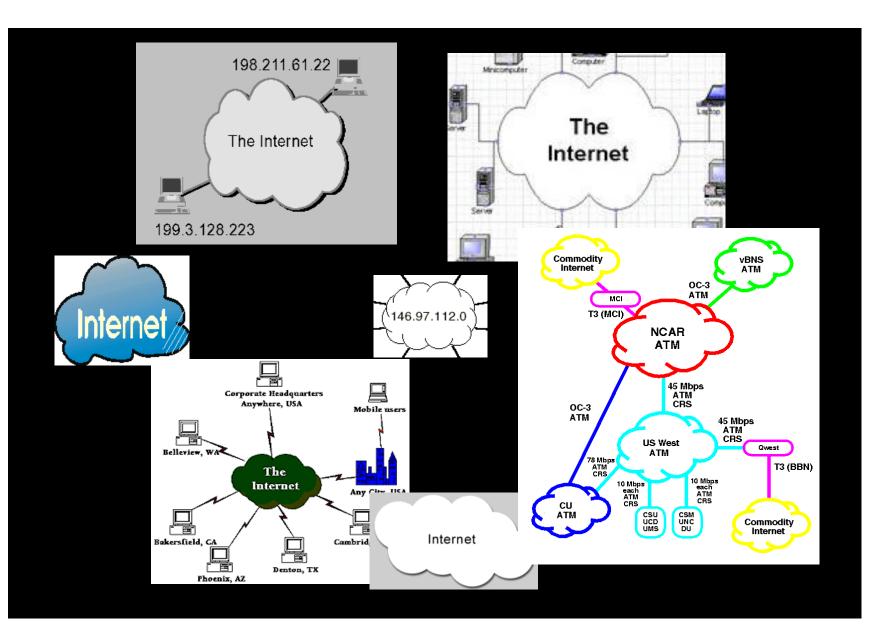
Seeing inside the cloud: some ways to map the Internet

Martin Dodge

www.cybergeography.org Centre for Advanced Spatial Analysis University College London

UCL Computer Science, Networks Research Group Seminar / 21st January 2004/





Maps let us look inside the cloud

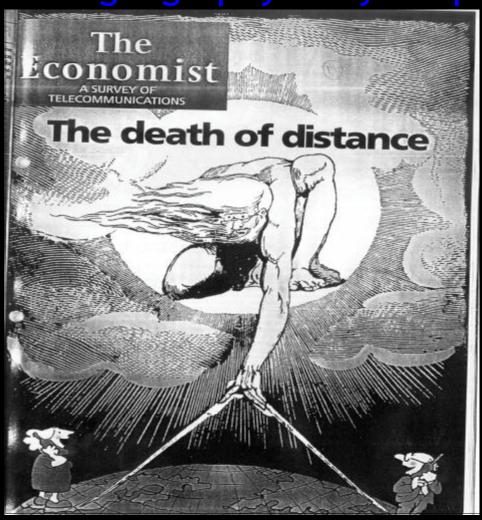
Is there a geography of cyberspace?

Bits, not atoms

Spaceless space

anything, anytime, anywhere

End of Geography



Cyberspace is everywhere and nowhere

friction-free economy

Cities dissolve

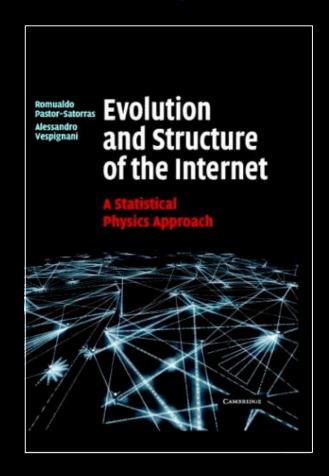
Weightless World

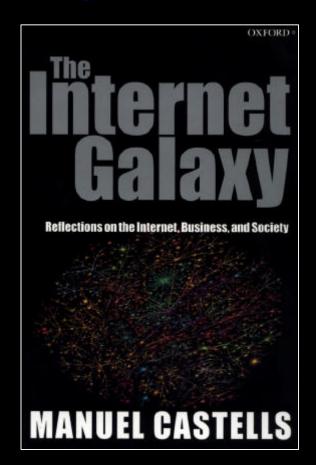
30th September 1995

Maps and imagination



Maps and imagination





Warriors of the Net

(Ericsson MediaLab, animation by Gunilla Elam)





http://www.warriorsofthe.net/

My definition of 'map'

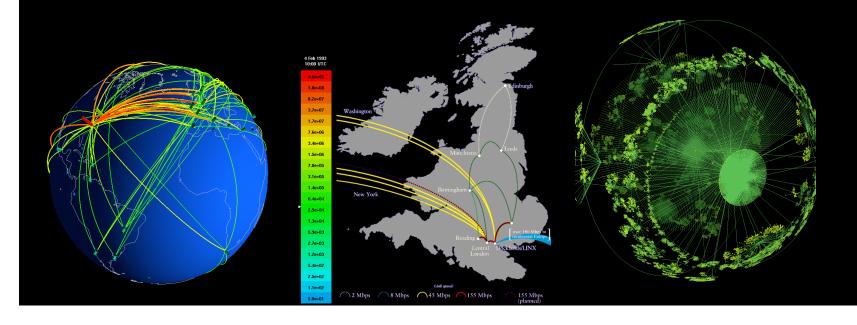
- half of your examples are not even maps!
- "maps are graphic representations that facilitate a spatial understanding of things, concepts, conditions, processes, or events in the human world"

(Harley and Woodward, *History of Cartography*, Volume 1, 1987)

map versus graph versus diagram....

Mapping the 'tin cans and string'

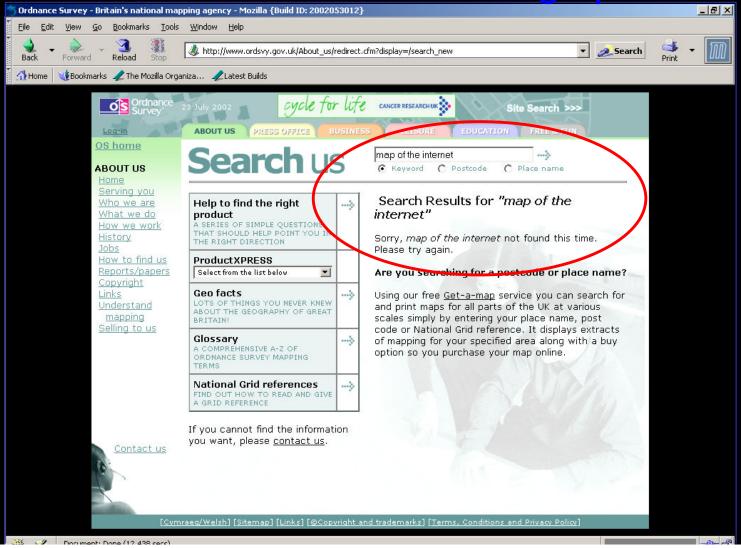
- many aspects of the Internet that you can map
- what they show? nodes, users, links, flows
- what form? geographic -> abstract; static -> dynamic
- what scale? buildings, companies, cities -> global



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?

