KerrisdaleCapital

December 2, 2014

Via Electronic Filing

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street SW
Washington, DC 20554

Re: Notice of Ex Parte
***Terrestrial Use of the 2473-2495 MHz Band for Low-Power Mobile Broadband Networks; Amendments to Rules for the Ancillary Terrestrial Component of Mobile Satellite Service Systems,* IB Docket No. 13-213, RM-11685**

Dear Ms. Dortch:

On December 1, 2014, Shane Wilson, Investment Analyst at Kerrisdale Capital Management, LLC (Kerrisdale); Russell Fox and Kara Romagnino of Mintz, Levin, Cohn, Ferris, Glovsky and Popeo; and the undersigned met with John Leibovitz, Chris Helzer, and (by phone) Brian Regan of the Wireless Telecommunications Bureau; Mark Settle of the Office of Engineering and Technology; and Troy Tanner, Jose Albuquerque, Karl Kensinger, and Stephen Duall of the International Bureau. Kerrisdale presented the attached slides and urged the Commission to foster the efficient and globally harmonized use of the unlicensed 2.4 GHz band by easing the restrictive out-of-band emissions (OOBE) rules that *de facto* preclude the use of Wi-Fi Channels 12 and 13 in the US – despite their widespread use in many other countries. We also described how the sophisticated LTE/Wi-Fi coexistence filters prevalent in many mobile devices today, which effectively treat Globalstar's MSS spectrum as a transition band, would, by subjecting Globalstar's proposed Terrestrial Low Power Service (TLPS) to high levels of rejection, substantially impair its usefulness. This filtering problem casts further doubt on the purported value of TLPS as a means to expand the available supply of mobile-broadband spectrum, especially relative to the superior alternative of expanding practical access to Channels 12 and 13, which are compatible with existing filters.

With respect to TLPS's potential negative externalities, we noted that, based on our previously submitted interference testing results,[1] TLPS would represent a uniquely damaging presence in the 2.4 GHz unlicensed band. There is a significant difference between the possibility of adding another broadband channel through a private TLPS and increasing the number of publicly accessible Wi-Fi

[1] *See* Letter from Sahm Adrangi, Kerrisdale Capital Management, LLC, to Marlene H. Dortch, Secretary, FCC, IB 13-213, RM-11685 (dated Oct. 22, 2014), *available at* http://apps.fcc.gov/ecfs/document/view?id=60000975262.

channels. Adding a channel for TLPS comes with a significant potential downside – the disruption of one of the most commonly used telecommunications technologies today – and is highly unlikely ever to achieve widespread adoption or commercial success. But there is no downside – and meaningful upside – to making another *unlicensed* Wi-Fi channel available, consistent with the practice of many other global regulators. Unlike other unlicensed spectrum use cases that can and do work to mutually minimize adjacent-channel interference, TLPS is inherently wedded to its own channel irrespective of the resulting damage. As further documented in the attached presentation, Globalstar's suggestions that Kerrisdale's interference testing was biased against TLPS because it involved Channel 14 operations using 802.11b at "unrealistic" density and signal strength[2] are misinformed: 802.11b's adjacent-channel emissions are no worse than 802.11n's and typically better, and multiple nearby Wi-Fi access points operating at -60 to -70 dBm of received signal strength are often observed in densely populated areas.

Pursuant to Section 1.1206(b)(2) of the Commission's rules, an electronic copy of this letter and the attachment is being filed for inclusion in the above-referenced dockets. Please direct any questions regarding this filing to the undersigned.

Respectfully submitted,

/s/ Sahm Adrangi

Chief Investment Officer
KERRISDALE CAPITAL MANAGEMENT, LLC

Attachment

cc: (via email)
John Leibovitz
Chris Helzer
Brian Regan
Mark Settle
Troy Tanner
Jose Albuquerque
Karl Kensinger
Stephen Duall

[2] Letter from L. Barbee Ponder IV, General Counsel and Vice President Regulatory Affairs, Globalstar, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 13-213, RM-11685, at 4 (dated Oct. 30, 2014), *available at* http://apps.fcc.gov/ecfs/document/view?id=60000977216.

KERRISDALE CAPITAL
Meeting with International Bureau, Office of Engineering and Technology, and Wireless Telecommunications Bureau

December 1, 2014

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OUTLINE

Globally Harmonizing the Upper ISM Band	3
TLPS and Coexistence Filtering	4
TLPS as a Threat to Unlicensed Spectrum Users	5
Flaws in the TLPS “Test Results”	6
Supporting Materials	7

Globally Harmonizing the Upper ISM Band

- Other major global regulators permit full-powered unlicensed operations at upper end of ISM band
  - No evidence of harmful interference resulting to Globalstar MSS
  - Globalstar's own recent Wi-Fi products pose far greater interference risk
- In 2.4GHz band, 1/5/9/13 channel plan would offer four non-overlapping *unlicensed* channels available to all users
  - 26th non-overlapping unlicensed Wi-Fi channel (including 5GHz band)
- TLPS would not be meaningful "fourth channel"
  - Restricted to small, unknown subset of authorized and compatible devices

TLPS and Coexistence Filtering

- Wi-Fi/LTE coexistence is a rapidly growing problem for mobile devices like smartphones and tablets, often requiring high-performance RF filters
- Common filters in popular devices would severely attenuate any Channel 14 signals; not designed to support TLPS frequencies
  - Would dramatically impair both propagation and throughput
  - No “quick fix” (e.g. software change) – transition band already tight, filters not programmable
- Impaired Channel 14 = ineffective way to expand usable supply of spectrum for mobile broadband
  - Filtering problem sharply limits usability of TLPS in existing devices (even if firmware altered to support it)

