Maximizing the Investment from Your Software Product Portfolio

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Today's Speaker

Linda Northrop is director of the Research, Technology, and System Solutions Program at the Software Engineering Institute where she leads the work in architecture-centric engineering, software product lines, systems of systems, and ultra-large-scale systems.

She is coauthor of *Software Product Lines: Practices and Patterns.* She recently led a year long study including leaders in the software community to define technical and social challenges to the creation of ultra-large-scale systems that will evolve in the next generation. The group published the study report, Ultra-Large-Scale Systems: *The Software Challenge of the Future (ISBN 0-9786956-0-7)*.

Before joining the SEI, she was associated with both the United States Air Force Academy and the State University of New York as professor of computer science, and with both Eastman Kodak and IBM as a software engineer.

Polling Question 1

How did you hear about this webinar?

Email invitation from the SEI

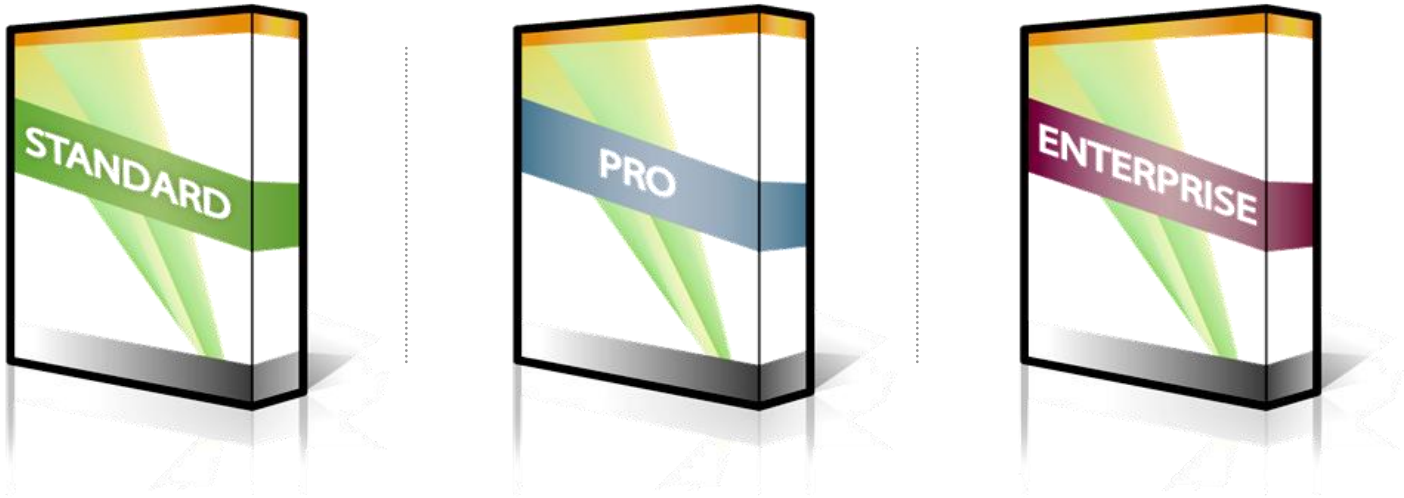
SEI Website

Website with webinar calendar (ie www.webinar-directory.com)

Social Media site (LinkedIn, Twitter)

SEI Member Bulletin

Few Systems Are Unique



Most organizations produce families of similar systems, differentiated by features.

A reuse strategy makes sense.

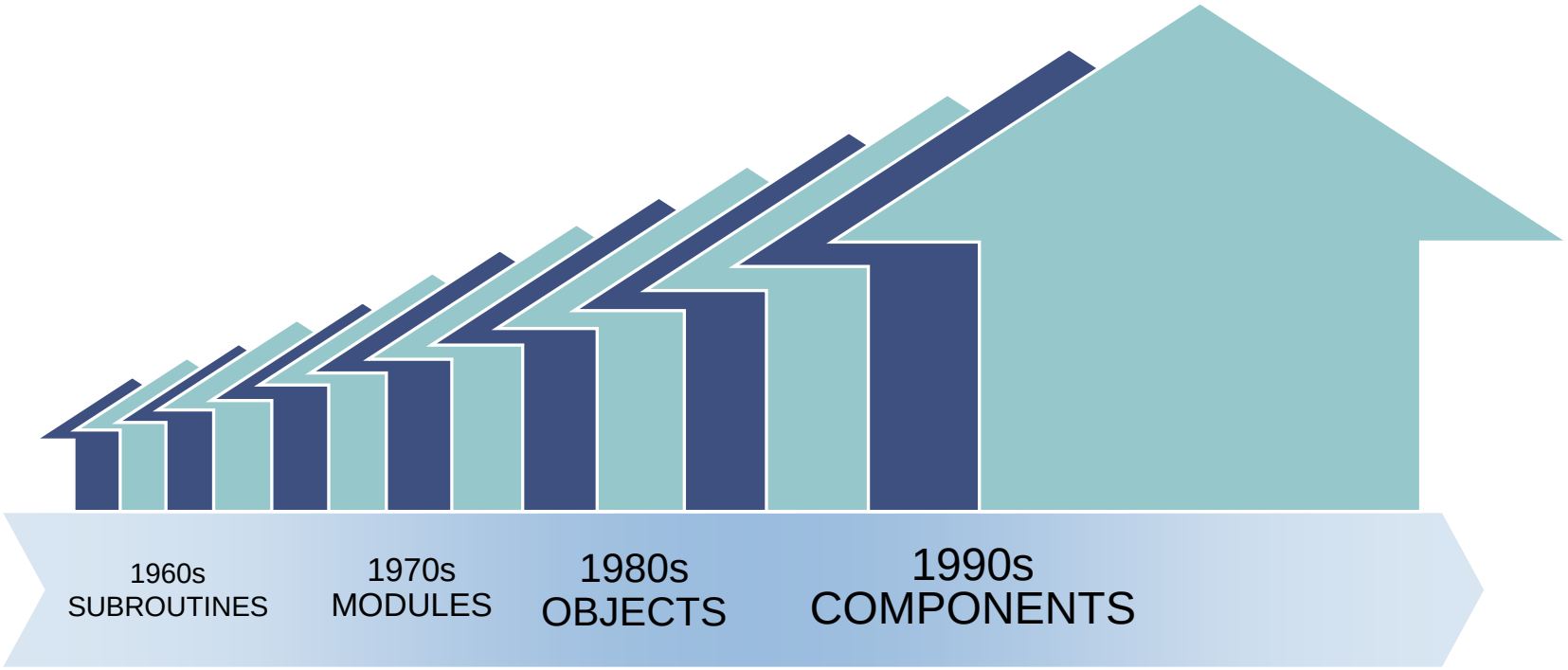
Traditional reuse strategies have had little economic benefit.

Polling Question 2

Does your organization have a portfolio that contains multiple distinct systems having similar features and capabilities?

1) Yes
2) No

Reuse History



Focus was small-grained, opportunistic, and technology-driven. Results did not meet business goals.

