Army Software Product Line Workshop

Linda Northrop
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Pittsburgh, PA 15213

Software Engineering Institute | Carnegie Mellon

Software Engineering Institute (SEI)

Department of Defense R&D Laboratory (FFRDC)

Created in 1984

Under contract to Carnegie Mellon University

Offices in Pittsburgh, PA; Washington, DC; and Frankfurt, Germany

SEI Mission: advance software and related disciplines to ensure the development and operation of systems with predictable and improved cost, schedule, and quality.

SEI Technical Programs

Networked Systems Survivability (CERT)
- Secure Software and Systems
- Cyberthreat and Vulnerability Analysis
- Enterprise Workforce Development
- Forensics

Software Engineering Process Management (SEPM)
- Capability Maturity Model Integration (CMMI)
- Team Software Process (TSP)
- Software Engineering Measurement and Analysis (SEMA)

Acquisition Support (ASP)

Research, Technology, and System Solutions (RTSS)
- Architecture-Centric Engineering
- Product Line Practice
- System of Systems Practice
- System of Systems Software Assurance
- Ultra-Large-Scale (ULS) System Perspective

Independent Research and Development (IR&D)

SEI Technical Programs

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- System of Systems Software Assurance
- Ultra-Large-Scale (ULS) System Perspective

Independent Research and Development (IR&D)

Mission of the SEI Research, Technology, and System Solutions Program

The **Research, Technology, and System Solutions Program** enables

- cost effective
- development, evolution, and recomposition of
- predictably high-quality systems
- at all scales

With regard to its **software product line effort**, it aims to

- make product line development and acquisition a low-risk, high-return proposition for all organizations.

Some of the Organizations Using RTSS Technology

Summary of SEI Contributions

Models and Guidance

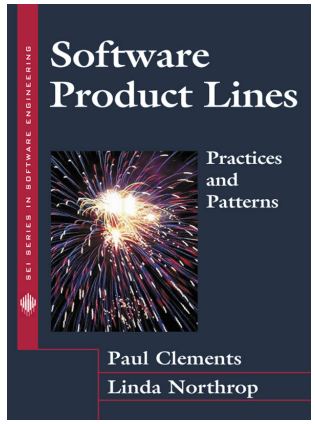
- *A Framework for Software Product Line Practice*[SM]
- *Software Product Line Acquisition: A Companion to A Framework for Software Product Line Practice*
- Product line practice patterns
- Product line adoption roadmap
- Pedagogical product line

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; Workshops 1997 - 2005; Army Product Line Workshop 2007

Technical Reports, publications, and Web site

DoD Product Line Workshops

Hands-on meetings to

- identify industry-wide best practices in software product lines
- share DoD software product line practices, experiences, and issues
- discuss ways in which the current gap between commercial best practice and DoD practice can be bridged
- gather material for and review the DoD Acquisition Companion to the SEI Framework for Software Product Line Practice (*Software Product Line Acquisition: A Companion to A Framework for Software Product Line Practice*)

Today's Workshop Is Funded by ASSIP

The goal of the United States Army Strategic Software Improvement Program (ASSIP) is to dramatically improve the acquisition of software-intensive systems.

ASSIP has funded the delivery of courses from the SEI Software Product Line Curriculum at Army locations and presentations on software product lines at PEO sites.

In addition, the ASSIP has funded the Army Senior Leader Program, which has involved tutorials on software architecture and software product lines among other topics.

ASSIP is funding this workshop to bring together those in the Army community who are using or trying to use product line practices.

Workshop Goals

Share Army and DoD product line practices, experience and issues, from both development and acquisition viewpoints

Examine barriers and enablers to much broader adoption of software product line practices within the Army

Determine the steps needed to make software product line practices more beneficial and relevant to Army programs

Discuss ways in which the Army's Strategic Software Improvement Program (ASSIP) can be of assistance

Agenda

0800 – 0830	Introductions		
0830 – 0915	Welcome and background: Linda Northrop, SEI		
0915 – 1000	A Proactive Product Line Acquisition Approach, John Bergey, SEI		
1000 – 1015	BREAK		
1015 – 1045	An Approach to Product Line Acquisition Planning, Larry Jones, SEI		
DoD software product line experience presentations			
	1045 – 1130	Paul Jensen	Overwatch, Textron Systems
	1130 – 1215	Brian Kemper	PEO STRI
1215 – 1300	LUNCH		
DoD software product line experience presentations continued			
	1300 – 1345	Don Snelgrove	BAE
	1345 – 1430	Ed Dunn	NUWC
1430 – 1445	BREAK		
1445 – 1600	Discussion: Product line acquisition support -needs and priorities.		
1600 – 1630	Workshop Wrap-up		

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.