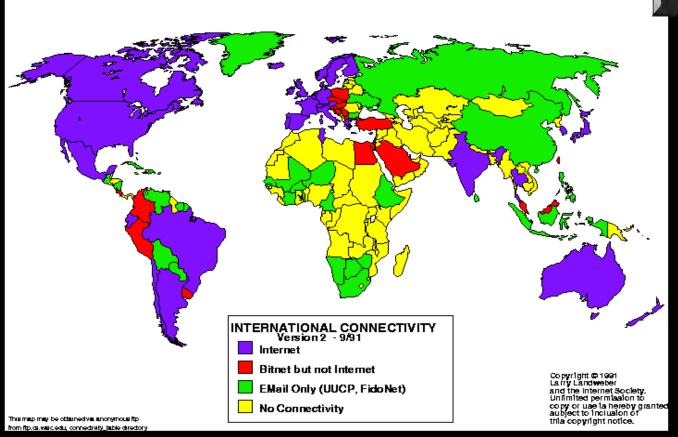
- its new, its fast changing
- complex and fast growing
- diversity of owners, heterogeneous, no one has overall responsibility
- banal, boring, background. Invisible internet
- secrecy network security and commercial confidentiality
- has not been seen as a vital strategic asset. although this is changing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



Statistical mapping:

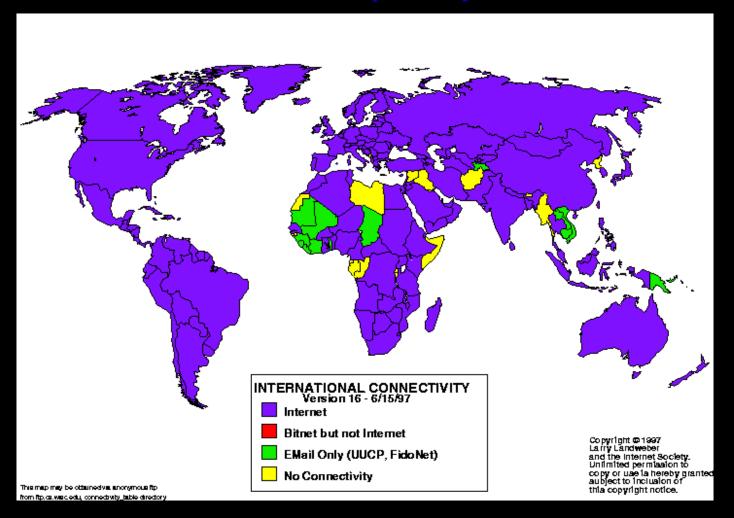
statistical maps by shading polygons or continuous surfaces

Larry Landweber & ISOC national level network connectivity maps from 1990s

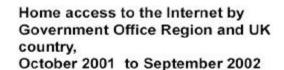


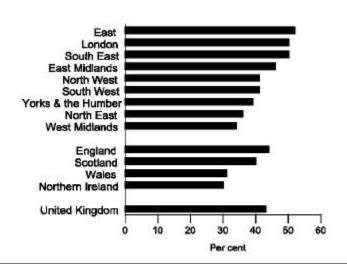
(http://www.cs.wisc.edu/~lhl/maps/)

the whole world now pretty much wired??

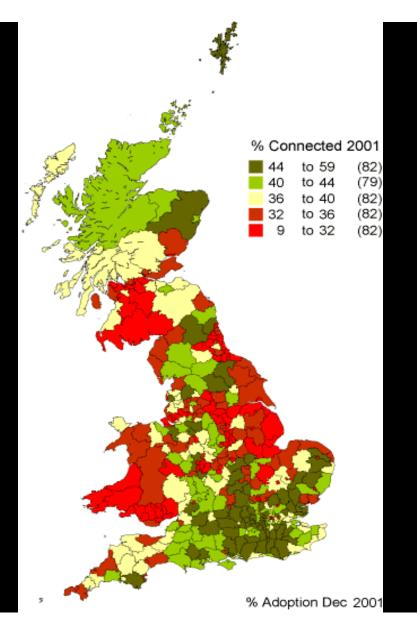


Regional variation in Internet access rates



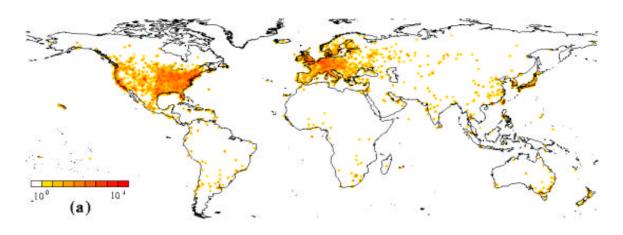


(http://www.e-envoy.gov.uk)