Strategic Reuse is Needed for Business Benefits

What Is A Software Product Line?

A *software product line* is a set of software-intensive systems sharing a common, managed set of features that satisfy the specific needs of a particular market segment or mission and that are developed from a common set of core assets in a prescribed way.

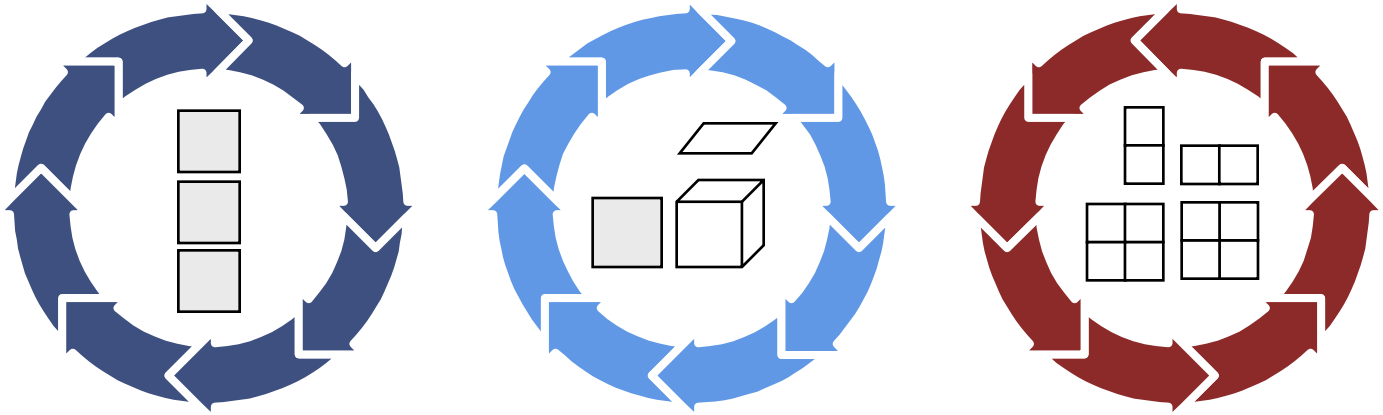
- a new application of a proven concept
- an innovative, growing concept in software engineering

The Key Concepts

Use of a core asset base

in production

of a related set of products



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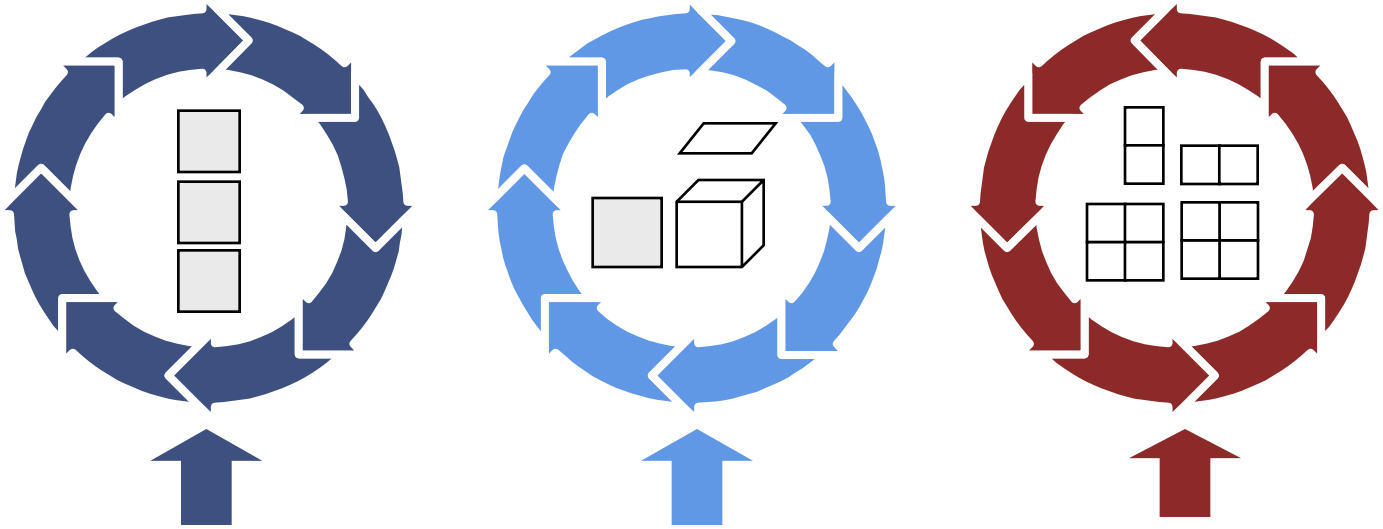


Architecture

Production Plan

Scope Definition
Business Case

Linda Northrop

Polling Question 3

Are you familiar with the concept of software product lines?

1) Have never heard of it.
2) Have heard about it but never tried it.
3) Have tried it but have not been too successful.
4) Have tried it and was successful.

Widespread Use of Software Product Lines

Successful software product lines have been built for families of among other things

- mobile phones
- command and control ship systems
- satellite ground station systems
- avionics systems
- command and control/situation awareness systems
- pagers
- engine control systems
- mass storage devices
- billing systems
- web-based retail systems
- printers
- consumer electronic products
- acquisition management enterprise systems
- financial and tax systems
- medical devices
- farm fish management software

Specific Examples - 1

akvasmart

Feed control and farm management software

BOEING

Bold Stroke Avionics

E-COM Technology Ltd.

Medical imaging workstations

hp invent

Firmware for computer peripherals

Lucent Technologies
Bell Labs Innovations

5ESS telecommunications switch

ABB **Asea Brown Boveri**

Gas turbines, train control, semantic graphics framework

Dialect

Internet payment gateway infrastructure products

ERICSSON

AXE family of telecommunications switches

LG

Elevator control systems

NOKIA

Mobile phones, mobile browsers, telecom products for public, private and cellular networks

AXIS COMMUNICATIONS

Computer printer servers, storage servers, network camera and scanner servers

DNV

Customized solutions for transportation industries

GM

Software for engines, transmissions and controllers

LSI LOGIC

RAID controller firmware for disk storage units

NASA

Interferometer product line

Specific Examples - 2

PHILIPS

High-end televisions, PKI telecommunications switching system, diagnostic imaging equipment

Rockwell Collins

Commercial flight control system avionics, Common Army Avionics System (CAAS), U.S. Army helicopters

symbian

EPOC operating system

NAVSEA WARFARE CENTERS

Test range facilities

RICOH

Office appliances

SALION TARGET. WIN. DELIVER.

