Information and Communication Networks

SIEMENS

Measured HTTP Performance and Fun Factors

J. Charzinski, Siemens AG, Munich, Germany

ITC 2001 Salvador da Bahia, Brasil, Dec. 2001

Outline

SIEMENS

Outline

- Introduction
- Measurement Results
  - single items
  - multiple items and parallel connections
- Fun Factors

SIEMENS

Introduction

Introduction

Measurement Results
- Single Items
- Multiple Items

Fun Factors

- Network QoS determines usability of streaming applications
  ... and joy of use for elastic applications

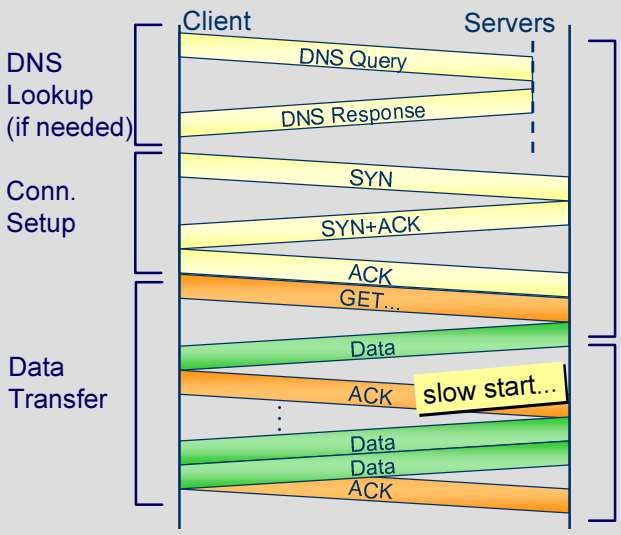
Why have QoS for elastic traffic?
- because commercial applications will require it
  - commercial information services
  - home / mobile shopping
  - home / mobile banking

QoS is not only important for continuous media!

- Our picture of the Internet is dominated by the QoS delivered with today's major services (elastic traffic)
  - Would you entrust your time critical applications to an Internet proving unreliable during "normal" operations like Web browsing?

SIEMENS

Introduction
Web Browsing



delay and rate components!

In addition:
- persistent connections
- request pipelining
- parallel connections

SIEMENS

Web Delay Components

Introduction

Measurement Results
- Single Items
- Multiple Items

Fun Factors

- DNS Latency
  - server delay, retries
- Network Delay
  - propagation, processing, queueing
- Server Reaction Times
  - SYN, GET, database lookups, page construction
- Client Reaction Times
  - reactions to DNS answer and TCP SYN
- Content Transmission Time
- Others (HTTP problems)
  - HTTP redirections, protocol mismatches (GET→RST)

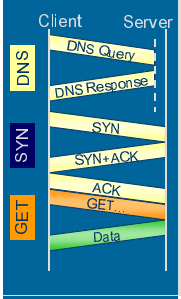
SIEMENS

Web Delay Components
Mean Shares during DNS - SYN - GET (one item)

Introduction

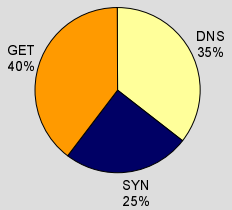
Measurement Results
- Single Items
- Multiple Items

Fun Factors

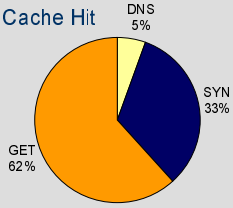


Habib/Abrams 2000

Cache Miss

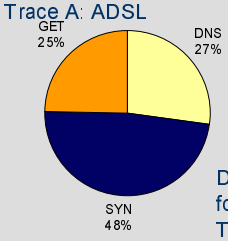


Cache Hit



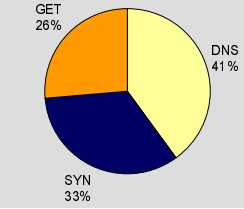
Charzinski 2001

Trace A: ADSL



DNS Lookup only for 11% of all TCP connections

Trace B: Modem/ISDN



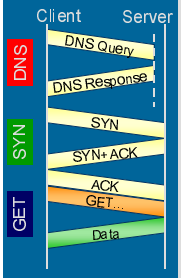
SIEMENS

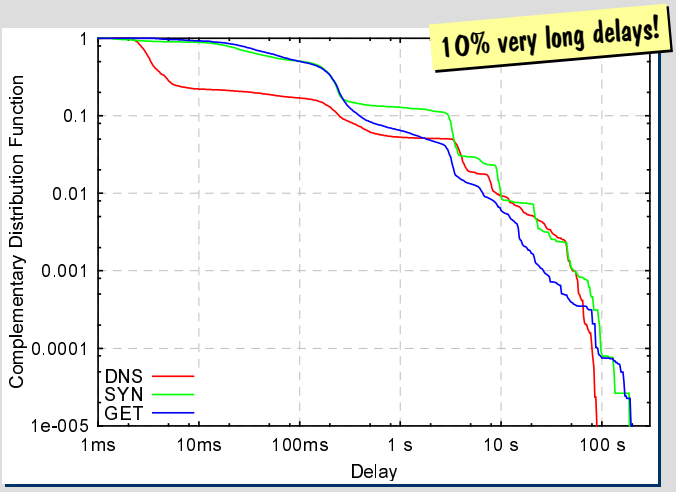
Web Delay Components
Delay distributions for DNS / SYN / GET (one item)

