

Computer Networks

Overview

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Fall 2022



Completion Summary

57 attempts have been completed

Question 1

When did you take your CSc226?

Within a year		25	(43.86 %)
More than a year, but less than three		23	(40.35 %)
More than three years ago		3	(5.26 %)
Not yet		6	(10.53 %)

Question 2

When did you take your CSc230?

Within a year		19	(33.33 %)
More than a year, but less than three		31	(54.39 %)
More than three years ago		3	(5.26 %)
Not yet		4	(7.02 %)

Question 3

When did you take your SEng265?

Within a year		31	(54.39 %)
More than a year, but less than three		21	(36.84 %)
More than three years ago		5	(8.77 %)
Not yet		0	(0 %)

Question 4

Have you taken CSc360?

Yes		26	(45.61 %)
Not yet		12	(21.05 %)
Also in the term		18	(31.58 %)
Not required by my program		1	(1.75 %)

First things first!

- Course website already alive on <http://bright.uvic.ca>
 - login and then find “Fall 2022 CSC 361”
 - can **pin** your current courses on the front page too
 - lectures, labs, tutorials, assignments, exercises, etc
 - discussion forum: get help and help others!
- Please volunteer for our course reps!
 - interact with the students attending this course
 - meet with course/lab instructors regularly
 - AAA: aggregate, anonymize, amplify
- CSc360 is not a prerequisite but highly recommended!

Reminder: Assignment 0 (A0)

- Due today 5pm: help us help you!
- On Brightspace
 - Assignments -> A0
 - things you already know about computer networks
 - things you want to know more about networks
 - what and how's your home Internet access? *
 - how can we help you and others better?
 - interested in IEEE/ACM, NSERC USRA, JCURA, etc?
 - any issues with logistics; **volunteer for course rep?**
 - set your Brightspace **profile picture** consistently
 - let me know you as well; for reference letters later, etc

Tutorials and Labs!

- **Tutorial starts in ECS116 1:30pm today!**
 - Please have your local software installed **in advance**
 - * see bright->forums->"software needed on your local computer"
- Lab starts in ECS360 next week
- Make sure you are enrolled in one of the sections
 - We have 6 lab sections Monday, Tuesday or Wednesday
 - Each section is up limited by 20 students
 - We cannot just “add” you in a full section
 - But you can switch with a fellow student
 - And also make it official in the system: through cscadvisor

Today's topic

- Internet in a nutshell, from the viewpoint of
 - users (human beings)
 - applications
 - things running on your computer and talking to another one over the network
 - computers
 - or formally “end systems” (ES)
 - networks
 - or formally “intermediate systems” (IS)
 - and more importantly, how are things put together?
 - or formally “network architectures”

Google or Alphabet?

- You have a newly installed computer or tablet
 - connected to the Internet, by wire or wireless
 - running a web browser, your favorite choice
 - and you type in *http://google.com*
- What will happen?
 - list as much as you can
 - from your experience
 - and the things you think should happen...

Application's view: Google...

- **\$ wget -d google.com**

- wget available on
linux.csc.uvic.ca

Resolving google.com... done.

caching google.com => **72.14.207.99**

connecting to google.com[72.14.207.99]:80... **connected.**

Created socket 4

---request begin---

GET / HTTP/1.0

User-Agent: Wget/1.10.2

Host: google.com

Accept: */*

Connection: Keep-Alive

Google: I am here...

- Continued from the last slide
HTTP request sent, awaiting response...
HTTP/1.0 301 Moved Permanently
Location: <http://www.google.com/>
Content-Type: text/html; charset=UTF-8
Date: Thu, 04 Sep 2008 07:36:45 GMT
Expires: Sat, 04 Oct 2008 07:36:45 GMT
Cache-Control: public, max-age=2592000
Server: GWS/2.1
Content-Length: 219
Connection: Keep-Alive
- Note: the above is not a verbatim copy*

Things involved

- You say “google.com”, I say “72.14.207.99”
 - Domain Name System (**DNS**)
 - User Datagram Protocol (**UDP**)
- “connected”
 - Transmission Control Protocol (**TCP**)
- “Created socket 4”
 - **Socket** Application Programming Interface (API)
- After “---request begin---”
 - HyperText Transfer Protocol (**HTTP**)

Network's view: from UVic to Google

• \$ **tracert** google.com

- traceroute NO LONGER available on linux.csc.uvic.ca

tracert: Warning: google.com has **multiple** addresses; using 72.14.207.99

tracert to google.com (72.14.207.99), 30 hops max, 38 byte packets

1 gw.net.**engr**.UVic.CA (142.104.127.254) 8.686 ms 1.471 ms 5.732 ms

...

5 csc1cled050.**bb**.uvic.ca (142.104.252.21) 1.375 ms 1.244 ms 1.156 ms

- traceroute sometimes fails to output for some hops due to security measures by ISPs

9/9/22

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CSC361

11

Why multiple addresses?

<http://www.traceroute.org/> or **tracert in windows**

Victoria, Vancouver, Seattle?!



- Continued from the last slide

8 UVicB-Policy1.**VICTX.BC.net** (207.23.241.221) 2.041 ms 1.821 ms

9 ra1cv-**ge3**-2-11.**gv**.bigpipeinc.com (64.251.72.41) 1.832 ms 1.937 ms

...

12 rc1wt-**pos**2-1.**wa**.shawcable.net (66.163.77.21) 7.415 ms 196.976 ms ...

13 six.**sea**01.google.com (198.32.180.17) 4.779 ms 4.769 ms 4.657 ms

14 72.14.233.55 (72.14.233.55) 23.586 ms 24.045 ms 23.684 ms

...

18 72.14.207.99 (72.14.207.99) 63.148 ms 63.026 ms 63.126 ms

More things involved

- “multiple addresses”, why?
 - Internet Protocol (**IP**) **addressing**
- “traceroute”
 - hop-by-hop **routing** in packet switching Internet
- “**gw**.net.engr.UVic.CA (142.104.127.254)”
 - router's name and address
- Links implied from i/f name, “...**ge**...”, “...**pos**...”
 - GE: Gigabit **E**thernet
 - POS: Packet over SONET

Computer's view

- “*Connected to the Internet*” means you or your Internet service provider has to know at least
 - computer's IP address
 - gateway's IP address
 - local DNS server's IP address
- In fact, in many cases you don't need to know
 - since they are configured automatically for you
 - e.g., Dynamic Host Configuration Protocol (DHCP)

Down to the wire

- **\$ tcpdump -i vlan1**

- available on linux.csc.uvic.ca
but CANNOT capture packets

08:36:35.235481 **arp** who-has 10.10.1.100 tell 10.10.1.1

08:36:35.235685 **arp** reply **10.10.1.100** is-at **00:17:9a:ba:9c:aa**

08:36:35.235769 IP 10.10.1.1.2051 > 72.14.207.99.80: **S**

2536105851:2536105851(0) win 5840 <mss

1460,nop,nop,sackOK,nop,wscale 0>

08:36:35.299498 IP 72.14.207.99.80 > 10.10.1.1.2051: **S**

4066950878:4066950878(0) **ack** 2536105852 win 1430 <mss

1430,nop,nop,sackOK,nop,wscale 6>

08:36:35.299939 IP 10.10.1.1.2051 > 72.14.207.99.80: . **ack** 1 win 5840

(App: “connected!”)

Oh, so many packets!

- Continued from the last slide

08:36:35.336792 IP 10.10.1.1.2051 > 72.14.207.99.80: P 1:76(**75**) ack 1
win 5840

08:36:35.400641 IP 72.14.207.99.80 > 10.10.1.1.2051: . ack 76 win 90

(App: “HTTP request sent, awaiting response...”)

08:36:35.407716 IP 72.14.207.99.80 > 10.10.1.1.2051: . 1:1431(**1430**) ack
76 win 90

08:36:35.408251 IP 10.10.1.1.2051 > 72.14.207.99.80: . ack 1431 win
8580

How to put these things together?

• Internet Protocol Suite (IPS)

