Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
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Promoting Investment in the 3550-3700 MHz Band	)	GN Docket No. 17-258
	)	

COMMENTS OF THE GENERAL ELECTRIC COMPANY

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EXECUTIVE SUMMARY

The General Electric Company ("GE") urges the Federal Communications Commission ("Commission") to retain its innovative census-tract framework for the Citizens Broadband Radio Service ("CBRS"). Census-tract licensing for Priority Access Licenses ("PALs") will encourage a broad range of parties to develop dynamic, diverse uses of this spectrum. GE and its industrial and critical-infrastructure customers, in particular, will utilize the CBRS band to bring the full benefits of the "Industrial Internet of Things" ("IIoT") to the American public. The Commission's current flexible, market-based licensing approach in the CBRS band will enhance spectrum efficiency, generate enormous economic and public safety benefits for U.S. industry and critical infrastructure, and catalyze U.S. technology innovation and leadership in the IIoT. In contrast, a shift to much larger Partial Economic Area ("PEA") licenses would leave this spectrum entirely under the control of established wireless carriers, reducing the utility of the CBRS band and squandering a historic opportunity to spur innovation and economic and public safety benefits through widespread scaling of the IIoT.

GE is a global digital industrial company involved in multiple lines of business around the world. As one of the leaders of the IIoT revolution that is transforming industrial activity, GE has a strong interest in the instant proceeding on the future of CBRS. The IIoT involves digital connectivity between machines, computers, and people that enables intelligent industrial operations. The IIoT is already driving greater levels of efficiency, productivity, and security in industries such as power generation and distribution, oil and gas, manufacturing, healthcare, rail, and aviation.

IIoT-related wireless communications are poised to deliver even greater benefits in the near future, given the explosive growth of industrial data and developments in "edge" computing. Next-generation, automated inspection and sensor technologies – including aerial drones, terrestrial crawlers, submersibles, robots, and other remote inspection equipment – can provide industrial and

critical-infrastructure customers with real-time HD video, imaging, audio, and other bandwidth-intensive sensing, monitoring, and inspection content. These technologies and machines can be utilized at oil refineries, deep-sea platforms, oil wells, pipelines, petrochemical flare stacks, airports, seaports and other maritime facilities, and manufacturing plants. Through real-time monitoring and Big Data analytics, IIoT systems enable industrial and critical-infrastructure operators to perform preventative maintenance of industrial equipment to reduce production downtime, troubleshoot problems almost instantaneously, and prevent accidents or equipment malfunctions involving jet engines, locomotives, and other industrial and critical-infrastructure equipment.

To realize the full potential of the IIoT, however, GE and its industrial and critical-infrastructure customers require a spectrum platform that provides secure, reliable, and cost-effective connectivity on a localized basis. Under the current rules, the CBRS band promises to fill this role by enabling GE and its customers to use their own licensed 3.5 GHz spectrum to "self-provision" IIoT wireless connectivity over geographically targeted, private TDD-LTE networks, rather than having to rely on wireless carrier services. Self-provisioned networks at 3.5 GHz will allow GE and its customers to reduce costs, minimize harmful interference, enhance safety, and optimize network and IIoT-system performance. With the CBRS band as a platform, the safety, performance, and economic benefits of the IIoT will spur dramatic productivity growth in the U.S. manufacturing sector, already a critical engine of U.S. economic activity.

Beyond its potential benefits for the IIoT, the Commission's CBRS framework is already a dramatic success story, sparking a wave of activity and collaboration between established and non-traditional wireless stakeholders. The Commission's innovative licensing approach is a fundamentally sound response to the unique spectrum environment at 3.5 GHz, where the presence of federal incumbents requires complex spectrum sharing. Licensing by census tract – which in 2015 was the compromise, "middle ground" between site-specific licenses and larger, traditional

license areas – is appropriate in a band where most operations are likely to be small-cell, localized wireless network deployments. Importantly, the Commission's CBRS rules are competitively and technologically neutral, and myriad CBRS use cases will be initiated by a range of businesses and other 3.5 GHz users, including GE and other IIoT providers, WISPs, hospitals, commercial real estate interests, hotels and resorts, state and local government agencies, and educational institutions.

An unnecessary overhaul of the CBRS framework would abruptly halt this momentum. PEA-based licensing would exponentially raise the cost of PALs and create substantial barriers to entry, converting licensed CBRS spectrum into a commercial mobile band like most others. GE and its customers would be highly unlikely to win PEA licenses at auction, since it would not be economically rational for them to outbid established wireless carriers for PEA licenses covering territory extending far beyond their geographically targeted deployments. Inevitably, the incumbent mobile operators that regularly spend billions of dollars on spectrum would acquire these PALs. By biasing the auction process and predetermining the entities and applications making use of the 3.5 GHz band, this policy would conflict with Chairman Ajit Pai's repeated warnings that the Commission has no business picking winners and losers in the marketplace.

Importantly, the Commission cannot count on the secondary market to avoid the harms from PEA-based licensing at 3.5 GHz. Large wireless operators holding these CBRS licenses would be unlikely to make meaningful amounts of 3.5 GHz spectrum available to GE, its IIoT customers, and other non-traditional spectrum users. Even where available on the secondary market, it is likely that this spectrum would come at an exorbitant, uneconomic cost or be subject to lease terms and conditions that prevent GE and its customers from realizing the full potential of IIoT connectivity.

Having initiated this re-examination of CBRS licensing policies against its better interest, the Commission now faces a stark choice between two very different outcomes in this band: census-tract licensing and a dynamic, heterogeneous spectrum ecosystem, or PEA-based licensing

and domination of the band by established commercial mobile operators. For a number of compelling reasons, census-tract licensing remains the better policy at 3.5 GHz.

First, census-tract licensing will yield better economic results. Compared to PEA-based assignments, census-tract licensing is a more flexible, market-based approach that will result in greater spectrum efficiency and make the highest and best use of this spectrum band. By maintaining low barriers to entry, census-tract licensing will stimulate greater innovation, competition, and investment in this band. Wider auction participation will ensure that CBRS licenses are held by the parties that value this spectrum the most. In addition, while carriers holding PEA licenses would likely "warehouse" spectrum in rural areas, census-tract licensees will make full use of the CBRS band with localized deployments across a variety of geographies.

As described above, census-tract licensing will generate essential economic and public safety benefits in the industrial and critical-infrastructure sectors. Numerous observers project that IIoT operations could add trillions of dollars to U.S. economic output over the next decade, and CBRS can serve as a springboard for GE and others to meet these projections and maximize the economic impact of next-generation IIoT applications. Robust IIoT systems at 3.5 GHz will also enhance public safety by making critical-infrastructure facilities more resilient, safe, and secure. In contrast, PEA-based licensing over time would likely result in hundreds of billions of dollars in lost U.S. economic growth and prevent significant improvements in critical-infrastructure safety and security.

Census-tract licensing will further the statutory goals of the auction provisions contained in Section 309(j) by avoiding an excessive concentration of licenses and fostering intensive use of the 3.5 GHz band. This licensing approach will also help position the United States as a global leader in the development of 5G and next-generation applications. If the Commission's CBRS licensing structure is successful, the 3.5 GHz band will become a template for innovative spectrum management, not only in this country but globally.

Concerns regarding auction complexity should not weigh against CBRS census-tract licensing. The Commission has the technical expertise, experience, and incentive to conduct an auction of census-tract PALs. On the heels of the Commission's Broadcast Incentive Auction, the Commission is certainly capable of designing and executing an auction of PALs in the CBRS band. Nor do spectrum access system ("SAS") issues favor a switch to PEA-based licensing. Developers and future administrators of SAS have made clear that this technology is fully capable of managing the RF environment resulting from the Commission's census-tract licensing framework.

The Commission asks for comment on a county-based licensing framework, but that approach would have largely the same effects as a PEA-based scheme. While smaller than PEAs, counties are much larger than census tracts, and the cost of county-based PALs would be well beyond what GE's industrial and critical-infrastructure customers are willing to spend. County-based PAL licensing would leave this spectrum in the control of large wireless carriers and established broadband operators, stifling innovation and reducing public interest benefits in the CBRS band.

For all of the reasons described above, the Commission's adoption of PEA-based licensing and elimination of the "innovation band" at 3.5 GHz would constitute a lost opportunity for U.S. spectrum policy. In this scenario, GE will have to pursue other regulatory routes to obtain licensed spectrum that supports the IIoT's future growth. At 3.5 GHz, GE might seek a mechanism similar to the Contained Access Facility proposal previously considered in this band. Elsewhere, it will have to advocate for innovative licensing policies in other newly available commercial bands – including the 3.7-4.2 GHz band – which offer substantial spectrum that could support the deployment of geographically targeted, private LTE and 5G networks at both indoor and outdoor industrial/critical-infrastructure facilities. GE and its IIoT customers simply cannot lose access to spectrum that provides secure, interference-protected, and cost-effective wireless connectivity.

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COMMENTS OF THE GENERAL ELECTRIC COMPANY

I. INTRODUCTION AND SUMMARY

The General Electric Company ("GE") hereby comments on the Federal Communications Commission's ("Commission's") October 2017 Notice of Proposed Rulemaking ("*NPRM*") in the above-captioned proceeding.[1] The Commission should retain its innovative census-tract framework for the Citizens Broadband Radio Service ("CBRS"). Census-tract licensing for Priority Access Licenses ("PALs") will encourage a broad range of parties to develop dynamic, diverse uses of this spectrum. GE and its industrial and critical-infrastructure customers, in particular, will utilize the CBRS band to bring the full benefits of the "Industrial Internet of Things" to the American public. The Commission's current flexible, market-based licensing approach in the CBRS band will enhance spectrum efficiency, put 3.5 GHz spectrum into the hands of parties that value it most, generate enormous economic and public safety benefits for U.S. industry and critical infrastructure, and catalyze U.S. technology innovation and leadership in the Industrial Internet of Things ("IIoT"). In contrast, a Commission decision to reverse course and shift to much larger Partial Economic Areas ("PEA") licenses – just two plus years

[1] *See Promoting Investment in the 3550-3700 MHz Band*, Notice of Proposed Rulemaking and Order Terminating Petitions, 32 FCC Rcd 8071 (2017) ("*NPRM*").

after its 2015 CBRS order[2] – would leave this licensed spectrum entirely under the control of established wireless carriers, reducing the utility of the CBRS band and squandering a historic opportunity to spur innovation and economic and public safety benefits through widespread scaling of the IIoT.

