Before the
Federal Communications Commission
Washington DC 20554

In the Matter of	)	
	)	GN Docket No. 17-183
Expanding Flexible Use in Mid-Band	)	
Spectrum Between 3.7 and 24 GHz	)	
	)	
	)	

COMMENTS OF THE
NATIONAL SPECTRUM MANAGEMENT ASSOCIATION

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The National Spectrum Management Association ("NSMA")[1] submits these comments regarding the above captioned Notice of Inquiry (NOI).

A. INTRODUCTION

In this NOI the Commission seeks input on potential opportunities for additional flexible access—particularly for wireless broadband services—in spectrum bands between 3.7 and 24 GHz. Their stated goal is the establishment of comprehensive, sound, and flexible spectrum policies, enabling innovations and investment to keep pace with technological advances, and maintaining U.S. leadership in deployment of next-generation services. Consideration should be given to the following possibilities:

Long-term strategies to promote flexible use opportunities

Coexistence between various services

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[1] The NSMA is a voluntary association of individuals involved in the spectrum management profession including service providers, manufacturers, frequency coordinators, engineers and consultants. NSMA's goal is to promote rational spectrum policy through consensus views formulated by representatives of diverse segments of the wireless industry.

Flexible point to point, point to multipoint or mobile broadband deployment

Rule modifications or elimination

Updating allocations to reflect technological progress

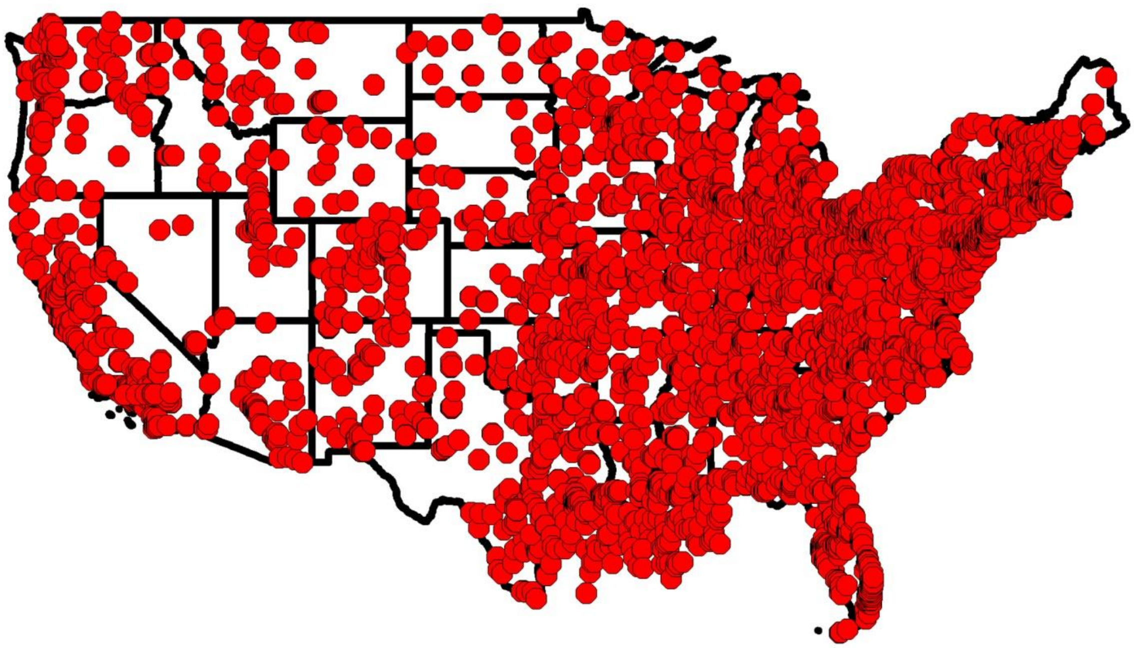
Incentives to increase efficient spectrum use

