Interplanetary Overlay Network

Networking in Space

Disruption-Tolerant Networking

- Communication between base stations, near-space and deep-space satellites and spacefaring devices
- Traditional networking priorities don't really work
  - Intermittent connectivity
  - Delayed transmission
  - Take advantage of predicted or opportunistic connectivity

Interplanetary Overlay Network

The most common implementation of a DTN stack

Organisations:

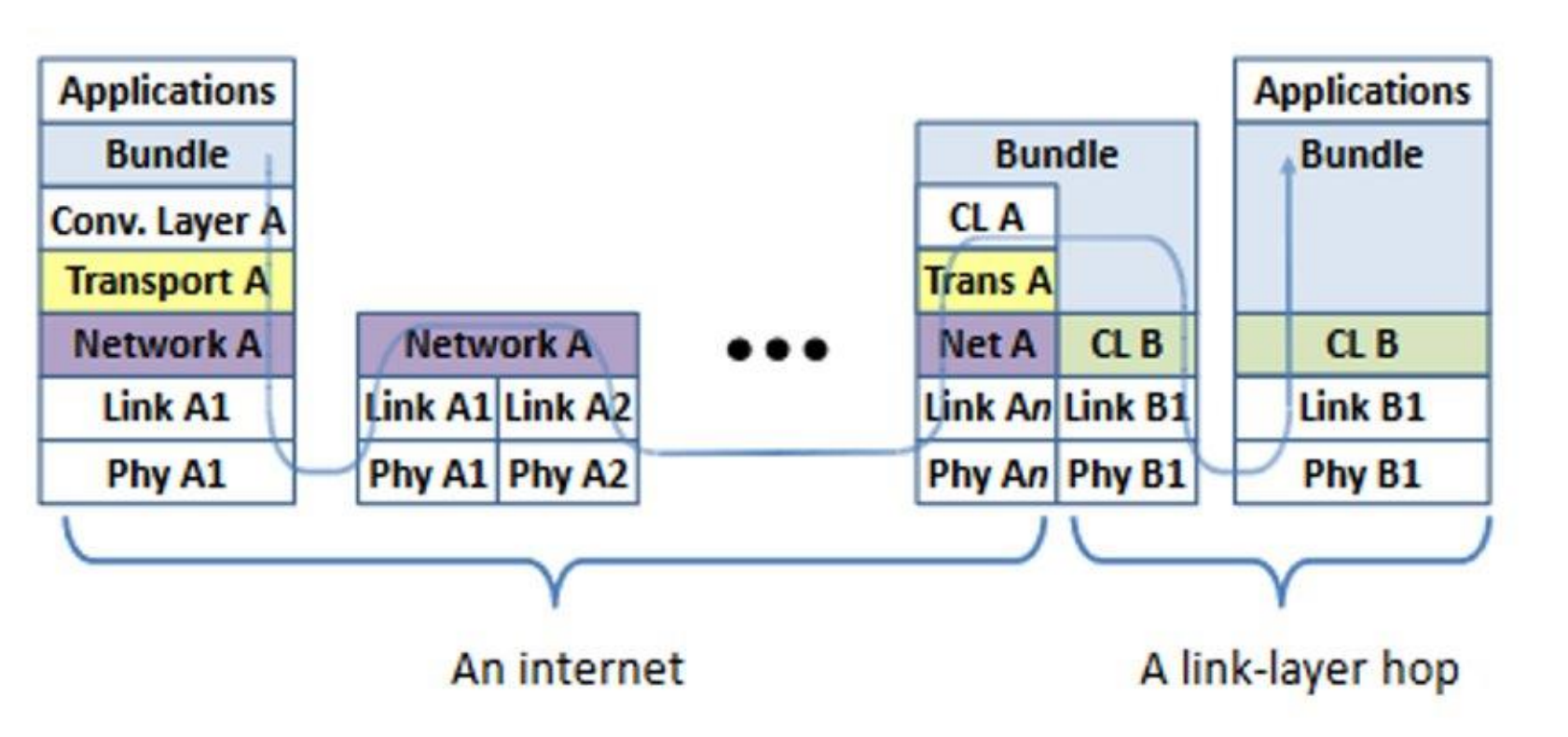
- NASA
- CCSDS (Consultative Committee for Space Data Systems)
- IETF (RFCs)

Network Stacks

OSI	
Application	HTTP, FTP
Presentation	TLS
Session	
Transport	TCP, UDP
Network	IP
Data Link	Ethernet, WiFi
Physical	Ethernet, WiFi

DTN	
Application	CFDP
Bundle	Bundle Protocol
Convergence/ transport	Licklider Transmisison Protocol
Data Link	Various, often proprietary
Physical	Cool space radios?

Bundle Protocol Communication



Testing Stack

Leave lower layers as normal

Builds DTN layers on top

DTN – Testing Stack	
Application	CFDP
Bundle	Bundle Protocol
Convergence	Licklider Transmisison Protocol
Transport	UDP
Network	IP
Data Link	Ethernet
Physical	Ethernet, virtual cable connections within CORE

CFDP

CCSDS File Delivery Protocol

For sending and receiving files

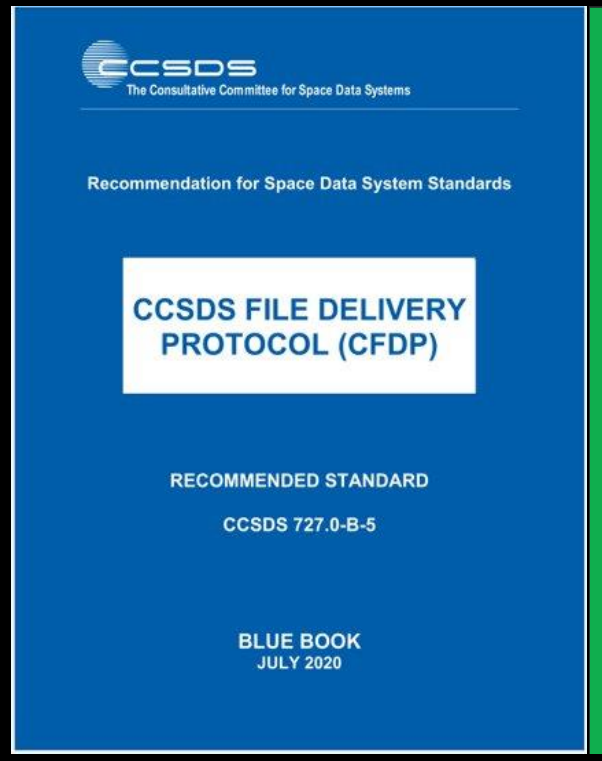
Doesn’t care what’s underneath it

Doesn’t care about how the data is stored

‘Acknowledged’ or ‘unacknowledged’ modes, for reliable and unreliable transport

‘Core’ and ‘Extended’ interactions, for situations where there are intermediary entities (‘waypoints’)

Forward error correction helps with transmission errors



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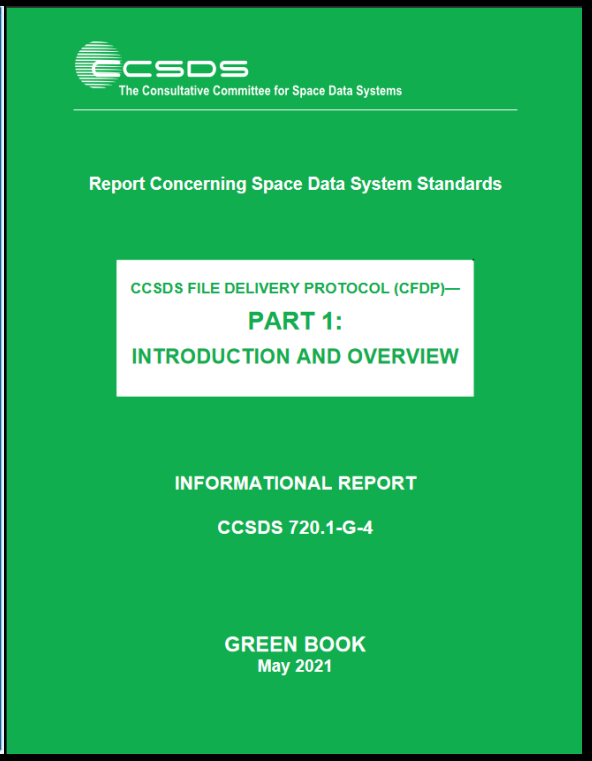

