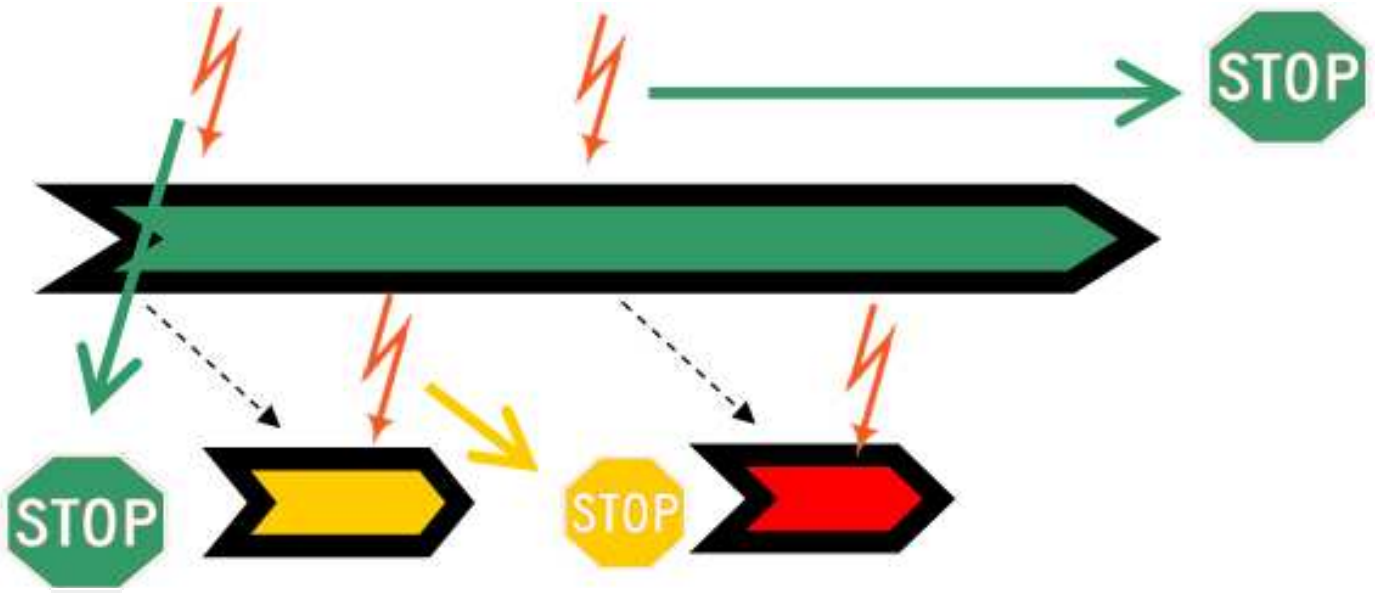

Oscar Slotosch

ISO 26262 Conforming Tool Qualification for Modular Tools

Content

- Motivation: ISO 26262
- Tool Chain Analysis
- Modular Tool Qualification
- Example Tool Architecture
- Summary

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Motivation & Goal

Motivation:

- **Many modular tools (Eclipse-based) in automotive industry**
  Some of them are frameworks
- **ISO 26262 requires tool confidence. Achieved by**
  - Tool qualification or
  - Evidence that potential errors would not affect safety

Goal:

- **Development modular method to provide tool confidence**
  - Qualification kit
  - Information (“Safety Manual”) to work with the tool in a safe way

ISO 26262-8, Chapter 11: „Confidence in the use of software tools“

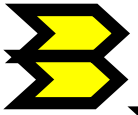
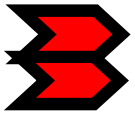
- **Classification in „Tool Confidence Level (TCL)“**
- **Tool Impact (TI)**
  - TI1: no impact => Tool is TCL1 
  - TI2: some impact
    - Tool Error Detection/prevention probability (TD)
      - TD1:high confidence => Tool is TCL1 
      - TD2:medium confidence => Tool is TCL2 
      - TD3: low/unkown confidence => Tool is TCL3 
- **Justification? Dokumentation? Confirmation Review!**

