



SDR Forum Smart Radio Challenge Written Qualification Submittal Preparation Instructions and Requirements

This document provides instructions for the creation of qualification submittals (Proposal) in Phase 1 of the SDR Forum Smart Radio Challenge. The goal of the proposal is to provide sufficient information so as to persuade the Phase 1 panel of judges that the team is qualified for advancement to Phase 2. Further, should more than 10 teams respond in any one topic area, the proposal will be utilized to down select from qualified teams to a maximum of 10. The Phase 1 panel of judges will evaluate the submitted proposal as follows:

- Overall technical approach (50%)
- Maturity of design process (10%)
- Use of materials provided by the corporate sponsors (10%)
- Feasibility and performance (10%)
- Commercial Viability (10%)
- Documentations and Deliverables (10%)

The quality of technical content of the proposal will be the principle basis upon which proposals will be evaluated. The proposed research and development must be responsive to the chosen Problem as selected from the Smart Radio Challenge Problem Set (Appendix 1), although it need not use the exact approach specified in the Problem. Each proposal must address only a single Problem.

Limitations on the Length of the Proposal

The Smart Radio Challenge is designed to reduce the investment of time and cost to student teams in preparing a written qualification submittal. Those who wish to respond shall submit a direct, concise, and informative research and development proposal of no more than 25 pages. Promotional or non-project related discussion is discouraged. In the interest of equity, pages in excess of the 25 page limitation, except as defined below, will not be considered or reviewed.

Format of Proposal

The proposal shall be submitted in English only. Pages shall be of standard 8.5" x 11" paper with one-inch margins. The type font shall not be smaller than 10 points. Engineering drawings, etc. may be provided on 11" by 17" (folded) paper should the team so choose, but these drawings will count as 2 pages in the 25-page count. Student teams shall choose a team name, and this name must be in the header of each page along with the Problem number. The footer must include the page number. Specific proposal sections that must be addressed are as follows.



Proposal Cover Sheet

The proposal coversheet shall include the team name as well as the names of the university, the team lead, and the technical advisor. Contact information for the team lead shall also be provided. The names of the other team members may also be included at the team's discretion. The Smart Radio Challenge Problem that the team has selected shall be stated, and a brief technical abstract shall be provided outlining key challenges in the Problem and the university team's proposed solution. The cover sheet is limited to one page in length, and counts as one page of the 25-page count.

Note that the information contained in the cover sheet of proposals selected for advancement to phase 2 will likely be published on the smart radio challenge website.

Problem Overview

In this section, the team must provide an overview of the Problem and the key challenges/risks they perceive in addressing the problem. The problem overview is limited to one page in length, and counts as one page of the 25-page count.

Technical Proposal

The technical proposal shall be limited to no more than 18 pages and counts as 18 of the 25 page count. It will include four subsections as follows:

- Proposed Solution - This subsection shall provide an explicit detailed description of the team's proposed solution to the problem. This section may include preliminary designs, analysis, simulations, etc. as defined by the team. Key elements that should be addressed in this section include, but are not limited to:
 - Trade-offs that were made in defining the proposed solution
 - Ability of the proposed solution to address the defined Problem
 - Technology readiness of the proposed solution
 - Size, weight and power of proposed solution
 - Constraints inherent in the proposed solution
- Risk Assessment - In this section, the teams shall identify the primary risks (cost, performance, schedule) in creating the proposed solution and what the plan is for mitigating those risks.
- Deliverables – In this subsection, the teams shall detail the proposed deliverables, including engineering notebooks, hardware and software documentation, source code, view cell presentations, papers, and demonstrations. Deliverables should include, at a minimum:



- Problem specific deliverables, as defined in the Smart Radio Challenge Problem Set, with supporting documentation
 - A monthly status report detailing progress that has been made to date, as well as identifying issues that have come up, and how these issues are being addressed.
 - Engineering Notebooks, showing daily work entries, written in English, from each team member, detailing the work that was performed, the design process that was followed and the trade-offs that were made
 - Anticipated published papers, with proposed publication dates. A minimum of one publishable paper must be produced in Phase 2.
 - A “final report” detailing what was accomplished and what was learned.
- Materials - In this subsection, the teams shall identify the materials they intend to utilize in the creation of the proposed solution. This includes a description of the use of materials provided by the corporate sponsors, as well as materials from other sources as appropriate. It is recognized that additional sponsors may offer their products during the proposal development time, or even during the development phase. The SDR Forum will make additional sponsor product notification to all teams if additional products are offered. The total cost of the resulting design, including assembly costs, will also be outlined in this section.

