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Globalstar TLPS

You're Kidding, Right?

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Globalstar TLPS: You're Kidding, Right?

Globalstar is lobbying hard with the FCC for its Terrestrial Low Power Service (TLPS). After reviewing publicly available materials (presentations, webinars), I have concluded that, despite Globalstar's posturing, the "TLPS solution" has reasonable applicability only in a very small set of use cases. The core idea is technically unsound and makes little sense.

What's the Big Idea?

Most of us are familiar with the old saying "follow the money." If you really want to understand Globalstar's motives, that's exactly what you have to do. If Globalstar gains exclusive access to the requested spectrum (2.473 – 2.495 GHz), and the FCC doesn't put some severe technical limitations on its use, Globalstar will use it for whatever they like – without consideration for others. They are proposing a one-channel Wi-Fi infrastructure (Wi-Fi's Channel 14) and want their own private spectrum to do it. Globalstar initially requested exclusive rights to 22MHz of spectrum citing possible use for LTE and various other unspecified technologies. The FCC seems not to have responded to that request.

Globalstar's next request for the exclusive use of this spectrum, seemingly in an attempt to leverage Wi-Fi's global popularity, was called "Globalstar's New Wi-Fi Super Highway" and is proposed to use standard Wi-Fi access points. Perhaps Globalstar's team was trying to take a page out Yoplait's strategy playbook.

> ***Important Note**: Since Globalstar is proposing to offer global services within the channel 14 region of spectrum, it's important to note that some countries only allow specific modulation types within certain frequency ranges. For example, Japan only allows 802.11b (DSSS & HR/DSSS with BPSK) in channel 14. It's unclear whether unlocking channel 14 on client devices would yield anything better than 802.11b (now obsolete) in some regulatory domains.*

There seems to be no doubt that a one-channel, Wi-Fi based offering is their goal, as in recent comments to the FCC, Globalstar states:

> *TLPS operations on Channel 14 are clearly consistent with the IEEE 802.11 standard, which provides for the use of Channel 14 at 2473-2495 MHz and thirteen other 22 megahertz channels across the 2.4 GHz ISM band.*

Globalstar made an amazingly inaccurate statement in their original presentation:

> *…with Spectral Efficiency Many Times That of Public 802.11 Applications.*

Not so fast, fellas... The Spectral Efficiency of public Wi-Fi channels in most locations is amazingly high. The non-overlapping channels of 1, 6, and 11 are used almost everywhere, nearly around the clock, to the point where near-saturation is often the norm. Efficiency isn't just about reducing overhead, but also about maximizing use. How long would it take Globalstar to build a global customer base that could produce spectral use to rival 15+ years of public Wi-Fi sprawl? Eons.

Realistic Use Cases?

One thing that TLPS may have going for it would be its low barrier-to-entry in terms of getting support from user devices. Nearly all smart phones, tablets, and computers manufactured since the early 2000s have had 2.4GHz radios embedded. Globalstar is banking on the fact that a large percentage of these mobile devices will be software upgradable/unlockable such that they can use channel 14. The same client devices, having the same embedded 2.4GHz (or dual-band) radios, are manufactured for global use in most cases. The only difference between devices shipped to various global regions is the software drivers that lock and unlock the available channels depending on the regulatory requirements of the region where they are being sold. To summarize, manufacturers only need to update their chipset drivers to unlock channel 14. This approach could, however, be stymied by hardware filtering on the client device. If the filter device starts its filtering at frequencies below channel 14, the device user is out of luck.

The Basic Problem: A One-Lane Road Is Not A Super Highway!

Such a small swath of spectrum will not support effective channel reuse, which is the single most important driver of Wi-Fi spectrum capacity. Globalstar is pitching a one-lane road as a *super highway*, and regardless of how clean channel 14 may be in any physical or geographic area, there is only one way that such a *super highway* assertion could be applicable: highly-distributed environments like in-home femto cells where Access Points on channel 14 would be less likely interfere with themselves.

