

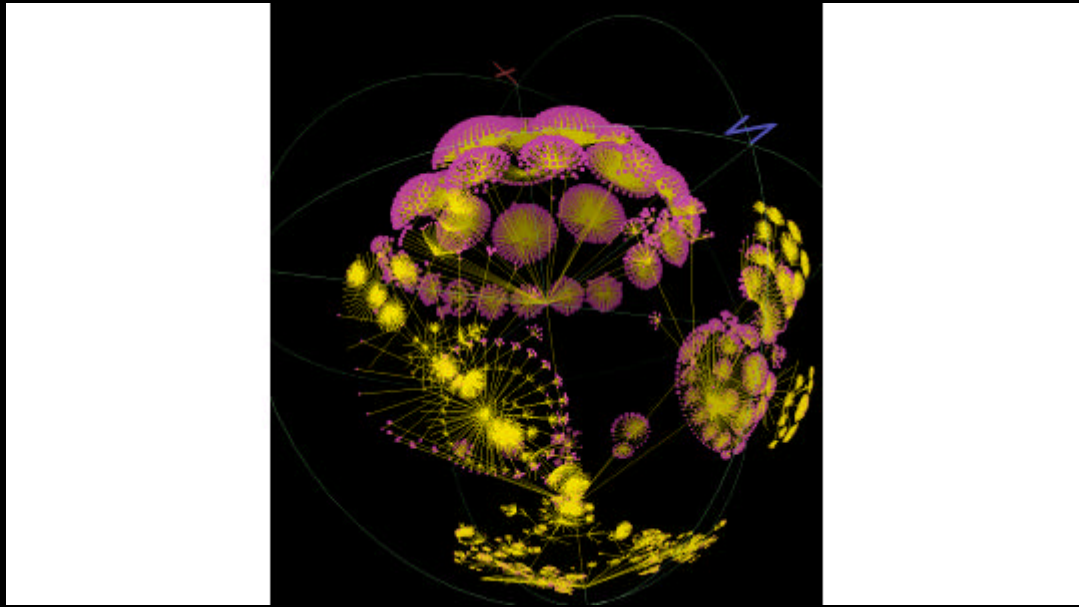


# Are there any good maps of cyberspace?

**Martin Dodge**  
[www.cybergeography.org](http://www.cybergeography.org)  
Centre for Advanced Spatial Analysis  
University College London

2nd December 2002

# Here are some cyberspace maps



But are they  
any good???

- is it accurate?
- is it interpretable?
- it is useful?
- is it ethical?

*the map is a help provided to the imagination through the eyes.*

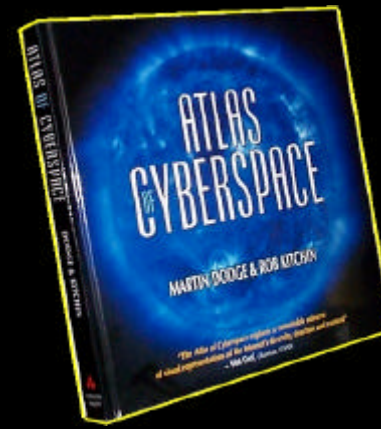
Henri Abraham Chatelain, Atlas Historique (1705)

# who am I?

- martin dodge like maps
- social geography, computing, GIS
- researcher in Centre for Advanced Spatial Analysis (CASA)
- now also a lowly lecturer in Geography at UCL
- part-time phd in cybergeography at UCL
- geography of the Net, cybergeography, cataloguing of diverse range of maps
- critical appraisal of maps and visualisation
- working with Peacock Maps

# BA geography with computing at UKC (1992)

what have I been doing for since graduation??

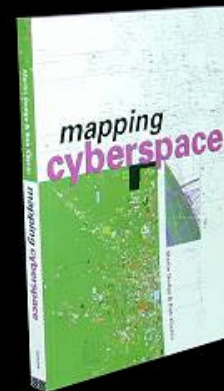


Oct. 2001

cybergeography



1996



Sept. 2000

Phd  
Thesis

2003 ?



# # include standard disclaimer

- I talk about maps
- but I am not a cartographer
- and I am not a programmer or network engineer
- I did NOT make any of the maps in this talk!
- a typical critic

## So the talk today

- some boring theory stuff
- bunch of examples of Internet infrastructure mapping
- a whole bunch more information maps
- conclude with some more theory (if I don't run out of time)

# understanding cyberspace with maps

- there are many ways to describe and understand cyberspace
- economics, legal, mathematics, art, sociology, etc..
- I'm a geographer, so I believe *maps* enjoy a privileged position
- maps have been powerful visual tools for understanding the world for 1000s of years
- maps have been key in framing our understanding places, their size, shape and the relations between them
- maps have been vital for navigation
- maps vital in war, commerce and government

# defining cyberspace mapping?

- cyberspace
  - the conceptual spaces of information and communications flows within the digital infrastructure of computing hardware, software code and high-speed telecommunications networks
  - it is not the technology or infrastructure itself, but the virtual spaces that this enables
- map and mapping
  - 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)



# defining cyberspace mapping?

- cyberspace mapping concerned with maps that show some aspect of ICT infrastructure or conceptual digital information spaces
- maps of cyberspace, not maps in cyberspace
- my framing of the domain of cyberspace mapping is obviously artificial
- cyberspace mapping being done by lots of different people, groups and organisations. but not conventional cartography or GIS industry

# who makes them? not cartographers!

Ordnance Survey - Britain's national mapping agency - Mozilla {Build ID: 2002053012}

File Edit View Go Bookmarks Tools Window Help

Back Forward Reload Stop  Search Print

Home Bookmarks The Mozilla Organiza... Latest Builds

23 July 2002 **OS** Ordnance Survey *cycle for life* CANCER RESEARCH UK Site Search >>>

Log-in ABOUT US PRESS OFFICE BUSINESS LEISURE EDUCATION FREE & FUN

**Search us**

Keyword Postcode Place name

**Search Results for "map of the internet"**

Sorry, *map of the internet* not found this time. Please try again.

**Are you searching for a postcode or place name?**

Using our free [Get-a-map](#) service you can search for and print maps for all parts of the UK at various scales simply by entering your place name, post code or National Grid reference. It displays extracts of mapping for your specified area along with a buy option so you purchase your map online.

**Help to find the right product** →  
A SERIES OF SIMPLE QUESTIONS THAT SHOULD HELP POINT YOU IN THE RIGHT DIRECTION

**ProductXPRESS**  
Select from the list below

**Geo facts** →  
LOTS OF THINGS YOU NEVER KNEW ABOUT THE GEOGRAPHY OF GREAT BRITAIN!

**Glossary** →  
A COMPREHENSIVE A-Z OF ORDNANCE SURVEY MAPPING TERMS

**National Grid references** →  
FIND OUT HOW TO READ AND GIVE A GRID REFERENCE

**ABOUT US**  
[Home](#)  
[Serving you](#)  
[Who we are](#)  
[What we do](#)  
[How we work](#)  
[History](#)  
[Jobs](#)  
[How to find us](#)  
[Reports/papers](#)  
[Copyright](#)  
[Links](#)  
[Understand mapping](#)  
[Selling to us](#)

[Contact us](#)

[Cymraeg/Welsh] [Sitemap] [Links] [©Copyright and trademarks] [Terms, Conditions and Privacy Policy]

Document: Done (12.438 secs)

# but can we really map cyberspace?

- a common question, based on 2 misconceptions
  - maps have to be geographical
  - cyberspace is non-spatial and separate from geography
- challenge the 'death of distance' notions
- mapping is much wider than the OS, Times Atlas and A-Z street maps
- it hard to do though
  - cyberspace is new, its rapidly evolving, its fluid and its diverse. a lot of it is (increasingly) private space
  - breaks Euclidean conventions
  - we have very few good examples!
- there is no one true map of cyberspace

# why map cyberspace?

- why are these maps interesting and significant?
- maps of cyberspace are important because they can tell us things about cyberspace
- and cyberspace is becoming increasingly important in our lives
- the human desire to explore the unknown
- cyberspace is one of the most significant terra incognita of the 21st century
- revealing what is hidden. making the invisible visible. enhancing our understanding
- maps as a census of cyberspace. feeding into government policy and business decisions



# why map cyberspace?

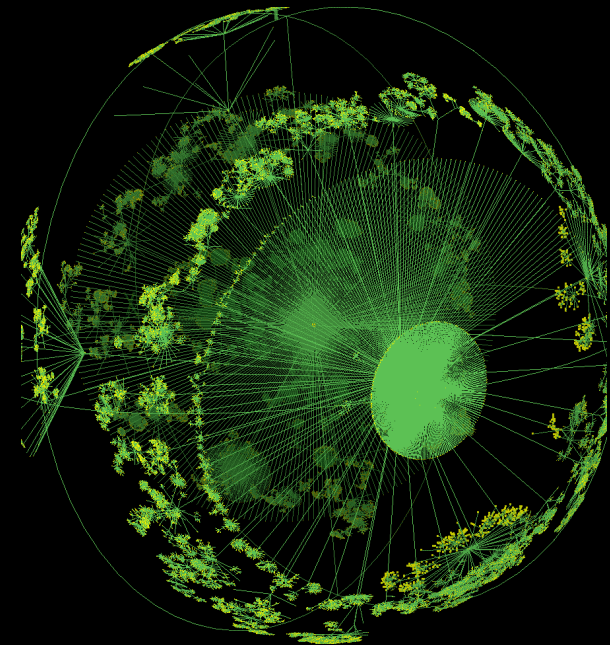
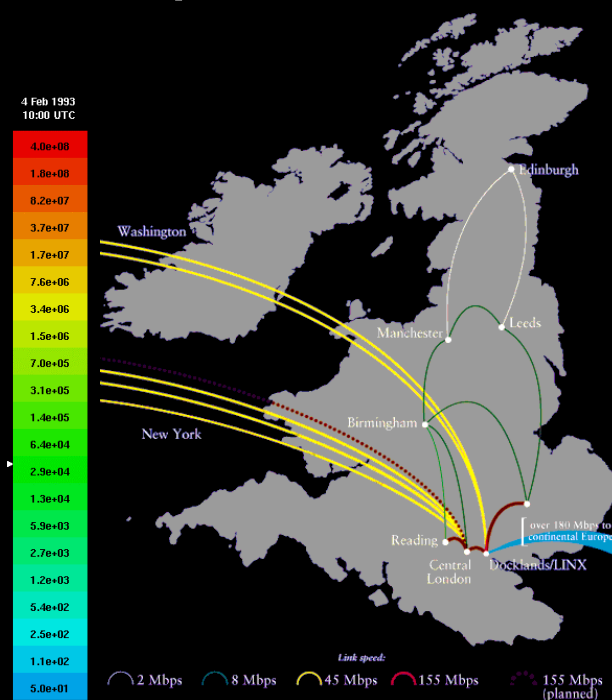
- maps shape our perception and knowledge of cyberspace. maps frame space
- maps also tell us things about the people who made them, and how they view cyberspace
- power, money and control
  - property maps of cyberspace
  - military and policing
  - what you can see, you can control and exploit
  - cartography redux
- increasingly our lives involve visual, CMC, screen-based interaction. who controls the 'geography of the screen'?

