

# Army Software Product Line Workshop

Linda Northrop  
Director  
Research, Technology, and System  
Solutions Program

Software Engineering Institute  
Carnegie Mellon University  
Pittsburgh, PA 15213



# Report Documentation Page

Form Approved  
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE <b>12 FEB 2009</b>		2. REPORT TYPE		3. DATES COVERED <b>00-00-2009 to 00-00-2009</b>	
4. TITLE AND SUBTITLE <b>Army Software Product Line Workshop</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>Carnegie Mellon University, Software Engineering Institute, Pittsburgh, PA, 15213</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>					
13. SUPPLEMENTARY NOTES <b>Presented at the SEI Army Software Product Line Workshop, 12 Feb 2009, Orlando, FL.</b>					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
<b>unclassified</b>	<b>unclassified</b>	<b>unclassified</b>	<b>Same as Report (SAR)</b>	<b>45</b>	

# Software Engineering Institute (SEI)

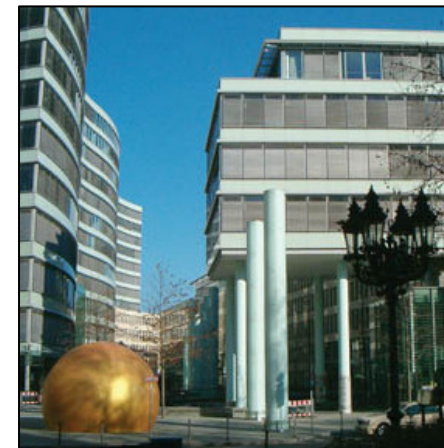
Department of Defense R&D Laboratory (FFRDC)

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

---

## **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)**



# 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



Honeywell®



AIRBUS



GENERAL DYNAMICS



U.S. AIR FORCE

Raytheon

FedEx

BOSCH

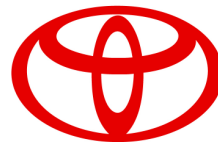


UNISYS

GENERAL DYNAMICS



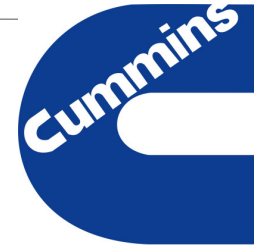
BOEING



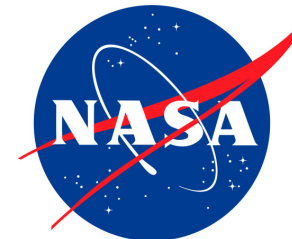
TOYOTA



NCR



THALES



intuit.



U.S. ARMY

Rockwell Collins



MOTOROLA



Software Engineering Institute

Carnegie Mellon

Linda Northrop

© 2009 Carnegie Mellon University

# Summary of SEI Contributions

## Models and Guidance

- *A Framework for Software Product Line Practice<sup>SM</sup>*
- *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<sup>SM</sup> (PLTP<sup>SM</sup>)
- 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*

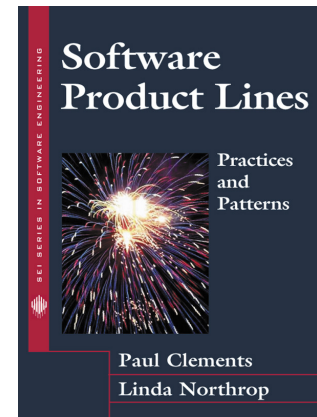
## Curriculum and Certificate Programs

- 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



### SPLC | Software Product Lines Conferences





# 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.

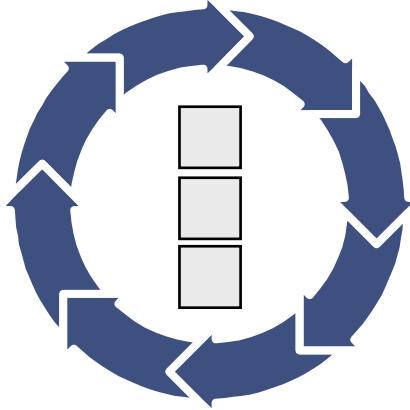
- a new application of a proven concept
- an innovative, growing concept in software engineering



