Space Test Program Standard Interface Vehicle Lessons Learned (STP-SIV)

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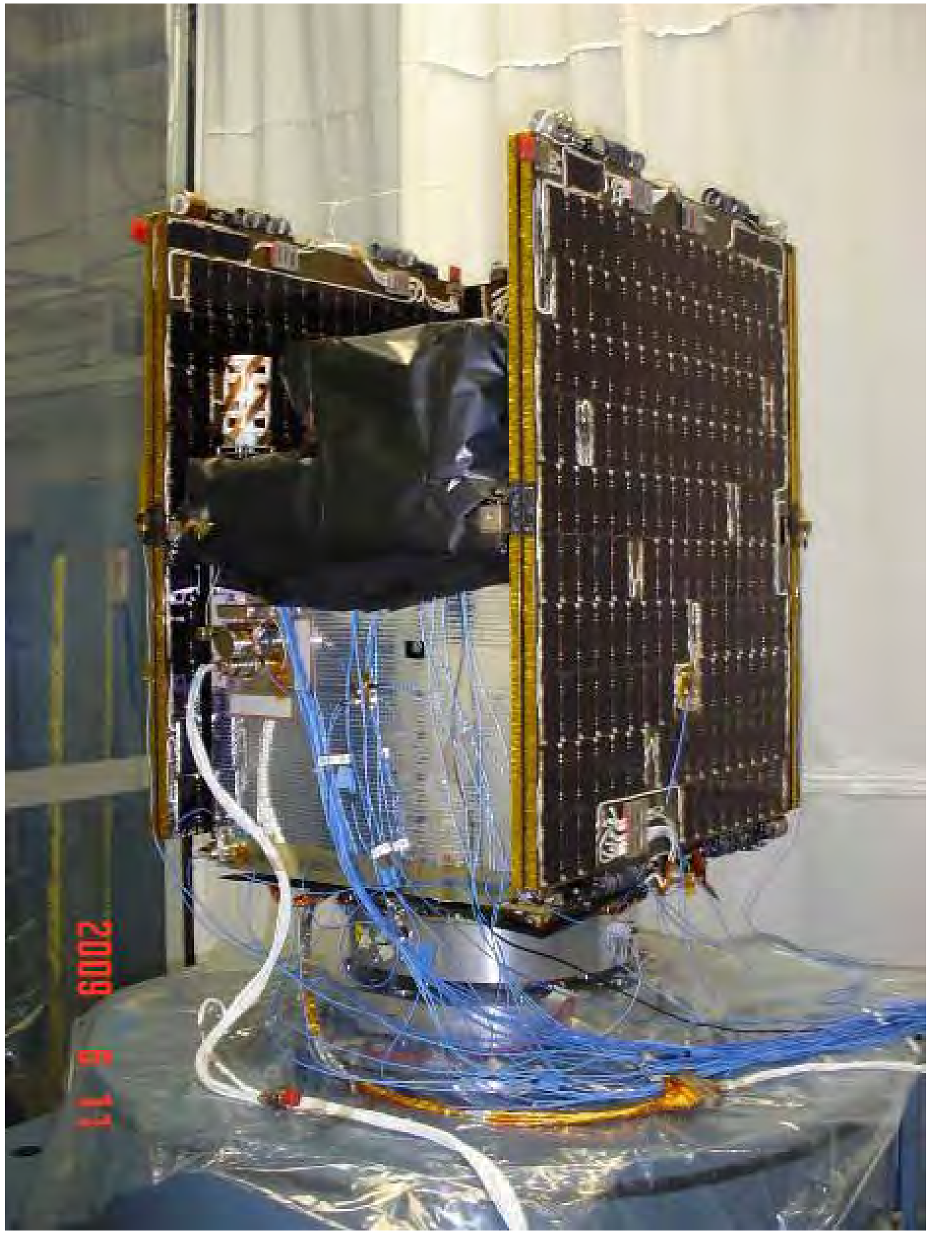
Common Instrument Interface Workshop -21 April 2011

