MEASURING INTEGRATED PRODUCT TEAMS

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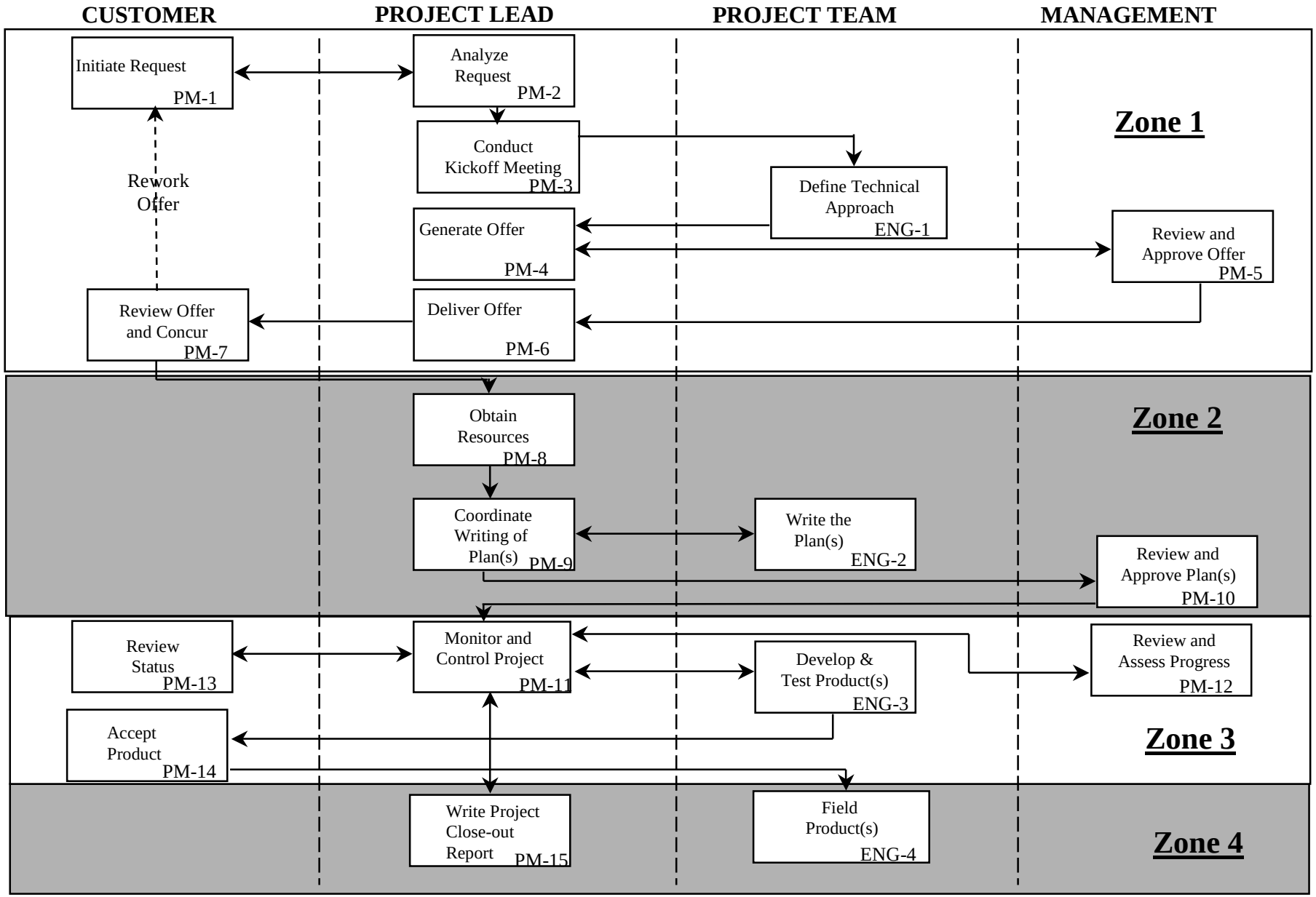
Organization's Background

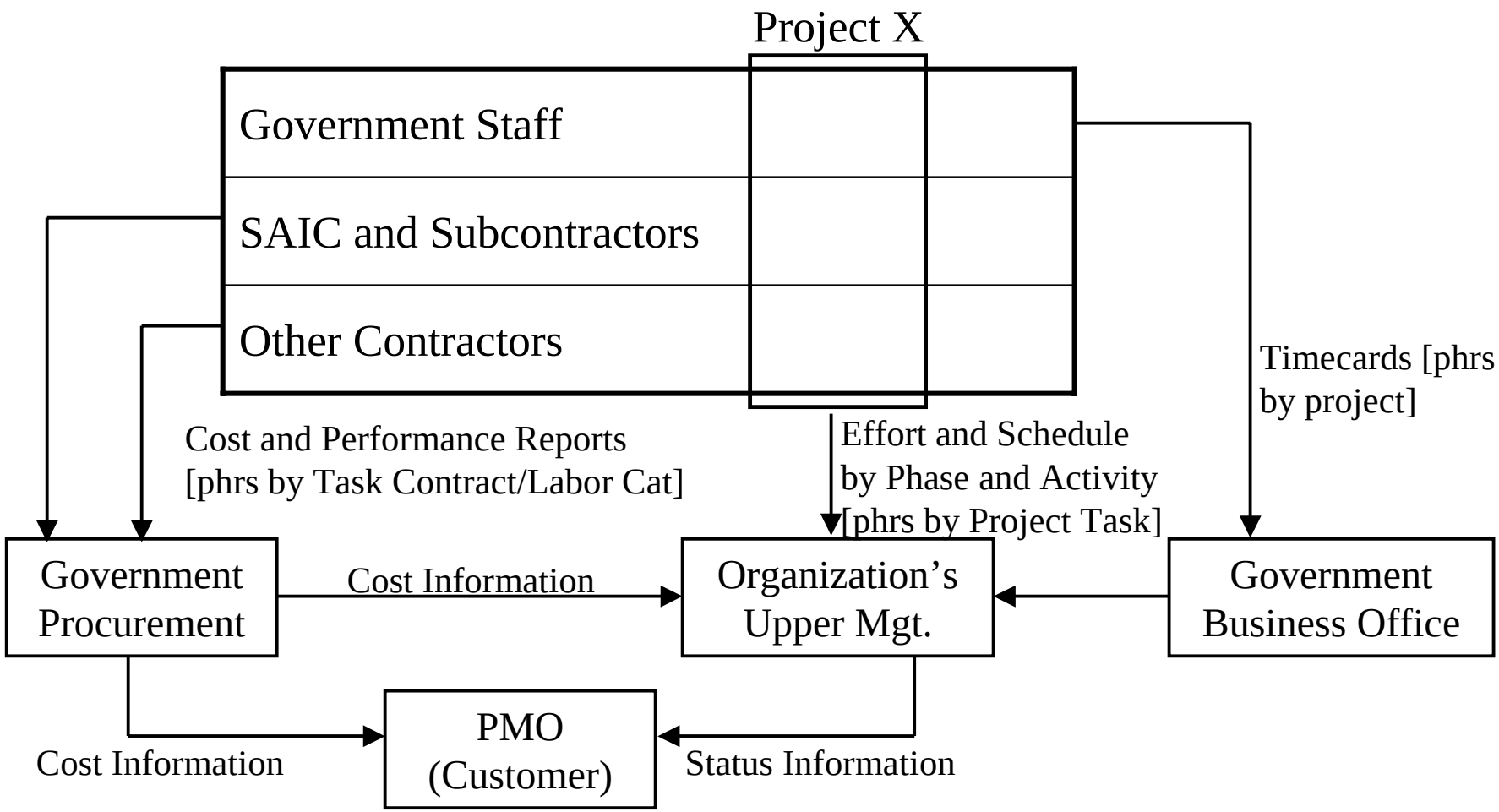
- **Develop and sustain software for:**
  - Tactical Missiles
  - Air Vehicles
  - Command and Control Systems
  - Test, Measurement and Diagnostic Equipment
- **Process improvement history**
  - Sep '91 First Assessment
  - May '94 Rated CMM Level 2
  - Nov '96 Rated CMM Level 3
  - Apr '00 Rated CMM Level 4

Challenges

- **Diversity**
  - Several domains (C2, trainers, fire control, aviation, etc.)
  - 11 High Order Languages
  - 50 Active Projects (new development, transition, sustainment)
  - Team size: 3-25 people
  - Build cycle: 3-18 months
- **IPT**
  - SAIC
  - Subcontractors
  - Government
  - Competitive Contractors


CUSTOMER
PROJECT LEAD
PROJECT TEAM
MANAGEMENT
Initiate Request PM-1
Analyze Request PM-2
Conduct Kickoff Meeting PM-3
Define Technical Approach ENG-1
Rework Offer
Generate Offer PM-4
Review and Approve Offer PM-5
Review Offer and Concur PM-7
Deliver Offer PM-6
Zone 1
Obtain Resources PM-8
Coordinate Writing of Plan(s) PM-9
Write the Plan(s) ENG-2
Review and Approve Plan(s) PM-10
Zone 2
Review Status PM-13
Monitor and Control Project PM-11
Develop & Test Product(s) ENG-3
Review and Assess Progress PM-12
Accept Product PM-14
Zone 3
Write Project Close-out Report PM-15
Field Product(s) ENG-4
Zone 4

Challenge: Multiple Accounting Systems

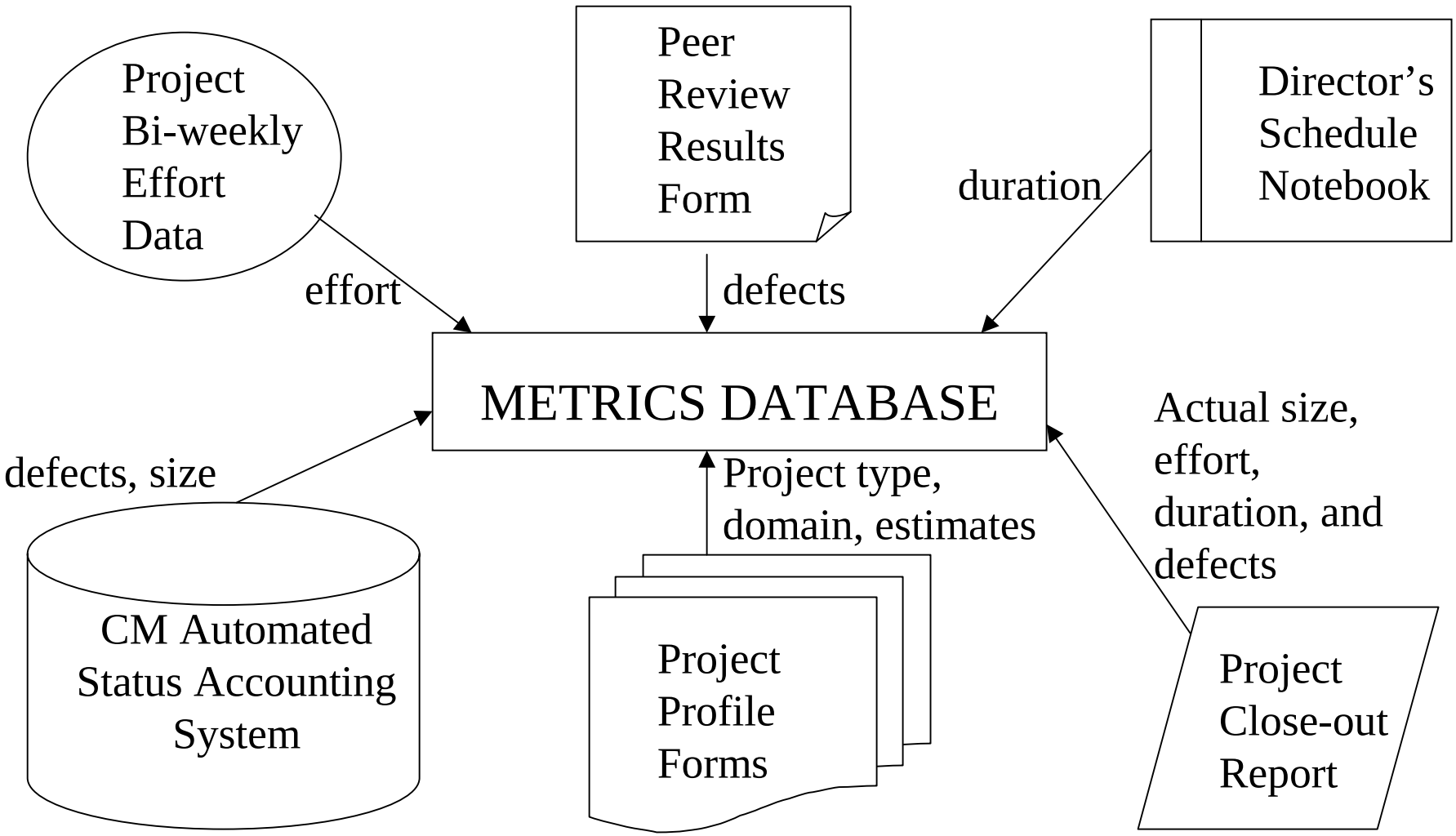


BI-WEEKLY EFFORT COLLECTION FORM (SUSTAINMENT)

PROJECT: _____ **BUILD:** _____ **PERIOD ENDING** _____

ROLES	ZONE 1	ZONE 2	ZONE 3					ZONE 4	Customer Support	Training
			Analyze Rqmts.	Design Product	Perform Code & Unit Test	Conduct Product Tests	Baseline Products			
S/W Eng.										
Proj. Lead/ Tech. Lead										
QA										
CM										
H/W Eng.										
V & V										
Interop.										
Other										

How Data Gets to the Metrics Database



Project Profile Data

- **Customer**
- **Funding Type**
- **Product type (tactical system, trainer, C3, etc.)**
- **Project type (ND, TR, SU)**
- **Build type (normal, emergency, engineering)**
- **Life cycle model (waterfall, incremental, …)**
- **Exceptional features (narrative)**
- **Estimated/Actual size (equivalent new PSLOC by language)**
- **Estimated/Actual effort**
- **Estimated/Actual duration**

