

# Christian Doppler Laboratory

Software Engineering Integration For Flexible Automation Systems

## AML Analyzer – Web Browser for Project-Level Navigation and Querying of AutomationML Data

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<http://cdl.ifs.tuwien.ac.at>



<AutomationML/>

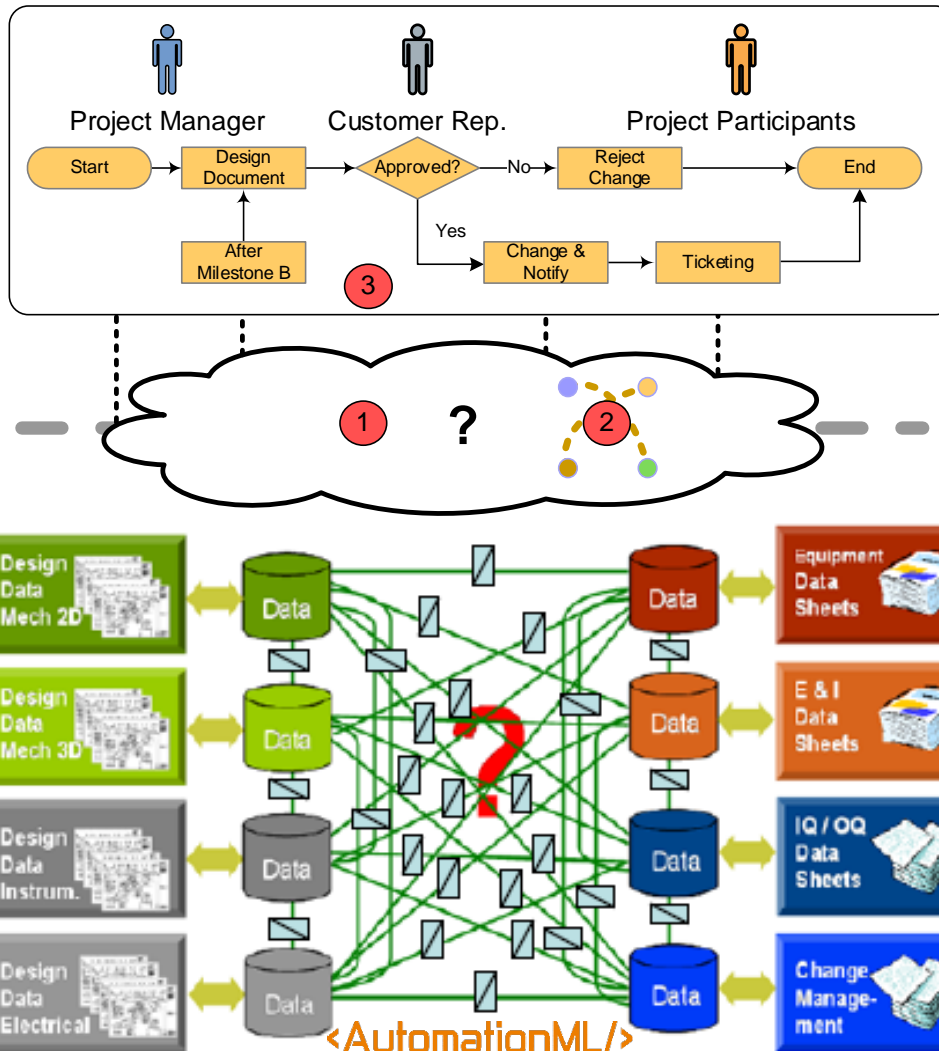


LieberLieber  
software gmbh



