

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

**and**

**THE NATIONAL TELECOMMUNICATIONS AND INFORMATION  
ADMINISTRATION  
Washington, D.C. 20230**

In the Matter of	)	
	)	
Federal Communications Commission Seeks	)	ET Docket No. 06-89
Public Comment on Creation of a Spectrum	)	
Sharing Innovation Test-Bed	)	
	)	
National Telecommunications and Information	)	
Administration Notice of Inquiry	)	NTIA Docket No. 060602142-6142-01

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**COMMENTS OF THE SOFTWARE DEFINED RADIO FORUM**

The Software Defined Radio Forum (SDR Forum) is an international, non-profit organization dedicated to promoting the development, deployment and use of software defined radio (SDR) technologies. More than 110 organizations throughout the world are members of the SDR Forum.<sup>1</sup> Participants in SDR Forum activities are decision-makers, planners, policy-makers, technologists, educators, and managers from a wide variety of commercial, educational, scientific and government organizations. SDR Forum hereby submits these comments in response to the FCC's Public Notice and NTIA's Notice of Inquiry relating to the establishment

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<sup>1</sup> See [http://www.sdrforum.org/sdrf\\_members.html](http://www.sdrforum.org/sdrf_members.html)

of a Spectrum Sharing Innovation Test-Bed.<sup>2 3</sup> As further described below, SDR Forum supports the identification of spectrum for experimentation of spectrum sharing technologies.

The President issued an Executive Memorandum, on May 29, 2003, initiating an examination of the existing legal and policy framework for spectrum management in order to better optimize the use of Federal and non-Federal spectrum assets.<sup>4</sup> In response to this directive, The Department of Commerce has issued two reports recommending the development of a Spectrum Sharing Innovation Test-Bed that could be utilized to determine how spectrum could be shared between Federal and non-Federal users.<sup>5</sup> To facilitate implementation of this recommendation, the FCC and NTIA are soliciting public comment on the purpose and feasibility of the Test-Bed program as well as the logistics of creating the Test-Bed program.<sup>6</sup>

The SDR Forum supports creation of two Test-Bed programs that will ultimately improve spectrum utilization and efficiency. Two Test-Bed programs will allow experiments that can center on unique propagation characteristics of spectrum, interference avoidance mechanisms for spectrum below 1GHz as well as development of efficient local broadband technologies and spectrum sharing techniques for spectrum with line of sight propagation characteristics typically above 1GHz. The FCC and NTIA should authorize multiple entities to utilize the Test-Beds but should allow only a single experiment to be conducted within a specific geographic region at any

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<sup>2</sup> *Federal Communications Commission Seeks Public Comment on Creation of a Spectrum Sharing Innovation Test-Bed*, ET Docket No. 06-89, Public Notice, FCC 06-77 (June 8, 2006) (“FCC Public Notice”).

<sup>3</sup> NTIA Docket No. 060602142-6152-01, Notice of Inquiry, Vol. 71 Fed. Reg. 33282 (June 8, 2006) (“NTIA NOI”)

<sup>4</sup> *Presidential Memorandum on Spectrum Policy for the 21<sup>st</sup> Century*, Vol. 69 Fed. Reg. 1568 (Jan. 6, 2004).

<sup>5</sup> *Spectrum Policy for the 21<sup>st</sup> Century – The President’s Spectrum Policy Initiative: Report 1 Recommendations of the Federal Government Spectrum Task Force (Recommendation 11)* and *Spectrum Policy for the 21<sup>st</sup> Century – The President’s Spectrum Policy Initiative: Report 2 Recommendations From State and Local Governments and Private Sector Responders (Recommendation 6(b))*, NTIA, U.S. Department of Commerce (June 2004), available at <http://www.ntia.doc.gov/reports.html/>.

