NORTHROP GRUMMAN
Information Technology

3rd Annual CMMI Technology Conference and User Group

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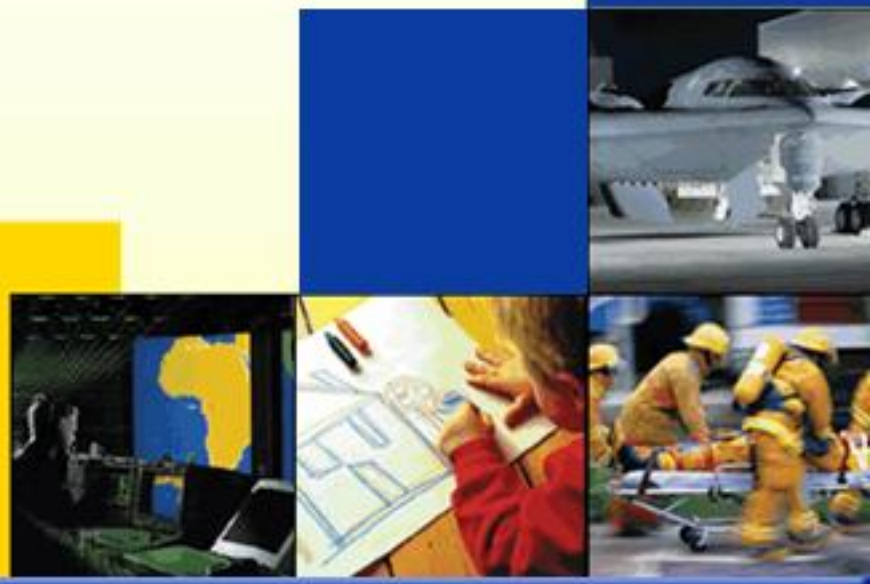
Defense Enterprise Solutions
Northrop Grumman Information Technology
November 18, 2003



Organizational Perspective

- Northrop Grumman
  - $26 B in revenue; 120,000 employees; 50 states; 25 countries
- Information Technology (IT) Sector
  - $4.7 B in sales; 23,000 employees; 48 states; 15 countries
- Defense Enterprise Solutions (DES) Business Unit
  - $610 M in sales; 3,045 employees, 23 states, 4 countries
- DES provides enterprise-wide technology solutions to the Defense marketplace
- Major Application Areas:
  - Logistics
  - Mission Support
  - Science & Technology
  - Simulation, Analysis, and Training
  - Communications & Infrastructure

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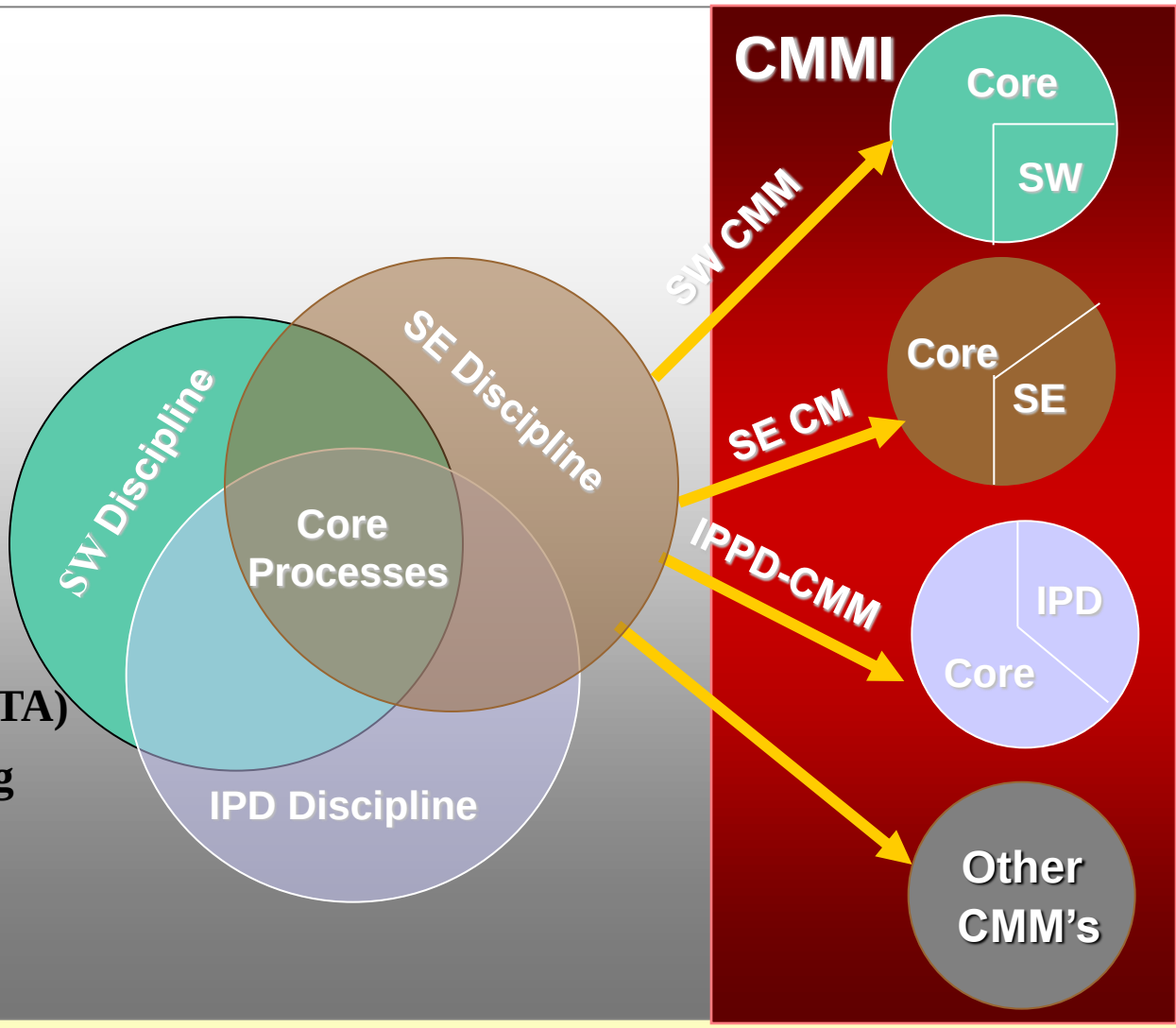
Core Processes Common to Multiple Disciplines