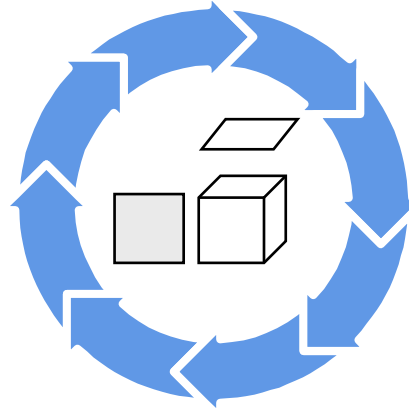
# The Key Concepts

---

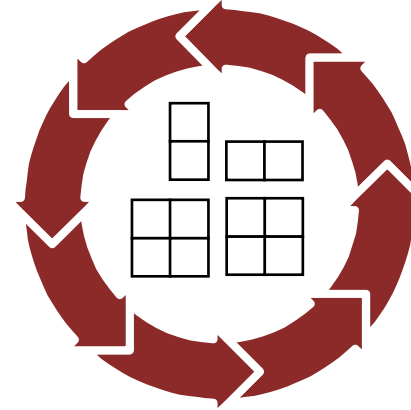
**Use of a core  
asset base**



**in production**



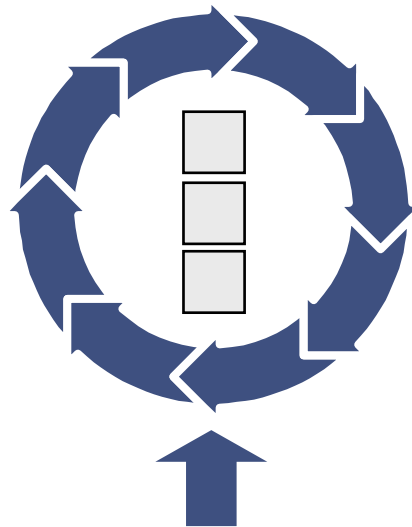
**of a related  
set of products**



# The Key Concepts

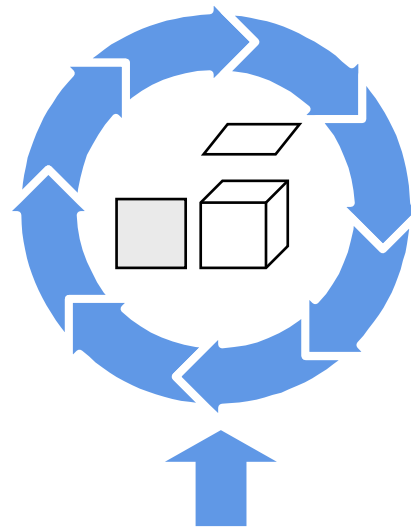
---

**Use of a core  
asset base**



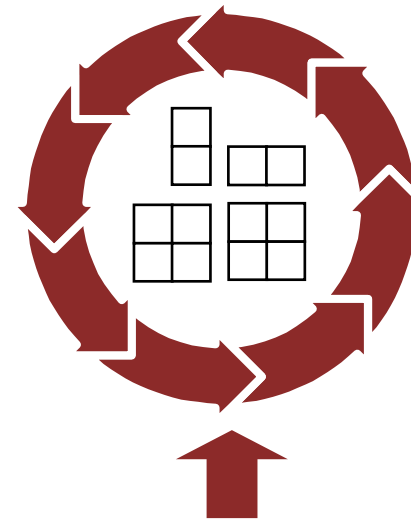
**Architecture**

**in production**



**Production Plan**

**of a related  
set of products**



**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



Feed control and farm management software



Bold Stroke Avionics

**E-COM Technology Ltd.**

Medical imaging workstations



Firmware for computer peripherals



Lucent Technologies  
Bell Labs Innovations

5ESS telecommunications switch



**Asea Brown Boveri**

Gas turbines, train control, semantic graphics framework



Dialect

Internet payment gateway infrastructure products

**ERICSSON**



AXE family of telecommunications switches



Elevator control systems

**NOKIA**

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



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



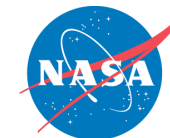
Customized solutions for transportation industries



Software for engines, transmissions and controllers



RAID controller firmware for disk storage units



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



Test range facilities

**RICOH**

Office appliances

**SALION™**  
TARGET. WIN. DELIVER.™

Revenue acquisition  
management systems

**TELVENT**

Industrial supervisory control  
and business process  
management systems




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.

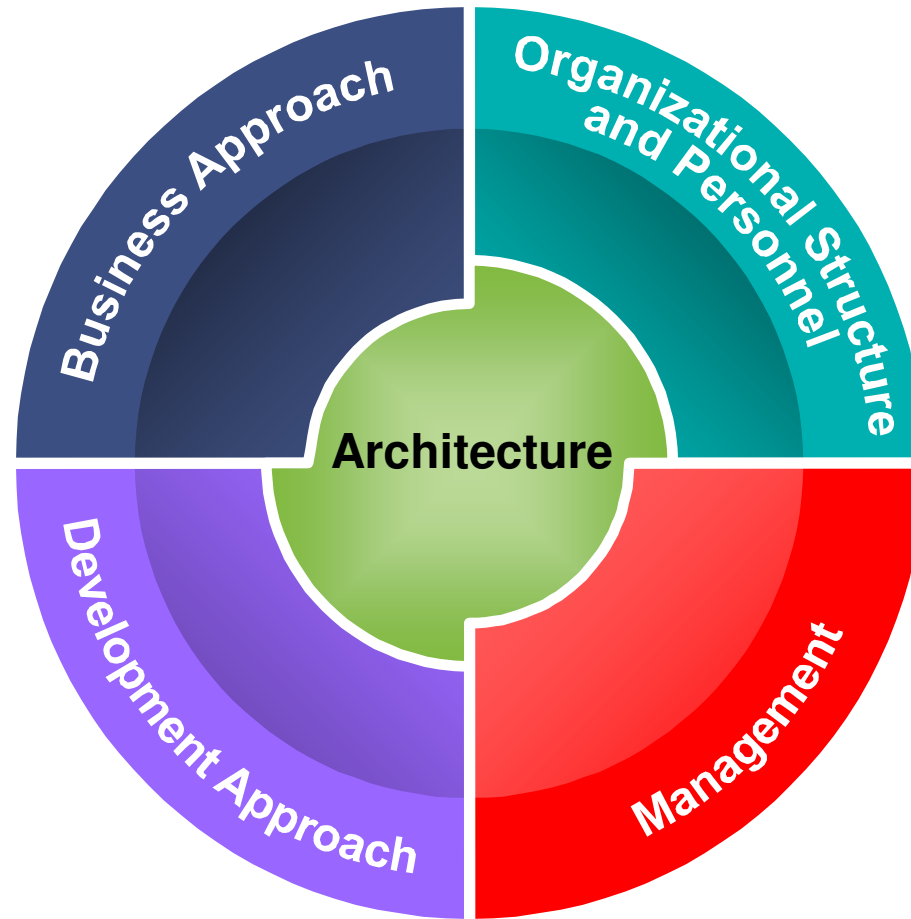
- The exact opportunities and their certainty are impossible to predict.
- Organizations need a way to conduct product experiments in low-cost, low-risk ways.
- Software product lines permit those kind of experiments through predefined variation points that can be exercised to meet new needs.

