Before the

Federal Communications Commission

Washington, D.C. 20554

In the Matter of	**)**	
Use of Spectrum Bands Above 24 GHz for	**)**	GN Docket No. 14-177
Mobile Radio Services	**)**	

REPLY COMMENTS

OF

ANGIE COMMUNICATIONS USA B.V.

ON THE

NOTICE OF INQUIRY

TO EXAMINE USE OF BANDS ABOVE 24 GHZ FOR MOBILE BROADBAND

FEBRUARY 23, 2015

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On the Comments of NYU Wireless

We support the case put forward by Professor Rappaport of NYU Wireless in his Comment, urging the Commission to act steadfastly in terms of rule-making. NYU Wireless even points out the statutory mandate to act in new technologies and not to delay consideration, based on specific provisions of the Communications Act of 1934 -namely §7(a) and §303(g)- that both authorize and urge timely deliberations. [1]

We also share the concerns by NYU Wireless in terms of the lack of pro-active guidance and financial support in terms of R&D by the USA government, in contrast to other governments (e.g. China, Japan and Korea) that champion innovation and research and development by academia and industry.[2]

We second the fact that empowered mmWave communications could help the USA bridge the "digital divide" between rural and urban centers. We would like to add that this divide even exists in urban, suburban and exurban areas, not just in rural regions. The digital divide is a multi-headed beast as it could be (to name a few reasons) the result of lack of access (as NYU Wireless alludes to), and it could be the result of pricing (access is available, but still too expensive), and it could be the result of landlord/property owner lack of willingness to allow "hooking up" their properties. We are committed to bring communications at gigabit speeds to everyone, everywhere, at the lowest prices possible. The mmWave connectivity is an important part of our plans to provide fiber-like speeds through wireless technologies where building fiber is not an (immediate) option. To approximately 10% of the USA

[1] Comments of NYU Wireless, Theodore Rappaport, January 15, 2015, pp. 10-11.

[2] Id. pp. 9, 10, 15.

population, this could mean the difference between no high-speed connection at all and becoming fully-participative citizens.

With regards to international harmonization, we agree with NYU Wireless in its recommendation of the Commission considering the clear statement by Qualcomm, stating that the Commission should start designating some bands for mmWave mobile use in the immediate future while working with the ITU to bring about harmony where possible.[3]

We also agree with the statement, …"[N]o commenting parties have given a cogent reason why the Commission should move away from the 1987 precedent of not requiring technical standards other than interference-related ones."[4]

On the matter of spectrum above 100 GHz, we agree with the summarized outline and statement provided by NYU Wireless.

> … *[T]he FCC should work with all parties to develop rules for access of the spectrum above 95 GHz that respect all legitimate concerns. Particularly given the fact that international standards bodies (IEEE 802.11 and 802.15) already are working on Terahertz wireless devices (from 275 to 3,000 GHz), the US must have spectrum allocations for its wireless industry to compete for products, services, and human capital.* [5]

and

[3] Id. p. 17

[4] Id. p. 22

[5] Id. p. 26

> *… [I]nternational competitiveness issues require the FCC to begin to dismantle the artificial spectrum ceiling that now exists at 95 GHz, so that higher frequencies may be immediately supported for wireless communications. Technologies at or above these frequencies are either here already, or are rapidly coming.79 The continuance of this frequency ceiling, along with NTIA's reluctance to allow experiments that offer virtually no risk of interference, threatens US leadership in wireless technology."*

In addition to the recommendations by NYU Wireless, we would also urge the Commission to increase power range and relax fixed beam antenna specifications *in the E-Band spectrum*. Insofar that it makes mobile service/mobile access possible. [6]

On the Comments of Straight Path Communications[7]

With regards to mobile services, we agree with the statements and recommendations put forward by Straight Path. Nonetheless, we would like to add that the Commission's considerations on those very recommendations should be extended also to the E-Band, where and if so relevant and applicable.

Furthermore, no specific band between 24 GHz and 100 GHz should be prioritized over another as some, including Straight Path, have proposed. We urge the Commission to proceed to proposed rulemakings on all mmWave bands between 24 GHz and 100 GHz swiftly, but also in a concerted effort.

