

Applying PSM and Insight within a Small Organization

***5th Annual 2001
PSM Users' Group Conference***

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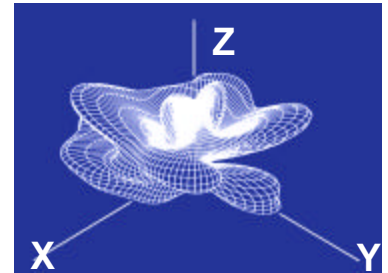
IIT Research Institute

Agenda

- ***Organizational Profile***
- ***Background***
- ***Challenges***
- ***PSM and Insight to the rescue!***
- ***ITRI'S Software Measurement Program***
 - ***PSM and Insight Implementation***
 - ***FY01 Enhancements***
- ***Lessons Learned***

Organizational Profile

- **Not-for-profit research facility under contract to the Joint Spectrum Center (JSC)**
- **Spectrum management & electromagnetic environmental effect (E3) engineering and software services**
- **450 personnel**
 - ≈ 150 in software development & maintenance
 - ≈ 250 in E3 engineering and database operations
- **25-30 small software projects**
 - Multiple sponsors, customers, and funding sources
 - Mix of development, re-engineering & maintenance
 - Development/ re-engineering = 58% of total S/W effort
 - Maintenance = 42% of total S/W effort



Background

- ***CMM-based software process improvement initiated in 1991***
- ***Software measurement program initiated in early 1994 as an software process improvement (SPI) initiative***
 - *Core Measures defined via:*
 - *GQM “paradigm”*
 - *Adopting core measures from existing measurement guidance & standards*
- ***PSM process & guidance adopted in 1998***
- ***Insight adopted for Organizational Database in early 1999***
- ***PSM Workshops with projects initiated in mid-1999***
 - *Re-defined core measures using PSM I-C-M*
- ***CMM Level 3 assessment in late 1999***

Challenge

- **25-30 small independent software projects**
 - *2 to 10 staff members per project*
 - *Each project develops or maintains one or more systems*
 - *Mix of development, re-engineering and maintenance per system*
 - *Many legacy systems without history data*

Challenge

- **25-30 small independent software projects**
 - 2 to 10 staff members per project
 - Each project develops or maintains one or more systems
 - Mix of development, re-engineering and maintenance per system
 - Many legacy systems without history data
- **Implementing a Level 3 measurement program while at Level 1 and Level 2 maturity**
 - Lack of definitive organizational-level & project-level goals
 - Lack of senior management use of quantitative data for project performance evaluation
 - Initial lack of resources for establishing & sustaining an organizational measurement program
 - Process implementation not consistent across all software projects



to the rescue! - 1

- **Issue driven approach**
 - *Not all projects can articulate definitive goals, but all projects can speak to issues and risks*
 - *Projects, overall, relate to issues and risks that are common to all projects despite project's individual characteristics*
 - *Measurement-oriented workshops to identify common project issues & risks promote buy-in by the majority of projects*



to the rescue! - 1

- **Issue driven approach**
 - *Not all projects can articulate definitive goals, but all projects can speak to issues and risks*
 - *Projects, overall, relate to issues and risks that are common to all projects despite project's individual characteristics*
 - *Measurement-oriented workshops to identify common project issues & risks promote buy-in by the majority of projects*
- **DoD & Industry proven guidance**
 - *PSM identifies the measures that have been effectively used within the software industry (DoD & non-DoD)*
 - *PSM Guide provides all the information needed towards defining:*
 - *measurement processes*
 - *measures, attributes & data items*
 - *indicators & analyses*



to the rescue! - 1

- ***PSM community of experts provide measurement support with great promise of a future***
 - *Not just a process, but a vital network of experienced & successful measurement practitioners*
 - *Expanding PSM user base within government and commercially*
 - *Active PSM user involvement lends support to each other and to measurement novices*



to the rescue!

- ***Intuitive, actively supported, free!***
- ***Embodies the PSM methodology and guidance***
- ***Easily customizable***
- ***Appropriate for organizational and project level data***
- ***Consistent with latest PSM methodology advancements***



Key principles and rules we initially adopted to guide our measurement program

From PSM

- *Project goals and issues drive the measurement requirements*
- *The developer's software process defines how the software is actually measured*
- *Collect and analyze data at a level of detail sufficient to identify and isolate software problems*
- *Integrate software measurement into the project management process throughout the software life-cycle*