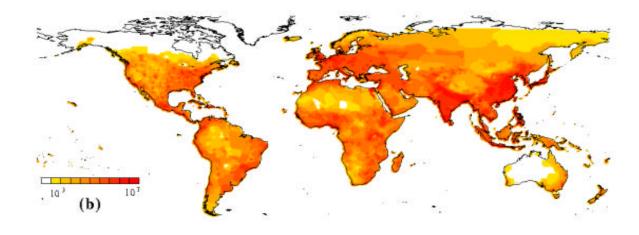


Geographic density of Internet routers

Router density

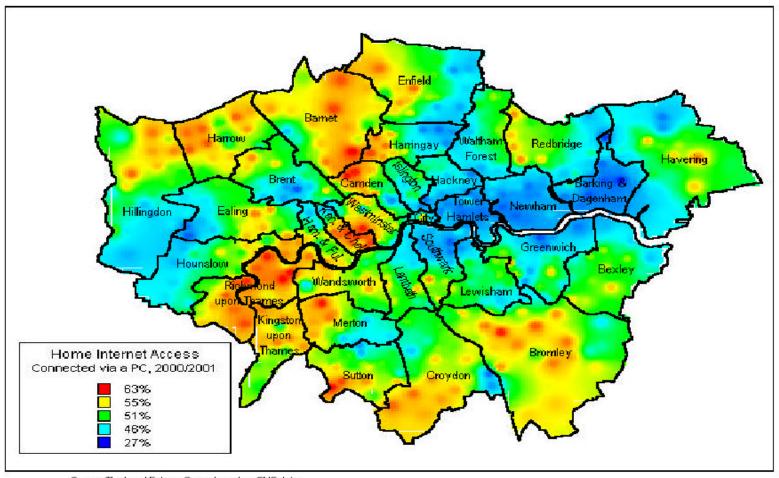


Population density



(source: Modeling the internet 's large-scale topology, http://xxx.lanl.gov/abs/cond-mat/0107417)

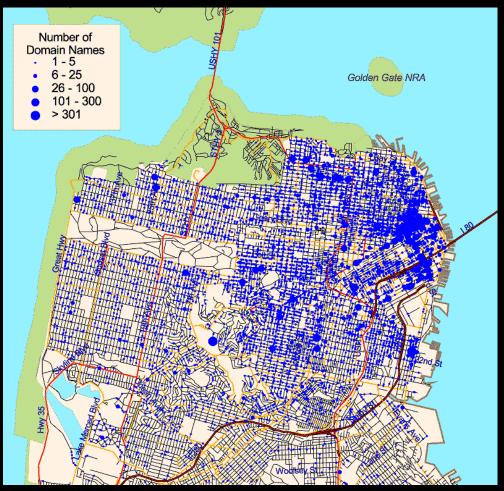
Chart 8: The Geography of Home Internet Access in London



Source: The Local Futures Group, based on ONS data

(source: E-London and the London Plan)

Dotcom domain names



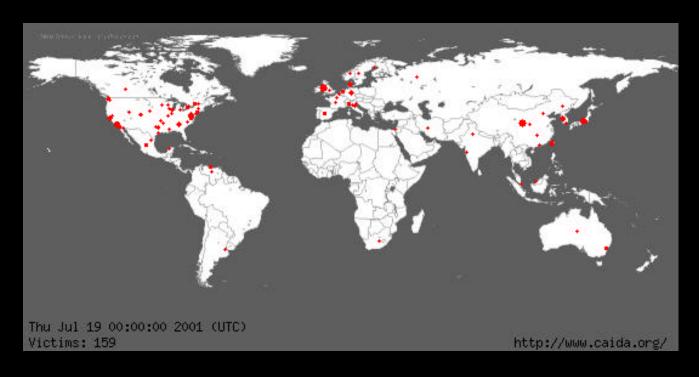


(source: Matthew Zook, www.zooknic.com)

War driving wifi nodes



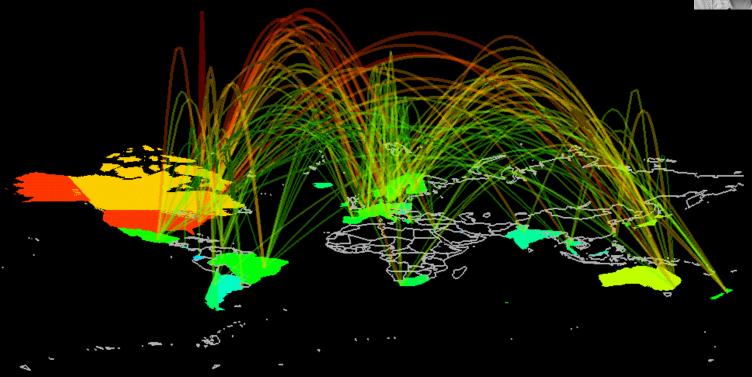
Mapping virus diffusion - Code-Red



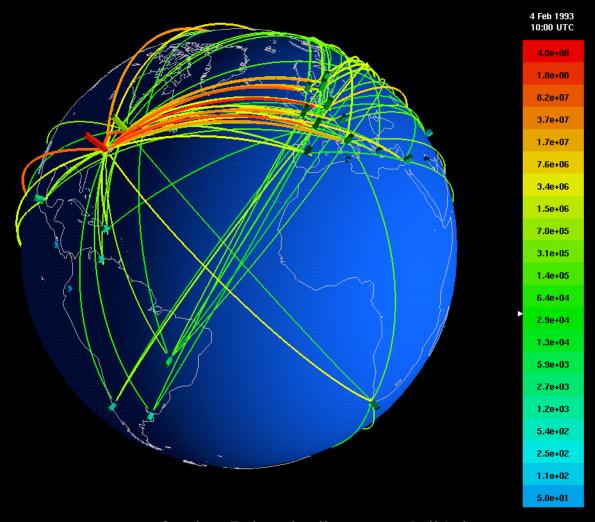
(source: Caida, www.caida.org/analysis/security/code-red/)

Internet as missile tracks





(source: Stephen Eick and colleagues at Bell Labs, 3D Geographic Network Display, 1996)

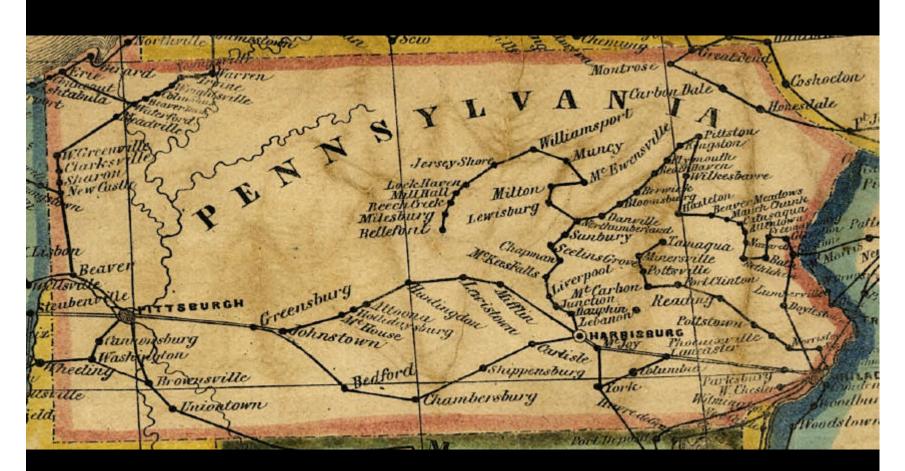


(source: Stephen Eick and colleagues at Bell Labs, 3D Geographic Network Display, 1996)

Where do the cables go?