TLPS as a Threat to Unlicensed Spectrum Users

- TLPS is unlike unlicensed Wi-Fi systems – a much worse “neighbor”
  - Normal Wi-Fi systems agnostic to channel
  - Touted benefits of TLPS only apply to single channel, no flexibility to change
- Ch 14 will certainly cause adjacent-channel interference to Ch 11
  - Throughput degradation documented in our commissioned lab tests
  - Globalstar claim of “no impact on public Wi-Fi operations” is false and could not have been supported (even in principle) by the evidence presented

Flaws in the TLPS "Test Results"

- Globalstar/Jarvinian "results" do not resemble real performance tests used by Wi-Fi vendors and customers
  - No information on throughput, devices used, number of clients supportable…
- Ruckus AP model purportedly used not permitted under relevant experimental license
- No user devices ever authorized under experimental licenses
  - Impossible to measure actual throughput without UE transmissions
- Focus on signal-to-noise ratio overstates range because weak signals may be unusable irrespective of noise level
- Failure to assess multi-client performance and congestion risk
- No serious demonstration of any benefits to public

SUPPORTING MATERIALS

The Availability of Upper ISM Band Channels Globally

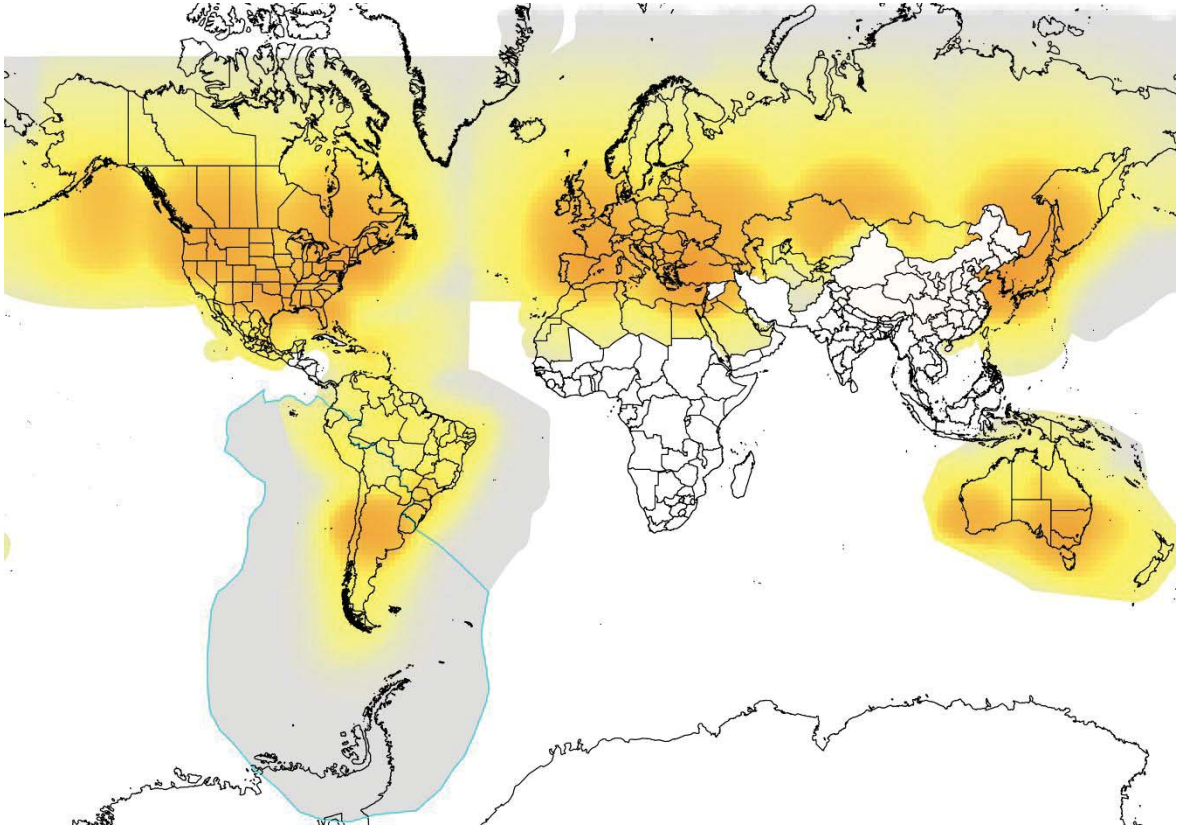
- Countries that allow Wi-Fi Channels 1-13 (sorted by region/population)
  - Europe/Middle East/Africa
    - Pakistan
    - Nigeria
    - Russia
    - Egypt
    - Germany
    - Turkey
    - France
    - UK
    - Italy
    - South Africa
    - Spain
    - Ukraine
    - Kenya
    - Algeria
    - Poland
    - Iraq
    - Morocco
    - Saudi Arabia
    - Ghana
    - Romania
    - Netherlands
    - Belgium
    - Greece
    - Tunisia
    - Czech Republic
    - Portugal
    - Sweden
    - United Arab Emirates
    - Austria
    - Israel
    - Switzerland
    - Bulgaria
    - Serbia
    - Libya
    - Denmark
    - Finland
    - Slovakia
    - Norway
    - Ireland
    - Croatia
    - Lebanon
    - Oman
    - Bosnia/Herzegovina
    - Lithuania
    - Macedonia
    - Slovenia
    - Latvia
    - Bahrain
    - Estonia
    - Cyprus
    - Montenegro
    - Luxembourg
    - Malta
    - Iceland
    - Liechtenstein
    - Monaco
    - Gibraltar
  - Asia/Pacific
    - China
    - Japan
    - Vietnam
    - Thailand
    - South Korea
    - Malaysia
    - Sri Lanka
    - Hong Kong
    - Singapore
    - Macau
    - Brunei
  - Americas
    - Jamaica

Source: derived from Cisco compliance materials associated with Aironet 3700 series access points
- Cisco Aironet 3700 Series Access Points Data Sheet
- Cisco Wireless LAN Compliance Status (last updated November 17, 2014)

Note: Globalstar has sought to use Cisco Aironet 3700 APs under its San Carlos experimental-license application, file no. 0742-EX-PL-2014.

