Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

CS2031 Telecommunications II

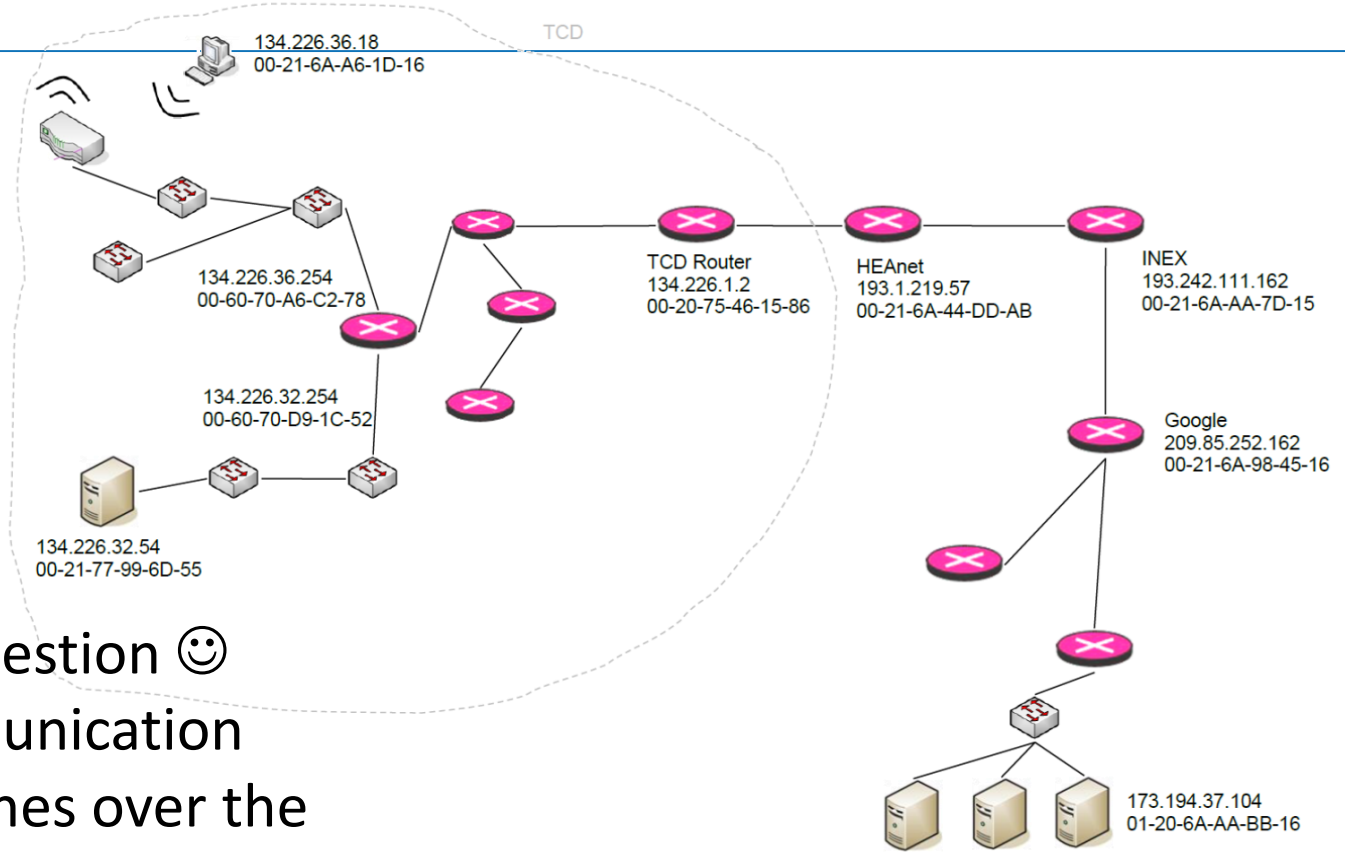
Introduction

Stefan Weber
sweber@tcd.ie

Overview

- Motivation/HTML use-case
- Housekeeping
- Overview of Assignments

Common Scenario



Recent Interview Question ☺
"Describe the communication between two machines over the Internet in as much detail as you can."

Dublin-located Games Company,
2014: 67 million players, 7.5mil/hr at peak

Clients & Servers

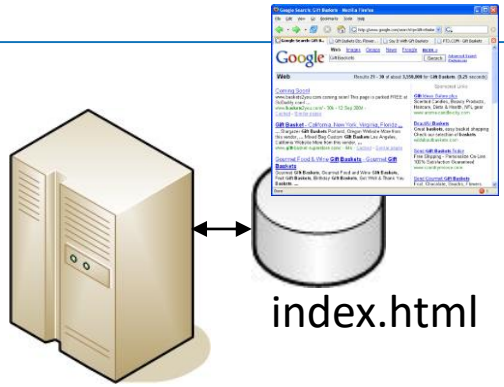
www.scss.tcd.ie

URL: http://www.scss.tcd.ie/index.html

SCSS Webserver

Clients & Servers

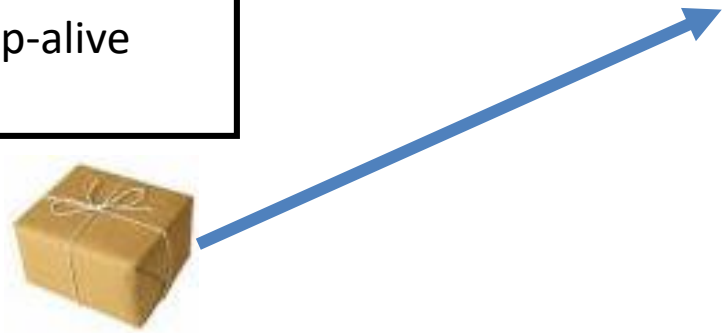
URL: http://www.scss.tcd.ie/index.html



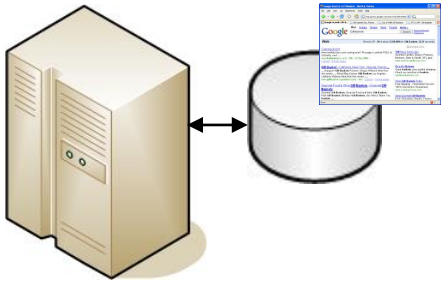
www.scss.tcd.ie

To: www.scss.tcd.ie:80

GET index.html HTTP/1.1
Host: www.scss.tcd.ie
Connection: keep-alive
....



Domain Name Servers (DNS)



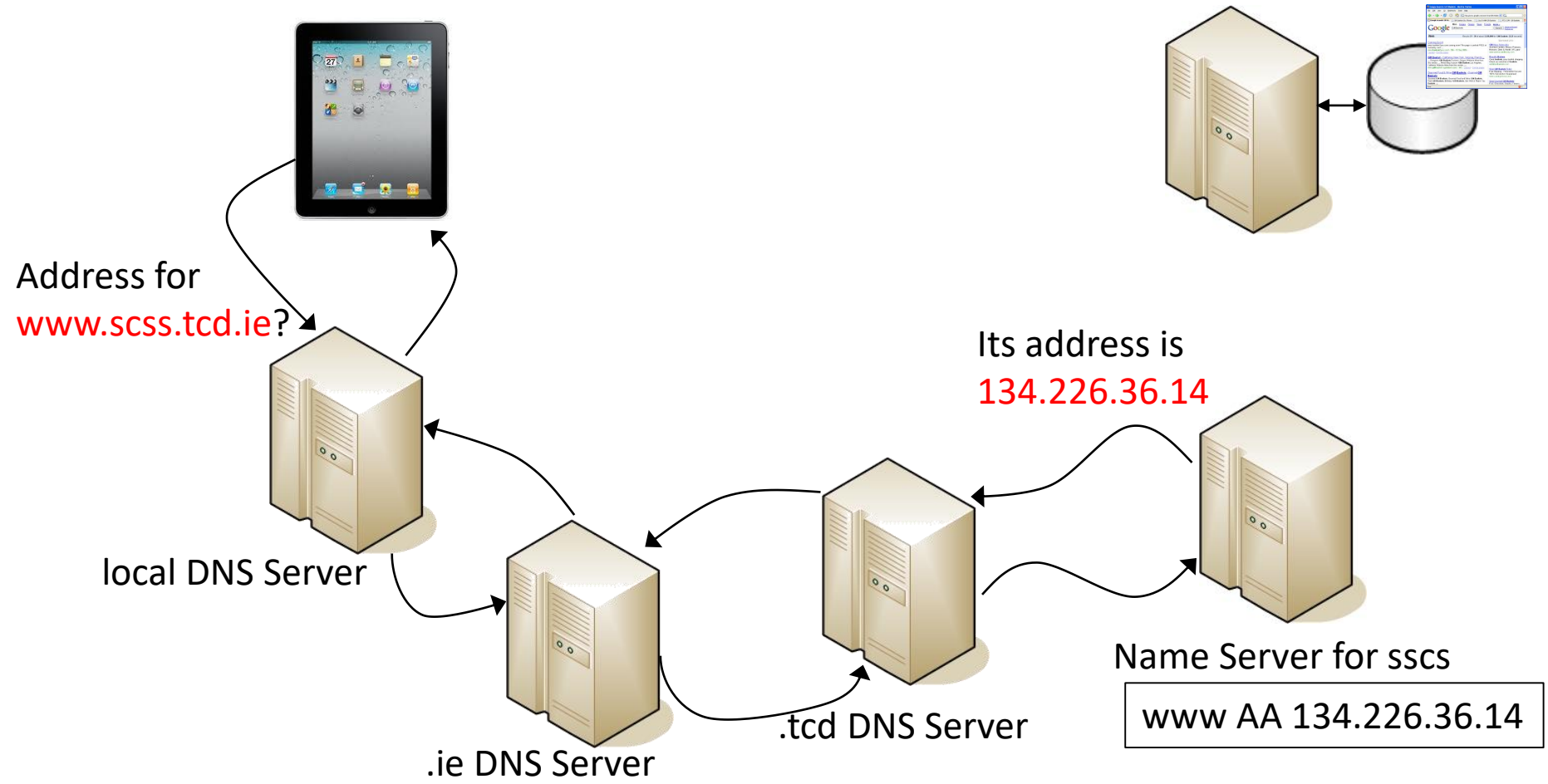
Its address is
134.226.36.14

What is
www.scss.tcd.ie?