Introduction

Measurement Results
- Single Items
- Multiple Items

Fun Factors





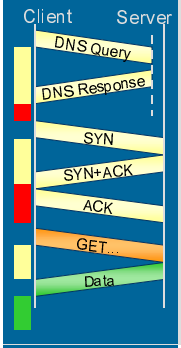
Data: ADSL Münster 1998 (Trace A)

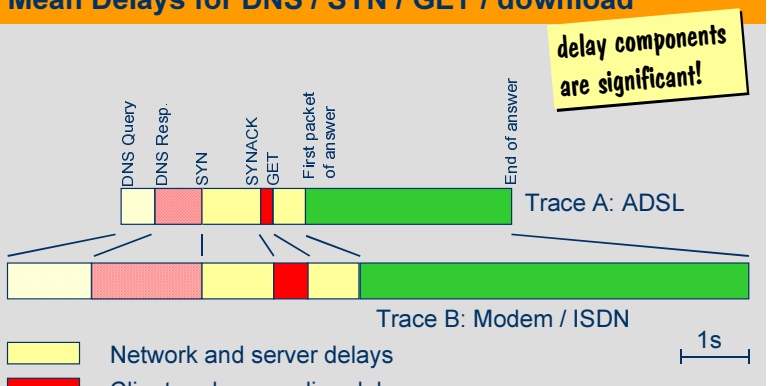
SIEMENS

Web Delay Components
Mean Delays for DNS / SYN / GET / download

Introduction

Measurement Results
- Single Items
- Multiple Items





- with DNS (11%): 44% sequential waiting
- without DNS: 28% sequential waiting

SIEMENS

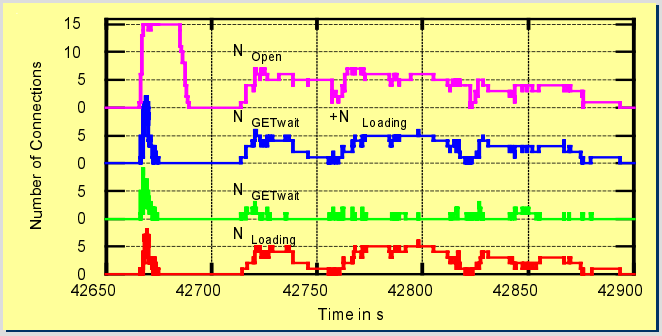
Parallel Connections

Introduction

Measurement Results
- Single Items
- Multiple Items

Fun Factors

- Excerpt from a trace for one client

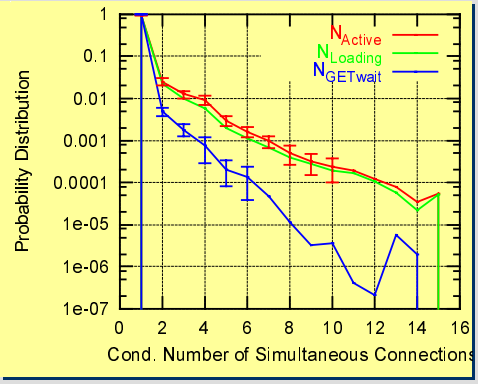


... most models assume one connection per user ...

SIEMENS

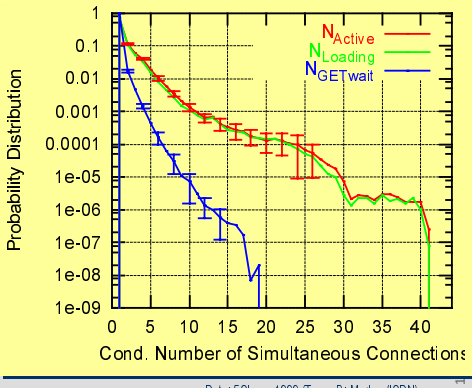
Parallel Connections

>40 loading connections per client observed!



