

**NORTHROP GRUMMAN** DEFINING THE FUTURE  
*Mission Systems*

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# Quantitative Management of COTS-Based Systems: The Role of Cost Estimation

**GSAW2003**

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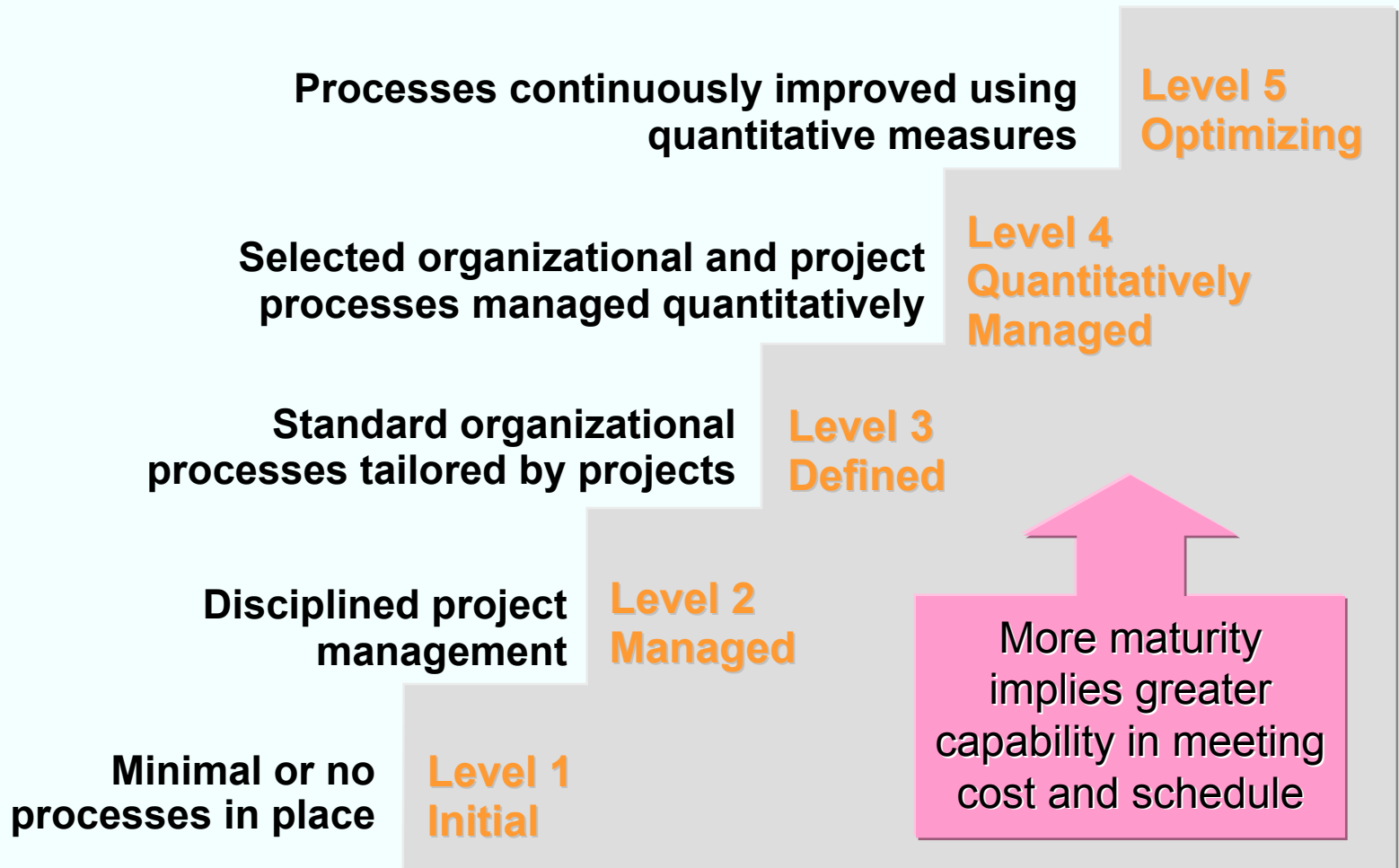


## Topics

- **CMMI Framework for Quantitative Management**
  - **Organizational Process Performance**
  - **Quantitative Project Management**
- **Capability Baselines and Usage**
- **Challenges of Estimating COTS Integration**
- **Example: Hybrid COTS Software Estimating Method**
- **Summary**



# CMMI Maturity Level – An Organizational Ranking





# Organizational Process Performance

The purpose of *Organizational Process Performance (OPP)* is to establish and maintain a quantitative understanding of the performance of the organization's set of standard processes, and to provide the process performance data, baselines, and models to quantitatively manage the organization's projects.

