Lockheed Martin Benefits Continue Under CMMI®

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Agenda

- Context
- Background on Lockheed Martin's (LM) CMMI® transition approach
- Benefits in the Software CMM® and CMMI® eras
  - LM Systems Integration (Owego, NY)
  - LM Maritime Systems & Sensors – Tactical Systems (Eagan, MN)
  - LM Maritime Systems & Sensors – Radar Systems (Syracuse, NY)
  - LM Maritime Systems & Sensors – Undersea Systems (Manassas, VA)

Context

- Lockheed Martin organizations that tracked quantitative process improvement benefits during their SW-CMM® high maturity journey have now transitioned to CMMI®
- Previously reported data showed these benefits continued with CMMI® implementation
  - ↗ This trend continues in 2004
- However, benefits derived are not attributable ***only*** to CMMI®
  - ↗ Many initiatives are underway concurrently with CMMI® deployment (and were underway when the SW-CMM® was in use)

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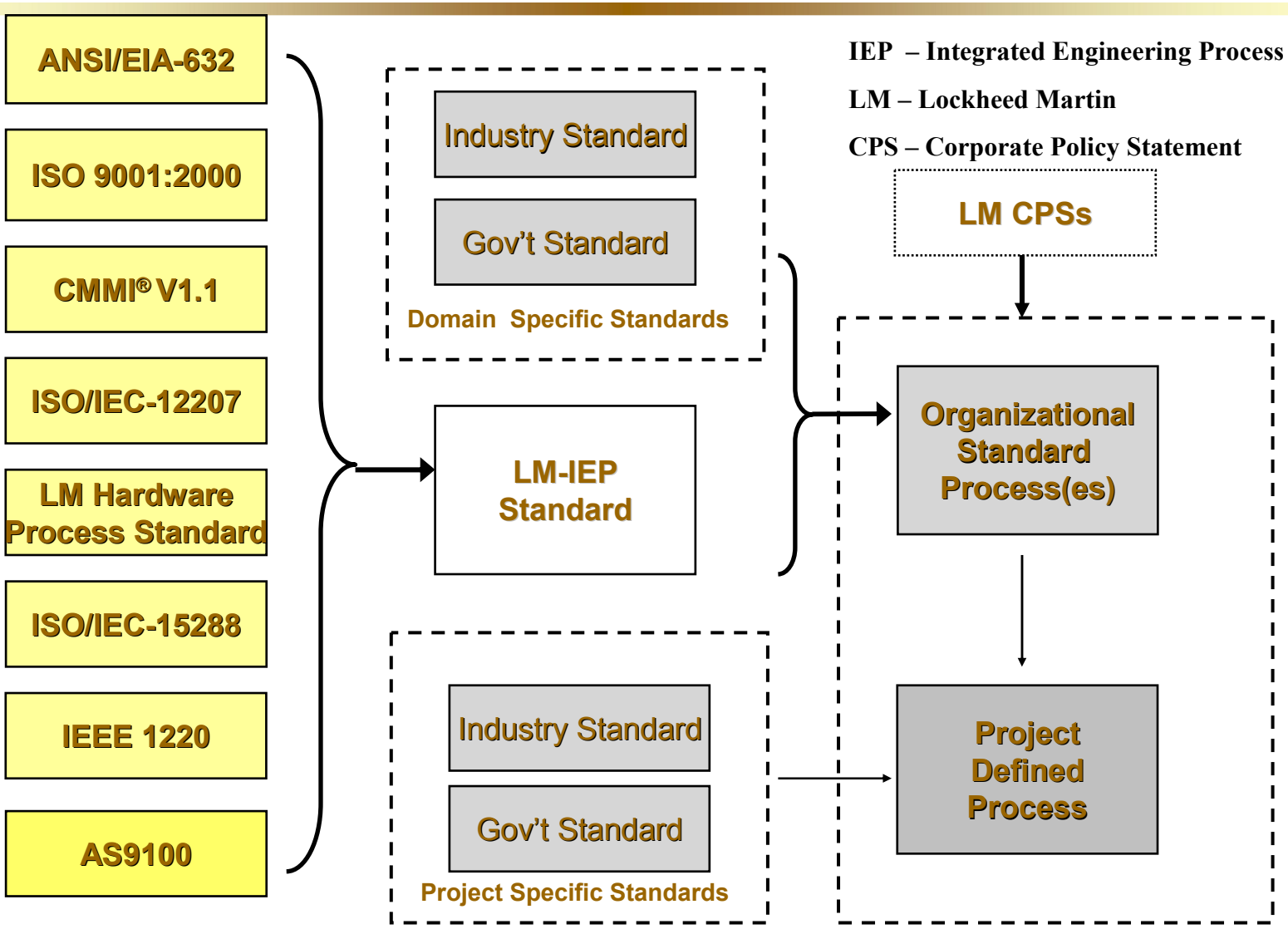
Key Tenets of Lockheed Martin's CMMI® Transition

- Address CMMI® in the context of your organization's business requirements
  - Lockheed Martin's Integrated Engineering Process (LM-IEP) standard includes CMMI®, in addition to other standards and requirements (e.g., ISO/IEC 15288, ISO 9001:2000)
- Use SCAMPI^{SM} A for benchmarking
- Adopt an incremental appraisal approach for process improvement and SCAMPI^{SM} readiness
  - Lockheed Martin Continuous Appraisal Method (CAM) has been successfully deployed with CMMI®

^{SM} SCAMPI is a service mark of Carnegie Mellon University.

