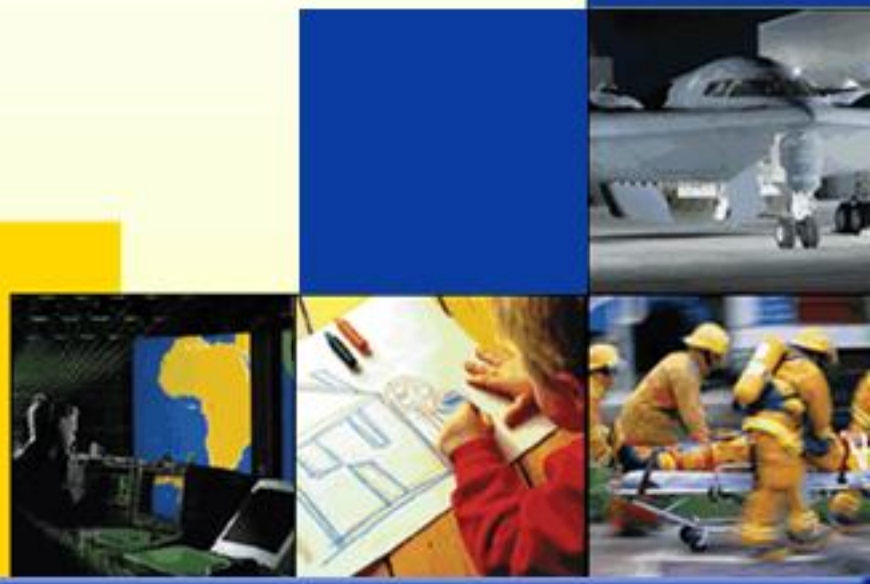
NORTHROP GRUMMAN
Information Technology

Quantitatively Measured Process Improvements at Northrop Grumman IT

Craig Hollenbach
Northrop Grumman IT



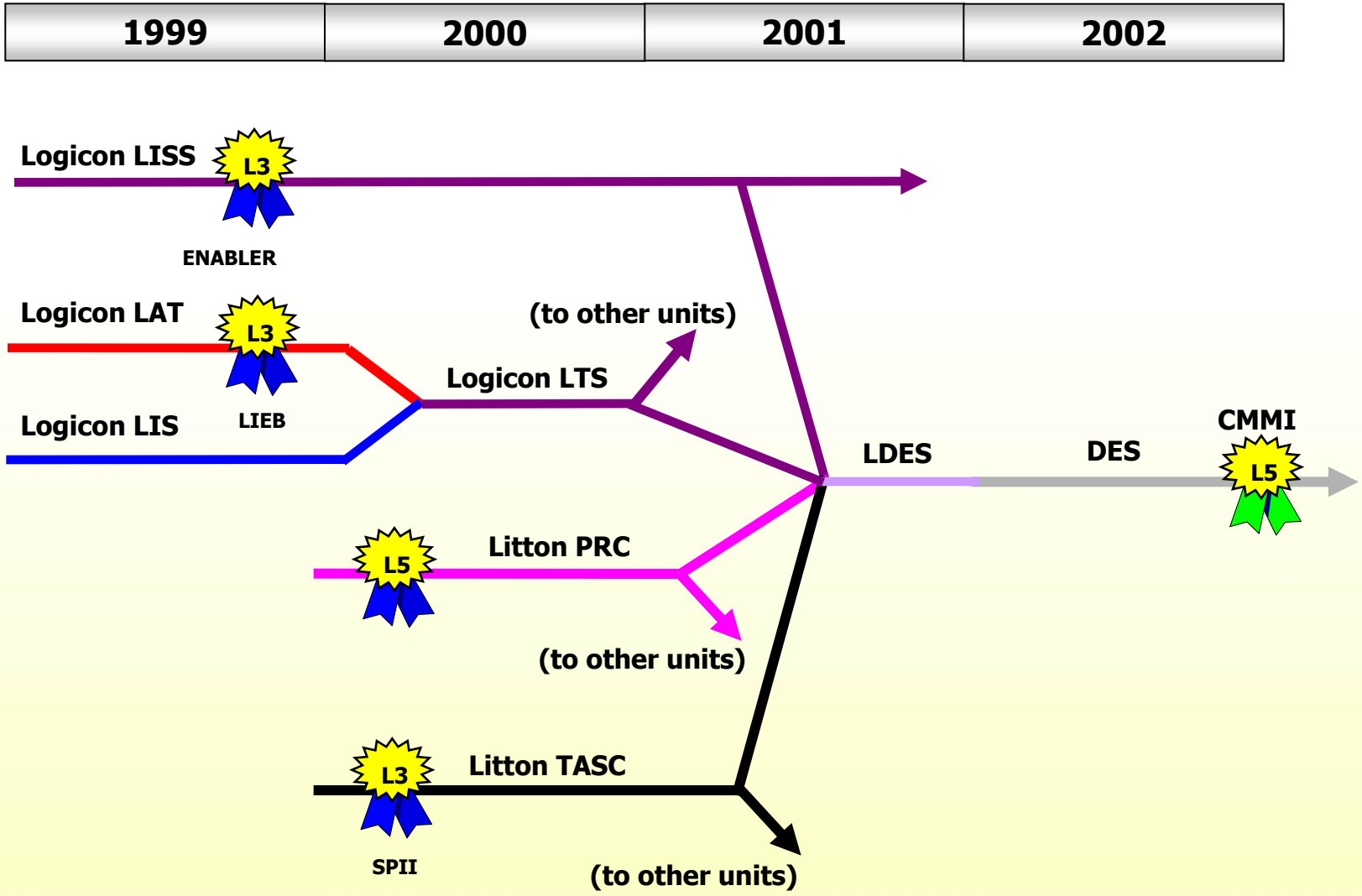
Agenda

- Northrop Grumman IT Overview
- 2002 SCAMPI Appraisal
- Sample Project Data
  - Inventory Tracking System (ITS)
  - AIT
  - JPATS
  - SIGS
- Conclusions

Northrop Grumman Overview

- Northrop Grumman
  - $26 B in revenue; 120,000 employees; 50 states; 25 countries
- Information Technology (IT) Sector
  - $4 B in sales; 22,000 employees; 48 states; 15 countries
- Defense Enterprise Solutions (DES) Business Unit
  - $548 M in sales; 2,900 employees, 23 states, 3 countries
- DES provides enterprise-wide technology solutions to the Defense marketplace
- Major Applications:

