

Techniques for COTS Software Evaluation

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Outline

- **Introduction**
- **Fundamentals of COTS Product Evaluation**
- **PECA - An Evaluation Process**
- **Techniques for Evaluation**
- **Last Words**

Background

- **COTS - Commercial Off-The-Shelf**
- **Tutorial co-developed by NRC and SEI**
 - NRC (Software Engineering Group)
 - SEI (COTS-Based Systems Initiative)
- **One and a half years in development**
 - Only one of the results of a 5-year collaboration

What Is a COTS Product?

Introduction

- **A product that is**
 - sold, leased, or licensed to the general public
 - offered by a vendor trying to profit from it
 - supported and evolved by the vendor, who retains the intellectual property rights
 - available in multiple, identical copies
 - used without modification of the internals

Almost-COTS Products

Introduction

- **Freeware/Shareware**
 - Vendor “profit” may not be dollars but some sort of brand recognition.
- **Open source**
 - The “vendor” is the community.
- **Restricted distribution products**
 - “General public” may have restricted meaning.
Ex: In the U.S., products with strong encryption can only be sold to U.S. companies.

What Is a COTS-Based System?

Introduction

- **Any system partially or completely constructed using COTS software products as integral components.**
 - not measured in percentages
- **Examples include**
 - enterprise resource planning (ERP) systems
 - Army C3/C4 systems constructed using a combination of custom and COTS software



A Spectrum of COTS-Based Systems

Introduction



COTS-Solution Systems

One substantial product (suite) used (and sometimes tailored) to provide significant system functionality

- tailoring focus
- vendor maintained

COTS-Aggregate Systems

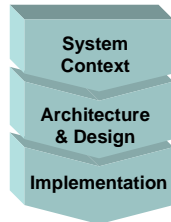
Multiple products from multiple suppliers integrated to collectively provide system functionality

- integration focus
- project maintained

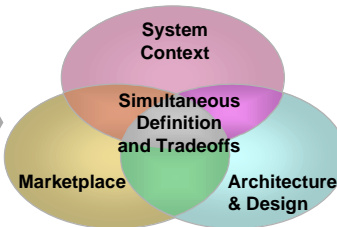
The Fundamental Change

Introduction

Traditional Development Approach



Required COTS Approach



This change applies to *business and contractual* activities, as well as to *engineering* activities.

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What Is COTS Product Evaluation

Fundamentals

- **The examination of COTS products for the purpose of determining the products' fitness for use in a particular context.**
- **Fitness for use means such things as**
 - **Does it provide adequate functionality?**
 - **Does it interoperate with other components?**
 - **Can you adapt it to fit your need?**

Simple View of COTS-Based Systems

Fundamentals

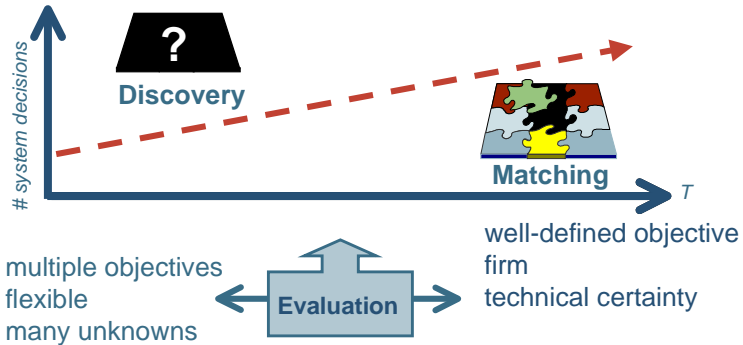
- Building a COTS-based system is like completing a puzzle. Filling each hole in the puzzle requires an evaluation.
- The shape and size of the remaining hole changes with each evaluation. The shape and size of the pieces also change with time!



Discovery vs. Matching

Fundamentals

COTS product evaluations have different goals depending on the phase of the CBS project.

