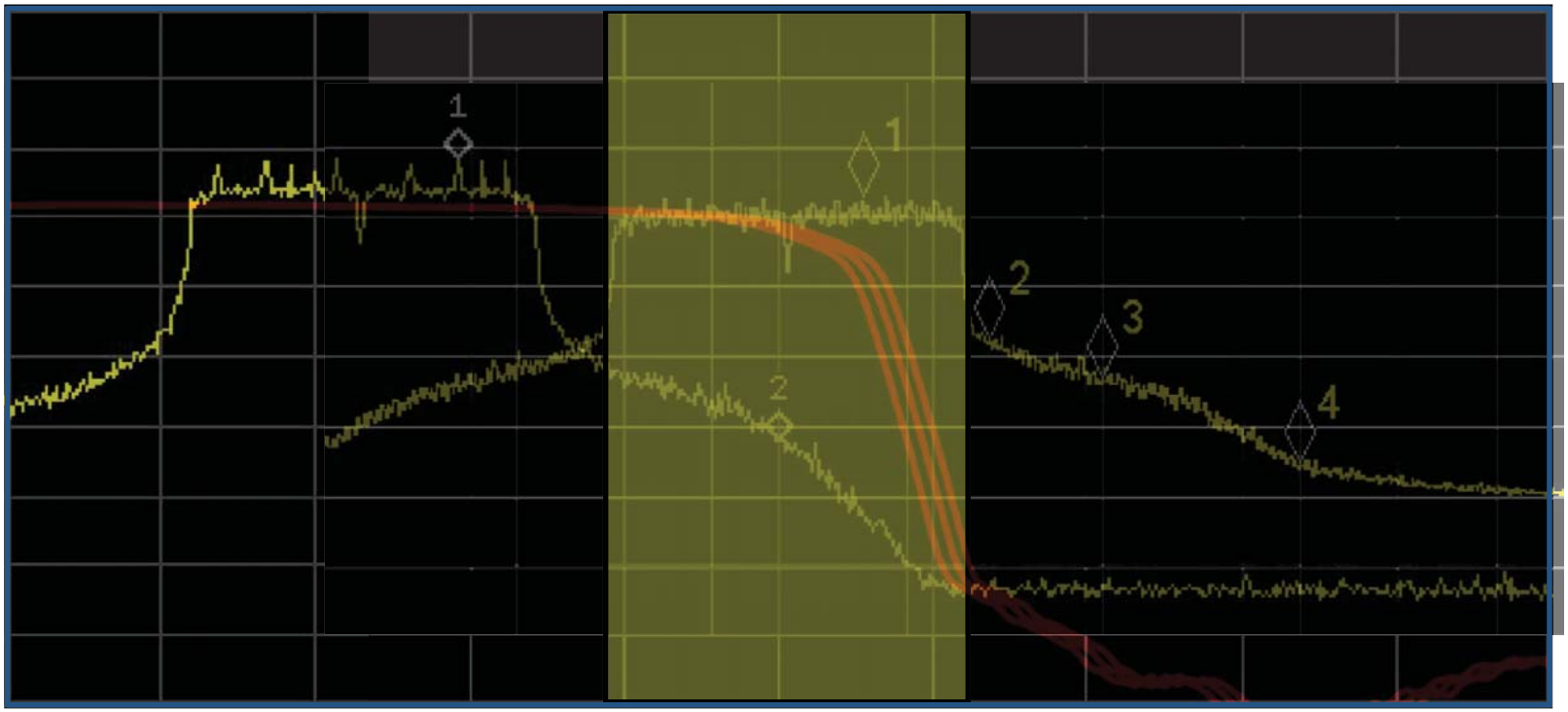
Test Type	Manufacturer	Model	FCC ID	Serial Number
Conducted	Ruckus Wireless	ZoneFlex 7982 AP	S9G-MPE2N33A, S9G-MPE5N33A	141403003812
Radiated	Ruckus Wireless	ZoneFlex 7982 AP	S9G-MPE2N33A, S9G-MPE5N33A	471473600229

Table 1 – Sample Device List (EUT)

[13]See report TR 15-1002, "ELECTROMAGNETIC EMISSIONS CHARACTERIZATION OF SAMPLES USED AT TLPS DEMONSTRATION", prepared by the FCC OET, Section 1.1 "Executive Summary", Page 8 (May 7, 2015)

COMPARATIVE ANALYSIS OF EMISSIONS DATA SHOWS TLPS HARDWARE WAS MODIFIED

Starting with Part 15.247 emissions data, overlay/align TR 15-1002 channel 14 data in frequency and power. Finally, overlay insertion loss profile of two popular coexistence filters (Avago ACPF-7124 & ACFF-1024 insertion loss profile show in RED at high, middle, and low operating temperatures).



