THE SOFTWARE-DEFINED RADIO & COGNITIVE RADIO INTER-CONSORTIA AFFILIATION

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1 ABSTRACT

The evolution of the Software Communications Architecture (SCA) has sprung from a vision for the SDR/CR community to maximize the value of radio interoperability, reusability, and portability, and it has come with a fair share of challenges.

The SDR/CR community is splintering or diverging from the initial SCA vision for varied reasons: use case differences, competing standards, heavyweightedness, scoping, cost and profitability, conflicting technological views, misperception, or not being aware of other similar activity.

This paper cannot address all these issues, but does seek to address the developing inter-consortia affiliation of consortia that is aiming to collectively review and address standards development pertinent to the SDR/CR community.

The focus of this paper, then, is to explore this affiliation, its chemistry and its ongoing developments.

2 INTRODUCTION

A Software Defined Radio (SDR)[1] is a collection of hardware and software technologies that enable reconfigurable system architectures for wireless networks and user terminals. Through programmatic reconfiguration, radio hardware can be reset over time to perform varying functions. This sets the stage for common platform technologies supporting varied infrastructure services, and would enable better scalability, reusability, interoperability, and portability of platforms and waveforms. Programs and organizations such as JTRS, STRS, HC3 (defense), OMA (commercial), ITU-T (international), SAFECOM, CommTech (public safety) – to name a few, each have SDR/CR objectives.

Leadership of a few consortia have recently convened to identify common goals and prepare a collaborative roadmap for standards across some of these programs – talks are ongoing.

The following are a few of the activities & organizations that have ongoing support for SDR/CR standards development.

1. Software Communications Architecture (SCA:JPEO/JTRS)[2]
2. Specialized Hardware Processors Extension to the SCA (SHPE:JPO)
3. PIM/PSM For Software Radio Components (P^2SRC:OMG)[3]
4. P1900 (IEEE EMC Society)
5. Space Telecommunications Radio System (STRS:NASA)[4]
6. High Capacity Communications Capability (HC3)
7. End-To-End Reconfigurability (E^2R)
8. Open Mobile Alliance (OMA)[5]

Each of these groups and their respective initiatives have high potential of giving new birth to the SDR and Cognitive Radio (CR) technologies, including requirements, technology development, and standards processing. It is recognized that, conflict and cost will both rise without agreeable coordination among the aforementioned initiatives.

The benefits of convergent opportunity with fresh perspective[6], with more minds focused on common objectives, each contributing to a common SDR/CR standards set based on their core competency(ies) are significant.

3 PARTNERSHIP DESCRIPTION

The SDR/CR Partnership is not a new organization. It is, rather, an open and growing set of existing SDR/CR stakeholders collaborating to establish standards in SDR/CR under bilateral agreements.

While a common Vision Statement is pending from the initiating parties (SDR Forum, OMG, IEEE P1900), the anticipated result is consortia and industry working together with common SDR/CR standards objectives, combined with agreed upon roles and process flow for the generation of those standards.[7]

The underlying goal of the partnership is to foster the development of common SDR/CR standards that will provide radio set and waveform application interoperability, reusability, and portability to end-users both locally and internationally.

3.1 Objectives

"Standards provide a reference framework, or a common technological language, between suppliers and their customers – which facilitates trade and the transfer of technology." Additionally, "the widespread adoption of standards means that suppliers can base the development of their products and services on reference documents which have broad market relevance. This, in turn, means that they are increasingly able to compete on many more markets domestically and internationally."[8]

To that end, the long-term objectives of this partnership are to:

1. Foster SDR/CR interoperability, portability and reuse through common SDR/CR standards

2. Encourage collaborative efforts from stakeholders with common interests (NASA, JTRS/JPEO, IEEE, OMG, SDR Forum, NCOIC, DHS, Project 25, FEMA, GNU Radio, TMF, OMA, the Scope Alliance and others)
3. Encourage expansion of scope to include: public safety, space, defense, and commercial[9] use cases, both locally and internationally
4. Help distribute the burden of certification and waveform repositories to certification agencies

The short-term objectives of this partnership are to:

1. Approximate stakeholder intentions (interests and objectives)
2. Submit issues to the OMG P^{2}SRC Revision Task Force (RTF) supporting stakeholder needs
3. Determine and agree upon the strengths each other brings to the table, identify candidate tasking, and allocate tasking based upon our agreed upon strengths
4. Address IEEE P1900 involvement for addressing certification and regulation requirements
5. Review the JTEL Repository concept in terms of business models, and certification distribution (mini-JTEL's)

4 Partnership Storyboard

Collaborative efforts foster the centralization, mindshare, and synergistic standards processing, and will help increase SDR/CR interoperability through improved waveform interoperability, decrease cost and complexity to both SDR/CR developers and consumers, and increase business opportunity.

