



# Modular Reasoning for Crosscutting Concerns with Contracts

Thomas Thüm

University of Magdeburg  
thomas.thuem@ovgu.de

**Abstract:** Separation of concerns into modules is an active research area since four decades. Modularization is beneficial for complex software systems, as it enables a divide-and-conquer strategy to software development and maintenance. A key ingredient for modularization is that modules can be studied to a certain extent in isolation, which is important for program comprehension as well as for verification. Design by contract is a means to formalize implicit assumptions for module boundaries and thus facilitates modular reasoning. While design by contract was initially proposed for object-oriented programming, we focus on the modularization of crosscutting concerns. We discuss several approaches to combine design by contract with modularization techniques for crosscutting concerns. While some of these approaches have been discussed previously, we unify them to achieve synergies. Our experience with case studies suggests that we can achieve fine-grained trade-offs between openness to extensions by other modules and closeness for modular reasoning. We argue that our approach generalizes the open-closed principle known from object-oriented programming to crosscutting concerns.

In this talk, we give an overview on our experiences in specifying crosscutting concerns with modular contracts. For further reading and a list of all involved co-authors, we refer to previously published articles [TSKA11, STAL11, TSAH12, Thü12, TAZ<sup>+</sup>13, Thü13, SST13, AvRTK13].

## References

- [AvRTK13] Sven Apel, Alexander von Rhein, Thomas Thüm, and Christian Kästner. Feature-Interaction Detection based on Feature-Based Specifications. *Computer Networks*, 57(12):2399–2409, August 2013.
- [SST13] Reimar Schröter, Norbert Siegmund, and Thomas Thüm. Towards Modular Analysis of Multi Product Lines. In *Proc. Int'l Workshop Multi Product Line Engineering (MultiPLE)*, pages 96–99, New York, NY, USA, August 2013. ACM.
- [STAL11] Wolfgang Scholz, Thomas Thüm, Sven Apel, and Christian Lengauer. Automatic Detection of Feature Interactions using the Java Modeling Language: An Experience Report. In *Proc. Int'l Workshop Feature-Oriented Software Development (FOSD)*, pages 7:1–7:8, New York, NY, USA, August 2011. ACM.

- [TAZ<sup>+</sup>13] Thomas Thüm, Sven Apel, Andreas Zelend, Reimar Schröter, and Bernhard Möller. Subclack: Feature-Oriented Programming with Behavioral Feature Interfaces. In *Proc. Workshop Mechanisms for Specialization, Generalization and Inheritance (MASPEGHI)*, pages 1–8, New York, NY, USA, July 2013. ACM.
- [Thü12] Thomas Thüm. Verification of Software Product Lines Using Contracts. In *Doktorandenagung Magdeburger-Informatik-Tage (MIT)*, pages 75–82, Germany, July 2012. University of Magdeburg.
- [Thü13] Thomas Thüm. Product-Line Verification with Feature-Oriented Contracts. In *Proc. Int'l Symposium in Software Testing and Analysis (ISSTA)*, pages 374–377, New York, NY, USA, July 2013. ACM.
- [TSAH12] Thomas Thüm, Ina Schaefer, Sven Apel, and Martin Hentschel. Family-Based Deductive Verification of Software Product Lines. In *Proc. Int'l Conf. Generative Programming and Component Engineering (GPCE)*, pages 11–20, New York, NY, USA, September 2012. ACM.
- [TSKA11] Thomas Thüm, Ina Schaefer, Martin Kuhlemann, and Sven Apel. Proof Composition for Deductive Verification of Software Product Lines. In *Proc. Int'l Workshop Variability-intensive Systems Testing, Validation and Verification (VAST)*, pages 270–277, Washington, DC, USA, March 2011. IEEE.