- 5: application layer

- e.g., HTTP, DNS

- 4: transport layer

- e.g., TCP, UDP

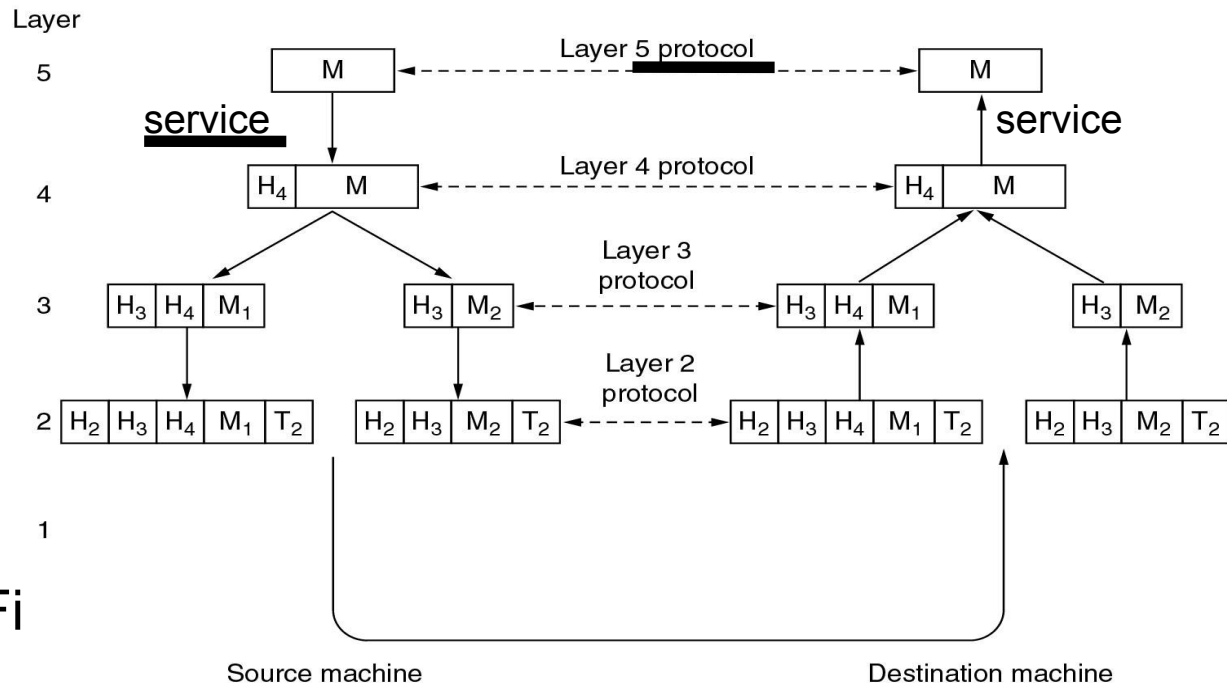
- 3: network layer

- IP

- 2: link layer

- e.g., Ethernet, WiFi

- 1: physical layer

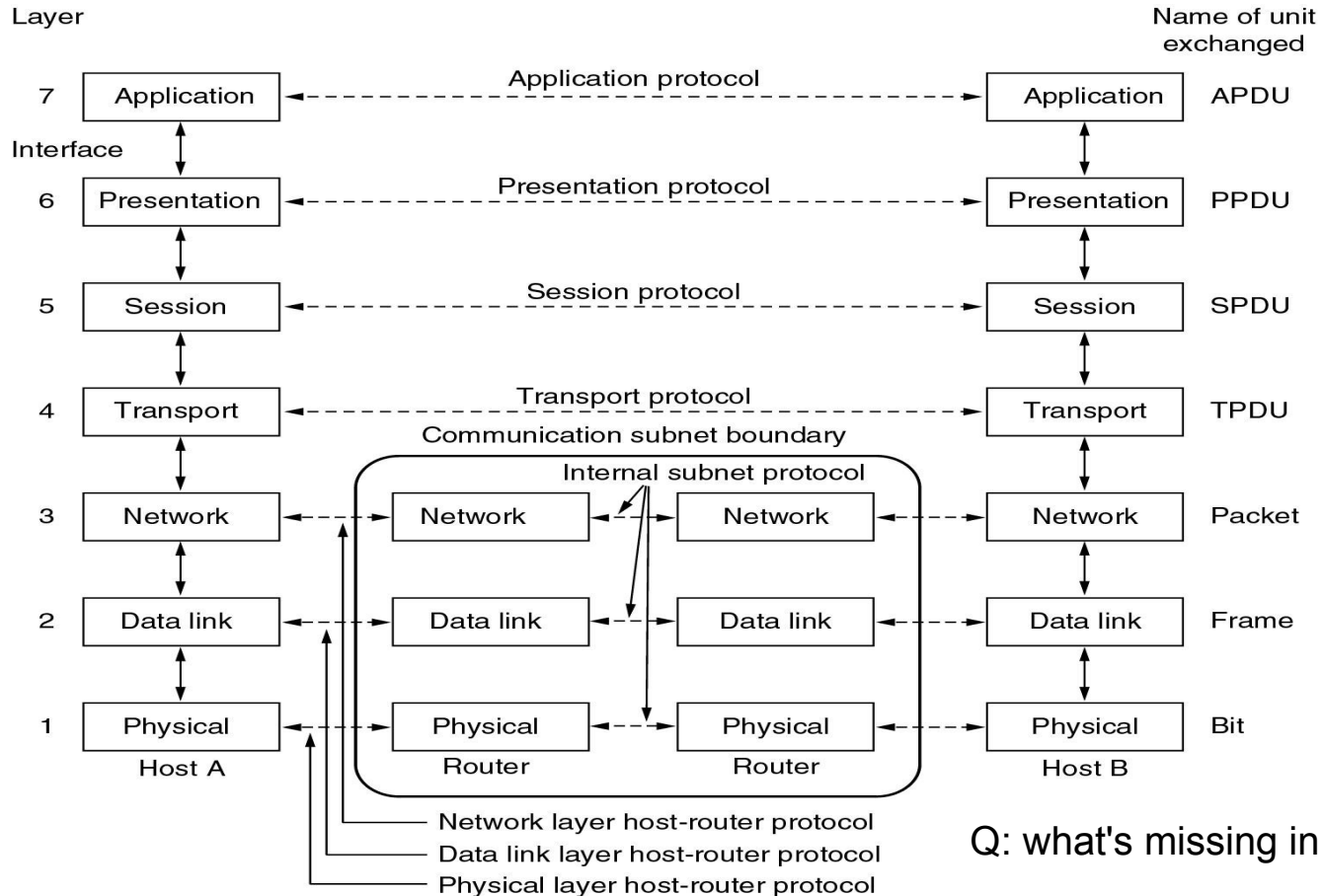


```

▶ Frame 6 (129 bytes on wire, 96 bytes captured)
▼ Ethernet II, Src: Cisco-Li_70:a9:ad (00:18:f8:70:a9:ad), Dst: pc-wan (00:17:9a:ba:9c:aa)
  ▶ Destination: pc-wan (00:17:9a:ba:9c:aa)
  ▶ Source: Cisco-Li_70:a9:ad (00:18:f8:70:a9:ad)
    Type: IP (0x0800)
▼ Internet Protocol, Src: 10.10.1.1 (10.10.1.1), Dst: 72.14.207.99 (72.14.207.99)
  Version: 4
  Header length: 20 bytes
  ▶ Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00)
    Total Length: 115
    Identification: 0x224d (8781)
  ▶ Flags: 0x04 (Don't Fragment)
    Fragment offset: 0
    Time to live: 64
    Protocol: TCP (0x06)
  ▶ Header checksum: 0xf5bb [correct]
    Source: 10.10.1.1 (10.10.1.1)
    Destination: 72.14.207.99 (72.14.207.99)
▼ Transmission Control Protocol, Src Port: clearvisn (2052), Dst Port: http (80), Seq: 1, Ack: 1, Len: 75
  Source port: clearvisn (2052)
  Destination port: http (80)
  Sequence number: 1 (relative sequence number)
