Globalstar, Inc. (GSAT)

The Most Egregious $4 Billion Stock Promotion Since Sino-Forest

Globalstar's equity is worthless. It is not worth $4 billion, or $3 billion, or $1 billion. It is worth nothing, and it takes little more than a rudimentary understanding of wireless communications to realize that. In this report and future reports, as well as live presentations, webinars, and our website www.factsaboutglobalstar.com, we will demonstrate clearly and irrefutably that (1) Globalstar's Terrestrial Low Power Service ("TLPS") concept is laughable and will never be commercially viable and (2) Globalstar's spectrum holdings are unlikely to generate material value in any other use case. In virtually all scenarios, the combined value of the company's unprofitable core satellite business and the potential terrestrial applications of its spectrum assets falls below its massive debt burden, making the stock a zero. Though some speculators view final FCC approval of TLPS as a positive "catalyst" for Globalstar, *we already assume that TLPS will be approved.* (If it isn't, or if the rules are merely less favorable than expected, then the Globalstar bubble will just deflate that much more rapidly.)

Globalstar (GSAT), currently trading at a fully diluted market capitalization of $3.6 billion after successfully convincing numerous hedge funds to buy into its story, is by far the most ludicrous stock promotion we have seen since our time exposing fake Chinese companies in 2011. The fourth-largest player in the slow-growing mobile satellite services (MSS) market, GSAT uses its constellation of low-Earth-orbit satellites to offer basic mobile voice and data services in remote areas of the planet. Over the twelve months ended June 30, 2014, GSAT generated just $88 million of revenue, $15 million of adjusted EBITDA, and *negative* $95 million of operating income. Since emerging from bankruptcy in 2004, it has racked up cumulative operating losses of $463 million, increased its share count by a factor of 13, been de-listed from the NASDAQ in 2012, defaulted on its debt in 2013, and put itself on a path to violate its financial covenants again in the near future.

Yet GSAT today has a $4 billion enterprise value thanks to an outpouring of misleading and ill-informed hype over its plan to exploit its spectrum licenses terrestrially. According to the company and its cheerleaders, this plan will unlock tremendous riches and incite a frantic bidding war among every technology and telecom company of significance. In reality, in the words of one of the many subject-matter experts to whom we have spoken, "If it [the TLPS proposal] went through, no one would care."

GSAT's TLPS concept is nothing more than the addition of one new Wi-Fi channel in the legacy 2.4GHz band – a licensed, for-profit channel that only authorized devices could use. In a world that already has three free, unlicensed channels in the 2.4GHz band and an additional *22* in the 5GHz band, the notion that one more channel, hypothetically accessible to only a circumscribed subset of users, could be worth many billions of dollars has elicited chuckles of ridicule and disbelief from every Wi-Fi engineer we could find.

Notwithstanding GSAT's fear-mongering about debilitating "Wi-Fi congestion," modern technology and network design have rendered co-channel interference perfectly manageable even in challenging settings like the Super Bowl and the Olympics, let alone less extreme but still densely populated environments like university lecture halls and Starbucks cafés. The immense success of Wi-Fi in high-density areas using free, unlicensed spectrum relies on spreading traffic across multiple channels; by contrast, TLPS, with just a single channel, is terribly ill-suited for exactly those places where GSAT claims it will help. Ironically, TLPS, pitched as a *solution* to "congestion," would suffer from it dramatically more than true Wi-Fi. The irrelevance of TLPS will be reinforced by the rapid ascent of the next-generation Wi-Fi protocol 802.11ac, which operates exclusively in the 5GHz band and will achieve performance that the 2.4GHz-only TLPS could never match. Ultimately TLPS is nothing more than GSAT's latest gimmick to stave off bankruptcy, a stunt that rivals Allen Chan's fake forests as the most successful stock-market fantasy we've ever come across.

Outside of TLPS, many analysts value GSAT as if its spectrum holdings – currently authorized only for use in its satellite business – were about to become on par with AT&T or Verizon's, but this is profoundly mistaken. While mobile network operators have the legal authority to transmit over their proprietary frequencies at high power levels – for example, 1,640 watts – TLPS would neighbor the unlicensed 2.4GHz band and thus face power limits that are *400x lower,* dramatically increasing the number of base stations needed to cover a given physical area. These onerous power restrictions, as well as other features specific to GSAT's spectrum that we'll discuss later in the report, render GSAT's spectrum useless to potential acquirers. Though GSAT *sought* the FCC's permission for full flexibility to use its spectrum terrestrially in a high-powered LTE network – akin to the treatment DISH Network (DISH) received for its spectrum – the FCC snubbed this request and only agreed to move forward with the lower-value TLPS option.

Even if GSAT were to abandon its ludicrous, quixotic dream of one day using its 1.6GHz spectrum for terrestrial purposes (despite more severe GPS interference problems than the disastrous LightSquared), its 2.4GHz band still wouldn't add up to much. It's not exclusive to GSAT; it runs the risk of severe interference with important and heavily used neighboring bands; and it's difficult and impractical to incorporate into a plausible consumer device. Amusingly, even if we ignore all of these fatal flaws, GSAT is *still* trading at a valuation far in excess of what appropriate precedent transactions suggest. For example, applying the price that Sprint paid just last year for Clearwire's high-frequency spectrum – which GSAT's CEO has characterized as "functionally equivalent" to GSAT's own – implies ~80% downside for GSAT's stock price. Given how many optimistic assumptions are imbedded in that estimate, *100%* downside is perfectly reasonable as a more realistic base case.

GSAT's shareholders are baselessly ascribing enormous value to the company's TLPS concept and its spectrum, hoping that a greater fool will write a multi-billion-dollar check to cash them out. No such fool exists. Fundamentally, the company's equity is worth nothing. Like its satellites, GSAT's stock price has a long, long way to fall before crashing back to Earth.

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I. Investment Highlights

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 vendor

Yikes. Snake oil for the modern world here…Channel 14 does NOTHING to better 802.11ac, and is a desperate, weird, gimmicky ploy to make 2.4 GHz better.

—Wi-Fi engineer managing large-scale networks

Globalstar proposes to combine the features of the amazingly successful WiFi 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)

GSAT's Wi-Fi Concept Will Never be Commercially Viable

GSAT hopes to gain regulatory approval to roll out a new, exclusive Wi-Fi channel by linking up 11.5 megahertz (MHz) of its own licensed spectrum in the 2.4GHz band with 10.5 MHz of spectrum in the neighboring unlicensed band used by conventional Wi-Fi. The company has dubbed this concept – which would provide Wi-Fi-like internet access utilizing a mixture of licensed and unlicensed spectrum – "TLPS," short for Terrestrial Low Power Service. The prospect of near-term FCC approval for TLPS has driven much of the appreciation of GSAT's stock price over the past year; some investors apparently perceive it as tremendously valuable. But they're wrong. The reality is that TLPS is something that no one needs, wants, would actually deploy, or would be willing to pay a dime for.

- **In a world with 25 *free* Wi-Fi channels, a single *costly*, *for-profit* channel is irrelevant and worthless**. TLPS is nothing more than an extra Wi-Fi channel that GSAT and its boosters hope someone will be willing to pay handsomely to access. Perhaps Wi-Fi users themselves would foot the bill, or perhaps – as GSAT bulls, intuiting that consumers have virtually no appetite to pay for Wi-Fi, are quick to add – some third party, like a cable company, would step in on their behalf. But there are already 25 available Wi-Fi channels that cost nothing to use and work very well; *GSAT's business plan is to compete with free* (using outdated technology to boot). Not only are all the existing Wi-Fi channels free; Wi-Fi service using those channels is also increasingly provided as a complementary amenity, like bathrooms and napkins. All of the available data demonstrates that consumers are largely unwilling to pay for Wi-Fi access at all, let alone pay *more* for "improved" Wi-Fi. Worse still, given the substantially superior performance of 5GHz Wi-Fi systems now and in the future, GSAT bulls apparently believe that people will happily pay through the nose for TLPS Wi-Fi that is actually *worse* than the 5GHz Wi-Fi they can get for free. Competing with free while selling an inferior product: this is the TLPS vision.

- **"Wi-Fi congestion" is a problem that can be routinely solved in almost every scenario.** With a good enough underlying connection, an adequate number of modern access points, and a basic awareness of frequency reuse and channel planning, almost any normal environment can avoid "Wi-Fi congestion" using existing resources at a low cost. GSAT claims that TLPS is the solution to Wi-Fi congestion, a supposedly dire crisis in America today. GSAT has even argued that Wi-Fi spectrum will be exhausted *by 2014* – a forecast that, needless to say, does not appear likely to pan out. But every data point confirms that existing Wi-Fi is not only *capable* of delivering excellent performance but *already does* deliver excellent, and improving, performance. Average Wi-Fi speeds exceed average cellular speeds, even for 4G, and large-scale, high-density Wi-Fi networks have worked extraordinarily well even at huge football stadiums and massive tech conferences. If engineers can deliver high-quality Wi-Fi – and resolve "congestion" – at the Super Bowl without any help from GSAT's surplus spectrum, then who exactly needs it?

  Though GSAT would like to attribute all disappointing Wi-Fi experiences to "congestion," the truth is that weak underlying internet connections, outdated technology and bad network designs are the real root causes of almost all bad Wi-Fi and have nothing to do with a deficit of spectrum. GSAT has a non-solution for a non-problem.

- **5GHz is the present and future of Wi-Fi; 2.4GHz is the past.** TLPS is stuck in the legacy 2.4GHz band, which GSAT bulls love to bad-mouth as riddled with interference and almost unusable. Not only is this grossly exaggerated, but it misses a crucial point – the 5GHz unlicensed band has abundant available spectrum and is used by millions of existing Wi-Fi devices *today.* This is not some hypothetical, untested technology: with the exception of the now obsolete iPhone 4s, every Apple and Samsung phone, tablet, and laptop support 5GHz Wi-Fi. Wi-Fi engineers today routinely design networks *first* for 5GHz devices and only as an after-thought for 2.4GHz; one described 2.4GHz-only networks to us as "'90s technology."

  While 2.4GHz Wi-Fi offers only three non-overlapping channels in the US and thus can raise occasional congestion issues, 5GHz Wi-Fi offers an additional 22 non-overlapping channels, with more likely on the way thanks to the FCC's efforts. With so much free, scarcely used bandwidth available elsewhere, TLPS's pathetic single channel has no hope of gaining traction. In fact, there is so much available spectrum in the 5GHz band that networks often combine 20MHz channels to form 40, 80, and even (soon) 160MHz channels, with proportional increases in download speeds. TLPS will never be able to do this. If that wasn't bad enough, the next-generation "gigabit Wi-Fi" standard 802.11ac – recently promoted at high-profile public events by Apple and T-Mobile – will only function in 5GHz, as will all future versions. TLPS will thus offer outdated technology and skimpy, congestion-prone bandwidth – a much uglier yet more real version of the fictitious crisis that GSAT suggests exists in standard Wi-Fi.

The claim that 5GHz signals propagate less well than 2.4GHz signals is widely circulated to defend TLPS. But this is a complete red herring and betrays profound ignorance of Wi-Fi realities. (Ask any knowledgeable Wi-Fi engineer, and he or she will be happy to explain it to you.) 5GHz signals do propagate less well, meaning that at a given distance from an access point, the power received by a user device will be lower on 5GHz than on 2.4GHz. But users don't care about how much power they receive; they care about throughput. As any independent hardware test will demonstrate – see, for example, Miercom's analysis of the performance of the Aruba Networks AP-225 AP (at distances of 5, 30, 75, 100, and 120 feet) or Hardware.info's detailed comparison of numerous consumer-grade 802.11ac routers (at distances of 3 and 10 meters (~9.8 to 32.8 feet)) – 5GHz can deliver superior throughput relative to 2.4GHz at any reasonable distance, notwithstanding the greater attenuation. More important, *covering a wide area with a single AP is not the goal of any serious Wi-Fi architect.* 5GHz can easily cover an entire single-family home. For more demanding applications, the goal is to deliver *capacity,* not coverage – i.e. to support a large number of active users in a small space. In these settings, the greater range of 2.4GHz *is a bug, not a feature,* since the entire focus of the design efforts is to create coverage cells that are as small as is possible (and cost-effective). We urge GSAT bulls who purport to know more about Wi-Fi than Cisco, Apple, and every certified wireless engineer to address their complaints about the unusability of 5GHz to those parties. They will surely be very interested to hear that they have built the entire future of a crucial and incredibly popular technology on an unworkable frequency band. What an embarrassing blunder!

- **In a large-scale Wi-Fi network, TLPS would add no value.** Bulls dream of a nationwide network of TLPS-enabled access points offering ubiquitous connectivity. But any company can build a large-scale Wi-Fi network today if it so chooses, provided it can marshal sufficient backhaul (i.e. internet access), electricity, and real estate. GSAT has nothing whatsoever to offer on this front, and thus even in a hypothetical nationwide TLPS network, almost all the value would be generated by, and accrue to, whoever actually did the hard and costly work of building out the footprint. The only thing GSAT has to offer is its incremental channel, which would increase the value of the network by a factor of virtually zero. Moreover, integrating this channel poses a host of practical problems. For example, existing APs couldn't support non-TLPS-enabled and TLPS-enabled clients simultaneously, thereby excluding non-TLPS clients from the network entirely. But custom TLPS-only APs couldn't just be plugged into existing infrastructure. They'd have to be manually configured and managed – something no large-scale network operator would ever consider doing.

- **Enabling existing devices for TLPS is no easy task.** Though GSAT's investor-facing communications suggest that all existing Wi-Fi devices can be activated for TLPS in a snap, it's crystal-clear from the company's FCC filings (and from basic reasoning) that the process would be dramatically more burdensome than that. GSAT openly and repeatedly states that TLPS would require *newly manufactured* access points, which someone would have to create and install in high-traffic locations before the service were usable. Meanwhile, under the FCC's proposed rule, existing user devices (like phones and laptops) could only be authorized for TLPS if they were *physically re-labeled with new regulatory information one by one.* Even if the FCC allows some more streamlined process, device manufacturers, not GSAT, would be responsible for making any firmware changes and might easily not bother, especially for a service that no one needs, wants, would actually deploy, or would be willing to pay a dime for. There is absolutely no reason to believe that it would be cheap or easy to convince dozens of manufacturers of millions of different devices, many of them years out of date, to attempt to remotely modify low-level firmware settings for the benefit of some hypothetical paid Wi-Fi network that there is no demand for.

- **There is no "international story" for TLPS.** In the minds of GSAT bulls, TLPS in the US is just the beginning. Soon, they believe, every other country in the world will also move forward with similar regulatory approvals. But as worthless as TLPS is in the US, it's actually even more ridiculous anywhere else. The entire pitch for TLPS is that it opens up a fourth non-overlapping channel in 2.4GHz Wi-Fi – *but every other major jurisdiction in the world already has four non-overlapping channels.* Channels 1, 5, 9, and 13 – the last of which is perfectly available outside of the US – are, in fact, collectively non-overlapping when using the 20MHz channels that have defined 2.4GHz Wi-Fi since the 802.11g standard came out in 2003. Sure enough, many overseas Wi-Fi networks do use this channel plan, especially in the absence of neighboring networks using the US-centric 1/6/11 model. Given widespread usage of channel 13 abroad, a rollout of TLPS's channel 14 would generate destructive adjacent-channel interference. In other words, TLPS would only possibly make sense in the US – and it doesn't make sense here either. There is zero international option value. Then again, there is also zero domestic option value.

GSAT's Spectrum Is Not Valuable for Terrestrial Purposes

Much of the appeal of the GSAT narrative stems from the vague sentiment that spectrum is scarce and thus is always very precious. But not all spectrum is the same, as investors of LightSquared have found out the hard way, and GSAT's holdings are even worse than LightSquared's. Outside of its originally designated purpose of supporting mobile satellite services, Globalstar's spectrum has little value.

- **TLPS authority is much more restrictive than true cellular authority**. Even assuming that the FCC finalizes the TLPS rulemaking, GSAT will by no means be permitted to operate a cellular-style high-powered network of base stations covering large geographic areas – what the company itself, in its original petition to the FCC, characterized as the "highest and best terrestrial use" of its spectrum. Instead, it will be limited to low-power access points operating at a 400x lower wattage. As with standard Wi-Fi, this low power results in tiny coverage areas relative to cellular deployments on similar frequencies, likely requiring *hundreds of millions* of access points, rather than tens of thousands of base stations, to provide anything like national scope. No phone carrier or other telecom firm would ever consider this spectrum at a valuation anywhere approximating typical cellular spectrum, or would probably even consider it at all.

- **GSAT's 2.4GHz spectrum has little value.** Having already established that TLPS – GSAT's only actual strategy for making terrestrial use of its 2.4GHz band – is not commercially viable, we ask whether GSAT's 2.4GHz spectrum might have some other use case years down the road, assuming the company survives that long. Unfortunately for GSAT, it doesn't. At best, with hypothetical FCC approval, GSAT could try to repackage its spectrum as a 10MHz supplemental downlink band. We doubt, however, that the FCC would permit a high-powered LTE network sandwiched between, on one side, the hugely popular and economically important 2.4GHz Wi-Fi band and, on the other side, the spectrum that Sprint recently acquired from Clearwire; the interference issues would be too severe. Even if the FCC allowed it, no carrier would be willing to pay much for the spectrum. It's not internationally standardized, has no existing device support, would experience substantial interference from Wi-Fi transmissions, and would be difficult to cram into a realistic user device without giving rise to self-jamming.

Making matters worse, GSAT does not actually have exclusive rights to its 2.4GHz terrestrial spectrum. It shares the band on a co-primary basis with broadcast engineers, who use it to transmit live video feeds from wherever newsworthy events are happening and who are legally entitled to interference protection. This unusual arrangement renders GSAT's spectrum rights messy and undesirable.

Even without these devastating flaws, and setting aside the previously discussed legal encumbrances, the 2.4GHz band is high-frequency, and high-frequency spectrum is worth *exponentially less* than low-frequency spectrum given its far worse ability to propagate over long distances. Similar high-frequency spectrum has recently fetched prices of $0.13 to $0.30 per MHz-pop in the US and $0.001 to $0.20 per MHz-pop abroad, underscoring the absurdity of using $1-$2/MHz-pop valuations for GSAT, as many bulls do. And even these precedents, which alone imply ~80% downside for GSAT's stock, do not take account the fact that any actual attempt by GSAT to repurpose its 2.4GHz spectrum for LTE use would face endless regulatory and practical hurdles. The company's terrestrial spectrum will never generate enough value to come close to justifying its ludicrous valuation; most likely, it will never generate any value at all.

- **GSAT's spectrum is highly encumbered**. Even with TLPS, GSAT's ability to use its spectrum terrestrially is firmly legally tethered to its satellite business. (By contrast, DISH Network, which acquired the bulk of its spectrum holdings from bankrupt satellite companies, managed to win full-fledged terrestrial authority.) Since this business burns millions of dollars every year and requires multi-billion-dollar capital expenditures every 10-15 years to replace worn-out satellites, any prospective buyer of GSAT's spectrum would face major ongoing costs just to maintain the license.

- **GSAT's 1.6GHz spectrum is worse than LightSquared's**. Although the GPS interference problems that initially brought down LightSquared focused on the high-powered base stations that would operate on its downlink band, the GPS industry and numerous government agencies have also expressed – and recently reiterated – profound concerns about terrestrial use of its *uplink* band as well. Since GSAT's uplink band is actually *closer* in frequency to GPS and other navigation systems than LightSquared's, there is no way that the FCC will open it up for terrestrial use – certainly not in the next decade and probably not ever.

GSAT's Actual Business Is Weak and Headed for Default

When it was first proposed, TLPS was merely the last-ditch attempt of a highly insolvent company to distract investors from its looming bankruptcy. It has since taken on a life of its own, but, beneath the hype, there still remains a deeply indebted, unprofitable, fourth-rate satellite company saddled with unachievable financial covenants. To be fair, after a protracted period of terrible network performance, GSAT has recently enjoyed an operational rebound, but it still falls far short of profitability. Moreover, to meet the minimum EBITDA targets under its debt covenants, the company must increase its adjusted EBITDA by more than 2x by 2H 2015, more than 3x by 2H 2016, and more than 4x by 2H 2017 – and the requirements just keep ratcheting up from there. GSAT has violated similar covenants in the past, only to renegotiate them far lower but reassure creditors via additional shareholder dilution; if the recent capital raise of competitor Iridium is any guide, then the same thing will recur soon with GSAT. Even if GSAT miraculously executes the long-term MSS business plan it provided to its lenders, requiring revenue and EBITDA to grow to 2x and 5x their all-time highs, we estimate that its MSS business would still be worth only $0.15 per share.