Table 2 — Qualification of software tools classified TCL3

Methods		ASIL			
		A	B	C	D
1a	Increased confidence from use according to 11.4.7	++	++	+	+
1b	Evaluation of the tool development process according to 11.4.8	++	++	+	+
1c	Validation of the software tool according to 11.4.9	+	+	++	++
1d	Development in compliance with a safety standard[a]	+	+	++	++

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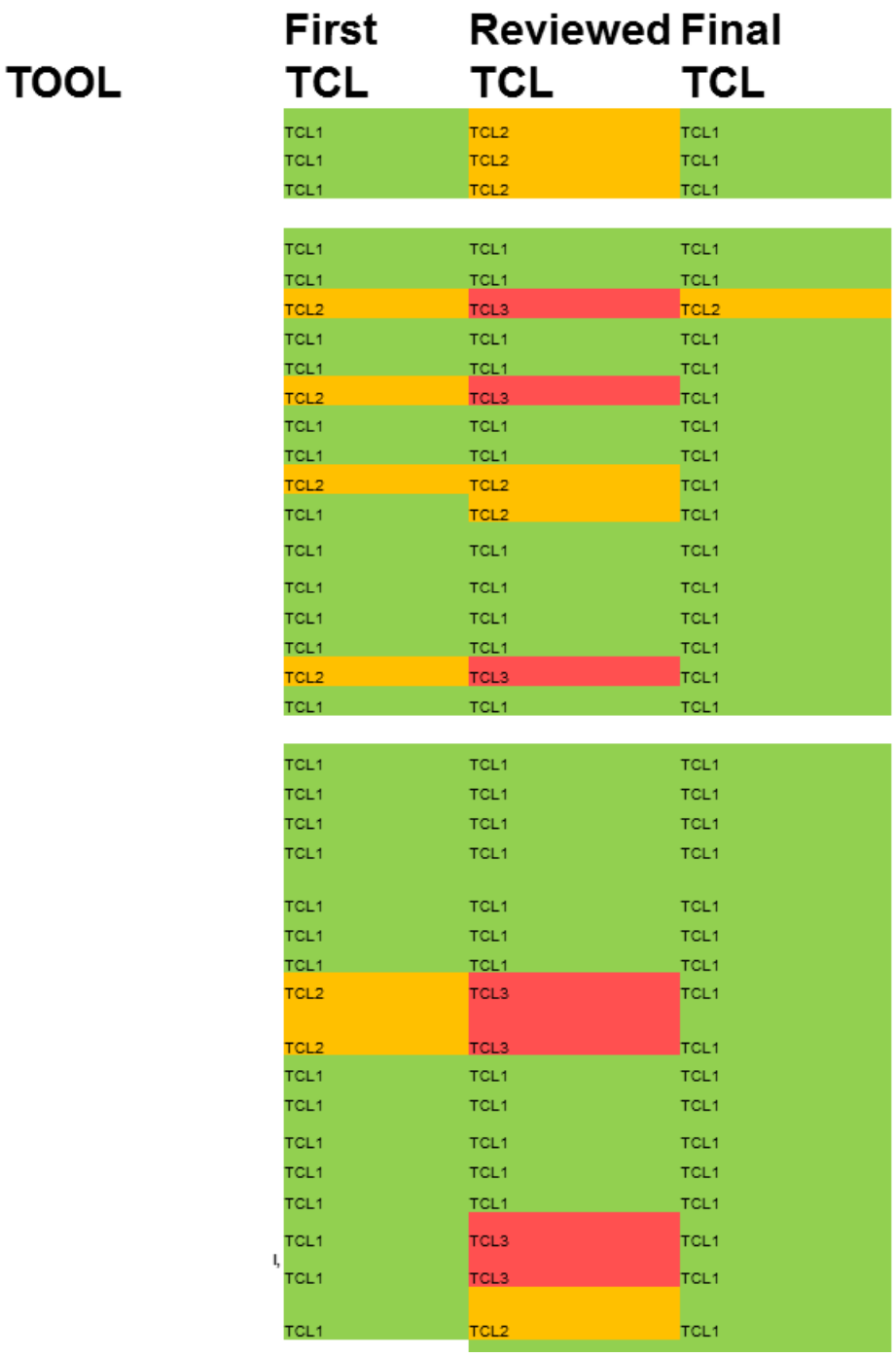
Tool Chain Analysis: Method & Tool