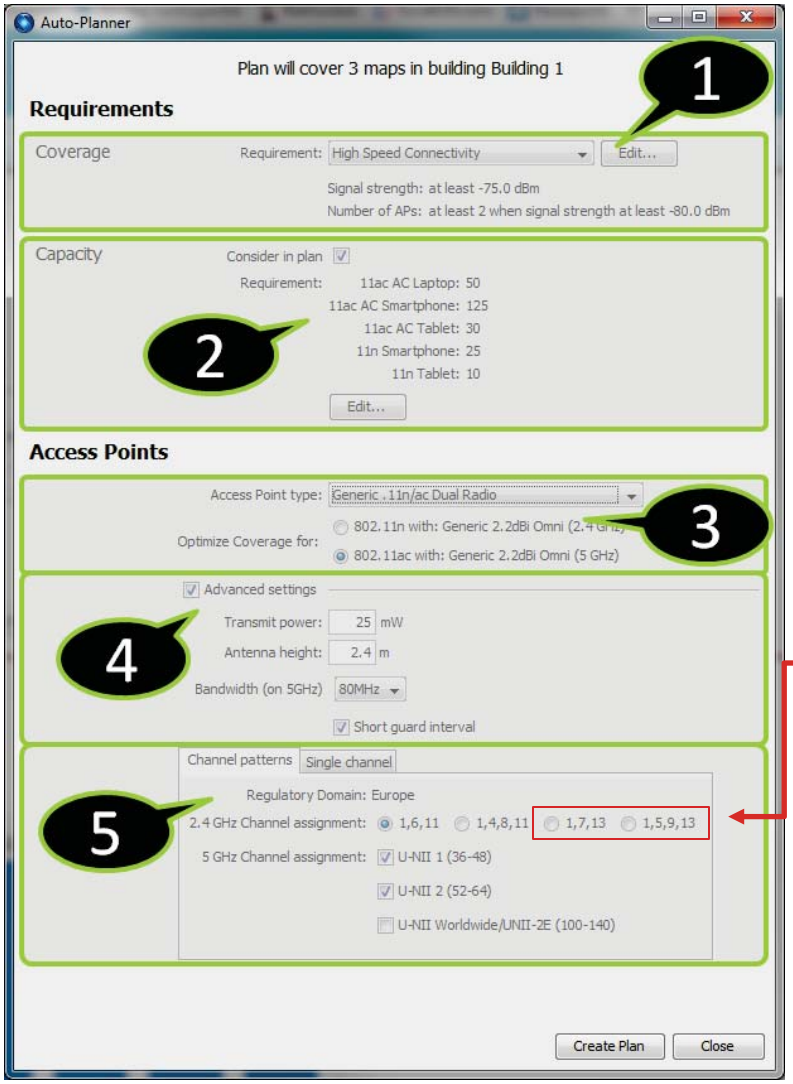
Globalstar's Duplex Coverage Map

- Many regions that Globalstar's MSS covers use Ch 12/13
  - UK, Europe, Japan, Russia, China…



Source: Globalstar, dated Oct. 31, 2014. Globalstar defines orange as "primary Globalstar service area," yellow as "extended Globalstar service area," and gray as "fringe Globalstar service area."

1/5/9/13 and 1/7/13 Supported by Major Design Tools



- Ekahau Site Survey is one of the leading RF planning/design tools used by Wi-Fi professionals
- "Auto-Planner" tool estimates best locations/channels for APs
- Channel pattern options include:
  - 1, 7, 13
  - 1, 5, 9, 13

Source: derived from Cisco compliance materials associated with Aironet 3700 series access points
- Cisco Aironet 3700 Series Access Points Data Sheet
- Cisco Wireless LAN Compliance Status (last updated November 17, 2014)

WLAN Designers Can Deploy Ch. 12/13 When It Makes Sense

- Example of a nuanced discussion of 1/5/9/13 in Europe:

1-6-11 vs 1-5-9-13 channel planning are a central point of debate at MetaGeek. In fact, Mark and I were just talking about it on Friday!

In the US, channels 1 through 11 available. When you figure that each wireless network is 20 MHz wide, the only three non-overlapping channels are 1, 6, and 11.

In Europe, channels 1 through 13 are available. This means that it is possible to use a four-channel plan: 1, 5, 9, and 13.

But... that leaves us with quite a problem. We have many friends in Europe, and we've heard repeatedly from them that most routers ship on channel 6 by default. If we subscribed to a 1-5-9-13 channel scheme and accidentally suggested that a customer use channel 5 or channel 9, then they would likely partially overlap with a network on channel 6 and... adjacent-channel interference galore! The whole issue ends up being quite a conundrum.

But wait, there's more!

DSSS (802.11 prime) and HR-DSSS (802.11b) channels are 22 MHz wide. ERP-OFDM (802.11g/n) is 20 MHz wide. If you have an 802.11n access point, you are only 20 MHz wide, right?

