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Building on Uncle Sam's "Beachfront" Spectrum: Six Ways to Align Incentives to Make Better Use of the Airwaves

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The federal government controls large swaths of the electromagnetic spectrum, but the current system for managing it lacks effective ways to incentivize agencies to use it efficiently. Congress and the Biden administration should promote good stewardship of spectrum and better enable it to power both federal missions and the commercial wireless ecosystem.

KEY TAKEAWAYS

- The federal government has important missions that require the use of electromagnetic spectrum. But federal spectrum lacks market discipline and profit motives, so it does not tend toward efficient use.
- Congress and the Office of Management and Budget (OMB) should make the Spectrum Relocation Fund (SRF) more flexible so it can be used for both upgrading equipment and longer-term planning and research of spectrum efficiency gains.
- Policymakers should auction more overlay licenses to create profit opportunities for those who can persuade federal agencies to vacate some spectrum by paying for relocation, upgrading equipment, or otherwise protecting the incumbent use.
- The federal government should reduce its spectrum footprint by increasing the quality of its receivers and migrating bespoke services to commercial 5G networks wherever possible.
- The executive branch should take a more active role in managing agencies' spectrum use, both through better accounting for the costs of federal uses and by making increasing commercial spectrum capacity a high-level priority.

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INTRODUCTION

The federal government's use of spectrum dates back to the beginning when radio frequencies were used to communicate—and so does the policy question of how to apportion spectrum access between government and private uses. As early as the 1912 Radio Act, Congress established rules for private actors to give way to the Navy at "important seaports" for the first 15 minutes of every hour.[1] And while spectrum technology has improved, the potential for conflict between private and federal spectrum uses remains. Indeed, it has become only more acute as existing federal holdings threaten to hamper the growth of the wireless economy that is increasingly important to connect all Americans to beneficial, and often essential, applications. The current system, however, has resulted in an outsized portion of spectrum under federal control, and policymakers should prioritize reforms that will incentivize efficient use of spectrum and create more capacity for private uses.

FEDERAL SPECTRUM HOLDINGS ARE IMMENSE

The federal government controls large portions of spectrum in frequency ranges most desirable for wireless services. In 2012, the President's Council of Advisors on Science and Technology (PCAST) found that the federal government had exclusive or dominant use of 58.1 percent of the frequencies below 3 GHz—often called "beachfront" spectrum because their propagation characteristics match common communications applications, so they are highly sought after.[2] Today, mid-band spectrum is the new beachfront, and a recent study estimates that 61 percent of "low mid-band" spectrum (defined as 3–8.4 GHz) was allocated to federal use.[3]

INCENTIVES WORK DIFFERENTLY FOR FEDERAL SPECTRUM

There are good reasons for the federal government to have access to spectrum. Everything from weather satellites to military radar relies on reliable access to radio frequencies, and we all have an interest in these systems working well. But there are also good reasons to approach federal spectrum holdings with a degree of skepticism.

In private markets with profit-seeking actors, the price of a resource increases when it becomes more valuable in other uses. For example, when more people want to move to Manhattan, the price of land there goes up. This increase both incentivizes people to make more efficient use of the real estate they have (smaller apartments in taller buildings) and makes owners rethink the best use of property (farms would be better situated upstate). The same dynamic exists for spectrum usage rights that are subject to private markets. With mid-band licenses selling for billions of dollars, mobile providers must think hard about how to squeeze the maximum productivity out of each hertz. The result of this market process is resources tend to flow toward more productive uses, since anything else would entail someone turning down a profit opportunity. The same incentives do not exist for federal users for two related reasons.

The absence of market prices, and the lack of a profit incentive, undermine many of the traditional methods of increasing spectrum efficiency.

First, federal users do not face market discipline because their spectrum is unpriced. Federal spectrum is managed by the National Telecommunications and Information Administration (NTIA), housed within the Department of Commerce. While NTIA evaluates potential trade-offs and charges a nominal fee to spectrum users, there is nothing close to a market-based usage fee to incentivize agencies' economization of their spectrum use, either by using a smaller range of frequencies to accomplish the same goals or by reducing the number of goals for which they rely on spectrum.[4]

Second, federal users (and their employees) do not profit from the efficiency of the services they provide. Even if federal agencies saw the full costs of their spectrum use or the benefits of using spectrum more efficiently, it is not clear it would actually change agency behavior. For privately licensed spectrum, the financial costs and benefits of buying and selling spectrum rights are internalized by the licensees and its shareholders. If a firm saves money using spectrum more efficiently or makes money by selling off frequencies it doesn't use, the company can better achieve its goal of turning a profit. The same is not true for federal agencies. Individuals in federal agencies are tasked with a mission that supports the role of the agency in implementing federal policy writ large. Since the government is not a profit-seeking enterprise, the success of these missions is not strictly tied to their economic efficiency. A member of the Department of Defense (DOD), for example, gains nothing by finding a way to operate a radar device in a smaller range of frequencies and may, perhaps, be chastised if the improvement loses the agency access to spectrum rights it had before. To an agency engaged in a critical mission, it is better to keep what works than it is to change what works in order to benefit someone else at the expense of the certainty and power it derives from the status quo.

