TEU00311
What is the Internet doing to me? (witidtm)

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https://github.com/sftcd/witidtm
https://down.dsg.cs.tcd.ie/witidtm

URLs accessed 20200925 (not all content from URLs updated)

What're we here for?

- We all use the Internet all the time

- You may or may not know what's happening under the hood, and shouldn't need to know all the nitty-gritty detail

- But, to make better decisions as to what you do, it's good to know something about some of those details

- This module aims to help you learn enough to make better decisions about what you want, and how to get it, as you interact with the Internet

- I hope: you'll apply those lessons, tell others about it all and maybe agitate for a better Internet for a better society (but you won't fail the module if you don't agitate:-)

Administrivia

TCD Personnel/Contacts

- Lectures:
  - Dr. Stephen Farrell, stephen.farrell@cs.tcd.ie
  - Dr. Dave Lewis, dave.lewis@cs.tcd.ie
    - You'll see Dave on **TBD**
  - Dr. Eoin O'Dell, eoin.odell@tcd.ie
    - You'll see Eoin on **TBD**

Who are we? (SITS as of Sep 25th)

- 8 Computer Engineering
- 7 Global Business
- 4 Political Sci and Geography PDE Joint Pathway
- 4 Law Single Pathway
- 4 Engineering with Management Single Pathway
- 4 Business and Economics
- 3 Theoretical Physics Single Pathway
- 3 Environmental Sciences
- 2 Sociology and Social Policy Single Pathway
- 2 Psychology Single Pathway
- 2 Mechanical and Manufacturing Engineering
- 2 Biochemistry
- 1 TSM Geography and Sociology (Freshman)
- 1 TSM French and Spanish (Freshman)
- 1 TSM English Literature and German (Freshman)
- 1 TSM Economics and Mathematics (Freshman)
- 1 TSM Ancient History and Archaeology and Jewish and Islamic Civilisations (Freshman)
- 1 Sociology and Drama Studies

- 1 Religion Single Pathway
- 1 Physics and Astrophysics Single Pathway
- 1 Molecular Medicine
- 1 Middle Eastern Jewish and Islamic Civilisations and Classical Civilisation Joint Honors
- 1 Microbiology
- 1 Law and Political Sci Joint Pathway
- 1 Irish and French Joint Honors
- 1 Human Genetics
- 1 History of Art & Architecture and Italian Joint Honors
- 1 History of Art and Architecture Single Honors
- 1 History and Political Science Joint Honors
- 1 Geoscience Single Pathway
- 1 Geography and Sociology Joint Honors
- 1 Film Studies and History Joint Honors
- 1 Electronic and Computer Engineering
- 1 Course Name
- 1 Chemistry
- 1 Business Economics and Social Studies
- 1 Business and Political Science
- 1 Bioengineering
- 1 Dunno
- 1 Me

about:me

- SCSS research fellow

- Research topics: security, privacy & delay-tolerant networking

- Currently a member of Internet Architecture Board
    - https://iab.org
        - Note: definitely not the other (IMO less nice;-) IAB - https://www.iab.com/

- Other courses taught, pubs, CVish stuff etc:
    - https://www.scss.tcd.ie/Stephen.Farrell/

Initial survey (21 answers **TBD**)

How familiar are you with how Internet related technolgies work?

- Not at all familiar 14.285%
- A little familiar 42.857%
- Fairly well informed 38.095%
- Expert for some bits 4.761%

Which of the following would you regularly bring to college?

- Laptop running windows 52.38%
- MAC laptop 38.095%
- iPhone 52.38%
- Android phone 38.095%

Which of the following sevices do you use regularly?

