Overview of Relevant Standards Activities

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Mars IT Infrastructure Working group

14 July 2000

Drivers for Interoperability

- Multiple missions from multiple agencies
- Overlapping operational timelines
- Varying levels of spacecraft size & functionality
- Requirements for reliable data & file transfer
- Requirements for data relaying from low capability missions
- Requirements for cross-support

Potential Mission Set

(very much subject to change)

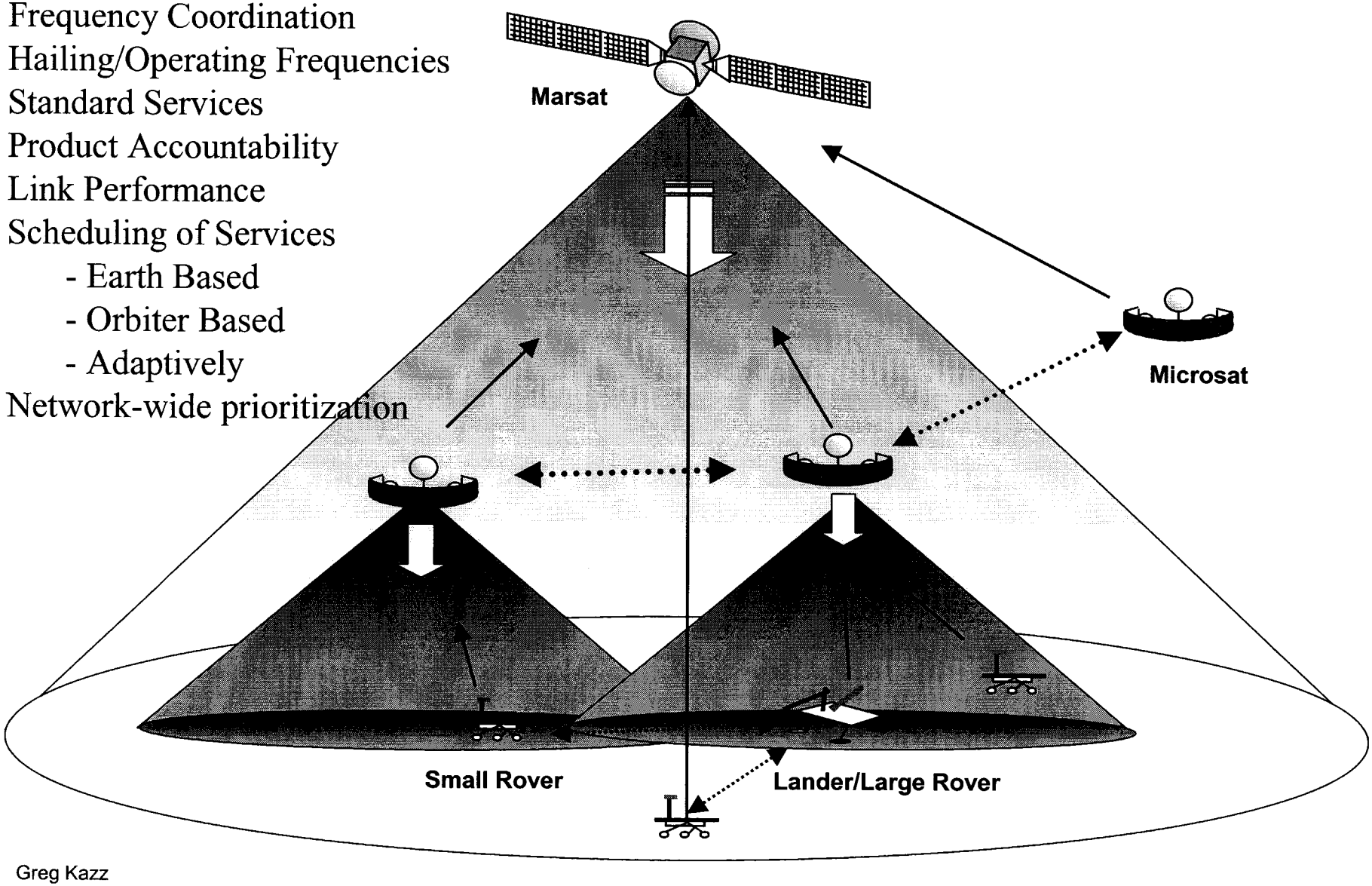
- Orbiters
  - Mars Express
  - Mars '01
  - Telesat (1+)
  - Science '03
  - Mars Sat
  - ...

- Landers
  - Beagle
  - Mars '03 ?
  - Netlanders '05 (20)
  - Scouts
    - '03 (2)
    - '05 (4)
  - ...

N.B. Even if these specific missions do not fly on these particular dates, some set of missions, with similar composition, will fly ... they will not interoperate by accident.

