Computer Networks

Access Networks

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Fall 2022

Feedback on your A0

- Please help us help you better
  - we have a very wide spectrum of students
  - a lot of interested topic, and we cover basics first
  - lectures, tutorials and labs: why and what for?
    - written assignment (w1) and weekly homework (a*)
    - programming assignments (p*)
    - midterm exams (m*)
    - we need more course reps—please volunteer!
    - *add your mugshot to brightspace profile photo*

First things first

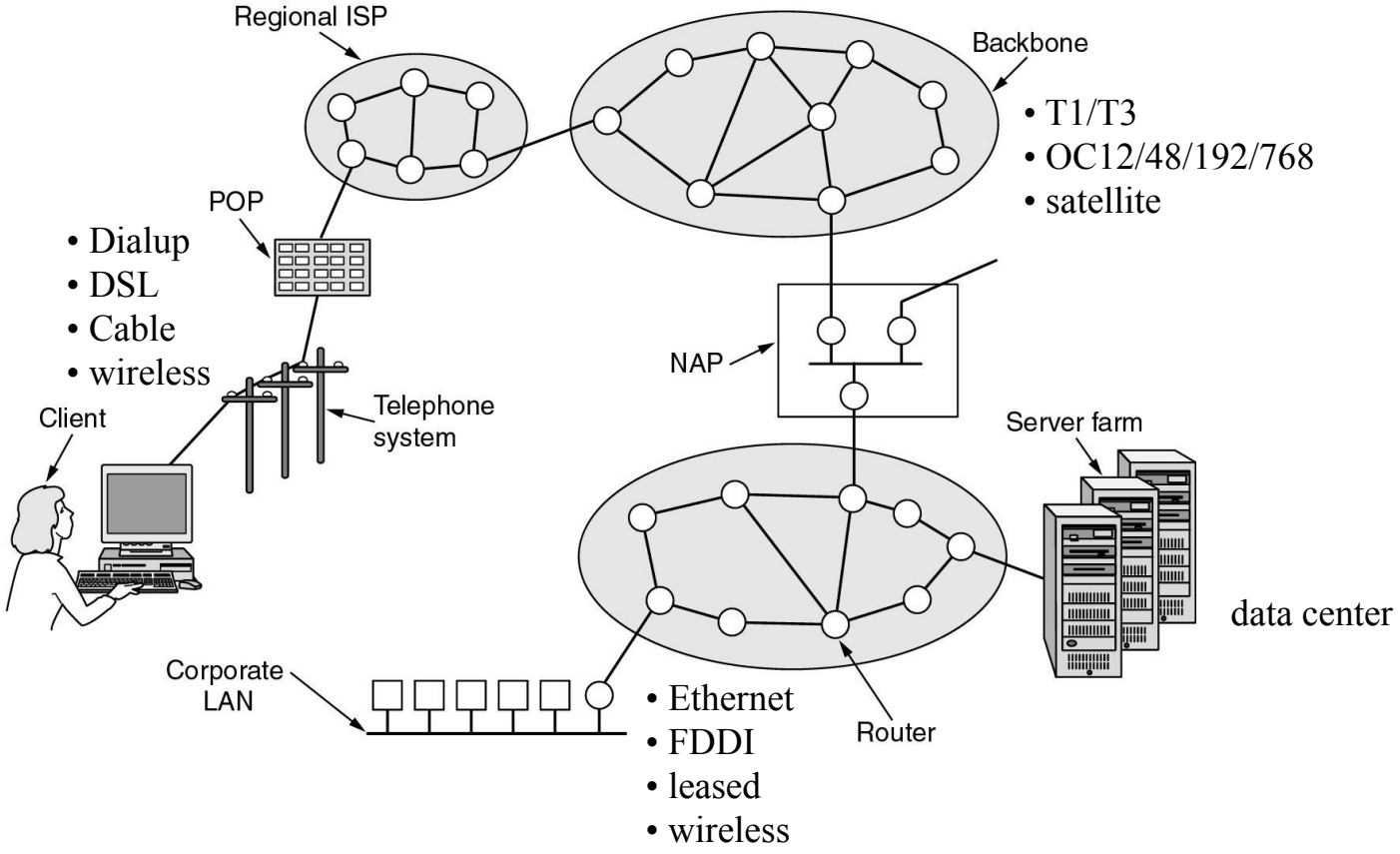
- Lab started from this Monday for B01/02!
  - more on Tuesday and Wednesday in ECS360
    - login with your CSc account *** UVic NetLink ID authentication**
    - say “picolab” in a Linux Terminal
  - first lab session *** engrcard@engr.uvic.ca for keycard issues**
    - get familiar with PicoNet (Dockerized in Linux KVM)
    - get familiar with tcpdump (in PicoNet)
    - download captured files to analyze in Wireshark
    - try some examples seen in the lectures and tutorial
    - *refresh Python (and socket) programming*

do a1 during lab 1 too!

Today's topic

- Internet access technologies
  - goal: to understand the basic communication technologies underneath the Internet
    - Internet access, from home or at work
    - **a little bit EE-flavored**
    - but very important for CS/CE/SENG/etc as well
      - networking is jointly pursed by both EE and CS
  - network acronyms (you will see a lot of them!)
    - google: internetworking terms and acronyms
    - https://www.cisco.com/c/en/us/td/docs/ios/system/messages/guide/sm_cngls.html

“The Internet”



* nowadays a lot of mobile access too!

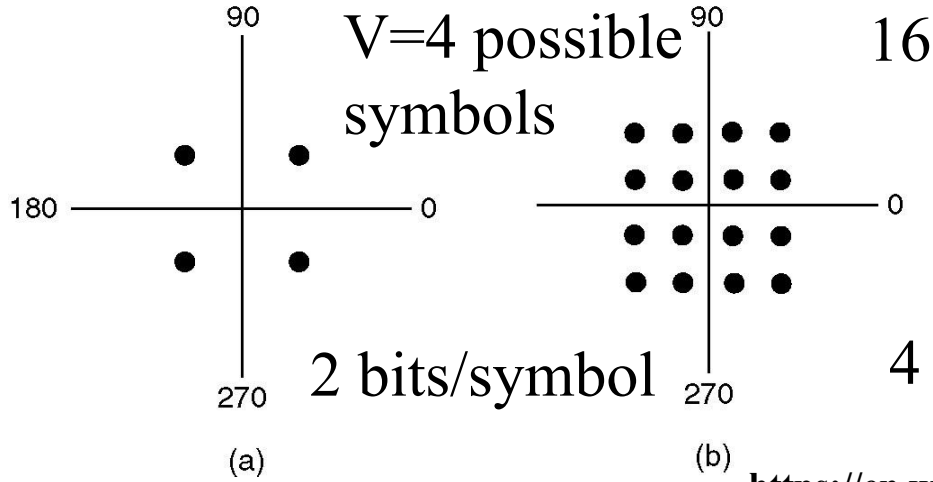
http://en.wikipedia.org/wiki/Dial-up_Internet_access check youtube too!

