# Doctoral Thesis Defense

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## ABSTRACT

Software security hardening becomes increasingly important. It is any process, methodology, product, or combination that is used to increase the security of software. The implementation of security hardening solutions often interacts with the core functionality of software. This results in tangled and scattered code which is hard to maintain and understand. In this respect, Aspect-Oriented Programming (AOP) is an appealing approach that allows the separation of crosscutting concerns. AOP appears to be a promising paradigm for software security hardening and can have a substantially beneficial impact on it. Despite the fact that AOP technology fits well to security-relevant problems, the theoretical foundations, applications, or tools that address AOP and security together are rare. Besides, none of the AOP theoretical research efforts have targeted the definition of security aspect calculi. The main objectives of this thesis are to address the theoretical foundations of aspect-oriented programming in the presence of security together with the practical experiments to demonstrate the viability of the proposed ideas. Actually, we present a description for the most prominent AOP paradigms followed by an analysis for these paradigms from a security point of view. In addition, we explore the security appropriateness of AspectJ and we identify new security constructs for this language. We also define an aspect-oriented calculus for security called λ-SAOP. It is based on the λ-calculus and on the effect-based type system. Depending on AspectJ assessment from a security perspective, we design and implement new security-related pointcuts: addition, multiplication, subtraction, and dataflow within AspectJ compiler ajc-1.5.0. Finally, we lift the defined approach in this thesis one step more to be tangible in mainstream languages. For this purpose, we develop an aspect-oriented approach based on GIMPLE for the systemization of application security hardening.