Parallelized Network Security Protocols

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Talk Outline

Motivation

Parallelism in Network Protocols

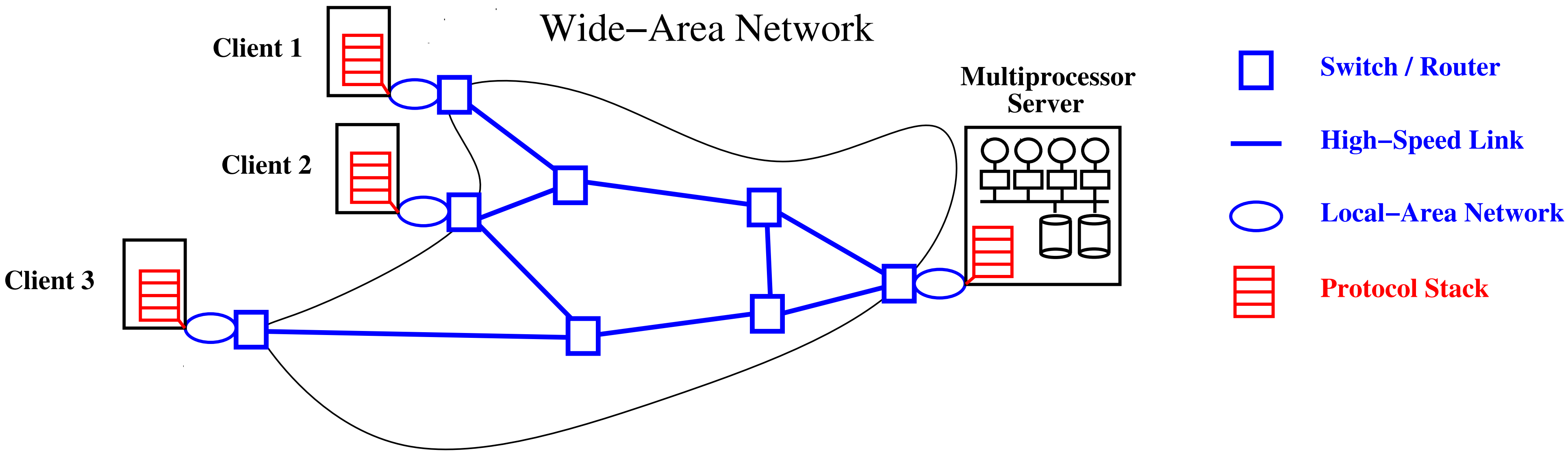
Implementation and Experiments

Packet-Level Parallelism

Connection-Level Parallelism

Summary

Motivation



Networked Information Servers

- World-Wide Web, Video, Image, File servers
- Large amounts of information

$\Rightarrow$ *Determine appropriate networking support for shared-memory multiprocessor servers*

