

“Better?”

Bulk Transfer Alternatives To The CCSDS File Data Protocol (CFDP)



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*This presentation does not contain any ITAR
restricted material.*

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Agenda

- What Is CFDP?
- Why Consider Alternatives To CFDP?
- Alternative Protocols
 - SCPS File Protocol (SCPS-FP)
 - Trivial File Transfer Protocol (TFTP)
 - Simple Mail Transport Protocol (SMTP)
- Qualitative and Quantitative Comparison

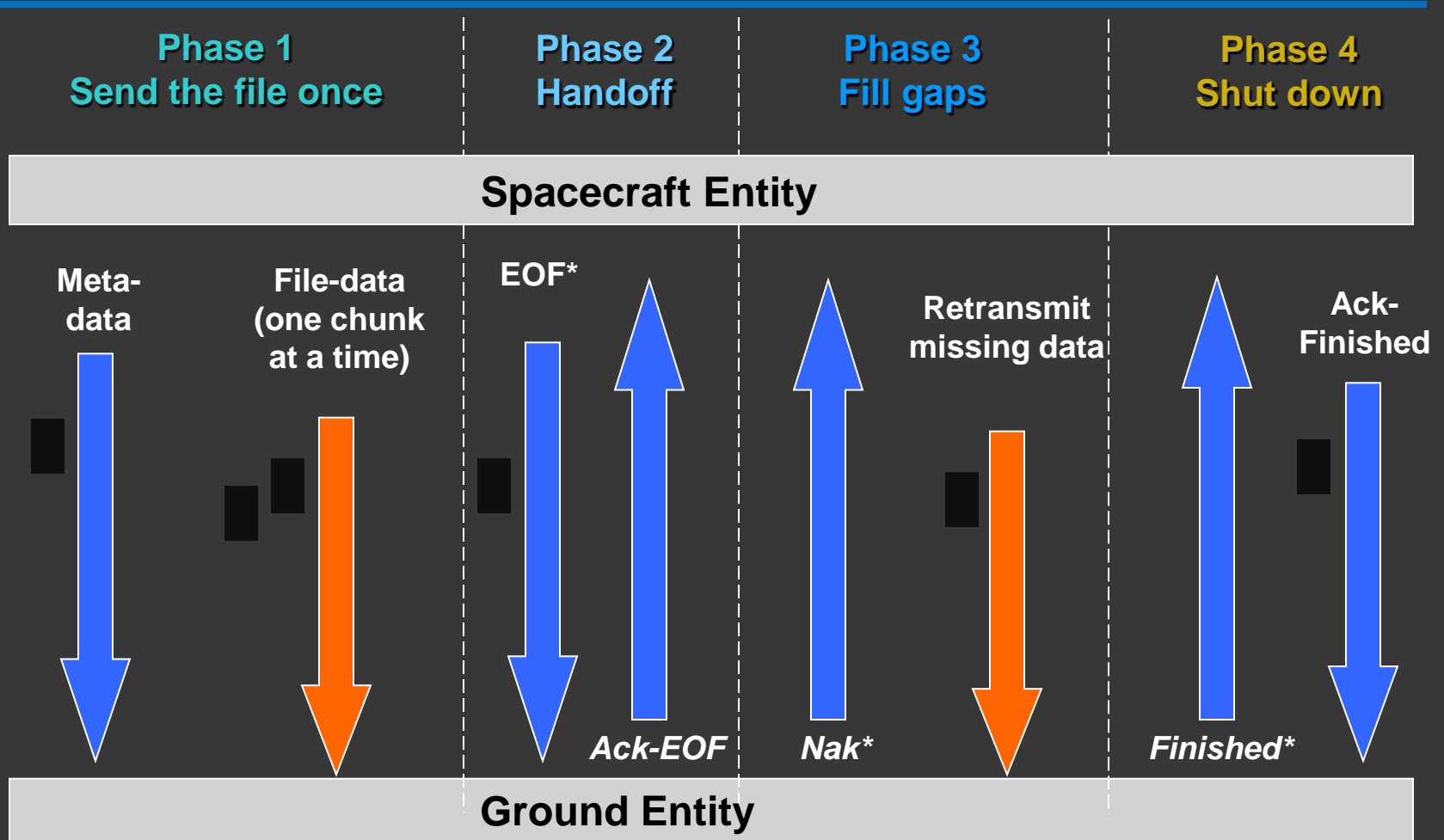


What Is CFDP?

