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April 14, 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 April 14th, 2015, I met with Ronald Repasi, Bruce Romano, Mark Settle, Patrick Forster, Rashmi Doshi, Chad Beattie, Reza Biazaran of the Office of Engineering Technology (OET); and Mindel De La Torre, Troy Tanner, Jennifer Gilsenan, Lynne Montgomery, Jose Albuquerque, and Karl Kensinger of the International Bureau (IB). I presented the attached slides and invited the Commission to conduct their own diligence on the technical issues I've identified. I stated my belief the analysis stands on its own, and while it doesn't answer exactly what will happen under realistic traffic loading, it clearly proves "something will happen". Under a benign channel capacity scenario (single "MCS7 User" @ 3.75MBps), Bluetooth SIG test statistics showed TLPS caused a material increase in packet error rates for Bluetooth and Bluetooth LE. I stated that, if anything, the Bluetooth SIG's test statistics imply my analysis of "Bit Impairment Rate" is conservative, and that the severity of impact on Bluetooth's usability remains unknown without thorough system testing.

I also proposed a test strategy that would ultimately produce the level of technical information necessary for the Commission to make a final, informed decision regarding Globalstar's TLPS proposal.

I raised two additional issues: 1) Whether Globalstar's lack of a plan to finish their "Gen2" satellite network is at odds with requirements in the NPRM, and 2) If TLPS were approved, whether Globalstar would be allowed to deploy something other than an 802.11-based system. The TLPS proposal entails giving Globalstar not only the use of their own licensed spectrum for terrestrial purposes, but also the unlicensed region from 2473-2483.4MHz. If Globalstar ultimately chose a non-802.11 technology covering this portion of the unlicensed band, it would impact existing unlicensed technologies differently than TLPS as currently proposed. In essence, Globalstar would have gained approval under one set of technical assumptions (802.11-based), while deploying a technology that might have an even more detrimental effect on technologies like Bluetooth and Wi-Fi. For this reason, I requested the Commission consider changing the NPRM to restrict TLPS to be based on 802.11 technology.

After my meeting with members of the OET and IB, I met individually with the following members of the Commissioners' staff:

Renee Gregory – Legal Advisor (Engr. and Tech., Wireless, & Incentive Auction) to Chairman Wheeler
Louis Peraertz – Senior Legal Advisor (Wireless, International, & Public Safety) to Comm'r Clyburn
Priscilla Argeris – Senior Legal Advisor (Wireless, International, & Public Safety) to Comm'r Rosenworcel
Brendan Carr – Legal Advisor (Wireless, Public Safety, and International) to Comm'r Pai
Erin McGrath – Legal Advisor (Wireless, Public Safety, and International) to Comm'r O'Rielly

In each meeting, we reviewed the same set of attached slides and discussed many of the same issues. In order to illustrate a "real world" Wi-Fi traffic environment for (4 of 5) Commissioners' staff members, I ran a free "wireless sniffer" software program (Acrylic Wi-Fi) on my laptop. The last two attached figures are screenshots taken from two locations on the 8th floor of the FCC building (Lobby and Conference Room 2). While reviewing presentation slides 5&6, I explained that the FCC's "real world" Wi-Fi deployment on the 8th floor would have resulted in an even worse impact of TLPS on Bluetooth and Bluetooth LE than the assumptions given in my presentation. I showed that, in addition to access points

operating on Channels 1, 6, and 11 (as in my slides), the FCC's 8th floor had devices transmitting on Channels 2, 3 and 10 as well. If TLPS were deployed on the 8th floor of the FCC building, I explained the number of "free" Bluetooth channels would drop from nine to three (a 66% decrease).

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: Renee Gregory
Louis Peraertz
Priscilla Argeris
Erin McGrath
Brendan Carr
Julius Knapp
Mindel De La Torre
Ronald Repasi
Bruce Romano
Mark Settle
Patrick Forster
Troy Tanner
Jennifer Gilsenan
Lynne Montgomery
Rashmi Doshi
Chad Beattie
Reza Biazaran
Jose Albuquerque
Karl Kensinger

Analysis of Globalstar's TLPS Proposal

Presented to Members of the:

International Bureau

Office of Engineering Technology

Wireless Telecommunications Bureau

Presented to Staff Members of:

Chairman Wheeler

Commissioners Clyburn, Rosenworcel, Pai, & O'Rielly

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AGENDA

Four Technical Facts Regarding TLPS Proposal

1) TLPS Will Increase Co-Channel Interference with Bluetooth
2) Wi-Fi has an outlet for 2.4GHz congestion (5GHz), Bluetooth Does Not
3) TLPS Will Increase Adjacent-Channel Interference for Wi-Fi Channel 11
4) Devices with Coexistence Filters will Impair TLPS

Proposed Test Strategy

- Require Input, Review, and Justification from key Interested Parties
- Transparent, technically thorough tests
- Low-cost, limited-duration tests will provide necessary data for FCC decision

AGENDA: TIME PERMITTING

Beyond TLPS, What are Globalstar's Plans?

- 25% of Globalstar's Mobile Satellite Service (MSS) constellation is at or near the end of demonstrated life
- Globalstar's recent SEC filings imply no plans to finish the "Gen2" satellite deployment
- If approved, would Globalstar deploy TLPS, or market to carriers for LTE-U/LAA?
- Does NPRM account for the possibility of Globalstar deploying something other than an 802.11-based system?
- LTE-U/LAA Interference with Bluetooth and "Free Wi-Fi" is potentially worse than TLPS

Fact #1:TLPS will increase Co-Channel Interference with Bluetooth

- **Co-Channel Interference Occurs when two or more users attempt to use the <u>same frequency</u> at the <u>same time</u>[1]**