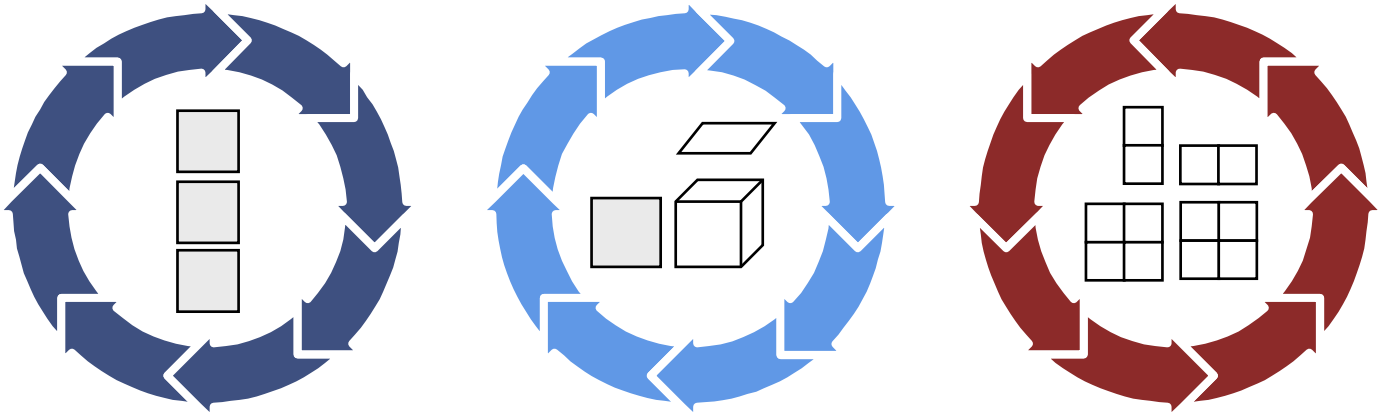
- a new application of a proven concept
- an innovative, growing concept in software engineering

The Key Concepts

Use of a core asset base

in production

of a related set of products



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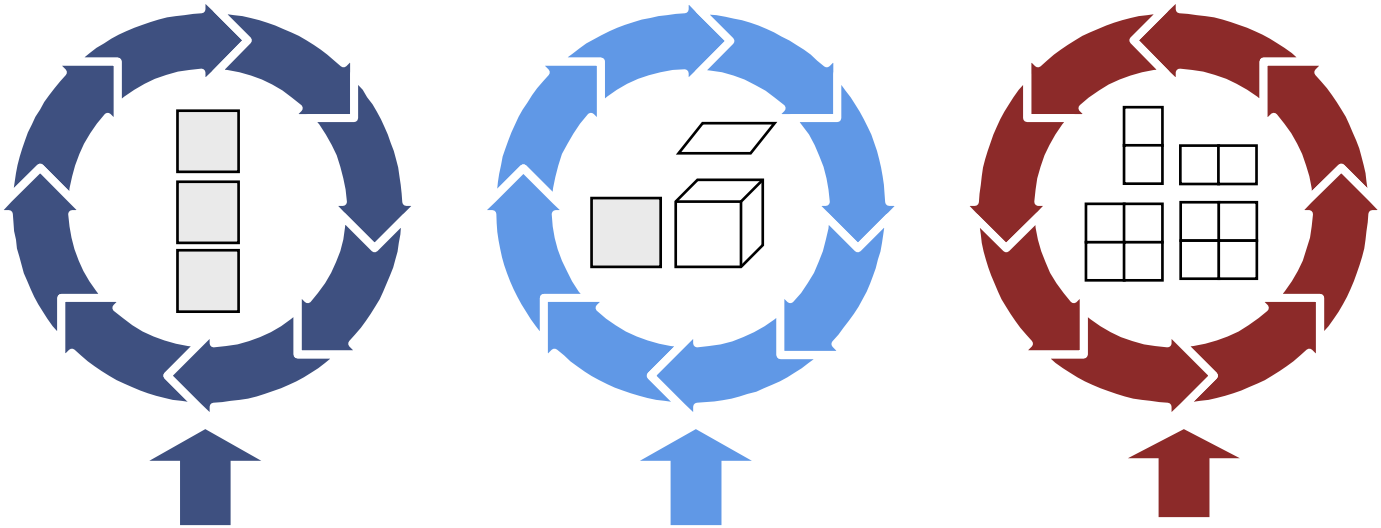


