

Tarski: A Platform for Automated Analysis of Traceability using Constraint Solvers

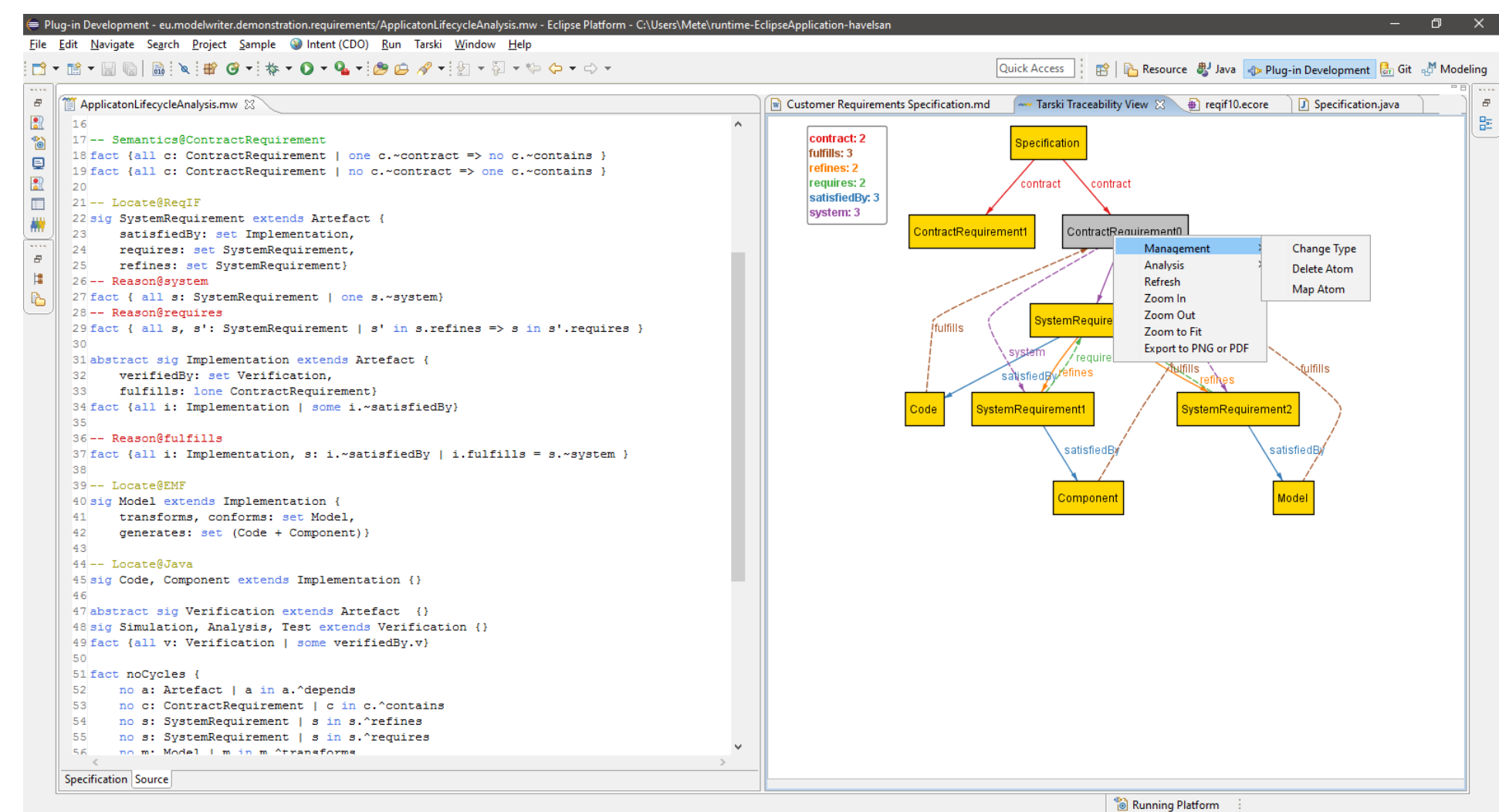
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Introduction

In this project, we introduce a new approach with its supporting platform which enables the user to interactively configure and analyze trace relations between different work products (artefacts) of the development process. The user formalizes the semantics of traceability in first-order relational logic to perform automated analysis such as consistency checking, reasoning on trace relations and trace element discovery. The usefulness of the approach is demonstrated in the context of application life-cycle platform in software industry and being tested in aviation industry.

Approach

Formal Specification & Model Management. The user is able to upload a formal specification to the Tarski platform to formalize the semantics of traceability in first-order relational logic [3] to perform consistency checking and reasoning on the trace instance. To address the scalability of the approach, we adopt the **lightweight formal method** [2] which makes analysis economically feasible. Tarski extracts a type hierarchy from the specification to enable the user to assign to trace elements. Furthermore, Tarski platform provides functions to modify the model.

