Ogden Air Logistics Center

Making TSP Work at CMMI Level 5

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TSP Symposium 2007

Objectives

- Present a Case Study
  - A CMMI® Level 5 Assessment
  - Focusing on a Team Software Process (TSP)SM Team
- Provide Guidance for TSP Teams
  - Does TSP Guarantee CMMI Level 5?
  - How can TSP be used to support a CMMI Level 5 Assessment?
  - What did this team do to meet CMMI Level 5 objectives?

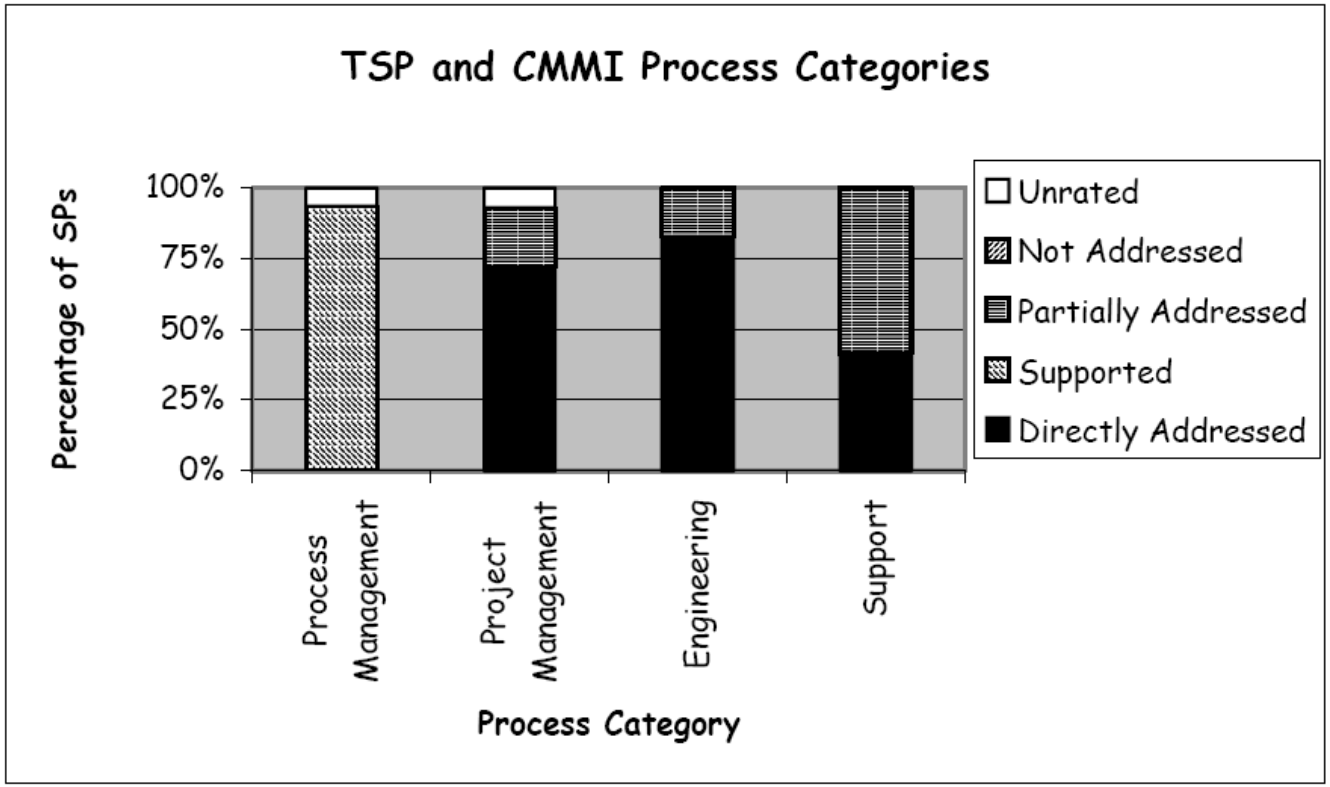
The audience should be familiar with the concepts of the TSP and the Personal Software Process (PSP)SM

TSP Supports CMMI

- In the late 1980s and early 1990s the SEI developed the Capability Maturity Model (CMM) which captured organizational best practices for software development
- SEI Fellow, Watts Humphrey, decided to apply the underlying principles of the CMM to the software development practices of a single developer
- The result of this effort was the Personal Software Process (PSP), designed to be a ***CMM level 5*** process for individual software developers
- Humphrey then developed the Team Software Process (TSP) for the smallest operational unit in most organizations, the project team. TSP was designed to be a ***CMM level 5*** process for project teams.

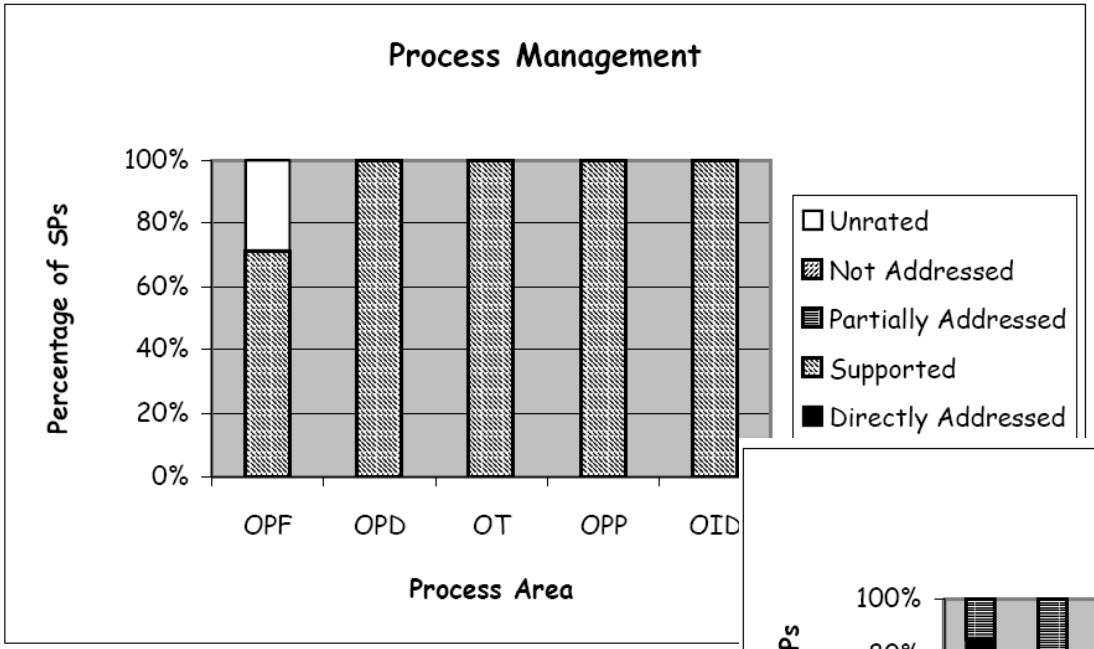
Source: TSP and CMMI: A Brief History (http://www.sei.cmu.edu/tsp/history.html)

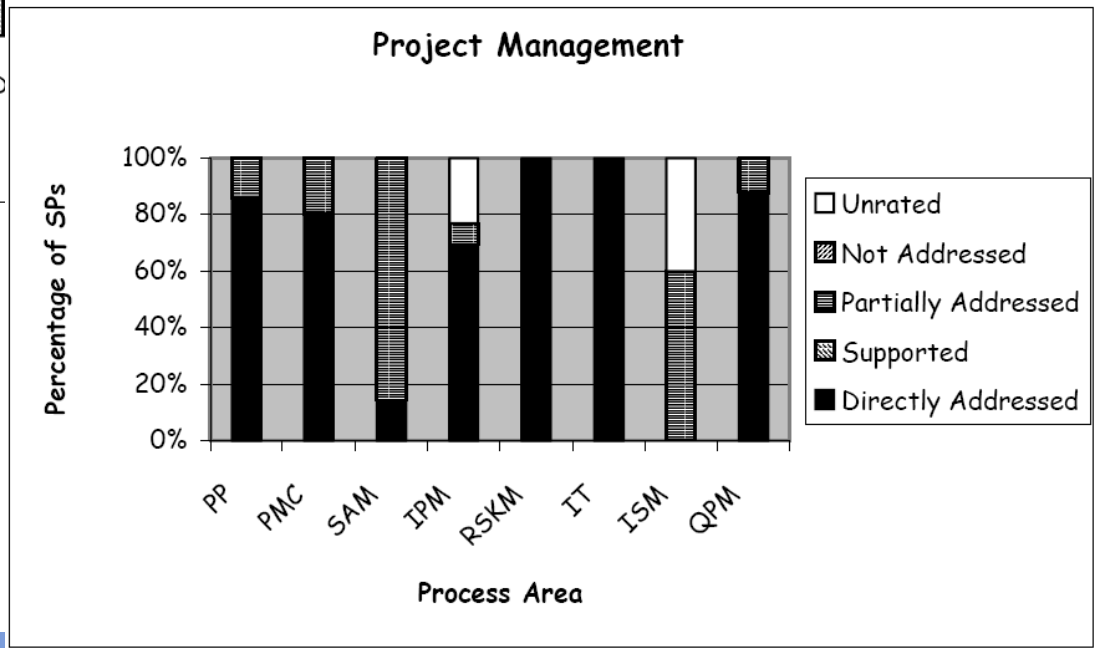
SEI's TSP to CMMI Mapping – 1



Source: James McHale and Daniel S. Wall Mapping TSP to CMMI (CMU/SEI-2004-TR-014)