There is simply no rational basis for GSAT's $3.6 billion market cap – indeed, any market cap greater than zero. The company's creditors would be well advised to insist on a capital raise now, before the hype dissipates and it's too late. We commend all the lucky souls who have profited from the silliness thus far, but we doubt the current valuation will survive a thorough debate about the company's true business prospects.

II. Company Overview

Globalstar is the fourth-largest player in the mobile satellite services (MSS) market (source: public disclosures and Iridium estimates, p. 10) and uses its constellation of low-Earth-orbit satellites to offer basic mobile voice and data services in remote areas of the planet to customers such as energy, mining and timber companies. Monthly average revenue per user ranges from $38 for full "duplex" (bidirectional voice) service to $3 for "simplex" (unidirectional data) service. Below is a snapshot of GSAT's capital structure, valuation metrics and recent financial performance.

Capitalization & Multiples

($ in mm except share price)	
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**

Financial Performance

($ in mm)	2013	2014 H1 run rate	2015 covenant
Revenues	$ 82.7	$ 89.1	
Cost of revenues	49.6	57.6	
Gross profit	$ 33.1	$ 31.5	
Opex excl. D&A	29.9	32.0	
EBITDA	$ 3.2	$ (0.5)	
Plus:			
Inventory write-down	5.8	14.6	
Non-cash comp.	2.3	2.8	
R&D	0.6	0.3	
Other	0.0	0.4	
"Adjusted" EBITDA	$ 11.9	$ 17.6	$ 40.4
Depreciation/am./accr.	90.6	90.7	
"Adjusted" EBIT	$ (78.7)	$ (73.1)	
Cash flow from ops	$ (6.5)	$ 4.7	
Capital expenditures[3]	(45.3)	(26.4)	
Levered free cash flow	$ (51.8)	$ (21.7)	
P&E, gross	$1,460.1	$1,466.9	
Accum. depreciation	(290.3)	(335.0)	
P&E, net	$1,169.8	$1,131.9	

Source: GSAT 2013 10-K, 2014 Q2 10-Q, 2014 Q2 earnings call, COFACE Facility Agreement, Capital IQ, Kerrisdale analysis

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.

3. 2014 H1 run rate is based on NTM management guidance from the 2014 Q2 earnings call.

Below is a ten-year summary of GSAT's financial results. Despite enormous investments over a long period, the company has utterly failed to generate material positive cash flow or earnings. To stay alive, it has repeatedly diluted its shareholders and piled up debt.

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[1]	$3.3	$0.6	$0.4	$50.0	$238.3	$463.6	$664.5	$723.9	$751.0	$669.3	
Stock price[2]			$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	

Source: GSAT 2008 10-K, 2009 10-K, 2010 10-K, 2011 10-K, 2012 10-K, 2013 10-K, 5/29/14 investor presentation, Capital IQ, Kerrisdale analysis

1. Primarily as a result of embedded derivatives, the carrying value and principal amount of GSAT's debt have diverged in recent years. The figures above show carrying values in order to create a consistent time series given the lack of disclosure in older filings.

2. After emerging from bankruptcy, GSAT completed its IPO in November 2006.

In view of these atrocious results, GSAT desperately needs its spectrum story to succeed in order to justify its massive valuation. The kernel of the story has been the same for almost a decade: GSAT believes that the frequencies its subscribers use to send signals to and receive signals from its satellites would generate far more value if used purely terrestrially, ideally without involving the satellites at all. After a number of failed attempts to execute this strategy, GSAT's latest scheme, called Terrestrial Low Power Service (TLPS), calls for leveraging its spectrum holdings in the 2.4GHz band to offer an exclusive Wi-Fi channel that only authorized devices would be able to access. This scheme requires FCC approval to move forward, and, as indicated earlier, we do not dispute that the FCC will grant its blessing shortly. What matters, however, is not just regulatory approval but commercial success. TLPS is doomed to be a colossal failure.

III. GSAT's Wi-Fi Concept Will Never Be Commercially Viable

> *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, emphasis added)*
>
> *You're competing with "free". It's really hard to make money when your competitor is giving away the thing.*
>
> —prominent Wi-Fi consultant

To cut through the market hype surrounding TLPS, it's important to understand a few of the principles underlying modern Wi-Fi. GSAT contends (p. 9-10) that TLPS is its "solution" to "the Wi-Fi 'traffic jam'" – a "managed, carrier grade service" with "increased data speeds and range" that "leverages existing infrastructure." Most of these claims are wrong or misleading. Wi-Fi performs well today and already enjoys access to abundant spectrum; TLPS will not use existing access points (the most natural reading of "infrastructure") according to GSAT's own submissions to the FCC; and TLPS is *not* inherently faster than legacy 2.4GHz Wi-Fi but *is* inherently *slower* than the emerging 802.11ac standard, which is exclusive to 5GHz.

How Does Wi-Fi Work So Well? A Basic Overview

Most people have installed Wi-Fi access points in their homes or logged into Wi-Fi networks using their phones and laptops, all without any inkling of how the technology actually works. Yet Wi-Fi – defined by a set of formal rules known as the IEEE 802.11 standards – is so robust that it typically functions well even without careful planning or expertise. In fact, as we detail below, the anarchic patchwork of Wi-Fi deployments actually performs *better* on average than the telecom operators' precision-engineered cellular networks.

At first glance, Wi-Fi's success is even more surprising since it appears to have a handicap: it relies on a shared medium that anyone can access without permission. While AT&T and Verizon, like the owners of a radio station, transmit signals using specific frequencies of electromagnetic radiation that only they are legally allowed to use, Wi-Fi employs a range of free, public frequencies that belong to no one. In lieu of centralized coordination, Wi-Fi relies on a "politeness protocol," often described as "listen before talk": devices using a certain channel try to determine whether *any other* device is already transmitting on that channel before they begin to transmit themselves. If the channel is in use, they wait for a brief, random interval and try again.

If there were only one channel available, this sharing mechanism might work for a modest number of users, especially if they were not attempting to consume much data simultaneously (e.g. merely checking email every few minutes), but with enough users the channel would become saturated. Depending on the mix of devices (e.g. laptops vs. phones) and other factors, a given channel can support ~20-100 concurrent users looking at web sites, downloading images, watching YouTube videos, etc. With enough would-be users, though, each device would spend a long time waiting for other devices to finish transmitting, and the network would slow to a crawl. In reality, though, Wi-Fi users *today* can choose from *25 non-overlapping channels*, including three in the 2.4GHz band and 22 in the 5GHz band. As users pile up, administrators can add additional access points utilizing different channels to handle the increased traffic. That's how modern university lecture halls and football stadiums handle thousands of users in compact, highly dense areas. (Outside the US, users benefit from an additional fourth non-overlapping channel in the 2.4GHz band.) Moreover, a recent FCC order just opened up another three channels (previously blocked because of potential interference with weather-detecting radar systems used at airports), and related rulemaking is already underway to add another 12 channels, for a likely total over the next few years of 37 channels. (All of these figures assume the most common 20MHz channel width; network designers can also opt for wider (e.g. 40MHz) but fewer channels within the same spectrum bands.)

This abundance of available public spectrum makes the problem of too many users on a given channel, known as "co-channel interference" or "co-channel contention," readily manageable in almost every real-world setting. Even in extremely difficult environments like huge sports arenas and cavernous convention centers, where thousands upon thousands of users armed with data-hungry devices all try to access the internet at once, skilled network engineers using up-to-date technology have managed to deliver extraordinary speed and reliability again and again. At the other extreme, the best-selling router on Amazon, made by TP-LINK and selling for just $19.99, uses low-quality, outdated components and works only with the three non-overlapping channels in 2.4GHz, setting it up for bad performance if severe co-channel contention were truly pervasive. Yet the product is exceptionally popular and has garnered over 1,000 five-star reviews. Evidently these people are happy with three channels, let alone 37.

Wi-Fi's ability to make the best use of the available public spectrum also benefits from its short range, caused in part by the low maximum power levels imposed upon it by the FCC. The typical Wi-Fi signal can travel roughly 100-150 feet in most settings. User A and User B may both be on channel 1, but if they're, say, 300 feet apart, it probably doesn't matter: their signals won't reach each other. Everyone who's ever encountered Wi-Fi knows that it only works within a small radius around each access point; by contrast, no one expects his or her cellular service to fail as soon a cell tower is out of view. Wi-Fi's short range allows the same set of frequencies to be reused many times within a small geographic area, limiting the need for top-down management. As long as two Wi-Fi networks are far enough apart, the issue of co-channel contention does not even arise because the networks can't "hear" each other.

Thus, while co-channel contention is certainly a key concern for designers of high-performance Wi-Fi networks, it is successfully addressed every day using existing planning techniques, spectrum resources, and equipment designs. Meanwhile, in the less demanding home and small-office settings that account for the vast majority of actual Wi-Fi usage, co-channel contention scarcely rates as a problem at all.

Against this factual backdrop, the TLPS concept of an additional yet exclusive Wi-Fi channel is, as one wireless expert to whom we spoke described it, “somebody’s engineering solution looking for a business problem to solve” – and looking in vain. Far from a solution to co-channel contention, TLPS would be much more of a *victim* of it than Wi-Fi, since all potential users must cram themselves onto a single channel. In a high-density environment, TLPS will fail, and in a low-density environment, many other clear channels are already available for free. Thus TLPS has no compelling use case and no economic value.

Wi-Fi in Action Today: A Look at the Data

Levi’s Stadium in San Francisco, September 2014: home to the 49ers and a flawless free Wi-Fi network. One commenter estimates that “40,000 people could live-stream a movie over the Internet while watching a football game.”
Source: Mobile Sports Report/Paul Kapustka/Sports Illustrated

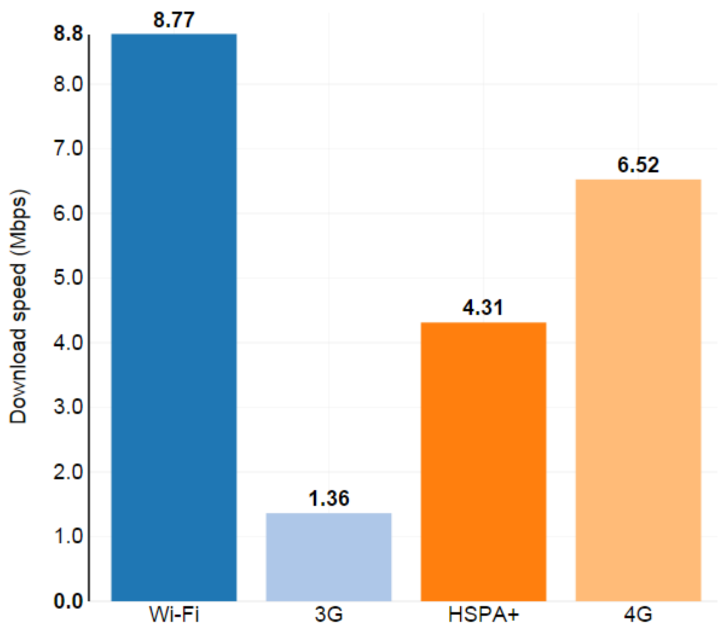
The claim that Wi-Fi works well may ring hollow in the ears of someone with a vivid memory of bad Wi-Fi service in an airport or café. To be sure, bad Wi-Fi networks – like bad networks of any type – do exist. The Wi-Fi expert Keith Parsons, in a useful blog post entitled “Rules for Successful Hotel Wi-Fi,” offers an example of such a network:

> [T]he current hotel I’m working from today has all its access points set to channel 6. All of them – all 150 of them are all on the exact same channel. … The designer of this hotel’s Wi-Fi didn’t understand the basic fundamentals of how 802.11 works. … Sure – each device gets a great RSSI [received signal strength indication]… but the noise floor is also very high, and since all devices hear each other, the retransmission rates are

high, CRC errors are high, and the resulting data rates drop to bare minimum in spite of having a high signal strength.

(Note that this nightmarish failure of a network foreshadows how a single-channel TLPS deployment would perform.) To be sure, this hotel's Wi-Fi would experience "congestion," but only because of its incompetent design, not because of any shortage of spectrum.

Instead of focusing on one-off anecdotes about bad performance, consider the aggregate data. A July report from OpenSignal, drawing on almost *two million* crowd-sourced measurements across 454,618 distinct Wi-Fi hotspots in the US, found that the average Wi-Fi download speed was 8.77 megabits per second (Mbps) – substantially faster than both 3G (1.36 Mbps) *and* 4G (6.52 Mbps) cellular connections that rely on licensed spectrum. At McDonald's restaurants, speeds average about 4 Mbps; at Starbucks stores benefiting from Google-sponsored Wi-Fi (upgraded from AT&T), speeds average 9 Mbps. For reference, the FCC's Broadband Speed Guide recommends speeds of 0.5 Mbps for email and basic web browsing, 1.5 Mbps for standard streaming video, and 4 Mbps for HD streaming video.



Source: OpenSignal

In other words, Wi-Fi today *already* delivers more than enough throughput for the vast majority of users. Moreover, according to the analytics firm wefi, throughput is actually *improving:* "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." Though the absolute measured speeds are lower than in the OpenSignal data, the trend is clearly positive. Imagine that: a traffic jam that makes the cars speed up.

More broadly, a wide range of evidence belies the notion that Wi-Fi is in crisis:

- *High-density Wi-Fi works well.* There are many recent examples of highly successful large-scale Wi-Fi deployments. For example, at the Sochi Winter Olympics, 2,500 Wi-Fi access points enabled 120,000 mobile devices to download and upload at high speeds. At Mobile World Congress 2014, an industry conference held in Barcelona, more than 80,000 attendees enjoyed free Wi-Fi and generated 19.1 terabytes of traffic. During the San Francisco 49ers' first regular-season home game at the new Levi's Stadium, the free Wi-Fi network hit peak concurrent connections of 19,000, moved 3.3 terabytes (3,300 gigabytes) of data, and "only got a couple of complaints about network issues," one of which "was solved before [the stadium technology team] could respond." While these feats of wireless engineering certainly required good equipment and careful planning, they did *not* require any new or licensed spectrum.

- *Users prefer Wi-Fi access to licensed cellular.* Survey results indicate that both consumers and business users actually prefer Wi-Fi to cellular along almost every dimension, regarding it as superior – by wide margins – in cost, speed, reliability, and ease of use. (Cellular still outdoes Wi-Fi in terms of coverage and availability.) This stark preference exists despite the fact that cellular providers carefully manage their exclusive spectrum to minimize interference. Since users already prefer unlicensed Wi-Fi to licensed cellular, why would they put any value on a licensed variant of Wi-Fi?

- *Users don't bother to buy non-Wi-Fi data service for their tablets.* The iPad and many other tablets come in both Wi-Fi-only and cellular-enabled models; the latter can access low-interference, licensed spectrum if the user is willing to pay for a data subscription. If the Wi-Fi "traffic jam" were truly dire, tablet buyers would shun the Wi-Fi-only option and spring for cellular. In reality, the reverse is true: data from Infonetics Research shows that Wi-Fi-only tablets outsell their fuller-featured brethren by 4 to 1.

- *Several major companies are rolling out nationwide Wi-Fi networks.* A consortium of cable companies called CableWiFi, including Comcast, Cablevision, Time Warner, Cox, and Bright House, has deployed more than 250,000 access points in the past two years to supply mobile connectivity to broadband subscribers. "Facebook Wi-Fi" enables businesses that buy special routers to offer their customers free internet access in exchange for "checking in" to the businesses' Facebook pages; Google is reportedly planning a similar effort. AT&T provides free Wi-Fi at McDonald's and Burger King. Google provides free Wi-Fi at Starbucks (having recently replaced AT&T). Again, none of these projects have required licensed spectrum; certainly Comcast did not wait for the outcome of Globalstar's TLPS rulemaking before deciding to create the largest Wi-Fi network in North America. Does it really make sense that companies like Facebook, Google, and AT&T would bet so heavily on Wi-Fi if, as GSAT claims, a terrible "traffic jam" were "exhausting" the available unlicensed spectrum?

- *Public hotspots perform well.* According to data gathered by the engineering firm Allion, Comcast's public Wi-Fi hotspots in San Francisco, Boston, Philadelphia, and Baltimore provided average download speeds of 8 to 16 Mbps, which are 1.6 to 3.2x *faster* than what Netflix recommends for streaming HD-quality video and >16x faster than the usual recommendation for web browsing and email (see e.g. Cisco as well as the FCC guidance cited above). If congestion is such a big problem, then why are these public hotspots working so well?

While GSAT suggests that the existing 2.4GHz Wi-Fi channels are filled to the brim, numerous studies point to the opposite conclusion: on average, as researchers from Microsoft and UC Santa Barbara put it, "Wi-Fi Networks Are Underutilized":

- In a study covering 179 locations in Belgium and the Netherlands, including residential, office, and industrial environments, researchers measured the empirical Wi-Fi "duty cycle" – that is, the fraction of time that the local Wi-Fi airwaves were actually in use. The median observed duty cycle was a mere 1.4%, while even the 95th percentile was only 10.4%, indicating that for the vast majority of time this spectrum is unoccupied.

- Though many cite the number of access points "visible" from a given location (e.g. by pulling up a list of available SSIDs on a smartphone or laptop) as a measure of Wi-Fi congestion, researchers in one study measured many aspects of the local Wi-Fi environment (in Boulder, Colorado) and found that "[*A*]*ll of these objective metrics of channel utilization are un-correlated with the number of access points*." The same researchers, using granular, census-tract-level data on population density, calculate that "**90% of the [US] population would be within interference range of less than 20 other people**," a level of contention unlikely to cause material performance problems, especially when internet usage is not necessarily simultaneous or continuous.
  - We note that this calculation, demonstrating the low likelihood of high interference for the vast majority of the country, assumes only three open channels in the 2.4GHz band. The abundance of additional channels in the 5GHz band would drive the odds of co-channel contention even lower.

- Examining Wi-Fi networks across more than a dozen locations in California and Washington state, including a UC Santa Barbara Computer Science building and a Microsoft office building, and focusing only on typical busy periods (e.g. 9am-6pm in office areas), another study found that "the median utilization is less than 30%, which is quite low. Even the 75th percentile is less than 40% in most cases. … [W]hile we do see very high values of utilization, this happens quite rarely." Furthermore, "[w]e see that there is no correlation between the number of APs seen, and the utilization. The median is always around 30%, regardless of the number of APs." "[L]ikely the simplest explanation," the researchers conclude, "is that average utilization is low because the average demand is low." In other words, relative to the amount of available Wi-Fi bandwidth, users' hunger for data simply isn't that high, even within the computer-science department of a large university.

- A long, detailed report commissioned by the UK telecom regulator Ofcom included Wi-Fi field data gathered from many different real-world locations, including houses, apartments, cafés, and shopping centers. As the report put it, "**Overall the available LE [license-exempt] spectrum is not heavily used and periods of very high usage, when they occur, are short term events**. … High levels of occupancy were rare, suggesting that, despite the large numbers of users of these bands (the 2.4

GHz band particularly), the bands are not approaching their maximum capacity to carry WLAN traffic." The 5GHz band in particular "is much less prone to interference between networks, because the allowable channels do not overlap and [the band] is hardly used at all at most of the sites surveyed." Even during periods of peak usage, "occupancy" – the percentage of time that the Wi-Fi spectrum is actually in use – is modest: "We conclude that the occupancy of the 2.4 GHz band is typically about 3% (low) and the 5 GHz band around 0.3% (low) when averaged across the entire day. If just the busiest hour is of interest then the occupancy is typically much higher and the median is in the order of 10% (moderate) in the 2.4 GHz band and 1% (low) in the 5 GHz band."

- Synthesizing the available literature as well as their own measurements, an international group of university researchers concluded, in a 2013 paper entitled "The Emperor Has No Problem," that "**there is currently no evidence for pervasive Wi-Fi congestion**."

