Short: Globalstar, Inc. (GSAT)

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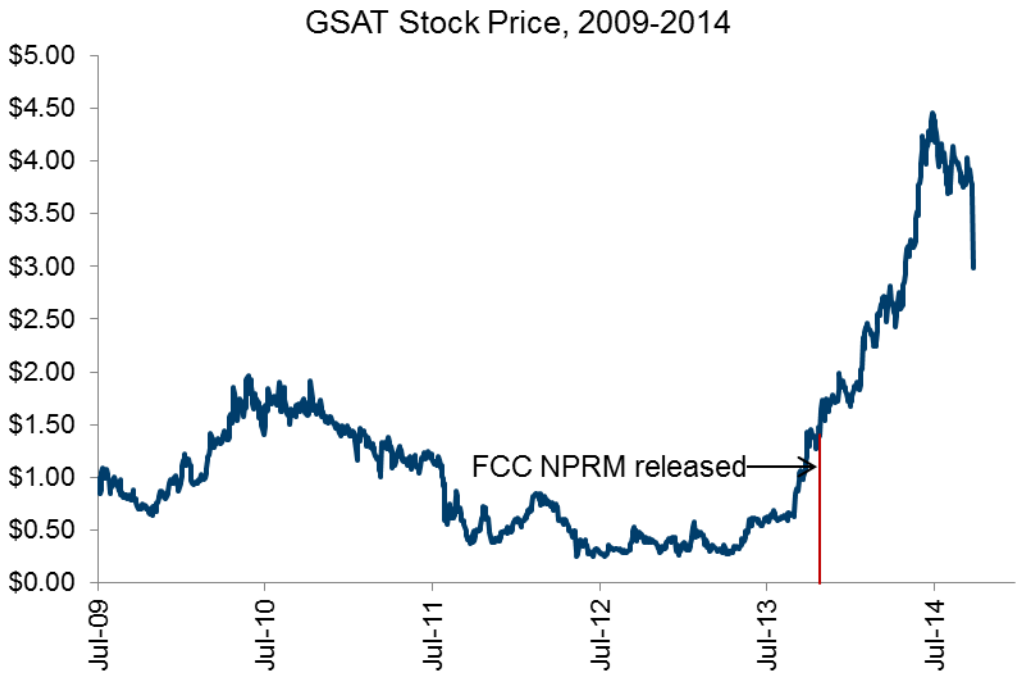
We Are Short Shares of Globalstar, Inc. (GSAT)

- GSAT is the #4 largest Mobile Satellite Services (MSS) firm, selling voice and data products in the niche market for satellite phones and similar devices
- $3.6B market cap, $4.1B EV, ~$88mm LTM revenues
- Only purported justification for outrageous valuation: TLPS / spectrum "asset"
- Bulls believe that TLPS, upon approval, will be worth billions of dollars. The reality is that TLPS, upon approval, will be worthless:
  - TLPS merely provides one additional licensable channel in 2.4GHz, when there are already 25 channels available for *free,* such that any network engineer using modern technology and best practices can solve co-channel interference, or "Wi-Fi congestion", in even the highest-density environments
  - TLPS will never be commercially viable, and the concept has been dismissed by virtually every subject-matter expert we've spoken with
- Outside of TLPS, Globalstar's spectrum is worthless, due to specific characteristics unique to GSAT's frequencies
- GSAT is deeply indebted and will likely violate its financial covenants
- **Kerrisdale estimates an equity FV of $0, or 100% downside**

An Incredible Rally Driven by Spectrum Hype

- GSAT share price up 856% over the last 18 months
- Complex capital structure obscures actual valuation

Share price	**$ 3.01**
Fully diluted shares (mm):	
Shares O/S, 2014 Q2:	
Voting	764.0
Nonvoting	209.0
Subtotal	973.0
Dilutive effects:	
Subordinated loan	111.1
Convertible notes	51.7
Warrants	44.1
Stock options	5.6
Subtotal	212.5
Fully diluted shares	1,185.5
Fully diluted market cap	**$3,568.3**
Non-convertible debt:	
COFACE facility	$ 586.3
Restructuring fees payable[1]	20.8
Gross debt	$ 607.1
Less: cash[2]	(61.7)
Net debt	$ 545.4
Total enterprise value	**$4,113.8**



1. Due no later than 12/31/17. See 2013 10-K, p. 63.
2. Includes restricted cash in the "debt service reserve account" under the COFACE facility.

Investors have already valued GSAT's spectrum at ~$4B

KerrisdaleCapital

A Brief Review of GSAT's History

- 1993: founded
- 1995: first IPO
- 2002: Chapter 11 bankruptcy
- 2004: emerges from bankruptcy
- 2006: second IPO
- 2007: announces first of many significant satellite malfunctions
- 2012: delisted from NASDAQ
- 2013: defaults on 5.75% Convertible Senior Notes (but obtained forbearance and ultimately refinanced capital structure)
  - 2013 10-K notes material weakness in internal control
- 2014: relisted on NYSE MKT
- Cumulative 2004-13 financial results: op. income $(418)mm; FCF $(1.3)B

GSAT has a long track record of financial distress and operational weakness

GSAT: Highly Levered, No Earnings

GSAT 10-Year Performance Summary

($mm)	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Revenue	$84.4	$127.1	$136.7	$98.4	$86.1	$64.3	$67.9	$72.8	$76.3	$82.7	$896.7
Op. income	(3.5)	21.9	15.7	(24.6)	(57.7)	(53.8)	(59.8)	(73.2)	(95.0)	(87.4)	(417.5)
Adj. EBITDA	3.6	27.3	33.8	21.8	(14.2)	(12.6)	(8.5)	(6.4)	9.8	11.9	66.5
CF from ops	14.6	13.7	14.6	(7.7)	(30.6)	(18.4)	(23.3)	(5.5)	6.9	(6.5)	(42.3)
Less: capex	4.0	9.9	107.5	170.0	286.1	324.1	208.4	88.2	57.5	45.3	1,301.0
Levered FCF	10.6	3.8	(93.0)	(177.7)	(316.7)	(342.5)	(231.7)	(93.7)	(50.6)	(51.8)	(1,343.3)
End of period											
Debt @ book	$3.3	$0.6	$0.4	$50.0	$238.3	$463.6	$664.5	$723.9	$751.0	$669.3	
Stock price			$13.91	$8.00	$0.20	$0.87	$1.45	$0.54	$0.31	$1.75	
Shares O/S			72.5	83.7	136.6	291.1	310.0	353.1	489.1	844.9	

GSAT has been in dire straits for years

Warning: Spectrum Stories Have a Way of Not Coming True

Clearwire

- 2011 investor presentation says **$0.50-$1.00**/MHz-pop:

  ➢ Spectrum valued at $23.2Bn to $46.3Bn assuming $0.50 to $1.00 per MHz-POP

- 2013: sold to Sprint for **$0.30**/MHz-pop

ICO/DBSD

- 2005 offering memo says **$1.64**/MHz-pop:

  Access to Spectrum Could Enhance Value of ICO. ICO should be an attractive partner to communications and media providers. Recent large U.S. spectrum transactions in the 1.9 GHz band have established a median valuation of $1.64 per MHz POP. Using this valuation benchmark, the value of ICO could be enhanced by $4 billion to $10 billion depending on the amount of 2 GHz spectrum ultimately assigned to ICO.

- 2009: satellite sub declares bankruptcy
- 2012: sold to DISH for **$0.15**/MHz-pop

TerreStar

- 2007 investor presentation says **$0.65**/MHz-pop:

  ➢ **Implied spectrum value of over $4 billion[2] based on AWS-Auction 66 REAG market values**

  [2] Based on $0.65/MHz POP of average D, E, and F Auction 66 REAG values, 330 million POPs, and 20 MHz of spectrum

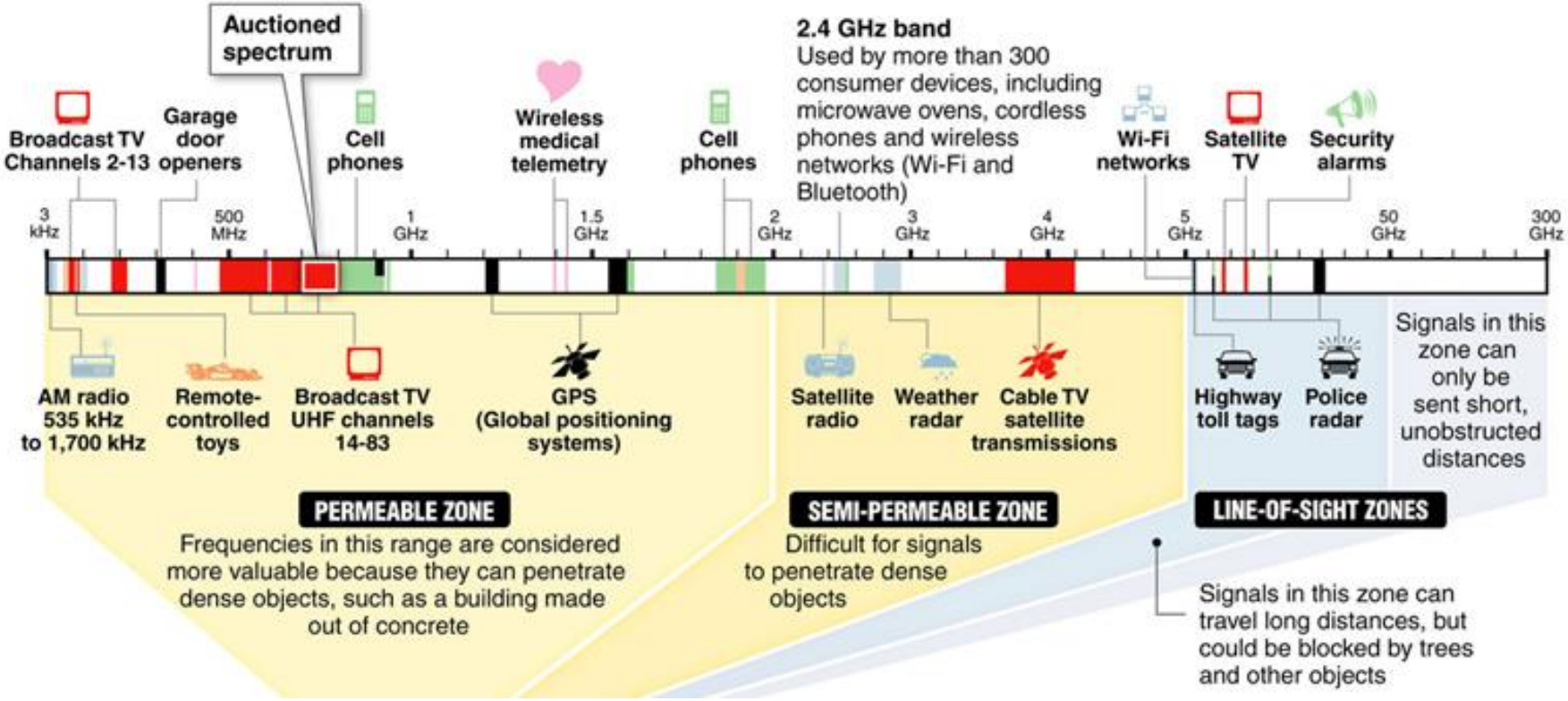
- 2010: declares bankruptcy
- 2012: sold to DISH for **$0.13**/MHz-pop

GSAT bulls had better hope that this time is different

GSAT and Its Spectrum: An Introduction

Spectrum 101: Some of the Basics

- Wireless communications use specific chunks, or “bands”, of electromagnetic spectrum to send signals
- Spectrum utilized by a variety of users, including radar, GPS, TV broadcasting, etc.
  - Frequencies expressed in millions or billions of cycles per second (MHz or GHz)



Spectrum 101: Cellular and Wi-Fi

- Cellular phone service and Wi-Fi both use a variety of bands to transmit signals
- Bands defined by a specific range of frequencies (i.e. “700MHz band”)
  - Often further subdivided into “blocks” or “channels”
- Spectrum can be “licensed” (exclusive to the licensee) or “unlicensed” (public)
  - Example: AT&T holds the license to the 700MHz B block in the New York area
  - Wi-Fi uses unlicensed spectrum in the 2.4GHz “ISM” band and 5GHz “U-NII” bands
- The Federal Communications Commission determines who gets to use which bands of spectrum and for what purposes
  - The FCC regularly changes the conditions under which different users utilize different bands of spectrum, with the goal of maximizing public good
    - ⇨ i.e. FCC revoked Lightsquared’s ability to use its spectrum, because it interfered with GPS
  - When the FCC devises rules on how spectrum may be used, it issues a “Notice of Proposed Rulemaking”, requesting comments from all interested parties
- No one “owns” spectrum
  - The FCC has enormous discretion to modify and revoke licenses

Spectrum 101: A Brief History of Satellite Spectrum

- In the late 1990s, numerous Mobile Satellite Services ("MSS") firms emerged to provide satellite phone and data service
  - The FCC gave MSS carriers free spectrum to use for mobile satellite services
- These companies invested billions of dollars to launch satellites into space, but realized too late that "terrestrial" mobile service (e.g. Verizon) superior to satellite
  - Virtually all MSS carriers went bankrupt in early 2000s
  - Satellite phones became a niche product used only by customers who were out of the range of cell phone coverage areas, like drillship crewmen, mountain climbers, etc.
- Disappointed by the prospects for their satellite operations, MSS carriers began lobbying the FCC to allow them to re-purpose their spectrum for terrestrial usage
  - In midtown Manhattan, where no one would use a satellite phone, MSS carriers asked the FCC to allow them to use their spectrum to provide cell phone or broadband coverage, utilizing land-based base stations (i.e. cell towers) instead of satellites
- FCC faced a dilemma:
  - The problem: Terrestrial cell companies like AT&T and Verizon ***paid*** for their spectrum via auctions, whereas MSS carriers were given their spectrum for free
  - The solution: Allow MSS to re-purpose their spectrum on earth for terrestrial usage, but require them to maintain their satellite operations
    - ⇨ MSS carriers were required to maintain spare satellites, provide coverage in all 50 states, etc.

GSAT's Spectrum

- GSAT is the exclusive licensee to the following spectrum for terrestrial usage:
  - 7.775 MHz of spectrum between 1610 MHz and 1617.775 MHz
    - ⇨ This spectrum resides in the same band as LightSquared's spectrum, which as we'll discuss later renders this spectrum relatively worthless for terrestrial purposes
  - 11.5 MHz of spectrum between 2483.5 MHz and 2495 MHz
    - ⇨ This is the spectrum which forms the underpinning for GSAT's valuation

2003 **The FCC created framework of conditions under which MSS carriers like GSAT could re-purpose their satellite spectrum for terrestrial purposes**

2008 **The FCC authorizes GSAT to lease its spectrum to its newly created partner, Open Range Communications**

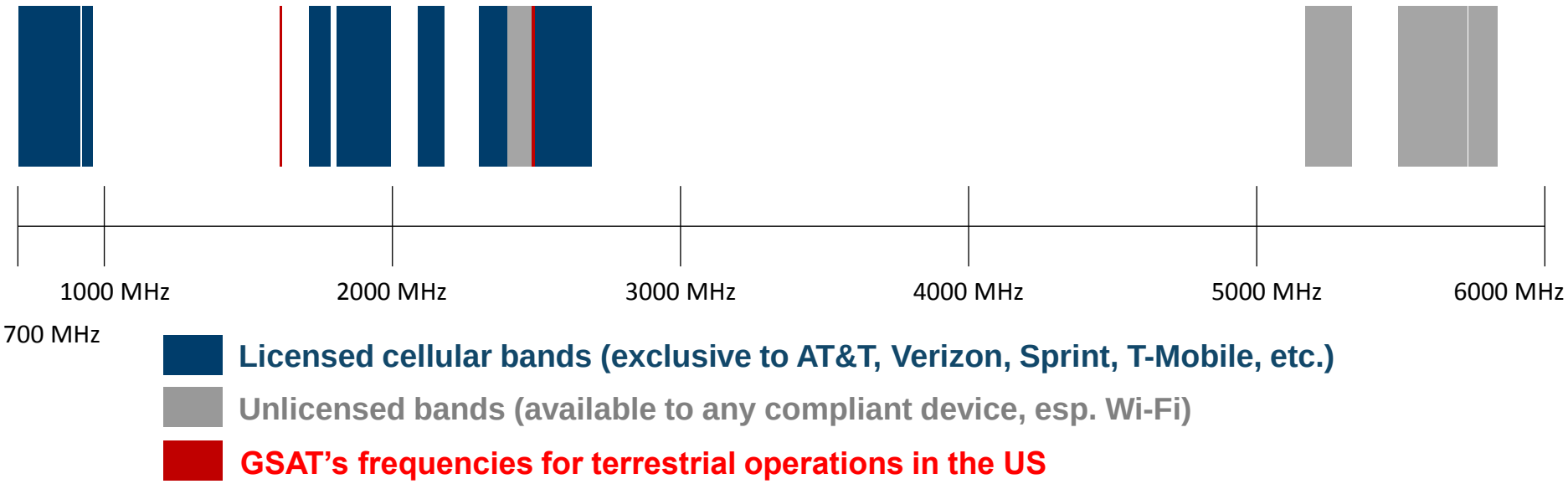
2010 **Open Range was a complete failure and FCC revoked GSAT's right to use satellite spectrum for terrestrial usage, until it came up with a better idea**

GSAT's Better Idea

2011	***DISH buys two defunct MSS companies (Terrestar and DBSD) out of bankruptcy***
2012	***FCC grants DISH's request to convert the acquired spectrum to fully terrestrial use and waives requirements to maintain satellite business***
2012	***In November 2012, GSAT petitions the FCC to allow it to use its spectrum for cellular usage, like DISH, and for a new offering called Terrestrial Low-Power Service ("TLPS")***
2013	***FCC disregards GSAT's request to re-purpose satellite spectrum for cellular usage, but issues Notice of Proposed Rulemaking ("NPRM") on TLPS, soliciting comments from interested parties***
2014	***Comment period for NPRM closed in June 2014, and the public currently awaits the FCC's next actions on the topic***

GSAT's Spectrum in Context (to Scale)

Frequencies that an iPhone 6[1] Can Use Today + GSAT



- The GSAT spectrum story has quietly evolved over time
  - Originally: turn **red** into **blue (ie. Open Range, 2012 FCC petition)**
  - Now: turn **red** into **gray (TLPS is a paid Wi-Fi channel)**
  - (Very different propositions, yet bulls use the same comps)

1. LTE bands supported by iPhone 6 Model A1586. Some bands may not be available in the US.

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A Closer Look Into TLPS

What Is GSAT's TLPS Concept?

- If the FCC authorizes Globalstar's "Terrestrial Low Power Service" (TLPS), GSAT would use its spectrum to create a new "channel" for Wi-Fi transmissions
- What is TLPS?
  - TLPS is a Wi-Fi channel composed of GSAT's licensed spectrum (between 2483.5 MHz and 2495 MHz) and a neighboring unlicensed band (between 2473 MHz and 2483.5 MHz)
  - GSAT would *not* have exclusive access to neighboring band
    - ⇨ Shared with traditional Wi-Fi, Bluetooth devices, etc.
- TLPS is nothing more than one exclusive, licensable Wi-Fi channel
  - Unfortunately for Globalstar, there are 25 other free Wi-Fi channels already available (3 in 2.4GHz and 22 in 5GHz), with potentially more on the way
  - As we'll demonstrate, 25 channels are more than enough to provide fast Wi-Fi in even the highest-density Wi-Fi deployments

Why Does GSAT Say We Need TLPS?

- Below are excerpts from GSAT's FCC filings and website:
  - "The Commission's terrestrial low power rules would deliver substantial and immediate benefits to consumers… by almost immediately expanding the nation's wireless broadband capacity and ***alleviating the worsening Wi-Fi traffic jam*** in the 2.4 GHz band. Accelerating Internet usage and resulting ***congestion*** have diminished the quality of Wi-Fi service at high-traffic "hotspots," and Wi-Fi has become an unreliable way to access broadband in many urban environments."
  - "TLPS would deliver substantial public interest benefits by adding to the nation's supply of broadband spectrum, helping to alleviate the worsening ***Wi-Fi traffic jam***, and expanding wireless broadband capacity for American consumers."
  - "The nation is out of Wi-Fi spectrum. The proliferation of Wi-Fi devices together with mass consumer adoption has resulted in a ***"Wi-Fi Traffic Jam"*** with more data being transported over Wi-Fi than any other medium. Most consumers encounter the "Jam" when attempting to download mobile content in densely populated settings such as airport terminals, apartment buildings, school campuses, or a favorite coffee shop located on a busy street corner."
- Globalstar makes it clear that the main thrust of TLPS is to alleviate "congestion" and "traffic jams" in current Wi-Fi deployments

TLPS supposedly solves the Wi-Fi congestion epidemic

What Benefits Does TLPS *Not* Offer?

- ✕ Creating a "private" Wi-Fi network
  - Wi-Fi networks are generally already private! Authorized users only
- ✕ Creating a "national" Wi-Fi network
  - Has nothing to do with licensed vs. unlicensed spectrum
  - US cable co's (e.g. Comcast) already building out huge hotspot footprints with existing technology and spectrum
  - Large Wi-Fi networks already popular in Europe (Fon, The Cloud…)
  - (Who would pay for all the equipment? Where would it go?)
- ✕ Creating a "lightning-fast" Wi-Fi network
  - Maximum speed would be no better than existing 2.4GHz Wi-Fi (e.g. 802.11n)
  - Maximum speed would be *substantially lower* than next-gen Wi-Fi (802.11ac)
    - ⇨ (802.11ac exclusive to 5GHz, would not work with TLPS)
  - Faster service *only relative to a highly congested network*

Companies already provide private, national and fast networks without TLPS

Is Wi-Fi Congestion Actually a Major Problem?

- GSAT and its promoters: of course it is!
- Below are images from GSAT's website:

"WI-FI TRAFFIC JAM" — 2.4 GHZ UNLICENSED SPECTRUM EXHAUSTED

"WI-FI TRAFFIC JAM" WILL BECOME WORSE AND CONSUMER SATISFACTION WILL DETERIORATE

2014

Existing Wi-Fi Spectrum (2.4 GHz Band) is likely to reach saturation by 2014.
– CableLabs, May 28, 2013

GSAT paints a dire picture of the Wi-Fi status quo…

How GSAT Bulls Envision Existing Wi-Fi Spectrum

A More Accurate Mental Image

The I-10 Katy Freeway in Houston, July 2009. Source: Socrate76 via Wikipedia.

Is Wi-Fi Congestion ***Actually*** a Major Problem?

- If Wi-Fi congestion is so bad, how do you explain the new SF 49ers' Levi's Stadium:

- "Levi's will offer free Wi-Fi, which allows all 60k+ fans to simultaneously connect. Its Wi-Fi infrastructure is designed to be 30 times faster than any other stadium" (bit.ly/49ers-60kfans)
- In home opener, 30k+ of 71k fans at stadium connected to the Wi-Fi network, with peak usage of 19k fans just before kickoff
- One commentator estimated: "40,000 people could live-stream a movie over the Internet while watching a football game." (bit.ly/40k-livestream)

More Examples of Successful Large-Scale Wi-Fi Deployments

- Sochi 2014 Winter Olympics
  - 2,500 Wi-Fi access points supporting 120,000 simultaneous mobile devices
- Super Bowl XLVIII
  - Free Wi-Fi for 82,529 fans. At halftime, 13,500 were connected to Wi-Fi
  - 3.2 terabytes of traffic (1 TB = 1,000 GB)
- Mobile World Congress 2014 (Barcelona)
  - Free Wi-Fi for >80,000 attendees
  - 19.1 terabytes of traffic
  - 5GHz vs. 2.4GHz usage: 58%/42%
- Stanford University Computer Science dept. building
  - 2,700 unique clients per month
  - 1.32 terabytes of monthly traffic
  - Supporting robot users as well as humans!

Engineers have created great Wi-Fi in challenging environments

We Sought Out Alternative Views…

- We spoke to many experts as part of our research, including:
  - Consultant on satellite and wireless business issues
  - Principal of wireless/mobile advisory firm
  - Wi-Fi network architect with extensive experience on national buildouts
  - Wi-Fi network architect specializing in stadium and other high-density deployments
  - Wi-Fi engineers at access point manufacturers
  - Consultant on telecom infrastructure, former director of tech strategy at major carrier
  - Vice president of technology research firm (specialized in wireless networking)
  - Attorney focused on telecom regulation
  - Public-policy expert at open-Internet advocacy group
  - Chief of product management at mobile technology start-up
  - Sales manager at Wi-Fi technology firm
  - President of FCC-approved TCB (Telecommunications Certification Body)
  - (and many more)

What do outside experts think about TLPS?

Expert Views on TLPS, Part 1

"If it [*the TLPS proposal*] *went through, no one would care."*

—head of wireless/mobile advisory firm

"The people you are talking to are full of it. Unlicensed [*spectrum*] *is nowhere near exhaustion…On top of that, FCC is bending over backwards to give us tons of additional spectrum."*

—senior technical leader at top mobile-networking firm

"If performance is the issue, why aren't we moving to 5 GHz? … This is somebody's engineering solution looking for a business problem to solve that doesn't understand how these things actually are regulated."

—engineer and former voting member of Wi-Fi standards body

Expert Views on TLPS, Part 2

[Q. Do you think there's a big [Wi-Fi] interference issue?...Does that sound like a real business problem to you?]

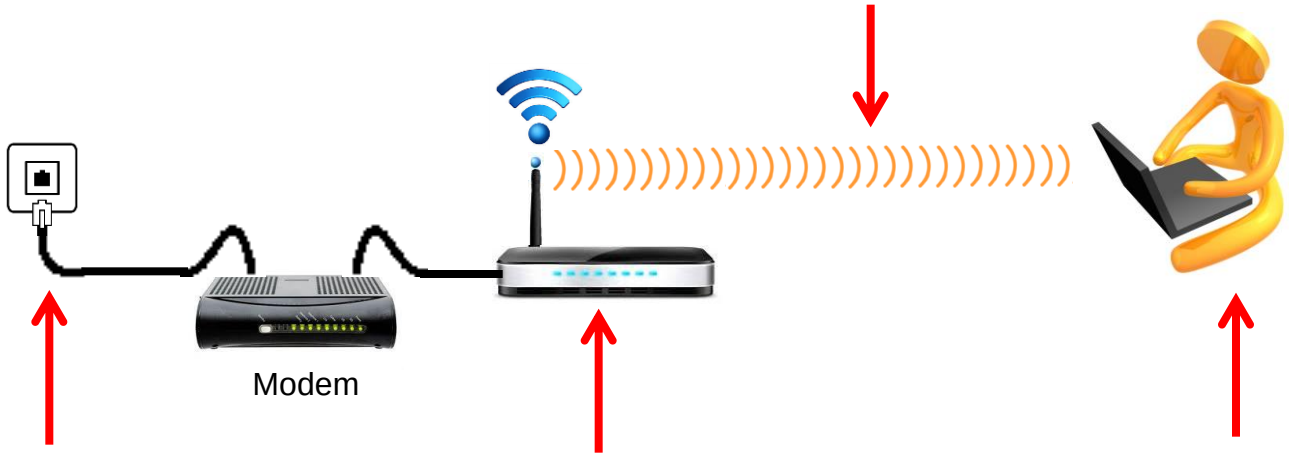
"The answer to that, and how I advise clients, is "no." Interference is the direct result of not understanding how to design the environment to achieve the operational parameters which you're trying to have implemented. If you don't – for example, if you don't design to the right signal-to-noise ratio, you're going to have interference. If you do…you don't have a problem. I've been designing networks for 30 years, and when we're doing mission-critical wireless designs this isn't a problem. So when did this just start coming up? This is marketing…At 5GHz I've got 26 different channels, and we're not seeing any issues being able to move throughout those bands anywhere. And even if I did have adjacent channel interference or capability issues, proper design of the signal-to-noise ratios and the transmit power associated with the access point is how we fix those problems…. So there are a lot of tools that we've always used to be able to solve these problems. If you don't use the tools, then yeah, you can create a bad network. Geez, I can create a bad Ethernet network too! … Interesting thought process, but mostly marketing fluff."

—engineer and former voting member of Wi-Fi standards body

What is a Wi-Fi “Channel”?

- A Wi-Fi channel is a band of spectrum frequencies, typically 20MHz wide, across which Wi-Fi signals are transmitted between “access points” (i.e. routers) and “user devices” (i.e. smartphones, laptops, etc.)

Wi-Fi signals are transmitted from Access Points to User Devices across a **“channel”**, which is a ~20Mhz band in the electromagnetic spectrum



Internet signals come in through wired cable / fiber provided by Time Warner, Verizon FiOS, Comcast, etc.

