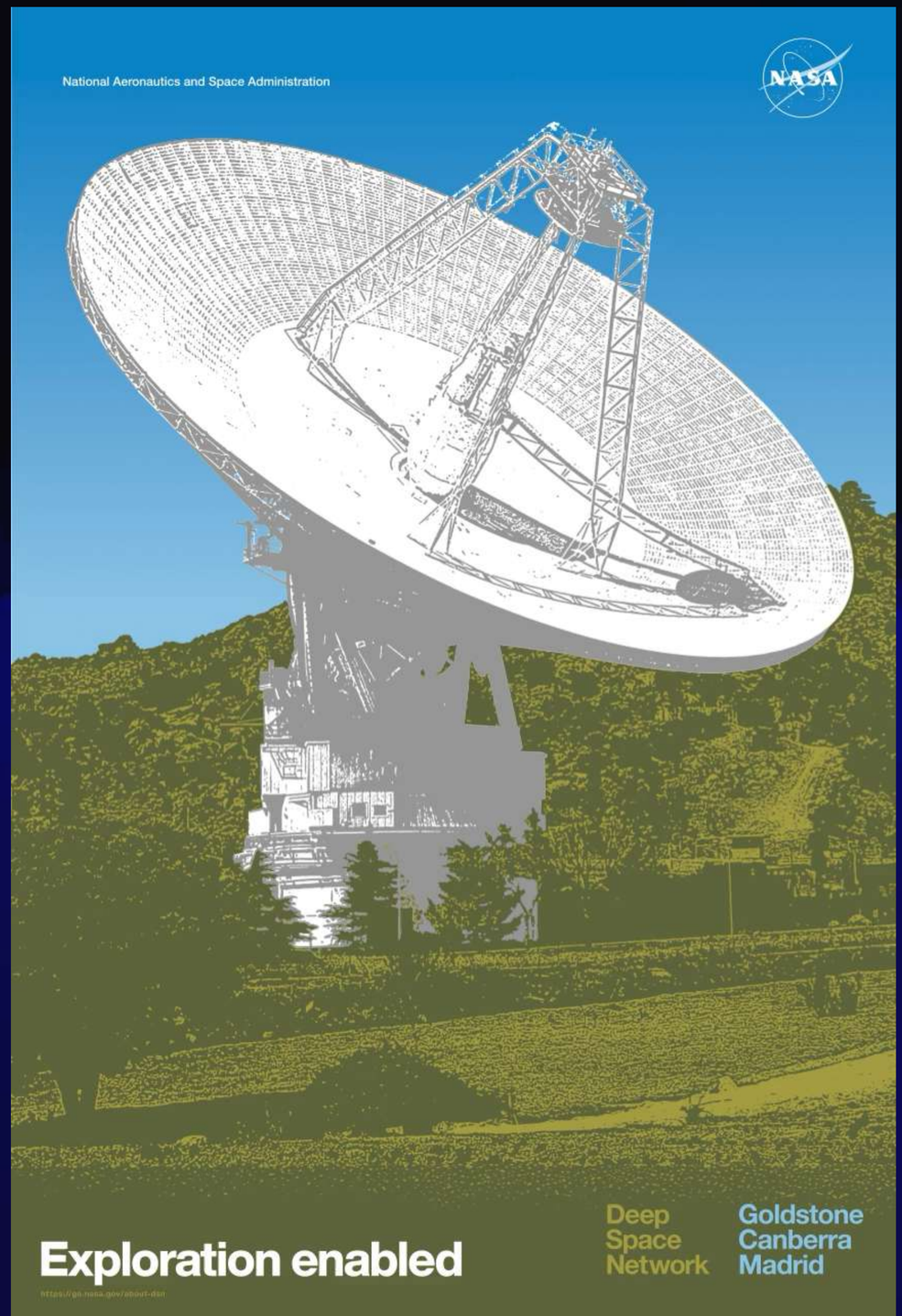
Whispers from Space

NASA's Deep Space Network

Tony Rice, NASA/JPL SSA August 2025



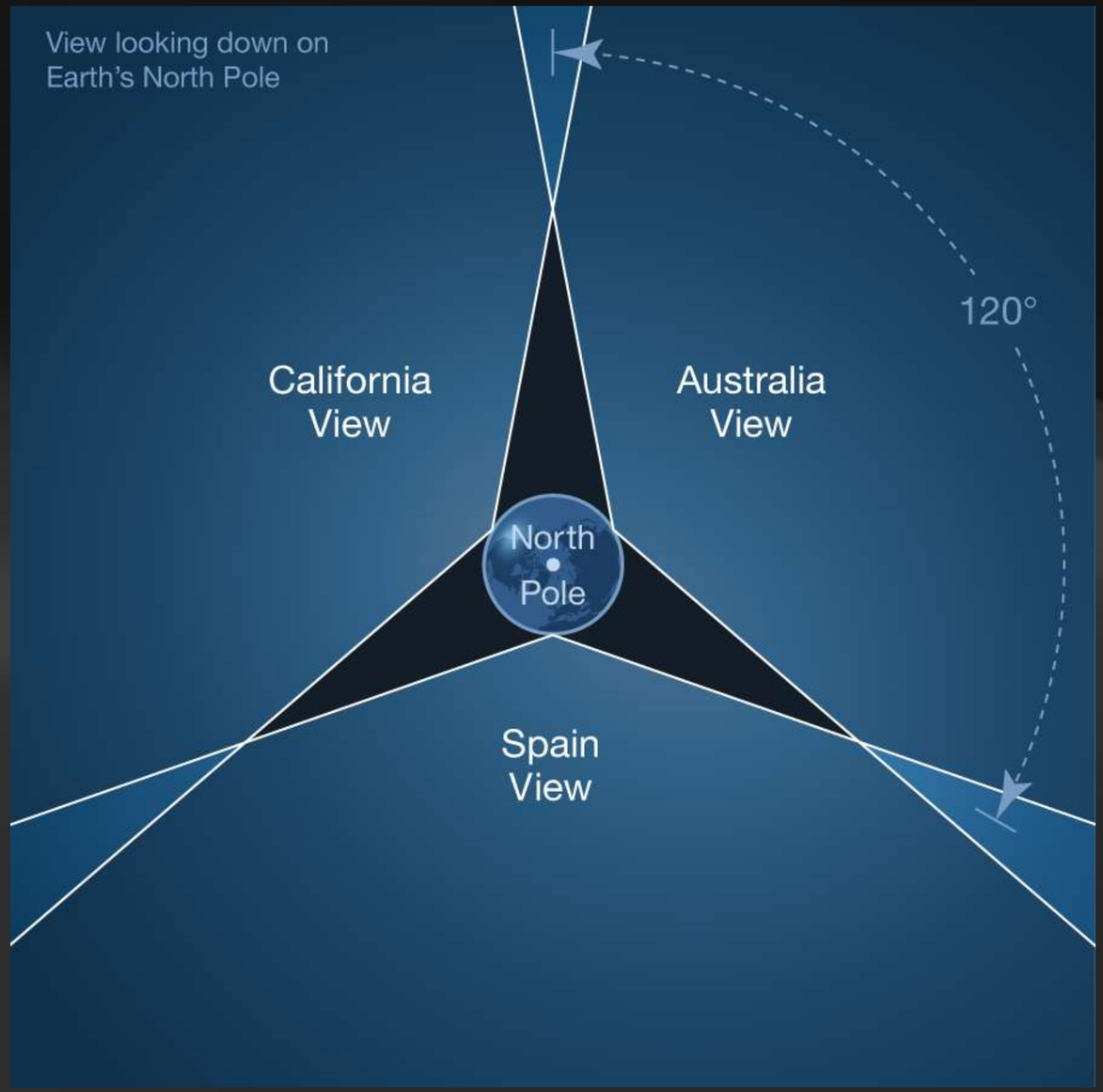

National Aeronautics and Space Administration
Exploration enabled
Deep Space Network
Goldstone
Canberra
Madrid
National Aeronautics and Space Administration
Our conversation with the universe starts here
Deep Space Network
Goldstone
Canberra
Madrid
National Aeronautics and Space Administration
Don't leave Earth without us
Deep Space Network
Goldstone
Canberra
Madrid


