Balancing Performance, Quality and Cost in Commercial Space

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Agenda

- Program Overview & Status

- Balancing Performance, Quality and Cost in Commercial Space
  - Internal Approach: Design > Test > Shipment
  - External Approach: Managing the Supply Chain
  - The Balance
  - New Supplier Growth
  - The Future

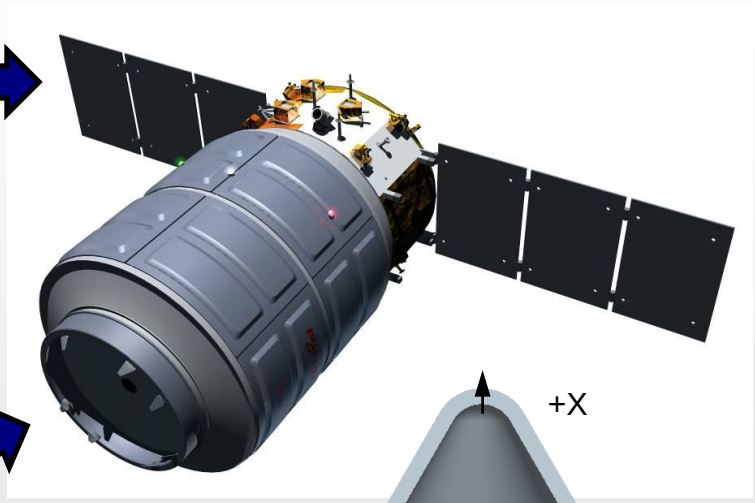
- Summary

Cygnus Program Overview

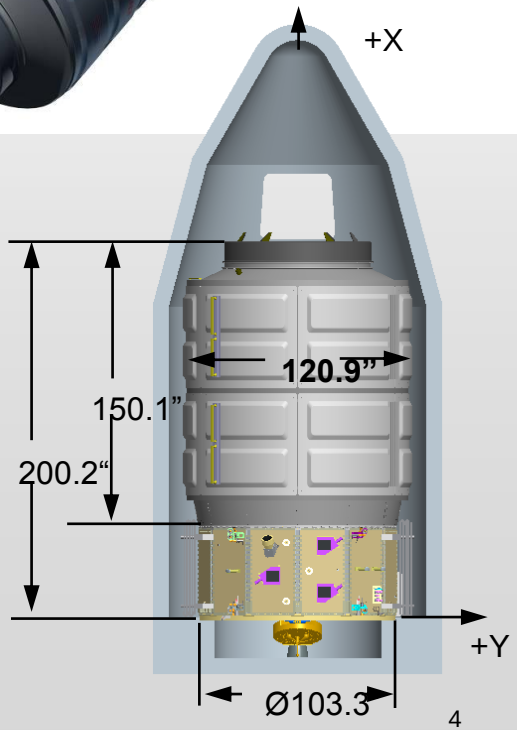
Cygnus Overview

- **The Cygnus vehicle is comprised of two major modules -**

- **Service Module (SM)**
  - Heritage: Orbital GEO and LEO missions
  - Power Generation: 2 Fixed Wing Solar Arrays,
  - Power Output: 3.5 kW (sun-pointed)
  - Propellant: Dual-mode
  - Compatible with Antares

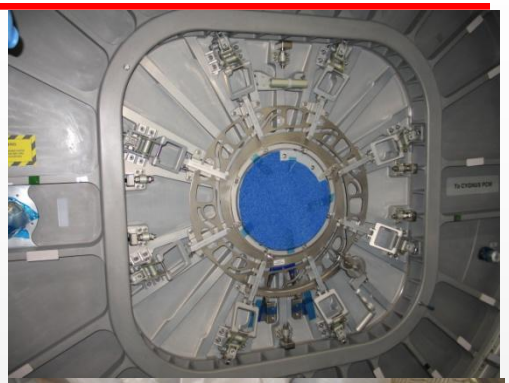


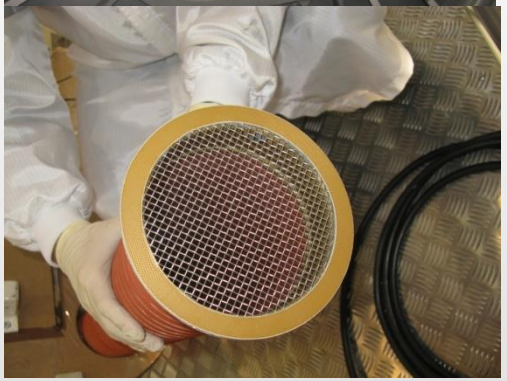
- **Pressurized Cargo Module (PCM)**
  - Heritage: Multi-Purpose Logistics Module (ISS); ATV
  - Total Payload Mass: 2,000 kg, 2700 kg
  - Pressurized Volume: 18.7 m3, 27 m3
  - Berthing at ISS: Node 2 Common Berthing Mechanism

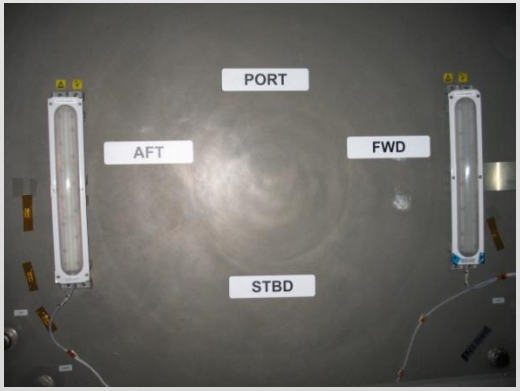


Pressurized Cargo Module (PCM)

- PCM features for operability
  - A 37 inch square hatch; similar but smaller than the ISS 50 inch square hatch.
  - Cargo stowed using simple cargo straps
  - Minimal secondary structure connected using pip pins and bolts
  - Ventilation provided by flexible duct deployed through the hatch. Duct has screen to prevent ingress of large items. Ventilation meets NASA requirements for airflow
  - LED lighting provides ample illumination for crew operations



