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# **Acquisition Pilot: Product Line Acquisition and Measurement at NUWC**

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## Report Documentation Page

*Form Approved  
OMB No. 0704-0188*

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1. REPORT DATE <b>JAN 2004</b>	2. REPORT TYPE	3. DATES COVERED <b>00-00-2004 to 00-00-2004</b>			
4. TITLE AND SUBTITLE <b>Acquisition Pilot: Product Line Acquisition and Measurement at NUWC</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					
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>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>	<b>Same as Report (SAR)</b>	<b>18</b>	



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# Agenda

What are product lines?

Why a pilot in measurement?

How did the pilot apply goal-driven software measurement to product line acquisition?

Results and next steps



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# Product Line Framework

## **A Framework for Software Product Line Practice**

Version 4.0

<http://www.sei.cmu.edu/plp/framework.html>

- provides 29 practice areas for software product lines

## **Software Product Line Acquisition: A Companion to A Framework for Software Product Line Practice**

Version 2.0

<http://www.sei.cmu.edu/plp/companion.html>

- places practice areas in acquisition context



## What are product lines?

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

<b>Product Line Definition</b>	<b>For NUWC</b>
Set of software intensive systems	Data acquisition, display and control systems for ranges
Sharing a common, managed set of features	Features for tracking, archiving, playback, debriefing, analysis, other applications to support range operations
(The systems must) •satisfy the specific needs of a selected market segment or mission •(and be) developed from a common set of core assets	T&E / training range community Rangeware assets including common architecture, pre-built applications, scripts for production builds
In a prescribed way	NUWC processes for : •Java development and maintenance for RangeWare •Production plan for range systems •Configuration management plan



## Applying RangeWare – Savings

Program Name	Lines of Code Estimated (in 000's)	Actual Lines Developed	Estimated Cost (in 000's)	Actual Cost (in 000's)	Years of development
Subsystem A	250	(Est.) 75	1562		
<b>ECSWTR</b>	<b>245</b>	<b>80</b>		<b>1300</b>	
Subsystem B	150	(Est.) 45	937		
<b>AHRP</b>	<b>165</b>	<b>25</b>		<b>200</b>	<b>99-01</b>
<b>LSVTC</b>	<b>150</b>	<b>20</b>		<b>210</b>	<b>01-02</b>
<b>OASYS</b>	<b>150</b>	<b>28</b>		<b>219</b>	<b>01-02</b>
<b>SCORE</b>	<b>150</b>	<b>20</b>		<b>115</b>	<b>01-02</b>
Eng Prot A	150	(Est.) 45	937		
<b>TSMADS</b>	<b>152</b>	<b>22</b>		<b>540</b>	<b>99-02</b>



## **Pilot Goals Description**

Demonstrate successful product line acquisition practices for measurement within a DoD setting

Goals for the pilot

- Serve as example for future PWS work by demonstrating the overall effectiveness of the Acquisition Companion
- Work hand-in-hand with acquisition organization to obtain and report on adoption from within DoD
- Serve as example for other Navy systems considering product line approaches

Acquisition pilot allows low risk opportunity to apply acquisition practices in such areas as Structuring the Organization, Data Collection, Building a Business Case, Customer Interface Management, and Technology Forecasting



# Value and Significance

What is the value to the customer?

- Leverages current improvement plan with SEI processes
- Makes case for strategic funding through measurement and tracking guidance
- Promotes long-term vision for sustained product line development

What is the value to the SEI?

- Leverages development and validation of new methods through work with DoD organization and variety of users
- Matures Acquisition Companion Guidelines through customer work
- Applies cross-functional teams (PLP, SEMA, ASP)

What is the value to the Acquisition community?

