ipv6
(and some internet history)
(and not very much Pi)

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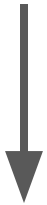
What is the internet?

lots of definitions, eg social view / products

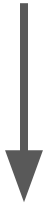
for *this talk*, the internet is computer systems that can talk to each other using the Internet Protocol

Normal people: HTTP, NetFlix, DNS, Online shopping, E-mail, Instant messaging, Tinder

Pi people: Controlling art, temperature sensors, spycams

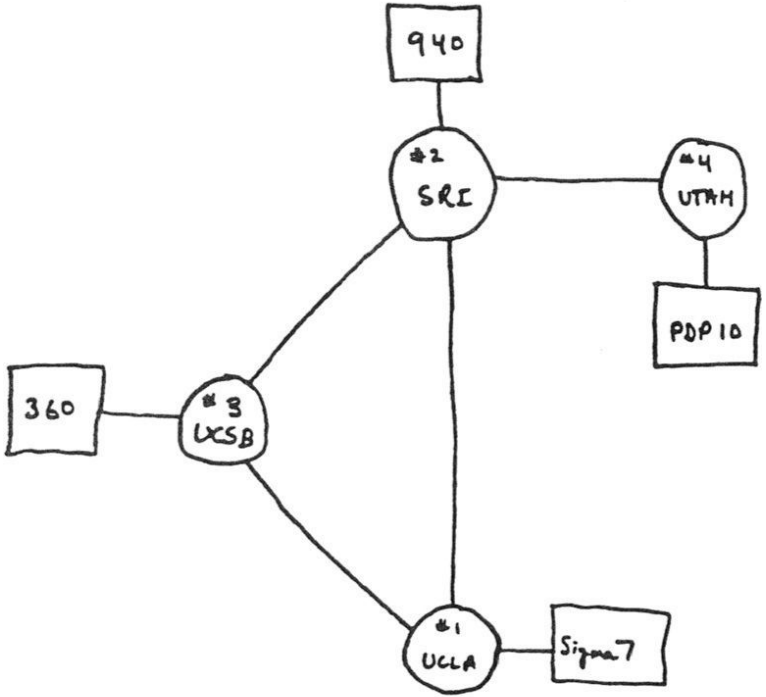


IP - Internet Protocol



Wifi, 5G, Dialup, Ethernet cable, ADSL, Satellite, (Pigeons)

