NATIONAL DEFENSE INDUSTRIAL ASSOCIATION

11TH ANNUAL
SYSTEMS
ENGINEERING
CONFERENCE

October 20-23
2008

Paper 7289

Can Patterns of Process Reuse Help Accelerate IPPD?

Larry Earnest

Northrop Grumman Corp.
larry.earnest@ngc.com

Azad M. Madni, PhD

Intelligent Systems Technology Inc.
amadni@intelsystech.com

Robert Cloutier, PhD

Stevens Institute of Technology
Robert.Cloutier@stevens.edu

Updated 10/13/08

Introduction

- In response to Industry Standards, SE organizations have begun cataloguing their SE processes in an effort to standardize and accelerate IPPD work product development.
  - We advocate that the view of Process Reuse is implicit in systems engineering standards but has yet to be systematically operationalized.
- In this presentation, we explore what it takes to make process reuse effective.
- Specifically, we investigate whether or not process patterns can help accelerate IPPD process development while lowering costs

Note: This research is a continuation of research presented at the NDIA 9th Annual Systems Engineering Conference, San Diego, CA, 23-26 October 2006

Motivation

- To convey the value proposition of reusable process assets for systems engineering, specifically the IPPD process.
- A recent study[1] shows that top performing organizations achieve 76% of their engineering targets and a 30% reduction in design time through information reuse.
  - Conversely, companies that did not implement a reuse strategy only achieved 26% of their engineering targets.
  - It is anticipated that SE process reuse will show similar benefits for developing complex systems
  - Best practices and lessons learned are emerging.

CAUTION

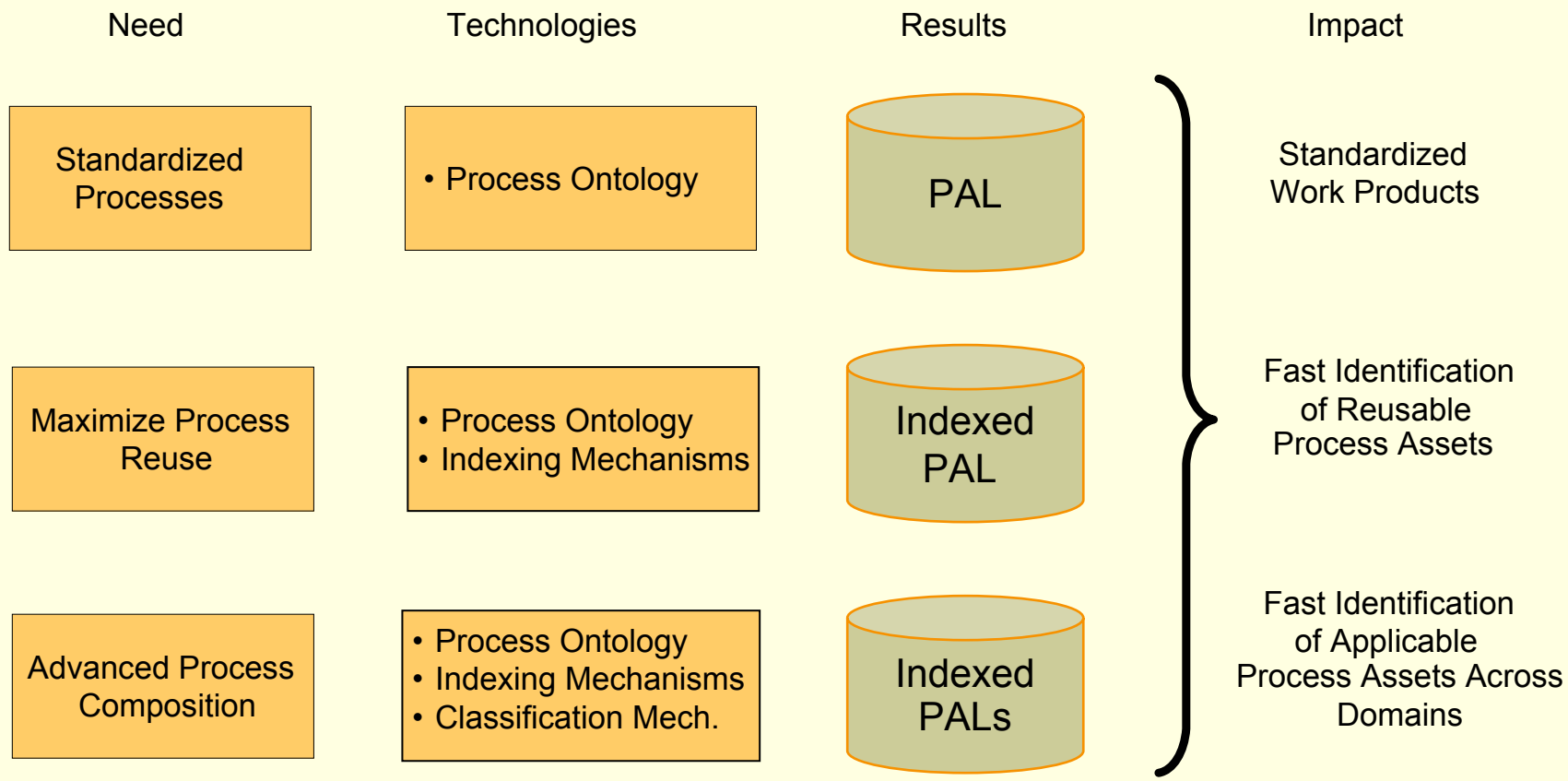
[1] *2007 Aberdeen Report,* The Design Reuse Benchmark Report