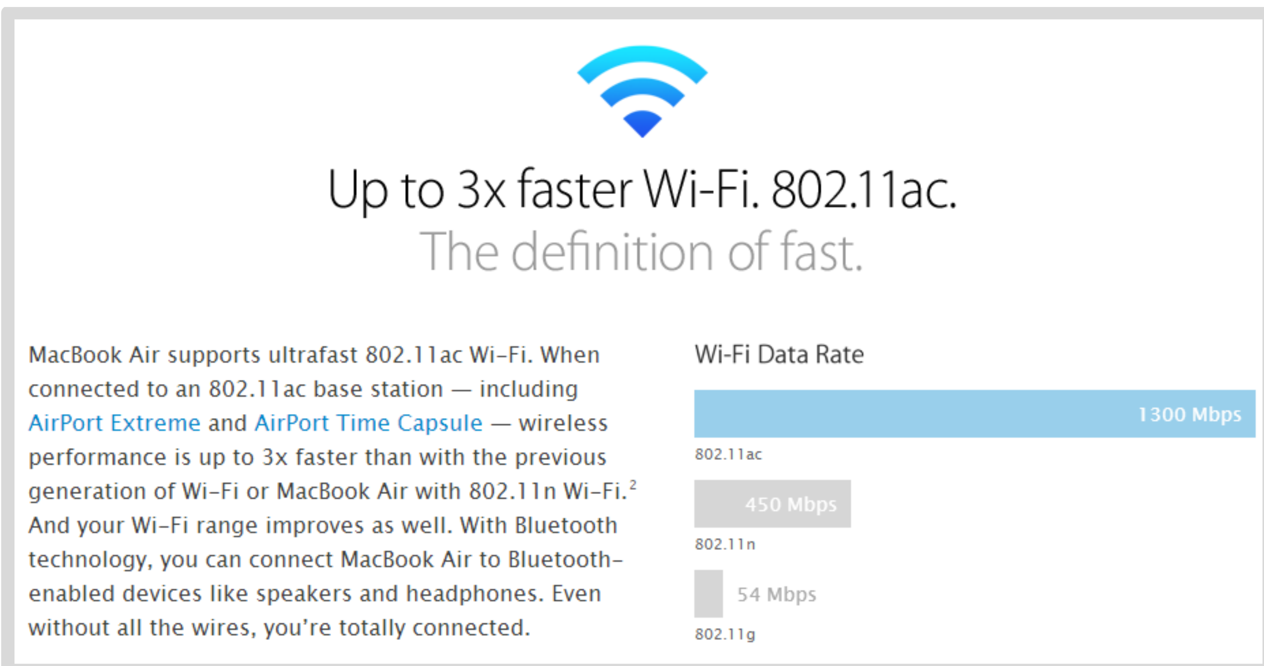
Academic research thus confirms what anecdotal data points suggest: Wi-Fi congestion is not a material problem, even without accounting for the availability of the massive 5GHz band. Indeed, the underutilization of available Wi-Fi spectrum explains why companies like Fon in Europe and Comcast in the US can share residential Wi-Fi signals without causing noticeable performance issues, while the start-up BandwidthX is working to create a real-time marketplace for spare Wi-Fi capacity. If congestion were a widespread challenge, there would be no spare capacity to market. Instead, we observe the opposite. To be sure, in certain niche markets like sports stadiums, dealing with interference and congestion is a challenge – but one already successfully handled by technical specialists, such as in the most recent Super Bowl, where 82,529 visitors had access to free Wi-Fi inside MetLife Stadium, without the need for any new licensed spectrum.

A non-solution to a non-problem does not merit a $4 billion valuation.

5GHz Wi-Fi Deeply Undermines the Hypothetical Value of TLPS

> The benefits promised by Globalstar's latest business plan pale in comparison to the public benefits that will be achieved as the Commission opens the 5.35-5.47 GHz and 5.85-5.925 GHz bands for Wi-Fi use and allows the potential of IEEE 802.11ac to be fully realized. … As the Commission has recognized, the recently-adopted 5 GHz-only IEEE 802.11ac MAC/PHY can deliver much faster speeds to consumers, in large part because it takes advantage of the much wider maximum channel bandwidths available at 5 GHz as compared to those available at 2.4 GHz and because the **wealth of spectrum at 5 GHz** promises to reduce the congestion that can slow the 2.4 GHz band to a crawl. Thus, as more IEEE 802.11ac-compliant equipment is deployed, an increasing percentage of Wi-Fi traffic will be driven to the 5 GHz band to take advantage of the benefits of higher speeds and reduced congestion.
>
> —Cisco Systems, Inc. (May 5, 2014, emphasis added)

GSAT and its supporters often claim that, by "adding" one additional channel to Wi-Fi's existing three, TLPS would effectively increase Wi-Fi capacity by a third. While this is misleading even with respect to the 2.4GHz band, it neglects a far more important point: the vast majority of the nation's modern Wi-Fi devices also operate in the unlicensed 5GHz band, which is the only band that future state-of-the-art Wi-Fi standards will cover. While 5GHz Wi-Fi suffers from more signal attenuation than 2.4GHz and thus tends to propagate worse, it benefits from an enormous amount of available bandwidth: while GSAT seeks to profit off of exclusive access to a mere 20 MHz, the 5GHz band already offers *555 MHz* of free, unlicensed spectrum that existing devices can use today. For example, eight of the top 10 best-selling smart phones in the world, including the iPhone 5 (both s and c models), support 5GHz Wi-Fi; the only exceptions are the now obsolete iPhone 4s and the very low-end Xiaomi Hongmi. Going forward, this spectrum will become even more useful as more devices – for example, the latest MacBook Air and the recently announced iPhone 6 – support the "Gigabit Wi-Fi" standard, 802.11ac, which will enable tremendous potential increases in data speeds, as Apple points out:



Source: Apple

Crucially, 802.11ac *only runs on the 5GHz band,* meaning that TLPS users would never be able to achieve these "definition of fast" speeds. "As a result," wrote Wi-Fi expert Matthew Gast in a piece entitled "2.4 GHz networking is five feet under with 802.11ac," "802.11n [the latest major iteration of the Wi-Fi standard] 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." Though the shift toward 802.11ac is only just beginning, ABI Research noted in February 2014 that sales are "rapidly accelerating":

> More device manufacturers started to ship 802.11ac products in 2013; the majority of them provide dual-band access to support existing 802.11n devices. "Although 802.11n devices hold the largest market share of the consumer Wi-Fi device shipments in 2013, 802.11n share of shipments is likely to start declining in 2014 as 802.11ac device adoption continues to grow. **802.11ac devices are expected to represent 45% of consumer Wi-Fi equipment shipments at the end of 2014**…

The FCC is also encouraging this transition by easing technical restrictions on 5GHz transmissions – for example, allowing higher-power outdoor equipment – an effort that GSAT has cynically opposed. Even more dramatically, the FCC has initiated rulemaking to free up an additional *195 MHz* – the so-called "U-NII-2B" and "U-NII-4" bands – for Wi-Fi use, an effort explicitly mandated by Congress (Pub. L. No. 112-96, § 6406, "Unlicensed use in the 5 GHz band").

Though all the Wi-Fi professionals we have encountered concur that 5GHz is the present and future of Wi-Fi – for instance, they plan their networks primarily based on 5GHz coverage and capacity and only then consider how best to support legacy 2.4GHz devices – there are several technical nuances that do make the 5GHz band somewhat more complex. For example, to avoid interference with certain specialized radar systems, 5GHz-capable devices must implement "dynamic frequency selection" (DFS), which essentially forces them to jump to a non-interfering channel when they detect a possible radar signal. (For three specific channels, not included in our previously mentioned figure of 22 20MHz channels in 5GHz, more acute concerns regarding Terminal Doppler Weather Radar led the FCC to issue an absolute ban until recently.)

In years past, only a subset of client devices did a good job of handling DFS channels, and some network designers feared that even sporadic radar signals (or false positives) would lead to unstable performance. Thus they avoided relying on these channels and fell back on the nine non-DFS channel (still a massive improvement over 2.4GHz). Today, however, DFS support is rapidly becoming the norm. Cisco's July 2014 white paper on its enormous Mobile World Congress 2014 network reported that *58% of the traffic used 5GHz Wi-Fi* and that the DFS channels functioned well:

> Cisco access points did not detect any above-normal instance of radar signatures and were able to use all of the available DFS channels.

In a live presentation in February 2014, Aruba Networks engineer Chuck Lukaszewski, giving a talk entitled "Engineering High Density WLANs," responded to a questioner who asked, "Is it safe to use DFS channels?" (around 45:20):

> The answer is absolutely, positively yes. And the cost of not using them vastly outweighs the potential cost of using them. … You have to use them. There's just no way not to use them. You can break the world into four categories of devices: iOS, Mac OS, Windows, and Android. Of those, only Android does not do DFS channels reliably, and the new

> ones [i.e. devices] do. So anything that's [802.11]ac-capable does DFS channels. … We've been looking at this a really long time, and we see very, very, very few DFS events. I ask a lot of people about it… In my day-to-day activities, I see a radar hit once or twice a year, and the radios are really good now. It's not like the first generation of the [802.11]n APs where the DFS and TPC requirements were basically laid on us retroactively and the silicon was already built, so we had a lot of false positive. We're multiple generations past that now.

Depending on the environment and the proximity to the relevant radar systems, DFS events could be more frequent – for example, Lukaszewski cited lower Manhattan as a problem area. In general, however, DFS support is rapidly growing. For 5GHz Wi-Fi overall, though no reliable aggregate statistics exist, anecdotal reports suggest that 60-75% of network traffic is already taking place in the 5GHz band today.

With more and more Wi-Fi usage migrating toward 5GHz spectrum and ultimately to 802.11ac, which will only utilize the 5GHz spectrum, the 2.4GHz-only TLPS concept will look even more like a solution in search of a problem. However pressing a concern Wi-Fi congestion is today – not very, we contend – it will become even less pressing in the near future thanks to innovative, open-access technologies that GSAT had nothing to do with and, on the contrary, fought against. In light of these trends, the notion that the TLPS concept merits a multi-billion-dollar valuation is ludicrous.

Wi-Fi Networks Don't Need More Spectrum to Mitigate Congestion

In its breathless, sensationalistic rhetoric about Wi-Fi "congestion," GSAT implies that more spectrum is the only way to alleviate the problem. But this is completely wrong. Engineers have developed a host of sophisticated yet low-cost techniques to manage co-channel contention and wring the most throughput possible out of the available airtime.

For example, AP vendors like Cisco and Aruba have created their own proprietary implementations of a similar set of radio management techniques to optimize spectrum usage – Radio Resource Management (RRM) for Cisco, Adaptive Radio Management (ARM) for Aruba, etc. One key technique is called "band steering": APs nudge "dual-band" client devices that are capable of using both 2.4GHz and 5GHz to use 5GHz only. Not only does this tend to improve performance for the 5GHz clients; it also frees up more spectrum for legacy 2.4GHz-only devices. The popularity of this feature in carrier- and enterprise-grade APs is just another demonstration that, counter to GSAT bulls' ill-informed protests, 5GHz Wi-Fi is already widely in use today.

More broadly, almost every AP, including low-end consumer-oriented devices, engages in some form of automatic channel selection. When turned on, and often at regular intervals thereafter, the AP will scan the local Wi-Fi environment and attempt to discern which channel is least used or offers the best expected throughput, taking into account the presence of other nearby networks. At the high end of the market, Ruckus Wireless's ChannelFly algorithm is among the most advanced instantiations of this concept, but even Linksys does more than just blindly stick to a busy channel:

> **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 [2.4 and 5GHz] bands.

Another parameter that network designers calibrate to reduce co-channel contention is power. To prevent one of a network's APs from interfering with a neighboring AP on the same channel – assuming the environment is so high-density that it's impossible to keep them far enough apart to achieve this naturally – designers may manually or automatically reduce the power output of their APs, resulting in a smaller cell radius and thus less overlap with neighboring cells.

In addition to adjusting transmit power, APs can also adjust the signal strength at which they will recognize an incoming signal. Cisco's implementation of this technique, called RX-SOP ("Receiver Start of Packet"), allows APs to disregard sufficiently weak transmissions, potentially making them more resistant to co-channel contention. Again, these techniques – automatic channel selection, band steering, power management – impose no incremental expenses on network designers and already allow them to do much more with the spectrum they have, even in 2.4GHz. It's pure silliness to suggest that anyone would try to shift to a costly licensed channel rather than simply implement these well-understood and widely used tactics – essentially for free.

TLPS Would Be Far Slower than State-of-the-Art Wi-Fi

One of the best techniques for managing co-channel contention is simply to maximize the use of high data rates (and often to disable the use of low data rates). The faster a given device can transmit a given number of megabytes, the more quickly it can get on and off the airwaves and allow other users to take their turns. But in this regard, TLPS itself is at a distinct and permanent disadvantage, because it can only make use of one 20MHz channel using the 802.11n protocol. By contrast, professionally designed Wi-Fi networks often exploit the vast swathes of available bandwidth in 5 GHz by using 40MHz-wide channels, which can deliver more than twice the data rate of a corresponding 20MHz channel. Going further, with 802.11ac in 5GHz, better modulations, more spatial streams, and complex antenna techniques can deliver astronomical data rates. Understanding the details of these technologies is not critical to the case against TLPS, and it's certainly fair to note that real-world speeds, burdened by backhaul limitations, noise, and other frictions will fall far short of theoretical maxima. But it is certainly the case that the highest speeds TLPS would ever be able to offer are substantially lower than the highest speeds normal Wi-Fi networks can offer today and will offer in the future.

To quantify the speed difference between TLPS and next generation Wi-Fi, while TLPS's maximum data rate for a lower-end, single-stream client would be 72 Mbps, a 40MHz channel using 802.11ac could deliver *2.8x better performance.* At the very limit of what's possible under the standards, TLPS could achieve at best 289 Mbps; by contrast, 802.11ac could achieve a stunning 6.9 Gbps, *almost 24x higher.* To reiterate, all of these figures measure peak, not typical, performance, and the application throughput experienced by all users collectively could be only 40-60% as high. Furthermore, essentially no existing hardware could actually achieve the true theoretical ceiling under the standards (either 802.11n or 802.11ac) given, for instance, their insufficient number of independent antennas. But these are still apples-to-apples comparisons, highlighting the weakness of TLPS and its greater propensity for congestion:

TLPS Can Never Be as Fast as Modern Wi-Fi

	Max. possible data rate (Mbps)		
Protocol/technology	20MHz channel	40MHz channel	160MHz channel
Single spatial stream			
TLPS (802.11n)	72	n/a	n/a
802.11ac (5GHz only)	87	200	867
Maximum spatial streams			
TLPS (802.11n)	289	n/a	n/a
802.11ac (5GHz only)	693	1,618	6,933

Source: adapted from Matthew Gast, 802.11ac: A Survival Guide, p. 35, Table 2-6, Kerrisdale analysis

As 5GHz 801.11ac networks become commonplace in the coming months and years, it would be more and more difficult to maintain the illusion that TLPS could be a superior technology. In fact, the constraints of its channel width and spectrum band render it fundamentally inferior to the state of the art.

TLPS Would Add No Value to a Large-Scale Wi-Fi Network

In the dreams of GSAT bulls, GSAT, after receiving final FCC authorization for TLPS, will join forces with a business partner or acquirer to deploy a vast network of access points across the country, all emitting Wi-Fi signals on the exclusive TLPS channel. As discussed in greater detail below, GSAT has repeatedly stated that these access points will be new pieces of equipment under GSAT's control (in part in order to manage potential interference with its MSS operations, as well as co-primary licensees in its 2.4GHz band).

A network of Wi-Fi APs is valuable only inasmuch as the APs have robust access to electricity, internet connectivity (backhaul), and a critical mass of potential users within signal range. But GSAT has absolutely no advantage in getting hold of any of these resources. It has no backhaul, no real estate, and no money. If another firm wants to build out a large-scale Wi-Fi network that it could offer exclusively to its own customers, it can do that today using the available unlicensed spectrum. (Indeed, this is precisely what cable companies like Comcast have been doing.) The question in assessing TLPS is not what the value of a large Wi-Fi network would be. The question is how much *incremental value* (if any) access to GSAT's spectrum would contribute over and above the value of standard Wi-Fi. *At best,* the value of TLPS would be a small fraction of the value of the underlying network.

How much are exclusive Wi-Fi networks worth? The best reference point is Boingo Wireless, Inc. (WIFI). Boingo subscribers can use more than one million hot spots around the globe, including approximately 20,000 in North America (source: Boingo 2013 10-K and 2014 Q2 10-Q), concentrated in high-traffic, data-intensive areas like the busiest major airports. In addition to direct subscription revenue, Boingo creates value by selling ads and partnering with carriers to offload cellular traffic onto Wi-Fi. But despite its large portfolio of enviable locations and the overall trend toward increased wireless data consumption, Boingo's enterprise value is just $225 million, less than 6% of GSAT's. If we assume, counterfactually and purely for the sake of argument, that access to GSAT's spectrum could boost Boingo's value by 10% and *all* of that hypothetical increase were retained by GSAT – another profoundly unrealistic assumption – then TLPS would still be worth, at most, $23 million.

Boingo's experiences highlight the growing difficulty of profiting off of Wi-Fi access. Since its 2011 IPO, its stock has declined almost 50%, largely driven by investor disappointment over its ability to actually coax revenue out of its network. Though people generally prefer Wi-Fi to cellular, that doesn't mean they'll pay for it; indeed, the fact that Wi-Fi-based internet access is so often free of charge is one of the reasons people prefer it. Even in the environments that are most congenial to monetizing Wi-Fi, where users are largely captive and often price-inelastic – airports and hotels – there has been a clear shift toward free access. As a Boingo spokesman said in 2012, "Ten years ago, pretty much every airport was pay and pretty much every hotel was pay…Some of the midtier hotels started to go free, then everybody did it, and it was a race to the bottom…No one wants to pay for anything, but everything needs to be state-of-the-art or people complain."

Today, of the 52 domestic airports reviewed by Airfarewatchdog, 42 offer some form of free Wi-Fi. With the recent announcement by the Port Authority that JFK, La Guardia, Newark, and Stewart airports will all begin to offer 30 minutes of free service per user starting in the fall, that number is set to increase. A similar trend is apparent in the latest annual Wi-Fi report published by the web site HotelChatter. Noting that at least 64% of hotels now offer free Wi-Fi, the report reversed the practice of prior years: instead of listing hotels that *did* supply free Wi-Fi, it only listed "10 hotels that are STILL charging for WiFi," asking, "Geez, why don't hotels just make it free already?" While some hotels continue to charge for higher-speed, "premium" Wi-Fi, industry experts believe that "only a relatively small percentage of guests will pay for premium service," despite prices of only a few dollars per day.

In general, now that available download speeds are typically already far in excess of what's needed for basic web browsing, email, or even YouTube viewing, users assign little value to higher speeds. For example, in a small study conducted by AT&T Research, subjects were exposed to two different speed tiers and asked how much they would be willing to pay per month for each. On average, they said they would be willing to pay only $6.48 for the slow tier and $21.08 for the fast tier – a $15 difference *for a 16-fold increase in download speeds.* In another arm of the same study, subjects experienced speeds ranging from 128 kbps to 32 Mbps but could not reliably distinguish them, often asserting an identical willingness to pay for widely differing speeds and sometimes even claiming to prefer the slower speed. As the researchers noted, "[a] user who typically checks emails a couple of times a day will not be affected drastically by a speed tier change."

Further evidence of users' low sensitivity to speeds comes from a recent Deloitte survey. Asked how much more they'd be willing to pay their wireless carriers (AT&T, Verizon, etc.) for "speeds between **3 to 5 times higher** than [their] current speeds," the majority of respondents, 55%, said they were "*not willing to pay any more.*" Another 22% said they were willing to pay just $10 more for an enormous increase in speeds.

Consumers' unwillingness to pay for faster Wi-Fi is further confirmed by a recent survey cited by Ruckus Wireless, which asked users how much of their time, let alone money, they'd be willing to give away in exchange for mere Wi-Fi access, let alone faster Wi-Fi access:

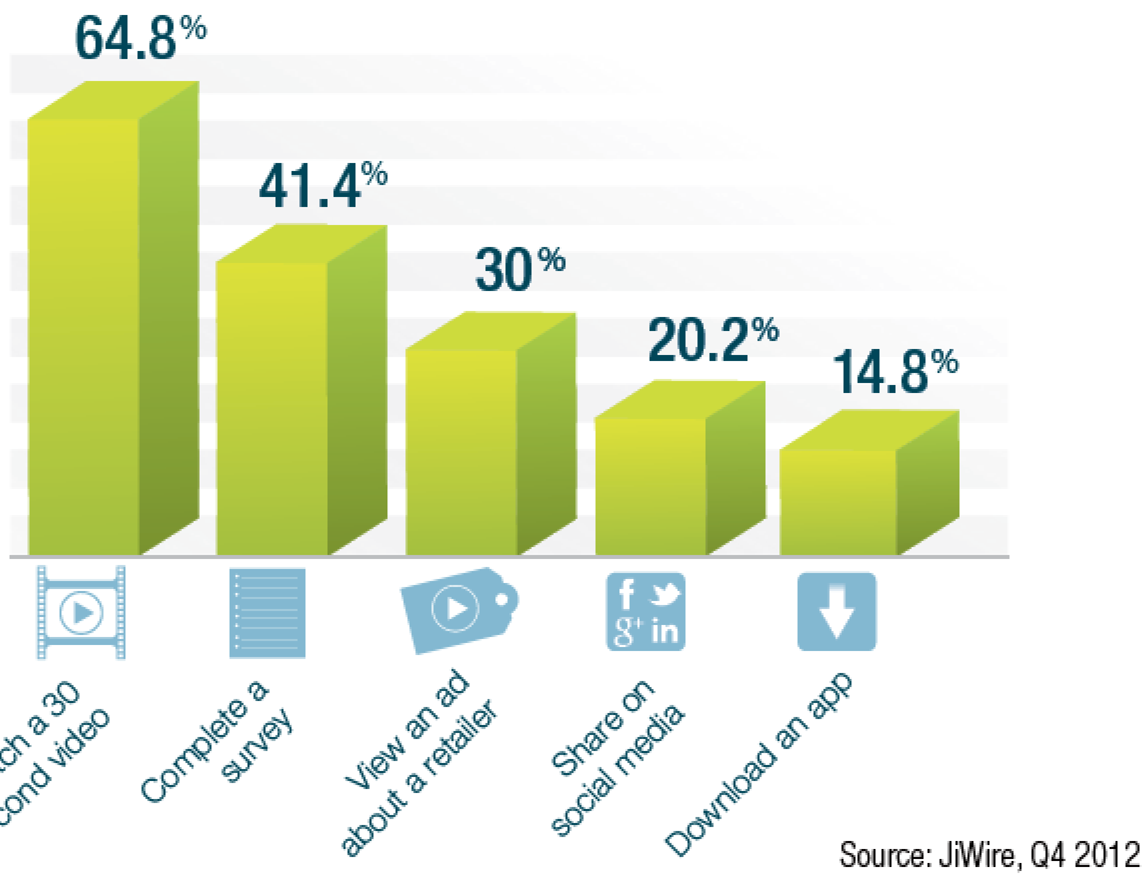


Figure 15: What sort of sponsor engagement would you be willing to do for free Wi-Fi?

