CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS

SPACE INTERNETWORKING SERVICES AREA REPORT

Report to ISO TC20/SC 13 USTAG13

October 2004

Space Internetworking Services Area Overview

- **Scope – end-to-end communications**
  - **Between spacecraft and ground**
  - **Among spacecraft**
  - **Within a heterogeneous spacecraft**

- **Network through Application layers**
  - **Independent of (and potentially spanning multiple) subnetwork technologies**
  - **Independent of application data semantics**

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- LIST OF CURRENTLY ACTIVE WGs AND BOFs
- SUMMARY TECHNICAL STATUS OF EACH WG & BOF
- CROSS-AREA TECHNICAL ISSUES
- OTHER ISSUE AND CONCERNS
- PROPOSED RESOLUTIONS/ACTION ITEMS

LIST OF CURRENT WGs AND BOFs

1. Space Packet Protocol WG
2. Unacknowledged CFDP Extensions WG
3. CFDP Interoperability Testing WG
4. Cislunar Space Internetworking WG
5. Delay Tolerant Networking BOF
6. Asynchronous Messaging Services BOF
7. Licklider Transmission Protocol (LTP) BOF

SUMMARY TECHNICAL STATUS: Space Packet Protocol WG

Goal: Review and revise Space Packet Protocol as a result of restructuring.

Status: Active ___ Idle _X__

status:		CAUTION	
comment:		Resource issue	

Progress since last meeting:

- **ISO DIS 22646 out for international review: Review and Approval required.**
- **Need to address Green Book 130.3-G-X – not yet started.**

Problems and Issues: BNSC funding hiatus has adversely affected the schedule.

Internal review by SPP WG to be completed by TBD

Revised green book and WG shutdown, end of TBD

SUMMARY TECHNICAL STATUS: Unacknowledged CFDP Extensions WG

Goal: Extend CFDP to support unacknowledged operation in the presence of out of order data arrival.

Working Status: Active _x_ Idle ____

Summary progress:

Status:	OK		

Progress since last meeting:

- **Revised Draft Standard out for Agency review and approval. Available from CCSDS Web Site:**
  http://www.ccsds.org/review/rpa410/index.html
  http://www.ccsds.org/review/rpa410/727x0p21.pdf

Problems and Issues: none.

SUMMARY TECHNICAL STATUS: CFDP Interoperability Testing WG

Goal: Complete CFDP SFO and Extended Procedures interoperability testing

Working Status: Active _X_ Idle _____

Summary progress:

status:		CAUTION	
comment:		Persistent resource problems, slow pace of progress.	

Progress since last meeting:

23 August 2004	**Initial interoperability testing ("shakedown testing") began.**
6 October 2004	**First test series (SFO) began.**
1 November 2004	**First test series complete**
2 November 2004	**Second test series (Extended Procedures) begins**

SUMMARY TECHNICAL STATUS: CFDP Interoperability Testing WG (Continued)

Problems and Issues: Persistent resource contention issues have caused delays in WG testing schedule.

Remaining Schedule:

29 November 2004	**Second test series complete**
10 December 2004	**Test Execution Report and final Test Notebooks available**
30 December 2004	**WG dissolved.**

SUMMARY TECHNICAL STATUS – Cislunar Space Internetworking WG

Goals: **CCSDS SIS working group to design a communications architecture for cislunar and possible Mars in-situ environments and to update existing CCSDS standards to reflect recent advances in telecommunications.**

Working Status: Active _X_ Idle ____

Summary progress:

Status:	OK		
Comment:	WG Charter Approved by CESG-03-017 14 JUNE 2004; CMC approval ???		

Progress since last Meeting:

- **WG Charter approved by CESG, recommended to CMC. CMC status unknown.**
- **Interim telecon held 12 August 2004 among NASA, other US, and QinetiQ representatives**
- **Ad hoc membership (pending formal resource allocation) includes reps from JPL, GSFC, Aerospace Corp, Xiphos, QinetiQ, JHU/APL, and ESA**

SUMMARY TECHNICAL STATUS – Cislunar Space Internetworking Working Group

Problems and Issues:

- **Management council approval and resources.**

US Participation Solicited

- **USTAG13 participants who expressed interest in the Cislunar Space Internetworking BOF are being subscribed to the sis-csi mailing list sis-csi@mailman.ccsds.org**
- **Other interested parties can sign up: http://mailman.ccsds.org/cgi-bin/mailman/listinfo/sis-csi**

Cislunar Internetworking Services Working Group Charter

1. **Create a top-level architecture and operations concept (CCSDS Green Book) for communicating effectively over the whole range of cislunar distances. The architecture will address the projected needs of new lunar exploration programs and their mapping into (and interoperation with) similar capabilities that will be needed on and around Mars.**

2. **Review current and emerging CCSDS standards and recommend any updates required to keep them current and to support cislunar communication (Green Book, Pink Sheets).**

3. **Examine the spectrum of new Internet development activities that are proceeding within Internet standardization groups, such as the Internet Engineering Task Force (IETF), and identify where they may be applicable to the operations concept developed above. Candidate activities include:**
   a) **The Stream Control Transmission Protocol SCTP.**
   b) **The Datagram Congestion Control Protocol (DCCP).**
   c) **Voice Over IP (VOIP).**
   d) **Disruption Tolerant Networking (DTN).**
   e) **LEMONADE enhancements to Internet email to support diverse service environments.**
   f) **Internet over Digital Broadcast Video Networks.**

4. **Recommend standards for cislunar communications (CCSDS Red / Orange Books) with the proviso that these standards should, whenever possible, be extensible to larger communications distances such as Earth-Mars.**

Proposed Protocols for Cislunar Exploration

- Application Services: Shared message queues, …
- Transport Layer: TCP / UDP
  - QoS: Diffserv, Intserv (RSVP)
  - Proxies: SCPS-TP
- Network Layer: IP
  - Routing: Static, Link-State + modifications
- Data Link Layer: Prox-1
- Physical Layer:

Goals of a Cislunar Internetworking Services Working Group

- **Determine requirements of possible new Lunar exploration programs and their mapping into similar capabilities that will be needed on and around Mars**
  - **Products: Yellow Book on cislunar / Mars comm. Requirements**
- **Create a top-level operations concept for communicating effectively over the whole range of cislunar distances**
  - **Products: Green Book for Cislunar Communication**
- **Review existing capabilities (CCSDS space internetworking standards, other standardization groups (such as the IETF))**
  - **Products: Technical Reports on existing communications capabilities**
- **Protocol development if needed**
  - **Products: Blue Book(s) describing protocols for cislunar communications**

SUMMARY TECHNICAL STATUS – Delay/Disruption Tolerant Networking Birds of a Feather (BOF)

Goals: **Develop a suite of protocols for scaleable, reliable message-based store and forward operation in high delay environments (bundling)**

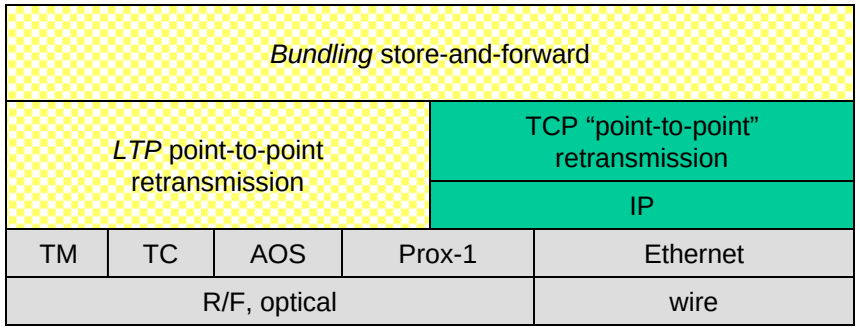
Working Status: Active _X_ Idle ____

Summary progress:

Status:	OK		
Comment:	**Initial DTN BOF meeting November 2004, Toulouse**		

Progress since last Meeting:

- **BOF chartered**



Delay Tolerant Networking for Deep Space use

- **General-purpose capability for scalable, reliable communications across deep space.**
- **Extending and streamlining the capabilities of CFDP:**
  - **Built-in security (authentication and confidentiality).**
  - **Flexible, dynamic multipath route selection.**
  - **Deferred transmission, store-and-forward routing for tolerance of intermittent connectivity.**
  - **Point-to-point retransmission for efficient reliability.**
  - **Custody transfer for early release of retransmission resources.**
- **Will enable CFDP to scale up to large deployment configurations.**
- **Will enable development of other application protocols without replection of capability and effort (e.g., Asynchronous Messaging)**

SUMMARY TECHNICAL STATUS – Licklider Transmission Protocol Birds of a Feather (BOF)

Goals: **Separate the reliability mechanisms from the current CFDP into a reusable protocol layer for deep space (long delay) reliable operation**

Working Status: Active _X_ Idle ____

Summary progress:

Status:	OK		
Comment:	**Initial LTP BOF meeting November 2004, Toulouse**		

Progress since last Meeting:

- **BOF chartered**

Licklider (or Long-haul) Transmission Protocol

- **LTP is Licklider (or "Long-haul") Transmission Protocol.**
- **Directly descended from CFDP Core reliability procedures, with a few simplifications:**
  - **It's not file-oriented. LTP divides a *block* into *segments* for reliable transmission. No filestore commands, no metadata. (File-oriented mechanisms are left to CFDP, above bundling.)**
  - **Indications analogous to EOF, Finished, Prompt, etc. are combinations of bit flags in the standard header.**
  - **The last segment of a block carries an "end of block" flag. There's no separate "EOF" segment, so a small block may be entirely contained in a single segment.**
  - **Negative acknowledgment segments are sent reliably, so there's nothing like the NAK timer cycle. All timeout intervals can be computed from operational data: no guesswork.**
  - **No transaction-specific Suspend and Resume, no flow labels.**

SUMMARY TECHNICAL STATUS – Asynchronous Messaging Services Birds of a Feather (BOF)

Goals: **Develop a delay-tolerant set of application messaging services for deep space use**

Working Status: Active _X_ Idle ____

Summary progress:

Status:	OK		
Comment:	**Initial AMS BOF meeting November 2004, Toulouse**		

Progress since last Meeting:

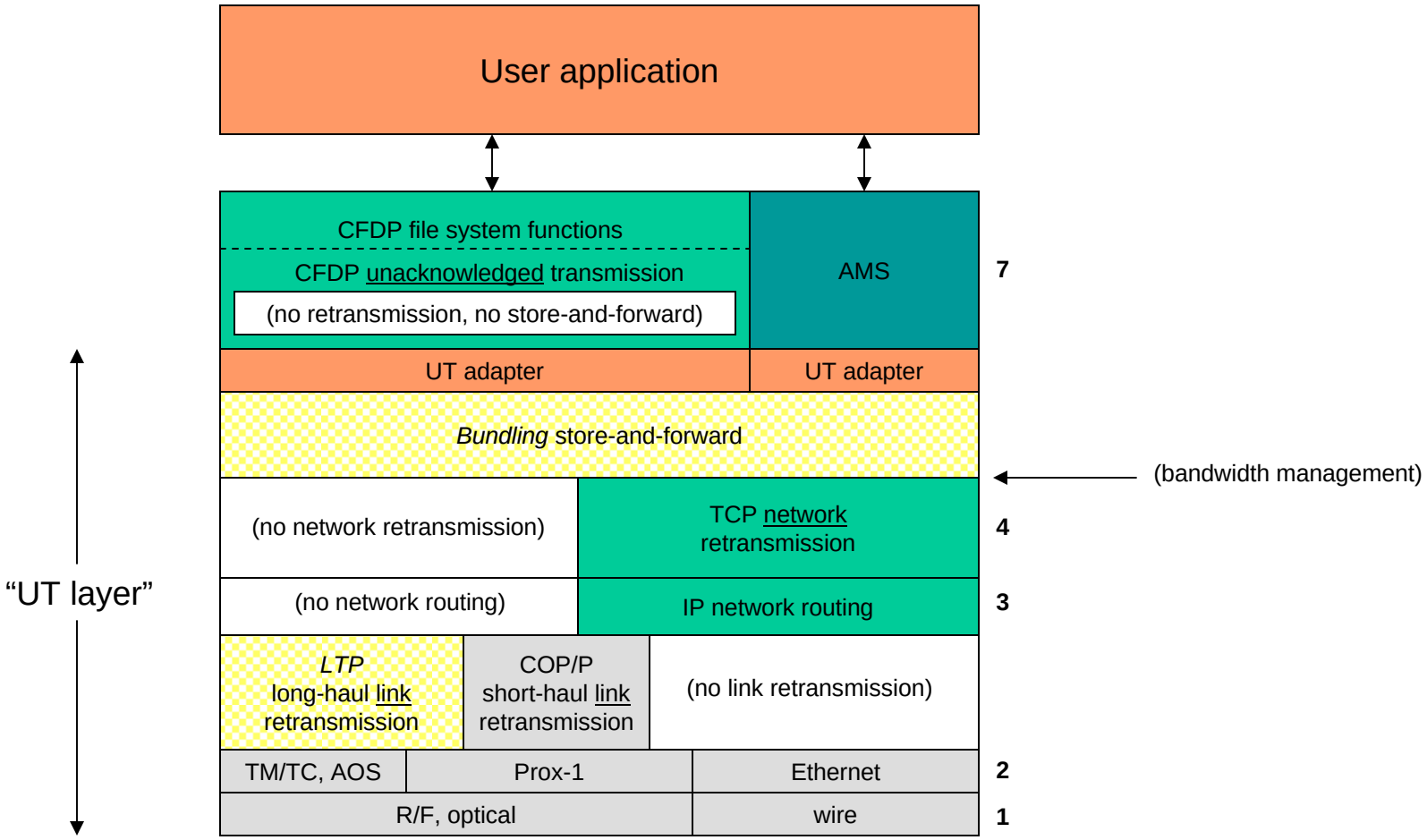
- **BOF chartered**

Asynchronous Messaging Services

- **In addition to file transfer, event-driven *asynchronous message exchange* may also be useful for deep space communications with and among spacecraft :**
  - **Streaming engineering (housekeeping) data**
  - **Real-time commanding**
  - **Continuous collaborative operation among robotic craft**

- **Challenges in large-scale asynchronous message exchange:**
  - **Heterogeneous platforms, security regimes, communication environments, QOS requirements, performance requirements.**
  - **Changing topology: requires autonomous discovery of communication endpoints, automatic reconfiguration.**
  - ***Publish/subscribe* message exchange model scales better than client/server.**

CFDP/AMS/DTN/LTP stack for deep space use



CROSS-AREA TECHNICAL ISSUES From Spring Meeting

A. **Cislunar WG needs to coordinate with SLS WGs to communicate any link requirements identified as part of the Cislunar internetworking architecture development**

B. **External liaison issue: Cislunar WG needs to coordinate with DVB-RCS about standardizing PEPs and PEP interactions.**

C. **Conducted SIS/SOIS TCONS cross-area meeting to discuss interfaces. No issues identified. Resulted in clarification of TCONS coexistence with other onboard networks (see next slide).**

CROSS-AREA TECHNICAL ISSUES (Continued)

Co-existence of TCONS and Other Networks

- TCONS delivery requirements mandate that subnetwork resources be under the strict control of the TCONS scheduler. It is not acceptable that the coexistence of other networks interferes in any way with TCONS having deterministic access to TCONS resources.

- TCONS and Other networks can coexist on a spacecraft and indeed in a single Data System (processor/memory resources notwithstanding) in the following circumstances:
  - A. TCONS and other networks operate over independent subnetworks. This involves no interaction between the two protocol stacks.
  - B. A subnetwork can only provide satisfactory services to TCONS by allowing exclusive TCONS access. Other networks can only be accommodated by tunneling via TCONS services.
  - C. A subnetwork can provide deterministic guaranteed resources simultaneously to both TCONS even when accessed simultaneously by other networks. The subnetwork prevents interaction between the two networks.

OTHER ISSUES AND CONCERNS

A. Status of DEPUTY AREA DIRECTOR funding

B. Each Working Group (and BOF) should have a web page hosted on the CCSDS web site; the repository for all working documents should be CCSDS-controlled (i.e., the DocuShare system)

PROPOSED RESOLUTIONS AND ACTIONS FOR CESG/CMC APPROVAL

Resolutions from May 2004:

PROPOSED RESOLUTION 1

SIS requests that the CESG forward to the CMC the UCE Pink Sheets to 727.0-B-2 for formal agency review and approval.

CMC resolution CMC-S04-R11 approved May 2004 at St. Hubert, CA; distributed for review 19 October 2004

PROPOSED RESOLUTION 2

SIS requests that the Cislunar Working Group charter be reviewed and approved and resources allocated as soon as possible.

CESG resolution CESG-03-017 approved 14 June 2004, CMC status unknown.