

Global Military SDR Solutions – *Practical Methods for SCA Radio Compliance and Deployment*

Mark R. Turner
Harris Corporation
1680 University Avenue
Rochester, New York 14610 USA
mark.turner@harris.com Phone: (585) 242-3261; Fax: (585) 242-3150

ABSTRACT

The application of the Joint Tactical Radio System (JTRS) Software Communications Architecture (SCA) [1] within the U.S. DoD domain and promulgation across national boundaries throughout the global military radio space highlights the need for effective and efficient SCA test, evaluation and certification models. This paper discusses the current state of SCA test, evaluation and certification in conjunction with the evolving needs of the growing U.S. DoD and international community. Current challenges are identified along with discussion of potential improvements and recommended solutions. This discussion leverages a combination of real-life experience with the testing, certification and fielding of SCA based secure military radios and considerations from various industry and Government perspectives including the Software Defined Radio (SDR) Forum SCA Test and Evaluation Working Group.

Harris Corporation has significant experience with the current SCA test, evaluation and certification process; deploying more than 95,000 SCA certified Type 1 secure military radios, including the first certified SCA compliant platform with no waivers, the AN/PRC-152 (c) Hand-held (HH) radio. This radio is also the first and only platform to deploy waveform applications developed specifically for the JTRS Information Repository that have been ported and fielded.

The SDR Forum SCA Test and Evaluation Working Group has been actively considering SCA compliance testing and certification in the context of a generic role based process. The SCA test, evaluation and certification current operating model will be reviewed from multiple perspectives, including capacity and cost. Conclusions and recommendations will be offered for consideration.

1. INTRODUCTION

The U.S. DoD JTRS Program has been a driving force for the transformation of military SDR technology. The overall purpose of the JTRS Program is to contribute enabling

technology for information superiority on the battlefield, providing secure and reliable connectivity to the war-fighter on the ground into networking capabilities that are delivered through the Global Information Grid (GiG). The use of interoperable wireless communications elements is essential for achieving the necessary levels of connectivity and information exchange to support this mission. Specific objectives for the JTRS Program that are relevant to wireless communications interoperability and connectivity include:

- Broad frequency spectrum coverage (2 Mhz – 2Ghz).
- Multiple, simultaneous channel operations with re-transmission across frequency bands and waveforms.
- Programmable Information Security (INFOSEC) in accordance with National Security Agency (NSA) Cryptographic Modernization Program requirements.
- Portability of waveform applications software across radio platforms and domains (i.e., Ground, Air, Space).
- Scalable solutions to enable additional future capacity with modular and pluggable technology insertion.

These objectives are also relevant to many other military defense organizations throughout the world, including: the North Atlantic Treaty Organization (NATO), the European Defense Agency (EDA), coalition partnerships and specific national interests.

2. STANDARDIZATION DRIVES FORMAL TEST, EVALUATION AND CERTIFICATION

In the military defense domain, formal test, evaluation and certification processes and practices provide assurance of compliance with established standards. In the specific case of wireless military communications, these processes and practices serve as a key enabler for reliable wireless connectivity and interoperable communications. The Software Communications Architecture (SCA) [1] developed under the JTRS Program is a key element for satisfying several of the above identified objectives. The SCA is managed and maintained by the U.S. DoD through

the JTRS Joint Program Executive Office (JPEO). The SCA consists of a set of rules and protocols, which define a Common Open Standards Architecture for SCA applications. Component Based Development (CBD) is the underlying technology for the SCA. CBD promotes the advent of interchangeable software parts, built to predefined specifications. The ability to reuse existing software components across multiple radio applications, coupled with the encapsulation of hardware specific capabilities and platform services through well-defined APIs serve as the foundation for waveform application portability, affordability, time-to-market and interoperability.

The software components which provide for the management and execution of SCA applications and devices comprise the SCA Operating Environment (OE). The SCA supports implementation of waveform application software that can be re-used or “ported” across multiple radio sets (platforms and/or form factors). A Board Support Package (BSP) binds the OE to specific radio set hardware. The OE and BSP can be considered “platform software”, collectively providing an appropriate abstraction of the underlying radio set hardware implementation. Waveform applications contain the business logic for specific communications requirements, using platform software capabilities. Refer to Figure 1 for a high level block diagram of the SCA.