Also, while Angie intends to spend approximately $18.5 Billion in the USA by 2021 on CapEx alone, exclusive licensing is not something it really believes in, and which in fact, would truly cause us to reconsider our plans for the USA. We believe that the zero-sum approach professed by the likes of Straight Path only serves to compel the Commission into giving deep-pocketed players another allocated

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[6] Id. p. 30

[7] Comments of Straight Path Communications, Inc. – January 15, 2015 and Notice of Exparte.

"beach front" property, but this time in the mmWave bands – making especially their own spectrum holdings increase in value, exponentially, in the near future.

As Straight Path states:

> … *[P]ermitting existing licensees in these bands to provide mobile services is the most straightforward and expedient way to make exclusively licensed spectrum available for 5G.*[8]

We highly doubt this is the case, especially because Angie intends to invest more than any other new entrants on this so-called 5G service (most likely also in the 39 GHz band, if allowed). We do therefore not agree with Straight Path's in this regard.

Again, deep pocketed operators (whether new, legacy or continuing entities) should not be allowed to hoard spectrum and/or beacon off swaths of spectrum. The economic benefits if licenses were to be sold for high prices (which would befall the USA people one way or the other) can be off-set easily by the order of magnitude of efficiency and opportunity that opens up for the USA people and business from day one, for the rest of their lives.

It seems to us that Straight Path is trying to make a case solely for its own benefit in the 39 GHz band (which it has holdings in) while trying to steer offloading and crowd-sourcing to the higher bands. This self-serving attitude is condensed in their everything-for-us strategy: 1) exclusive license, 2) fixed wireless/backhaul, 3) mobile access, and 4) prioritize rulemaking on 39 GHz and LMDS.

Thus, as Straight Path lays out the hybrid approach for the 37/42 GHz bands, those should apply for the 39 GHz and LMDS bands too.

Straight Path furthermore claims that

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[8] Id. p. 9

> *… Spectrum bands that already include several incumbents and/or do not currently contemplate sharing – i.e., the 39 GHz and LMDS bands – are more suitable for exclusive licensing.*[9]

It does not seem like Straight Path has provided proof (even though some vendors agree) to substantiate their claim that these bands are more suitable for exclusive licensing than any other form of licensing, other than in some financial terms. Interference and other management issues can just as easily be overcome in this band as in any other mmWave bands.

The Commission should move to change the licensing scheme in the 39 GHz and LMDS bands to a multi-tier scheme (as intended with the 3.5 GHz). Since the road to hell is paved with great intentions, it would be wise not to wait on future promises of "5G" roll out by anyone, and instead also allow spectrum for other/new entrants.

If flexibility versus availability versus opportunity should be part of an equation, it could be that the Commission would apply such a hybrid licensing approach to certain (or all) other bands too initially, and revise it after five or so years – of course all the while taking keeping an eye on the required construction period commitments.

This non-precluding approach would allow the occasional newcomer to plan with confidence, and it would perpetually keep open the scenario of more choices for the people.

[9] Id. p. 10

On the Comments of Google

As described above, our vision with regards to mmWave licensing is almost similar to Google's. We would add, as before, that the Commission should allow mobile service/access in all possible mmWave bands.[10]

On the Comments of Open Technology Institute / Public Knowledge[11]

We agree with OTI/PK that,

> *[T]he Commission should extend the balanced approach exemplified in the agency's proposed 3.5 GHz band Citizens' Broadband Radio Service and ensure that there is an appropriate mix of licensed, unlicensed, and particularly hybrid approaches that ensure spectrum allocations promote opportunistic access, intensive small cell re-use, innovation, market entry, and competition…*

However, we disagree with the observation (page 2) on "the realities of the propagation characteristics of high-frequency bands" by OTI/PK, implying that mmWave spectrum would not be able to sufficiently enable mobile services. The concerns listed by them and others, discounting potential mobile access services in the mmWave spectrum and keeping it in the Line-of-Sight/ backhaul realm, rely on outdated data and myths that have been analyzed and researched in-depth by hundreds of accomplished researchers all over the world. As the Notice shows, the Commission is aware of the most recent advancements in this field.