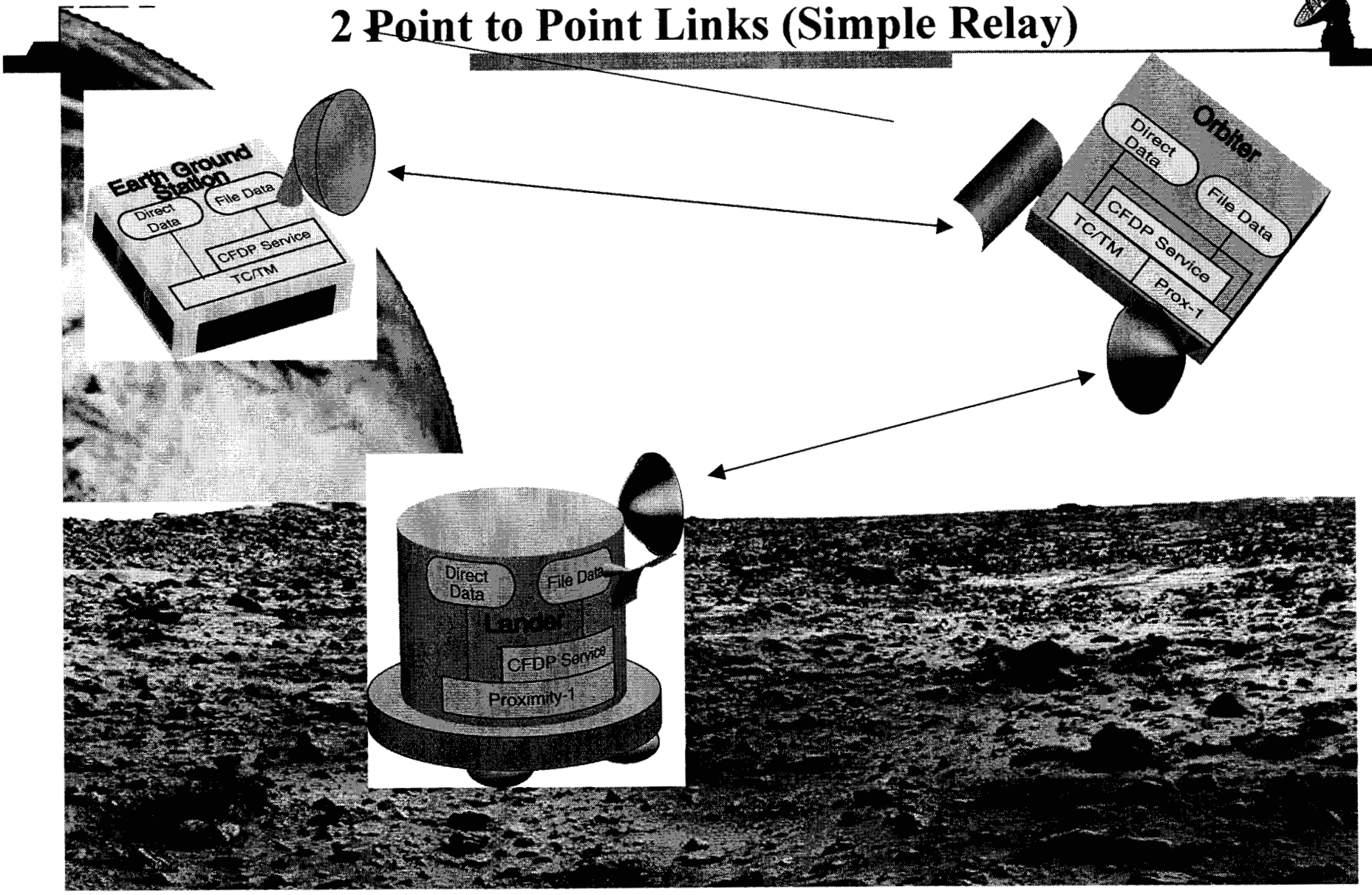
Future Potential Mars Environment

- Frequency Coordination
- Hailing/Operating Frequencies
- Standard Services
- Product Accountability
- Link Performance
- Scheduling of Services
  - Earth Based
  - Orbiter Based
  - Adaptively
- Network-wide prioritization

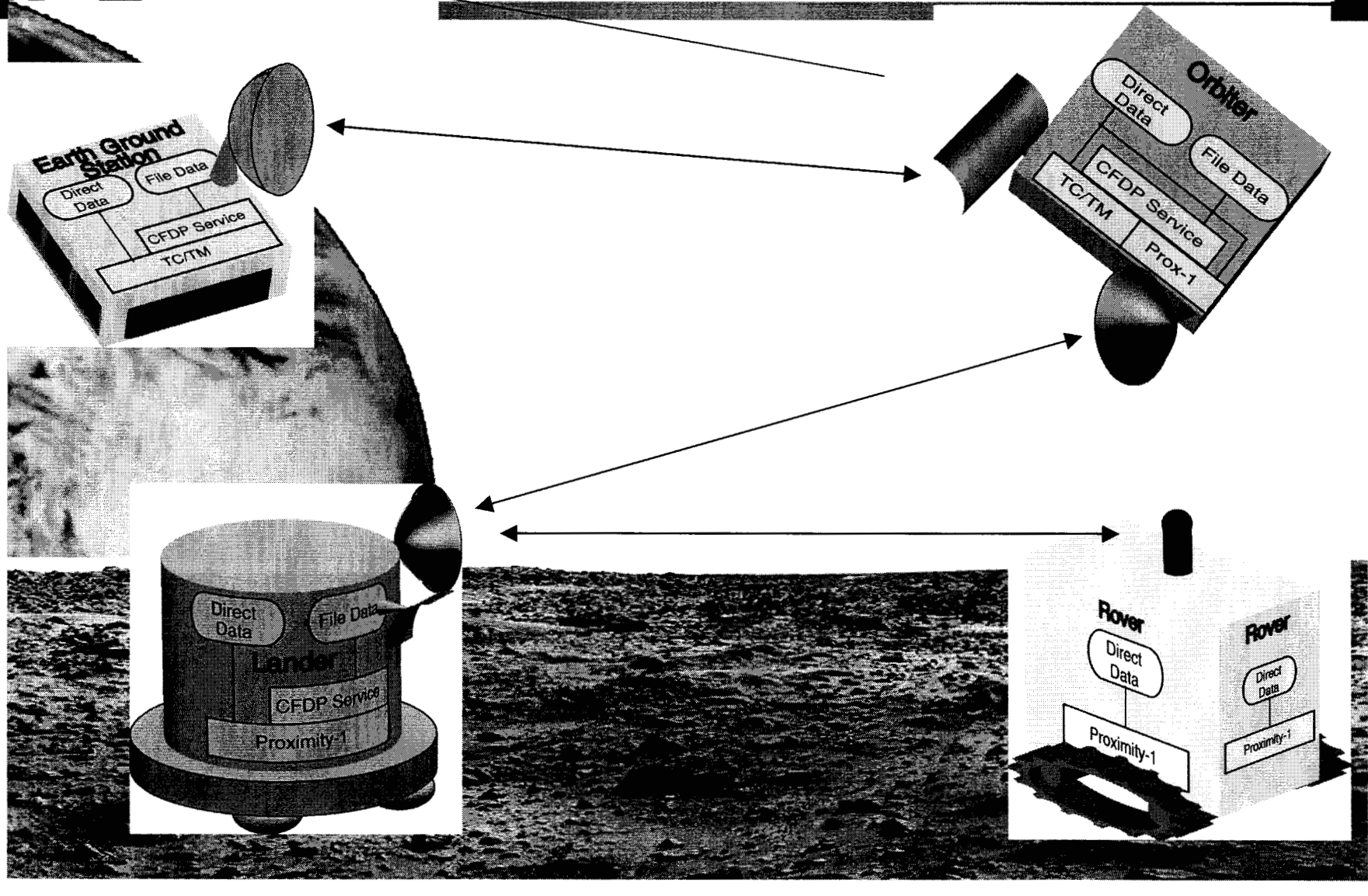


Greg Kazz

Mars IT Infrastructure
Scenario 1
2 Point to Point Links (Simple Relay)



Mars IT Infrastructure
Scenario 2
Multiple Point to Point (Multi-Hop Relay)



