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CMMI ®

Capability Maturity Model® Integration (CMMI®) Overview

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Objectives

Provide an overview of CMMI by describing the following:
- Background and motivation
- Models
- Representations
- The bottom line
- Benefits and improvements

Software Engineering Institute (SEI^{SM})

Federally funded research
and development center
(FFRDC) established 1984

Awarded to Carnegie Mellon
University

Sponsored by the Office of the
Under Secretary of Defense for
Acquisition and Technology
[OUSD (A&T)]

Administered by Electronic
Systems Center (ESC)

The State of the Practice

Is this the state of affairs in your organization?
- "I'd rather have it wrong than have it late. We can
  always fix it later."

    - A senior software manager (industry)

- "The bottom line is schedule. My promotions and raises
  are based on meeting schedule first and foremost."

    - A program manager (government)

If it is, are managers and practitioners unhappy with the
status quo?
- Sufficiently unhappy to change things?
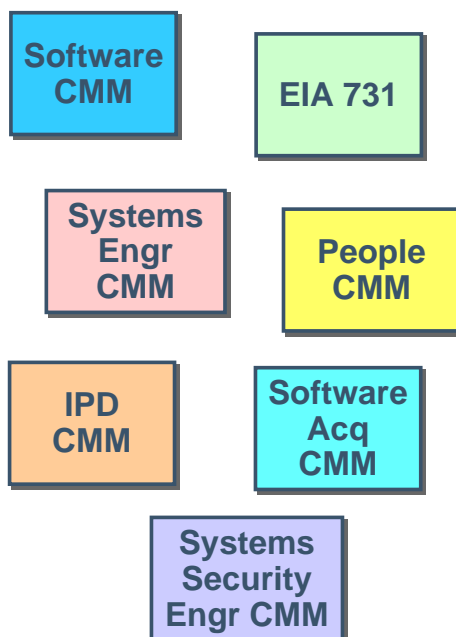- Willing and able to attack the known problems?

The Process Management Premise

The quality of a system is highly influenced by the quality of the process used to acquire, develop, and maintain it.

This premise implies a focus on processes as well as on products.

- This is a long-established premise in manufacturing (and is based on TQM principles as taught by Shewhart, Juran, Deming, and Humphrey).
- Belief in this premise is visible worldwide in quality movements in manufacturing and service industries (e.g., ISO standards).

Multiple Process Models

Software CMM

EIA 731

Systems Engr CMM

People CMM

IPD CMM

Software Acq CMM

Systems Security Engr CMM

Success of the Software CMM® caused development of other CMMs, but they

- Have different structures, formats, terms, ways of measuring maturity
- Cause confusion, especially when more than one are used
- Are difficult to integrate into a combined improvement program
- Are difficult to use in supplier selection

The Next Step Is CMM Integration[SM]

The CMM Integration Project was formed to
- build an initial set of integrated models
- improve best practices from source models based on lessons learned
- establish a framework to enable integration of future models
- create an associated set of appraisal and training products

Collaborative endeavor (over 100 people involved)
- Industry
- Government
- Software Engineering Institute (SEI)

Enterprise-Wide Improvement

CMMI enables organizations that want to pursue process improvement in multiple functional areas to do so with less additional investment for each additional function.

- CMMI supports process integration and product improvement.

- CMMI integrates multiple disciplines into one process-improvement framework.

- CMMI provides a framework for introducing new disciplines as needs arise.

Bodies of Knowledge Captured in CMMI Models

An organization selects the bodies of knowledge most relevant to achieving its business objectives. Bodies of knowledge* available in CMMI models include
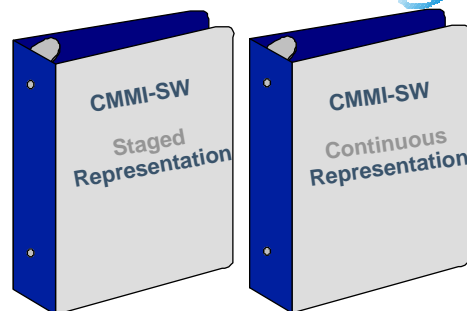
- software engineering

- systems engineering

- integrated product and process development (IPPD)

- supplier sourcing (SS)

*Each body of knowledge related to product or process development in CMMI is considered a discipline.