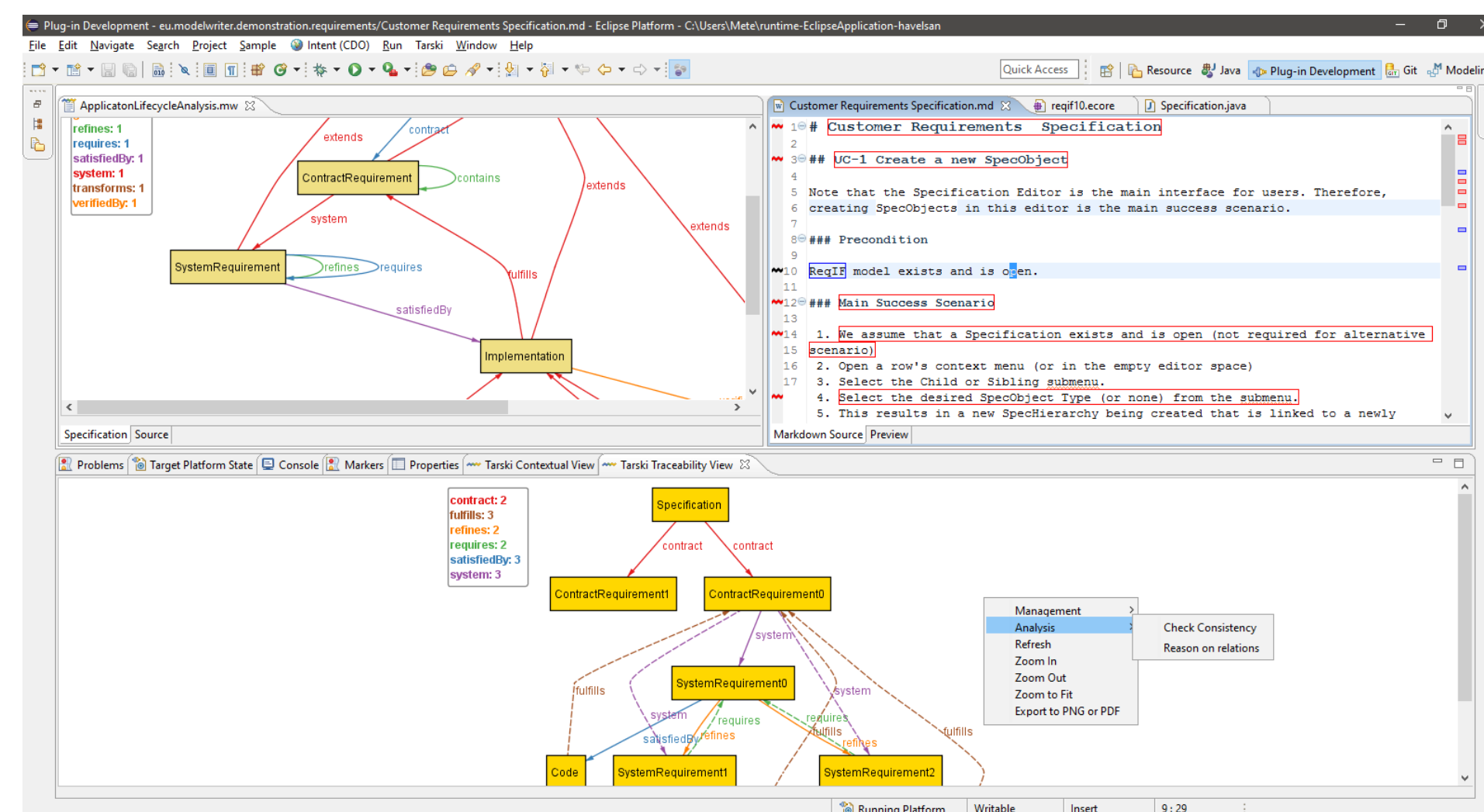


Consistency Checking. As each interaction of the user with the platform mutates the tuples in the universe, it is not guaranteed that the first order relational model satisfies the constraints. In Tarski platform, the first order model interpreted from the traceability information is automatically encoded in KodKod [4] using

the exact bounds to check the possible inconsistencies and the satisfiability of the given model is reported to the user.

Trace Elements Discovery. In addition to the reasoning on relations, the proposed framework can reason on the provided trace elements and related relations to suggest the missing trace elements based on the semantic rules.

Reasoning on Relations. Inferencing is the activity of deducing new relations based on the semantics which is already specified. To realize this reasoning, user guide the reasoner using annotations to define the relation on which the reasoning is targeted.



