Standardization is Key to Success in Systems Engineering

Dr. Bernd GRAHLMANN

Dr. Bernd GRAHLMANN – Bio Highlights / Background …

Dr. Bernd GRAHLMANN

Expert / Trainer / Consultant

25+ years of stories experienced in Systems Engineering

(focus RE/RM + V&V + Safety …)

Setup / developed processes and tools worldwide in various industries

(medical devices, railway, automotive, space, aviation, aerospace, defense, energy, banking, pharma, semiconductors, software, elevators, building, gaming, ...)

Trained thousands of engineers worldwide

(SE + RE/RM + V&V + DOORS …)

Agenda

01 **Goals of the Presentation**

02 **‘Suffering from Mess’ versus ‘Benefitting from Standardization’**

03 **3 Customer Stories experienced**

04 **Types of Specifications & Types of Objects**

05 **Attributes & Types (incl. Versions / Variants Management)**

06 **Customer Stories experienced - Outcomes**

4 Main Goals of the Presentation

Understand Problems

- Awareness

  Raise awareness ‘suffering from mess’ versus ‘benefitting from standardization’ – helping to avoid trouble

- Traceability visualization, reporting and tool migrations

  3 Stories experienced highlighting impact of lack of good standardization: traceability visualization, report generation + tool migrations – helping to avoid trouble in unexpected areas

Provide Solutions/Take-Aways

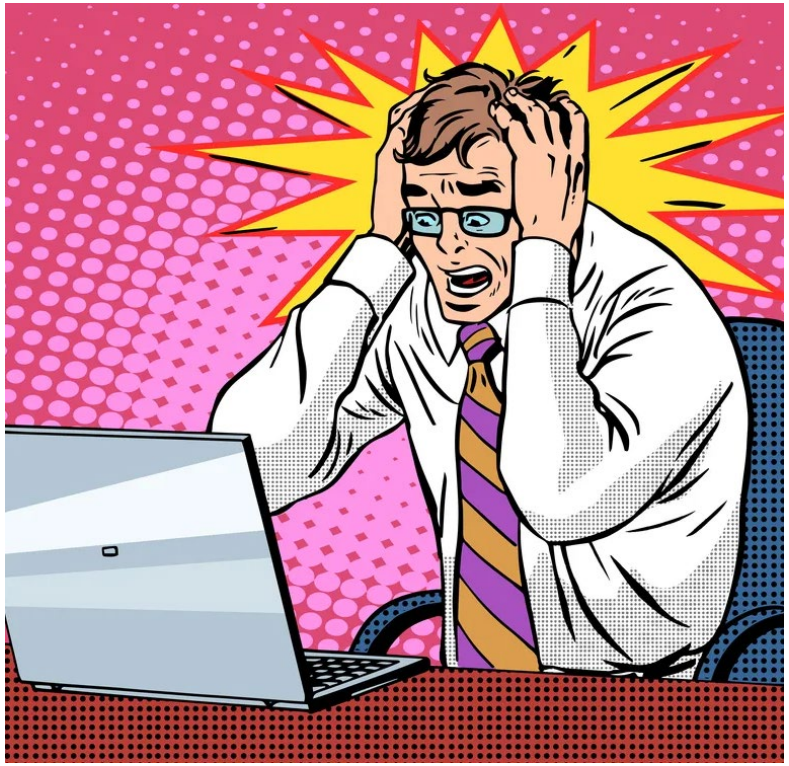
- Types of specifications and their types of objects

  Provide good standard for types of specifications and their types of objects – providing a jump start

- Attributes (and their types)

  Provide good standard for attributes (and their types) for a Technical Requirements Specification – providing a jump start + highlighting not so obvious attributes

Suffering from Mess



Everyone experienced these stories - without standardization nothing works smoothly:

- Finding specifications
- Knowing in which attributes to look
- Filtering
- Report Generation
- Traceability visualization
- Migrations to a new tool
- Data exchanges
- Tool integrations
- KPIs
- …

3 Customer Stories Experienced (over and over again)

Traceability visualization

Men years wasted on yet another view and/or script ☹
Traceability not showing attributes (correctly) ☹
Traceability not showing correct traces for certain objects ☹
Filters not working properly ☹
Reviews way more complex and time consuming than needed ☹

Report Generation

Men years wasted on yet another reporting template and/or script ☹
Reports not showing attributes (correctly) ☹
Reports not showing correct traces for certain objects ☹
Reporting way more complex and time consuming than needed ☹

