To: NTIA National Spectrum Strategy

Fr: Richard Bennett, High Tech Forum

Subject: Request for Comments on Implementing the National Spectrum Strategy

The National Spectrum Strategy fails to pay significant attention to the research priorities for improving and disciplining spectrum use by government incumbents, chiefly the Department of Defense. It's not enough to merely identify bands for study, the strategy needs to dig deeply into the technical aspects of present systems.

The Defense Department has a history of dragging its feet on increasing the efficiency of its spectrum-based systems while touting highly speculative moon-shot programs such as JTRS and CBRS that fail to materialize as valuable, functional systems. Effectively, this approach to spectrum amounts to running out the clock while leaving legacy systems in place.

DoD needs guidance from spectrum experts who are not on its payroll and who don't have vested interests in maintaining the status quo. ITS and the FCC have spectrum experts on staff already, but their effectiveness is limited by DoD insistence on confidentiality and by DoD's internal culture of self-protection.

Rather than launching ever more studies with open-ended objectives, government incumbents need to start with a blank sheet of paper and determine the best ways to accomplish mission objectives with current and near future technologies.

Questions

- Is it necessary to operate military radar on exclusive spectrum bands, or could it piggyback on commercial systems?
- Is it wise to train in the US with pristine spectrum when overseas combat takes place in entirely different conditions?
- Is it better to disguise military communication with drones and LEO satellites as ordinary commercial communications or to make it stand out for what it is?
- Do we have means for jamming enemy communications without harming allied signals?

The following post from High Tech Forum expands on these themes. The bottom line is that the focus on study means we are not placing enough emphasis on the directions and objectives of improving incumbent systems.

The issue isn't which bands to study, it is which applications are most in need of improvement. Instead of an analog focus on bands and frequencies, the strategy needs to lean into coding and modulation.

Best regards,

Richard Bennett, Wi-Fi Pioneer

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DoD Drags Down the Spectrum Strategy

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A telecommunications revolution is underway, with wired networks giving way to wireless ones. Wire will not be eliminated, as it has a vital role to play in knitting wireless footprints into a coherent whole. But wireless is ascendant as the technology of choice at the network edge.

This being the case, the right to access radio spectrum is under increasing stress. Every application that seeks to use the wireless edge has to contend with the demands of every other application. Regulators have the unenviable – but vitally important – task of mediating competing demands for spectrum rights. They have precious little sound historical precedent to guide them.

In the US and elsewhere, the spectrum management dilemma is muddied by history. 100 years of spectrum rights assignment to a variety of uses over a multitude of assignment methods and strategies has resulted in a messy and effectively random system rife with interference and inefficiency.

NTIA's National Spectrum Strategy

The US National Spectrum Strategy (NSS), recently published by NTIA, is an attempt to impose some order on this nightmare of a system. This 23-page document grasps dynamism as a compass; it mentions "dynamic spectrum sharing" nine times, "dynamic" 24 times, and "sharing" 37 times. It makes study recommendations for dynamic use of five swathes of spectrum but no assignments.

Its unstated assumption is that dynamic spectrum sharing makes the whole greater than the sum of the parts, thus alleviating the scarcity that bedevils spectrum-dependent use cases. If this approach were fruitful, the hard choices that rob Peter to pay Paul could be circumvented as the pool of available, shareable spectrum would be effectively bottomless.

This is wishful thinking.

A Political Problem

NTIA seems to offer a political solution to problems that appear to be technical and economic in nature, never a wise move. While there is a political dimension to all Washington, DC issues, spectrum stakeholders expected a deeper analysis from an agency noted for its technical prowess.

The NSS echoes the infamous PCAST Report of 2012, "Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth". The PCAST report, controlled by business leaders seeking defense contracts, assumed that the demand for spectrum rights would outstrip the capacity of the traditional systems of licensing by rule or by auction, so a new approach was needed.

This approach was "new spectrum-sharing technologies" of an unspecified nature. It ultimately gave us CBRS, the controversial and somewhat dysfunctional system that left control over sharing in the hands of government incumbents, chiefly the Pentagon. It wasn't especially dynamic either.

What is Dynamic Spectrum Sharing Anyway?

