Different types of efficiency in data networks

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Theses:

- backbone transport is a commodity, should be provided in an undifferentiated uniformly high quality
- any necessary quality and price differentiation should be provided at the edges
- intelligence continues to move to the edges
- costs, and therefore also revenue opportunities, continue to move to the edges
- lots of opportunities for optimization, but more limited than consensus has it, and often in unexpected places

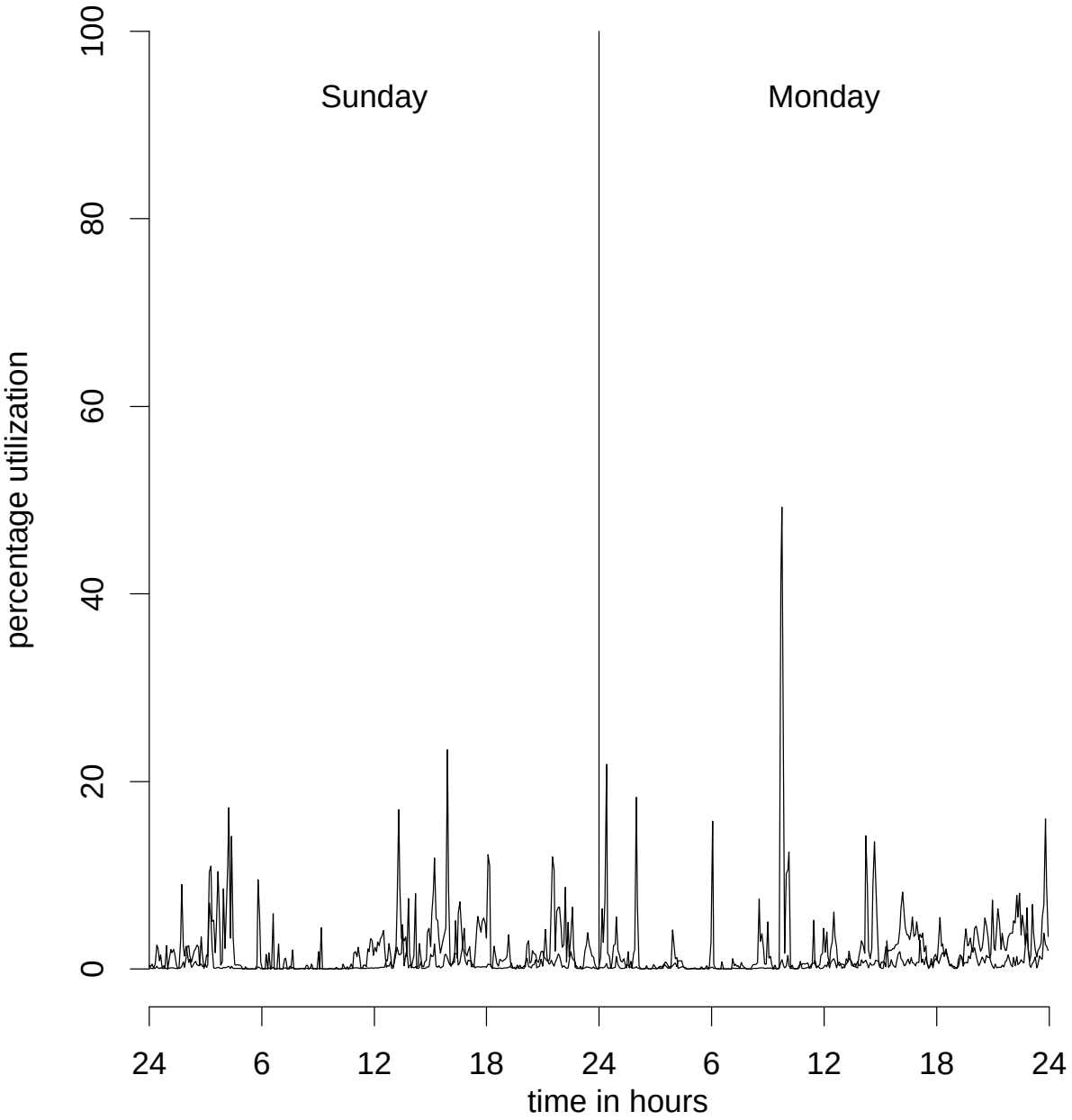
Current research agenda dominated to a harmful extent by preoccupation with engineering efficiency, trying to run network at high fractions of capacity