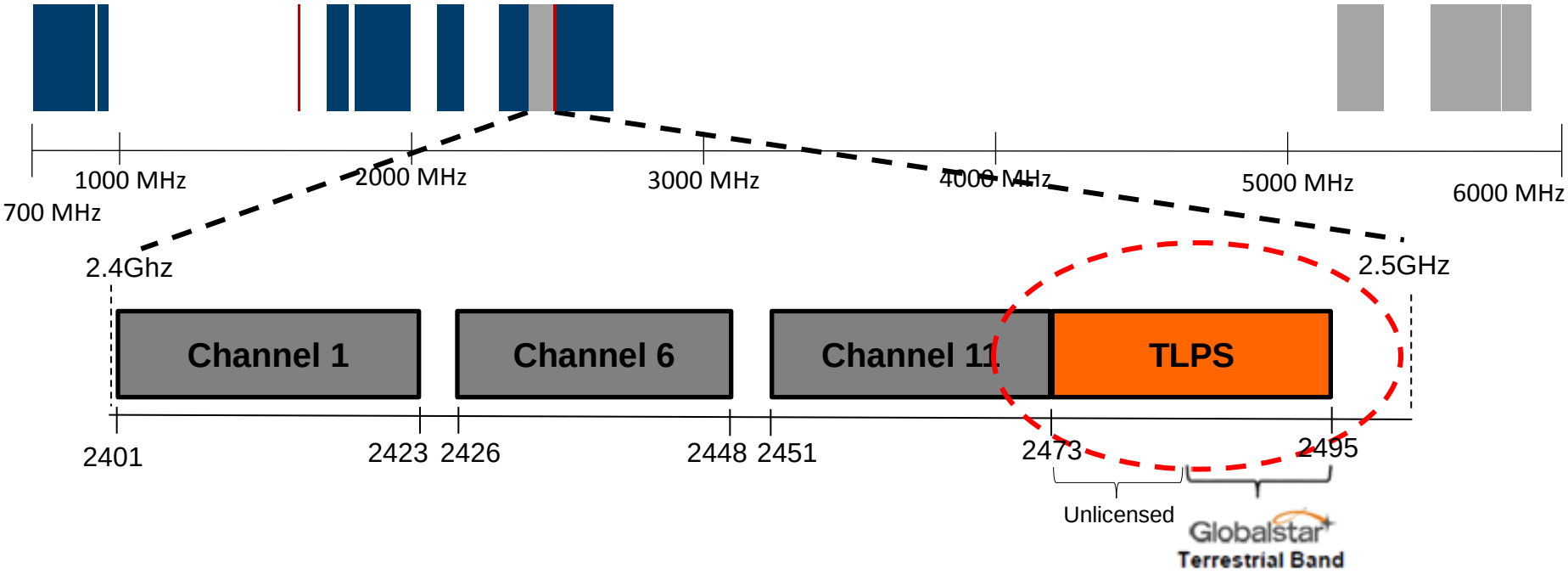
Wi-Fi “access points” transmit signals to and receive signals from user devices

“User devices” include smartphones, tablets, laptops, etc.

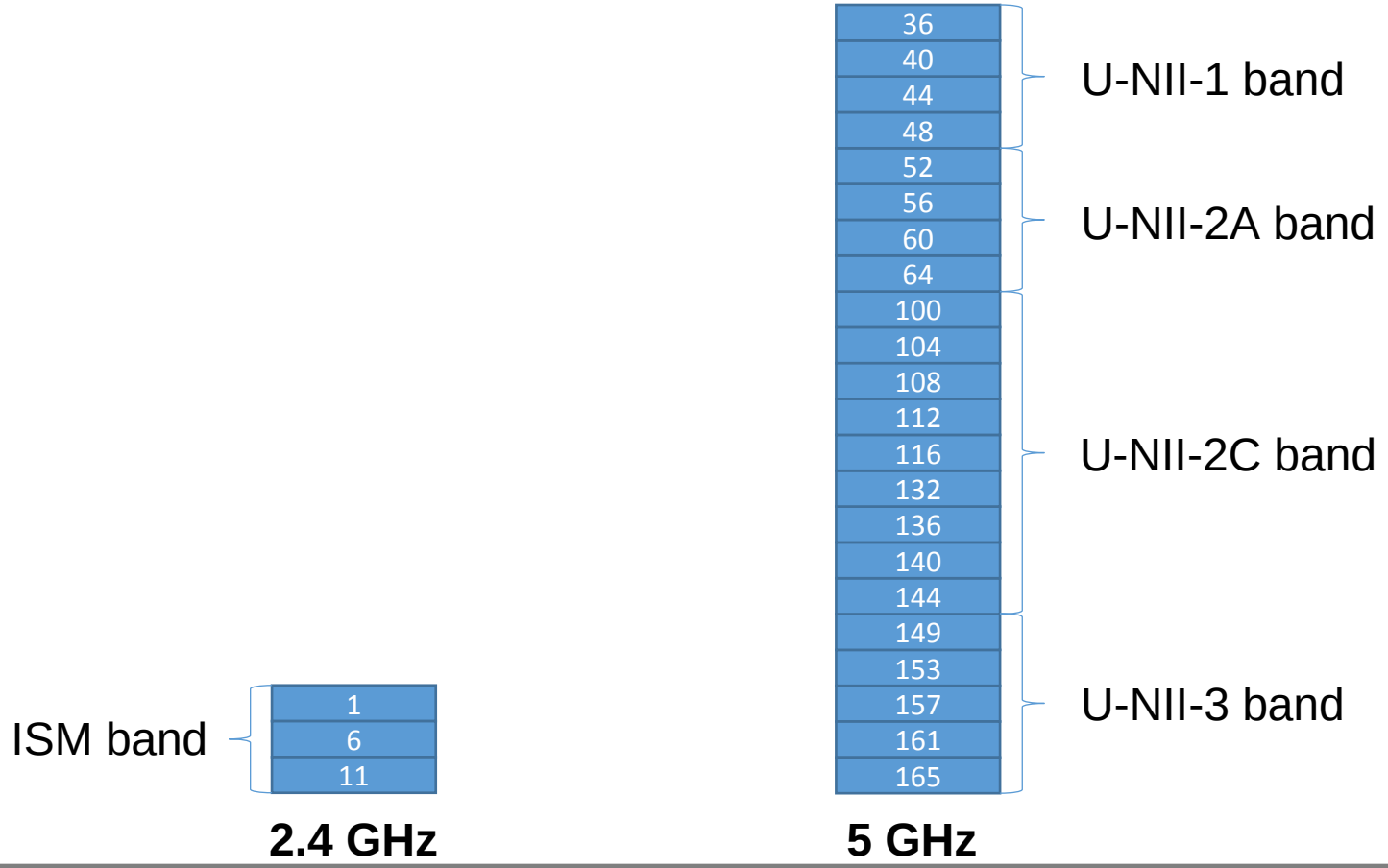
Graphic Representation of GSAT's TLPS Concept

- The 2.4GHz unlicensed band is used by Wi-Fi. In the U.S., users predominantly transmit signals on channels 1, 6, and 11
- TLPS would be a 4th non-overlapping channel (called channel 14) between 2473MHz to 2495MHz, and would be exclusive to GSAT and its customers

Below are the spectrum frequencies used for cellular and Wi-Fi, with a focus on the 2.4GHz band

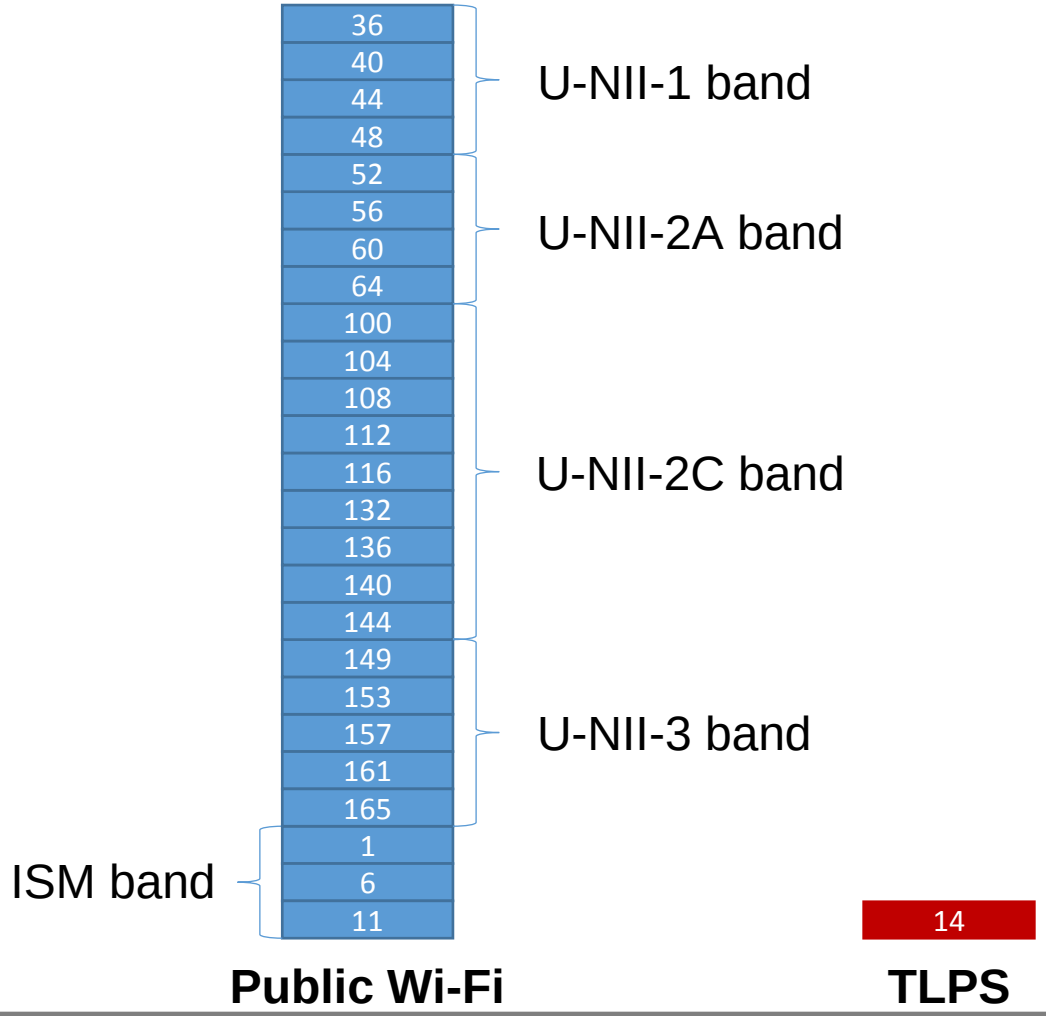


How Many Wi-Fi Channels Are There?



Free channels in US today: 3 in 2.4 GHz, 22 in 5 GHz

What Would TLPS Contribute?



TLPS = one additional channel *when there are 25 other ones available!*

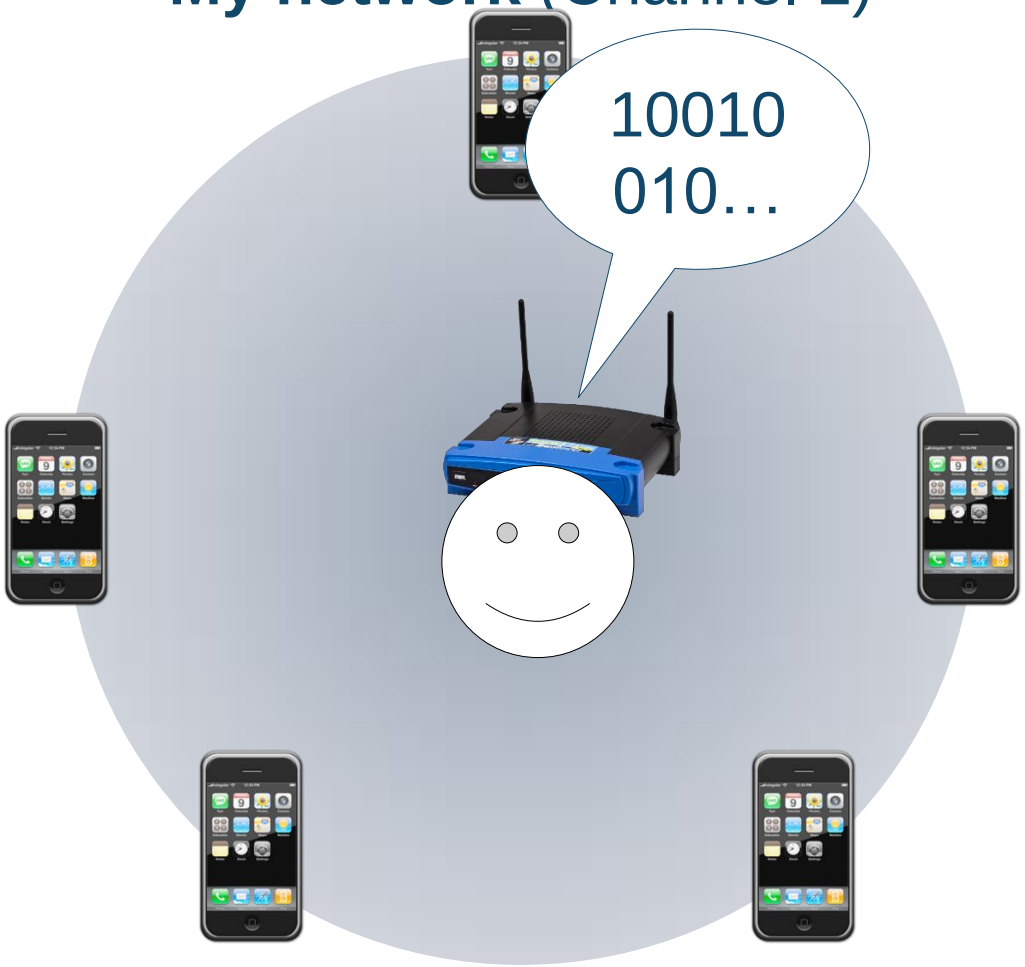
What Exactly is Wi-Fi Congestion?

- Wi-Fi congestion is more commonly called "Co-channel interference"
- Co-channel interference results when there are too many signals on a single channel
  - The issue: too many devices trying to share a single channel in a single location
  - Too many users on one access point or too many access points sharing a channel
- Wi-Fi signals follow a 'politeness protocol' → APs / user devices scan channels to see if there are other signals on channel before transmitting
  - Wi-Fi's Politeness Protocol = **LISTEN BEFORE YOU TALK!!!**
  - Many signals on channel → APs / user devices keep waiting and waiting → slow speeds

If multiple access points are all using the same channel, and many user devices (i.e. 20+) are utilizing substantial bandwidth at the same time on that channel, co-channel interference can cause slow Wi-Fi

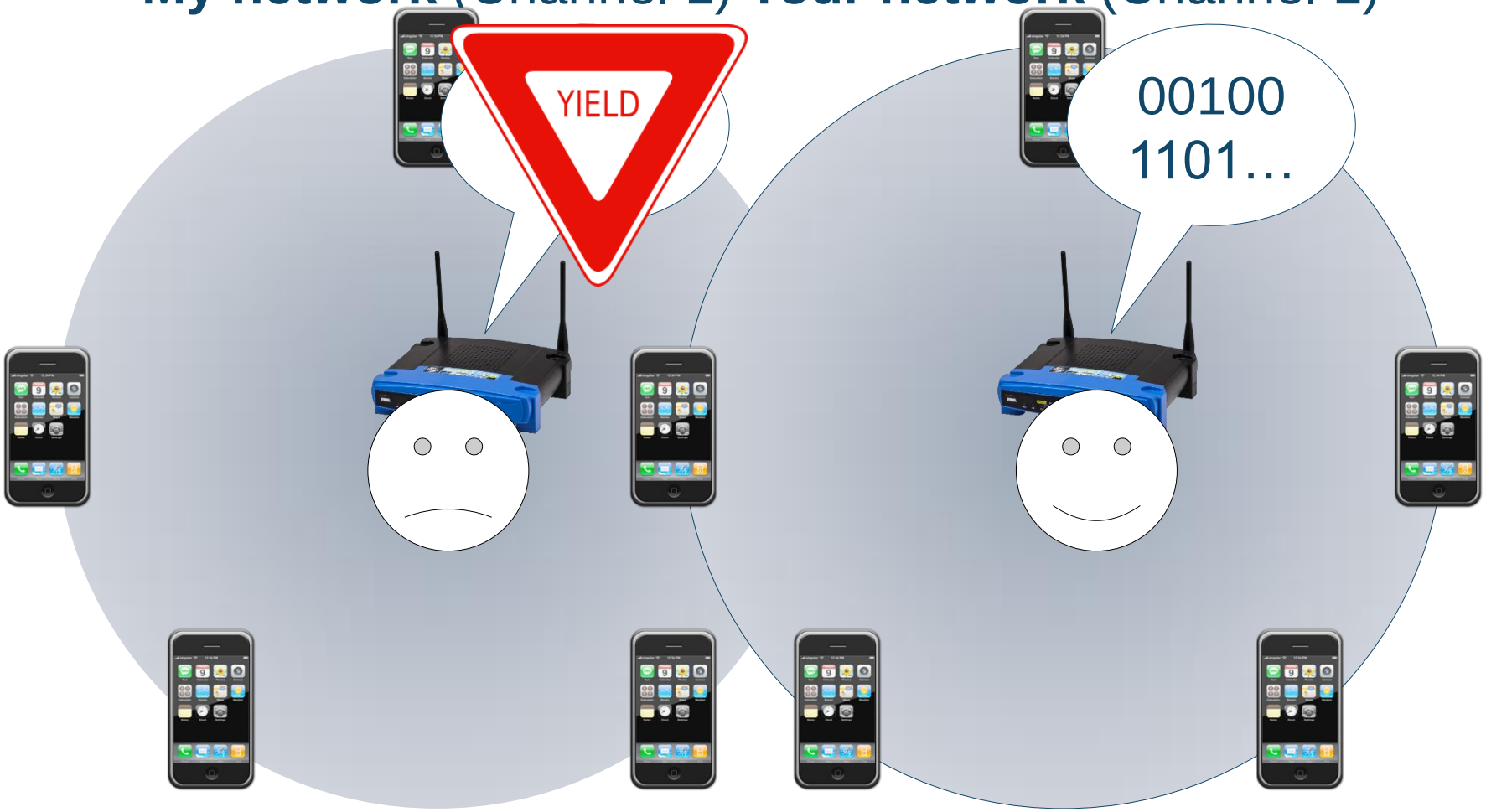
Explaining Co-Channel Interference

My network (Channel 1)



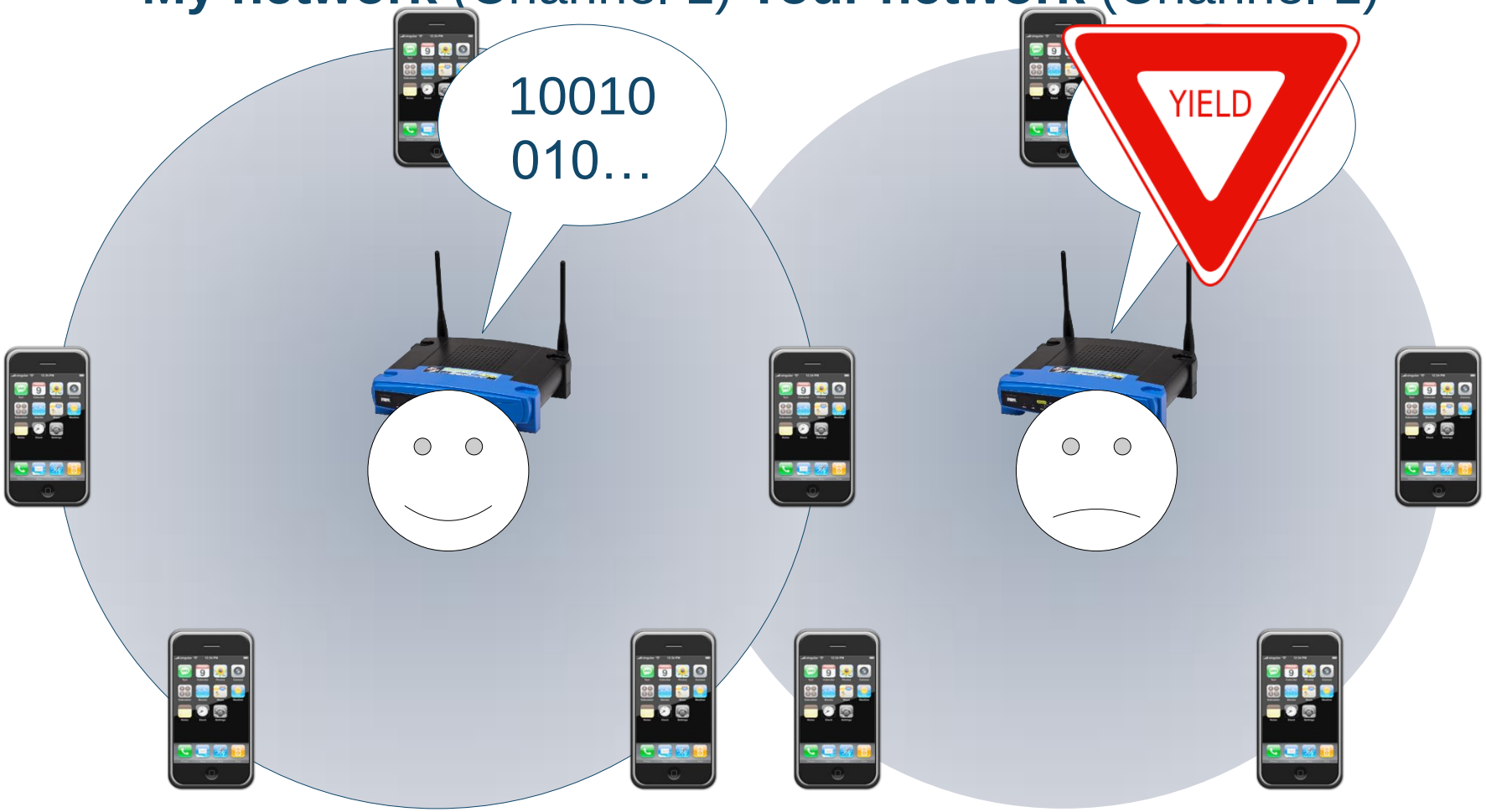
Explaining Co-Channel Interference

My network (Channel 1) **Your network** (Channel 1)



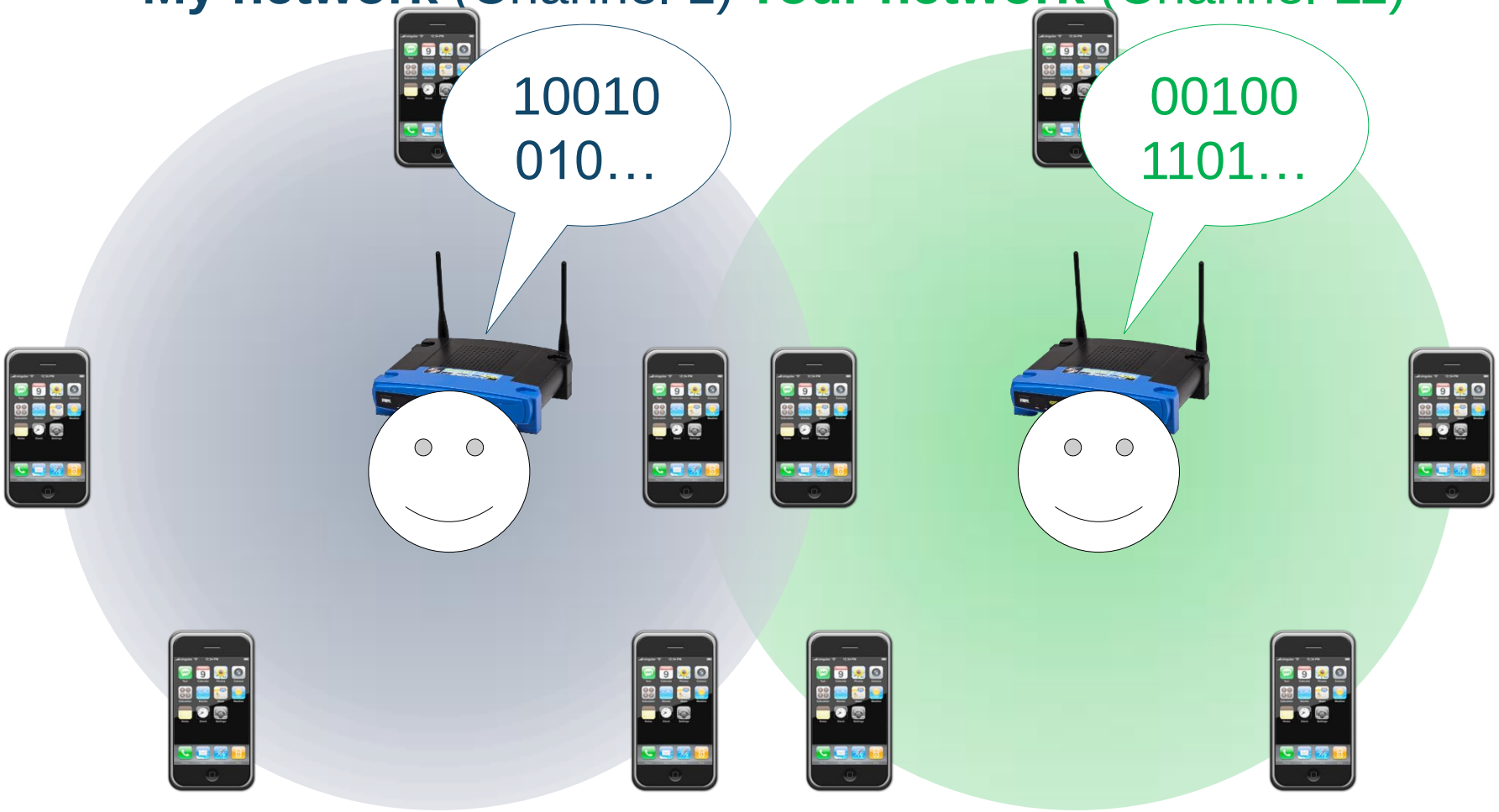
Explaining Co-Channel Interference

My network (Channel 1) **Your network** (Channel 1)



Explaining Co-Channel Interference

My network (Channel 1) **Your network** (Channel 11)



How Do You Solve Co-Channel Interference?

Deploy Multiple Access Points

- Unlike cellular signals, Wi-Fi signals travel short distances:
  - Wi-Fi signals typically travel ~100 feet, whereas cellular signals travel 1+ mile
  - If access points are 300 feet from each other, they won't necessarily detect each other
- A channel can comfortably handle ~30 user devices

+

Access Points Use Different Channels

- There are 25 different channels that can be used
  - 3 in 2.4GHz, 22 in 5GHz

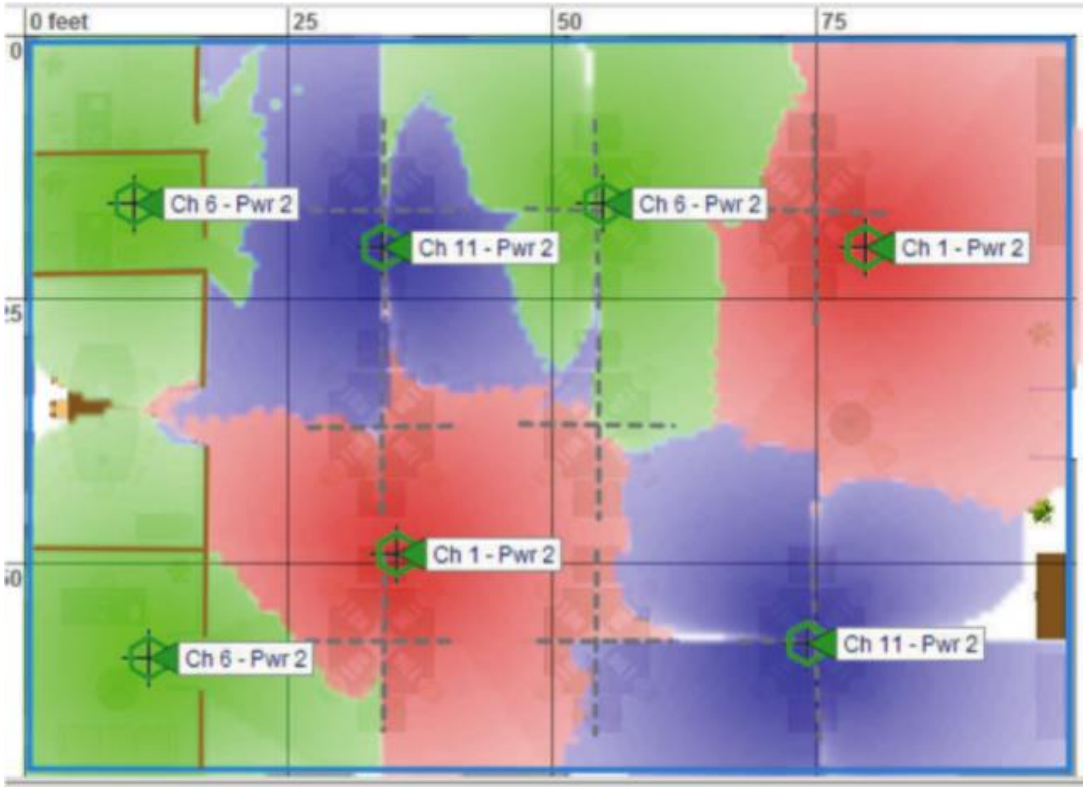
+

Channel Re-Use

- Because Wi-Fi signals travel short distances, access points can be placed far enough away from one another such that channels can be re-used
- Power of access points can be turned down and artificial / natural barriers utilized to further prevent channel overlap

Channel Reuse, in Picture Form

- Below is a 1-6-11 channel reuse pattern

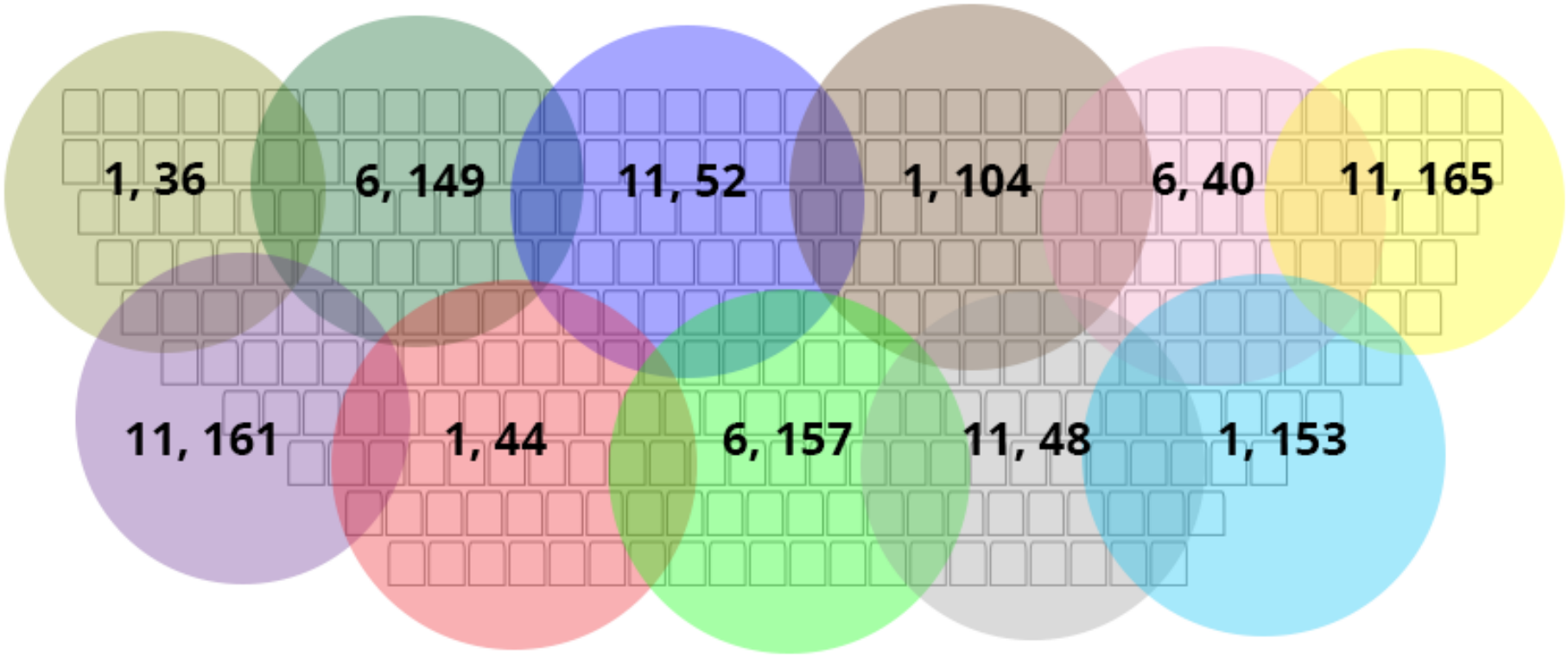


http://blogs.aerohive.com/blog/the-wireless-lan-training-blog/wifi-back-to-basics-24-ghz-channel-planning

- As Wi-Fi has become more popular, it's become obvious that deployments would benefit from having more than 3 channels to reuse. The solution? 5 GHz!

