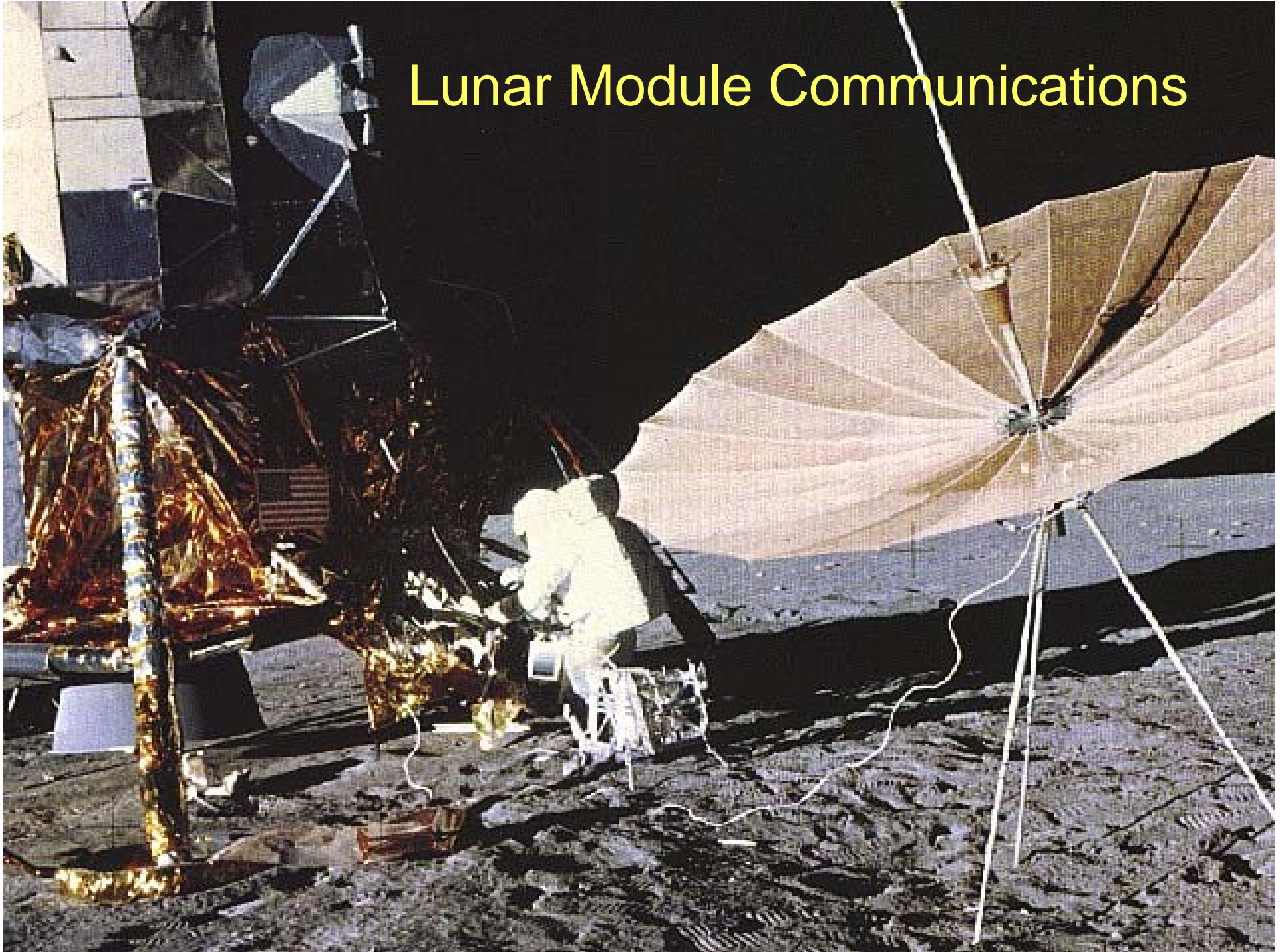


# Lunar Module Communications



# Objectives

- Describe the different types of antennas on the Lunar Module
- Describe the different communications paths during Earth line of sight periods
- Describe the different communications paths during periods when there was no Earth line of sight
- Describe the different communications paths during Lunar Surface operations
- Describe the interfaces to and function of the Signal-Processing Assembly (SPA)
- Describe the interfaces to and function of the Instrumentation system

## Lesson Outline

1. Gotchas in reading the Apollo era documents
2. Lunar Module Antennas and Functions
3. Earth Line of Sight Communications Links
4. No Earth Line of Sight Communications Links
5. Lunar Surface Communications Links
6. Signal-Processing Assembly
7. Instrumentation System
8. Some Communications Problems Encountered

# Apollo Document Terminology

Line of Sight (LOS) – non-obstructed, point to point path. Don't confuse with the modern term of Loss of Signal.

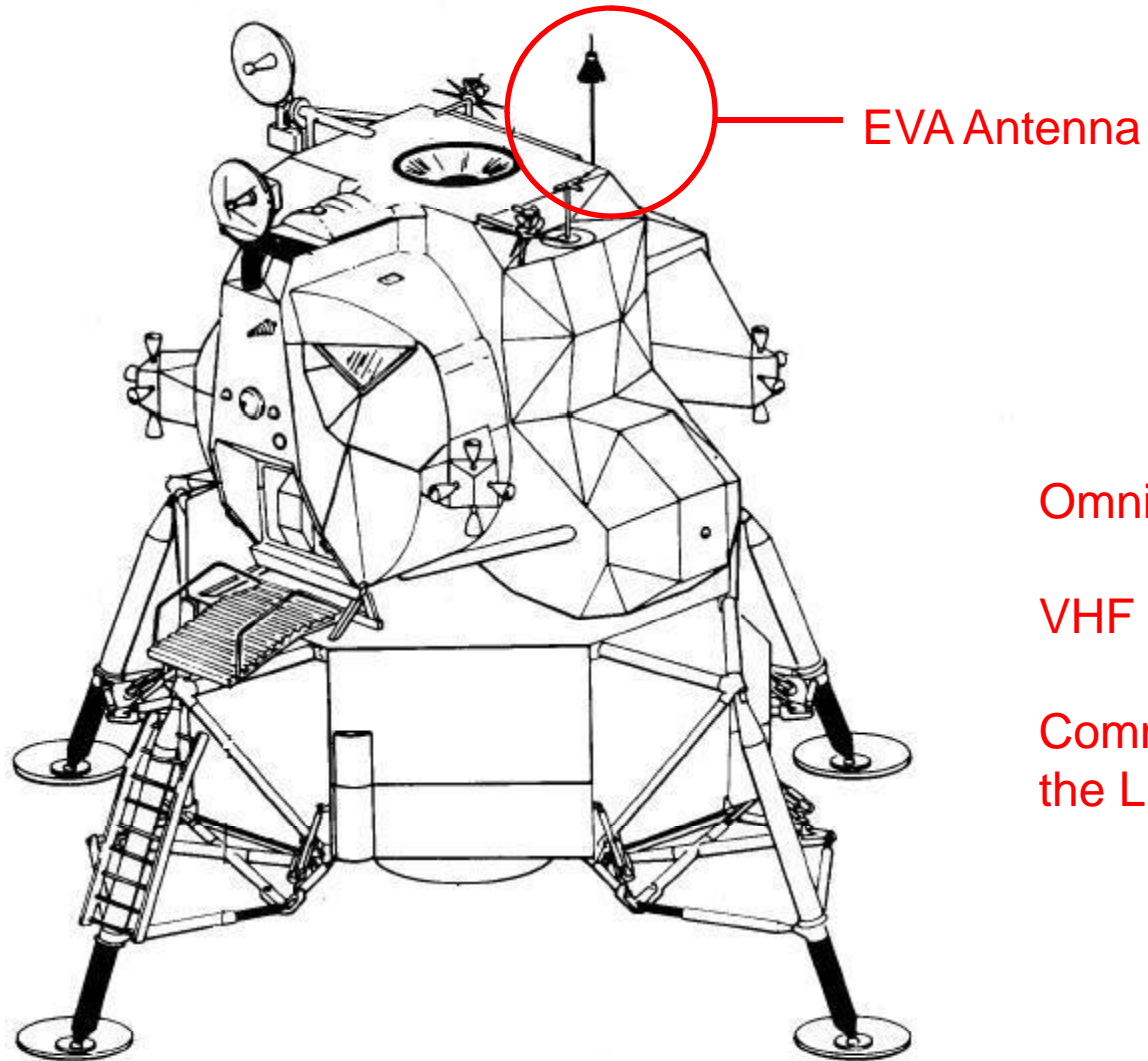
Very High Frequency (VHF) – a frequency band used by the Lunar Module for communications. We now call the specific frequencies used by the LM, Ultra-High Frequency (UHF). They are the same set of frequencies used by the shuttle program.