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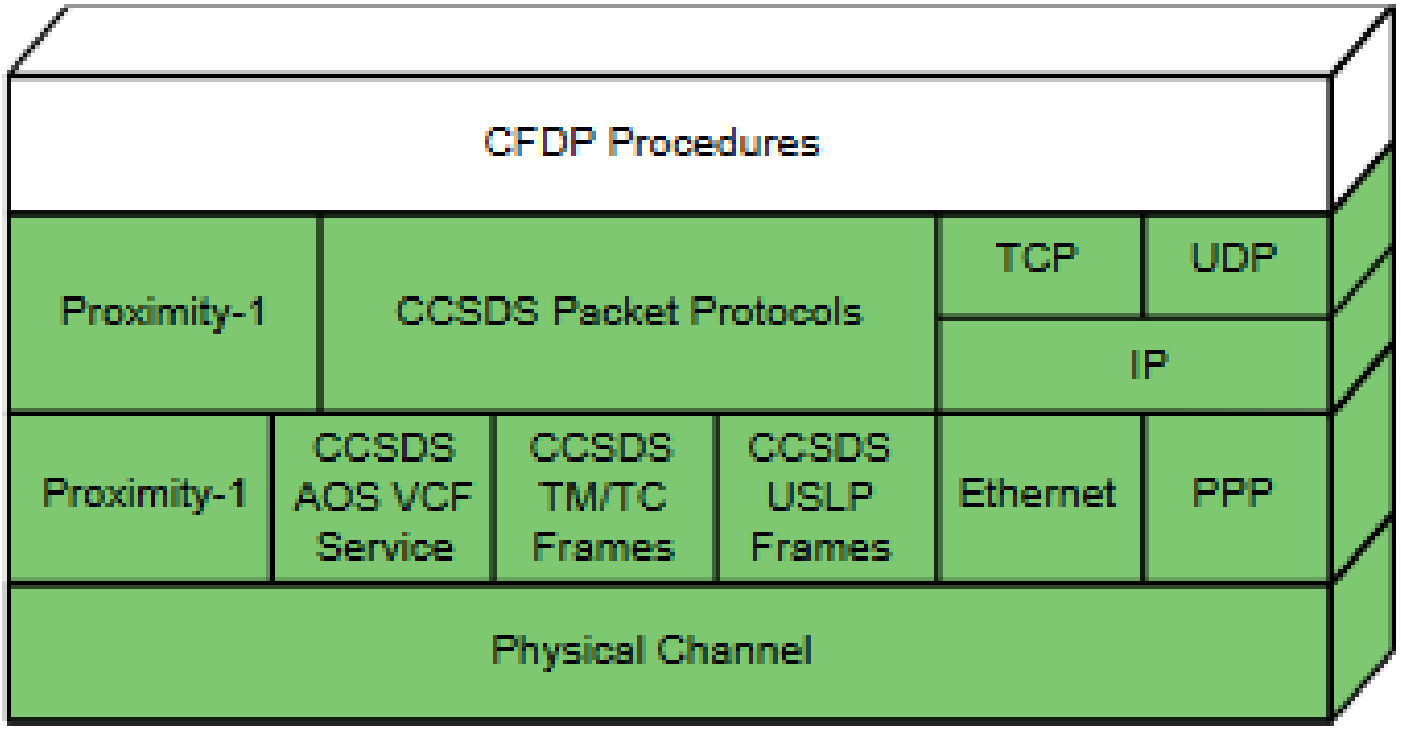

Figure 2-1: The CFDP Operates over a Wide Range of Underlying Protocols

Bundle Protocol

- Disruption-Tolerant Network protocol, used in space communications
- Bundle Protocol sits between LTP (or sometimes UDP) and the Application Layer
- Some parallels to IP, some to TCP/UDP
  - Addressing (instead of 10.0.1.1:80 you have ipn:2.1)
  - Routing

Bundle Protocol Extensions

Additional headers to the Bundle which indicate other features:

- Confidentiality (Encryption)
- Integrity (signing)
- Sequencing
- Administrative records (status reports, logs)

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Licklider Transmission Protocol

Sits between BP and Link Layer

Stateful – keeps track of what's at the other end

First part 'red blocks' always reliable

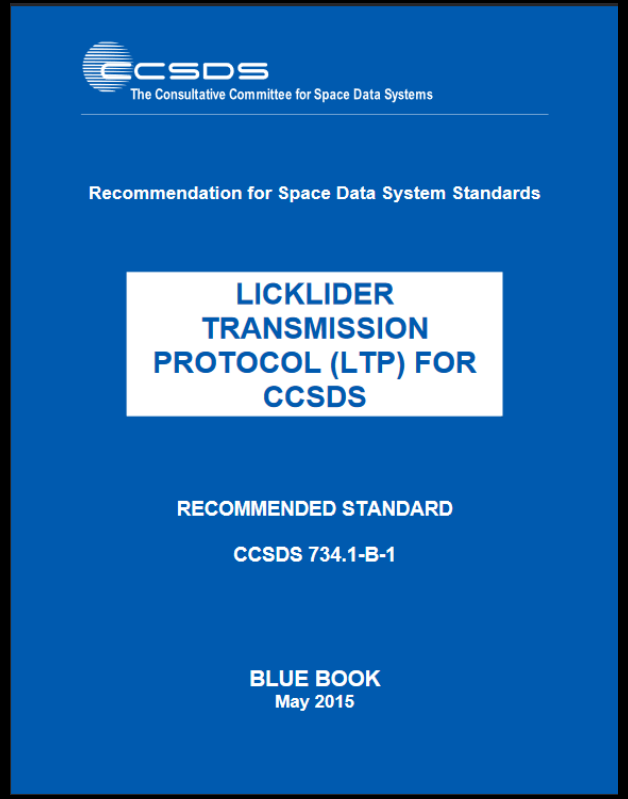
- Contains details about rest of block

First part 'green blocks' unreliable

- Contains details about rest of block

Extensions

- Cookies (to avoid DOS)
- Authentication (signing)