Standards use cases would include unique interests from commercial, international, public safety, space, and defense domains. These stakeholders are illustrated in Fig. 1: SDR/CR Standards Stakeholders & Artifacts with their relationship to the partnering organizations occurring through the defined SDR/CR standards. Additionally regulators and waveform and software repository owners would add to or otherwise impact the use cases defined by the domain experts.

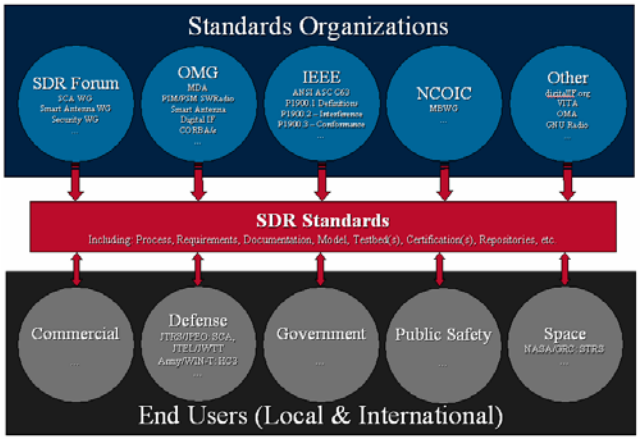

Fig. 1: SDR/CR Standards Stakeholders & Artifacts

SDR/CR standards have many deliverables (as illustrated in Fig. 2: SDR/CR Standards Development), each with significant time consuming tasking. Associated user profiles & use cases are wide & varied – all needing representation. The partnership among the consortia (including broad membership / influence from the SDR/CR user base) ensures user profiles and use cases are fully represented. The partnership liaisons partition their collective tasking based upon their agreement on strengths and collective consensus.

5 SDR/CR Standards Lifecycle

Fig. 2: SDR/CR Standards Development identifies general participants and general deliverables in the SDR/CR standardization process. Given the varied interests, directives, and objectives of the participants illustrated here, how will consensus be built?

5.1 Business Model

Organizations such as these often choose to collaborate to leverage each other's core competencies. Often however, such collaborations are hampered due to differences in the business and operating models associated with each entity. These differences can be summarized as follows:

- Financial Models: Organizations generally require funding to operate, and the primary mechanisms for which organizations obtain this funding generally fall into one of four categories:
  1. Government funded
  2. Funded through paid membership
  3. Funded through sale of work product
  4. Funded through conferences and events

  Issues can arise in a collaborative effort when the sources of funding are in conflict. For example, if two organizations wishing to collaborate both use the revenue generated from conferences and events as a primary source of funding, a conflict can ensue if a conference held by one of the organization's on the collaborative topic reduces attendance at the other organizations event. Similarly, if one organization receives its operating funds through member dues, and as such openly publishes its work products, while another organization receives its operating funds through the sale of its completed work products, the differences in business model may make collaboration difficult.
- Intellectual Property Rights: Collaboration between organizations generally requires some type of document sharing, and these documents often contain the intellectual property of each organization's member companies. Difficulties can arise when the models for handling these intellectual property rights within the respective organizations are in conflict. For example, one organization may, as a policy, be very open with input documents that are shared by member companies. Conversely, another organization may have very strict rules for sharing said documents in order to allow for a freer flow of protected IP. If an organization with strict rules wishes to collaborate with an organization with open rules, the former may need to impose its own set of by-laws on the latter to protect the intellectual property rights of its members. This may not be tenable for the more open organization. The issue becomes further

complicated when standards that are collaboratively developed incorporated protected IP, since the requirement for licensing said IP under reasonable and non-discriminatory (RAND) terms may be handled differently in each organizations by-laws.