Source: Ruckus Wireless, "The Business Case for Cable Operator Wi-Fi Deployments" (August 2013)

While 65% of respondents would watch a 30-second video in exchange for Wi-Fi, the majority would *not* complete a survey, and only 15% would agree to download an app. It's no wonder, then, that cable companies primarily view Wi-Fi deployment as a way to reduce churn in their existing subscriber base rather than as a revenue source in its own right.

The clear, repeatedly demonstrated unwillingness of consumers to pay much (or anything) for Wi-Fi access, coupled with the voluminous evidence that available Wi-Fi spectrum is not congested, implies *de minimis* value for GSAT's TLPS concept. As Cisco pointed out, "TLPS will be nothing more than a paid Wi-Fi offering" on a newly usable 2.4GHz channel. Since the underlying technology will be identical, the only possible reason that TLPS would be any faster or higher-quality than existing Wi-Fi is that its exclusive Channel 14 would be less occupied than other channels. Of course, if TLPS were to actually become popular, this advantage would disappear, as more and more devices crowded into Channel 14; paradoxically, the more users it gets, the lower will be its value. Moreover, if a Wi-Fi network operator really wanted to deliver low congestion and high bandwidth, it could easily do so in the 5GHz band without paying anything to access the spectrum – all while likely delivering superior throughput thanks to more advanced technology and wider channels. Even if TLPS were superior to standard Wi-Fi, it would add negligible value to a real-world network; worse still, it is actually inferior.

Another unanswered question about TLPS is how real-world access points would actually be able to use the exclusive channel. Imagine, for instance, a single, modest-sized café that offers Wi-Fi – say, an individual Starbucks with one dual-band access point. One radio within the AP will be tuned to the 5GHz band and thus unable to transmit TLPS. The other radio will be tuned to the 2.4GHz band and could potentially be nudged via a firmware change to transmit on Channel 14. But if it does so, the Starbucks will no longer be able to offer Wi-Fi access to anyone using a 2.4GHz-only device who has not obtained the corresponding user-device firmware update, the availability of which will be up to individual device manufacturers and users, not Globalstar. (Would, say, Lenovo really waste energy trying to cause the owners of five-year-old, likely out-of-warranty single-band laptops to download new firmware just to be able to access TLPS? How could it possibly *force* this update?) Starbucks would thus have to decide *not* to offer Wi-Fi to customers with older devices – hardly a popular move – or would be forced to install a second, potentially TLPS-only access point operating on Channel 14, requiring additional cabling and the cost and nuisance of new hardware installation. And all for what? To justify these operational headaches, TLPS would have to offer a stellar value proposition. In reality, it offers almost nothing.

Contrary to GSAT's Hype, TLPS Cannot be Deployed "Almost Immediately"

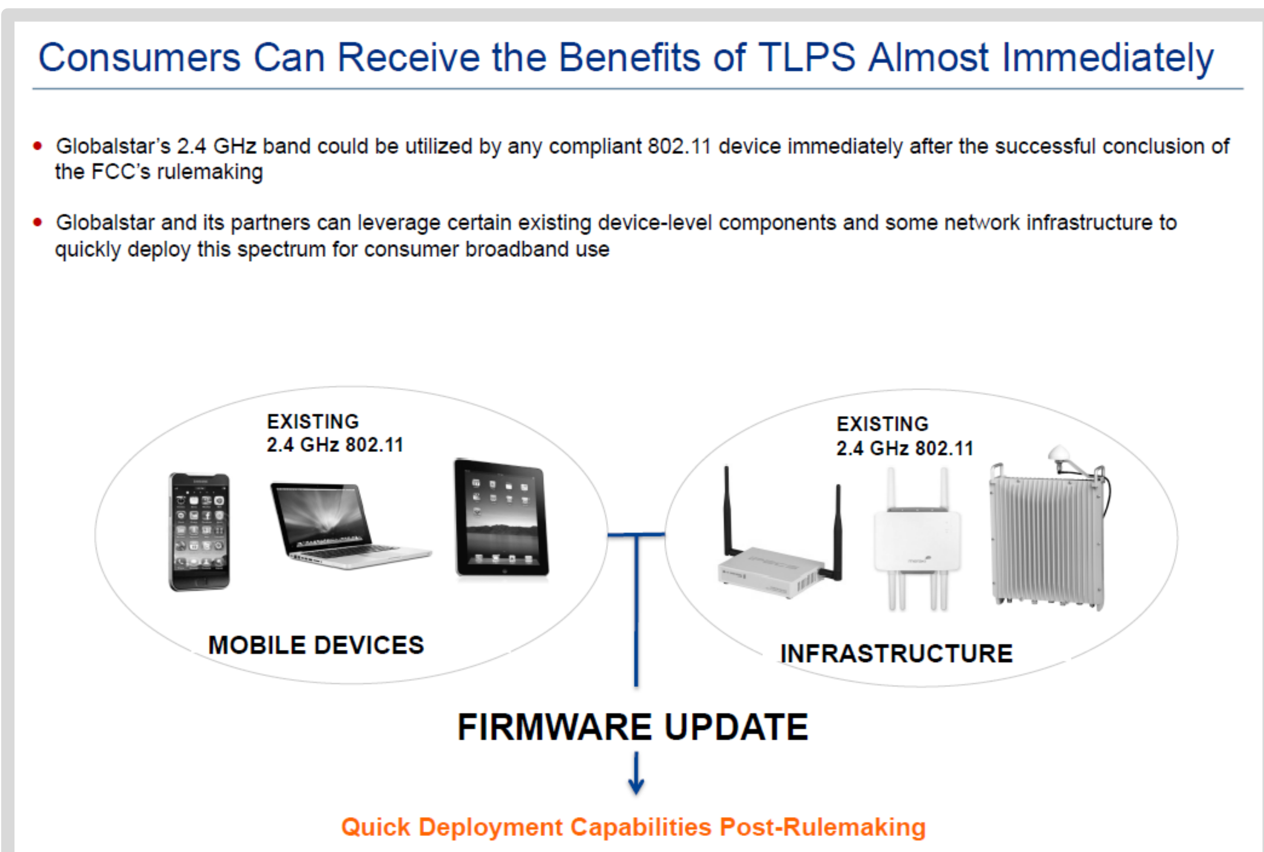
> It should be clear that it's going to take more than just Globalstar to make it [TLPS] a reality. It's going to take the participation and support of the broader wireless industry.
>
> —L. Barbee Ponder, GSAT general counsel and VP of regulatory affairs (January 2013 technical webinar)

> Globalstar's proposal for implementing TLPS is not a simple one, what with IEEE 802.11 device manufacturers being responsible for securing the equipment authorization necessary to make software changes, and with Globalstar, and perhaps even "future terrestrial partners", responsible for controlling access to those software modifications. This approach raises a series of complicated questions…
>
> —Cisco Systems, Inc. (May 2014)

> Under this approach…any deployed equipment in the 2473-2495 MHz band **would need an equipment certification**…We propose to require equipment manufacturers to **certify all terrestrial low-power equipment**…
>
> —FCC *Notice of Proposed Rulemaking* (November 2013, p. 9 and 18, emphasis added)

> Certainly, the re-certification of all consumer devices receiving the TLPS software update would be a **prolonged process** and impose substantial and unnecessary costs on consumers, manufacturers, Globalstar and its terrestrial partners, and the Commission. Original grantees would be required to submit certification filings that included all the exhibits typically required for a new approval. Telecommunications Certification Body ("TCB") or Commission approval of these new certification requests could take **months or more**, and then **grantees would have to physically attach new FCC ID labels to every single consumer device that receives the software update**. As the Commission recognizes in the *NPRM,* this lengthy and burdensome process could **discourage manufacturer participation in TLPS, and diminish the benefits of this new service**…Globalstar **urges** the commission to authorize such software updates either through its existing permissive change procedures or through an even more streamlined…approach.
>
> —Globalstar (May 5, 2014), emphasis added

One of the claimed benefits of TLPS relative to a conventional LTE network is that existing devices could easily use it because conventional Wi-Fi radios have the *technical* ability to access GSAT's licensed frequencies but are prevented from doing so via firmware. Thus a simple "over the air" upgrade could enable authorized devices to use TLPS. This is the story GSAT told in a recent investor presentation:



Source: GSAT investor presentation, April 25, 2014, slide 14

But is this really true? While the presentation suggests that "existing 2.4 GHz 802.11 infrastructure" – access points and routers – will be TLPS-capable with just a "firmware update," this is *not* what GSAT told the FCC in its initial petition:

> Globalstar anticipates that…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.

The FCC then reiterated this point in its NPRM:

> Globalstar also indicates that its proposed deployment would involve new equipment.

GSAT repeated itself again in a May submission:

> In conjunction with its terrestrial partners, Globalstar expects that, over time, it would deploy potentially hundreds of thousands or even millions of newly-manufactured TLPS access points across the United States, concentrating on areas where existing Wi-Fi congestion is most severe.

One reason GSAT would need to rely on "newly manufactured equipment" is laid out, albeit in jargon, in the Technical Analysis appendix to GSAT's petition:

> OFDM (802.11g) emissions from a TLPS base station with a conducted output power above 23 dBm (200 mW) do not comply with the emissions mask proposed in Globalstar's Petition for Rulemaking. For such applications, pulse shaping alone will not be sufficient to meet OOBE limits. Instead, TLPS base stations with conducted powers above 23 dBm will require the addition of remedial hardware filtration (e.g. a high selectivity passive filtration component).

In other words, off-the-shelf Wi-Fi access points modified via firmware changes to transmit on Channel 14 fail to comply with emissions restrictions designed to prevent interference with adjacent frequencies. As a result, existing equipment would have to be replaced with new TLPS-enabled devices. Of course, since TLPS has not even been approved by the FCC yet, no such devices exist today (other than a few experimental prototypes). Moreover, to prevent interference with its MSS operations and co-primary licensees of its band, GSAT has contended that it needs to have ultimately control over all TLPS APs.

While over-the-air upgrades may work on the user-device side from a technical perspective, there remains the question of *certification.* When the FCC permits the sale of a radio device, it only authorizes it for a specified range of frequencies. For instance, until recently, the iPhone could not use T-Mobile's high-speed network because it didn't transmit on T-Mobile's frequencies. No existing devices are currently authorized to operate on Channel 14. Changing this authorized frequency range under existing FCC rules requires a lengthy technical review process for each device model and, as GSAT points out in the discussion quoted above, would literally require "grantees [the original device manufacturers]…to physically attach new FCC ID labels to every single consumer device that receives the software update."

Though GSAT sought less burdensome treatment in its petition, the FCC rejected this request and reiterated its normal requirements, though it did solicit comment on whether some form of streamlined protocol was called for. A number of companies and industry groups, however, have pointed out the dangers of just assuming that upgraded devices will comply post-upgrade with all relevant FCC requirements, and there are few compelling grounds for granting GSAT special treatment. Even if GSAT wins its preferred "permissive change" treatment, it would be up to *device manufacturers,* not GSAT, to submit their individual models for approval, and many may well choose not to bother. After all, if the idea of a licensable 26th Wi-Fi channel makes no practical commercial sense, what's the use of filing a bunch of FCC paperwork so that users have the ability to access a purely theoretical service that's unlikely to ever become commercially viable? And if there are no TLPS-enabled user devices, what's the use of deploying access points?

GSAT has never publicly articulated a coherent TLPS business model that would address these sorts of concerns, instead vaguely alluding to "discussions…with broad groups of participants." Even if GSAT gains approval for TLPS (without suffering from any delays introduced by requirements for additional testing that the FCC may well impose) and surmounts these logistical obstacles flawlessly, it would still end up with a low-value product. (Currently Boingo charges just $4.98 per month for unlimited Wi-Fi access in North and South America for two separate devices.)

Moreover, it is difficult to imagine how the rollout could be "almost immediate" when new access points need to be manufactured and installed (in some unknown set of locations that GSAT has no particular rights to); device makers need to (at their discretion) submit their models for re-certification or, at best, "permissive change"; the FCC (or a designated third-party certification body) needs to accept and approve these applications; and consumers need to accept "upgrades" to their devices to make them TLPS-capable (and thereby cede a large degree of control to GSAT, which claims it will manage all these devices on its own "network operating system"). At some point, of course, all of this work is supposed to result in revenue for GSAT, so either consumers must pay for this service or someone must pay for it on their behalf – but it does not appear that any of these crucial details have been worked out.

It's shocking that the equity market is, for now, willing to ascribe $3.6 billion of value to a business plan so inchoate and a hypothetical product whose purported benefits are so tenuous. After all, GSAT is in no meaningful sense a technology company: in its actual satellite business, it gets all of its equipment and systems from outside suppliers like Thales, Qualcomm, and Hughes. Even the TLPS concept apparently came from Jarvinian, a third-party investment firm. Despite holding itself out as a great technological visionary, GSAT booked research and development expenses of only $452k over the twelve months ended 6/30/14. Amusingly, this R&D expense is actually added back in its “adjusted EBITDA” presentation, presumably on the theory that it’s non-recurring and non-core (see e.g. the 2014 Q2 earnings release, “Reconciliation of GAAP Net Loss to Adjusted EBITDA”).

TLPS is a clever attempt to turn lemons into lemonade – to harvest some scrap of value for GSAT’s spectrum – but it does not come close to justifying GSAT’s current valuation. Any fair-minded, objective assessment of its potential value would imply massive if not total downside for the stock.

TLPS Has No Value Internationally

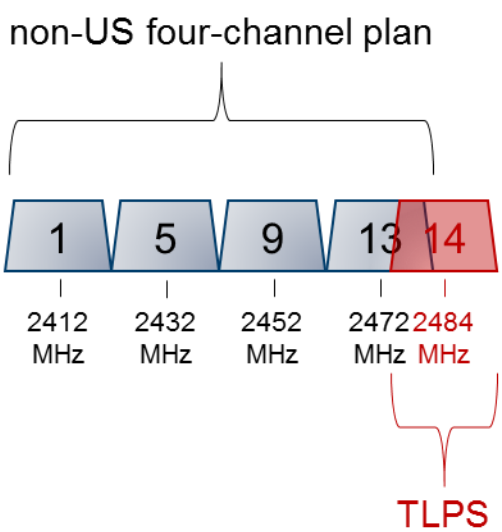
Occasionally GSAT bulls argue that, rather than analyze TLPS from a US-only perspective, investors should consider the possibility that, after receiving FCC approval, GSAT will be able to obtain similar authorizations around the world. After all, GSAT’s MSS spectrum allocation is global, unlike terrestrial-only spectrum allocations that vary from one jurisdiction to the next. Of course, just because GSAT has satellite authority in no way means that any country will grant it terrestrial rights in the same band, let alone automatically follow in the FCC’s footsteps. Indeed, there is no reason why foreign telecom regulators would not require GSAT to pay hefty license fees in exchange for terrestrial rights, as opposed to simply handing it a windfall.

More to the point, though, the TLPS concept makes even less sense abroad than it does in the US. While Wi-Fi’s Channel 14 is today only legally permitted in Japan (and even then only using the 15-year-old 802.11b protocol), Channels 12 and 13, which go unused in the US as a result of uniquely restrictive FCC emission rules, are common almost everywhere else. Using the 20MHz channel widths characteristic of all recent Wi-Fi standards (not the 22MHz that GSAT bizarrely insists on), channels 1, 5, 9, and 13 collectively form a non-overlapping quartet. Sure enough, Wi-Fi network designers in Europe and elsewhere do, in fact, deploy multiple access points based on a 1/5/9/13 channel plan as opposed to the more common 1/6/11 plan seen in the US. The main reason *not* to use such a plan is simply that the network might be in range of another network on 1/6/11 and thus experience harmful adjacent-channel interference. For example, the *Certified Wireless Network Administrator Official Study Guide* says:

> In Europe and other regions of the world, more channels are legally available for license-free communications in the 2.4 GHz ISM band. In Europe, a WLAN [wireless local area network] four-channel reuse pattern of channels 1, 5, 9 and 13 is sometimes deployed. Although there is a small amount of frequency overlap between those four channels, the performance might in some cases be better if the medium contention overhead of co-channel cooperation can be reduced because there is less bleed-over.

The guide goes on to cite some of the potentially offsetting disadvantages of this four-channel pattern, including interference with neighboring 1/6/11 networks and inaccessibility to North American devices. But it’s clear from numerous other sources as well as our industry contacts that, outside of the US, four-channel plans, though not as common as 1/6/11 plans, are perfectly normal and functional.

Amusingly, this simple fact has devastating consequences for the overall TLPS narrative. The entire argument for TLPS's utility rests on the notion that a fourth non-overlapping 2.4GHz channel will be massively valuable. But Europe and the rest of the world *already has* a fourth non-overlapping 2.4GHz channel – and it's not as if foreign countries dramatically outperform the US on Wi-Fi performance. Furthermore, with 1/5/9/13 channel plans already in use in many locations outside the US, Channel 14 would be subject to tremendous adjacent-channel interference from Channel 13 anywhere it appeared:



Source: Kerrisdale analysis.
Note: as with the Channels 1, 6, and 11, Channels 1, 5, 9, and 13 are regarded as "non-overlapping" under the 802.11 standard but do overlap slightly in real-world usage.

However worthless TLPS is in the US, then, it's even *more* worthless overseas, where it would actively harm and be harmed by pre-existing Wi-Fi networks (which would in turn undermine its usability further). There is simply no logic to using Channel 14 when Channels 12 and 13 are already open and in use. Indeed, one step that the *FCC* could take and that multiple commenters in the TLPS proceeding have proposed is to adopt rules more like those prevailing abroad and thus open up Channels 12 and 13 to greater usage. This could modestly improve 2.4GHz Wi-Fi without costing a cent – while also eliminating the entire rationale for TLPS.

How Much Does GSAT Really Know about Wi-Fi?

We have established that Wi-Fi congestion is a ludicrously overhyped problem; that 5GHz Wi-Fi alone renders TLPS worthless; that large-scale Wi-Fi networks generate only modest value and would not benefit from an additional 2.4GHz channel; that an actual roll-out of TLPS would be far more burdensome and costly than GSAT portrays it; and that TLPS is an even more pointless concept internationally than it is in the US. Before we turn to the question of whether the GSAT bubble can be justified on the basis of pure non-TLPS spectrum value – spoiler warning: it can't – we would be remiss if we did not point out some of the strange errors and omissions in GSAT's public TLPS-related materials. While these glitches are minor, they paint an unappealing picture of a company that has little real-world experience with modern Wi-Fi yet hopes to build its entire future on it. Of course, why *would* GSAT have much knowledge of Wi-Fi? It's fundamentally a satellite-phone company with almost no R&D budget. Wi-Fi is far from a core competency.

For instance, in its petition for rulemaking and elsewhere, GSAT repeatedly says "it will add 22 megahertz to the nation's wireless broadband spectrum inventory." That 22MHz figure appears again and again. But not since the 802.11b standard, released back in 1999, has the baseline 2.4GHz Wi-Fi channel width been 22 MHz. In 802.11g and n (dating back to 2003 and 2009, respectively) as well as the 5GHz-only 802.11ac, the standard channel width is 20 MHz.

