COMMERCE SPECTRUM MANAGEMENT ADVISORY COMMITTEE

OPPORTUNITIES RELATING TO THE SPECTRUM SHARING TEST BED

December 6 2007

SUMMARY

The Test-Bed program was proposed as a vehicle for achieving the objectives embodied in the President's Spectrum Policy Initiative ("SPI"), including the more efficient use of spectrum, the rapid deployment of new and innovative technologies, and addressing the spectrum needs associated with critical government functions, such as national security, homeland security, and public safety. Consistent therewith, the Test-Bed should be used to evaluate technologies that foster these objectives.

The goal of the Test-Bed program was clearly spelled out by the Department of Commerce — to study the feasibility of federal and non-federal users sharing the same spectrum. The NTIA NOI proposed eight criteria that should be used to determine whether a particular technology or application were suitable for the Test-Bed program. The Committee agrees with these selection criteria.

There can be no question that the President and NTIA have recognized the fundamental importance of broadband to our national economic and homeland security development. Extensive comments in the NTIA record and in the President's Technology Agenda underscore this point. Thus broadband should be a component of any technology chosen for deployment in the Test-Bed program, to the extent feasible. Nonetheless there are numerous government operations, including telemetry and radars, that may be able to more efficiently use the spectrum resource without a broadband solution. Therefore, although the use of broadband technologies are quite valuable and are generally preferred, the federal government may also benefit from test bed applications that improve the efficiency of narrowband technologies.

Based on its review of the record and additional materials provided to the Committee, four specific technologies and services have been identified for the Test-Bed to date: dynamic spectrum access; multi-antenna signal processing ("MAS"); airborne video; and mobile satellite service with an ancillary terrestrial component ("MSS/ATC"). As set forth below, each of these technologies/services was evaluated under the eight selection criteria and only two — dynamic spectrum access and multi-antenna signal processing — satisfied each of the criteria. Dynamic spectrum access includes both terrestrial and airborne applications. Accordingly, the Test-Bed program should ultimately address these technologies. To the extent multiple Test-Beds are available, however, providing airborne video and MSS/ATC proponents access to a Test-Bed also would be consistent with the objectives of the President's SPI, especially the goal of maintaining United States global leadership in communications technology. NTIA, in assessing each Test-Bed proposal, should not limit itself to any one family of technologies or any particular company's form of technology.

The record demonstrates overwhelming support for the formation of multiple Test-Beds and this approach would best accomplish the SPI objectives. Participation of federal users is essential, also, because the goal of the Test-Bed is to evaluate technologies that would foster spectrum sharing between federal government and non-federal government users. Unfortunately, it is unlikely that federal users will have the technical staff to support multiple Test-Beds. The Committee thus recommends that NTIA evaluate whether these staffing and resource issues could be resolved by allowing private sector participants to bear the costs associated with the Test-Bed, allowing some testing to occur without federal government staffing, or seeking additional appropriations or reallocating funding to support multiple Test-Beds (including the necessary federal staffing).

As with the number of Test-Beds, the number of participants will be determined by the resources available for monitoring and participating in the Test-Bed evaluation process. The Committee recommends permitting the maximum number of participants possible given the available resources.

The Test-Bed program is an outgrowth of the SPI which seeks to "promote the more efficient and beneficial use of spectrum without harmful interference" to incumbent licensees. Consistent with this objective, Test-Beds should be implemented in a manner that protects incumbent licensees. One way to facilitate this goal initially is to deploy Test-Beds in areas where there are few incumbencies and limited complexity. Depending on the nature of the deployment, this first phase could be completed in a private laboratory environment or as part of the official test bed program. The FCC has indicated that one advantage to such an approach is that the risk of causing harmful interference to an incumbent licensee is reduced. If this initial phase proves successful, then a second phase would be conducted in environments with sufficient density of traffic to produce meaningful real-world results useful to future deployments. This requires an analysis of both spectrum bands and geography. The Committee believes this second phase of testing is important because some risk is necessary if the results of the Test-bed are to be useful. The record demonstrates that the optimal location for Test-Beds is within spectrum below 1 GHz or above 4.9 GHz. A variety of test bed environments is essential to the production of meaningful data.

Part 5 should be used as the legal basis for operation of the Test-Bed program. Part 5 was adopted specifically "to prescribe the manner in which parts of the radio frequency spectrum may be made available for experimentation." Although the FCC has eliminated the need for a written report under Part 5, the Committee recommends that public reports be made a condition of participation in the Test-Bed program. Moreover, these reports should be subject to a peer review process. The findings of this process could be incorporated into the report requested by the Department of Commerce summarizing the results of the Test-Bed program. We emphasize that the release of public reports does not specifically require release of proprietary design information related to the hardware and software used to achieve the test bed results. The objective of the Test-Bed is to demonstrate the principles of new technologies and services, not to develop commercial products.

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INTRODUCTION

In May 2003, President George W. Bush established the "Spectrum Policy Initiative" ("SPI") which called for "a comprehensive review of spectrum management policies . . . with the objective of identifying recommendations for revising policies and procedures to *promote more efficient and beneficial use of spectrum without harmful interference to critical incumbent users.*"[1] Shortly thereafter, President Bush added an additional goal for his spectrum policy — the universal availability of affordable broadband technology.[2]

The SPI directed the Secretary of Commerce, after consultation with other agencies and public meetings, to prepare reports with recommendations for:

- Facilitating a modernized and improved spectrum management system;
- Identifying policy changes that would create incentives for more efficient and beneficial use of spectrum, particularly given the inefficient manner in which government spectrum has traditionally been used;
- Encouraging scientific research and developing methods for streamlining the deployment of new and innovative technologies, while preserving national security, homeland security, and public safety;
- Addressing the spectrum needs associated with critical government functions, such as national security, homeland security, and public safety.[3]

These reports were released in June 2004 and, among other things, recommended:

- Establishing a Spectrum Management Advisory Committee ("CSMAC" or "Committee") "to advise the Assistant Secretary of Communications and Information, Department of Commerce on needed reforms to spectrum policies and management

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[1] Presidential Memo on Spectrum Policy: Spectrum Policy for the 21st Century, 39 Weekly Comp. Pres. Doc. 726, 727 (May 29, 2003) ("SPI Memo"), *available at* http://www.whitehouse.gov/news/releases/2003/06/20030605-4.html.

[2] Remarks by the President on Homeownership, Before the Expo New Mexico, Albuquerque, New Mexico (Mar. 26, 2004), *available at* http://www.whitehouse.gov/news/releases/2004/03/20040326-9.html.

