

Before the  
**FEDERAL COMMUNICATIONS COMMISSION**  
Washington, D.C. 20554

<b>In the Matter of</b>	)	
	)	
<b>Expanding Flexible Use of the 3.7 to</b>	)	<b>GN Docket No. 18-122</b>
<b>4.2 GHz Band</b>	)	
	)	
<b>Expanding Flexible Use in Mid-Band</b>	)	<b>GN Docket No. 17-183</b>
<b>Spectrum Between 3.7 and 24 GHz</b>	)	

**REPLY COMMENTS OF ROBERT BOSCH LLC**  
**AND SUPPORTING PARTIES**

Robert Bosch LLC (Bosch), by counsel, for itself and on behalf of the Supporting Parties noted herein<sup>1</sup> and pursuant to Section 1.415(c) of the Commission’s Rules [47 C.F.R. §1.415(c)], hereby respectfully submits these reply comments in response to those submitted pursuant to the *Notice of Proposed Rule Making*, FCC 18-91, released July 13, 2018 in the captioned docket proceedings (the *Notice*).<sup>2</sup> The *Notice* sought comment on various proposals for transitioning all or part of the 3.7-4.2 GHz band for flexible use, terrestrial mobile applications, and it explores options for more efficient and intensive fixed use of the same band, all while protecting incumbent C-Band satellite earth stations from harmful interference. In the continued interest of ensuring sufficient spectrum for private local networks to facilitate innovations in industrial manufacturing systems and in other flexible deployments of this mid-band spectrum, and in

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<sup>1</sup> Bosch is authorized to note that the following companies, each of which is engaged in manufacturing activities in the United States, support the positions enunciated herein, and each is a signatory hereon: ABB Automation Products, GmbH; Belden, Inc.; Endress+Hauser Automation Instrumentation, Inc.; ESR Pollmeier, GmbH; Mercedes-Benz US International; and Sennheiser Electronic Corporation. These companies are collectively referred to herein as “the Supporting Parties.”

<sup>2</sup> The Notice, published in the Federal Register on August 29, 2018, established a reply comment date of November 27, 2018. 83 Fed. Reg. 44128 et seq. Therefore these reply comments are timely filed.

response to comments previously submitted in this proceeding, Bosch and the Supporting Parties state as follows:

1. As would be expected in connection with spectrum that is currently occupied by thousands of C-Band downlink facilities used for program delivery for broadcast operations, but which is proposed for additional flexible use applications, the majority of the comments in this proceeding fall into two basic categories. There are those of broadcast entities and Fixed Satellite Service (FSS) providers which are dependent on the availability of ubiquitous, full-arc-coverage downlinks to obtain feeds of programming which at ground level have low received signal levels. These commenters are understandably concerned with their ability to retain the use of their receive-only C-Band antennas and with the absence of a practical alternative for reliable program delivery. Since this proceeding commenced, due to the opening of a filing window, there have been many thousands of C-Band antenna registrations filed recently, apparently totaling more than 15,000 nationwide. The comments of the C-band receive-only antenna users note that the Commission has committed to protecting the incumbent C-band antennas, and accordingly oppose an auction-based approach to accommodating flexible use. They do not wish to vacate the band and do not perceive an economically feasible, reliable alternative for reception of program material for broadcast.

2. The second major group of comments includes those of commercial mobile wireless service providers which urge the use of competitive bidding for most or all of the spectrum between 3.7 and 4.2 GHz, and urge the clearing of the spectrum of incumbents, by negotiated settlements, reverse auctions or some other method. Some of these commenters suggest that Section 309(j) of the Communications Act of 1934 necessitates that auction processes be used to allocate this spectrum, and that a “market-based” approach not involving competitive bidding