Geographic link-node mapping, physical or logical?

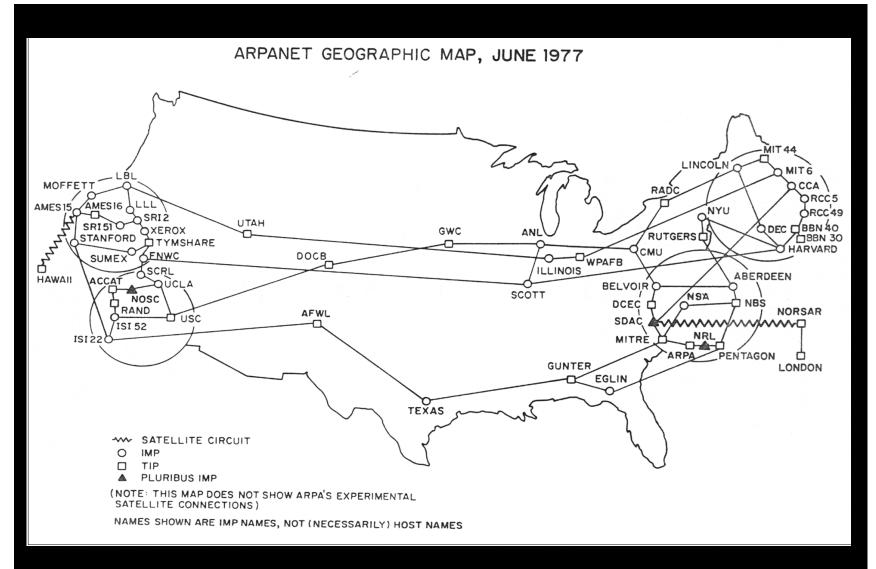
Just nodes and links



Victorian internet, circa 1853

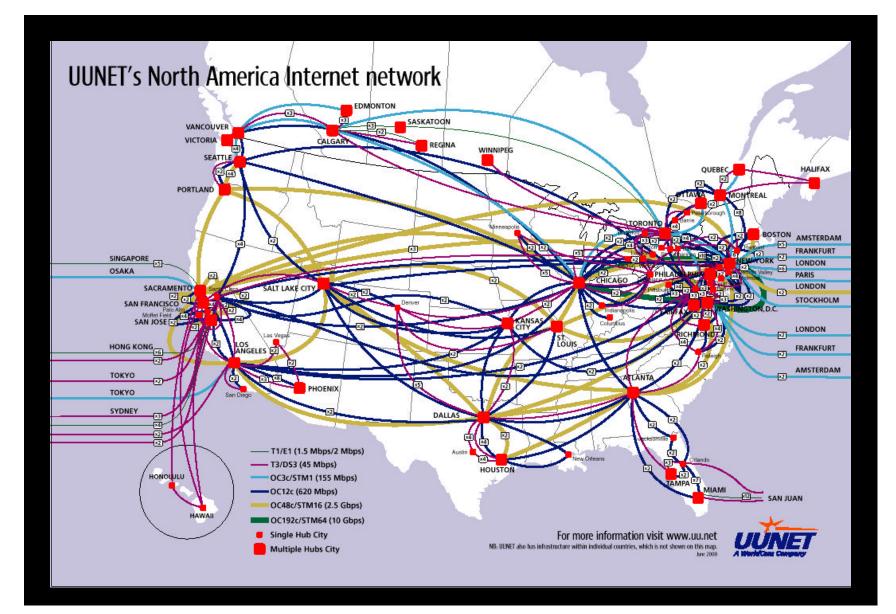


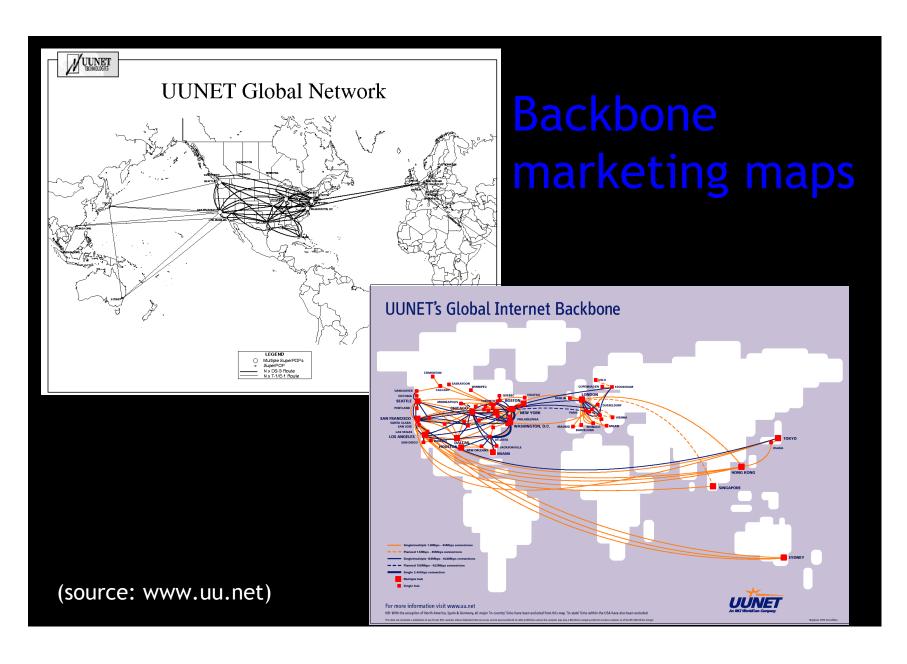
(source: Library of Congress, http://hdl.loc.gov/loc.gmd/g3701p.ct000084)



(source: Internet Archive, ARPANET documents)







