

# 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

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# 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

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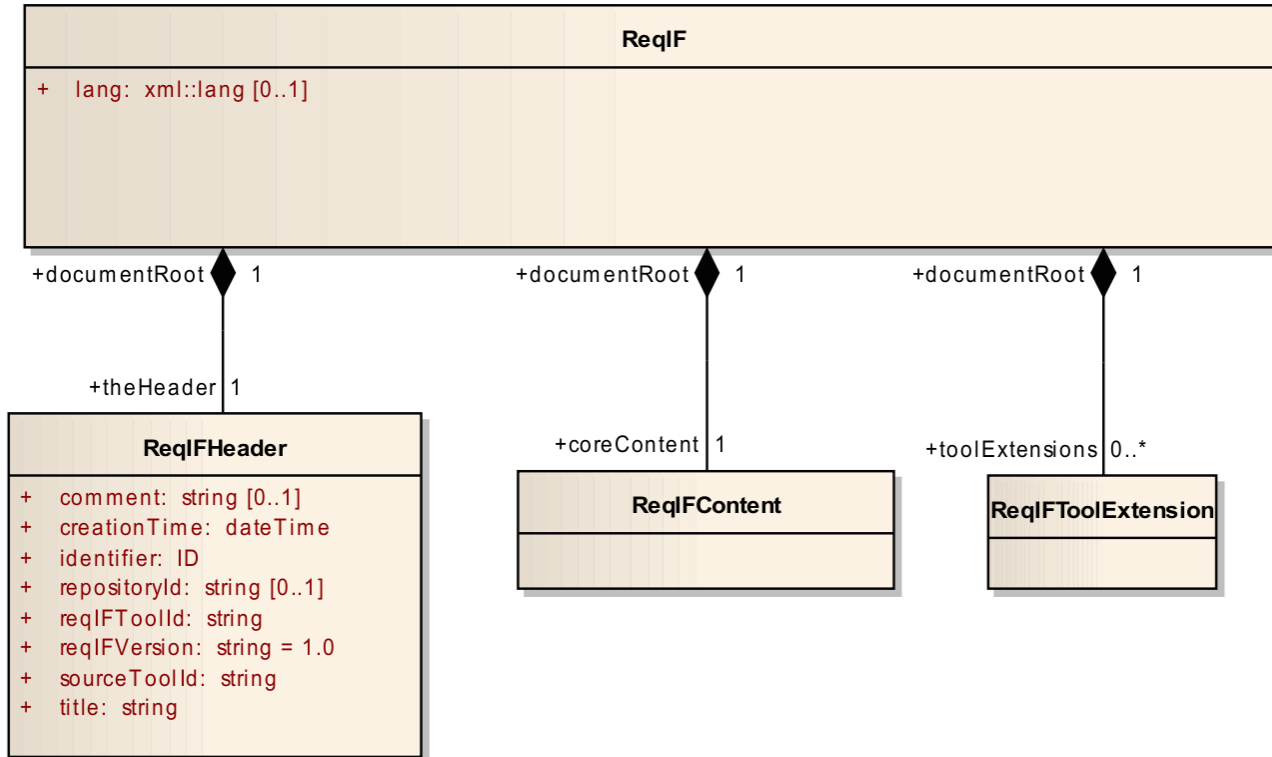
# RIF / ReqIF Standard

