COTS Integration Cost Model Status Briefing

CSE Affiliates
Annual Research Review

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USC Center for Software Engineering
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Presentation Outline

- COTS Research Effort Overview
- Preliminary Survey Results Update
- Current Candidate Cost Model Form
- Second Round Survey Draft
- Summary Recap
- Next Steps
COTS Research Effort Overview:

Context

- Aspect on-going COCOMO II extension efforts

Near Term Goals

- Prototype COTS software integration cost estimation tool
- Guidelines for scoping COTS software integration costs and schedules
COTS Research Effort Overview:
Funding and Sponsorship

Additional to COCOMO II Affiliates Sponsorship:

- Formal Contract: Air Force Electronic Systems Center
- Original Funding Level: $55k for 12 months (3/1/96 to 3/1/97)
- No Cost Four Month Extension Granted (3/1/97 to 6/29/97)
- Supports
  - Data collection & analysis/Cost model design
  - Guidelines development/Prototype tool creation
COTS Research Effort Overview: Data Collection

Two Phase Approach

- Preliminary Survey
  - Identifies Sources of COTS Integration Experience
  - First Pass at Identifying Likely Cost Drivers

- Follow-up Survey
  - Captures Project Level COTS Integration Experience
  - Looking for Specific Cost Factors
COTS Research Effort Overview: Data Collection

Parallel Effort

Controlled Small Sample Data

- Source: current USC graduate software engineering class projects involving COTS integration
- Value:
  - real-time effort data retrieved weekly as development in progress
  - fixed known schedule
  - can be quickly pared with final actual development size
- Will be used for cost model initial test validation & calibration
Preliminary Survey Results Update:
Data Returns

- 800+ Surveys Mailed
- 25 Responses to Date
- ~3% Return - (typical for such mailings)
- Initial Analysis Presented last November
  - survey responses since have not changed initial conclusions regarding appropriate cost drivers
Current Cost Model Form:

Formula

\[ ESIZE = UF_{current} \times (1.0 + \frac{BRAK}{100}) \]

\[ PM = A \times (ESIZE)^B \times \prod_{i=1}^{13} (EM) \]

where:

- \( A \) = (as yet unspecified)
- \( B = 1.0 \)
- \( EM_i \) = (5 possible ratings: VL,L,N,H,VH, nominal = 1.0)
Current Cost Model Form: Thirteen Candidate Effort Multipliers (EM<sub>i</sub>)

- CPDM - COTS Product and Documentation Maturity
- CVEW - COTS Vendor Product Extension Willingness
- CIEP - COTS Integrator Experience with Product
- CREL - COTS Reliability
- CPAX - COTS Product and Application Complexity
- CIPC - COTS Integrator Personnel Capability
- CIAR - COTS Integrator Architecture/Risk Resolution
- CCOS - COTS Compliance with Open Interface Standards
- CPER - COTS Performance
- CIXI - COTS Integrator Experience with COTS Integration
- CVMS - COTS Vendor Maturity and Product Support
- CVPT - COTS Vendor Provided Training
- CPRT - COTS Portability
Current Cost Model Form:
Cost Estimation Procedure

- Sizing - UFP from weighted External Interface Files
- Breakage - estimate percent UFP breakage (BRAK) during development; Function of:
  - number COTS packages, average new releases per package, average interface breakage per release
- Effective Size - ESIZE = UFP \((1.0 + \text{BRAK}/100)\)
- Scaling - initially set linear for simplicity
- Effort Multipliers - approach as in COCOMO II
- Estimated Effort - \( PM = A \times (ESIZE)^B \times \prod_{i=1}^{13} (EM_{i \rightarrow 5}) \)
Second Round Survey

• Initial Draft Included in Packets
  - asks for Project Level & COTS Component level
    size, effort, and schedule data
  - asks for ratings of 13 COTS Effort Multipliers

• Invite Feedback
5.5 Integration Life-cycle Phases

Circle the life-cycle phases the integration schedule reported in 5.4 covers.

