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Performance Comparison of DTN Bundle Protocol Implementations

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Motivation

Several Bundle Protocol (BP) implementations for Linux exist

- DTN2: DTNRG's reference implementation
- IBR-DTN: Implementation for embedded OpenWRT devices
- ION: JPL's implementation for spacecrafts running on RTOS
- Postellation: Viagenie's closed-source (?) BP implementation
- Spindle: Closed-source BP implementation by Raytheon BBN Technologies

Performance?

- No quantitative evaluation and comparison has been performed (yet)

Motivation (cont'd)

Why is performance evaluation of BP implementations important?

- Contacts are rare and short, communication has to be efficient
- Broken interoperability *can* point out ambiguities in the specs

Goals of this paper

- Concentrate on open-source TCPCL implementations for Linux
- Quantitative "test bench" performance evaluation
- Quantitative opportunistic performance evaluation
- Systematic evaluation of interoperability

Metrics

Application Layer Throughput

- For different storage backends
- Between different implementations
- In an opportunistic scenario

Interoperability

- Can implementations discover each other?
- Throughput between different implementations

Communication Efficiency

- In an opportunistic scenario

Experimental Setup

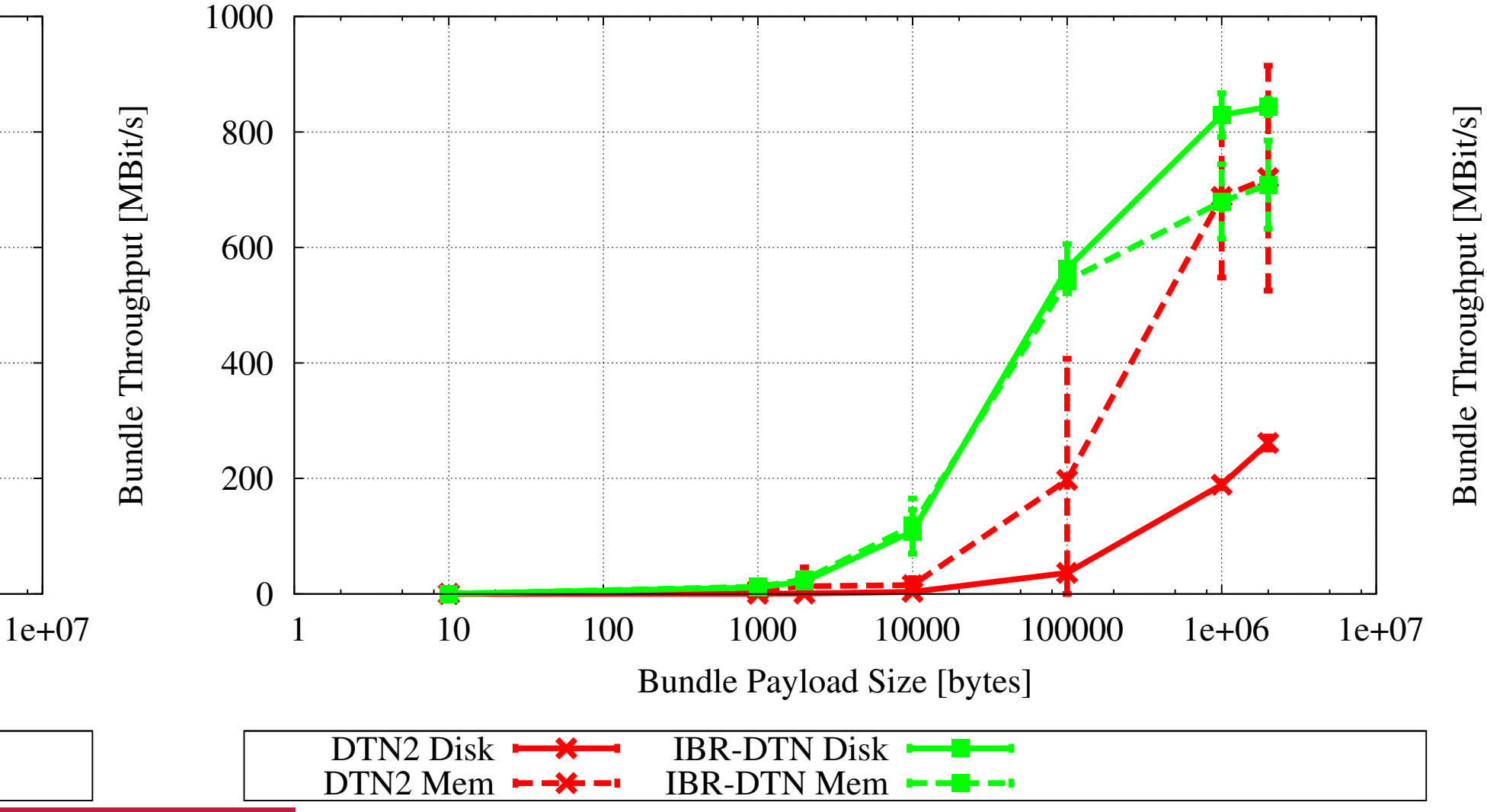
Hardware

- Athlon II X4 2.8 GHz CPUs with 4 GiB RAM
- 1 GBit Ethernet (good for 940 MBit/s TCP goodput with iperf)
- Different Ethernet ports for measurement and control traffic
- Samsung Spinpoint F3 500GB (HD502HJ) hard drive

Software

- Ubuntu Linux 11.04
- DTN2 v2.7, IBR-DTN v0.6.3, ION v2.4.0
- Connection blocked via iptables (IBR-DTN) or daemon's control interface (DTN2, ION)

Storage Backends: BP Throughput



Interoperability: Discovery, Bundle Exchange

Discovery Capabilities

- DTN2 uses a "proprietary" discovery beacon format
- IBR-DTN supports IPND v0 & v1 and DTN2 discovery format
- ION is focussed on scheduled contacts only

Interoperability Evaluation Results

- DTN2 and IBR-DTN discover each other just fine
- Bundles can be exchanged in both directions
- ION exchanges bundles with DTN2 and IBR-DTN

Interoperability: BP Throughput

Throughput (memory storage, 1 MByte payload size)

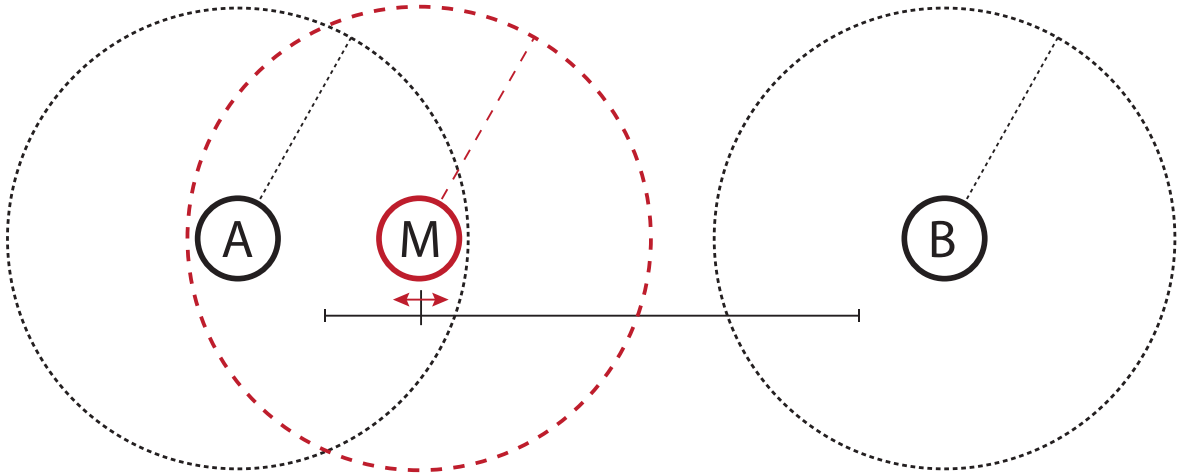
TX \ RX	DTN2	IBR-DTN	ION
DTN2	687 MBit/s	635 MBit/s	93 MBit/s
IBR-DTN	881 MBit/s	679 MBit/s	90 MBit/s
ION	872 MBit/s	926 MBit/s	449 MBit/s

Observations

- DTN2 may have a bottleneck in the TX component
- IBR-DTN and ION show unclear bottlenecksshows unclear bottlenecks
- Fastest result is between ION and IBR-DTN

