



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

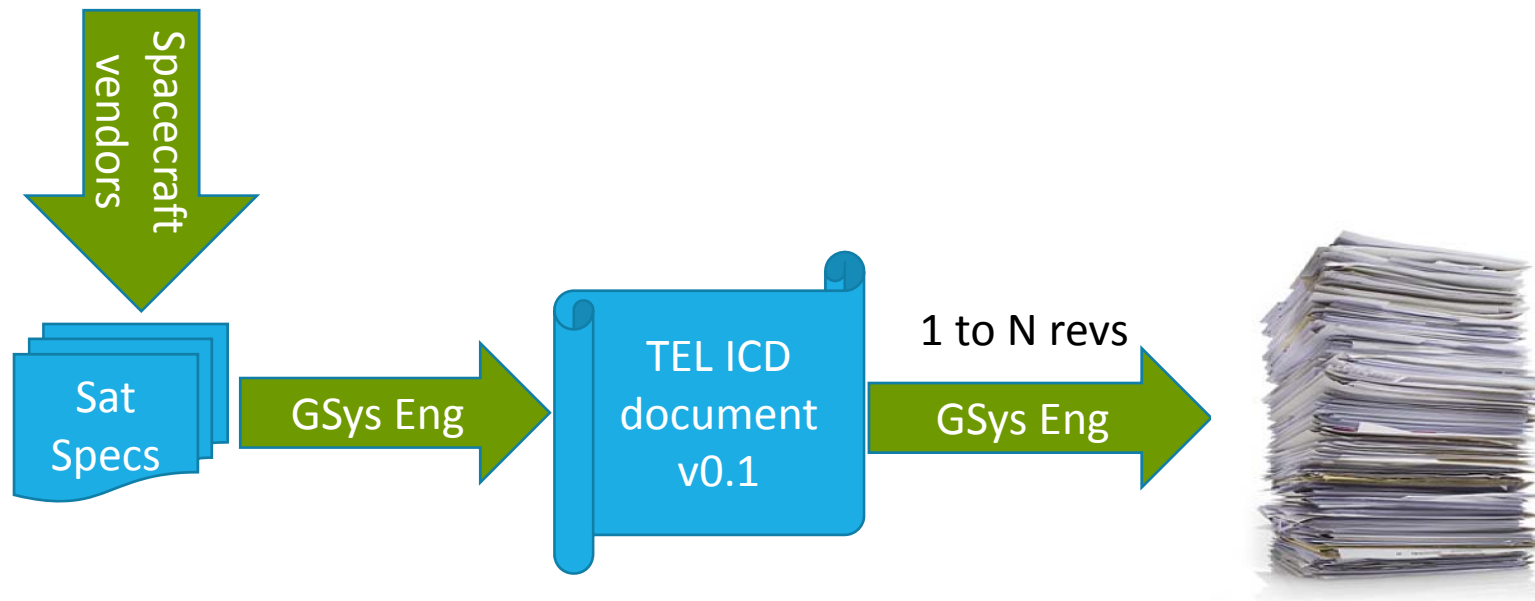


- Interface Control Document management
 - Multiple disparate teams interpret and implement software based on changing ICDs
 - Multiple parallel baselines in flight at any one time
- Development lifecycle
 - Large, coupled software deploys were required when releasing a new ICD version
 - Multiple actively 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

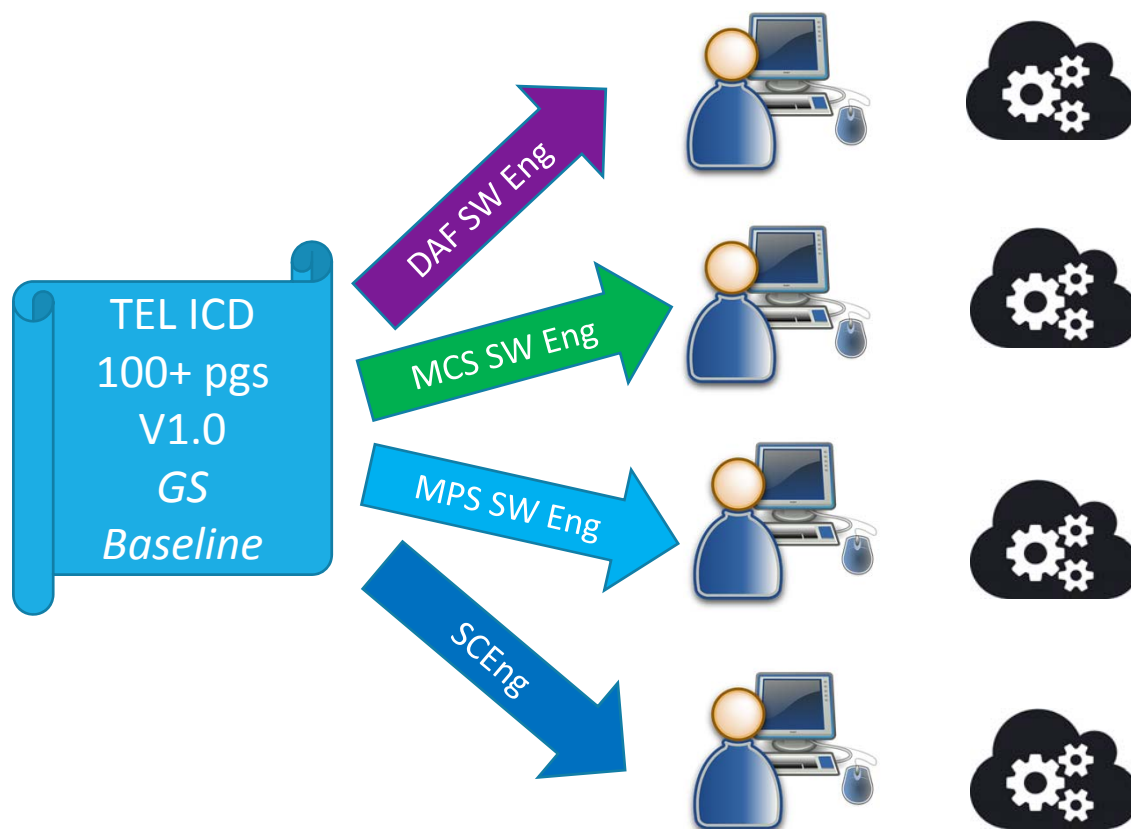


- Phase 1 – Define initial TEL ICD based on satellite specifications



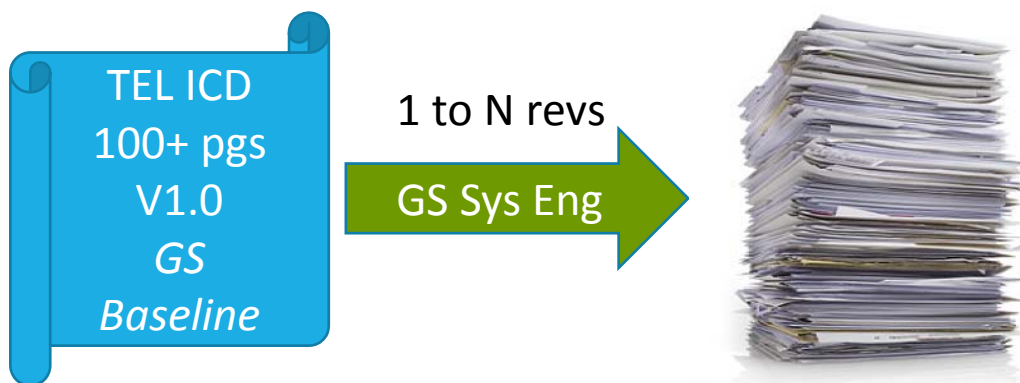
Document Management: Distribution

- Phase 2 – Distribute and utilize ICD for software creation



Document Management: Distribution

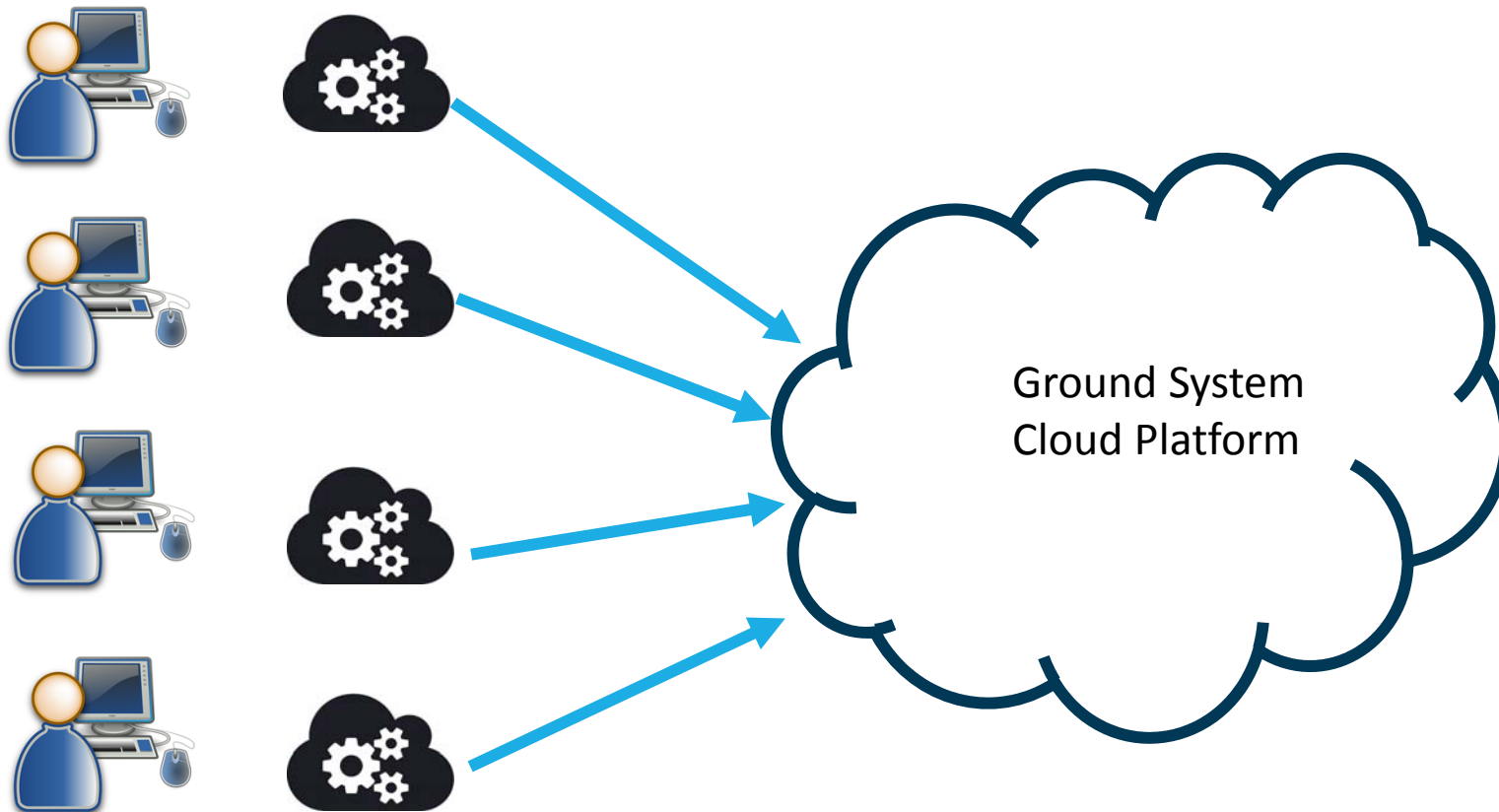
- Phase 2 – ICD Change requests and enhancements



Document Management: Initial Integration



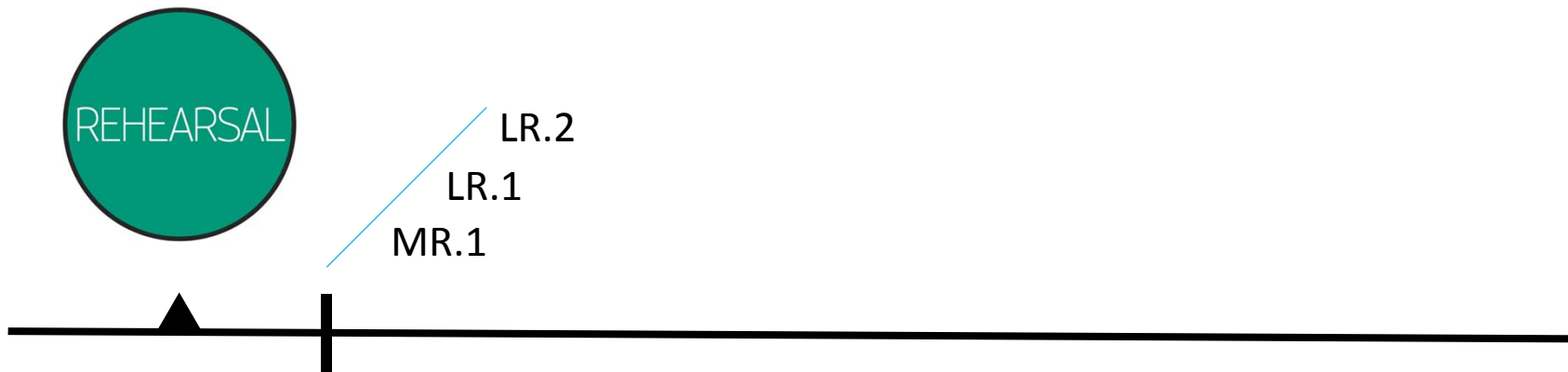
- Phase 2 – Software integration into the ground system platform



Document Management: Integration



- Phase 3 –Rehearsals



Document Management: Launch



- Phase 4 – Launch!