These two phenomena—the absence of market prices and the lack of a profit incentive—undermine many traditional methods of increasing spectrum efficiency. The political power of

agencies and their missions is a third complicating factor. Federal agencies do have important missions to achieve and often need spectrum to meet them, but they enjoy a rhetorical high ground from which breathing the words "national security" or "safety" muzzles further interrogation of the efficiency with which they achieve those worthy objectives. Just as the lack of market incentives comes with the territory of federal spectrum allocation, so does this political and rhetorical dynamic, so policymakers must be prepared to address agencies with both carrots and sticks.

REFORMS TO ALIGN FEDERAL SPECTRUM INCENTIVES WITH U.S. SPECTRUM POLICY

We should protect the ability of federal agencies to carry out their essential functions, but with spectrum capacity filling up and the agencies themselves lacking the structural incentives to economize on their own, it is no longer enough to take agencies at their word when they assert the necessity for extensive spectrum holdings.

Since federal spectrum holdings are a perennial source of debate, many of the following suggested solutions have been proposed before and should be considered in conjunction with that extensive existing literature in which many similar ideas have been alternately proposed, attacked, and defended.[5]

Despite the recurring nature of the problem of federal spectrum holdings, bold action to implement any significant reforms has been lacking. There are certainly valid questions as to whether they will work in practice, but it is incumbent on policymakers, who now routinely lament the lack of greenfield spectrum necessary for U.S. leadership in future generations of wireless technology, to at least attempt reforms that will enable spectrum to be available for such a feat. The following six proposals would be good places to start.

1. Reform the Commercial Spectrum Enhancement Act

Under the Commercial Spectrum Enhancement Act (CSEA), federal agencies can recoup the costs of making federal spectrum available for nonfederal or shared use by drawing from the Spectrum Relocation Fund (SRF).[6] The SRF is funded by spectrum auction proceeds and managed by the Office of Management and Budget (OMB).[7] The CSEA currently places counterproductive restrictions on the use of SRF funds. Most notably, agencies may use relocation funds to replace existing equipment with that which has a "comparable capability" to the old systems.[8] In other words, an agency cannot use SRF money to buy improved equipment that may use spectrum more efficiently. This limitation produces the perverse result of keeping lower-quality radio equipment in the field when better equipment is available, which reduces the overall productivity of radio frequencies and diminishes the potential effectiveness and security of federal services by relegating them to old, rather than state-of-the-art, devices. Removing this limitation would foster the adoption of more advanced technology during the relocation process; it would also incentivize agencies to use the SRF, since clearing spectrum would come with the potential for upgraded equipment. Modernized federal spectrum usage, which would be more efficient and up to date with technological advances, would likely see concomitant national benefits.

Similarly, the CSEA should cover a wider scope of activities. Currently, funds are available for planning processes and research and development efforts that fit into prescribed categories with

a general catchall for "other planning activities intended to improve the efficiency and effectiveness of the spectrum use."[9] While this catchall provision could be read broadly, more explicit authorization would encourage OMB to allow more forward-looking, and therefore sometimes only indirectly beneficial, programs that improve long-run spectral efficiency while still meeting agencies' operational requirements.

2. Create a Market for Persuasion: Sell Overlay Licenses

Given the lack of traditional incentives available to drive federal users to economize on their use of spectrum, we could create a market for persuasion tactics by auctioning overlay licenses. An overlay license gives the owner a right to use a federal agency's spectrum if that agency agrees.[10] A top-down, legislative demand to give up frequencies may often meet with foot-dragging noncompliance, but a private actor with the time, skill, money, and motivation to account for an agency's day-to-day concerns and facilitate solutions could better craft an arrangement that is win-win even from the agency's perspective. While, in other contexts, the goal of overlay licenses is for the new entrant to buy out the incumbent, for federal users, the end goal would be to make the agency comfortable that it can accomplish its mission just as well—or better—without maintaining exclusive use of its spectrum. Overlay licenses, then, create a market for persuasion: The license can only result in commercial use of the spectrum if the licensee is successful in convincing the agency to allow it, possibly by upgrading equipment so the agency is better off. Thus, this plan would replace the endless handwringing of policymakers (and think tankers) seeking a generalized silver bullet for government spectrum with a competition between the best engineers and sweet talkers—who have their own money at stake—to find customized solutions that allow for profitable commercial use while preserving the functionality of federal systems. Indeed, overlay licenses have successfully accelerated the deployment of commercial wireless services in the AWS-1 auction.[11]

A private actor with the time, skill, money, and motivation to account for an agency's day-to-day concerns and facilitate solutions could better craft an arrangement that is win-win even from the agency's perspective.