Goldstone, California
Madrid, Spain
Canberra, Australia

An uninterrupted view

of the solar system

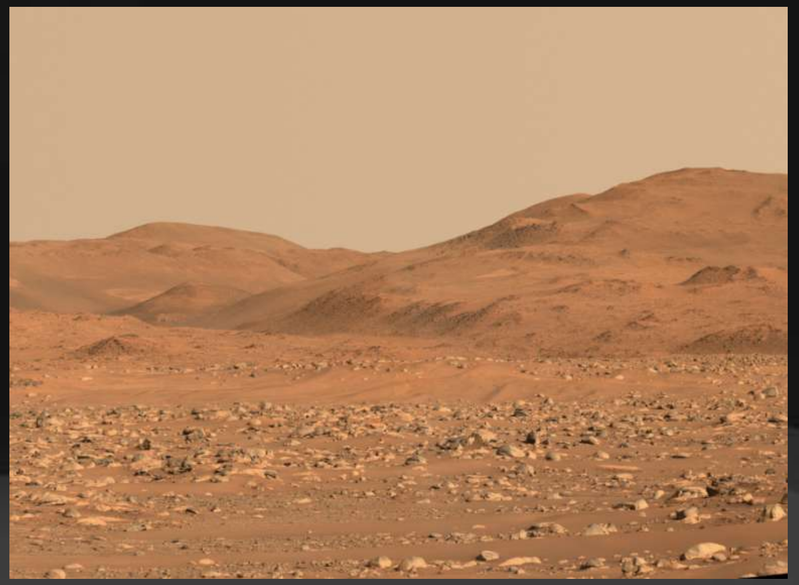
- Goldstone near Barstow in California's Mojave Desert
- Robledo near Madrid, Spain
- Tidbinbilla near Canberra, Australia
- Space Flight Operations Facility JPL building 230, Pasadena, California

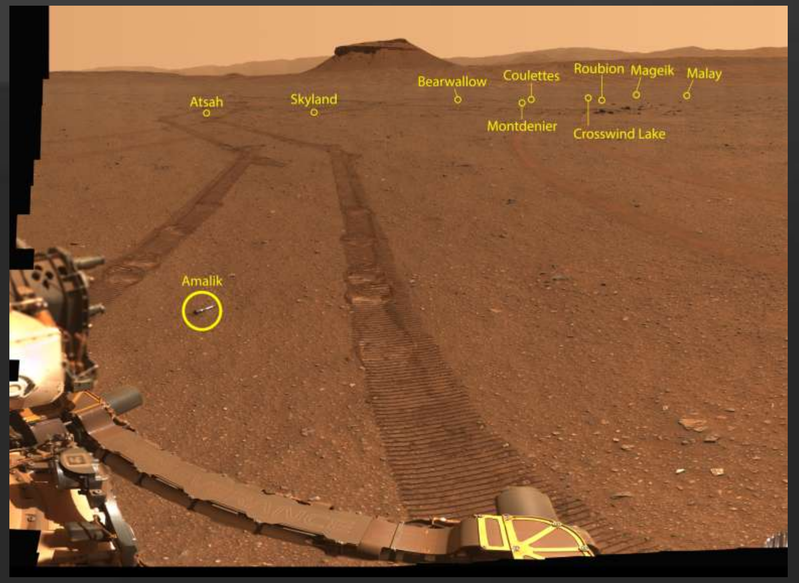


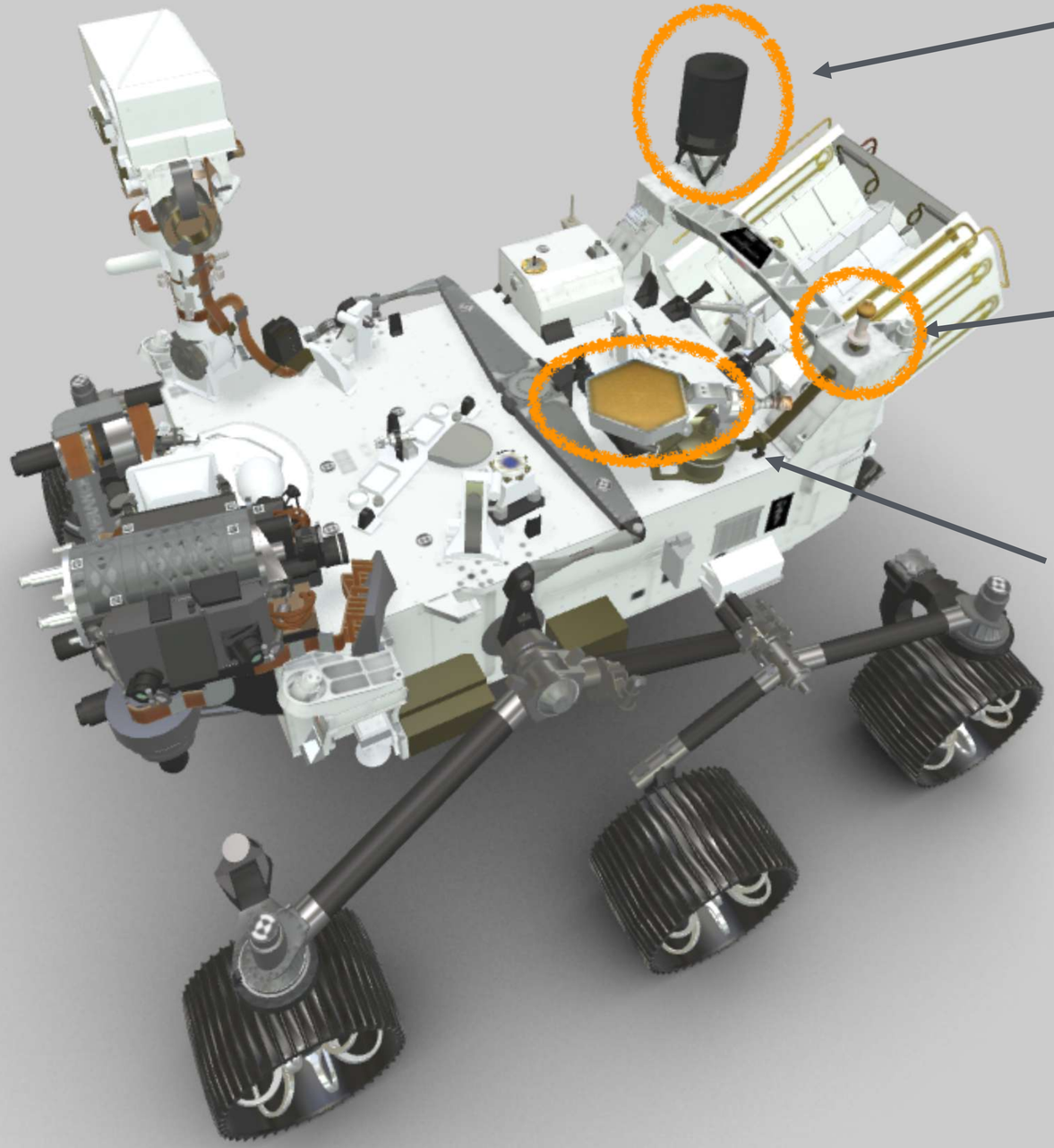
NASA's Deep Space Network

Rho Ophiuchi cloud complex

NASA, ESA, CSA, STScI, Klaus Pontoppidan (STScI)




Atsah
Skyland
Bearwallow
Coulettes
Roubion
Mageik
Malay
Montdenier
Crosswind Lake
Amalik