Relocation of incumbent users to enable spectrum access

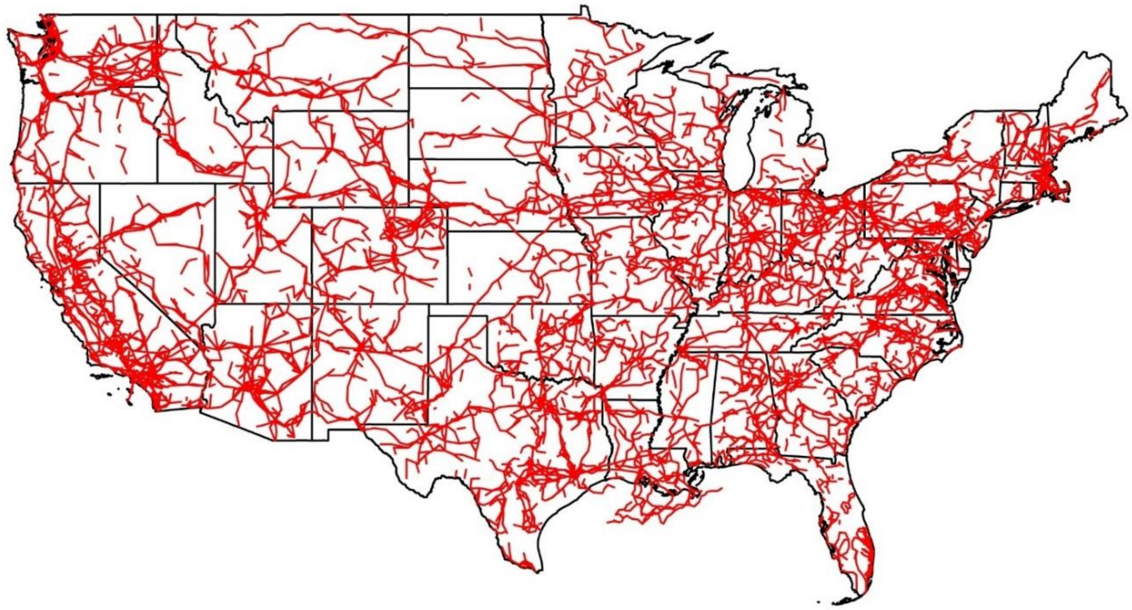
In particular, they request detailed comment on three specific bands: 3.7-4.2 GHz ("4 GHz"), 5.925-6.425 GHz ("Lower 6 GHz") and 6.425-7.125 GHz ("Upper 6 GHz").

B. Existing Users

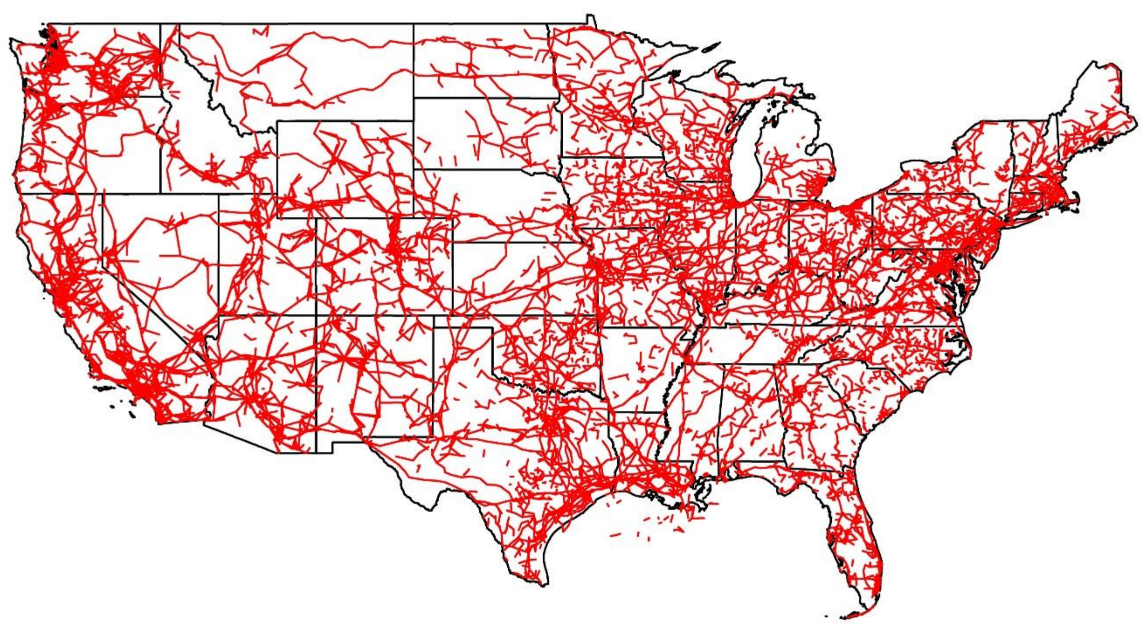
The specific bands the Commission proposes using are already heavily utilized.



