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

In the Matter of:	)	
Use of Spectrum Bands Above 24 GHz For Mobile Radio Services	)	GN Docket No. 14-177
Amendment of the Commission's Rules Regarding the 37.0-38.6 GHz and 38.6-40.0 GHz Bands	)	ET Docket No. 95-183 (Terminated)
Implementation of Section 309(j) of the Communications Act – Competitive Bidding, 37.0-38.6 GHz and 38.6-40.0 GHz Bands	)	PP Docket No. 93-253 (Terminated)
Petition for Rulemaking of the Fixed Wireless Communications Coalition to Create Service Rules for the 42-43.5 GHz Band	)	RM-11664

COMMENTS OF MOTOROLA MOBILITY LLC

Motorola Mobility LLC ("Motorola Mobility") hereby responds to the FCC's Notice of Inquiry examining the potential for providing mobile radio services in bands above 24 GHz.[1] Motorola Mobility supports the Commission's efforts to examine the spectrum and technologies that will be necessary to meet future mobile broadband needs.

I. INTRODUCTION

The Commission's inquiry into potential use of spectrum bands above 24 GHz is a necessary step toward addressing future mobile radio service needs. The Commission's inquiry into options for utilizing higher frequency band spectrum, including bands above 24 GHz (often referred to as millimeter wave, or "mmW," bands), will support efforts worldwide to explore

[1] Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, GN Docket No. 14-177, *Notice of Inquiry*, 29 FCC Rcd 13020 (2014) ("*Notice*").

spectrum and technical requirements for future generations of advanced mobile wireless systems. However, it is essential that the Commission work in concert with other governments and industry stakeholders in exploring spectrum and technical requirements for next generation mobile systems. Ensuring global compatibility with next generation systems will inure to the benefit of consumers in the United States and abroad. At the same time, the Commission's investigation of spectrum resources above 24 GHz should not delay progress on lower band spectrum initiatives—including AWS-3, 600 MHz, and 3.5 GHz—that can have a more immediate impact on wireless broadband availability in the United States.

The Commission's inquiry into next generation mobile systems should be a technology-neutral examination of potential spectrum resources. With next generation standards and protocols still under development, the Commission should avoid making premature determinations regarding service and licensing rules for spectrum bands above 24 GHz.

II. EVALUATING SPECTRUM OPTIONS ABOVE 24 GHZ SHOULD BE PART OF THE COMMISSION'S COMPREHENSIVE SPECTRUM APPROACH.

Motorola Mobility supports the expansion of the Commission's mobile spectrum considerations to higher band spectrum above 6 GHz, including spectrum above 24 GHz. This spectrum should be included in the Commission's comprehensive spectrum strategy, in conjunction with its continued international engagement and ongoing work on near-term spectrum opportunities below 6 GHz.

Motorola Mobility agrees with the Commission's premise that technological development will enable more robust use of higher band spectrum in support of mobile services than previously was expected. The wireless industry currently uses spectrum bands above 24 GHz for a variety of purposes, including wireless backhaul, fixed point-to-point, and fixed point-

to-multipoint wireless systems. Because the mmW bands are well-suited for high-throughput, fixed deployments, the wireless industry already benefits from such uses.

As the Commission detailed in the *Notice*, technical development and experimentation related to use of these bands for mobile services has begun in a variety of industry, government, and multi-stakeholder fora.[2] Initial results of such efforts have demonstrated that these bands hold promise for wireless access. In particular, the propagation characteristics of these higher frequency bands are well-suited for indoor and small cell deployments, making the spectrum especially appealing as a source of extra capacity in highly-congested areas.

Motorola Mobility has long been exploring potential uses of higher frequency spectrum—both in frequencies near 24 GHz and much higher—and believes that there is commercial potential in such spectrum, although further technological development will be required. For example, in the early 1990s, prior to the widespread adoption of Wi-Fi, Motorola, Inc. developed and marketed a wireless local area network ("WLAN") product called Altair™, operating in the 18 GHz band, which featured a 6-sector antenna and a Gallium Arsenide Monolithic Microwave Integrated Circuit ("MMIC") to improve performance and reduce the product cost, size and weight.[3] Additionally, more than ten years ago, Motorola, Inc. designed, built, and tested a 60 GHz wireless link using 1 GHz bandwidth transmissions in outdoor applications up to 50 meters, which achieved a 3 Gbps link at 10 meters with a Bit Error Rate ("BER") less than 1e-12.[4] Motorola Mobility's own research, in addition to the efforts cited in

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2 *Notice* at ¶¶ 7-15.

3 W. Hollemans and A. Verschoor, "Performance study of WaveLAN and Altair Radio-LANs," *Wireless Networks - Catching the Mobile Future, 5th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications*, 1994.