LM-IEP Context Diagram

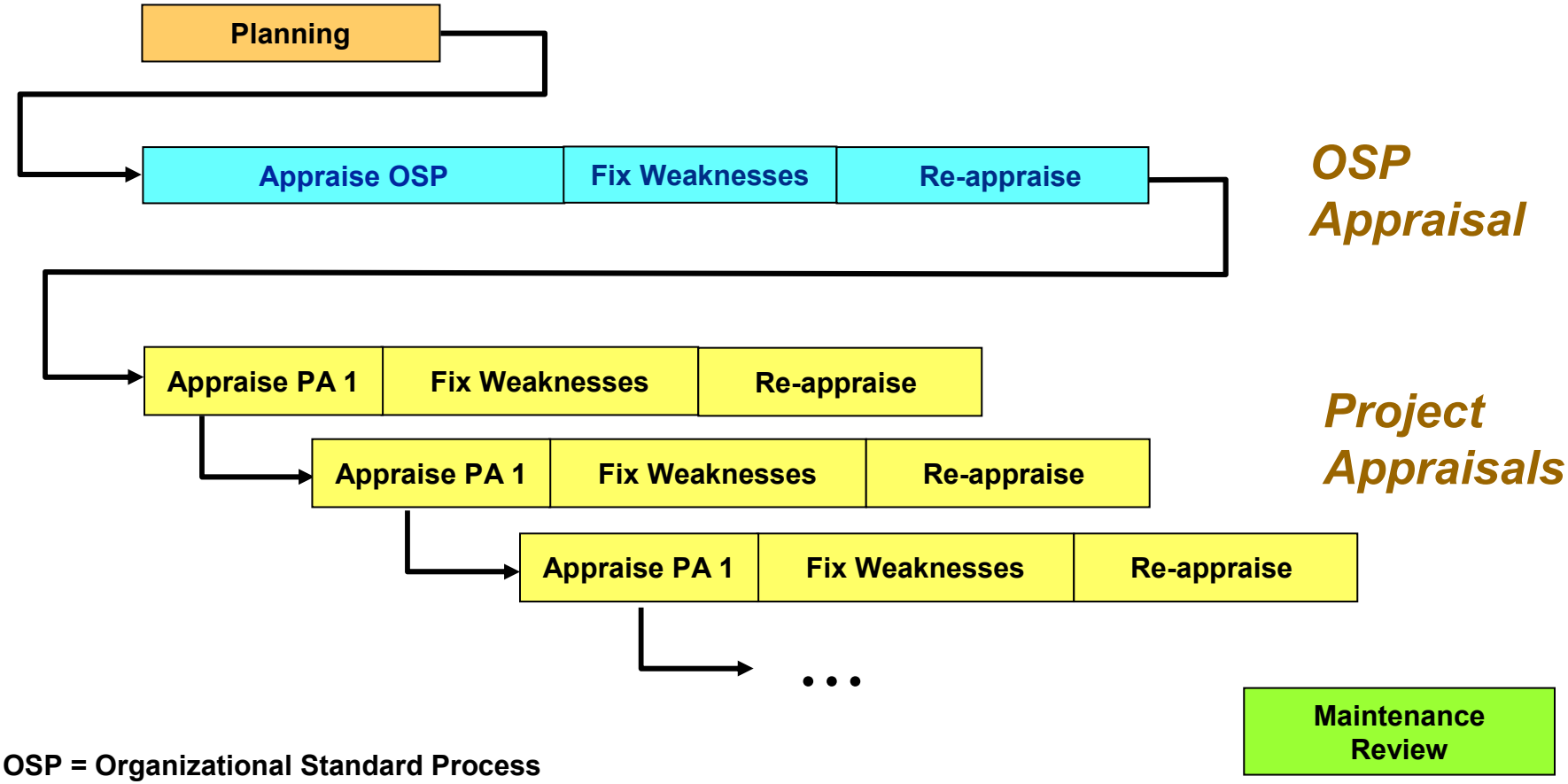


Continuous Appraisal Method (CAM) Design Goals

- Minimize appraisal preparation and reduce cost
- Integrate process improvement with process appraisal activities
- Facilitate appraisal scheduling and minimize disruption for participants
- Provide an appraisal environment conducive to process improvement
- Promote institutionalization

CAM was originally developed for use with EIA/IS 731 and is being used with CMMI®

Overview of Incremental Appraisal Using CAM



OSP = Organizational Standard Process
PA = Process Area

Institutionalization focus with minimal project disruption

Feedback on CAM usage

- 14 CAMs have been completed or are underway at Lockheed Martin operating units using CMMI®
  - 6 prior CAMs have been completed using EIA/IS 731
- Experience with CAM has been positive:
  - More focus on process improvement
    - Facilitated by the incremental approach
  - Less invasive to programs
  - Less stressful to the organization
  - More value-add, in-depth findings
  - More cost effective
  - Effective method to prepare for SCAMPI℠

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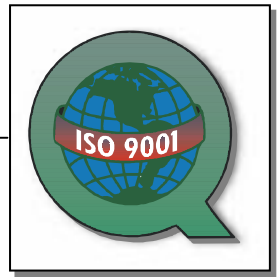
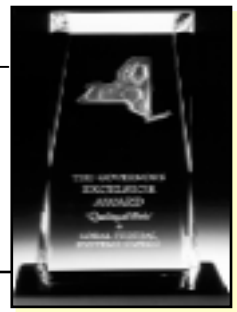
Lockheed Martin Systems Integration - Owego Process Credentials