DES Maturity Pedigree



2002 CMMI Approach

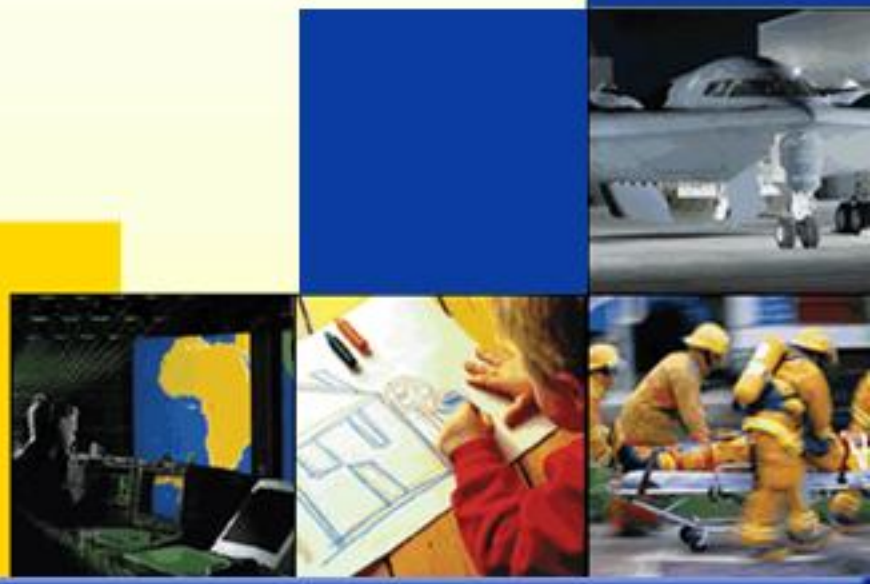
- **Background**
  - **Kent's quote about problems at beginning of 2002**
- **Personnel & Teams**
  - **PA Process Owners**
  - **DES Organizational Units (e.g., EPG, training, procurement)**
  - **High Maturity Process Area Teams, composed of project representatives (L4WG, L5WG, MO, DPWG, TCMSIG)**
- **Approach**
  - **DES Organizational Improvements**
    - CMMI Process Gap Analysis
    - Built Umbrella processes for legacy orgs
  - **DES Project Improvements**
    - Assigned support reps to assist project personnel
    - Project representatives participated on high maturity process area teams

2002 SCAMPI Appraisal

- SCAMPI appraisal led by independent SEI-certified appraisers in December 2002 determined that DES achieved
  - CMMI-SE/SW maturity level 5
  - CMMI-SE/SW capability level 5 in PMC, IPM, TS, and VER
  - SW-CMM maturity level 5
- DES works with other IT Business Units to transfer our process improvement experience throughout the sector

NORTHROP GRUMMAN
Information Technology

Inventory Tracking System (ITS)