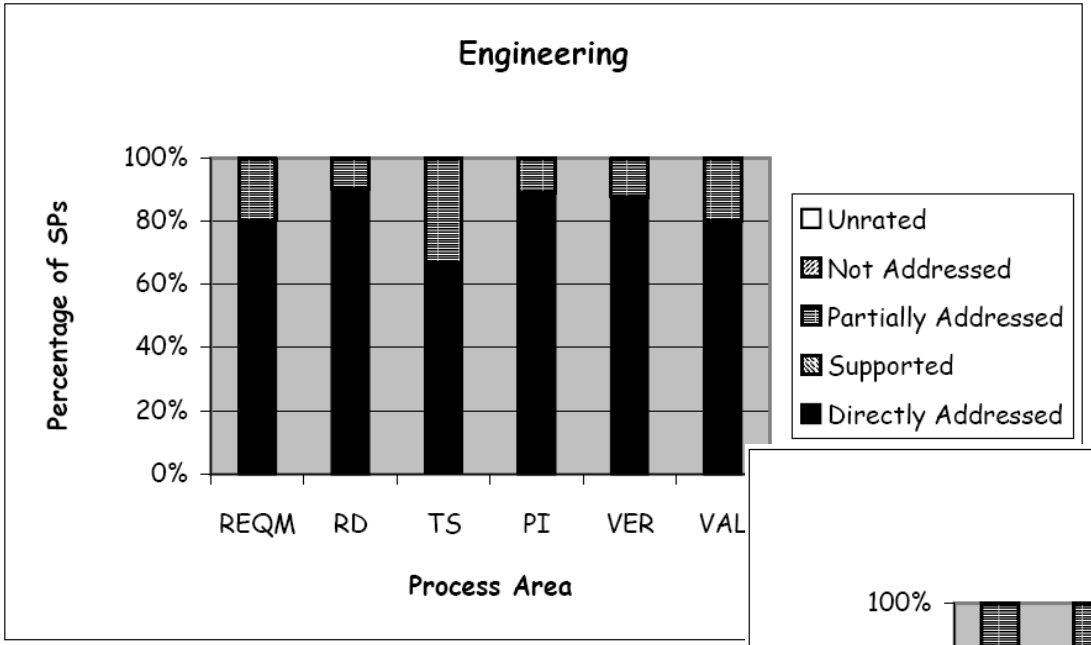
SEI's TSP to CMMI Mapping – 2

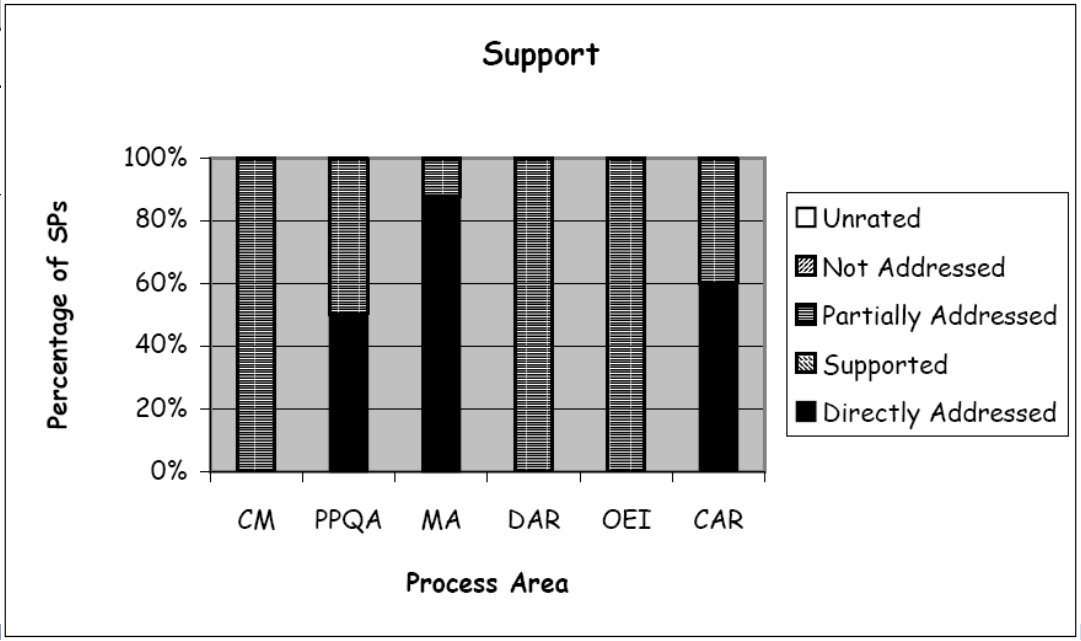




Source: James McHale and Daniel S. Wall
Mapping TSP to CMMI
(CMU/SEI-2004-TR-014)

SEI's TSP to CMMI Mapping – 3

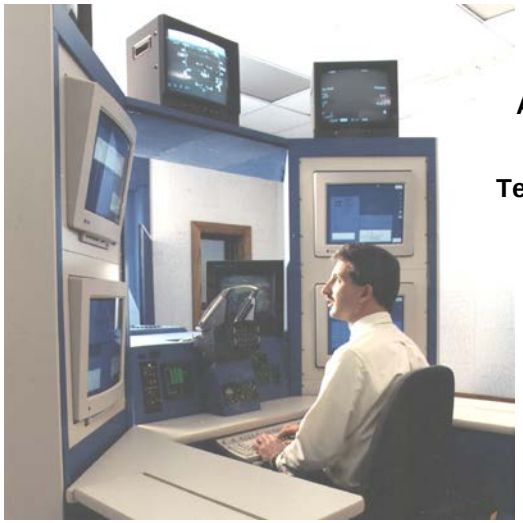


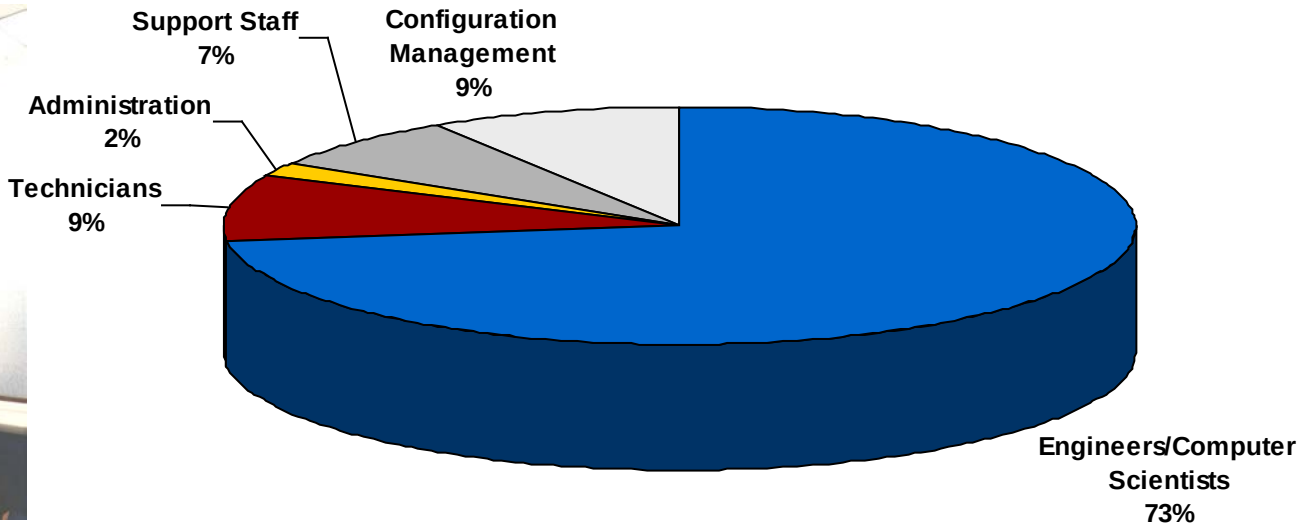


Source: James McHale and Daniel S. Wall
Mapping TSP to CMMI
(CMU/SEI-2004-TR-014)

309 SMXG Background

- **Large Cadre of Talented People:**
  - **700+ Civilian Personnel**
  - **Average over 10 years technical experience**
  - **Growing by ~50 PEs/Year**





