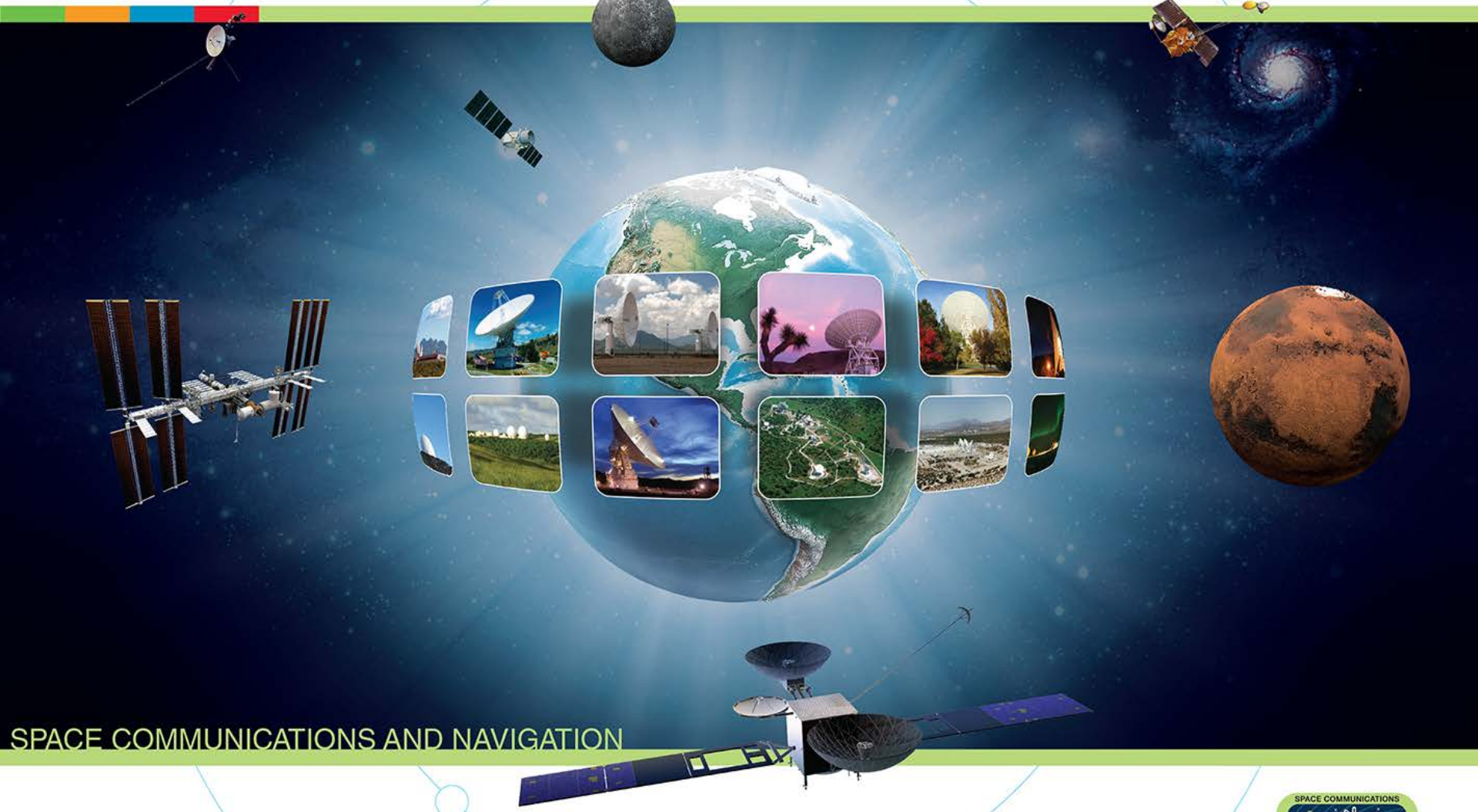
National Aeronautics and Space Administration