Ultra-High Frequency Antenna

orbiter communications

The X-Band Low-Gain Antenna

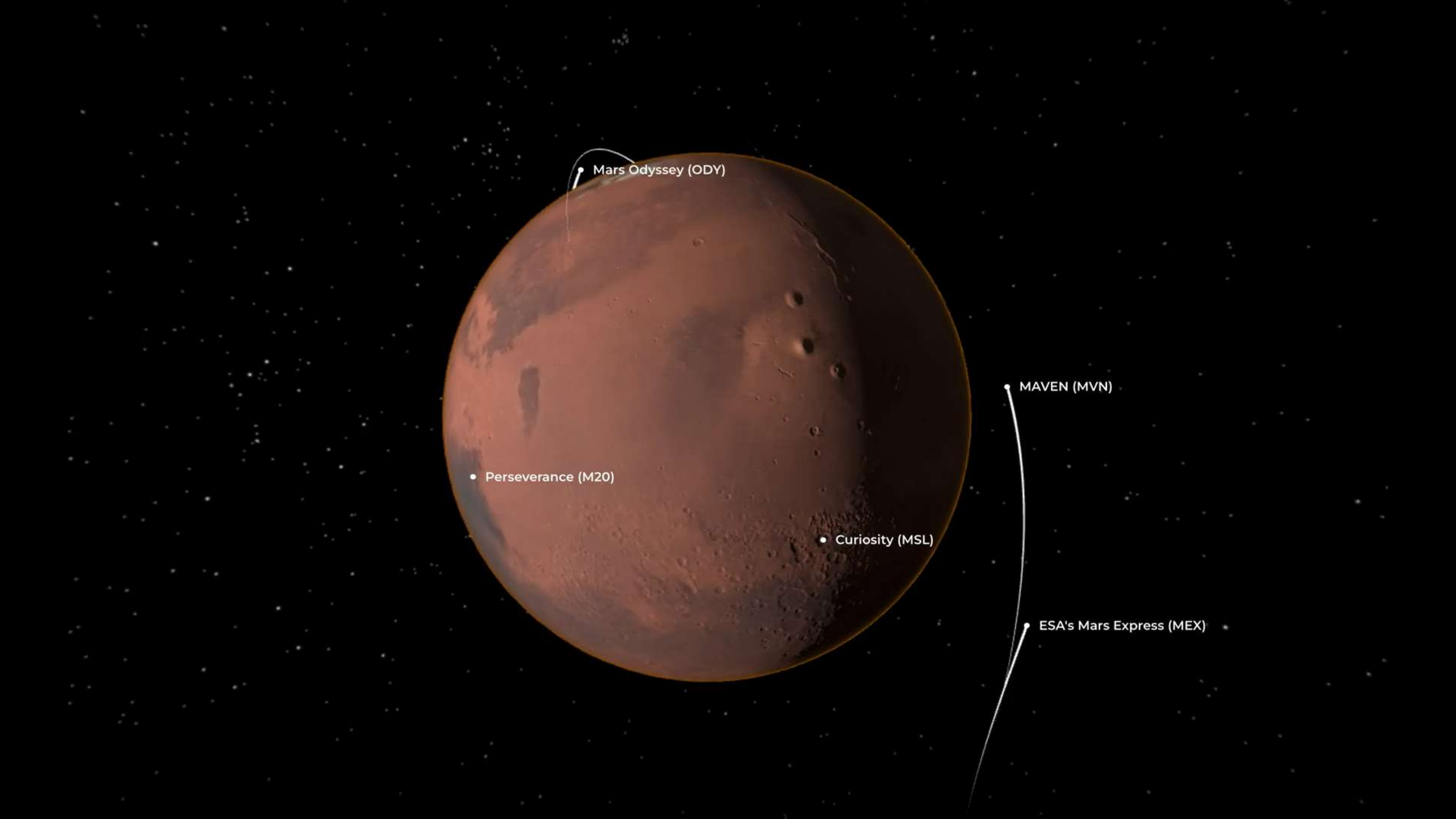
always-on omni-directional receiver

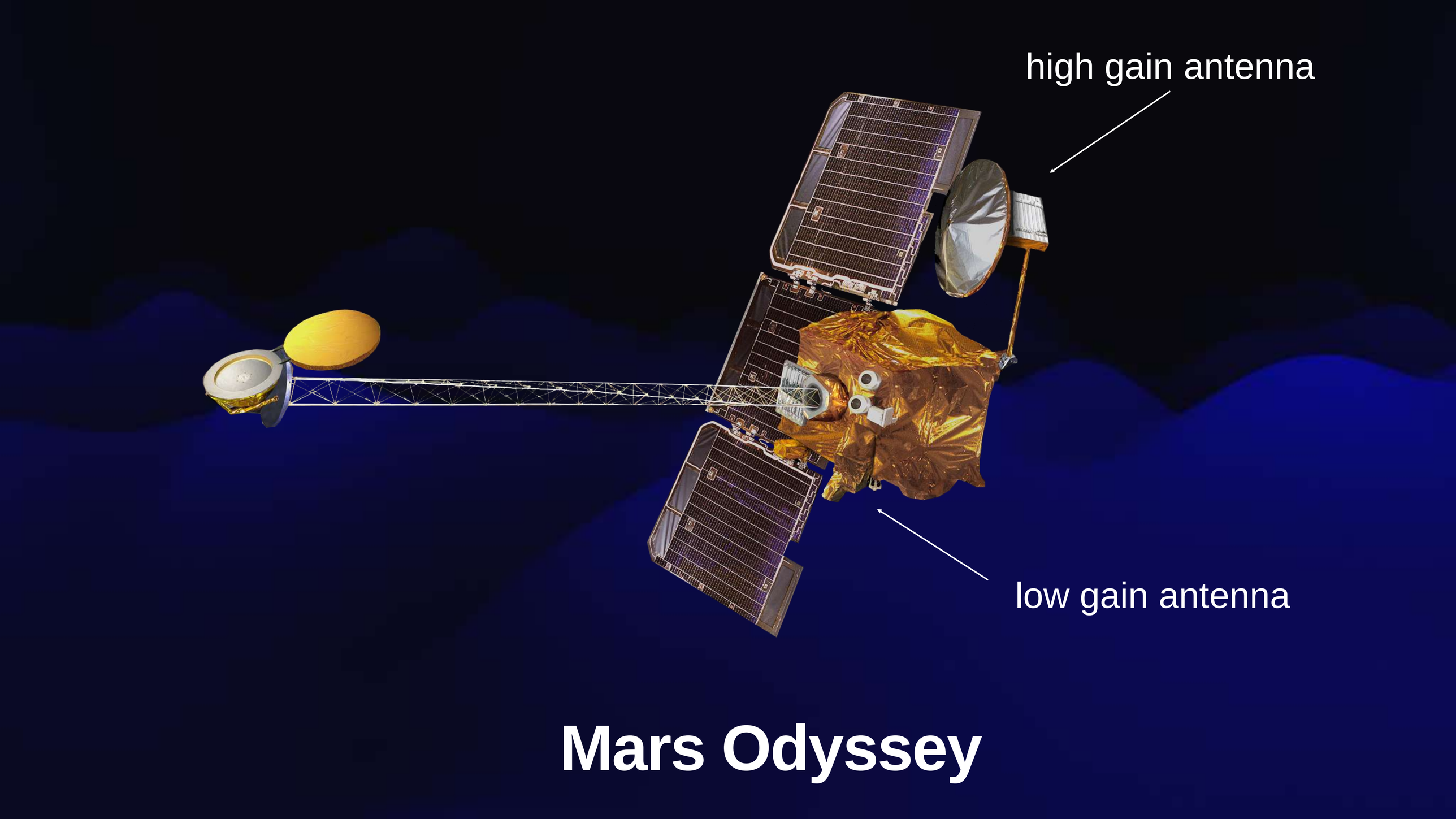
The X-Band High-Gain Antenna

Transmitting directly to Earth

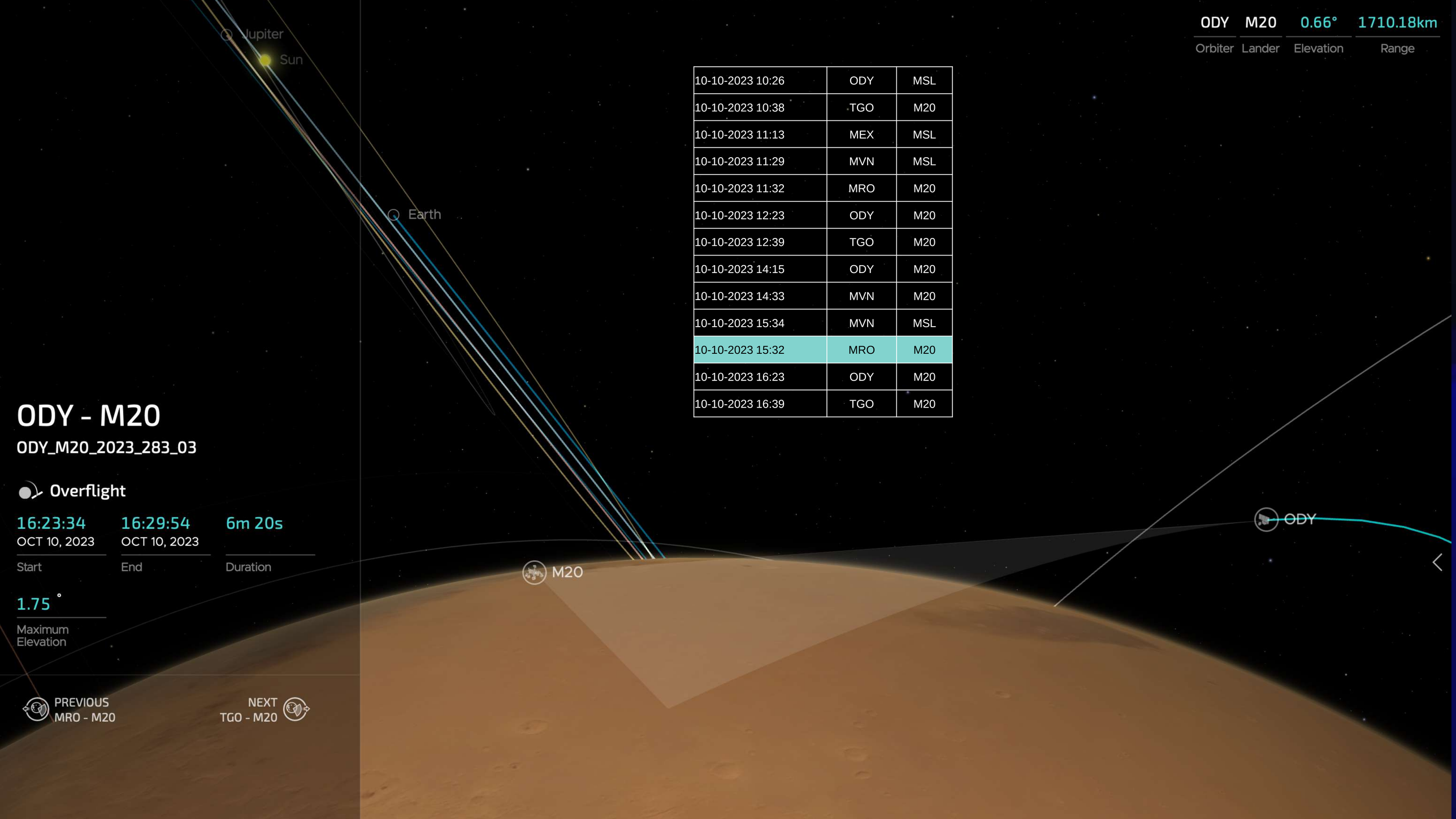
MARS 2020 PERSEVERANCE

CURIOSITY


Mars Odyssey (ODY)
MAVEN (MVN)
Perseverance (M20)
Curiosity (MSL)
ESA's Mars Express (MEX)



Mars Odyssey



ODY	M20	0.66°	1710.18km
Orbiter	Lander	Elevation	Range

10-10-2023 10:26	ODY	MSL
10-10-2023 10:38	TGO	M20
10-10-2023 11:13	MEX	MSL
10-10-2023 11:29	MVN	MSL
10-10-2023 11:32	MRO	M20
10-10-2023 12:23	ODY	M20
10-10-2023 12:39	TGO	M20
10-10-2023 14:15	ODY	M20
10-10-2023 14:33	MVN	M20
10-10-2023 15:34	MVN	MSL
10-10-2023 15:32	MRO	M20
10-10-2023 16:23	ODY	M20
10-10-2023 16:39	TGO	M20

ODY - M20

ODY_M20_2023_283_03

Overflight

16:23:34	16:29:54	6m 20s
OCT 10, 2023	OCT 10, 2023	
Start	End	Duration

1.75 °

Maximum Elevation

PREVIOUS