- Spotify 95.238%
- Gmail 95.238%
- Youtube 90.476%
- Whatsapp 80.952%
- Netflix 80.952%
- Wikipedia 71.428%
- Facebook 71.428%
- Instagram 71.428%
- Snapchat 47.619%
- Reddit 23.809%
- Linkedin 14.285%
- Soundcloud 9.523%
- Openstreetmap 9.523%

Schedule

- All online for now (sigh;-)
- Lecture slots, all BB collaborate "ultra":
  - Tuesday 1000-1050
  - Thursday 1600-1750
- "Office hours":
  - Monday 1100-1130+ via BB collaborate "ultra"
  - Lecturer(s) will hang out there/then, any of you welcome to join & chat
  - Might swap that time some weeks depending on conflicts with other schedules
- Reading week: Week 11, November 9th

Assessment

- 3 Assignments, submit via BB

- GDPR request and anonymised report – 30 %

- "Ethics canvas" – 30 %

- Individual project (report) – 40 % - **TBC**

- No exam unless you flunk, then … eh, not sure yet;-)

Module Materials

- There is no book – feel free to recommend some if you like

- Materials will be linked to from, or on, the module web page:
  - https://down.dsg.cs.tcd.ie/witidtm

- Content of module web page is also in Github at:
  - https://github.com/sftcd/witidtm

- Clone that repo and/or visit that page often, as it will change during the runtime of the module!
  - Who knows what "clone that repo" means?
  - I'll be happy to take PRs, if offered – if **very** good I might even give some marks or let someone off an assignment

Style

- Unless otherwise stated, all lecture slots will be recorded
  - If you don't consent to that, let us know!
- We encourage active participation via chat and audio
- For some lecture slots, we'll minimise the presentation to encourage interaction
  - Don't sit there and say nothing!
- It is entirely ok to ask what might appear to be less-than-clever questions, e.g. "Who makes money from YouTube?" - supposedly naive questions can be good and the answers might be quite subtle
- It is entirely ok to comment on what we tell you, e.g. "That's nonsense – I use <foo> all the time and it's fine afaics" - this is about you after all, so (dis)agreeing with us and one another is desirable (but don't be an ass, and do listen)
- If you don't comment or ask questions, we'll all be more bored and I'll get cranky!
- So, let's start...

Here're some questions we'll come back to at the end of the slide-deck (today or next day, whenever) but please start to ponder them...

I think the Internet is great
(and have for 30+ years)
but
are the 3-4 billion people connected
all your friend?

How do you interact with the Internet?

Do you care about your, my, or all of our, security on the Internet?

If so, what do you care about most?

Do you care about your, my, or all of our privacy?

That's all for now, we'll be returning to those questions as we go.

But… what other questions should we be considering?

What else?

- Your topic here... what'd you like to cover?

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-

-

(we can revisit this multiple times)

Meanwhile… let's start with…

Is the Internet a network?

Is the Internet a network?
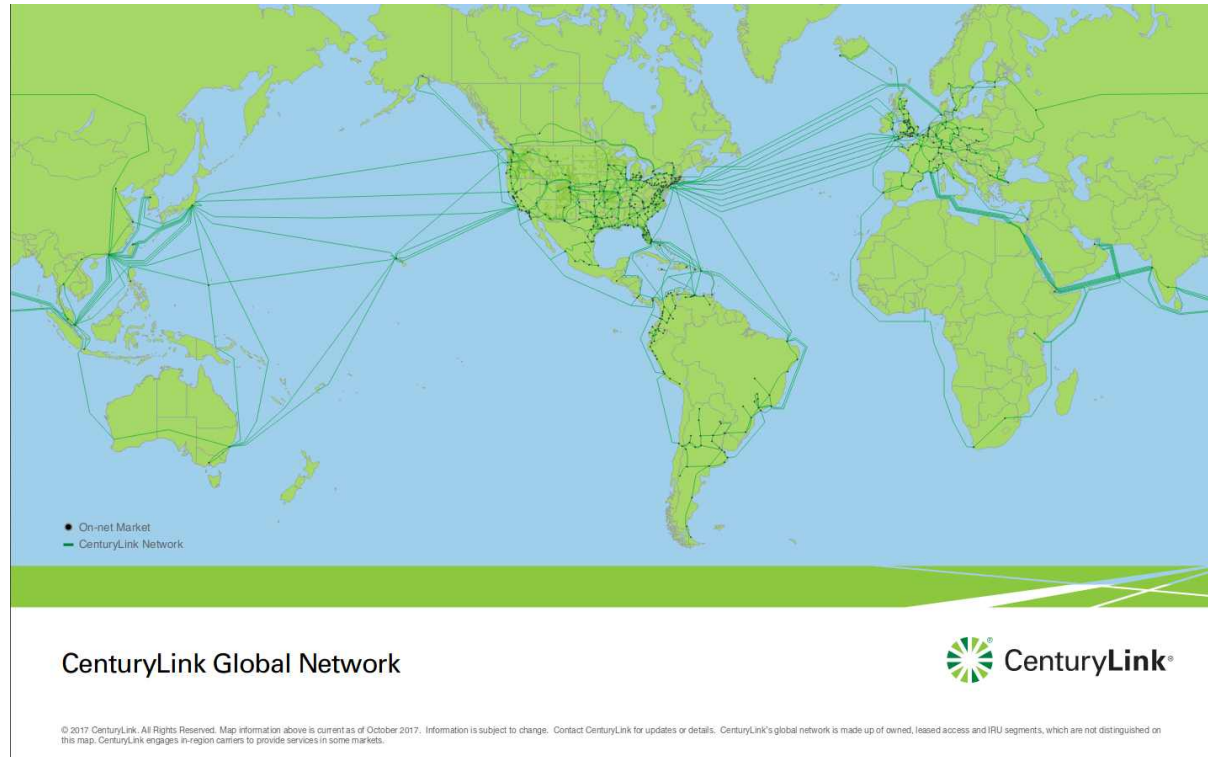(hint: the answer is "no":-)