Information Technology Products & Services in Constant Change

- IT Consulting
- Sys Arch, Engin & Delivery
- Enterprise Integration
- IT Infrastructure Management
- Applications Management
- Sys Eng & Tech Assistance (SETA)
- Functional Process Outsourcing



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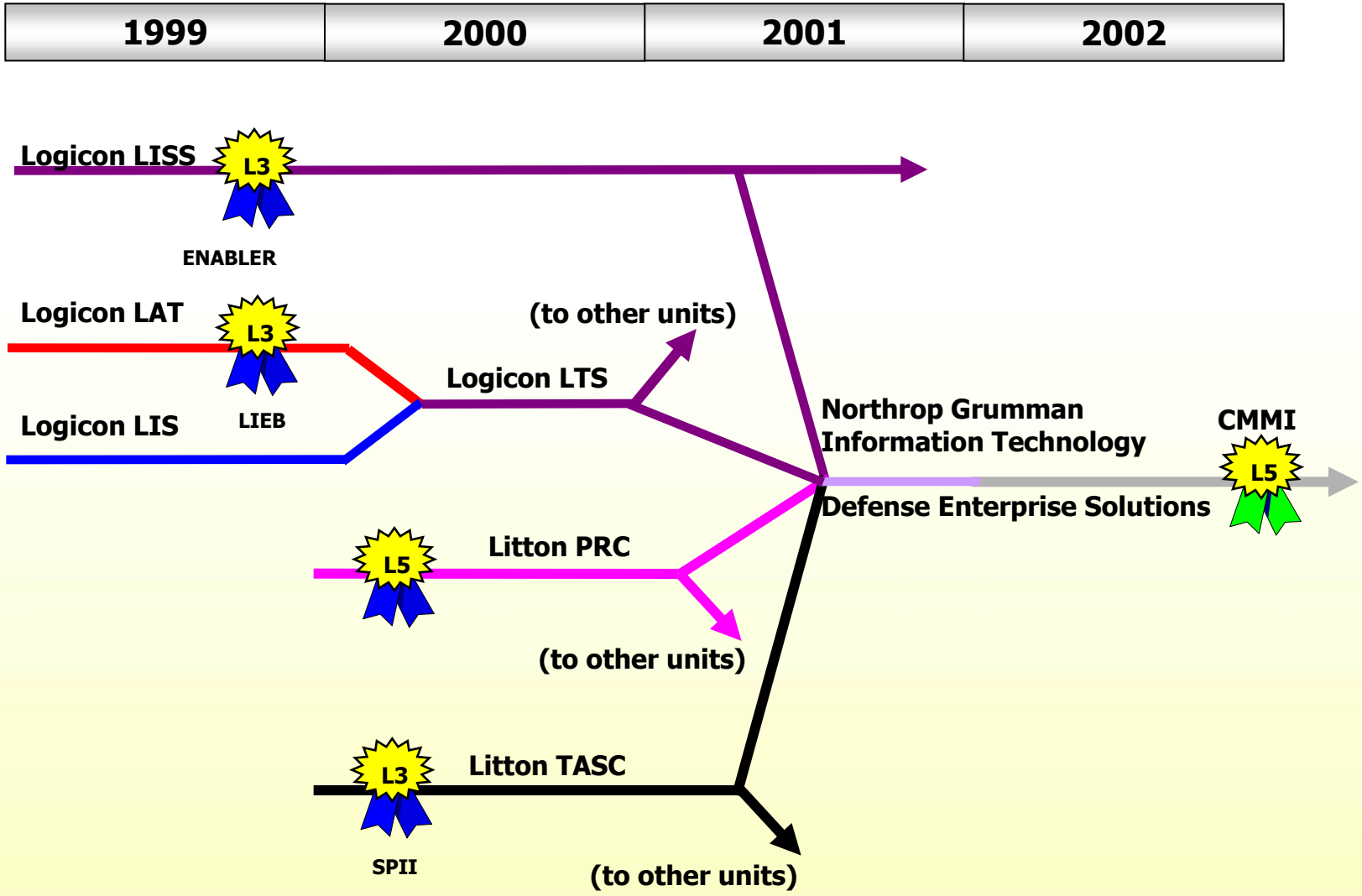
Organizational Process Maturity Pedigree



