

# CS2003: Internet and The Web

## Overview of the Internet

# This week

- Examples of practical networks and equipment:
  - An introduction to Internet infrastructure.
- Terminology:
  - Lots of TLAs (Three Letter Acronyms)!
- Key Concepts & Basic Architecture:
  - **Engineering vs Architecture.**
  - **(Functions vs Packaging.)**
- Examples of simple Java API and programs for communication on CS lab machines.
- Thanks to Prof Saleem Bhatti for the slides (and the pictures as you will see shortly)

# What is the Internet?

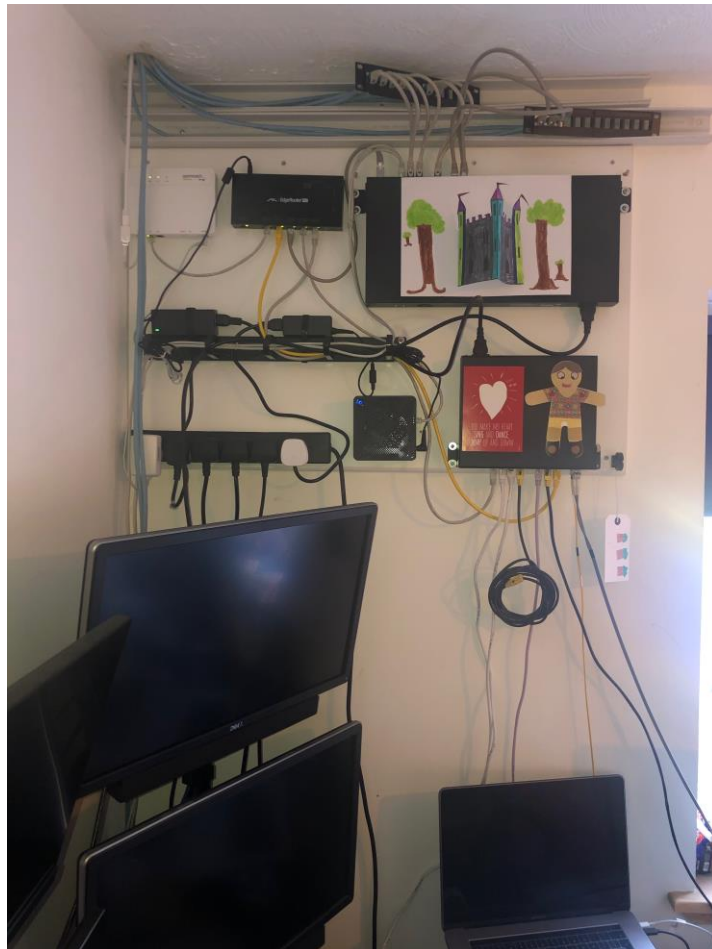
# The Internet: view points

- **A global interconnection of different data networks.**
- **Services:**
  - services provided by **applications**.
  - **programs** that perform useful functions for **users**.
- **Computers:**
  - on which those applications and services run.
  - where your data is stored.
- **Communication systems:**
  - allowing applications to **transfer data and information**.
  - (the applications typically run as **distributed systems**.)
  - **computer networks**.

