How the Internet Goes Wrong

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Let's look at what can go wrong

- We take the Internet for granted
- Until something doesn't work!

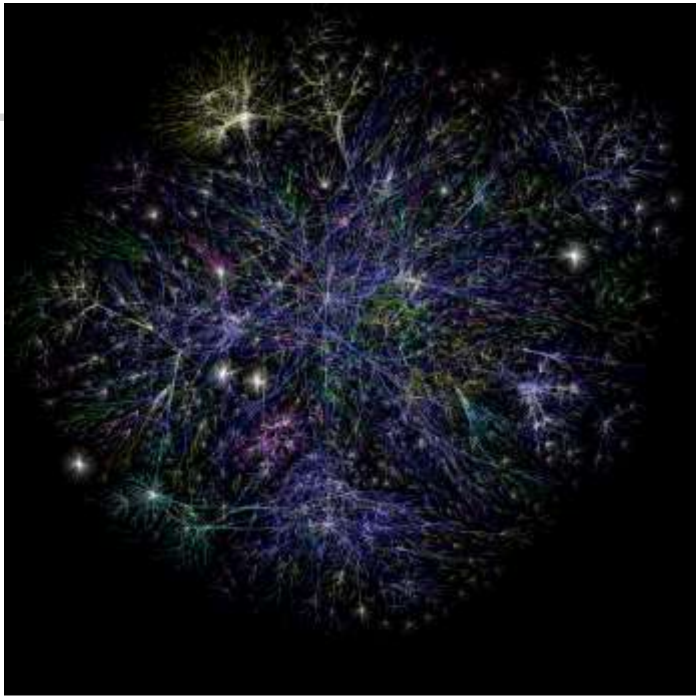
- Let's look at three common problems
  1. Why can't I get to a web site?
  2. Why's my download suddenly go slow?
  3. Why's my computer just got virused?

Outage!

- Aside from wires coming unplugged, or computers crashing (yours or theirs) there are several reasons you might not be able to get to a website :-

1. Names
2. Addresses
3. Routes

The Wires…

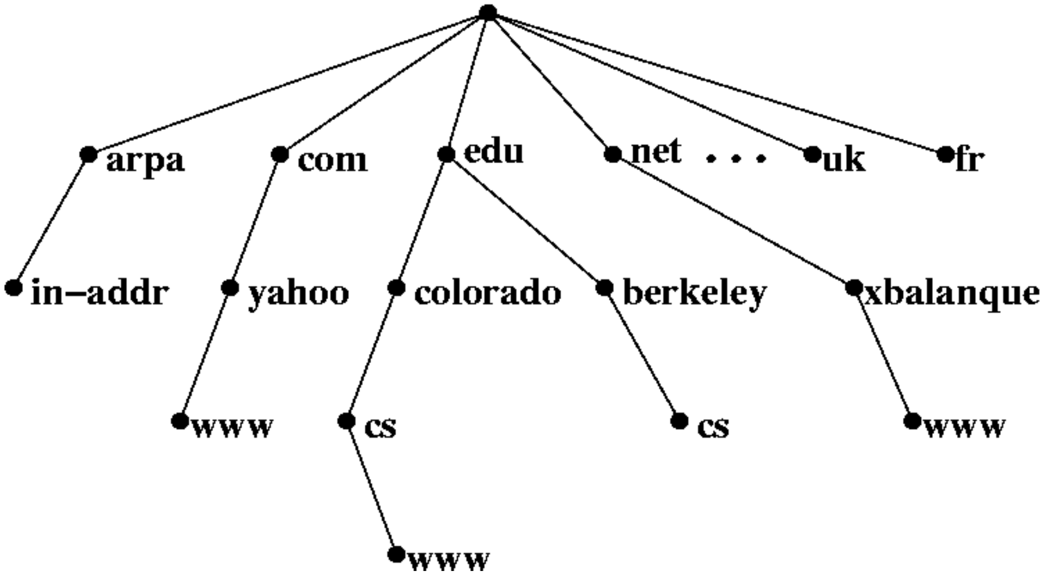


Flakey hardware improved by Smart Software

- Wires get broken
  - People kick cables out
  - Turn computers off
  - Power fails
- Can we make up for this by making the whole
  - Smarter than the sum of the parts?
- Yes - control software!!

