Command & Service Module Communications
Objectives

1. Define System Capabilities
2. Describe the S-Band & VHF Systems
3. Discuss Communications during:
   1. Pre-Launch
   2. Ascent
   3. In-Flight
   4. Entry
• Closing Remarks
Capabilities

- Communication System Capabilities
  - CSM-Earth
    - 2-way Voice & Data (S-Band & VHF)
    - Television Downlink
    - Precise Vehicle Tracking
  - CSM-Lunar Module (LM)
    - 2-way Voice & Data
    - VHF only
  - CSM-Extra Vehicular (EV) Members
    - Voice capability with EV members
    - VHF only
CSM – Earth Communications (S-Band)

2-Way Voice

Telemetry & Command

Vehicle Ranging

TV Downlink
CSM - EV Crewman Communications (VHF)

2-Way Voice

EV Crew Telemetry

2-Way Voice

EV Crew Telemetry
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S-Band Communications

• S-Band System Overview
  – Data Rates
  – Operating Frequencies

• Major System Components
  – Pre-Modulation Processor
  – Unified S-Band Electronics
  – S-Band Power Amplifier
  – S-Band Antennas
S-Band System Overview

• Data Rates
  – Transmit:
    • 51.2 kbps High-Rate Data (Shuttle 128 kbps)
    • 30kHz Voice Sub-Carrier
  – Receive
    • 70kHz Command Sub-Carrier
    • 30kHz Voice Sub-Carrier

• Frequencies
  – Transmit 2287.5 MHz
  – Receive 2106.4 MHz
Major S-Band Components

• Pre-Modulation Processor (PMP)
  – “Brains” of the Comm. System

• Unified S-Band Equipment (USBE)
  – Transmitter & Receiver

• S-Band Power Amplifier (PA)
  – High, Low, and Bypass modes

• S-Band Antennas
  – 1 Deployable High Gain Array
  – 4 Omni-Directional’s, mounted 90° apart
S-Band Antenna Locations

4 Omni-Directional Antennas

High-Gain Array
VHF System Overview

- **What did it provide?**
  - Data and Voice capabilities with Ground Stations, LM, and EV Members
  - Max reliable range of 1500 nautical miles

- **Data Rates**
  - 51.2kbps to Ground Sites
  - 1.6kbps to/from LM and EV crewman

- **Frequencies**
  - Transmit 296.8Mhz, Receive 259.7Mhz
  - Simplex & Duplex Modes
Major VHF Components

- VHF Transmitters & Receivers
  - Provided AM and FM capability

- VHF Multiplexer
  - Allowed up to 6 VHF transmitters or receivers to utilize the same antenna simultaneously

- VHF Antennas
  - 2 “Scimitar” Antennas, mounted 180° apart
  - 2 Deployable Recovery Antennas
  - 1 Deployable HF Antenna (Block I Only)
VHF Antenna Locations

- 2 Recovery Antennas
- 2 Scimitar Antennas
- 1 HF Antenna
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Pre-Launch Communications

- Launch Umbilical
  - Provided 2-way voice, telemetry, and television from the launch pad

- Merritt Island Ground Station
  - Manned Space Flight Network (MSFN) Station
  - Provided 2-way voice, telemetry, command and ranging capabilities
Ascent Communications

• Ground Sites (MSFN Sites)
  – Ground Sites around the world that provided S-Band, VHF, Command, and Ranging capabilities

• Apollo Ships
  – Converted WWII Oil Tankers and Liberty Ships that provided S-Band, VHF, and Ranging

• ARIA
  – Converted planes that provided limited MSFN capabilities such as S-Band and VHF communications
In-Flight Communications

- **Ground Sites (MSFN Sites)**
  - VHF and S-Band capabilities with the CSM, LM, and Saturn IVB/IU

- **Deep Space Network (DSN)**
  - S-Band voice, telemetry, television, and ranging
    - Madrid, Goldstone, Canberra
Entry Communications

- **Ground Sites (MSFN Sites)**
  - When “in view” ground sites would attempt communications during reentry.
  - Negated mostly by plasma effects

- **Recovery Ships**
  - Used VHF and HF systems to find CM recovery beacon
  - Swimmer plugged into CM for communication link with crew

- **ARIA**
  - Four minute “Black Out Period” negated some of ARIA’s effectiveness
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• Closing Remarks
• Overall, CSM communication system was rated highly by flight controllers and crew

• No major issues encountered during flight

• System was mostly autonomous for both crew and flight controllers

• Communications didn’t use satellite links like TDRS system Shuttle & ISS use today

• For more information on Apollo Comm. Systems, please visit the Apollo Wiki