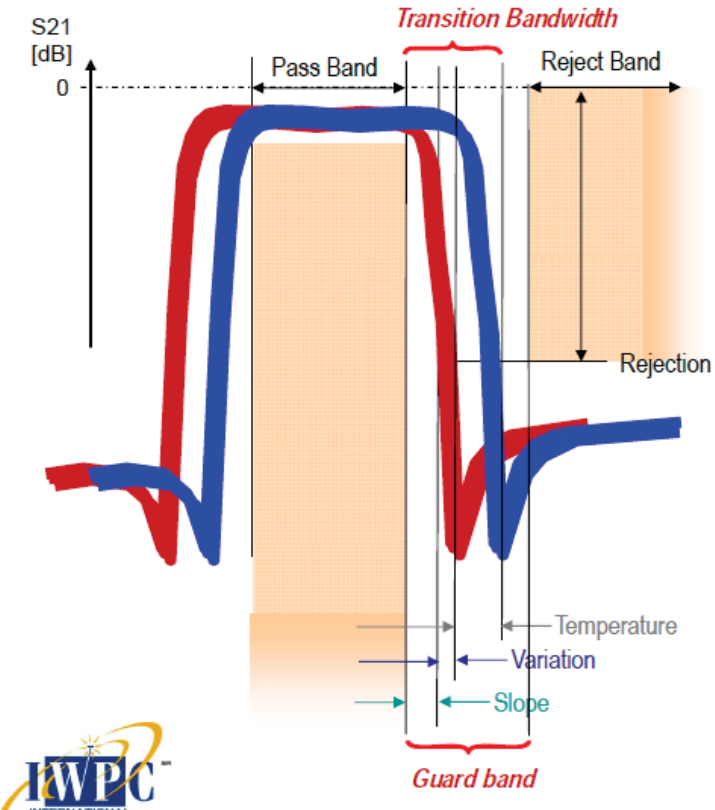
Well... the problem is that most (read: all) overhead is sent at legacy data rates, like 1 mbps. 1 mbps is achieved with DSSS (802.11 prime), so your channel really ends up being 22 MHz wide whenever overhead is being sent, which is pretty much all of the time. If you have a really nice enterprise-grade AP, you can uncheck data rates 1-11 and get rid of that problem, but in the SOHO world (small office, home office), you can't turn off those legacy data rates and protection mechanisms.

Ultimately, if you have a SOHO... you really are going to be 22 MHz wide most of the time, so the 1-6-11 scheme ends up being the way to go. **If you are an enterprise WLAN admin, and you have more control of the RF, then you can disable legacy data rates and deploy an excellent enterprise network with a 4-channel scheme.**

> *—Joel Crane (human-interface team at MetaGeek), MetaGeek message board, May 31, 2014. Emphasis added.*

Filter Basics from IWPC Mobile RF Filter Group

Transition Bandwidth vs. Guard Band



The **Transition Bandwidth** is the amount of frequency separation needed between the pass band and the reject band to ensure the required level of rejection and insertion loss is achieved across all filters and over the operating temperature range.
It consists of three components:

1. The slope of the filter
2. The variation in frequency centering filter to filter
3. The motion the filter has over the specified operating temperature range

The **Guard Band** is the frequency separation between adjacent bands for which interference concerns are relevant.

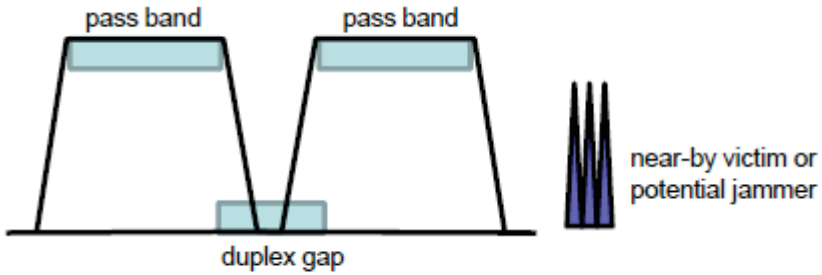
8

Source: April 2011 IWPC Mobile RF Filter Group presentation included as attachment to letter from Don Brown to Marlene H. Dortch, Secretary, FCC, GN 12-268 (dated Nov. 27, 2012), *available at* http://apps.fcc.gov/ecfs/document/view?id=7022066310 (slide 8)

2.4GHz ISM Band Already Viewed as "Very Hard" to Filter

Bands Aren't All the Same: Very Hard Bands

CHALLENGING Bands:
Very narrow duplex gap (<1.0%) or nearby victims / potential jammers make the filtering very difficult