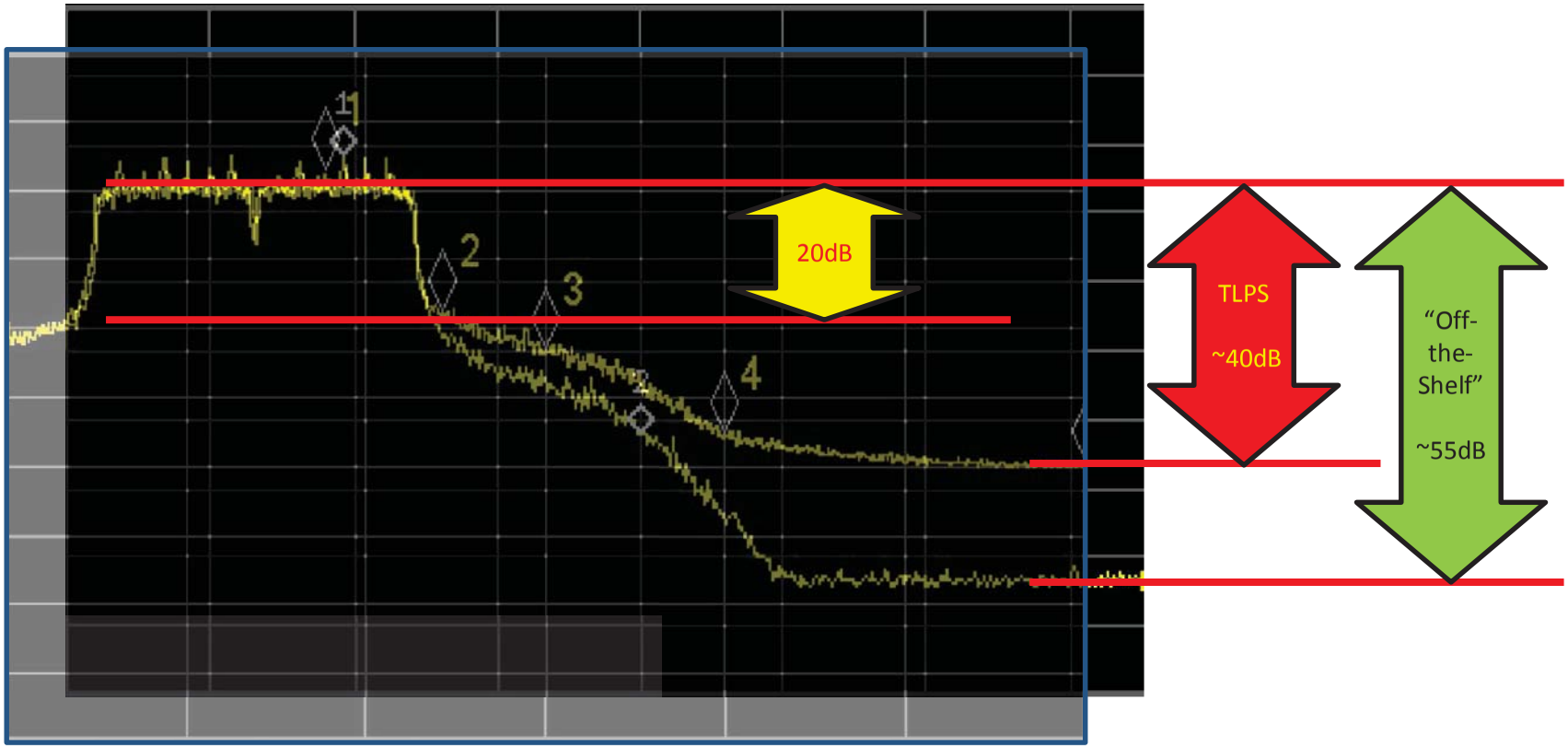
Emissions data for "off-the-shelf" Ruckus 7982 clearly indicates the presence of a coexistence filter

<u>Emissions data for Ruckus 7982 hardware used in TLPS demonstrations exhibits NO EFFECT FROM A COEXISTENCE FILTER</u>

COMPARATIVE ANALYSIS OF EMISSIONS DATA SHOWS TLPS HARDWARE WAS MODIFIED

Overlay & align emissions mask for Channel 11 from Part 15.247 & Channel 14 from TR 15-1002 with frequency and power axes to scale[14].

