asureSIGN™

The Benefits of Requirements Driven Verification and Test

Abstract

Due to the rising complexity, time to market demands and variability involved in building requirements-critical hardware and software systems, it is absolutely essential to have a robust requirements sign-off capability. This particularly applies to systems where the financial cost of failure is significant, when systems are safety critical or there is a high security factor.

The following White Paper outlines a requirements driven verification and test approach to achieving cost-effective product sign-off based on the asureSIGN software tool and the associated best practice it embodies.

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Current Industry Practice

Even though a wide array of tools are available for analysing source code and testing executable code, there are no tools that automatically track the results of tests as they apply to requirements.

Current common practice in requirements tracing stops at test definition, leaving unattended the need to ensure that requirements have tests defined against them and that these tests have successfully completed.

This means there is a gap between the requirements capture tools available in products such as Rational® DOORS® and Reqtify and the features available in the wide array of test-only products.

To ensure companies produce a correct product in a timely manner there is a clearly identified need for an approach and a tool that can address the key issues in requirements engineering and ensure requirements traceability through the complete workflow.

Typical factors that can cause issues are:
- Requirement interpretation may change through the work flow
- Manual mapping of documents with identifiers is time-consuming and subject to error
- Translation or moving of data may cause corruption or error
- Linking to proofs of implementation/results is currently manual
- Visibility of Requirements through the entire tree is complex
- Communication across domains (pre-silicon, post-silicon, software and system) is complex

The Requirements Driven Approach

The Requirements Driven Verification and Test (RDVT) methodology enables project progress to be analysed and managed by accumulating data on the status of verification and test metrics over the duration of the project and automatically relating these back to the specified requirements. In this way every functional requirement can be mapped to a proof of implementation. Additionally any verification and test activity not relating to a requirement can be identified and questioned.

Improved Product Sign-Off

The RDVT methodology describes a number of activities and processes that can improve the sign-off process:
- Requirements Capture & Management

The Advantages of RDVT

RDVT offers many advantages to Requirements, Verification and Project management and those working on Compliance and Audit.

Requirements Management
- Mapping of requirements through tests to results, for requirements engineering completion
- Using requirements within the test flow allows test engineers early analysis for planning
- Requirements driven test methodology assists with achieving a complete and high quality set of requirements

Verification Management
- Easy interpretation of result metrics, at multiple levels of hierarchy; help to identify recurring or common issues
- Independently work on your verification environment with no dependency on any one EDA tool chain
- Achieve improved decision making due to high quality, real-time information on the project status
- Understand verification status in terms of externally focused customer requirements rather than internal metrics

Project Management
- Reusability of data across projects allows for reduced ramp up times

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1 The need for such an approach was identified as a key finding in the “Verification Roadmapping” report into verification carried out by TVS for the National Microelectronics Institute http://www.nmi.org.uk
- Variant management across projects helps to easily identify redundant tests and new tests needed
- Milestone grading assists with resource management and allows for improved communication across the project
- Provides visibility of the early verification efforts, leading to better project management by making it easy to identify areas that need attention
- Enables risk-based testing (e.g. adapting the level of testing according to risk or SIL assignment)
- Combine data from multiple tools into one system or combine data from multiple projects into one underlying database
- The visibility of requirements mapping to tests allows for a secondary requirement quality check and a process to ensure completeness of the requirements

Compliance / Audit Management

- Documentation for audits is held within the tool and is readily available to incorporate into deliverables
- Compliance to different industry standards

A Quick Introduction to asureSIGN

asureSIGN implements the RDVT methodology by starting with the top level ‘product’ requirements or Test Plan that has been refined to a suitable level of granularity either externally to asureSIGN or within the tool itself. A top level requirements hierarchy may also be written as a standalone test plan.

The rich suite of tools within asureSIGN implement the core functions of, and realise the advantages of, RDVT.

asureSIGN has been developed from the bottom up through in-depth industry collaboration to become a proven solution to the problems identified within current tool flows. By helping to drive the change from traditional test and verification coverage driven methodologies to a more requirements driven methodology, asureSIGN can complement current workflows and tooling to ensure that all requirements are proven to be implemented and working correctly.

Using a combination of a Graphical User Interface (GUI) and a Command Line Interface (CLI), asureSIGN combines ease-of-use with flexibility, with the CLI providing an indispensable means to achieve automation, provide access to an extended command set and allow for batch updates via XML import and export.

Figure 1: Typical asureSIGN GUI Dashboard Screen

The main interactive windows for editing, interpreting and analysing the data are:
- Dashboard
- Editor
- Analyser

Large, annotated screen shots are available in the Appendix of this white paper.