[3] SPI Memo at § 2.

to enable the introduction of new spectrum dependant technologies and services including expediting America's access to broadband services;[4]

- Creating a Test-Bed for the purpose of evaluating technologies and methods for improving spectrum sharing between federal government and non-federal government users;[5] and
- Facilitating interoperability of first responder communications and other government communications.[6]

In November 2004, President George W. Bush directed the heads of executive departments and agencies to implement the recommendations from the June reports. In response, the Secretary of Commerce established the CSMAC and instructed the Committee to focus on, among other things:

> Expediting the introduction of wireless broadband services; addressing governmental and commercial concerns regarding public safety spectrum management issues; . . . assisting in efforts to encourage the establishment of long-range spectrum planning processes; . . . gathering input on the latest technology and market trends; examining the latest radio-frequency research and development outputs; and evaluating the value of spectrum to the public and private sectors.[7]

Further, on June 7, 2006, the Department of Commerce's National Telecommunications and Information Administration ("NTIA") solicited public comment on "the establishment of a spectrum sharing Test-Bed to explore innovative ways to make more intensive use of the nation's airwaves and promote continued economic growth and national security."[8]

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[4] *See* Spectrum Policy for the 21st Century — The President's Spectrum Policy Initiative: Report 2 — Recommendations from State and Local Governments and Private Sector Responders at B-2 (June 2004) ("Report 2").

[5] *Id;* Spectrum Policy for the 21st Century — The President's Spectrum Policy Initiative: Report 1 — Recommendations of the Federal Government Spectrum Task Force at B-2 (June 2004) ("Report 1").

[6] Report 1 at B-2.

[7] SMAC Charter at 1.

[8] "NTIA Seeks Public Comment on Creation of Spectrum Sharing Innovation Test Bed," United States Department of Commerce News (June 7, 2006); *The President's Spectrum Policy Initiative Spectrum Sharing Innovation Test Bed,* Docket No. 060602142-6142-01, *Notice of Inquiry*, 71 Fed. Reg. 33282 (June 8, 2006). On June 8, 2006, the FCC initiated a companion proceeding. *Federal Communications Commission Seeks Public Comment on Creation of a*

(continued on next page)

The initial SMAC meeting was held on December 13, 2006. The first task was to evaluate and make recommendations regarding the creation of a Test-Bed to examine ways of facilitating increased sharing between federal and non-federal users of spectrum. Two subcommittees were established: the Technical Efficiency Subcommittee ("TES") and the Operational Efficiency Subcommittee ("OES"). Working groups were formed within each subcommittee, and Working Group 1 within the TES was given the following charge:

> **Working Group 1 ("WG1") – Opportunities Relating to the Spectrum Sharing Test Bed**
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> The purpose of this working group is to objectively summarize and compare and contrast the comments that have been filed in the NTIA Test-Bed proceeding and to inform the full committee of that review. In addition to reviewing the materials that have been filed in the proceeding, the subcommittee should also identify any information that is lacking in the record and either provide that information based upon its own experience/expertise or develop a strategy for obtaining the information in the follow-on task. The subcommittee will develop alternative next steps in the evaluation of the comments and compilation of additional material and present those alternatives for consideration by the full committee.[9]

WG1 reviewed the comments submitted in the NTIA and FCC Test-Bed proceedings, as well as other available data, and made recommendations in a draft report to the Committee. Moreover, since the record in the Test-Bed proceedings closed, there has been a particular focus at the federal level on public safety communications needs. The President's National Security Telecommunications Advisory Committee has issued a report on Emergency Communications

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Spectrum Sharing Innovation Test-Bed, ET Docket No. 02-135, *Public Notice*, FCC 06-77 (rel. June 8, 2006) ("*FCC Notice*"). Comments submitted in response to the NTIA NOI are cited as "NOI Comments," and comments submitted in response to the *FCC Notice* are cited as "FCC Comments."

[9] Spectral efficiency is another critical factor in evaluating spectrum sharing technologies. This issue, however, is being addressed by a separate working group, Working Group 2 ("WG2") – Understanding Technical Efficiency.

and Interoperability[10] and the Federal Communications Commission recently sought comment on the communications needs of public safety.[11] Information from all these proceedings was utilized by WG1 to make its recommendations. The full Committee adopted those recommendations and the instant report now represents the findings of the CSMAC. In particular, the CSMAC makes the following proposed recommendations:

- The Test-Bed should be available for a wide variety of tests utilizing a variety of technologies, with a particular focus on broadband;
- To the extent feasible, there should be multiple Test-Beds located in different geographic areas to permit simultaneous testing of different, potentially incompatible, technologies;
- Test-Bests should be authorized pursuant to Part 5 of the FCC's rules;
- The Test-Bed program should be controlled by the government and should not become a vehicle for endorsing a single, proprietary technology;
- Test-Beds should be conducted in a variety of environments. Initially technologies should prove themselves in a less congested setting. However, to achieve fully the President's spectrum sharing goals, the technologies will have to demonstrate their utility in congested spectrum bands as well.

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[10] NSTAC Report to the President on Emergency Communications and Interoperability (Jan. 16, 2007), *available at* http://www.ncs.gov/nstac/reports/2007/NSTAC%20Report%20on%20Emergency%20Communications%20and%20Interoperability.pdf.

[11] *Implementing a Nationwide, Broadband, Interoperable Public Safety Network in the 700 MHz Band*, PS Docket No. 06-229, *Ninth Notice of Proposed Rulemaking*, FCC 06-181 (rel. Dec. 20, 2006) ("*Ninth NPRM*"), *summarized*, 72 Fed. Reg. 1201 (Jan. 10, 2006); *Service Rules for the 698-746, 747-762 and 777-792 MHz Bands* (WT Docket No. 06-150), *Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems* (CC Docket No. 94-102), *Section 68.4(a) of the Commission's Rules Governing Hearing Aid-Compatible Telephones* (WT Docket No. 01-309), *Biennial Regulatory Review – Amendment of Parts 1, 22, 24, 27, and 90 to Streamline and Harmonize Various Rules Affecting Wireless Radio Services* (WT Docket No. 03-264), *Former Nextel Communications, Inc. Upper 700 MHz Guard Band Licenses and Revisions to Part 27 of the Commission's Rules* (WT Docket No. 06-169), *Implementing a Nationwide, Broadband, Interoperable Public Safety Network in the 700 MHz Band* (PS Docket No. 06-229), *Development of Operational, Technical, and Spectrum Requirements for Meeting Federal, State and Local Public Safety Communications Requirements Through the Year 2010* (WT Docket No. 96-86), *Report and Order and Further Notice of Proposed Rulemaking,* FCC 07-72 (rel. April 27, 2007) (referred to herein as the "*Report and Order*" and the "*FNPRM*").