Support for Secure Servers

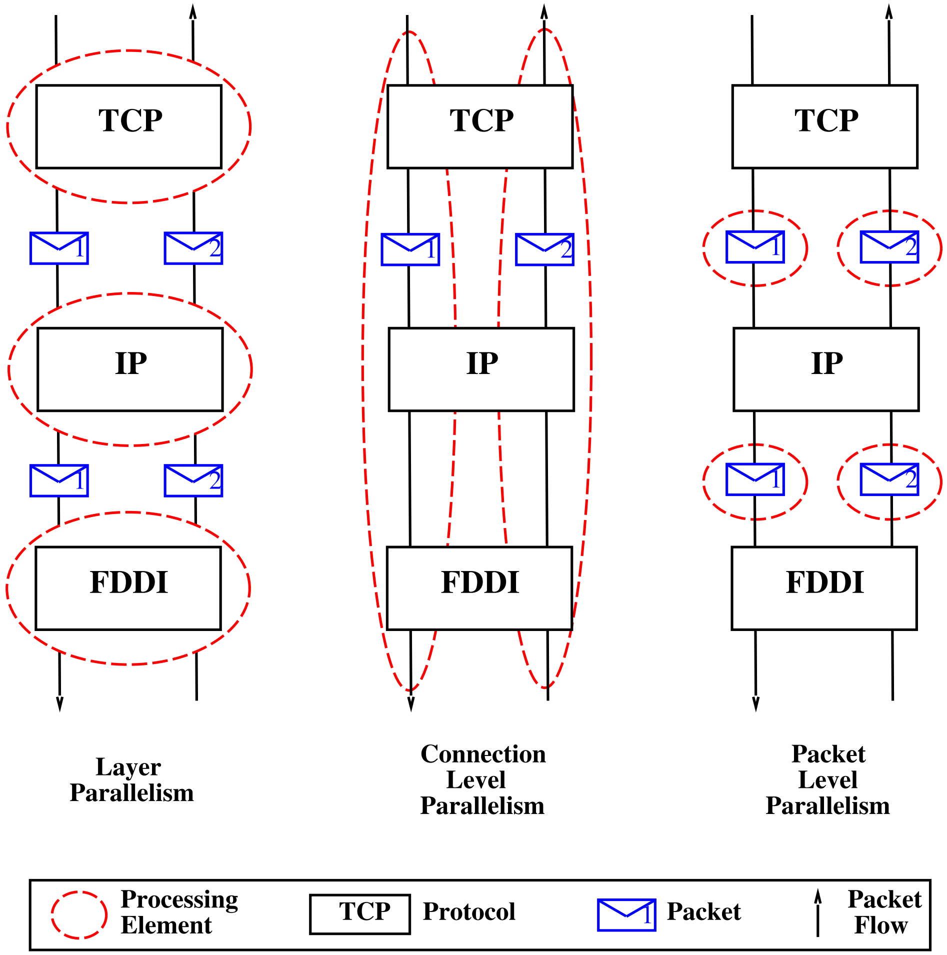
Security and privacy growing concerns

- Commerce on the Internet
- Multiple standards: secure IP, SHTTP, SSL

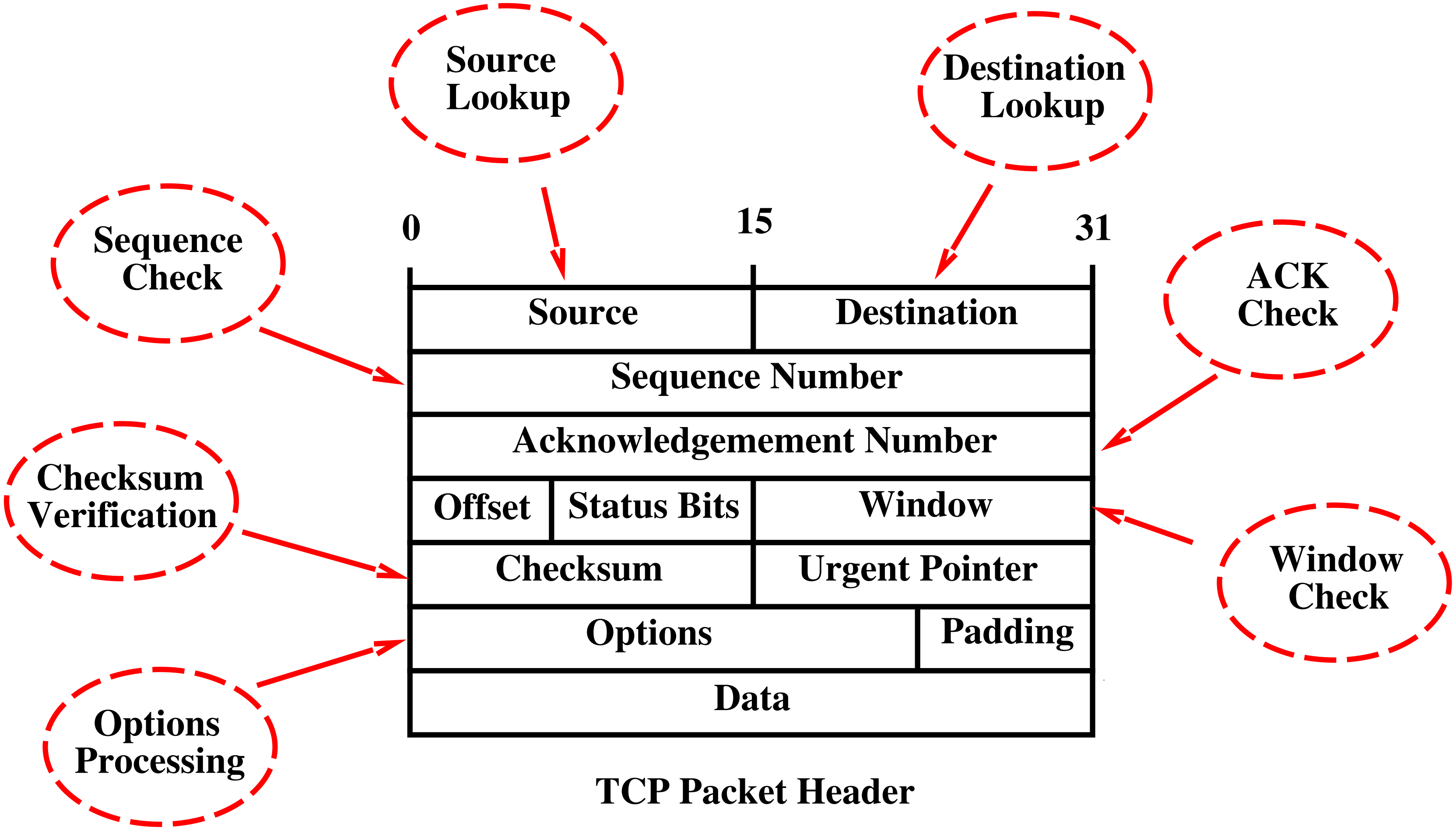
Crypto is slow, but still needs to be in software

- Multiple, evolving standards
- Multiple protocols in each standard
- Software cheaper, flexible
- Certain algorithms won't benefit from hardware