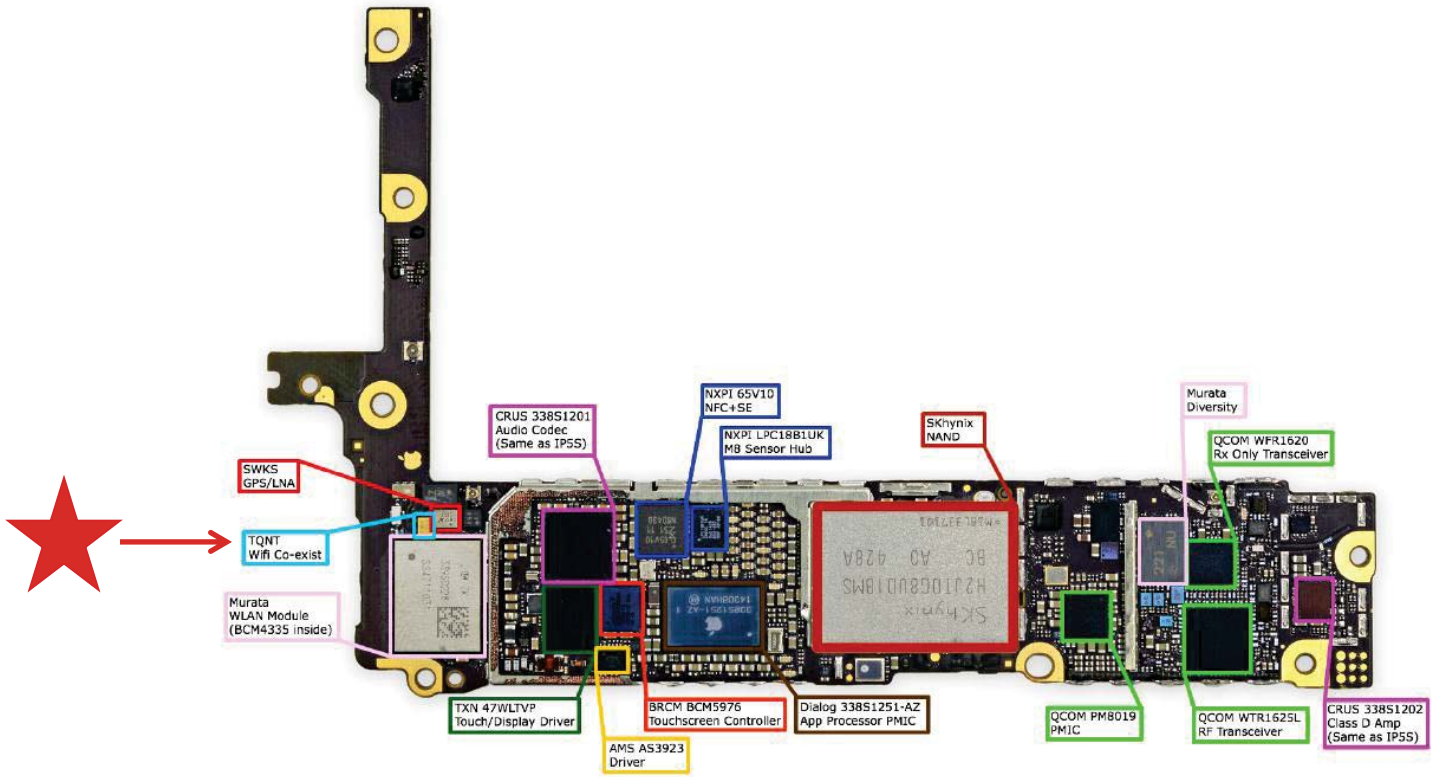


Band Name	Uplink	Downlink	Duplex	Where	Comment
Sprint 800 ext. 3GPP BC10	817-824 (0.9%)	862-869 (0.8%)	FDD 4.51%	US	only 1 MHz to re-banded Public Safety Radio
3GPP B7	2500-2570	2620-2690	FDD	Worldwide	"very hard" – 16.5MHz (**0,66%**) above WiFi, no guard band to B38
3GPP B38	2570-2620	2570-2620	TDD	Europe, China	currently "impossible" – **no guard band** to B7 uplink and downlink
3GPP B40	2300-2400	2300-2400	TDD	China, India, E. Europe	currently "impossible" – only 1 MHz guard band from B40 (2300-2400) to WiFi CH1
WiFi	2400-2483.5	2400-2483.5	TDD	US Europe / Asia	"very hard "–16.5MHz (**0.66%**) to B7, Only 1 MHz guard band from B40 (2300-2400) to CH1, 12.5MHz (0.05%) to B41 (2496-2690)

Source: April 2011 IWPC Mobile RF Filter Group presentation included as attachment to letter from Don Brown to Marlene H. Dortch, Secretary, FCC, GN 12-268 (dated Nov. 27, 2012), *available at* http://apps.fcc.gov/ecfs/document/view?id=7022066310 (slide 21). Emphasis added.

Example of a Wi-Fi/LTE Co-Existence Filter: iPhone 6 Plus

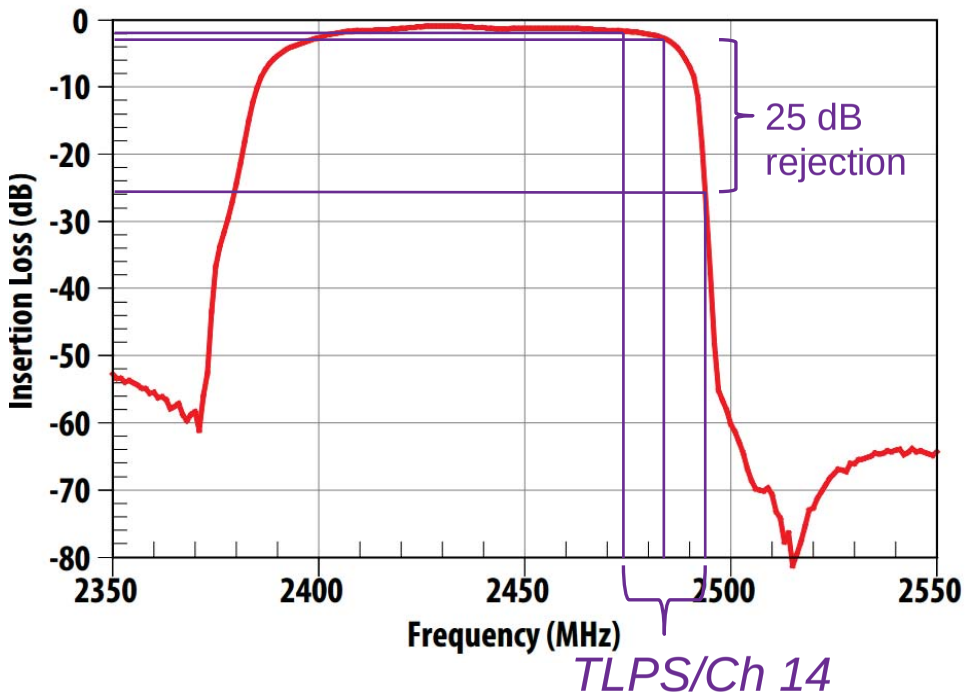
FIGURE 3
iPhone 6 Plus Circuit Board - Back



Source: iFixit, Chipworks, and Barclays Research

Source: Barclays equity research, "U.S. Semiconductors: iPhone 6 Teardowns – Preliminary Thoughts for Semis," September 19, 2014, p. 4. Emphasis added.

