Requirement Traceability in Topcased with the Requirements Interchange Format (RIF/ReqIF)

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Agenda

- Overview & Intention

- Technologies

- Topcased Integration

- Conclusion / Next Steps

Overview

The Big Picture

- Topcased provides a lot of functionality for systems engineering, including requirements

- Ongoing research (Verde & Deploy) projects deal with trends in requirements engineering: standardization (RIF/ReqIF) and formalization.'

- Implementation is ongoing as Open Source

- But: Open Source often reinvents the wheel

- Goal: Introduce and discuss possible synergies of VERDE, Deploy and Topcased with users and developers.

Verde

- "VERification- oriented & component-based model Driven Engineering for real-time embedded systems"

- Aim of providing a generic tool platform for the verification- and validation-orientated development of embedded systems

- Verde develops new tools and methods in the areas where there are gaps in existing tool-chains and procedures

- Focus is on component models (UML, MARTE, LwCCM)

Deploy

- **FP7 Research Program**
  "to make major advances in engineering methods for dependable systems through the deployment of formal engineering methods"

- **Stewardship of Rodin**
  "Eclipse-based IDE for Event-B that provides effective support for refinement and mathematical proof"
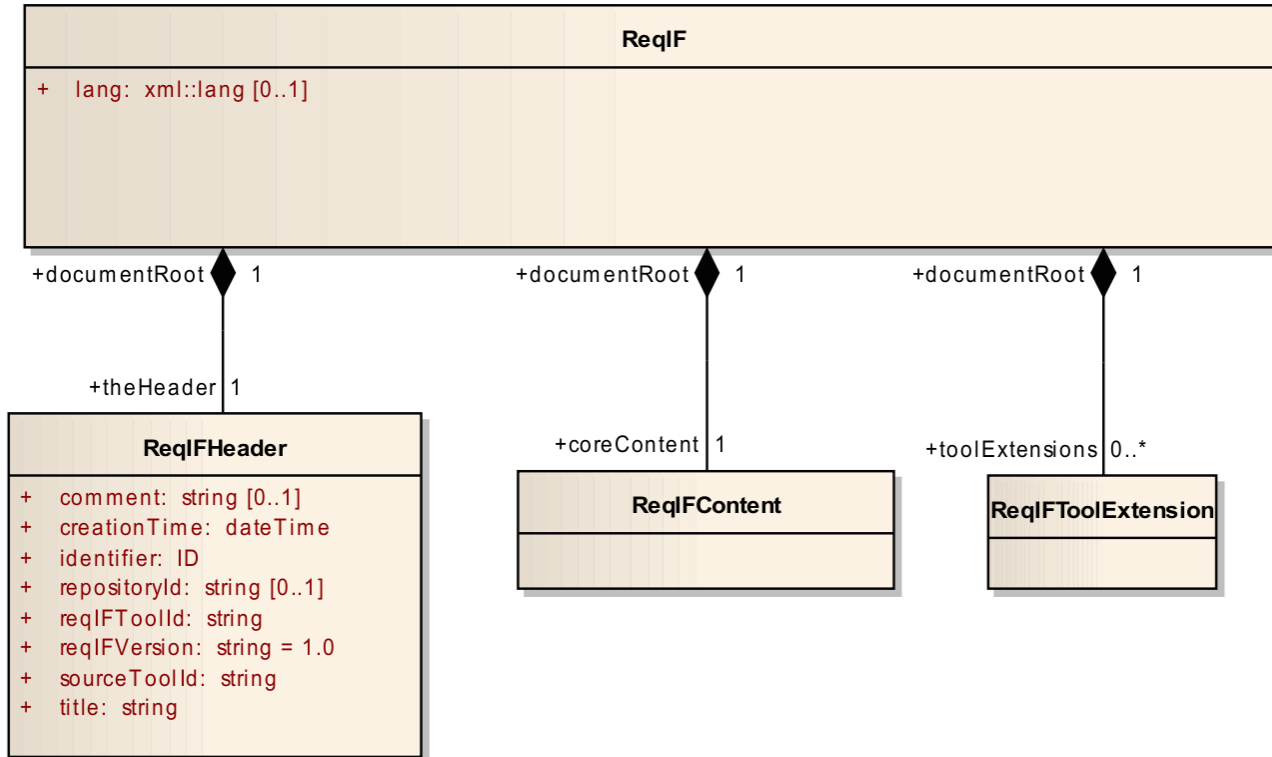
- **More Information:**
  http://www.deploy-project.eu/
  http://www.event-b.org/