Scaling a one-channel offering would be very difficult, if not impossible, in multi-tenant buildings (commercial or residential) and most corporate environments, due to co-channel contention. A borderline viable use case might be to move ALL enterprise Wi-Fi users to 5GHz and then configure all 2.4GHz access point radios to channel 14 for low-bandwidth, application-specific use (e.g. Voice over Wi-Fi (VoWiFi), Wi-Fi based location-tracking services such as Ekahau and AeroScout, bar code scanners, and similar). The primary issue with that approach is that there would be no radios for 2.4GHz-only devices on channels 1-13 without implementing two separate infrastructures (aka an *overlay design*, discussed below).

2.4GHz frequencies penetrate obstacles quite well, which causes them to often be in contention with themselves (non-WiFi interferers left for another discussion) in any kind of uncoordinated, contention-based system such as when using the IEEE 802.11 protocol. Contention avoidance comes only by very careful design, deployment, and testing, which Globalstar could have no intention of doing due to the overwhelming costs of large numbers of highly-trained field engineers.

Futile Marketing Spew

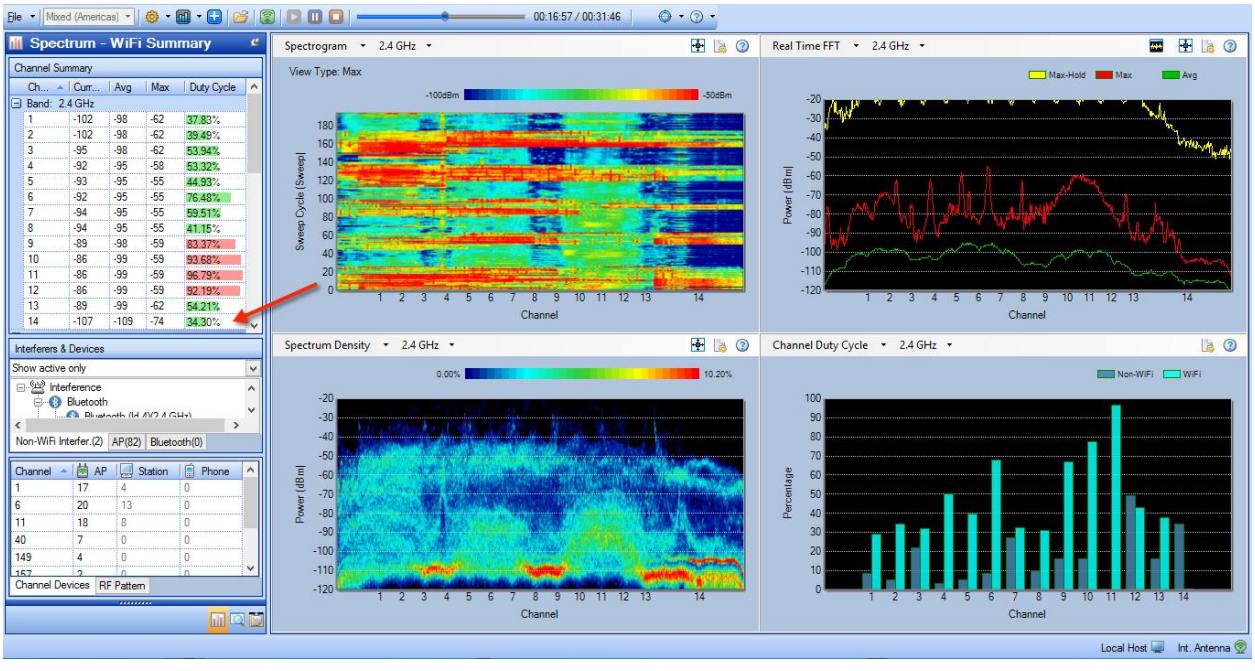
Their marketing of TLPS is right about one thing: *2.4GHz is toast*. However, they seem to be using that message as a rallying cry to get a large group of sheeple to buy into the idea that a one-lane, 22MHz "super highway" is the saving grace of our spectrum woes. Having worked in Wi-Fi for 15 years and in RF since 1988, I think this notion is beyond silly.