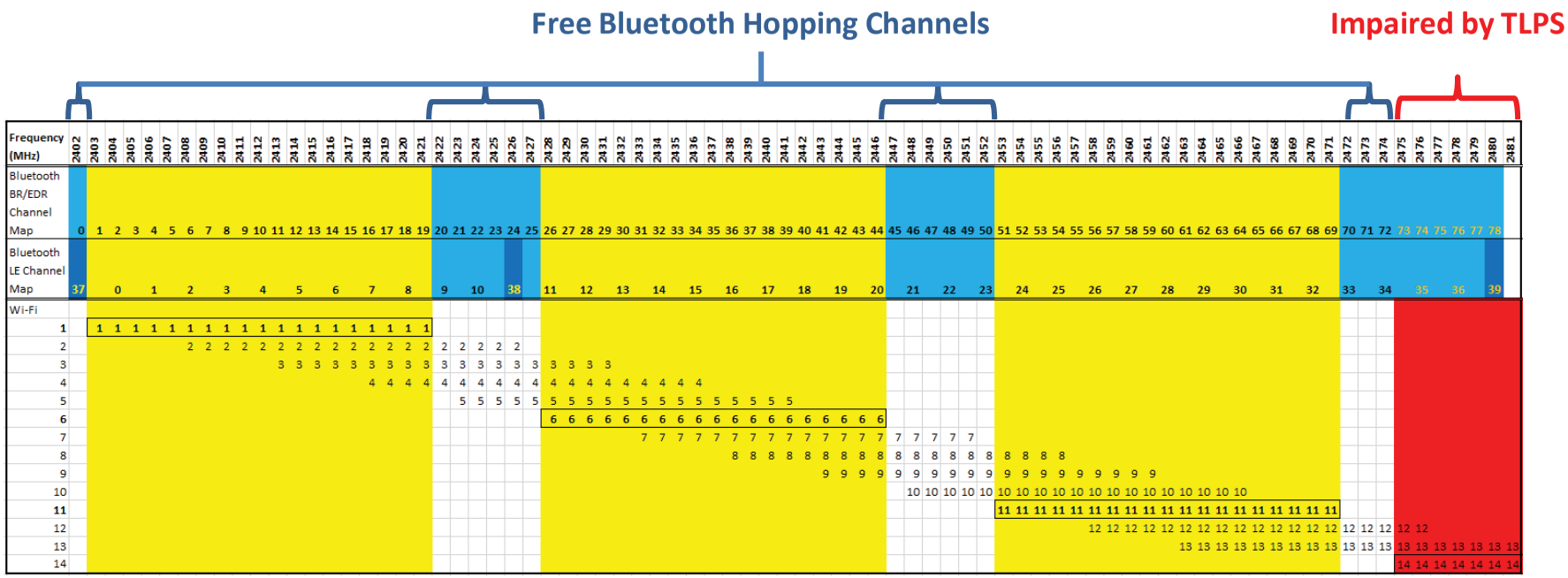
- **Requires analysis in "Frequency Domain" AND "Time Domain"**

  Globalstar's TLPS<>Bluetooth demonstrations emphasized the frequency domain, while deemphasizing the time domain with a low traffic scenario

- **TLPS will increase co-channel interference with Bluetooth, regardless of assumed Wi-Fi Traffic Scenario**

[1]With the exception of CDMA-based modulation schemes which are not applicable to the TLPS Proposal

TLPS will materially increase Bluetooth BR/EDR error rates

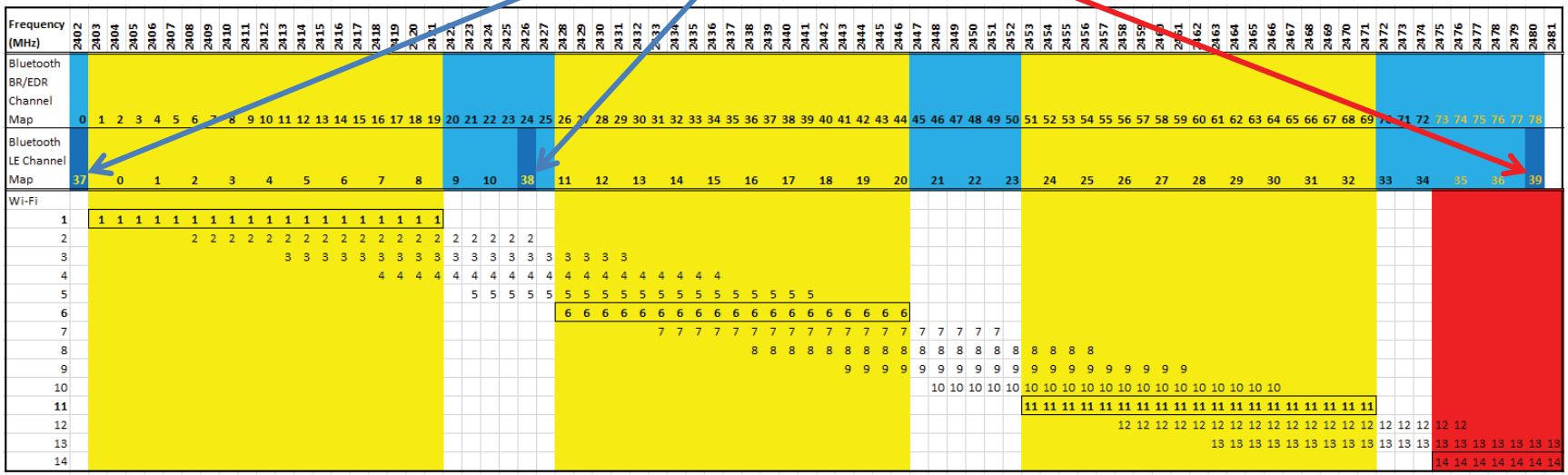


- **TLPS decreases Bluetooth's free hopping channels from 22 to 16 (assume Wi-Fi traffic on 1/6/11). Bluetooth specification requires minimum of 20**

- **With TLPS, 4 of the minimum 20 (20%) Bluetooth BR/EDR hopping channels will be "busy". All else equal, TLPS guarantees Bluetooth bit errors where none existed before**

TLPS impact on Bluetooth Low Energy is even worse…

TLPS impairs 1/3rd of BLE's advertising channels (37,38,39)