A network of networks

- The Internet is made up of about 65,428 Autonomous Systems (ASes)
  - https://en.wikipedia.org/wiki/Autonomous_system_%28Internet%29
  - 69762 ASes as of 2020-09-25, (https://www.cidr-report.org/as2.0/)
    - Was: 65,428 in Aug 19
- Think of these as the set of Internet Service Providers (ISPs, like Eircom, Vodafone, Virgin), other networks (e.g. HEANET which is TCD's "ISP"), big companies (e.g. Google, FB) and oddities like Internet eXchange Points (IXPs, like INEX)
- Each is (in principle and often in practice) an independent network (or set of networks) and their operators can do whatever they want
  - They're essentially defined by sets of numbers: Static: AS number (ASN); Dynamic: sets of IP address prefixes
- They interact using Internet protocols (like IP, TCP, BGP)
  - IP: Internet Protocol; TCP: Transmission Control Protocol; BGP: Border Gateway Protocol
- We'll delve more into all that later, but first… some pretty pictures

CAIDA Map of ASes
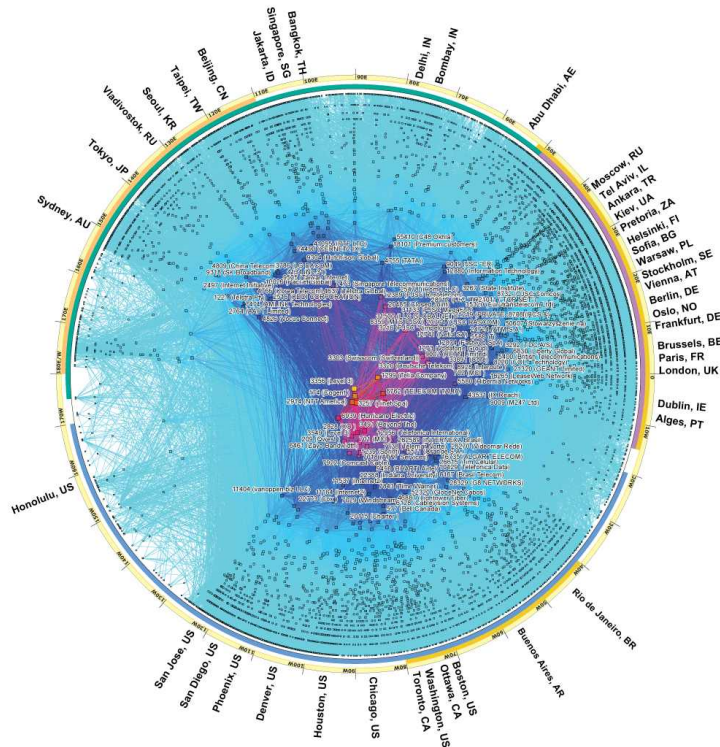
- CAIDA (Center for Applied Internet Data Analysis) is a UC San Diego Internet measurement organisation
  - You can measure **a lot** of what happens on the Internet as it happens!
- This is a 2017 map of the ASes as they were then
  https://www.caida.org/research/topology/as_core_network/2017/
- More central => more connected, serving more people
  - You can see Dublin at about 3 o'clock
  - In the middle (if you zoom) you could see level3 and cogent which are large ASes

