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# **Advanced Space-Based Testbed (XST): “On the Shoulders of Giants”**

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# XST Concept Overview

- **Motivation (EPIC SPEED to increase Developmental Test (DT))**
- **Background (Numerous demands for speed & improvement)**
- **Concept (Improve DT)**
- **Concurrent Concept Development Mechanics**
- **Way ahead**
  - **Leverage existing technology, on-going S&T in-Space Assembly (iSA) Space Forum discussions Nov 6-7 '18**
  - **Provide link to immediately on ramp concepts & provide new strategic thinking pathfinders**



# Motivation: SMC 2.0 EPIC SPEED

SPACE AND MISSILE SYSTEMS CENTER



## Enterprise

- Shared vision & strategy
- Resilient, multi-layered architectures & infrastructure services
- Ability to dynamically reallocate resources



## Partnerships

- A wide network of suppliers including both traditional & innovative start-ups
- Collaboration with Inter-agency & international allies to share costs, move faster, & improve capability



## Innovation

- **A culture that encourages fast-failure & fast-learning**
- **Balanced portfolio providing incremental improvement & opportunities for innovation**
- **Strategic innovative investments in high pay-off tech & game-changing capabilities**



## Culture

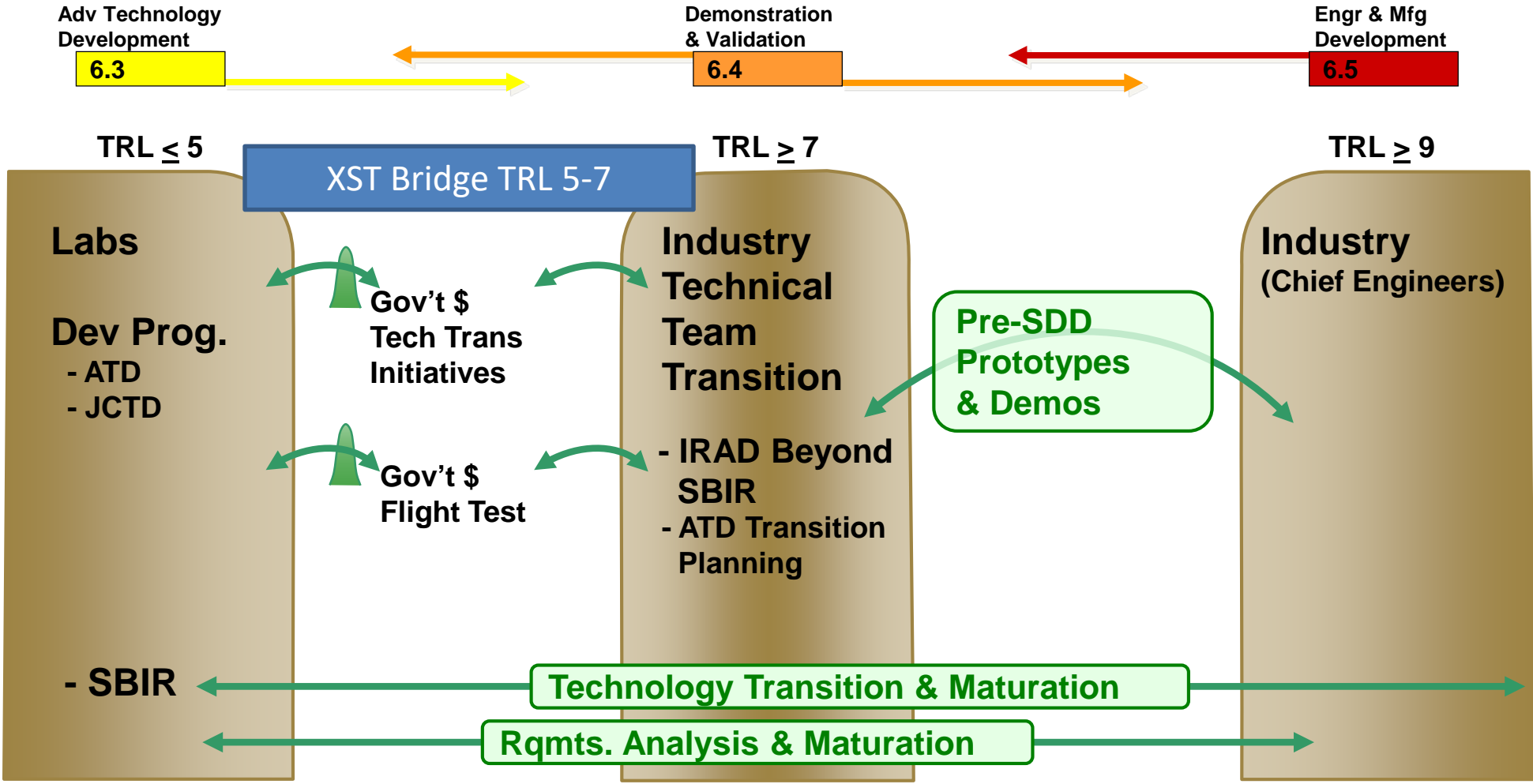
- Mission-focused, motivated, knowledgeable, & empowered workforce
- A culture of risk-taking & continuous improvement
- Talent management system designed to develop leaders, empower teams, and reward performance