GE is a global digital industrial company involved in multiple lines of business around the world. As one of the leaders of the Industrial Internet of Things revolution that is transforming industrial activity, GE has a strong interest in the instant proceeding, which will have a substantial impact on the future trajectory of the IIoT. The IIoT involves digital connectivity between machines, computers, and people that enables intelligent industrial operations. The IIoT is already driving greater levels of efficiency, productivity, and security in industries such as power generation and distribution, oil and gas, manufacturing, healthcare, rail, and aviation.

IIoT-related wireless communications are poised to deliver even greater benefits in the near future, given the explosive growth of industrial data and developments in "edge" computing. The development of next-generation, automated inspection and sensor technologies – including aerial drones, terrestrial crawlers, submersibles, robots, and other remote inspection equipment – can provide industrial and critical-infrastructure customers with real-time HD video, imaging, audio, and other bandwidth-intensive sensing, monitoring, and inspection content. These technologies and machines can be utilized at oil refineries, deep-sea platforms, oil wells, pipelines, petrochemical flare stacks, airports, seaports and other maritime facilities, and manufacturing plants. Crawlers, submersibles, and other equipment can undertake inspections in areas inaccessible to human inspectors, enhancing maintenance efforts and safely providing

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[2] *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd 3959 (2015) ("*2015 Order*").

access to data that would otherwise be unavailable. Through real-time monitoring and Big Data analytics, IIoT systems enable industrial and critical-infrastructure operators to perform preventative maintenance of industrial equipment to reduce production downtime, troubleshoot problems almost instantaneously, and prevent accidents or equipment malfunctions involving jet engines, locomotives, and other industrial and critical-infrastructure equipment.

To realize the full potential of the IIoT, however, GE and its industrial and critical-infrastructure customers require a spectrum platform that provides secure, reliable, and cost-effective connectivity, functionality, and bandwidth on a localized basis. Under the current rules, the CBRS band promises to fill this role by enabling GE and its customers to use their own licensed 3.5 GHz spectrum to "self-provision" IIoT wireless connectivity over geographically targeted, private TDD-LTE networks, rather than having to rely on wireless carrier services. Self-provisioned networks at 3.5 GHz will allow GE and its industrial and critical-infrastructure customers to minimize costs, control service quality, enhance safety, and optimize network and IIoT-system performance. With the CBRS band as a platform, the safety, performance, and economic benefits of the IIoT will spur dramatic productivity growth in the U.S. manufacturing sector, already a critical engine of U.S. economic activity.

Beyond its potential benefits for the IIoT, the Commission's CBRS framework is already a dramatic success story, sparking a wave of activity and collaboration between established and non-traditional wireless stakeholders. The Commission's innovative licensing approach in the *2015 Order* is a fundamentally sound response to the unique spectrum environment at 3.5 GHz, where the presence of federal incumbents requires complex spectrum sharing. The technical characteristics of the 3.5 GHz band also favor a novel, granular licensing approach for CBRS. Licensing by census tract – which in 2015 was the compromise, "middle ground" between site-

specific licenses and larger, traditional license areas – is appropriate in a band where most operations are likely to be small-cell, localized wireless network deployments. Importantly, the Commission's CBRS rules are competitively and technologically neutral. Myriad CBRS use cases will be initiated by a range of businesses and other 3.5 GHz users, including GE and other IIoT providers, WISPs, hospitals, commercial real estate interests, hotels and resorts, state and local government agencies, and educational institutions.

The Commission's unnecessary overhaul of the CBRS framework would abruptly halt this momentum. PEA-based licensing would exponentially raise the cost of PALs and create substantial barriers to entry, thereby converting licensed CBRS spectrum into a commercial mobile band like most others. GE and its customers would be highly unlikely to win PEA licenses at auction, since it would not be economically rational to outbid established wireless carriers for wide-ranging PEA licenses covering territory extending far beyond their geographically targeted, localized deployments. Inevitably, the nationwide incumbent mobile operators that regularly spend billions of dollars on spectrum would acquire these PALs. By biasing the auction process and in turn predetermining the entities and applications making use of the 3.5 GHz band, this revised policy would conflict with Chairman Ajit Pai's repeated and sound warnings that the Commission "ha[s] no business picking winners and losers in the marketplace."[3]

The Commission cannot count on its secondary market mechanisms to avoid the harms from PEA-based licensing in the 3.5 GHz band. Large wireless operators holding these CBRS licenses would be unlikely to make meaningful amounts of 3.5 GHz spectrum available to GE, its IIoT customers, and other non-traditional spectrum users. Even where available on the secondary

[3] *See* Ajit Pai, Chairman, FCC, Remarks on Restoring Internet Freedom (Nov. 28, 2017) ("We have no business picking winners and losers in the marketplace.").

market, it is likely that this spectrum would come at an exorbitant, economically untenable cost or be subject to lease terms and conditions that prevent GE and its customers from realizing the full potential of IIoT connectivity.

Thus, having initiated this re-examination of CBRS licensing policies against its better interest, the Commission now faces a stark choice between two very different outcomes in this band: census-tract licensing and a dynamic, heterogeneous spectrum ecosystem, or PEA-based licensing and domination of the band by established commercial mobile operators. For a number of compelling reasons, census-tract licensing remains the better policy at 3.5 GHz.[4]

First, census-tract licensing will yield better economic results. Concurrently filed with GE's comments is a report authored by Dr. William Lehr, an economist, researcher, and industry consultant in the Computer Science and Artificial Intelligence Laboratory at the Massachusetts Institute of Technology.[5] As Dr. Lehr describes in his report, compared to PEA-based assignments, census-tract licensing is a more flexible, market-based approach that will result in greater spectrum efficiency and make the highest and best use of this spectrum band. By maintaining low barriers to entry, census-tract licensing will stimulate greater innovation,

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[4] Some parties have suggested that the Commission move to county-based licensing as a compromise solution in the 3.5 GHz band, and the Commission asks for comment on a county-based approach in the *NPRM*. *NPRM* ¶ 25. County-based licensing would have largely the same effects, however, as a PEA-based scheme. While smaller than PEAs, counties are much larger than census tracts. On average, U.S. counties hold about 23 times the population of census tracts, and many counties encompass thousands of square miles. Over half of the population of the United States lives in just 146 counties, and population-heavy counties such as the County of Los Angeles in California and Suffolk County in New York cover enormous geographic territory. Overall, county-sized licenses are far too large for geographically targeted CBRS deployments, and the cost of county-based PALs would be well beyond what GE's industrial and critical-infrastructure customers are willing to spend. As a result, county-based PAL licensing would leave this spectrum in the control of large wireless carriers and established broadband operators, similar to the outcome under a PEA-based licensing approach.

[5] Dr. William Lehr, *Analysis of Proposed Modifications to CBRS PAL Framework*, WT Docket No. 17-258 (Dec. 28, 2017) ("Lehr Analysis").

competition, and investment in this band. Wider auction participation will ensure that CBRS licenses are held by the parties that value this spectrum the most. In addition, while carriers holding PEA licenses would likely "warehouse" spectrum in rural areas, census-tract licensees will make full use of the CBRS band across a variety of geographies.

Census-tract licensing will also generate substantial economic and public safety benefits in the industrial and critical-infrastructure sectors. Numerous observers project that IIoT operations could add trillions of dollars to U.S. economic output over the next decade; for instance, Accenture forecasts that the IIoT could add at least $6.1 trillion in cumulative gross domestic product ("GDP") by 2030, while IndustryARC projects that the global IIoT market will reach $123.89 billion by 2021.[6] Under the current rules, CBRS will serve as a springboard for GE and others to meet these projections and maximize the economic impact of next-generation IIoT applications and services. In addition, robust IIoT systems at 3.5 GHz will enhance public safety in the United States by making critical-infrastructure facilities more resilient, safe, and secure. A shift to PEA-based licensing, on the other hand, would ultimately cost the United States hundreds of billions of dollars in lost economic and industrial growth and prevent significant improvements in critical-infrastructure safety and security. The Commission would also forego important public interest benefits resulting from educational, municipal, and rural broadband use of the CBRS band.

Census-tract licensing for PALs will further the statutory goals of the auction provisions contained in Section 309(j) by avoiding an excessive concentration of licenses and fostering intensive use of the 3.5 GHz band. In addition, this licensing approach will help position the United States as a global leader in the development of 5G and next-generation applications. If

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6 *See* notes 8-9, *infra*.

the Commission's CBRS licensing structure is successful, the 3.5 GHz band will become a template for innovative spectrum management, not only in this country but globally.

Concerns regarding auction complexity should not weigh against CBRS census-tract licensing. The Commission has the technical expertise, experience, and incentive to conduct an auction of census-tract PALs. On the heels of the Commission's broadcast Incentive Auction – likely the most complex spectrum auction ever – the Commission is certainly capable of designing and executing an auction of PALs in the CBRS band. Nor do spectrum access system ("SAS") issues favor a switch to PEA-based licensing. Developers and future administrators of SAS have made clear that this technology is fully capable of managing the radio-frequency ("RF") environment resulting from the Commission's census-tract licensing framework.

Finally, given the benefits of the existing CBRS licensing framework, there is no need for the Commission to extend the PAL license term to ten years and make these licenses renewable under the criteria applicable to other commercial mobile licenses. A simultaneous move to longer license terms and renewable PALs would only exacerbate the harms from a shift to larger license areas, further raising barriers to entry by IIoT interests and other non-traditional spectrum users.

For all of the reasons described above, the Commission's adoption of PEA-based licensing and elimination of the "innovation band" at 3.5 GHz would constitute a lost opportunity for U.S. spectrum policy. In this scenario, GE will have to pursue other regulatory routes to obtain licensed spectrum that supports the IIoT's future growth. At 3.5 GHz, GE might seek a mechanism similar to the Contained Access Facility ("CAF") proposal previously considered in this band. Elsewhere, it will have to advocate for innovative licensing policies in other newly available commercial bands – including the 3.7-4.2 GHz band – which offer

substantial spectrum that could support the deployment of geographically targeted private LTE and 5G networks at both indoor and outdoor industrial/critical-infrastructure facilities.