Level3 is one of those (a BIG one)

CenturyLink Global Network

© 2017 CenturyLink. All Rights Reserved. Map information above is current as of October 2017. Information is subject to change. Contact CenturyLink for updates or details. CenturyLink's global network is made up of owned, leased access and IRU segments, which are not distinguished on this map. CenturyLink engages in-region carriers to provide services in some markets.

https://www.level3.com/~/media/files/maps/en-network-services-level-3-network-map.ashx

Cogent similarly

Cogent's network stretches over 204 markets throughout **43 countries** in North America, Europe and Asia, with over **57,400 route miles of long-haul fiber** and more than **34,100 miles of metropolitan fiber** serving over **840 metropolitan rings**. Our end-to-end optical transport network consists of IP-over-WDM fiber links running up to **2,120 Gbps** intercity capacity and **2,000 Gbps** on metropolitan rings, located in Cogent's major markets throughout North America, Europe and Asia. On the IP layer, Cogent's Tier 1, IPv6 and MPLS enabled network has direct IP **connectivity to more than 6,760 AS** (Autonomous System) networks around the world with over **185 Tbps** internetworking capacity.
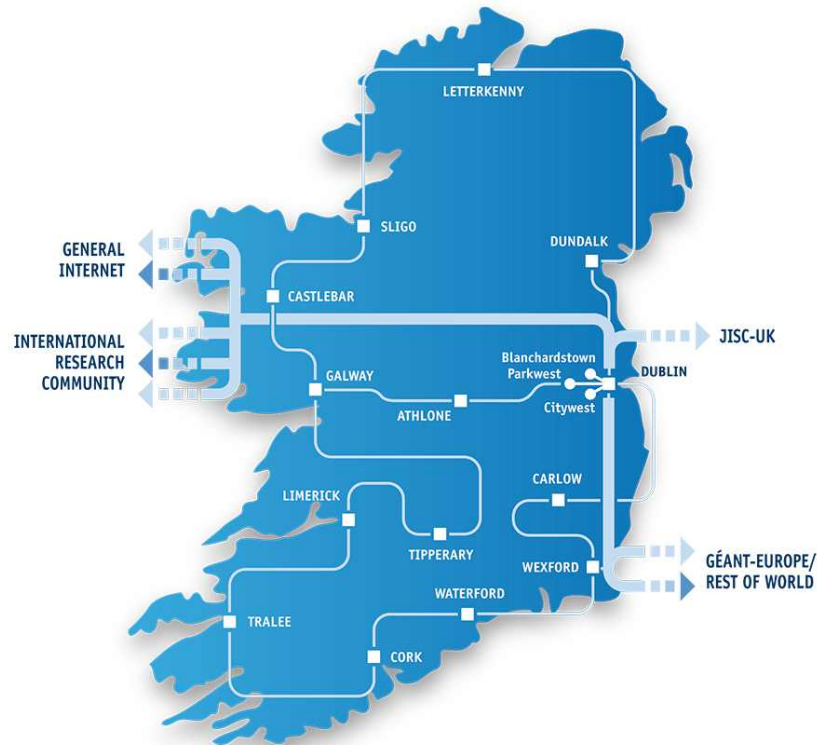
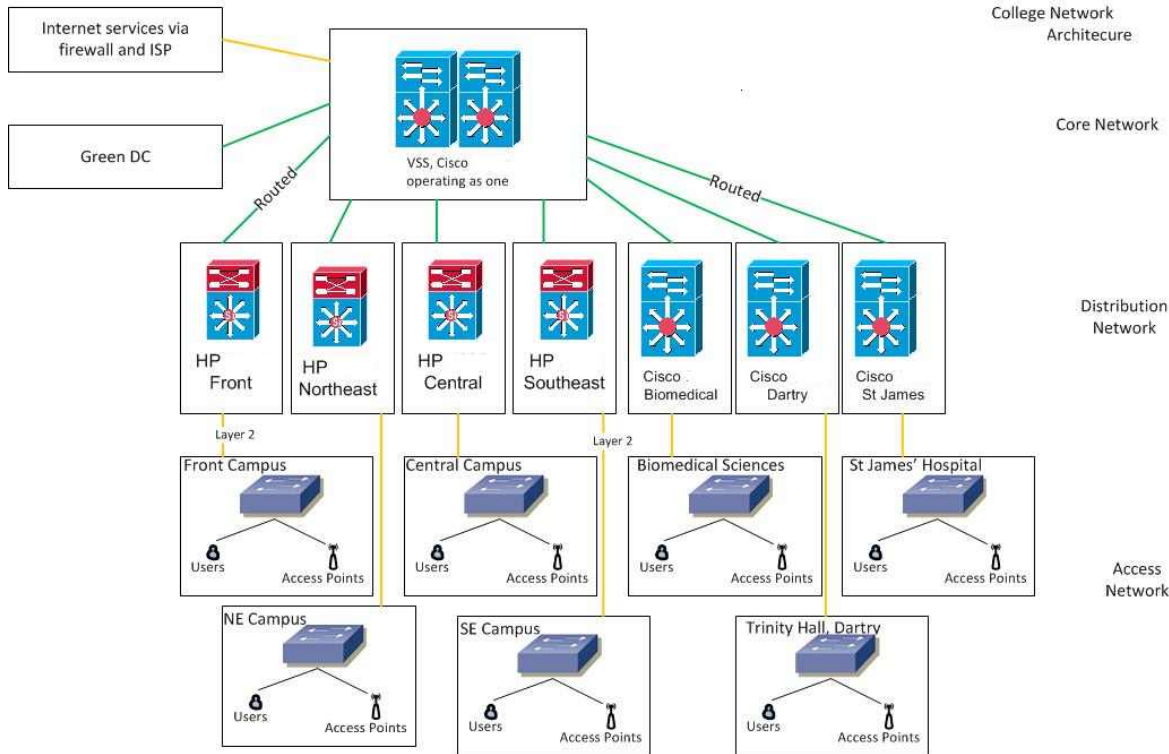https://www.cogentco.com/en/network/network-map
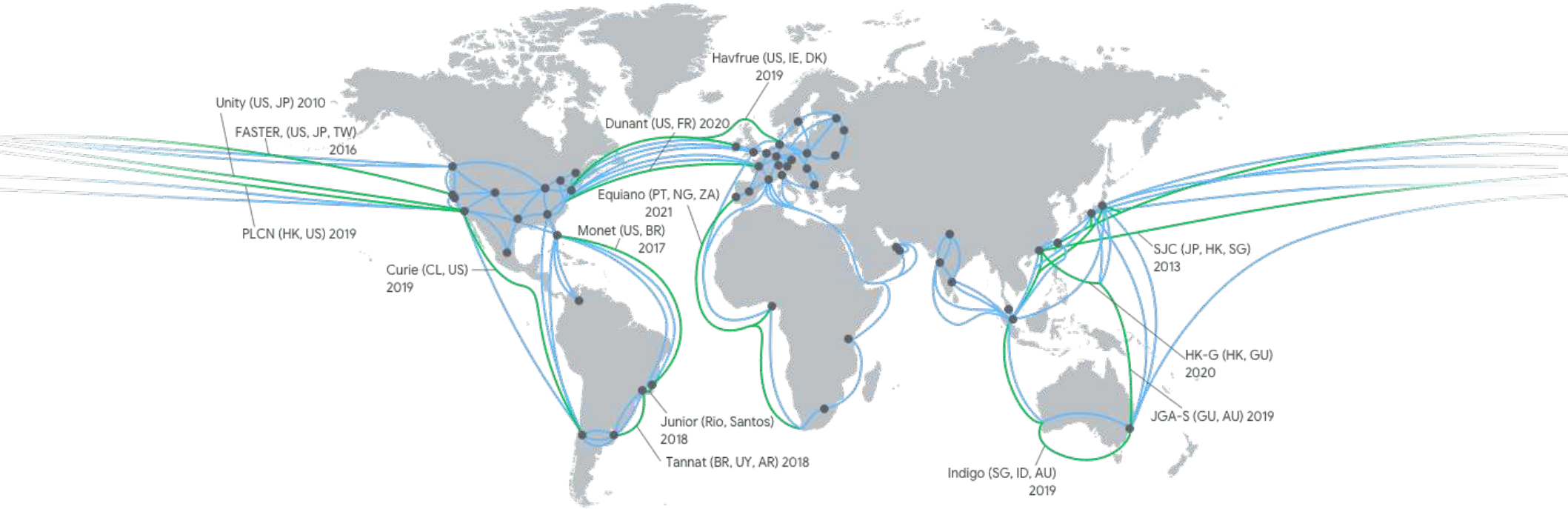
Google cloud

