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Semantic Traceability: How to keep the digital thread all along the Systems Engineering lifecycle



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- Introduction to The REUSE Company and the speaker
- Basic concepts about traceability management
- > What is semantic traceability
- > End-to-End traceability: all along the Systems Engineering Lifecycle
- > Live demo
- > Q&A

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Introduction to The REUSE Company





What we do:

The REUSE Company is a tool vendor specialized in the application of semantic technologies and artificial intelligence to improve the digitalization of the Systems Engineering life cycle.

SES ENGINEERING Studio





> The Systems ENGINEERING Suite

- RQA QUALITY Studio
- RAT AUTHORING Tool
- > TRACEABILITY Studio
- > V&V Studio
- KM Knowledge Manager
- SES ENGINEERING Studio



José Fuentes



- Current Position: Chief Sales Manager of The REUSE Company
- Former Product Manager of RQA and the Systems Engineering Suite
- INCOSE CSEP Certified
- Graduated in the INCOSE Institute for Technical Leadership
- Member of the board of AEIS The Spanish chapter of INCOSE
- > Active contributor to the INCOSE Guide to Writing Requirements
- Other certifications: ITIL
- > Other interests: Project Management, Business Analysis, Risk Management



Basic concepts about

Traceability

What is traceability?





- > The capacity to find where a product was made
- > What raw material and added components were used
- > How it was produced
- > Where it was stored
- > How it has been released
- > All along the logistic chain
- > ...
- > From beginning to end



Basic traceability: within a software environment



"

* "A software requirements specification is traceable if (i) the origin of each of its requirements is clear and if (ii) it facilitates the referencing of each requirement in future development or enhancement documentation"

Source: ANSI/IEEE Standard 830-1984



• " A requirement is verifiable if, and only if, there exists some finite cost-effective process with which a person or machine can check that the software product meets the requirement"

Source: ANSI/IEEE Standard 830-1984



Basic traceability: traceability matrix

Sample traceability matrix

Requirement Identifiers	Reqs Tested	REQ1 UC 1.1	REQ1 UC 1.2	REQ1 UC 1.3	REQ1 UC 2.1	REQ1 UC 2.2	REQ1 UC 2.3.1	REQ1 UC 2.3.2	REQ1 UC 2.3.3	REQ1 UC 2.4	REQ1 UC 3.1	REQ1 UC 3.2	REQ1 TECH 1.1	REQ1 TECH 1.2	REQ1 TECH 1.3
Test Cases	321	3	2	3	1	1	1	1	1	1	2	3	1	1	1
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1.1.4	1			x											
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1.1.6	1		х												
1.1.7	1			x											
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1.2.3	2								x	x					
1.3.1	1										X				
1.3.2	1										х				
1.3.3	1											x			
1.3.4	1											x			
1.3.5	1											x			
etc															
5.6.2	1														x



Might be good <mark>as</mark> a first step



Allows to check where every requirement comes from



Allows you to check completeness of tests



Ensures that implementation meets specification



Enough for some projects (e.g. SW)

Not enough in complex projects

No support to req. decomposition or design



Doesn't satisfy standards like: ARP4754, DO-174, DO-254, ISO26262...



J Listed below are the processes the supplier should provide to show they are meeting the ARP4754A objectives:

- Requirements management process, including traceability and allocation processes
- Requirements validation process
- > Requirements verification process
- Safety analysis process
- Configuration control processes (for DA data)
- > Change management process (covering change impact and regression analysis)
- Problem reporting process
- > PA (audit/assessment process to verify adherence to the processes)

Source: DOT/FAA/TC-16/39

Safety Issues and Shortcomings With Requirements Definition, Validation, and Verification Processes Final Report





JJ G The following objective statement is from ARP4754A, Section 5.3.1.1, Safety Requirements:

"Requirements that are defined to prevent failure conditions or to provide safety related functions should be uniquely identified and traceable through the levels of development. This will ensure visibility of the safety requirements at the software and electronic hardware design level."

Requires to **prove** that requirements' sets are sufficiently **correct** and **complete** so that the final product will **meet the customer' needs**.

Functional Safety: IEC 61508

- EN 50128 Railway
- IEC 60601 Medial Equipment
- IEC 61511 Process Industry
- IEC 62061 Machinery
- EN 60880 Nuclear
- ISO 26262 Automotive

Similar requests with regards to traceability





FIGURE 3.5 Iteration and recursion. Reprinted with permission from Garry Roedler. All other rights reserved.