Illustrative Example: Access Points in an Auditorium

- Below is an illustrative example of access points in an auditorium
- Each circle refers to an access point's range, and the numbers in the circle refer to the 2.4GHz and 5GHz channels on each access point
- A typical access point can easily handle 20-100 user devices

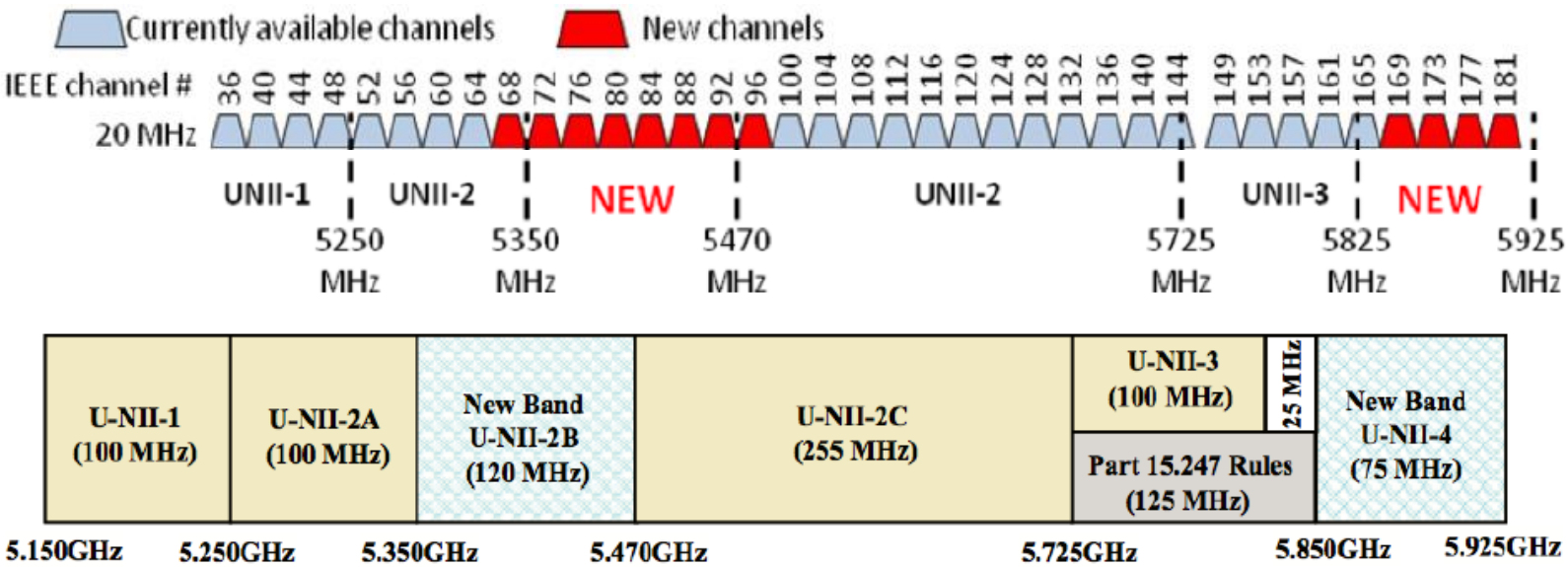


Examples of Channel Re-Use Wi-Fi deployment

- By deploying numerous access points that each have limited ranges, and having access points utilizing different channels, and benefitting from the fact that each access point can typically handle 30+ user devices, “Wi-Fi congestion” is a problem that’s solved routinely by network administrators all over the world
- Because access points can have limited ranges, power levels can be reduced, and barriers can be utilized to block signals, channels can be re-used many times in the same environment
- Examples
  - We spoke with the network administrator of a major university, and in their main library, the university deploys 26 access points which utilize ~12 channels in both 2.4Ghz and 5GHz, and provide Wi-Fi services to peak usages of 2,000 students
  - At Interop Las Vegas, 68 APs provided service to a maximum of 1,496 concurrent users (http://www.theruckusroom.net/2014/06/a-wi-fi-gamble-at-interop.html)
  - Fashion Institute of Technology: network of 1,000 802.11ac APs serving 10,000 students along with faculty, staff, and a museum with 100,000 annual visitors
  - Sheraton Gateway LAX: 802 guest rooms (500,000+ square feet), covered with 48 APs

5GHz Provides 22 Channels! And that Will Increase in the Future!

- 5 GHz provides more than enough channels for IT professionals to deploy Wi-Fi in even the most high-density, high-use environments
- Many high-density environments only use 8-12 channels, because they don't even need the remainder
- The FCC is studying the addition of another ~12 channels in the future



Source: Andrew von Nagy, "Going Beyond RF Coverage: Designing for Capacity," from wirelessLAN Professionals Summit 2014

Regulators are pushing to make 5GHz Wi-Fi spectrum even more abundant

Statistics on 5GHz Usage Today and In the Future

- 5GHz is widely used today, and its use will increase in the future
- Examples
  - At the Mobile World Congress, 58% of devices at the 2014 Mobile World Congress used 5GHz (mobileworldcapital.com/en/article/457)
  - At the Cisco Live 2014 conference, 60% of wireless devices used 5GHz and 80% of wireless traffic was transmitted over 5GHz (bit.ly/1vVotoO)
  - At a major sporting and concert venue in Vegas, 5GHz usage was 40% in 2013, 50% at beginning of 2014 and ~80% today
- Commentary
  - "We heavily rely on band select to place as many devices as possible on 5Ghz where more channels are available." *–Joe Rogers, Associate Director of Network Engineering at University of South Florida (bit.ly/joerogers)*

5GHz is widely used today, and will only be more widely used in the future

5GHz in Practice, in the Words of a Practitioner

- Below is an excerpt from DigitalAir Wireless Networks, an IT consultancy based in the UK, in their “A Quick Guide to 5GHz in the UK”

To demonstrate why 5GHz is pretty awesome; imagine 500 people in a single room together all using wireless devices. Now lets take an enterprise level access point capable of sensibly handling 50 clients on its 2.4GHz radio. With 3 of these in a single room (channels 1, 6 and 11) you have no channel overlap and the capacity for 150 clients. But what about the other 350 you ask? Well no problem, lets change these 3 access points for dual radio 2.4/5GHz access points. Now each 5GHz radio can take on 50 clients too... that results in 300 clients now being looked after by the network. But wait, there are still 200 clients not being looked after... The problem is we have used the 3 non-overlapping 2.4GHz channels so can't really use them again as it is a single room with no walls to attenuate the signal. Have no fear though! This is where the larger number of usable 5GHz channels comes in handy. By adding another 4 access points which only have their 5GHz radios switched on you can now handle all 500 clients and haven't reused any channels anywhere in the room (3 access point radios on 2.4GHz and 7 radios on 5GHz). Hurrah!

Now the above is just a simple example, and assumes that all the devices being used are dual band devices that support both 2.4GHz and 5GHz. Also, in reality with some clever design incorporating a mixture of cleverly placed directional access points, the right power levels and various other tricks of the trade you may be able to re-use some of your 2.4GHz channels without it being too detrimental but hopefully you get the idea.

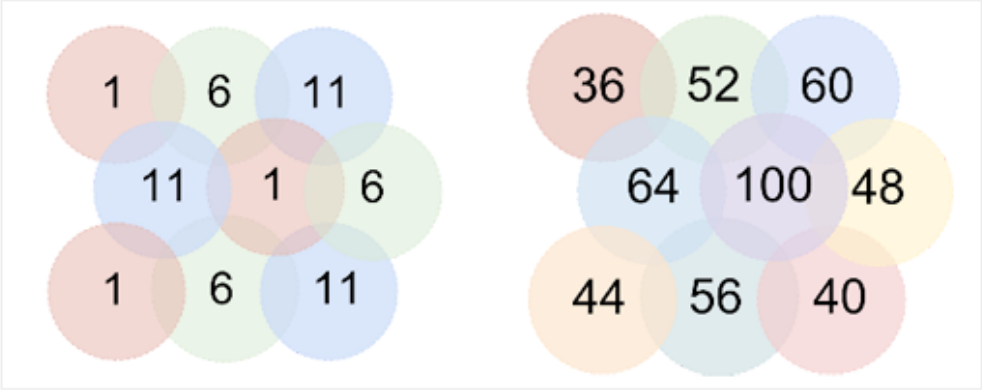
Source: http://www.digitalairwireless.com/wireless-blog/t-eirp/quick-guide-to-5ghz-uk-part-2.html

Wi-Fi Practitioners are flawlessly deploying Wi-Fi in many high-density settings

5GHz Wi-Fi Makes Channel Planning Even Easier

- Metageek (major producer of Wi-Fi network-analysis tools for IT professionals)

Below are two channel diagrams used to plan deployments. In the 2.4 GHz deployment, Channels 1, 6, and 11 are reused and spread apart. The 5 GHz deployment is able to use nine different channels with no danger of sharing a channel.



Channel Planning in 2.4 and 5 GHz.

Now, you have a good foundation of the differences between the 2.4 GHz and 5 GHz bands. You've seen real examples of what activity looks like as seen in MetaGeek's Chanalyzer spectrum analysis software, as well as simulated coverage maps that compare the two. By using dual-band access points for your wireless deployments, you'll be able to double your potential wireless bandwidth, lower the impact of interference, and enjoy an all-around better Wi-Fi network.

← 5 GHz: *"no danger of sharing a channel"*

"The 5 GHz band…is relatively empty"

Automatic Channel Selection

- Thus far, we have focused on high-density managed networks with multiple access points provided by the same provider
- What about environments comprised of multiple different parties each utilizing 1 or 2 access points?
  - i.e. What about co-channel interference in a busy Manhattan street with a McDonald's, Starbucks, Burger King, Pret a Manger, and other parties each with their own access point?
- Access points utilize automatic channel selection algorithms to scan the surrounding area and select channels that are being unused or underutilized
  - i.e. If neighboring access points are utilizing channels 1 & 6, access point selects channel 11
- Even the most basic Linksys routers have auto channel selectors:

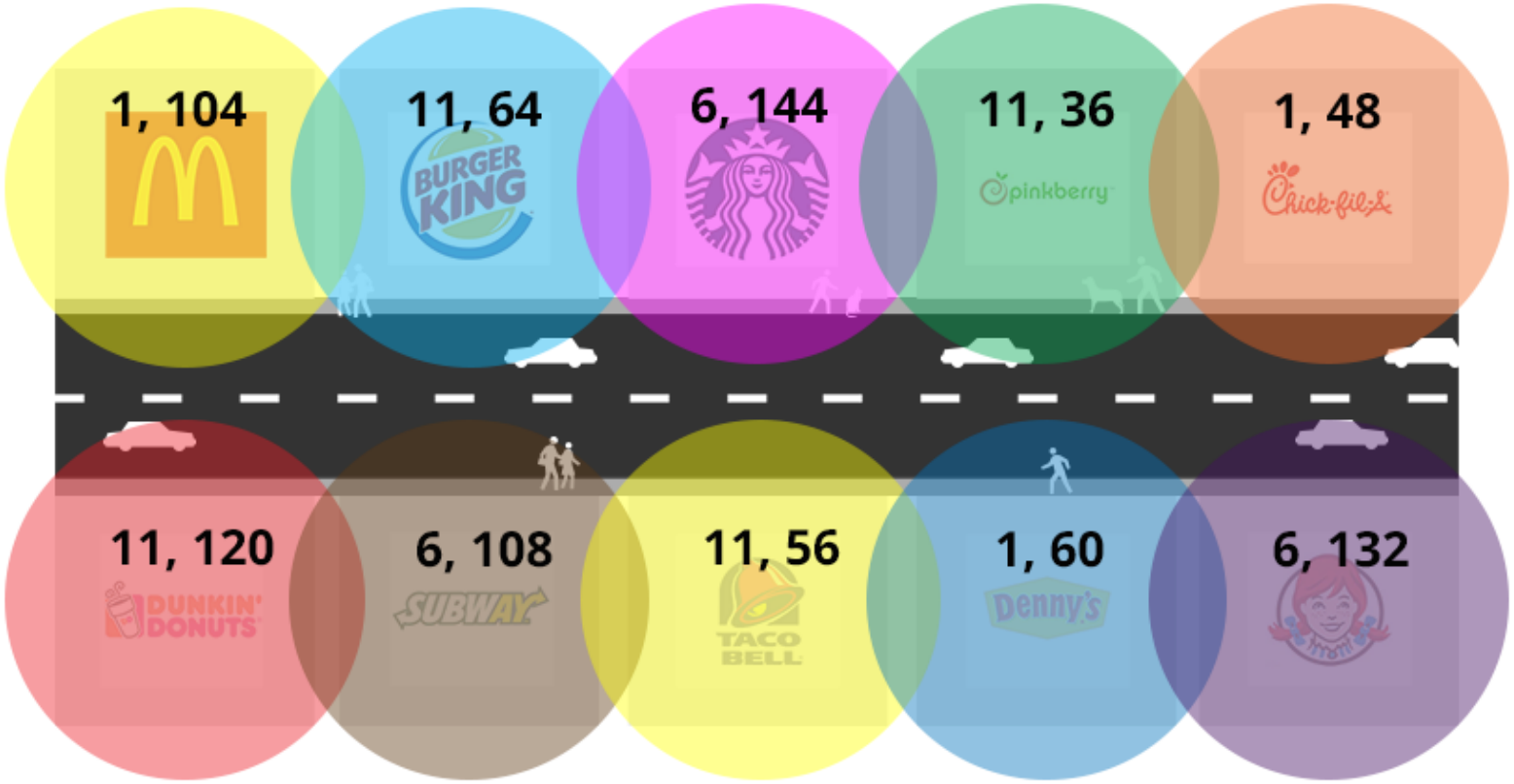
g. **Channel**—Choose the operating channel for each band. Your router will automatically select the channel with the least amount of interference if you leave the default **Auto** setting. We recommend keeping the default settings for both bands.

From Linksys EA6900 User Guide

- Enterprise access point makers like Ruckus have sophisticated auto channel selectors like ChannelFly, that dynamically change channels as usage ebbs and flows between different APs: www.ruckuswireless.com/technology/channelfly

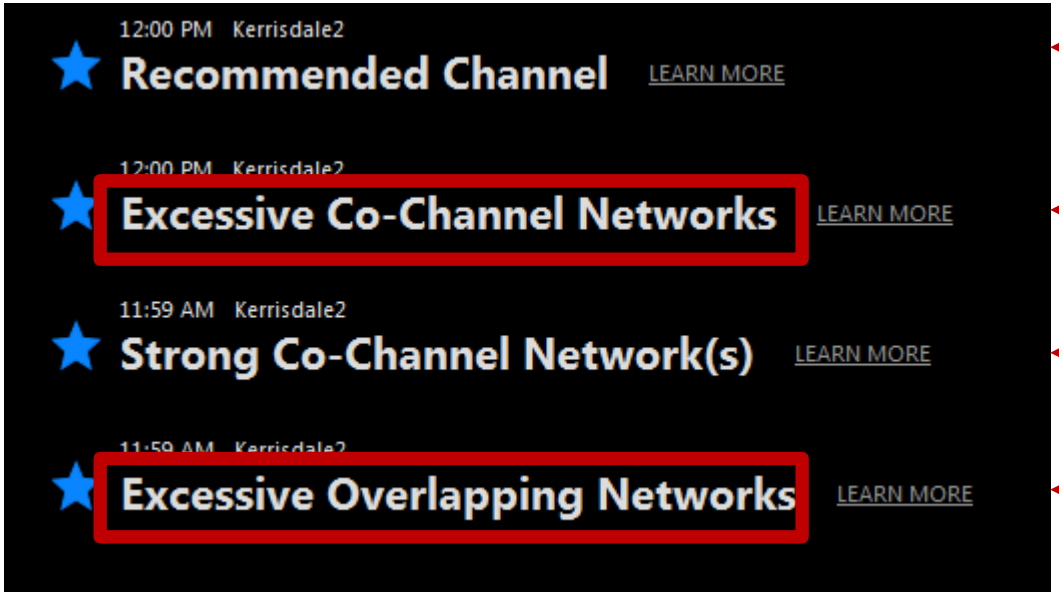
Illustrative Example: Access Points on a Busy City Block

- Below is an illustrative example of an unmanaged network
- Each circle refers to an access point's range, and the numbers in the circle refer to the 2.4GHz and 5GHz channels on each access point



Wi-Fi Shortcomings: A Real-Life Case Study

- Small Wi-Fi network in Midtown Manhattan
  - One access point, ~20 users
  - Ran Metageek software to analyze performance
    - ⇨ Lots of problems!



Using a sub-optimal channel

Sharing channel with many other networks…

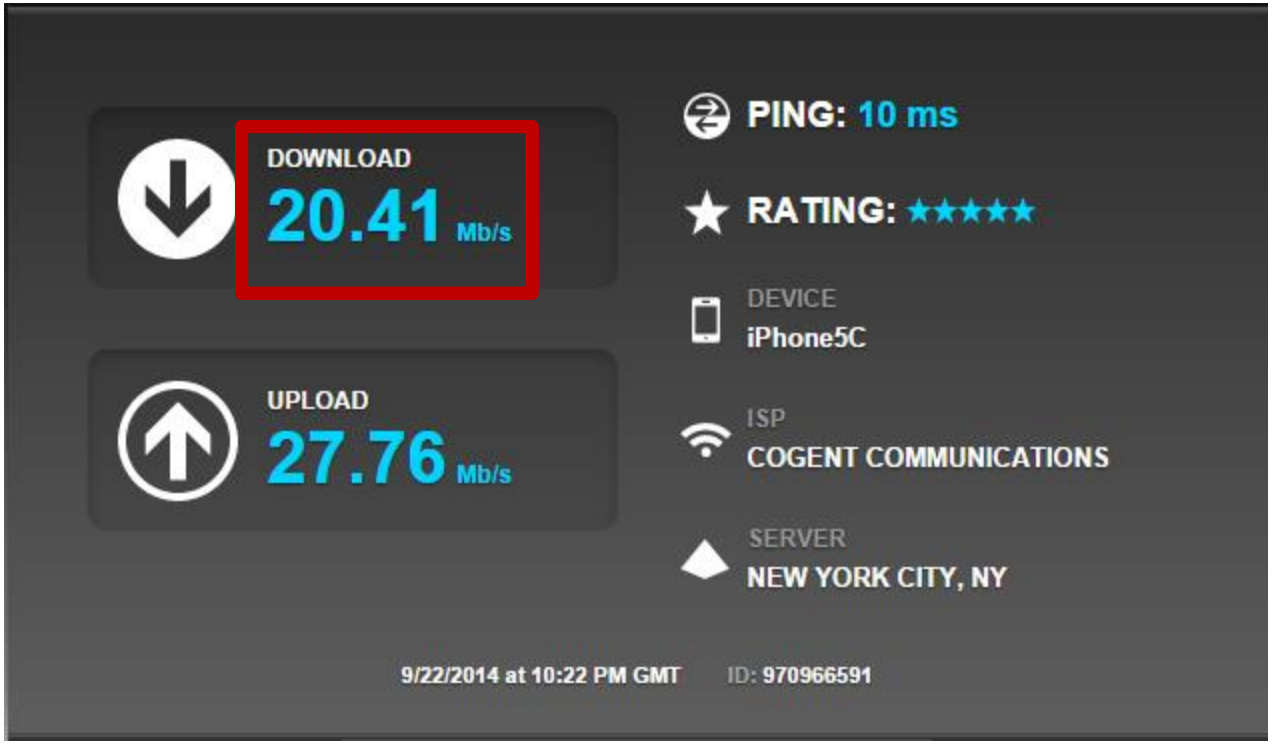
…with high signal strength

Lots of networks in neighboring channels

Screenshot from Metageek inSSIDer Office

This is a Wi-Fi congestion nightmare…

But Is This Network Really So Bad?



Screenshot from Ookla SpeedTest

- Result: 4x the throughput that Netflix recommends for HD streaming
  - So…who cares?

…but "congestion" may not mean bad performance

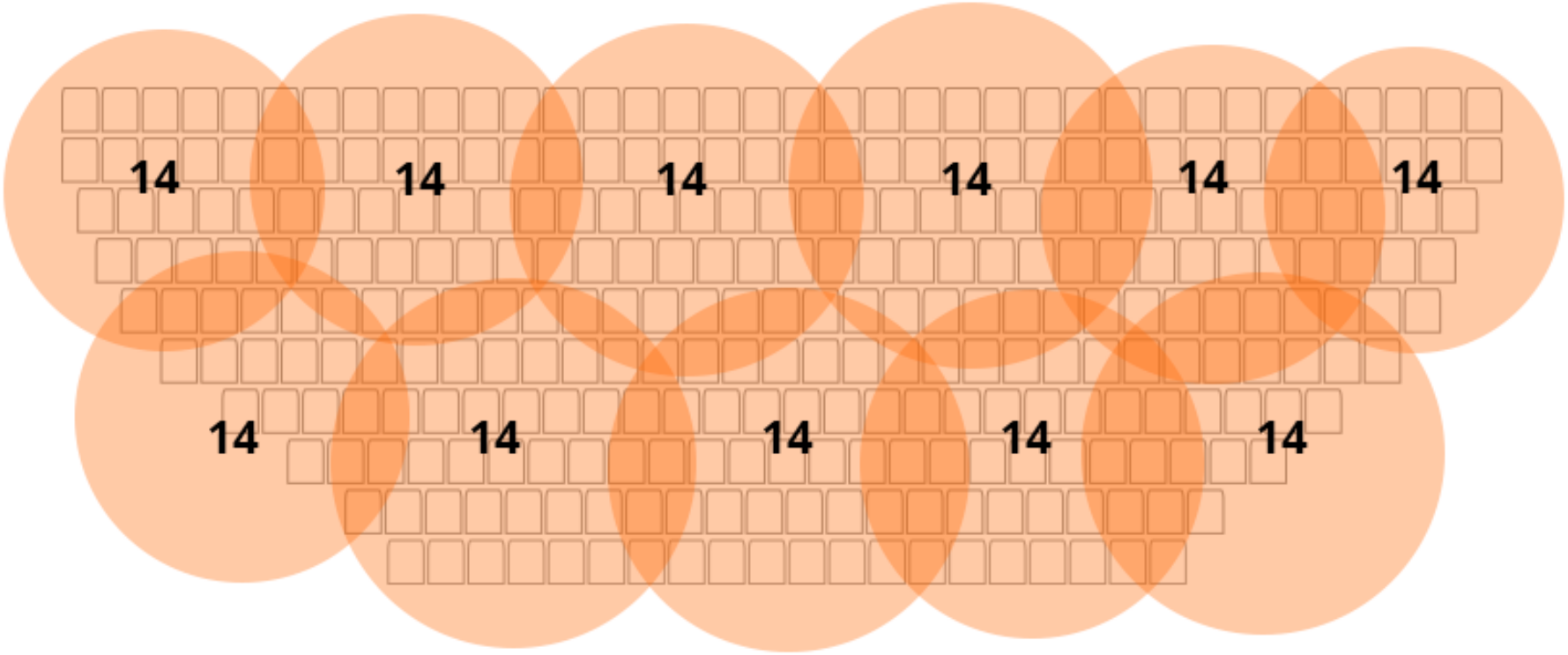
Bad Wi-Fi Has Many Possible Causes

- On average Wi-Fi performs well, but (of course) performance varies
- Many reasons for bad performance that TLPS can't address, e.g.:
  - Legacy devices on the network (esp. 802.11b)
  - Low-quality AP or controller hardware
  - Slow backhaul (e.g. old DSL connection)
  - Too many users per access point
  - Badly chosen access-point locations (e.g. placed near barriers)
- Huge improvements possible with *no new spectrum:*
  - Starbucks switching to Google/Level 3 for in-store Wi-Fi
    - ⇨ Expected speed improvement: 10x
  - Aruba Networks field test in Hong Kong university environment
    - ⇨ "Band steering" toward 5GHz doubled average throughput
    - ⇨ 60% of devices achieved speeds >10 Mbps, up from 20% w/o band steering

Bad Wi-Fi typically does not have anything to do with "congestion"

What Would TLPS Actually Look Like? Part 1

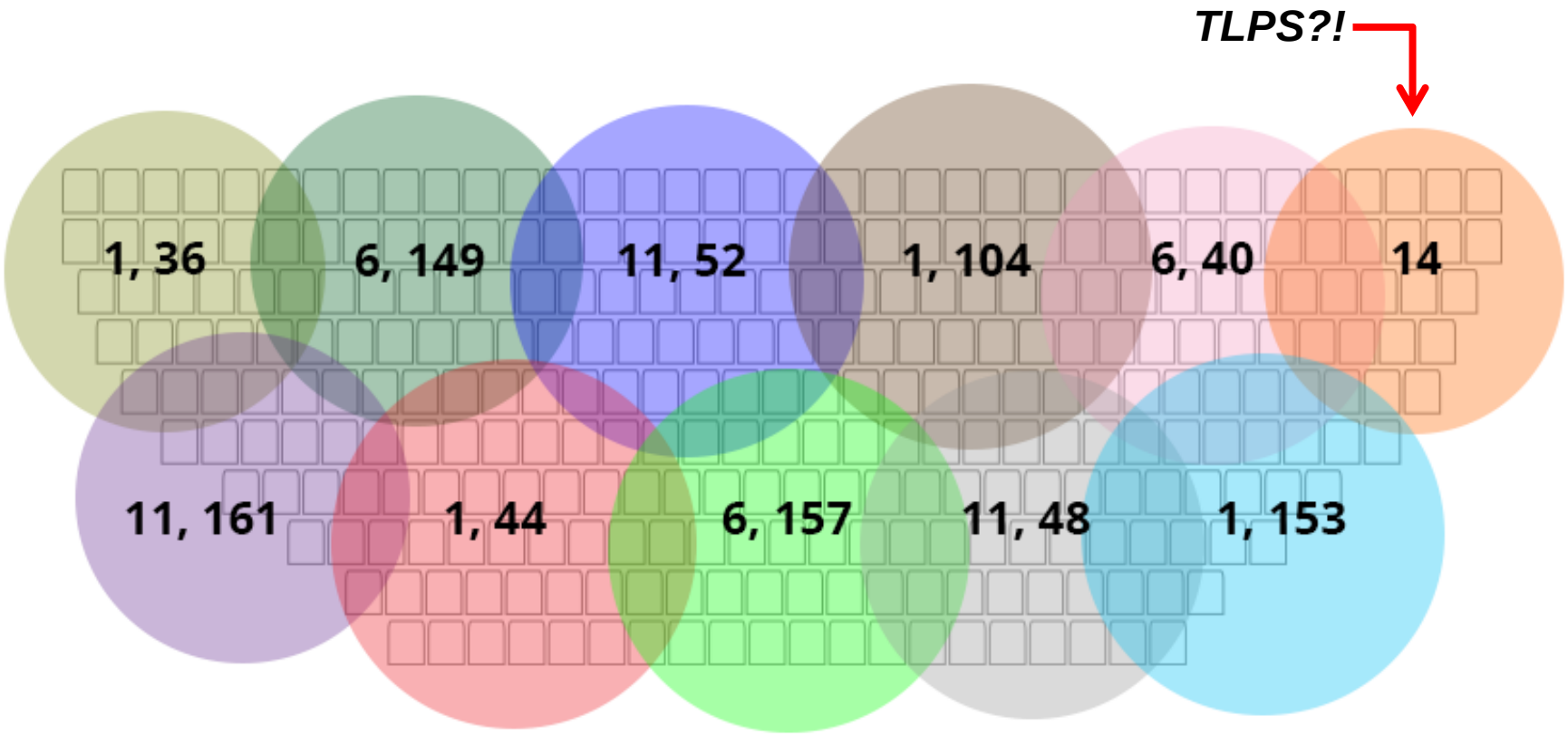
- In a managed network, would it be one licensable channel being constantly re-used?



This is a Wi-Fi congestion nightmare, everyone's using the same channel!