Technologies

RIF / ReqIF Standard

- Emerging Standard for Requirements Exchange

- Driven by Car Industry

- Data Model + XML Exchange Format

- RIF 1.0 created in 2004
  - RIF 1.2 in 2008
  - ReqIF 1.0 currently in development

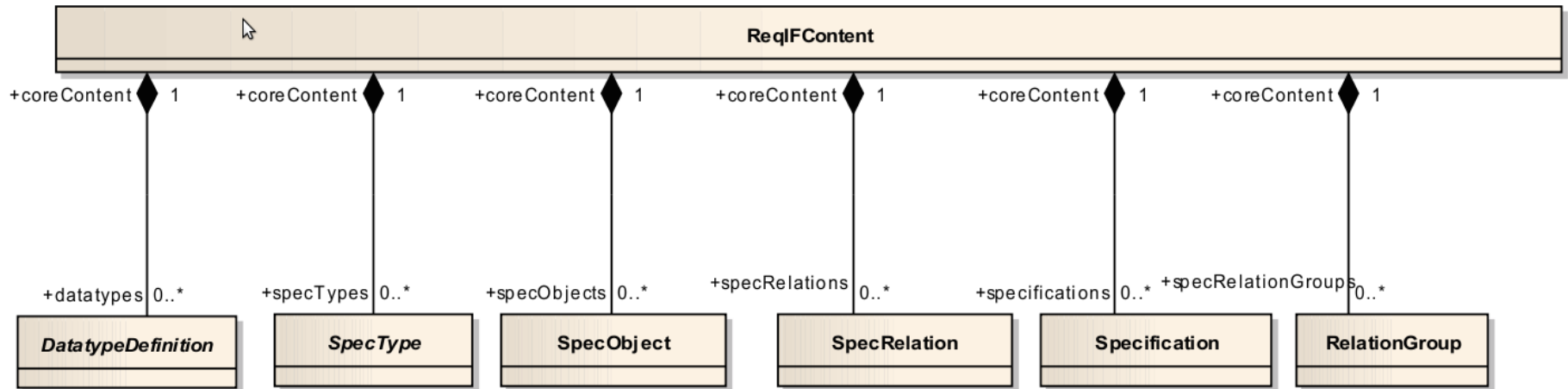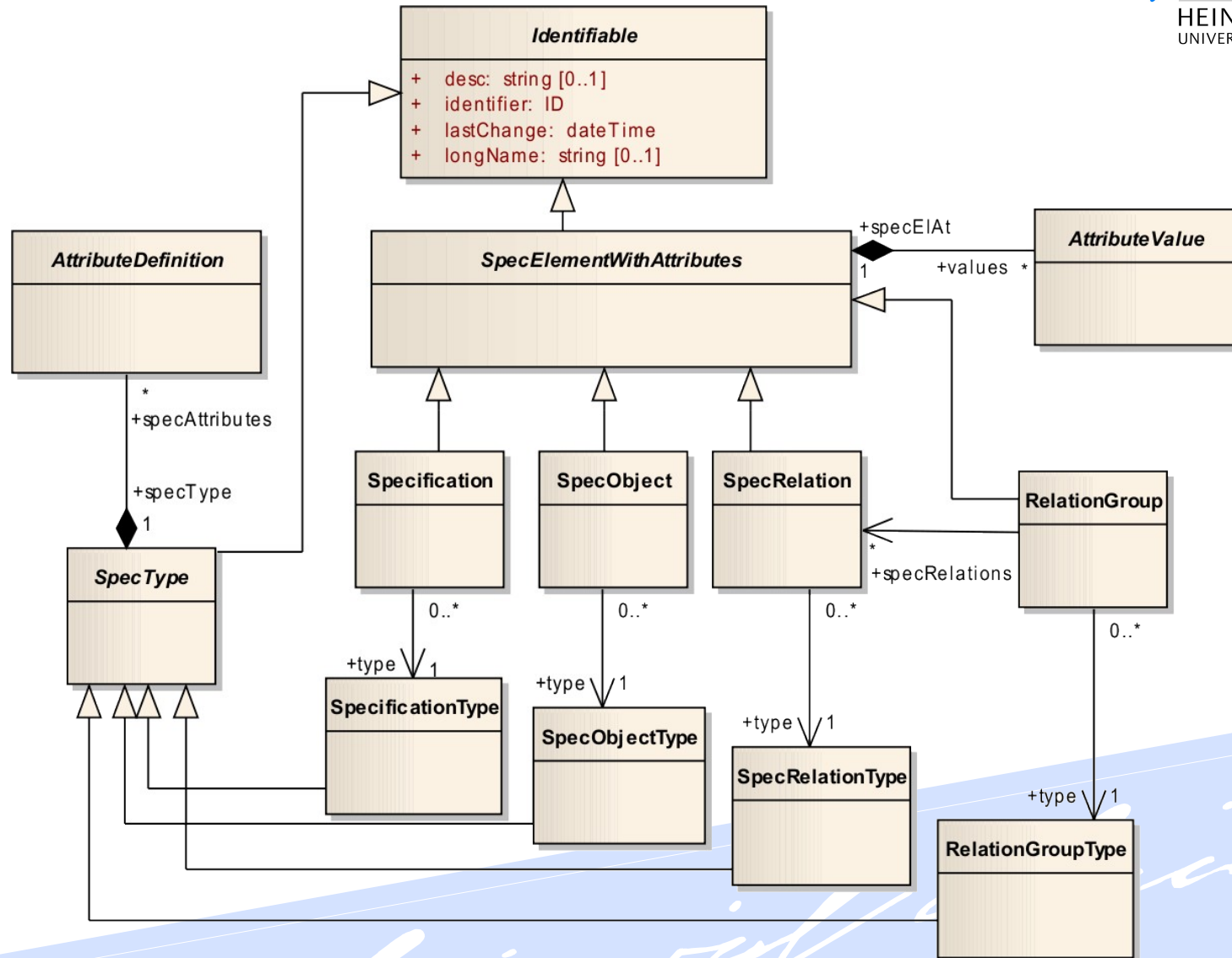- Already supported by a number of tools
  - Including IBM DOORS

