Systems Engineering Challenges for an Army Life Cycle Software Engineering Center

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SED Functions

- **The Software Engineering Directorate located at Redstone Arsenal, AL is One of the U.S. Army Life Cycle Software Engineering Centers**
- **Provides Cradle to Grave Software Engineering Support to Army Customers**
- **Performs System/Software Maintenance, New Product Development, & Services (e.g., System/Software Acquisition, IV&V, IA)**
- **Required Domain Specific Knowledge/Functional Experience**
  - **Avionics**
  - **Complex Electronics (e.g., FPGA's)**
  - **Software Safety/Airworthiness**
  - **Missile Seeker**
  - **Radar**
  - **BMC4I**
  - **System/Software Architecture**
  - **Ground Systems (Vtronics)**
  - **Information Assurance**

SED Vision Statement/Business Goals

Vision Statement

Be the Army's Center of Excellence for Systems and Software Engineering development and sustainment of aviation and missile systems in support of the Warfighter.

Business Goals

Provide customers with best value products in terms of quality, cost and schedule

Maintain a technically competent, well-trained and highly satisfied workforce

Be a leader in Systems Engineering technology and innovation

Process Improvement

Goals:

- **Improve & mature the SED system development process, personnel, & technologies**
- **A process supporting SED Projects which contributes value to delivered products**

Strategies:

- **Develop a CMMI v1.2 compliant process**
- **Develop an Integrated Information Management System to facilitate process functionality, compliance, & institutionalization**
- **Migrate from "One Process Fits All" to a Process Definition Framework with Multiple Process Areas**

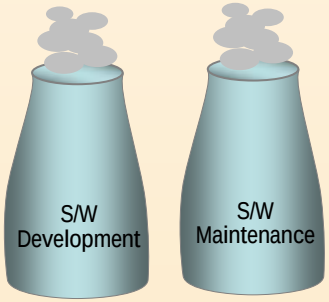
AMRDEC SED's Path to CMMI

PAST

500 People
25 Projects
15 Project Leads

SEPH 4.0
↳ SEPH 5.0
↳ SEPH 5.1

CMM-2 1994
↳ CMM-3 1996
↳ CMM-4 2000



Software

Software Capability Maturity Model (CMM)

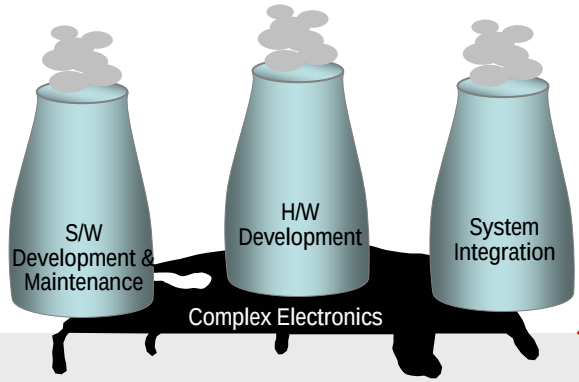
PRESENT

1400 People
110 Projects
60 Project Leads

SEPH 5.1 → SEP 6.0

Transition One Process at a Time

CMMI (Dev) Focused on System Engineering 2003 - 2007



Software
Hardware

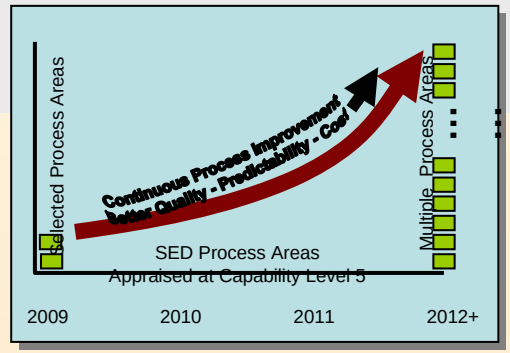
FUTURE

2000+ People
120+ Projects
75+ Project Leads

Real Time Tailorable Process Set (RTT P S)

SEP 6.0+ Using Automated Tools

2007+ Integrated Information Management System



"Continuous Model" Appraised Level 5 Using Information Portal, Dimensions® and Other Tools

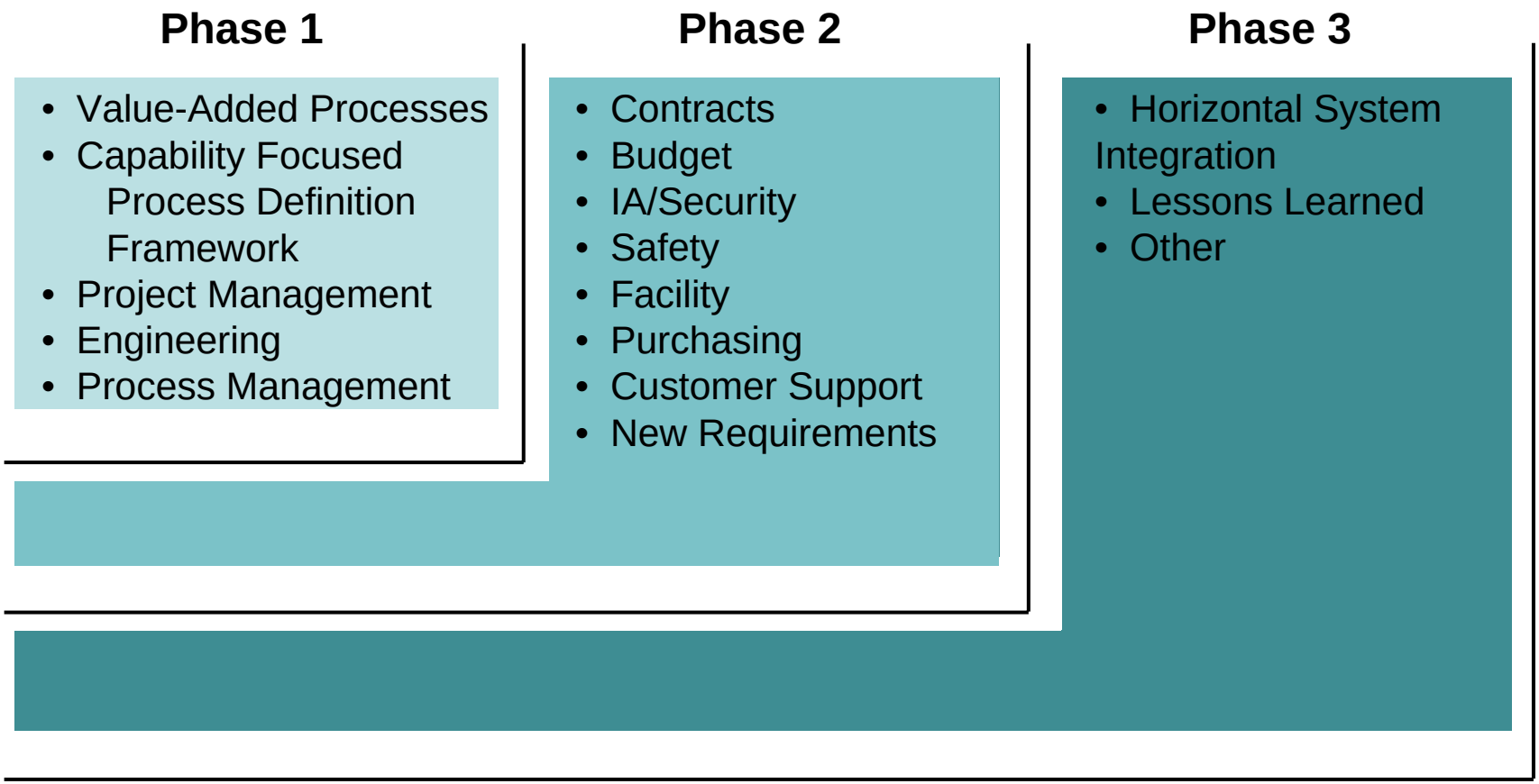
Software
Hardware
Complex Electronics

S/W, H/W, CE Development
System/Software Maintenance
Systems Integration
System & SoS Test

Better Quality – Predictability - Cost

Software and Systems Engineering Capability Maturity Model Integrated (CMMI)

Process Implementation Approach

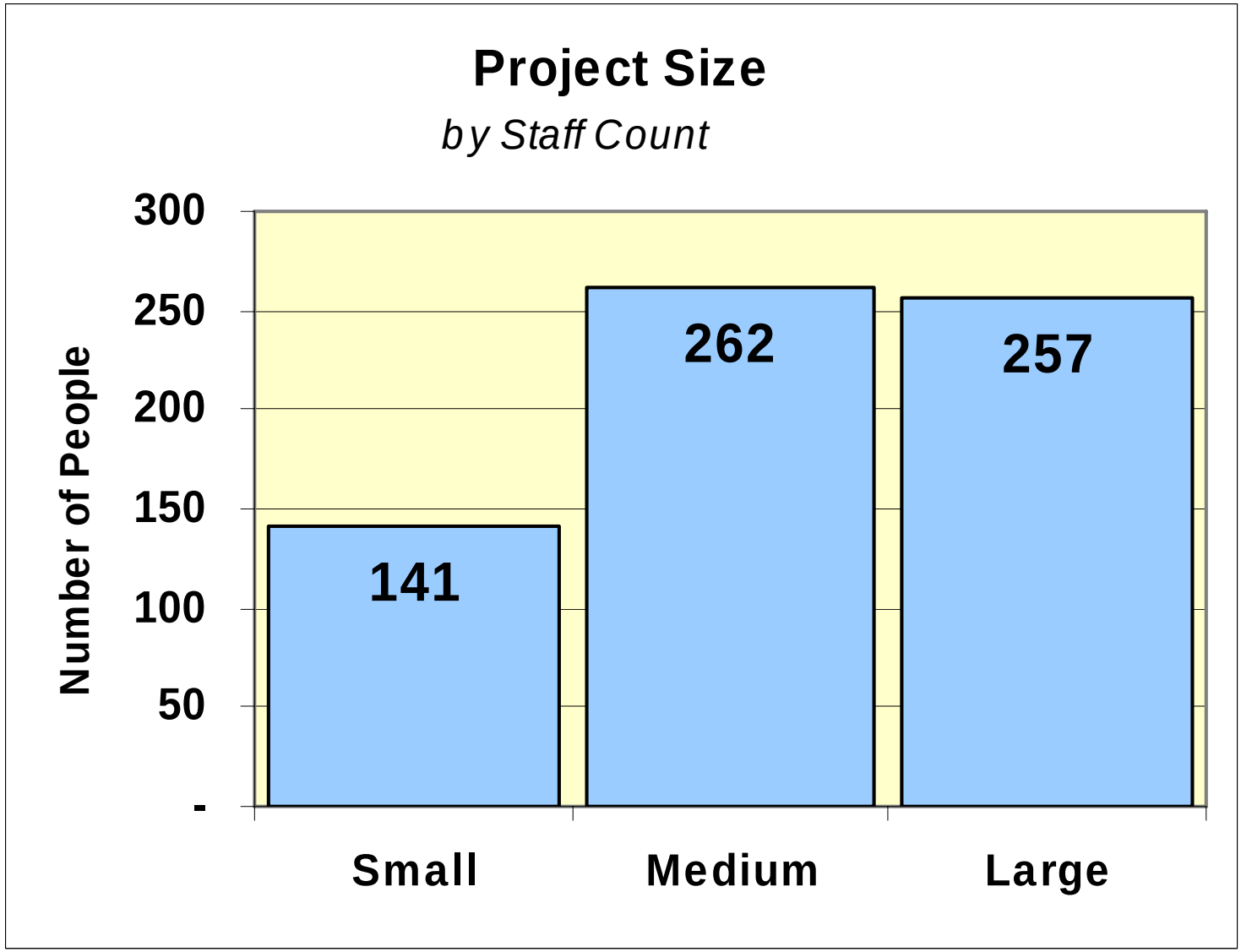


A PHASED PROCESS IMPLEMENTATION APPROACH WOULD ALLOW NEW SED PROCESS ARTIFACTS/TOOLS/METRICS TO BE INTRODUCED IN MUTUALLY SUPPORTIVE BLOCKS

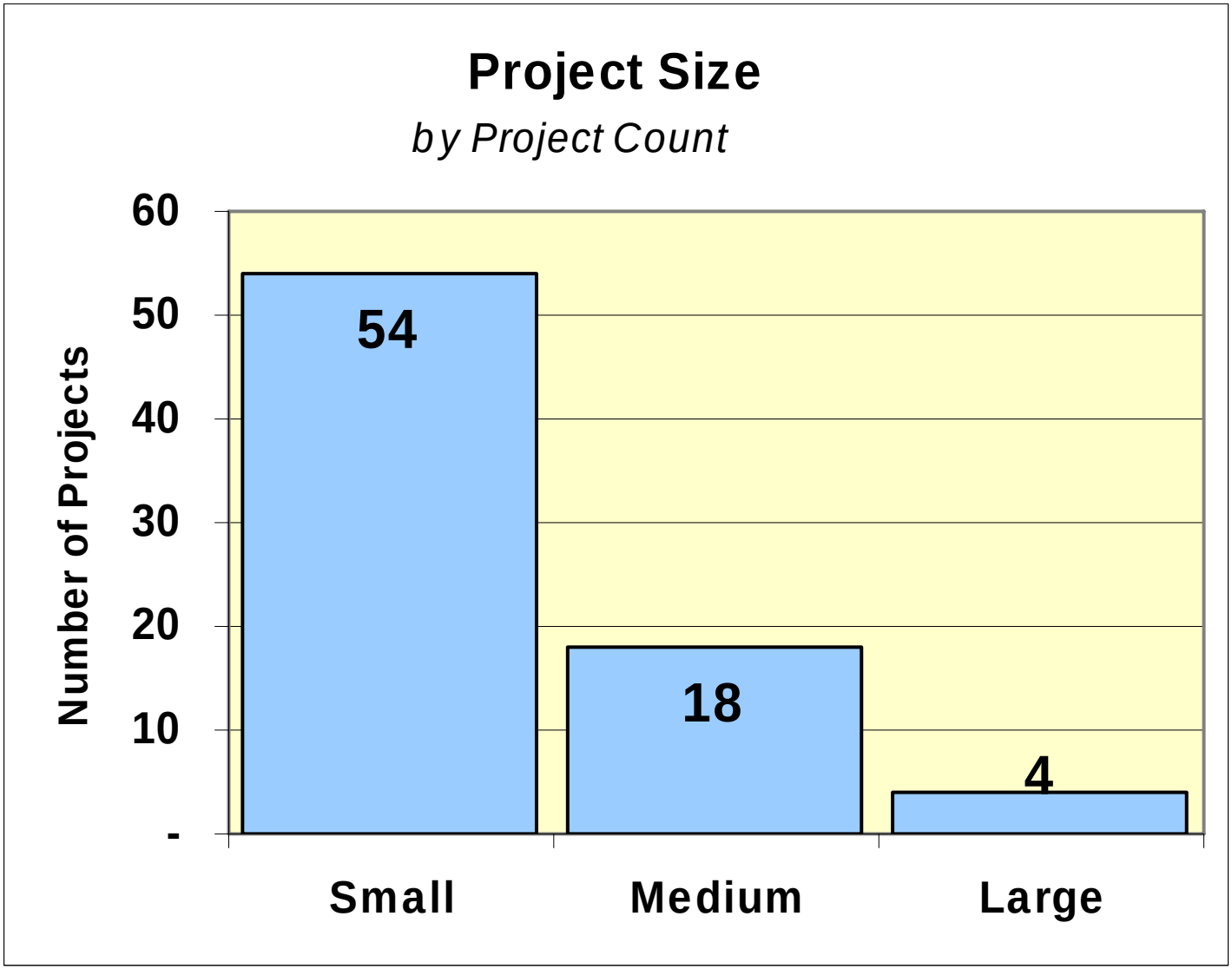
Software Engineering Directorate (SED)

- SED metrics team interviewed 36 of the Current SED Project Leads
- Included 76 SED Projects
- Provides a good understanding of the breadth and depth of SED

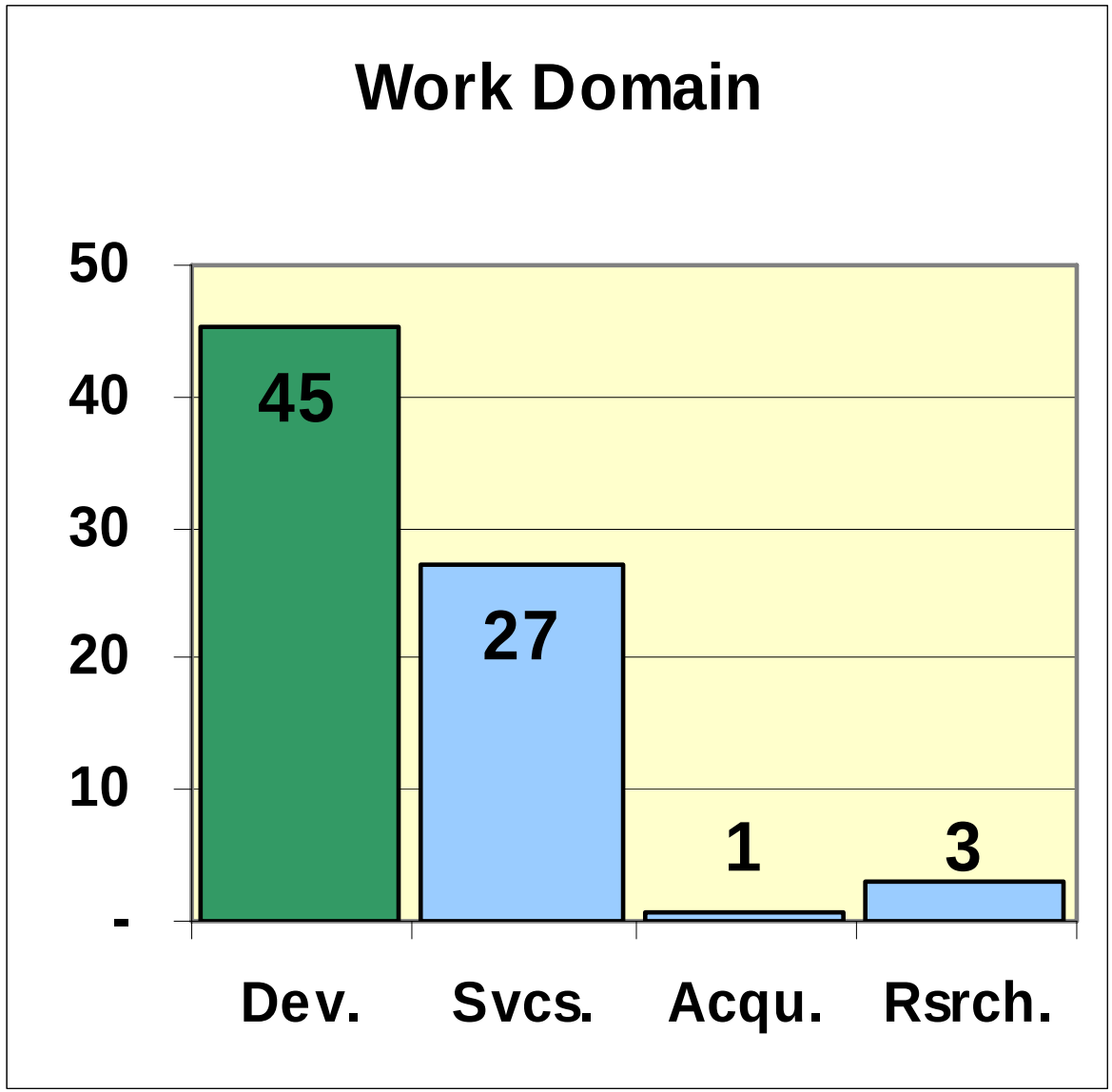
SED Project Size (Staff)



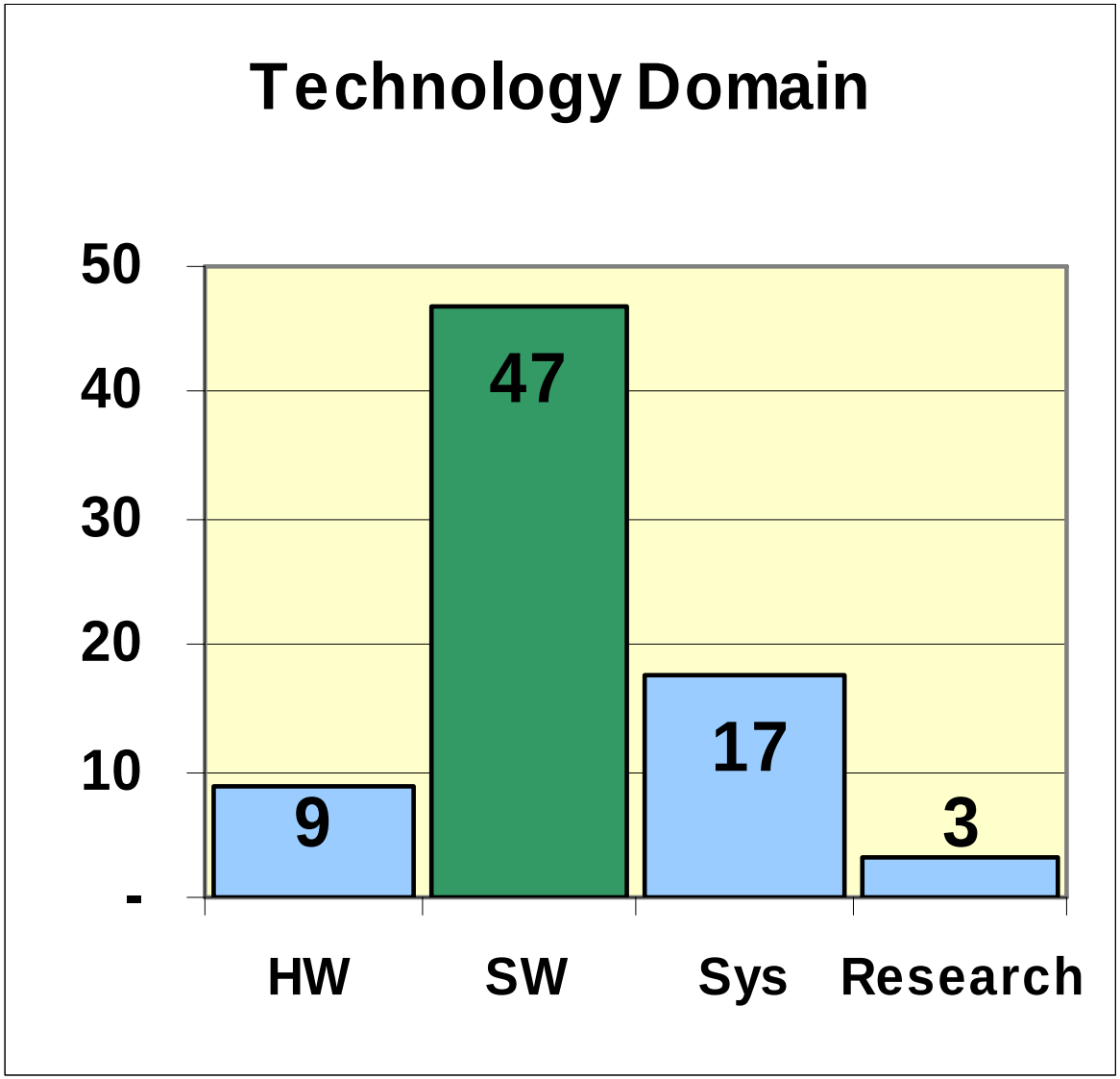
SED Project Size



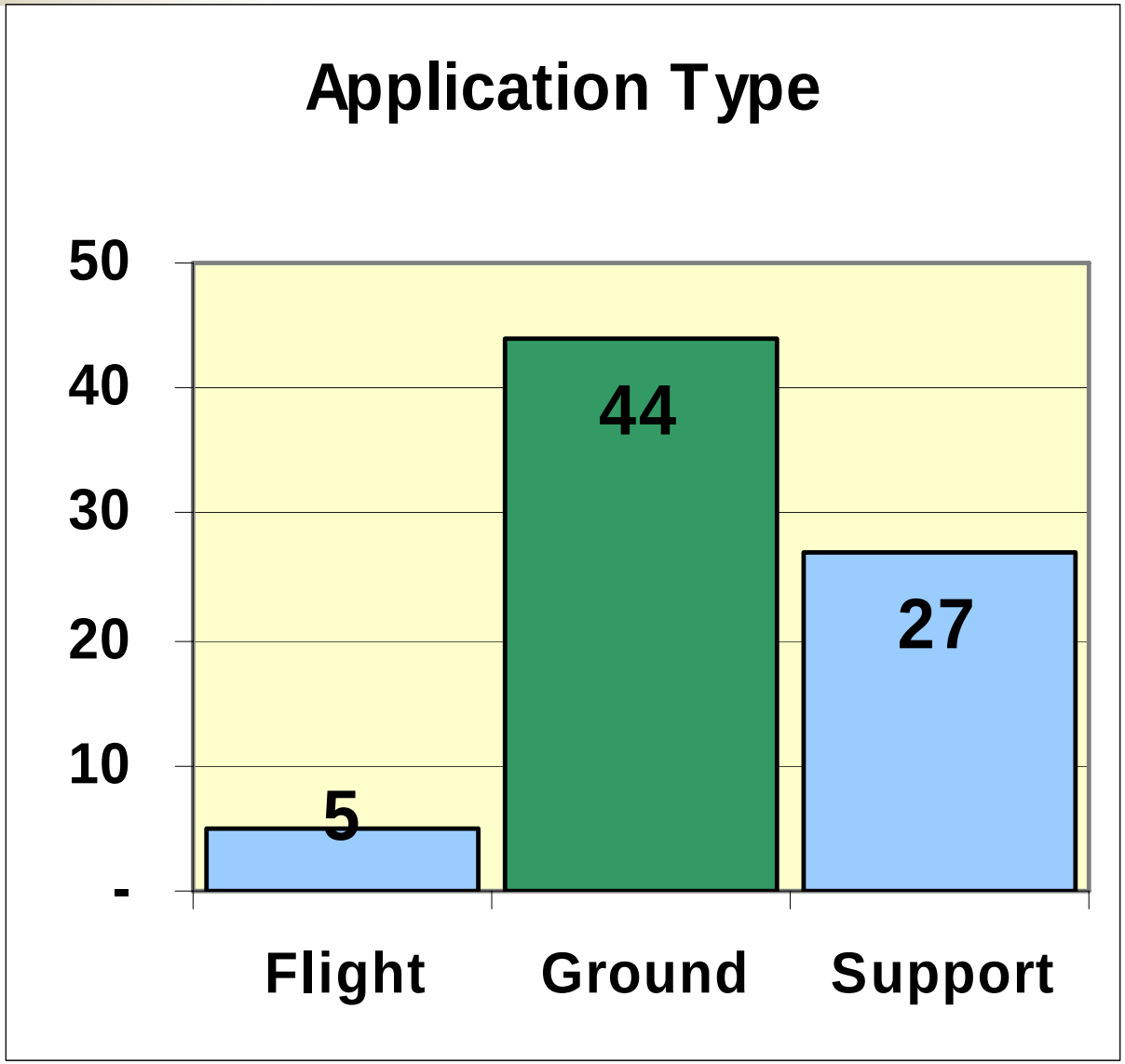
SED Projects by Work Domain



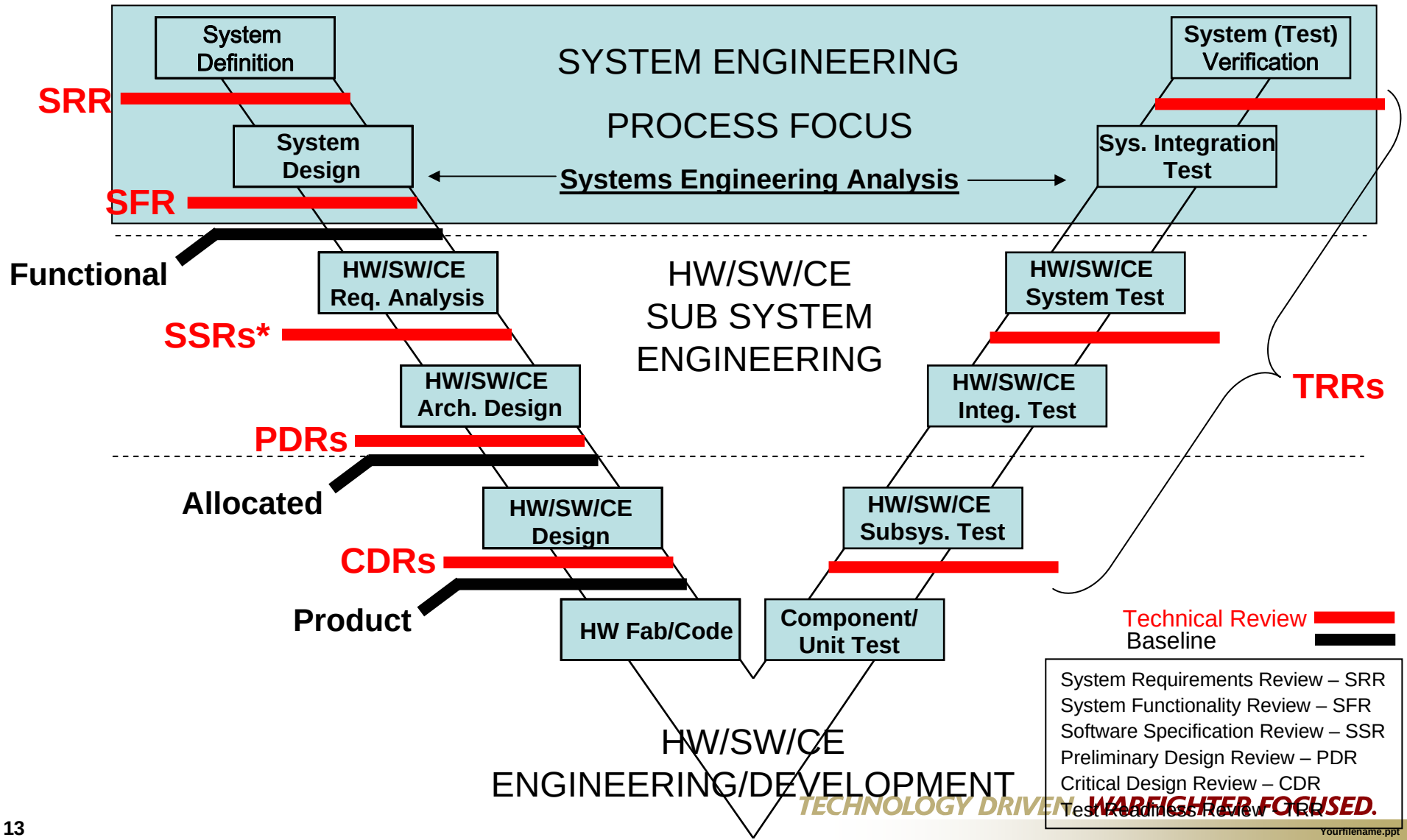
SED Projects by Technology Domain



SED Projects by Application Type



SED Engineering Process



Challenge # 1

Scoping of CMMI Process to SED's Mission & Systems Engineering (SE) Responsibilities

<u>ISSUE:</u> Project Engineering Responsibilities (Attributes) Vary:

- **S/W Development Only**
- **S/W Development & Some H/W and/or CE Development and/or SE Responsibilities**
- **Project Leads May Tailor Procedures Based Upon their Project Engineering Attributes & Not be Fully CMMI Compliant**

Challenge # 1 (Cont'd)

<u>APPROACH:</u> SED CMMI Process Provides for Full S/W, H/W, CE Development & SE Responsibility (PLs Need to Tailor)

- **At Project Startup the Project Lead (PL) Inputs from Menu the Project Engineering Attributes to the "STARTUP WIZARD"**

- **"STARTUP WIZARD" Down Selects from SED CMMI Process Definition & specifies the Required Procedures to be CMMI Compliant – Avoids Non-compliance Issue**

Challenge # 2

Defining Process Standards

ISSUE: Army Programs Generally Follow Defense Acquisition University (DAU) Guidance, but Often Adopt One of the Industry Standards (often Development Contractor's Choice), e.g.,

- IEEE 1220
- INCOSE
- EIA 632
- ISO/IEC 15528

Challenge # 2 (Cont'd)

<u>APPROACH:</u> SED's CMMI Process is Compliant with DAU SE Guidance:

- **SED CMMI Process Handbook Maps CMMI Process to Most Industry Standards**
- **Mapping Allows PL's to Implement the CMMI Process & Meet Program Adopted SE Standards**

Challenge # 3

SED Organizational Issues

ISSUE: **Ability to Provide SE Staff/Capability**

Challenge # 3 (Cont'd)

APPROACH: Develop SED SE Staff and Provide SE Organization

- **Perform Existing Staff SE Knowledge, Skills, & Abilities Assessment**
- **DAU SE Training for SED Staff**
- **UAHuntsville SE PhD Program; Currently 12 Active SED Candidates**
- **Use SE Integrated Design Team**
- **Establish an SED SE Functional Organization to Perform SE Guidance**

Challenge # 4

Minimize Impact on SED Existing CMMI Process/Procedures

<u>ISSUE:</u> Specify/Integrate SE Procedures, with Minimum Changes, into SED Existing CMMI Process

Challenge # 4 (Cont'd)

APPROACH: Augment Existing CMMI Procedures by Incorporating Unique SE Procedures

- **Use Existing Support & Management Procedures with small Modifications; add only SE Unique Procedures (e.g., SEP, Systems Simulation)**
- **Use Existing Engineering Procedures with Modifications, e.g.,**
  - **Develop ICDs; Modify Existing IRS Procedure**
  - **Develop System Requirements; Modify SRS Procedure**
- **Incorporate Unique SE Procedures, e.g.,**
  - **System Trade Studies**
  - **Integrated Logistics Support Strategy**

Challenge # 5

Accommodate Small Projects & Maintain SE CMMI Process Integrity

<u>ISSUE:</u> Small & Short Term Projects Cannot Afford to Implement all Procedures & Produce all Artifacts as Specified

Challenge # 5 (Cont'd)

APPROACH: Build on Existing CMMI "Workbook" Concept; Some Procedures & Artifacts can be Tailored & Combined to Reduce Inefficiencies & Overhead, e.g.,

- **Project Plan may also include SDP items, SE Plan items, CM Procedures**
- **Peer Review Procedures may be Less Formal**
- **Design Documents May be Combined into Fewer Documents & Updated with Additional Detail & Modifications**

Challenge # 6

Update Specific CMMI Metrics

ISSUE: Existing Software Development Metrics Require Modification & New SE Metrics need to be Specified

APPROACH:

Increase Scope of Existing Documentation Metrics to Support SE Documents, e.g.,

- Documentation Change Rate
- System Requirements Verification Metrics

Develop SE Unique Metrics, e.g.,

System Reliability (e.g., MTBF)

Maximum Time to Repair

Challenge # 7

Identify and Implement Automation at the SED Organizational Level

<u>ISSUE:</u> Define Automation that Guides Project Leads Through the Steps of Each Procedure, Captures Results & Artifacts, & Provides Assistance to Perform CM Procedures & Manage Baselines.

Challenge # 7 (Cont'd)

- **<u>APPROACH:</u> Integrate an Application Life Cycle Management Tool into Process Implementation.**
  - **Performed a Trade Study of Available Application Life Cycle Management Tools which Resulted in Selection of "Serena Dimensions"**
  - **Peer Review Procedures: Review Meeting Attendance, Meeting Minutes Capture, Defects Capture, & Resolution Status**
  - **Artifacts and Code Change Management**
  - **Establishing & Archiving Baselines**
  - **Support the Metrics Measurement Data Collection & Reporting**
  - **Incrementally Incorporate new Tool Features (e.g., Requirements Management)**

Challenge # 8

Ensure that SED Process has Grass Roots Input and Support

- **ISSUE: Procedures and Automation Must Not Increase the Project Leads Effort to Learn/Implement:**
  - **Procedures and Automation Must Assist Project Leads in Process Implementation and Provide Useful Outputs**
  - **Must be "Easier to Use" than "Not to Use"**
  - **New and Modified Procedures Must be Adopted in Small Steps**
  - **Project Leads Must be Part of the Process Definition/Automation**

Challenge # 8 (Cont'd)

- **APPROACH: Use Senior Project Leads on the Process Improvement Teams (i.e., Appraisal, Implementation, Automation)**

- **Submit Procedures for Early Use and Critique as new Projects Startup (Continuous Process Improvement). "Grandfather" Existing Procedures for In-process Projects.**
- **Utilize "STARTUP WIZARD" to Down Select Essential Procedures for the Minimum Required Set to be CMMI Compliant.**
- **Provide SED Staff with Process Training and Mentoring Support**
- **Exploit Experience and Lessons Learned from Previous CMMI Definition and Implementation**

Summary

The 8 Challenges Shall be Overcome

- Higher Management Endorses Approach
- Currently Educating 12 Selected SED Technical Staff in Systems Engineering Techniques in PhD Program at UAHuntsville
- Implementing Process Improvement Communications Plan
- Implementing new procedures gracefully (baby steps)
- Implementing Working Groups to Ensure Appropriate Focus (e.g., Systems Engineering, Project Management, Metrics)
- Stay in close touch with reality; listen to PLs comments & recommendations