# why map cyberspace?

- people are making the maps regardless, so need to get in there and analyse them
- the maps are being used to make important decisions, regardless of their efficacy or ethics
- just because you can map, you do map it
- these are early maps, but like a lot of technology, the first map can set the conditional pathways for the future
- ethical dilemmas for researchers in the Internet and information visualization

# Mapping the 'tin cans and string'

- many aspects of the infrastructure that you can map
- what they show? hubs, network links & traffic flows
- what form? geographic -> abstract; static -> dynamic
- what scale? buildings, company, cities -> global
- function? research, operations, marketing, regulation



# why is it hard to map the Internet?

- its new, its complex, its fast changing and fast growing
- diversity of owners, heterogeneous, no one has overall responsibility
- secrecy - network security and commercial confidentiality
- most people don't care about it
- its just banal technicalities, deterministic assumed to non-political and neutral
- has not been seen as a vital, strategic asset. although this is changing with growing fears of cyber-terrorism



# the invisibility problem



# logical versus physical network maps

- where do the cables go??
- how do they interconnect?
- 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





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

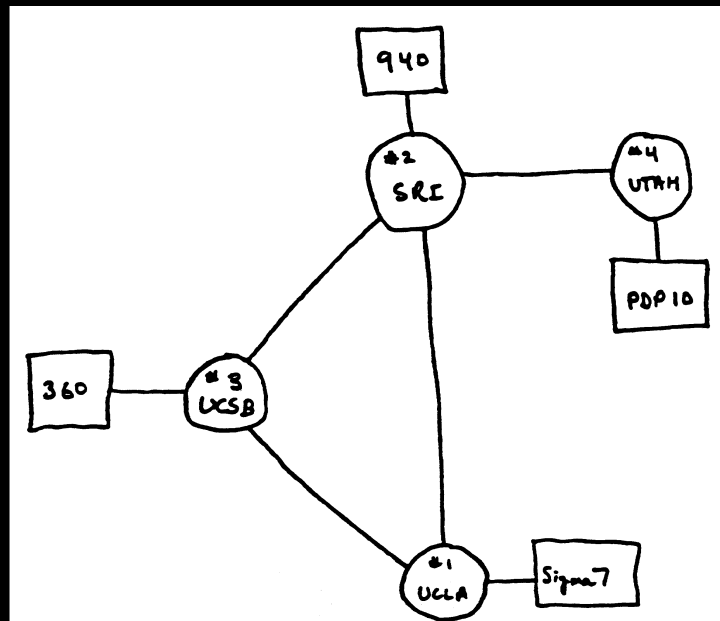


its all just nodes and links





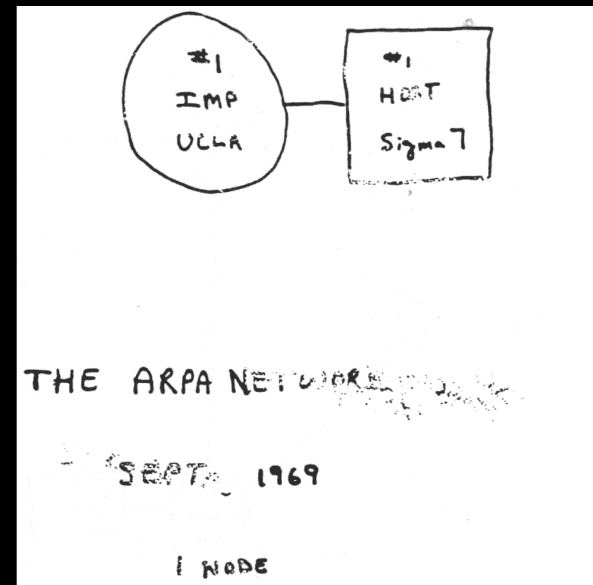
# logical maps network, ARPANET (1969-89)



THE ARPA NETWORK

DEC 1969

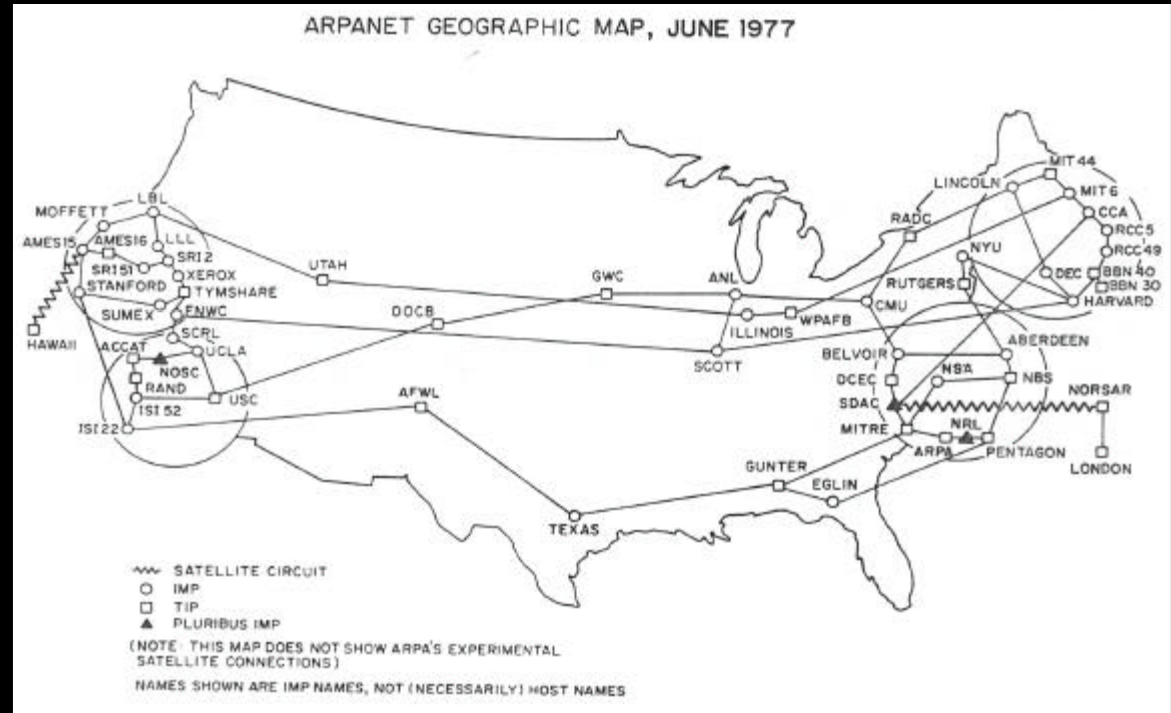
4 NODES



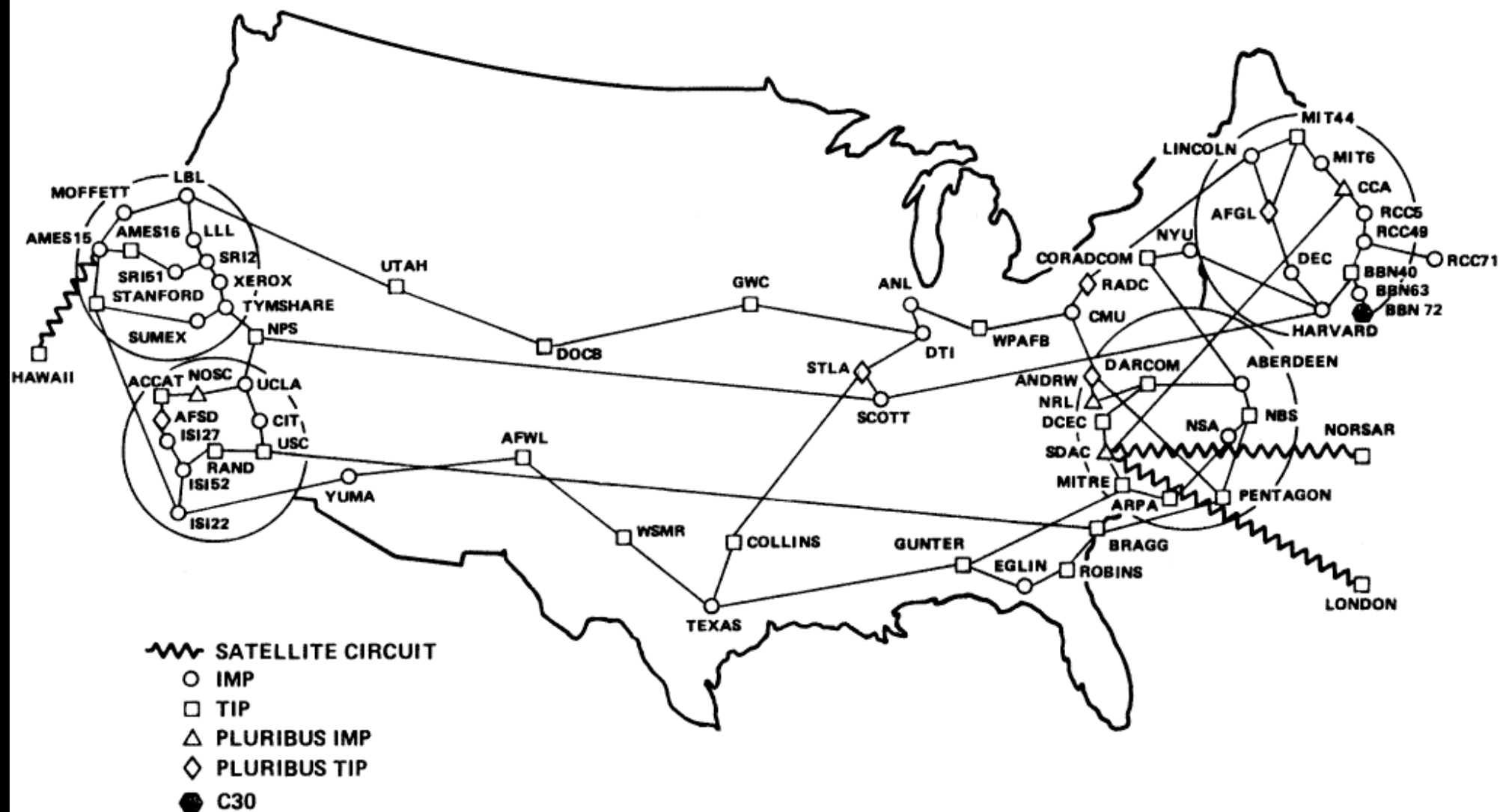
THE ARPA NETWORK

SEPT. 1969

1 NODE



# ARPANET GEOGRAPHIC MAP, OCTOBER 1980



(NOTE: THIS MAP DOES NOT SHOW ARPA'S EXPERIMENTAL SATELLITE CONNECTIONS)  
 NAMES SHOWN ARE IMP NAMES, NOT (NECESSARILY) HOST NAMES

Points for spotting which of  
these network operators has  
not filed for bankruptcy this  
year!!