Limitations that were of yesteryears' concern, such as path-loss, blockage, propagation issues are today easily overcome by use of smart planning and by (existing or developing/upcoming) technologies –

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[10] Comments of Google, Inc. January 15, 2015

[11] Reply Comments of Opent Technology Institute at New America and Public Knowledge, February 18, 2015

as proven by countless field and lab tests and analyses. In fact, the most limiting aspect of mobility in mmWave spectrum is rooted in the power levels that are imposed by the Commission.

Angie's extensive internal technology analysis report, dealing in-depth with exactly these issues (among others), may be published online in order to sway the public opinion and view of future mmWave mobile communications. In case we decide to publish, we will notify the OTI/PK and the Commission.

The ICT world is different today from even five years ago. It is about time that, and it seems like, the Commission acknowledges this and moves to level the playing field for once and for all.

On the Reply on Comments by Samsung Electronics America, Inc. and Samsung Research America[12]

While we share the overall same vision with Samsung, we would like to point out some issues that we believe need some consideration.

Samsung requests that,

> *Commission should focus primarily on the provision of licensed mobile broadband systems in the 28 GHz and 39 GHz LMDS bands as well as 37/42 GHz bands for 5G, with a secondary eye toward other bands such 60 GHz.*

We would, however, request the Commission to develop and establish mobile access policy in all mmWave spectrum and not prioritize any specific bands.

[12] Reply comments of Samsung Electronics and Samsung Research, February 18, 2015.

Samsung has been the first to prove 7.5 Gbps speeds, and even though that was in the 28 GHz band, it has also been proven that the E-Band (namely 73 GHz) propagation and data rate characteristics do not differ much from those of the 28 GHz bands in terms of point-to-multipoint and/or mobile access.

> *… We observe that the predicted value are very close the measured values, and the path loss exponent and the shadow fading standard deviation at 73 GHz are not much worse than the NLOS values seen at frequency bands below 6 GHz.... And… 28 and 73 GHz channels are surprisingly similar, where 73 GHz are not much more lossy.*[13]

Thus, prioritization of any band has no real technological justification, especially not for the purpose of mobile access/services, which is the main objective of the Notice.

Also, we recommend that future utilization of the mmWave bands should be in the form of either unlicensed or a hybrid/multi-tier licensing scheme, allowing the market to adapt and react in order to compete on the merits of business models and deployment characteristics, much like today Wireless Internet Service Providers have been doing.

Our own research and analyses efforts were concluded with the fact that spectrum above 24 GHz is most suitable for the deployment of 5G networks, and mobile access should not be excluded from this unique advancement.

In summary, prioritization and pure-focus on the lower segment of the mmWave spectrum is not necessary. In fact, we champion an equal-opportunity approach by the Commission with regards to the entire mmWave spectrum, even above 100 GHz (see comments above in relation to NYU Wireless). In no event should the Commission simply prioritize rulemaking on a certain section of the mmWave spectrum.

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[13] **Evaluation of Empirical Ray -Tracing Model for an Urban Outdoor Scenario at 73 GHz E-Band ,** Huan Cong Nguyen, George R. MacCartney Jr., Thimothy Thomas, Theodore Rappaport, Benny Veijlgaard, Preden Mogensen, 2014

On the matter of exclusive licensing regimes, we have stated before that we do not share those concerns as ventilated by Samsung and Straight Path and certain others. We do not believe that investment in 5G would come to a grinding halt if there were a lightly regulated or unlicensed or hybrid licensing (multi-tier) scheme for those bands where some incumbents are vested. In fact, we believe that the world is ready for people-centric networks, where operators are primarily enablers of communications infrastructure/networks and not the end-all and be-all of communications. An unlicensed and/or hybrid schemes could bring about this revolutionary paradigm shift.

Our Reply Comments on Certain Questions in the Notice.

In light of comments made by others, we have taken the opportunity to include our view on certain questions that were posited in the Notice. Our answers are underlined.

