

# **COSYSMO: Constructive Systems Engineering Cost Model**

Status Briefing: GSAW 2002

March 2002

# Agenda

- Introduction to COSYSMO
  - Goals of effort and scope
- The COSYSMO reference system
- The COSYSMO model
  - Model mathematics
  - Size and cost drivers
- Plans and milestones
- Current status of effort
- Summary and conclusions

# Goals of Effort

- Build a COCOMO II-like model for estimating effort and duration of system engineering tasks
  - Member of the COCOMO family of models
- COSYSMO (Constructive System Engineering Model) developed to fill the holes not covered by COCOMO II software model

**Inception**

**Elaboration**

**Construction**

**Transition**

MBASE life cycle model phases

# Scope of Effort

- Use USC seven step model building process
- Keep things simple
  - Start with Inception phase now, other phases later
  - Use EIA 632 to bound systems engineering effort
  - Focus on software intensive systems
- Build on previous cost modeling work
- Shoot for having something meaningful done by mid-March 2002
  - Much of the work done by volunteers, so must be conservative in estimates

# Participants

- Chris Abts, Texas A&M
- Elliot Axelband, USC
- Kim Bell, Aerospace
- Joe Betser, Aerospace
- Barry Boehm, USC
- Linda Brooks, TRW
- Sunita Chulani, IBM
- Lisa Finneran, SPC
- Don Greenlee, SAIC
- Gary Hafen, LMCO
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- Garry Roedler, LMCO
- Walker Royce, Rational
- Evin Stump, Galorath
- Gary Thomas, Raytheon
- Ariel Tonnu, US Air Force
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# Reference System

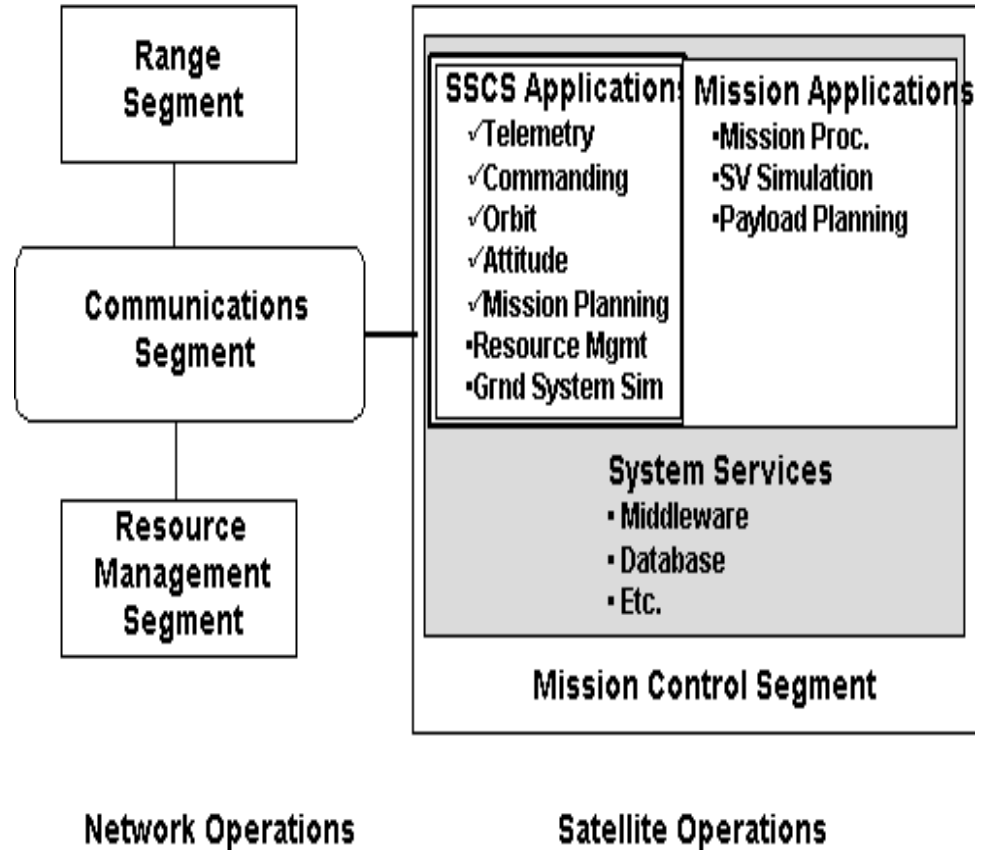
- Framed using a Satellite Ground System as a reference system
  - Identified system engineering activities
  - Defined the components of the effort estimates
- System facilitated the definition of system engineering tasks in terms of:
  - Systems, Hardware, Software, and Communications Architecture (interfaces view)
- COSYSMO scope based on the example system