4 GHz and Lower 6 GHz Fixed Satellite Service Earth Station Locations



Lower 6 GHz Fixed Point to Point Terrestrial Microwave Networks



Upper 6 GHz Fixed Point to Point Terrestrial Microwave Networks

It should be remembered that existing radios are impacted by other radios as far away as 250 miles (NSMA Recommendation WG 3.90.026, *Coordination Contours for Terrestrial*

Microwave Systems). There is no location in the United States where new radios could be placed that would not potentially impact existing fixed service users in the bands of interest.

C. Use of the Bands

The 4 GHz band is primarily used by fixed service satellite earth station receivers (although news services also employ mobile satellite earth stations). The fixed service satellite earth station transmitters operate in the Lower 6 GHz band. The Lower and Upper 6 GHz bands are used by fixed point to point terrestrial microwave systems. These networks are used by cellular network operators (including 911 support), oil and gas pipeline operators (requiring real time reliable control), railroad companies (monitoring cars to insure transportation reliability), electrical power grid operators (to maintain grid stability and availability) and state and local governments (including support for public safety operations). All of these users are operating these networks to provide critical commercial and public safety services. Loss of quality of these networks would seriously impact the safety and quality of life of many American citizens.

D. Frequency Management of the Bands

Fixed point to point microwave networks have been deployed since the early 1950s. The Commission's "Above 890" ruling in 1959 introduced wide area private user systems. The Commission's 1972 "Open Skies" ruling created domestic satellite communications carriers. As microwave systems proliferated, the need for frequency management became clearer. In 1972 the Operational Fixed Microwave Council (OFMC) and Electronic Industries Association (EIA) jointly published the first edition of Industrial Electronic Bulletin (EIB) 10A. One of the primary features of this bulletin was "Interference Calculation Considerations." Over the years this bulletin was updated (currently TIA/EIA Bulletin 10F) to add concepts such as C/I and T/I for the interference management of microwave systems. In the mid-eighties, the National

Spectrum Management Association was created to formalize the recommendations needed to operate fixed service microwave systems.

Interference was managed as two different effects: Short Term and Long Term. Since all microwave bands involved stationary services, interference could be evaluated on a fixed basis. In the current environment, Short Term interference was low probability “over the horizon” interference from stationary transmitters a long distance away. For the proposed introduction of new services, this form of interference could be much more important. Long Term interference (typically the limiting factor) is the “flat earth” interference from nearby existing radio transmitters. TIA and NSMA developed guidelines and recommendations to standardize interference analysis. Frequency coordinators facilitated the introduction of new microwave links into existing radio bands.

Interference mechanisms from other stationary licensed users are well understood. System tests performed at path commissioning to confirm lack of interference are standard practice. This is fortunate since determining relatively low level Long Term interference is not possible on an in-service basis. Very low levels of interference will degrade the fade margin of the path. This is not obvious during normal operation but will degrade the long-term availability of the path. Usually Short-Term interference, although potentially disrupting, only occurs during rare weather events and, by conservative design, is quite rare. If it happens, it has the same impact as a short term received signal fade. Interference from new services may have interference characteristics not currently covered by existing coordination procedures.

For the bands of interest, since the interfering transmitter characteristics and locations are well known, interference prediction is now standardized. It is eliminated during the initial path design phase. It cannot be measured directly on an operational basis although it’s effects would be observed over time as an operational degradation of the radio path. For this reason, the current users are understandably concerned about the potential introduction of new mobile services into a dense network of fixed service systems. The existing success of the current fixed service bands has been a direct result in the prediction and control of external interference prior to system initiation using methodologies which evolved over the last 40+ years. The introduction of mobile or other technology transmitters into mission critical networks without a trusted method of frequency management is troubling.

E. Specific Commission Interests

The Commission, in its NOI, requested consideration be given to the following possibilities:

Long-term strategies to promote flexible use opportunities

To implement flexible use in the bands considered would require new methodologies of interference prediction and estimation. Current fixed service radio receiver technology does not permit in-service monitoring of interference. A method of identifying interference occurrence, source location and operator and a method of eliminating that interference would need to be developed.

Coexistence between various services

Currently the engineering practices necessary to insure the successful coexistence among the various fixed service services have been developed over several years. It is not clear if adding mobile services to these fixed service bands is practical. If it is, the development of appropriate practices, which currently do not exist, would need to be developed. This will take a significant industry effort and will not occur quickly.

Flexible point to point, point to multipoint or mobile broadband deployment

This is really two different issues. Mobile broadband deployment, since it is new, is addressed in the above points. Processes for frequency management of point to point and point to multipoint deployment currently exist. Multipoint deployment often uses Time Division Duplex (TDD) technology (rather than conventional Frequency Division Duplex (FDD) radios. This can impact spectrum utilization efficiency.

