Collaborative Model Review Support for AutomationML Change Sets

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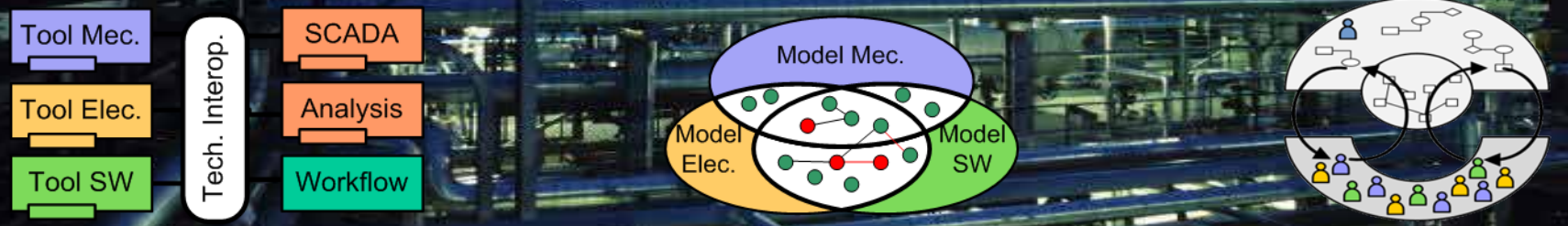

Context and Motivation

- **Multi-Disciplinary Engineering** (MDE) with parallel engineering.
- Technical and semantic heterogeneous tools and data models.
- **Changes** incur higher risk if not propagated accordingly.

- **Critical impact** of defects: robot crash, inconsistent data, unclear manufacturing systems behavior.

- **Reviews can help to identify defects early and efficient**, but
  - Limited tool support available.
  - Expert knowledge required.
  - No integrated data for efficient defect detection.

- Goal: Collaborative model review tool support for AutomationML and organization-specific artifacts.

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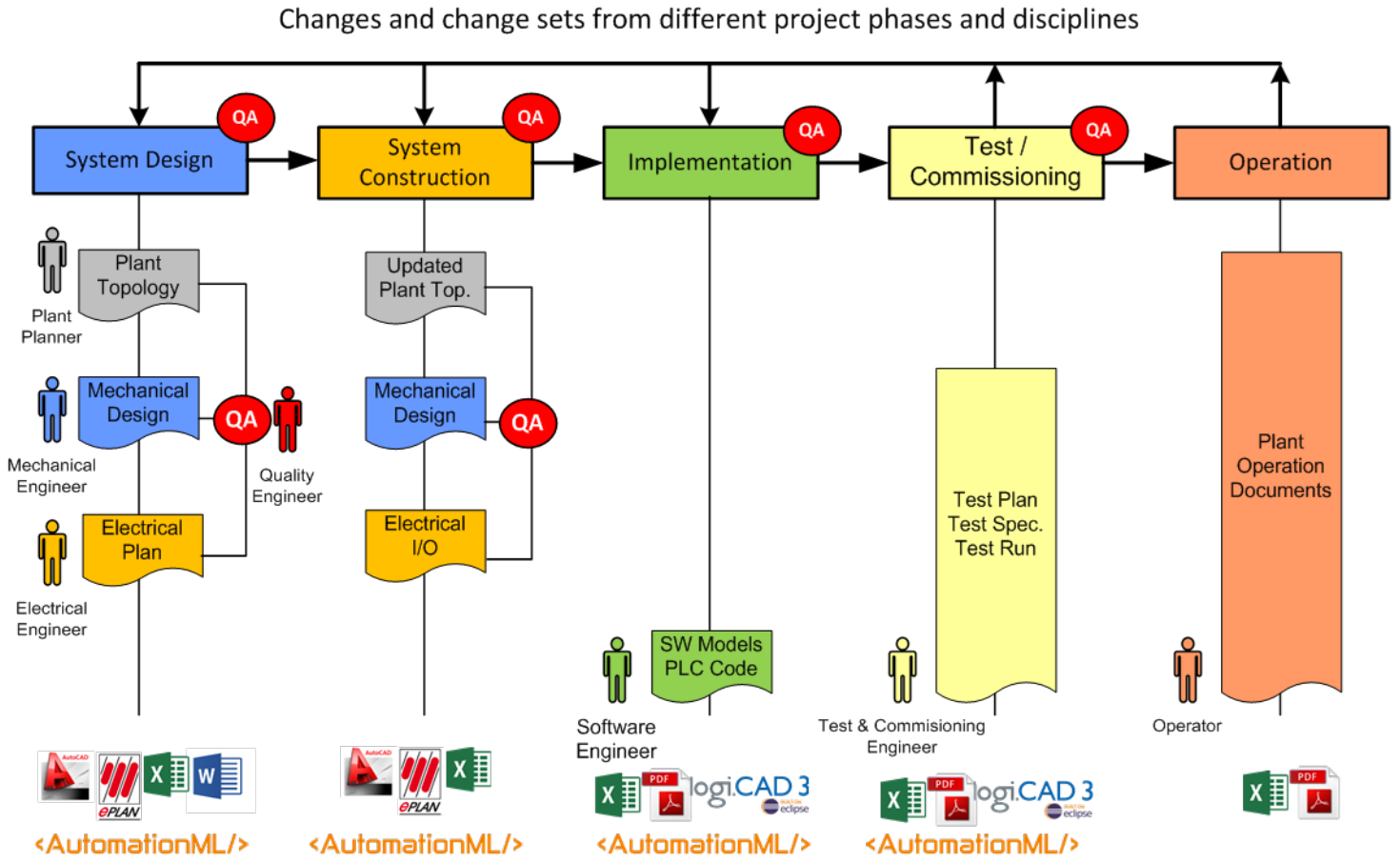
Sequential Engineering Processes

- **Sequential engineering process** with parallel activities.
- **Various artifact document types**
  - AutomationML, PDF, office.
  - Organization and tool specific data formats.
- **Manual data synchronization**
- **Quality Assurance and Reviews**
  - Large data sets.
  - Manual reviews on purpose.