Overlay licenses are also compatible with clearing the incumbent agency, splitting the band into federal and nonfederal use, or implementing a sharing system. The government does not need to predetermine the access regime when it sells the overlay rights. Rather, the agency and overlay licensee can negotiate whatever regime is most beneficial to them. This process would, in turn, facilitate the development of more sophisticated and reliable sharing mechanisms, since federal agencies would be more amenable to commercial use if a reliable technology could preserve their existing rights.

3. Improve the Quality of Federal Receivers

Increasing commercial use of spectrum near federal applications is only a problem if the commercial uses cause harmful interference. Therefore, improved interference immunity by federal receivers, through more advanced filters or computational techniques, would increase the availability of spectrum for all uses.

As the Federal Communications Commission (FCC) is currently reviewing ways to improve the interference immunity of receivers operating in spectrum under its jurisdiction, the federal

government should do the same.[12] While it is more difficult to objectively characterize the performance of a receiver than that of a transmitter, working toward technological developments that can improve the status quo is essential. The alternative is receivers that are vulnerable to interference from nearby bands, which either threatens the integrity of the federal service or precludes commercial operations well outside the federal agency's band.[13] Therefore, federal procurement should prioritize state-of-the-art receivers. Investing in high-quality receivers at the beginning of a deployment would reduce the future costs of retrofits or harmful interference. Funding for these efforts should be part of the broadened SRF previously suggested.

Federal agencies should also undertake periodic reviews of the standards for devices they use or regulate. These reviews should account for technological developments in addition to current and future changes to the interference environment. Even if these reviews do not always result in wholesale retrofits, knowing the capabilities of receivers in the field and what improvements are technologically possible is a valuable input to the spectrum policy process. Assuming this more proactive role would thus increase the long-run reliability of federal services while also minimizing their spectrum footprint.

4. Increase the Compatibility of Federal Services With Commercial Networks

Federal users can also become better stewards of spectrum by investing in services that run on commercial spectrum rather than bespoke federal systems. Just as the federal government procures other mission-critical supplies from private contractors, it should seek to, for example, leverage existing 5G networks for its communications systems. While there are many types of communications technologies, increasing license flexibility would allow private carriers to offer most services under their existing licenses. This move would have two advantages. First, since a commercial wireless provider internally manages its network, there would be less need for regulations to impose frequency separation and other limits that reduce the usability of spectrum. Second, federal users would benefit from commercial research and development into wireless technologies, rather than having to develop innovative systems in-house with a more limited budget than that of private industry.[14]

A network that can seamlessly transition between services through dynamic sharing would also point the way toward continuity of operations when dealing with malicious transmissions on a battlefield.

To say that federal agencies should run applications in commercial spectrum is not to say they should accept only mass-market levels of reliability and security. While many federal uses of spectrum implicate sensitive national security interests or stringent reliability requirements, there is no reason to think that private companies would be unable or unwilling to meet these goals in the same way other contractors bid to match the federal government's exacting standards.

Helpfully, the DOD is already looking for more ways to migrate its needs to 5G networks. For instance, it has contracted to conduct experiments and tests on bases throughout the United States, aiming to capitalize on 5G developments in the commercial sector in ways that support war-fighting applications.[15] Furthermore, many private and federal technological advances are dual use: Advances in network security or spectrum sharing, for example, can enhance the quality and productivity of private spectrum while also expanding federal capabilities in military applications.[16] A network that can seamlessly transition between services through dynamic

sharing would also point the way toward continuity of operations when dealing with malicious transmissions on a battlefield. The DOD should continue these efforts and work in good faith to maximize the advantages of commercial wireless capabilities.

5. Price Agency Spectrum

Spectrum is far from the only scarce resource important to federal agencies' missions, yet the current policy framework treats it as unique. Everything from land to computers to paper is scarce, but that is no reason for the government not to purchase those resources at market prices. Likewise, agencies' budgets should reflect the costs of maintaining access to the wavelengths they use.

It is a problem inherent to federal spectrum use that individual agencies and their employees bear no responsibility for the alternative uses they preclude by maintaining their own rights to a spectrum band. More executive-branch management of federal spectrum—specifically, management that checks internal agency inertia in favor of overall spectrum policy and efficiency—could improve this process.[17]

For example, instead of each agency being responsible for its own real estate, federal real estate management is lumped together and controlled by the Government Services Administration (GSA). This allows experts in land acquisition to make good deals that account for efficiency trade-offs that an agency may not consider if it is simply maximizing for its own goals. A similar structure for disparate agencies' spectrum use would help alleviate some of the inefficiencies generated by users with conflicting needs and no incentive to work together. It could also facilitate consolidation if different agencies could run similar systems side by side in a smaller range of frequencies.

One should not assume, however, that such an allocation system would come close to solving the aforementioned incentive problems: Individuals in agencies still don't experience those financial costs and wouldn't see the financial benefits of saving money. In fact, due to the often arcane budgeting process both from Congress and OMB, an agency's savings from reducing its spectrum footprint would likely provoke a decrease in its total funding. Likewise, even if the costs of a larger spectrum footprint were quantified, agencies might simply see their budgets increase, since federal missions are generally deemed too important not to fund. This process thus often nets out benefits and renders the accounting merely an academic exercise.

Spectrum is also a more subtle type of resource than land. While a building's location is important, there are often innumerable places and types of structures that can serve the government's purpose. Furthermore, physical objects in the real world have less potential for overlap and conflict, or at least better pathways to handle them, compared with the world of complex interference management for radio frequencies. These factors mean the central spectrum controller would inevitably be involved in making more policy judgments about the functioning of federal systems in a way GSA does not have to undertake with real estate.[18]

Despite these shortcomings, Congress should require administrative pricing for spectrum consumed by federal agencies, as a better approximation of the costs of federal spectrum uses would improve acquisition processes and allow for greater independent capacity management. It would also create more avenues for other actors to nudge agencies to more efficient spectrum use. Fiscally conscious members of Congress might investigate whether relatively simple

spectrum applications result in outsized budget requests, and a central agency skilled in assessing the amount of bandwidth necessary for particular uses could serve as a further check on agency inertia, which might otherwise lead agencies to maintain use of any spectrum they already have. The acquisition process would also benefit from a formalized accounting of the costs of spectrum use. This reform would incentivize private contractors to prioritize more spectrally efficient proposals, since using more spectrum would result in a less competitive bid.[19]

Many of these reforms would simply take attention and OMB guidance. A more high-level look at federal spectrum in pursuit of efficiency gains would be a potential role for NTIA, though it would need significantly greater funding and statutory authority to perform these functions well.

This recommendation goes hand in hand with the creation of a comprehensive spectrum inventory. This inventory should include all DOD spectrum holdings. Though these must often remain classified, policymakers and other personnel with proper clearances should be able to assess the Pentagon's spectrum choices, rather than allowing it to hide behind the cloak of "national security."

6. Assert White House and Congressional Leadership

Above all federal spectrum interests sits the president. Indeed, a dispute between the department of Transportation and Commerce is between the president's own employees. If the White House were to state and take an interest in implementing a national policy of efficient spectrum use by federal agencies, it could cut down on interagency bickering and force intransigent agencies to come to the negotiating table. Indeed, while each agency has its own mission in support of the national interest, the executive branch should have overarching policy goals that include the availability of spectrum for commercial applications. As much as any band may be valuable to a federal agency, it is also valuable to American consumers, and the White House is best positioned to ensure the latter group is represented when evaluating that trade-off. By using its de jure leadership alongside its bully pulpit, the White House can facilitate a more productive and collaborative attitude that ensures a balanced approach toward spectrum holdings.

Legislation should mandate DOD part with some of its rights to the lower 3 GHz band and include a larger "spectrum pipeline" of other bands for future reallocation.

Likewise, Congress has been a driving force behind past successful reallocations of spectrum from federal to commercial use. A legislative mandate removes excuses for inaction and shifts the executive branch's focus from whether to reallocate a band to how to comply with the law. This is one reason why upcoming legislation should mandate DOD part with some of its rights to the lower 3 GHz band and include a larger "spectrum pipeline" of other bands for future reallocation. Furthermore, since Congress itself is motivated by deadlines and dollar signs, legislative efforts should extend the FCC's authority to auction spectrum (which often raises large sums for the Treasury) but maintain a future sunset, which would serve as another deadline to spur congressional action in the future.

CONCLUSION

These proposals are compatible with the resulting capacity being used for licensed, shared, and unlicensed access regimes. Indeed, many of them may contribute to the development of sharing technologies reliable enough to give incumbents the certainty necessary to agree to shared uses that preserve the overall productivity of a band—a feat not yet fully accomplished.[20] A pipeline of spectrum flowing toward the commercial market can then allow policymakers to balance the allocations to licensed and unlicensed use.

As wireless services become increasingly essential to daily life—and often to safety of life—it is essential that inefficient federal spectrum holdings not squander precious bandwidth. None of the arguments presented herein, however, are intended to imply that agencies are being malevolent or intentionally difficult for no reason. Indeed, in many cases, they probably would leap at the opportunity for upgraded equipment that could better serve their mission with a smaller spectrum footprint. But it is important to recognize the ways the current system undermines the incentives for more efficient use and is biased toward the inefficient status quo. Disrupting these incentives with more virtuous ones is the key to a more balanced and productive spectrum ecosystem.

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