309 SMXG

Process Improvement History

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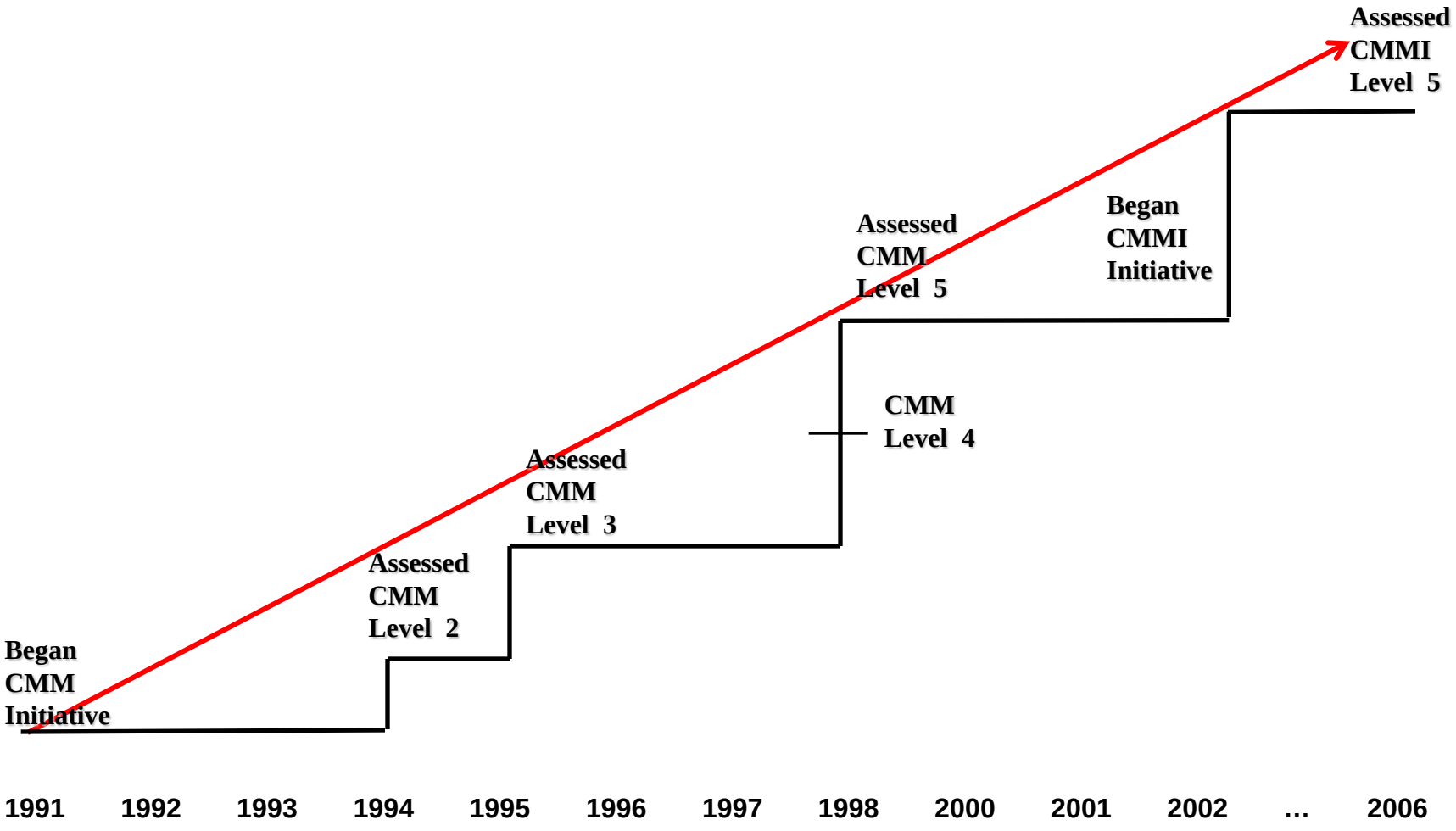
- Focused on process improvement since 1991
- Assessed in 1998 to be Capability Maturity Model (CMM) - Level 5
- Earned AS9100 & ISO 9001 Registration in 2006
- Assessed in 2006 to be Capability Maturity Model Integration (CMMI) – Level 5

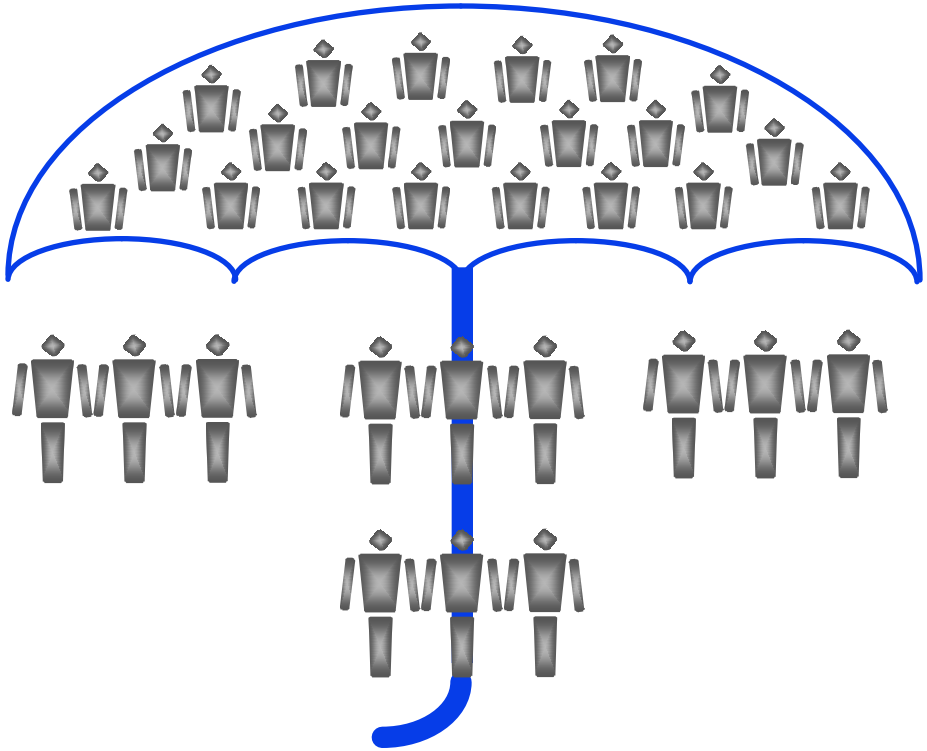
SMXG & CMM / CMMI



Focus Project: GTACS

CMMI Level 5

Focus Project for CMMI Assessment



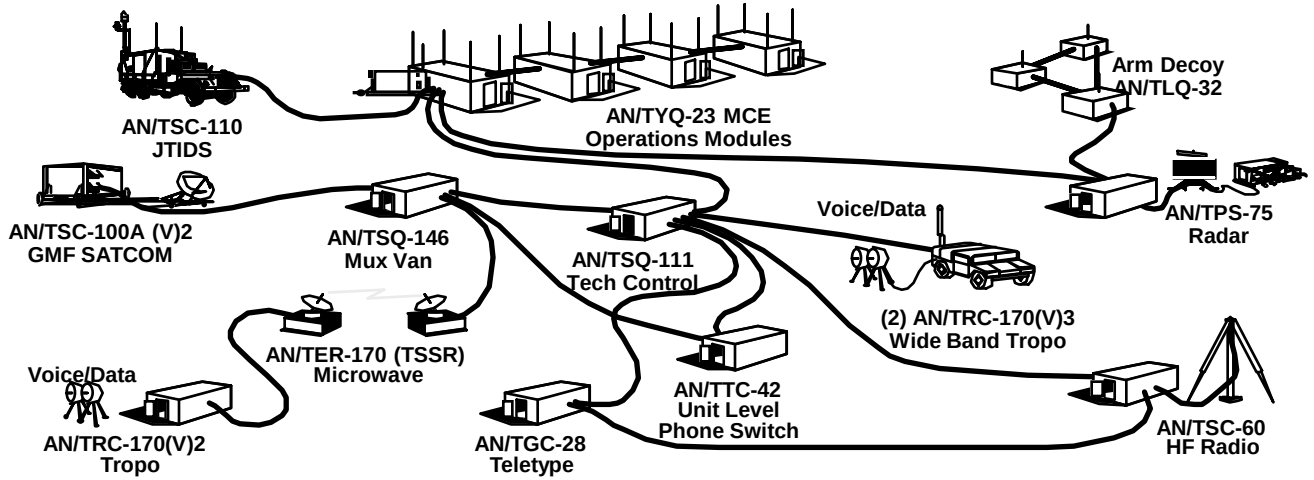
CMMI: Capability Maturity Model Integration improves the organization's capability; management focus

TSP: Team Software Process improves team performance; team and product focus

PSP: Personal Software Process improves individual skills and discipline; personal focus

GTACS Overview

- **Ground Theater Air Control System (GTACS)**
  - **Modular Control Equipment (MCE) & Tactical Air Operations Modules (TAOM) create a ground-based computer network systems that coordinate radar and communications data signals. GTACS modules coordinate ground, airborne, and naval elements to plan, execute, and evaluate joint operations.**



GTACS MCE Software Updates

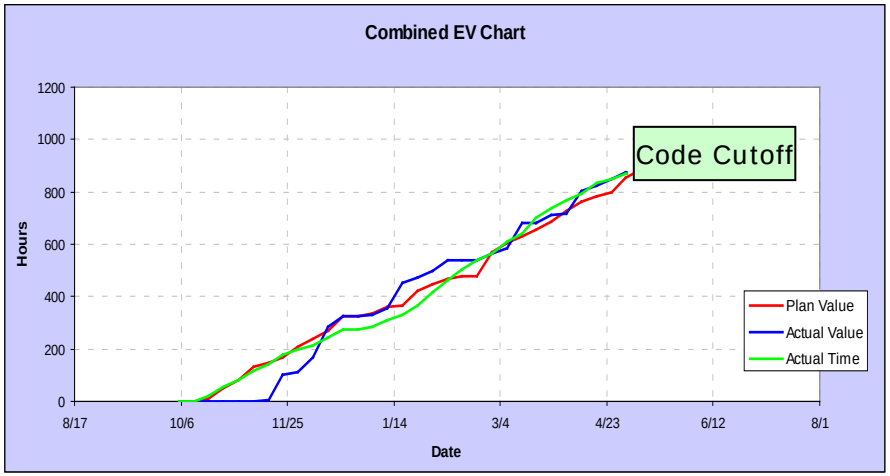
- 309 SMXG provides Module Control Equipment (MCE) software updates for:
  - New Features:
    - Updates to MIL-STD Communications Protocols
    - User-Initiated Switch Action & Display Changes
    - Interfaces with New Weapons and Systems
  - Defect Corrections:
    - Software Development Defects
    - Government Acceptance Test Defects
    - Field-discovered Problem Reports

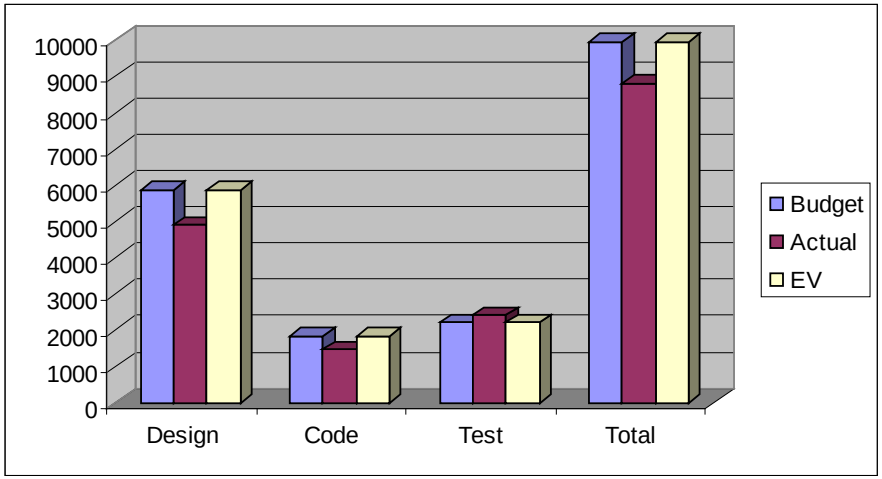
GTACS TSP Tracking Tools

- **GTACS Uses The Process Dashboard Tool to:**
  - **support individuals and the team in using high-maturity processes for software development**
  - **simplify the work involved in following a high-maturity process**
  - **help individuals to follow a defined process and collect metrics data**
  - **improve the accuracy of collected metrics**

GTACS & TSP: Productivity

- TSP Schedule Improvement
  - Zero missed deadlines
  - Zero “returned” workload
- TSP Quality Improvement
  - Zero integration defects
  - Zero integration rework
- TSP Productivity Improvement
  - 417% increase in SLOC/Hour!
  - Completely recouped TSP investment cost after about 1 month!



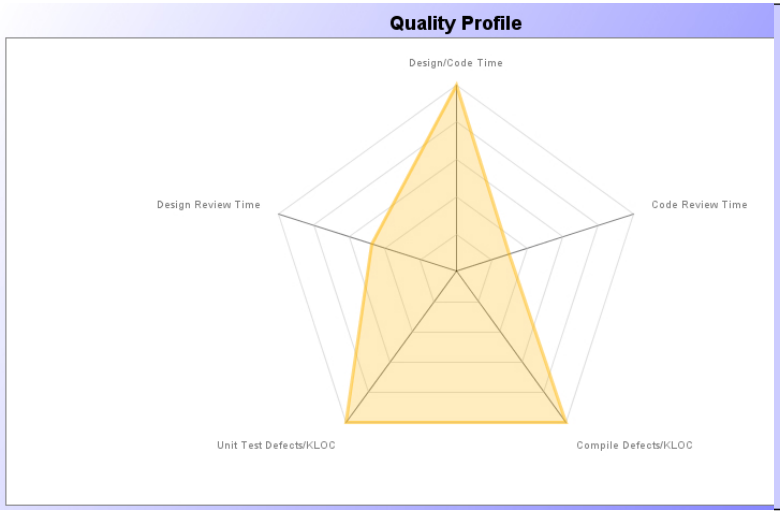


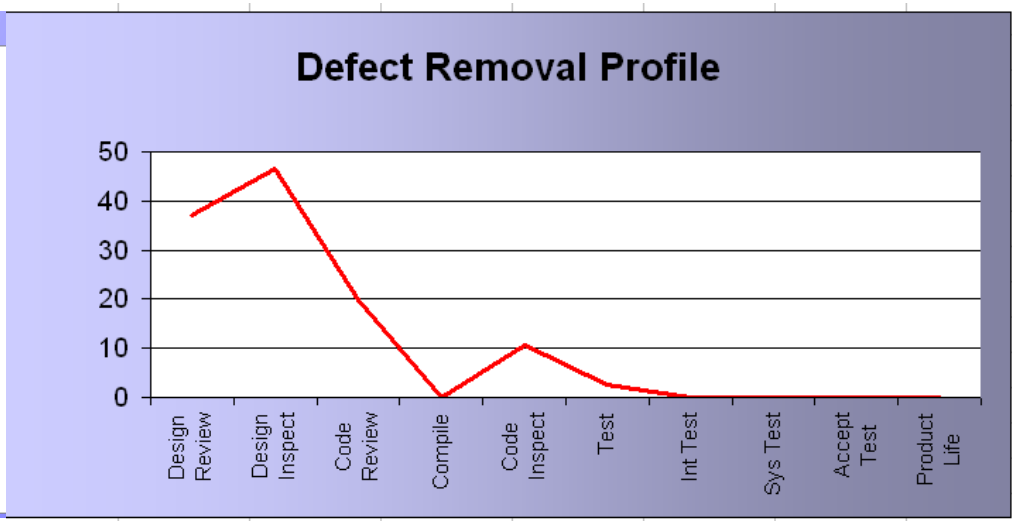
GTACS & TSP: Quality

- **TSP Promotes High Quality Processes**
  - **Personal Reviews**
  - **Team Peer Reviews**
  - **Integrated Systems Engineering Peer Reviews**
- **GTACS Team Achieves 99.4% Defect Removal Before Release**

Process Yields

	Plan	Actual
% Before Compile	81.4%	93.1%
% Before Unit Test	97.2%	98.1%
% Before Build and Integration Test	99.6%	99.4%
% Before System Test	99.9%	99.4%