4 B. Bosco, S. Franson, R. Emrick, S. Rockwell and J. Holmes, "A 60GHz Transceiver with Multi-Gigabit Data Rate Capability," *Proceedings of the 2004 IEEE Radio and Wireless Conference*, pp. 135-138.

the *Notice*, demonstrate the viability of higher band spectrum for commercial mobile applications.

Motorola Mobility therefore supports the Commission's examination of higher band spectrum. This effort, however, should be done in concert with governments and industry partners internationally. For example, while the Commission correctly notes that the International Telecommunication Union ("ITU") has begun work on identifying the technical and spectral elements of next generation mobile broadband protocols,[5] these efforts to date have focused only on spectrum below 6 GHz. As a practical matter, detailed consideration by the international community of higher frequency spectrum for next generation communications systems may be limited prior to the 2018/2019 World Radiocommunication Conference. The Commission should monitor international efforts to ensure global compatibility with the next generation systems. The uniform identification of spectrum bands for mobile reallocation in all three ITU regions of the world would promote consistent utility of new spectrum bands globally and would drive down equipment costs, which would benefit consumers in the United States and abroad.

Moreover, while now is the time to begin examining the potential uses of higher frequency spectrum bands, the Commission should not lose focus on lower frequency bands that might be put to more productive use in a shorter time frame. In light of the complexities related to deployment over higher band spectrum—such as propagation characteristics and allocation/incumbent relocation issues—and given the length of time required to bring higher band spectrum to market, the Commission should continue to prioritize short- and mid-term spectrum reallocation below 6 GHz, many of which are already addressed in current or

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[5] *Notice* at ¶ 8.

upcoming standards and potentially can have a more immediate impact on meeting the increased demand for mobile broadband spectrum. Although the Commission has several spectrum bands in the pipeline—including AWS-3, 600 MHz, and 3.5 GHz—these bands may not be sufficient to satisfy the spectrum demand in the near future. Therefore, the Commission should continue to look into the reallocation of additional spectrum below 6 GHz.

III. THE COMMISSION'S INQUIRY SHOULD EVALUATE THE UTILITY OF VARIOUS BANDS WITHOUT PREDETERMINING TECHNOLOGICAL CHOICES.

The Commission correctly points out in the *Notice* its "longstanding practice of adopting flexible service rules for mobile wireless services, and . . . generally eschew[ing] mandating the use of specific technologies or standards."[6] Motorola Mobility agrees that this flexible, technology neutral regulatory approach generally best promotes innovation and technology development. Consistent with that approach, the Commission should examine the specific characteristics and utility of candidate bands for addressing future mobile radio service needs without predetermining technical and operational specifics. Further investigation of candidate frequency bands and development of technical standards should be completed before it would be fruitful for the Commission to consider adopting potential technical rules or licensing regimes for spectrum above 24 GHz.

A. The Commission Should Prioritize Frequency Bands That Can Support Robust Mobile Broadband Deployments.

In examining higher frequency spectrum bands, the Commission should prioritize candidate bands based on objective criteria related to their suitability for robust mobile broadband deployment. Among other factors, the Commission should examine the frequency range, amount of spectrum available, possible band configuration, and incumbent issues. These

[6] *Notice* at ¶ 3.

considerations, among others, will be relevant to determining a band's suitability for mobile broadband use.

Although Motorola Mobility believes commercial potential exists in many higher frequency bands, higher frequencies for terrestrial wireless systems generally present greater propagation limitations. Propagation losses can be caused by rain, foliage, and the atmosphere, among other sources, and these losses increase with higher frequency transmissions.[7] Indeed, propagation measurements suggest a difference of 10 dB in propagation between 28 GHz and 70 GHz, which translates into significant differences in deployment possibilities for these bands. Propagation characteristics are more favorable in frequency bands below 45 GHz. Above that range, network coverage areas become very small and terrestrial wireless deployments might practically be limited to providing service indoors or even within a single room.

The Commission is correct to "seek comment on how much contiguous spectrum will be needed to support advanced mobile services" above 24 GHz.[8] To satisfy high capacity demands, future technologies will support wider channels than current 3G and 4G systems. More contiguous spectrum will be required in any new band to maximize the utility of next generation technologies, and 100 MHz per operator should be the minimum threshold for higher frequency band systems. To accommodate very large channel bandwidths and to support carrier aggregation of spectrum bands, Motorola Mobility agrees with the suggestion in the *Notice* that new bands ideally should be 1 to 2 GHz wide.