**Optical fibre submarine systems**

Systems supplied by Alcatel  
Systems supplied jointly by Alcatel and others  
Other manufacturers' systems  
Cables already under construction or planned  
Cables already under construction  
Cables already under construction  
Planned systems

ALCATEL

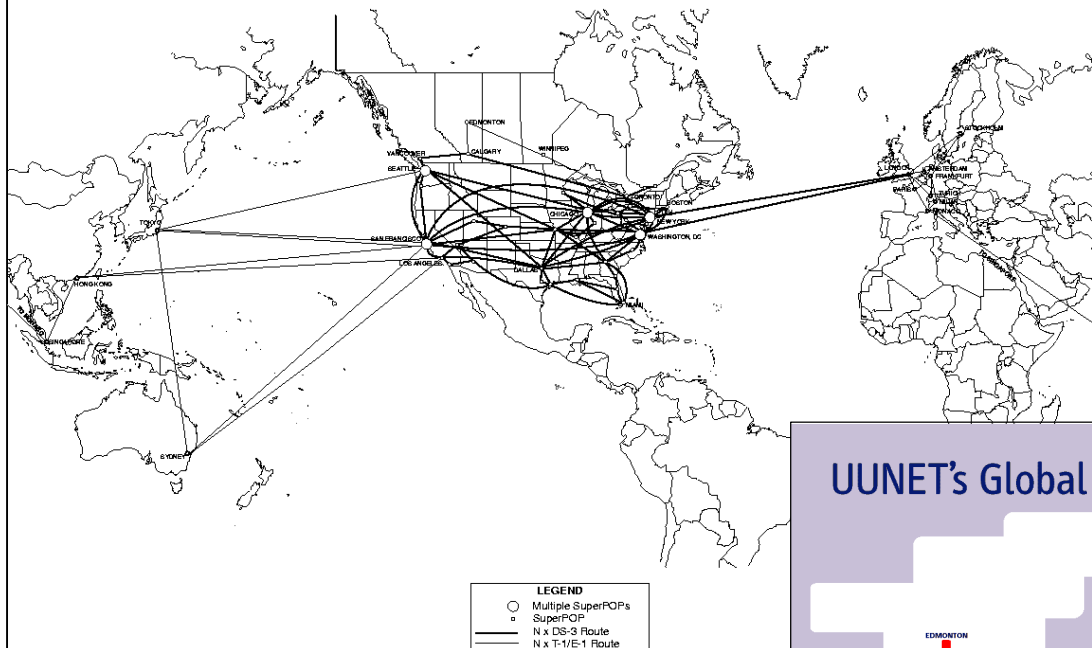
(<http://www.alcatel.com>)

(<http://www.alcatel.com> )



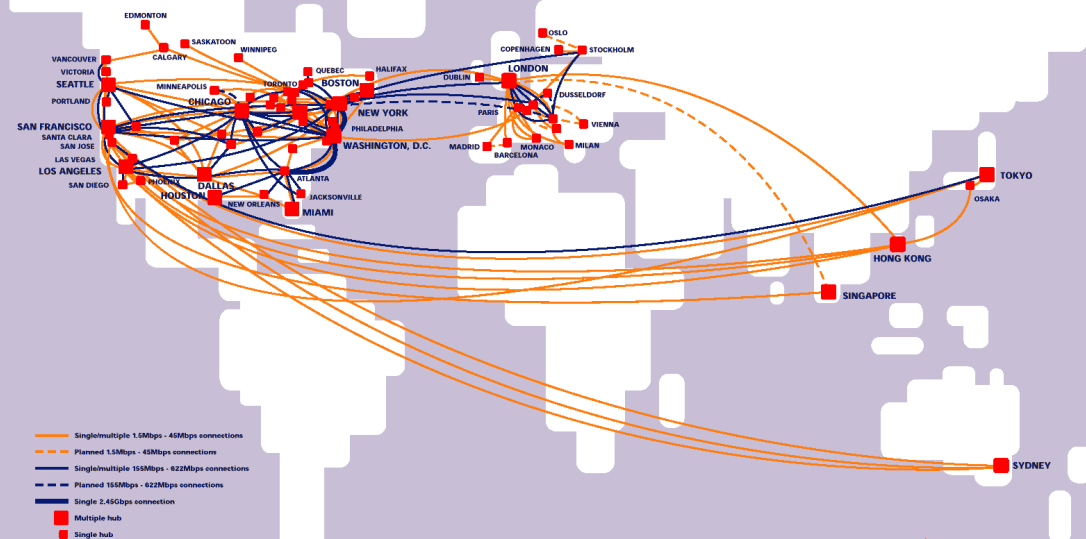


# UUNET Global Network



marketing maps

## UUNET's Global Internet Backbone



(<http://www.uu.net>)

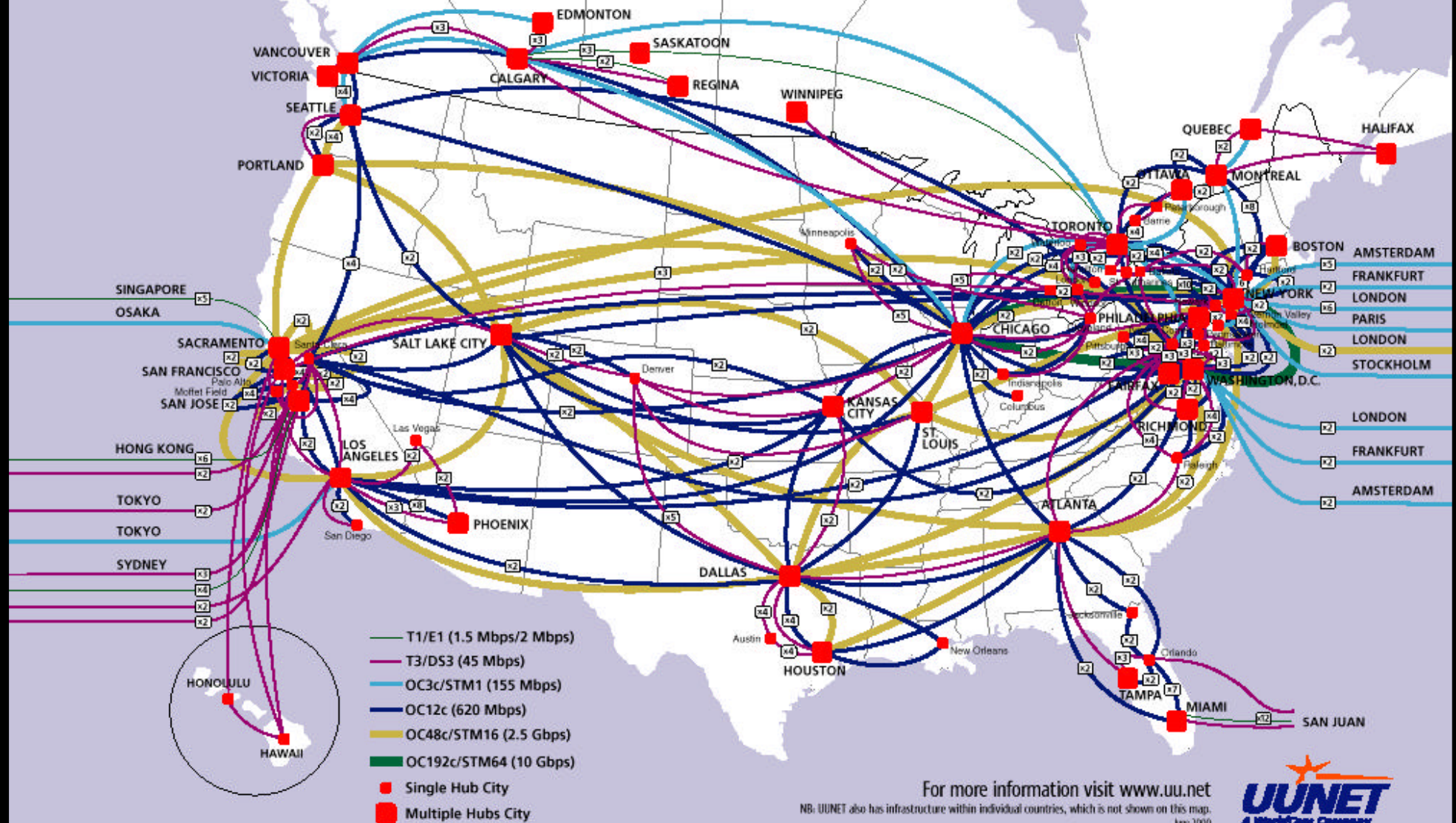
For more information visit [www.uu.net](http://www.uu.net)

NB. With the exception of North America, Spain & Germany, all major 'in-country' links have been excluded from this map. 'In-state' links within the USA have also been excluded.

This does not constitute a solicitation of any former MCI customer whose dedicated Internet access service was transferred to Cable & Wireless unless the customer was also a WorldCom company Internet services customer as of the MCI WorldCom merger.



# UUNET's North America Internet network



For more information visit [www.uu.net](http://www.uu.net)

NB: UUNET also has infrastructure within individual countries, which is not shown on this map.  
June 2000



(<http://www.uu.net>)



The Only Wholesale-Only Multi-Service Network.™



www.williamscommunications.com

January 2000

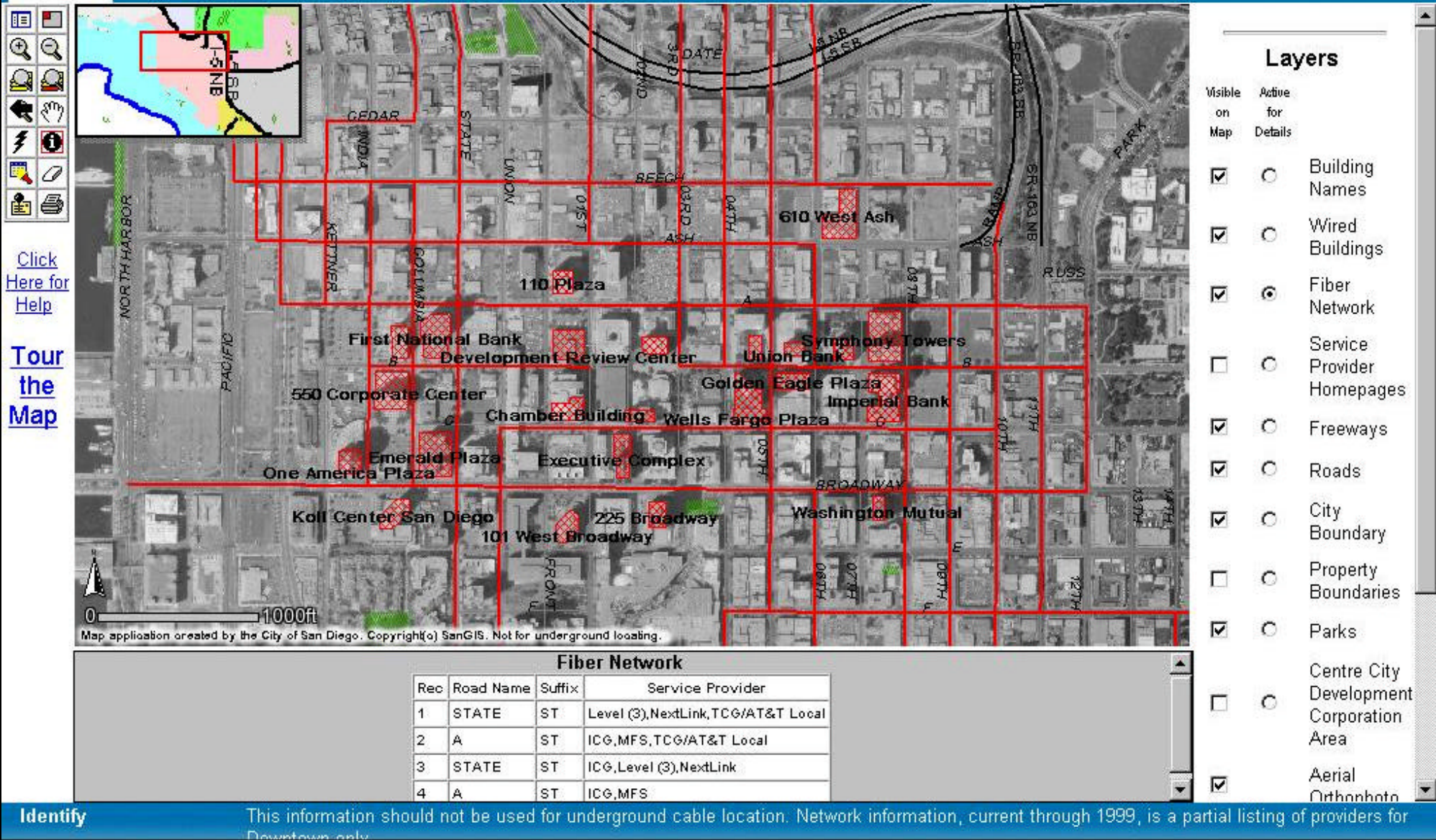
©2000 The Williams Companies, Inc.

