Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Model City for Demonstrating and Evaluating Advanced Spectrum Sharing Technologies	))	ET Docket No. 14-99
	)	

COMMENTS OF NOKIA SOLUTIONS AND NETWORKS US LLC

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Nokia Solutions and Networks US LLC ("Nokia Networks") hereby respectfully responds to the Joint Model City Public Notice ("PN")[1] by the Federal Communications Commission's (FCC) and National Telecommunications and Information Administration (NTIA) seeking comment on the President's Council of Advisors on Science and Technology recommendation ("PCAST Report")[2] that "*the Secretary of Commerce establish a public-private partnership to facilitate the creation of an urban test city that would support rapid experimentation and development of policies, underlying technologies, and system capabilities for advanced, dynamic spectrum sharing*".

Contents

[1] Commission Seeks Comment on "Model City for Demonstrating and Evaluating Advanced Spectrum Sharing Technologies", ET Docket No. 14-99

[2] *See* PCAST, Report to the President: Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth (July 20, 2012)

I. INTRODUCTION

Nokia Networks is the world's specialist in mobile broadband. Innovating at the forefront of each generation of mobile technology, Nokia Networks provides the world's most efficient mobile networks, the intelligence to maximize the performance of these networks, and the services to make it all work seamlessly. Nokia Networks is leading the commercialization of Long Term Evolution (LTE), both its Frequency Division Duplex (FDD) and Time Division Duplex (TDD) versions, in terms of commercial references and live network performance. This includes pioneering efforts in reducing the footprint of mobile base station infrastructure, from compact yet full power macro sites down to the full range of "small cell" solutions. Nokia Networks also offers the industry's most comprehensive portfolio of services for integrating heterogeneous networks ("HetNets"), encompassing analysis, optimization, deployment and management.

As Nokia Networks and our mobile broadband industry peers consistently reiterate, cleared, exclusively licensed spectrum suitable for mobile networks unquestionably remains the top priority. Nokia Networks also believes, however, that in certain cases, access to government-held spectrum on a shared basis by the commercial wireless industry can also help spur economic growth.

Therefore, a "Model City" concept as described in the PCAST recommendation can prove to be quite useful as a tool to facilitate experimentation and validation of proposed concepts that could lead to improved spectrum sharing methods and techniques. Several concepts have already been put forth to facilitate various degrees of spectrum sharing, including

Authorized/Licensed Shared Access (ASA/LSA) as one example[3]. Within these concepts, some questions still remain about how far the spectrum sharing can be taken toward an ultimate desired goal of co-existence of multiple systems with as little physical separation between interfering systems as possible consistent with acceptable system performance for each system attempting to share the same spectrum in the same geographic area. One such example is sharing between U.S. Government Radar systems and LTE in the 3.5 GHz band.[4] There have been suggestions based on simulations or measurements that the existing exclusion zones derived by NTIA for the 3.5GHz band are overly conservative.[5] [6]

II. CHARACTERIZING MORE ACCURATELY THE PROPAGATION ENVIRONMENT IN A SPECTRUM SHARING CONTEXT SHOULD BE PART OF THE MODEL CITY PROGRAM

Efforts to better understand and quantify the limitations of spectrum sharing depend heavily on an understanding of the propagation between the different systems trying to share the same spectrum. To date, the Irregular Terrain Model (ITM) has been the preferred model used in simulations performed by government agencies[7] and some field measurements have been taken

[3] *See* Nokia Solutions and Networks comments in GN Docket No. 12-354 "Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550- 3650 MHz Band."

[4] Commission Seeks Comment on "In the Matter of Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band", GN Docket No. 12-354, Further Notice of Proposed Rulemaking (FNPRM), FCC 14-19, Released: April 23, 2014

[5] *See* NTIA, An Assessment of the Near-Term Viability of Accommodating Wireless Broadband Systems in the 1675-1710 MHz, 1755-1780 MHz, 3500-3650 MHz, 4200-4220 MHz, and 4380-4400 MHz Bands (rel. October 2010) (NTIA Fast Track Report), available at http://www.ntia.doc.gov/files/ntia/publications/fasttrackevaluation_11152010.pdf .

[6] *See* Nokia Solutions and Networks US LLC Comments at 5-9 and Reply Comments at 5-8 (providing technical analysis); *see also* Alcatel-Lucent Comments at 6-8; AT&T Comments at 34-37; CTIA Comments at 11-13; Ericsson Comments at 10-12; Microsoft Comments at 6-9; Motorola Mobility Comments at 12-15; Motorola Solutions Comments at 9-10; Qualcomm Comments at 7-8 (citing previous analysis); TIA Comments at 4; T-Mobile Comments at 6-8; Verizon Comments at 5-6.