Key principles and rules we initially adopted to guide our measurement program

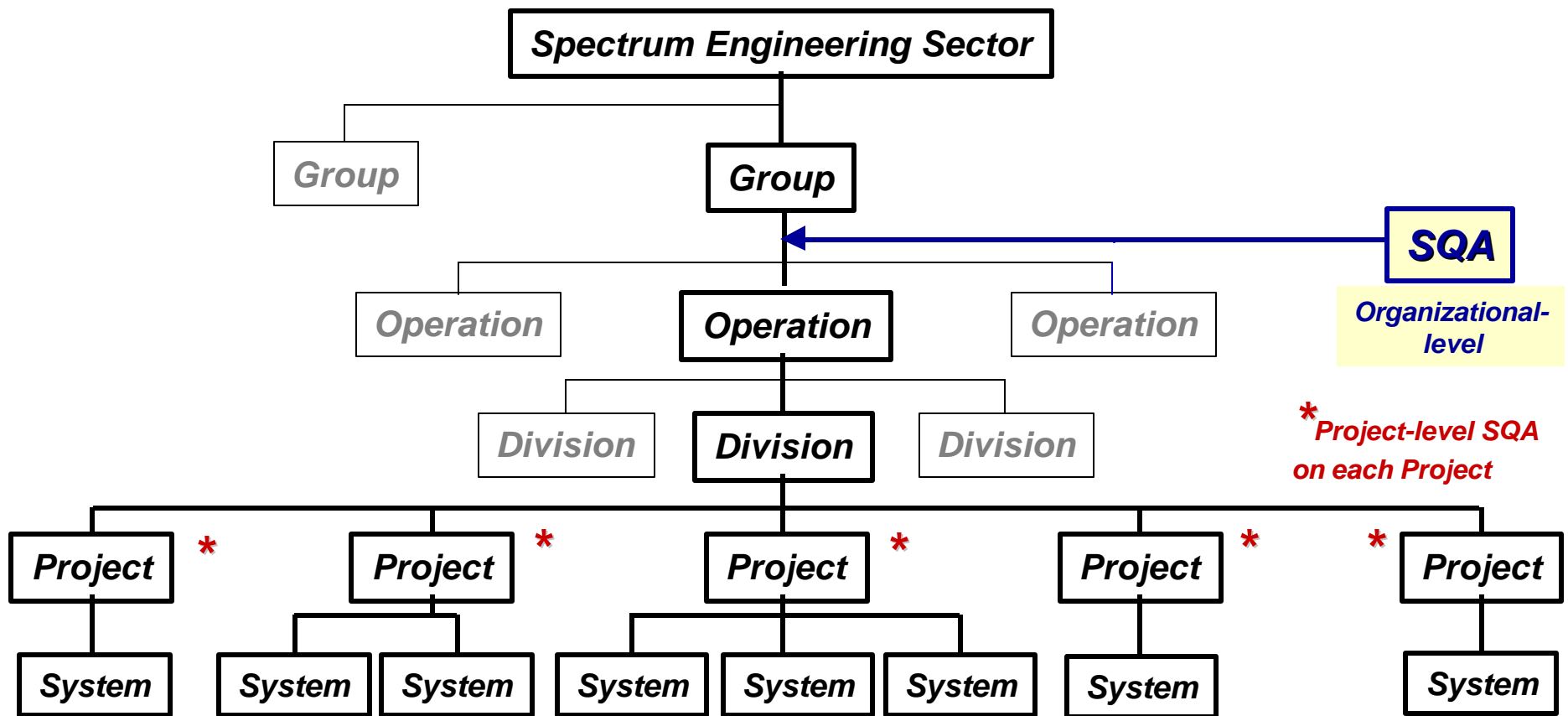
• **From PSM**

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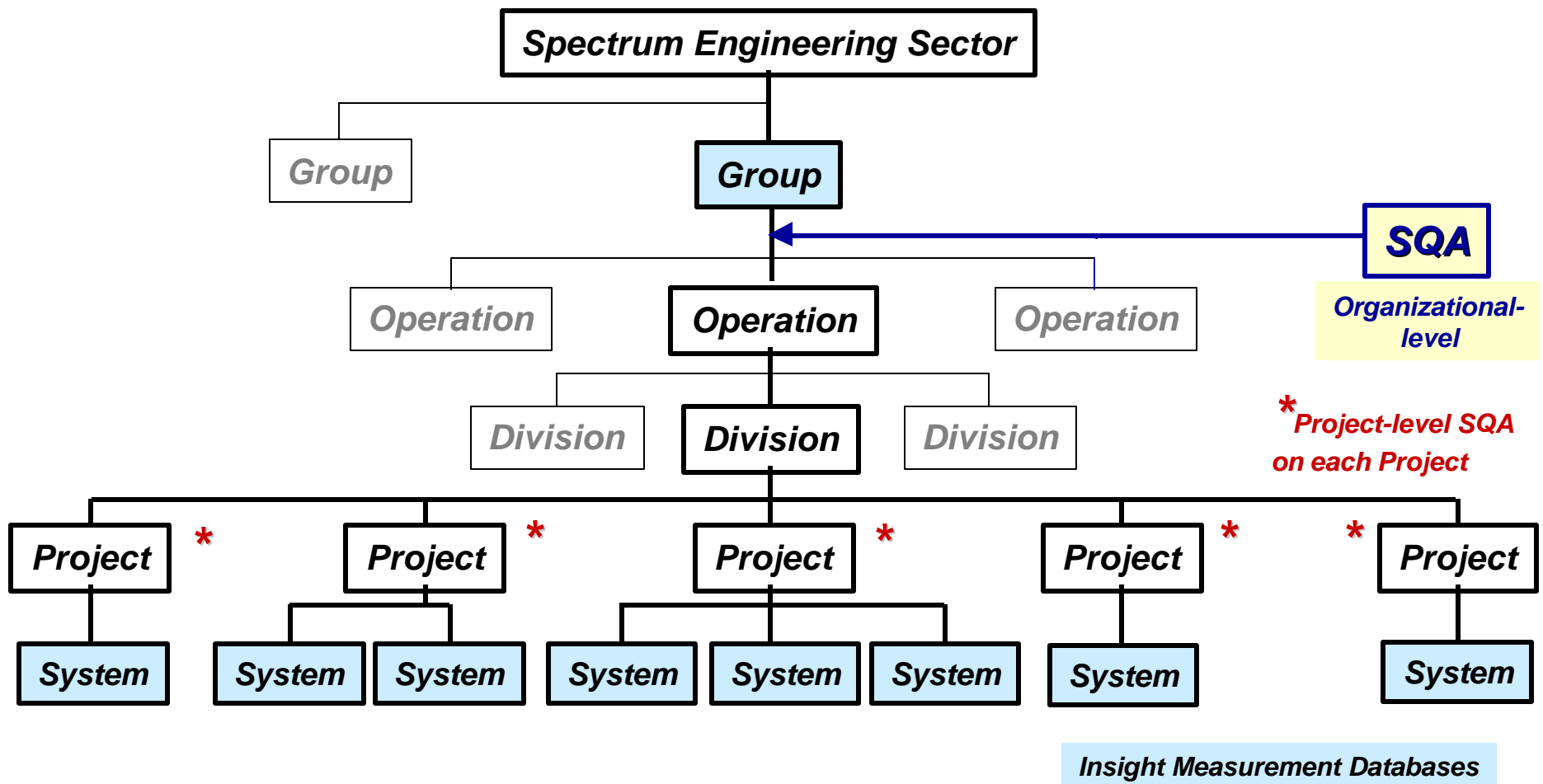
• **From other organizations successful in measurement**

- *Provide centralized measurement support to projects*
- *Start small*
- *Keep the number of measures to a minimum; begin with a set of core measures*
- *Make providing data easy*
- *Avoid over-reporting measurement data*

IITRI's Organizational Structure - a driver of our S/W Measurement Program Infrastructure



IITRI's Organizational Structure - a driver of our S/W Measurement Program Infrastructure

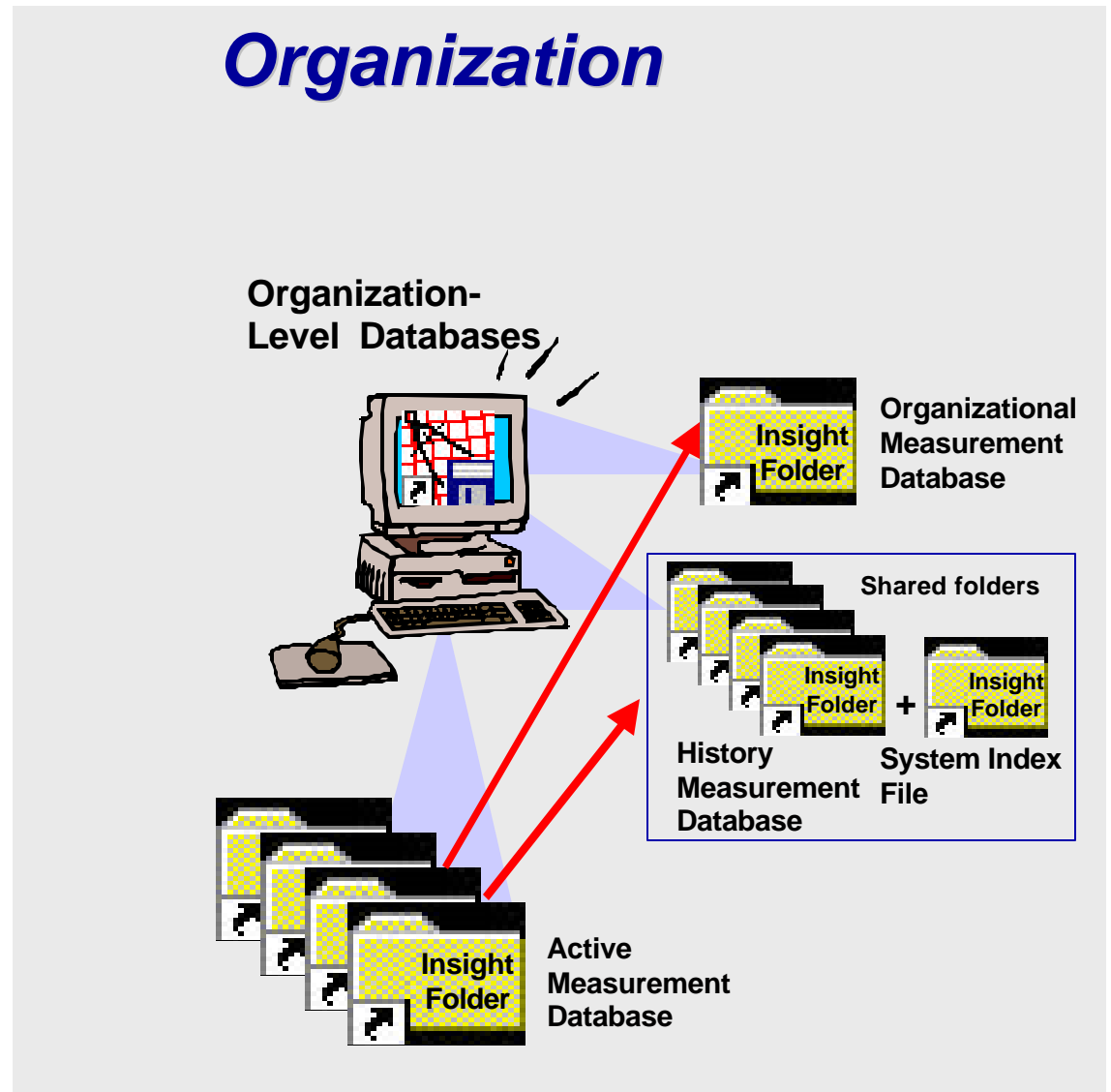


Our S/W Measurement Program Infrastructure

	Project/System	Organization
Databases	<ul style="list-style-type: none"> Active Measurement DB 	<ul style="list-style-type: none"> Active Measurement DB History Measurement DB Organizational Measurement DB
Processes	<ul style="list-style-type: none"> Develop/Maintain Measurement Plan Collect & Submit Data Analyze indicator Reports for SPTO Use History Data for SPP 	<ul style="list-style-type: none"> Plan/Direct Measurement Program Conduct Measurement Workshops Acquire/Import/Validate Data Prepare Indicator Reports/Analysis Archive Data in History DB Build Organizational DB Analyze Organizational Data Evaluate Measurement Program
Roles	<ul style="list-style-type: none"> Measurement Coordinator Management Team 	<ul style="list-style-type: none"> Measurement Program Director Measurement Analyst Measurement Working Group
	Minimized Impact to Projects	Centralized Measurement Support