Frequency Division Duplex (FDD), which transmits data signals in one frequency channel and receives in another (separated by several MHz), has been the staple of licensed frequency bands between 2 and 38 GHz worldwide. Each direction of transmission is the same capacity and full duplex (both transmissions are simultaneous).

Time Division Duplex (TDD) uses a single radio channel to send and receive data. Data is transmitted for a short period of time followed by reception of data. This is a common technique employed in unlicensed microwave transmission bands such as 2.4 and 5.8GHz. Transmission each direction can be different capacities with obvious advantages in point to multipoint systems. Unfortunately, FDD systems cannot exist on a channel directly adjacent to a TDD system due to inherent "frequency bucking" by the TDD system. Since the TDD system only uses one channel of a paired channel allocation, the other paired channel typically goes unused for FDD systems.

In theory, the most efficient way to deal with TDD and FDD is to segregate the two technologies into separate sub-bands with a suitable guard band between the two. This "pre-allocation" reduces the spectrum available to either technology and is itself inherently inefficient but is still more efficient than simply mixing the two technologies in the same band.

Rule modifications or elimination

Historically frequency allocations have placed similar services in similar band allocations. The proposal to place mobile service in a fixed service band is a new concept. In general, this will complicate the implementation of both services. It is not clear if any rules will be eliminated. It seems more likely rules will be both modified and added.

Updating allocations to reflect technological progress

Historically fixed terrestrial microwave networks have been point to point. FDD technology served that requirement well. Point to multipoint networks are becoming more popular. TDD technology serves that requirement well. From a frequency management spectrum utilization efficiency, those two technologies do not mix well. Allocation of different bands to the different technologies would permit more efficient spectrum utilization. See comments on "Flexible point to point, point to multipoint or mobile broadband deployment" above.

Incentives to increase efficient spectrum use

Today license fees are based on a site basis with no consideration of the bandwidth employed (§101.147), spectral efficiency (§101.141) of the transmission or beam width (§101.115) of the antenna (which effectively defines the "foot print" of the path). These factors might be considered for future license fees.

Relocation of incumbent users to enable spectrum access

Relocation of incumbent users is an effective way to clear spectrum. The PCS reallocation of 2 GHz is a well-known example. If the current users in the bands under consideration were moved, they would need to be moved to frequencies with comparable propagation characteristics to their current allocations. That means they would need to go to frequencies well below the current 11 GHz FCC band. However, there appears to be insufficient FCC spectrum available for such a relocation. The Federal 7 GHz spectrum would be technically feasible, but is not considered in this NOI.

F. Specific Network Operator Concerns

The existing network of 4 GHz, Lower 6 GHz and Upper 6 GHz stations has been carefully engineered to create a very complex mosaic of non-interfering stations. As each new station is added, its technical parameters are carefully studied to determine the interference-causing potential to incumbents. Given the density of deployment in the band, designers frequently determine that a proposed station cannot be added and a more expensive means of transport must be selected. For fixed microwave stations, interference assessment is a careful and complex process. Successful designs are reviewed for interference potential by all existing licensees within up to 250 miles.

The interference that would be added with the incorporation of mobile stations into this network, especially considering the additional complexity and significant uncertainty associated with mobile operations, would deteriorate the quality of service designed into the existing network for the following reasons:

1. Microwave links are typically designed for availabilities on the order of at least 99.999%. This allows outages of only about 30 seconds per month due to all causes including fading and equipment failure.

2. Incumbent point-to-point microwave station operators will not know if they are being affected by interference.

a. Fixed service microwave operations cannot monitor links for interference. From a data traffic point of view, the effects of short-term interference are not distinguishable from fading; in either case errors will occur or, in the cases when adaptive modulation is employed, the link will reduce the complexity of its modulation, thus restricting maximum traffic flow. In either case, service is degraded.

b. Microwave systems are most vulnerable to interference when the signal is faded to just above the receiver threshold due to propagation anomalies. This occurs rarely, e.g., less than 0.1% of the time. However, interference occurring when the signal is faded is much more likely to cause errors and can substantially affect availability.

c. Very weak signals, well below the microwave receiver threshold, can cause interference. As large numbers of mobile stations are deployed, the aggregated power of multiple transmissions will create interference in situations where one or a few mobile transmissions might not. This effect (the artificial raising of the radio receiver noise floor) is noticeable today in many cities in the 5.8 GHz unlicensed band.

d. Service may be expected to degrade over time as more mobile stations are deployed. The fixed service operator will be unable to detect this change until long after to occurrence.