## SPEED

- Increase decision-making velocity with flatter organization & delegated authorities
- Streamlined processes, documentation & reviews tailored for the acquisition strategy

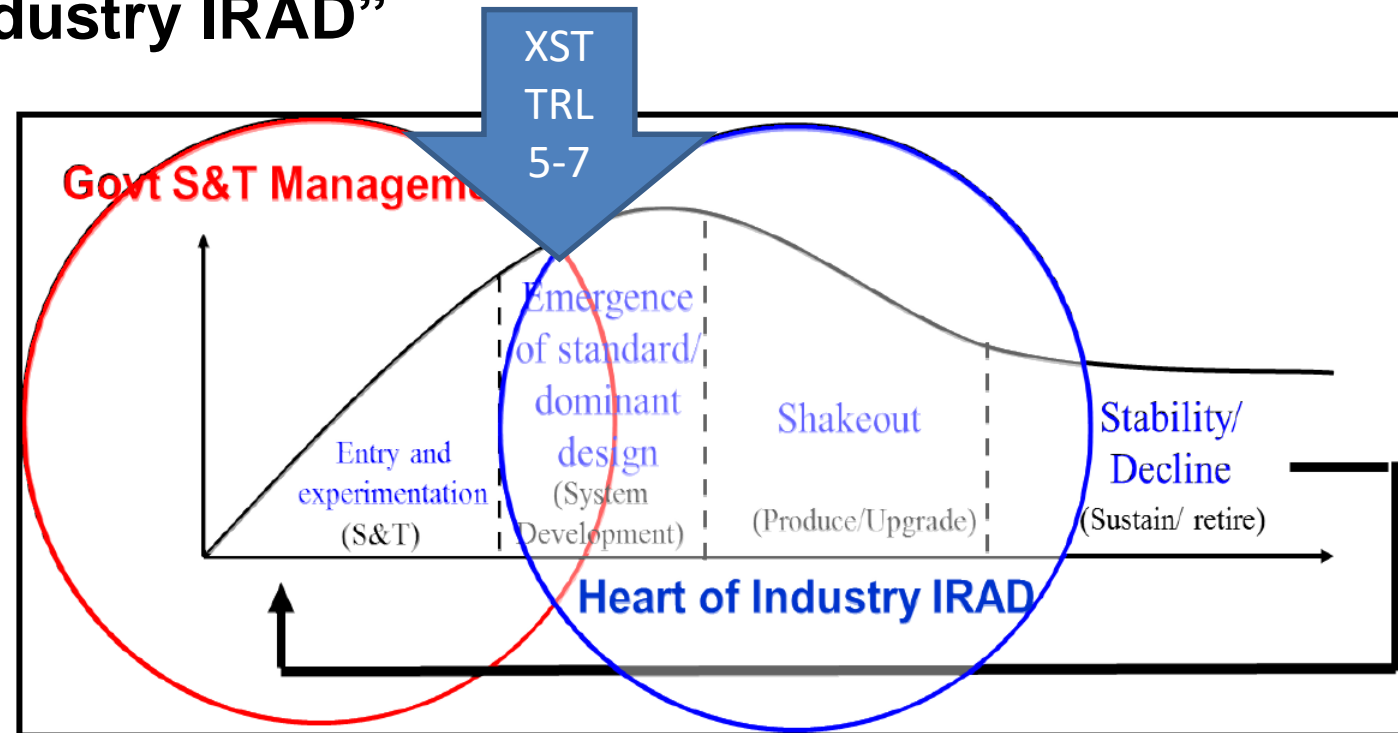
# Background: Integrated Technology Transition