Manned Spaceflight Network (MSFN) – the ground communications network that support communications links between the control center and the vehicles. We now refer to these assets as the Ground and Space Network.

Megacycles (MC) – an older terminology used in Apollo era documents for what we now more commonly call megahertz (MHz).

Ranging – the determination of the distance to a target based upon sub-carrier, turnaround tones (S Band and VHF)

# Antennas



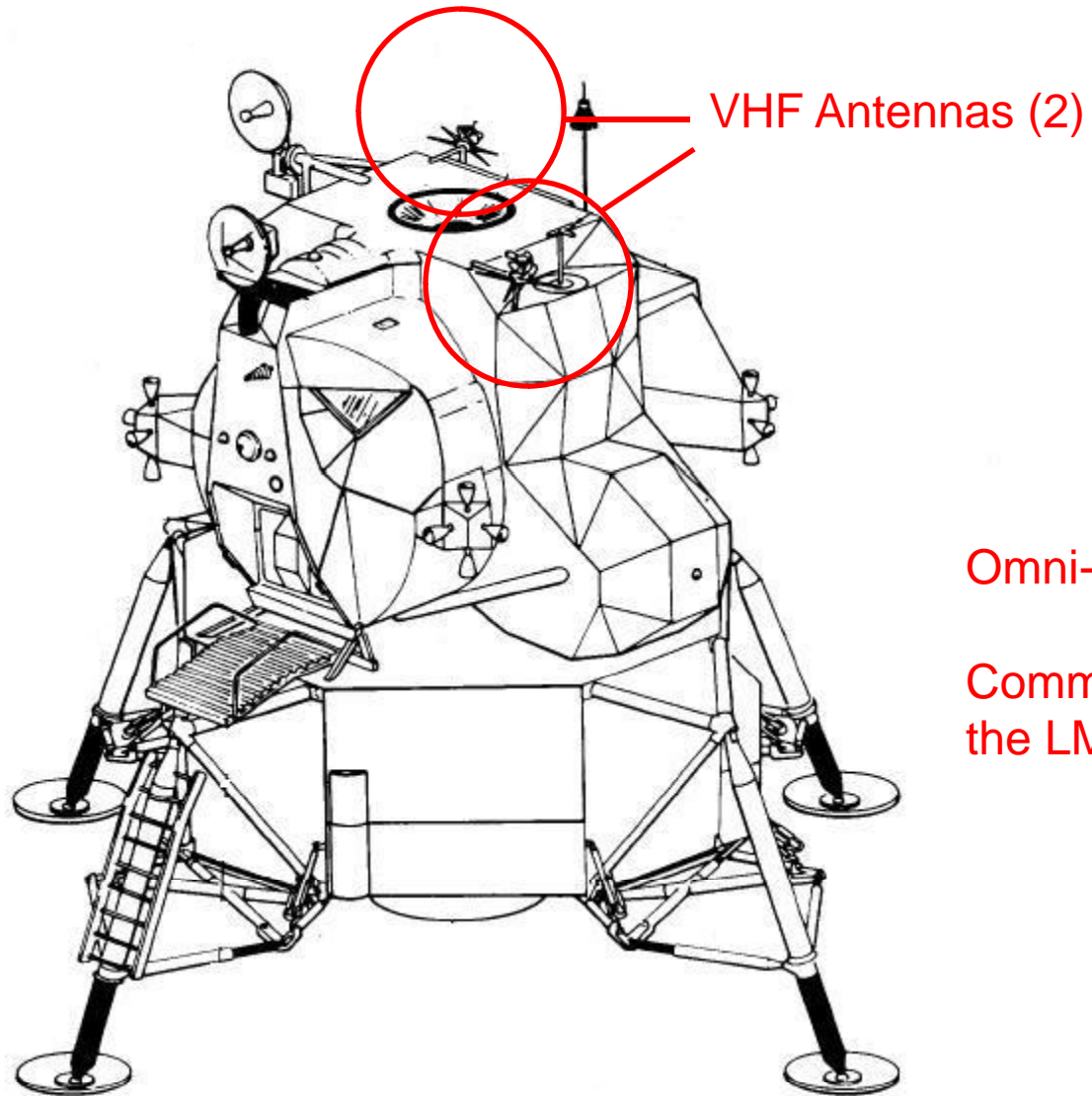
EVA Antenna

Omni-directional

VHF

Communications between  
the LM and the EVA crew

# Antennas

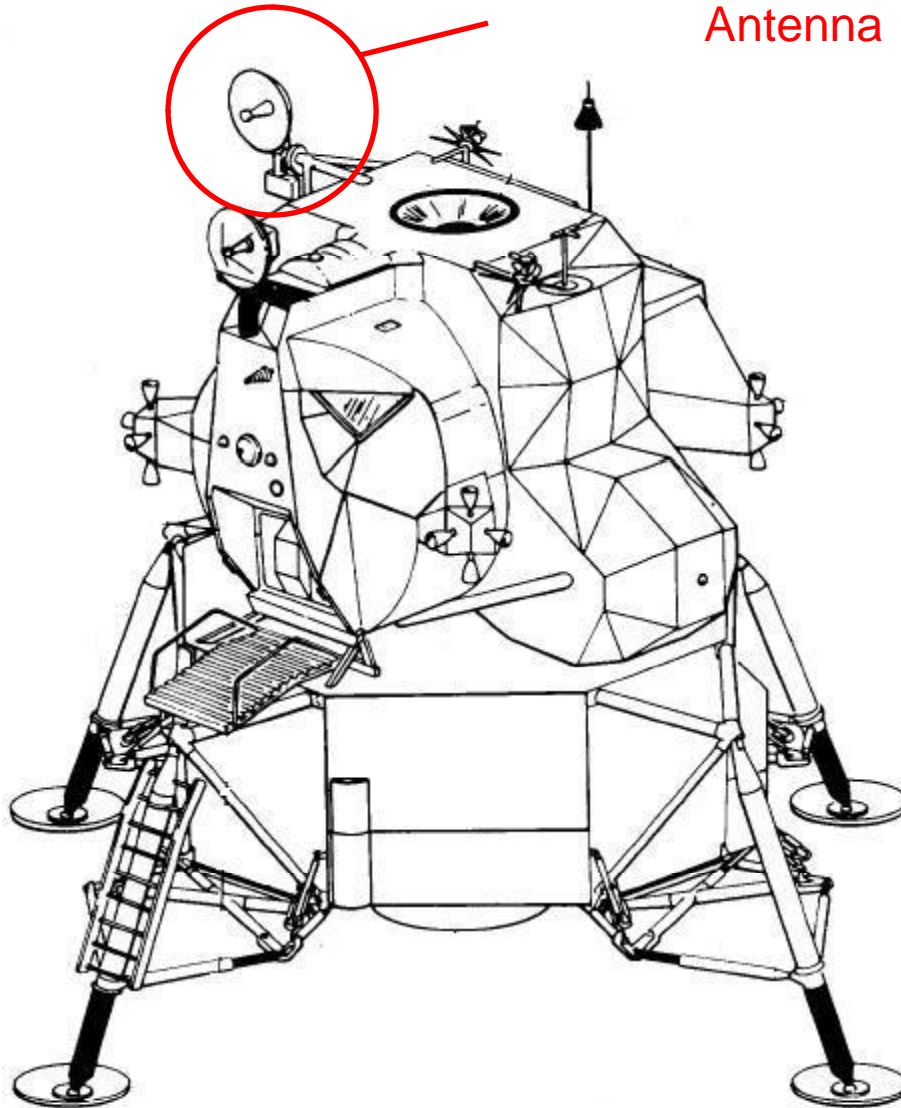


Omni-directional