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<sup>sm</sup>

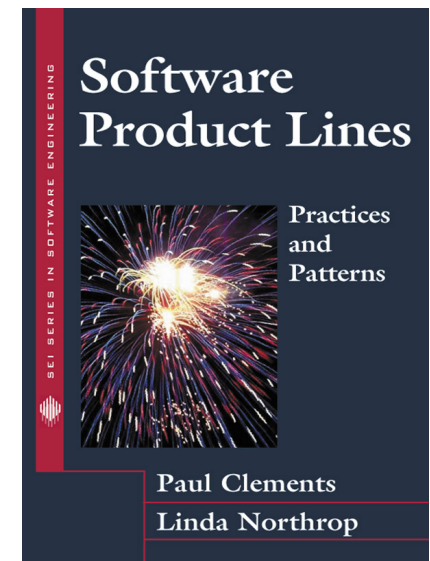
---

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.

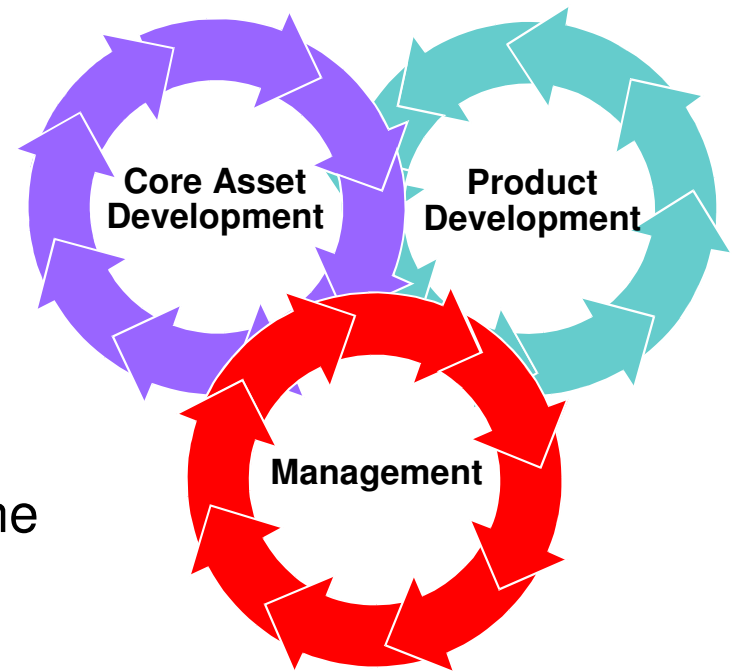
- In some contexts, existing products are mined for core assets.
- In others, core assets may be developed or procured for future use.

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.

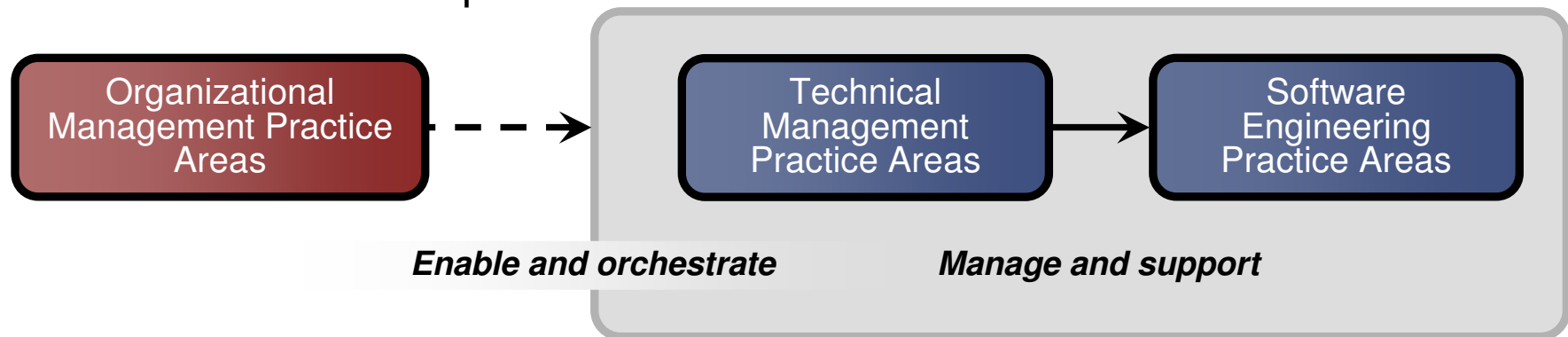
Management orchestrates all activities and processes needed to make the three essential activities work together.





