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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,

Last week, Globalstar posted photos and video footage of their TLPS user demonstrations that took place at the FCC Technology Experience Center on March 6, 9, and 10, 2015. Evidence from Globalstar's own filings and website perfectly illustrate why their demonstration system should not be used to decide policy: their "Bluetooth – TLPS Demonstration" system was unlikely to cause interference ~90% of the time. Their conditions were far from challenging, and do not represent real world interference scenarios.

Interference between Wi-Fi and Bluetooth devices only occurs when both attempt to use the same frequency ("frequency domain" overlap) ***at the same time*** ("time domain" overlap). While Bluetooth employs a frequency hopping scheme, its performance is ultimately limited by the number of available hopping channels. In the presence of overlapping (in frequency) systems such as Wi-Fi, the lower the number of "free hopping channels", the higher the probability of performance degradation.

The following table (included in my February 11, 2015 comment) provides a simple illustration of Wi-Fi's "frequency domain" overlap with Bluetooth channels. The two tables at the top of Figure 1 quantify the impact on "Free BT/BLE Channels" with and without TLPS.

Impact on Bluetooth Basic Rate/Enhanced Data Rate (BR/EDR):	Channels
Bluetooth BR/EDR Ch's Outside Wi-Fi Channels 1/6/11:	22
Bluetooth BR/EDR Ch's Outside Wi-Fi Channels 1/6/11/14:	16
Channel 14/TLPS Impact on BR/EDR Ch's "Outside Wi-Fi":	-27%

Impact on Bluetooth Low-Energy (LE):	Data Ch.	Adv. Ch.
Bluetooth LE Ch's Outside Wi-Fi Channels 1/6/11:	9	3
Bluetooth LE Ch's Outside Wi-Fi Channels 1/6/11/14:	7	2
Channel 14/TLPS Impact on BT LE Ch's "Outside Wi-Fi":	-22%	-33%

BT Channel (BR/EDR)	BT Channel Frequency (BR/EDR)	BT Channel (BR/EDR)	BT Channel Frequency (BR/EDR)
0	2402	40	2442
1	2403	41	2443
2	2404	42	2444
3	2405	43	2445
4	2406	44	2446
5	2407	45	2447
6	2408	46	2448
7	2409	47	2449
8	2410	48	2450
9	2411	49	2451
10	2412	50	2452
11	2413	51	2453
12	2414	52	2454
13	2415	53	2455
14	2416	54	2456
15	2417	55	2457
16	2418	56	2458
17	2419	57	2459
18	2420	58	2460
19	2421	59	2461
20	2422	60	2462
21	2423	61	2463
22	2424	62	2464
23	2425	63	2465
24	2426	64	2466
25	2427	65	2467
26	2428	66	2468
27	2429	67	2469
28	2430	68	2470
29	2431	69	2471
30	2432	70	2472
31	2433	71	2473
32	2434	72	2474
33	2435	73	2475
34	2436	74	2476
35	2437	75	2477
36	2438	76	2478
37	2439	77	2479
38	2440	78	2480
39	2441		

BT Channel (LE)	BT Channel Frequency (LE)	Advertising Channels (LE)
37	2402	LE Adv
0	2404	
1	2406	
2	2408	
3	2410	
4	2412	
5	2414	
6	2416	
7	2418	
8	2420	
9	2422	
10	2424	
38	2426	LE Adv
11	2428	
12	2430	
13	2432	
14	2434	
15	2436	
16	2438	
17	2440	
18	2442	
19	2444	
20	2446	
21	2448	
22	2450	
23	2452	
24	2454	
25	2456	
26	2458	
27	2460	
28	2462	
29	2464	
30	2466	
31	2468	
32	2470	
33	2472	
34	2474	
35	2476	
36	2478	
39	2480	LE Adv

WiFi Channel Frequency Range				
Channel	1	6	11	14
Center	2412	2437	2462	2484
Low	2403	2428	2453	2475
High	2421	2446	2471	2493

*** Bluetooth Channels "Occupied by Wi-Fi 1/6/11/14" is computed as: Range = Center +/- 9MHz (round 17.5/2)**

Figure 1: Overlap of Wi-Fi Channels 1/6/11/14 with Bluetooth (BT) and Bluetooth Low Energy(BLE) Channels:

Yellow= BT/BLE Overlap with "Free Wi-Fi" Channels 1/6/11

Red= BT/BLE Overlap with Wi-Fi Channel 14 (TLPS)

Green= "Free BT/BLE Channels" (no overlap with Wi-Fi Channels 1/6/11/14)

Assuming a fixed set of Wi-Fi channels (whether 1/6/11, or 1/6/11/14), the "frequency domain" overlap with Bluetooth (lower table in Figure 1) remains constant. Therefore, varying the level of "time domain" interference is the key driver, and this is almost exclusively determined by the traffic level as a percentage of total capacity.

As stated above, Wi-Fi and Bluetooth only interfere with each other if their transmissions overlap in **both** time and frequency. The less aggregate traffic being transmitted on Wi-Fi and/or Bluetooth, the lower the probability of interference. The lighter the traffic load, the greater the chance of "peaceful coexistence" between the two.

Analysis of Evidence from Globalstar's Ex Parte Filings, as well as Photos and Videos Posted to Globalstar's Website (at "Home->Globalstar's TLPS->Status of Proceeding")

Section 3 of the "Bluetooth – TLPS Demonstrations At The FCC Technology Experience Center" document contained within Globalstar's Ex Parte filing on March 12, 2015 describes the "TLPS and Wi-Fi Setup" as follows (highlights are mine):

> - One client device was used per AP, with AP-client pairs operating on Wi-Fi channels 1, 6, 11, and 14, the channels being used depending on the stage of the demonstration. The APs were set to operate at 20 dBm (100 mW), representative of an indoor deployment.
>
> - The Wi-Fi traffic generated between each AP-client pair consisted of emulated high-definition (HD) video streaming at a nominal rate of 3.75 Mbps. The emulated video stream was provided by the AT4 performance tool. The network protocol used over the wireless link was UDP over IP. The streaming traffic was in the downlink (AP to client) direction.

According to information provided in the "TLPS Operation Demonstration" slides, the TCP downlink capacity of each access point is AT LEAST 50Mbps (the maximum aggregate capacity achieved for that demonstration). Since the UDP protocol normally achieves higher bandwidth than TCP, the implied downlink capacity for the "Bluetooth-TLPS Demonstrations" is likely even higher. Though Globalstar fails to even specify the channel capacity of their demonstrations' access points, let's assume the capacity is 50Mbps.

A single client streaming in one direction at 3.75MBps is using 7.5% (=3.75/50) the traffic capacity available on a given Wi-Fi channel. If we use the approximation that this value represents the percent of time the Wi-Fi channel contains traffic, then Globalstar's demonstration system would not interfere with Bluetooth (in overlapping frequencies) more than 90% of the time.

To get a visual idea of this effect, we can refer to Globalstar's own videos. On the Globalstar website, go to Home->Globalstar's TLPS->Status of Proceeding, and click on the video titled "*Mike Needham with Roberson & Associates demonstrates Bluetooth devices operating with Channels 1, 6, 11 and 14*". The following is a snapshot taken at the 2:24 point in the video.

The picture below shows a "Spectrogram" on the left side, and a "Spectrum Analyzer" on the right side. The spectrum analyzer's horizontal frequency (in MHz) range encompasses Wi-Fi channels 1 to 14, with the vertical axis representing the power level (in dBm). The left side spectrogram (or waterfall) encompasses the same frequency range, with time scrolling downward on the vertical axis.

The video footage shows the spectrum analyzer data rapidly changing. Conceptually, you can think of the power vs. frequency data from each spectrum analyzer "snapshot" being translated from a number scale to a color scale (higher power-> "oranger/redder"), then being inserted as a horizontal "time slice" on the spectrogram. The "time slices" scroll downward with time.