Exploiting Parallelism

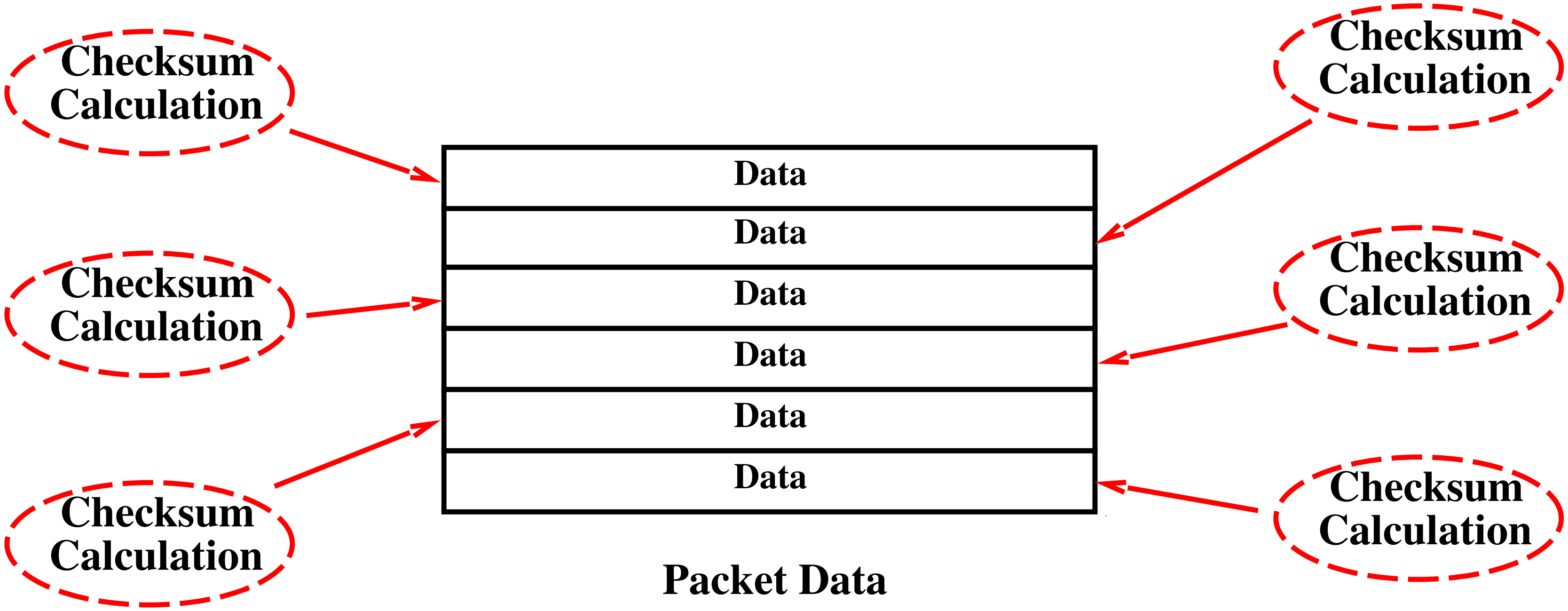


Functional Parallelism



TCP Packet Header

Data-Level Parallelism



Research Issues

What's the impact of cryptographic protocols?

What's the available parallelism?

- Packet-Level Parallelism (PLP)
- Connection-Level Parallelism (CLP)

Research Infrastructure

SGI Challenge multiprocessor (12 100 MHz R4400)

Parallelized x-kernels (PLP & CLP)

Parallelized Internet-based protocol stacks:

- TCP/IP
- TCP/MD5/IP
- DES/TCP/MD5/IP
- 3-DES/TCP/MD5/IP

In-memory drivers

Experimental Methodology

Throughput tests

Isolated machine

30 second runs, 30 second warmup

Avg. of 10 runs, 90 % conf. intervals

PLP: Single-connection tests

CLP: 12-connection tests

Packet-Level Parallelism (PLP)

Implementation:

- Access to data structures serialized via locks
- Threads contend for them

Advantages:

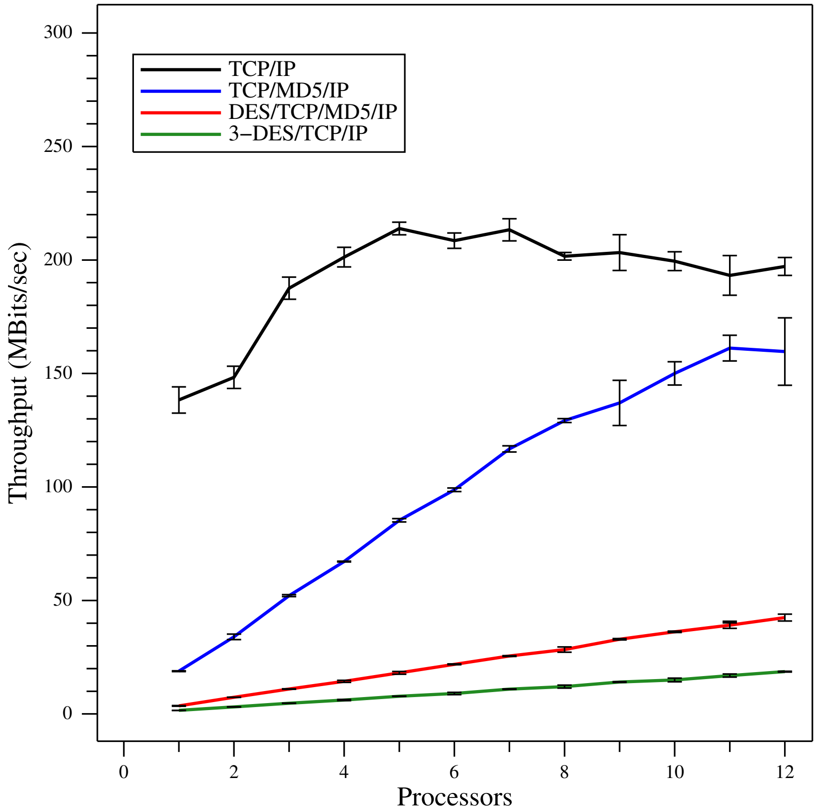
- No restrictions on packet processing
- Good available parallelism for UDP