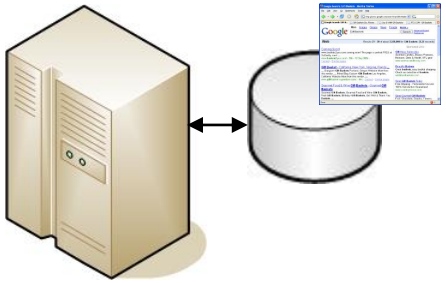
Name Server for sscs.cs.tcd.ie

www AA 134.226.36.14

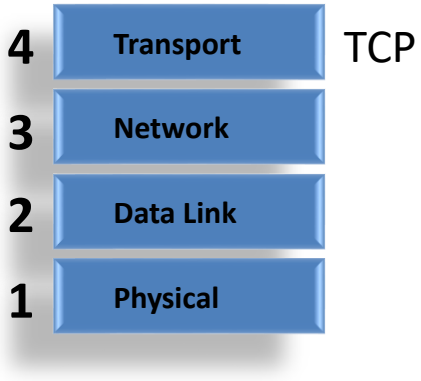
Domain Name Servers (DNS)



Transport Layer

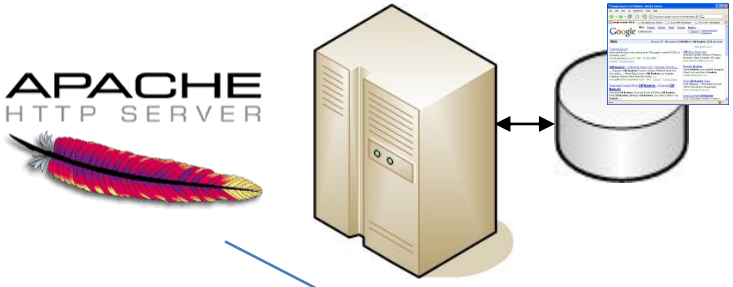


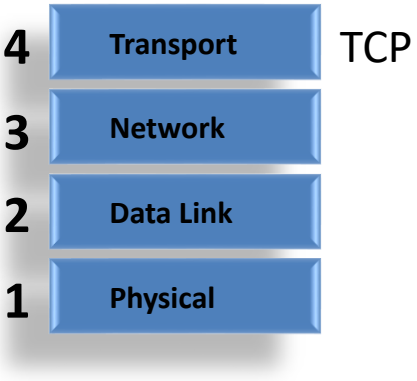
I need to talk to 134.226.36.14 :80

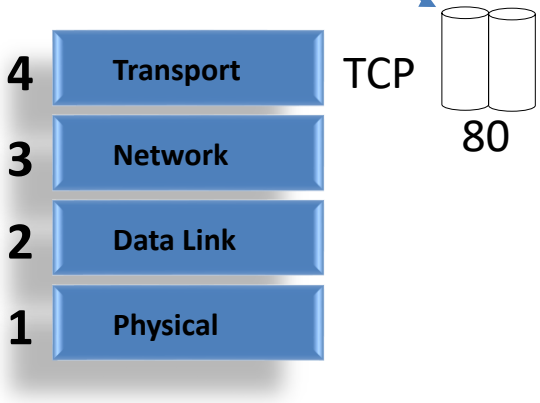


Transport Layer

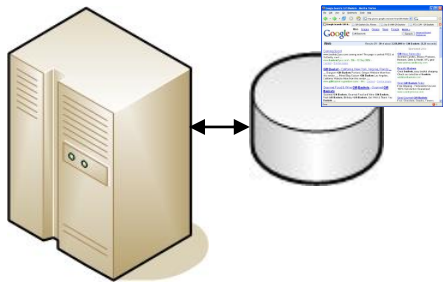
I need to talk to 134.226.36.14 :80







Transmission Control Protocol (TCP)



I need to talk to 134.226.36.14 :80

socket.connect (134.226.36.14, 80)

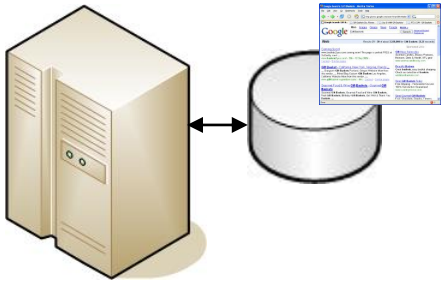
TCP Socket

80

Incoming

Outgoing

Transmission Control Protocol (TCP)



I need to talk to 134.226.36.14

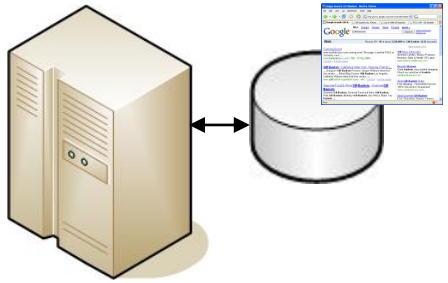
socket.connect (134.226.36.14, 80)

TCP Socket

Incoming Outgoing

Incoming Outgoing

Transmission Control Protocol (TCP)



socket.connect(134.226.36.14, 80)

Synchronize State

Socket: 54321

Incoming

Outgoing

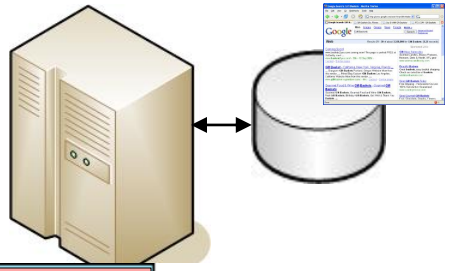
TCP Packet: Header & Payload

socket.connect(134.226.36.

Socket: 54321

Incoming

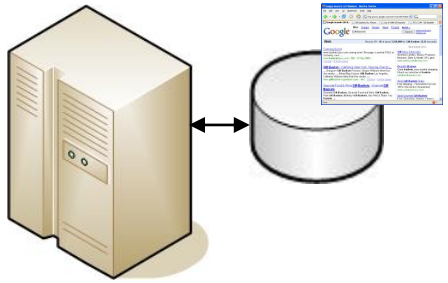
Outgoing



Header | HTTP Request

Source port address 16 bits								Destination port address 16 bits
Sequence number 32 bits								
Acknowledgment number 32 bits								
HLEN 4 bits	Reserved 6 bits	urg	ack	psh	rst	syn	fin	Window size 16 bits
Checksum 16 bits								Urgent pointer 16 bits
Options and padding								

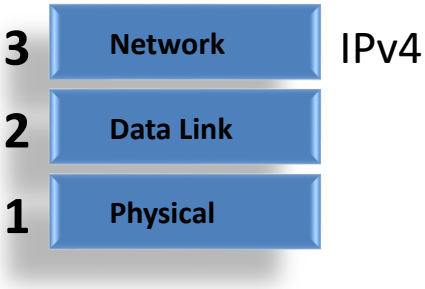
Transmission Control Protocol (TCP)



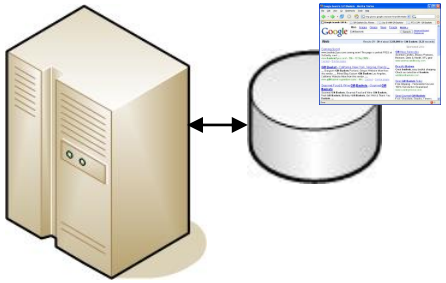
socket.connect(134.226.36.14, 80)

Synchronize State

Socket: 54321

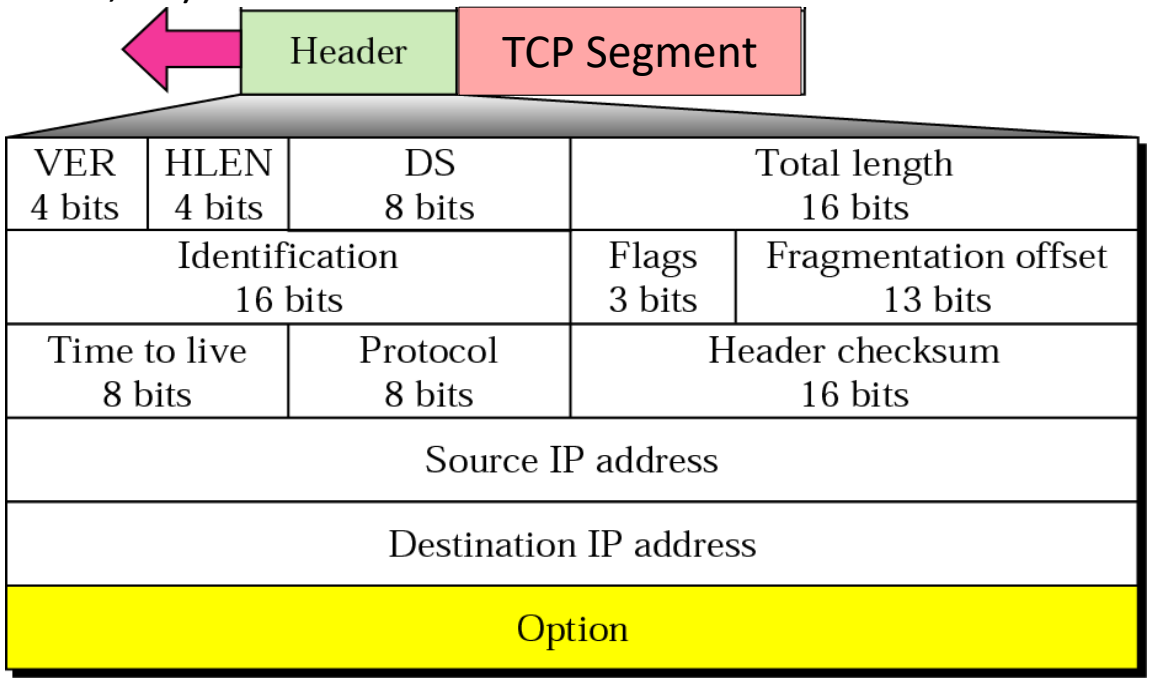


Internet Protocol (IPv4)



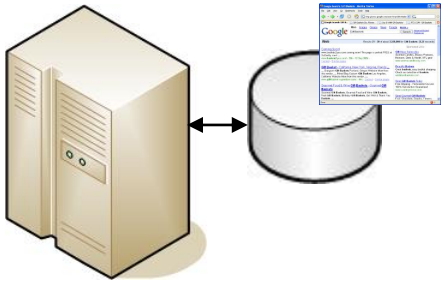
socket.connect(134.226.36.14, 80)

Socket: 54321



Internet Protocol (IPv4)

socket.connect(134.226.36.14, 80)