ReqIF: Top Level

ReqIF: Core Content

ReqIF: Attributes

Eclipse

- Platform for General Purpose Applications

- Known as IDE

- Facilities for GUI, Help, Team Support & more

- Plug-In support through OSGi

Eclipse Modeling Framework

- Modeling Framework
  - Extensible

- Code generation facility
  - For Data Model
  - For GUI

- Adapter for Rodin Available
 - Used by UML-B
  - Used by Camille

Rodin & Event-B

- Rodin, a tool platform for Event-B modeling

- Eclipse-based tool

- Traceability between model elements and requirements actively researched

Event-B

- State-based Modeling Method

- Proof obligations to verify properties of the model

- Variables define state

- Invariants constrain State

- State Changes through Events

- Supports Refinement
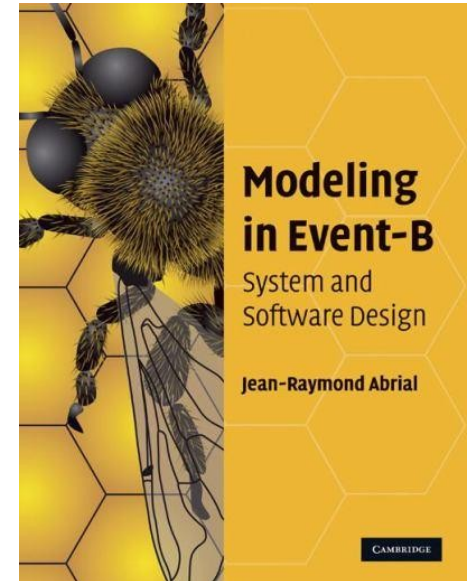
Event-B Example

```
machine tl_mac

variables
  tl_cars  // Trafficlights for cars
  tl_peds  // Trafficlights for pedestrians

invariants
  @inv1 tl_cars ∈ BOOL
  @inv2 tl_peds ∈ BOOL
  @inv3 tl_cars = TRUE ⇒ tl_peds = FALSE

events
  event setCarsLight
    any    state
    where @grd1 state = TRUE ⇒ tl_peds = FALSE
    then   @act tl_cars ≔ state
  end

  event setPedsLight
    any    state
    where @grd1 state = TRUE ⇒ tl_cars = FALSE
    then   @act tl_peds ≔ state
  end

  event INITIALISATION
  then
    @act1 tl_cars ≔ FALSE
    @act2 tl_peds ≔ FALSE
  end
end
```
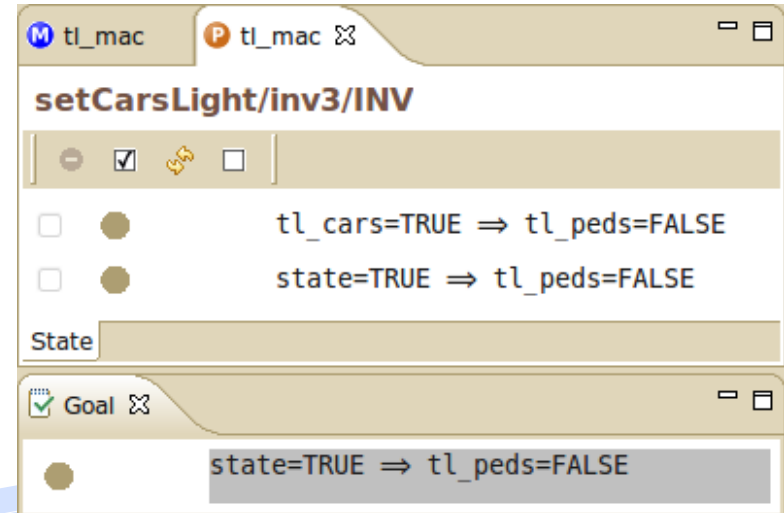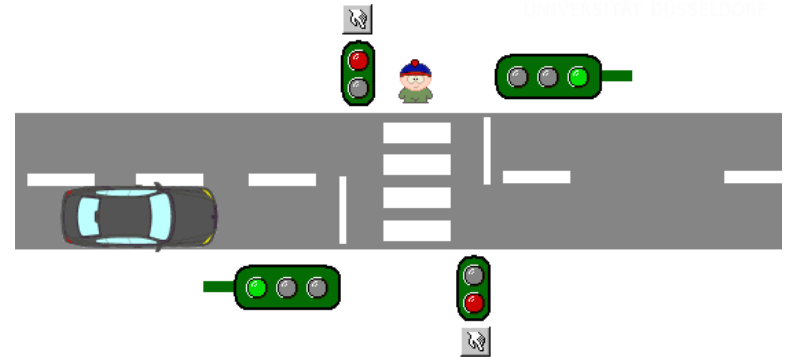
Refinement

- **Introduce new Features**

  e.g. Push Button

- **Refine Data Structures**

  e.g. Map Booleans to Trafficlight Colors

- **Implement Algorithms**

  e.g. Implement a Sorting Algorithm

- **Provide Structure**

- *e.g. One New Feature per Refinement*

Problem: Does it do what it should do?

Disconnect between Requirements and Model

Answer: Bridge Requirements and formal Model

- Four Variable Model (Parnas)

- Problem Frames (Jackson)

- KAOS (van Lamsweerde)

- WRSPM (Gunter)

- SysML (Laleau)

RIF/ReqIF Core

- Ecore Model for RIF, including RIF-compliant serialization to XML (90%)

- Model-Driven Development: Ecore derived from the specification (Enterprise Architect UML model) by model transformation

- Development / Maintenance hibernating until ReqIF is officially published.

