CLOSING KEYNOTE ADDRESS AT THE SPECTRUM HALL OF SHAME: THE WORST (AND BEST) RADIO POLICY DECISIONS*

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Thank you for the introduction and the opportunity to participate in today's policy discussions.

The Trump Administration has been hard at work developing a strategic approach to spectrum policy that will ensure America's leadership in spectrum and telecommunications long into the future. We have engaged stakeholders, both in government and the private sector to lay out a strong path forward. The Administration has repeatedly stressed the importance of developing our nation's telecommunications infrastructure, exploring ways to bring America into the future with 5G networks, developing the FirstNet nationwide emergency response network, and launching a multistakeholder effort to increase security and transparency for software components. An administration-wide focus on space commerce shows that we are forward looking and focused on addressing not just the problems of today but the spectrum needs of tomorrow.

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* This speech has been edited for publication. David Redl delivered these remarks at the Silicon Flatirons Spectrum Hall of Shame: The Worst (and Best) Radio Policy Decisions at the University of Colorado Law School on September 6, 2018. The focus of Redl's closing keynote address was the importance of taking risks in spectrum development. For a video of the speech, see Silicon Flatirons, *9/6/18 Spectrum Hall of Shame: Closing Keynote: David Redl*, YOUTUBE (Feb. 12, 2018), https://youtu.be/I_6AqBSc9aA?list=PLTAvIPZGMUXPbohP9Ix5Ftan5cQiB2DOn [https://perma.cc/M3EC-23EE].

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But if I read the name of this event correctly, we are not here to discuss our success. In fact, it takes a special kind of failure to make it into the Spectrum Hall of Shame. Taking time to study failure helps to ensure that we actually do learn from our errors. This event provides a great place to have those discussions and map a strategy for the future.

For nearly every "shameful" spectrum policy, I can point to the lessons we in the spectrum policy community learned and an application of those lessons that led to a success. We do that by looking back at what has worked well, and what hasn't.

We're all familiar with the Silicon Valley startup model of failing fast, or failing forward. The idea is that you can learn more from failure than moderate success. Making mistakes and learning from them quickly is what leads to innovation.

But I think it's important to remember why we've had these failures. It turns out the spectrum community in this country has something in common with Silicon Valley. We have failed, and will continue to fail, because we are pursuing innovative approaches that no one has tried before.

Take a classic example of a problematic band—the 800 MHz band. An effort to implement a new channel plan that would ease interference issues for public safety operations ended up taking more than a decade because of cost issues and cross-border coordination with Canada and Mexico. But, ultimately, we have learned a lot about how to negotiate cross-border issues, as well as how to ease potential interference between public safety and mobile services. Those lessons will pay off in the future in the 800 MHz and 700 MHz bands.

Or consider the case of automatic garage door openers. If you lived near a military base in the early 2000s, chances are one day you woke up and your garage door opener didn't work. And so you did what anyone would do in that situation—you called up your local news station and complained. While this was clearly a public relations disaster, it led to a quick turnaround for consumers when regulators collaborated to fix the problem.

Spectrum policy mistakes are the unfortunate downside of taking risks—but these are risks that have paid big dividends for the United States because most of the time we get things right. This is why the United States is the world's leader in spectrum policy, creating innovations that are studied and sometimes imitated by governments all over the world.

WIRELESS LEADERSHIP

How did we build this type of leadership? Through risk-taking, making mistakes, learning from failures and creating successes.

The wireless industry today supports nearly 5 million jobs and contributes about half a trillion dollars to the economy. It has benefitted from smart spectrum policy and regulatory tools that enabled new services and technologies to develop in a competitive market. A look at the history of spectrum management shows that an innovative spirit can flourish even in the most unlikely of places.

In the mid-1990s, the government implemented spectrum auctions to enable some of the earliest commercial mobile services that built on advances in cellular technology, known then as "personal communications service" or "PCS." The rest is history. This is the obvious example of a risk that worked out, so while I will not dwell on it, it is hard not to at least mention it. Further, these traditional auctions were a steppingstone to the novel and complex voluntary incentive auction in the UHF TV band. A question the administration is exploring, as others have before, is whether any of the concepts behind these and other market-based mechanisms could have applicability to federal spectrum use. This could include the ability to lease access to federal spectrum to nonfederal users. It's complicated for sure, but so is almost anything worth exploring in spectrum policy.

Congress created the Spectrum Relocation Fund, or the SRF, to promote more efficient usage of spectrum and better address how we compensate federal agencies for their work to accommodate new commercial services in bands they have relied on for years. Congress has continued to add to the ways we can use the SRF, including to research additional bands that could be opened up for access, and I am not sure they are done.

These tools haven't always worked perfectly, but the result is a healthy and creative dynamic that values innovative solutions.

As a government, our work on finding innovative spectrum solutions is ongoing. A major chunk of that work happens at NTIA through our Office of Spectrum Management, OSM, and right here at our research lab in Boulder, NTIA's Institute for Telecommunication Sciences, or ITS.

ITS produces independent research that informs policy decisions, and ultimately helps the ability of spectrum users to deploy advanced telecommunication technologies. For example, ITS has been a leader in developing, validating, and freely disseminating the radio propagation models that allow industry and government to plan, develop, and implement communications systems to minimize interference and maximize spectrum efficiency.