309 SMXG CMM / CMMI Assessments

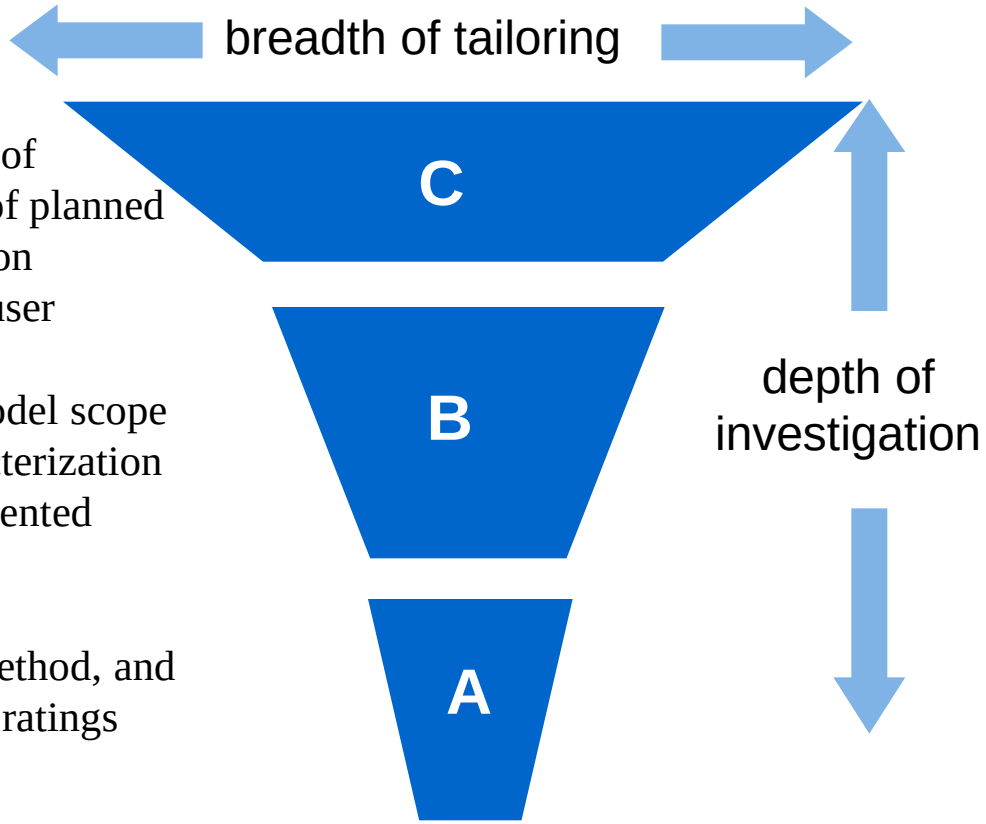
- 1998: Assessed SW-CMM Level 5
- 2001: Evaluated Moving to CMMI vs Another SW-CMM Assessment
- 2003: Began CMMI Transition
- 2005: Performed Two SCAMPI B's on Potential Focus Projects
- 2006: Performed SCAMPI A on Focus and "Depth" Projects

SCAMPI Family of Appraisals

SCAMPI C: provides a wide range of options, including characterization of planned approaches to process implementation according to a scale defined by the user

SCAMPI B: provides options in model scope and organizational scope, but characterization of practices is performed on implemented practices

SCAMPI A: Is the most rigorous method, and is the only method that can result in ratings



SCAMPI B #1 Results – 1

GTACS Project Only*

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	REQM	PP	PMC	SAM	M&A	PPQA	CM	RD	TS	PI	Ver	Val	OPF	OPD	OT	IPM	RSKM	IT	ISM	DAR	OEI	OPP	QPM	OID	CAR
Specific Goal 1																									
SP 1.1	L	L	L		L		M	L	M	L	L	L				L	M					M	L		H
SP 1.2	L	L	L		L		L	L	L	L	L	L				L	L					M	L		H
SP 1.3	H	L	L		L		L		L	M	L	L				L	L					M	L		
SP 1.4	L	L	H		L											L						M	L		
SP 1.5	L		H													M						M			
SP 1.6			L																						
SP 1.7			L																						
Specific Goal 2																									
SP 2.1	L	L			L		L	L	L	L	L	L				L	L					L			H
SP 2.2	L	L			L		M	L	L	L	L	L				L	L					M			H
SP 2.3	H	L			L			L	L		L					L						M			M
SP 2.4	L				L				M													L			
SP 2.5	L																								
SP 2.6	H																								
SP 2.7	M																								
Specfic Goal 3																									
SP 3.1	L						L	L	L	L	L						L								
SP 3.2	L						M	L	L	L	L						M								
SP 3.3	M							L		L															
SP 3.4								L		L															
SP 3.5								L																	
Specific Goal 4																									
SP 4.1																									
SP 4.2																									
SP 4.3																									
Generic Goal 2																									
GP 2.1	L	L	L		L		L	L	L	L	L	L				L	L					L	L		L
GP 2.2	L	L	L		M		L	L	L	L	L	L				L	L					L	L		L
GP 2.3	L	L	L		L		L	L	L	L	L	L				L	L					L	L		L
GP 2.4	L	L	L		L		L	L	L	L	L	L				L	L					L	L		L
GP 2.5	M	M	M		M		L	M	L	L	L	L				M	M					M	M		M
GP 2.6	L	L	L		L		L	L	L	L	L	L				L	L					L	L		L
GP 2.7	M	M	L		L		M	M	L	M	L	L				L	L					L	L		L
GP 2.8	L	L	L		L		L	L	L	L	L	L				L	L					L	L		L
GP 2.9	L	L	L		L		L	L	L	L	L	M				L	L					L	L		L
GP 2.10	L	L	L		L		L	L	L	L	L	L				L	L					L	L		M
Generic Goal 3																									
GP 3.1	H	L	L		L		M	L	L	L	L	L				L	L					L	L		L
GP 3.2	L	L	L		L		M	L	L	L	L	L				L	L					L	L		L

LEGEND
L = Low Risk
M = Medium Risk
H = High Risk

*IPPD PA's not addressed. PPQA, OPF, ODP, OT and DAR were assessed at the Organizational level. SAM was N/A for GTACS.

SCAMPI B #1 Results – 2

GTACS Project Only

Risk Level	Total Risks	Process Risks	Artifact Risks	Document Risks	Non-Team Risks
High	19	1	17	0	1
Medium	67	15	18	6	28
Low*	0	0	0	0	0
Total	86	16	35	6	29

*Low risks were not categorized in the first SCAMPI B

- **Definitions**
  - **Risk Level**
    - the risk that the final SCAMPI A Assessment will have a negative finding
  - **Process Risks**
    - the GTACS team had no process in place
  - **Artifact Risks**
    - the assessment team found insufficient artifacts to assess
  - **Document Risks**
    - GTACS process documentation needed to be updated
  - **Non-Team Risks**
    - the responsibility of a team other than the TSP team, such as the group's SEPG or the GTACS CM Team

SCAMPI B #1 Actions

- Addressed Causal Analysis & Resolution (CAR) Findings (High Risk)
  - Focused on executing CAR process
  - Gathered data / created CAR artifacts
- Process Framework & Documentation
  - Identified missing elements (Requirements Management, Project Planning, Project Monitoring & Control)
  - Created/Implemented Process Improvement Proposals
- Team Resources
  - No special resources devoted to CMMI
  - Work was done by the team and led by the team's process manager (a standard TSP role)

SCAMPI B #2 Results – 1

GTACS Project Only*

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	REQM	PP	PMC	SAM	M&A	PPQA	CM	RD	TS	PI	Ver	Val	OPF	OPD	OT	IPM	RSKM	IT	ISM	DAR	OEI	OPP	QPM	OID	CAR
Specific Goal 1																									
SP 1.1	L	L	L		L	L	L	L	M	L	L	M	L	L		L	L			L		H	L	L	L
SP 1.2	L	L	L		L	L	L	L	L	L	L	L	L	L		L	M			L		H	L	L	L
SP 1.3	L	L	L		L		L		M	L	L	M	L	L		L	L			H		H	L	L	
SP 1.4	M	L	M		L									L		L				H		H	L	L	
SP 1.5	L		L											L		L				H		H			
SP 1.6			L																	H					
SP 1.7			L																						
Specific Goal 2																									
SP 2.1	L	L			M	L	L	L	L	M	L	L	L			L	L					L	L	L	
SP 2.2	L	L			L	L	L	L	L	L	L	L	L			L	M					M	L	M	
SP 2.3	L	L			L			L	L		L		L			L						M	M	L	
SP 2.4	L				L				M				L									M			
SP 2.5	L																								
SP 2.6	L																								
SP 2.7	L																								
Specfic Goal 3																									
SP 3.1	L						L	L	L	L	L						L								
SP 3.2	L						L	L	L	L	L						L								
SP 3.3	L							L		L															
SP 3.4								L		L															
SP 3.5								L																	
Specific Goal 4																									
SP 4.1																									
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Generic Goal 2																									
GP 2.1	L	L	L		L	L	L	L	L	L	L	L	L	L		L	L			L		L	L	L	L
GP 2.2	L	M	L		L	L	L	L	L	L	L	L	M	M		L	L			L		M	L	L	L
GP 2.3	L	L	L		L	L	L	L	L	L	L	L	L	L		L	L			H		H	L	L	L
GP 2.4	L	L	L		L	L	L	L	L	L	L	L	L	L		L	L			L		H	L	L	L
GP 2.5	M	M	M		M	H	L	M	M	M	L	M	L	L		M	M			M		H	L	H	M
GP 2.6	L	L	L		L	L	L	L	L	L	L	L	L	L		L	L			M		H	L	L	L
GP 2.7	L	L	L		L	L	L	L	L	L	L	L	L	L		L	L			M		H	L	L	L
GP 2.8	L	L	L		L	L	L	L	L	L	L	L	M	M		L	L			H		H	L	L	L
GP 2.9	L	L	L		L	L	L	L	L	L	L	L	L	L		L	L			L		H	L	L	L
GP 2.10	L	L	L		L	M	L	L	L	L	L	L	L	L		L	L			L		L	L	L	L
Generic Goal 3																									
GP 3.1	L	L	L		L	L	L	M	L	L	L	L	L	L		L	L			L		H	L	L	L
GP 3.2	L	L	L		L	L	L	L	L	L	L	L	L	L		L	L			H		H	L	L	L

LEGEND
L = Low Risk
M = Medium Risk
H = High Risk

*For this SCAMPI B, PPQA, OPF, ODP, and DAR were assessed at the Project level. OT was Org level. SAM was N/A for GTACS.