Revenue acquisition management systems

TELVENT

Industrial supervisory control and business process management systems

U.S.ARMY

Command and control simulator for Army fire support

BOSCH

Automotive gasoline systems

SIEMENS

Software for viewing and quantifying radiological images

testo

Climate and flue gas measurement devices

alltel FIDELITY NATIONAL FINANCIAL

Support software

MOTOROLA

Pagers product line

Real World Motivation

Organizations use product line practices to:

- achieve large scale productivity gains
- improve time to market
- maintain market presence
- sustain unprecedented growth
- achieve greater market agility
- compensate for an inability to hire
- enable mass customization
- get control of diverse product configurations
- improve product quality
- increase customer satisfaction
- increase predictability of cost, schedule, and quality

Cummins Inc.: Diesel Control Systems

Over 20 product groups with over 1,000 separate engine applications

- Product cycle time was slashed from 250 person-months to a few person-months.
- Build and integration time was reduced from one year to one week.
- Quality goals are exceeded.
- Customer satisfaction is high.
- Product schedules are met.

Second Generation Product Lines

Cummins launched a Core II product line

- not from emergency business needs, as was Core I
- from a mature realization that the organization could do better

Core II includes

- a new core asset base
- newly derived products
- a new product line process
- a new production method, strategy, and plan
- a new organizational structure
- a new operational concept
- a powerful, new toolset

Core II is meeting its goals.

It is a much fuller and more mature product line capability.

Software Product Lines Today at Cummins

The overall impact of a software product line approach on Cummins as measured by Core II results includes

- freed up resources (time, money, and people) to invest in new technologies and state-of-the-art tools and simulation capabilities
- an all-time high in product quality
- continuously shrinking time to market
- an ability to handle increased breadth and complexity of products
- an ability to outpace its market rivals

Product lines have now become institutionalized at Cummins.

Software Product Lines Value Proposition

The systematic use of software product line practices results in significant organizational benefits including

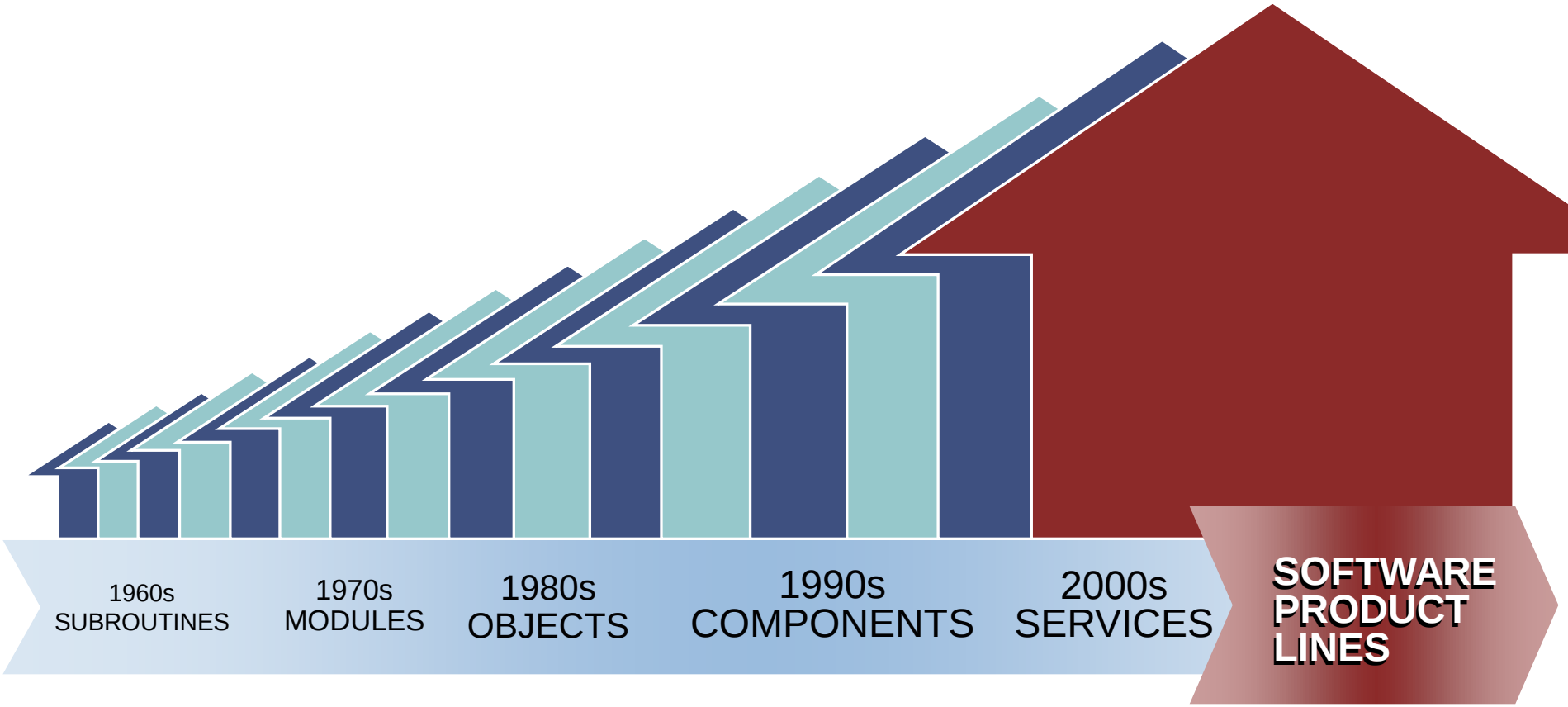
- increased quality
  - by as much as 10x
- decreased cost
  - by as much as 60%
- decreased labor needs
  - by as much as 87%
- decreased time to market (to field, to launch...)
  - by as much as 98%
- ability to move into new markets
  - in months, not years

The Value of Options

A software product line approach provides options to future market opportunities.

- The exact opportunities and their certainty are impossible to predict.
- Organizations need a way to conduct product experiments in low-cost, low-risk ways.
- Software product lines permit those kind of experiments through predefined variation points that can be exercised to meet new needs.

Reuse History: From Ad Hoc To Systematic



Software Product Lines Are Not

Clone and own: single-system development with reuse

- modifying code as necessary for the single system only

Fortuitous small-grained reuse

- reuse libraries containing algorithms, modules, objects, or components

Just component-based or service-based development

- selecting components or services from an in-house library, the marketplace, or the Web with no architecture focus

Just versions of a single product

- rather, simultaneous release and support of multiple products

Just a configurable architecture

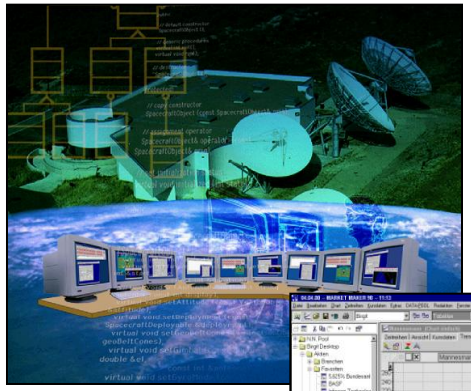
- a good start, but only part of the reuse potential

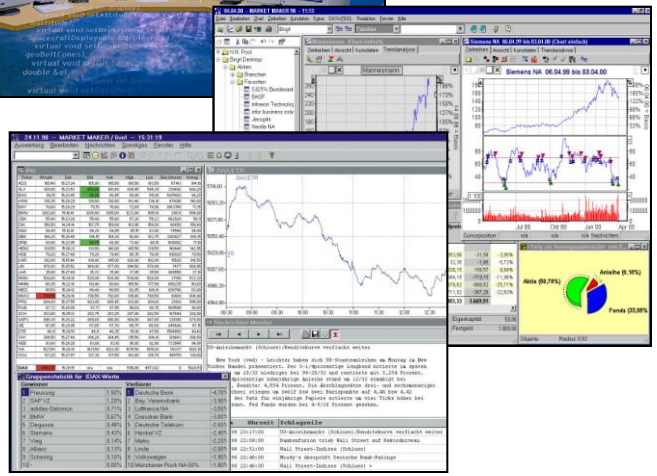
Just a set of technical standards

- constraining choices without an architecture-based reuse strategy

Software Product Lines Are

Software product lines involve strategic, planned reuse that yields predictable results.