- The sharing polices developed through the test bed process should first be targeted at less congested and thus less utilized bands – where the potential increase in efficiencies through sharing are most dramatic.

- Applicants for Test-Bed participation must demonstrate that the proposed experiment will not cause harmful interference to any incumbent licensee;

- Public reports detailing the progress and, ultimately, the final results of the Test-Bed should be required; and

- Given the SPI's emphasis on public safety and homeland security, special attention in the Test-Bed process should be given to technologies that would facilitate spectrum sharing between the federal government and state/local public safety entities.

I. THE PURPOSE OF THE TEST-BED PROGRAM

The goal of the Test-Bed program was clearly spelled-out by the Department of Commerce — to study the feasibility of federal and non-federal users sharing the same spectrum.[12] The Test-Bed program was proposed as a vehicle for achieving the President's SPI objectives, including the more efficient use of spectrum, the rapid deployment of new and innovative technologies, and addressing the spectrum needs associated with critical government functions, such as national security, homeland security, and public safety.[13] Consistent therewith, the Test-Bed should be used to evaluate technologies that foster these objectives.

At the outset, the Committee notes that there are multiple facets of sharing. First, there appear to be at least six possible methods for sharing spectrum: frequency division multiple access ("FDMA"); time division multiple access ("TDMA"); code division multiple access ("CDMA"); integrated sharing (*e.g.*, radar transmissions modulated with communications data);

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[12] *See* National Telecommunications and Information Administration, U.S. Department of Commerce *Spectrum Policy for the 21st Century – The President's Spectrum Policy Initiative: Report 2 Recommendations From State and Local Governments and Private Sector Responders*, at 23 (June 2004) ("Spectrum Policy for the 21st Century"). Accordingly, the Test-Bed should not be used primarily to identify technologies whose primary application would be to increase sharing among non-federal users.

[13] *See* Report 1 at B-2; Report 2 at B-2.

spatial sharing including space- division multiple access ("SDMA"); and technology managed sharing (*e.g.*, dynamic spectrum access).[14] Additionally sharing can take place using hybrid combinations of some or all of the above.

Sharing also may make use of a single frequency channel (time division duplex or TDD) or a pair of frequency channels (frequency division duplex or FDD), again in combination with all of the six possible spectrum sharing methods outlined above. Sharing also can be conducted on a preemptible or primary/secondary basis.[15] In addition, sharing may occur on a cooperative/non-cooperative, mutual/one-sided, or active/passive basis. Furthermore, various systems may be deployed over the same spectrum, each with a different approach. Cooperative sharing requires users to coordinate spectrum use, whereas non-cooperative does not require coordination. Mutual sharing requires all users to adjust their usage based on the demands of others, whereas one-sided sharing excludes a user or group of users from any adaptation requirements — similar to a primary/secondary approach. Finally, "active" sharing requires a user to take affirmative steps to make the adjustments necessary to share spectrum without harmful interference whereas a passive approach requires no action by the user, the adaptation is achieved through techniques designed to sense the presence of the other users and adjust usage based on a set of rules or spectrum etiquette.

Wireless priority access is a prime example of a preemptible sharing regime — public safety receives priority access to commercial networks in certain emergency situations, with public safety calls being placed first in queue for available channels. Relatedly, recent FCC proceedings highlight a variety of proposals for sharing between commercial operators and state

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[14] *See Review of Bandsharing Solutions — Final Report*, Repot No: 72/05/R/281/R at 8 (Roke Manor Research Sept. 2005).

and local governments through a shared infrastructure approach. Adaptive radios[16] are examples of sharing on a primary/secondary basis. These devices are able to sense and adapt to their spectrum environment, finding vacant spectrum and using it until a primary user attempts to occupy the spectrum, at which time the adaptive radio switches to different spectrum.[17] Another example of such sharing involves systems that simply deny service to low priority services during an emergency, or reduce the quality-of-service to low priority services, in favor of emergency requirements.

Any Test-Bed proposal should seek to maximize the data produced from a wide variety of sharing approaches. No single sharing model provides the best approach for all sets of facts. Thus, different "rules of the road" should be adopted for each different sharing permutation. NTIA may want to seek additional information on the state of scientific data regarding each of the aforementioned sharing concepts so that it can more effectively target its efforts.

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[15] Although secondary, preemptible services often do not enjoy interference protection, they do obtain access to spectrum utilized by others. Thus, even without interference protection, efficiencies are still achieved.

[16] These are also commonly referred to as software defined radios ("SDRs") or cognitive radios.

[17] *See, e.g.,* D. Hatfield, and P. Tenhula, "The Potential Value of Decentralized Trunking as Regulatory Precedent for the Introduction of Dynamic Spectrum Access Technology," in Proc. of the IEEE Symposium on New Frontiers in Dynamic Spectrum Access Networks, April 2007; M. McHenry, E. Livsics, T. Nguyen and N. Majumdar, "XG Dynamic Spectrum Sharing Field Test Results," in Proc. of the IEEE Symposium on New Frontiers in Dynamic Spectrum Access Networks, April 2007; also forthcoming in IEEE Communications (June 2007); F. Seelig, "A Description of the August 2006 DARPA XG Phase III Demonstrations at Fort A.P. Hill," in Proc. of the IEEE Symposium on New Frontiers in Dynamic Spectrum Access Networks, April 2007; K.N. Steadman, A. Rose, and T. Nguyen, "Dynamic Spectrum Sharing Detectors," in Proc. of the IEEE Symposium on New Frontiers in Dynamic Spectrum Access Networks, April 2007; F. Perich, "Policy-based Network Management for NeXt Generation Spectrum Access Control," in Proc. of the IEEE Symposium on New Frontiers in Dynamic Spectrum Access Networks, April 2007; J.B. Bernthal, T.X Brown, D. Hatfield, D. Sicker, P. Tenhula, and P. Weiser, "Trends and Precedents Favoring a Regulatory Embrace of Smart Radio Technologies," in Proc. of the IEEE Symposium on New Frontiers in Dynamic Spectrum Access Networks, April 2007.

