

# **Benefits of CMMI Within the Defense Industry**

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# Outline

- Introduction
- Benefits of CMMI Implementation
  - Quantitative
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- Perspectives on CMMI Adoption
- Appraisal Trends - 2010
- Looking Ahead
- Summary

**This report was created with the cooperation of the Systems Engineering Division (SED) of the National Defense Industrial Association (NDIA) and their member companies and DoD organizations.**



# Purpose of Presentation

## Present new evidence about effective implementations of CMMI

- Examples are provided by the defense industrial base and DoD organizations.
- New examples are based upon the measures that practicing organizations use to track value to their businesses.
- Examples are provided by organizations that have tracked and measured performance improvements from using CMMI over many years.
- Many of the organizations emphasize high maturity results and show that they enabled superior performance.
- Their data indicate why CMMI is important to the DoD & its suppliers.

**The new data presented in this report demonstrates that effective implementation of good practices aided by use of CMMI can improve cost, schedule, and quality performance.**



# CMMI: Major Benefits to DoD



“Does CMMI work?” We asked our nation’s defense contractors, as well as government agencies, to share results from their performance improvement efforts using CMMI. The results spoke for themselves: **“Yes, CMMI works!”**

The following slides include information from six defense organizations that responded.\*

**Raytheon**

***NORTHROP GRUMMAN***

***HARRIS***



\*Results reported in this presentation are not attributed to protect confidentiality.



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# Background on the Data for this Presentation

Organizational and project leaders decided which measures were most useful to them when tracking the results of CMMI-based improvements.

A common thread was their interest in measuring the effect CMMI had on schedule, effort and cost, and quality.

The summarized results demonstrate the wide scope of business values and goals of the participating organizations.

The source studies in this presentation used current data as follows:

- 2010: Organizations 1, 2A, 3, & 6
- 2009: Organizations 5 & 7
- 2008: Organization 2B



# Quantitative Measures: Schedule Performance Results Summary



Measure Used By The Organization	Performance Result
On-time deliverables (Organization 2a)	On-time deliverable improvement of 4.9% out of a possible 5% improvement – closed the gap to within 0.1% of perfection (organization went from 95% to 99.9% of deliveries on time)
Earlier Defect Detection and Repair (Organization 1)	6.35 times less defect discovery and repair hours after start of system testing; potential savings of 5 – 6.5 months in schedule delay after system tests begin for average sized project
Schedule performance index (Organization 7)	Increased from .78 to .93 over three years (a 19.2% improvement in estimation and execution of schedule)



# Quantitative Measures: Effort (Rework) and Cost Performance Results Summary



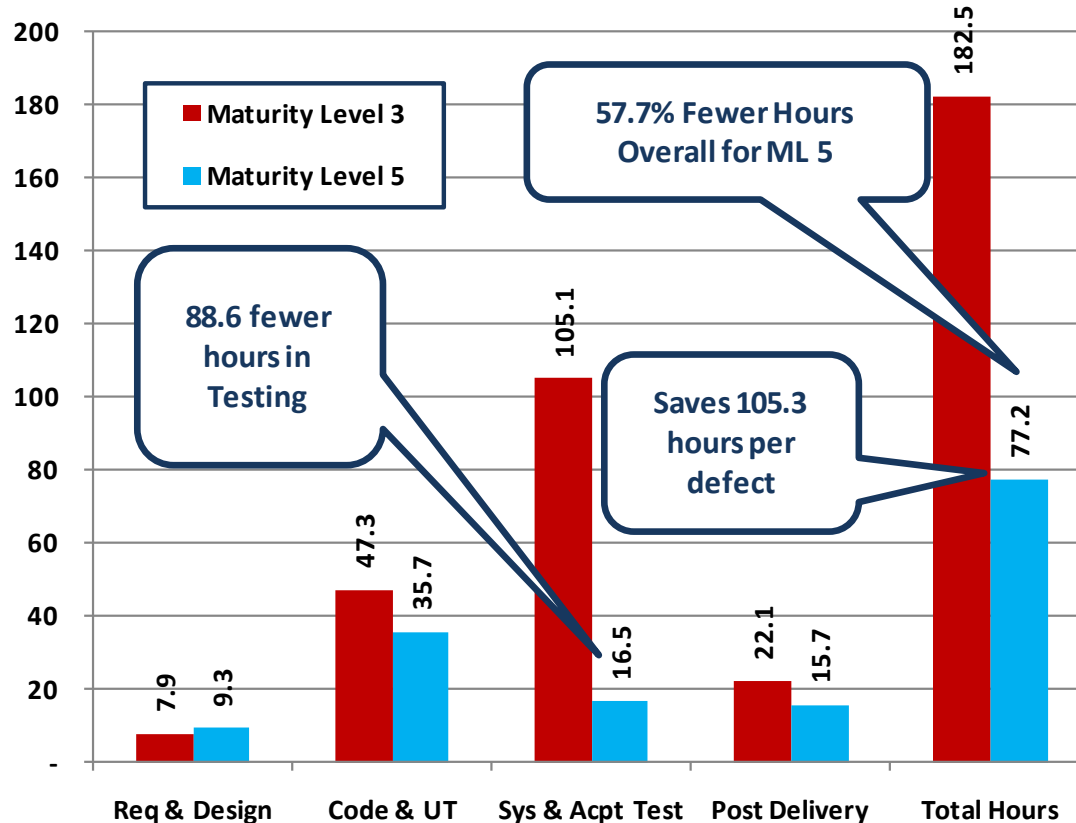
Measure Used By The Organization	Performance Result
Total hours for defect repair (Organization 1)	58% fewer hours needed to repair defects for ML5 versus ML3; Result: a potential cost savings of \$1.9 to \$2.3 M per average-sized project (defined as 233 KESLOC [Kilo Equivalent Source Lines of Code])
Hours per KLOC to find and fix defects for CMMI ML5 relative to the SW-CMMI ML3 baseline (Organization 6)	Defect find and fix cost down 22%
Effort hours needed to repair high severity defects in integration and test phases (Organization 4)	24% reduction in effort hours per defect
Cost performance index (Organization 4)	Increased from .88 to .96 over two years
Overhead rates for CMMI ML5 relative to the SW-CMMI ML3 baseline (Organization 6)	Reduced by 7.3%
Software development cost for CMMI ML5 relative to the SW-CMMI ML3 baseline (Organization 6)	Reduced by 28%