CMMI Models

Source Models

- Capability Maturity Model for Software V2, draft C (SW-CMM V2C)

- EIA 731, System Engineering Capability Model (SECM)

- Integrated Product Development Capability Maturity Model, draft V0.98 (IPD-CMM)

CMMI-SW
Staged Representation

CMMI-SW
Continuous Representation

Software Engineering model

- **Meets the needs of software development and maintenance organizations**

- **Meets the needs of information technology organizations**

- **Benefits from best practices contributed from all three source models**

Understanding CMMI Representations

There are two types of representations in the CMMI models:

- staged
- continuous

A representation allows an organization to pursue different improvement objectives.

The organization and presentation of the data are different in each representation. However, the content is the same.


Staged Representation

Provides a proven sequence of improvements, each serving as a foundation for the next

Permits comparisons across and among organizations by the use of maturity levels

Provides an easy migration from the SW-CMM to CMMI

Provides a single rating that summarizes appraisal results and allows comparisons among organizations

Indicates maturity of an organization's standard process -- to answer, "What is a good order for approaching improvement across the organization?"
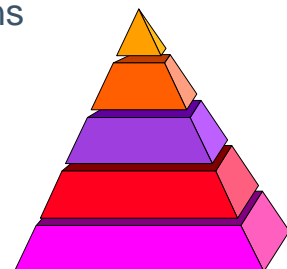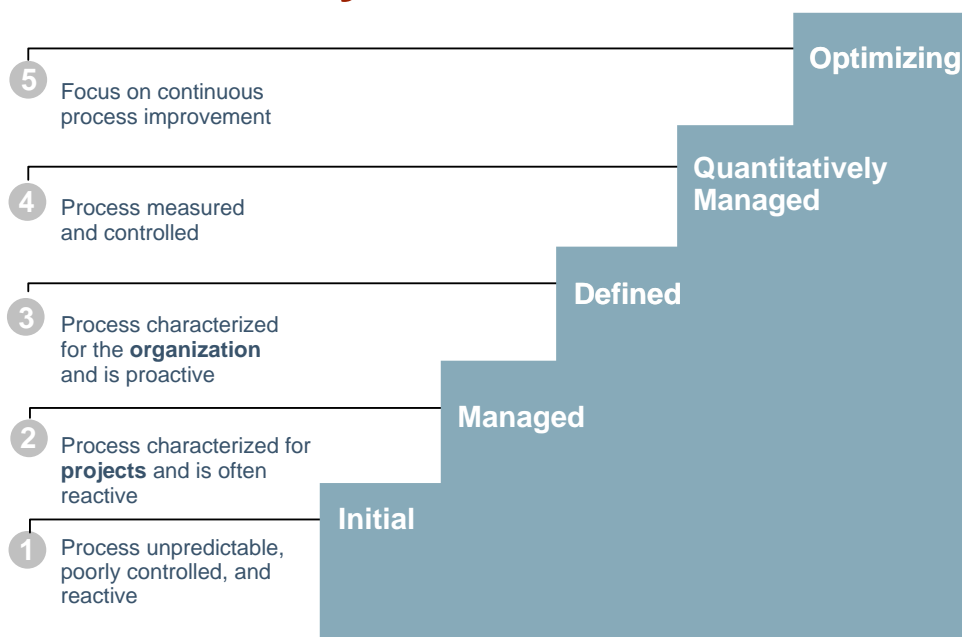
Maturity Levels

A maturity level is a well-defined evolutionary plateau of process improvement.