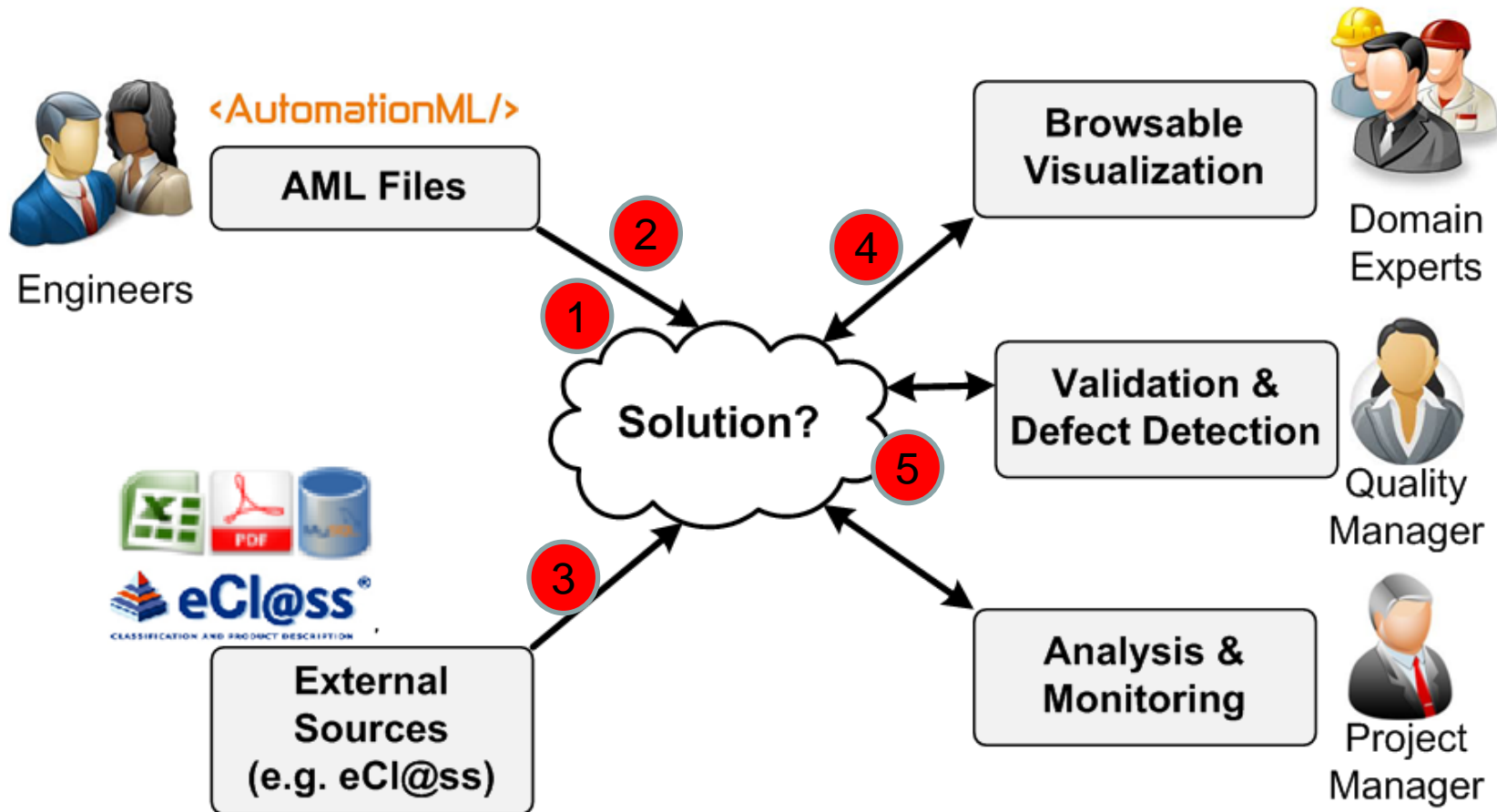
logi.cals®

# Challenges in AutomationML-Tool Networks



1. Tool networks do not ensure sufficient **data consistency**.
2. Data cannot be queried using an **uniform interface**.
3. Tool networks do not make data easily and efficiently **accessible on project level**, e.g., for risk management, test automation or observation of project progress.