Technology Developments

1. We seek to develop a record on technological developments relevant to the use of bands above 24 GHz for mobile services and what service rules would be necessary to facilitate mobile use of those bands. We seek comment on the following general questions and later in this inquiry invite comment on specific frequency bands:

a) Will it be feasible to provide mobile services in bands above 24 GHz?

a. Yes. We concur with Professor Theodore Rappaport in his extensive reply to this question in his Comment.[14] Propagation can often be increased to ranges of 300 – 400 meters. We are of the opinion that the range will increase by time as technology matures, and obviously (especially) when new power levels allow.

b) To what extent will the viability of mobile service above 24 GHz be dependent on having complementary access to mobile services in lower frequency bands?

a. Angie focuses its efforts on Mobile Broadband/Wireless Access, where the mobile broadband part refers to its nationwide, full-coverage network (based on lower frequency) and Wireless Access network refers to more populated areas (even then including many rural areas). Complementary access to mobile services would ensure Angie's subscribers reliable connectivity and service, even in rural areas. Being able

[14] Comments of NYU Wireless, Theodore Rappaport, January 15, 2015, page 20.

to offer an all-in-one subscription means that the service becomes attractive for even the most critical and choosey subscribers. Having lower-frequency bands available would allow a faster deployment of 5G in the USA as the likes of Angie could then start (building) from a top-down approach where building local, wide and metro wireless networks would be rolled out simultaneously.

b. Where Rappaport et al deem pure-play mmWave nationwide coverage maybe possible in 15-20 years, we believe that it could be a matter of years instead of decades, but only if the Commission accommodates innovative services. In Angie's view and vision, 4G (or 4.5G) services (on LTE-Advanced technology) would be the fallback option of choice in the very near future, while mmWave-centric MB/WA services would be the central point, thus realizing a converged infrastructure for mobile, wireless and nomadic use. This mmWave-centric MB/WA network would, of course, co-exist with and even rely on the heterogeneous (HetGen) components such as Wi-Fi access points, femto-cells etc. that are inherently closer to the user, and of course for reliable ultra-high-speed connectivity and unified communications services, in-building and indoors.

c) What characteristics of the anticipated technology will be relevant to the choices of frequency bands above 24 GHz such as required bandwidth, propagation, availability of electronic components, antenna designs and costs of deployment?

a. For Angie the main focus is on building something from scratch, without having to consider any legacy systems/ technologies. Therefore, Angie is taking a "wait and see" to see how the stars align. It seems like technological innovations improve the odds for Angie on an almost daily basis. Nonetheless, we prefer to look at the higher regions of the mmWave spectrum, namely the E-Band. Technology-wise we do not see any major detriments to our strategy or unsurmountable obstacles.

b. Once the Commission allows and enables mobile access, innovation would take an even greater flight, bringing about the era of 5G ubiquity in the USA, most likely ahead of the rest of the world. Although it must be said that the UK OfCom seems to have set an even more ambitious agenda in terms of decision-making deadlines.[15]

d) What characteristics of the anticipated technology are likely to inform the agency's determination of what regulatory framework (or frameworks) for mobile services in the mmW bands will best serve the public interest?

a. We concur with Rappaport in this regard.

b. However, we object to exclusive-license policies in the mmWave spectrum. See our comments above, especially in relation to Straight Path.

e) What characteristics of the technology are relevant to the manner in which mobile services in the mmW bands might coexist without impact on incumbent services that occupy the relevant frequency bands?

a. As technology and innovation adapts, moves and improves each and every second, we do not believe that there will be any limiting aspects that would prevent coexistence with incumbent services.

f) Are there frequency bands contemplated for mobile use that are being considered for alternative uses and, if so, what might those alternative uses be? To what extent are such uses compatible or incompatible with the kinds of mobile wireless technologies being explored in this NOI?

g) **What technical and operational characteristics as well as interference mitigation techniques of the anticipated technologies for these bands need to be considered in assessing sharing and compatibility with in-band and adjacent band incumbent**

[15] Spectrum above 6 GHz for future mobile communications, Call for Input, OfCom, January 16, 2015

services? Are there other technical considerations the Commission should examine in enabling deployment of mobile services in bands above 24 GHz?