134.226.36.14

Socket: 54321

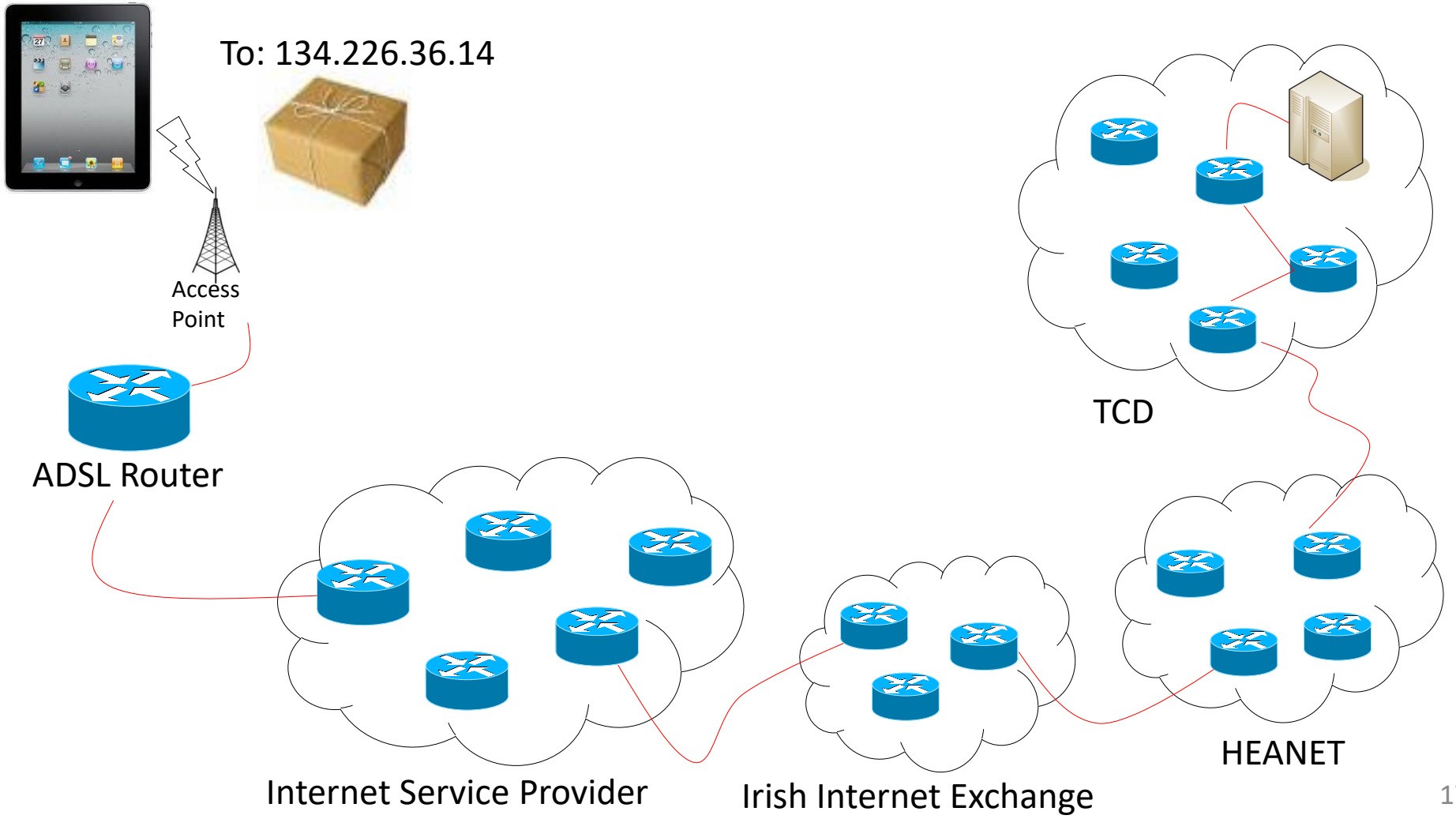
	20		40
			0
TTL: 128			
Src Addr: 134.226.34.15			
Dst Addr: 134.226.36.14			
Src Prt: 54321			Dst Prt: 80
Initial Seq. Num: 333			
20			