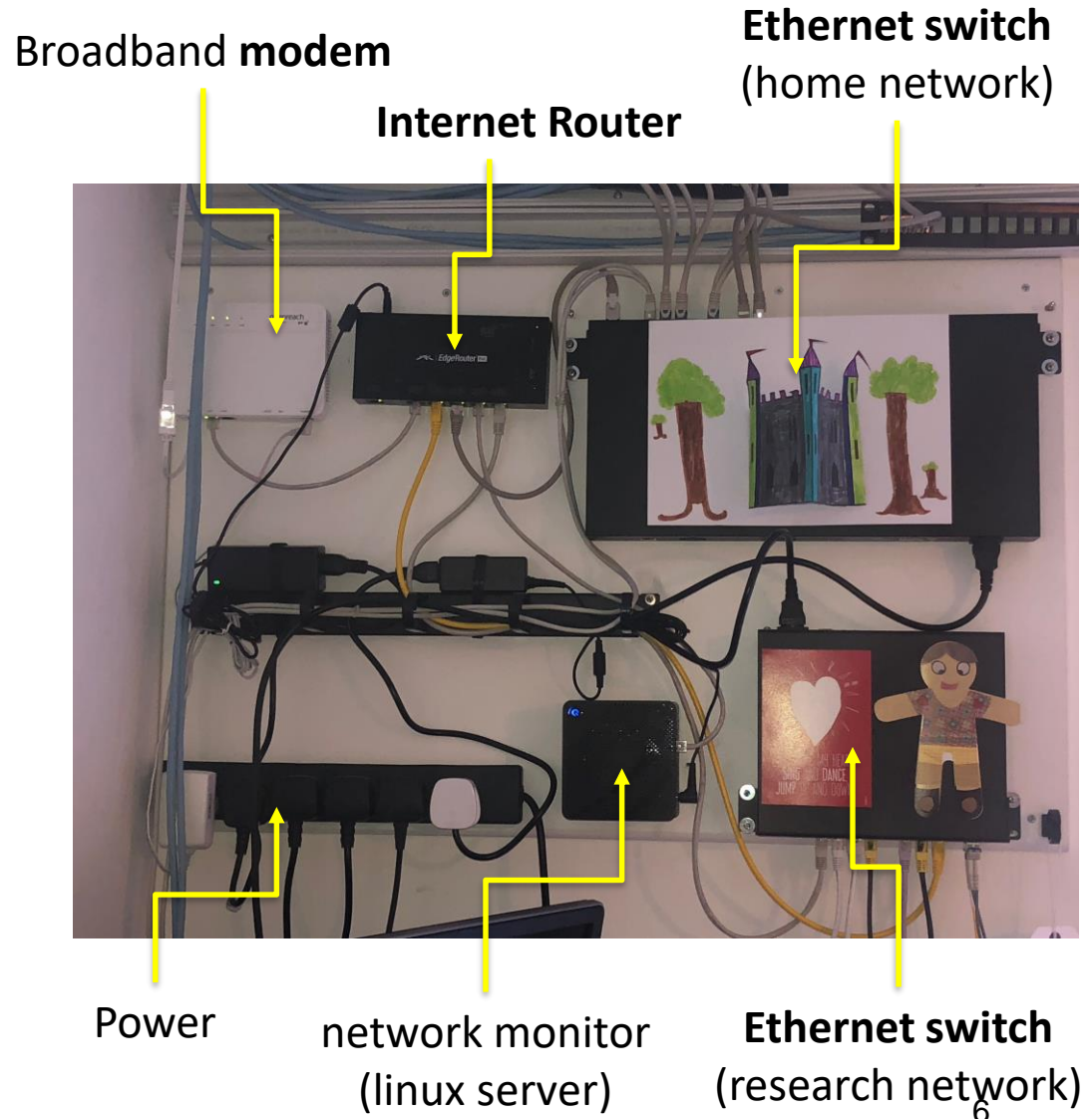
# Computer communication networks

- **end-systems:**
  - hosts, workstations (user / client applications).
  - servers (shared applications / services).
- **connectivity:**
  - radio, e.g. WiFi (IEEE 802.11), mobile phone 3G & 4G.
  - electrical, e.g. Ethernet (IEEE 802.3).
  - optical, e.g. fibre-to-the-home, between servers.
- **network equipment – relays:**
  - e.g. modems, bridges, switches, routers.