I applaud that Globalstar will do whatever it can to maximize use of channel 14, but no matter what adjustments and/or enhancements they make, it won't be enough. While Ruckus's smart antennas are great for interference rejection, and their AP performance is top-notch, they are still required by God to abide by the laws of physics - no exceptions. There's only so much data you can get across

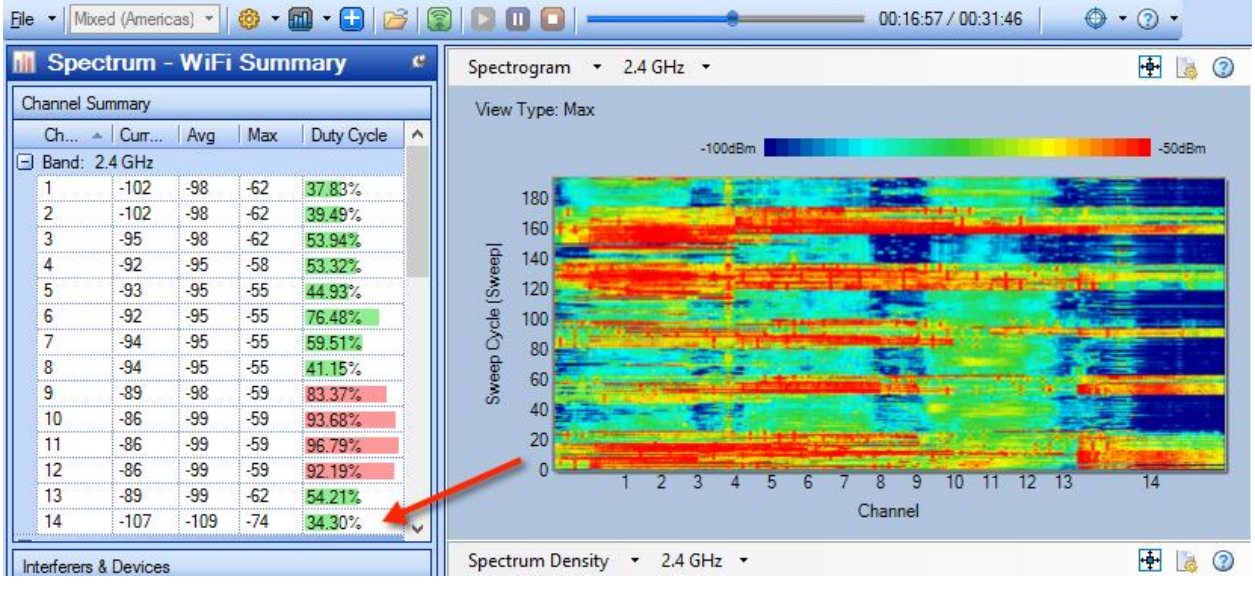
a channel before you run out of usable airtime, and trying to reuse a channel over and over when the penetration characteristics of the channel's frequencies are so high is a futile effort. Been there, done that.