3. Even if interference were detected, there is no way to <u>identify</u> the interfering mobile station. Interference from multiple exposure makes this problem even more intractable.

4. Even if interference were detected, there is no way to <u>locate</u> the interfering mobile station. Interference from multiple exposure makes this problem even more intractable.

5. The incumbent microwave operator has no recourse even if the interfering mobile(s) are identified.

a. For unlicensed mobiles, there is no responsible licensee and no way to effectively control proliferation.

b. For both licensed and unlicensed operations, market momentum makes it infeasible to reverse the deployment process. Licensees and unlicensed users will have vested interest in deployed assets and be reluctant to abandon them.

6. Some percentage of mobiles may be expected to be defective; with large deployments, this produces the potential for additional interference. As noted above, the likelihood of identifying and locating malfunctioning mobiles is extremely low.

7. The cost of testing fixed service interference to fixed service stations is very high and disrupts traffic. Testing for mobile interference to fixed service stations would likely be even more costly.

G. Performance Risk of Mobile Operation in the Fixed Service Bands

Digital point-to-point microwave systems used for telecommunications are often engineered for extremely low outages. Availability of 99.999%, corresponding to about 5 minutes of outage per year, is quite common. This reliable service requires significant investment in the equipment, using redundant hardware, large antennas, high performance filters, high powered transmitters and often tall towers. It is not unusual for system deployments of a station or radio link in a fixed service band to require hundreds of thousands of dollars. In order to ensure that the availability this investment is intended to provide is realized, stringent interference limits are enforced in this band. Interference that degrades the receiver threshold by 10 dB would increase the outage time due to multipath fading of that link by a factor of ten from its intended designed value (or put a satellite link out of service). Therefore, current engineering practices require that interference power from all sources degrade a point-to-point radio threshold level by less than 1 dB. This requirement means that the interference power be at least 6 dB below the radio receiver's noise floor.

The theoretical noise floor level (kTB) of a radio system using a 30 MHz channel is about -99.2 dBm. Assuming the noise figure of the receiver is just over 3 dB, its actual noise floor is around -96 dBm. Therefore the acceptable interference level into the receiver, under current engineering practice, is about -102 dBm. Consider now a single co-channel mobile device operating 3 Km from the point-to-point receiver antenna that happens to be in its main beam and has clear line-of-sight back to it. The free space loss of a 3 Km path at 6 GHz is about 117.5 dB. Furthermore if the mobile device transmit power is 250 mW (+24 dBm), has no antenna gain towards the point-to-point receiver (0 dBi gain) and the point-to-point system is using the smallest category A antenna with 38 dBi gain, the interference power comes in at around -55.5 dBm. This would clearly be an unacceptable situation as the interference power is 46.5 dB, nearly a factor of 45000, too high

Of course, the likelihood that a mobile would be in the main beam of the point-to-point antenna at 3 Km will depend on the particulars of the terrain along the path profile. However, it is clear from this analysis that the operation of co-channel mobile devices in an uncontrolled manner in the vicinity of point-to-point radios pose a significant unacceptable risk to the performance of those systems.

Under the previous assumptions, mobiles operating 3 Km from a victim point-to-point receiver will need to have at least 46.5 dB of terrain obstruction loss and antenna discrimination for acceptable operation. For mobiles operating 300 m from the victim receiver, where line-of-sight is quite likely, at least 66.5 dB of antenna discrimination is needed. And these loss values ignore the effect of multiple mobile users. It would be a significant engineering challenge to somehow ensure that interference from co-channel mobiles in the vicinity did not degrade the performance of point-to-point microwave systems.

CONCLUSION

NSMA supports efforts by the FCC to increase spectrum utilization and efficiency. The Commission seeks to add wireless broadband services in bands between 3.7 and 24 GHz. It is clear this is necessary to maintain U.S. leadership in deployment of next-generation services. Never the less, it is necessary to maintain the quality and integrity of the existing services supported by the lower frequency bands. These bands support services critical to the entire country.

From a practical matter, if broadband services are to be introduced into a fixed service band, some methodology for protection and continued deployment of existing licensed services must be implemented. Existing frequency coordination methodologies in the bands of discussion protect existing systems and only allow introduction of new systems if every potentially impacted existing user has reviewed the potential new service and agreed that that service will not harm existing users. How this could be implemented for new services is not yet clear. If this approach is to be feasible, new engineering procedures and federal regulations will be required. NSMA stands ready to help facilitate those procedures based upon the modified or new federal regulations.

Respectfully submitted,

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