IP Header

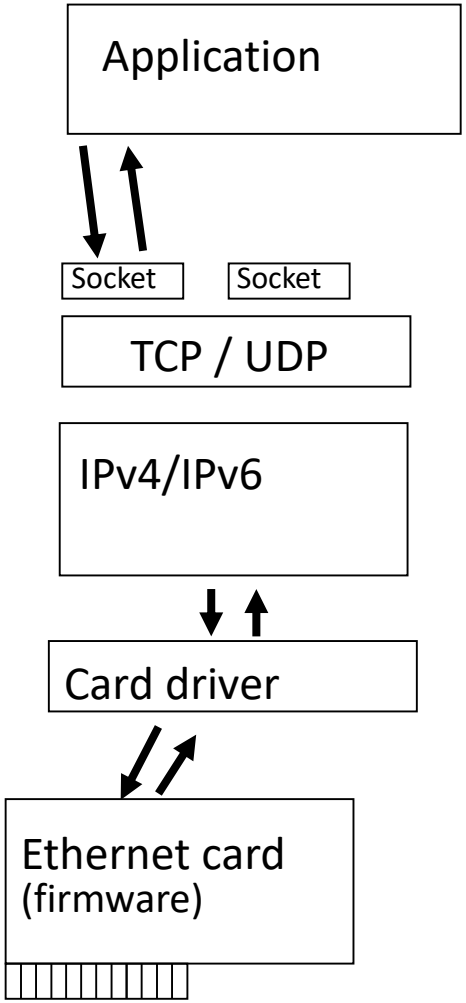
TCP Header

SYN FLAG

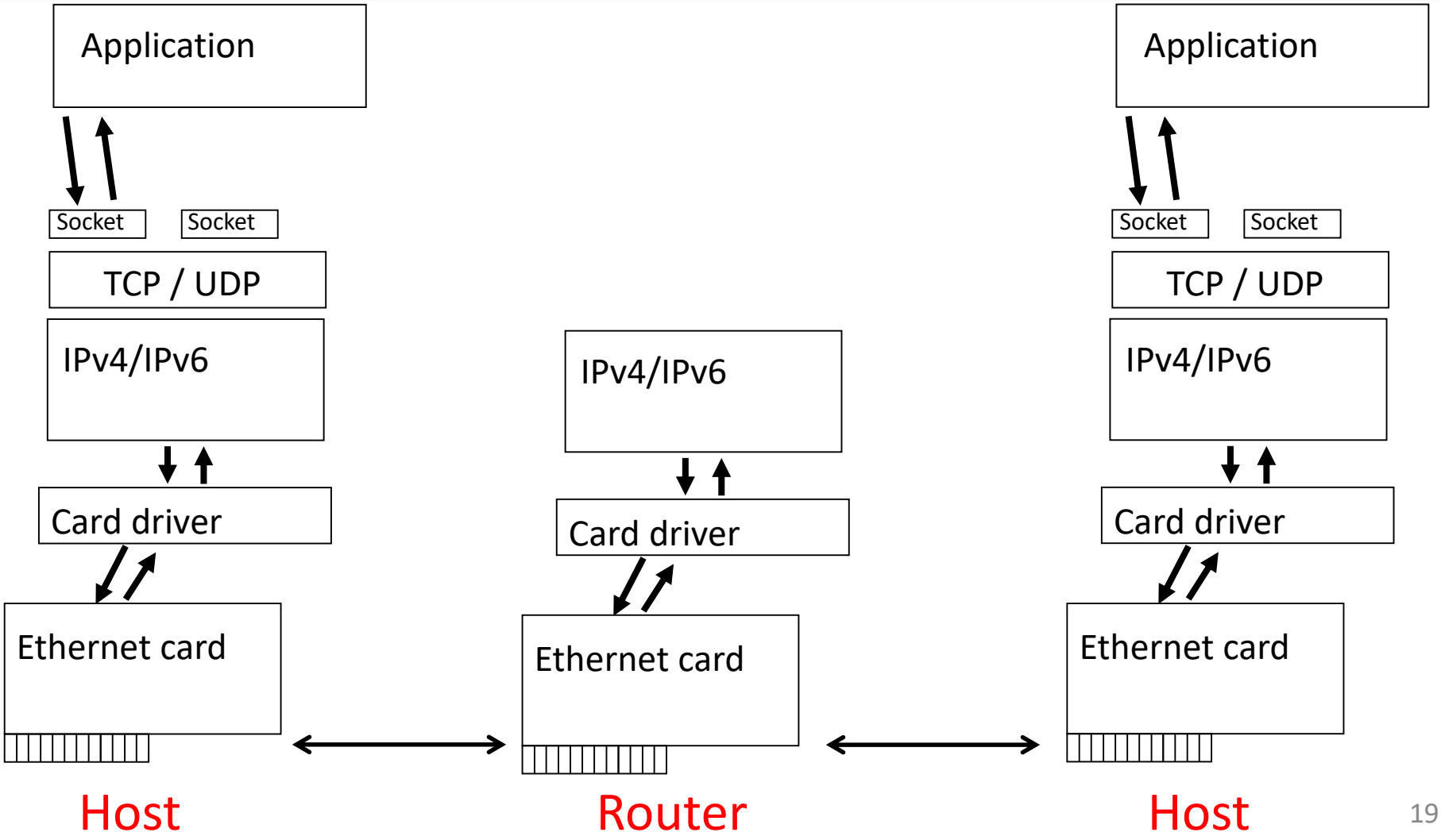
Internet: Network of Networks



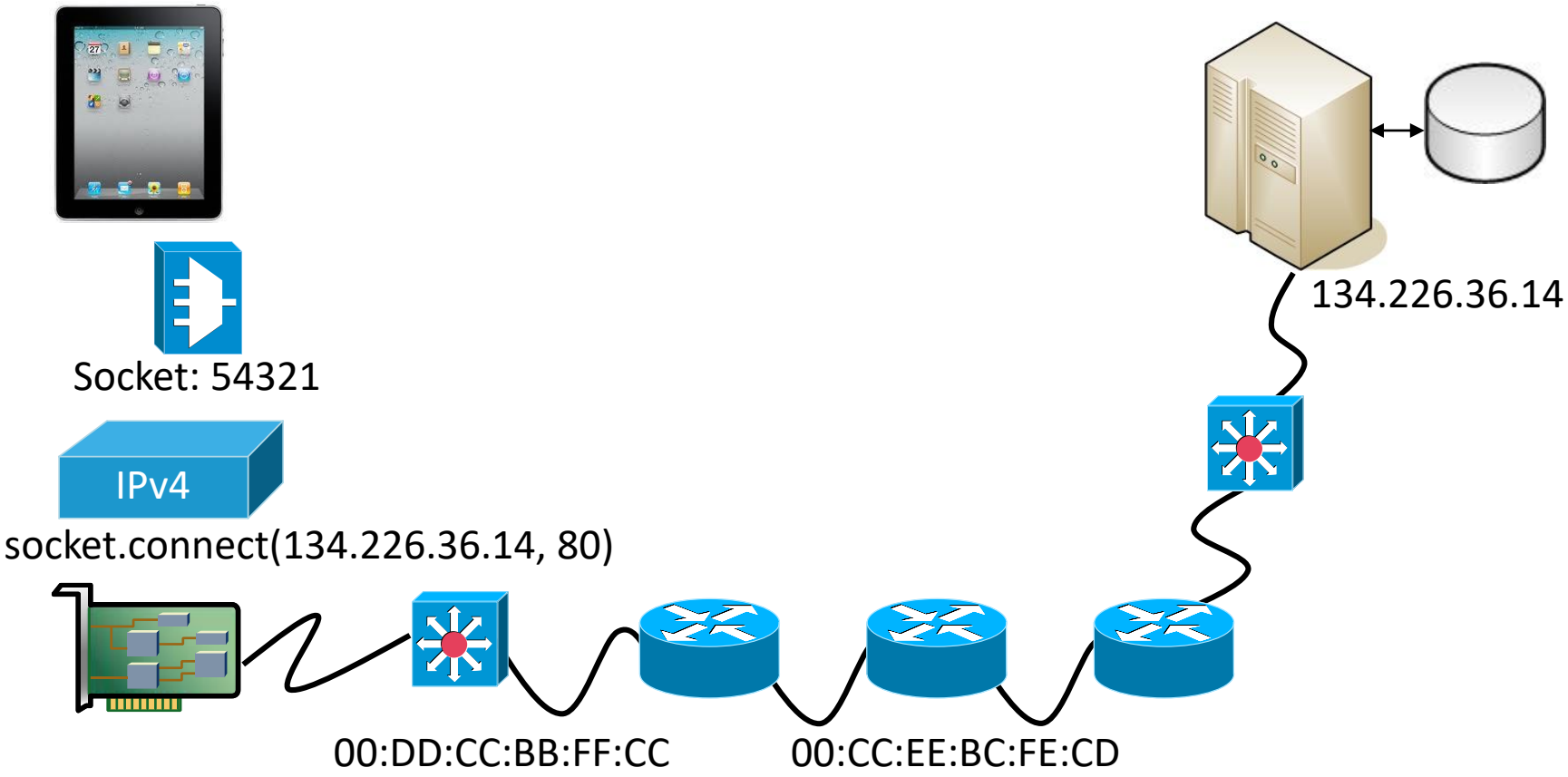
Layer 4 to Layer 2



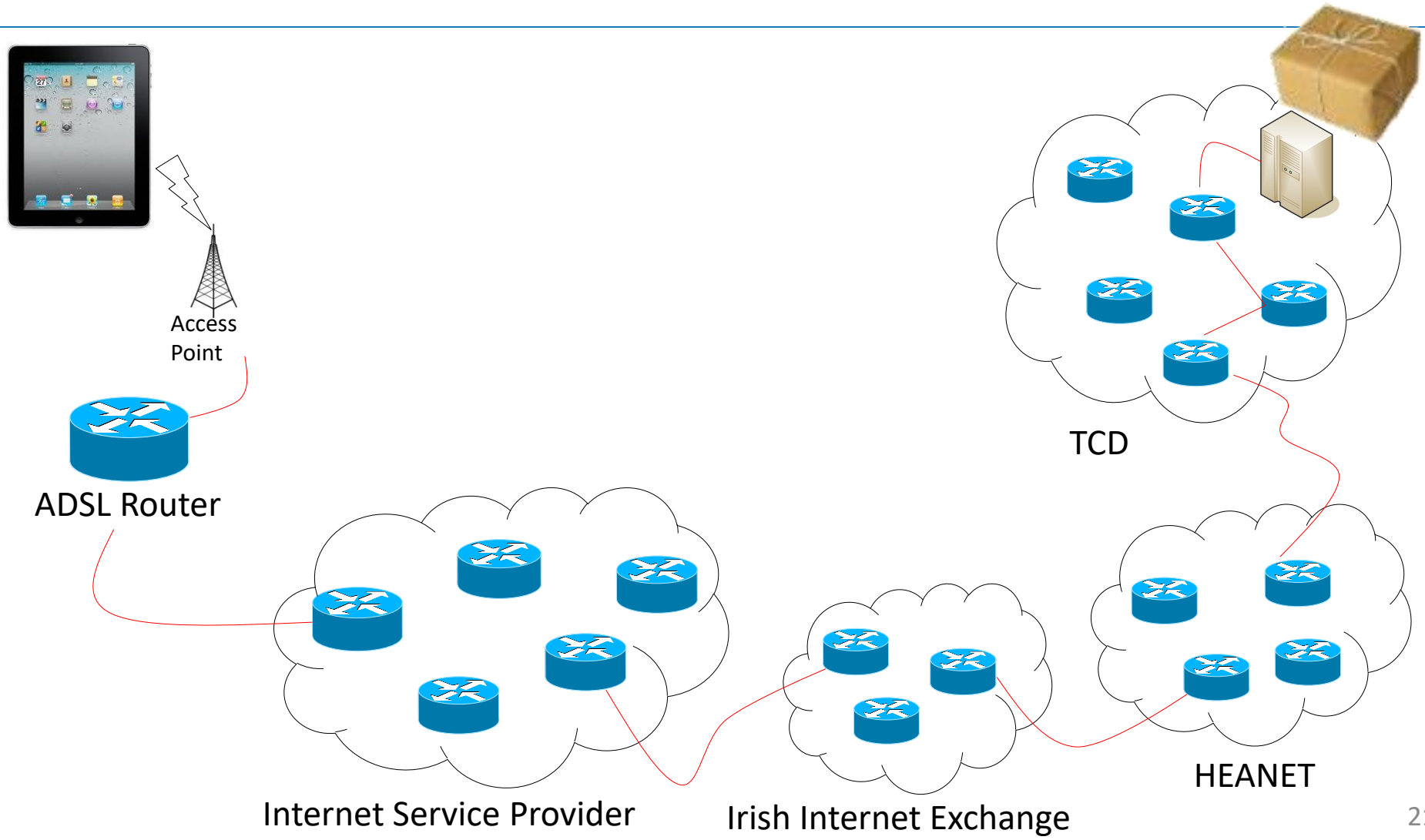
Host to Router to Host



Ethernet between Routers



Internet: Network of Networks

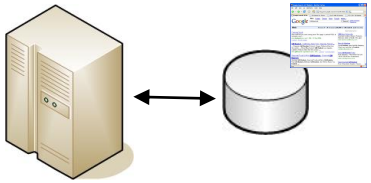


Message Exchange

Connection?