constitutes a violation of that provision of the Communications Act. Bosch and the Supporting Parties would suggest that these commenters apply an overly broad construction of Section 309(j). It is our view that there is no obligation under that Section of the Communications Act or pursuant to subsequent legislative actions that automatically necessitates the use of competitive bidding in this context. Under Section 309(j) of the Communications Act, if (and only if) mutually exclusive applications are accepted for any initial license, then the Commission must grant the license or permit to a qualified applicant through a system of competitive bidding. *See*, 47 U.S.C. §309(j)(3). Even if there is created mutual exclusivity in applications in the assignment process, the Commission still has the obligation in the public interest to use engineering solutions, negotiation, threshold qualifications, service regulations, and other means to *avoid* mutual exclusivity in application and licensing proceedings in the first place.<sup>3</sup> Therefore, the current method of shared use of this band between FSS and point-to-point microwave links under Part 101 of the Commission's rules has been legal all along. If no mutual exclusivity is created by the assignment process, there is no competitive bidding obligation whatsoever.

3. The Commission, at paragraph 66 of the *Notice* in this proceeding suggested a third alternative, which is the adoption of rules that would facilitate a market-based approach to “transitioning incumbents” from some or all of the 3.7-4.2 GHz band. The Commission suggested that it could authorize incumbent FSS operators to voluntarily clear all or part of the band on a nationwide basis. Satellite operators in the band could choose to make some or all of the spectrum available to terrestrial operators of whatever sort in a secondary market, in exchange for compensation. Under such an approach, satellite operators could be responsible for clearing the portion of the band that would be made available for flexible use, including

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<sup>3</sup> 47 U.S.C. §309(j)(6)(E).

notifying Earth station users of the need to modify their operations and compensating them for any costs associated with that transition. The Commission suggested, and some commenters did agree, that such a secondary market approach might make spectrum available more quickly than would auctions, and thus facilitate rapid deployment of 5G wireless broadband networks, relying on market incentives to promote economic efficiency. Not unexpectedly, however, the commercial mobile broadband providers were, as a group, not enthusiastic about this proposal because it left the process largely in the hands of the FSS satellite service providers. Furthermore, since it did not provide any opportunity for C-Band satellite receive-only antenna users to have a voice in the negotiation process at all, the Commission's view of a "market-based approach" was not popular with the users of C-Band receive-only antennas, though it was received better than was a pure competitive bidding arrangement, which would disenfranchise them completely. So the situation is difficult and apparently rather polarized.

4. As far as can be determined from a review of the Comments filed in this proceeding, no commenter, other than Bosch and the Supporting Parties, has proposed the implementation of localized, 5G private networks in support of Industry 4.0 and next-generation manufacturing in the United States in this band.<sup>4</sup> Bosch would suggest that the least intrusive means of implementing flexible 5G technology in the band as a compatible overlay, without disrupting incumbent FSS receive-only facilities<sup>5</sup> is through a prior coordination notification process

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<sup>4</sup> As Bosch and the Supporting Parties indicated in comments filed in this proceeding, 5G implementation worldwide is proceeding at a rapid pace. One of the many reasons for this is the benefit of 5G technology immediately available in numerous industry sectors (referred to as "5G verticals") including connected driving and in manufacturing. In the manufacturing sectors, the success of "Industry 4.0" is dependent on availability of 5G technology and adequate mid-band spectrum therefor. Fundamental to this "fourth industrial revolution" is the implementation of a reliable communication layer capable of dealing with an increase of several orders of magnitude in the number of assets, volume, variety of information and reaction times in future manufacturing systems relative to current technology.

<sup>5</sup> Authorizing spectrum for private 5G local networks in support of manufacturing is consistent with the Commission's stated intention to protect the many thousands of incumbent C-band downlink Earth stations in the 3.7-4.2 GHz band used by the broadcast industry for important program distribution on an ongoing basis. Given the

