Experiential Learning of Networks (Past, Present and Future)

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Resources

- https://acc.digital/experiential-learning/
- https://www.rprustagi.com/ELNT/Experiential-Learning.html
- https://github.com/rprustagi
- RFCs and protocol standards
- https://tools.ietf.org/html/rfc2616

Experiential Learning of Networks

- Evolution
- Network models and Topologies
- Multiple network stacks
- Tools: Diagnose and debugging, Performance
- Present state of network
- Cloud networking
- Data Center networking
- Future networks
- Summary

NETWORK

Acronym

- **N**ovel
- **E**xperience of
- **T**heoretical,
- **W**orking,
- **O**perational, and
- **R**ealized
- **K**nowledge

Story of work

- Story of team of four people
  - *Everybody*, *Anybody*, *Somebody*, *Nobody*
- An important work was to be done
  - Team was asked to do it
  - **Everybody** thought **somebody** would do it
  - **Anybody** could have done it
  - **Nobody** did it

Story of work

- Result
  - **Somebody** got angry as it was **everybody**'s job
  - **Everybody** knew that **anybody** could do it
  - **Nobody** realized that **somebody** wouldn't do it
- Summary
  - Job was not done
  - **Everybody** blamed **somebody**
  - **Nobody** did what **anybody** could have done

Corollary: Story of Right Time

- Four types of day
  - Every day, Any day, Some day, No day
- What we wish
  - I dream **everyday**
  - I will prepare **anyday**
  - I will work hard **no day**
  - I will be offered a job **someday**

Corollary: Story of Right Time

- To fulfill your wish
  - **Everyday** is learning day
  - **No day** is holiday
  - **Any day** to start is today
  - **Some day** will be fruitful day
- Summary/conclusion
  - **Start today**
    - To reach your goals

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Internet Generation

- Internet 1.0
  - 1970-1990
  - Single ownership, complete trust, simple routing
- Internet 2.0
  - 1990-2010
  - Multiple ownership
  - policy based routing
- Internet 3.0
  - 2010 onwards
  - content by users, host ownership
  - mobility, clouds, services

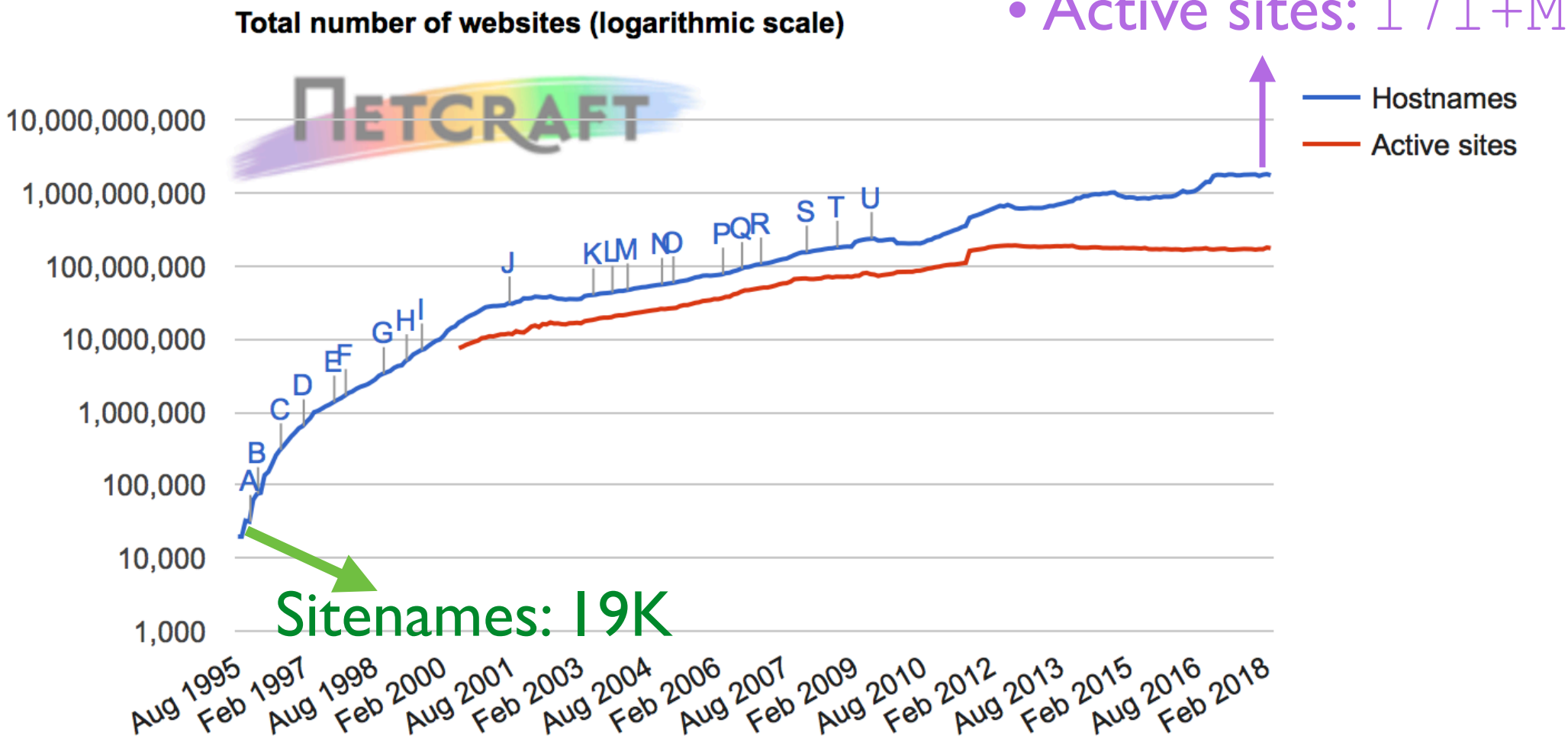
Src: Prof Raj Jain, WUSTL, http://www.cse.wustl.edu/~jain

