

Appendix A

WNUF Scope of Work

S2 - Extreme Bandwidth Analyzer and Correlator Test Effort

1. Background and Purpose

S2 Corporation has developed an Extreme Bandwidth Analyzer and Correlator (EBAC) photonic based system that utilizes a crystalline material to perform absorption of light for signal processing. The EBAC is capable of performing persistent radio frequency sensing, signal processing and direction finding with low latency over 0.5-30 GHz allowing spectral users to more accurately characterize the RF environment.

S2 proposes to test the EBAC in various spectral emitting environments at the Wireless National User Facility (WNUF). The primary goals of the effort include performing passive RF spectrum collects as follows:

1. Spectral monitoring (SM) from 0.5-20 GHz at EBR-1
2. SM from 10-30 GHz at EBR-1
3. Direction finding (DF) on transmitted RF signals over 0.5-10.5 GHz
4. DF on transmitted RF signals over 10.5-20 GHz
5. Identification of unknown signals of interest over 0.5-10.5 GHz

2. Points of Contact

INL Technical Lead	INL Business Lead	User Technical Lead
Dustin Bacon	Rangam Subramanian	Dr. Kris Merkel
Test Lead, WNUF Test Lead / Principle Investigator	Chief, Wireless Technology and Business Strategy	President & CEO
Battelle Energy Alliance, LLC	Battelle Energy Alliance, LLC	S2 Corporation
2525 N. Fremont Avenue	2525 N. Fremont Avenue	2310 University Way, 4-1
Idaho Falls, ID 83415-3420	Idaho Falls, ID 83415-3420	Bozeman, Montana 59715
E-mail: dustin.bacon@inl.gov	E-mail: rangam@inl.gov	E-mail: merkel@s2corporation.com
Telephone: 208.526.1137	Telephone: 208.526.0870	Telephone: 406.922.0334 x 101
Cell: 208.569.3975	Cell: 630.803.4759	Cell: 406.579.6044

3. SCOPE OF WORK

3.1 Overview

The Idaho National Laboratory’s (INL) Wireless National User Facility (WNUF) shall support S2 Corporation’s (referred to hereafter as User) wireless testing needs through logistical support, spectrum approval and active transmissions of WNUF radio equipment. INL, in collaboration with User, shall evaluate the transmitting radio options available and determine the appropriate systems, locations and times for daily transmissions.

3.2 Proposed Test Configuration

The proposed User test configuration is provided in Figure 1 below:

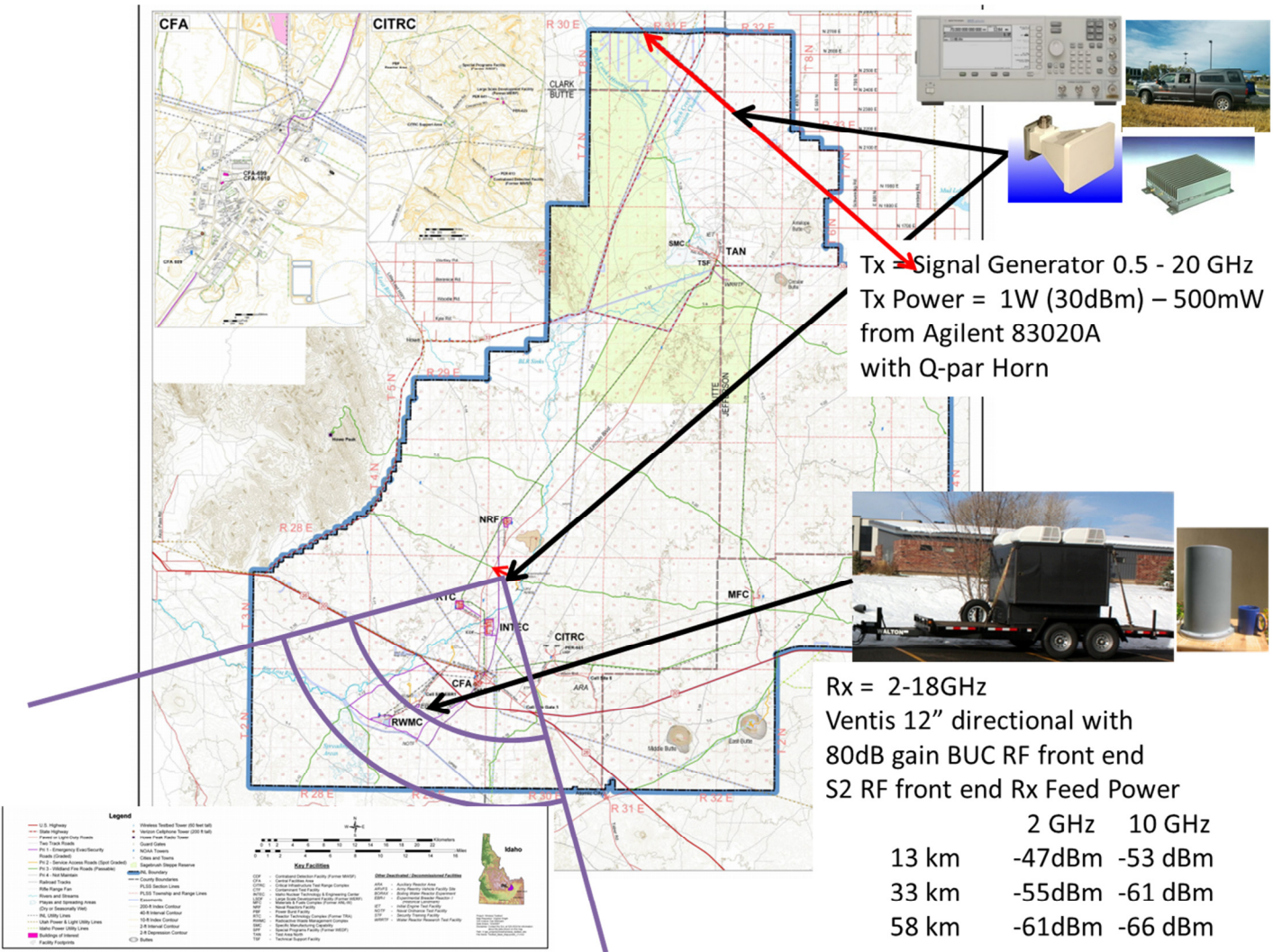


Figure 1 - User Test Configuration

3.3 Users' Test Objective

3.3.1 The WNUF Users' test will be conducted over a 5 day period for the following Test Objectives, in the order of priority:

1. S-250 Shelter deployment and configuration at EBR-1 & CFA
2. Localized Spectral Monitoring
3. Signal Direction Finding
4. Signal Identification
5. Environment change due to WNUF transmitting equipment
6. Mobile transmissions with User Signal Generators

3.4 Equipment and Facilities Responsibility

3.4.1 Users' Provided Equipment

Table 1 - User Provided Equipment

Index	Quantity	Description	Vendor	Part number
1	2	Signal Generator	Agilent	E8257D
2	1	Arbitrary Waveform Generator	Tektronix	AWG7102
3	1	Signal Generator	Anritsu	MG3696B
4	1	Spectrum Analyzer	Agilent	8564
5	1	Oscilloscope	LeCroy	N/A
6	1	Optical Spectrum Analyzer	Advantest	Q8384
7	1	RF Spectrum Analyzer	Axiom	8565EC
8	2	Omni Antenna	Qpar Omnis	0.8-40 GHz
9	1	Sinuous Antenna	Qpar Sinuous	2-18 GHz QsPDCP2-18SRA
10	2	Spiral Antenna	Qpar Spiral	18-42 GHz OmniWave1
11	3	Generators	Yamaha	N/A
12	1	Portable Deployable Mast	Will-Burt	N/A
13	2	Antenna Rotator	Zaber	Stage
14	1	Truck 4x4	Ford	F-350
15	1	Military Shelter	N/Z	S-250
16	1	Trailer	Alton	Tandem axil 14'
17	N/A	Amplifiers	Various	Various
18	N/A	Computers Monitors Cables	Various	Various
19	N/A	General Electronics	Various	Filters / Oscillators / LNA
20	N/A	Equipment Racks	Various	Mounting Support

