Computer Networks

Term Review

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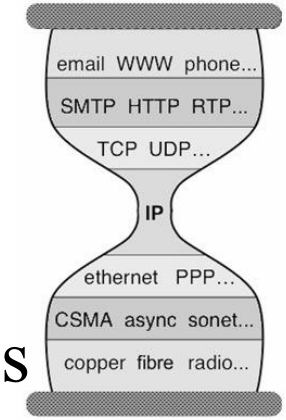
Fall 2020

It's online **participation** too ;-)

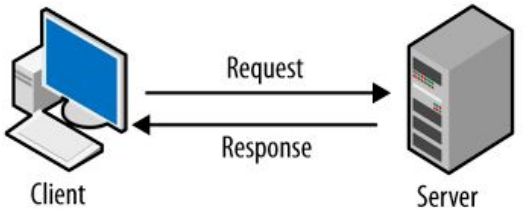
about computer networks:
I will answer or find
someone who can do so

Term Review

- Network architecture
  - layered network protocol architecture
  - access network technologies
  - backbone network technologies and structures



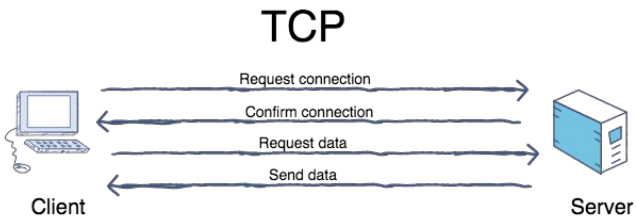
- Application layer
  - HTTP: client-server, request-response
    - linked vs embedded objects; weak vs strong consistency
    - non-persistent vs persistent connection
  - DNS: hierarchical structure
    - recursive vs iterative query

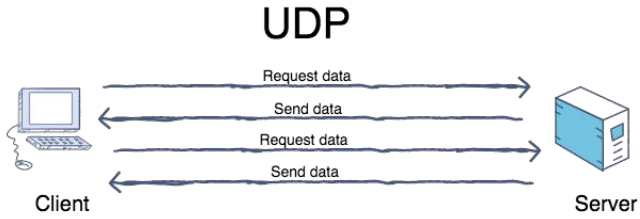


* P1 (SWS): socket() programming for client/server and request-response applications; select(): event-driven programming

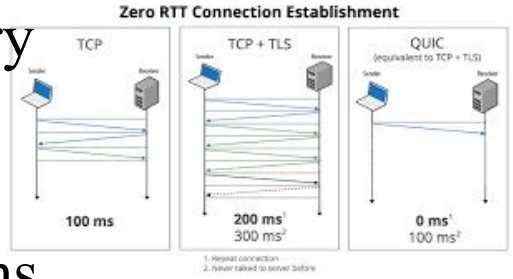
Why?
How?
What?

Review (2)





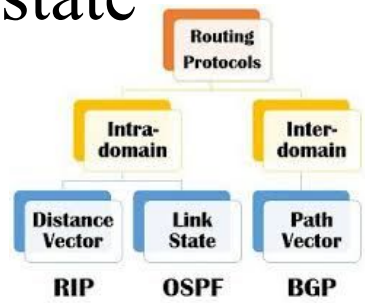
- Transport layer
  - UDP: connectionless, unreliable
    - port multiplexing
  - TCP: connection-oriented, reliable
    - connection management: SYN/FIN packet handshake
    - flow control: seqno, ackno, winsize
    - error control: detection, notification, recovery
      - packets get lost, corrupted, reordered, duplicated
      - TCP/IP checksum
    - congestion control: principle and mechanisms
      - slow start, congestion avoidance, timeout retransmit, fast retransmit
      - fast recovery



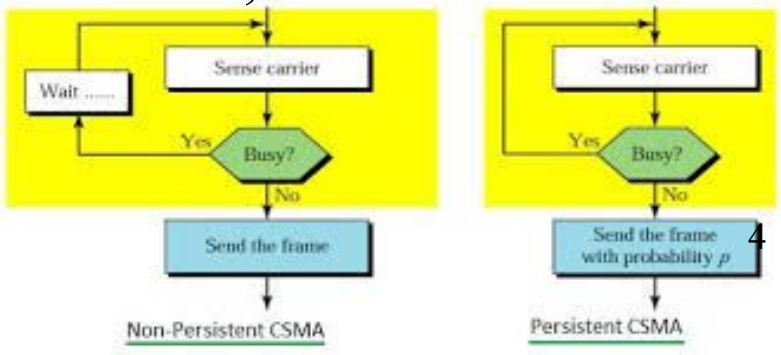
* P2 (RDP): TCP-like connection management and flow and error control based on UDP (sounds like Google's QUIC? ;-)

Review (3)

- Network layer
  - IP addressing: class-based, classless, NAT, subnet
  - routing algorithms: distance vector vs link state
  - routing protocols: RIP, OSPF, BGP



- Link layer
  - frame, flow and error control: HDLC, SLIP, PPP
  - media access control: IEEE 802.3, IEEE 802.11
    - Aloha, *p*-persistent CSMA, CSMA/CD, CSMA/CA
  - interworking: STP, ARP
    - switches, routers



* ~~*P3 (routing and forwarding)*~~ => P3 (SoR): SWS (P1) over RDP (P2)

More systems/networks courses!