# System Description

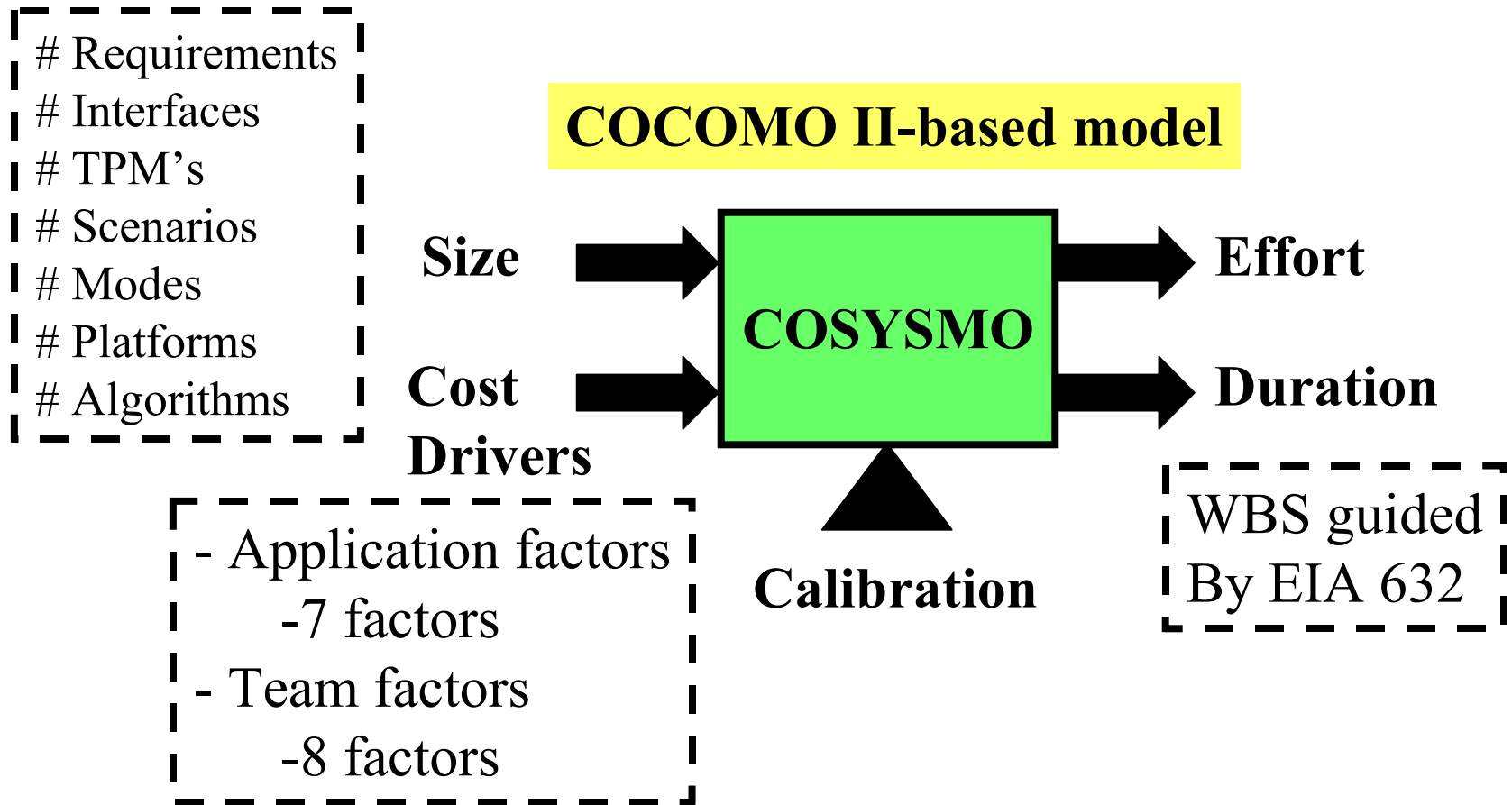
- External to system are elements of network operations
  - **These elements provide the antennas used to track satellites, the communications equipment for TT&C and centralized resource management functions**
- Internal to the system are the hardware and software to perform:
  - **Mission planning**
  - **Telemetry processing**
  - **Satellite commanding**
  - **Orbit data processing**
  - **Attitude data processing**
- Simulation and resource management are outside the scope of the system in this analysis