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Business performance linked to Process and Quality Performance

DES Business Goals	DES Process & Quality Performance Objectives
• Achieve Customer Satisfaction rating (CPAR or equivalent) of Blue or Green on 90% of contracts over $5 million annual revenue or deemed to be of significant strategic value. The percentage of contracts with a Blue rating will be at least 33%. • Achieve Revenue, Profit and other financial goals	1. Achieve Cost Perf. Index = 1 ± 0.1 (monthly) 2. Achieve Schedule Perf. Index = 1 ± 0.1 (monthly). 3. Achieve Est-To-Complete-Variance = 1 ± 0.1 (monthly) 4. Achieve 10% improvement in Defect Density for each life cycle phase (from previous baseline) Objectives are monitored on a monthly basis for the projects; organizational baselines are evaluated on semi-annual basis.

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Organizational and Project Quantitative Management Process Overview

DES Business Objectives

1 **DES management selects quality and process goals & measurements**

6 **DES management checks org and project data against DES goals (process capability baseline).**

Organization

Project

2 **Projects select related goals & measurements for each life cycle phase.**

5 **Projects check performance against project goals and business objectives.**

3 **Projects track process performance over time.**

4 **Projects improve performance by removing root causes for out-of-bound conditions.**

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Quantitative Management

- **Measurable contractual commitments:**
  - **Delivering products and services on time and under budget**
  - **Delivering quality (low-defect) products**
- **Measurable process and quality commitments; DES developed process performance and product quality goals to tract program performance:**
  - **Cost**
  - **Schedule**
  - **Quality**
- **Demonstrable senior management commitment**
  - **DES tracks this through its senior management operations reviews (a sample follows)**

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S&T/ITS Program and QM Indicators

