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COMMON LUNAR LANDER COMMUNICATION SUBSYSTEM DESIGN FINAL PRESENTATION

BY

TRACKING AND COMMUNICATION DIVISION
HENRY CHEN/EE7

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INTRODUCTION

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A Division Team effort

EE2/ Richard Sinderson, K.D. Mclain
EE3/ Tim Early
EE7/ Henry Chen
LESC/ Dr. Zafar Taqvi, Phil Lipoma

The communication subsystem is required to provide downlink for telemetry data and uplink for command data. It also provides Doppler/Ranging for the state-vector generation.

Detailed trades, system designs and requirements analysis were performed to provide the most realistic estimates for the project.

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TRADE STUDIES

Data rate considerations
- Based on LifeSat and Surveyor designs
- 11.6Kbps was selected to size the communication subsystem
- Multiple data rates option was provided (500bps, 2.5Kbps, 11.6Kbps and 40Kbps)

Deep Space Network (DSN) subnet selection
- 70m vs. 34m vs. 26m subnet
- DSN 34m subnet was selected due to its scheduling and performance advantage

Frequency Trade
- L-band vs. S-band vs. X-band
- S band [redacted]s selected because of hardware availability

Motorola transponders
- NASA Standard Near Earth Transponder was selected for its simplicity and availability
- Minimum amount of modification is required

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TRADE STUDIES (CONT.)

Antenna selection

- Omni antennas were proposed to provide near spherical coverage and to avoid complicated support and pointing mechanisms

Circuit margin and system level trade studies were completed

- 18 different configurations were evaluated

Companies/organizations consulted

- TRW, Watkin-Johnson, M-A Comm., Motorola, Teledyne, Gore, Loral Videospection, JPL, GSFC

Programs studied

- Space Shuttle, Space Station Freedom, Surveyor. Viking, LifeSat.
- SMEX, CRAF, CASSINI, GRO, HEAO, FLTSATCOM, Solar Max, COBE, OMV

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BASELINE DESIGN

Current baseline design

- S-band system using Deep Space Network (DSN) 34m subnet
- Motorola DSN Near Earth transponder
- 10W solid state power amplifier
- (2,7) convolutional coder
- PCM/PSK/PM modulation scheme
- Multiple data rates
- Log conical spiral antennas for near spherical coverage

Hardware information

- All modules have at least 2000 hrs. MTBF
- Single string implementation was selected
- Temperature range: -20 to 60 degrees C in avionics bay and -55 to 155 degrees C for externally mounted components

CLL COMMUNICATION SUBSYSTEM BLOCK DIAGRAM

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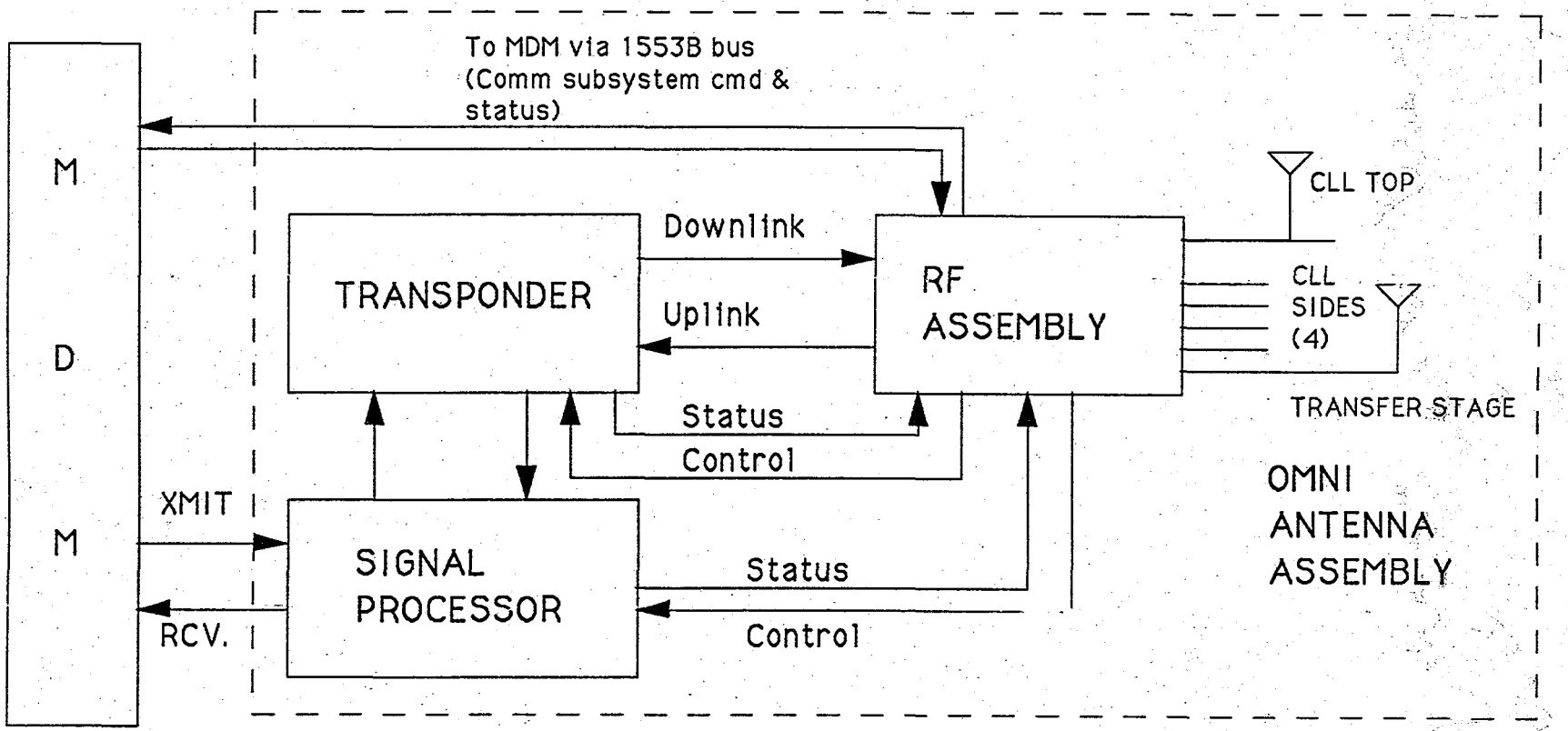

COMMON LUNAR LANDER RF COMMUNICATION SUBSYSTEM

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POWER, WEIGHT, SIZE AND COST

UNIT	WEIGHT	VOLUME	POWER	COST	#	VENDOR
RF assembly Qualification in 24 month	7.4Kg	7800cc 16x20x24	71W (p) 18.8W (a)	0.65M	1	custom**
Transponder Qualification in 24 months	3.3Kg	3500cc 16x20x11	17.5W (p) 8.0 (a)	1.1M	1	Motorola
Antennas Qualification in 20 months	5.5Kg	8640cc	0	0.39M	6	W-J
Cable Qualification in 6 months	2.4Kg	900cc	0	0.03M	1 set	GORE
Signal Proc. Qualification in 6 months	3.0Kg	4800cc 16x20x15	27W	1.0M	1	custom**
TOTAL	21.6Kg	23,400cc	115.5/ *** 53.8W	3.2M*		

* Cost does not include integration and system testing
** Equipment built from components with established track record
*** 115.5W during operating mode and 53.8W during standby mode

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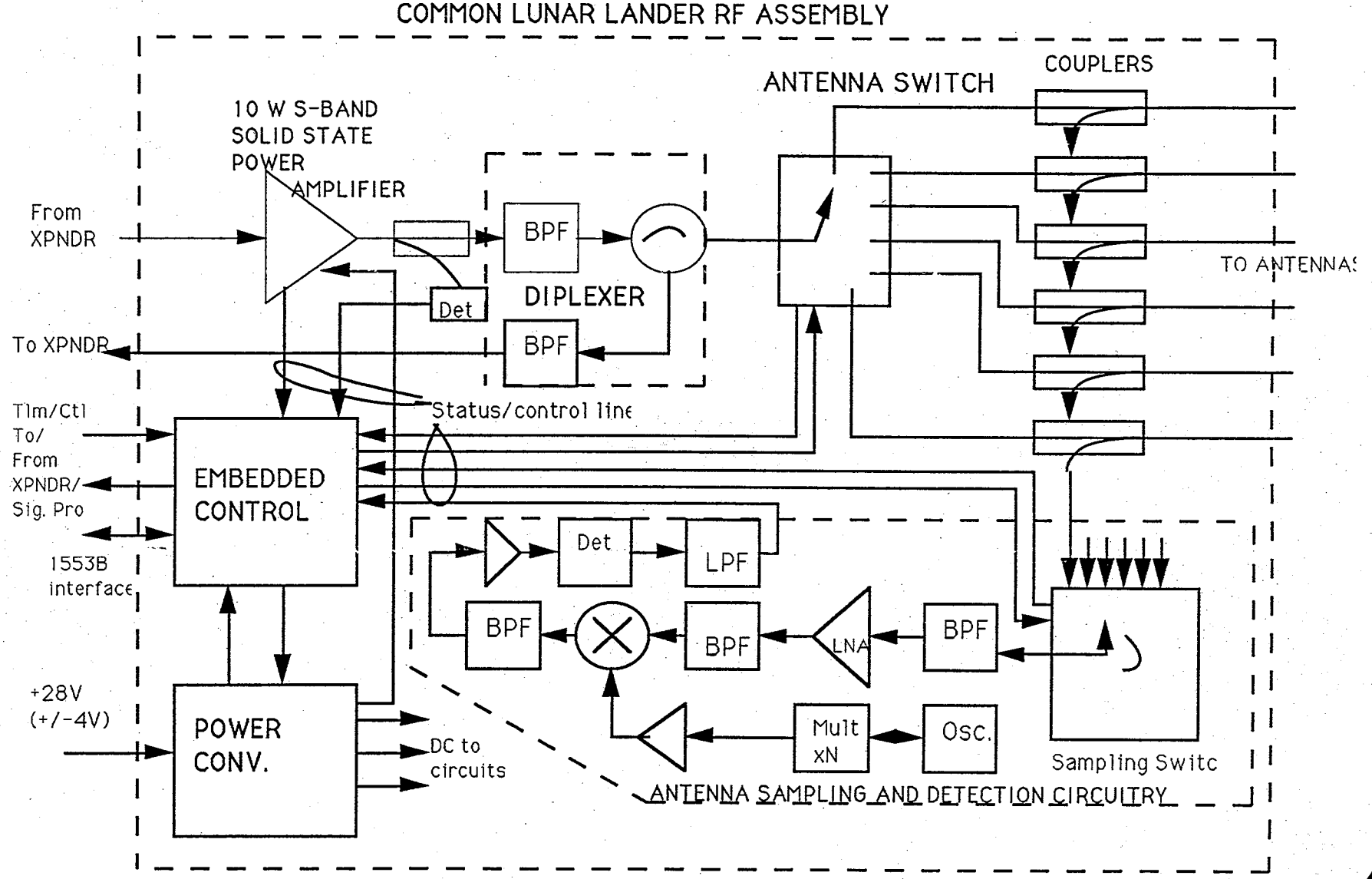
RF ASSEMBLY BLOCK DIAGRAM



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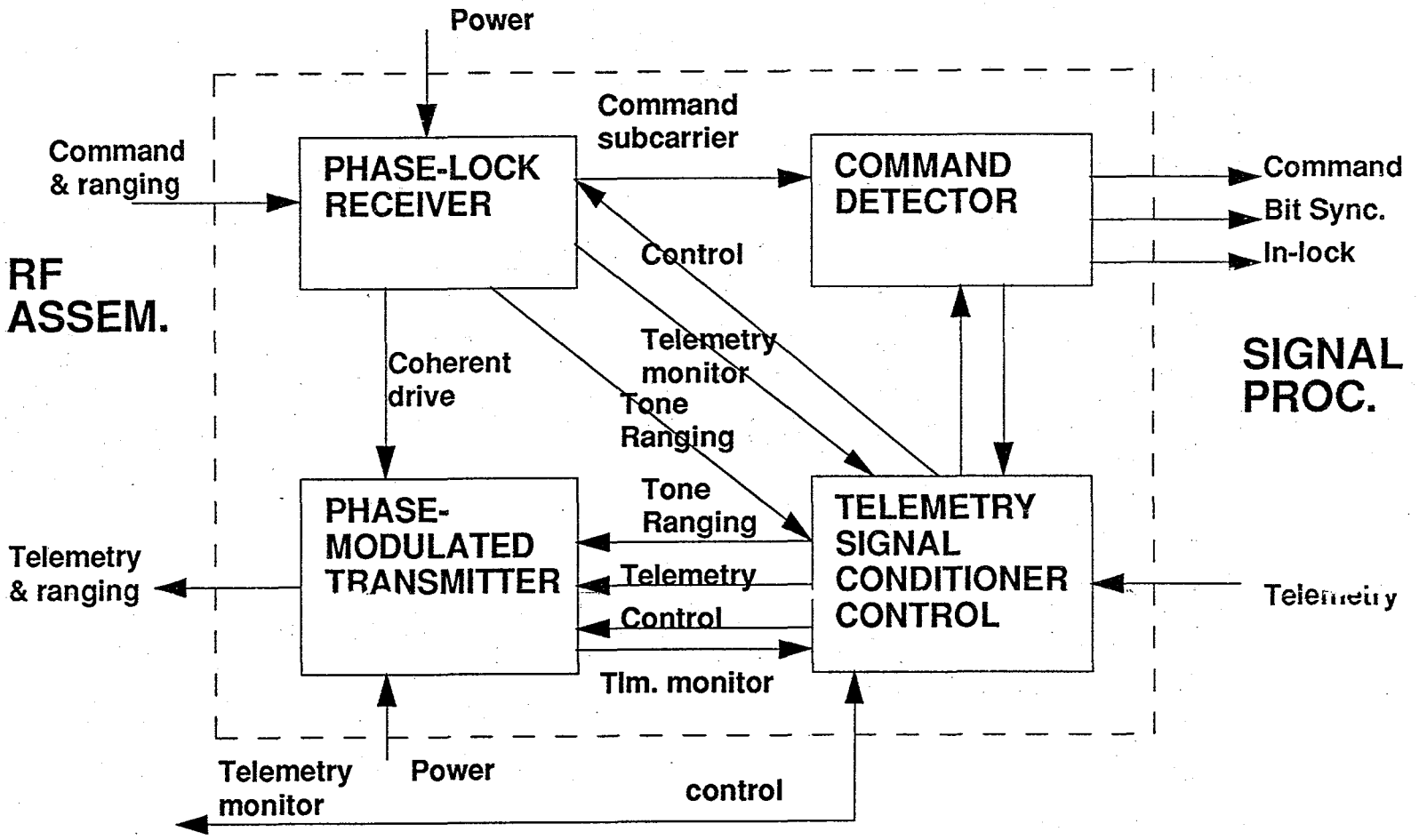
MOTOROLA TRANSPONDER



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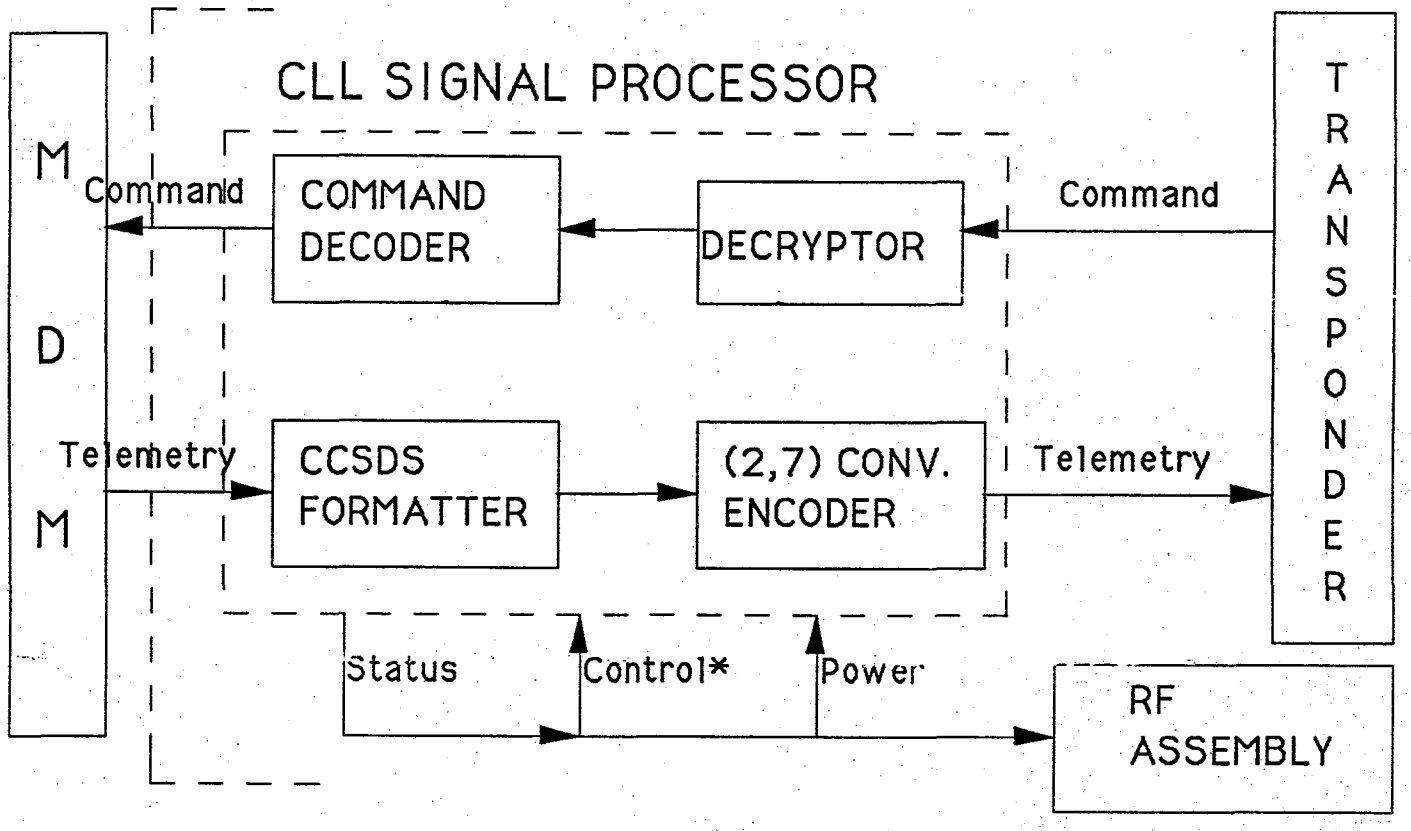
SIGNAL PROCESSOR BLOCK DIAGRAM



* Control performs two functions: (1)switches between stand-by and operation modes and (2)select multi-data rate modes.

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ANTENNA SELECTION

Proposed antenna usage

Phase	Primary	Secondary
Translunar stage	1 antenna on transfer stage	4 antenna on CLL sides
Lunar orbit	4 antennas on CLL sides	1 antenna on CLL top
Lunar landing	1 antenna on CLL top	4 antennas on CLL sides

The log conical spiral antennas are built by Watkins-Johnson. They were flown on Solar Max. They are 9cm tall and 10cm in diameter. The antennas are mounted on standoffs to achieve a more preferred orientation.

The antenna switching uses a passive algorithm. Signals from all antennas are sampled. The detector then picks the antenna which provides the strongest signal.

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FUTURE STUDIES

Design and analyze CLL communication subsystem during the next phase of design activity

Evaluate possible approaches for reduction in power, weight, size and cost

- Given trajectory, vehicle configuration, DSN schedule, etc., we can perform antenna coverage analysis to possibly reduce the number of antennas
- Integrate 3 distinct modules into 1 assembly
- Integrate functions into chip sets using VLSI technology
- Continuing trade studies for other critical areas

Evaluate the application of low data rate/analog video to facilate payload checkout