[7] *See* footnote [5] above

to predict or measure the level of interfering signals at specific locations where another victim receiver is located under specific scenarios.[8] Unfortunately, there is limited empirical data to validate the parameterization of the ITM models that are usually accepted as the standard propagation by the FCC, NTIA and others under various deployment scenarios where interference could pose a significant concern. Further, field data taken to date is limited to a small number of locations and without any real attempt to provide a generalized model for the propagation channel in terms of the environment around the victim receiver, the interfering transmitter, the topology between the two and the scattering or multipath environment resulting from the environment, all of which will impact the link performance and hence system performance to varying degrees.

Commercial systems requirements are often standardized under the oversight of SDO's (Standards Development Organizations). Examples of these include 3rd Generation Partnership Project (3GPP) and Institute of Electrical and Electronics Engineers (IEEE). Within these SDO's are various working groups which are tasked with the creation of standards for different aspects of the radio system being developed or standardized. One important element in the development of performance standards and in fact the overall design of the radio link for both Layers 1 and 2 is a set of agreed radio propagation models. Since the early days of second generation systems such as GSM and CDMA and continuing through the development of 3G standards and 4G standards of WCDMA and LTE respectively, there have been agreed channel models to serve as a basis for developing the radio standards and supporting innovations that provide improved radio link performance. The same can be said of IEEE 802.11 based standards where channel

[8] *See* Google Reply Comments (15 August 2014) to FCC's Further Notice of Proposed Rulemaking (FNPRM) "In the Matter of Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band", GN Docket No. 12-354, FCC 14-19, Released: April 23, 2014

models were defined and agreed upon as the basis for designing and optimizing the radio links and their implementation.

The models used within 3GPP were derived from numerous field measurements at many locations and in many different environments considered to be representative of anticipated deployments of commercial systems. The models generally include path loss as well as multi-path descriptions as both are critical to understanding the performance of a radio link. Additionally, there are agreed system deployment models used for evaluating system performance under different deployment scenarios through computer simulation techniques. One such example of such models can be found in 3GPP for the evaluation of LTE system performance.[9] The ability to model and simulate a system deployment is vitally important to innovate and facilitate the development of quality solutions that yield desired performance of any wireless system. Without this capability, it would be prohibitively expensive to utilize a trial and error method of actual implementation in hardware and software of prototypes to be tested in the field under a wide variety of different deployment assumptions and iterating on those physical designs. Computer simulations of the link, inclusive of channel models, facilitate a means to try different solutions prior to committing significant resources in field measurements and validation of new algorithms and solutions.

Unfortunately, the models developed by 3GPP and IEEE among others are not necessarily well suited to evaluating the radio performance of the relevant radio standards when the deployment scenarios fall outside of the model ranges. For example, the 3GPP models generally assumed for evaluating LTE systems assumes interference from a model LTE deployment with limited radius and propagation models that are valid over those distances and

[9] 3GPP TR 36.814 V9.0.0 (2010-03), "Further advancements for E-UTRA physical layer aspects", Release 9.

multipath environments. While reasonably skilled people can estimate extensions to these models to evaluate very different deployment scenarios, there is always doubt as to the validity of those estimated models as applied to the coexistence scenarios of LTE with government systems such as radar in 3.5GHz or Airborne Combat Training Systems in 1755-1780MHz.

Similarly, there is doubt as to the validity of ITM as applied to the coexistence of LTE with government systems as expressed during the extensive work performed by the Commerce Spectrum Management Advisory Committee Working Groups (CSMAC WGs), comprised of government and commercial wireless industry representatives, "to facilitate the implementation of commercial wireless broadband in the 1695-1710 MHz and 1755-1850 MHz band." [10] [11] Based on the results of the analysis, the CSMAC WGs were able to identify a number of items for potential follow-up work and research, as well as "lessons learned" that can be considered for future spectrum sharing assessments. One such item discussed was the limitation of the ITM model in the analysis that was performed by CSMAC as follows:

"***Possible Effects of Clutter and Terrain –*** *The ground-to-ground analyses conducted in WG-5 took into account terrain effects via the features included in the Irregular Terrain Model (ITM) in conjunction with a USGS terrain database. The air-to-ground analyses, using ITU-R Recommendation P.528, did not take into account terrain effects. As discussed and agreed by WG5 at the outset of the work, clutter and terrain effects were not considered in any of the baseline interference analyses because timely agreement could not be reached on how they should be applied. Whether to do so, and how to do so, in future analyses remains under*

[10] *See* http://www.ntia.doc.gov/category/csmac. The Commerce Spectrum Management Advisory Committee (CSMAC) advises the Assistant Secretary for Communications and Information at NTIA on a broad range of spectrum policy issues.
[11] *See* CSMAC WG 5 Final Repot, March 4th 2014, "1755-1850 MHz Airborne Operations (Air Combat Training System, Small Unmanned Aircraft Systems, Precision-Guided Munitions, Aeronautical Mobile Telemetry)" http://www.ntia.doc.gov/files/ntia/publications/wg5_final_report_posted_03042014.pdf

discussion. In particular, additional study of the impact that clutter and terrain have on propagation, particularly in air-to-ground analysis, would provide greater confidence in the analysis and may have the potential to significantly impact protection distances.