Data: ADSL Münster 1998 (Trace A: ADSL)

$P\{N_{Active}>0\} = 17\%$
$P\{N_{Loading}>0\} = 15\%$
$P\{N_{GETwait}>0\} = 3.3\%$



Data: 5SL.org 1999 (Trace B: Modem/ISDN)

$P\{N_{Active}>0\} = 51\%$
$P\{N_{Loading}>0\} = 48\%$
$P\{N_{GETwait}>0\} = 11\%$

results depend on implementations:
- browser, server and TCP

SIEMENS

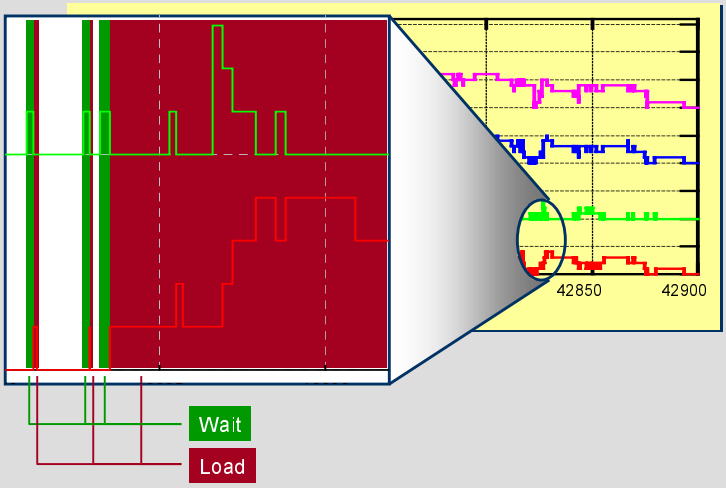
Parallel Connections

Introduction

Measurement Results
- Single Items
- Multiple Items

Fun Factors

- Excerpt from a trace for one client



SIEMENS

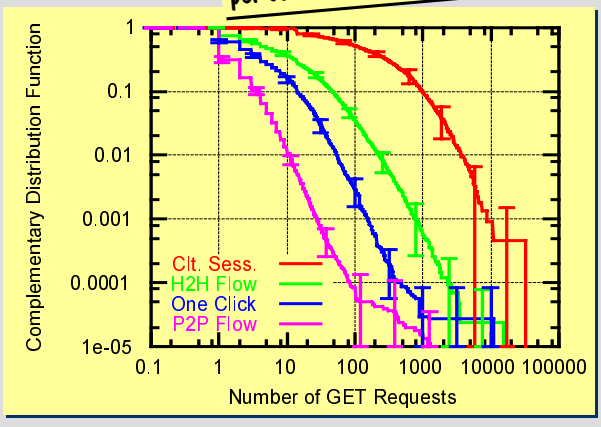
Number of Items

Introduction

Measurement Results
- Single Items
- Multiple Items

Fun Factors

heavy tailed distributions even in number of items per connection / Web page / server / session



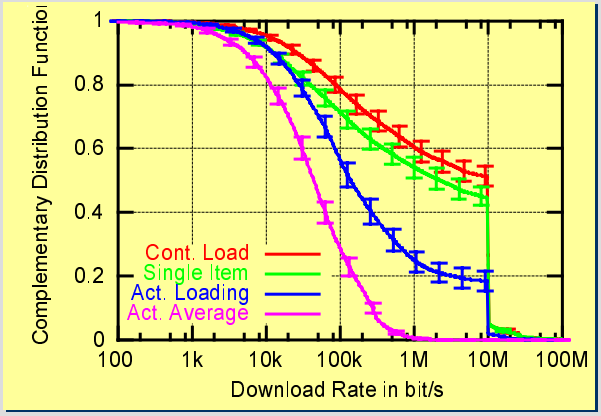
SIEMENS

Download Speed

Introduction

Measurement Results
- Single Items
- Multiple Items

Fun Factors



many single-packet transfers

high speeds reached even back in 1998

SIEMENS

Fun Factors

Introduction

Measurement Results
- Single Items
- Multiple Items

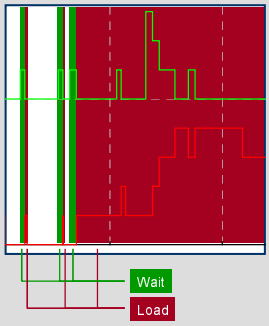
Fun Factors

- Capture the relevant performance measures for HTTP applications
- delay is relative to amount of data → consider rate
- on a scale of [0,1]
  - 0 = no fun at all
  - 1 = “ideal fun“
- components for different connection phases
  - waiting → delay based component
  - download → rate based component

SIEMENS

Fun Factors

- Observed sum of delays T_D
- Sum of loading times T_L
- Sum of element sizes B_L
- Observed Rate $R_L = B_L / T_L$



- evaluation relative to target values
  - (maximum allowed) delay d_t
  - (minimum expected) rate r_t

