Delay/Disruption-Tolerant Networking

Theodoros Amanatidis
ComNet Research Group
Democritus University of Thrace

Outline

- ✓ Challenged Networks
- ✓ DTN Concept
- ✓ DTN Architecture and Functionality
- ✓ CCSDS File Delivery Protocol (CFDP)
- ✓ DTN Open Issues

Challenged Networks

- ✓ Intermittent Connectivity
- ✓ Long and Variable Delays
- ✓ Asymmetric Data Rates
- ✓ High Error Rates

Examples:

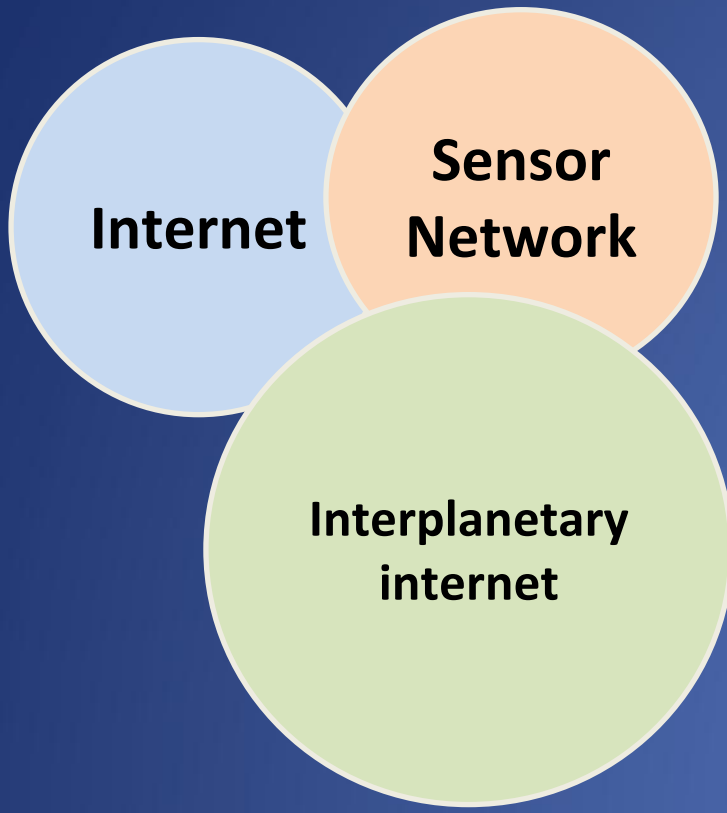
- ✓ Terrestrial Mobile Networks
- ✓ Sensor Networks
- ✓ Ad-Hoc Networks
- ✓ Interplanetary Internet

Contacts

- ✓ Persistent
- ✓ On-Demand
- ✓ Intermittent - Scheduled
- ✓ Intermittent - Opportunistic
- ✓ Intermittent - Predicted

DTN Concept

- ✓ Network of “regional” networks
- ✓ Interoperability between different networks



