THE SPECTRUM SHARING INNOVATION TEST-BED PILOT PROGRAM FISCAL YEAR 2011 PROGRESS REPORT

NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION

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I. BACKGROUND

The National Telecommunications and Information Administration (NTIA), in coordination with the Federal Communications Commission (FCC) and the Federal agencies, established a Spectrum Sharing Innovation Test-Bed (Test-Bed) pilot program to examine the feasibility of increased sharing between Federal and non-Federal users. This pilot program is an opportunity for the Federal agencies to work cooperatively with industry, researchers, and academia to examine objectively new technologies that can improve management of the nation's airwaves.

The Test-Bed pilot program evaluates the ability of Dynamic Spectrum Access (DSA) devices employing spectrum sensing and/or geo-location techniques to share spectrum with land mobile radio (LMR) systems operating in the 410-420 MHz Federal band and in the 470-512 MHz non-Federal band.[1] To address potential interference to incumbent LMR spectrum users, the Test-Bed pilot program includes both laboratory and field measurements performed in three phases to characterize the interaction with DSA enabled devices:

Phase I – Equipment Characterization. Test-Bed participants sent equipment employing DSA techniques to the NTIA Institute for Telecommunication Sciences (ITS) in Boulder, Colorado to undergo characterization measurements of the DSA capabilities in response to simulated environmental signals.

Phase II – Evaluation of Capabilities. After successful completion of Phase I, NTIA will examine the DSA spectrum sensing and/or geo-location capabilities of the equipment in the geographic area of the Test-Bed.

Phase III – Field Operation Evaluation. After successful completion of Phase II, NTIA will permit the DSA equipment to transmit in an actual radio frequency signal environment. An automatic signal logging capability will be used during operation of the Test-Bed to help resolve interference events if they occur. NTIA will establish a point-of-contact to stop Test-Bed operations if interference is reported.

This progress report describes the activities related to the Test-Bed pilot program undertaken during Fiscal Year (FY) 2011.

1. Dynamic Spectrum Access technology allows a radio device to (i) evaluate its radio frequency environment using spectrum sensing, geo-location, or a combination of spectrum sensing and geo-location techniques; (ii) determine which frequencies are available for use on a non-interference basis; and (iii) reconfigure itself to operate on the identified frequencies.

II. OVERVIEW OF DYNAMIC SPECTRUM ACCESS TECHNOLOGIES

Table 1 provides a high level overview of the different DSA implementations participating in the Test-Bed pilot program based on the information provided by the participants.

Table 1.

Parameter	DSA Device				
	A	**B**	**C**	**D**	**F**
DSA Capabilities	Spectrum Sensing and Geo-Location	Spectrum Sensing	Spectrum Sensing	Spectrum Sensing	Spectrum Sensing
Transmit Bandwidth	Fixed	Variable	Variable	Fixed	Fixed
Channel Structure	Contiguous Channels	Non-Contiguous Channels	Non-Contiguous Channels	Single Channel	Single Channel
Monitoring Frequency Range	Variable	Fixed	Fixed	Fixed	Fixed
Monitoring Time	Variable	Variable	Variable	Variable	Variable
Duplex Channel Monitoring Capability	Yes	No	No	No	No
Detection Method	Power Level Exceeding Threshold	Power Level Exceeding Threshold	Power Level Exceeding Threshold	Statistical Signal Processing	Power Level Exceeding Threshold
Detection Threshold	Variable	Variable	Variable	Variable	Variable
Detection Time	Variable	Variable	Variable	Variable	Variable
Cooperative Sensing Capability	Yes	Yes	No	Yes	No
Feature Detection Capability	No	No	Yes	No	No
Control Channel	No	No	Yes	No	No
Channel Lock-Out Capability	Yes	Yes	Yes	Yes	Yes
Channel Clearance Time	Variable	Variable	Variable	Variable	Variable
Channel Re-Visit Time	Variable	Variable	Variable	Variable	Variable
Automatic Transmit Disable Capability	Yes	Yes	Yes	Yes	Yes

III. PHASE I TEST PLAN

The Phase I test plan breaks the test cases down into five categories for each Device Under Test (DUT): emission characterization, sensor characterization, spectrum access behavior, LMR emission characterization, and LMR receiver performance characterization. Figure 1 shows an overview of the proposed test cases to be performed under Phase I. All Phase I testing will be performed at the ITS laboratory.[2]