- Wireless Mobile Networks (CSC463)
- ***Advanced Computer Networks (CSC466)***
- Advanced Communication Networks (CSC467)
- Network Management and Security (Topics/DS)
- **Networking degree option in CS/SENG**
- Real-time/Embedded Systems (CSC460)
- *Multimedia Systems (CSC461)*
- Distributed Systems (CSC462)

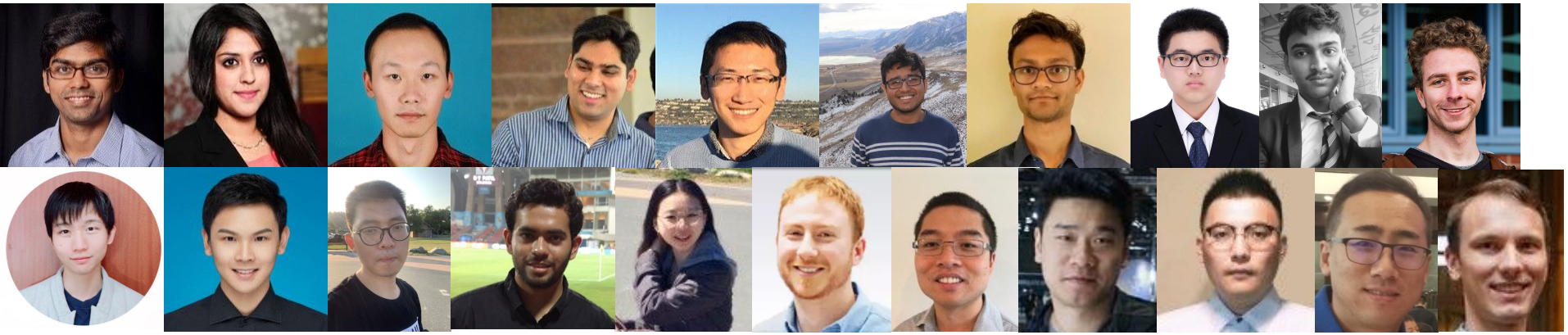
FUN: it's FUN to understand networks!

* CSC461 and CSC466 course projects demo: http://tinyurl.com/uvicfun

One more message...

- Research opportunities for undergraduates
  - NSERC USRA, UVic JCURA
  - MITACS internship, on-campus coop
  - directed studies (490), technical projects (499), etc
- Graduate study at UVic
  - UVic CS: systems/networking, theory, applications
  - UVic ECE: communications networks, ...
  - financial support
    - Vanier CGS, NSERC CGS/PGS, UVic Fellowship
    - research and teaching assistantship, coop

Our undergrad research students



Where they have been after UVic

Thanks!

- Our Lab/Tutorial instructor and Grad TA
  - Senior Lab Instructor (SLI): Victoria
  - Grad TA: Zhiming, Wenjun, Rui

    * nominate them to Andy Farquharson Award for Excellence in Graduate Student Teaching
- Also our lab support staff & course reps
  - Tomas Bednar, Robert Taylor, Kathryn Wilson, et al
  - Chris, Jennifer, Emily, Owen, and others
- We had an all-new lab platform and assignments
  - We will keep improving them for future offerings!

* let me know if you have any suggestions from experience

PicoHub: the PicoNet in a Hosted JupyterLab Cloud

Jianping Pan | University of Victoria, BC, Canada | Pan@UVic.CA

* readandspell.com

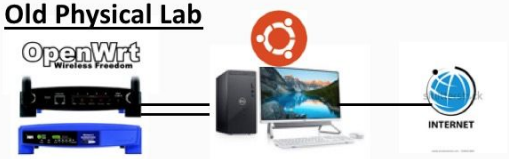
* dreamstime.com

Why? How?

