University of Southern California
Center for Software Engineering

Extending COCOMO II to Estimate the Cost of Developing Secure Software

Edward Colbert, Murali Gangadharan
Donald Reifer and Barry Boehm
{ecolbert, murali, boehm}@cse.usc.edu d.reifer@ieee.org

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Outline

- **Why Extend COCOMO II for Security?**
- The COCOMO II Family of Models
- New Security Cost Driver and its Factors
- COCOMO II Cost Driver Values
- Next Steps and Summary

Why Extend COCOMO II for Security

Why Extend COCOMO II for Security

- Military projects have considered security in developing software since the early 1980s
- Until recently commercial projects often gave it little weight
- Threat to business-critical systems & private information has grown
  - Security can no longer be ignored
- Few cost models (including COCOMO II) include security factors
  - Based 1980s military perspective (Orange Book)
  - Developing secure systems has changed dramatically

Adding Security to Cost Models

- Several approaches for addressing security
  - Modernize existing models
    - Primarily by updating definitions of cost drivers
  - Add new cost drivers to cost models
  - Develop separate security model

Adding Security to Cost Models

- USC has taken intermediate approach
  - Add factor that addresses security from 3 viewpoints
    - Development
    - Operational
    - Physical
  - Include factors as appropriate to all COCOMO II family cost models
  - Address both commercial & military projects regardless of
    - Size
    - Domain
    - Level of maturity

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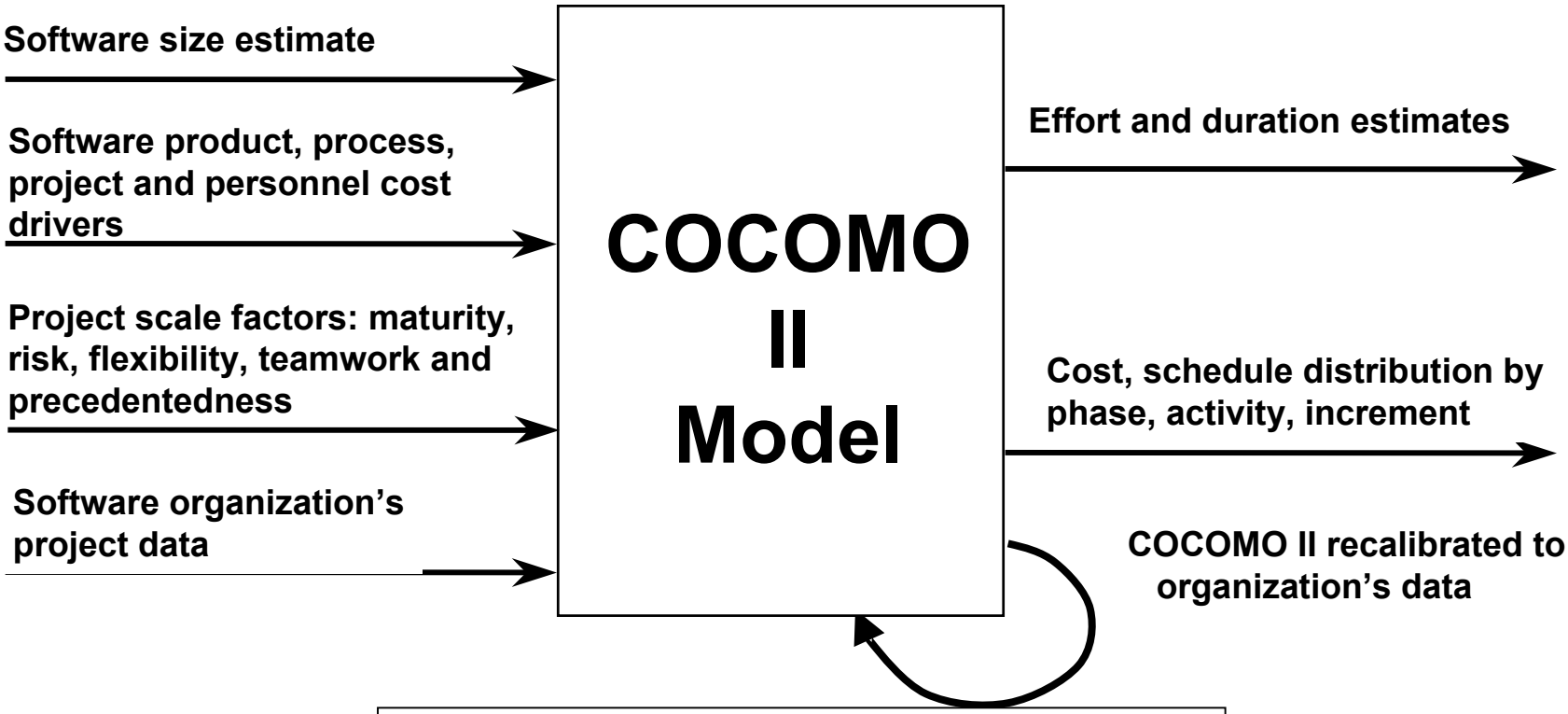
COCOMO II Refresher