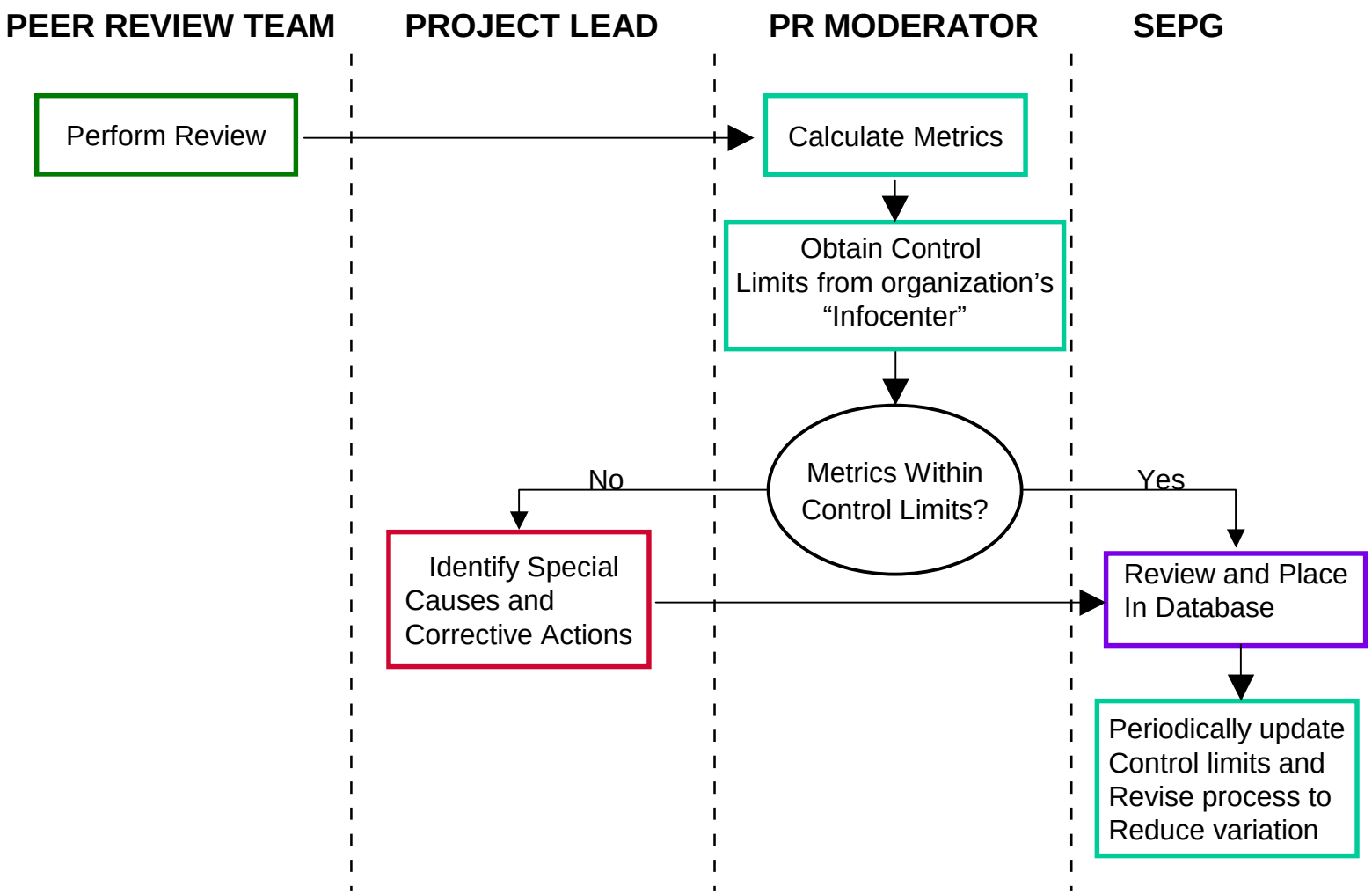
Database Overview

- **Project Characteristics**
  - Project Team: 3-25 people
  - Build cycle: 3-18 months
  - Maintained Source Lines of Code: 5-800 KSLOC
- **Database Characteristics**
  - Began collecting data in 1990 (some forensic accounting and conversions used for early data)
  - 230 Builds
  - > 350 Peer Reviews
  - > 275,000 phrs of labor
  - > 283 KPSLOC delivered (11 languages, 49 key builds)

Characteristics of Key Builds

Type	# in Sample	Average Effort (phrs)	Effort Allocation %				# Per Year
			PM	SWE	QA	CM	
ND	11	4650	22	65	10	3	1.5
SU	33	3345	18	63	9	10	4.0

Analysis of Peer Review Data



Our Three Peer Review Metrics

- Process Metrics
  - Review Rate = Amount reviewed (LOC or pages) / (Prep + Meeting Time)
  - Time Ratio = Sum of Preparation Time/Sum of Meeting Time
- Product Quality Metric
  - Defect Density = Sum of Defects/Size

  where size is either KLOC Reviewed or Pages Reviewed/100

  For SU Peer Reviews, size only includes the amount added, changed, and deleted and NOT the total in the product.

*Originally, “Time” was the total effort for all participants. In late 2000, “Time” will be redefined as the average effort per person (in person-hours).

Document Peer Review Data (30Jun02)

New Development (61 data points)

Metric	Average	Lower Control Limit	Upper Control Limit
Review Rate (pages/hour)	3.6	0.0	9.1
Time Ratio (Preparation Time/Meeting Time)	1.3	0.0	3.0
Defect Density (defects/100 pages)	14.1	0.0	46.3

Sustainment (115 data points)

Metric	Average	Lower Control Limit	Upper Control Limit