One SIV Complete and Second Underway

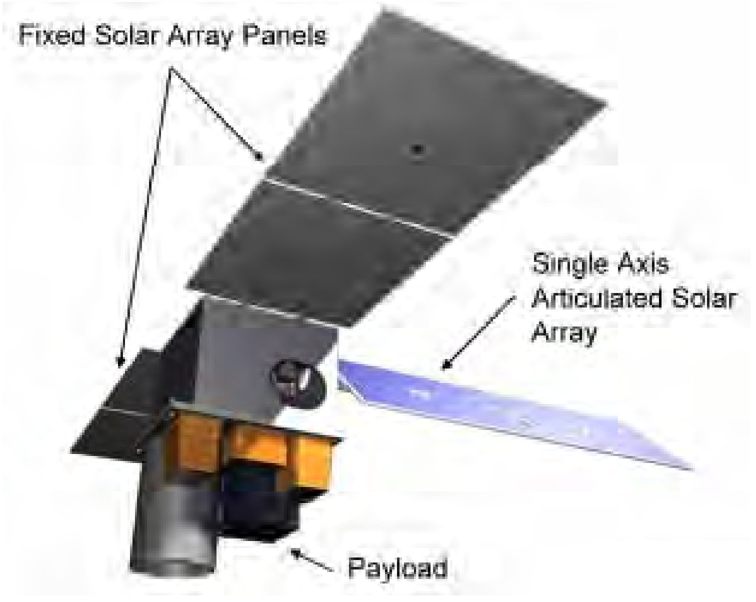


- Overview of SIV Capabilities
- Acquisition plan “as-envisioned vs. as-realized”
- System requirements, standards and risk posture
- Standardized interfaces enhance cost efficiency and responsiveness
- Economies of a standard spacecraft design
- Incorporation of lessons learned reaping benefits on second spacecraft

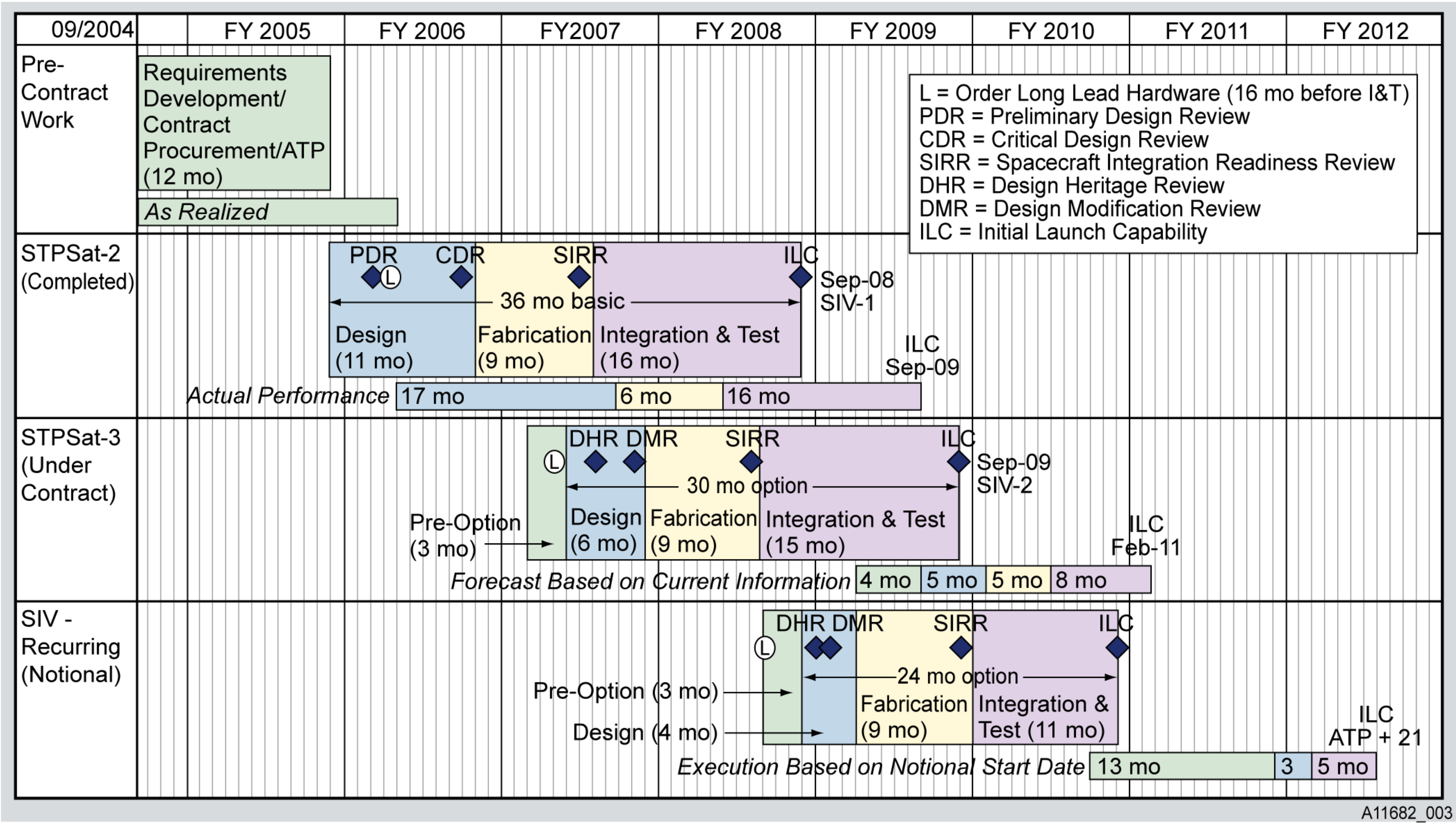
STP-SIV - Designed to Support Scientific, Technology Development and Risk-Reduction Missions