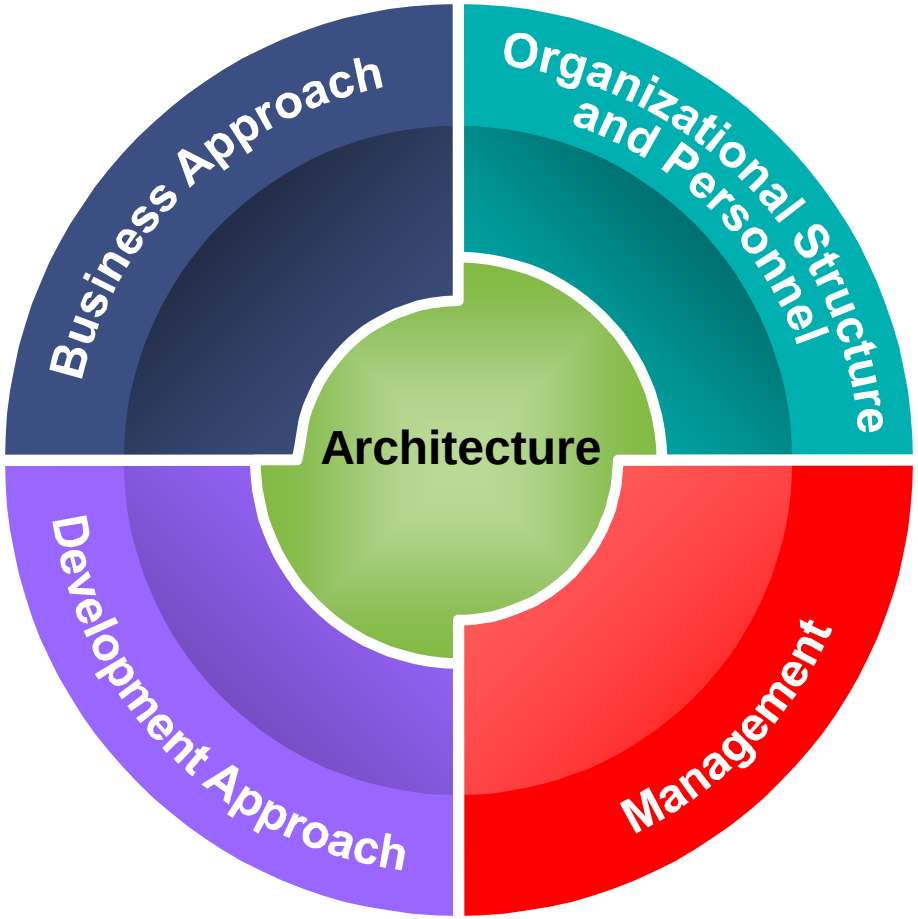


Polling Question 4

Do you use a form of software reuse at your organization?

1) clone and own
2) reuse library or repository
3) component-based or service-based approaches
4) application frameworks or standard architectures
5) some combination of the above

Necessary Changes



The product line architecture is central to success.

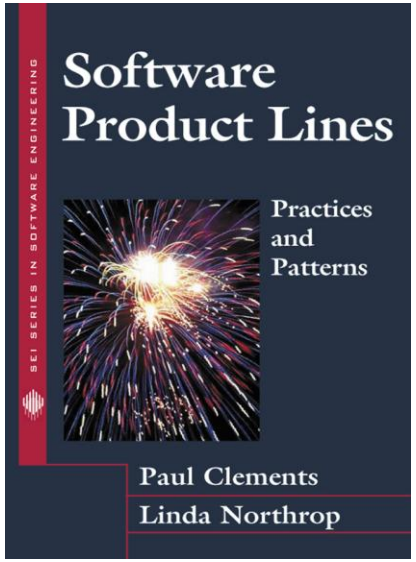
The SEI Framework For Software Product Line Practice[sm]

The SEI Framework for Software Product Line Practice is a conceptual framework that describes the essential activities and twenty-nine practice areas necessary for successful software product lines.

The Framework, originally conceived in 1998, is evolving based on the experience and information provided by the community.

Version 4.0 –
in *Software Product Lines: Practices and Patterns*

Version 5.0 –
http://www.sei.cmu.edu/productlines/framework.html



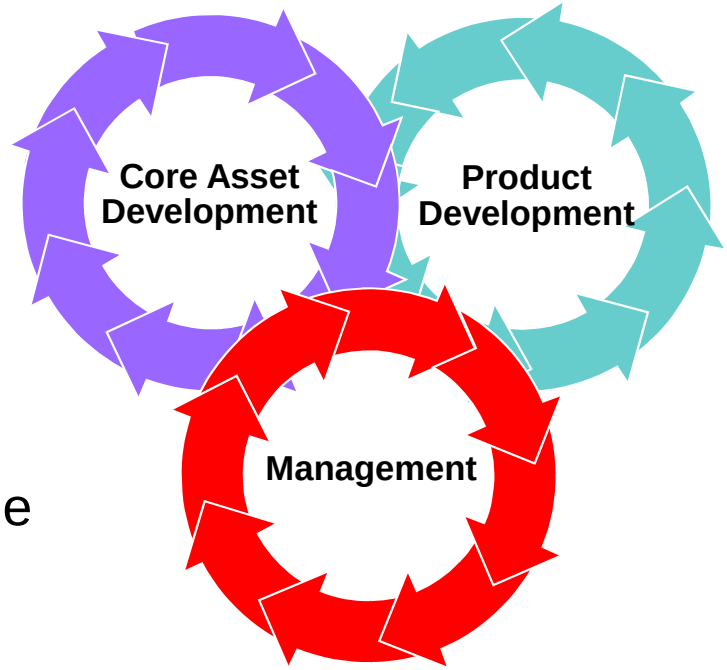
Three Essential Activities

All three activities are interrelated and highly iterative.

There is no “first” activity.

- In some contexts, existing products are mined for core assets.
- In others, core assets may be developed or procured for future use.

There is a strong feedback loop between the core assets and the products.