**Build Better Transition Capabilities & Processes to Mitigate Technology Transition "Valley of Death"**

# IRAD “S” Curve & the XST

- Key to appropriately overlapping the Government “S&T Management” with the “Heart of the Industry IRAD”



- Coordinate existing efforts & programs (e.g., SBIR/SB Tech Transfer, University Research, Rapid Innovation Fund, DoD Tech Transfer, Commercialization Readiness, etc.)
- Leverage these programs in conjunction with IRAD

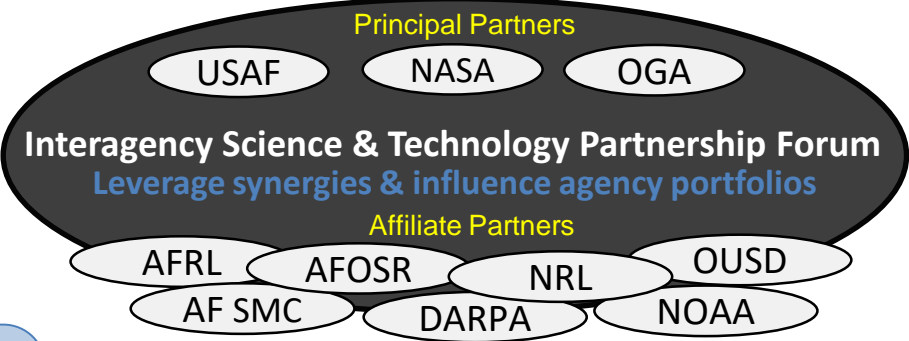
# Space Science & Technology (S&T) Partnership Forum: Introduction

- Introduction
- In-Space Assembly
- S&T Partnership Forum**
- Value Proposition
- Strategic Framework
- Stakeholder Goals & Design Drivers
- Capability Needs
- Conclusions

Allow large, persistent space assets to be assembled & routinely upgraded in space

Transform space operations capabilities with economic & performance benefits for both U.S. Government & commercial space endeavors

The Space S&T Partnership Forum is a strategic forum established in 2015 to identify synergistic efforts & technologies.



The S&T Partnership Forum has identified & prioritized pervasive goals (collaboration topic areas) that focus on key game-changing technologies across government space

- Other Topics
- Small Satellite Technology
  - Big Data Analytics
  - Cybersecurity

1. Facilitate cross-agency collaboration & strategize on technical solutions to common pervasive needs
2. Maintain awareness of each agency's space S&T investments to reduce duplication & identify areas worthy of collaboration
3. Identify impediments to collaboration & formulate solutions