- Rules of State: Organizations are bound by the laws of the country or counties in which they operate. This may require different behaviors in organizations that have different geographic centers, and can impede collaboration in a number of key areas. For example, organizations operating in the US are subject to the International Traffic in Arms Regulations (ITAR), which restricts the sharing of technical data related to certain technologies to non-US entities. Organizations operating in Europe may not be restricted in sharing technical data on these same technologies, and as such may be able to collaborate amongst themselves, but may not be able to openly work with an organization in the US for the betterment of both organizations.

Ultimately, organizations wishing to collaborate need to enter into a formal relationship that addresses these differences in operating model to the mutual satisfaction of all parties. These relationships can take the form of a membership swap (eg: the OMG and the SDR Forum are now members of each others organizations, with all the privileges of such membership), where rules are established to allow one organization to participate as a member of another organization, following the policies and rules of the host organization. More often, collaborative relationships take the form of a Memorandum of Understanding, which establishes the topic upon which the organizations wish to collaborate, and the specific rules agreed to by both sides in allowing said collaboration. The key in creating these formal relationships often lies in the ability of the primary negotiators of these agreements on all sides to recognize any issues that may arise due to these differences in operating model, and to codify mechanisms for resolving the issues in the collaboration agreement.

5.2 Responsibility Delegation

The following are high-level tasks that compose the SDR/CR Standards Lifecycle. In the developing inter-consortia affiliation, stakeholder liaisons will collectively (under direction of their hosting organization) agree upon these and other tasks, including their definition, and the mapping of the tasking to the stakeholder(s) with the appropriate core competency.

6 Define & Model the Business Cases

Business cases provide an understanding of the SDR/CR issues to be resolved through standards processing. They define and briefly address the change impact, ensure stakeholder understanding of what is being standardized, high-level business needs/requirements, and how it will be used.

6.1.1 Define Requirements

Requirements from all stakeholders need collection and representation. They are to establish and maintain agreement among the stakeholders as to what the standards must support. RFI's, RFC's and RFP's are common tools for obtaining requirements. It is important to note requirements include both systems and the regulation of those systems, requiring therefore both SDR/CR users and regulators in the requirements gathering process and later the test and certification process.

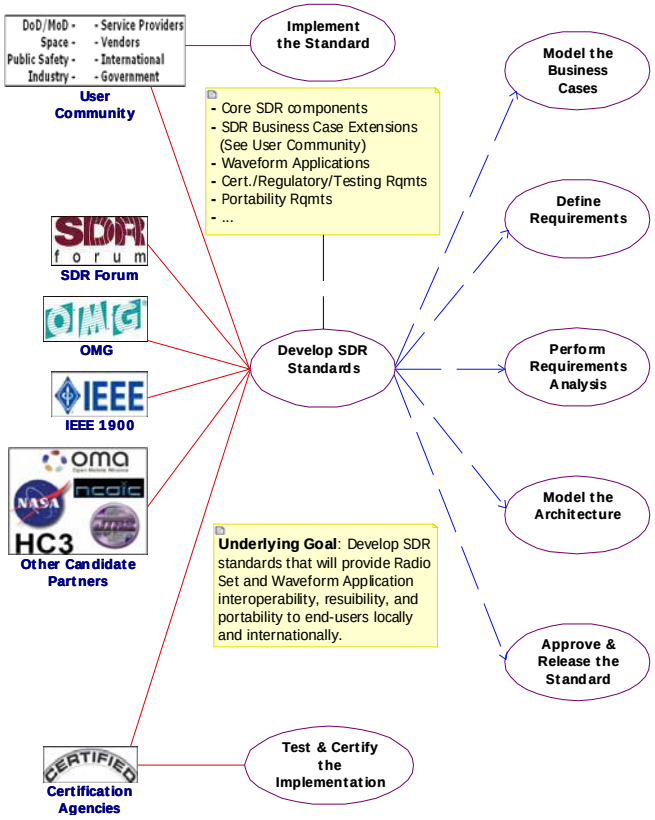

Fig. 2: SDR/CR Standards Development (Notional)

6.1.2 Perform Requirements Analysis

A thorough understanding of the requirements is necessary to ensure the business model is fully supported and that there are no requirement conflicts. A high-level behavioral and flow assessment is performed to ensure a cohesive requirement set. Analysis classes (concepts of what things will be defined by the standard that have responsibility and/or behavior) are created. Use cases are defined that establish the analysis classes.