- Consultative Committee for Space Data Systems (CCSDS) File Delivery Protocol (CFDP):
 - Bulk transfers data to/from mass memory devices
 - CCSDS Blue Book 727.0-B-4
- Classes of Service:
 - Class 1 – Unreliable Transfer
 - Class 2 – Reliable Transfer
 - Class 3 – Unreliable Transfer via one or more waypoints in series
 - Class 4 – Reliable Transfer via one or more waypoints in series.



Operation of CFDP Reliable Transfer



* Timers are used to ensure retransmission of the EOF, Nak, and Finished messages as required. The Nak message reports all missing data (including Metadata).

Why Consider Alternatives To CFDP?

- Implementation Size
 - Magnetospheric Multiscale:
 - Compiled out unneeded receiver portion of the GSFC CFDP engine in order to fit images in EEPROM.
 - 108,808 bytes with Receiver
 - 56,076 bytes without Receiver
 - Messenger Mission [1]:
 - “CFDP-Lite” version of the JPL protocol implementation
 - Library modifications made to tightly couple the FSW and CFDP
 - Receiver portion not included



Why Consider Alternatives To CFDP?

- Processor Time
 - Magnetospheric Multiscale:
 - 25 MHz SPARCV8 LEON2
 - Approximately 30% CPU utilization needed to support playback operations
 - Hybrid hardware/software approach [2] needed to reduce CPU load
 - Hardware formats File Data PDUs
 - Software formats File Directive PDUs
 - Messenger Mission [1]:
 - 25 MHz RAD6000
 - Approximately 55% CPU utilization needed to support playback operations

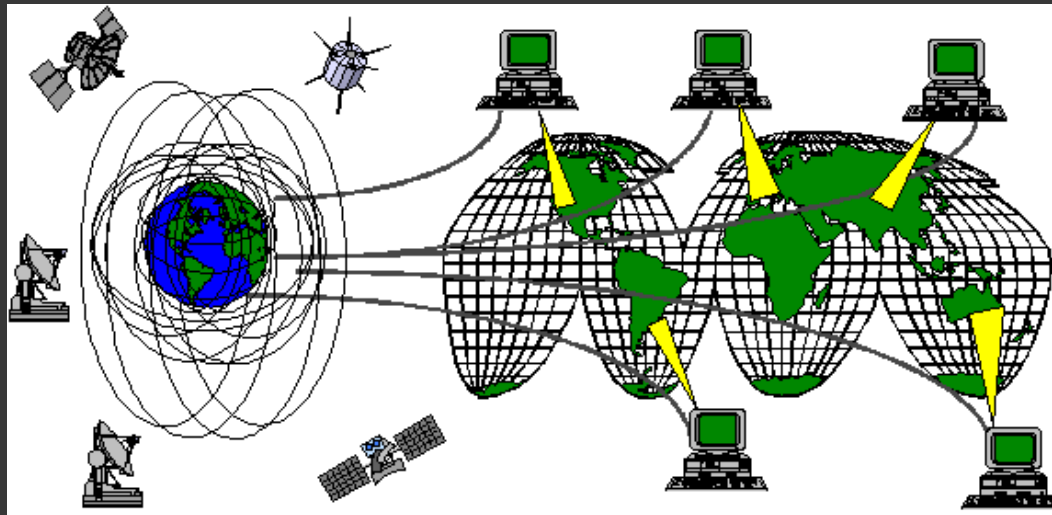


Alternative Protocols

#1: SCPS File Protocol (SCPS-FP)

#2: Trivial File Transfer Protocol (TFTP)

#3: Simple Mail Transport Protocol (SMTP)



#1: SCPS File Protocol (SCPS-FP)

- Defined by CCSDS Blue Book 717.0-B-1
- Primary Features:
 - Uses FTP standards when possible, replaces or augments them when required
- Biggest Advantages:
 - Terrestrial FTP – widely available open-source implementations
 - Built on top of SCPS-TP or TCP
 - TCP is a common terrestrial Ethernet protocol which supports retransmission