## Goal SG1

Baselines and models that characterize the expected process performance of the organization's set of standard processes are established and maintained.

## Goal GG3

The process is institutionalized as a defined process.



## OPP Specific Practices

- Select the processes or process elements in the organization's set of standard processes that are to be included in the organization's process performance analyses.
- Establish and maintain definitions of the measures that are to be included in the organization's process performance analyses.
- Establish and maintain quantitative objectives for quality and process performance for the organization.
- Establish and maintain the organization's process performance baselines.
- Establish and maintain the process performance models for the organization's set of standard processes.





# Quantitative Project Management

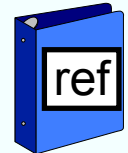
The purpose of the *Quantitative Project Management (QPM)* process area is to quantitatively manage the project's defined process to achieve the project's established quality and process performance objectives.

<b>Goal SG1</b>	The project is quantitatively managed using quality and process performance objectives.
<b>Goal SG2</b>	The performance of selected sub-processes within the project's defined process is statistically managed.
<b>Goal GG3</b>	The process is institutionalized as a defined process.



## QPM Specific Practices

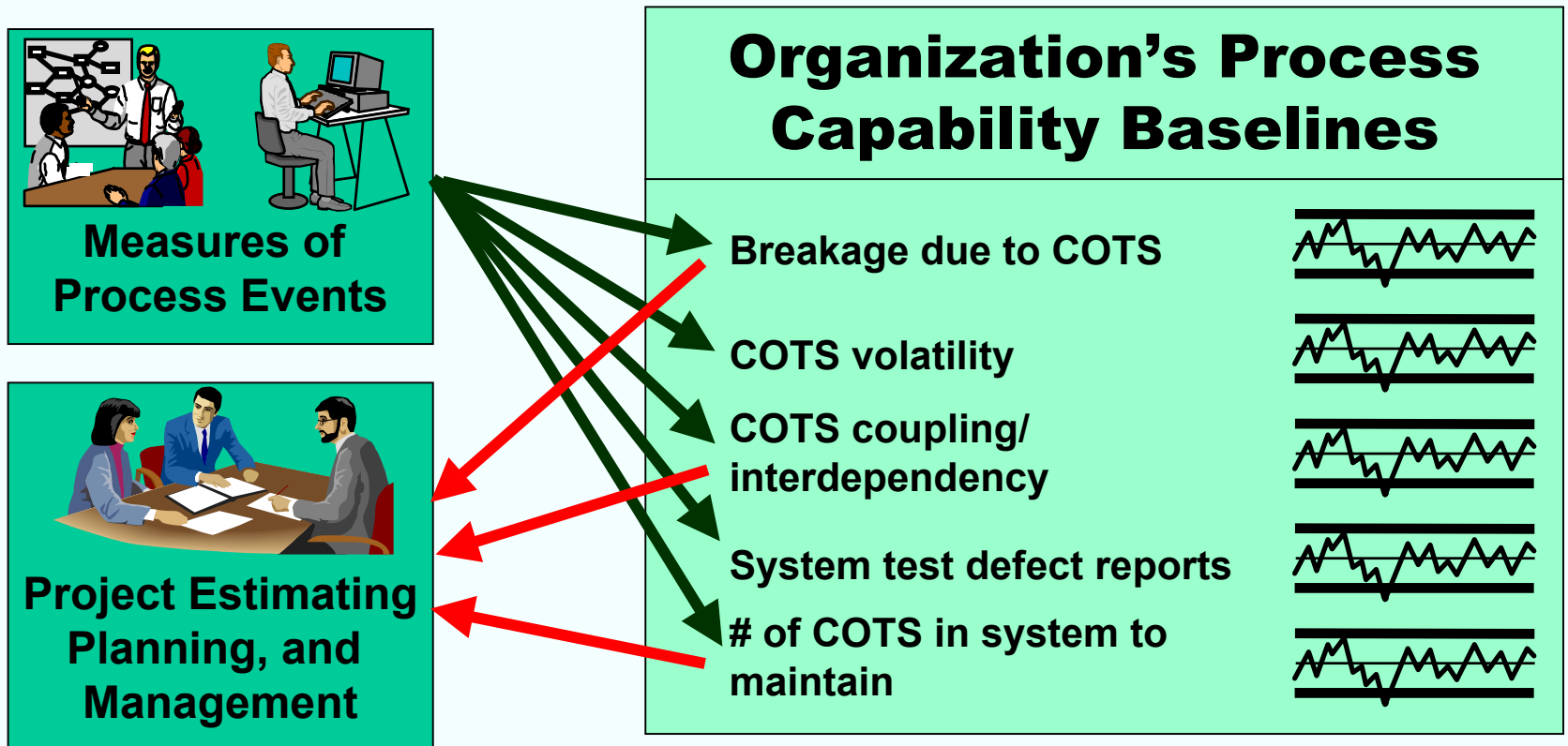
- Establish and maintain the project's quality and process performance objectives
- Select the processes and process elements that comprise the project's defined process based on historical stability and capability data
- Select the subprocesses of the project's defined process that will be statistically managed
- Monitor the project to determine whether the project's objectives for quality and process performance will be satisfied, and take corrective action as appropriate.
- Select the measures and analytic techniques to be used in statistically managing the selected subprocesses
- Establish and maintain an understanding of the variance of the selected subprocesses using the selected measures and analytic techniques
- Monitor the performance of the selected subprocesses to determine their capability to satisfy their quality and process performance objectives, and take corrective action as necessary
- Record statistical and quality management data in the organization's measurement repository