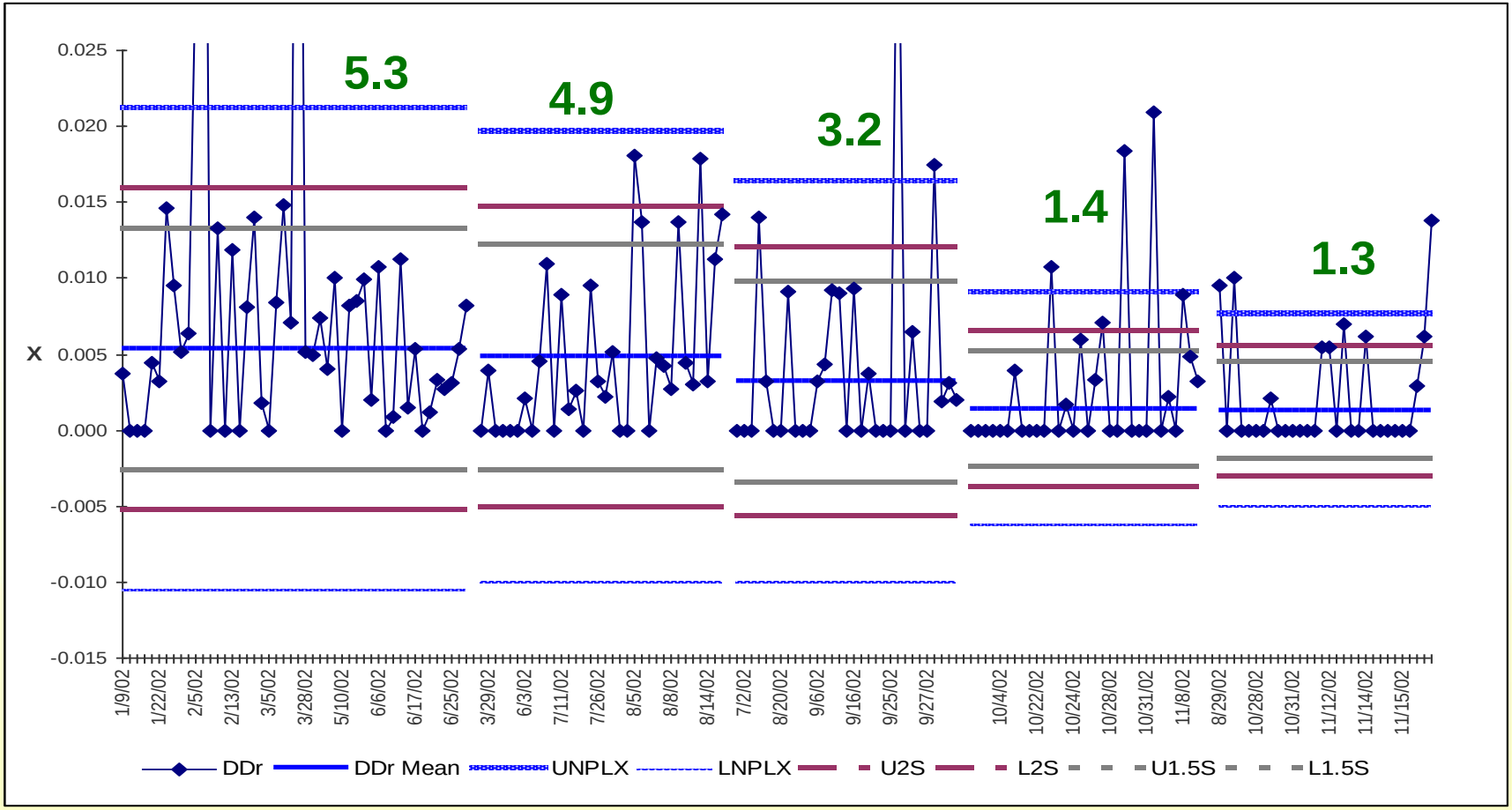
Inventory Tracking System

- Project Description:
  - USAF/AFMC/MSG Inventory Tracking System (ITS) Modernization
  - A 3.5-year, $11M Firm-Fixed Price project with a development staff of approximately 15 members
  - Development Team uses SEI Personal Software Process (PSP)
  - Implemented CMMI Level 5 quantitative management processes to dramatically improve the cost, schedule, and delivered quality of the software
  - Currently in preparation for 1st contractual customer driven test cycle
  - Contractual Quality Goal is to deliver no known severity 1-3 defects (1-Critical, 2-Urgent, 3-Routine).

ITS Critical + Urgent Defect Density

Peer Review - Builds 1 - 5

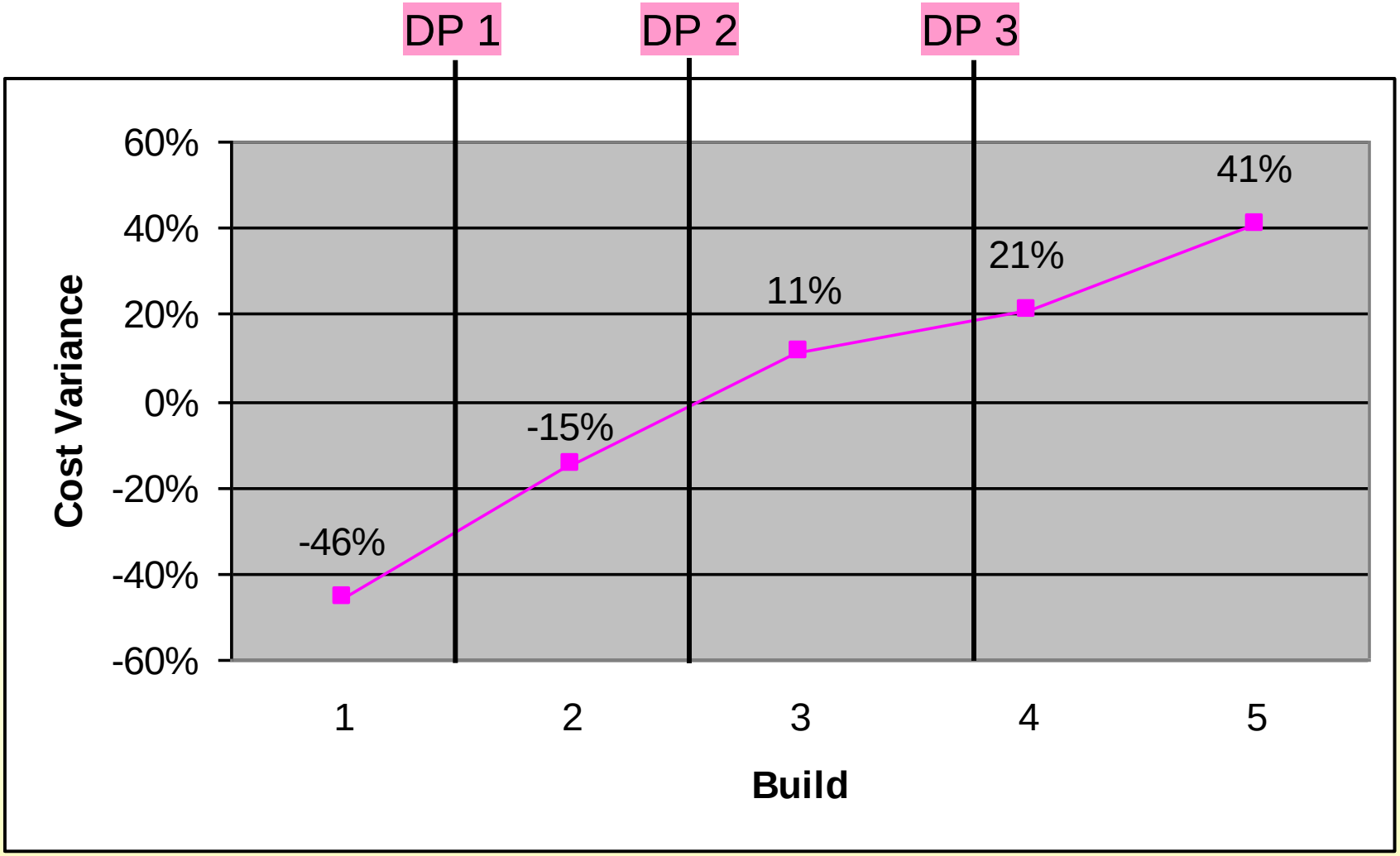
Quantitative Management Plan Goal: ≤ 5/KLOC for Critical + Urgent