II. GENERAL ELECTRIC AND THE INDUSTRIAL INTERNET OF THINGS

GE is a global digital industrial company involved in multiple lines of business around the world. Headquartered in Boston, GE's wide variety of products and services include power generation, water processing, aircraft engines, freight locomotives, mining equipment, security technology, oil and gas production, medical imaging and life science technologies, business and consumer financing, and "Big Data" software analytics. With a market capitalization of over $150 billion, GE operates in more than 178 countries and has approximately 295,000 employees worldwide, including more than 130,000 in the United States.

As one of the leaders of the "Industrial Internet of Things" revolution that is transforming industrial activity around the world, GE has a strong interest in the instant proceeding, which is likely to have a substantial impact on the future of the IIoT in the United States. IIoT involves connectivity between machines, computers, and people that enables intelligent industrial operations. Utilizing machine-to-machine ("M2M") communications, industrial-scale Big Data analytics, and related information technologies, IIoT systems monitor, collect, and analyze industrial data and deliver valuable information and insights to critical-infrastructure entities and other businesses. The IIoT is already driving greater levels of efficiency, productivity, security, and performance in industries such as power generation and distribution, oil and gas, manufacturing, healthcare, freight rail, and aviation. The IIoT will enhance public safety and save companies billions of dollars a year by detecting industrial failures before they occur and preventing life-threatening and high-risk situations in industrial environments.

Over time, the IIoT is expected to increase the productivity and global competitiveness of the U.S. manufacturing sector by a significant margin. The manufacturing sector is already a

critical engine of productivity for the U.S. economy, generating a gross output of $5.9 trillion in 2013, which represented 35.4% of the U.S. gross domestic product that year. The manufacturing sector also supported a total of 29.1 million jobs in the United States in 2013, more than one-fifth of total U.S. employment that year.[7] Looking forward, numerous observers and analysts have concluded that IIoT will trigger substantial growth in the industrial-manufacturing sector and in the global and U.S. economies more generally. Accenture estimates that IIoT could add $14.2 trillion to the global economy by 2030, and projects that the U.S. economy will gain at least $6.1 trillion in cumulative U.S. GDP by that same year.[8] IndustryARC projects that the global IIoT market will reach $123.89 billion by 2021,[9] while Markets and Markets estimates that the IIoT's market value will climb to $195.47 billion by 2022, with an annual growth rate of approximately eight percent.[10] Meanwhile, McKinsey has forecast the potential global impact of smart cities, transportation, healthcare, retail,

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[7] Robert E. Scott, *The Manufacturing Footprint and the Importance of U.S. Manufacturing Jobs*, ECONOMIC POLICY INSTITUTE, at 4 (2015), http://www.epi.org/files/2015/bp388-manufacturing-footprint.pdf.

[8] Paul Daugherty and Bruno Berthon, *Winning with the Industrial Internet of Things: How to Accelerate the Journey to Productivity and Growth*, ACCENTURE, at 2-3 (2015), https://www.accenture.com/t00010101T000000Z__w__/at-de/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Dualpub_11/Accenture-Industrial-Internet-of-Things-Positioning-Paper-Report-2015.ashx.

[9] *The Industrial Internet of Things (IIoT): the Business Guide to Industrial IoT*, I-SCOOP, https://www.i-scoop.eu/internet-of-things-guide/industrial-internet-things-iiot-saving-costs-innovation (last visited Dec. 28, 2017).

[10] *Industrial IoT Market by Device & Technology (Sensors, RFID, Industrial Robotics, DCS, Condition Monitoring, Smart Meters, AHS, Camera System, Networking Technologies), Software (PLM Systems, MES, SCADA), Vertical, and Geography – Global Forecast to 2022*, MARKETSANDMARKETS, at Summary (Feb. 2017), http://www.marketsandmarkets.com/Market-Reports/industrial-internet-of-things-market-129733727.html.

manufacturing, and other IIoT applications to be $3.9 to $11.1 trillion per year by 2025.[11] These various projections are consistent with GE's own internal forecast that IIoT technologies will add $15.3 trillion to global GDP by 2030[12] and that investment in the IIoT will exceed $60 trillion by that year.[13]

GE's existing applications and services for the IIoT. Today, GE provides hardened, mission-critical technologies and communications networks for leading industrial and critical-infrastructure entities. Tailored to meet customers' objectives and unique geographic requirements, GE's applications, equipment, and services enable customers to optimize their industrial and utility-related operations, making them more efficient, reliable, and secure. As described below in these Comments, IIoT-related "edge to cloud" wireless communications are poised to deliver even greater benefits to its customers, the U.S. economy, and the public interest in the coming decade.

While the IIoT's greatest benefits lie ahead, GE has for years provided a diverse range of Supervisory Control and Data Acquisition ("SCADA") products to its U.S.-based industrial and public utility customers. SCADA applications use computers, networked data communications, and graphical user interfaces for remote, high-level process management. These systems monitor and control the delivery of essential electric, gas, water, and other services to the public. SCADA

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11 *See The Internet of Things: Mapping the Value Beyond the Hype*, MCKINSEY GLOBAL INSTITUTE, at vii, 2 (June 2015), https://www.mckinsey.de/files/unlocking_the_potential_of_the_internet_of_things_full_report.pdf.

12 Peter C. Evans and Marco Annuziata, *Industrial Internet: Pushing the Boundaries of Minds and Machines,* GENERAL ELECTRIC, at 29 (Nov. 26, 2012), http://www.ge.com/docs/chapters/Industrial_Internet.pdf.

13 *See* Press Release, General Electric, *GE Announces Predix Cloud – The World's First Cloud Service Built for Industrial Data and Analytics* (Aug. 5, 2015), http://www.ge.com/digital/press-releases/ge-announces-predix-cloud-worlds-first-cloud-service-built-industrial-data-analytics.

systems have transformed the operation of critical-infrastructure facilities, enabling these entities to control large-scale processes over multiple sites, reduce infrastructure costs, increase ease of maintenance and integration, and improve worker safety.

To deliver this SCADA capability, GE has taken full advantage of the Commission's non-exclusive licensing framework in the 3650-3700 MHz band ("3.65 GHz band"), developing and marketing industrial communications systems to customers all over the United States. GE has developed its own suite of technologies that support fixed point-to-point wireless connections in the 3.65 GHz band. In total, GE has supplied its industrial and critical-infrastructure customers with over 8,500 radios operating at hundreds of sites across the country.[14]

GE's MDS Mercury Series – its most commercially successful SCADA product line – is a highly secure, industrial-grade WiMAX communications platform that uses the 3.65 GHz band and other spectrum for SCADA and mission-critical industrial applications. The MDS Mercury 3650 system supports data rates up to 30 Mbps and allows GE's customers to build a communications infrastructure tailored to their specific business and geographic needs.[15] This product was designed to comply with stringent industrial specifications and support a diverse range of applications, including smart metering, utility substation automation, positive traction control for trains, oil and gas pipeline monitoring, wastewater management, heavy mining, and other forms of IIoT and M2M telemetry.[16]

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[14] GE is one of over 2,000 terrestrial wireless Part 90 licensees in the band with more than 25,000 registered sites. Numerous utilities have extensive communications systems in this band, including some with thousands of locations.

[15] *See* General Electric, *MDS Mercury 3650*, http://www.gegridsolutions.com/Communications/catalog/MercurySeries.htm (last visited Dec. 28, 2017).

[16] GE provided a full description of the MDS Mercury 3650 product, including several different operating scenarios, earlier this year. *See* Reply Comments of The General Electric Company, WT Docket No. 12-354, at 4-7 (Aug. 8, 2017).

CBRS and the future of the IIoT. Going forward, the Commission's CBRS regulatory framework at 3.5 GHz will enable GE and its critical-infrastructure customers to generate even greater economic, performance, and safety benefits from the IIoT and industrial and critical-infrastructure-related communications. GE is currently working with technology vendors to develop new IIoT connectivity solutions that take advantage of CBRS and private LTE networks for automating, monitoring, and managing industrial assets. In this effort, GE capitalizes not only on the availability of 3.5 GHz spectrum, but also on the convergence of two important developments in industrial information technology.

First, through its subsidiaries Avitas Systems and AIROS, GE is a leader in the development of next-generation inspection and sensor technologies, including the use of aerial drones, terrestrial crawlers, submersibles, robots, and other remote inspection equipment. This automated inspection capability can provide industrial and critical-infrastructure customers with real-time HD video, imaging, audio, and other bandwidth-intensive sensing, monitoring, and inspection content at oil refineries, deep-sea platforms, oil wells, pipelines, petrochemical flare stacks, and other facilities. Crawlers, robots, and other machines can undertake inspections in areas inaccessible to human inspectors, safely providing access to data that would otherwise be unavailable. Industrial and critical-infrastructure entities can use this information to troubleshoot problems on a real-time basis, ensure compliance with environmental and other regulations, and optimize their operations. This inspection technology will also reduce human exposure to hazardous and dangerous environments, thereby protecting human life and enhancing public safety.[17]

[17] Rather than have human inspectors performing inspections in such dangerous environments as oil and gas refineries, railroad yards, and factories relying on heavy machinery, automated devices can carry out such functions.

Second, the development of edge computing technology provides new options for the storage and processing of the enormous volumes of data generated by industrial and critical-infrastructure sensors, inspection equipment, and other monitors. Currently, this information is typically transmitted back to a centralized, remote cloud – in GE's case, the Predix open architecture software platform, which collects and analyzes huge amounts of industrial data.[18] Within the near future, GE's IIoT systems will rely not only on the Predix platform, but also increasingly on edge computing capabilities, with analytics and data processing occurring at the edge of the network near the source of the data. This decentralized IIoT approach will minimize latency and optimize control of industrial and critical-infrastructure facilities.

To take full advantage of this explosion in industrial data and developments in edge computing, GE and its customers require improved wireless connectivity and greater bandwidth at their facilities. Today, they are often unable to obtain this wireless functionality from commercial mobile operators on a cost-effective basis. Many industrial and critical-infrastructure customers are located in remote areas beyond the reach of conventional commercial mobile networks. In addition, traditional wireless operators are typically not focused on the delivery of substantial throughput to indoor environments, such as those found at industrial, medical, and critical-infrastructure facilities, whether in urban or rural areas. Overall, the major wireless carriers have placed greater emphasis on delivering commercial mobile service to consumers than on developing data-intensive IIoT-related applications, services, and capabilities and network service level agreements ("SLAs").