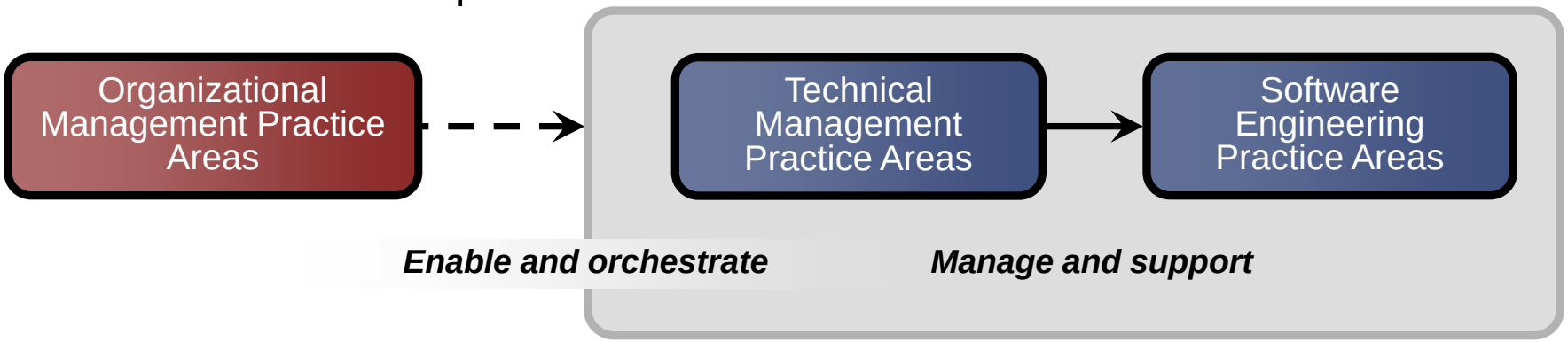
Strong management at multiple levels is needed throughout.

Management oversees core asset and product development.

Management orchestrates all activities and processes needed to make the three essential activities work together.

Driving the Essential Activities

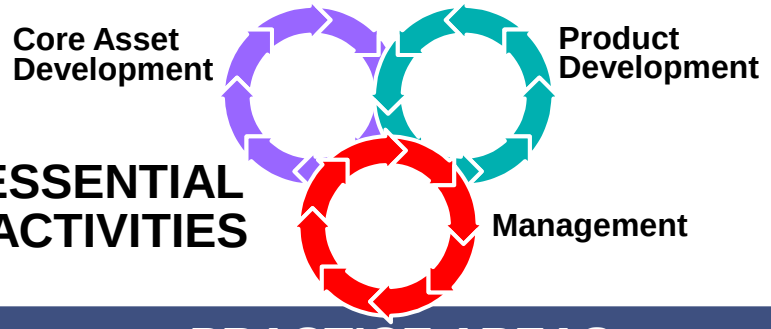
Supporting the essential activities are essential practices that fall into practice areas. A ***practice area*** is a body of work or a collection of activities that an organization must master to successfully carry out the essential work of a product line.



Three Categories Of Practice Areas

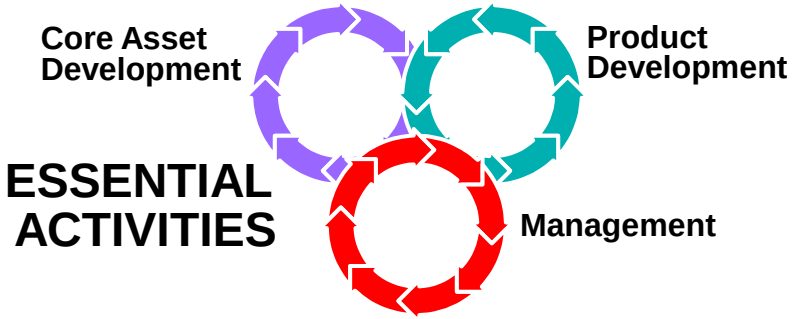
The practice areas represent common activities in software development that are adapted to the needs of a product line approach.

Framework Version 5.0



PRACTICE AREAS		
Software Engineering	Technical Management	Organizational Management
Architecture Definition	Configuration Management	Building a Business Case
Architecture Evaluation	Make/Buy/Mine/Commission Analysis	Customer Interface Management
Component Development	*Measurement and Tracking*	Developing an Acquisition Strategy
Mining Existing Assets	*Process Discipline*	Funding
Requirements Engineering	Scoping	Launching and Institutionalizing
Software System Integration	Technical Planning	Market Analysis
Testing	Technical Risk Management	Operations
Understanding Relevant Domains	Tool Support	Organizational Planning
Using Externally Available Software	Key: *New Name and Substantial Change* Substantial Change	Organizational Risk Management
		Structuring the Organization
		Technology Forecasting
		Training

Dilemma: How Do You Apply The 29 Practice Areas?



PRACTICE AREAS		
Software Engineering	Technical Management	Organizational Management

GUIDANCE			
Case Studies	Patterns	Probe	Curriculum

Case Studies

CelsiusTech – CMU/SEI-96-TR-016
http://www.sei.cmu.edu/publications/documents/01.reports/96.tr.016.html

Cummins, Inc. *Software Product Lines: Practices and Patterns*

Market Maker *Software Product Lines: Practices and Patterns*

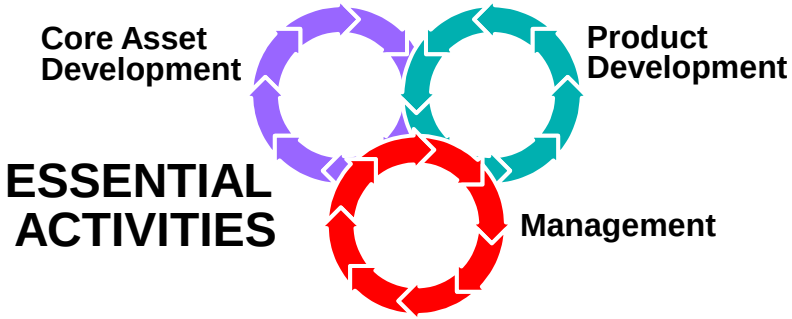
NRO/Raytheon – CMU/SEI-2001-TR-030
http://www.sei.cmu.edu/publications/documents/01.reports/02tr030.html

NUWC – CMU/SEI-2002-TN-018
http://www.sei.cmu.edu/publications/documents/02.reports/02tn018.html

Salion, Inc. – CMU/SEI-2002-TR-038
http://www.sei.cmu.edu/publications/documents/02.reports/02tr038.html

U.S. Army – CMU/SEI-2005-TR-019
http://www.sei.cmu.edu/publications/documents/05.reports/05tr019.html

Help To Make It Happen



PRACTICE AREAS		
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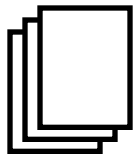
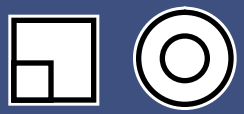
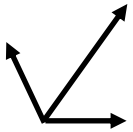
GUIDANCE