Tool migration

Thousands of specifications to be migrated ☹
Their types not standardized / fuzzy ☹
Hundreds of not standardized attributes (Prio vs Priority vs … + 1-10 vs ‘none’, ‘low’, ‘medium’, ‘high’ vs …) ☹
Men Years wasted on analyzing status and cleaning / mapping to (standard in) new tool ☹

Types of Specifications with their Types of Objects (I)

(Orange = important for traceability)

- Feature List

  Feature, Information, (Heading)

- (Goals of) Use Cases

  Use Case, Operational Scenario, Goal, Actor, Pre-Condition, Post-Condition, Use Case Diagram, Basic-Flow, Alternative-Flow, Exception-Flow, Step, Junction, Information, (Heading)

- Original Customer Requirements Specification / Original Standards & Regulations / Original Internal Standard

  Incoming requirements to be allocated and requirements collected to scopes

  Requirement, V&V Requirement, Process Requirement, Mix Requirement, Information, Deliverable, Interface, Goal, Assumption, Design Details, V&V Details, Domain Knowledge, (Heading)

- Customer Requirements Specification / Standards & Regulations / Internal Standard

  Requirements collected (according to allocation) into specification for one scope

  Requirement, V&V Requirement, Process Requirement, Mix Requirement, Information, Deliverable, Interface, Goal, Assumption, Design Details, V&V Details, Domain Knowledge, (Heading)

Types of Specifications with their Types of Objects (II)

- Technical Requirements Specification

  Requirement, V&V Requirement, Process Requirement, Mix Requirement, Information, Deliverable, Interface, Goal, Assumption, Design Details, V&V Details, Domain Knowledge, (Heading)

- Verification & Validation Specification

  V&V Summary, V&V Anomalies, V&V Suite, Master V&V Case, V&V Case, V&V Resources, V&V Prep Step, V&V Step, V&V Termination Step, V&V Information, Information, (Heading)

- Architecture

  Architecture Element, Reference to Requirements, Derived Requirement, Interface, Information, (Heading)

- Risk Management Hazard Analyses

  Hazard, Risk Control Measure, Risk Control Measure Details, Information, (Heading)

Main Attributes
(Technical Requirements Specification)

Object Text

Text of requirement …

‘*The Automotive Airbag System shall implement data encryption for all stored and transmitted data to protect against unauthorized access and ensure data integrity.*’

Name / Title

A meaningful short ‘name’ / ‘title’ for the requirement …

‘*Data Security*’

Object Type

Requirement, *V&V Requirement*, *Process Requirement*, *Mix Requirement*, *Information*, *Deliverable*, *Interface*, *Goal*, *Assumption*, *Design Details*, *V&V Details*, *Domain Knowledge*, *(Heading)*

