Rapid Assembly, Integration and Test Demonstration

Interim Update

Mr. George Moretti

Capt Lisa Baghal

Mr. John DiPalma

Mr. Guy Robinson

Agenda

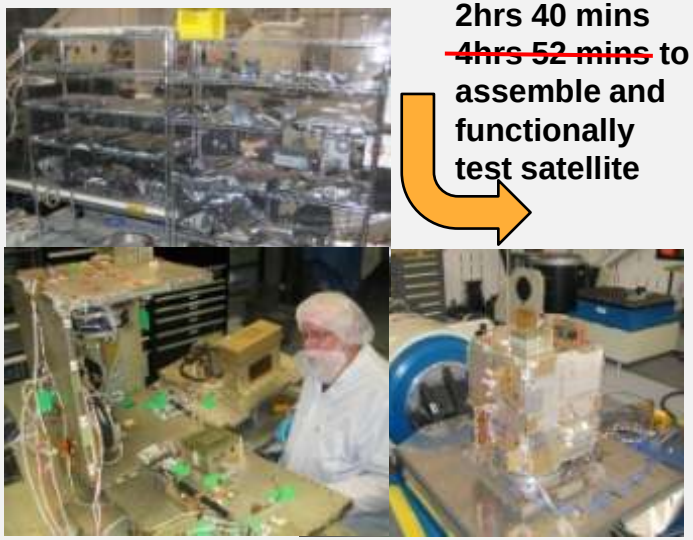
- Demonstration Overview
- Demonstration Status
  - Trial Summary
  - Test Data
  - Lessons Learned
  - Future Trials
- ORS Standard ICD Status
- Conclusions

Demonstration Overview

Rapid AI&T Mission

- Assured Space Power Focused on Timely Satisfaction of the Joint Force Commanders' Needs *- ORS OFFICE*

- **Objectives**
  - Demonstrate PnP Architecture in ORS mission
  - Identify level of maturity and issues with PnP Arch
  - Prototype a Rapid Response Space Works facility
    - Includes Launch, Ground, Ops, SV, Test, Logistics Cells



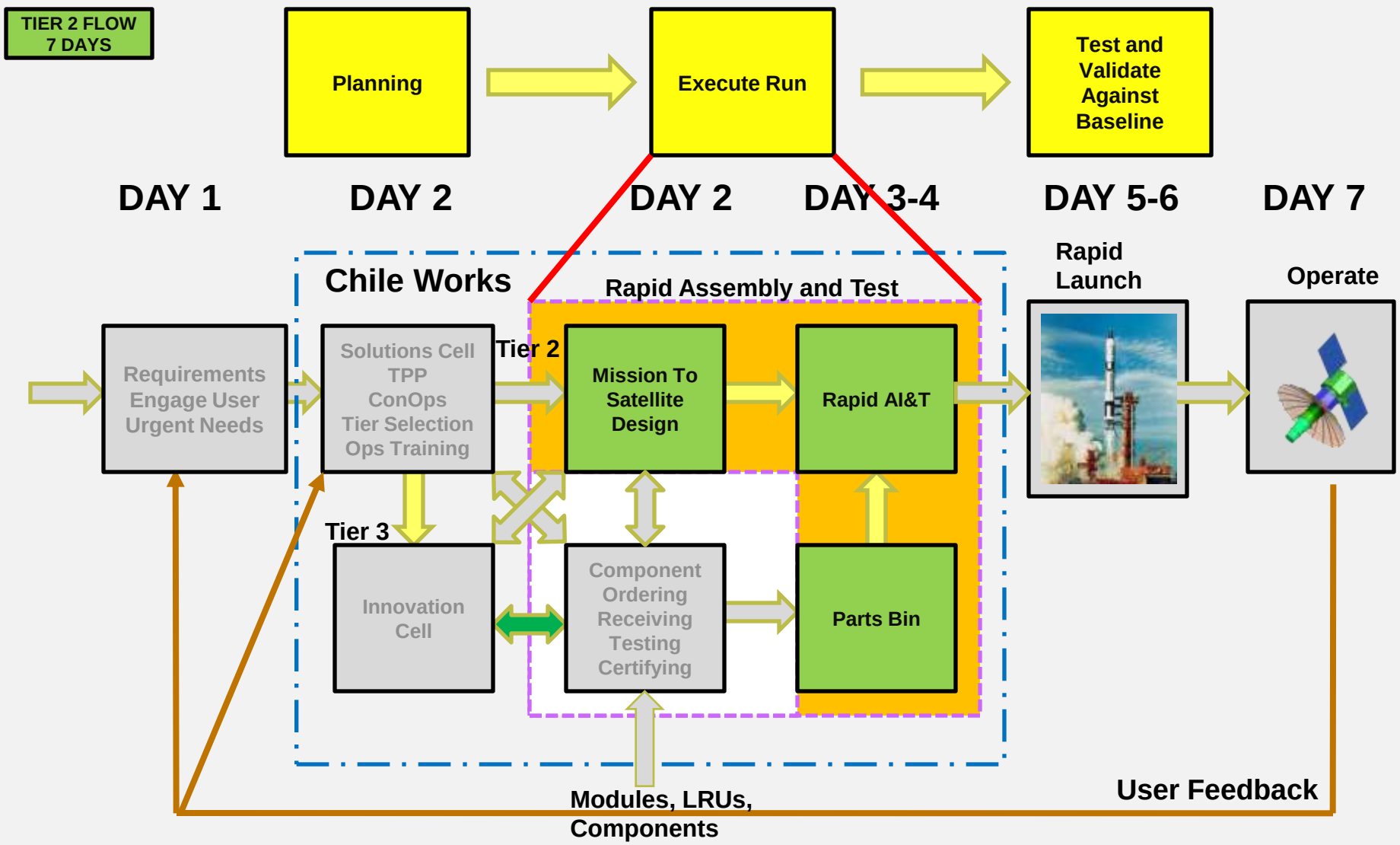
2hrs 40 mins ~~4hrs 52 mins~~ to assemble and functionally test satellite

- **Lessons to Learn**
  - Appropriate level of modularity
  - Effect of touch labor on reliability and how to minimize
  - Activities to front load
  - SPA--Reliability and suitability for depot personnel

4

Rapid AI&T Demos

- Assured Space Power Focused on Timely Satisfaction of the Joint Force Commanders' Needs *- ORS OFFICE*



Trial Flow

- Assured Space Power Focused on Timely Satisfaction of the Joint Force Commanders' Needs *- ORS OFFICE*

RUN	OBJECTIVE	COMMENT
1	INITIAL RAPID AI&T FLOW	"**Experts**" conduct the Rapid AI&T process with the "newbies" learning.
RS7	LIVE FOR RS7	WEBCAM, AUDIENCE PICK A MISSION; **5 people** on team; **experts** in lead role
2	ALL NEW PERSONNEL	The "**newbies**" will conduct the Rapid AI&T process with the "experts" monitoring. **3 people** on team.
3	NEW MISSION	Low inclination imager is now a sun-synch AIS imager. **Same Lego pieces-different layout**.
4	TIME TRIALS; S/W FLOW	TBD—variety of options exist based upon learning and gaps to date.

Demonstration Status

Trial Summary

Test Data

Lessons Learned

Future Plans

Examples From Industry

- **Lessons from Industry:**
  - Develop modular spacecraft design.
  - Standardize interfaces.
  - Automate functional tests to ensure repeatability and consistency.
  - Eliminate/reduce tests as confidence in AI&T process is built.
  - Test only functionality, rather than performance, in system-level tests.
  - Personnel should perform one operation to maintain proficiency.
  - Determine a threshold for likeness between Qualification and Flight Models.
  - Design facility to reduce hazardous and timely spacecraft movement operations, GSE movement, and cut time between operations.
  - Utilize on-line systems to control and catalog procedures, drawings, and test data.

Lessons Learned: Processes

- **Strict AI&T discipline must be enforced.**
  - Cover unused connectors (GSE and Flight HW), follow procedures, do not alter scripts or GSE setup without QA-approved redline (not verbal).
- **Configuration Control is a full-time job.**
  - Utilize inventory control SW
- **Number of personnel is not as critical as the correct mix of skill sets**
  - Personnel should be trained in specific areas of expertise and perform only those operations to maintain proficiency and have clearly defined roles.
- **Assembly and Test Procedure format requires investigation.**
  - Assembly drawing vs. assembly procedure
- **Determine contingency procedures** – troubleshoot vs. ignore vs. replace component vs. remove article from assembly line and start over.
- **Automated test scripts should be "Go/NoGo" type with adequate limit checking.**

Lessons Learned: Spacecraft

- **Design S/C and components for testability**
- **Use larger or captive fasteners on connectors**
- **Use Connector Keying whenever possible**
- **A variety of connector covers and cable lengths should be available in assembly facility.**
  - Should be included in parts list, like number/size of bolts, washers
- **Nothing should be Hard-Coded or Hand-Coded.**
  - Flight software should not be designed for a specific set of components or vehicle configuration
  - Solar Array orientation hard-coded in ADCS SW
  - Config Files do exist on PnPSat but are hand-coded
- **Thermal Blanket and Tape customization method is needed**
  - Utilized automated cutting table in Trial 3 – tapes cut in few hours, installed in fraction of time.
  - Some trade-off in coverage as shapes are simplified
  - Previously fabricated blankets used for all trials

Lessons Learned: GSE

- **For maximum flexibility, use adjustable GSE.**
  - RF test equipment should avoid the use of fixed attenuators or items tuned for specific frequencies.
- **Design Integration Stand for ease of assembly and with multiple functions.**
  - Measurement of vehicle mass and CG can be performed by a support stand with integrated load cells.
  - Integration Stand should provide adequate access to all panels, even the bottom.
- **Replacement/Spare GSE parts must be stocked/available**.
  - Assumption that common parts like computers will be available is false – updated PC hardware and software may not be compatible. (XP vs. Vista)
  - GSE should be regularly tested/inspected/calibrated.
  - Cover unused connectors to prevent failures.
- **Lifting interface should be standardized across ORS vehicles so that a standard lifting fixture could be designed with adjustable supports and leveling capabilities**

Lessons Learned: Facility

- **Test equipment should be located inside the clean room.**
- **Display procedures and drawings on monitors in clean room to eliminate paper and pen FOD.**
- **Facility power is critical:**
  - Accurate map of available circuits and ratings
  - Plan GSE load distribution to prevent tripping breakers
  - Power strips are not adequate without load distribution plan
- **Ensure software on all equipment is up to date and compatible.**
  - AFRL cutting table had old version of SolidWorks, recreated drawings to get tapes made within week.

Conclusions

Conclusions

- **Validated Rapid Assembly in Multiple Configurations.**
  - With proper GSE/Facility/Spacecraft design, AI&T timeline can be reduced.
  - PnP is a key enabler.
  - Standard Procedures = Repeatability and Consistency.
  - Right mix of skill sets is critical.
- **Building confidence in Rapid AI&T Test Suite.**
- **Valuable Lessons Learned have been documented for integration into future Chile Works contracts.**