Review Rate (pages/hour)	3.1	0.0	8.5
Time Ratio (Preparation Time/Meeting Time)	1.6	0.0	3.4
Defect Density (defects/100 pages)	16.6	0.0	55.7

Improvements in Metrics Collection

- **Prior to FY 95**
  - **Project Leads manually collected metrics data for the projects.**
  - **Oldest data is from FY90.**
- **FY 95**
  - **Metrics Team began collecting project metrics through interviews with the Project Leads.**
- **FY 96**
  - **SEPG initiated bi-weekly manual collection of project metrics.**
- **FY98**
  - **SEPG updated metrics process, procedures, and standards**
  - **SEPG added process performance and product quality goals**
- **FY99**
  - **SEPG initiated automated collection of effort using MS Access.**
  - **SEPG added statistical process control of Peer Review data.**
- **FY01**
  - **Improved integration of database**
- **FY02**
  - **Implemented Web-based data collection**
  - **Ported database to Oracle**

Lessons Learned

- **We need precise operational definitions**
  - Example: No format for standard schedule (Received schedules from 1 to 38 pages)
  - "Size" for sustainment is hard to define (all versus portion touched, combined review of code and documents)
- **Staff must know the definitions**
  - Paper forms include definitions on back
  - On-line forms have on-line help messages
  - Provide training on use of forms

Lessons Learned (continued)

- **The definitions will change**

Before 4/96	Total effort*
4/96-8/98	Effort for 15 activities
9/98-Present	Effort for 4 zones with variable activities by role

*Effort is the hardest metric to collect.