II. TEST-BED SELECTION CRITERIA

The Test-Bed program should focus initially on two areas — dynamic spectrum access and multi-antenna signal ("MAS") processing technology. The record identifies both of these whether implemented independently or deployed together, as key technologies that will improve spectrum utilization and efficiency. Recent developments occurring primarily after the close of NTIA's Test-Bed inquiry indicate that applications in future public-private spectrum sharing arrangements will inevitably require broadband data speeds.[18] Therefore, broadband applications also should be encouraged within the Test-Bed program. However, CSMAC also recognizes that government operations may benefit from improved sharing among narrowband technologies. Test bed proposals that focus on these improvements should also be given careful consideration. Ultimately, NTIA should be flexible in evaluating all test bed technology proposals and focusing on the public interest benefits from each – as opposed to sanctioning only particular families of technologies.

The NTIA NOI proposed eight criteria that should be used to determine whether a particular technology or application were suitable for the Test-Bed program. The CSMAC generally supports these criteria, with minor modifications to ensure that the criteria conform to the goals of the Test-Bed:

1. How well does the proposed technology or service achieve the goal of the Test-Bed?
2. How readily available is the equipment proposed for the Test-Bed?
3. How well does the proposed technology or service explore creative and original concepts in spectrum sharing, including more efficient spectral use?[19]
4. For the proposed technology or service, can the results of the Test-Bed be disseminated broadly to enhance scientific knowledge and understanding?

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[18] *Ninth NPRM*, FCC 06-181 (rel. Dec. 20, 2006); *FNPRM,* FCC 07-72 (rel. April 27, 2007).

[19] In the NOI, Criteria 3 was limited to technologies. Consistent with the other criteria, and the SPI generally, WG1 modified Criteria 3 to refer to proposed technologies or services. For example, broadband service does not imply a particular technology but should be a permitted use within the Test-Bed program. The Committee agrees with this approach.

5. How well does the proposed technology or service address the potential impact on the incumbent, licensed spectrum user(s)?
6. Can the proposed technology or service be adapted for a variety of situations, including, military/homeland security, and public safety?[20]
7. Are there any technical factors that limit the proposed technology or service to a specific frequency range?
8. Will the necessary technical support be provided to assure performance of the equipment during the Test-Bed?

Based on its review of the record and relevant materials, four technologies and services have been identified for the Test-Bed to date: dynamic spectrum access; multi-antenna signal ("MAS") processing technology; airborne video; and mobile satellite service with an ancillary terrestrial component ("MSS/ATC"). WG1 subjected each of these technologies/services to the eight selection criteria and determined that only two — dynamic spectrum access and MAS — satisfied each of the criteria. The Committee agrees with this analysis.

Criterion 1 – Satisfaction of the Test-Bed Objective

The record clearly demonstrates that dynamic spectrum access technology holds the promise to satisfy the Test-Bed objective — improving the ability of federal and non-federal users to share the same spectrum. The record demonstrates that this technology is likely to enhance spectrum efficiency and to facilitate sharing.[21] MAS technology, through the use of techniques such as adaptive interference cancellation, eliminates or minimizes interference between the entities sharing a band of spectrum.[22] Accordingly MAS satisfies this criterion.

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[20] In the NOI, Criteria 6 was limited to technologies. Consistent with the other criteria, and the SPI generally, WG1 modified Criteria 6 to refer to proposed technologies or services. The Committee agrees with this approach.

[21] ADAPT4, LLC NOI Comments at 3-5; Software Defined Radio Forum ("SDR Forum") NOI Comments at 3-4; Shared Spectrum Company ("SSC") NOI Comments at 3-6.

[22] A host of naming conventions have been used to refer to MAS. One of the most common is MIMO (Multiple Input, Multiple Output).

Airborne video links using adaptive spectrum access technology could also enable sharing between government and private users.[23] For example, a sheriff's helicopter could use the 2 GHz Auxiliary Band. Another example would be a commercial company providing UAV border patrol video service using Unmanned Reconnaissance Vehicles ("UAVs") operating in Federal Government spectrum. Additionally, UAV video downlinks are of critical importance to the DoD and currently have significant spectrum access difficulties that could be mitigated by adaptive airborne spectrum radios. Thus, these airborne video services could be tested as a subset of adaptive radios.

MSS/ATC also was identified as a possible candidate for the Test-Bed program.[24] There was no evidence presented, however, that this technology would facilitate spectrum sharing between government and non-government users.[25] Accordingly, MSS/ATC may not be an appropriate use.

Criterion 2 — Readily Available Equipment

The record demonstrates that broadband MAS and dynamic spectrum access equipment, such as adaptive radios, is currently available.[26] Airborne video equipment is also currently available.[27] Accordingly, these services satisfy Criteria 2.

There was no evidence in the record to demonstrate that MSS/ATC equipment was currently available.

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[23] *See* Los Angeles County Sheriff Department FCC Comments at 1.

[24] Terrestar Networks, Inc. ("Terrestar") NOI Comments at 1-5.

[25] Terrestar mentioned the potential for sharing between federal and non-federal satellites, but provided no nexus to its MSS/ATC proposal. *Id.* at 3.

[26] *See* Adapt4, LLC FCC Comments at 1-2 (noting availability of XG1 cognitive radio); ArrayComm LLC FCC Comments at 2; SSC NOI Comments at 5 (noting current field tests of prototype radios); Shure Incorporated FCC Comments at 4-5 (noting certification of dynamic spectrum access equipment in the 5 GHz band);

[27] *See* Los Angeles County Sheriff Department FCC Comments at 2.

Criterion 3 — Facilitate Spectrum Sharing

Broadband technology also has great potential for facilitating spectrum sharing. Motorola submitted comments proposing a broadband network that would permit sharing by federal and non-federal users.[28] Moreover, the FCC has recently been evaluating the need for public safety access to broadband, interoperable networks.[29] A common question in these proceedings has been whether it is viable for commercial and public safety systems to share a single network for the provision of these services. Data from the Test-Bed could be instrumental in examining this question. Accordingly, broadband technology satisfies Criteria 3.

Dynamic spectrum access technology allows a radio device to (i) sense its RF environment, (ii) determine which frequencies are available for use on a non-interference basis, and (iii) reconfigure itself to operate on the identified frequencies. This technology shows substantial promise, and may facilitate spectrum sharing between government and private carriers.

Multi-antenna signal processing technology has been deployed abroad to facilitate spectrum sharing,[30] but the opportunity for sharing between diverse systems has not been explored in the United States. MAS may also be used as part of a deployment utilizing dynamic frequency selection to improve efficiency. This improved efficiency may ultimately facilitate additional sharing. The international experience indicates that this criterion can be satisfied.