1. Lightweight on students laptop
2. Lightweight on lab provisioning

3. Fun labs!

Old Physical Lab

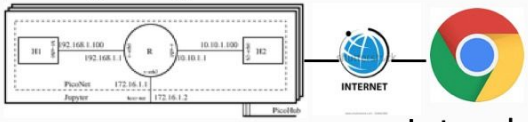


Intermediate Virtual Lab

Works well in a Physical Lab, *not* on students laptop

Physical Lab *not* accessible
VM too heavy on laptop
MiniNet too powerful

New Lightweight Virtual Hosted Lab



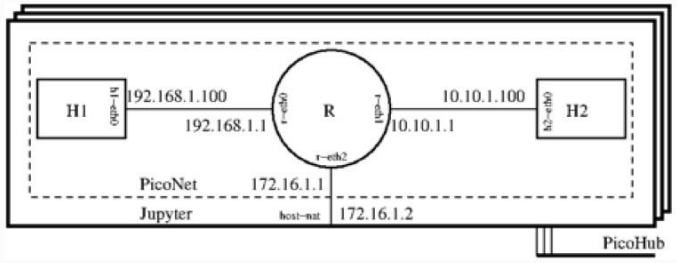
Hosted in the Cloud

Just a web browser on students laptop

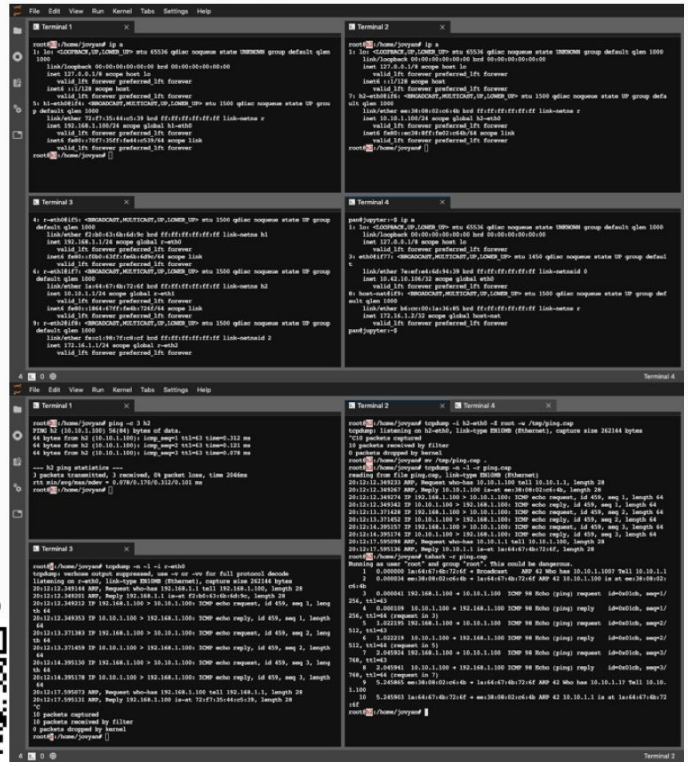
University of Victoria | Learning and Teaching Support and Innovation