[18] Today, GE utilizes cloud analytics technology to assess and improve production and performance across a wide range of industrial activities, including those involving jet engines, wind turbines, hydro-electric pumps, heating and air conditioning equipment, and MRI scanners.

The Commission's licensing framework at 3.5 GHz can change the economic equation for industrial and critical-infrastructure entities, providing the cost-effective capacity, functionality, and security necessary to support data-intensive IIoT wireless operations. As the Commission envisioned in its *2015 Order*, GE and its industrial and utility customers can take advantage of the CBRS framework to deploy licensed services that "require some measure of interference protection and yet are not appropriately outsourced to a commercial cellular network."[19] Rather than rely on established wireless carriers, GE and its customers will be able to use their own dedicated, licensed 3.5 GHz spectrum to self-provision these services over geographically targeted, private TDD-LTE networks. Even for industrial facilities in areas with commercial wireless coverage, it may often make business sense for GE and its customers to deploy their own private CBRS networks. Such self-provisioning at 3.5 GHz will provide GE and its customers with the kind of network control necessary to minimize costs, ensure quality of service, enhance safety, support data-intensive throughput, and optimize network and IIoT-system performance.[20]

In the future, GE hopes to use the 3.5 GHz band to seamlessly and cost-effectively provide its IIoT customers with "connectivity in a box." Described below are three potential IIoT use cases in the 3.5 GHz band, involving the deployment of localized private LTE networks at an airport, an oil field, and a hospital:

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[19] *2015 Order* ¶ 6.

[20] With the deployment of next-generation, automated inspection and remote monitoring technologies, future bandwidth requirements at industrial and critical-infrastructure facilities are likely to substantially exceed throughput requirements for standard consumer-oriented commercial mobile services. Continuous, real-time transmissions from a remote-monitoring HD camera in an industrial/critical-infrastructure environment will realistically generate more than 1,500 GBs of data per month, while an average smart-phone customer typically consumes up to 18 GBs of data per month (through both LTE and Wi-Fi). With their own licensed private LTE networks in the CBRS band, GE and its customers will be in far better position to manage this intensive system throughput.

- **Airport:** GE deploys a private LTE network that provides 300 Mbps connectivity for automated downloading of aircraft sensor data (*e.g.*, fuel monitors and auxiliary power units) and flight data recorder information as aircraft land and taxi to the airport gate and servicing areas. This connectivity supports simulations and predictive analysis on engines, fuel efficiency, and avionics systems immediately upon aircraft landing. These capabilities also enable real-time diagnostics of all aircraft sensors, with automated push of software updates.

- **Oil Field:** GE deploys a private LTE network that provides 200 Mbps connectivity to approximately 6,000 devices, including oil well sensors, crawlers, HD cameras, and modems. This network supports consistent wireless coverage across an entire oil field and remote, real-time video monitoring of multiple oil wells and sensors.

- **Hospital:** GE deploys a private LTE network that provides 100 Mbps connectivity to approximately 500 devices, including tablets, health management devices, MRIs, MRI sensors, and HD cameras. GE's private LTE network supports real-time, over-the-air firmware updates to all health management devices to ensure reliable operation while not interrupting devices during active or peak monitoring times. This connectivity also ensures quality of service and low-latency access to MRI machines for remote image viewing as well as managed network security for HIPAA compliance.

GE partnerships at 3.5 GHz. To develop private LTE connectivity solutions for its customers, GE has formed technology partnerships with other wireless industry entities. Earlier this year, GE partnered with Nokia and Qualcomm Technologies to create a private, 3.5 GHz TDD-LTE network incorporating device chipsets, base station infrastructure, cloud service, and GE's Predix operating system.[21] In addition, GE is working with Intel and Ericsson to create a Silicon Valley innovation center – "5GI" – that will enable technology companies, industry leaders, and academic participants to develop pilot programs for the application of IIoT 5G technologies. These pilot programs will be fully transparent, allowing other participants to join and build on these efforts to extend 5G innovation to new industries and environments.[22]

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[21] Press Release, Qualcomm, *GE, Nokia and Qualcomm Unveil First Private LTE-based Trial Network Customized for Industrial IoT* (Feb. 22, 2017), https://www.qualcomm.com/news/releases/2017/02/22/ge-nokia-and-qualcomm-unveil-first-private-lte-based-trial-network.

[22] Press Release, Intel, *Intel and Ericsson Launch 5G Innovators Initiative with Honeywell, GE and the University of California Berkeley* (Feb. 21, 2017), https://newsroom.intel.com/

III. THE EXISTING CBRS FRAMEWORK IS FUNDAMENTALLY SOUND POLICY THAT IS GENERATING SUBSTANTIAL INNOVATION AND COLLABORATION

In 2015, the Commission unanimously adopted its innovative regulatory approach for CBRS, calling this spectrum an "innovation band."[23] The CBRS framework is fundamentally sound policy that will invigorate wireless operations in the United States and encourage robust IIoT deployments and other dynamic, non-traditional uses of commercial spectrum.

The Commission's CBRS licensing scheme – including census-tract licensing and shorter, non-renewable license terms – is an appropriate regulatory response to unique spectrum factors in the 3.5 GHz band. Unlike most other commercial wireless bands, the 3.5 GHz band cannot be cleared of incumbents and devoted exclusively to conventional, commercial mobile use. Federal incumbents will remain at 3.5 GHz, and commercial users of this band will have to share this spectrum with ground-based and shipborne military radar systems as well as with commercial earth station licensees. SAS operations will be necessary to control spectrum access in areas containing approximately half of the U.S. population.[24] This spectrum environment provided the Commission with a logical opportunity to provide new modes of spectrum access to non-traditional spectrum users and operators.

The technical characteristics of the 3.5 GHz band also strongly favor an innovative, granular licensing approach for CBRS. Unlike lower-band transmissions, 3.5 GHz signals travel

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newsreleases/intel-ericsson-launch-5g-innovators-initiative-honeywell-ge-university-california-berkeley/.

[23] *See 2015 Order* ¶ 2 (describing the 3.5 GHz band as an "innovation band" that would "dissolve some age-old regulatory divisions, between commercial and federal users, exclusive and non-exclusive authorizations, and private and carrier networks").

[24] Given PAL operators' need to share with federal incumbents, their CBRS spectrum will not be available at certain times and locations. For example, when Naval ships are located in U.S. ports, CBRS users have reduced spectrum access in those areas due to Naval radar operations.

only limited distances, are affected significantly by terrain blocking, and are often unable to penetrate building walls. Licensing by census tract – which the Commission viewed as a "middle ground" between site-specific licenses and larger, traditional license areas[25] – is appropriate in a band where most operations are likely to be small-cell, localized deployments.

As the Commission previously described, census-tract licensing and other CBRS elements "promote a diverse array of network technologies"[26] and "make the 3.5 GHz band hospitable to a wide variety of users, deployment models, and business cases."[27] Thus, rather than advancing one particular business model or industry sector, the Commission's regulatory approach in this band is competitively and technologically neutral. Myriad CBRS use cases will be initiated by a wide range of businesses and other 3.5 GHz users, including GE and other IIoT interests, WISPs, hospitals, commercial real estate interests, hotels and resorts, state and local government agencies, and educational institutions. Geographically targeted CBRS deployments are likely to occur in such diverse environments as factories, construction sites, power plants,

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[25] When the Commission in 2015 unanimously adopted census-tract licensing for PALs, it concluded that census tracts were an appropriate "middle ground" between site-specific licenses and the smallest potential license areas (*e.g.*, census block groups) and larger, more established license areas used in other wirelesss bands (*e.g.*, PEAs, Economic Areas, Cellular Market Areas). *2015 Order* ¶ 96. The Commission found that census tracts are "sufficiently granular to promote intensive use of the band and are large enough, either on their own or in aggregate, to support a variety of use cases, including small cell base stations and backhaul." *Id.* ¶ 101. The Commission also noted that census tracts "generally align with the borders of political boundaries (*e.g.*, city lines) . . . [or] natural features." *Id.* ¶ 97. Census tracts "naturally mirror key considerations" that service providers account for when developing their investment and deployment strategies. *Id.*

[26] *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Further Notice of Proposed Rulemaking, 29 FCC Rcd 4273, ¶ 2 (2014) ("*2014 FNPRM*").

[27] *2015 Order* ¶ 6. In response to petitions for rulemaking from T-Mobile and CTIA, most parties opposed significant changes to the Commission's 3.5 GHz CBRS rules. This record reflects the broad range of parties that hope to take full advantage of the spectrum opportunities presented by the Commission's licensing framework in this band.

airports, seaports, hospitals, schools, universities, hotels and resorts, office buildings, stadiums, arenas, and race tracks. As discussed *supra* at 13-15, companies like GE and its industrial and critical-infrastructure customers will use licensed CBRS spectrum to deploy self-provisioned IIoT solutions at their own facilities, reducing these companies' costs and boosting their competitiveness in the United States and globally.

The Commission's flexible approach at 3.5 GHz also strikes the right balance with respect to the nascent 5G ecosystem. While 2G, 3G, and 4G produced incremental improvements to traditional commercial mobile networks, 5G applications are evolving and not yet fully defined. In lieu of this traditional focus on conventional commercial mobile operations, a more compelling 5G vision involves a broad-based, heterogeneous ecosystem that includes a diversity of operators, technology vendors, and spectrum users. Such a vibrant ecosystem – including IIoT developers and users – should support the development of networks that deliver exponential improvements in latency, throughput, connectivity, and other wireless parameters.[28] While CBRS alone cannot deliver the full benefits of 5G, the Commission's unique framework at 3.5 GHz can serve as a significant driver toward this goal.