Internet access: phone line

- Analog dial-up
  - to computer w/ ISA, PCI, serial, USB
  - to modem w/ RJ11
  - to telephone line
    - unshielded twisted pair (UTP) or flat
  - up to 56 Kbps downstream
- Digital access
  - ISDN: 2x64Kbps (2B+D)

(a)

* ALL Old Modem Sounds (300 baud to 56K) https://www.youtube.com/watch?v=ckc6XSSh52w

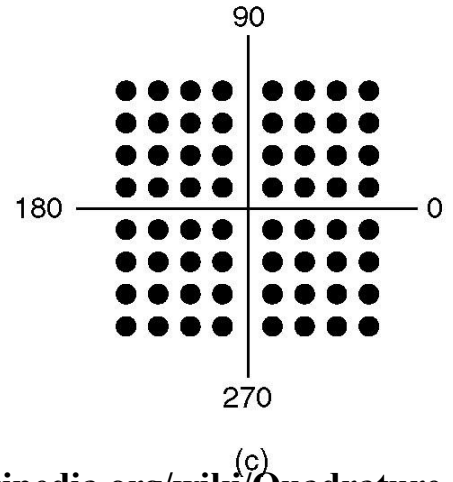


V=4 possible symbols

2 bits/symbol

16

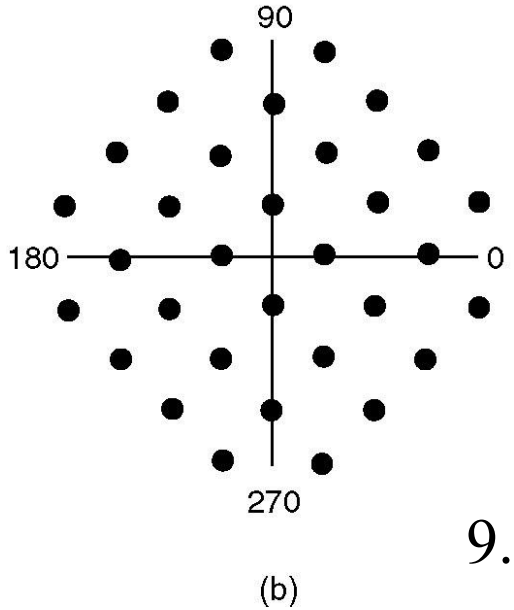
4



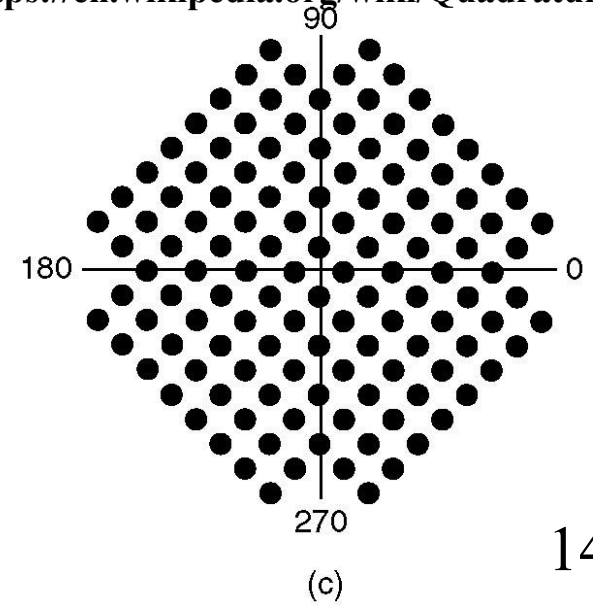
64-QAM

6

https://en.wikipedia.org/wiki/Quadrature_amplitude_modulation



9.6Kbps



14.4Kbps

How to pack more info in one symbol? minimum euclidean distance?

More on modems

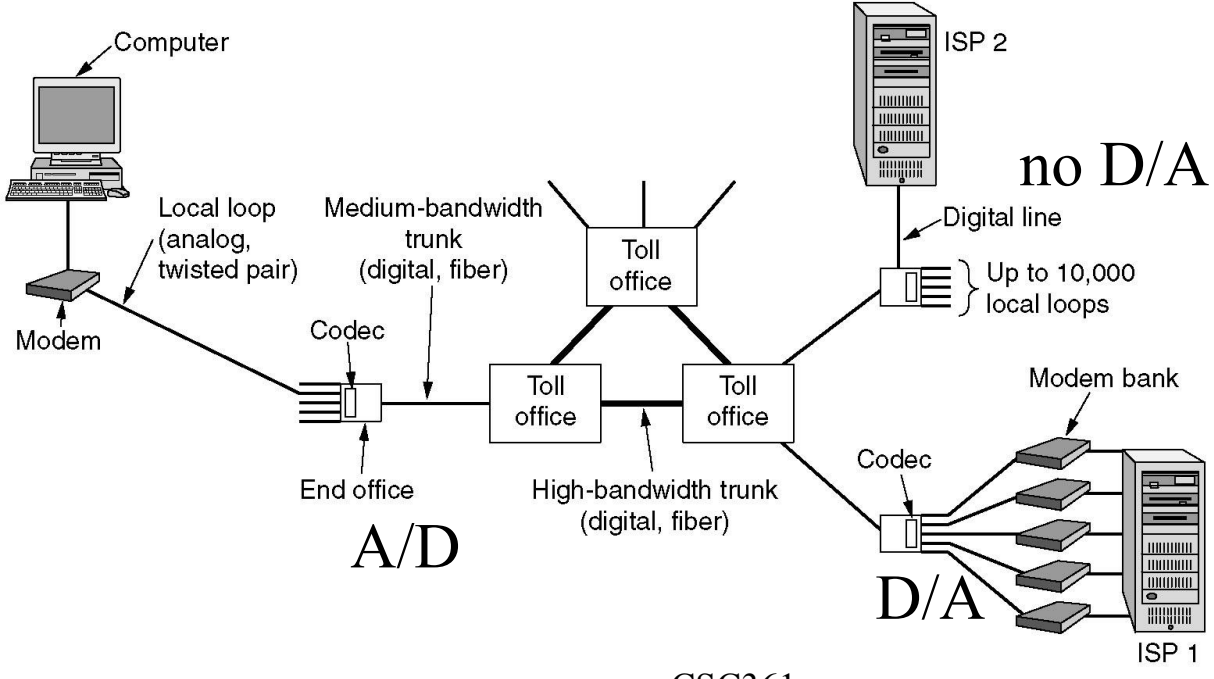
- Nyquist limit (idealistic, noiseless channel)
  - $2H \log_2 V$ bps
- Shannon limit (noisy channel)
  - $H \log_2 (1+S/N)$ bps
    - analog local loop: H=3000~4000Hz; S/N=30**dB**=10^3
- Bandwidth, sample, symbol, bit, data rate
  - (bits / symbol) * (symbols / second) = bps
    - **baud** rate: 2400; data rate: 9.6, 19.2, 28.8, 33.6Kbps

H: channel bandwidth
V: # of different kinds of symbols
S: signal
N: noise
S/N: signal-to-noise ratio (SNR)