# Building and Using Capability Baselines

Process capability baselines are built from project data

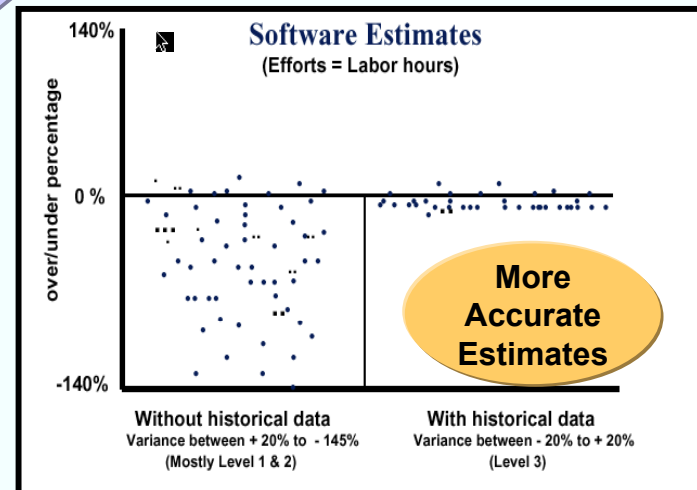
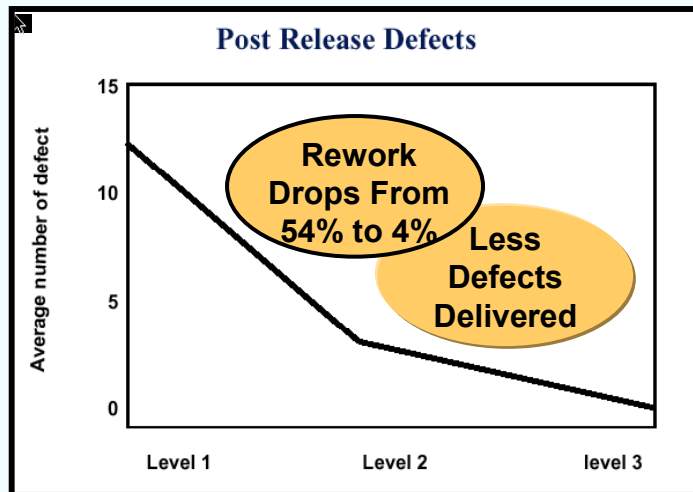
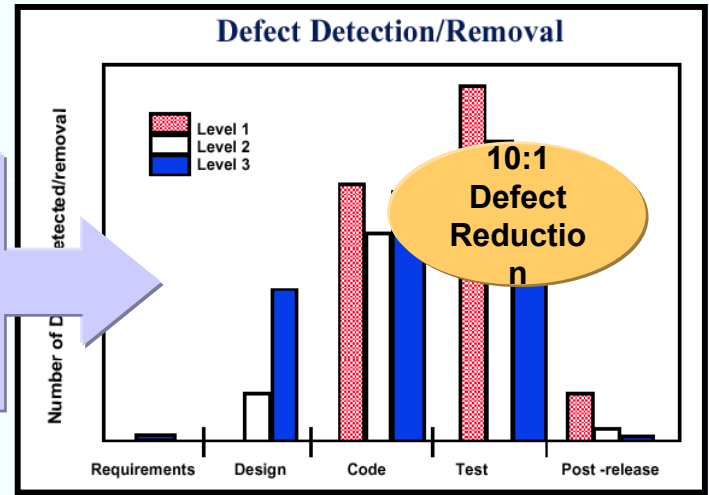
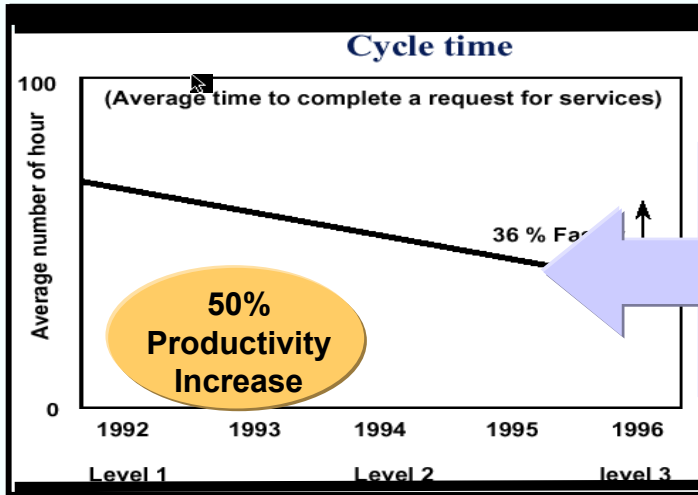