similar to that used under Parts 74 and 101 now relative to FSS and point-to-point microwave facilities and relative to BAS fixed facilities in bands shared with other Part 74 and 101 users.<sup>6</sup> This can be done successfully because the Commission now has a current, accurate and complete registration database of protected C-Band satellite receive-only antennas. Contributing to the success of the process is the relatively localized nature of private 5G networks. The coordination process can be done in the private sector similar to the prior coordination notification process applicable to that called for in licensing point-to-point microwave facilities, and fixed broadcast auxiliary facilities that has been used successfully in the Part 101 context for many years.<sup>7</sup> It will allow rapid implementation and deployment of private 5G local networks in support of manufacturing processes and in other localized applications, while providing predicted, calculated protection for registered, incumbent C-Band receive-only Earth stations. It is not proposed that the entire 3.7-4.2 GHz band be made available for localized private networks. Rather, Bosch and the Supporting Parties reiterate the suggestion made in their earlier-filed comments that for now, the segment in common between the 3.7-4.2 GHz band and the mid-band spectrum identified by the European Commission at 3.4-3.8 GHz as a pioneer band for 5G networks in Europe (i.e. 3.7-3.8 GHz) should be made available for private, localized 5G networks for flexible uses, including manufacturing, in the United States. This would permit at

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local deployments of the private 5G networks; the low power levels relative to 5G macro base stations; the anticipated geographic separation between industrial manufacturing facilities and broadcast studios; and taking into account the possibility of unlicensed but registered or limited licensing of coordinated, private 5G local networks for manufacturing, the private 5G local networks would provide a compatible partial overlay on spectrum heavily used for C-band satellite downlinks without creating any mutual exclusivity at all and obviating the need for use of auctions completely.

<sup>6</sup> This process elegantly facilitates geographic sharing with ubiquitous, incumbent FSS receive-only antennas by allowing, for example, a new or upgraded manufacturing facility which will incorporate a private, 5G local network to notify all registered C-Band receive-only dish user in the vicinity of its intention to implement a licensed local network in advance of that implementation, specifying technical parameters of the RF portion of the proposed network. The C-band antenna users would then have an opportunity to raise interference concerns, if any, and those can be resolved by negotiation between the parties and technical solutions implemented.

<sup>7</sup> See, 47 C.F.R. § 101.103(d) and 47 C.F.R. §74.502(d).

least partial international harmonization in the mid-band 5G rollout as between Europe and the United States.

5. In order to appreciate the value of incorporating 5G technology in manufacturing in the United States, it is useful to compare the factories of the past with those near-future factories enhanced with 5G connectivity. Factories of the past have been static and of necessity were optimized for one particular product. Those of the future are flexible and offer almost unlimited optimization. In the factory of the future, the only fixed components are the floor, walls and ceiling. It will have ubiquitous, wireless connectivity for plug-and-play and mobility, and 5G will become the “central nervous system” for the entire factory. It will connect rotating and moving parts; it will connect mobile devices; it will permit easy retrofitting; it will permit higher flexibility and versatility; leveraging of cloud computing; lower maintenance costs; it will decrease outages; and it will permit built-in localization support.

6. Examples of just a few near-term potential applications for 5G in factories are autonomous guided vehicles in factories and product warehouses;<sup>8</sup> motion control systems; modular production units;<sup>9</sup> mobile human/machine interfaces;<sup>10</sup> augmented reality<sup>11</sup> and wireless sensor networking.<sup>12</sup> With respect to robotics alone, the applications are almost unlimited.

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<sup>8</sup> Autonomous Guided Vehicles (AGVs) perform logistical functions inside the warehouse. Wireless connectivity is necessary due to the mobility of AGVs. Communication between AGVs is possible, as is communication with the environment. It shifts intelligence to the network. AGVs have a low tolerance for latency and high requirements for reliability, seamless mobility support and data rates.

<sup>9</sup> Wireless connectivity between different production modules is one of the principal components of the high level of flexibility & versatility of Industry 4.0. This connectivity permits easy reconfigurations with full self-management.

<sup>10</sup> Mobile control panels support workers in an intuitive manner. Wireless connectivity allows high reuse; one panel can be used to interact with many different machines at the same time. The panels permit safety-critical functions as emergency stops. This application has the lowest tolerances for latency (~4 ms), and the highest requirements for reliability (>99.9999%) and seamless mobility support.