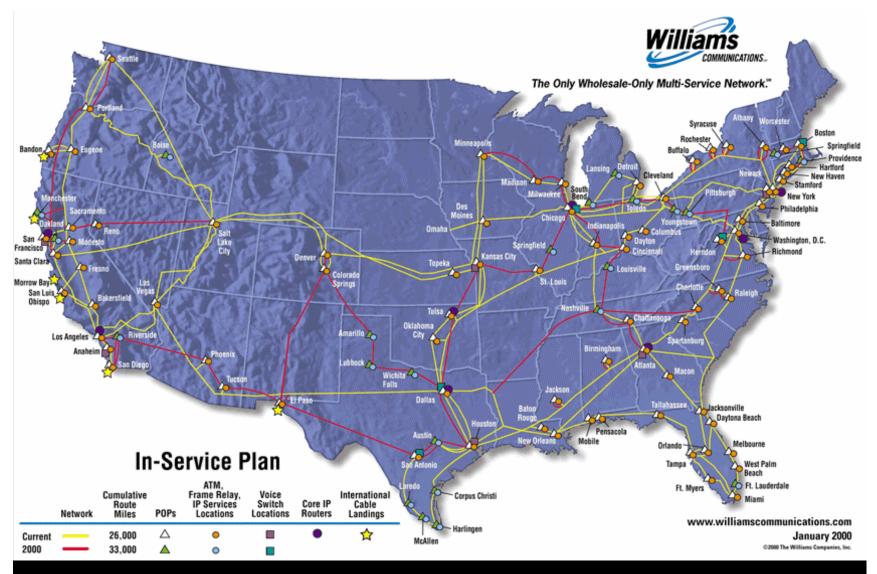


Bandwidth Bay Fiber Network Map

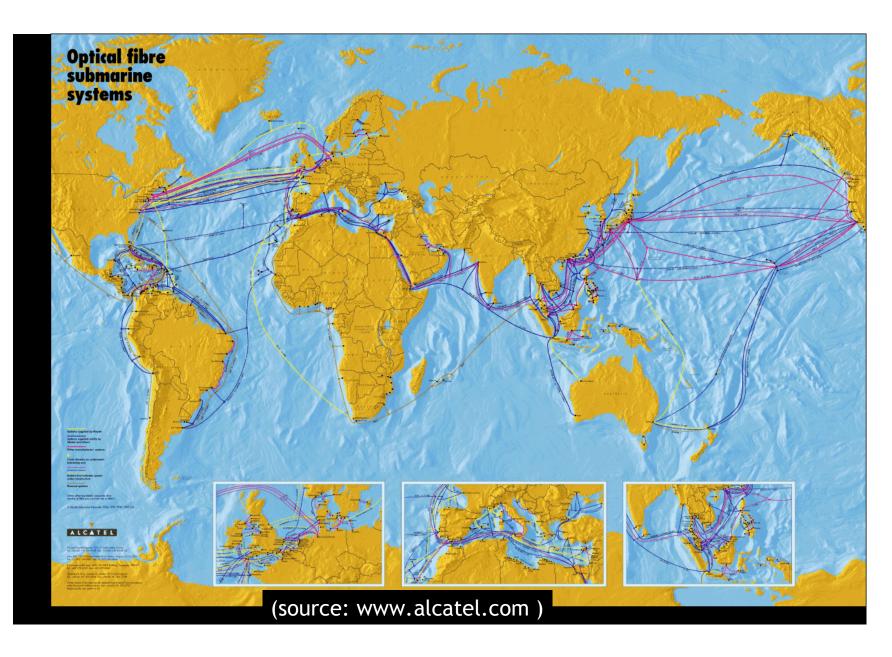




(source: www.sangis.org/sangis/intmaps/fibermap.htm)



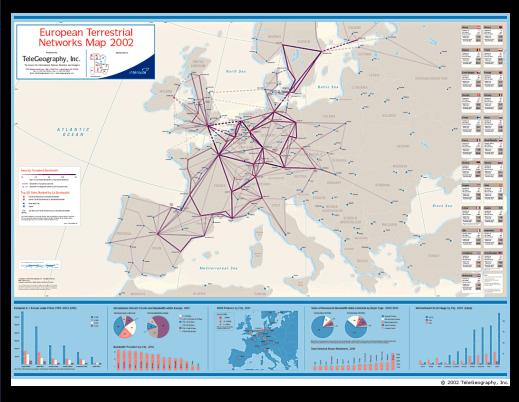
(source: www.williamscommunications.com)



Poster maps of telco facilities (\$\$)

SOUTH AMERICAN FIBEROPTIC ROUTES PLANNED AND IN PLACE

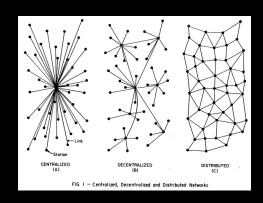




www.kmicorp.com

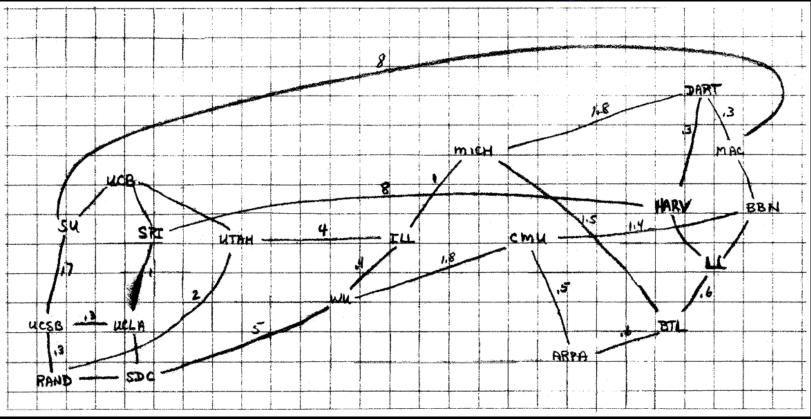
www.telegeography.com

Bye, bye to the geographic world



- focus is on topology, not geography
- Internet engineers don't care about where things are, but how they are logically connected
- wiring diagrams rather than maps