- Driven by itemis.

- Eclipse Public License

ProR – Overview
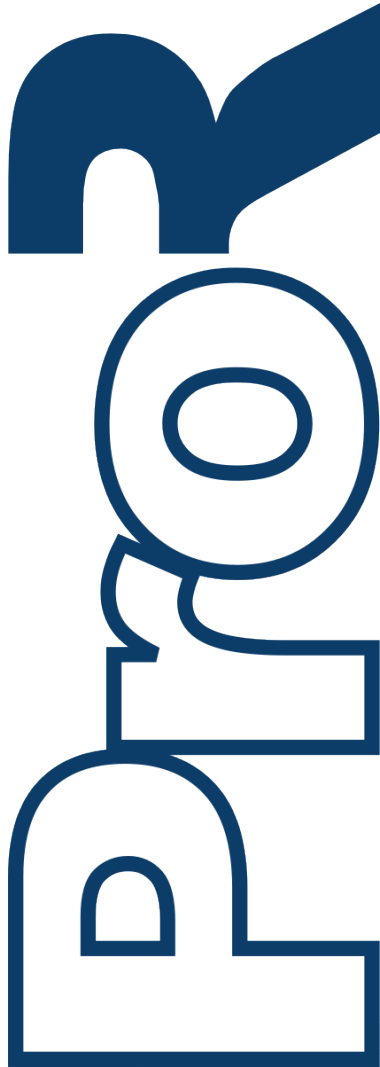
- Platform for managing natural language requirements

- Uses the Verde RIF Core

- Deploy-sponsored project focused on Rodin integration

- Formal Methods (Rodin/Event-B) Integration (RE Traceability)

- Usefulness (hopefully) beyond Academia

ProR GUI (running in Rodin)

Rodin Integration

	ID	Description	Link
1	®	**Trafficlight Specification**	
2	® REQ-1	The System is controlling cars on a road and pedestrians crossing the road.	
3	® REQ-2	The System is equipped with two traffic lights for the cars [tl_cars], with the [COLORS] [RED], [YELLOW] and [GREEN].	0 ▷ ® ▷ 5
3.1	®	inv02_1: tl_cars ⊆ COLORS	
4	® REQ-3	The System is equipped with two traffic lights for the pedestrians [tl_peds] with the [COLORS] [RED] and [GREEN].	
5	® REQ-4	[tl_cars] stop the cars on both sides of a crosswalk.	

In- and Outgoing Links

Enable show links

Event-B Model Element

Highlighted Event-B Model Element Names

3	® REQ-2	The System is equipped with two traffic lights for the cars [tl_cars], with the [COLORS] [RED], [YELLOW] and [GREEN].	0 ▷ ® ▷ 5
	▷ LINK-1		COLORS (ctx01)
	▷ LINK-2		RED (ctx01)
	▷ LINK-3	This color is not used for the Pedstrian light [tl_peds]	YELLOW (ctx01)
	▷ LINK-4		GREEN (ctx01)
	▷ LINK-5		tl_cars (mac02)
3.1	®	inv02_1: tl_cars ⊆ COLORS	