Core Functions Supported by asureSIGN

Requirements Capture

Within the requirement engineering process the requirements need to be elicited from the various sources, analysed for completeness and quality and harmonised within a central storage solution. asureSIGN provides the flexibility of a relational database to track how a project is developing over time for every feature and requirement, and how these features relate to the tests that are used to measure their progress.

Dependent on the project size, the requirements sources can range from word, pdf and excel to database solutions such as DOORS, Integrity, ENOVIA® Requirements Central™, Quality Center Enterprise, TeamCentre®, Visure™ and many others. The choice of tooling will depend on what level of requirements engineering is needed and it may involve interfacing to change management systems and quality analysers such as RQA/RAT™.

The data driven import capabilities, including templates for XML and Excel, enable asureSIGN to interoperate with existing tools and helping to significantly reducing the risk of data translation errors.

It is also possible to use asureSIGN as an independent requirements engineering tool; collating all the requirements within the tool itself; refining them into goals; mapping them into metrics and the results and finally producing a

2 For the purposes of this document Test Plan and Requirements are interchangeable terms.
standalone audit report. This option gives the user the added benefit of not having to find a solution to map disparate tools to one another within the requirements engineering flow, as asureSIGN can essentially act as an all-in-one solution.

Change Management

Any changes to the requirement during the lifecycle of a project can be managed through direct editing within the tool or through a partial import. A partial import enables a particular level of Requirements from an external source to be imported. The tool then performs an intelligent analysis of where in the hierarchy a changed requirement should fit. If an equivalent requirement is found it then compares all of the attribute values to see if there is a change.

Any changes need to ensure that mapped goals or impacted sub-features (refined requirements) are analysed to see if they still satisfy the changed requirement. The affected mappings and goals will be highlighted as ‘suspect’ to ensure the user is pro-active in accepting that the requirement is satisfied.

Compliance and Auditing

For some standards Requirements engineering is now mandated. There are many ways in which requirements engineering can be implemented - mapping through various documents, tools and databases.

Many of the tools and documents are currently unable to map automatically to test results and are reliant on a manual process to map the test plans into the tests and results, with asureSIGN this is all embedded within the tool, the requirements are mapped to a test, assigned a type and the details on how to recognise a passing result is configurable within the tool to allow for automation. This assists with the audit process, information on the person who has written the goals (test plan), pass criteria, passing result, manual sign off info, URL links and visual sign off criteria are all available within asureSIGN.

Any documents required for audit purposes can be produced in PDF format and checked into a configuration management tool.

Auditable Documented Proofs

From asureSIGN the user has the ability to export either in PDF or an XML format, any of the fields within the Requirements and the Goals. The PDF format can be in tabular or list format dependent on preference. It also gives a colour indication of whether or not a goal is mapped or unmapped - Mapped indicates that a goal is mapped to a metric (test plan is mapped to an actual test) - unmapped indicates that the mapping is still to be done - so a test needs to be written etc.

The XML interface means that information is able to be exported and read into other external requirements, management or test analysis tools.

Regression Analysis & Graphing

Integrated graph tools show regressions results over time and allow users to quickly and easily review the progress of the project over time, interpret spikes and dips and analyse the underlying data to identify issues. asureSIGN can remove the need for external charting or reporting tools by automatically constructing a progress graph and allowing configurable reporting within the tool. Future developments (see below) will also include an API to enable developers to build extensions and tight integrations with external tooling.

EDA Tool Independence

asureSIGN supports information from a wide variety of third party tools and vendors for translation. Within the hardware world this is made easier with the acceptance of the Accellera standard UCDB/UCIS standardised format.

Configuration & Version Management

asureSIGN has the ability to interface and store the information from external software versioning and revision control systems such as Git, SVN and Rational® ClearCase®. If there is no external versioning software in use then the tool is able to save timestamp information in its place. The tool also supports ‘base-lining’ for both configuration/change management and recovery purposes.

Reuse and Variant Management

With the ability to export and import in a round trip manner not only are users able to do bulk updates if needed but they are also able to reuse requirements and mapping across projects as well as managing the differences between the product variants when dealing with product families.

A full asureSIGN database can be copied from either a master containing a superset of the feature level requirements or from a previous version, and the requirements updated directly if being used as a requirements database. This process will identify all the unmapped features (those requiring new tests/goals to be written) and the orphans (those that do not need to be maintained on the new project), while allowing mappings to be maintained.

If the requirements are changed in an external requirements database tool - then during a partial import asureSIGN will highlight all of the changes and the user can decide whether to accept the changes or not - it will also identify new and removed requirements.

