WiBra Web Measurements

Binoy Chemmagate (UH)

Markus Isomaki (Nokia)

Markku Kojo (UH)

Agenda

- Introduction
  - ❑Motivation
  - ❑Objectives
- Issues - Browsing in Cellular Networks
  - ❑Radio Delays, DNS Delays, and Protocol Limitations
  - ❑HTTP and TCP
- Performance Measurement System
  - ❑Network Setup
  - ❑Websites and Statistics
- Results
  - ❑HTTP, SPDY, and TCP Results
- Conclusion and Future Work

Motivation

- Nowadays, mobile web browsing is gaining popularity. Recent surveys and studies show that, in 2010, 29.6% of Internet traffic is generated by mobile devices and there are 666 million mobile Internet users in the world as of 2009 [Cisco white paper].

- The QoS plays a major role in mobile web browsing. The QoS can be limited by many factors such as network, protocols, and the device itself.

- User experience can be made better in mobile web browsing by modifying or changing the existing infrastructure. Detailed study of the proposals currently made in real network settings was required, which was the motivation behind this work.

Objectives

- Analyze the current issues in mobile web browsing and evaluate proposed solutions.
- Conduct a comprehensive measurement study on QoS parameters in mobile web browsing such as Page Load Time(PLT).
- Analyze the SPDY protocol proposed by Google and compare SPDY to HTTP.
- Observe the advantages/disadvantages of higher TCP initial congestion window.
- To develop a simple and reliable measurement system for measuring the QoS parameters.

Issues – Browsing in Cellular Networks

Radio Delays : The time required to setup a high speed radio channel for data transfer.

DNS Delays : The time required to send and receive a DNS query/response.

Protocol Shortcomings

- IPv4 and IPv6 : The time for fall-back to IPv4 if IPv6 fails
- TCP Connections and Multiplexing : Efficient use and saving time in establishing new connections.
- SSL/TLS : Extra RTT and solutions like FalseStart and SnapStart.

HTTP and TCP

Header and Payload Compression

- According to Google statistics, average website size is 320KB on the wire/medium.