To take into account terrain and clutter effects into the analysis, a validated model is necessary. The technical working group has been considering proposals to account for terrain and clutter effects including, a proposal to compare measured data of aggregation of power from LTE to the airborne systems with the model currently being used for the analysis to understand the difference in loss, understanding that such measurements must be based on the ground truth of what an actual LTE network deployment for the band would be and the actual airborne systems that operate in the band. That process was not concluded."

It would be very beneficial to those who design and manufacture radio equipment to have reasonably validated propagation models in order to innovate and seek good solutions to the challenges of sharing spectrum with disparate systems ideally to the point of co-existing with those systems rather than trying to simply avoid them. Such models would facilitate the use of simulation and modeling to reduced costs associated with deriving innovative solutions toward co-existence which is the ultimate goal of spectrum sharing. It would also make field testing of innovative ideas more productive and efficient as they would be more focused on testing well thought out and laboratory tested concepts that are worthy of field testing rather than using field testing as a pure trial and error tool to test new concepts in the early stages of development.

Nokia Networks, therefore, believes that one significant value to the Model City program could be in conducting the measurements required to develop various propagation models for anticipated commercial deployment scenarios and use of the spectrum relative to the continued use of that same spectrum by incumbent users of the spectrum many of whom are U.S. Government departments and agencies. This is likely to be a cooperative arrangement among public and private companies, industry interest groups and standards organizations, universities and U.S. Government agencies such as NTIA among others.

III. THE MODEL CITY PROGRAM SHOULD ALSO CONSIDER FUNDING OTHER THAN JUST PRIVATE INDUSTRY

The effort to do this work with quality results is not a simple task and has historically involved multiple companies and universities working together with government funding for the benefit of the entire ecosystem. Further, the programs are sometimes a direct result of the need to pursue implementation of government policies in areas such as telecommunications or to facilitate the creation of new policies that support new services and economic activity in general. Examples can be found in Europe through such activities as the WINNER program[12]. These programs have been funded in part through European Research programs such as FP7[13], formally known as the 7th Framework Program for Research and Technological Development, and more recently through the new HORIZON 2020 program[14]. The results of propagation studies and propagation model creation funded through these European Union (EU) funded programs directly impacted the creation of 3GPP standards and contributed to the fostering of innovation in wireless telecommunications by industry participants.

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[12] *See* http://www.ist-winner.org/index.html

[13] See http://ec.europa.eu/research/index.cfm

[14] *See* http://ec.europa.eu/programmes/horizon2020/

To the extent that spectrum sharing in the U.S. is driven by the need to foster economic development through wireless telecommunications policies and the U.S. Government is asking industry as well as government agencies to facilitate the implementation of spectrum sharing, we believe that it is appropriate to consider some form of funding from sources other than just private industry. The EU funded programs could serve as a possible framework to provide a similar model in the U.S. either through supportive funding from entities such as the National Science Foundation, the U.S. Department of Commerce or other means. This is not to suggest that all funding be government provided; rather, we seek to augment the significant resources already being spent by industry to meet the ever increasing and difficult challenges of finding reasonably low cost and meaningful solutions to the spectrum sharing problem and we would expect that industry and affected Government entities such as the U.S. Department of Defense and similar agencies impacted by the spectrum sharing topic would contribute some of their internal R&D funding and other resources toward addressing the problem.

IV. CONCLUSION

Nokia Networks applauds the efforts by the FCC and NTIA to establish, fund, and conduct the Model City program to experiment with innovative spectrum sharing technologies and policies. In these comments, we provide some recommendations on how to move forward with the Model City using the European Union funded projects as a possible framework. We also suggest that one significant value to the Model City program could be in conducting the measurements required to develop various propagation models for anticipated commercial deployment on a shared basis with government systems. Indeed, as mentioned in our comments, the CSMAC Working Groups, which worked on spectrum sharing between commercial and government systems in 1695-1710MHz and 1755-1850MHz, identified the development of a validated propagation model as one important area for future work.

Nokia Networks looks forward to working with the agencies as the Model City program evolves.

Respectfully submitted,

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