Scalable

Due to the export/import XML capabilities with asureSIGN it is possible to import data from multiple projects and edit the data in a larger grouping to allow scalability - this might be used when building systems or subsystems and wishing to reuse some of the tests etc. from units or module test environments for example.

Light Tool Flow
AsureSIGN

The ability to map the full requirements engineering flow within one tool gives the user the ability to have a light tool flow. Many Requirements engineering tool flows are reliant on multiple tools interacting with one another - although the industry is currently trying to solve this, it is still more complex and leads to the need to buy in multiple tools which also increases the costs.

Quality and Completeness

Implementing asureSIGN with a good process can help to improve the quality and completeness of the requirements.

As the requirements also need to be described within a design specifications, when that specifications is released, if, during the review process, the test or verification engineer is unsure of the features in the specification either due to the meaning of them, the reason they exist or sees any missing then this highlights a number of issues.

- Missing features mean that the requirements are not being fully satisfied, are misunderstood or are in conflict over the meaning of a feature in relation to a requirement, which generally indicates a poorly written requirement.
- Extra features which do not relate back to a requirement according to the test/verification engineer can mean that either there are missing requirements, or that there is some over-engineering, both needing remedial action.

Earlier visibility of the requirements also allows for earlier test planning (where final planning may be dependent on the implementation details) and also introduces an extra review process on the quality of the requirements as the design and the test teams will be reviewing the requirements directly.

Future Developments

- Cross-Project Analysis Dashboard
- API for easier in-house integration and scripting
- Full support for Regular Expressions
- HTML reporting
- Web frontend

Cross Project Analysis Dashboard

A near-term release of asureSIGN will include a cross domain analyser for larger projects split amongst multiple groups or sites.

Large companies often suffer from blind spots in communication between different groups and due to this have a tendency to overcompensate by replicating testing unnecessarily. This costs time and money.

The new dashboard will be configurable and allow users to decide what information they wish to see and to what level of detail. Many times data is shown or replicated within tools when it is either not needed, not used or merely obscures the required information.

Configurability will allow different users to analyse the project progress with the information that is important to their roles. A project manager would most likely want to see every requirement and analyse which domain it is being tested in, who to contact and what the status of the test is. A verification manager is more likely to want to see a subset of the features and look in more detail at what the coverage results were or the pass/fail rate.

Additional Resources

For additional information on asureSIGN please visit:

- [www.testandverification/solutions/requirements](http://www.testandverification/solutions/requirements)
Appendix

AsureSIGN System Requirements

- Currently supported on Linux
- Windows version under development

Required Software

The following software should be installed on the host.

- Java Runtime Environment (JRE) v1.6 or later
- Perl v5.10.x or later with the following modules:
  - Perl DBI module (libdbi-perl)
  - Perl DB::MySQL (libdb-mysql-perl)
  - MySQL Server (Ver. 5.5.x or later)

Supported Operating Systems:

- Ubuntu Linux v10.10 x64 or higher
- CentOS 6.3 or equivalent Redhat Linux

Terminology

The following terminology is used with asureSIGN.

- EXECUTED: Is when a metric has been run and completed
- FAIL: A metric that is failing its target metrics
- FEATURES: Are the functions needed to satisfy the product requirements and are proven via sub features or goals achieving their specified metrics.
- GOALS: Are the atomic unit of a feature or sub-feature to which result metrics (coverage/test) are associated. A goal is a measurable unit. Goals may be set on a per milestone basis
- GOAL/METRIC TYPE: Type of a particular goal/metric like Directed Test; Cover Bin, Cover Point...
- GOAL/METRIC ITEM: Name of a particular goal or a metric.
- GOAL MISSING: A goal that was previously mapped and is now no longer mapped in a particular regression.
- MAPPED: Those metrics which are mapped to one or more goals
- MAPPING: Is a pattern or string and may contain some wild* characters. Mapping acts as a link between a goal and a metric and is bi-directional.
- METRIC MISSING: A metric that was previously executed and is mapped to a goal, but is no longer executed so no PASS/FAIL rate is available.
- MILESTONES: Is a significant stage or event in the development of the project.
- NEW METRIC: A metric which was captured in a particular regression which was not present in the earlier one.
- PASS: A Goal that is passing its target metrics
- REQUIREMENTS: Are the statements of stakeholder’s needs, objectives, and expectations of a product (equivalent to a Top level test plan)
- STATE: Describes the status; PASS, FAIL, METRIC_MISSING, GOAL_MISSING
- UNMAPPED: Those metrics which are not yet mapped to any goal.
Sample asureSIGN User Interface Screens

Main Dashboard

Analyzer
Regression Testing

Proof of Implementation
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