Web 2.0

- Web 1.0
  - Mostly the web contents generated before year 2000
  - Web content within the browser
  - Content generated for user not by user
  - No user inputs on web content
- Web 2.0
  - Loose definition
    - Social networking /interaction, collaboration
    - Tagging, blogging
    - AJAX
    - Rich Media
- Web 3.0 ??
  - Semantic web

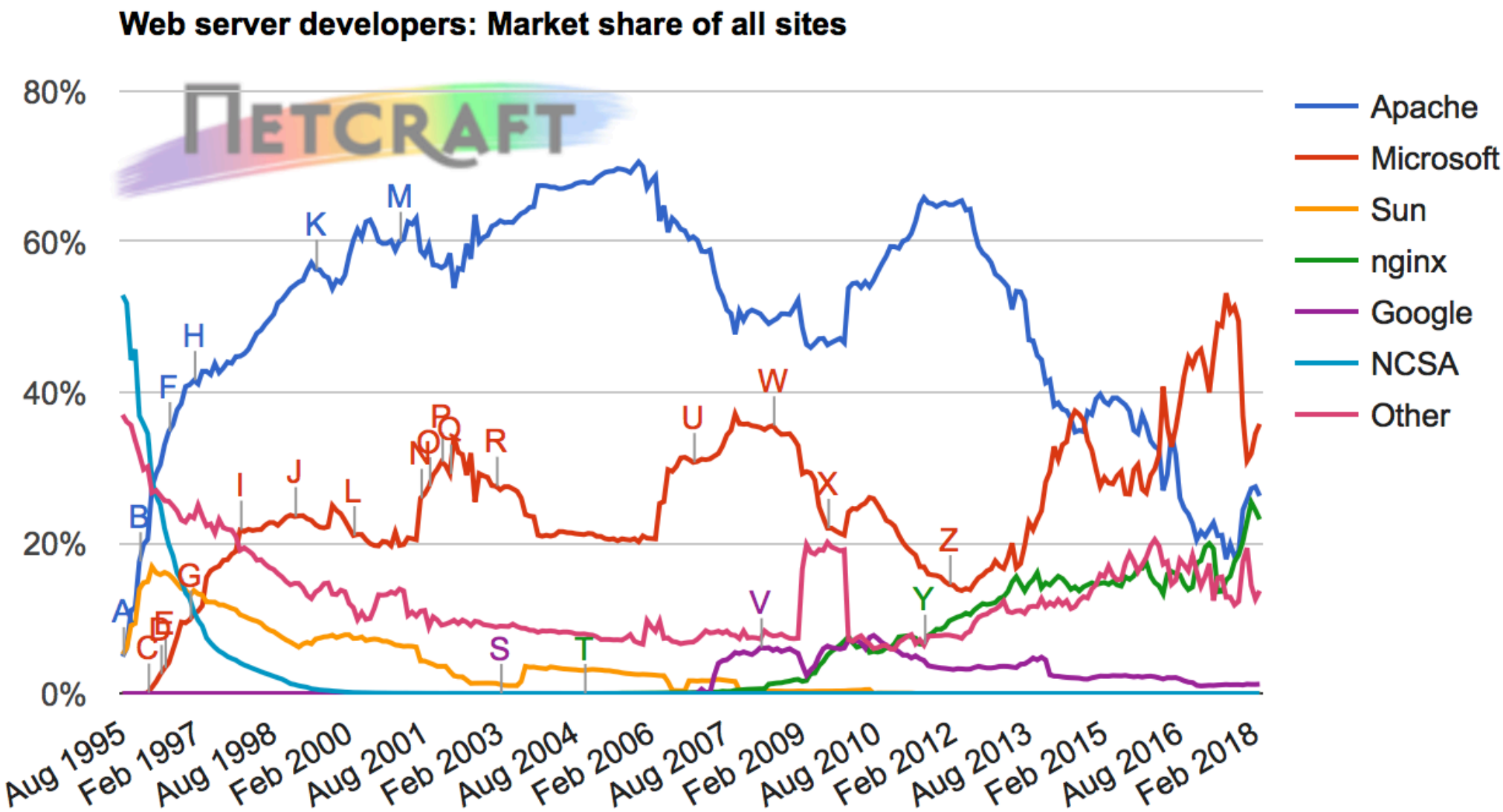
Number of Websites

- Sitenames: 1.7+B
- Active sites: 171+M



src: https://news.netcraft.com/archives/category/web-server-survey/

Web Servers Today



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The Web

- Different from other TV, Radio
  - Operates on demand
    - Does not force users to tune in
  - Enables every one to become the producer
  - Channels (URLs) are way too many
  - Search engines enables easy navigation
- RIAs, Social Media make users engrossed
- Web page today
  - *base HTML-file*, includes *several referenced objects*

HTTP Protocol Evolution

- HTTP 0.9 (Unofficial)
- HTTP 1.0
- HTTP 1.1
- HTTP 2

Internet Impact

- Availability of internet is considered necessary
  - Like food and water
  - Any disruptions may cause havoc
  - Punishing someone: bar the internet access
- Internet etiquettes
  - Avoid using slang, goofy spellings, acronyms etc
  - Avoid spamming
  - Social media/blogs: avoid vain content
  - Overly personal, obscene comments, ranting
  - Avoid exchange of personal info on wall papers