Effort in Person Month

$$PM_{estimated} = A \times (Size)^{(SF)} \times \left\{ \prod_i EM_i \right\}$$

SF: Scale Factors (5) EM: Effort Multipliers(17)

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COCOMO II Security Driver (SECU)

- Viewpoints
  - Physical Security
  - Operational Security
  - Development for Security
- Security strategies embraced
  - Ad hoc Defense (Low)
  - Passive Defense (Nominal)
  - Active Defense (High)
  - Layered Defense (Very High)
  - Defense in Depth (Extremely High)

Security Factors

- Development for Security
  - Effect of processes for development & validation when security a factor
- Operational Security
  - Effect of security policies, processes, tools and facilities that:
    - Permit identification of security events
    - Define subsequent actions to identify key elements
    - Report pertinent information to appropriate individual, group, or process
- Development Constraints
  - Constraints placed on development when protecting software facilities:
    - From outside perimeter to inside office space
    - Includes all of information system resources

Development for Security Rating : Low & Nominal

- Low
  - No security requirements
  - No protection other than provided by execution environment
- Nominal

Requirements	❑Informal security requirements formulated for system
Design	❑Analysis of security functions using –Informal functional & interface specification –Descriptive high-level design –Demonstration of corresponding pairs
Testing	❑Developer tests implementation of requirements –Black box testing
Life-cycle controls	❑ Simple Configuration Management (CM) with version numbers

Development for Security Rating : High

- Nominal +

Requirements	❑Fully defined external interfaces ❑Informal security policy modeling
Design	❑Security enforcing high-level design ❑Informal low-level design description
Testing	❑Independent testing of all functional requirements ❑Inspection of COTS source code if available
Life-cycle controls	Detailed delivery & installation procedures ❑Identification of security measures for life-cycle

Development for Security Rating: Extremely High

- Very High +

Requirements	❑ Fully defined external interfaces ❑ Informal security policy modeling
Design	❑ Semi-formal high level explanation ❑ Structured implementation with reduction of complexity ❑ Secure container for COTS and Open-source
Testing	❑ Analysis of coverage of tests ❑ Ordered functional testing with tests of low-level design ❑ Covert channel analysis
Life-cycle controls	❑ Compete automation of CM – with coverage for developer tools ❑ Standardized life-cycle model – with compliance to implementation standards

Operational Security Rating: Low & Nominal

- Low
  - No organization-wide security policies
  - Ad-hoc security practices
  - Optional firewall & virus protection
- Nominal

Administration	❑ Basic Security policies – inc. • Password and Virus Protection policy • Network access and system use policy ❑ Guidelines for administrators & users
Protection	❑ Reasonable practices for – Checksum Verification – Software firewall(s) – Operating system logging
Authentication	❑ Simple password-based authentication schemes

Operational Security Rating: Very High

- High +

Administration	❑Comprehensive Security policies – inc. • Business continuity plans • Disaster recovery plans ❑Incident response teams handle security breaches
Protection	❑A layered defense strategy is implemented to protect the system with reasonable practices for – Proxy servers – Layered system monitoring with Intrusion Detection Systems
Authentication	❑Digital certificates & signatures used for – Authentication – Message integrity – Non-repudiation

Development Constraints Rating Description

- Nominal
  - None
- High
  - All source materials are locked up when not in active use
- Very High
  - High +
    - Audited security markings in code
- Extremely High
  - Very High+
    - Multi-compartment developer communication constraints