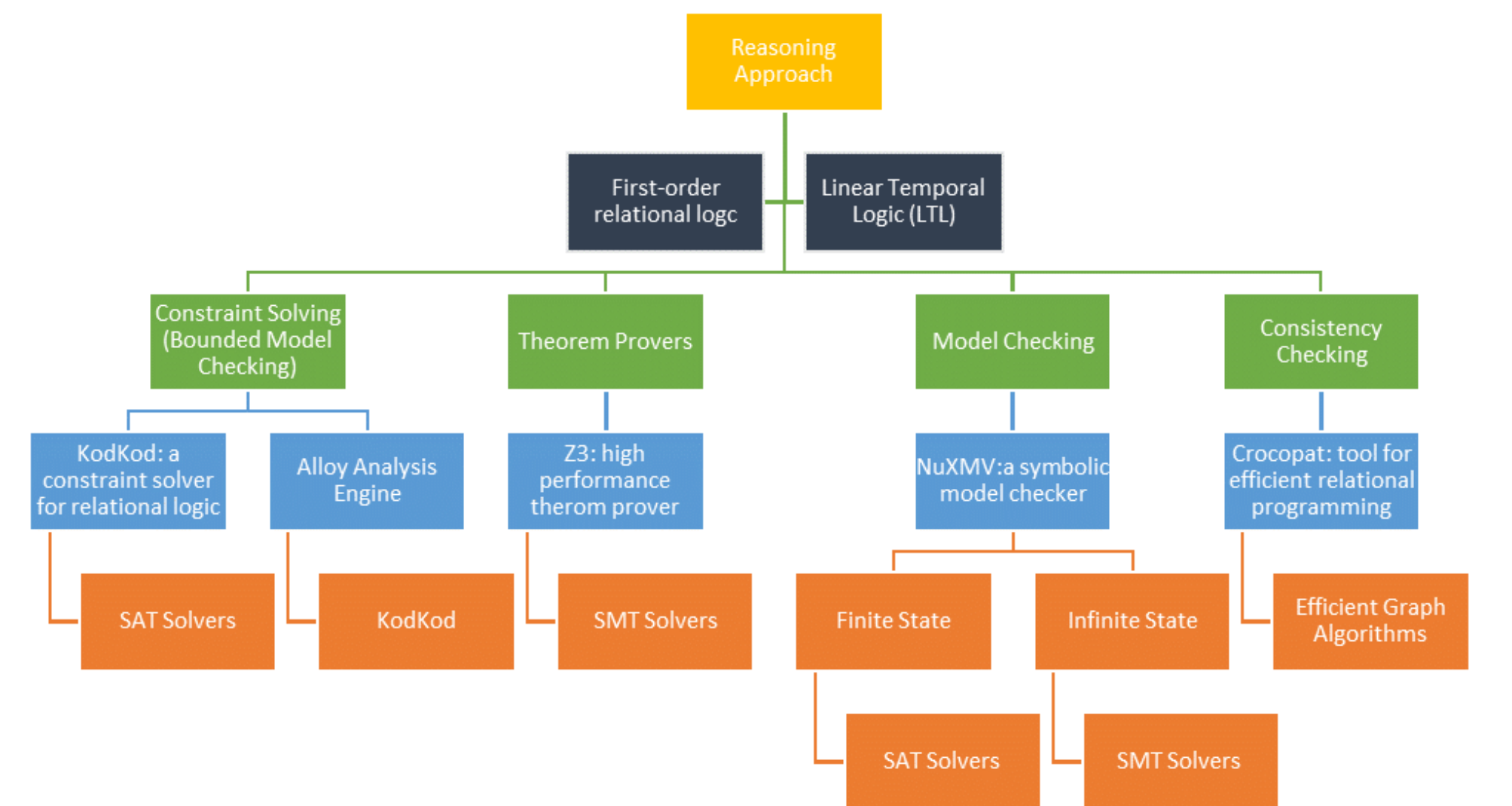
When the user accepts a suggested unary or binary relation on the visualization view of Tarski platform, the relation will be encoded as a new constraint of the model and further reasoning will be done on this new model. This mechanism will provide an evolutionary approach to develop the models.

Validation of the Approach

In this study, we have been validating the approach as a **Cyber-physical System** scenario in the formal analysis of different models and specifications produced by **Airbus**, a leading aircraft manufacturer in the world, along its system installation process. These artefacts constitute a set of design rules to formalize various aspects of the system installations on airplanes. Moreover, we've applied the approach on the **Application Lifecycle Management** platform of **Havelsan**, one of the largest systems and software company in Turkey.

Discussion

We have been working on integrating different decision procedures to incrementally and effectively repair broken trace links and discover new trace elements.



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References

- [1] D. Beyer, A. Noack, and C. Lewerentz. Efficient relational calculation for software analysis. *IEEE Transactions on Software Engineering*, 31(2):137–149, Feb 2005.
- [2] D. Jackson. *Lightweight Formal Methods*, pages 1–1. Springer Berlin Heidelberg, Berlin, Heidelberg, 2001.
- [3] D. Jackson. Alloy: A lightweight object modelling notation. *ACM Transaction Software Engineering Methodology*, 11(2):256–290, Apr. 2002.
- [4] E. Torlak. *A constraint solver for software engineering: finding models and cores of large relational specifications*. PhD thesis, Massachusetts Institute of Technology, 2008.