

5G ENABLES SMART CITIES

FAST, FOCUSED WIRELESS TECHNOLOGY WILL
REVOLUTIONIZE OUR CONNECTED WORLD.

BY GARY ARLEN

Although 5G (Fifth Generation) wireless technology is still in its early field trial phase, projections for its vital role in upcoming “smart cities” developments are already underway. 5G’s capabilities to provide “cost-effective high bandwidth, low latency and pervasive connectivity” are lauded by the Alliance for Telecommunications Industry Solutions (ATIS) as vital for “citizen-centric functions, improving traffic flow, public safety and more.”

Ideas for better living that will rely on 5G are also emerging, such as “radically programmable” city streets with markings that can change to authorize loading zones or street hockey, depending on the time of day. Technologies to further improve the low-latency (milliseconds) and to expand the range into licensed and unlicensed spectrum are also in play. As a result, policymakers are also exploring 5G’s role in smart cities.

Right now, as wireless carriers and equipment makers accelerate their push for new technology and civic officials evaluate service delivery in an era of budget constraint, there are countless fertile dialogues about the role of 5G in the smart cities movement. Growing interest in “sustainable cities” is tempered with concerns about how to deploy microcell equipment (tiny as it might be) for 5G transmissions. By some estimates pervasive 5G service will require twice the number of small cell towers now in use. Although 5G will have ultra-low power consumption, the ability to connect more sensors and devices will come with its own management burdens.

And of course, there are the ever-present questions about privacy and security as 5G technology works its way throughout the civic ecosystem.

Such challenges are not fazing the technicians and policymakers who are pushing ahead with their plans. Donald Stockdale, chief of the Federal Communications Commission's (FCC) Wireless Telecommunications Bureau, affirmed the agency's objective "to encourage and protect innovation-driving competition and to remove regulatory barriers to deployment. By unleashing the potential for 5G, we can accelerate the growth of our economy, create new jobs and new opportunities, and improve the quality of life for all Americans," Stockdale said in a July speech to a Free State Foundation seminar about 5G. He explained that the FCC "is working to free up spectrum in all ranges" that could be used for 5G.

Major U.S. wireless carriers and suppliers, global telecom providers and civic groups have quickly taken up 5G for its implications in business as well as a public service opportunities.

Whether it's Internet of Things (IoT) devices, autonomous vehicles, smart roads, healthcare or any other part of the emerging connected society, fast-emerging 5G wireless technology is expected to play a vital role. Its impact on the evolving "smart cities movement" can be extrapolated from the growing number of such projects. A recent CTA study identified a 38 percent jump in the number of smart city projects globally from 2013 to 2016. CTA estimates that the global smart cities market will be a \$34.35 billion sector by 2020.

Understanding Smart Cities and 5G Technology

Nearly 100 U.S. communities, and hundreds more around the world, are developing systems to provide security, safety and convenience for their residents in projects that range from traffic management, garbage collections, first-responder capabilities and parking meters. Smart roads equipped with sensors and monitoring systems are being integrated with the features of smart cars (both self-driving vehicles and ones with other enhanced capabilities). Firefighters who have access to dynamic diagrams of buildings could do their jobs more effectively.

Smart grid electric distribution could produce \$160 billion in benefits and savings through reduced power usage and fuel costs. And drivers could access current status information about nearby gas stations and electric recharge stations via such systems.

At the same time, 5G development is hurtling forward. Accenture Strategy estimates that the economic impact of 5G will:

- Create three million new jobs
- Boost annual GDP by \$500 billion
- Drive \$275 billion investment from telecom operators