Similarly, in its January 2013 technical webinar on TLPS (slide 19), GSAT suggests that the peak Wi-Fi data rate is 54 Mbps. This was true of 802.11g, but 802.11n is by now five years old, and its peak data rate is more than ten times higher. Elsewhere (slide 16), GSAT shows the power spectral density of a Channel 14 test AP, which exhibits the signature rounded shape of the DSSS (direct-sequence spread spectrum) modulation used in 802.11b, not the more angular shape of the OFDM (orthogonal frequency-division multiplexing) modulation characteristic of all the more recent standards. Stepping back from the technical details, the question is clear: why is GSAT stuck in the past?

One possibility is that, because Channel 14 is authorized for use in Japan only under the 802.11b standard, GSAT is simply using Japanese equipment in its testing and is thus forced to rely on a 15-year-old standard. But if so, why has the company never discussed this shortcoming openly? We have given it the benefit of the doubt by assuming that TLPS will ultimately be able to achieve 802.11n performance levels, but we have to wonder what's really going on.

IV. GSAT's Spectrum Is Not Valuable for Terrestrial Purposes

> Not all spectrum is created equal…
>
> —Federal Communications Commission (May 15, 2014)

We believe that most GSAT investors and analysts ascribe the vast majority of the company's current enterprise value to TLPS's potential success. Some, however, rightly or wrongly, prefer not to delve into the concrete mechanics of Wi-Fi technology and instead regard GSAT more abstractly as a holder of spectrum rights. Irrespective of the details of TLPS, they believe, GSAT's spectrum would be tremendously valuable if repurposed for terrestrial use. After all, just look at the prices paid by carriers like Verizon and T-Mobile for other spectrum assets – sometimes billions of dollars! Surely GSAT can garner a similar valuation.

Alas, this line of pseudo-reasoning is deeply mistaken. Even if the TLPS rulemaking is finalized by the FCC, GSAT's spectrum will be inherently far less valuable than the fully terrestrial cellular spectrum in which carriers transact. Thanks to higher transmitted power levels and more sensitive receivers, cellular signals propagate orders of magnitude farther than Wi-Fi signals requiring far fewer nodes in a network to provide equivalent degrees of coverage. Providing national coverage using GSAT's 2.4GHz frequency band *with cellular-like terrestrial authority* might require tens of thousands of base stations, but doing so *under the restrictive legal and technological limits of TLPS* would take hundreds of millions if not billions of access points. No spectrum buyer would ever pay for TLPS-authorized spectrum more than a tiny fraction of what it would pay for true cellular spectrum.

The History behind TLPS: Low Power, Low Value

In order to understand the tremendous shortcomings of TLPS relative to typical cellular service, it helps to review the history of how it transpired that TLPS became GSAT's latest savior. When GSAT and other mobile satellite firms were founded, the FCC handed them spectrum rights for free; by contrast, cellular operators like Verizon and AT&T have had to pay many billions of dollars for their spectrum. The MSS spectrum rights, however, were restricted to space-oriented activities – communications between mobile "stations" (handsets) and orbiting satellites. By the early 2000s, it had become clear that MSS operators, despite their gifted spectrum and expensive satellite networks, would never reach a mass market and would be forever relegated to a tiny niche relative to terrestrial cellular operators. One failed MSS company, ICO, ran through the facts in a 2001 letter to the FCC:

> As the Commission is well aware, the MSS sector has been decimated by a string of failure:
>
> - Iridium went through bankruptcy and nearly had to deorbit its satellites. After spending more than $5 billion on its system, Iridium was able to muster only about 55,000 subscribers…
> - Globalstar, "suffering from anemic revenue and flip-flops in its marketing strategy, indefinitely halted repayments on $3 billion of debt in January, and hired an investment bank to pursue "strategic alternatives." The default led analysts to predict that Globalstar "will find it virtually impossible to raise additional financing."
> - Citing "hard lessons learned…in the Mobile Satellite Service industry," Motient recently filed an application in which it concluded that "a satellite-only system is ideal for rural areas but has insufficient capacity and poor urban coverage, particularly near and inside buildings, to be affordable and competitive."…
>
> Because of these difficulties, capital markets have simply lost confidence in mobile-satellite service projects. Merrill Lynch, for example, recently described Globalstar's equity value as "worth zero under its current capital structure."

Plus ça change, plus c'est la même chose…

As an attempt to counter the weaknesses of the MSS value proposition, the industry proposed, and the FCC ultimately approved, a concept called "ancillary terrestrial component," or ATC. In the words, again, of ICO, "Use of an ATC would involve just what its name implies – the use of ancillary terrestrial base stations to re-use assigned MSS frequencies in indoor and urban areas that would otherwise go unserved by a satellite-only MSS network." In other words, the idea was that in indoor and urban areas ATC base stations (e.g. cell towers), rather than satellites, would transmit to customer devices on the same frequencies that the MSS operators used for satellite-to-earth communications.

Of course, given the much greater value of the terrestrial cellular market compared to the MSS market, MSS operators might be tempted to make ATC the entire focus of their business and thus use their freely granted spectrum to obtain unfair windfalls. Remember, after all, that MSS carriers never paid for their spectrum. To prevent this and ensure that ATC would remain truly "ancillary" to MSS, the FCC imposed a number of so-called "gating criteria" – conditions that MSS companies would have to meet before being allowed to create an ATC. These criteria, laid out in the *Code of Federal Regulations* at 47 CFR 25.149, include operating an in-orbit spare satellite, providing adequate satellite coverage in all 50 states, and integrating the ATC network with the satellite network – for instance, by requiring "dual-mode" handsets capable of acting both as satellite phones and as conventional cellular phones. This last requirement in particular has rendered ATC authority disappointingly irrelevant, since the high cost, bulky form factor, and large antennas of satellite phones are extremely out of step with modern consumer tastes.

In the past, as described in further detail below, GSAT has attempted to generate value from its ATC authority – most notably in its partnership with a rural broadband provider called Open Range, which was driven into bankruptcy by a combination of a misguided business plan and GSAT's operational incompetence. While GSAT retains ATC authority on paper, it does not meet the gating criteria and thus, without further FCC action, is limited to using its spectrum for satellite purposes.

In 2012, however, GSAT tried a new approach. DISH Network, the satellite TV firm, had recently bought up spectrum rights from two bankrupt MSS firms, DBSD (a subsidiary of ICO) and TerreStar, and had successfully petitioned the FCC to convert those firms' ATC authority to fully terrestrial cellular rights detached from any satellite operations. GSAT desperately wanted to achieve the same treatment for itself and submitted its own petition to the FCC, explicitly modeled on DISH's. The petition indicated that GSAT's long-term plan and, in its own words, the "highest and best terrestrial use" of its spectrum, was to build out a conventional, *high-powered* cellular network based on the latest LTE technology. However, GSAT knew it faced enormous difficulties overcoming FCC and industry resistance to such a plan, thanks in part to its similarity to the failed plan of the bankrupt satellite firm LightSquared, which ran aground on GPS interference concerns that GSAT's proposal would also raise. Thus, along with the thinly described LTE concept, GSAT proposed, in the meantime, to offer the "Terrestrial Low Power

Service" discussed above using only its 2.4GHz spectrum, far removed from the vicinity of LightSquared.

Crucially, as the name implied, this was to be a *low-power service* compliant with the FCC's restrictive Part 15 rules, which cap power emissions (as measured by "equivalent isotropically radiated power" or EIRP) at 4 watts (equal to 36 decibel-milliwatts or dBm). By contrast, conventional cell towers typically transmit at 1,640 watts (62 dBm), *410x higher* than Part 15 devices. Since signal propagation is partially determined by transmission power, with high-powered signals remaining usable over longer distances than low-powered signals, this power limit severely restricts TLPS's range. In real-world settings, Wi-Fi (and, by extension, TLPS) signals are only effective within a radius of tens of meters around an access point; by contrast, cell towers operate on a scale of kilometers, at least two orders of magnitude greater. Since coverage *area,* as measured in e.g. square kilometers, scales with the *square* of the radius, a 100x shorter range would translated to a *10,000x* greater number of transmitters needed to cover a given geography.

GSAT proposed this low-power limitation precisely to circumvent complaints that it would interfere with other communications systems operating in the same or neighboring frequency bands. For example, it argued:

> TLPS access points should *not* be required to meet the more stringent OOBE [out-of-band emission] limit that is normally applicable to high-power commercial wireless base stations, which operate at up to four hundred times the effective radiated power level of these TLPS access points. TLPS access points will typically operate at a power level of 4 watts (36 dBm), making these transceivers more analogous to commercial wireless end-user devices than to CMRS [commercial mobile radio service] base stations.

Ultimately, the FCC completely snubbed GSAT's long-term LTE proposal, taking no action on it. It has only chosen to move forward with the less controversial and, *according to GSAT itself,* less valuable TLPS proposal. While GSAT management has attempted to spin this as a victory, it's no wonder that the initial reaction of its general counsel was so negative:

> **I must admit that when I began reading the first pages of the notice, that sinking feeling set in that this is not what we requested.** (*Source: GSAT investor call, November 6, 2013*)

External observers, like telecom attorney Donald Evans, reacted similarly (emphasis added):

> Interestingly, the approach taken by the FCC toward Globalstar differs from the more expansive approach toward DISH Network and its ATC authorizations. The FCC relieved DISH of any obligation to continue providing satellite service at all. To get to that result, the FCC changed the regulatory regime for the DISH spectrum from Part 25 of the FCC Regulations (satellite operations) to Part 27 (normal terrestrial wireless operations). DISH was also relieved of all gating requirements, permitting it to use its spectrum in all

respects as terrestrial – **a much higher value use. By contrast, the FCC rejected Globalstar's request for Part 27 treatment akin to DISH's and instead chained Globalstar firmly to its Part 25 satellite status.**

Even with TLPS authorized, therefore, GSAT's spectrum will remain "chained…firmly" to its satellite operations, which incur pre-tax operating losses of roughly $70 million a year. Capitalizing these losses at a modest 10x multiple implies that any potential spectrum-focused acquirer of GSAT, in addition to paying $4 billion to take out its debt and equity, would in effect be shelling out another ~$700mm to fund its value-destroying MSS business to perpetuity – a necessary condition to maintaining its terrestrial spectrum authority. It's inconceivable that anyone would value spectrum with this sort of substantial and unusual encumbrance as highly as normal, unencumbered spectrum authorized for full terrestrial use.

The Implications of Low Power: GSAT's Equity Is Worthless, Redux

Clearly TLPS's power limitations render any naïve attempt to equate GSAT's spectrum rights (post–TLPS approval) with cellular spectrum rights totally meaningless. Moreover, not only do cellular/LTE base stations transmit at much higher power levels than do Wi-Fi APs, but LTE user-device radios are also substantially more sensitive to incoming signals than equivalent Wi-Fi radios, thereby extending the usability of a given signal even farther.

Precisely calculating the coverage area of a given transmitter assuming a given receiver in a given location using a given technology is a complex, difficult task best left to radio-frequency engineers. However, a simplified version of such a "link budget" calculation helps to quantify just how dramatically less valuable GSAT's spectrum under TLPS would be compared to standard cellular spectrum. Our illustrative calculation is presented below.

Illustrative Link Budget: Wi-Fi vs. LTE Downlink

			Ratios	
	Wi-Fi	LTE	LTE to Wi-Fi	Wi-Fi to LTE
Transmit power (EIRP in dBm)	36	62	398x	0.003x
Less: receiver sensitivity (dBm)	(70)	(100)	0.001x	1,000x
Minimum coupling loss (dB)	106	162	398,107x	0.0000x
Center frequency (MHz)	2484	2484		
Maximum cell radius (m)	43	4,815	112x	0.0089x
Cell area (km²)	0.006	72.835	12,565x	0.0001x
Area of contiguous US (km²)	8,080,464	8,080,464		
# of base stations to cover US	1,394,017,181	110,941	0.0001x	12,565x
Cost per base station	$ 2,500	$ 250,000	100x	0.0100x
Total cost ($B)	$ 3,485	$ 28	0.0080x	126x

Source: Kerrisdale analysis. See e.g. Salo, Nur-Alam, and Chang, "Practical Introduction to LTE Radio Planning," or SNS Telecom, "LTE Radio Link Budgeting and RF Planning," for similar but more refined estimates.
Note: maximum cell radius is derived from path-loss models. For Wi-Fi, we use the model in Faria, "Modeling Signal Attenuation in IEEE 802.11 Wireless LANs," with a path-loss exponent of 4.02. For LTE, we use the standard Okumura–Hata model using large-city parameters, a base-station height of 30 meters, and a mobile-station height of 1.5 meters.

First, we assume that the transmitter (access point or base station) EIRP is 36 dBm for Wi-Fi and 62 dBm for LTE, a difference of ~400x (given the decibel's logarithmic nature). The receiver sensitivity is also ~1,000x better for LTE radios than for Wi-Fi. Thus we find that the maximum path loss than can be endured between a Wi-Fi transmitter and receiver, in the downlink direction, is 106 decibels, while for an LTE base station and user device it is 162 decibels.

We translate these path losses into distance using standard path-loss models from the technical literature, as outlined in the caption above. (We admit that we are somewhat exceeding the frequency range to which the Okumura–Hata model properly applies, but in that regard we have good company: GSAT's technical advisor and the original source of the TLPS concept, a firm called Jarvinian, used this same model in a recent presentation to the FCC (slide 11) while describing the superior value of low-frequency relative to high-frequency spectrum bands, a point to which we shall return.) We conclude that the expected signal range, or cell radius, of a Wi-Fi or TLPS signal is 43 meters, in line with real-world experience. By contrast, we estimate the range of an LTE signal using the same center frequency to be 4.8 km (approximately 3 miles). This in turn translates into a circular coverage area *12,565x larger* than the coverage area of a Wi-Fi access point.

Loosely speaking, then, we can calculate how many base stations or APs it would take to cover the 8 million square kilometers of the contiguous US with Wi-Fi or with LTE cellular. We conclude that while it would take ~100,000 cell sites, it would take *over one billion* APs. One might reply that cell towers are expensive and APs are cheap, but this difference alone will not rescue the economics of large-scale Wi-Fi. Based on our industry research, we estimate that the per-AP cost of an enterprise-grade Wi-Fi installation is at least $2,500, comprising both the ~$1,000 cost of the AP and related hardware as well as a low-ball estimate of the costs of site rental, installation, backhaul, electricity, etc. By contrast, we assume a base station cost of ~$250,000, derived in part from American Tower's estimates (see e.g. slide 27). Notwithstanding the large discrepancy in capital outlay per network node, which favors Wi-Fi, the cost of national coverage under one operator would still be vastly higher for Wi-Fi than for LTE: $3.5 *trillion* for Wi-Fi and just $28 billion for LTE, a 126-fold difference.

In other words, one formula for valuing GSAT's spectrum is as follows: take whatever you think its high-frequency, 2.4GHz spectrum would be worth if authorized for cellular usage and if not otherwise encumbered or impaired. Then **divide by 126** to account for the differences between the power limits of TLPS and LTE. Then adjust further downward based on the other flaws of GSAT's spectrum rights. It won't take long to conclude that the company's equity is worthless. For example, some sell-side analysts assume, based on deeply faulty logic further debunked below, that GSAT's spectrum should be valued at $1 per MHz-pop (a common spectrum valuation metric akin to a stock's P/E ratio) and that that multiplier should be applied both to GSAT's exclusively licensed spectrum *and* to neighboring unlicensed spectrum that it hopes to use under TLPS. On that basis, they estimate a spectrum value of ~$7 billion: $1/MHz-pop x 314 million US residents x 22 MHz supposedly employed in TLPS. But the $1/MHz-pop figure, which is already ~3-4x too high *even on the basis of appropriate cellular precedents,* is ludicrously too high given all the shortcomings of TLPS just described. Even if we temporarily accept, for the sake of argument, the underlying assumptions about *cellular* spectrum valuation, we must then divide by 126 (or some similar figure of the same order of magnitude) to convert from cellular to TLPS. In this case, even using the downright silly $7 billion cellular figure, we would arrive at a TLPS-adjusted value of **only $56 million**. Given the company's debt burden and loss-making core satellite business, this line of reasoning immediately establishes that the equity is worthless.

The point is not that GSAT would actually seek to spend $3.5 trillion to deploy TLPS in *some* form, in some far more limited set of locations; the point is that whatever buildout it might hope to accomplish would pale in comparison to what a mobile operator could achieve in the same frequency range using cellular-enabled spectrum rights. Unfortunately for GSAT, even if it wins approval for TLPS, it will still not have this full-fledged terrestrial authority, dramatically reducing its potential value.

GSAT's 1.6GHz Spectrum Is Worse than LightSquared's

Since we believe most GSAT holders already accept this point, we do not wish to belabor it, but it's worth briefly explaining why GSAT's 7.775 MHz of exclusively licensed spectrum in the 1.6GHz band has no value outside of its current use case (as the uplink frequency range over which GSAT's customers' handsets and other devices communicate with its satellites). In short, LightSquared, the disastrous failure of a satellite firm previously controlled by Phil Falcone's Harbinger Capital, had hoped to establish a terrestrial cellular network using its ATC authority and spectrum resources. After receiving initial but contingent FCC approval to move forward with this plan, LightSquared collapsed into bankruptcy, where it still remains, when an analysis conducted by a consortium of government and industry experts determined that its network, in particular its high-powered base stations, would pose unacceptable risks of harmfully interfering with the extremely widely used Global Positioning System (GPS). In addition, more recently (e.g. July 2014) government officials at the Department of Transportation as well as the National Telecommunications and Information Administration have highlighted additional serious concerns about LightSquared's proposed *uplink* band, even though uplink transmissions (from mobile devices toward base stations) would operate at low power. As a result, LightSquared's plans have come to nothing and are not expected to bear any fruit, at least for years to come.

GSAT's MSS uplink band is *even closer* to GPS and other radionavigation frequencies than LightSquared's band in 1.6GHz. Thus if multiple government agencies are unwilling to gamble on LightSquared's network (and thus potentially endanger the lives of aircraft passengers whose pilots rely on GPS for navigation, for instance), they are certainly never going to entertain a similar but even more dangerous gamble on GSAT. (The only people unwilling to concede this point appear to be the members of GSAT's management team.) Thus GSAT's 1.6GHz spectrum, while useful to its (loss-making) satellite business, has no value in any terrestrial application.

(In passing, we also note that the duplex gap – i.e. the bandwidth separating GSAT's satellite uplink and downlink bands – is extraordinarily wide compared to what is seen in conventional cellular bands like AWS-1 or 800MHz. Some experts believe that such a wide duplex gap could not be easily supported in the small form factor of a smart phone, except perhaps by adding an entire extra antenna system. Thus even if the GPS issue miraculously vanished overnight – which it won't – it would still be extremely difficult to use the 1.6GHz band terrestrially in concert with the 2.4GHz band.)

