What is the best way to map the Internet?
Maps let us look inside the cloud
The talk in a nutshell

- there is no best way
- no one true map of the Internet
- there are good examples and (lots) of bad examples
- easy to map, much harder to map well
- but all the maps are interesting to some degree
- need maps that are fit for purpose. what do you want to show, what is the story you want to tell
- maps are less fixed. maps are increasingly just ‘thinking tools’ for interactive exploration of data
- only looking at published / public maps
mapping the ‘tin cans and string’

- many aspects of the Internet that you can map
- function, form, scale
- what they show? nodes, users, links, flows
- what form? geographic -> abstract ; static -> dynamic
- what scale? buildings, companies, cities -> global
• 30 years worth of maps, but most are from the last decade
• very diverse range of styles and forms
• Internet has no ‘natural’ representation, but some obvious visual metaphors keep popping up
• relevance of real-world geography?
My definition of ‘map’

• hey, half of your examples of not even maps!

• “maps are graphic representations that facilitate a spatial understanding of things, concepts, conditions, processes, or events in the human world”
  (Harley and Woodward, History of Cartography, Volume 1, 1987)

• map versus graph versus diagram....
Purpose of Internet maps

• network planning
• network ops and maintenance
• network research (prove new theories)
• network marketing
• visualisation research
• market research & census taking
• security and policing
• grad student projects
• the urge to map it because its there
• (eye candy for posters, books & talks)
who makes them? not cartographers!
Why is it hard to map the Internet?

- its new, its fast changing
- complex and fast growing
- diversity of owners, heterogeneous, no one has overall responsibility
- banal, boring, background. Invisible internet
- secrecy - network security and commercial confidentiality
- has not been seen as a vital strategic asset. although this is changing with growing fears of cyber-terrorism
Okay, enough waffle. show me some maps.....

- where do the cables go? or logical routing?
- scales of mapping facilities
  - CAD schematics of rooms and buildings
  - street layout of fibre grids
  - city wide
  - regional
  - national
  - continental
  - global grids of glass, undersea cables
  - out into space - satellite constellations
- lets start at the most obvious map metaphor - links + node, with real-world geographic layout
- (try to spot any of the networks that are still in business)
Just nodes and links
mapping ARPANET’s logical structure - topology v. geography

(source: Internet Archive, ARPANET documents)
MAN maps from TeleGeography

(source: www.telegeography.com)
Bandwidth Bay Fiber Network Map

(source: www.sangis.org/sangis/intmaps/fibermap.htm)
(source: www.williamscommunications.com)
UUNET’s North America Internet network

For more information visit www.uu.net
backbone marketing maps

(Source: www.uu.net)
Optical fibre submarine systems

(source: www.alcatel.com)
Comparing backbone networks

(source: Mapnet by CAIDA, www.caida.org/tools/visualization/mapnet/)
Poster maps of telco facilities ($$)

www.kmicorp.com

www.telegeography.com
Teledesic satellite
Internet

(source: Lloyd Wood, www.ee.surrey.ac.uk/Personal/L.Wood/software/SaVi/ )
Beyond the flat map
(source: Tamara Munzner
www.cs.ubc.ca/~tmm/)
Bye, bye to the geographic world

- focus is on topology, not geography
- Internet engineers often don’t care about where things are, but how they are connected
- wiring diagrams rather than maps
ARPA NETWORK LOGICAL MAP, MARCH 1977

(Please note that while this map shows the host population of the network according to the best information obtainable, no claim can be made for its accuracy.)

Names shown are IMP names, not necessarily host names.
UCL’s dept. networks

SuperJANET ATM Topology

Updated by Baoyu Wang on 27 September, 1996
korean internet topology

(Source: KR-NIC http://stat.nic.or.kr)
(Source: Hal Burch & Bill Cheswick
Internet Mapping Project
www.lumeta.com/mapping.html)
Census maps of Internet geography
Larry Landweber & ISOC national level network connectivity maps from 1990s

(source: ftp.cs.wisc.edu/connectivity_table/)
the whole world now pretty much wired??
Geographic density of Internet routers

Router density

Population density

Uneven bandwidth geography - stylised TeleGeography ‘map’
Mapping virus diffusion - Code-Red

(source: Caida, www.caida.org/analysis/security/code-red/)
Dotcom domain names in SF

(source: Matthew Zook, www.zooknic.com)
War driving wifi nodes

(source: Frank Keeney, http://pasadena.net/apmap/)
Distortion and deception
"how to lie with maps"

- all maps are subjective
- all maps are selective
- most obvious being through
  - data selection/omission
  - projections
- how are maps of Internet deceiving?
- clearly there are many ways to project the Internet onto a map
Maps of the Internet on your wall
Peacock Maps Posters, www.peacockmaps.com

Also available at www.thinkgeek.com
• many other aspects of the cyberspace to map, especially the information spaces
• many different ways to map and visualise
• I’m still waiting for the best map of the Internet
• these slides are at
  www.casa.ucl.ac.uk/martin/cambridge_seminar.pdf
• comments ?? welcome to send feedback to
  m.dodge@ucl.ac.uk

more info, many more maps -
www.cybergeography.org