Communications between  
the LM and CSM

# Antennas

S Band Steerable  
Antenna



Unidirectional

Gimbaled Movement

Crew Manually Points

Auto-tracking

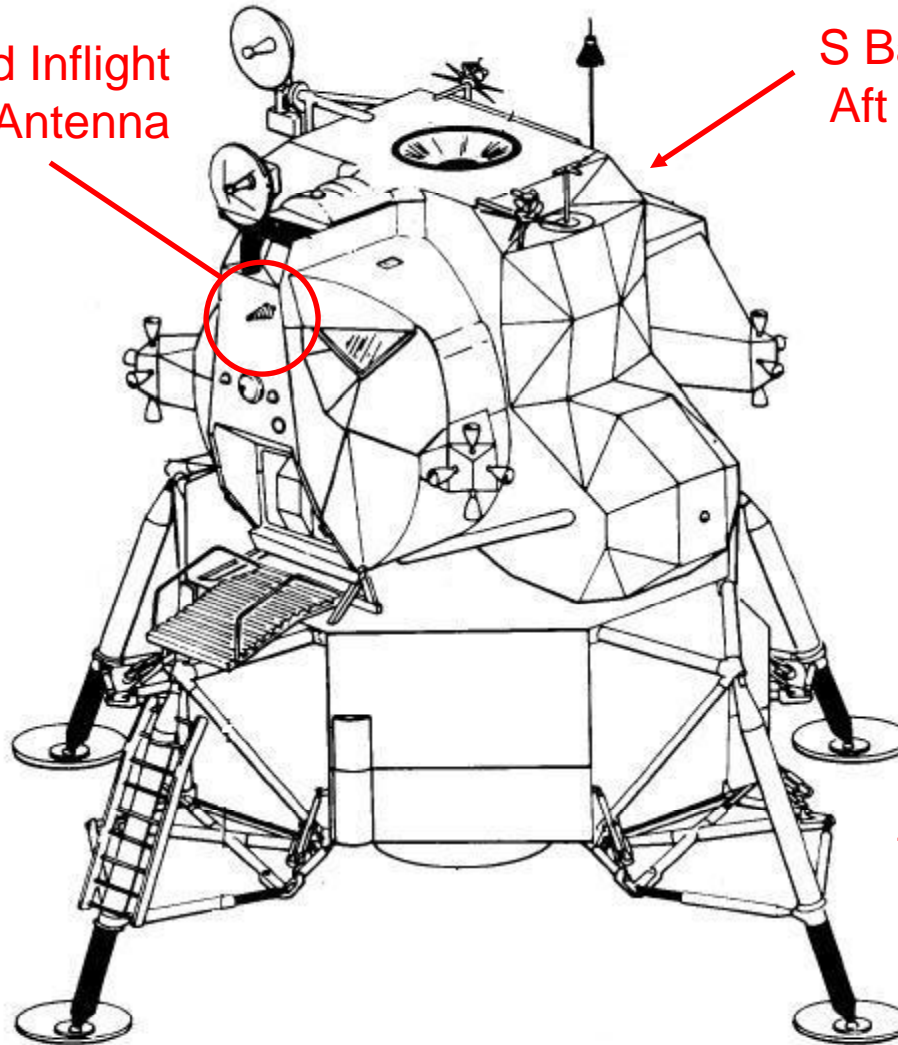
Communications between  
the LM and MSFN



# Antennas

S Band Inflight  
Forward Antenna

S Band Inflight  
Aft Antenna



Omni-directional

Only one antenna at a time

Communications between  
the LM and MSFN



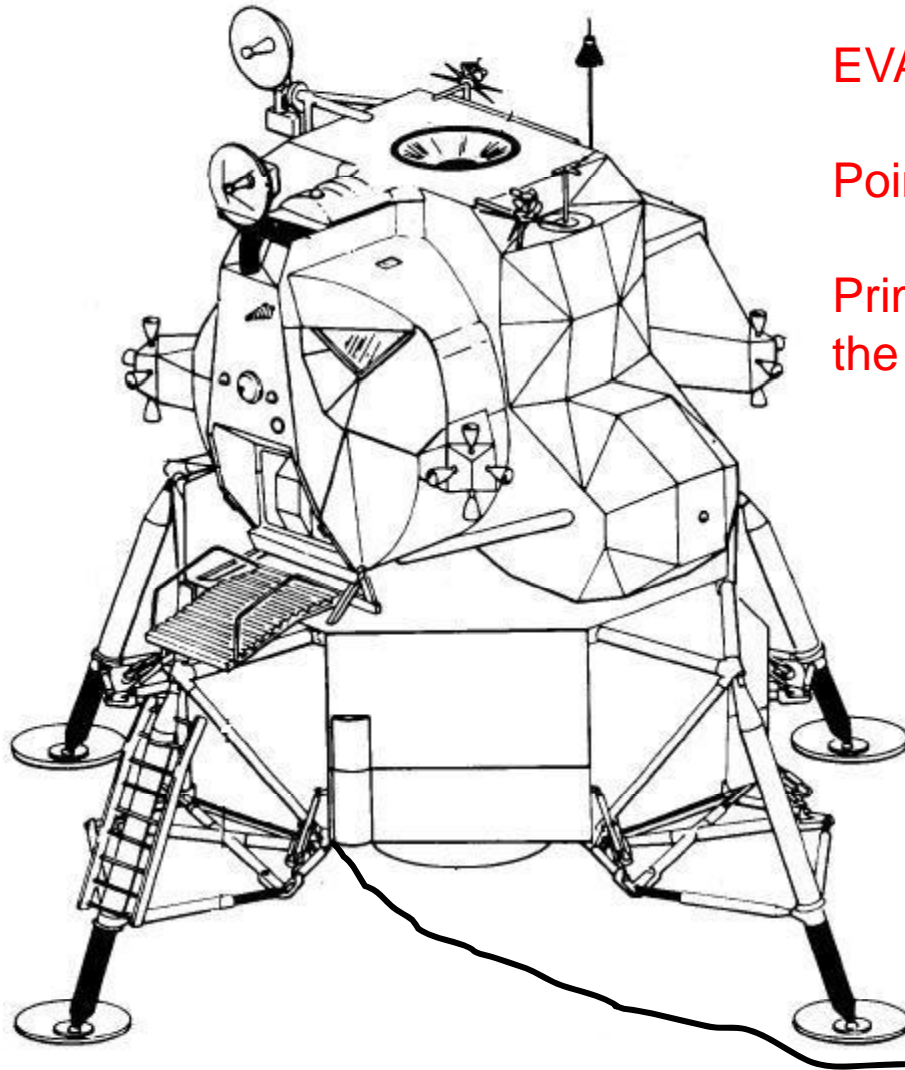
# Antennas

Lunar Stay usage

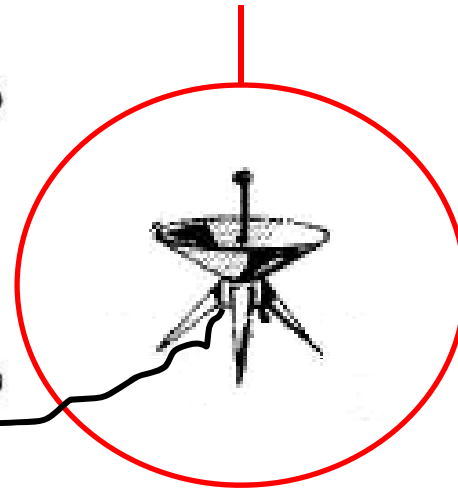
EVA Setup

Point at Earth

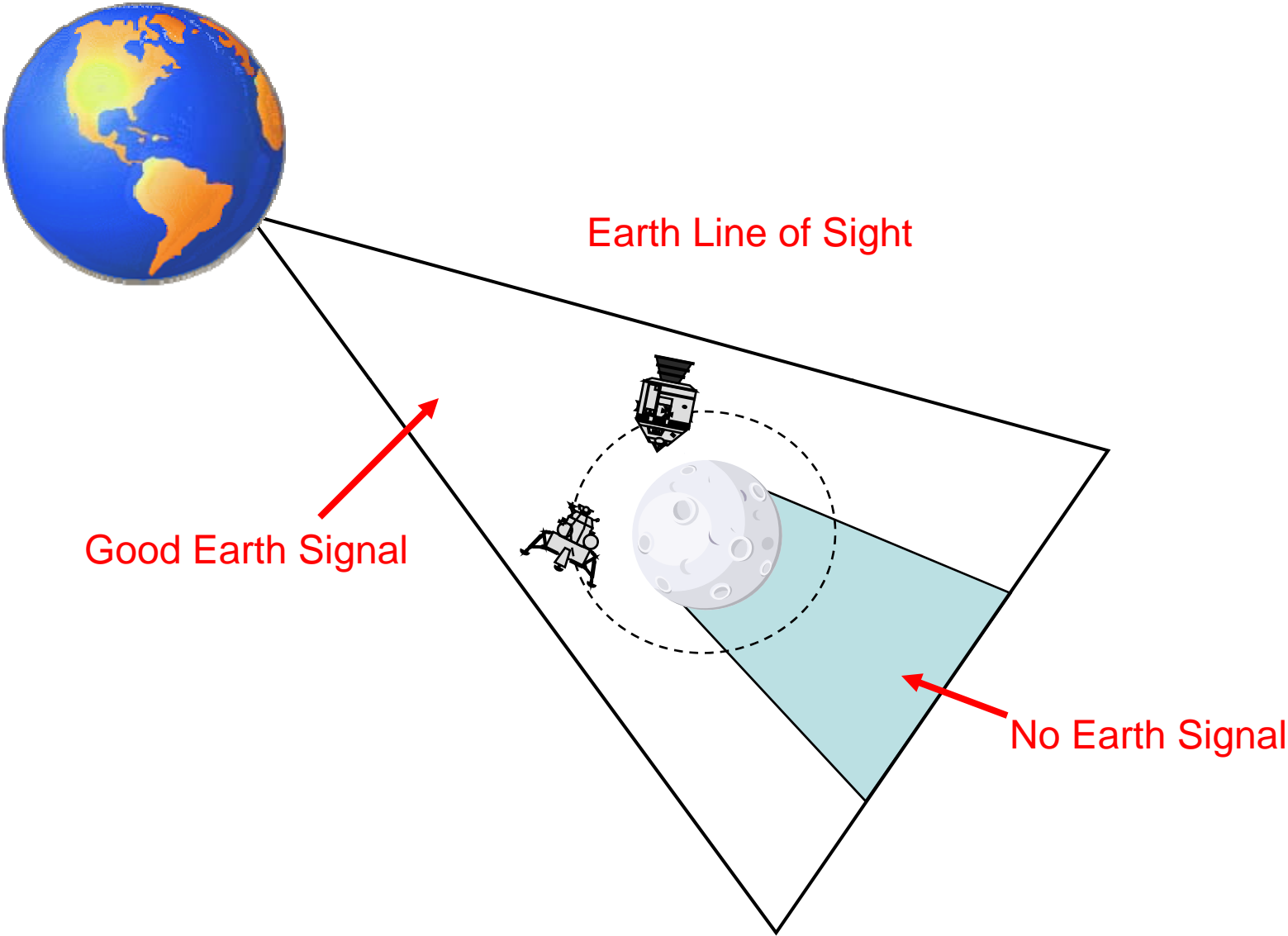
Prime communications link between the LM and MSFN during lunar stay