Example of a Wi-Fi/LTE Co-Existence Filter: Avago ACFF-1024



Source: Avago Technologies ACFF-1024 data sheet (p. 3). Purple lines and text added by Kerrisdale.

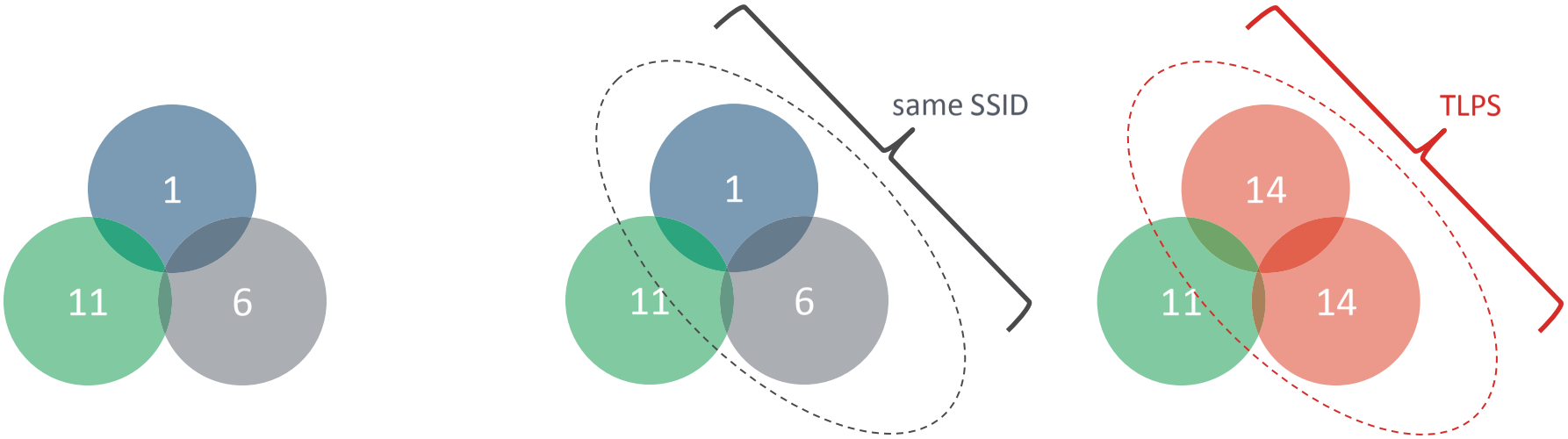
Summarized Performance of Wi-Fi/LTE Filters

- Common Wi-Fi/LTE coexistence filters would dramatically impact TLPS in mobile devices
- Reduced propagation, reduced SNR (implying reduced throughput)

		*Insertion loss **in dB** at given frequency*			
Manufacturer	*Part number*	2474 MHz	2484 MHz	2494 MHz	**Reduction in signal strength at 2494 MHz**
TriQuint	885032	1.8	3.5	26.9	**491x**
TriQuint	885033	1.4	2.4	16.6	**45x**
TriQuint	885017	1.6	3.8	24.5	**284x**
TriQuint	885062	1.7	2.3	12.5	**18x**
Avago	ACFF-1024	1.9	2.8	25.6	**362x**
Avago	ACPF-7024	1.7	2.5	15.0	**32x**
TDK	B9604	2.4	3.9	25.3	**335x**

Source: vendor data sheets, Kerrisdale analysis

TLPS: A Uniquely Bad Neighbor



three independent single-AP networks

two independent networks

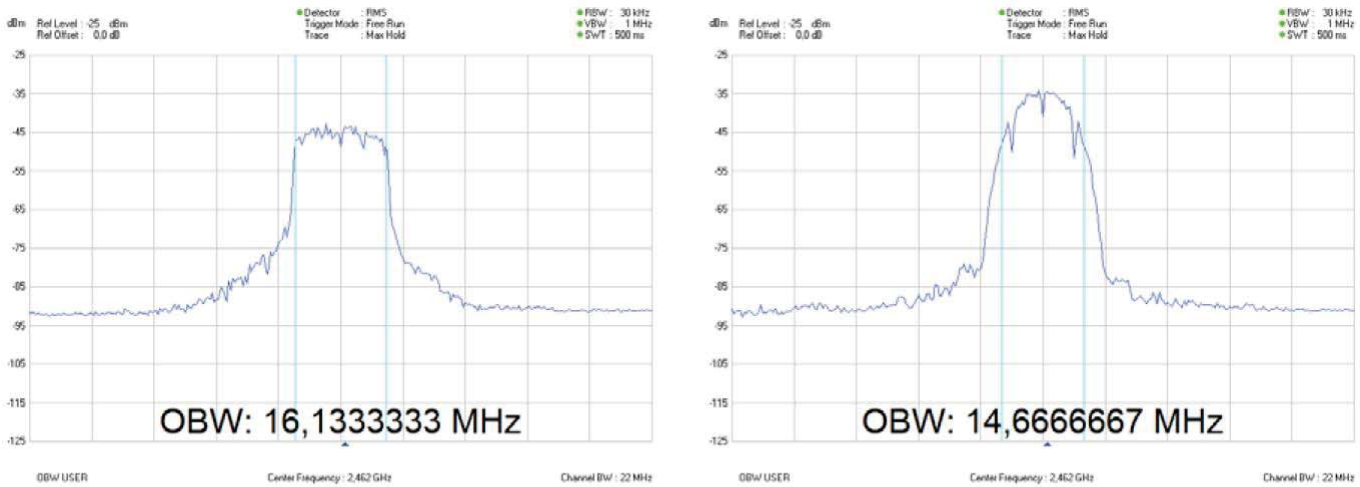
TLPS vs. unlicensed network

- Existing unlicensed networks can mutually minimize ACI
- As a single-channel service, TLPS can't and won't