What Would TLPS Actually Look Like? Part 2

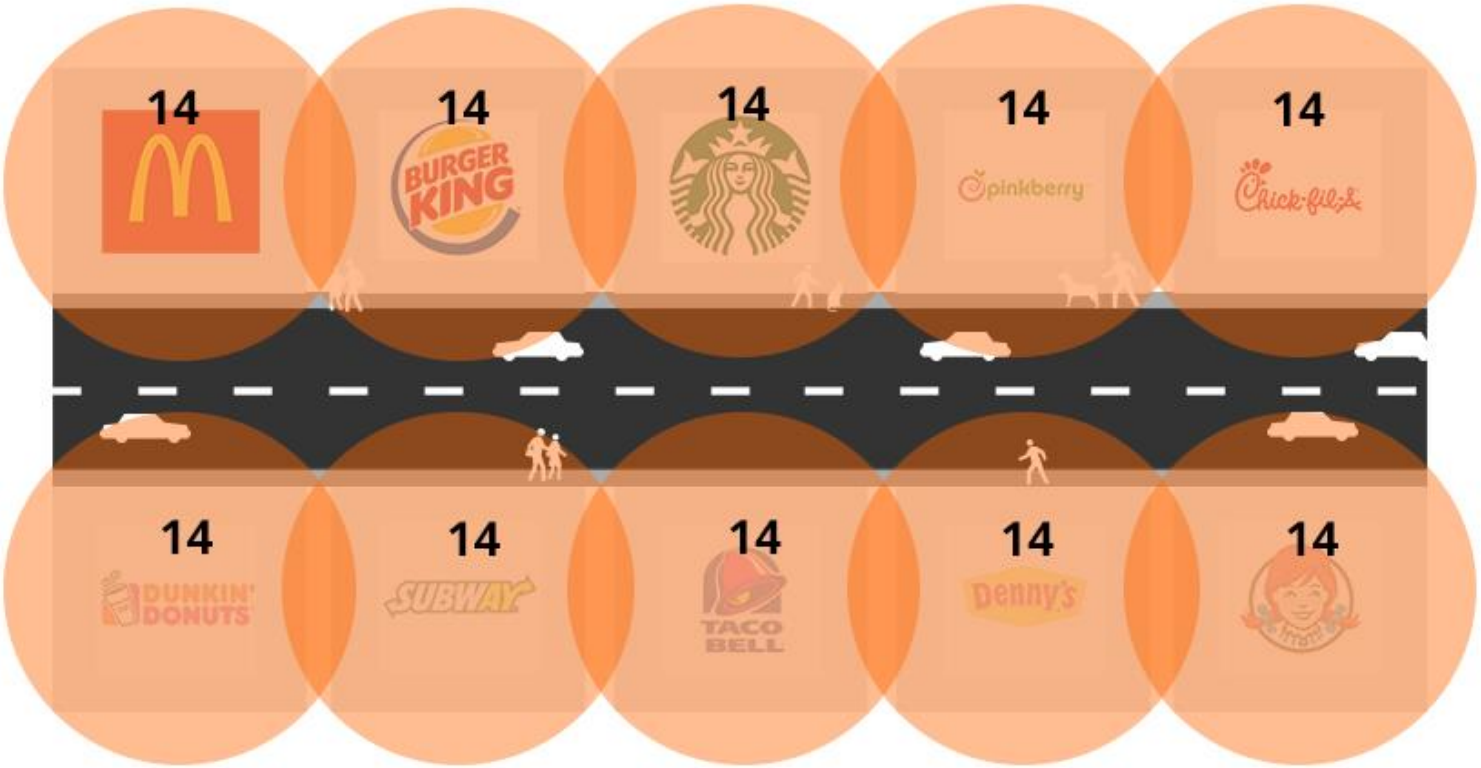
- In a managed network, would it be one licensable channel when the others are free?



Why would you use Channel 14, when there are 25 free channels?

What Would TLPS Actually Look Like? Part 3

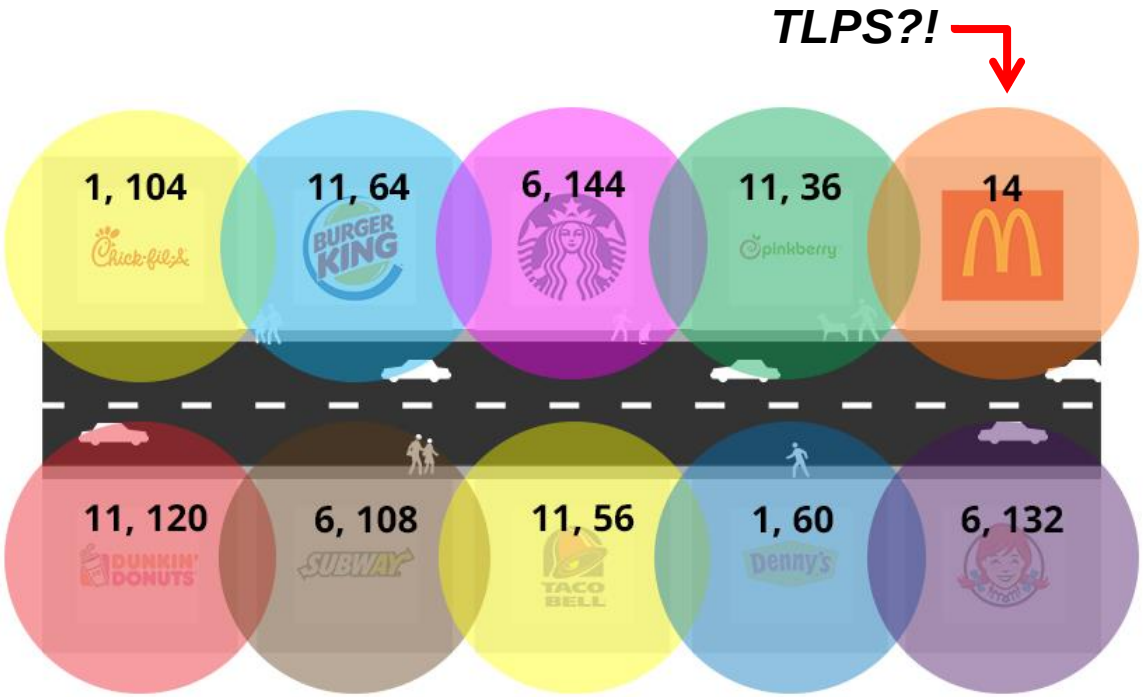
- In an unmanaged environment, would everyone have TLPS?



This is a Wi-Fi congestion nightmare, everyone's using the same channel!

What Would TLPS Actually Look Like? Part 4

- In an unmanaged environment, who would pay for a Wi-Fi channel that can be gotten for free?



- **Can't use 802.11ac or 5GHz**
- **Can't use 40MHz+ channel sizes**
- **Can't have multiple access points**
- **Must pay Globalstar a fee**

And what's the benefit? Just add an AP with a new 5GHz channel if co-channel interference is *that* much of a problem!

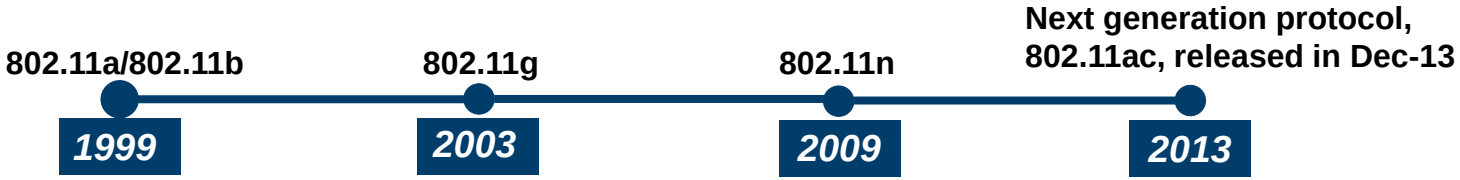
WHY WOULD ANYONE NEED A PAID WI-FI CHANNEL?!

IF THERE ARE 25 WI-FI CHANNELS THAT CAN BE RE-USED OVER AND OVER AND OVER AGAIN FOR FREE, WHY WOULD ANYONE PAY FOR A 26TH WI-FI CHANNEL?!

TLPS is a Non-Solution for a Non-Problem

Next-Generation Wi-Fi at 802.11AC Exclusive to the 5GHz Band

- Wi-Fi is governed by the IEEE 802.11 protocol, which is a set of network access specifications that provides the rules by which Wi-Fi wireless user devices and wired networking infrastructures communicate with one another
- Every few years, the IEEE LAN/MAN Standards Committee release a new generation of 802.11



- 802.11ac uses ONLY 5 GHz, and does not even operate on 2.4 GHz!!
  - 802.11ac provides faster speeds, better spectral efficiency, boosts throughput
- Over the next few years, the vast majority of Wi-Fi traffic will utilize 802.11ac

2.4 GHz networking is five feet under with 802.11ac

Wednesday, October 12, 2011 by *Matthew Gast*

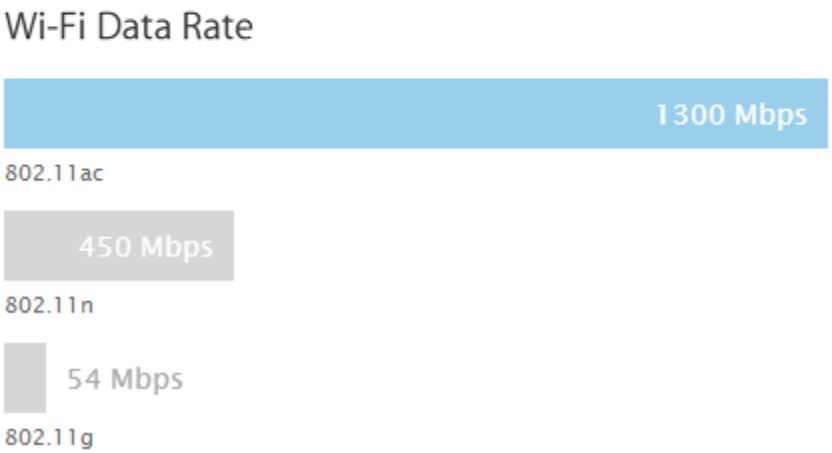
As a result, 802.11n is likely to be the capstone technology in the 2.4 GHz band. 802.11n is as good as it gets for 2.4 GHz. New standards will bring higher speeds, but the new standards won't come to 2.4 GHz.

TLPS can never be as good as 802.11ac can

Next-Generation Wi-Fi Is Starting to Appear

Up to 3x faster Wi-Fi. 802.11ac.
The definition of fast.

MacBook Air supports ultrafast 802.11ac Wi-Fi. When connected to an 802.11ac base station — including AirPort Extreme and AirPort Time Capsule — wireless performance is up to 3x faster than with the previous generation of Wi-Fi or MacBook Air with 802.11n Wi-Fi.[2] And your Wi-Fi range improves as well. With Bluetooth technology, you can connect MacBook Air to Bluetooth-enabled devices like speakers and headphones. Even without all the wires, you're totally connected.



Source: Apple

Stuck on 2.4GHz, TLPS users will never enjoy these lightning-fast speeds

Access Point Manufacturers Are Urging Increased Use of 5GHz

- Access point manufacturers are guiding enterprise users to maximize usage of 5 GHz and minimize usage of 2.4 GHz:

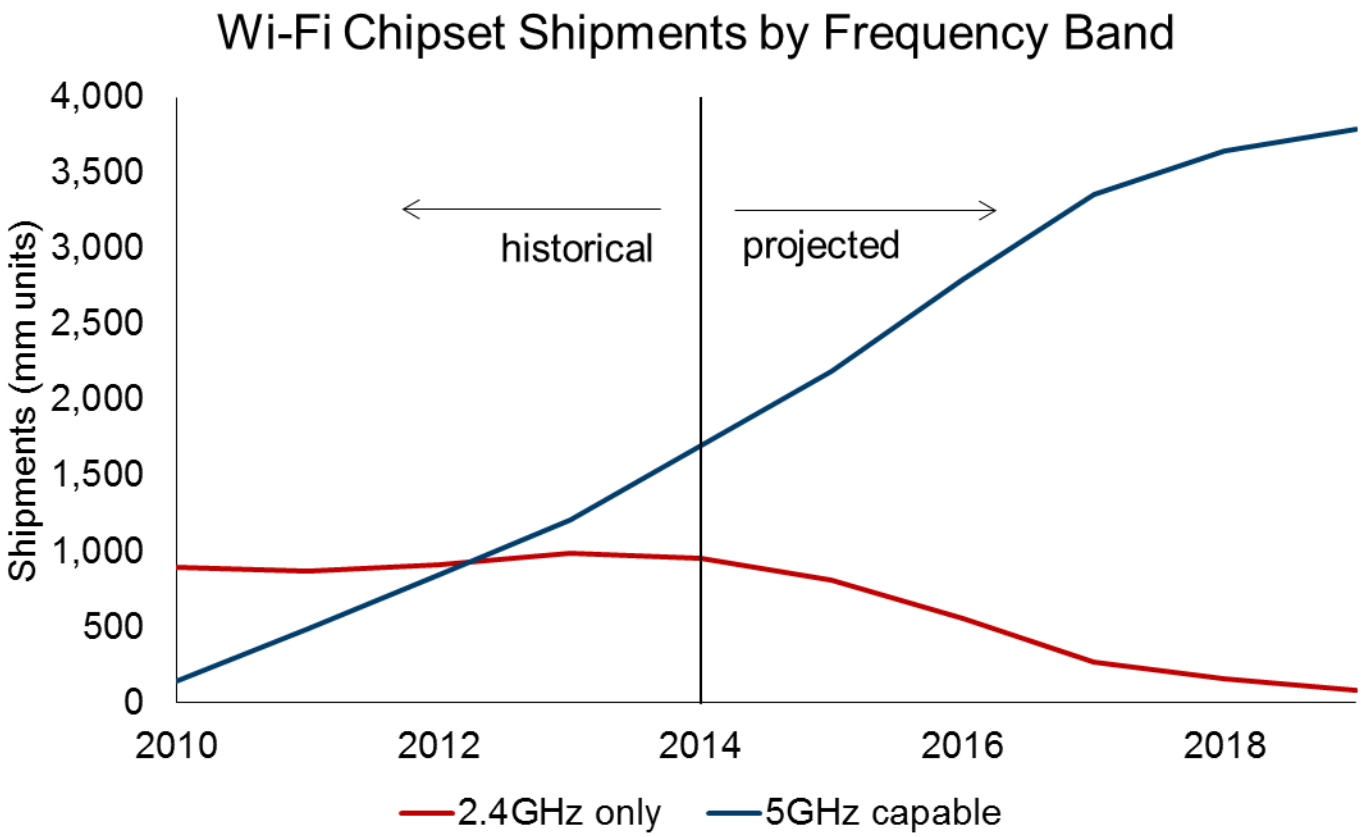
" The multimedia-grade residence hall *must* use the 5 GHz band as the primary service band for students. Using the 5 GHz band as the primary band may be a mindset change for some network administrators. However, we must stop thinking of "offloading" the 2.4 band (which implies that 2.4 GHz is primary). Instead, we must think of the 2.4 GHz band as the "legacy" or safety-net band to provide service to those devices that are not capable of using the extra capacity and speeds of 5 GHz.

The 2.4 GHz band has only three to four low-capacity channels available, and it will never scale to deliver high-capacity services. However, the 2.4 GHz band plays a vital role, which is to "bridge the gap" and allow legacy and low-speed devices to communicate within the microcell infrastructure… Smartphones are easily capable of overwhelming 2.4 GHz channels, so it is a good idea to partition their traffic on a separate band."

- Aruba Networks White Paper on "Next Generation Wireless Architecture for Multimedia-Grade Residence Halls"

Don't Use 2.4 GHz!!

5GHz Wi-Fi Has Been Here for Years

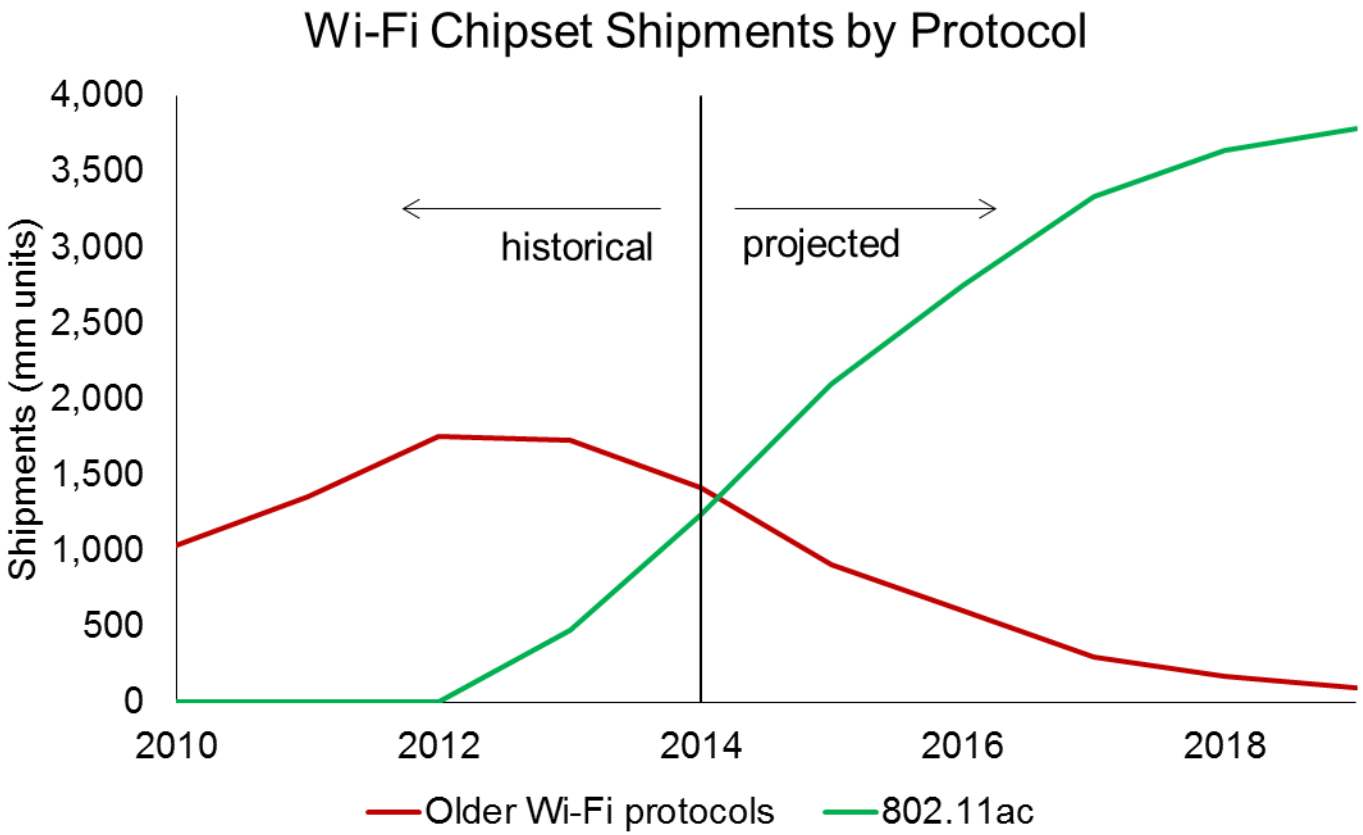


Source: ABI Research, Kerrisdale analysis. Note: 802.11g/b/a category assumed to be 2.4GHz only. 802.11ad-only WiGig devices excluded.

2.4GHz-only chips are rapidly going extinct

802.11ac Is Here Today and Will Dominate in the Future

- Key 802.11ac features require 5GHz's abundant bandwidth, low interference



Source: ABI Research, Kerrisdale analysis. Note: 802.11ad-only WiGig devices excluded.

In 2018 TLPS will *still* be using an obsolete, decade-old technology

Band Steering Shows that Experts Prefer 5GHz Today

- Cisco Meraki: "the MR18 uses band steering to automatically serve 5 GHz-capable clients with the 5 GHz radio, maximizing capacity in the 2.4 GHz range for older 802.11b/g and 2.4 GHz-only clients"
- Aruba Networks: "Adaptive Radio Management" (ARM) → "No more RF interference"
  - "ARM's band steering feature encourages dual-band capable clients to stay on the 5GHz band on dual-band APs, freeing up resources on the 2.4GHz band for single-band clients"
  - "Band steering reduces co-channel interference and increases available bandwidth for dual-band clients, because there are more channels on the 5GHz band than on the 2.4GHz band"
- Ruckus Wireless: "5 Ghz – The Key to Client Density"
  - "[T]he 5 GHz band has much more capacity. Depending on a specific nation's regulations there may be as many as 23 non-overlapping channels available in the 5 GHz spectrum!"
  - "Ruckus APs now support Band Steering to help with exactly this type of deployment"
- Aerohive Networks: "Moving user traffic to the 5 GHz radio band…is a long-standing technique to increase total throughput"

Enterprise-grade hotspots push users toward 5GHz

Expert Views on TLPS, Part 3

There's just nothing in the Globalstar thing that I see as all that exciting …That's what I'm trying to figure out. What is the application? … I don't know what you do with this or where, to be honest.

Nobody's doing [*2.4GHz-only networks*]. *That's like a '90s thing.*

It's not like you're doing anything revolutionary with this.

I don't mean to throw water on it, but I feel like that's what I'm doing.

—Wi-Fi engineer managing network that serves >100,000 devices

Expert Views on TLPS, Part 4

We design for 5-gig exclusively. The 2.4 is an afterthought. … No one writes for 2.4 anymore because it's stupid. The only reason, only only only reason, for 2.4 is if you have a device that's so old it can't use 5-gig.

If you call me four years from now and say, "I've got this cool idea about 2.4," I'd say, "What are we doing in 2.4? We stopped using that years ago!"

I would strongly recommend that Globalstar just give it up and put [*the spectrum*] *back in the public domain… but then their investors wouldn't get any cash. But I don't think they're going to get any cash anyway!*

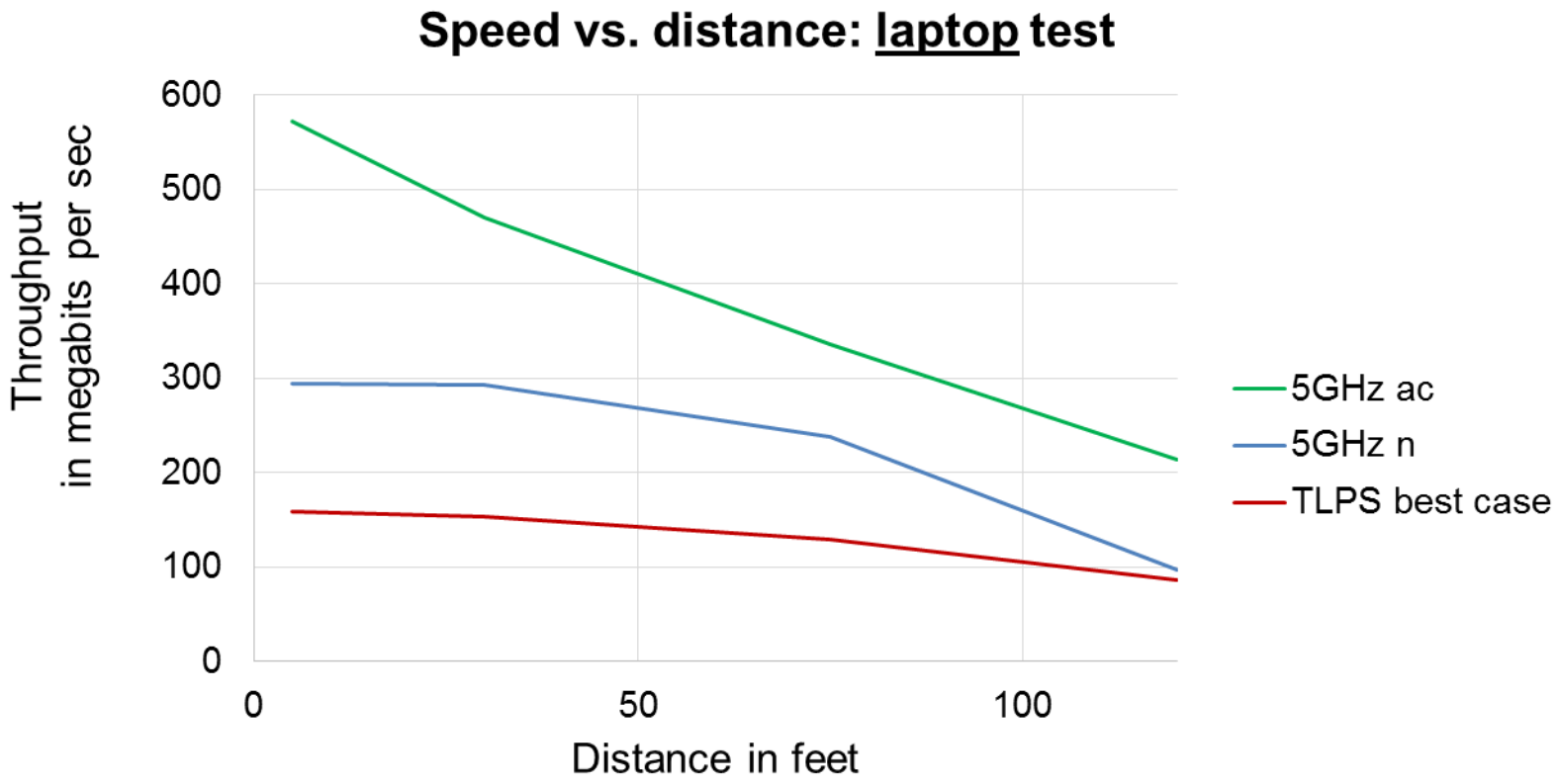
—high-profile Wi-Fi expert with more than a decade of experience

TLPS = Slower Wi-Fi, Part 1

- Common market perception: TLPS would be faster than normal Wi-Fi
- But remember: *no new technology*
  - TLPS cannot *possibly* outperform other 2.4GHz channels unless they are suffering from major interference
  - TLPS would almost certainly be **slower** than 5GHz Wi-Fi
    - ⇨ Even with 802.11n
    - ⇨ *Especially* with 802.11ac
- Inherent throughput disadvantages of TLPS:
  - Narrow bandwidth
  - Less efficient modulations (no 256-QAM)
  - More adjacent-channel interference (e.g. with Channel 11)
  - Harder to create small cells

TLPS would pale in comparison to state-of-the-art Wi-Fi

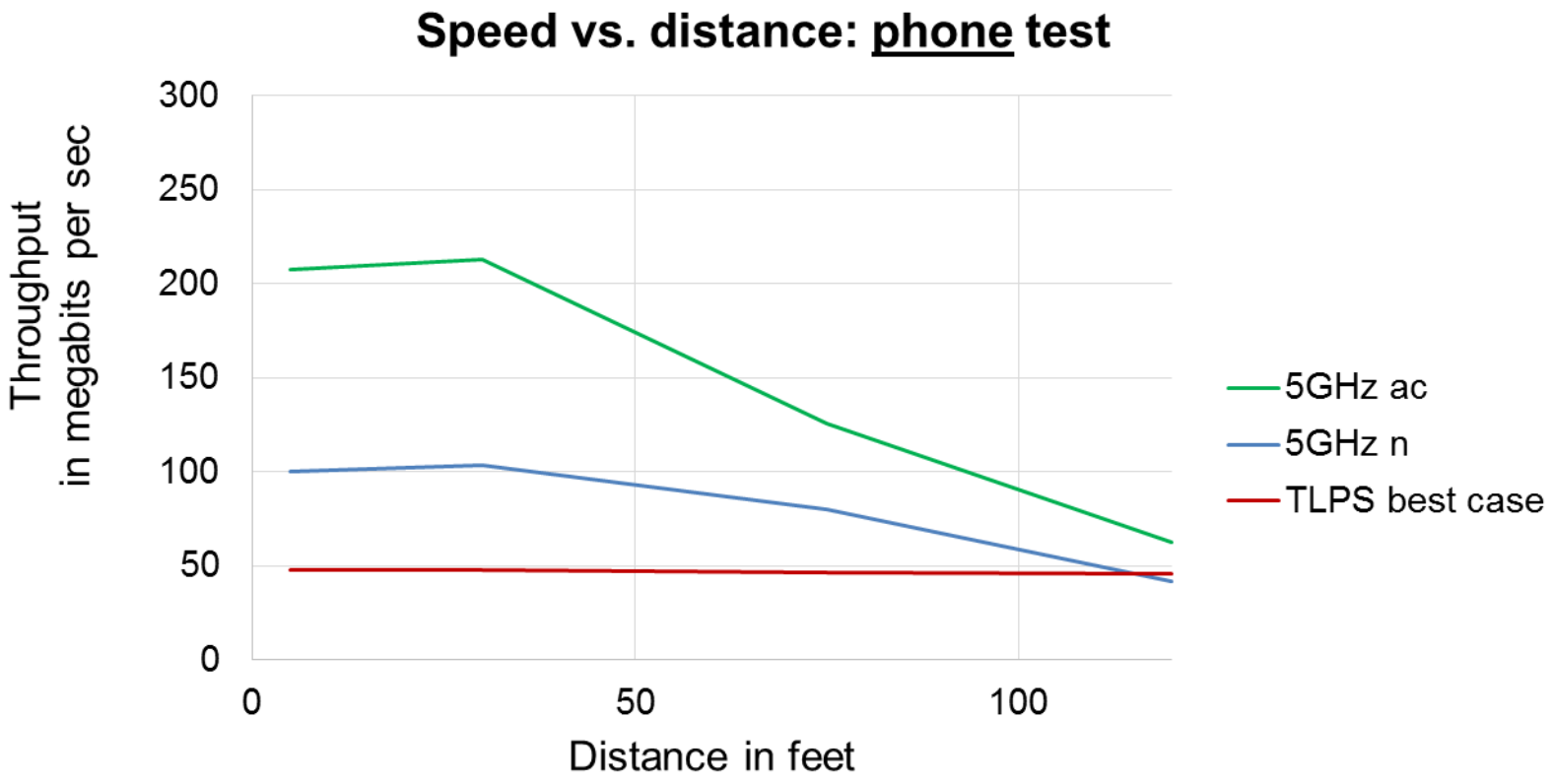
TLPS = Slower Wi-Fi, Part 2



Source: Miercom Report 130916, Oct 2013, Figure 11

On a *laptop,* 5GHz would outperform TLPS at any reasonable distance

TLPS = Slower Wi-Fi, Part 3



Source: Miercom Report 130916, Oct 2013, Figure 13

On a *phone,* 5GHz would outperform TLPS at any reasonable distance

TLPS Enthusiasm Driven by a Host of Misconceptions

Bull beliefs	Reality
Typical Wi-Fi experience is bad	Typical Wi-Fi experience is good (thus users prefer it)
Bad Wi-Fi is caused by “congestion,” which TLPS can solve	Many possible reasons for bad Wi-Fi that have nothing to do with congestion
Wi-Fi spectrum facing “exhaustion”	Plenty of spectrum to go around
Rolling out TLPS would be a snap	Lots of logistical, regulatory, and economic hurdles to overcome
Google, Microsoft, Amazon, Apple, the cable companies, and the carriers are all desperate to buy GSAT and will be pay much more than $5B	These companies can address the few instances of congestion for a fraction of GSAT's equity value. Also, acquirers would seek out spectrum that doesn’t feature GSAT’s power limitations and other problems

If Wi-Fi Is Terrible, Why Is It So Popular? Part 1

- Cisco **consumer** survey:

Figure 4. Preferred Network Access.

