DELAY-TOLERANT NETWORKS

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- Content of this presentation is based on the papers [1], [2]

- Images were mostly taken from [2]

[1] RFC4838 2007 Delay-Tolerant Networking Architecture

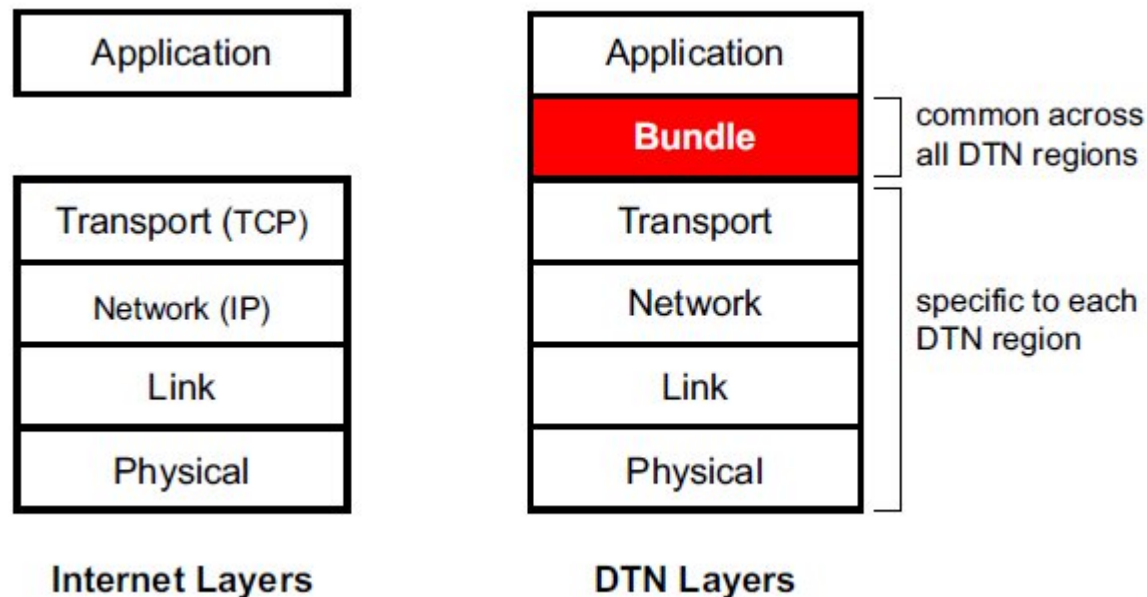[2] Warthman, F. 2003 Tutorial. Delay-Tolerant Networks (DTNs)

Outline

- Introduction
  - Concept
  - Internet vs. DTN
  - Features
- Protocol and architecture details
- Challenged networks
- Evaluation of DTN

Concept

Delay-Tolerant Network (DTN)

- is an overlay on top of regional networks
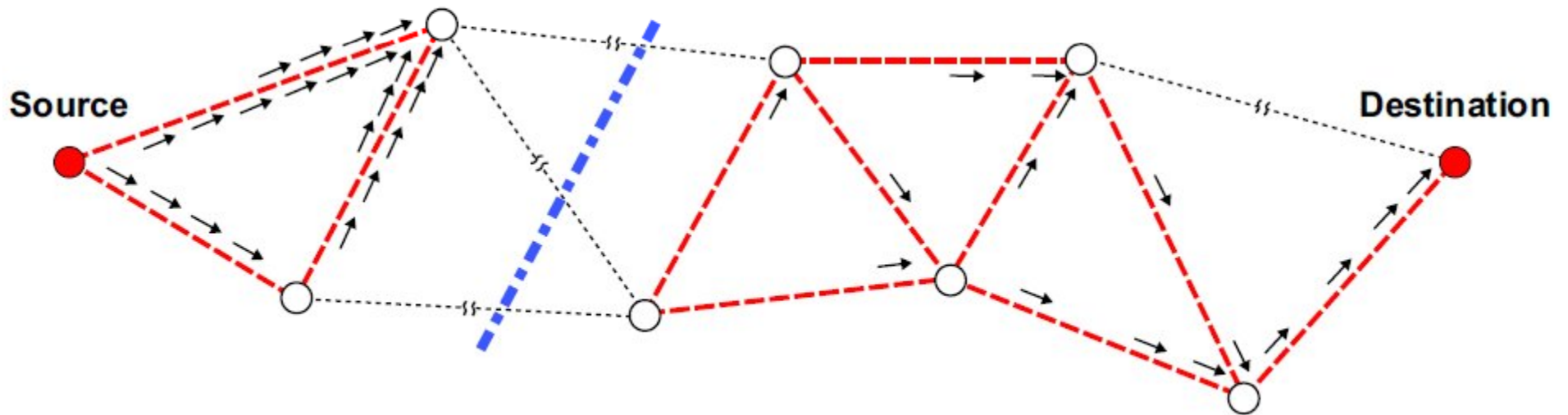 - built on top of region-specific lower layers
  - messages are called bundles