a. In terms of interference, we point to the analysis provided by Professor Robert Heath in his Comment.[16]

b. Nonetheless, the concerns stated by Heath have for the most part been "taken care of" or are already topic of interest in several studies. Some conclusions:

   i. The small wavelengths involved in the mmWave bands allow much more directional antennas for reasonable antenna sizes than at lower bands. This means that transmissions will be more [thermal] noise-limited than interference-limited, since energy is beamed in specific directions using higher gain antennas… [17]

   ii. … [B]eamforming makes it easy to distinguish desired signal and interference. As a result, the beamforming can be used to provide spatial division multiple access (SDMA) which is able to offer superior performance in radio multiple access communication systems. The strong straightforwardness of the millimeter-wave band helps to prevent a signal spread and interference. Therefore, the spectral efficiency of the central network can increase through spatial reuse with the prevention of signal spread and interference. [18]

   iii. "…[D]ue to the narrow beam width of MMB transmissions, the interference among MMB base stations is a lot smaller than traditional cellular systems,

[16] Comments of Robert Heath Jr., February 18, 2015

[17] Comments of Theodore Rappaport, p.35 and "Millimeter Wave Cellular Wireless Networks : Potentials and Challenges" (Sundeep Rangan , Theodore S. Rappaport, Elza Erkip) , p. 10. January 11, 2014.

[18] System Coverage and Capacity Analysis on Millimeter-Wave Band for 5G Mobile Communications, Jun Suk Kim et al. International Journal of Antennas and Propagation, pp 3, 10; Published July 2, 2014.

and the coverage of neighboring base stations significantly overlap."[19]

Furthermore, for an in-depth analysis, please see Sarabjot Singh's dissertation.[20]

Antenna Technology

a. Base Station Antennas

What do commenters anticipate the size and configuration of the antenna arrays will be, including the orientation of the vertical and horizontal elements and the predicted number of beams?

a. As of yet, this is still a topic of study for most of the mmWave spectrum. With regards to mmWave spectrum in the E-band, multiple antenna techniques will be essential to provide beamforming gain to compensate the inherent propagation loss, Peng Wang et al state[21] that "the high transceiver complexity in large MIMO systems with a massive number of antennas as one of the few remaining challenging technical issues."

and

b. "E-band transmissions suffer much more power loss than those over conventional microwave bands. For example, the propagation at 75GHz is 30dB worse than that at 2.4GHz (the operating frequency for WiFi networks). Thus to guarantee the same signal power (and in turn the same quality of service) at the receiver, the transmitted

[19] An introduction to millimeter-wave Mobile Broadband Systems Farooq Khan, Zhouyue Pi, IEE Com magazine, June 2011, p. 107.

[20] Load Balancing in HetGen Cellular Networks, Sarabjot Singh (Dissertation - 2014), page 157, etc.

[21] Multi –Gigabits Millimeter Wave Wireless Communications for 5G: From Fixed Access to Cellular Network, Peng Wang, Yonghui Li , Lingyang Song , Branka Vuccetic, October 16, 2014. Pp. 7-12.

power at 75GHz must be 30dB higher than that at 2.4GHz. This makes the signal transmission/reception through a single omnidirectional antenna practically infeasible in E-band systems."

however

c. … [O]ne approach to compensate the severe E-band power loss is to equip a massive number of antennas at both link ends to provide a large beamforming gain… The synthesized low-cost antenna arrays can be electronically steered to provide adaptive yet highly directional links permitting a flexible deployment. In principle, the number of antenna elements that can be packed into a given aperture size is increased by four times for every doubling the operating frequency, providing about 6dB beamforming gain at each link end if these antennas are compactly located to form an equivalent directional antenna for steering a "pencil beam".

d. To further enhance the link capacity, we need rely on multiple antenna techniques to achieve a multiplexing gain such that transmissions of multiple spatially independent signal streams can be supported simultaneously without interfering with each other.

e. Rappaport et al reported on their research that in their 28 GHz prototype system "… [W]e equipped each transmitter and receiver with a 64-antenna array about the size of a Post-it note. However, we divided this array digitally into two 32-antenna MIMO channels. Each channel used 500 MHz of spectrum and was capable of forming a 10-degree-wide beam.[22]