6.1.3 Model the Architecture

A further decomposition of analysis classes and use cases into specific functionality and behaviors that are independent of the implementation defines a platform independent architectural model. Subsequently, platform specifics can be addressed, using the platform independent model, but applying it to the specific environments in which it will be used.

6.1.4 *Approve & Release the Standard*

An overall process to issue RFPs, evaluate RFP responses, ensure alignment with other standards and consortia is necessary to release standards. Agreements, MoUs, etc., are necessary among consortia and other stakeholders to ensure standards that can be acceptable to all.

6.1.5 *Implementation of the Standard*

One or more stakeholders implement the standards to: provide a reference model, to deploy to customer, or to establish a toolset for quicker realization of the standard.

6.1.6 *Test & Certify the Implementation*

For a complete realization of the SDR/CR standard, the implementation would require full test and certification against the original requirements.

7 ANALYSIS OF CORE COMPETENCIES

The inter-consortia SDR/CR affiliation is an informal collaboration between liaisons from interested SDR/CR standardization stakeholders. It is not an agency, it is an activity of consortia working together. leveraging the core competencies of its participants to foster SDR/CR standards collaboration. To do this, liaisons and other interested participants look to what has worked and is working to emphasize stronger consensus building, task collaboration and sharing, and broader technology distribution among the standards bodies and their members.

The following are the primary current participants / candidate participants in the SDR/CR Partnership.

7.1 Software-Defined Radio Forum (SDR Forum)

The SDR Forum is an association of 125 member companies that was originally created to develop and advance Software Defined Radio technologies. The vision of the Forum is to act as the leading international organization devoted to the development and promotion of software-based systems and devices supporting ubiquitous wireless communications. Toward this goal, the SDR Forum strives to accelerate the development, promotion and proliferation of SDR and cognitive concepts, technologies and standards for wireless communications systems and devices, and to support the needs of all user domains including consumer, commercial, public safety, and military markets, and stakeholders such as regulatory authorities. Members of the Forum encompass all aspects of the wireless value chain: component manufacturers, development tool and middleware providers, subsystem vendors, application software providers, original equipment manufacturers, operators/service providers and end users/subscribers.

To achieve its objectives, the SDR Forum strives to achieve the following goals:

1. Provide an international forum to research and engineering organizations, software and technology developers, equipment and subsystem vendors, radio communication service providers, user groups, regulators, and other interested parties to exchange ideas, develop concepts, establish requirements, recommendations, specifications and standards.
2. Define functionality, internal and external system interfaces, and reference models for hardware and software modules which the industry can use as guidelines in building products and systems.
3. Promote the development of standards for SDR, including those focused on SDR equipment and those in supporting service application areas, and in underpinning core technologies. These standards will be supported either directly or through appropriate liaison to other industry associations and standards bodies. The SDR Forum will pursue industry wide acceptance of these standards.
4. Promote national and international compatibility and interoperability, conduct cooperative research, develop reference implementations and test-bed, perform tests and prepare and disseminate informational materials. The SDR Forum shall make the results and benefits of its activities available on an industry-wide basis.
5. Promote the use of SDR technology to emerging markets and applications such as cognitive radios.
6. Assist the wireless and supporting industries, including the regulatory bodies, in understanding the value and benefit of SDR by addressing market requirements, quantifying the market, and developing timelines relative to the use of SDR.
7. Establish liaison with other associations involved in the development of communications technologies and with the regulatory organizations, both at national and international levels, to promote and accelerate the deployment of SDR technology.

7.2 Object Management Group (OMG)

The OMG is dedicated to solving complex industry problems through the development of software specifications. OMG members develop these specifications through a mature, proven technology adoption process.[10] That process is summarized in the Hitchhikers Guide[11], that serves as an aid to navigating through and complying with the OMG technology adoption process, and is an interpretation of the formal OMG Policies and Procedures document. The RFI, RFC, and RFP processes are key in the OMG technology roadmaps. Organizations, including other consortia, contribute to and have voting privilege on specification development and approval.