    - Everyone else is watching
  - Tweets
    - Should be more than one word and meaningful
    - Don't hold entire conversation on twitter

Internet Trends Today

- Top internet sites
  - **http://www.alexa.com** (20-04-2018)

Global
Google
YouTube
Facebook
Baidu
Wikipedia
Reddit
Yahoo
Google.co.in
QQ

Internet Trends Today

- What is common about these top sites?
  - Did they sell any products to install?
  - Do you know about their software releases?
  - Any support calls?
  - Did they exist a decade ago?
- **All offer services, not products**
- Services are
  - Mobile apps
  - Global
  - Cloud based
    - Requires reliable internet acces

SDN

- Today's Paradigm shift
  - Google:
    - in past known as search engine company
  - Apple
    - in past known as Mac
- What is common between Google, Apple
  - Mobile Device companies
  - bringing paradigm shift
  - networking is moving to mobile devices
  - needs cloud, internet
  - traditional network doesn't work
    - **SDN?**

SDN

- Networking : Failure vs Successes
  - src: http://www.cse.wustl.edu/~jain/talks/ftp/adn_mcs.pdf
  - 1986: MAP/TOP (vs Ethernet)
  - 1988: OSI (vs TCP/IP)
  - 1994: CMIP (vs SNMP)
  - 1995: FDDI (vs Ethernet)
  - 1997: ATM to desktop (vs Ethernet)
  - 1998: ATM Switches (vs IP routers)
  - 1999: Token Ring (vs Ethernet)
  - 2003: HomeRF (vs WiFi)
  - 2007: Resilient Pkt Ring (vs Carrier Ethernet)
  - IntServ, DiffServ, ...

