Glue-Code Assessment for Interoperability

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Outline

• Background
• Component Selection Method for Interoperability
• Facilitators
• Example – Caroline’s Closet
Background

• Most projects employ piecewise COTS Evaluation

• Common Interoperability Issues
  – Functional mismatch
  – Non-functional mismatch
  – Architectural mismatch
  – Component conflicts
  – Interface conflicts

• Effort/Line of glue code = 3 * Effort/Line of normal code
COTS Component Selection for Integration

0: Entry Conditions -
From Assessment Process:
- Objective Constraints and Priorities (OC&Ps) for the project
- Identified the need for glueware to integrate COTS products

1: Identify candidate third-party, legacy and reusable components to be integrated
2: Classify them into function groups
3: Evaluate alternatives with respect to functional and non-functional OC&Ps
4: Buy information to reduce risk
5: Filter out unacceptable alternatives
6: Evaluate available component combinations
7: Prototype to reduce risk
8: Preserve options to maintain trade-space
9: Exit to Decision Making and Integration -
- Set of COTS compatible products that satisfy project OC&Ps
10: Re-negotiate OC&Ps with stakeholders
11: Develop a custom component to the specific functionality

Can adjust OC&Ps?
Yes
No

No acceptable component in a specific group

95x115
Selection Method Description II

• 2: Classify components into function groups

Back office retail
Communication protocols/packages
Compilers
Configuration mgmt/build tools
Data conversion packages
Databases
Device drivers
Disk arrays
Emulators
Engineering tools
Graphic information system
GUIs/GUI builders

Middleware
Network managers
Operating systems
Problem mgmt
Report generators
Software process tools
Telecommunication & infrastructure
Telemetry Analysis
Telemetry processing
Word processing
Selection Method Description IV

• 4: Buy Information to reduce risk
  • Dominating technologies related to COTS
    – E.g. XML for Data exchange
  • Business process information
    – Business process techniques followed at similar or competing organizations
  • Product standards in the assessment domain
  • Product standards compatibility
    – E.g. MySQL and J2EE compatibility
  • Vendor access to the definition of such technology standards
  • Evolution and support
    – Product upgrade frequency
    – # of features dropped during backward compatibility
    – Vendor position in the market
      » Innovators, early adopters, early majority, late majority, laggards
Selection Method Description IV

- 6: Evaluate available component combinations
Selection Method Description V

• 7: Prototype to reduce risk
  – Selection of Connectors
  – Available COTS interfaces and their support connectors
  – Architectural mismatches between COTS packages
COTS Component Selection for Integration - Recap

1: Identify candidate third-party, legacy and reusable components to be integrated

2: Classify them into function groups

3: Evaluate alternatives with respect to functional and non-functional OC&Ps

4: Buy information to reduce risk

5: Filter out unacceptable alternatives

6: Evaluate available component combinations

7: Prototype to reduce risk

8: Preserve options to maintain trade-space

9: Exit to Decision Making and Integration - Set of COTS compatible products that satisfy project OC&Ps

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Can adjust OC&Ps?

Yes

No

Objective Constraints and Priorities (OC&Ps) for the project

Identified the need for glueware to integrate COTS products

- Objective Constraints and Priorities (OC&Ps) for the project
- Identified the need for glueware to integrate COTS products
Facilitators

• Evaluated taxonomy of component conflicts
• Evaluated taxonomy of integration approaches
  – Taxonomy of Connectors
• Calibrated models of key OC&P satisfaction
  – COCOTS
• Evaluated taxonomy of model approaches
  – Software process model decision table
Taxonomy of Component Conflicts

- Conflicts between components
  - Underlying component assumptions
- Architectural mismatches between components
  - Assumptions made by component architectures and related styles
- Conflicts between component interfaces
  - Component interfaces not compatible
Taxonomy of integration approaches –
Taxonomy of Connectors

• Selection of Connectors
  – Communication (Data)
  – Coordination (Control)
  – Facilitation (Control)
  – Conversion (DATA)

• Available COTS interfaces and their support connectors
  – E.g. Eclipse supports: Invocation, Data sharing, Application Programming Interfaces, User Interface Integration
## Connector types and Services

<table>
<thead>
<tr>
<th>Connector</th>
<th>Communication</th>
<th>Coordination</th>
<th>Conversion</th>
<th>Facilitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure Call</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Event Bus</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shared Data Access</td>
<td>Yes</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Linkage</td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Stream</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arbitrator</td>
<td></td>
<td>Yes</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Adaptor</td>
<td></td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Distributor</td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
</tbody>
</table>
Calibrated models of key OC&P satisfaction - COCOTS

1. COTS Assessment
2. COTS Tailoring
3. COTS Glue Code Development

Application Code Development, Integration, and Test Separate from COTS Effects

LCO – Lifecycle Objectives
LCA – Lifecycle Architecture
IOC – Initial Operational Capability

LCO (requirements review)
LCA (preliminary design review)
IOC (system delivery)

COCOTS Effort Estimate
COCOMO II Effort Estimate
COTS Glue Code Cost Drivers I

• Personnel Drivers
  – ACIEP: COTS Integrator Experience with Product
  – ACIPC: COTS Integrator Personnel Capability
  – AXCIP: Integrator Experience with COTS Integration Process
  – APCON: Integrator Personnel Continuity

• COTS Component Drivers
  – ACPMT: COTS Product Maturity
  – ACSEW: COTS Supplier Product Extension Willingness
  – APCPX: COTS Product Interface Complexity
  – ACPPS: COTS Supplier Product Support
  – ACPTD: COTS Supplier Provided Training and Documentation
COTS Glue Code Cost Drivers II