SCAMPI B #2 Results – 2 GTACS Project Only

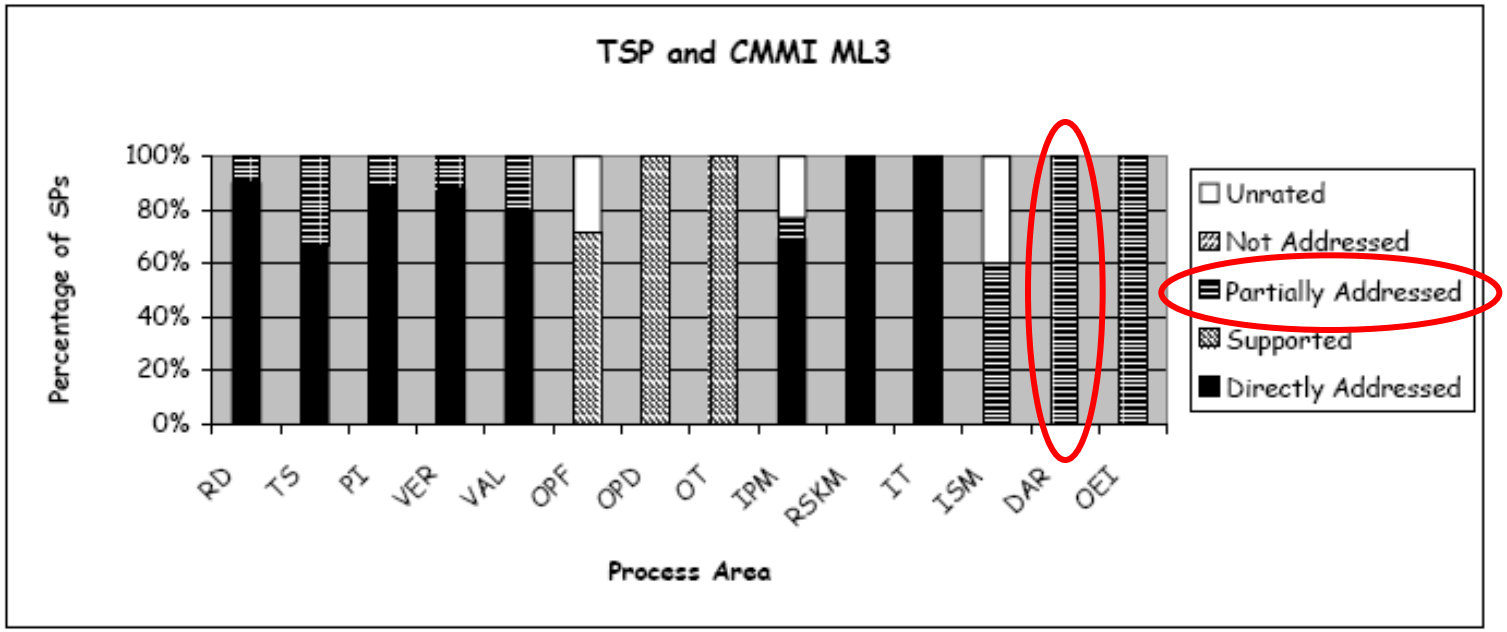
Risk Level	Total Risks	Process Risks	Artifact Risks	Document Risks	Non-Team Risks
High	23	0	8	0	15
Medium	38	7	6	17	8
Low	22	0	1	11	10
Total	83	7	15	28	33

- **Decision Analysis & Resolution (DAR):**
  - **7 High, Artifact**
  - **3 Medium, Artifact**
  - **1 Low, Document**
- **Organizational Process Performance (OPP):**
  - **13 High, Non-Team**
  - **1 Medium, Non-Team**
  - **1 Low, Non-Team**
- **Training:**
  - **1 High, Artifact**
  - **2 High, Non-Team**
  - **12 Medium, Document**
  - **1 Low, Artifact**
  - **1 Low, Non-Team**
- **Others with GTACS responsibility:**
  - **18 Medium - 17 Low**
  - **Spread throughout model**
  - **QPM, CAR, and Risk Management required process changes**

DAR Findings

- **Scope**
  - **During 1st SCAMPI B, DAR was focused at the organizational level**
  - **This proved to be insufficient to produce the necessary artifacts**
  - **An Organization level DAR process was developed by representatives throughout the 309th**
  - **The new DAR process became a requirement for GTACS**
- **Timing**
  - **The majority of the time between the first and second SCAMPI B's was spent at the Organizational level**
  - **GTACS defined its process, conducted training, but did not execute the process prior to the second SCAMPI B**

DAR "Supported" by TSP



- **SEI's Report: All DAR Specific Practices "Partially Addressed"**
- **Underestimates Risk and Effort for TSP Teams**
  - **TSP is consistent with DAR philosophy but is nowhere near sufficient**
  - **TSP as it now stands is insufficient to pass a CMMI assessment**
  - **TSP DAR procedure is required to produce proper and meaningful artifacts**

DAR for GTACS TSP Team

- **Institutionalization**
  - **The 309th provided DAR training for GTACS**
  - **GTACS adapted the Organization level DAR process for use on their team**
  - **Determined to use the TSP approach**
    - **Scripts**
    - **Forms**
- **Adaptation**
  - **GTACS created a draft operational process in the form of a TSP script**
  - **The DAR script was then used to analyze several different types of issues**
    - **product design**
    - **tool selection**
    - **process**

DAR TSP Script for GTACS

DAR Process Script

Purpose	To guide the team in making formal decisions.
Entry Criteria	Either - A Critical measurement exceeds the thresholds defined in the GTACS DAR threshold matrix or - A critical decision needing a formal analysis is identified.
General	- Critical decisions are ones that have potential impact on the project or project team. Issues with multiple alternative approaches and multiple evaluation criteria are particularly well suited for formal analysis..
Tailoring	- This procedure may be used to make and document other decisions

Step	Activities	Description
1	Planning	- A POC is assigned • The POC may be self assigned if the POC is responsible for the critical decision • The team lead assigns the POC otherwise The team that will perform the DAR analysis and selection activities (the DAR team) is assigned - The POC completes the Entry section of the MXDE Decision Analysis and Resolution Coversheet (section I)
		• The completed MXDE Decision Analysis and Resolution Coversheet • Scoring and analysis worksheets • CM is notified that the DAR is complete and that the DAR artifacts can be archived to the GTACS data management repository

Exit Criteria	- The MXDE Decision Analysis and Resolution Coversheet is completely filled out - The artifacts produced during the DAR activities have been archived in accordance with the GTACS DMP

Note: The entire process script can be found in the Crosstalk article “CMMI Level 5 and the Team Software Process”

OPP and QPM

- GTACS Weaknesses in OPP and QPM
  - GTACS data were not analyzed at the sub-process level
  - Data analyses did not address an understanding of process variability
- TSP Paradigm is Not Consistent with CMMI Expectations
  - TSP teams use data for three purposes:
    - project planning
    - project monitoring and oversight
    - process improvement
  - TSP fundamentally considers the software development process as a single entity

OPP Solutions

- **GTACS Addressed OPP by**
  - **Helping the Organization address Organizational Process Performance requirements by Organizational Subprocess (Process Category)**
  - **Mapping detailed TSP project data to Organizational data structures**
  - **Using Organizational goals to guide data analyses**

MXDE Historical Data Worksheet

Project Name:			
Flight:			
TPM:			
Number of PEs:			
Project Type:			
Product Size:		Sizing Units	
Completion Date:			version 0.7

Process Performance Data

MXDE Standard Engineering Process Category	Estimated Effort at Kickoff	Final Negotiated Effort	Actual Effort at Completion	Estimated Schedule Duration at Kickoff	Final Negotiated Schedule Duration	Actual Schedule Duration	Defects Injected in Category	Defects Removed in Peer Review	Defects Removed in Test Event	Effort to Remove Defects	Externally Detected Defects	Category % of Total Effort
Planning												0.0%
Design												0.0%
Development												0.0%
Test												0.0%
Support												0.0%
Overall	0	0	0	0	0	0	0	0	0	0	0	0.0%