S Band Erectable  
Antenna



# Line of Sight



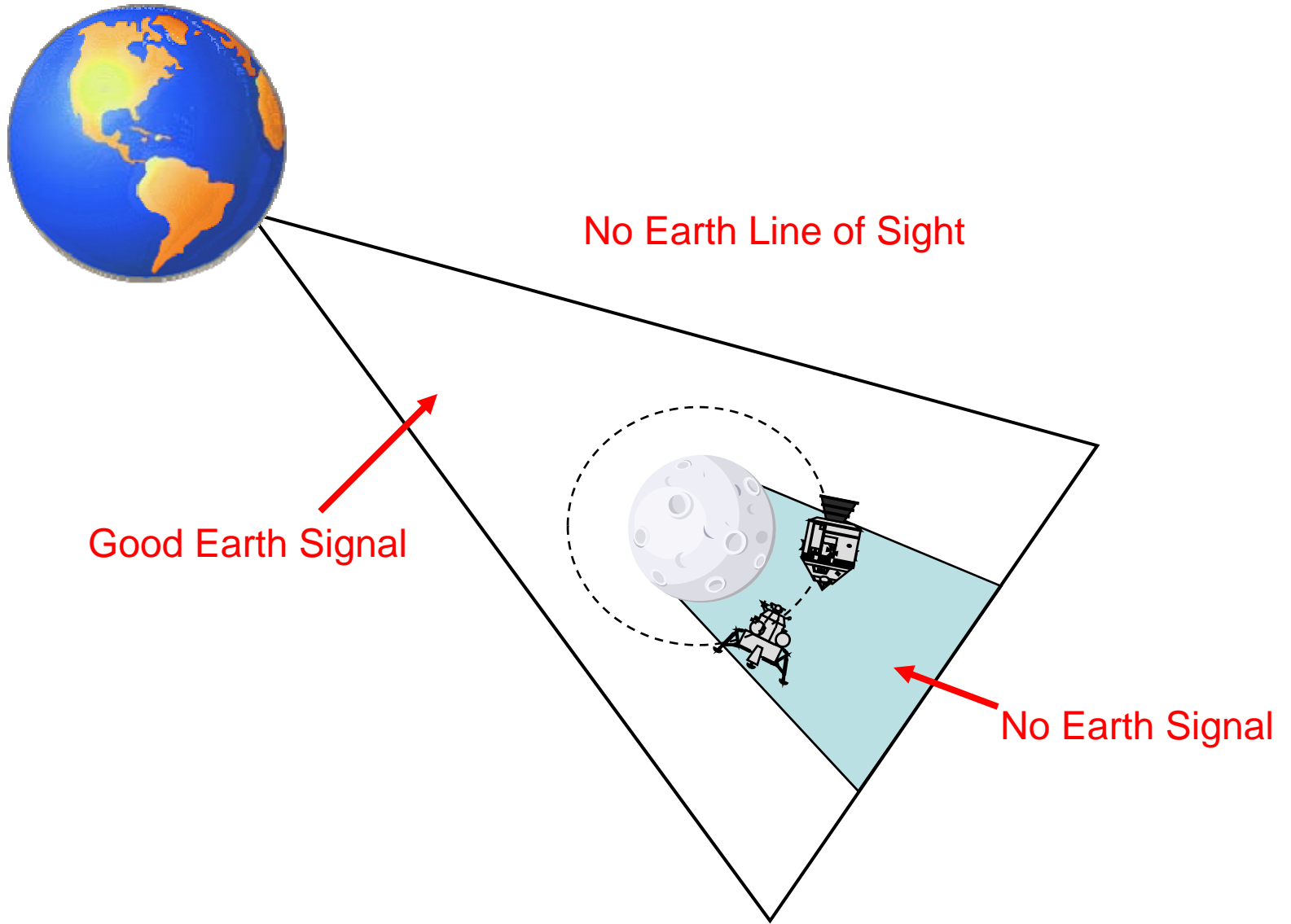
Earth Line of Sight

Good Earth Signal

No Earth Signal

Not To Scale

# Line of Sight



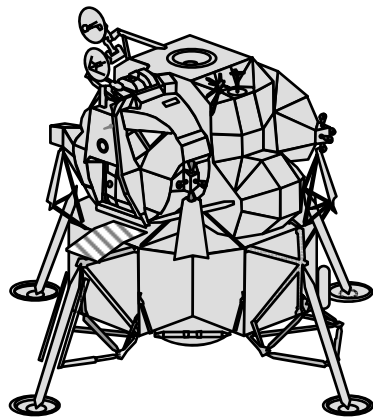
Good Earth Signal

No Earth Line of Sight

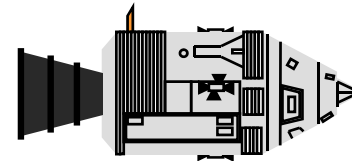
No Earth Signal

Not To Scale

# Earth Line of Sight Comm



VHF  
Voice



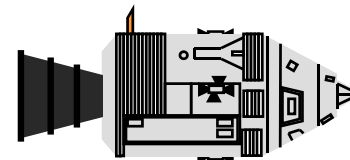
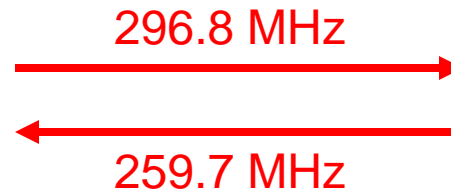
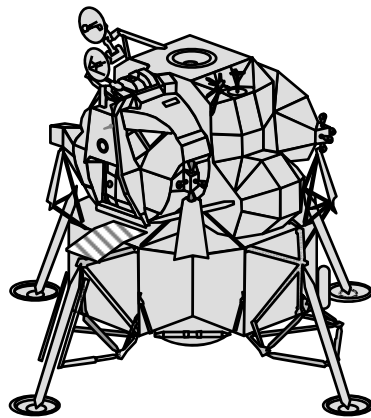
# Earth Line of Sight Comm



Note:

296.8 MHz = VHF Channel A

259.7 MHz = VHF Channel B



Duplex Operations = Transmit and Receive on different frequencies

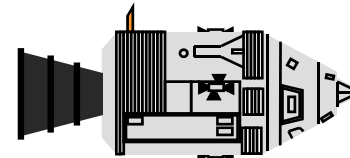
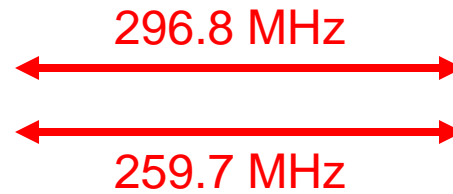
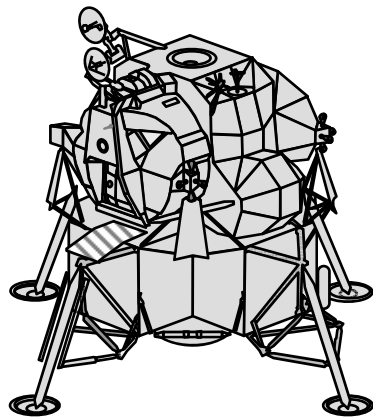
# Earth Line of Sight Comm



Note:

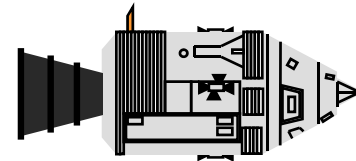
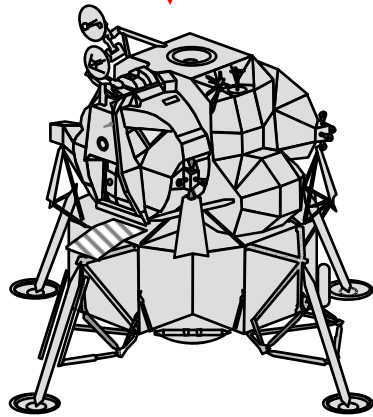
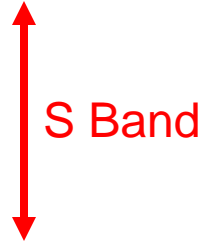
296.8 MHz = VHF Channel A Prime

259.7 MHz = VHF Channel B Backup



Simplex Operations = Transmit and Receive on the same frequency.