2003 CMMI Level 5 / AS 9100A 2003

2002 Q-100 Award 2002

2001 ISO 9001:2000 / SEI CMMI Pilot Site 2001

2000 Lean / Six Sigma 2000

1998 LM21 Best Practices 1998

1997 SW CMM Level 5 1997

1996 ISO 9001:1994 / SW CMM Level 3 1996

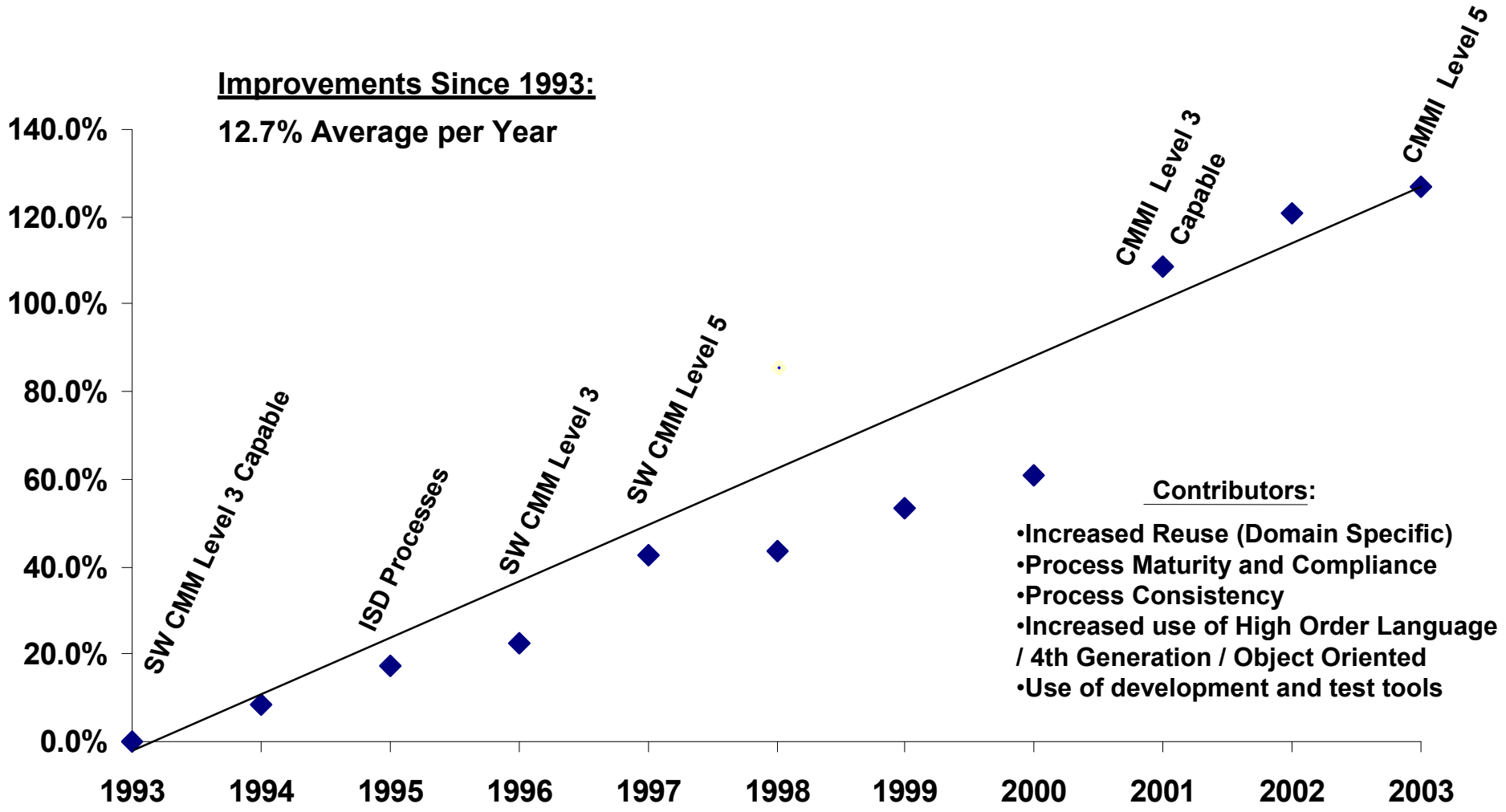
1995 RIT / USA TODAY Quality Cup Finalist 1995

