A Cost Model for Software Product Lines

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Abstract. In this paper we present a first-order cost model that describes the costs associated with developing products in a product line organization. The model addresses a number of issues that we present as a set of scenarios. The goal of this work is to develop models of varying granularity that support a manager's decision-making needs at a variety of levels. The basis of these models is the relationships among the artifacts of the product line.

Introduction

Software product lines have been touted as a preferred software development paradigm because of the large (in some cases, order-of-magnitude) economic improvements they bring compared to one-at-a-time software system development. However, this economic argument has to date been based on singular data points derived from case studies [1], convincing arguments based on reasonableness and simplistic cost curves such as the one in [9].

We believe the time has come to do better. At the recent Dagstuhl seminar on product family development [2], the authors of this paper constituted a working group that began to form an economic model for product lines that will help a manager answer questions such as:

- Should I develop our next product as a member of an existing product line, or by itself? What are the costs and benefits of each approach?
- Will it pay to merge two product lines together, or will we be better off by keeping them separate? If we merge, what will it cost?
- Which product in our planned product line would be most cost-effective to build first?

The contribution of this work is to build on previous work [4,8] to produce a model that can have immediate practical application.

The product line approach to software development seeks to provide benefit by achieving strategic levels of software reuse. Much work has been done in the area of

F. van der Linden (Ed.): PFE 2003, LNCS 3014, pp. 310–316, 2004.

software reuse economics [2,5,6,7,9]. This work has provided a valuable starting point for our model; however, the benefits of a product line stem from more than the reuse of software. The long-term goal of our work is to build a comprehensive model that fully represents the relationships among the artifacts of a product line organization and the contribution of those artifacts to the costs and benefits of the product line.

Economic Models and Cost Models

An economic model of a system presents all of the variables, such as costs and benefits, which are needed to explain how changes in a cost affect an anticipated benefit. While a full-fledged economic model for product line development is certainly needed, it is a long way off. Such a model would let a manager predict return on investment in a product line initiative in all of its various forms: new market share, staffing needs, productivity, time to market, and cost. For the time being, however, we limit ourselves to a first-order model of the cost aspect: What will be the development cost of starting, running, adding to, merging, splitting, or retiring a product line?

Of course, even the most sophisticated economic model might not replace a manager's experience or instincts. The best economic model probably won't take into account intangibles such as customer loyalty, organizational culture, political influences, or personality factors. It will, however, constitute an important tool in a savvy manager's decision-making tool kit.

Requirements for a Cost Model

Two levels of cost models are needed. A first-order model is needed for quick, gross estimates and a more detailed model is needed for detailed planning. Our work currently focuses on the first-order model. We feel that the first-order cost model should have the following qualities:

- It should provide gross estimates quickly and easily
- It should apply to most, if not all, of the scenarios with which a product line manager is faced (more on these in the next section);
- It should, where possible, make use of cost models that already exist for software development and not re-invent them.
- It should provide guidance and insight into commonly occurring product line situations and answer commonly asked cost-based questions.

To address the last requirement, we make use of product line scenarios.

Product Line Scenarios

To begin work on a cost model, it is useful to think of a set of common situations that occur in product line practice for which cost information would be helpful, such as the scenarios given in Table 1.