Based on the record, it appears that airborne video and MSS/ATC are based on existing, licensed services and do not appear to represent a new technology for spectrum sharing between

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[28] Motorola NOI Comments at 7.

[29] *See, e.g., Implementing a Nationwide, Broadband, Interoperable Public Safety Network in the 700 MHz Band*, PS Docket No. 06-229, *Ninth Notice of Proposed Rulemaking*, FCC 06-181 (rel. Dec. 20, 2006) ("*Ninth NPRM*"), *summarized*, 72 Fed. Reg. 1201 (Jan. 10, 2006); *see also* M2Z Networks, Inc. NOI Comments at 1-12.

government and non-government users. These services could be viable Test-Bed candidates, however, if they are being provided via any number of new, spectrum sharing technologies.

Criterion 4 — Broaden Scientific Knowledge Relative to Spectrum Sharing

As discussed above, there is substantial debate regarding the ability of commercial and public safety entities to share a single broadband network. Evaluation of this concept in the Test-Bed would produce substantial data that would be useful in addressing whether such a joint broadband network, and associated spectrum sharing, can be readily implemented.

The deployment of dynamic spectrum access technology in the Test-Bed is likely to contribute to a greater understanding of the ability of this technology share spectrum with a variety of users on a non-interference basis. Technical data generated by the Test-Bed program likely would resolve concerns about the ability of this technology to operate on a non-interference basis.

There is already a large and growing body of theoretical information about multi-antenna signal processing technology. Although there is a reluctance to share proprietary information, dissemination of the results of sharing situations is likely to involve little proprietary information if it is restricted to performance rather that to the specific techniques and algorithms. This is also true for results of dynamic spectrum access.

Neither the airborne video nor MSS/ATC proponents explain how inclusion in the Test-Bed is likely to produce data that would substantially advance scientific understanding of spectrum sharing. Accordingly, absent additional information, Criteria 4 is not satisfied by airborne video or MSS/ATC at this time.

Criterion 5 — Protection of Incumbent, Licensed Users

[30] MAS has been deployed in, among other places, Australia, China, Japan, and South Africa. *See* http://www.arraycomm.com/serve.php?page=proof.

The record contained little evidence regarding how each of the potential Test-Bed technologies and services would protect incumbent licensees.[31] Each of the technologies and services identified in the record, however, could be deployed in the Test-Bed in a manner that would assist in determining whether the deployment of the technology would have an adverse impact on incumbent licensees. The answer to this issue would depend on the particular test plan submitted by a potential Test-Bed participant and it presupposes the deployment of appropriate instrumentation to identify the source and cause of any such interference during the testing. However, any technology that reduces or eliminates interference in a measurable and predictable way positively addresses the potential impact on incumbent spectrum licensees.

Criterion 6 — Broad Applicability of the Technology or Service

Each of the technologies and services identified in the record can satisfy Criteria 6. Broadband technology is being deployed across virtually all government and commercial platforms. Some commercial carriers already are testing the ability of commercial IP multimedia subsystems ("IMS") to satisfy both public safety/national security and commercial broadband needs over a single network.[32]

Neither dynamic spectrum access nor multi-antenna signal processing technology is limited to a particular industry or application. Dynamic spectrum access already has been tested for military applications[33] and could be deployed on commercial and public safety networks. There are several proposals before the FCC today that offer to share commercial and

[31] The only party to provide such information was ADAPT4 LLC Inc. regarding adaptive radios.

[32] IMS permits the sharing of different media during a single transmission — *i.e.*, numerous applications such as voice communications, video feeds, and file transfers can be utilized simultaneously. For example, on May 2, 2006, at Rash Field in the Inner Harbor of Baltimore, Maryland, AT&T participated in a demonstration of the wide variety of public safety/national security applications possible over commercial UMTS/HSDPA networks via IMS. A similar demonstration was conducted late last year in Washington, D.C.

[33] *See* SSC NOI Comments at 2-6.

military/homeland security, and public safety situations. Accordingly, Criterion 6 can be satisfied for these technologies.

The proponent of airborne video technology claims that the Test-Bed can be used to demonstrate the ability of new encryption technologies to protect data transmitted from airborne stations to ground locations. This ability has widespread application for both the government and private sector.

MSS/ATC technology can be utilized by the commercial sector, public safety, homeland security, and other governmental entities, especially with regard to the ability to communication with rural areas and remote areas.

Criterion 7 — Potential for Use Across Various Spectrum Bands

No data was provided in the record to indicate that any of the technologies or services identified as potential Test-Bed candidates would be limited to a particular spectrum band. Accordingly, this factor apparently can be satisfied by all of the identified technologies and services.[34]

However, in further evaluating candidate technologies under this factor, mere "potential" should generally be insufficient to justify access to the Test-Bed program. An applicant should be required to demonstrate that the candidate technology could be economically deployed on a widespread basis within five to ten years if the Test-Bed confirms the viability of the technology.

Criteria 8 — Availability of Technical Support

There was little record evidence regarding the availability of technical support for any of the candidate technologies or services. Any party seeking access to the Test-Bed would be willing to agree to provide all necessary technical support. Such support should be a condition

[34] Although it may be possible to operate across a wide spectrum range, equipment for airborne video appears limited largely to the 2.3 - 2.4 GHz range.

of Test-Bed participation. Moreover, if funding permits, CSMAC recommends that NTIA — with the participation of other federal incumbent users — provide technical oversight for Test-Bed experiments as they are designed, deployed and conducted.[35]

Based on the foregoing, only two technologies/services satisfied all 8 criteria — dynamic spectrum access and MAS. Accordingly, the Test-Bed program should initially be limited to these technologies. To the extent multiple Test-Beds are available, however, providing airborne video and MSS/ATC proponents access to a Test-Bed would be consistent with the objectives of the President's SPI, in particular the ability of the United States to maintain global leadership in communications technology.[36] Moreover, airborne video and MSS/ATC services may be evaluated in the Test-Bed program to the extent they are deployed utilizing new, innovative sharing technologies.

III. STRUCTURE OF TEST-BED

A. Number of Test-Beds

The record demonstrates overwhelming support for the formation of multiple Test-Beds.[37] One of the key goals of the SPI was improving the ability of the United States to maintain global leadership in communications technology.[38] Global leadership is maintained by constant innovation and experimentation by both government and industry, which can be supported by the Test-Bed program. The ability to quickly trial numerous new technologies

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[35] For example, the Institute for Telecommunication Sciences ("ITS"), the research and engineering branch of NTIA, has a long history of studying interference (*e.g.*, UWB interference into GPS receivers).