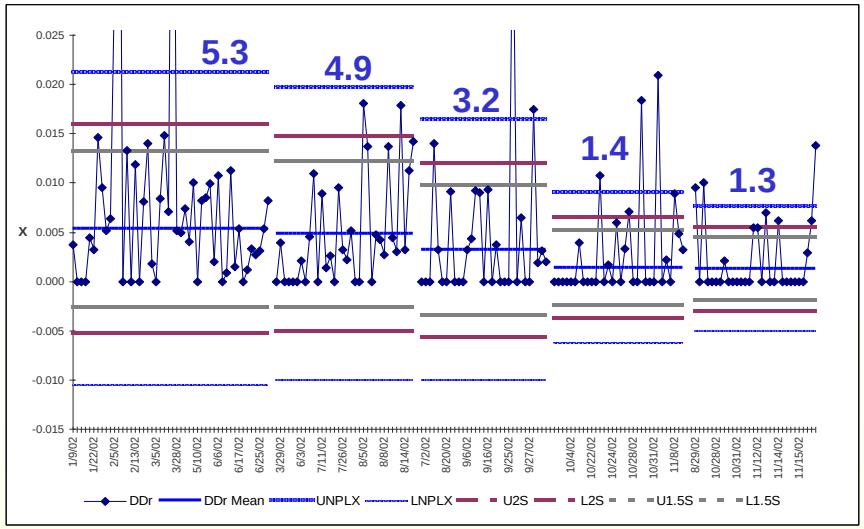
S Technical Code

- **Goal:**

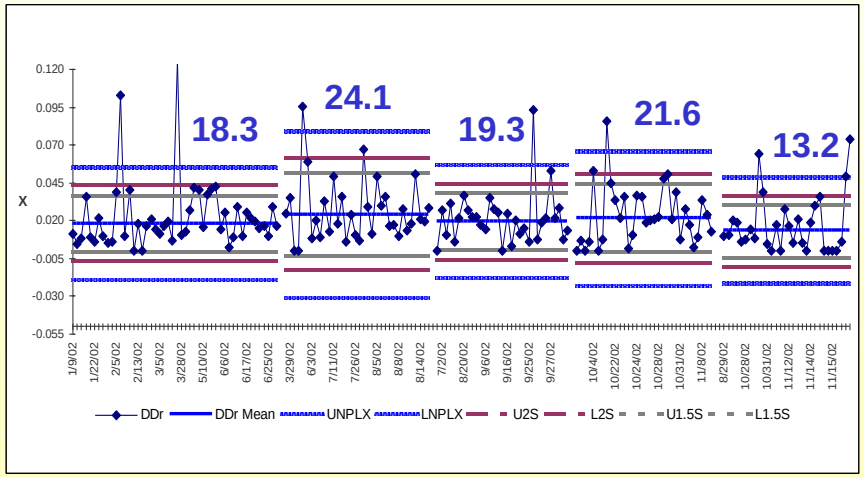
Critical/Urgent Defect	Total Defects
≤ 5/KLOC	≤ 10/KLOC

- **Action**:
  - DP Cycle #1 **countermeasures are effective. Reduced targeted "checking" defects from 2.6/KLOC to 1.2/KLOC.**
  - DP Cycle #2 **focused on defects escaping the PSP Cycle. Follow up from countermeasures show improvement in schedule and quality.**
  - DP Cycle #3 **focused on units with highest test defects. Countermeasure approved to peer review code again prior to customer dry run testing.**
  - SCoVs **– 6 complete, 2 in progress, 5 approved for Builds 4 & 5.**
  - DDt – **SPC for Defect Density by test (DDt) is not useful, investigating alternate metrics, began Rayleigh Curve.**
- **Technical Highlights**: Construction Complete
  - Inspection & Test **- 100% of all code was peer reviewed. 100% Unit Test and Internal Integration Test complete.**
  - Total DDt in Unit Test - **1.39/KLOC (Goal ≤ 2)**
  - Total DDt Internal Integration Test - **.44/KLOC (Goal ≤ 1)**

Critical/Urgent Defect Density/KLOC (Peer Review)



Total Defect Density/KLOC (Peer Review)



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S&T/ITS Program and QM Indicators

E Technical Test

- **Goal:**

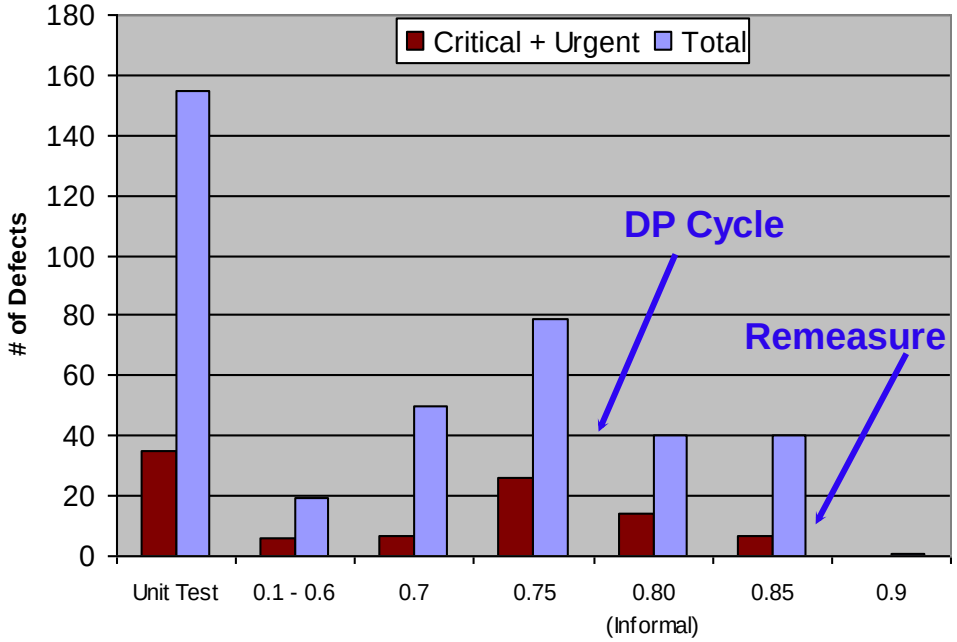
Critical/Urgent Defect		Total Defects
DDt Unit	≤ .5/KLOC	≤ 2/KLOC
DDt	≤ .25/KLOC	≤ 1/KLOC

- **Action:**
  - **None for Defect Density goals.**
- **Technical Highlights:**
  - UNDER Cycle Goals!