The NSS doesn't offer a coherent definition of DSS – the closest it gets is a definition of dynamic spectrum management, to wit:

> *The U.S. Government also will promote and facilitate the research community's continued exploration of dynamic and secure spectrum sharing to improve coexistence among spectrum utilizing systems (e.g., radar, passive scientific measurements, and wireless broadband communications technologies) and to advance the effectiveness of dynamic spectrum management systems (e.g., Spectrum Access Systems and Automated Frequency Coordination).*

This says Dynamic Spectrum Management follows the CBRS model, with a permission database (Spectrum Access System) and some sort of coordination system. That's not the way things work in dynamic commercial systems.

Dynamic Spectrum Sharing in Practice

The major wireless carriers in the US all use DSS in the day-to-day management of their networks to accommodate 4G LTE and 5G New Radio (NR.) Samsung has written a nice white paper on how it works, aptly titled *Technical White Paper: Dynamic Spectrum Sharing*.

> *…LTE-NR spectrum sharing emerges as a technology that allows service providers to deploy LTE and NR in the same carriers and bands. That is to say, spectrum sharing enables both LTE and NR to be simultaneously deployed and share resources in the carrier, as shown in Figure 2. The time-frequency resources in the carrier are dynamically assigned to either LTE or NR according to their respective traffic demands. This dynamic allocation is known as dynamic spectrum sharing (DSS). In an early NR market, DSS is advantageous in that it allocates only the required amount of time-frequency resources to the few NR users, and reserves the remaining resources for LTE services. Over time, as the number of NR users increases, DSS accordingly allocates the required resources for NR purposes. In turn, this flexible spectrum sharing solution allows for a smooth 5G migration.*

So here we have spectrum sharing between 4G/LTE and 5G/NR on a dynamic basis. Instead of dedicating separate radio channels to the two use cases, a single channel is shared in the channel's time domain. This is distinct from exclusive, non-shared use and is also distinct from static resource assignment.

CBRS is Static Sharing

CBRS is a three-tier system in which spectrum either *belongs* to the government incumbent, to a Priority Access License holder, or to the public to use opportunistically like Bluetooth or Wi-Fi. Allocation by tier is effectively static, apart from the right of the government user to pre-empt the other tiers as it deems fit.

That's a kind of sharing, but the only thing dynamic about it is the use case in which the government overlord is idle and no license has been purchased. Sharing thus takes place on a day-by-day basis or, optimistically, hourly.

Truly dynamic commercial sharing is only possible because the spectrum resource being shared is managed by a single control point. LTE and NR signal their desire for transmission rights to a common spectrum manager who mediates their access on a millisecond-by-millisecond basis. CBRS can't do this because its latency is several orders of magnitude greater than that of a dynamic system.

It's About Efficiency

Dynamic spectrum sharing is alluring for two reasons:

1) It promises to make more spectrum available to more use cases by eliminating dead time; and
2) It makes difficult questions about whose use case takes priority over the others moot. Everybody gets what they want!

DSS has the capacity to marginally increase the pool of useable spectrum, but it's a stretch to imagine that it can solve disputes over spectrum rights once and for all. In its current state it certainly can't.

NTIA realizes this and therefore advocates for research on more advanced spectrum sharing techniques. That's about half right because we can share spectrum more effectively but the means to do that don't necessarily come from real-time reallocation.

The Real Problem is Interference

In a perfect world, spectrum users would be able to shape their signals such that they can only be seen and decoded by their intended recipient. We might have a dozen spectrum conversations taking place in one place at one time over one frequency when we can cloak transmissions from random receivers while making them clear to their intended audience.

That sort of perfection will be achievable someday, but not by DSS. Rather, it will come about by signal manipulation. DSS is at most a stopgap that enables more use cases that have the capability to cause interference to be packed into today's spectrum bands.

The long-term goal of spectrum research is therefore to make DSS unnecessary. But we nevertheless need better ways of implementing it than we currently have. True dynamism is an important short-term goal. NTIA shouldn't be so enamored with short-term solutions or with non-solutions such as spectrum access systems and automated frequency coordination.