There are five maturity levels.

Each level is a layer in the foundation for continuous process improvement using a proven sequence of improvements, beginning with basic management practices and progressing through a predefined and proven path of successive levels.

The Maturity Levels

5 Focus on continuous process improvement

Optimizing

4 Process measured and controlled

Quantitatively Managed

3 Process characterized for the **organization** and is proactive

Defined

2 Process characterized for **projects** and is often reactive

Managed

1 Process unpredictable, poorly controlled, and reactive

Initial

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Maturity Levels Should Not Be Skipped

Each maturity level provides a necessary foundation for effective implementation of processes at the next level.

- Higher level processes have less chance of success without the discipline provided by lower levels.
- The effect of innovation can be obscured in a noisy process.

Higher maturity level processes may be performed by organizations at lower maturity levels, with the risk of not being consistently applied in a crisis.


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Continuous Representation

Allows you to select the order of improvement that best meets your organization's business objectives and mitigates your organization's areas of risk

Enables comparisons across and among organizations on a process-area-by-process-area basis

Provides an easy migration from EIA 731 (and other models with a continuous representation) to CMMI

Indicates improvement within a single process area -- to answer, "What is a good order for approaching improvement of this process area?"
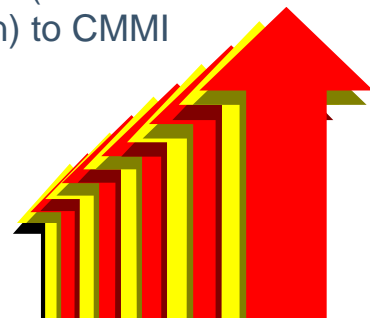
Capability Levels

A capability level is a well-defined evolutionary plateau describing the organization's capability relative to a process area.

There are six capability levels.

For capability levels 1-5, there is an associated generic goal.

Each level is a layer in the foundation for continuous process improvement.

Thus, capability levels are cumulative, i.e., a higher capability level includes the attributes of the lower levels.
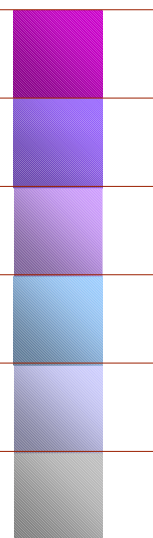

The Capability Levels

5 Optimizing

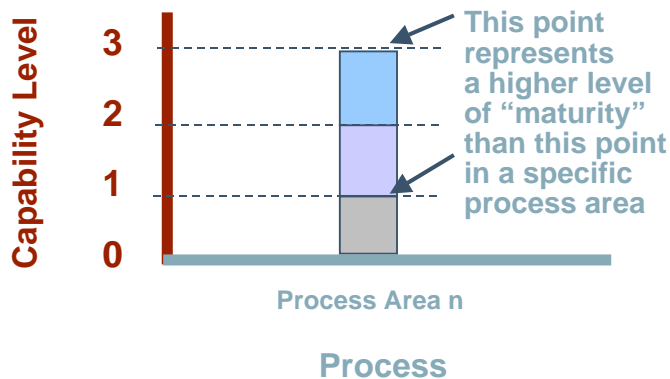**4 Quantitatively Managed**

3 Defined

2 Managed

1 Performed

0 Incomplete

Representing Capability Levels for a Single Process Area

The process area capability of an implemented process can be represented by a bar.

Relating Process Area Capability and Organizational Maturity

Organizational maturity is the focus of the staged representation, whereas process area capability is the focus of the continuous representation.

Organizational maturity and process area capability are similar concepts.

The difference between them is that organizational maturity pertains to a set of process areas across an organization, while process area capability deals with a set of processes relating to a single process area or specific practice.

Why Two Representations?

The representation of each source model was different
- Software CMM—Staged
- SECM—Continuous
- IPD CMM—Hybrid

Combining different representations required deciding on a representation for CMMI models.

