Before the

Federal Communications Commission

Washington, D.C. 20554

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

COMMENTS OF THE WIRELESS INNOVATION FORUM ON THE FEDERAL COMMUNICATIONS COMMISSION NOTICE OF INQUIRY ON EXPANDING FLEXIBLE USE IN MID-BAND SPECTRUM BETWEEN 3.7 AND 24 GHZ

The Wireless Innovation Forum (Forum) is a U.S. based international non-profit organization driving technology innovation in commercial, civil, and defense communications around the world. Forum members bring a broad base of experience in Software Defined Radio (SDR), Cognitive Radio (CR) and Dynamic Spectrum Access (DSA) technologies in diverse markets and at all levels of the wireless value chain to address emerging wireless communications requirements through enhanced value, reduced total life cost of ownership, and accelerated deployment of standardized families of products, technologies, and services. In 2014, the Forum created a Spectrum Sharing Committee focused on implementing the U.S. Federal Communications Commission's regulations for three-tiered spectrum sharing in the 3550-3700 MHz (CBRS) band. The Committee presently has broad participation from over 50 organizational stakeholders in the new 3.5 GHz band, including wireless operators, Spectrum Access System developers, equipment manufacturers, satellite operators, Wireless Internet Service Providers (WISPs), utilities, the U.S. government, and others.

The Forum applauds the Commission on the release of this important Notice of Inquiry. While the Forum does not have detailed comments on the specific bands identified in the Notice, we do offer the following general comments that apply across the identified mid-band frequency range.

Technology and Service Neutrality

The Forum advocates for technology and service neutrality across the band to enable innovative and efficient use of spectrum. The Forum believes that increased neutrality with respect to the specific uses of licensed spectrum results in increased innovation in wireless applications.

In addition, the Forum advocates allocating spectrum with licenses adapted towards a spectrum usage rights method that has the minimum necessary technical restrictions to provide adequate protection against harmful interference. Optimal use of radio spectrum is more likely to be secured if the market, and not the regulator, decides what technology or service should be provided in a particular frequency band. The increase in users' flexibility and ability to respond faster to changing market and deployment conditions will enhance the ability to increase spectrum usage efficiency. Licenses should not necessarily restrict the technology or application.

Multiple Licensing Models

The Forum advocates a regulatory model that includes combinations of licensed and unlicensed, sharing and hierarchical, cooperative and co-existent domains for the optimal utilization of spectrum. This approach will also permit the use of spectrum that is currently unavailable due to warehousing or is no longer used though the license remains active. While exclusive-use spectrum is a necessary regulatory condition, it is insufficient to ensure that

national spectrum resources are optimally leveraged to maximum benefit. The integration of unlicensed access models and establishment of spectrum sharing regulations, including increased tolerance of nominal levels of interference where appropriate, coupled with effective interference resolution processes are critical.

Reallocation of Spectrum

The Forum believes that reallocation of spectrum is not a sustainable basis for sound spectrum policy. Given the complex intertwining of existing spectrum licenses, reallocation of spectrum is no longer feasible due to high cost, length of time to implement and disruption of service.[14] A number of regulatory mechanisms exist to increase the shared use and access of selected bands, while continuing to ensure that systems can operate without disruption or harmful interference.

Spectrum Access Databases

The Forum advocates the unified active management of spectrum (terrestrial / air / space / maritime) to maximize spectrum utilization. The use of spectrum access databases is one important tool to enable increased sharing and thereby increase the dynamic nature of spectrum management.

The Forum strongly supports the use of networked and synchronized databases accessed with device location information. These databases have emerged as a critical technology for enabling and managing spectrum access.

Basing management and policy decisions in networked and synchronized databases allows regulations and services to adapt over time and vary by band while protecting incumbent users. Networked databases provide access to information beyond what is immediately observable by a radio, thereby mitigating hidden node problems in spectrum sharing scenarios.

They provide a simpler mechanism for managing upgrades to spectrum management and dynamic access schemes by updating rules in a small set of databases rather than in millions of individual radios.

Furthermore, this approach has additional foreseeable benefits in that it starts the community down a path towards gathering real-time spectrum information and awareness from many distributed users, thereby helping to achieve the real-time spectrum dashboard vision endorsed by the Forum. It also simplifies the integration and application of non-spectrum domain information into spectrum management decisions, and such a solution should scale well over time. Databases could be made an integral part of a coexistence architecture given their visibility into the locations and operational states of many different radios from disparate wireless networks. Such a solution would need relatively rapid database responsiveness to account for changing environmental conditions. This could be helped by adopting a hierarchical architecture of databases with local caching.

However, the Forum notes that managing spectrum access in such a manner should account for the following considerations:

- The possibility of a catastrophic single-point of failure implies that the system should have redundancies built in.

- The possibility of disparate information leading to conflicting and potentially difficult to trace decisions means that these multiple redundant databases should be well-synchronized.

- Spectrum sharing systems leveraging networked databases have a greater need for secure communications and authentication due to the potential for impacting a large number of systems.

- Further, as with all databases, there exists the possibility of incomplete or erroneous information.

Thus there is value to incorporating fail-safe mechanisms, such as spectrum sensing, which could provide a mechanism for assessing the presence of protected users independently of databases.

Spectrum Sensing

The Forum advocates for the use of spectrum sensing technologies to better enable cooperative, opportunistic access and recommends that advances in spectrum sensing technologies not be discounted in future regulatory and system planning.

A spectrum sensing device intelligently detects whether a band of electromagnetic spectrum within radio frequencies is currently in use. Technologies for spectrum sensing include both non-cooperative (e.g. matched filters, energy detection, cyclostationary analysis, wavelet analysis, and covariance detection) and cooperative sensing. Cooperative sensing helps to improve detection by providing readings from multiple users who collaborate with each other to refine non-cooperative spectrum sensing devices. Cooperative sensing provides both users and network administrators an appropriate spectrum context for implementation and optimization of policy based spectrum management. Multiple independent observations may be useful in identifying hidden nodes, minimizing false alarms, and may provide more accurate signal detection.

Spectrum Sharing and Small Cell Technologies

The Forum advocates the use of spectrum sharing and small cell technologies. The Forum believes that clearing and reallocating Federal Spectrum is not a sustainable basis for spectrum policy due to high cost, length of time to implement and disruption to the mission of essential

and critical communications. The Forum recommends the use of new technologies, and paradigms such as spectrum sharing and small cells that address the emerging spectrum crisis. These recommendations have been supported by the work of the Forum, its members and its partners over the past several years including work by the Forum's Cognitive Radio Work Group on quantifying the benefits of cognitive radio technologies including spectrum sharing. Spectrum sharing was explored in the use cases developed by the Forum's Public Safety Special Interest Group for cognitive radio. A separate report by the Public Safety Special Interest Group identified advanced radio technologies as key to realizing innovative partnerships that would allow public safety to benefit from more efficient spectrum utilization. These reports acknowledge spectrum sharing as an important component of future public safety communications capabilities, given the unique incident-based spectrum and capacity requirements of the public safety community.

Cooperative Sharing

The Forum advocates legacy users augmenting their existing systems, where possible to facilitate cooperative sharing of spectrum. There is an inherent inefficiency of spectrum etiquettes that do not account for the presence or behavior of other radio systems. To share spectrum, radio systems' operational parameters are implemented so both systems have access to the spectrum. While many parameters such as transmitted power (e.g., transmit power control), frequency (e.g., dynamic frequency selection) and time (e.g., predictive scheduling) directly impact coexistence metrics and are obvious candidates for cognitive radio control, many other parameters can be set to ensure and enhance coexistence such as route selection (choosing routes to minimize interference), network association (preferentially connecting to a network with greater protective measures), and application layer parameters (such as reducing video quality

which reduces occupied bandwidth)[23]. Conceptually, virtually every parameter, setting, and/or process which influences the transceiver operations of a radio can be controlled to ensure or enhance the coexistence of cognitive radio systems with other users.

Out of necessity, most proposed techniques for gaining information about legacy systems (e.g., satellite) adopt a non-cooperative approach, where the cognitive radio system has to gain relevant information without help from the incumbent. Cooperative techniques such as has been proposed for systems utilizing a Radio Environment Map database are therefore generally limited to use for coexistence between cognitive radio systems accessing available "white space". However, this need not be the case as with the proper inducements, legacy users could augment their existing systems to aid cognitive radio systems' observation and orientation processes. This includes registering accurate transmitter and receiver characteristics for legacy radio systems with the radio environment map database.

The members of the Forum endorse this approach, which allow for the design, development and standardization of a "spectrum dashboard" providing a real time or near real time view of the radio environment map at a given location and at a given time. Such a dashboard will be a key tool in determining the etiquettes that the cognitive radio must consider when making its decisions.

Final comments

In its Report and Order establishing rules for the Citizens Broadband Radio Service ("CBRS") in the 3550 MHz band, the Commission observed that "a multi-stakeholder group focused on the complex technical issues raised by this proceeding could provide us with a wealth of valuable insights and useful information."[1]   The Wireless Innovation Forum once again commends the Commission for providing industry the opportunity to develop answers to the

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[1] FCC 15-47 at Paragraph 416.

questions and issues raised in the CBRS rules, and hopes that the Commission will consider a similar model in advancing rules under this new proceeding.

Respectfully submitted,

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Dated:2 October, 2017