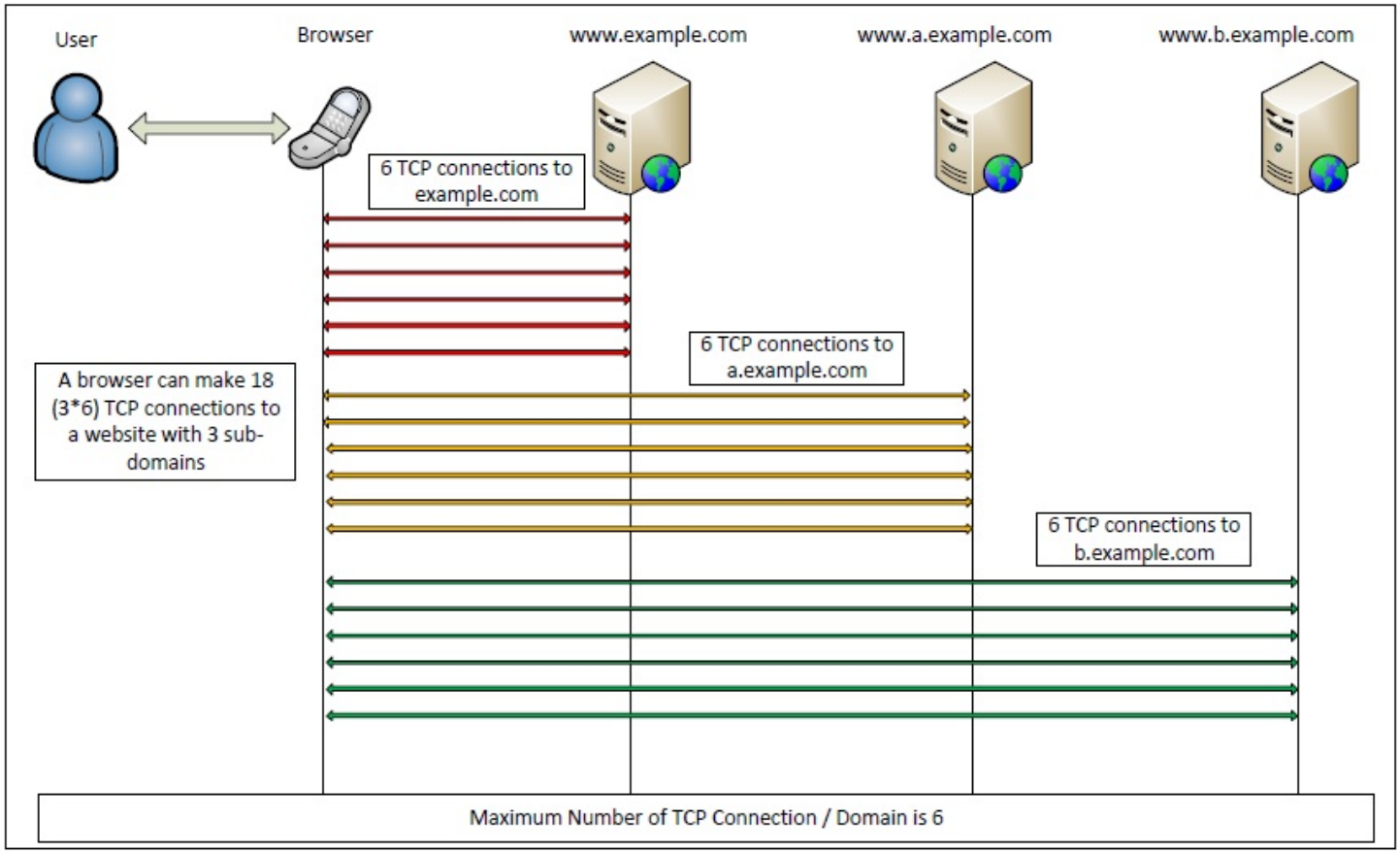
Pipelining and Multiplexing

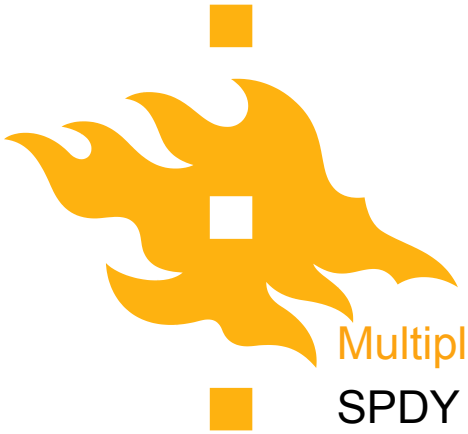
- The cost (time) of opening a new TCP connection can cause delay in high latency networks.

TCP initial congestion window (initcwnd)

- The most common value is 3 segments and there are discussions in IETF to increase the value to 10 segments.

TCP Connections in web browsing





SPDY Introduction

Multiplexed Streams:

SPDY uses fewer TCP connections per sub-domain. Data streams are multiplexed over this single TCP connection for efficient use of TCP connection. The data streams are tightly packed and make use of the existing TCP connection.

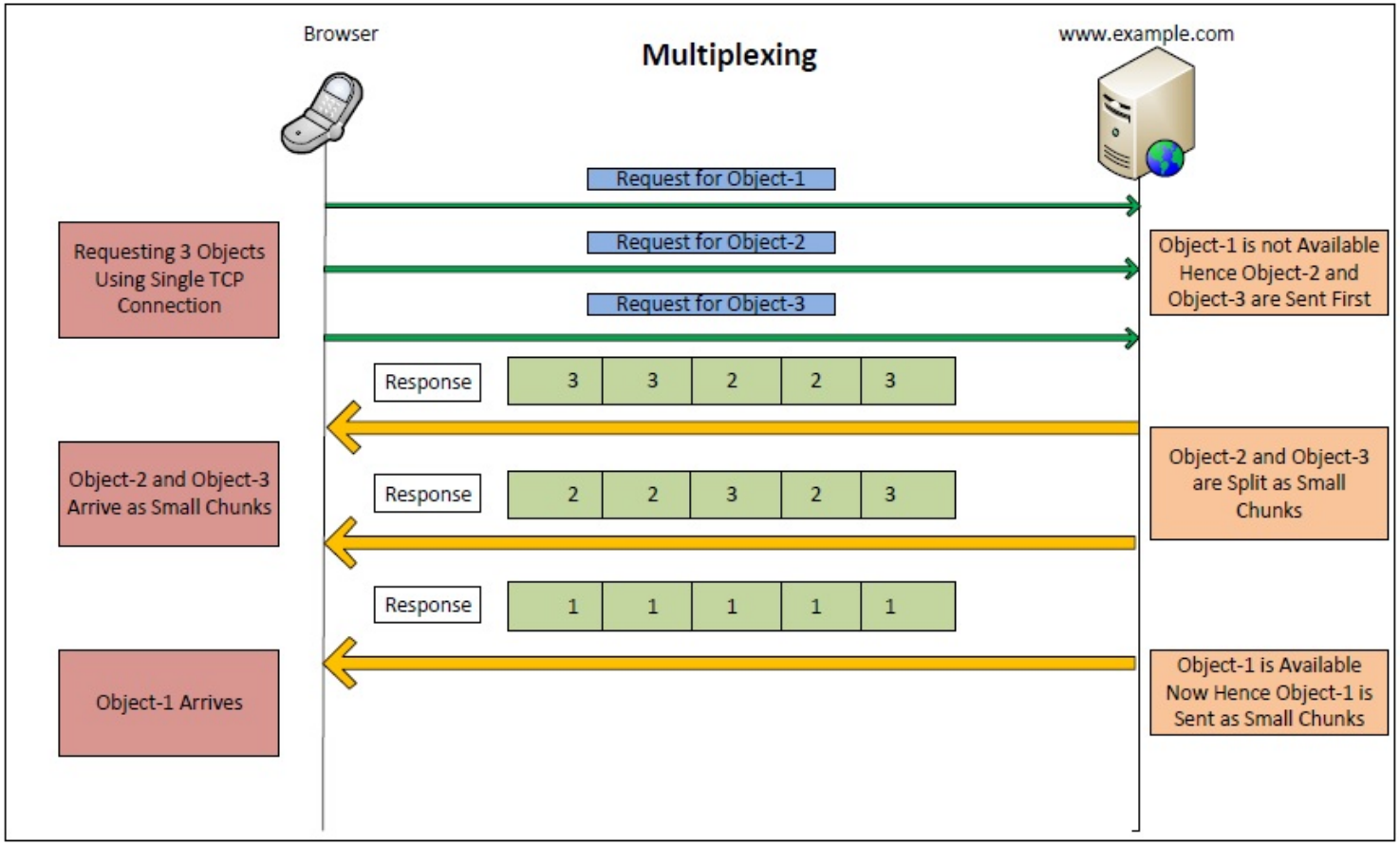
Request prioritization:

Client can set priority for the resources it needs from the server hence it can get the high priority resource faster than the low priority one's.