Ultimately, the project decided to incorporate the benefits of both staged and continuous representations.

Comparison of Representations

Staged

Process improvement is measured using maturity levels.

Maturity level is the degree of process improvement across a predefined set of process areas.

Organizational maturity pertains to the "maturity" of a set of processes across an organization

Continuous

Process improvement is measured using capability levels.

Capability level is the achievement of process improvement within an individual process area.

Process area capability pertains to the "maturity" of a particular process across an organization.

Advantages of Each Representation

Staged

Provides a roadmap for implementing
- groups of process areas
- sequencing of implementation

Familiar structure for those transitioning from the Software CMM

Continuous

Provides maximum flexibility for focusing on specific process areas according to business goals and objectives

Familiar structure for those transitioning from EIA 731

CMMI in a Nutshell

A CMMI model provides a structured view of process improvement across an organization

CMMI can help
- set process improvement goals and priorities
- provide guidance for quality processes
- provide a yardstick for appraising current practices

The Bottom Line

Process improvement
should be done
to help the business—
not for its
own sake.

"In God we trust,
all others bring data."
- W. Edwards Deming

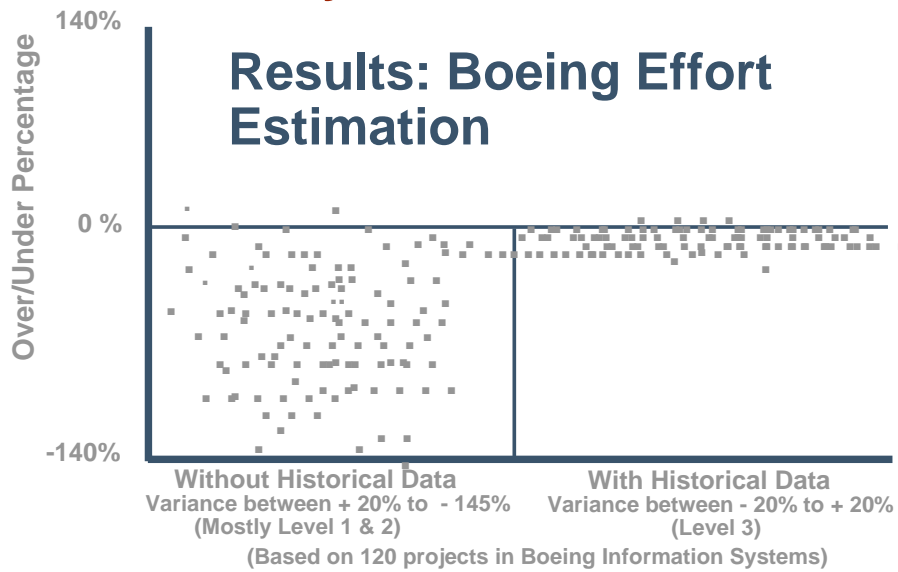# Categories of Process Improvement Benefits

Process improvement benefits fall into one of eight general categories:

1. Improved schedule and budget predictability

2. Improved cycle time

3. Increased productivity

4. Improved quality (as measured by defects)

5. Increased customer satisfaction

6. Improved employee morale

7. Increased return on investment
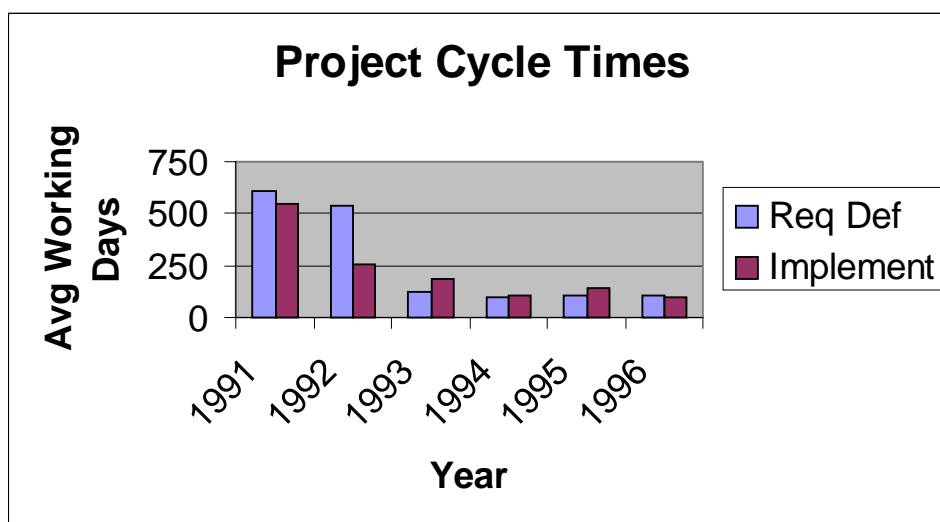
8. Decreased cost of quality

Benefits realized by organizations using the Software CMM are expected with CMMI.

Improved Schedule and Budget Predictability

**Results: Boeing Effort Estimation**

140%

0 %

-140%

Over/Under Percentage

Without Historical Data
Variance between + 20% to - 145%
(Mostly Level 1 & 2)

With Historical Data
Variance between - 20% to + 20%
(Level 3)

(Based on 120 projects in Boeing Information Systems)

Reference: John D. Vu. "Software Process Improvement Journey: From Level 1 to Level 5."
7th SEPG Conference, San Jose, March 1997.

Improved Cycle Time

Project Cycle Times

750

500

250

0

Avg Working Days

☐ Req Def
☐ Implement

1991 1992 1993 1994 1995 1996

Year

Source: Software Engineering Div., Hill AFB, Published in *Crosstalk,* May 1999

Increased Productivity
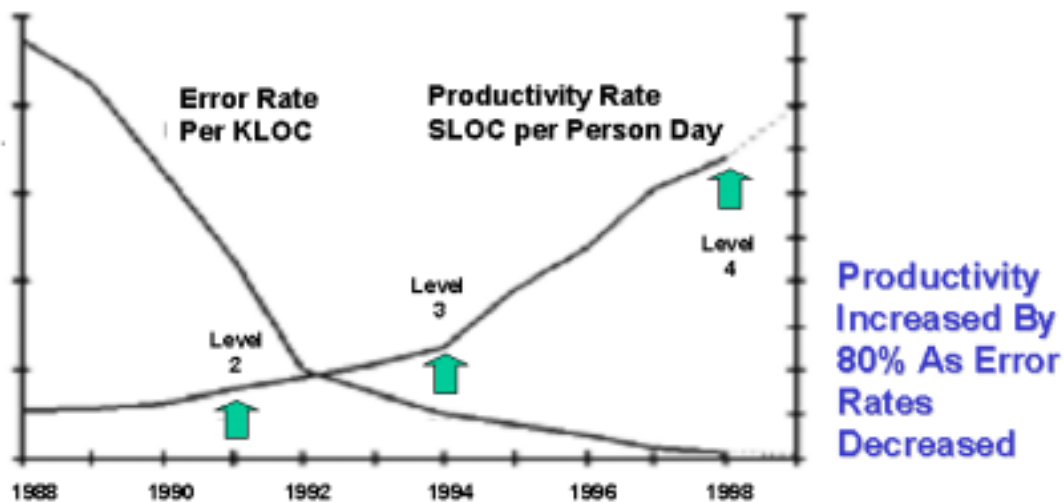
Man-hours per LOC
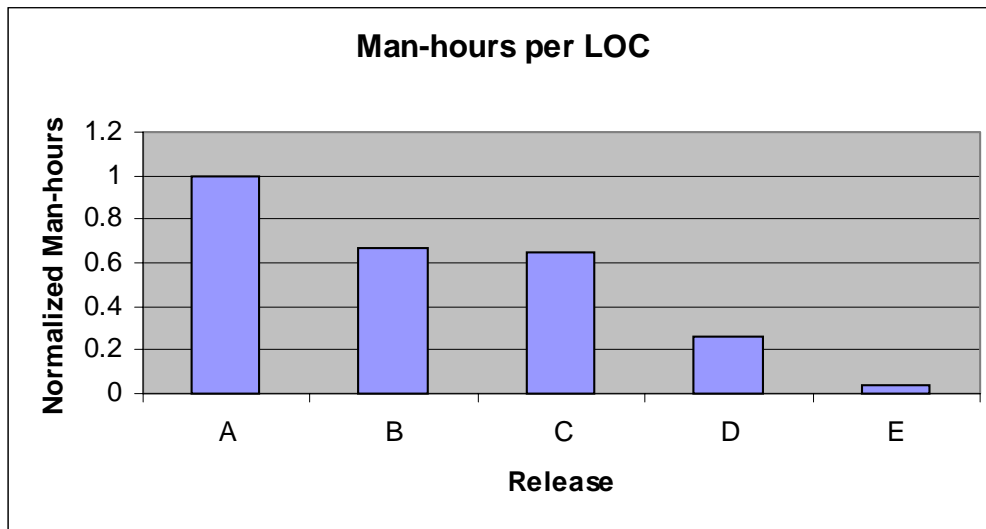
Source: Software Engineering Div., Hill AFB, Published in *Crosstalk,* May 1999