Projects use the organization's process capability baselines in managing performance and quality results



# CMMI Linkage to Operational Performance

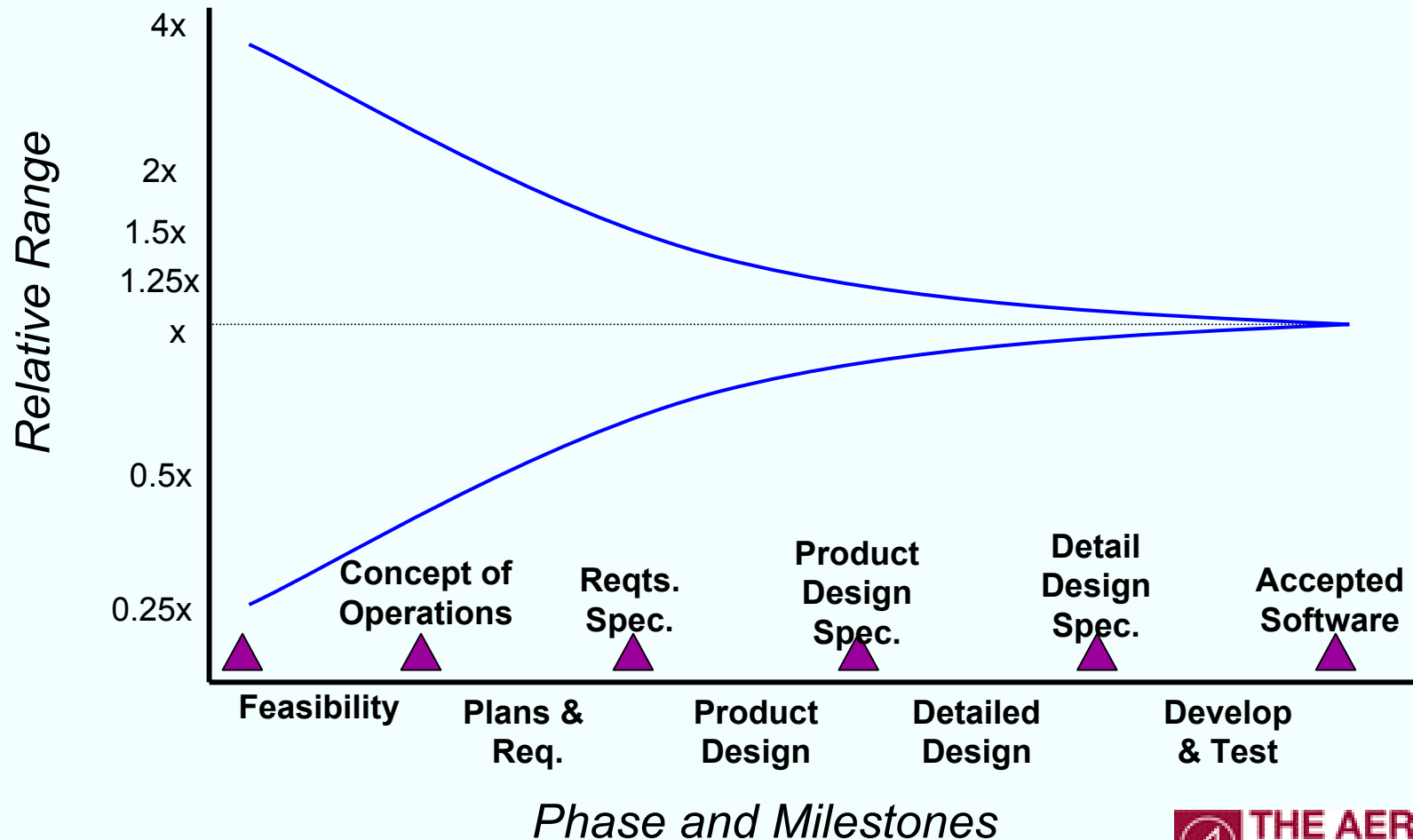
**Industry Results Show Overwhelming Benefits Using CMMs**