Figure 2

Left Side: Spectrogram Showing "RF activity" on Channels 1/6/11/14 during "reenactment" of Globalstar's Bluetooth/Wi-Fi Demonstration taken on March 10, 2015.
Right Side: Spectrum Analyzer "snapshot" (catches a "quiet" period on most channels)
NOTE: Per demonstration plan, each AP has one client streaming video at ~3.75MBps

On the same webpage, click on the "VIEW>>" link next to the "PHOTO GALLERY", and choose "GLOBALSTAR DEMONSTRATION". The seventh photo is shown below. Note the contrast in "RF activity level" (i.e.: the spectrogram's "color density" per Wi-Fi channels) for the "Bluetooth-TLPS Demonstration" in Figure 2, and the unspecified scenario associated with the photo below. Judging by the spectrogram's color density in Figure 3, I am guessing this was taken during one of the "TLPS Operation Demonstration" scenarios where channels 1, 6, 11, and 14 were concurrently loaded with traffic from three clients. In Scenario #1, each access point had 4 clients with each client receiving data at ~10-12MBps. In Scenarios #2, #3, and #4, each access point had 3 clients with each client receiving data ~14-16MBbps.

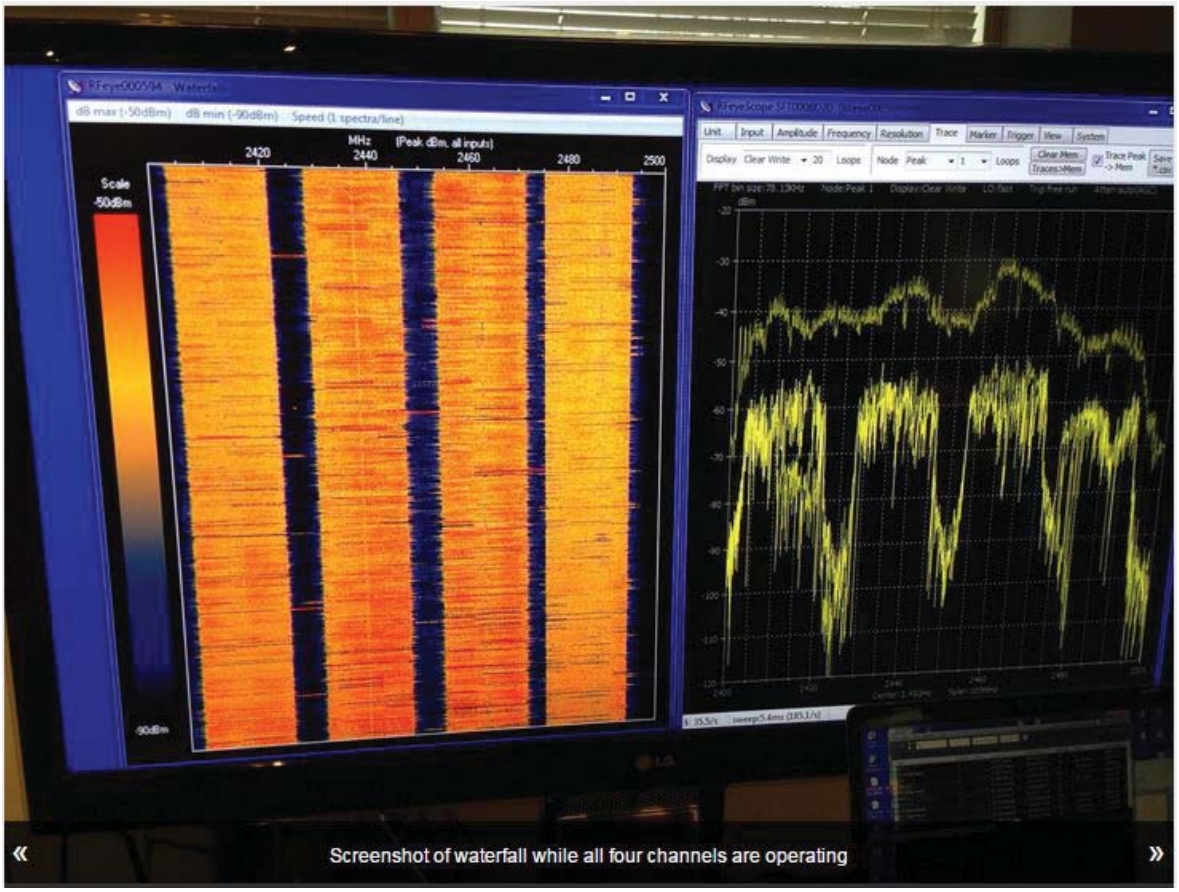

Figure 3

Left Side: Spectrogram Showing "RF activity" on Channels 1, 6, 11, and 14 (scenario not specified).
Right Side: Spectrum Analyzer "snapshot" (likely representative of most snapshots in this scenario)