[22] Smart Antennas could open up new spectrum for 5G, Theodore Rappaport, Wonil Roh, Kyungwhoon Chen, August 28, 2014 – IEEE, http://spectrum.ieee.org/telecom/wireless/smart-antennas-could-open-up-new-spectrum-for-5g

f. In the same article, the authors reported that they found it possible to fit as many as 32 (28 GHz patch) antennas on the Galaxy Note II, around the top and bottom edges while still providing 360 degrees of coverage.

g. With regards to base stations, they expect future mmwave base station to be able to house 100 or more antennas.

h. Researchers from DIT University, Dehradun, India, have proposed a "micro-strip patch antenna" (namely for the 28 and 38 GHz center frequency), which they claim has attractive and widespread features due to its low profile, small size, light weight, low cost as well as to the fact these are very simple to design, suited to planer and non-planer surfaces.[23]

For an in-depth analysis on Massive Antenna Structures and relevant research, please refer to System Coverage and Capacity Analysis on Millimeter-Wave Band for 5G Mobile Communications by Jun Suk Kim et al. [24]

With respect to antennas located at base stations, what factors are likely to affect the physical size of and space needed for the antenna arrays?

a) Please see footnotes 21-24.

[23] Millimeter-wave Mobile Communications Microstrip Antenna for 5G - A Future Antenna, Brajlata Chauhan, Sandip Vijay and S.C. Gupta, International Journal of Computer Applications, Volume 99 – No. 19, August 2014, p 15.

[24] System Coverage and Capacity Analysis on Millimeter-Wave Band for 5G Mobile Communications, Jun Suk Kim et al. International Journal of Antennas and Propagation; published July 2, 2014.

How will the base stations manage the transmitted effective isotropic radiated power (EIRP) of each antenna beam to generate the desired gain? What will the typical gain be for an individual element of the array? Will each element in the antenna array have a variable power that can be managed depending on the demand placed on the base station? Will the aggregate transmitter power for the base station increase as more elements of the array are used for operation? What are the vertical and horizontal beamwidths that the antenna array could cover? What type of sectorization is being considered for a base station array? What is the desired PA output power and EIRP of the base station?

a) Above questions are best to be answered by equipment manufacturers.

b) With regards to the PA output power and EIRP, we concur with the statement by Rappaport: [25]

> … *"[T]he focus of regulation (from a base station or relay perspective) should not be EIRP limits, but rather power flux density (PFD) limits (far-field values) that protect cochannel and adjacent channel users, and RF safety-based limits that ensure heating effects do not cause human damage. The use of PFD will allow users of varying bandwidths and beamforming antenna arrays to trade off power and antenna beamwidth (gain) over a wide range of channel bandwidths.*

c) In case the Commission would not be able or willing to change its approach from EIRP limits to PFD limits, the statement by SiBeam, Inc. in its Comment would be most appropriate, and we concur:[26]

[25] Comments of NYU Wireless, Theodore Rappaport, January 15, 2015, page 45.

[26] Comment by SiBeam, January 15, 2015 - http://apps.fcc.gov/ecfs/document/view?id=60001013930

… SiBEAM encourages the Commission to revisit the 70/80 GHz band rules and lower the minimum antenna gain requirements and the RPE requirements to support the implementation of 70/80 GHz links using practical phased array antennas with wide beam steering range.

d) Rulemaking on this should be swift as commercialization of (pre-standard) equipment still takes considerable time. Furthermore, the Commission should be pro-active in allowing and facilitating research and development and testing of equipment, followed up by swift approval of such equipment. This should be done in a matter of months, rather than years, as long-term returns on investments are not welcomed or even considered by investors. This would in turn be to the severe detriment of the mmWave (mobile) industry.

How will antenna arrays be configured to deal with varying deployment scenarios while still providing the desired level of connectivity to the user? What potential challenges may be encountered with an indoor deployment versus an outdoor deployment? How will the orientation of the handset affect the connectivity? How will such factors as "head loss" affect connectivity?

a) In their Comments, Nokia[27] and Huawei[28] have provided some excellent information on Base Station antennas.