Work Plan

In this section, an explicit detailed work plan for creating the proposed solution shall be provided. The work plan must detail the development process that will be followed and include a schedule that identifies key milestones with that development process. The planned role of each team member in achieving said milestones must also be identified, and a schedule of deliverables must be included. The Work Plan must not be more than 3 pages, and will count as three pages of the 25-page count.

Facilities

In this section, the student team will identify the physical facilities that they will utilize in creating the proposed solution. This includes identifying laboratory space, test equipment, fabrication facilities, etc. Also state whether the facilities where work will be performed meet environmental laws and regulations of federal, state, and local governments for, but not limited to, the following groupings: airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid bulk waste disposal practices, and handling of toxic and hazardous materials. The facilities description shall be no more than 2 pages in length and will count as two pages in the 25-page count.

Intellectual Property

All information that is either provided in the proposal, or will be used in the creation of the proposed solution, and is considered the protected intellectual property of the



university or 3rd party affiliate must be identified. This material does NOT count towards the 25-page count.

Curriculum Vitae of Team Members

A resume or Curriculum Vitae of no more than 2 pages shall be provided for each member of the team. This material does NOT count towards the 25-page count.

Proposal Section Markings

The proposal sections shall be marked as follows:

- Cover Sheet – No marking
- 1.0 Problem Summary
- 2.0 Technical Proposal
 - 2.1 Proposed Solution
 - 2.2 Deliverables
 - 2.3 Materials
 - 2.4 Risk Assessment
- 3.0 Work Plan
- 4.0 Facilities
- 5.0 Intellectual Property
- 6.0 Curriculum Vitae

Smart Radio Challenge Terms and Conditions

The faculty advisor and a representative of each teams university must sign the “Smart Radio Challenge Terms and Conditions” included in Appendix 2. This signature is the confirmation of the team members that they will abide by all rules of the contest and of the sponsors, and that the faculty advisor will monitor and affirm that the team has done so. The signed document must be returned with each proposal in order for the proposal to be considered. The terms and conditions document does not count towards the 25 page limit.

Delivery

Electronic delivery of the proposal must be made no later than midnight GMT (8:00 PM US-EDT) 19 October 2007. Proposals should be in PDF format and should be emailed with the subject line “Radio Challenge Proposal from team <team name>_” to info@sdrforum.org. Teams may follow up with paper proposals should they so choose.

Questions during Phase 1

Student teams are encouraged to ask questions of the SDR Forum during the phase 1 development. Questions and responses will be posted on the Radio Challenge website in a Phase 1 FAQ.



Appendix 1 The Problem Set

Problem 1: Communications from an Infrastructure Damaged Area

Sponsored by the SDR Forum Public Safety Special Interest Group

The Scenario:

You are in a team of first responders on the scene following a major incident in a city subway. You need to be able to identify to your command structure and other first responders, via your dispatch center,

- the magnitude of the affected area
- the number of casualties,
- hazards to avoid when entering the subway
- and how much assistance you may need.

You are equipped with a radio that is programmed to operate with a two-way voice radio system. However, due to a series of explosions the communications links that normally provide network coverage underground have all been severed, and the only means of communicating back to the overall command structure is walk to an opening in the tunnel and exiting to the point where your radio is within the coverage footprint of the network. You are very concerned that your inability to communicate information quickly from the actual scene of the explosion to the proper recipient is costing peoples lives.

The Challenge:

Demonstrate a smart radio system that will **automatically** create an ad-hoc *extension* to the existing communications network such that voice communications can be relayed to/from the incident site out of the shadowed area to/from the above communications infrastructure. The network extension can utilize simplex (peer-to-peer) links among radios and reconfigure at least one radio as a repeater.

The Problem in Detail:

Students will demonstrate a cognitive radio system (hardware and software) operating in the 2.4 GHz ISM band with individual “remote radios” capable of knowing when they has been disconnected from the existing infrastructure. A remote radio that has disconnected will then attempt to reestablish a connection to the infrastructure by means of identifying other remote radios in range that may be configured to serve as a relay to the original infrastructure.

First, each remote radio in the system must be capable of being reconfigured to function as a network extension (e.g., the radios can operate on appropriate spectrum; the radios



have reconfiguration algorithms, and so on). Second, there must be some level of cognitive capability for a collection of radios to “understand” that they have lost their ability to communicate with the system infrastructure. The remote radios must be capable of:

- Determining that they are disconnected from the system infrastructure;
- Finding and identifying peer remote radios;
- Among the peer radios
 - Identifying and authenticating those that are reconfigurable compatible radios;
 - Determining which radio is within coverage of the infrastructure and which radios are not within the coverage of the infrastructure;
- Forming a satisfactory network extension route to the infrastructure from each affected radio using non-interfering frequencies for each “hop”;
- Adjusting the network as responders arrive and depart from the area where coverage is unavailable;
- At all times preserving the level of security of the baseline network in the network extensions.

In this problem, students must demonstrate at least 1 hidden radio, 3 repeater remote radios, one infrastructure radio and one command radio interacting with the infrastructure. Bidirectional communications is required between the hidden radio and the command radio. The exact modulation structure or protocol schemes that will be used are to be proposed by the student teams.



Problem 2: Automated Spectrum Mapping

Sponsored by the SDR Forum Cognitive Radio Working Group

The Scenario

You are in any crowded location (a major city, university campus, etc.) where there are a lot of wireless users. You have noticed that every day within a given time span the QoS deteriorates (e.g. voice quality) and that eventually leads to dropped calls. Other people in the area that you know do not experience the same problem you have, leading you to think that other parts of the spectrum are not as crowded as the one you are using. You would like to explore the possibility of using different parts of the spectrum during the congested times without adversely affecting other users. You feel that a better coordination of the resources could be obtained by creating a data base, containing spectrum information based on time and location, which can be exchanged through a distributed interface.

The Challenge

Develop a smart radio system that will be able to effectively communicate information regarding spectrum utilization through a cooperative spectrum access protocol. The incorporation of some type of market mechanism to stimulate decision making is a plus.

The Problem in Detail

Students will develop a secondary user cognitive transceiver system capable of detecting primary user signals operating in the 2.4 GHz ISM band and determine the occupied spectrum, transmission times, and geographical locations to sufficient resolution to avoid interfering with legacy systems while operating within that band.

- To facilitate this problem, the Forum will establish multiple primary radio networks using multiple different commercial wireless technologies operating in the 2.4 GHz band. The frequency of operation of the Forum radio's will change during the demonstration. Student teams must produce a log file detailing their Spectral Map, and will be evaluated on the accuracy of the Spectral Map versus location and time.
- The modulation structure, communications protocols, etc. used by the cognitive transceiver systems shall be proposed by the student teams.
- The demonstration shall show that the spectral properties of the student's cognitive transceivers are FCC specification [part 15b & 18 ISM band] compliant. How this is to be demonstrated is to be proposed by the student teams.
- The system must be capable of allocating transmissions times and frequencies with minimum spectral allocation sizes to be determined by the student teams. The Spectral Map must support at least three subscribing devices of varying spectrum demand.



- Students must demonstrate that the cognitive transceiver system does not interfere with the primary communications systems. Student teams will propose how minimal interference will be quantified within this context.
- Interference from the primary communications systems onto secondary systems must be incorporated into a database which all devices can contribute to and retrieve information from to synthesize and develop awareness of the available spectrum. The language and details of the database are to be proposed by the student teams.