Yep

Fine



Give me index.html

APACHE HTTP SERVER

Bye

Bye

TCP Socket

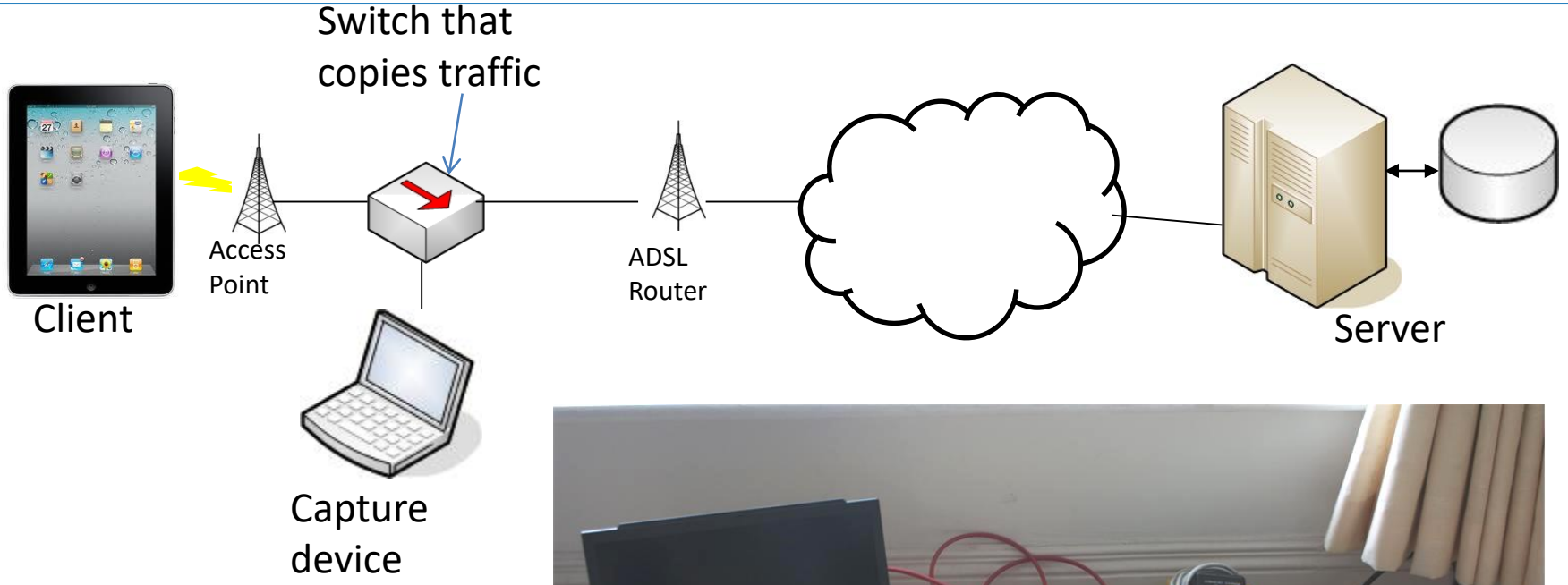
Incoming

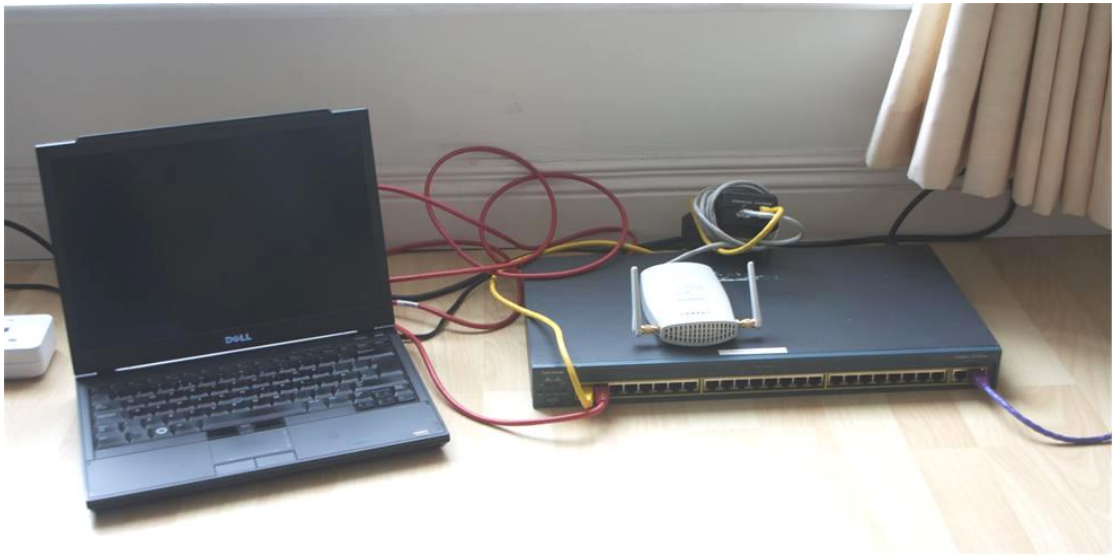
Outgoing

Incoming

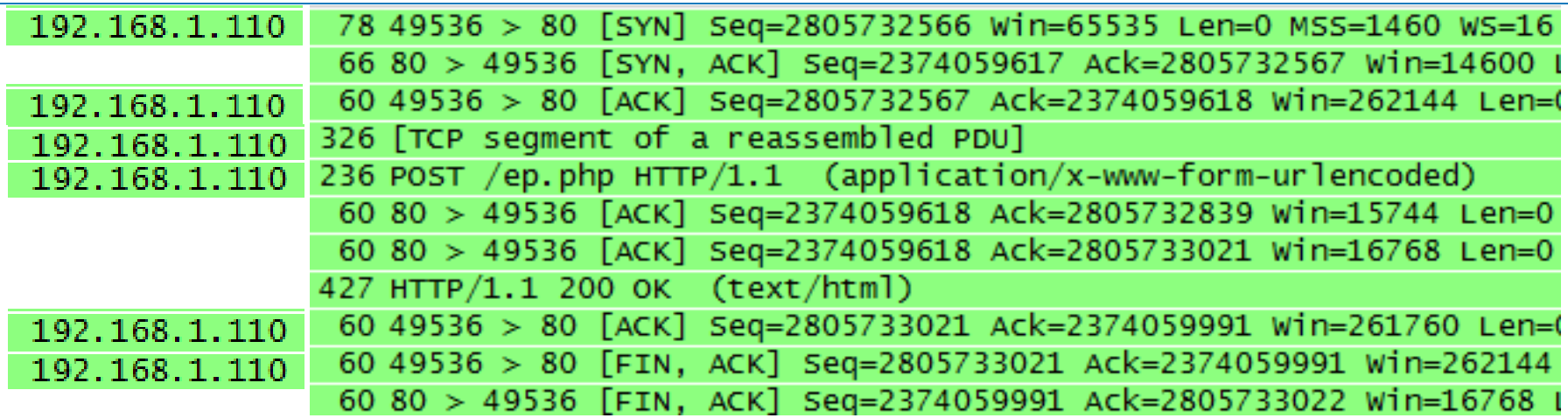
Outgoing

Capturing Traffic





Captured IP Packets



POST /ep.php HTTP/1.1
Host: foo.bar.com
User-Agent: foo/1.5 CFNetwork/548.1.4 Darwin/11.0.0
Content-Length: 182
Accept: */*
Accept-Language: en-us
Accept-Encoding: gzip, deflate
Content-Type: application/x-www-form-urlencoded
Connection: keep-alive

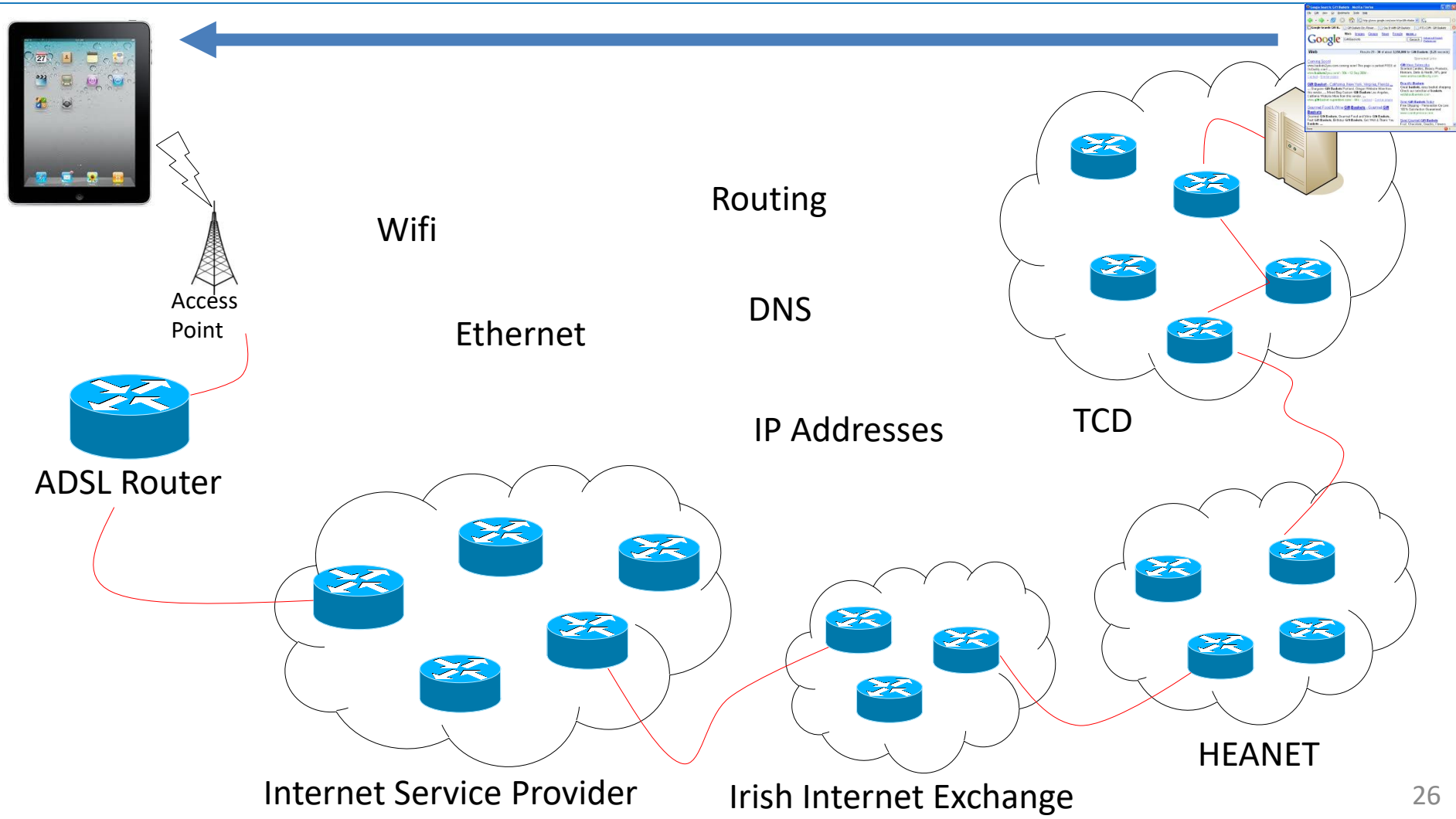
udid=09e83bc00abc45f01f4935adf46803635052e677&
rand=985268246&hash=a4ae73033d507f4d1c99781d6e30d592&
action=getStatus&params=rating%3Ainvites%3Agifts%3Aposts
%3AblogDate&lang=en&ver=1.5

Another Example

```
POST /game/mobile?h=ff518de9a04 HTTP/1.1
Host: en8.forgeofempires.com
Accept: */*
Accept-Encoding: gzip,deflate
Cookie: sid=450gr3xiwf28
X-Requested-With: XMLHttpRequest
User-Agent: Mozilla/5.0 (iPad; CPU OS 8_3 like Mac OS X) AppleWebKit/600.1.4
(KHTML, like Gecko) Mobile/12F69
Content-Length: 401
Content-Type: application/x-www-form-urlencoded

HTTP/1.1 200 OK
Server: nginx
Date: Fri, 17 Apr 2015 18:01:18 GMT
Content-Type: application/json
Transfer-Encoding: chunked
Connection: keep-alive
X-Powered-By: PHP/5.5.18-1~dotdeb.1
P3P: CP="IDC DSP COR ADM DEVi TAIi PSA PSD IVAi IVDi CONi HIS OUR IND CNT"
X-JoinUs: If you found it and want help us improving our Games, go to
career.innogames.com and mention this header!
Cache-Control: public
Content-Encoding: gzip
```

Endgoal...