# System Context Diagram

- **Network operations external to boundary**
- **Satellite operations includes:**
  - **COTS hardware**
  - **Software**
  - **Communications**
- **Signals to control antennas and remote facilities assumed to be digital in form**



# COSYSMO Operational Concept



# COCOMO II Effort Equations

## Basic Equation

$$\text{EFFORT} = a \prod_{i=1}^n (\text{EM})_i [\text{Size}]$$

$$\text{Size} = \sum_{j=1}^m \text{SD}_j$$

**Where:**  $a$  = constant

$\text{Size}$  = estimate of the size of the system engineering effort or the volume of work involved

$\text{SD}_j$  = size drivers

$\text{EM}_i$  = effort multipliers

# EIA Scope Drivers

- From EIA 632:
  - Supplier Performance
  - Technical Management
  - Requirements Definition
  - Solution Definition
  - Systems Analysis
  - Requirements Validation
  - Design Solution Verification
  - End Products Validation/Purchased Products

# Size Drivers (First Pass)

## Size Drivers

## Measure of:

## Counted By:

# requirements

Functional requirements

# shalls in System Spec

Performance requirements

# Measures of Performance/  
# Measures of Effectiveness

# interfaces

Interface requirements

# interfaces needed to be  
bounded via ICD's/MOA's

# TPMs

Managerial requirements

# of TPMs to be reported

# scenarios

Operational requirements

# operational threads and/or  
system level use cases

# modes

Operational requirements

# operational modes to be  
supported

# platforms

Operational requirements

# platforms to be supported

# algorithms

Operational requirements

# of new algorithms that  
system engineering must  
develop to solve problem

# Cost Drivers (Initial List)

- **Application factors**
  - **Requirements understanding**
  - **Architecture understanding**
  - **Level of service requirements, criticality, difficulty**
  - **Legacy transition complexity**
  - **COTS assessment complexity**
  - **Platform difficulty**
  - **Required process reengineering**
- **Team factors**
  - **Number and diversity of stakeholder communities**
  - **Stakeholder team cohesion**
  - **Personnel capability**
  - **Personnel experience/continuity**
  - **Process maturity**
  - **Multi-site coordination**
  - **Formality of deliverables**
  - **Tool support**

**Initial definitions distributed as part of our Delphi exercise**

# Plan of Action & Milestones

<u>Task</u>	<u>Due Date</u>	<u>Status</u>
• Develop reference system	11//01/01	Complete
• Define cost drivers	11/16/01	Complete
• Define size drivers	11/16/01	Complete
• Define effort scope	11/16/01	Complete
• Finalize survey instrument	11/30/01	Complete
• Send materials out for review	12/03/01	Complete
• Hold net meeting/discuss results	12/11/01	Complete
• Updates done/Delphi defined	01/14/02	Complete
• Send Delphi out	01/15/02	Complete
• Complete Delphi round	02/15/02	In Progress
• Update done based on results	03/05/02	
• Present results at annual review	03/12/02	

\* Axelband/Boehm involved in all activities

# Delphi Round 1

- Objectives:
  - Calibrate the model based on expert opinions
- Questionnaire divided into three sections
  - Scope, size and cost
- Questionnaire will be used to determine the range for size driver and effort multiplier ratings
- Data from completed systems will then be used to statistically confirm or deny initial ratings
- Initial Delphi inputs due 15 February 2002

# Summary and Conclusions

- Making significant progress with the model development activities
- Team of volunteers from industry, academia and government doing a great job
- Team needs inputs from system engineering experts to make Delphi exercise successful
- Any of you who would like to participate are encouraged to do so

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