Architecture

Production Plan

Scope Definition
Business Case

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

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

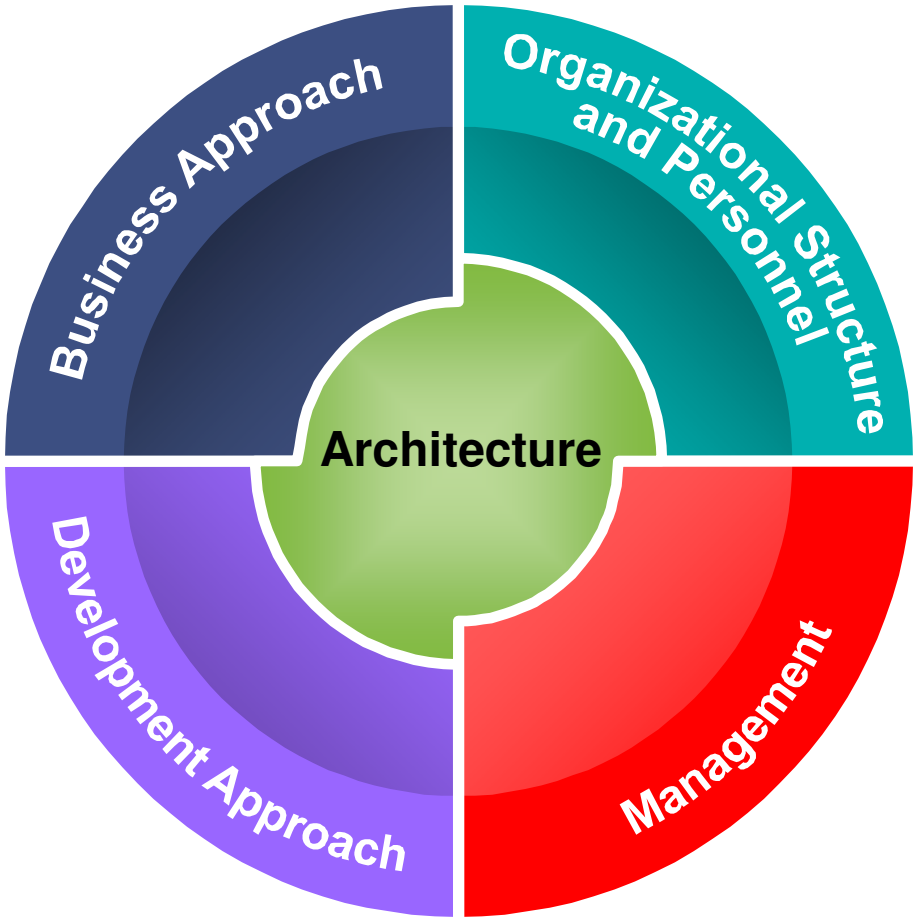
The Value of Options

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.

Options to future mission needs are important to the DoD.

Necessary Changes



The product line architecture is central to success.

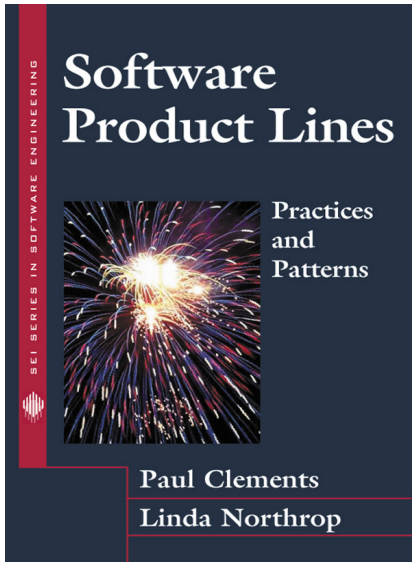
The SEI Framework For Software Product Line Practice[sm]

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.

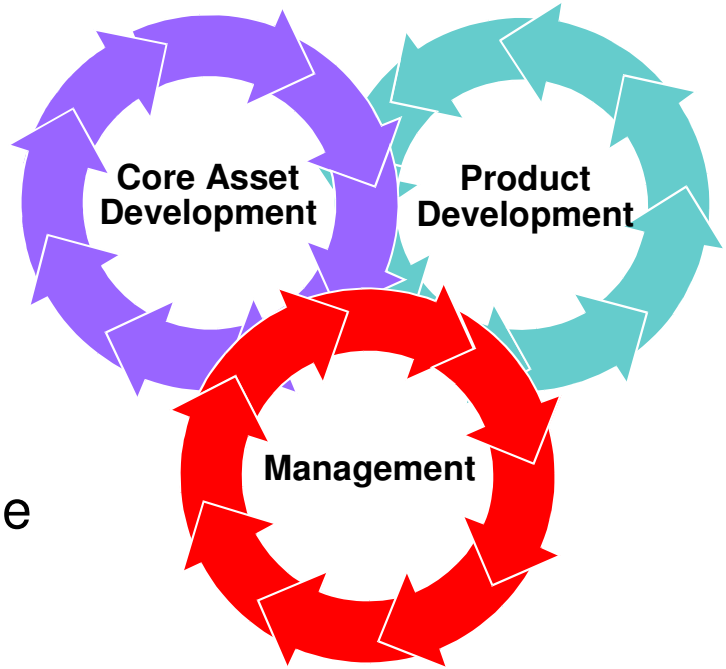
Version 4.0 –
in *Software Product Lines: Practices and Patterns*

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.