NOTE 1: Based on videos, this is NOT the traffic scenario used for the "Bluetooth-TLPS Demonstrations".
NOTE 2: Was this taken during one of the "TLPS Operation Demonstration" scenarios run by AT4? If so, it represents either 4 Clients/AP, each at ~10-12MBps, or 3 Clients/AP, each at ~14-16MBps (resulting in an aggregate rate of ~40-50MBps vs. ~3.75MBps for Bluetooth demonstration)

The light Wi-Fi traffic load during the "Bluetooth-TLPS Demonstration" (Figure 2) presents a far more benign environment for Bluetooth operation than would the much higher Wi-Fi traffic load illustrated in Figure 3. Yet, Globalstar's website has the following claim (emphasis is mine):

> "In demonstrating the operation of Bluetooth and Bluetooth Smart devices in the presence of Wi-Fi and TLPS systems in close proximity, we had little doubt that the devices would perform flawlessly. Our past experiences with Bluetooth-based devices and applications has shown us that the technology can adapt and operate in even the most challenging interference conditions, due to its use of agile frequency hopping and interference avoidance. It is certainly one of the most advanced and robust wireless data protocols in use today." - Mike Needham, Roberson and Associates

In regards to the first sentence, I would concur 100% with Mr. Needham of Roberson and Associates. Given the light level of Wi-Fi traffic loading on their "Bluetooth – TLPS Demonstration" system, I too would have little doubt the BT/BLE devices should perform flawlessly. Especially considering that about 90% of the time, there will be no chance for Bluetooth/Wi-Fi interference.

However, I do have the following questions for Mr. Needham, Roberson and Associates, and Globalstar management:

- Did the traffic configurations used in the "Bluetooth-TLPS Demonstration" really represent "the most challenging interference conditions"? Do you consider Wi-Fi channels that are "quiet" ~90% of the time to be "challenging interference conditions" for Bluetooth?

- Will BT/BLE devices still "perform flawlessly" if you configure a system where Channels 1, 6, and 11 are near traffic capacity (say >90%), and increase the traffic level on Channel 14 from <10% up towards 100% capacity? Are you confident the increasing traffic on Channel 14 will have no discernable impact on BT/BLE devices that previously operated "flawlessly" in the presence of heavily loaded channels 1, 6, and 11?

- In an already lightly loaded traffic scenario, why does the following figure seem to show even less activity on Channel 14 vs. Channels 1/6/11 (snapshot taken at the 12 second mark, after Channel 14 data had started)? <u>With the demonstration plan specifying EACH channel is streaming HD video at a nominal rate of 3.75MBps, why does the spectrogram seem to indicate less activity on Channel 14 than the others?</u>

Figure 4

Spectrogram Showing "RF activity" on Channels 1/6/11/14 during "reenactment" of Globalstar's Bluetooth/Wi-Fi Demonstration taken on March 10,2015. Color density seems to imply less traffic on Channel 14 vs. Channels 1/6/11

The fact that I am investment manager with a short position in Globalstar's stock obviously implies a bias on my part. However, I have a B.S. and M.Eng. in Electrical Engineering and have managed organizations responsible for the detailed test and characterization of complex wireless systems. During my time at Cisco, if a test manager developed and executed the "demonstration plan" as described by Roberson & Associates, then attempted to make the same claims, they would be lucky to still have a job.

While technology demonstrations have their place, information from Globalstar clearly shows their recent demonstration system is insufficient to declare "the absence of any material real-world effects from TLPS operations".

Depending on the contents of others' comments, I may file a further comment analyzing results provided in the "TLPS Operation Demonstration" slides. My analysis would further illustrate why Globalstar's user demonstration systems are not adequate to answer key technical questions regarding their TLPS proposal. I would be happy to share any analysis files with FCC staff.

Respectfully Submitted,

Greg Gerst
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