Challenges and Needs for Review Support

- **Traceable review processes for AutomationML artefacts.**
  - Engineers focus on building the system.
  - Systematic reviews are not conducted very often.

- **Effective and efficient defect detection with tool support.**
  - Defects result in high rework effort, additional cost, and project delays.
  - Limited tool support for reviews in MDE environments.

- **Focus on change sets and interdisciplinary changes.**
  - Changes are not considered sufficiently.
  - High effort for reviewing large change sets.

Vision:

- Collaborative review process and tool support, embedded with the engineering process.

Data Integration with AML.hub

Manual review activities

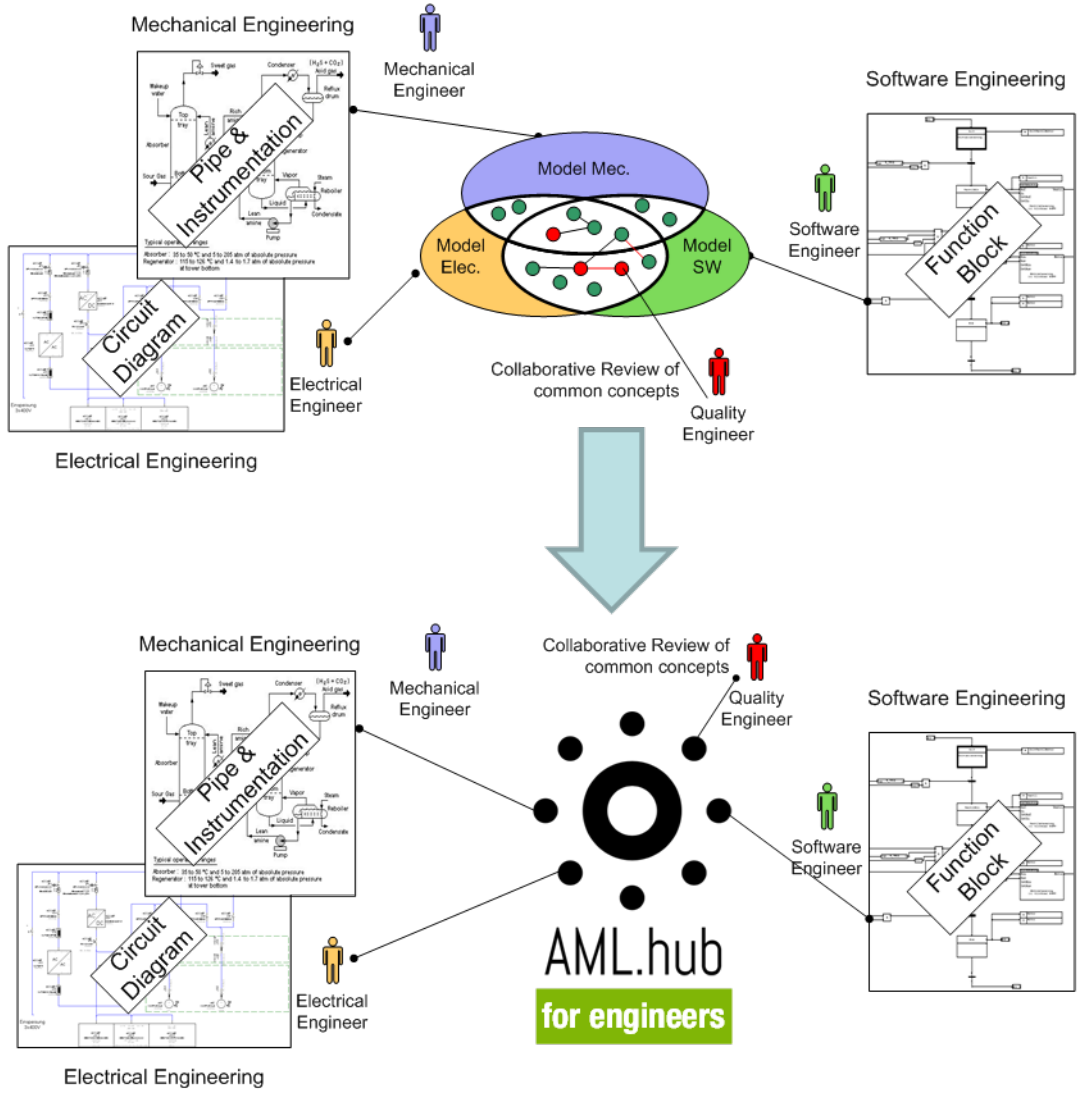
- Based on common concepts.
- High human expert effort.
- Risky for large data sets.

AML.hub

- AML = standardized data exchange format.
- AML.hub = technical platform for data exchange.
- Manual reviews based on change sets*.

Challenge

- Systematic **review process** support with **tools** needed.



