Advanced EHF
Mission Control Segment (MCS)
Software Maturity

GSAW 2008 Presentation

31 March – 3 April 2008
**Agenda**

- System Overview
- Introduction
- Reliability Growth Model Analysis
- Process Improvements

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This presentation describes work performed under IWTA-C CJ25V0801N to Lockheed Martin Space Systems Company, Space and Strategic Missiles, Sunnyvale, CA under prime contract F04701-02-C-0002 to U. S. Air Force, SMC/MCA, Los Angeles AFB, El Segundo, CA.
System Overview

**Milstar**

- Space Vehicle
  - System Timing
  - Autonomous Fault Detection and Correction
  - Jamming/Nuclear Protection

**AEHF**

- Payload
  - Communication and Routing
  - Antenna Coverage/Comm Capacity

**TSAT**

**AEHF Space Segment (3 Space Vehicles)**

- **Baseband**
  - Direct I/F to User
  - User Interoperability
  - End-to-End Services

- **Terminals**
  - AEHF and Milstar
  - International Partners
  - User Comm Services
  - User Resource Control

- **Mission**
  - Apportionment Planning
  - Sustainment
  - Terminal Control

- **Control Segment**
  - Command and Control
  - Training and Simulation
  - Over-the-Air Rekey
  - Ground Mobiles

"TSAT Photo courtesy of Military Satellite Communications Systems Wing. Other photos reprinted courtesy of the United States Department of Defense."
Characteristics

- Function: Command & Control, Telemetry, etc.
- Object Oriented / Database Driven Design
- OO, Unix, C++, FORTRAN, SCL, Oracle, SQL

Test Program Description

- Modified waterfall
- Incremental Development
- Test Approach
  - Element test – req’ts based
  - MCS test – scenario based

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Introduction

• This brief provides results of our work to develop accurate and practical software defect density estimates using Weibull and Yamada-S Reliability Growth Models (RGM)

• Significant findings include:
  – Analysis of RGM curves developed with DR data in the “calendar-domain” can lead to inaccurate (and optimistic) estimates of total DRs in the code. The contributions of test effort on DR detection rates must be understood.
  – Aggregation of data (components, priority levels, etc.) from populations with dissimilar maturity characteristics degrades accuracy of estimates.
  – RGM results can provide useful information to software testing and release decisions
What are Reliability Growth Models (RGM)

- As we progress through the software test program, defect detection becomes increasingly more difficult.
- RGMs are families of mathematical functions (Weibull, NHPP, etc.) that model the detection rate of software DRs during development (and operations).
- RGM analysis can be used to predict future detection rates and DR density once the code begins to demonstrate reliability growth.
- RGMs are robust, although the DR data must still satisfy a number of assumptions.
Analysis of Calendar-Based DR Detection Rates

- Calendar-based models assume a constant test effort across all periods (hours, days, weeks, etc.)
- RGM analysis of MOPS DRs show strong reliability growth with 93% of total estimated DRs found to date

What is driving the drop in DR detection rates?
Analysis of Calendar-Based DR Detection Rates

- Calendar-based models assume a constant test effort across all periods (hours, days, weeks, etc.)
- RGM analysis of MOPS DRs show strong reliability growth with 93% of total estimated DRs found to date
- Hours profile shows strong correlation between effort and DRs

Test effort, not reliability growth, is driving DR detection rates
Analysis of Calendar-Based DR Detection Rates

- Test hours alone explain 80% of the change in DR detection rates.
- Data demonstrates a strong correlation between test effort and DR detections.
- Reliability growth is a minor contributor to changes in MOPS DR detection rates.

Calendar-Based approach is highly susceptible to changes in effort.
Analysis of Effort-Based DR Detection Rates

Comparison between Calendar- and Effort-Based DDPs:
- Calendar-based analysis
  - With 93% of total estimated DRs found the software is in the strong reliability region of its S-curves and ready for fielding
- Effort-based analysis
  - With 65% of total estimated DRs found the software is in the weak reliability region of its S-curves and not ready for fielding

Calendar-Based estimates can yield unreliable results.
Test Effort Profile Estimates

Our goal is to develop a profile that depicts the relative on-console test effort from labor data which includes many other test-related activities.

• Method 1: Total hours across all test accounts and activities
  • Pros: Easiest metric to collect and implement
  • Cons: Assumes all test stages have equal efficiency

• Method 2: Length of test procedures and hours charged to test accounts
  • Pros: More accurate test effort profile: introduces test phase efficiency coefficients
  • Con: More difficult to implement

Both methods yield adequate test profiles
Process Improvements

• Established a set of Software Maturity metrics to track the progress of the software through the development / test lifecycle.
  – Observations from the RGMs along with other key metrics provide great insight into the reliability and readiness of the software.
  – Utilizing RGMs based on test effort provides a more accurate depiction of software reliability
• Developed additional metrics including software change frequency metrics which have identified specific areas requiring additional attention.
• Improved our processes to include a forum for the analysis and discussion of software reliability.
• Developing software maturity goals which can be eventually used to help answer the age-old questions “is the software ready to ship and if not, when will it be ready?”