• Application/System Drivers
  – ACREL: Constraints on Application System/Subsystem Reliability
  – AACPX: Application Interface Complexity
  – AXPER: Constraints on COTS Technical Performance
  – ASPRT: Application System Portability

• Nonlinear Scale Factor
  – AAREN: Application Architectural Engineering
## Evaluated Taxonomy of Model Approaches - Example

<table>
<thead>
<tr>
<th>Objectives, Constraints</th>
<th>Alternatives</th>
<th>Model</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth Envelope</td>
<td>Understanding of Requirements</td>
<td>Robustness</td>
<td>Available Technology</td>
</tr>
<tr>
<td>Limited</td>
<td>Low to Medium</td>
<td>Partial COTS</td>
<td>Medium</td>
</tr>
<tr>
<td>Limited</td>
<td>Low to Medium</td>
<td>Large Reusable Components</td>
<td>Medium</td>
</tr>
<tr>
<td>Limited</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Limited to Large</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Limited to Medium</td>
<td>Low to Medium</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Very Large</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Medium to Large</td>
<td>Low</td>
<td>Medium</td>
<td>Partial COTS</td>
</tr>
</tbody>
</table>
Caroline’s Closets -

• Objectives (Online shopping store)
  – Web-based inventory management
  – Online shopping cart
  – Secure credit card payment system
  – Online client information management
  – Automated order processing
  – Administration capabilities

• Constraints
  – Initial operational capability within 24 weeks
  – 5 person teams
  – $0 COTS licensing costs
  – Interface with Bank of America credit card transaction processing system
# Process Application Overview

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Iteration 0, 1</th>
<th>Iteration 2, 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developers, customer, end-users, COTS vendors</td>
<td>Bank of America (COTS Vendor)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OC&amp;P’s</th>
<th>Iteration 0, 1</th>
<th>Iteration 2, 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web-based inventory management, Online shopping cart, Online client information management, Automated order processing, Administration capabilities</td>
<td>Secure credit card transaction using Bank of America’s system</td>
<td></td>
</tr>
<tr>
<td>COTS licensing cost ≤ $0K; evaluate Website Service Providers, IOC developable in 24 weeks</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COTS Alternative Evaluation</th>
<th>Iteration 0, 1</th>
<th>Iteration 2, 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>No single COTS satisfies all capabilities; Identified a set of shopping carts: Dansie Cart, Better Cart Pro, SalesCart, CartManager, Online Store Builder 2.1, CatalogIntegrator Cart, Xrom, X-Hub Enterprise Cart, AutomatedShops, Cart32, Click Cart Shopping Cart</td>
<td>Evaluated for Interoperability Shopping Carts: Dansie Cart, Cart32, X-Hub Enterprise Cart</td>
<td></td>
</tr>
<tr>
<td>Database Servers, and Application Servers + Custom Code</td>
<td>Database Servers: MSAccess, MSSQL, MySQL</td>
<td></td>
</tr>
<tr>
<td>Application Servers: Apache, Apache Tomcat, MS IIS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product Elaboration</th>
<th>Iteration 0, 1</th>
<th>Iteration 2, 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eliminated Better Cart Pro, SalesCart, CartManager, Online Store Builder 2.1, CatalogIntegrator Cart, Xrom, AutomatedShops, Click Cart Shopping Cart, due to cost and effort constraints</td>
<td>Identified Feasible Combinations: MSSQL, MS IIS, Cart 32</td>
<td></td>
</tr>
<tr>
<td>MS Access, MS IIS, Cart 32</td>
<td>MySQL, Apache, Danise Cart</td>
<td></td>
</tr>
<tr>
<td>MySQL, Apache Tomcat, X-Hub Enterprise Cart</td>
<td>MySQL, Apache Tomcat, X-Hub Enterprise Cart</td>
<td></td>
</tr>
</tbody>
</table>
Interoperability Analysis

Glueware ability to integrate the components to meet the OC&Ps with minimal effort

Database Applications
- MySQL
- MS-Access
- MSSQL

Application Servers
- Microsoft IIS
- Apache-CGI
- Apache-Tomcat

Shopping Carts
- Cart 32
- Danise Cart
- X-Hub Enterprise Cart
Conclusions

• Focusing COTS selection based on piecewise evaluation risky
• Proposed method successfully applied to multiple USC-e-Services projects
• Compatible with USC CBA Framework
Questions?
Additional Slides
Selection Method Description I

• Entry Conditions:
  – Established Objectives, Constraints and Priorities (OC&Ps)

• 1: Identify candidate, legacy and third-party components
  – Sources of identification:
    • Sourceforge
    • http://www.eCOTS.org
      http://www.componentsource.com
    • Internet search
Selection Method Description III

• 3: Evaluate alternatives with respect to OC&Ps
  – Functional evaluation
    – E.g. Storing XML documents
  – Non-functional evaluation
    – E.g. Portability to Mac and Unix
Selection Method Description VI

• 8: Preserve options to maintain trade-space
  – Identify top n combinations
    • As a fallback plan
    • For negotiations during acquisition and licensing

• 9: Exit to decision-making and integration
  – Prioritized list of COTS combinations
Selection Method Description VI

- **10: Re-negotiate OC&Ps with project stakeholders**
  - No COTS combinations available
- **11: Develop custom components**
  - Full custom application
  - Partial COTS and custom application