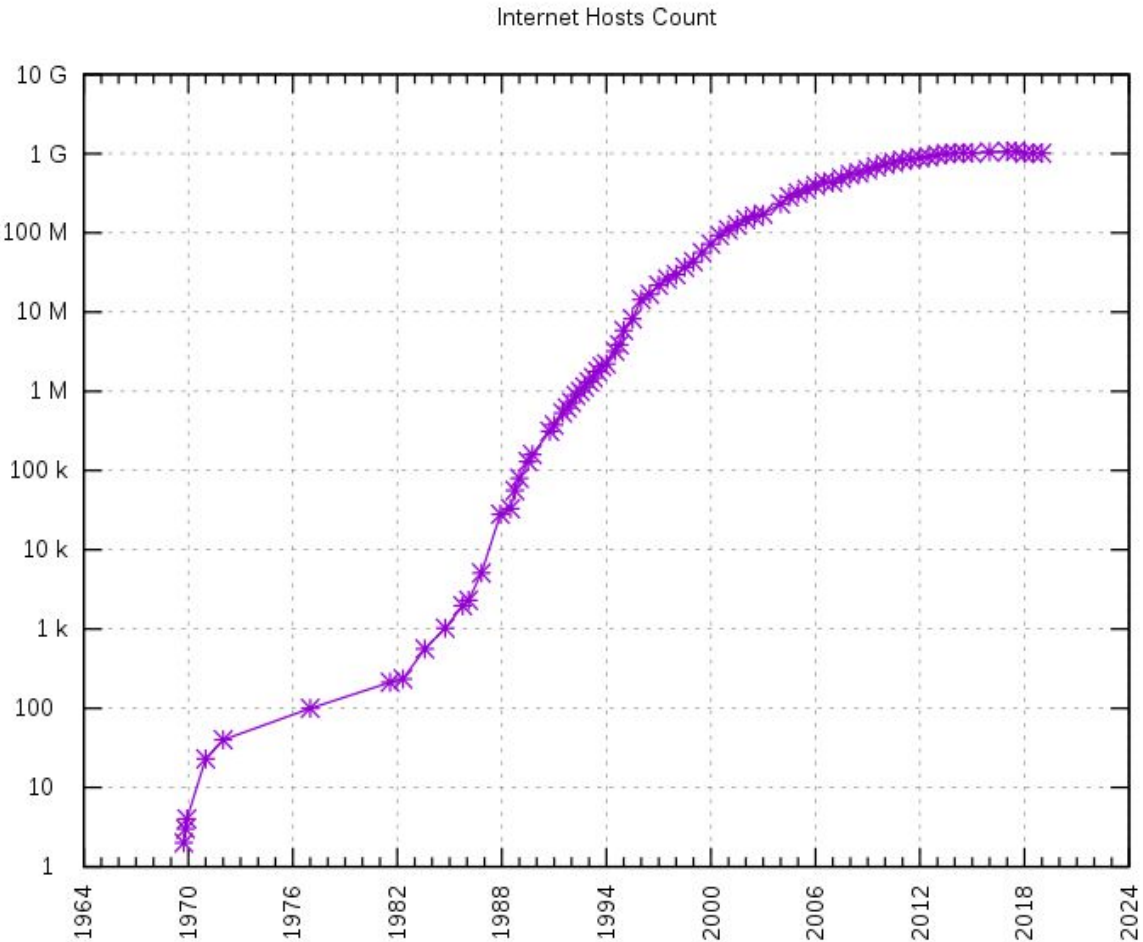
1969: The first four ARPANET nodes



THE ARPA NETWORK

DEC 1969

4 NODES



https://en.wikipedia.org/wiki/History_of_the_Internet#/media/File:Internet_Hosts_Count_log.svg

Internet Protocol (v4) addresses

ARPANET -> Internet Protocol, 1st January 1983

Addresses look like: 144.76.238.216

32 bits, written as 4 decimal bytes

32 bits -> 4294967296 potential addresses - but deliberately not used 100% for other useful reasons (eg routing)

What's using all the addresses? What can have an IP address?

things that run Linux/Windows/Android/iOS.
things you can browse the web on.
Raspberry Pis.
Alexa.
Servers in The Cloud.
Network infrastructure (routers)

eg my house:

- 2 x router
- 4 x raspberry pi
- 2 x phone
- 1 x laptop
- 3 x temperature probe
- + visitors

eg my hosted servers:

- 2 x DNS
- 1 x mail server
- 1 x web server

Population of earth vs IPv4 addresses

Population of earth: ~7000000000

Max IP addresses: ~4000000000

Not even enough addresses for eg. 1 phone per person / 1 IP address per phone, even if 100% efficiency

By ~2010, started running out - see https://en.wikipedia.org/wiki/IPv4_address_exhaustion

Workarounds to insufficient ipv4

Network Address Translation (NAT) - in your home/office router

- share IP addresses: every device in your home/office has a "fake" ip address, and your router does magic stuff to use one shared "real" IP address.

Upsides: hundreds of devices behind one IP address

Downsides:

- two classes of device on the internet now: ones with "real" connectivity, and ones restricted by NAT - no way to name it, so no way to make a connection to it, so (eg) no web server on that device

- no end-to-end connectivity between devices

Workarounds to insufficient ipv4

Markets to push on denser utilisation of IPv4 - IPv4 addresses are now tradeable

eg Cloud - Amazon - ~£3 per month per IP address

ipv6 - Internet Protocol (version 6)

Various changes vs IPv4 - the big one is:

IPv6 addresses are 128 bits long. (vs 32 bits in IPv4).

They are written like this: 2001:8b0:1638:9d8::2

128 bits = 300000000000000000000000000000000000 possible addresses

eg give every bacteria cell on Earth 100,000,000 IPv6 addresses

In practice, split as:

48 bits identifies "organisation", 16 bits identifies network, 64 bits identifies host on network

Now everything can have an IP address again!

Just like in the olden days…

So we can have end-to-end connectivity again.

eg Pi in my house … pi in my parents house can talk to each other

eg Mythic Beasts hosted Pi service - ipv6 native, and then several workarounds for IPv4 (NAT, other stuff)

What does this look like on a Pi?

You might already have ipv6:

load ipv6 into the kernel

… or maybe you need to:

```
# sudo modprobe ipv6
```

… and see what happens.

not much else to do

If your network already has ipv6, it's very likely that lots of your stuff is using ipv6 without you even realising it: eg google/facebook

Otherwise - get an ISP that does IPv6. (recommend Andrews & Arnold for geeks with money)

Lots of software will already use it - browsers. ssh. ping.