The Good News

While the NSS splashes about in the DSS pool, a current of coexistence runs through the document with 11 mentions. The underlying message is: "Evolving to a "designed to share whenever feasible" mindset will accelerate efficient and effective use of spectrum for all users."

This is something we can act on as a nation immediately. While the Strategy pretends that commercial use cases need incentives to use spectrum efficiently and reliably, they already have them in the form of license fees.

The sector that gets its spectrum for free is the one that lacks incentives for robust, efficient systems that may well have a higher purchase price than bargain basement models. Spectrum mavens already know that government (esp. Pentagon) procurement practices need drastic reform when the equipment in question uses spectrum.

The Lower 3 GHz Band

The lower 3 GHz band is a stark example of incentives. The private sector wants to use this band for 5G in the U. S., as it is in 50 other countries. The Pentagon wants to continue using it for military radar, the most primitive use of spectrum in the whole toolkit.

CTIA has done a coexistence study demonstrating that the feasibility of sharing at least part of this band for radar and 5G:

> *The global communications industry has aligned on the lower portion of the 3 GHz band—3300-3450 MHz—as a core 5G workhorse, providing the capacity needed to connect the industries of the future. Nearly 50 countries are already using full-power 5G networks in the lower 3 GHz band, with even more planning to do so soon. Over 70 countries in total are planning for or using 5G in this band. More than 30 of those countries feature 5G deployments that are successfully coexisting with the same U.S. military radar systems that are used domestically, strongly suggesting that 150 megahertz of full-power, licensed spectrum can be made available from 3.3-3.45 GHz in the U.S. without risking harmful interference to military systems*.

For equipment portability and interoperability reasons, it's important to harmonize spectrum assignments globally. But the Pentagon is skeptical of the findings of CTIA, GSMA, CCS Insight, and DLA Piper, separately and *in toto*.

The Pentagon Doesn't Want to Share

The Pentagon study of the band is classified in part, so its reasoning is hard to verify. We do know that Sen. Mike Rounds, the Pentagon ally who was instrumental in ending the FCC's auction authority, has told Axios that the Pentagon doesn't want to play ball.

The NSS and testimony by Administrator Alan Davidson on Tuesday, December 5, 2023 commit to continuing to work with the DoD to free this band for public use, but the issue is unlikely to be resolved for at least two years. The Pentagon hints that interference mitigation, rather than DSS, is the gateway to sharing this band, but NTIA's NSS holds out hope for DSS:

[https://youtu.be/1u-N1Zh34mg]

> *DoD determined that sharing is feasible if certain advanced interference-mitigation features and a coordination framework to facilitate spectrum sharing are put in place. The Departments of Commerce and Defense will co-lead any follow-on studies to the Emerging Mid-band Radar Spectrum Study (EMBRSS) that focus on future use of the 3.1-3.45 GHz band. Additional studies will explore dynamic spectrum sharing and other opportunities for private-sector access in the band, while ensuring DoD and other Federal mission capabilities are preserved, with any necessary changes.*

DSS is not going to happen in this band, but we may get a static sharing system that NTIA characterizes as DSS. The Pentagon knows what it has to do because its B-21 Raider has blazed the trail. The problem is the aging inventory built on worst practices. (Hmm…what can the US do with obsolete warfighting equipment?)

We Have a Long Way to Go

While NTIA is nominally in charge of managing government spectrum, the real decision makers are in the Pentagon. NTIA has identified many of the bands that deserve study, but these studies are worthless if they don't lead to action. The Pentagon's history with radio frequency spectrum doesn't inspire confidence. As we explained in 2020:

> *DoD has been fascinated with magic radios for a long time. In 1997, it launched the 15 year Joint Tactical Radio System project to create one radio to rule them all. Rather than making radios tailored to applications operating with known parameters on a defined set of frequency bands, JTRS was supposed to be a software-based radio that could be all things to all applications in all terrains.*
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> *After pouring $6B into this project, the Pentagon purchased 100,000 JTRS-compliant radios that took ten minutes to boot and could only operate on battery power for 30 minutes. The prototype for JTRS, the 1991 SpeakEasy Multiband Multimode Radio (MBMMR) Program, managed to fill the back of a truck with a single radio, but at least it more or less worked.*
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> *The generals wanted to build a Software Defined Radio (SDR), which is fine as far as it goes. But putting ever-changing software in the same old hardware year after year after year is fundamentally at odds with Moore's Law, the thing that ultimately makes software possible.*

The Pentagon has invested heavily in moonshot programs like JTRS while ignoring the advances in radio tech that have come out of the private sector. It needs to take a more humble and practical approach.

Hiding in Plain Sight

As we explained in August, the Pentagon does employ a few people who understand its spectrum dilemma deeply, such as Gen. Jeth Rey, the director of the Network Cross-Functional Team at Army Futures Command. Rey realizes that DoD needs to develop the ability to hide its command and control signals inside normal-looking civilian radio traffic.

> *As the general explains the insight, it's a takeaway from Putin's war on Ukraine:*
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> > *Because the Department of Defense will never have protected access to the EMS, U.S. adversaries such as Russia, China, and Iran have the capability to detect, restrict, or deny the EMS at the time and place of their choosing. Russia's current use of advanced electronic surveillance to detect, locate, and target Ukraine positions is a clear reminder that detection equals horrific destruction. We must address the U.S.'s ability to hide in plain sight on the battlefield by reducing electromagnetic signature, improving training, and sensing and understanding electronic signals.*
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> *It's hard to overstate what a radical departure this insight is from traditional Pentagon spectrum policy. As long as I've been involved in spectrum policy – since 1990 – the Pentagon has insisted that it must have primary rights to spectrum in the US.*

When this is the case, the argument for pristine spectrum for training exercises in the US evaporates. The football/military adage that "you fight as you train" doesn't mean training in a spectrum environment utterly unlike the one DoD encounters in battle.

Conclusion

America's spectrum dilemma is largely a consequence of institutional inertia in the Pentagon. While there are forward-thinking savants in DoD from time to time, they don't tend to last.

The Pentagon needs to keep its own spectrum strategy up-to-date, just as its battlefield tactics need to be adjusted to reflect current conditions. For example, the war in Ukraine has demonstrated the supremacy of "hedgehog" tactics and electronic warfare over precision guided artillery:

> *As for lessons for the future, Petraeus and Roberts believe that generals around the world are busily adjusting their battle plans after studying events in Ukraine. Russia's success in withstanding Ukraine's counteroffensive has, they suggest, led Nato to rethink its strategy in the event of war with Moscow. Nato will be considering a "hedgehog" defensive approach, they believe, assuming that "manoeuvre" — as displayed by the US-led forces in the Gulf war and at the start of the Iraq war — is "extremely difficult" in an age of hyper-accurate drone-guided artillery. China's generals, meanwhile, will see events in Ukraine as a cautionary tale for would-be attackers as they war-game scenarios over Taiwan…*
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> *As for the battlefield lessons, Russia's shift to a war of "attrition" is not surprising, Freedman argues, pointing out how regularly that occurs in wars. But when it comes to the importance of leadership he is at one with Petraeus and Roberts: Putin, he concludes, "is left dealing with a catastrophe, for Russia as well as Ukraine, of his making."*
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> *What about the future of weaponry? Among the innovations of this war, open-source intelligence from social media and mobile phone data has aided the accuracy of artillery and missiles. Petraeus and Roberts also stress that the conflict has underlined how electronic warfare can defeat precision weaponry, but that this will require "huge and ongoing investment".*
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> *The point is well-timed, given the debate in Britain and elsewhere over levels of military spending. The authors believe that defence establishments in the west will need to invest in vast new stocks of arms and ammunition, having been shown how quickly they can run down in a hot war. They will also have to consider more public-private partnerships to fund defence innovation. In particular, they stress the increasingly varied potential of drones, suggesting that their use in Ukraine heralds a revolution that could lead to their being deployed at sea for up to six months, for example.*

The Pentagon needs to strive to become a better partner with private sector innovators while revising its spectrum strategy from one of dominance to one of cooperation. This mindset change will enable the US to provide better and more effective radio applications for both the civilian and miliary sectors.

Making that happen may be all the spectrum strategy we need.