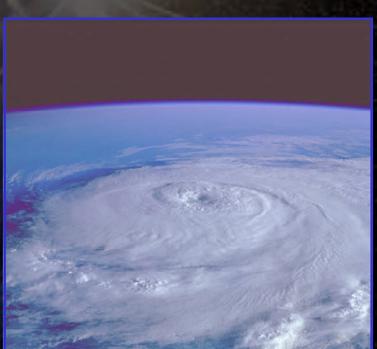
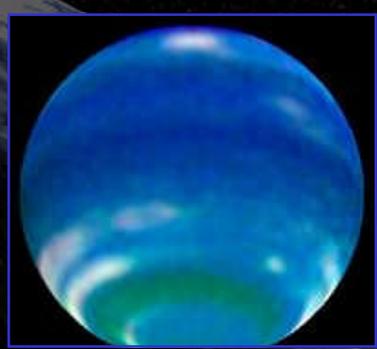
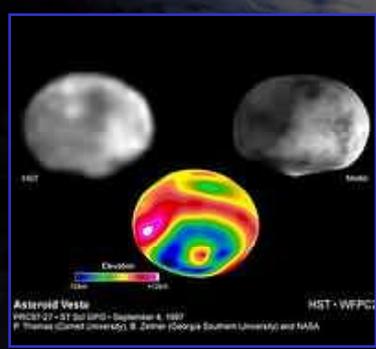


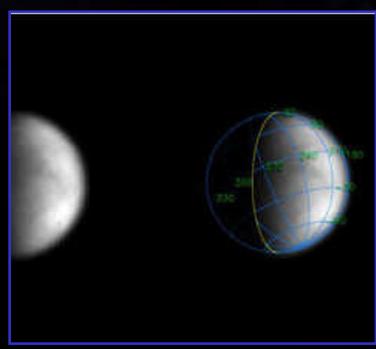
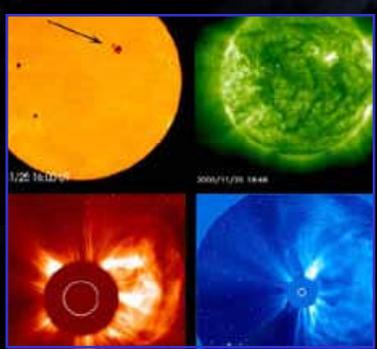


# **Space Communications Capability Roadmap Interim Review**

**Robert Spearing  
Michael Regan  
March 24, 2005**

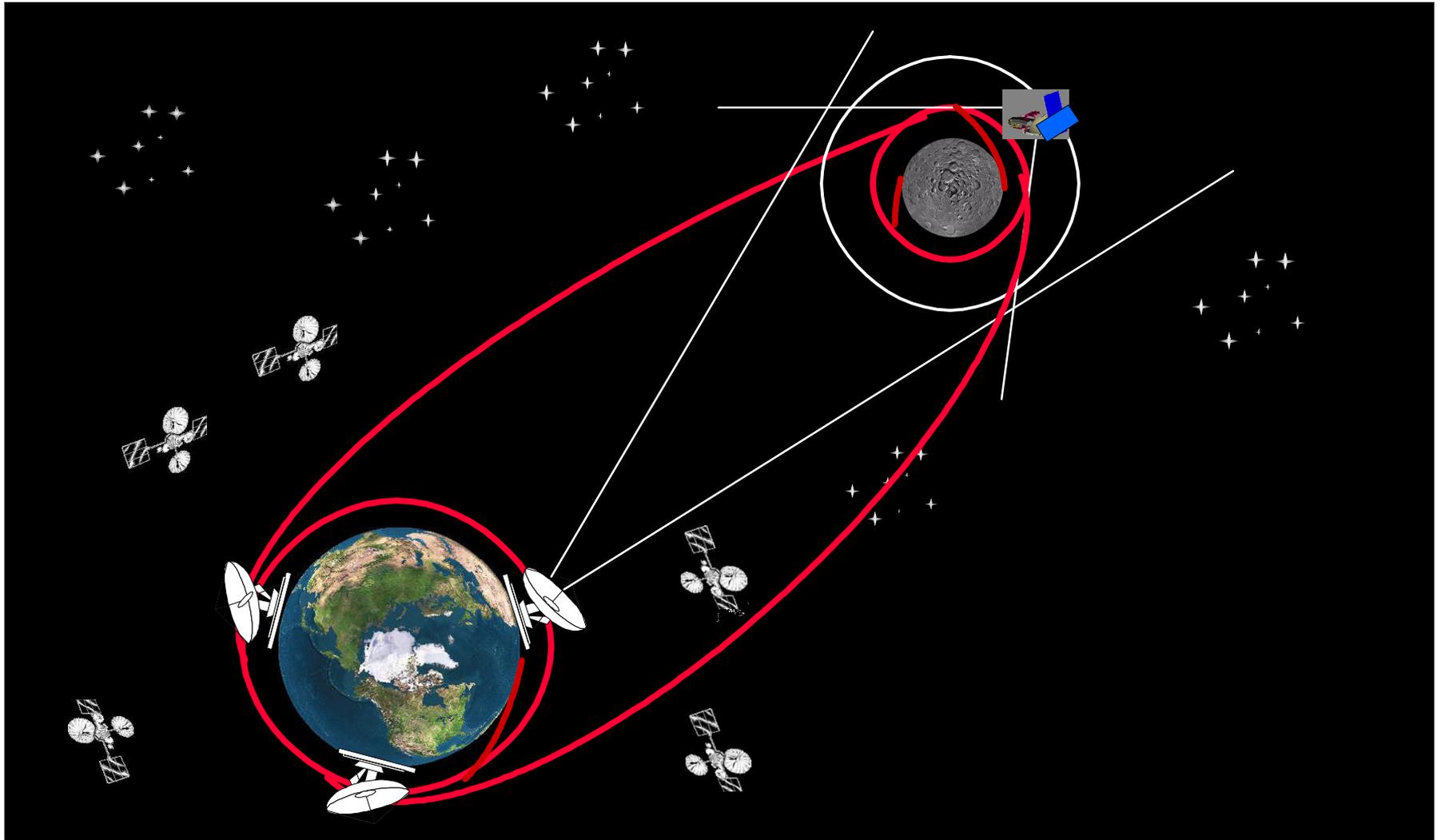


**NO COMMUNICATIONS**  
No Data  
No Commands  
No Pictures  
No Video  
No Voice  
No Safety  
**NO SCIENCE**  
**NO EXPLORATION**





# Comm Critical: All Phases of Flight...

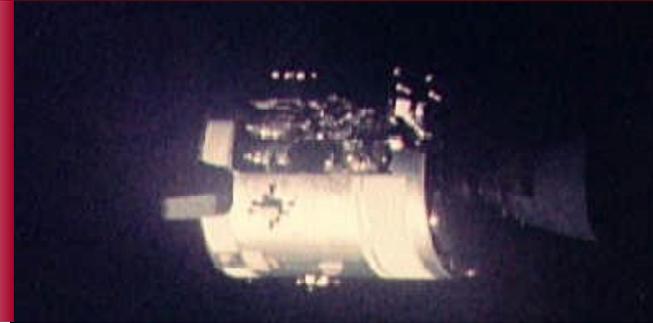




# Comm-Critical Mission Safety: Apollo 13 Recovery



The Apollo 13 malfunction was caused by an explosion and rupture of an oxygen tank...All oxygen stores were lost within about 3 hours, along with loss of water, electrical power, and use of the propulsion system.



Communications with the ground support crew enabled dozens of engineers to work to find a solution



Mission Control devised a way to attach the CM canisters to the LM system by using plastic bags, cardboard, and tape- all materials carried on board.



**Communications  
resources should  
be enabling,  
not constraining**



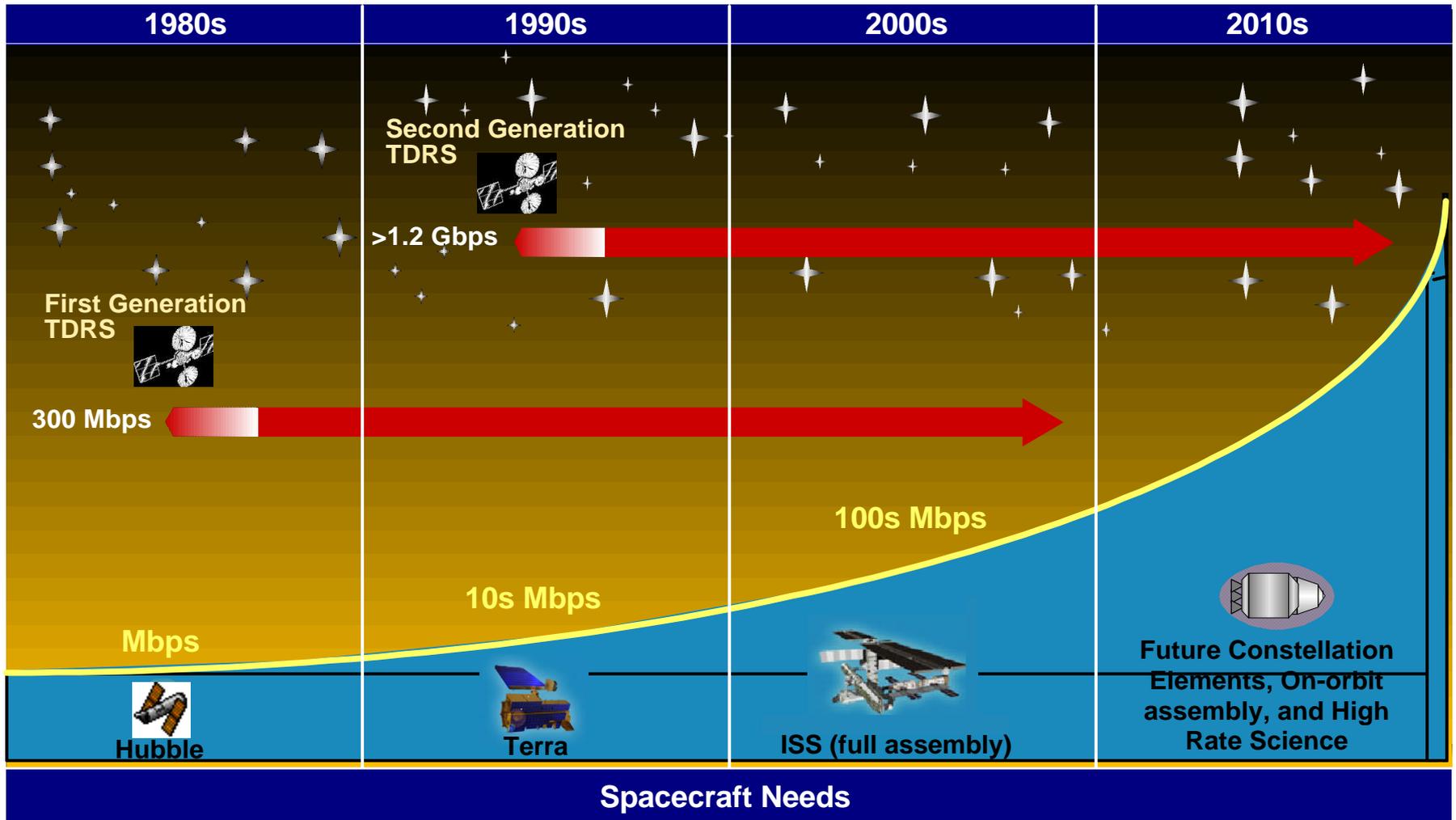
## **Timely Investment Remove Communications Constraints for Users**



- **NASA has traditionally made strategic investments in communications capability ahead of user mission need**
  - **Must be available before mission operates**
  - **Long lead times to develop communication systems such as relays require advanced acquisition**
- **Goal for exploration and science communication capability: enable missions by providing ample, unconstraining capability**



# Investing: The TDRSS Example





# Executive Summary



- **Identify the need for a robust communications and navigation architecture for the success of exploration and science missions**
- **Describe an approach for specifying architecture alternatives and analyzing them**
- **Establish a top level architecture based on a network of networks**
- **Identify key enabling technologies**
- **Synthesize capability, architecture and technology into an initial capability roadmap**