# Problem Overview

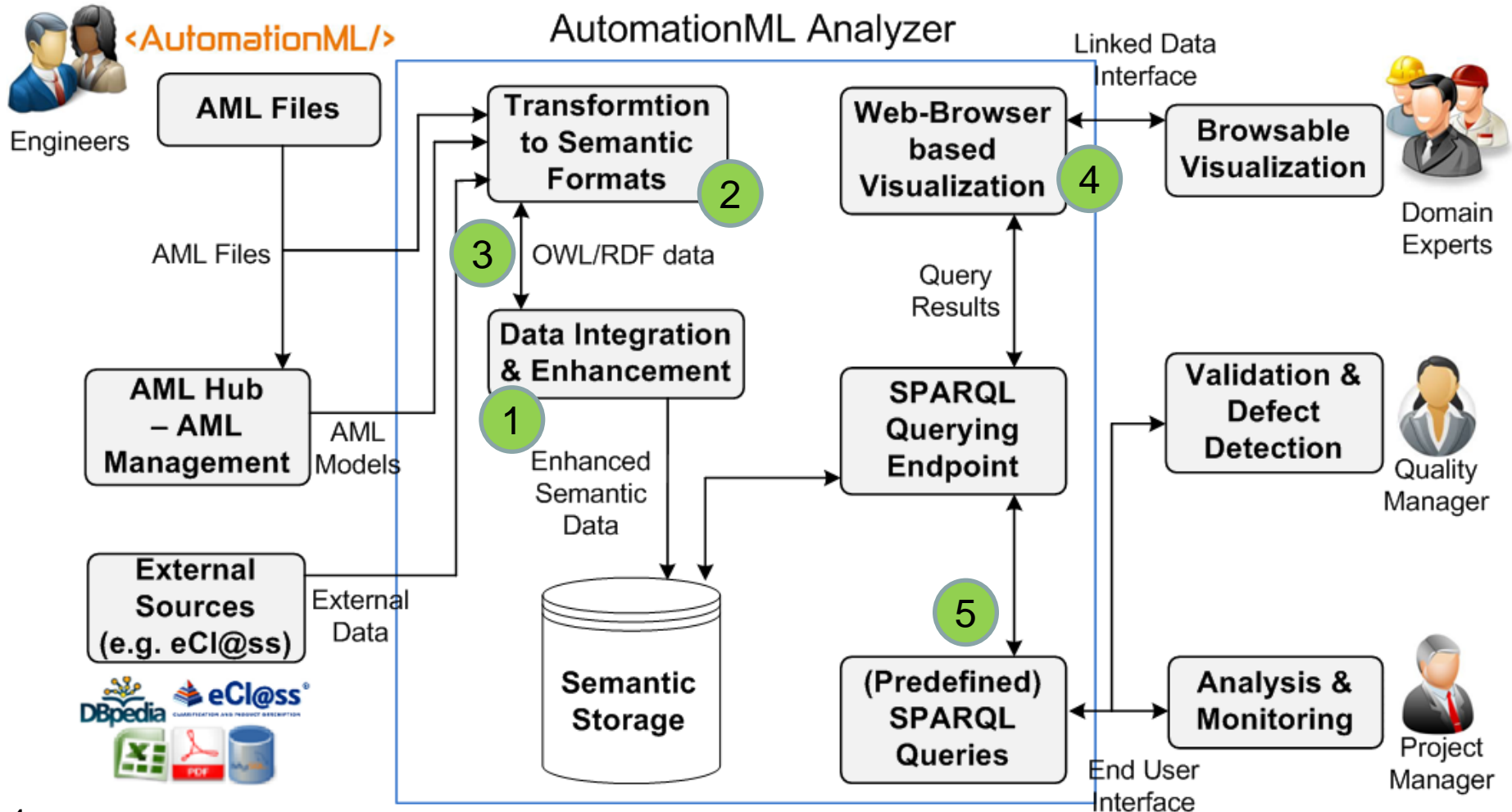


1. Complex data structure with **intricate links** between disciplines
2. **Integration** of AutomationML data from **different disciplines** is important
3. Integration with **other internal and external** data
4. Limited options for platform independent **browsing** of AutomationML data
5. Limited support for **cross-disciplinary analytics**

# Solution: AutomationML Analyzer



Enables efficient **integration**, **browsing**, **querying**, and **analysis** of diverse engineering models and data represented in the AutomationML.