Spacecraft Parameter	SIV Capability
Orbit Altitude	400 – 850 km
Orbit Inclination	40° – 98.8°
Launch Mass	≤ 180 kg
SV Dimensions (cm)	60.9 x 71.1 x 96.5
SV Lifetime	1 year
Stabilization Method	3-axis
Pointing Modes	Nadir, Solar, Inertial
Attitude Knowledge	0.022° 3σ
Attitude Control	0.1° 3σ (nadir mode)
Bus Voltage	28 V ± 6 V
Comm Frequency	Secure SGLS
Command Rate	2 kbps uplink (via AFSCN)
Telemetry Rate	2 Mbps downlink (via AFSCN)

- Designed for a range of LEO orbits without design changes
- Standard payload-to-spacecraft interface for all experiments
- Compatible with a variety of launch vehicles including ESPA
- Designed/tested to rigorous requirements
  - compliant to MIL-STD-1540e
- IDIQ contract allows quick response - demonstrated <90-day turn-on with STPSat-3

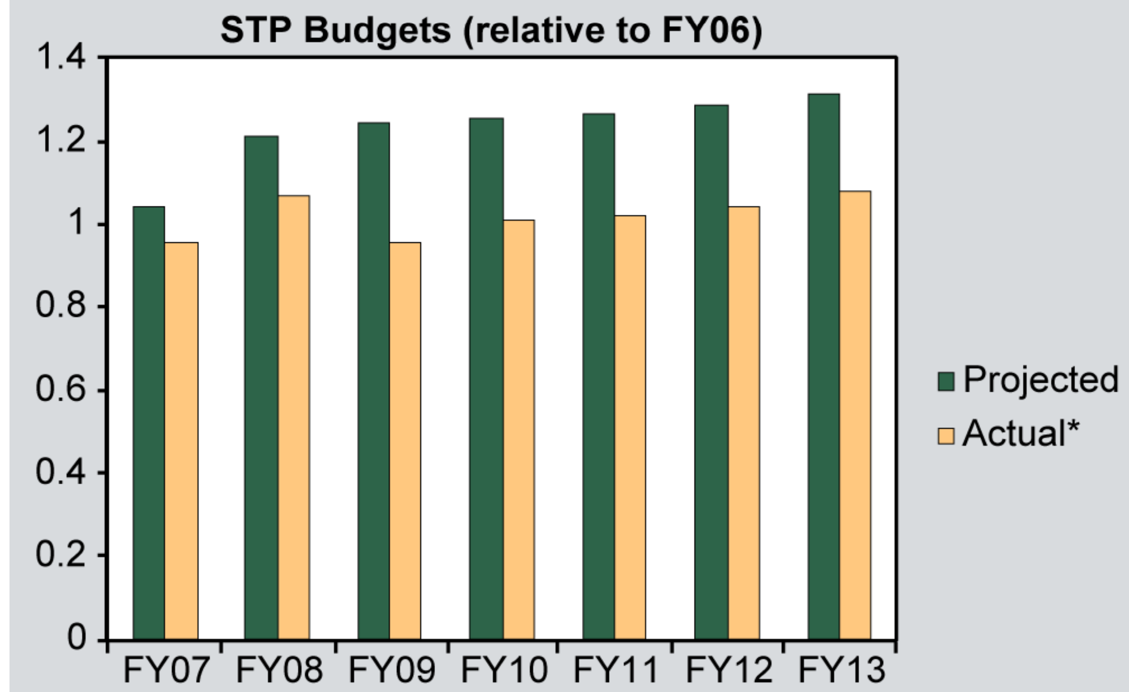


Acquisition Plan As-Planned vs. As-Envisioned



Second SIV Started 2 Years Later than Planned

- Reasons
  - Invalid budget assumptions
  - Cost growth and launch delays on other SDTD missions reduced available funding to start DO#2
  - Designing for wide range of missions and orbits and associated analysis more than designing for single mission affecting cost and schedule
  - Cost growth on Delivery Order (DO) #1
- Impacts
  - Cost growth on second set of components
  - Delayed realization of cost synergy between DOs
  - Benefit: ability to capitalize on I&T lessons learned