- 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

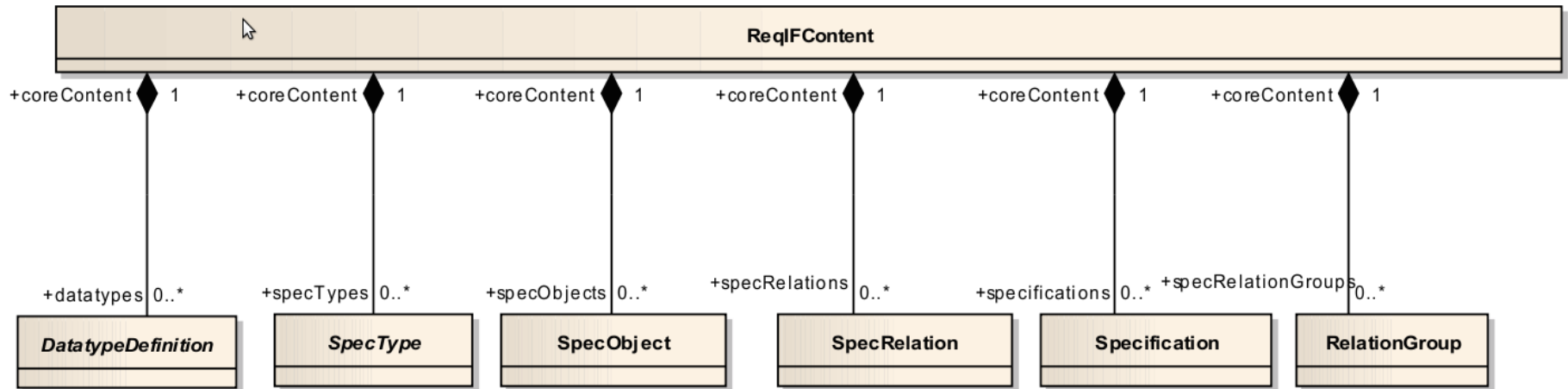




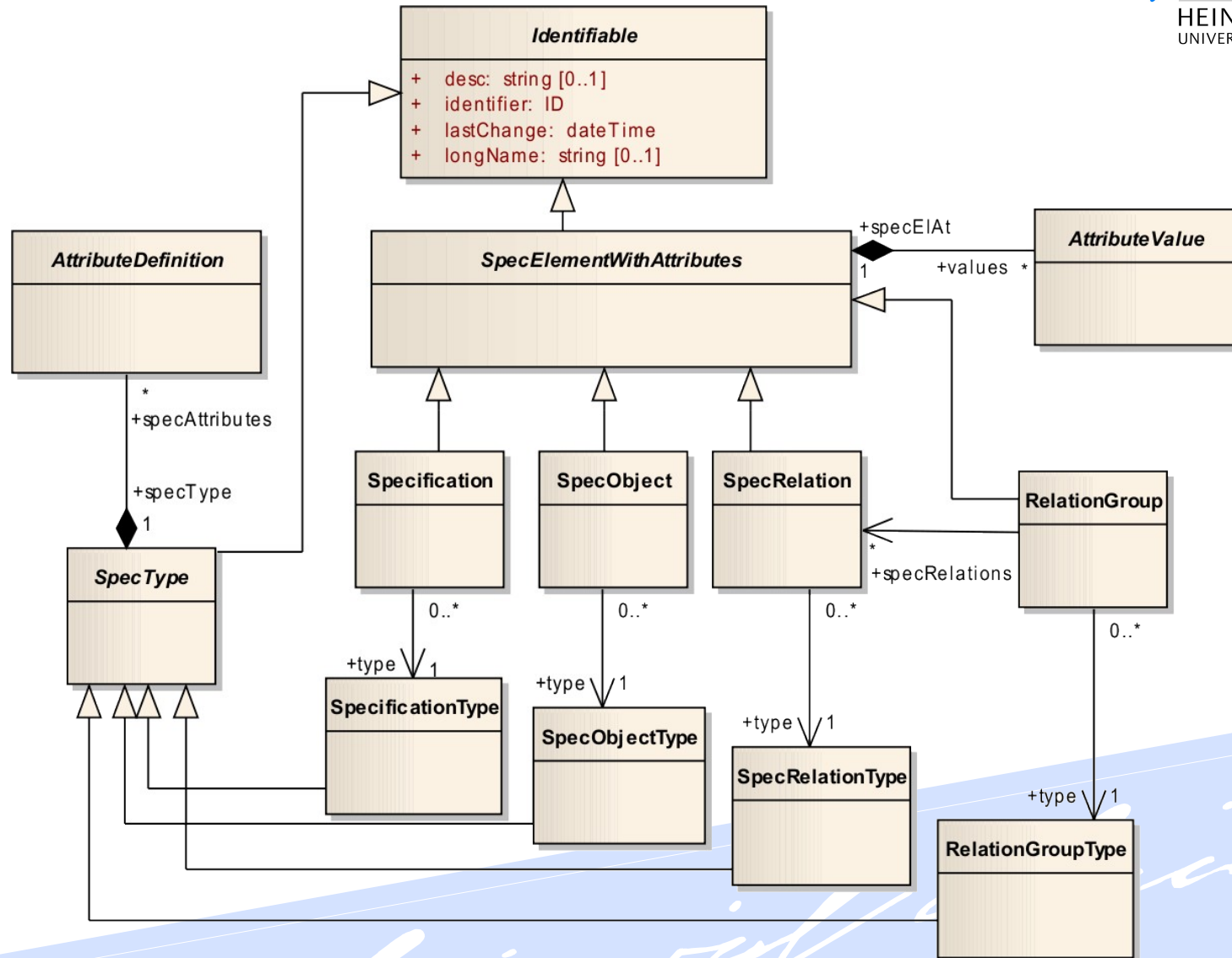
# ReqIF: Top Level



# 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

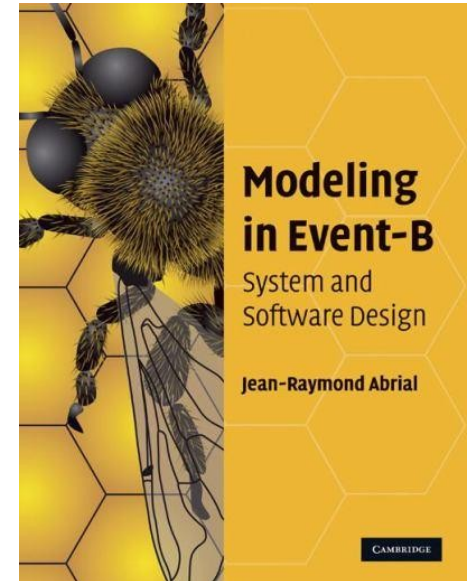