Disadvantages:

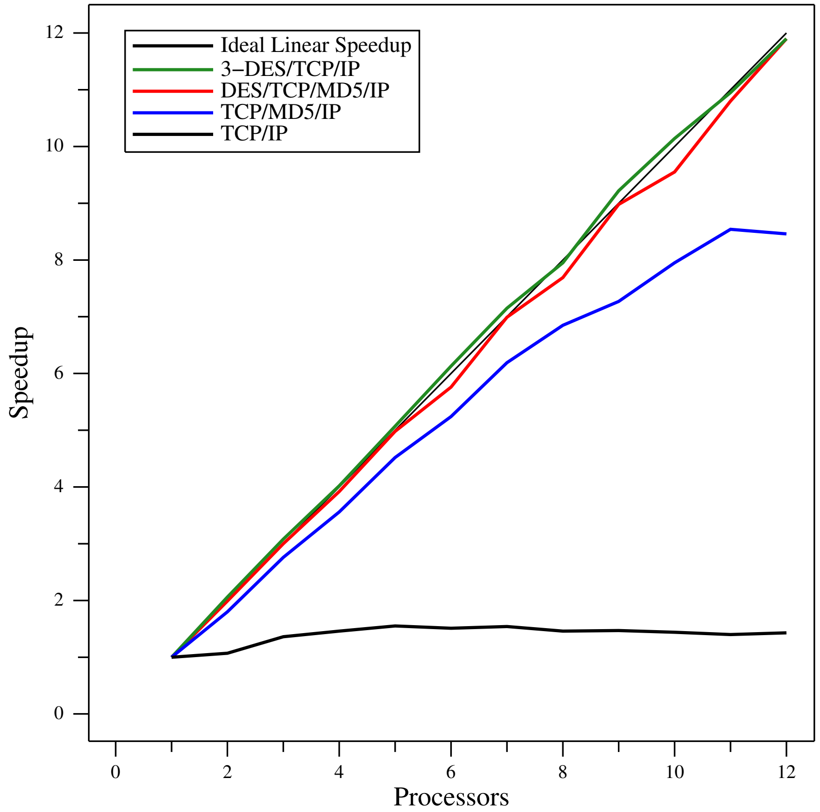
- Limited single-connection parallelism for TCP

PLP Results

Throughputs



Speedup



Much greater available parallelism

Why does speedup change?

Protocol Stack	Send Side	Inc. Cost	Recv Side	Inc. Cost
TCP/IP	236		189	
TCP/MD5/IP	1737	1500	1708	1519
DES/TCP/MD5/IP	8982	8746	9179	8990
3-DES/TCP/IP	21461	21225	21121	20932

Latency in usec.

Cryptographic processing happens outside scope of locks

Connection-Level Parallelism (CLP)

Implementation:

- Data structures replicated per-connection
- Demultiplexing done by packet filter