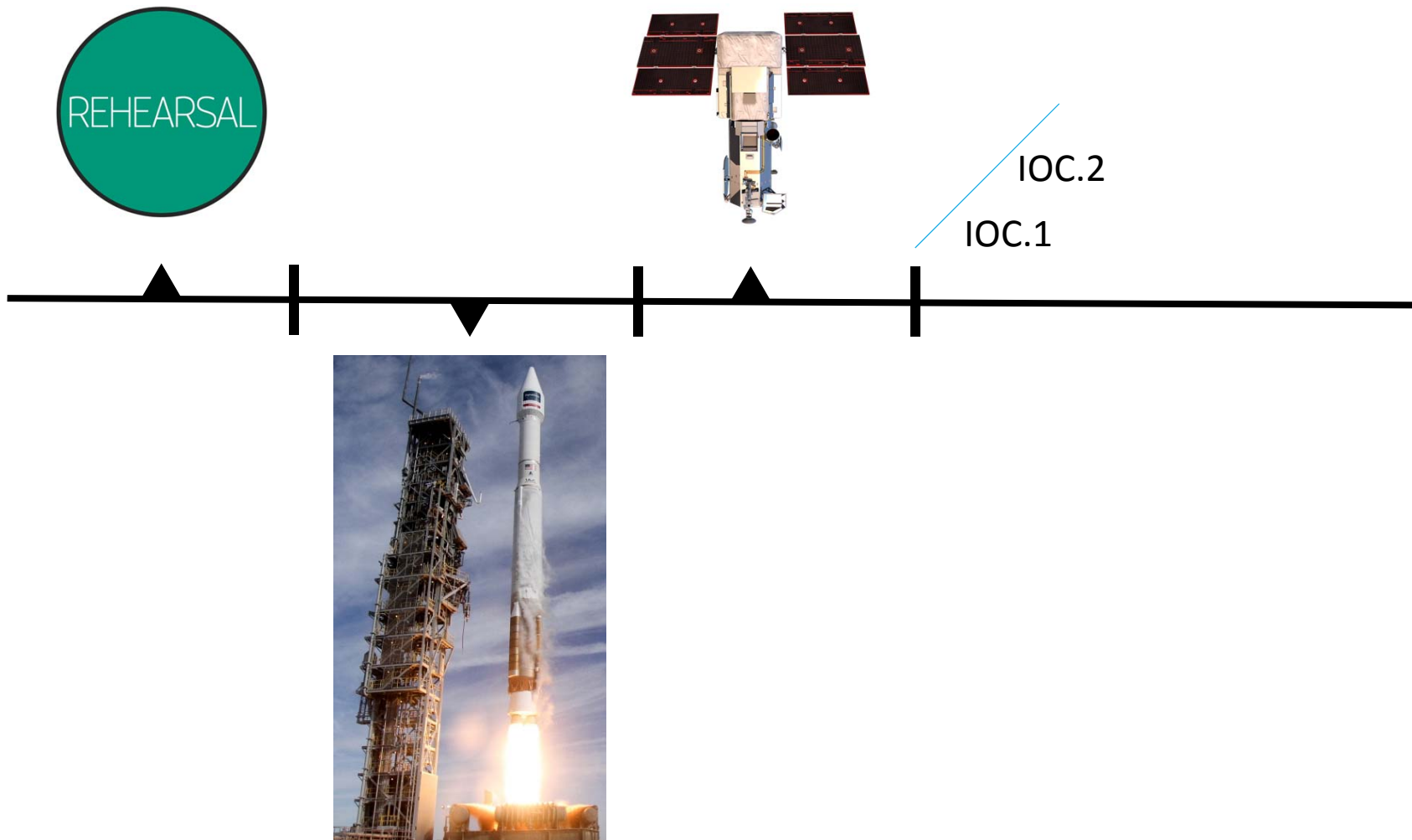


L.1

Document Management: Operations



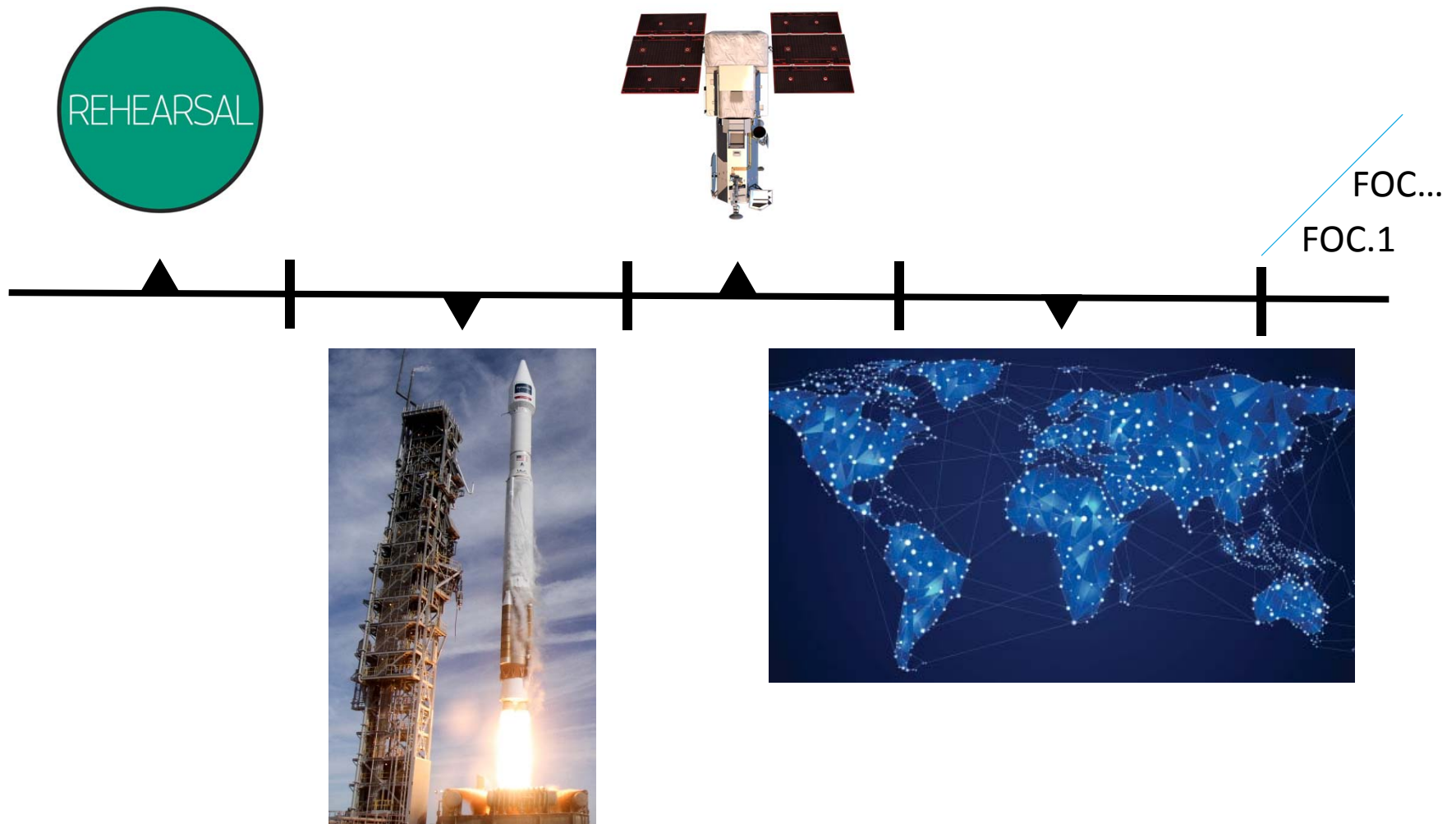
- Phase 5 – Initial Operations Capability



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 2π] radians: *If Mode is POSITION*
 - GimbalY – float [0 to $\pi/2$] radians: *If Mode is POSITION*

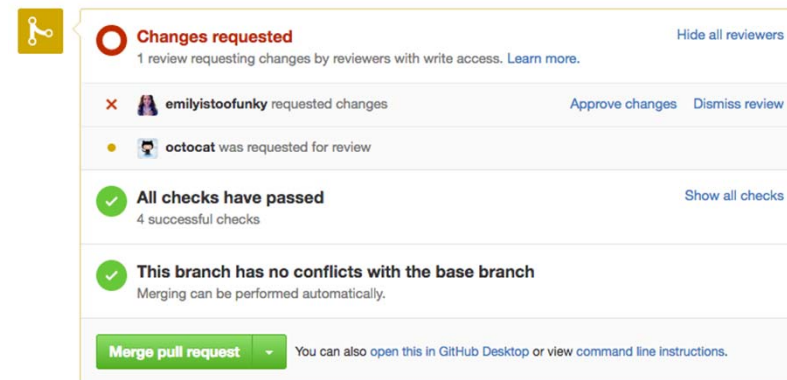
THEMIS Document Management Example



- Modify FOC version 1 parameters
 - New SCAN mode added



- Review new modifications
 - Built on GitHub

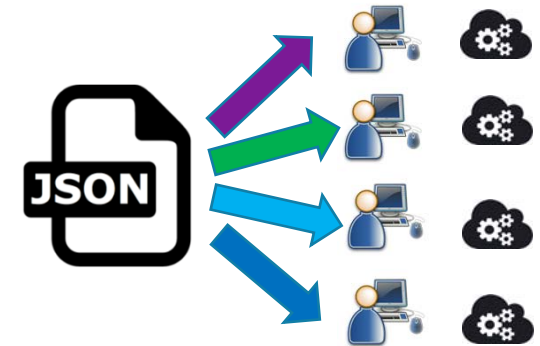


- Once reviewers approve, create new baseline

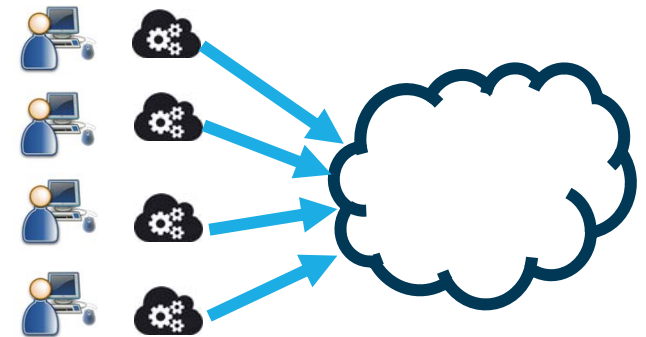
THEMIS Document Management Example



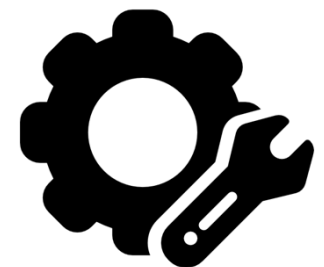
- Software teams ingest updated ICD



- Implement software updates



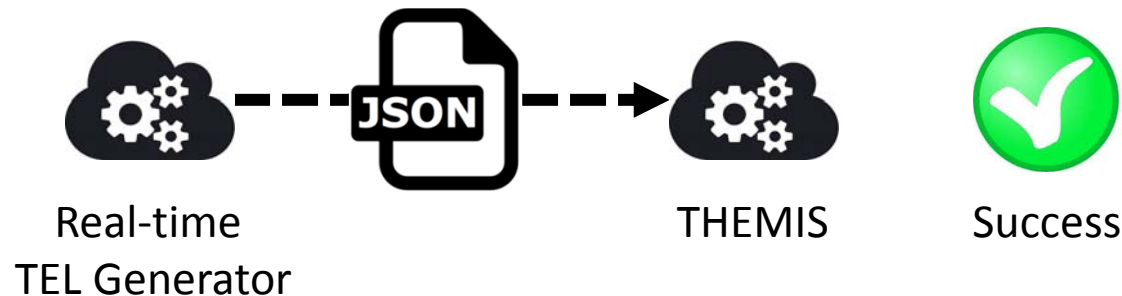
- Finally, update service level configuration



THEMIS Real-time Workflow Example



- THEMIS nominal workflow

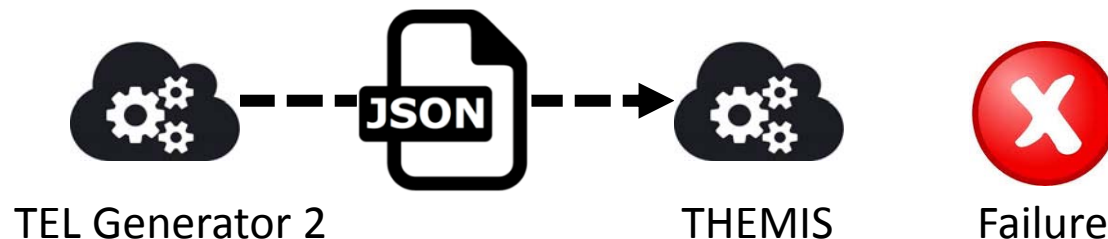


- Validate parameter types
- Validate range conditions
- Validate logic statements

THEMIS Integration Testing Example



- THEMIS non-nominal testing workflow
- Team 2 missed the gimbal conditional
 - GimbalX – float [0 to 2π] radians: *If Mode is POSITION*



- 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.