  [Next sequence number: 76 (relative sequence number)]
  Acknowledgement number: 1 (relative ack number)
  Header length: 20 bytes
  ▶ Flags: 0x18 (PSH, ACK)
    Window size: 5840
  ▶ Checksum: 0xac4e [unchecked, not all data available]
▼ Hypertext Transfer Protocol
  ▶ GET / HTTP/1.1\r\n
    Host: 72.14.207.99\r\n
  [Packet size limited during capture: HTTP truncated]

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OSI reference model

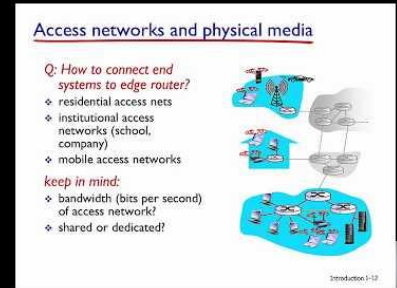


Q: what's missing in IPS?

Next lecture

- Access networks

- read Kurose&Ross: Computer Networking, 4+th Ed
 - term reading: csc361-toc-7ed.pdf on brightspace*
 - Video tutorial (see Brightspace -> Forums -> “the textbook we use” -> “video tutorial following the textbook”**)
- Explore further
 - traceroute to www.google.com from school and home?
 - by your own computer or wait to use PicoLab in ECS360
 - share and discuss them on Brightspace forum
 - What’s the difference between from school vs home?



9/9/22

CSC361

20

* yellow: required; blue: informational

* we will follow the chapter order

** anand is kind to allow our students to mirror it