Attribute	Mobile/ Cellular	Wi-Fi	No Difference	N*
Lowest Cost	20%	56%	24%	746
Speed of Network	18%	58%	24%	800
Best Reliability	31%	46%	23%	794
Best Performance for My Applications	27%	46%	27%	759
Best Coverage	46%	35%	19%	792
Most Secure	34%	35%	31%	753
Easier to Use	29%	40%	31%	821

* Don't Knows removed from sample.

Q38. Thinking about Wi-Fi and mobile/cellular networks, which type of wireless network do you think offers the most desirable performance or features in each of the following areas?

Source: Cisco IBSG, 2012

Consumers prefer Wi-Fi along almost every dimension

If Wi-Fi Is Terrible, Why Is It So Popular? Part 2

- Cisco **business** survey:

Figure 4. Preferred Network Access.

Attribute	Mobile/Cellular	Wi-Fi	No Difference	N*
Lowest cost	22%	57%	21%	387
Speed of network	21%	59%	20%	387
Best reliability	32%	49%	19%	387
Best performance for my applications	27%	50%	23%	387
Best coverage	48%	36%	17%	387
Most secure	36%	36%	27%	387
Easier to use	32%	42%	26%	387

*Don't Knows removed from sample.

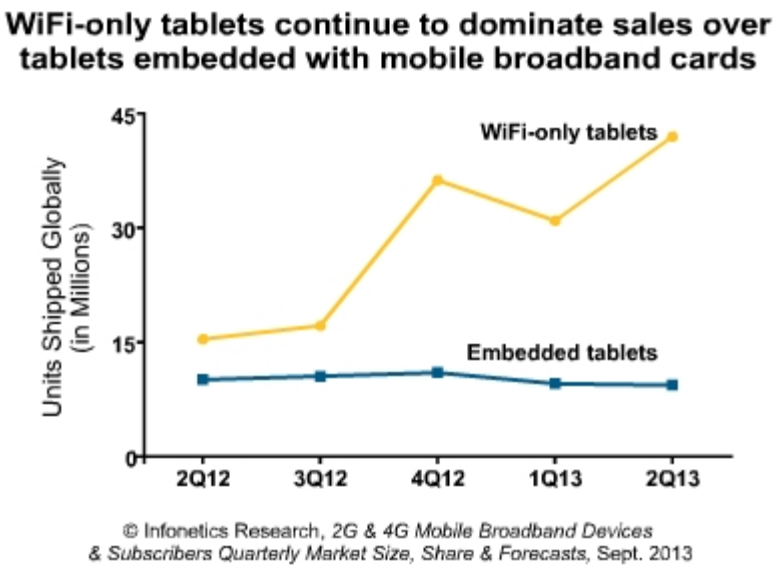
Q38. Thinking about Wi-Fi and mobile/cellular networks, which type of wireless network do you think offers the most desirable performance or features in each of the following areas?

Source: Cisco IBSG, March 2012

Businesses prefer Wi-Fi along almost every dimension

If Wi-Fi Is Terrible, Why Is It So Popular? Part 3

- Vast majority of tablet buyers don't want cellular data plans, happy with Wi-Fi alone:



Tablet buyers not bothering with cellular data because Wi-Fi works

If Wi-Fi Is Terrible, Why Is It So Popular? Part 4

- Wi-Fi analytics firm wefi, Q1 2014 report:
  - Consumers see Wi-Fi as "**a superior experience**" vs. cellular

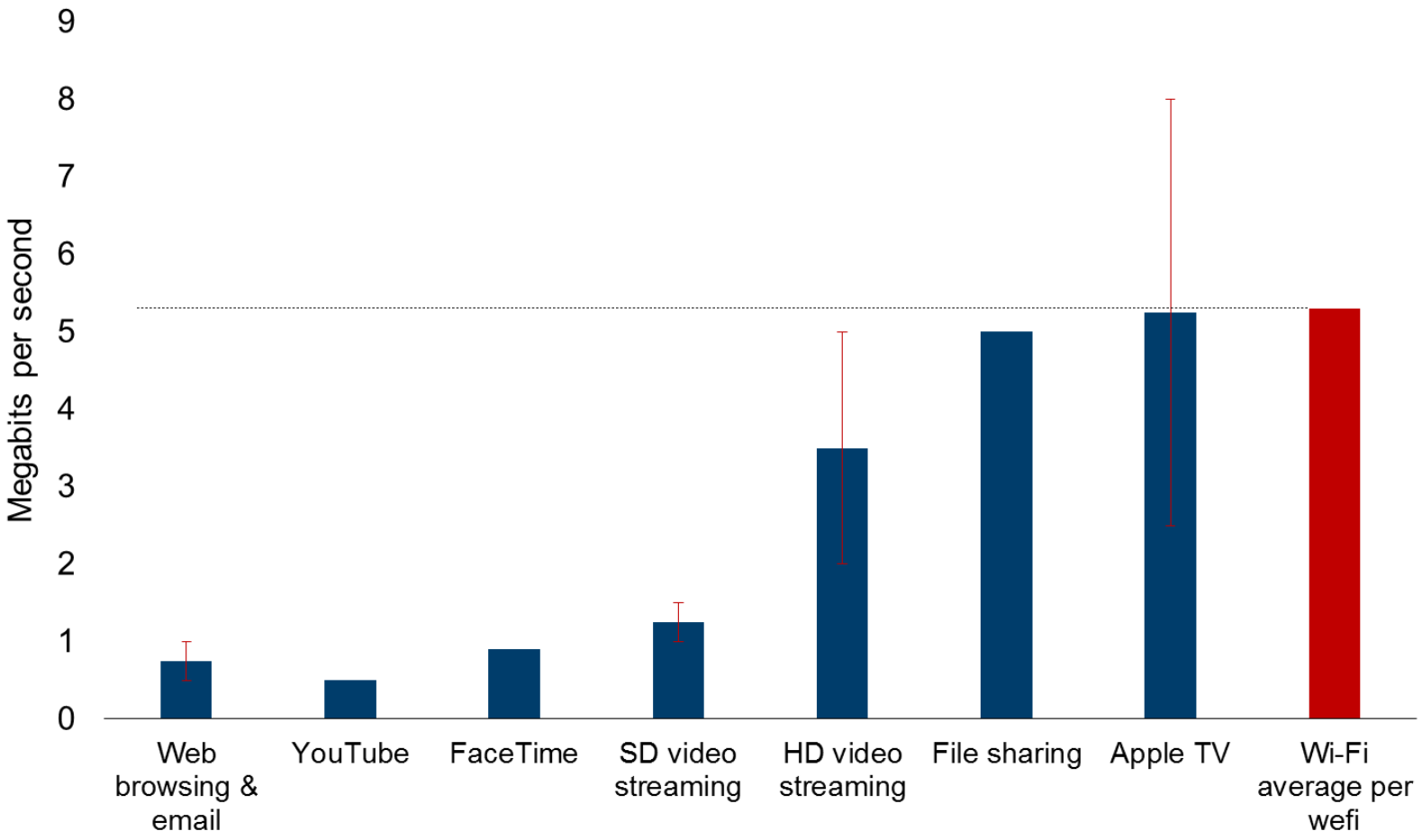
> **Q1 2014 Wi-Fi Analytics Report Points to Continued Growth in Nationwide Data Offloading**
> Consumers have come to recognize that Wi-Fi connectivity presents a superior experience compared to consuming content via cellular networks. This, coupled with devices that automatically sense and log users into Wi-Fi networks when they are present, contributes to the growing use of Wi-Fi and the overall rise in Wi-Fi offloading nationwide.

  - ***Average Wi-Fi speeds are 27% faster year-over-year***

> - Wi-Fi and cellular networks were faster in Q1 2014 compared to the same time last year (based on average of states with the top 5 fastest speeds):
> - Wi-Fi networks were 27 percent faster in Q1 2014 with an average speed of 5.3 Mbps compared to Q1 2013 with an average speed of 4.2 Mbps. Massachusetts, Maryland, Iowa, Illinois and Connecticut clocked in with the fastest Wi-Fi connections this quarter.

Wi-Fi quality is getting better, not worse

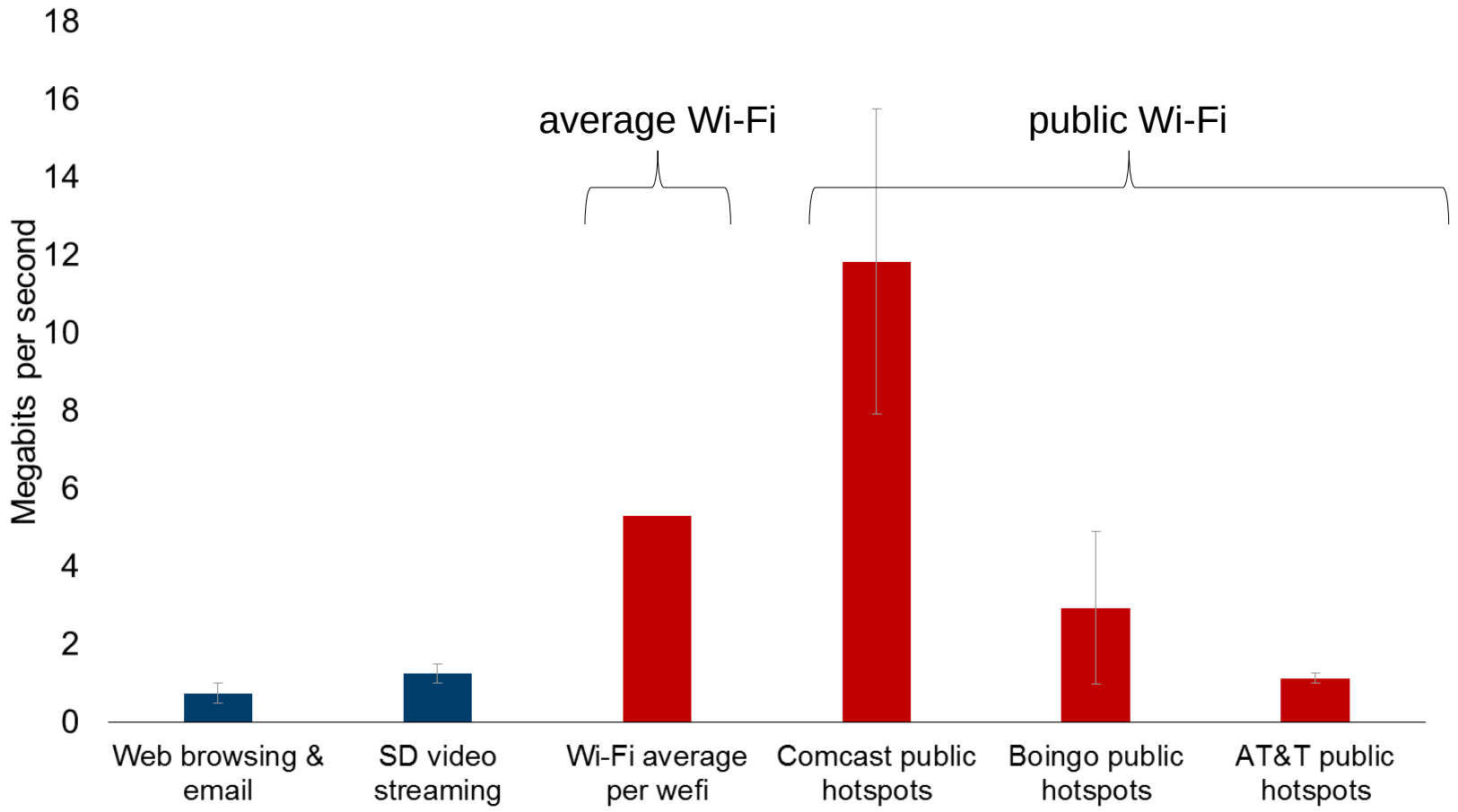
How Much Speed Do You Need?



Throughput requirements from Aerohive's white paper High-Density Wi-Fi Design Principles. Red error bars indicate ranges.

Average Wi-Fi performance more than adequate for wide range of uses

How Much Speed Do You Get? Part 1

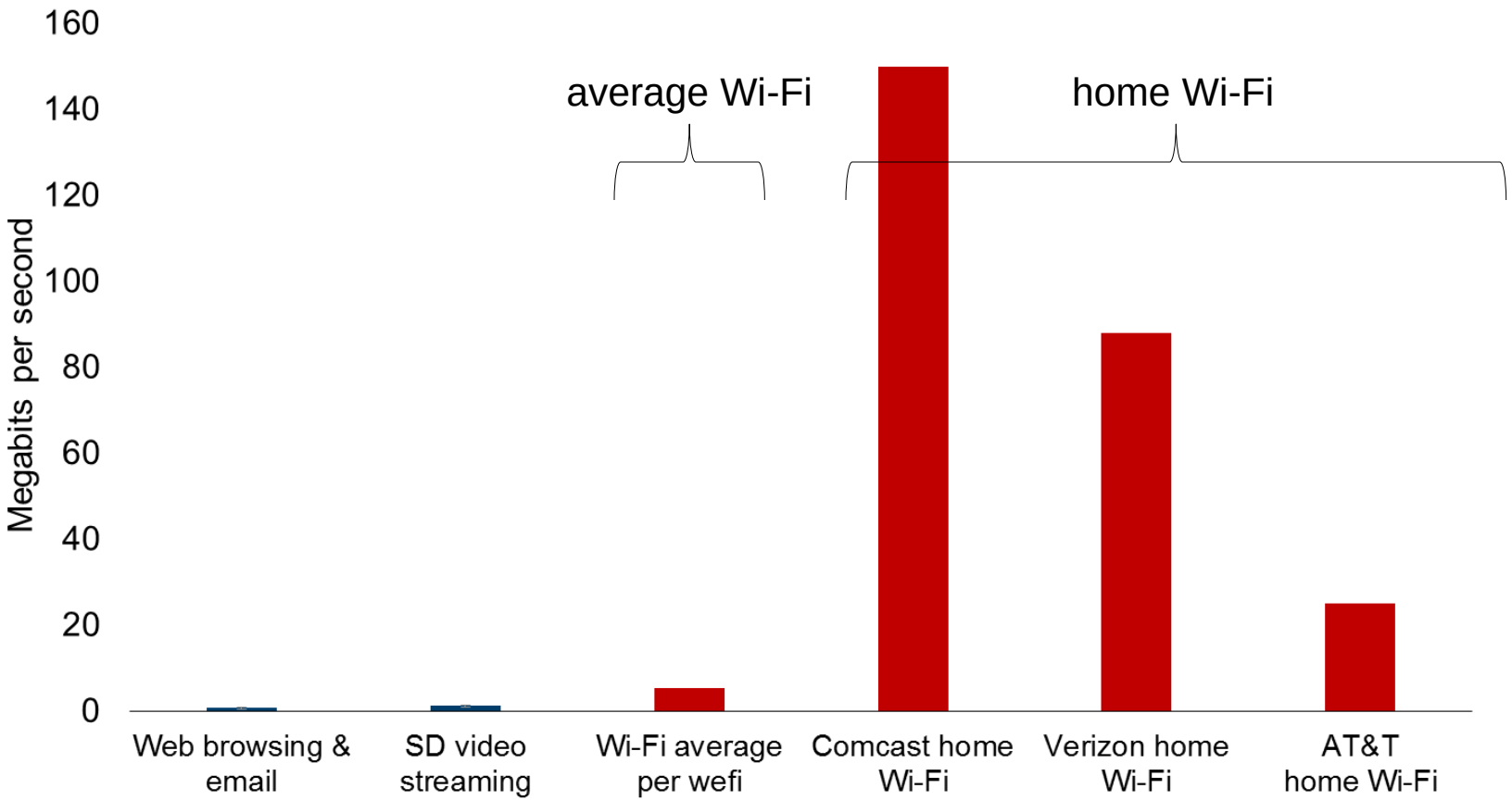


Hotspot performance data from June 2013 Allion report.

Public Wi-Fi: good enough for most uses, sometimes excellent

KerrisdaleCapital

How Much Speed Do You Get? Part 2



ISP wireless gateway performance data from April 2013 Allion report.

Home Wi-Fi: fantastic

How Much Speed Do You Get? Part 3

- A more rigorous assessment: Sommers & Barford, "Cell vs. WiFi: On the Performance of Metro Area Mobile Connections" (2012)
  - Draws on crowd-sourced data from Speedtest.net
  - Looks at 15 different metro areas over 15-week period
  - *Over 3 million observations*
  - Compares unlicensed Wi-Fi vs. licensed cellular performance
- Conclusions:

> Our basic performance comparisons show that (i) **WiFi provides better absolute download/upload throughput, and a higher degree of consistency in performance**; (ii) WiFi networks generally deliver lower absolute latency, but the *consistency* in latency is often better with cellular access; (iii) throughput and latency vary widely depending on the particular access type (e.g. HSPA, EVDO, LTE, WiFi, etc.) and service provider.

  - In other words, where it's available, *Wi-Fi beats cellular*

Unlicensed, disorganized Wi-Fi outperforms licensed, managed cellular

How Much Speed Do You Get? Part 4

- Detailed US data from Sommers & Barford, Table 3:

Location	Median cell throughput (Mbps)	Median Wi-Fi throughput (Mbps)	Which is better, cell or Wi-Fi?
New York, NY	1.7	7.0	**Wi-Fi**
Los Angeles, CA	1.3	5.6	**Wi-Fi**
Chicago, IL	2.3	7.8	**Wi-Fi**
Columbia, SC	1.3	4.3	**Wi-Fi**
Syracuse, NY	1.1	7.9	**Wi-Fi**
Madison, WI	0.9	5.7	**Wi-Fi**
Jackson, TN	0.8	3.2	**Wi-Fi**
Lawrence, KS	1.2	4.6	**Wi-Fi**
Missoula, MT	0.7	3.6	**Wi-Fi**

Wi-Fi performance beats cell performance across the country

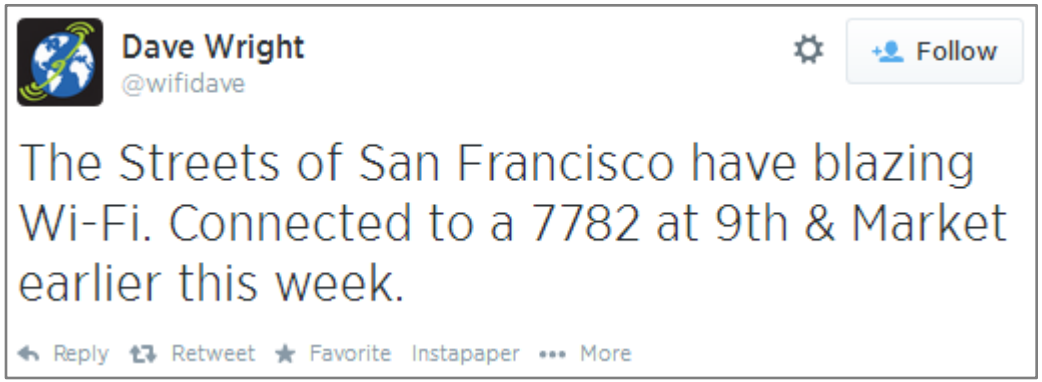
The Success of Large-Scale Wi-Fi Deployments, Part 1

- Apple Worldwide Developers Conference 2014
  - 1,000 Apple engineers and 5,000 third-party developers
  - The results:

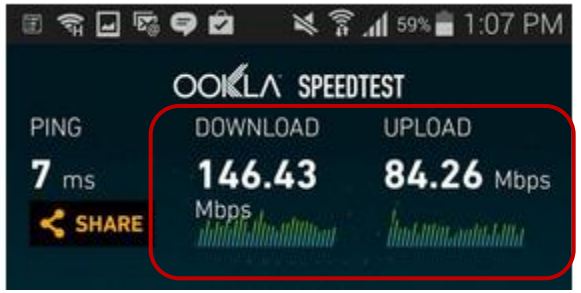
…even for the most discriminating audiences

The Success of Large-Scale Wi-Fi Deployments, Part 2

- San Francisco: 3 miles of free public Wi-Fi along Market Street
  - 250,000 daily visitors
  - The results:

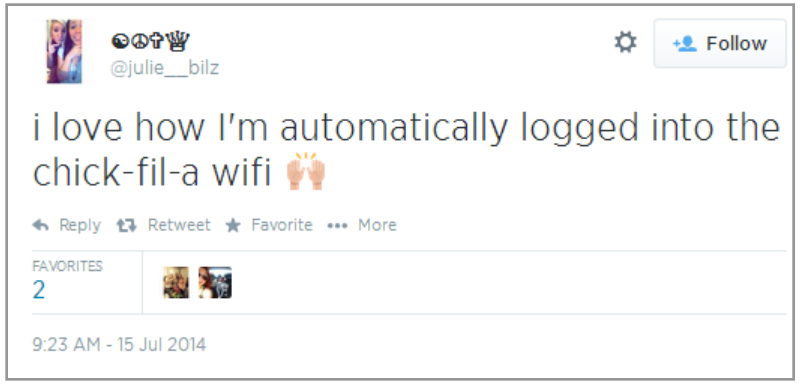


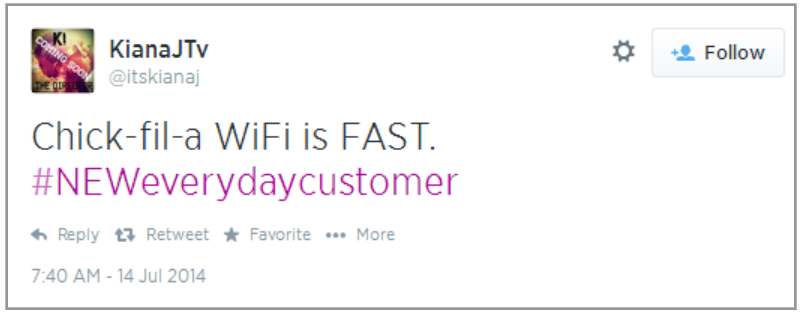
"7782" = Ruckus ZoneFlex 7782 outdoor access point

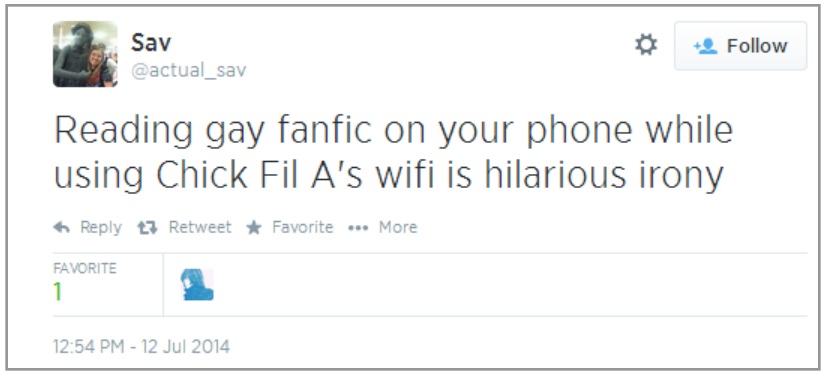


…even for the most discriminating audiences

Even Chick-fil-A Has Good Wi-Fi!







Wi-Fi Practitioners Plan Their Way Around Potential Congestion

- Cisco, *Wireless LAN Design Guide for High Density Client Environments in Higher Education*
  - "In any Wi-Fi design, the effects of CCI [co-channel interference] can be limited by isolating the individual cells from one another through the use of non-overlapping channels and natural environment attenuation (walls, ceilings, file cabinets and cubes)."
  - "In a normal design, the environment and distances we are covering generally permit adequate coverage without a lot of CCI."
- Certified Wireless Network Administration official study guide
  - "When overlapping coverage areas with colocated devices, make sure the output power is not higher than is needed"
- *802.11 Wireless Networks: The Definitive Guide* (Matthew Gast, O'Reilly)
  - "If there is contention for radio resources, changes should work to reduce that contention. One of the best ways to increase performance is to reduce the power on access points."
- *Aerohive Design & Configuration Guide: High-Density Wi-Fi* (Andrew von Nagy)
  - "You can increase spectral capacity within a physical coverage area by deploying adjacent or colocated APs that operate on nonoverlapping channels…"
  - "…and by applying a channel reuse plan that minimizes co-channel interference"

IT experts solve co-channel interference every day using existing spectrum

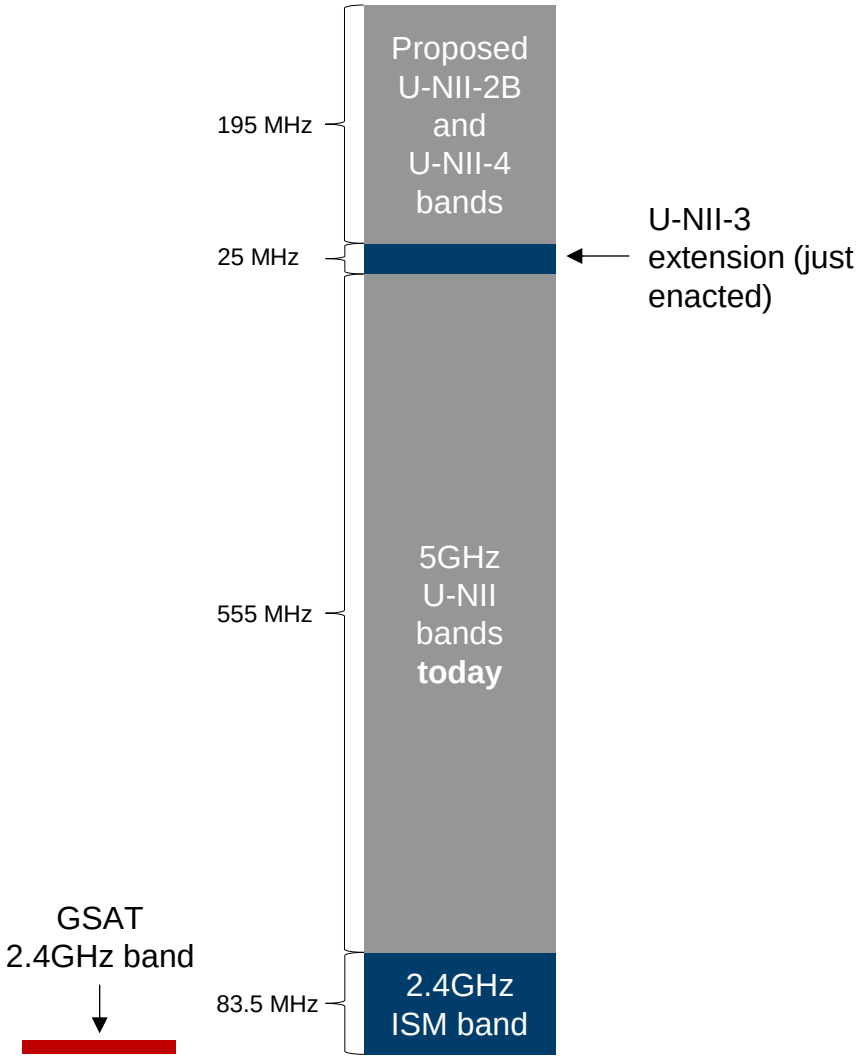
Wi-Fi "Congestion": A Brief Recap of What We've Learned

- Current Wi-Fi performance using unlicensed spectrum is quite good
- With proper planning and infrastructure Wi-Fi works well even with
  - huge numbers of concurrent users
  - huge data loads
- Wi-Fi failures often have nothing to do with inadequate spectrum
- Co-channel contention routinely addressed with simple fixes
- Wide-open 5GHz band promises even greater performance improvements
  - Not a far-off future technology but something widely used *today*
- **The odd man out: GSAT's TLPS concept**
  - TLPS provides a *paid* Wi-Fi channel, when the alternatives are free
  - Based on 2.4GHz band (5GHz increasingly relevant)
  - Only adds value where co-channel contention is a major problem (rare)
    - ⇨ $4B "solution" to a challenge that engineers overcome daily without fanfare

Stripped of the hype, it's clear that TLPS has little value

GSAT's Spectrum vs. Unlicensed Wi-Fi Spectrum (to Scale)

- We compare the amount of GSAT's available spectrum with the amount of available unlicensed Wi-Fi spectrum
- GSAT's spectrum in the 2.4GHz band is a tiny fraction of the total unlicensed Wi-Fi spectrum, which includes:
  - 83.5 MHz in the 2.4GHz ISM band, available today
  - 555 MHz in the 5GHz U-NII bands, available today
  - 25 MHz recently added to the U-NII-3 band
  - 195 MHz in the proposed U-NII-2B and U-NII-4 bands, which the FCC is working to free up



Cisco: TLPS "Nothing More Than Paid Wi-Fi Offering"

Behind Globalstar's new moniker, **TLPS will be nothing more than a paid Wi-Fi offering** using the legacy IEEE 802.11b/g/n amendments – an offering that is only possible because of the happenstance that Globalstar's MSS spectrum is adjacent to the unlicensed commons. …

While Globalstar has claimed TLPS will offer higher data rates than traditional Wi-Fi at 2.4 GHz, the Commission should note that **Globalstar is not proposing here any technological advancement**. To the contrary, Globalstar's plan is built around use of the legacy IEEE 802.11b/g/n amendments. To the extent that Globalstar's TLPS may offer higher speeds, it will simply be because **fewer users will be willing to pay Globalstar for the privilege of using its spectrum** and thus fewer users will be sharing Channel 14 compared to other 2.4 GHz Wi-Fi channels.