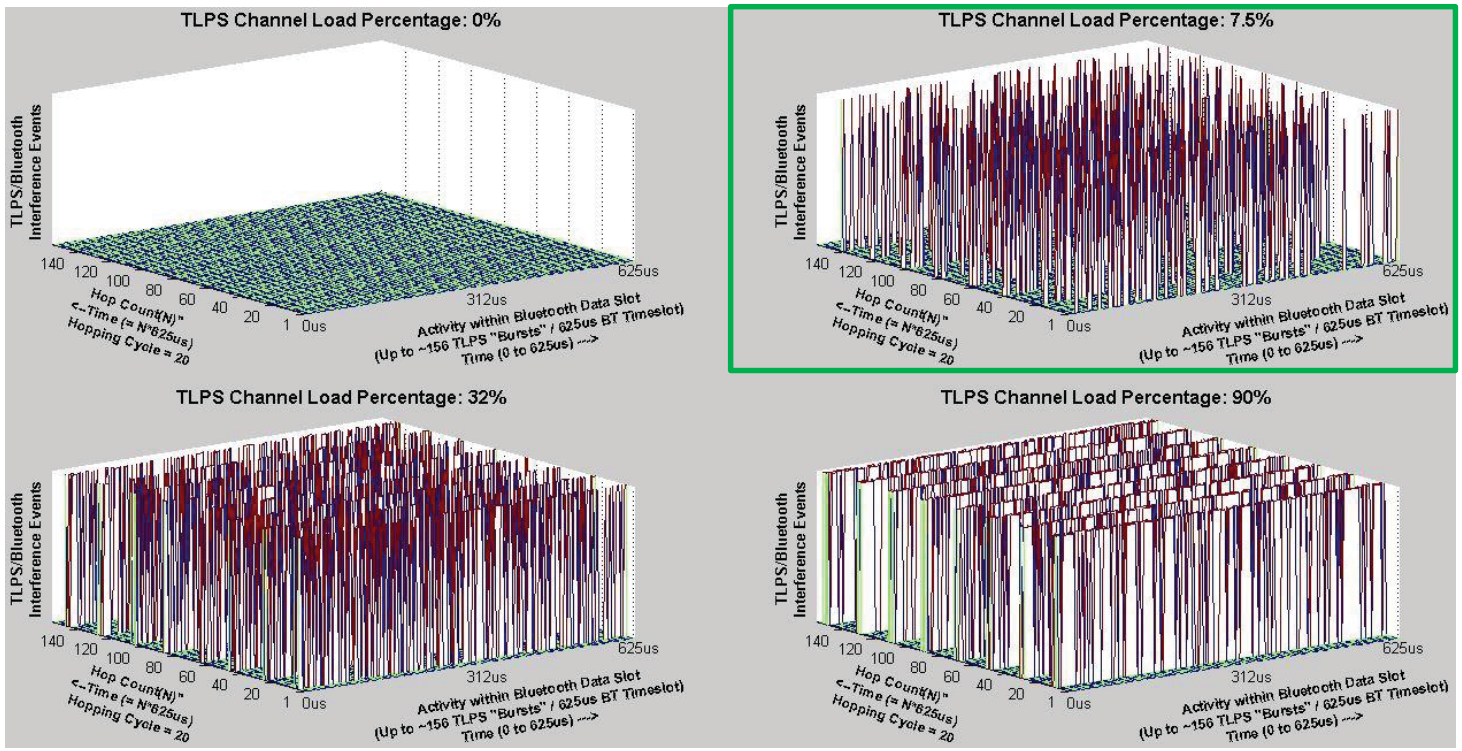
Advertising Channels are Critical to the Overall Operation of BLE

33% of BLE Advertising Channels Impaired by TLPS
VS.
20% of Bluetooth BR/EDR Channels Impaired by TLPS

TIME DOMAIN

TLPS % Channel Loading drives TLPS<>Bluetooth Co-Channel interference

Guaranteed Bluetooth bit errors from BT<>TLPS "Interference Events"



Each spike represents the impairment of ~3.2 Bluetooth bits

TIME DOMAIN

We can estimate the Bluetooth BR "Bit Impairment Rate" (BIR) caused by BT<>TLPS Interference Events

Assuming a single Bluetooth BR Device streaming data at the maximum 1MBps, the "Bit Impairment Rate" can be estimated as:

$$\cong \frac{BT\ Slots\ Imp.\ by\ TLPS(4)}{BT\ Spec'd\ Min\ Hops(20)} \times \frac{802.11n\ Data\ Time(3.2\mu s)}{802.11n\ Time\ slot(4.0\mu s)} \times \%\ TLPS\ Channel\ Load$$

Impairment effect worsens as Bluetooth rate drops below maximum. All else equal, the same level of "impairment/interference events" are spread over a lower volume of transmitted bits

For 802.11n HT20 (800 ns Guard Interval), "Bit Impairment Rate" simplifies to:

$$\cong 20\% \times 80\% \times \%\ TLPS\ Channel\ Load = 16\% \times \%\ TLPS\ Channel\ Load$$

Bluetooth bit impairment rate is driven by more than a single-user's throughput rate

Single User Summary Data

BT "Bit Impairment Rate" with TLPS<>Bluetooth Co-Channel Interference VS. 802.11n HT20 Channel Capacity VS. *Single User* Throughput

	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
Receive Sensitivity (dBm)	-82	-79	-77	-74	-70	-66	-65	-64
Data Bits/Wi-Fi Time slot	26	52	78	104	156	208	234	260
Wi-Fi PHY Capacity(MBps)	6.5	13.0	19.5	26.0	39.0	52.0	58.5	65.0
TCP-Level Capacity(MBps)[1]	5.0	10.0	15.0	20.0	30.0	40.0	45.0	50.0
Single User's TCP-Level Throughput (MBps)								
1.00	3.2%	1.6%	1.1%	0.8%	0.5%	0.4%	0.4%	0.3%
3.75	12.0%	6.0%	4.0%	3.0%	2.0%	1.5%	1.3%	1.2%
11.25	N/A	N/A	12.0%	9.0%	6.0%	4.5%	4.0%	3.6%
18.75	N/A	N/A	N/A	15.0%	10.0%	7.5%	6.7%	6.0%
26.25	N/A	N/A	N/A	N/A	14.0%	10.5%	9.3%	8.4%

[1]Assume TCP/PHY Rate = ~77% Per TLPS Demo

Globalstar & BT SIG TLPS<>BT Demonstrations

Single user @3.75MBps Throughput with 50MBps TCP-Level capacity

Total Bit Impairment Rate Driven by

SUM of Individual Users' TLPS % Channel Loading

- **1 "MCS0" User @ 3.75MBps BIR = 10 "MCS7" Users @ 3.75MBps BIR = 12% BIR**
- **4 "MCS2" Users @ 3.75MBps BIR = 40 "MCS5" Users @ 1MBps BIR = 16% BIR**