ID

A unique ID provided by the tool + potentially a ‚meaningful‘ ID

‚*Airbag.TRS_42*‘

Comments

All kind of comments

Versions/Variants of Products
➔ Version/Variant Specific Attributes

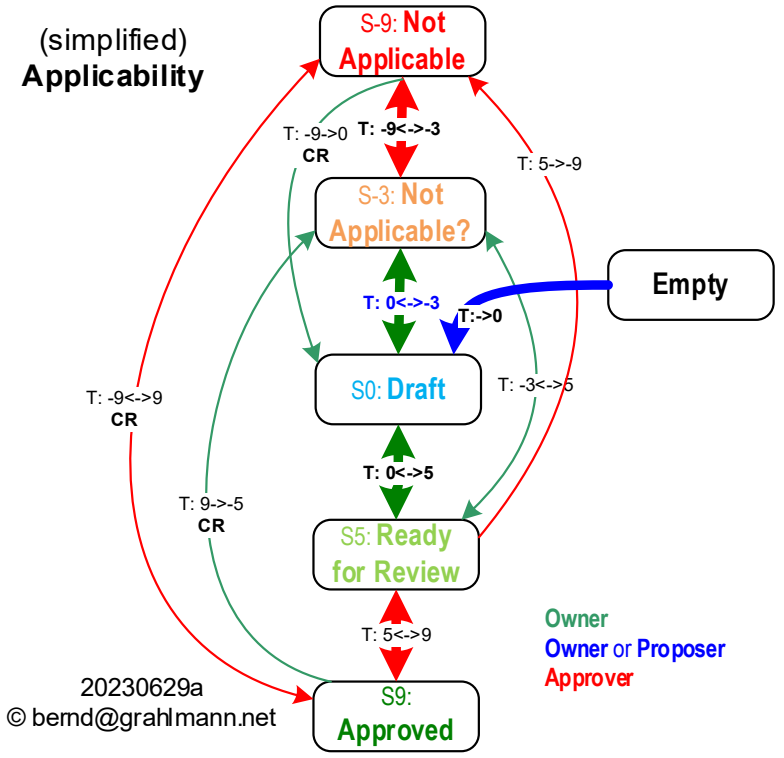
Applicability is key

Manage the main ‘status’ of a feature, requirement, architecture element, V&V case, V&V step, … via applicability per variant / version:

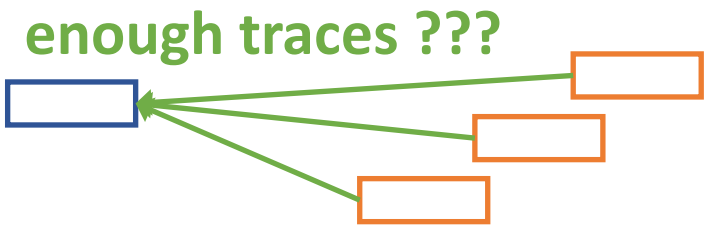
Applicability (per product version/variant)
(whether or not the requirement or feature or architecture element or V&V case or … is applicable for the product version/variant)
e.g., [{**Not Applicable**, Not Applicable?, Draft, Ready for Review, **Approved**}]

Typical ‚work-flows‘ are:

1. Draft -> Ready for Review -> Approved;
2. Draft -> Not Applicable? -> Not Applicable



More (Traceability) Status related Attributes



- Has a Requirement (or Feature) sufficient traces?
  Manually set via reviews …
  TBD, N/A, Not *Detailed/Satisfied/Qualified/Realized*,
  Partially *Detailed/Satisfied/Qualified/Realized*,
  Detailed/Satisfied/Qualified/Realized
- Why? What is the argument?
- Rather Version/Variant specific

➔ Important for overall (KPI) top-level status calculation

Detailed Level and Argument

On the same level / scope

Has a Feature been detailed by technical requirements?
Has a technical requirement been detailed by design details?

Qualification Level and Argument

From Qualification / Verification & Validation / Testing down/right

Has a technical requirement been qualified by V&V / Test Cases?

Satisfaction Level and Argument

From next level / scopes down

Has a technical requirement been satisfied by technical requirements from next level / scopes down?

Realization Level and Argument

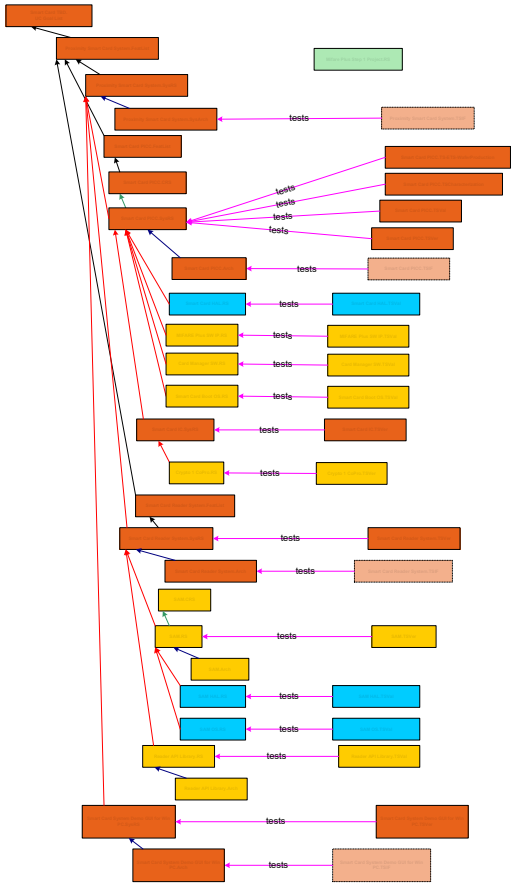
From Implementation

Has a technical requirement been implemented/realized?