Two Networking Evolution

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Computers & Communication

- Computers
  - Fixed (no mobility), reserved address
  - Reliable data transmission
    - No Loss, duplication, corruption, (Un) Ordered
  - End entity: machine/application
  - Conn less (inherently) and conn. oriented
- Communications
  - Mobility is key requirement, no fixed address
  - Unreliable transmission
  - End entity: human
  - Connection oriented

Transport Layer Reliability Support

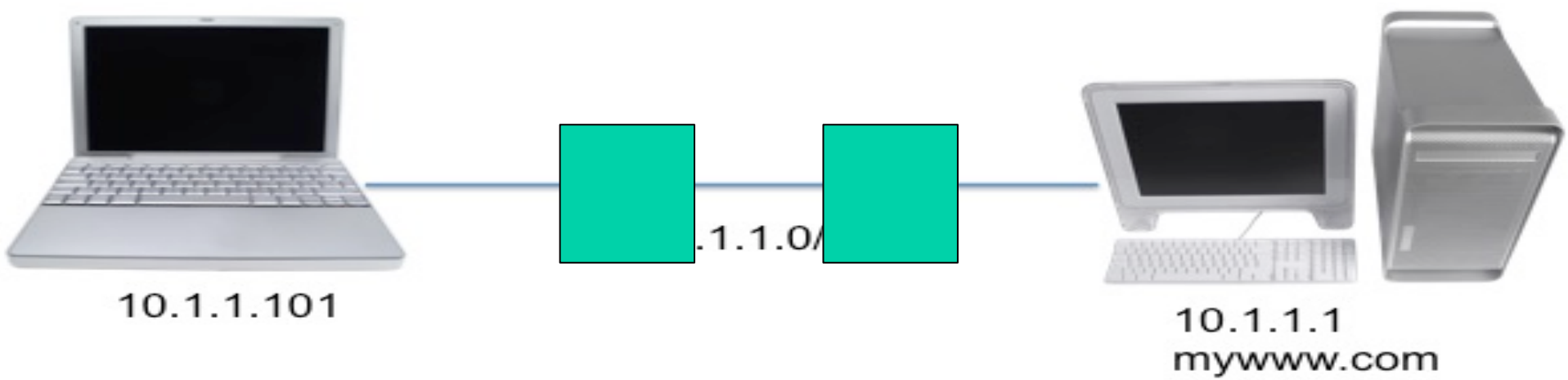
- Reliability
  - Needs error and flow control
    - Compels slower service
- Unreliable protocol
  - No extra overheads
- Reliability at data link layer
  - Provides error and flow control
  - Why do we need it at Transport layer when Link layer provides the same

TCP Characteristics

- *point-to-point*: One sender, one receiver
- *reliable*, *in-order byte steam: No "message boundaries"*
- *pipelined: TCP congestion and flow control set window size*
- *full duplex data: Bi-directional data flow in same connection*
  - *MSS: maximum segment size, determined from link/ frame size*
- *connection-oriented*: Handshaking (exchange of control msgs) inits sender, receiver state before data exchange
- *flow controlled*: Sender will not overwhelm receiver

Experiencing Packet Loss & Recovery

- Data Transfer
  - Clients sends data (100 bytes) every 2s (10 times)
  - `AA`.. (1st pkt), `BB`..(2nd pkt), …, `JJ`..(10th pkt)
  - Break the link between switch at 7th sec and restore after `12th` sec
- Server reads 50 bytes at a time
- What would server receive:



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Network Model

- Architecture
  - IBM SNA Architecture
  - OSI Model
- Model
  - BAN, PAN, LAN, WAN,
  - Enterprise and cloud
- Medium
  - Wired and wireless
  - Cables, Microwaves, Satellites, Powerlines