MXDE Process Peformance Objectives

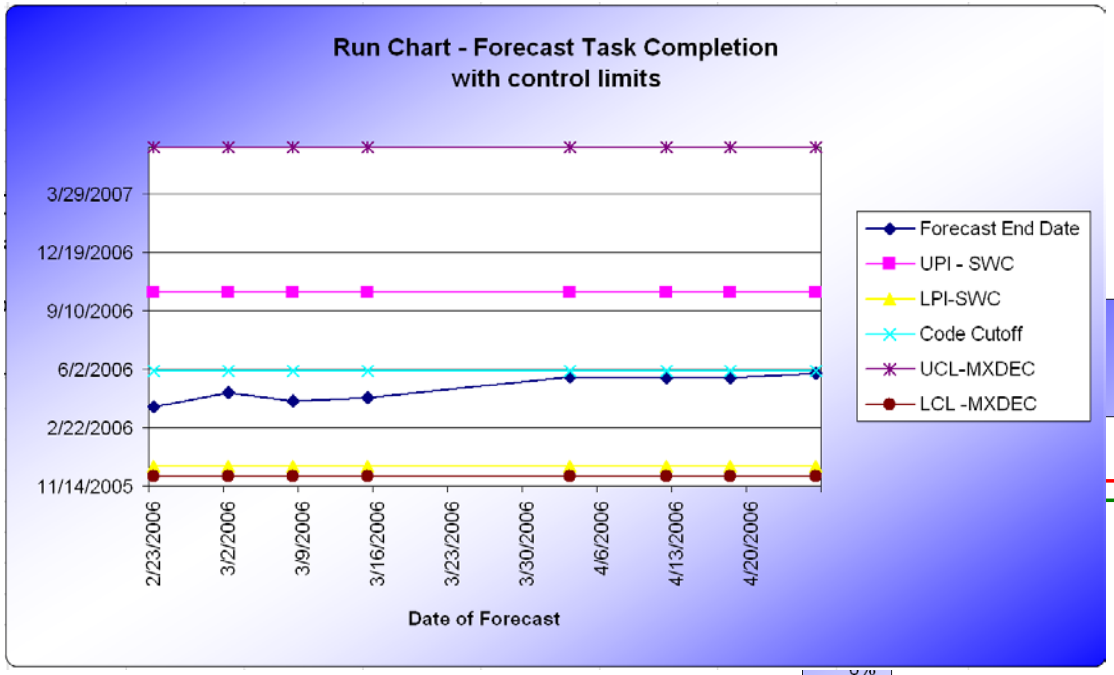
MXDE Standard Engineering Process Category	Cost: CEV% (KickOff)	Cost: CEV% (Negotiated)	Schedule: SEV% (Kickoff)	Schedule: SEV% (Negotiated)	Quality: DIR	Quality: DDR Peer Reviews	Quality: DDR Test Event	Quality: DDR Overall	Quality: DD	Quality: Rework% Actual	Productivity (Size/Hour)
Planning	0.0%	0.0%	0.0%	0.0%	0.00	0%			0.00	0%	0
Design	0.0%	0.0%	0.0%	0.0%	0.00	0%			0.00	0%	0
Development	0.0%	0.0%	0.0%	0.0%	0.00	0%			0.00	0%	0
Test	0.0%	0.0%	0.0%	0.0%	0.00	0%			0.00	0%	0
Support	0.0%	0.0%	0.0%	0.0%	0.00	0%			0.00	0%	0
Overall	0.0%	0.0%	0.0%	0.0%	0.00	0%	0%	0%	0.00	0%	0

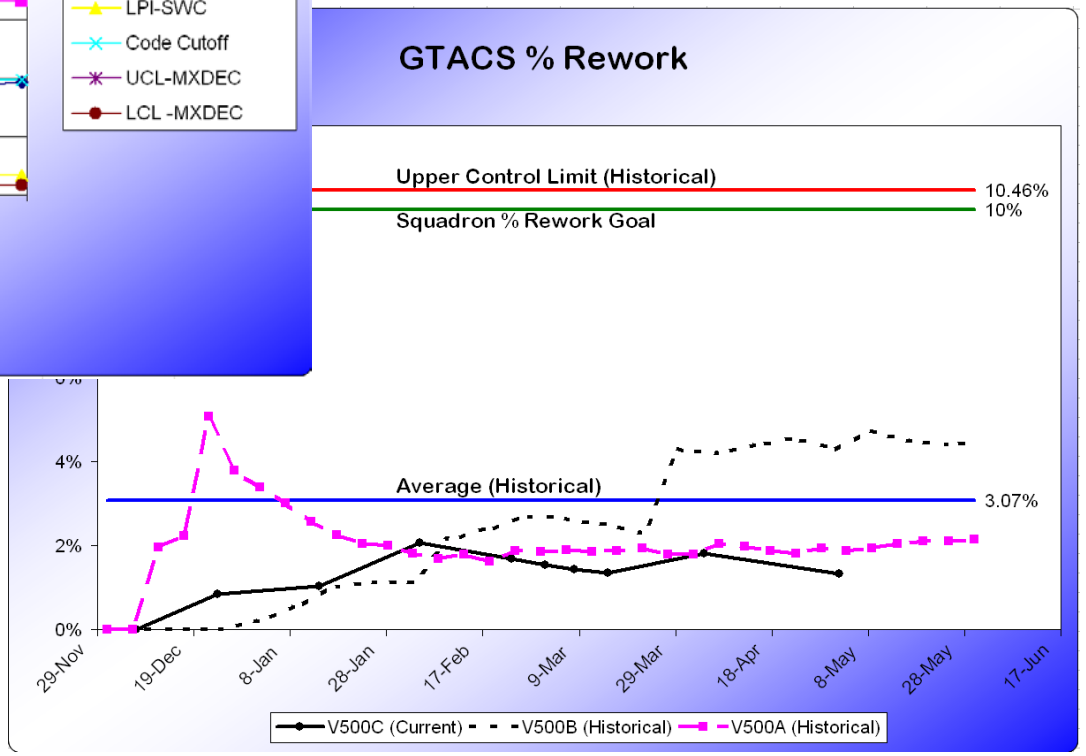
Milestone Performance

QPM Solutions – 1

- **Utilized Existing TSP Data**
  - **Earned Value**
    - For project management, the Projected Completion Date is one of the key items of interest
    - GTACS had more than one year's worth of statistically significant data on Earned Value
  - **Rework**
    - TSP teams collect a great deal of Defect data, including time spent in the finding and fixing of defects
    - GTACS defined Rework as the percent of total project time spent finding and fixing defects (consistent with the Organizational definitions)
    - GTACS had more than one year's worth of statistically significant data on Rework

QPM Solutions – 2





QPM Solutions – 3

- The Bad News
  - The TSP "holistic process" approach is not consistent with CMMI's requirement for quantitatively managing at the subprocess level
    - The TSP and PSP approach is to manage *projects* using measures and metrics
    - The CMMI approach is to manage *processes*
  - The "alternate practice" used in CMMI version 1.1 level 5 assessment was to treat each project module (baseline change request) as a complete PSP subprocess
  - This approach was adequate at the time
  - Since that time, SEI has increased the rigor of high maturity assessments
  - Our approach may not pass a CMMI version 1.2 assessment using the recently implemented high maturity assessment standards

CAR

- TSP Postmortem Process
  - Currently calls for a detailed analysis of project and process data, including identification of improvements
  - This provides a great deal of support for CAR
- TSP Postmortem Lacks CAR "Formality" and "Feedback"
  - CAR artifacts not specifically defined nor required
  - No examination of data to determine if implemented process improvements really worked
- GTACS Updated the TSP Postmortem Scripts
  - Directly addresses Causal Analysis and Resolution
  - Created a CAR Report
    - Details the data analysis which was performed
    - Identifies any weaknesses discovered
    - Suggests process improvements to address these weaknesses
    - Requires an analysis of previous project improvements

CAR Script

TSP Postmortem Script

Purpose	- To gather, analyze, and record phase and project data - To analyze project performance against plans and goals - To identify potential areas for improvement - To identify and submit GCARs
Entry Criteria	- All planned work for the phase has been completed. - All project and process data are available. - Team Dashboard with data from the phase being analyzed - Current Project Notebook - Note: postmo

Step	Activities	Descript
1	Meeting Roles	Select the - The lau - The tim - The rec insures - The Pro Notebo
2	Baseline Evaluation	The suppo managem
3	Plan Evaluation	The plann - actual v
4	Quality Performance	The quali - quality - team pe
5	Planning Data	Provide u - size, re - defect,
6	Process Causal Analysis	The team - A discussion is held of key process capabilities (e.g., estimation accuracy, productivity, quality) and compared with desired numeric goals - A determination is made to identify any process capability deficiencies that exist or

6	Process Causal Analysis	The team lead leads the team in an analysis of the team's process capability - A discussion is held of key process capabilities (e.g., estimation accuracy, productivity, quality) and compared with desired numeric goals - A determination is made to identify any process capability deficiencies that exist or if there are process capability improvement opportunities. Key process capabilities are analyzed Where improvement opportunities are identified Identify process, training, tool, support, or management actions Submit GCARs as required
7	Quality Causal Analysis	The quality manager leads the team in an analysis of the team's defect data - A determination of which defects to analyze is made through an analysis of: Pareto charts for the most costly and most common defect types All defect escapes from Unit Test - For those defects and defect types selected: Their defect log entries are analyzed to determine root cause Where improvement is needed Identify process (e.g., checklist(s) update), training, tool, support, or management actions Submit GCARs as required

