Essentials of Successful Product Line Practice

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Software has become the bottom line for many organizations who never envisioned themselves in the software business.
Business Goals

- High quality
- Quick time to market
- Low cost production
- Low cost maintenance

improved efficiency and productivity
Software (System) Strategies

Process Improvement
Technology Innovation
Reuse
Reuse History: From Ad-Hoc to Systematic

- 1960’s: Subroutines
- 1970’s: Modules
- 1980’s: Objects
- 1990’s: Components
- 2000’s: Product Lines
What Is a Product Line?

A product line is a group of products sharing a common, managed set of features that satisfy specific needs of a selected market.
Developing, acquiring, and maintaining multiple software products one product at a time is no longer economically viable if a multi-project business case exists.

*Strategic software reuse* is key to achieving fast, efficient, predictable, low-cost, high-quality production and maintenance.
How Do Product Lines Help?

Product lines amortize the investment in these and other *core assets*:
- requirements and requirements analysis
- domain model
- software architecture and design
- performance engineering
- documentation
- test plans, test cases, and data
- people: their knowledge and skills
- processes, methods, and tools
- budgets, schedules, and work plans
- components

*product lines = strategic reuse*
Product Line Core Assets

Products pertain to Market strategy/Application domain

Products share an Architecture

Products are built from Components
What is Product Line Practice?

Product line practice is the **systematic use of software assets** to modify, assemble, instantiate, or generate the multiple products that constitute a product line.

Product line practice involves **strategic, large-grained reuse** as a business enabler.
The Key Concepts

Use of a Common Asset Base

in Production

of a Related Set of Products
Real World Motivation

Product Line Practice needed:

- to achieve large scale productivity gains
- to improve time to market
- to continue health in the market
- to maintain market presence
- to sustain unprecedented growth
- to compensate for an inability to hire
- to achieve systematic reuse goals
Necessary Changes

Business approach
Organizational structure and personnel
Architecture
Development approach
Management

The architecture is the foundation of everything.
Examples of Product Line Practice

CelsiusTech - on board ship systems
- hardware-to-software cost ratio changed from 35:65 to 80:20

Motorola - FLEXworks Project (family of one-way pagers)
- 4x cycle time improvement
- 80% reuse

Hewlett Packard
- 2-7x cycle time improvement (some 10x)
- Sample Project
  - shipped 5x number of products
  - that were 4x as complex
  - and had 3x the number of features
  - with 4x products shipped/person
State of Product Line Practice

**Commercial Sector**

- has succeeded with systematic reuse through software product lines in many domains (HP, AT&T, Lucent, Nokia, Raytheon, Lockheed Martin, Hughes, Motorola, Ericsson, Bosch, CelsiusTech, ALLTEL, Phillips, Caterpillar, Cummins, Buzzeo, etc.)
- is seeing a growing trend toward product lines (Boeing, Ford, Chrysler, Allied Signal, etc.)
- has realized reduced time to market, improved quality, reduced development and maintenance costs, improved efficiency, increased interoperability through software product lines
- has developed proprietary technical, business, management, and acquisition product line practices

**DoD**

- has requirements for faster, better, cheaper, architecture-based reuse
- has need for systematic reuse
- has had many reuse efforts and a few successes
- is attracted to product line idea but has not been able to make it happen as a practice
- wants proven, off-the-shelf practices and support tools

How to Bridge the Gap???

- validate
- distill
- codify
- tailor
- transition
Product line development is a **low risk, high return proposition**.