note this is just google cloud, not all their stuff

Heanet national n/w

https://www.heanet.ie/network-maps

The TCD network

- Network Core - Routers (High-availability pair)
- Distribution Layer - routed Layer 3 switches serving x7 campus zones
- Access Layer - Layer 2 Ethernet switches in building comms rooms and wireless Access Points
- External internet connectivity via L3 WAN block to ISP - Border Routers and Firewalls, DMZ hosting web services
- Data Centre network connectivity - central server and application hosting

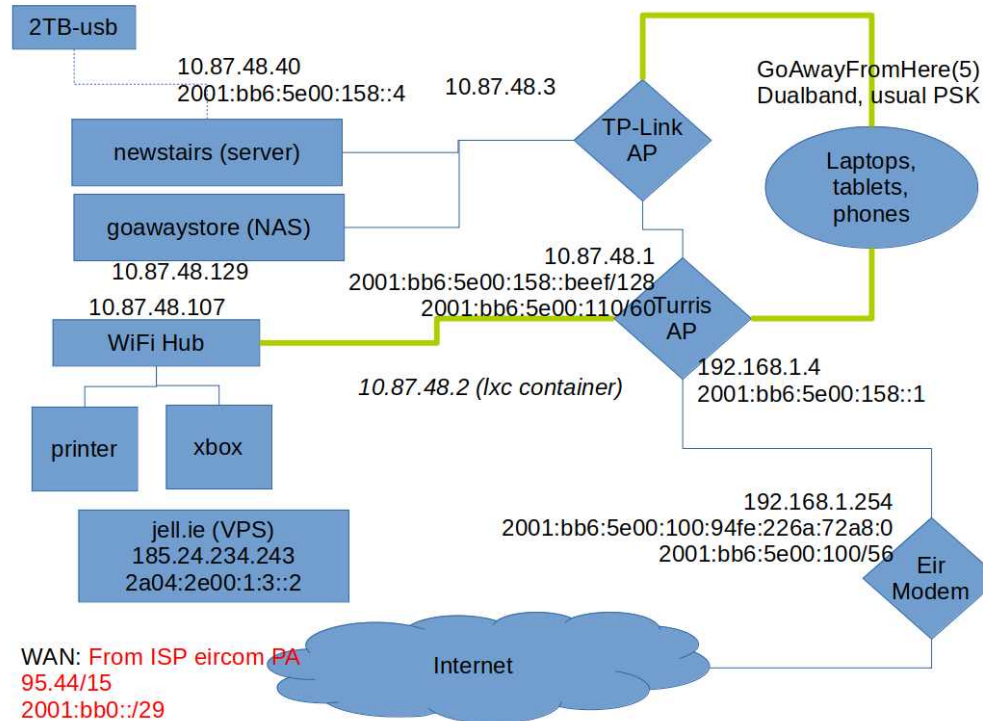Thanks to TCD IT for providing this anonymised diagram – doing that's not a no-brainer btw!