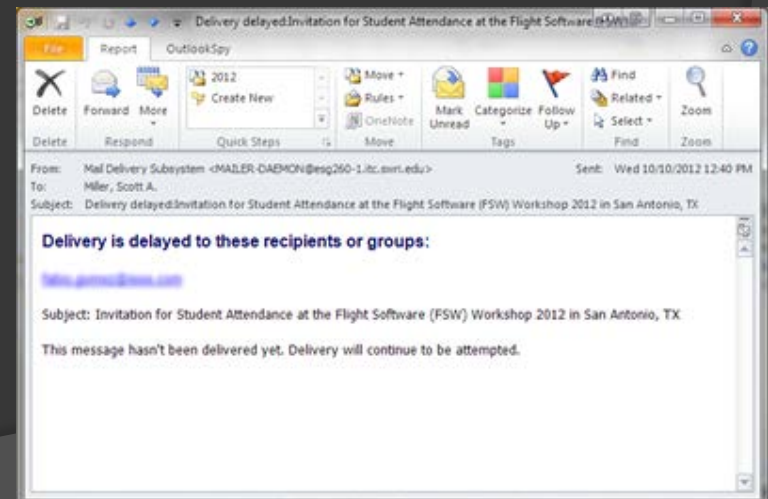
#2: Trivial File Transfer Protocol (TFTP)

- Defined by IETF Request for Comments (RFC) 1350
- Primary Features:
 - Simple File Transfer Protocol (FTP)
 - No user authentication
 - No directory listing (full paths must be known in advance)
 - Modern-day uses include IP phones, thin clients, routers.
- Advantages:
 - Due to simple design, has small memory footprint
 - Ubiquitous open source
 - Example: “OpenTFTP”
 - Entire Server is one C++ file of 2500 lines.



#3: Simple Mail Transport Protocol (SMTP)

- Defined by IETF Request for Comments (RFC) 5321
- Primary Features:
 - Modern day use is to deliver Internet E-Mail
 - Text-based protocol (limited to 7-bit characters)
 - Store and Forward
- Advantage:
 - Comparable to CFDP Class 3 and 4



#3: Simple Mail Transport Protocol (SMTP)

- Text-Based Protocol:
 - Greater than 2 times data bandwidth needed (vs. binary protocol)
- Example:
 - 32 bit data pattern: "0xDEADBEEF"
 - Binary protocol would transmit 32 bits.
 - Text-Based protocol would convert each hex character (4 bits) into ASCII character (8 bits).
 - 32 bit transmission becomes 64 bit transmission
 - Double the bandwidth needed!



Qualitative Comparison

Protocol	Advantages	Disadvantages
CFDP	High Space Mission Heritage Provides for Store and Forward Can be Tailored for the Mission	Available by Request High CPU Utilization Moderate Memory Footprint
SCPS-FP	Reference Implementations are Available Improves upon FTP	Requires modified IP Stack No Notable Mission Heritage Uses TCP/SCPS-TP for reliability
TFTP	Simple Ubiquitous Open Source Implements its own reliability	Requires IP stack Software Provenance
SMTP	Simple Ubiquitous Open Source Provides for Store and Forward	Requires IP Stack Uses TCP for reliability Text-Based, Poor Link Utilization Software Provenance



Quantitative Comparison

Attribute	CFDP	TFTP	SCPS-FP	SMTP
Code Size (SLOCs)	6789	2253	10498	2877
Compiled Size	56,076	60,768	-	20,737
CPU Utilization	30%-55%	-	-	-

Work in
Progress



Questions?



Acronyms

CCSDS	Consultative Committee for Space Data Systems
CFDP	CCSDS File Delivery Protocol
FTP	File Transfer Protocol
IETF	Internet Engineering Task Force
OSI	Open Systems Interconnection
RFC	Request For Comments
SCPS	Space Communications Protocol Specification
SCPS-FP	SCPS File Protocol
SCPS-TP	SCPS Transport Protocol
SMTP	Simple Mail Transfer Protocol
TFTP	Trivial File Transfer Protocol



References

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2. Klar, et. al., “A Hybrid Hardware-Software Architecture for Implementation of the CCSDS File Delivery Protocol (CFDP)”. Flight Software Workshop, November 2008.
3. Space Communications Protocol Specification – File Protocol (SCPS-FP). Recommendation for Space Data System Standards, CCSDS 717.0-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, May 1999.
4. K. Sollins, “The TFTP Protocol (Revision 2),” RFC 1350, July 1992. <http://tools.ietf.org/html/rfc1350>
5. J. Klensin, ed., “Simple Mail Transfer Protocol,” RFC 2821, April 2001. <http://tools.ietf.org/html/rfc2821>