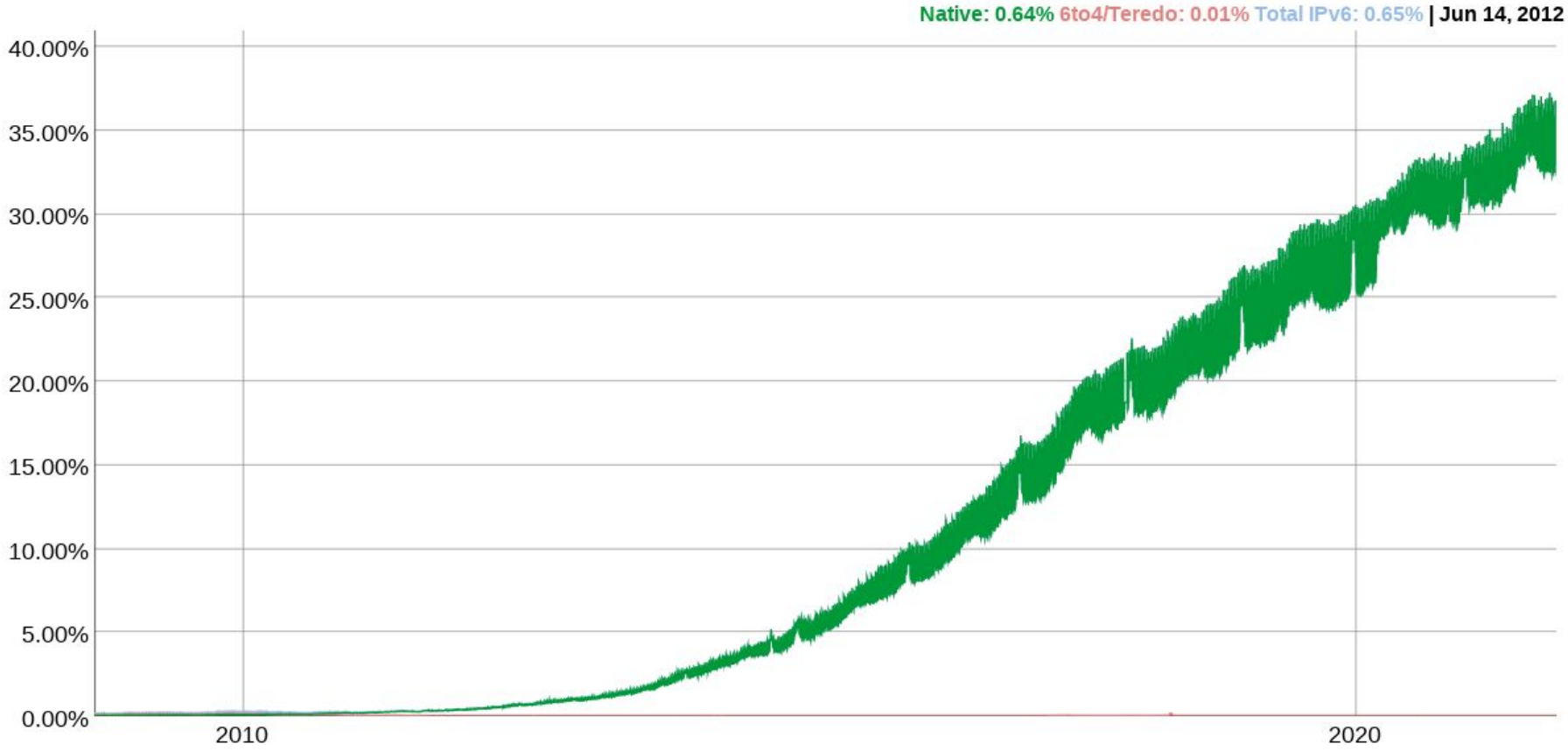
Inbound connections: (eg for running your own servers)

- you might have to configure your router to allow it - eg my "domestic" router blocks connections, my "serious" router allows all connections.

- put an AAAA record in DNS to point to your address

IPv6 Adoption

We are continuously measuring the availability of IPv6 connectivity among Google users. The graph shows the percentage of users that access Google over IPv6.



https://www.google.com/intl/en/ipv6/statistics.html#tab=ipv6-adoption

3 IP (v6) addresses on my Raspberry Pi ethernet

```
ip addr show dev eth0
```

Two "global" addresses:

```
inet6 2001:8b0:1638:9d8:f812:856c:d08b:10a5/64 scope global dynamic
inet6 2001:8b0:1638:9d8:f122:856c:d08b:10a5/64 scope global dynamic
```

2001:8b0:1638: = allocated to me (48 bits)

:9d8: = my home network (16 bits = 65536 possibilities)

::3 = I chose this number because its simple (64 bits)

One "link-local" address:

```
inet6 fe80::f812:856c:d08b:10a5/64 scope link
```

Automatically assigned, no need to co-ordinate with anyone else, unroutable

demo of simple commands like ping / ssh to show its real.