Boundaries

Delay

Connectivity

Data-rate Asymmetry

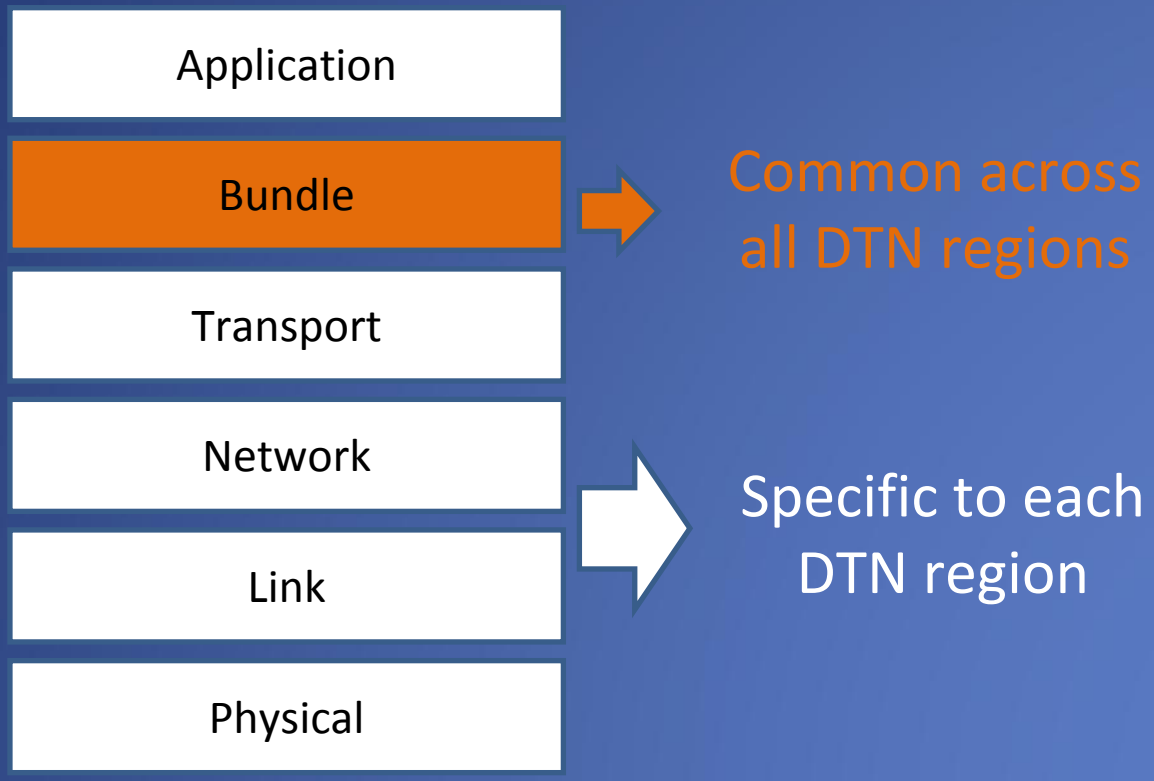
Error Rate

Addressing

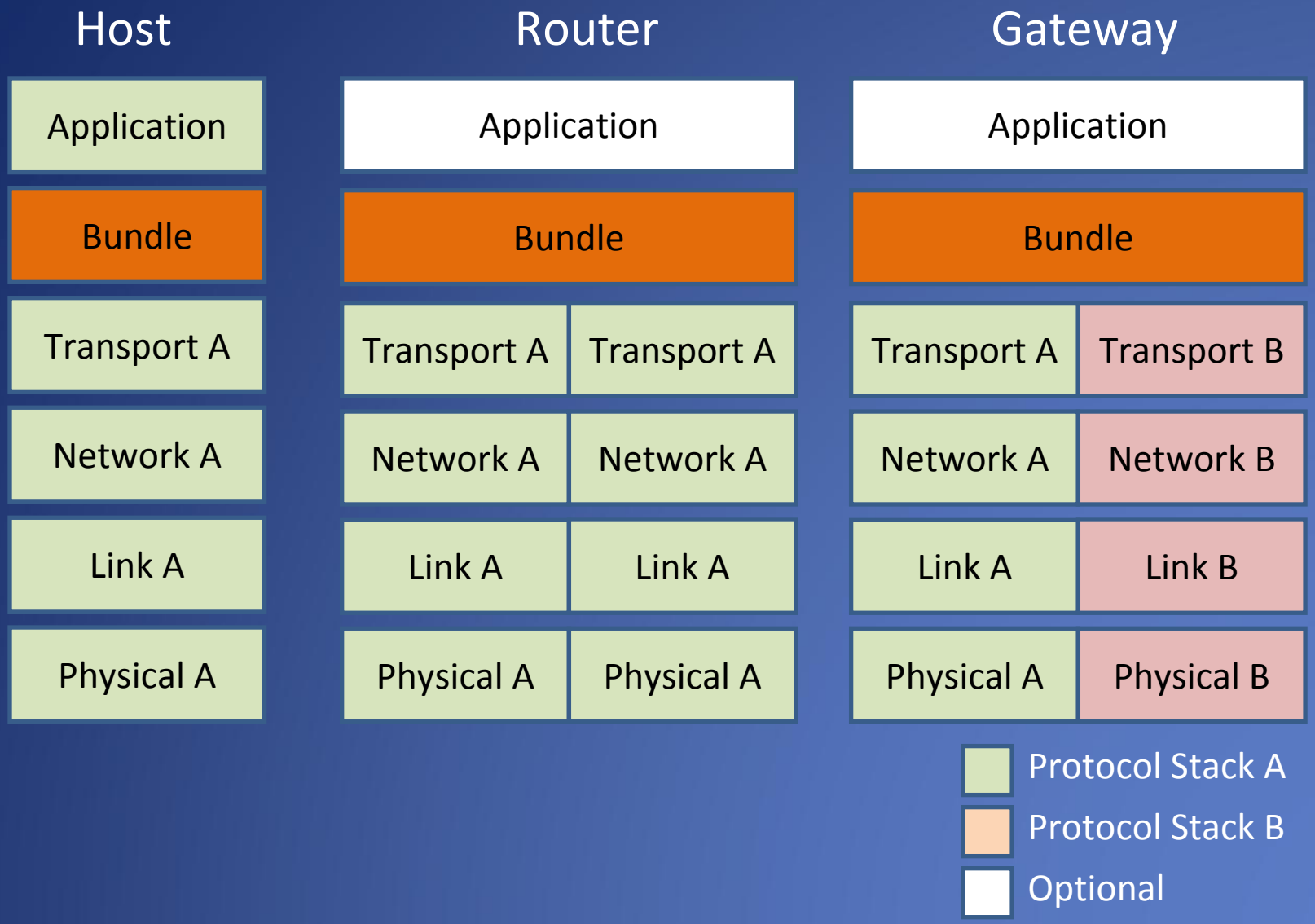