# Earth Line of Sight Comm

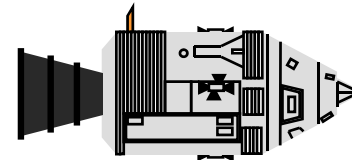
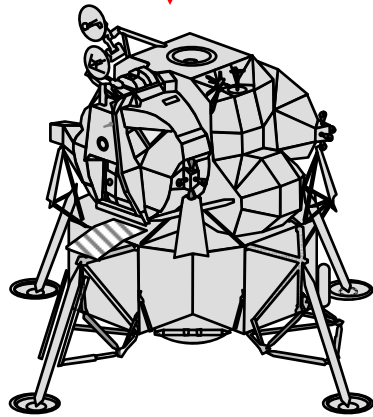




# Earth Line of Sight Comm



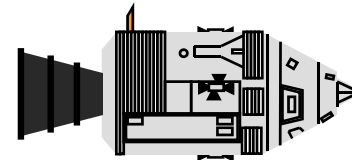
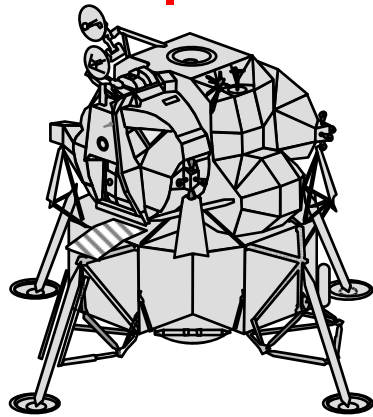
Voice  
Ranging  
2101.8 MHz



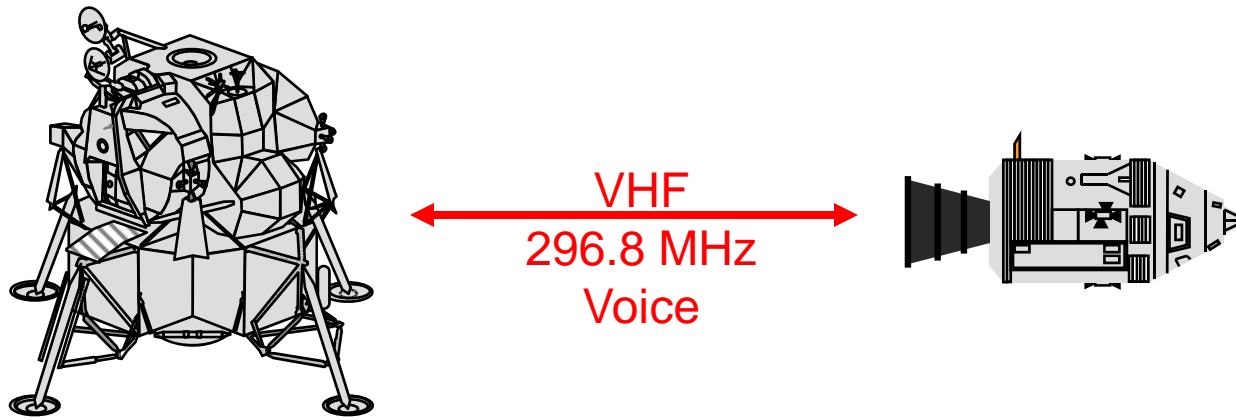
# Earth Line of Sight Comm



↑ Voice  
Data (51.2 kbps)  
Ranging  
2282.5 MHz

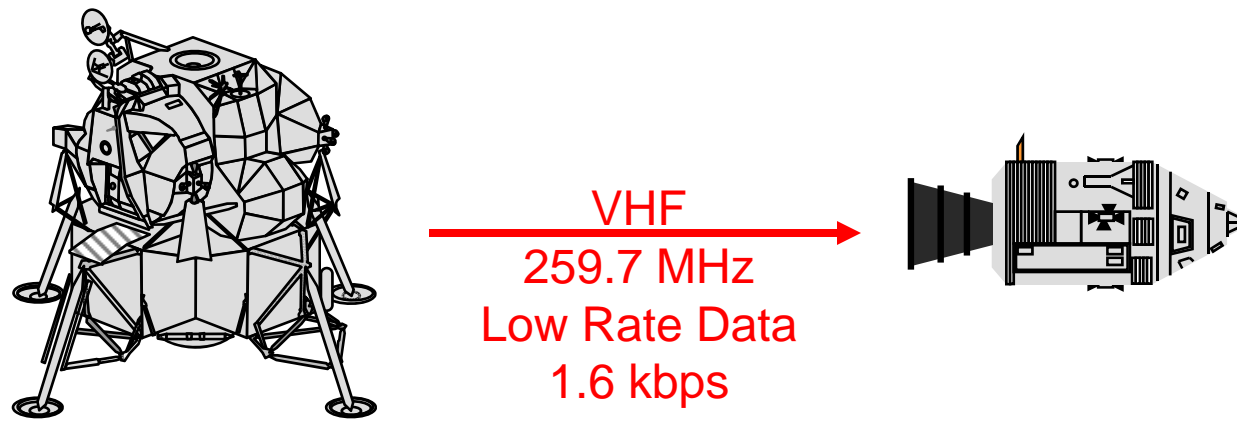


# No Earth Line of Sight Comm



Simplex Operations = Transmit and Receive on the same frequency

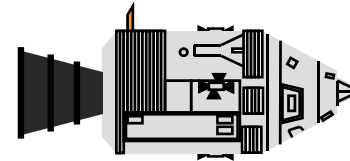
## No Earth Line of Sight Comm



Data from the LM would be recorded on the CSM and played back to the ground when the CSM was in Earth LOS.

About two hours of recording time on the CSM

# Lunar Stay Comm

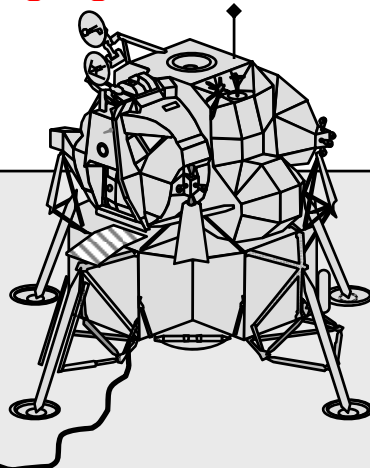


2282.5 MHz  
Voice and Data  
Ranging

2101.8 MHz  
Voice  
Ranging



S Band  
Antenna



Mode 1 = Frequency Modulation, High Power (20 watts)  
included TV

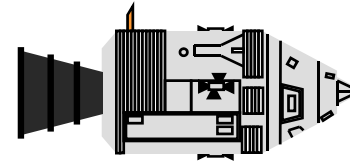
Mode 2 = Phase Modulation, Low Power (.75 watts)  
without TV