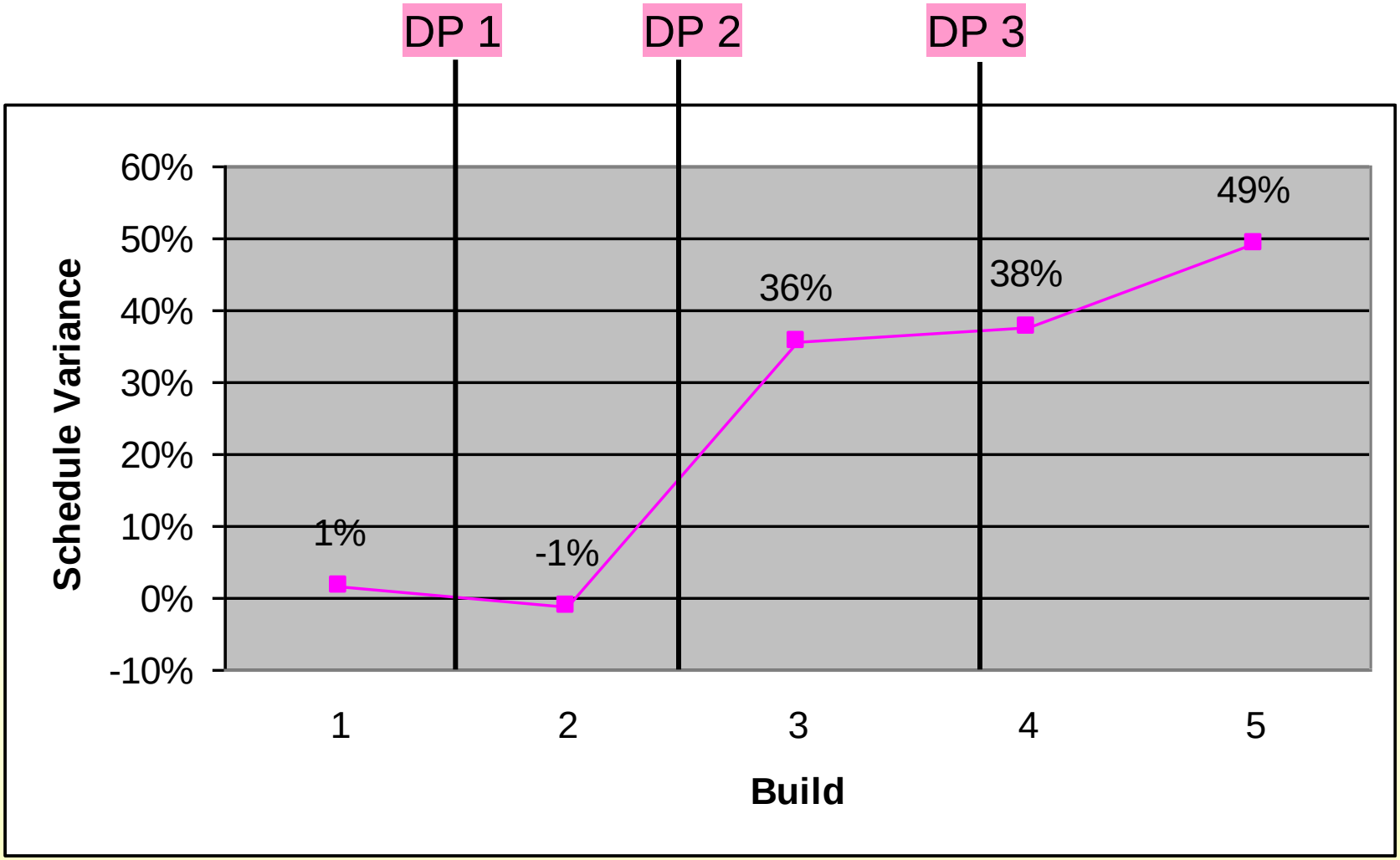
KLOC = Thousand Lines of Code

Peer Review Defect Density (Critical + Urgent cont.)

Cost Variance by Build



Schedule Variance by Build

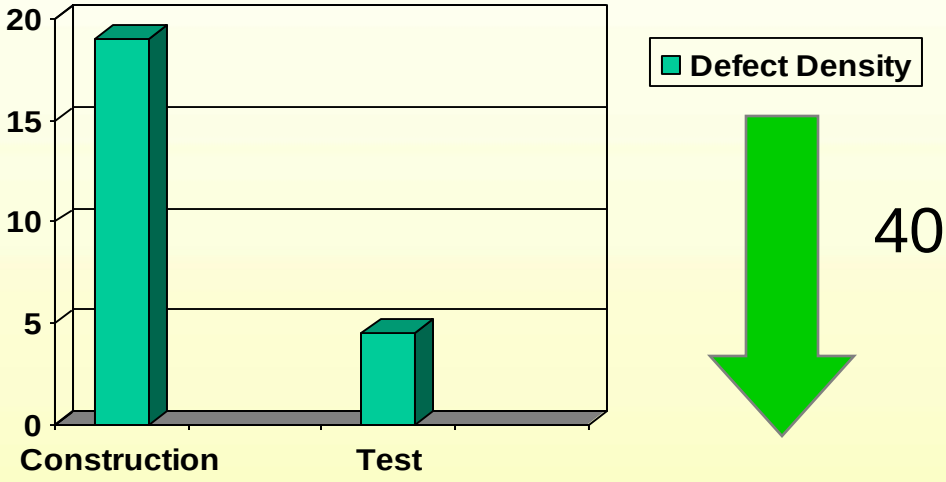


Return on Investment – Construction Phase

- **Hours invested:** 124
  - **Team training: 48**
  - **Conducting DP Cycles: 76**
- **Defects avoided:** If the Defect Density had remained at 6.6 (Build 1), we would have injected 110 more defects.
- **Hours saved:** At an estimated cost of 15 hours per defect this equals 1650 hours.
- **Return:**
  - **Hours:1650/124 =** 1330%
  - **Customer satisfaction:** Priceless! **– "The contractor has always provided products and services with less defects that industry standards. Most have been provided with no defects. Personnel have been used that show a complete understanding of their subject area and are able to convey this information in a highly professional manor."**

Inventory Tracking System – Test Phase

- **Need to understand Total Defect Density in Peer Review in Construction Phase to relate to Defect Density in Test Phase**
  - **DP Cycles had an effect on Total defect density also**
    - Build 1 Total defect density = 21.6 defects/KLOC
    - Build 5 Total defect density = 13 defects/KLOC
  - **Total Defect Density for Construction Phase = 19 defects/KLOC**
  - **Total Defect Density for Testing to Date = 4.5 defects/KLOC**

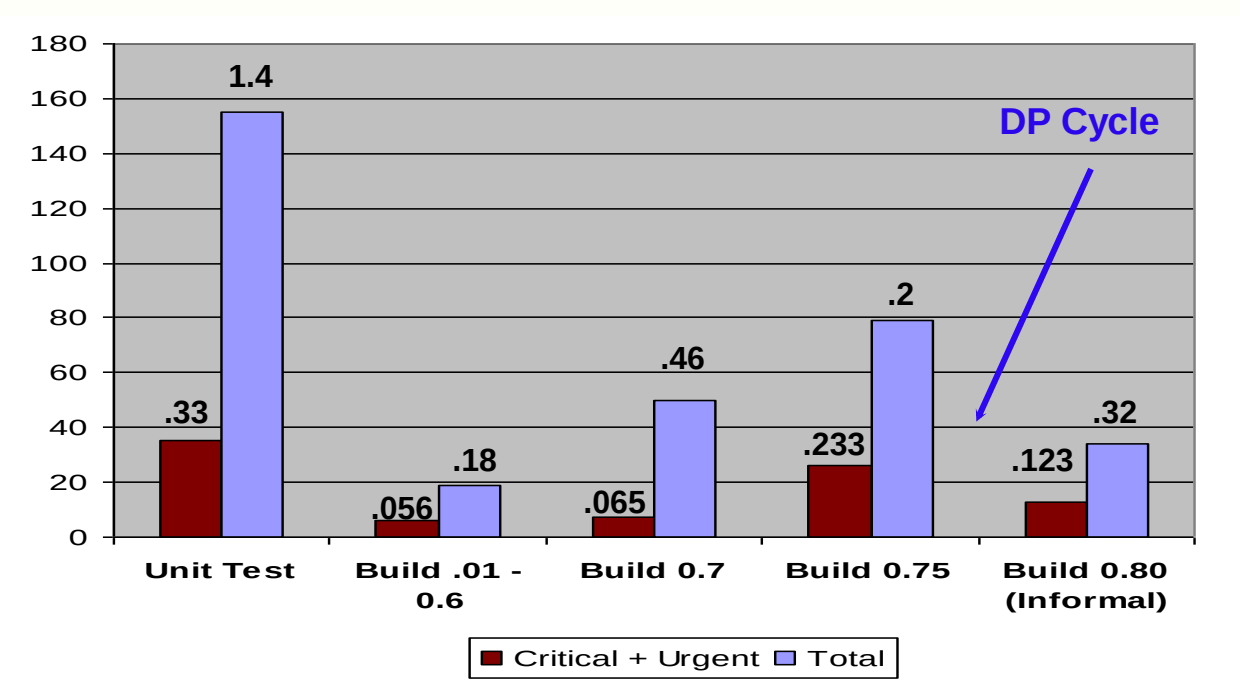


400% Reduction

Inventory Tracking System – Test Phase

Management Goals in Test are being exceeded!

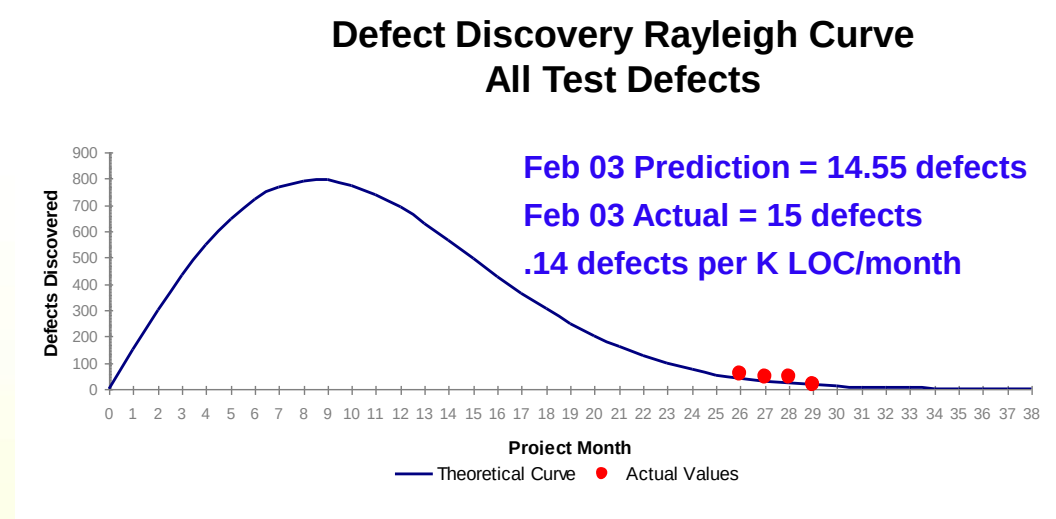
	Critical/Urgent Defect	Total Defects
DDt Unit	≤ .5/KLOC	≤ 2/KLOC
DDt (all internal integration cycles)	≤ .25/KLOC	≤ 1/KLOC

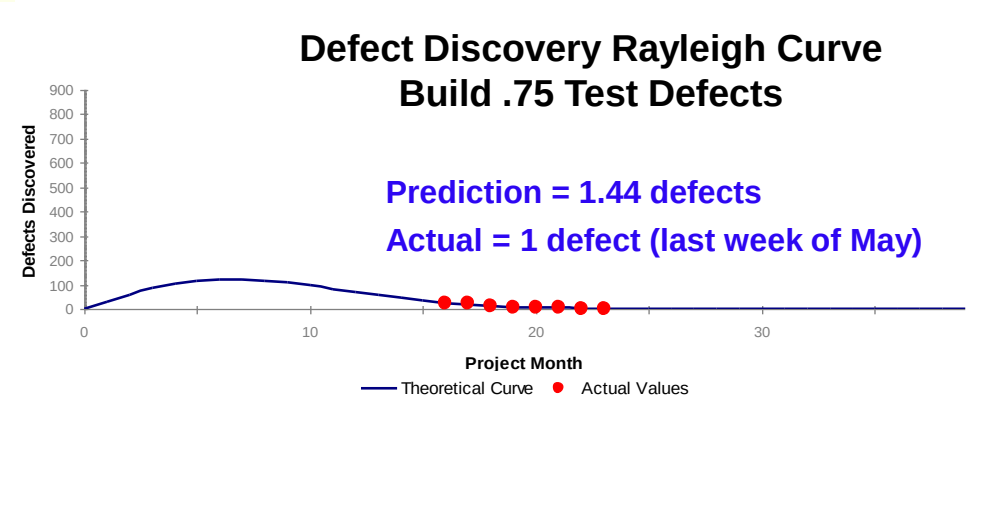


Inventory Tracking System – Test Phase

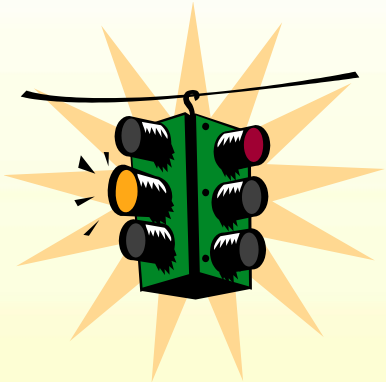
Quantitative Management Plan Goals:

DDs – Defect Discovery ≤ 1/KLOC





When the Total Defect Discovery rate falls under 1 defect per KLOC per month the project manager and test lead have enough confidence to stop test cycle.