<sup>11</sup> Augmented reality can be used, for example, to support workers on site with information on production status, handling instructions, remote assistance, etc. Use of augmented reality includes high requirements for data rate (~Gbps) and latency (~10 ms).

<sup>12</sup> 5G technology permits connectivity between hundreds or thousands of sensors at once. Potential applications include condition monitoring, predictive maintenance, anomaly detection, etc. Wireless connectivity also allows easy installation and retrofitting.

Current robotic technology for factories using 5G private networks includes mobile Human-Machine Interfaces (HMI) without cables and without latency (low latency is critical to safety in factories). 5G is used also for robot control and video processing, allowing the shifting of intelligence to the network and edge cloud computing. It allows a high degree of precise indoor localization enabling indoor autonomous movement. It permits use of integrated sensors in robotic devices for predictive maintenance and condition monitoring. Also, it allows device-to-device communications, permitting flexible collaboration between robots.

7. Challenges in modern factories for competitive manufacturing are several. First, they require a very high level of reliability. Communications service availability has to be essentially constant. Device synchronicity must be instantaneous, with less than 1 microsecond delay and end-to-end transmission latency must be less than one millisecond. In terms of safety and security, there can be no compromise, and tailored or customized, optimized solutions are required. There must also be seamless interplay with industrial Ethernet solutions. Finally, the communications in some cases must be in the form of private wireless networks rather than traditional public or commercial communications networks, as is further explained below. Each of these challenges is successfully addressed by incorporation of 5G technology as outlined herein.

8. There are special properties of industrial applications and venues necessitating the use of localized, private 5G networks. There is a good deal of predictable communications traffic sent in small packets. The factory setting is highly controlled, and ultra-reliable, low latency communications are often needed over very short distances, often line-of-sight. The environment is somewhat challenging, with numerous metal objects present and potentially high ambient noise levels. Pure, cloud-based networking is possible with a single point of processing. These

issues are addressed by 5G technology. With it, the efficiency and reliability of factories is radically improved.

9. Bosch and the supporting parties do not argue that there is no place for commercial mobile 5G broadband networks in Industry 4.0 implementation. Quite the contrary, some Industry 4.0 applications of 5G can be facilitated using commercial mobile 5G broadband from service providers. However, some cannot. The point is that manufacturers should have the flexibility to select the best option – commercial mobile broadband versus private local networks - according to their use-cases and individual needs. There are numerous reasons for this. To expand on the comments filed by Bosch and the Supporting Parties earlier in this proceeding, the basic reasons for needing localized private 5G network systems for manufacturing include performance and autonomy, security and privacy, liability issues, and access to spectrum. Relative to performance, the communications needs for future factories are local, and it is best for manufacturing to keep the system local. Private local networks allow the network configuration to be optimized to the extent necessary for production. It is important for manufacturing to not be locked into or dependent upon any particular commercial operator. Localized, private networks minimize costs and permit United States manufacturing to be competitive with their counterparts internationally. For security and privacy purposes, it is critical for the business entity to keep full control over deployed equipment, people, security mechanisms and algorithms, and the like. Minimizing manufacturing downtime is a critical element of manufacturing operations. There are huge damages from network downtime, making local control extremely important. Finally, with respect to macro-economic considerations, quick and easy access to 5G spectrum is critical to assuring competitiveness in manufacturing. Manufacturing facilities cannot be dependent on commercial operators to decide when suitable



5G service will become available in a given area. That must be determined by the manufacturer. The location of a factory may not be a priority for a commercial mobile broadband provider, and the resultant delays can be crippling for American manufacturing. In short, exclusive access to spectrum is a key aspect of ultra-reliable, low-latency communications in manufacturing. Manufacturers are typically unwilling to rely on third party, commercial broadband network operators for performance, security, privacy, the economics of the service provided, and for liability reasons. The operation of private 5G local networks within a factory environment is a necessity for the success of 5G in the industrial domain.