<table>
<thead>
<tr>
<th>System Requirements</th>
<th>COTS Assessment</th>
<th>Detailed Glue Code Design</th>
<th>Integration and Test</th>
</tr>
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<tbody>
<tr>
<td>Software Requirements</td>
<td>Preliminary Glue Code Design</td>
<td>Code and Unit Test</td>
<td>Maintenance</td>
</tr>
</tbody>
</table>

5.6 Integration Effort

Record the total effort expended in Person-Months from the time the component integration activity began through the time it was completed (or to the current date if project is on-going).

Person-Months: 

5.7 Integration Effort Life-cycle Phases

Circle the life-cycle phases the total effort reported in 4.8 covers.

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5.8 COTS Product Releases

Record the number of new releases (both major and minor) of the COTS component the vendor issued during the integration effort and which caused additional work as a result.

Major Product Releases: 
Minor Product Releases: 

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### 6.6 CIPC - COTS Integrator Personnel Capability

What are the overall software development skills and abilities which your personnel bring to the COTS product integration task?

<table>
<thead>
<tr>
<th>Very Low</th>
<th>Low</th>
<th>Nominal</th>
<th>High</th>
<th>Very High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff on average has well below average capability as compared to industry accepted standards for skill levels expected of personnel according to time on the job.</td>
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<td>Staff on average has average capability as compared to industry accepted standards for skill levels expected of personnel according to time on the job.</td>
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### 6.7 CIAR - COTS Integrator Architecture/Risk Resolution

How much effort is expended by your integration staff in ensuring that potential risks to the COTS integration task are identified and mitigated, including through the examination of potential architectural mismatches between the COTS components and the overall system, or between the COTS components themselves? How thorough is the project’s Software Architecture Review?

<table>
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<th>Low</th>
<th>Nominal</th>
<th>High</th>
<th>Very High</th>
</tr>
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<tbody>
<tr>
<td>No risk mitigation is done.</td>
<td>Little risk mitigation is done, with no addressing of architectural issues.</td>
<td>Standard risk mitigation/architectural assessment is performed.</td>
<td>Marginally more risk mitigation is done, with some assessment of architectural issues.</td>
<td>Extensive risk mitigation is done, with particular and special attention paid to architectural issues.</td>
</tr>
</tbody>
</table>

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Summary Recap

- Initial Survey, Expert Panel Input Produced Current Candidate Set of Cost Drivers
- Mathematical Form of Model Established
  - including basic estimation procedure
- Draft Second Round Survey Ready
- Controlled Data Collection Exercise in Progress
Next Steps

- Delphi Experiment
  - seeking consensus on cost driver parameter values
- Begin Second Round Data Collection
  - arrange site visits
  - phone interviews as backup
- Analyze Second Round & Controlled Exercise Data
  - leads to calibrated model
- Create Spreadsheet Version of Tool & Estimation Guidelines Report
1) CPDM - COTS Product and Documentation Maturity

How many copies of the COTS product have been sold? How long has it been on the market? Has the product established a reputation for utility and reliability, i.e., a known track record? Does the product come with the necessary, well-written documentation to install, maintain, and use the package?

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</thead>
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<tr>
<td>Product in pre-release beta test.</td>
<td>Product on market less than 1 year.</td>
<td>Product on market between 1 and 2 years.</td>
<td>Product on market between 2 and 5 years.</td>
<td>Product on market more than 5 years.</td>
</tr>
<tr>
<td>1.50</td>
<td>1.20</td>
<td>1.00</td>
<td>0.90</td>
<td>0.82</td>
</tr>
</tbody>
</table>

PR = 1.50/0.82 = 1.83

Your Adjusted PR =

Rationale:

2) CVEW - COTS Vendor Product Extension Willingness

How willing is the vendor of the COTS product to modify the design of their software to meet your specific needs, either by adding or removing functionality or by changing the way it operates?

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<tbody>
<tr>
<td>Vendor will not change the product.</td>
<td>Vendor will make minor changes only.</td>
<td>Vendor will make one major change or a few minor ones, but not both.</td>
<td>Vendor will make one major changes and any minor ones desired.</td>
<td>Vendor will change the product any way you desire essentially without restriction.</td>
</tr>
<tr>
<td>1.21</td>
<td>1.10</td>
<td>1.00</td>
<td>0.87</td>
<td>0.75</td>
</tr>
</tbody>
</table>

PR = 1.21/0.75 = 1.61

Your Adjusted PR =

Rationale: