



Support Systems Associates, Inc.

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# Technical Performance Assessment: Mission Success in Software Acquisition Management

James E. Jones

Track 6: Tuesday, 27 April 2010

*Achieving Acquisition Excellence - Changing The Game*

# Report Documentation Page

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# Topics

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- Background
- Acquisition Challenges and Success
- The Acquisition Environment
- Contract Requirements
- Key Technical Performance Assessment Areas
  - ❑ Process
  - ❑ Quality Gates
  - ❑ Software Products
  - ❑ Software Testing
- Summary



# My Software Acquisition Journey

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## Programs

### US Air Force C-130 AMP

**Software Engineering Advisory and Assistance Services**

- 9 years (2001 – Present)

### Lockheed Martin C-130J Hercules

**Software Subcontract Management**

- 4 years (1995 – 1999)

### FAA NAS Plan Programs

**Software Engineering Advisory and Assistance Services**

– 10 years (1984 -1994)

## Roles

### **Integrated Product Teams Support**

**Systems Integration Facility (SIF)**

**Operational Flight Program (OFP) Software Systems Requirements, Design & Test**

### **Supplier Manager**

**Review and approve SDRL items**

**Monitor supplier activities**

**Witness acceptance testing**

**Coordinate with FAA DER**

### **(AAS) System Development Manager**

**(TDWR) SPO Software Lead**

**Software Subject Matter Expert (e.g., VSCS, MLS<sup>1</sup>, RCE<sup>1</sup>, NADIN II, MCCP/MCC<sup>2</sup>)**

1 Terminated for Default: Deposited by AT&T (RCE), GAO Audit (MLS)

2 Terminated for Convenience

**Plus a foundation of 19-years Software Development and Process Improvement**

**United States Patents #4451702, #4479034**



# The Software-Intensive Systems Crisis

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*How many of you heard-about **Software-Intensive Systems** that have experienced cost overruns, schedule overruns, and performance problems?*

- ❑ Studies shown that **technical performance, cost, and schedule risks** are inherent for Software-Intensive Systems [GAO 1999]
  - GAO 1999 (U.S. General Accounting Office, “High Risk Series: An Update.” GAO/HR-99-1. Washington, D.C.:GAO, Jan. 1999. <http://www.gao.gov/pas/hr99001.pdf> ).
- ❑ 70% of the Pentagon’s 96 major weapons programs over budget, totaling 295 billion [GAO 2009]
  - GAO 2009 (U.S. General Accounting Office, “DEFENSE ACQUISITIONS: Charting a Course for Lasting Reform”, GAO-09-663T, Washington, D. C. <http://www.gao.gov/new.items/d09663t.pdf> )
  - **A Solution**: Weapon Systems Acquisition Reform Act of 2009 (Public Law 111-23, 22 May 2009)
    - Ensure that the problems are diagnosed and adjustment are made in the process



# Objectives

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- Illustrate how **Software Engineering Advisory and Assistance Services** help organizations achieve
  - ❑ Acquisition excellence
  - ❑ Objectives of the *Weapon Systems Acquisition Reform Act of 2009 (PL 111-23), Title I Sec 103 Performance Assessments and Root Causes Analysis for Major Defense Acquisition Programs*
  - ❑ Higher software development capability maturity
  
- Discuss how **Key Technical Performance Assessment Areas**
  - ❑ Enables determining accuracy and adequacy of supplier's process and deliverable software products
  - ❑ Provides measurable results for determine effectiveness of the supplier's process and quality of the deliverable software products
  
- Provide detailed **Practical Examples/Recommendations** from major defense and federal acquisition programs



# Acquisition Challenges and Success

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## ➤ Why is Software Acquisition a Challenge?

### Examples

- ❑ **Design constraints** make software acquisition and development extremely critical
  - Application domain – Operational Flight Program, Air Traffic Control
  - Software size – Source Lines-of-Code (SLOC) in Millions
  - Complexity - real-time embedded systems of systems
  - Reliability – failure-free software
  - Safety-critical – RTCA/DO-178B
- ❑ **Software size estimation** -- critical factor in determining cost, schedule, and effort [Jones 2004] [Jones 1999]
  - Software size estimation typically driven by the supplier's agreement terms –
    - Contract vehicle (Fixed-Price, Cost-Reimbursement)
    - Statement of work
    - Deliverables (Contract Data Requirements List-CDRL)
    - Technical requirements (safety-critical)
    - Supplier's software development capability maturity



# Acquisition Challenges and Success

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## ➤ Why is Software Acquisition a Challenge?

- ❑ Acquires **must** take overall accountable for satisfying the user while allowing the supplier to perform the tasks to delivery the product
- ❑ **Obstacles**
  - Inadequate training in software acquisition planning and execution
  - Inadequate resources and funding
  - Capability maturity fails to match the supplier
  - Inability to recognize quality work

**“Acquirers must recognize quality work before they can require and accept it”**

**----Watts Humphrey, 2009**



# Examples of Acquisition Problems

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## FAA NAS Programs

### o AAS

Cornerstone of the  
FAA NAS Plan

- o Inadequate requirement baseline control
- o Cost and Schedule Overruns
- o Restructured in 1994
  - **contract cost increased from \$3.6 billion to \$7.6 billion**

### o NADIN II

- o Cost and Schedule Overruns

### o MCCP/MMC

- o ***Termination for Convenience***

### o MLS

- o ***Termination for Default***

### o RCE

- o ***Termination for Default***

***RCE: Deposited by AT&T BEFORE THE DEPARTMENT OF TRANSPORTATION BOARD OF CONTRACT APPEALS DOT BCA No. 2479***



# Examples of Acquisition Success

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## FAA NAS Programs

- TDWR<sup>1</sup>
  - Delivered First Production Unit six months early
  - Received IEEE Computer Society award
  - Operational at 45 Airports
  - 1991, software process evaluated a SEI CMM® Level 3

® CMM registered in the U.S. Patent and Trademark Office by Carnegie Mellon University

**acquirer and supplier capability maturity levels matched**

## ○ VSCS Upgrade

- Production completed
- 100% on-time system delivery of all 23 systems
- FAA Contractor of the Year Award
- Human Factors Engineering Society Award

**acquirer - supplier relationship (communication)**

*1 Successful Acquisition of FAA Terminal Doppler Weather Radar, Third Annual Conference on the Acquisition of Software-Intensive Systems (Experience Track, 26 January 2004). [Jones 2004-1]*

<http://www.sei.cmu.edu/library/abstracts/presentations/jonesjan2004.cfm>



# Examples of Acquisition Success

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## C-130 AMP<sup>1</sup>

**Boeing” program has stayed on schedule since 2005”** <http://www.beurs.nl/nieuws/artikel.php?id=198658&taal=US>

- o Sep 19, 2006 – First Flight for AMP1 (H2, 89-09101)
- o Mar 25, 2007 – First Flight for AMP2 (H2.5, 91-01239)
- o Sep 5, 2008 – Completed software development (Core Complete 2.2)  
<http://www.air-attack.com/news/article/3336/Boeings-C-130-AMP-Flight-Marks-Completion-of-Software-Development.html>
- o Jan 17, 2009 – First Flight for AMP3 (H3, 94-6704)

**Three weeks ahead of schedule**

- o Jan 28, 2010 – DD-250 Software Development Workstation to Robins AFB  
(SOF/EISE Lab)

