

# Understanding the Modular Operators of Delta-Oriented Programming

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## SUMMARY

This paper describes the use of the L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> `speauth.cls` class file for setting papers for *Software—Practice and Experience*. Copyright © 2014 John Wiley & Sons, Ltd.

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## 1. INTRODUCTION

There is a growing interest in the research and development of variant intensive software systems (such as software product lines [1]), leading to the design of several techniques for modeling, modularising, implementing, and reasoning about software variability. That is the case of Delta-Oriented programming, a prominent technique for implementing variant systems that has evolved from an experimental, prototypical based approach [2] for dealing with software variability composition to a full fledged Java implementation [3].

In the context of variant intensive software systems, modularity is recognized as a fundamental property, and the relation between modularity and variant systems (in general) is clearly discussed within the Baldwin and Clark theory [4], which states that “*a modular design is a fundamental property that allows a designer to experiment with different alternatives*”. Therefore, based on a modular design supported by established design rules, developers should be able to evolve a software product line (SPL) according to software engineering design principles (e.g., the open-closed and principles). Nevertheless, Neves et al. describe that evolving software product lines is a challenging and error prone task (even for small product lines) [5], because it requires deeper impact analysis and the involvement of both domain and product engineers to reason about the consistence among SPL assets that represent and relate the variability space (usually described using feature models) to the solution space (i.e., detailed requirements and design, source code, test cases, test scripts, and so on).

It is usually assumed that Delta-Oriented programming improves the modular decomposition of features. For instance, Schaefer et al. compared Delta-Oriented programming with Feature-Oriented programming [6], concluding that the first simplifies the evolution of SPLs. In addition, a recent study compared two implementations of a text editor product line: one implementation developed using DeltaJ 1.5 (a Java 5 implementation of Delta-Oriented programming) and another

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implementation developed using a plugin based architecture on top of the Eclipse Rich Client Platform. The authors conclude that Delta-Oriented programming is more intuitive and simplifies both product line implementation and configurability, by reducing the necessary code base. However, the involved trade-offs of using Delta-Oriented programming are not fully understood. In particular because (a) the first study is based on qualitative assessments and lacks the use of a rigorous approach to support its claims, and (b) the second study focuses on building a product line from scratch and investigates redundancy and program comprehension. Although these perspectives relate to modularity, they do not investigate other characteristics of a modular design—which should support independent development and flexibility to evolve.

In this paper we first investigate the use of Delta-Programming to extract a SPL from an existing project. This is a typical approach for software product line engineering that reduces the risks of product line adoption. We then investigate how Delta-Oriented programming accommodates the evolution of a software product line with respect to typical evolutionary scenarios of a product line [4]. Therefore, the contributions of this paper are three fold . . .

## 2. DELTA-ORIENTED PROGRAMMING

## 3. STUDY SETTINGS

### 3.1. Case Study: IRIS email client

### 3.2. First Sprint: extract product line

#### 3.2.1. Second Sprint: Initial evolution of the product line

#### 3.2.2. Third Sprint: Final evolution of the product line

### 3.3. Metrics and Tools

## 4. RESULTS

## 5. THREATS TO VALIDITY

## 6. RELATED WORKS

## 7. FINAL REMARKS

## ACKNOWLEDGEMENT

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[www.sunrise-setting.co.uk](http://www.sunrise-setting.co.uk)

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