Techniques for COTS Software Evaluation

John C. Dean, CD, CSTE
Software Engineering Group
Institute for Information Technology
National Research Council Canada

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*

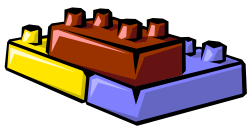
Introduction

- 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



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A Spectrum of COTS-Based Systems

COTS-Solution Systems	COTS-Aggregate Systems
One substantial product (suite) used (and sometimes tailored) to provide significant system functionality	Multiple products from multiple suppliers integrated to collectively provide system functionality
• tailoring focus	• integration focus
• vendor maintained	• project maintained

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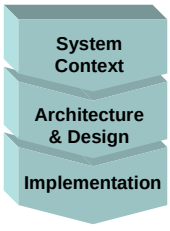
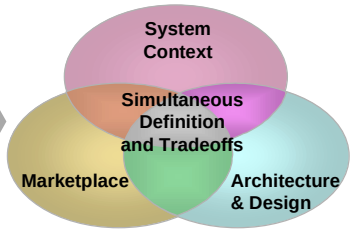
The Fundamental Change

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?

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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!**

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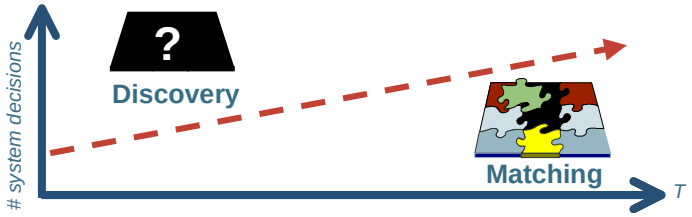
Discovery vs. Matching

Fundamentals

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



multiple objectives
flexible
many unknowns

Evaluation

well-defined objective
firm
technical certainty

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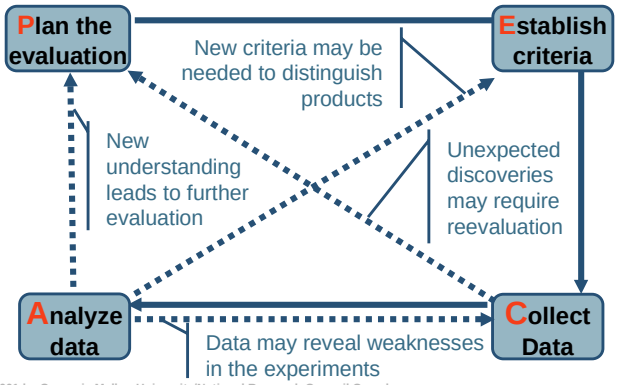
PECA – A Recommended Process

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?

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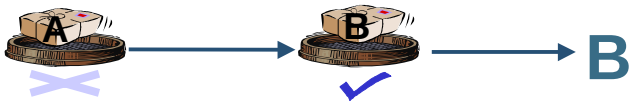
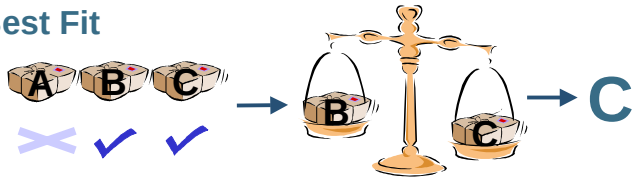
Picking the Approach: First Fit vs. Best Fit

Techniques

First Fit



Best Fit



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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

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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.

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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.

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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?

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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

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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

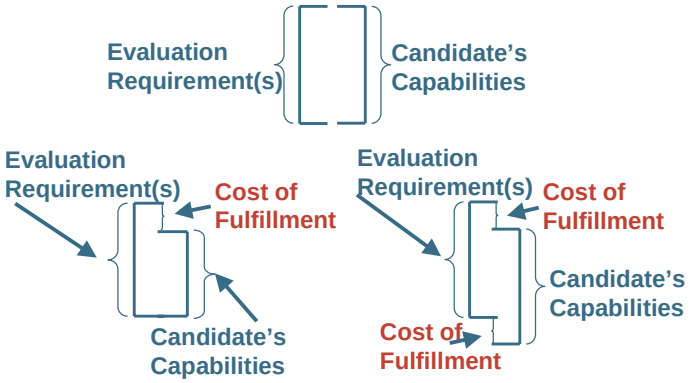
Cost of Fulfillment

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.

Contact

John Dean
E-mail: John.Dean@nrc.ca
Phone: 991-6975

Software Engineering Group
Institute for Information Technology
National Research Council Canada
Ottawa, Ontario K1A 0R6

Contact

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