Fact #2: When 2.4GHz is congested, Wi-Fi has an outlet (5GHz), Bluetooth does not

- **Congestion in 2.4GHz is the very reason Globalstar claims TLPS is necessary. Yet this same congestion is what impairs Bluetooth when TLPS is present**

- **Wi-Fi users have a simple solution: Use 5GHz**
  - **Corporate/Enterprise Wi-Fi deployments are rapidly transitioning to 5GHz**
  - **Awareness among home and small business users is increasing**

- **Bluetooth has no such option**

Fact #3: TLPS will increase adjacent channel interference for Wi-Fi Channel 11

"Free Wi-Fi" Channel Spacing vs. Adjacent-Channel Interference has been studied extensively.
Not so for TLPS & Channel 11

25 MHz

Both channels operate at maximum capacity (Ch1<>Ch6, Ch6<>Ch11)

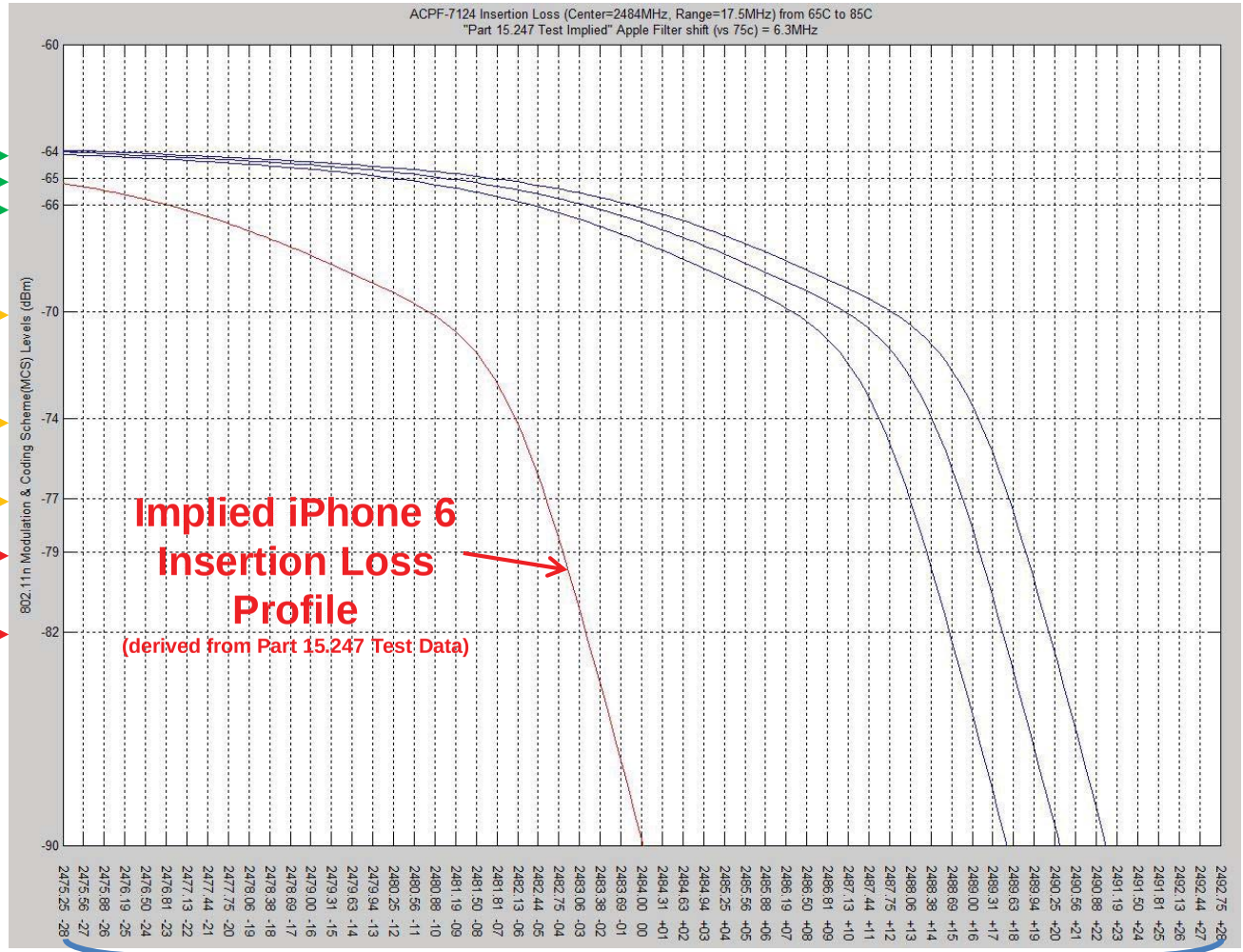
22 MHz ?

There are no controlled, quantitative studies to determine the impact of 22MHz channel spacing (Ch11<>Ch14/TLPS)

20 MHz

Both channels operate materially below capacity (Ch1<>Ch5,Ch7<>Ch11,etc.)

Fact #4: Devices with co-existence filters will impair TLPS



MCS7 (65.0 MBps)
MCS6 (58.5 MBps)
MCS5 (52.0 MBps)
MCS4 (39.0 MBps)
MCS3 (26.0 MBps)
MCS2 (19.5 MBps)
MCS1 (13.0 MBps)
MCS0 (6.5 MBps)

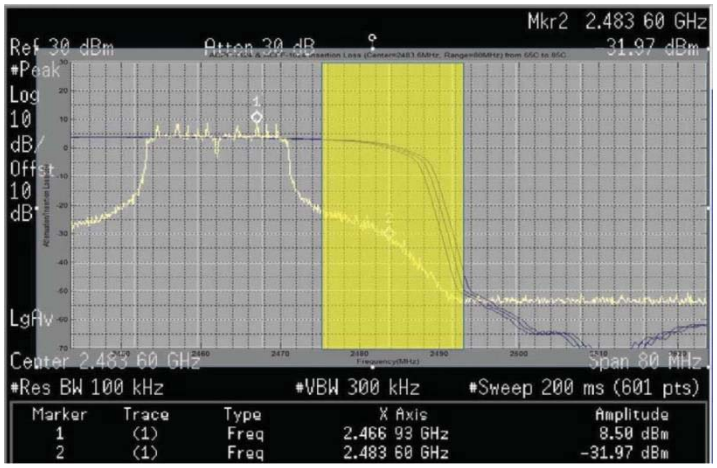
Avago ACPF-7124 Coexistence Filter Insertion Loss Profile Overlaid with 802.11n MCS Levels