* 10dB=1B=10^1 up limit? Calculation on blackboard

Dial-up ISPs

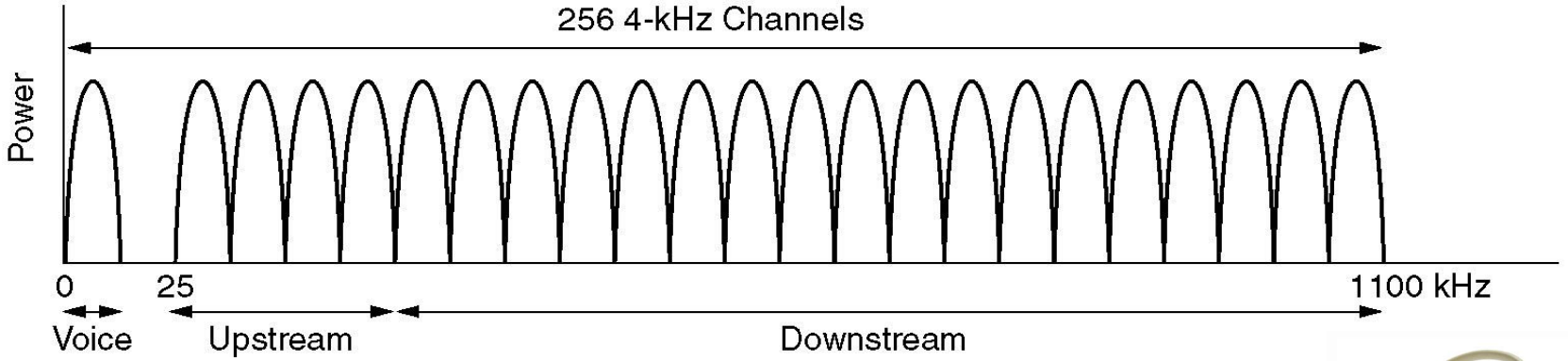
- 56Kbps?
  - increased *S/N*, asymmetric *H*

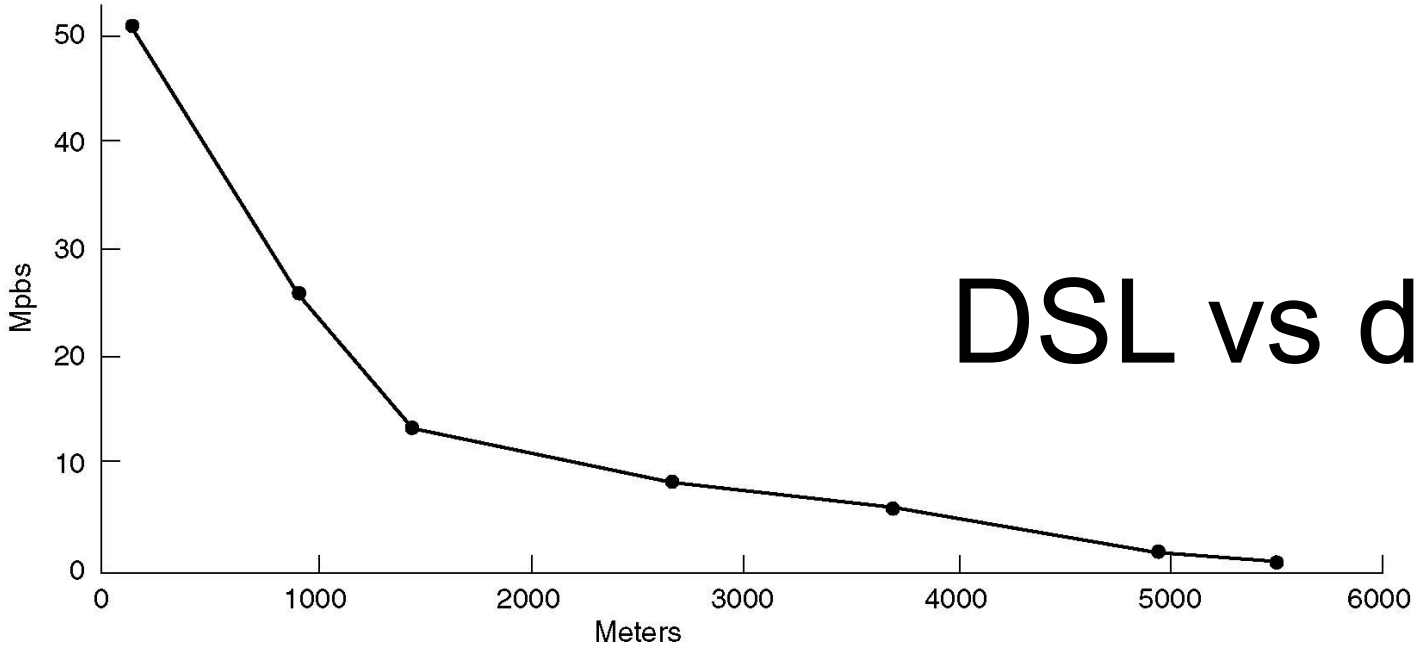


ISP 1 vs 2: which one is faster?

Digital subscriber lines

- Asymmetric DSL (ADSL)
  - free up more *H*
  - frequency division multiplexing (FDM)
    - or discrete multi-tone (DMT)
    - telephone: filter for regular phones
    - upstream: small bandwidth
    - downstream: larger bandwidth
  - DSL modem
    - Ethernet or USB connection to computer/router





DSL vs distance

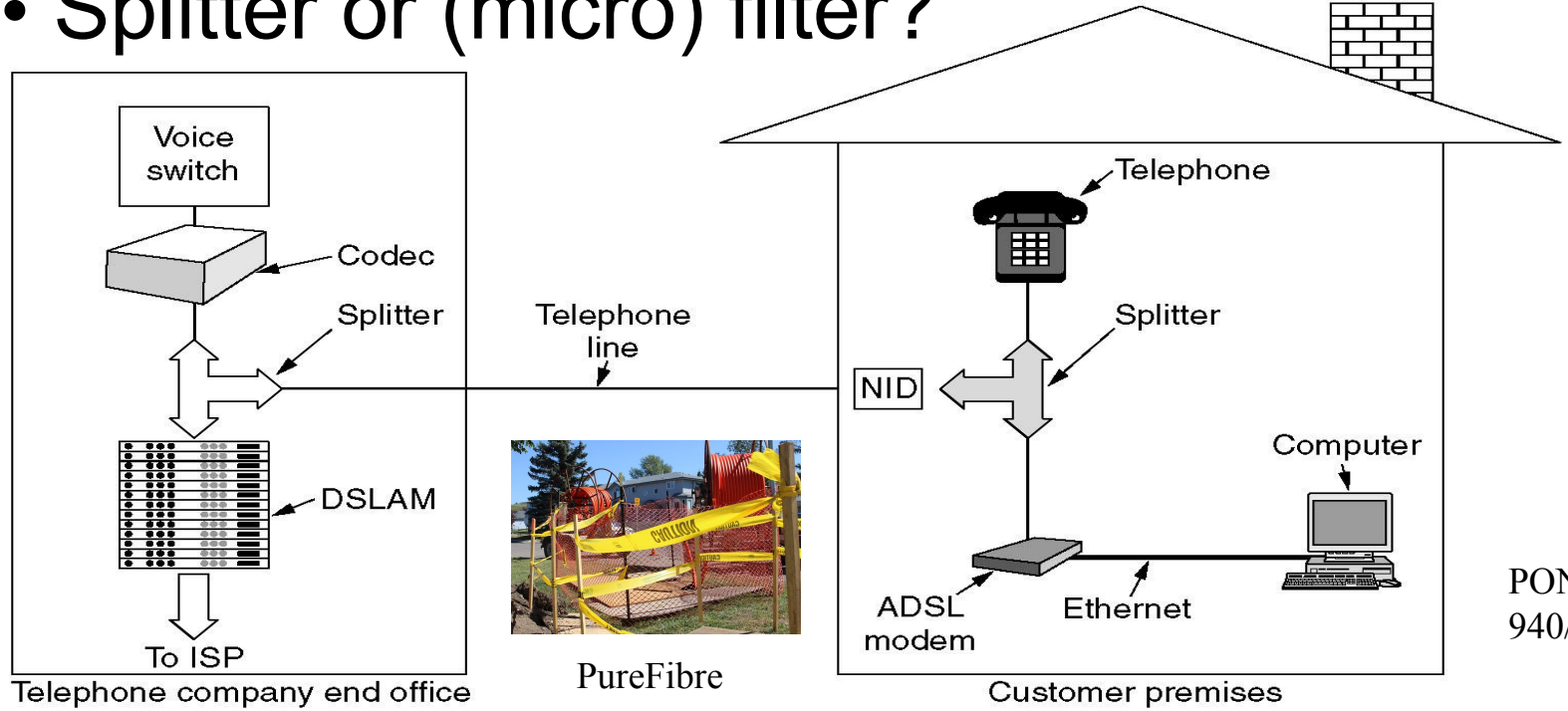
tech check: what's the latest offering from Telus? PureFibre?