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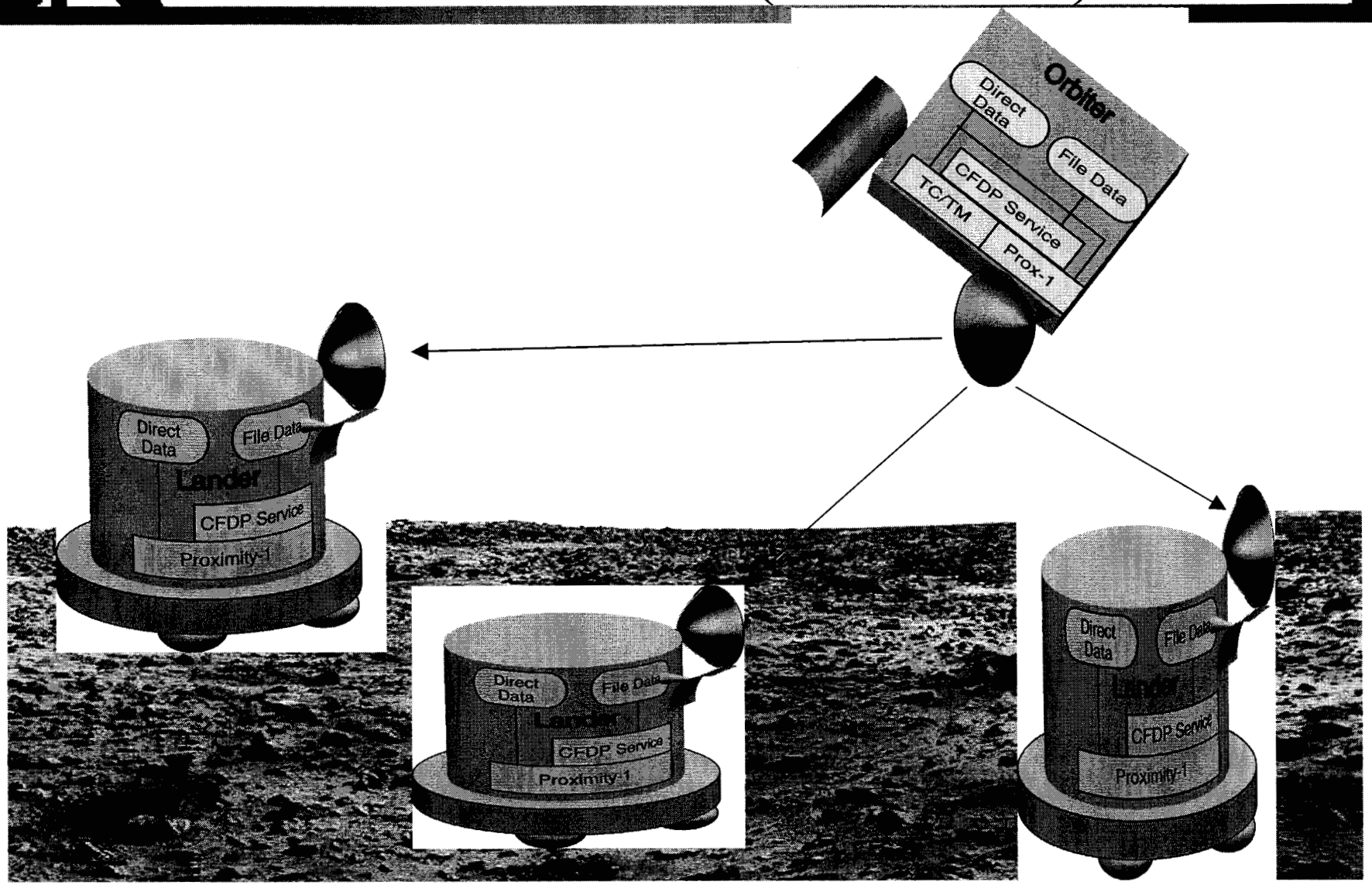
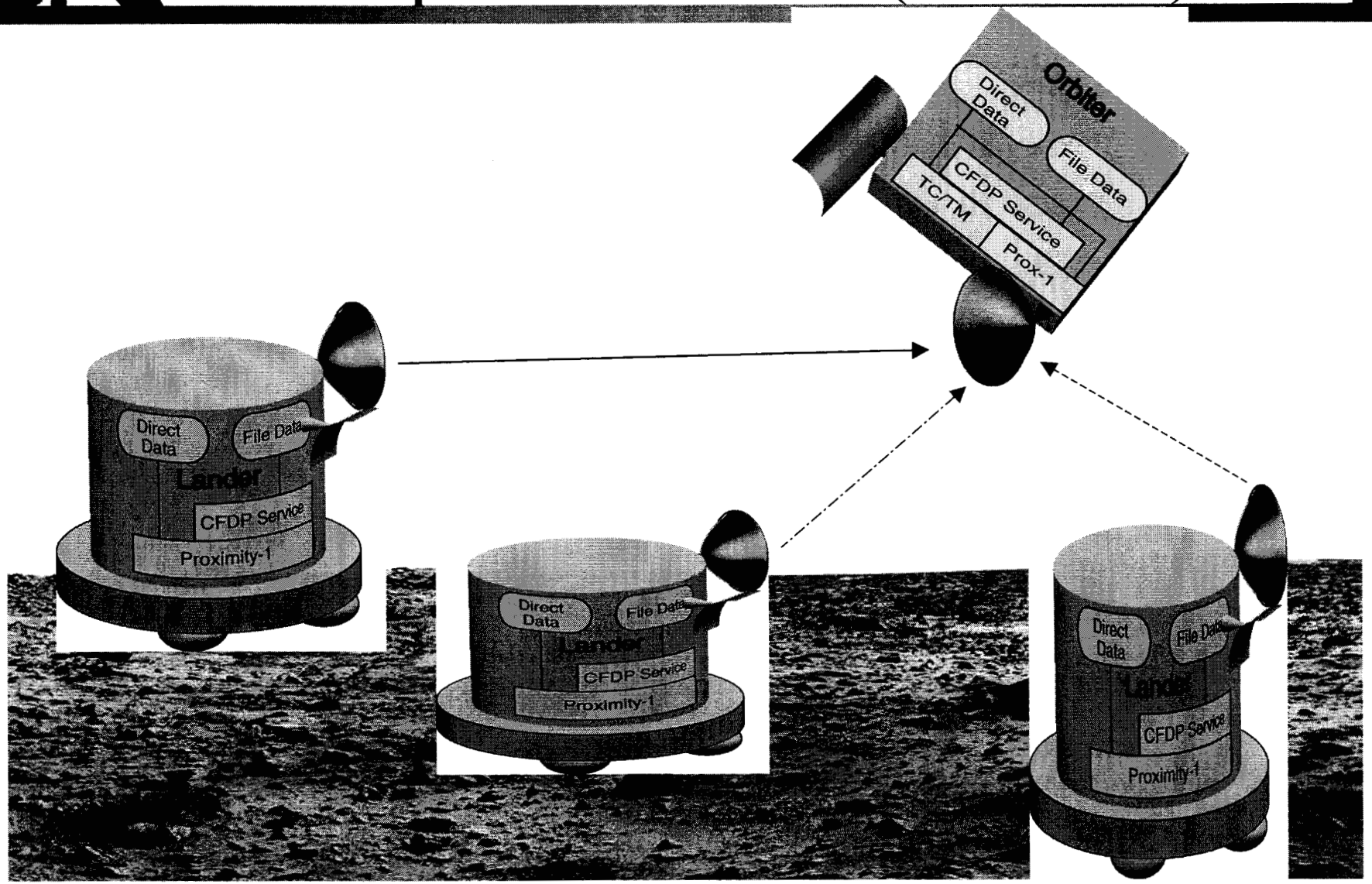
Scenario 3
Point to Multi-Point (Forward Link)

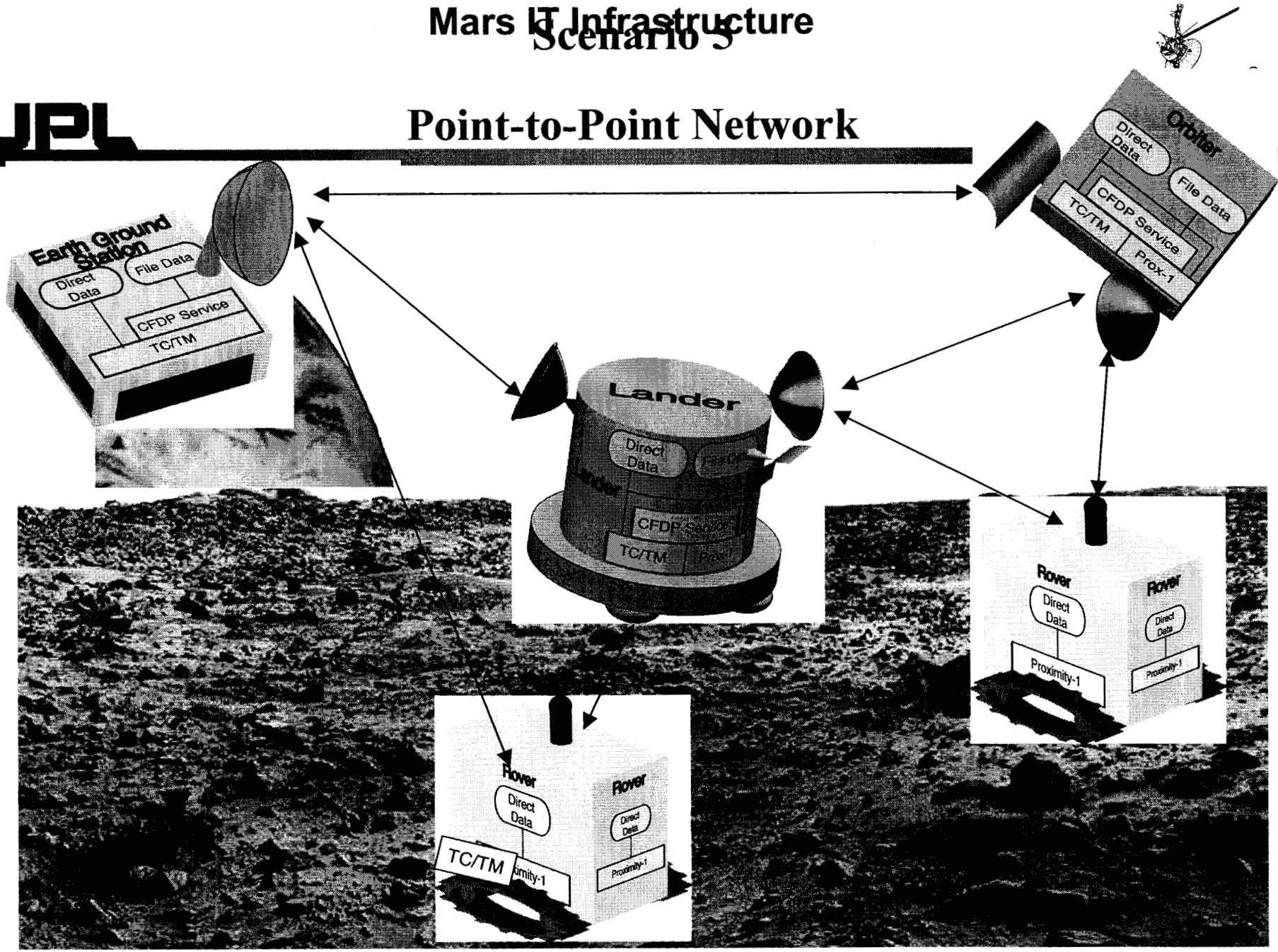


Mars IT Infrastructure
Scenario 4
Time-Sequenced Point to Point (Return Link)



Mars IT Infrastructure Scenario 5

Point-to-Point Network



CFDP Protocol Key Characteristics

- An international standard for automatic, reliable or expedited bi-directional file transfer between spacecraft or spacecraft and ground, built on top of CCSDS link protocols.
- Requires no handshaking, it's datagram and transaction based to deal with long round-trip light times and non-persistent links.
- Metadata associated with each transaction describing the data transfer including what to do with it once it arrived.
- Envisioned to be the end-to-end space link protocol over which applications will transport their data products.
- Able to route data across multiple relay points, some of which may be separated by interplanetary distances.

CFDP Core features

- Copies files between file systems across interplanetary distances.
- Concurrent transfer transactions, multiple retransmission buffers; incremental (possibly out of order) delivery.
- Delivery is reliable -- protocol automatically retransmits lost or corrupted data.
  - CRCs and file checksums, in addition to link layer FEC.
  - Unreliable (unacknowledged) transmission is also supported.

Core features (cont'd)

- Metadata can be associated with each transaction.
  - Small messages to user applications.
  - Remote file system operations: cp, mv, rm, mkdir, etc.
  - "Flow labels" for implementation-specific control of transmission ordering.
  - Transaction may be nothing but metadata, i.e., file length may be zero.
- Files can be structured (CCSDS packets) or unstructured (octets).

Extended features

- Multi-hop transfers.
  - Store and forward. ("Custody transfer")
  - Retransmission is point-to-point, but transaction state is tracked end-to-end [e.g., rover to desktop].
- Simple routing across a network of relays ("waypoints").
- Deferred transmission: application can request a file delivery at any time, without knowledge of when the communication link will be available.

Operations Orientation

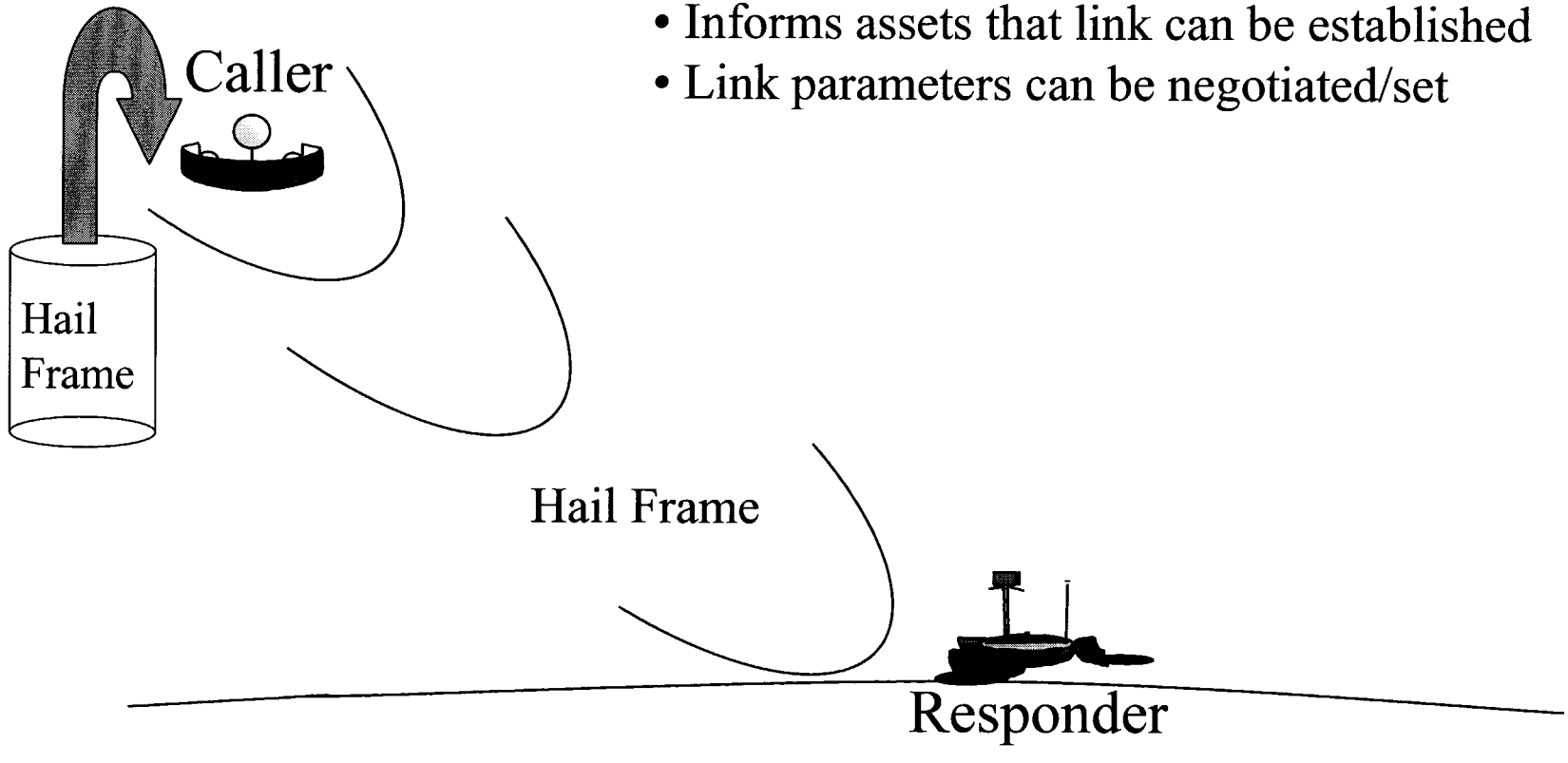
- CFDP is an automated protocol. By design it minimizes operator management of communication links, but management functions are provided in case they're needed.
  - Suspend and resume commands are provided, but JPL implementation relies on R/F system interface cues to suspend and resume transmission automatically.
  - Deferred and immediate lost-segment detection procedures are automatic, but prompted mode is also supported.
- Unlike familiar Internet protocols, CFDP has to deal with very long round-trip times and intermittent connectivity.
  - Unlike ftp, CFDP is not interactive in real time.
  - The right mental model is a postal system (somewhat like email) rather than a telephone system.

Proximity-1 Protocol Key Characteristics

- Bi-directional protocol
- Two Qualities of Service (QoS) - reliable and unrelaible
- Modeless (no TC/TM distinction)
- Supports all types of directionality, radiometric, timing services
- Maximizes data driven methods
- Supports Coded or Uncoded links
- Supports Asynchronous (variable frame) vs Synchronous (fixed frame) links
- Communications is point-to-point but includes one to many on forward link

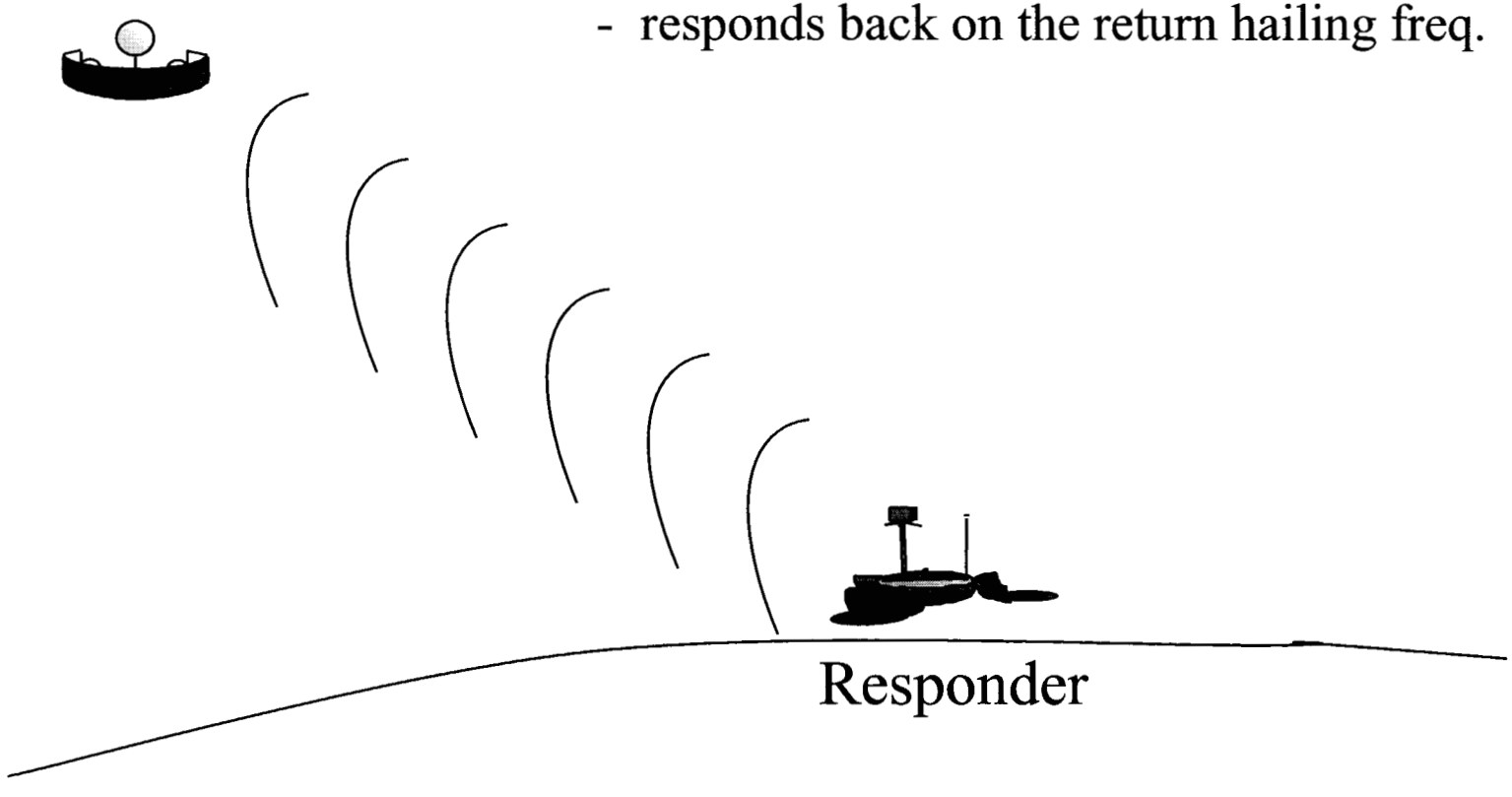
Link Establishment (1 - 3)

- Occurs over dedicated hailing channel
- Informs assets that link can be established
- Link parameters can be negotiated/set



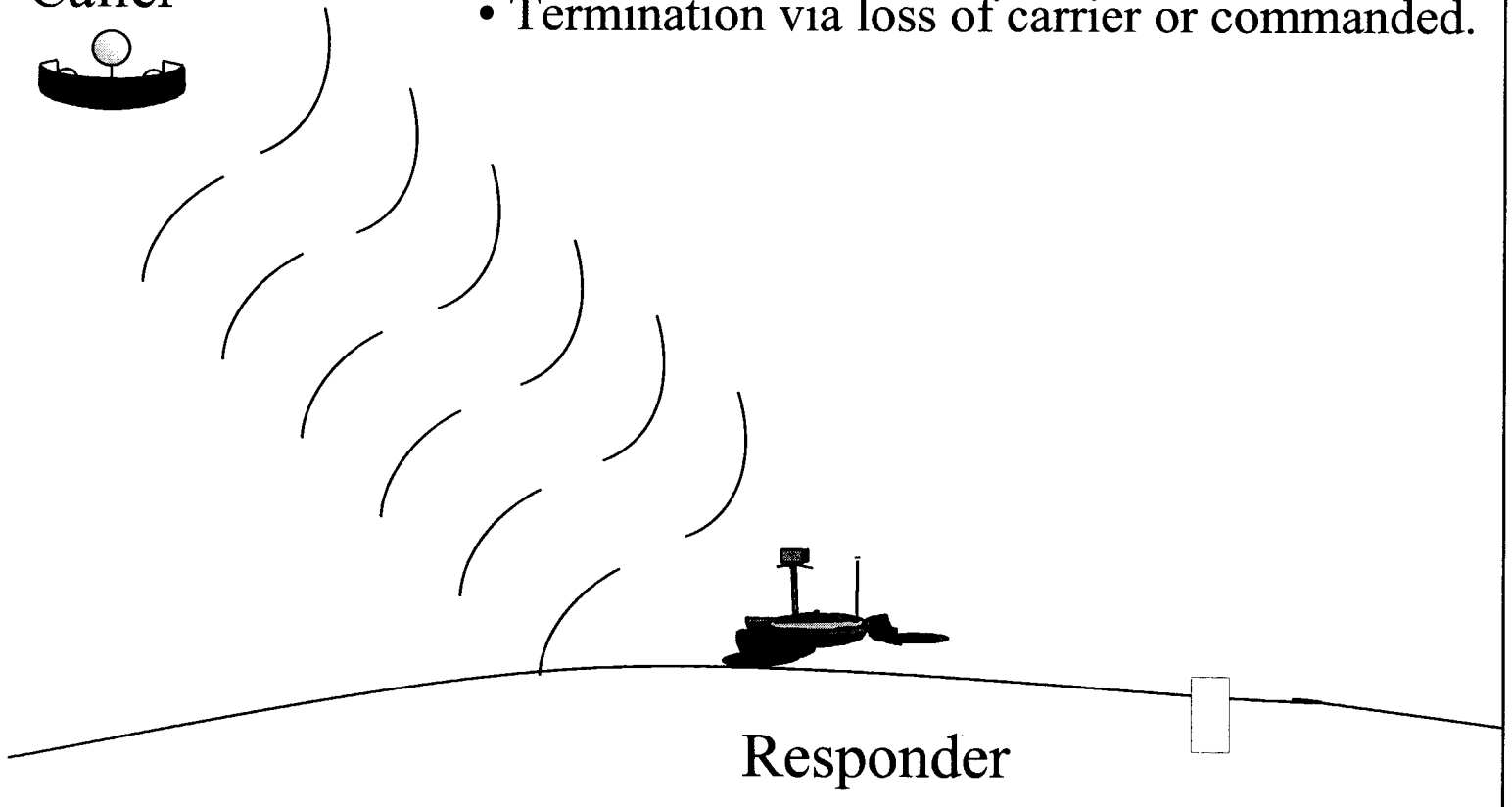
Link Establishment (2 - 3)

- Upon verification of the hail frame responder
  - sets it's communication parameters
  - responds back on the return hailing freq.