A 2nd campus example

University of Michigan Network — And connections to the World
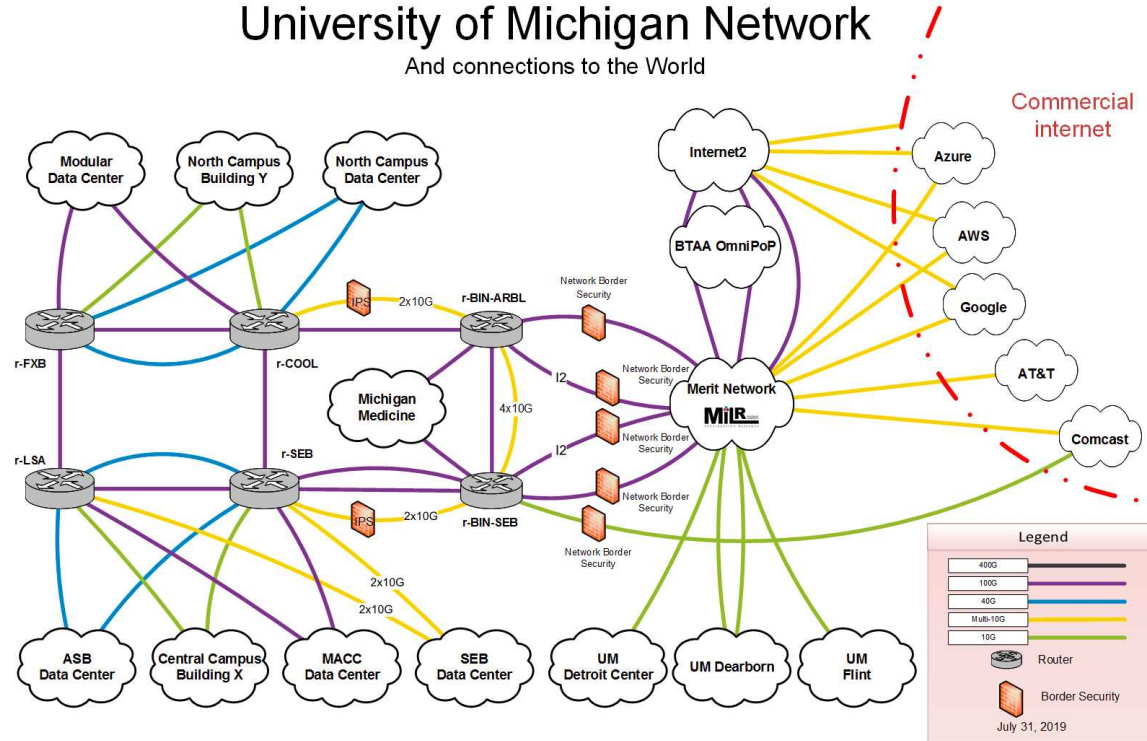
My home network

That's from a few years ago – numbers are out of date:-)

Interoperability

- To make the Internet work we need to agree on how to **interoperate** for some basic/minimal set of things
  - That means defining/agreeing on Internet Protocols
  - Where we need to agree on how to interoperate, a lot of that is done by the Internet Engineering Task Force (IETF) and other Internet standards bodies (IEEE SA, W3C)
    - I'm quite involved with IETF stuff, so consider me biased there:-)
- But we do not aim to agree about everything in everyone's network
  - So an awful lot happens at the "application layer" in code written by people and organisations, e.g. FB, Google, banks, Netflix, ...
  - Those services are **not the Internet** – they depend on the Internet!
- And yet more happens when people configure services that use generic code

What's a network protocol?
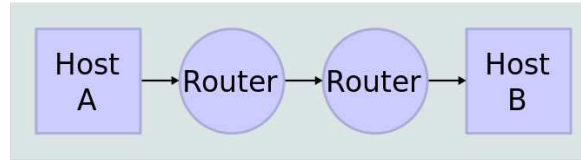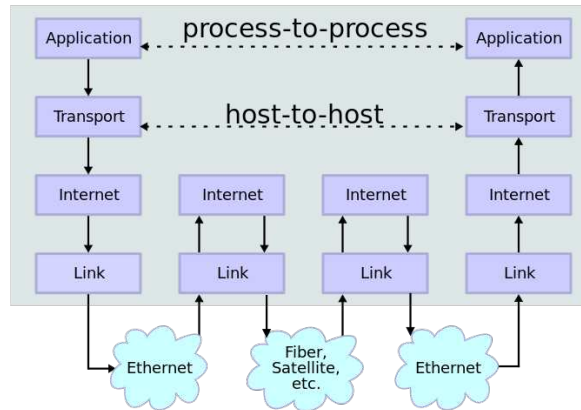
https://en.wikipedia.org/wiki/File:IP_stack_connections.svg