- Satisfies requests by others for support in same practice areas (e.g., FBCB2)
- Provides extended case studies of successful technology adoption
- Extends the current NUWC case study in specific practice areas for new product line work at NUWC



## Results

Applying Goal Driven Software Measurement to NUWCs product line adoption

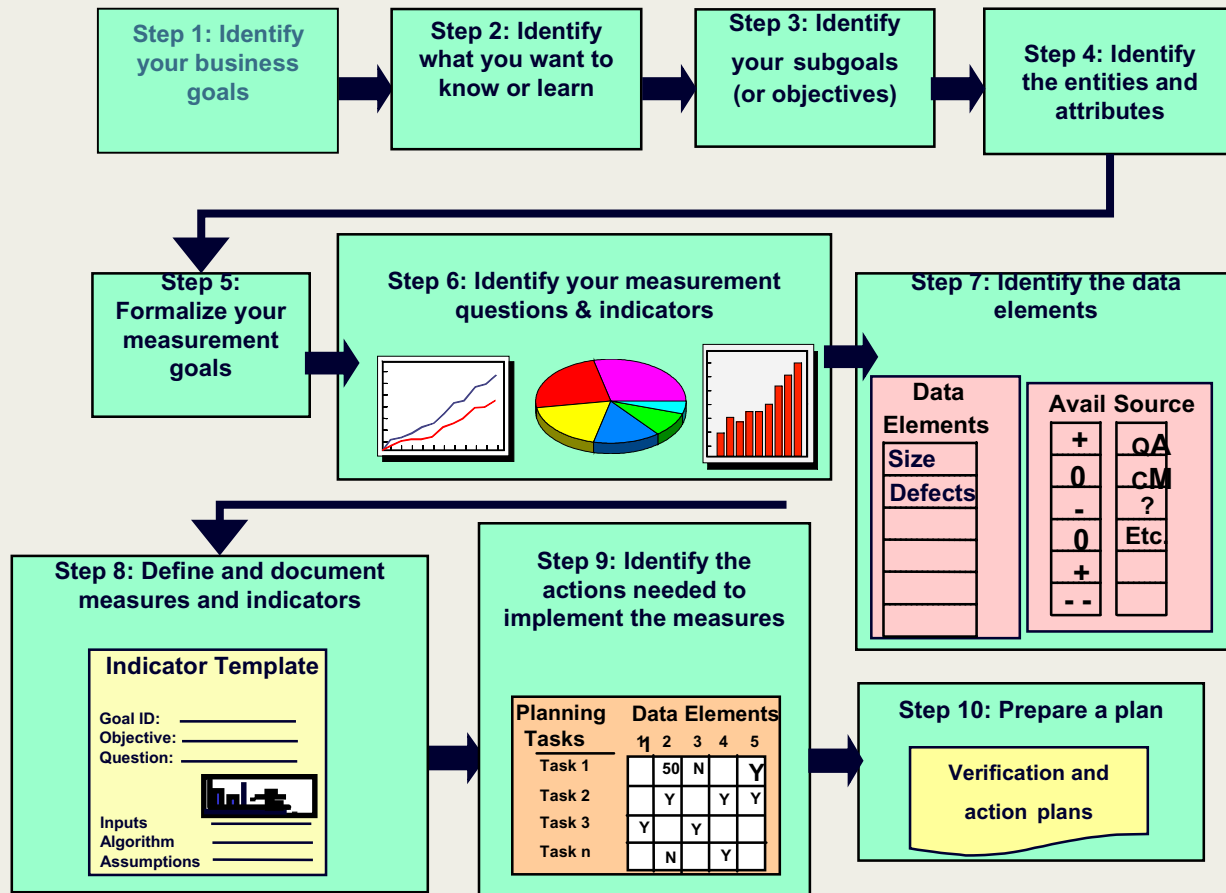
- NUWC has established measurement goals and indicator
- Tracking effort data from Off-board Advanced System Stimulus (OASYS) project
- Three other projects will also be capturing data
- Measurement group with representatives from 4 projects in place

Unexpected and beneficial discoveries

- Goal-Driven Software Measurement to provide basis for product line measurement practices
- Project effort must track WBS, action items, problems reports, other sources of requirements
- New NUWC projects will be applying results of pilot



# Goal-Driven Software Measurement





Business Goal



Business Subgoals



Measurement Goals



Questions & Indicators



Data Elements

***Become the best value supplier of  
high quality range software***

- Improve accuracy of effort estimation process
- Measure effectiveness of Product Line Approach
- Improve ability of products meeting customer requirements

<b>Object of Interest</b>	<b>Effort estimation process</b>
<b>Purpose</b>	<b>Divide SCPs into units that are trackable. Improve ability to make reliable estimates of effort.</b>
<b>Perspective</b>	<b>Analyze causes of deviation from effort estimates. Establish correlation between types of software changes to assets and how these affect schedule</b>
<b>Environment and Constraints</b>	<b>Use TrackWeb to estimate, track and report effort</b>

- How reliable are schedule estimates?
- What causes deviations from estimates?
- Etc.