- **Computes automatically the TCL of tools and checks qualifications for ASIL**
- **Based on a simple but formal model of tools, use cases, errors, checks, etc.**
- **Many helpful features**
  - Report generation
  - Assumptions modeling
  - Model validation (no empty descriptions, no use case without errors,..)
  - Modularity and reuse concepts
  - Excel interface (check list generation,..)
- **Supports systematic error analysis**
- **Prototype developed from Validas AG in research project** recomp Reduced Certification Costs for trusted Multi-core Platforms
- **Bases on Eclipse, EMF, graphviz and docx4j**
- **Download from http://www.validas.de/TCA152.zip**

Result: Tool Confidence Levels

- **Tool Chain: 39 tools**
- **Only one tool with TCL 2**
- **Improvement: Reviewed -> Final**
  - Added wins & quick wins (Process changes)
- **Input for tool qualification**
  - Critical features
  - Undetected errors
- **ISO 26262 compliant**
- **Better than**
  - Defaults (from literature)
  - IEC / DO classifications

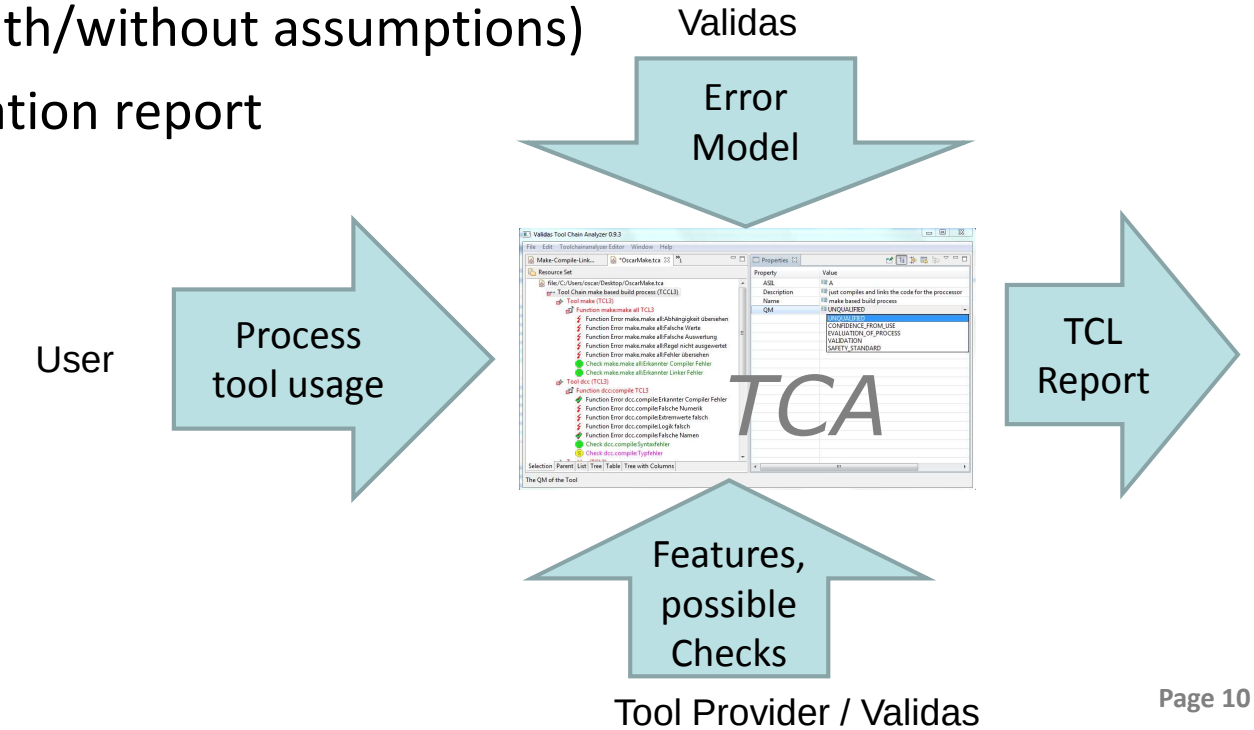


Why Can we Trust?