1994 New York State Excelsior Award 1994

1993 IBM Baldrige Gold Award 1993

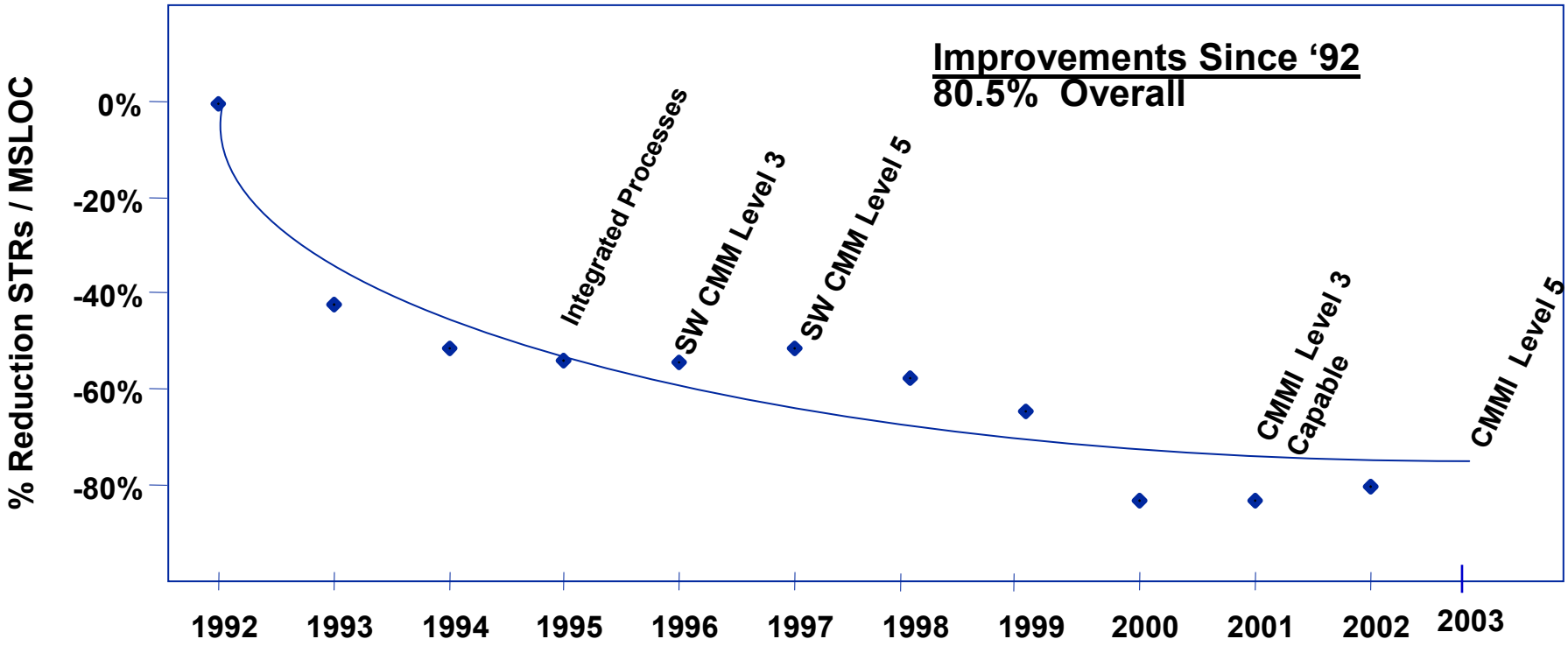
1990 TQM 1990

Software Productivity (All Software including Reuse)



Lockheed Martin Systems Integration Owego - Quality

Software Defects per Million Delivered Source Lines of Code



Note: Started counting defects differently in 2004. Redefined from "Latent" to "Open at Delivery".

LM Maritime Systems & Sensors Tactical Systems Process Improvement Credentials

- Oct. 1999 – Attained SW-CMM® level 4
- Dec. 2000 – Attained Systems Engineering Capability Model (EIA 731) level 3
- Jan. 2001
  - Began focus on integrated process improvement
  - Began transition to CMMI®
- June 2002 – May 2003 CAM Appraisal
  - OSP: Target profile 5 for CMMI®-SE/SW/IPPD/SS
  - Projects: Target profile 3 for CMMI®-SE/SW
- August 2003 – SCAMPI^{SM} Appraisal
  - Achieved maturity level 3 using CMMI®-SE/SW

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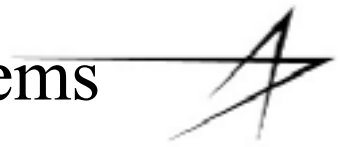
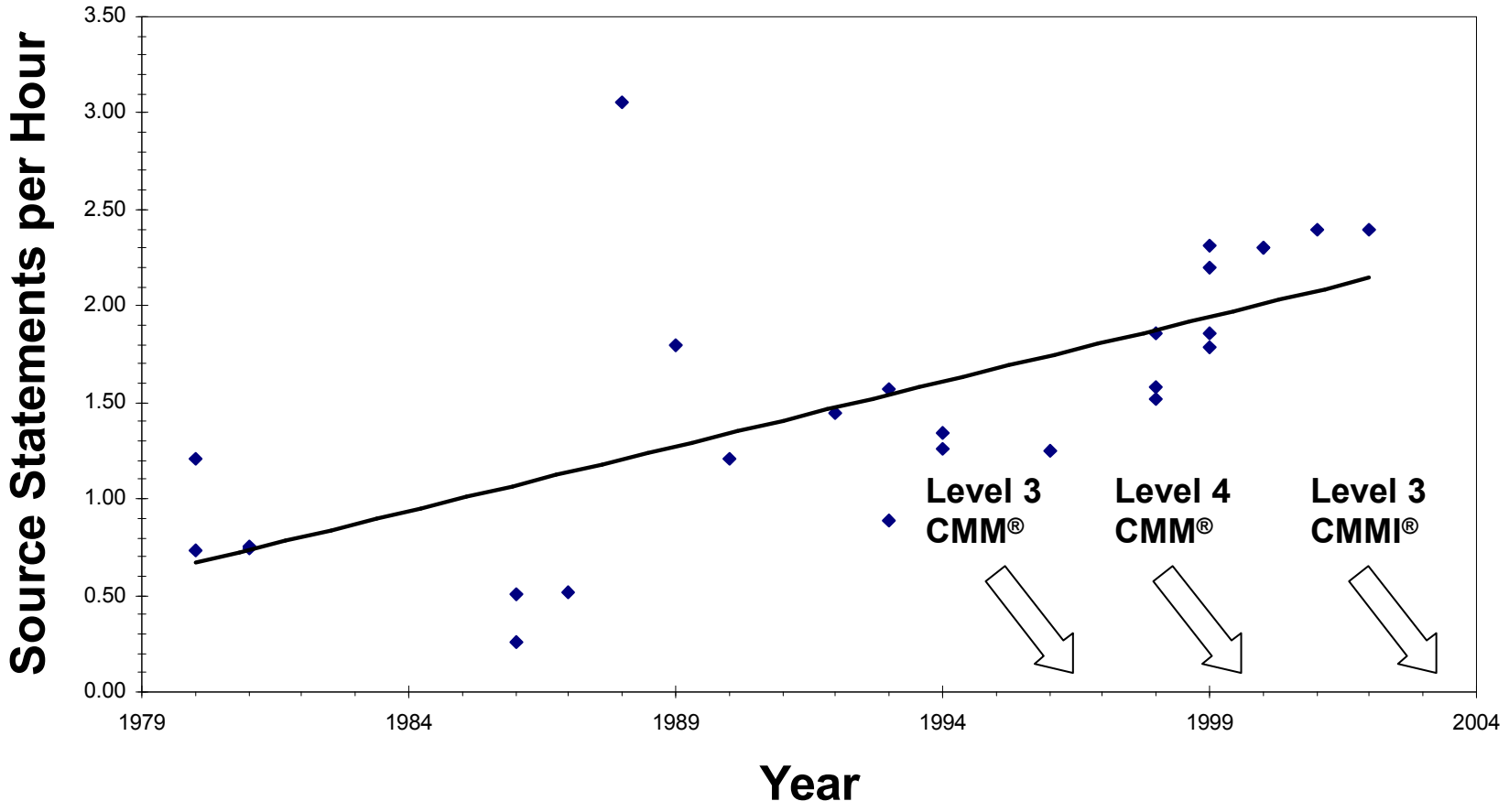
LM Maritime Systems & Sensors Tactical Systems 2004 Initiatives