- "Classic" definition

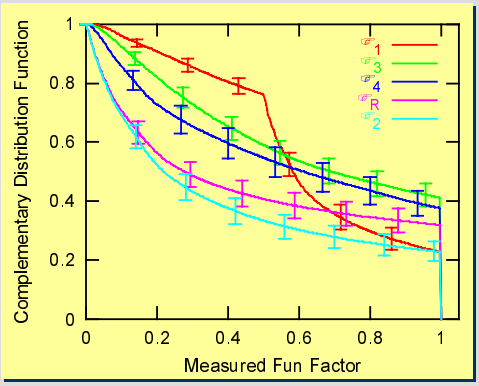
$$\Phi_R = \min\left[\frac{R_L}{r_t}, 1\right]$$

- weighted compensation

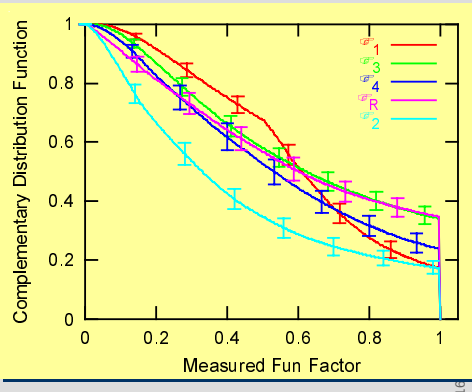
$$\Phi_4 = \min\left[\frac{d_t + B_L / r_t}{T_D + T_L}, 1\right]$$

SIEMENS

Fun Factors
Measurement Results



d_t = 0.5s P{T_D<d_t} = 62±2.5 %
r_t = 500kbit/s P{R_L>r_t} = 32±3 %



d_t = 0.5s P{T_D<d_t} = 61±1.8 %
r_t = 50kbit/s P{R_L>r_t} = 35±3 %

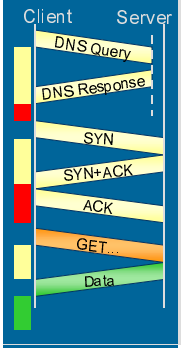
SIEMENS

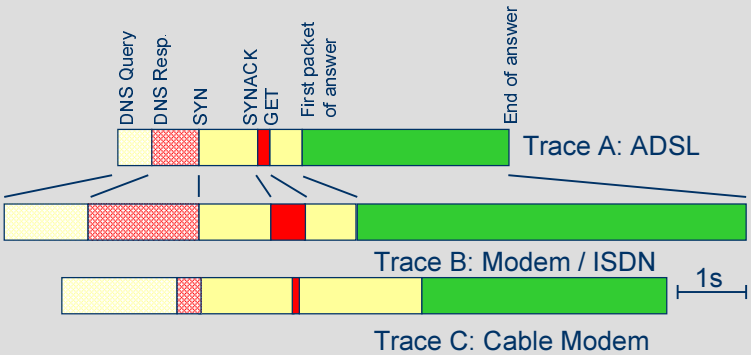
Salvador Special

New Measurement, 25000 packets
PII 300, Linux, Netscape
Bahia Othon, Salvador Dec. 4/5, 2001

SIEMENS

Web Delay Components
Mean Delays for DNS / SYN / GET / download





06.12.2001 page 18

Information and Communication Networks

Fun Factors
Measurement Results

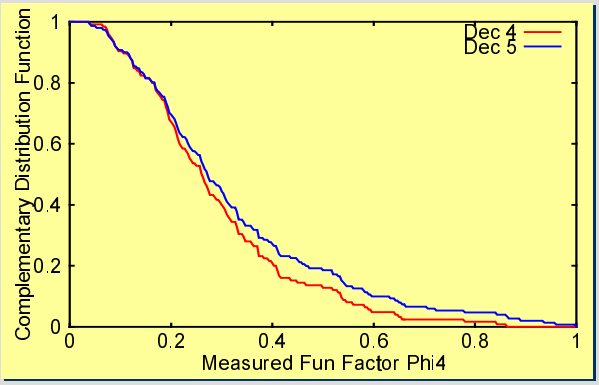
SIEMENS

Introduction

Measurement Results
- Single Items
- Multiple Items

Fun Factors

Salvador Special



d_i = 0.5s P{T_D<d_i} = 62±2.5 %

r_i = 100kbit/s P{R_L>r_i} = 32±3 %

Summary

SIEMENS

Introduction

Measurement Results
- Single Items
- Multiple Items

Fun Factors

Summary

- Heavy tails in sizes, durations, number of elements
  - even in idle times and client reactions
- parallel connections depend on browser software
- 30–40% of the loading times are pure serial delay
  - can hardly be reduced by increasing the line rate
- ~10% of all downloads experience exceptionally long delays
- fun factors combining delay and rate performance are available

SIEMENS

To Do

- Check Fun Factors in user experiments
  - determine useful target values for delay and rate
- Use TCP slow-start model for rate target
- Find simple models for parallel connections per user