SCP	Schedule variance	Effort Variance
1	0.1	0.1
2	-0.5	0.2
3	-0.5	-0.2
4	0.6	0.1
5	-0.4	0.1
6	0.5	-0.1
7	0.1	0.1
8	-0.4	-0.2
9	0.5	-0.1
10	0.1	-0.1
11	1.0	-0.1
12	-0.1	-0.1
13	0.1	0.1
14	1.0	-0.1
15	-0.7	0.2

- SCP type
- Effort estimate
- Degree of reuse

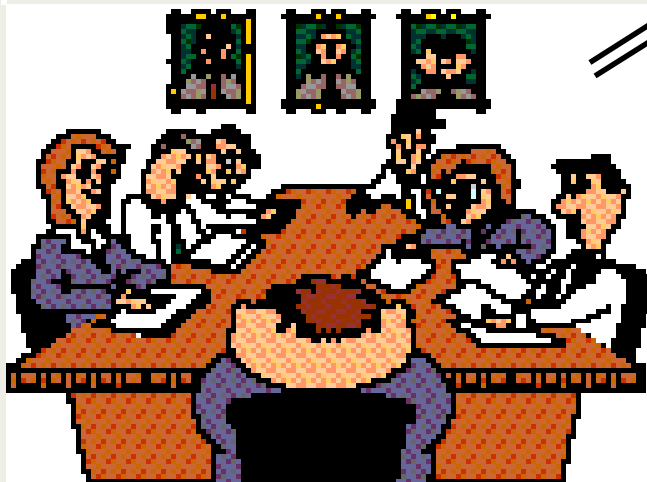


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## NUWC Code 71 Business Goal

...Become the best value  
supplier of high quality  
range software systems

Our principal business  
subgoals are ...



**Subgoal #1: Improve  
accuracy of effort  
estimation process**

**Subgoal #2: Measure  
effectiveness of Product  
Line Approach**

**Subgoal #3: Improve  
ability of products to meet  
customer requirements**



## Improve accuracy of effort estimation process

For each project:

- Track effort as budgeted compared to effort at completion
- Track budgeted schedule and cost in similar fashion

Use SCP's, AI's, and WBS tasks as the level for tracking this information

Across projects, track variations in use and effect of use of assets (element of Subgoal #2)



## Other Indicators

### Subgoal #2

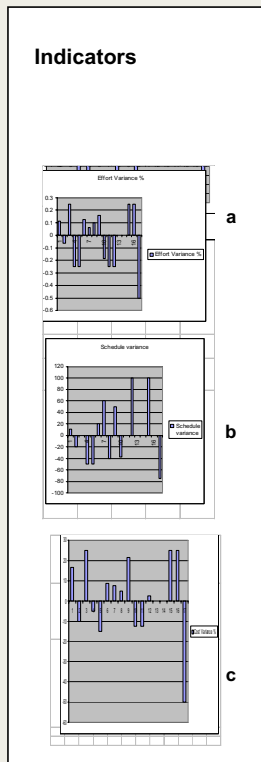
- Cost savings from asset use
- Effort savings from asset use

### Subgoal #3

- % coverage (degree of reuse)
- Degree of change of assets for meeting customer needs