The OMG has developed the Model Driven Architecture, or MDA.[12] The MDA provides a set of guidelines for structuring specifications expressed as models and the mappings between those models. MDA enables different applications to be integrated by explicitly relating their models; this facilitates integration and interoperability and supports system evolution (deployment choices) as platform technologies change. The three primary goals of MDA are portability, interoperability and reusability, consistent with the goals of the JTRS SCA (See section 7.5).

Based on the MDA and the SCA, the OMG's Software-Based Communications Domain Task Force (SBC DTF) has developed the Platform Independent Model (PIM) / Platform Specific Model (PSM) for Software Radio Components Specification (recently approved). This specification defines the PIM (the general SDR model), and a single PSM which

transforms the PIM to SCA platform specific requirements. Other PSMs can be developed for specific languages, middleware, and hardware – which may differ from SCA requirements.

7.3 IEEE P1900[13]

The IEEE P1900 Standards Group was established in the first quarter 2005 jointly by the IEEE Communications Society (ComSoc) and the IEEE Electromagnetic Compatibility (EMC) Society. The objective of this effort is to develop supporting standards dealing with new technologies and techniques being developed for next generation radio and advanced spectrum management.

There are currently 5 sub-topics in the P1900 effort:

1. P1900.1: *Working Group on Terminology and Concepts for Next Generation Radio Systems and Spectrum Management.* P1900.1 will develop a standard which will facilitate the development of these technologies by clarifying the terminology and how these technologies relate to each other.
2. P1900.2: *Working Group on Recommended Practice for Interference and Coexistence Analysis*. A primary goal of these initiatives is to improve spectral efficiency. This standard will provide guidance for the analysis of coexistence and interference between various radio services.
3. P1900.3: *Working Group on Recommended Practice for Conformance Evaluation of Software Defined Radio (SDR) Software Modules.* A primary purpose of this initiative is to provide recommended practices that will help assure compliance with requirements for spectrum use by using formal mathematical concepts and methods.
4. P1900.A: *Study Group on Dependability and Evaluation of Regulatory Compliance for Radio Systems with Dynamic Spectrum Access*. This study group is investigating how regulatory authorities and manufacturers can work together to assure that devices and systems with dynamic spectrum access are safe and non-interfering. The three study areas are conformance testing techniques, design techniques to reduce the challenge of conformance testing, and hazard analysis to determine what levels of assurance are required.
5. P1900.B: *Study Group on Coexistence Support for Reconfigurable, Heterogeneous Air Interfaces*. The overall goal of this study group is the proposal of a system architecture guaranteeing an efficient coexistence of heterogeneous wireless systems. This shall be achieved by introducing new building blocks into an existing system landscape; *the modification of existing standards shall be avoided*. The corresponding novel building blocks are expected to cover the following main three aspects: Network Reconfiguration Management, Radio Enabler of Reconfiguration Management, and Terminal Reconfiguration Management.

7.4 NCOIC[14]

The NCOIC represents over 80 IT, aerospace, defense, and communications companies from around the world that form the production chain for network centric systems. The NCOIC membership is comprised of engineers whose job within their company is the design and integration of systems. The NCOIC technical scope spans all disciplines to provide end-to-end capabilities. This makes the NCOIC uniquely qualified to evaluate standards, exchange best practices, and to converge on solution patterns that are fielded in real world systems.

In addition to the developing and ongoing collaboration among IEEE, OMG, and SDR Forum, NCOIC is now assessing the merits of a stronger collaboration with them, and are developing an internal Statement of Work (SOW) on how they can contribute to the developing alliances. As of the writing of this paper, that SOW is active within the NCOIC process.

7.5 JPEO JTRS

The purpose of the Joint Tactical Radio System (JTRS) is to develop, produce, integrate and field a family of interoperable, digital, modular, software-defined radios that operate as nodes in a network to ensure secure wireless communications and networking services for mobile and fixed forces.

The JPEO JTRS has oversight over the Software Communications Architecture (SCA) and the associated APIs currently under development. The OMG and the SDR Forum have members associated with the development of those APIs and there is growing interest among several stakeholders (consortia and industry) in a potential convergence of the SCA and P^2SRC standards

7.6 High Capacity Communications Capability (HC3)[15]

This program is central to the Army's transformational net-centric communications efforts, providing for the implementation of a comprehensive "Command and Control on the Move" capability for above 2GHz (A2G) waveform applications. HC3 is the anchor program for high capacity satellite access for the Army's Warfighter Information Network-Tactical (WIN-T), and for the Marine Corps' Tactical Data Network (TDN). The process will include adaptation of software compliant architecture and joint technical architecture policies, as utilized for the Joint Tactical Radio System (JTRS).