VDSL2 3~15/1, 5~25/5, 20~50/10, 150/50
pair bonding
12~30MHz
200Mbps D

DSL/Fiber ISPs

2.5Gbps

- Splitter or (micro) filter?



PON? AON?
940/940

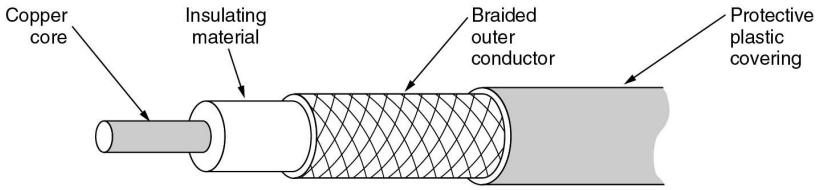
Big green box?

ADSL, ADSL2+, VDSL2, optik tv/internet?

TV: ~6MHz/channel

Internet access: cable line

- Traditionally, cable TV is 1-way broadcast
  - one-way amplifier
  - shared coaxial cable



- Internet access through HFC (DOCSIS)
  - two-way communication channels
    - small upstream bandwidth
    - larger downstream bandwidth
  - smaller (shared) cable segment
    - security

DOCSIS3.1'13
channel bonding
4096QAM
10/1Gbps D/U

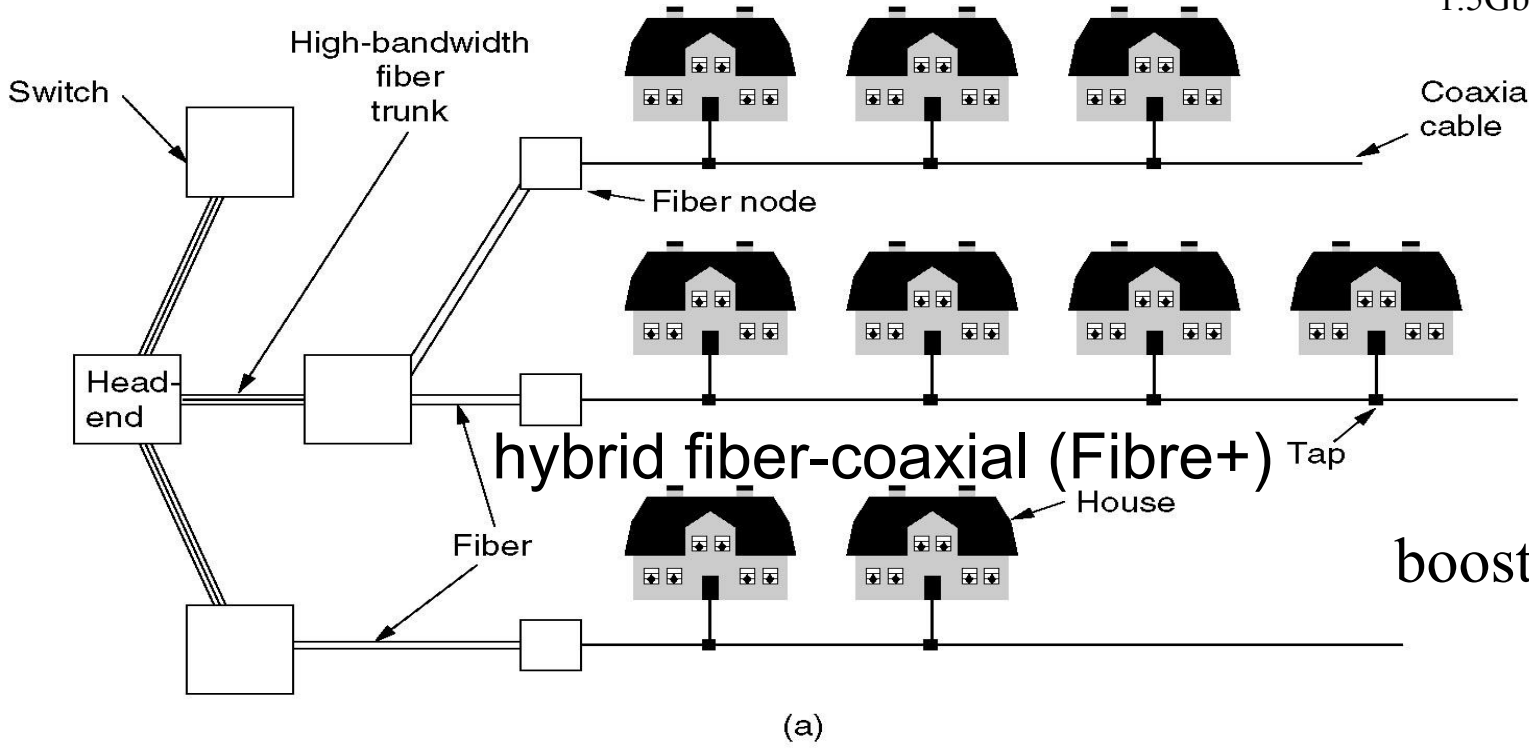
Coaxial vs UTP

Analog->digital over-the-air/cable TV

up to 5/0.5, 15/0.5, 30/5, 150/15?

