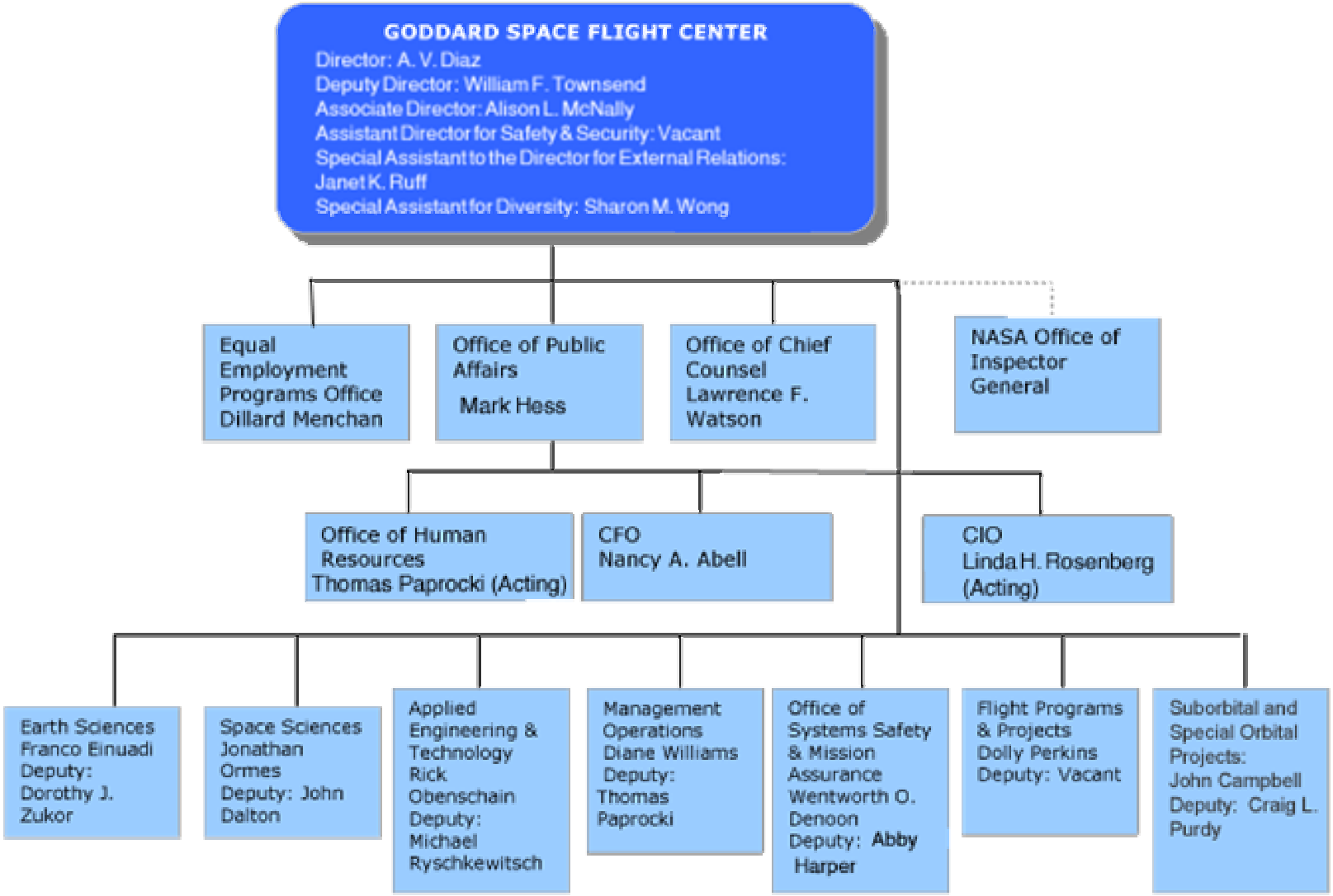
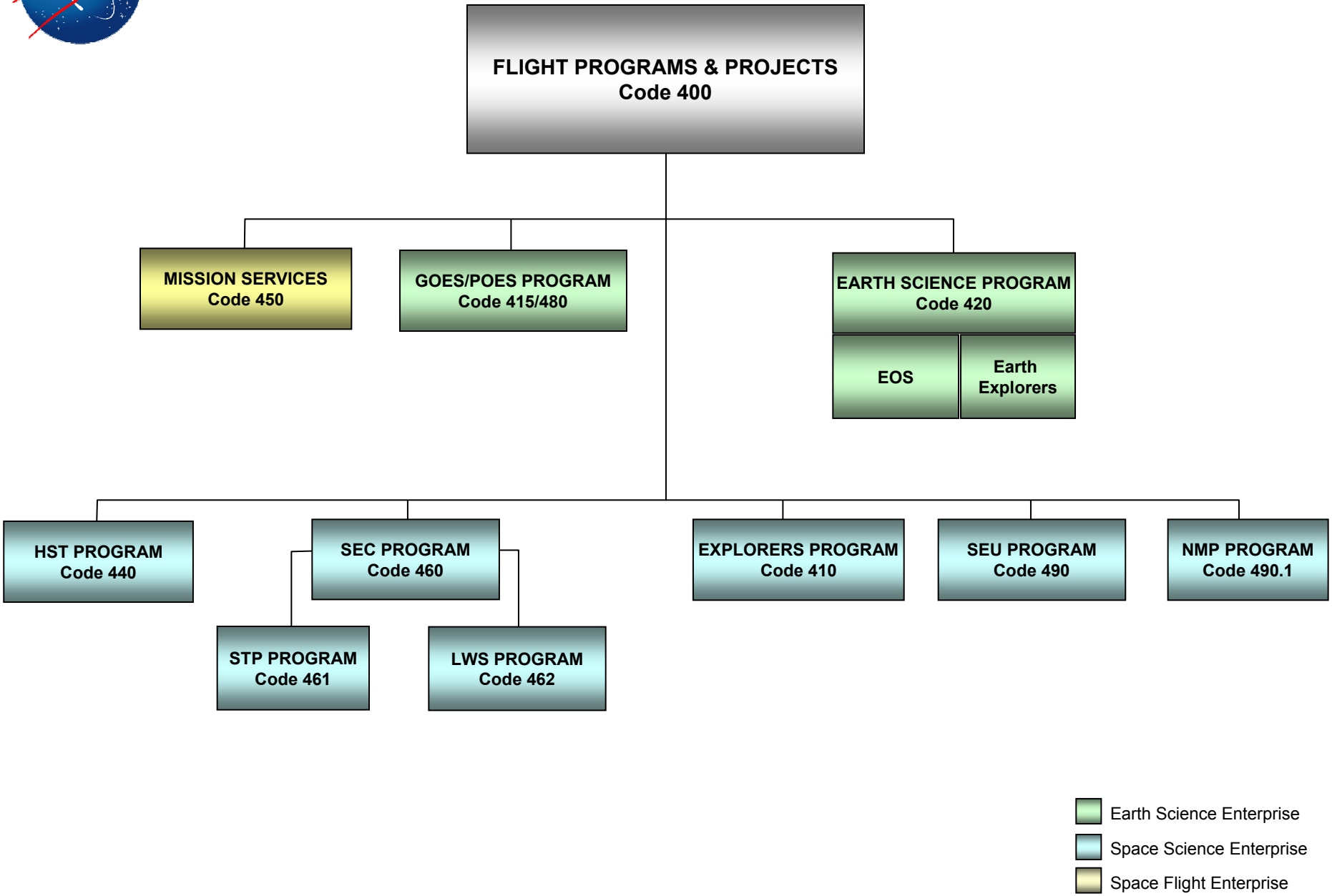
Mission Services Overview

June 2003

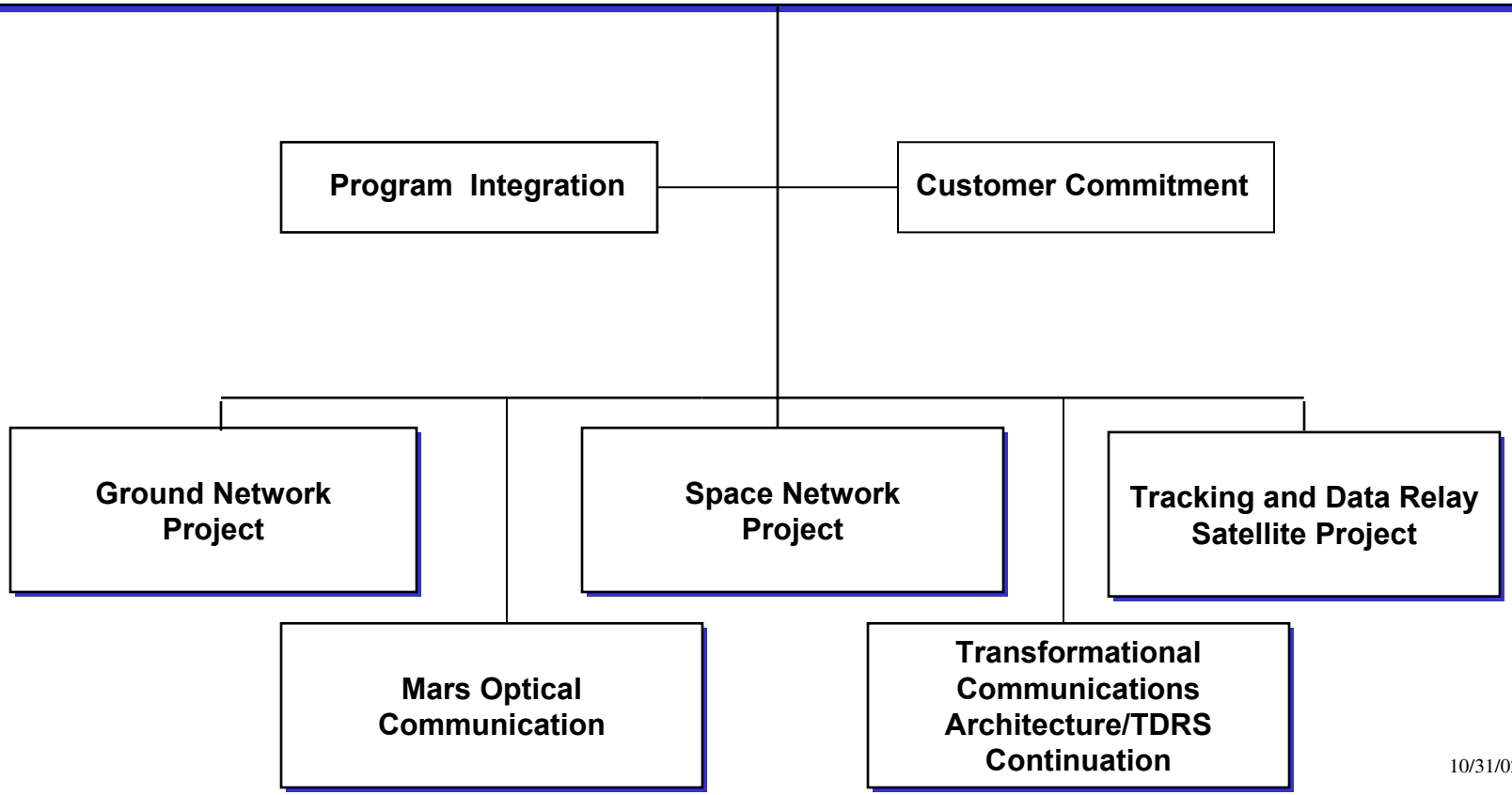
Phil Liebrecht NASA Goddard

Goddard Space Flight Center



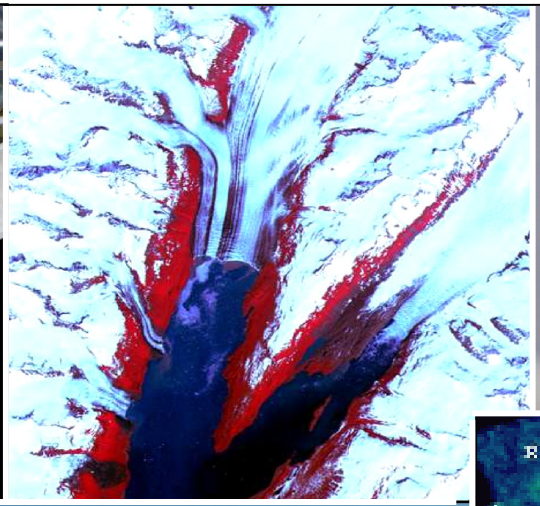

FLIGHT PROGRAMS & PROJECTS
Code 400
MISSION SERVICES
Code 450
GOES/POES PROGRAM
Code 415/480
EARTH SCIENCE PROGRAM
Code 420
EOS
Earth Explorers
HST PROGRAM
Code 440
SEC PROGRAM
Code 460
STP PROGRAM
Code 461
LWS PROGRAM
Code 462
EXPLORERS PROGRAM
Code 410
SEU PROGRAM
Code 490
NMP PROGRAM
Code 490.1
Earth Science Enterprise
Space Science Enterprise
Space Flight Enterprise

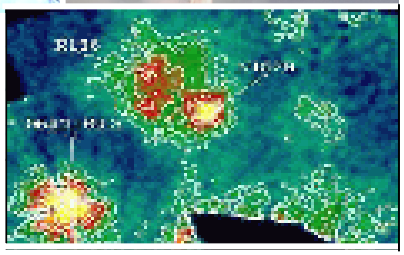
Mission Services Program Office
Code 450

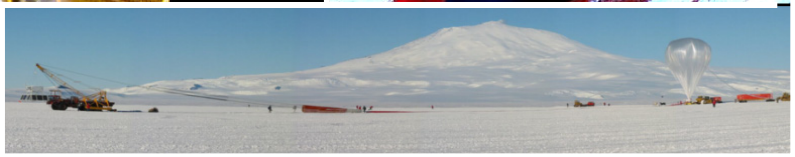


10/31/02

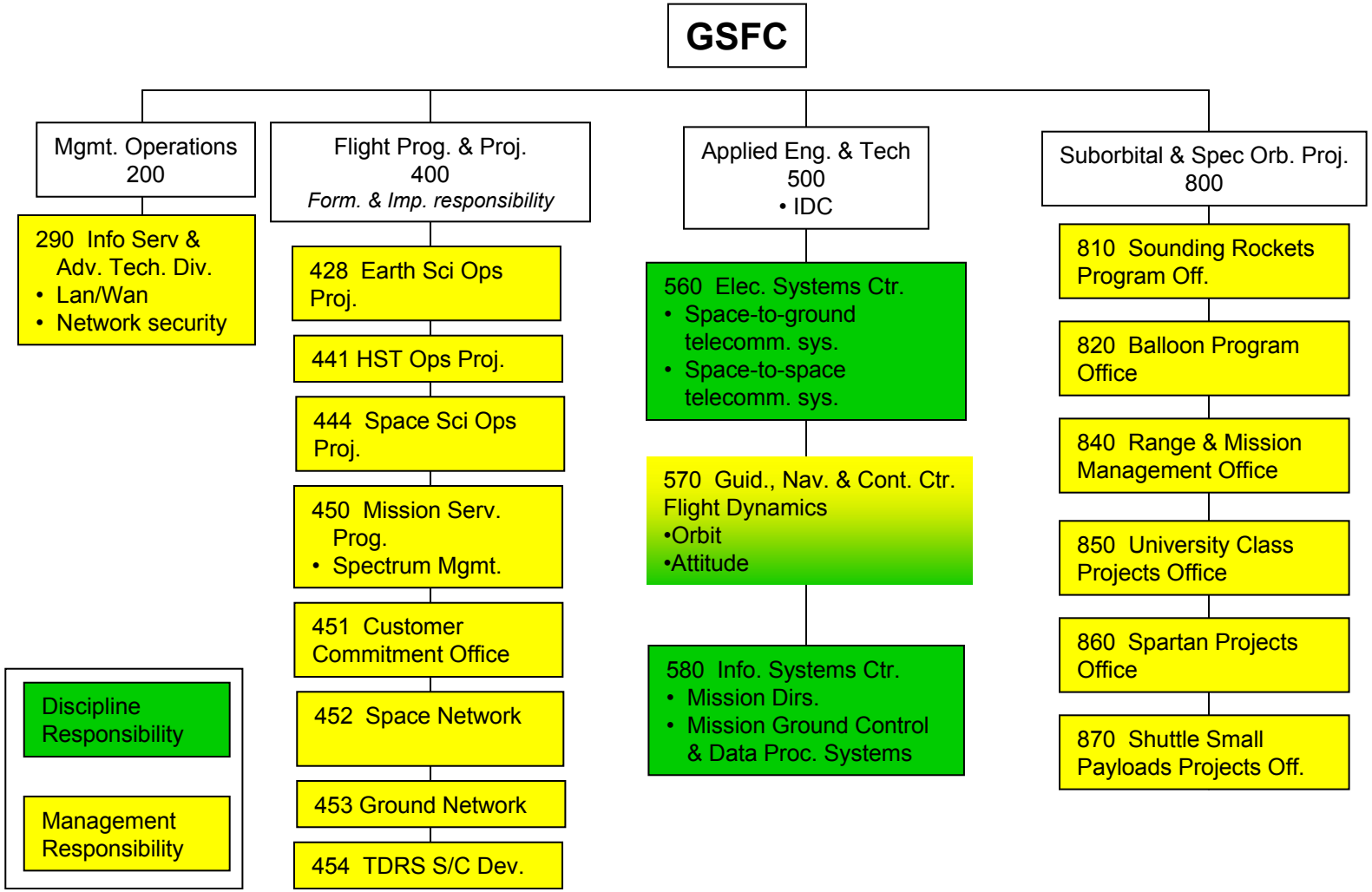
MSP Customer Support



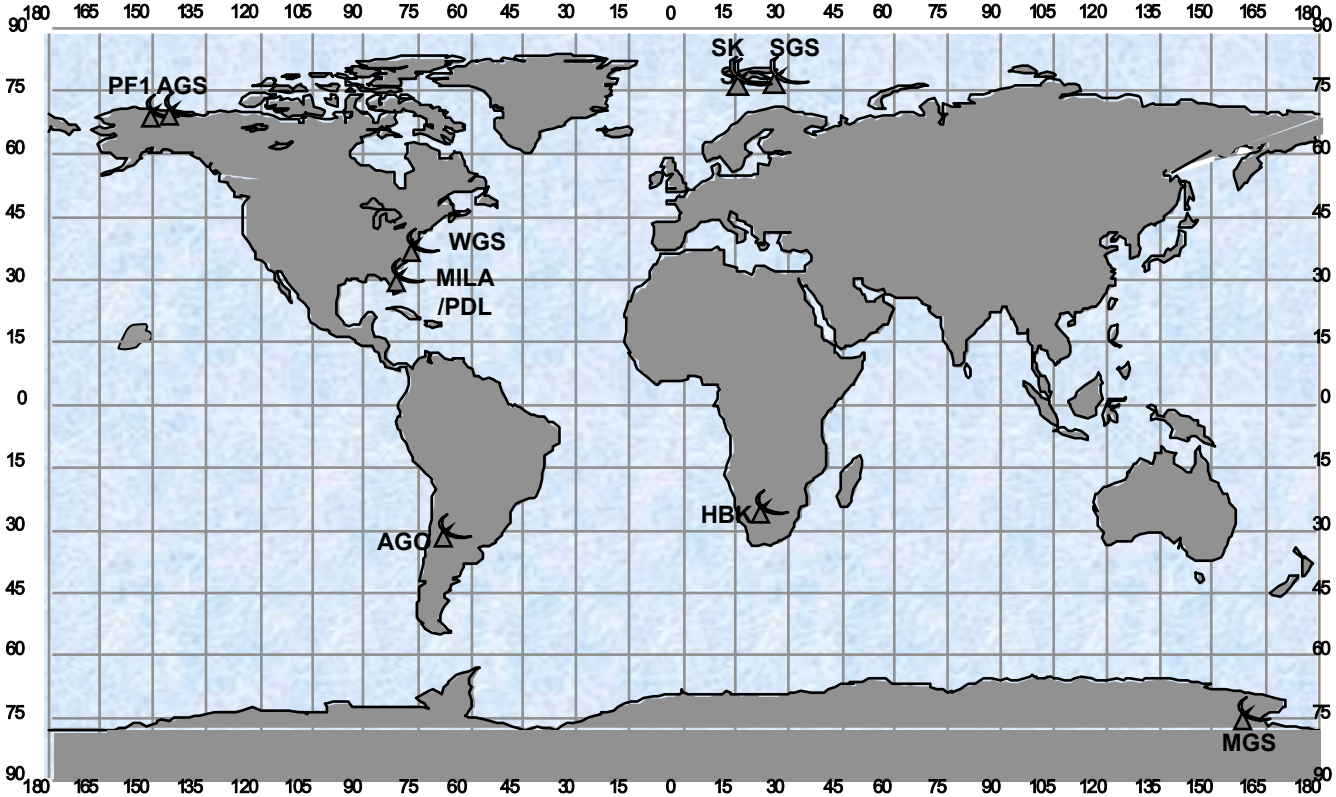




Space Operations Roles at GSFC



Ground Network Stations



AGO – Santiago Ground Station, Santiago Chile
AGS – Alaska Ground Station, Poker Flat Alaska
HBK - Hartebeesthoek Ground Station, South Africa
MILA/PDL – Merritt Island Launch Annex/Ponce De Leon, Florida

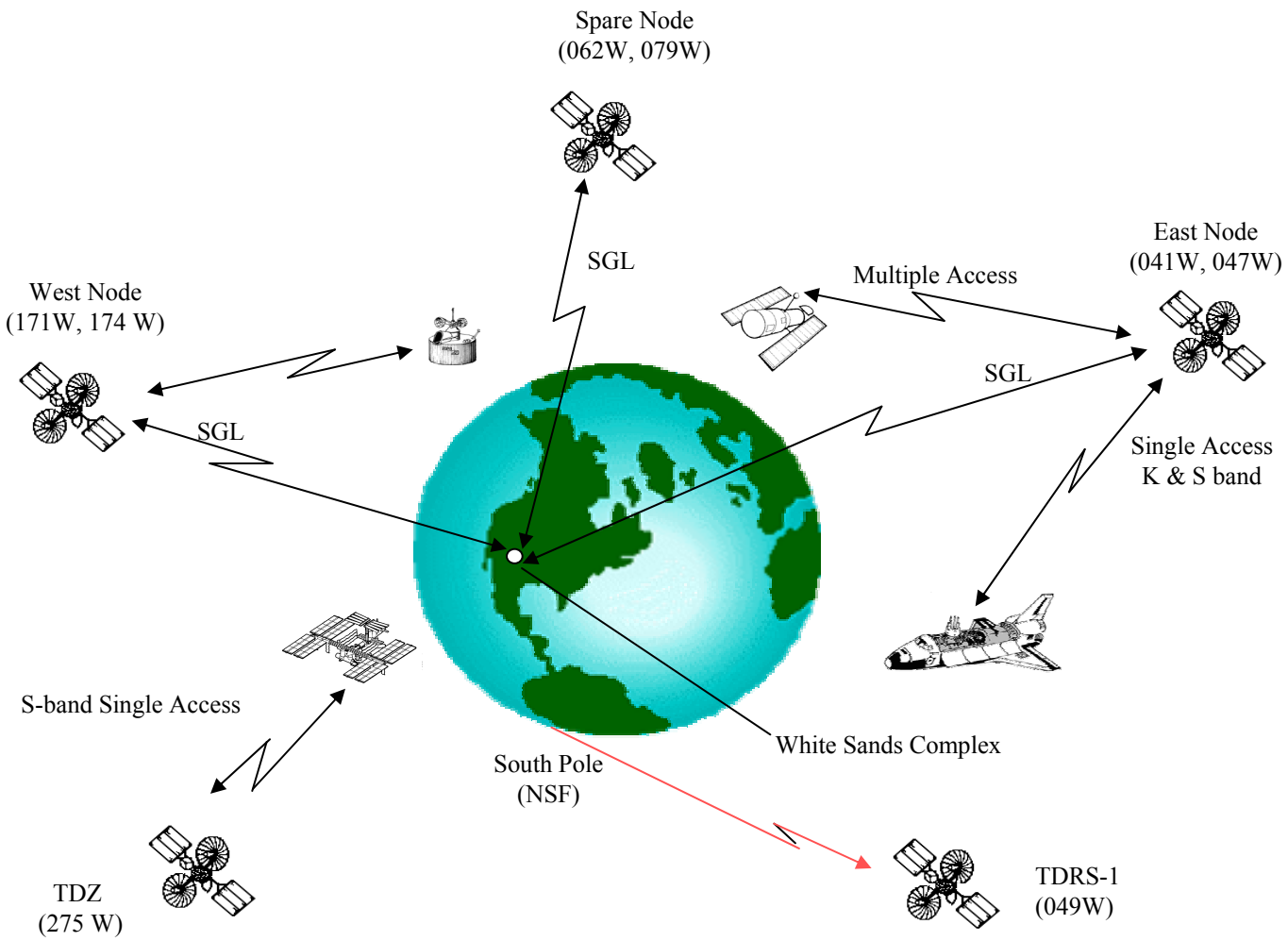
PF 1 – Poker Flat One, Poker Flat Alaska
MGS – McMurdo Ground Station, Antarctica
SGS – Svalbard Ground Station, Svalbard Norway
SKS – Svalbard Kongsberg Station, Svalbard Norway
WGS – Wallops Ground Station, Wallops Island Virginia

The Near Earth Orbit Ground Network

SGS, Longyearbyen, Spitzbergen, Norway

WGS, Wallops Flight Facility, Wallops Island, Virginia

Tracking and Data Relay Satellite System Baseline Configuration



White Sands Complex

A major element of the ground segment is the White Sands Complex (WSC) which is located near Las Cruces, New Mexico. It consists of two functionally identical ground terminals, the White Sands Ground Terminal (WSGT) and the Second TDRSS Ground Terminal (STGT). Each ground station employs three 18/19m diameter high-gain antennas.

The scheduling function was moved from GSFC for the SN & GN to the Data Systems Management Center at WSC in June 2002.

Another component of the WSC is the Guam Remote Ground Terminal (GRGT). The GRGT allows for the closure of the the Zone of Exclusion.

Tracking and Data Relay Satellites

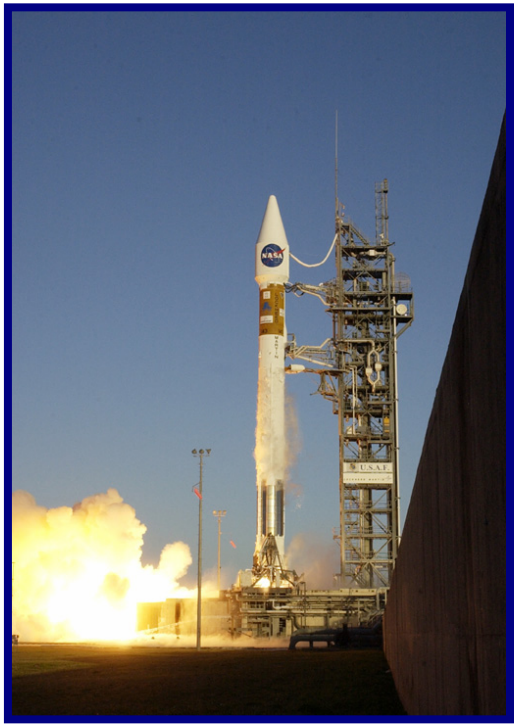
First Generation TDRS
F-1 through F-7

Second Generation TDRS
F-8 through F-10

TDRS-I and TDRS-J Launched in 2002

The TDRS System is the primary source of space-to-ground voice, data and telemetry for the Space Shuttle. It also provides communications with the International Space Station and scientific spacecraft in low-Earth orbit such as the Hubble Space Telescope. This new advanced series of satellites will extend the availability of TDRS communications services beyond 2010.

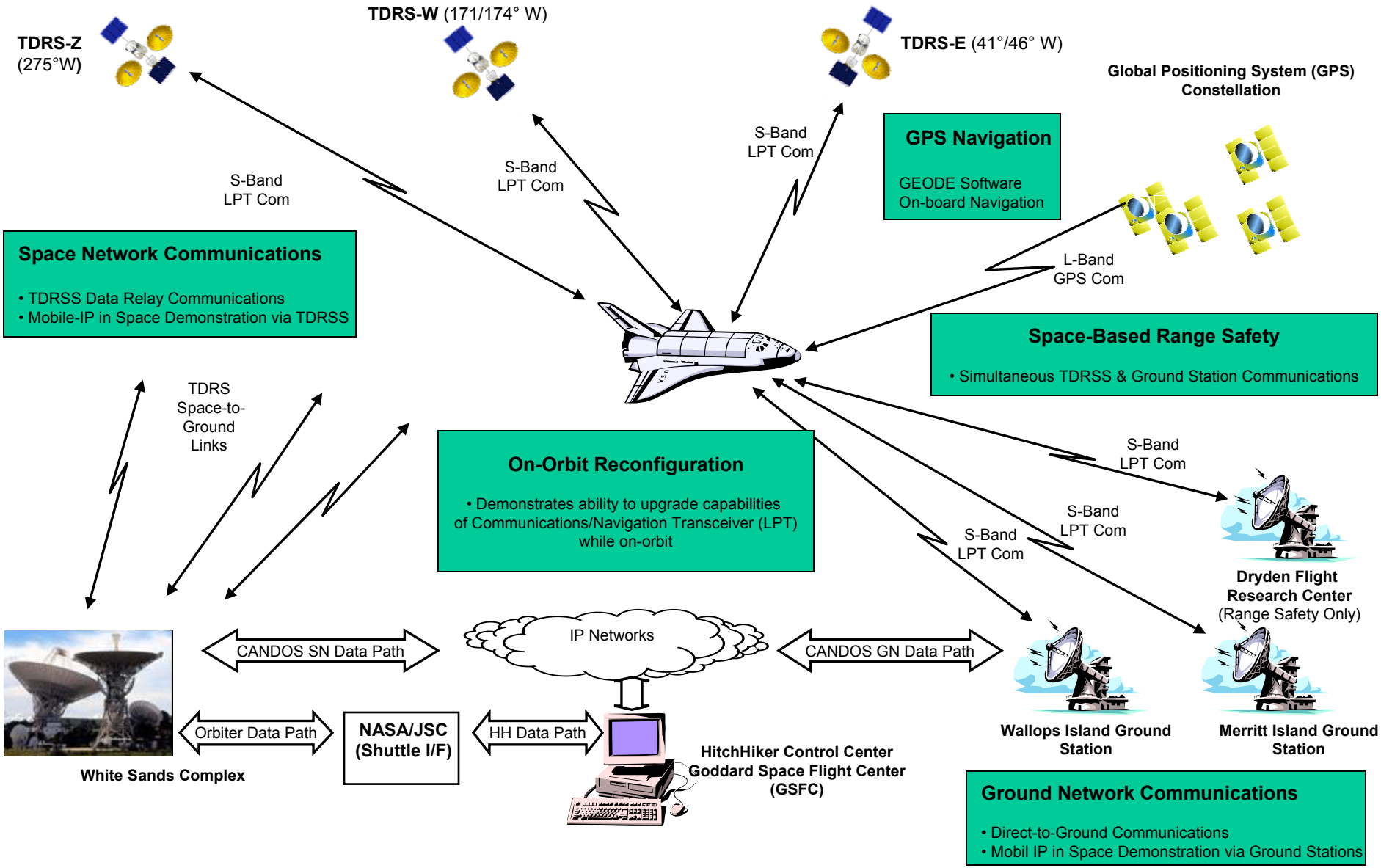
TDRS H,I,J

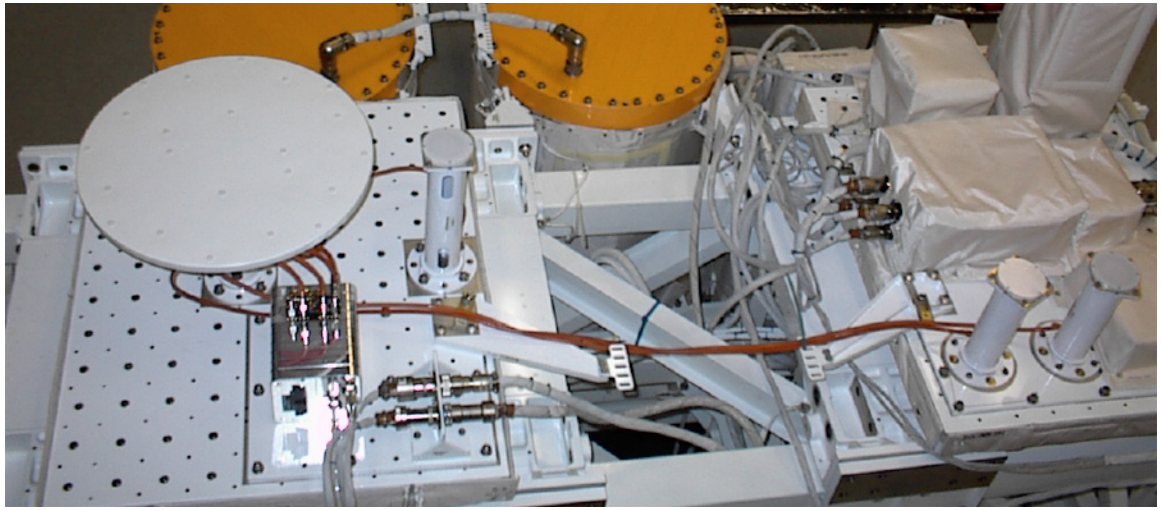


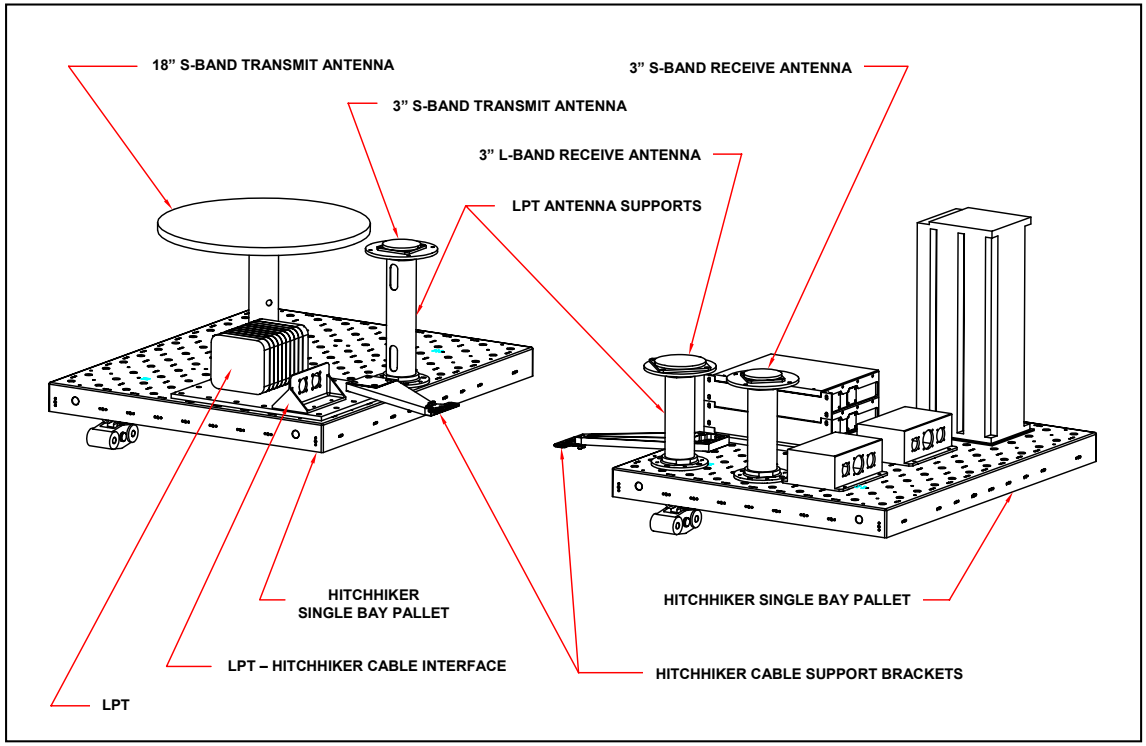
March 8th : TDRS-I successfully launched at 5:59 p.m. EST

December 4th: TDRS-J successfully launched at 9:42 p.m. EST

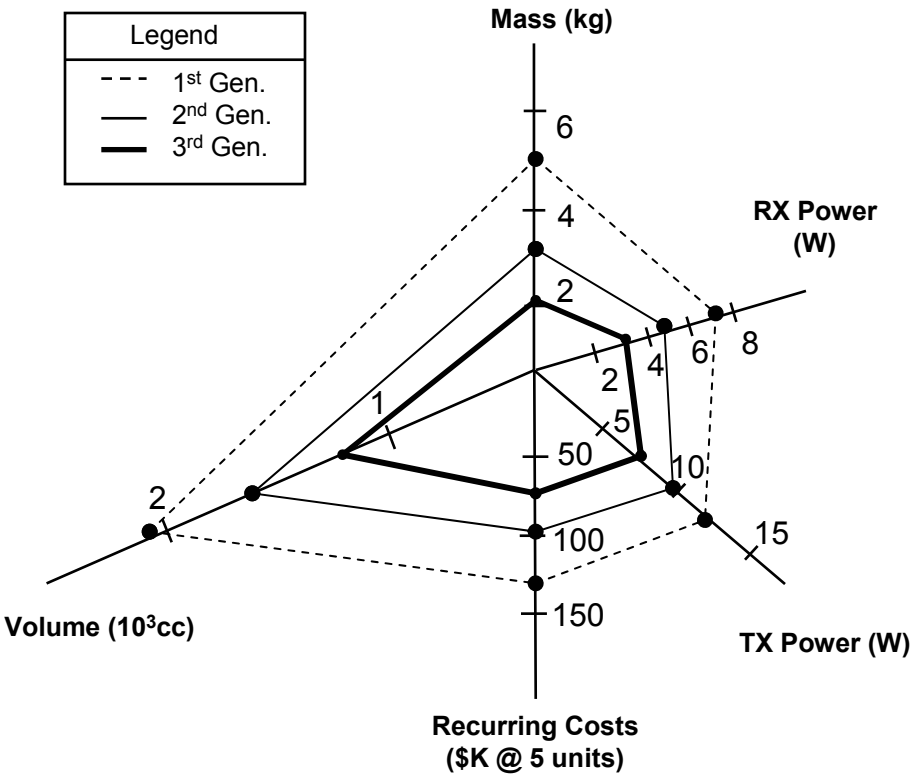
Communications And Navigation Demonstration on Shuttle (CANDOS)






18" S-BAND TRANSMIT ANTENNA
3" S-BAND RECEIVE ANTENNA
3" S-BAND TRANSMIT ANTENNA
3" L-BAND RECEIVE ANTENNA
LPT ANTENNA SUPPORTS
HITCHHIKER
SINGLE BAY PALLET
HITCHHIKER SINGLE BAY PALLET
LPT – HITCHHIKER CABLE INTERFACE
HITCHHIKER CABLE SUPPORT BRACKETS
LPT

SN & GN Technology and Upgrades
Communications Development
S-Band Communication and Navigation
- Low Power Transceiver (LPT) -



* All generations may be augmented with 10W or 30W HPAs

Key Features:

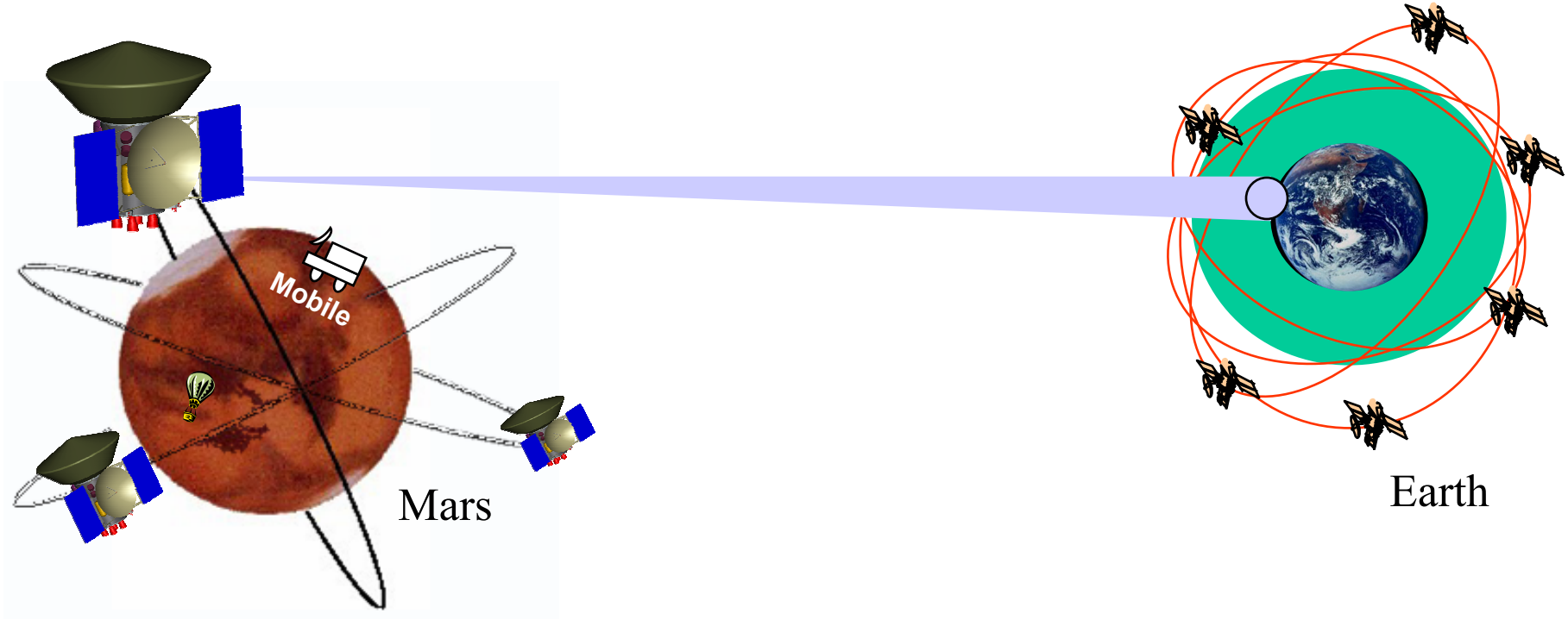
Generation 1:
- S-Band Tx/Rx Communications
- L-Band GPS C/A Navigation
- Ruggedized Chassis

Generation 2:
- Increased channel capacity
- Adaptive Beamforming
- Multi-User Detection
- Rake Receiver
- 20% reduction in size, power, weight

Generation 3:
- Integrated Tx and Rx layers
- Additional Channel Capacity
- Improved Signal Processing
- 33% reduction in size, power, weight

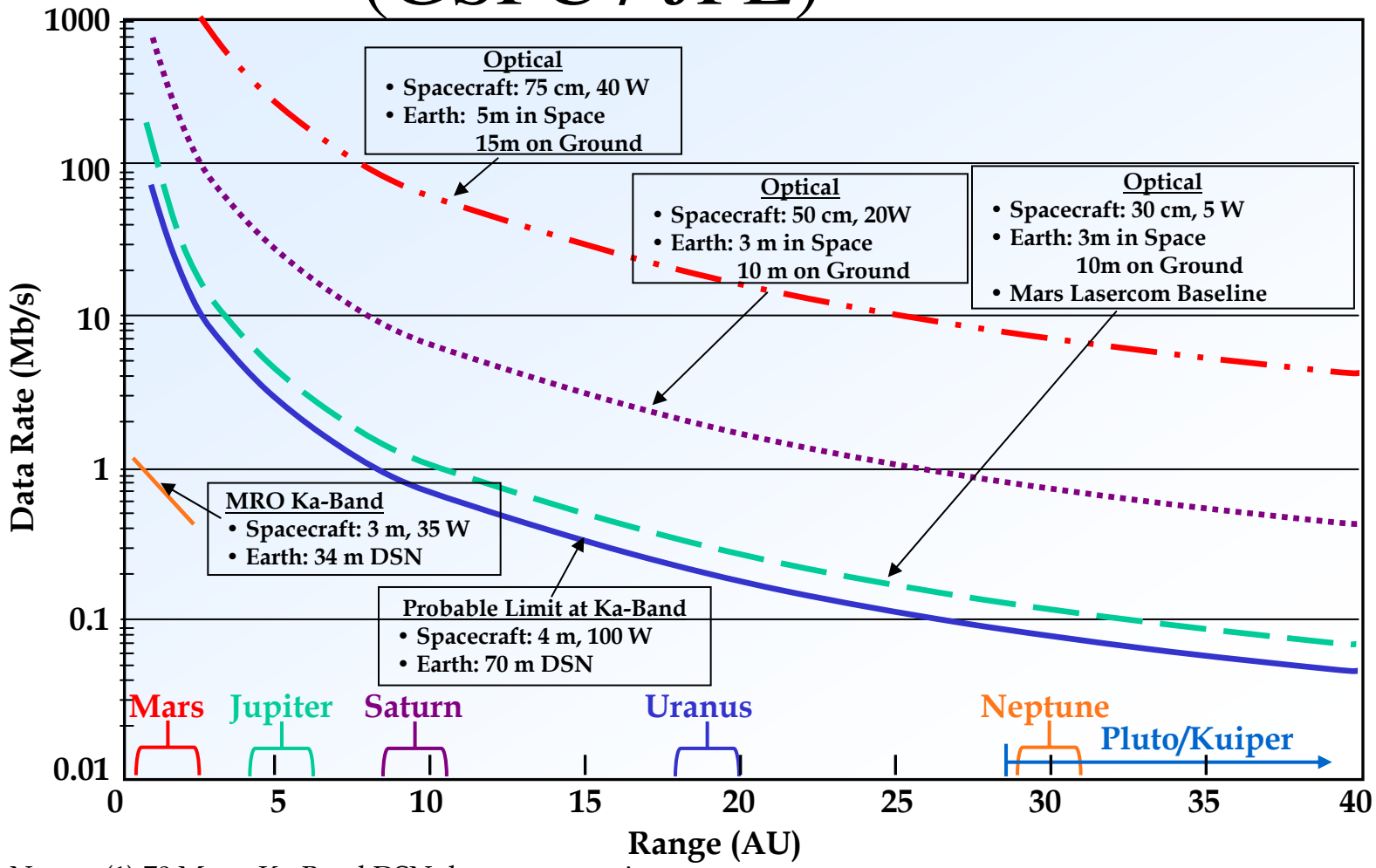
	Generation 1 Specification	Generation 2 Specification	Generation 3 Specification
Number of communications and navigation channels	12	16	16-32
S-Band Receive and Transmit	Y	Y	Y
L-Band Receive	Y	Y	Y
SN and GN Communication	Y	Y	Y
GPS Navigation	Y (point solution only)	Y (Geode SW requires an additional CPU layer)	Y (GPS software integrated into “core” hardware)
Mass	4.5 kg	3 kg	2 kg
Rx Drain	7 W	5 W	3.5 W
Tx RF Output	1 W*	1 W*	1 W*
Tx/Rx Drain	12W	10W	7.5W
Volume	11 x 14.5 x 12.7 cm	11 x 13.5 x 12 cm	7.3 x 13.5 x 12 cm
Qualification	Terrestrial; Air; Short Duration Space Flight	Terrestrial; Air; Short Duration Space Flight	Flying on CADOS (STS-107) and selected for USAF AFRL’s TecSat

MARS Laser Communications Demonstration



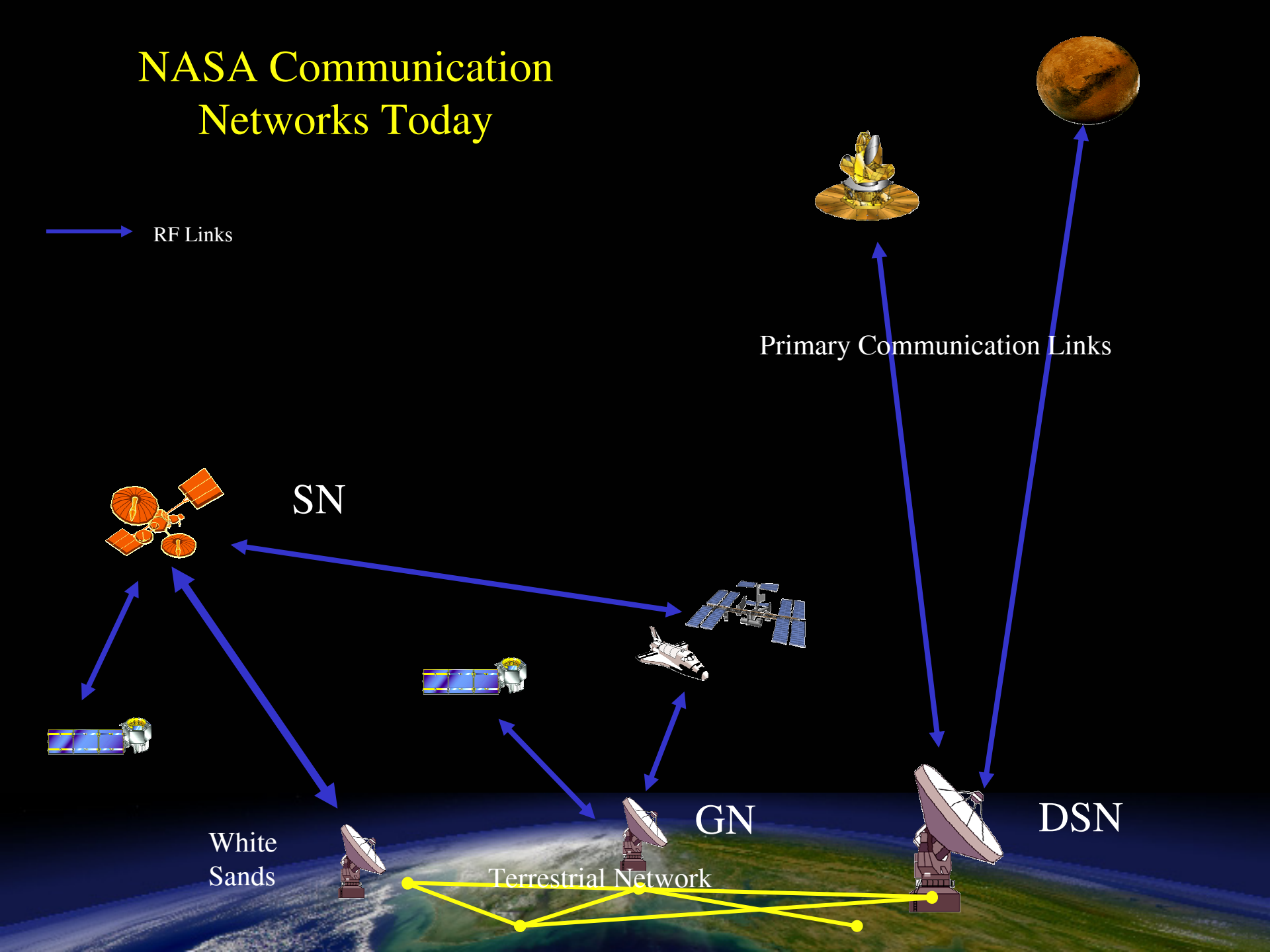
- Laser Comm will revolutionize Space Exploration
  - Order of magnitude higher data rates (Demo up to 200Mb/s from MARS)
  - Earth Science like science at the outer planets
- Mars Reconnaissance Orbiter will take 21 months to map 20% of the surface of Mars.
  - Laser Comm could enable the <u>entire</u> Martian surface to be mapped in a few months.
- Demonstration scheduled to fly on MARS Telecom Orbiter 2009
- LaserComm is a Prominent (Page 3) initiative in NASA's Strategic Plan

The Potential of Laser Communications (GSFC / JPL)

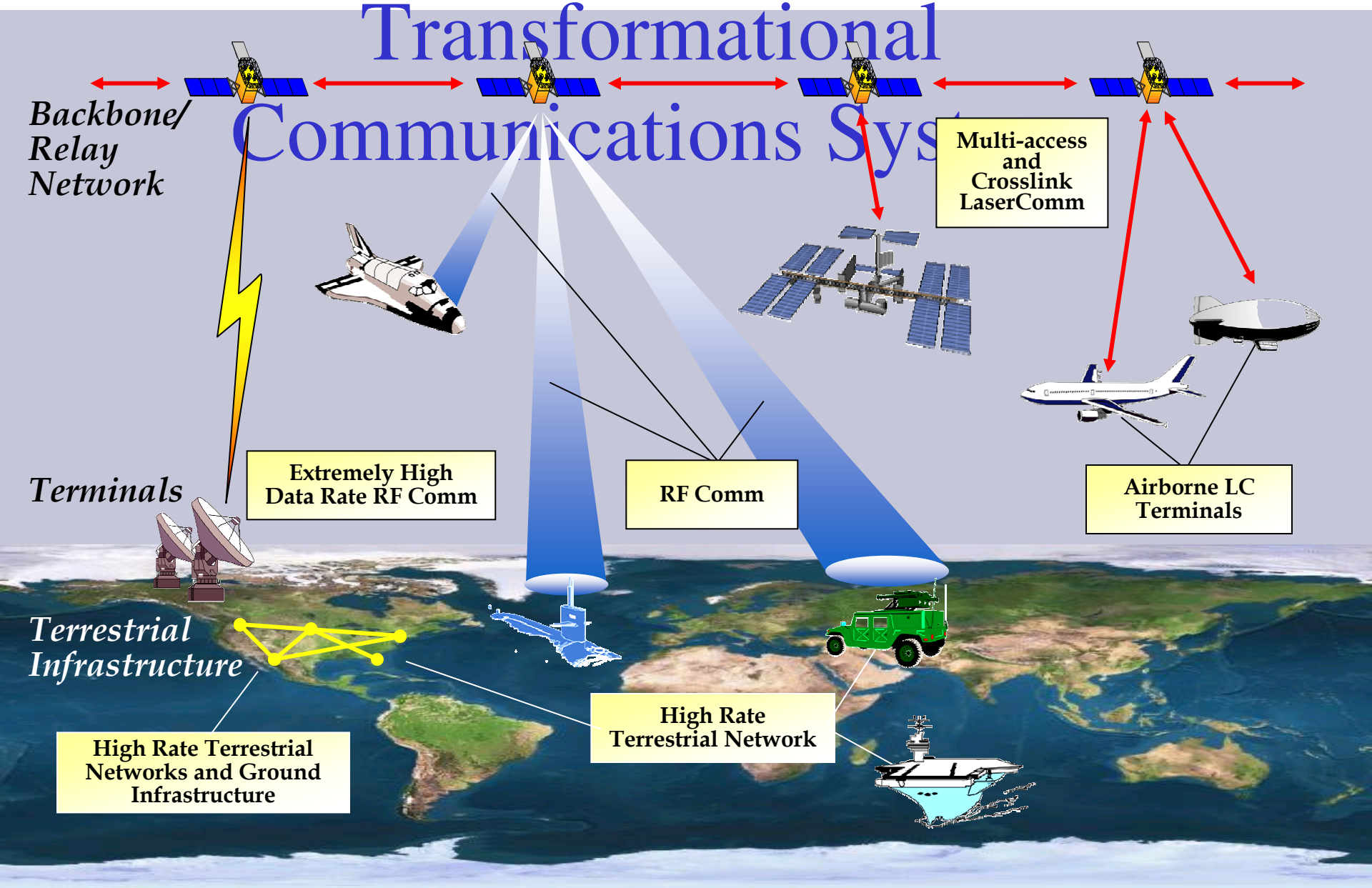


Notes: (1) 70 Meter Ka-Band DSN does not yet exist
(2) 3 meter in space performance can be matched by 10 m on Earth only for close planets (MIT/LL Study)

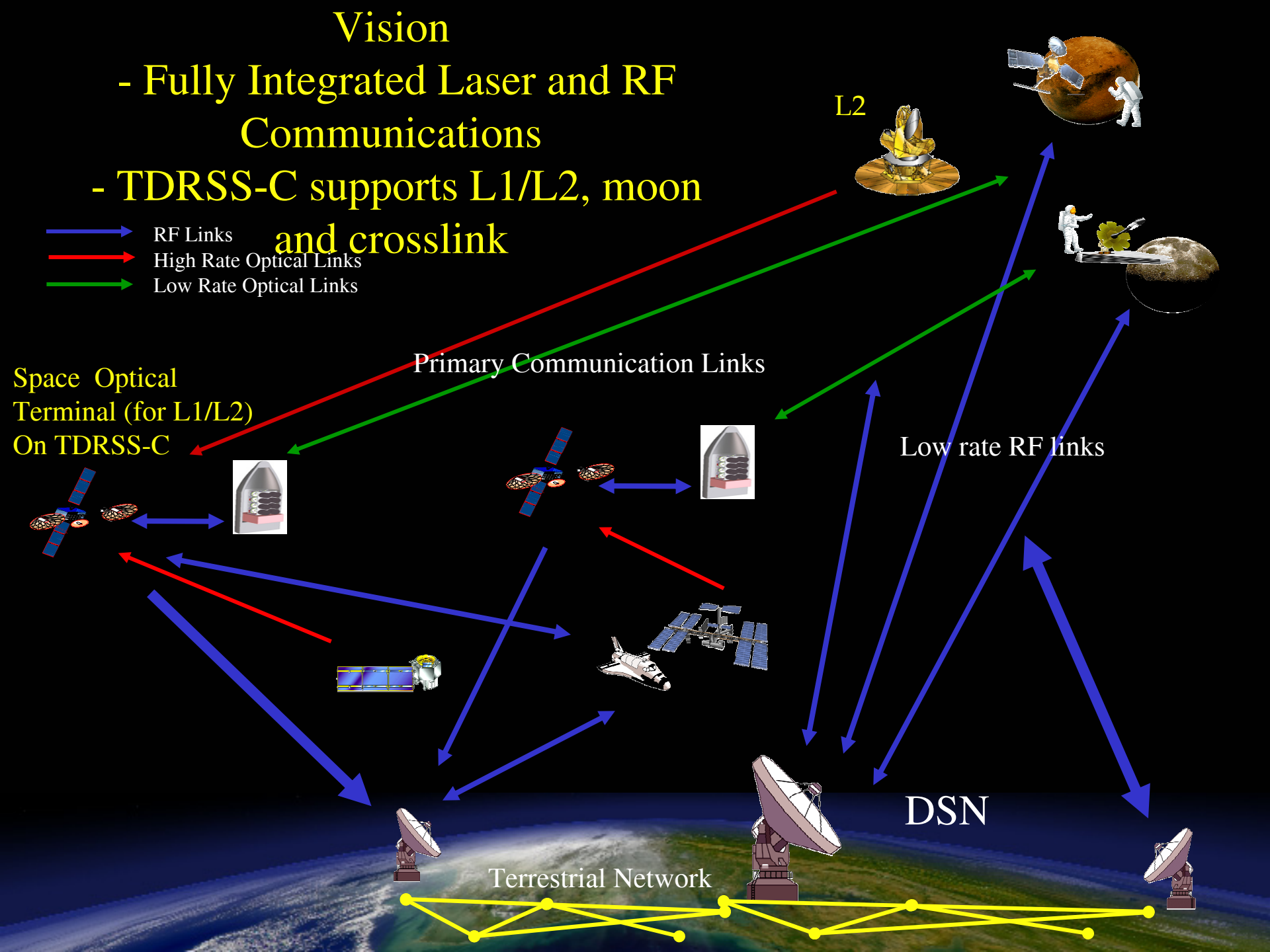
NASA Communication Networks Today



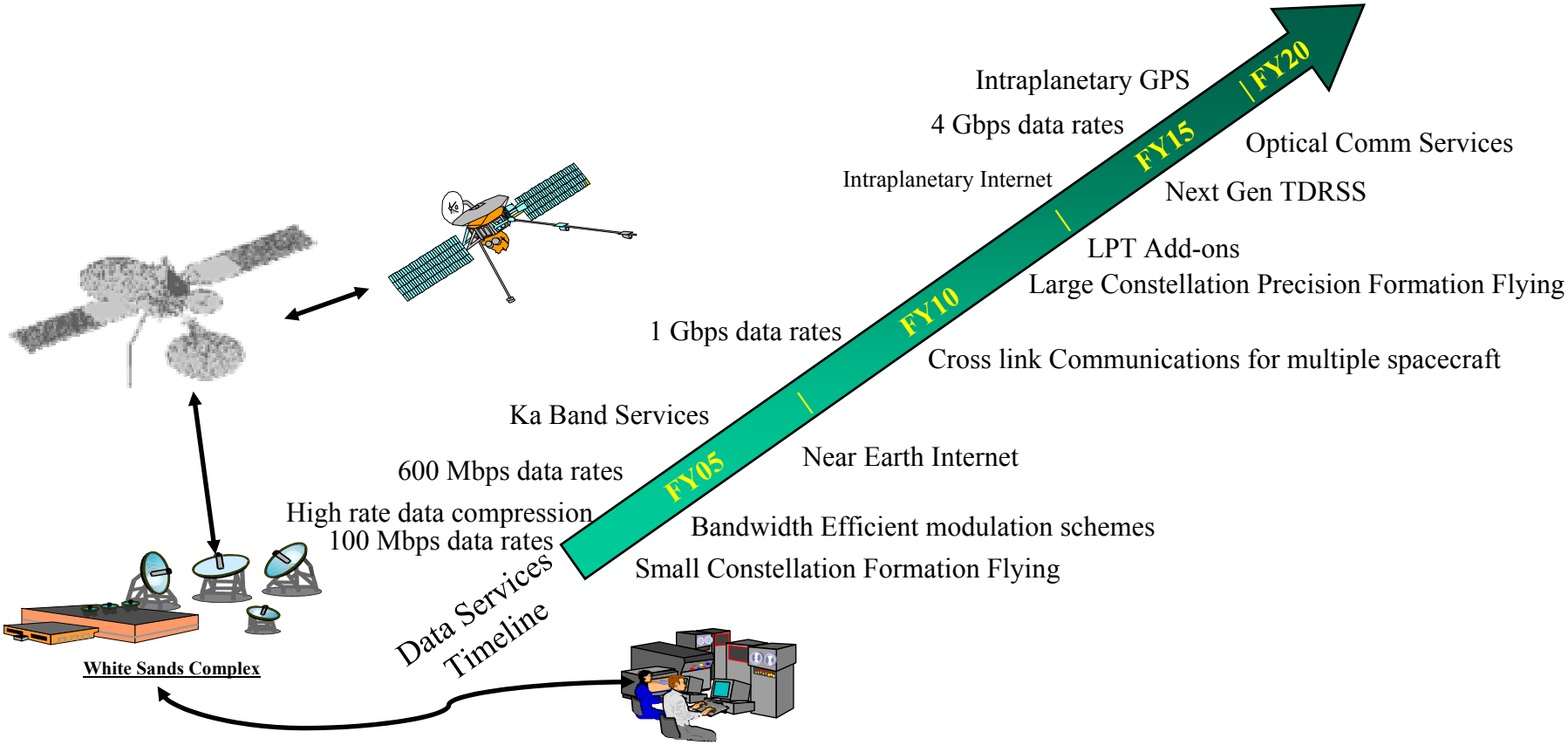
The United States Transformational Communications System



Vision
- Fully Integrated Laser and RF Communications
- TDRSS-C supports L1/L2, moon and crosslink

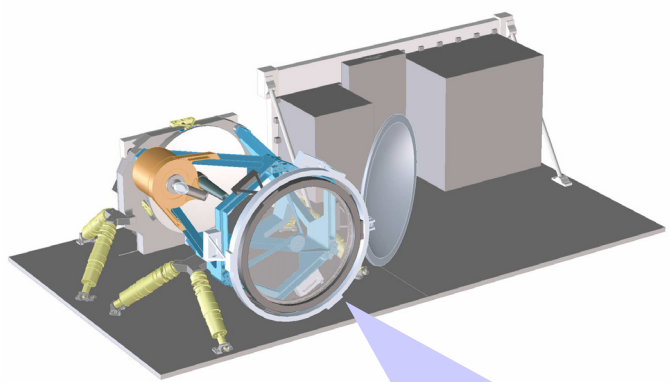


"Technology Path to the Future"



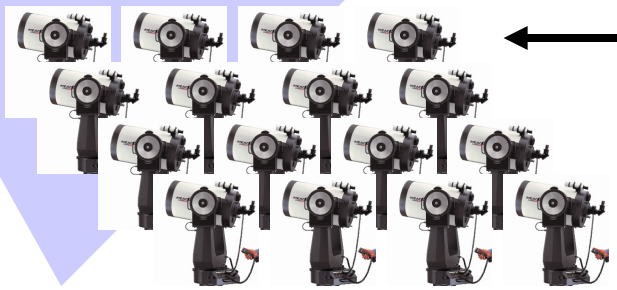
Backup Charts

Telesat Lasercom Approach



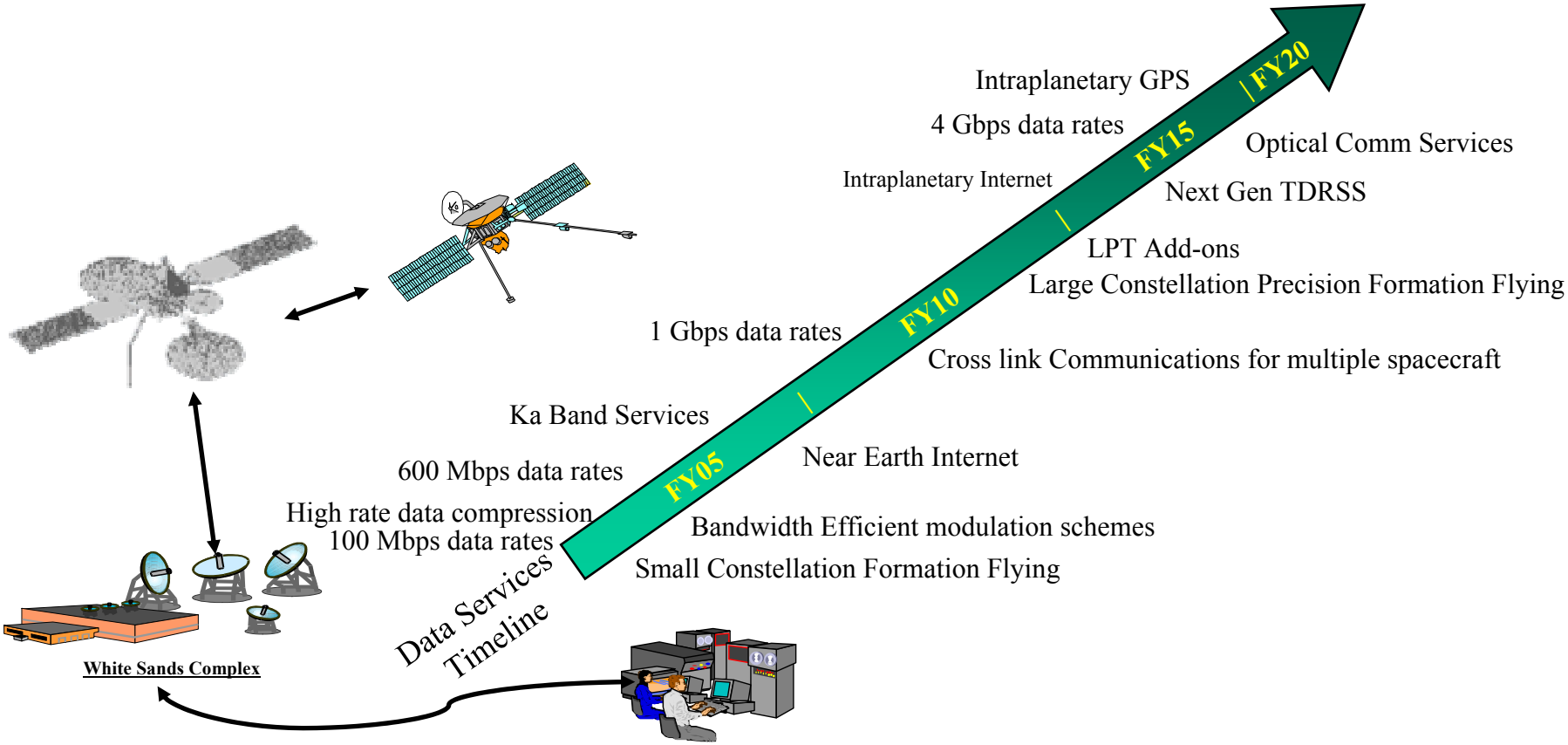
- 5 W Yb doped-fiber amplifier (1.06 μm)
- High order PPM with concatenated coding
- 30 cm telescope
- Hybrid inertial/beacon pointing & stabilization

- Networked array of small telescopes
- TE-cooled, photon-counting APD arrays
- Iterative decoding



Central processor:
-Pointing
-Timing
-Demod/decode

"Technology Path to the Future"

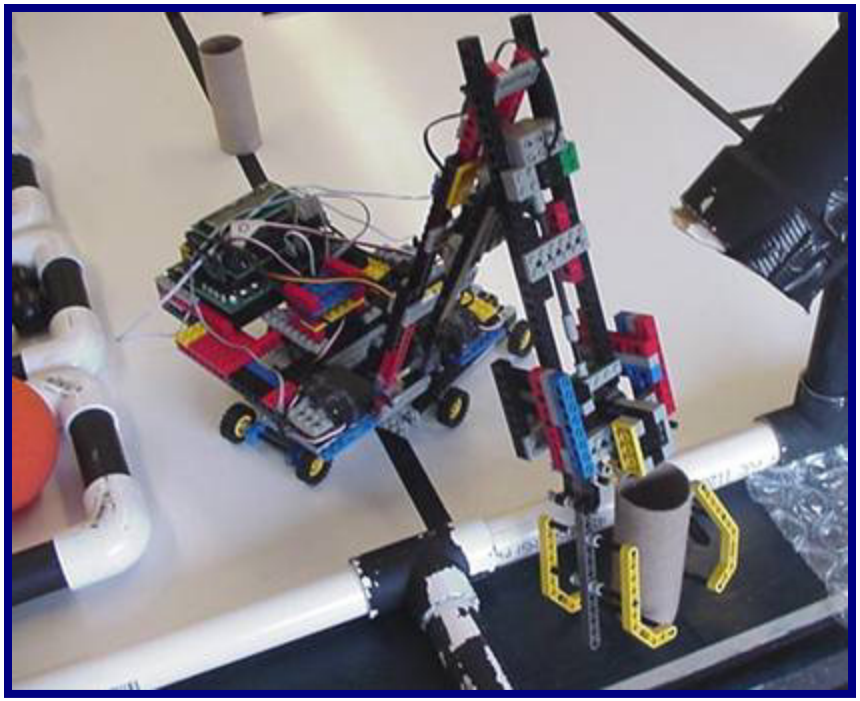


TDRS Project Outreach Activities

Project supports FIRST Robotics and Botball Competitions

For the second year in a row, the TDRS Project has provided financial support to the Hope Chapel Academy's Beach Bot team's participation in the FIRST (For Inspiration and Recognition of Science and Technology) Robotics Competitions. Also, for the second consecutive year, the Project has supported the Washington, DC Botball competition event.