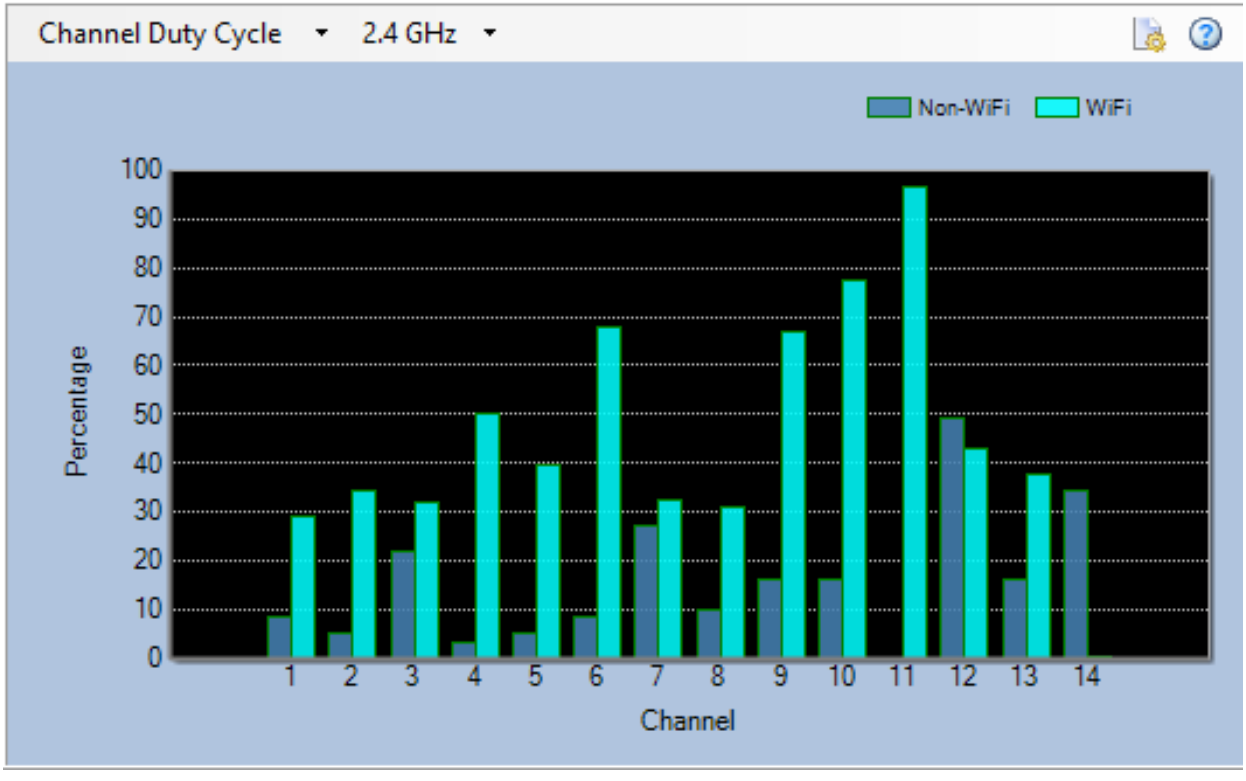
The Technical Facts

Let's see a recent visual example (taken by me less than 30 days ago in an office building on the outskirts of Atlanta) of how channel 14 is trampled upon by non-WiFi transmission sources such as cordless phones and headsets. As you can see in the spectrum analyzer screenshot below, all legal 2.4GHz Wi-Fi channels (1-11) are experiencing high or saturated utilization (i.e. "duty cycle"), and channels 12-14 aren't looking too healthy either. Whether or not such transmission sources *should* be using channel 14 is questionable, but the reality is that they actually do use it.



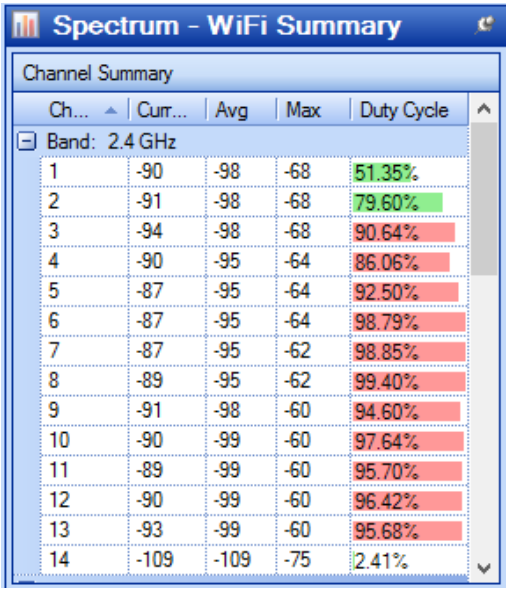
The screenshot above shows the channel utilization (duty cycle) of channels 1-14 in a variety of ways. The most important are the Channel Summary, Spectrogram, and Channel Duty Cycle, so let's zoom in on them, shall we?





When considering the launch of a global managed service offering based on a single channel having enough capacity, perhaps it would be wise to consider devices like older, leaky microwave ovens and high-power 800MHz transmitters (large harmonics across the 2.4GHz band), and those pesky FHSS headsets. To such devices, the entire 2.4GHz band, not just channel 14, is a meaningless afterthought.

Just how bad can it get? Channels 1-13, even in the US where use of channels 12 and 13 aren't allowed for Wi-Fi connectivity, can be utterly saturated, and with the coming of IoT and endless numbers of non-WiFi interferers, channel 14, whether "protected" by FCC rules or not, will die a horrible death. Take a look at the screenshot below, taken within the same office environment as the previous captures.