HFC ISPs

1.5Gbps/100Mbps



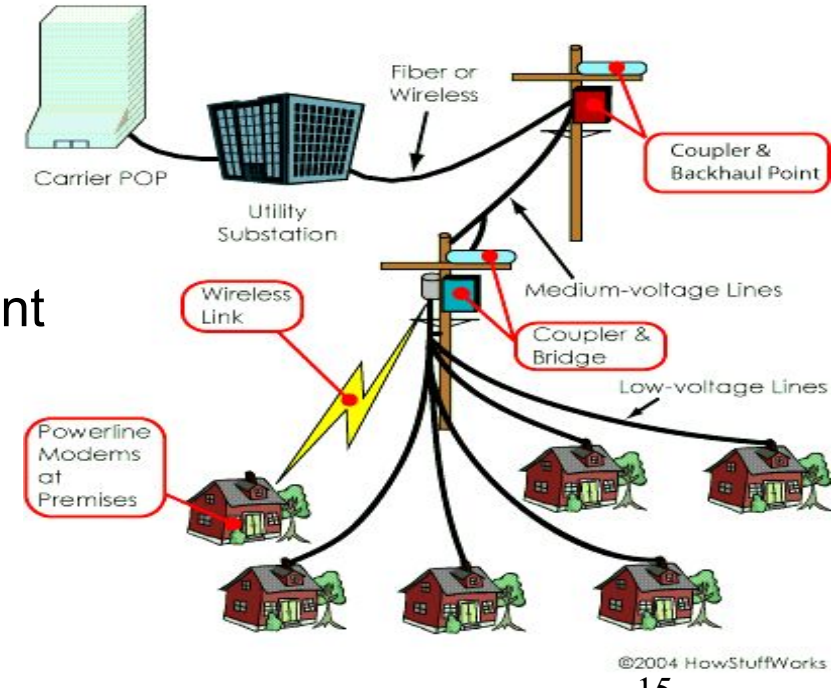
boost mode?

- Cable vs DSL

Big black box? tech check: what's the latest offering from Shaw?

Internet access: powerline

- Broadband over Power Line (BPL)
  - high voltage lines
    - very noisy
  - medium voltage lines
    - coupler or repeater
      - to bypass transformer
  - low voltage lines
    - bridge
      - wired/wireless access point
    - customer
      - plug-and-play
- Challenges
  - noisy channel
  - frequency interference

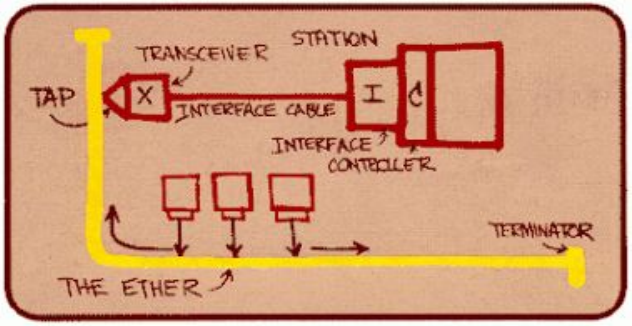


Home networking

- Broadband home networks
  - IPTV, PVR, etc whole-house entertainment apps
- Ethernet
  - preferred, but if non-existence, rewiring is costly
- No-new-wires
  - Phoneline
    - Home Phone Networking Alliance (HPNA) in ATT U-verse
  - Cableline
    - Multimedia over Coax Alliance (MoCA) in Verizon FiOS
  - Powerline
    - Home Powerline Alliance (HPPA)
- Wireless (WiFi)

NNW: http://ieeexplore.ieee.org/iel5/4656373/4664131/04664296.pdf

Internet access: LAN



- UVicNet: 10/100Mbps switched Ethernet
  - RJ45
    - old days: AUI, BNC w/ coaxial, shared
  - UTP Cat3: 10Mbps
  - UTP Cat5: 100Mbps
    - more twists per inch
- ResNet: 10Mbps switched
  - was 10Mbps shared

ECS or newer: GigE to desktop!

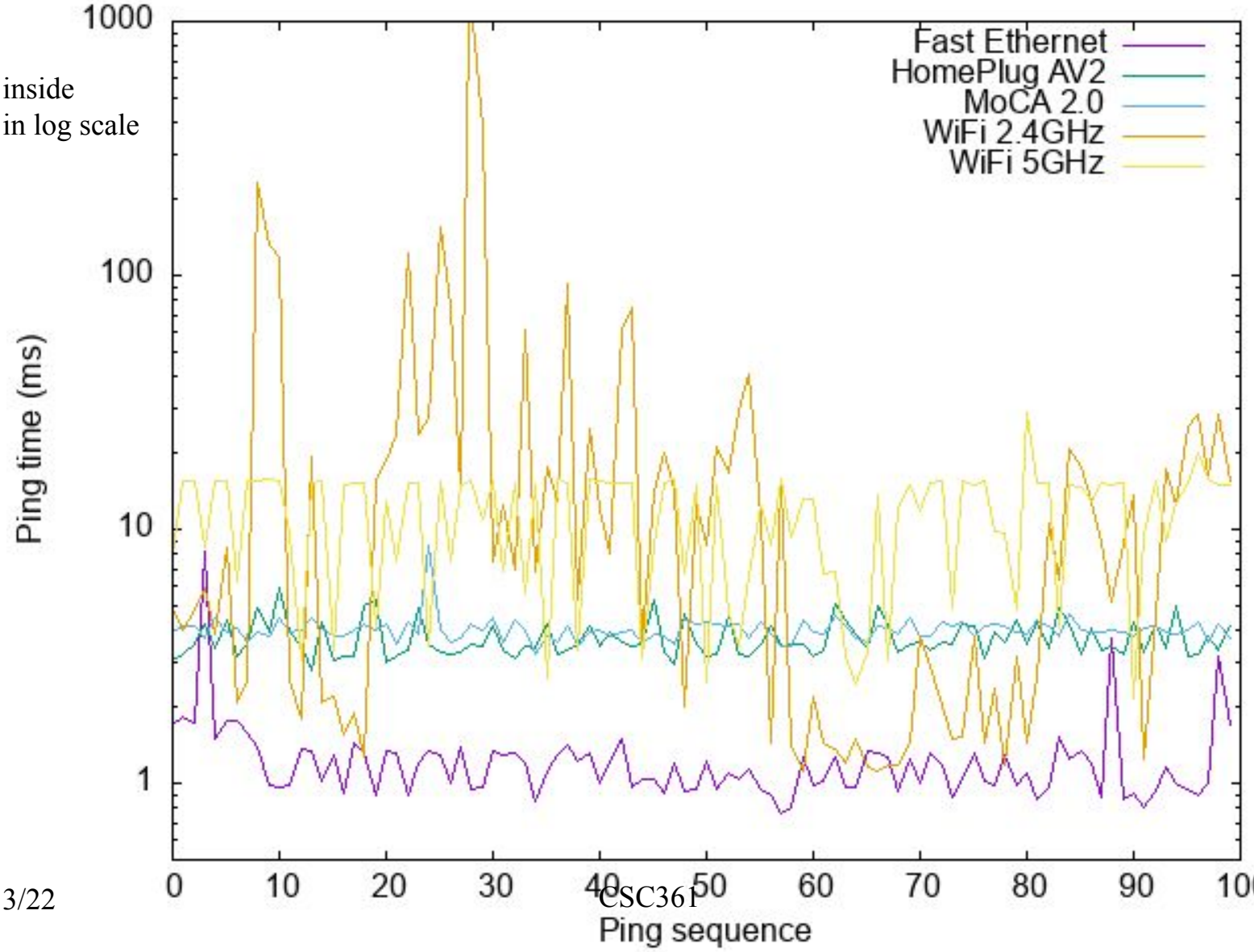
Internet access: WLAN

- WiFi (e.g., UVic AirNet)
  - 802.11b: 2.4GHz, 100ft@11Mbps
    - direct sequence spread spectrum
    - 11 overlapping channels
    - channel 1, 6, 11 independent
  - 802.11a: 5GHz, 54Mbps
    - orthogonal frequency division multiplexing
  - 802.11g: 2.4GHz, 54Mbps
- Security

802.11n?
802.11ac?
802.11ax?