# 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.

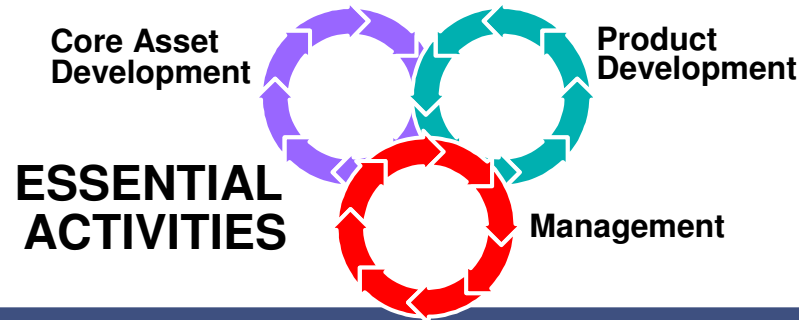


## Three Categories Of Practice Areas

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



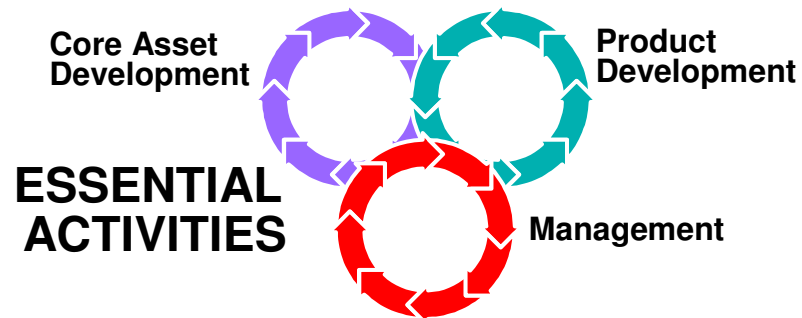
# Framework Version 5.0




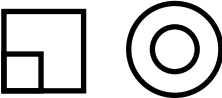
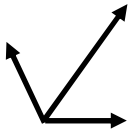
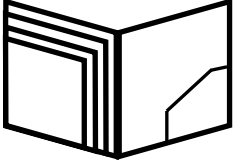
PRACTICE AREAS		
Software Engineering	Technical Management	Organizational Management
Architecture Definition	Configuration Management	Building a Business Case
Architecture Evaluation	Make/Buy/Mine/Commission Analysis	Customer Interface Management
Component Development	<i>Measurement and Tracking</i>	Developing an Acquisition Strategy
Mining Existing Assets	<i>Process Discipline</i>	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
<i>Using Externally Available Software</i>	Key: <i>New Name and Substantial Change</i> 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			
 <b>Case Studies</b>	 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

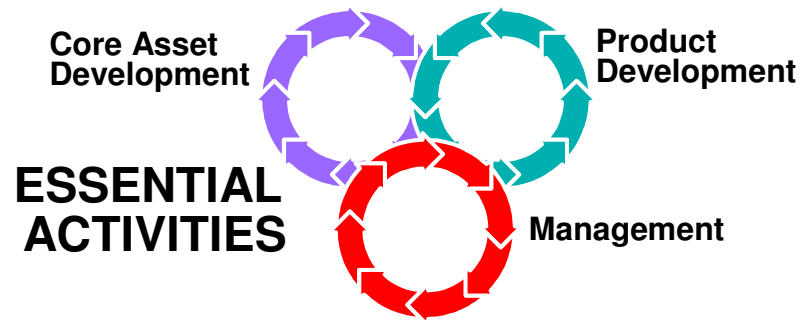
<http://www.sei.cmu.edu/publications/documents/02.reports/02tr038.html>

**U.S. Army** – CMU/SEI-2005-TR-019

<http://www.sei.cmu.edu/publications/documents/05.reports/05tr019.html>



# Help To Make It Happen

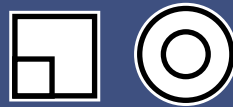


PRACTICE AREAS		
Software Engineering	Technical Management	Organizational Management