Source: The Boeing Company



# Software Cost Estimating Accuracy Versus Development Phase



Source: Dr. Barry Boehm, COCOMO II



## Challenges of Estimating COTS

- **Sizing**
  - **Scoping the functionality to be used**
- **Productivity**
- **Limited availability of data**
- **Non-separable effort in development**
- **Capturing additional activities that need to be performed**



## COTS Software Integration Activities (1 of 2)

- **Assessment (COCOTS)**
  - The up-front research and evaluation of COTS products that is necessary for selecting the products that will be used
  - May be further divided into :
    - Initial filtering of products
    - Detailed assessment and evaluation
- **Cognition (SEER-SEM)**
  - Understanding the functionality of the COTS software so as to have insight into, knowledge of, and comprehension of the receiving system/software in order to integrate it with the system or with other COTS components
  - Can take the form of training, system administrators, “tool smiths” (cadre of COTS experts), vendor consulting, etc.

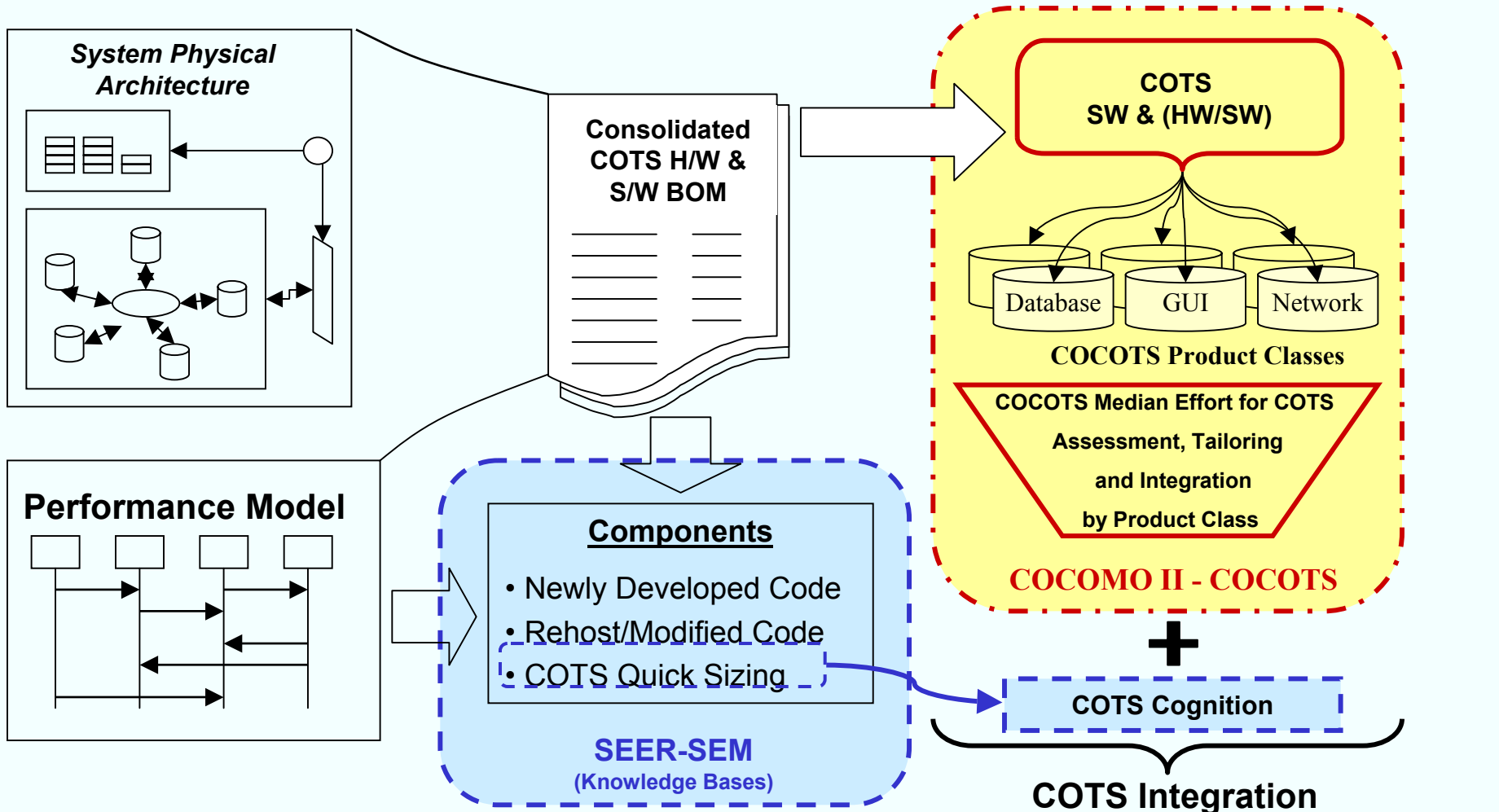


## COTS Software Integration Activities (2 of 2)

- Tailoring (*COCOTS*)
  - The modification or customization of the product for its intended use that provides the required functionality missing in the COTS product, or isolates users and/or developed software from unrequired/undesired capabilities or overly complex interfaces (e.g, “wrappers”)
  
- “Glue” code (*COCOTS, SEER-SEM*)
  - Software developed in-house that is
    - Needed to facilitate data or information exchange between the COTS component and the system or other COTS components into which it is being integrated
    - Needed to connect or “hook” the COTS component into the system or to other COTS components but does not necessarily enable data exchange
    - Quantified in equivalent source lines of code (ESLOC), function points (FP), etc.