(<http://www.williamscommunications.com>)



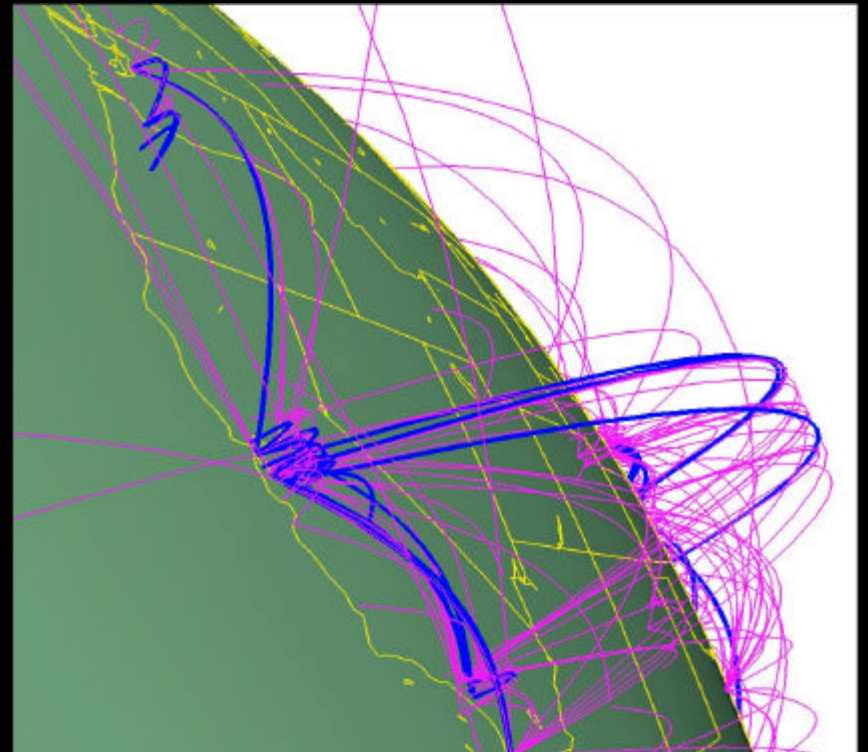
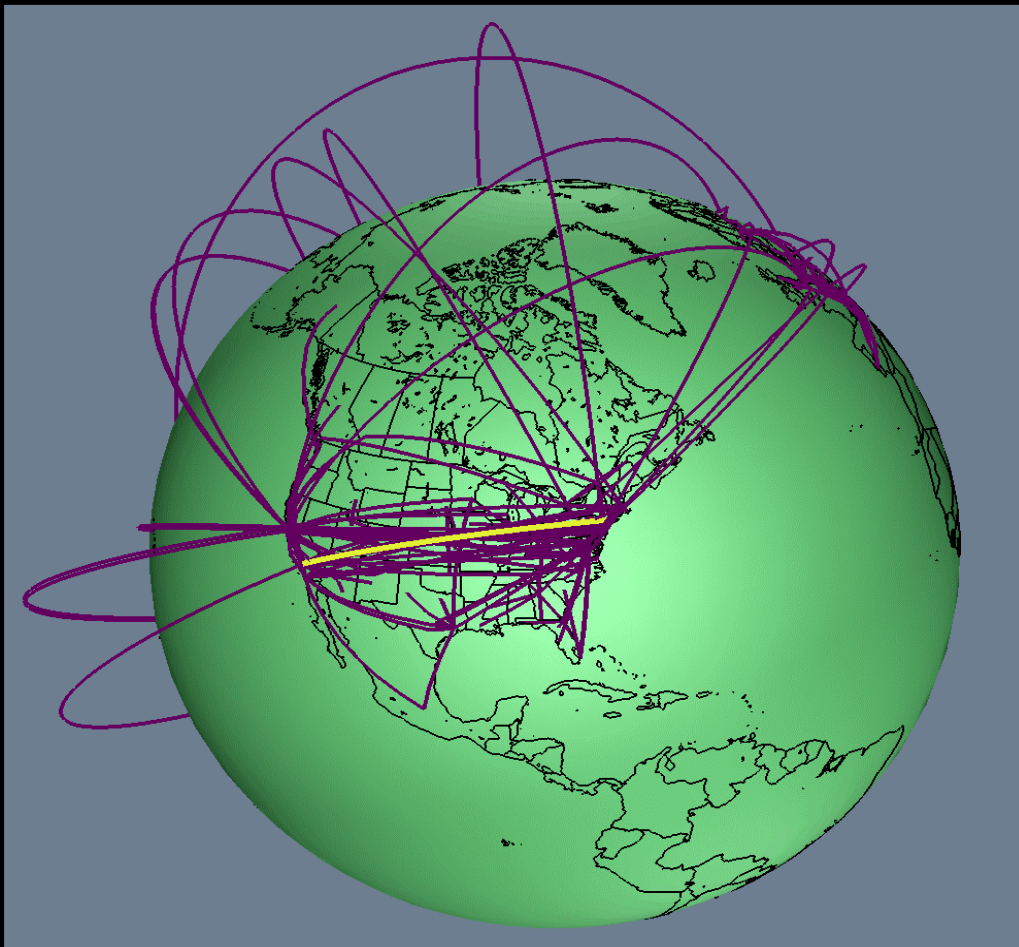


# Bandwidth Bay Fiber Network Map



(<http://www.sangis.org/sangis/intmaps/fibermap.htm>)



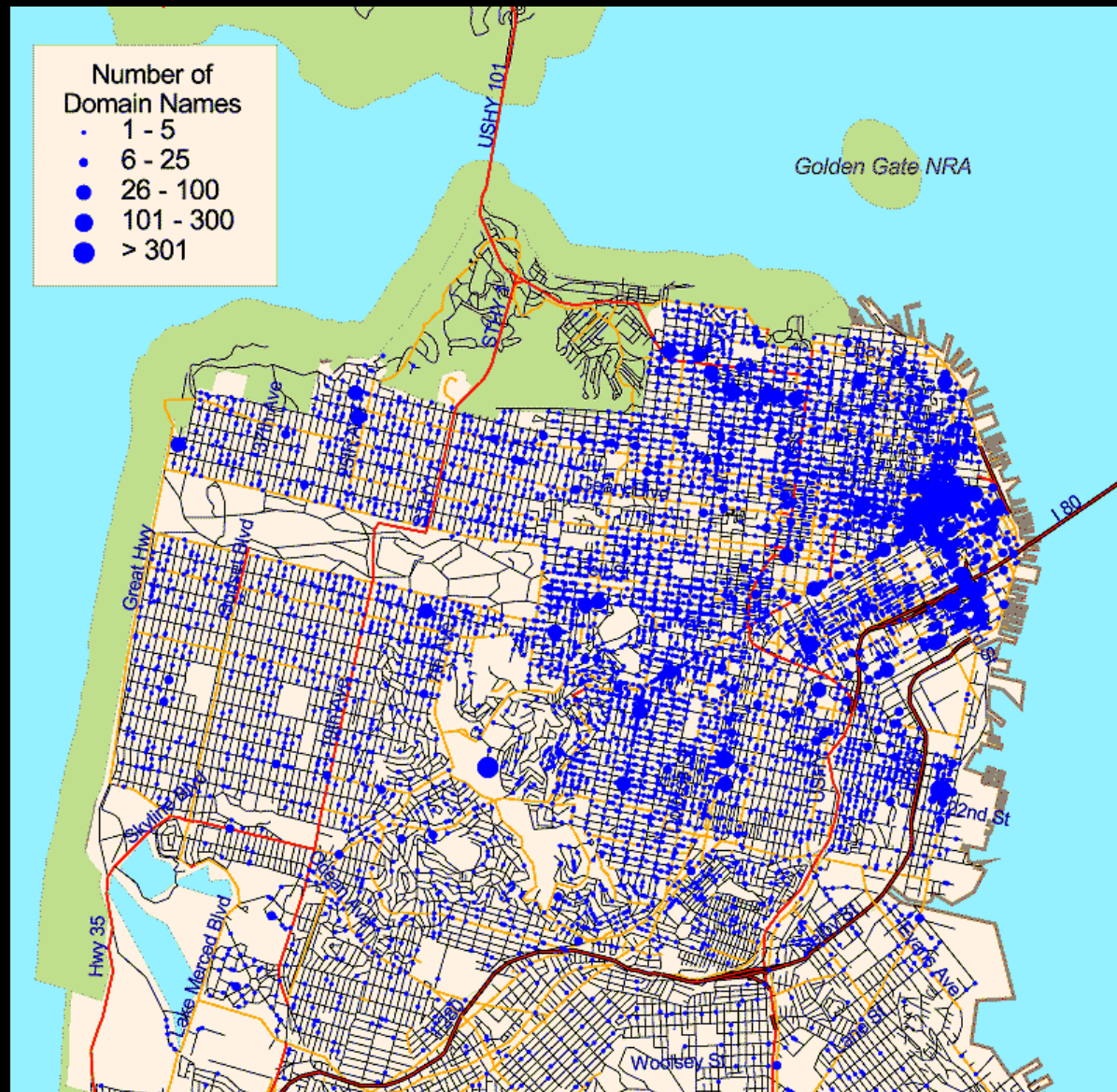


(Tamara Munzner,  
<http://www.cs.ubc.ca/~tmm/> )

Dots on a map

where are all the nodes?