Process Definition

- A process is simply a documented way we do something.
  - A process converts inputs into a value-added result subject to resource constraints and business rules.
- Systems Engineering defines a process as the documented set of activities, performed in collaboration, resulting in a work product which contributes to the development of the desired system.
  - The CMMI model defines a well-defined process as "*A process that includes readiness criteria, inputs, standards and procedures for performing the work, verification mechanisms (such as peer reviews), outputs, and completion criteria.*"

What does it take to make process reuse effective ?

Process Reuse Maturity Levels



Developing and Tailoring new processes is hard. One way to avoid the act of developing and tailoring processes is to reuse existing known and effective processes.

Process Maturity Levels

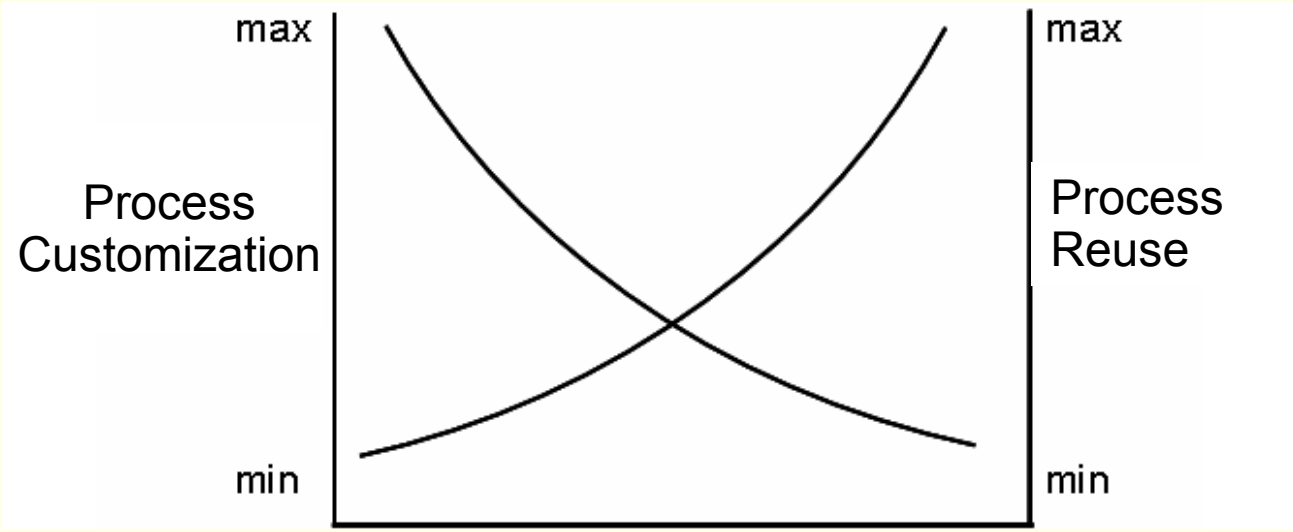
- Level 1 – Has well-defined Processes
  - Build every process from scratch believing every process and problem is unique Vaguely aware that portions of one process are similar to others Build overly complex and difficult to understand processes.
- Level 2 – Has ability to find and implements Process-Reuse
  - Aware that process patterns exist and consciously use some of the most common in their process solutions
  - Build complex processes that are simple to understand and maintain
- Level 3 – Advanced Process-Reuse
  - As a matter of routine, rapidly compose processes using a combination of patterns.
  - Combine patterns to create elegant and insightful processes