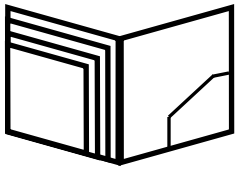
Case Studies



Patterns

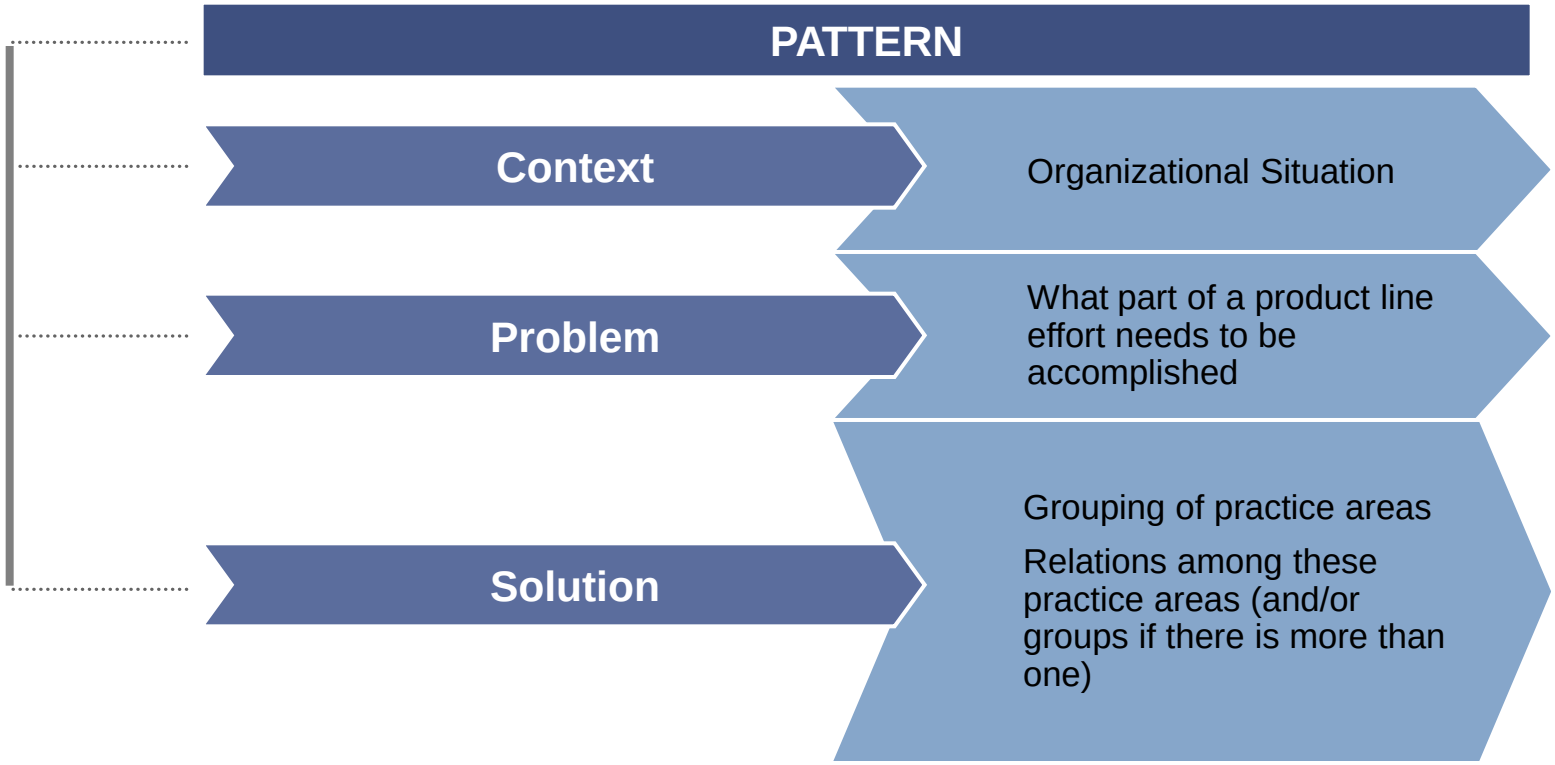


Probe



Curriculum

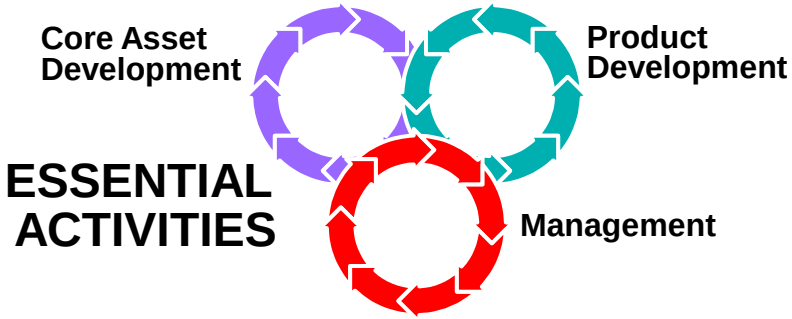
Software Product Line Practice Patterns



Current Set Of Patterns

Pattern	Variants
Assembly Line	
Cold Start	Warm Start
Curriculum	
Each Asset	Each Asset Apprentice Evolve Each Asset
Essentials Coverage	
Factory	Adoption Factory
In Motion	
Monitor	
Process	Process Improvement
Product Builder	Product Gen
Product Parts	Green Field Barren Field Plowed Field
What to Build	Analysis Forced March

Help To Make It Happen



PRACTICE AREAS		
Software Engineering	Technical Management	Organizational Management

GUIDANCE

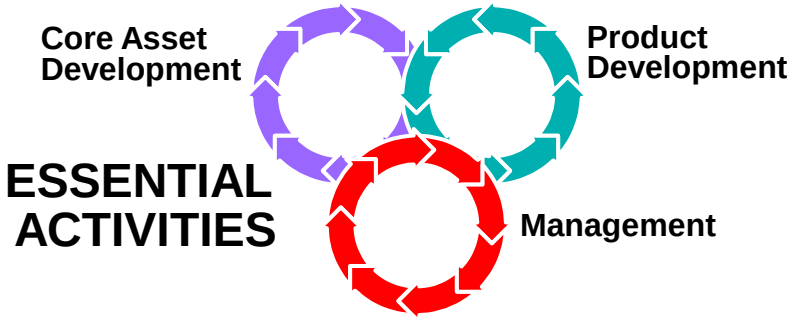
Case Studies | Patterns | **Probe** | Curriculum

What Is An SEI Product Line Technical Probe (PLTP)?

The SEI PLTP is a method for examining an organization's readiness to adopt or ability to succeed with a software product line approach.

- It is a diagnostic tool based on the SEI Framework for Software Product Line Practice.
- The 29 practice areas are the basis of data collection and analysis.