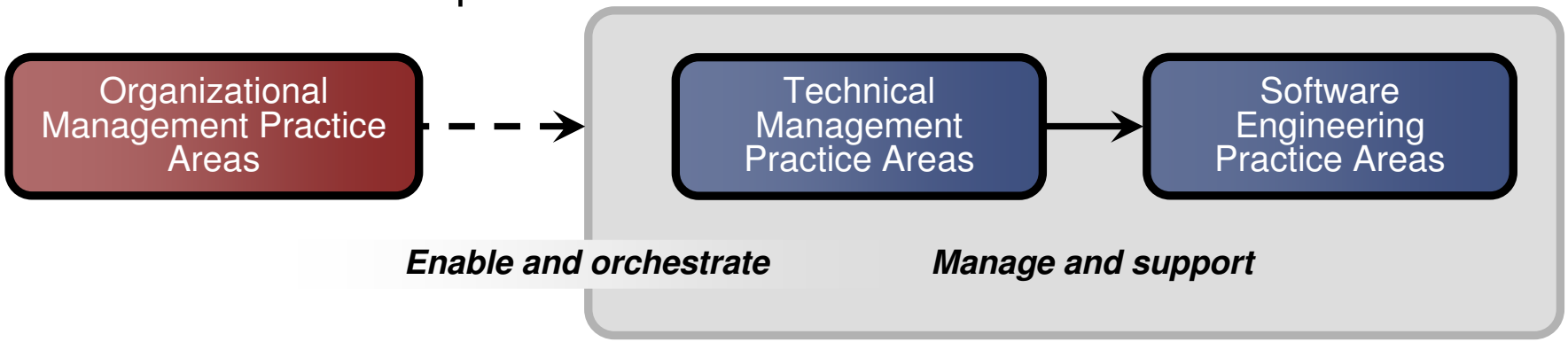
Strong management at multiple levels is needed throughout.

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

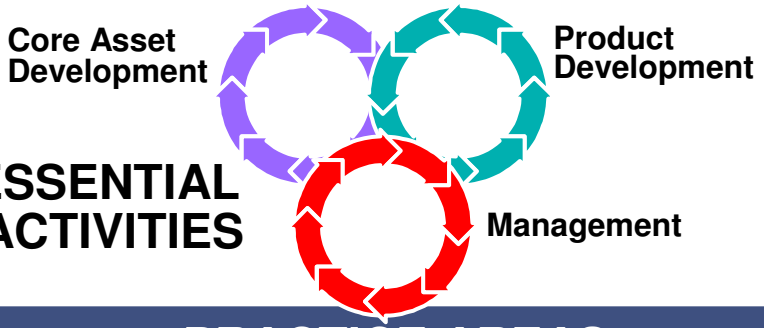
Supporting the essential activities are essential practices that fall into practice areas. A ***practice area*** is a body of work or a collection of activities that an organization must master to successfully carry out the essential work of a product line.



Three Categories Of Practice Areas

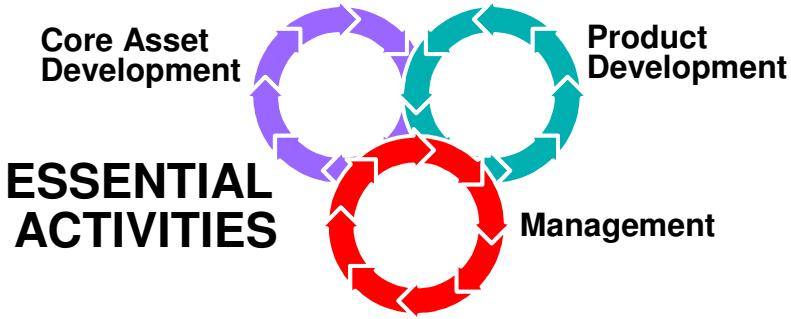
The practice areas represent common activities in software development that are adapted to the needs of a product line approach.

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*

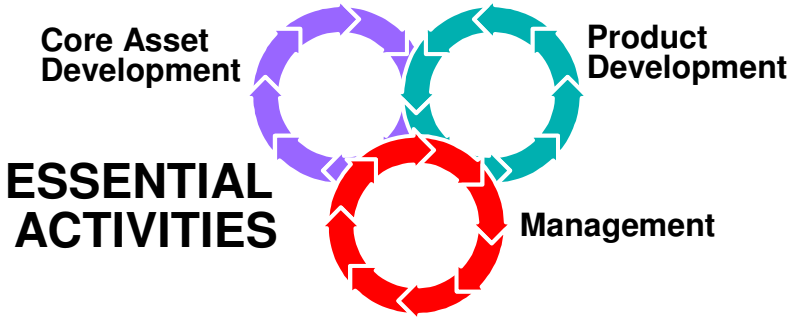
NRO/Raytheon – CMU/SEI-2001-TR-030
http://www.sei.cmu.edu/publications/documents/01.reports/02tr030.html

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



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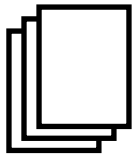
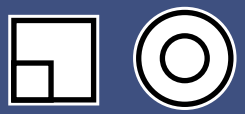
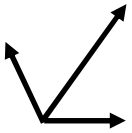


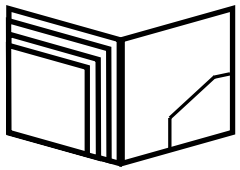
Case Studies



Patterns

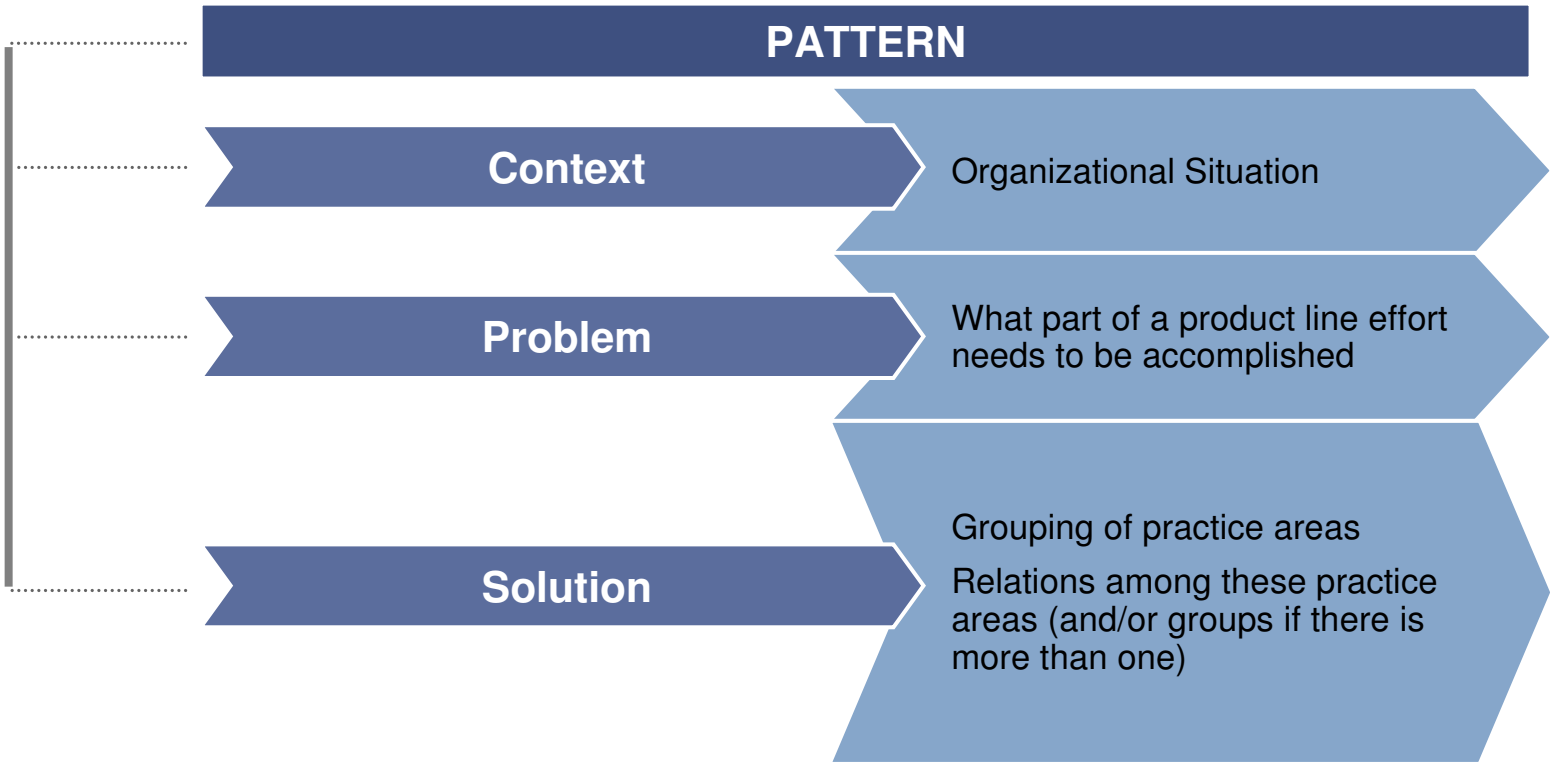


Probe



Curriculum

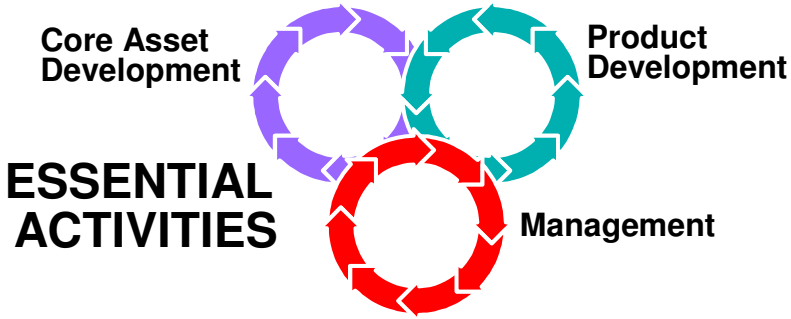
Software Product Line Practice Patterns



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



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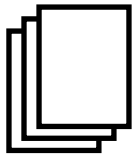

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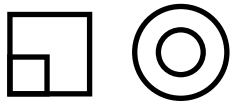

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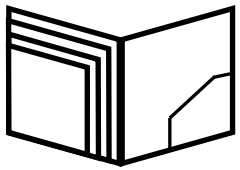


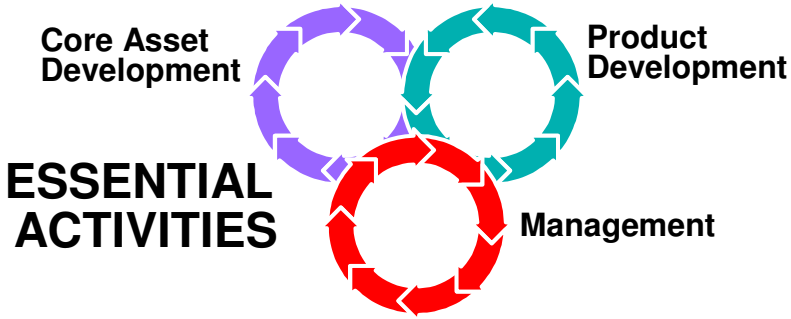
Curriculum

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