While the Commission's CBRS framework is only two-and-a-half years old, it is already a dramatic success story, contrary to the claims of some large carriers. The Commission's regulatory approach in this band has triggered a wave of activity and innovation exceeding expectations. Since the Commission's *2015 Order*, GE and a wide range of other parties have devoted substantial resources to the development of wireless equipment and applications for the 3.5 GHz band, in full reliance on census-tract licensing and other aspects of the Commission's rules. With the Commission's CBRS rules opening the door to a range of business models, 3.5

[28] *See* Lehr Analysis at 17.

GHz development has involved collaboration and coalitions between established and traditional and non-traditional wireless stakeholders.

The Wireless Innovation Forum ("WInnForum") includes forty-seven companies that have spent of thousands of hours developing technical standards for the implementation of CBRS. Serving as a common industry and government standards body, WInnForum has made substantial progress on establishing policies and protocols for Environmental Sensing Capability and SAS operations.[29] The CBRS Alliance, meanwhile, is made up of fifty-five diverse industry stakeholders working collectively on LTE-based CBRS technologies, use cases, and business development. The CBRS Alliance has established a product certification program that promotes multi-vendor interoperability in the 3.5 GHz band.[30] GE and its industrial and critical-infrastructure customers will benefit from this interoperability and a robust ecosystem of standards-based, cost-effective technology solutions for deploying private wireless networks for IIoT-based operations.

In addition to GE's collaborative arrangements described *supra* at 15, other agreements and partnerships are advancing the CBRS ecosystem at 3.5 GHz. For instance, Ruckus Wireless and Qualcomm have developed technologies for the 3.5 GHz band that involve the deployment of neutral host-capable small cells supporting cost-effective in-building coverage. Earlier this

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[29] According to the WInnForum Spectrum Sharing Committee's most recent report to the Wireless Telecommunications Bureau and Office of Engineering and Technology, the Committee has completed or almost completed work on various CBRS requirements and protocols related to operations, interoperability, security, and device testing and certification. *See* Wireless Innovation Forum, Spectrum Sharing Committee Release Schedule (Nov. 29, 2017), attached to Letter from Lee Pucker, The Software Defined Radio Forum Inc., to Marlene H. Dortch, FCC Secretary, GN Docket No. 15-319 (Dec. 7, 2017).

[30] *See* Press Release, CBRS Alliance, *WISPA and CBRS Alliance Enter Cooperation Agreement to Advance Commercialization of the 3.5 GHz CBRS "Innovation Band"* (Nov. 15, 2017), http://www.marketwired.com/press-release/wispa-cbrs-alliance-enter-cooperation-agreement-advance-commercialization-35-ghz-2240864.htm.

year, Nokia, Alphabet Access, and Qualcomm partnered with stock car race operators on the use of 3.5 GHz band technologies to create "a 360-degree virtual reality zone inside a stock car to provide a streaming, real-time virtual user experience at speeds over 180 mph."[31] Multiple companies have also applied for certification as SAS administrators, with seven receiving the Commission's conditional approval in December 2016.[32] Federated Wireless has been involved in forty trials of its SAS technology, ranging from technology demonstrations to operational pilots, and it expects to receive final Commission certification for its 3.5 GHz CBRS product during 2018.[33] Google's Alphabet Access, meanwhile, has also engaged in extensive SAS testing and performed the "first end-to-end demonstrations of CBRS mobile devices."[34] Numerous other companies have obtained experimental authorizations from the Commission to test equipment, explore network architectures, evaluate market demand, and assess a mix of innovative uses. Clearly, the opportunities created by the existing CBRS framework have sparked intense industry interest in the 3.5 GHz band.

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[31] Comments of Google Inc. and Alphabet Access in Response to Petitions for Rulemaking, GN Docket No. 12-354, at 7 (July 24, 2017) ("Google/Alphabet July 2017 Comments") (quoting Letter from Kalpak Gude, President, Dynamic Spectrum Alliance, to Marlene H. Dortch, FCC Secretary, GN Docket Nos. 12-354 and 15-319, at 2 (Apr. 20, 2017)).

[32] *See* Public Notice, *Wireless Telecommunications Bureau and Office of Engineering and Technology Conditionally Approve Seven Spectrum Access System Administrators for the 3.5 GHz Band*, 31 FCC Rcd 13355 (2016) (conditionally approving the following seven entities as SAS administrators: Amdocs, Inc.; Comsearch; CTIA-The Wireless Association (CTIA); Federated Wireless; Google, Inc.; Key Bridge; and Sony Electronics, Inc. (Sony)).

[33] Comments of Federated Wireless, Inc., GN Docket No. 12-354, at 7, 10 (July 24, 2017). In September 2017, Federated received $42 million in funding from Charter Communications, American Tower, Arris International, and GIC, Singapore's sovereign wealth fund. Monica Alleven, *Federated Wireless Debuts CBRS Spectrum Controller, Gets Backing from Charter, American Tower, Arris*, FierceWireless (Sep. 14, 2017), https://www.fiercewireless.com/wireless/federated-wireless-debuts-cbrs-spectrum-controller-gets-backing-from-charter-american.

[34] Google/Alphabet Access, *Preserving Opportunity in the CBRS Band*, at 5 (Oct. 16, 2017) ("Google/Alphabet October 2017 *Ex Parte*"), attached to Letter from Austin C. Schlick, Google, to Marlene H. Dortch, FCC Secretary, GN Docket No. 12-354 (Oct. 16, 2017).

IV. UNDER A PEA-BASED LICENSING APPROACH, ESTABLISHED WIRELESS CARRIERS WOULD DOMINATE THE CBRS BAND

In the face of rapid progress at 3.5 GHz, the Commission's contemplated, counter-productive overhaul of the CBRS framework would abruptly stop this momentum. Such action would convert CBRS into a yet another commercial mobile band dominated by the large nationwide wireless carriers. This spectrum would no longer support self-provisioned IIoT operations and other geographically targeted deployments by localized, licensed spectrum users.

A. The Cost of PEA Licenses Would Prevent IIoT Interests and Other Non-Traditional Users from Obtaining CBRS Spectrum at Auction

A shift from census-tract licensing to PEA-based licensing would exponentially increase the cost of a CBRS license at auction. The greater the square mileage and the larger the population in a license area, the higher the auction price will be for that license. The average population in each of the approximately 74,000 U.S. census tracts is only 4,000 people. While the 416 U.S. PEAs are highly variable, PEAs on average are 178 times larger and more populous than the average census tract. Overall, 337 of the 416 PEAs cover an area with a population exceeding 100,000 people, and the top 60 U.S. PEAs all have populations greater than one million. Given these size differences, PEA licenses at 3.5 GHz would be far more expensive at auction than their census-tract counterparts. Participants in a PEA-based PAL auction would require an enormous amount of upfront capital, justification for acquiring dedicated spectrum over a wider area than needed, and a robust commercial use case to justify the expense of their bids.

Inevitably, the nationwide commercial mobile operators that regularly spend billions of dollars on spectrum would acquire the available PEA licenses in a CBRS auction. The nation's large wireless carriers remain aggressive in their efforts to secure commercial mobile spectrum, and it would be difficult if not impossible for GE and other non-traditional users with localized

deployment plans to win these 3.5 GHz PALs.[35] While GE and its customers would compete vigorously in auctions for *census-tract* licenses, it would not be economically rational to outbid established wireless carriers for PEA licenses covering territory extending far beyond their geographically targeted, localized wireless network deployments.[36] Rather than serve as an "innovation band," the CBRS band would extend the decades-long status quo by locking in the use of additional spectrum for conventional commercial mobile operations. The likelihood of this outcome is demonstrated by the results of the broadcast Incentive Auction earlier this year. In that auction, the vast majority of 600 MHz PEA licenses were obtained by multi-billion dollar global and domestic operators. Of the 2,776 licenses that were auctioned, 2,295 (82.7%) were won by just five bidders – T-Mobile, DISH Network, Comcast, AT&T, and U.S. Cellular.[37]

Thus, a decision to move to PEA-based licensing would change the 3.5 GHz band dramatically overnight. The Commission would skew its CBRS auction process, create substantial barriers to entry at 3.5 GHz, and exclude the myriad parties currently investing substantial time and resources into developing this spectrum. GE and IIoT users, WISPs, real estate interests, educational institutions, state and local agencies, and numerous other potential users would all be essentially shut out of this band.[38] In contrast to the existing framework's

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35 *See* Lehr Analysis at 7, 12.

36 *See id.* at 12, 22, 25. Wireless deployments by GE and its industrial and critical-infrastructure customers will typically cover less geographic territory than a census tract. Given this fact, these deployments will obviously occupy just a minute fraction of the geographic area covered by PEAs, which, as indicated above, are on average 178 times larger than census tracts.

37 *See* Public Notice, *Incentive Auction Closing and Channel Reassignment Public Notice*, 32 FCC Rcd 2786, at Appendix B (2017) (DA 17-314) ("*Incentive Auction Closing Public Notice*") (announcing winning bidders for a total of 2776 licenses, of which 23 licenses were won by AT&T Spectrum Holdings LLC; 73 licenses by Comcast affiliate CC Wireless Investment, LLC; 486 licenses by DISH affiliate ParkerB.com Wireless L.L.C.; 1525 licenses by T-Mobile License LLC; and 188 licenses by United States Cellular Corporation).

38 *See* Lehr Analysis at 31.

technologically neutral approach, the Commission's new scheme would predetermine the entities and applications that could make use of this spectrum. The dominant nationwide wireless operators would be the beneficiaries of this change, at the expense of the diverse use cases essential to realizing the nation's 5G and other spectrum policy goals. This approach would run directly counter to Chairman Pai's repeated and sound admonitions that the Commission should not choose marketplace winners and losers.[39]

B. Under a PEA-Based Licensing Approach, Secondary Market Mechanisms Would Not Be a Viable Means of Spectrum Access by IIoT Interests and Other Non-Traditional Users

The Commission cannot rely on its secondary market mechanisms – spectrum leasing, partitioning, and disaggregation – to avoid the harms from PEA-based or county-based licensing in the 3.5 GHz band.[40] Under a PEA-based framework, the large wireless operators holding these CBRS licenses would be unlikely to make meaningful amounts of 3.5 GHz spectrum available to GE, its IIoT customers, and other non-traditional spectrum users. PAL licensees would have no legal obligation to lease or partition spectrum, and there would be no mechanism to compel them to make their frequencies available to third parties. In many cases, large carriers choose to warehouse their frequencies rather than convey spectrum to parties that might use that resource to develop competitive offerings.[41] In some areas, carriers would use 3.5 GHz frequencies for their

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[39] *See* Ajit Pai, Chairman, FCC, Remarks on Restoring Internet Freedom, at 5 (Nov. 28, 2017), https://apps.fcc.gov/edocs_public/attachmatch/DOC-347980A1.pdf ("We have no business picking winners and losers in the marketplace."); Ajit Pai, Commissioner, FCC, Opening Remarks at the Mobile Future Forum, "Designing for Auction Success: Lessons Learned from Around the World," at 1 (Apr. 24, 2014), https://apps.fcc.gov/edocs_public/attachmatch/DOC-326731A1.pdf ("We should not pick winners and losers.").