Help To Make It Happen



PRACTICE AREAS		
Software Engineering	Technical Management	Organizational Management

GUIDANCE

Case Studies

Patterns

Probe

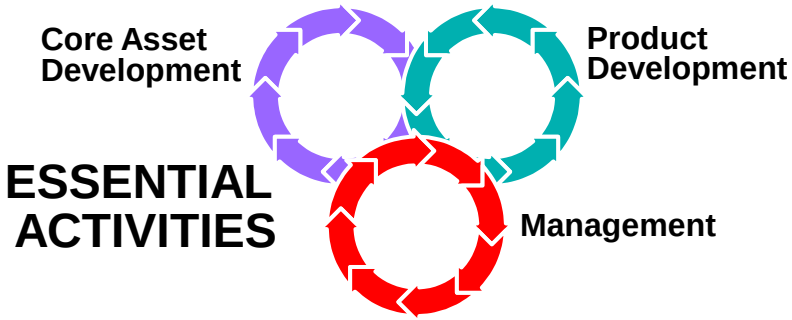
Curriculum

The SEI Software Product Line Curriculum

Five Courses	***Three Certificate Programs***		
	Software Product Line Professional	**PLTP Team Member**	**PLTP Leader**
Software Product Lines	✓	✓	✓
Adopting Software Product Lines	✓	✓	✓
Developing Software Product Lines	✓	✓	✓
PLTP Team Training		✓	✓
PLTP Leader Training			✓
PLTP Lead Observation			✓

✓ **: course required to receive certificate**

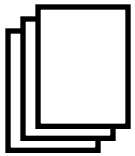
Adding An Adoption Roadmap

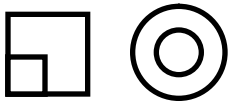


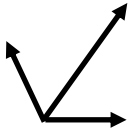
PRACTICE AREAS

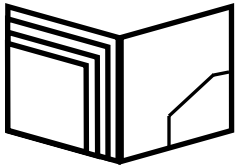
Software Engineering	Technical Management	Organizational Management

GUIDANCE


Case Studies


Patterns


Probe


Curriculum

ADOPTION FACTORY

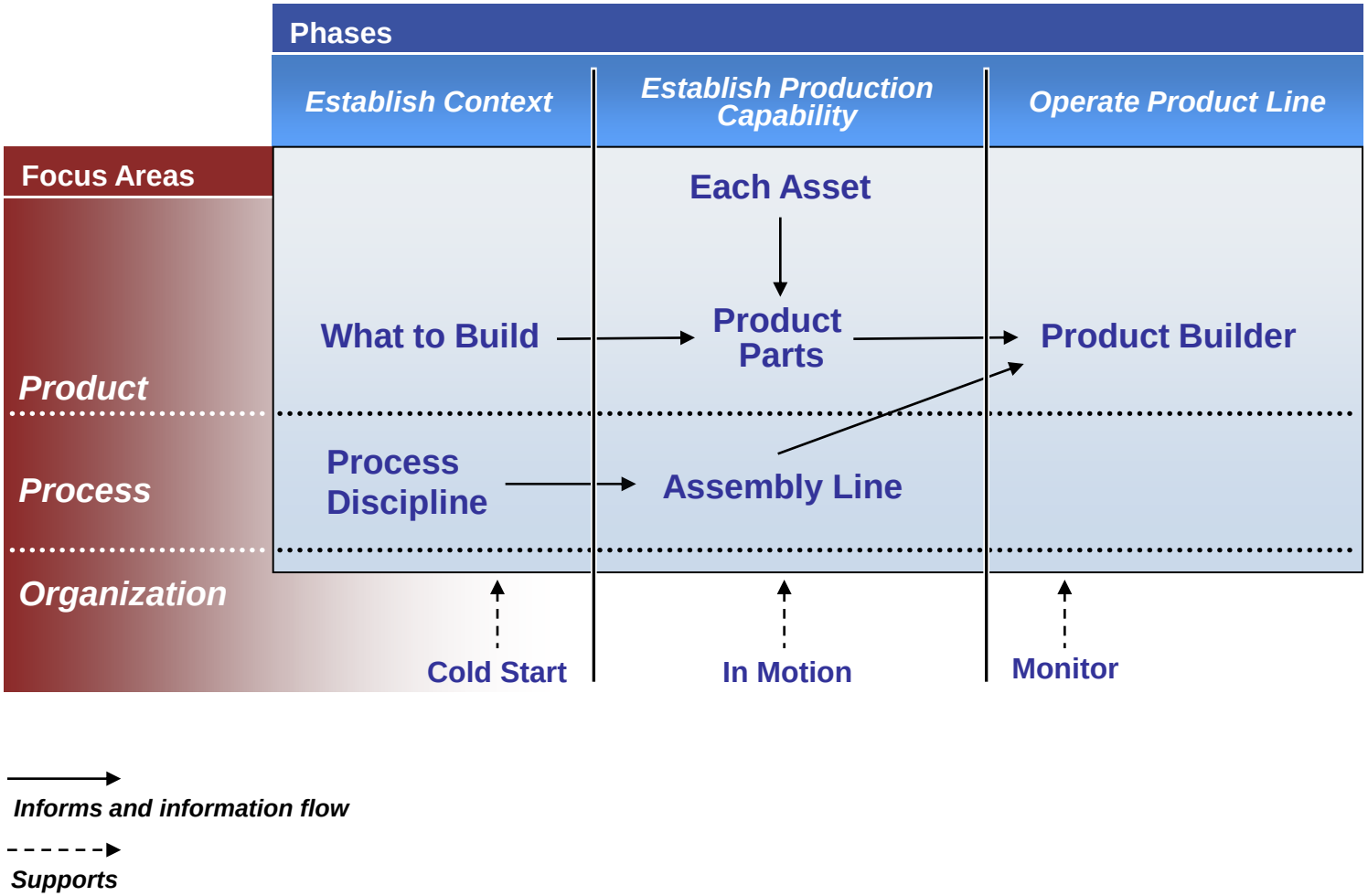
The Product Line Adoption Endgame

To have an **operational software product line.**

To do that, an organization must

- have
  - a core asset base
  - supportive processes and organizational structures
- develop products from that asset base in a way that achieves business goals
- prepare itself to institutionalize product line practices

The SEI Adoption Factory Pattern



Linda Northrop

Associated Practice Areas

	Establish Context	Establish Production Capability	Operate Product Line
Product	• Marketing Analysis • Understanding Relevant Domains • Technology Forecasting • Building a Business Case • Scoping	• Requirements Engineering • Architecture Definition • Architecture Evaluation • Mining Existing Assets • Component Development • Using Externally Available Software • Software System Integration • Testing	• Requirements Engineering • Architecture Definition • Architecture Evaluation • Mining Existing Assets • Component Development • Using Externally Available Software • Software System Integration • Testing
Process	• Process Discipline	• Make/Buy/Mine/Commission • Configuration Management • Tool Support • Measurement and Tracking • Technical Planning • Technical Risk Management	
Organization	• Launching and Institutionalizing • Funding • Structuring the Organization • Operations • Organizational Planning • Customer Interface Management • Organizational Risk Management • Developing an Acquisition Strategy • Training	• Launching and Institutionalizing • Funding • Structuring the Organization • Operations • Organizational Planning • Customer Interface Management • Organizational Risk Management • Developing an Acquisition Strategy • Training	• Measurement and Tracking • Technical Risk Management • Organizational Risk Management • Customer Interface Management • Organizational Planning

What's Different About Reuse With Software Product Lines?