—Cisco Systems, Inc., May 5, 2014, submission to FCC

TLPS is simply one licensable Wi-Fi channel

TLPS is Just a Gimmick for GSAT to “Totally Not Go Bankrupt”

Globalstar proposes to combine the features of the amazingly successful Wi-Fi Band with the amazingly unsuccessful business model of Clearwire to totally not go bankrupt this time. Globalstar will offer a “terrestrial low-power service” (TLPS) which it will offer to lease out to people or otherwise make money by giving people WiFi they could get for free, but make them pay for it. According to Globalstar, TLPS will be infinitely superior to cruddy old WiFi because it is “licensed” and therefore “carrier grade” and therefore people will totally pay gajillions for this even though the thing they like about WiFi is that it’s free and they don’t have to deal with a wireless carrier.

— Harold Feld, senior vice president of Public Knowledge, a public-interest nonprofit focusing on telecom and internet policy (December 30, 2013)

TLPS is simply one licensable Wi-Fi channel

Spectrum Valuation

In Response to 2012 Petition, FCC Only Considered TLPS

- In November 2012, GSAT petitioned the FCC to authorize its spectrum for (1) cellular usage, like DISH, and (2) for TLPS, a Wi-Fi like service
- The FCC disregarded GSAT's request to re-purpose its satellite spectrum for cellular usage
- Current rulemaking is considering converting GSAT's spectrum to "Wi-Fi" spectrum, NOT cellular spectrum
- Cellular and Wi-Fi spectrum are highly different from one another, in numerous ways, and should be valued very differently

Wi-Fi and Cellular Bands Should be Valued Very Differently

- The FCC imposes different power restrictions on different bands of spectrum, and this is a subject of intense debate in FCC rulemakings
  - The FCC is concerned about licensees of bands interfering with co-licensees of the same band, or with neighboring bands
  - Example: AT&T and Sirius fought for more than a decade on power and usage restrictions in AT&T's licensed spectrum in 2.3GHz. Ultimately, AT&T agreed not to use the 10 MHz of its 20Mhz of its spectrum that neighbors Sirius's spectrum, to appease Sirius and FCC
- TLPS = Terrestrial **Low-Power** Service
- Wi-Fi / TLPS signals must be transmitted at **much lower power** than cellular signals
- Wi-Fi, and TLPS, power emissions are capped at 4 watts (36 dBm) whereas cell towers can typically transmit up to 1,640 watts (62 dBm)

Higher-Power Cellular Base Station

Vs.

Low-Power Wi-Fi Access Points

Low Power Means Much Higher Deployment Costs

- Low power → signals have short range → more "base stations" needed per unit area → higher deployment costs
- Conventional cell towers can transmit at **400x** TLPS's maximum allowable power level
  - National coverage using ~2.4GHz cellular spectrum: tens of thousands of base stations
  - National coverage using Wi-Fi / TLPS: hundreds of millions of access points
    - ⇨ Too expensive, so one provider will ever offer ubiquitous service
- The power limits imposed upon GSAT's spectrum in 2.4 GHz render it worthless
  - Neither cellular providers like Verizon or AT&T nor spectrum aggregators like DISH Networks would be interested in spectrum with such onerous power restrictions
  - Likewise, if tech companies like Google, Microsoft or Amazon wanted to purchase spectrum for a new innovative use, they would purchase spectrum that does not have onerous power restrictions

	TLPS Spectrum	Cellular Spectrum
# of Sites for National Buildout	1,394,017,181 APs	110,941 base stations
Cost for National Buildout	$3,485bn	$28bn

Source: Kerrisdale estimates, background provided in full Kerrisdale report

Why Did FCC Snub GSAT's Request to Use Spectrum for LTE?

- The FCC never specified precisely why it did not entertain GSAT's request to utilize its spectrum for cellular purposes
- We believe that the FCC anticipates tremendous difficulties and complications in re-purposing GSAT's spectrum for cellular usage:

	Rationale
Reason 1	High power in GSAT's 2.4GHz band could cause interference to Wi-Fi
Reason 2	GSAT must share its spectrum with numerous licensees on TV Broadcast Auxiliary Services (BAS) Channel A10
Reason 3	1.6GHz band is way too close to GPS

We don't think GSAT's 2.4GHz band will ever be authorized for cellular usage

Globalstar Has the Wrong Neighbors

- GSAT's 2.4GHz band neighbors unlicensed band used for Wi-Fi, Bluetooth, ZigBee, microwave ovens and many other devices
  - Given the importance of Wi-Fi and other unlicensed users in 2.4GHz, the FCC would likely be highly concerned that potential GSAT cellular signals would cause interference to lower-power signals of unlicensed users, including Wi-Fi, at 2483 and below
  - FCC has been willing to entertain GSAT's TLPS proposal because, given its low power levels, it likely poses only a modest threat to existing Wi-Fi

Like LightSquared, GSAT is much less important than its spectral neighbors

The FCC's View on Interference Issues

- Below is a nuanced discussion of the FCC's general views on interference issues by spectrum users from telecom expert Howard Feld:

> *FCC's engineers on spectrum issues are extremely conservative. Indeed, I have often argued they are too conservative. This is not because they are in the pay of the incumbents, but because they recognize that making predictions about possible interference is not nearly the precise science that people like to think it is. So the FCC's engineers tend to err well on the side of caution when setting interference limits. From an engineering standpoint, it is easier to loosen interference restrictions later if you were too conservative than try to mitigate interference if you were too optimistic… The FCC generally tries to balance competing interests, taking into consideration things such as how important (economically and politically) is the existing service and how useful (from the FCC's perspective) would the new service be.*

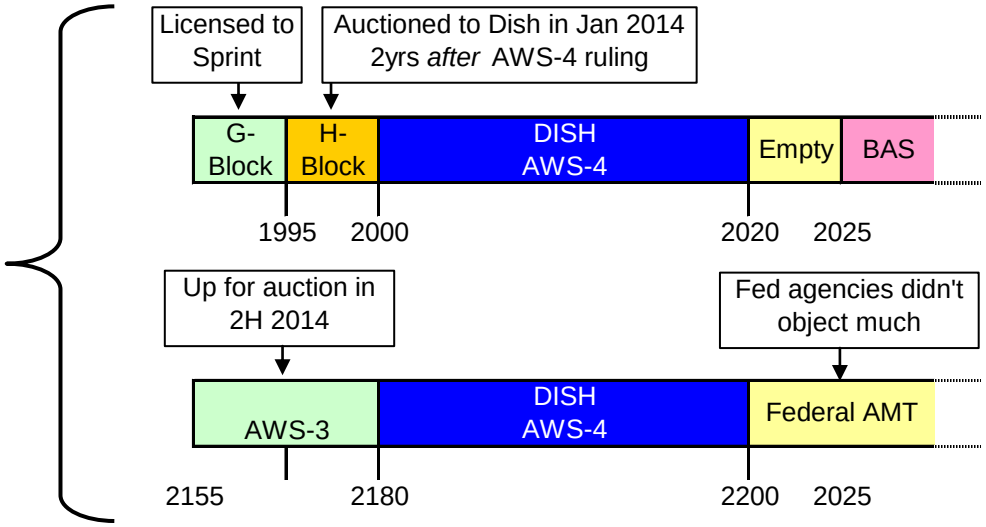
— Harold Feld, *senior vice president of Public Knowledge, a public-interest nonprofit focusing on telecom and internet policy (December 30, 2013)*

Unlicensed bands = Very important, GSAT Cellular = Not important at all

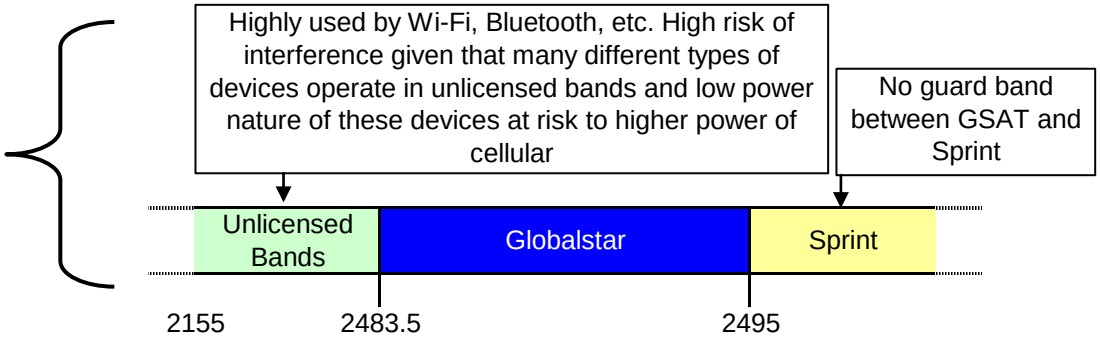
A Comparison of DISH's Neighbors and Globalstar's Neighbors

- To better understand why DISH was able to convert its spectrum to cellular spectrum, but Globalstar could not, we need to examine the neighboring bands to Globalstar's spectrum:

DISH's spectrum neighbored either empty bands, other cellular providers, or federal agencies that were flexible about resolving any interference issues

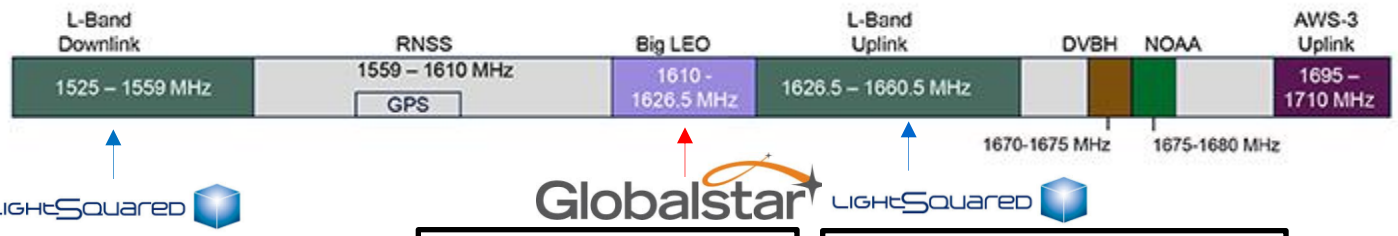


GSAT's spectrum neighbors unlicensed bands that are highly used by many different types of devices, many of which, like Wi-Fi, operate at powers much lower than cellular signals



What is Globalstar's 1.6GHz Band Worth?

- Analysts and longs that we have spoken with agree that the 1.6 GHz band is unlikely to be worth anything
- LightSquared precedent renders GSAT's 1.6GHz spectrum unusable
  - As with the bankrupt LightSquared, GSAT's uplink band is very close to GPS frequencies
  - Serious interference concerns preclude non-satellite use cases (as even bulls concede)
  - Thus any value that exists resides in GSAT's 11.5 MHz of 2.4GHz downlink spectrum



Lightsquared has offered to relinquish its spectrum at 1545.2-1555.2 for terrestrial use given the problematic GPS interference

Like 1545-1555, GSAT's 16MHz in 1.6 GHz neighbors GPS. Even Lightsquared's L-Band at 1626-1660, which is even *further* from the GPS bands, continues to raise numerous interference concerns

US regulatory agency NTIA released letter on July 1 discussing how govt engineers at Department of Transportation expressed numerous concerns over Lightsquared using this spectrum for terrestrial cellular

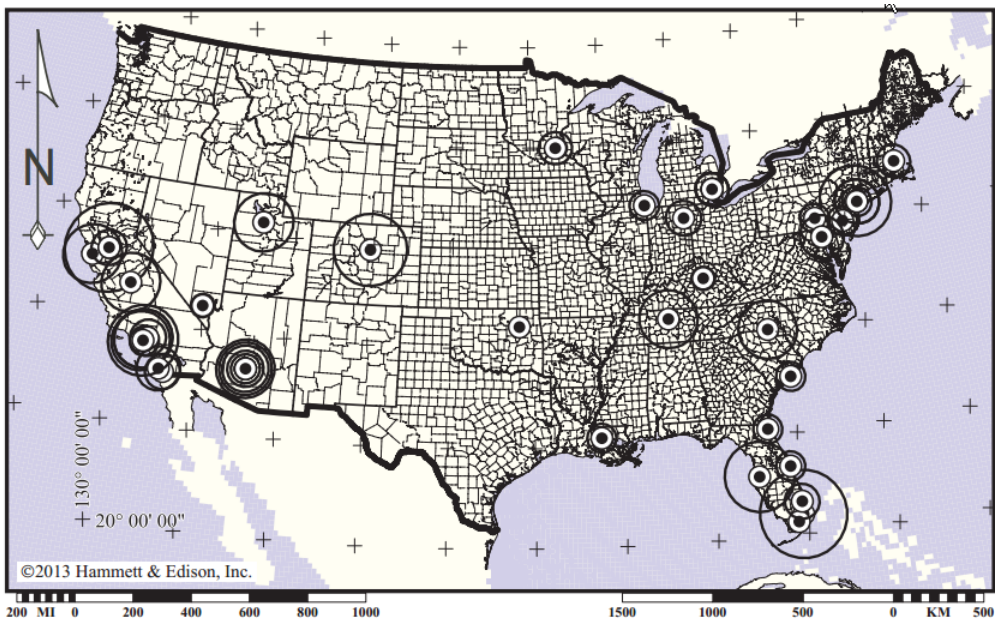
GSAT's spectrum at 1.6GHz is likely worthless

GSAT Cellular Signals Would Interfere with Co-Licensee BAS

- GSAT's license is "co-primary" with ~60 licensees who use the TV Broadcast Auxiliary Services (BAS) Channel A10, which operates from 2483.5 to 2500 MHz
  - These broadcasters use Channel A10 primarily for electronic news-gathering (ENG), deploying mobile news vans to obtain footage remotely and transmit back to headquarters
  - Examples include ABC affiliate in New York (WABC) and FOX affiliate in LA (KTTV)
- Low-powered Wi-Fi service may not threaten these A10 licensees, but high-powered LTE service clearly would
- GSAT's previous partner, Open Range, caused numerous instances of interference with BAS A10 operators throughout 2010-2011

Interference Issues with GSAT's Co-Licensee BAS A10, Part 2

- Licensees exist in key metro areas, including New York, Chicago, Miami, Phoenix, Los Angeles, San Francisco, DC, Philadelphia, and Detroit
- Map below shows the many large areas where Ch A10 licensees are legally entitled to interference protection:



Operational areas of grandfathered TV BAS Channel A10 TV Pickup stations. Where the license specifies an ambiguous operational area, the U.S. Atlas reference coordinates for the parent TV station's city of license, and a radius of 90 km, have been used, as the Commission did in the WT Docket 10-153 "TV BAS Flexibility" rulemaking.

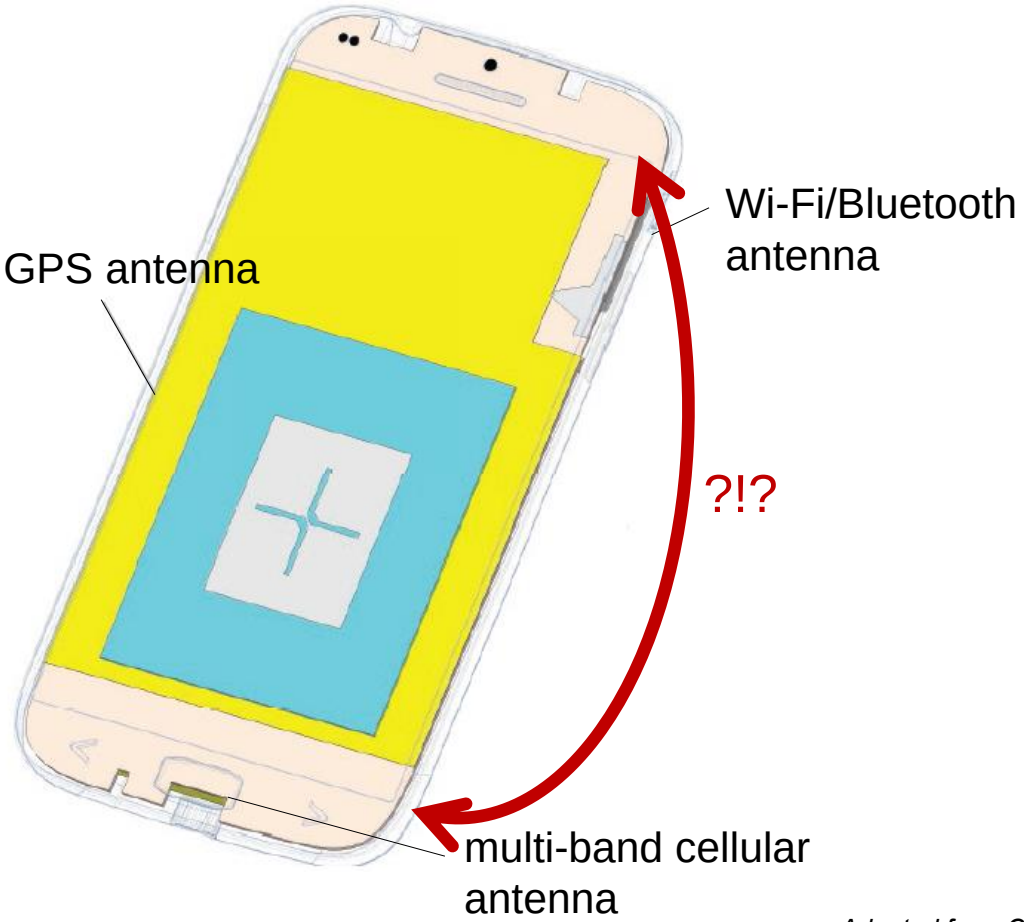
Why a "Globalstar LTE" Band Would Never Be Acquired

- Additional features of the Globalstar LTE band would make GSAT's spectrum unappealing to cellular acquirers

	Rationale
Reason 1	Onerous power restrictions → deployment costs too high
Reason 2	Acquirer would likely have to finance the re-location of BAS Channel A10 users to another frequency
Reason 3	Unusable 1.6GHz renders the 2.4GHz spectrum unpaired
Reason 4	GSAT's extremely close proximity to Wi-Fi will likely cause "self-jamming" in resulting smartphones, as well as interference *from* Wi-Fi
Reason 5	Acquirer would inherit and have to maintain money-losing satellite business
Reason 6	High frequency 2.4GHz spectrum far less valuable than lower frequency spectrum
Reason 7	With neighbors on either side, GSAT LTE would remain a thin 10MHz band forever

Way too many headaches for 10MHz of unpaired high frequency spectrum

LTE Technical Problems: Self-Jamming

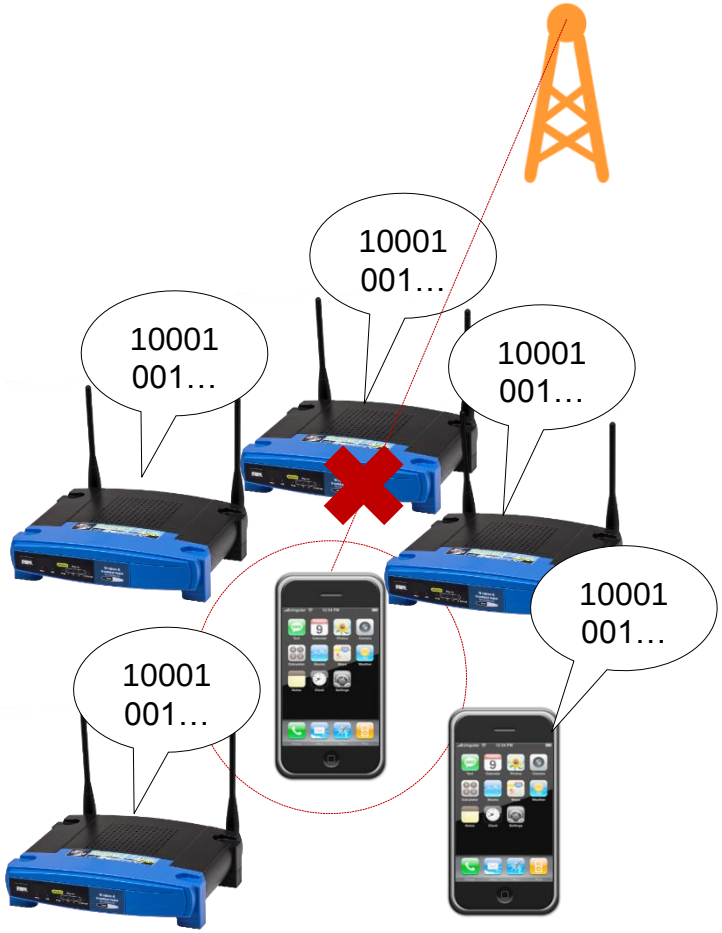


- Smartphones are already jam-packed with many different radio systems
- Very easy for Wi-Fi transceiver to interfere with "GSAT LTE" due to close proximity of frequencies
- Very easy for LTE radio using Sprint 2.5GHz spectrum to interfere with "GSAT LTE" due to close proximity of frequencies
- Need to convince device makers and standards bodies to validate any new LTE band

Adapted from CST AG, "Analyzing RF Coexistence in a Mobile Handset"

Many practical hurdles to using a narrow, oddball LTE band in real devices

LTE Technical Problems: Interference *from* Wi-Fi

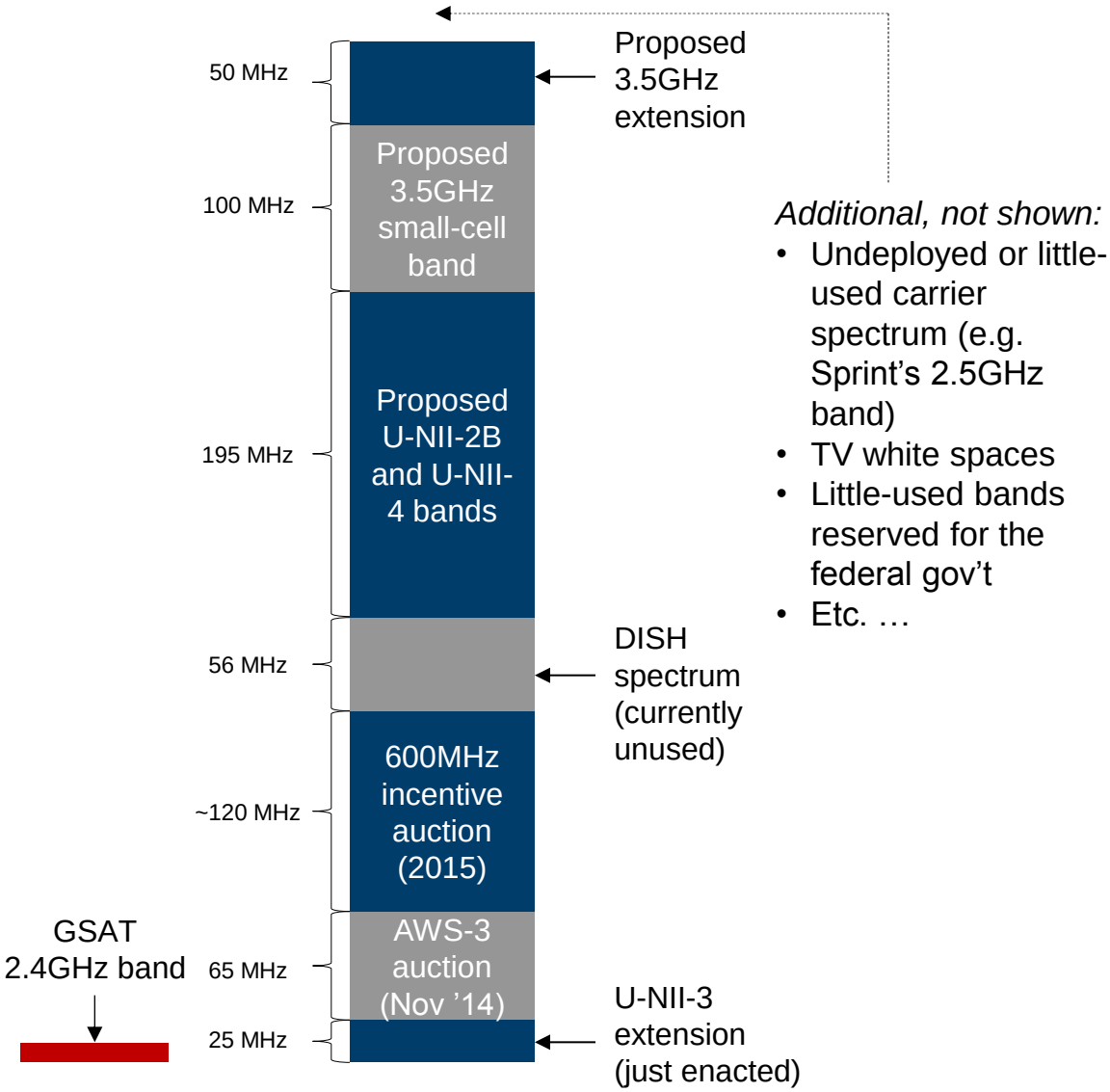


- Nearby Wi-Fi transmissions could block "GSAT LTE" cellular signals
  - Looks like you have full bars, but you'd miss incoming phone calls
  - Difficult and frustrating for user to assess
- Already a struggle for bands like Sprint's in 2.5GHz
- LTE receivers are exquisitely sensitive
  - Even when complying with regulatory limits, Wi-Fi signals still sound "loud" to LTE devices
- GSAT's band much closer to Wi-Fi than similarly problematic band
  - Challenges thus much worse

Wi-Fi devices would likely overpower "GSAT LTE"

GSAT vs. Other Sources of New Spectrum Supply (to Scale)

- We compare the amount of GSAT's available spectrum with the amount of new spectrum supply
- For any prospective buyer, there is a substantial amount of spectrum that is or will be available to buy or utilize



For Argument's Sake…

- We've discussed how the FCC has rejected Globalstar's proposal to authorize its spectrum for cellular usage, and we've discussed why its spectrum is unlikely to ever be considered for cellular usage
- But hypothetically, if it was, what would it be worth?
- Even if Globalstar's spectrum was authorized for cellular usage, GSAT is *still* massively overvalued
  - As we will demonstrate in the following slides, even if GSAT's spectrum were authorized for cellular usage, which we strongly believe it never will be, the stock would still be ~5x overvalued!

Even with cellular approval, GSAT would have 80% downside

How Much Does Spectrum Cost, Anyway?

- How do you compare the price of, say, the 700MHz A Block license covering Honolulu to the AWS-1 B Block license covering Bangor, Maine?
- A common pricing metric: **dollars per MHz-pop**
  - Normalizes for 1) bandwidth (in MHz) and 2) covered population (for regional licenses)
- A recent example:
  - At an FCC auction in February, DISH bought all 176 regional licenses to the AWS H Block (1915-1920/1995-2000 MHz) for $1.564B
  - Bandwidth = 10 MHz (5 MHz uplink, 5 MHz downlink)
  - Population = 312,846,492 (US population per FCC, based on 2010 decennial census)
  - Dollars per MHz-pop = $1.564B / (10 MHz x 312.8mm people) = **$0.50**
- But what is the "right" $/MHz-pop value to apply to GSAT?
  - Bulls cite an array of precedents covering a wide range of values – from ~$0.20 to ~$2
  - Often take some average (say, $1+)
  - Example: One sell-side target price assumes $1/MHz-pop but considers values as low as $0.25

GSAT bulls apply precedent pricing arbitrarily…

What is GSAT's Market-Implied Spectrum Value?

