Performance of circuit switching in the Internet

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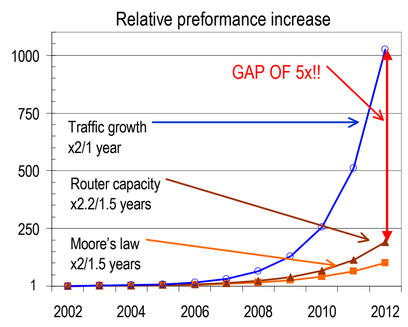
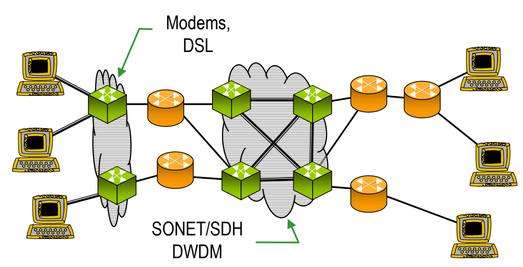
Recent interest in circuit switching



- Cost and complexity of five times as many central offices is prohibitive
- Optical circuit switching can close the gap

There is already a lot of circuit switching in the Internet



What end users care about

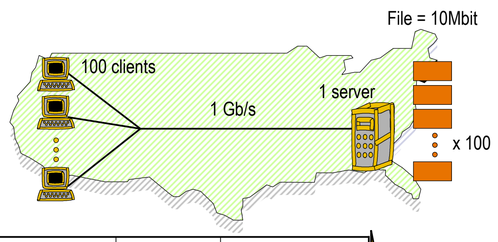
- **Very connection use of the Internet**
  - TCP: > 90% traffic

→ **Circuit switching fits well with this usage**

- **Download of information is most common application**
  - Web and P2P file sharing
  - Have to wait for download to complete

→ **<u>Response time</u> is a key performance metric**

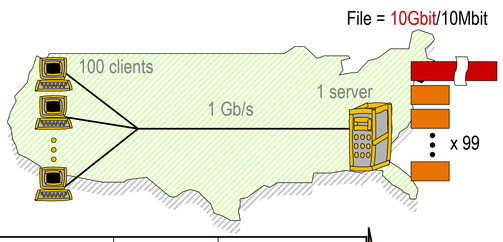
Response time of packets and circuits



	Circuit sw	Packet sw
Flow BW	1 Gb/s	10 Mb/s
Avg response time	0.505 s	1 s
Max response time	1 s	1 s

→ All but one of circuits finish earlier

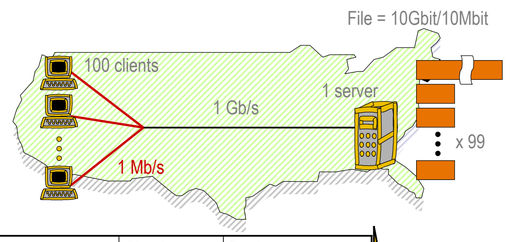
Response time when blocking occurs



	Circuit sw	Packet sw
Flow BW	1 Gb/s	10Mb/s→1Gb/s
Avg response time	10.495 s	1.099 sec
Max response time	10.990 s	10.990 sec

→ A big file can kill CS if it blocks the link

Response time with flow rate limits

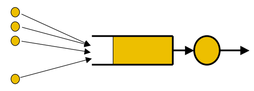


	Circuit sw	Packet sw
Flow BW	1 Mb/s	1 Mb/s
Avg response time	109.9s	109.9sec
Max response time	10,000 s	10,000 sec

→ No difference between CS and PS in core

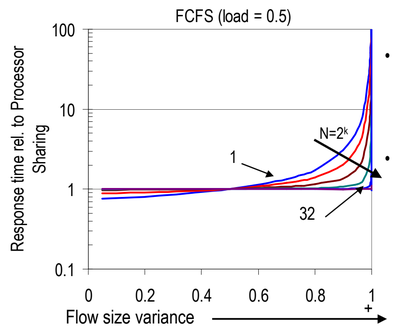
Analytical modeling

- **Fluid model:**



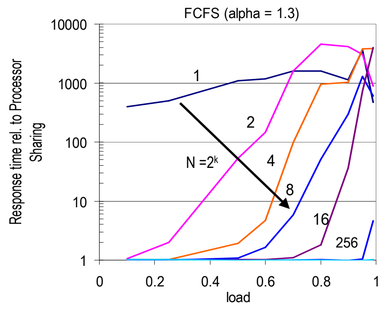
- **Many independent arrivals ⇒ Poisson**
- **Service policies:**
  - Packets: Processor Sharing
  - Circuits: FCFS
- **Service time distribution:**
  - Flow size variance: Bimodal $P(X=A)=p; P(X=B)=1-p$
  - Realistic flow size distribution: Pareto $f(x) \propto x^{-\alpha}$

M/Bimodal/N fluid model



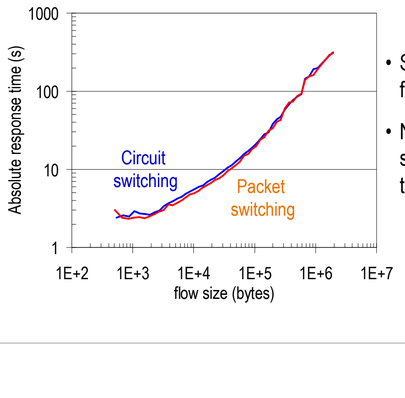
- Flow rate limited by BW ratio between core and access link (N)
- Same response time regardless of flow size variance, if N is large

M/Pareto/N fluid model



- Response time similar to IP if core/access ratio N is large
- Typically N >> 1,000

Users see little difference in response time



- Simulation of full networks
- N is large ⇒ same response time

Other performance criteria

Users
- Response time
- Service Level Agreement (QoS)

Carriers
- Cost: Bandwidth efficiency
- Reliability and stability
- Low complexity
- Traffic engineering

We would greatly benefit from more circuit switching in the backbone

Stanford University