3.4.2 INL Provided Equipment

Table 2 - INL Provided Equipment

Index	Quantity	Description	Vendor	Part number
1	1	Mobile WiMAX	Alvarion	3.5 GHz
2	1	Residential Gateways	Alvarion	3.5 GHz
3	1	OFDM Access Point	Redline	4.9 GHz
4	1	OFDM Subscriber Modules	Redline	4.9 GHz
5	3	GSM Networks	Nokia	900/1800/1900
6	6	GSM Handsets	Various	2 Each @ 900/1800/1900
7	1	UMTS Network	Nokia	2100 MHz
8	2	UMTS Handsets	Various	2100 MHz
9	1	RTSM System	Agilent	Analyzers

3.4.3 INL Provided Facilities

INL shall provide the following facilities.

- EBR-1
 - Customer Deployment Area
 - INL Cellular Site for GSM, UMTS & WiMAX
 - Portable work trailer as needed
- CFA Area
 - Customer Deployment Area
 - Portable work trailer as needed
- CFA-609
 - INL Cellular Site for GSM, UMTS & WiMAX
- Gate-1
 - INL Cellular Site for GSM, UMTS & WiMAX
- CFA-1609
 - Network Operation Center (NOC)
- WRRTF
 - Parking area
- Lincoln RR
 - Parking area
- Paved Roads
 - Lincoln, Wilson, Jefferson and Various CFA

3.5 Tasks

3.5.1 INL and User shall establish required INL wireless systems for RF environment monitoring.

3.5.1.1 Actual network configuration(s) and locations shall be mutually agreed on between INL and User and approved by the INL.

3.5.1.2 Actual handset use, including location, mobility and traffic shall be mutually agreed on between INL and User and approved by the INL.

3.5.2 INL Specific Tasks:

- 3.5.2.1 INL shall collaborate with User to finalize and approve the test configuration.
- 3.5.2.2 INL shall review Users' created test plan to provide comments and provide final approval of test plan.
- 3.5.2.3 INL shall install, configure, and maintain wireless networks and transmitting equipment listed in Table 2 Above.
- 3.5.2.4 INL shall obtain spectrum approval through the NTIA authority for WNUF equipment and aid the user with obtaining spectrum approval through the FCC.

3.5.3 Users' Specific Tasks

- 3.5.3.1 User shall develop and write a test plan that outlines the use and location of wireless networks, transmission sources, test personnel and mobile devices. The test plan shall detail what activities that Users' and INL participants are responsible for. Details for each test objective will be provided to understand what will be done by whom, when, where and how.
 - 3.5.3.1.1 INL shall provide supporting information for the development of the test plan.
 - 3.5.3.1.2 INL shall provide comments to S2's test plan and final approval of the work required to meet all test requirements.
 - 3.5.3.1.3 Actual test plan shall be mutually agreed upon between INL and User and shall be approved by the INL.
- 3.5.3.2 User shall submit STA(s) to FCC by the date defined in Table 3, for frequency use of all User RF emitting equipment to be used at INL.
 - 3.5.3.2.1 The User's Test Dates defined in Table 3 are dependent on receipt of FCC approval of the Users STA. The User's Test Dates will be delayed until FCC approval is received to dates agreed upon by User and WNUF and approved by WNUF.
- 3.5.3.3 User shall provide, install, configure, and maintain all S2 equipment during the effort.
- 3.5.3.4 User shall appoint a Test Director who shall be at the INL WNUF during all testing activities.
 - 3.5.3.4.1 User Test Director shall direct all testing activities and directly communicate with the INL WNUF Test Lead.
- 3.5.3.5 User shall provide, install, configure, maintain and monitor the measurement tools and equipment under test during the test sequence and collect RF data for post test analysis.

