Requirement Traceability in Practice

How to turn the challenge into an opportunity

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Systemite

Founded 2000 in Gothenburg, Sweden
Large footprint in Swedish automotive industry
Location
  Headquarters in Göteborg/Gothenburg
  Branch office in Stockholm
  Representation in Republic of Korea: ESG Solutions Ltd
  Representation in China: ADG - Auto Development Group

Concept

Improved information management
Specialized in automotive embedded systems development processes
ALM/ESLM (Embedded Systems Lifecycle Management)
  100% focus since day one
  Long experience in deploying ALM/ESLM solutions to automotive domain

Trusted by

Volvo Cars
Volvo Construction Equipment
DongFeng/T-engineering
Delphi Automotive (AUTOSAR)
CEVT/Geely
Volvo Global Truck Technology (incl Renault, Mack, UD)
NEVS / SAAB
KAERI (Korean nuclear research)
dSPACE GmbH

Research Projects

MAENAD  CRYSTAL  SYNLIGARE  HEAVY ROAD  EMC2
In the automotive industry

- A major part of the value of data comes from its **context** and how it **relates** to other data artifacts.
Traditional approach

Fragmentized system description
- Low traceability
- Duplication of information
Leads to
- Quality issues
- Inconsistencies
- Efficiency problems

Low traceability and redundant information

Manual work to manage changes – keeping the system consistent

Status unclear
Integrated approach
One unified model – many views

Everything from one model
• Correct
• Consistent
• Complete
Integrated data management

- In a complex system such as a modern car
  - Many people collaborating
  - Late integration $\Rightarrow$ high costs (even with defined interfaces)
  - Information continuously integrated in its context $\Rightarrow$ less assumptions, less complexity, more reuse

- Continuous integration benefits from single source of information
  - Doesn’t mean all the information in one “tool”
  - Means that information is accessible, traceable, reportable, searchable, and analyzable from one place.
Automotive OEM

- Requirements for bill of material
- Safety requirements
- Requirements for in-house development
- Design & architecture
- Simulation models
- Behavior models
- ...

- All of these are requirement beyond the notion of requirements as specification
Traceability on different levels
Four main methods of managing data

- **File-based**
  - Example: Word & Excel

- **Silos**
  - Example: Doors & ClearQuest

Why the move towards integrated data? What are the benefits?

- **Weakly connected silos**
  - Example: Jazz (OSLC)

- **Integrated information management**
  - Example: SystemWeaver
Benefits of integrated data

When you create data in its context you can:

- Ensure **consistency**
- **Generate** instead of create
- **Analyze** (completeness, correctness, progress, process analysis & ...)
- View from **many perspectives** (change impact, requirements, tests per requirements & ...)
- **Visualize**
- **Integrate solutions**
- Using links to keep data **up-to-date**
3.1 DI - Turn Signal

E2E_DiInd_Req-716 DI - Function Operation
Type: Functional Requirement
Verification Method: Test
This requirement is a prerequisite to all other requirements.

The turn signal function is only operational in

E2E_DiInd_Req-815 DI - Turn Signal Activation
Type: Functional Requirement
Verification Method: Test

Task formulation
Add functionality for monitoring the direction indicators so that the operator is alerted upon a broken indicator light.

Former system design
In ART-E telltale were used to diagnose a broken indicator light.

Two direction indicator telltale were used. Normally both telltale would be activated simultaneously. Broken indicator light on the dump body was detected, one of the two telltale would be off the one.
Traceability for Single Requirement

- 130+ Specifications and Reports
- 10+ Products
- 40+ Test Suites
Traceability to Lower Level Abstractions

E2E requirement impact analysis for: Direction Indicators

Description of requirement:
If the direction indicator malfunctions (i.e., a broken lamp) the operator shall be alerted.

Note: This is so that the operator is made aware that his direction intentions may not be perceived by the surroundings.

Impact analysis

<table>
<thead>
<tr>
<th>Analysis function</th>
<th>Analysis requirement</th>
<th>Design Component</th>
<th>Design requirement</th>
<th>Real allocation target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direction Indicator Monitoring</td>
<td>Direction Indicator Diagnostics A-DIM-1 v1</td>
<td></td>
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<td>Direction Indicator Diagnostics A-DIM-2 v1</td>
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<tr>
<td>Direction Indicators Lamp Diagnostics</td>
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</tr>
</tbody>
</table>

Log: Creating report... Report Done
As Used in Test & Verification Planning

1 Allocation to Test Specification:

2 Allocation to Test Case:
Example: ISO 26262 – Safety management

Many different types of data

Organizational changes
Integration facilitates...

Generate safety case for an item

Argument

Evidence

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Integration facilitates ...

Generate progress reports for an item's safety goals

Safety goal coverage

Real-time test progress report
Integration facilitates ...

Which products include component A & which version of it?

Fine-grained information

Generate instead of Search and create

What functions are allocated to that component in each product?
Integration facilitates ...

- Fix bugs in component A once, get the effect in all products including component A
- Change impact analysis
- Consistency check

Exponential growth of number of files in file-based approach
Reflections

- Academic research: utilizing the opportunities of using integrated data
  - An overemphasis on the mechanisms of storing integrated data and research on special cases but little on studying the benefits
  - There is a gap between purely technical and from-scratch contributions that are hard to apply in industry and observational interview studies.
  - Use the existing platforms to make more actionable research and get closer to studying organizations through their data and maybe guided by interviews.
Reflections 2

- Data analysis on more structured data gives insights not only into the data and the product but also into the organization.
- Important to keep data consistent and up-to-date; Not only for efficiency and cost but also for quality and creating new opportunities and raising the complexity to higher levels of abstraction.
- Utilize the traceability of data to keep the data updated.
Thank you

15 000 files or one integrated source of information?