* Winkler D., Biffl S.: “Focused Inspections to Support Defect Detection in Multi-Disciplinary Engineering Environments”, Research Preview Paper, In: Proceedings of the 16th International Conference on Product-Focused Software Process Improvement (PROFES), Bozen-Bolzano, Italy, December 2-4, 2015

Requested Review Tool Capabilities

- **Review processes**
  - Traceable review process.
  - Increase reviewing performance (i.e., more effective and more efficient).
- **Small change sets in text and in model elements**
  - AutomationML support and AutomationML change analysis.
- **Simple annotation of engineering plans** (e.g., in pdf documents)
  - Need to give comments and annotate AML/organization specific documents.
  - Tool support and tool chain.
- **Efficient browsing** of linked engineering model elements.
  - Need to efficiently identify relationships between model elements.
- **Efficient integration** into typical engineering tool chains.
  - Need to support collaborative review by (different) tools along the review process.
- No available tool supports all needs.

Source: Internet

.. derived from Industry Partners in MDE Environments

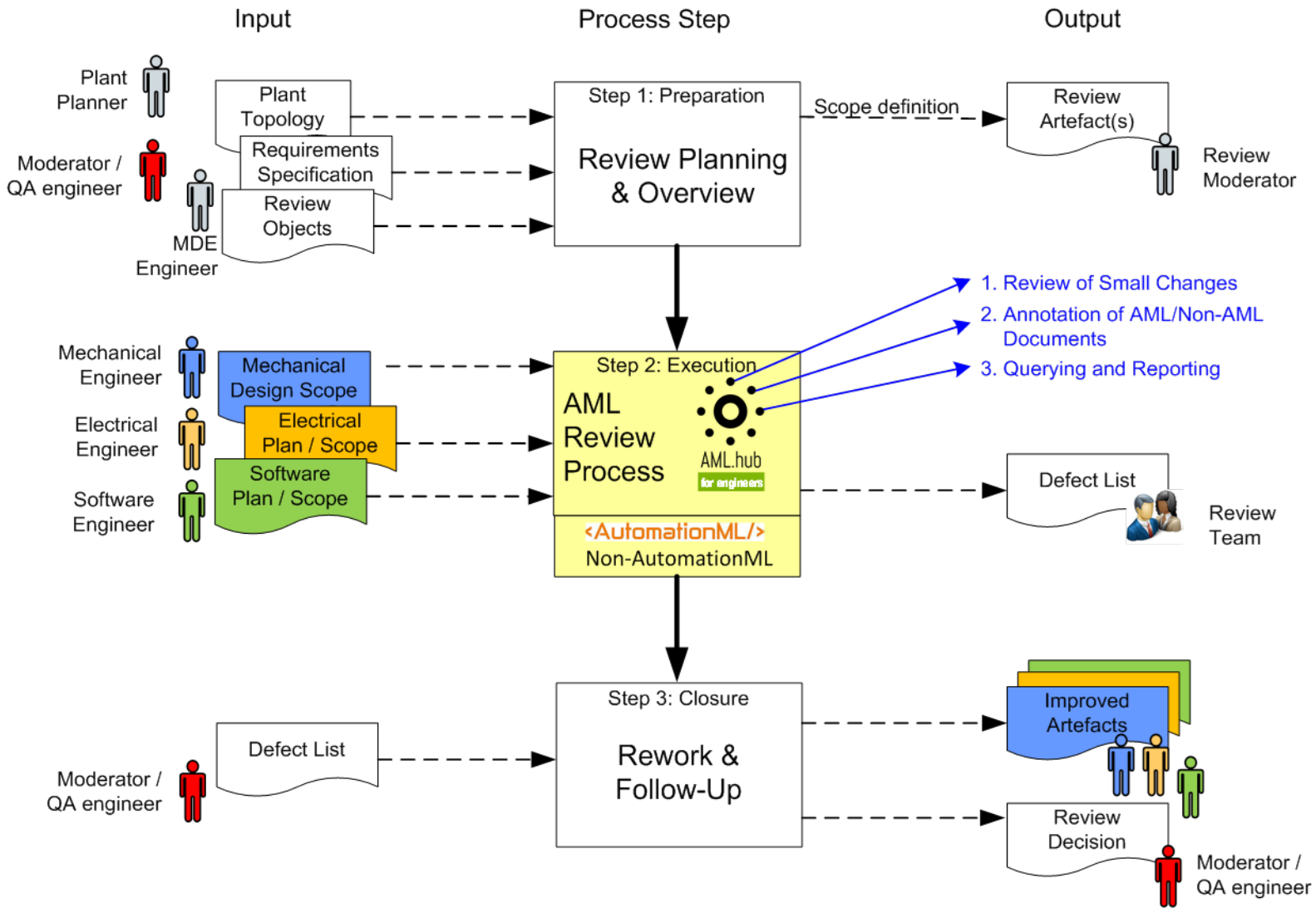
Collaborative Review Process*

Basic Process Approach

1. **Review preparation:**
   review planning & overview.

2. **Review execution**:
   engineering Model/AML review.

3. **Review closure**:
   Rework & Follow-Up.



*Winkler D., F.J. Ekaputra, Biffl S.: "AutomationML Review Support in Multi-Disciplinary Engineering Environments", Proceedings of the 21st IEEE International Conference on Emerging Technologies and Factory Automation (ETFA), Berlin, Germany, 2016.