10. Bosch and the Supporting Parties would note that manufacturing in the United States is not by any means the principal application of localized 5G technology, but it is a good example of the fact that the means by which the band 3.7-4.2 GHz is rolled out in the United States should be flexible, just as the Commission envisions the uses of the band to be. The European Commission, in its 30 January, 2018 *Radio Spectrum Policy Group Strategic Spectrum Roadmap Towards 5G For Europe - RSPG Second Opinion on 5G networks* (RSPG18-005 FINAL) notes among other things that “The [Radio Spectrum Policy Group of the European Commission] recognises that 5G promises to enable the delivery of a diverse set of applications and new services in a number of different markets, going beyond the traditional mobile broadband market.” As such, the “RSPG is of the opinion that Member States will need flexibility in the way they authorise access to spectrum, for example: appropriate geographical areas (e.g. national, regional, city or hyper-local, e.g. for use in a factory), individual licencing or under a general authorisation framework.” The ultimate point is that it would be inefficient and inequitable to American manufacturing to simply auction the entire 3.7-4.2 GHz band to commercial broadband providers in the normal course and allow them to clear the band of

incumbents using reverse auctions or whatever other incentives might appear most expeditious. That would foreclose the opportunity for American manufacturers to implement revolutionary innovations in industrial manufacturing and to compete effectively in a worldwide market. Far more creatively, and far more beneficial for the American economy, the Commission should reserve at least a portion of the band, and especially the portion at the lower end that overlaps the planned European 5G allocation at 3.4-3.8 GHz, for smaller geographic area deployments on an interference-free basis, premised on the prior coordination notice procedure being conducted relative to incumbents, and allow private, local 5G networks to be developed flexibly and quickly within communities or factories or otherwise at the local level.

11. Bosch and the Supporting Parties would reiterate that the partial harmonization of the mid-band 5G allocation in the United States - relative to the configuration under discussion in Europe - would facilitate an exceptionally flexible opportunity for manufacturing in both the United States and Europe within the band segment available in common to both: 3.7-3.8 GHz. The German Federal Network Agency (Bundesnetzagentur) has proposed an innovative means of flexibly rolling out mid-band 5G spectrum in Germany. Under that proposal, the band 3.4-3.7 GHz would be allocated and assigned by auction to traditional mobile broadband providers. The 3.7-3.8 GHz segment, however, would be *flexibly deployed locally by individual manufacturing and industrial entities*. The local deployment by the private sector would be a key component to the rollout of 5G in support of Industry 4.0 initiatives in manufacturing and industrial applications. The United States should adopt a similar strategy, which is entirely consistent with the Commission's proposal in the *Notice* to work upward from 3.7 GHz toward 4.2 GHz in the deployment of 5G therein. At the same time, the configuration proposed herein enables frequency re-use (through a prior coordination procedure, pre-licensing, that has proven useful in

both Part 101 and Part 74 licensing processes among fixed and mobile applications); it protects registered incumbent C-Band receive-only antennas; and it constitutes a flexible and efficient use of spectrum across vertical markets. It provides opportunities not only for industrial manufacturing, but also for chemical and pharmaceutical manufacturing, energy generation, healthcare, smart transportation systems, and news and entertainment program production (among many other applications).

12. For all of the above reasons, Bosch and the Supporting Parties remain of the view that the authorization of private 5G local networks in the band segment 3.7-3.8 GHz is an urgent component to the Commission's proper focus on timely rollout of 5G mobile and fixed operation in the 3.7-4.2 GHz band. The availability of these private local networks constitutes a highly flexible and preferential means of allocation of radio service throughout the United States pursuant to the Commission's statutory obligation in that respect. 47 U.S.C. § 307(b). The success of Industry 4.0 is dependent on the integration of 5G technology at the local level. It promises a great leap forward in industrial efficiency and output with unlimited future potential for American manufacturing.

Therefore, the foregoing considered, Robert Bosch LLC and the Supporting Parties again respectfully request that the Commission make 5G technology available on a flexible, coordinated basis for private 5G local networks in the band 3.7-3.8 GHz for use in support of

Industry 4.0 applications as proposed herein.

Respectfully submitted,

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