# Dotcom domain names in SF



(Matthew Zook, [www.zooknic.com](http://www.zooknic.com))

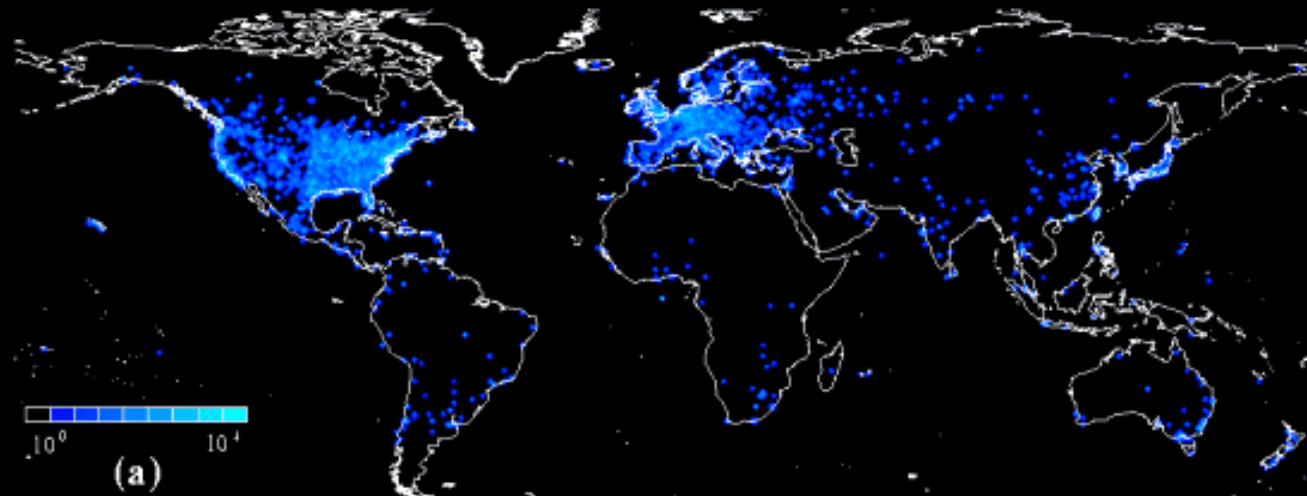


# Wardriving wi-fi hotspots in LA

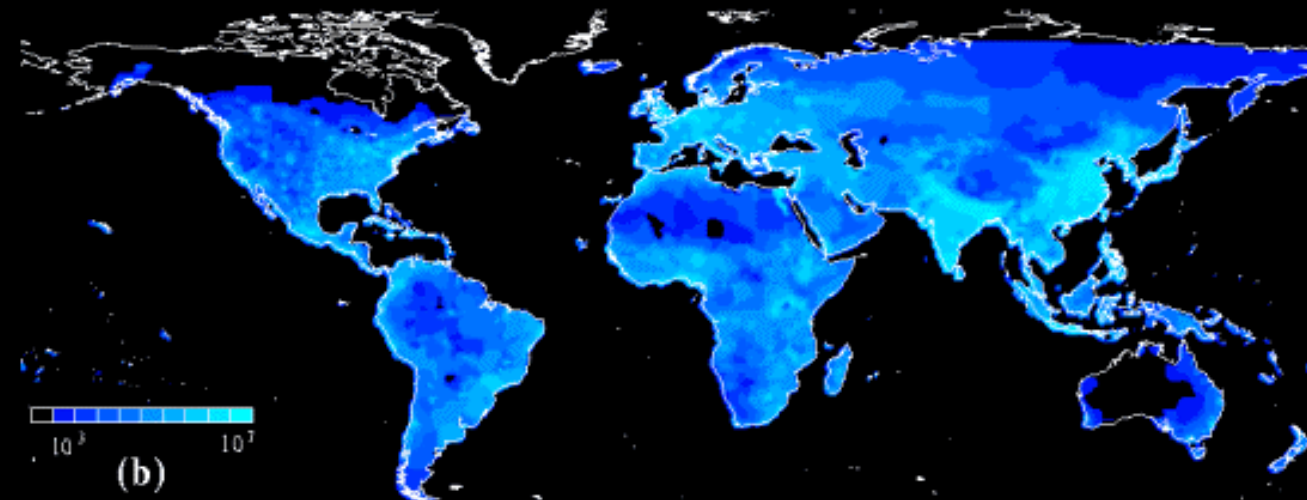


# Global digital divides

Router  
density



Population  
density



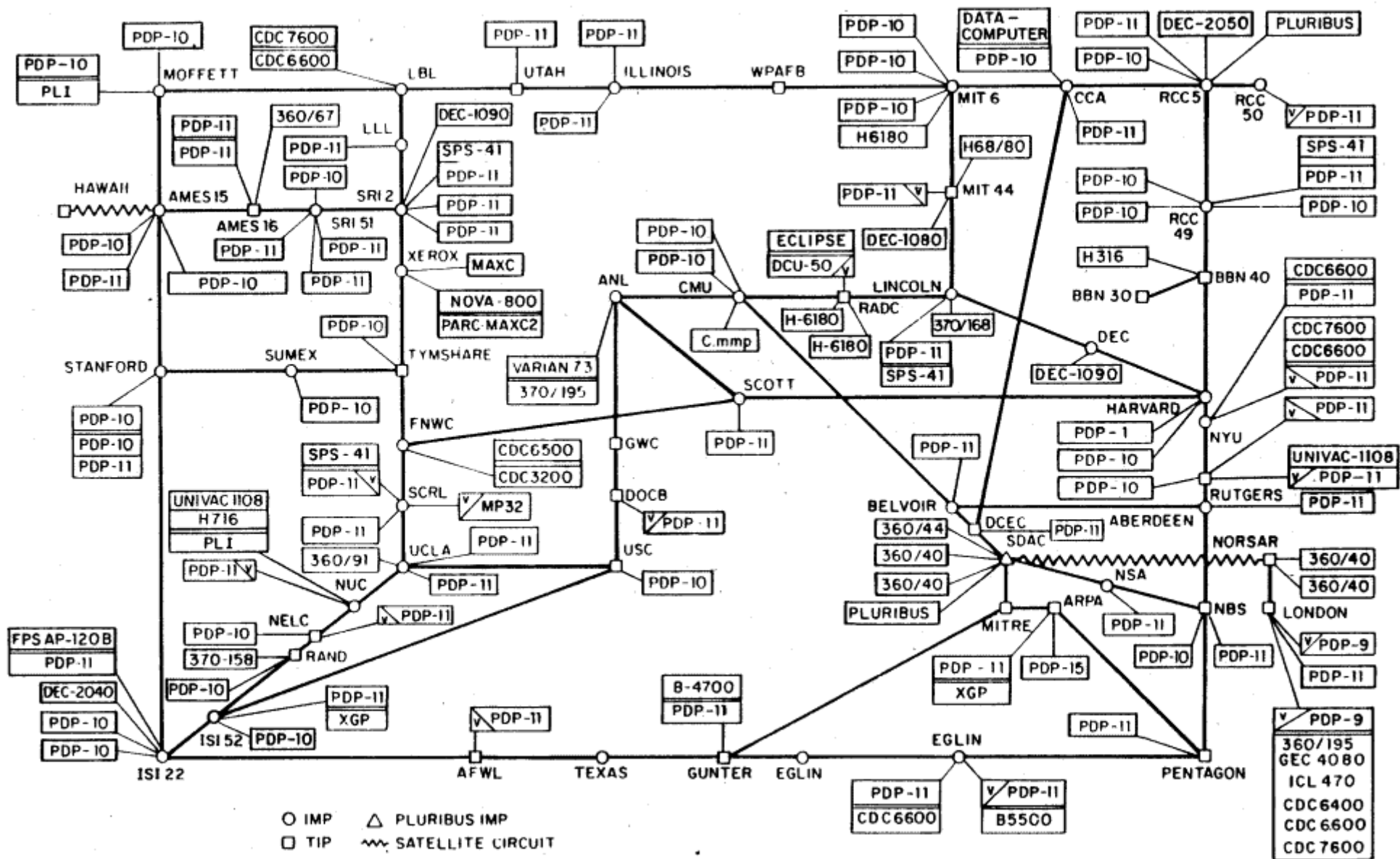
(<http://arxiv.org/abs/cond-mat/0107417>)



# bye, bye to the geographic world

- focus is on topology, not geography
- network engineers don't care about where things are, but how they are connected
- into the realm of wiring diagrams rather than maps

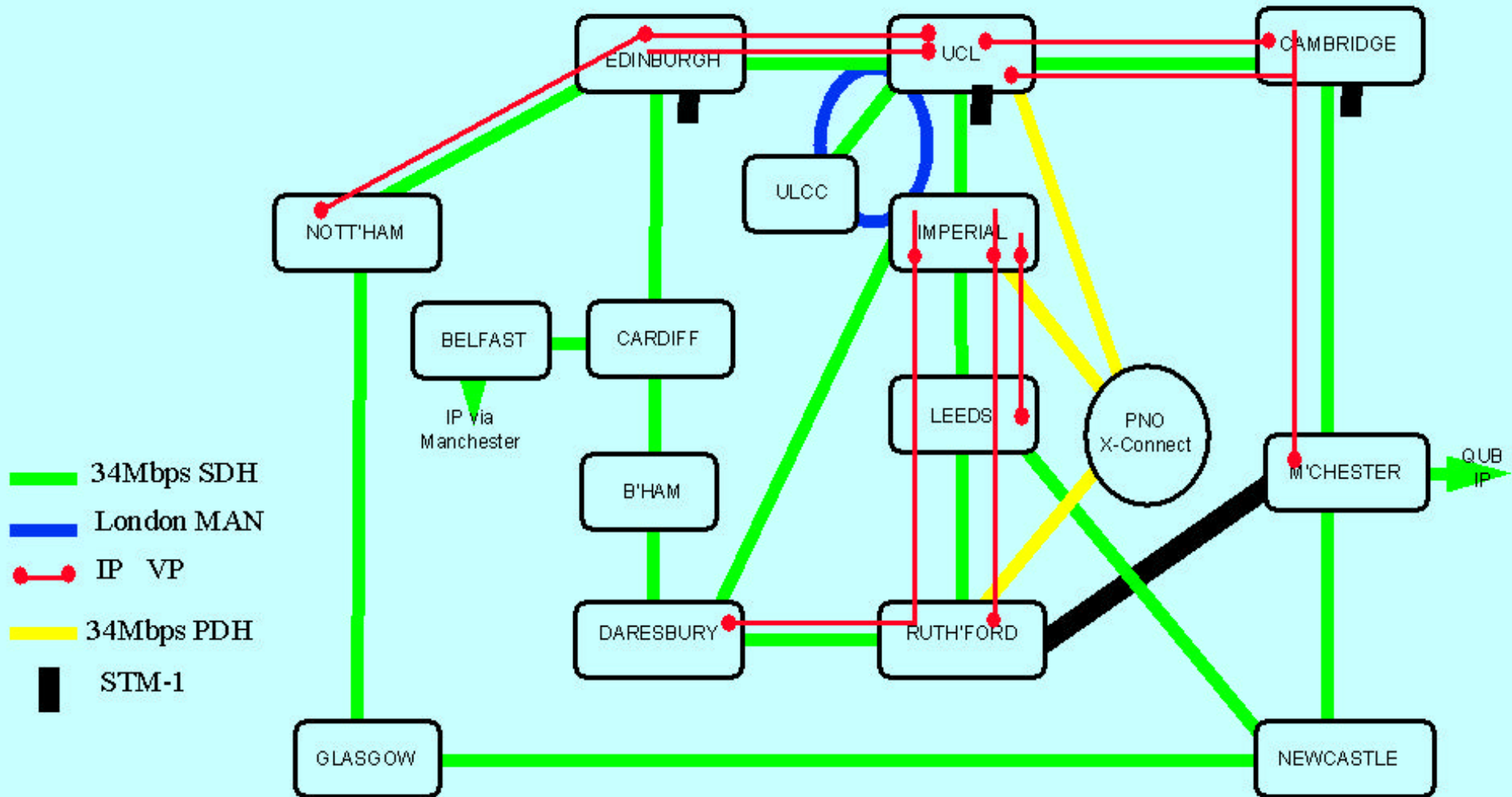
ARPANET LOGICAL MAP, MARCH 1977



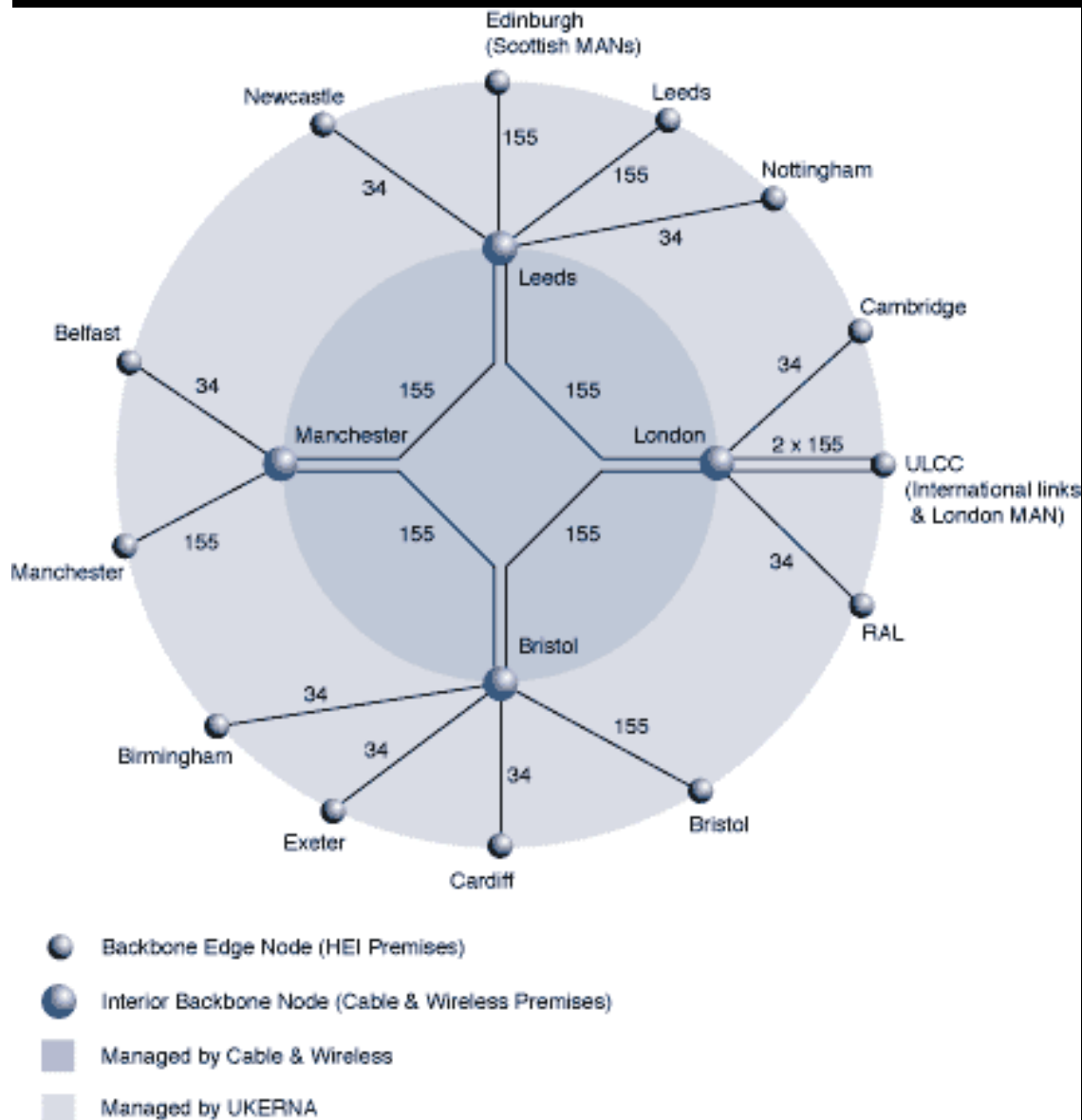
(PLEASE NOTE THAT WHILE THIS MAP SHOWS THE HOST POPULATION OF THE NETWORK ACCORDING TO THE BEST INFORMATION OBTAINABLE, NO CLAIM CAN BE MADE FOR ITS ACCURACY)

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

# SuperJANET ATM Topology

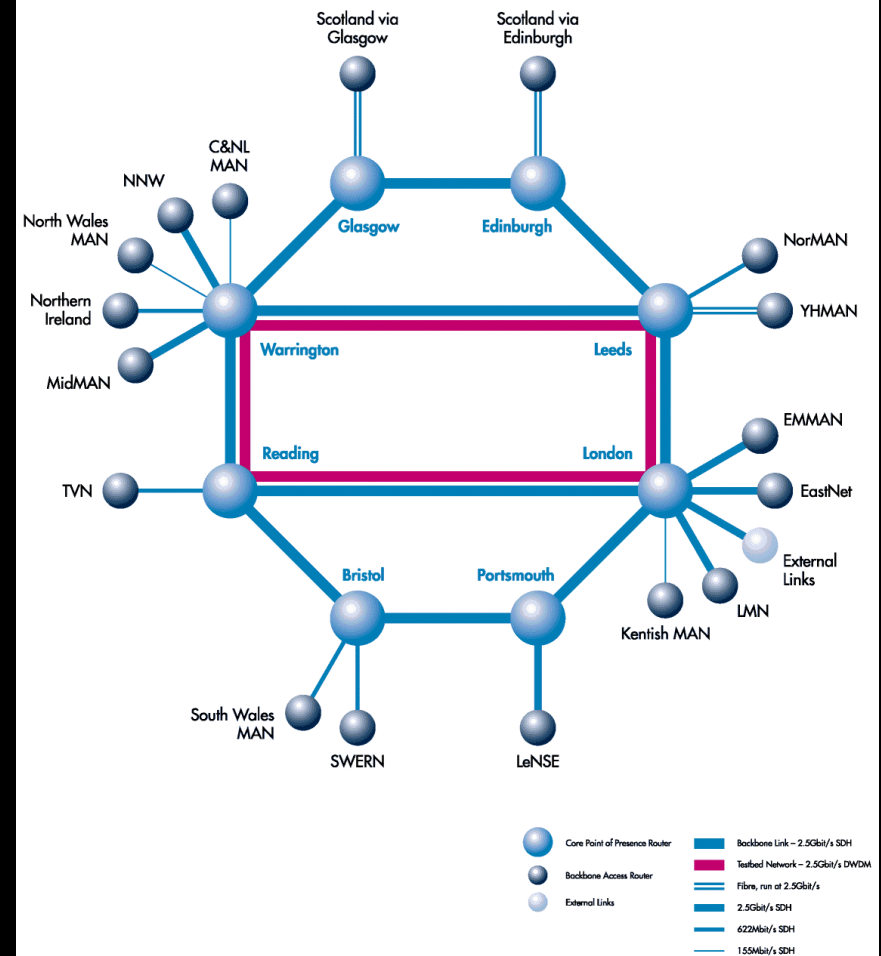


Updated by Baoyu Wang on 27 September, 1996



## The JANET Backbone

Showing topology and link capacity

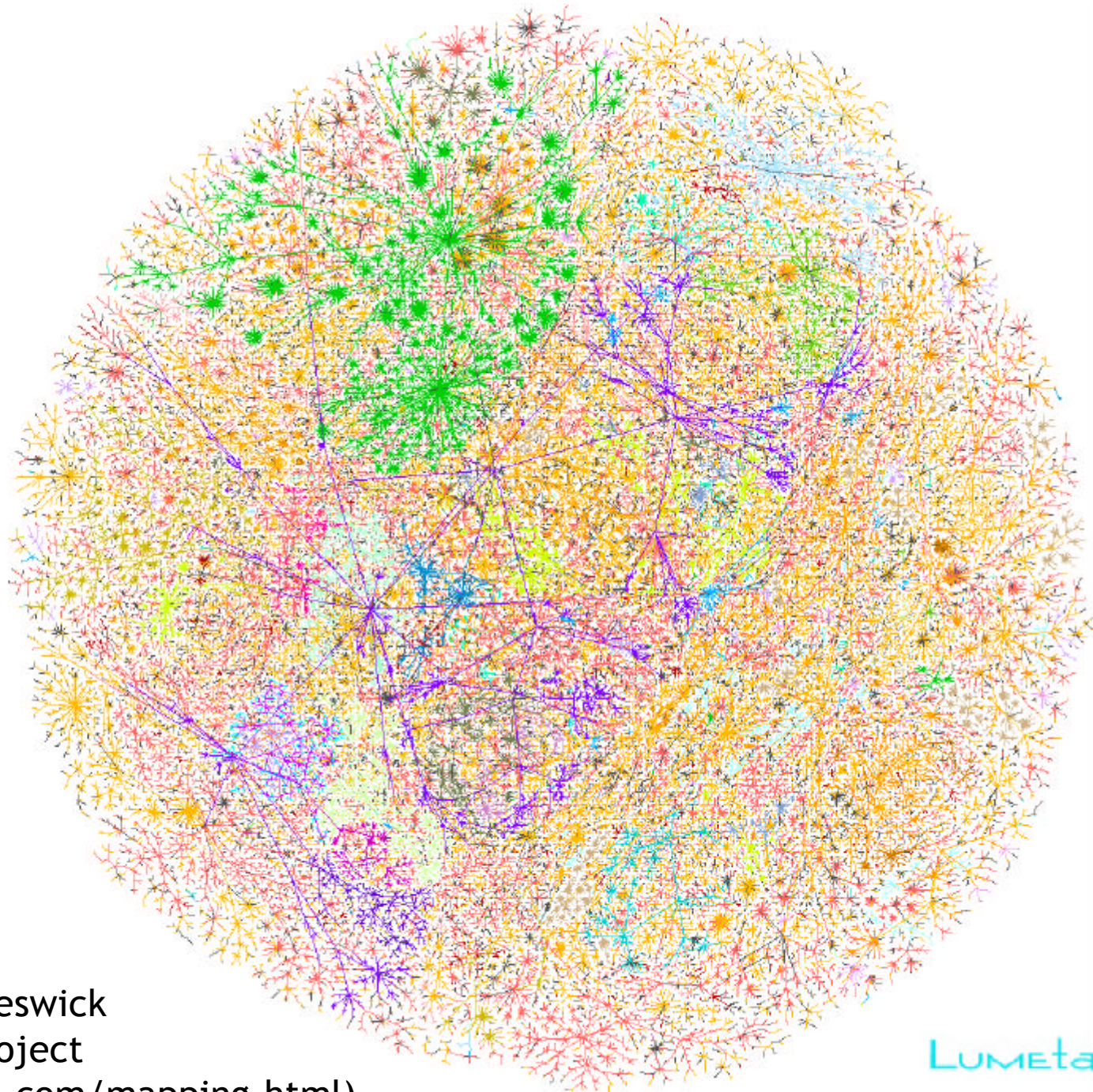


(<http://www.ja.net>)