- Implement CMMI®-SE/SW maturity level 4
- Streamlining of references and guidance documents which supplement the OSP
- Conduct LM-IEP gap analysis
- Risk management methodology best practice
- Populate Process Asset Library (PAL)
- Self audit process compliance
- Mechanical engineering guidebook
- Airworthiness manual
- Work product templates
- Cost Estimation Relationships Guide

LM Maritime Systems & Sensors Tactical Systems Software Productivity



LM Maritime Systems & Sensors - Syracuse Process Improvement Credentials

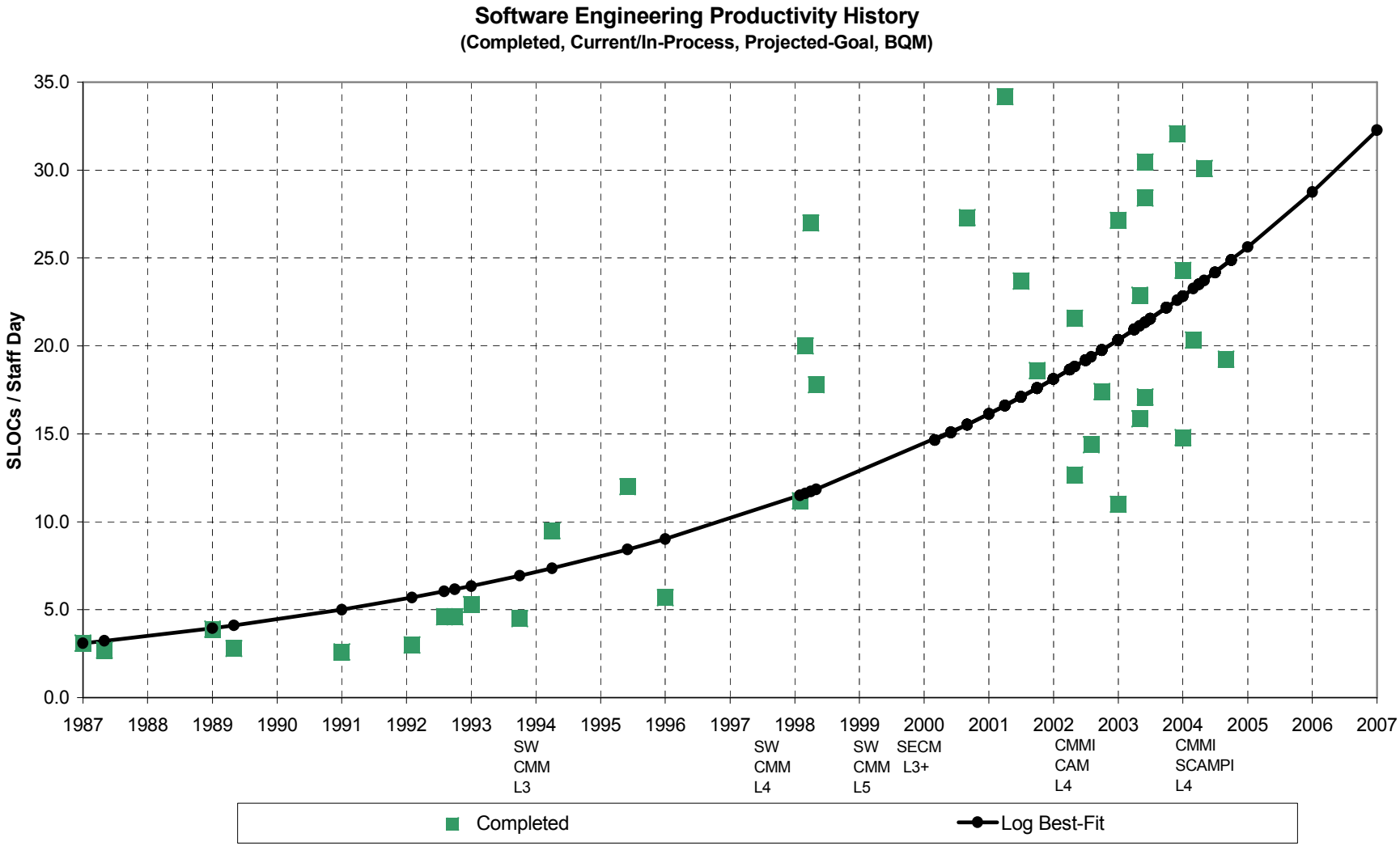
- SW-CMM® level 5 (CBA IPI[SM]) in Dec. 1999
- Systems Engineering Capability Model (EIA/IS 731) level 3+ (CAM) in Dec. 1999
- Focus on integrated process improvement including hardware began in 2000
- Transition to CMMI® began in 2000
- CMMI®-SE/SW/IPPD target profile 4 (CAM) in Nov. 2002
- CMMI®-SE/SW maturity level 4 (SCAMPI[SM]) in May 2004