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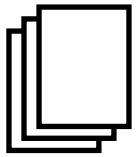

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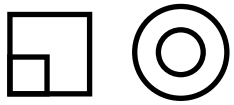

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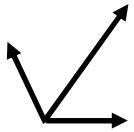

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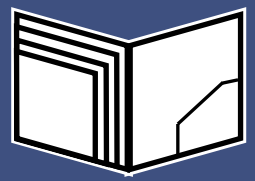


Curriculum

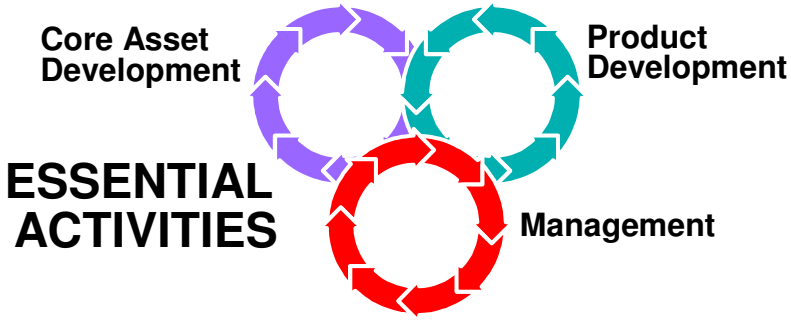
The SEI Software Product Line Curriculum

Three Certificate Programs

Five Courses	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



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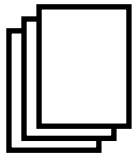
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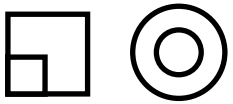
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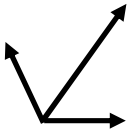
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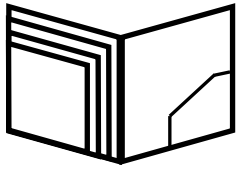

Curriculum

ADOPTION FACTORY

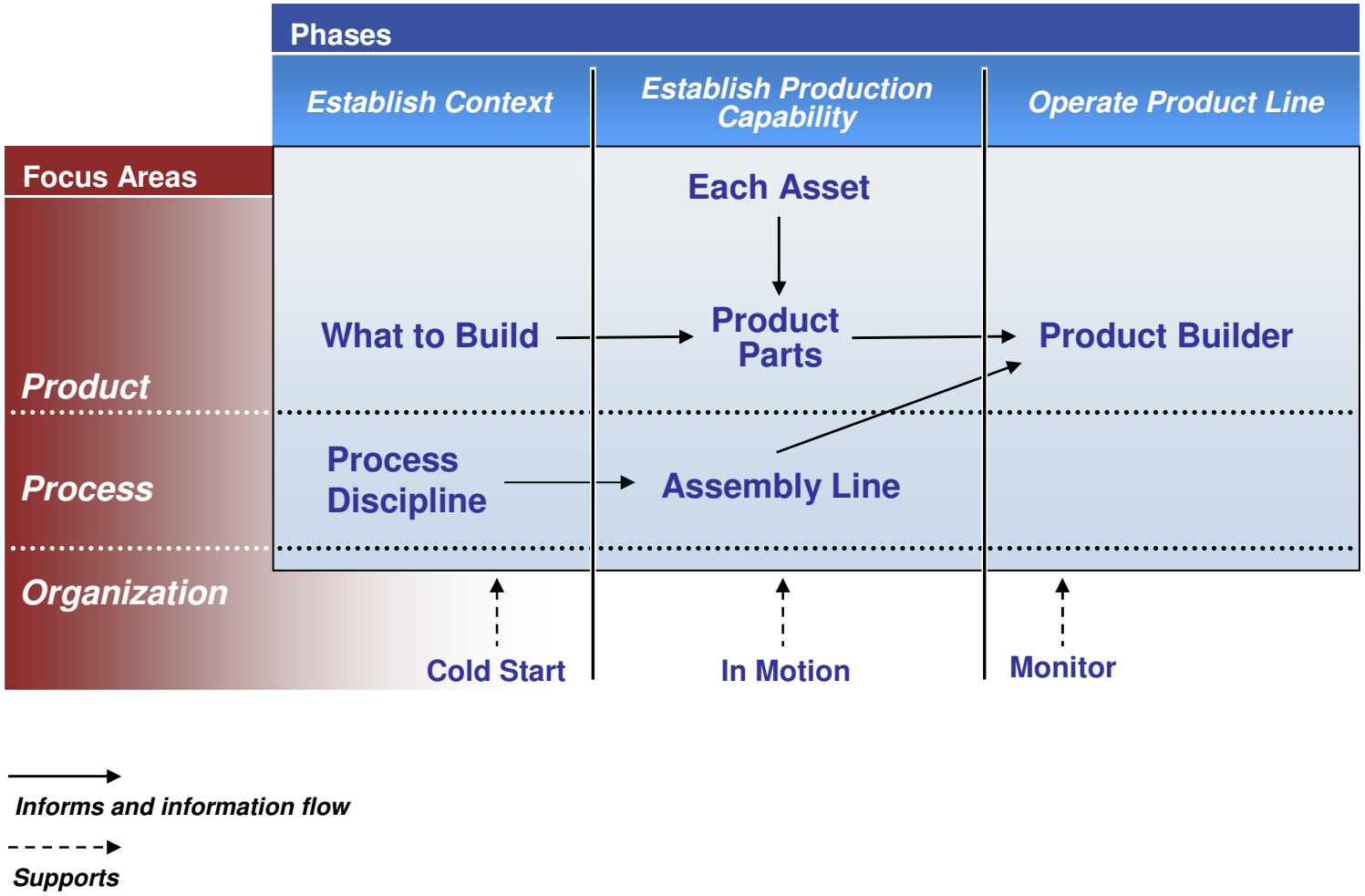
The Product Line Adoption Endgame

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

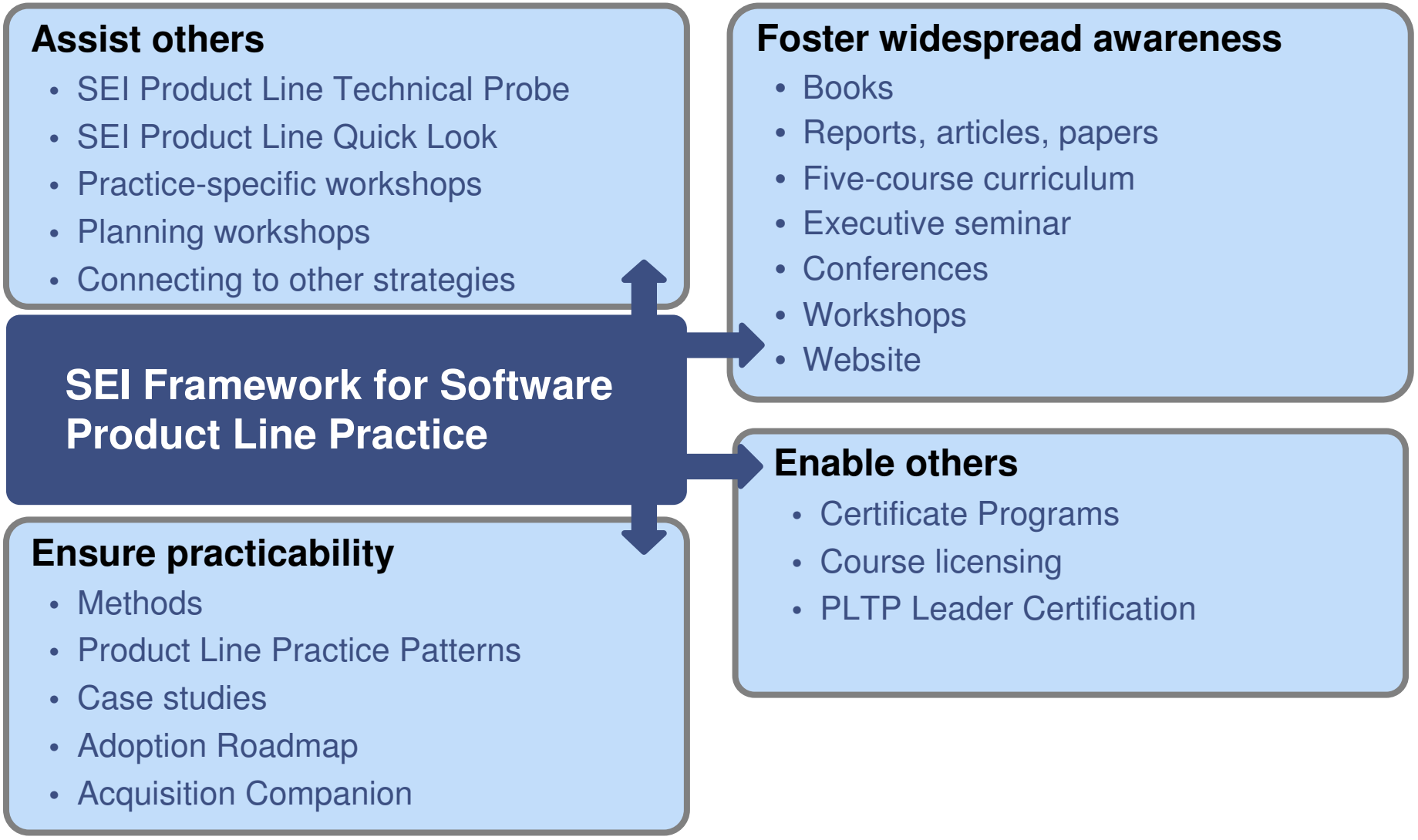
The SEI Adoption Factory Pattern



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

PLP Products and Services



What's Different About Reuse With Software Product Lines?

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

Challenges - Emerging Solutions

Variation mechanisms and variation management