Techniques for finding and exploiting system commonalities and for controlling variability are **standard software engineering practice** in the DoD, government, and industry.
Develop an *integrated* business and technical approach to product line practice

- Select, refine, and codify practices of demonstrated effectiveness for creating and acquiring software product lines in different domains and organizational contexts

**Build and nurture a **community** interested in and informed about product line practice**

- Transition product line practices and enable their use in the DoD
Information Sources

Case studies, experience reports, and pilots

Workshops
- SEI Product Line Practice Workshop (Dec. 1996)
- WISR 8: Reuse and Product Lines (Mar. 1997)
- Software Architecture in Product Line Acquisitions, Engineering or Witchcraft?, (June 1997)
- OOPSLA '97: Object Technology and Product Lines
- SEI Product Line Practice Workshop (Nov. 1997)

Surveys

Customer collaborations on actual product lines
General Remarks

Contexts for product lines vary widely.
- nature of products
- nature of market
- process maturity
- artifact maturity

BUT, there are essential elements and practices based upon today’s prevailing success factors.
Product Line Practice Framework

Describes essential product line elements

Accommodates various organizational contexts and starting points

Describes essential and proven product line practices for
• software engineering
• technical management
• enterprise management
  - acquirer
  - developer

For individual practices
• highlights the delta for the product line approach
• distinguishes between core asset development/acquisition and development/acquisition with core assets
Product Line Practice Framework

Core Asset Development / Acquisition

Enterprise Management

Product Development / Acquisition

Domain Engineering

Application Engineering
Product Development / Acquisition

- Requirements
- Product List
- Core Assets
- Production Plan

Enterprise Management

Products
Essential Product Line Practice Areas

Software Engineering

Technical Management

Enterprise Management
Software Engineering Practices

- Requirements Management
- Domain Analysis
- Architecture Development and Evaluation
- Mining Existing Assets
- Component Development
- Testing
The Architecture is Key

A **software architecture** describes the structural properties of the software, typically the components and their interrelationships and guidelines about their use.

Architecture is the **foundation** for the product line.
Architecture forms the organizational plan for component development.

Architecture is the root of **system qualities**.
Architecture ensures that variability across products can be accomplished by changes confined to one or a select set of components.
Technical Management Practices

Metrics, Data Collection, and Tracking

Configuration Management

Planning
Enterprise Management Practices

Ensuring a sound business model

Achieving the right organizational structure

Assuring pro-active management

Building and maintaining appropriate skill levels

Managing the organization’s customer interface

Ensuring inter-group collaboration
Achieving the Right Organizational Structure

Three different types of structures need to be developed, each with its own life cycle for:

- enterprise-wide product line identification
- business analysis
- core asset management
- product management

A Product Line Concept of Operations should be developed.
Organizational Structure: Product Line Partners

A new division of labor is required.
Product Line Skill Set

Marketers
- understand domain
- have deep product line knowledge
- understand customer needs
- understand trends
- negotiate and sell

Core Assets Group
- understand domain
- understand application
- design with ease and skill
- can abstract
- are technically current
- can mediate

Product Line Production Group
- understand application
- understand customer problems
- can engineer from “building blocks”
- can customize
- have implementation expertise

Managers
- have vision
- make decisions
- can lead
- are technically savvy

Deep Domain Expertise is Essential

sell the product line

develop components

choose components

support the product line
Note: An individual or small highly specialized team must have responsibility for the architecture.
Management

Commitment

- training
- enforcement
- reward system
- culture

Support

Leadership
Key Themes Among Successful Product Lines

Long and deep domain experience

A legacy base from which to build

Architectural excellence

Management commitment
There are benefits, but there are also costs and risks.
Product Line Risks

Up front investment

Possible required change in organizational structure and policies

Technology adoption—training, culture change

Customer re-education

Poor architecture quality

Poor component quality

Technology, product staleness

Domain instability

Major technology shifts

Constancy of management purpose and organizational direction
Product Line Challenges

Developing product line architectures

Evolving product line architectures and assets

Product line migration strategies for legacy systems

Business models to support strategic reuse decisions

Acquisition strategies that support systematic reuse through product lines

Repeatable, integrated technical, management, and enterprise practices
The Bottom Line

If properly managed, the benefits of a product line approach far exceed the costs.

Strategic software reuse through a well-managed product line approach achieves enterprise goals of:

- efficiency
- time to market
- productivity, and
- quality

Product Line Practices will pervade software engineering in the new millennium