Results

- **CMMI Quantitative Management & Defect Prevention Cycles have a huge return on Investment in the Construction Phase.**
  - **Specific results from the first coding cycle to the fifth are: Critical / Urgent defect density reduced by 68%, Cost Variance improved from -59% to +39%, and Schedule Variance improved from +26% to +49%.**
- **This return has a significant effect on the Test Phase**
  - **Where most projects have the highest defect detection rate in Test, ITS has its lowest defect detection rate. Latent defect analysis estimates delivering a defect density of between 0.35 and 0.7; a total of 20 to 40.**
- **Understanding the quality of the product allows for better management decisions and with highly satisfied customers.**

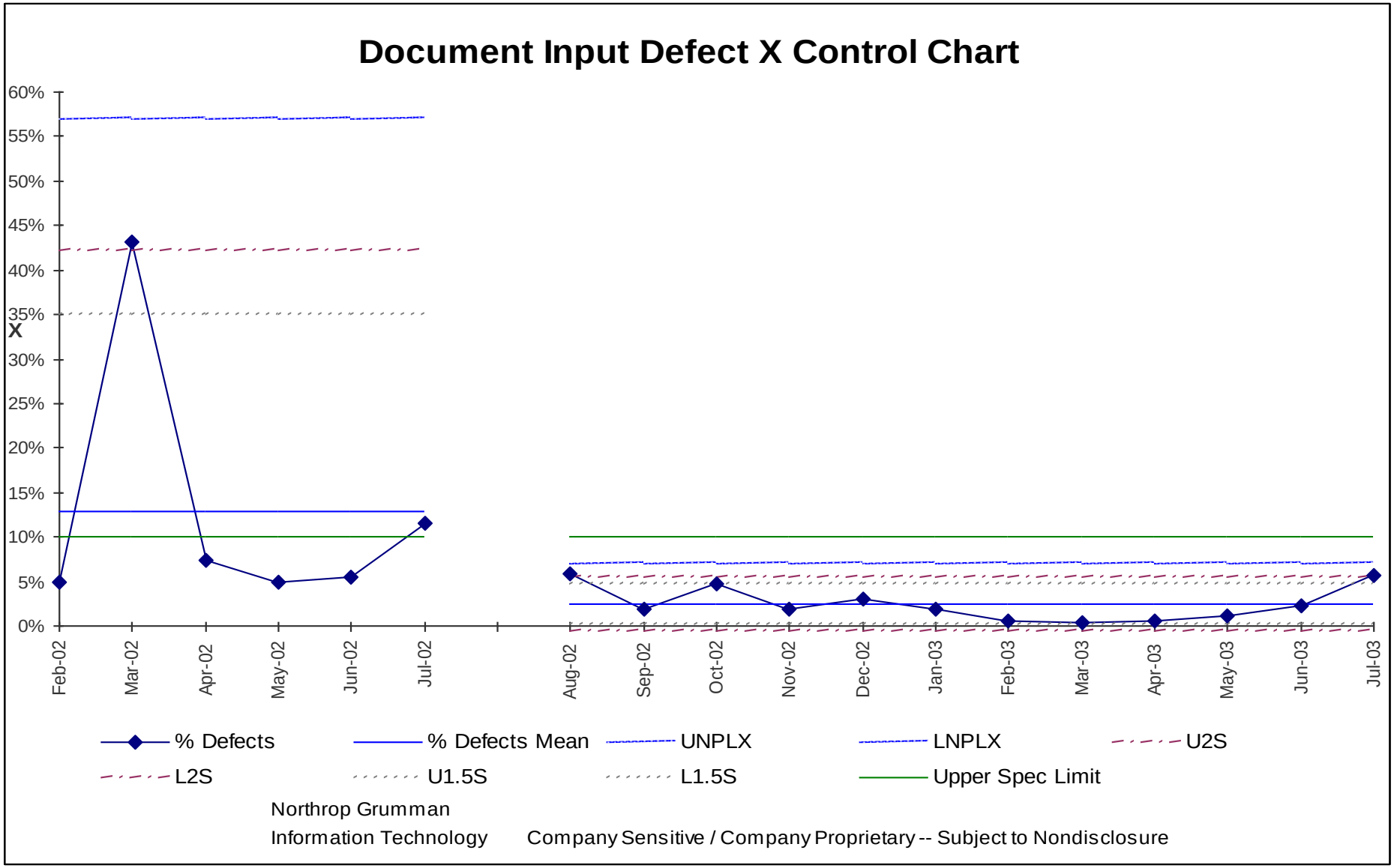
NORTHROP GRUMMAN
Information Technology

Automated Identification Technology (AIT)

AIT Document Defect Data QM

- **Began collecting data in Feb '02 as part of DP Cycle**
  - **Process improvement techniques per DP Cycle identified**
    - Use of CM controlled Templates for documents enforced for authors
    - Type classification identified for defects: technical/non-technical
    - Documentation Input Defect Report checklist completed
      - ✓ **Identify number of pages each document**
      - ✓ **Identify document types**
      - ✓ **Identify defects as technical/non-technical**
    - Management and personnel awareness of data collection and purposes
  - **Six months data had defect rate vary from 4.9% to 11.6%, with one outlier higher**
- **Process Improvement implementation**
  - **Resulted in re-evaluation of upper and lower limits**
  - **Increased personnel and management focus on data**
  - **Data for last 12 months has defect rate vary from 0.4% to 5.9%**