AOP/AOSD | SOA | End-User Programming

Automating all or part of the production process

PACC | MDA | DSL | DDD | Generative Programming

Lowering adoption cost

Agile, Phased Approaches | Tool Support

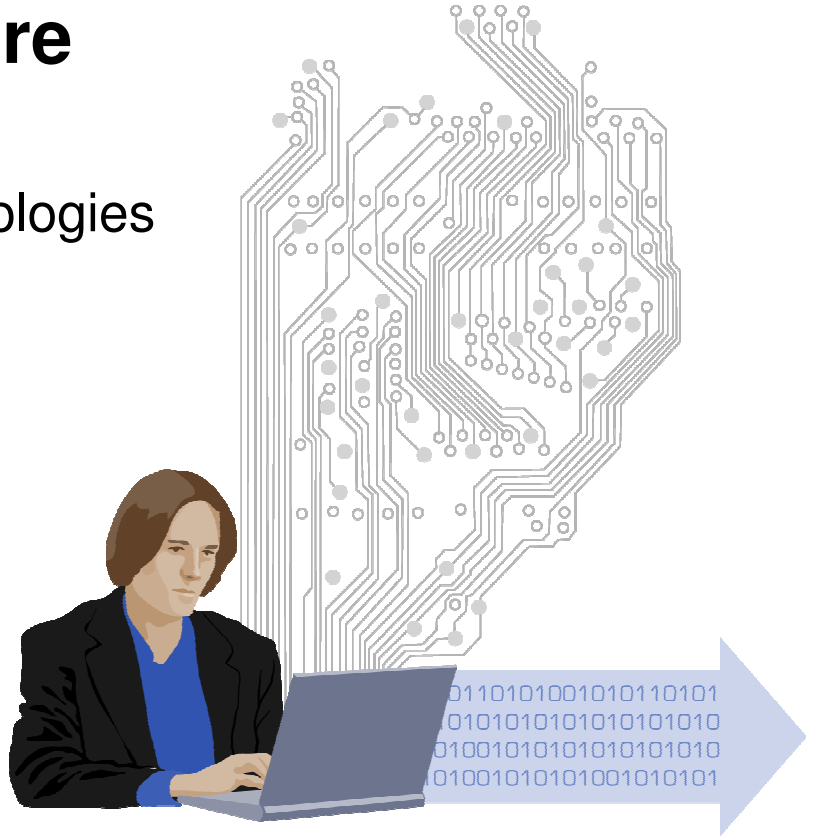
Distributed development and evolution

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.

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

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

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