<u>"Off-the-Shelf" hardware exhibits >15dB additional out-of-channel attenuation vs. TLPS hardware.</u>



[14]Key spectrum analyzer settings are identical (RBW = 100kHz, VBW = 300kHz) in both reports, allowing for comparability after scaling axes.

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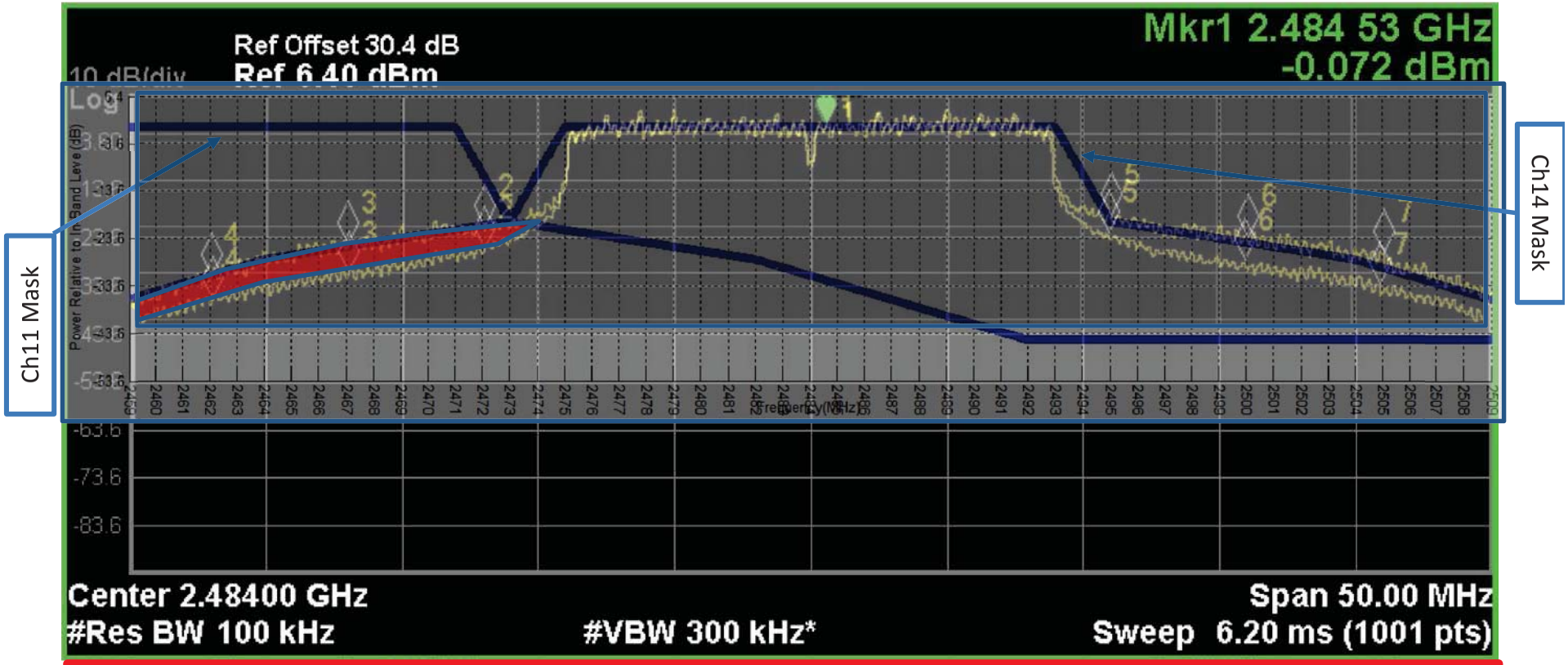
5) Gerst Capital Response to NPRM

Emissions Mask Overlay with TLPS AP Power at P0(Max Pwr) & P1(March Demo Pwr)



OET Emissions Report Data & Figures illustrate multiple issues:

- ***Setting the TLPS AP Power to P1 allowed Globalstar to reduce interference by ~6dB in Wi-Fi Channel 11 (red-shaded region). Using 3dB attenuators at antenna ports, Globalstar could have configured TLPS APs at Maximum Power, and still achieved the same effective radiated power seen in the March Demonstration***
- ***Reduced adjacent channel interference levels also favored Globalstar in Bluetooth<>TLPS Tests***
- ***If a high-end, expensive Access Point fails to meet IEEE and FCC[15] Emissions masks operating on TLPS, the FCC can NOT assume other "consumer grade" devices will meet these specs "by design".***

[15]Paragraph 28 of the NPRM Implies the Part 15.247(d) requirement for 20dB attenuation at 2483.5MHz would shift to 2495MHz for TLPS Devices

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5) Gerst Capital Response to NPRM

Response to NPRM:

- Paragraph 1: "..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.
  - Response: Information available in this proceeding's record is not sufficient to enable the commission to approve the proposed rule changes. To the contrary, multiple independent parties have provided the Commission information that demonstrates "detrimental impacts on unlicensed devices". In the absence of comprehensive system test results demonstrating "peaceful coexistence" between widely used unlicensed services and TLPS, the Commission should terminate this proceeding.

BT/BLE Interference

- Paragraph 3: "Channel 14 is unused by IEEE 802.11 devices today in the United States because such devices are not authorized to operate in frequencies above 2483.5 MHz. Globalstar argues that consumers could use their existing Wi-Fi enabled devices with wireless access points Globalstar plans to deploy if restrictions in radiofrequency (RF) software in the current devices are lifted by modifying the devices' software."
  - Response: Publicly available information cited in this filing and others proves this statement is not true for all devices. The analysis provided to the Commission on 5/14/15, 7/27/15 (some info. repeated here on Slides 18&19) proves Globalstar found it necessary to modify commercial hardware used in the March demonstration. Publicly available Part 15.247 test reports for a variety of client devices shows TLPS will, at best, be impaired for the majority of LTE-enabled client devices, and in certain cases (ex: iPhone 6) will not work at all. Ironically, Globalstar currently doesn't know which LTE-enabled devices will or will not work with TLPS since most "Tier 1" manufacturers do not disclose specifications for proprietary coexistence filters used in their devices. If the data in the Apple iPhone 6 Part 15.247 test report is any indication, it is possible the majority of popular smartphones are not capable of supporting TLPS operation at all. If a decision regarding TLPS rests on the assumption that all, or even the majority, of existing Wi-Fi devices will support unimpaired operation on TLPS via a "software upgrade", then publicly available evidence indicates the Commission should terminate this proceeding.

Coexistence Filter

Response to NPRM:

- Paragraph 16: "We believe that Globalstar's proposal to deploy a low-power terrestrial system in the 2473-2495 MHz band should be examined to determine whether it is possible to increase the use of this spectrum terrestrially in the near term, without causing harmful interference to users of this band and adjacent bands, and without compromising Globalstar's ability to provide substantial service to the public under its existing MSS authorization. …As a result, these changes may induce increased investment and innovation throughout the industry and ultimately improve competition and consumer choice…. We note that significant concerns have been raised about potential detrimental impact on unlicensed devices, such as Bluetooth, that are currently used extensively for various wireless broadband services and applications. We specifically seek further information and supporting detailed technical analysis regarding concerns with any potential detrimental impact on existing unlicensed devices in the 2400-2483.5 MHz band. We also seek comment on the results of testing of Globalstar's low-power mobile broadband network."
  - Response 1: Even with the limited testing done to date, the commission has evidence that TLPS will cause harmful interference to existing users of the unlicensed band. It is up to the Commission whether they will request additional technical information from Globalstar and/or opposition parties to gain a better understanding of how much harm TLPS will cause existing unlicensed services. We support the idea that the Commission should "strongly encourage more involvement by neutral and collaborative forums rather than by individual stakeholders", as suggested by the Hearing Industry Assocation[1]. However, if the Commission does not contemplate such a forum, and/or does not intend to require interested parties to provide information of sufficient depth and breadth necessary to further understand the technical risks posed by TLPS to existing unlicensed devices in the 2400-2483.5MHz band, then this proceeding should be terminated now.

  - Response 2: Contrary to the idea that "these changes may induce increased investment and innovation throughout the industry", it is conceivable TLPS impairments to Bluetooth (and BLE) and Wi-Fi could have the opposite effect. For example, if TLPS creates widespread quality problems for Bluetooth Low Energy devices, it will hinder/slow down investment in this rapidly growing area.

BT/BLE Interference

[1]*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), page 3.*

Response to NPRM:

- Paragraphs 21 & 22: "Globalstar argues that since Bluetooth devices are frequency-hopping systems that operate on constantly varying 1 megahertz channels throughout the 2400-2483.5 MHz band, the 2473-2483.5 MHz band segment represents just one small portion of the unlicensed spectrum that is utilized by Bluetooth technology and its low-power network is no more likely to cause harmful interference to a Bluetooth device than already existing IEEE 802.11-based Wi-Fi operations elsewhere in the 2400-2483.5 MHz band. Globalstar contends that Bluetooth devices and other unlicensed equipment will be able to coexist with its low-power network and continue to operate in the 2473-2483.5 MHz band, ***without any loss of spectrum for Bluetooth*** and other existing and future unlicensed technologies"
  - Response: Information presented here (Slide 3) and in an earlier filing[2] presents a straightforward analysis illustrating why the addition of TLPS to a high-traffic Wi-Fi environment (i.e.: three "busy" non-overlapping channels) will cause increased interference to Bluetooth and Bluetooth Low Energy devices. Furthermore, the Bluetooth SIG test cited on Slide 3 quantitatively proves the problem is real. If this test were somehow improperly designed or executed, it would be a simple matter for Globalstar to obtain the necessary devices and test equipment to provide a quantitative rebuttal. The combination of a simple analysis and simple tests prove TLPS creates harmful interference for, at least, Bluetooth Low Energy Hearing Aids. We believe this alone is reason enough for the Commission to terminate this proceeding now.

BT/BLE Interference

[2]*See Attachment to Letter from Gerst Capital, LLC to Marlene H. Dortch, Secretary, FCC, IB Docket 13-213 (April 14, 2015) "Analysis of Globalstar's TLPS Proposal", Slides 4-10.*

Response to NPRM:

- Paragraph 23: "We seek comment on any costs, in terms of impacts on unlicensed operations both in the 2473-2483.5 MHz band and below 2473 MHz (i.e., in the 2400-2473 MHz band) that might flow from Globalstar's proposed low-power terrestrial network. To the extent that any party asserts that Globalstar's low-power network may cause interference or substantially constrain other operations, we encourage the party to submit technical analyses detailing their concerns, as well as a detailed assessment of any associated costs."
  - Response: In regards to Wi-Fi, much of the focus has been on the negative impact on Channel 11, the channel closest to TLPS in the US. However, the information presented on Slides 7 & 8 of the July 27th filing[3] describes the potential for TLPS to have a negative impact on all Wi-Fi users on all channels in a scenario of co-located TLPS and non-TLPS deployments. We encourage the Commission to solicit input from industry to determine the extent of RRM/SON system usage in Wi-Fi networks, as well as the potential impact if such networks were co-located with a TLPS deployment.

[3]*See Attachment to Letter from Gerst Capital, LLC to Marlene H. Dortch, Secretary, FCC, IB Docket 13-213 (July 27, 2015) "Open Technical Issues Regarding Globalstar's TLPS Proposal", Slides 7 & 8.*

Response to NPRM:

- Paragraph 28: "... Section 15.247 specifies limits for unlicensed operations by digitally modulated communications equipment operating in the 2400-2483.5 MHz band. We believe it is appropriate to apply the same limits with respect to the 2483.5-2495 MHz band, given the nature of the proposed operations, including the use of digital modulation, and the widespread use of this limit in designing Part 15 devices. We seek comment on this proposal."
  - Response 1: Based on information presented in this filing and others, the Commission can not assume all Wi-Fi devices will support TLPS operation with a simple "software upgrade". If a device requires hardware modification (such as removal of a coexistence filter) to support TLPS, as did the Ruckus 7982 Access Points used in the March Demonstration, existing FCC rules require that device must go through Part 15.247 compliance testing again. Since coexistence filters have a significant impact on a device's emissions profile at the lower and upper portion of the 2400-2483.5Mhz band, removal of this filter may result in the modified devices failing compliance tests they had passed previously.

  - Response 2 : Given the likelihood a material percentage of existing and future Wi-Fi devices will not support TLPS due to the coexistence filter issue (or exhibit unpredictable impairments), it raises the question of whether there will be two distinct compliance test regimes (Part 15.247 and "TLPS-Compliant") . Furthermore, would a "TLPS-Compliant" device also need to pass the full set of 15.247 tests (namely the 2483.5MHz emissions limits while transmitting on Channel 11)?

  - Response 3: This paragraph implies the Part 15.247(d) test that effectively requires 20dB attenuation at 2483.5MHz (relative to the highest level in the desired channel) will be shifted to 2495MHz. Though not intended to be a comprehensive compliance test, information in the OET Emissions report indicates the modified Ruckus 7982 Access Point hardware used in the March demonstration would fail this test[4]. If the Commission allows this proceeding to continue, we ask that the commission a) publish the details of a proposed modified set of Part 15.247 tests to be used for TLPS-enabled devices, and b) require Ruckus to submit their TLPS-enabled hardware to an FCC-certified compliance tests lab and publish the test results to this proceeding. Given the single TLPS-capable device with publicly available emissions data appears to fail a critical emissions limit, it seems the Commission should require a test report from at least one client device to ensure "consumer grade" hardware is capable of meeting this difficult emissions requirement. Among others, parties with licensed spectrum starting at 2495MHz would likely have interest in these test results.

Coexistence Filter

[4] *See report TR 15-1002, "ELECTROMAGNETIC EMISSIONS CHARACTERIZATION OF SAMPLES USED AT TLPS DEMONSTRATION", prepared by the FCC OET (May 7, 2015), Figures 32, 35, 38, 41, 44, and 50. Compute the power difference between Marker 1 and Marker 5.*

Response to NPRM:

- Paragraph 29: "…Globalstar further argues that its access points and higher powered terminal devices will be equipped with high selectivity passband filters, which will further segregate Channel 14 operations from those on Channel 11. We seek comment on these concerns and claims."
  - Response: Globalstar has presented no material to backup their claim of "high selectivity passband filters which will further segregate Channel 14" resulting in a benefit to Wi-Fi Channel 11. Information presented in the July 27, 2015 filing[5] (Slides 10-15) presents controlled test results indicating the 22MHz channel spacing between Channels 11 and TLPS results in higher interference than the standard 25MHz non-overlapping channel spacing. The OET Emissions Test report for the modified Ruckus 7982 provides no support there is any additional filtering on the lower edge of Channel 14/TLPS (vs. the upper edge of Channel 14 or either edge of Channel 6). In fact, the only high selectivity bandpass filter (the coexistence filter) was REMOVED for the TLPS-enabled version of the Ruckus Access Point.

Adjacent Channel Interference With Wi-Fi Ch. 11

Coexistence Filter

[5]*See Attachment to Letter from Gerst Capital, LLC to Marlene H. Dortch, Secretary, FCC, IB Docket 13-213 (July 27, 2015) "Open Technical Issues Regarding Globalstar's TLPS Proposal", Slides 10-15.*

Response to NPRM:

- Paragraph 30: "We seek comment on the appropriate limit for unwanted emissions below 2473 MHz resulting from Globalstar's proposed low-power operations at 2473-2495 MHz. One possible limit is specified in Section 15.247(d) of the Commission's rules. That rule, applicable to spread spectrum or digital modulation systems operating in the 2400-2483.5 MHz band, specifies that in any 100 kilohertz bandwidth outside the frequency band in which a device is operating, the unwanted emissions shall be at least 20 dB below the fundamental power in the 100 kilohertz bandwidth within the band that contains the highest level of desired power. We recognize that unlicensed use of IEEE 802.11 Channel 11 (2451-2473 MHz) is directly adjacent to Channel 14 (2473-2495 MHz) with no guard band between these two channels, and as pointed out by Globalstar, the overwhelming majority of IEEE 802.11 access points operate on non-overlapping Channels1, 6, and 11.82 In light of this, <u>we seek comment on whether the current unwanted emissions limit provided in Section 15.247(d) is compatible with systems operating below 2473 MHz from Globalstar's proposed operations at 2473-2495 MHz. If this limit is not appropriate, we seek comment on an appropriate limit.83 Parties proposing such an emission limit should provide technical analyses and/or studies adequate to demonstrate that their proposed limit is appropriate</u>.
  - Response: Information provided on July 27th (Slides 10-15)[6] and in earlier filings points to increased interference on Channel 11 in the presence of TLPS. Coming up with an emissions limit that sufficiently protects operations of Wi-Fi Channel 11 while not being overly conservative requires further testing. The current level of testing and analysis is insufficient for any party to technically justify whether the Part 15.247(d) limit of 20dB is sufficient. If possible, the Commission should require "both sides" to come together and devise a comprehensive test plan that would address this issue and many others.