Globalstar Confuses Co-Channel and Adjacent-Channel Effects

- Globalstar has criticized our interference testing for using 802.11b on Channel 14
- Compliant Wi-Fi devices are limited to 802.11b (DSSS modulation) on Channel 14, even in Japan – not Kerrisdale's choice
- 802.11b user devices degrade overall network performance *for other users on the same channel* because of their low data rates
- Our testing assessed *adjacent-channel interference*, not co-channel contention
  - Channel 11 receivers "hear" Channel 14 transmission as noise, not signal
  - 802.11 DSSS mask stricter than OFDM mask when it comes to OOBE

Comparing OFDM and DSSS ACI: Side by Side



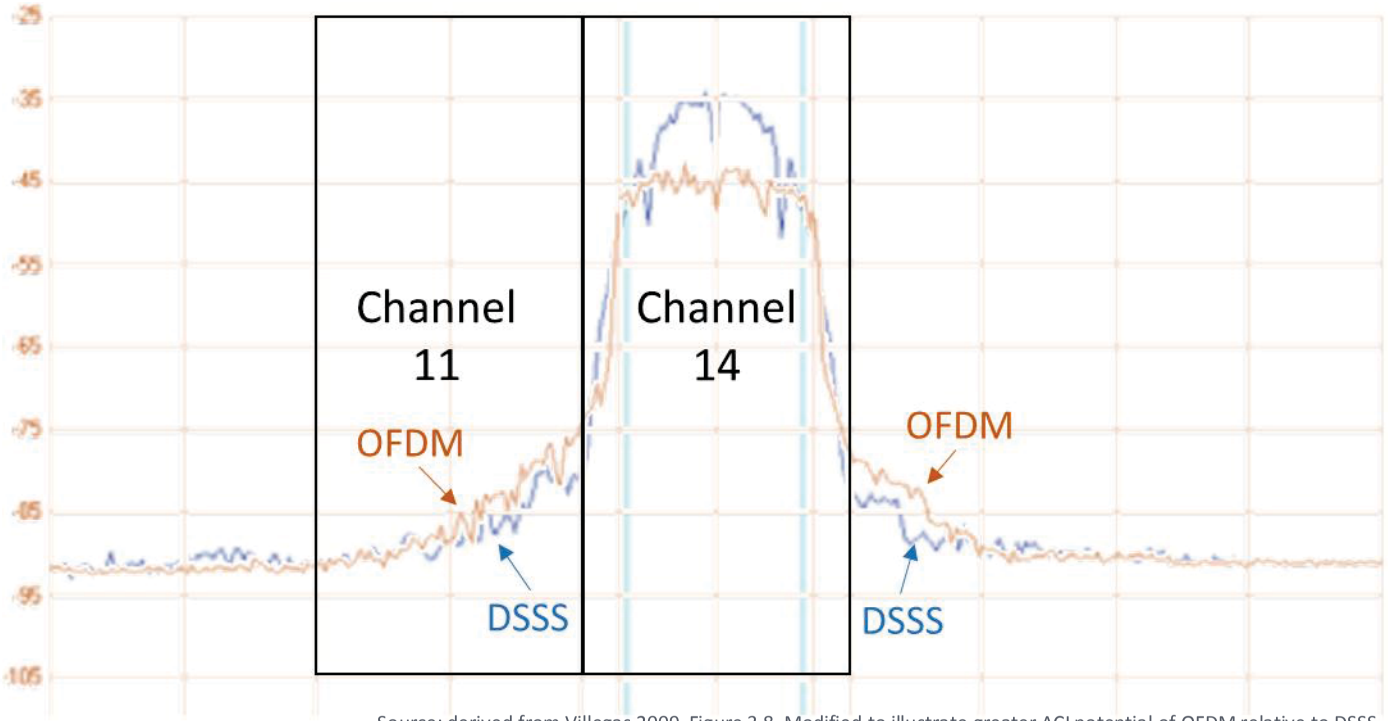
(a) Occupied bandwidth of an OFDM signal (99%) (b) Occupied bandwidth of a DSSS signal (99%)

Figure 3.10: Occupied bandwidth of different IEEE 802.11 signals

Source: Eduard Garcia Villegas, *Self-Optimization of Radio Resources on IEEE 802.11 Networks*, 2009 Ph.D. thesis (Universitat Politècnica de Catalunya), p. 60

- OFDM (e.g. 802.11n) signal has *wider* "occupied bandwidth" than DSSS (e.g. 802.11b)
  - More "bleed" into Channel 14
  - Thus use of 802.11b in interference testing is *conservative*

Comparing OFDM and DSSS ACI: Superimposed



Source: derived from Villegas 2009, Figure 3.8. Modified to illustrate greater ACI potential of OFDM relative to DSSS.

