C-17 Software Development Process

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Introduction

- The C-17 airlifter is a software intensive system with an ongoing avionics upgrade program
- Software process is inseparable from Systems engineering process
  - Robust avionics systems and software engineering processes are critical to success
  - Process improvement is an essential component of performance improvement
Topics

- C-17 Program
- Avionics Systems and Software Engineering Process
- Challenges, Lessons Learned and Improvement Strategies
- Summary
C-17: A High Performance Program

Over 898,750 Flight Hours!
USAF Fleet – 872,885  UK Fleet – 23,085

As of 3 August 2005
Unique C-17 Capability

Delivers Heavy and Outsize Cargo into Short Runways

and/or

Semi-prepared Runways

through

Small Ramps or Narrow Body Slots

Direct Deliveries Over Intercontinental Distances into Small Austere Airfields

Carries Airborne Troops Anywhere: "Long Flight, Ready to Fight"

Reduces Manpower: 3-Person Aircrew; Breaks Less and is Easier to Fix
C-17 Bed Down Locations

145 of 184 Delivered

- Travis AFB: 13 A/C (2007)
- Dover AFB: 13 A/C (2008)
- Brize Norton: 4 A/C (2001)

C-17 Bases

Next Base

Future Bases
C-17 Flight Software Summary

- Over 2 million source lines of code
- Mix of military and commercial software
- Software development/maintenance
  - Approximately 50%-50% Boeing/Supplier split
  - Over 20 suppliers
- Many software languages
  - Migrating to Ada 95 and C/C+ as equipment is modernized
Avionics Systems and Software Engineering Process
Systems and Software Engineering Process

- System Requirements
- System Analysis, Operational Concept, Top level design
- Concept of Operations Review with Customers
- Detailed System Design
- Software Requirements
- Software Design
- Software Code
- Software Qualification Test
- Unit/Integration Test
- System Test
- Aircraft Certificate of Conformance
- Flight Test
- Configuration Audit and Delivery
Software Development Process

- Software Requirements Analysis
- Software Architectural Design
- Software Detailed Design
- Software Implementation (coding)
- Software Unit Test
- Software Unit Integration
- Software Qualification Test

DO-178B
Mil-Std-498

Contractual process documented in C-17 Software Development Plan
Software process improvement is a key component in the quality journey.
C-17 Software Process Evolution

1999

CMM Level 3

2000

MIL-STD-498

CMM Level 5

2001

CMMI Level 5

2002

CMMI Reassessment

2003

CMMI Level 5

2004

CMM to CMMI Transition

2005

Airlift and Tankers Organizational Process

2006

C-17 Tailored Process

Process Compliance Artifacts

MIL-STD-498/DO-178B

The C-17 Globemaster III is an advanced, multi-purpose, large-cargoplane system designed to meet the needs of military and civil transportation markets. The C-17 is a high-speed, large-cargo aircraft with a payload capacity of 70,000 pounds. The C-17 is designed to operate in a variety of environments, including high-altitude and high-temperature conditions. The C-17 is capable of flying at altitudes of up to 50,000 feet and speeds up to 500 miles per hour. The C-17 is powered by four GE Aircraft Engines, which provide a thrust of over 25,000 pounds each. The C-17 is designed for mission flexibility, with a range of up to 7,000 nautical miles. The C-17 can be configured for a variety of missions, including cargo transport, aerial refueling, and humanitarian assistance. The C-17 is currently operated by the United States Air Force, and has been deployed in numerous conflict situations, including Operation Desert Storm, Operation Enduring Freedom, and Operation Iraqi Freedom.
Challenges, Lessons Learned and Improvement Strategies
Challenges and Lessons Learned

- Supplier SW management
- Documentation
- Managing overlapping development
- Maintaining process discipline
Approximately half of C-17 software is developed and maintained by suppliers.

Boeing-Supplier teamwork is essential for success.

Supplier Software Management Team
- Software engineering experience
- Software acquisition experience

Software acquisition tools
- Lifecycle data/product review checklists
- Template Statement of Work

Supplier Selection and Monitoring Processes

Supplier Software Metrics

Repository for review artifacts
Capturing and verifying airborne software life cycle data is a complex task
- Thousands of requirements
- Thousands of pages
- Traceability
- Milestone review entry criteria

Solutions
- Implemented DOORS
- Improved product evaluations
Multiple Software block upgrades occur simultaneously with different effectivity

Challenges
- Laboratory Capacity
- Flight Test Capacity
- Manpower availability

Solutions
- Integrated block planning
- Block Integration
- Alternate test resources
- Staff versatility
- Earlier error detection - reducing late phase rework
Strategic Process Improvement

- Systems Engineering Processes
- Software Engineering Processes

Value Stream / Process Mapping
- Product processes
- Monitoring processes
- Tools

Next Generation Strategic Implementation Plan
- Eliminate Redundancy
- Eliminate Non value added steps

Increased Process Commonality and efficiency
- Reduced development costs
- Increased staff “portability”
- Reduced training costs/learning curves
- Reduced process management costs

Continuous Improvement
Summary
Summary

- Systems and software processes are inseparable
  - Both directly affect product delivery
  - Both directly affect product quality
- C-17 Software process has evolved through the Boeing quality journey
  - Current plans are to further optimize systems and software processes for improved commonality and efficiency
- Process discipline is an integral part of the C-17 software mission assurance strategy