[40] *See* Lehr Analysis at 12-13.

[41] *See id.* at 10, 12-13 ("[T]he national cellular operators . . . have an incentive to deny access to the spectrum from other potential CBRS users because such usage threatens the national cellular operators' businesses in multiple ways.").

own services, making that spectrum unavailable for leasing. GE's customers have industrial and critical-infrastructure facilities in urban and suburban areas, for instance, where commercial mobile operators might use their CBRS spectrum to densify their networks.

Historical evidence from other wireless bands indicates that these carriers would largely hold onto their CBRS spectrum, even frequencies lying fallow or underused in rural and remote areas. A 2013 report revealed that only 11.01% of the MHz/POPs transferred or assigned from 2003 to 2013 were conveyed from nationwide operators to non-nationwide operators, while only 8.58% of the MHz/POPs leased between 2003 and 2013 were leased by nationwide operators to non-nationwide operators. In comparison, nationwide carriers received 67.58% of all MHz/POPs transferred or assigned during that period (from nationwide and non-nationwide operators), while nationwide operators leased 75.71% of all MHz/POPs leased during that timeframe (again, from both nationwide and non-nationwide operators).[42]

Even where wireless carriers' 3.5 GHz CBRS holdings were available on the secondary market, this spectrum would likely come at an exorbitant and economically untenable cost to GE, its IIoT customers, and other non-traditional spectrum users. Wireless carriers would likely extract substantial economic rents at 3.5 GHz, and parties seeking targeted spectrum could be held hostage by hold-out sellers and speculators. Any spectrum leasing arrangements offered by wireless carriers might include terms and conditions that prevent GE and its customers from realizing the full potential of IIoT connectivity. There would also likely be significant transaction costs associated with these secondary market arrangements, which would require administrative filings at the Commission and could involve extensive, complex negotiations. As

[42] Mobile Future, *FCC Spectrum Auctions and Secondary Markets Policies: An Assessment of the Distribution of Spectrum Resources Under the Spectrum Screen*, at 18-19 (Nov. 2013), attached to Letter from Johnathan Spalter, Mobile Future, to Marlene H. Dortch, FCC Secretary, GN Docket No. 12-268 (Nov. 13, 2013).

Dr. Lehr points out in his report, these transaction costs would in all likelihood fall primarily (and asymmetrically) on non-traditional users, who would need to induce carriers to either partition or lease their spectrum.[43]

In addition, for GE and its industrial and critical-infrastructure customers, General Authorized Access ("GAA") spectrum is not a viable alternative to census-tract PALs. Unlicensed GAA frequencies do not provide users with interference protection or a guaranteed quality of service. GE's wireless solutions support mission-critical functions and help ensure the safe, reliable, and secure operation of industrial and critical-infrastructure facilities. PAL spectrum – preferably under a census-tract licensing framework – offers the certainty needed for these important operations.

If the Commission adopts PEA-based licensing (or county-based licensing) at 3.5 GHz and effectively forecloses the licensing of PALs to non-traditional users, GE will be forced to pursue other regulatory routes to obtain spectrum that can support the future of the IIoT. At 3.5 GHz, GE could request a mechanism similar to the Contained Access Facility proposal previously considered in this band. In its 2014 Further Notice of Proposed Rulemaking on CBRS, the Commission proposed to allow "Contained Access Users," such as hospitals, public safety organizations, and local governments, to request up to 20 megahertz of GAA spectrum for indoor use within their designated "Contained Access Facilities" (or "CAFs").[44] This CAF proposal was supported by numerous parties as a means of providing CBRS spectrum for secure,

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43 Lehr Analysis at 12. As discussed *infra* at 27-30, the Commission will achieve a higher level of economic utility and efficiency by retaining the existing census-tract framework than it would by adopting PEA-based licensing and relying on an inefficient secondary market to cure the problems associated with that approach. Census-tract assignments will put CBRS spectrum in the hands of parties that will put this spectrum to its highest and best use rather than simply deliver that spectrum to the nation's dominant wireless carriers.

44 *2014 FNPRM* ¶ 60.

private, internal radio services at industrial, medical, and critical-infrastructure facilities and other geographically limited indoor sites. Nevertheless, the Commission in 2015 declined to adopt this policy because it believed that its innovative CBRS regulatory framework would support and protect a wide variety of indoor operations in this band, including private wireless networks, thereby obviating the need for the CAF mechanism.[45]

GE agrees that the existing census-tract PAL licensing approach is the best policy in the 3.5 GHz band and sufficient to meet the wireless connectivity requirements of the IIoT revolution. A switch to PEA-based licensing, however, would revive the business need and policy rationale for CAF authorizations by making it virtually impossible for industrial and critical-infrastructure entities to gain access to their own licensed spectrum at 3.5 GHz. As a potential remedy to this harm, GE and its customers could seek a revised version of the CAF mechanism that supports greater operational flexibility and service quality than the Commission's 2014 proposal.

In the event of PEA-based CBRS licensing, GE will also have to advocate strenuously for innovative licensing policies in other newly available commercial bands – including the 3.7-4.2 GHz band – that could support the deployment of private LTE networks at industrial and critical-infrastructure facilities.[46] GE and its IIoT customers simply cannot lose access to spectrum that provides secure, interference-protected, and cost-effective wireless connectivity on a localized basis.

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45 *2015 Order* ¶¶ 164-169.

46 *See Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Inquiry, 32 FCC Rcd 6373 (2017) ("*Mid-Band NOI*"). GE is also submitting the instant comments into the Commission's docket for the *NOI*.

V. FOR NUMEROUS COMPELLING REASONS, THE COMMISSION SHOULD RETAIN CENSUS-TRACT LICENSING IN THE CBRS BAND RATHER THAN SHIFT TO PEA-BASED LICENSING

The Commission's decision to revisit its CBRS regulatory structure leaves it with a stark choice between two very different outcomes in this band. The Commission can retain census-tract licensing and realize a dynamic, heterogeneous spectrum ecosystem at 3.5 GHz, or it can move to PEA-based licensing and commit this band to conventional commercial mobile use. For a number of compelling reasons, GE believes that census-tract licensing in the 3.5 GHz band remains the far better policy. From an economic perspective, census-tract licensing is a flexible, market-based approach that will result in greater spectrum efficiency and place PALs in the hands of parties who will make the highest and best use of this spectrum. Beyond pure economic gain, census-tract licensing will yield important public interest benefits stemming from more robust IIoT deployments and other varied uses of the 3.5 GHz band. In addition, as described below, census-tract licensing will do more to further the statutory objectives of Section 309(j)'s auction provisions, and will help maintain U.S. leadership in the development of 5G and next-generation wireless technologies.

A. The Commission Will Maximize Economic Utility and Spectrum Efficiency at 3.5 GHz by Retaining Census-Tract Licensing for PALs

In his concurrently filed report, Dr. Lehr concludes that census-tract licensing in the 3.5 GHz band is preferable to PEA-based licensing from an economic efficiency and cost-benefit perspective.[47] By maintaining low barriers to entry at 3.5 GHz, census-tract licensing will enable flexible market forces to determine the most efficient use of CBRS spectrum. With a broad range of entities utilizing an array of business models and technologies at 3.5 GHz, this approach will stimulate greater innovation, competition, and investment in this band. In addition, the

[47] Lehr Analysis at 11-13.

combination of more auction bidders and smaller license areas should result in a more efficient allocation of 3.5 GHz spectrum. As Dr. Lehr describes, large wireless carriers and non-traditional spectrum users alike will be able to maximize their bids in discrete geographic areas, ensuring that these CBRS licenses are held by the parties that value them the most.[48]

A shift to PEA-based PALs, meanwhile, would also reduce spectrum efficiency at 3.5 GHz. Large commercial mobile operators would use PEA licenses to densify existing mobile networks and add capacity in urban and other high-traffic locations. Given the expense of small-cell deployment and lower consumer demand, these carriers would have little incentive not to warehouse rural-area spectrum and leave those frequencies unused for many years (or even indefinitely). Thus, these companies are likely to waste licensed CBRS spectrum across much of their PEAs, in the process preventing potentially efficient uses of this band.[49]

In contrast, the Commission's existing census-tract framework will enable operators and spectrum users to match their wireless deployment plans with geographically precise spectrum assets, thereby maximizing spectrum use and value.[50] Under this approach, parties will not be forced to purchase spectrum in areas where they lack build-out plans. Rather, GE, its IIoT customers, and other diverse users will make intensive use of their licensed spectrum with geographically targeted, localized wireless network deployments that will generate jobs and economic growth, including in rural and remote areas.[51] In addition, as Dr. Lehr indicates, "with

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48 *Id.* at 11-12.

49 *Id.* at 11, 13.

50 *Id.* at 11.

51 A shift to PEA-based licensing, in contrast, would stifle the CBRS-related investments by non-traditional users and technology vendors shut out of the CBRS band. Lehr Analysis at 22. In addition, as Dr. Lehr explains, even wireless carriers dominating this band might have less incentive to invest this spectrum than under census-tract licensing, given the reduced competition in the band resulting from an exclusionary licensing policy. *Id.* at 17.

PALs sized to allow more efficient mapping of licenses to spectrum needs, all users of CBRS will be better able to balance the use of PAL and GAA spectrum."[52]

It is also important to note that census-tract PAL licensing will not prevent large wireless carriers from deploying commercial mobile facilities at 3.5 GHz. Carriers can acquire numerous census-tract licenses at auction and aggregate these licenses into larger, contiguous service areas. Because census tracts "nest" into PEAs, commercial wireless operators could systematically assemble 3.5 GHz footprints that match their coverage in other bands. Certainly, it will be considerably easier for large commercial mobile operators to acquire and aggregate census-tract PALs at auction than it would be for GE and other non-traditional users to gain access to 3.5 GHz spectrum under a PEA-based licensing scheme (either at auction or on the secondary market).