# Selected Results: High Maturity Reduces Costs for Repair (Organization 1)



Average Hours per Defect per Phase



## High Maturity Projects Discover defects earlier

Early detection and repair lowers Costs

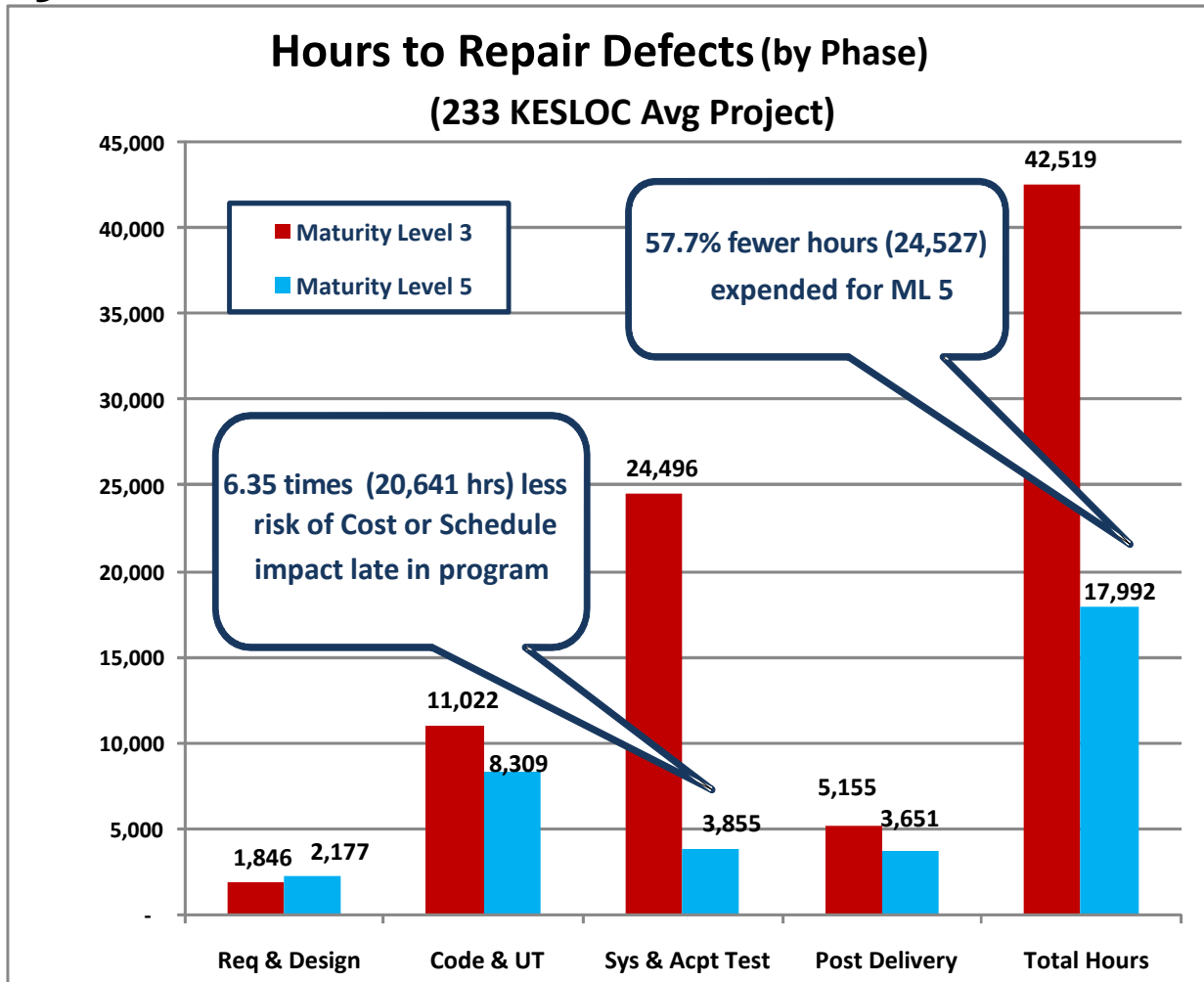
**57.7%** fewer hours for ML5 projects expended to repair defects versus ML3

- 105.3** fewer hours per defect
- **88.6** fewer hours during Testing alone
  - When largest risk to schedule occurs





# Selected Results: Effort to Repair Defects by Phase (Organization 1)



**Potential Cost Savings From \$ 1.9 M to \$2.3 M per average sized program**



# Quantitative Measures: Quality Performance Results Summary



Measure Used By The Organization	Performance Result
Defect density by severity, ML5 compared to ML3 (Organization 1)	62.5% fewer high-severity defects with ML5 projects
Defect density in circuit board design (Organization 2a)	65% improvement
Defect containment by phase (Organization 3)	The fix of defects within the phase they were injected increased by 240%
Defect containment, ML5 compared to ML3, by phase per KLOC (thousands of lines of code) (Organization 2b)	Defect containment improved 13%
User acceptance test defects per KLOC (Organization 7)	Less than 0.15 defects per KLOC
% of defects removed prior to system test (Organization 7)	>85%

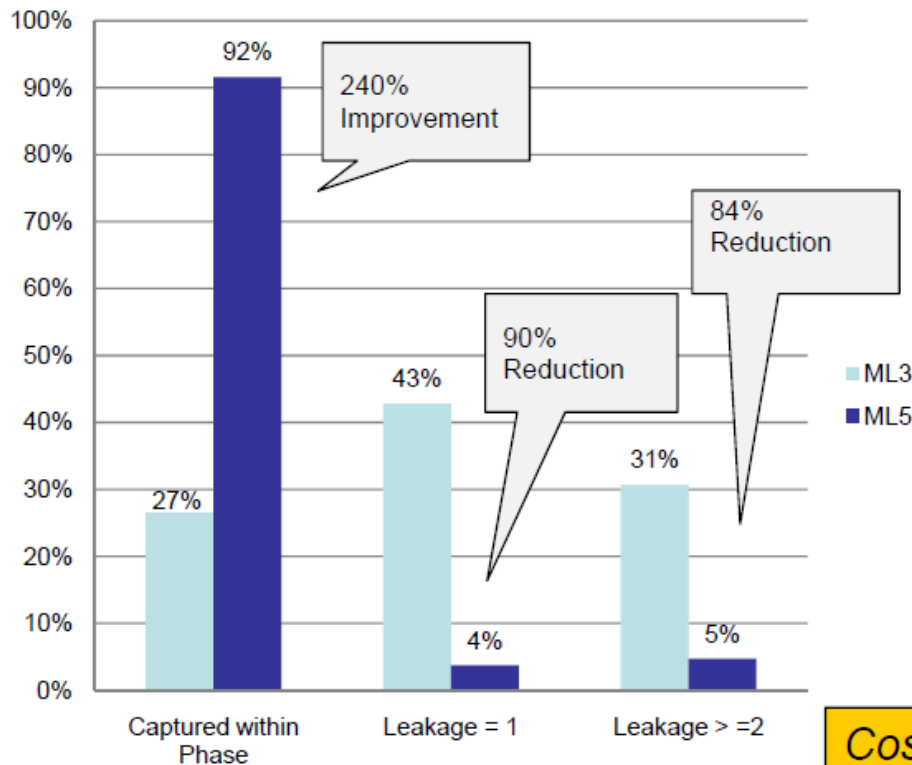


# Selected Results: Quality Performance

(Organization 3)



## Defects Phase Containment / Leakage (High Severity Defects - Priority 1, 2 & 3)



*Within ML5 projects:*

- Defect containment (within phase) is increased by 240%
- Leakage is reduced by 90% for defects discovered "1 phase later"

*84% reduction in defects leaked "2 or 2+ Phases"*

*Optimizing verification activities:*

- Peer reviews
- Unit testing
- Integration testing

*Cost avoidance realized:*

- Less rework late in the life cycle when it is most expensive to repair
- Resulting in reduced schedule risk