Increased Productivity and Quality

Productivity Rate and Quality Performance
* For Software Programs

Error Rate Per KLOC

Productivity Rate SLOC per Person Day

Level 2

Level 3

Level 4

Productivity Increased By 80% As Error Rates Decreased

1988   1990   1992   1994   1996   1998

Improvements from Adopting Software CMM

Savings vs. cost of software process improvement (median) 5:1

- Productivity (increase)
- Time to market (reduction)
- Post-release defect reports (reduction)

Annual Medians

35% 19% 39%

Percentage Improvement
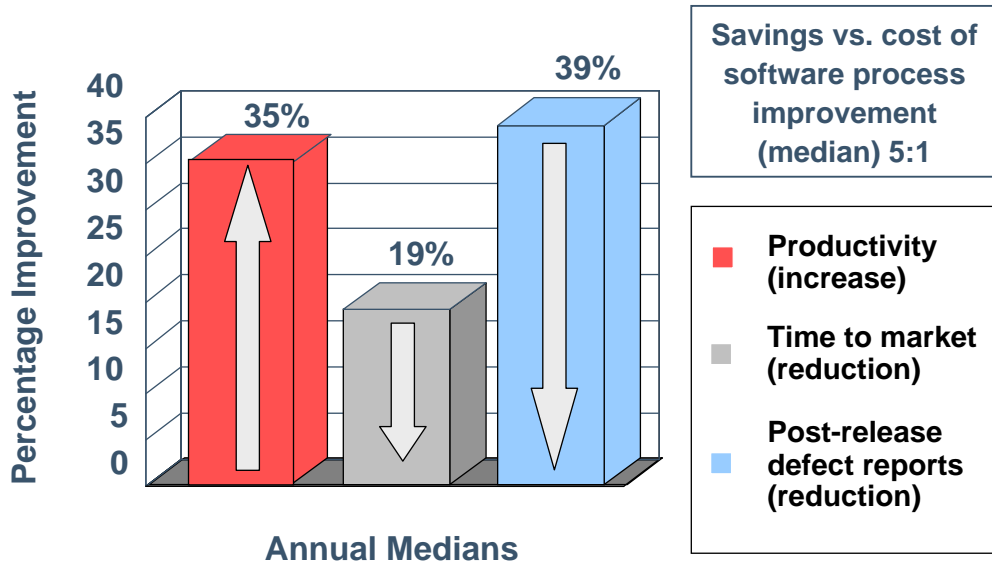
Benefits of Continuing Process Improvement

SEI Software CMM Level 5: For the Right Reasons*

- Defects are now nearly all found and fixed before testing begins.