** For FY11 -13 "actual" represents the revised forecast following STP budget re-plan*

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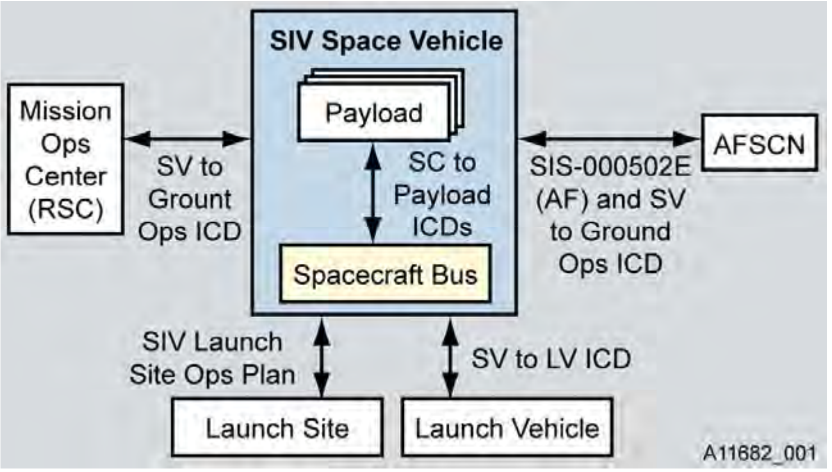
Achieving Common Understanding of Requirements and Risk Posture is Critical for Successful Program Execution

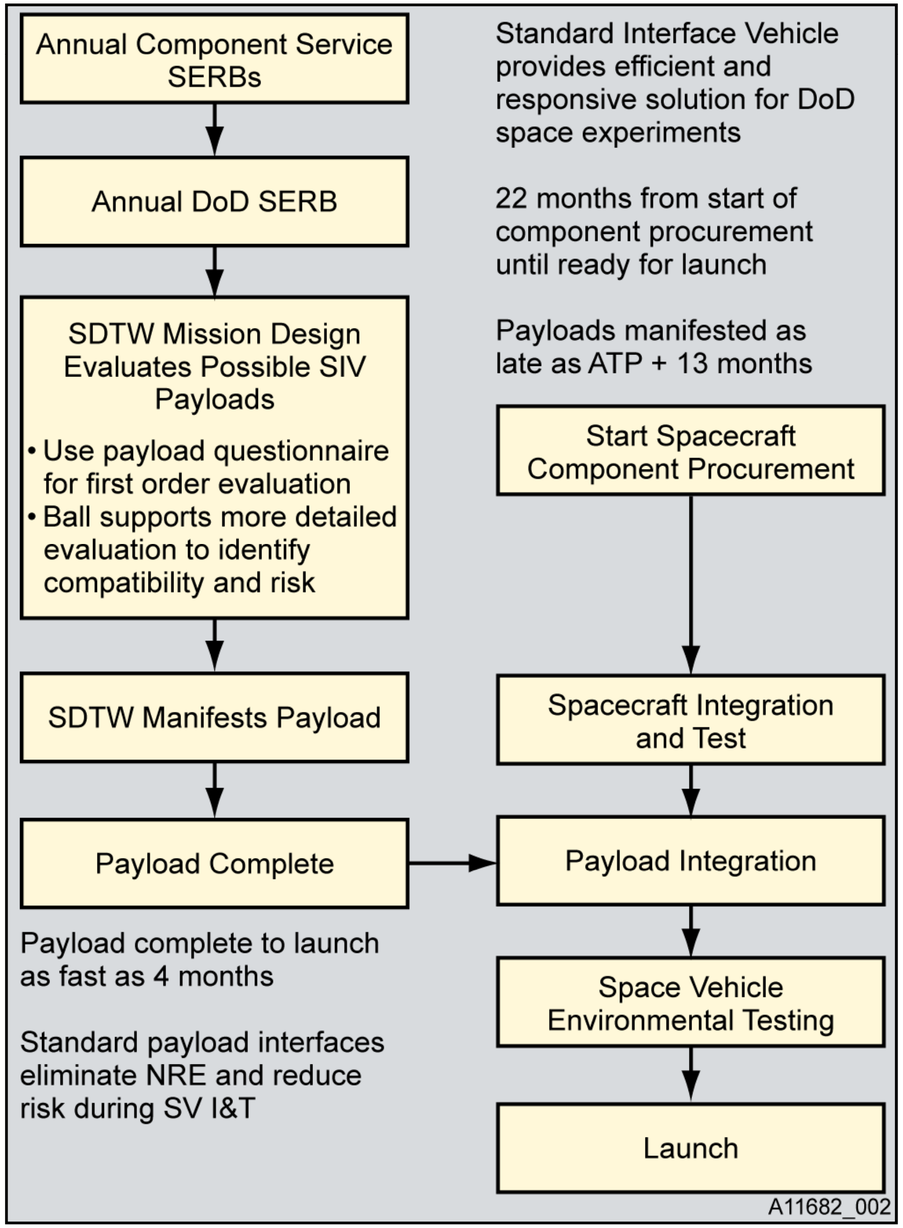
- Frequent communication regarding program requirements and risk evaluations is critical to keeping the program on cost and schedule
- In general, Technical Requirements Document was well defined with few TBDs
  - Thorough review of requirements at contract start resulted in numerous clarifications but few changes that affected proposed design
  - Communication allowed for some design simplification leading to cost reduction
    - Example: Elimination of deployed SGLS antenna
  - Some ambiguous language did provide challenges: 'tailoring consistent with Class C spacecraft'
    - Government and contractor had different expectations that led to non-trivial cost growth
- Risk tolerance challenging to quantify
  - Individual interpretation and experience influence interpretation of risk strategy
  - Ball included Air Force program office in risk board – still took over a year for both organizations to reconcile the other's vision for risk posture
- Lessons learned incorporated into plans and requirements for sustaining a product line that spans many years and multiple deliveries