The Commission also should prioritize identifying large swaths of contiguous spectrum that will permit the same technical requirements to be applied across the entire band, as the

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[7] T. S. Rappaport, S. Shu, R. Mayzus, Z. Hang, Y. Azar, K. Wang, G. N. Wong, J. K. Schulz, M. Samimi and F. Gutierrez, "Millimeter Wave Mobile Communications for 5G Cellular: It Will Work!," *IEEE Access*, vol. 1, pp. 335-349 (2013).

[8] *Notice* at ¶ 30.

spectrum should be capable of supporting both frequency division duplex ("FDD") and time division duplex ("TDD") technologies. TDD modes of operation might be the preferred option, as TDD systems are more accommodating to the use of the adaptive antenna technologies that might be needed in bands above 24 GHz. However, as research in this area is still ongoing, the Commission should look for bands that could support both FDD and TDD systems.

The Commission also should be mindful of issues related to relocation and coordination with incumbent users. Ideally, spectrum would be available both internationally and nationwide with a minimum of exclusion or coordination zones. While advances in spectrum sharing are occurring and will probably mature in a few years, exclusive allocations are preferred where possible.

Based on these considerations and an examination of the bands identified by the Commission, Motorola Mobility believes that the 27.5-28.35 portion of the LMDS band, the 39 GHz Band, and the 37/42 GHz band each warrants further attention from the Commission. While the Commission should focus on these bands in terms of spectrum above 24 GHz, it should not close the door on consideration of higher-frequency spectrum. There might be certain interest in bands above 45 GHz for particular uses, such as short- or medium-range unlicensed operation. For example, there may be certain interest in deployments in the 60 GHz and 70/80 GHz bands, as demonstrated by recent research, including channel measurements at 73 GHz.[9]

B. It is Premature to Consider Technical and Licensing Rules at This Time.

Motorola Mobility agrees with the Commission that "[g]iven that the technology is still in the early stage of development, . . . it is premature to seek comment on detailed technical rules

[9] G.R. MacCartney, T.S. Rappaport, "73 GHz millimeter wave propagation measurements for outdoor urban mobile and backhaul communications in New York City," *Proceedings of the 2014 IEEE International Conference on Communications*, 10-14 June 2014, Sydney, Australia, pp. 4862-4867.

at this time."[10] Technical service rules have to be developed based on the frequency band selected for next generation mobile deployment and the specifics of the mobile communications protocol. Similarly, licensing and operational restrictions should be responsive to the needs within a specific band. Rather than delving into the specifics of technical and licensing rules at this juncture, resources would be more fruitfully directed toward evaluating and harmonizing spectrum bands internationally and developing next generation wireless technology.

Different bands will have vastly different technical requirements, based on the adjacent services, propagation characteristics, and other factors. As such, it is premature to speculate on the transmit power limits and out-of-band emissions ("OOBE") restrictions that might apply to mobile deployments in spectrum above 24 GHz.[11] For example, while the typical OOBE attenuation factor for mobile systems of 43 + 10 log (p) dB has served well to date for congested lower band spectrum, it is not clear that it will be necessary or appropriate for bands above 24 GHz, where systems will use much wider bandwidths and may have different incumbent protection considerations. Similarly, while the Commission typically does not develop regulation with an eye to a specific technology, next generation air interfaces for these higher bands have yet to be developed and standardized, which makes the characteristics of their emissions and other technical protocols unknown. The Commission should not define OOBE and transmit power requirements before the technology has sufficiently evolved.

Motorola Mobility also believes that it is too early for detailed consideration of licensing frameworks or spectrum sharing mechanisms. As mobile industry commenters have explained

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10 *Notice* at ¶ 40.

11 *Id.* at ¶¶ 41-42.

previously,[12] exclusive licensing on a geographic service area basis is the preferred mechanism for commercial mobile broadband access systems. However, this might not be possible in all cases, and therefore spectrum in certain frequency bands or geographic areas may only be available on a shared basis. Under these circumstances, it would be appropriate to consider and develop a mechanism for dynamic shared access to the spectrum for next generation wireless technology.

IV. CONCLUSION

Motorola Mobility supports the Commission's leadership in examining potential uses of spectrum above 24 GHz for future mobile broadband systems. However, the Commission should ensure that its actions are in concert with the work being done by other countries and the wireless industry internationally. While the Commission should investigate the feasibility of various higher frequency spectrum bands, it also should continue efforts to make available spectrum in the lower bands that can be deployed in the short- to medium-term.

Respectfully submitted,

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[12] *See, e.g.*, Comments of CTIA—The Wireless Association at 2, GN Docket No. 12-268 (filed Jan. 25, 2013) ("[T]here is no substitute for licensed, exclusive-use spectrum with flexible service rules to deliver on the incredible benefits of mobile broadband").