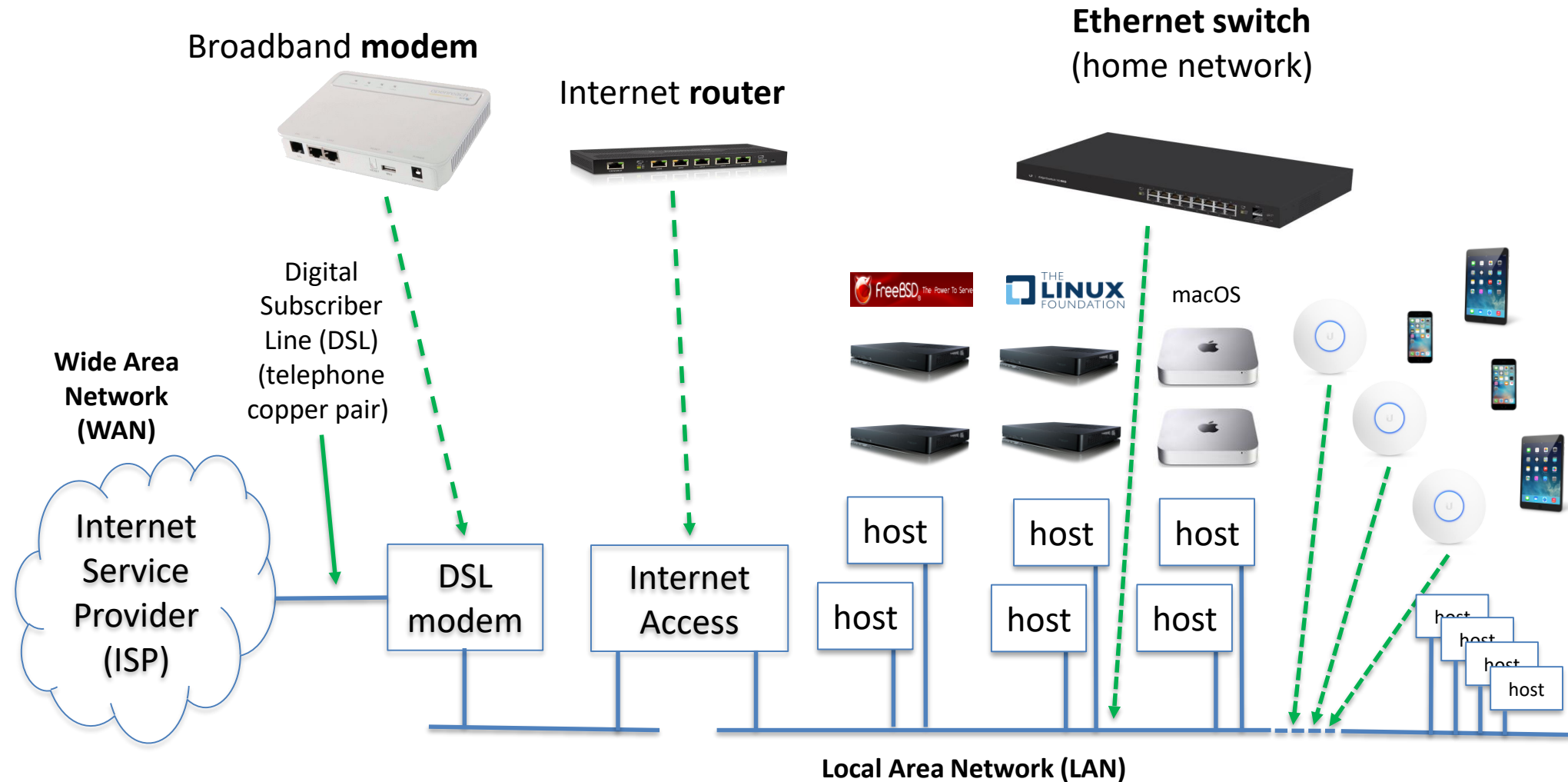
# Saleem's home network (1)



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# Home network (2)



# Home network (3)

- **DSL modem:**
  - “Local” connection to WAN (point-to-point connection).
  - Connects you to your **ISP only**.
- **Internet router** (global *packet* relay):
  - Knows how to communicate with your ISP.
- **Ethernet switch** (local *packet* relay):
  - Provides wired connections for local devices.
- **Bridge** (local packet forwarding):
  - Provides connections for local devices, “hiding” low-level, physical connectivity.
- **All of these perform different functions.**



# Summary of some network terminology

- **Wide Area Network (WAN):**
  - Global networks, **point-to-point** links.
- **Local Area Network (LAN):**
  - Home, office, building, small campus, shared infrastructure.
- Metropolitan Area Network (MAN):
  - campus, town, regional.
  - Historic see e.g. FaTMAN  
<https://web.archive.org/web/20071006141900/http://www.fatman.net.uk/history.htm>
- **Internet Service Provider (ISP):**
  - Provider of global Internet connectivity (and sometimes also WAN connectivity for customer).
- **Different forms of connectivity and equipment:**
  - A modem, a bridge, a switch, a router (lots of others).
  - **Why?**