® SW-CMM and CMMI are registered in the U.S. Patent and Trademark Office by Carnegie Mellon University.
[SM] SCAMPI is a service mark of Carnegie Mellon University.

LM Maritime Systems & Sensors - Syracuse
2004 Functional Excellence Initiatives

- LM21 Business Excellence
- Design for Six Sigma (DFSS)
- Technical Assurance
- Integrated Product Development
- Digital Dashboard
- CMMI®-SE/SW Maturity Level 4
- Continuous Process Improvement
  - ↗ Process Development
  - ↗ Quantitative management

LM Maritime Systems & Sensors - Syracuse
Software Productivity



LM Maritime Systems & Sensors – Undersea Systems Process Credentials

- Systems & Software Engineering*
  - Software CMM® Level 4 (CBA IPI) - June 1995
  - Software CMM® Level 5 (CBA IPI) - February 1999
  - CMMI® & EIA-731 target profile 3 (CAM) - October 2001
  - CMMI®-SE/SW/IPPD/SS target profile 5 (CAM) - October 2002
- Quality Management
  - ISO 9001:1994 - September 1995
  - AS9000 - November 1997
  - Defense Contract Management Agency (DCMA) ISO 9001 Qualified - December 1997
  - ISO 9001:2000 - December 2000
  - AS9100A – December 2002

***Assessed programs comprise over 80% of the Undersea Systems development programs, and all parts of the development cycle.**

LM Maritime Systems & Sensors – Undersea Systems Process Chronology

1970s
- Top-down Structured Programming
- Design & Code Inspections

1980-2
- Functional Decomposition
- SW Engineering Workshop
- Advanced Design Workshop

1983
- SW Management Workshop

1984
- Ada Workshop

1985
- Requirements Inspections

1986
- FSC Practices & Measurements

1988
- SW Technology Steering Group
- Organizational Operating Procedures

1990
- SW Engineering Process Group Formed
- First SW-CMM® Assessment (Level 3)
- Formal Estimation Procedures

1991
- Market Driven Quality
- Reuse Focus

1992
- Defect Prevention Process

1993
- Integrated Teams
- Standard Development Environment
- Integrated Process Group

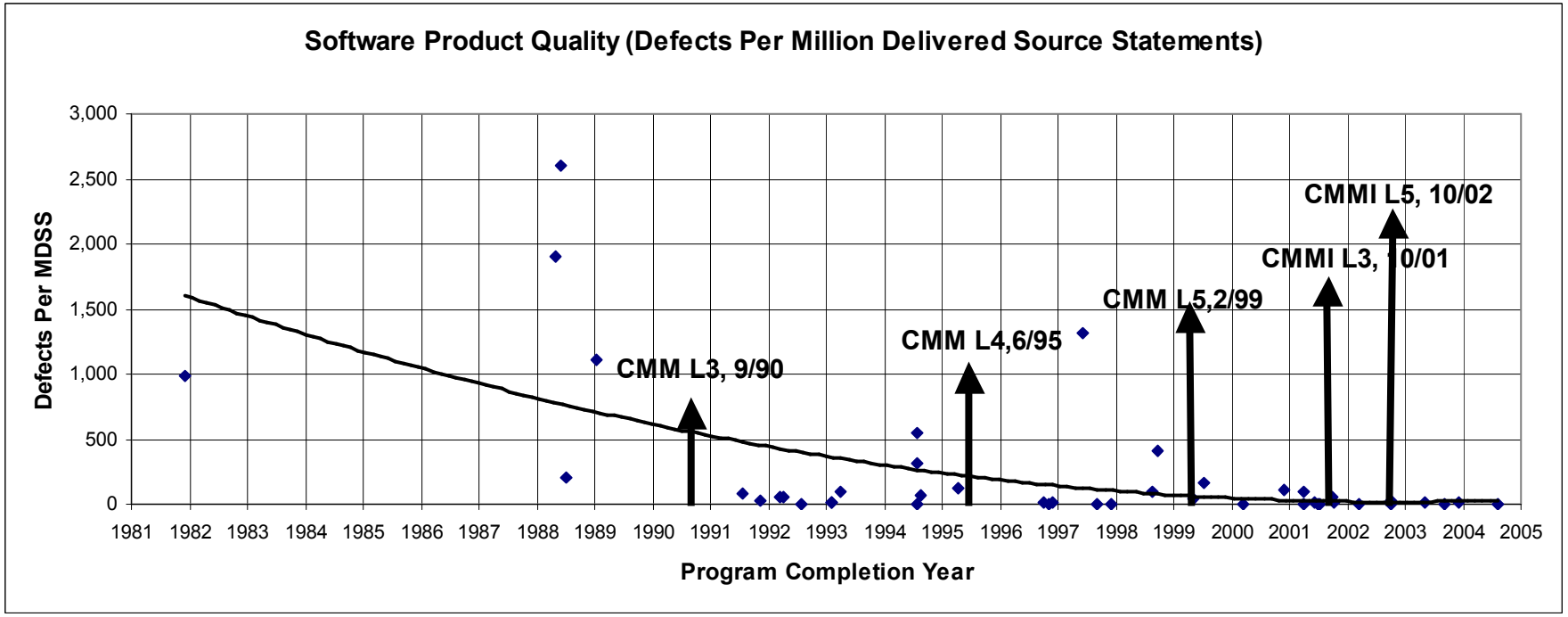
1994
- Automated Metrics
- Process Coordination Group (PCG)