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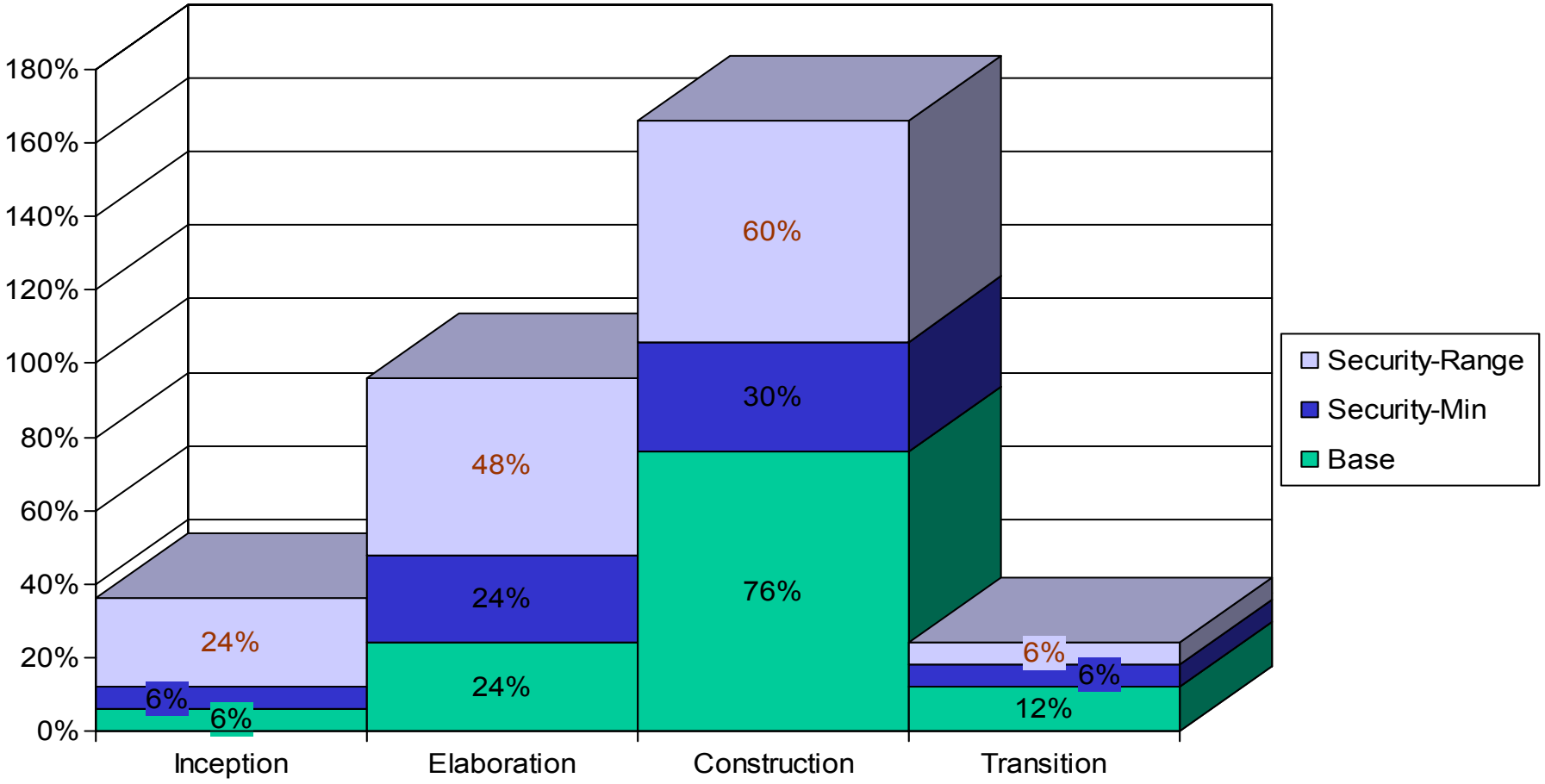
Draft Baseline Security Effort Distribution

- With wide standard deviations



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Next Steps

- Reach consensus on cost drivers
  - FAA Workshop on security-May 03
  - Delphi run & calibration of factors in works
- Initiate efforts to statistically validate accuracy of model
  - Survey available 160+ COCOMO project data
  - Perform initial calibration
- Create enhanced COCOMO data collection forms
  - gather security related efforts
- Compare actual project data to expert opinions
  - Calibrate the model by weighting
    - Actual data
    - Expert opinions using Bayesian statistical techniques

Summary

- Proposed extensions to COCOMO for development of Secure Systems
  - Based on *Common Criteria*
  - 1 Driver: SECU
  - 3 Factors:
    - Development for Security
    - Operational Security
    - Physical Security
  - Affects on other COCOMO II Drivers
    - RELY, CPLX, DOCU, SITE, TOOL
  - Affects on Size
  - Affects on project risk
- Hopefully stimulated your interest and motivated you to participate by sharing project data