Adjacent Channel Interference With Wi-Fi Ch. 11

[6] *See Attachment to Letter from Gerst Capital, LLC to Marlene H. Dortch, Secretary, FCC, IB Docket 13-213 (July 27, 2015) "Open Technical Issues Regarding Globalstar's TLPS Proposal", Slides 10-15.*

Response to NPRM:

- Paragraph 41: "The Wi-Fi Alliance requests that the Commission consider revising the band-edge restriction and unwanted emissions limits specified in Sections 15.205 and 15.209, respectively, to enable the use of Channels 12 and 13 by Wi-Fi and other unlicensed devices, provided that use does not interfere with Globalstar's licensed low-power ATC operations in the upper portion of Channel 14, i.e., in the 2483.5-2495 MHz band. Globalstar indicated that it does not object to seeking comment on this issue, but notes that the limits are necessary in order to protect MSS in the 2483.5-2495 MHz band, and that it is fully committed to maintaining that service. Accordingly, we seek comment on this issue. Would relaxation of the limits in order to enable use of Channels 12 and 13 degrade MSS capabilities, particularly if those capabilities are not deployed on the same managed basis as Globalstar contemplates for its operations in Channel 14?"
  - Response: In considering this idea, it is important the Commission consider the implications for Bluetooth and Bluetooth Low Energy devices. In making any decision regarding the addition of Channels 12, 13, and/or TLPS, the Commission should consider the impact on the number of "free" Bluetooth channels assuming a maximum number of non-overlapping channels are in moderate-to-heavy use. The analysis provided on Slide 4 shows any combination of three non-overlapping (25MHz spacing) channels spread among Channels 1-13 allows for 22-23 "free" Bluetooth channels. While adding TLPS results in a fourth "non-overlapping" Wi-Fi channel (though spaced at 22MHz, not 25MHz), it reduces the number of "free" Bluetooth channels by 27%. It should also be noted most modern Wi-Fi devices support operation in both the 2.4GHz band as well as the 5GHz band. If we include the (maximum possible) 23 non-overlapping 5GHz channels, Wi-Fi users have a total of 26 channels to choose from. Adding TLPS results in about a 4% capacity addition (as opposed a 33% increase assuming only 2.4GHz). In contrast, Bluetooth can ONLY operate in the 2.4GHz band. Given the current usage patterns, the addition of a fourth "non-overlapping" channel in the form of TLPS results in substantially reduced Bluetooth and Bluetooth Low Energy channels, and as the test cited on Slide 3 shows, impaired performance.

BT/BLE Interference

Dramatic Throughput Claims from Globalstar's 9/10/15 Filing

Response to NPRM:

- Paragraph 44: "Globalstar maintains that Wi-Fi enabled devices can be upgraded through software based modification. We seek comment on requiring applicants for certification of certain equipment that operates in the 2483.5-2495 MHz band to provide evidence of Globalstar's consent to the applicant's request for equipment certification. Specifically, we propose limiting this requirement to equipment that operates in the 2483.5-2495 MHz band that is used as a network access point and that will operate as a master device as defined in Section 15.202 of the rules, since the master device in a system controls the frequencies on which other devices in the system (client or end user terminal devices) can operate.121 We therefore do not believe a requirement to obtain Globalstar's consent is necessary for the certification of devices that operate exclusively as a client to a master device. We seek comment on this approach. Globalstar expects that network access points operating in the 2483.5-2495 MHz band would be new devices. We believe that requiring this additional step would not place a significant burden on the device manufacturers. We seek comment on this proposal.
  - Response: Given evidence from publicly available Part 15.247 reports, the OET Emissions report, and analysis of publicly available coexistence filter specifications, it is clear that not all "Wi-Fi enabled devices can be upgraded through software based modification". Slides 17-20 from the July 27th filing[7] illustrate that Globalstar even had to modify the Ruckus Access Points used in the March demonstration to allow for unimpaired operation of TLPS. Prior analysis indicates most, if not all, LTE-enabled devices will suffer impairments when attempting to operate on the TLPS channel (with variations in levels of impairment within the same make/model, and even within the same device over the course of a day)[8]. Analysis also indicates at least one popular smartphone (iPhone 6) will almost certainly not operate at all on TLPS. We believe the revelation that not all devices will work with TLPS via a "software based modification", still not publicly acknowledged by Globalstar, has implications for Equipment Certification. We believe TLPS-enabled devices should be required to pass a modified set of Part 15.247 compliance tests to assure devices (especially those that required modifications from original Wi-Fi designs) meet emissions requirements both above and below the TLPS range. We request the Commission provide further details in terms of specific modifications to Part 15.247 for TLPS devices.

