Real-time Propagation of Spacecraft Tasking Interface Changes

A Ground System Design Overview – Ground System Architectures Workshop 2018
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Agenda

• Problem Overview
• Legacy Document / Code Generation Workflow
• New Solution
• Example
• Conclusions
Definitions

- ICD: Interface Control Document
- DAF: Direct Access Facility
- SCEng: Spacecraft Engineering
- LEOP: Launch and Early Operations
- MCS: Mission Control System
- MPS: Mission Planning System
- CI/CD: Continuous Integration, Continuous Delivery
- Collection Planning: Constellation wide image planning software
- TEL: Tasked Event List
- Effectivity: Time/Version correlated ICD document
- THEMIS: Software Service Suite addressing TEL ICD management
Problem Overview

• Interface Control Document management
  • Multiple disparate teams interpret and implement software based on changing ICDs
  • Multiple parallel baselines in flight at any one time

• Development lifecycle
  • Large, coupled software deploys were required when releasing a new ICD version
  • Multiple actively changing ICD versions in dev, test, and production environments further complicates the development lifecycle / synchronization issue

• ICD document editing and review
  • Reviewing changes is tedious given the format and tools available
  • Version management is the responsibility of the ICD editor

• Business specific use case
  • TELs generated by multiple sources (DAF, collection planning, SCeng), consumed by multiple SW components (e.g. simulators, command generator)
Document Management: ICD Creation

• Phase 1 – Define initial TEL ICD based on satellite specifications
• Phase 2 – Distribute and utilize ICD for software creation
Document Management: Distribution

- Phase 2 – ICD Change requests and enhancements
Document Management: Initial Integration

- Phase 2 – Software integration into the ground system platform

Ground System Cloud Platform
Document Management: Integration

- Phase 3 – Rehearsals
Document Management: Launch

• Phase 4 – Launch!
• Phase 5 – Initial Operations Capability
Document Management: Operations

• Phase 6 – Full Operations Capability
Document Management: Version Review

• Versions
  • Initial creation
  • Ground station buildout versions
  • Mission/Launch Rehearsals
  • Mission Effectivities
    • Launch
    • Initial Operations
    • Full Operations
• Sustaining
A new solution: THEMIS!

- Scalable Micro-service Suite
  - RESTful cloud-enabled backend service
  - Angular Single Page Application frontend
  - Horizontally scalable

- Capabilities
  - Real-time TEL validation in operational workflow
  - JSON ICD document management at the effectivity level
THEMIS Document Management Example

- Wideband communication example
- Given an event WBCOM exists
  - Has parameters location, mode, gimbalX, gimbalY
    - Location – one of [ANT1, ANT2, ANT3]
    - Mode – one of [POSITION, TRACK]
    - GimbalX – float [0 to $2\pi$] radians: If Mode is POSITION
    - GimbalY – float [0 to $\pi/2$] radians: If Mode is POSITION
THEMIS Document Management Example

- Modify FOC version 1 parameters
  - New SCAN mode added

- Review new modifications
  - Built on GitHub

- Once reviewers approve, create new baseline
THEMIS Document Management Example

- Software teams ingest updated ICD
- Implement software updates
- Finally, update service level configuration
THEMIS Real-time Workflow Example

- THEMIS nominal workflow

![Diagram]

- Validate parameter types
- Validate range conditions
- Validate logic statements
THEMIS Integration Testing Example

• THEMIS non-nominal testing workflow

• Team 2 missed the gimbal conditional
  • GimbalX – float [0 to $2\pi$] radians: If Mode is POSITION

  ![Diagram](image)

  TEL Generator 2 → JSON → THEMIS → Failure

• Validate parameter types
• Validate range conditions
• Validate logic statements
Conclusions

• Managing ICD versions, contents, and specifications is never easy.

• Integrating GitHub capabilities has been a great success.

• Increased efficiency due to catching TEL issues earlier in the workflow.

• THEMIS has already found inconsistencies in both our internal and external software components.