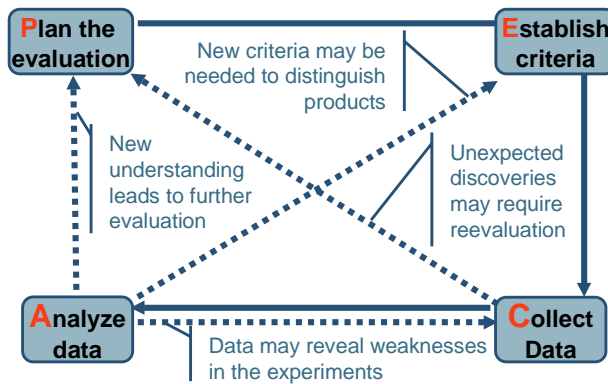


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PECA – A Recommended Process

PECA



There Is More Than Just Process

Last Words

- The evaluation process is a high-level description of *what* we need to do.
- Techniques are low-level descriptions of *how* to do it.

Tailored Process

+ Techniques

Instantiated Process

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Forming Evaluation Teams

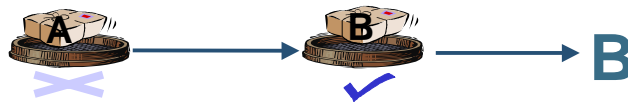
Techniques

- An effective team is critical for a successful evaluation.
- Diverse skills are necessary, such as those held by
 - developers and technical people
 - domain experts
 - business people
- Good balance of power is important.
- Are dedicated teams a good idea?

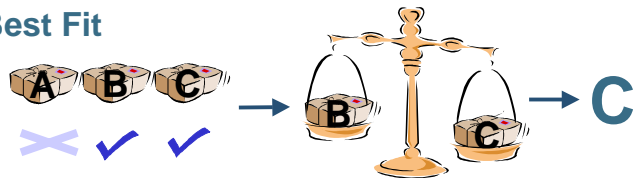
Picking the Approach: First Fit vs. Best Fit

Techniques

First Fit



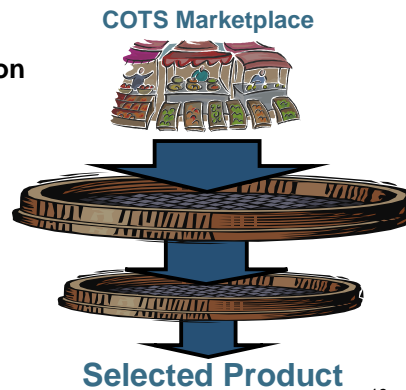
Best Fit



Picking the Approach: Filters

Techniques

- As selection is narrowed the evaluation techniques become more rigorous.
- Factors to consider
 - Size of candidate field
 - Discriminating criteria
 - Evaluation budget



Requirements vs. Criteria

Techniques

- Evaluation requirements are stated in terms of needs.
 - “Information transfer shall be protected from unauthorized access.”
- Criteria are stated in terms of capabilities to satisfy those needs.
 - “support for secure sockets or equivalent security mechanism”
- Criteria are quantifiable, evaluation requirements may not be.

Defining Criteria

Techniques

- Two ways to define criteria
 - reuse preexisting criteria
 - generate new criteria
-
- We can reuse criteria to cover aspects that are not system specific.
 - product feature checklist
 - organizational checklist
-
- We must generate criteria to cover system-specific requirements.

Product Feature Checklists

Techniques

- Feature checklists are standard fare for product comparisons; they are
 - a kind of specification for a class of products
 - often reflective of only common, not unique, features
 - as reliable as the source

Internet Server	Netscape Enterprise
Can require password	✓
Supports SSL v. 2	✓
Supports SSL v.3	
Supports S-HTTP	
Supports PCT	✓
Prohibit by domain name	✓
Prohibit by IP address	✓

↑ Relevant for your context? Why?