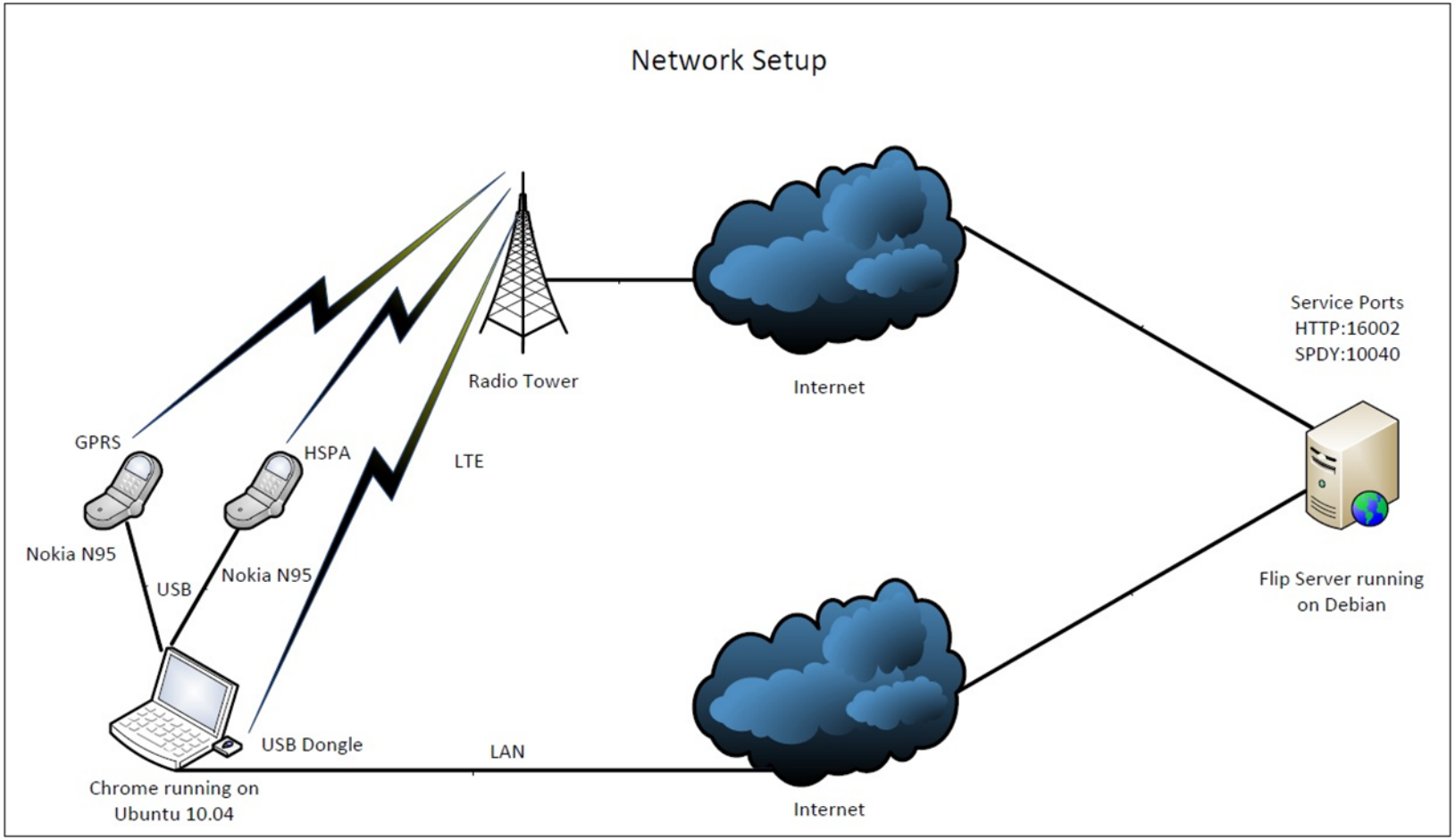
Header compression:

The client sends a lot of redundant header information. This information is exchanged every time client requests a new page, this data can be compressed and number bytes can be reduced by introducing header compression. Header compression can bring significant reduction in size of request and response headers.

Multiplexing in SPDY



Measurement System



Test cases

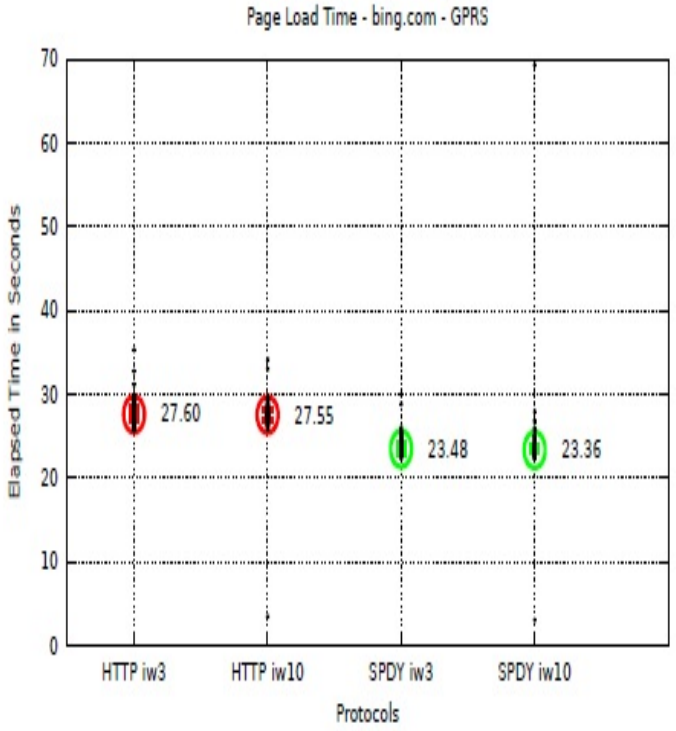
30 desired websites were chosen from Alexa.