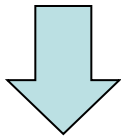


# Semantic Web Tech for Data Management



## DB Vision

SQL

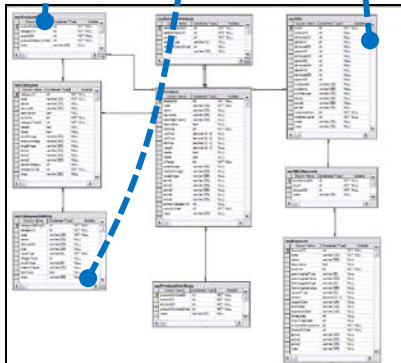


Data



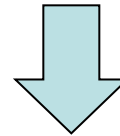
Schema

Tables  
and keys  
to link  
them



## SW Vision

SPARQL

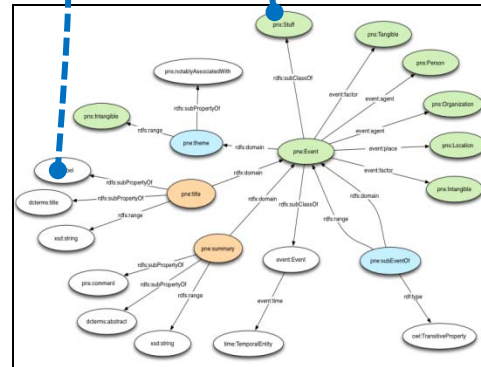


**Knowledge** bases  
instead of **data** bases

**RDF** as data format  
**XML Schema** data types

**OWL, RDF(S),**  
mappings to define  
relations

**Richer relations and  
constraints means**





# SQL and SPARQL



## SQL

Columns to include  
in final result

SELECT Persons.name

FROM Persons Tables

WHERE

Persons.friend IS NOT NULL

Match  
conditions

ORDER BY Persons.name

Order of rows in the result set

## SPARQL

Knowledge bases & external sources

PREFIX foaf: <http://xmlns.com/foaf/0.1/>  
...

Variables to  
appear  
in query result

SELECT ?person ?name

WHERE {

?person foaf:name ?name .

?person foaf:knows ?friend .

...

Match  
conditions

}

ORDER BY ?name

Order of the result set

# Demo...



# Browser based visualization



AutomationML Analyzer

Queries ▾

Model Navigation

Advance Querying

AutomationML Ontology

[collapse all](#) | [expand all](#)

CAEXFile\_0

- instanceHierarchy
- Produktionsmodell-1
  - Conveyor0-1
    - Band\_Conveyor-6
    - Gestell\_Conveyor-5
    - Induktivsensor\_Conveyor-6
    - Motor\_Band\_Conveyor-6
  - Conveyor1-1
  - Conveyor2-1
  - Conveyor3-1
  - Conveyor4-1
  - Conveyor5-1
  - Conveyor6-1
  - Conveyor7-1
  - Conveyor8-1
  - Conveyor9-1
  - FL\_IL\_24\_BK\_BusKoppler-1
  - Maschine1-1
  - Maschine2-1
  - Maschine3-1
  - Turntable0-1
  - Turntable1-1
  - Turntable2-1
  - Turntable3-1
  - Turntable4-1
  - Turntable5-1
  - Turntable6-1
  - Turntable7-1
  - WAGO\_750\_342\_BusKoppler1-1
  - WAGO\_750\_342\_BusKoppler2-1
- roleClassLib
- systemUnitClassLib
- interfaceClassLib