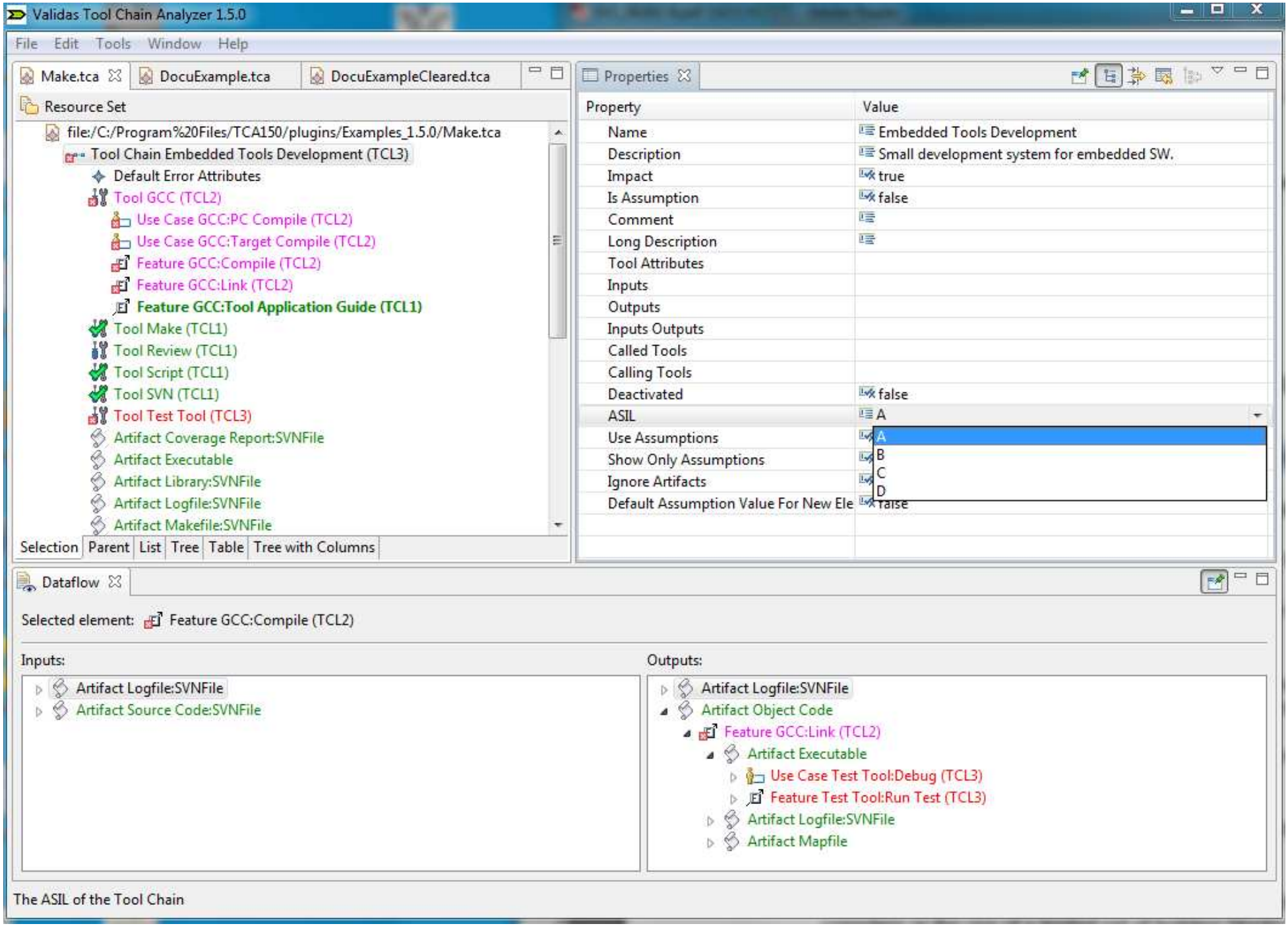
- Independent/external analysis performed from experts (Validas)
- TCLs are computed with a calculus (based on a formal model)
- Systematic error model for tools applied (black-box & white-box)
- Tool chain model and error model have been reviewed
- Analysis was tool supported (Tool Chain Analyzer)
- Detailed report (14 pages per tool in the example) explaining every error and every check/restriction