The Future Architecture of Space Communications and Navigation

Badri Younes, Deputy Associate Administrator

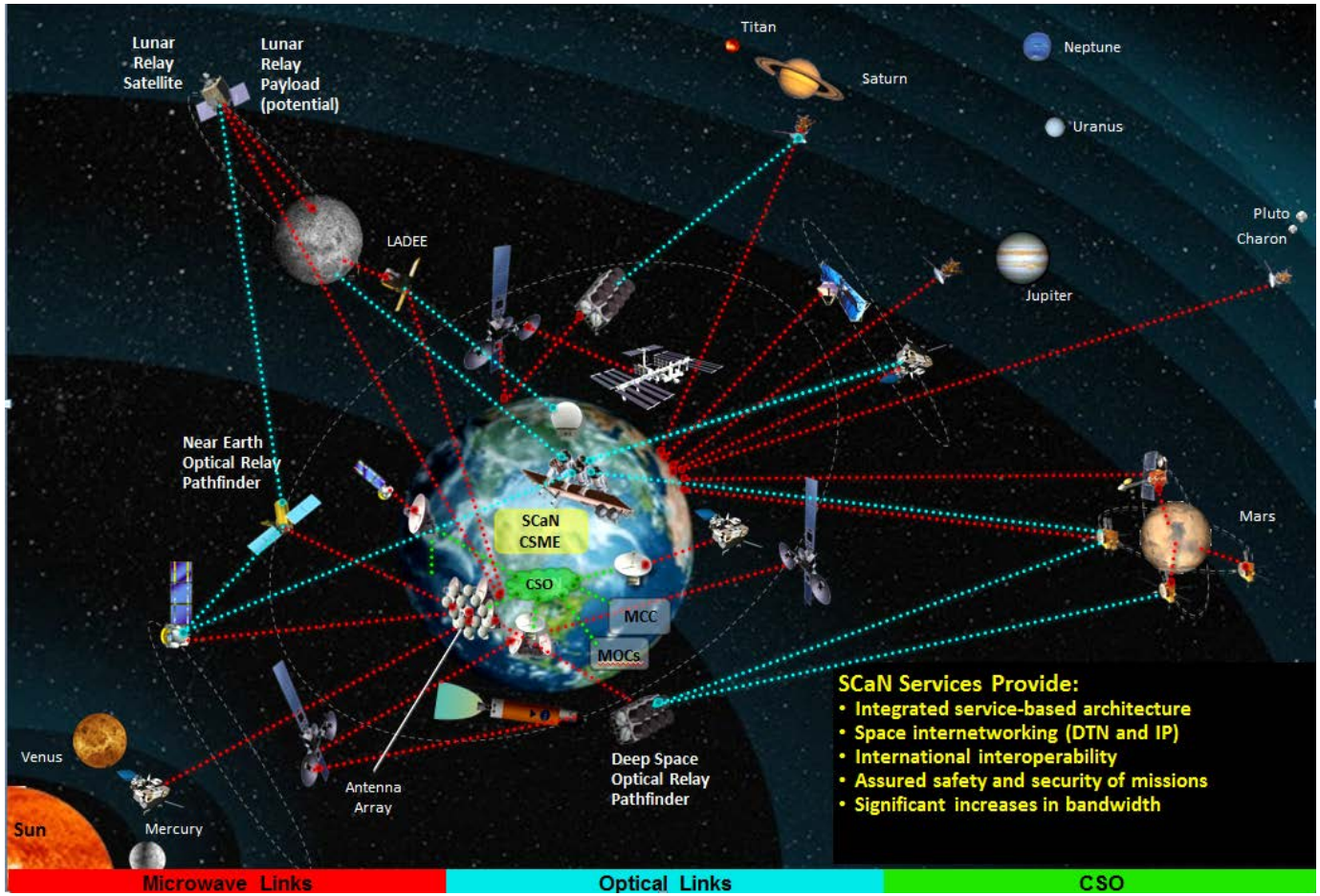
January 23, 2013

www.nasa.gov

SPACE COMMUNICATIONS SCaN AND NAVIGATION

What Do We Do?

We connect spacecraft with Earth through world-class communication and navigation capabilities.

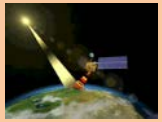


SCaN Network

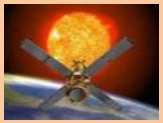
Human Spaceflight Missions

Sub-Orbital Missions

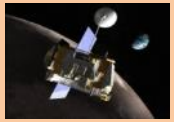
Earth Science Missions



Space Science Missions



Lunar Missions



Solar System Exploration

Alaska Satellite Facility, Fairbanks

USN Alaska Poker Flat & North Pole

Gilmore Creek, Alaska (NOAA)

Wallops, Virginia Ground Station

KSAT Svalbard, Norway

SSC Kiruna, Sweden

USN Germany Weilheim

KSAT – Kongsberg Satellite Services
SSC – Swedish Space Corporation
USN – Universal Space Network

KSAT Singapore, Malaysia

Goldstone Complex California

Guam Remote Ground Terminal

USN Hawaii South Point

Canberra Complex Australia

White Sands Ground Station New Mexico

USN Australia Dongara

DSN
NEN
SN

White Sands Complex New Mexico

SSC Santiago, Chile

Madrid Complex Spain

KSAT TrollSat, Antarctica

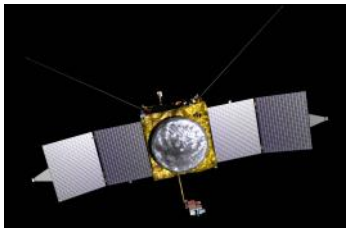
SA National Space Agency Hartebeesthoek, South Africa

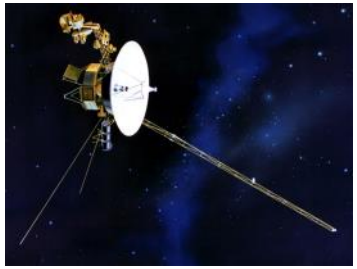
McMurdo, Antarctica Ground Station

Overview of the Three Networks

Deep Space Network

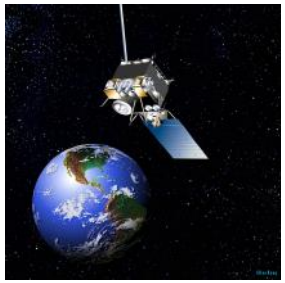
Large, slow-tracking antennas located ~ 120 degrees apart around the Earth – optimized for tracking spacecraft beyond Geosynchronous Orbit (GEO)





Near Earth Network

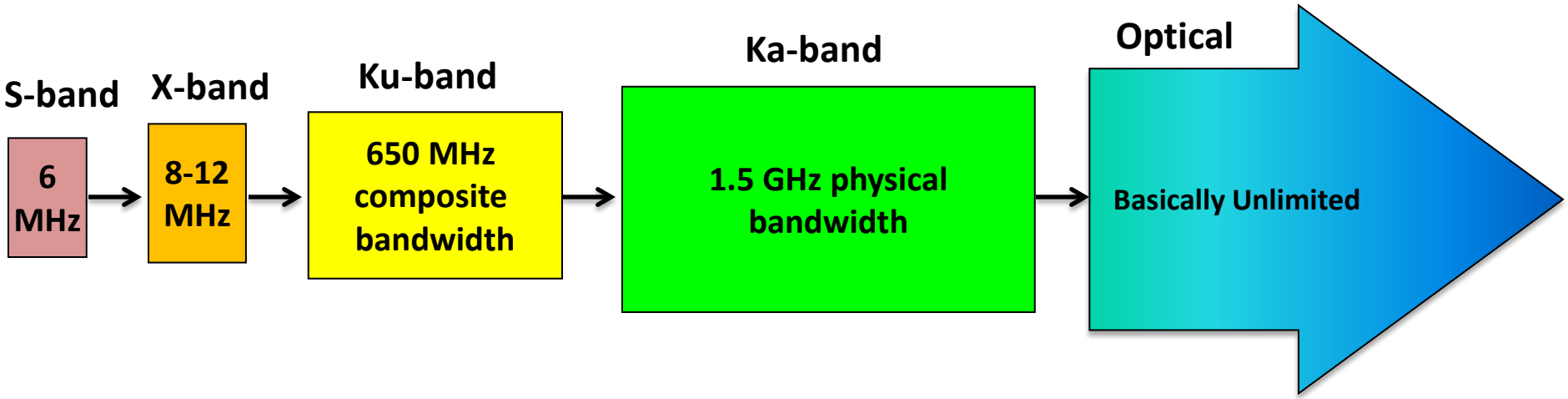
Small, fast-tracking antennas in many locations – optimized for short-pass tracking of Low Earth Orbit (LEO) spacecraft



Space Network

Downward-looking Earth-orbiter-based antennas – optimized for highly-capable LEO spacecraft, including human spaceflight

Downlink Bandwidth Capability



- Lower bands (S-band, X-band) provide limited bandwidth, low data rates (downlink limited by SFCG Recommendations)
- Spectrum below 10 GHz is heavily used /shared and under increasing pressure for re-allocation to commercial wireless
- Ku-band allocation is secondary and faces increasing risk from “mobile” VSAT satellite uses
- Way Forward:
  - Increase usage of Ka-band, both deep space and near Earth
  - Ultimate use of optical technology

Lunar Laser Communications Demonstration (LLCD)

LADEE launch from Wallops Island, VA

LADEE Spacecraft

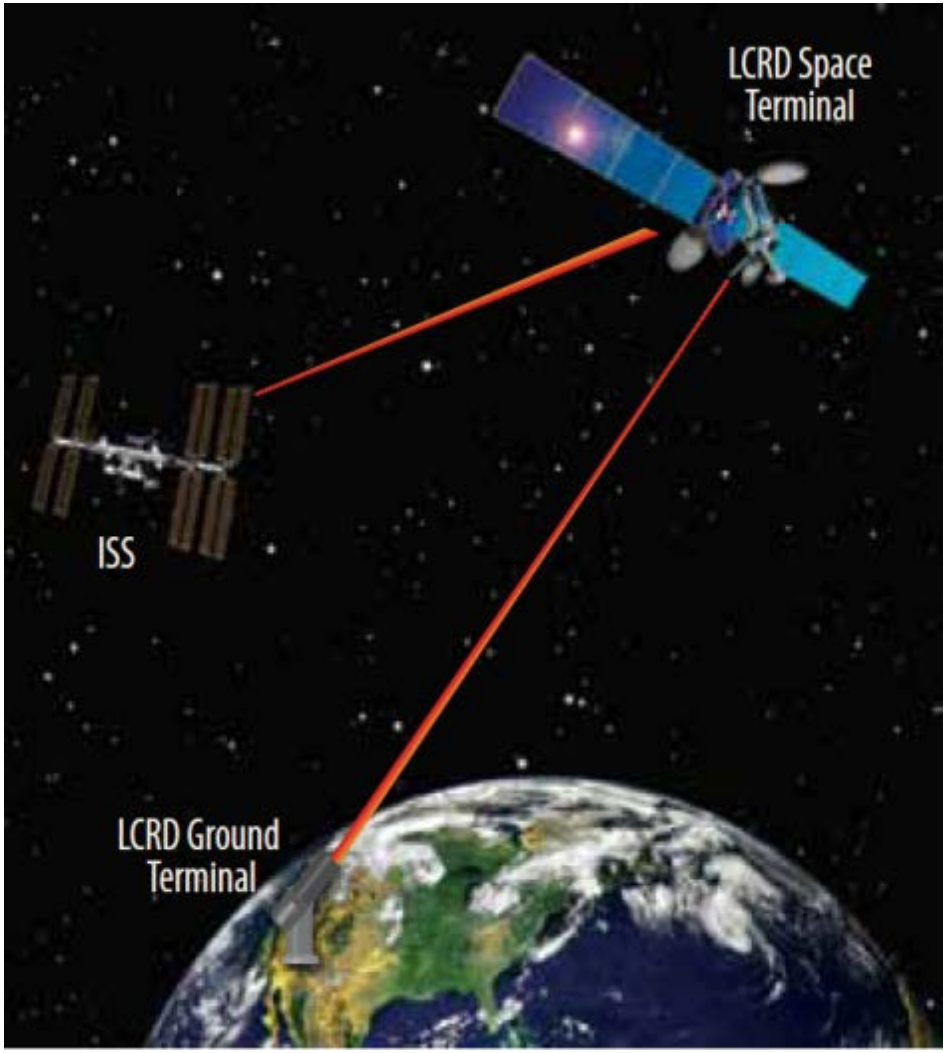
Primary Ground Terminal White Sands, NM

Lunar Laser Communications Demonstration (LLCD) onboard Lunar Atmosphere and Dust Environment Explorer (LADEE) – launched September 6 from Wallops Island, VA

- LLCD is critical to validate optical communications technology for future space communications

- LLCD transmitted data from lunar orbit to Earth at a rate of 622 megabits per second (Mbps) on October 18
  - Upload rate was 20 Mbps
  - White Sands, NM received the signals
- LLCD transmitted data from lunar orbit to Tenerife, Canary Islands on October 26 at 40 Mbps
- The LLCD Demonstration has confirmed the overall optical communication architecture, both flight and ground, that SCaN has developed over the past 10 years

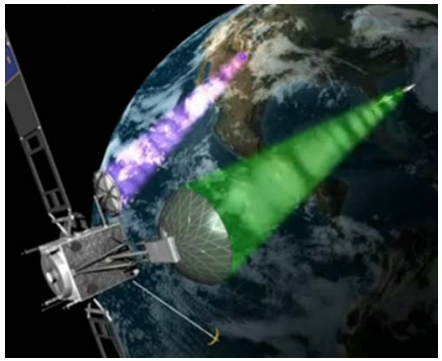
Laser Communications Relay Demo (LCRD)



- LCRD will fly in 2017 and demonstrate optical communication for possible inclusion in NASA's Next Generation Tracking and Data Relay Satellite (TDRS).
- LCRD will be a network node with two optical terminals based on the LLCD design.
- Data transfer will be at variable data rates up to 2.8 Gbps.
- Onboard processing will implement Disruption Tolerant Networking (DTN) protocols to help address atmospheric conditions.

Space Network of the 2020's

Current



Sensor Web Capability
Schedule Free Service

Future

Software Radios
Formation Flyers

Future Capabilities of the Space Network

- Backward Compatible →
  - Ku-Band (300 Mbps)
  - Ka-Band (550 Mbps)
  - SSA (6 Mbps)
  - MA (300 Kbps)
  - DAS
  - IP/SLE/CCSDS
  - Beacon
  - SNAS
- Full 2-way Demand Access
- Ka-Band (1.2 to 1.5 Gbps)
- Multiple Access Enhancements
  - Beacon
  - Frequency and polarization flexibility
- Optical
  - Low Earth Orbit Including Optical Multi Access
  - L1/L2 (Lagrangian Points)
  - Deep Space

Future Characteristics of the Space Network

- Government/Commercial Partnerships
- Reduction of size, weight, power, and cost
- Increased efficiency and capacity
- Increased service flexibility
- Ideas that leverage new technology
- Next Generation Relay Satellites

For more information, visit NASA:

www.nasa.gov

or

Space Communications and Navigation (SCaN):

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