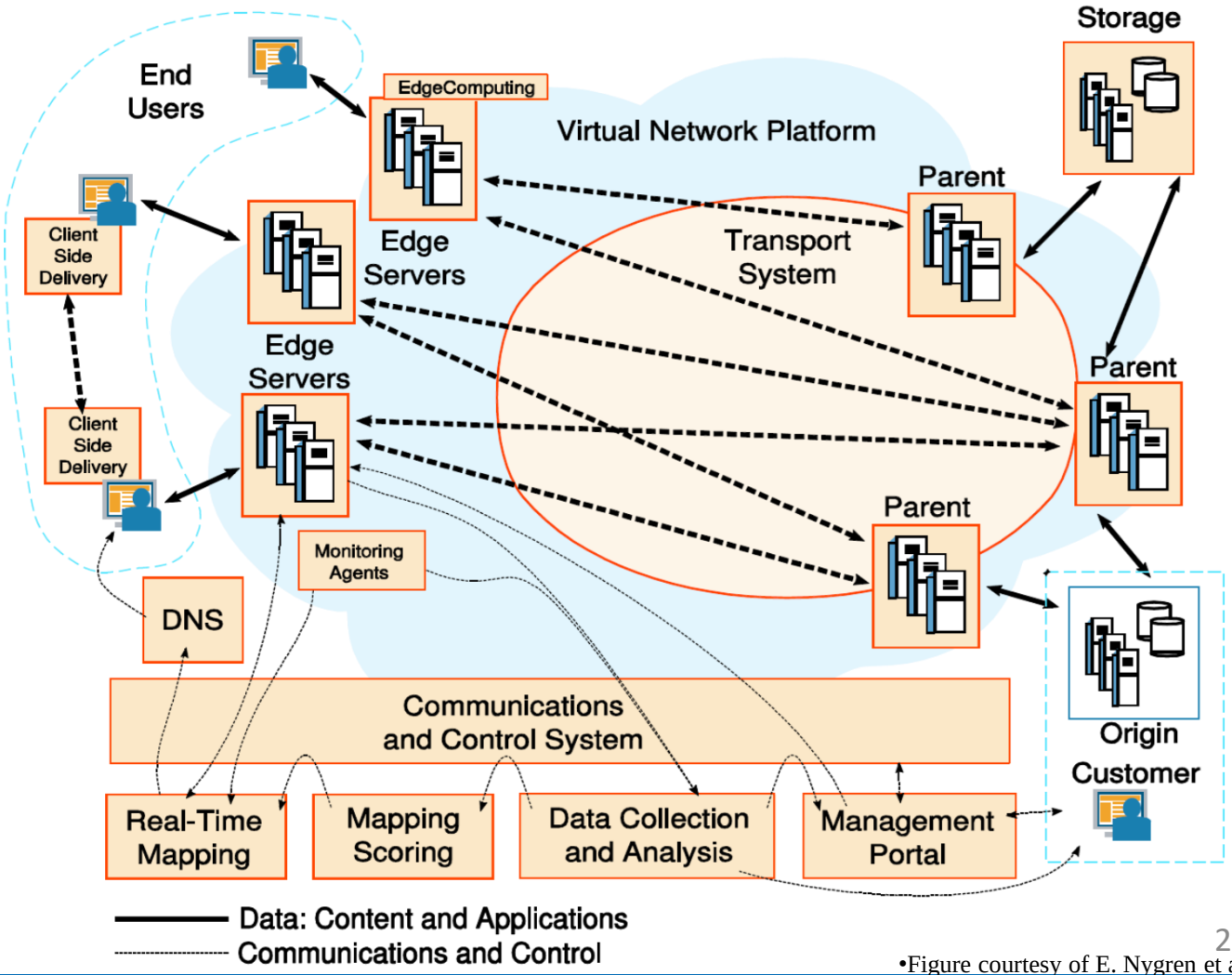

Wifi
Routing
DNS
Ethernet
IP Addresses
Access Point
ADSL Router
TCD
Internet Service Provider
Irish Internet Exchange
HEANET

Advanced Topics
(Topics not in Textbooks)

- Data Centre Comms
  - Amazon/Google/etc Services
- Software-Defined Networking
- Network-Function Virtualization
- Data-Centric Networking
- Content-Delivery Networks
- Internet-of-Things (IoT)