- 3.5.3.6 User shall generate a non-proprietary test report at the conclusion of the test to: Showcase the practical application of the Extreme Bandwidth Analyzer and Correlator (EBAC); Address the technical considerations of the unit; Details of testing performed; Implications of the technology testing at INL for advancing the research. The Test Report shall be submitted to INL by the date defined in Table 3.
- 3.5.3.7 Prior to any publishing of the research results as a result of this testing, including in a nationally recognized open scientific publication, the User shall provide copies of articles for review and comment at least 14 days prior to publication.

3.6 Project Schedule

- 3.6.1 Table 3 provides milestone activities & required dates for each group:

Note: If the agreed upon test date is delayed, an updated Table 3 - WNUF User Test Schedule and Milestones, agreed upon by the User and the WNUF and approved by the WNUF, shall be amended to Appendix A – SOW.

Table 3 - Project Schedule and Milestones

Task No.	Tasks	INL Responsibilities	INL Task Due Date	User Responsibilities	User Task Due Date
1	User Equipment operational specification(s)	Review & provide User Comments	10/15/13	Provide operational specification(s) of all User supplied radiating equipment to INL	10/14/13
2	Submit STA for Frequency Approval	Submit NTIA STA and assist User with FCC STA	11/8/13	Submit FCC STA	11/8/13
3	Establish Representative RF environment and required networks	Verify requirements & configuration can be supported within SOW	11/14/13	Provide network requirements	11/12/13
4	Develop and Write Test Plan	Review test plan and provide feedback	11/14/13	Submit test plan to INL for review	11/12/13
5	Approve Test Plan	Approve Test plan	11/21/13	Submit final test plan	11/19/13
6	Ship/transport all required test equipment	Receive by	12/3/13	Ship User equipment to INL	11/30/13
7	Test Dates: Perform Test	Effort Support	December 9-13, 2013	Conduct Test Plan	December 9-13, 2013
8	Develop final test report	Provide feedback to draft report and contribute to final report	Draft: 1/9/14	Generate draft and final reports and solicit/compile contributions from relevant stakeholders	Draft: 12/23/13 Final: 1/23/14
9	Possible publications based on test results, in a nationally recognized open scientific publication or otherwise.	Provide review and comment to draft publication	Within 14 days of receiving the publication from User.	Send publication for review and comment	Any time after testing, at least 14 days prior to intended publication

4. REPORTS, DATA AND OTHER DELIVERABLES

Table 4 - Report Deliverables

Task No. Reference	Deliverable	Responsible Party
1	Test Plan	User
2	Test Report	User

5. SPECIAL CONSIDERATIONS

5.1 GENERAL

5.1.1 One (1) day site survey at the INL WNUF.

5.1.1.1 Tentative Survey date: As defined in Table 3

5.1.2 Five (5) days of wireless testing and data acquisition at the INL WNUF.

5.1.2.1 Test dates: As defined in Table 3

5.1.2.1.1 The User's Test Dates defined in Table 3 are dependent on receipt of FCC approval of the Users FCC STA. The User's Test Dates will be delayed until FCC approval is received to dates agreed upon by User and WNUF and approved by WNUF.

5.1.2.2 Planned test hours: 8:00 AM to 5:00 PM

5.1.3 Extended testing hours, debugging and issue resolution with/without INL support may be allowed after coordination with the INL Test Lead.

5.1.4 User shall be aware that other User groups may be simultaneously testing on site and coordination efforts may be required to mitigate impact to each group's testing efforts.

5.1.5 User shall provide operational specification(s) of all User supplied radiating equipment by date defined in Table 3 to the INL Test Lead for frequency coordination activities to ensure harmful interference is not induced on operational commercial or government systems.

5.1.5.1 User shall be aware that the User must submit a Special Temporary Authority (STA) to the Federal Communications Commission (FCC). The INL spectrum manager shall work with the User to develop the STA, but the User must submit the STA to the FCC. The INL shall also submit an STA to the NTIA for the same radiating equipment as well as INL systems used for the User Test.