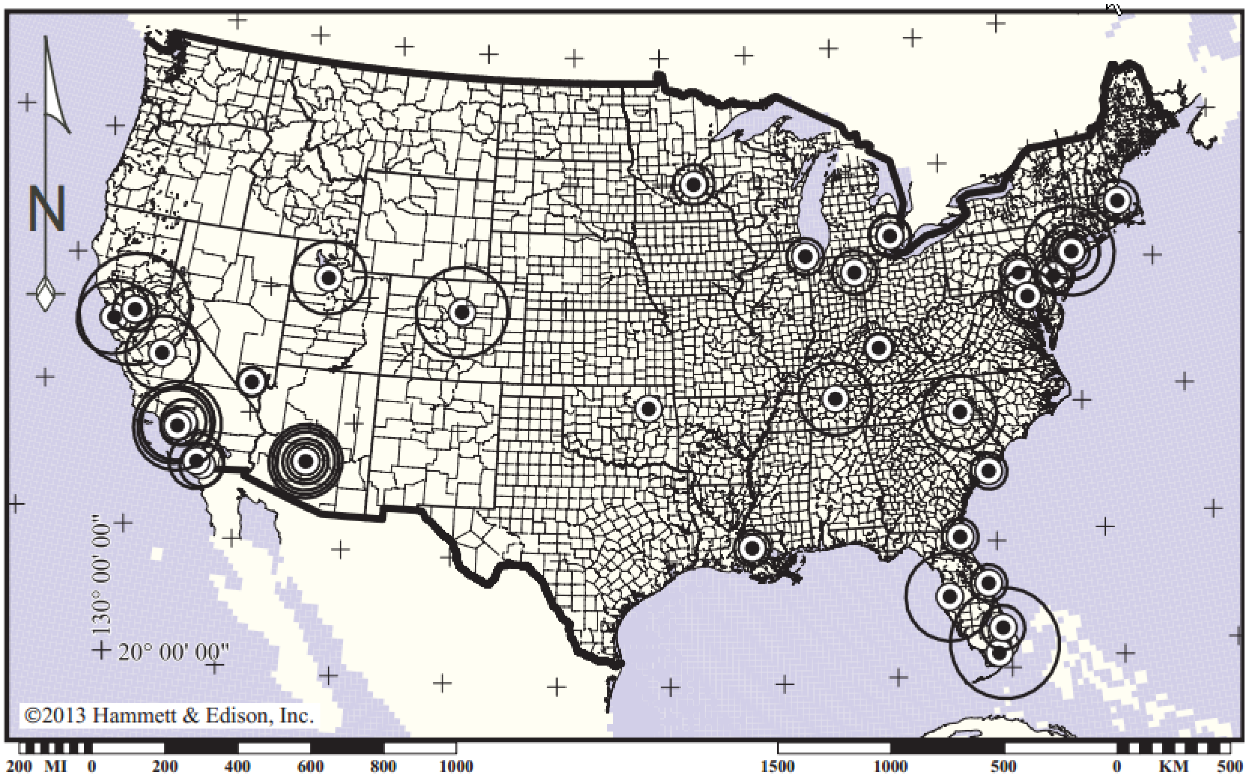
GSAT's 2.4GHz Spectrum Is Highly Encumbered and Must Be Shared

Though market participants often speak loosely about GSAT's spectrum holdings as if the frequency band running from 2483.5 MHz to 2495 MHz were its exclusive domain, that's not actually correct. GSAT's license is "co-primary" with many other licensees (approximately 60, according to the FCC's Universal Licensing System web site) who use the TV Broadcast Auxiliary Services (BAS) Channel A10, which operates between 2483.5 and 2500 MHz. These licensees, including the ABC affiliate TV station in New York (WABC-TV) and the CBS affiliate in Los Angeles (KCAL-TV), use Channel A10 primarily for electronic news-gathering (ENG). In other words, they deploy mobile news vans to obtain footage remotely and then transmit it back to headquarters. These transmissions use the same range of frequencies as do GSAT's satellites in their transmissions to Earth.

Source: Wikipedia

Given the low power of GSAT's satellite signals by the time they reach the planet's surface, the TV-station licensees have been able to coexist with MSS for many years. However, the more GSAT attempts to convert its spectrum to terrestrial use, the greater the risk of interference, which poses a problem for GSAT since it's legally required to protect Channel A10 licensees, whose co-primary rights outrank GSAT's since they are of earlier vintage.

The topic of potential A10 interference may seem esoteric, but if GSAT were ever again to seek high-powered terrestrial operations, the issue would be quite serious. To be sure, only in areas with nearby A10 licensees would GSAT have trouble; elsewhere, there would be no co-channel interference concerns. Unfortunately for GSAT, A10 licensees exist in most of the top markets in the country, and under the terms of their licenses they are authorized to operate over very wide areas. For example, WABC-TV is authorized to use the 2483.5-2500MHz band within a 75-mile radius centered on the Empire State Building. (As a result, TLPS would probably not function well near this location.) The map below, created by the broadcast-engineer industry group EIBASS (Engineers for the Integrity of Broadcast Auxiliary Services Spectrum), illustrates the magnitude of the problem. While the FCC is currently entertaining the possibility that low-powered Wi-Fi service would not threaten these A10 licensees, high-powered LTE service clearly would. GSAT would thus be hobbled in any attempt to one day win cellular rights in key metro areas like New York, Chicago, Miami, Phoenix, Los Angeles, San Francisco, DC, Philadelphia, and Detroit. Certainly no buyer or lessee of spectrum would ever overlook such a value-destructive encumbrance when determining how much it would be willing to pay.



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.

Source: EIBASS via FCC

These interference concerns are not just theoretical. In the late 2000s, GSAT attempted to monetize its spectrum by allying itself with a much ballyhooed firm called Open Range Communications, which aimed to supply wireless internet access in rural areas by leasing GSAT's ATC rights. GSAT proudly promoted this arrangement as "a template for how our global spectrum may be used more efficiently to the benefit of Globalstar, our partners and our customers." But Open Range never gained much traction, and in 2010 the FCC revoked GSAT's ATC authority because, contrary to its promises, it failed to come into compliance with the ATC gating criteria. This in turn pushed Open Range into bankruptcy. While this debacle is eye-opening in a number of respects, what's interesting to note in this context is that, despite its very limited scale and scope of operations prior to dissolving, Open Range actually *did* cause interference to A10 licensees, earning it the scrutiny of the FCC's enforcement team, which forced Open Range to shut down certain base stations. EIBASS documented these incidents (emphasis added):

> The Open Range base station at St. John, Indiana caused harmful interference to the electronic news gathering (ENG) operations of Station WBBM-TV...Chicago, IL…; and to the ENG operations of Station WGN-TV…, Chicago, IL…EIBASS has also learned that an Open Range base station at Sutter Buttes, near Yuba City, CA, has similarly caused harmful interference to the ENG operations of TV Station KOVR (CBS)…serving the Sacramento-Stockton-Modesto, CA, Designated Market Area. … The Chicago interference, caused by an Open Range base station **90 km from the ENG receiving location atop the Hancock Center and the Sears Tower,** demonstrates conclusively that S-band MSS ATC and co-primary, grandfathered, and earlier-in-time Channel A10 ENG operations cannot coexist.

Remarkably, even with just a handful of customers and base stations, and at a distance of more than 50 miles, Open Range, using GSAT's spectrum, caused noticeable interference with protected A10 licensees. Of course, with any large-scale buildout, the damage would only be greater. Given this material encumbrance alone, we doubt that the FCC would ever risk re-authorizing high-powered terrestrial operations in GSAT's 2.4GHz band without imposing tight geographic restrictions that would exclude GSAT from almost all of the best markets.

Could GSAT simply pay the A10 licensees to go away? While GSAT itself lacks the financial resources to make any sizable payment to anyone – indeed, it even pays certain vendors in shares (at a discount to the market price) in lieu of burning more cash – even a partner would find such an undertaking expensive and difficult. For instance, Sprint was forced to engage in a similar exercise starting in 2004, reimbursing broadcasters for converting their equipment to use a different spectrum band – and it cost $750 million and took five years to finish.

Regulators Will Not Allow GSAT to Damage Its Neighbors

Given the worthlessness of TLPS, is it possible, as we considered for the sake of argument above, that GSAT will instead try again to obtain the authority to create a high-powered LTE network? The only remotely plausible path such an approach could take is for GSAT to renounce its hopes of using the 1.6GHz band and try instead to package its 2.4GHz spectrum as a 10MHz-wide supplemental downlink band, to be used or purchased by a carrier like AT&T or Sprint. Even if we very generously imagine that this authority could be detached from GSAT's satellite business – and completely set aside the important issue of coexistence with Channel A10 – GSAT's spectrum still faces great challenges.

As we already know from our discussion of TLPS, GSAT's 2.4GHz band is directly adjacent to the ISM band currently used for 2.4GHz Wi-Fi as well as Bluetooth, ZigBee, cordless phones, baby monitors, microwave ovens and many other devices. While the 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, high-powered operations in the same band are a different story altogether. Wi-Fi devices are ubiquitous, popular, and increasingly relied upon. FCC officials like Commissioner Jessica Rosenworcel have increasingly acknowledged the great benefits of unlicensed spectrum and taken action to free up more. Regulators will be loath to jeopardize this vibrant ecosystem just to extend the life of a moribund satellite company by a few more years.

Industry interests would also oppose any attempt to overpower Wi-Fi with a neighboring LTE service. Indeed, before it was clear that the FCC was not moving forward with this proposal, both the Consumer Electronics Association ("the principal U.S. trade association of the consumer electronics and information technologies industries") and Microsoft, as well as the Wi-Fi Alliance, Bluetooth Special Interest Group, and others (who continue to oppose the TLPS rulemaking), objected strenuously. It's hard to see how a renewed version of that proposal in the wake of TLPS's commercial failure could survive the same level of resistance.

A Thin, Peculiar Band with Unusual Interference Challenges Would Attract Little Interest

Even if the FCC could somehow be convinced to move forward with a hypothetical high-powered LTE authorization, it is still unlikely that any carrier would find it worth the headache to actually use the spectrum. What carriers most desire is spectrum that is unencumbered and internationally standardized to insure lower-cost handsets and economies of scale. But GSAT's spectrum would have none of these advantages: it would be a narrow, one-off band. Furthermore, crammed as it is between Wi-Fi and Sprint, it would require exquisitely precise design and engineering to prevent "self-jamming." In other words, without remedial measures like the installation of higher-quality and more expensive filters, a smartphone containing not just a Wi-Fi radio and a Sprint 2.5GHz radio (like the iPhone 6) but also a hypothetical "GSAT LTE radio" would be highly likely to interfere *with itself.* This problem, sometimes called "in-device coexistence," is already a design concern for existing mobile devices given the proliferation of LTE bands but would be greatly exacerbated if GSAT attempted to stick yet another band in between two that were already in use. In exchange for all this difficulty, GSAT has effectively only 10 MHz to offer, not its full 11.5MHz terrestrial allocation, given the realities of widely deployed, standardized LTE channel bandwidths that come in multiples of 5 MHz. Indeed, GSAT itself essentially admitted this last point in a January 2013 webinar (see slide 11, showing only a "10MHz LTE channel" as a "conventional use" of the 11.5MHz terrestrial allocation.)

In addition, just as a neighboring high-powered LTE system would interfere with 2.4GHz Wi-Fi, Wi-Fi in turn would greatly interfere with a neighboring LTE system. While LTE base stations and user devices are subject to strict out-of-band emissions limits under the specifications promulgated by 3GPP, the industry standards body, Wi-Fi devices enjoy looser guidelines. Even while operating at low power, a Wi-Fi device in reasonably close proximity to an LTE device operating on an adjacent band – for example, within the same room – could very easily generate substantial amounts of noise from the perspective of the LTE device. This is true even assuming that the Wi-Fi device complies (as it legally must) with the FCC's unusually strict out-of-band-emissions rules within GSAT's band. For example, at a legally permitted out-of-band emissions level of -41.2 dBm/MHz, even with 30 to 50 decibels of path loss over a short (1 to 10 feet) distance, a Wi-Fi transmitter could increase noise levels for a nearby LTE device by many orders of magnitude, effectively preventing it from receiving a signal from its base station. For instance, the base station might be trying to notify the device that it had an inbound call, but as a result of interference from Wi-Fi, the device would not realize it. In the words of one of our radio-frequency industry contacts, "That's why operators are hesitating placing any spectrum close to unlicensed bands." In a hypothetical "GSAT LTE" scenario, these problems would be substantially worse than in any existing band, where they already create meaningful concerns. Again, no carrier would be interested in tackling these difficulties if the price were an astounding $4 billion and the bandwidth in question were merely 10 MHz. Thus, not only would regulators likely block a high-powered network using GSAT's 2.4GHz spectrum; potential acquirers or lessees would also be uninterested in it for purely economic and technical reasons. In short, the laughable TLPS concept is, pathetically, GSAT's best bet.

Frequency Drives Spectrum Pricing, and GSAT's High-Frequency Spectrum Merits a Low Price

> 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 [*a company that later became part of LightSquared*] 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.
>
> —Globalstar chairman and CEO James Monroe III (May 7, 2008, emphasis added)

While we are reluctant to stack hypothetical on top of hypothetical in a vain attempt to come up with some logical justification for GSAT's current market value – there is no reason to give a company with its track record the benefit of the doubt – we will consider what its 2.4GHz spectrum might be worth if authorized for LTE in the absence of all of the impairments just outlined. To reiterate the main impairments:

1. TLPS approval would only allow GSAT to operate over the short distances characteristics of Wi-Fi, implying an incredibly high build-out cost to achieve cellular-like coverage and rendering cellular precedent transactions wholly irrelevant. Any discussion of the value of GSAT's spectrum for cellular service is thus extremely speculative and implicitly assumes some future FCC rulemaking years down the road that is not yet even a glimmer in a bureaucrat's eye today.
2. GSAT is legally obligated to protect co-channel, co-primary, more senior TV BAS Channel A10 licensees, which likely precludes large-scale high-powered use in almost all of the most valuable geographies.
3. LTE operations in adjacent frequencies would damage existing 2.4GHz Wi-Fi systems and thus face great scrutiny from the electronics industry and the FCC.
4. GSAT's spectrum is not internationally standardized for terrestrial use and is not supported for LTE service in any existing device.
5. LTE devices in GSAT's band would experience material interference from nearby Wi-Fi devices and might also interfere with themselves.

Gritting our teeth, however, and setting aside all these fatal flaws, we find that *even if GSAT's spectrum rights were perfectly "normal"* it would still be impossible to justify GSAT's current valuation. The key point is that GSAT's band is high-frequency, and because high-frequency signals propagate *exponentially more poorly* than low-frequency signals, high-frequency spectrum is worth exponentially less than low-frequency spectrum. Nonetheless, many bullish analysts implicitly assume that all cellular spectrum (and even GSAT's non-cellular spectrum) is fungible – yet another bizarre and gargantuan error.

Backing into the Implied Valuation of GSAT's Spectrum

By all accounts, the vast majority of GSAT's current enterprise value stems from its TLPS concept and/or its more abstract spectrum potential, not its actual MSS business. One sell-side firm, for example, noted in May that GSAT's "[v]aluation is less sensitive to changes in EBITDA from the constellation and much more by the spectrum value" – an understatement given that, using its own target-price methodology, *95%* of GSAT's "fair" enterprise value is tied to spectrum alone. In fact, since the firm pegged the MSS business's fair EV at just $338mm, materially lower than GSAT's net debt (excluding convertible obligations) of $545 million, spectrum would account for *more than 100%* of GSAT's equity value.

Looking at satellite competitors' valuations supports the same conclusion. We'd note though that GSAT is a weaker operator than its peers, being the fourth-tier player within the highly competitive MSS market niche and having only ~5% share. As well, its largest publicly traded peers – Inmarsat (IMASF), Iridium (IRDM), and ORBCOMM (ORBC) – trade at optically generous valuations, with a weighted-average EV-to-forward-revenue ratio of ~5x and EV-to-forward-EBITDA of ~9x. Nevertheless, we will still use peer valuation multiples in valuing GSAT's satellite business.

Mobile Satellite Services: Competitors' Valuation Metrics

	Inmarsat	Iridium	ORBCOMM	Aggregate
Metrics ($mm)				
Enterprise value	7,197	1,399	342	8,939
Revenue:				
LTM	1,274	399	83	1,756
NTM consensus	1,300	415	112	1,827
EBITDA:				
LTM	655	192	13	860
NTM consensus	688	217	26	932
Ratios				
EV/revenue:				
LTM	5.6	3.5	4.1	5.1
NTM consensus	5.5	3.4	3.0	4.9
EV/EBITDA:				
LTM	11.0	7.3	25.9	10.4
NTM consensus	10.5	6.4	13.1	9.6

Source: Capital IQ, Kerrisdale analysis

Applying these average multiples to GSAT yields a range of values for the satellite business from $151 million to $475 million, with an average of $325 million, in line with sell-side estimates:

Valuing GSAT's MSS Business

	Multiple	GSAT value	Implied GSAT EV
(*$mm*)			
EV/revenue:			
LTM	4.9x	88.1	427
NTM consensus	4.7x	100.9	475
EV/EBITDA:			
LTM	9.9x	15.2	151
NTM consensus	9.2x	26.8	246
Average value			**325**

Source: Capital IQ, GSAT presentation (for LTM adjusted EBITDA), Kerrisdale analysis

Using this estimate of the value of the satellite business, we can infer the value that the market ascribes to GSAT's spectrum. We express this valuation in the form of the commonly used spectrum metric of "price per megahertz-pop," meaning price divided by the product of bandwidth and license-area population. Many cellular spectrum licenses pertain only to specific geographies, not the US as a whole, creating a need to normalize the prices paid for different licenses based on the underlying populations covered. Similarly, different licenses involve different amounts of bandwidth (in megahertz), creating another need to normalize. Pulling it all together, we derive a market-implied spectrum valuation of **$1.19 per MHz-pop** – a downright stupid number.

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

Source: US Census Bureau, Kerrisdale analysis

Applying a More Reasonable Spectrum Valuation

At what price *should* this spectrum trade, assuming for the sake of argument that it did not suffer from all the flaws it suffers from? The words of GSAT's CEO quoted above suggest an obvious way to proceed: since GSAT's high-band spectrum is, in his words, "functionally equivalent" to that of the now defunct Clearwire, simply apply an appropriate $/MHz-pop value derived from that company. Fortunately, this is straightforward, because, after a competitive bidding process that pitted Sprint against DISH Network and Verizon, Clearwire sold itself a year ago. The final deal terms valued its spectrum at **only $0.30 per MHz-pop** (noted in, e.g., Evercore's June 2013 presentation to Clearwire's board, slide 5, as well as the first full sentence of Sprint and Clearwire's joint press release). Needless to say, this is a far cry from where GSAT is trading. Below we go through the arithmetic, concluding that in this unfathomably optimistic scenario GSAT's equity would still be worth almost 80% less than its current market price.

Value of Hypothetical LTE Deployment

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%**

Source: Kerrisdale analysis

For those accustomed to the exuberant rhetoric of GSAT bulls, the $/MHz-pop figure used above might look light. One sell-side firm, for instance, values GSAT's spectrum at $1.00 per MHz-pop, contending that "[s]ome comparable spectrum transactions have gone for much more than $1.00 per MHz-POP, so we do not think our valuation is pushing the envelope." GSAT itself, in a September 2011 presentation, seemed to endorse the much lower $0.50/MHz-pop figure used by another firm but presented a range of precedent transaction values:

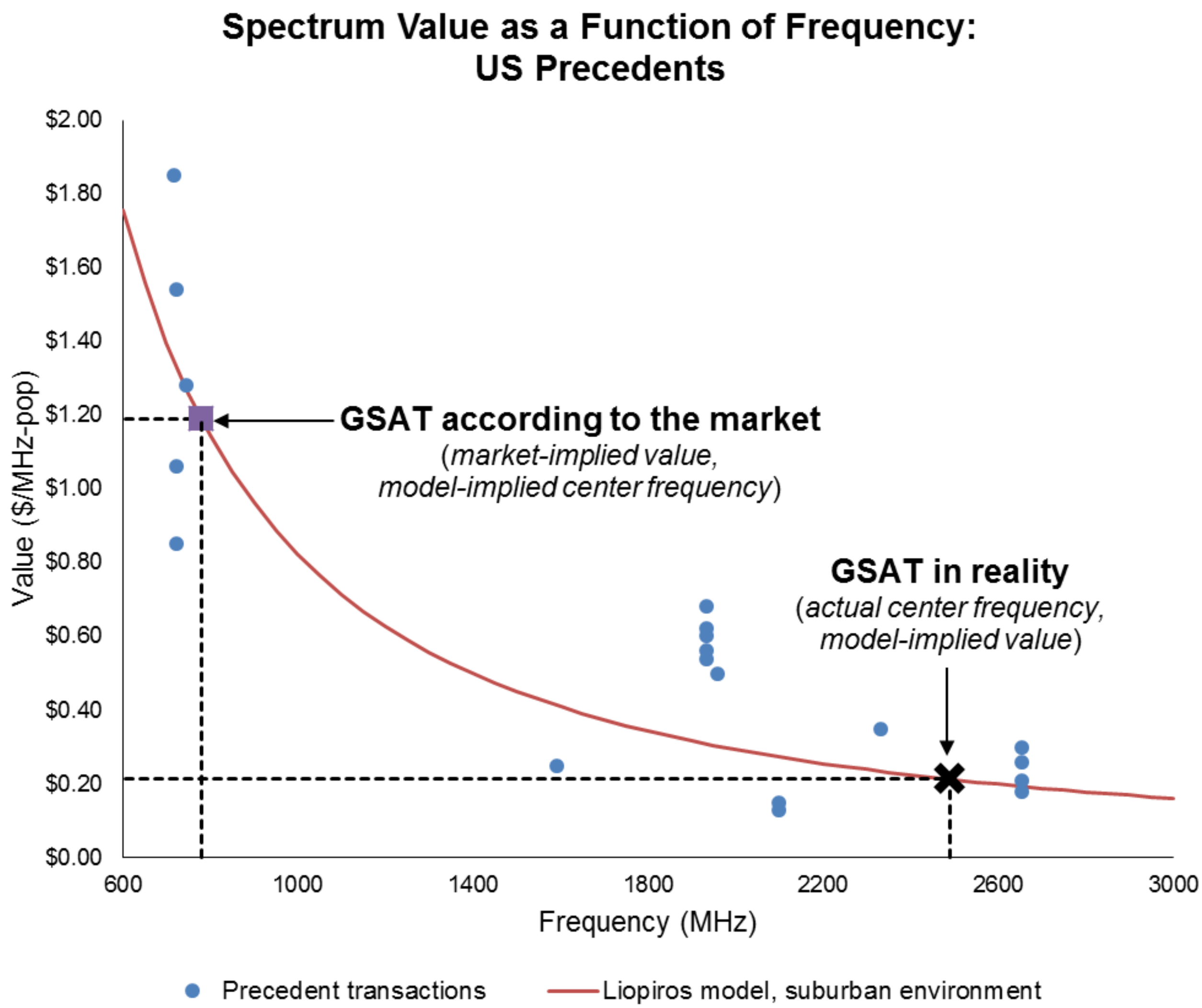
Spectrum Precedents

Auction / Transaction	Dates	$ / MHz POP Value
AWS (Auction)	April 2006	$0.55
AT&T / Aloha Transaction (Spectrum Acquisition Transaction)	October 2007	1.06
700 MHz (Auction)	March 2008	1.29
AT&T / QCOM (Spectrum Acquisition Transaction)	December 2010	0.87
Dish / DBSD (Bankruptcy Acquisition)	March 2011	0.24
Dish / TSTR (Bankruptcy Acquisition)	July 2011	0.22

"Assuming the FCC revalues Globalstar's ATC spectrum as expected, a ~ $0.50 MHz-POP valuation in-line with the AWS-1 spectrum auction, could be used" STONEGATE SECURITIES Research – August 7, 2011

Source: GSAT World Satellite Business Week presentation, September 2011, slide 17

How is one to make sense of this enormous range of spectrum prices, which vary by a factor of almost six from the low of $0.22 to the high of $1.29? Matters become much clearer in a plot of price against frequency:



The Black X indicates GSAT's actual center frequency and model-implied value. The purple square indicates its market-implied value and the hypothetical model-implied center frequency that would justify that value.