<sup>6</sup> FCC Public Notice at 2; *The President’s Spectrum Policy Initiative Spectrum Sharing Innovation Test-Bed*, NTIA Docket No. 060602142-6142-01, Notice of Inquiry, 71 Fed. Reg. 33282 (June 8, 2006) (“NTIA NOI”).

given time. The benefits of the Test-Bed will be maximized by providing participants maximum flexibility to enter into a wide range of experiments with standardized as well as proprietary technologies. Finally, while general advancements in spectrum sharing spectrum and efficiency improvements are likely, adoption of specific metrics that determine the success of the Test-Bed program should be delayed until more is known about the specific Test-Beds deployed.

**I. THE PROPOSED SPECTRUM SHARING INNOVATION TEST-BED WILL IMPROVE SPECTRUM UTILIZATION AND EFFICIENCY.**

New applications and enhanced services are continuing to be developed as well as the variety of uses for spectrum. With this expansion comes increasing need for additional spectrum. Access to spectrum, however, is becoming increasingly limited. Therefore, a key challenge is improving spectrum utilization and efficiency to enable these new applications and services without adversely affecting incumbents that utilize existing services.<sup>7</sup>

Industry and academia have been researching techniques that could conceivably improve spectrum efficiency through improved sharing techniques; however, experimentation with these technologies is difficult given the need to protect incumbent operations. In many situations, critical services are using this spectrum and any disruption in service could cause significant harm.

For example, the SDR Forum recently published a report<sup>8</sup> that identified SDR technology as providing significant potential for addressing interoperability challenges for Public Safety. Capabilities cited in the Forum's report particularly applicable to interoperability include multi-band and multi-service radios. The proposed Test-Bed could provide a crucial opportunity to test

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<sup>7</sup> See FCC Public Notice Question 1(b) (What challenges spectrum users face that the Test-Bed could be used to resolve).

<sup>8</sup> *Software Defined Radio Technology for Public Safety*, SDR Forum, Document 2006-A-0001, 14 April 2006, available at [www.sdrforum.org](http://www.sdrforum.org).

and evaluate technologies that could enhance interoperability among Public Safety agencies, particularly between Federal and non-Federal users.

The Test-Beds should provide an environment in which new technologies to improve spectrum utilization can be tested without risking interference to incumbent operations. In order to achieve this objective, the Test-Bed should focus specifically on (1) the capabilities of cognitive radios, (2) ways to reliably identify harmful interference, (3) measuring spectrum efficiency, (4) determining ways to increase spectrum efficiency, and (5) investigation of new efficient technologies.<sup>9</sup> In addition, the Test-Bed experiments must be executed in a controlled manner in order to reliably detect and report incidents of harmful interference and avoid conflicts between simultaneous uncoordinated experiments. If done properly, these experiments could lead to improved spectrum sharing mechanisms that enhance interference avoidance capabilities while enabling increased spectrum efficiency.<sup>10</sup>

## **II. THE FCC AND NTIA SHOULD AUTHORIZE MULTIPLE CANDIDATES TO UTILIZE THE TEST-BED**

The Test-Bed pilot program holds the potential of aiding a wide variety of entities in the development of cognitive and spectrum-efficient technologies. Restricting the number of entities that can utilize the Test-Bed could reduce the range and variety of experiments, thus negatively impacting the Test-Bed program while limiting the benefits achieved by the program to a small number of entities. The FCC and NTIA should authorize multiple entities to utilize the Test-Bed, but should allow only a single experiment to be conducted within a given geographic region and at any given time.<sup>11</sup> This will allow entities to execute controlled experiments and ensure

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<sup>9</sup> See FCC Public Notice Question 1(a) (Are there particular technologies or areas of interest the Test-Bed should focus).

<sup>10</sup> *Id.*, Question 1(b) (What type of issues the Test-Bed could be expected to resolve).

<sup>11</sup> *Id.*, Question 8 (Should multiple candidates be selected).

the effectiveness of the experiments. Note that a single experiment might comprise simultaneous operation of multiple systems by multiple entities to investigate interaction effects.