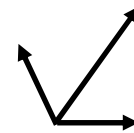
## GUIDANCE



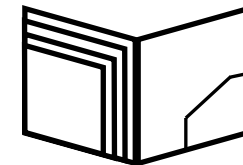
Case Studies



Patterns



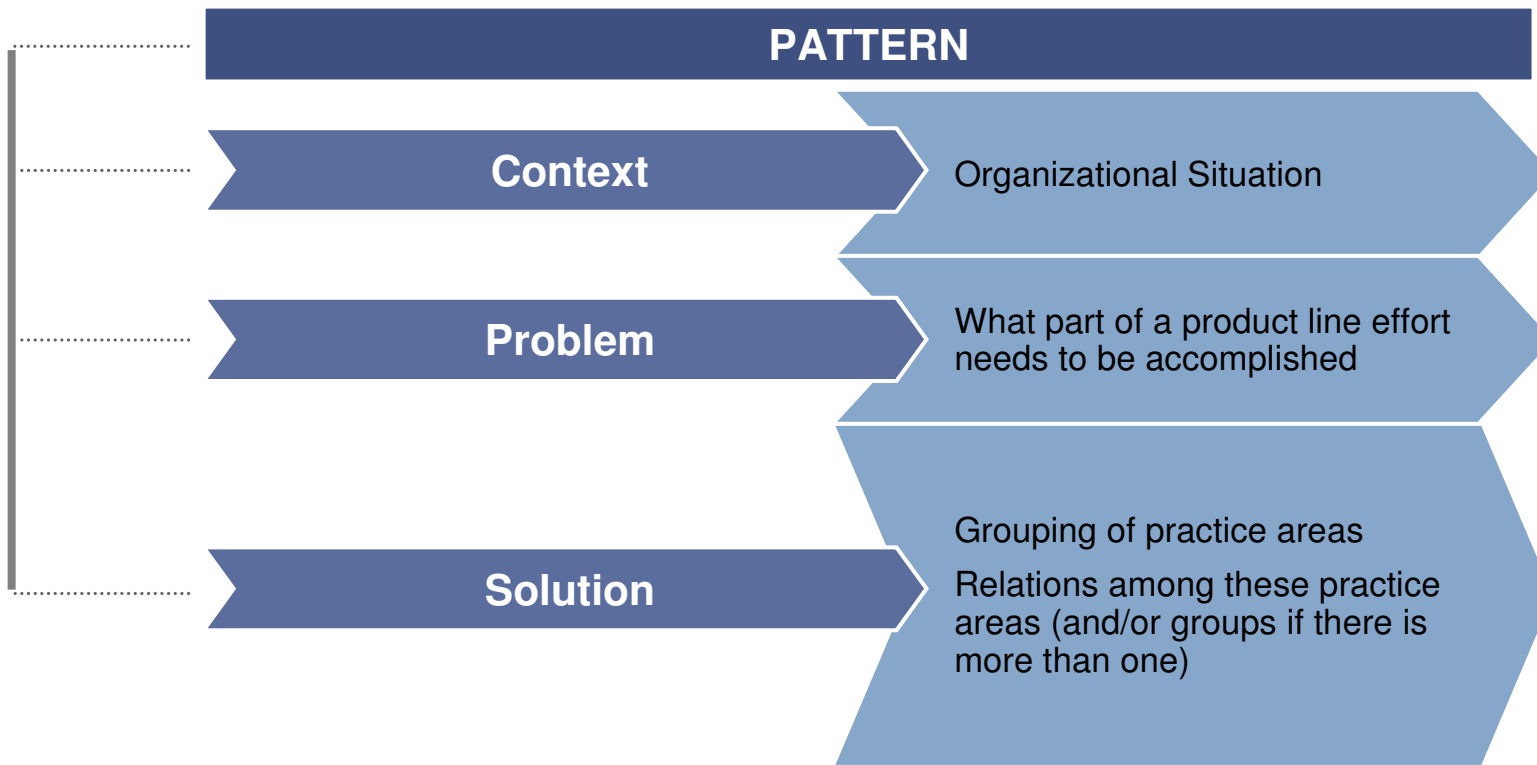
Probe



Curriculum



# Software Product Line Practice Patterns

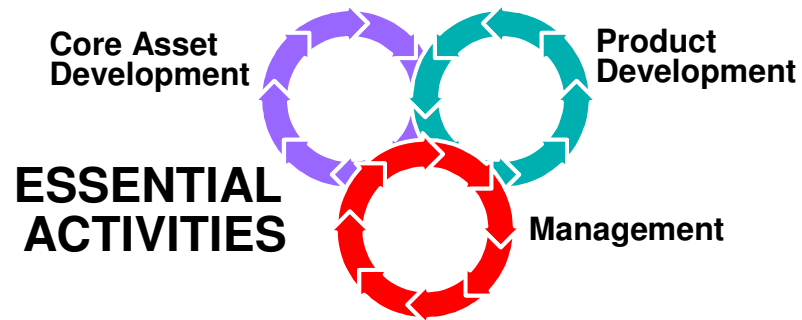


# Current Set Of Patterns

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

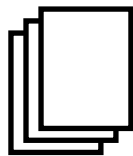


# Help To Make It Happen



PRACTICE AREAS		
Software Engineering	Technical Management	Organizational Management

## GUIDANCE



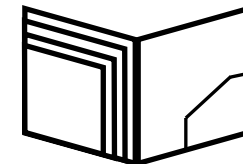
Case Studies



Patterns



Probe



Curriculum





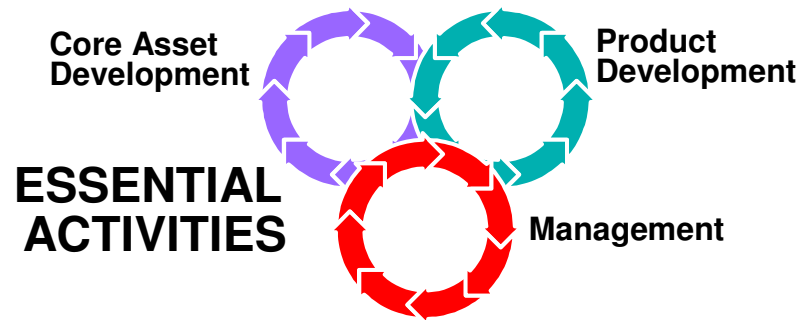
# What Is An SEI Product Line Technical Probe (PLTP)?