Build	Critical + Urgent	Total
Unit Test	.33	1.4
0.1 – 0.6	0.056	0.18
0.7	0.065	0.46
0.75	0.233	0.73
0.8	0.132	0.38
0.85	**0.066**	**0.38**
0.9		

DP Cycle

ITS Test Defects By Test Cycle
Defect Density by KLOC



- Completed Dry Run Test (.85) with enough time to review enhancements. Decrease in showstopper defects.
- DP Cycle remeasure led to new ideas for team and enhancements analysis

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S&T/ITS Program and QM Indicators

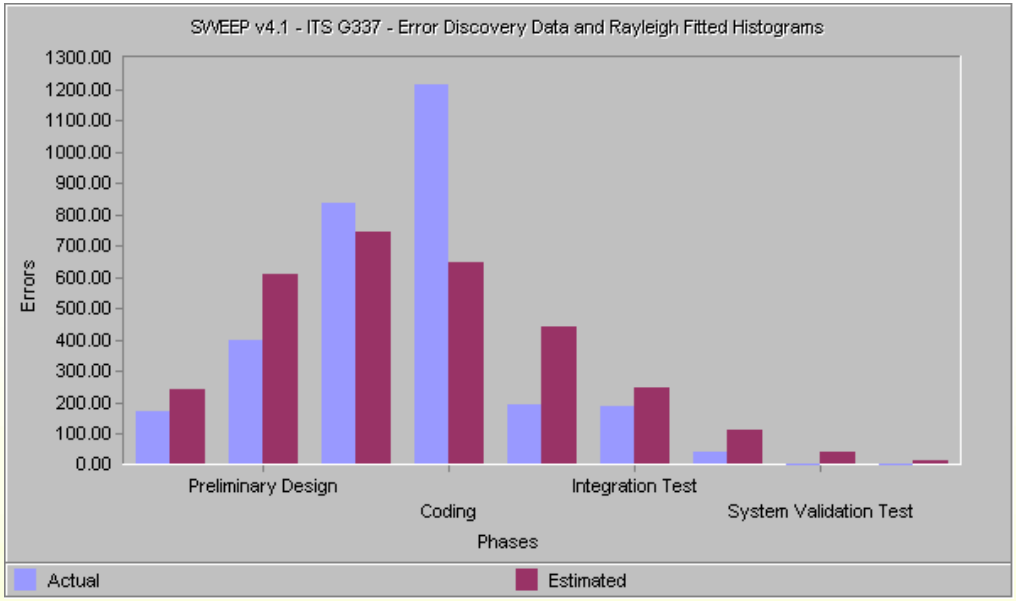
E Technical Test

- **Goal:**
  - DDs **– Defect Discovery**

Critical/Urgent	Total Defects
≤ .25/KLOC	≤ 1/KLOC

- **Action:**
  - **None for Defect Discovery goals.**
- **Technical Highlights:**
  - Total Test Defect Density **- Sept 2003 is 5.2/KLOC! There is no significant change to defect density this month. This is relative to 19/KLOC in Peer Review!**
  - DDs
    - Dry Run Test Latent = 0.044/KLOC
    - Discovery Predictions next = 0.405/KLOC
    - Discovery Predictions next = 0.132/KLOC

ITS Phase Based Estimates after Dry Run Test (8/31/03)



Projected Latent	Error Discovery Efficiency	Next Phases Estimates
4.725	99.85%	43, 14

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E Technical Documentation

Goal: **Total Defects ≤ 1/Page**

Actual:

Total STF Defects = .688/Page

Total User Manual Defects = .709/page

Total Misc. Doc Defects = .701/page

(Critical & Urgent = .165/page)

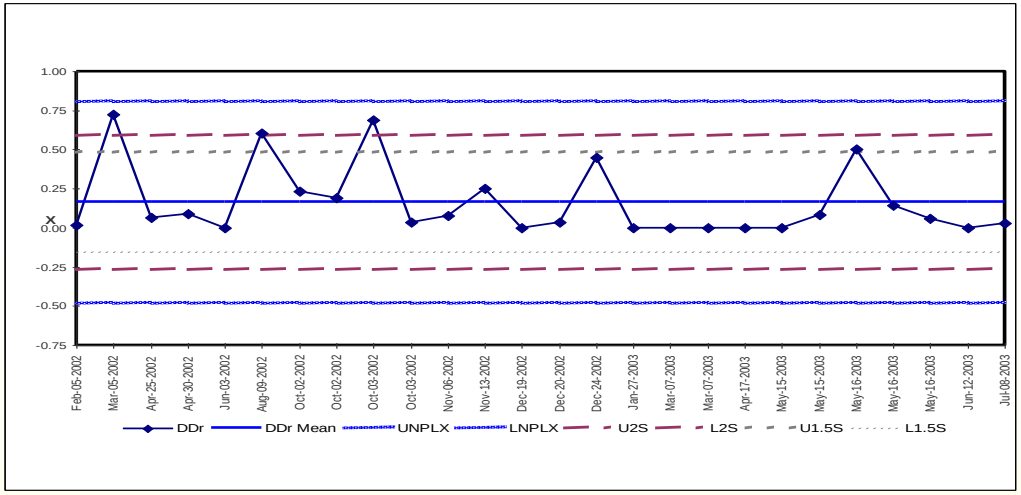
Action: **No new SCoV**

Technical Highlights:

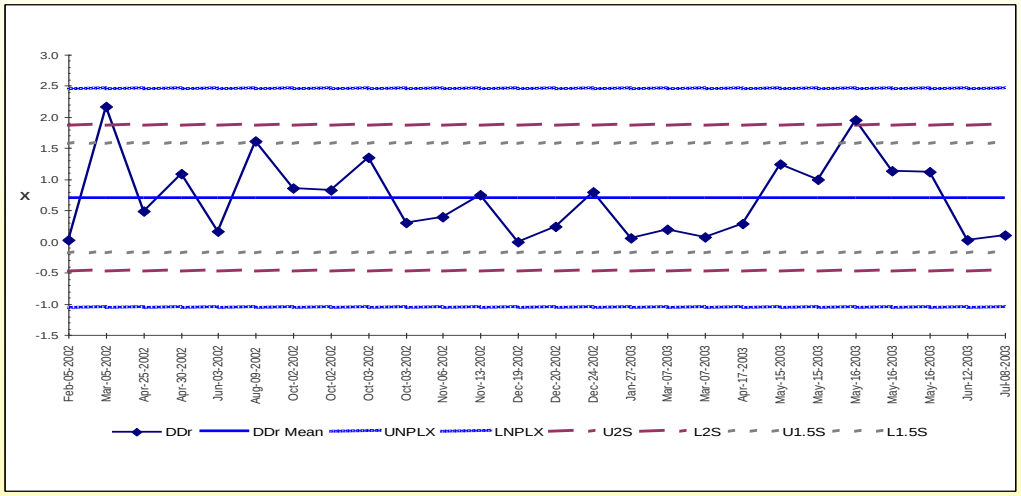
Reviewed 100% documentation

100% documentation DDr exceeds goal (Misc Documentation Mean Critical + Urgent continues to decrease)

Critical/Urgent Defect Density – Misc. Documentation



Total Defect Density – Misc. Documentation



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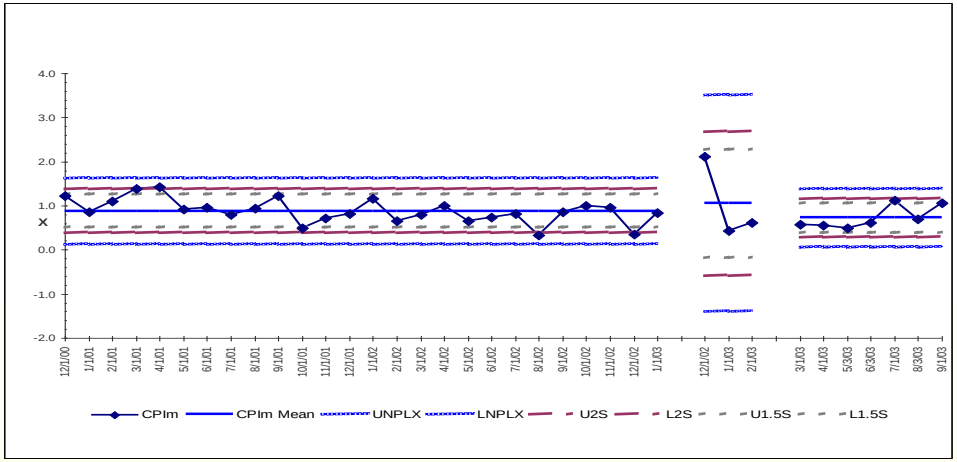
S&T/ITS Program and QM Indicators

S Financial

- **Goal**: 1 ± 0.1 (0.9 - 1.10)
- **Actual**: Current CPIm Mean = .730
- **Action**: Continue ECP plans and attempt cost impact recovery from customer as part of the DMSI schedule alignment ECP.
- **Technical Highlights**: As expected the CPIm remains out of goal. Low number of defects allowed a positive cost variance to increase the mean by 5.7%.