Document defect data Feb ’02 – Jul ‘03



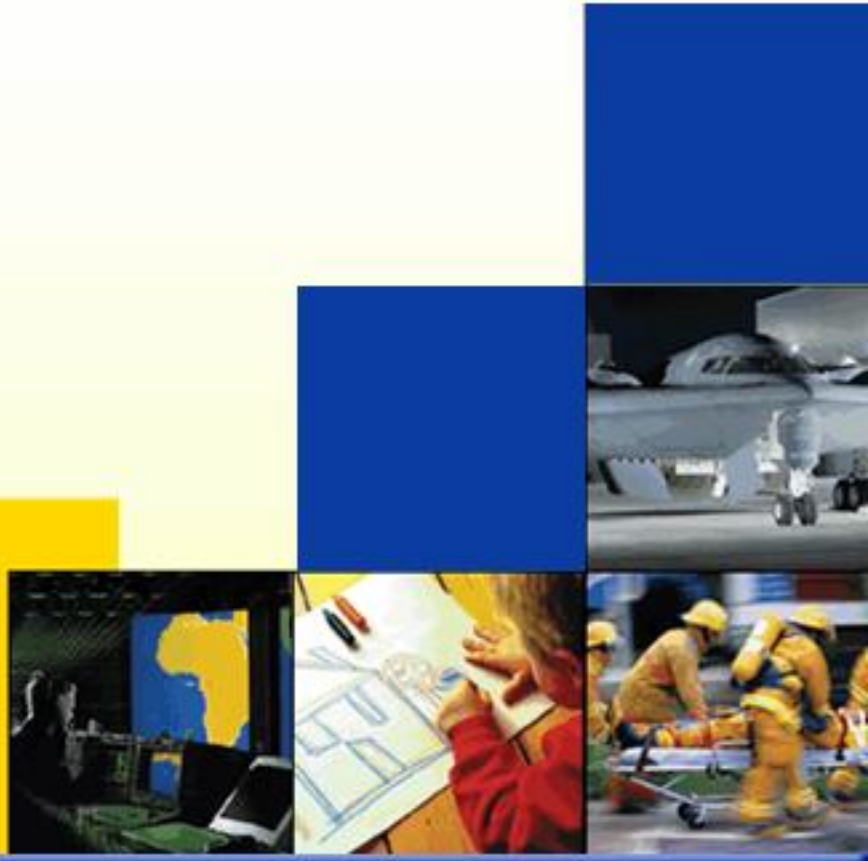
Northrop Grumman
Information Technology

Company Sensitive / Company Proprietary -- Subject to Nondisclosure

NORTHROP GRUMMAN
Information Technology

NORTHROP GRUMMAN
Information Technology

JPATS TIMS



JPATS Challenge

- **JPATS Build 1.05 (June 2002)**
  - **The first build to be released after progressing from "Development" to the "Maintenance" phase of the program.**
    - Builds 1.01 – 1.04 were internal builds, not released for customer verification
  - **Used "development"–style processes for fixing STRs**
  - **Failed 9/30 (30%) of the on-site STR verification tests with customer witnesses.**
    - NOTE: STRs Fixed vs. STRs Accepted is a measure that is quantitatively measured by the JPATS Program

- **As a Result … Kicked off JPATS DP Cycle #1**
  - **GOAL: Reduce the STR verification failures to < 5% for JPATS builds 1.0.6 and 1.07**

DP Cycle Findings

- **Root causes included**
  - **Lack of "maintenance"-style processes (e.g. streamlined for dealing with many (~30-130) STRs/build)**
  - **Lack of "maintenance"-style build planning & tracking**

- **~40 Countermeasures identified**
  - **Many top-tier countermeasures focused on improving/updating our STR build processes**
    - Most of these were approved for action by the sponsor

