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
• 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 – Earth Communications (VHF)

2-Way Voice

Telemetry Only
CSM – LM Communications (VHF)

2-Way Voice

Telemetry Only

LM Ranging
CSM - EV Crewman Communications (VHF)
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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
S-Band System Block Diagram

BASIC SPACECRAFT SYSTEM FOR CM

- UPLINK VOICE
- UPDATA
- CM VOICE
- LM RELAY VOICE
- EM VOICE & BIOMED
- TELEVISION
- PCM TLM
- EM KEY

PMP

PM MODULATION PROCESSOR

PM RECEIVER

PM EXCITER

FM EXCITER

FINAL AMPLIFIER AND SWITCHING CIRCUITRY

PA

ANTENNAS

HI-GAIN ANTENNA

OMNI-ANTENNA
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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  - Entry
- Closing Remarks
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