Link Establishment, Maintenance, Termination (3 - 3)

- Once established move to working channel.
- Data services provided during the session.
- Termination via loss of carrier or commanded.



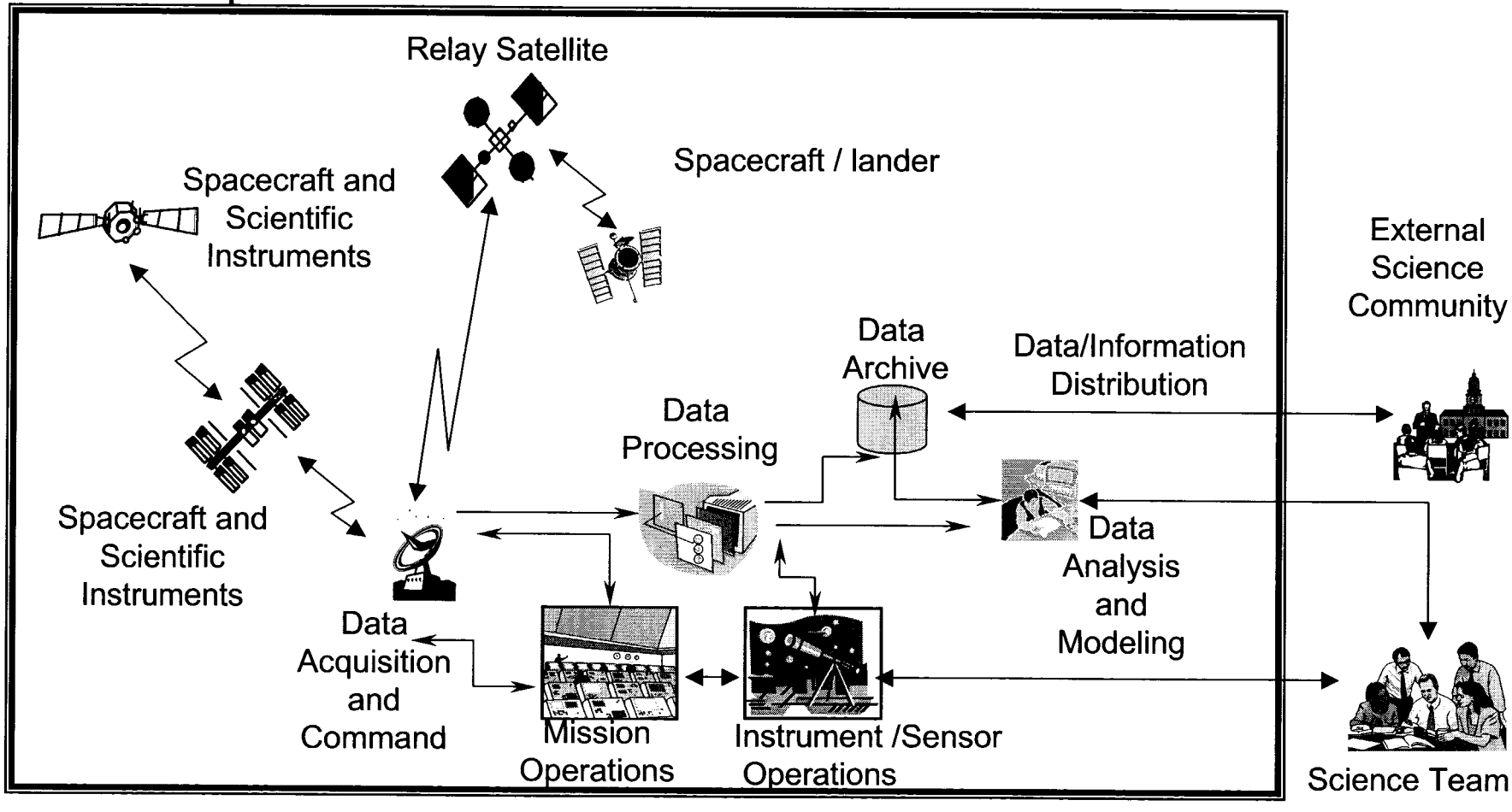
Teasers

- OMG Space, Satellite, Ground System Working group
  - Reference architecture
  - Intended as a joint CCSDS / OMG venture
- Spacecraft Onboard Interfaces (SOIF)
  - New CCSDS Panel 1K

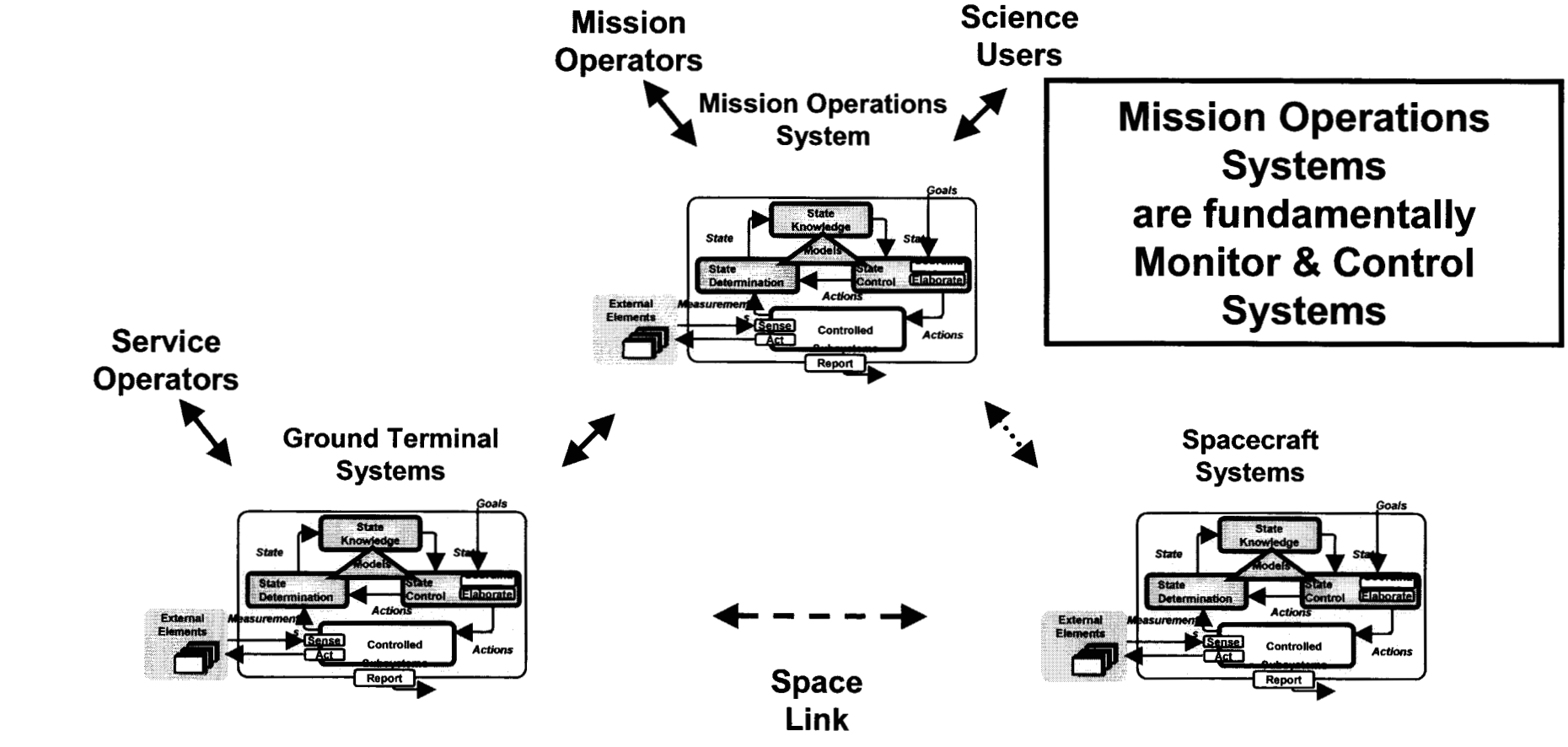
Possible subjects for future talks

OMG WG Space Domain (Information Flow)

Problem Space

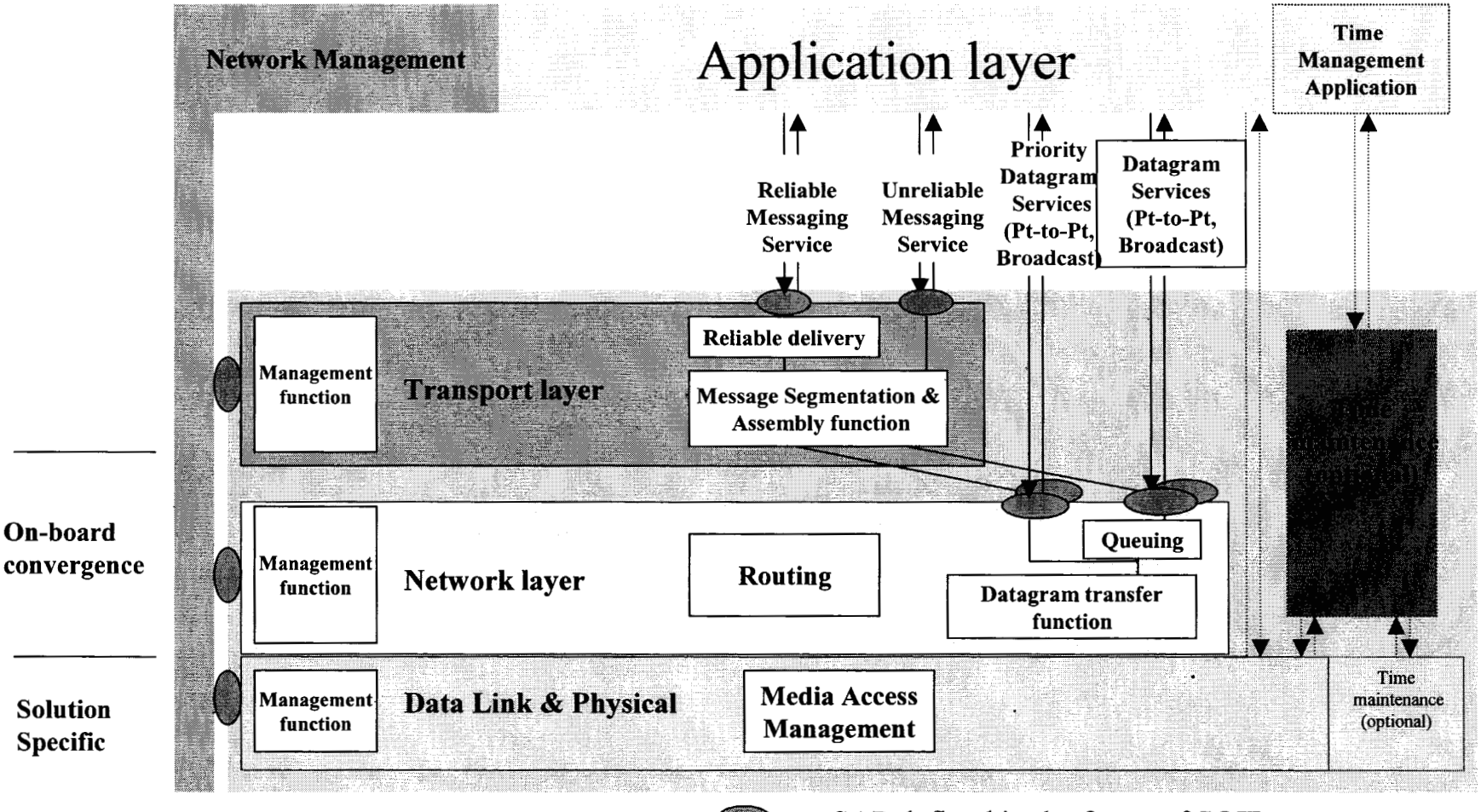


SSGSWG Mission Control System Elements



OMG SSGSWG, with acknowledgements to MDS

SOIF Reference Model : Overview



are SAP defined in the frame of SOIF

Other Interesting Issues

- Overall "system" operating scenarios and evolutionary approach
- “Constellation” operations (including planning, control, station keeping, manual vs autonomous)
- Distributed communications infrastructure (communications paths, routing & route management, naming/addressing, connection establishment / management, planning and controlling all of this)
- Distributed information infrastructure (staging, store & forward,"middleware" messaging layer, data and control information interchange, membership (full / partial))