# Quantitative Measures: Productivity Results Summary



Measure Used By The Organization	Performance Result
Productivity Gain with ML5 (Organization 1)	42% gain with ML5 organizational practices over 9 years
Organizational productivity vs. Galorath SEER SEM Estimation Model (Organization 1)	Production hours reduction: 33.0% at ML3; 37.4% at ML5
Productivity for CMMI ML5 relative to the SW-CMM ML3 baseline (Organization 6)	Productivity up 25.2%



# Selected Results: Software Productivity

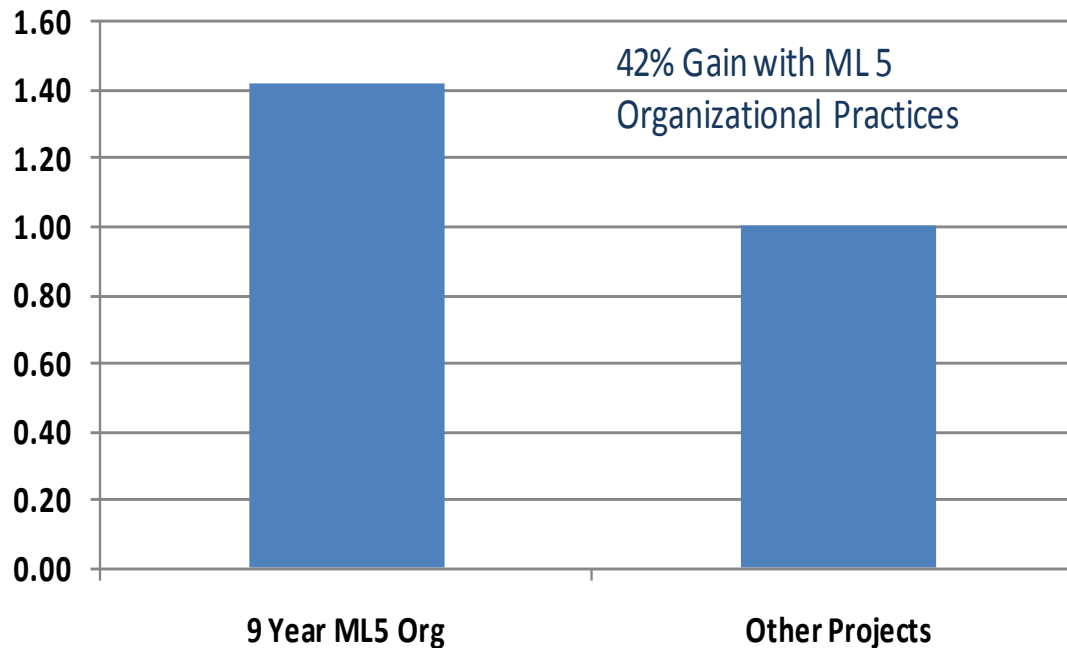
(Organization 1)



Average project size was 233 KESLOC

Largest = 1,360 KESLOC  
Smallest = 29 KESLOC

## Productivity Gain with Long Term ML 5



**Average customer project savings due to increased productivity**

- Equivalent of 406 work months per project (33.8 work years)



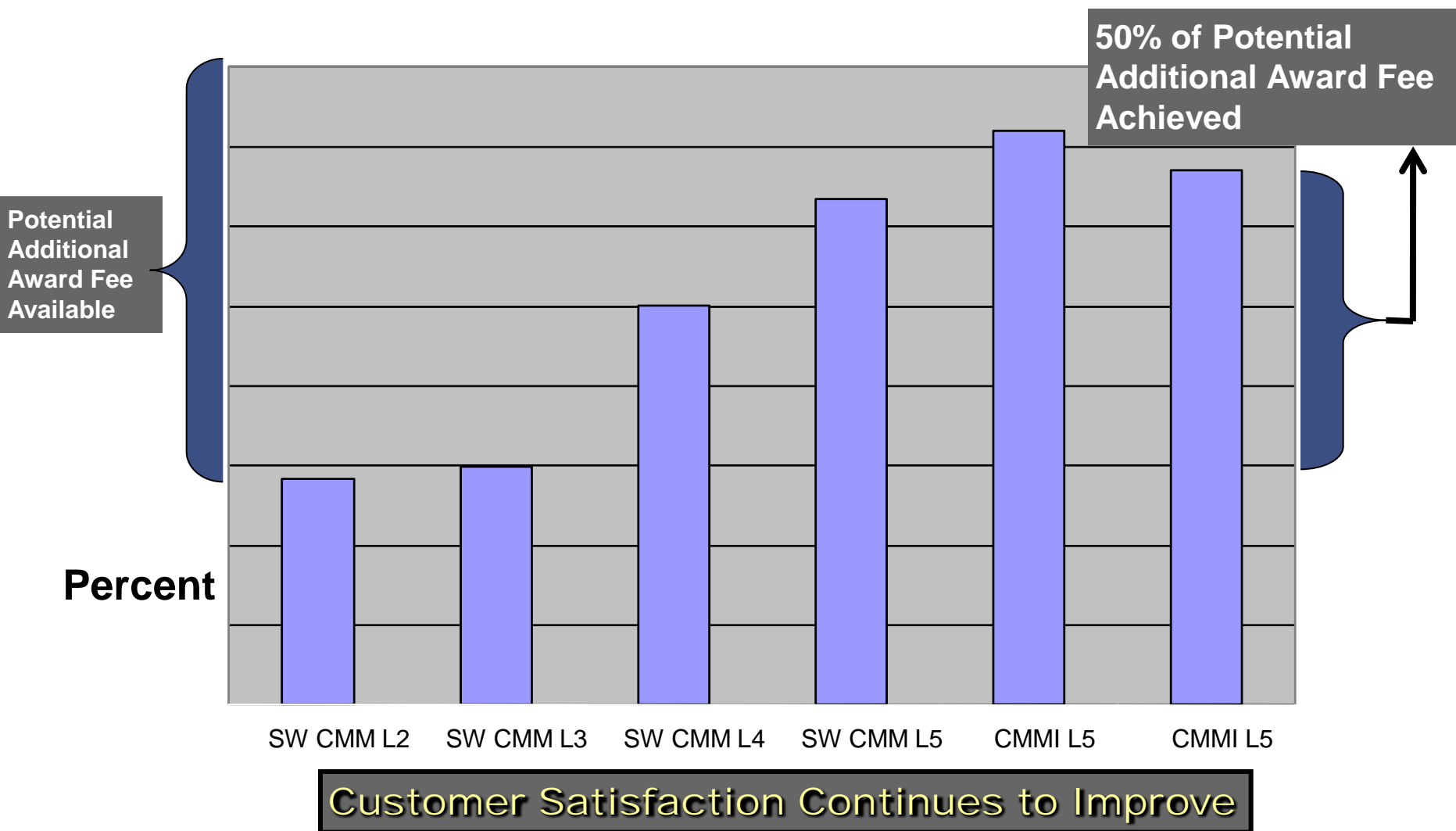
# Quantitative Measures: Customer Satisfaction Results Summary



Measure Used By The Organization	Performance Result
Award fee (used as an indicator of customer satisfaction) for CMMI ML5 relative to the SW-CMM ML2 baseline (Organization 6)	50% of potential additional award fee achieved
Cost savings to customer in a cost-plus contract (Organization 1)	Rose from 5.7 M to 7.1 M (25%)



# Selected Results: Award Fee (Organization 6)



# Quantitative Result: Return on Investment

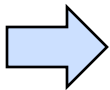
(Organization 2a)



Organization 2a reported their quantified ROI from CMMI Maturity Level 5 activity to be **24 : 1**.