PANDALAB

PicoNet: the Minimized MiniNet



https://picohub.csc.uvic.ca



```
root@h1:/home/jovyan# ping -c 3 h2
PING h2 (10.10.1.100) 56(84) bytes of data.
64 bytes from h2 (10.10.1.100): icmp_seq=1 ttl=63 time=0.312 ms
64 bytes from h2 (10.10.1.100): icmp_seq=2 ttl=63 time=0.121 ms
64 bytes from h2 (10.10.1.100): icmp_seq=3 ttl=63 time=0.078 ms
--- h2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2046ms
rtt min/avg/max/mdev = 0.078/0.170/0.312/0.101 ms

root@r:/home/jovyan# tcpdump -n -l -i r-eth0
tcpdump: verbose output suppressed, use -v or -vv for full protocol
listening on r-eth0, link-type EN10MB (Ethernet), capture size 262144
20:12:12.349144 ARP, Request who-has 192.168.1.1 tell 192.168.1.100,
20:12:12.349201 ARP, Reply 192.168.1.1 is-at f2:b0:63:6b:6d:9c,
20:12:12.349212 IP 192.168.1.100 > 10.10.1.100: ICMP echo request, id
20:12:12.349353 IP 10.10.1.100 > 192.168.1.100: ICMP echo reply, id
20:12:13.371383 IP 192.168.1.100 > 10.10.1.100: ICMP echo request, id
20:12:13.371459 IP 10.10.1.100 > 192.168.1.100: ICMP echo reply, id
20:12:14.395130 IP 192.168.1.100 > 10.10.1.100: ICMP echo request, id
20:12:14.395178 IP 10.10.1.100 > 192.168.1.100: ICMP echo reply, id
20:12:17.595073 ARP, Request who-has 192.168.1.100 tell 192.168.1.1,
20:12:17.595131 ARP, Reply 192.168.1.100 is-at 72:f7:35:44:c5:39,
^C
10 packets captured
10 packets received by filter
0 packets dropped by kernel

root@h2:/home/jovyan# tcpdump -i h2-eth0 -Z root -w /tmp/ping.cap
tcpdump: listening on h2-eth0, link-type EN10MB (Ethernet), capture
size 262144 bytes
^C10 packets captured
10 packets received by filter
0 packets dropped by kernel
root@h2:/home/jovyan# mv /tmp/ping.cap .
root@h2:/home/jovyan# tshark -r ping.cap
Running as user "root" and group "root". This could be dangerous.
 1   0.000000 1a:64:67:4b:72:6f → Broadcast    ARP 42 Who has
 2   0.000034 ee:38:08:02:c6:4b → 1a:64:67:4b:72:6f ARP 42 10.10.1.100
 3   0.000041 192.168.1.100 → 10.10.1.100  ICMP 98 Echo (ping)
 4   0.000109  10.10.1.100 → 192.168.1.100 ICMP 98 Echo (ping)
 5   1.022195 192.168.1.100 → 10.10.1.100  ICMP 98 Echo (ping)
 6   1.022219  10.10.1.100 → 192.168.1.100 ICMP 98 Echo (ping)
 7   2.045924 192.168.1.100 → 10.10.1.100  ICMP 98 Echo (ping)
 8   2.045941  10.10.1.100 → 192.168.1.100 ICMP 98 Echo (ping)
 9   5.245865 ee:38:08:02:c6:4b → 1a:64:67:4b:72:6f ARP 42 Who has
10   5.245903 1a:64:67:4b:72:6f → ee:38:08:02:c6:4b ARP 42 10.10.1.1
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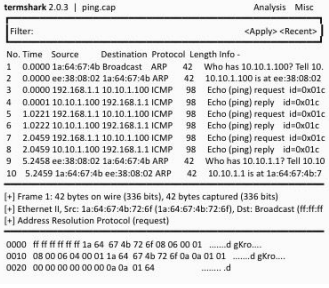
termshark 2.0.3 | ping.cap
Analysis Misc
Filter:
<Apply> <Recent>
No. Time Source Destination Protocol Length Info
1 0.0000 1a:64:67:4b Broadcast ARP 42 Who has 10.10.1.100? Tell 10.
2 0.0000 ee:38:08:02 1a:64:67:4b ARP 42 10.10.1.100 is at ee:38:08:02
3 0.0000 192.168.1.1 10.10.1.100 ICMP 98 Echo (ping) request id=0x01c
4 0.0001 10.10.1.100 192.168.1.1 ICMP 98 Echo (ping) reply id=0x01c
5 1.0221 192.168.1.1 10.10.1.100 ICMP 98 Echo (ping) request id=0x01c
6 1.0222 10.10.1.100 192.168.1.1 ICMP 98 Echo (ping) reply id=0x01c
7 2.0459 192.168.1.1 10.10.1.100 ICMP 98 Echo (ping) request id=0x01c
8 2.0459 10.10.1.100 192.168.1.1 ICMP 98 Echo (ping) reply id=0x01c
9 5.2458 ee:38:08:02 1a:64:67:4b ARP 42 Who has 10.10.1.1? Tell 10.10
10 5.2459 1a:64:67:4b ee:38:08:02 ARP 42 10.10.1.1 is at 1a:64:67:4b:7
[+] Frame 1: 42 bytes on wire (336 bits), 42 bytes captured (336 bits)
[+] Ethernet II, Src: 1a:64:67:4b:72:6f (1a:64:67:4b:72:6f), Dst: Broadcast (ff:ff:ff
[+] Address Resolution Protocol (request)
0000 ff ff ff ff ff ff 1a 64 67 4b 72 6f 08 06 00 01 ....d gKro....
0010 08 00 06 04 00 01 1a 64 67 4b 72 6f 0a 0a 01 01 ....d gKro....
0020 00 00 00 00 00 00 0a 0a 01 64 .....d
```

More Lab modules on HTTP, DNS, TCP, UDP IP, NAT, ICMP, routing Ethernet, ARP and more at

http://tinyurl.com/picohub

Thanks: Mantis, Miguel, Tomas Victoria, Zhiming, Rui, Wenjun

ACM SIGITE Information Technology Education
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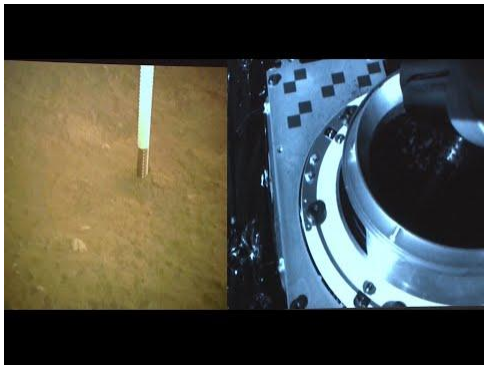
Thanks for an *all-online* Fall 2020!

More questions and new updates?

now or in the future

drop a line to

pan@uvic.ca



* also course experience survey http://ces.uvic.ca