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NASA DTN-ION Dev Kit

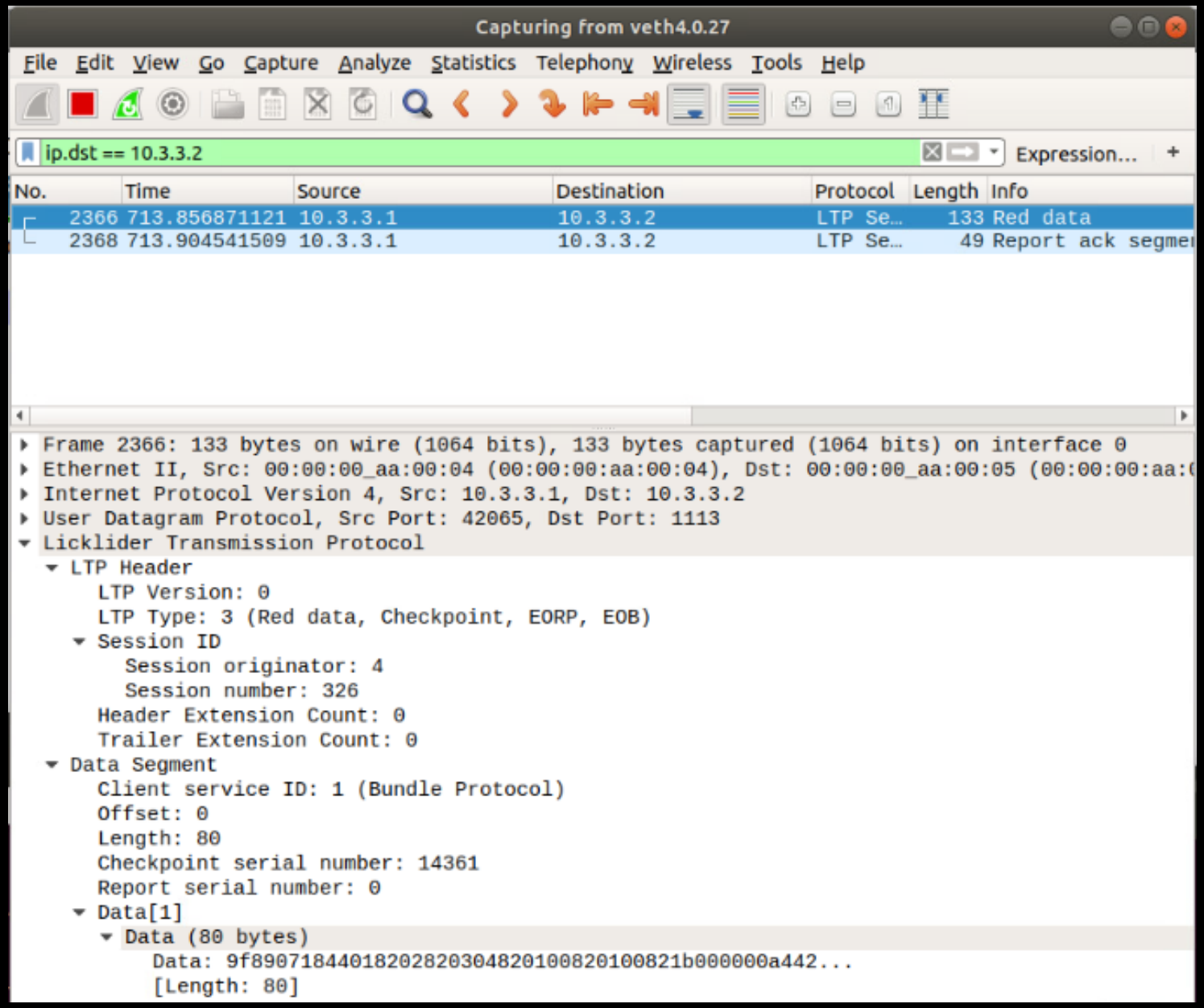
NASA publishes a set of C programs for communicating in CFDP, BP and LTP

Downloadable https://sourceforge.net/projects/ion-dtn/

NASA released an Ubuntu based system for testing and development

- Uses CORE (Common Open Research Emulator) https://github.com/coreemu/core
- Comes with premade
- Has C apps compiled ready to go
- We added PyION - Python interface to these apps

(Sometimes) available at https://www.mitre.org/download-nasas-dtn-development-kit
Contact me if you want it - site is generally broken



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