Using the data in *Performance Results of CMMI® -Based Process Improvement* (CMU/SEI-2006-TR-004) they were able to compare their ROI performance to others in industry:

- Median ROI 4 : 1
- Lowest ROI 1.7 : 1
- **Organization 2a** **24 : 1**
- Highest ROI 27.7 : 1



These results are a consequence of meaningful process improvement aligned with the business and engineering objectives.





# Putting This Presentation In Perspective



The reporting organizations have a long history of commitment to CMMI

Many have a history of multiple reappraisals at high maturity levels over many years

All these organizations clearly embody an approach that incorporates adherence to process as part of their operating principles

None of these organizations would have been able to collect and analyze the years of data needed to document these results if they were “bookshelf process” organizations



# Putting This Presentation In Perspective - 2



Each organization measured their own internal processes

- CMMI measures how well an organization follows their process
- Maturity Levels are used to provide a relative basis of comparison
  - CMMI is a good tool to define states of maturity
  - Measurements demonstrate the value received

The benefits described came from execution of each organization's processes

- Each organization identified areas different areas of focus
- Gains were achieved when process focus occurred

The combination that yielded value:

CMMI provided the benchmark and the framework

Adherence to their processes produced the value.



# CMMI Provides Many Qualitative Benefits as Well\*



Organizations also gathered various qualitative measures to compliment their quantitative measurements. They found qualitative benefits such as:



- Reduced overtime and less intense pressure
- Clear roles and responsibilities for business execution
- Common language (i.e., defined processes, measures) across business units
- Decrease in replanning
- Products with lower levels of defects and lower risk; one organization offers a lifetime warranty on products
- Improved program insight, control, and tracking
- Reduced training: process documentation enables knowledge transfer to new generation of workers
- Process transformation (via consistency, integration, coordination)
- Personnel retention and job satisfaction

\*based on published benefits from a wide variety of organizations



# The Bottom Line

**Why improve processes? - Because processes are the foundation for all other business improvements, and critical for**

- lasting improvements
- successful technology insertion

If a performance management system is not in use, leadership is unaware of what is and is not working.

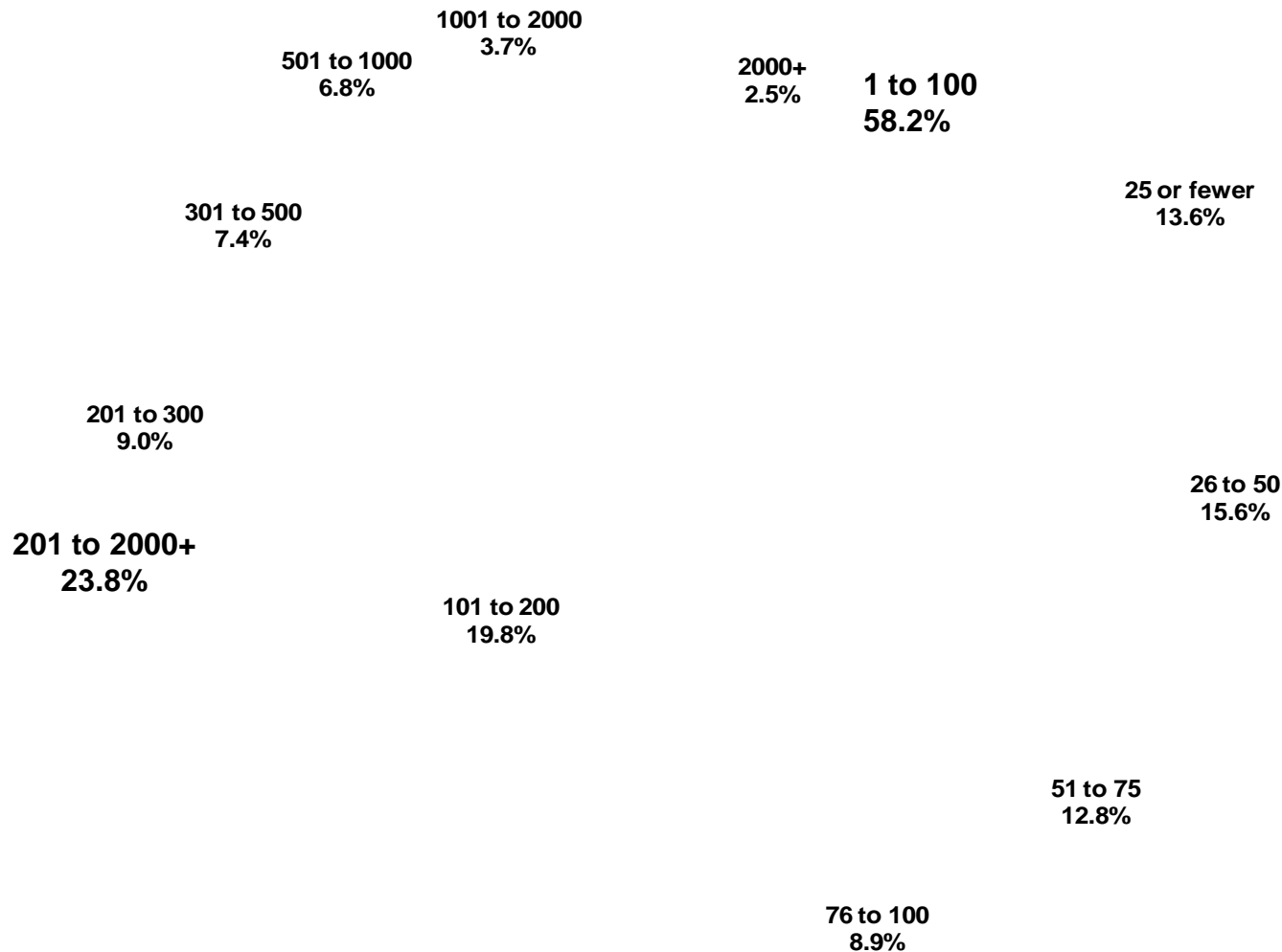
**CMMI is a proven approach to performance management – with more than a decade of results showing it *does* work.**

Organizations have provided data that shows CMMI

- enables the delivery of lower-defect products, with predictable cost, schedule, and quality
- improves business performance
- serves as competitive discriminator