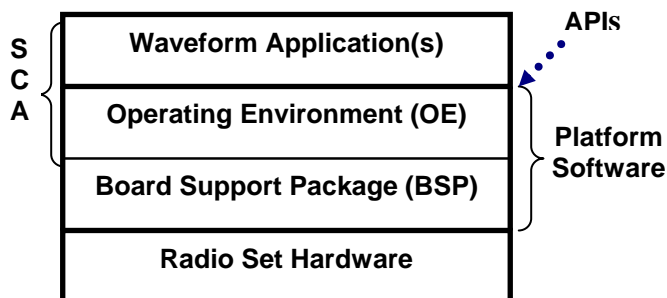


Figure 1 SCA High Level Block Diagram

3. SCA TEST, EVALUATION AND CERTIFICATION

The SCA specification has been published as a standard Software Defined Radio (SDR) architecture by the U.S. DoD and subsequently other organizations worldwide have been actively evaluating and adopting SCA based solutions. This promulgation of the SCA outside the U.S DoD has resulted in the need for consideration of a broader approach to SCA test, evaluation and certification. There is a diverse set of stakeholders that have a vested interest SCA test, evaluation and certification capabilities, including [2]:

- Product and system users (the mission communicators)
- Governments and associated procurement authorities
- Radio providers (developers and manufacturers)

- 3rd party software developers (applications providers)
- Tools providers (supporting developers, testers, etc.)
- Others (i.e., independent test and certification entities)

Radio platforms with certified SCA implementations can provide users and procurement authorities with high confidence that the products and systems acquired to accomplish interoperable mission operations will meet expectations. Radio providers can be assured that their products meet a key set of requirements adopted by the customer community for both current and future communications needs. Radio providers can potentially leverage certified SCA implementations across multiple platforms to reduce aggregate development costs and associated product time-to-market, providing war-fighters with necessary capabilities in a more timely and cost effective manner. [2]

4. SCA TEST AND CERTIFICATION CHALLENGES

This section identifies a set of four key challenges facing the current SCA test, evaluation and certification process. The JTRS Test and Evaluation Laboratory (JTEL) is administered by the JTRS JPEO and is the designated authority to provide test and evaluation for all DoD programs required to meet SCA compliance. As such, the JTEL provides SCA development support to DoD programs and conducts formal SCA testing of radio platforms, resulting in a recommendation of certification/non-certification for the radio product under test. JTEL activities are performed at facilities located in the Space and Naval Warfare Systems (SPAWAR) Center, San Diego California.

CHALLENGE: Intellectual Property (IP).

SCA test and evaluation methods employed by the JTEL are inherently intrusive, evaluating software source code and associated design documentation for compliance with SCA specifications.

JTEL SCA test and evaluation utilizes a combination of multiple “white-box” test methods to verify SCA requirements, including both automated testing and manual code inspection. With these “white-box” techniques, Radio providers who develop SCA implementations at private expense must submit their Intellectual Property (IP) to the U.S. Government for the testing and evaluation process. This IP potentially represents a significant level of private investment must be carefully protected through specific non-disclosure or licensing terms (which is an uncomfortable position for Radio providers).

Approved, standardized test procedures and test tools are used to perform the testing, specifically, the JTRS Test Application (JTAP) automated test tool. The SCA test and

evaluation performed by the JTEL is currently limited to Core Framework (CF) requirements, with the expectation to include API compliance at some future time. Upon completion of test and evaluation, the JTEL generates a formal test report and provides a recommendation to the JTRS JPEO for final determination of certification.

Based on experience with the SCA certified AN/PRC-152 (C) HH and AN/PRC-117G (C) Man-pack (MP) radios, the JTEL does a fair and thorough job of conducting SCA testing and evaluation. From a sample of multiple SCA test, evaluation and certification cycles across multiple radio platforms, a typical JTEL test and evaluation schedule can be on the order of 14 calendar weeks consisting of 70 business days. There are several factors that can significantly influence the duration of the test and evaluation execution period, including:

- Depth of the JTEL work queue and relative priority of the radio platforms to be tested (i.e., platforms developed under Programs of Record vs. platforms developed at private expense).
- Scope of the testing (today it is limited to OE requirements exclusive of the published APIs).
- Specific findings encountered during test and evaluation activities.