[27] Comments of Nokia Solutions and Networks US LLC, January 15, 2015 – pp. 7-11

[28] Comment of Huawei Technologies, Inc., January 15, 2015 – pp. 6-7.

b) We encouraged the Commission to enable in its rulings the best/longest/widest radius-reach possible in terms of mobility and mobile access.

c) Due to proprietary network design, we cannot disclose our vision on deployment. We can disclose, however, that close cooperation between the operator (us), the municipality, and the end-user or building/site-manager will be necessary in order to ensure quality of service on the access level.

Could elements of the licensing model that presently applies to the 70/80 GHz bands be adapted to facilitate coordination with advanced mobile service if it were to be authorized in those bands? Could the automated coordination and registration system that applies to fixed stations in this band be applied to advanced mobile service base stations, and, if so, would that adequately protect Federal government operations and other non-Federal government operators from interference from commercial base stations? Alternatively, we seek comment on the advisability of allowing unlicensed Part 15 operations in the 70/80 GHz band segments.

a) Considering our upcoming multi-ten-billion-dollar spending on CapEx (over the stretch of 5 years), we can guarantee that our decisions to focus on mmWave spectrum have been justified (and inspired) by plenty scientific research. On all counts (e.g. interference, propagation) we have found substantial proof that we can build a superior mobile infrastructure, if enabled by the hoped-for rules by the Commission. In the case of 70/80 GHz, we feel confident that it is as suitable for mobile service/access as others in the mmWave spectrum, which –as a matter of fact- we do not exclude from our plans.

b) Wang et al note:[29]

> *… The superior propagation characteristics of E-band frequencies enable this band a preference over the other segments of MMW bands. Although E-band transceivers are presented with new design challenges such as increased phase noise, limited amplifier gain and the need for transmission line modelling of circuit components, the electronics industry develops rapidly that produces component electronics with ever reducing physical sizes and power consumption.*

and

c) Related to the overall 70/80 GHz policy-making, we request the Commission to look into a recommendation made by Peng et al with regards to a channelization plan:

> *In the United States and Canada, both the 71-76 GHz and 81-86 GHz bands are divided into four unpaired 1.25 GHz segments (eight in total) without mandating specific channels within them and these segments may be aggregated without limit. In Europe, UK and Australia, a 125MHz guard band is set at the top and bottom of each 5GHz sub-band of the E-band spectrum to prevent potential interference to and from adjacent bands. In particular, UK and Australia have no explicit channel plan for the rest*

[29] Multi –Gigabits Millimeter Wave Wireless Communications for 5G: From Fixed Access to Cellular Network, Peng Wang, Yonghui Li , Lingyang Song , Branka Vuccetic, October 16, 2014. Pp. 7-12.

segments of the E-band, while Europe further divides each of the two 4.75 GHz bands into nineteen 250 MHz channels and allows aggregation of any number of channels from 1 to 19. Furthermore, the specified channels may be used for either time division duplex (TDD) or frequency division duplex (FDD) systems either within the single band or in combination with other bands. Here we propose a possible frame structure for the EMB system based on the Europe channelization plan.[30]

As a side note, their proposed frame structure is also applicable to the UK and Australia.

d) We agree with the Wi-Fi Alliance[31] and others that the Commission should extend Part 15 Unlicensed Authorization to the 64-71 GHz Band so that it covers the full 57-71 GHz range.

Conclusion

We urge the Commission to move swiftly with regards to enable mobile services in the mmWave bands.

Since the industry is moving fast, we urge the Commission not to wait until the ITU readies 5G specifications and instead makes its own informed decisions.

We urge the Commission to adopt a multi-tier licensing scheme in the mmWave bands.

[30] Id. pp. 19-20, see also the last bullet-point on page 21.

[31] Comment by Wi-Fi Alliance, January 15, 2015, http://apps.fcc.gov/ecfs/document/view?id=60001013785

We recommend that the Commission accommodates frequency above 100 GHz in their rulemaking efforts and policies.

We recommend the Commission to adopt Part 15 rules for unlicensed operations in the 70/80 GHz bands.

We commend the Commission on their foresight in recognizing the importance and viability of mmWave spectrum for 5G (and beyond).

Respectfully submitted,

_____/s/_____

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