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Internet of Things

As 'Internet of Things' Evolves, FCC's Spectrum Strategy Will Be Put to the Test

BY PAUL BARBAGALLO

After decades of creating and implementing policies to aid the rise of mobile devices, the Federal Communications Commission may soon find its greatest challenge yet in the ''Internet of Things.''

By 2025, if analysts' predictions are correct, the Internet of Things will have transformed our lives; we will be able to control and monitor virtually any *thing*—not only the thermostats, refrigerators, and light bulbs in our homes, but our cars, the crops on our farms, even our heart rates—all from tiny, powerful devices.

But while the Internet of Things (or IoT for short) is still evolving, one fact will remain, in 2025 and beyond: These *things* need connectivity. This global network of objects, both large and small, each embedded with sensors, must be connected to the Internet somehow, and in many cases wirelessly. For the FCC and the world's communications regulators, this means freeing up more spectrum—and at a time when the airwaves are running out of free space.

As of now, most IoT systems operate in unlicensed radio frequencies, namely in the ISM (industrial, scientific, and medical) bands: The sub-125 kilohertz (kHz) for video surveillance and access control systems; 13.56 megahertz (MHz) for near-field communications (NFC) to support mobile payments; and 900 MHz for Electronic Product Code (EPC), one of the industrial standards for global Radio Frequency Identification (RFID) usage, just to name a few. And they make their critical connections using a range of different (and sometimes competing) wireless connectivity standards, such as Bluetooth, ZigBee, Z-Wave, and Wi-Fi, all of which were designed to work in *unlicensed* spectrum.

''There are no spectrum bottlenecks for dedicated IoT systems yet, but we are seeing Wi-Fi services get maxed out, as there are only so many channels you can cram into the available spectrum,'' Kevin Ashton, co-founder and former executive director of Massachusetts Institute of Technology's Auto-ID Center, who coined the phrase ''Internet of Things,'' told Bloomberg BNA.

''There has been a lot of innovation in managing the channels,'' he added, ''which gets incorporated into new standards, but using existing ISM bands means that we are cramming a lot of traffic into a small space. We will see similar challenges in the other ISM bands that IoT systems use in the future, as the Internet of Things scales.''

Ashton: More Unlicensed, Less Licensed. The solution? In Ashton's view, regulators should make almost all global spectrum unlicensed and subject to ISM-band-type rules about sharing, with exceptions for emergency and security systems.

''That will take a big paradigm shift,'' he said. ''National governments have become so used to auctioning off spectrum corridor monopolies for specific applications.''

In the United States, the FCC will soon auction 65 MHz of spectrum in the AWS-3 (Advanced Wireless Services) band to wireless carriers led by Verizon Wireless and AT&T Inc. In 2016, the commission will hold the world's first ''incentive'' auctions of spectrum, which will involve paying TV stations to vacate their channels, then selling those channels to the wireless carriers, with the hope of reclaiming as much as 100 MHz of spectrum and raising more than $10 billion for the General Treasury.

For its part, however, the commission *has* tried to strike a balance between auctioning spectrum for specific applications and leaving spectrum unlicensed.

In March, the commission made available 100 MHz of spectrum in the 5.1 gigahertz (GHz) band for use by high-powered, outdoor Wi-Fi equipment, part of a broader plan by the agency to release more 5 GHz frequencies for Wi-Fi over the next five years. And as part of the FCC's *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions* order, unlicensed uses will be allowed in 600 MHz ''guard bands,'' Channel 37, and the ''duplex gap.'' (The FCC is now seeking comment from the public on how that could, and should, work.)

But even this approach has drawn the ire of the wireless industry and some House and Senate Republicans. Both want the FCC to auction and license as much spectrum as possible. The carriers want to reduce the effect of network congestion, guarantee customers a certain quality of service, and remain competitive in the United States and abroad; the Republicans want revenue for the General Treasury.

''Politicians do not understand spectrum, or radio, but they do understand money, and there are many more people lobbying for spectrum corridor monopolies than for the full spectrum to become unlicensed,'' Ashton said. ''The bad news is that driving this change will take a long time. The good news is that we have some time before this will become a problem. So we need to start now. Current spectrum policy is pre-globalization and all analog, a relic of the early 1900s. We need a new approach for a global, digital world.''