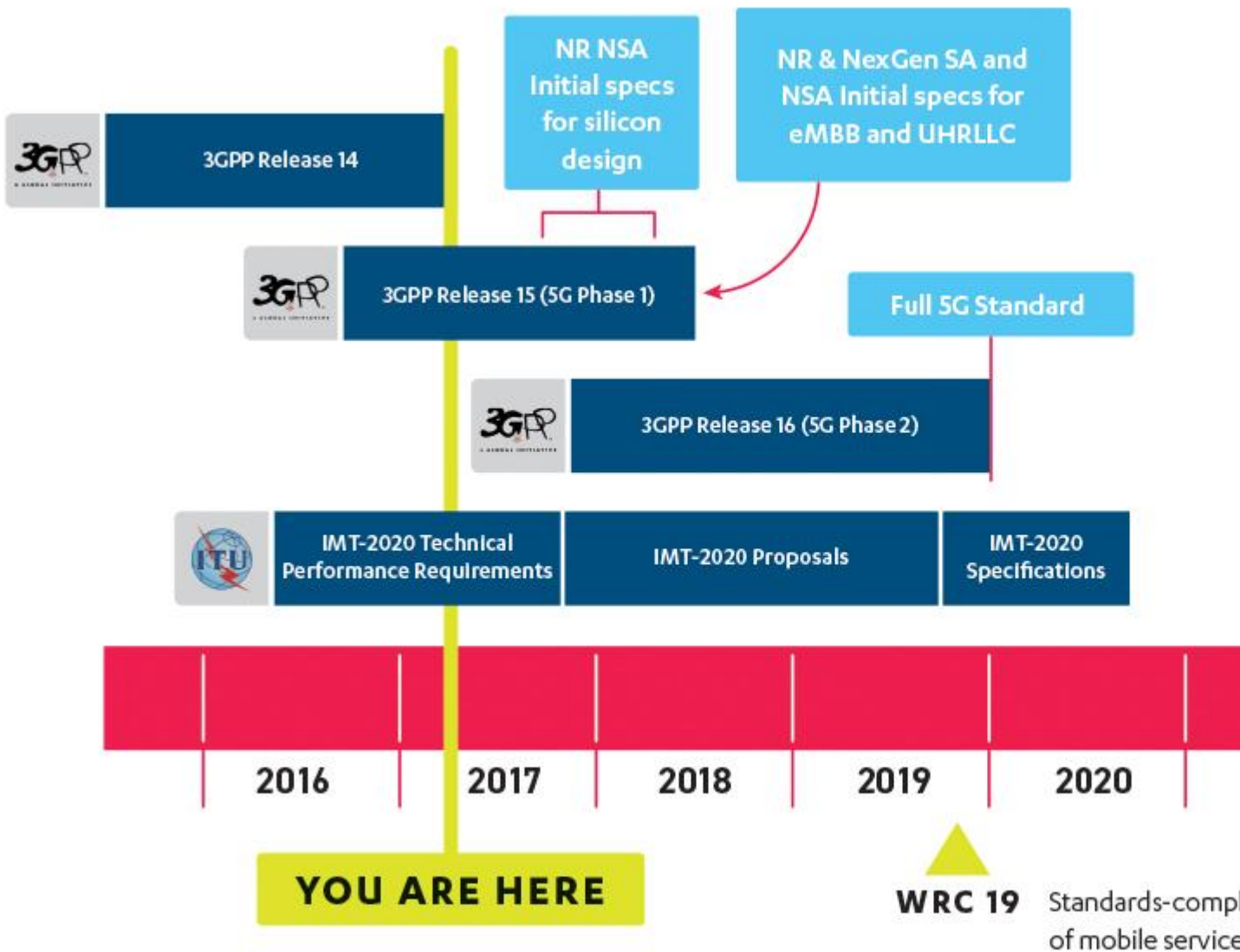
5G means “the automation of everything,” according to Marcus Weldon, chief technology officer at Nokia. With technology that can operate at 40 times — and eventually 100 times — faster than today’s standards, 5G is considered a gateway to unlimited new services. Sensors in self-driving cars can identify a potential collision in two milliseconds, and stop the vehicle almost instantly. Qualcomm research points out that 5G can deliver “fiber-like performance, ushering in the next generation of highly immersive, always-connected user experiences.”