7.7 NASA

The National Aeronautic and Space Administration (NASA) is developing an open architecture description for SDR. The Space Telecommunications Radio System (STRS) SDR/CR architecture provides architecture level specifications for hardware and software development to abstract the software waveforms from hardware platforms. The architecture strives to support existing (e.g. legacy) communications needs and capabilities while providing a path to more capable, advanced network connectivity that promotes scalable, modular, reconfigurable, and upgradeable functionality and features.

NASA is drawing on its years of experience in space technology and development along with space operations to achieve a radio architecture to meet mission needs. NASA has the opportunity to share its requirements, technical expertise, and spacecraft resource and risk concerns with the SDR community to achieve a common radio standard. NASA must weigh the benefit of adopting new technologies into its missions, such as leveraging JTRS-SCA, the OMG

MDA and developing a unique architecture appropriate for the space domain. The promise of savings and benefits across the radio development and mission and operations phases must be compelling for NASA missions to migrate into new SDR technology.

7.8 OMA

OMA is the leading industry forum for developing market driven, interoperable mobile service enablers. It is the focal point for the development of mobile service enabler specifications, which support the creation of interoperable end-to-end mobile services. OMA drives service enabler architectures and open enabler interfaces that are independent of the underlying wireless networks and platforms. OMA creates interoperable mobile data service enablers that work across devices, service providers, operators, networks, and geographies. Toward that end, OMA will develop test specifications, encourage third party tool development, and conduct test activities that allow vendors to test their implementations.

8 EXAMPLES OF COLLABORATIONS

8.1 Smart Antenna & Digital IF

An example of a multi-consortia collaboration is in the areas of Smart Antenna & Digital IF. The work is based on two RFPs issued from the OMG. Members from both the OMG and the SDR Forum are responding. In the SDR Forum, a scoping of the requirements is a focus. In the OMG the focus is on the modeling of the requirements and management of the standardization process. Virginia Tech is leading the Smart Antenna effort with support from L-3 Corporation and THALES. THALES is leading the Digital IF work.

8.2 SDR/CR Definitions & Ontology[16]

The IEEE P1900.1 effort to establish definitions in the SDR/CR software component context is expanding in its reach. The IEEE is coordinating the technical effort and standard, and the SDR Forum and NASA are both bringing their knowledge to the table. A Memorandum of Understanding was recently completed between the 1900.1 and SDR Forum bodies.

8.3 Consortia Meeting Collocation

Each of the consortia approach the SDR/CR standards development lifecycle with a unique view and core competency. There is, however, extraordinary challenge for consortia membership (and industry in general) to remain aware of the wide variety of initiatives among all the consortia. Additionally, costs are high to attend and keep up with those many initiatives.

To address this, consortia leaders recently met face-to-face, and are developing a common vision and in fact are already beginning to collocate at each others meetings.

Benefits are emerging from collocation in terms of solving the cost and awareness issues, but more importantly, the initiatives are now collaborating face-to-face, core competency awareness is increasing, common vision and goals are emerging, and a synergism is developing which is enabling stronger standards development, and potentially overall quicker delivery of standards artifacts, with broader interest and adoption.

8.4 NASA Space Telecommunications Radio System Collaboration

The STRS is a SCA-like technology emerging from NASA. The SCA in its current form does not respond well to the space use case. Typically space components lag ground counterparts by seven to ten years. Impacts include: mission duration, space environment effects (electrical upsets due to radiation). Direct application of successful terrestrial radios architectures must be analyzed for the space domain, and the SCA infrastructure or framework must accommodate profiles different from the typical defense profile it currently supports.

Member companies of the SDR Forum are collectively convening to provide a response to NASA's STRS RFI. This is evolving to become a working "Industry Consensus" business pattern that could be applied to other emerging or changing SDR/CR efforts. Customer and engineering organizations (including competing organizations) have more open dialog on a given emerging technology and the associated requirements. There is increased motivation (driven by the customer organization) for all parties to build a stronger overall collaboration on a given effort.