Coexistence Filter

[7] *See Attachment to Letter from Gerst Capital, LLC to Marlene H. Dortch, Secretary, FCC, IB Docket 13-213 (July 27, 2015) "Open Technical Issues Regarding Globalstar's TLPS Proposal", Slides 17-20.*

[8] *See Attachments to Letter from Gerst Capital, LLC to Marlene H. Dortch, Secretary, FCC, IB Docket 13-213 (March 10, 2015).*

Response to NPRM:

- Paragraph 46: "We seek comment on the capability of existing Part 15 devices to be modified through software directly provided by Globalstar to use the 2473-2495 MHz frequency band with the transmission format that Globalstar proposes. In particular, we seek comment on whether the currently deployed devices have the hardware capability to operate in the additional frequency band with the Globalstar proposed protocol. We also seek comment on whether existing devices could be modified though over-the-air software changes, or whether changes to the devices' firmware would be necessary. We also seek comment on the means that Globalstar plans to use to control the availability of software updates and prevent unauthorized modifications to certified equipment. We seek further comment on how Globalstar will limit operation of equipment to parties that are authorized to use its spectrum, and also how we would ensure that the modified devices would be compliant with the proposed rules."
  - Response: See prior comments regarding how coexistence filters in LTE-enabled client devices and some access points (such as the commercial version of the Ruckus 7982) will impair, if not prevent, TLPS operation. Given the unknowns created by this situation (variability of impairments within the same make/model, and even within a given device over different temperatures), the only practical solution is that every TLPS-capable device go through a modified version of Part 15.247 compliance tests (plus other tests motioned). If Globalstar proposes TLPS be enabled on any device containing a coexistence filter, tests should account for manufacturing variances and temperature effects on the filter. Based on analysis[9], widely used coexistence filters begin attenuating the signal well within the TLPS frequency range, and due to "temperature motion", the impact on TLPS operation will vary even within a given device. Combining this with manufacturing variability, it is entirely possible a single sample from a given make/model operates successfully on TLPS and passes all compliance tests. However, if there is not sufficient margin, other samples of that same make/model may exhibit widely varying impairments while on the TLPS channel, ranging from severe distance limitations to non-operation. It seems the Commission will need to take this into account when thinking about consumer protection.

Coexistence Filter

[9] *See first attachment to Letter from Gerst Capital, LLC to Marlene H. Dortch, Secretary, FCC, IB Docket 13-213 (March 10, 2015), "Even if Approved, Globalstar's TLPS Will Underperform Free Wi-Fi On (Tens Of) Millions of Existing Devices".*

Response to NPRM:

- Paragraph 47: "….If the client devices can be modified by over-the-air software upgrades by Globalstar, how should such change be classified under our current rules and which party should be held responsible for compliance of the devices?"
  - Response: See response to paragraph 46. Given the uncertainties described earlier, we believe the Commission should require a new grant of certification and a new FCC ID for all TLPS-enabled devices, or at minimum, those known to have coexistence filters.

Coexistence Filter

Supporting Links:

- Link to IEEE 802.11-2012 Specification: https://standards.ieee.org/findstds/standard/802.11-2012.html
  - Click on “Access via the IEEE Get Program”, enter “User Type” and “Email Address” and click “ACCEPT”

- Link containing explanation of different “clause numbers” of 802.12-2012 and changes from 802.11-2007: http://blogs.aerohive.com/blog/the-wi-fi-security-blog/why-did-80211-2012-renumber-clauses

- Links regarding Ixia:
  - http://ixiacom.com/
  - http://www.ixiacom.com/products/ixveriwave