# Necessary Data Elements



Data Elements	Indicator			Avail	Source
	a	b	c		
<b>Required</b>					
1 Identifier	x	x	x	+	WBS, SCP, AI
2 Description	x	x	x	+	WBS, SCP, AI
3 Requirement	x	x	x	000	Requirements doc.
4 Baseline (Effort, Completion)	x	x		+	WBS (sometimes), AI
5 Revised Baseline	x	x		00	Staff
6 Number of Revision (history)	x	x		00	Staff (not collected now)
7 Rationale for Revision	x	x		00	Staff (not collected now)
8 Actual Effort to Date	x			00	Timesheets, staff
9 Estimate Effort to Complete	x			00	Staff
10 Est. Actual Completion Date		x		00	Staff
11 Revised Completion Date		x		00	Staff
12 Labor Resource Cost			x	00	Staff
13 Revised Costs			x	00	Staff
14 Other Task Cost			x	00	Staff
15 Actuals (effort,schedule,cost) at complete	x	x	x	00	Staff
<b>Compute</b>					
Baseline cost (labor and other)			x	00	Baseline effort * Labor Cost
Costs to date			x	00	Actual Effort * Labor cost
% Completed (schedule, effort)	x	x		00	Actual/Baseline *100
% Actual Effort Spent	x	x		00	Actual/To Complete * 100
Estimate (effort, cost) at complete	x		x	00	To Complete – Actual
Variance (effort, schedule, cost))	x	x	x	00	To Complete/Baseline * 100

Code	Meaning
+	Available
0	Not explicitly available - can be derived from other data - can be obtained via minor effort - can be obtained via significant effort
00	
000	
-	Not available now
--	Impossible to obtain or extremely difficult



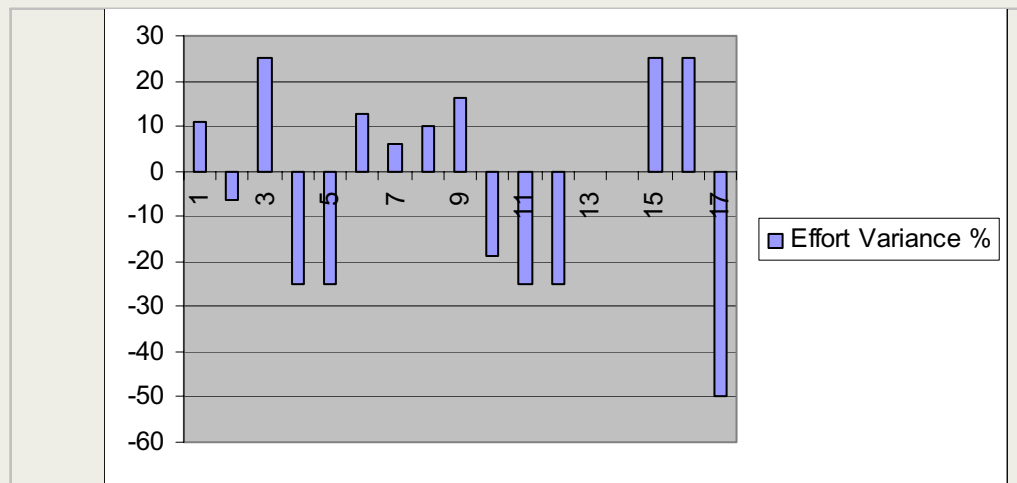
## Results: Example Indicator – Effort Variance %

Purpose – measure effort to completion (estimated) against  
baseline effort

$EV\% = (\text{actual effort} - \text{budgeted effort}) / \text{budgeted effort} * 100$

Perspective - analyze when and why variance occurs

Environment and Constraints – use Trackweb or spreadsheet  
template to update effort





## **Next Steps**

Examine other subgoals in depth

- Develop questions and indicators
- Identify data items and sources

Use measurement results as basis for analysis across projects in product line

Refine business case



## References

Sholom Cohen, Ed Dunn, Albert Soule. “Successful Product Line Development and Sustainment: A DoD Case Study.” CMU/SEI-2002-TN-018. September 2002.

Sholom Cohen, Dave Zubrow, Ed Dunn. “NUWC Case Study: A Measurement Program for Product Lines.” CMU/SEI-2003-TN-039, December 2003. (In final production)



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### World Wide Web:

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

## Resources

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

- Detailed software product line case studies
- Software product line practice framework and acquisition companion
- SEI software product line products and services
- Info about courses and training
- Upcoming events in the software product line community
- Details about SPLC 2004, Boston, Aug-Sep 2004.