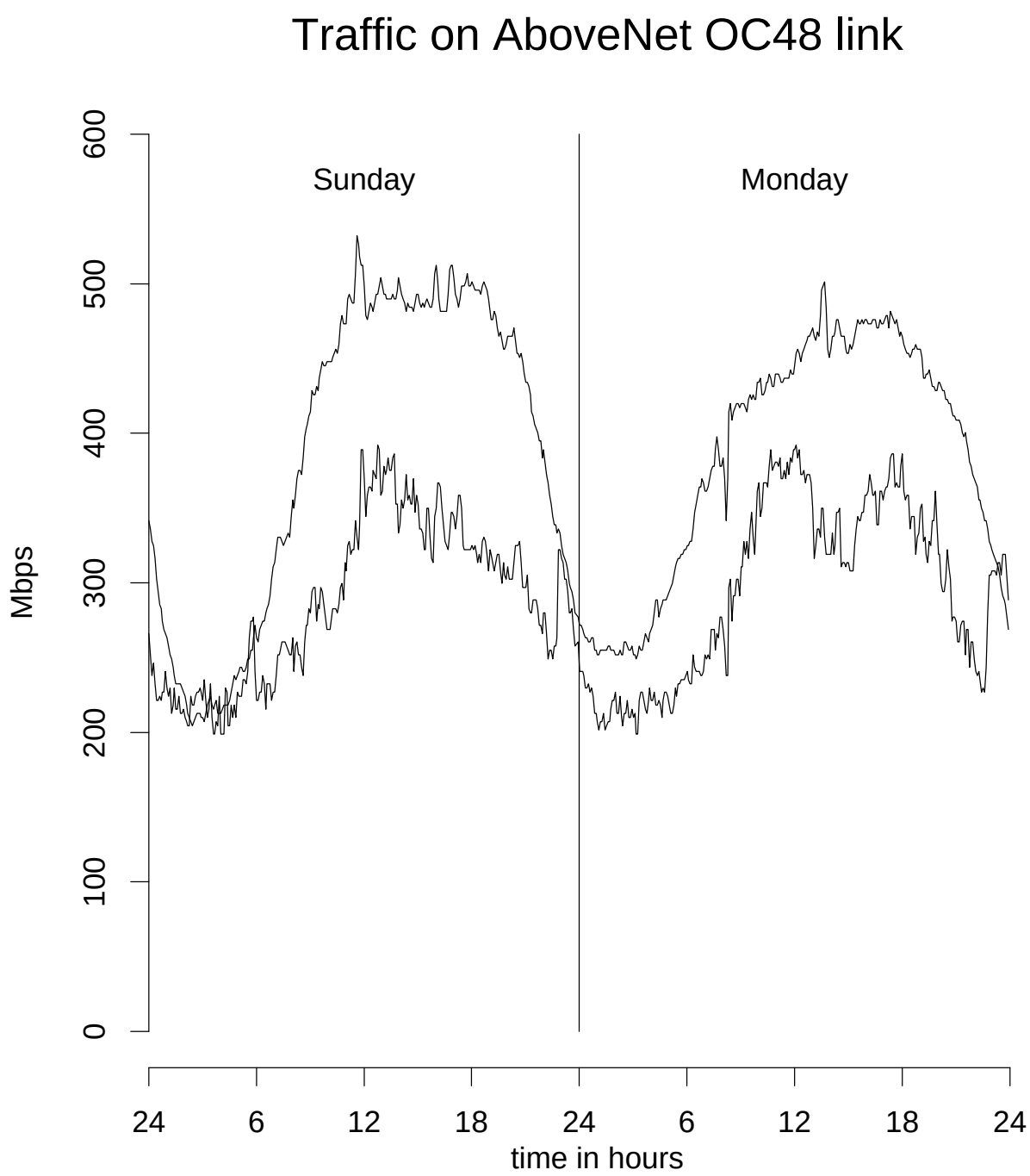
Should instead focus on economic efficiency, satisfying customer needs

Should also overcome the (often implicit) preoccupation with streaming multimedia

General lack of appreciation of some key facts about data networks:

- Access links are extremely lightly utilized, since their main purpose is to provide low transaction latency
- Even backbone links are lightly utilized, as a result of factors such as rapid growth of traffic, chunky nature of capacity, ...