### Legend

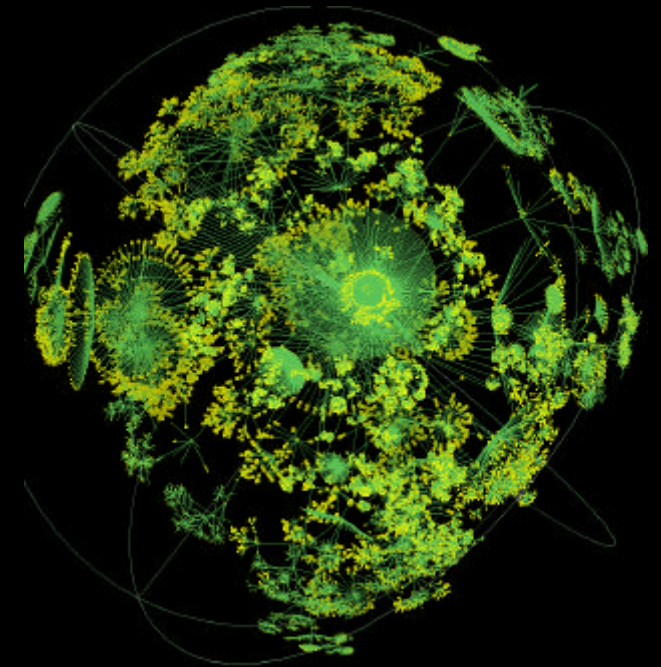
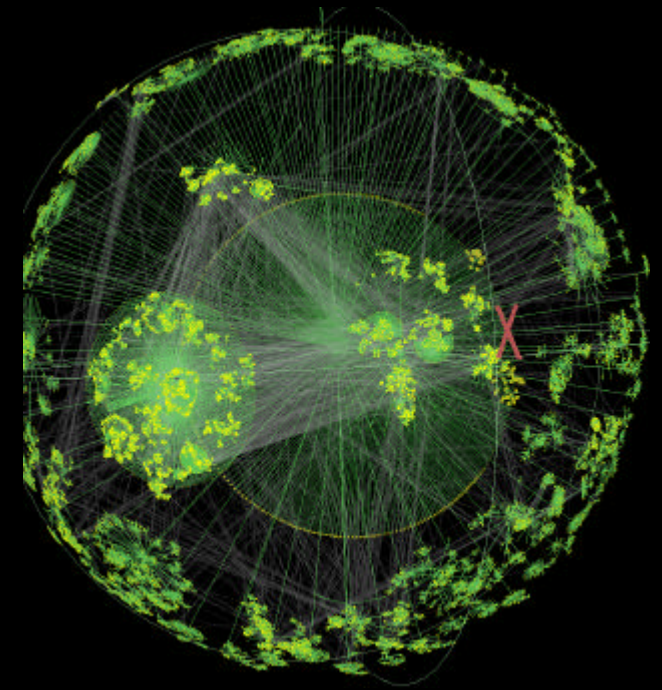
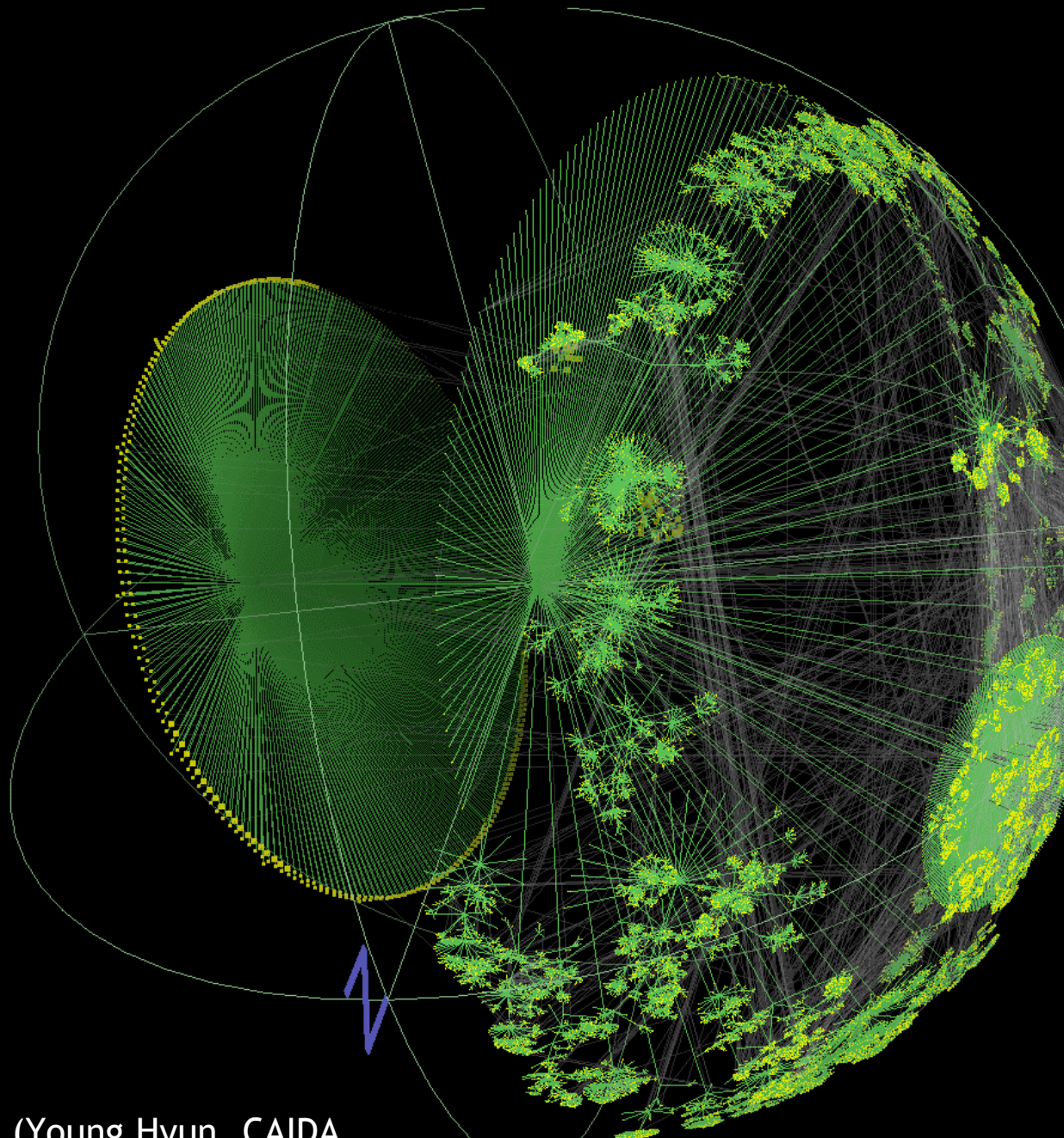
■	cw.net	6070
■	alter.net	3997
■	sprintlink.net	2479
■	att.net	2294
■	apnic.net	2219
■	ripe.net	2032
■	ans.net	1843
■	uu.net	1545
■	bbnplanet.net	1438
■	qwest.net	1243
■	telstra.net	1120
■	psi.net	1120
■	verio.net	1056
■	knmic.net	897
■	bellsouth.net	866
■	gbx.net	688
■	teleglobe.net	586
■	gip.net	581
■	level3.net	536
■	pnap.net	514
■	digex.net	510
■	exodus.net	496
■	swbell.net	431
■	uswest.net	422
■	savvis.net	375
■	icix.net	374
■	kpnqwest.net	326
■	cerf.net	307
■	pbi.net	305
■	other ISPs	32871
■	not an ISP	
■	error	



(Hal Burch & Bill Cheswick  
Internet Mapping Project  
<http://www.lumeta.com/mapping.html>)

Lumeta



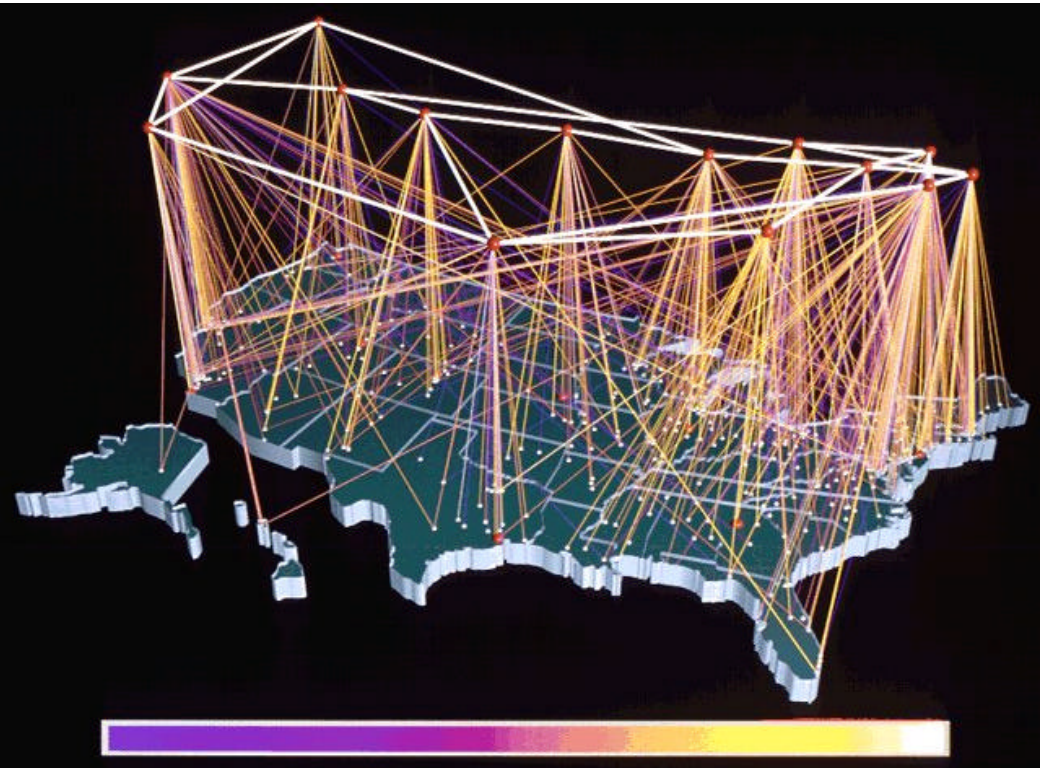


(Young Hyun, CAIDA  
<http://www.caida.org/tools/visualization/walrus/>)