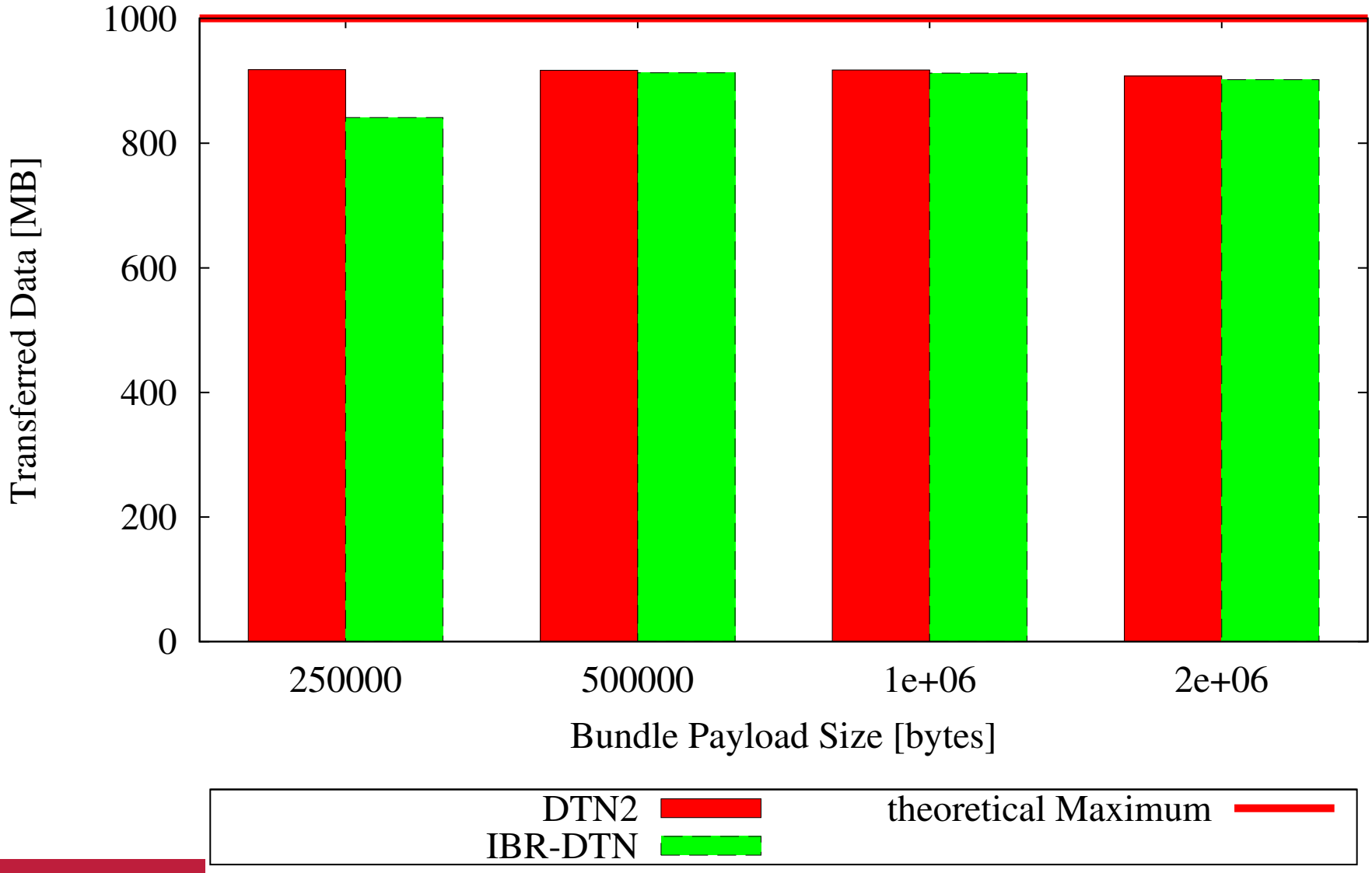
Opportunistic Scenario: Setup

Scenario

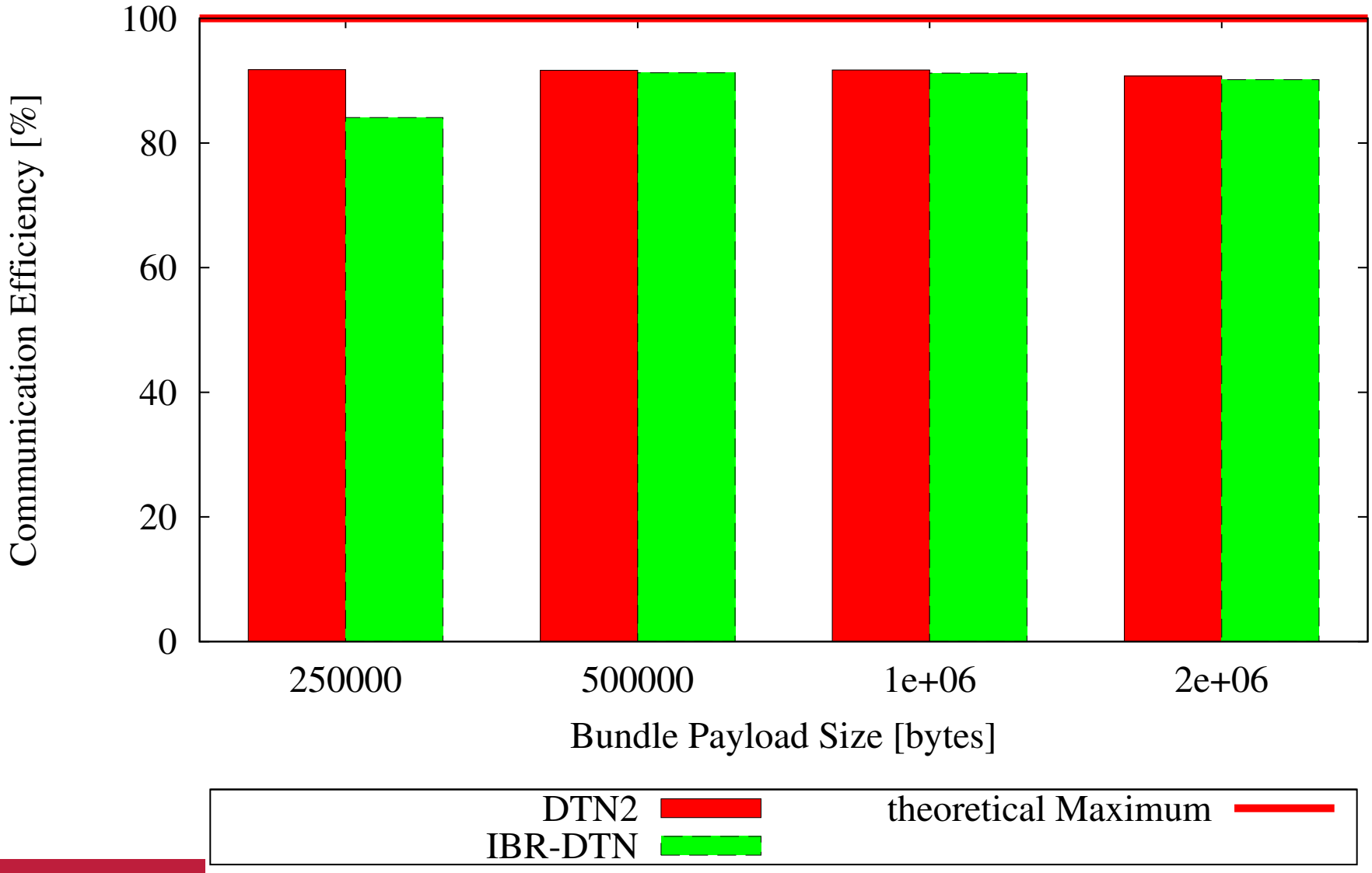


- Memory-based storage backends
- A creates bundles for B at constant rate, M commutes from A to B
- TCP throughput limited to 12.7 MBit/s (based on measurements)
- Cycle: 72 s contact time, 30 s travel, 72 s contact time, 30 s travel
- (almost) 9 complete cycles in 30 minutes measurement time

Opportunistic Scenario: Transferred Data



Opportunistic Scenario: Communication Efficiency



Conclusions

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Motivation

- Performance of BP implementations is important!
- Comparison of three BP implementations: DTN2, IBR-DTN, ION