Organizational Checklists

Techniques

- Organizations need (want) consistency in IT.
 - represent corporate interests
 - avoid incomplete criteria
- Organizational checklists provide some uniformity and predictability.
 - in coverage of corporate needs
 - in the overall evaluation process

Categories of Criteria (Level 1)

Technical Requirements
 Compatibility w/ other COTS
 Adaptability, Flexibility
 Reliability, Maintainability
 System Integration
 System Integrity
 Security
 Vendor Support
 Training
 Documentation
 License Restrictions

Example of Technical Criterion

Techniques

- Requirement
 - “The system shall calculate longitude.”
- Capability statement
 - “Given input data accurate to five decimal places, the system shall calculate longitude to an accuracy of four decimal places.”
- Quantification method
 - “Provide various values of valid input to the system and confirm that the longitude is accurate to four decimal places.”

Risk-Driven Criteria Generation

Techniques

- **Feature driven rather than requirements driven**
 - Products are reviewed to compile a list of features.
- **Focuses on risk rather than fitness**
 - Features are analyzed to determine the risk associated with the presence or absence of that feature in a product.
 - The risk statement is the explicit mapping of a product feature to a system need.

Risk-Driven Criteria Generation

Techniques

- Step 1: **identify interesting product features**
- Step 2: **assert risk to system of a product not exhibiting a feature**
- Step 3 (optional): **categorize and quantify risk**
- Step 4 (optional): **identify mitigations**

Example: Risk-Driven Generation

Techniques

- **Product features are the source of criteria.**

Feature	Risk
Automatic load balancing of servers based on user connects	Response time worse than required by users
Vendor is foreign-owned	None: "buy America" not required

Collecting Data

Techniques

- **You collect data to provide the basis for your analysis.**
- **Less obvious but equally important**
 - degree of confidence in data
 - architecture and design implications of the product
 - limitations/conditions placed on use of product
 - options for use of the product uncovered during measurement
 - deficiencies in assessment methods and in evaluation requirements or criteria

Data Collection Techniques

Techniques

- **There are several different families of techniques.**
 - literature review
 - vendor appraisals
 - hands-on experiments
- **You may want to use multiple data collection techniques for a single criterion.**
- **For example, data collection techniques for “transactions per second” include**
 - trust the provided documentation
 - extrapolate from pre-existing benchmarks
 - perform a specific experiment for the operational environment

Literature Review

Techniques

- **Vendor sources**
 - user manuals, marketing brochures
 - release notes, version history
 - vendor references
- **Internet survey**
 - on-line research of reference materials
 - gossip and rumor (beware of unchecked references)
- **Consumer report and user groups**
 - experiences of other parties with a particular product

Vendor Appraisal

Techniques

- Vendor appraisal is the analysis of the vendor organizations' processes, personnel, and organizational capabilities as they affect the COTS product.
- Sources include
 - basic vendor business and capability information (e.g., interviews, vendor literature, capability evaluations)
 - independent financial analyses (e.g., Standard & Poor's)
 - strategic information and lists of users (e.g., trade journals, vendor information)
 - customer kudos and complaints (e.g., web sites, user groups)

Hands-on Techniques

Techniques

- Unless the product choice you are making is trivial, you *will* need to use hands-on techniques with the COTS product to
 - verify claims
 - determine interactions with other components
 - determine feasibility of proposed architectures and designs
 - determine performance, reliability, etc. *in your context*
 - identify assumptions made by the product
- Techniques include product probe, prototypes, and scenario-based testing.

Product Probe

Techniques

- An experiment in which specific features of a product are investigated
 - guided experimentation
 - discovery (a.k.a. “playing around”)
- Types of guided experimentation
 - error testing
 - stress testing
 - data stream fault insertion
 - reactions at or near the boundaries

Even “playing around” requires discipline to record the sequence of activities that led to a result.

Prototypes

Techniques

- A *prototype* is a small-scale version of the system to demonstrate critical features and design decisions.
- Prototypes allow experimentation with the COTS product in the real context.
- Prototypes are useful to observe:
 - interfaces with major components of the system
 - user interaction
 - critical product features (performance, robustness...)
 - areas of high technical risk (integration with legacy system, interoperability with external sources...)

Scenario-Based Evaluation

Techniques

- A *scenario* is a step-by-step description of a function that a system must perform.
- Scenarios focus on a specific system pattern of use.
 - are most useful for determining “fitness for use”
 - help identify products that exceed evaluation requirements
- We can define scenarios based on Use Cases.

