JAXA Software IV&V activity 2005

Pre-SAS @ NASA IV&V Facility
Aug. 8, 2005

Masa Katahira
Japan Aerospace Exploration Agency
Outline of JAXA IV&V tasks

- **Purpose**
  - Projects’ IV&V software assessment
  - Research of new software engineering methodologies
  - Introducing those methodologies into development team and contractors

1. **New Methodology Research**
   - Research and Development of new methodology based on projects’ needs (focused points for particular projects’ weakness) and case studies
   - International collaboration with other IV&V facilities such as NASA, ESA

2. **Methodology empirical verification**
   - Sample application in real projects to verify the effectiveness of methodologies
   - Building up lessons learned and effectiveness data for projects’ characteristics

3. **Projects’ IV&V**
   - Based on Project team requests, planning the IV&V by selecting methodologies from verified storage
   - IV&V assessment reports at milestone reviews

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Project IV&V Status (2004.4–2005.7)

Manned Systems
- HTV
- Centrifuge
- JEM
- HTV
- Centrifuge
- JEM
- HTV
- Centrifuge
- JEM

Satellites
- WINDS
- SELENE
- JEM operation control system
- H-IIA Launch Vehicle flight safety system

Ground Segments
- Data Handling
- Attitude Control
- Mission Data Handling
- Data Handling
- Attitude Control
- Antenna Drive

Full set

Lightweight

From early phase of development
IV&V flow

Issue Analysis

- Issues found by Problem Report
- Issues found By Project Team Interview
- Lessons Learned In IV&V team

Planning

- Guideline/DB (tools & methods)
- Research of new methodology
- If no appropriate Method in Guideline

Strategic Planning
Selection of methods and team

Assessment
- Applicability, Effectiveness, & Cost data, Lessons Learned

Assessment Report

Correction & Additional test

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Issues found by Problem Report

- Problem Trend Assessment
  - Type of problem
  - Process (Task) in which a problem was introduced
  - Process (Task) in which a problem has been found
  - Process (Task) in which a problem should have been found
  - Related or similar software modules

- Statistical Analysis (Software Reliability Growth Model: SRGM)
  - Adjustment by size of efforts and stepwise testing

- Comparison with measurement data such as the complexity calculated by code checking tool
  - Problem Reports vs. corrective actions

- Essential Factors (Causes)

- What can be studied are:
  - Trend of root causes for each software/each team & staff
  - Satisfaction of software test and reviews/inspection
  - Findings of weak processes and problem module which IV&V should focus on
  - Integrity level of product and processes (Fault Tolerance and Robustness)
  - Feedback to development process (additional reviews and testing)
New Methodologies Research 2004–2005

- SpecTRM Based Robustness Test Environment (SpecRobusT) which is an automated test case generation, testing, test results comparison environment
- IV&V Review of Requirements Management and Traceability Analysis
- Checklist for Satellite Data Handling system
- Tool supported interface verification
- Meta Modeling Language and Model Checking with IV&V and Development Team
- Code Clone Technology to use reliability measurement
- Maps for software test technology for ultra high reliable software which is cooperate with other area of industries

⇒ Manned Systems
⇒ Satellites
⇒ Ground Segments
SpecTRM (Model) Based Robustness Test Environment (SpecRobusT)

Outline:
- By using specification models, the important test cases are generated for full software simulation during development contractor’s test phase automatically and comparing results.
- Especially, all inputs are verified in the model to generate the test cases.
- Auto tests are performed at 10,000 – 100,000 cases / sec.

Results:
- # of Test Case: 550,870,000,000
- Benefits:
  - Verification at very early phase
  - Introduction to automated test environment
  - Introduce “Test Before Development” paradigm into development process

Implementation Procedure
IV&V Review of Requirements Management and Traceability Analysis

- DOORS/Add-on Toolset

  - System Specification → System Integration Test
  - Software Requirement Specification → Software Integration Test
  - Software Design Specification → Source Code

- Lessons Learned
  - Independent Review of traceability correctness and specification completeness
  - Particular granularity of specification description
  - Tracking rationales of specification (Add-on Toolset)
  - Difficulty of treating tables and figure definition instead of sentence

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Selection and Scalability of Methodologies

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Examples of methodologies selection

- Completeness, Consistency, and Reachability (model checking) by using formal specification
- Test case generation and reasonable case deduction at IV&V review
- Analysis of Design Robustness and Coverage
- Problem Report Analysis and Accident Analysis
- Verification by reverse engineering tools
- Code Static Analysis by code checking tools

Manned Systems

Satellites

Ground Segments

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Strategic IV&V planning

- Restructuring IV&V methodologies by the following categories:
  - Purpose (5 majors, 17 minors)
    Consistency with Operational scenario, Adequacy of specification, ...etc.
  - Attributes (79 attributes)
    Consistency of State Transition, Timing Consistency, ...etc.
  - Techniques (109 techniques)
    SpecTRM modeling, Voyager–Galileo Checklist, ...etc.
  - Several data for all above combination, such as cost–effectiveness and effectiveness to severity of system are defined for modeling IV&V tasks toward future strategic IV&V planning

- We have just started to take those data and analyze them. All results will be presented in IV&V TIM@ ESTEC in October, 2005.
Additional Topic in Software Engineering Team: 
Software Process Improvement

- **Purpose**
  - To define the integrated process between JAXA and Contractors including IV&V
  - To monitor the goodness of process in order to avoid being dead process by using metrics etc.
  - No target to particular level such CMMI level 5

- **First Goal**
  - Gap analysis and finding process issues
    - Interviews: JAXA, Contractor Engineers and Managers
    - Problem Reports Analysis (more than 2000)
    - Giving self-improvement motivation into contractors
  - Integrated Process and Process Standard (at first, satellite version will issue in 2005)
    - establishes a stable development process
    - makes clear on the Roles and Responsibilities of both JAXA and contractors, and their process interfaces
  - Introduction of new tools and methods such as process and product metrics
Additional Topic in Software Engineering Team:
High Reliable Real-Time (RT) OS/ Verification Process

- **Purpose**
  - To Establish the high reliable verification process in order to assure enough quality and reliability of RTOS.

- **Topics**
  - Establishment of High Reliable Verification Process (as Standard)
    - Minimum Verification Process Requirement to assure RTOS (additional testing)
  - High Reliability functions implementation
    - (Open Source) RTOS which can provide the function to be supportive to develop enough safety system
Current works and Future works

- Model Based Assessment
  - Model Checking to Model Based Development
  - Analysis of consistency between operation tasks and system specification behaviors

- Test Bed
  - Independent Test based on CPU emulators for code robustness check
  - Software Test Bed for New 200MIPS MPU

- Operational Scenario Assessment
  - Study the modeling method to analyze the operational scenario from early phase of development