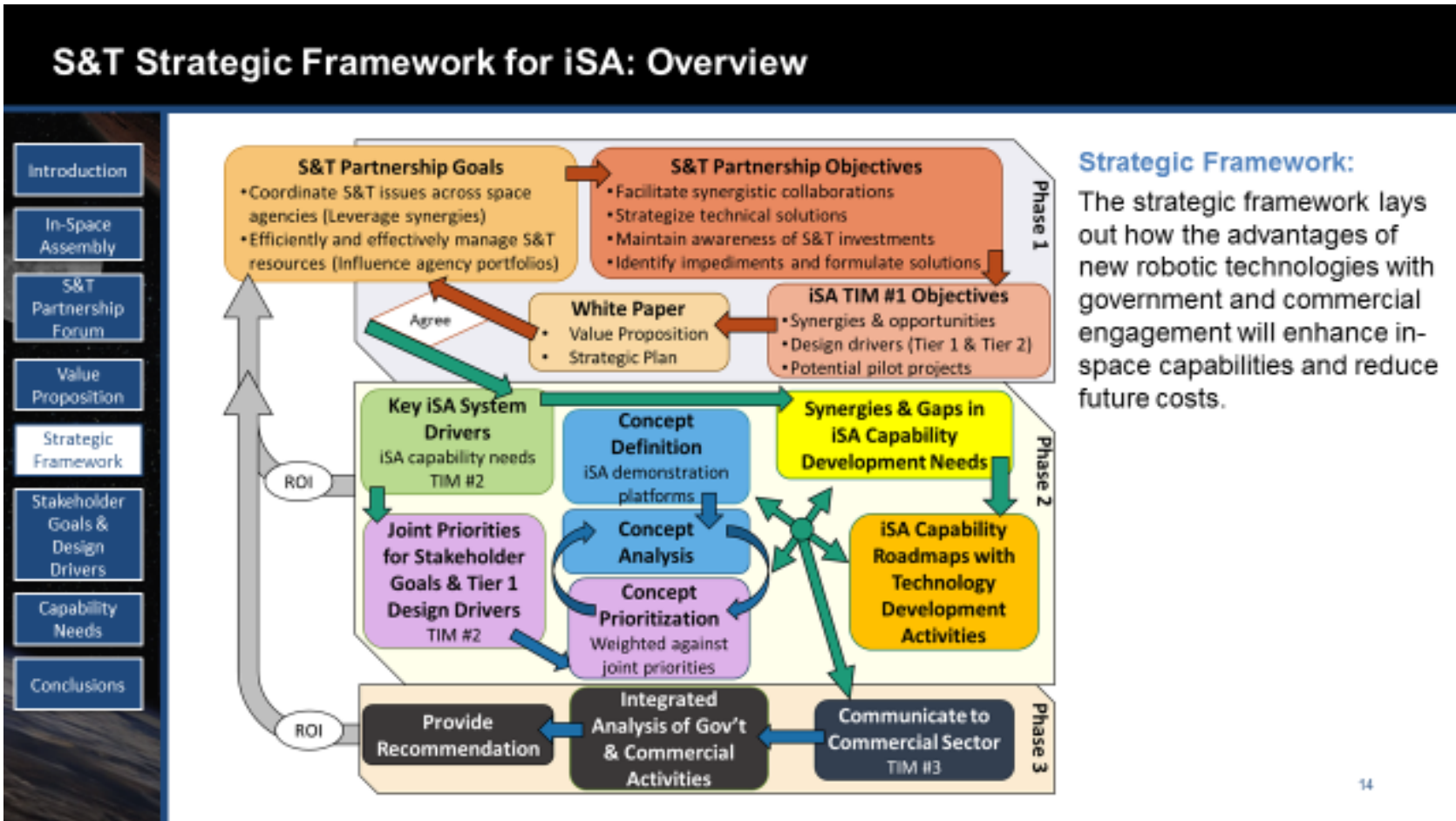
In-Space Assembly

**Aim to identify cross-cutting applications & benefits of developing a robust iSA capability for future space assets**

# Under NASA iSA Analytics

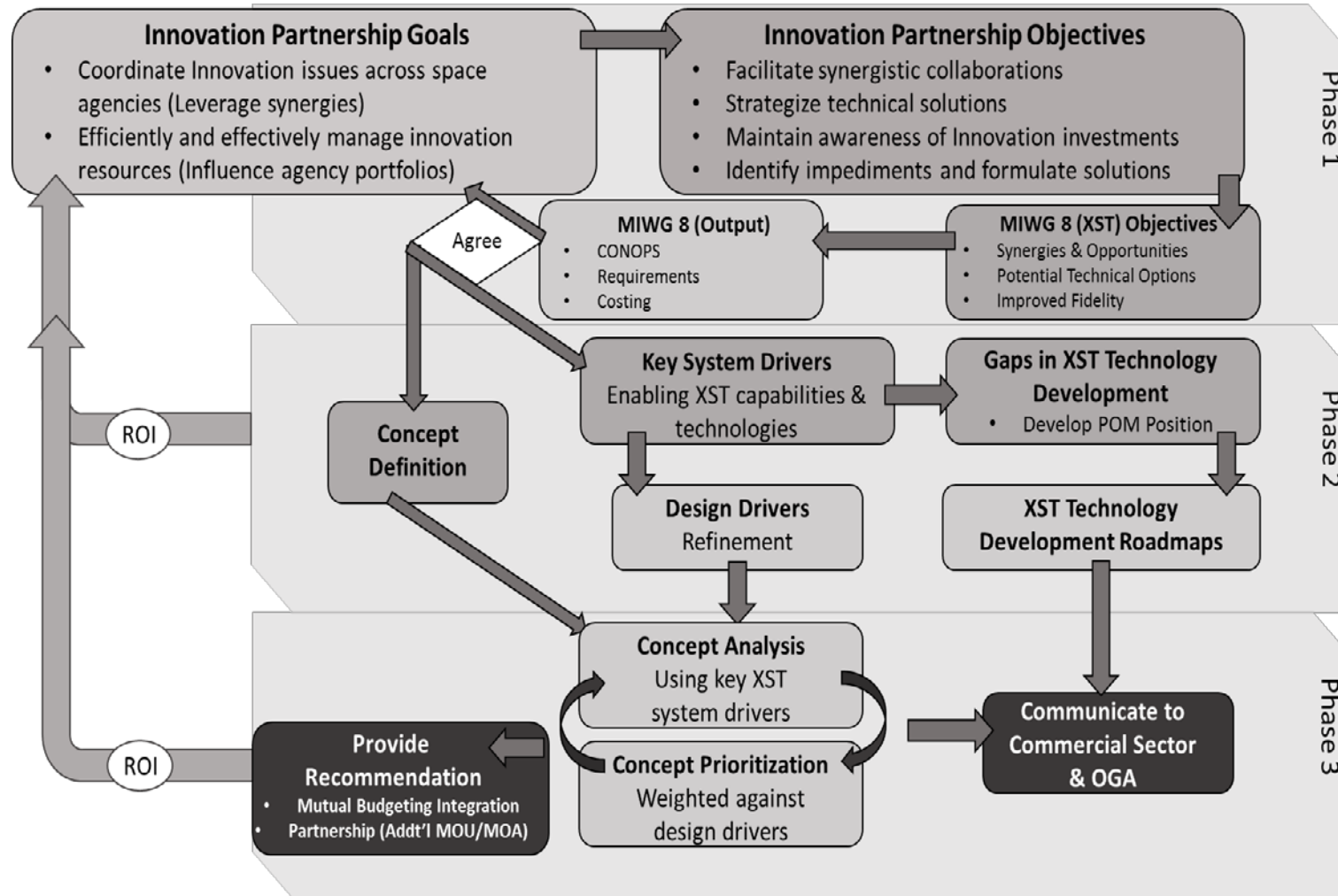
- **Four Concepts were considered:**
  - **Space Logistics (key enabler – short-mid term emphasis with a family of technologies & program options)**
  - **Developmental Test (key enabler – short-mid term emphasis for S&T pervasive technologies)**
  - **Space Power (mid-long term emphasis)**
  - **Space Situation Awareness (short term emphasis)**
- **These were scored along with the other S&T Partnership concepts**
- **What follows is the description of the analytics & the way ahead for one of those:**
  - **Developmental Test: Advanced Space-Based Testbed (XST)**