[36] *See* Presidential Memorandum, 69 Fed. Reg. at 1569

[37] ADAPT4 NOI Comments at 5; Amateur Radio NOI Comments at 7; Motorola NOI Comments at 4; Rockwell NOI Comments at 7; SDR Forum NOI Comments at 2; Terrestar NOI Comments at 3; ADAPT4 FCC Comments at 5; Amateur Radio FCC Comments at 7; Cingular Wireless FCC Comments at 6; Motorola FCC Comments at 4; Rockwell FCC Comments at 7; SDR Forum FCC Comments at 2; Progeny FCC Reply Comments at 5; Terrestar FCC Comments at 3.

[38] *See* Presidential Memorandum, 69 Fed. Reg. at 1569

would be yet another method to foster the ability of the United States to remain at the forefront of communications policy and technology. Thus, the Test-Bed program will best serve these objectives if it is comprised of multiple Test-Beds located in separate geographic areas in order to maximize the number of technologies that can be tested during the duration of the program. To the extent feasible, the government should authorize the majority of the Test-Bed experiments to be conducted in the vicinity of the participant's facilities.

Flexibility also should be encouraged so that simultaneous tests of incompatible air interfaces and access technologies are possible — *e.g.,* multiple Test-Beds in different geographic locations.[39] For example, it should be possible to conduct a test in one area utilizing Frequency Division Duplex access, while a test evaluating the merits of Time Division Duplex access is being conducted simultaneously in another Test-Bed.[40] Criteria should not be established that would inhibit the ability to test a wide variety of incompatible technologies on a simultaneous basis.

Although multiple Test-Beds are the optimal approach for the program, this approach may not be feasible. The goal of the Test-Bed is to evaluate technologies that would foster spectrum sharing between federal government and non-federal government users. Thus, participation of federal users is essential. It may prove difficult for federal users to provide sufficient technical staff to support multiple Test-Beds. Similarly, to the extent the Test-Bed program is utilized to evaluate opportunities for spectrum sharing with public safety, these entities do not have the resources to participate in numerous Test-Beds. The Committee thus recommends that NTIA seek additional funding or repurpose existing funds to support the

[39] *See* Amateur Radio NOI Comments at 8; Cingular Wireless FCC Comments at 3; Motorola NOI Comments at 10; Progeny NOI Comments at 5; Progeny FCC Reply Comments at 7; SDR Forum NOI Comments at 8.

[40] ArrayComm FCC Comments at 15; Cingular Wireless LLC NOI Comments at 6.

federal staffing that would be necessary for multiple Test-Beds with simultaneous testing. NTIA also should evaluate whether the federal staffing and resource issues could be resolved by requiring private entities participating in the Test-Bed program to bear all costs or whether there are testing regimes that could produce useful data without federal resources. The government may not need to monitor all Test-Bed operations. Rather, participants could self monitor and execute the majority of the tests as is currently done with FCC Special Temporary Authority testing.

To the extent possible, the government should make public the design and software used in its Test-Bed evaluation equipment so that participants can replicate this function. Methods to measure interference, to generate simulated signals, to establish limiting interference-to-noise ratios ("INRs"), *etc.* could be made public at the start of the program and will be updated periodically. This information will also make the work of the Test-Bed more transparent.

Finally, to ensure maximum participation (and thereby increase the potential for identifying new technology and sharing techniques), NTIA should consider potential incentives for private sector involvement in the Test-Bed program. Although participation in a Test-Bed with the federal government would potentially expedite the willingness of the government to permit spectrum sharing utilizing the tested technology or product, the open nature of the process may create a "free rider" problem that would discourage participation by certain entities. One way to address this disincentive may be an agreement by the federal government to share spectrum if a Test-Bed proposal is successful. Other incentive possibilities which may exist or may be strengthened include: access to federal government facilities and researchers, financial incentives, and press attention. NTIA should consider the full range of possibilities to ensure the President's Test-Bed initiative fulfills its potential.

B. Number of Test-Bed Participants

As with the number of Test-Beds, the resources available to federal users for monitoring and participating in the Test-Bed evaluation process will affect the number of possible participants. The CSMAC recommends permitting the maximum number of participants possible given the available federal resources.[41] The Test-Bed should accommodate as large a number of participants as possible to avoid a complex selection process.

Nonetheless if NTIA must limit the number of Test-Bed participants, it should do so based on the public interest benefits created by each proposal. This could be accomplished through an evaluation of the eight factors discussed above as well as through a due diligence screening process (as discussed below). In an effort to ensure government resources are allocated to the most promising Test-bed operators, NTIA may wish to consider a two-stage process. After a basic due diligence process, an applicant would be granted an initial Test-Bed authorization. This initial stage would provide an opportunity to validate the proposed concept in the field and gain access to federal government spectrum staff resources and mentoring. If this "proof of concept" stage is successful, a subset of applicants would be given a broader Test-Bed opportunity to advance the state of the research. This two stage process will ensure resources are spent on the most promising proposals.

C. Test-Bed Location — Frequencies and Geographic Area

The purpose of the Test-Bed program is to "promote the more efficient and beneficial use of spectrum without harmful interference" to incumbents licensees.[42] This objective must be satisfied both at the Test-Bed stage and, ultimately, at the full deployment stage if the Test-Bed results in the authorization of a new technology or service. One way to avoid harmful

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[41] *Accord* Amateur Radio NOI Comments at 9; Motorola NOI Comments at 2; SDR Forum NOI Comments at2, 4-5.

interference during the initial testing stage may be to ensure that Test-Beds are located in areas with relatively few incumbents.[43] This can be accomplished either on a spectrum or geographic basis. However, if the Test-Bed is conducted solely in an area with low density of users, it is possible that the results will only have limited usefulness (since pressure for sharing may be greatest in the most congested bands). Thus additional testing should also be conducted in more congested environments if the initial Test-Bed deployment confirms that the technology being tested should not cause harmful interference to incumbent, licensed users. These subsequent tests would be used to confirm the technology's effectiveness in more challenging environments. If a Test-Bed is successful and results in the authorization of a new technology/service, the Test-Bed data should clearly demonstrate that incumbent licensees remain protected when the new technology is fully deployed.