In the December 2006 OMG meetings, the Space WG in the SDR Forum will be submitting for approval a Space PIM/PSM RFP to extend the P^2SRC with the inclusion of Space-based use cases.

9 COLLABORATIVE MODELS

Given the interest of these and other stakeholders, it is critical to identify a model that will help their partnership build a common set of SDR/CR standards that service their need collectively and individually wherever possible.

The following are models being used by various consortia that have shown success, or in the case of the waveform repository concept, poses challenges to the collaborative sharing of information among partners.

9.1 SysML Partnership[17]

This is an informal partnership of modeling tool users, vendors and government agencies that was organized May 2003 to respond to the UML for Systems Engineering RFP (OMG doc# ad/03-03-41). The SysML Partners are collaborating to define a modeling language for systems engineering applications, called Systems Modeling Language (SysML). SysML will customize UML 2.0 to support the specification, analysis, design, verification and validation of complex systems.

9.2 SDR Forum's Space Working Group

Referred to earlier, the Space WG, chaired by Richard C. Reinhart (NASA GRC) has brought industry together with the Space Telecommunications Radio System (STRS) RFI. Competing companies are working together to help respond to this RFI.

9.3 The Challenge of the Waveform Repository

In addition to applying international standards to SDR/CR technologies, there is increasing demand for the collection and distribution of certified waveforms/applications executed by those technologies.

How is a waveform certified? How is a deployed waveform guaranteed to remain certified? What mechanism encourages working commerce between waveform providers and consumers? How can the repository be guaranteed to have the latest, highest quality waveforms available? How does waveform collection and distribution work?

Whatever the waveform repository (or repositories) become, and whoever the services agencies/stakeholders are that manage them, these questions need answers. Those answers could come in the form of additional artifacts to the SDR/CR International Standards set as it matures, and would supplement the Common Vision of the partnering consortia.

Fig. 3: Certification & Acquisition Process illustrates a notional idea that could suggest solutions for these issues. It represents a candidate approach for Radio/Waveform Certification and Acquisition. It is based on the NIST/NSRL approach.[18] It is highly simplistic, and conceptual in nature. A separate RFI/RFP to collect requirements and suggest correct architecture and flow(s) for the variety of cases under which it could be used would be needed.

The following is a hypothetical flow for illustrative purposes. There could be many repositories and certification agencies established for specific needs and use cases. Each one could have its own unique structure and flow.

1. SDR/CR Partnership member organizations (made up of standards committees, regulation agencies, requirements managers, end users, etc.) provide SDR/CR standards and regulations to the certifying agency.[19]
2. Radio and/or Waveform providers (implementing based on the SDR/CR standards & regulations) provide source, build environment, radio set artifacts etc., as required to the certifying agency

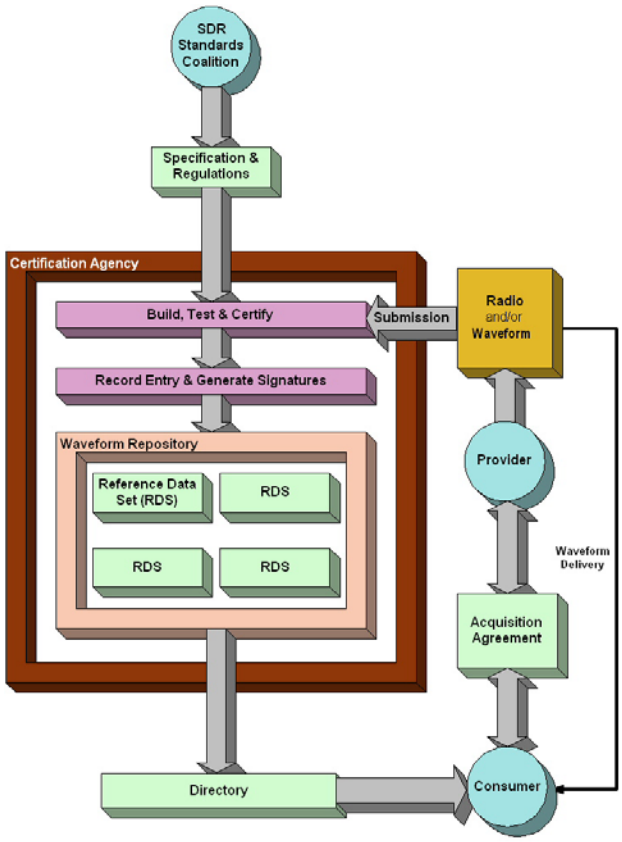

Fig. 3: Certification & Acquisition Process (Notional)

