



Software Communications Architecture (SCA) Test and Certification

“Insights into testing an SCA based SDR”

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“Insights into testing an SCA based SDR”



A feature and portion of a Software Defined Radio (SDR) is abiding to the software principals of the Software Communications Architecture (SCA). To make sure an SDR conforms to SCA principals, an independent, third party, test laboratory must verify and validate the SDR. However, before starting any tests, the test laboratory must have well defined test methods and well developed tools to efficiently and accurately assess an SDR abides to the SCA. Although, the SCA specification is widely available, the information how to establish, and start testing an SCA based SDR is not.

The immediate objective of this paper is to provide general insights and an understanding how an SDR test lab accomplishes its testing efforts. For example, experienced test engineers know many tasks are required before testing can begin. Therefore, one objective of this white paper is to provide a description and explanation of the process required before conducting and testing an SDR. Furthermore, more knowledge and information is required during and after testing an SDR. This paper will provide useful information for understanding what the SCA based SDR test lab accomplishes before, during and after testing an SCA based SDR.

Agenda



- Definition of Verification and Validation
- Verification Techniques Defined
- Validation Techniques Defined
- The Certification Process
- Questions

Independent Study regarding V&V



- A 1999 Carnegie Mellon University study found:
 - V&V must start early in the development lifecycle
 - There are many different V&V techniques used that are applicable at different stages of the development life cycle
 - The results of a V&V forms an important component which is a document used to support Certification
 - Certification is usually pursued due to legal reasons or economic advantages
 - The Certification process also starts from the beginning of the Life Cycle
 - The Certification process requires cooperation between the developer and test agency from the very start.

Independent Study regarding V&V

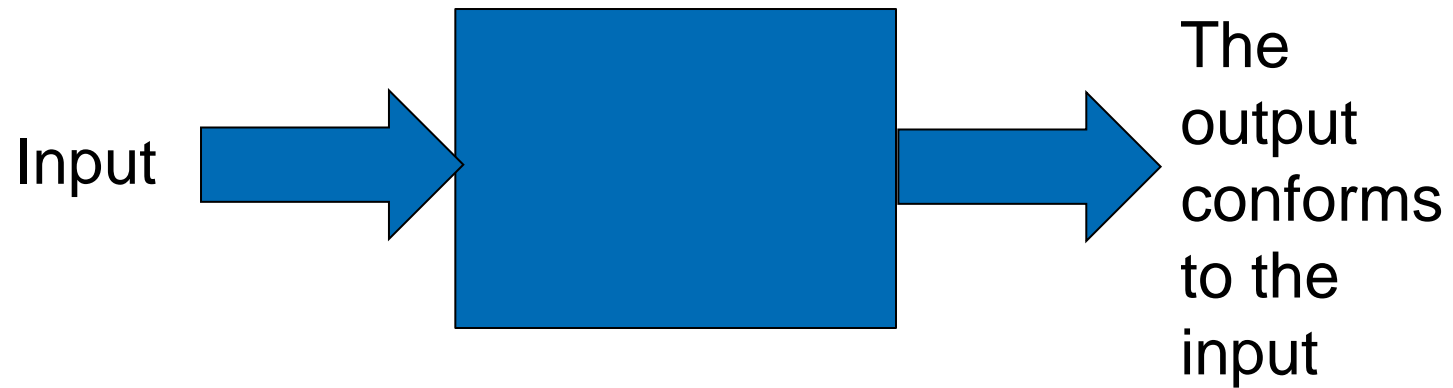


- A 1999 Carnegie Mellon University study found:
 - Certification does not prove the System is correct, safe, or dependable
 - Planning of V&V is necessary at the beginning of a development life Cycle
 - V&V is time consuming process
 - Consists of
 - Planning from the start
 - The development of test cases
 - The actual testing
 - Finally, the analysis of the testing results
 - It's vital there are people specifically in charge of V&V that can work with the designers.

Definition of Verification & Validation



- Verification
 - “The process of evaluating a system or component to determine whether the products of a given development phase satisfy the conditions imposed at the start of that phase.”
- Validation
 - “The process of evaluating a system or component during or at the end of the development process to determine whether it satisfies specified requirements.”
- Verification demonstrates whether the output of a phase conforms to the input of a phase as opposed to showing that the output is actually correct.
- It is not enough to only depend on verification, so validation is necessary to check for problems with the specification and to demonstrate that the system is operational.
- Certification is "A written assurance that a system or component complies with its specified SCA requirements.”



(testing conducted throughout the development process)

VERIFICATION TECHNIQUE

Verification Techniques



- 2 Categories of Verification Testing (Dynamic & Static)
- Dynamic Testing (involves the exe of a sys or comp)
 - A number of automated test cases, consisting of input data which is used to determine output test results
 - Three (3) types of Dynamic tests:
 1. Functional – testing whole parts of the SDR
 2. Structural – testing specific areas of the SDR
 3. Random Testing (using randomly determined inputs to detect faults that can go undetected by other systematic testing) – exercising random tests to gauge a level of compliancy.

Verification Techniques



- Static Testing (doesn't necessarily involve the operation of a system or component)
 - Consists of manual and automated tests
 - Two (2) types of Static tests:
 1. Consistency Techniques – Tests to ensure accurate program properties (e.g. correct syntax, parameter matching, correct typing, correct requirements, and specification translation).
 2. Measurement Techniques – Tests that measure properties correctness (e.g. error proneness, understandability, and well structured-ness).