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

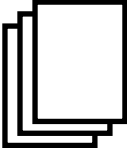

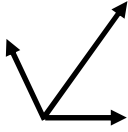
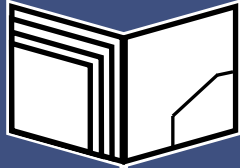
- It is a diagnostic tool based on the SEI Framework for Software Product Line Practice.
- The 29 practice areas are the basis of data collection and analysis.



# 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

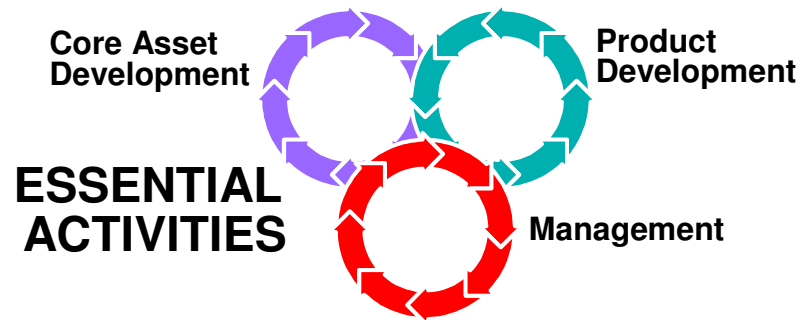
## Three Certificate Programs

	Software Product Line Professional	PLTP Team Member	PLTP Leader
<i>Five Courses</i>			
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



## GUIDANCE



## ADOPTION FACTORY



# The Product Line Adoption Endgame

---

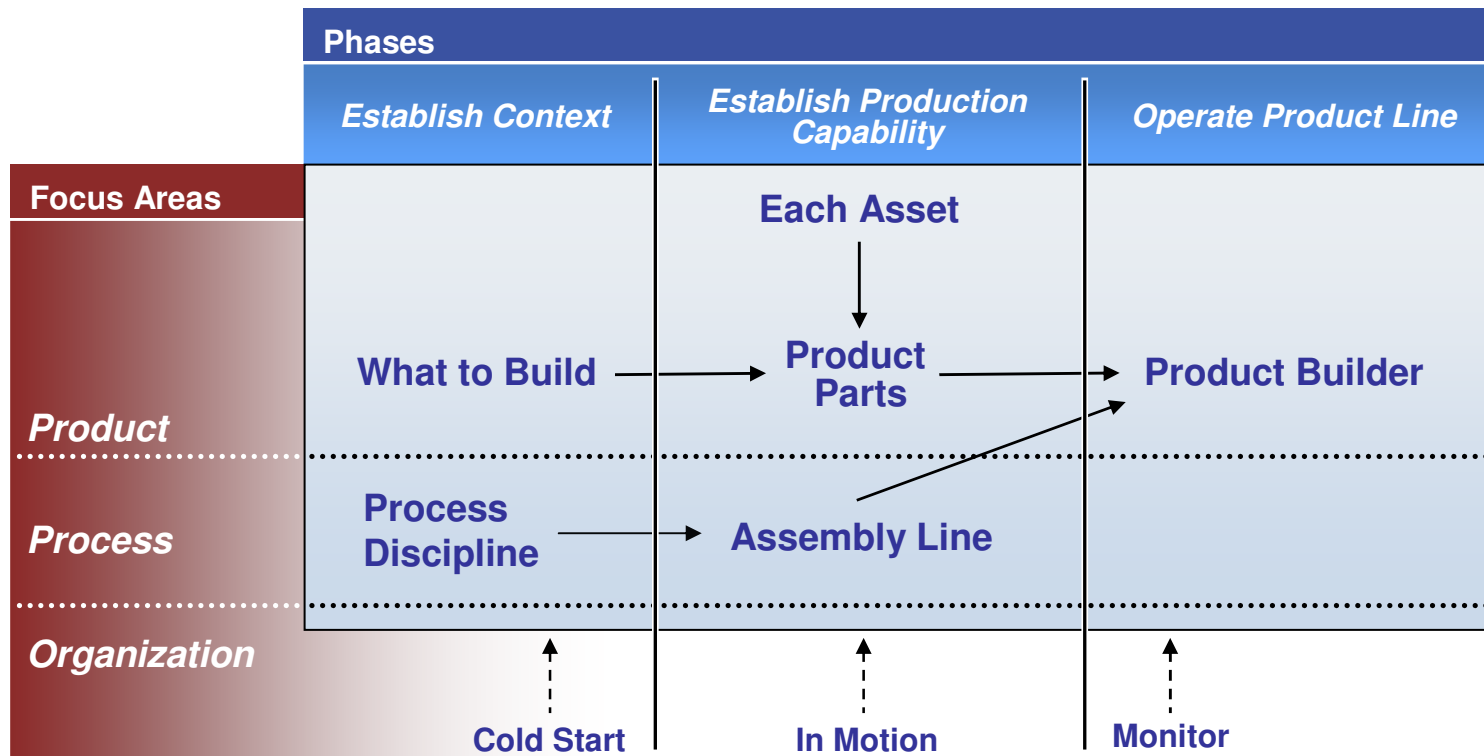
To have an **operational software product line**.