3. Certifying Agency builds, tests, and certifies submission against specified SDR/CR standard(s) & regulation(s)
   a. For each soft artifact in the certified set, create a repository record and four signature files. Put resulting signatures and identifying information in a "Reference Data Set" (RDS) and submit the RDS to the repository
   b. Publicize the updated Standard Reference Data Group (SRDG) Radio/Waveform Directory
4. Consumer reviews the directory to identify available certified radios and/or waveforms
5. Consumer contacts provider. Consumer and provider negotiate an acquisition agreement
6. Agreement is executed and product is delivered. The following are two candidate methods that can be pursued, based on agreements between the provider and the certification agency:
   a. The provider regenerates signature files at time of consumer acceptance and the signature files are compared against the original RDS. If they are identical the provider delivers the system to the consumer. The regeneration process would be periodically audited by the certification agency
   b. The deliverable software artifacts are stored in the repository together with the RDS. The certification agency delivers those artifacts to consumer when provider grants privilege (based on a fully executed acquisition agreement).

Note: there currently is no provision in this candidate scenario for management of hardware in the repository.

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[1] IEEE P1900.1 Definition of SDR: A radio is considered to be a software defined radio if some or all of the baseband or RF signal processing is accomplished through the use of digital

signal processing software and can be modified post manufacturing.

[2] "Collaborate across the JTRS government / industry enterprise team to provide common technical solutions", Rich North, SDR Forum presentation, June 2005, referring to the JPEO planned approach

[3] http://www.omg.org/docs/dtc/05-08-03.pdf

[4] http://procurement.nasa.gov/eps/eps_data/118663-OTHER-001-001.pdf

[5] http://www.openmobilealliance.org/release_program/docs/Arch/OMA-Service-Environment-V1_0_2-20050803-A.pdf

[6] http://www.coe.neu.edu/~jsmith/Publications/MobileComm_V10c.pps represents some thoughts that have been previously presented

[7] Overlapping or competing standards bodies tend to cooperate purposefully, by seeking to define boundaries between the scope of their work, and by operating in a hierarchical fashion in terms of national, transnational and international scope; international organizations tend to have as members national organizations; and standards emerging at national level (such as BS 5750) can be adopted at transnational levels (BS 5750 was adopted as EN 29000) and at international levels (BS 5750 was adopted as ISO 9000). http://en.wikipedia.org/wiki/Standards_organizations

[8] http://www.iso.org/iso/en/aboutiso/strategies/isostrategies_2004-en.pdf

[9] Because the commercial community business model traditionally varies from government models, a study is recommended that would explore and identify common business model attributes that would increase the viability of SDR collaboration for both domains.

[10] http://www.omg.org/memberservices/TechAdoptProcess.pdf (Brief overview of the OMG process)

[11] http://www.omg.org/cgi-bin/doc?hh - The Hitchhikers Guide can be downloaded from this location.

[12] http://www.omg.org/docs/ormsc/06-02-03.pdf

[13] http://www.ieeep1900.org

[14] http://www.ncoic.org/about

[15] http://investor.raytheon.com/phoenix.zhtml?c=84193&p=irol-newsArticle&ID=518597&highlight=

[16] Ontology is a specification of a conceptualization of a knowledge domain. An ontology is a controlled vocabulary that describes objects and the relations between them in a formal way, and has a grammar for using the vocabulary terms to express something meaningful within a specified domain of interest. The vocabulary is used to make queries and assertions. Ontological commitments are agreements to use the vocabulary in a consistent way for knowledge sharing.

[17] http://www.sysmlforum.com/docs/pres/SysML-INCOSE-MDSD-Review-050710.pdf

[18] http://www.nsrl.nist.gov/Project_Overview.htm

[19] Example scenario would be for SDRF, NASA, JTRS to deliver T&E requirements to IEEE P1900.xx for regulatory formalization. Provider of source requirements would be active in that process, each of them could implement the regulatory standard, and therefore become a Certification Agency