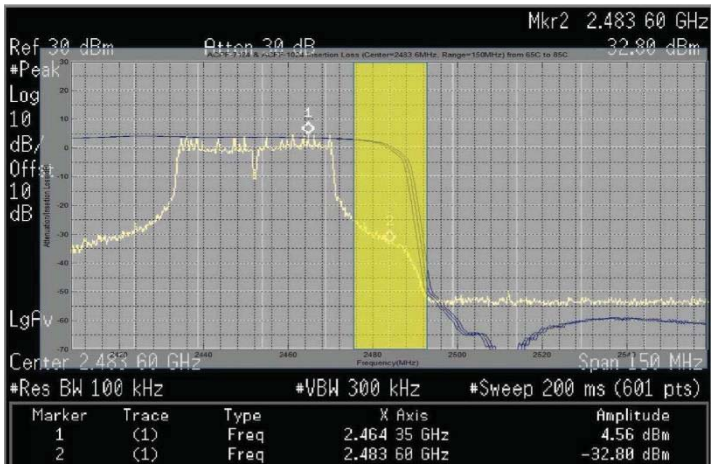
Frequency Axis Aligned with 802.11n HT20 Sub-Carriers on Channel 14/TLPS

Without emissions test data, we have no idea which LTE-Enabled devices will work on TLPS

- No Part 15 (or “Part 15 like”) test results have been published for any device configured for 802.11n HT20 on Channel 14/TLPS
- Due to propriety coexistence filter designs, no one knows which make/model of devices will work on TLPS. What are implications for equipment certification?
- The same filter technology is used in both APs and Client devices. If the coexistence filter causes problems for the Access Point, it will cause problems for Client devices as well
- Understanding whether the Ruckus 7982 AP was modified for TLPS demonstrations (and/or field trials) is material to Globalstar’s claims

Ruckus 7982 Part 15.247 tests imply co-existence filter





"Demonstrations" are inadequate. Rigorous testing required for an informed decision

Proposed Test Strategy

- **Require Interested Parties (Globalstar, Bluetooth SIG, NCTA, Wi-Fi Alliance, etc.) to develop a TLPS System Test plan**
  - Specifics of test equipment, test cases & procedures jointly developed
  - FCC Engineers arbitrate disputes
  - With appropriate expertise and focus, a reasonably thorough, yet concise, plan could be developed in weeks
  - Quantifying and characterizing key technical issues does not require field testing
- **Require Interested Parties to agree on, and contract with, independent test laboratory to execute the TLPS System Test plan**
- **Results of independently executed test plan will provide FCC technical staff and policy makers the necessary level of information to make an informed decision regarding the TLPS proposal**

Technology Demonstrations vs. System Testing

From Wikipedia entry for "Technology Demonstration":

A technology demonstration or Demonstrator model is a prototype, rough example or an otherwise incomplete version of a conceivable product or future system, put together as proof of concept with the primary purpose of showcasing the possible applications, feasibility, performance and method of an idea for a new technology. They can be used as demonstrations to the investors, partners, journalists or even to potential customers in order to convince them of the viability of the chosen approach, or to test them on ordinary users.

From Wikipedia entry for "System Testing":

System testing is performed on the entire system in the context of a Functional Requirement Specification(s) (FRS) and/or a System Requirement Specification (SRS). System testing tests not only the design, but also the behaviour and even the believed expectations of the customer. It is also intended to test up to and beyond the bounds defined in the software/hardware requirements specification(s)

Assuming TLPS is based on the most advanced version of Wi-Fi at 2.4GHz, the implied "software/hardware requirements specifications" for TLPS are the 802.11n HT20 specifications

Globalstar's MSS Constellation is composed of 24 "Gen2" + 8 "Gen1" satellites

- Though they originally planned to build a fleet of 48 "Gen2" satellites, Globalstar only ended up launching 24, plus a "ground spare"
- Globalstar's filings from 2006 through 2009 imply the estimated life of "Gen1" satellites turned out to be ~6-8 years
- Due to impaired service quality, Globalstar was forced to launch 8 "Gen1" satellites in 2007, prior to the availability of their "Gen2" satellites
  - The four launched in May 2007 will be 8 years old in May 2015
  - The four launched in October 2007 will be 8 years old in October 2015
- Historical data implies the 8 "Gen1" satellites could begin failing (if they haven't started already) in the coming year
- What happens to service quality if/when 25% of the current MSS constellation is impaired?

Latest 10-K filing implies Globalstar has no plans to replace the 25% of their constellation that, according to historical data, may begin failing anytime.

Risks Related to Our Business

The implementation of our business plan and our ability to generate income from operations assume we are able to maintain a healthy constellation and ground network, and products and services capable of providing commercially acceptable levels of coverage and service quality, which are contingent on a number of factors.

Our products and services are subject to the risks inherent in a large-scale, complex telecommunications system employing advanced technology. Any disruption to our satellites, services, information systems or telecommunications infrastructure could result in the inability of our customers to receive our services for an indeterminate period of time.

Since we launched our first satellites in the 1990's, some first-generation satellites have failed in orbit and have been retired, and we expect others to fail in the future. Although we designed our second-generation satellites to provide commercial service over a 15-year life, we can provide no assurance as to whether any or all of them will continue in operation for their full 15-year design life. Further, our satellites may experience temporary outages or otherwise may not be fully functioning at any given time. There are some remote tools we use to remedy certain types of problems affecting the performance of our satellites, but the physical repair of satellites in space is not feasible. We do not insure our satellites against in-orbit failures after an initial period of six months, whether the failures are caused by internal or external factors.