Modeling Method / Process for TCA

1. **Planning:**
   1. Build a formal model of tool usage based on tool and process information
   2. Validate the model (Review, Checklists)
2. **Tool Evaluation**
   1. Systematically build an error model (black box / glass box)
   2. Model detection and prevention (including assumptions)
   3. Validate **assumptions** and error/detection/prevention model
   4. Compute the TCL (with/without assumptions)
   5. Generate tool evaluation report
3. **Tool Qualification**



Tool Chain Analyzer



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Modular Tool Qualification

- **Goal: use tool modules with confidence (in many tools)**
- **Similar to "Safety Element out of Context" (SEooC)**
  - Elements: "Tool Modules", e.g. Libraries / Plugins
  - Assumptions on the usage of the modules in the context (tool)
- **A tool module description should contain**
  - List of available functions e.g. actions, methods,..
  - Input and output elements of the functions e.g. model elements, parameters
  - Potential errors in functions
  - Proposals for error mitigations (detection/prevention) with probabilities
  - Set of tests (for each function) that shows the correctness
    - Eventually restricted to a subset of models
    - Eventually restricted to the absence of some potential error classes
  - Documentation (including known bugs and used modules)
- **Using a module in a tool requires**
  - To check the assumptions of the module
    - Mitigate them in the tool or
    - Add them to the assumptions of the tool ("Safety Manual")

Module Qualification Kits

Qualification kit consists of

- **Test automation e.g. JUnit, Scripts for verifying the results,..**
- **Tests with expected results for**
  - Functions and
  - Inputs
- **Should cover the relevant code (in the module)**
- **Should mention the requirements of used plugins (functions & inputs)**
- **Safety Manual to avoid/detect potential tool errors**

A qualification kit is an additional product for every module

Assumption Examples

Depend on tool use cases and potential error mitigations

- **User Requirements (“Safety Manual”)**
  - Reopen saved models to verify persistency
  - React on warnings
  - Check log files
  - Make a training/tutorial
  - Execute an installation test
  - Verify environment variables & resources
  - Apply redundancy
  - Review results
  - Check known bugs
- **Developer Requirements**
  - Catch exceptions
  - Check return codes, parameters values
  - Consider programming rules
  - Provide qualification kit

Vision: Eclipse Qualification Process

- **Determine requirements for every used plugin:**
  - Used functions, inputs
  - Check assumptions of plugins
- **Show that assumptions of modules are satisfied**
- **Collect assumptions for the tool (user)**
- **Apply qualification kits for every plugin according to the identified requirements**
- **Measure code coverage during qualification**

Qualification

- **Measure code coverage of the application during usage**
- **Compare it with sum of all qualification coverage**
  - Application coverage $\subseteq$ qualification coverage $\Rightarrow$ OK
  - Application coverage $\not\subset$ qualification coverage $\Rightarrow$ NOK
    - Refine requirements & improve qualification kits (coverage)
    - Manually check correctness

Application

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Tool Chain Analyzer: Developer View (White-Box)