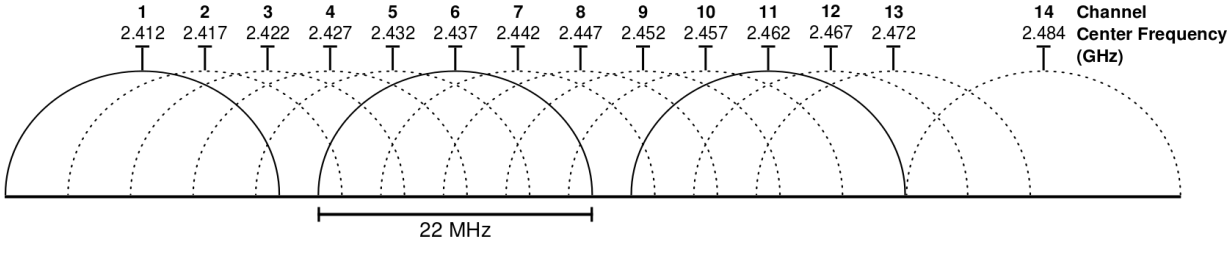
Ch...	Curr...	Avg	Max	Duty Cycle
Band: 2.4 GHz				
1	-90	-98	-68	51.35%
2	-91	-98	-68	79.60%
3	-94	-98	-68	90.64%
4	-90	-95	-64	86.06%
5	-87	-95	-64	92.50%
6	-87	-95	-64	98.79%
7	-87	-95	-62	98.85%
8	-89	-95	-62	99.40%
9	-91	-98	-60	94.60%
10	-90	-99	-60	97.64%
11	-89	-99	-60	95.70%
12	-90	-99	-60	96.42%
13	-93	-99	-60	95.68%
14	-109	-109	-75	2.41%

Gee, I wonder why this customer's 2.4GHz Wi-Fi wasn't working so well? In this screenshot, channel 14 got lucky. This physical area of the building didn't have significant channel 14 interference, but many areas did. I don't know about you, but seeing the spectrum in this condition made me laugh.

Time for my one shameless plug:

> ***If your Wi-Fi performance isn't where you want it to be, contact Divergent Dynamics for a free 1-hour consult – no strings attached.***

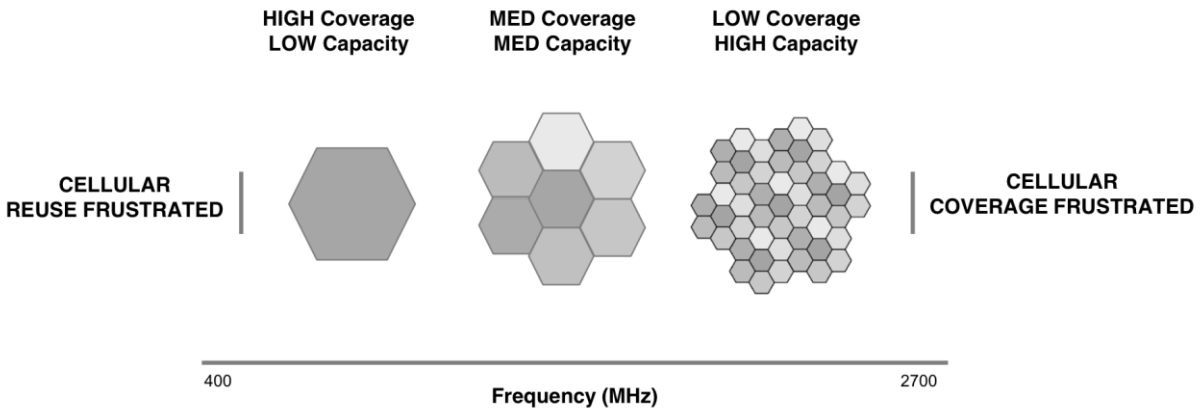
As you can see from the Wi-Fi channel list below, channels 12 and 13 both readily overlap with channel 14. Having just visually proven that channels 12, 13, and 14 experience a tremendous amount of interference, and keeping in mind that channels 12 and 13 are allowed by some regulators around the globe for Wi-Fi connectivity, the technical merit of using only channel 14 doesn't hold up under even the lightest scrutiny.