# Ethernet switch

- Note: the word “switch” is hugely overloaded!
- Note: the word “port” is hugely overloaded!
- **Local** interconnection:
  - **Local** forwarding /delivery of **frames** (chunks) of data.
- Allows **devices** within a network to communicate.
- Ethernet switch:
  - Devices wired to physical **ports** on switch.
  - Switch forwards / relays frames between ports.
  - (Switch can be considered as an aggregated bridge!)



# Modem

- **Modulator / Demodulator.**
- Creates a signal compatible with the WAN network technology.
- DSL broadband:
  - create appropriate electrical signal for **copper pair**.
  - **framing** of bits for electrical transmission.
  - (error control, bit-synchronisation & timing).
  - (channel coding and line coding).
- General: **transceiver** creates / reads a physical signal:
  - different transceivers for optical, electrical, radio.



# Bridge

- Connects two different physical interfaces for the same technology, or interconnects to segments of a LAN.
  - Copies a *frame* (chunk) of data from one network to another.
- IEEE 802 family of LAN technologies:
  - IEEE 802.3 **wired** LAN (aka Ethernet)
  - IEEE 802.11 **wireless** LAN (aka WiFi)
  - (not actually quite the same, but not relevant for now)
- IEEE 802.3 bridge:
  - Connects IEEE 802 family networks “transparently”.
  - Bridge “knows” which devices connect to it.
- A WiFi **basestation** or **access point** is a **bridge**.



# Router

- Note: the word “packet” is hugely overloaded!
- Interconnects two (or more) **different** networks.
  - **Internetworking.**
  - Needs suitable transceivers (for each network).
- Provides **global** connectivity:
  - Allows communication between **networks**.
  - Sends chunks of data as **packets**.
  - Can connect networks using (same or) different sub-network technologies, e.g. DSL and Ethernet.



# Things to note : everything is “different”

- **Different** technologies:
  - **Different** hardware systems.
  - **Different** systems software.
  - **Different** companies / providers.
- **Different** operating systems.
- **Different** application platforms:
  - Programming languages.
  - Application Programming Interfaces (APIs).
  - User Interfaces.
- **How do they all “talk” to each other “nicely”?**
  - **common architecture (logical),  
different engineering (implementation)**

