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Variation Mechanisms and Multi-view Architecting in Platform-based Product Family Development

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Rijksuniversiteit Groningen

VARIATION MECHANISMS AND MULTI-
VIEW ARCHITECTING IN PLATFORM-
BASED PRODUCT FAMILY DEVELOPMENT

Proefschrift

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Abstract

Over the past decades, the size and complexity of software within products has grown rapidly. Furthermore, the variation in products has increased. One way to cope with these trends is to develop products within the context of a product family. Product family development introduces a structured approach for reusing software across the products within the family. Product families are gaining in importance in the software industry.

This thesis presents the work we have performed at Philips Research using industrial cases. It consists of three parts, each addressing an area of research related to product family development.

In the first part we deal with the question how variation can be supported in a product family. We describe two methods for dealing with variation. The first method uses component frameworks with plug-in components. The component frameworks capture the generic functionality and form a stable part of the software architecture. The plug-in components provide the specific functionality that is needed to make a specific product. We focus especially on component frameworks, where the functionality is defined in the form of services. We describe a second method that is used for the development of a platform with reusable components. For a specific product components can be reused from this platform. An important element of this method is the explicit handling of interfaces, allowing the exchange of components providing the same interface. Another important element is the use of information models, which describe the data that are exchanged via the interfaces.

In the second part of this thesis we describe a method that contributes to the management of complexity, especially product families. This method uses design aspects, which are related to views that crosscut the main decomposition of a system, such as data logging or error handling. They provide a valuable structuring mechanism for the various phases of development; we will give various examples of this. Design aspects help to obtain components that can be easily reused. Since design aspects do not deal with domain specific functionality, the design aspects and their relation to the architecture requirements we describe in our study are broader applicable.

In the third part we deal with the question how a product family approach can be successfully introduced and maintained. In this part, we deal not only with technical issues, but also with business, process and organization issues. Based on a number of case studies, we identify important factors that must be considered to obtain successful product family development. Furthermore, we

introduce a classification scheme for product family approaches, which is based platform coverage and variation mechanisms. This classification scheme supports the selection of a suitable product family approach and can be used to evaluate and compare existing product families. We also discuss product family introduction strategies using the scheme.

Samenvatting

De laatste jaren is de omvang en complexiteit van software in producten snel gegroeid. Bovendien is de productvariatie toegenomen. Eén manier om met deze trends om te gaan is het ontwikkelen van producten in de context van een productfamilie. Productfamilie-ontwikkeling introduceert een gestructureerde aanpak voor het hergebruiken van software in de producten van de familie. Het belang van productfamilies groeit in de software industrie.

Dit proefschrift presenteert het werk dat we bij Philips Research hebben uitgevoerd, gebruik makende van studies van industriële systemen. Het bestaat uit drie delen, die elk een onderzoeksgebied adresseren gerelateerd aan productfamilie-ontwikkeling.

In het eerste deel behandelen we de vraag hoe variatie ondersteund kan worden binnen een productfamilie. We beschrijven twee methoden om met variatie om te gaan. De eerste methode maakt gebruik van raamwerkcomponenten en insteekcomponenten. De raamwerkcomponenten bevatten de generieke functionaliteit en vormen een stabiel onderdeel van de software architectuur. De insteekcomponenten bieden de specifieke functionaliteit die nodig is om specifieke producten te maken. Wij richten ons met name op service-raamwerkcomponenten, waarbij de functionaliteit is gedefinieerd in de vorm van services. We beschrijven een tweede methode die gebruikt wordt voor de ontwikkeling van een platform met herbruikbare componenten. Voor een specifiek product kunnen componenten worden hergebruikt uit dit platform. Een belangrijk element van deze methode is het expliciet omgaan met interfaces, waardoor het mogelijk wordt om componenten uit te wisselen die dezelfde interface aanbieden. Een ander belangrijk element is het gebruik van informatiemodellen, die de data beschrijven die via interfaces worden uitgewisseld.

In het tweede deel van dit proefschrift beschrijven we een methode die bijdraagt tot het beheersen van de complexiteit, met name in productfamilies. Deze methode maakt gebruik van ontwerpaspecten, die gerelateerd zijn aan gezichtspunten die de hoofdpdeling van een systeem doorsnijden, zoals het loggen van data of het afhandelen van fouten. Ze bieden een waardevol structureringsmechanisme voor de verschillende ontwikkelfases; we zullen hiervan verschillende voorbeelden tonen. Ontwerpaspecten dragen bij tot het verkrijgen van componenten die gemakkelijk hergebruikt kunnen worden. Aangezien ontwerpaspecten geen betrekking hebben op domeinspecifieke

functionaliteit, zijn de ontwerpaspecten en hun relatie tot de architectuureisen, die we beschrijven in onze studie, breder toepasbaar.

In het derde deel behandelen we de vraag hoe een productfamilie-aanpak op een succesvolle manier kan worden geïntroduceerd en onderhouden. In dit deel behandelen we niet alleen technische zaken, maar ook bedrijfs-, proces- en organisatiezaken. Gebaseerd op een aantal systeemstudies, identificeren we belangrijke factoren die in acht genomen moeten worden om te komen tot succesvolle productfamilie-ontwikkeling. Daarnaast introduceren we een classificatieschema voor productfamilie-aanpakken dat gebaseerd is op platformdekking en variatiemechanismen. Dit classificatieschema ondersteunt de keuze van een geschikte productfamilie-aanpak en kan gebruikt worden om bestaande productfamilies te evalueren en vergelijken. We bespreken ook introductiestrategieën voor productfamilies, gebruikmakende van dit schema.

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During my work at Philips Research Laboratories I have had the opportunity to work in various projects related to software architecture and product families. These projects have been performed in cooperation with Philips Kommunikations Industrie (PKI) in Nuremberg (Germany) and Philips Medical Systems (PMS) in Best (Netherlands). Results of this work have been published in various papers on software architectures and product families. Six of these papers form the core of this thesis. I would like to thank my bosses at Philips Research, Jaap van der Heijden and Henk Obbink, for their support and for giving me the opportunity to work in these challenging projects. I would like to thank my bosses Ronald Begeer and Madhusudan Iyer at the Innovation Center Eindhoven of Philips Semiconductors for supporting the completion of this thesis.

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