CLIN 1 and CLIN 2 – CPIm (Monthly – Sep 03)



S Schedule Performance

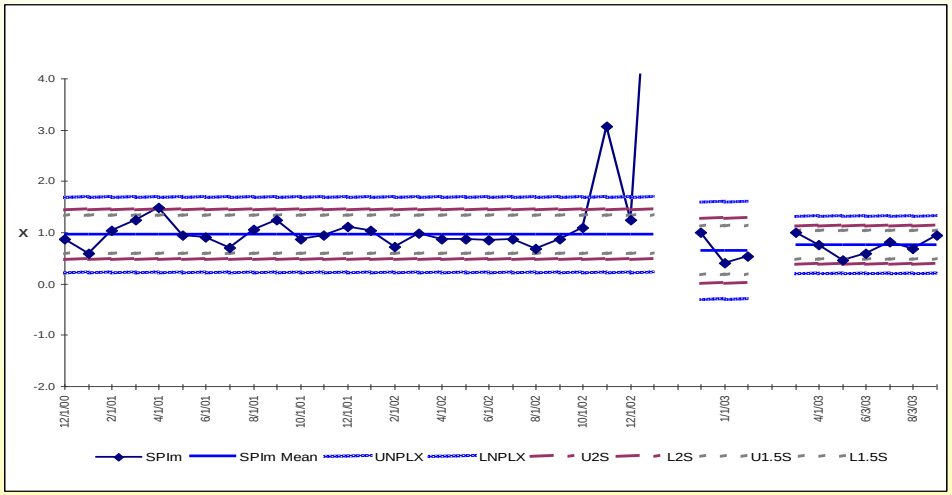
Goal**: 1 ± 0.1 (0.9 - 1.10)**

Actual**: Current SPIm Mean = .753**

Action**: Continue with ECPs and Test Activities**

Technical Highlights**: Released CBT. Preparing Software Test Report.**

CLIN 1 and CLIN 2 – SPIm (Monthly – Sep 03)



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S&T/ITS Program and QM Indicators

E Customer Satisfaction

As stated in the ITS Quantitative Management Plan

Category 1: Customer Satisfaction

- **Goal**
  - **Deliver no known open Level 1-3 severity defects**
  - **Achieve contractual expectations as defined in the ITS SRS and implied customer expectations as defined in the ITS SQASP**
- **Actual**
  - **100% known peer review and test defects have been repaired.**
  - **Customer completed performance survey. ITS was rated** "Exceptional" **in all categories. Looking to receive CPARs in CLIN 2. None received to date.**
- **Action** None
- **Technical Highlights**
  - **Customer continues to fund contract mods to keep team momentum and buy conversion data schedule time. Customer continues to fund T&M CLIN. Requested synchronized ITS schedule to DMSI schedule.**

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Organizational Innovation

- To provide higher quality and better services to our customers, DES:
- Set aggressive goals based on past quantitative performance
- Research innovations internally and externally to measurably improve our performance.
- Report out monthly on performance…

- An example follows…

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Project Comparisons

- **Two projects with:**
  - **Same customer (different divisions)**
  - **Similar applications**
  - **Both Client-Server (PowerBuilder / Oracle)**
  - **Similar level of team expertise and training**
  - **Estimated to be similar size and effort (~$2 Million)**

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Key Process Insertion Differences

- **Project A:**
  - **Disciplined team design process used to create sound developer work packets**
  - **Personal Software Process used consistently by developers**
    - SEI developed course for software developers which provides process at an individual level for producing software components and documentation (user & technical)
  - **Peer Reviews conducted on the most critical 20% of the software**

- **Project B:**
  - **We decided that this project was “too far along” to benefit from process insertion**

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Project Test Time / Cost

	Project A	Project B
Integration / Acceptance Test Cost	**$78.K**	**$612K**
Normalized (per KLOC)	$0.95K	$4.05K
Time to Accept (months)	**3.7**	**14.6**
Normalized (months per 100 KLOC)	4.5	9.7

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Project Quality

	Project A	Project B
Duration (months)	31.8	43.0
Size (KLOC)	82	151
Developer Defect Density	9.4	17.3
Peer Review Exit Density	4.78	17.3
Delivered Defect Density	1.55	5.27

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Positive Effect of Process Insertion

- **Mature Processes & PSP led to**
  - Project A's Integration and Acceptance Test Costs were 24% of Project B
  - Project A's Test Duration was 46% of Project B
  - Project A's delivered defect density was 29% of Project B