Overall (KPI) top-level Status Calculation (Attributes)

Ultimate goal is to get the current overall top-level status for each requirement:

1. Not Typed
2. Requirement
3. Applicable Requirement
4. Satisfied Requirement
5. Realized Requirement
6. Qualified Requirement
7. V&V Passed Requirement



This uses attribute values and traceability information of the whole traceability of the requirement:

- Object Type
- Applicability
- Detailed Level
- Satisfaction Level
- Qualification Level
- Realization Level
- V&V Status
- …

Some not fully obvious Attributes

- (Design) Assurance / Safety Performance Level assigned + achieved

  (Depending on the industry) Design Assurance Level or Safety Performance Level – SIL, ASIL, … - like (from ISO 13849 EN1175):

  TBD, None, PLa, PLb, PLc, PLd, Ple

  'Assigned' / 'Needed to be achieved' versus 'Achieved'

- Conformance Evidence Type + Conformance Evidence

  (company/product/industry/… specific) Enumeration of types of conformance evidence to be provided

  (Text) List of conformance evidence created

- V&V Measures + V&V Status

  Enumeration of types of (company/product/industry/… specific) V&V Measures to be provided

  Manually (via review) determined V&V Status

  TBD, N/A, V&V Failed, V&V In Progress, V&V Accepted, V&V Passed

- Target Sub-Systems

  First architecture step – (multiple) selecting the contributing Sub-Systems (one level / scope down)

Usual Suspects

A lot well-known attributes may need less mentioning:

- Risk Level + Risk Description + Risk Mitigation Status
- Customer Priority + Company Priority
- Rationales
- Review Feedback
- Source References
- …

Customer Stories experienced - Outcomes

For various customers in many different industries …:

1. Types of specifications and their types of objects + attributes and their types have been fully documented (incl. naming conventions) + DOORS templates have been developed (incl. versions/variants management, traceability visualization, RPE reporting, …)

   ➔ MBSE Foundation

ID	Doors Attribute Name	Module / Object Level?	Defintion / Variant specific?	Applicable Module Types	Presence of value	Presence Of Attribute	(c) bernd@grahlmann.net - iDARM Attributes & Types Documentation	Attribute Purpose	Type Details	Attribute Usage	DOORS Attribute Type Name
Attributes .DOC-13							**2 DOORS Attributes**				
Attributes .DOC-205							**2.2 Attributes for Requirements Specifications**				
Attributes .DOC-446							**2.2.3.2 'Qualification' related Attributes**				
Attributes .DOC-237	a_<VariantName>_ QualificationLevel	Object	Var	OSTD OCRS OINT TRS	Only when applicable TRS-Mandatory xRS-Mandatory	TRS-Mandatory xRS-Mandatory	Qualification Level	Specifies for a variant whether sufficient V&V activities (in particular, test cases) - to test the realisation of the requirement on this scope - have been written and linked to the requirement.	[Enumeration]: TBD N/A Not Qualified Partially Qualified Qualified	Note, that 'Qualification' is meant as being more general and covering Validation and Verification and Testing … no matter which definition one uses (note that hardware guys often define verification/validation differently from software, … guys). In 'Qualification Level' one important status of requirements is tracked - whether there are sufficient V&V activities (in particular, test cases) - to test the realisation of the requirement on this scope - have been written and linked to the requirement (such that 'passing' those V&V activities implies that the requirement has been sufficiently validated and verified). …	aType_QualificationLevels

2. iDARM tooling has been developed to automate the migration of IBM Rational DOORS databases towards a chosen standard

3. A powerful solution (approach, templates, tooling, …) has been developed to improve and automate the migration from DOORS to Siemens Polarion:
   - Extracting what exists in DOORS and Polarion
   - Planning and reviewing the migration / mapping / standardization
   - Generating what's needed to turn the migration basically into a 1-click

Questions & Answers

Contact me via email: **Bernd@Grahlmann.net** or phone **+41 792967651**
QR code for https://www.grahlmann.net/bernd_grahlmann_business_card.htm

or check via https://www.grahlmann.net/doors_requirements_management_training_overview.htm
or LinkedIn: https://www.linkedin.com/in/grahlmanndoorstelelogic/
or Xing: https://www.xing.com/profile/Bernd_Grahlmann/

or join ‚my' LinkedIn groups:

- ‚Requirements Engineering Tools' https://www.linkedin.com/groups/12821233/
- ‚IBM Rational DOORS and DOORS Next Generation - DNG (ex Telelogic DOORS) User Group' https://www.linkedin.com/groups/769057/ ('active group' with >5K members)
- ‚Siemens Polarion' https://www.linkedin.com/groups/12004818/

Thanks a lot ☺