1995-6
- Integrated Process Library
- ISO 9001 Registration
- Software CMM® Level 4

1997-9
- ISO 14001 Registration, AS9000 & DCMA ISO 9001 qualification
- Software CMM® Level 5

2000->
- ISO 9001: 2000 Certification
- EIA-731 Level 3
- AS9100A Certification
- CMMI®-SE/SW/IPPD/SS Target Profile 5 (CAM)

LM Maritime Systems & Sensors – Undersea Systems
Software Product Quality



Note: CMM® levels were achieved via CBA IPI. CMMI® levels indicate the result of CAM assessments using CMMI®-SE/SW/IPPD/SS with a lead appraiser outside of Undersea Systems.

LM Maritime Systems & Sensors – Undersea Systems
Software Quality

Product Quality Level is in Five Sigma Range

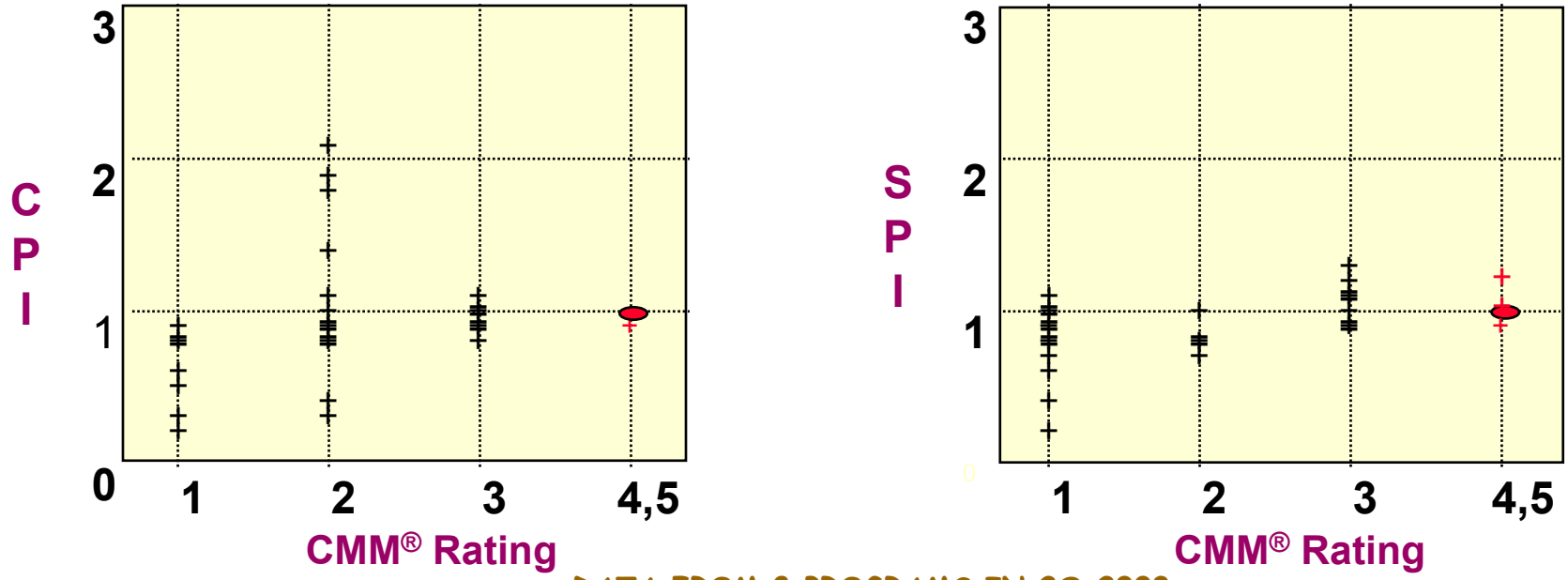
Sigma	Defects/MS
1	690,000.0
2	308,537.0
3	66,807.0
4	6,210.0
5	233.0
6	3.4

MS = Million Source Statements

LM Maritime Systems & Sensors – Undersea Systems
Cost & Schedule Estimates vs. Actuals at Maturity Level 5

Cost Performance Index (CPI) & Schedule Performance Index (SPI)

SCATTER PLOTS BETWEEN "1" AND "3" RATINGS ARE INDUSTRY SAMPLES.
LOCKHEED MARTIN DATA HAS BEEN ADDED IN RED.