Prior to 2014 our ability to generate revenue and cash flow was impacted adversely by our inability to offer commercially acceptable levels of Duplex service due to the degradation of our first-generation constellation. As a result, we improved the design of our second-generation constellation to last twice as long in space, have 40% greater capacity and be built at a significantly lower cost as compared to our first-generation constellation. Anomalies with our satellites have and may continue to develop that could affect their ability to remain in commercial service, and we cannot guarantee that we could successfully develop and implement a solution to these anomalies.

We initially designed our ground stations to operate with our first-generation satellites. These ground stations will require upgrades to enable us to integrate the technology and service offerings with our second-generation satellites. We have entered into various contracts to upgrade our ground network, but the completion of these upgrades may not be successful.

In order to maintain commercially acceptable service coverage long-term, we must obtain and launch additional satellites. As discussed in Note 7: Contingencies in our Consolidated Financial Statements, we and Thales may negotiate the terms of a follow-on contract for additional satellites, but we can provide no assurance as to whether we will ultimately agree on commercial terms for such a purchase. If we are unable to agree with Thales on commercial terms for the purchase of additional satellites, we may enter into negotiations with one or more other satellite manufacturers, but we cannot provide any assurance that these negotiations will be successful.

Where are Globalstar's plans to replace the "Gen1" satellites in orbit?

Capital Expenditures

We have entered into various contractual agreements related to the procurement and deployment of our second-generation network, as summarized below. The discussion below is based on our current contractual obligations to these contractors.

Second-Generation Satellites

We have a contract with Thales for the construction of the second-generation low-earth orbit satellites and related services. We successfully completed the launches of our second-generation satellites. Discussions between us and Thales are ongoing regarding certain deliverables under the contract.

We had a contract with Arianespace for the launch of these second-generation satellites and certain pre- and post-launch services. All obligations pursuant to this contract have been fulfilled.

The amount of capital expenditures incurred as of December 31, 2014, related to the construction and deployment of the satellites for our second-generation constellation and the launch services contract is presented in the table below (in thousands):

Capital Expenditures	Payments through December 31, 2014
Thales Second-Generation Satellites	$ 622,690
Arianespace Launch Services	216,000
Launch Insurance	39,903
Other Capital Expenditures and Capitalized Labor	60,237
Total	$ 938,830

As of December 31, 2014, there are no remaining future capital expenditures related to the construction and deployment of the satellites for our second-generation constellation and the launch services contract.

Where are Globalstar's plans to replace the "Gen1" satellites in orbit?

Contractual Obligations and Commitments

Contractual obligations at December 31, 2014 are as follows (in thousands):

Contractual Obligations:	2015	2016	2017	2018	2019	Thereafter	Total
Debt obligations (1)	$ 6,450	$ 32,835	$ 75,756	$ 102,428	$ 94,870	$ 485,255	$ 797,594
Interest on long-term debt (2)	21,178	21,423	22,046	20,394	18,558	30,620	134,219
Purchase obligations (3)	28,964	8,033	—	—	—	—	36,997
Contract termination charge (4)	21,308	—	—	—	—	—	21,308
Operating lease obligations	1,237	1,152	1,148	1,083	269	374	5,263
Pension obligations	970	965	956	970	993	5,163	10,017
Liability for contingent consideration (5)	481	—	—	—	—	—	481
Total	$ 80,588	$ 64,408	$ 99,906	$ 124,875	$ 114,690	$ 521,412	$1,005,879

- Based on total cost to build/launch the first 24 "Gen2" satellites, an additional 8 would cost slightly over $300M
  - Globalstar's "Contractual Obligations" shows they do not (yet?) have a contract in place to replace the 25% of their constellation approaching "end of life"
  - Given the imminent risk of MSS service degradation, it seems such a contract should be in place by now

Are Globalstar's MSS plans, or lack thereof, consistent with requirements of the NPRM?

A. Part 25 Rule Proposals

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. If supported by the record, this action could potentially increase the usefulness for terrestrial mobile broadband purposes of 11.5 megahertz of licensed spectrum. As a result, these changes may induce increased investment and innovation throughout the industry and ultimately improve competition and consumer choice. Therefore, we propose to make the changes to Part 25 of the rules necessary to provide for the operation of low-power ATC in the licensed MSS spectrum in the 2483.5-2495 MHz band. We seek comment on this proposal to add technical and operational provisions to Part 25 to align with uses that are compatible with Part 15 uses. We note that significant concerns have been raised about potential detrimental

Are Globalstar's MSS plans, or lack thereof, consistent with requirements of the NPRM?

2. ATC Gating Requirements

25. In the *ATC R&O*, the Commission adopted rules establishing several prerequisites, or "gating criteria" that MSS operators must meet in order to be allowed to offer ATC. These gating criteria are set forth in Section 25.149 of the Commission's rules. To ensure that ATC would be ancillary to the provision of MSS, the Commission adopted, among other rules, a requirement that MSS operators must provide substantial satellite service to be eligible for ATC authorization.[69] The Commission defined substantial satellite service as the capability of providing continuous satellite service over the entire geographic area of satellite coverage required in its rules,[70] maintenance of spare satellites to expeditiously replace destroyed or degraded satellites,[71] and commercial availability of service throughout the mandatory coverage area.[72] The Commission also required that MSS and ATC services be offered on an integrated basis.[73]

26. We believe that relieving Globalstar from certain ATC gating criteria for its low-power network may facilitate spectrum use in both the 2483.5-2495 MHz band as well as unlicensed operations in the adjacent band, and thus could serve the public interest. We propose, therefore, to create a limited exception from some provisions of the ATC gating criteria in order to streamline the authorization process and to facilitate deployment of Globalstar's proposed low-power broadband network. Specifically, we propose to modify the gating criteria to require a demonstration, as noted in the attached rules, that the proposed licensee is offering commercial MSS.[74] Under this proposal, we would provide an exception for low-power ATC from rules requiring detailed showings concerning satellite system coverage and replacement satellites. Globalstar is continuing to develop and pursue MSS operations in the portion of the Big LEO spectrum designated for its use, and has recently announced that it has substantially replenished its satellite constellation by completing a launch campaign, at a cost of more than $1 billion, for 24 new satellites that are now in full commercial service.[75] This substantial capital investment has facilitated re-initiation of voice and other two-way services. We believe that Globalstar continues to be invested in the provision of MSS. Thus, we believe a simplified evidentiary showing may be sufficient to address a fundamental goal of the ATC rules—that the deployment of terrestrial facilities is in fact ancillary to satellite operations. We seek comment on this approach.