The fundamental purpose of any Test-Bed is to explore ways in which the spectrum can be more intensively used without adversely impacting the effectiveness of the licensed systems and technologies already deployed. Thus highly congested bands – which are already intensively used and produce substantial public interest benefits – are not the primary candidates for new sharing proposals. Instead the Test-Bed may most fruitfully pursue testing in bands where the current use is more limited – in numbers of users, time, or location. This approach may counsel against use of most spectrum above 1 GHz and below 5 GHz in light of the congestion that typifies these bands.[44] Commenters generally favored avoiding congrested bands.[45] In

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[42] Presidential Memorandum, 69 Fed. Reg. at 1569.

[43] *See FCC Public Notice* at 4.

[44] *See* ADAPT4 NOI Comments at 2 (identifying spectrum below 500 MHz); Cingular Wireless NOI Comments at 4 (suggesting spectrum above 5 GHz); CTIA NOI Comments at 6; Motorola NOI Comments at 4-8 (stressing preference for unoccupied spectrum); NSTC NOI Comments at 4 (suggesting high band VHF spectrum in the 150-170 MHz band); SDR Forum NOI Comments at 7 (identifying spectrum below 1 GHz and above 4.9 GHz); SSC FCC Reply Comments at 5-7 (identifying spectrum below 1 GHz); *see also Amendment of the Commission's Rules to Provide*

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particular, broadcast white spaces below 1 GHz and above the 4.9 GHz band were identified as optimal Test-Bed locations due to the uncongested nature of these bands. Indeed, the record demonstrates wide support for the idea that the prime location for Test-Beds is within spectrum below 1 GHz (excluding the public safety and cellular bands)[46] and above 4.9 GHz.

Ultimately, Test-Beds should be authorized for geographic areas that encompass a wide variety of environments to permit tests in areas with different propagation characteristics — forests, in-building, mountainous, urban canyons. If Test-Beds are authorized for small geographic areas that do not encompass all such environments, participants should be permitted to move Test-Bed locations in order to ensure that tests are conducted under the widest variety of conditions. Similarly, where possible, the Test-Bed areas should be co-located with the participant's facilities to reduce costs and to maximize test time. Once the participant's

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for Unlicensed NII/SUPERNet Operations in the 5 GHz Frequency Range, ET Docket No. 96-102, *Notice of Proposed Rule Making*, 11 F.C.C.R. 7205, 7217 (1996) (noting the spectrum scarcity below 5 GHz generally); *The Development of Operational, Technical, and Spectrum Requirements for Meeting Federal, State and Local Public Safety Agency Communication Requirements Through the Year 2010*, WT Docket No. 96-86, *Notice of Proposed Rule Making*, 11 F.C.C.R. 12406, 12486 (1996) (noting the congested nature of spectrum below 1 GHz); *Revision of Part 22 and Part 90 of the Commission's Rules to Facilitate Future Development of Paging Systems; Implementation of Section 309(j) of the Communications Act -- Competitive Bidding,* WT Docket No. 96-18, *Notice of Proposed Rule Making,* 11 F.C.C.R. 3108, 3139 (1996) (stating that with this rulemaking the FCC plans to encourage more efficient use of spectrum in congested areas, such as PCS); *Amendment of Part 90 of the Commission's Rules to Facilitate Future Development of SMR Systems in the 800 MHz Frequency Band and Implementation of Section 309(j) of the Communications Act – Competitive Bidding 800 MHz SMR,* PR Docket No. 93-144, *Further Notice of Proposed Rulemaking,* 10 F.C.C.R. 7970, 7985 (1994) (noting that SMR spectrum is significantly more congested than broadband or cellular); Spectrum Policy Task Force ("SPTF"), Report of the Spectrum Rights and Responsibilities Working Group, at 13 (Nov. 15, 2002) (noting the rapid proliferation of PCS); SPTF Report at 10 (noting that some bands, such as those used by cellular base stations, are heavily used).

[45] *See, e.g.*, Cingular Wireless NOI Comments at 4; Motorola NOI Comments at 4-8; SDR NOI Comments at 5-6.

[46] *See* SDR Forum NOI Comments at 7 (identifying spectrum below 1 GHz with the exception of "Public Safety, Cellular, and other heavily used channels").

equipment undergoes initial testing at a government facility, operation in the vicinity's area should be authorized.

In addition to identifying appropriate spectrum for Test-Bed operations, geographic parameters must be established. The FCC has noted that it may be appropriate to limit Test-Beds to rural areas in order to limit the risk of harmful interference to incumbent licensees.[47] The Committee agrees that such a limitation will minimize the risk of harmful interference, but believes that such an approach would unduly restrict Test-Bed experiments. The placement of Test-Beds in generally unoccupied spectrum should minimize the need for a rural limitation.[48] Moreover, the Test-Bed will be most productive if its can produce data under a number of different scenarios – including congested operations in urban areas. The optimal approach would be to verify the data generated by the Test-Bed in uncongested areas by subsequent testing in high traffic locations that more closely approximate real-world deployment scenarios. This verification process could occur during the second step of a two-stage Test-Bed program, as discussed below.

Finally the Test-Bed spectrum should provide the opportunity to test a variety of technologies and sharing concepts. So, for example, some broadband systems have minimal channelization schemes that require 1.25 MHz. Other technologies require certain minimum bandwidths in order to function properly and to enable shared use. Similarly, certain communications platforms, like satellites, only operate in certain bands. The Test-Bed spectrum bands should provide for the test environments needed to address a wide variety of technologies.

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[47] *See FCC Notice* at 4-5.

[48] If a Test-Bed were approved for deployment in the 1-5.9 GHz range, however, a rural restriction would be essential to ensuring that the potential interference to incumbents is minimized.

D. Limited Duration

The final report on the Test-Bed is to be completed by December 2008 and commenters addressing the duration of the test bed suggested between 30 days and 3 years. Given the report deadline and the current status of NTIA's efforts to establish the Test-Bed program, it is evident that, absent other actions, the Test-Bed must be limited in duration — perhaps 90 days. However, because of the importance of the Test-Bed program to the President's SPI and the potential limitations of a short Test-Bed duration, CSMAC recommends that NTIA investigate the feasibility of extending the duration of the Test-Bed activities beyond December 2008.

As discussed above, one option may be adoption of a two-stage Test-Bed program. Stage One would be a 90 day experiment to verify the assumptions underlying an applicant's Test-Bed proposal and produce preliminary data to demonstrate whether further experiments are necessary. In essence, a 90-day review would determine whether the technology or service being tested shows promise for advancing spectrum sharing. Stage Two would consist of further testing to confirm the preliminary results obtained for promising technologies. These Stage Two tests could be permitted over much longer periods of time. As discussed below, CSMAC recommends that status reports be a condition of Test-Bed participation. Status reports could be required at the completion of Stage One and form the basis for preparing the December 2008 report.