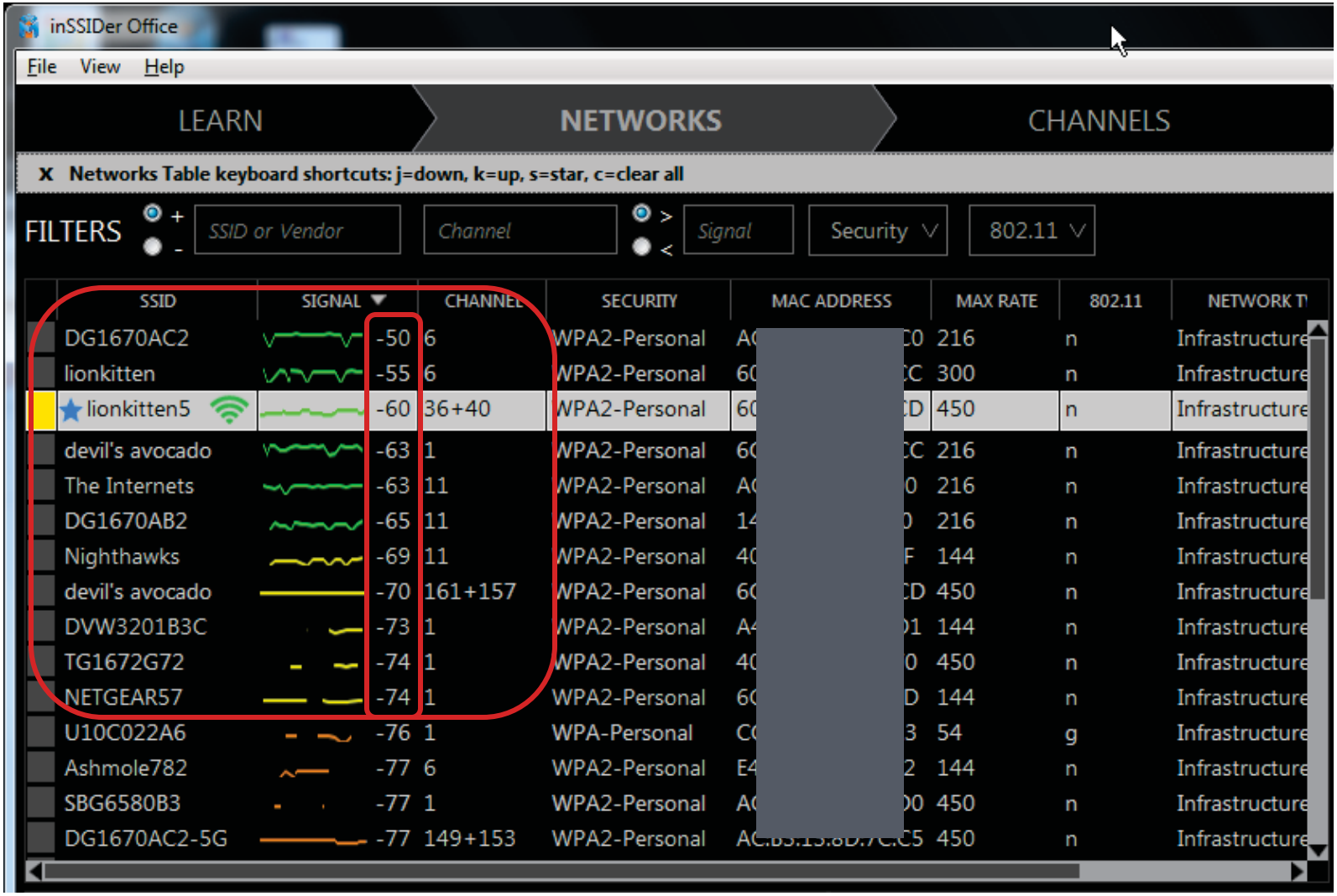
- Real-world spectrum analysis confirms higher emissions into adjacent channels from OFDM signals relative to DSSS signals

Kerrisdale's Tests Are Reasonable and Informative

- Globalstar: "*the density and close physical proximity of this equipment are entirely unrealistic and would never exist in practice*"*
- Incorrect, especially in a dense area
  - In Kerrisdale tests conducted by Allion, Ch 14 signals attenuated to -60 dBm to -70 dBm – realistic signal strength for multiple nearby APs
  - Next slide provides one real-world example from Brooklyn, NY, Nov. 6, 2014

*Source: Globalstar ex parte, 10/30/14

A Case Study of Signal Strengths in High-Density Areas



Source: screenshot from Metageek inSSIDer Office v. 3.1.1.6, Brooklyn, NY, November 6, 2014. Red emphasis added and MAC addresses blocked out.

An Example of Genuine Wi-Fi Testing (1)

- Aruba marketing document comparing Aruba vs. Cisco 802.11ac APs
- Sample results and background information provided:

Table 1: Test results summary

Test Scenario	Aruba AP-225	Cisco 3702i	Aruba Advantage
Single Client downstream TCP throughput at 10ft	882	574	54%
Single Client upstream TCP throughput at 30ft	534	376	42%
Multi-client bidirectional TCP throughput with 30 clients using large packets (1500B)	412	288	43%
Multi-client downstream UDP throughput with 30 clients using small packets (256B)	157	43	3.6x
Multi-client downstream TCP throughput with 30 clients when co-channel interference is present	378	187	2x

Source: *Wi-Fi Performance Benchmark Testing: Aruba Networks AP-225 and Cisco Aironet 3702i* , January 2014

An Example of Genuine Wi-Fi Testing (2)

Table 2: Devices under test

Vendor	Device	Quantity	Firmware version
Aruba	AP-225	1	6.3.1.2 build 41701
	7210 Mobility Controller	1	6.3.1.2 build 41701
Cisco	Aironet 3702i	1	7.6.100.0
	5508 WLAN Controller	1	7.6.100.0

Source: *Wi-Fi Performance Benchmark Testing: Aruba Networks AP-225 and Cisco Aironet 3702i* , January 2014

An Example of Genuine Wi-Fi Testing (3)

Table 3: Test equipment

Item	Component	Specifications		Details
1	**Device OS/Type**	**Make and Model**	**Quantity**	**OS Version**
	Laptops	MacBook Pro (3SS 802.11ac)	12	10.9.1
		MacBook Air (2SS 802.11ac)	20	10.9.1
2	Performance evaluation tools	IxChariot, one wired endpoint, client on each device		7.10 SP5
3	Switch	Cisco Catalyst 3750G		12.2 (50) SE5
4	Power Injector	PowerDsine 9001G PoE+ injector		N/A
5	Co-Channel Interference source	Aruba AP-225, 7210 Mobility controller		6.3.1.2 build 41701

Source: *Wi-Fi Performance Benchmark Testing: Aruba Networks AP-225 and Cisco Aironet 3702i* , January 2014