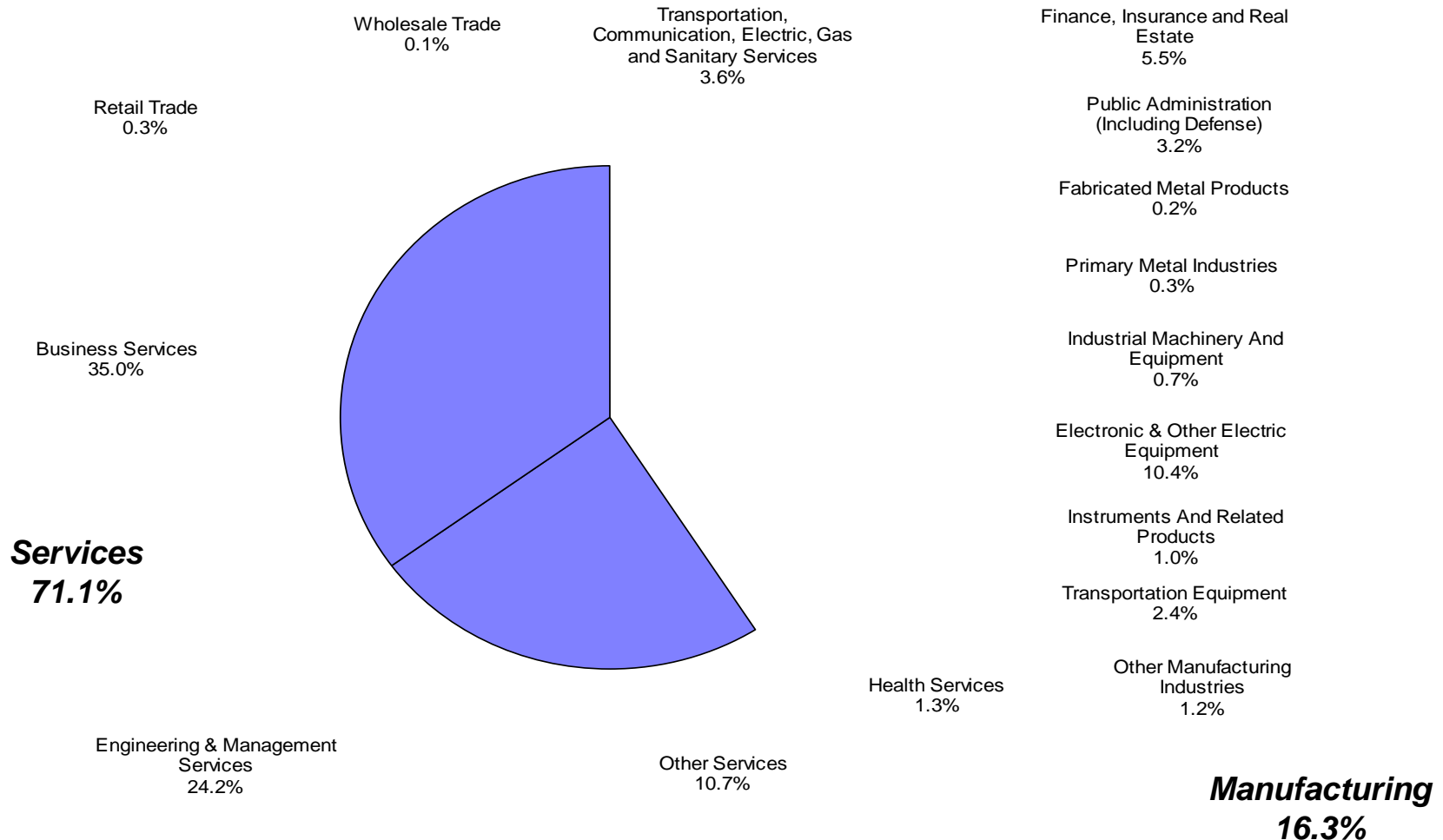
# CMMI Works for Organizations of All Sizes



Source for these statistical analyses: <http://www.sei.cmu.edu/cmmi/casestudies/profiles/cmmi.cfm>



# CMMI Adoption Is Multi-Sector



Source for these statistical analyses: <http://www.sei.cmu.edu/cmmi/casestudies/profiles/cmmi.cfm>

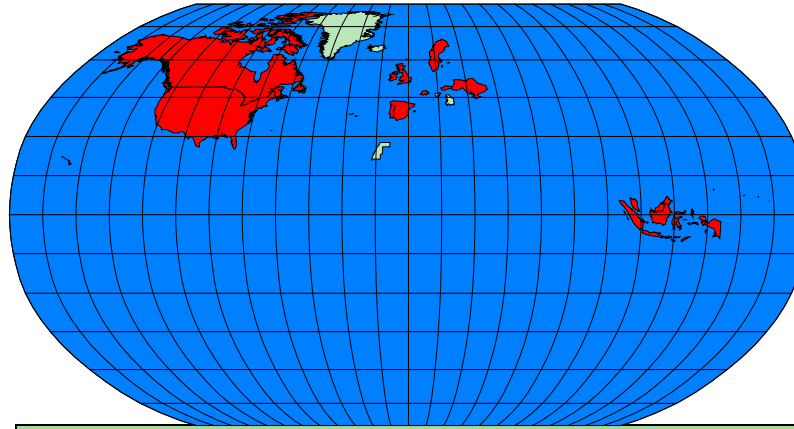


# CMMI Adoption Knows No Borders



There are 33 countries with more than ten appraisals as of March 2010:

USA	1582
China	1229
India	524
Japan	306
Spain	180
France	168
Korea (ROK)	165
Brazil	144
Taiwan	134
U.K.	113
Mexico	86
Argentina	77
Germany	76
Malaysia	71
Canada	59
Egypt	43
Italy	43
Thailand	38
Chile	37
Australia	36



An estimated 1.8 million people work in organizations that have had at least one SCAMPI A appraisal since April 2002.

Also: Colombia, Pakistan, Philippines, Singapore, Israel, Hong Kong, Vietnam, Turkey, Netherlands, Portugal, Sri Lanka, Ireland and Russia