Level 4 – Patterns of Process Reuse

Process Reuse vs. Process Customization Tradeoffs

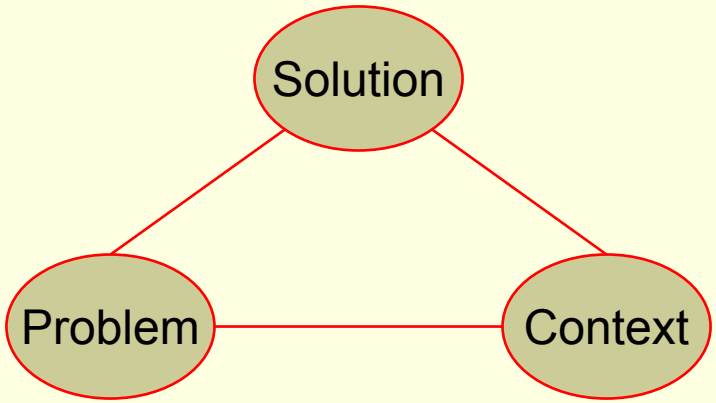
- There is an inverse relationship between the level of process customization performed and the level of process reuse achieved.
- Guiding Principle:
  - minimize degree of process customization to maximize process reuse if reuse is key to cost/risk reduction

(Madni, 2000)



What is a Pattern

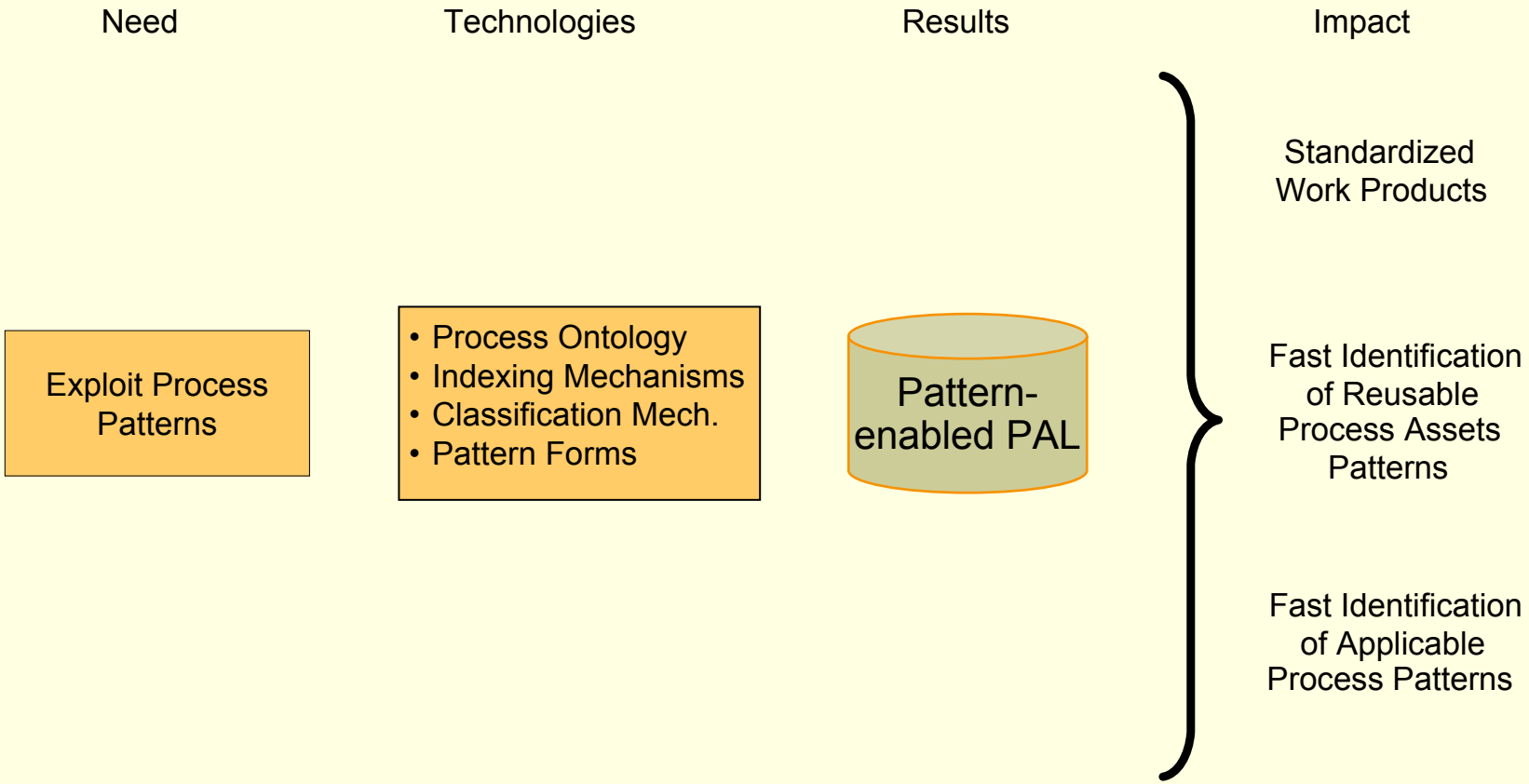
- A pattern is defined as “a solution to a problem in a context.” This is known as the minimal triangle. Any missing element of the three-tuple will result in a trivial pattern[1]



- Additional elements are still needed to document and complete the pattern form

[1] Gaffar and Moha, Semantics of a Pattern System. Concordia University, Quebec, Canada

IPPD Process/Pattern Reuse



What is a Process Pattern

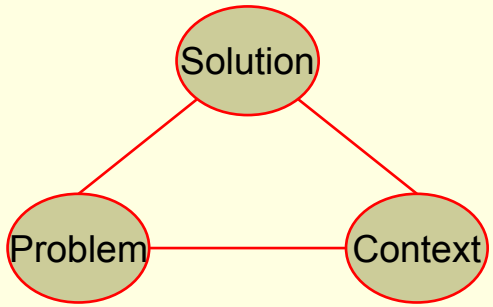
- A process pattern is a general Process solution to a common problem or issue that occurs in a particular context
  - Process patterns are processes that reoccur across different projects
- An important aspect of all pattern forms is to identify and document why the pattern was successful and will be useful as a point of departure for future reuse.
- The knowledge expressed in a pattern form should be general enough to be applied in a reasonably similar context, yet specific enough to give constructive guidance.

Integrated Product Process Development

- A management process that integrates all activities from product concept through production/field support, using multi-functional teams to persistently optimize work products to meet cost and performance objectives.
- A key tenet of IPPD is ***Concurrent Development of Products and Processes***
  - Processes should be developed concurrently with products which they support.
  - It is critical that the processes used to manage, develop, manufacture, verify, and test be considered during development.
  - Product and process design and performance should be kept in balance.

IPPD Process Areas

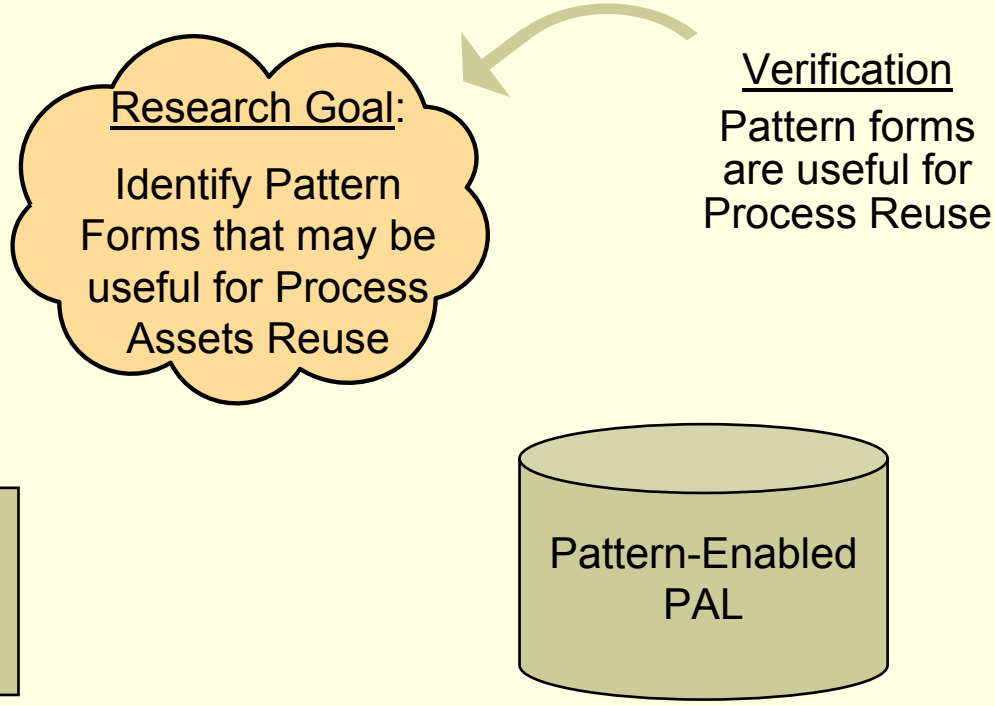
- Focus on Integrated Product and Process Development (IPPD) work products.
  - Proposal Development
  - Cost Models
  - Schedule Models
  - Technical Planning and execution
  - Risk Planning and Management
  - Requirements Development
  - Architecture Development
  - Configuration management and control
  - Integration, Verification and Validation (IV&V)



Future Research Needs

- Establish/Mine Pattern Forms for process reuse
- Identification of frequently used process patterns to facilitate reuse
- Quantification of the benefits of process/patterns reuse relative to the status quo

Research Overview



- Has Problem(s) in a Context:
  - Technical Requirements
  - Mission need
  - Acquisition Goals

Looking for Solutions

- Has successful work products *(Solutions)* to known Problems in a Context
  - The *Solutions* we are looking for are the IPPD Processes
- Has Integrated assets that tie P-C-S

Cited Literature and Resources

- *2007 Aberdeen Report,* The Design Reuse Benchmark Report
- *Madni, A.M. Thriving on Change through Process Support: The Evolution of the ProcessEdge™ Enterprise Suite and TeamEdge™, in International Journal on Information, Knowledge, Systems Management, Special Issue Vol. 2, No. 1, Spring, 2000.*
- *Madni, A. M. and Madni, C. C. Process Support for IPPD-Enabled Systems Engineering, 1998 IEEE/SMC*
- *Cloutier, Robert, Applicability of Patterns to Architecting Complex Systems, Doctoral Dissertation, Stevens Institute of Technology, Hoboken, NJ, April 2006*

http://www.patterns4se.com/index.htm

END

Pattern Forms

- a Pattern Form is a format and structure used to write a pattern. Some well known forms are:

Alexandrian Form	Canonical Form
Coplien Form	GoF form
Compact Form	Cockburn PmForm
Portland Form)	Beck Form
Fowler Form	Cloutier Arch Pattern

- The main difference between Pattern Forms are domain specific.
- Common elements in a pattern form include:
  - why the pattern is a good solution
  - where the pattern has been documented to have been reused.

Key Challenges

- Technical challenges include:
  - Indexing process assets for potential reuse.
  - Indentifying processes for reuse.
  - Ensuring that the context of retrieved assets are not misapplied.
- Non-technical challenges include:
  - Overcoming cultural issues, ingrained habits and institutional resistance.
  - Securing executive sponsorship, and making the requisite investments in infrastructure to enable work product reuse.

SE Process Assets Library

- A SE Process Assets Library/repository contains process description documents, tailoring guidelines, templates, tools, examples, contextual information, and other related enterprise perspectives that contribute to determining if the work product is a good fit for reuse.

Process Assets (PA)

- Well-defined processes are supported by additional Enterprise Perspectives:
  - Policies,
  - Guidelines
  - Procedures
  - Standards
  - Training materials and examples
  - Measurement specifications
  - Tools
- Indexing Process Assets with Domain meta-data enhances pattern identification.

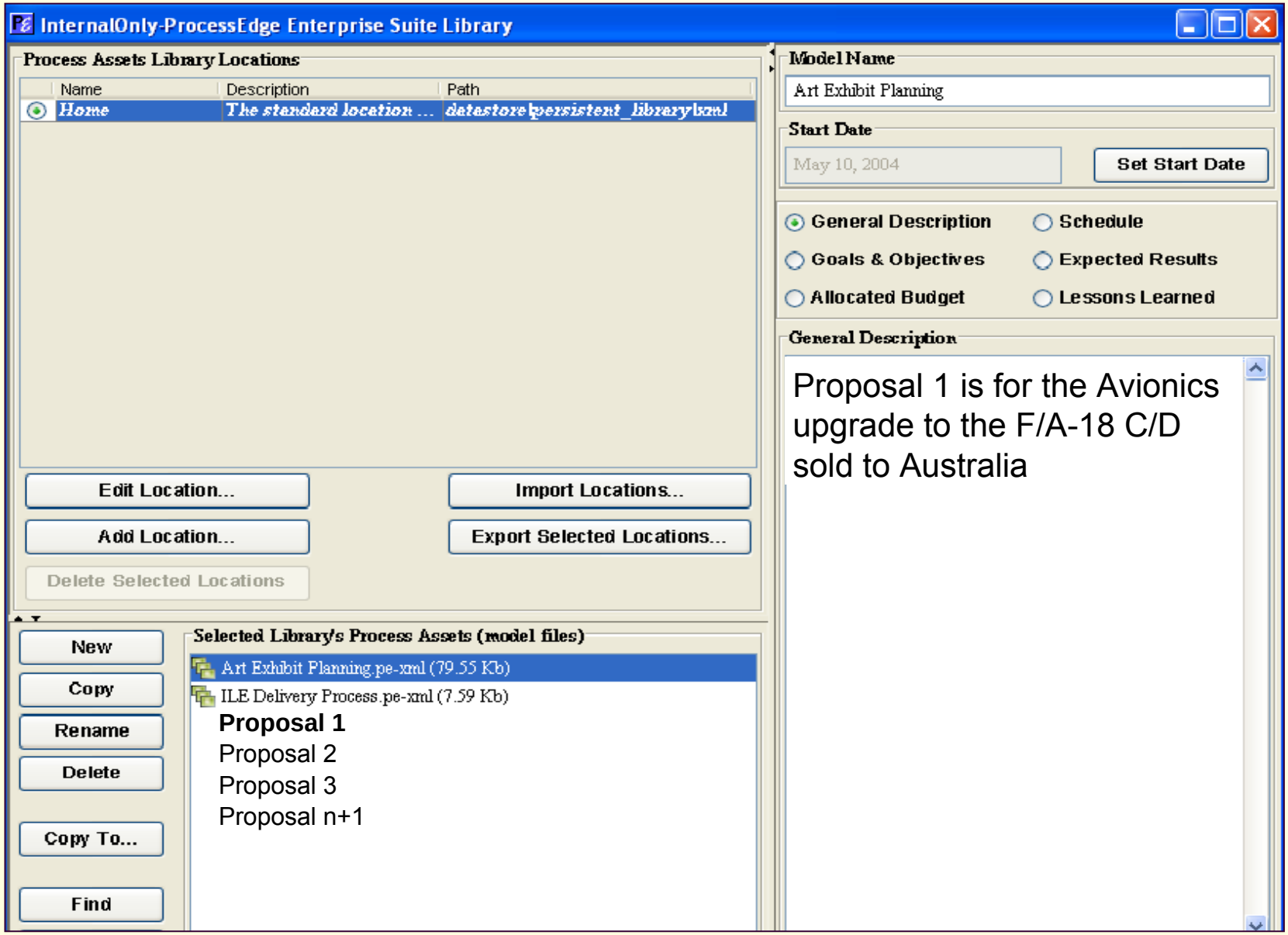
Reusable Process Assets (RPA)