"Permissionless innovation"

- One important point is: in principle each network operator can do whatever it wants so long as it interoperates "nicely" with others (and even when it doesn't act particularly nicely;-)
  - That also applies to your home network (if you want and are able)
  - There are no protocol police (yet!)
- This is one of the main reasons why the Internet has been so successful
- Related: the classic "End-to-end argument" paper
  - Salzer, Reed. Clark,"End-to-end arguments in system design" ACM ToCS (1984).
    - https://web.mit.edu/Saltzer/www/publications/endtoend/endtoend.pdf
  - I recommend a read of that!
  - Don't consider it as gospel though – it's the end-to-end **argument** and not really the end-to-end **principle** even though it gets called the latter a lot

"Tussles"

- Repeating: we do not aim to agree about everything in everyone's network...
  - So an awful lot happens at the "application layer" in code written by people and organisations
  - And yet more happens when people configure services that use that code
- When the "policies" reflected in those collide then "fun" follows;-)
  - If protocols or application code constrains what operators can do then people complain
  - If what n/w operators are doing breaks (esp changes to) applications then people complain
  - In both cases people often complain at the wrong place;-)
- Another paper:
  - Clark, David D., et al. "Tussle in cyberspace: defining tomorrow's Internet." ACM SIGCOMM Computer Communication Review. Vol. 32. No. 4. ACM, 2002.
    - https://www2.cs.duke.edu/courses/compsci514/cps214/spring09/papers/p347-clark.pdf
  - Same "Clark", but older:-) Interestingly, the 2002 paper is IMO far more dated (and wrong!) than the 1984 paper!
- We'll consider a "topical" example later (Search for "DNS over HTTPS" if you want to check it out); don't worry if this issue seems a bit too hard to grok at this point

Aside: Cyber<blah>

- Be wary of anyone who uses a term like "Cyber<blah>"

- ~90% of the time, that's a strong indicator that they don't really know what they're talking about (if they did, they'd use a more precise and well-defined term)

- Sadly, about 10% of the time (and increasing) such terms are used because "industry" keeps on doing it and people just repeat stuff thoughtlessly

- Don't be afraid to ask someone to define "Cyber<blah>" if they use such a term, and don't be surprised if they find that hard!
    - E.g. "Does cyberspace include a person driving a car that's had it's license plate automatically scanned?" or "What's not included in cybersecurity?"

The Internet is not the web

- Another important point!
- The web is (roughly) the set of computers that speak the HTTP protocol
  - HTTP == HyperText Transfer Protocol (http://example.com)
  - HTTPS == HTTP/Transport Layer Security (https://example.com)
- Email doesn't use HTTP, but rather (mostly) the Simple Mail Transfer Protocol (SMTP) which is a couple of decades older than HTTP
- Mobile network internals (3G, 4G, 5G...) mostly run over IP using a bunch of protocols you'd prefer to never have to know about
- But lots of our interactions with the Internet are via the web

Some of the things we'll do later...

- Understand what happens under the hood when your browser loads a web site

- Get an overview of advertising networks

- Talk a bit about spam and phishing (email badness)

- Learn how to watch network traffic

- We'll look more at the web soon, meanwhile back to you...

How do you interact with the Internet?

Do you care about your, my, or all of our, security on the Internet?

If so, what do you care about most?

Do you care about your, my, or all of our privacy?

That's all for now, we'll be returning to those questions as we go.

But… what other questions should we be considering?

What else?

- List from 20190912 lecture:
  - Use of personal data in politics
  - Banking
  - HOWTO do coding
  - Encryption
  - U18 and their rights
  - Cryptocurrency BTC
  - Spyware

-

  (we can revisit this multiple times)

What else?

- List from 202009xx lecture:

  –

-

  (we can revisit this multiple times)