# Lunar Stay Comm



2282.5 MHz

2101.8 MHz

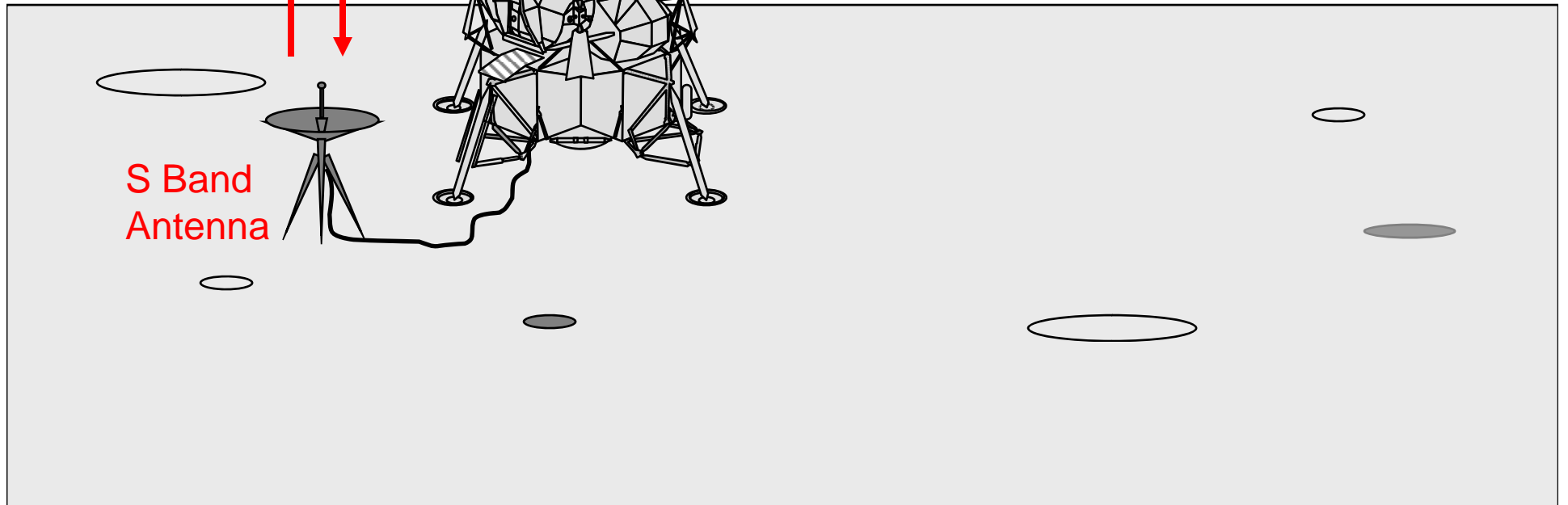


2282.5 MHz

2101.8 MHz

Each leg of communications took about 1.5 seconds, so turnaround time was a total of 6 seconds for response.

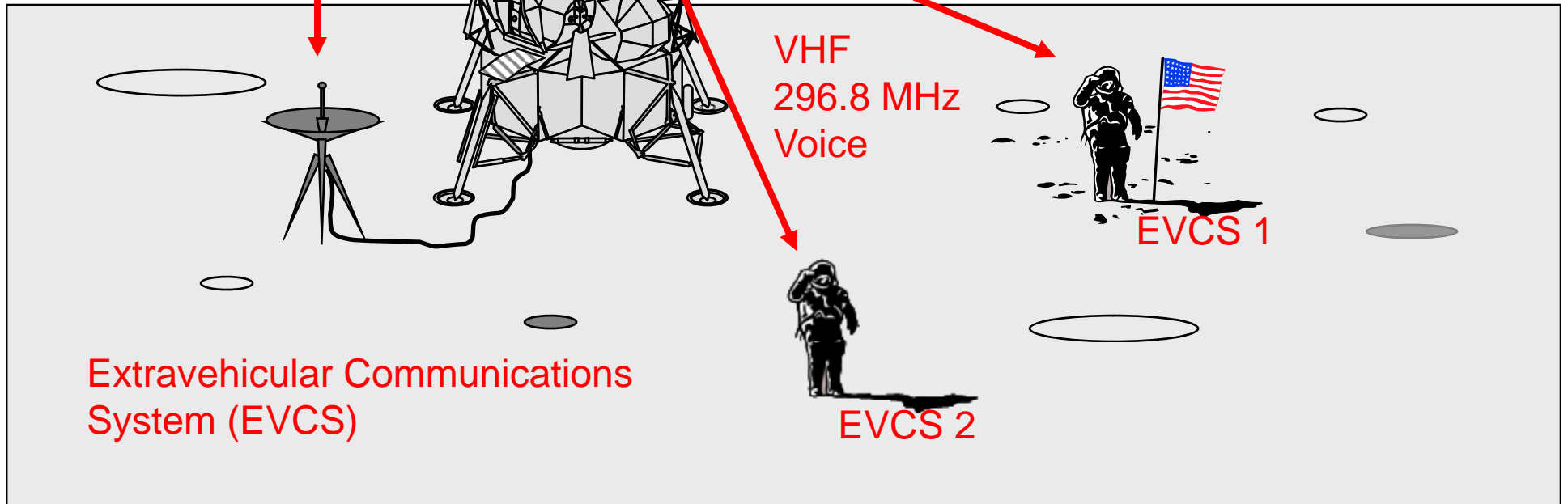
S Band  
Antenna



# Lunar Stay Comm EVA Communications

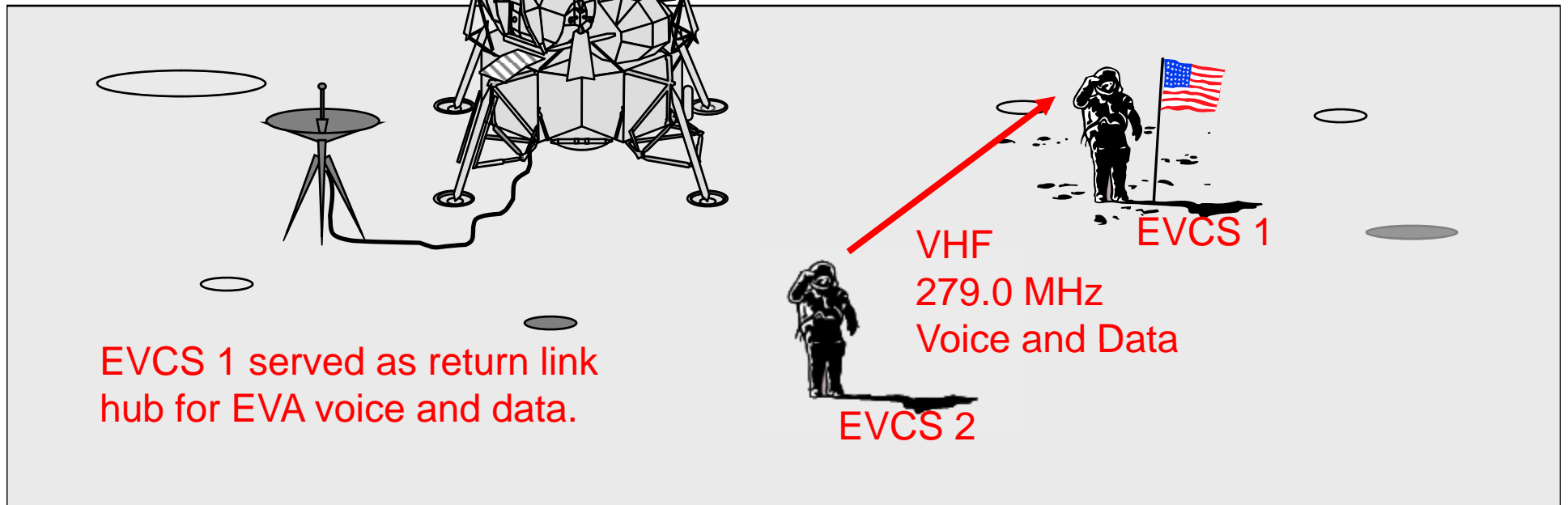


S Band  
2101.8 MHz  
Voice





# Lunar Stay Comm EVA Communications

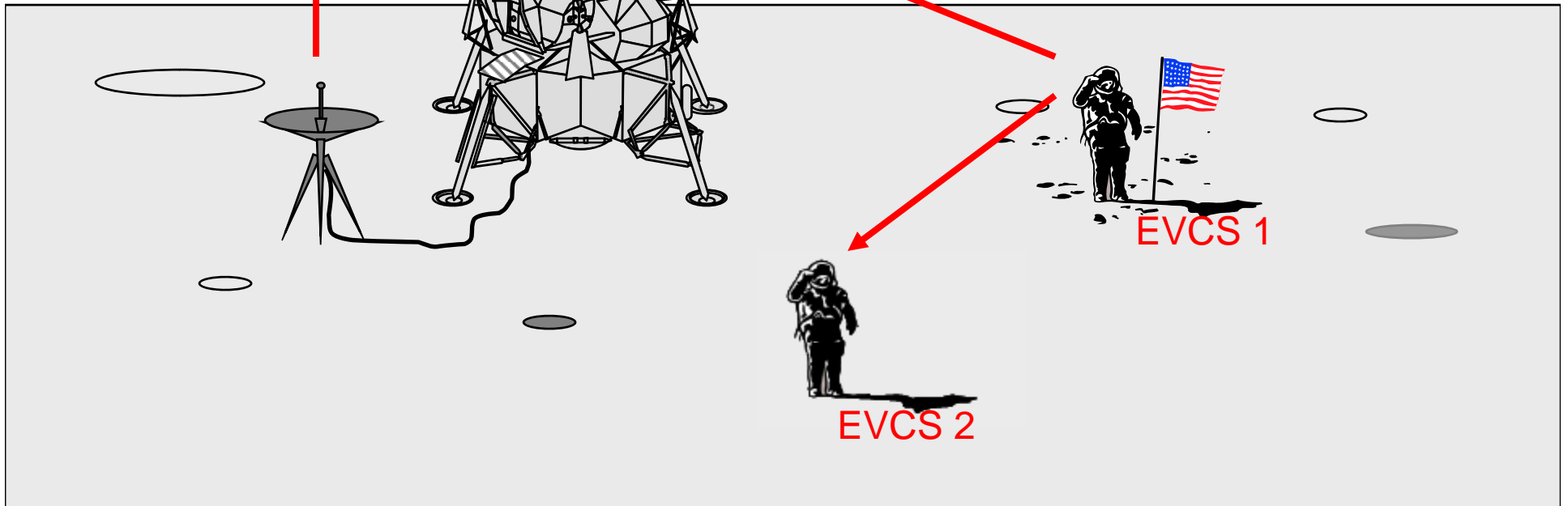


# Lunar Stay Comm EVA Communications

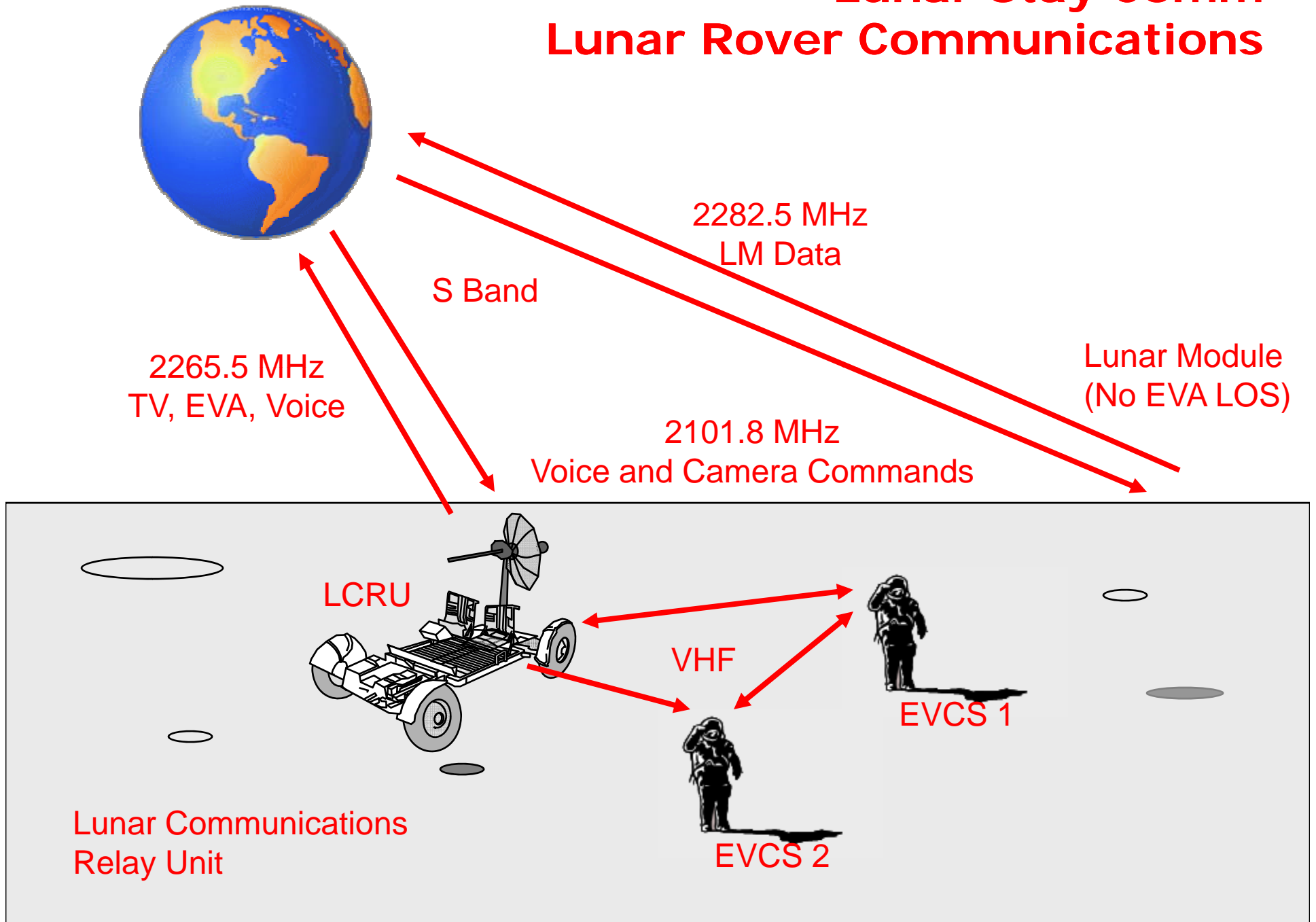


S Band  
2282.5 MHz  
Voice and Data (LM, TV and EVA)