Problem 3: Next Stop ... Elbonia

Sponsored by the SDR Forum Design Process and Tools Working Group

The Scenario

You are a wireless product manager developing the next generation access point for broadband streaming media in the home. It must be out by Christmas, or your entire division is going to be fired. Everything is going well, till you hear a rumor that a crackerjack team based in Absurdia has developed a radical new communications protocol that is far superior to what you have designed to. Furthermore, they will be shipping units by Christmas! Its going to be bigger than the iPhone, everyone is going to want it. You must make your product compatible with this new protocol, but the specification isn't public yet. The best you can get is some general performance bounds rumors that you pick up while lunching with your industry colleagues. The spec will be released on November 3 (at the start of the SDR 08 Technical Conference). You must ship by November 5 (end of judging) to get into stores by Christmas. You must plan for the worst, and make your system and your team as flexible as possible so that you can respin your entire system, from design all the way through live field trials, in under 2 days. If you don't make it... well, I hear they are hiring in Elbonia.

The Challenge

Develop a smart radio terminal and a rapid development model defining sufficient software and firmware infrastructure to allow new air interfaces to be added to the platform very quickly. During the challenge, teams will be given a specification for an air interface standard supported by a Forum radio that will be transmitting a secret message. The first team that can decode this message, and transmit a suitable response will be deemed the winner.

The Challenge

Develop a smart radio terminal that will communicate in the 2.4 GHz ISM band frequency band.

- The terminal will incorporate processing devices capable of supporting transmitted data rates from 16 kbps to 6 Mbps
- Payload data ingress and egress for the terminals will be via an on-board 10/100 ethernet port.
- The terminal's architectural model must include a well defined operating environment with an application framework (such as the SCA core framework).
- In support of their development process, the student must develop a mechanism for standardizing the application interfaces of the various processing devices in the terminal (FPGA, DSP, GPP, etc.). The mechanism must support both intra and inter device communications and may be based on an industry standard such as MHAL, CORBA, OCP, the IT-API, OpenClovis, etc. or it may be developed by the student teams to address their specific needs. As a part of this development,



- a trade-off analysis must be performed showing the impact on size, weight, power, cost and waveform portability in adopting the mechanism
- Students will document the design process that they will use to develop a waveform once the waveform spec is provided.
 - The waveform specification will be provided in the form of a word document and Matlab test bench data.
 - Students will develop and demonstrate a process that will allow them to create, download, and test a complex digital air interface onto the terminals in less than 24 hours. Possible parameters that may be required include:
 - Multiple Access – TDMA, FDMA, or CSMA
 - Multi Carrier: One to 32 information carriers OFDM (128 Point FFT, 10% cyclic redundancy, 10% pilot channels)
 - Baud rates from 16 K baud to 50 K baud
 - Information Carrier Modulation Types: BPSK, QPSK, 8PSK, 16QAM
 - Selectable FEC: None, Viterbi ($R=1/2, 1/3, K=5,7$)
 - Data structure will include a specification of a standard preamble, header and protocol format.



Appendix 2 Terms and Conditions

I / we certify that we agree to follow all rules of the Smart Radio Challenge contest, as described on the web page www.radiochallenge.org/rules.html,
And as further explained on www.radiochallenge.org/FAQ.html

I / we agree to all terms and conditions of license for all tools and products provided to our team from the sponsors of the Challenge. If we are unable to agree to the terms and conditions associated with any sponsor product, we will notify the SDR Forum of this condition, and will return the associated tool or product to the SDR Forum. At the conclusion of the contest, we agree to return tools or products and to remove these tools and products from the computers on which they were installed, if that is a condition of the sponsored product license.

I / we agree to identify all intellectual property used, to include references to publications by others used in this development, and to abide by international intellectual property rights, patents, and copyright law.

----- Printed name of teammate 1	----- Signature of teammate 1	----- date
----- Printed name of teammate 2	----- Signature of teammate 2	----- date
----- Printed name of teammate 3	----- Signature of teammate 3	----- date
----- Printed name of teammate 4	----- Signature of teammate 4	----- date
----- Printed name of advisor	----- Signature of advisor	----- date
----- Printed name of Team	----- Printed Name of University	----- date