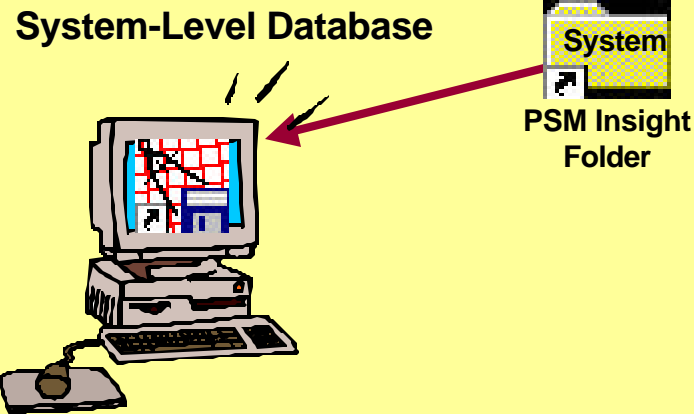


How Insight is Implemented - 1

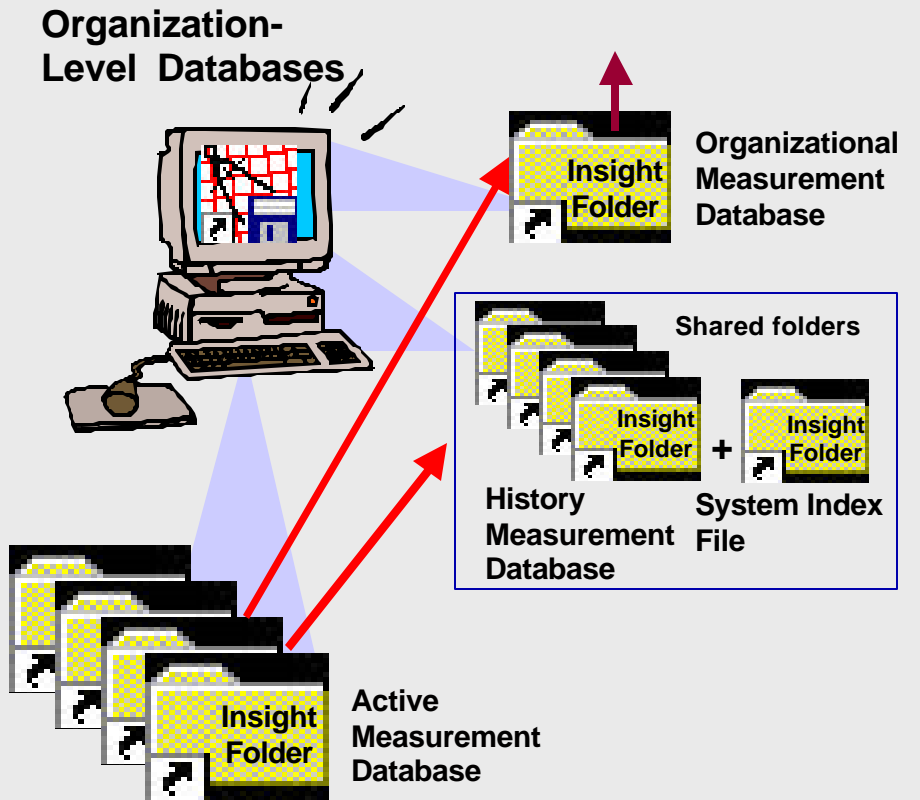


How Insight is Implemented - 1

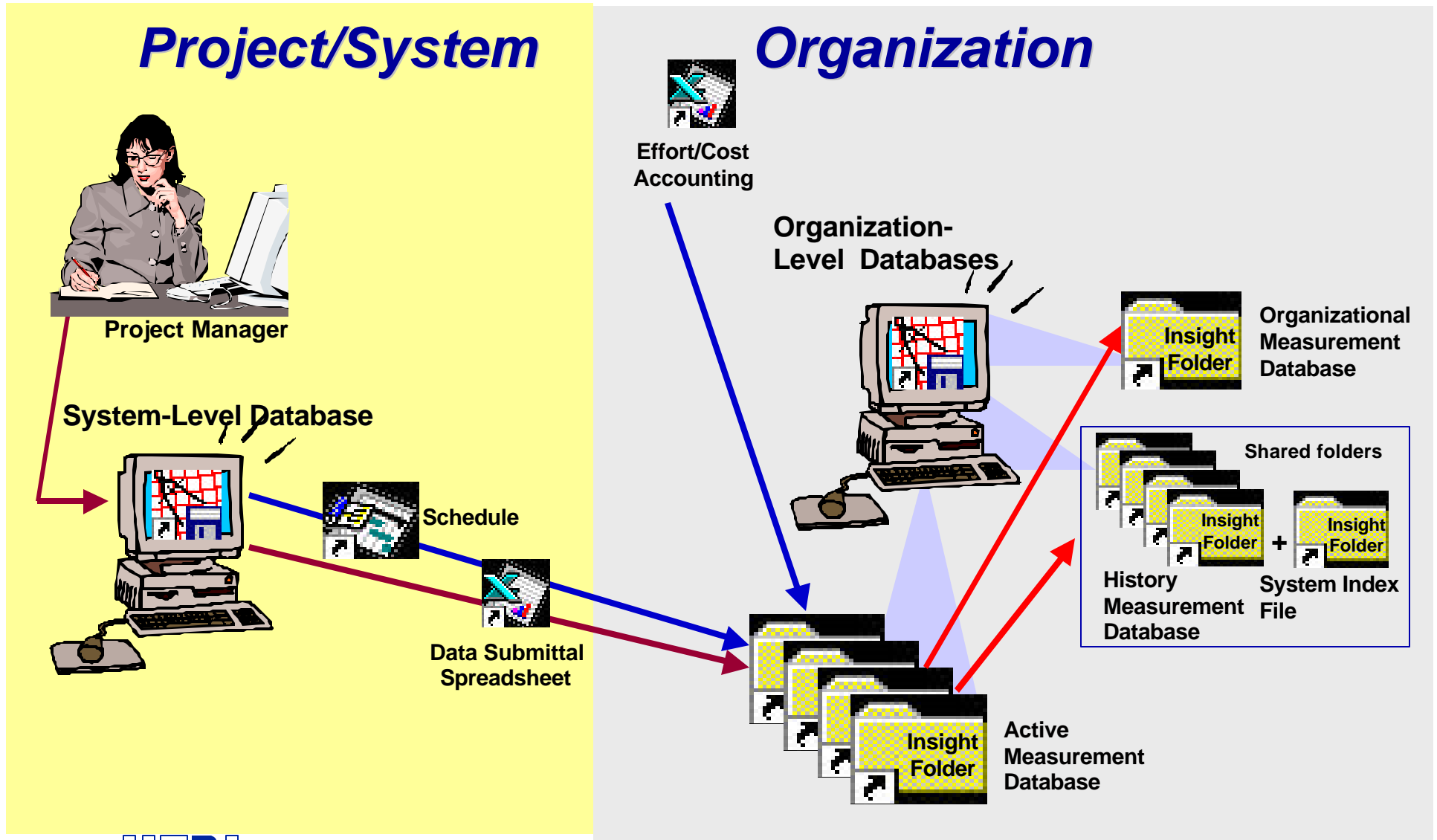
Project/System



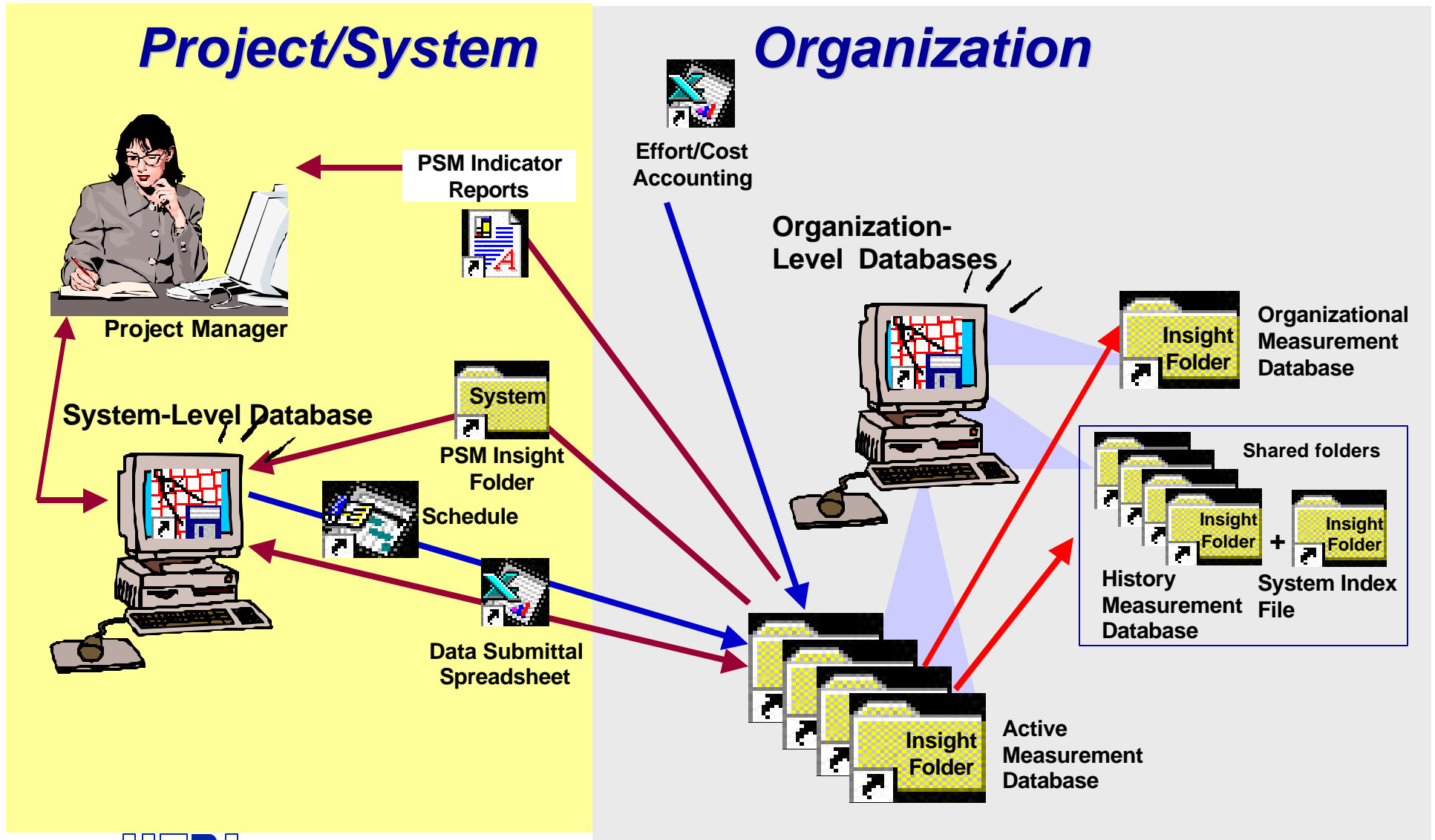
Organization



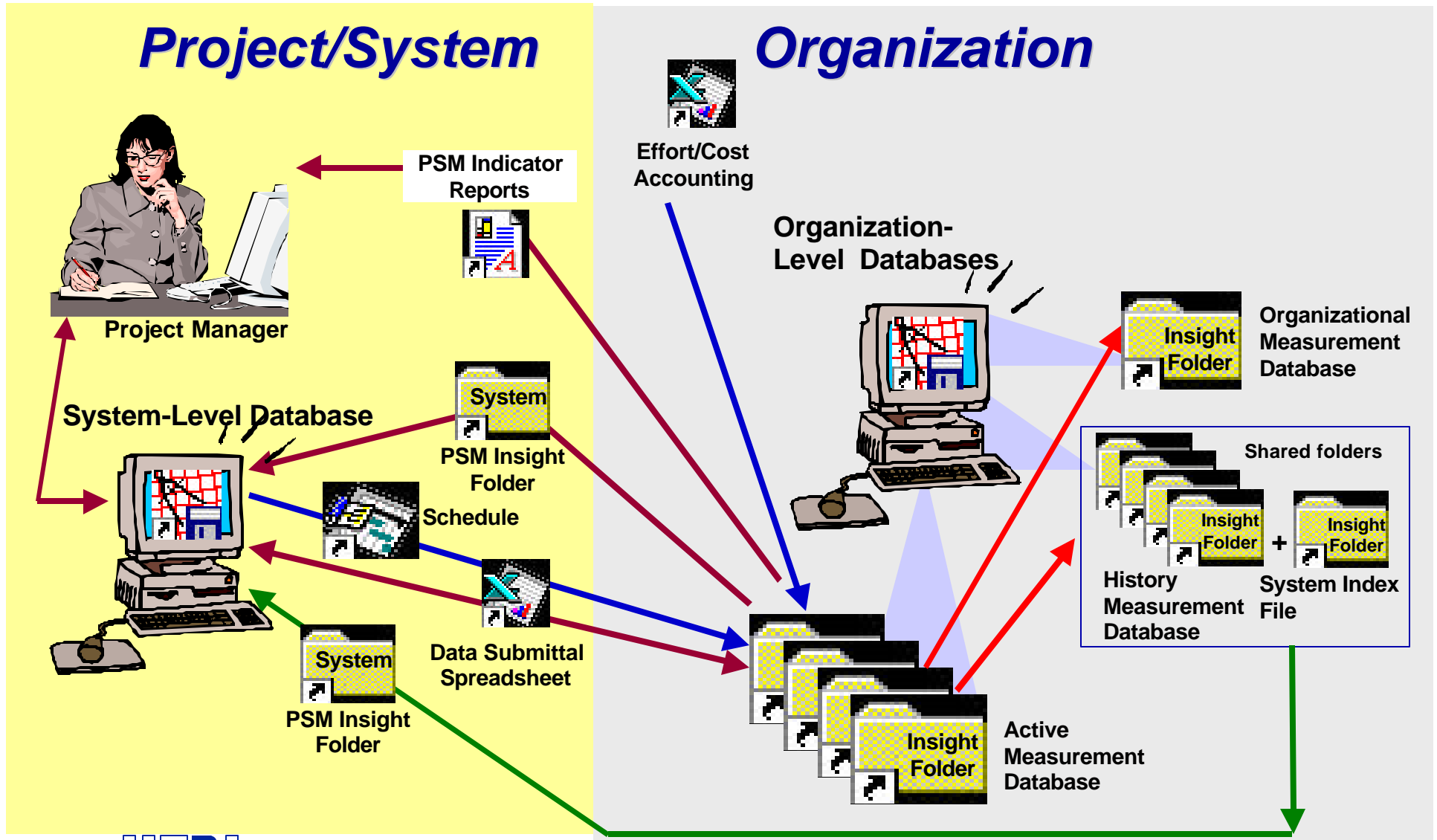
How Insight is Implemented - 1



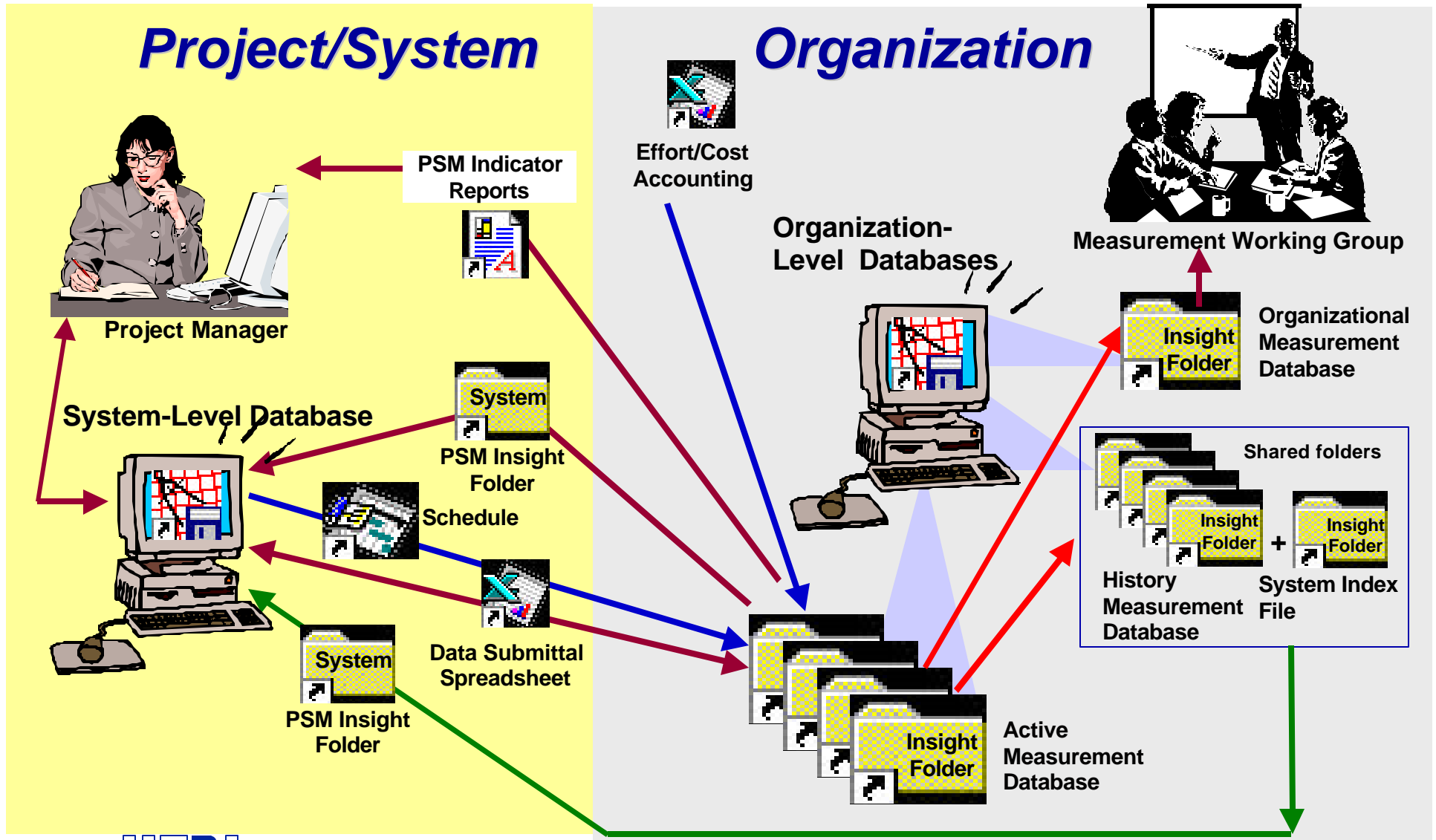
How Insight is Implemented - 1



How Insight is Implemented - 1



How Insight is Implemented - 1



How Insight is Implemented - 2

The screenshot displays the 'PSM Insight - Project Index - [Project List]' application window. The interface includes a menu bar (File, Lists, Windows, Help), a toolbar with 'Select' (Projects, Issues, Mapping, I-C-M, Structures, Attributes) and 'Apply' (Data, Indicators) sections, and a secondary toolbar with 'Add', 'Edit', 'Delete', 'Open', 'Pack', 'Unpack', 'Report', 'Help', and 'Close' buttons.

The main area is divided into two panes. The left pane, titled 'Open Project: Project Index', contains a list of project entries:

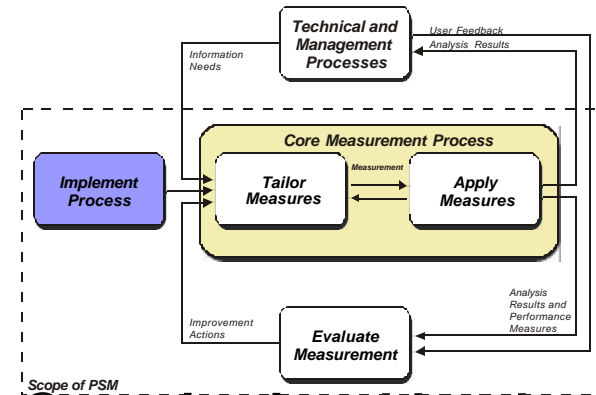
- Project Index
- FY00 RACS P0067 History
- FY00 COSAM P0813 History
- FY00 EMCS P0844 History
- FY00 MSE-NPT P1024_1 History
- FY00 ISYSCON P1024_2 History
- FY00 AFP P1295 History
- FY00 SatPro P1408 History
- FY00 BEI P1431 History
- FY00 ECS P1431 History
- FY00 IDR P1431 History
- FY00 TACDB P1431 History
- FY00 SMO P1432 History
- FY00 Spectrum XXI P1458 History
- FY00 MRFL2 P1510 History
- FY00 JOERAD P1548 History
- IITRI SES
- FY01 AAPG P0813
- FY01 CMC2 P1510
- FY01 COSAM P0813
- FY01 JOERAD P1510
- FY01 JAS Dev P1584
- FY01 JAS Maint P1584
- FY01 ECS P1431
- FY01 IDR P1431
- FY01 TACDB P1431

The right pane shows details for the selected 'Project Index' project:

- Project:** Project Index
- Description:** Project Index is a database of the Project Characteristics, Software Size Profile, and Process Attributes for all or most of the software projects at IITRI SES. The intended use of this database is serve as an index of all the projects for which a History Measurement database exists. Sorting or filtering data within the Project Index will lead to the selection of projects with history data of interest.
- Comments:** This database is populated by the Software Measurement Analyst from all the individual project's System Characteristics, Software Size Profile, and Process Attributes measures.

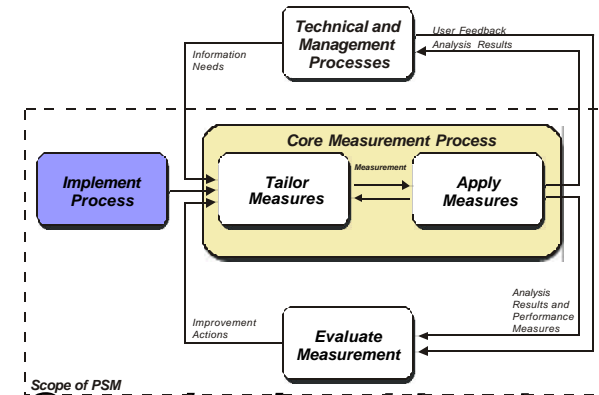


How PSM is Implemented - 1



- **Measurement Program funded by the Organizational-level SQA Project**
 - Measurement Program Director - SQA Advisor (1/4 time)
 - Measurement Analyst - Senior software engineer (full time)
 - Meas. Working Group - SQA Advisors, Meas. Analyst, Project SQA
- **Measurement Coordinator assigned per system/project**
 - Funded by the S/W development/maintenance projects

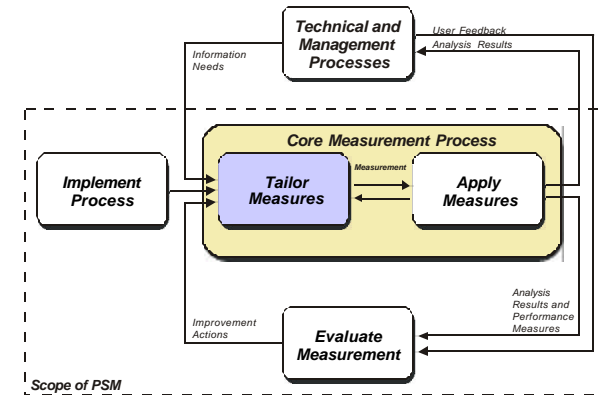
How PSM is Implemented - 1



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 - Measurement Program Director - SQA Advisor (1/4 time)
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 - Meas. Working Group - SQA Advisors, Meas. Analyst, Project SQA
- **Measurement Coordinator assigned per system/project**
 - Funded by the S/W development/maintenance projects
- **Senior management performance reviews initiated**
 - Identify organizational issues and goals
 - Review organizational measurement analysis results
- **Management & technical staff briefed periodically**
 - Introduce measurement-related policies & processes
 - Review organizational measurement analysis results

How PSM is Implemented - 2

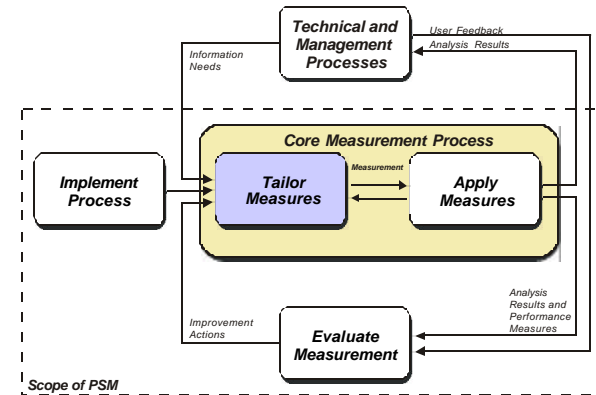
Tailor Measures



- **Workshops including all S/W Project Managers**
 - Identify goals, issues & risks common across projects/systems
 - Define common measures (i.e., Core Measures) and indicators
- **One-on-one meetings with each Project/System**
 - Conduct throughout the project/system's life-cycle
 - Identify project-specific goals/issues/risks
 - Define project-specific measures and indicators
 - Tailor set of Core Measures based on project's life-cycle & processes
 - Identify improvements to project processes & artifacts (e.g., logs)

How PSM is Implemented - 2

Tailor Measures

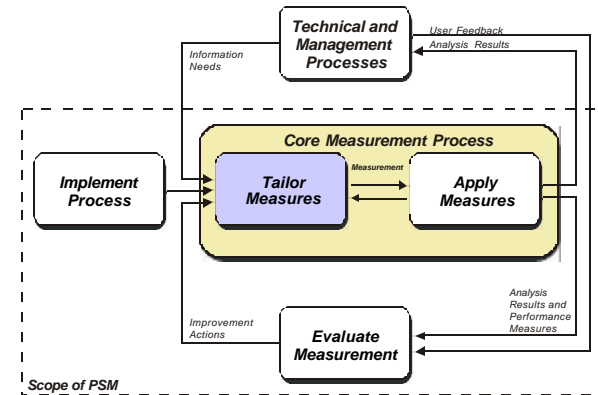


PSM I-C-M Templates & Indicators -
a planning & operational guide

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How PSM is Implemented - 2

Tailor Measures



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 - Tailor set of Core Measures based on project's life-cycle & processes
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- **Formal Measurement Plan for the Organization**
 - Use STSC's Measurement Planning Template
- **Informal measurement plan per project/system**
 - Review and approval by Senior Management

Core Measures - 1

- **Consistent our standard S/W process**


Issue	Category	Measure
Schedule & Progress	Work Unit Progress	Development Status
Schedule & Progress	Work Unit Progress	PCR Status
Product Quality	Problem Reports	DDCR Status
		Inspection Defects
		Testing Defects/STRs
Resources & Cost	Personnel	Effort & Cost
		Staff Experience
		Staff Volatility
Growth & Stability	Functional Size & Stability	Requirements
	Product Size	SLOC
Development Performance	Project/Process Characteristics	System/CI Characteristics
		System/CI Size Profile
		Process Attributes
		Lessons Learned



Core Measures - 2

- **Consistent our standard S/W process**

- Quantitative**
 - **Development Status** (i.e., component or task completion)
 - **Effort & Cost** (by defined S/W life-cycle activity, including rework)
 - **Staff Experience** (by experience factor - e.g., domain, language)
 - **Staff Volatility** (staff lost and gained per period)
 - **Requirements Volatility** (added, modified, or deleted per period)
 - **Source Lines of Code** (SLOC delivered by language)
 - **Inspection Defects** (by priority, type, origination, discovery)
 - **Testing Defects** (by priority, origination, discovery)
 - **Change Requests** (by priority and origination phase)
 - *I.e., delivered defects*
- Qualitative**
 - **System Characteristic**
 - **Process Attributes**
 - **System Size Profile**
 - **Lessons Learned**

Composite for all systems
=  System Index File



Core measures in all our Measurement Databases

Core Measures - Profiles the Product and Process

<i>System/CI Characteristics</i>	<i>System CI Size Profile</i>	<i>Process Attributes</i>
Version Project Domain Project Mode Software Level Language Database Name DBMS Development Computer Development Operating System Development Environment Target Computer Target Operating System	Version Language # Physical SLOC # Logical SLOC Executable # MBytes Delivered Total # Pages of Documentation Percent of Software Reuse Reuse Source Application Version Start Date Version End Date Average Staff Size Peak Staff Size Total Staff Hours of Effort # Number of PCRs Completed # of Requirements # of Classes # of Database Tables # of Queries # of Reports # of Screens Delivered # of Routines Delivered # of Documents Delivered # of Briefings Delivered	Version Life-Cycle Model Req. Eng. Approach Design Approach C & UT Approach System Test Approach Acceptance Test Approach Project Mgmt Approach SCM Approach SQA Approach Training Approach Tools Standards CMM/CMMI Maturity Rating