**Acquirer - Supplier Relationship (Communication)**



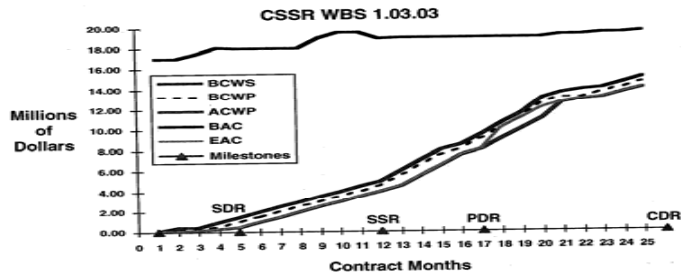
# Examples of Performance Measures

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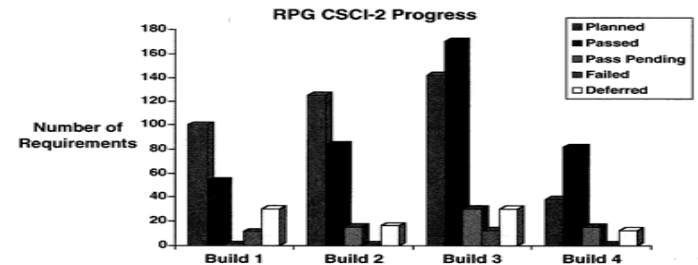
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## TDWR System Software Design



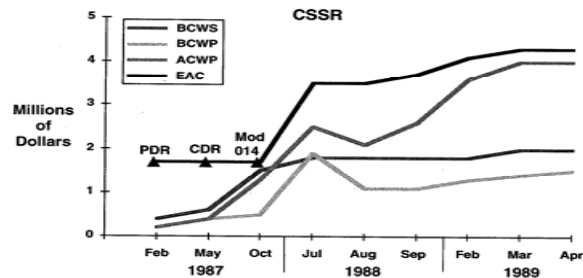
Cost/Schedule Deviation

## TDWR Formal Qualification Testing



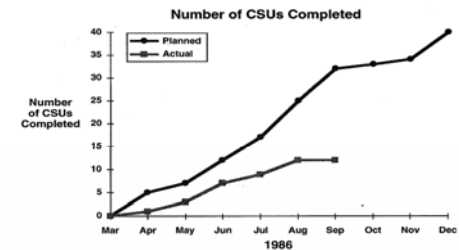
FQT Progress

## RCE System Software Design

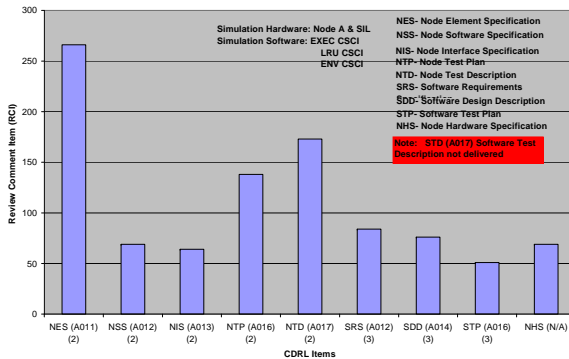


Development Progress

## MLS Software Detailed Design

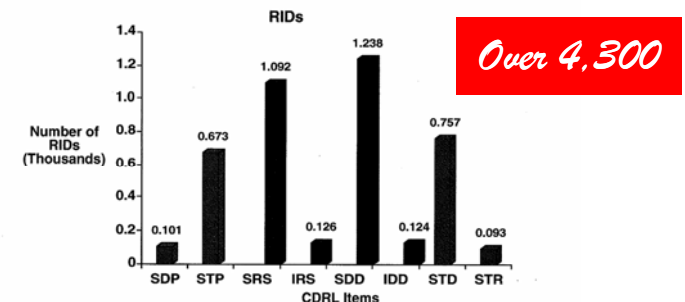


## SIF CD/TK Critical Design TIM



Document Review Item Discrepancies

## TDWR Software Development Documentation



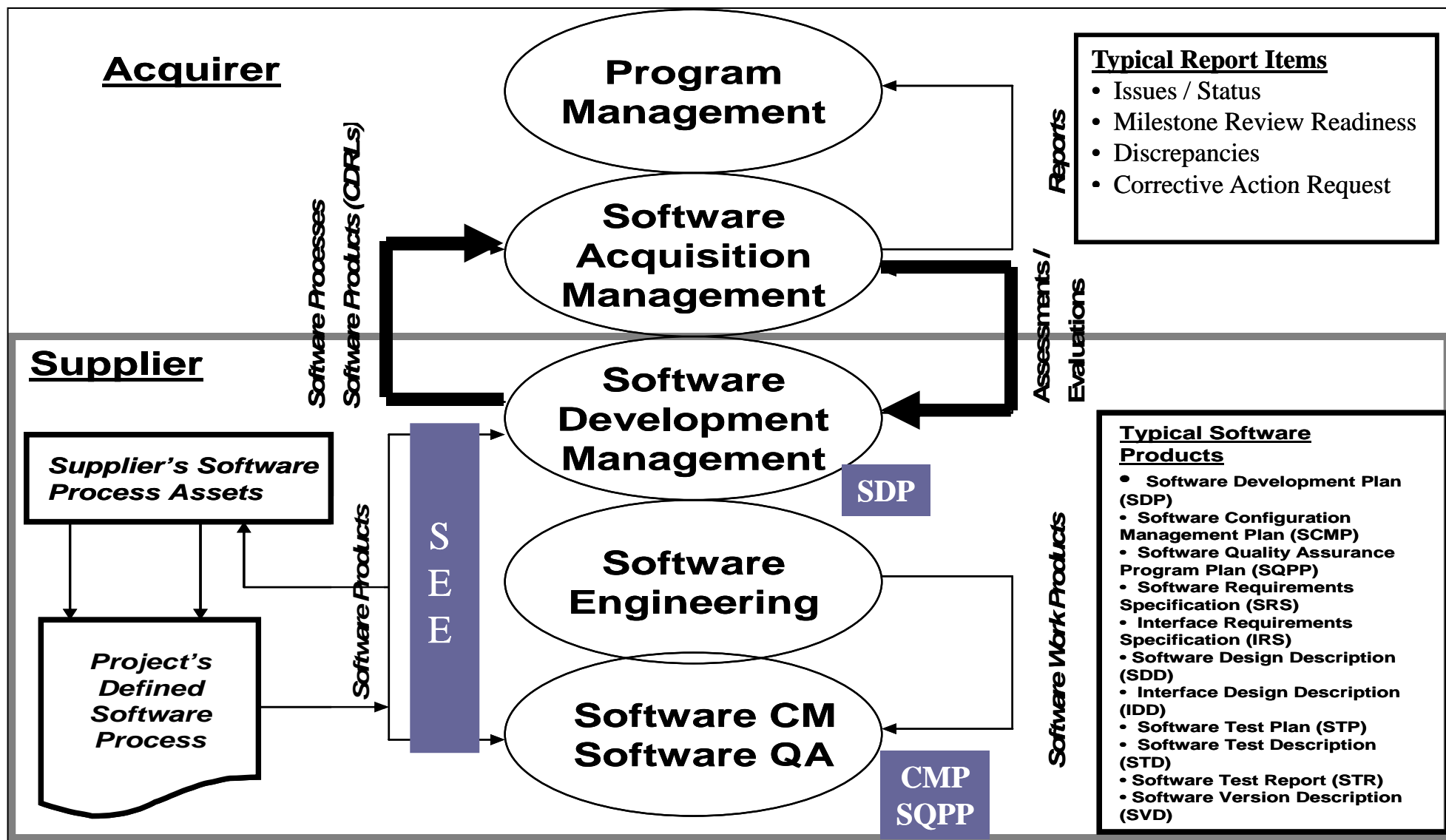


# The Acquisition Environment

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SDP – Software Development Plan  
SEE – Software Engineering Environment

CMP – Configuration Management Plan  
SQPP – Software Quality Program Plan



# Practical Examples

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## Acquirer / Supplies ...

Establish agreed upon contractual requirements

Examples

- *CDRL Data Item Description (Format and Content)*
- *Milestone Review (Entrance and Exit Criteria)*
- *Mutual understanding of the functional baseline*

## Acquirer...

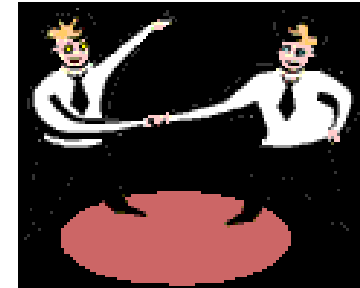
Determines accuracy and adequacy of supplier process and products

- *Software Development Plan*
- *Software Requirements Specification*

Determines product readiness for Milestone Reviews

## Supplier...

Provides tangible evidence of product's design, status, and progress





# Practical Examples - Acquirer

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- Software engineering ***should*** be integrated in **ALL Software-Related Source Selection Factors**
- Software acquisition team ***should*** have software expertise
  - ▣ *Application domain, acquisition, process, project management, engineering, and safety, as needed*
- The software acquisition team ***should*** have adequate resources and funding to perform the acquisition activities
- A software lead ***should*** be designated to be responsible for establishment and managing the software acquisition activities

*“Acquirers must recognize quality work before they can require and accept it”*

*----Watts Humphrey*



# Practical Examples - Supplier

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- The supplier **should** follow a set of defined software processes tailored from the organization's standard processes
- The supplier **should** have documented and institutionalized software plans
  - ❑ **Software Development Plan (SDP)**
  - ❑ **Software Configuration Management Plan (SCMP)**
  - ❑ **Software Quality Assurance Plan (SQP)**
- The supplier software plans **should** provide the acquirer with
  - ❑ Insight into the processes, procedures, and desk instructions
  - ❑ Tools and methods used
- The supplier development environment **should** be augmented by management practices
  - ❑ Measuring and monitoring progress
  - ❑ Judging the quality of the software
  - ❑ Validating the deliverable
  - ❑ Conducting milestone reviews and in-process reviews



# Contract Requirements

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- **Why have Contract Data?**
  - ❑ Enables the acquirer to assess the accuracy and adequacy of the deliverable software product
  - ❑ Enables the supplier to determine production methodology and the required resources for the product

*Contract data benefits the acquirer and supplier*

- **Key Software-Related Contract Data in the Request-For-Proposal**
  - ❑ Statement of Work (SOW)/Statement of Objective (SOO)
  - ❑ Contract Data Requirements List (CDRL) Items
  - ❑ System Specification
  - ❑ Data Rights

Success of an acquisition is directly linked to the quality of the RFP  
--- (Army 2007)



# SOW/SOO

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- What is the Statement Of Work (SOW) / Statement Of Objectives (SOO)?
  - ❑ Basis for communicating acquirer requirements to the supplier
    - SOW defines specific tasks
    - SOO defines objectives
  - ❑ Primary document for translating management requirements into contractual tasks / objectives
  - ❑ Sufficient detail **should** be provided to allow the supplier to scope the effort, cost it, and provide a responsive technical solution
  - ❑ Tasking information **should** be defined for the preparation of deliverable data (artifact)
    - Each tasking statement **should** reference applicable **Contract Data Requirements List** (CDRL) item which will be delivered by that task.

The SOW/SOO should not tell the supplier how to do the required work  
The SOW/SOO should not specify selection of major software components



# Contract Data Requirements List (CDRL)

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- What is the Contract Data Requirements List (CDRL) Items?
  - ❑ A **natural by-product** of the development process to capture results of each activity
  - ❑ Primary vehicle for acquiring software data
  - ❑ A list of authorized data requirements for a specific procurement that forms a part of the contract.
  - ❑ Defense Federal Acquisition Regulation Supplement (DFARS) **Subpart 215.470 Estimated Data Prices**
    - Requires a CDRL (DD Form 1423) when delivery of data is required
  - ❑ **CDRL items** referenced in the Statement of Work (SOW) describing the development effort

*CDRL Items absolutely essential for managing software development*



# Practical Examples

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- **Contractual Requirements** *should* be agreed upon
  - ❑ CDRL DID Format and Content
- **Software CDRL items** *should* be delivered prior to the milestone reviews to allow **significant time to enable:**
  - ❑ Acquirer evaluation and to provide discrepancies
  - ❑ Supplier to disposition the discrepancies
- **Milestone reviews** *should* include agreed upon supplier discrepancies disposition
- **Software CDRL items** *should* be prepared by the software team
  - ❑ Reviewed by all applicable distribution addressee organization
  - ❑ Approved by either the appropriate Chief Engineer, Program Manager or Data Requirements Review Board



# System Specification

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- **What is the System Specification?**
  - ❑ Establish top-level technical performance, design, development, integration, and verification requirements
  - ❑ Sound system requirements are the backbone of good **Key Performance Parameters** – essential to the development of effective capabilities
  - ❑ Examples of requirement statements
    - All safety-critical software **shall** be modified or developed in accordance with the requirements of RTCA/DO-178B or equivalent level of safety.
    - All newly developed software **shall** be written in a higher order language (HOL).
    - Meteorological algorithms **shall** be implemented in high order language (HOL)
    - Use of commercial software **shall** be approved by the SPO



# Data Rights

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## ➤ What are Data Rights?

- Enable the use, maintenance, and replication of the software data

## ➤ Data Rights Categories

- **Unlimited rights** - right to use, modify, reproduce, release, in whole or in part, in any manner and for any purpose whatsoever, and to have or authorize others to do so. **Associated with computer software developed exclusively with acquirer funds.**
- **Acquirer Purpose rights** - rights to use, modify, reproduce, release, within the acquirer's organization/company without restriction. **Software development with mixed acquirer and supplier funding.**
- **Restricted data rights** apply only to noncommercial computer software and mean that the acquirer's rights are as set forth in a Restricted Rights Notice. **Supplier funds all development.**

**Secretary of the Air Force Memo - Data Rights and Acquisition Strategy (3 May 06) - directing the acquisition of technical data and associated rights to be addressed specifically in all Acquisition Strategy Plans, reviews, and associated planning documents for Acquisition Categories (ACAT) programs – software intensive systems and subsequent source selections.**

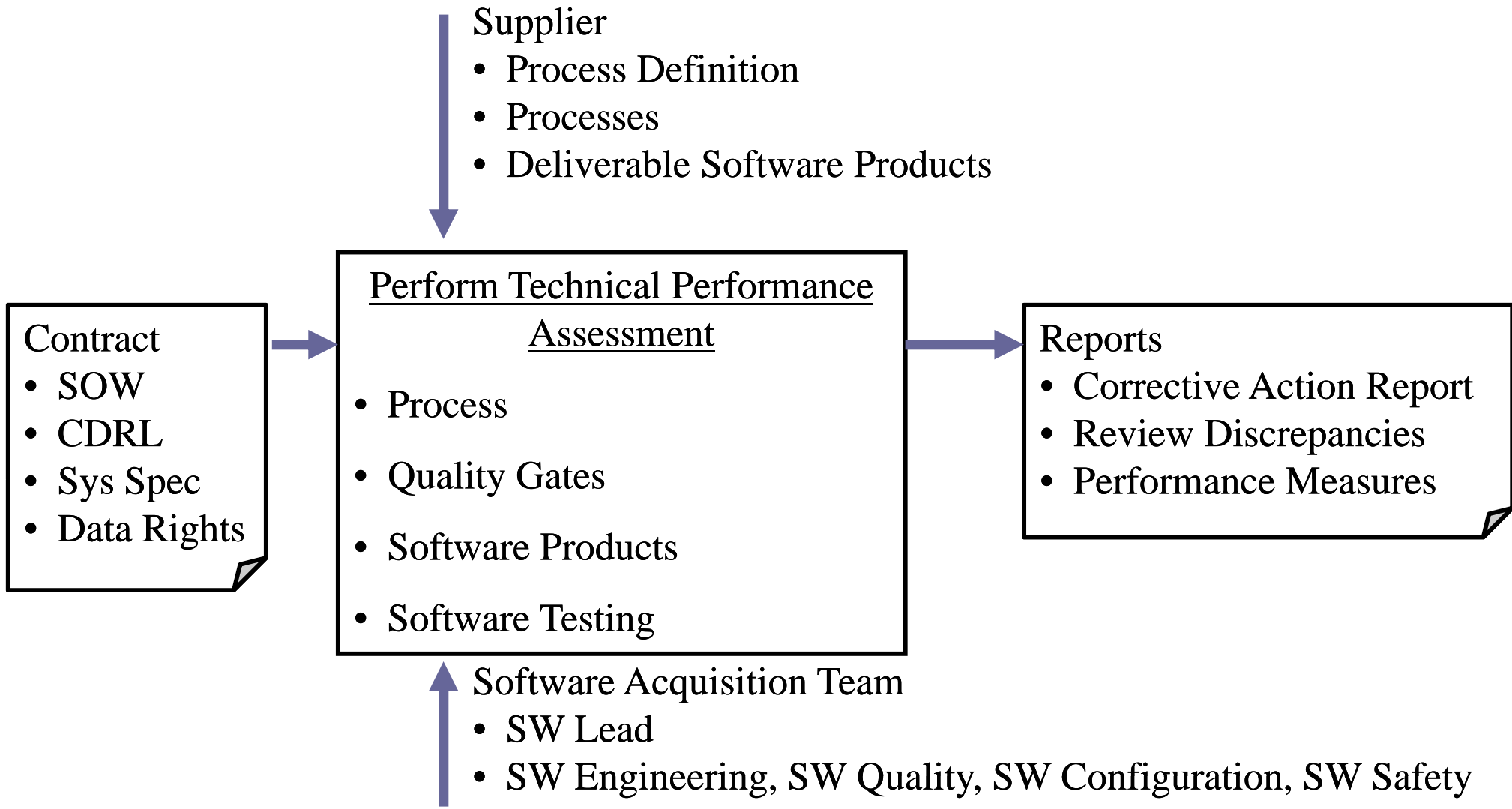


# Technical Performance Assessment

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Gaining Visibility to Reduce Technical Performance Risks



# Technical Performance Assessment

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## Technical Performance Assessment

- An evaluation technique in which process, quality gates, software product, and software testing are examined in detail to detect defaults and compliance with standards
- **Objectives**
  - ❑ To reduce software development **technical performance** inherent risks
- **Benefits**
  - ❑ **Ensures compliance** with contractual requirements and supplier's defined software process and plans
  - ❑ **Provides visibility** into accuracy and adequacy of the of the deliverable products
  - ❑ **Provides measurable results** for determine effectiveness of the process and the quality of the products
  - ❑ **Provides feedback** to improve the software process
  - ❑ **Reduce** software development technical performance risks



# Technical Performance Assessment

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## ➤ Key Technical Performance Assessment Areas

- ❑ Process
- ❑ Quality Gates
- ❑ Software Products
- ❑ Software Testing

**Meeting the objectives of the DoD Weapon Systems Acquisition Reform Act 2009  
Public Law 111-23-May 22, 2009**

**- - Title I, Section 103:** Performance assessments and root cause analyses for major defense acquisition programs



# Process Area

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## ➤ Objective

- ❑ Ensures compliance with contractual requirements and supplier's defined software process and plans
  - software management, engineering, configuration management, and quality assurance activities

Process Assessment key focus is “what is done and the product being built”

## ➤ Examples of Software Plans

- ❑ Software Development Plan (SDP)
- ❑ Software Configuration Management Plan (SCMP)
- ❑ Software Quality Assurance Plan (SQAP)

*The Contract **must** provide mechanism to gain access to supplier process and plans*



# Practical Examples

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## ➤ **Contract: SOW**

- ❑ Maintain the software development process, and SDP
- ❑ Process remain up to date with the current development activities, and the SDP remains consistent with the actual activities being performed.
- ❑ Implementation of software configuration management in accordance with the approved configuration management and software development plans using IEEE/EIA 12207.0, 12207.1 and 12207.2 as guides
- ❑ Development and maintenance of a SDP for each supplier furnished avionics Operational Flight Program (OFP) Computer Software Configuration Item (CSCI)



# Practical Examples

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## ➤ Activities Performed

- ❑ Acquirer reviews supplier's defined software process
- ❑ Acquirer evaluates supplier's plans against SOW
  - If CDRL items, provides discrepancies
- ❑ Acquirer monitors supplier management and engineering activities in accordance with supplier's defined software process and plans
- ❑ Acquirer conducts periodic reviews and/or audits of the supplier's software configuration management and software quality assurance activities
- ❑ Acquirer provides discrepancies and/or audit reports to the supplier and acquirer management



# Quality Gates Area

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## ➤ Objective

- ❑ Determines the adequacy of the supplier's efforts in performing the software development activities, surface and resolve issues, and provide feedback

## ➤ Examples of Quality Gates

- Program Management Review (PMR)
- Milestone Reviews
- Technical Interchange Meetings (TIM)
- ❑ *Typical Milestone Reviews:* ← **Now: No official standards**
  - *Software Specification Review (SSR)*
  - *Preliminary Design Review (PDR)*
  - *Critical Design Review (CDR)*
  - *Test Readiness Review (TRR)*

## ➤ Example of Audits

- *Functional / Physical Configuration Audits*



# Practical Examples

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## ➤ **Contract: SOW (Milestone Reviews)**

- ❑ Conduct Milestone Reviews in accordance with the Contractor Integrated Master Plan (IMP).
- ❑ Example of an IMP Attribute
  - Event: Conduct Critical Design Review (CDR)
  - Accomplishments: Software Detailed Design performed and documented in the Software Detailed Design document (CDRL Item)
  - Criteria:
    - Peer reviewed and placed under Configuration Management Control
    - CDRL Item submitted for Acquirer review

**Milestone Reviews should be evidence-based**

-----*Critical Success Factors for Milestone Review Risk Identification*, [Dr. Barry Boehm](#), USC  
NDIA 12<sup>th</sup> Annual Systems Engineering Conference, 2009



# Practical Examples

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## ➤ Activities Performed (Milestone Reviews)

- ❑ Supplier prepares the documents in accordance with the CDRL Item DID and places under configuration control
- ❑ Supplier delivers CDRL Items in accordance with the CDRL Items
- ❑ Acquirer evaluates the CDRL Items to determine evidence-based (acceptability) and provides discrepancies to supplier
  - **Maturity of CDRL items serves as entrance criteria for milestone review**
- ❑ Supplier disposition CDRL items discrepancies prior to the Milestone Reviews
- ❑ Supplier conducts the Milestone Reviews in accordance with supplier's process
- ❑ Acquirer and supplier agree upon supplier's CDRL Item discrepancies disposition

**Key Focus---What is done and the product being built**



# Software Products Area

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## ➤ Objective

- ❑ Provides insight into the accuracy and adequacy of the supplier's deliverable software products
- ❑ Provides measurable results for determining the quality of the software products and **process effectiveness**
- ❑ Ensures software products meets contractual requirements
  - Statement of Work (SOW)
  - Contract Data Requirements List (CDRL) Item - Data Item Description (DID)
- ❑ Provides evidence-based for milestone reviews (quality gates) to determine readiness



# Practical Example

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## ➤ Activities Performed

- ❑ After contract award, acquirer and supplier agree upon the CDRL DID format and content
- ❑ Prior to delivery to the acquirer, supplier evaluates CDRL items and places under configuration control
- ❑ Supplier delivers CDRL items prior to the milestone review to allow **significant time** for acquirer detailed evaluation and disposition of discrepancies
  - **CDRL delivery and discrepancies disposition serves as entrance criteria for the milestone review**
- ❑ Acquirer provides discrepancies and recommendations to supplier within an agreed upon time after receipt of the CDRL items
- ❑ Supplier incorporates agreed upon corrections



# Practical Example

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- **Example of Document Review (DR) Form**
  - ❑ **Capture CDRL items evaluation discrepancies**
    - Documentation Identification (e.g., CDRL Title, CDRL Item Number, Document Title, Document Number/Date/Revision)
    - Comment Location (e.g., Page, Paragraph, Figure)
    - Comment (e.g., consistency, completeness, correctness, ambiguous, traceability, etc)
    - Recommendation / Suggestion
  - ❑ **Capture supplier disposition of discrepancies**
    - Concur / non-concur / Action
  - ❑ **Capture acquirer agreement**
  - ❑ **Track Closure**
    - Date / Action



# Practical Example

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- **Examples of CDRL Items Assessment Criteria**
  - ❑ Compliance with DID format and content
  - ❑ Completeness (e.g., missing requirements, testing, interfaces, etc.)
  - ❑ Traceability (e.g., test traced to requirements, etc.)
  - ❑ Consistency with upper level documents
  - ❑ Internal consistency
  - ❑ Ambiguity of requirements (understandable, testable?)
  - ❑ Conflicting requirements
  - ❑ Test coverage of requirements
  - ❑ Appropriate analysis, design, and coding techniques used



# Practical Example

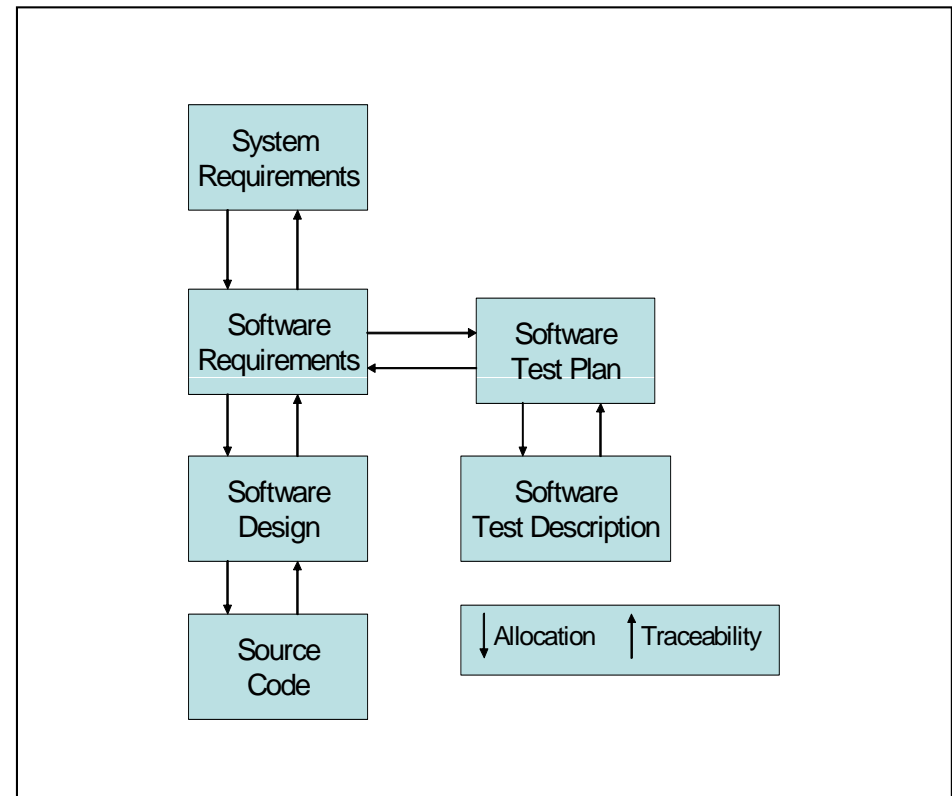
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## ➤ Bidirectional Traceability

- ❑ Required by the **CDRL Item DID**
- ❑ **Allocation** ensures the right products been built
- ❑ **Traceability** ensures the evolving product is not expanding the scope
- ❑ Reduce effort required to determine change impact
- ❑ **Should** be documented in a requirements database
  - Examples: DOORS®, RTM



**Bidirectional traceability**



# Practical Examples

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## ➤ C-130 AMP Contract

- ❑ 8 Software-Related CDRL Items specified by the SOW
  - *SRS (A012), IRS (A013), SDD (A014), IDD (A015), STP (A016), STD (A017), STR (A018), SPS (A019)*
  - ***Final submittal 60 days before EMD completion*** for the SIF nodes and final submittal 60 days after software FCA for other CSCIs.
  - ***The CDRL noted : “Only final version of data/document to be formally delivered in accordance with the above stated milestone. Any initial, preliminary, draft, or other interim versions of the data/document referenced in the contractor’s IMP will be made available informally to the government.”***

## ➤ C-130 AMP SPO Activities

- ❑ Software IPT responsible for MP OFP Software CSCIs
- ❑ SIF IPT responsible for SIF Hardware and Simulation Software CSCIs
- ❑ Submitted over **3500** Document Comment Items (DCI)
  - **90% acceptance**



# Practical Examples

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- **FAA NAS (TDWR) Contract**
  - ❑ 16 CDRL Items specified by the SOW
  - ❑ Submittal (preliminary and final) linked to design review (e.g., SSR, PDR, etc)
  - ❑ Acquirer approval within 30-calendar days
- **Raytheon**
  - ❑ 45 Total CDRL Items delivered
- **TDWR Software IPT**
  - ❑ Over 4300 Review Items Discrepancies (RID) approved



# Software Testing Area

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## ➤ What is Software Testing?

- ❑ Software development involves a series of activities in which opportunities for human induced defects are enormous
  - **46% - 60%** of all software defects originate in the software requirements analysis phase [Endves 1975] [Voges 1979]
- ❑ **Software Testing** is the quality assurance technique used to evaluate the “**as-built**” software product to **ensure the probability of failure** due to latent defects is low enough for acceptance
- ❑ Software testing consists of three levels of testing
  - *Unit Testing, Integration, and Formal Qualification Testing*

Software testing represents the ultimate evaluation of the software requirements, design, and coding activities [Jones 1993-1]

Software testing can make the software product more reliable and usable [Musa 1987] [Dunn1984]



# Software Testing Area

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## ➤ What is required in the Contract?

- ❑ Unit Testing, Integration, and Formal Qualification Testing (FQT) activities and artifacts **should** be documented in the supplier's defined software process and the Software Development Plan
- ❑ FQT activities and artifacts **should** be specified in the Contract SOW

## Examples

- ❑ **Software Test Plan (STP) – DI-IPSC-81438A**
  - *Describes plans for qualification testing, test environment, identify tests to be performed, and schedule*
  - *Tests trace to requirements in the SRS*
- ❑ **Software Test Description (STD) –DI-IPSC-81439A**
  - *Describes the test preparation, test cases, and test procedures*
- ❑ **Software Test Results (STR) – DI-IPSC-81440A**
  - *A record of the qualification testing*



# Practical Example

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## ➤ Activities Performed

- ❑ Supplier delivers software test CDRL Items at designated quality gates - **Milestone Reviews** (i.e., PDR, CDR, and TRR) in accordance with CDRL Items
- ❑ Supplier conducts **Test Readiness Review (TRR)** in accordance with supplier's process
- ❑ Supplier conducts software **Formal Qualification Testing (FQT)** in accordance with supplier's process, software test plan, and software test procedures
- ❑ Acquirer and supplier's Software Quality Assurance witness all software FQT activities
- ❑ During FQT activities, supplier documents and disposition test anomalies detected in accordance with supplier process
- ❑ Supplier performs corrective action, as required, in accordance with Supplier's process



# Practical Example

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- Example of Supplier Corrective Action Process
  - ❑ Establish and maintain a **Configuration Change Board**
    - Determine the severity of all problems detected or changes requested
    - Analyze the changes to determine impact to the work product, related work product, and schedule
    - Analyze the problem closure to determine the impact to the software release milestone
  - ❑ Perform corrective action life cycle in accordance with Supplier's process

*Change control system should be used to determine the aspects of process improvement and effectiveness of previous activities*



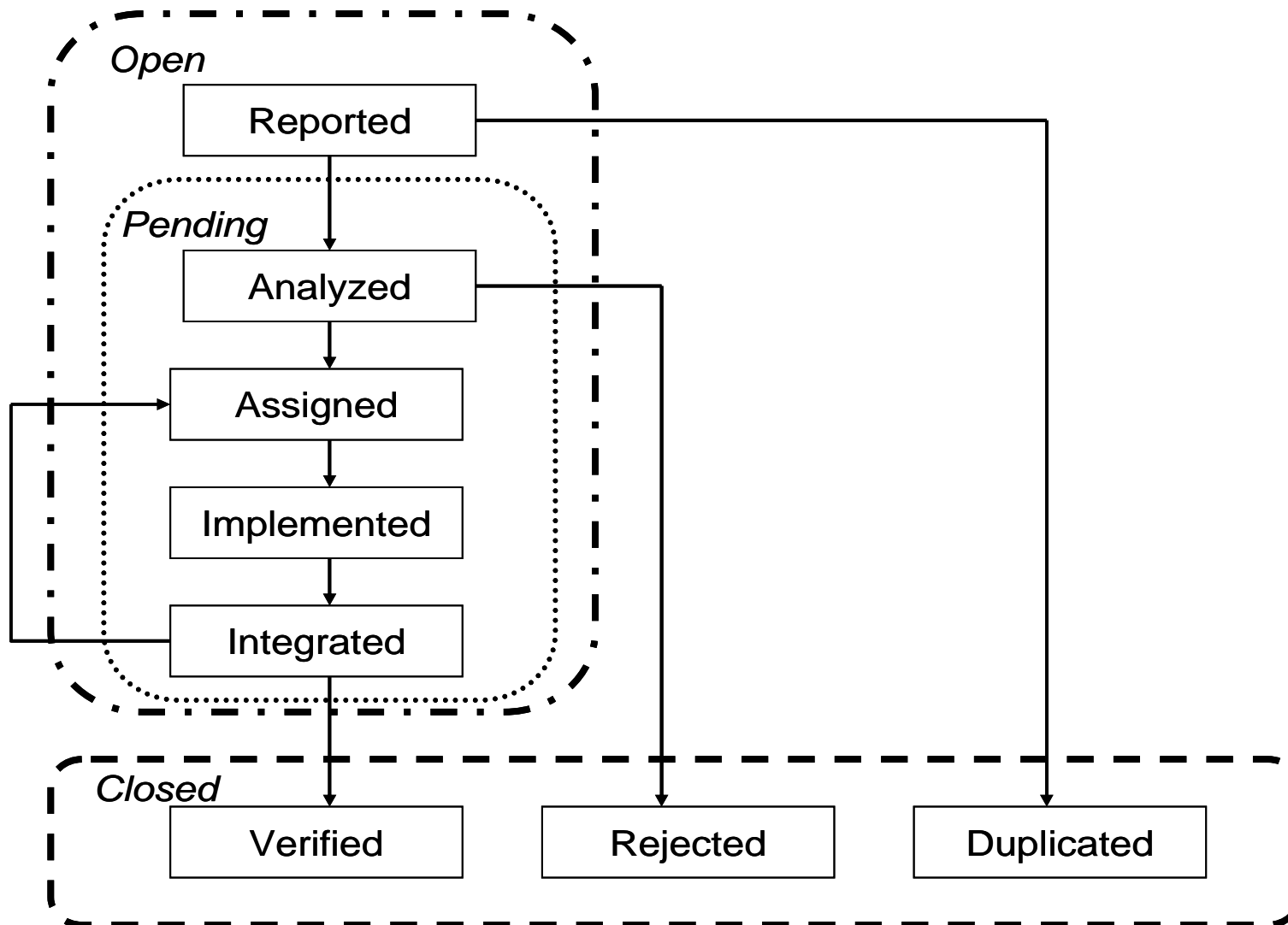
# Practical Example

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## Typical Corrective Action Life Cycle





# Software Testing Area

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## ➤ How much testing is enough?

- ❑ Complete test coverage is generally not possible [Jones 1993-1]
- ❑ **Test Case** design methodology **should** be documented
- ❑ Acquirer and supplier **should** mutually agree on completion criteria

### Examples

- Completion of a number of test runs with no open priority 1 and 2 severity problems
- ❑ Acquirer and supplier **should** establish a **failure intensive objective (FIO)** using a software reliability growth model:

### Examples

- Time-Between-Failure Models
- Error-Count Model

Acquirer and supplier face a difficult decision when to release the software product

Complete test coverage is generally not possible...[Jones 1993-1]



# Summary

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## Achieving Acquisition Excellence – *Changing The Game*

- Software Engineering Advisory and Assistance Services
  - ❑ Effective software acquisition expertise is essential
  
- Supplier
  - ❑ Performs effective software estimation (***software size, cost, and schedule***) early and during the life cycle
  - ❑ Mature software development capability
  
- Technical Performance Assessment
  - ❑ Determine accuracy and adequacy of supplier's process and deliverable software products
  - ❑ Ensure "as-built" meets software requirements
  - ❑ Provide measurable results for determining effectiveness of the supplier's process and quality of the deliverable software products



# Summary

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## ➤ Way Forward – *Changing The Game*

- ❑ Establish software acquisition team with knowledge and skills
  - *Effective software engineering advisory and assistance services*
- ❑ Establish adequate resources and funding
- ❑ Getting things right from the start
  - *Establishing effective and efficient software Contractual Requirements*
    - *Statement of Work, Contract Data Requirement List Items, Systems Specification, Data Rights*
    - *Validating software estimates (Size, Cost, and Schedule)*
- ❑ Gain visibility into technical performance risks

Establishing more discipline and accountability



# Summary

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## ➤ Improvements in Software Acquisition

- ❑ Public Law 107-314 Section 804 of the National Defense Authorization Act, released in December 2002 [Section 804-2003]

Public Law 111-23 Weapon Systems Acquisition Reform Act of 2009

- ❑ The best practice model Capability Maturity Model® Integration (CMMI®) for Acquisition



# Questions ?

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*What are you doing to achieve acquisition excellence?*

James E. Jones

Support Systems Associates, Inc.

Warner Robins, GA 31088

Email: [jjones@ssai.org](mailto:jjones@ssai.org)



# Selected Publications and Presentations

Support Systems Associates, Inc.

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- [\*Achieving Acquisition Excellence- Making It Happen Effectively\*](#), NDIA 12<sup>th</sup> Annual Systems Engineering Conference, 29 October 2009, San Diego, CA
- [\*Software Acquisition Management Practical Experience\*](#), Systems & Software Technology Conference, 22 April 2009, Salt Lake City, UT
- [\*Process Improvement in a Small Company\*](#), Proceedings of the First International Research Workshop for Process Improvement in Small Settings, 2005 Software Engineering Institute, Pittsburgh, PA
- [\*Successful Acquisition of FAA Terminal Doppler Weather Radar\*](#), Third Annual Conference on the Acquisition of Software-Intensive Systems, 26 January 2004, Arlington, VA
- [\*Mission Success: Estimating Software Projects\*](#), The International Society of Parametric Analysts, 26<sup>th</sup> Annual Conference, May 10, 2004, Frascati, Italy
- ***Estimating Software Size, Cost, and Schedule: Mission Success Through Life Cycle Process***, 1999 Joint ISPA/SCEA Conference, 1999, San Antonio, TX
- ***Software Metrics Effectiveness in Software Acquisition Management***, 38<sup>th</sup> Air Traffic Control Association Fall Conference, 1993, Nashville, TN
- ***Software Testing: Methods and Techniques***, 38<sup>th</sup> Air Traffic Control Association Fall Conference, 1993, Nashville, TN
- ***Software Acquisition Management: Managing The Acquisition of Computer Software Using DoD-STD-2167A***, 37<sup>th</sup> Annual Air Traffic Control Association Conference Proceeding, November 1992



# Acronyms

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AAS	Advanced Automated System
ACAT	Acquisition Category
AMP	Avionics Modernization Program
ATC	Air Traffic Control
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CIP	Capital Investment Plan
CNS/ATM	Communications/Navigation Surveillance / Air Traffic Management
CO	Contracting Officer
COTS	Commercial Off-The-Shelf
CPAF	Cost-Plus Award Fee
CSCI	Computer Software Configuration Item
CY	Calendar Year
DCI	Document Comment Item
DER	Designated Engineering Representative
DFARS	Defense Federal Acquisition Regulation Supplement
DID	Data Item Description
DoD	Department of Defense
DOORS	Dynamic Object-Oriented Requirements Systems
ECP	Engineering Change Proposal
EMD	Engineering, Manufacturing and Development
FAA	Federal Aviation Administration
FFP	Firm Fixed-Price
FFPI	Firm Fixed-Price Incentive

FQT	Formal Qualification Testing
IDD	Interface Design Description
IRS	Interface Requirements Specification
MP	Mission Processor
NAS	National Airspace System
ONP	Operational Flight Program
OPF	Operational Flight Program
PCO	Procuring Contracting Officer
PDR	Preliminary Design Review
SCM	Software Configuration Management
SDD	Software Design Description
SOF	Special Operations Forces
SOO	Statement of Objective
SOW	Statement of Work
SPO	System Program Office
SQA	Software Quality Assurance
SRS	Software Requirements Specification
SSR	Software Specification Review
STD	Software Test Description
STP	Software Test Plan
STR	Software Test Report
SVD	Software Version Description
TRR	Test Readiness Review