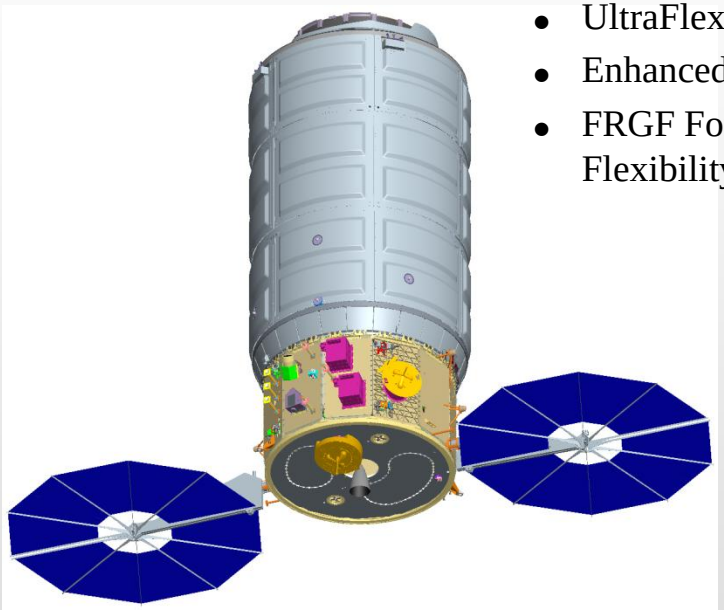




Enhanced Cygnus

Standard Cygnus

Enhanced Cygnus

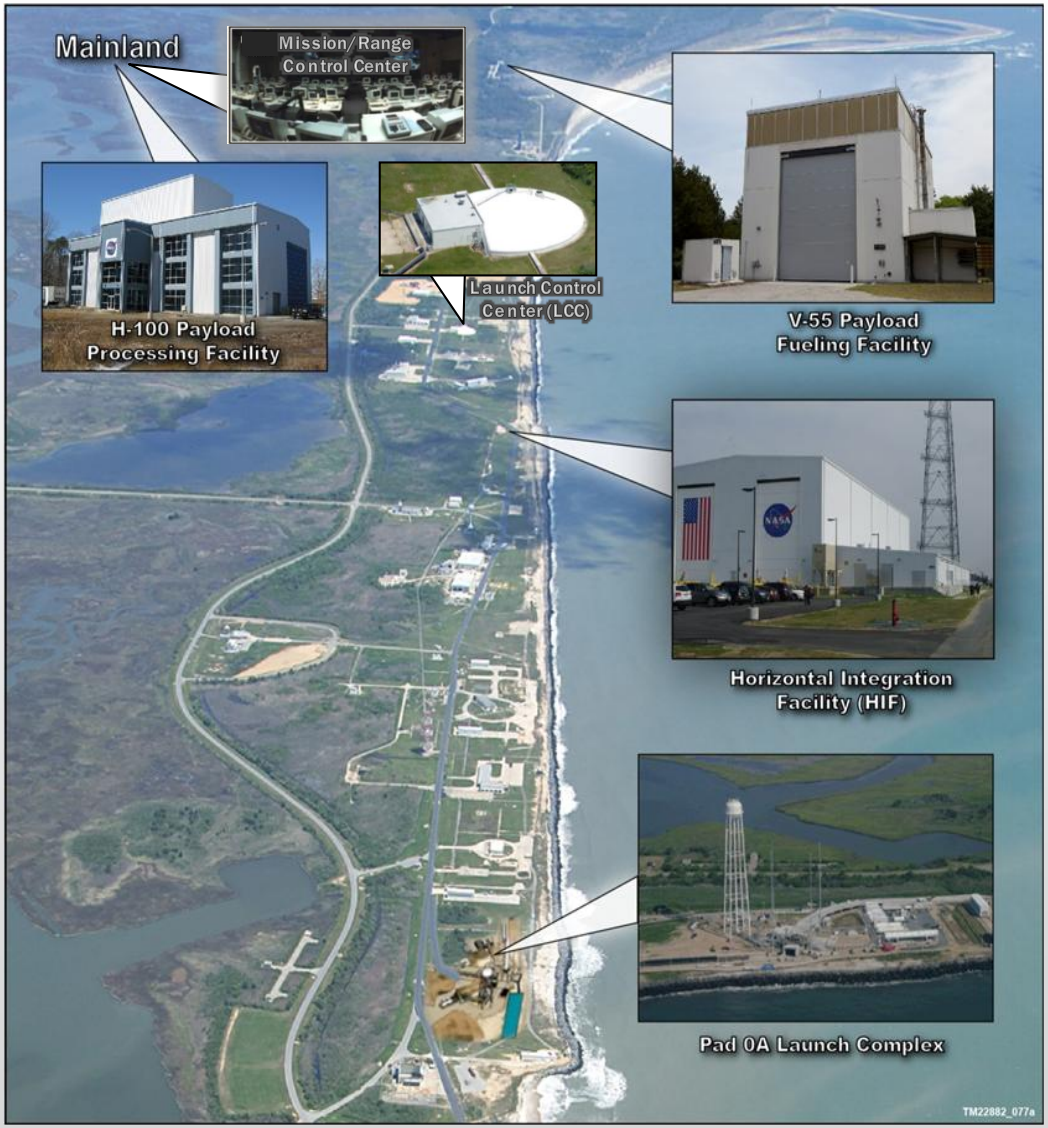


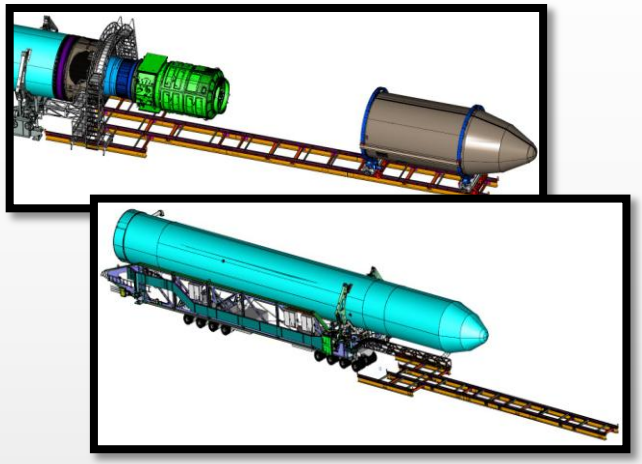
- Redesigned Structure
- UltraFlex Solar Array
- Enhanced PCM
- FRGF For Berthing Flexibility

- Cygnus Will Implement A Larger PCM and Design Improvements To Achieve Significant Increase In Cargo Mass Capability
- Changes Will Be Implemented On Orb-4 Through Orb-8

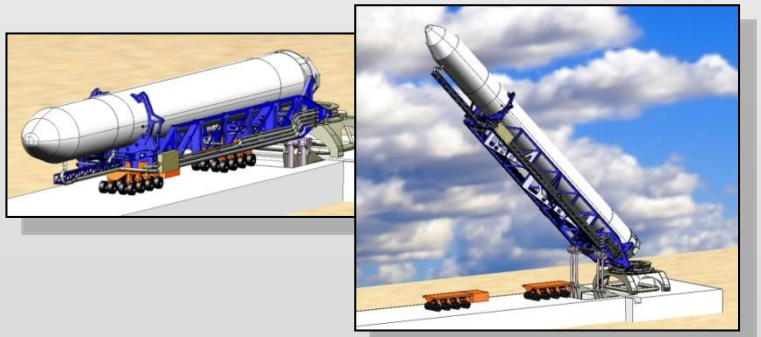
Cygnus Service Modules for Demo and 1st Operational Mission at Dulles VA