# A home / business “gateway”

DrayTek Vigor 2862L Series

<https://www.draytek.co.uk/products/business/vigor-2862l>

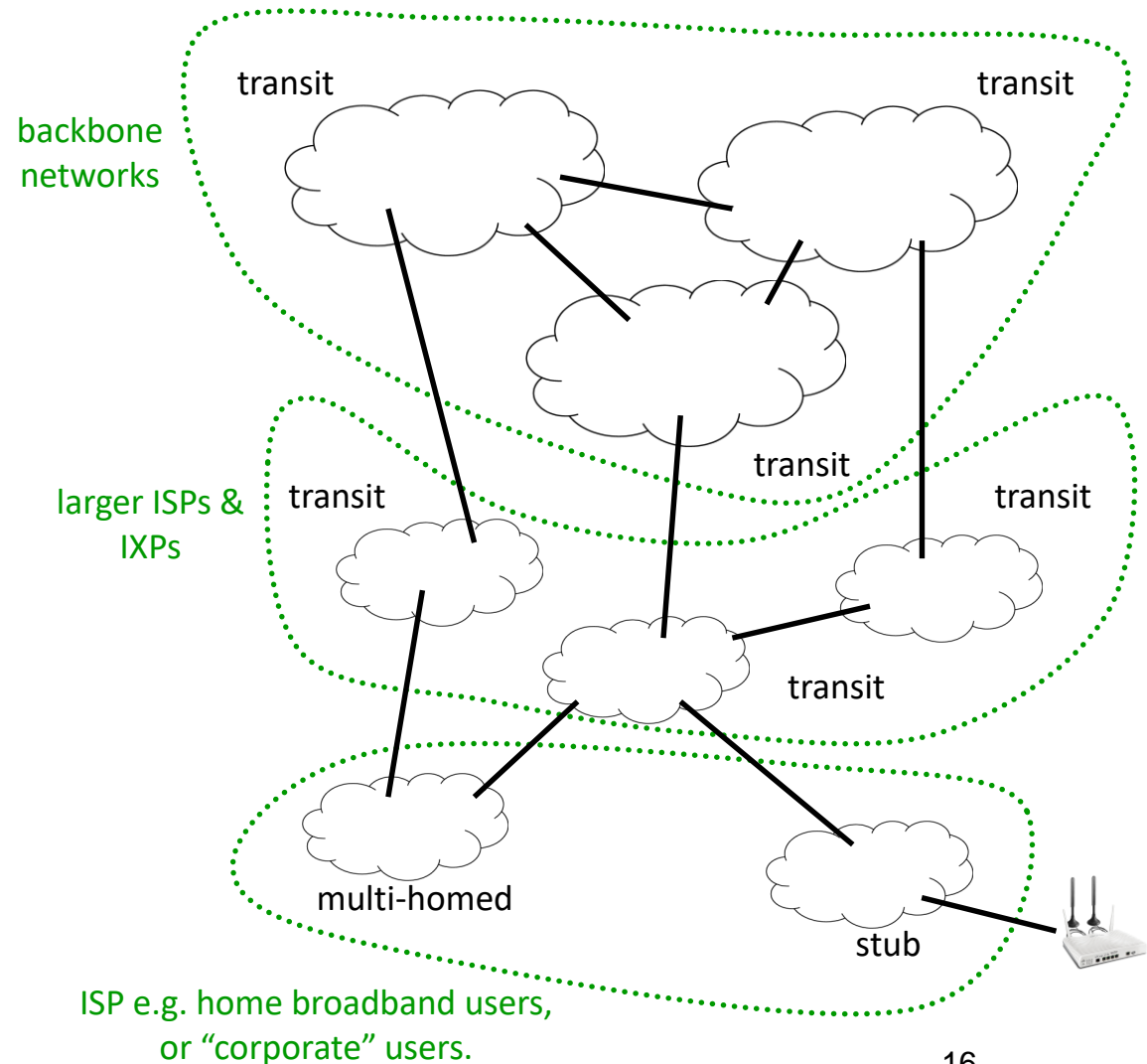
## Conveniently, many functions in one box:

- WAN, modem / connection:
  - DSL, 3G/4G, alternate routes
- Internet **packet** routing / forwarding.
- Wired LAN: Ethernet Switch
- Wireless LAN: WiFi (IEEE 802.11)
- DHCP (local host configuration):
  - dynamic host configuration protocol
- DNS (name resolution)
  - domain name system
- NAT (local addressing):
  - network address translation
- Firewall (network border security)
- (and many other functions possible)