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




  
*Informs and information flow*


  
*Supports*

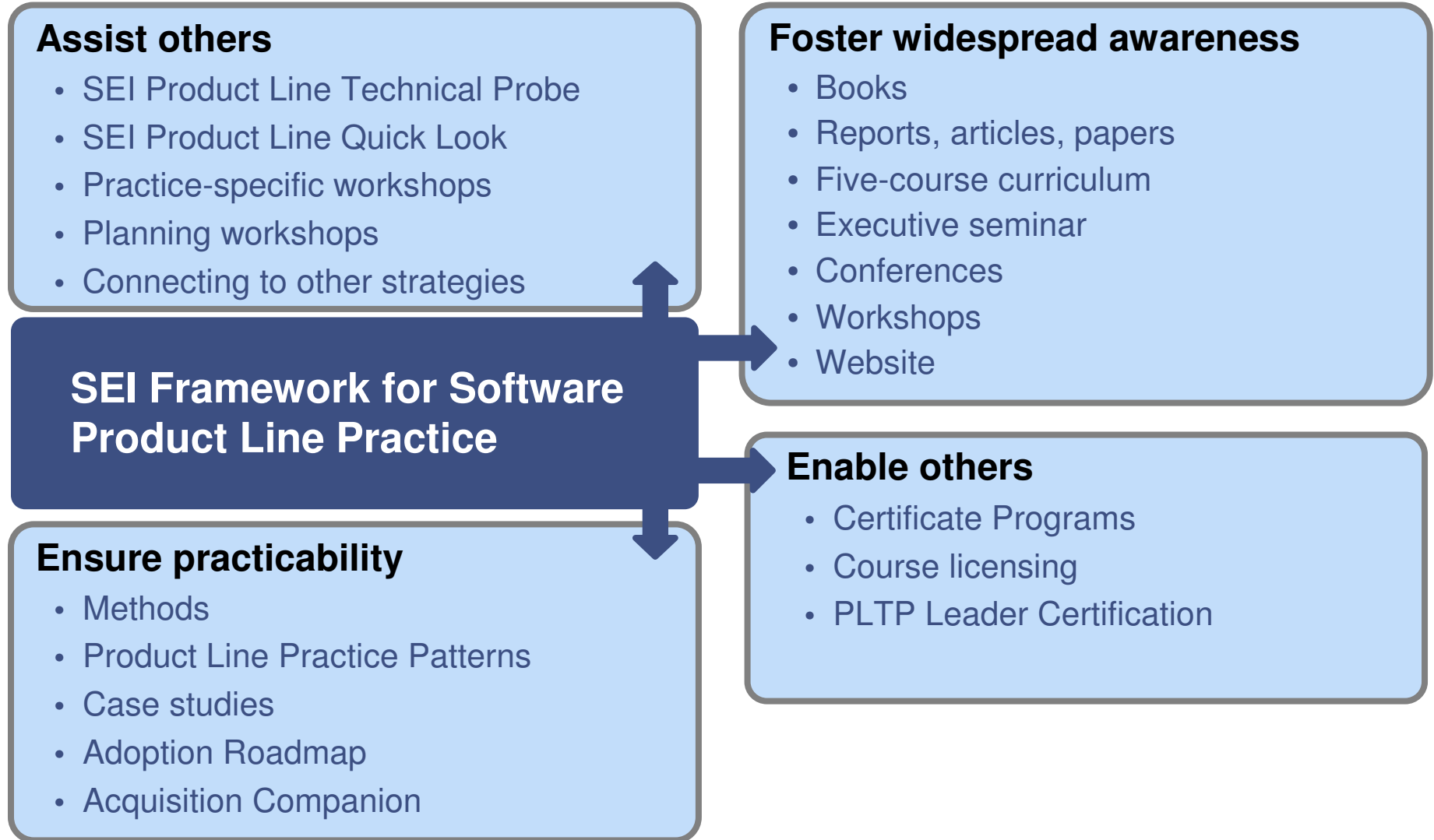


# Associated Practice Areas

	Establish Context	Establish Production Capability	Operate Product Line
Product	<ul style="list-style-type: none"> <li>• Marketing Analysis</li> <li>• Understanding Relevant Domains</li> <li>• Technology Forecasting</li> <li>• Building a Business Case</li> <li>• Scoping</li> </ul>	<ul style="list-style-type: none"> <li>• Requirements Engineering</li> <li>• Architecture Definition</li> <li>• Architecture Evaluation</li> <li>• Mining Existing Assets</li> <li>• Component Development</li> <li>• Using Externally Available Software</li> <li>• Software System Integration</li> <li>• Testing</li> </ul>	<ul style="list-style-type: none"> <li>• Requirements Engineering</li> <li>• Architecture Definition</li> <li>• Architecture Evaluation</li> <li>• Mining Existing Assets</li> <li>• Component Development</li> <li>• Using Externally Available Software</li> <li>• Software System Integration</li> <li>• Testing</li> </ul>
Process	<ul style="list-style-type: none"> <li>• Process Discipline</li> </ul>	<ul style="list-style-type: none"> <li>• Make/Buy/Mine/Commission</li> <li>• Configuration Management</li> <li>• Tool Support</li> <li>• Measurement and Tracking</li> <li>• Technical Planning</li> <li>• Technical Risk Management</li> </ul>	
Organization	<ul style="list-style-type: none"> <li>• Launching and Institutionalizing</li> <li>• Funding</li> <li>• Structuring the Organization</li> <li>• Operations</li> <li>• Organizational Planning</li> <li>• Customer Interface Management</li> <li>• Organizational Risk Management</li> <li>• Developing an Acquisition Strategy</li> <li>• Training</li> </ul>	<ul style="list-style-type: none"> <li>• Launching and Institutionalizing</li> <li>• Funding</li> <li>• Structuring the Organization</li> <li>• Operations</li> <li>• Organizational Planning</li> <li>• Customer Interface Management</li> <li>• Organizational Risk Management</li> <li>• Developing an Acquisition Strategy</li> <li>• Training</li> </ul>	<ul style="list-style-type: none"> <li>• Measurement and Tracking</li> <li>• Technical Risk Management</li> <li>• Organizational Risk Management</li> <li>• Customer Interface Management</li> <li>• Organizational Planning</li> </ul>