Source: model derived from Kostas Liopiros, "Formulation of a Weighted Spectrum Screen" (Feb. 2014); Kerrisdale analysis

The graph above incorporates not just the six auctions and secondary-market transactions cited by GSAT in its September 2011 presentation but 13 others, including two conducted just a few months ago: T-Mobile's purchase, announced in January, of coveted, low-frequency 700MHz spectrum from AT&T for an estimated $1.85/MHz-pop (incorporating T-Mobile's assumption about the value of the higher-frequency spectrum that constituted part of its payment) and DISH Network's purchase at an FCC auction in late February of high-frequency (~2000MHz) spectrum for $0.50/MHz-pop. The table below lists all of the transactions included in the graph.

Recent US Spectrum Transactions

Description	Period	Spectrum type	Frequency (MHz), approx. midpoint[7]	Price ($ / MHz-pop)
AWS auction[1]	Apr 2006	AWS	1933	$0.54
Clearwire/BellSouth[2]	Feb 2007	EBS/BRS	2654	$0.18
AT&T/Aloha[3]	Oct 2007	700MHz	722	$1.06
700 MHz auction[1]	Mar 2008	700MHz	744	$1.28
Sprint/Clearwire[2]	May 2008	EBS/BRS	2654	$0.26
Harbinger/SkyTerra[2]	Sep 2009	MSS	1593	$0.25
AT&T/Qualcomm[1]	Dec 2010	700MHz	722	$0.85
Dish/DBSD[2, 4]	Mar 2011	MSS	2100	$0.15
Dish/TerreStar[2, 4]	Jul 2011	MSS	2100	$0.13
Verizon/Cox[1]	Dec 2011	AWS	1933	$0.56
Verizon/SpectrumCo[1]	Dec 2011	AWS	1933	$0.68
Verizon/Savary Island[1]	Dec 2011	AWS	1933	$0.62
Verizon/Leap[1]	Dec 2011	AWS/PCS	1933	$0.60
Leap/Verizon[1]	Dec 2011	700MHz	722	$1.54
AT&T/NextWave[2]	Aug 2012	WCS	2333	$0.35
Sprint/Eagle River[2]	Oct 2012	EBS/BRS	2654	$0.21
Sprint/Clearwire (final)[2]	Jul 2013	EBS/BRS	2654	$0.30
T-Mobile/AT&T[5]	Jan 2014	700MHz	716	$1.85
H Block auction[6]	Feb 2014	AWS	1958	$0.50

Source: Kerrisdale analysis
1. Price source: Moelis presentation re: LightSquared, p. 68/slide 8.
2. Price source: Evercore presentation re: final Sprint/Clearwire deal, slide 8.
3. Price source: GSAT World Satellite Business Week presentation, September 2011, slide 17.
4. Excludes the value of the seller's net assets (per Evercore's calculation).
5. Price source: T-Mobile Jan. 2014 presentation, slide 9.
6. FierceWireless Feb. 27, 2014 article.
7. In most cases represents the midpoint of the entire generic spectrum band (e.g. AWS-1 uplink starts at 1710MHz, and AWS-1 downlink ends at 2155MHz, so the generic AWS midpoint used is the average of those endpoints). Upper and lower 700MHz bands are distinguished where possible.

It's very clear from the data points on the graph that higher-frequency spectrum is invariably far less valuable than low-frequency spectrum; *all* of the thrillingly high-priced precedents cited by GSAT bulls come from low-frequency deals. The reason is simple: low-frequency radio waves experience less attenuation as they travel and are more able to penetrate through barriers like walls and buildings. As a result, they enable wider coverage areas and better indoor reception than high-frequency waves. In a report commissioned by Sprint in February, Kostas Liopiros, a seasoned IT consultant with a Ph.D. in electrical engineering from Princeton and 30 years of experience in broadband wireless and spectrum issues, explains:

> Low-band spectrum, below 1 GHz, provides superior range and building penetration compared to high-band spectrum, located significantly above 1 GHz. Low-band spectrum can provide more affordable coverage in a variety of propagation environments, from low-density rural environments to high-density urban environments.…The additional base stations required to achieve an equivalent coverage with a high-band network result in a greater cost to deploy and operate a wireless network.

Liopiros goes on to develop a set of simple models to estimate the value of one type of spectrum relative to another in a variety of stylized environments based on their frequencies. To translate these relative valuations into absolute dollars per MHz-pop, we use as a reference point the 700MHz FCC auction in 2008, in which spectrum traded for an average price of $1.29/MHz-pop. (This is a cleaner baseline than the more recent T-Mobile transaction because it was a pure exchange of dollars for spectrum, not a swap of spectrum for spectrum.) The red line in the graph above shows the predicted spectrum value in dollars for a given frequency based on the following equation (adapted from Liopiros's equation 4.5), which assumes a suburban environment:

$$P_\nu = P_{ref} \left(\frac{\nu_{ref}}{\nu}\right)^{1.49}$$

where P_ν is the price in \$/MHz-pop for a given frequency ν, P_{ref} is the reference price (here, $1.28), ν_{ref} is the reference frequency (here, 743 MHz, representing the midpoint of the 698-787MHz band), and 1.49 is the overall path-loss exponent derived from empirical experience. Though obviously not perfect, this model fits the data fairly well, correctly predicting that spectrum prices decline *exponentially* as frequency increases.

Looking again at GSAT's spectrum and setting aside the portion that lies next to LightSquared's potentially worthless holdings, the Lioprios model, calibrated to the 2008 700MHz auction, predicts a price based on GSAT's frequencies of $0.21/MHz-pop (shown by the dashed green lines in the graph). Though Clearwire sold for higher than this ($0.30), the prediction is hardly ridiculous: in the other most comparable precedent transactions (involving the high-frequency EBS/BRS band), prices ranged from $0.18 to $0.21, and lower-frequency deals involving distressed satellite operators similar to GSAT (DBSD and TerreStar) came even lower at $0.13-0.15.

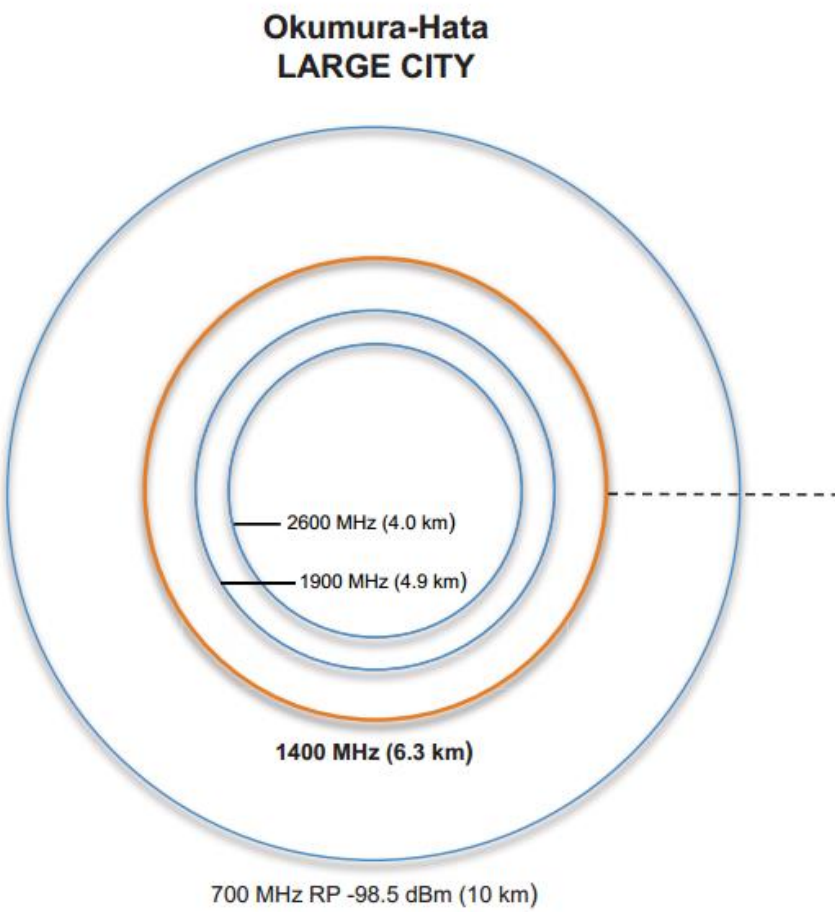
Liopiros's model also enables us to estimate the frequency that would *actually justify* the market's current inflated opinion of GSAT's value, by finding the frequency that would generate the market-implied price of $1.19/MHz-pop. This works out to approximately 780 MHz, a massive spectral distance from GSAT's actual home near the 2.5GHz band. **In effect, bulls are treating GSAT's high-band spectrum as if it were unimpaired, fully terrestrial, high-power, low-frequency spectrum**, neglecting the tremendous economic difference between the two (of which industry professionals are well aware). This sleight of hand may have deceived equity investors, but any credible acquirer or business partner would see right through it. A recent discussion on the industry site *FierceWireless,* for example, illustrates the low opinion that many telecom professionals have of high-frequency spectrum extremely similar to GSAT's (specifically, Clearwire's spectrum in the 2.5GHz band):

> red_dog007: "It isn't the best spectrum, but there is a lot of it."
>
> S. Ali: "No matter how magical 8t8r equipment [*a type of antenna technology*], 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…"
>
> Ken P: "Too bad Sprint's 2.5 GHz spectrum can't penetrate its way out of a paper bag."
>
> MagentaUser: "Exactly. It's garbage spectrum that will require a gazillion towers which they dont have the money to spend nor the incentive"
>
> wicketr: "These maps would be much more useful if they separated out the low frequency spectrum and the high frequency spectrum. That 2.5 GHz is virtually useless…"

To be clear, we must again point out that GSAT's spectrum is in fact massively *less* valuable than $0.20-$0.30 per MHz-pop, but it's staggering to realize just how overvalued the company would be *even if* these sorts of comparisons make sense.

Indeed, even Jarvinian, the investment firm that created the TLPS concept and brought it to GSAT, appears to agree with us both qualitatively and quantitatively about the low value of high-frequency spectrum. In an unrelated matter involving TerreStar, Jarvinian produced the following slide, highlighting how TerreStar's scrap of 1.4GHz spectrum could be substantially more valuable than higher-frequency bands:

Equivalent Power vs. Propagation Distance (1.4 GHz —)



Source: Jarvinian Advisors, slide 11

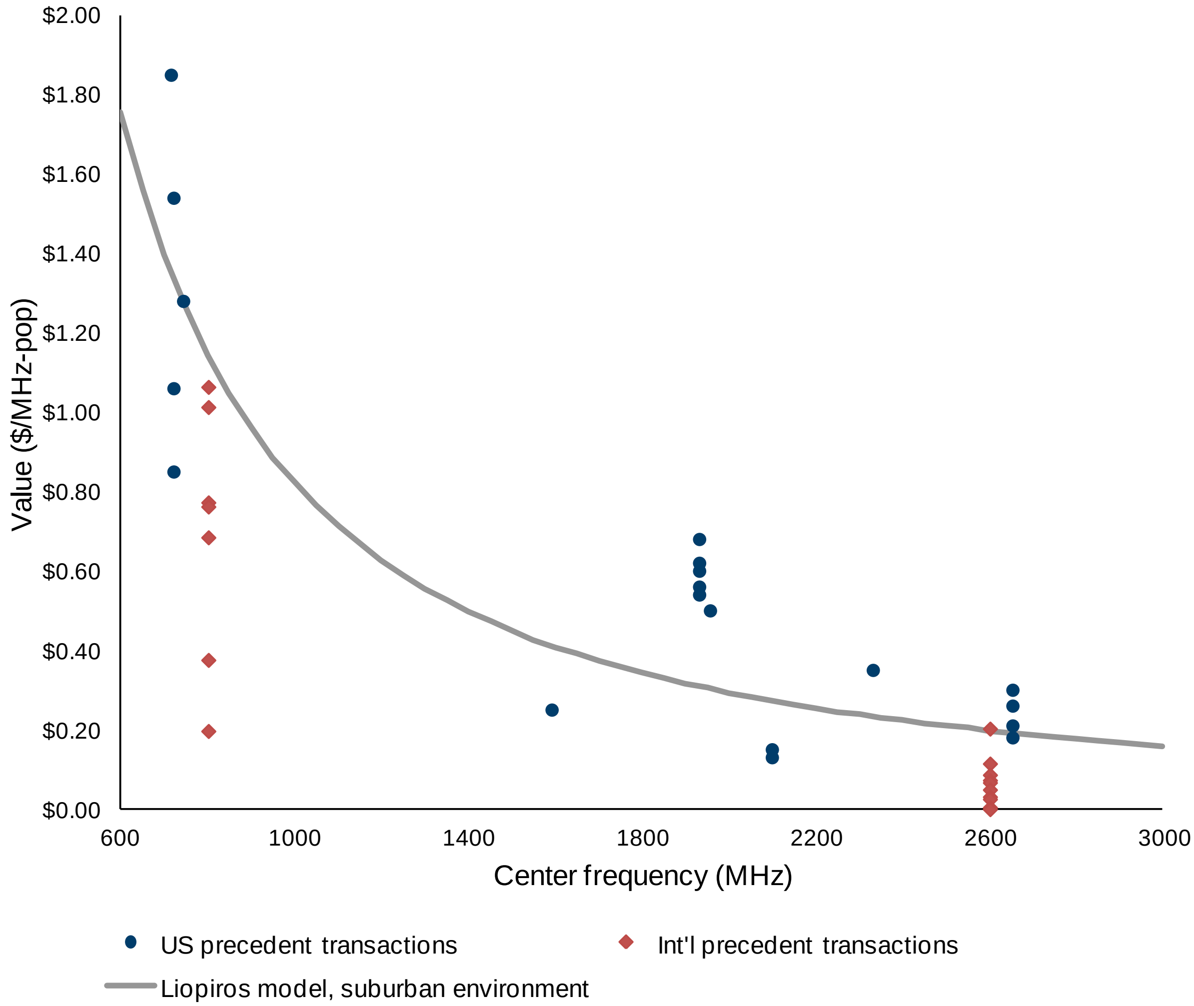
Applying the same Okumura–Hata model to GSAT's frequency range (as opposed to the slightly higher-frequency 2600 MHz spectrum shown in the chart), we find that the implied radius at a target received power of -98.5 dBm would be 4.1 km. In other words, the range of a GSAT ~2.5GHz LTE signal would be ~40% of that of a 700MHz signal, implying a coverage *area* only 16% as large (40% x 40%) as with 700MHz. This in turn would translate to a proportional increase in the number of base stations required to cover a given area. If we simply apply that 16% multiplier to the most recent large-scale 700MHz transaction – T-Mobile's purchase from Verizon at $1.85 per MHz-pop – we arrive at a $/MHz-pop value for GSAT's frequency band of $0.296, exactly in line with the Clearwire precedent. This confirms yet again that *even if* every problem afflicting GSAT's TLPS concept and its spectrum rights were to disappear, its equity would still be worth a tiny fraction of its current value.

International Experience Confirms the Low Value of GSAT-Like Spectrum

The benefits of low-frequency spectrum relative to high-frequency spectrum stem from basic physics, and thus we ought to observe a similar pricing dynamic in foreign data as we do in domestic data. This is, in fact, what we see. Ofcom, the British equivalent of the FCC, commissioned a helpful report on the "Spectrum value of 800MHz, 1800MHz, and 2.6GHz" in July 2012 to prepare for its own spectrum auction held in February 2013. The report noted the following (emphasis added):

> Unlike the case of 800MHz where regulators often set higher reserve prices to reflect the likely higher market value, for the 2.6GHz band reserve prices were mostly set at **a LBNT ["low but not trivial"] level**.

Compiling data across countries including Germany, Italy, France, Portugal, Spain, Sweden, Denmark, Belgium, Norway, Netherlands, and Finland, the report underscored the enormous gulf in value between low-frequency and high-frequency spectrum. Across 10 countries, the average 2.6GHz spectrum price was just **$0.07/MHz-pop**:



Source: Ofcom, Kerrisdale analysis
Note: GBP values converted to USD based on Ofcom's assumed exchange rate of $1 per 0.67 GBP (see p. 13, footnote 13). Only shows paired 2600MHz spectrum; unpaired values are even lower.

In Sweden, for example, 800MHz spectrum sold for $0.38/MHz-pop, while 2.6GHz spectrum sold for half that. In Germany, the gap was even larger: 800MHz sold for $1.07, similar to the US, while 2.6GHz sold for a mere $0.03. In the UK's own auction in 2013, analysts estimated that the 2.6GHz band fetched just £0.07 (~$0.11) per MHz-pop. While GSAT bulls often tout the company's nebulous long-term international opportunities, they fail to realize that international prices for frequencies like GSAT's are even more laughably low than domestic prices, hardly indicating a great global thirst for its spectrum. At a price like $0.11/MHz-pop, GSAT's equity would be worth almost nothing – what Ofcom might deem a "low but not trivial" level.

Though emerging markets have less experience with spectrum auctions, one country is worth mentioning: Brazil. On GSAT's 2008 Q1 earnings call, CEO James Monroe III expressed his optimism about the company's future there:

> …[W]hen people look at the value of ATC they almost always look at it only within the context of the United States or sometimes the United States and Canada. They don't look at ATC from a valuation perspective from Globalstar's more worldwide perspective. So you end up in a situation where somebody wakes up one day and says, "My lord, Brazil has got 200 million people and **spectrum there is worth $0.40 per megahertz pop**…" and that starts to be baked into Globalstar's value…

GSAT has no authority to operate terrestrially in Brazil (or anywhere else, for that matter), but the country did auction off 2.5GHz spectrum in 2012, providing a useful point of comparison for Monroe's earlier remark. The spectrum sold not for $0.40, as Monroe suggested, **but for $0.048 per MHz-pop**, based on the analysis of telecom advisor Frank Rayal. Thus Monroe was off by a factor of 10. But who's keeping score?

The Solaris Precedent Would Imply Zero Value for GSAT's Equity

Worse still, a recent European transaction supplies an even closer comparable for GSAT and implies an even lower valuation. Solaris, an Ireland-based mobile-satellite company formed as a joint venture between Eutelsat and SES, was sold to EchoStar (SATS), a sister company of DISH Network, for a price of just $51.8mm (including $10.3mm in assumed liabilities) (source: EchoStar 2013 10-K, p. F-9). In essence, EchoStar just bought Solaris's spectrum licenses, because its actual business was largely defunct:

> In December 2013, we acquired 100.0% of Solaris Mobile which is based in Dublin, Ireland and licensed by the European Union ("EU") and individual Member States to provide MSS and a complementary ground component services covering the entire EU using S-band spectrum. On the acquisition date, Solaris Mobile lacked certain inputs and processes that would be necessary to be considered a business. Accordingly, we accounted for the transaction as an acquisition of net assets. The primary acquired asset was an EU Regulatory Authorization for S-band frequencies, which had a cost of $51.8 million, consisting of $43.4 million in cash payments and $10.3 million in assumed liabilities.