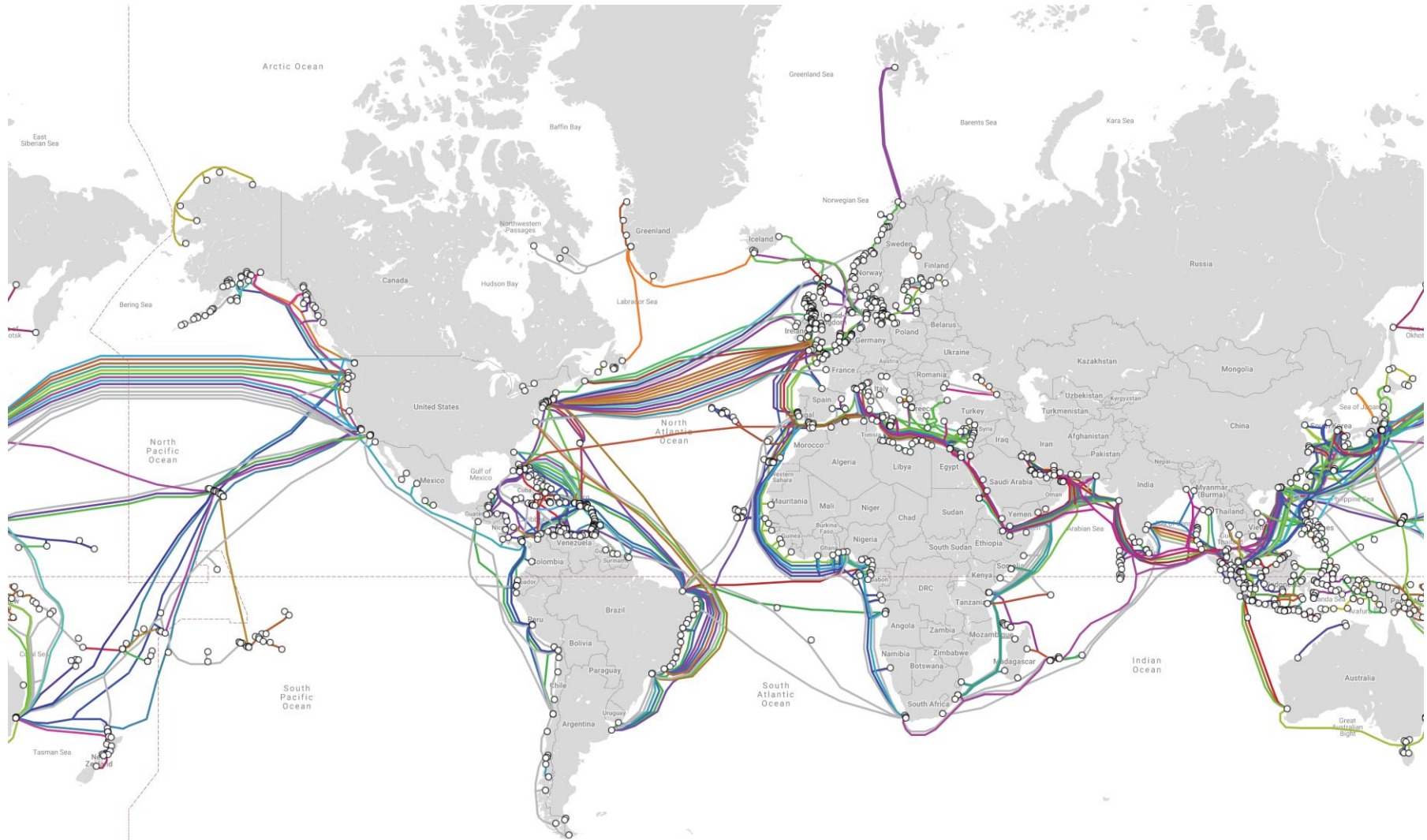
# Beyond the home router

- **Transit network:**
  - No hosts directly connected.
- **Autonomous Systems (AS):**
  - **stub** AS: e.g. site network.
  - **multi-homed** AS: e.g. larger ISP, & IXP (Internet eXchange Point).
  - **transit AS:** e.g. international or national provider.
- **Internet:**
  - Collection of interconnected stub, multi-homed and transit Ass, point-to-point links and routers.
- **Applications!**
  - Servers / services at edges.





# Global communication networks: fibre



<https://www.submarinecablemap.com/> (as of 28 August 2019)

# Standards bodies

- IEEE (systems technologies):
  - Institute of Electrical and Electronic Engineers.
  - <https://www.ieee.org>
- Internet RFC documents – Request for Comments:
  - Defines Internet-wide standards.
  - <https://www.rfc-editor.org>
- ITU – International Telecommunications Union:
  - ITU-T (standardisation), ITU-R (radio), ITU-D (development)
  - <https://www.itu.int/>
- W3C – World-Wide Web Consortium:
  - WWW standards (HTML, CSS, XML) and application areas.
  - <https://www.w3.org>

# Further questions

- Why can a host not just connect more “directly” to “the Internet”?
  - Why all these different devices and connectivity?
  - For example, why do we need switches and routers?
- How does data get to / from the correct places?
- What about applications?
  - How do applications “talk” to each other?
  - How can I write my own applications to use the Internet for communication?

# Summary

- The Internet is a collection of many:
  - Different services and applications.
  - **Different networks.**
  - **Different technologies.**
  - **Different service providers.**
- Many entities and actors all have to interwork to permit global communication.
- **How?**