STP-SIV Defined Standard Interfaces



- *Launch Vehicle Interface* – STP-SIV designed for multiple launch vehicles (Minotaur I, Minotaur IV, Pegasus, ESPA)
  - Powered off at launch minimizes required signal interfaces
  - Designed and tested to enveloping environments
- *AFSCN Interface* – Designed to SIS-00502
- *Mission Operations Complex Interface* – Multi-Mission SOC Ground Support Architecture (MMSOC-GSA)
  - Operating multiple missions on same ground system allows reuse of command and telemetry databases and operators are familiar with spacecraft operations
- *Payload Interface* – Most volatile of interfaces
  - Standardization maximizes SDTD's ability to manifest SERB payloads
  - Documented standard interface allows payloads to design prior to manifest decision

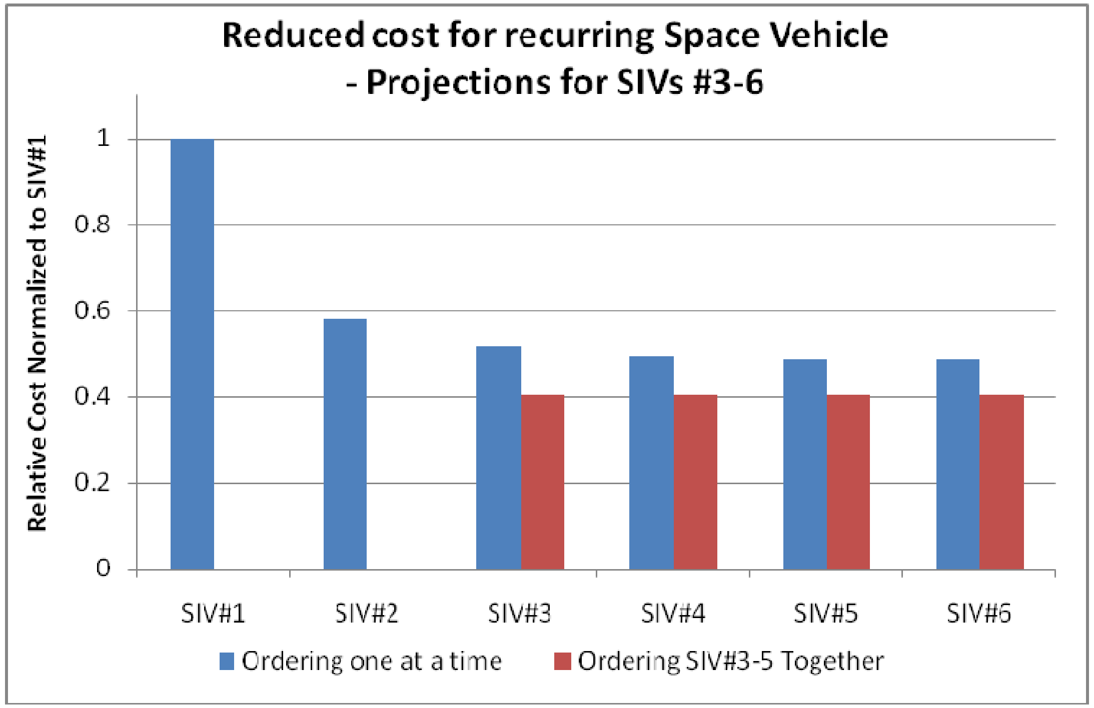
Standardization maximizes mission flexibility