Solaris was one of the only satellite companies to have won authority for a "complementary ground component" – the European version of an "ancillary terrestrial component" – using its 30MHz of spectrum in the 2GHz band. Like GSAT, it had great plans to use its spectrum for mobile broadband services, but, in the word of *Space News*, it "struggled to find a market," experienced damaging operational failures, and left its owners "fed-up" and wondering "what to do with an asset into which they had invested a combined 130 million euros ($175 million)." Ultimately, they gave up and cut their losses.

What does EchoStar's purchase price for Solaris imply for GSAT's value? In short, nothing good:

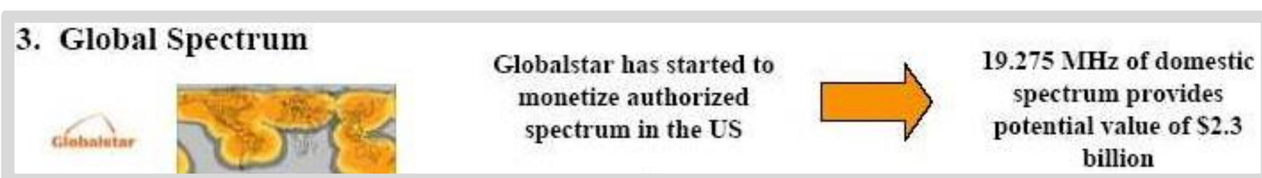
Solaris: Implied Spectrum Price per MHz-Pop	
Licensed terrestrial spectrum (MHz)	30
Population (mm)	506
MHz-pops	15,180
Sale price ($mm)	$ 51.8
Price/MHz-pop	**$ 0.0034**

Source: Kerrisdale analysis

With tremendously more MHz-pops than GSAT, Solaris sold for *1%* of GSAT's enterprise value. Given GSAT's high level of debt, a valuation like this would clearly mean death for its equity. This transaction demonstrates that satellite-based "spectrum plays" with no clear business model garner little interest from acquirers, underscoring the fact that applying conventional spectrum comps to GSAT is delusionally, indefensibly optimistic.

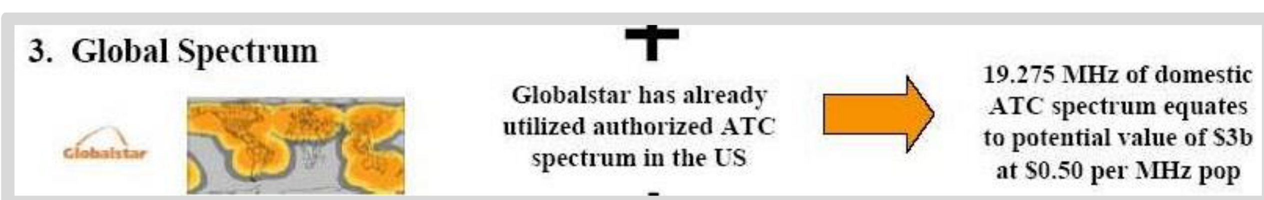
Past Management Guidance Put Far Less Value on GSAT's Spectrum than the Market Does Today

There is no shortage of reasons to question the validity of GSAT's sky-high implied spectrum valuation, but one of the simplest is that *GSAT management itself* previously ascribed a far lower valuation of $2.3-3.0 billion to the same spectrum (at a time when its market cap was substantially lower). Beginning with its 2009 Q3 earnings-call presentation and continuing for the following two quarters, GSAT included in its "Value Drivers" slide the following indication of the "potential value" of its spectrum:



Source: GSAT 2009 Q3 investor presentation, slide 32

This $2.3 billion figure corresponds to a $/MHz-pop value of just $0.40. In 2010 Q2, management quietly bumped up the valuation by $700 million by applying a $0.50/MHz-pop price:



Source: GSAT 2010 Q2 investor presentation, slide 24

Management never discussed these estimates on its earnings calls, and after 2010 Q2 the disclosure vanished. It's easy to see why the company would like to leave such remarks buried: given the tremendous run GSAT's stock price has enjoyed, even these optimistic figures now imply excruciating downside, especially now that the LightSquared precedent has rendered GSAT's 1.6GHz spectrum unusable terrestrially.

GSAT's Previous Attempts at Spectrum Monetization Created Little Value and Ultimately Failed

Unfortunately, investors sometimes have short memories, and GSAT investors are no different. Looking back at GSAT management's past remarks about the value of its spectrum (as shown above), it is interesting to see the claims that "Globalstar has started to monetize authorized spectrum in the US" and "has already utilized authorized ATC [ancillary terrestrial component] spectrum in the US." Though accurate, these comments raise the question of what actually became of GSAT's initial efforts to cash in on its spectrum. The answer is that they failed miserably. In late 2007, GSAT announced an agreement with a start-up firm called Open Range Communications (alluded to briefly earlier), which planned to lease GSAT's spectrum in order to provide wireless broadband service in rural areas. Management touted the great value of this deal on its 2007 Q3 earnings call (emphasis added):

> Open Range has options to increase its coverage up to 50 million people. We believe that based upon Open Range's debt-financing assumptions contained in their RUS [Rural Utilities Service] loan, and based upon the potential fixed and variable payments to be made by Open Range, **the indicated value of this spectrum is between $0.30 and $0.40 per megahertz-pop** over the initial 30-year term. According to the agreement, Open Range's down payment will be $3.6 million, and annual payments in the first six years will grow from approximately $1.2 million to $10.3 million. While this agreement covers only a small portion of our spectrum, **we believe it establishes a framework for how additional spectrum may be monetized**.

GSAT's 2007 10-K, however, was more measured, noting that $0.30-$0.40 (a quarter to a third of] the valuation implied by GSAT's current stock price) was not actually "the indicated value" but the *highest* value that could possibly be achieved (emphasis added):

> Based on Open Range's business plan used in support of its application for a $268.0 million loan under a federally authorized loan program, the fixed and variable payments to be made by Open Range over the initial term of 30 years indicate **a maximum value for this agreement between $0.30—$0.40/MHz/POP**.

Not only did GSAT supply Open Range with spectrum; it also invested $3 million of cash in its equity. By 2010, though, it had written off this investment completely. By October 2011, Open Range was bankrupt and ultimately was liquidated when its stalking-horse bidder backed out. At that point, Open Range had only accumulated 26,000 subscribers – a far cry from the millions that Globalstar had expected.

More important to its failure, though, was the fact that Open Range lost access to the necessary spectrum thanks to GSAT's own operational shortcomings. In general, GSAT's license gives it *no* authority to use its spectrum for purely terrestrial purposes. However, if it complies with certain "gating criteria," including maintaining spare satellites and providing continuously available satellite services in certain geographic areas, then the FCC might permit it to operate an "ancillary terrestrial component" (ATC) consisting of base stations and terminals on the ground that run on the same licensed frequencies. When Open Range and GSAT entered into their agreement, GSAT's satellite constellation was in the midst of a multi-year deterioration of service that necessitated the launch of numerous replacement satellites and resulted in massive customer loss. GSAT was thus unable to meet the appropriate gating criteria, but it pledged to the FCC that it would shortly come into compliance, and on this basis the FCC temporarily waived the requirements. In 2010, however, the FCC lost patience with GSAT's repeated delays and excuses and revoked its waiver, rendering GSAT unable to use its spectrum terrestrially. (Indeed, in its November 2012 petition to the FCC, GSAT pointed out that it still "currently cannot operate terrestrial systems because it does not meet the Commission's ATC 'gating' criteria.") Though GSAT tried to blame uncontrollable forces like an earthquake that struck a supplier's factory, the FCC laid the responsibility squarely on GSAT's shoulders and accused the company of misrepresentation:

> The record shows that Globalstar missed a series of monthly payments to Thales [the supplier] beginning in 2008 and continuing well into 2009. Thus, Globalstar should have known…that its previous representations to the Commission regarding the schedule for deploying 24 second-generation satellites were unrealistic, and that delays were foreseeable.…[D]elivery of the satellites was well behind schedule even before the April 2009 earthquake.…[A] more rigorous in-orbit testing plan and increasing pre-launch processing time seem to be ordinary contingencies of a sort that Globalstar should have anticipated and made allowance for in its initial projections upon which the Commission relied…In sum, we find that Globalstar's failure to deploy 24 second-generation satellites by the July 1, 2010 deadline, and its admitted inability to do so sooner than 16 months thereafter, is due to ordinary contingencies and a shortage of funds that prevented Globalstar from fully meeting its contractual payment obligations, not to circumstances beyond its control.

Thus ended the attempted "monetization" of its spectrum that GSAT had so optimistically promoted just a few months earlier. Indeed, the timing is interesting: after pegging its spectrum value at $0.30-$0.40 per MHZ-pop in late 2007 based on the Open Range deal, increasing it to $0.40 in late 2009, and bumping it again to $0.50 in August 2010, GSAT was publicly taken to task by the FCC in September 2010 and stripped of its ATC authority, after which it never again provided such clear-cut estimates.

We believe that TLPS will be just as much of a commercial disaster as Open Range and will utterly fail to resuscitate GSAT. Even if GSAT were then to seek another bite at the apple with another hare-brained scheme to exploit its spectrum terrestrially, it would still be unable to extract meaningful value from its holdings. There is simply no way out.

V. GSAT's Actual Business Loses Money, Burns Cash, and Will Likely Violate Its Debt Covenants

Since spectrum hype is by far the main driver of GSAT's valuation, it's necessary to address it head on. However, one must keep in mind that this speculative opportunity is tethered to a company that is heavily indebted (even after a prior bankruptcy), constantly incurs losses, consumes cash, and has no clear path to sustainable profitability. Having spent $1.3 billion on capex over the last 10 years, GSAT generates just $18mm of annualized EBITDA, for a gross return on capital of ~1%. Of course, *net* of depreciation, GSAT loses money at a rate of some $70-80 million a year.

While depreciation is, of course, a non-cash expense, it's economically quite important for a satellite operator. This is very clearly demonstrated by GSAT's experience beginning in 2007, when its first-generation satellite constellation began to fail, as announced just a few months after its IPO (triggering shareholder litigation):

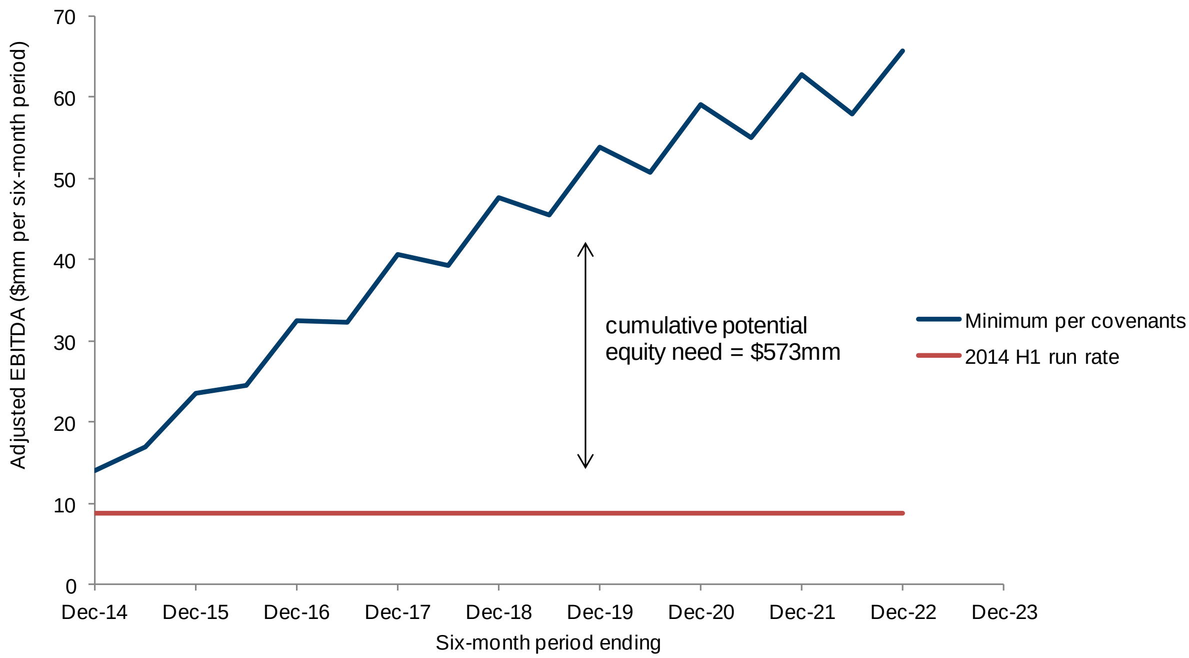
> As previously disclosed in the Company's public filings, a number of its satellites have experienced various anomalies over time, one of which is a degradation in the performance of the solid-state power amplifiers of the S-band communications antenna. … Based on its most recent analysis, the Company now believes that, if the degradation of the S-band antenna amplifiers continues at the current rate or further accelerates, and if the Company is unsuccessful in developing additional technical solutions, the quality of two-way communications services will decline, and by some time in 2008 substantially all of the Company's currently in-orbit satellites will cease to be able to support two-way communications services.

Almost seven years and more than a billion dollars of capex later, in 2013 Q2-Q3, GSAT finally restored its pre-failure service quality and, as a result, has enjoyed a bump in its operational and financial metrics, affecting in particular its "duplex" (two-way) business, including voice, as opposed to purely data, service revenue.

Without an enormous amount of *additional* operational momentum, however, GSAT will face grave difficulties meeting the financial covenants under its credit facility, the most important of which is a detailed schedule of minimum adjusted EBITDA levels over half-year periods starting from 2013 H2 and ending in 2022 H2. For example, for 2014 H1, GSAT had to achieve adjusted EBITDA of $9.9mm (or make up for the difference via an "equity cure contribution" in cash). Based on its own management reporting, GSAT actually *missed* this target by $1.1 million; however, minor recurring and non-recurring discrepancies between EBITDA as defined under the debt facility and EBITDA as defined by management were enough to bail the company out.

But the challenges do not stop with the second quarter. For instance, by the second half of 2015, GSAT's adjusted EBITDA must be 137% higher than the 2014 H1 minimum target in order to meet its covenants (or else make an offsetting cure contribution). The full range of semi-annual minimum covenants is illustrated below, along with the company's actual run-rate performance as of 2014 H1:

GSAT Minimum EBITDA Covenants, 2014-2022



Source: COFACE Facility Agreement §20.3, Kerrisdale analysis

As indicated on the graph, if GSAT were to hold constant its current level of adjusted EBITDA through 2022 and thus violate its covenants, the cumulative amount of cash equity it would need to raise to cure the repeated covenant violations would be almost $600 million. At the risk of stating the obvious, going from GSAT's current low run-rate EBITDA all the way up to its lofty out-year minimum requirements doesn't look easy.

Recall, though, that these are the *minimum* requirements. As part of its debt restructuring, GSAT also submitted to its creditors a set of very specific "Projections" under an "Agreed Business Plan," and it appears that these projections formed the basis for the EBITDA covenants, since the covenant levels are all (on a full-year basis) exactly 80% of the "Business Plan" levels. Since GSAT is not on target to achieve even its minimum covenants, it's wildly off target relative to this business plan. Still, it's worth considering these projections – freely accessible as an appendix to GSAT's July 2013 Global Deed of Amendment and Restatement (Schedule 9) – as a way to assess how much upside there might be if GSAT's satellite business can somehow hit its targets. Below we summarize the projections and extrapolate them out three years to 2025, at which point, based on the 15-year design life of GSAT's second-generation constellation, its satellites will no longer function. Thus, there is no terminal value.

GSAT's Own Business Plan Implies Almost No Equity Value

		GSAT projections, July 2013									Extrapolated values		
($mm)	2014 H1 run rate	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023E	2024E	2025E
Revenue	89.1	114.9	141.8	169.5	195.3	218	238	255.7	268.9	279.4	290.3	301.6	313.4
% growth		*39%*	*23%*	*20%*	*15%*	*12%*	*9%*	*7%*	*5%*	*4%*	*4%*	*4%*	*4%*
Adj. EBITDA	17.6	30.0	50.5	71.2	91.1	108.8	124.2	137.4	147.3	154.7	162.5	170.6	179.2
% growth		*-9%*	*68%*	*41%*	*28%*	*19%*	*14%*	*11%*	*7%*	*5%*	*5%*	*5%*	*5%*
OCF (ex. interest)	25.4	40.1	56.1	72.4	91.2	109.2	124.5	138.3	148.1	155.5	163.3	171.4	180.0
% growth		*n/m*	*40%*	*29%*	*26%*	*20%*	*14%*	*11%*	*7%*	*5%*	*5%*	*5%*	*5%*
Capex	-26.4	-38.5	-17.1	-12	-2.4	-2.4	-2.4	-2.4	-2.4	-2.4	-2.4	-2.4	-2.4
Unlevered FCF	-1.0	1.6	39.0	60.4	88.8	106.8	122.1	135.9	145.7	153.1	160.9	169.0	177.6

Discount rate	8%
NPV of unlev. FCF	750
Less: net debt	545
Equity value	204
Fully diluted shares	1,187
Value per share	**$0.17**

Source: Global Deed of Amendment and Restatement (Schedule 9), Kerrisdale analysis

Under these stupefyingly bullish projections, GSAT's revenue grows by a factor of 3.5x relative to the current run rate and 2x relative to the all-time high in 2006; adjusted EBITDA likewise grows by a factor of 10x relative to the current run rate and 5x relative to the all-time high in 2006. Even so, and even using a discount rate of just 8%, *the equity value is only ~$200mm, implying a per-share value of just $0.17.* Again we see quite starkly just how badly GSAT's valuation depends on the baseless expectation of a titanic spectrum windfall.

Iridium Precedent Highlights the Risk of an Equity Raise

Equity investors may not care about the fate of GSAT's satellite business or the trajectory of its cash flow, but GSAT's creditors certainly do, and they may be far less content to wait for the company's spectrum scheme to bear fruit. A noteworthy case study on the impatience of COFACE, the French credit insurer, comes from GSAT's larger competitor Iridium. In 2013, Iridium began to declare publicly that it would struggle to meet the unrealistic EBITDA and other financial targets embedded in its credit facility, which, like GSAT's, comes from a syndicate of banks and is guaranteed by COFACE:

> We expect to need modifications to the Credit Facility from our lenders for some financial covenants with measurement dates beyond the next twelve months, and there can be no assurance that the lenders will agree to such modifications.

After prolonged negotiations, Iridium did manage in early May to amend its COFACE facility, but the amendment was conditional on raising "at least $217.5 million through the sale of equity securities" within the subsequent two months (which the company did). Iridium is profitable and a market leader, yet lenders insisted on a more robust equity cushion to compensate for the firm's failure to achieve its required EBITDA levels fast enough. For GSAT, a marginal and loss-making competitor, it's hard to imagine why lenders would be any less exacting, raising the risk that as GSAT misses its targets it will be forced to issue more shares.

VI. Conclusion

Spectrum hype has an ignominious history in financial markets. In 2011, Clearwire told investors that its spectrum was worth $0.50 to $1.00 per MHz-pop; in 2013, Sprint bought it for just $0.30. When Clearwire management had to explain the discrepancy, it noted that buyers just weren't very interested:

- 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

Source: Sprint/Clearwire investor call, December 17, 2012

Similarly, in 2006 the sell-side firm Jefferies argued that the spectrum holdings of both TerreStar and DBSD, two satellite operators, were worth at least $0.50 per MHz-pop. By 2010 both firms had filed for bankruptcy and were ultimately purchased by DISH for $0.13-$0.15 per MHz-pop.

LightSquared is perhaps the most prominent case study in failed spectrum speculation. Though the final conclusion to that tale has yet to be written, what's clear is that experienced investors poured billions of dollars into an unworkable scheme, and many of them are unlikely to ever recover a cent.

Now, the spectrum hype machine has roared back into action, and GSAT shareholders have benefited massively, with the company's stock price rising 856% over the past eighteen months. But GSAT's spectrum story is just that: a story, a work of fiction – and not a very compelling one either. TLPS is premised on a non-existent Wi-Fi congestion crisis that it would not even improve, and GSAT has only gotten away with depicting TLPS as a lucrative leap forward because of investors' ignorance of basic Wi-Fi mechanics and trends. It is ludicrous to equate GSAT's spectrum with far higher-value assets held by others, but even if one ignores every single reason to draw that distinction, GSAT's equity is still almost worthless.

With over $500 million of net debt and an unprofitable core business, GSAT needs more than stories to keep the lights on. If the FCC issues a final rulemaking permitting TLPS to go forward, the hype machine may kick into even higher gear, but as the hopelessness of GSAT's terrestrial ambitions becomes unmistakable, investors will finally come to their senses, and GSAT, which has lived on borrowed time and fed off market gullibility and greed for so long, will once again make contact with reality.

VII. Full Legal Disclaimer

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