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# Back-Up

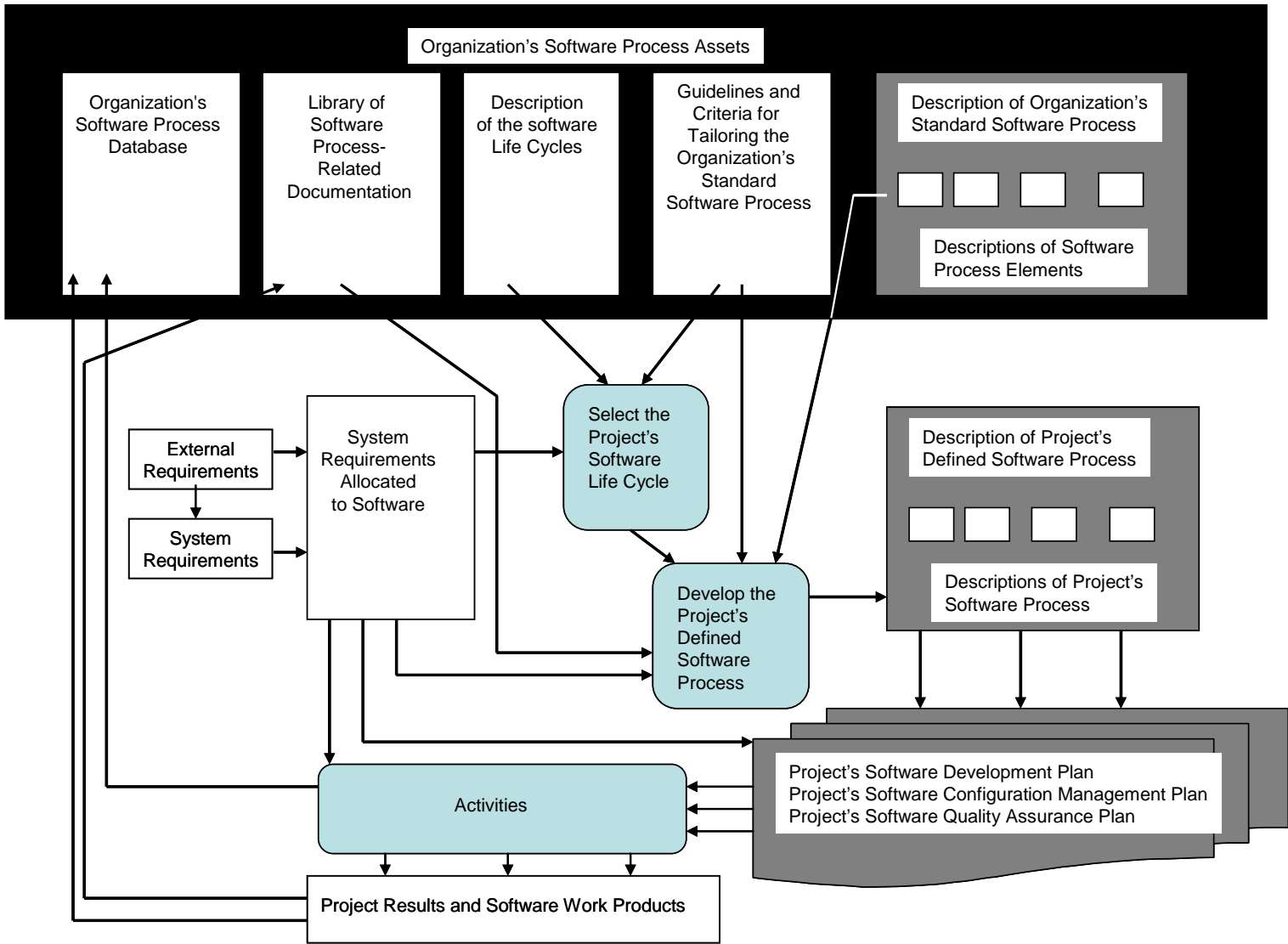


# Typical Supplier's Software Process Definition

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# SOW/SOO

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## ➤ Examples of Key Software Tasking

- ❑ **Software development process** – perform software management and engineering in accordance with project's processes, procedures, and desk instruction
- ❑ **Software management** – manage software development in accordance with software plans (*e.g., SDP, CMP, SQPP*)
- ❑ **Software engineering** – perform software activities (i.e., requirements analysis, preliminary design, detailed design, code and unit test, integration, and formal qualification testing)
- ❑ **Software tools and environment** – used to produce the software
- ❑ **Risk management** – established and maintained risk management systems
- ❑ **Milestone reviews** – *conduct milestone reviews with the acquirer: Software Specification Review (SSR), Preliminary Design Review (PDR), Critical Design Review (CDR), and Test Readiness Review (TRR) [used as quality gates]*
- ❑ **Technical Interchange Meetings** – used to identify and resolve technical issues
- ❑ **In Process Reviews** – determine evidence readiness



# Examples of SOW Software Engineering Tasking

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- **Software Requirements Analysis**
  - ❑ Perform software requirements analysis. Prepare software requirements specification document in accordance with CDRL No. A001
- **Software Design**
  - ❑ Perform software preliminary and detailed design. Prepare software design description document in accordance with CDRL No. A002
- **Software Test Planning**
  - ❑ Perform software test planning. Prepare software test planning document in accordance with CDRL No. A003
- **Software Test Description**
  - ❑ Define the test environment, test cases and test procedures. Prepare software test description document in accordance with CDRL No. A004
- **Software Formal Qualification Testing**
  - ❑ Conduct software formal qualification in accordance with the test procedures in the software test description CDRL A004. Prepare the test report document in accordance with CDRL No. A005



# Typical Software CDRL Items

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- **SOFTWARE REQUIREMENTS SPECIFICATION (SRS) – [DI-IPSC-81433A](#)**
  - *Describes the behavior of the software to be developed and methods to be used to ensure each requirement has been met*
  - *Basis for the design and qualification*
  - **Enables the acquirer to access the adequacy of the software requirements**
  - **Interface Requirements Specification (IRS) – DI-IPSC-81434A** may be appendix to SRS
- **SOFTWARE DESIGN DESCRIPTION (SDD) – DI-IPSC-81435A**
  - *Describes the design needed to implement the software*
  - **Interface Design Description (IDD)-DI-IPSC-81436A**, may be appendix to SDD
  - **Database Design Description (DBDD)-DI-IPSC-81437A**, may be appendix to SDD
    - *Describes the data base design and elements (content and format)*
- **Software Test Plan (STP) – DI-IPSC-81438A**
  - *Describes plans for qualification testing, test environment, identify tests to be performed, and schedule*
- **Software Test Description (STD) –DI-IPSC-81439A**
  - *Describes the test preparation, test cases, and test procedures to be used to perform the qualification testing*
  - **Enables the acquirer to access the adequacy of the qualification testing**
- **Software Test Results (STR) – DI-IPSC-81440A**
  - *A record of the qualification testing*
  - **Enables the acquirer to access the testing and its results**
- **Software Version Description (SVD) – DI-IPSC-81442A**
  - *Identifies and describes a software version (“as-built” software)*



# CDRL Item Key Blocks

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## ➤ CDRL Item Key Blocks Elements

Block	Description
4	Authority (Data acquisition Documentation No.) <b>Data Item Description (DID<sup>1</sup>)</b> – Defines format and content preparation instructions for data product generated by task requirements <b>Assist-Quick Search</b> used to access the current DID <b>1</b> Should be tailored to meet contract requirements (Block 16)
5	Contract Reference - <b>Reference Statement of Work paragraphs</b>
6	Requiring Office – Organization have primary responsibility for reviewing the data and recommending acceptance/rejection of the data
8	Approval Code - (A) Approved by the Contracting Officer <b>Should specify approval at each milestone (e.g., SSR, PDR, CDR, etc.)</b>
10, 11, 12, 13	Delivery Requirements <b>Should be associated with milestone reviews (e.g., SSR, PDR, CDR, etc.)</b>



# Weapon Systems Acquisition Reform Act of 2009 (Public Law 111-23, 22 May 2009)

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## *TITLE I—ACQUISITION ORGANIZATION*

Sec. 101. Cost assessment and program evaluation.

Sec. 102. Directors of Developmental Test and Evaluation and Systems Engineering.

Sec. 103. Performance assessments and root cause analyses for major defense acquisition programs.

Sec. 104. Assessment of technological maturity of critical technologies of major defense acquisition programs by the Director of Defense Research and Engineering.

Sec. 105. Role of the commanders of the combatant commands in identifying joint military requirements.

## *TITLE II—ACQUISITION POLICY*

Sec. 201. Consideration of trade-offs among cost, schedule, and performance objectives in Department of Defense acquisition programs.

Sec. 202. Acquisition strategies to ensure competition throughout the lifecycle of major defense acquisition programs.

Sec. 203. Prototyping requirements for major defense acquisition programs.

Sec. 204. Actions to identify and address systemic problems in major defense acquisition programs prior to Milestone B approval.

Sec. 205. Additional requirements for certain major defense acquisition programs.

Sec. 206. Critical cost growth in major defense acquisition programs.

Sec. 207. Organizational conflicts of interest in major defense acquisition programs.

## *TITLE III—ADDITIONAL ACQUISITION PROVISIONS*

Sec. 301. Awards for Department of Defense personnel for excellence in the acquisition of products and services.

Sec. 302. Earned value management.

Sec. 303. Expansion of national security objectives of the national technology and industrial base.

Sec. 304. Comptroller General of the United States reports on costs and financial information regarding major defense acquisition programs.