Optimizing IV&V Benefits Using Simulation

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Motivation

• There is a critical need for cost effective IV&V

• Key Questions:
  – What is the benefit of a given IV&V technique?
  – How can the economic benefit of IV&V technologies be optimized?
  – At what point in the development process should an IV&V technique be inserted? How does the benefit change?
Optimizing IV&V Benefits Using Simulation

• Long Term Goal:
  – Decision support tool that can recommend an optimal portfolio of IV&V techniques for a given project

• First Year Goal:
  – To develop prototype models for one development process used on NASA projects and one IV&V technique in order to illustrate the capabilities of SPSM technology

Key Features of Our Approach

• Graphical Models of the Process
• Software Process Simulation Models (SPSMs) uniquely capture the structure of the development process at a detailed level
• Predict performance in terms of cost, quality and schedule
• SEI Process Definition Approach to Process Modeling
• Process Tradeoff Analysis Method (PTAM)
  – Integrated decision support framework
• Designed for rapid deployment
Questions of Interest to NASA IV&V

- What would be the costs and benefits associated with implementing a selected IV&V technique on a selected software project?
- What is the benefit if a given IV&V technique is applied at different insertion points in the development process or applied multiple times?
- What is the benefit of applying one combination of IV&V techniques to a given process vs another?
- How can the economic benefit of IV&V technologies be optimized?
Applying IV&V Technique in Parallel

Applying IV&V in Sequence
Applying IV&V at the Top Process Level

Requirements Traceability

Applying IV&V Later in the Process

Requirements Traceability
Applying IV&V During Testing

Applying Multiple IV&V Techniques at Multiple Points in the Process
Modify Parameters from Pre-set Values Based on Actual Data

Potential Model Output

- Baseline Development Process without IV&V
  - Development Cost 527 person-months
  - Project Schedule 18 months
  - Product Quality 117 Delivered defects

- Development Process Performance with IV&V –
  - Requirements Traceability (parallel)  521 PM, 17 M, 83 D
  - Requirements Traceability (sequential) 523 PM, 16 M, 85 D
  - Requirements Traceability (During Coding) 523 PM, 17 M, 86D
  - Requirements Traceability (During Testing) 524 PM, 17 M, 88 D
  - Combination 1 (RT, CFA, DFA, MC)  503 PM, 16 M, 78 D
  - Combination 2 (RT, CFA, DFA, MC) 507 PM, 16.5 M, 61 D
  - Etc.

- Determine return on investment and rank order for optimal IV&V allocation
IV&V Business Case

- For the Project X, using process Y
- Midex project, 1500 FP, using C++
- Option #7 gave best results:
- IV&V Techniques planned:
  - Traceability applied at Requirements and Detailed design, and Coding
  - Model Checking applied at High-level and detailed design
- Estimated IV&V Cost = $1.5 Million
- Estimated Cost Savings = $3.1 Million
- Estimated Return on Investment = 2.07

Data Requested

<table>
<thead>
<tr>
<th>Data Category</th>
<th>Items Requested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process</td>
<td>Process diagrams, work flow diagrams or value mappings of the full Software Development Life Cycle and sub-steps</td>
</tr>
<tr>
<td>Product</td>
<td>Size of software being developed by CSCI and by CSC if possible</td>
</tr>
<tr>
<td>Effort</td>
<td>Productivity, earned value, number of staff, number of hours of effort by activity by CSCI. We need to understand the effort consumed by development, rework, inspections and testing activities.</td>
</tr>
<tr>
<td>Schedule</td>
<td>Duration of each process step from earliest start to last finish</td>
</tr>
<tr>
<td>Defects</td>
<td>Defects injected and detected by type by phase</td>
</tr>
</tbody>
</table>
Current Status and Accomplishments

• Verifying and Validating Prototype Tool
• Developed model of IEEE 12207 software development process complete and corresponding data set
• Delivered memo identifying initial data needs
• Developing workflow models of IV&V techniques
• Looking for data

Potential Contributions to NASA IV&V

• Justify the costs of IV&V to NASA projects
• IV&V 'What-If' Calculator to assess the cost-benefit trade-offs between different IV&V techniques
• Models to evaluate the structure and quality of the process (IV&V Software Development Process)
• A method to cost-justify a particular IV&V plan versus an alternate proposal made by the projects.
Potential Contributions to NASA IV&V (cont)

- An ability to assess the benefit if a given IV&V technique is applied at different insertion points in the development process or applied multiple times.

Future Plans

- Develop Versions 2 and 3 of the Simulation Tool
- Incorporate multiple new software development lifecycle process templates into the tool
- Incorporate additional IV&V techniques into tool
- Design report templates tailored for IV&V
  - Special tracking for IV&V resources
Future Plans

- Integrate the Simulation tool with the ICE tool
- Incorporate ROI results from other initiatives
- Transfer this tool to NASA

Conclusions

- Simulation modeling is a viable approach for assessing the costs and benefits of IV&V on NASA projects
- Not a silver bullet
- Process Tradeoff Analysis Method supports decision making
  - Gives framework and focus to metrics program
  - Supports business case development for process improvement by assessing the financial benefit associated with IV&V activities.
  - Provides quantitative risk assessment of benefit
Conclusions

- Supports higher software development maturity
  - Training, Process Definition, and Metrics Definition (Levels 2 and 3)
  - Quantitative Process Management and Software Quality Management (Level 4 KPAs)
  - Defect Prevention, Process Change Management, Technology Change Management (Level 5 KPAs)

The End

Questions?
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