(AML) Code Review Support
Review of Small Changes

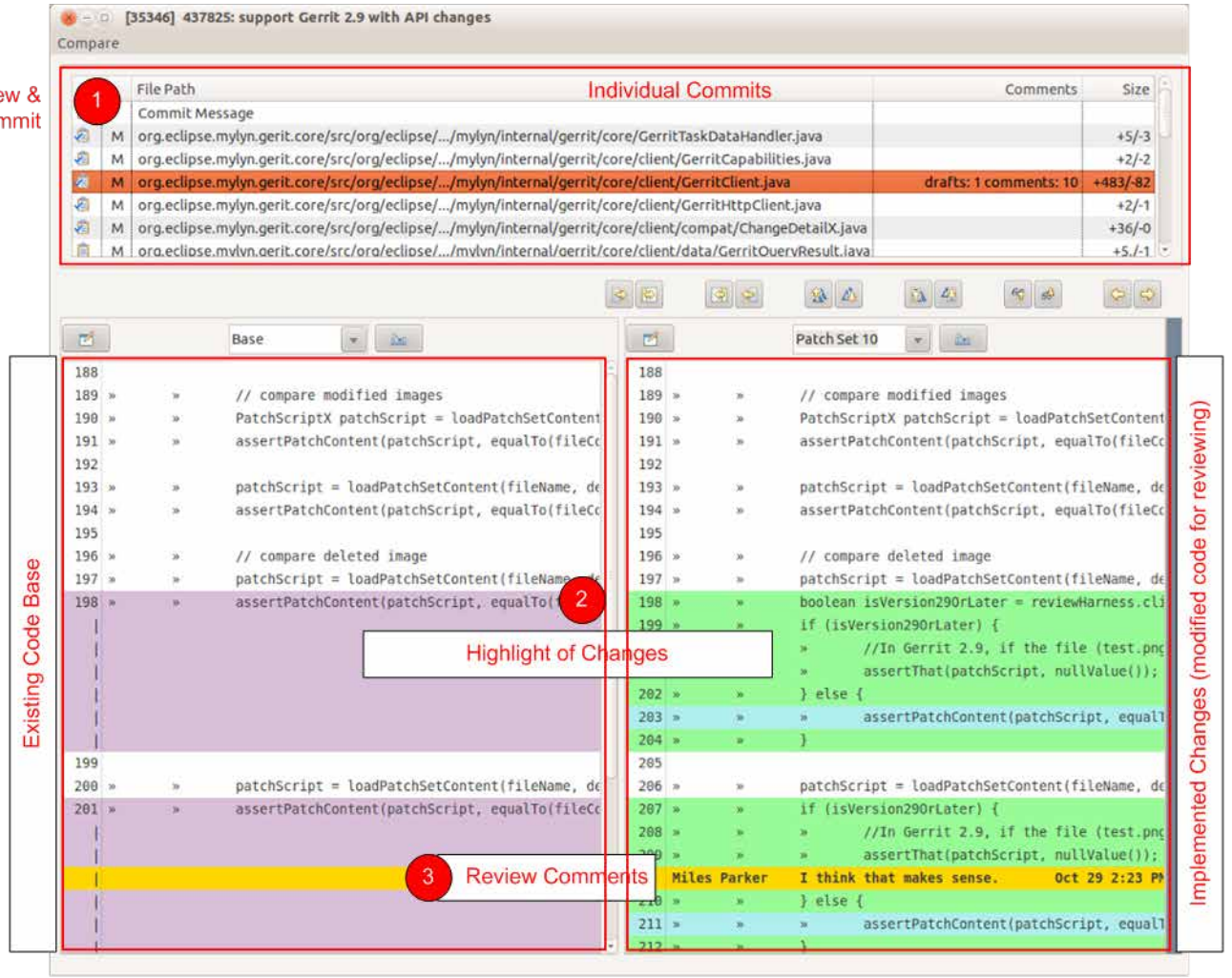
Key Characteristics

- *Gerrit Code Review** in Software Engineering.
- Focus on small change sets.
- Versioning support with *GIT***.
- Difference views for new, modified, and removed code fragments.
- No support of non-structured data.

Selected features for model review in MDE.

1. Commit overview.
2. Code fragment comparison and highlighting of deviations and changes.
3. Supporting features, like commenting.

Review of small change sets with the AML.hub based on integrated data.



* Gerit Code Review: https://www.gerritcodereview.com/
** GIT: https://git-scm.com/

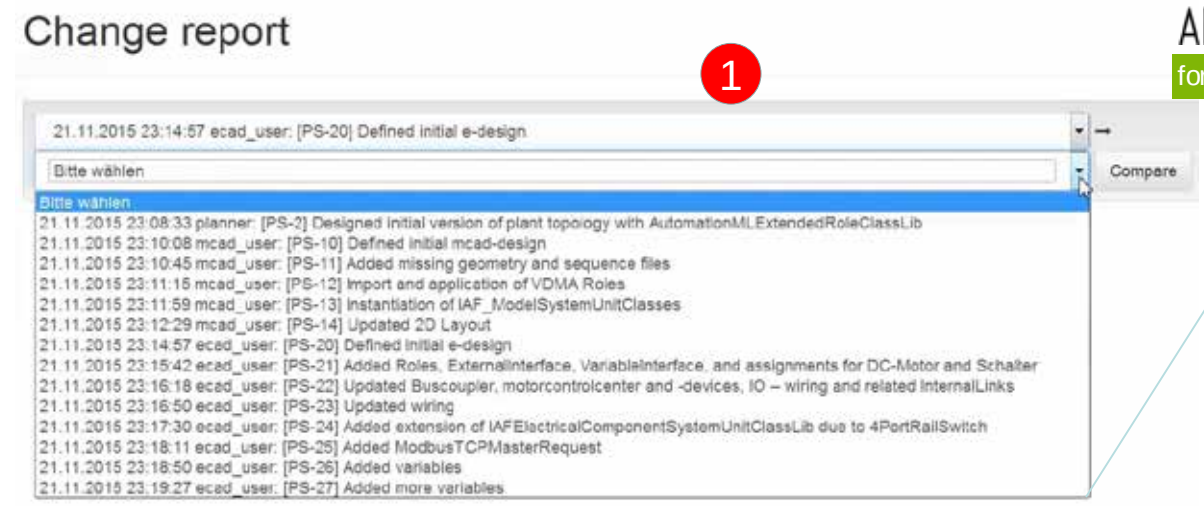
AML Review with Light-Weight Gerrit
Review of Small Changes

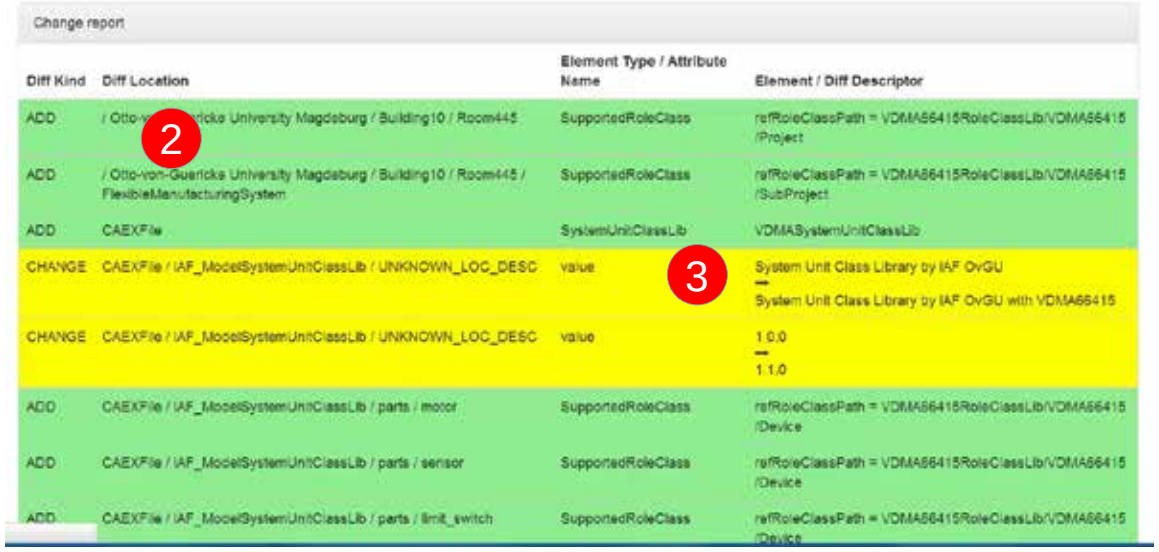
Light-Weight Gerrit

- AML Review.
- Small change sets.
- Model versioning.
- AML.hub.

Core Features (current implementation):

1. **Commit overview**
   - Individual commits & selected commit messages.
2. **Model fragment comparison**
   - Original AML model vs. modified and committed model.
3. **Deviations/Changes**
   - Added/Removed/Changed model parts.





Annotation for Non-AML Documents

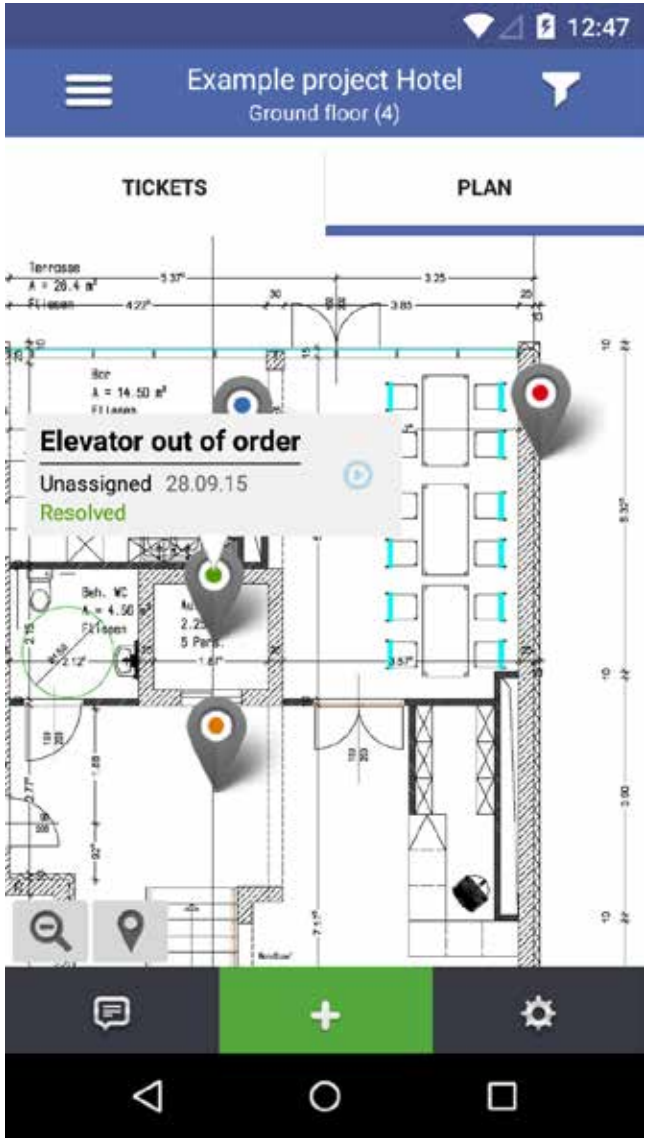
Needs:

- Annotations help reviewers to identify certain model elements.
- Comment and issue management.