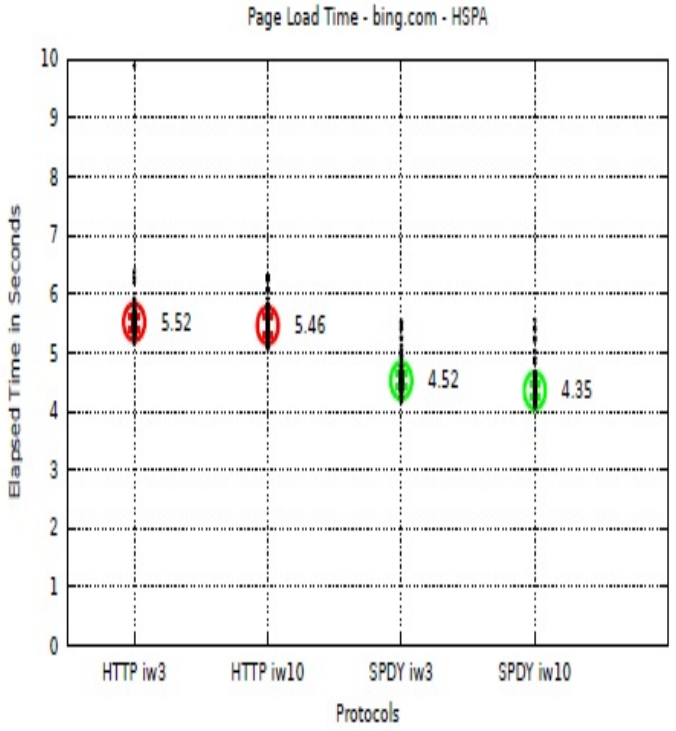
Test Cases			
Network	initcwnd	Protocol	Max. Parallel TCP connections
GPRS	3	HTTP	6 per domain
	3	SPDY	1 per domain
	10	HTTP	6 per domain
	10	SPDY	1 per domain
HSPA	3	HTTP	6 per domain
	3	SPDY	1 per domain
	10	HTTP	6 per domain
	10	SPDY	1 per domain
LTE	3	HTTP	6 per domain
	3	SPDY	1 per domain
	10	HTTP	6 per domain
	10	SPDY	1 per domain
LTE - 200 ms	3	HTTP	6 per domain
	3	SPDY	1 per domain
	10	HTTP	6 per domain
	10	SPDY	1 per domain

Webistes and Properties

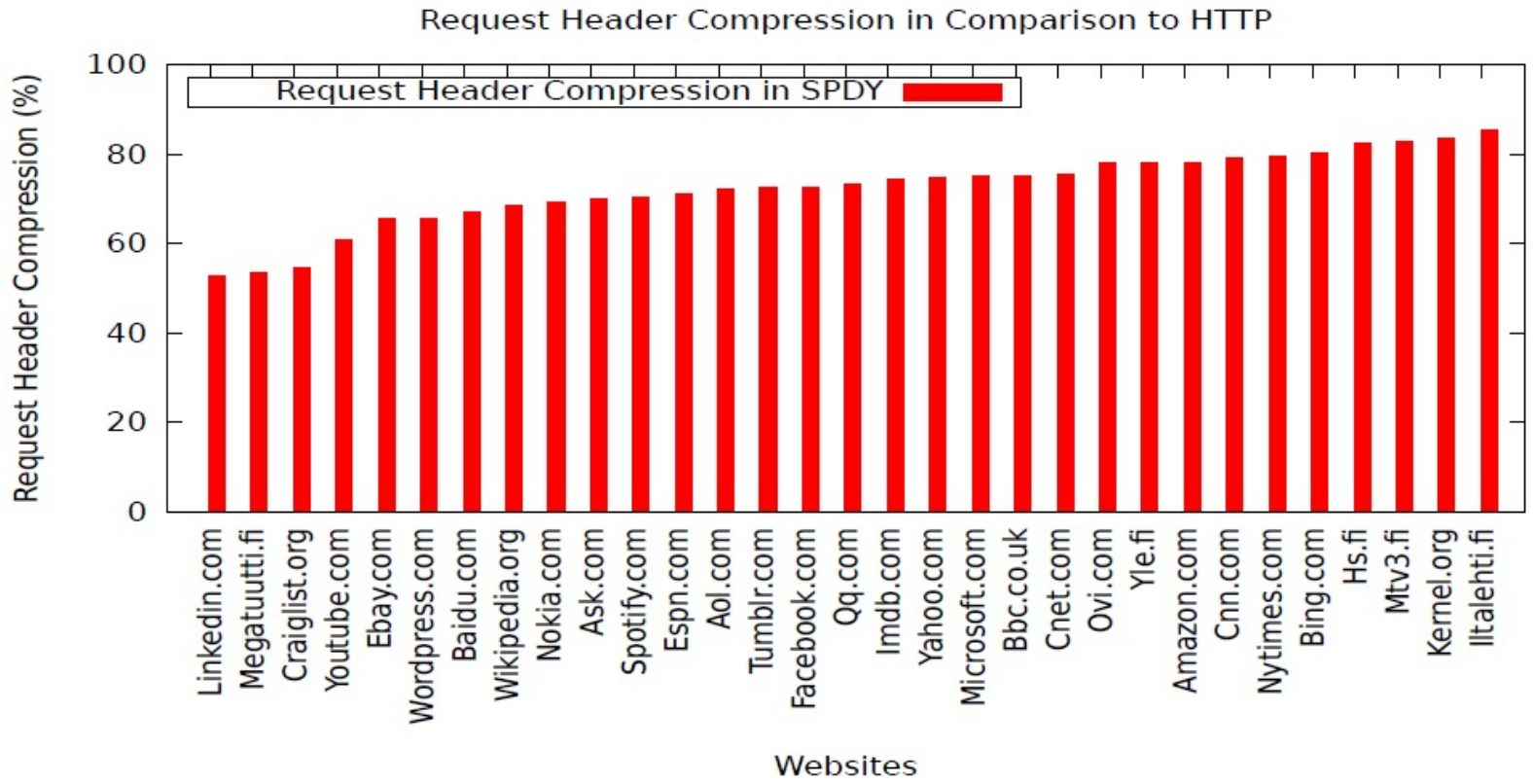
Website	Domains	Objects	Website	Domains	Objects
Baidu.com	2	7	Cnet.com	22	160
Bing.com	5	16	Microsoft.com	14	78
Amazon.com	8	82	Spotify.com	6	27
Craiglist.org	4	8	Nytimes.com	20	140
Ebay.com	12	38	Qq.com	16	86
Facebook.com	3	15	Iltalehti.fi	8	204
Imdb.com	13	82	Hs.fi	20	226
Kernel.org	1	15	Yle.fi	7	64
Linkedin.com	7	15	Mtv3.fi	8	120
Megatuutti.fi	1	2	Aol.com	15	75
Ovi.com	4	39	Cnn.com	12	125
Wikipedia.org	5	16	Espn.com	18	88
Wordpress.com	13	48	Tumblr.com	4	21
Yahoo.com	8	54	Bbc.co.uk	11	65
Youtube.com	8	22	Ask.com	10	34

Test Case of Bing.com

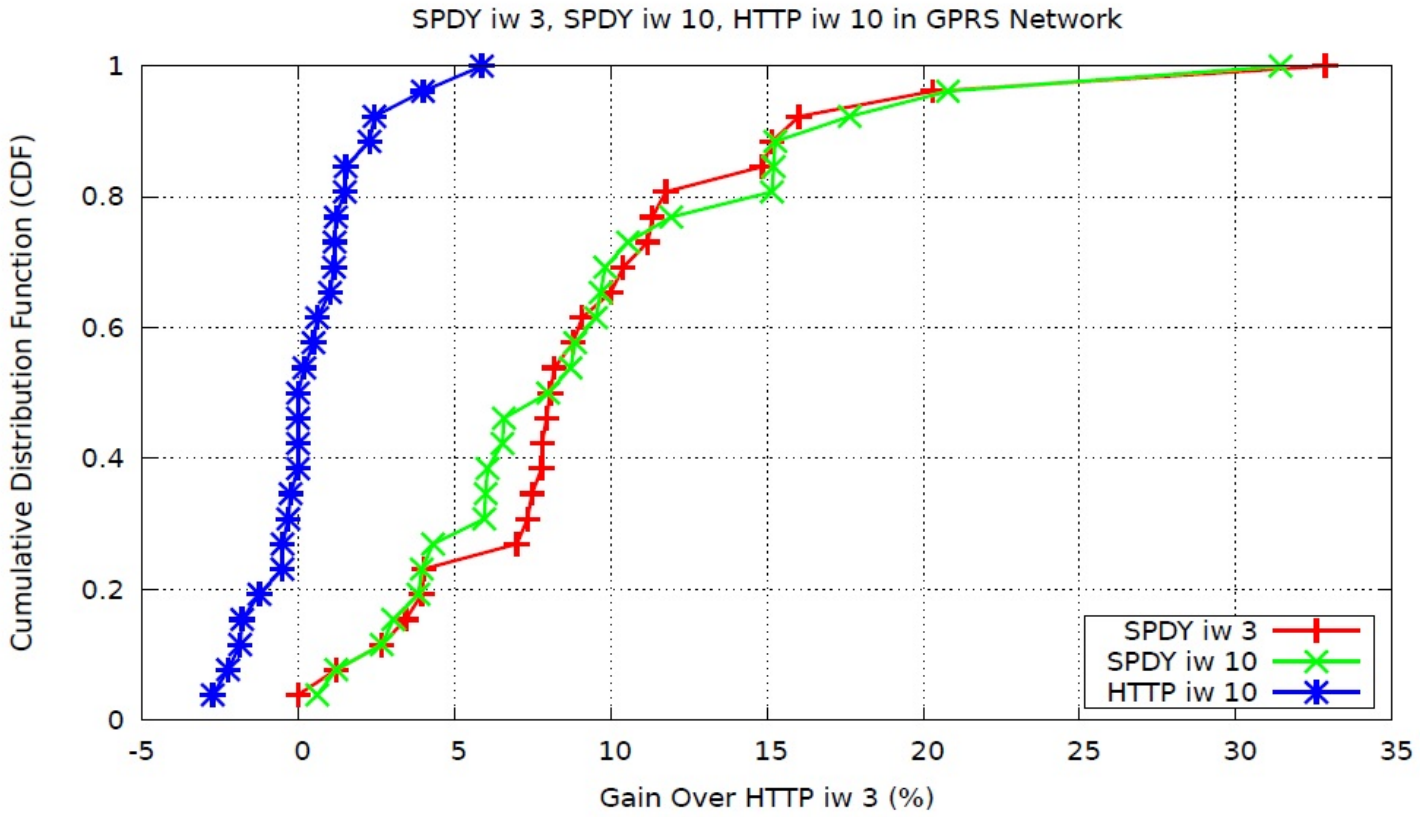




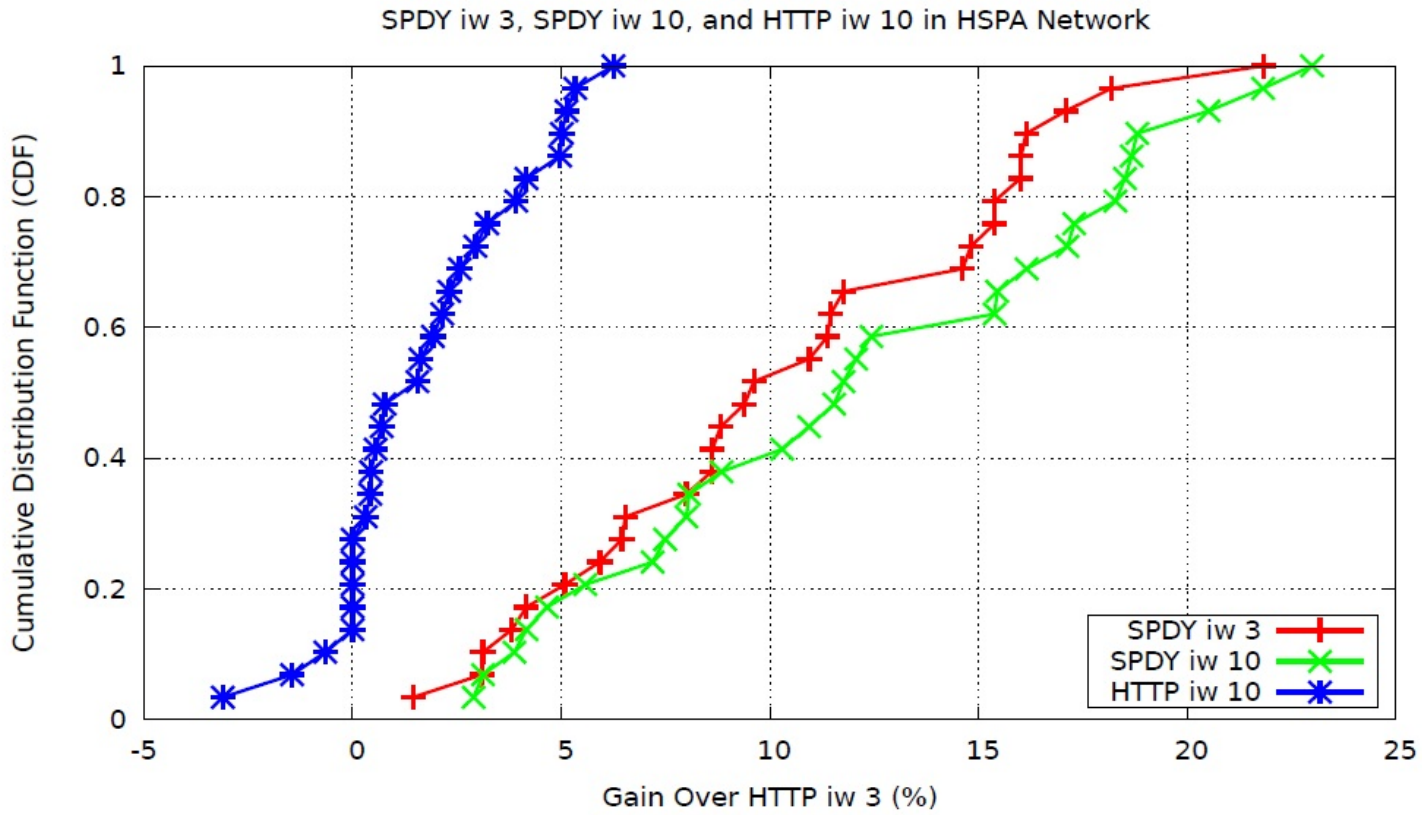
Request Header Compression



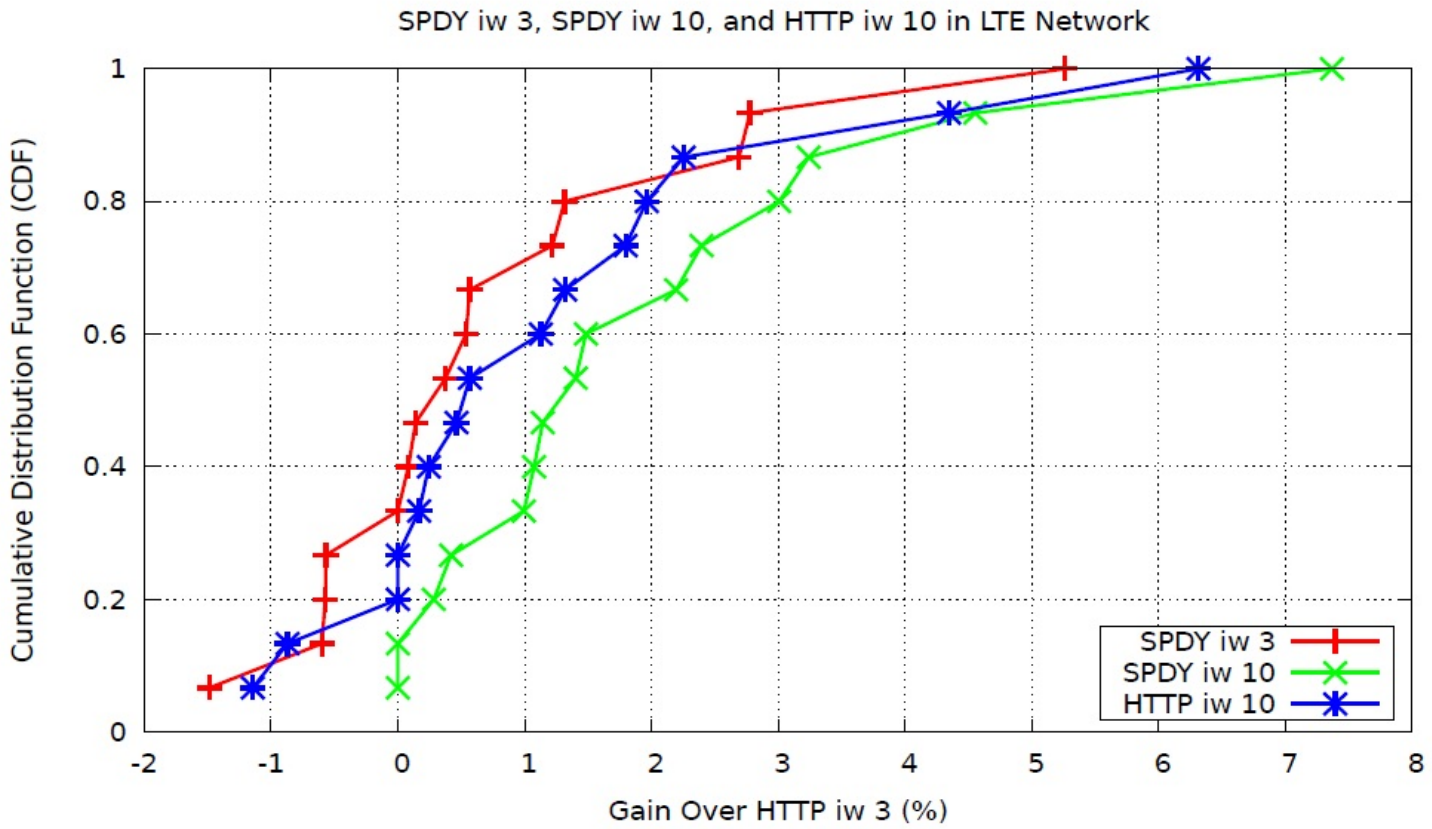
SPDY over GPRS network



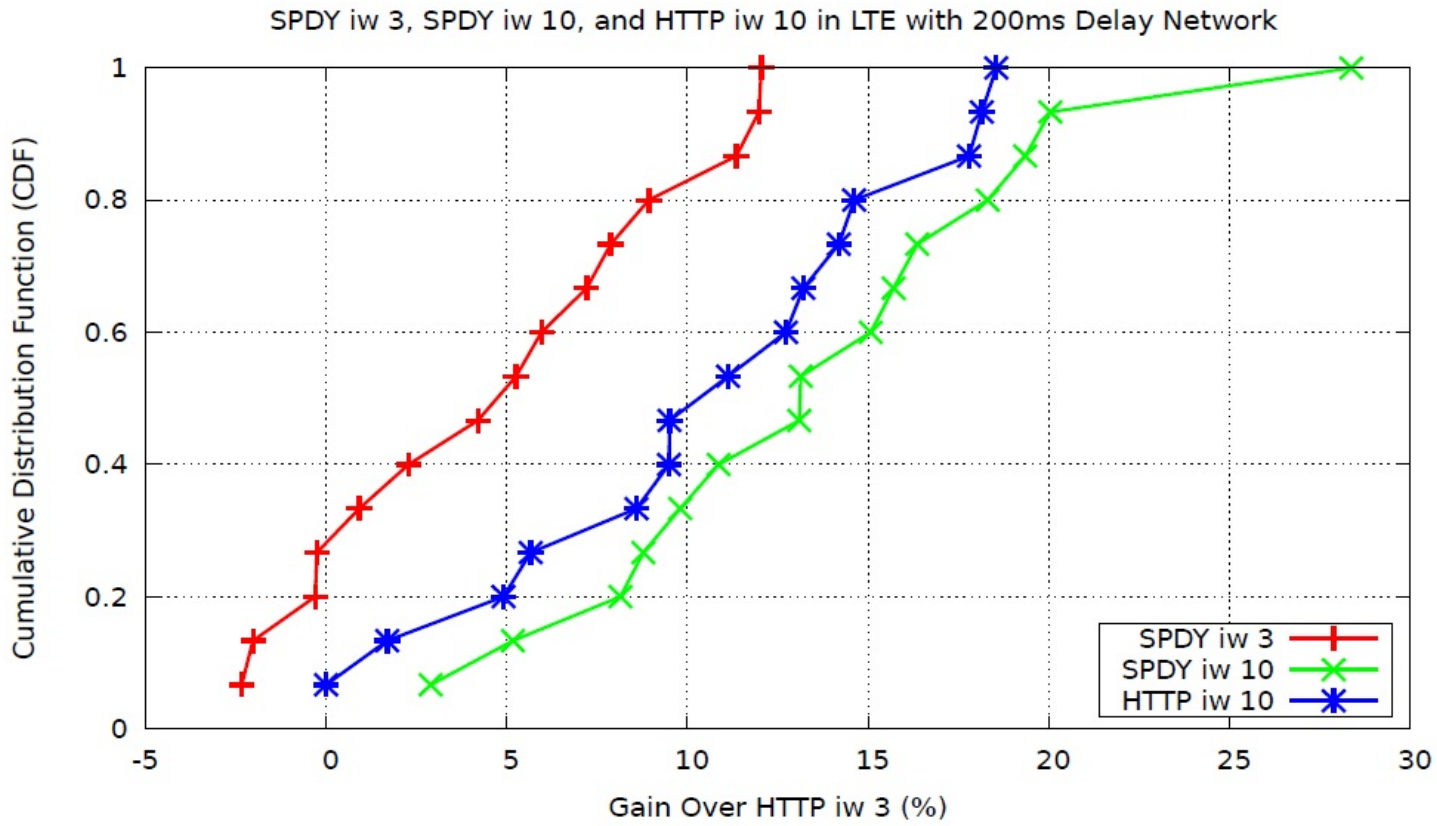
SPDY over HSPA network



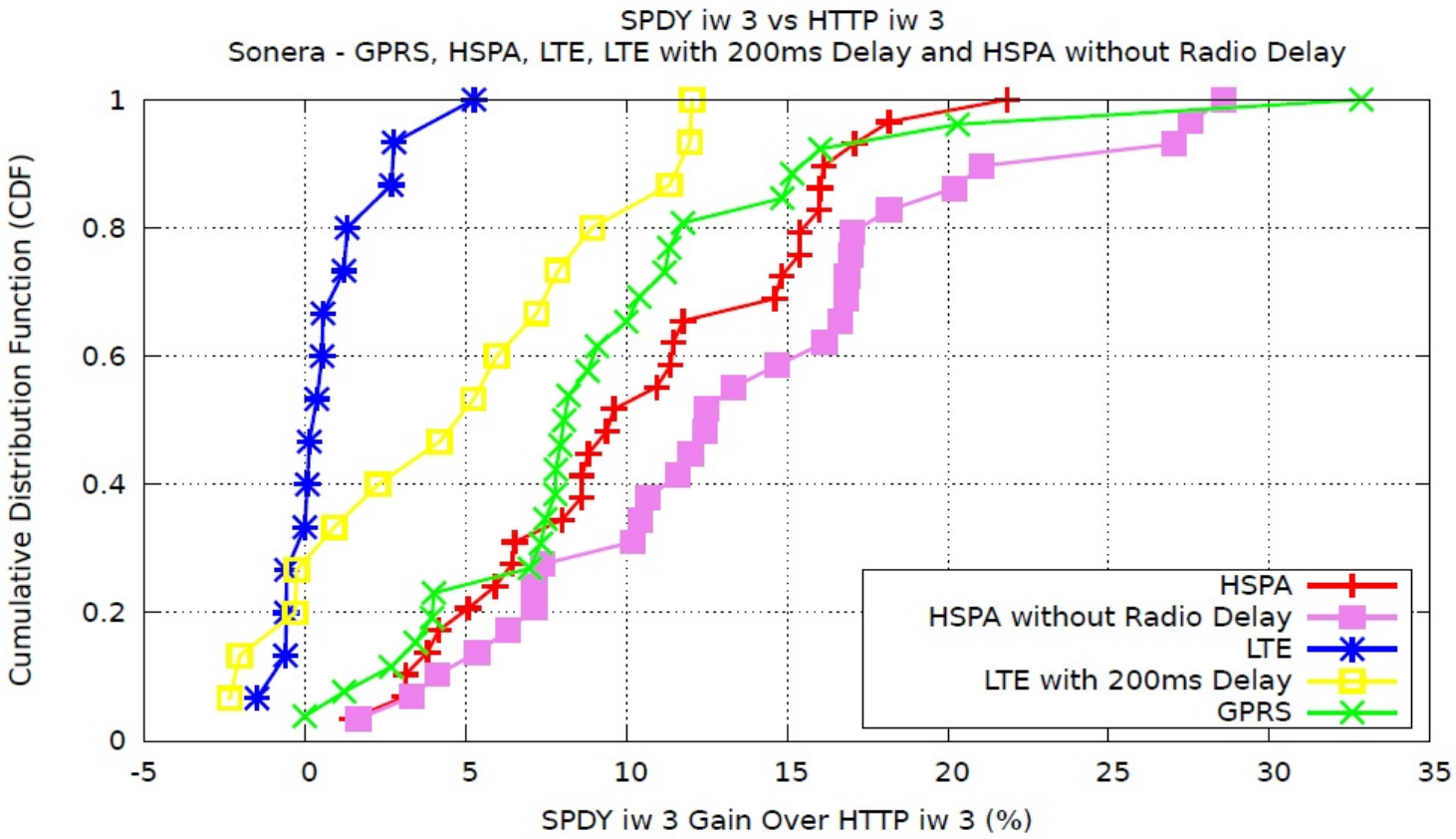
SPDY over LTE network (prelims)

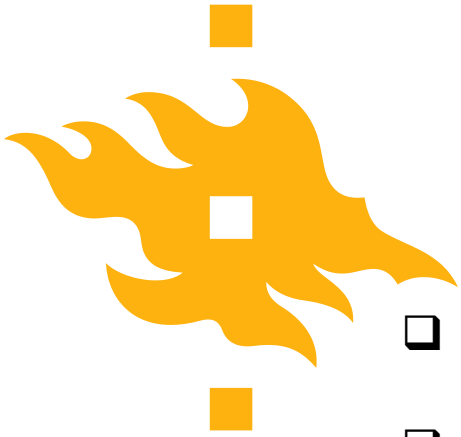


SPDY over LTE (200ms) network (prelims)



Summary of Results





Conclusion

- Radio state transitions causes delay in mobile web browsing, especially in HSPA network.
- In GPRS network, we see an average gain ranging from 0 % to 33 % using SPDY protocol.
- In HSPA network, we see an average gain ranging from 1 % to 35 % using SPDY protocol.
- In LTE network, there is no considerable gain/loss in using SPDY protocol.
- In LTE network with 200ms delay, the TCP initial window of 10 shows average gain ranging from 0% to 19 % in HTTP and 1 % to 23 % in SPDY.
- When network latency is high and bandwidth is high SPDY works efficiently as multiplexing helps.
- In all of the tests, except for LTE with 200 ms delay, there is no significant effect of higher TCP initial congestion window.

Future Work

Future Work

- Using SSL/TLS enabled SPDY and testing the wesbite PLT
  - Security is essential in future.
- Running other applications on SPDY
  - The services running on HTTP, E-mails, App updates, M2M communication
- New set of experiments on WLAN and LTE.
  - Check how SPDY behaves in WLAN and LTE in detail.

Practical examples

- Google services on https are already running SPDY.
- Silk browser of Amazon kindle has adopted SPDY features.

Thanks

binoy.chemmagate@cs.helsinki.fi