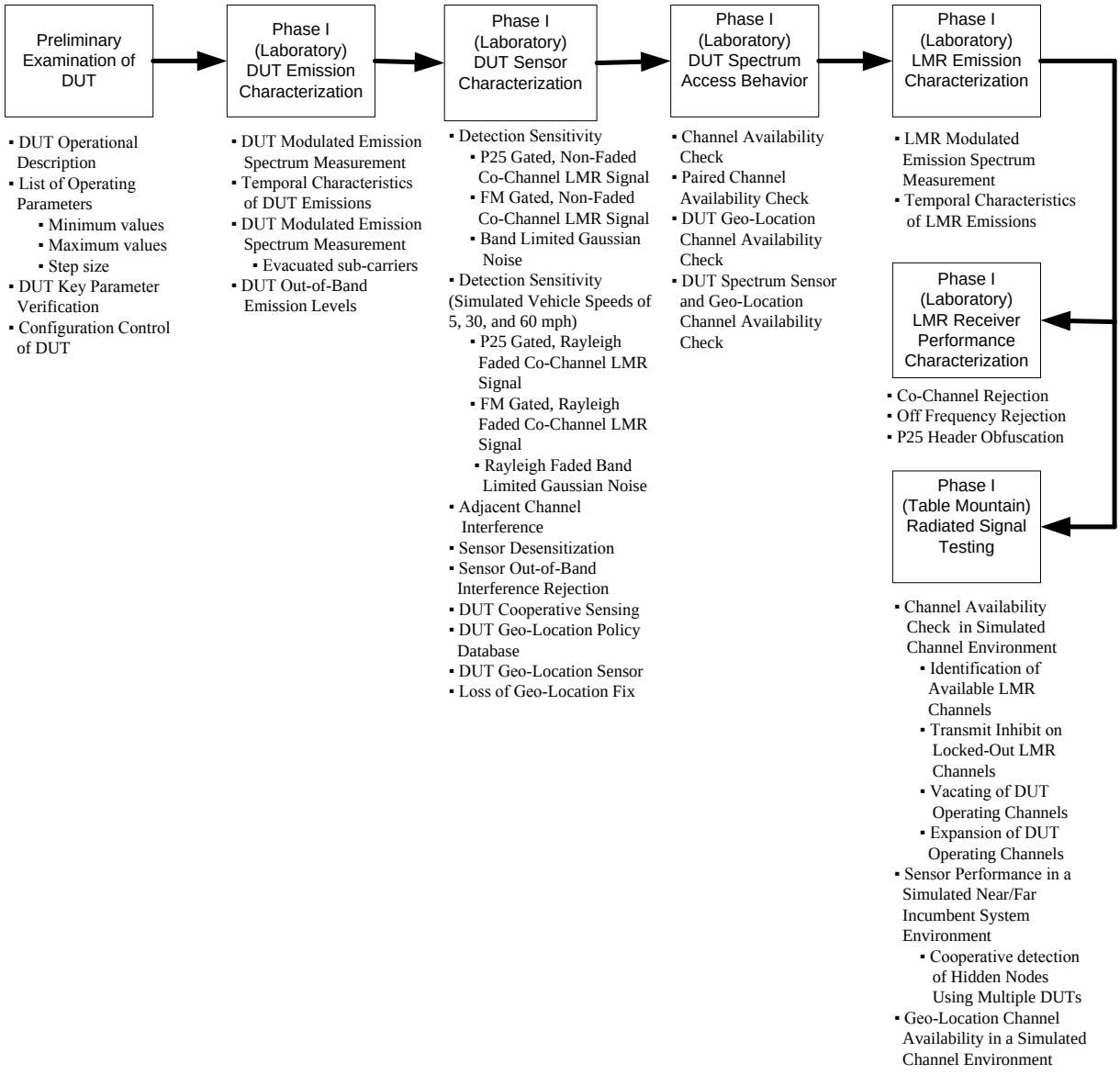

Figure 1.

2. Additional information related to the Test-Bed pilot program is available on the NTIA website at http://www.ntia.doc.gov/category/spectrum-sharing?page=1.

IV. STATUS OF PHASE I TESTING

NTIA ITS has completed the Phase I laboratory testing of the DSA Device A. The NTIA Office of Spectrum Management (OSM) is preparing a test report for DSA Device A based on the Phase I measurement data.

NTIA ITS has completed the Phase I laboratory testing of DSA Device B. During Fiscal Year 2011, one of the DSA devices failed and was replaced. This necessitated limited regression testing of the DSA device to ensure previous test results were valid.