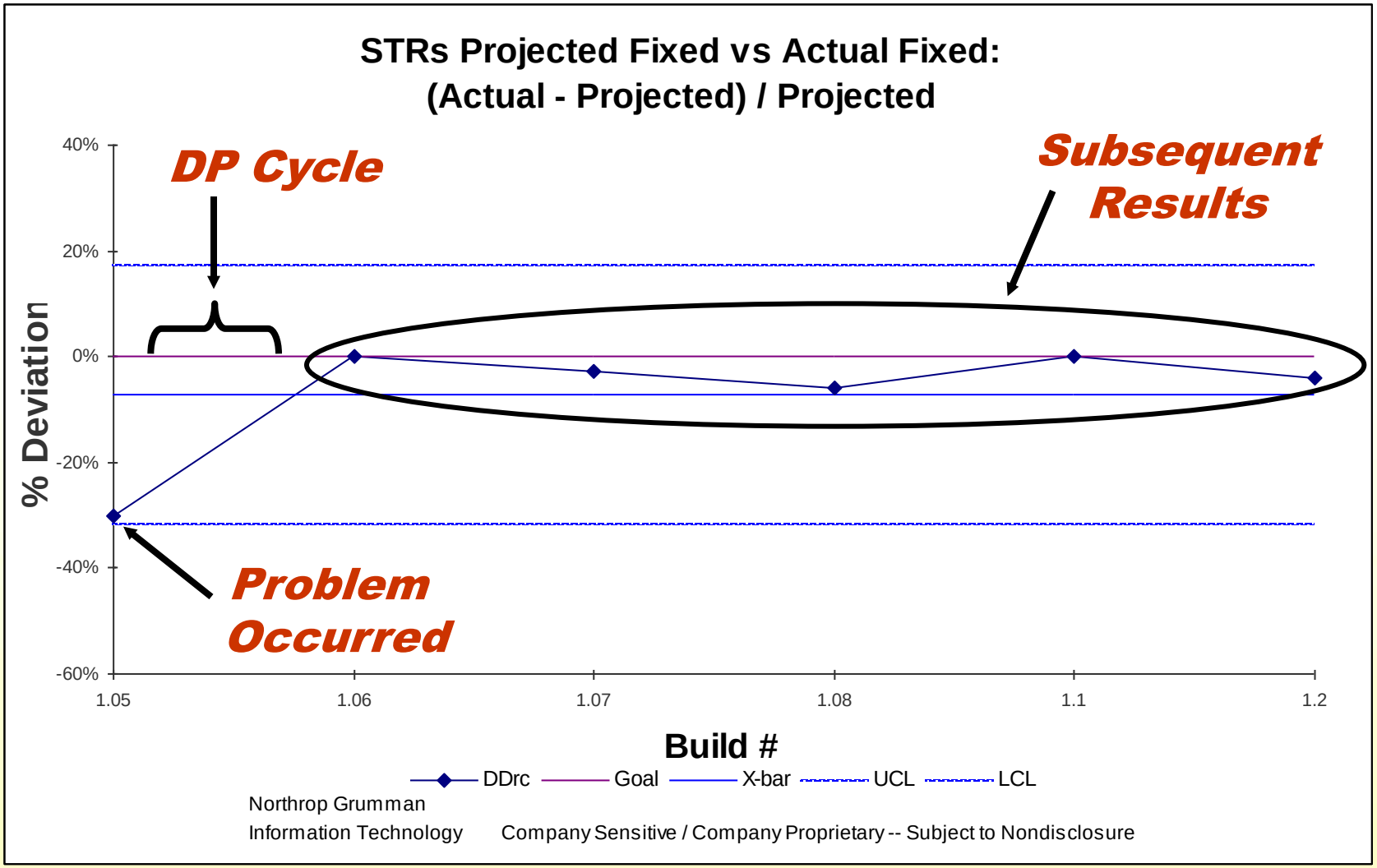
DP Cycle Improvements

- **Actions**
  - **JPATS updated/developed the following processes specifically for the Contractor Logistics Support (CLS = maintenance) phase**
    - BP 100, CLS Software Build Process
    - BP 200, Define a Build
    - BP 300, Plan and Track a Build
    - BP 400, Develop a Build
      - ✓ **UT 100, Unit Test Procedure**
      - ✓ **PR 100, Peer Review Procedure (Code)**
      - ✓ **RT 100, Regression Test Procedure**
    - BP 500, Deploy a Build
  - **JPATS developed a build planning and tracking matrix called the "STR Big Board" to track all the elements required by the process per STR across all STRs**

DP Cycle Effectiveness

- **Build 1.06 (July 2002)**
  - **0% STR verification failure rate (0/11)**
  - **Goal of verification failure rate < 5% was met**
- **Build 1.07 (Oct 2002)**
  - **2.7% STR verification failure rate (3/113)**
  - **Goal of < 5% verification failure rate was still met**
- **Subsequent builds have continued to perform well**
  - **See next slide showing current JPATS QM measure for STR Verification**

DP Cycle Effectiveness

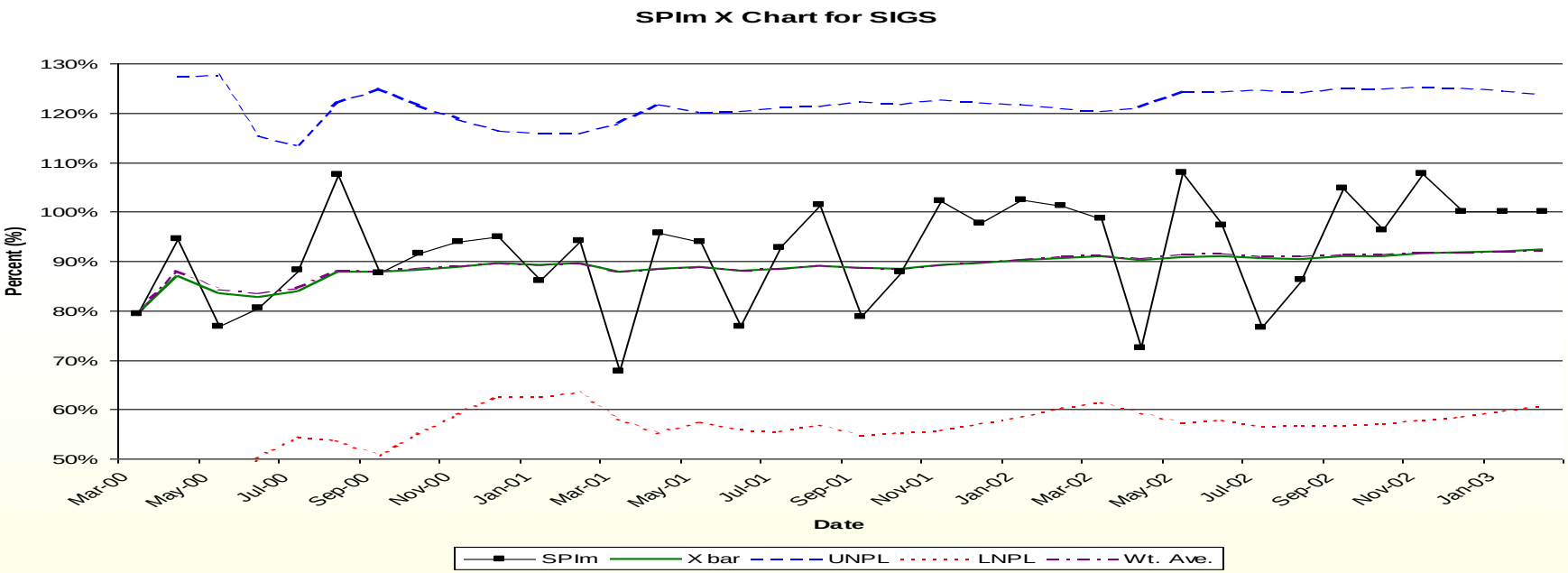


Company Sensitive / Company Proprietary -- Subject to Nondisclosure

NORTHROP GRUMMAN
Information Technology

Synthetic Imagery Graphical System (SIGS)

SIGS Schedule Performance



- **Goal:** SPI (X bar) of 85% in the 1st third of each PoP, 90% in the 2nd third, and 95% in the last third
- **Actual:** 92.1% over multiple PoPs; 88.3% at the end of the 1st PoP; 88.7% at the end of the 2nd; and 96.8% at the end of the last PoP
- **Highlights:** Cost Performance (CPI) was 96.8% over the same period; Award Fee average was 99% over the same period

SIGS Schedule Performance (Cont'd)

- **Situation:** O&M project undertaking a major redesign of the system over multiple years using new technology
- **At the beginning:** unfamiliar technology meant that schedule estimates had large uncertainty since there was no available historical data to support the basis of estimate
- **Process changes:** introduced Earned Value (EV) tracking combined with statistical process control (SPC) techniques allowed better monitoring of progress against the plans and identifying when there are special causes of variation
- **Improvement:** by closely tracking the actual effort required to complete the earlier activities, we were able to feed that back into the estimates for the later activities and thus able to produce schedules with less uncertainty

Conclusions