Antares Wallops Launch Site & Operations





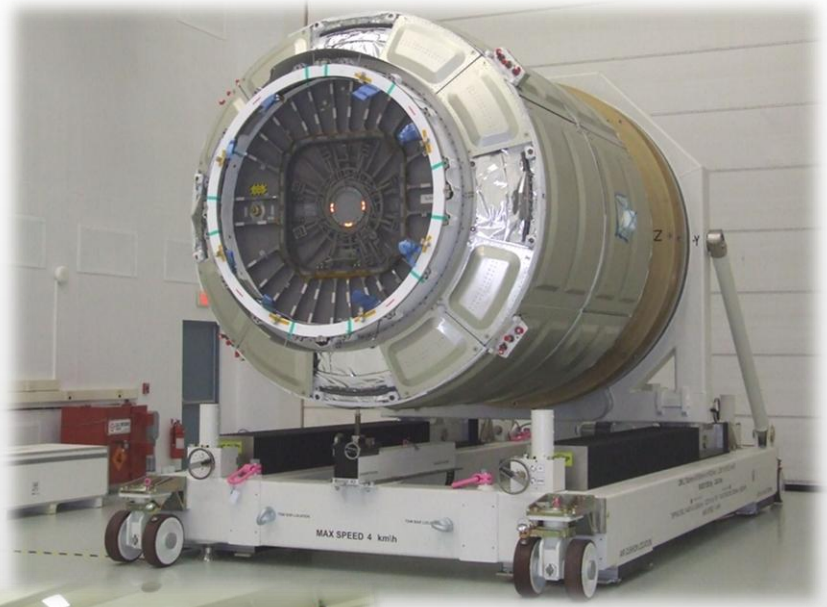
Horizontal Integration for Efficient Processing



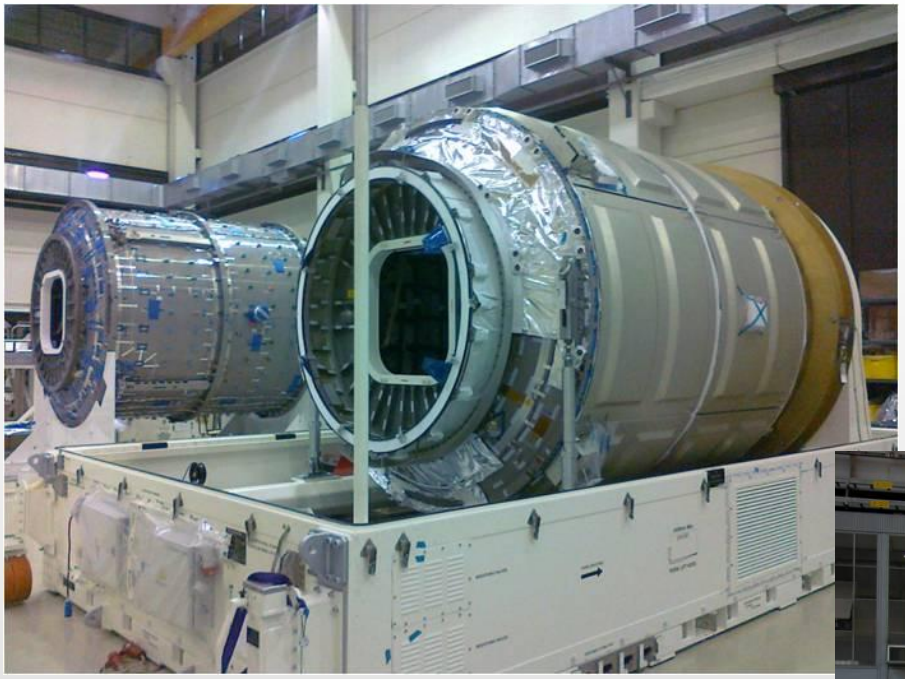
Transporter/Erector/Launcher System Designed for Safe, Rapid Transfer of LV to Pad

Wallops Payload Processing Facility

Cygnus Pressurized Cargo Module and GSE



Pressurized Cargo Modules In Production



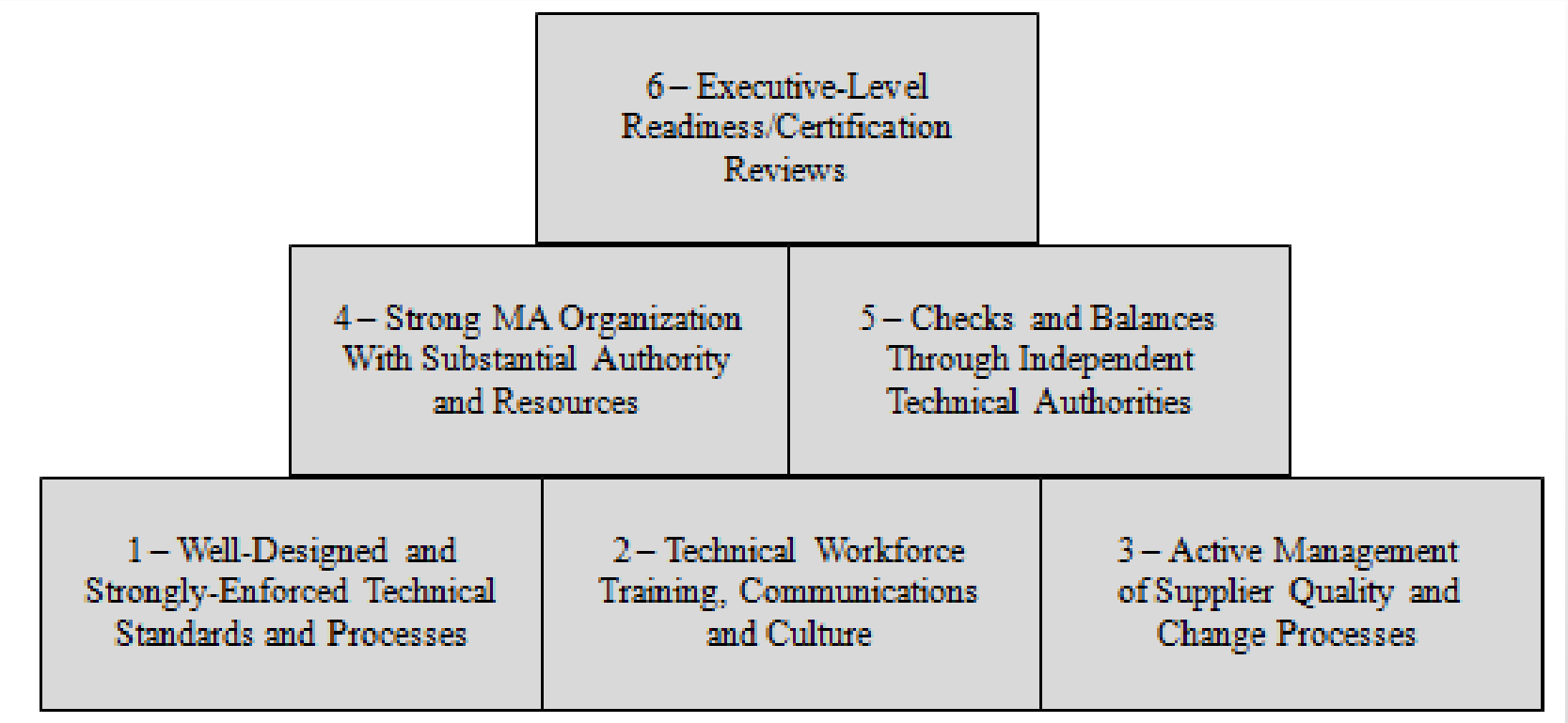
Cygnus Mission Control

- **Cygnus mission operations will be managed from Orbital's state-of-the-art Mission Control Complex in Dulles, Virginia, in concert with NASA's Johnson Space Center in Houston, Texas).**
- **After being launched into low-Earth orbit by Antares, the Cygnus spacecraft will transport it's cargo from a low parking orbit to the ISS.**
- **After the cargo delivery is complete, and is loaded with disposal material, Cygnus is steered to a safe destructive reentry over the Pacific Ocean.**
- **Orbital is conducting monthly joint integrated simulations with NASA JSC and JAXA to prepare for rendezvous and departure operations.**

Balancing Performance, Quality and Cost in Commercial Space

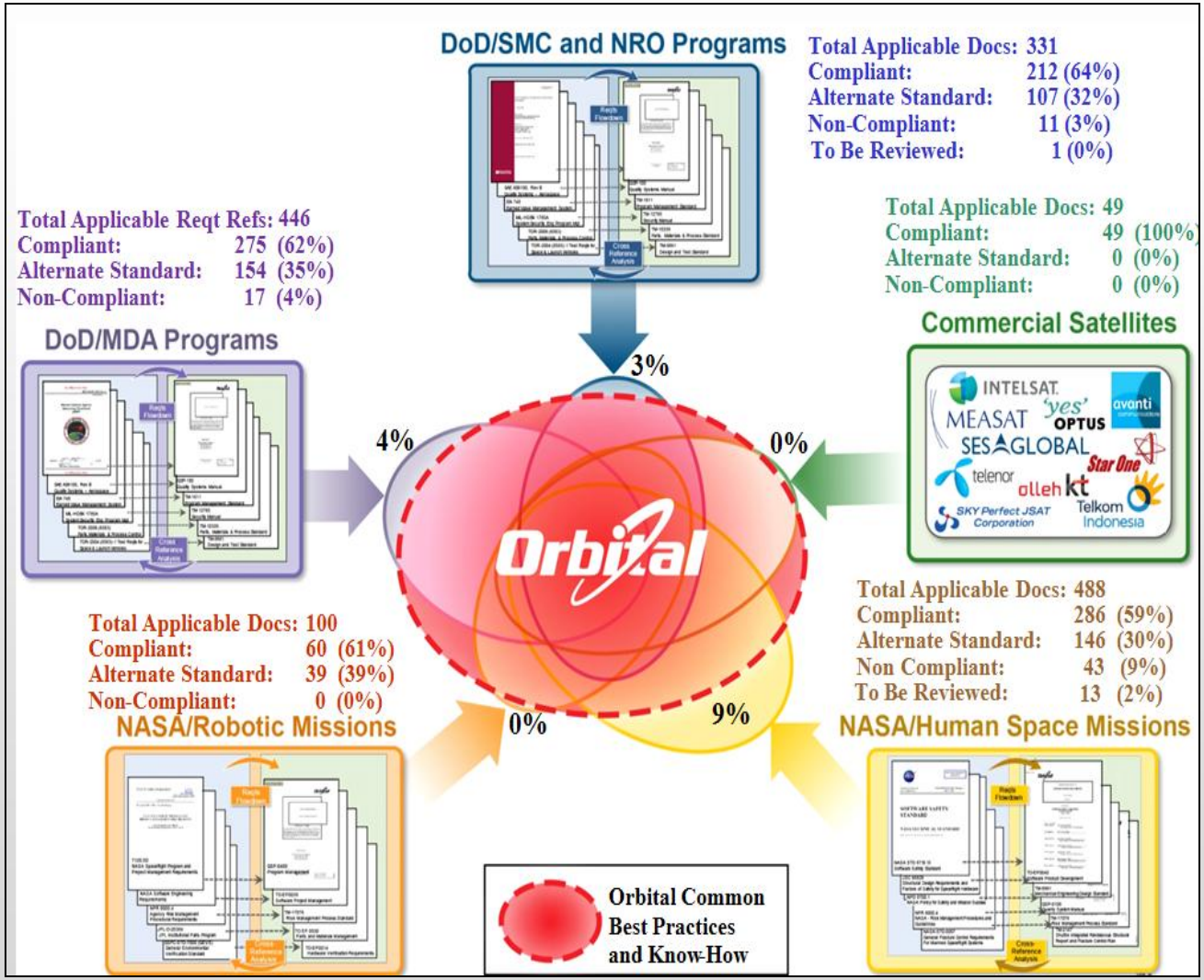
Safety & Mission Assurance
Internal Approach

Orbital's 6-Part Mission Success Program



Orbital's Focus - Core Standards & Processes

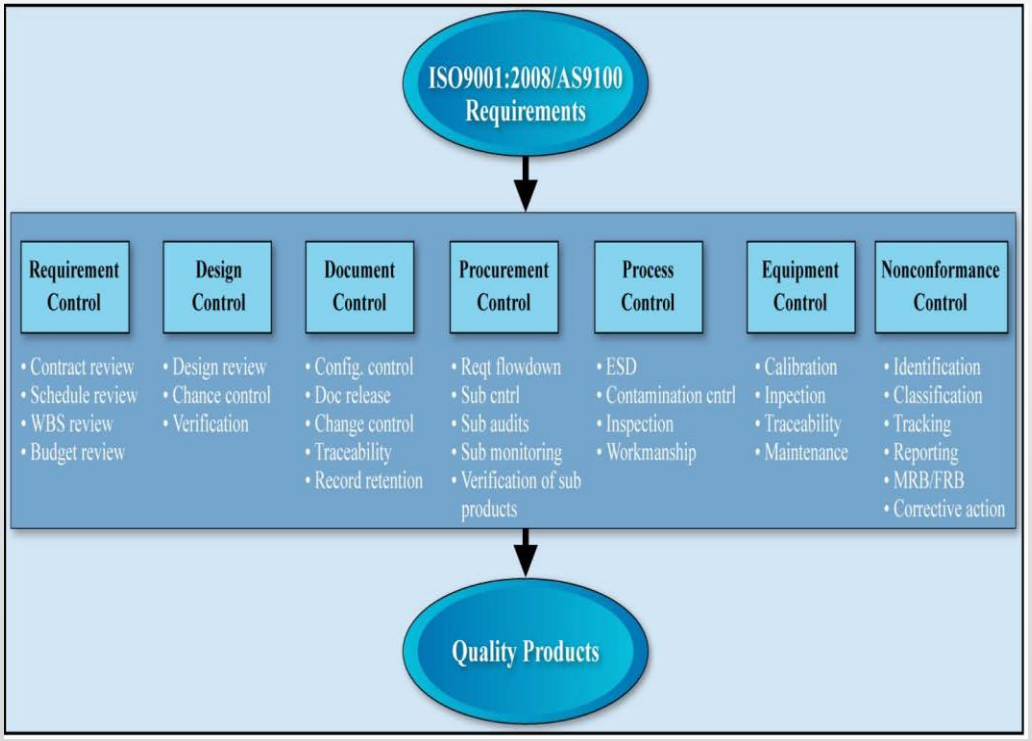
Over the Last 15 Years, Orbital Has Developed and Implemented a Set of Core Technical Standards and Processes That Address the Vast Majority of Its NASA, DoD/IC and Commercial Customers' Requirements



Quality Management Approach

- Orbital has a Quality Assurance Program that conforms to the requirements of ISO 9001:2008 and AS9100C for the design, development, production, installation, and servicing of products as described in the Orbital Quality System Manual, Procedures, and Instructions.

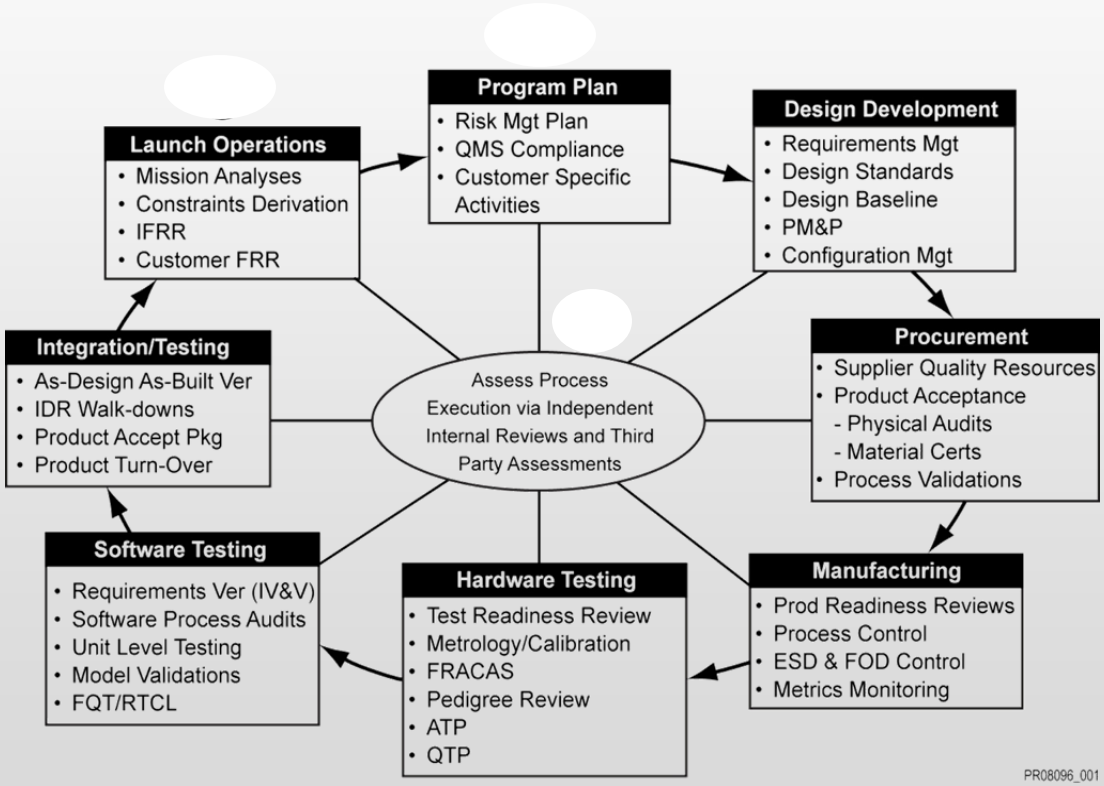
- The intent of the Quality Assurance Program is to meet or exceed Customer expectations, mission objectives, and corporate goals through prevention of non-conformances and monitoring of all stages of product realization, from concept design to on-orbit mission operations. This program is defined by QSP-0100, *Quality System Manual.*



Flight Assurance Across the Lifecycle

- The Flight Assurance Manager (FAM) works collaboratively with other technical leads from the Engineering organization in preparing CDRL items that require cross-functional coordination, and in providing inputs to the Program Manager on all issues affecting mission success.

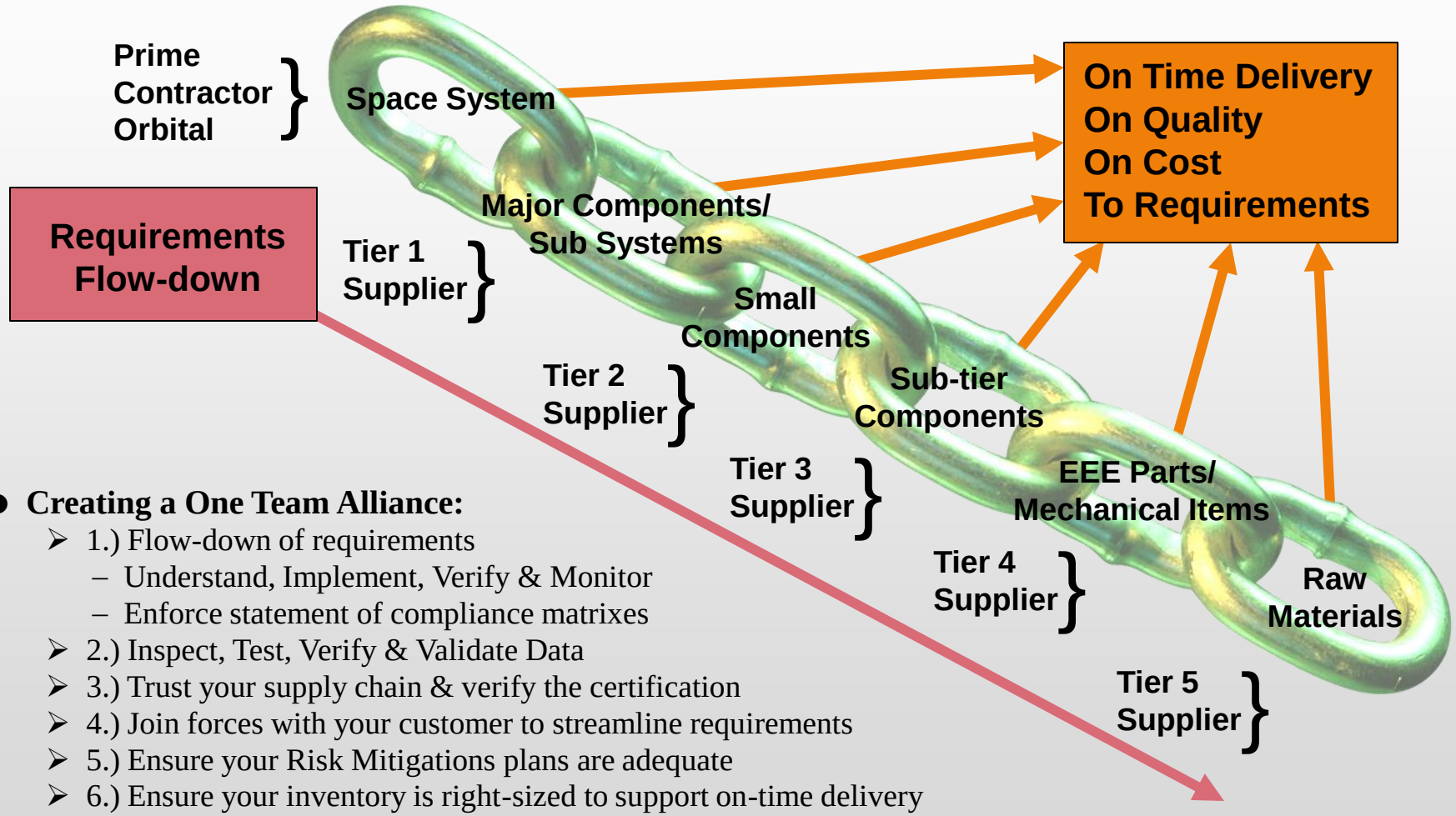
- The FAM is accountable to the Program Manager for delivering professional, timely, Safety & Mission Assurance services to the program but is expected to make risk-based decisions on the basis of mission success and not cost or schedule.