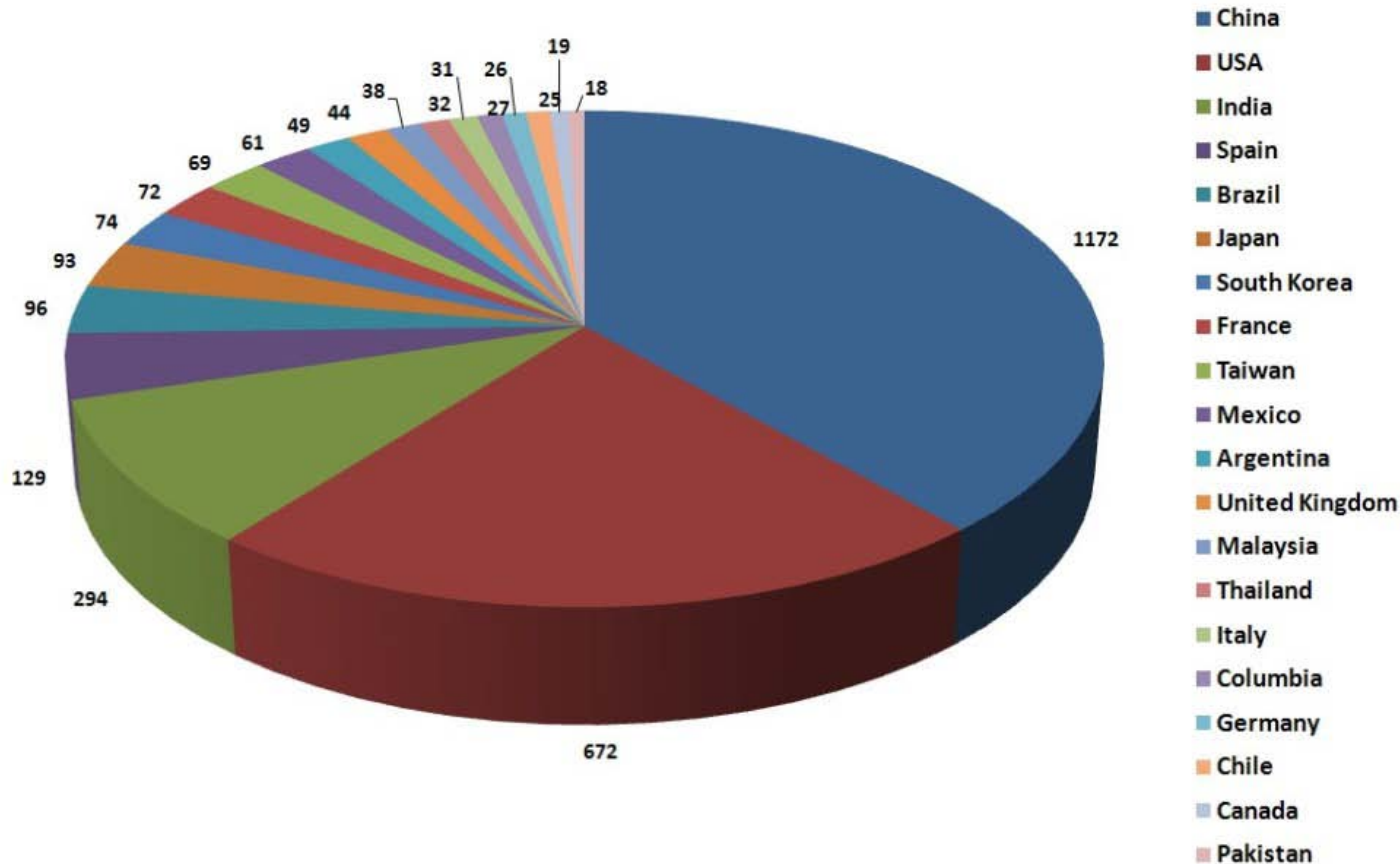


# Countries With Current Appraisals

## - This List Might Contain Several Surprises



Distribution of Appraisals by Country - Top 20



Data through  
Nov 12, 2010





# Results Depend on Implementation

Simply deciding to “do CMMI” is not enough to achieve benefits.

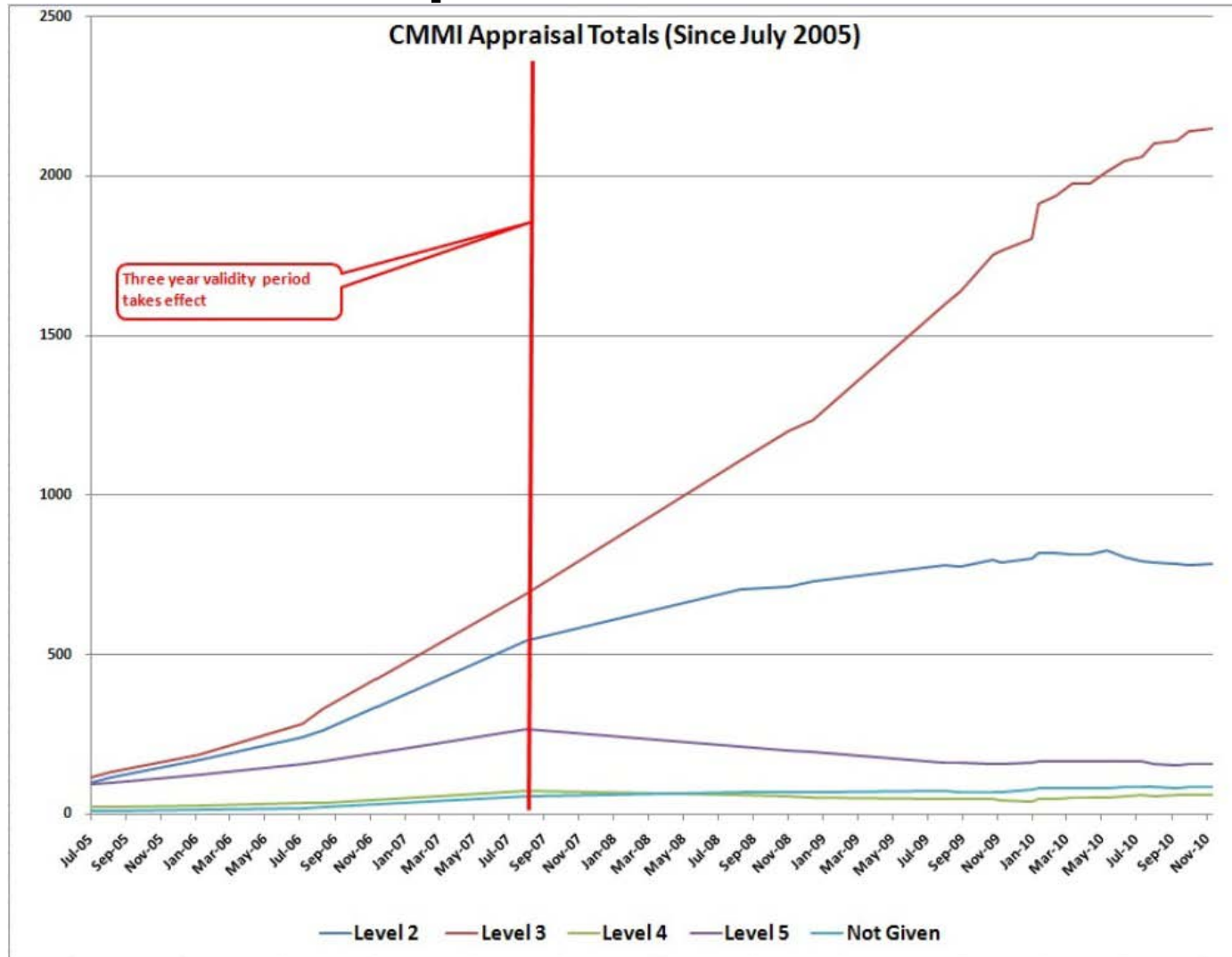
Defining good processes, using them, measuring the results, and making improvements based on what you learn are all key to reaping the benefits described in this presentation.