- RPA are process assets that are created for uses beyond their original purpose.
- RPA need to be easily accessible and potentially tailorable for new applications.
- Easy access to process assets requires multiple ways of indexing the assets such that a variety of users with different intentions can gain access to them.

Transforming PA to RPA

- Transformation could involve going from:
  - Drawing or picture to a process model
  - Prose description to a process model
  - Video clip to a process model

Exemplar PAL



Exemplar PAL

- Contain Well-defined processes (ETVX) and is supported by additional reusable process assets:
  - Killer Graphics
  - Parametric Cost
  - Schedule
  - Policies,
  - Guidelines
  - Procedures
  - Standards

Value Proposition of a SE-PAL

- Capitalizing on key legacy accomplishments that provide leverage for future program reuse
- Process tailoring and reuse
- IMP/IMS generation
- Cost generation for proposal bids
- Cost tracking during program execution
- Continuous estimating improvement for generating SE process assets based on comparison of actuals verses predicted.
- SE Planning reuse
- Process Model improvement

Barriers to Process Reuse

- 80% of all assets (including process assets) are not reused, partly because they are unstructured and difficult to locate and use in context.
- 50 to 70 percent of all reuse initiatives fail[2]
  - Technology required to make unstructured data searchable
  - Methods for storing assets for potential reuse
  - Time expended in manually sorting through the corpus of unstructured documents to identify reusable content.
  - Reuse risk due to misapplication. Contextual differences in the original context and the user's current context.

2. Stewart, Thomas A - Reengineering: The hot new managing tool

Enablers to Asset Reuse

- Features of a successful reuse culture must include:
  - Underlying ontology (domain rules) which permit the creation of standardized work products
  - Process that create work products that are intended to be reusable
  - The ability to locate assets for reuse – that are contextually correct for the current application.
  - The ability to modify/tailor the asset
  - Well-defined processes for creating standard work products

IPPD Pattern Identification

- There are many potential factors that drive the development of complex systems, but what we are looking for are the key patterns that will correspond to the reuse of IPPD Processes without having to tailor from scratch. If the pattern criteria matches, we propose using the process assets as a point of departure or as-is.
- factors that We were looking for the primary drivers to see if a pattern emerges. We then posit that if a new program fits the pattern then that program can simply use the set of processes as-is and forgo the expense of tailoring. We then looked at other program tailoring documents to see if there was a correlation to the already documented process tailoring pattern.