**III. THE FCC AND NTIA SHOULD ESTABLISH TWO TEST-BEDS TO CENTER ON FAVORABLE AND UNFAVORABLE PROPAGATION CHARACTERISTICS.**

The FCC and NTIA should establish two Test-Beds because propagation characteristics differ so significantly across spectrum frequency ranges. The technical challenges of improving sharing and efficiency while avoiding interference are radically different depending on whether the signals of interest penetrate or reflect off of structures and foliage. Spectrum below 1 GHz has favorable propagation characteristics and is an ideal Test-Bed that could be used broadly to experiment with a wide range of spectrum efficient technologies to validate interference avoidance mechanisms. The second Test-Bed could be used exclusively for the development of efficient local area broadband technologies that would facilitate shared spectrum use between Federal and non-Federal public safety agencies as well as other potential high speed and broadband applications.

Consistent with the President's Executive Order, the FCC and NTIA should identify a minimum of 20 MHz for a Test-Bed below 1 GHz.<sup>12</sup> Ideally this spectrum should be unoccupied in the geographical area of the experimental Test-Bed and divided into two contiguous blocks for Federal and non-Federal exclusive use.<sup>13</sup> The use of unoccupied spectrum would allow the greatest flexibility for the experiments while minimizing impact to existing primary users. Utilizing contiguous spectrum for each block will ensure an adequate amount of spectrum in

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<sup>12</sup> *Id.*, Question 4 (How much spectrum should be identified and whether the FCC should identify this spectrum or allow marketplace mechanisms to do so).

<sup>13</sup> *Id.*, Questions 3, 4(b) (What criteria should be used to identify candidate frequency band(s) and whether the Test-Bed requires contiguous or non-contiguous spectrum).

each block for experiments that include a wide range of technologies and testing across a number of services could occur.

In selecting frequency allocations and geographic locations for the Test-Beds, the FCC should adopt several guidelines.<sup>14</sup>

- The FCC should select frequencies that minimize or reduce the cost of the radio equipment that researchers must acquire to carry out experiments. If the equipment is too expensive, few experiments will be performed and the Test-Bed will have a significantly reduced benefit. One important way to reduce equipment cost is to allocate the Test-Bed frequencies as a few large blocks of spectrum rather than a larger number of scattered smaller blocks. It would also be highly beneficial if the selected frequencies enable use of off-the-shelf frequency converters, filters, amplifiers and antennae.
- The allocated Test-Bed frequencies should be completely free of incumbent users in at least one geographic region within the continental US large enough that (a) operation of cooperative relay networks is required, and (b) tests involving moving vehicles, including aircraft, are possible. Cooperative relay networks are critical to test since they introduce significant technical complexity into the spectrum sharing problem. This geographic region should not be a military base, as many of the research teams that will seek to exploit the Test-Bed will involve foreign entities or participation of non-US citizens.
- If incumbent free spectrum in a geographical region cannot be identified; Public Safety and other protected bands where interference to incumbent users could

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<sup>14</sup> *Id.*, Questions 3, (what criteria should be used to identify candidate frequency band(s)).

cause significant harm must be avoided, in order to reduce the level of review required for experimental proposals before the experiments are authorized. For broadband technology experiments, in band and adjacent band interference mechanisms must be avoided.

- The allocation of spectrum for specific experiments should be sufficiently flexible to accommodate a variety of types of experiments. For example, voice interoperability across Federal and non-Federal bands may require some narrowband channels in multiple frequency bands below 1 GHz in addition to the contiguous Test-Bed spectrum. On the other hand, experiments considering accommodating degradation of video channels could use channel sizes from 1.25MHz to 5MHz and greater. Also, the Test-Bed should incorporate sufficient spectrum to allow two simultaneous non-interfering broadband channels to consider cross-channel allocation schemes.