VHF  
259.7 MHz  
Combined Voice and Data

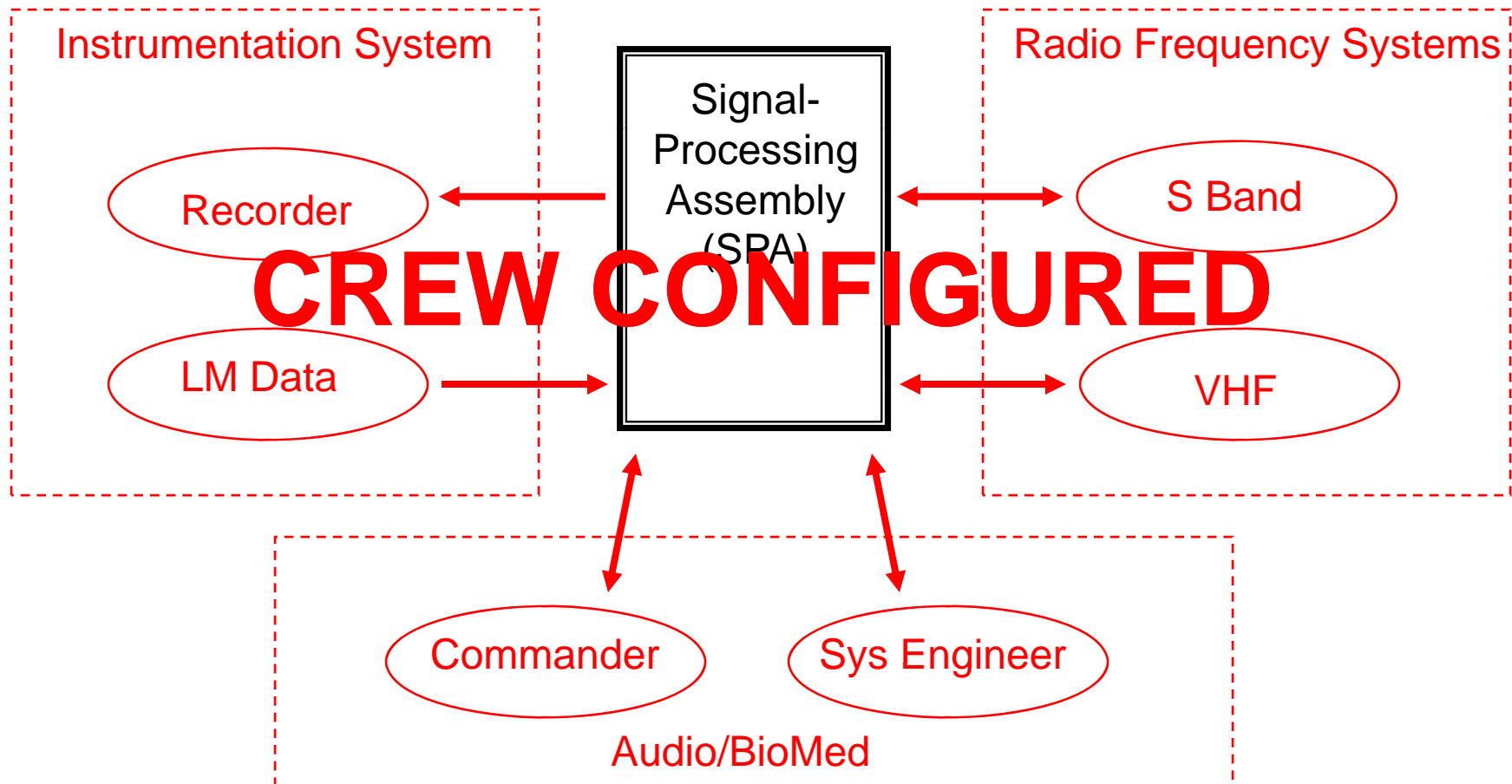


# Lunar Stay Comm Lunar Rover Communications

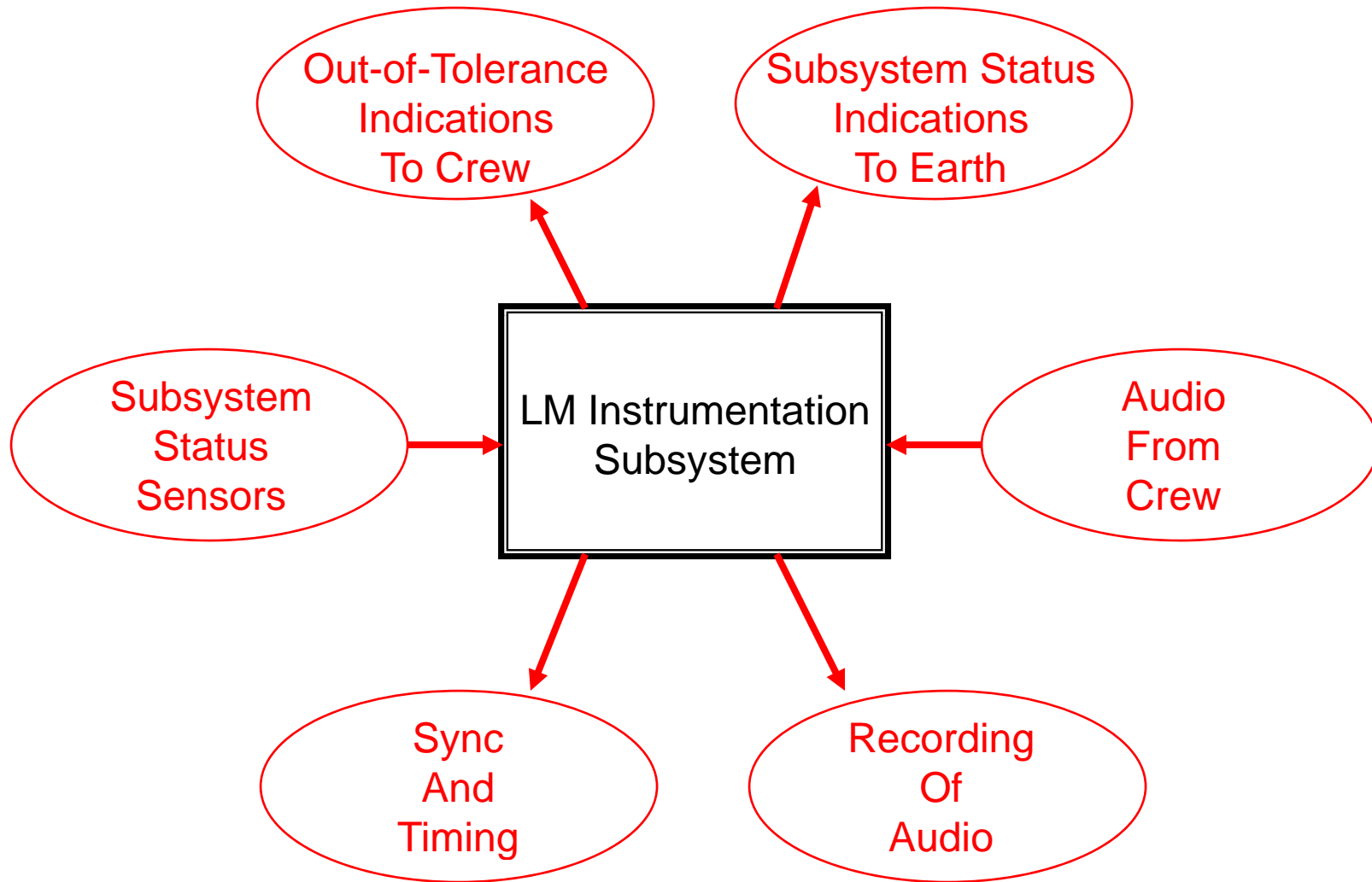


# Signal Processing Assembly

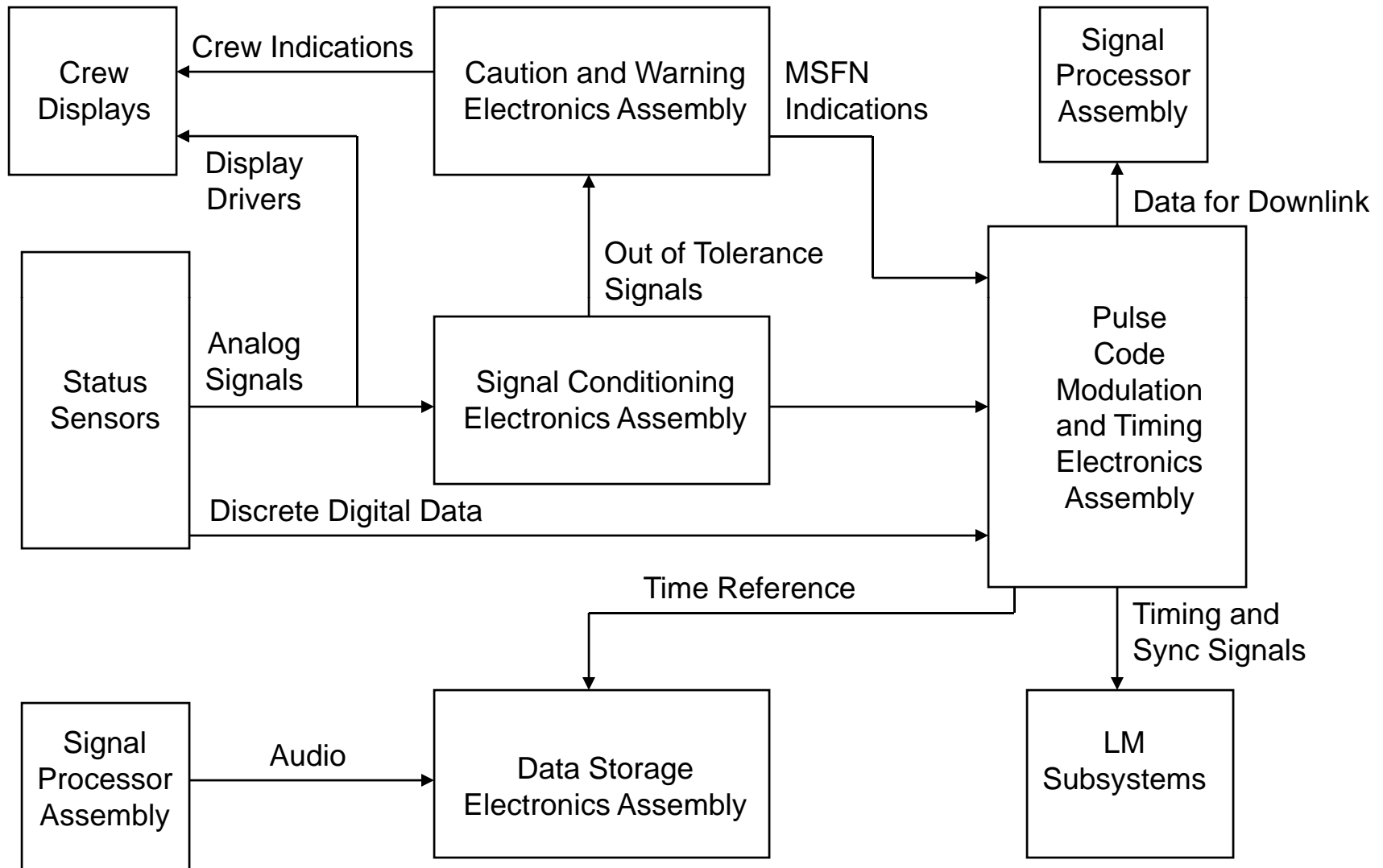
All signals transmitted or received by the comm subsystems are processed here.



# Instrumentation System



# Instrumentation System



# LM Communications Problems

## Improper Systems Configuration

### MSFN Configurations

Apollo 9 – Loss of Voice to LM

### Crew Configurations

Apollo 11 – LM Pilot Intermittent EVA Voice

Apollo 14 – No EVA Voice During Checkout

Apollo 15 – No CSM/LM VHF Voice During Lunar Descent

## S Band Steerable Antenna Problems

### Antenna Oscillations

Gimbal Hardstops/LM Body Blockage

## Hardware Failures

Apollo 9 LM Pilot Audio System

Apollo 16 Steerable Antenna Failure



## Lunar Module Communications Systems

S Band System – Voice and Data link between LM and MSFN  
Ranging Data between LM and MSFN

VHF System – Voice and Data link between LM and CSM  
Voice and Data link between LM and EVA  
Ranging Data between LM and CSM

Radio Frequency Systems Usage – During Earth Line of Sight  
During No Earth Line of Sight  
During EVA Operations

Function and Interfaces of the Signal Processing Assembly and the Instrumentation System

# Objectives

- Describe the different types of antennas on the Lunar Module
- Describe the different communications paths during Earth line of sight periods
- Describe the different communications paths during periods when there was no Earth line of sight
- Describe the different communications paths during Lunar Surface operations
- Describe the interfaces to and function of the Signal-Processing Assembly (SPA)
- Describe the interfaces to and function of the Instrumentation system

# Lunar Module Communications