The CMMI models are a foundational part of a comprehensive approach to process improvement that helps organizations understand

- **why** they should improve
- **what** frameworks and tools would best fit their needs
- **how** to implement them



# What Does Adoption Data Tell Us

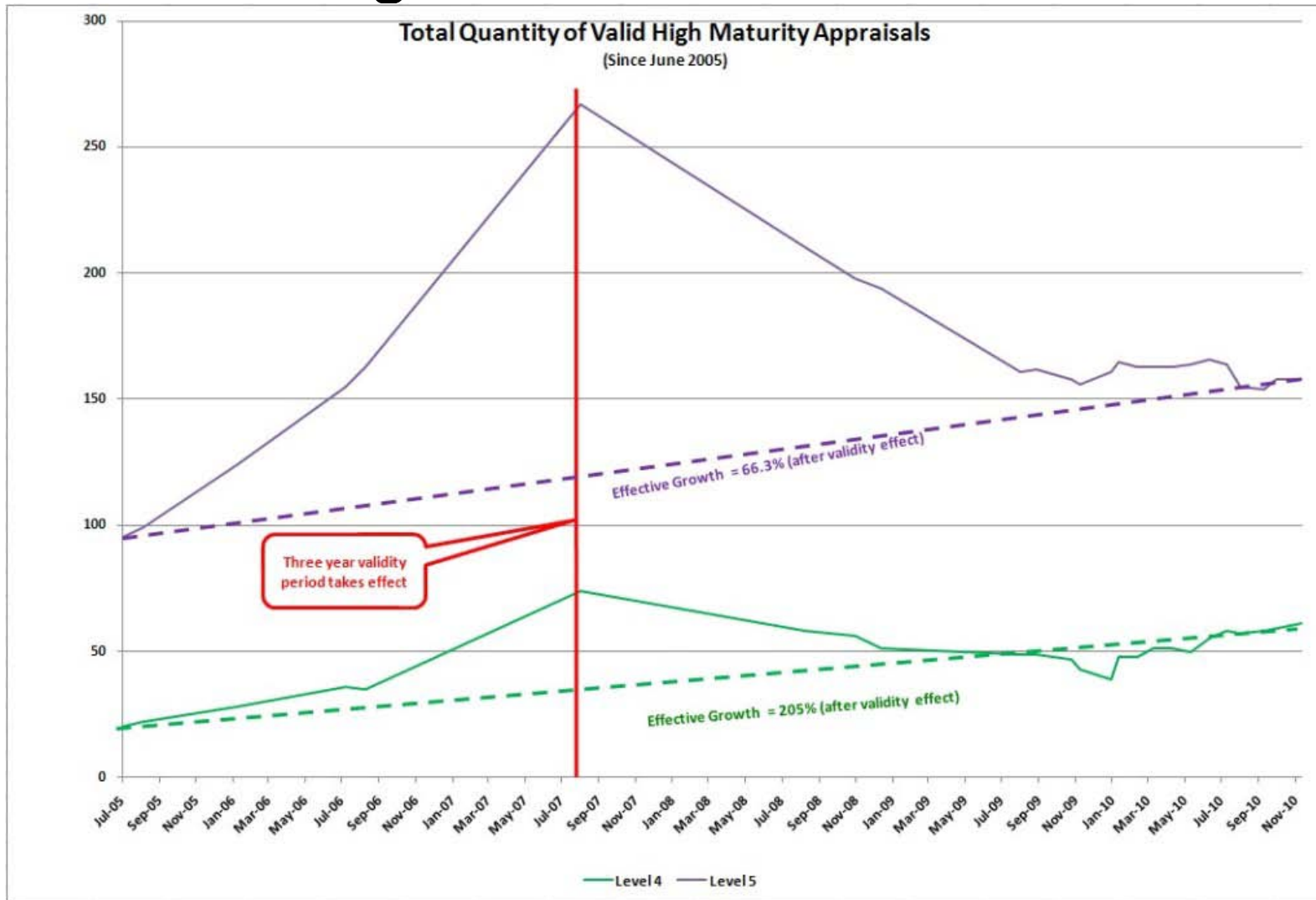


Data through  
Nov 12, 2010

**Growth in High Maturity appears to be stagnated**



# Unmasking the HiMat Trends

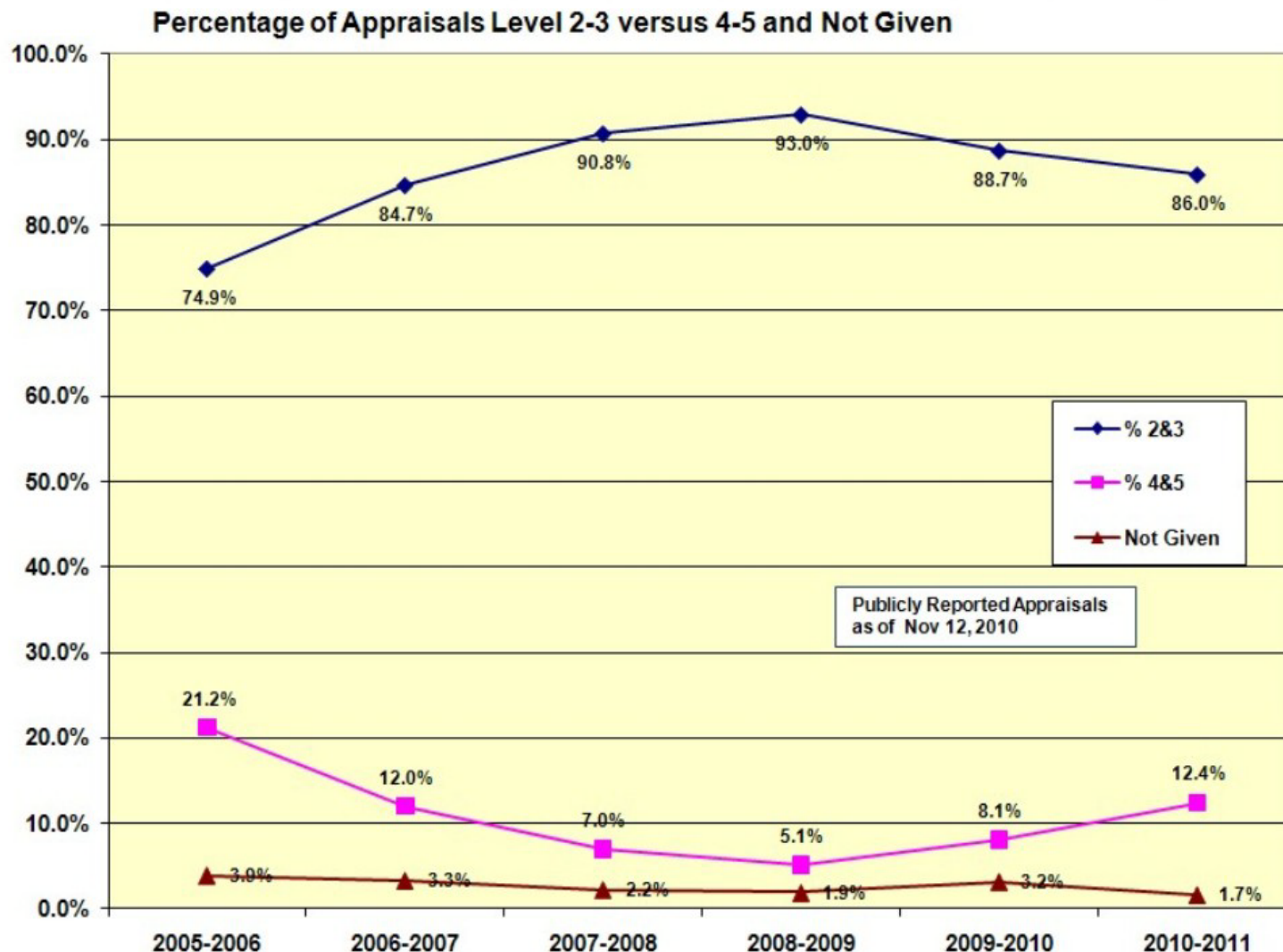


Data through  
Nov 12, 2010

**Real Growth in ML 4 & ML 5 over 5 years – recent ML 4 tracks the ML 3 surge**



# Positive Trend in Hi Mat since 2008



Data through  
Nov 12, 2010



# Misreading the Tea Leaves on HiMAT?



The huge surge in ML 2 & 3 appraisals starting in 2007 may have created a masking function as the validity limit on appraisal life was taking effect