UVic, UVicStart, eduroam?

* delay inside
a home in log scale



Internet access: WirelessMAN

- "Wireless cable"
  - MMDS: 198MHz@2.5GHz
    - range: 25~50km; 3Mbps downstream 200Kbps up
  - LMDS: 1.3GHz@28~31GHz
    - range: 2~5km, line-of-sight!
    - wireless DSL: 36Gbps downstream 1Mbps up/sector

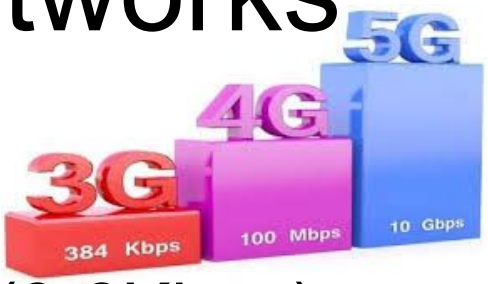
- IEEE 802.16: WiMax
  - 10~66GHz (802.16a: 2-11GHz NLOS), OFDM
    - Rogers "Portable Internet", Bell "WiMax Unplugged"

multi-channel multi-point vs local multi-point distribution service

Wireless*AN

- ***P***ersonal area network (IEEE 802.15)
  - range: up to 10m
  - Bluetooth (802.15.1): 1Mbps; headset-to-phone
  - UWB (802.15.3): 400Mbps; wireless USB
- ***L***ocal area network (802.11)
  - range: up to 100m
- ***M***etropolitan area network (802.16)
  - range: up to 50km

Internet access: cellular networks

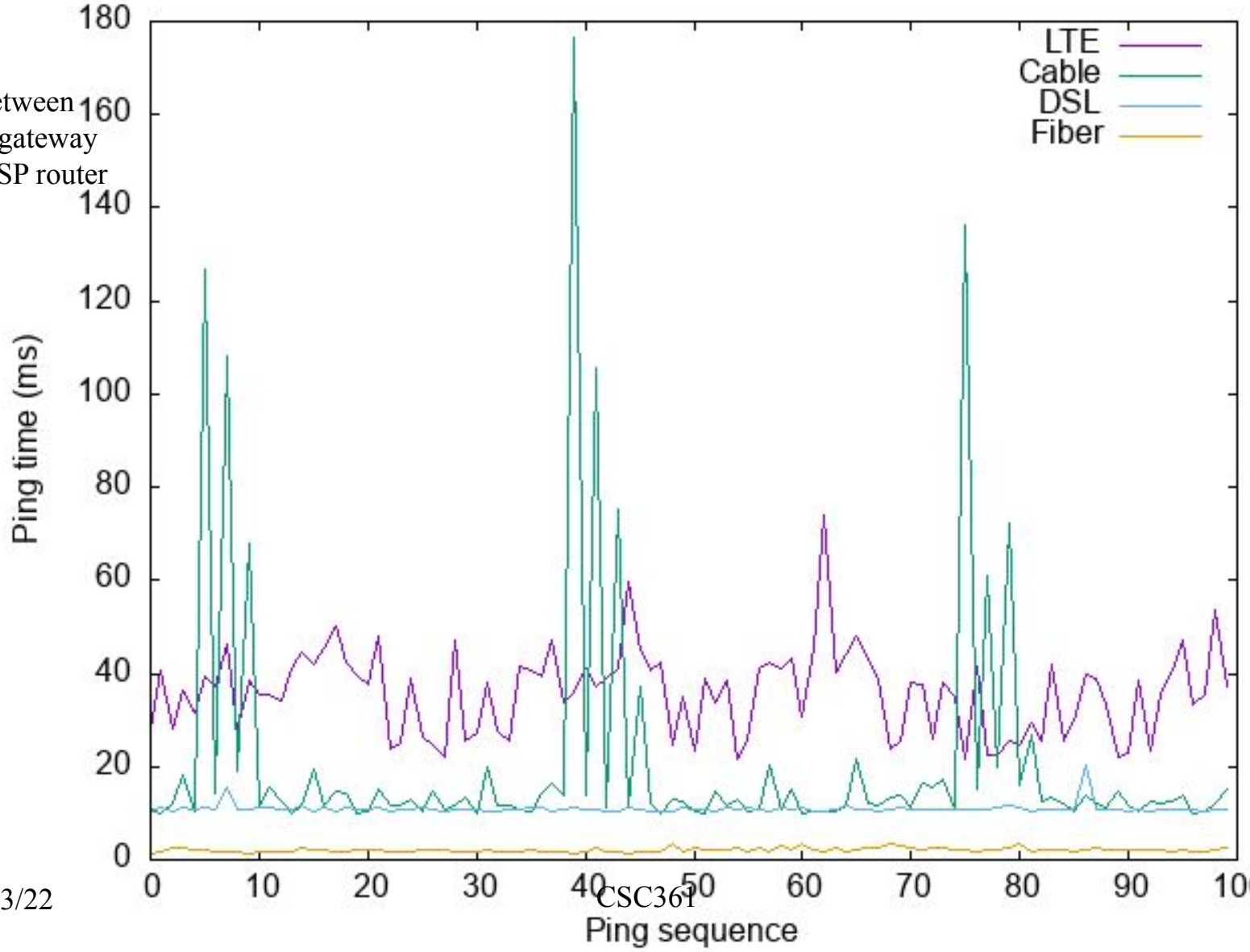


- Cellular systems
  - 1st generation (80's): analog voice (9.6Kbps)
    - AMPS: cells, frequency reuse, cell split; FDMA
    - base station, mobile switching center, handoff
  - 2G (90's): digital voice (14.4Kbps)
    - TDMA, GSM, CDMA
    - 2.5G (~100Kbps): GPRS, EDGE, EV-DO, EV-DV
  - 3G: digital voice and data (384Kbps, 2Mbps)
    - WCDMA, CDMA2000, TD-SCDMA

* starlink?

4G: LTE? 5G? 6G?