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In Small Steps, FCC Begins Addressing Challenges of IoT. To its credit, the FCC has already begun to confront the technical and engineering challenges of the Internet of Things.

Earlier this year, the FCC's Technology Advisory Council convened an IoT working group to identify the ''key areas in the evolving Internet that should drive the work of the commission'' in the Internet of Things.

Broadly, the working group will attempt answer several questions for the commission, such as *What new demands will the Internet of Things place on the network?* and *What technology policy challenges exist in the evolution towards an Internet of Things?* Though the task may seem daunting, the group is expected to issue a report to the FCC in early December covering a wide range of topics and interest areas, including, for example, the social and economic benefits of the IoT; security, spoofing, and device vulnerability; data privacy; public safety; business models; standards and best practices; and the ''spectrum challenges and opportunities.''

Speaking in October at Hogan Lovells US LLP's Winnik International Telecoms & Internet Forum in Washington, Julie Knapp, chief of the FCC's Office of Engineering and Technology, suggested that, in the end, the agency might not even have to reserve a slice of airwaves solely for the Internet of Things.

''The flexible use that we provide for both licensed and unlicensed'' technology negates the need for such a dedicated allocation, Knapp said.

But while that may be the case, the FCC is still keeping its options open. Just last month, the FCC launched a formal review of whether spectrum above 24 GHz could become a future permanent home for 5G networks—and also, possibly, the Internet of Things. Historically, such higher-band spectrum has been suitable only for applications where the radio has a direct line of sight to the receiver, but new technologies developed by Samsung and Ericsson may now be able to overcome those limitations in bands ranging from 5 GHz to 72 GHz.

For Spectrum Policy, Flexibility Is Paramount. ''This represents an opportunity to get substantial amounts of valuable spectrum in the marketplace that could be used for Internet of Things applications,'' Peter Pitsch, executive director of communications policy and associate general counsel for Intel Corp., told Bloomberg BNA.

Pitsch, the former chief of the FCC's Office of Plans and Policy from 1981 to 1987, said the agency's staff was wise to take both a technologically and competitively neutral approach to its study, disabusing themselves of any notions about *how* the spectrum should be allocated.

As Pitsch explained, when the FCC first issued licenses in the early days of cellular telephones, the agency's spectrum policies were far too rigid. The commission had mandated far too many technical standards and build-out requirements and overly limited the amount of spectrum doled out to each licensee. Since then, Pitsch said, the FCC has gradually shifted to more market-based policies—licenses in large, contiguous blocks and technological flexibility to the winning bidders. Over time, the FCC has also made unlicensed spectrum more of a priority, opening up new bands (2.4 GHz, for instance) for new technologies (Wi-Fi and Bluetooth, to list just two).

''With unlicensed spectrum, device manufacturers and chipset makers can get their products in the marketplace as long as they meet certain limited power-emissions requirements,'' Pitsch said. ''Similarly, with flexible licensed spectrum, operators can move from an old technology to a new technology without getting hung up in some long, involved regulatory process. That's exactly the world we need more of to enable technology to move quickly, or as quickly as makes sense, in IoT.''

Yet even with a going-forward policy of flexibility, will there simply be enough spectrum to meet the demands of all these interconnected devices?

According to a 2012 Organisation for Economic Co-operation and Development paper, *Machine-to-Machine Communications: Connecting Billions of Devices*, the number of IoT devices could reach 50 billion by 2020.

How will they all work?

Confronting the Known Unknown. ''If you went back in time and looked at the forecasts of spectrum at other technology inflection points, you'd probably find that the demand for spectrum is underestimated,'' said Adi Reschenhofer, founder and CEO of Wyconn, an IoT product supplier and member of the Industrial Internet Consortium, a group formed this year by the likes of AT&T, Inc., Cisco Systems Inc., General Electric, IBM, and Intel to create engineering standards for the Internet of Things.

''Initially, we expect that [spectrum] demands will be modest, partly because the number of devices and the data they're sending back and partly due to the cost to transmit data across that spectrum,'' Reschenhofer told Bloomberg BNA. ''But as devices and capabilities increase, we'll see a rapid rise in demand, and may see something of an 80 percent-20 percent split, with 20 percent of apps using 80 percent of the data. The question is, 'what application will be the Facebook of IoT?' ''

Indeed, most current IoT applications do not consume that much bandwidth. But as technology improves and prices fall, analysts expect video-rich applications to proliferate, which may place new burdens on wireless carriers' 4G LTE networks. At this point, however, any forecasts of bandwidth consumption are speculative at best.

''With the Internet of Things, the traffic patterns are much less known,'' Michael Peeters, chief technology officer for the Wireless Division at Alcatel-Lucent, the French-American telecom infrastructure giant, told Bloomberg BNA.

As a point of contrast, during the wireless industry's transition from 3G to 4G networks, the spectrum needs were fairly easy to comprehend:

''It's content. People consume it, whether it's data or data and video,'' Peeters said. ''But for the Internet of Things, where it's more about a lot of small sensors and *things* that . . . pop up, generate some data, and then disappear again, this is very different. The traffic models, as well as the underlying business models, are not completely understood yet outside of certain verticals, and those verticals don't scale to a wider environment.''

Cellular Will Play Crucial Role in IoT. True as it is, that has not stopped the wireless industry from seeking more licensed spectrum.

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Practically speaking, the way most IoT systems work is that the connected device sends data to a smartphone or tablet via Bluetooth, and the smartphone or tablet then uses a Wi-Fi or cellular network—3G or 4G—to send that data to the cloud.

Thus, with smartphones and tablets becoming the default ''hub'' device for the Internet of Things, the carriers' 3G, 4G LTE, and perhaps even 5G networks will likely be carrying more traffic (they are faster and more secure, after all), and the need for more bandwidth will be even greater.

''This means that the FCC and the National Telecommunications and Information Administration will need to put more spectrum in the market over the next few years for wireless carriers,'' Craig Wigginton, vice chairman and U.S. Telecommunications Sector Leader for Deloitte & Touche LLP, told Bloomberg BNA. ''Delays or continued spectrum shortages could create opportunities for other countries to take the lead in the Internet of Things, in industries like telematics, mHealth, mCommerce, or mLogistics.''

Sharing May Be Option. For regulators, one answer may be glimpsed in President Obama's Council of Advisers on Science and Technology (PCAST) 2012 report, ''Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth.''

In that report, PCAST called for as much as 1,000 MHz of government-held spectrum to be opened up for sharing with the private sector.

Among the report's recommendations was the creation of a geolocation ''spectrum access system'' to delineate priority of access for users sharing the spectrum. As envisioned by PCAST, federal government licensees, such as the Department of Defense, would be granted the highest priority of access, while commercial entities, such as the wireless carriers, would be given secondary access. A third group, ''tertiary'' users, would be afforded ''general authorized access,'' similar to Wi-Fi network operators.

The FCC is currently exploring such sharing possibilities for the 3.5 GHz band, which the agency has called the ''Innovation Band.''

''The dynamics of the IoT is something that we've never seen before,'' said Mark Gorenberg, founder and managing director of Zetta Venture Partners, a PCAST member who contributed to the council's 2012 report. ''We're projecting millions of apps, billions of connected devices, billions of sensors. There's going to be a huge amount of data created by all this. And that's going to put a lot of pressure on the system.''

Gorenberg sees the 3.5 GHz band as an attractive option for emerging IoT systems, whose operators, he notes, need to constantly balance the certainty of licensed cellular networks (speed, quality of service) and the uncertainty of unlicensed Wi-Fi networks (potential interference).

''It's going to be pretty straightforward to be able to live in this three-tiered system,'' Gorenberg told Bloomberg BNA. ''Once we implement these spectrum access systems, it's going to give the federal government the assurances they need, as well as give a quality of service to people who want to use this spectrum. I think you're going to see it proliferate pretty quickly once it's implemented. And IoT is going to be a huge driver for this.''

'All of the Above.' Ultimately, it may not be new policies that the Internet of Things requires, but a deliberate execution of what several FCC commissioners have referred to as the ''all of the above'' spectrum strategy—making possible the addition of not only licensed spectrum, but unlicensed spectrum and shared spectrum.

For while wireless carriers want more auctions, the Wi-Fi and Bluetooth boosters more unlicensed frequencies, they both need more opportunities to share spectrum with the federal government. But the Internet of Things needs them all.

With assistance from Lydia Beyoud in Washington and Tim McElgunn in Cherry Hill, N.J.

To contact the reporter on this story: Paul Barbagallo in Washington at pbarbagallo@bna.com

To contact the editor responsible for this story: Bob Emeritz at bemeritz@bna.com