Key Characteristics:

- *DefectRadar** is a commercial tool from building automation.
- Annotations of organization specific documents, e.g., PDFs.
- Limited support for AML and text documents.

Annotations for organization specific documents, such as PDF, for AML review support.



* DefectRadar: https://www.defectradar.com

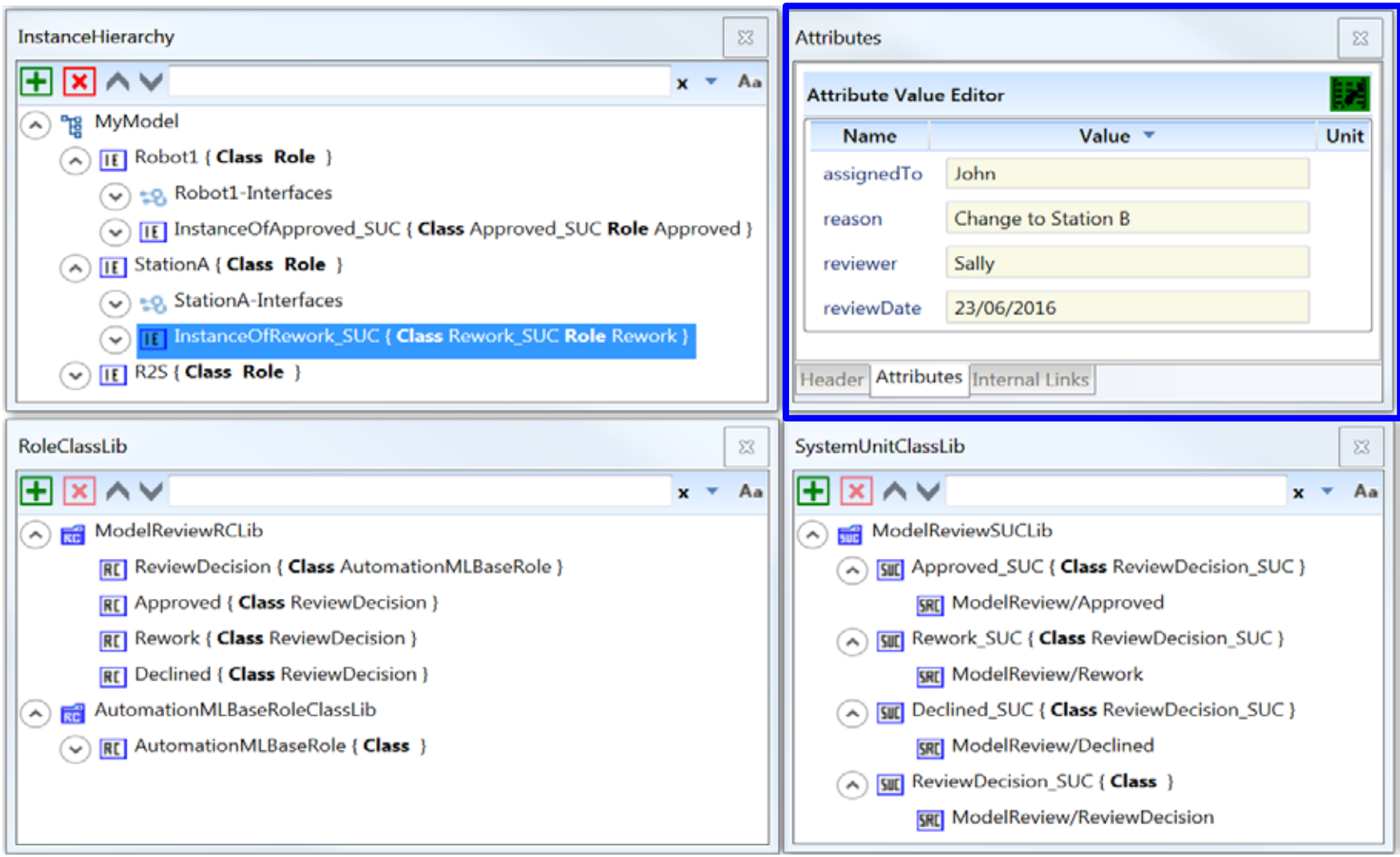
Annotation of AML Data

Needs:

- Annotation and tool support for AML Data.
- Release process of AML elements (review process support).

Solution Concept:

- Based on the AML Editor.
- AML language extension.
- In-Process comments of AML model elements.
- Browsing though the AML plant structure.