QoS

Bundle Layer

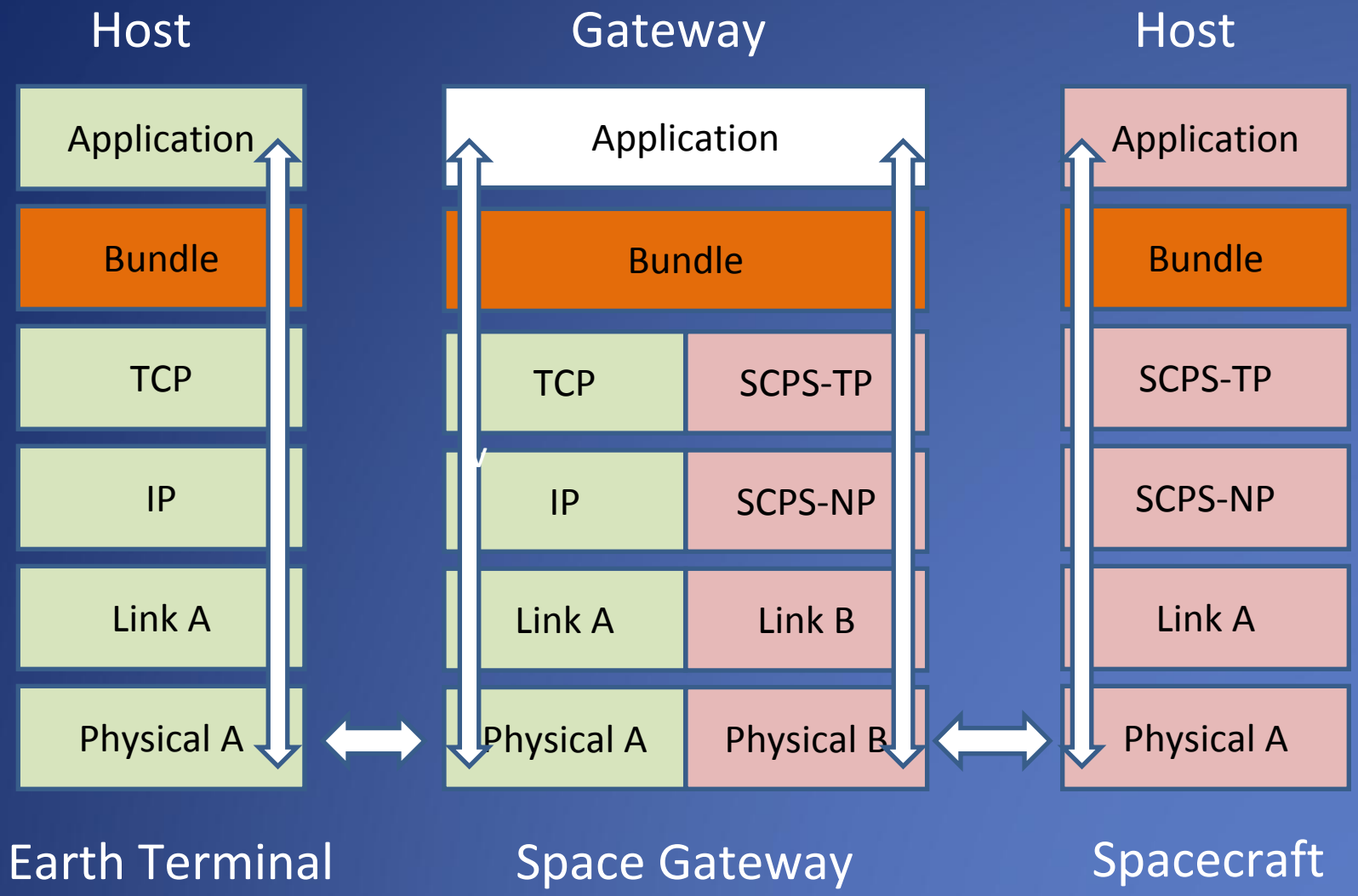
- ✓ Store-and-Forward message switching
- ✓ Persistent Storage
- ✓ Custody Transfer



DTN Nodes


Host
Router
Gateway
Application
Application
Application
Bundle
Bundle
Bundle
Transport A
Transport A
Transport A
Transport A
Transport B
Network A
Network A
Network A
Network A
Network B
Link A
Link A
Link A
Link A
Link B
Physical A
Physical A
Physical A
Physical A
Physical B
Protocol Stack A
Protocol Stack B
Optional

Example


Host
Gateway
Host
Application
Application
Application
Bundle
Bundle
Bundle
TCP
SCPS-TP
SCPS-TP
IP
SCPS-NP
SCPS-NP
Link A
Link B
Link A
Physical A
Physical A
Physical B
Physical A
Earth Terminal
Space Gateway
Spacecraft

Naming

Endpoint Identifier (ID) = group of DTN nodes

Minimum Reception Group

- Unicast
- Anycast
- Multicast

Uniform Resource Identifier (URI)

< scheme name > : < scheme specific part >

example : dtn://sandbox.dtnrg.org.dtn/dtnping.5010

Bundle

Basic information to route and process bundles

- ✓ Source and Destination endpoints IDs
- ✓ Report-to and Custodian endpoints IDs
- ✓ Block Length
- ✓ Creation Timestamp and Lifetime
- ✓ Bundle Processing Control Flags
  - General Flags (fragment, do not fragment, etc)
  - Class of Service (bulk, normal, expedited)
  - Request Status Report etc.

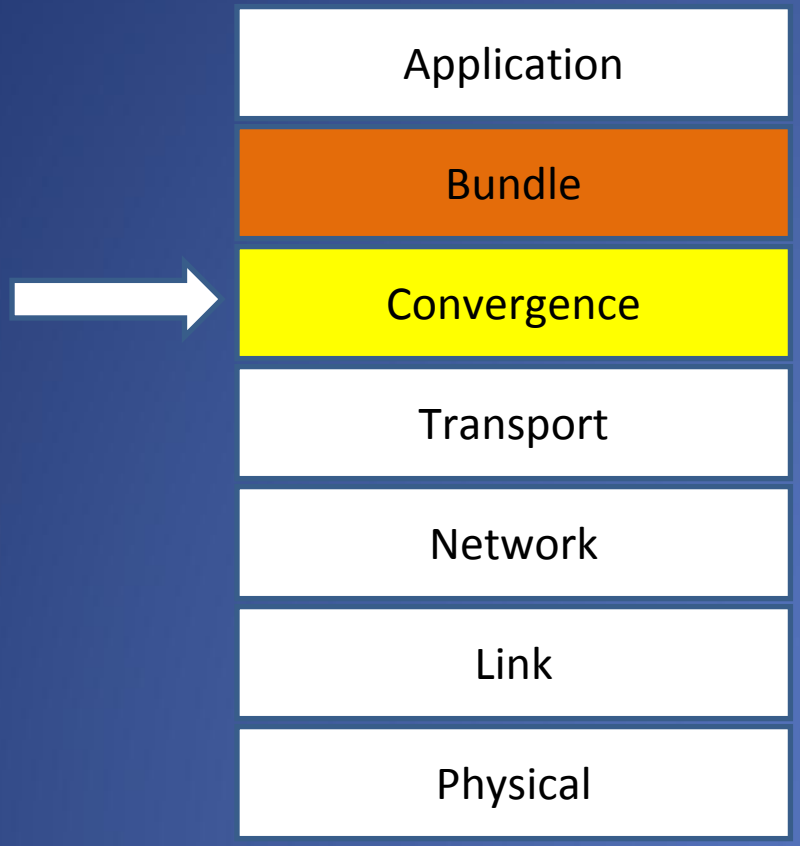
No Fixed Sizes ➡ Self Delimiting Numeric Values (SDNV)

Delivery Options

- ✓ Custody Transfer Requested
- ✓ Source Node Custody Transfer Required
- ✓ Report when Bundle Delivered
- ✓ Report when Bundle Acknowledged by App
- ✓ Report when Bundle Received
- ✓ Report when Bundle Custody Accepted
- ✓ Report when Bundle Forwarded
- ✓ Report when Bundle Deleted

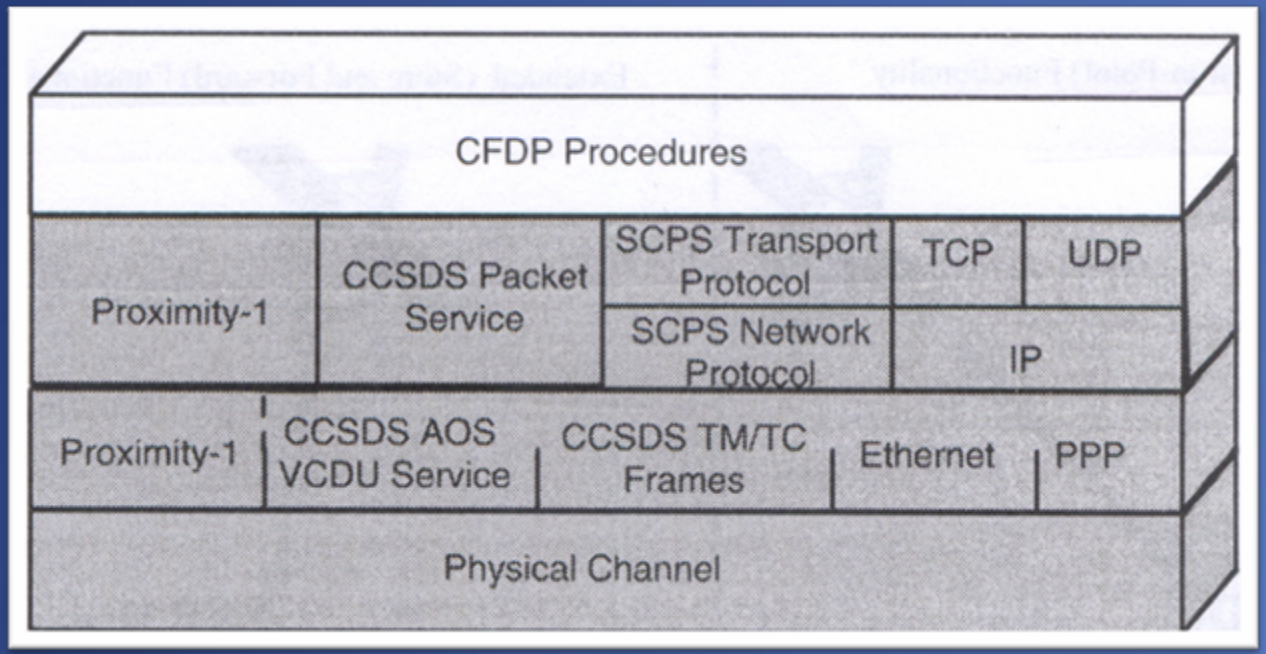
Convergence Layers

- ✓ Interface to underlying protocols
- ✓ Different for each transport layer protocol



CFDP

- ✓ File-Oriented Application Protocol
- ✓ Transport Layer Functionality
  - ✓ Reliably (Acknowledged Mode) , NACKs, ACKs
  - ✓ Unreliably (Unacknowledged Mode)



- ✓ Does not support multiple paths in parallel

Open Issues

- ✓ Routing
- ✓ Security
- ✓ Combination with IP ?

Questions ?