Use Cases

Techniques

- A *use case* is a sequence of interactions between an Actor and the system.
- An Actor is anything that communicates with, but is external to, the system.
 - can play a single role only
 - is not necessarily a user
- A single user may adopt multiple roles.

Steps for Scenario-Based Evaluation

Techniques

- **Step 1: Define scenario by isolating a particular (sub)process.**
 - may involve multiple Use Cases
- **Step 2: Define specific test procedures for scenario.**
 - include expected outcomes
- **Step 3: Establish an environment.**
 - emulates or simulates area of inspection
- **Step 4: Insert product(s) into environment.**
- **Step 5: Run tests and record results.**

Other Techniques

Techniques

- Benchmark: **Experiment to determine some quantifiable characteristic of the product**
- Product insertion: **Experimental (and usually limited) fielding of the product**
- Demonstration: **Vendor guided preview of product capability**

Analyze Data

Techniques

- **Consolidation** *summarizes* data to extract information.
- **Analysis** *reasons* about that information in order to make a recommendation.
- **Reasoning** is by nature a highly creative task. However, some techniques may help:
 - sensitivity analysis
 - gap analysis
 - cost of repair

Sensitivity Analysis

Techniques

- **Every evaluation is subject to uncertainty.**
 - Are my measured values accurate?
 - What if my assumptions concerning weights are invalid?
 - How dependent are the results on a particular criterion?
- **Uncertainty creates risk.**
- **Sensitivity analysis shows how your selection results react to changes in your weights or scores.**

Gap Analysis

Techniques

- Gap Analysis provides a sense of best fit.
 - especially useful to understand end-user process mismatches
 - doesn't use mathematical aggregation
 - can provide a basis for cost of fulfillment calculations
- A gap analysis typically uses a matrix
 - criteria down the side
 - candidates across the top
 - cells may be filled with text on
 - how a product feature provides the function
 - how well the product fulfills the criterion

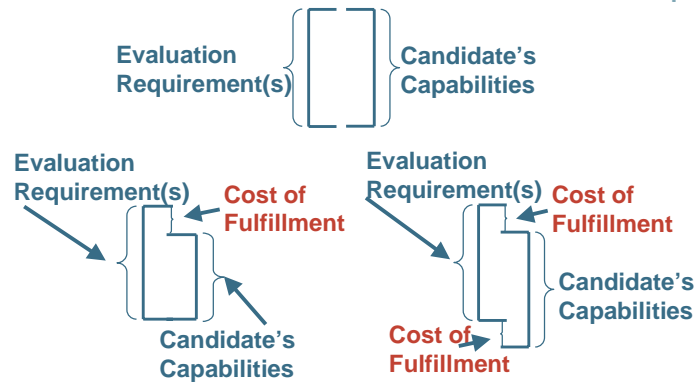
Cost of Fulfillment

Techniques

- One way to view results is to consider the cost of fulfilling a deficit in a product.
 - “deficit” is judged with respect to the system needs
- Understanding the cost of fulfillment requires you to make assumptions about the use of the product in the system:
 - architecture and design
 - impact on maintenance
 - business considerations
- This requires expertise outside the scope of evaluation.
 - Evaluators must team with others to determine possible approaches to the fulfillment and their estimated costs.

Cost of Fulfillment

Techniques



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A Little Dose of Reality

Last Words

- **The process is a means, not the end.**
 - **Boundaries between steps may become blurred.**
 - **There is no “one size fits all” in COTS evaluation.**
 - **The process should never get in the way of making a good recommendation.**
- **COTS evaluation is an ongoing activity.**
 - **Evaluation is not once and done.**
 - **Evaluations build on previous evaluations.**

A Little More Reality

Last Words

- **Uncertainty is a part of COTS evaluation.**
 - **Even a great job will leave doubt and risk.**
 - **Sometimes there is no clear winner.**
 - **Time erodes confidence.**
- **COTS evaluation is not an isolated task.**
 - **It is performed in the context of a larger process.**
 - **It is performed in the context of the system.**

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