IV. TEST-BED REQUIREMENTS

A. Legal Authorization

To the extent parties addressed the appropriate mechanism for authorizing Test-Bed operations, the record clearly supported the use of Part 5 of the FCC's rules.[49] The Committee

[49] *See* ADAPT4 NOI Comments at 4; Amateur Radio NOI Comments at 8; Motorola NOI Comments at 9; Rockwell Collins NOI Comments at 6; SDR Forum NOI Comments at 2; Shure
(continued on next page)

agrees that Part 5 should be used as the legal basis for operation of the Test-Bed program. Part 5 was adopted specifically "to prescribe the manner in which parts of the radio frequency spectrum may be made available for experimentation."[50] Although the FCC has eliminated the need for a written report under Part 5,[51] CSMAC recommends that reports be made a condition of participation in the Test-Bed program as set forth below.

B. Interference Protection

The record and relevant materials demonstrate that the ultimate success of the Test-Bed program depends upon the ability of participants to protect incumbent federal and non-federal government users from harmful interference.[52] The Committee believes that the potential for harmful interference to incumbent users of federal spectrum can be successfully avoided by (a) careful selection of Test-Bed locations (as described previously), (b) subjecting the test plans and associated equipment and interference avoidance techniques to a rigorous paper review and controlled laboratory and field measurements prior to actual field testing, (c) testing and measurements with appropriate instrumentation during the initial phases of the testing and (d) providing the participants (where possible) with detailed information (location, power level, emission type, etc) about the existing user systems in the surrounding area. With regard to (b), it is the Committee's belief that ITS has the technical expertise and the requisite experience to conduct this review. Accordingly, the CSMAC recommends that the Institute for Telecommunications Sciences (the research and engineering branch of NTIA, also called "ITS") or a comparable laboratory (with similarly qualified personnel and instrumentation) or a

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FCC Reply Comments at 4; SSC NOI Comments at 3-4. In addition, NTIA and the FCC should exempt testing within anechoic chambers from any prior approval requirements.

[50] 47 C.F.R. § 5.1(b).

[51] *See* 47 C.F.R. § 5.73.

[52] *See, e.g.,* Cingular NOI Comments at 4-5; CTIA NOI Comments at 6; Motorola NOI Comments at 3, 9; Shure FCC Comments at 3; SSC NOI Comments at 7-8.

comparable laboratory conduct the objective reviews and equipment testing prior to actual field evaluation in the Test-Bed. Similarly, the Committee recommends that the Institute for Telecommunications Sciences, the research and engineering branch of NTIA, or a comparable laboratory (with similarly qualified personnel and instrumentation) be used during the initial phases of the Test-Bed to verify interference free operation and to expeditiously resolve harmful interference situations if they should unexpectedly occur.[53]

C. Due Diligence Process

Before a particular Test-Bed proposal is authorized, CSMAC recommends that the applicant be required to submit its credentials and proposal for a preliminary due diligence. This review should screen potential Test-Bed participants for competency (technical, financial, and otherwise) and verify that the proposed experiment is technically sound and would not cause harmful interference to incumbent licensees. This due diligence process should be expeditious to ensure that promising technologies are not stuck in an endless review cycle. Accordingly, the Committee recommends requiring that this due diligence must be completed within a 30 day "shot clock" of the applicant's submission of its credentials and the technical details of its proposed experiment. Applicants seeking to advance to a Stage Two Test-Bed would be subject to a similar 30 day review process to assess whether the Stage One results warrant additional testing.

D. Status Reports and Peer Review

The underlying purpose of the Test-Bed program was to facilitate spectrum sharing between the government and industry and increase technical cooperation between these groups to

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[53] *See, e.g.,* Cingular NOI Comments at 4-5; CTIA NOI Comments at 6; Motorola NOI Comments at 3, 9; Shure FCC Comments at 3; SSC NOI Comments at 7-8.

promote the development of new technologies.[54] One of the key Test-Bed selection criteria is whether the candidate technology or service would broaden scientific knowledge regarding spectrum sharing. Use of the test beds to generate proprietary information or develop proprietary technology would be inconsistent with these objectives.[55] To ensure that the test beds are not used in such a manner, the Test-Bed program should be coordinated by the government.[56] The Test-Bed program should be used to share information throughout the government and private sector in order to promote the development of new, efficient technologies designed through a public/private partnership.

Consistent with the collaboration envisioned for the Test-Bed program, information regarding each Test-Bed should be publicly available — unless access to such information would compromise national security.[57] Test-Bed candidates should be required to submit, for public availability, a detailed description of the proposed experiment and objectives. In particular, this description should set forth the objective, assumptions, and predicted results for the experiment.[58] In addition, it should describe how incumbent licensees will be protected from harmful interference. The government should also provide information on the methods being used to evaluate the Test-Bed systems.

Once selected for inclusion in a Test-Bed, participants should be required to submit monthly status reports that would be publicly available. These status reports will help ensure

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[54] *See* Report 2 at 23.

[55] *See FCC Notice* at 5; Amateur Radio NOI Comments at 10; Cingular NOI Comments at 5; CTIA NOI Comments at 6.

[56] *See FCC Notice* at 5; Amateur Radio NOI Comments at 10; Cingular NOI Comments at 5; CTIA NOI Comments at 6.

[57] This approach is consistent with approaches taken abroad with regard to evaluating bandsharing possibilities. *See* Bandsharing Project Plan: 2007 at 6 (Public Safety Spectrum Testing Group, Feb. 2007).

[58] *See, e.g.,* Motorola NOI Comments at 12.

that the Test-Bed experiment is being conducted consistent with the plan and to provide an opportunity for the public to comment on the continuation of the Test-Bed if the preliminary results are at odds with the pre-test assumptions. Once the experiment has been completed, participants should be required to submit a final public report containing detailed technical results and conclusions to the relevant government agencies — those actually participating in the Test-Bed, as well as the FCC and NTIA.

Finally, to the extent feasible, the reports generated by the various Test-Beds should be subject to a peer review process.[59] As noted in the record, "[a] peer review process is essential to assessing the results of any given experiment" and is the best mechanism for identifying potential problems and verifying successful tests.[60]

[59] Motorola NOI Comments at 12; SDR Forum NOI Comments at 11.
[60] Motorola NOI Comments at 12.