# iSA Framework is Multi-Purpose





# Modified iSA Flow for XST Use





# Concept: “Advanced Space-Based Testbed (XST)”

- Devise an in-space (orbital) facility primarily for DT but allow options for:
  - Joint/Cross Agency T&E
    - **Collaboration** improves cost effectiveness
  - Operational T&E
    - Can be an off-ramp
  - **Pervasive S&T**
    - Rapidly leverage 6.1-6.3 (into field faster using 6.4)



# Concept: “Advanced Space-Based Testbed (XST) (cont)

- **Technology from Industry (IRAD, CRADA)**
  - **Move development from primarily industry to industry & gov’t**
  - **Better understand the intellectual property & data rights**
  - **Improve requirements generation/refinement earlier & concurrently**
  - **Shortest path to Operational Test & Evaluation (OTE)**
- **Training**
  - **Government personnel need hands-on knowledge**
  - **Operational logistics & operational training on new technologies**

# What is XST

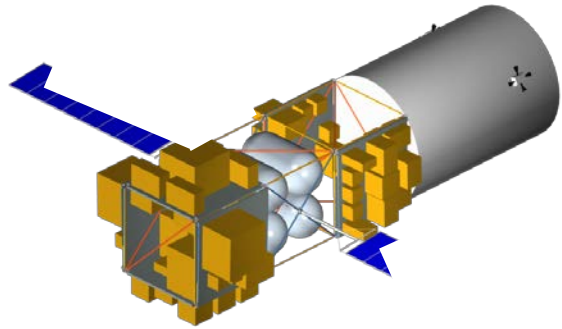
- **This T&E platform vision will be:**
  - **Partially or fully autonomous assembly with space robotics utilizing iSA techniques**
  - **Serviceable & persist over a long-lifetime**
    - **XST subsystems, assemblies, units, & test articles can be added, subtracted, & reconfigured**
    - **Maintain positive attitude control, electrical power, & thermal control margins**
  - **Operate at LEO, possibly sun synchronous – trade analysis based on set of test candidates**

# What is XST (cont)

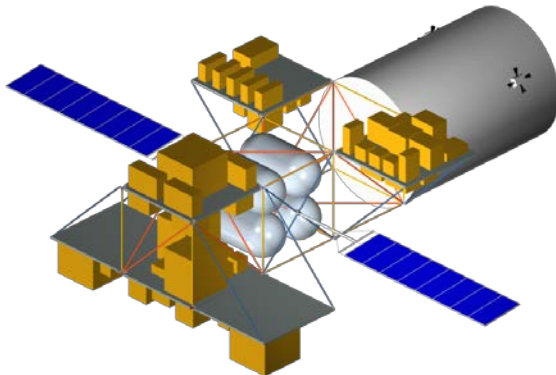
- **The XST will employ a set of Standardized-User Defined Adapters (UDAs) to interface the test items to the test platform.**
  - **These UDAs can accommodate a variety of user test articles, test equipment and/or demo hardware.**
  - **In turn, the UDA will be integrated to the XST structure using autonomous, dexterous robotic space vehicle systems.**
- **Initially, NASA Structure is free flyer w/ potential for expansion; uses iSA to modify structure & to reconfigure test candidates & XST modular assemblies**

# Possible Design For “XST”

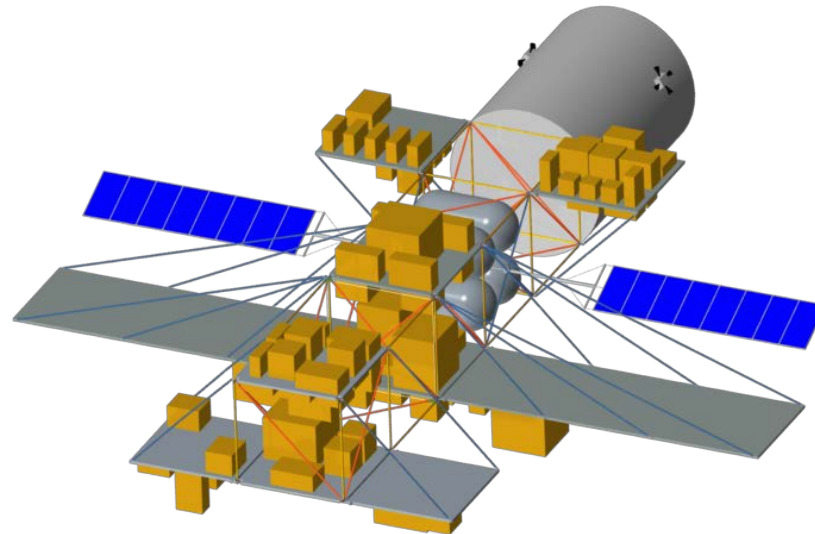
## NASA Structure Packaged for Launch



## Deployed



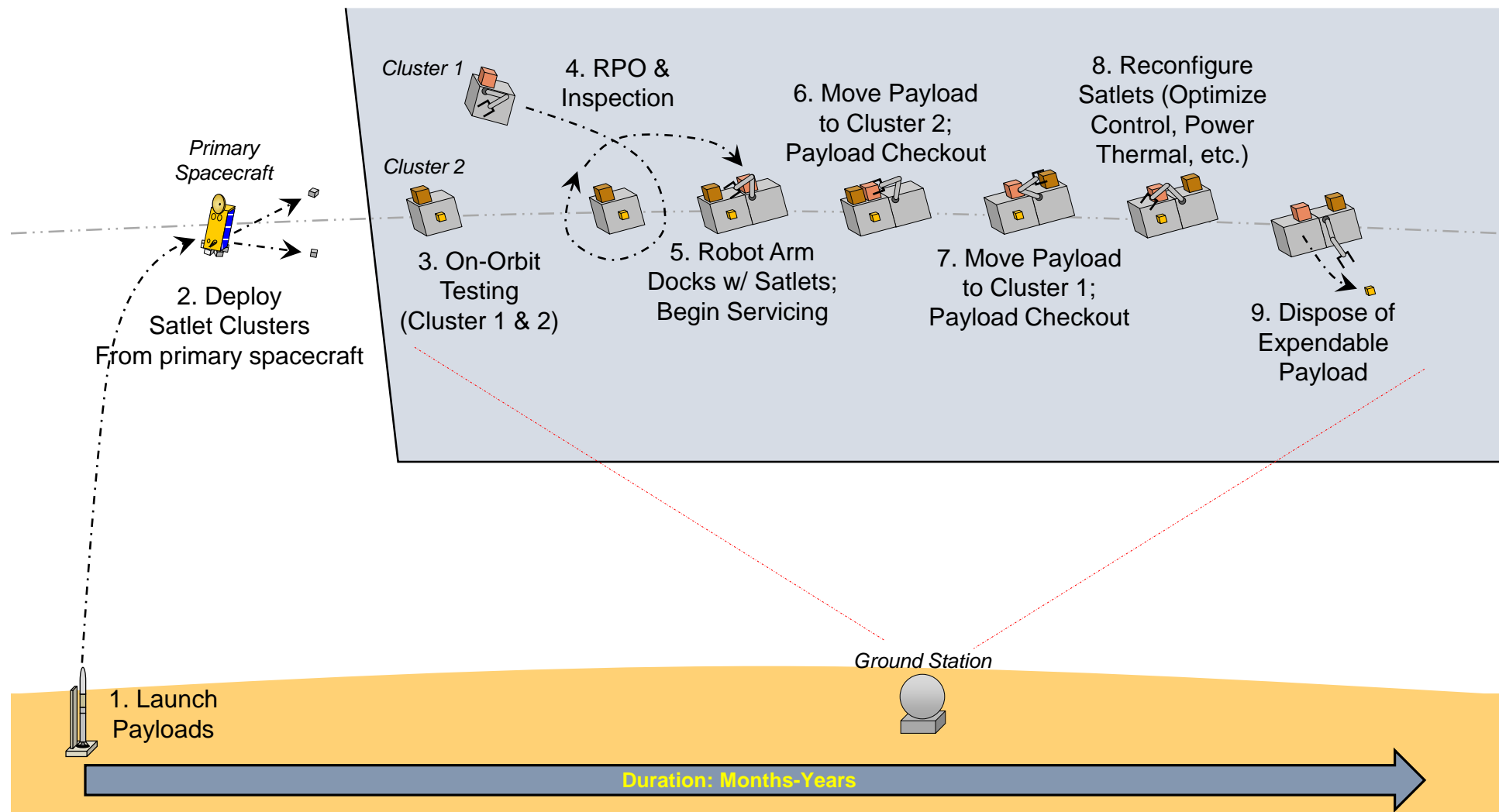
- Basic NASA structure-using iSM, iSA, & iSS (i.e. Restore-L) to:
  - Add Instrumentation/Communication
  - Add ADCS
  - Add UDA points for test candidates/eqt/etc.
- Logistics brings new test candidates & modular assemblies to XST



# Mini-XST Demonstration for the Near Term

- **Configure two separate satlet clusters;**
  - **Cluster #1 will be a freeflyer & accommodate a couple of test articles/payloads**
    - **One of those payloads will be a tele-robotically operated dexterous robotic arm**
  - **Cluster #2 will be a freeflyer & accommodate a couple of test articles**
    - **One of the other two payloads – long-duration testing > 1 year**
    - **One of the other two payloads – short-term & disposable via subsequent release**
- **Perform rendezvous proximity operations, docking, robotically remove, move, & install test articles**

# Mini-XST Demonstration OV-1





# Conclusion

- **Need to accelerate Space Acquisition**
- **One way to increase acquisition speed is to enhance/increase DT**
- **XST concept could rapidly provide that DT**
- **S&T iSA Space Partnership Forum collaboration can lower cost**
- **Create a broad based platform/facility for energizing rapid space improvements**
  - **Large NRE already paid**
  - **Mini-XST Demonstration possible 2-3 years**

# Key Reference Documents

- **SMC Orbital/Sub-Orbital Hazards & Debris Mitigation User's Handbook**
- **NASA-HANDBOOK 8719.14 "Handbook for Limiting Orbital Debris 2018-04-10**
- **NASA-STD-8719.14A Process for Limiting Orbital Debris 2011-12-08**
- **Space Debris Mitigation Standard, NASDA-STD-18, March 28, 1996**
- **U.S. Government Orbital Debris Mitigation Standard Practices, Dec 2000**
- **SMC Standard SMC-S-015 (2010) - Disposal of GEO Satellite**
- **Open Mission System/Universal Command & Control Interface (OMS/UCI) standard, & Modular Open Systems Approach (MOSA)**
- **Digital Engineering (DE) Strategy, Department of Defense (DoD), June 2018 – DoD DE page (reference):**  
[https://www.acq.osd.mil/se/initiatives/init\\_de\\_pol.html](https://www.acq.osd.mil/se/initiatives/init_de_pol.html)
- **Multiple AIAA Papers at SPACE 2018 on iSA (Erica Rodgers, et al.)**
- **Ewart, R., Betser, J. “Innovation Strategies: Maximizing Payoff of Industry Research & Development Investments for National Security Space”, AIAA Space Conference & Exposition, 2015. 4473**