CAR Report

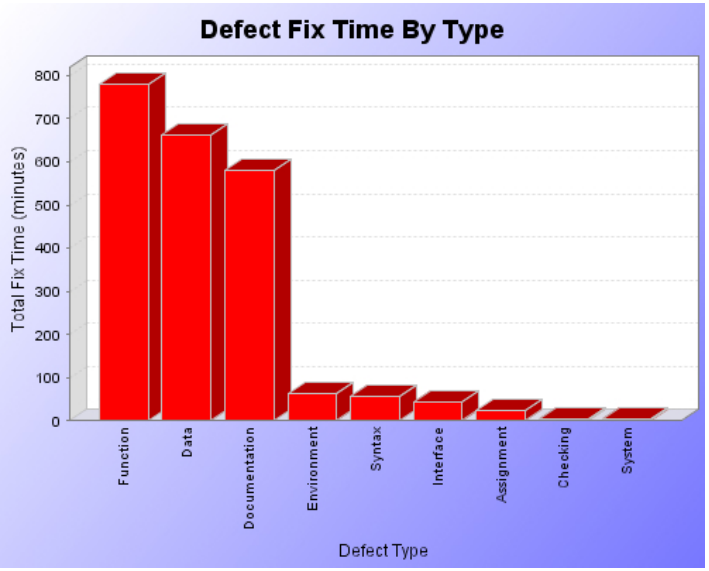
V500A Causal Analysis and Resolution

1 Selecting Defects for Problem Analysis

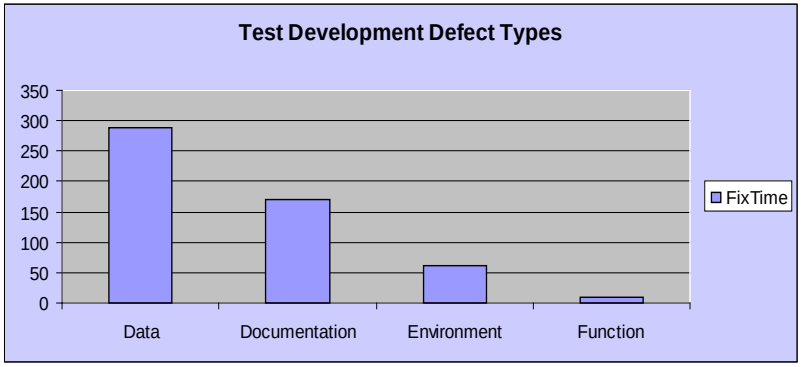
During the postmortem phase for V500A an analysis of the defect data was performed in an attempt to find ways to improve our process and our product quality. The focus of the analysis was to find the kind of errors that were the most expensive to correct or perhaps occurred most frequently. We also wanted to look at problems that occurred during the V500A development phase that were possibly not logged as defects but cost the team in terms of schedule.

1.1 Most Common Defect

The initial V500 Defect data showed that the most expensive type of defect was type function.

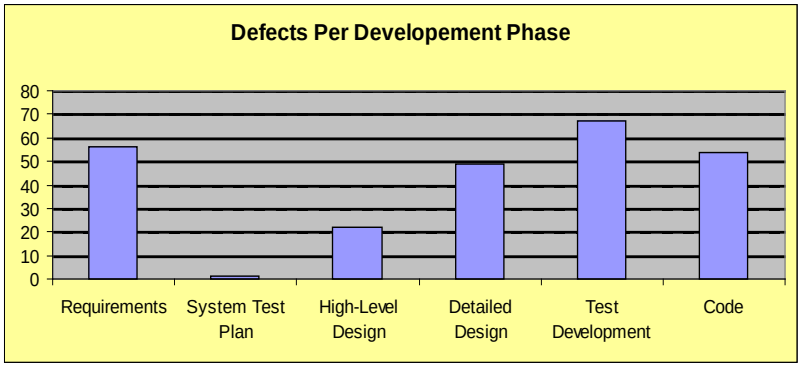


The GTACS defect type of data is defined to be any defect caused by the improper design or implementation of a data element. This type of error also happens to be the most expensive error type logged by our team for errors in the test development phase.



1.1 Defects by Phase

Another metric that was evaluated was the total number of defects injected in a development phase of our process. The Test Development Phase has the most total defects logged.



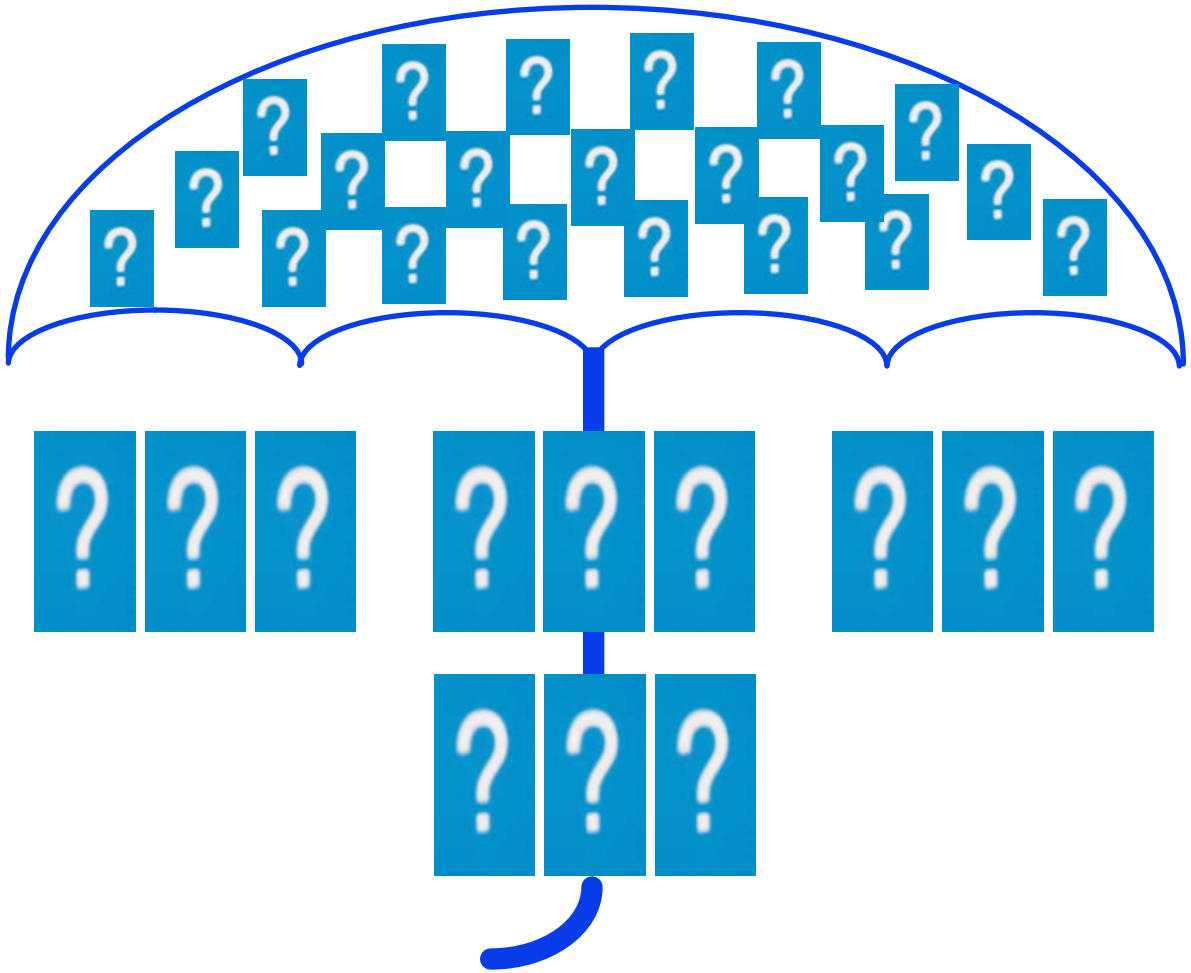
Training

- **TSP Training Covers Many CMMI Requirements**
  - **Personal Software Process Training for Engineers**
  - **Managing TSP Teams for Managers & Team Leader**
  - **Addressed the training requirement (SP 2.5) for:**
    - **Project Planning**
    - **Project Monitoring & Control**
    - **Integrated Project Management**
    - **Process and Product Quality Assurance**
    - **Measurement & Analysis**
    - **Causal Analysis & Resolution**
    - **Verification (partially addressed)**
- **A Training Plan was Developed for the Remaining Process Areas**

Summary

- TSP Does Not Guarantee CMMI Level 5
- SEI's Mapping of TSP to CMMI is a Good Starting Point
- TSP Teams Should Focus on:
  - Causal Analysis & Resolution
  - Decision Analysis & Resolution
  - Organizational Process Performance
  - Quantitative Project Management
  - Training
- TSP Does Provide All the Data and Discipline Required
- Additional Scripts, Forms and Reports are Needed

Questions?



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