MRO - M20

NEXT
TGO - M20


UTC
069:18:30:38
5 YEARS SPIRIT
+065:13:55:38
6 YEARS OPPORTUNITY
+044:13:25:38
S/C ANT START END
STB 15 069/17:45 070/00:45
JNO 21 069/15:00 069/21:50
VGR1 43 069/15:50 069/20:15
VGR2 45 069/15:40 069/20:45
MRO 54 069/14:50 070/01:20
M01O 54 069/14:55 069/22:35
STF 55 069/15:45 069/18:45
STF 63 069/15:45 069/18:45
THB 65 069/18:05 069/20:05
069/18:30
NASA
70 – Meter Antenna
UTC
069:18:30:38
WISE LAUNCH
+086:04:21:05
H-000:00:00:00
Multi-Mission GDS
Odyssey/Phoenix Relay
Mars Exploration Rover
Mission Control
NASA/JPL

Jet Propulsion Laboratory | California Institute of Technology

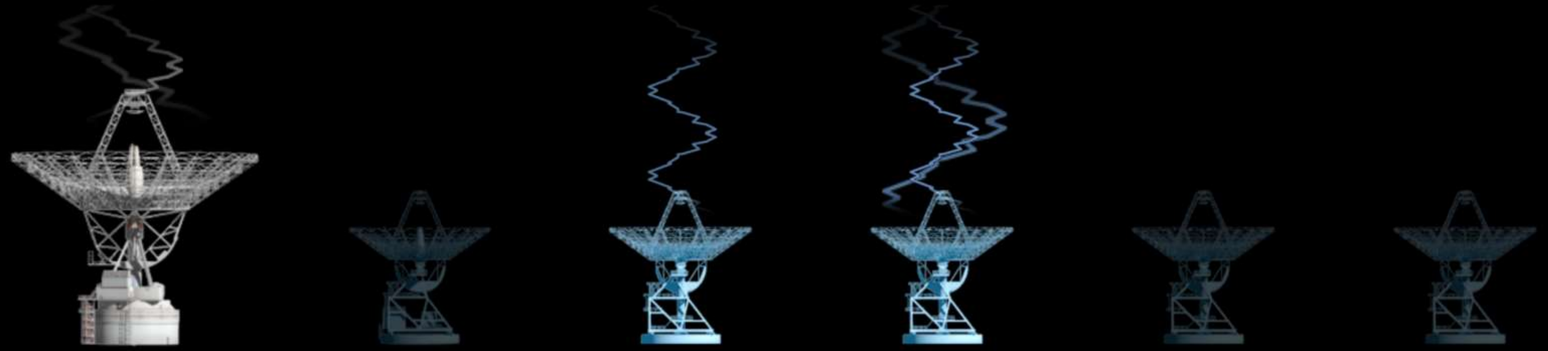
DEEP SPACE NETWORK *NOW*

LAST UPDATED: OCT 8 8:39 PM (UTC)

DSN home

MADRID

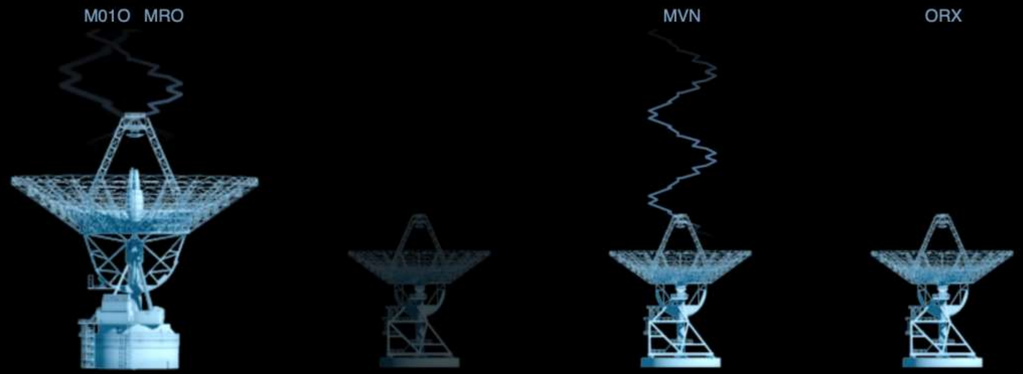
OCT 8
10:39 PM



63 | 65 | 53 | 54 | 55 | 56

GOLDSTONE

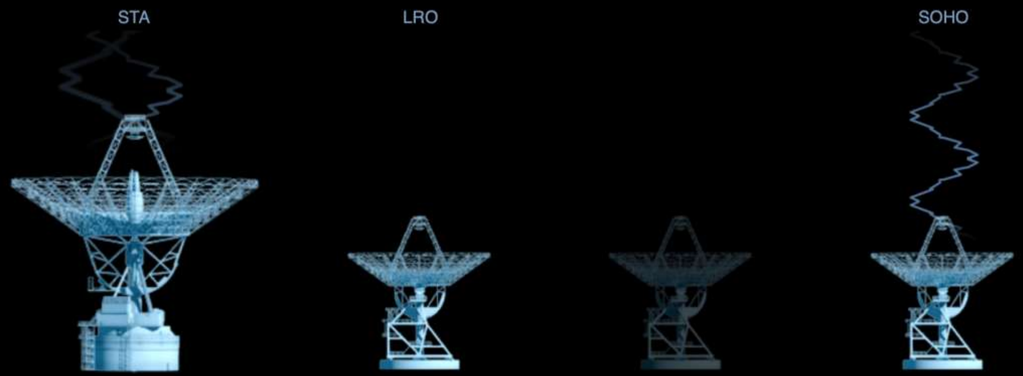
OCT 8
1:39 PM



14 | 24 | 25 | 26

CANBERRA

OCT 9
7:39 AM



43 | 34 | 35 | 36

Frequency & Timing (F&T)

DSN Data Types

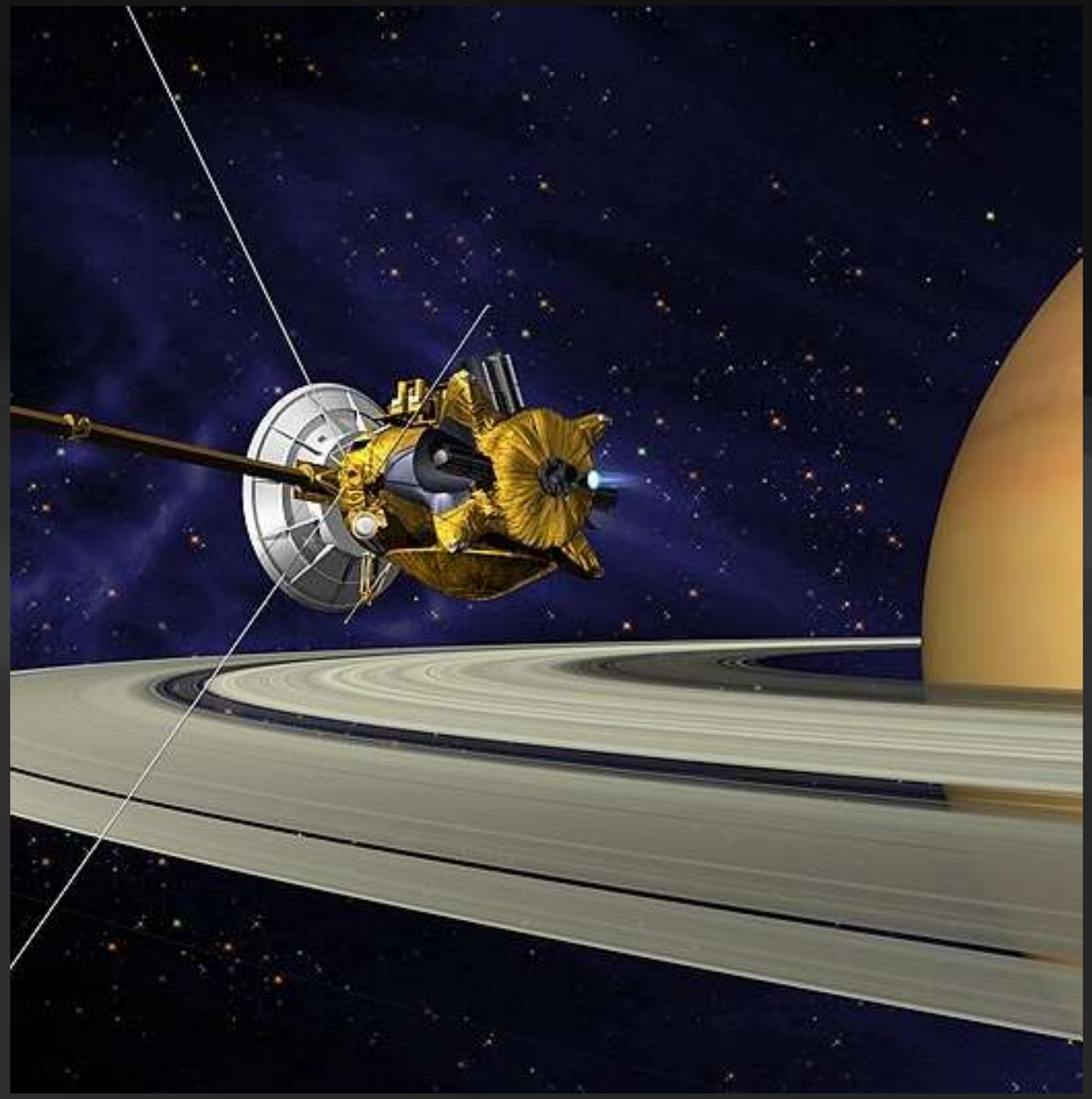
- Atomic clock for deep space
- Hydrogen maser & Caesium-133 clocks
- Cryogenic sapphire oscillator (CSO)
- Referenced to GPS and US Naval Observatory master clock
- Leap Days and Leap Second handled

Images: STScI, Douglas Van Bossuyt

Tracking (TRK)

DSN Data Types

- Doppler, ranging, & predicts
- Measure distance to spacecraft within ~1m
- determine a spacecraft's trajectory
- infer gravity fields of bodies that affect the spacecraft.



NASA/JPL

Comand (CMD)

DSN Data Types

- Tells the spacecraft
  - what to science to do (instruments, cameras, etc.)
  - where to go (navigation)
- Upload software updates
- Like telemetry-in-reverse

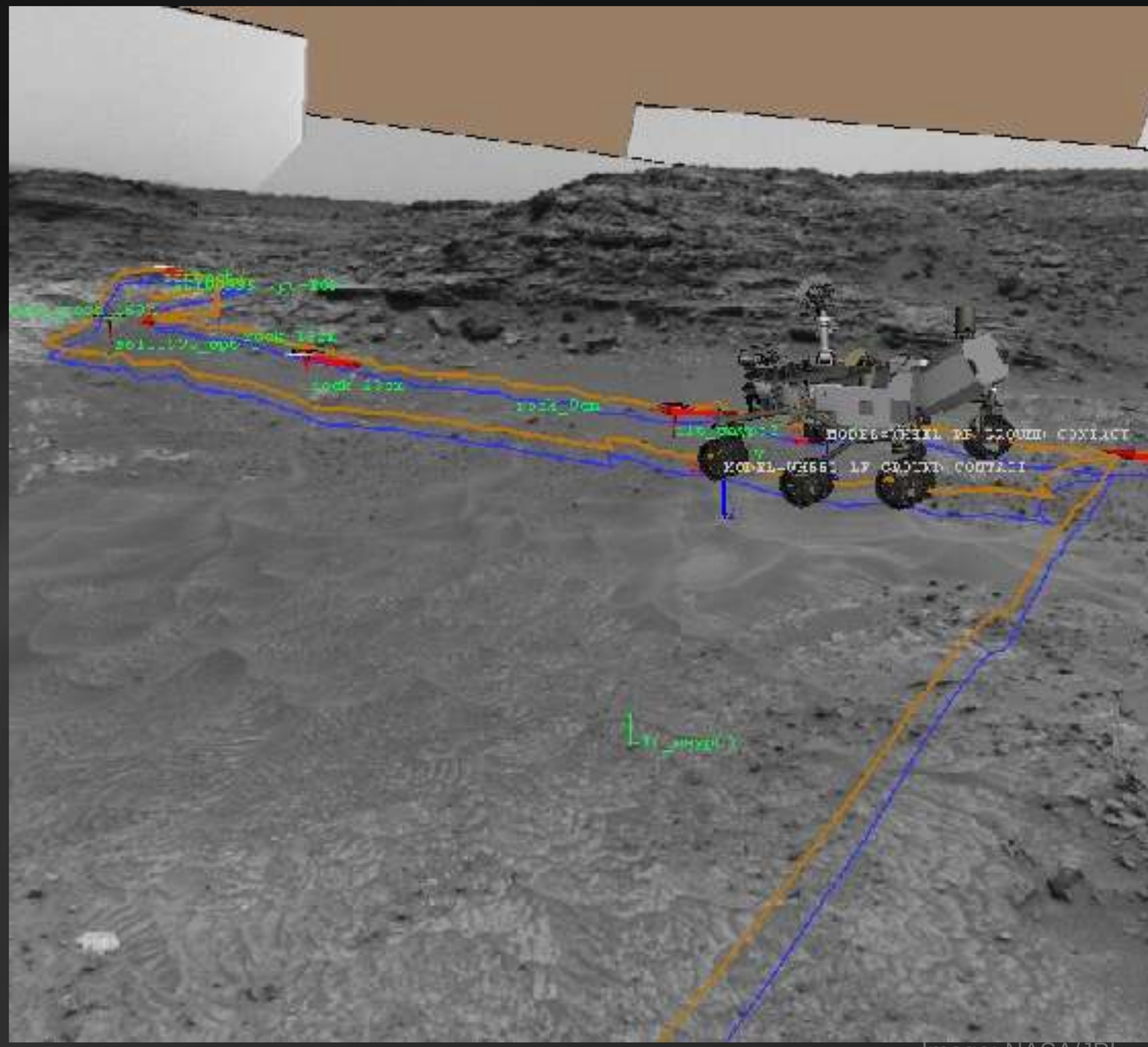


Image: NASA/JPL

Telemetry (TLM)

DSN Data Types

- From the greek "tele" (far off), and "metron" (measure)
- Download data
- engineering measurements like
  - temperatures of parts of the spacecraft
  - images from its cameras
  - data from science instruments

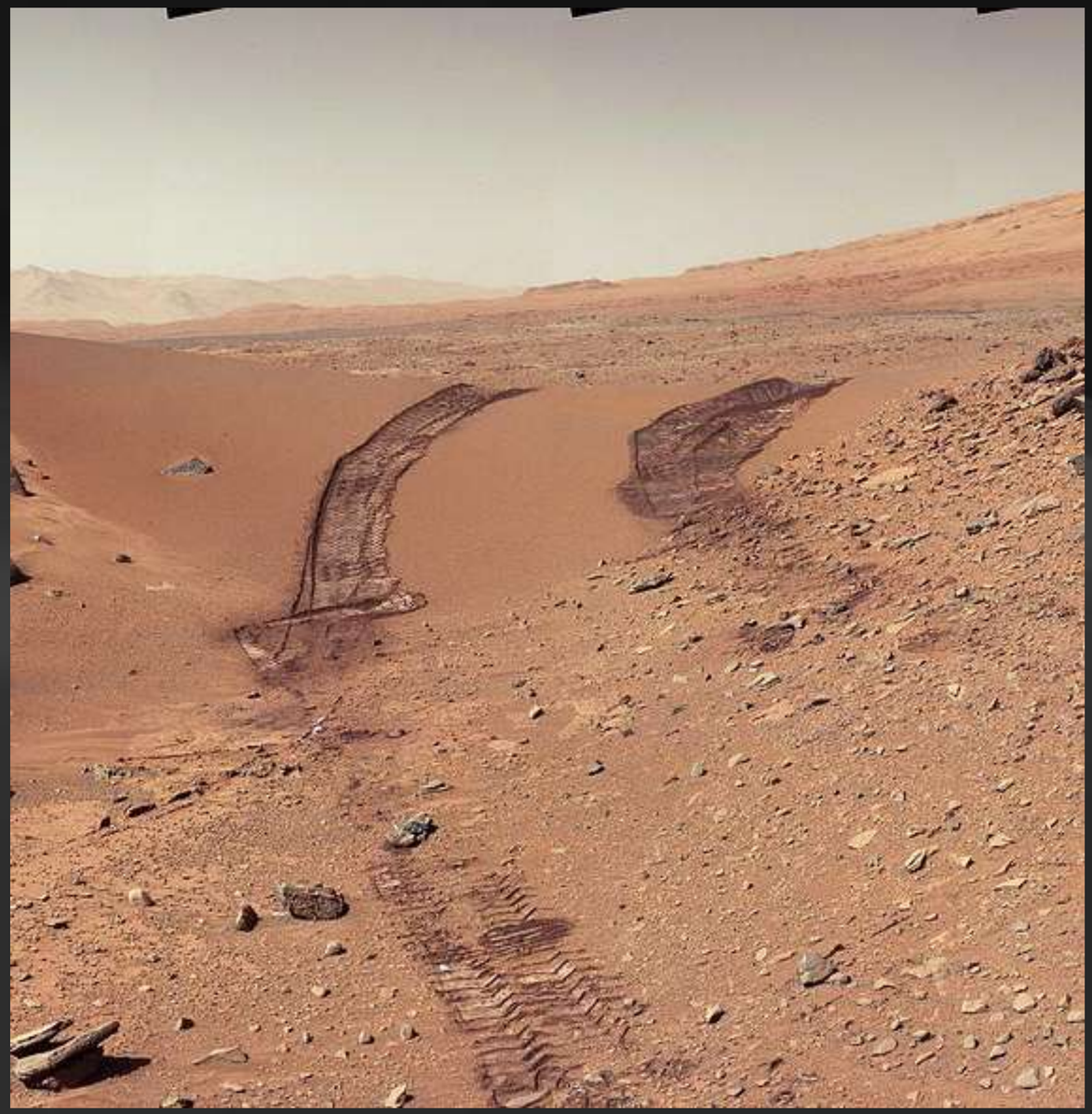


Image: STScI

Radio Science (RS)

DSN Data Types

- uses the spacecraft radio and the DSN together as a science instrument
- Measures things like:
  - Atmospheres of planets and moons
  - Gravititational influences
  - Planetary rings

Image: STScI

Very Long Baseline Interferometry (VLBI)

DSN Data Types

- Special kind of radio science
- Uses widely space DSN dishes
- Observes a wide range of frequencies
- Used to observe:
  - Quasars
  - Very large objects via synthetic aperature

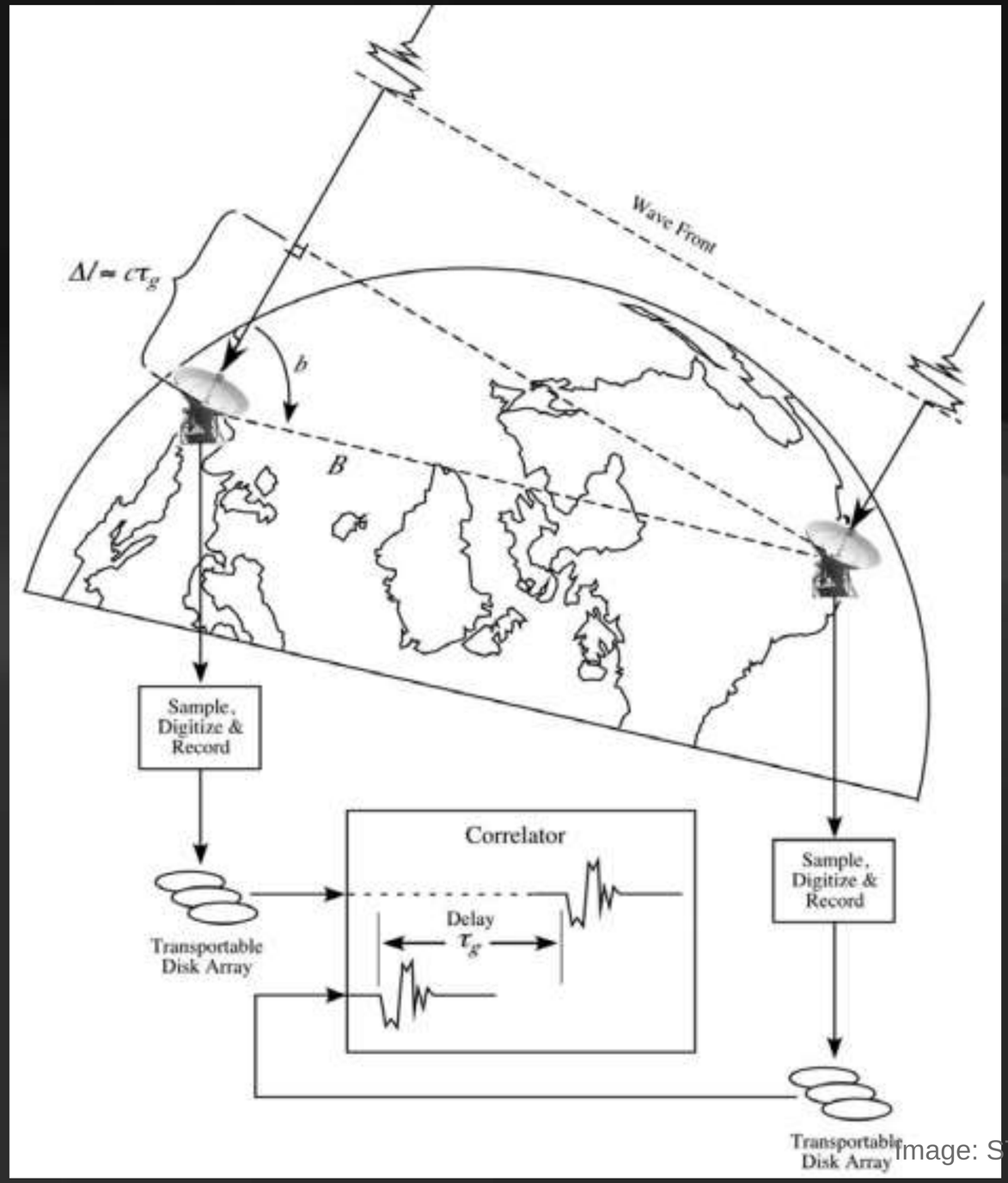


Image: STScI

Monitor (MON)

DSN Data Types

- reports on the operation and performance of the DSN itself

Image: STScI

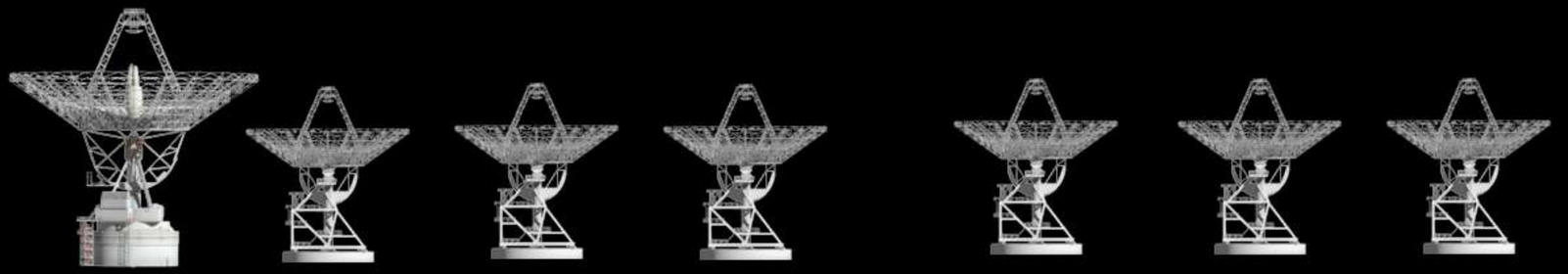
Canberra

Tidbinbilla, Australia

- Built in 1963 to support Apollo program
- Upgraded for Voyager, HST & STS programs
- Surrounding ridges sheild radio interference
- Kangaroos, lizards, & parrots
- Visitor Center

Active

Retired



DSS-43
64->70 meter
Apollo
1972-

DSS-34
34-meter
Beam Wave Guide
1997-

DSS-35
34-meter
slab cooling
2014-

DSS-36
34-meter
added capactity
2016-

DSS-45
34-meter
Mariner program
(1986-2016)

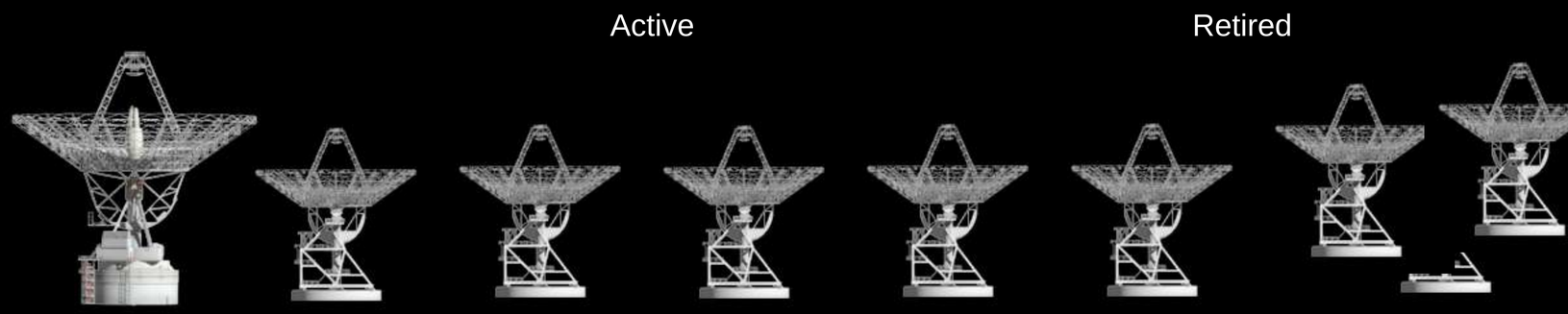
DSS-42
26->34-meter
Mariner program
(1964-2000)

DSS-33
11-meter
radio astronomy
(1996-2008)

Madrid

Robledo, Spain

- Built in 1963 to support Apollo program



Goldstone

California High Desert

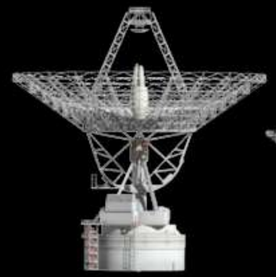
- Built in 1958 to support the Pioneer (lunar probe) program
- First DSN site
- Burros, tarantulas, tortoises

Visitor Center in the Harvey House, Barstow, CA

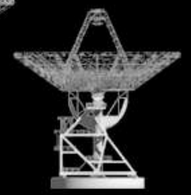
NASA/JPL

Active

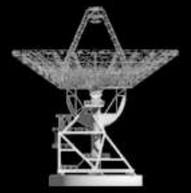
Retired



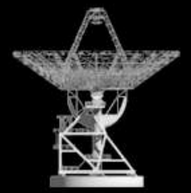
DSS-14
64-70 meter
"Mars"
1973-



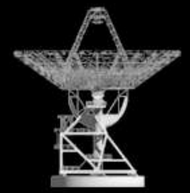
DSS-24
34-meter
1987-



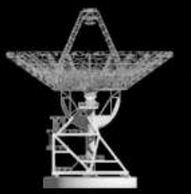
DSS-53
34-meter
2022-



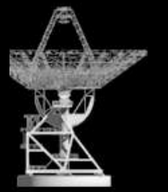
DSS-26
34-meter
1997-



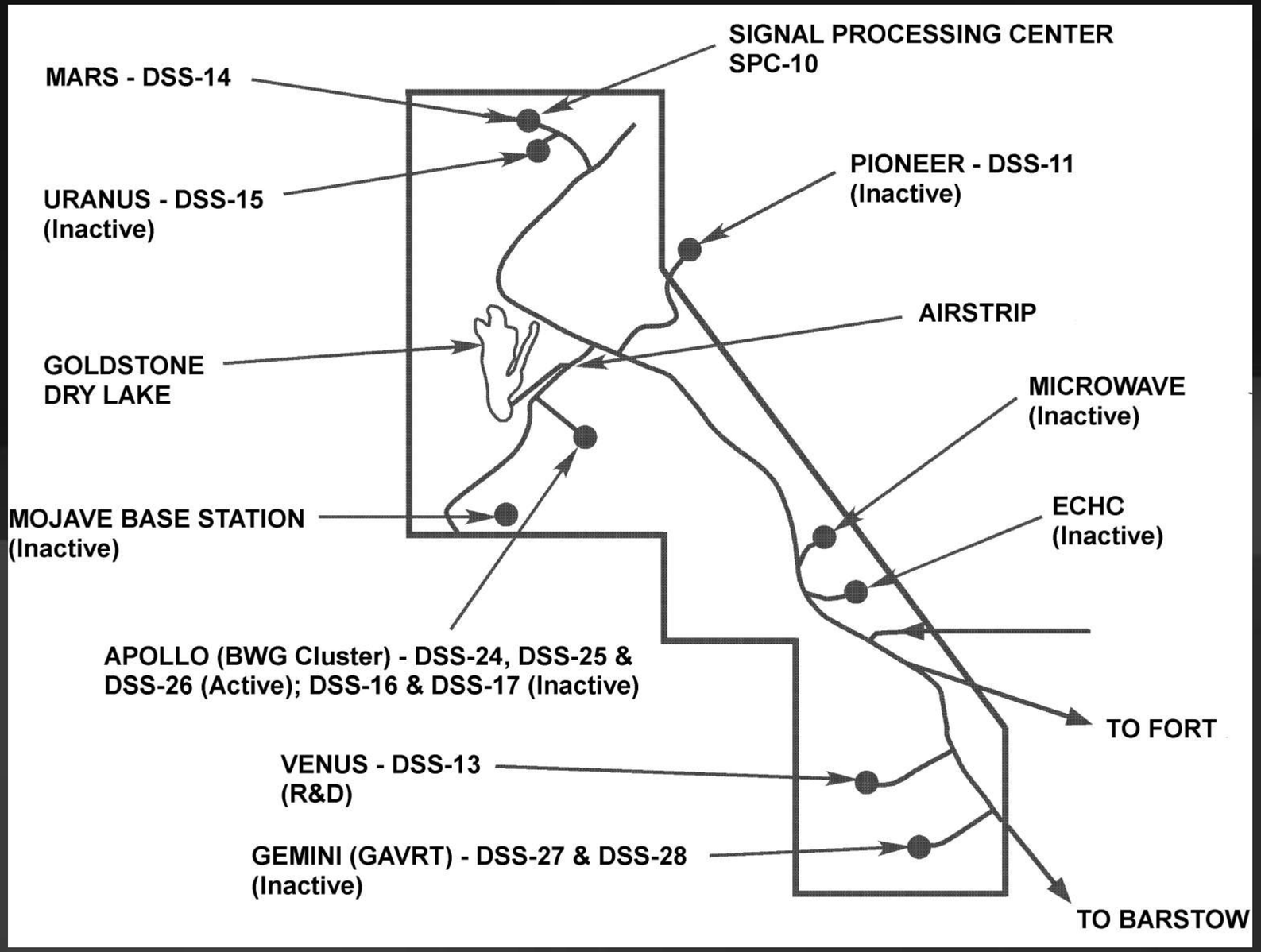
DSS-11
26-meter
"Pioneer"
(1958-1981)



DSS-12
26-meter
"Echo"
(1962-2012)



DSS-13
26-meter
"Venus"
(1962-1981)


SIGNAL PROCESSING CENTER
SPC-10
MARS - DSS-14
URANUS - DSS-15
(Inactive)
PIONEER - DSS-11
(Inactive)
AIRSTRIP
GOLDSTONE
DRY LAKE
MICROWAVE
(Inactive)
MOJAVE BASE STATION
(Inactive)
ECHC
(Inactive)
APOLLO (BWG Cluster) - DSS-24, DSS-25 &
DSS-26 (Active); DSS-16 & DSS-17 (Inactive)
TO FORT
VENUS - DSS-13
(R&D)
GEMINI (GAVRT) - DSS-27 & DSS-28
(Inactive)
TO BARSTOW


WELCOME
TO Fabulous
LAS VEGAS
NEVADA
Goldstone
JPL
LA


Goldstone

DSS-14 Mars

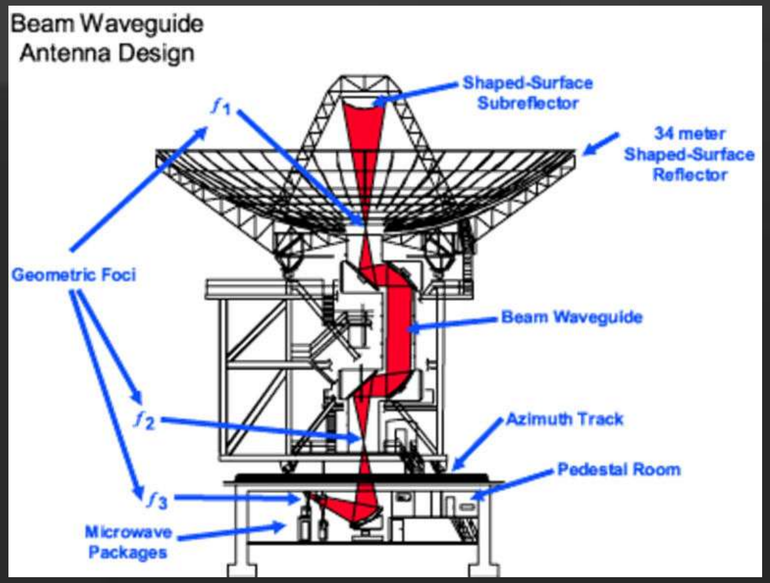
dish surface area: ~ 1 acre

NASA/JPL, Rice

DSS-24, 25, & 26 "Apollo"

NASA/JPL, Rice

Antenna Design

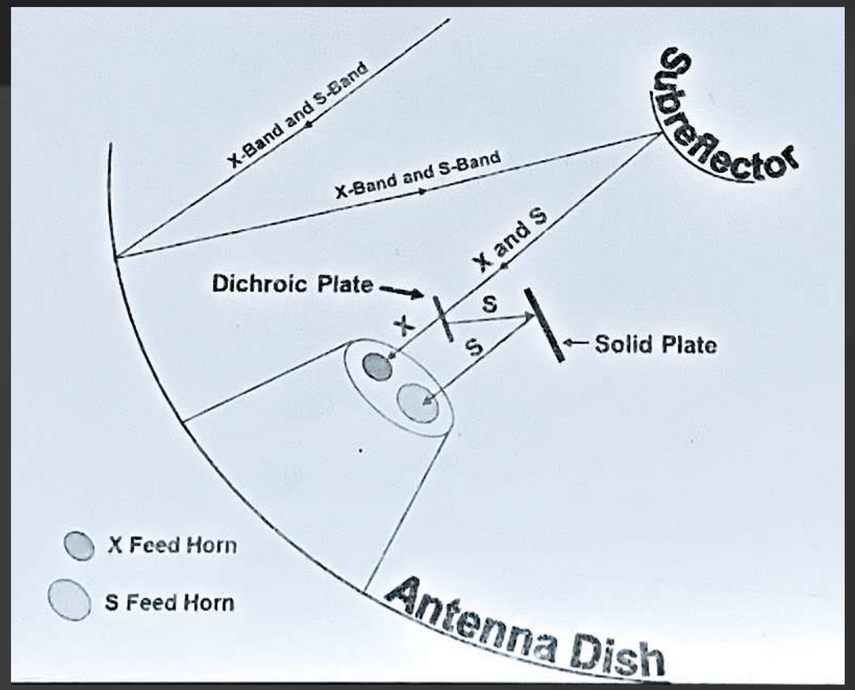


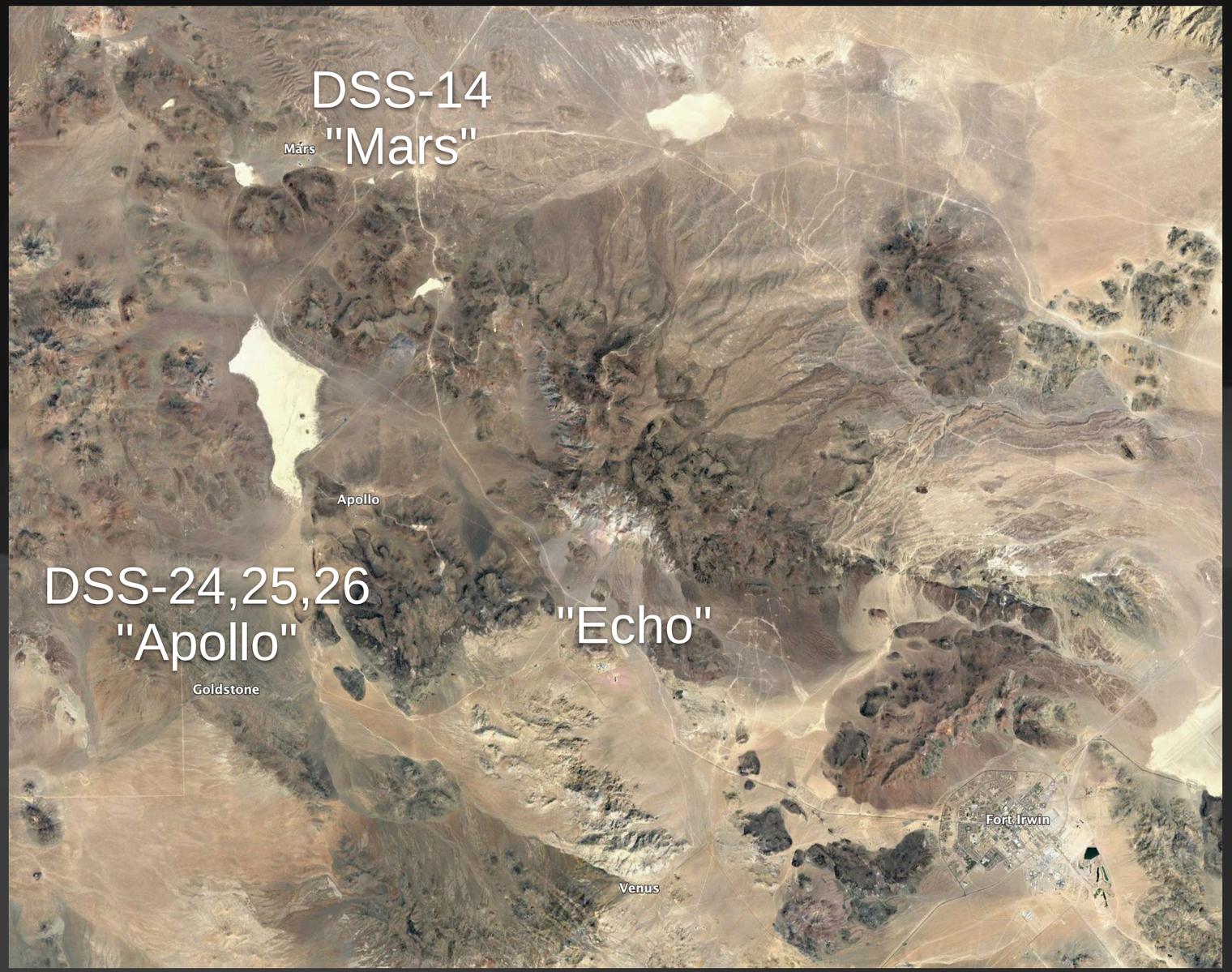
Rice, NASA

Dichroic Plate

34-meter beam waveguide

- Holes are precision aligned reflect certain frequencies, allow others through




DSS-14
"Mars"
Mars
Apollo
DSS-24,25,26
"Apollo"
"Echo"
Goldstone
Fort Irwin
Venus


BEWARE
OF
SHARK


Questions?
Jet Propulsion Laboratory | California Institute of Technology
DEEP SPACE NETWORK NOW