Credit: Wikipedia

In their webinar, Globalstar asserted that cross-channel interference is rare due to out-of-band emission limits. This is absolutely not the case, and I explain why in this blog. Depending on the variables that I address in this video, channels 1 and 11 can easily interfere with each other, and I have witnessed it first hand many times. While teaching early CWNP classes, we used to build adjacent channel interference (ACI) labs in class, and students were always shocked to see channels 1 and 11 interfere with each other. In my experienced opinion, channels 11 and 14 would commonly interfere with each other in the real world due to these same deployment variables.

Globalstar calls TLPS a *Wi-Fi Super Highway*, but in their own documents (see figure below) illustrate that a one-channel offering is doomed to low capacity due to no channel reuse in the same physical area. The only reuse possible is by geographically dispersing each access point (e.g. small distributed enterprises and homes).



Credit: Globalstar

Single Channel Architecture (SCA) Is A Bust

There are only two SCA-capable vendors in the market today. One of them has essentially abandoned its decade-long attachment to SCA in favor of Multiple Channel Architecture (MCA) in enterprise environments due to its scalability and robust interference avoidance capabilities. The other has near-zero market share, has a less robust solution, and sells mostly into highly-niche environments.

Using a single channel, no matter how clean that small swath of spectrum or how coordinated the network operating system may be, there is simply not enough spectrum to scale voice, video, or data in any meaningful way. It's for this reason that even SCA vendors now regard SCA as a niche feature rather than an architecture unto itself.

When both modulated and unmodulated interference is minimal, 22MHz of spectrum could support a reasonable number of voice calls. The industry best practice for VoWiFi is no more than 7 simultaneous calls per AP due to limitations in the standard quality of service (QoS) mechanism, called Wi-Fi Multimedia (WMM). VoWiFi density can be increased beyond 7 simultaneous calls per AP of course, but only to a limited degree and with quality repercussions both to coexisting data flows and VoWiFi calls on the same AP.

It seems like an exceedingly inflexible and limiting network design move to change all of the 2.4GHz radios across an enterprise to 2.4GHz and then implement SCA technology. All scalability would be lost, and 2.4GHz would be useful only for specific, low-bandwidth applications such as voice, RTLS, and similar.

Overlays Are Expensive

One of the issues that has plagued the Wireless Intrusion Prevention System (WIPS) market for years is the cost of deploying the sensors alongside access points in a one-to-many design. Sensors, cabling, Ethernet ports, power, and deployment manpower all have associated costs, so over the last decade, we have seen WIPS get mostly integrated into Wi-Fi infrastructure systems as a set of features rather than a hardware/software combination solution. This approach has its downsides, but it fixed the cost issue well enough.

Globalstar's approach to deploying channel 14 everywhere is similar. If an enterprise already has dual-radio access points deployed, and they are feeling the spectrum squeeze in 2.4GHz, Globalstar

would be asking them to give up channels 1, 6, and 11 in favor of channel 14 only. That doesn't make any sense. The most logical and cost-effective move is to migrate as many client devices as possible to 5GHz, leaving 2.4GHz only for those legacy devices that don't support 5GHz. The next step would be to transition those legacy Wi-Fi client devices out of the network altogether, making even more room in the 2.4GHz spectrum for non-WiFi devices.

5GHz Spectrum Is Better

Globalstar touts in its June 2013 presentation that its "Near Term Plan" includes:

> *"providing 20,000 TLPS-capable access points to schools, libraries, hospitals, and/or other special interest organizations."*

These organizations don't need channel 14, and as a network architect, I recommend that my clientele move away from 2.4GHz, and onto 5GHz, as expeditiously as possible due to broad spectrum availability (25 channels now, and 12 more proposed), lower utilization (practically zero in most places), lesser penetration (which is fantastic for enterprise Wi-Fi deployments), and higher capacity (who doesn't want higher capacity?). With K-12's 1:1 initiatives, libraries becoming social technology hubs, and hospitals moving toward new business models (e.g. integrating retail) that increase Wi-Fi capacity needs, a single 2.4GHz channel will not only add zero value, but will in fact steer these organizations toward a much higher cost by keeping 2.4GHz radios enabled when they should be removed.