5.1.5.2 User shall be aware that a transmit termination will be enforced if interference is induced on commercial or government systems until a work

around has been mutually agreed upon between the INL and the User test team.

- 5.1.6 User and INL personnel shall participate in pre-test requirements discussions via teleconference and email correspondence to define and agree on test requirements and configurations.
 - 5.1.6.1 Test requirements and configurations shall be mutually agreed upon between INL and User test team personnel as defined in Table 3.
- 5.1.7 User shall inform the INL Test Lead and obtain approval of any changes or additions to testing scope prior to execution, which includes the arrival of any new personnel for assignments, after the initial range safety briefing has been delivered on the first day on the test range.
- 5.1.8 INL shall cover User's travel and shipping expenses associated with the participation in the WNUF test as negotiated and approved by the WNUF as defined in Appendix B - WNUF Funding for WNUF User Test.

5.2 TEST AND SUPPORT LOGISTICS

- 5.2.1 INL shall designate a WTB Test Lead to support User testing and act as the test team point of contact for INL.
- 5.2.2 INL shall provide network configuration information to the User test team in the form of a User package that outlines the configuration, procedures, settings, test contacts, RF simulations, and other test range related information.
- 5.2.3 INL shall review and provide comments to the User created test plan and approve the final User test plan.
- 5.2.4 INL shall verify the operational state of the mobile network devices (handsets).
- 5.2.5 Modifications to the network configuration shall be facilitated during the testing period at the request of the User.
- 5.2.6 INL shall provide access to User field test locations that have been pre-approved by both the User and INL.
- 5.2.7 INL shall provide access to the support/staging areas.
- 5.2.8 INL shall provide land mobile radios (LMRs) for communication among all test personnel.
- 5.2.9 INL shall provide any INL mandated safety equipment (excluding PPE) such as: first aid kits, field kits, safety vests, shovels, WTB identification placards, etc.
- 5.2.10 INL shall conduct required pre-job, safety, and field worker briefings.
- 5.2.11 INL shall provide bottled water for all test participants.
- 5.2.12 User shall be responsible for providing food for their test team.

- 5.2.13 User shall create the test plan and provide to INL for review and comments.
- 5.2.14 User shall be responsible for providing vehicles for all User test personnel, vendors or sponsors.
- 5.2.15 User shall be responsible for providing adequate personal protective equipment (PPE) required for outdoor exposure conditions such as: heat, cold, wind, precipitation, sun, insects, etc.
- 5.2.16 User shall provide power supplies, cabling, connectors, processing equipment and any other supporting materials for their test equipment.
- 5.2.17 User shall make arrangements for transport of test equipment to/from Idaho Falls.
- 5.2.18 User shall ship/transport all required test equipment to arrive at the INL shipping address as defined in Table 3.

5.3 COMPLIANCE

- 5.3.1 INL WTB personnel will notify security personnel of test dates and locations prior to beginning any testing activities. Test vehicles on range will be identified by attaching the commonly used WTB placards and colored test team placards (if necessary) to an easily visible location on the vehicle(s).
- 5.3.2 Any tasks or efforts, outside of the discretion of the User test team, requiring INL mandated training, identified as such by the INL Test Lead or Laboratory Space Coordinator (LSC), shall be completed only by INL qualified personnel.

5.4 RANGE ACCESS

- 5.4.1 User shall obtain range access to the test facility by completing the INL Visitor Notification forms which shall be provided once the Non Proprietary User Agreement has been established.
- 5.4.2 User POC shall provide a list of all test participants, visitors and/or observers to INL by the date defined in Table 3, with the following information:
 - 5.4.2.1 First name, Middle initial, Last name
 - 5.4.2.2 Company/Organization Affiliation
 - 5.4.2.3 Citizenship Status
 - 5.4.2.4 Dates visiting the INL test range
 - 5.4.2.5 Contact Information