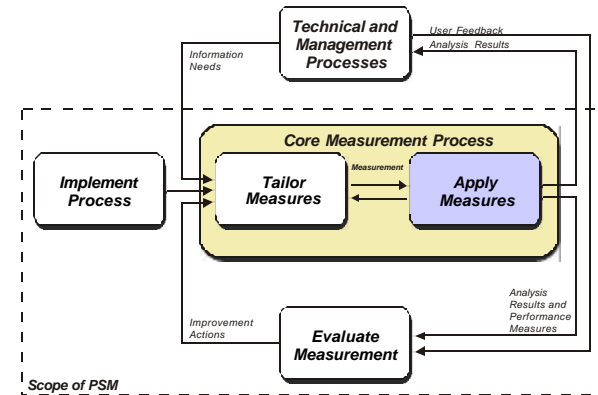
In Insight

**Attribute
Data Item**



How PSM is Implemented - 3

Apply Measures



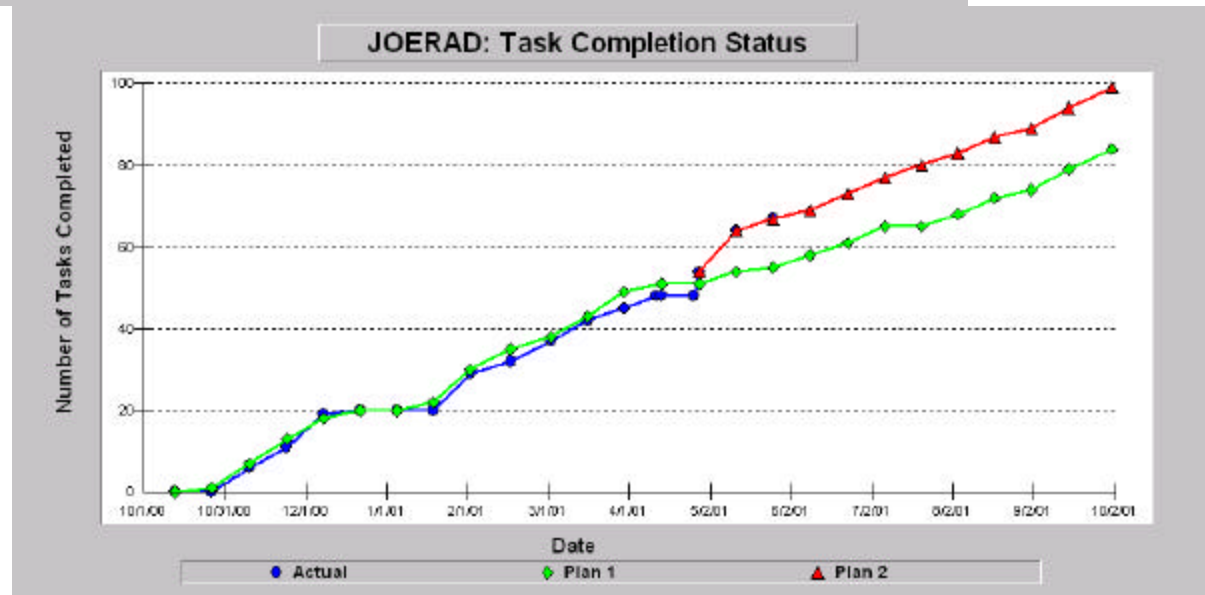
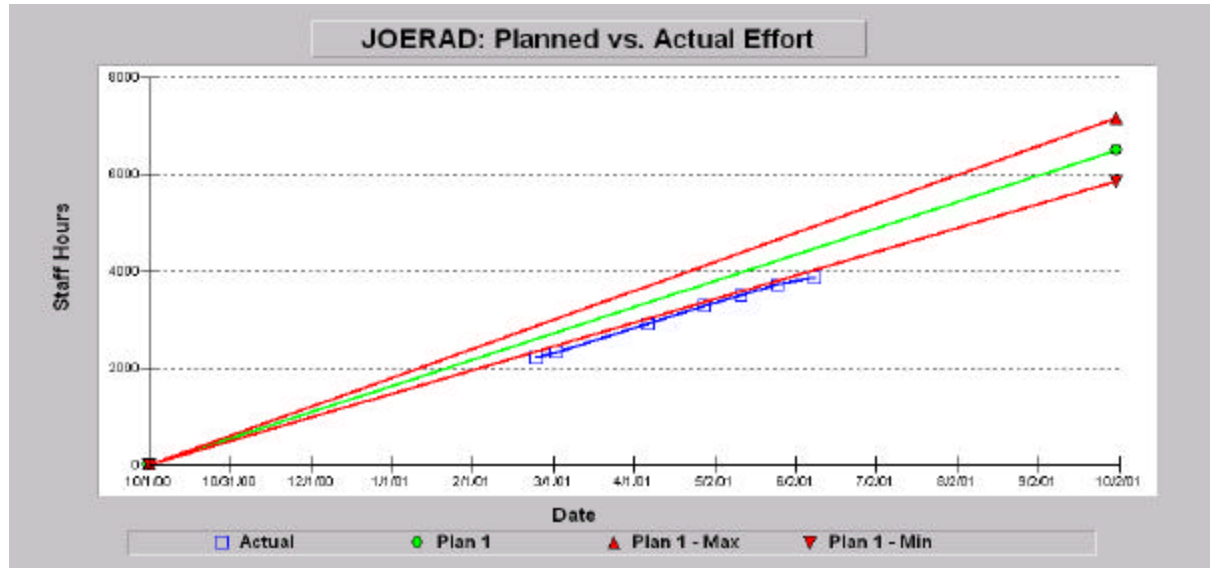
- Active Measurement Database
- **Data collected & submitted bi-weekly by each Project/System**
 - Submitted by Measurement Coordinator to Measurement Analyst
 - Submittal tool = Excel workbook with one spreadsheet per measure
 - **Data processed by Measurement Analyst**
 - Validates & imports data for each Project/System into Active Measurement Database (i.e., one Insight folder per Project/System)
 - Generates indicators for each measure (tailored to the data submitted)
 - Provides Indicator Analysis Report to Project/System management
 - **Indicator reports analyzed bi-weekly by Management & SQA Advisor**
 - Compares actual results to the plans, & analyzes data trends/profiles
 - Reviews analysis results against project performance goals
 - Revises issues/risks/goals/plans as required; identifies corrective action

Tailored Indicators for each Measure

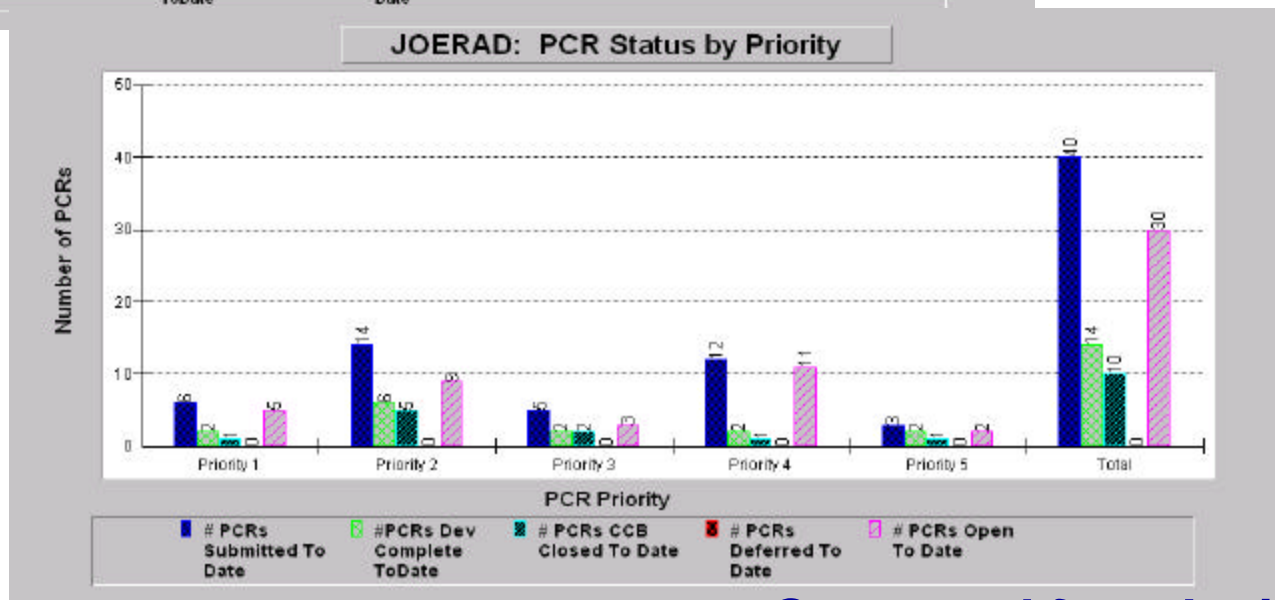
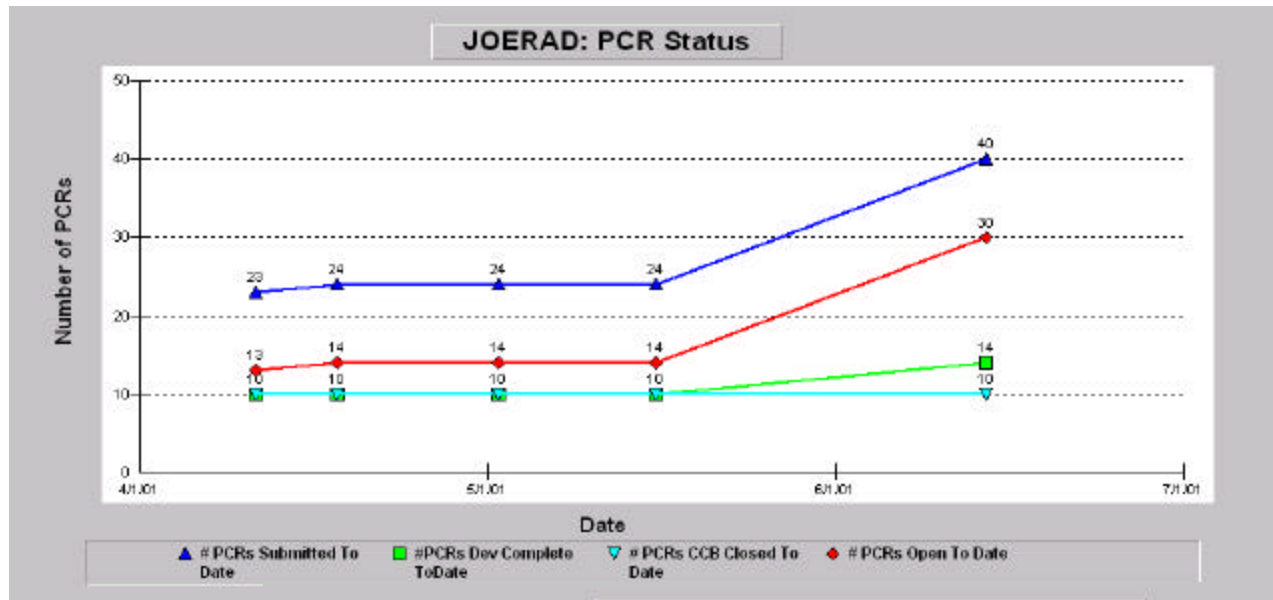
Measure	Standard Indicators
Effort & Cost	Planned vs. Actual Effort & Cost Over Time % Current Effort & Cost by Activity Effort by Activity Compared to Rework Over Time
Staff Volatility	Plan vs. Actual Staff Over Time Staff Lost and Gained Over Time – Per Period
Development Status	Task Completion Over Time
PCR Status (same for DDCR Status)	PCR Status Over Time PCR Status by Priority Open PCRs by Priority Over Time PCR Status by Type & Origin
Requirements - Functional - Tasking	Total # Requirements Over Time vs. # Requirement Changes Per Period Type of Requirement Changes Over Time Requirements by Source
Inspection Defects	Defect Status Over Time Defects by Origination Activity Defects by Priority & Defect Type Requirements, Design, Code, & Test Case Defects by Discovery Inspection
Testing Defects/STRs	STRs Over Time STRs by Priority Open STRs by Priority Over Time STRs by Origination Phase Requirement, Design, Code STRs by Discovery Test



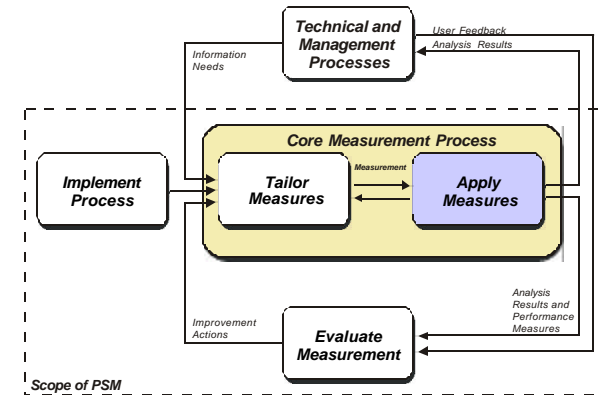
Sample Indicators



Sample Indicators



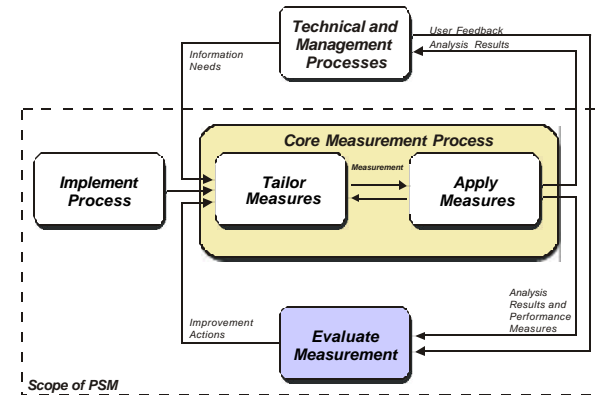
How PSM is Implemented - 4



- **History Measurement Database maintained by Measurement Analyst**
 - Project/System Active Measurement data archived upon system release
 - History data from all projects made available to Project Managers for planning
 - Stored on a shared drive on the Intranet
 - Index File used to identify similar projects
- **Organizational Measurement Database maintained & used by Measurement Working Group**
 - Project/System Active Measurement data archived quarterly
 - Data analyzed quarterly by Measurement Working Group
 - Analyze data across projects/systems for trends & profile
 - Review analysis results against organizational performance goals
 - Report results to Senior Management (IITRI & JSC)

How PSM is Implemented - 5

Evaluate
Measurement

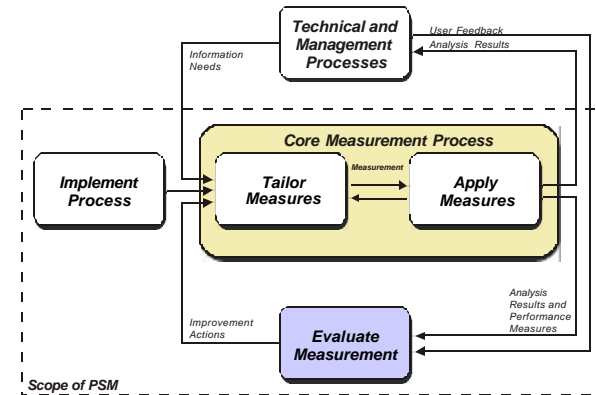


Update Organizational Measurement Plan

- **Measurement Working Group assessment of Measurement Program**
 - Analysis of data at organizational level against performance goals → improvements to Core Measures
 - Senior management feedback on organizational analysis measurement reports → improvements to Indicators
 - On-going use of organizational measurement processes → identification of lessons learned & improvements needed
 - Assessment of Measurement Program against CMMI requirements for Level 2 and 3
 - Work in progress ...
 - Planning Measurement Program Enhancements against CMMI Level 4
 - Work in progress ...

How PSM is Implemented - 6

Evaluate Measurement



Update Organizational Measurement Plan

- **Project/System-level assessments of Measurement Program**
 - One-on-one meetings with Project Manager & Measurement Coordinator
 - Workshops including all S/W Project Managers
 - Analysis of data at project level against issues, risks & project performance goals → improvements to Core Measures
 - Project management feedback on project-level analysis measurement reports → improvements to Indicators
 - On-going use of project-level measurement processes → identification of lessons learned & improvements needed