If approved, does the NPRM account for the possibility of Globalstar attempting to deploy something other than an 802.11-based system?

- **It is not clear the NPRM would limit TLPS to be based on 802.11**
- **Given industry trends, it is possible Globalstar could change plans and market their spectrum to wireless carriers for LTE-U/LAA use**
  - The impact of LTE-U/LAA on Bluetooth and "Free Wi-Fi" could be worse than TLPS (see http://apps.fcc.gov/ecfs/document/view?id=60001042850 , GN Docket No. 12-354)
  - In order to cover this scenario, the NPRM should be changed to require any TLPS or similar system deployed by Globalstar be based on 802.11n
    - *OR If Globalstar wants the option to use their spectrum for LTE-U/LAA, they should be required to detail a technical proposal allowing for interested parties to review and comment*

SUPPORTING MATERIAL

"The Math" Behind Fact #1

$Bluetooth\ BR\&EDR\ Minimum\ Hops(BTHop_{min}) = 20$
$Bluetooth\ Channels\ Free\ of\ WiFi\ without\ TLPS(BFree) = 22$
$Bluetooth\ Channels\ Free\ of\ WiFi\ with\ TLPS\ (BTFree_{TLPS}) = 16$
$Bluetooth\ Channels\ Impaired\ by\ TLPS\ (BT_{imprd}) = BTHop_{min} - BTFree_{TLPS} = 4$

$$Percent\ of\ Bluetooth\ Channels\ with\ Bluetooth <> TLPS\ Co-Channel\ Interference = \frac{BT_{imprd}}{BTHop_{min}} = 20\%$$

$WiFi\ User\ Throughput\ (WF_{tput}) = 0\ to\ 65\ MBps$
$WiFi\ Channel\ Capacity\ (WF_{capacity}) = 6.5\ to\ 65\ MBps$
$\%\ WiFi\ Channel\ Load\ (\frac{WF_{tput}}{WF_{capacity}}) = 0$ to 100%

$WiFi\ Timeslot(WF_{ts}) = 4\mu s$
$WiFi\ Data(WF_{ds}) = 3.2\mu s$
$$\frac{WF_{ds}}{WF_{ts}} = 80\%$$

$$Bluetooth\ Bit\ Impairment\ Rate\ (@1Mbps\ streaming)$$

$$\approx \frac{WF_{tput}}{WF_{capacity}} \times \frac{WF_{ds}}{WF_{ts}} \times \frac{BT_{imprd}}{BTHop_{min}}$$

$$= \%\ WiFi\ Channel\ Load \times 16\%$$

This can be summarized as % of Bluetooth bits impaired per "interference event"

Summary Data

% BT Bits Impaired Per TLPS<>Bluetooth "Interference Event"
VS. 802.11n HT20 Channel Capacity
VS. *Single User* Throughput

	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
Receive Sensitivity (dBm)	-82	-79	-77	-74	-70	-66	-65	-64
Data Bits/Wi-Fi Time slot	26	52	78	104	156	208	234	260
Wi-Fi PHY Capacity(MBps)	6.5	13.0	19.5	26.0	39.0	52.0	58.5	65.0
TCP-Level Capacity(MBps)[1]	5.0	10.0	15.0	20.0	30.0	40.0	45.0	50.0
TCP Throughput Rate: (MBps)								
1.00	16.0%	8.0%	5.3%	4.0%	2.7%	2.0%	1.8%	1.6%
3.75	60.0%	30.0%	20.0%	15.0%	10.0%	7.5%	6.7%	6.0%
11.25	N/A	N/A	60.0%	45.0%	30.0%	22.5%	20.0%	18.0%
18.75	N/A	N/A	N/A	75.0%	50.0%	37.5%	33.3%	30.0%
26.25	N/A	N/A	N/A	N/A	70.0%	52.5%	46.7%	42.0%

[1]Assume TCP/PHY Rate = ~77% Per TLPS Demo

Globalstar & BT SIG TLPS<>BT Demonstrations

Single user @3.75MBps Throughput with 50MBps TCP-Level capacity

Links to two (of many) studies of Wi-Fi Adjacent Channel Interference

- http://pe.org.pl/articles/2012/9b/73.pdf
  - See Figure 4 on second page. Note PC2-AP2 remains on Channel 5 while PC1-AP1 goes from Channel 1 to 13. Rate degraded until spacing reaches 25MHz (Ch5<>Ch10)
  - There is not a linear relationship between channel spacing and rate. Any spacing less than 25MHz shows material degradation
- https://sar.informatik.hu-berlin.de/research/publications/SAR-PR-2011-14/aci_80211n_.pdf
  - See Figure 7 on page six. Top right plot shows material rate degradation for all spacing less than 25MHz (<5 channel separation)
  - It is interesting to note the 20MHz spacing (4 channel separation) has worse performance than 0, 5, 10, or 15Mhz spacing

Fact #4: Devices with co-existence filters will impair TLPS

Despite evidence to the contrary, Globalstar continues to:

Claim a broad and immediate ecosystem of devices, even though LTE-Enabled smartphones, tablets, and laptops contain co-existence filters

Insist that all devices can be enabled for TLPS through a "firmware update", even though co-existence filters are non-programmable hardware

