COSYSMO
COnstructive SYStems Engineering Cost MOdel

GSAW
Meet the Technological Challenges of Spacecraft Ground Systems

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Outline

• COSYSMO Overview
• COSYSMO and Ground Systems
• Drivers
  – Size
  – Cost
• Additional Proposed drivers
• Calendar
COSYSMO: Overview

- Parametric model to estimate system engineering costs
- Covers full system engineering lifecycle
- Focused on use for Investment Analysis, Concept Definition phases estimation and tradeoff analyses
  - Input parameters can be determined in early phases
COSYSMO Operational Concept

Size Drivers

- # Requirements
- # Interfaces
- # Scenarios
- # Algorithms
- Volatility Factor

Effort Multipliers

- Application factors
  - 5 factors
- Team factors
  - 7 factors
- Schedule driver

Calibration

Effort

Duration

WBS guided by
ISO/IEC 15288

March 2003
COSYSMO and Ground Systems

<table>
<thead>
<tr>
<th>Conceptualize</th>
<th>Develop</th>
<th>Oper Test &amp; Eval</th>
<th>Transition to Operation</th>
<th>Operate, Maintain, Enhance</th>
<th>Replace or Dismantle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Command and Control System</td>
<td></td>
<td></td>
<td>1. COSYSMO-IP</td>
<td></td>
<td></td>
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<tr>
<td>Satellite Ground Station</td>
<td></td>
<td></td>
<td>2. COSYSMO-C4ISR</td>
<td></td>
<td></td>
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<tr>
<td>Joint Strike Fighter</td>
<td></td>
<td></td>
<td>3. COSYSMO-Machine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Future Combat Systems</td>
<td></td>
<td></td>
<td>4. COSYSMO-SoS</td>
<td></td>
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</tbody>
</table>
4 Size Drivers

1. Number of System Requirements
2. Number of Major Interfaces
3. Number of Operational Scenarios
4. Number of Unique Algorithms

• Each weighted by complexity, volatility, and degree of reuse
Number of System Requirements
This driver represents the number of requirements that are typically taken from the system or marketing specification. A requirement is a statement of capability containing a normative verb such as “shall” or “will.” It may be functional, performance, feature, or service-oriented in nature depending on the methodology used for specification. System requirements can typically be quantified by counting the number of applicable “shall’s” or “will’s” in the system or marketing specification.

<table>
<thead>
<tr>
<th>No. of System Requirements</th>
<th>Easy</th>
<th>Nominal</th>
<th>Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Well specified</td>
<td>- Loosely specified</td>
<td>- Poorly specified</td>
</tr>
<tr>
<td></td>
<td>- Traceable to source</td>
<td>- Can be traced to source with some effort</td>
<td>- Hard to trace to source</td>
</tr>
<tr>
<td></td>
<td>- Simple to understand</td>
<td>- Takes some effort to understand</td>
<td>- Hard to understand</td>
</tr>
<tr>
<td></td>
<td>- Little requirements overlap</td>
<td>- Some overlap</td>
<td>- High degree of requirements overlap</td>
</tr>
<tr>
<td></td>
<td>- Familiar</td>
<td>- Generally familiar</td>
<td>- Unfamiliar</td>
</tr>
<tr>
<td></td>
<td>- Good understanding of what’s needed to satisfy and verify requirements</td>
<td>- General understanding of what’s needed to satisfy and verify requirements</td>
<td>- Poor understanding of what’s needed to satisfy and verify requirements</td>
</tr>
</tbody>
</table>
12 Cost Drivers

Application Factors (5)

1. Requirements understanding
2. Architecture complexity
3. Level of service requirements
4. Migration complexity
5. Technology Maturity
Requirements understanding
This cost driver rates the level of understanding of the system requirements by all stakeholders including the systems, software, hardware, customers, team members, users, etc…

<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>Poor, unprecedented system</td>
<td>Minimal, many undefined areas</td>
<td>Reasonable, some undefined areas</td>
<td>Strong, few undefined areas</td>
<td>Full understanding of requirements, familiar system</td>
</tr>
</tbody>
</table>


12 Cost Drivers (cont.)

Team Factors (7)
1. Stakeholder team cohesion
2. Personnel capability
3. Personnel experience/continuity
4. Process maturity
5. Multisite coordination
6. Formality of deliverables
7. Tool support
Additional Proposed Drivers

• # of recursive levels in the design
• # and diversity of installations/platforms
• # of years in operational life cycle
• Degree of Distribution
Calendar of Activities: 2003

- USC CSE Annual Research Review
- INCOSE 2003
- ISPA
- GSAW
- INCOSE IW
- COCOMO Forum
- Conference on Systems Integration
- Working Group Meeting
- Practical Software & Systems Measurement Workshop
- Paper & tutorial submitted
- Paper submitted
Key Members of the COSYSMO Working Group

Aerospace Corp.    Karen Owens, Marilee Wheaton
Galorath           Evin Stump
LMCO               Garry Roedler, Gary Hafen
Raytheon           Gary Thomas, John Rieff
SAIC               Tony Jordano, Don Greenlee
SPC                Chris Miller
TRW                Steven Wong
US Army/PSM        Cheryl Jones
USC                Barry Boehm, Elliot Axelband,
                   Don Reifer, Ricardo Valerdi
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