Since 5G signals can penetrate walls, foliage and barriers that interfere with other signals, there are new opportunities for faster, more uniform data rates both inside and outside buildings. Adaptive beamforming and beam tracking techniques make it possible for 5G signals to go around obstructions.

“5G will be a unifying, more capable communications fabric that will take on a much bigger role than previous generations of mobile technology,” explains Matt Branda, director of Technical Marketing at Qualcomm. “It’s a layer of connectivity that will become fundamental to our cities, jobs, homes and ourselves.”

Telecommunications carriers are eager to jump into the 5G arena, even though full rules and standards are not expected until 2020. For example, AT&T launched its “5G Evolution” service in about 20 markets during 2017, giving customers who use Samsung Galaxy S8 or S8+ handsets access to speeds about twice as fast as on AT&T’s 4G LTE network. AT&T said it was “laying the foundation ... for our evolution to 5G while the 5G standards are being finalized.” AT&T cited values such as reduced gaming lag and less buffering when watching your favorite videos on the go. In addition, AT&T allowed participants to stream live TV via DIRECTV NOW, the offshoot of the satellite TV service that the company acquired in 2015.

Projected 5G Standards Timeline



SOURCE: AT&T IN ATIS SMART CITIES ROADMAP REPORT

For its part, Verizon had 11 5G field trials running by mid-2017 (Ann Arbor; Atlanta; Bernardsville, NJ; Brockton, MA; Dallas; Denver; Houston; Miami; Sacramento; Seattle; and Washington, DC). Among them was a test in Florida using License Assisted Access (LAA), a technique that mixes licensed and unlicensed spectrum, in this case the same 5GHz channels now used for Wi-Fi. Data rates reached gigabit speeds via existing 4G Long-Term Evolution (LTE). Verizon expects to begin commercial rollout for initial 5G services in 2018 as it gathers results from the current trials, which seek performance experience in different environments and settings.



Robert S. Fisher, senior vice president, Federal Government Affairs at Verizon, cited “a sense of urgency” in the 5G agenda, calling for the need “to bring together private industry and public policymakers – industry and citizens” – to deal with infrastructure and rights-of-way issues. Speaking at the Free State Foundation event, Fisher pointed out that “driverless cars don’t work without robust wireless networks.”

Raising Awareness

Typical for new developments, especially ones that intersperse advanced technology with massive societal implications, there is relatively low public awareness about smart cities and the 5G applications being proposed.

According to the CTA's report, *The Evolution of Smart Cities and Connected Communities*, a recent Frost & Sullivan market study found that barely one-third of Americans were familiar with the "smart city" concept, although people with higher education and/or income levels said they have heard the term.

Identifying Values for Smart Cities

In June 2017, the U.S. Department of Transportation issued results of its first "Smart Cities Challenge," which sought ideas from mid-sized cities on how to create integrated, innovative smart transportation systems that would use data, applications and technology to help people and goods move more quickly, cheaply and efficiently. More than 70 cities offered proposals after the December 2015 announcement, and seven finalists (Austin, Columbus, Denver, Kansas City, Pittsburgh, Portland, OR, and San Francisco) worked with DOT to further refine their concepts.

Among the proposals: systems to implement autonomous shuttles to move city residents, to electrify city fleets, and to collectively equip more than 13,000 buses, taxis and cars with vehicle-to-vehicle Dedicated Short Range Communications (DSRC) technology.

Among the plans are Austin's effort to create a Mobility Marketplace that will improve access to mobility services for unbanked users, older Americans and those with disabilities. Columbus, OH authorities focused on the needs of newborns, citing the high infant mortality rate. New features will include a system to integrate an electronic appointments and scheduling platform for doctor visits with transit tracking so that rescheduling is automated and mothers do not need to wait weeks to reschedule appointments. The Kansas City plans call for an open data architecture to allow for "unprecedented studies in transportation engineering, urban systems operation, planning and the social sciences" with a goal of promoting entrepreneurship and empowering citizens.

Other cities' proposals include an array of telecom-based innovations. For example, the Atlanta proposal includes a network of multimodal transportation centers serving as hubs for mobility, economic development and community activity, while the Boston plan focuses on "radically programmable" city streets with dynamic markings that can change from loading zones to thoroughfares to spaces for street hockey, depending on the time of day and season." The Las Vegas vision features "new connected autonomous shuttles" to transport

workers to Las Vegas Boulevard, and new solar powered electric vehicle charging stations to reduce emissions.

Although the plans did not necessarily specify 5G as the enabling technology, the imaginative collection of projects represented viable transportation initiatives that would benefit from the sturdy, dynamic capabilities of the service.

In its seminal report *Smart Cities Technology Roadmap*, ATIS, a standards-setting organization, emphasizes that, "The promise of high bandwidth/low latency networks are embodied in the development of 5G solutions and standards."

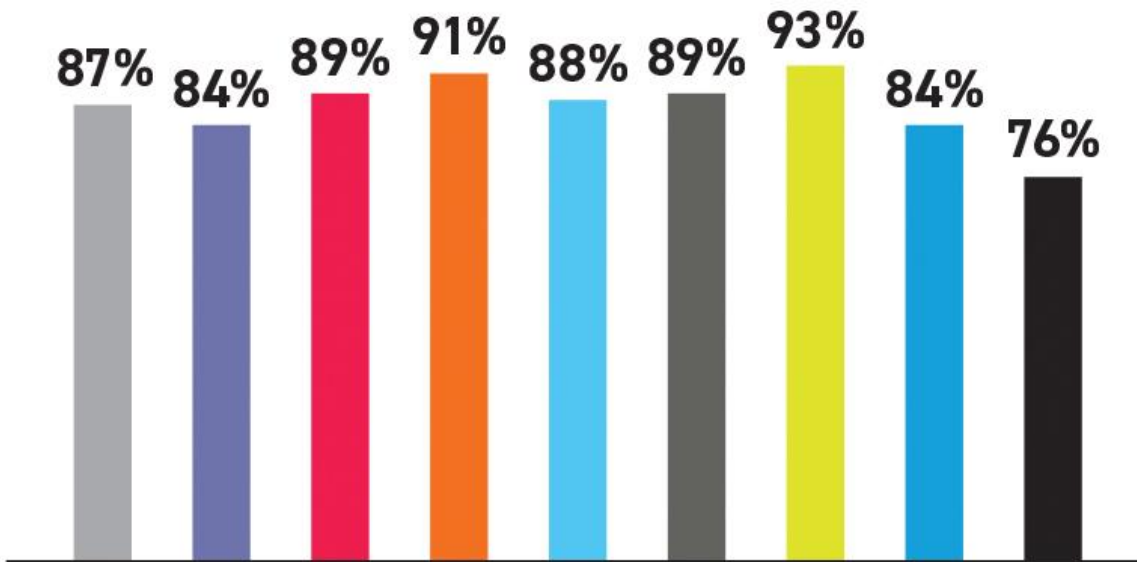
"While 5G is expected to experience widespread commercial adoption, the application to smart cities is impactful and extensible," the analysis continues, noting that "5G in the marketplace can be viewed as the product of three core elements: massive machine type communication, enhanced mobile broadband and ultra-reliable low-latency communications."

"Mobile network advancements are also key to the integration of municipal services with citizen-based commercial applications" for smart city values, ATIS concludes.

Tom Anderson, ATIS's senior technology consultant, describes the evolving 5G use cases as "dreams that are used to create the specifications." Anderson expects the initial 5G applications will "beam gigabit enterprise services," but that it won't take long for the new facilities to deliver "much higher bandwidth that can reach people and devices" throughout a community.

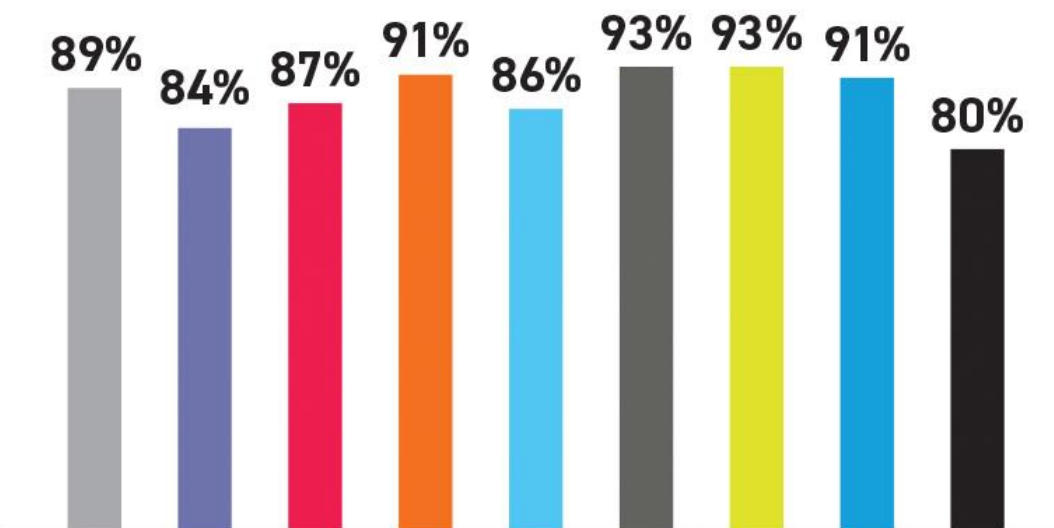
"Everyone stands to gain, including startups," he says. "Everything will flow over incumbent networks, which will see more traffic." He expects small operators to "create cool applications that will drive these businesses." Like others, Anderson foresees augmented reality as an initial popular application, offering users a "more immersive experience as they move through a venue."

5G Use Cases by Industry



Next-generation mobile networks will be a real game changer.

Scenarios of IMT for 2020 and Beyond



Next-generation mobile networks will allow us to implement services and products that are even more compelling for our customers/citizens than now.

- Total
- Automotive
- Utilities
- Public Safety
- Hi-Tech Manufacturing
- Internet/Digital Natives
- Healthcare
- Financial Services
- Media

SOURCE: ERICSSON, OPPORTUNITIES IN 5G

5G as a Game Changer

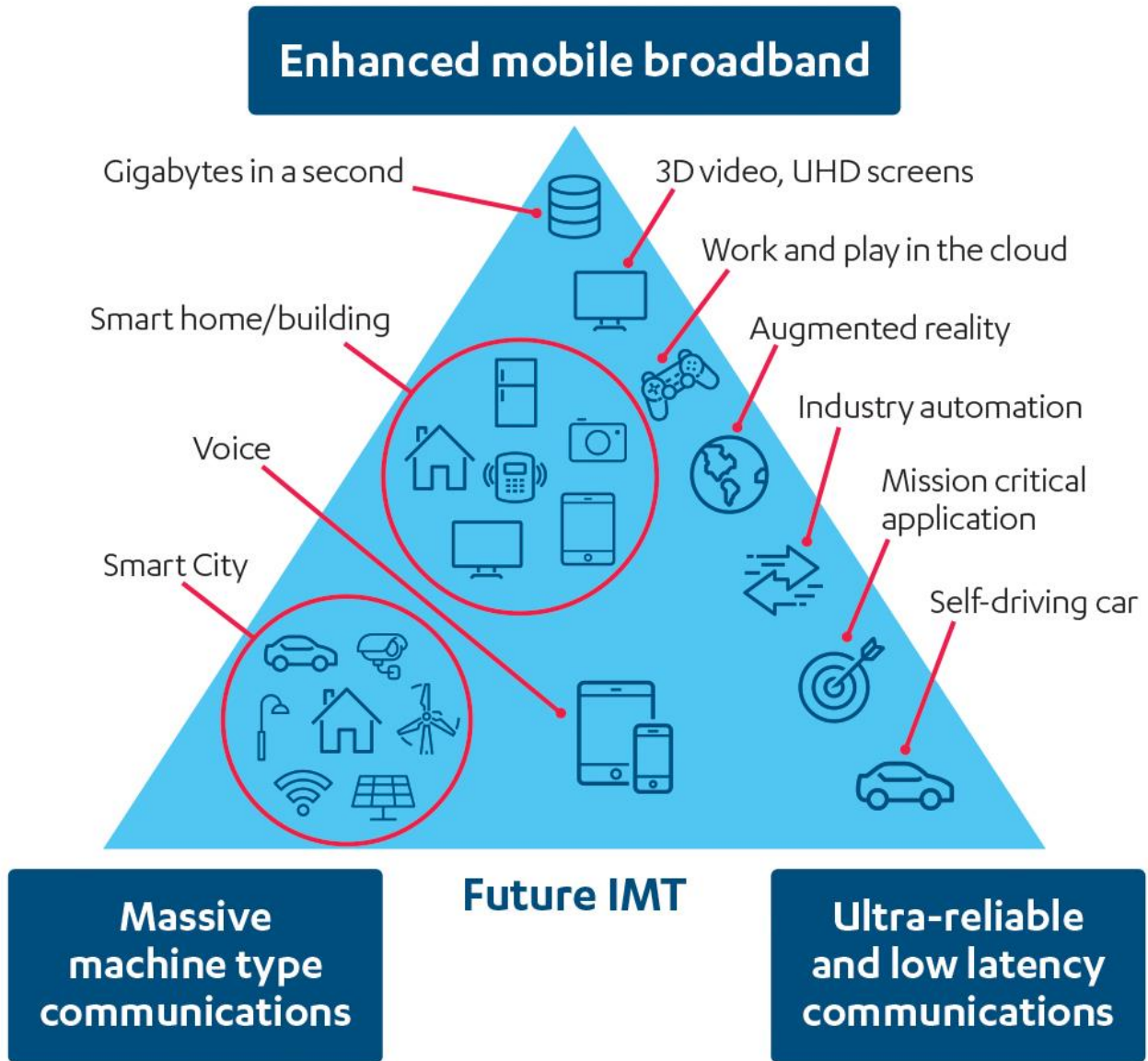
In its *Opportunities in 5G* survey of industry leaders from different lines of business, Ericsson concludes that executives perceive next-generation mobile networks as a “game changer” for their industries. They say that 5G will pave the way for innovative new technologies and services in industries such as healthcare, where remote diagnosis and surgery could radically broaden the delivery of medical services.

At the same time, many respondents voiced concern about the disruptions already underway or expected ahead thanks to new broadband connectivity and cloud services. In the Ericsson survey, public safety and healthcare organizations were among the categories with the highest levels of concern (61 percent each) about disruptions by new entrants and new business models. On the other hand, both those categories have high confidence (93 percent each) that 5G will enable them to create compelling new offerings (see chart).

Refining the Technology

The International Telecommunications Union (ITU) has also recognized the value of the features that are embedded in 5G technology. In its framework for future telecom systems, ITU singled out the relationship between the International Mobile Telecommunication (IMT) system and 5G, stressing the value of “working towards realizing the future vision of mobile broadband communications.” ITU called IMT “an essential foundation of modern society, a global force for change and empowerment, [and] increasingly the sole means for accessing communication, information, and entertainment.”

Scenarios of IMT for 2020 and Beyond



SOURCE: INTERNATIONAL TELECOMMUNICATIONS UNION: ITU-R RECOMMENDATION M.2083-0

ITU's triangle of Future IMT characteristics (see chart) includes enhanced Mobile Broadband (eMBB), massive machine communications and ultra-reliable/low-latency connections. Companies supporting the 5G agenda invariably point to this ITU structure as a mainstay of their agenda.

Inevitable Regulatory Hurdles

Since 5G technology is not confined to any specific spectrum frequency, the game is afoot to snag airwaves that best suit the services that 5G will deliver. In August, the FCC launched a proceeding to identify how mid-band spectrum (3.7 Gigahertz to 24 GHz) could be allotted for new uses. A coalition of wireless

carriers and equipment makers lauded the initiative, calling it “particularly timely given that wireless data services are expected to increase 500 percent over the next four years.” The proponents include AT&T, Broadcom, Cisco, Comsearch, CTIA, Ericsson, Google and Alphabet Access, HPE, Intel Corp., Information Technology Industry Council (ITI), Nokia, Samsung, T-Mobile, Verizon and the Wi-Fi Alliance.

Meanwhile, the FCC continues to deliberate larger issues of 5G deployment, pointing out that, “Future 5G networks will rely on three key elements: spectrum, infrastructure and backhaul.” The Commission says it is “taking steps in all of these areas to ensure that the U.S. will lead the world in the deployment of next-generation wireless technologies.”

In his remarks to the Free State Foundation in July, FCC Commissioner Michael O’Rielly focused on the immense cost and the construction process for 5G. “The biggest obstacle standing in front of 5G networks is infrastructure deployment,” he said. “To realize its potential 5G will require a densified network of millions of small cells. This will clearly be a timely and capital intensive undertaking. “He noted some local and state regulatory hurdles and voiced concern that providers are being asked to pay “astronomical fees” for the micro-cell towers that would be used in 5G technology.

Nonetheless, O’Rielly concluded with optimism about “the enormous potential of 5G networks to change the commercial wireless marketplace and the individual consumer’s wireless experience.”

CTA has weighed in on the FCC deliberations, pushing for increased access to spectrum, noting that “5G will revolutionize our connected world” with higher data rates and systems that are “five times more responsive than today’s networks.” Julie Kearney, CTA’s vice president of regulatory affairs, says that, “Connecting millions of IoT devices will place unprecedented demands on the wireless network infrastructure, so regulatory efforts must directly promote the deployment of 5G.”

Separately, in response to a Department of Commerce request for input about its “Green Paper” on ways to advance the Internet of Things, CTA recommended coordination by government agencies in approaching the topic “due to the complex, interdisciplinary, cross-sector nature of IoT.” CTA also

recognizes the value of such coordination “when working with international and private sector partners.”

“Voluntary, consensus-based, global standards are best positioned to help advance IoT development and innovation because they promote interoperability and provide a clearer path along which technologies can evolve,” CTA explains, citing the benefit of agencies (including the National Institute of Standards and Technology and the National Telecommunications and Information Administration – both agencies within the Commerce Department) working together to develop such standards.

On Capitol Hill, Rep. Mike Doyle (D-PA) has circulated a “5G Acceleration Act” to spur Congressional discussion and set deadlines for the FCC and NTIA to push ahead with 5G agendas. “Wireless broadband is a major driver of our economy, and spectrum is the infrastructure of the 21st century,” Doyle said. “This draft bill is intended to benefit consumers, wireless providers and the stakeholders who use unlicensed wireless technologies.”

The complicated standards approval process involves several major technology groups, including the 3GPP (3rd Generation Partnership Project), a consortium of seven global standards development “Organizational Partners” that worked on earlier wireless standards. It is now involved in establishing 5G specifications. The Next Generation Mobile Networks Alliance, a Germany-based organization of 80 mobile operators, manufacturers and researchers, is, among other things, examining 5G use cases for their diverse requirements in such categories as user experience, system performance, enhanced services, business models and network operation.

Work in Progress

As with any fast-evolving technology, 5G is facing continual enhancements. For example, Qualcomm is citing the broad support for its 5G NR (New Radio) platform, pointing to the expected completion of its Stage 3 Non-Standalone (NSA) features in December 2017, followed by the Stage 3 completion of a standalone (SA) version in June 2018. According to Qualcomm, 5G NR NSA will use “the existing LTE radio and core network as an anchor for mobility management and coverage while adding a new 5G carrier. This is the configuration that will be the target of early 2019 deployments (in 3GPP terminology, this is NSA 5G NR deployment scenario Option 3).”

In the Accenture Strategy vision for 5G, there is a complex matrix of activities and cost savings, ranging from energy to parking meter management. For example, Accenture predicts that by spacing self-driving cars at a safe distance apart, to reduce air flow drag over a convoy of vehicles, fuel savings would be 25 percent. For public transportation, smart wireless systems would optimize bus inventory and reduce rider wait times. In the public safety category, Accenture cites the ability of micro-cell sensors to identify the location of gunshots and assist police in responding to emergency incidents.

Security and Privacy

Whether it's tinkering with an automated parking meter or hijacking the controls of a self-driving vehicle or a catastrophic incursion into the smart grid or community water system – cyber threats are part of the new equation of smart cities and wireless technology. Public policy is addressing such concerns on multiple levels, well beyond the scope of this 5G status report. For example, in its filing on the Commerce Department's IoT Green Paper, CTA honed in on the issues of "Cybersecurity and Privacy." It endorsed programs to support and promote "policies that encourage risk-based approaches, security by design, and the ability to patch insecure software and devices" as well as the use of strong encryption and consumer education programs.

"IoT unquestionably presents serious security issues that must be grappled with by all elements of the marketplace, including device makers, product dealers, hardware and software vendors, service providers and other stakeholders," CTA says. "Multi-layered protection must at least protect storage, and enable device identification and authentication, software authentication and trusted execution environment."

ATIS, in its broad report, asserts that "encryption is becoming a pervasive reality in the networks we run today, and 5G will be no exception to that rule. It is critical to have visibility at all layers of a communications stack as well as at different points in the network, allocated equally as pervasive" to assure safety throughout "the critical infrastructure that operates the mobile networks today."

Despite such challenges, the 5G juggernaut continues to plow ahead. As Ericsson points out in its assessment of 5G use within the public utility sector, 5G "will play a major role" in cutting costs and securing facilities.



5G at CES 2018

The Smart Cities Marketplace and a conference track about connected and smart technologies will converge at CES 2018. Collectively, they will bring together an important topic that CES has showcased in recent years, such as leading-edge smart city innovations, Internet of Things devices, self-driving technology, smart home systems and drones.

The Smart Cities Marketplace will feature enabling technology such as artificial intelligence systems, sensors, data analytics, transportation, network infrastructures, and other devices and services. The multiday conference agenda will highlight 5G technologies and public/private partnerships with presentations by experts in utilities, health, safety and other public services.

Gary Shapiro, president and CEO, CTA, cites the new CES initiatives as a showcase of developments that “are making our cities more efficient, sustainable and responsive through the use of data to enable better processes and decision making.” He adds the new Smart Cities agenda is “a perfect stage for city planners and decision makers to explore these world-changing technologies because of the diversity of technologies and industries in attendance, including mobile, transportation, data and sensors and digital health.

How Big Will 5G Be?

With so much 5G development underway, forecasters are having a field day guesstimating the size of the market. Here are a few recent predictions.

Ovum Ltd., a British analyst firm, expects 389 million 5G subscriptions globally by the end of 2022. That will mark a sizeable jump from around 100 million 5G subs worldwide by the end of 2021. Ovum explains that it upped its forecast (which previously had topped at 25 million worldwide at the end of 2021) because of an expected surge of usage in the Asia-Pacific region. It also cited the accelerated timeline for 5G standards.

Meanwhile, Ericsson is even more enthusiastic, forecasting that the world will have more than a half billion 5G users by the end of 2022. It too cites the recent technology momentum and fast-track standardization. Ericsson pointed to “large-scale” trials and deployments that will start in 2019. Its calculation does not include machine-based connections or fixed wireless access services. ■