Results

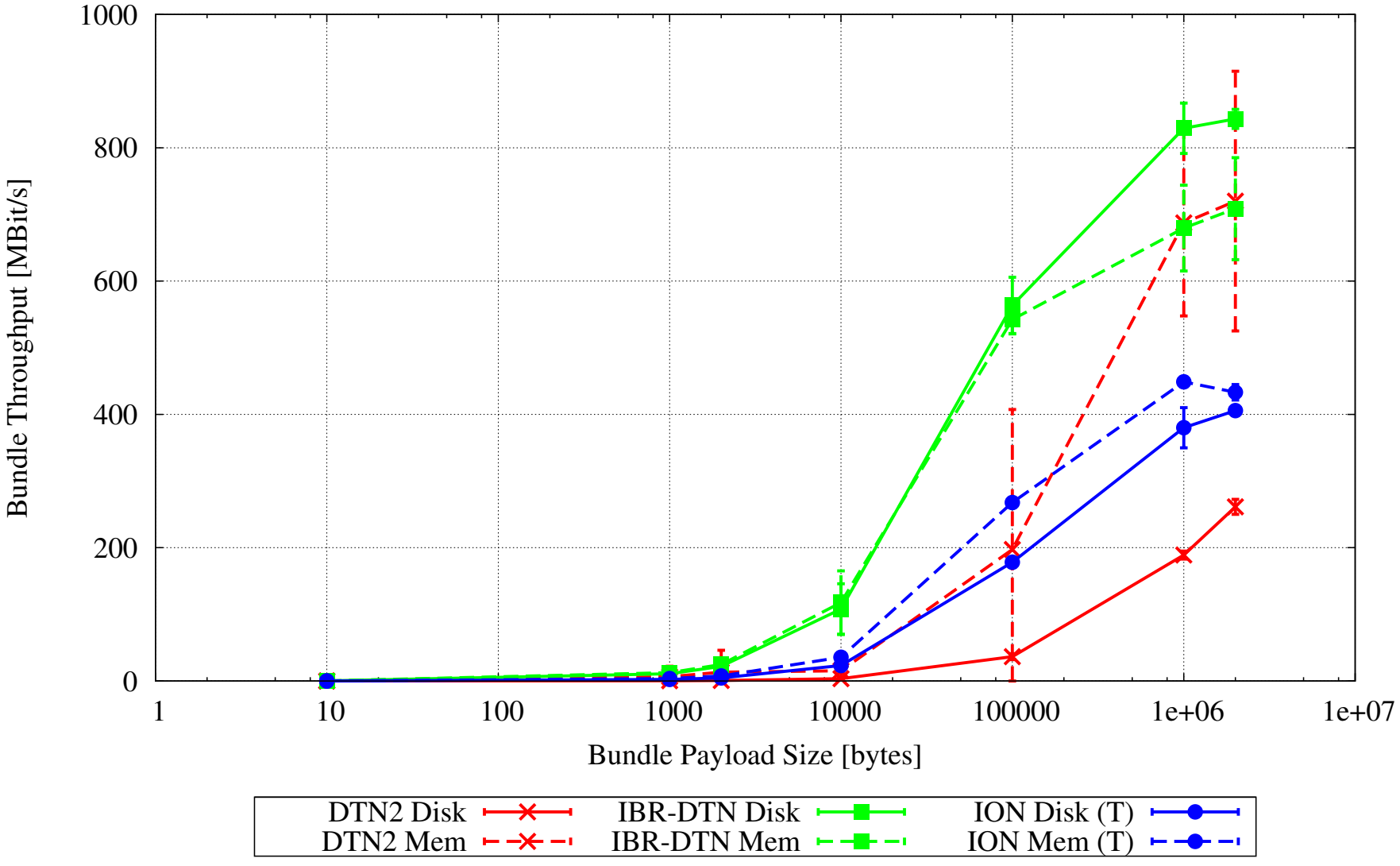
- All three implementations are interoperable
- Performance varies widely and unpredictably
- Fastest result between ION and IBR-DTN
- Working with the implementations is not easy

More results

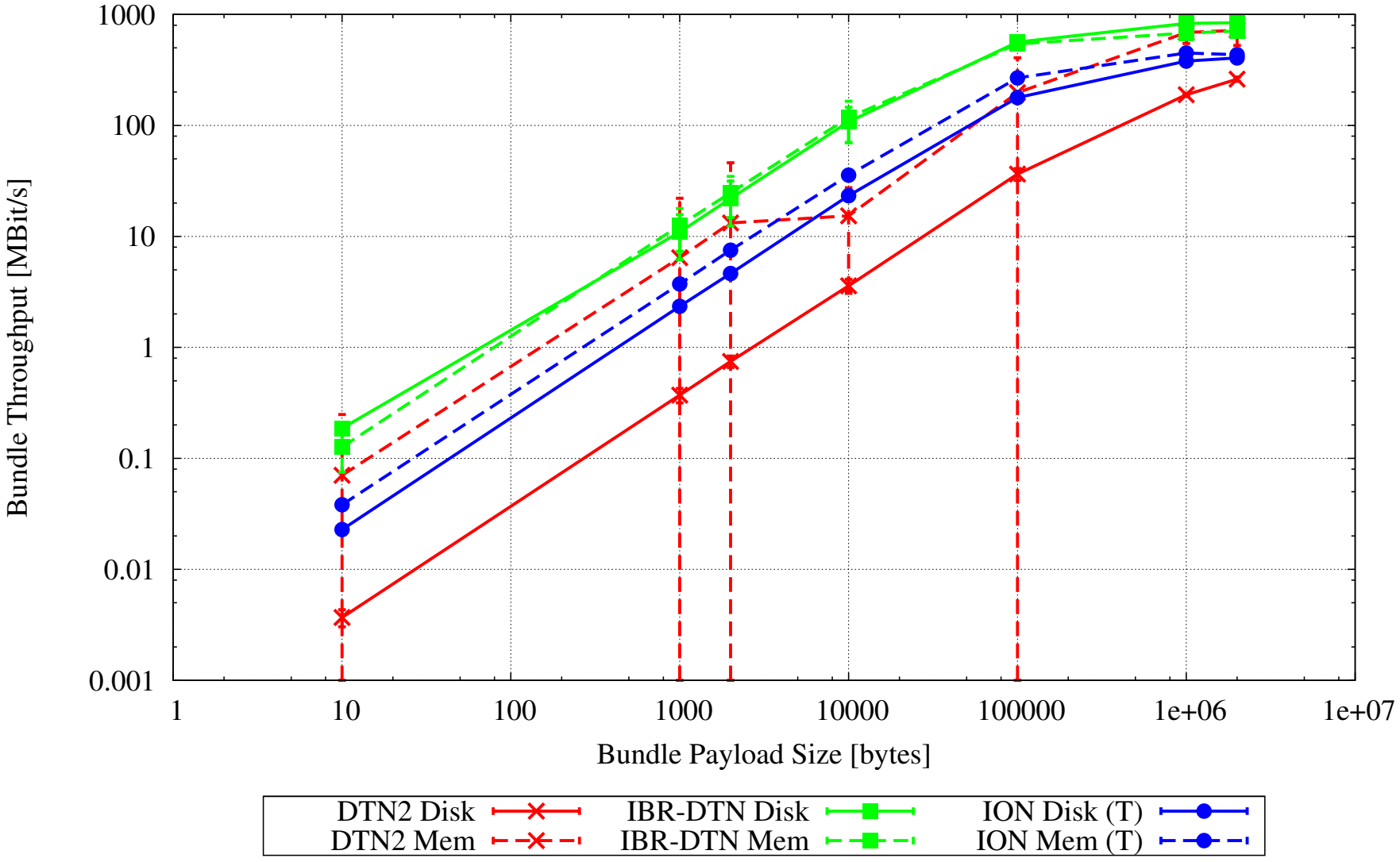
- More results in our technical report (WiP, look for updates)

BACKUP SLIDES

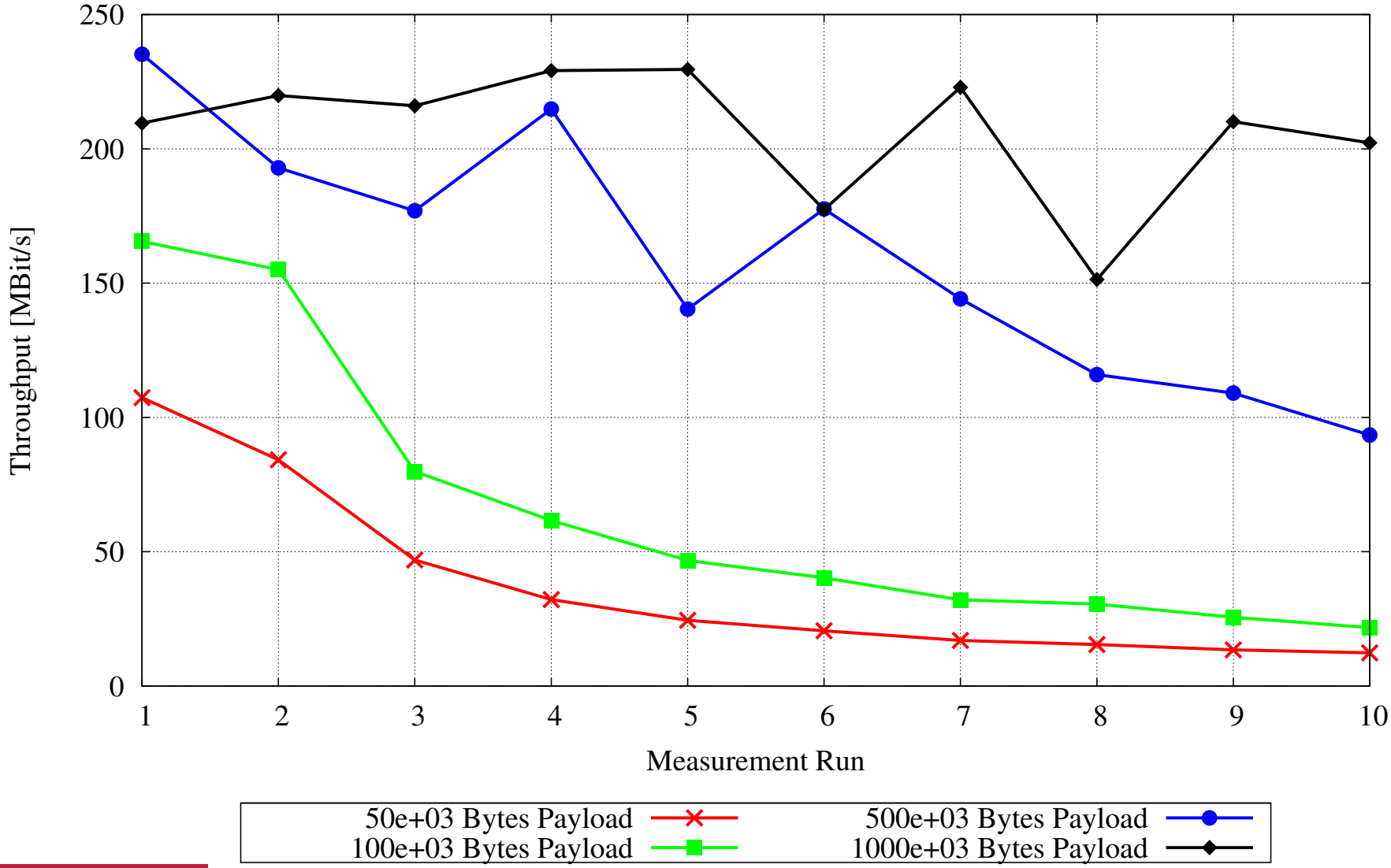
Throughput (linear y)



Throughput (logarithmic y)



DTN2 Slowdown



Interoperability: BP Throughput

Throughput (memory storage, 100 KByte payload size)

TX \ RX	DTN2	IBR-DTN	ION
DTN2	197 MBit/s	193 MBit/s	72 MBit/s
IBR-DTN	677 MBit/s	542 MBit/s	76 MBit/s
ION	455 MBit/s	420 MBit/s	268 MBit/s

Throughput (memory storage, 1 MByte payload size)

TX \ RX	DTN2	IBR-DTN	ION
DTN2	687 MBit/s	635 MBit/s	93 MBit/s
IBR-DTN	881 MBit/s	679 MBit/s	90 MBit/s
ION	872 MBit/s	926 MBit/s	449 MBit/s