# Rodin & Event-B

- 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

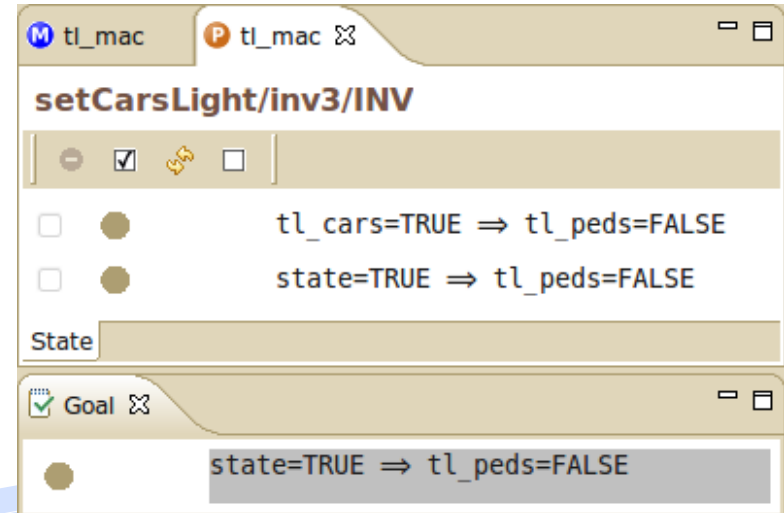
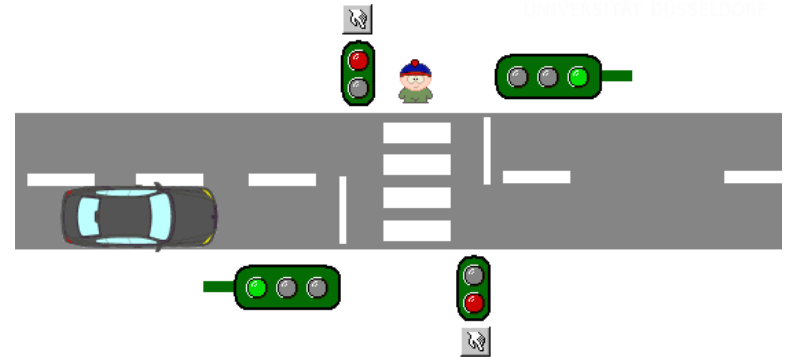
variables
  tl_cars    // Trafficlights for cars
  tl_peds    // Trafficlights for pedestrians

