

FSW Workshop 2011

Application of a Low Tier Process to the Robotic Lunar Lander Risk Reduction Activity

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The logo for Applied Physics Laboratory (APL) at Johns Hopkins University, consisting of the letters 'APL' in a large, bold, sans-serif font.

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Agenda

- **Background – Improving the APL Engineering Process for Software**
- **Major Changes to the Process**
- **Background – The Robot Lunar Lander Risk Reduction Activity**
- **The Software Development Process**
- **Conclusion - Lessons Learned**

Background – Improving the APL Engineering Process for Software

- **In 2009 the Laboratory Quality Council began an effort to streamline the system, hardware and software engineering processes. The motivation for this activity was**
 - 1) to provide a simplified document format for improved usability,**
 - 2) to provide clear process flow diagrams,**
 - 3) to enable user self-training to the greatest extent possible, and**
 - 4) to provide consistency with other APL engineering processes.**

Major Changes to the Process

- **Various combinations of attributes, such as schedule risk and software criticality used to drive process formality are now consolidated into a **High Tier** process and a **Low Tier** process**
- **Documents and records required for each software activity are explicitly defined**
- **Software Development Plan (SDP) is required**

Background – The Robotic Lunar Lander Risk Reduction Activity

- **RLL is a joint Marshall Space Flight Center (MSFC)/APL project funded by NASA. The software development activities are designed to reduce risk for descent and landing algorithm technology. The goals of the software risk reduction activity are:**
 - **Develop and test Guidance Navigation & Control (GN&C) software and the Least Squares Optical Flow (LSOF) algorithm on a flight-like processor.**
 - **Support MSFC Warm Gas Test Article (WGTA), a free-flying Earth-based lander that the RLL project is developing to demonstrate the final moments of the RLL landing sequence.**
 - **Support field testing, which includes tests in a helicopter that can provide high rates of lateral motion, which cannot be obtained with the WGTA.**

Software Development Process

- **A Six Step Development Process is used for all software**
 - **Planning**
 - **Requirements Definition**
 - **Design**
 - **Implementation**
 - **Testing**
 - **Deployment**

The Six Step Development Process - Planning

- **The planning activities required for low tier projects are :**
 - **Determination of criticality attributes**
 - **Determination of tier level**
 - **Determination of software development model**
 - **Development of Software Development Plan (SDP)**

The Software Development Plan

- **Objectives, Scope, References, Plan Introduction**
- **Goals and Constraints**
- **Project Work Products**
- **Organization and Responsibilities**
- **Dependencies and Assumptions**
- **Plans for Support Activities** - Configuration Management, Defect **Action Item** Tracking
- **Project Facilities and Resource** – Identification, Responsibilities, Planning
- **Risk Management**
- **Software Development Model**
- **Project Control** - Status Reporting, Project Change and Approval, Project Records
- **Project Metrics**
- **Quality Control Assurance**
- **Project Effort Estimate**
- **Project Schedule** - Project Work Breakdown Structure (WBS), Detailed Schedule
- **Project Cost Estimate** - Labor Costs, Non-Labor Costs
- **Project Transition**
- **Project Training**

Tailoring of the Software Development Plan

- **Defect Tracking to Action Item Tracking** - Intent was for RLL risk reduction activity to eventually evolve into a mission. Allowed team to capture/track anything significant that might impact a future mission, but not all software defects found during development/testing.
- **Added Quality Control Assurance** - Only required for a High Tier process. Team wanted to specifically state that quality control oversight performed by the software system engineer and the software leads.
- Some activities normally addressed in a software mission development plan not included for RLL: overview of build functionality, description of heritage code and maintenance details.

The Six Step Development Process – Requirements Definition

- **The requirements definition activities required for low tier projects are:**
 - **Develop software requirements**
 - **Complete informal peer review (*Low Tier tailoring)**
- **RLL software team developed and maintained flight and testbed requirements using Microsoft Word.**
- **Requirements baselined after successful completion of a peer review and closure of action items.**
 - **Any change after that was reviewed and approved by the software system engineer before becoming part of an updated requirements baseline.**
 - **Capturing and closing action items for the requirements review is not required for the low tier process, but the team felt that it was desirable to retain that history and best practice**

The Six Step Development Process – Design

- **Design activities required for low tier projects are:**
 - **Develop design**
 - **Complete informal V&V plan (*Low Tier tailoring)**
 - **Complete informal peer design review (*Low Tier tailoring)**
- **Design phase products included design documentation (review material and action items) and Interface Control Documents (ICDs). ICDs were not required, but were used very effectively to communicate information to the MSFC personnel.**
- **V&V plans, procedures and results were kept informally by each engineer.**

The Six Step Development Process – Implementation

- **Implementation activities required by low tier projects are:**
 - **Establish Configuration Management Repository**
 - **Develop software code**
- **NOTE: Code reviews are optional for either tier.**
 - **Although no code reviews were conducted, the software team worked closely together to review and debug code during the implementation phase so there was some level of independent review given to various parts of the software.**

The Six Step Development Process – Testing

- **The testing activities required for low tier projects are:**
 - **Implement defect tracking**
 - **Develop and execute V&V procedures**
 - **Deliver V&V results to System Engineering (As a “software-only” project, V&V results are delivered to the software system engineer)**
- **The RLL team tracked software deficiencies, changes or enhancements after delivery to MSFC. This will allow the software system engineer to generate a report at the end of this activity to include in the Lessons Learned Database**

The Six Step Development Process – Deployment

- **The deployment activities required for low tier projects are:**
 - **Development of required deliverable documentation**
 - **Delivery of final products to System Engineering (As a “software-only” project, final products are delivered to the software system engineer)**
 - **Ongoing support and maintenance as required**

- **At the project direction, formal delivery of software was via CDROM to MSFC for distribution to the WGTA team. Informal deliveries and information were exchanged via a secure SFTP site hosted by APL and accessible to registered WGTA team members. Further support is performed via telecons and email.**

Conclusion – Lessons Learned

- **As the first APL Flight Software project to use the new software development project, the RLL software team quickly came up to speed on the new software development process.**
- **The team was able to prove out the goals of the new process – easier to understand and use and clearly defined products and activities.**
- **The RLL team was able to tailor the software process for rapid design, development and delivery while still maintaining high quality.**