The spectrum encompassing television broadcast channels 38 to 51 could be utilized in the Test-Bed to avoid Public Safety, Cellular, and other heavily used channels below 1GHz where interference to incumbent critical uses could cause significant harm. Vacant or unused broadcast channels with appropriate guard bands could be aggregated for Test-Bed experiments in a specific geographic area. While it may not be possible to have contiguous spectrum, the incumbents are easy to identify and protection criteria is well understood.

Spectrum around 5GHz has line of site propagation that is well suited for local area broadband services. Non-Federal public safety organizations currently have access to 50 MHz of spectrum at 4940-4990 MHz (4.9 GHz) for local area broadband application, but this spectrum is not available for Federal Government use on a routine basis. For public safety applications, the

FCC and NTIA should consider conducting a Test-Bed with 50 MHz of spectrum in the 4.9 GHz band (already allocated by the FCC) and 50 MHz of spectrum near 5.1 GHz band (authorized by NTIA). Equipment can be developed that would cover both the 4.9GHz and 5.1GHz band, enabling a Test-Bed experiment with new shared use technologies without jeopardizing existing deployments. More specifically, the combined 100MHz allow primary / secondary use services with state and local public safety primary at 4.9GHz and secondary at 5.1GHz and Federal utilizing 5.1GHz as primary and 4.9GHz as secondary. This primary/secondary mechanism would provide the basis for joint operations while maintaining the security deemed necessary by Federal and state/local pilot participants. The Test-Bed would provide an environment in which Federal, state, and local public safety can develop effective ways of deploying joint operations, as well as test new productivity enhancing broadband applications, which will lead to improvements in sharing of spectrum among public safety users.

**IV. PARTICIPANTS SHOULD BE PROVIDED MAXIMUM FLEXIBILITY TO ENGAGE IN A WIDE VARIETY OF EXPERIMENTS.**

The Test-Bed holds great promise to develop increasingly spectrally efficient technologies. It is critical to experiment with a wide variety of technologies in order to maximize this promise. To allow this, participants should be provided the maximum flexibility to engage in a wide variety of experiments with proprietary technologies.<sup>15</sup> To facilitate multiple simultaneous experiments (for example, in different geographic areas or frequency bands), applicants should provide an experiment plan to include relevant information such as the experiment objectives, expected results, milestones, geographic area, time frame, frequencies, the generalized modulation methods to be utilized during the planned experiment, test

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<sup>15</sup> *Id.*, Question 14 (Should use of proprietary technologies be permitted in the Test-Bed).

procedures, coverage areas, and protection for incumbent users if any.<sup>16</sup> In order to protect the entities, the FCC and NTIA could restrict what information that is released to the public to the results of the experiment and protect proprietary technologies and related information from Freedom of Information Act requests. In order to gather the greatest understanding of spectrum sharing technologies a range of population densities should be included in the Test-Bed. By allowing participants to utilize geographic areas of different size in the Test-Bed a range of population densities could be included. For example, experiments may need to be conducted in an urban environment to obtain realistic information on in-building and multipath propagation; likewise some experiments may require large geographic areas to test roaming outside of home coverage areas or to test at fringe coverage areas of a system.<sup>17</sup> Large geographies that include urban areas within the experimental area are particularly important because those are in greatest need of increased spectrum access and efficiencies.<sup>18</sup>

Given this flexibility, participants should be required to file with the FCC and NTIA, within a specified period of time following the initiation of tests, more detailed information (as appropriate) concerning the specific geographic area, time, frequencies and the generalized modulation methods to be utilized during the planned experiment.<sup>19</sup> The FCC and NTIA should also consider requiring participants to submit information on incumbents operating within the geographic area of the proposed experiment as well as the planned interference avoidance method to be utilized in the experiment. Sharing of this information will allow incumbents to

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<sup>16</sup> *Id.*, Question 7 (What information should be provided to the FCC).

<sup>17</sup> *Id.*, Question 6 (seeking comment on the geographic size over which experiments should be permitted and whether experiments could be limited to rural areas).