- Defects escaping into the field have been reduced from 11% to practically 0%.

- Programs consistently reach customer satisfaction and performance targets.

- Peer reviews increase total project costs by 4%, but reduced rework during testing by 31%. R.O.I. is 7.75:1.

* Reference: Yamamura and Wigle, Boeing Space and Transportation Systems, *Crosstalk*, Aug, 1997.

CMM"I" – Improvement

The CMMI Product Suite provides a foundation for *enterprise-wide improvement* and adds

- new emphasis on products and services as well as process
- emphasis on both process capability and organizational maturity
- early emphasis on measurement and analysis

The CMMI model improves upon Software CMM V1.1 and Software CMM V2.0 Draft C.

CMM"I" – Integration

Provides expanded model scope for *integration*

- Integrated Product Management
- Integrated Supplier Management
- Decision Analysis and Resolution
- "Relevant Stakeholder" planning and execution
- Inclusion of the Integrated Product and Process Development body of knowledge

Improving on the Software CMM

CMMI Models improve on the best practices in Software CMM Version 2.0 Draft C:

- Incorporates 4+ additional years of learning
- More explicitly links management and engineering activities to business objectives
- Expands the scope of and visibility into the product life cycle and engineering activities to ensure the product or service meets customer expectations
- Incorporates additional areas of best practice (e.g., measurement, risk management, bi-directional traceability in requirements management, decision analysis and resolution, and supplier management)
- Captures more robust high-maturity practices
- Addresses additional generic practices needed for institutionalization
- More fully complies with relevant ISO standards

CMMI Transition Status

As of 12/18/02

Training
- Introduction to CMMI – 6,323 students
- Intermediate CMMI – 424 students
- Introduction to CMMI Instructors – 140 candidates
- SCAMPI^{SM} Lead Appraisers – 1209 candidates

Authorization
- Introduction to CMMI Instructors – 102
- SCAMPI Lead Appraisers^{SM} – 145

SCAMPI Appraisals

SCAMPI appraisals conducted since 1999 and reported to the SEI by October 2002

- 40 appraisals
- 30 organizations
- 24 participating companies
- 6 reappraised organizations
- 141 projects
- 54.5% offshore organizations

CMMI is being adopted!

CMMI – What's Happening in 2003?

Adoption and transition activities:
- quarterly transition workshops
- annual NDIA/SEI CMMI User Workshop
- Interpretive Guidance for software projects
- development of class B and C appraisal methods

Technical notes and special reports:
- CMMI and Product Line Practices
- CMMI and Earned Value Management
- Interpreting CMMI for Operational Organizations
- Mapping CMMI with other standards and models
- Specific interests (e.g., safety, security)

Publication of SEI Series Book with Addison-Wesley

CMMI Schedule

Available now
- CMMI-SW, V1.1
- CMMI-SE/SW, V1.1
- CMMI-SE/SW/IPPD, V1.1
- CMMI-SE/SW/IPPD/SS, V1.1
- SCAMPI Method Definition Document, V1.1
- V1.1 model and method training

December 2003
- Sunset period for the Software CMM and EIA 731 completed (no more public courses, no more new lead assessors).

CMMI Can Benefit You

CMMI provides

- Efficient, effective assessment and improvement across multiple process disciplines in an organization

- Improvements to best practices incorporated from the Software CMM

- A common, integrated vision of improvement for all elements of an organization

- A means of representing new discipline-specific information in a standard, proven process-improvement context

For More Information About CMMI

Go to CMMI Web site:

http://www.sei.cmu.edu/cmmi
http://seir.sei.cmu.edu

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