According to Dr. Lehr, arguably the primary economic "benefit" from PEA-based licensing would be the ability of commercial mobile operators to access 3.5 GHz spectrum at a lower overall cost than under a census-tract licensing approach. As Dr. Lehr explains, however, there are a number of factors that will minimize this benefit.[53] Unlike the varied parties who will gain rare access to commercial mobile spectrum under census-tract licensing, large carriers already hold extensive spectrum portfolios. These carriers also integrate unlicensed spectrum into their networks and will have additional opportunities to acquire licensed mid-band spectrum in the near future.[54] Thus, cheaper access to the 3.5 GHz band would only have a marginal

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52 Lehr Analysis at 11.

53 *Id.* at 17-18, 31.

54 During 2018, the Commission will likely initiate a rulemaking to provide commercial mobile access to additional 5G-capable spectrum in the 3.7-4.2 GHz band and other frequency bands above 3 GHz. *See Mid-Band NOI*. Of course, it is not even clear that the largest wireless carriers need more spectrum to achieve their goals for 5G, next-generation commercial mobile service. Two commentators in 2015 concluded that policymakers must be careful when relying

impact on their 5G deployment plans; these carriers will invest in small-cell technology and densify their networks in urban areas whether or not they are able to obtain CBRS licenses.[55]

Finally, Dr. Lehr points out that a shift to PEA-based licensing in the 3.5 GHz band would jeopardize the IIoT-related economic growth referenced at 9-10 *supra*.[56] Under the Commission's revised CBRS approach, GE and other IIoT interests would lack dedicated, licensed spectrum for self-provisioned private LTE networks that support next-generation IIoT applications and services. GE and its customers would likely be unable to obtain the required wireless connectivity from traditional carriers on a cost-effective basis, given carriers' continued focus on consumer-based services. As a result, IIoT investment, innovation, and deployment would likely be delayed and reduced. Given the forecasted value of IIoT to the U.S. economy – for instance, Accenture's projection that the U.S. economy will gain $6.1 trillion in value due to IIoT by 2030 – the Commission's action could cost the United States hundreds of billions of dollars in economic and industrial growth.

B. Census-Tract Licensing Will Realize Important Public Interest Benefits, Including Enhanced Safety and Security for U.S. Critical Infrastructure

Beyond the economic impact described above, the Commission's existing CBRS licensing framework will realize important public interest benefits. With all other commercial wireless bands supporting conventional commercial mobile services, there is an inherent value in having an alternatively licensed "innovation band" that gives critical-infrastructure entities and

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on spectrum forecasts, stating that "[o]verestimating the growth of mobile network traffic and focusing on exclusive-use licenses, for example, can crowd out other types of wireless communication by increasing scarcity." Aalok Mehta & J. Armand Musey, CFA, JD/MBA, *Overestimating Wireless Demand: Policy and Investment Implications of Upward Bias in Mobile Data Forecasts*, 23 CommLaw Conspectus 300, 307 (2015) (citation omitted).

55 Lehr Analysis at 31.

56 *Id.* at 23, 28, 31-32.

other non-traditional users a rare chance to access commercial spectrum. The Commission should preserve the opportunities afforded by this unique regulatory structure.

Most relevant to GE and its customers, the existing CBRS framework will enhance the resiliency, reliability, safety, and efficiency of the nation's critical-infrastructure facilities, an important public policy goal. Given the crucial nature of these facilities – providing safe transport, clean water, electricity, oil and gas power, nuclear energy, and other important societal resources – their internal communications systems are built and maintained to exceptionally high standards. These private wireless networks must be more reliable and resilient than commercial mobile systems, since they must sustain critical-infrastructure communications during natural disasters and other emergencies and support connectivity in remote areas beyond commercial coverage.[57]

While utilities and other critical-infrastructure entities have made substantial investments in their networks (including in GE's MDS Mercury products), these facilities require additional spectrum to meet growing coverage and capacity demands related to new smart-grid and security requirements.[58] CBRS will deliver the cost-effective capacity and functionality necessary to support low-latency, data-intensive IIoT wireless operations using localized (and often self-provisioned) private LTE networks. Enhanced IIoT capabilities will enable critical-

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[57] By facilitating the provision of IIoT applications and services to railways, airports, seaports, waterways, transit systems, and other critical elements in the America's infrastructure, the Commission's existing CBRS framework is also consistent with the President's recently issued National Security Strategy. *See* National Security Strategy of the United States of America at 19 (December 2017), https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf (in addition to physical infrastructure improvements, seeking to "improve America's digital infrastructure by deploying a secure 5G Internet capability nationwide").

[58] *See, e.g.*, Letter from Brett Kilbourne, Utilities Technology Council, to Marlene H. Dortch, FCC Secretary, GN Docket No. 12-354, at 1 (July 21, 2017).

infrastructure entities to prevent serious system failures and proactively avoid life-threatening and high-risk scenarios.

Census-tract licensing will also extend the Commission's protection of industrial and critical-infrastructure facilities currently relying on the 3.65 GHz band for their internal communications needs. The Commission's 2015 decision to grandfather these 3.65 GHz operations – "without need to retrofit or abandon their existing equipment"[59] – has so far minimized any adverse effects on these facilities. With census-tract PAL licensing, GE and its customers can acquire PALs at auction and continue their SCADA and other wireless operations. These 3.65 GHz users could also take advantage of enhanced wireless connectivity in the near future, as GE and other companies transition to private LTE deployments and more robust IIoT applications. In contrast, a shift to PEA-based licensing would disrupt existing wireless operations at 3.65 GHz and harm GE's customers. Without access to PAL spectrum, existing 3.65 GHz SCADA operations at many locations would have to be terminated at the end of the relevant grandfathering periods.[60]

Of course, CBRS will benefit the public not only by making the nation's critical infrastructure more reliable, efficient, and secure, but also through future innovative use of this band by WISPs, educational institutions, hospitals, municipalities, and other non-traditional spectrum users. A shift to PEA-based licensing would forego all of these varied public interest benefits. This action would frustrate these parties' efforts at 3.5 GHz and undercut their reliance

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59 *2015 Order* ¶ 397.

60 Because GE's services are deeply embedded into its 3.65 GHz customers' operational systems and integrated into their employees' training, these customers would have to implement significant changes to systems and employee protocols, thus incurring substantial costs and potentially slowing or halting operations during the transition to a new network.

on the Commission's 2015 and 2016 CBRS orders.[61] The Commission's elimination of its "innovation band" at 3.5 GHz would constitute a discouraging lost opportunity for U.S. spectrum policy as well as for the critical infrastructure and manufacturing segments of the U.S. economy.

C. Census-Tract Licensing for PALs Will Further the Statutory Goals of Section 309(j)

Census-tract licensing for PALs will further the statutory goals of the auction provisions contained in Section 309(j) of the Communications Act of 1934, as amended. As the Commission recognizes in the *NPRM*,[62] Section 309(j) identifies objectives that the Commission "shall seek to promote" when it uses a competitive bidding process to grant licenses.[63] The Commission is directed to promote "the development and rapid deployment of new technologies, products, and services for the benefit of the public" while "disseminating licenses among a wide variety of applicants" and "avoiding excessive concentration of licenses."[64] The Commission's auction process must also advance the "efficient and intensive use of the electromagnetic spectrum."[65]

Census-tract licensing for CBRS PALs furthers all of these statutory objectives. As discussed above, this policy will lower barriers to entry at 3.5 GHz and result in a wider variety of licensees than found in other commercial wireless bands. There should be no "excessive concentration" of census-tract PALs in the CBRS band. In addition, by matching applicants'

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61 *2015 Order; Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3640 MHz Band*, Order on Reconsideration and Second Report and Order, 31 FCC Rcd 5011 (2016).

62 *See NPRM* ¶¶ 15, 24-25, 31, 39, 42.

63 47 U.S.C. § 309(j)(3). The use of "shall" indicates that when designing systems of competitive bidding, the Commission may not simply ignore the objectives listed in this section.

64 47 U.S.C. §§ 309(j)(3)(A)-(B).

65 47 U.S.C. § 309(j)(3)(D).

deployment plans to geographically tailored authorizations, census-tract licensing will minimize warehousing and foster intensive, efficient, localized use of 3.5 GHz spectrum. In contrast, PEA-based licensing would effectively assign control of the licensed CBRS band to a small number of very large wireless carriers that would likely leave spectrum fallow outside of core populated areas. Finally, GE believes that census-tract licensing will trigger a more rapid deployment of diverse and innovative services and applications in the CBRS band than a PEA-based framework. While commercial mobile operators would likely integrate CBRS systems into their multi-band networks gradually on an extended timetable, non-traditional spectrum users with geographically targeted deployment plans will have strong incentive to implement their systems as early as possible.

D. Census-Tract Licensing Will Enhance U.S. Leadership on 5G and Next-Generation Wireless Technologies

Contrary to some claims, the 3.5 GHz licensing policies in other countries do not weigh in favor of PEA-based licensing in the CBRS band. The spectrum environment in this band in the United States – including extensive federal operations requiring complex sharing rules in areas covering half the U.S. population – is quite different from the situation in most other developed countries. Moreover, the licensing structures in other countries do not change the fact that the Commission must provide broader access to licensed wireless spectrum for the United States to maintain its global lead in wireless innovation and competition. Other nations' policies at 3.5 GHz should have no bearing on the Commission's decision in this proceeding.

In fact, the Commission's unique licensing framework at 3.5 GHz positions the United States as a global leader in the development of 5G and next-generation wireless applications. Around the world, policymakers and regulators have shown a strong interest in the Commission's innovative spectrum-sharing paradigm and census-tract licensing approach. Other

nations are interested in leveraging the Commission's policies as they consider making additional spectrum available for commercial uses, including for 5G. If the Commission's CBRS licensing structure is successful, the 3.5 GHz band in the United States will become a template for innovative spectrum management, not only in this country but globally. As the world moves to 5G, a late Commission reversal at 3.5 GHz will only weaken U.S. leadership on these issues.[66]

VI. CENSUS-TRACT LICENSING IN THE CBRS BAND WILL NOT BE TOO COMPLEX TO ADMINISTER

Concerns regarding auction complexity should not push the Commission toward PEA-based licensing in the 3.5 GHz band. The Commission has the technical expertise, experience, and incentive to conduct an auction of census-tract PALs in this band.