Internet Layers	DTN Layers	
Application	Application	
	Bundle	common across all DTN regions
Transport (TCP)	Transport	specific to each DTN region
Network (IP)	Network	
Link	Link	
Physical	Physical	

Concept

Delay-Tolerant Network (DTN)
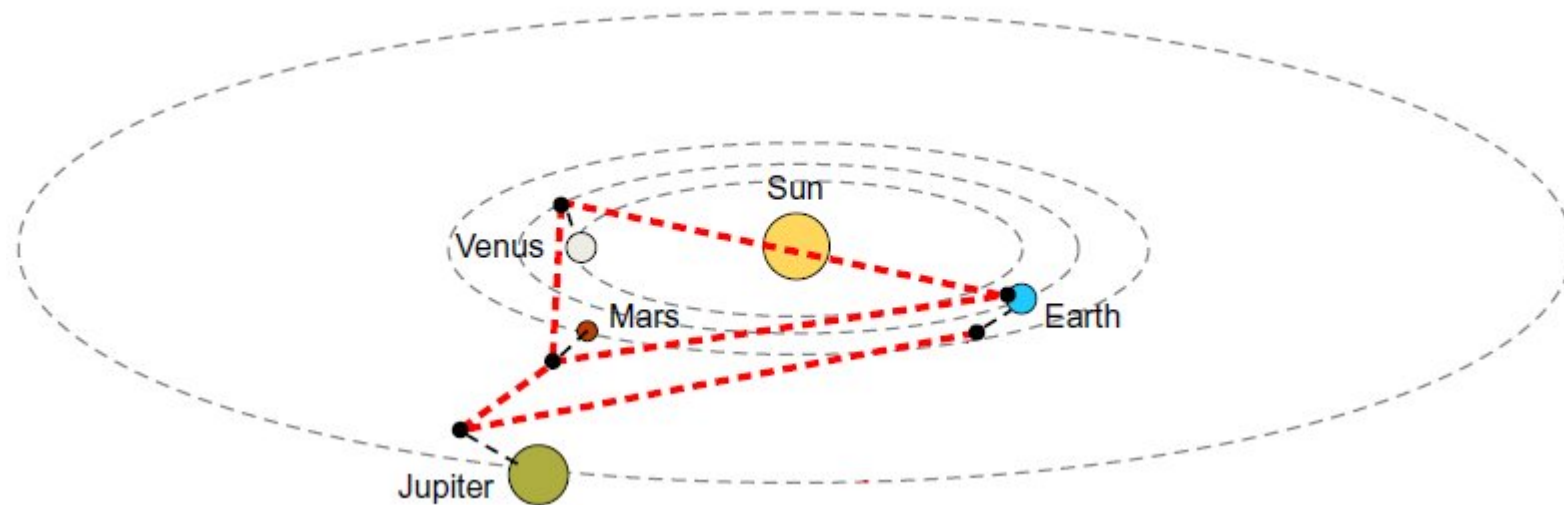
- is a network of regional networks

Concept

Delay-Tolerant Network (DTN)

- was originally designed to support the InterPlanetary Internet (IPN)
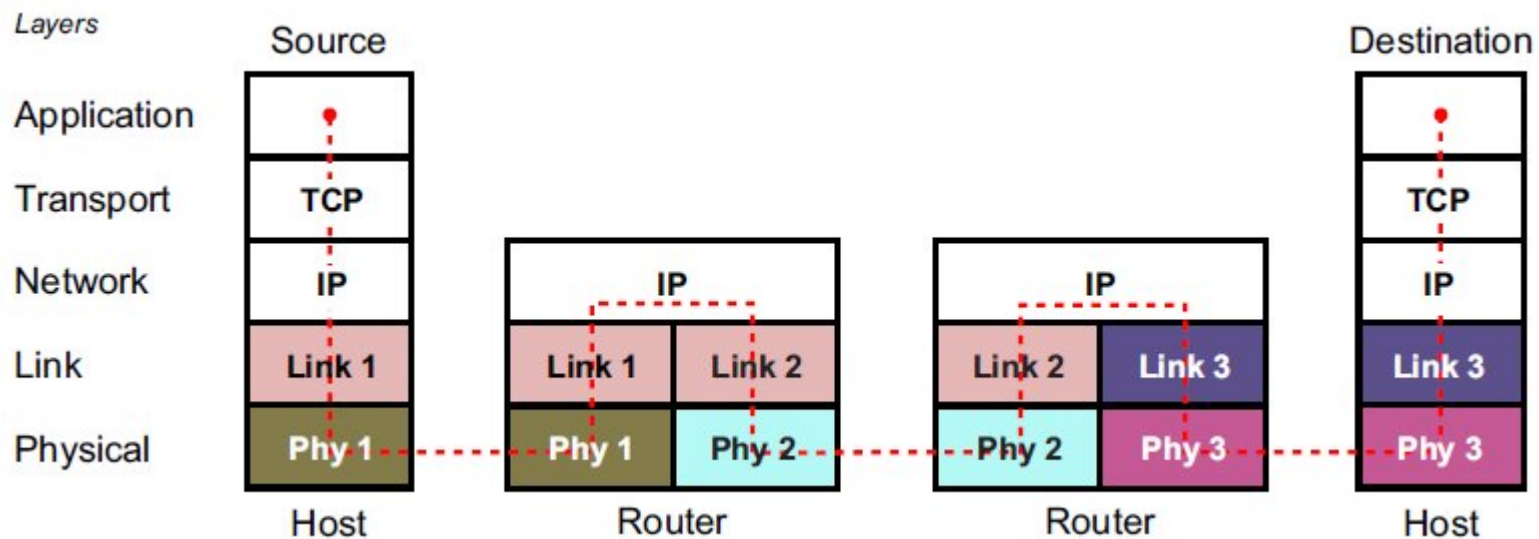
Internet vs. DTN

Internet

- is mainly based on packet switching
- nodes are continuously connected
- IP protocol is used on the network layer
- excessive network traffic in case of errors

Layers	Source			Destination
Application	•			•
Transport	TCP			TCP
Network	IP	IP	IP	IP
Link	Link 1	Link 1	Link 2	Link 2	Link 3	Link 3
Physical	Phy 1	Phy 1	Phy 2	Phy 2	Phy 3	Phy 3
	Host	Router	Router	Host

Internet vs. DTN

DTN

- uses the store-and-forwarding method
- messages might be sent to unavailable end hosts
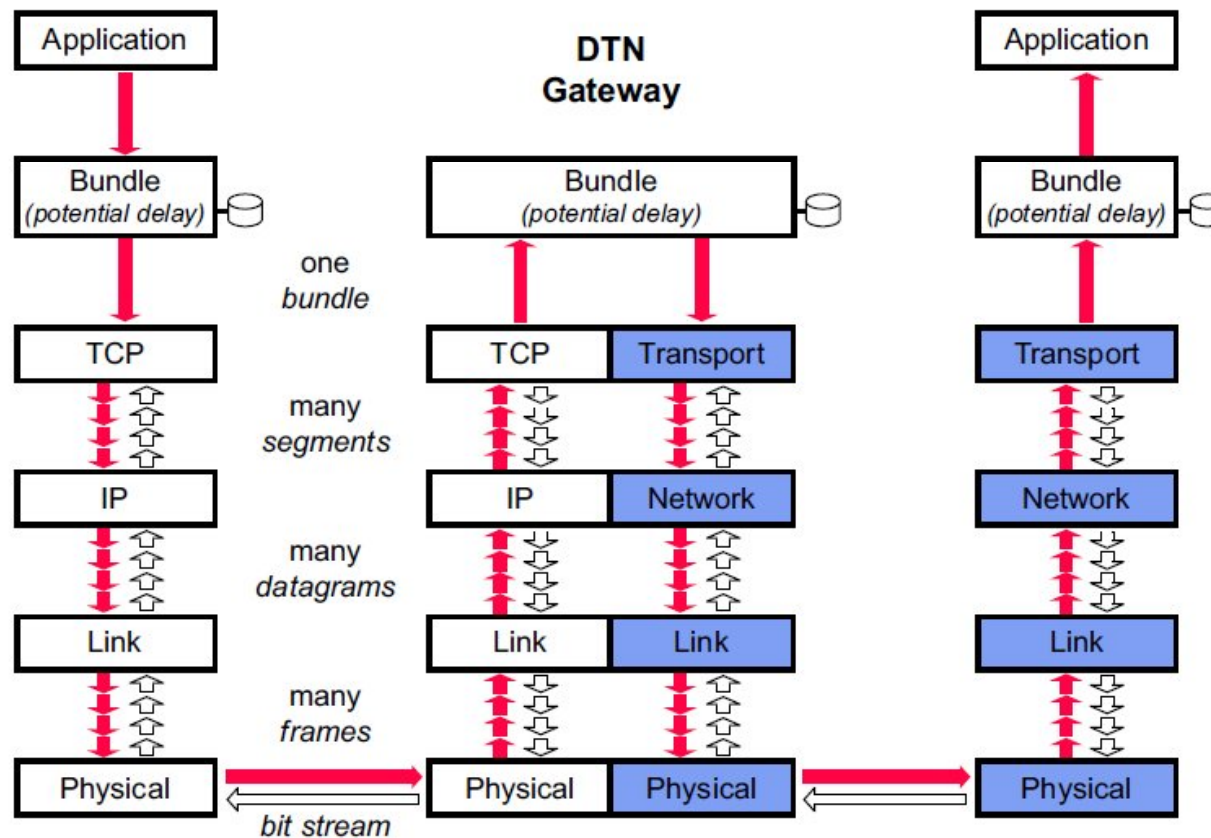- hop-to-hop retransmission in case of errors
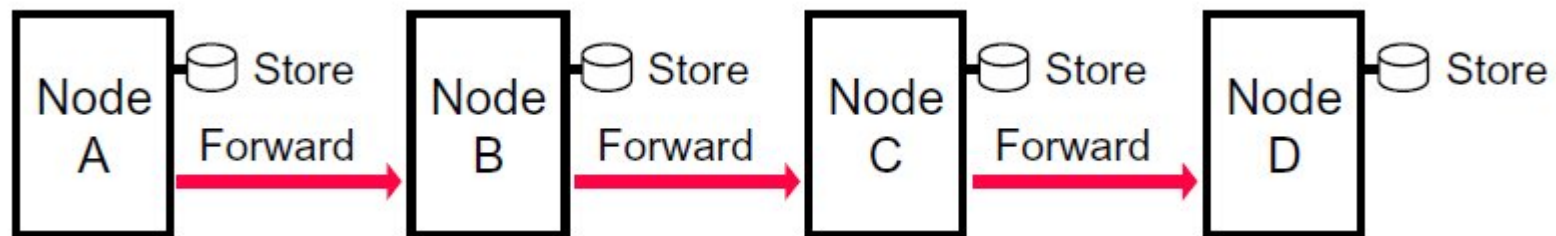
Internet vs. DTN

DTN

- isn't necessarily built on top of TCP/IP

Internet vs. DTN

Communication on the Internet is mainly based on packet switching

DTNs use store-and-forward message switching
- very similar to the way email systems work

Features

- Intermittent connectivity
  - Opportunistic contacts
  - Scheduled contacts
- Non-conversational protocol
- Security

Outline

- Introduction
- Protocol and architecture details
  - Types of nodes
  - Node names
  - Addressing
  - Security
- Challenged networks
- Evaluation of DTN

Types of nodes

- Host

- Router
    - works within a single DTN region

- Gateway
    - connects neighboring networks

Node names

☐ based on URIs

☐ consist of region and entity ids

Example:

  dnt://earth.sol.int/src.someclient.com

Addressing

- unicast
  - dnt://earth.sol.int/src.someclient.com
- anycast
  - dnt://earth.sol.int/*.someclient.*
- multicast
  - dnt://earth.sol.int/*.someclient.*
- broadcast
  - dnt://earth.sol.int/*

Security

- Network routers participate in authentication
- Private and public certificates are used
- Each message contains a "postage stamp" keeping a signature of the sending node
- A new signature is generated every time the message arrives to the next node

Outline

- Introduction
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- Challenged networks
- Evaluation of DTN

Challenged networks

- Terrestrial Mobile Networks
  - may easily become partitioned
- Exotic Media Networks
  - longs delays and connection interruptions
  - communication with submarines or low-earth orbiting satellites, deep space RF communication
- Sensor-based Networks
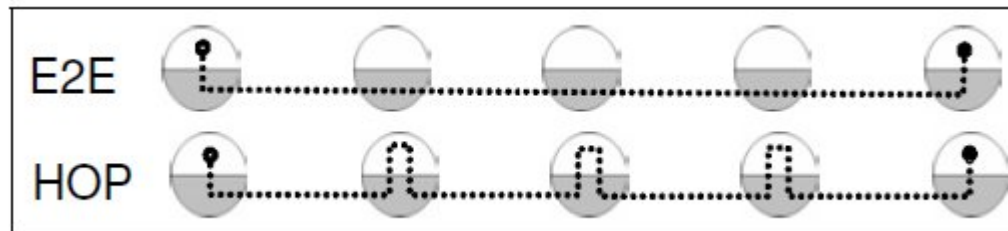 - scheduled communications to save power

Outline

- Introduction
- Protocol and architecture details
- Challenged networks
- **Evaluation of DTN**
    - Test 1
    - Test 2
    - Test 3

Evaluation of DTN

- In the paper "Implementing Delay Tolerant Networking", authors created and evaluated a DTN network
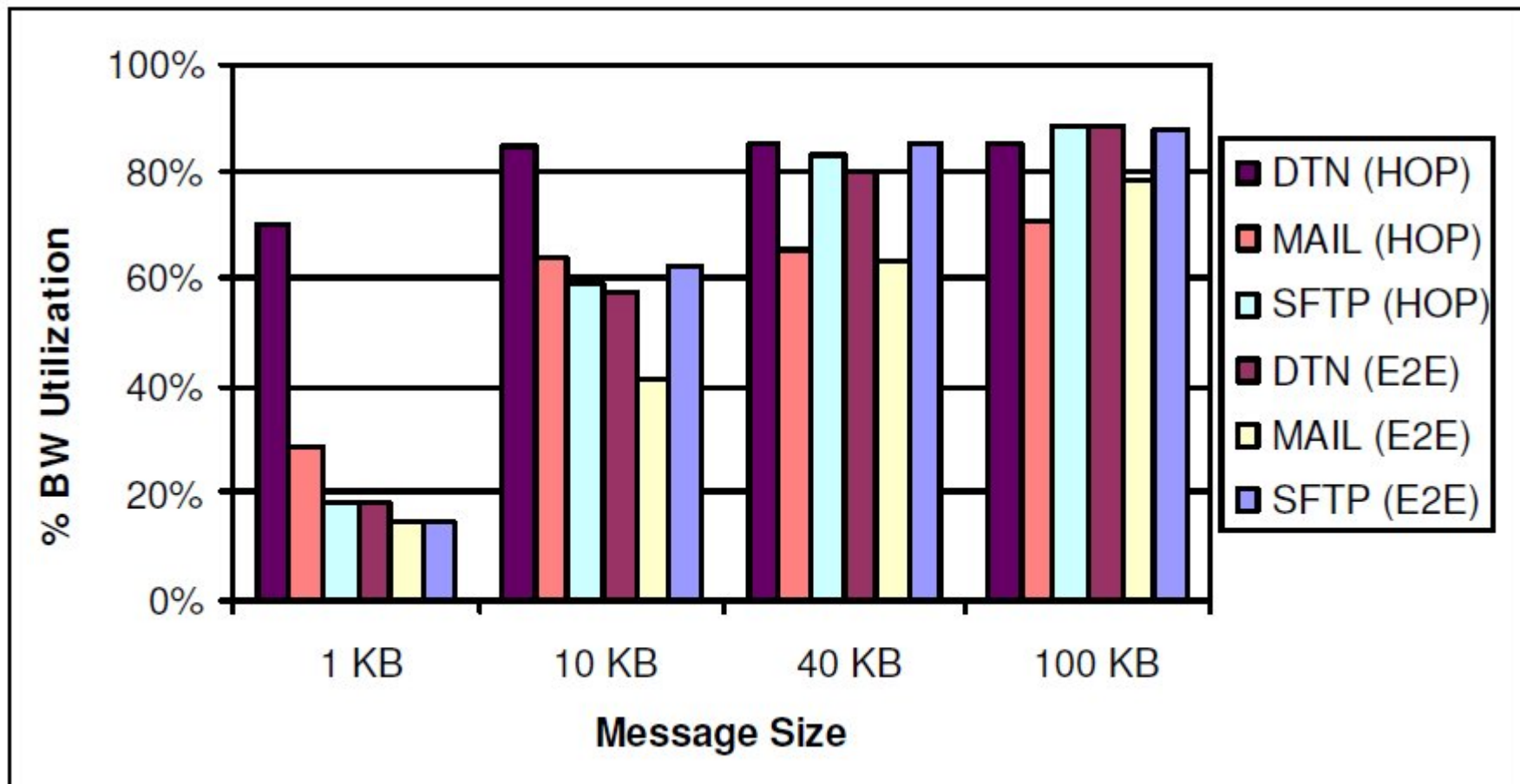- Tests were run on end-to-end and hop-by-hop configurations

- DTN, Mail and SFTP protocols
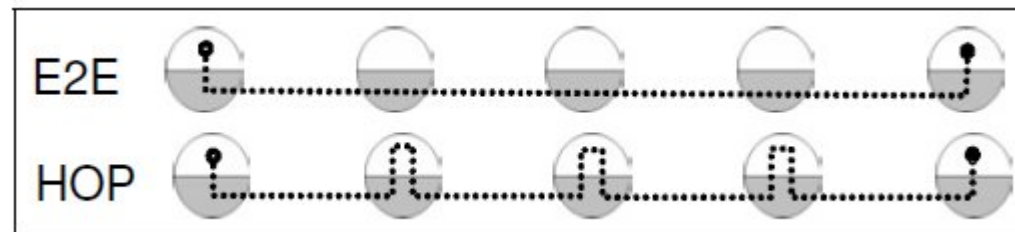
Test 1

- No disconnections

Test 2

- Periodic disconnectivity of each node
- Disruptions are cyclical
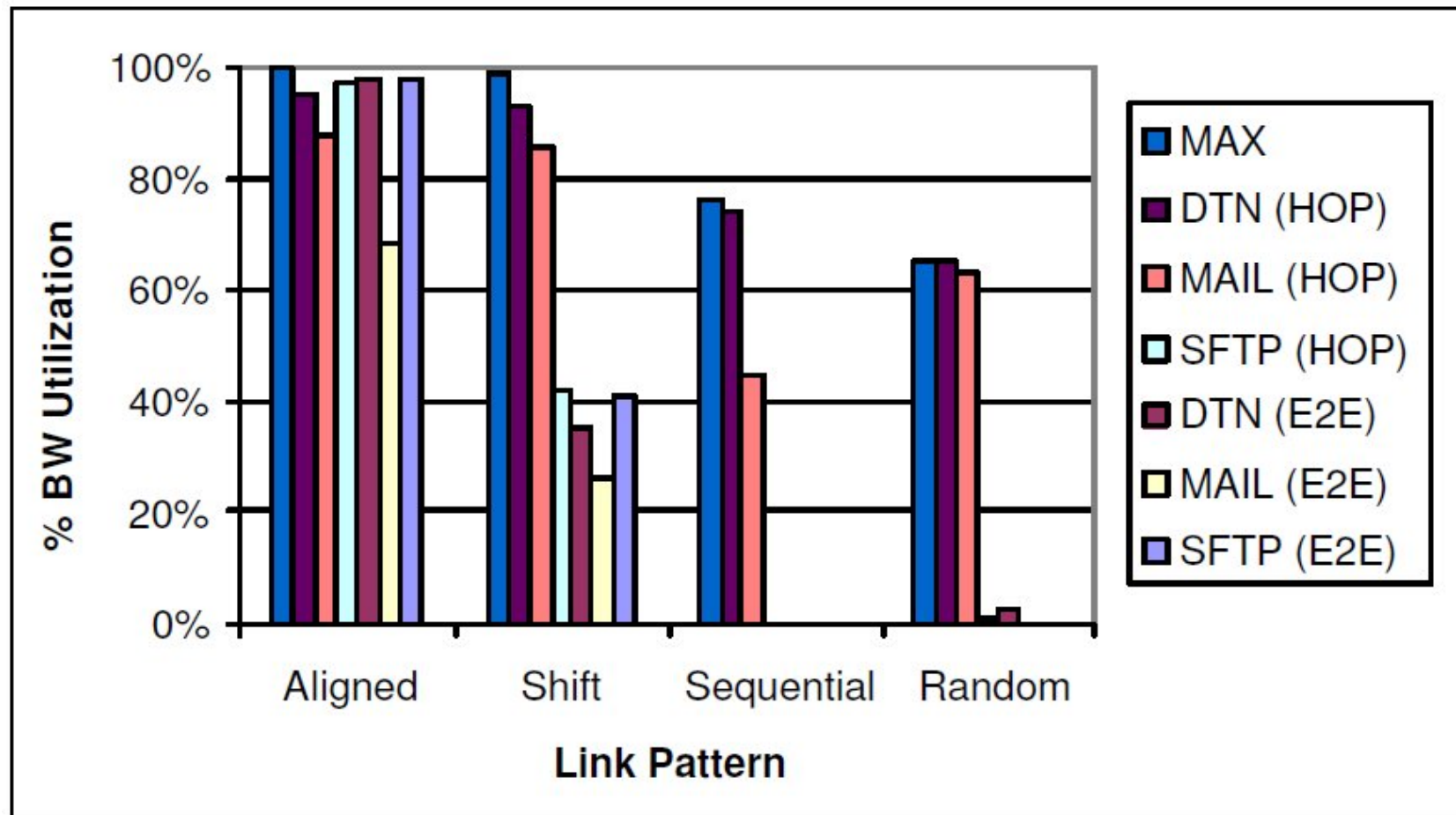- Links are up for one minute, then down for three
- Message sizes are 40K

Test 2

- 4 types of disruptions:
  - aligned
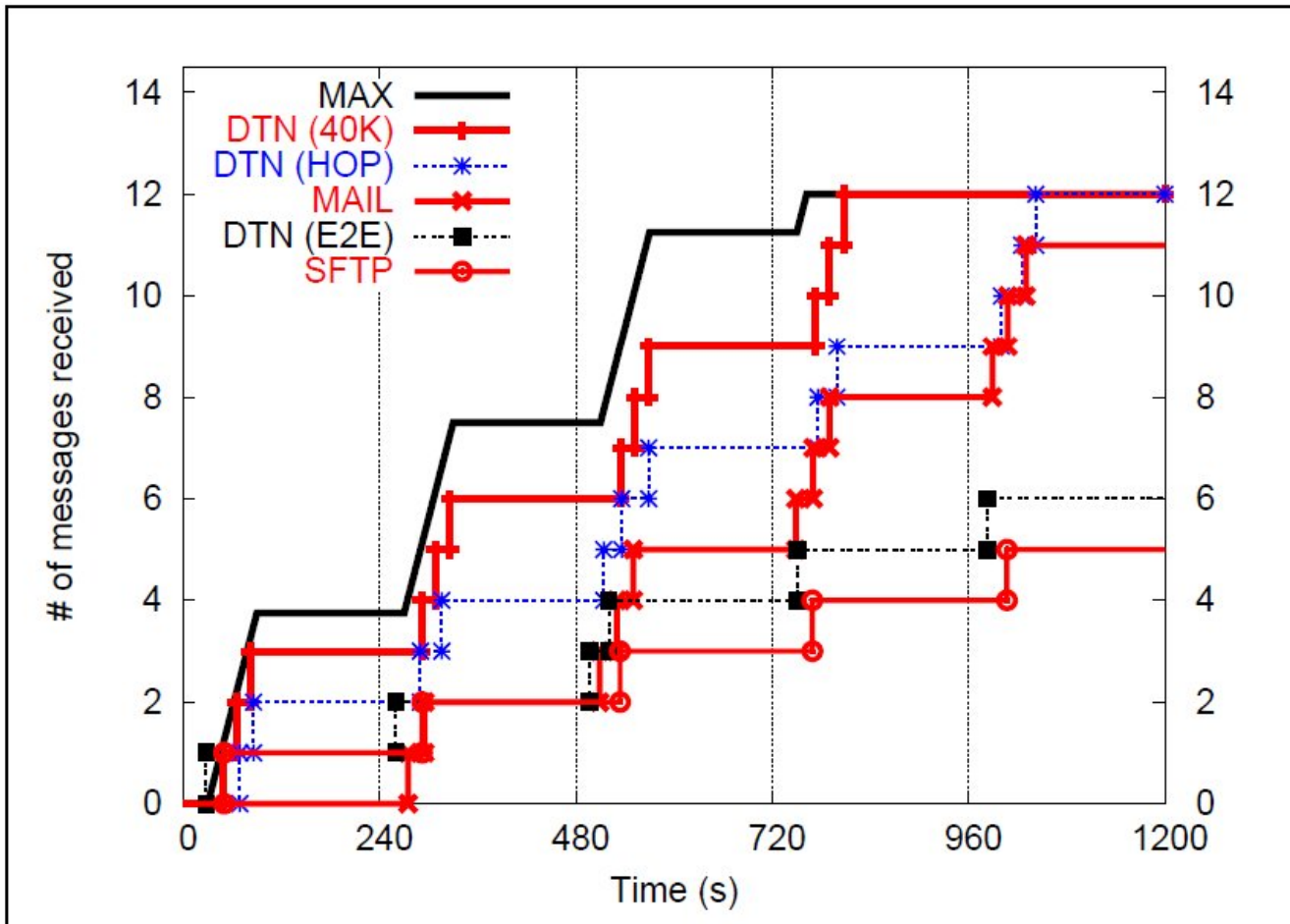 - shift (10 sec.)
  - sequential
  - random

Test 2

Test 3

- 10 sec. phase shift scenario
- 200 KB messages
- pro-active fragmentation in DTN
  - into smaller 40KB bundles

Test 3

Questions and Discussion