Balancing Performance, Quality and Cost in Commercial Space

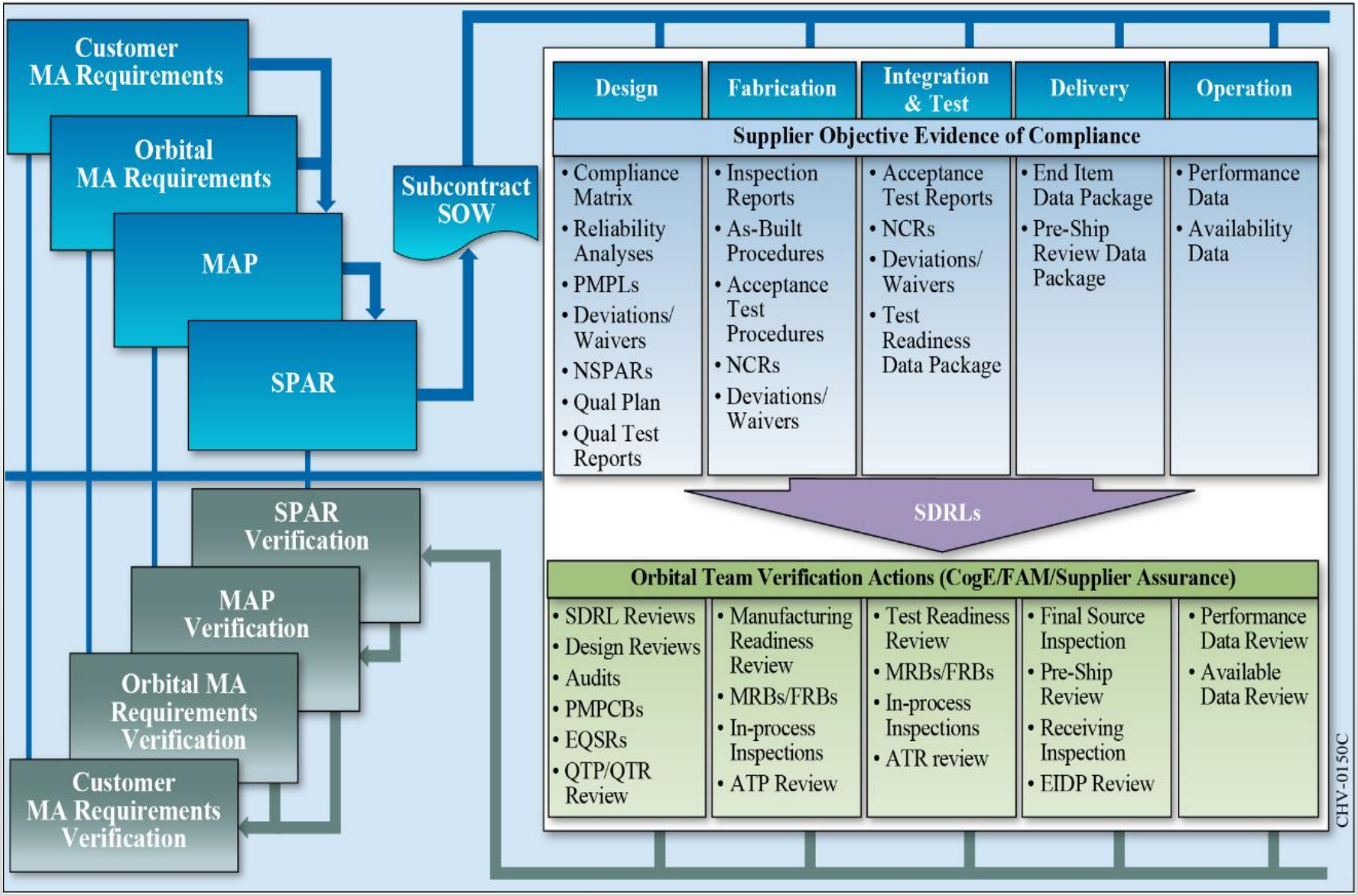
Supply Chain Management External Approach

External Approach - First Step
JOIN FORCES WITH YOUR Supply Chain



- **Creating a One Team Alliance:**
  - 1.) Flow-down of requirements
    - Understand, Implement, Verify & Monitor
    - Enforce statement of compliance matrixes
  - 2.) Inspect, Test, Verify & Validate Data
  - 3.) Trust your supply chain & verify the certification
  - 4.) Join forces with your customer to streamline requirements
  - 5.) Ensure your Risk Mitigations plans are adequate
  - 6.) Ensure your inventory is right-sized to support on-time delivery
    - Prepare for natural disasters throughout your Supply Chain

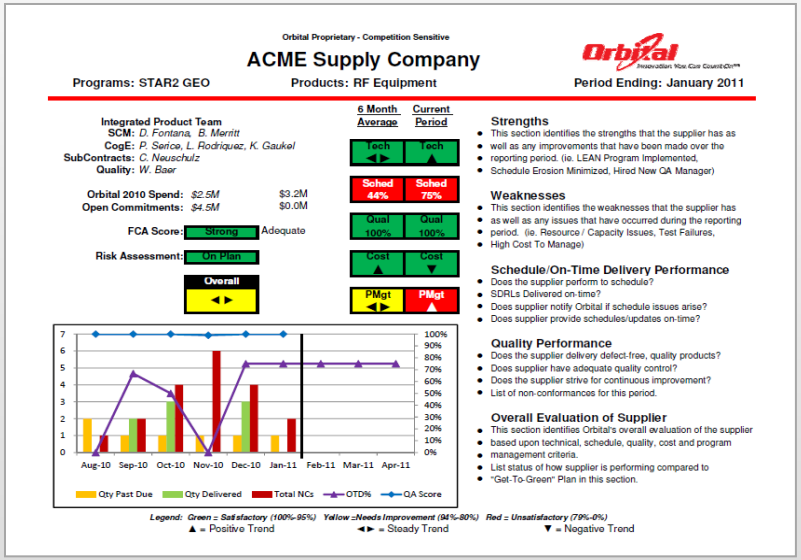
Mission Success – Supplier Flowdown



Supplier Surveillance & Scorecard Reporting

Active Supply Chain Management (SCM)

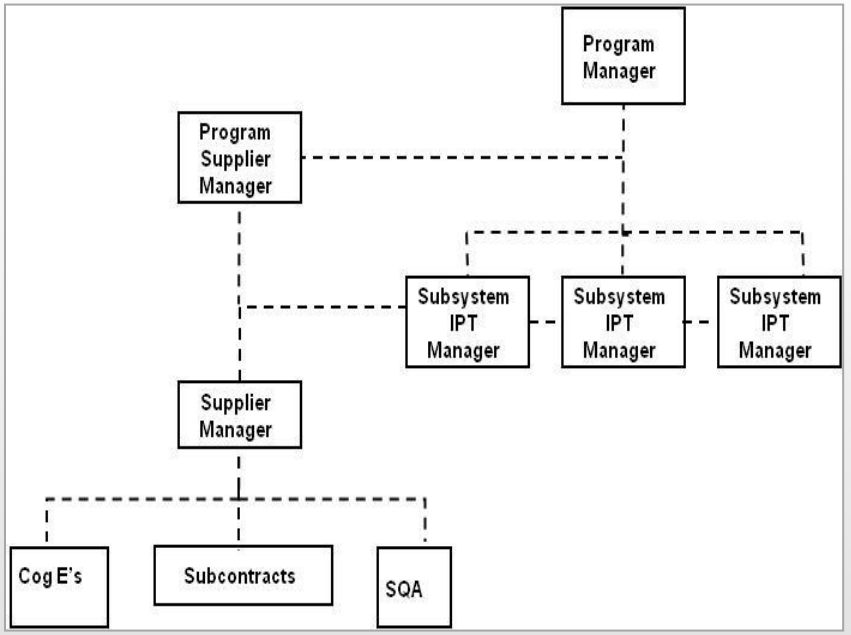
- **Supplier Manager Leads IPT With Cog E, Subcontracts and Supplier Quality Assurance**
- **Supply Chain Management Tempo on All Critical Suppliers**
- **Supplier Executive Involvement With Periodic On-site Visits**
- **On-site Surveillance on Critical Components**
- **Monthly One-Company Scorecards**



Risk Mitigation Planning

- **Early Identification of Risk and Mitigation Plans**
- **Identification of Opportunities Early in Value Stream**
- **Use of Strategic Supplier Improvement Plans**
- **Aggressive Tracking and Closure of Risk Plans**

SCM "Virtual" Organization Under IPT Concept



Key Quality Flow Downs

- **Standardized Flow Down Note Codes to Customer Needs**
- **Require Delivery of all Tech Doc Compliance Matrixes**
- **Non-Conformance & Test Failure Involvement**
- **End-to-End Traceability Requirements**
- **Parts, Materials, and Processes/Certificate of Compliance**
- **Orbital Approval of Changes in Supplier's Design**
- **Prohibited Materials / Parts Obsolescence / Counterfeiting**
- **Procurement from an OEM / Authorized Distributor**

Product Risk Management Value Mapping

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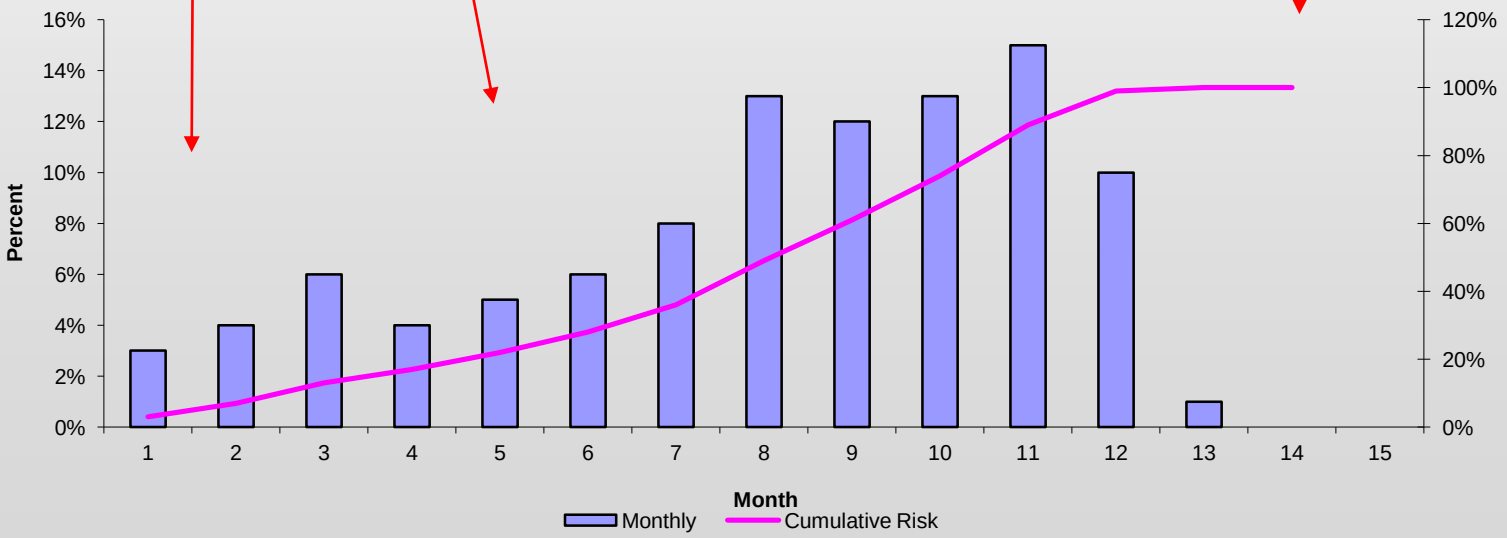
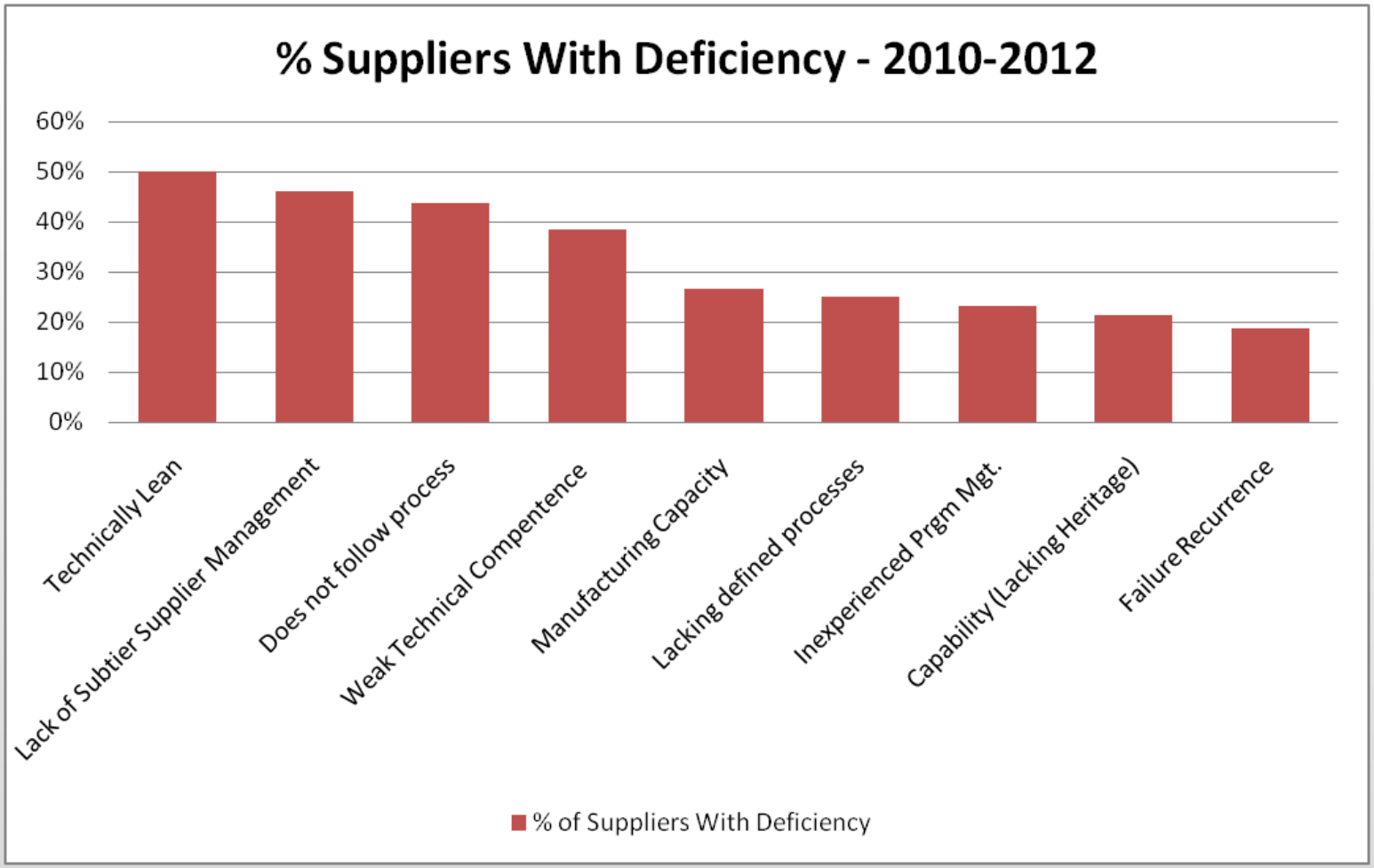
- **Early Identification of Risk Mitigation in the Value Stream is the Key to Success!**

Phase	Requirements	Design	Fabricate	Test	Deliver	Support
Tasks	Spec SoW System Concept Design to Cost Delivery Schedule Contract Ts & Cs Make/Buy Plan ISO Systems Risk Mitigation Plan	Syst Reqts. Review PDR CDR Struct. Analysis Thermal Analysis Electrical Analysis Reliability Analysis Safety Analysis	Bill of Material Supplier Mgmt. Scheduling Planning	Test Reqts. Test Planning TRR Test Witness Test Data Rev EIDPs	Data Reqts. Packing Shipping ITAR Customs	Failure Support AIT Support



Critical Supplier Deep Dive Results for 2010-2012



Striving for Balance

Price

Contract Terms and Conditions

Schedule

Quality Requirements

Customer Oversight

Growing New Suppliers

- In a commercial market, competition is key
- The on-ramping of new suppliers, or existing suppliers into new markets provides great benefits to system integrators
  - Increased competition
  - Existence of secondary and tertiary suppliers
- Often requires significant investment of resources on the part of the system integrator to foster success
  - Multiple examples of success in this area at Orbital

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The Future…

Cygnus System Facilitates Exploration Goals

- **Orbital's successful management of our suppliers in a commercial environments enables:**

- **Affordability** - Evolutionary approach with utilization of existing space qualified systems and cargo missions to ISS, provides lower cost under tightening budget constraints
- **Early Schedule** - Utilization of existing capability provides opportunity for near-term mission support. Potential to "piggy-back" on currently planned CRS missions (8 missions through 2016)
- **Maturity / Reliability** - Cygnus heritage and redundancy provides reliability
- **Technology Advancement** - Cygnus utilization provides new technology risk reduction in flight environments
- **Flexibility** - Cygnus system elements are adaptable to evolving mission needs, goals and requirements
- **Partnership** - Involvement of Cygnus concepts in NASA Exploration assessments promotes commercial / NASA / international partnership

Cygnus System Adaptable To New Missions

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ISS Resupply Mission

Inflatable Structure Demo

Life Support Demo

Exploration Subsystem Testing

Free Flyer Lab

Deep Space Radiation Shield Demo

Deep Space Habitat

HST Repair

Space Tug

Lunar Resupply Mission

HIAD Entry Demo

Satellite Servicing

Free-Flyer Rendezvous & Docking Demo

ISS Lab/Prop Module

Cygnus Provides an Affordable and Near-Term Capability To Support NASA Goals

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Summary

- A healthy, well functioning, well managed supply chain is the key to the success in a commercial market
- Orbital supplier management techniques have proven themselves in multiple market areas, including commercial space
- Striking a balance in the relationship with a supplier is key to creating an environment of success for all involved
- The development of new suppliers takes effort, but has been proven to be worthwhile

Questions?