Network Stack and Protocols

- OSI
- TCP/IP
- Now
  - Layering is getting muddled

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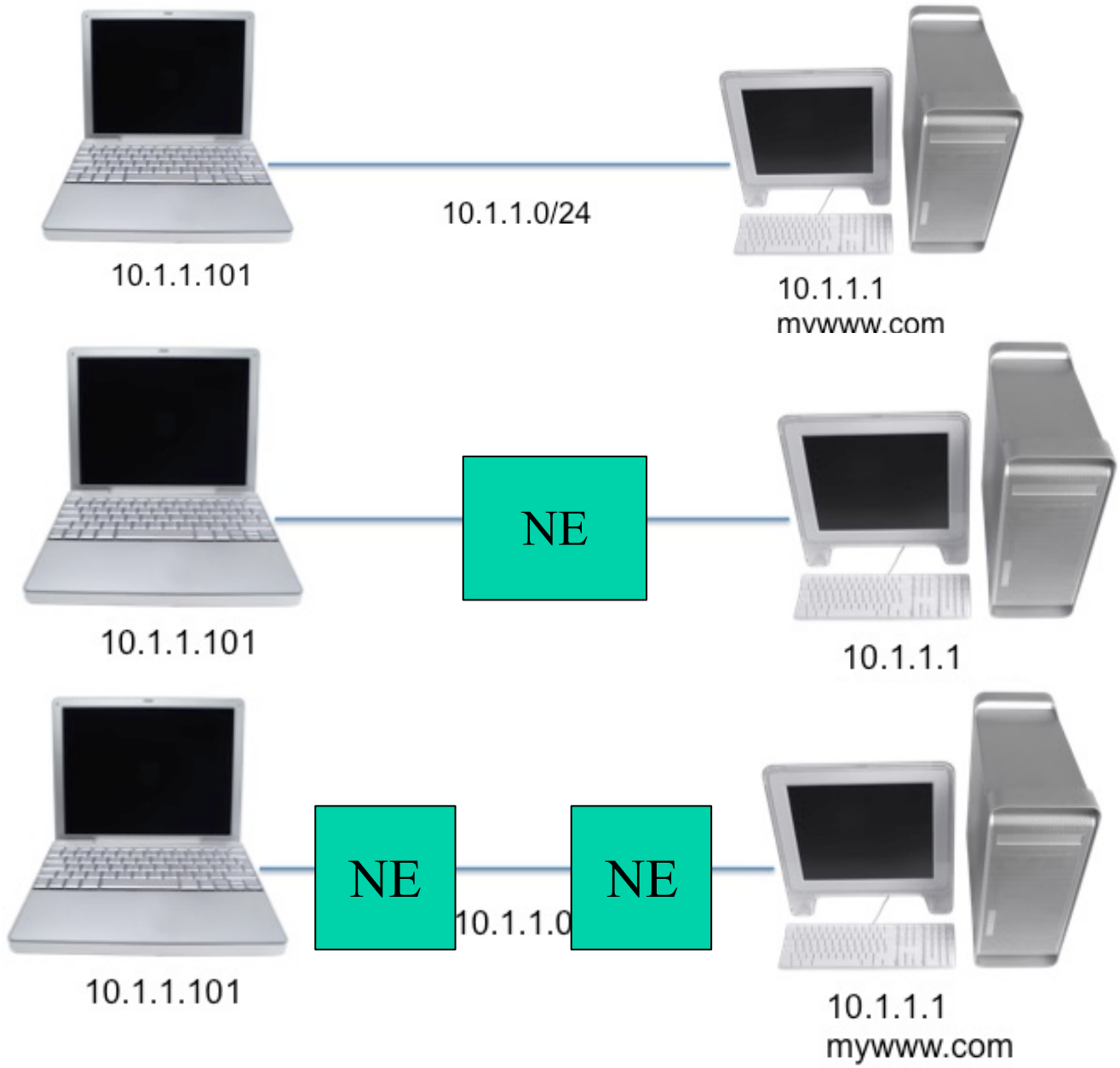
Setup Requirement