- **Eclipse structure: Plugin Projects (RCP)**

de.validas.tca.report 799 [https://svn.validas.de/repos/ISO26262_Toolqualifizierung, Trunk: TCA]
de.validas.tca.report.word 681 [https://svn.validas.de/repos/ISO26262_Toolqualifizierung, Trunk: TCA]
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Examples 773 [https://svn.validas.de/repos/ISO26262_T
ExcelInterface 465 [https://svn.validas.de/repos/ISO262
org.docx4j 548 [https://svn.validas.de/repos/ISO26262_
ToolChainAnalyzer 778 [https://svn.validas.de/repos/ISC
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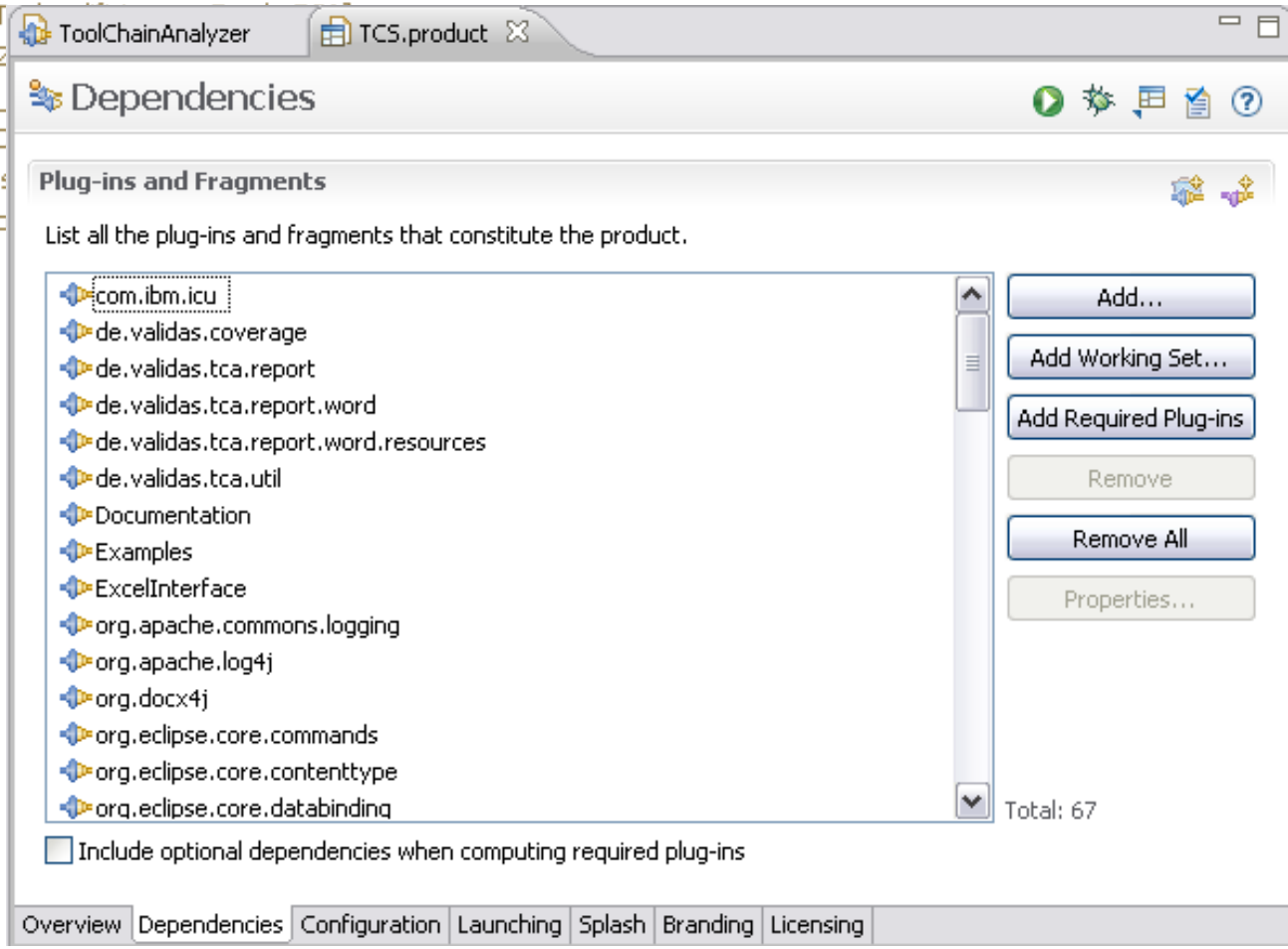
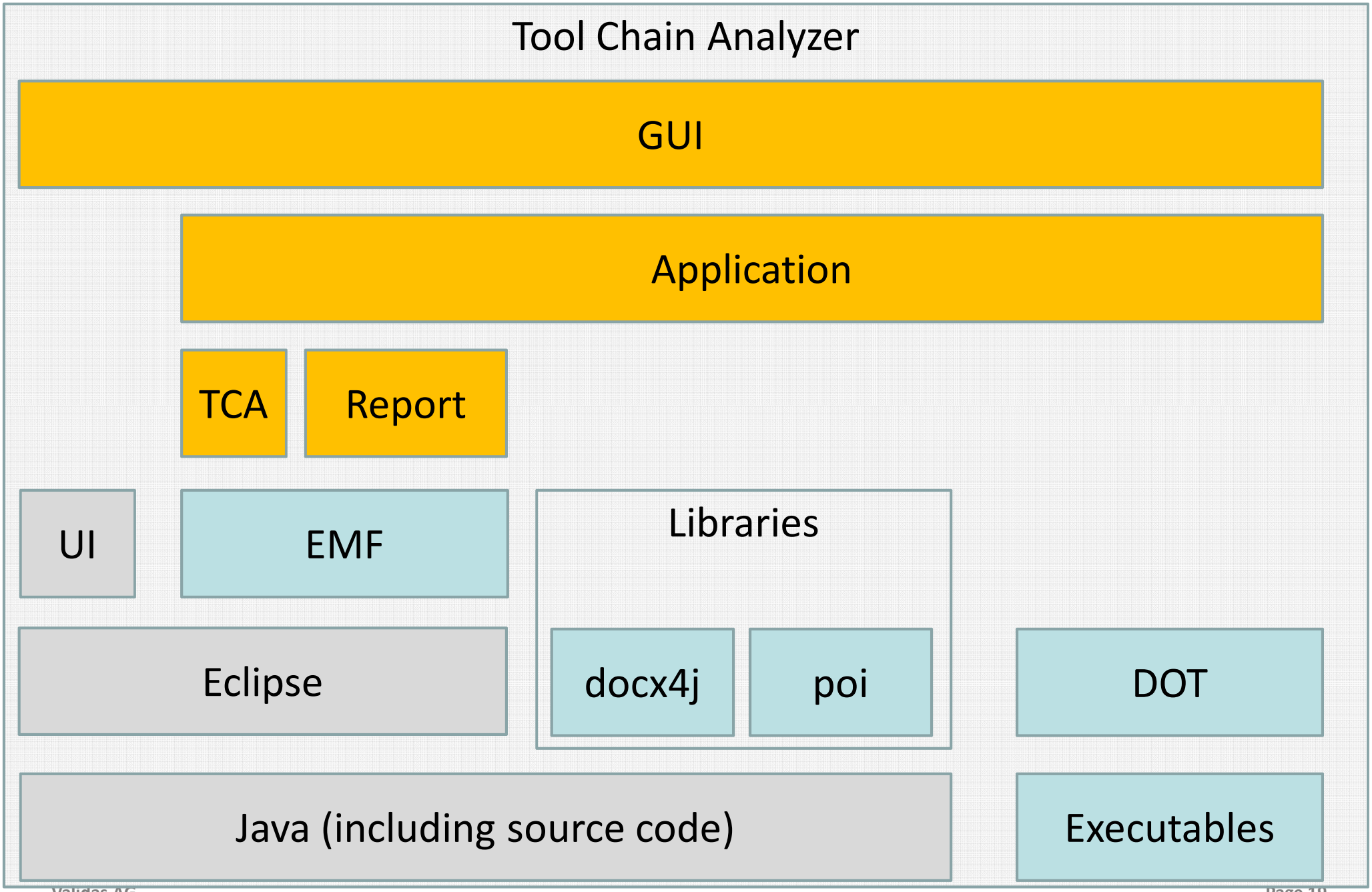
ToolChainAnalyzer.editor 785 [https://svn.validas.de/rep
ToolChainAnalyzer.tests



- **Many dependencies to Eclipse plugins**
- **Furthermore**
  - Integration of graphviz
  - Excel-Interface (Read & Write)
  - Word Generator

Logical Architecture



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Summary

- **ISO 26262 requires to classify (evaluate) all and qualify some tools**
- **Tool chain analysis**
  - Can reduce qualification needs
  - Determines critical use cases and potential errors of tools
- **Modular Qualification Approach (like SEooC)**
- **Tool chain analyzer as example for discussion of qualification methods**

Thank You!

VALIDAS

Arnulfstraße 27
80335 München
www.validas.de
info@validas.de

Backup

Possible Next Steps

- **Analyze more Eclipse architectures & middleware**
- **Build examples for modular qualification kits**
- **Build reference architecture, based on EMF?**
- **Build qualifcation infrastructre for EMF?**
  - Test automatization
  - Coverage analysis
    - Code coverage
    - Model coverage