* delay between the home gateway and first ISP router

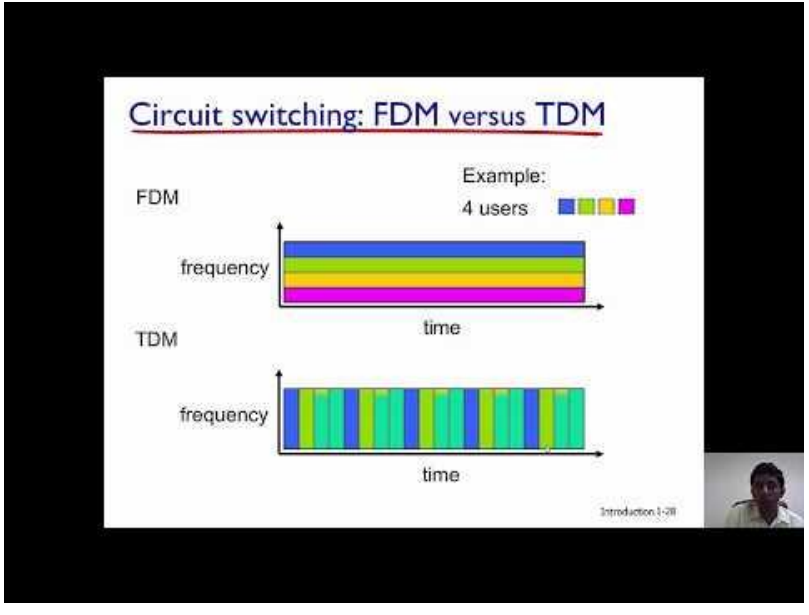


This lecture

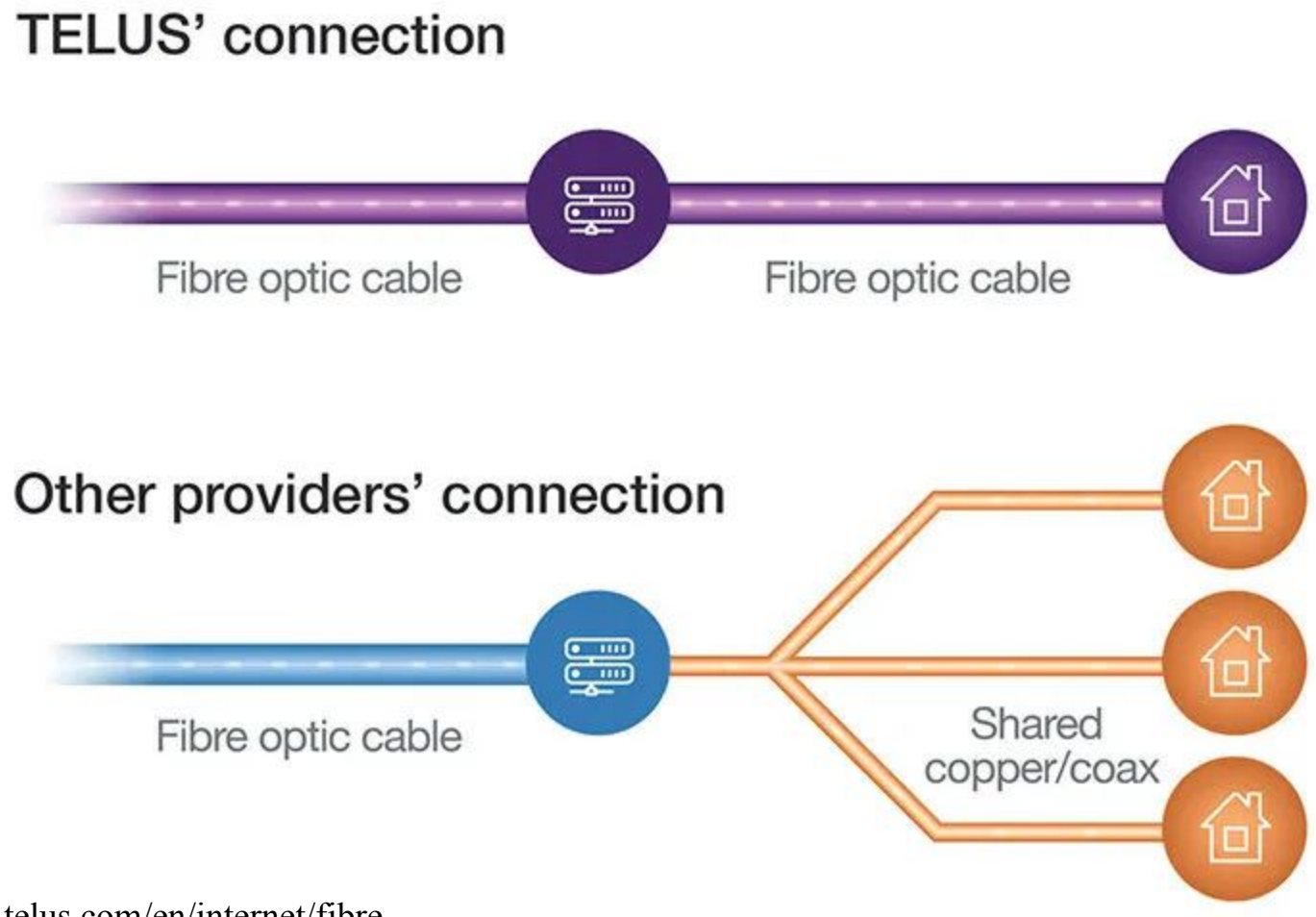
- Internet access
  - from home: phone line, cable line and power line
  - and at work: ethernet and wifi
- Explore further
  - your internet service provider
    - offerings and features; uplink vs downlink bandwidth
    - find a green/black box near you; take a photo for us
  - compare with your classmates' on bright forum
    - http://speedtest.net and http://youtube.com/my_speed

Next lecture

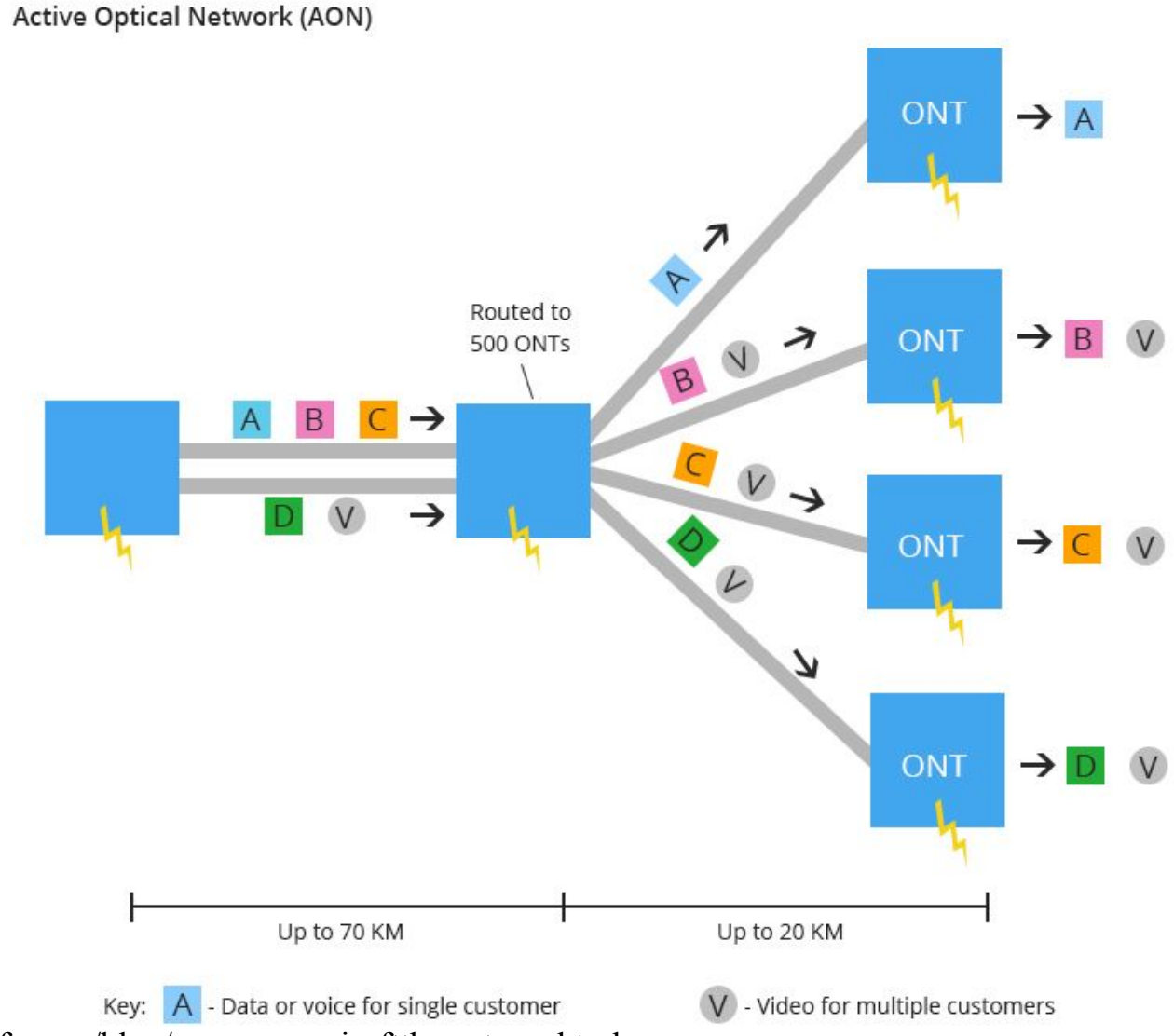
- Backbone networks
  - read Kurose&Ross: Computer Networking, 4th Ed
    - Chapter 1, particularly 1.3, except 1.6