Tools

- **wireshark**
- **tcpdump:**
- **wget**
- **nc**
- **ping**
- **traceroute**
- **ttcp**

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Understanding Networks

- What happens when user enters a URL e.g.
  - `flipkart.com`, or `amazon.in` or …
  - What kind packets goes out of machine?
    - What are the activities carried out by network?
  - Which protocols are involved?
  - Does it depend upon user network environment?
  - Does it depend upon environment of website hosting?
  - Does it depend ISP and intermediate network?
  - Does it depend device being used?
  - Does snooping, MITM affects it

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Future Networking

- IoT impacts networking landscape
  - Device form factors
  - Energy aware networking
  - Scaling (much beyond you can think of)
- Security
  - It was not the concern initially
  - Business, commerce requires it
- User Engagement
  - Networking is like plumbing (taken for granted)
  - User wants immediate gratification
  - Is networking using you?

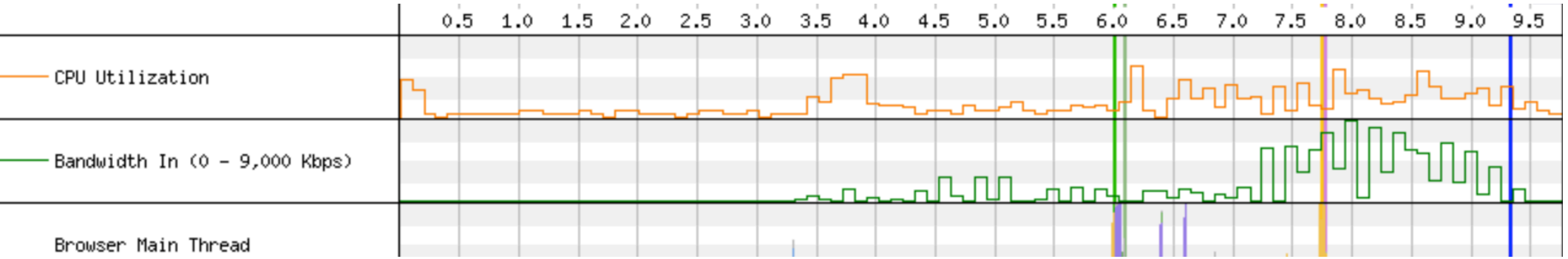
Performance of vtu.ac.in

- src: http://www.webpagetest.org
  - browser : chrome, link: 4G (12Mbps)
  - Location: Mumbai

Load Time	First Byte	Start Render	Speed Index	First Interactive (beta)
10.275s	4.387s	7.000s	8638	8.062s

Document Complete			Fully Loaded			
Time	Requests	Bytes In	Time	Requests	Bytes In	Cost
10.275s	61	1,441 KB	10.692s	62	1,443 KB	$$$--

Performance of vtu.ac.in



Request Details

#	Resource	Content Type	Request Start	DNS Lookup	Initial Connection	SSL Negotiation	Time to First Byte	Content Download	Bytes Downloaded	Certificates	Error/Status Code
1	http://www.vtu.ac.in/	text/html	0.411 s	208 ms	200 ms	-	1050 ms	-	0.0 KB	-	301
2	http://vtu.ac.in/	text/html	1.989 s	324 ms	203 ms	-	1302 ms	100 ms	10.0 KB	-	200
3	http://vtu.ac.in/wp-...tu/lib/css/reset.css	text/css	3.302 s	-	206 ms	-	206 ms	-	0.9 KB	-	200
4	http://vtu.ac.in/wp-...lib/css/defaults.css	text/css	3.31 s	-	203 ms	-	207 ms	5 ms	1.9 KB	-	200
5	http://vtu.ac.in/wp-...themes/vtu/style.css	text/css	3.506 s	-	203 ms	-	208 ms	4 ms	6.2 KB	-	200
6	http://vtu.ac.in/wp-...tstrap.css?ver=3.7.1	text/css	3.51 s	-	207 ms	-	215 ms	6 ms	7.8 KB	-	200
7	http://vtu.ac.in/wp-...tcodes.css?ver=3.7.1	text/css	3.515 s	-	204 ms	-	208 ms	1 ms	2.4 KB	-	200

Thank You