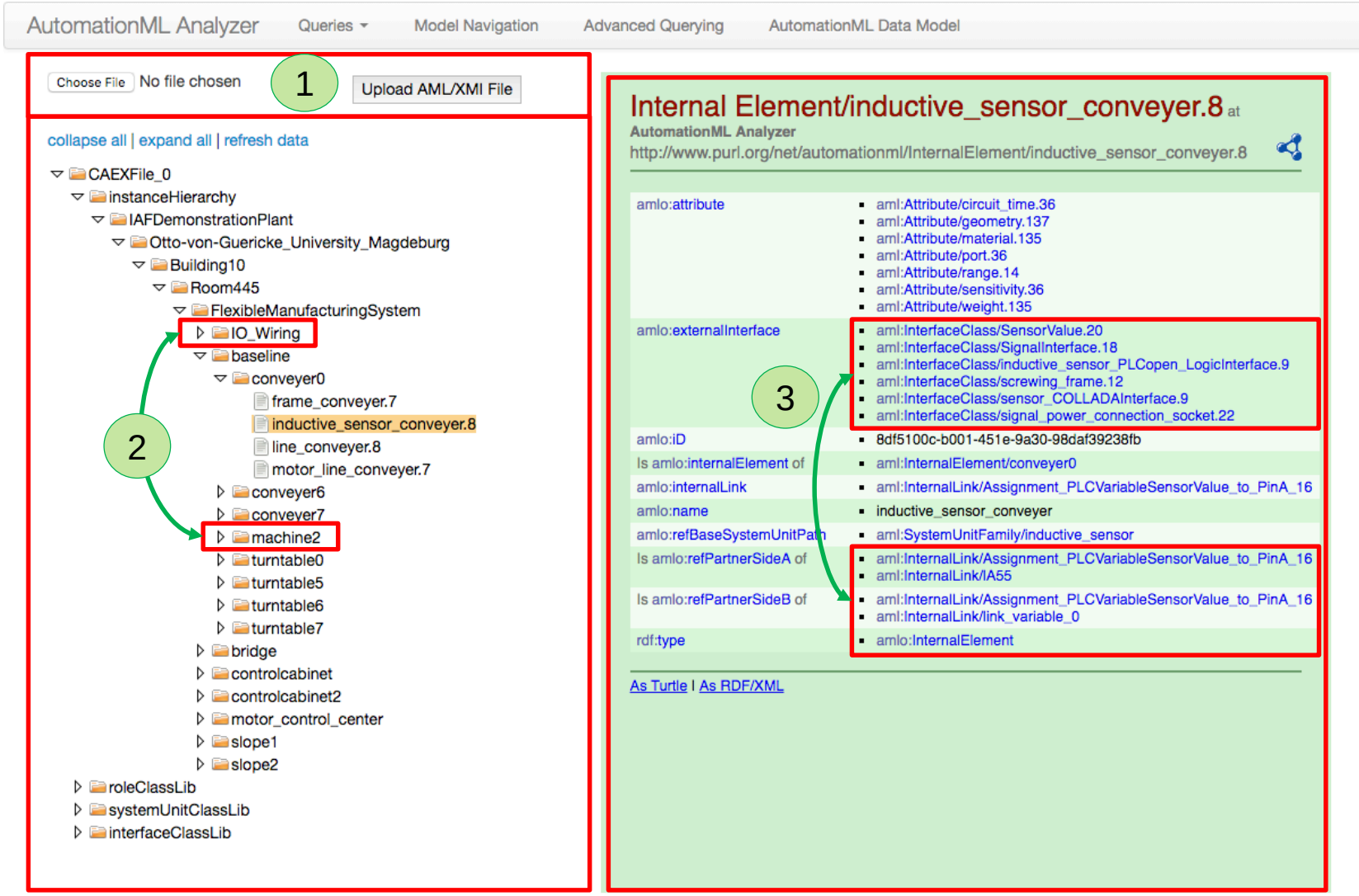
AutomationML Analyzer* Prototype
Querying and Reporting

Queries enable analyzing and monitoring of AutomationML files.

1. Select AML file.
2. Discipline-specific structure elements.
3. Detailed view on attributes and interfaces.

Traces between files, models, and disciplines become visible.

Queries for analysis and monitoring.



* Sabou M, Ekaputra FJ, Kovalenko O (2016) Supporting the Engineering of Cyber-Physical Production Systems with the AutomationML Analyzer. In Proc. of the CPPS Workshop, at the Cyber-Physical Systems Week, Vienna; Prototype available: http://data.ifs.tuwien.ac.at/aml/analyzer

Solution Approaches, Advantages, and Limitations

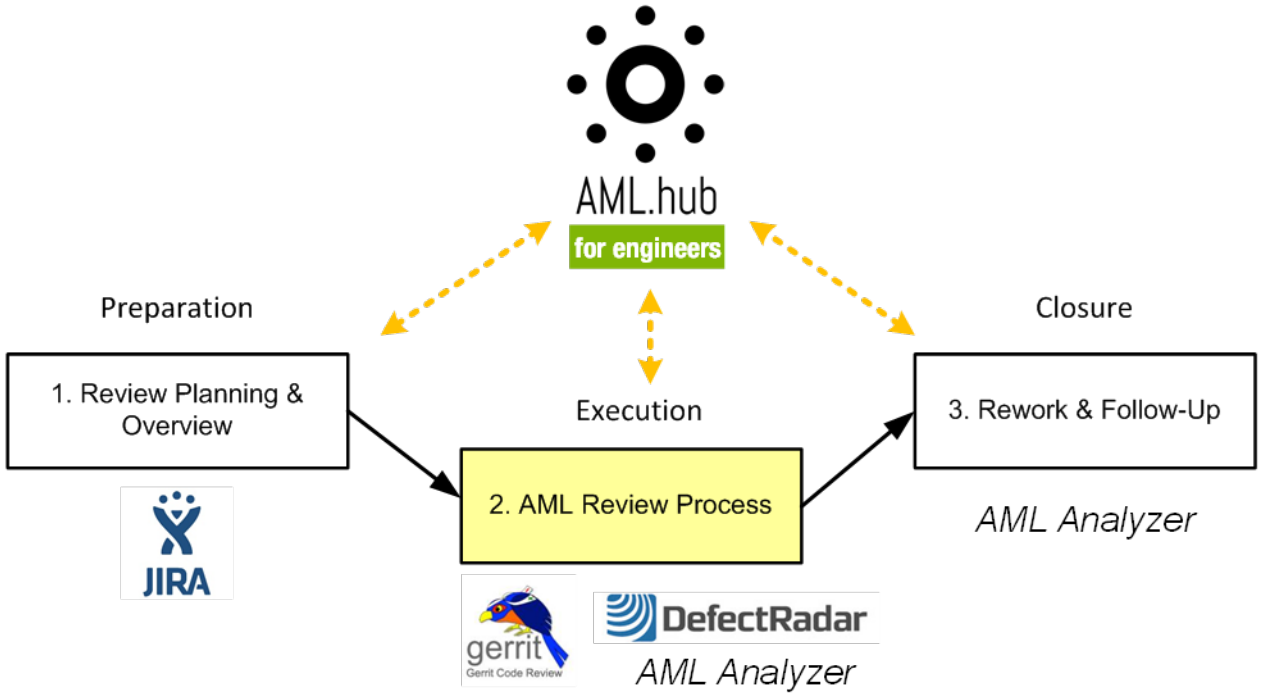
	Manual Reviews	Gerrit-Approach	DefectRadar	AML-Editor Extension	AML Analyzer	Integrated Tool Chain
Traceable Review Processes	O	+	+	O	O	++
Focus on Small Change Sets						
+ AutomationML	O	++	O	++	++	++
+ Organization speicif documents (PDF)	+	-	++	O	O	++
Simple annotation of engineering plans						
+ AutomationML	O	++	+	++	O	++
+ Organization speicif documents (PDF)	O	-	++	O	O	++
Efficient browsing and Querying	-	O	O	+	++	++
Effective and efficient defect detection	-	+	O	+	++	++