- After subtracting an estimated value for the satellite business, we can determine the valuation ascribed to GSAT's spectrum
- In the below calculation, we assume that 10 MHz of GSAT's spectrum in 2.4GHz is useable

	Backing Out GSAT's Market-Implied Spectrum Value	
	($mm)	
A	Total EV	4,114
B	Less: EV attributable to MSS business (based on comparables)	325
C = A−B	Implied EV attributable to terrestrial use of spectrum	3,789
	% of total EV	*92%*
D	Usable terrestrially licensed spectrum (MHz)	10
E	US population (mm)	318
F = D x E	MHZ-pops	3,184
C / F	Implied spectrum value per MHz-pop	$1.19

GSAT's spectrum value of $1.19 is ludicrously high given multitude of issues

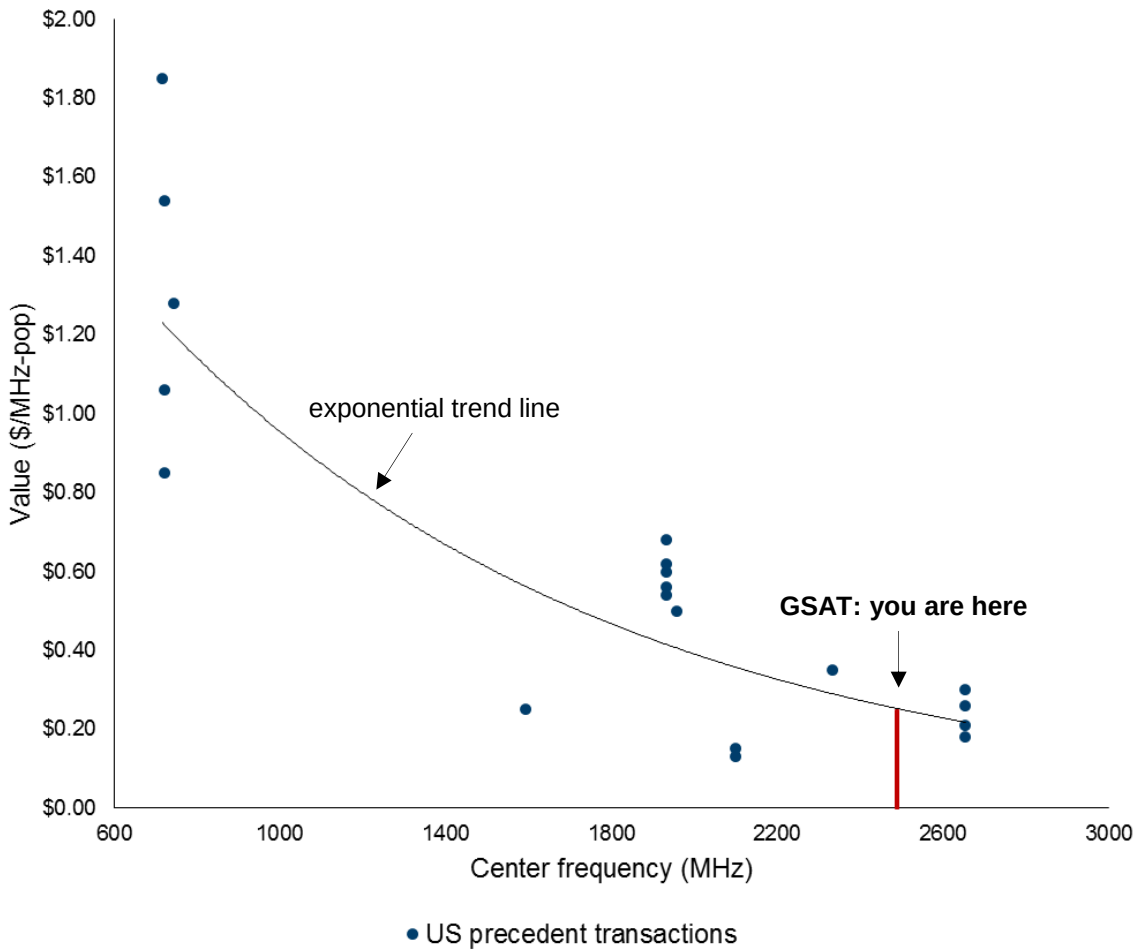
Historical Precedent Spectrum Transactions

- Below are various historical spectrum transactions

Description	Period	Spectrum type	Frequency (MHz) Approx. midpoint	Price ($/MHz-pop)
AWS auction	Apr 2006	AWS	1933	$0.54
Clearwire/BellSouth	Feb 2007	EBS/BRS	2654	$0.18
AT&T/Aloha	Oct 2007	700MHz	722	$1.06
700 MHz auction	Mar 2008	700MHz	744	$1.28
Sprint/Clearwire	May 2008	EBS/BRS	2654	$0.26
Harbinger/SkyTerra	Sep 2009	MSS	1593	$0.25
AT&T/Qualcomm	Dec 2010	700MHz	722	$0.85
Dish/DBSD2	Mar 2011	MSS	2100	$0.15
Dish/TerreStar	Jul 2011	MSS	2100	$0.13
Verizon/Cox	Dec 2011	AWS	1933	$0.56
Verizon/SpectrumCo	Dec 2011	AWS	1933	$0.68
Verizon/Savary Island	Dec 2011	AWS	1933	$0.62
Verizon/Leap	Dec 2011	AWS/PCS	1933	$0.60
Leap/Verizon	Dec 2011	700MHz	722	$1.54
AT&T/NextWave	Aug 2012	WCS	2333	$0.35
Sprint/Eagle River	Oct 2012	EBS/BRS	2654	$0.21
Sprint/Clearwire (final)	Jul 2013	EBS/BRS	2654	$0.30
T-Mobile/AT&T	Jan 2014	700MHz	716	$1.85
H Block auction	Feb 2014	AWS	1958	$0.50

Source: Please see full report for footnotes and additional details

Frequency Is a Key Driver of Spectrum Valuation



- Shown on graph: 19 US spectrum transactions from Apr 2006 to Feb 2014
  - 16 secondary trades
  - 3 primary FCC auctions
- **All of the high-priced transactions involve low-frequency spectrum**
- Based on a simple exponential trend line, GSAT's spectrum is worth only ~$0.25/MHz-pop
  - **~80% less than current stock price implies**

…but precedent pricing shows that frequency is king

KerrisdaleCapital

Why Does Frequency Matter So Much?

- Low-frequency radio waves are more able to penetrate through barriers
  - Better coverage inside buildings
  - Usable signal over a wider area
- Wider coverage area per base station → fewer base stations → lower costs
  - Magnitude of the benefit varies depending on environment, but effect is exponential
- Estimates compiled by one expert (Kostas Liopiros), based on physics and empirics:

Relative Costs and Spectrum Weights

Band	Relative Cost*			Spectrum Weight		
	Rural	Suburban	Urban	Rural	Suburban	Urban
Lower 700 MHz	0.72	0.78	0.89	1.39	1.28	1.12
Upper 700 MHz	0.88	0.91	0.96	1.14	1.10	1.05
800 MHz (ESMR and Cellular)	1.00	1.00	1.00	1.00	1.00	1.00
AWS-1	4.33	2.97	1.69	0.23	0.34	0.59
PCS	5.11	3.36	1.79	0.20	0.30	0.56
WCS	7.69	4.55	2.07	0.13	0.22	0.48
BRS	10.15	5.59	2.29	0.10	0.18	0.44

*Relative cost refers to the cost to deploy and operate a wireless network in one frequency band compared to the cost to deploy and operate a wireless network in the 800 MHz Band (ESMR and Cellular).

- High-frequency BRS spectrum (similar to GSAT's) worth 10-44% of 800MHz value

The frequency effect is real, logical, and grounded in science

None of This Is News to Industry Insiders

- Selections from comments section on FierceWireless (July 2, 2014):

Ken P · 7 days ago
Too bad Sprint's 2.5 GHz spectrum can't penetrate its way out of a paper bag.
13 · Reply · Share ›

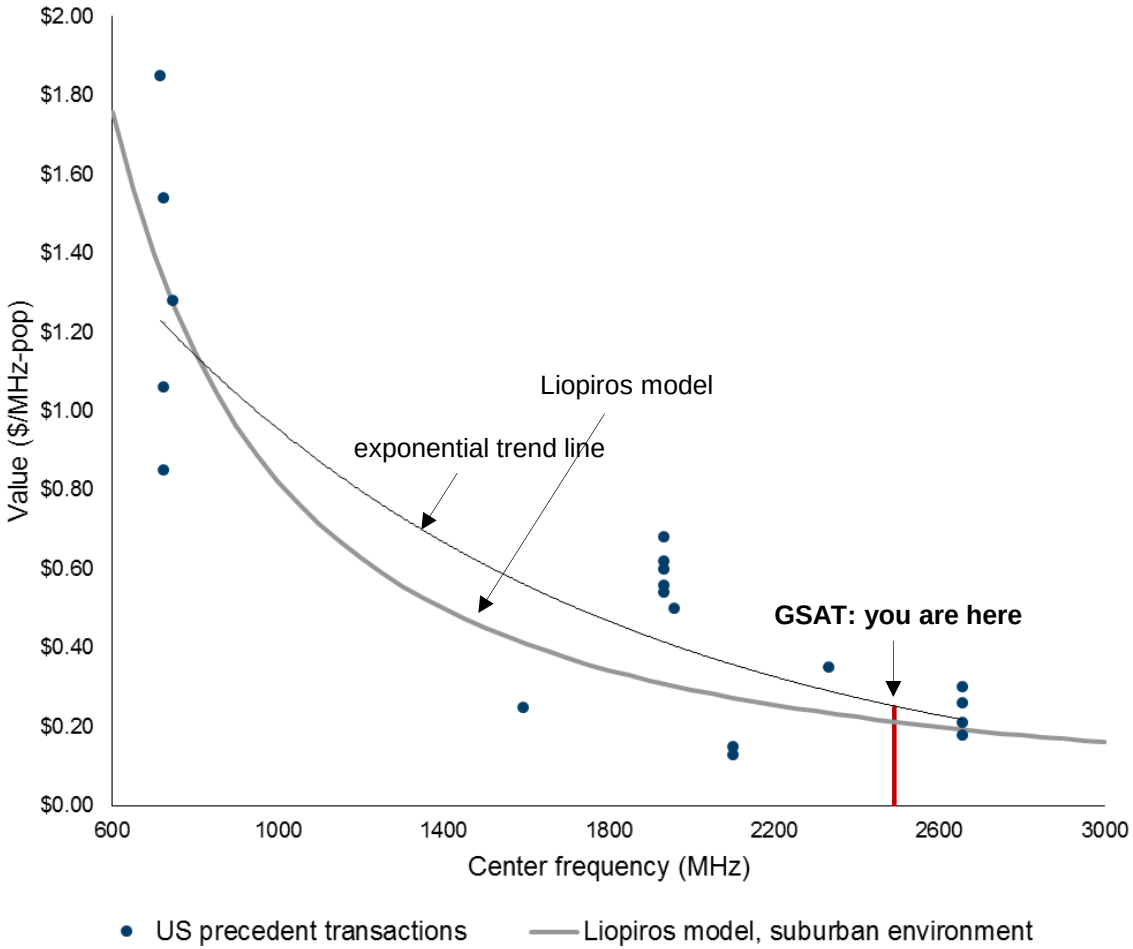
MagentaUser ➦ Ken P · 7 days ago
Exactly. It's garbage spectrum that will require a gazillion towers which they dont have the money to spend nor the incentive
8 · Reply · Share ›

S. Ali ➦ red_dog007 · 7 days ago
There are many problems with this strategy

1.) No matter how magical 8t8r equipment, 2.5ghz spectrum CANNOT penetrate most buildings. Ask anyone who has WiMax service how their signal would drop to 3G the moment they stepped foot in a building. It doesn't matter how much beamforming gimmickry you do. When I used to have their service, if you weren't within 100 yards of a tower, forget it, you were on 3G. Sprints own tests show that the tech works best in open flat areas, not in urban environments where its needed the most (at least without additional small cell deployments).

Many telecom experts view high-frequency spectrum as low-value

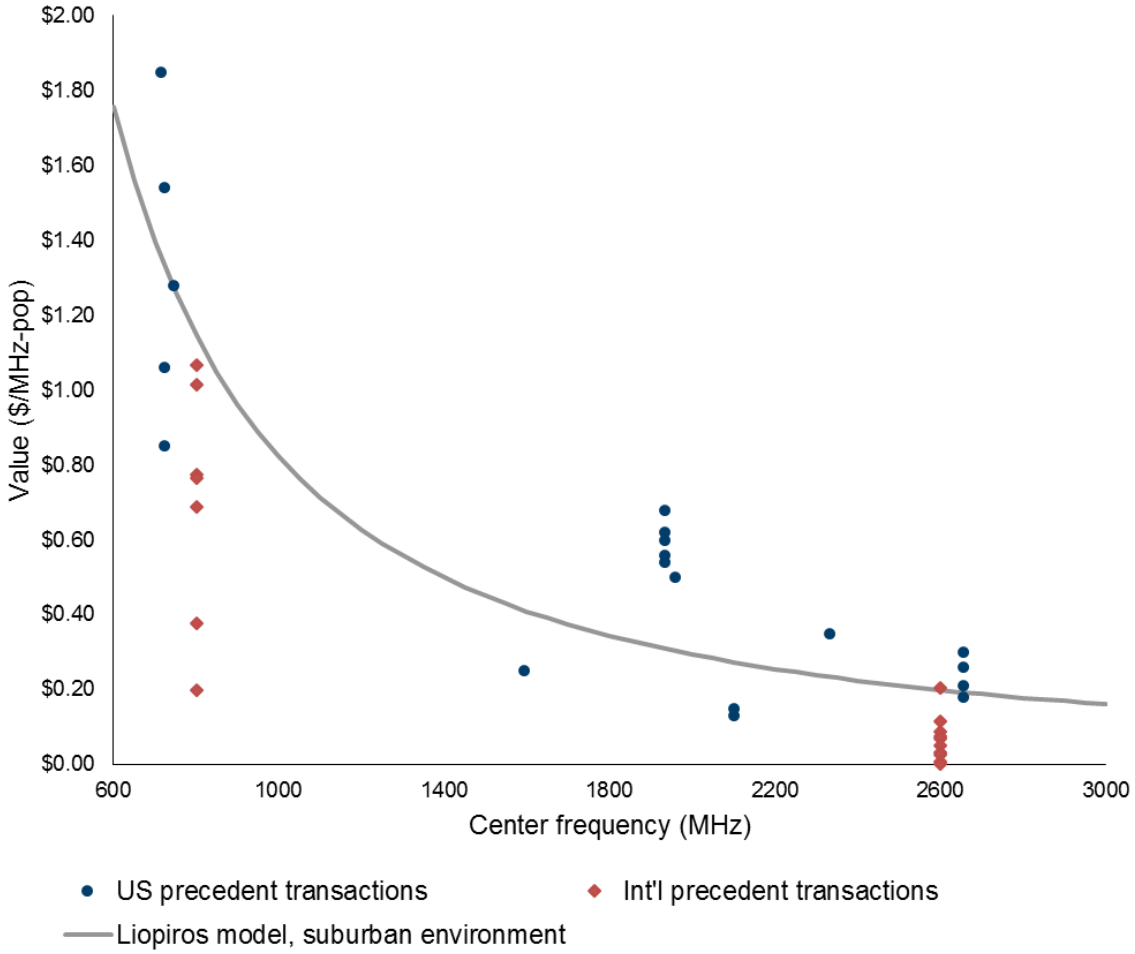
Combining Theory and Data



- Shown on graph: same precedents + theoretical model based on Liopiros study
  - Assumes suburban environment
  - Dollar value for a given frequency benchmarked to 700MHz auction
- Predicted GSAT spectrum value: $0.21/MHz-pop
  - Slightly lower than simple exponential fit, but similar
- Liopiros model not 100% accurate, but clearly helps make sense of the data

Viewed correctly, spectrum precedents imply enormous downside

International Spectrum Pricing: Another Nail in the Coffin



- If the low- vs. high-frequency effect is real, we should see it outside of the US…
- ...and we do (except prices are even lower):
  - Germany
  - Italy
  - France
  - Portugal
  - Sweden
  - Denmark
  - Belgium
  - Norway
  - Netherlands
  - Finland
- 2013 UK auction (not shown): ~$0.11/MHz-pop for 2.6GHz spectrum

Global precedents confirm the low value of high-frequency spectrum

Not a Fan of Models? Just Look at the Best Available Comps…

From a utility perspective a lot of our spectrum abuts Clearwire and Sprint's spectrum and so it is functionally equivalent. Another swath of our spectrum abuts MSV and is functionally equivalent there. **So again it is not clear to me why we would have a spectrum value which was substantially different than others.**

—Jay Monroe, chairman & CEO of Globalstar, May 7, 2008

GSAT's own argument: Clearwire & MSV are the best comps

What Happened to Clearwire and MSV?

- MSV
  - Name changed to SkyTerra, acquired by LightSquared
  - LightSquared bankrupt, spectrum unusable for terrestrial purposes
- Clearwire
  - Dec. 2012 investor presentation: tried to sell/lease spectrum but failed
  - Bought by Sprint in July 2013 for $0.30/MHz-pop

- Hired investment bank to conduct auction in 2010
  - Resulted in handful of bids with spectrum values well below those recently speculated by some shareholders, analysts and reporters
  - Were not successful in reaching agreement before we elected to pursue other available financing options
  - Since then, engaged in series of conversations with a number of parties (no compelling offer resulted)
- Over past several weeks received one credible, but preliminary, proposal
  - Worked to improve proposal, but value well below recent speculation
  - Special Committee and Board concluded that Sprint transaction was better alternative for non-Sprint Class A shareholders
- Recently reached out again to all parties previously in discussions with – no new interest generated

GSAT's favorite comps imply that the company is horrendously overvalued

Doing the Arithmetic on the Clearwire Comp

Bandwidth (MHz)	10
$ per MHz-pop	$0.30
US population (mm)	318
MHz-pops	3,180
Implied spectrum value ($mm)	$ 954
MSS value	325
Total EV	$ 1,279
Less: net debt	545
Equity value	$ 733
Fully diluted shares (mm)	1,185
Equity value per share	**$0.62**
% downside	**-79%**

- One subtlety: LTE channel width typically in multiples of 5MHz
  - So 1.5 MHz of GSAT's 11.5 MHz would go to waste
- MSS value based on peer valuations (sell-side estimates are similar)

The "highest and best use" of GSAT's spectrum implies 80% downside

Just Ask Yourself…

- For spectrum that:
  - Is restricted to power levels *400x* lower than cellular power levels
  - Is unlikely to ever be considered for cellular usage by the FCC
  - Would require an acquirer to re-locate BAS Channel A10 licensees
  - Exists in the high frequency 2.4GHz band
  - Would require exquisitely engineered antennae to prevent self-jamming
  - Would receive interference *from* Wi-Fi
  - Is chained to a money-losing satellite phone business

Who would acquire GSAT's spectrum for a price greater than $0?

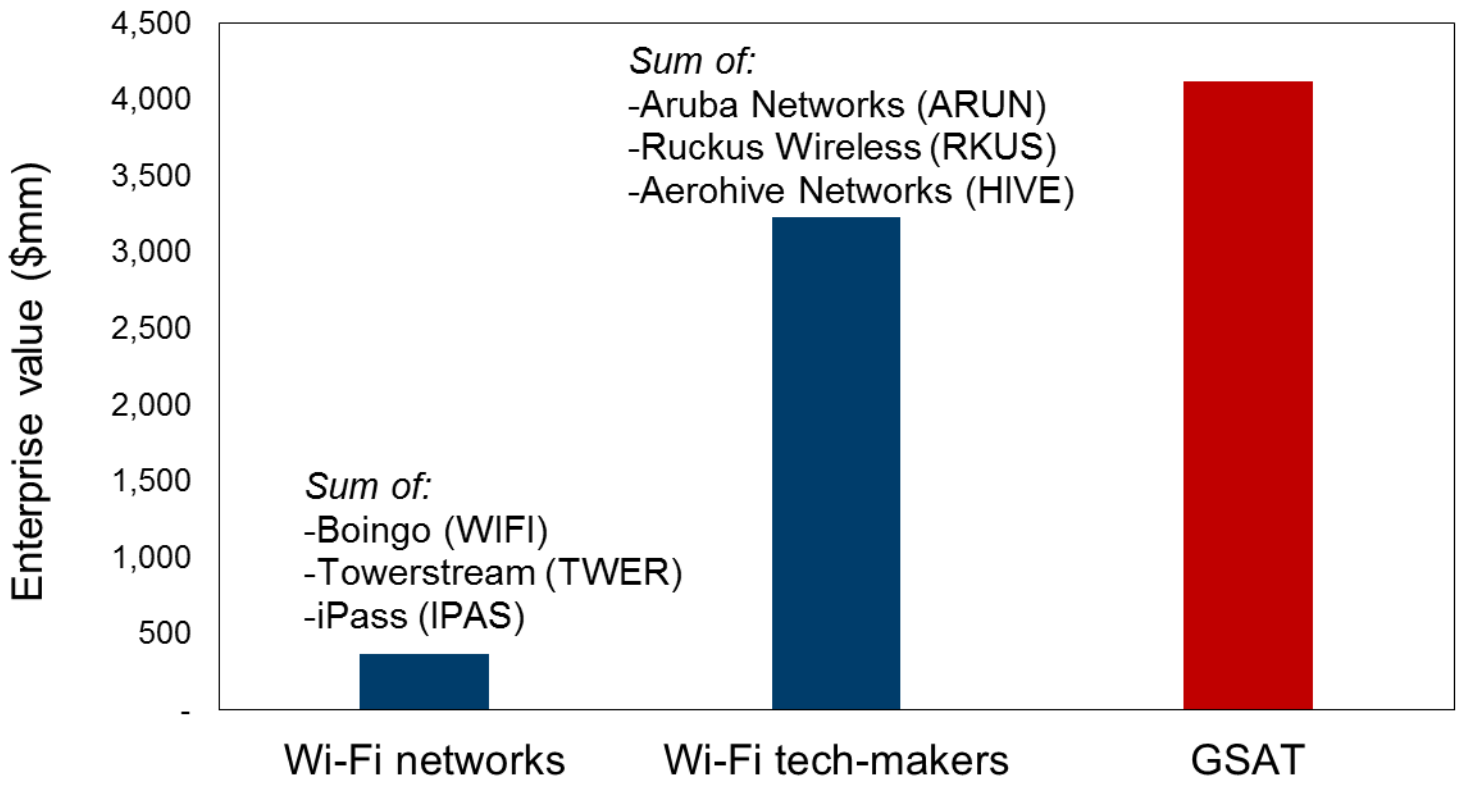
Additional Issues With TLPS

How Much Do People Value "Better" Wi-Fi Anyway?

- GSAT bulls must believe that "better" Wi-Fi via TLPS is very valuable
  - Either users pay for it themselves, or someone pays for it on their behalf
  - Either way, users have to ascribe great value to *a potentially slightly better Wi-Fi experience in certain high-utilization areas*
    - ⇨ Inherently implausible!
- Few people are willing to pay for Wi-Fi today
- Example: Boingo (WIFI)
  - Firm with greatest demonstrated ability to monetize Wi-Fi
  - Network (incl. roaming partners): >1 million commercial hotspots worldwide
  - Subscribers: 300,000 (y/y growth rate: -4%)
  - LTM revenue: $112mm
  - Enterprise value: $225mm
    - ⇨ *Only ~5% of GSAT's valuation*
- GSAT contributes nothing to key networking tasks: building APs, finding good locations, installing APs, marketing to users, getting backhaul…

Even industry leaders have struggled to monetize Wi-Fi

GSAT's Valuation Is Ludicrous Relative to Wi-Fi Comps



Source: Capital IQ, Kerrisdale analysis

GSAT EV = 11x the sum of all publicly traded "paid Wi-Fi offerings"

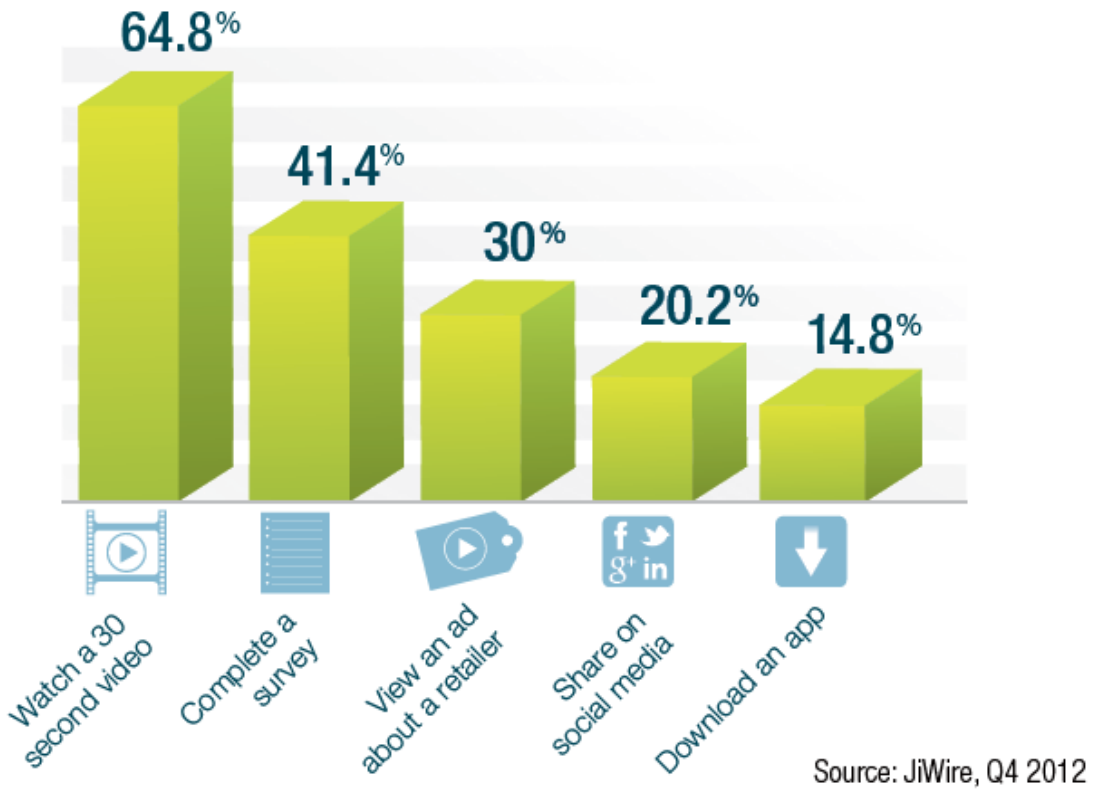
Wide-Reaching Trend Toward Free Wi-Fi

- Airports
  - 42 out of 52 tracked by Airfarewatchdog now offer some form of free Wi-Fi
  - JFK, La Guardia, and Newark rolling out free Wi-Fi soon (announced June)
- Hotels
  - According to one report, at least 64% of hotels now offering free Wi-Fi
  - Some attempt to charge for higher-speed “premium” Wi-Fi with little success
- Quick-service restaurants
  - Starbucks (via Google)
  - McDonald’s (via AT&T)
  - Burger King (via AT&T)
  - Dunkin Donuts
  - Panera
- Facebook Wi-Fi: log in for free at participating small businesses

Wi-Fi increasingly seen as complimentary amenity

More Free Wi-Fi Drives Down Willingness to Pay

Figure 15: What sort of sponsor engagement would you be willing to do for free Wi-Fi?

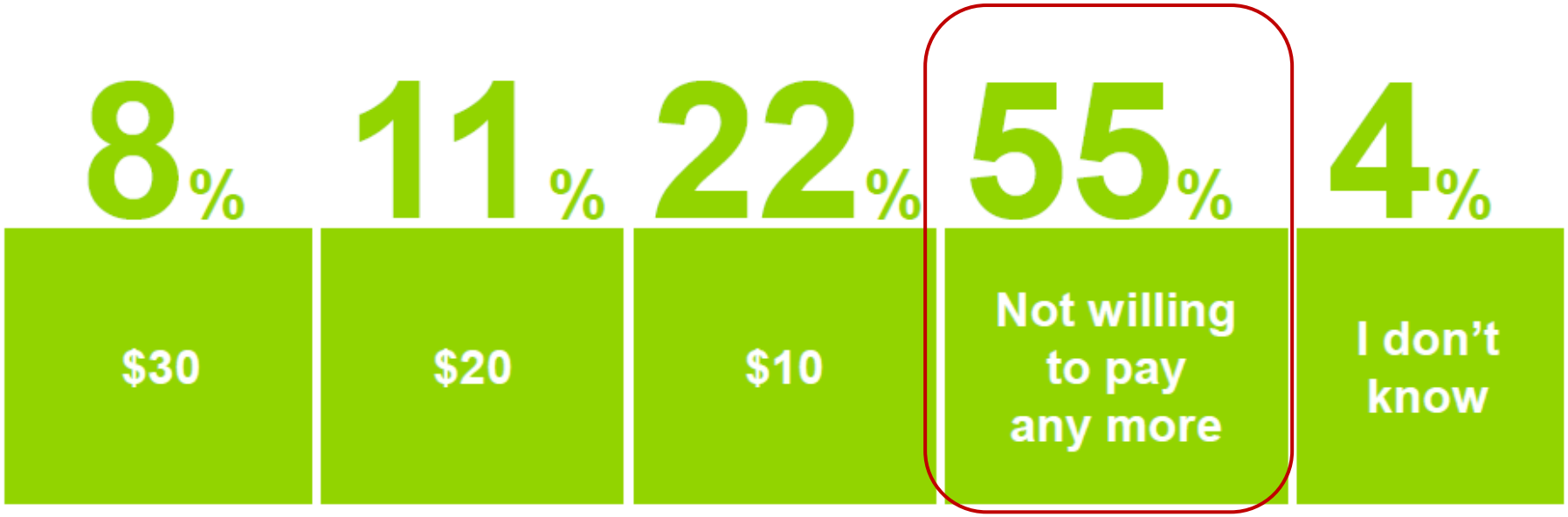


Source: Ruckus Wireless

Vast majority wouldn't even download an app in exchange for Wi-Fi!

Users Put Little Value on Higher Speeds, Part 1

How much would you be willing to pay if your wireless carrier would offer you speeds between 3 to 5 times higher than your current speeds?