- SDTD has more flexibility to respond to changing needs of the military
  - Space Experiment Review Board (SERB) annually prioritizes ~60 payloads
- Ability to leverage launch opportunities as they become available
- Payload manifest process can run in parallel with spacecraft integration
  - Minimizes Cost and Schedule for Space Vehicle Integration and Test
  - On STPSat-2, Navy's Ocean Data Telemetry Monitoring Link (ODTML) was added after CDR without spacecraft design changes
  - STPSat-3 components procured and heritage review complete prior to payload manifest
- Reduced risk and schedule at payload integration
  - Integrated 3 payloads on STPSat-2 in 4 days

Standard Design Provides Possibility of Significant Savings

- Cost drivers that can be mitigated for recurring vehicles include
  - spacecraft components acquisition
  - program timing and contract type selection
  - leveraging investment Non-Recurring Engineering
- Standardization allows for lower risk by using the same components
- Realizing maximum savings less straightforward
  - Minimizing changes maximizes reuse of procurement documents, design documentation, testing and reduces cost risk associated with late delivery (20% savings)
  - More significant savings can be realized through volume production (Up to 20% total program cost)
    - Supplier can capitalize on efficiencies – shared program resources, parts procurement, parallel processing
    - Volume purchases of standard vehicles could significantly improve program cost effectiveness, responsiveness to urgent mission needs, and total value to the government
- Both government and contractor need to emphasize limited change to realize savings



STPSat-3 Realizing Significant Savings with Procurement Strategy

- For a recurring spacecraft program, component procurement schedules typically drive the program I&T schedule
  - Typical components take up to one year to produce
  - Preparation for integration of recurring build is much shorter
- STP-SIV initiated long lead component production as a separate FFP program
  - Allows contractor to keep very limited staff to manage component procurement
  - FFP contract has fewer deliverables and simplified Earned Value (EVMS)
  - Government and contractor share savings generated with leaner program execution
- STP-SIV procured longest-lead components even further in advance
  - For $100K investment, purchased 5 ship sets of frequency dependent components and slip rings for solar array drive assembly
  - Cost and schedule savings through additional 2 months schedule reduction

Key Lessons Learned Are Successfully Being Applied on STPSat-3

- Establishing open communication and fostering an environment of mutual trust as a significant factor in controlling program cost
- Ensuring requirements and expectations are clearly established early in the program and captured to ensure continuity across normal staff transitions
- Establishing and enforcing standard interfaces to reap dividends in reduced NRE build-to-build, a compressed production schedule, and rapid response to changing defense priorities
- Seeking opportunities to purchase multiple components simultaneously and ordering targeted long lead elements in advance to reduce component procurement costs and schedules.

Manifesting Payloads on STP-SIV

- SDTD identifies candidate payloads for STP-SIV
  - DoD Prioritized PL list
  - Reimbursable PLs
- SDTD performs bundling study
  - Identify payloads with compatible mission reqts
- BATC performs more detailed compatibility study
  - Payload to SC
  - Payload to payload
  - Verifies Payload Suite within SC design limits
  - Identify potential mission risk
- Memorandum of Agreement between SDTD and PL
- Signed Space Flight Plan
- For More Information
  - stp@kirtland.af.mil