# 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

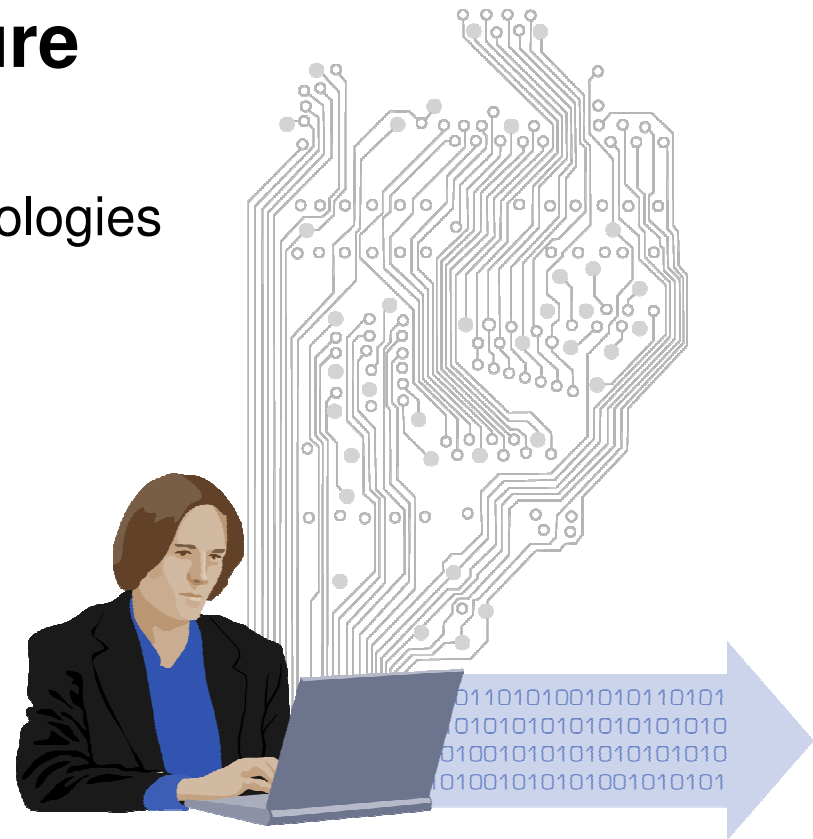
- metadata
- automated derivation
- SOA
- end-user programming

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



# Contact Information

---

## Linda Northrop

Research, Technology, and System Solutions Program

Telephone: 412-268-7638

Email: [lmn@sei.cmu.edu](mailto:lmn@sei.cmu.edu)



## U.S. Mail:

Software Engineering Institute

Carnegie Mellon University

4500 Fifth Avenue

Pittsburgh, PA 15213-3890

## World Wide Web:

<http://www.sei.cmu.edu/productlines>



Software Engineering Institute

Carnegie Mellon

Linda Northrop

© 2009 Carnegie Mellon University

## NO WARRANTY

THIS CARNEGIE MELLON UNIVERSITY AND SOFTWARE ENGINEERING INSTITUTE MATERIAL IS FURNISHED ON AN "AS-IS" BASIS. CARNEGIE MELLON UNIVERSITY MAKES NO WARRANTIES OF ANY KIND, EITHER EXPRESSED OR IMPLIED, AS TO ANY MATTER INCLUDING, BUT NOT LIMITED TO, WARRANTY OF FITNESS FOR PURPOSE OR MERCHANTABILITY, EXCLUSIVITY, OR RESULTS OBTAINED FROM USE OF THE MATERIAL. CARNEGIE MELLON UNIVERSITY DOES NOT MAKE ANY WARRANTY OF ANY KIND WITH RESPECT TO FREEDOM FROM PATENT, TRADEMARK, OR COPYRIGHT INFRINGEMENT.

Use of any trademarks in this presentation is not intended in any way to infringe on the rights of the trademark holder.

This Presentation may be reproduced in its entirety, without modification, and freely distributed in written or electronic form without requesting formal permission. Permission is required for any other use. Requests for permission should be directed to the Software Engineering Institute at [permission@sei.cmu.edu](mailto:permission@sei.cmu.edu).

This work was created in the performance of Federal Government Contract Number FA8721-05-C-0003 with Carnegie Mellon University for the operation of the Software Engineering Institute, a federally funded research and development center. The Government of the United States has a royalty-free government-purpose license to use, duplicate, or disclose the work, in whole or in part and in any manner, and to have or permit others to do so, for government purposes pursuant to the copyright license under