NTIA ITS received DSA Device F in October 2010 and has completed approximately 10 percent of the testing. Testing was discontinued due to technical issues with the control computers and the spectrum sensing implementation of the DSA device. NTIA returned the DSA devices and control computers to the Test-Bed participant so that it might resolve these issues. The schedule for resuming Phase I testing of DSA Device F has not yet been determined.

Test-Bed Participant C provided to NTIA a demonstration of its DSA devices to ITS staff members in January 2011 and training on their DSA devices at the NTIA/ITS laboratory in July 2011. Participant C provided its DSA devices for Phase I testing; however, Participant C determined that it will need to implement software changes to its devices before Phase I testing can begin. The schedule for beginning Phase I testing of DSA Device C has not yet been finalized.

Test-Bed Participant D informed NTIA in February 2011 that it would not provide DSA radios for the Test-Bed, but would instead provide a stand-alone DSA sensor with a selection of algorithms for processing incumbent LMR signals. Test-Bed Participant D is continuing to develop the DSA sensor and algorithms, and is expected to provide the sensing suite in the second quarter of 2012.

NTIA staff has continued to develop analytical capabilities to assess the potential interference to LMR systems from DSA devices. Phase I laboratory testing is providing insight into the characteristics of the DSA devices for use in developing these analytical capabilities.

Table 2 provides an overview of the Phase I testing.

Table 2.

DSA Device	Status
A	Phase I testing is complete. OSM is preparing a report documenting the test results.
B	Phase I testing is complete.
C	Device was delivered to ITS in September 2011. The testing has been delayed because software interfaces necessary for collecting the data specified in the Phase I test plan have not been implemented. ITS is working with the Test-Bed participant to update the software.
D	Device will be delivered to ITS in second quarter of 2012.
F	Testing is on hold while the Test-Bed participant reviews design problems encountered during the Phase I testing. The device was unable to distinguish itself from incumbent LMR radios and performed a channel change when it detected itself. Testing cannot be completed without hardware and software changes. The Test-Bed participant is examining options to continue in the pilot program.

V. PHASE II/III TESTING

NTIA/ITS staff developed a test plan for Phase II/II testing, and coordinated the test plan with the federal agencies on the Technical Subcommittee of the Interdepartment Radio Advisory Committee and the Test-Bed participants.[3] NTIA will seek public input on the test plan prior to commencing Phase II/III testing.

The Phase II testing will determine the effectiveness of the DSA device in detecting the presence of LMR signals in a live operating environment. The DSA devices will not be permitted to transmit during this test, or their transmissions will be suitably attenuated so as not to interfere with normal LMR operations. NTIA will observe the behavior of the DSA devices in the presence of LMR signals to assess their potential for sharing the spectrum without causing unacceptable interference.

The Phase III testing will evaluate the ability of the DSA devices to operate in the presence of LMR signals in a live environment. These tests include a number of scenarios that DSA devices will experience when operating in the same frequency band and geographic area as incumbent LMR systems. These tests will investigate the impact of DSA device operations on the received signal quality for conventional LMR base-to-mobile and mobile-to-base transmissions. These tests will also investigate the impact of DSA device operations on the control channel signaling between the base station and mobile stations for a trunked LMR system and will also consider scenarios where the LMR base station is a hidden node, and when a LMR mobile station is a hidden node.[4] The test plan includes a test scenario for geo-location enabled DSA devices that can

3. The IRAC, consisting of federal agency representatives, serves in an advisory capacity to the Assistant Secretary of Commerce for Communications and Information.

4. A hidden node is radio whose transmissions are either too weak or too infrequent to be detected by a DSA device.

control their behavior as the devices move between two geographic regions, each associated with distinct transmission characteristics specified by policies within the DSA devices. The transmission characteristics will be monitored as the DSA devices move between the two regions.

VI. PLANNED FISCAL YEAR 2012 ACTIVITIES

The Phase I laboratory testing will continue for DSA Devices C and D. The Phase I laboratory testing of DSA device F is currently on hold while the Test-Bed participant determines the next steps to resolve the technical issues with its device.

NTIA will seek public comment on the Phase II/III test plan via a Federal Register Notice during the second quarter of FY 2012. NTIA will commence the Phase II/III testing on the DSA devices from Test-Bed Participant A after finalizing the test plan, followed immediately by the DSA devices from Test-Bed Participant B.

NTIA staff will continue to develop the analytical capabilities to assess the potential interference to LMR systems from DSA devices.