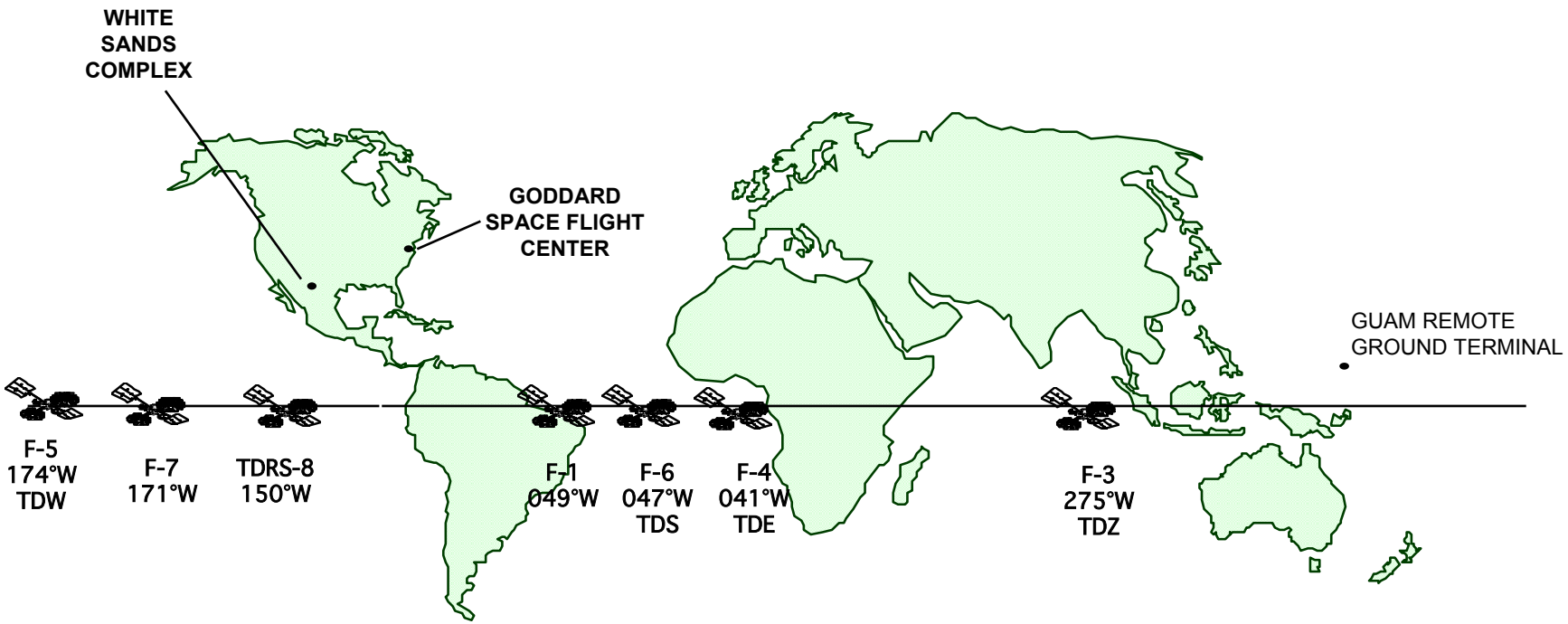
FIRST Robotics Competition



District of Columbia Botball Competition

Space Network

TDRS Constellation

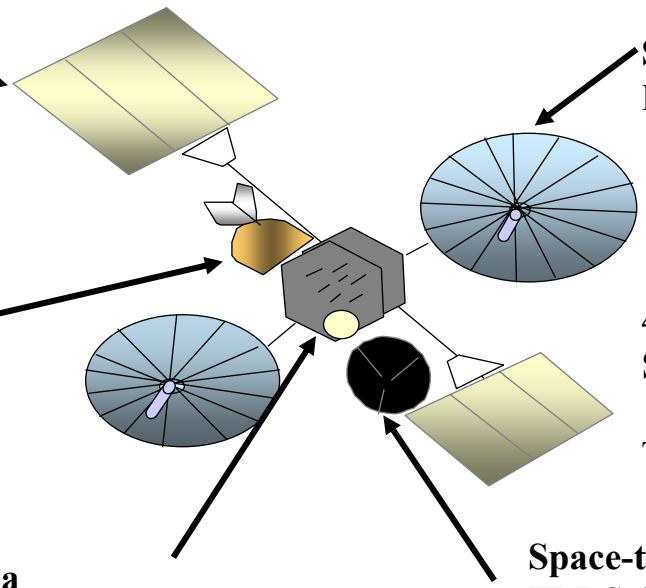


TDRS I & J have not yet been accepted by NASA

In a typical month the SN supports between 5,500 and 6,000 scheduled customer service events

Tracking and Data Relay Satellite (F1 - F7)

Solar array
Power output is approximately 1800 watts



Single Access Antenna
Dual frequency communications and tracking functions:
- S-band TDRSS (SSA)
- K-band TDRSS (KSA)
- K-band auto-tracking

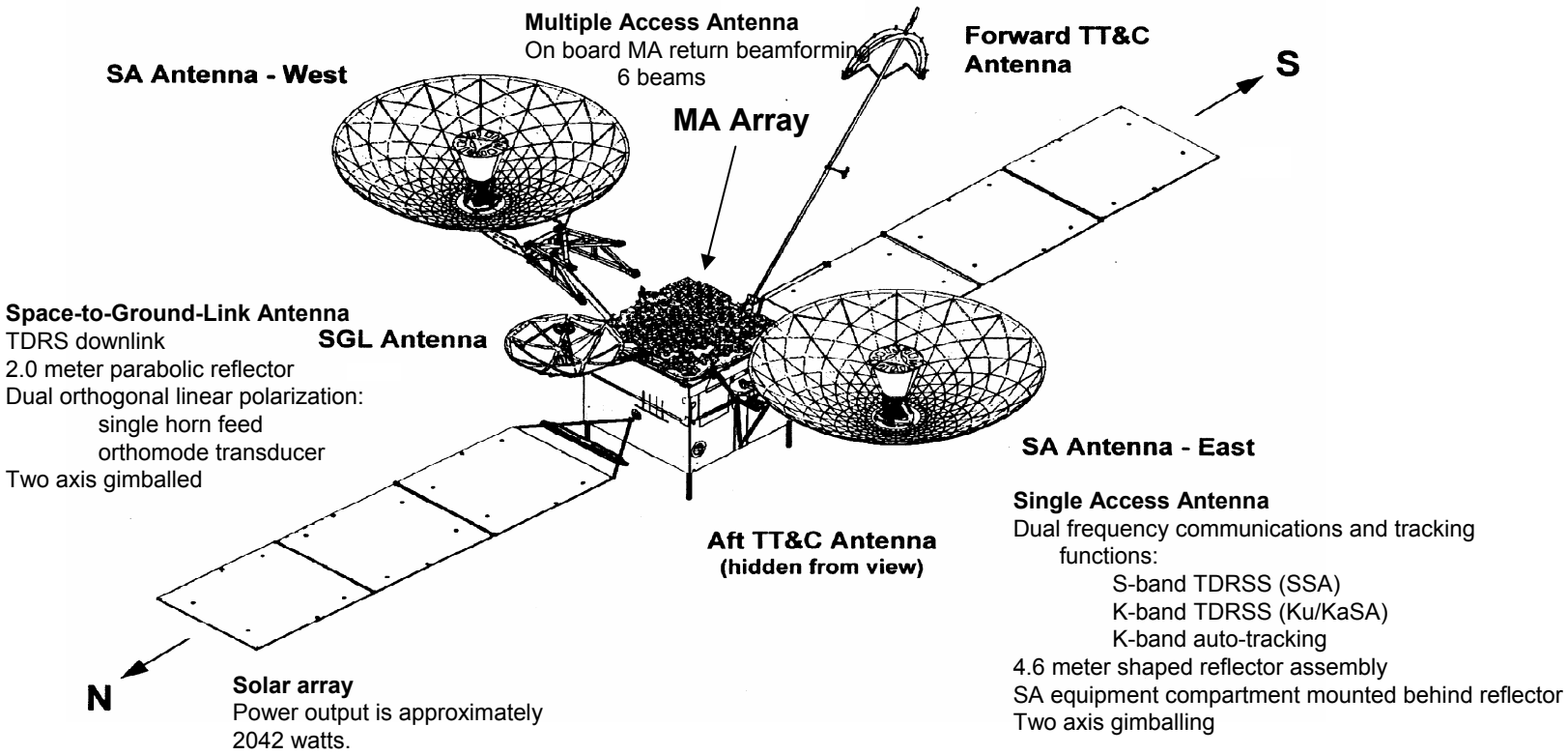
4.9 meter shaped reflector assembly
SA equipment compartment mounted behind reflector
Two axis gimballing

Omni Antenna (S-band) and Solar Sail

Multiple Access Antenna
30 helices:
- 12 diplexers for transmit
- 30 receive body mounted

Single commanded beam, transmit
20 adapted beams for receive
Ground implemented receive function

Space-to-Ground-Link Antenna
TDRS downlink
2.0 meter parabolic reflector
Dual orthogonal linear polarization TDRS:
- single horn feed
- orthomode transducer

Two axis gimballed

Tracking and Data Relay Satellite (H, I, J)