<sup>18</sup> If, as proposed above, spectrum that is largely unoccupied is identified for inclusion in the Test-Bed, incumbent users in congested urban areas will be protected from harmful interference even in the event an experiment is performed in the urban area.

<sup>19</sup> FCC Public Notice Question 7 (What information should be provided to the FCC prior to initiating use of the Test-Bed).

identify and report any interference in a thoughtful manner, will encourage cooperation between primary and secondary users, and can reduce the need for spectrum coordination procedures.<sup>20</sup> Participants should also be required to provide periodic status updates against milestones defined in the experiment plan. Utilizing these procedures will minimize the need for FCC and NTIA oversight.<sup>21</sup>

**V. THE FCC AND NTIA SHOULD DELAY ADOPTION OF SPECIFIC METRICS THAT WILL DETERMINE THE SUCCESS OF THE TEST-BED PROGRAM.**

It is early in the development of the proposed Test-Bed and impossible to predict the specific results of any experiments. Because of this uncertainty the FCC and NTIA should not prematurely set standards under which the success of Test-Bed experiments will be measured. The success of an experiment will depend on a great variety of factors, including the specific equipment utilized during the experiment, the parameters and service requirements of the experiment, as well as multiple unanticipated factors. Thus, the FCC should not adopt performance metrics at this time or determine whether specific experiments that ultimately do meet certain performance metrics will necessarily be expanded into other frequency bands.<sup>22</sup>

The most significant metric for the Test-Bed program as a whole is the number of experiments that are conducted and completed and the extent to which the goals of the Test-Bed are being realized. If there are a large number of proposed experiments, particularly more than can be accommodated, then consideration should be given to expanding the program. If the test-Bed is not being utilized, then the program should be examined to determine how best to restructure it to encourage utilization.

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<sup>20</sup> *Id.*, Question 9 (asking whether special procedures are necessary to coordinate federal usage of the Test-Bed with non-federal usage).

<sup>21</sup> *Id.*, Question 11 (Should FCC personnel be appointed as overseers to gauge the progress of the program).

<sup>22</sup> *Id.*, Questions 15-16 (What metrics should be used in evaluating the results of the Test-Bed and whether experiments that meet the performance metrics should be expanded to other frequency bands).

The FCC and NTIA should encourage a flexible peer review process which is essential to assessing the results of any given experiment.<sup>23</sup> Only through peer review can successes be confirmed and potential problems be identified and addressed. Test-Bed participants should be required to submit a report to the FCC and NTIA detailing the experiment goals, assumptions, methodology and results in order to facilitate peer reviews. Information relating to intellectual property declared in the experiment plan would be handled appropriately.

After an experiment is deemed a success through peer review, the FCC should initiate a rulemaking to determine ways in which the results of the test can be incorporated.<sup>24</sup> The motivation for these experiments is the expectation that a successful test will lead to more spectrum sharing between Federal and non-Federal users. The rulemaking would ensure that appropriate safeguards are adopted to prevent harmful interference and that fail-safe mechanisms are implemented to immediately terminate spectrum sharing if unexpected harmful interference ultimately occurs.

## **VI. CONCLUSION**

The SDR Forum fully supports the creation and implementation of two spectrum sharing Test-Beds. The success of these Test-Beds can lead to an increase in spectrum utilization, as well as increase in spectrum sharing between Federal and Non-Federal users. To facilitate this Test-Bed, the FCC should provide entities flexibility to enter a wide range of experiments using proprietary technologies. The SDR Forum promotes the development and use of SDR and

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<sup>23</sup> *Id.*, Question 18 (Should users be required to submit a report detailing the experiment at the conclusion of any experiment).

<sup>24</sup> *Id.*, Question 17 (Should there be an expectation that a successful experiment would translate into an FCC rulemaking proceeding to explore rule changes consistent with the experiment results).

cognitive technologies and is willing to support the FCC and NTIA in moving these Test-Beds forward.

Respectfully submitted,

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