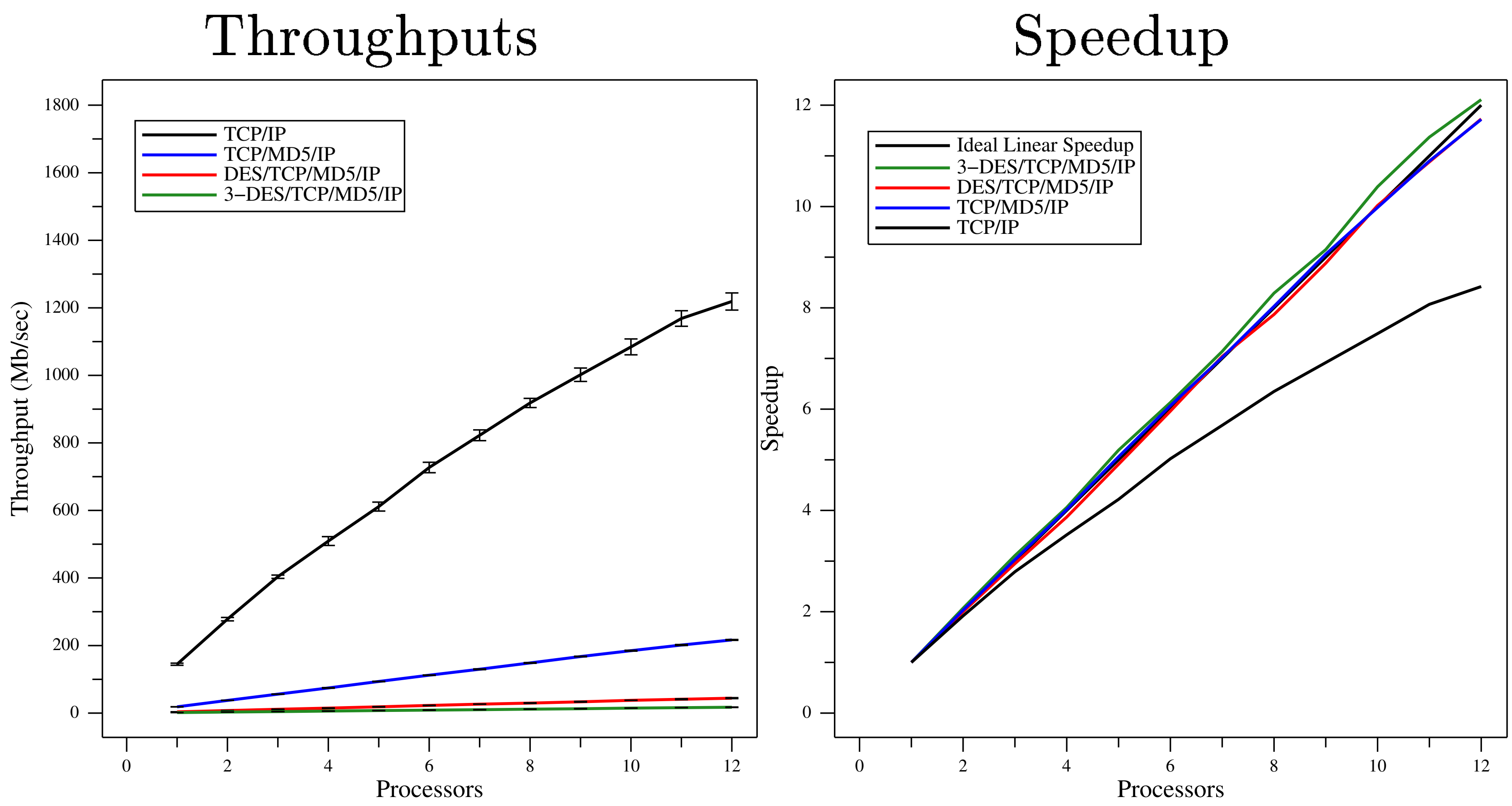
Advantages:

- Natural for large numbers of connections
- No synchronization on 'fast path'
- Good available parallelism for sufficient number of connections

Disadvantages:

- Traffic tends to be bursty

CLP Results



Greater available parallelism

Summary and Future Work

Results

- Parallelism is effective
- Available parallelism changes radically
- PLP exhibits linear speedup with DES
- CLP exhibits linear speedup with MD5

Future Work

- More fine-grained approaches to parallelism
- Connection setup and teardown