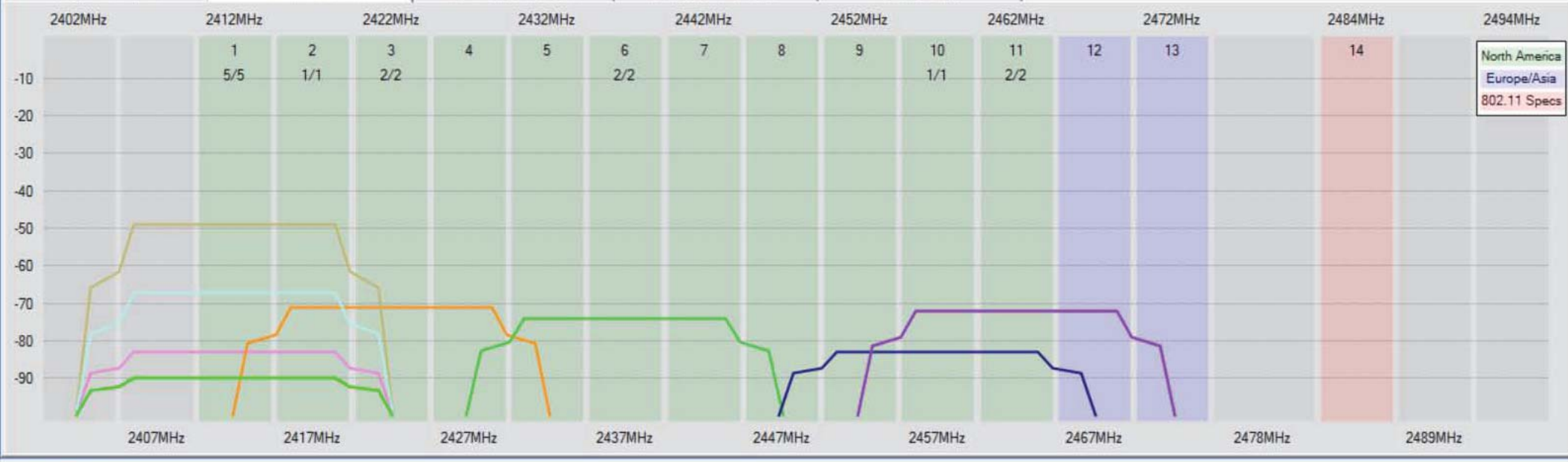
Acrylic Wi-Fi - Not for commercial use.

File Windows Tools Help Go Pro MODE Normal Wi-Fi Realtek RTL8723AU Wireless LAN 802.11n USB 2.0 Ne... STOP

SSID	Mac Address	Rssi	Chan	802.11	Max Speed	WEP	WPA	WPA2	WPS	Password	WPS PIN	Vendor	First Seen	Last Seen	T
FCC HotSpot Network	[redacted]	-83	1	b, g, n	144.4 Mbps			PSK-CCMP				CISCO SYSTEMS, INC.	10:53:13	10:53:28	In
[Hidden]	[redacted]	-71	3	b, g	54 Mbps			PSK-CCMP				CISCO SYSTEMS, INC.	10:53:13	10:53:28	In
FCC HotSpot Network	[redacted]	-74	6	b, g, n	144.4 Mbps			PSK-CCMP				CISCO SYSTEMS, INC.	10:53:13	10:53:28	In
MiFi4620L Jetpack 2741	[redacted]	-74	2	b, g	54 Mbps			PSK-CCMP				Novatel Wireless, Inc.	10:53:13	10:53:22	In
FCC HotSpot Network	[redacted]	-49	1	b, g, n	144.4 Mbps			PSK-CCMP				CISCO SYSTEMS, INC.	10:53:13	10:53:28	In
T-Stat-784b8737a23e	[redacted]	-91	3	b, g	54 Mbps	Open						Murata Manufacturing Co.Ltd.	10:53:13	10:53:16	In
FCC HotSpot Network	[redacted]	-72	11	b, g, n	144.4 Mbps			PSK-CCMP				CISCO SYSTEMS, INC.	10:53:13	10:53:28	In
FCC HotSpot Network	[redacted]	-91	6	b, g, n	144.4 Mbps			PSK-CCMP				CISCO SYSTEMS, INC.	10:53:13	10:53:16	In
FCC HotSpot Network	[redacted]	-67	1	b, g, n	144.4 Mbps			PSK-CCMP				CISCO SYSTEMS, INC.	10:53:13	10:53:28	In
HP7A5BF4	[redacted]	-83	10	b	11 Mbps	Open							10:53:13	10:53:28	A

Actions

Signal Strength | 2.4Ghz APs Channels | 5Ghz APs Channels | Networks Requested | Connectivity



Acrylic Wi-Fi - Not for commercial use.

File Windows Tools Help Go Pro MODE Normal Wi-Fi Realtek RTL8723AU Wireless LAN 802.11n USB 2.0 Ne... STOP

SSID	Mac Address	Rssi	Chan	802.11	Max Speed	WEP	WPA	WPA2	WPS	Password	WPS PIN	Vendor	First Seen	Last Seen
FCC HotSpot Network	[redacted]	-64	1	b, g, n	144.4 Mbps			PSK-CCMP				CISCO SYSTEMS, INC.	10:05:18	10:40:48
FCC HotSpot Network	[redacted]	-51	11	b, g, n	144.4 Mbps			PSK-CCMP				CISCO SYSTEMS, INC.	10:05:17	10:40:48
FCC HotSpot Network	[redacted]	-73	1	b, g, n	144.4 Mbps			PSK-CCMP				CISCO SYSTEMS, INC.	10:05:18	10:40:42
FCC HotSpot Network	[redacted]	-82	1	b, g, n	144.4 Mbps			PSK-CCMP				CISCO SYSTEMS, INC.	10:05:18	10:40:48
T-Stat-784b8737a23e	[redacted]	-73	3	b, g	54 Mbps	Open						Murata Manufacturing Co.Ltd.	10:05:18	10:40:45
FCC HotSpot Network	[redacted]	-73	6	b, g, n	144.4 Mbps			PSK-CCMP				CISCO SYSTEMS, INC.	10:05:18	10:40:48
FCC HotSpot Network	[redacted]	-83	6	b, g, n	144.4 Mbps			PSK-CCMP				CISCO SYSTEMS, INC.	10:05:18	10:40:00
FCC HotSpot Network	[redacted]	-95	11	b, g, n	144.4 Mbps			PSK-CCMP				CISCO SYSTEMS, INC.	10:05:21	10:40:45
[Hidden]	[redacted]	-95	3	b, g	54 Mbps			PSK-CCMP				CISCO SYSTEMS, INC.	10:05:18	10:40:27
MiFi4620L Jetpack 2741	[redacted]	-91	2	b, g	54 Mbps			PSK-CCMP				Novatel Wireless, Inc.	10:11:10	10:40:33

Actions

Signal Strength | 2.4Ghz APs Channels | 5Ghz APs Channels | Networks Requested | Connectivity