Project-level Measurement Plan

Workshops

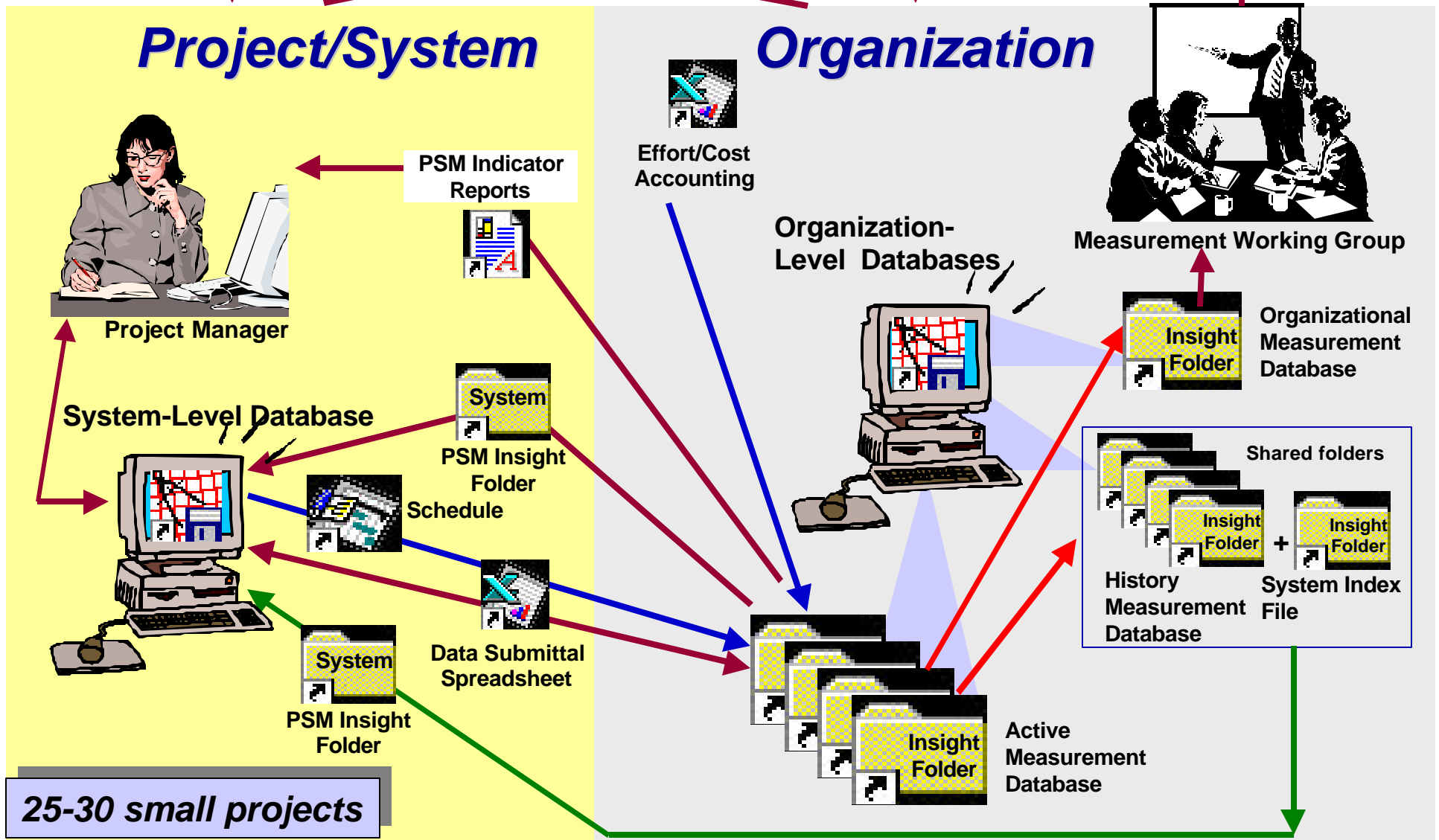
Organization Measurement Plan

Project Performance Status Reports

Issues/Goals

Project/System

Organization



25-30 small projects

Measurement Program Alignment with CMMI - work in progress...

- ***Establish Project Product Quality & Process Performance Goals***
- ***Baseline Project Performance***
- ***Assess Measurement Program against CMMI Levels 2 & 3 Measurement Requirements***
- ***Plan Measurement Program enhancements against CMMI Level 4 Measurement Requirements***

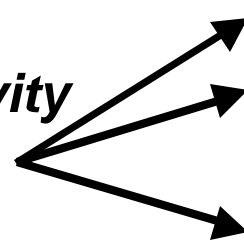
Current Project Performance Goals

Performance Category:

Continual improvement in:

Product Quality: → 1. **Product defect density levels**

**Project Productivity
and Efficiency:**



2. **Percentage of rework effort**

3. **Percentage of defects removed
before integration**

4. **Percentage of defects removed
before acceptance test**

Project Predictability:



5. **Project estimation, tracking, &
control capabilities**

Projects establish incremental % goals

Current Baseline of Project Performance - 1

Improved Performance Goals:

**Product Defect Density Level
(delivered defects)**

% Rework

% Defect Containment

**Estimation, Tracking & Control
Capability**

Core Measurement Data Analyzed:

PCRs Submitted , # SLOC Delivered

% Total Effort & Cost for Rework

**# Defects found by Inspections & Testing
Origination vs. Discovery Activity
PCRs Submitted (delivered defects)
Origination Phase**

Task Performance Index (TPI)
= (Actual # Completed Tasks) / (Planned # Completed Tasks)
% Task Completion Variance
= (Actual # Tasks - Planned # Tasks) / (Planned # Tasks)



Self-Assessment of Measurement Program

Level 4 - Quantitatively Managed				
Organizational Process Performance		Quantitative Project Management		
SG1. Baselines and models that characterize the expected process performance of the organization's set of standard processes are established and maintained.	GG3. The process is institutionalized as a defined process.	SG1. The project is quantitatively manages using quality and process performance objectives.	SG2. The performance of selected subprocesses with the project's defined process is statistically managed.	GG3. The process is institutionalized as a defined process.

Level 3 - Defined				
Verification	Validation	Organizational Process Focus	Organizational Process Definition	Integrated Project Management
SG2. Peer reviews are performed on selected work products.	SG2. The product or product components are validated to ensure that they are suitable for use in their intended operating environment.	SG2. Improvements are planned and implemented, process assets are deployed, and process-related experiences are incorporated into the organization's process assets.	SG2. Process assets that support the use of the organization's set of standard processes are available.	SG1. The project is conducted using a defined process that is tailored from the organization's set of standard processes.

Level 2 - Managed					
Measurement and Analysis		Project Planning		Project Monitoring and Control	
SG1. Measurement objectives and practices are aligned with identified information needs and objectives.	SG2. Measurement results that address identified information needs and objectives are provided.	GG2. The process is institutionalized as a managed process	SG1. Estimates of project planning parameters are established and maintained.	SG1. Actual performance and progress of the project is monitored against the plan.	SG2. Corrective actions are managed to closure when the project's performance or results deviate significantly from the plan.

Satisfied

Partially Satisfied

Unsatisfied



Measurement Program Enhancements in 2001 using the PSM Process & Insight - 1

- *Measurement workshops initiated to evaluate Measurement Program*



Measurement Program Enhancements in 2001 using the PSM Process & Insight - 1

- ***Measurement workshops initiated to evaluate Measurement Program***
- ***Core Measures added***
 - *SLOC (delivered)*
 - *Staff Experience*
 - *Staff Volatility*
 - *Task Completion Status*
 - *Task Performance Index (TPI)*
 - *% Task Completion Variance*
 - *Unscheduled Tasking Requirements*



Measurement Program Enhancements in 2001 using the PSM Process & Insight - 1

- **Measurement workshops initiated to evaluate Measurement Program**
- **Core Measures added**
 - SLOC (delivered)
 - Staff Experience
 - Staff Volatility
 - Task Completion Status
 - Task Performance Index (TPI)
 - % Task Completion Variance
 - Unscheduled Tasking Requirements
- **Core Measure attributes added/enhanced**
 - Project Activity Category - values added
 - Defect Origination Activity/Phase
 - Defect Discovery Inspection/Test
 - Defect Type
 - CMM Level



Measurement Program Enhancements in 2001 using the PSM Process & Insight - 2

- **Attribute values standardized**
 - *Effort Activity Categories*
 - *Defect, STR & PCR Priorities*
 - *Defect Types*
 - *Defect Origination Activity/Phases*
 - *Defect Discovery Inspections/Tests*



Measurement Program Enhancements in 2001 using the PSM Process & Insight - 2

- ***Attribute values standardized***
 - *Effort Activity Categories*
 - *Defect, STR & PCR Priorities*
 - *Defect Types*
 - *Defect Origination Activity/Phases*
 - *Defect Discovery Inspections/Tests*
- ***Organizational Measurement Database populated from History & Active Measurement Databases***

Measurement Program Enhancements in 2001 using the PSM Process & Insight - 2

- **Attribute values standardized**
 - *Effort Activity Categories*
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 - *Defect, STR & PCR Priorities*
 - *Defect Types*
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- **Measurement Plans - project & organizational levels**

Lessons Learned - 1

Software measurement on small projects

- Organizational-level measurement support → S/W project staff focus on software engineering not measurement process***
- Short, two-week cycle of collecting/submitting/analyzing data → keeps the measurement momentum going***

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Establishing a measurement program while maturing from Level 1 to Level 3

- ***Measurement collection must be integrated into processes as they are being defined***
- ***Inconsistent application of the standard S/W process across projects → inconsistent organizational measurement data***
 - *Standardize procedures & record keeping logs across projects*
 - *Establish consistent data collection points*

Lessons Learned - 2

Measurement based on project-level issues & goals

- ***Project-level measurement drivers must balance with organizational requirements***
 - *ROI analysis*
 - *CMM Level 4 process performance analysis*
 - *Senior management reporting*

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SQA administration of the measurement program

- ***Ensure consistent measurement data collection & validation - enhances measurement success***
- ***Establish a Measurement Working Group for analyzing measurement data at the organizational level***
- ***Nurture centralized measurement expertise - promotes the quality of the measurement program***

Summary

Benefits of PSM and Insight

- ***Springboard for initiating measurement efforts***
- ***Foundation on which to build, operate & advance***
 - *supports our CMMI and Level 4 requirements for advancement*
- ***Focus on the right measures for our projects & organization***
- ***Established database tool - supported, customizable***



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Cost of providing Centralized Measurement Support to Projects

- ***1% of organization's total software effort***
- ***0.8% of organization's total software cost***