Comparison of Manual and Tool-Supported Review Approaches (++ Very Strong Support, + Good Support, o neutral Support, - Weak Support)

- Gerit Code Review: https://www.gerritcodereview.com/
- DefectRadar: https://www.defectradar.com
- AML-Editor Extension: Winkler D., Wimmer M., Berardinelli L., Biffl S.: „Model Quality Assurance for Multi-Disciplinary Engineering", In: Biffl S., Lüder A., Gerhard D. (eds): "Multi-Disciplinary Engineering of Cyber-Physical Production Systems", Book Chapter, Chapter 17, 2016 (upcoming).
- AML Analyzer: Sabou M, Ekaputra FJ, Kovalenko O (2016) Supporting the Engineering of Cyber-Physical Production Systems with the AutomationML Analyzer. In Proc. of the CPPS Workshop, at the Cyber- Physical Systems Week, Vienna; Prototype available: http://data.ifs.tuwien.ac.at/aml/analyzer

Tool Chain for Collaborative Review Support

- **Review Planning**
  - Driven by software management application, such as Jira*.
- **Review Execution**
  - AML Code Review: *Light-Weight Gerrit*.
  - Annotation: *DefectRadar*.
  - Querying: *AML Analyzer*.
- **Review Closure**
  - Rework: Individual engineering tools.
  - Reporting: *AML Analyzer*.



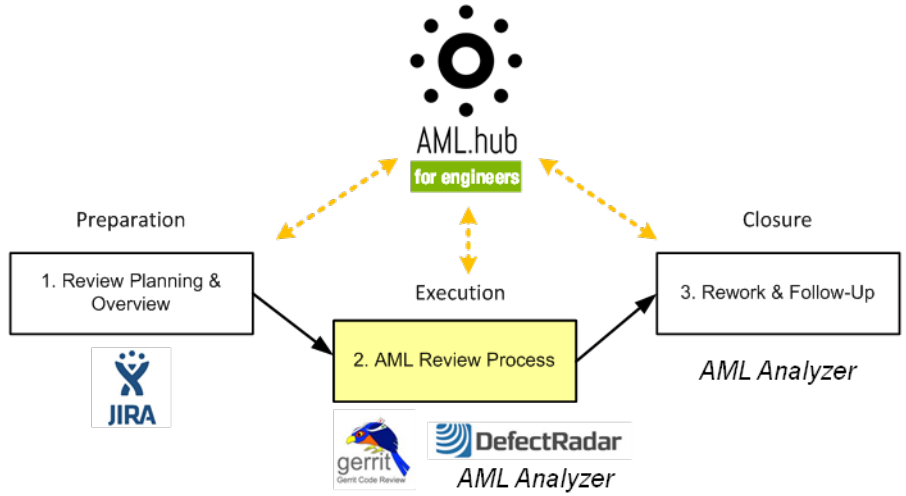
- **Prototype Review Tool Chain** include individual benefits for review support.
  - Analysis of small change sets; annotations; querying; reporting; process support.
  - Plans for the future: implemented tool chain that supports reviews throughout.
  - Establish as part of engineering process improvement initiatives.

* Jira: https://de.atlassian.com/software/jira

Summary and Lessons Learned

Lessons Learned

- **Limited review support** for early defect detection.
- Identified **key capabilities** have been evaluated with industry and research experts*.
- **Tool capabilities** like *Gerrit*, *DefectRadar* and the *AutomationML Analyzer* showed promising result for collaborate review support.
- **Review Tool Chain** helps improving review processes in MDE.



Benefits to Users

- **Systematic and traceable** review processes based on AutomationML.
- More effective and efficient **defect detection** for **AML and organization specific artifacts**.
- **Tool-Support** for review process support throughout the review process.
- **Major features** set for change set analysis, annotation, and reporting.

Introducing collaborative review can be a foundation for a continuous engineering process improvement initiative.

* Winkler D., F.J. Ekaputra, Biffl S.: "AutomationML Review Support in Multi-Disciplinary Engineering Environments", Proceedings of the 21st IEEE International Conference on Emerging Technologies and Factory Automation (ETFA), Berlin, Germany, 2016.

Thank you …

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