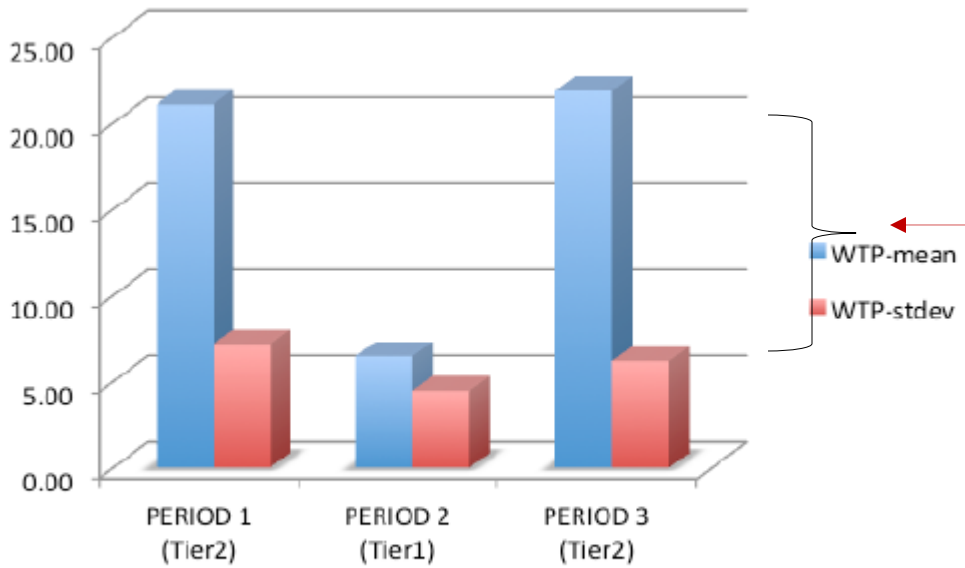


Source: Deloitte

Most consumers wouldn't pay *anything* for 3-5x speed improvement

Users Put Little Value on Higher Speeds, Part 2

- Study by AT&T Labs: "subjects seem to have a limited dynamic range of valuation for the wireless services regardless of the speed tiers offered"
  - Willingness to pay relatively insensitive to huge changes in speed



Tier2 vs. Tier1:
16x difference in speed
~$15 difference in "WTP"
(willingness to pay)

Fig. 3. WTP mean and stdev of the three periods among 12 trial participants

Source: Chen & Jana, "SpeedGate: A Smart Data Pricing Testbed Based on Speed Tiers"

Even a 16x increase in speed inspires little enthusiasm

Congestion in Practice, Part 1

- Study by Ofcom (UK FCC) surveying 38 different locations
  - "Overall the available [Wi-Fi] spectrum is not heavily used"

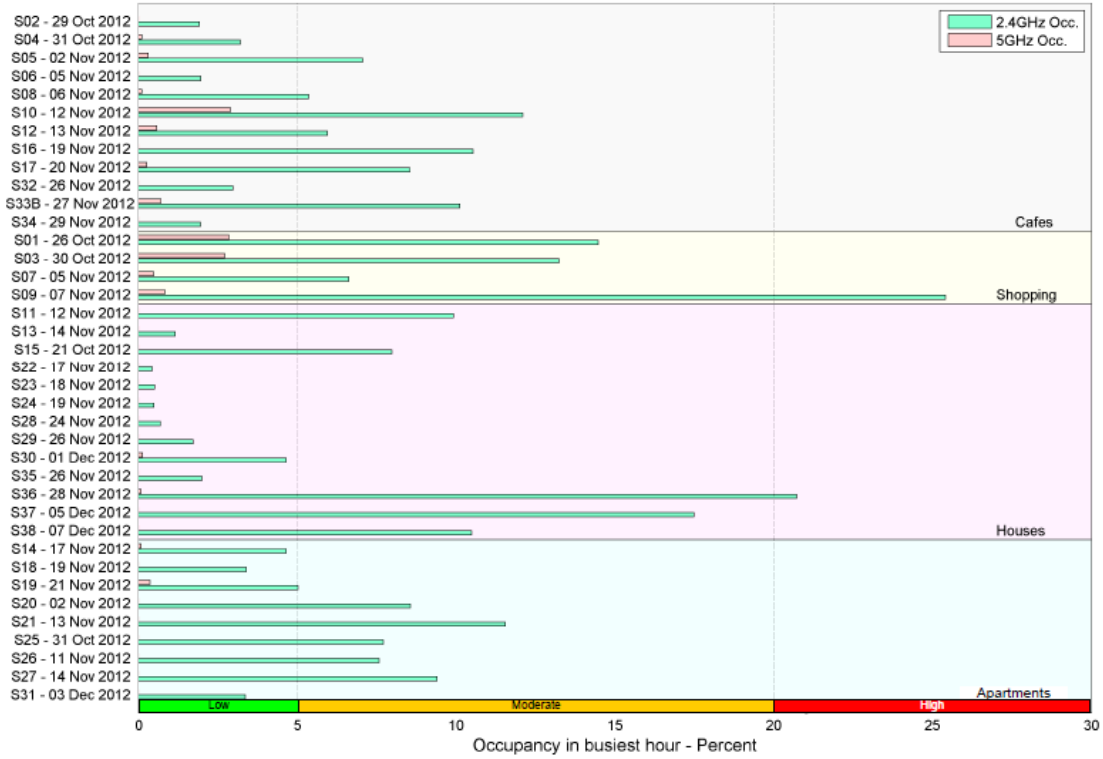


Figure 14 Occupancy in the busiest hour at each site

"High levels of occupancy were rare…
[T]he bands are not approaching their maximum capacity"

KerrisdaleCapital

Congestion in Practice, Part 2

- Study by Ghent University researchers
  - Wi-Fi “duty cycle” (% of time network is active) measured in a range of locations
  - “File transfer…results in highest duty cycles while surfing and audio streaming have median duty cycles lower than 3.2%”

Table 2
Number of locations per environment and 50th and 95th percentile of the duty cycle in different environments.

Environment	Number of locations	p_{50} (D) (%)	p_{95} (D) (%)	SD (D) (%)
Industrial	17	1.35	10.50	3.16
Rural	3	–	–	–
Suburban	30	1.18	4.55	7.37
Urban	82	1.43	11.05	7.14
Office	41	1.24	6.08	5.27
Residential	6	1.85	–	–
All environments	179	1.36	10.44	6.35

Empirical duty cycles are low across the board

Congestion in Practice, Part 3

- Review by RWTH Aachen and University of Colorado Law School Researchers

This work was motivated by the many claims that Wi-Fi is congested. We tried to understand what this claim might mean, and to test if it was true. We discovered that there are many ways to characterize wireless congestion, no unanimity on how to characterize service degradation, and little research about the connection between congestion and degradation. We concluded that there is as yet no hard evidence that congestion is rising to the level that would justify regulatory action.

…**The main lesson from this article is that congestion claims are indeed like the Emperor's missing robes**. It appears that excessive load is quite rarely observed, and very seldom well documented. Where the appropriate investment is made in infrastructure, as at the Super Bowl or well-run conference venues, lack of spectrum is not the binding constraint.

Source: de Vries et al., "The Emperor Has No Problem: Is Wi-Fi Spectrum Really Congested?"

"There is currently no evidence for pervasive Wi-Fi congestion"

Bulls Underestimate the Challenges of Rolling Out TLPS

- GSAT says: "Globalstar could implement TLPS almost immediately"
- But what does "implement" mean?
- Necessary process:
  1. Manufacture TLPS access points
  2. Deploy these TLPS access points
  3. Develop customized "network operating system" to manage APs
  4. Convince original equipment manufacturers (e.g. Apple, HTC, Lenovo) to ask the FCC to permit them to update user devices to access Channel 14
  5. Receive FCC approval for individual device models
  6. Get users to accept software updates
- Does this really sound like something that could happen "almost immediately"?
- And how will access point manufacturers, user device makers and others be convinced that all this is worth their time, effort and investment?

TLPS Logistical Hurdles Clear from GSAT's Own Filings

- GSAT, May 5, 2014: access points = **newly manufactured equipment**

> [85] As the *NPRM* indicates, Globalstar anticipates that, in contrast, most if not all TLPS access points will be newly manufactured equipment. These new access points along with next-generation TLPS-enabled consumer devices will receive new equipment certifications from the Commission.

- GSAT, June 4, 2014: access points need to be *centrally managed*
  - "Such control is critical to the commercial success of this managed service"
  - But the network operating system (NOS) doesn't actually exist yet
    - ⇨ Development still in very early ("Request for Information") stage:

> [34] Globalstar Comments at 15-16. Globalstar issued a Request for Information ("RFI") regarding its planned TLPS network in early March, including requesting solutions for hardware, software, backoffice, authentication, security, and network control. It has received RFI responses from nine technology vendors. Representative responses of Ericsson and Nokia Siemens Networks on network management technologies for TLPS are described *infra* at 27-28.

TLPS requires hardware and software that don't yet exist

Equipment Authorization: A Big Potential Headache, Part 1

- GSAT petition, November 2012: device makers will use "permissive change" filings for existing devices
  - Permissive change = less burdensome process than full re-certification

> [105] Under the Commission's equipment certification rules, in order to expand the operating frequency range of existing 802.11-enabled consumer devices to include Globalstar's licensed spectrum at 2483.5-2495 MHz, the original grantees for those device models (or their authorized third-party agents) will have to submit "permissive change" filings describing the proposed modifications. 47 C.F.R. § 2.1043. Once the Commission formally "accepts" these permissive changes for the relevant devices, the remote software updates can proceed and these devices can be used to receive TLPS. Globalstar anticipates that, in contrast, most if not all TLPS access points will be newly manufactured equipment, and that these base stations along with next-generation TLPS-enabled consumer devices will receive new equipment certifications from the Commission.

For existing devices, GSAT initially sought "permissive change" treatment…

Equipment Authorization: A Big Potential Headache, Part 2

- FCC NPRM, November 2013: certification, not permissive change!

> 42. A party seeking to market RF devices to the public must first comply with the Commission's equipment authorization procedures, which, *inter alia*, require a demonstration that the device complies with the Commission's rules.[112] We propose to require equipment manufacturers to certify all terrestrial low-power equipment under modified provisions specified in section 25.149 of the rules.[113] The proposed rules would not distinguish between low-power network access points and end user terminals or client devices, and would require certification for all low-power network equipment. Since the equipment will be operating simultaneously under the provisions of section 15.247 and modified provisions specified in section 25.149, we also tentatively conclude that the equipment must be certified under both the rule parts.[114] In such cases the device could be treated like a composite device subject to multiple rule parts. Composite devices are required to ensure compliance with the relevant rule parts.[115] We seek comment on this approach and how compliance should be demonstrated for such devices. We also conclude that the current certification procedures in Subpart J of Part 2 of the rules permit such approval.[116] We seek comment on this conclusion.

- Cisco rubs it in, May 2014:
  - GSAT *claims* it can use permissive change, but:
  - "As recognized by the *NPRM,* Globalstar is wrong."

…but the FCC (provisionally) said no

Equipment Authorization: A Big Potential Headache, Part 3

- GSAT to FCC, June 2014: please reconsider!

> The Commission…whether by interpretation, waiver, or rule change, should enable original equipment certification grantees to obtain permissive change authority to upgrade existing consumer devices for Channel 14 operations. … As described in Globalstar's comments, the re-certification of all consumer devices receiving the TLPS software update **would likely be an extended process and impose substantial and unnecessary costs** on consumers, manufacturers, and the Commission. Original grantees would be required to submit certification filings that include all the exhibits typically required for a new approval. Telecommunications Certification Body ("TCB") or Commission approval of these new certification requests **could take at least several months,** and then **grantees would have to attach new FCC ID labels to every single consumer device that receives the software update**. This lengthy and burdensome process could discourage manufacturer participation in TLPS and impede the development of this service.

The NPRM would require manufacturers
to physically re-label each individual TLPS user device!

Equipment Authorization: A Big Potential Headache, Part 4

- Even less burdensome "permissive change" filings could be challenging
  - Only original "grantees" can request permissive change, *not* GSAT
- Example: iPhone 5 on T-Mobile's network
  - Sep 2012: iPhone 5 released; no T-Mobile model
  - Apr 2013: T-Mobile announces first ever T-Mobile iPhone
    - ⇨ T-Mobile commits to buying billions of dollars' worth of devices
    - ⇨ Apple's FCC filings make clear that T-Mobile iPhone is just the AT&T iPhone with a *software* change, authorized via "permissive change" filing
    - ⇨ *Yet Apple choose not to make the filing until it had struck a deal with T-Mobile*
- GSAT must convince device-makers that TLPS is worth the effort
  - But TLPS only works if there are available access points!

Even "permissive change" suffers from a chicken/egg problem

Equipment Authorization: A Big Potential Headache, Part 5

- GSAT bulls argue that a mere firmware update will make existing user devices TLPS-capable
- But firmware updates are dangerous!

What Causes Devices To Be Bricked

Obviously, bricking a device is bad and you should try to avoid it. In general, devices are bricked by mistakes when overwriting their firmware and other low-level system software.

For example, let's say you have an iPhone, iPod, PSP, MP3 player, smartphone, digital camera, or anything else that uses firmware. You see a notification that indicates there's an update for your firmware. If you start the firmware update process and the device loses power during the process – say, if the battery dies, its power cord is pulled from the pocket socket, or the power in your house goes out – the device may have become bricked. If the firmware is half-overwritten, the device may no longer power on and function properly.

Source: How-To Geek

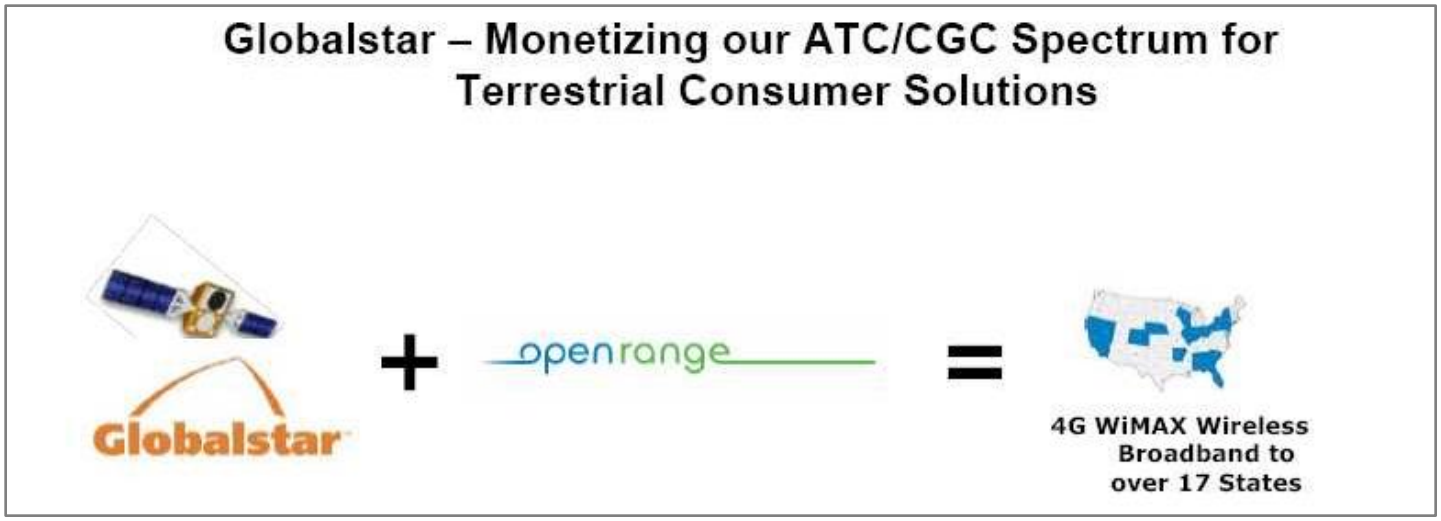
Galaxy S3 completely bricked after firmware update - Androi...
forums.androidcentral.com › ... › Samsung Galaxy S3
Mar 25, 2014 - Hey guys, My girlfriend did an over the air update of the **firmware** on her perfectly fine and functional Galaxy S3. The update reached 100%

How to Fix Bricked Iphone - Gamerguides - HubPages
gamerguides.hubpages.com › Technology
Jun 18, 2013 - **Bricked Iphone** or **bricked** electronics gadget means one thing. The **firmware** or operating system on that device were corrupted. There's ...

Firmware changes are risky, and TLPS isn't worth the hassle

History Lesson: The Open Range Misadventure, Part 1

- TLPS is not Globalstar's first attempt to monetize its spectrum
- In 2007, Globalstar asked the FCC to let it lease its spectrum to a newly created company, Open Range Communications
- Open Range would provide 4G WiMAX to customers in underserved rural areas



Open Range was GSAT's first attempt at spectrum monetization

History Lesson: The Open Range Misadventure, Part 2

- Open Range was a complete failure:
  - GSAT could not meet FCC's requirements to provide coverage in all 50 states, keep spare satellites, etc. → FCC suspends GSAT's terrestrial authority
- Open Range was destined for failure
  - Open Range woefully undercapitalized
  - WiMAX became a failed concept
  - Open Range targeted rural customers; CLWR failed even in urban areas
  - Execution failures: self-interference issues, poor network quality
  - Open Range only had a thin band of high frequency spectrum to work with
- Open Range partially funded with gov't-guaranteed debt, **cost taxpayers $73m**

"Hard to imagine where money went" with bankrupt Colorado broadband provider Open Range

By Ann Schrader
The Denver Post

POSTED: 11/13/2011 01:00:00 AM MST 14 COMMENTS

Posted at 03:31 PM ET, 10/26/2011

Democrats call for investigation into bankrupt Open Range federal loans

By Cecilia Kang

Updated to correct reference at bottom of story. Previous version incorrectly stated that Open Range failed to launch satellites. The company Globalstar failed to fulfill promises of expanding satellite coverage.

From the same management that's now bringing you TLPS

Just Ask Yourself…

- In a world where:
  - Unlicensed Wi-Fi, when available, is already superior to cellular service
  - Free Wi-Fi is offered by more and more businesses and venues
  - 5GHz Wi-Fi is supported by all new devices and will enable far faster peak speeds than 2.4GHz
  - <1% of the US population has demonstrated any willingness to pay a dime for Wi-Fi access, let alone *faster* Wi-Fi once they have access
  - The notion of unmanageable spectrum congestion is belied by the widespread success of Wi-Fi deployments in stadiums, universities, businesses, etc.

↓

How much would <u>you</u> pay for TLPS?

The Satellite Business and GSAT’s Financial Position

GSAT: Highly Levered, No Earnings

GSAT 10-Year Performance Summary

($mm)	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Revenue	$84.4	$127.1	$136.7	$98.4	$86.1	$64.3	$67.9	$72.8	$76.3	$82.7	$896.7
Op. income	(3.5)	21.9	15.7	(24.6)	(57.7)	(53.8)	(59.8)	(73.2)	(95.0)	(87.4)	(417.5)
Adj. EBITDA	3.6	27.3	33.8	21.8	(14.2)	(12.6)	(8.5)	(6.4)	9.8	11.9	66.5
CF from ops	14.6	13.7	14.6	(7.7)	(30.6)	(18.4)	(23.3)	(5.5)	6.9	(6.5)	(42.3)
Less: capex	4.0	9.9	107.5	170.0	286.1	324.1	208.4	88.2	57.5	45.3	1,301.0
Levered FCF	10.6	3.8	(93.0)	(177.7)	(316.7)	(342.5)	(231.7)	(93.7)	(50.6)	(51.8)	(1,343.3)
End of period											
Debt @ book	$3.3	$0.6	$0.4	$50.0	$238.3	$463.6	$664.5	$723.9	$751.0	$669.3	
Stock price			$13.91	$8.00	$0.20	$0.87	$1.45	$0.54	$0.31	$1.75	
Shares O/S			72.5	83.7	136.6	291.1	310.0	353.1	489.1	844.9	

GSAT has been in dire straits for years

GSAT's Satellite Operations Do Not Support Its Debt Load

- Sell-side valuation of satellite business:
  - 7.5x EBITDA multiple (arbitrary)
  - $45mm of EBITDA
    - ⇨ 2014 H1 annualized level: ~$18mm
    - ⇨ Thus price target assumes **2.5x increase** in satellite-related EBITDA
  - Result: $338mm EV
- Net debt excluding in-the-money convertibles: $545mm
- Implied equity value excluding terrestrial uses of spectrum: zero

Absent the spectrum story, GSAT equity is worthless

GSAT Operates under Strict, Detailed Financial Covenants

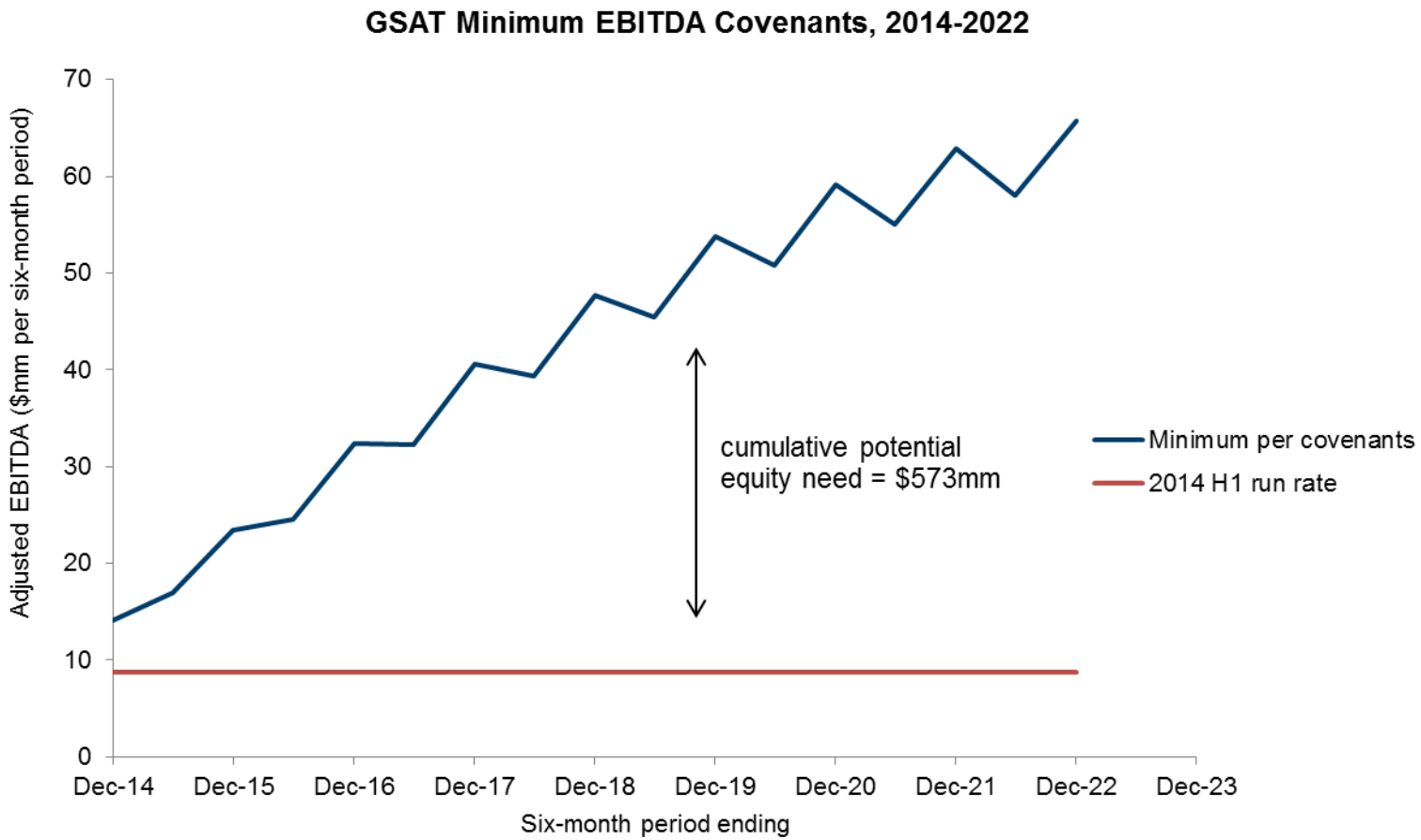
- Minimum "Adjusted Consolidated EBITDA" under COFACE credit facility:

Column 1 – Relevant Period	Column 2 – Amount	
Relevant Period commencing on 1 July 2013 and expiring 31 December 2013	US$	5,498,709
Relevant Period commencing on 1 January 2014 and expiring 30 June 2014	US$	9,915,905
Relevant Period commencing on 1 July 2014 and expiring 31 December 2014	US$	14,062,424
Relevant Period commencing on 1 January 2015 and expiring 30 June 2015	US$	16,957,844
Relevant Period commencing on 1 July 2015 and expiring 31 December 2015	US$	23,468,546
Relevant Period commencing on 1 January 2016 and expiring 30 June 2016	US$	24,502,077
Relevant Period commencing on 1 July 2016 and expiring 31 December 2016	US$	32,426,136
Relevant Period commencing on 1 January 2017 and expiring 30 June 2017	US$	32,213,650
Relevant Period commencing on 1 July 2017 and expiring 31 December 2017	US$	40,646,025
Relevant Period commencing on 1 January 2018 and expiring 30 June 2018	US$	39,374,425
Relevant Period commencing on 1July 2018 and expiring 31 December 2018	US$	47,694,042
Relevant Period commencing on 1 January 2019 and expiring 30 June 2019	US$	45,509,317
Relevant Period commencing on 1 July 2019 and expiring 31 December 2019	US$	53,829,858
Relevant Period commencing on 1 January 2020 and expiring 30 June 2020	US$	50,789,693
Relevant Period commencing on 1 July 2020 and expiring 31 December 2020	US$	59,114,411
Relevant Period commencing on 1 January 2021 and expiring 30 June 2021	US$	54,976,659
Relevant Period commencing on 1 July 2021 and expiring 31 December 2021	US$	62,840,452
Relevant Period commencing on 1 January 2022 and expiring 30 June 2022	US$	58,018,907
Relevant Period commencing on 1 July 2022 and expiring 31 December 2022	US$	65,708,169

enormous increase needed

GSAT has to massively ramp up its earnings…

GSAT Is Headed Toward Massive Covenant Violation



…but it's already terribly off track

Consumer Perception of GSAT Products, Part 1

★☆☆☆☆ **Poor quality; poor service**, September 4, 2013

By **Allen Gwinn** - See all my reviews
REAL NAME

This review is from: SPOT Global Sat Phone - Black (Unlocked Phone)

Without going into history of their defective satellites, I had maintained a Globalstar (SPOT) phone for years in case the service improved. They just finished their "second generation" network and their phones are still virtually unusable. You get connected, then the call drops. Maybe after 4 or 5 times you'll be able to get a call to last for more than a minute or so. Bottom line: extremely unreliable and expensive. Finally gave up and nixed the service.

Help other customers find the most helpful reviews
Was this review helpful to you? Yes No

Report abuse | Permalink
Comment

3 of 3 people found the following review helpful

★☆☆☆☆ **Worst money I've spent in a long time.**, February 12, 2014

By **Eric D. Stein** - See all my reviews
REAL NAME

Verified Purchase (What's this?)

early termination fee

This review is from: SPOT Global Sat Phone - Black (Unlocked Phone)

Others have hinted at the issues with the plans. I won't elaborate. Suffice to say I paid the ETF because the service is unusable.

I tried using the phone several times in Turks and Caicos over the period of 2 weeks, and not once was I able to complete a call. I was able to complete one phone call when I returned in my driveway but it also dropped one minute into the call.

Don't waste your time. Spend the money on a real sat phone and save the headache and wasted money.

Help other customers find the most helpful reviews
Was this review helpful to you? Yes No

Report abuse | Permalink
Comment

With a product this weak, no big rebound is in the offing

Consumer Perception of GSAT Products, Part 2

★★★★★ **If You Live in Southern California, avoid Globalstar. .,** June 20, 2014

By **Cold War Veteran MP** (California United States) - See all my reviews

Verified Purchase (What's this?)

This review is from: Globalstar gsp-1700 satellite phone - red over $150 (Unlocked Phone)

The phone itself great. The company Globalstar. .not so great. To be honest the worst so far. They have never really had reliable service. They instituted "Call Timers" a couple years ago till they got all their satellites up. I figured this would solve my constant drop call problem. Fast forward. All satellites up..still dropped calls. Come to find out, Southern California is not a "Primary" coverage area..but "limited" and subject to you guessed it..unreliable service. So..If you live anywhere other than Southern California you might have great coverage. But in Calif, you'd be better off with a can and string..

Help other customers find the most helpful reviews

Was this review helpful to you? Yes No

Report abuse | Permalink

Comment

"You'd be better off with a can and string"

Consumer Perception of GSAT Products, Part 3

★☆☆☆☆ **LIES,FRAUD,CRIMINAL NEGLIGENCE**, June 25, 2014

By **Jano Mossman "DLFRM"** (midwest) - See all my reviews

REAL NAME

This review is from: **Globalstar gsp-1700 satellite phone - red over $150 (Unlocked Phone)**

I had owned first a Qualcomm/Globalstar 1600 and then a Qualcomm/Globalstar 1700 for the last 12 years. There is nothing wrong with the phones, they are well made, fairly rugged and have nice features. The problem is with
the Globalstar Company. Take your worst nightmare experience dealing with a phone company than multiply it times 10.
At first the phone worked, then their satelites "degraded" until they wouldn't work anywhere at at time, at least long enough
to make a phone call. I was stupid enough to believe there lies that the system would be back to normal by the end of the year,year after year after year. I finally got an Iridium phone and called to cancel my Globalstar account, they then converted my account to strictly pay per use, just to keep their customer base looking good. As soon as they succeeded in partially restoring the network they canceled my account without notifying me, then sent me an email begging me to reopen my account. These guys are hoodlums that if there was any kind of consumer protection, they would have been indicted by now. They did settle a class action suit against them a few years ago for charging for services they were not providing, but as with most suits of these kinds the lawyers that filed them made some money, the rest of us got a token credit, and that prevented further action against them. Like a lot of phone companies the only thing these guys were good at was sending the bill like clockwork. and those bills were full of mistakes, charges for services not rendered,
credits promised but not applied that counted on you giving up before wrangling endlessly with their billing department.
If you need a sat phone, pay a little more and get one you can count on, Iridium

"Pay a little more and get…Iridium"

Iridium's Recent Equity Raise: A Noteworthy Precedent

- 2013: Iridium announces publicly that it's off track on its near-term financial covenants and will "need modifications"
  - Same guarantor as GSAT: COFACE
- May 2014: Iridium amends COFACE facility and re-strikes covenants
  - Condition: raising "**at least $217.5 million through the sale of equity securities"**
- *Why shouldn't GSAT get the same treatment?*

GSAT may be forced to raise equity

But…FCC Approval!

- Some GSAT bulls believe FCC approval of TLPS will be a big "catalyst"
- **But all of our analysis already assumes FCC approval**
- GSAT is dramatically overvalued *even with* approval
  - *Without* TLPS approval, hard to argue GSAT equity is worth anything
- GSAT bulls already assume very tight FCC timeline (Q4?)
  - Possible, but FCC has a lot on its plate, e.g. …
    - ⇨ Two pending auctions (AWS-3 in 2014 and 600MHz in ~2015)
    - ⇨ Rulemaking for 3.5GHz small-cell band
    - ⇨ Net neutrality (hundreds of thousands of public comments)

Logically, FCC approval is not a positive catalyst

Conclusion

- Globalstar short thesis is simple:
  - TLPS is worthless
  - Globalstar's spectrum has negligible value in any other non-TLPS use case
  - Globalstar's satellite business is worth less than its debt
  - Therefore, Globalstar equity is fundamentally worth zero

- Dreamy spectrum narratives tend to end badly
  - Clearwire
  - LightSquared
  - ICO/DBSD
  - TerreStar
  - Solaris

GSAT is overhyped, overvalued, and insolvent, with 100% downside

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