Lessons Learned (continued)

- **Must process the data promptly**
  - Accumulated data on 67 Peer Reviews
  - Then began analyzing the data
  - Had to discard 20 incomplete reviews
- **Automation is essential**
  - Reduces collection effort
  - Promotes completeness and consistency
  - Initially Excel spreadsheets (via disk and email)
  - Now on-line (via Web browsers)

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Supplemental Information

Collecting Project Effort Data

- Project's Bi-weekly Effort Collection Form (S-ME-001)
  - Allows measurement of the process
  - Divides the process into Zones
  - Uses variable level of detail for WBS elements (engineering activities subdivided into requirements, design, code, and test),
  - Simplifies the Project Team's reporting by categorizing the reporting based on project roles,
  - Incorporates the time spent performing documentation activities into the Zones

  Note: Projects may collect more detailed effort data (e.g. against WBS elements) if desired and roll-up to the Project's Bi-weekly Effort Collection Form (S-ME-001).

Collecting Project Effort Data, Continued

- The procedure for collecting project effort hours is P-ME-001.
  - Management is responsible for ensuring that metrics data is collected on applicable projects.
  - The Project Lead is responsible for gathering and submitting the effort data to the Metrics Database on a bi-weekly basis.
  - Project Team members submit effort data to Project Lead (or designee) on a bi-weekly basis.
  - The Project Lead (or designee) submits the project's bi-weekly cumulative effort data to the SEPG on the following Monday.
  - The SEPG collection location for the Project's Bi-weekly Effort Collection Form is the SED Front Desk.
  - The SEPG provides cumulative reports to the Project Lead/Management on a monthly basis.
  - The Project Lead (or designee) reports any issues or needed corrections to the Metrics Database Administrator.

Collecting Project Effort Data, Continued

- For New Development projects,
  - The Project Close-out Report (S-PM-016) records the software size data as follows:
    - Total SLOC in delivered product
    - Total SLOC in delivered product per language used
    - Reused SLOC in delivered product
  - The Project Close-out Report (S-PM-016) records the documentation size data as follows:
    - The number of pages of documentation developed as part of the Technical Data Package.
- The Project Lead submits a copy of the Project Close-out Report to the Process Asset Library. The SEPG ensures that the information from the Project Close-out Report is included in the Metrics Database.

Collecting Project Effort Data, Continued

- For Sustainment projects/builds
  - The Project Close-out Report (S-PM-016) records the software size data as follows:
    - Total SLOC in delivered product (includes “legacy code”)
    - Total SLOC in delivered product per language used
    - Total SLOC added/deleted/modified for the sustainment build
    - Reused SLOC introduced (added) for the sustainment build
  - The Project Close-out Report (S-PM-016) records the documentation size data as follows:
    - The number of pages of documentation changed or added to the Technical Data Package (TDP).
- The Project Lead submits a copy of the Project Close-out Report to the Process Asset Library. The SEPG ensures that the information from the Project Close-out Report is included in the Metrics Database.

Definition of Reused Code

- Reused Code – Source code (which can be modified and counted) integrated into the software build which has been previously developed and formally tested (by the SED or another organization).

Collecting Project Duration Data

- On the first Monday of each month the Project Lead submits a current project schedule (“baseline” and actuals) to the SEPG for inclusion into the Director’s Schedule Notebook.
- The Project Close-out Report (S-PM-016) documents the final project schedule (“baseline” and actuals). The Project Lead submits a copy of the Project Close-out Report to the Process Asset Library.
- The SEPG ensures that duration/schedule information from the Director’s Schedule Notebook and the Project Close-out Report is included in the Metrics Database.

Collecting Project Defect Data

- Two types of defects are collected:
  - Pre-delivery defects are reported from
    - ✓ Peer reviews
    - ✓ Formal Qualification Testing (FQT)
    - ✓ Activities following FQT (e.g. Site Acceptance Testing)
  - Post-delivery defects are those defects found following formal delivery to the Customer/User.