## Band\_Conveyor-6 at AutomationML Analyzer

[http://www.purl.org/net/automationml/Band\\_Conveyor-6](http://www.purl.org/net/automationml/Band_Conveyor-6)

|                           |  |
|---------------------------|--|
| aml:attribute             | <ul style="list-style-type: none"><li>aml:Geometrie-174</li><li>aml:Gewicht-172</li><li>aml:Material-174</li><li>aml:Traglast-66</li><li>aml:minimaler_Biegeradius-21</li></ul>          |
| aml:externalInterface     | <ul style="list-style-type: none"><li>aml:Band_COLLADAInterface-10</li><li>aml:Band_PLCCopen_LogicInterface-20</li><li>aml:Lagerung_Gestell-10</li><li>aml:Verzahnung_Motor-47</li></ul> |
| aml:id                    | <ul style="list-style-type: none"><li>{89cfba14-aca1-4f72-b733-f0c50073ecc4}</li></ul>   |
| Is aml:internalElement of | <ul style="list-style-type: none"><li>aml:Conveyor0-1</li></ul>  |
| aml:name                  | <ul style="list-style-type: none"><li>Band_Conveyor</li></ul>  |
| aml:refBaseSystemUnitPath | <ul style="list-style-type: none"><li>aml:Band_Conveyor-10</li></ul>   |
| Is aml:refPartnerSideB of | <ul style="list-style-type: none"><li>aml:Lagerung_Band_Gestell-8</li><li>aml:Verzahnung_Band_Motor-16</li></ul>   |
| aml:supportedRoleClass    | <ul style="list-style-type: none"><li>aml:Band-1</li></ul>   |
| rdf:type                  | <ul style="list-style-type: none"><li>aml:InternalElement</li></ul>  |

Browsable  
internal  
links

[As Turtle](#) | [As RDF/XML](#)



# Querying Integrated AutomationML Data



AutomationML Analyzer

Queries ▾

Model Navigation

Advance Querying

AutomationML Ontology

## #7. Show unit dev

Re-Run Query

- #1. What devices weight more than a specified maximum weight?
- #2. Show all attributes for each motor
- #3. Show what types of devices are inside the specific composite device (for all composites)
- #4. Amount of devices (both unit and composite) of a specific type grouped by device type
- #5. Amount of unit devices contained in a certain type of composite device (for all types)
- #6. Show all interfaces for all sensors
- #7. Show unit devices and their maximum and actual working hours
- #8. Show unit devices that exceeded their maximum working hours
- #9. Show amount of unit devices that NOT exceeded their maximum working hours AND OTHERWISE

Predefined  
SPARQL queries  
enable monitoring,  
analysis, validation  
and defect  
detection tasks

Results: 86 rows

| Nr | container   | component                  | working_hours | max_working_hours |
|----|-------------|----------------------------|---------------|-------------------|
| 1  | Conveyer-1  | Induktivsensor_Conveyer-3  | 5312          | 14000             |
| 2  | Conveyer-1  | Motor_Band_Conveyer-1      | 5312          | 14000             |
| 3  | Conveyer0-1 | Induktivsensor_Conveyer-6  | 5439          | 14000             |
| 4  | Conveyer0-1 | Motor_Band_Conveyer-6      | 5312          | 14000             |
| 5  | Conveyer1-1 | Induktivsensor_Conveyer-11 | 936           | 14000             |
| 6  | Conveyer1-1 | Motor_Band_Conveyer-11     | 7842          | 14000             |
| 7  | Conveyer2-1 | Induktivsensor_Conveyer-10 | 8567          | 14000             |
| 8  | Conveyer2-1 | Motor_Band_Conveyer-10     | 15234         | 14000             |
| 9  | Conveyer3-1 | Induktivsensor_Conveyer-4  | 245           | 14000             |
| 10 | Conveyer3-1 | Motor_Band_Conveyer-9      | 9578          | 14000             |
| 11 | Conveyer4-1 | Induktivsensor_Conveyer-1  | 15209         | 14000             |
| 12 | Conveyer4-1 | Motor_Band_Conveyer-3      | 3894          | 14000             |
| 13 | Conveyer5-1 | Induktivsensor_Conveyer-2  | 9862          | 14000             |
| 14 | Conveyer5-1 | Motor_Band_Conveyer-2      | 5312          | 14000             |
| 15 | Conveyer6-1 | Induktivsensor_Conveyer-7  | 1234          | 14000             |
| 16 | Conveyer6-1 | Motor_Band_Conveyer-5      | 1234          | 14000             |