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 one-page 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 facilitates 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) 30 September 2006. 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: Spectrum Access for First Responders

The Scenario:

You are a first responder on the scene following a major earthquake. To effectively do your job, you need share significant amounts of data with other first responders including, for example, digital video, high-resolution pictures, high-resolution maps, and building floor plans. However, given the number of responders on the scene, the airwaves are clogged and you can't send or receive the necessary data in a reliable manner using your conventional radio technology, and communications is compounded by urban propagation conditions. You are very concerned that your inability to communicate information quickly to the proper recipient is costing peoples lives.

The Challenge:

Develop a smart radio system that will automatically find available spectrum within a pre-defined band, rendezvous with the intended receiver, and transmit data over that band with a pre-defined QoS, in urban conditions.

The Problem in Detail:

Students will develop a cognitive transceiver system capable of detecting available 25 kHz of available bandwidth in the 5 MHz FRS Frequency Band (462 to 467 MHz).

- The system must establish a data transmission channel supporting a QoS setting selected by the user. At least 2 QoS settings must be demonstrated: one with 16 kbps, QPSK, Reed Solomon channel coding, CVSD vocoded voice, and the other showing a computer to computer link at 19.2 kbps using 8-PSK and a rate ½ convolutional channel code. Protocols beyond the physical layer are not defined and will be proposed by student teams as appropriate.
- In establishing this channel, the system may operate in a master-slave mode, with one radio paging the other radio on an available channel to establish the communications, or in infrastructure mode, with the channel between the two transceivers assigned by a 3rd infrastructure radio (which would be mounted in, for example, a command vehicle) that is monitoring the spectrum, or in another mode proposed by the students. Radio source and destination must accomplish rendezvous with each other (and infrastructure when tested in that mode) without producing interference to any other active communications traffic. Student teams will propose how interference will be quantified within this context.
- It must be possible to switch between the two QoS settings while in operation, with the procedure for switching and switching speed to be proposed by the student teams.

- The demonstration must show how a legacy FRS user can become active in using the channel, and the voice or data transmission automatically moves to another available channel without loss of service, while managing delay, and delay jitter.
- The demonstration shall show that the spectral properties of the transmitter are FRS specification compliant. How this is to be demonstrated is to be proposed by the student teams.

Problem 2: Communications Interoperability

The Scenario

A major forest fire has occurred in Southern California. This fire has spread out of control and has forced a number of local communities to evacuate as the fire approaches their homes and offices. Fire fighters and other emergency responders from organizations and jurisdictions nation wide have responded to this emergency, with each group bringing their own equipment. Unfortunately, the radio equipments from the various jurisdictions are not interoperable with each other or with the civilian radio infrastructure, and this lack of interoperability is causing a huge problem in coordinating efforts. Without a way to allow these various radio equipments to interoperate, this lack of coordination has put the responders at risk, and has forced many front line responders to carry several radios to allow an appropriate level of inter-organizational communication.

The Challenge

Develop a smart radio terminal that can automatically provide interoperability between radios with different modulations, voice, and network protocols, and which knows how to forward messages to the proper network – be it commercial or civil.

The Problem in Detail

Develop a single channel wireless terminal capable of detecting and interoperating with any one of three types communications systems: An AM citizens band radio, an FRS narrowband FM radio, and a digital cordless phone operating in the 900 MHz ISM band (902 to 928 MHz):

- Means must be provided to define the allowed spectrum usage policies to each mode of the radio, as if it were done by the regulatory body of the country in which the radio is operated
- Means must be provided for the using organization's telecommunication manager to define the frequency channels used by that organization within the allowed usage bands (CB, FRS, 900 Mhz).
- The wireless transceiver must automatically detect when any of the three types of communications are "on the air" and the load the appropriate air interface standard onto the terminal to communicate on that channel.
- If more than one waveform channel is being available, the terminal must notify the user and allow the user to select which channel to communicate with. The student team will propose a concept of operation to address this contingency
- The system should demonstrate bridging between multiple available services, such as allowing 3 way calling between the CB, the FRS radio, or the cordless phone, according to a connectivity plan specified by the communication system manager
- The system must follow the modulation type, frequency channelization, and power level following regulatory policies appropriate for each band:

  Policy:

CB must use 90% peak AM modulation, 10 Khz channelization between 26.965 and 27.405, using only the 40 numbered allowed CB channels, with a maximum power level of 1 watt.
FRS must use 10 Khz deviation NBFM with a 40 HZ PL tone squelch, 25 Khz channelization between 462.5625 and 467.7125 using only the 14 numbered channels, with a maximum power level of 0.5 watt
The cordless phone must use 16 Kbps CVSD encoded voice, modulated +/- 8 Khz FSK with 50 Khz channelization between 902 and 928 Mhz, with a maximum power of 0.1watt.