The Domain Name System

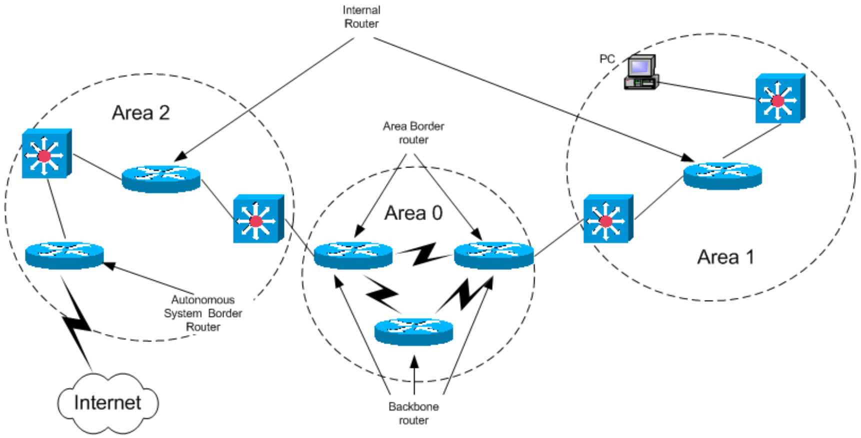
- When you type (or cut&paste) www.facebook.com, **what** you want…
- a “lookup” is done to
- Find the
- IP Address
- Which is
- **Where** it is



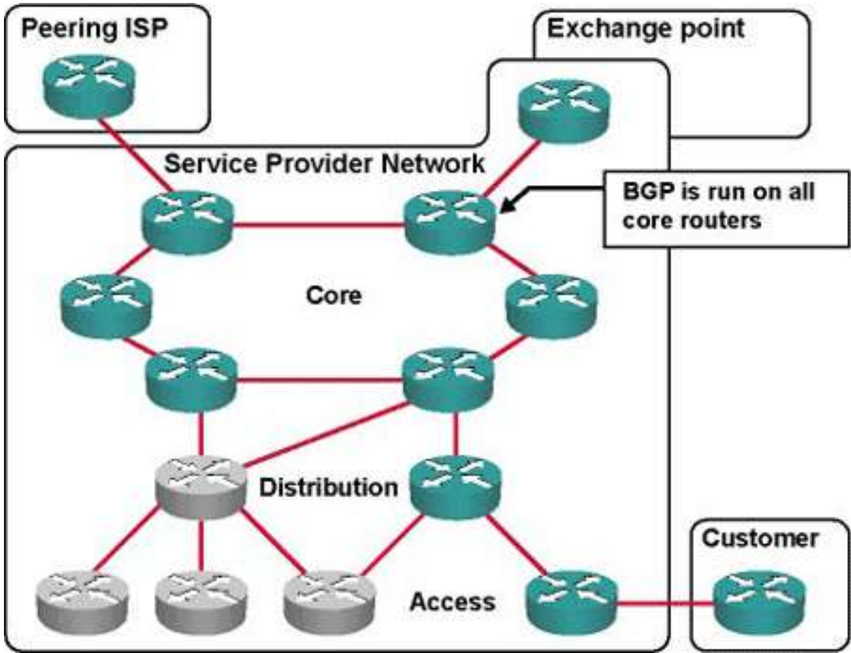
- The DNS may b
- Or you might just type something slightly wrong

Routing

- An address is where, but then you need a map and a compass to find the route

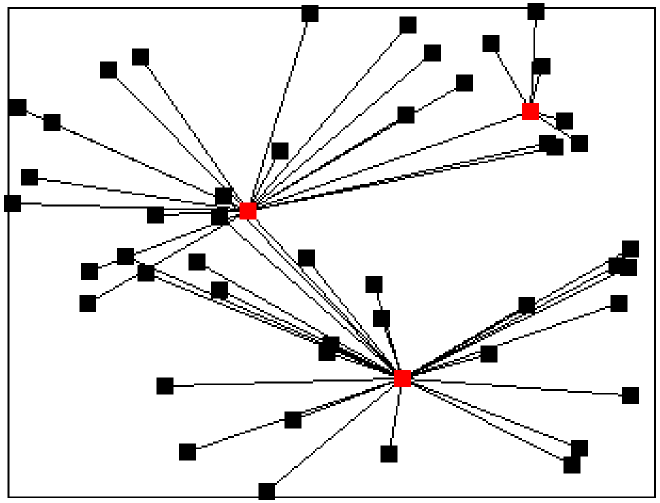


- The net does this
- For you in a
- Distributed way
- Which can go wrong!



