ISSRDC

Enhancing Primary and Secondary Services of the Cygnus Logistics Spacecraft for the ISS and Beyond

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Agenda

- Cygnus History
- Cygnus Capabilities
- ISS Reboost
- Enhanced Cargo
- Future Commercial Applications
- Conclusions

Cygnus History

10 Years of Service to ISS

- Cygnus flew its demonstration mission in 2013
- First Cargo Delivery Mission in January 2014
  - 18 missions since to date (average 2/year)
- Over 56 metric tons of cargo and 44 metric tons of trash disposal to date
- Provides 3,750kg of cargo mass per mission
- Compatible with 3 different launch vehicles
- Began adding secondary payload objectives on OA-4 (2016)
- Successfully deployed over 58 CubeSats to date
- Next Mission: NG-19, August 1, 2023

Photo Credit: NASA

Cygnus Evolves Capabilities to Support Evolving ISS Needs

- Provides 96-hour cargo delivery time to the ISS
- Cargo loading at launch minus 24 hours
- Demonstrated extended duration free flight on NG-11 mission
  - Cygnus flew for 232 days post-ISS departure
- Capable of CubeSat deployments from 2 different deployer types
- Planned enhancements include increased cargo carrying capability and docking
- First vehicle to use the Common Communications for Visiting Vehicles (C2V2) System
- ISS Orbit Raising Support via “Reboost” upgrades on NG-17+
  - Cygnus is the only US asset since the Space Shuttle to provide ISS Orbit Raising
- Each Cygnus can provide “ISS Extend-the-Lab” capabilities as well as transport up to 6 powered Mid Deck Lockers of payload, including locker health and status telemetry in free-flight
- Two Passive Flight Releasable Attachment Unit (PFRAM) attachment points on the PCM enable disposal of up to two Orbital Replacement Units (up to 1,200 kg)

ISS Reboost Using Cygnus

- Major Cygnus block upgrade implemented to the fleet beginning with NG-17 (2022)
  - Initially demonstrated with OA-9 (2018)
  - Primary thruster enables ISS Center of Mass targeting from Node 1 Nadir
  - Jointly developed processes and procedures with NASA to execute ISS translational maneuvers
- Every Cygnus mission supports ISS Reboost utilizing residual propellant from the primary mission
- Capability does not impact to the primary mission performance

Photo credit: NASA

Increased Cargo Enhancement

- Cygnus “Mission B” augments the Pressurized Cargo Module to increase cargo carrying capability from 3,750kg to 5,000kg per mission
  - Extends the module length by ~1.5m
- Maintains powered payload MDL capability
- Unchanged 1,200kg external (unpressurized) cargo disposal capability
- First launch capability planned for NG-23 mission

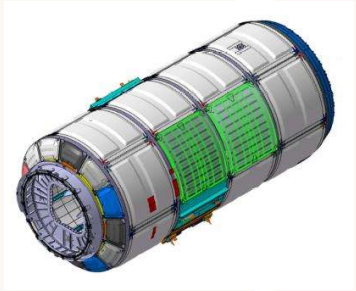

Photo Credit: Northrop Grumman

The Future includes Commercial Space Station Services

- The Cygnus spacecraft will continue to fly long after ISS, supporting the Commercial LEO Destinations
- Developments and enhancements are in work now to ensure cost-effective commercial use
- Leveraging capabilities developed for ISS to support orbital maintenance of commercial space station concepts (debris avoidance & station keeping)
- Northrop Grumman continues to work with industry partners and stakeholders to identify the needs of the future and determine how the existing vehicle may be evolved to support those endeavors

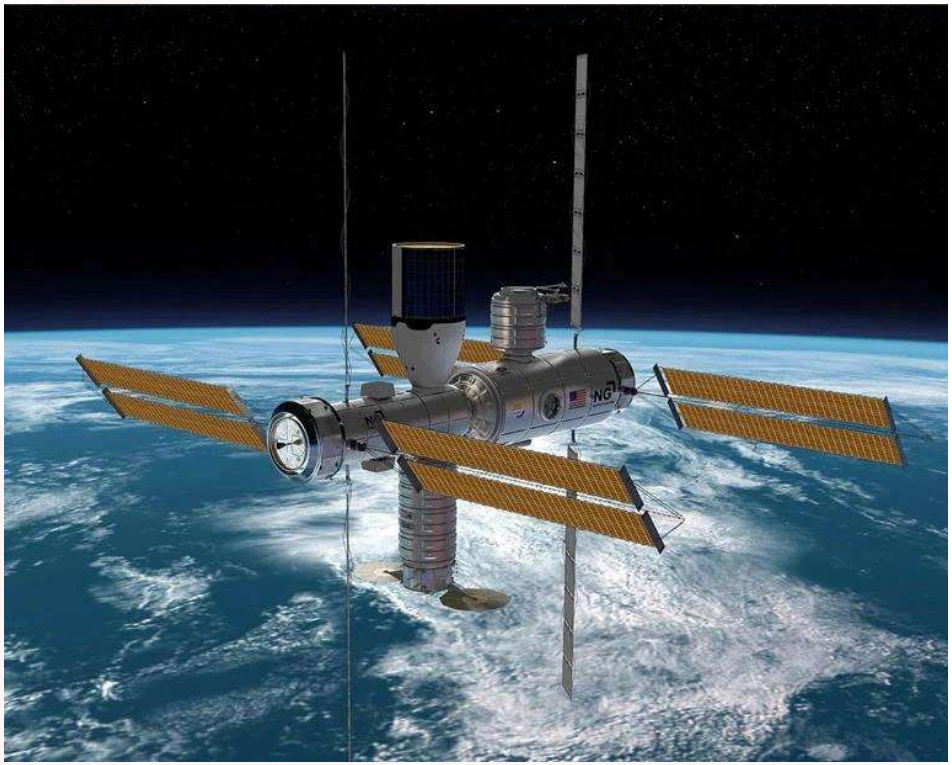

Photo Credit: Northrop Grumman

Past, Present, and Future

- Cygnus has a long history of enhancing its platform to add capability and services to NASA and other partners in the science and commercial space industry
- Recent developments of ISS Reboost and significant expansions to cargo capability represent major upgrades to the Cygnus fleet
- The ability to adapt the Cygnus spacecraft to a variety of purposes demonstrates Cygnus continues to be an opportunity for new technology demonstration and has a place in the future of supporting human spaceflight
- **The Northrop Grumman Cygnus Cargo Transportation System is reliable, resilient, and dependable!**

Photo Credit: NASA

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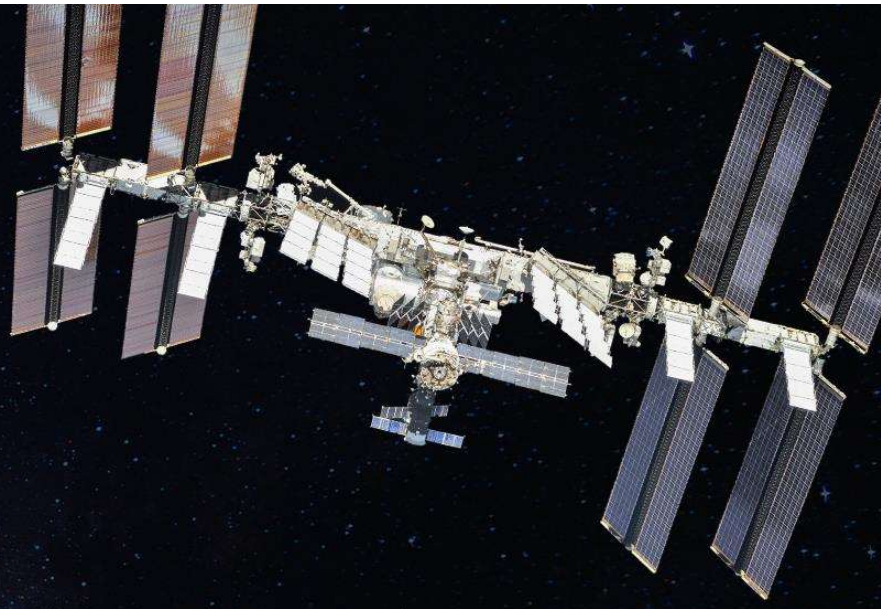

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