- The demonstration shall show that all modes are compliant with the spectrum requirements corresponding to that mode.

Problem 3: Traffic Management

The Scenario

You are driving into work, and the freeway is a parking lot. You listened to the traffic report on the radio, but given that the weather is poor, there are a lot of accidents, and as such there wasn't really a lot of information you could use to choose an alternate route. As you sit there with your engine running, watching your gas gauge move towards empty, you think to yourself that there must be a better way to manage these kinds of traffic problems.

The Challenge

Develop a smart radio system that can, using available spectrum, accurately detect the location of many vehicles within the city and assess the velocity along common roadways. The system will then provide user specific route guidance from starting point to ending point which will minimize total fuel consumption. The system must be future proof, to allow new features and capabilities to be added over an expected 10-year life span of the vehicle without requiring a visit to the dealer.

The Problem in Detail

Develop a traffic management system using smart radio technology that can track and report the location and velocity of a large number of radio controlled vehicles (at least 6) on a defined test track (to be presented at test time). Vehicular velocity will be monitored to determine obstruction. Best route guidance will be provided to at least one vehicle to avoid traffic.

- The system must work with an off the shelf radio controlled vehicle. One example of such a vehicle is the following: http://www.radioshack.com/product/index.jsp?productId=2123167&tab=techSpecs,
- The on-board radio "tag" must be mounted to the vehicle in a manner that allows the vehicle to operate in a normal manner
- When the radio tag is turned on, it must "register" with the traffic management system's infrastructure. The control link must operate in either the FRS band, or the IEEE 802.11 ISM band and can use any air interface standard and protocol of the students choosing so long as it doesn't interfere with any existing FRS or 802.11 radio communications.
- The system must track each vehicle's position versus time, and report average velocity, for at least 6 simultaneous vehicles. The algorithmic mechanism for identifying position, and velocity is left as an exercise to the students.
- The system must automatically control at least one vehicle to maneuver it over a predefined course associated with the location of that vehicle. Each course will include a straight route and a twisty route, with the route taken selected by the user monitoring the infrastructure system. Demonstration of this capability will take place at the SDR '07 Technical Conference, where a route will be established using orange cones in a parking lot of suitable size.

- The radio tag must be software defined and the waveform modulation (phy) and MAC and Link protocols must be reprogrammable.

Problem 4: Rapid Application Development

The Scenario

You are the lead system engineer for a mobile radio terminal that is going to be used by an oil exploration team. The details of the communications link required by this team are in flux, and will not be finalized until after you arrive at the site. You know that you have developed the radio hardware specifically to support these types of quick response requests, including the use of programmable processing devices such as FPGAs and DSPs for implementing the air interface, but are concerned that you may not have developed the platform's software infrastructure sufficiently to support the tight time frame for this request.

The Challenge

Develop two smart radio terminals and demonstrate a process that will allow them to communicate using a new advanced air interface standard that is developed and deployed on the terminals in less than 24 hours.

The Problem in Detail

Develop two smart radio terminals that will communicate in the FRS frequency band.

- The terminals 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 CORBA, OCP, the IT-API, OpenClovis, etc. or it may be developed by the students 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 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 – FDMA, CSMA
    - Multi Carrier: OFDM (128 Point FFT, 1 to 32 carriers modulated with traffic, 10% pilot channels, 10% cyclic redundancy,)
    - Carrier Modulation Types: BPSK, QPSK, 8PSK, 16QAM
    - FEC: Reed Solomon, Viterbi
    - Diversity selection, Optimal combining, MIMO

- Students will demonstrate their waveform development process efficiency, and the sophistication of the radio architecture infrastructure to be able to support a new waveform requirement.
- Demonstration of the terminals architecture and the efficiency of their waveform development process will be as follows: At the SDR ’07 Technical Conference, each student team will be handed an envelope containing a pre-defined “air interface specification”. The student teams will then have 24 hours to create, download, and demonstrate this waveform. This process will be timed, and once their development is complete they will contact a judge to have their completion time recorded. Final demonstrations will occur the next day.
- Student teams must propose a mechanism for validating that the waveform is running as defined during the demonstration process.

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