DATA FROM 8 PROGRAMS IN 2Q 2003

Reference: "A Correlational Study of the CMM® and Software Development Performance"
Lawlis, Flowe & Thordahl, CROSSTALK, September 1995

LM Maritime Systems & Sensors – Undersea Systems Process Maturity Benefits

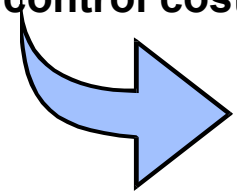
Continuous process improvement is rooted in Manassas' culture...and the benefits are so ingrained in our approach, we tend to take them for granted:

- **Consistency**
  - **More likely to get the same results each time within a small range**

  THIS IS A VERY REAL MEASURE OF QUALITY IN TODAY'S MARKETPLACE

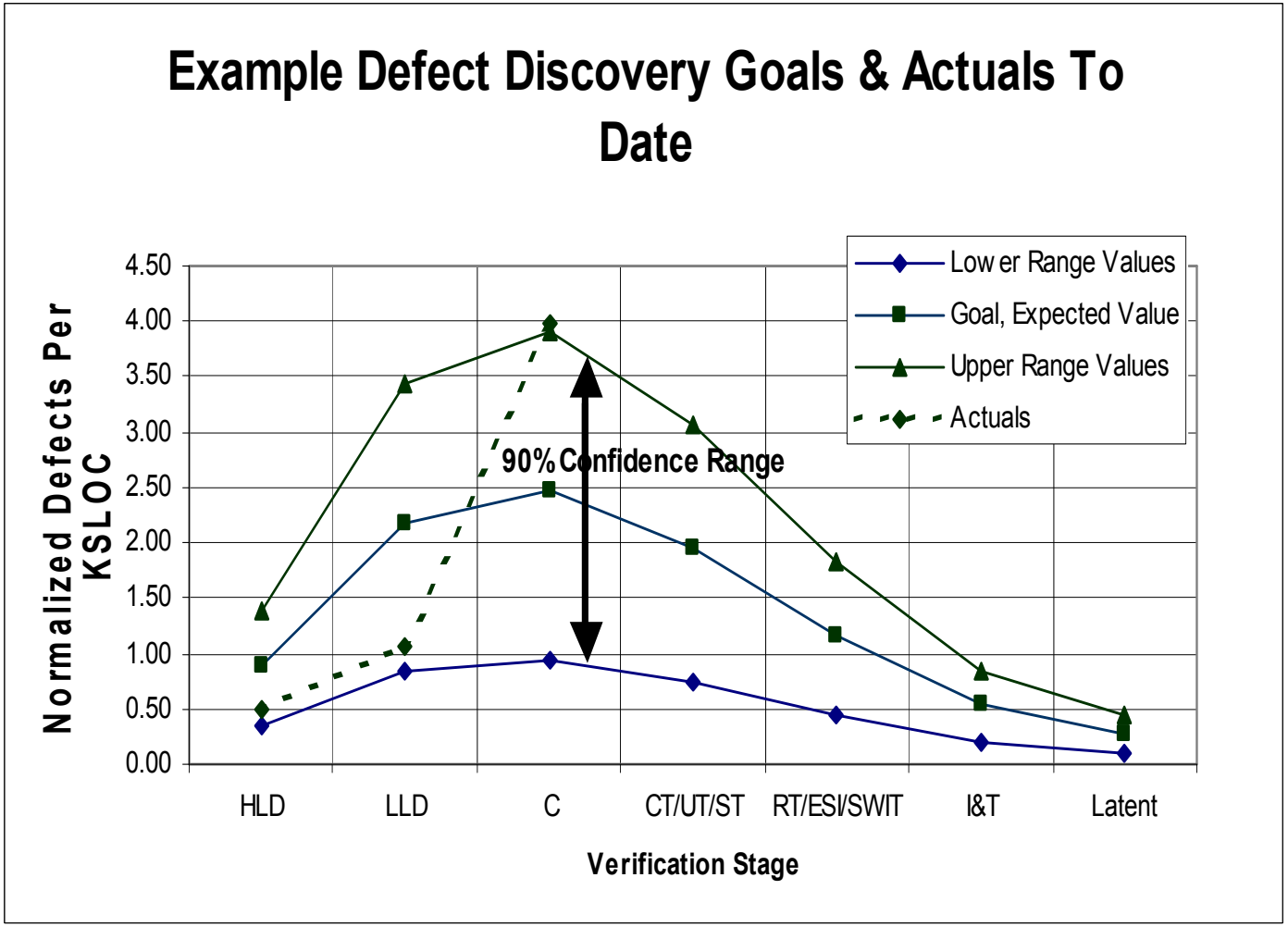
- **Predictability**
  - **Much easier to estimate work**
  - **Better able to assess impact of change**

- **Manageability**
  - **Able to measure and track progress**
  - **Better able to change and improve**
  - **Better able to control costs and meet schedule**



- ***IT ALL ADDS UP TO***
  - **IMPROVED QUALITY**
  - **IMPROVED PROFITABILITY**

Example of Defect Discovery Profile for Another LM Organization



Summary

- The trend previously reported continues:
  - ↗ Benefits derived during SW-CMM® implementation continued to be realized as CMMI® maturity evolves
- Allocating benefits to their sources is difficult when implementing multiple models/standards and initiatives
- SW-CMM® and CMMI® are viewed as significant (but not sole) contributors to process improvement benefits to date

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Acronyms

- ARC – Appraisal Requirements for CMMI®
- CAM - Continuous Appraisal Method
- CMM® - Capability Maturity Model
- CMMI® - Capability Maturity Model Integration
- ESLOC or ESS – Equivalent SLOC/SS; a normalized value derived from new development, plus SLOC/SS that are modified, retained, ported, etc.
- IPPD - Integrated Product and Process Development
- LM - Lockheed Martin
- LM-IEP - Lockheed Martin Integrated Engineering Process
- OSP – Organizational Standard Process
- PA - Process Area
- SLOC – Source Line of Code
- SS – Source Statement (sometimes called a “Logical SLOC”)