WEBINARS 2022

COMPANY



Traceability in complex projects: traceability map





Traceability in complex projects: traceability map





Semantic

Traceability



05 Reasoning

A combination of rules, tasks and groups to infer information from valuable assets



Formalization

Representation of assets semantic through SRL – System Representation Language



Vocabulary

Controlled Organizational and Project Vocabulary for a common understanding among stakeholders

SCM/Architectures

Recreate and capture the system architectures represented in views and models. Stablish relationships among system and system elements

Patterns

Represent requirements similarities and enable formal representation, automatic recognition and aid authors





> Inputs and outputs:

SR0254:"When ice is detected, the car shall show an ice icon in less than 0,5 s from its detection"











Semantic formalization

(output property):





Semantic traceability: the digital thread





Semantic traceability: suggestion of traces





Semantic traceability: suggestion of traces



SMART Traceability: the core of a successful systems engineering discipline



ARP-4754, DO-254, DO-178, ISO 26262 and Traceability between heterogeneous environments

Description:

Traceability is a core activity within the Systems Development Lifecycle, and it's a must when aiming to cope with ARP-4754, DO-254, DO-176, ISO 26262, and other guidelines and best practices in different industries (aerospace, defense, automotive, healthcare...). It's a key practice, but also a fadious and time-consuming one, especially when the traces involve items coming from different disciplines and lools. Therefore, teams must be provided with tools that allow connection to heterogeneous environments, allowing easy access to the different configuration items, the definition of traces among them, generation of traceability matrices and impact analysis, and providing also semantic analysis features to suggest missing traces and smartly manage subject links after changes.

In this webinar, The REUSE Company will present a new version of the tool TRACEABILITY Studio. This tool, fully integrated with the Systems Engineering Suite, features connectors to some of the mest widely-used tools in the systems engineering field; this includes requirements management tools, modeling tools, testing, simulation, and even connectors to NS Office. TRACEABILITY Studio provides an easy-to-use answer to all the challenges mentioned above, making this demanding additive, and affordable for companies of all sizes.

Agenda:

- · A brief introduction to The REUSE Company and the Systems Engineering Suite
- · The main challenges for an efficient traceability process
- Main capabilities of TRACEABILITY Studio
- Live demo

• Q&A

Date:

Wednesday March 17, 2021, 4:00 PM CET (Madrid)/ 8:00 AM PDT (Los Angeles)/11:00 AM EDT (Detroit)

Thursday March 18, 2021, 9:00 AM CET (Madrid)/ 5:00 PM JST (Tokyo)/ 7:00 PM AEDT (Sydney)



Download presentation

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End-to-End

Traceability



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- > Management of some key entities:
 - Requirements, tests, and risks
 - > Aside from other optional ones: release management, issue management
 - > Version control, configuration management, change management...
- > Quality management is "well implemented":
 - Based on the completeness of traces
 - Connection to testing platforms (JUnit, NUnit, Cucumber...)
 - This closes the loop between requirements and tests

But:

- Integration to other tools is normally done in a one-to-one fashion
- > What about the integration with non-structured sources: e.g. high-level needs, regulation, standards...
- > Connection to modelling tools: simulation, logical and physical modelling
- Connection to source code
- Information inside relational databases







End-to-End Traceability: complex ecosystems



Source: https://beyondplm.com/2014/07/22/plm-implementations-nuts-and-bolts-of-data-silos/



End-to-End Traceability: complex ecosystems

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End-to-End Traceability: changes



FIGURE 5.9 Requirements changes are inevitable. Derived from (Forsberg et al., 2005) Figure 9.3. Reprinted with permission from Kevin Forsberg. All other rights reserved.



- > SES ENGINEERING Studio has implemented the notion of *Interoperability hub*:
 - No one-to-one connector: every tool connects to the hub
 - Source tools from many different disciplines: RMS, MBSE, PLM, ALM, MS Office, PDFs, DBMS
 - > No wipe-out approach at all, those source remain as the Authoritative Source of Truth (ASoT)
 - > Changes in the source are notified in the SES ENGINEERING Studio and arise the notion of suspect links
 - > Removed elements in the source are also shown, and arise alerts in traces
 - > Changes in the SES ENGINEERING Studio are persisted in the corresponding source tool (ASoT)
- > SES ENGINEERING Studio orchestrates and synchronizes all the ASoT within the Interoperable Hub:



Traceability in complex projects

Pros

Ρ

It's a **must** in complex and safety critical projects Requested by **standards** and **good practices**: ISO26262, ARP4754... Provides **visibility** in complex projects

Cons

C

It's normally a **tedious** and **manual** task Involves **connection** of tools that are not easy to connect It has to be aware of **changes** and the evolution of the project



Demonstration

Traceability Live Demo: Use case



B, Enrig to Facilit

End-to-End Traceability: Steps: >

- Open MS Word to parse PDF documents (Goals, Regulatory documents)
- Connect the SES ENGINEERING Studio 2.
- 3. Establish traces between items in those PDFs and requirements in DOORS
- Create a connector to a Capella model 4.
- 5. Trace requirements to Capella elements
- Create a connector to code in Visual Studio 6. and 3D models in Solid Works
- Trace all these elements 7.
- 8. Generate a dynamic *impact analysis* report











- Connecting the Dots: Interoperability between your favourite Systems Engineering tools
 - > With the connections established and traces completed, you will now be able to INTEROPERATE between them.
 - Generating different types of models from textual requirements, transforming a model of specific type into a divergent one, automatic re-writing of Requirements to meet specific writing rules, etc.
 - **Dates:** November the 2nd and 3rd, 2022





Contact information















encusecompany



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RQA - QUALITY Studio SPELA UPP ALLA

RQA - QUALITY Studio allows you to define, measure, manage and improve the quality of your requirements, models, documents etc.



The REUSE Company in Youtube: https://www.youtube.com/user/TheREUSECompany