- Business dimension
- Iteration
- Architecture focus
- Preplanning
- Process and product connection

Polling Question 5

If you have been involved in a product line effort, where was the biggest challenge?

1) architecture
2) variation management
3) funding
4) management support
5) other

Remaining Challenges

Variation mechanisms and variation management

Automating all or part of the production process

Lowering adoption cost

Distributed development and evolution

Scaling to systems of systems and ultra-large-scale systems

Challenges - Emerging Solutions

Variation mechanisms and variation management

AOP/AOSD | SOA | End-User Programming

Automating all or part of the production process

MDA | DSL | DDD | Generative Programming

Lowering adoption cost

Agile, Phased Approaches | Tool Support

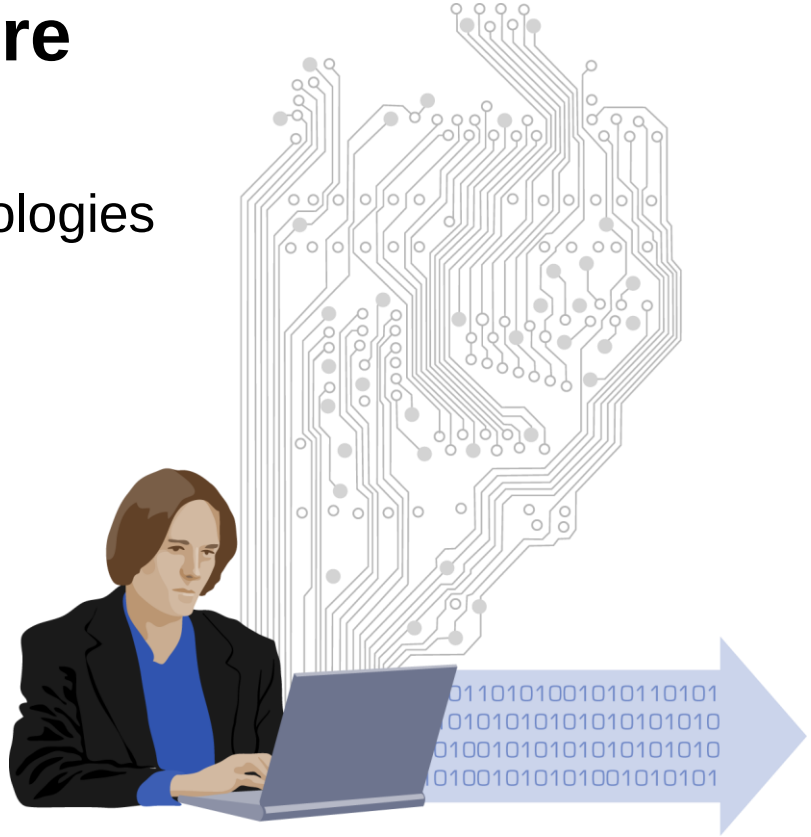
Distributed development and evolution

Open Source Models | Collaborative Environments | Virtual Worlds

Scaling to systems of systems and ultra-large-scale systems

Product lines reduce interoperability issues

Product Lines of the Future



Will harness new and emerging technologies

- metadata
- automated derivation
- SOA
- end-user programming

and new forms of collaboration

- cooperative models
- globalization
- virtual worlds
- collaborative environments

to make product lines more doable, pliable, and dynamic.

Tomorrow's product lines will accrue even greater benefits than those already demonstrated.

Summary of SEI Contributions

Models and Guidance

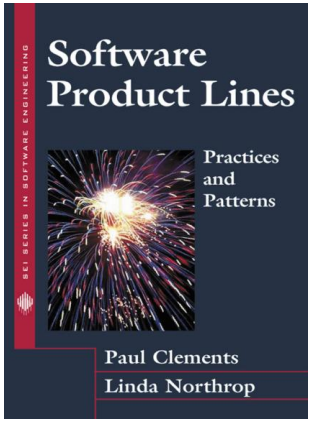
- *A Framework for Software Product Line Practice*[SM]
- *Software Product Line Acquisition: A Companion to A Framework for Software Product Line Practice*
- Product line practice patterns
- Product line adoption roadmap
- Pedagogical product line

Methods and Technology

- product line analysis
- architecture definition, documentation, evaluation (ATAM®), and recovery
- mining assets
- production planning
- Structured Intuitive Model for Product Line Economics (SIMPLE)
- Product Line Technical Probe[SM] (PLTP[SM])
- Product Line Quick Look (PLQL)
- Interactive workshops in product line measurement, variability management, product line management
- Prediction-enabled component technology

Book

Software Product Lines: Practices and Patterns



Curriculum and Certificate Programs

- Five courses and three certificate programs
- Product Line Executive Seminar

Conferences and Workshops

- SPLC 1, SPLC2, SPLC 2004; SPLC 2006; SPLC 2009; Workshops 1997 - 2005; Army Product Line Workshop 2007; Army Product Line Workshop 2009

Technical Reports, publications, and Web site

Ongoing SEI Product Line Research

Product derivation

- variation mechanisms
- production plan definition and implementation
- product line production including automated derivation

Product line adoption strategies

- economic models
- acquisition strategies

Adapting product line concepts to exploit new technologies and serve new contexts

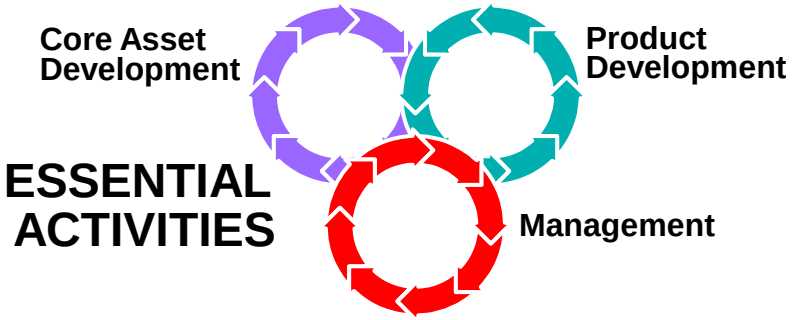
- system of systems
- service-oriented architectures
- open source
- globalization
- ultra-large scale systems

In A Nutshell

Software product lines epitomize the concept of strategic, planned reuse.

The product line concept is about more than a new technology. It is a new way of doing one's software business.

There are essential product line activities and practices areas as well as product line patterns to make the move to product lines more manageable.



PRACTICE AREAS		
Software Engineering	Technical Management	Organizational Management

Final Notes

Research in software product lines was inspired by the proven benefits of product line approaches in manufacturing, and was buoyed by the advent of object and component technology.

The SEI has been a leader in developing a body of knowledge and a set of standard models for software product lines.

Early product line adopters, like Cummins, Inc., are now on second generation product lines that have resulted in even far greater benefits.

Service-oriented and model-driven approaches, as well as developments in collaborative philosophies and environments, are extending the power of product line practice in exciting new ways.

Future product lines will make much greater use of dynamic variation and enable mass customization in ways not achievable today.

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Questions – Now Or Later

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