- Reductions evident in ML 4 & 5 have not been evident for ML 2 & 3

Maturity growth normally takes several years to occur

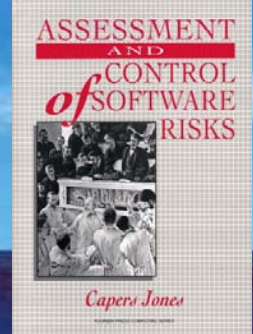
- SW CMM maturity took over 6 years to take hold so the condition is not new

We may have seen the HiMAT % reduced simply because appraisal totals were growing at an accelerated rate

**We need to monitor these trends.  
HiMAT growth may have been more stable than we thought**



# Recent Research on CMMI: Just the Tip of the Iceberg!



## Benefits of CMM-Based Software Process Improvement: Executive Summary of Initial Results

James Herbsleb  
Anita Carleton  
James Rozum  
Jane Siegel  
David Zubrow

September 1994

SPECIAL REPORT  
CMU/SEI-94-SR-013

## Approaches to Process Performance Modeling: A Summary from the SEI Series of Workshops on CMMI High Maturity Measurement and Analysis

Robert W. Woodward  
Dennis M. Stammers  
January 2000

TECHNICAL REPORT  
CMU/SEI-2000-140  
SEI-TR-2000-013  
Software Engineering Measurement and Analysis  
Customer feedback subject to the copyright

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## Performance Results of CMMI-Based Process Improvement

Cheryl L. Gilman  
Dennis M. Stammers  
Kathy Kuhl

August 2008

Software Engineering Institute | Carnegie Mellon

## Demonstrating the Impact and Benefits of CMMI: An Update and Preliminary Results

Dennis M. Stammers  
Cheryl L. Gilman

A-Z Index

Search

Technical Report  
CMU/SEI-94-TR-013  
ESC-TR-94-013  
August 1994

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## CMMI

Capability Maturity Model Integration (CMMI)

Overview | Getting Started | Research | Tools & Methods | Consulting | Case Studies | Our People

## Performance Results of CMMI

There is a widespread demand for credible, quantitative evidence about the results of process improvement based on CMMI models. The results presented here are from publicly available conference presentations, published papers, and individual collaborations with the SEI.

Together, these results provide proof of concept about the potential of CMMI-based process improvement. The results show that CMMI often leads to very impressive improvements in product quality, project performance, and organizational performance.

### Performance Results of CMMI

Collaborate with Us

### Related Links

CMMI Executive Overview

## Benefits of CMM-Based Software Process Improvement: Initial Results

James Herbsleb  
Anita Carleton  
James Rozum  
Jane Siegel  
David Zubrow



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# CMMI Research - References



## Bibliographic information cited in this presentation:

Gibson, Diane; Goldenson, Dennis R.; and Kost, Keith. <i>Performance Results of CMMI-Based Process Improvement</i> (CMU/SEI-2006-TR-004). Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University, August 2006.	Journal Issue: "Performance Results from Process Improvement." SoftwareTech News. Vol. 10, Number 1. March 2007.
Goldenson, Dennis R. and Gibson, Diane L. <i>Demonstrating the Impact and Benefits of CMMI®: An Update and Preliminary Results</i> . (CMU/SEI-2003-SR-009). Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University, October 2003.	Journal Issue: "CMMI: Getting a Handle on Process." CrossTalk. Vol. 23, Number 1. Jan/Feb 2010.
Herbsleb, James D.; Carleton, Anita; Rozum, James A.; Siegel, Jane; and Zubrow, David. <i>Benefits of CMM-Based Software Process Improvement: Initial Results*</i> (CMU/SEI-94-TR-013). Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University, August 1994. (*Also see SEI Special Report: <i>Benefits of CMM-Based Software Process Improvement: Executive Summary of Initial Results</i> , CMU/SEI-94-SR-013)	Stoddard II, Robert W. and Goldenson, Dennis R. <i>Approaches to Process Performance Modeling: A Summary from the SEI Series of Workshops on CMMI High Maturity Measurement and Analysis</i> (CMU/SEI-2009-TR-021). Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University, January 2010.
Jones, Capers. <i>Assessment and Control of Software Risks</i> . Upper Saddle River, NJ: Prentice-Hall, 1994 (ISBN 0-13-741406-4).	Website about CMMI at the Software Engineering Institute: < <a href="http://www.sei.cmu.edu/cmmi/index.cfm">http://www.sei.cmu.edu/cmmi/index.cfm</a> >



# Looking Ahead



## The road ahead for CMMI implementation

- **A continued focus on high maturity**

More and more organizations are striving for and achieving high maturity – and are collecting data demonstrating the benefits. Once at ML 4 or 5, organizations must maintain their focus on good implementation practices for continuous improvement.

- **Implementation of CMMI for Services (CMMI-SVC)**

CMMI-SVC extends the benefits of CMMI to a new audience. Service providers can use the model concept that has proven useful in the development community to specifically address their interests and concerns.

- **Implementation of CMMI for Acquisition (CMMI-ACQ)**

CMMI-ACQ helps organizations improve relationships with their suppliers and improve acquisition processes. The model can enable increased control of projects, better management of global sourcing of products and services, and more successful acquisition solutions.

- **Integration with other improvement paradigms (e.g., TSP, ISO, Lean Six Sigma)**

Organizations are finding that integrated improvement initiatives can produce outstanding results. Choosing CMMI doesn't mean discontinuing improvement efforts already in place or avoiding new ones that show promise.





# Summary



Many stakeholders are involved in the development and maintenance of CMMI models, with participants from commercial industry, government, and the DoD. Broad adoption has occurred worldwide. Adopters range from small and midsize organizations (these are the majority) to large and very large organizations.

Organizations that provide products and services to the DoD use CMMI to improve programs, systems, product and service management, systems and software engineering, work processes, and training solutions.

Quantitative and qualitative results have been documented by defense contractors and others, as shown in this report. There is a great deal of additional data showing the benefits of CMMI from a broad range of industries, including banking and finance, manufacturing, medical, and others.

CMMI enables performance improvement focused on business objectives, but the level of success depends on the implementation.



# Who Benefits from CMMI Today?



**We all do!**