The Irregular Terrain Model (ITM), first developed at ITS in the 1960s, is still one of the most widely used propagation models. ITM software is available free of charge from ITS, and has also been

implemented in many commercial and open source software packages used to plan wireless networks.

ITS has pioneered "gold standard" systems for making accurate and repeatable radio frequency measurements and has created spectrum occupancy measures that provide investors and regulators baseline assessments of spectrum usage and sharing feasibility. And ITS's measurements of device emissions are providing critical support for advancing new technologies in a shared environment.

Thanks to ITS's work, we have new options for exploring new approaches and technologies for spectrum sharing. This is increasingly vital in an era of many demands on spectrum that is more and more constrained and contested.

TURNING FAILURES INTO SUCCESSES

These are some of the things we've gotten right. I'm clearly proud of the spectrum achievements of NTIA and our country. But let's look at a few areas where we missed the mark at first.

In the early 2000s, Dynamic Frequency Selection, or DFS, was developed as a mitigation technique to protect existing radars from wireless local area networks being introduced into the lower 5 GHz U-NII bands.

DFS had problems right at the start: There were issues with enforcement of equipment standards that were embodied in FCC rules, in some cases stemming from illegal equipment modifications. As a result, some Wi-Fi equipment began to interfere with incumbent systems in these bands, including Doppler weather radar systems operated by the Federal Aviation Administration.

We clearly failed. When you think about what constitutes success in federal spectrum management, it's often defined by non-events. Radars working as designed. Planes landing safely. So causing problems with FAA radars is about as serious a failure as you can have.

That seriousness, however, meant that the issue was addressed head-on. We were able to improve both enforcement and interference mitigation, which enabled increased sharing between radar systems and local area networks and a growing Wi-Fi market in the 5 GHz band. Now let's look more closely at the faulty garage door openers.

This issue stemmed from the Department of Defense's decision to increase usage of the 380-399.9 MHz band for trunked land mobile radio systems on U.S. military bases—inadvertently triggering interference with unlicensed, Part 15 garage door openers owned by thousands of consumers in surrounding neighborhoods.

DOD had every right to use its existing assignments—and the garage door users had no rights to protection from interference under the FCC's Part 15 rules. But nevertheless, consumers complained to anyone who would listen, including reporters, Congressional representatives and the FCC.

NTIA and DOD worked together to calm the crisis by avoiding some of the most commonly used garage-door frequencies. The agencies also worked with the FCC, which issued a public notice explaining the cause of the issue and urged the manufacturers to replace some of the garage-door remotes.

This was an early example and lesson for how federal operations might co-exist with unlicensed services, and a prime example of how federal agencies and NTIA need to work with the FCC to defuse an issue—or even better, anticipate it and head it off.

For my final example, I want to look at two failures that have paved the way for forthcoming national commercial services in the 3.5 GHz band, known as the Consumer Broadband Radio Service, or CBRS.

In 2004, the FCC and industry began to enable so-called white space operations in the UHF TV band, which was allocated to broadcasters but unused in many locations. Despite best efforts, mass-market services have failed to emerge from this effort.

However, the effort to document available white spaces in basic databases provided a key lesson for the development of Spectrum Access System, or SAS, technology, which is now being deployed in conjunction with the tiered-access approach for the CBRS band.

Another key innovation that will drive CBRS in the 3.5 GHz band is Dynamic Protection Areas, or DPAs. When NTIA first studied 3500-3650 MHz for potential repurposing, it initially recommended protecting military radars in the band by imposing large geographic area exclusion zones along U.S. coastlines. This was a common approach at the time for mitigating potential interference between seemingly incompatible systems.

But you can't really have a nationwide service if coastal areas are off limits. Through industry and government collaboration, the older, static model of exclusion zones are being replaced by a dynamic sharing model that will allow multiple spectrum uses across time and geography. Along with SAS and Environmental Sensing Capability technology, we are now putting systems in place that can allow CBRS to flourish. We'll see over time how truly effective this model works but I expect it will influence our efforts in other spectrum bands, whether directly or simply through the lessons we collectively learn.

MODEL FOR FUTURE SUCCESS

Our willingness to take risks, turn around failures, and invent new solutions is a direct result of this lineage of U.S. spectrum policy decisions that while not always perfect have propelled us forward in expected and unexpected ways. This willingness to act, to be bold, is vital going forward as we face increasing competition and security challenges in the global economy. It's imperative that the U.S. maintain its technological leadership. Spectrum access is a key component of the formula to achieve this. As such, we need to leave no stone unturned in seeking new ways to make better and more efficient use of this resource.

Fortunately, we have a strong foundation in place through our work with stakeholders across the federal agencies, the FCC, Congress and industry. There is wide recognition of the need to weigh federal and nonfederal priorities to best serve the public interest; and a consensus around maintaining U.S. leadership in wireless technology, from 5G broadband to unlicensed technologies to satellite and space systems.

Finally, we are looking forward to guidance we expect to soon receive from the White House on developing a national spectrum strategy to further shape and inform our work. A framework for a longer-term, sustainable and flexible approach to spectrum policymaking will help us preserve and extend U.S. leadership and prepare us to meet the nation's future spectrum needs. I am confident that across this administration we are driven to make lasting progress in enhancing spectrum efficiency and maximizing its use.