# COTS Software Development Cost Estimation Methodology





# Risk/Domain/Scope/Technology Cost Scaling Analogs

Software Component	Historical Range Analogs	Software Technology Maturity Level	Cost Scaling Factor
Collaboration	<p><u>Examples</u></p> <ul style="list-style-type: none"> <li>• Undefined collaboration environment and concept of operations</li> <li>• Strict information assurance/security requirements</li> <li>• Technology Maturity (Native Language Translation/Viewing)</li> <li>• Enormous volumes of data/metadata</li> <li>• Complex infrastructure</li> <li>• Stringent performance requirements</li> </ul>		
Controlled Interfaces (Security)			
Graphic Visualization			
Database/RDBMS			
Middleware			
Resource Optimization			



## Other Helpful Hints

- **Ideally, estimate at least three configurations**
  - **Best, Worst, and Expected Baseline Cases**
- **Revise estimates as you obtain more or better information**
  - **Keep the estimate current**
- **Estimates and models may be used as a project management tool**
  - **Earned Value, Estimate-At-Completion, Metrics (Productivity, Defects, trend analysis, etc.)**
- **Ask the "What If" questions**
  - **Contingency factors will help estimating and planning**
    - **Imperative for trade-studies, and bounding one's risk**



## References

- **COCOTS Estimating Model, USC Center for Software Engineering**
  - <http://sunset.usc.edu>
- **SEER-SEM, Galorath, Incorporated**
  - <http://www.galorath.com>
- ***“Costing COTS Integration”*, Marilee Wheaton, GSAW 2002**
  - <http://sunset.usc.edu/GSAW/gsaw2002/agenda02.html>
- ***“Process Improvement in the Boeing Company”*, John D. Vu. “Software Process Improvement Journey: From Level 1 to Level 5”, 7th SEPG Conference, San Jose, March 1997**
- ***“Parametric Validation & Estimation Using Process Capability Metrics”*, Lori Vaughan and Steven Wong, PRICE Symposium 2002**
  - <http://www.pricesystems.com>