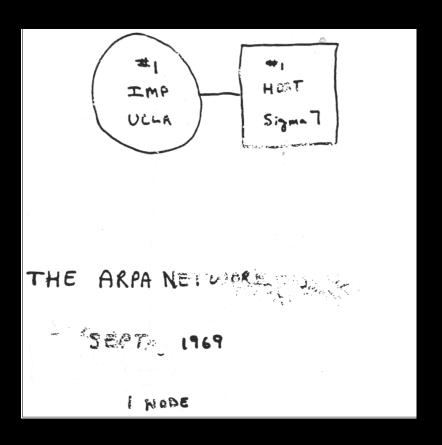
Back of the envelope

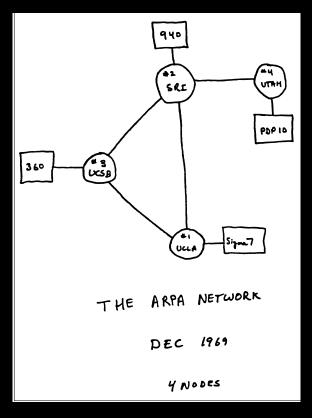




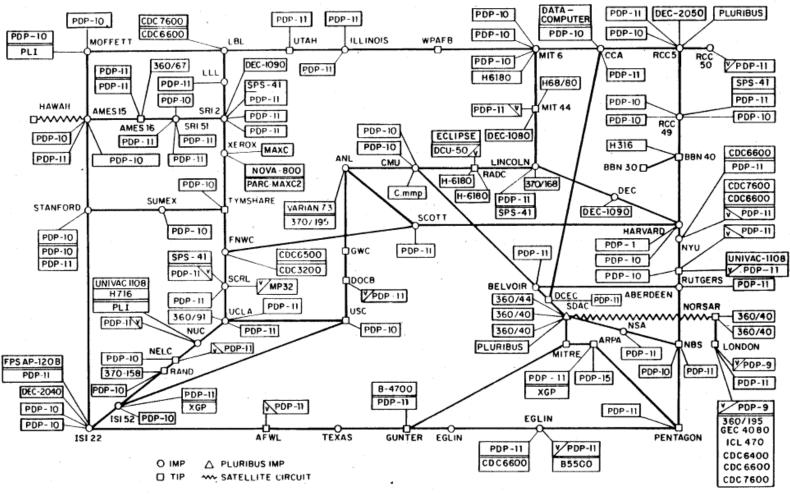
Larry Roberts (Source: from the 'Wizards' book)

Back of the envelope



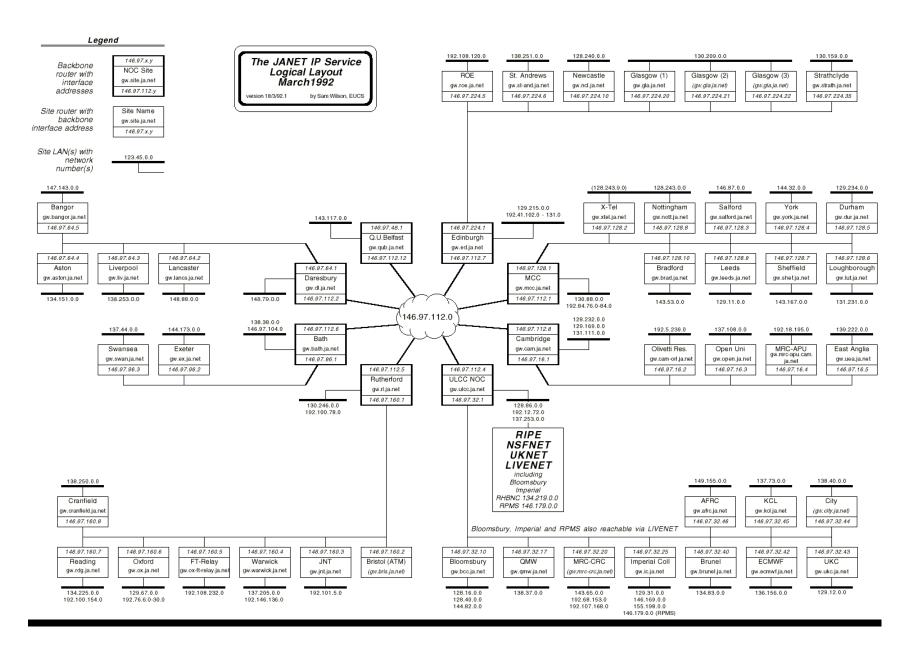


ARPANET LOGICAL MAP, MARCH 1977

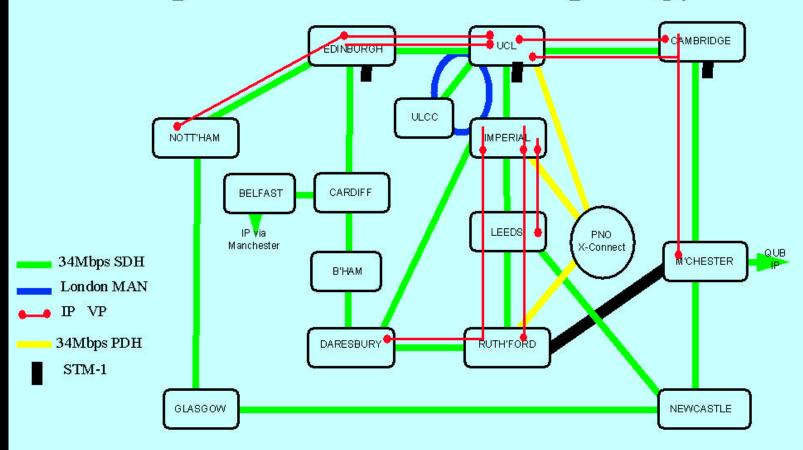


(PLEASE NOTE THAT WHILE THIS MAP SHOWS THE HOST POPULATION OF THE NETWORK ACCORDING TO THE BEST INFORMATION OBTAINABLE, NO CLAIM CAN BE MADE FOR ITS ACCURACY)

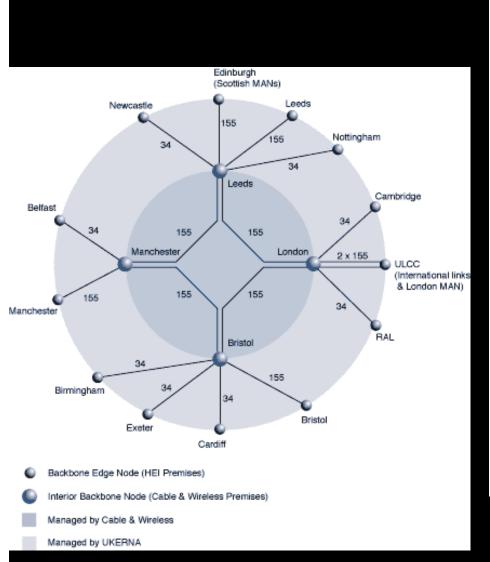
NAMES SHOWN ARE IMP NAMES, NOT (NECESSARILY) HOST NAMES

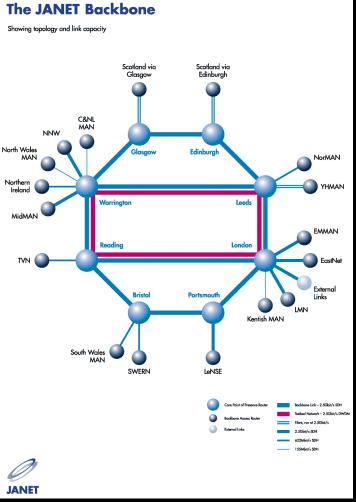


SuperJANET ATM Topology

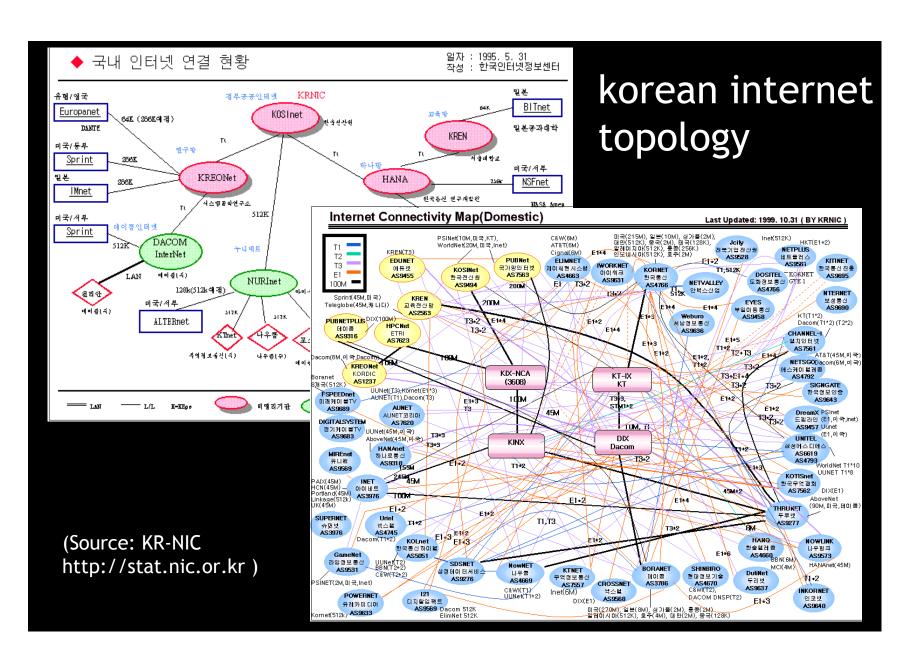


Updated by Baoyu Wang on 27 September, 1996

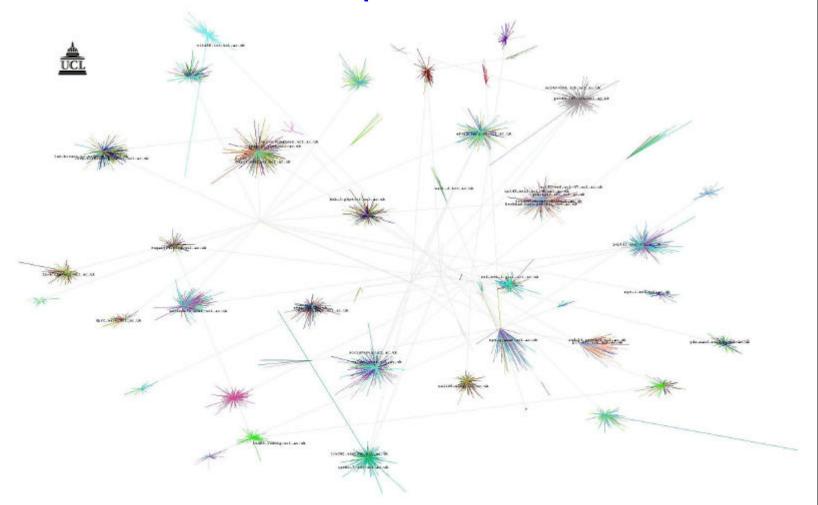




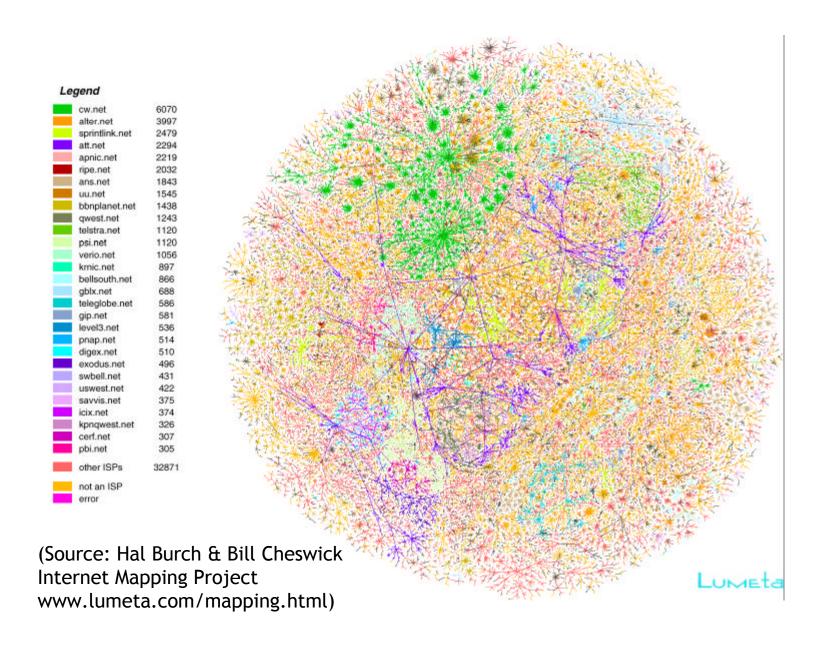
(source: http://www.ja.net)

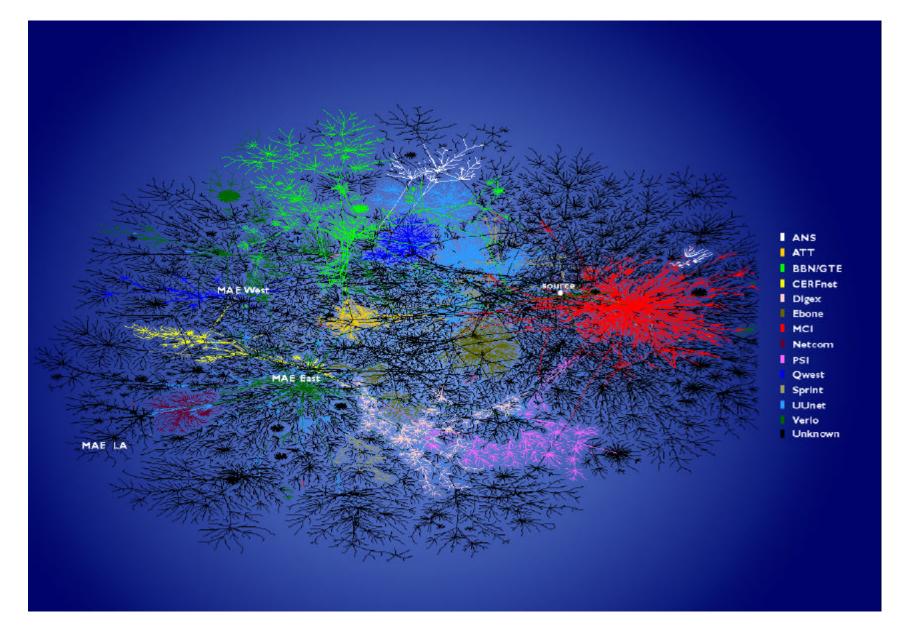


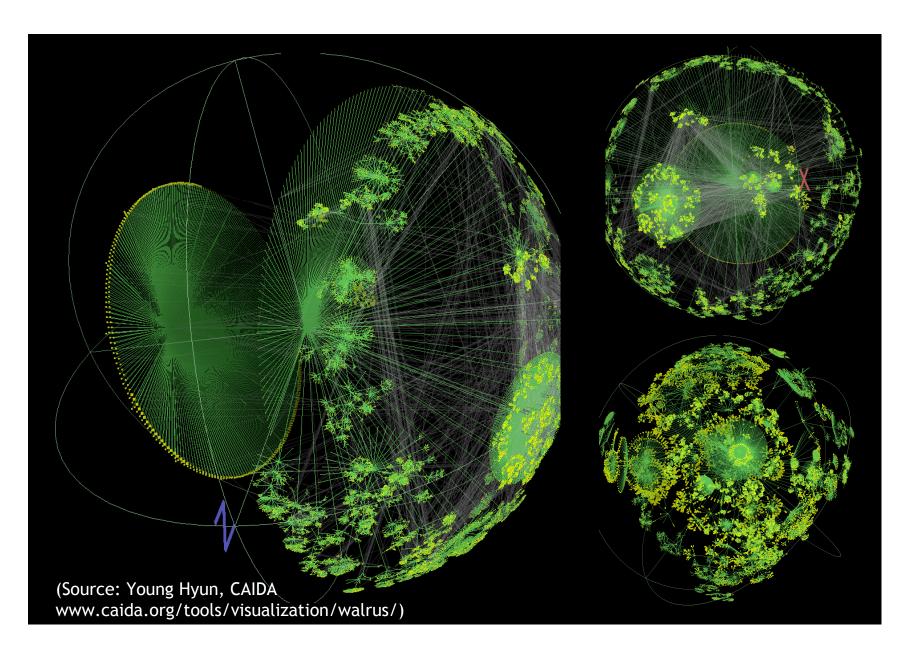
UCL's dept. networks

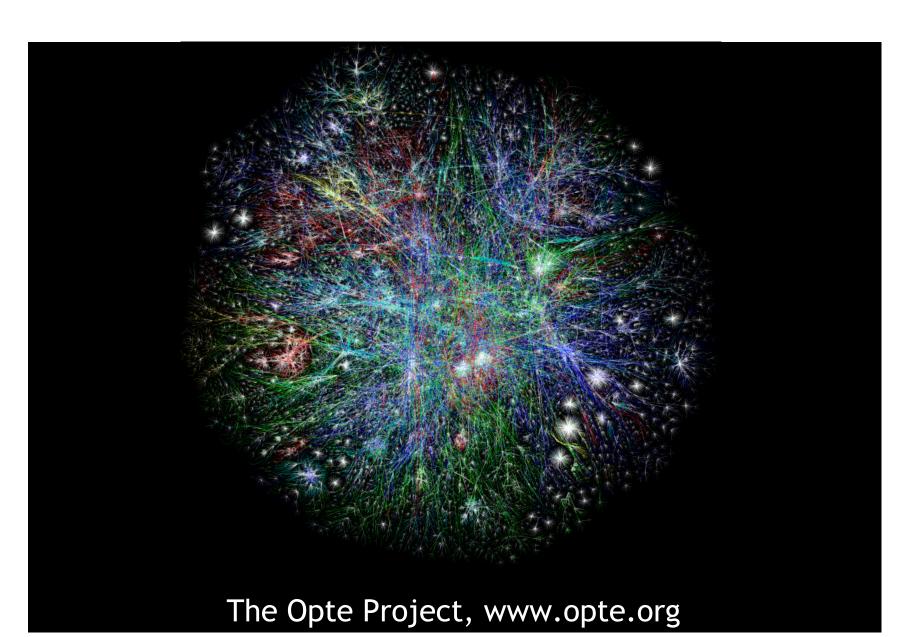


(source: Steve Coast, www.fractalus.com/steve/stuff/ipmap/index.html)



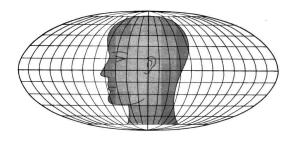


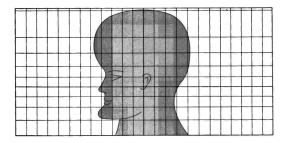


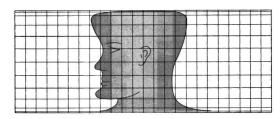


Distortion and deception "how to lie with maps"

- 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







A head drawn on the Mollweide projection (top) has been transferred to Mercator's projection (center) and to the cylindrical equal-area projection with standard parallels at 30° (bottom). Just because the profile looks most natural on Mollweide's projection, that projection is not necessarily "better." The natural profile could have been drawn on any projection and then plotted on the others.

- 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/ucl_nets.pdf
- comments ?? welcome to send feedback to m.dodge@ucl.ac.uk



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