Earlier this year, the Commission completed the Broadcast Incentive Auction, repurposing 84 megahertz of television broadcast spectrum in the 600 MHz band.[67] This reverse and forward auction was likely the most complex spectrum auction in history. Large wireless and other communications companies bid billions of dollars on these licenses. Following this dramatic auction success, the Commission is certainly capable of designing and executing an auction of PALs in the CBRS band.

While some wireless industry interests claim that a PAL auction would be excessively complicated and burdensome, they provide no compelling evidence to support this view. In fact,

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66 A move to PEA-based licensing would also make it harder for the United States to realize the ITU-R goals for IMT 2020 – 5G wireless – with respect to low latency communications, densification of network access, reliability, and accuracy of positioning services. The Commission will best meet the ITU's 5G goals by ensuring that a variety of technologies, manufacturers, and operators participate in this ecosystem. *See* Recommendation ITU-R M.2083-0 (09/2015), http://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2083-0-201509-I!!PDF-E.pdf.

67 *See Incentive Auction Closing Public Notice* ¶ 15 n.19.

it appears that such an auction is entirely feasible and reasonable. According to Paul Milgrom – professor of economics at Stanford University and an advisor on spectrum auctions in the United States and around the world – "[t]he characteristics of the 3.5 GHz spectrum and the FCC's priority licensing scheme obviate the need for the relatively complex auction designs that have been used to sell licenses for other frequencies."[68] Milgrom believes that PALs at 3.5 GHz can be assigned through a simultaneous, multiple-round clock auction, with prospective buyers submitting bids for their desired quantities of licenses in each area. Milgrom indicates that "[i]ncluding standard [auction] tools would make such a system easy to implement and use."[69] Reasonably sophisticated bidders should be able to participate successfully in such an auction without confusion or difficulty.[70]

In any event, the Commission should not determine an important broadband policy based on an interest in administrative convenience. Even if census-tract auctions absorb more administrative resources than other licensing alternatives, the enormous economic and public interest benefits of the existing licensing framework at 3.5 GHz far outweigh those additional costs.

Similarly, SAS issues should not weigh in favor of a switch to PEA-based licensing. Census-tract licensing of PALs will not create undue interference risks or lead to unmanageable

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[68] Letter from Paul Milgrom, Auctionomics, to Marlene H. Dortch, FCC Secretary, GN Docket No. 12-354, at 7 (Aug. 8, 2017) ("Milgrom *Ex Parte*"). Milgrom points out that the strong complement and substitute relationships for spectrum licenses in other commercial mobile bands are not a significant consideration in the 3.5 GHz band.

[69] Milgrom *Ex Parte* at 7.

[70] As Milgrom points out, real-world evidence demonstrates the feasibility of conducting large numbers of auctions on a single platform over a short time period. eBay typically has about one billion active listings at any one time, while most visits to commercial websites trigger an auction for the right to show an advertisement. Google supports approximately 40,000 searches every second, and its ad revenue from auctions exceeded $79 billion in 2016. Milgrom *Ex Parte* at 2.

challenges for SAS administrators or licensees in this spectrum. Developers and future administrators of SAS have made clear that this technology is fully capable of managing the RF environment resulting from the Commission's census-tract licensing framework.[71] Because SAS manages interference on a highly granular, device-by-device basis, the size of the PAL license area has virtually no effect on the complexity of SAS activity or licensee protections.[72] As Google has explained, interference protection results from a PAL licensee's actual deployment of one or more CBRS devices ("CBSD"); an SAS protects a PAL licensee's claimed actual service area, which is based on calculations of CBSD signal coverage.[73] Since the protected area is not defined by the PAL's formal boundaries, the abundance of PAL border territory in a census-tract framework will not unduly complicate SAS management of this band.

Any remaining fears regarding SAS complexity should be alleviated by the SAS selection process and recent demonstrations. More than ten parties submitted applications to be SAS administrators under the existing licensing framework, with seven receiving the Commission's conditional approval.[74] No SAS administrator candidate indicated that census-tract licensing is a concern or will prevent a smooth SAS implementation at 3.5 GHz. Meanwhile, Federated Wireless and Google's affiliate Alphabet demonstrated the interoperability of their 3.5 GHz SASs in 2016. Federated Wireless has conducted numerous technical trials of its SAS

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71 The Commission should accord substantial weight to the views of these companies, who have extensive experience and expertise on SAS-related issues.

72 While SAS developer Sony has observed that census-tract licensing requires somewhat more sophisticated spectrum management than PEA-based assignments, it states that "the difference between the two approaches is minor and entirely manageable with a sufficiently robust database implementation." Comments of Sony Corporation, GN Docket No. 12-354, at 2 (July 21, 2017).

73 *See* Google/Alphabet July 2017 Comments at 25 ("PAL areas receive protection from harmful interference based upon actual deployments of one or more PAL CBSDs.").

74 *See* note 32, *supra*.

technology and currently has ongoing field trials with such companies as Charter, Verizon, American Tower, and Ruckus. In conjunction with these trials, Federated has stated that it currently has more than 200 CBSDs connected to its SAS and that it is processing more than 18,000 spectrum grant requests per week. Federated has publicly indicated that it is ready for commercial launch of CBRS in mid-2018.[75] Likewise, Google's Alphabet Access has engaged in "extensive 3.5 GHz propagation testing," performed the "first end-to-end demonstrations of CBRS mobile devices," and "validat[ed] the SAS-to-SAS interface protocol."[76] Google's Preston Marshall, principal architect at Alphabet's Access, recently stated that the company is "actively pursuing clients" for SAS services and that soon it will likely announce contractual arrangements with major entities in the 3.5 GHz ecosystem.[77]

Finally, census-tract licensing should not be a problem for wireless carriers or other entities seeking to aggregate multiple census tracts for the provision of commercial mobile service. Large commercial mobile operators already manage thousands of wireless licenses, and these companies have existing internal systems that will enable them to administer 3.5 GHz wireless networks covering hundreds or thousands of census tracts.

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[75] Letter from Ross Vincenti, Federated Wireless, Inc., to Marlene H. Dortch, FCC Secretary, GN Docket Nos. 17-258 & 15-319, at 1 (Dec. 5, 2017).

[76] Google/Alphabet October 2017 *Ex Parte* at 5; *see also* Diana Goovaerts, *Nokia, Alphabet, Qualcomm Demonstrate Private LTE Network on CBRS Spectrum*, WIRELESS WEEK (Feb. 7, 2017), https://www.wirelessweek.com/news/2017/02/nokia-alphabet-qualcomm-demonstrate-private-lte-network-cbrs-spectrum; Monica Alleven, *Google-led SAS Ready to Test With 3.5 GHz Hardware Vendors for CBS Band*, FIERCEWIRELESS (Feb. 24, 2017), https://www.fiercewireless.com/tech/google-led-sas-ready-to-test-3-5-ghz-hardware-vendors-for-cbrs-band; Google/Alphabet July 2017 Comments at 5-11.

[77] Mike Dano, *Google's Preston Marshall on Company's 3.5 GHz CBRS SAS System: 'We're Probably the Furthest Along*,' FIERCEWIRELESS (Sep. 15, 2017), https://www.fiercewireless.com/tech/google-s-preston-marshall-company-s-3-5-ghz-cbrs-sas-system-we-re-probably-furthest-along ("We've done a large number of demonstrations. I believe we're probably the furthest along [of all the SAS vendors].").

VII. LONGER, RENEWABLE LICENSE TERMS WILL EXACERBATE PUBLIC INTEREST HARMS FROM PEA-BASED LICENSING

In the *NPRM*, the Commission proposes to extend the PAL license term to ten years and make these licenses renewable under the criteria applicable to other commercial mobile licenses.[78] As with PEA-based licensing, there is no need for such changes to the Commission's CBRS framework. The Commission's existing regulatory approach in the 3.5 GHz band will encourage dynamic, diverse use of this spectrum by a broad range of parties including GE and its industrial and critical-infrastructure customers, who hope to use this band to maximize the benefits of the IIoT. Certainly, if the Commission moves to PEA-based licensing at 3.5 GHz, GE opposes a simultaneous shift to longer license terms and PAL renewal. These additional rule changes would exacerbate the harms from larger license areas, further increasing the price of PAL licenses at auction and raising barriers to entry even higher for IIoT interests and other non-traditional entities.[79] The combination of PEA-based licensing and longer, renewable license terms would cement the status of CBRS as another commercial mobile band dominated by large wireless carriers. All of the reasons that militate against PEA-based licensing in the 3.5 GHz band weigh even more strongly against the combination of PEAs with longer, renewable license terms.[80]

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78 *NPRM* ¶ 13.

79 *See* Lehr Analysis at 14-16.

80 If the Commission maintains census-tract licensing in the CBRS band, GE could accept a moderate lengthening of the PAL license term, as some parties have previously proposed. *See* Letter from Stephen E. Coran, Counsel to the Wireless Internet Service Providers Association ("WISPA"), to Marlene H. Dortch, FCC Secretary, GN Docket Nos. 17-258 & 17-183, at 2 (Oct. 19, 2017).

VIII. CONCLUSION

For all of the reasons described in these Comments, the Commission should retain its innovative census-tract licensing framework in the 3.5 GHz band rather than reverse course just two and a half years after the *2015 Order*. While a PEA-based licensing scheme would leave this licensed spectrum under the control of large wireless carriers, census-tract licensing will encourage a broad range of parties to develop dynamic, diverse uses of the CBRS band. GE and its industrial and critical-infrastructure customers, in particular, will utilize this band to bring the full benefits of the IIoT revolution to the American public and the U.S. industrial and manufacturing sectors. The Commission should not squander this historic opportunity to spur innovation and enormous economic and public safety benefits through widespread scaling of the IIoT.

Respectfully submitted,

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