Utilization of a T1 link to the Internet
Sunday
Monday
percentage utilization
0
20
40
60
80
100
24
6
12
18
24
6
12
18
24
time in hours


Traffic on AboveNet OC48 link
Sunday
Monday
Mbps
0
100
200
300
400
500
600
24
6
12
18
24
6
12
18
24
time in hours

Basic point:

If QoS and complicated service offerings are so great, why not try them out on LANs and campus networks?

Usual answer: because LANs are inexpensive

But LANs is where most of the costs are!

Example of cost structure:

Data for around 500 DSL subscibers at a major university, heavy peer-to-peer users: average data flow around 10 Kb/s per user

If provide 20 Kb/s per user (to allow for uneven usage), at current costs for commercial Internet access of about $100 per Mb/s per month, each DSL user will cost about $2/month for Internet connectivity

Numerous other arguments for simplicity:

- historical precedents
- imperative to increase usage
- ...

Most common causes of performance problems as well as outages in networks today:

In roughly the order

1. Network Engineers (What's this command do?)

2. Power failures (What's this switch do?)

3. Cable cuts (Backhoes, enough said)

4. Hardware failures (What's that smell?)

5. Congestion (More Bandwidth! Captain, I'm giving you all she's got!)

6. Attacks (malicious, you know who you are)

7. Software bugs (Your call is very important to us....)

Sean Donelan, NANOG list, July 2, 2001

Only problem no. 5 could be alleviated by QoS!

In spite of all the arguments in favor of simplicity, and the failures of IntServ, DiffServe, RSVP, ATM, QoS, to be adopted, there is continuing talk of the need for QoS, for differentiated quality levels, ...

Probable underlying reason: economic incentives to maximize revenues by exploiting differences in willingness to pay

Key factor: economic desirability of price discrimination:

Charlie: willing to prepare a report on digital cash for $1,500

Alice: willing to pay $700

Bob: willing to pay $1,000

Uniform pricing makes transaction impossible

Charging Alice $650 and Bob $950 makes everybody better off (in conventional economic model)

The theory of price discrimination was first developed by French “econoengineers” around the middle of the 19th century, in the process of understanding railroad pricing

The comparison of railroads in the 19th century to airlines and the Internet today offers rich insights into the future of pricing.

It is not because of the few thousand francs which would have to be spent to put a roof over the third-class carriages or to upholster the third-class seats that some company or other has open carriages with wooden benches. What the company is trying to do is to prevent the passengers who can pay the second class fare from traveling third class; it hits the poor, not because it wants to hurt them, but to frighten the rich. And it is again for the same reason that the companies, having proved almost cruel to the third-class passengers and mean to the second-class ones, become lavish in dealing with first-class passengers. Having refused the poor what is necessary, they give the rich what is superfluous.

Jules Dupuit, 1849

Airlines and railroads: different services or price discrimination?

There was some doubt a century ago, when privacy (transferable tickets) limited what railroads could do, but today, it is clear that price discrimination is the main driving force behind airline yield management:

Fares offered at www.continental.com on Feb. 27, 2002:

Minneapolis to Newark, NJ on Wed., March 20, returning Fri., March 22: $772.50

Minneapolis to Newark, NJ on Wed., March 20, returning Wed., March 27: $226.50

Newark, NJ to Minneapolis on Fri., March 22, returning Fri., March 27: $246.50

Many price discrimination practices associated with government regulation derived from profit-maximizing strategies of private companies.

The terms for leasing two telephones for social purposes, connecting a dwelling house with any other building, will be $20 a year; for business purposes $40 a year, payable semi-annually in advance, ...

Bell Telephone Association, 1877

Many annoying features of government regulation also descend from profit-maximizing strategies of private companies.

> “Cats is ’dogs’ and rabbits is ’dogs’ and so’s Parrats, but this ’ere ’Tortis’ is a insect, and there ain’t no charge for it.”
>
> ”Punch,” 1869

The price discrimination incentive is very strong, and goes counter to basic architectural principles of the Internet, such as the “end-to-end” principle.

The Internet can and (for the good of the economy) should avoid the more intrusive methods (such as charging according to value of bits), but only because there are several countervailing forces, and (a real heresy) because the Internet is not all that big a thing.

More details in papers at

www.dtc.umn.edu/∼odlyzko