Links with comment

Target Element of Link

Verde Traceability

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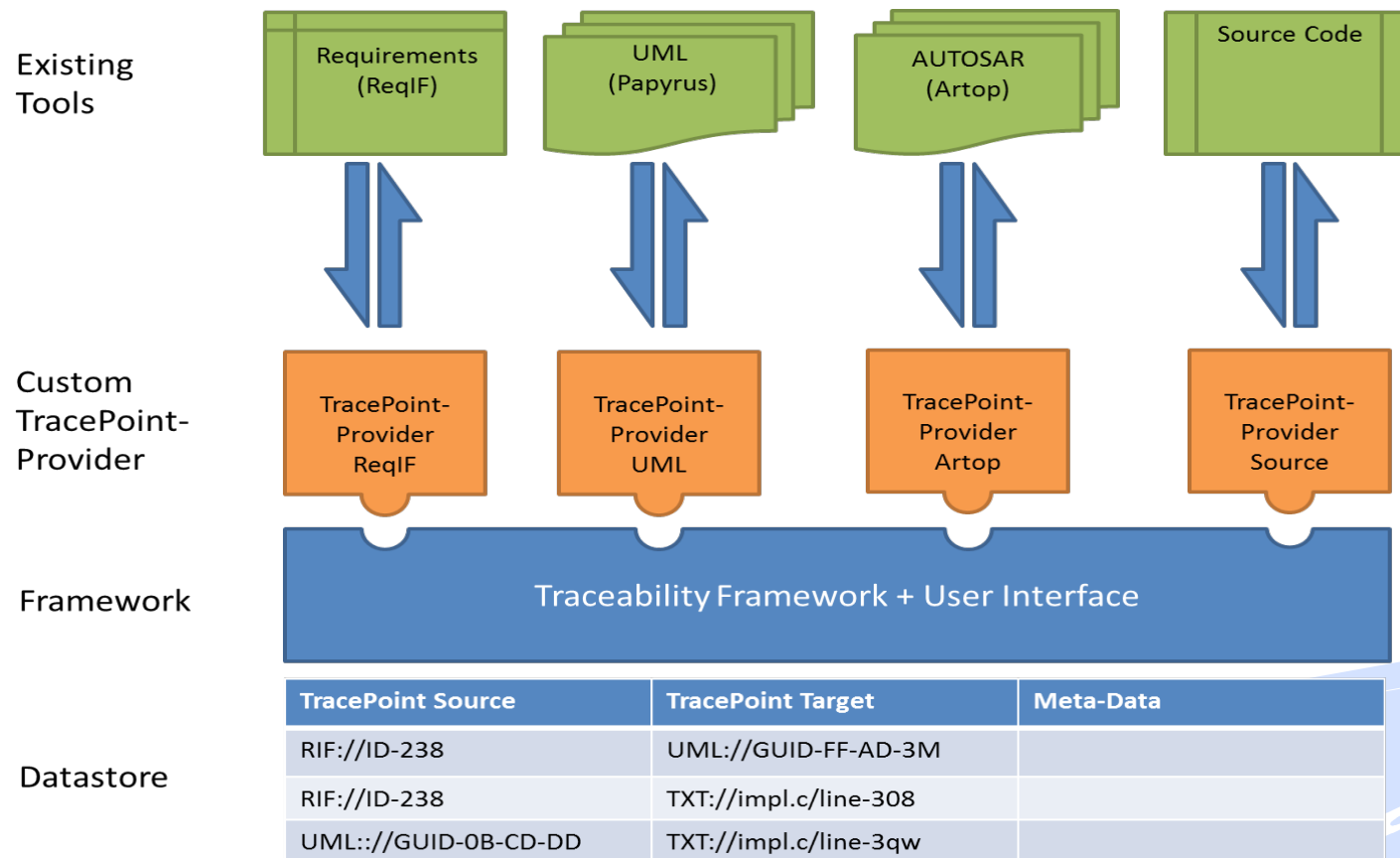
Topcased Synergies

Why Synergies with Topcased?

- Leveraging a successful, existing platform for System Development

- Providing Topcased with RIF/ReqIF interoperability (upcoming standard)

- Align development resources

Appraoches to Cooperation

- RIF import for Topcased

  - Easy approach

  - Would forgo many RIF features

- Adding a RIF Requirements model to Topcased

  + Tighter integration possible

  - Creates Redundancy in Topcased

    (two coexisting requirements models)

- EMF-Based Synchronizer inside Topcased

  + Should be fea to implement

  + Allows for tight integration

Status and Future Plans

- So far, we want to raise attention to the activities to avoid redundancy

- We want to test the waters

- What is the interest of the Topcased community in ReqIF?

- Do formal methods draw interest in the Topcased community.

Thanks & Acknowledgements

- Work supported in Part by Deploy

- Work supported in Part by ITEA-Verde and itemis AG

- Thank you

- Questions?