Verification Techniques



- Practical aspects of Verification testing:
 - Determine the entrance criteria, description, requirement(s), responsibility, reporting, and exit criteria.
 - Determine the maturity of the radio.
 - Develop and deliver test tool to manufacturers and provide assistance with configuring and using the tool
 - Independently witness test activities
 - Work with the SDR developer to assess test results and resolve design & implementation issues

Verification Techniques



- Practical aspects of Verification testing:
 - Collect information on the OE, ORB, OS, and CF
 - Work with the developer:
 - to ascertain SCA requirements misunderstandings,
 - to evaluate test results
 - to resolve all design and implementation issues
 - to ensure accurate SCA direction



(testing conducted at the end of the development phase)

VALIDATION TECHNIQUE

Validation Techniques



- Usually occur at the end of the Development Life Cycle
- Investigates the complete system vs verification
- The 1st of 4 Validation Techniques:
 1. Formal method – using mathematical and logical techniques to express, investigate, and analyze the SCA, SDR design, documentation, and behavior of both hardware and software.
 - Seeking the weakest link
 - Cross-referencing to the SCA
 - We connect the bridge between the SCA Requirement, the SDR design using developer documentation for hardware and software.

Validation Techniques



- The 2nd of 4 Validation Techniques:
 2. Fault Injection – intentional activation of faults by either hardware or software means to observe the system operational under fault conditions.
 - Force the SDR into a precarious state
 - Using automated software tools, tests are used to place the SDR under precarious behavior states.
 - These are error conditions or states or messages within the SCA that are expected.

Validation Techniques



- The 3rd of 4 Validation Techniques:
 3. Dependability Analysis – involving identifying hazards and then proposing methods that reduce the risk of the hazard occurring.
 - Looking for problem areas, weakness areas, etc
 - Investigating SDR Design documents and source code allows us to catch possible issues with SDR software.
 - We can bubble up developer issues and suggest or recommend course of actions.

Validation Techniques



- The 4th of 4 Validation Techniques:
 4. Risk Analysis – takes hazard analysis further by identifying possible consequences of each hazard and their probability of occurring.
 - Developer requests to be exempt or waived from a specific SCA requirement.
 - Under this scenario, we investigate the impact of these types of requests.

Validation Techniques



- Other known Validation Techniques:
 5. HW Fault Injection,
 6. SW Fault Injection,
 7. Hazard Analysisto name a few.



CERTIFICATION

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Certification Process



- V&V is part of the Certification process
 - Follows the V&V process
 - Compiles and reconciles all Test data, and Developer requests
- Even though Certification doesn't occur until the end of a development life cycle, planning must start at the beginning, for the following reasons:
 1. Due to the complication between the regulatory agency and the developer, the certification liaison between both parties must be established early in the process.
 2. Submit a plan for approval

Certification Process



3. On-going discussions between the developer and test agency to resolve possible areas of misunderstanding or disagreements
 4. Changes to the V&V methods used have to be approved to insure the certification will not be affected.
- The test Agency holds a series of reviews to discuss all submitted material.
 - Certification only proves a system has met the SCA. Doesn't guarantee the SDR is operational, or is interoperable, etc
 - Certification is only for a specific SDR hardware and/or software release, and/or SCA version.

Certification Process



- Certification process as it's currently conducted:
 - Compile and reconcile all the test results, developer oversights, requirements, etc
 - Generate a full scope V&V report
 - Make recommendations for SCA compliance certification
 - Participate in resolving discrepancies revealed by SCA compliance testing
 - Provide status reports to all stakeholders



IDEAL V&V PROCESS

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Ideal V&V process



- IV&V is involved from the start of the development life cycle
- Work side-by-side with the developer helping them understand the SCA
- Support questions and answers as it pertains to the SCA
- Provide automated test tools to the developer to self-assessment
- Support test tool results and help to identify root causes
- Support SCA interpretation issues and questions
- Attend design and development meetings to provide SCA guidance
- Establish a level of expectation and understanding between the developer and Test Agency.

Better to be informed



Development Milestone	Purpose	Activities
Software Requirements Review	Review functional analyses and requirements allocation	Attend review Participate in walkthrough Review Test Plans, Software Requirements Specification and Software Design Document
Preliminary Design Review	Review design, assess requirements adherence, risk, test strategies, cost	Attend review Review Design Specifications
Critical Design Review	Determine requirements satisfaction, assess risks, supportability	Attend review Review Design Specifications
Formal Testing	Verify software performance compliance with SRS, including vendor SCA compliance testing	Review Test Procedures Witness testing Develop Test Report

Ideal V&V process



- Results:
 - Quicker SCA V&V testing
 - Efficient and effective
 - Generate final Certification documents sooner
 - Less cost to the developer
 - More structured and less surprises



WHO ARE THE TEST AGENCIES

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Who can do V&V



- Can be performed by the same organization performing the design, development and implementation (self-assessment, or 3rd party)
- Sometimes performed by an Independent Testing Agency – Called Independent Verification and Validation (IV&V)
 - Usually accredited by a higher organization to be sure their results are dependable.
 - Cost effective, experienced SDR experts, quicker to launch
- SAIC is an independent test organization with years of experience in SDR. (not a SDR manufacturer)

How SAIC can help...



Our Center of Excellence can provide you with:

- SDR Training Services
- System Engineering and Integration Support
- SDR Architecture Design Review
- SCA & API Verification and Validation efforts
- Cryptographic Equipment Applications (CEA) Oversight
- Establishment and management of SCA Certification efforts
- SCA Test Methodologies and execution

Questions...