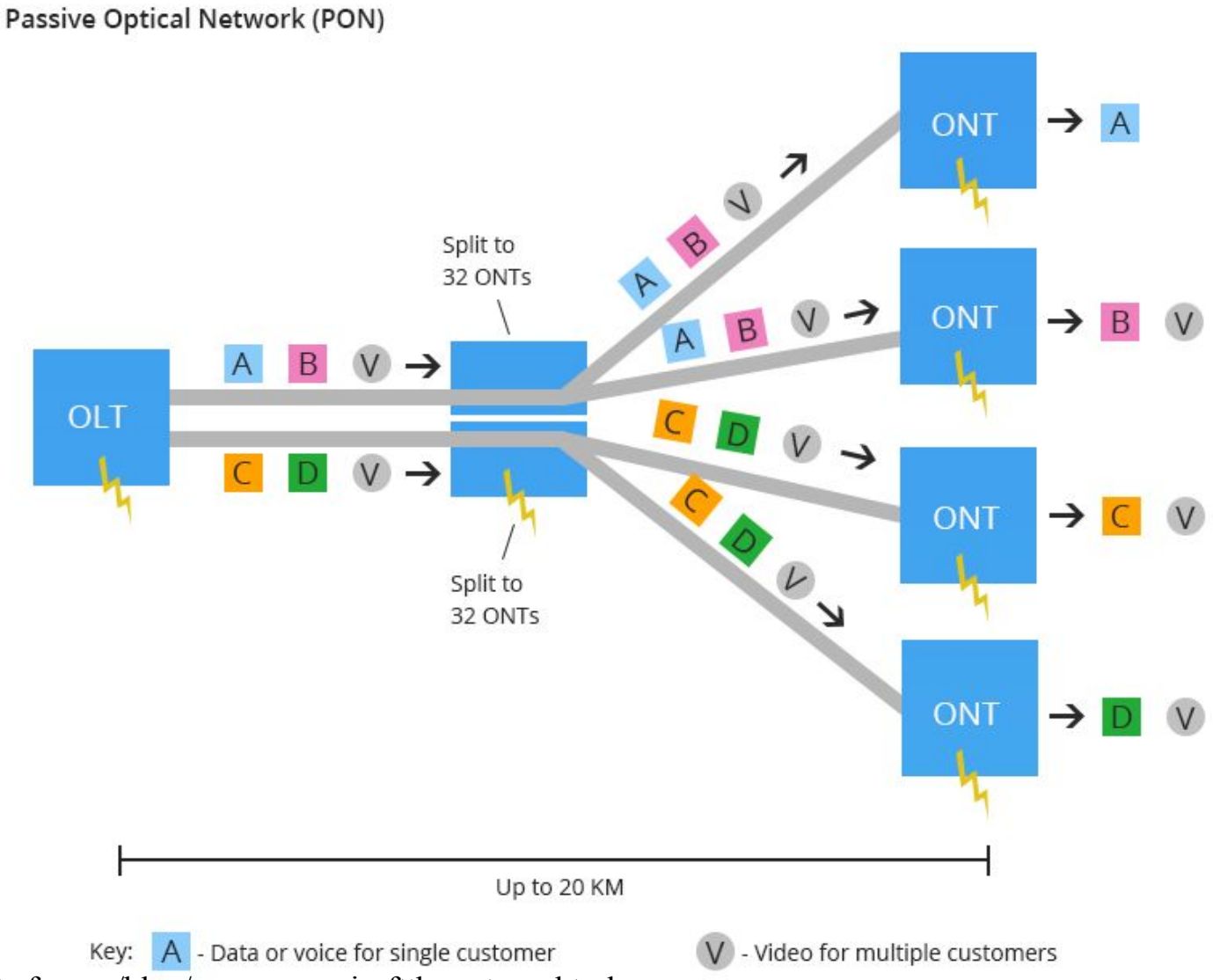
Why is this picture misleading?



https://www.telus.com/en/internet/fibre



https://community.fs.com/blog/pon-vs-aon-in-ftth-systems.html



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Why does gigabit end at 940Mbps?

The features you want	TELUS PureFibre Gigabit Internet	Shaw Gigabit Internet
Canada's most reliable internet technology [2]	✓	✗
100% fibre network direct to your door	✓	✗
Canada's fastest ISP 2 years in a row [4]	✓	✗
Top upload speeds	940 Mbps	100 Mbps
Top download speeds	940 Mbps	940 Mbps
	Now from $89/mo. on a 2 year term	$115/mo for 24 months

https://www.gigabit-wireless.com/gigabit-wireless/actual-maximum-throughput-gigabit-ethernet/

What does Shaw have to say?

Features	Our most popular Internet	Telus' most popular Internet
Why choose Shaw Fibre+ Internet		
Pause WiFi on any connected devices	✓	✓
Manage screen time with parental controls & customizable rules	✓	✗
Self-optimizing Fibre+ WiFi Pods adapt to speed & coverage needs	✓	✗
Rated best Internet service provider for gaming in Canada by PCMag[54]	✓	✗
Stay safe with Protected Browsing & optional Advanced Network Security	✓	✗

https://www.shaw.ca/gigabit-internet

What's wrong with others?

Why Bell | Packages | Wi-Fi | Fibre | Features | Pr

Bell pure fibre Internet. 100X faster than Rogers. Get the fastest technology.

The fastest Internet technology

With pure fibre Internet, you can get download speeds of up to 3 Gbps and upload speeds of up to 3 Gbps in select areas.[1] That's a total of 6 Gbps. Work and learn from home, video chat, stream and game online without missing a beat.

Apple spokesperson Michelle Del Rio provided the following statement on the matter:

> Thanks to the performance increases of M2, the new MacBook Air and the 13-inch MacBook Pro are incredibly fast, even compared to Mac laptops with the powerful M1 chip. These new systems use a new higher density NAND that delivers 256GB storage using a single chip. While benchmarks of the 256GB SSD may show a difference compared to the previous generation, the performance of these M2 based systems for real world activities are even faster.

2019 vs 2022