# Space Communication Capability Description



**The space communication and navigation capability will fully enable evolution of the exploration and science programs.**

- connectivity to exploration and science program vehicles**
- spacecraft position**
- transferring mission data**
- vehicle telemetry**
- voice and commands**



# Agenda



- **Benefits of the Communications and Navigation Capability Roadmap**
- **Capability Roadmap Team**
- **Capability Description and Capability Breakdown Structure**
- **Roadmap Process and Approach**
- **Assumptions and Requirements, Current State-of-the-Art**
- **Communications and Navigation Capability Roadmap**
- **Sub-capability Descriptions and Relevant Technologies**
- **Description of Architecture Options and Recommendations**
- **Description of Technology Initiatives**
  - **Benefits**
  - **Current State of Art**
  - **Technology Roadmap**
  - **Technical Challenges**
- **Summary and Forward Work**



# Presentation Flow



- **Speaker: Bob Spearing**
- **Subjects: Benefits, Roadmap Team, Capability Description**
- **Time: 30 min.**
  
- **Speaker: John Rush**
- **Subjects: Roadmap Process, Assumptions, Top-Level Roadmap, Sub-Capability, Architecture Options, Optical Communications Technology**
- **Time: 2 hrs 30 min.**
  
- **Speaker: Dan Williams**
- **Subjects: Spacecraft RF Technologies, Uplink Arraying, Programmable Communication Systems**
- **Time: 1 hr.**
  
- **Speaker: Bob Spearing**
- **Subject: Closing Remarks**
- **Time: 10 min.**



# Communications Roadmap Team



## Co-Chairs

- NASA: Robert Spearing, Office of Space Operations
- Government: Michael Regan, National Security Space Office

## Team Members

### Government

- Michael Hawes, NASA
- Michael Luther, NASA

### Ex Officio

- Pete Vrotsos, NASA
- Warren Wiley, NASA

### Industry

- Greg Akers, CISCO
- Thomas Brackey, Boeing

### Academia

- John Baras, UMD
- Patrick Smith, NSF

## Coordinators

- NASA SOMD, Michelle Gates
- NASA APIO, Steve Mecherle

## Technical Working Support

- Space Communications Architecture Working Group



# Space Communications Architecture Working Group



**John Rush (Chairperson)**

**Dan Williams (Technology Assessment)**

**Dave Struba (Spectrum)**

**Dave Graham (Cost Estimation)**

**Pete Vrotsos (Exploration)**

**Barry Geldzahler (Science)**

**Donna Shortz (ISS / STS)**

**Laura Hood (JSC)**

**Frank Stocklin (GSFC)**

**Hugh LaMaster (Ames)**

**Bernie Edwards (GSFC)**

**Ken Freeman (Ames)**

**Les Deutsch (JPL)**

**Scott Sands (GRC)**

**Wallace Tai (JPL)**

**Gene Fujikawa (GRC)**

**Fred Stillwagen (LaRC)**

**Rich Nelson (KSC)**

**Bart Graham (MSFC)**

**NASA  
Headquarters**

**NASA Centers**



# Space Communications Working Group



- **Established prior to exploration program**
- **Goals:**
  - **Provide mission supporting communications & navigation system architectures for the agency**
  - **Identify key technologies needed to implement future architectures**
- **Architecture & technology recommended to Multi-Directorate Board**
- **Membership consists of representatives from both communication system providers (SN, GN, DSN) and consumers (All Space Missions)**
- **Approved architectures & technology initiatives provide guidance for budget formulation**



# Space Communication Capability — Evolution



- We have an architecture in place today; this distinguishes comm/nav from most other roadmaps
- Must evolve the architecture to meet the future needs of the exploration and science programs
- Developing communication/navigation capability requires analysis of architecture alternatives and the enabling technologies

## Comm/Nav Capability

Architecture

Technology



# Capability Breakdown Structure: a Services Based Approach



## 4.0 Communications and Navigation Architecture Capability to Support Science and Exploration

4.1  
Launch

4.2  
Earth Orbit

4.3  
Transit

4.4  
Lunar

4.5  
Mars

4.6  
Solar System &  
Beyond



# Top Level Conceptual Communication Architecture ~2030