- **Process saved cost, reduced schedule, and improved quality**

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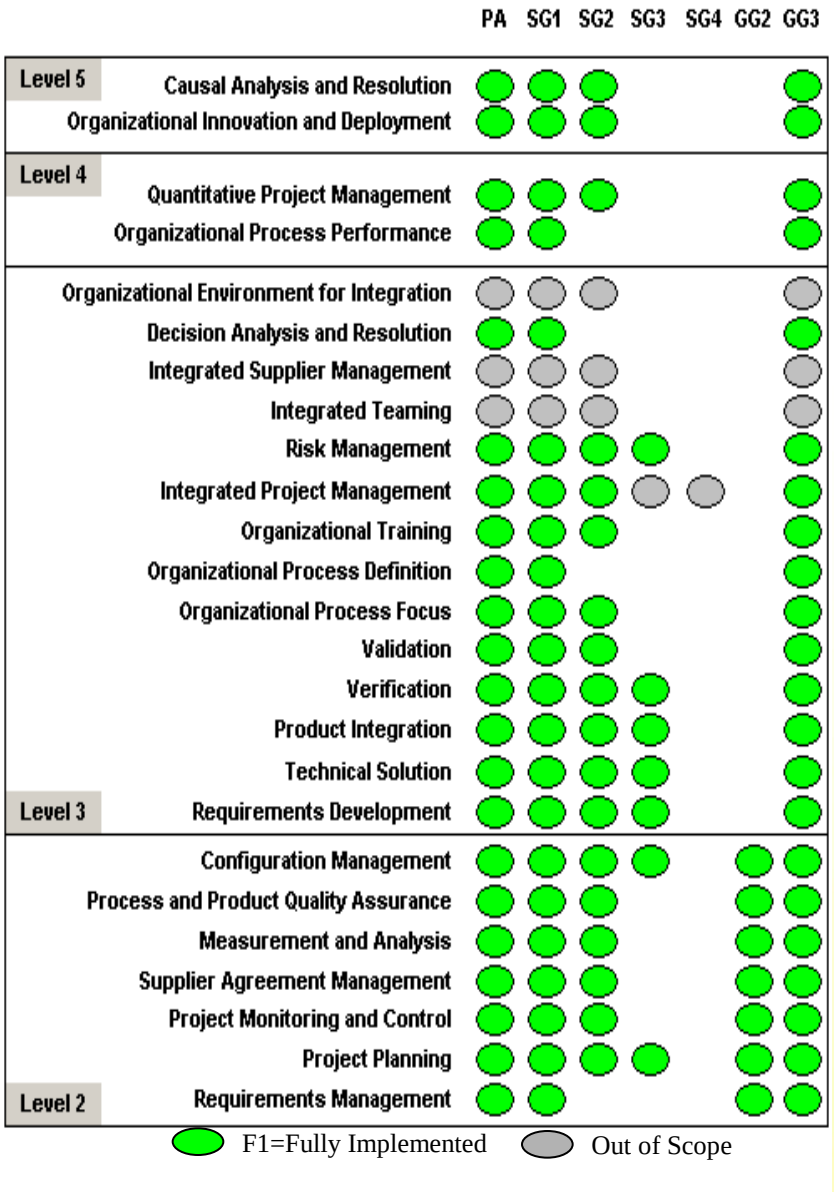
2002 SCAMPI Appraisal Results

Process Maturity

- CMMI SE/SW Level 5 for Staged and Continuous Representations
  - Software CMM Level 5 also
- Organizational Process Strengths
  - Integrated SE and SW Eng
  - Sharing and reusing process assets
  - Data driven corrective action
  - Technology Change Management
- Global Best Practices
  - Requirements Elicitation
  - Quantitative Data Management

Cost, Schedule and Quality Performance

- JEDMICS exceeds software quality goals (.0156 vs .06 defects/KSLOC)
- PERMS exceeds revenue goals by 11%
- AIT has 100% on-time delivery
- Only 2% of total defects found in delivered SIGS product
- ITS is on cost and schedule (CPIm = .965 & SPIm = .985, target = 1.0 +/- .1)
- SIGS averages a customer satisfaction of 98.5% over last four years



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Knowledge Management and Process Management

- ✓ We manage our Processes as a Community of Practice
- ✓ We help our integrated teams share and put process into action
- ✓ Processes underpin each "community of practice"

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CMMI Extensibility and Flexibility

Information assurance

Help desk

IT Managed services

Network management

Integrated Enterprise Process

Program Management Processes

Engineering Management Processes

Engineering Processes

LIFECYCLE														
PHASES	System Initiation	System Analysis & Design		System Component Design		System Implemen-tation	System Integration, Test, & Evaluation					System Operations & Support	
STAGES	System Feasibility / System Planning	System Rqmts Anlys	Sys. Dsgn	Software Development Subcycle: Sw Rqmts Anlys	Prelim Sw Design	Detailed Software Design	CSU Code / CSU Test	CSC Integ. & Test	CSCI Integ. & Test	System Integ. & Test	DT&E	OT&E	System Production / System Deployment	System Operations / System Maintenance

Process Infrastructure Processes

Asset management

Desktop/Server management

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Conclusions

- CMMI Practices have a direct and positive influence on cost, schedule, and quality performance
  - It helps to tie the quantitative goals and measures to customer needs and relevant project problems
- CMMI high maturity enables organizational and project agility in high priority areas
  - Projects can improve dramatically in 6 months or less using defect prevention cycles of 1 week or less
- The transition from SW-CMM to CMMI is not inherently difficult, costly, and time-consuming, but…
  - It pays to proactively improve against emerging models and standards
  - It is much easier to attain the same maturity level the second time
  - It is much easier to transition between models when you focus on performance

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