It is well documented that most (80% or more) Wi-Fi connectivity issues arise due to client device, not infrastructure, problems. A large portion of these client device issues are directly related to poor 2.4GHz connectivity, which is something that adding an additional channel will not help. Speaking as an experienced network designer, 2.4GHz should be left for non-WiFi devices such as Bluetooth, Zigbee, Cordless phones, and their ilk. 5GHz UNII bands are practically unused in comparison to 2.4GHz. Why not then move to 5GHz since it's already in place in these enterprises?

Why is Globalstar so concerned with using 2.4GHz in particular? The real answer is that 2.4GHz is all that Globalstar has. That's where the spectrum that it uses for its satellite phones sits. However, this rationally points to two additional reasons that could make sense:

- The sheer number of global customers that could use it with existing client devices (*assuming that they can overcome the filtering and modulation restrictions previously mentioned*)
- The penetration characteristics of 2.4GHz (e.g. 1 Femto-cell Per Home, instead of 2+).

If Globalstar were concerned with system-wide capacity and channel reuse, as is required in enterprise environments, it would be focused on using 5GHz instead of 2.4GHz. Globalstar readily admits being heavily focused on the US market, and the US market is ahead of most markets regarding new technology adoption. New Android and Apple mobile devices (e.g. phones & tablets) all have 5GHz capability, and most new laptops do as well. In its June 2013 presentation to the FCC, Globalstar tries to downplay this with a blatantly incorrect assertion:

> *Also, the physical and technical limitations that are inherent in the other bands under consideration --- 3.5, 5.0, and 60 GHz--- make them a poor second choice for the mobile broadband experience that consumers have come to enjoy and expect over the 2.4 GHz band.*

Regarding 5GHz, nothing could be further from the truth. They threw three distinctly different frequency ranges into one bucket and called it *bad*. 5GHz is well suited to most enterprise environments, and is suitable for most homes as well. Apple, Linksys, DLink, TrendNet, NetGear, Buffalo, and their dozens of ilk in the consumer Wi-Fi market have been offering 5GHz capable consumer-grade Wi-Fi for well over a decade. Why work so hard to get 22MHz of spectrum that already has some amount of interference when you can so easily move to sparkling clean 5GHz UNII bands where there are currently 25 available 20MHz channels (with 12 likely on the way!) that can be aggregated into 40MHz, 80MHz, and 160MHz channels? From a technical perspective, their proposal (and supporting points) doesn't add up. Another wild assertion:

> *TLPS creates a carrier resource that secures 2.4 GHz performance indefinitely.*

Hardly. Owning and strictly operating a tiny little patch of spectrum (2.473 – 2.495 GHz) doesn't mean that Globalstar will save us all from certain spectral destruction. They're right that the move from 2.4GHz to 5GHz in Wi-Fi is fueled by a near-saturated spectrum, and luckily for everyone, the FCC and Wi-Fi Alliance are both well ahead of that curve. One 22MHz channel, regardless of protocol type or quality, is not the end-all, even if there were no meaningful interference (which I've just proven that there is). It's an unrealistic notion altogether.

What Does the Wi-Fi Alliance Think?

The Wi-Fi Alliance, with its myriad Wi-Fi centric members, seems pretty dead-set against Globalstar's move on channel 14, citing:

- Filtering issues
- Potential loss of Wi-Fi's channel 11
- Potential loss of upper 2.4GHz band by Bluetooth (& Bluetooth Low Energy) and other future technologies
- Diminished use of 2.4GHz ISM commons
- Inconsistencies with globally-harmonized rules (which could harm manufacturers)

In a nutshell, they don't like it. Neither do I.

Conclusion

FCC should reject Globalstar's request because it's potentially harmful to the industry, their proposal rationale contradicts itself, and their proposal has minimal technical merit in proposed use cases.

Additional Information

You can find additional information on the current state of the 2.4GHz ISM band at http://DivDyn.net in my new whitepaper called ***2.4GHz is Dead***.

Disclosure

I've provided consulting services for a client who is short Globalstar shares.