CHALLENGE: Time-to-market.

The cumulative effect of multiple radio platforms and multiple product releases will dramatically increase the need for SCA test, evaluation and certification capacity.

As more SCA radio platforms are developed and reach the maturity level of field deployment, the question of capacity and flow through the JTEL test, evaluation and certification process needs to be considered. During an initial radio platform product release, the JTEL test, evaluation and certification can typically be performed in parallel with some other verification and validation activities, which mitigates some of the schedule impact associated with the JTEL process. During subsequent radio platform product releases there is generally less opportunity for activity parallelism and the JTEL process can become the critical path to deployment. In addition, Radio providers typically release radio platform software updates 2 to 4 times annually, with a combination of new features and capabilities, along with product improvements (i.e., software bug fixes), technology insertion and changes to overcome hardware component obsolescence. Further, maintenance software releases in support of production needs, can potentially have no impact to SCA requirement compliance, therefore the cost and time-to-market impact can be profound.

Many Radio providers offer a suite of radio products in order to meet diverse domains and market needs, each with multiple product releases during a given annual period stretching the demand for SCA testing capacity.

CHALLENGE: Cost.

The total cost of SCA test, evaluation and certification for a Radio provider can exceed \$200,000 USD per radio platform product release.

SCA test, evaluation and certification can also add significant cost to the Radio provider's business model. Radio providers with radio platforms developed at private expense are required to pay for JTEL services rendered in the execution of SCA test, evaluation and certification. A typical cost to cover the entire JTEL process for a single radio platform product release is more than \$120,000 USD. The Radio provider also typically provides on-site support at the JTEL facilities during the conduct of SCA test, evaluation and certification execution, adding another approximately \$30,000 USD to the cost. In addition, prior to the formal execution of SCA testing by the JTEL, Radio providers prepare for this activity through the execution of multiple dry runs of the JTEL procedures at a cost of \$50,000 or more. Therefore the total cost can exceed \$200,000 USD for each radio product platform release.

Note that the JTEL provides copies of the approved SCA test procedures and tools (JTAP) to Radio providers in advance of formal testing to facilitate efficient test preparation and minimizing the likelihood of problems detected during the formal conduct of testing by the JTEL.

CHALLENGE: Supported SCA Versions.

Simultaneous Test, evaluation and certification support for multiple versions of the SCA will be necessary to ensure the timely flow of radio platforms and capabilities to the war-fighter.

Consideration should be given to simultaneously supporting test, evaluation and certification for multiple versions and specifically identified variants of the SCA. Given the growing number of fielded SCA platforms, the transitions between published SCA versions needs to be carefully managed. The rolling out of software bug fixes or software changes in support of hardware component obsolescence likely should not be delayed due to the release of newer versions of the SCA specifications and subsequent product updates (it requires time for Radio providers to implement solutions for new or changed SCA requirements). SCA test, evaluation and certification can be sunset for older, obsolete versions of the SCA, however some overlap between multiple versions can help facilitate the timely flow of equipment and capabilities to the war-

fighter. The assignment of a designated time period where formal test, evaluation and certification can be performed for each version of the SCA could satisfy this challenge. Radio providers would indicate the specific version of the SCA to be tested and certified.

There are currently no formal SCA test, evaluation and certification authorities today, outside of the U.S. DoD and the JTEL described above. The challenges identified above will be exacerbated as the demand for SCA test, evaluation and certification expand beyond the U.S. DoD. Specific interests of international bodies who require SCA compliance will need to be accommodated, including: national sovereignty and SCA security compliance (i.e., security APIs).

4. POTENTIAL SOLUTIONS AND IMPROVEMENTS

There are several potential solutions and improvements which could be applied to the current SCA test, evaluation and certification operating model that would address the above identified challenges. This section provides a generic role based process oriented evaluation of the current operating model in conjunction with a recommended approach.

4.1 Generic Role Based Process

The SDR Forum SCA Test and Evaluation Working Group has considered a generic role based SCA test, evaluation and certification process. This process includes both an SCA certification preparation phase and an SCA certification execution phase. The roles and responsibilities were defined for this generic process as follows [2]:

- Standards Body – Responsible for development, issuance and maintenance of the SCA standard (currently the JTRS JPEO).
- Specification Body(ies) – Responsible for developing specifications containing radio system requirements, including application of requirements from the SCA standard (in part or in its entirety). These specifications are used to develop test materials. This body also provides feedback and recommendations to the Standards Body. This role is likely to consist of a collection of multiple entities in the future, such as military radio platform procurement authorities worldwide. For the U.S. DoD this is currently the JTRS JPEO, but could include individual U. S. military service elements as well as international interests.
- Definition Body(ies) – Responsible for providing interpretations and clarifications of the standard. This can be accomplished through a variety of activities, including publishing documents, holding workshops, or providing reference implementations. This body also

provides feedback and recommendations to the Standards Body. The SDRF is already heavily engaged in all of these activities.

- Test Developer(s) – Responsible for development and maintenance of the test procedures, test tools and test report forms for usage by the Test Laboratories. This role could be expanded to include test result evaluation (i.e., Test Developer/Evaluator).
- Test Laboratory(ies) – Responsible for executing tests in an accredited SCA test environment, using approved test procedures, test tools and forms. Test results are collected and reported using standard, approved forms. This role is likely to consist of multiple entities to ensure sufficient capacity to meet SCA testing demands.
- Test Laboratory Accreditation Body(ies) – Responsible for certifying that a test laboratory has the capability, the competence, the discipline and suitable quality assurance to reliably and credibly perform SCA testing.
- Certification Body(ies) – Responsible for granting SCA compliance certification based on test results from an accredited test laboratory. Could be a collection of multiple entities.

Figure 2 provides a general representation of the interactions and information flow between the roles defined in the above process.

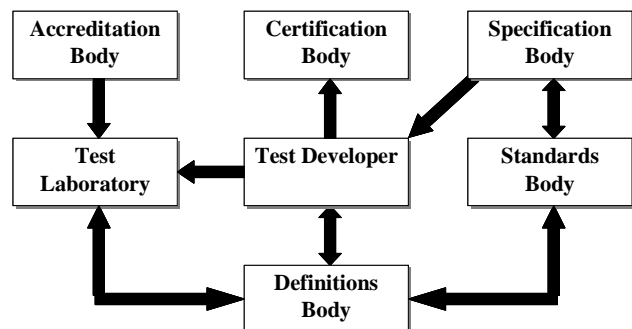


Figure 2 – SCA Certification Process Roles and Interactions

This generic role based process can be applied to different operating models. The following compares the current Government centric operating model with a more distributed model that is targeted specifically to address the previously defined SCA test, evaluation and certification challenges.

4.2 Current Operating Model Evaluation

The current operating model for SCA test, evaluation and certification is a highly centralized, Government oriented model used by the U.S. DoD as an integral part of the JTRS Program. This Government oriented model could be

proliferated throughout the international community on a national, multi-national organization and coalition basis. The following describes the roles and responsibilities for this model in the context of the SDR Forum's defined generic role based process, along with a summary risks/benefits assessment. Refer to Figure 3 for a graphical representation of the current operating model overlaid on the generic role based process:

- **Standards Body** – U.S. DoD (JTRS JPEO), potentially other international Government entities for variants of the SCA standard managed by the U.S. DoD..
- **Specification Bodies** - U.S. DoD, potentially other U.S. Government Agencies (i.e., NASA, Homeland Security), international organizations (i.e., NATO, EDA), specific international Government interests.
- **Definitions Body** – SDR Forum currently developing SCA guidance recommendations, has provided SCA reference implementations for the international SDR community.
- **Test Developers** – U.S. DoD (JTEL) has an existing set of test procedures, test tools and supporting material. Various international organizations and specific international interests are evaluating alternatives.
- **Test Laboratories** – U.S. DoD (JTEL) has existing facilities and associated business model for execution. Various international organizations and specific international interests are evaluating alternatives.
- **Test Laboratory Accreditation Bodies** – U.S. DoD (JTEL) role given current model. Applicability for international organizations and specific interests dependent on selected operating model.
- **Certification Bodies** – U.S. DoD (JTRS JPEO), would include various international organizations and specific national interests in the future.

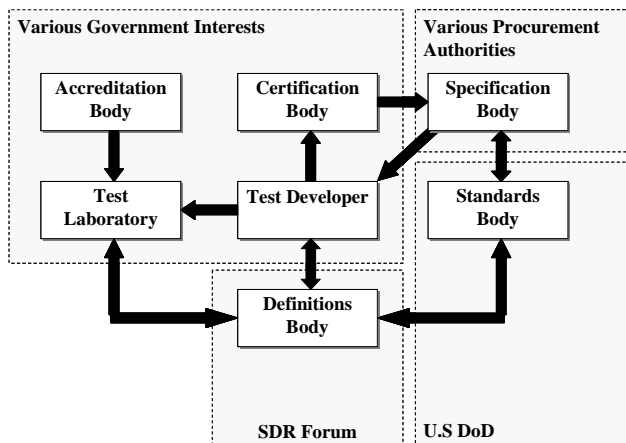


Figure 3 – Current Model with Role Based Process

Benefits:

1. The number of interactions and information flows are minimized since various Government interests are responsible for multiple roles, providing a level of efficiency.

Risks:

1. **Time-to-Market and Cost.** This approach relies on multiple instantiations of the current operating model to support international interests, linearly expanding the number of potentially redundant SCA test, evaluation and certification cycles that must be performed for the broad deployment of interoperable radio platforms. This model has the potential for significant bottlenecks and capacity constraints, and as such is likely to add significantly to existing time-to-market and cost challenges.
2. **IP Protection.** This challenge and Radio provider concern will increase dramatically with the proliferation of IP into multiple Government organizations and support staff.
3. **Supported SCA Versions.** This model does not offer any method for coordinating supported versions, leading to potentially significant Configuration Management issues for Radio providers, especially across a multiplicity of Specification Bodies.

4.3 Recommended Operating Model

The recommended operating model for SCA test, evaluation and certification provides a more distributed solution using a combination of Government, independent third parties and Radio providers to address the previously identified challenges. The SDR Forum is being recommended as a candidate independent third party to facilitate key elements of the SCA test, evaluation and certification process. This approach would introduce new roles for the SDR Forum, the Forum would continue to support its current mission focused on providing value to its membership and the SDR community, with new capability as a paid-for service to support the international SCA community needs. The following is a description of the recommended operating model. Refer to Figure 4 for a graphical representation of the recommended operating model overlaid with the generic role based process.

- **Standards Body** – U.S. DoD (JTRS JPEO), potentially other international Government entities for variants of the SCA standard managed by the U.S. DoD..
- **Specification Bodies** - U.S. DoD, potentially other U.S. Government Agencies (i.e., NASA, Homeland Security), international organizations (i.e., NATO, EDA), specific international Government interests.

4. Supported SCA Versions. The Test Developer can support multiple versions of the SCA for testing and evaluation, economies of scale applied to multiple Specification Bodies.

1. The SDR Forum does not currently support the Test Developer, Accreditation and Certification Body roles with its current business model. The Forum has been considering expanding capabilities into this area based on the growing needs of the international military SCA based radio platform community.

The promulgation of the SCA from the U.S. DoD JTRS Program to international organizations and national interests highlights the need for more efficient and effective model for testing, evaluation and certification. The SDR Forum SCA Test and Evaluation Working Group has considered this problem space, developing a Certification Guide that offers a generic role based process to provide the foundation for SCA testing, evaluation and certification operating models. The current Government oriented operating model does not scale well to meet the greater demands of the international community and has inherent challenges with time-to-market, costs, IP protection and multiple SCA version support.

This paper recommends a different operating model that distributes roles and responsibilities across the SCA test, evaluation and certification process addressing the four key challenges identified in this paper. The recommended operating model provides opportunities for a more timely and cost effective performance, less cumbersome and less risky IP handling and a more scalable approach for dealing with multiple versions of the SCA. The SDR Forum has the right foundation of domain knowledge and independence to become a key player with this recommended operating model, providing cohesive and coordinated services to the international military SCA based radio platform community.

- [1] Software Communications Architecture Specification MSRC-5000SCA version 2.2 and its supplements, dated 17 November 2001
- [2] Software Defined Radio Forum Contribution, “Test and Certification Guide for SDRs based on SDA”, SDR-08-0007-V0.0.7, dated February 2, 2009.