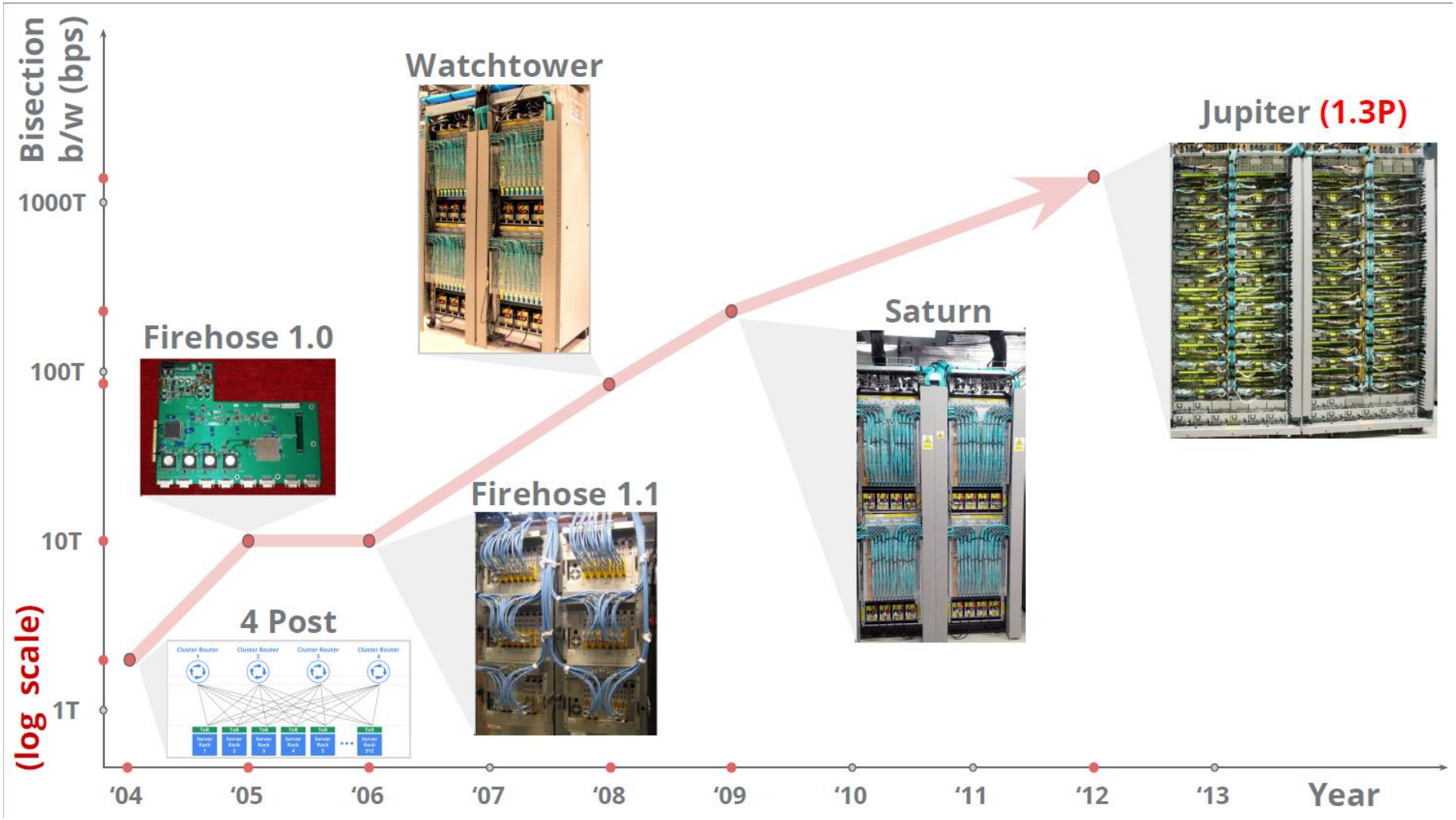
Akamai Scenario

- DNS redirection
- Clusters of servers at points of presence
- Replication

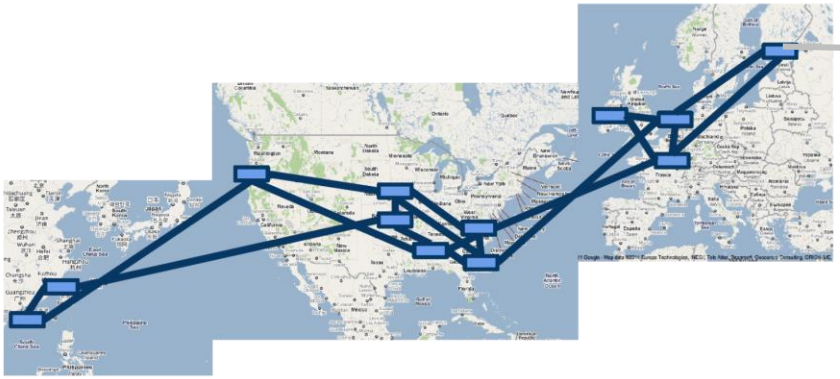


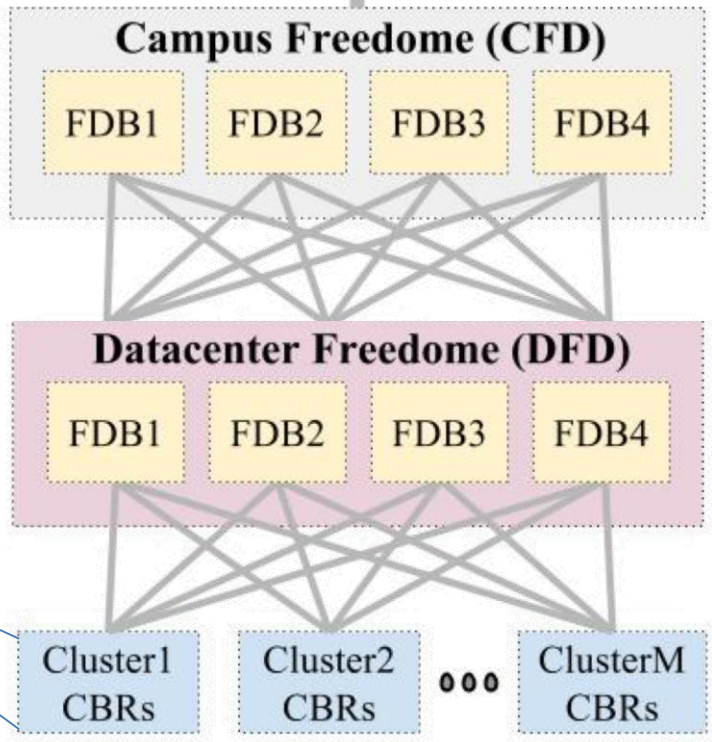
•Figure courtesy of E. Nygren et al

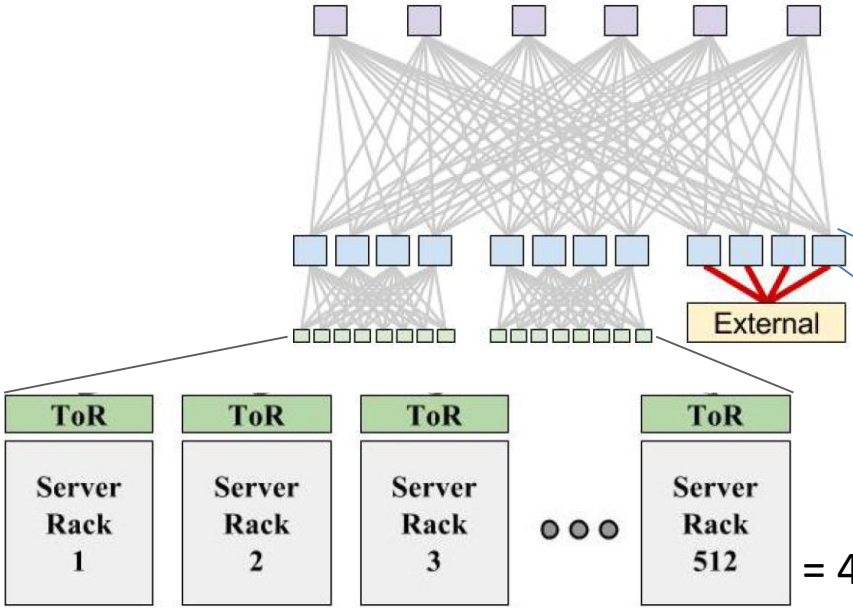
Google's Infrastructure



Google's B4 to Jupiter



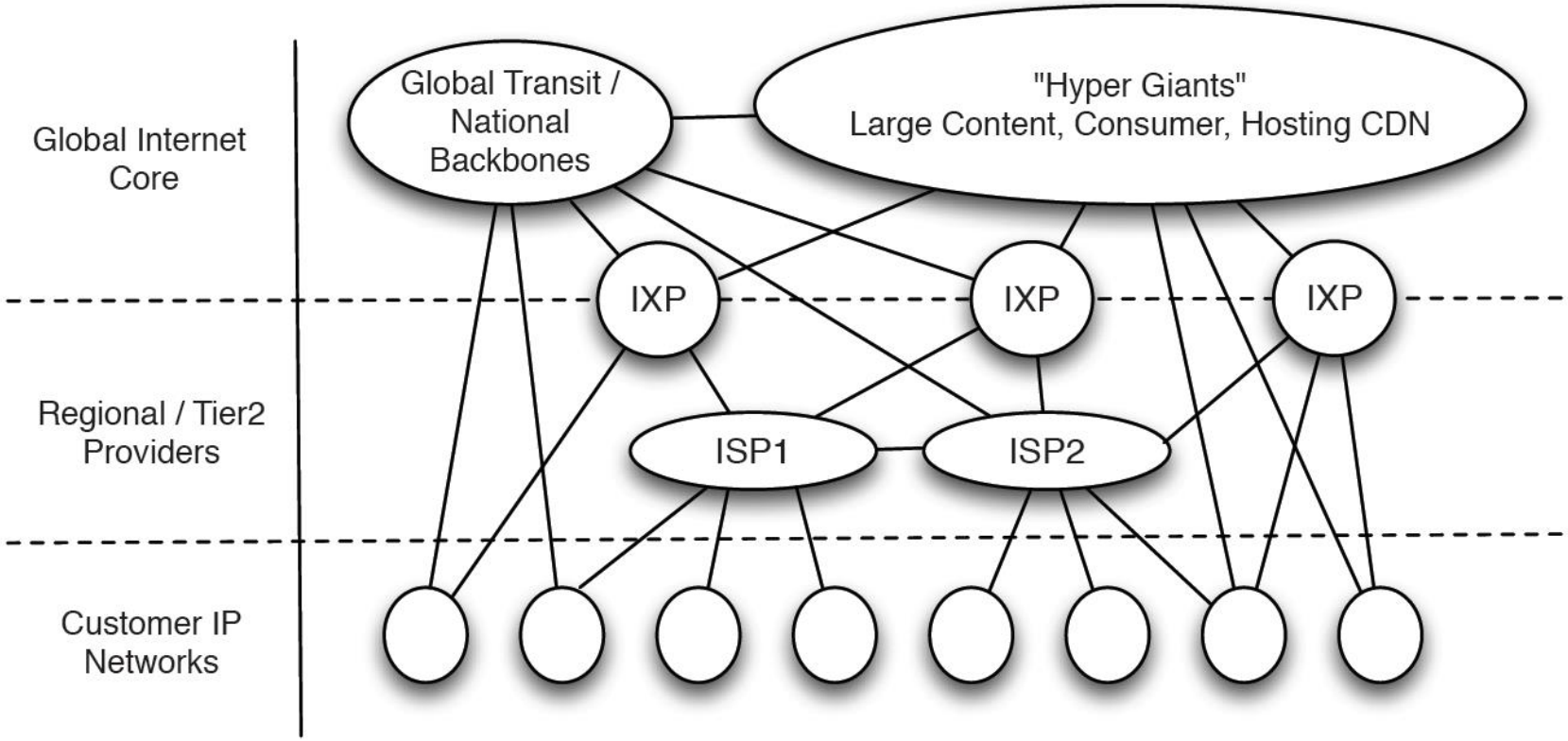




= 40 servers

FDB = Freedome Block
CBR = Cluster Border Router
ToR = Top-of-Rack Switch
B4 = WAN controlled by Openflow

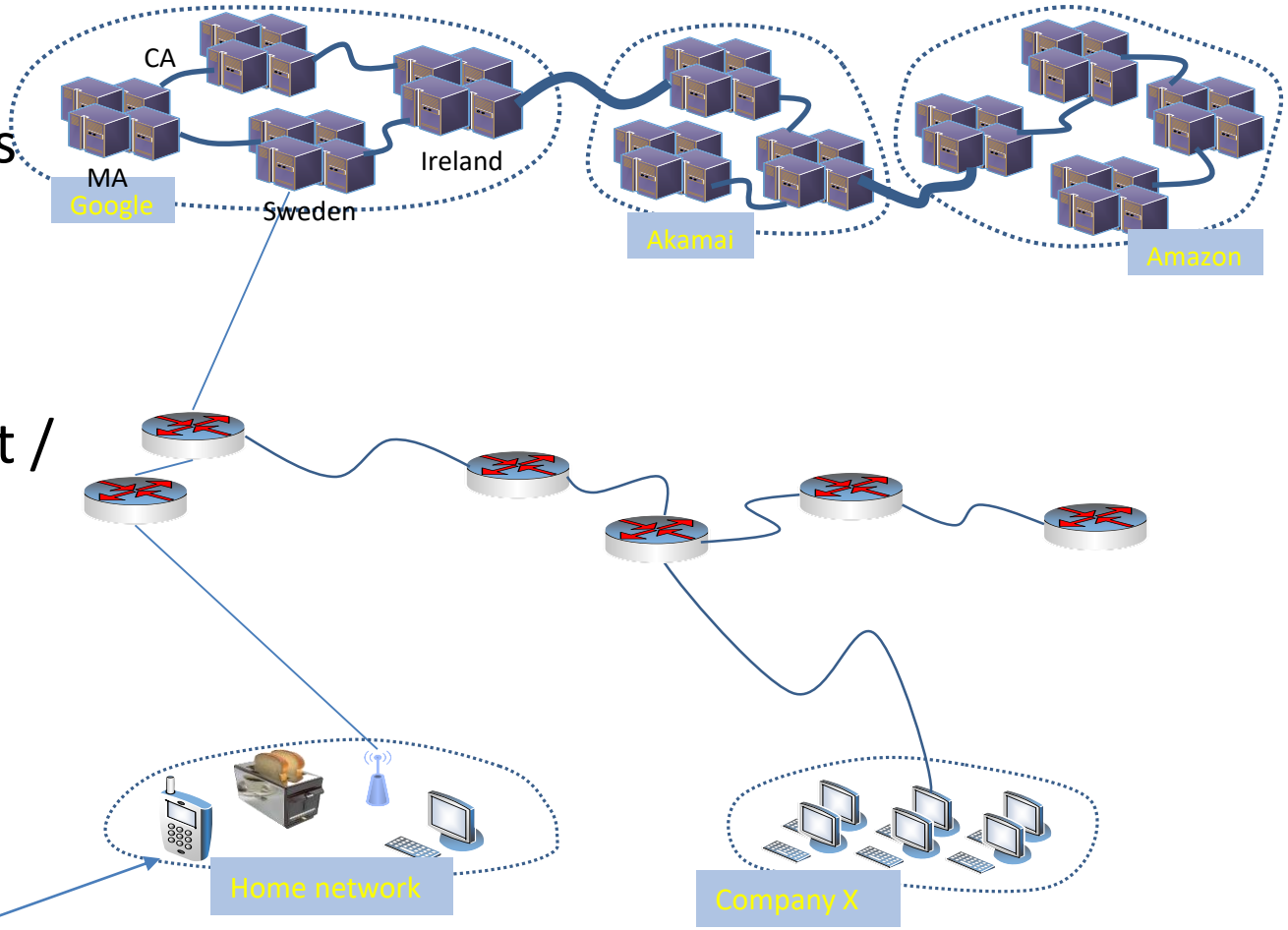
Emerging ‘Logical’ Internet Topology



* Figure is courtesy of C. Labovitz, et al, SIGCOMM 2010

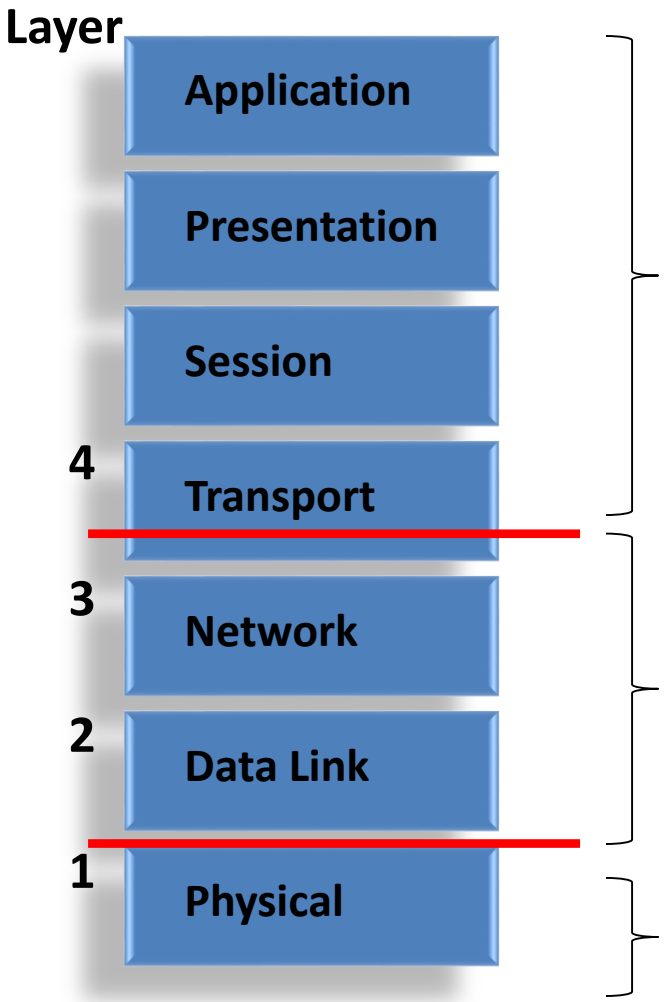
My view of “Future”* Networking

- Sets of Datacentres /Cloud(s)
- Traditional Internet / Access Network
- Edge networks



*or current?

OSI Stack



CS3031 (Hitesh T.)
- Protocols
- Security/Cryptography

CS2031
- ... from source to destination
- Networks...

CS1031?