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



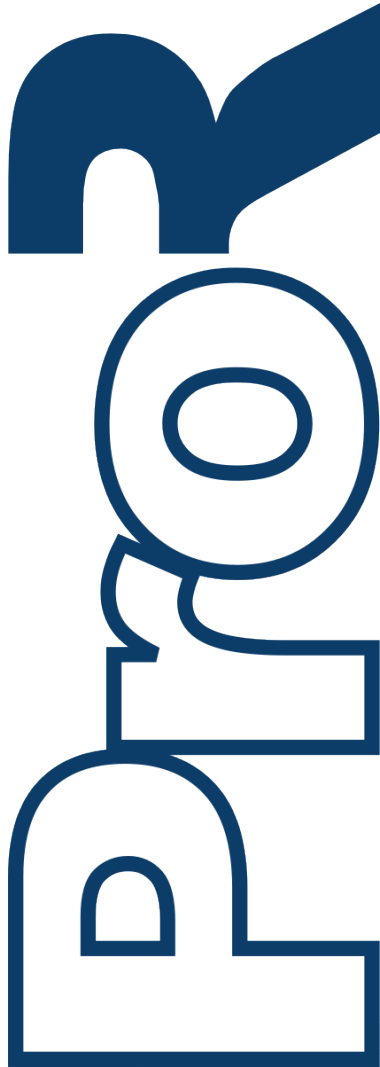
# Answer: Bridge Requirements and formal Model

- 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)

The screenshot shows the ProR GUI interface within the Rodin environment. The main window displays a 'Specification Document' with a table of requirements. Annotations highlight various features:

- Requirement**: Points to the 'REQ-1' entry in the table.
- Link**: Points to the 'LINK-1' entry in the table.
- Requirements Document**: Points to the 'Specification Document' tab.
- Requirements Properties**: Points to the 'Properties' tab at the bottom.
- Specifications**: Points to the 'Specifications' tab at the bottom.
- View-specific Attributes**: Points to the 'View-specific Attributes' section in the top right.
- Custom Presentation with color highlighting**: Points to the color-coded text in the requirement descriptions.
- Event-B Integration**: Points to the 'Event-B Integration' section in the bottom right.

The 'Specification Document' table contains the following data:

ID	Description	Status	Link
INF-1	<b>Trafficlight Specification</b>		
REQ-1	The System is controlling cars on a road and pedestrians crossing the road.	done	2 > 0
REQ-2	The System is equipped with two traffic lights for the cars [tl_cars], with the [COLORS] [RED], [YELLOW] and [GREEN].	open	0 > 1
LINK-1			> REQ-8
REQ-3	The System is equipped with two traffic lights for the pedestrians [tl_peds] with the [COLORS] [RED] and [GREEN].	open	
REQ-4	[tl_cars] stop the cars on both sides of a crosswalk.	done	
REQ-5	[tl_peds] stop the people on both sides of the crosswalk.	done	
REQ-6	Underneath [tl_peds], two call [button]s are mounted (one on each side of the street).		
REQ-7	The [tl_cars] are in sync (i.e. can be treated as one).		
REQ-8	The traffic lights for the pedestrians are in sync (i.e. can be treated as one).		
REQ-9	The lights for pedestrians and cars must never be "go" at same time.		0 > 1
LINK-2			> REQ-1
REQ-10	"go" means green for pedestrians and both green and yellow for		0 > 1

The 'Properties' tab shows the following data:

Property	Value
Misc	
Object	REQ-1
Requirement Type	
Description	The System is controlling cars on a road
ID	REQ-1
Status	done

The 'Event-B Integration' section shows a grid of symbols for Event-B notation.

# Rodin Integration

	ID	Description	Link
1	Ⓡ	<b>Trafficlight Specification</b>	
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

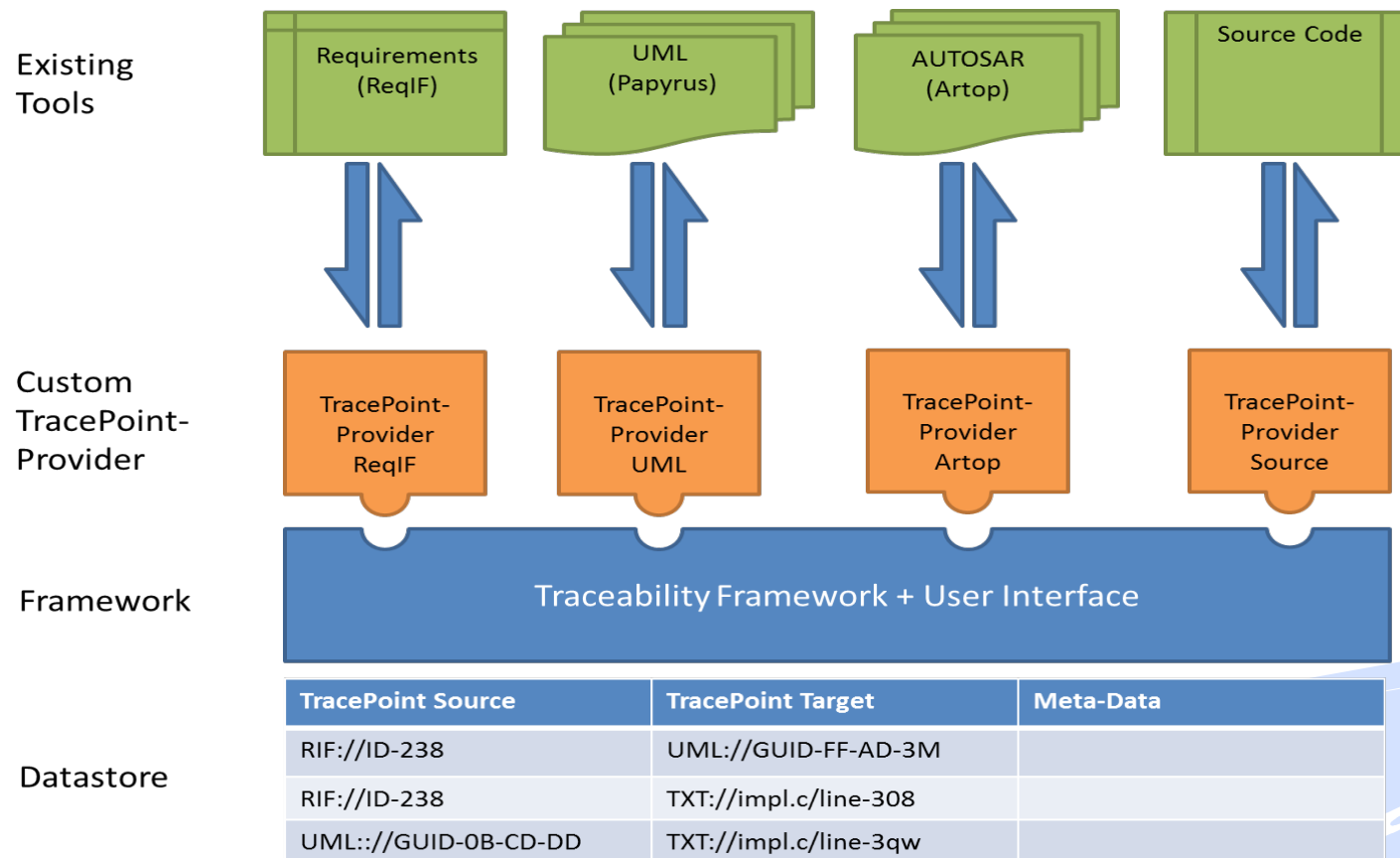
Highlighted Event-B Model Element Names

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 Pedstriar 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





# Topcased Synergies

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# Why Synergies with Topcased?

- Leveraging a successful, existing platform for System Development
- Providing Topcased with RIF/ReqIF interoperability (upcoming standard)
- Align development resources



# Approaches 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 feasible 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?