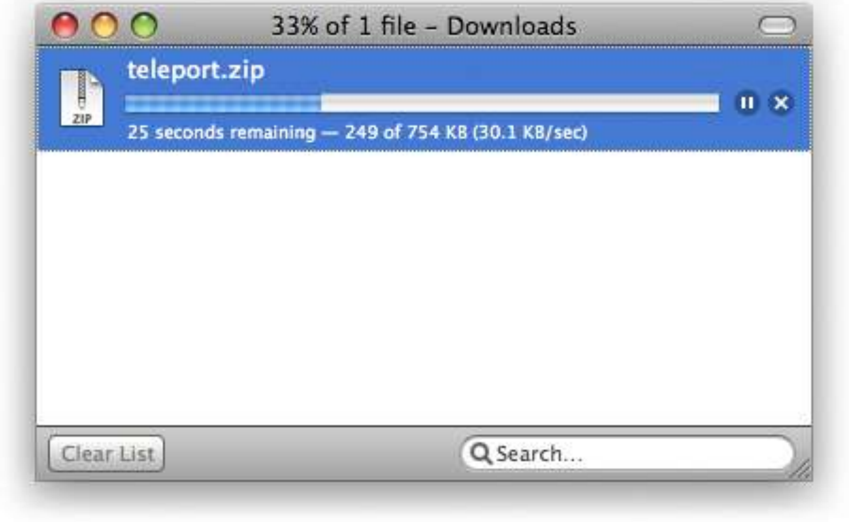
Dynamics

- Even as things change, software can keep track



Congestion

- Traffic jams can happen anywhere…on the internet too…



33% of 1 file – Downloads

teleport.zip

25 seconds remaining — 249 of 754 KB (30.1 KB/sec)

The Internet is shared, like roads

- Not so much like railways or flight paths
- So you have to wait your turn
- If there's a lot of users, the wait gets longer
- This is "implemented" by software in your computer which runs a *protocol*
- Called *TCP* - which cooperates with other computers implicitly to give a fair share…think about card games or anything where there are rounds…but where you can pass if you like
- It isn't exactly like that as it would take to long in a network, so instead it uses statistics

Insecurity!

- You may program your computer,
- But most the programmes you use were written by someone else (Microsoft, Apple, open source contributers)
- When you download a programme, how do you know who really wrote it, and what they really want to do with it?
- This is as true on your cell phone as it is on a notebook.
- This is true for Facebook Apps (and photo tagging) that invade your privacy.

Why do people write "malware"

- Sometimes they want to steal your ideas or your money
- But other times they want to use your computer to do things like
  - Spam
  - Botnets/ddos attacks
- Really bad guys pretend
- To be trying to help:

The Internet is quite complicated

- It isn't (usually) complex -
  - it's just made of a lot of pieces, each of which is really very simple.
  - For an "end to end" path to work
    - Properly, as expected, and to perform well
    - All the pieces have to function correctly
  - Amazingly, it does work most the time
  - Largely because we have got a lot better at designing and building computer software and hardware in the last 10-20 years
  - But there's a lot more to do still!

Highly Optimized Tolerance

- There are two possible problems that present a high risk

1. Topological
2. Temporal

Topology Problems

- The Internet exhibits scale-freeness
  - At many levels (link level and web level)
  - It also exhibits clustering
  - So we have small world….
  - which is good (for finding stuff)
  - But bad for attacks, due to "hub-iness"
  - Nodes of high betweenness (or spectral centrality) have to be protected/hardened
  - Its software, doh, and it's a net
  - so it isn't just thick lead walls and airgaps☺
  - We can reboot☺

Temporal Problems

- There are lots of synchronisation phenomena
  - Some happen all the time – the routing system is driven by clocks, for example
  - This can self-synchronise
  - The topology makes this more likely, not less
  - Bad stuff can synchronise with the routing system – an *scanning* attack can oscillate and end up blocking routing updates,
  - Leads to breaking connectivity, even if capacity, per se, wasn't in question
  - We can put in randomness to defend agains this

Cascades, Feedback, Dependencies

- The single biggest risk to the net is
- If we connect other nets to it
  - E.g. the power grid, transport, water ctl
  - We've measured HVAC vulnerabilities already
  - Imagine a cascading fail between power+comms
  - We've put all our eggs in one basket already for comms - Radio, TV and Telephone (including 3G/4G) already depend on IP…
  - How do you tell the population to keep calm if the net is under attack, and all your comms are out
  - Now imagine there's no power either
  - You are literally (and figuratively) in the dark.

Take Homes

- Risk if Internet Breaks is very bad indeed, if more other utilities come to depend on it for control –
- this should be prevented by legal/policy means – we need diverse networks (for energy, transport, food, knowledge), we do NOT want to couple them closely (or at all)
- The Internet itself could be made more robust/resilient, esp. to emergent bad behaviour
- People are aware of this in the tech community ☺