Housekeeping

- Lectures
  - 12 weeks (– reading week)
  - 2 slots per week

    Friday 10:00-11:00 & 11:00-12:00, LB01

- Tutorials
  - 1 slot per week
  - Friday 13:00-14:00, LB01

- Labs / Assignments
  - Mondays 16:00-17:00, ICT Lab1&2
  - Tuesdays 16:00-17:00, ICT Lab1&2

Tutorials

- Error Detection and Correction
- Data Compression
- Error and Flow Control
- Point-to-Point Protocol / HDLC
- Medium Access Control
- Spanning Tree
- Internet Protocol
- Routing

Assignments

- Lectures
- Tutorials
- Labs/Assignments
  - Flow Control
  - Routing

- Attendance
  - Use common sense ☺

Assignments

- Assignment 1:

  Connection Management

  Marking:

  50% Implementation

  50% Documentation

- Assignment 2:

  Routing Protocols

Assignment Timeline

- Preliminary Deadlines:

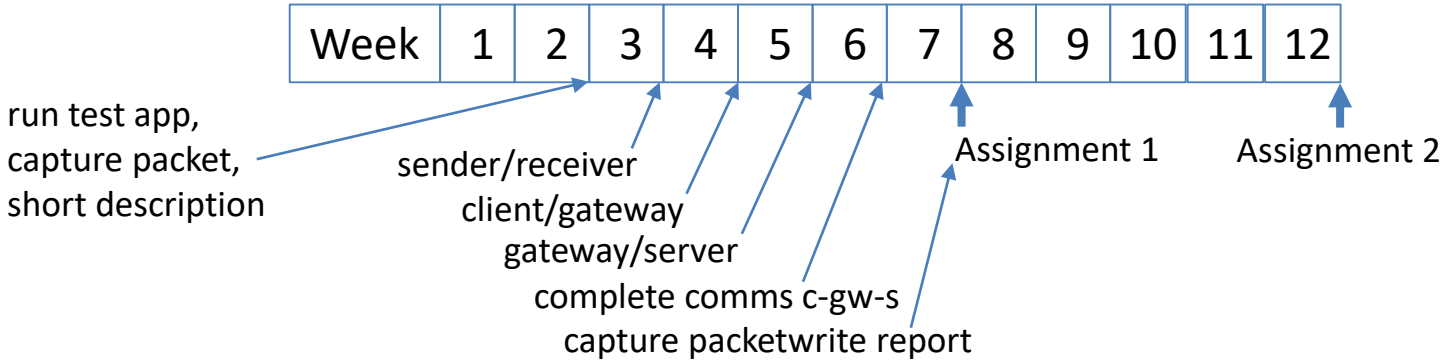
  10th November: Flow Control

  15th December: Routing Protocols

- Submission through Blackboard mymodule.tcd.ie
- Deadlines on Blackboard count

Changes from Last Year

- No Extensions past week 12....
- Weekly Milestones
  - Short report (Progress, Problems, Plan)



- Full Reports should include
  - Capture of traffic (Wireshark/TCPdump) and
  - Explanation of captured traffic

Recommended Books

- Andrew Tanenbaum & David Wetherall
  - Title: Computer Networks
  - ISBN-10: 0132126958

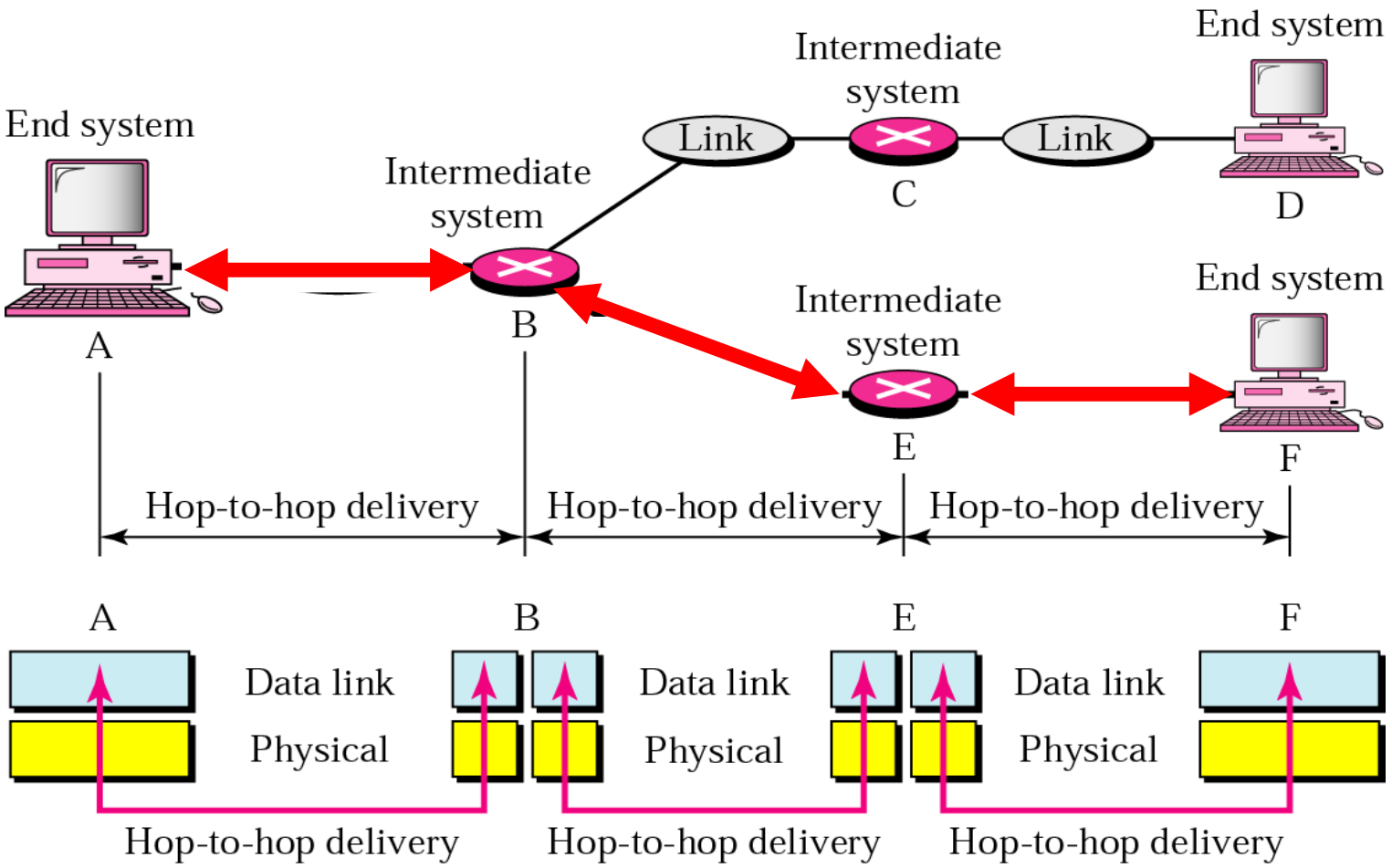
- Behrouz A. Forouzan
  - Title: Data Communications and Networking
  - ISBN: 9780071315869
  - Chapter 1, 2, 9-22 – 5th edition

Learning Outcome

What you should get out of this:

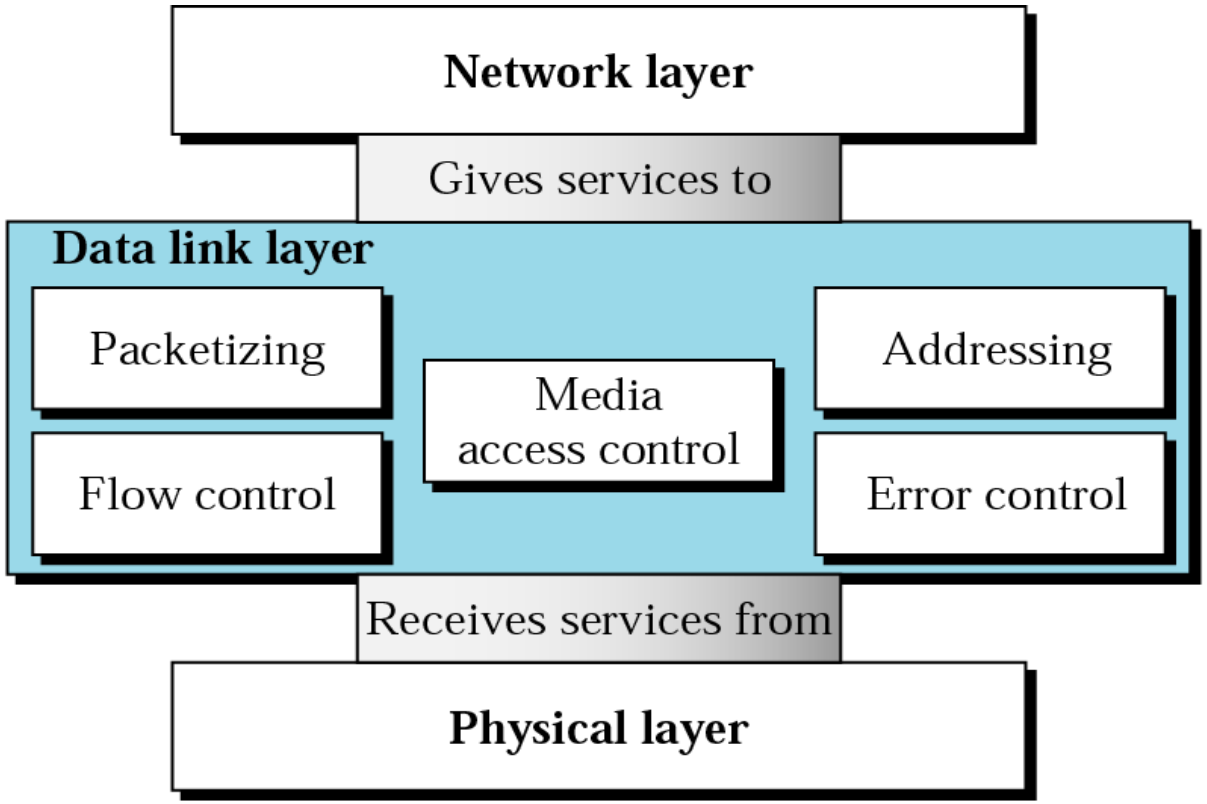
- Understanding of Protocol Design
- Understanding of Routing and IPv4
- Understanding Competition for the Medium
- Being able to use multi-threading

Link Layer



* Figure is courtesy of B. Forouzan

Duties of the Link Layer



The link layer is responsible for transmitting frames from one station to the next.

* Figure is courtesy of B. Forouzan

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin