Ground Systems Standardization and Commonality : Continuing the Dialogue

TDRS & JWST

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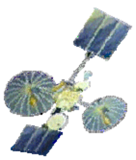
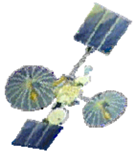
NASA GSFC

GSAW 2008



- Proposed questions for the initial panel discussion are:
- 1) What efforts have you used to identify other programs or systems to seek commonality with? How have you addressed cost-sharing with those programs or systems?
- 2) Have you experienced there regulatory or policy obstacles towards achieving greater commonality and, if so, how have you addressed those obstacles? Are there policy changes that could help enable standardization and reuse?
- 3) How have you obtained buy-in on use of standards and overcome resistance and skepticism?
- 4) What are the implications of trying to achieve commonality at different stages of development maturity? Does commonality always have to be planned for in the initial development or are there ways to leverage reuse for systems that are further along?
- 5) Does planning for commonality and reuse require different systems engineering processes?
- 6) How can costs and schedules for projects involving commonality and reuse be estimated accurately?
- 7) Are there management best practices that allow for successful use of commonality, standardization, and reuse in ground system projects? Are there specific pitfalls associated with management of vendors and subcontractors?



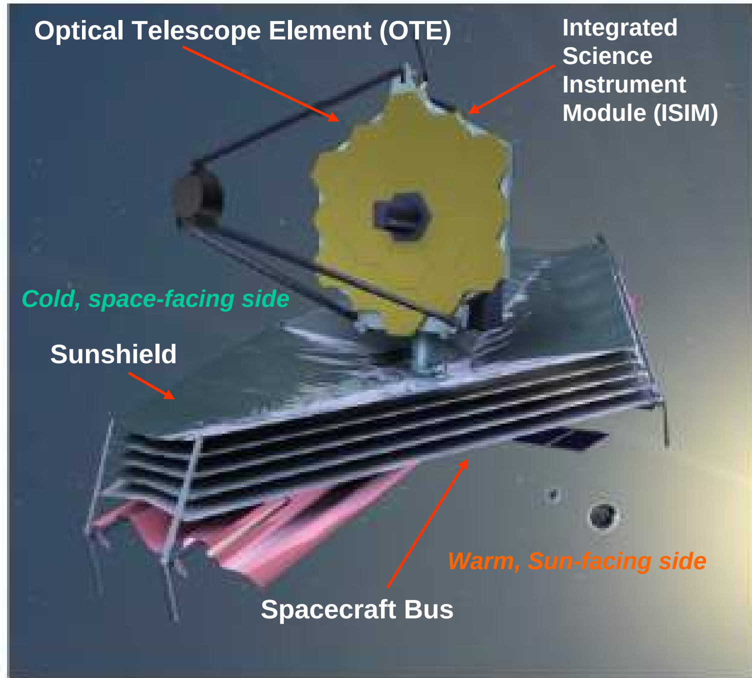
Vertical vs Horizontal optimization

- Module is defined based on core business: Mission centric vs infrastructure
- Missions optimize for Mission cost and objectives
- Infrastructure: Longer term and multiple users
  - TDRS is celebrating 25 years
  - upgrades require consideration to support exiting users (backwards compatibility)
  - Provides portion/service of the operations (Network, MOC, Archive etc)

James Webb Space Telescope (JWST)

Organization

- Mission Lead: Goddard Space Flight Center
- International collaboration with ESA & CSA
- Prime Contractor: Northrop Grumman Space Technology
- Instruments:
  - Near Infrared Camera (NIRCam) – Univ. of Arizona
  - Near Infrared Spectrograph (NIRSpec) – ESA
  - Mid-Infrared Instrument (MIRI) – JPL/ESA
  - Fine Guidance Sensor (FGS) – CSA
- Operations: Space Telescope Science Institute



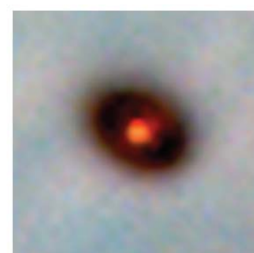
Description

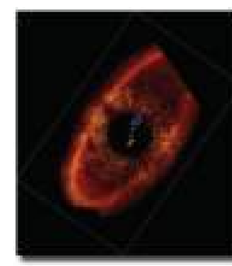
- Deployable infrared telescope with 6.5 meter diameter segmented adjustable primary mirror
- Cryogenic temperature telescope and instruments for infrared performance
- Launch June 2013 on an ESA-supplied Ariane 5 rocket to Sun-Earth L2
- 5-year science mission (10-year goal)

JWST Science Themes


End of the dark ages: First light and reionization

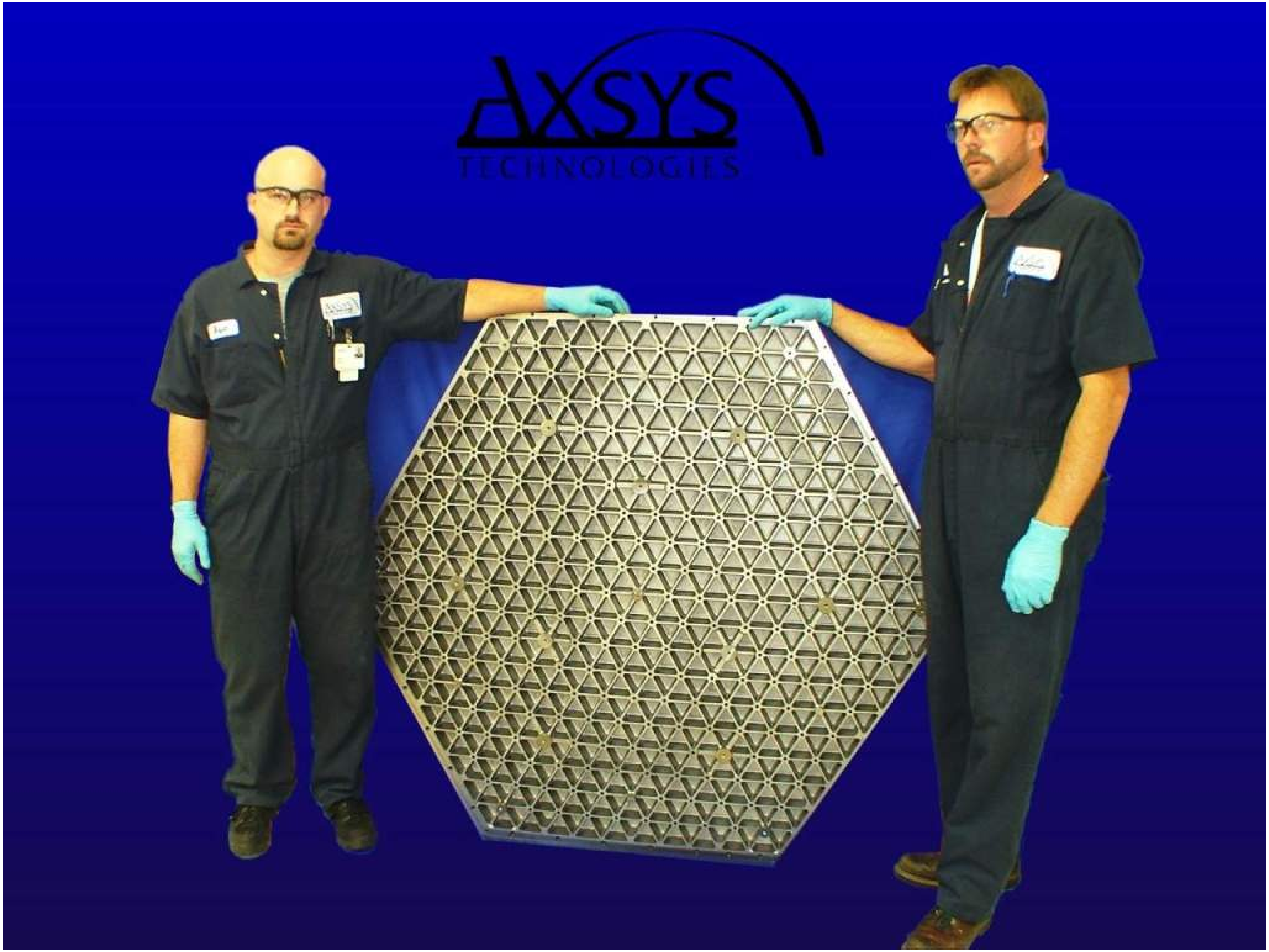

The assembly of galaxies


Birth of stars and proto-planetary systems


Planetary systems and the origin of life

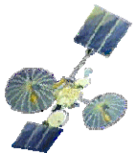
www.JWST.nasa.gov

JWST Full Scale Model at the GSFC


AXSYS
TECHNOLOGIES

The JWST mission architecture is optimized to enable key science requirements

- **JWST sees in the infrared because that is where its science is**
  - Light waves have been stretched by the expansion of space since the Big Bang. Visible light emitted by the first stars and galaxies has been shifted into the infrared by the time it reaches us.
  - Light from star and planet forming regions and from planets themselves is brightest in the infrared.
- **Large telescope optics collect and focus light**
  - With telescopes, size matters
    1. **Resolution** – objects of interest are far away and appear small. The bigger the aperture, the more detail you can see. We need to see details of structure to identify what we are observing.
    2. **Sensitivity** – objects of interest are far away and are faint. The bigger the aperture, the more light we gather and the fainter are the objects we can detect.
- **JWST's telescope is lightweight and deployable so it can be launched economically**
  - The required size of the main mirror is wider than any available or practical launch vehicle. Making its telescope lightweight and deployable makes JWST's large size feasible and affordable.
- **Telescope and Scientific Instruments are cold for sensitivity**
  - Infrared light is heat radiation. The telescope and the instruments (cameras and spectrometers) attached to it need to be cold so that their own warmth does not overwhelm the faint infrared signals they are trying to detect.
  - The detector chips at the heart of each instrument must be cold in order to function.
- **Sunshield allows the telescope and instruments to get cold**
  - The sunshield shades the telescope and instruments from the Sun, allowing them to radiate their heat to the extreme coldness of deep space and become very cold themselves
- **L2 is an ideal place for an infrared observatory**
  - The Sun-Earth L2 point is far enough away from the warm Earth to provide a benign thermal environment and enable efficient operations, yet close enough for easy launch and communications



JWST System Hierarchy

James Webb Space Telescope System

Launch Segment

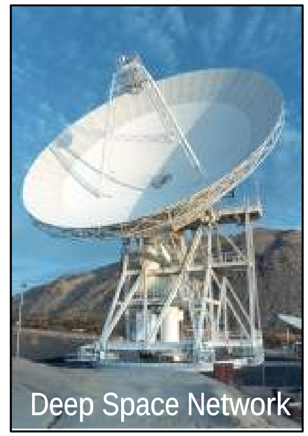
ESA

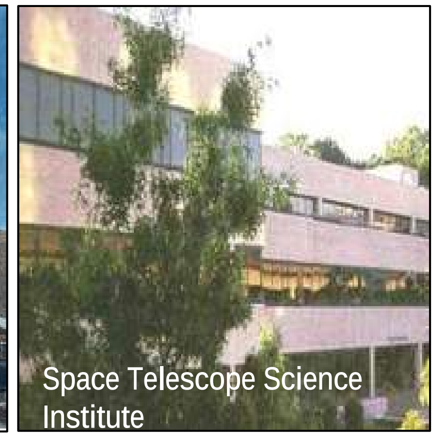
- Launch Vehicle
- Payload Adapter
- Launch Site Services

Observatory Segment

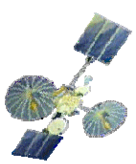
- Optical Telescope Element (OTE)
- Integrated Science Instrument Module (ISIM)
- Spacecraft Element (SE) ESA
  - Spacecraft Bus
  - Sunshield

Ground Segment

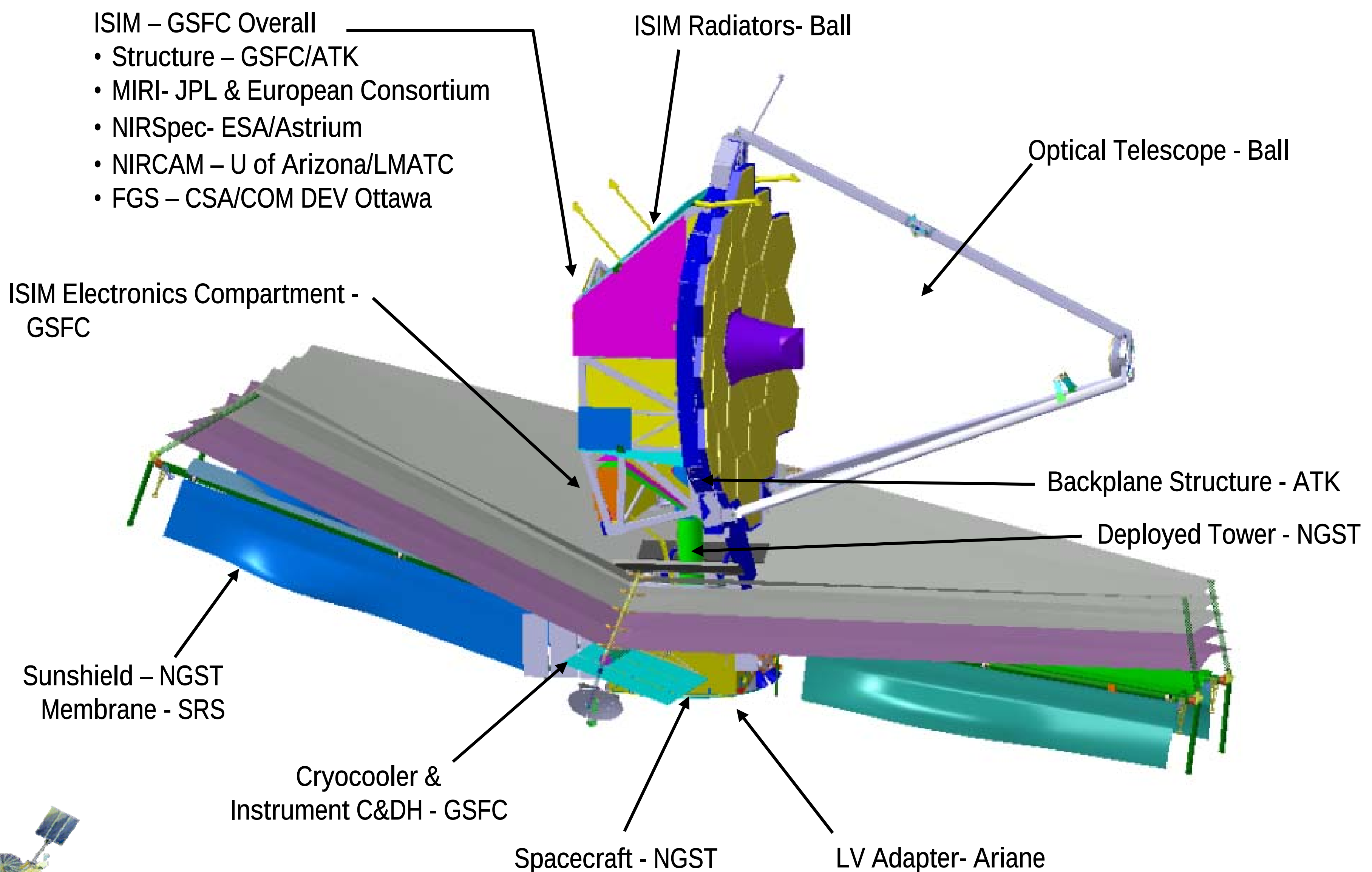




- Science and Operations Center (SOC)
- Institutional Services
- Common Command And Telemetry System (CCTS)

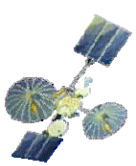


JWST Teams & Responsibilities



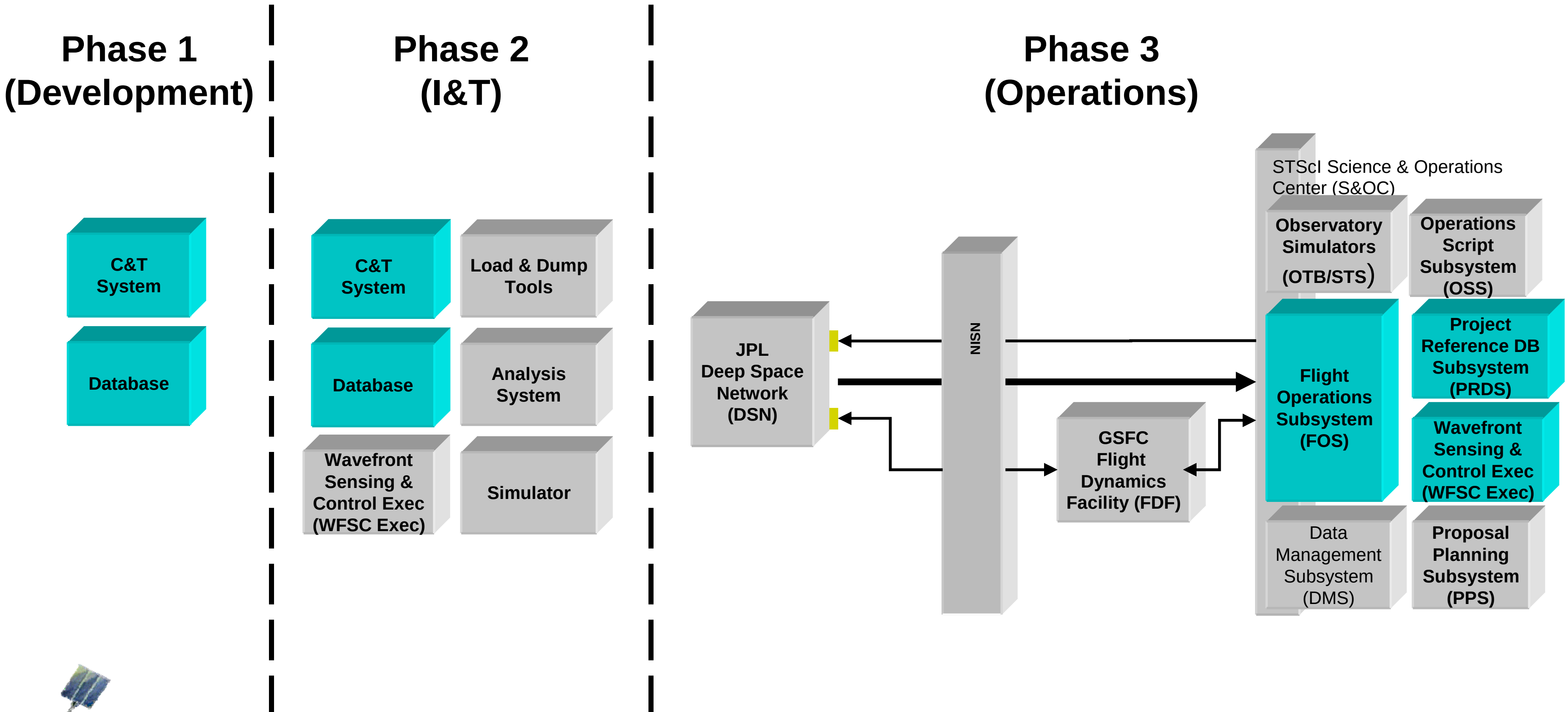
JWST Operations theme

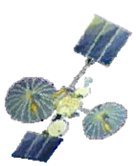
- Mission focus is optics: Operations is low risk:
  - Proven technology
  - Standard Base CCSDS,CFDP
  - Maximize use of institutional services: DSN
  - COTS based Command and telemetry
  - Best practices: same C&T system for I&T and ops
  - XML / XTCE project reference data base separate from C&T system
- Due to spectrum regulation and data rate needs, First mission to baseline Ka 26 , which will be flown in 2008 with LRO and SDO



adaptive architecture road map

Development and I&T ground systems built around eventual operations core components: Flight Operations System (FOS) and Project Reference Database System (PRDS)



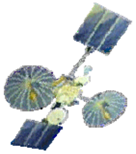


JWST Operations Lesson learned

- Is working and is low risk
- COTS and Standards require work around to meet mission needs:
  - Modified Eclipse C&T and Raytheon on contract to support
  - CFDP required work around to handle Physical vs logical End Of File resident Eclipse experts
  - Developing XTCE standard required JWST 1 EP /year
- LRO/SDO is reducing our risk using Ka 26..

Others will benefit

- LCDM, NPOES will be using JWST enhancements



TDRS K Mission Description

Mission Objectives: Two identical spacecraft (with options for two additional S/C) and modifications to the ground systems at White Sands Complex (WSC) to replenish the TDRSS communication network utilized by NASA and other government agencies.

Organizations: NASA GSFC, KSC (ELV), Prime Contractor Boeing Satellite Systems (BSS)

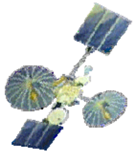
Mission Description: Two functionally identical spacecraft in geosynchronous orbits. WSC Ground upgrades to support new spacecraft while maintaining backward compatibility for operation of current constellation.

Period of Performance FY08 – FY25 (w options)

Launch: From KSC via Atlas V or Delta IV.

TDRS

- Communications system pushing technology in the 80's
  - Multiple services to multiple satellites
  - Coherent ranging services
  - High availability and reliability
  - We are now on the third generation of TDRS satellites
  - Bent pipe
- Second generation TDRS Ground (STGT) concept started mid 80 and system completed Mid 90:
  - Communication interfaces optimized for functionality (no standard)
  - Software design based on DEC VAX and DECnet using Ada
- Between the time system was conceived (mid 80) and completed (mid 90) architecture was obsolete….



Space Segment View

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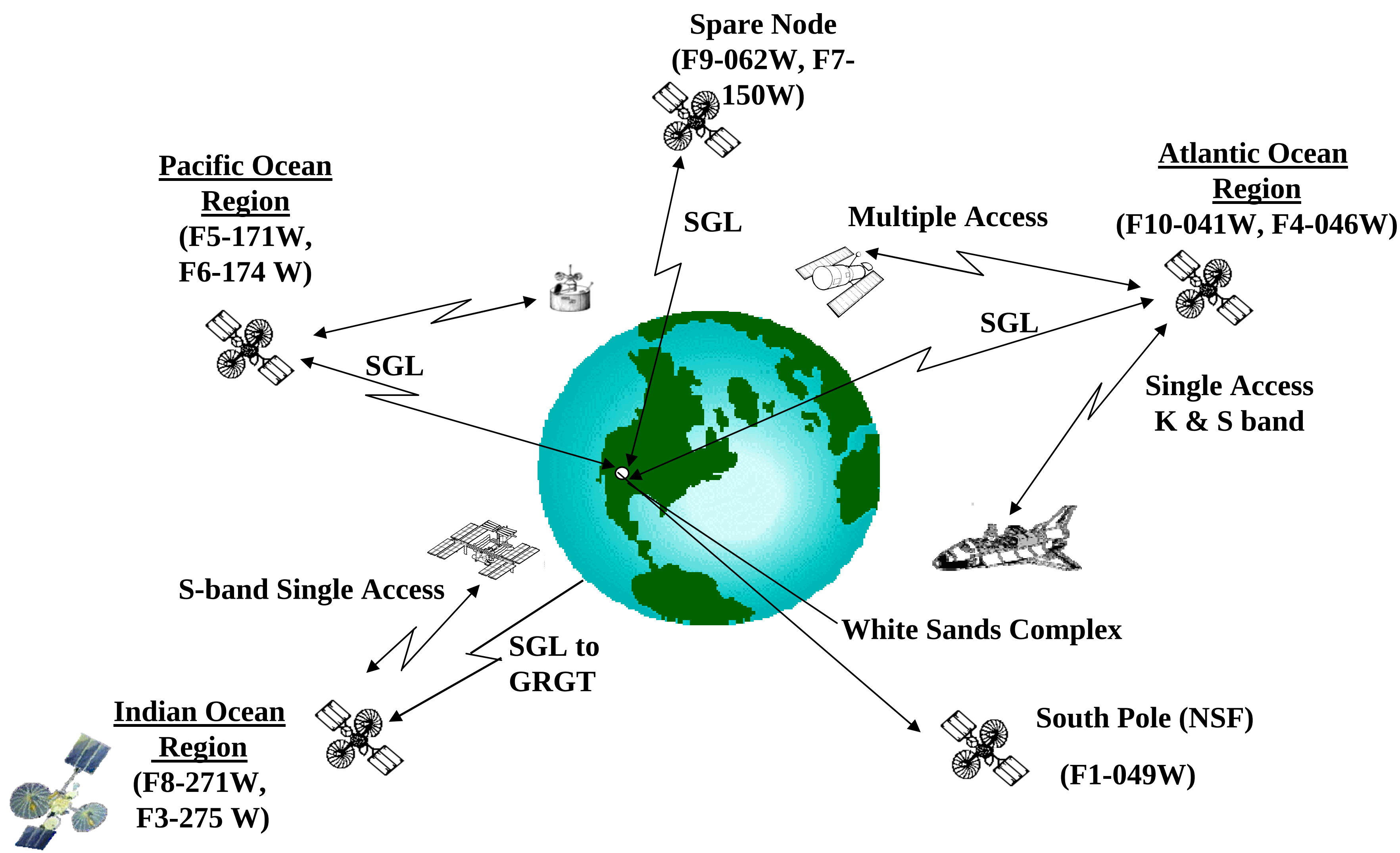
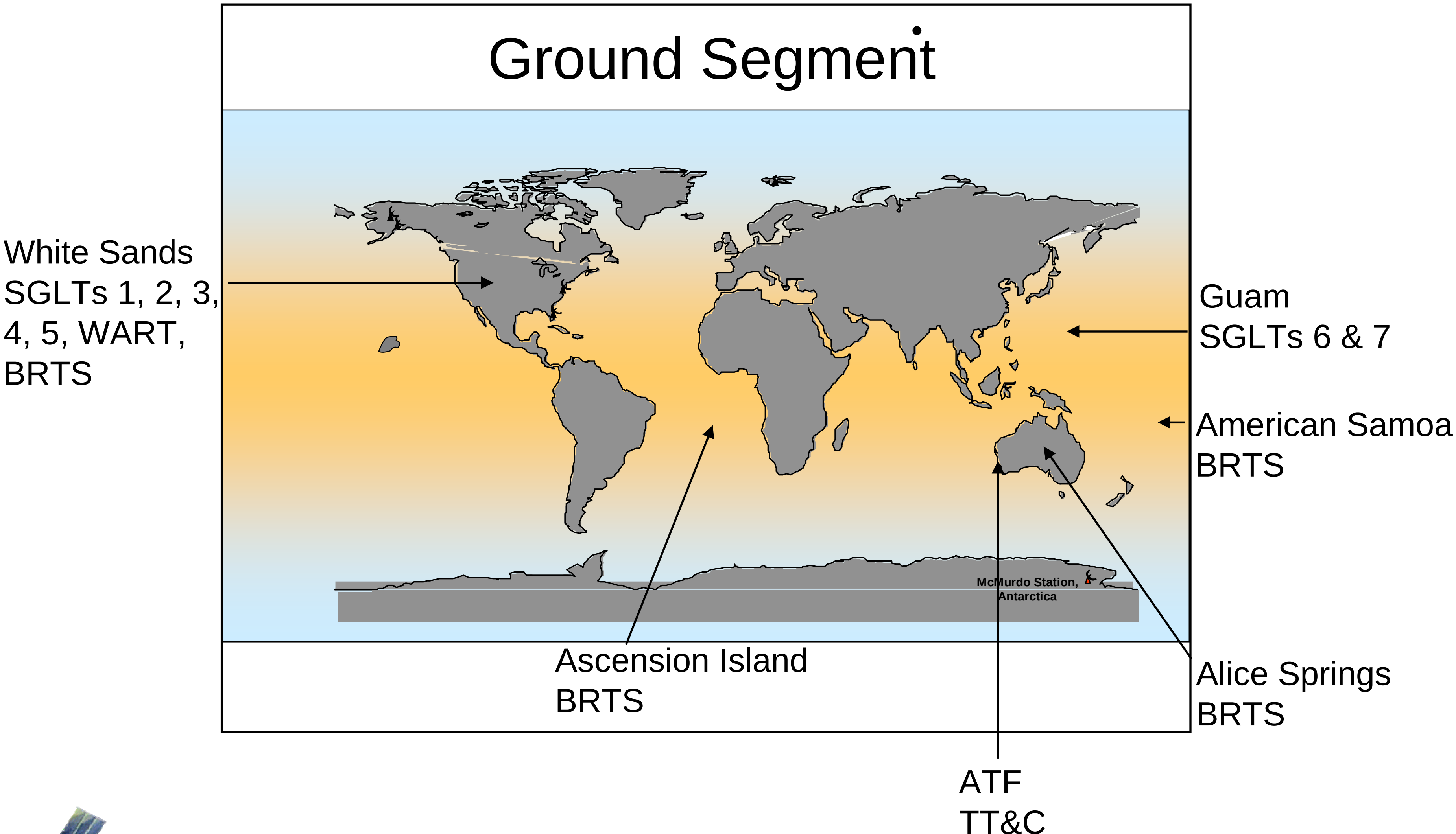
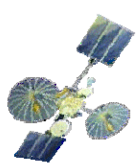


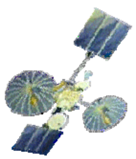
Ground Segment





TDRS Modernization

- TDRS ground system is facing major challenges:
  - Obsolesces and no Spare parts
  - User demanding IP services (packet services not bit services)
  - TDRS Modernizing project, currently in concept phase, call for use of standards: IP, Service Bus, Linux/Unix
  - Existing proprietary interfaces require a “big bang” development approach by building an entire Space Ground Link Terminal (SGLT)
  - Modernization cost in the   hundreds of millions of dollars



Conclusions

- Using COTS and standards has many pluses, provided they meet your requirements and you are not pushing the edge with your requirements
- "Deal or NO-Deal" lesson learned :
  - Timing Guts and Luck play a major role in success of selecting the proper Technology, Standard and COTS