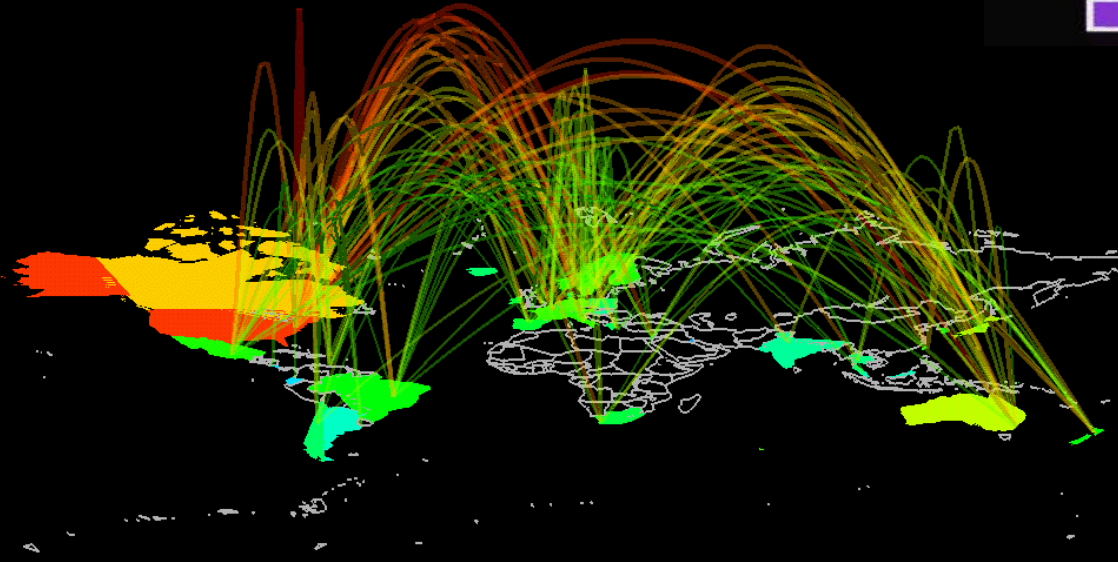
# one of the big unknowns - traffic

- there are no good traffic maps of the Internet today
- no one can tell you how much traffic is flowing across the Internet. no one knows how much, or from where to where
- how much of the Internet pipes are running empty?? -> the great telecoms collapse of 2002
- there a few weather maps of individual networks



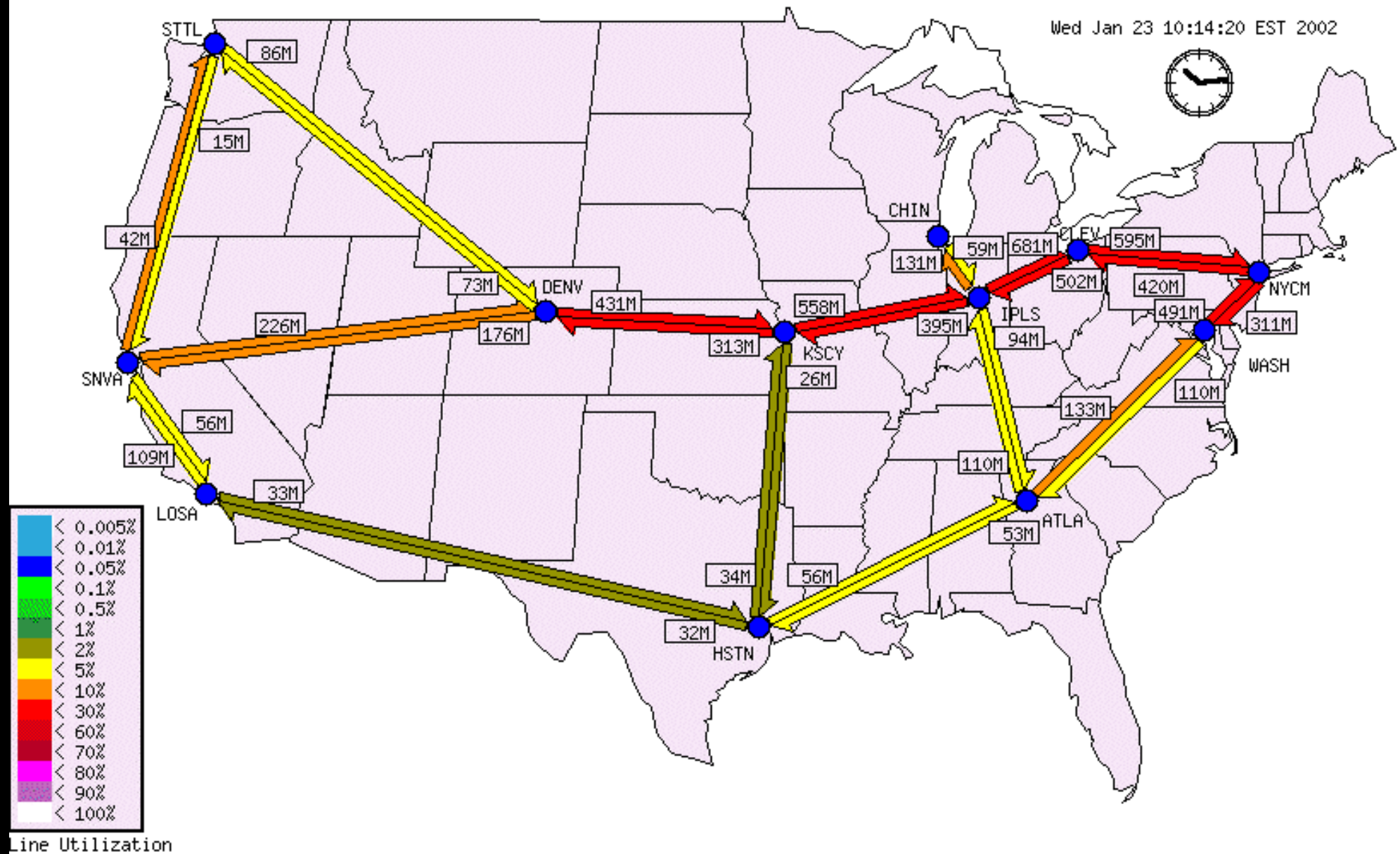


(Donna Cox and Robert Patterson,  
NCSA, 1992, [www.ncsa.uiuc.edu](http://www.ncsa.uiuc.edu) )



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

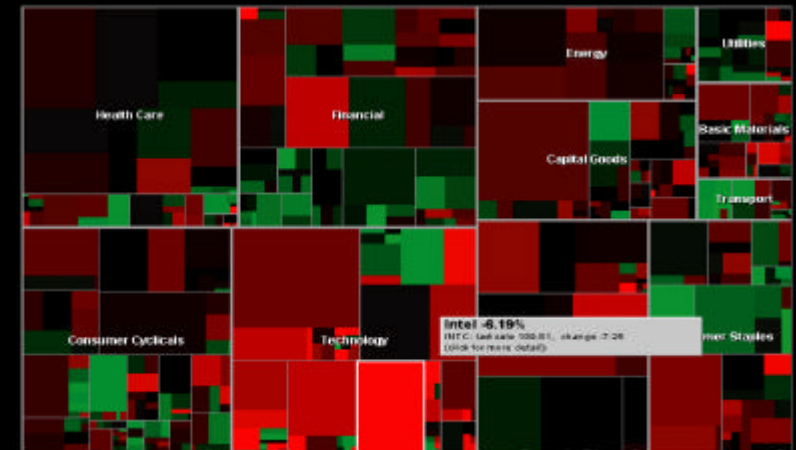
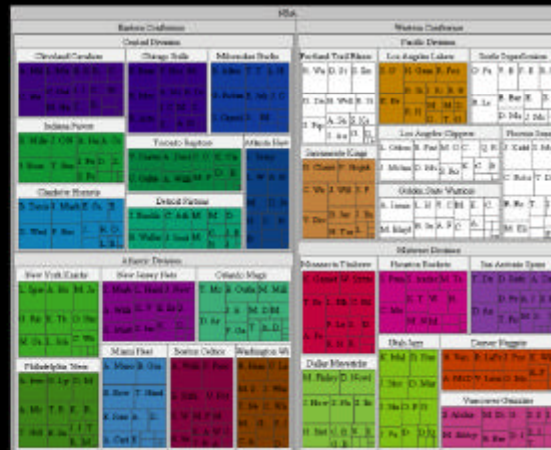
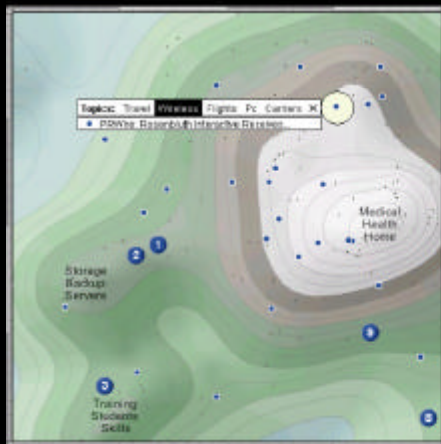
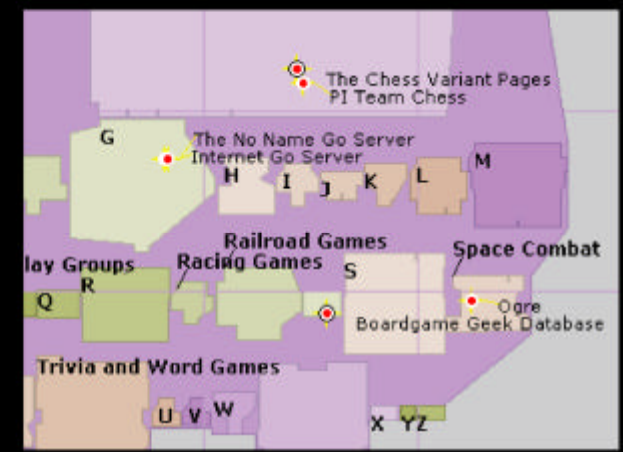
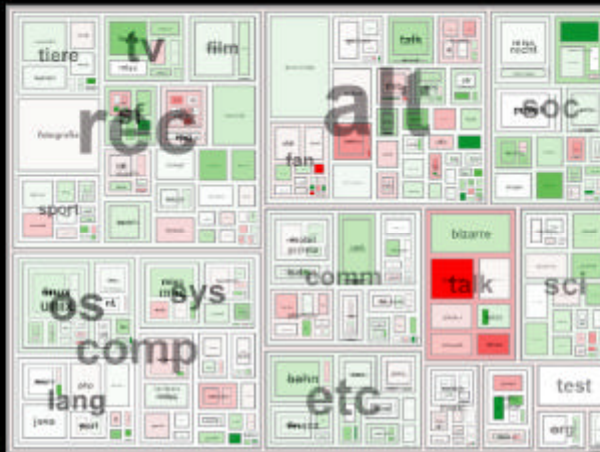
# INDIANA UNIVERSITY ABILENE NOC WEATHERMAP



(<http://hydra.uits.iu.edu/~abilene/traffic/>)

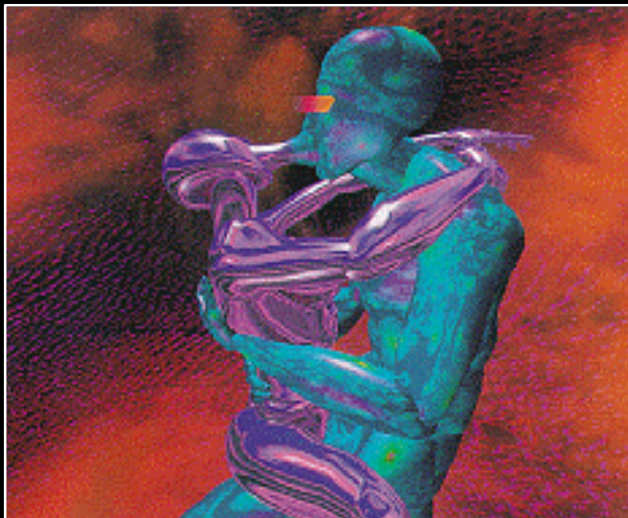
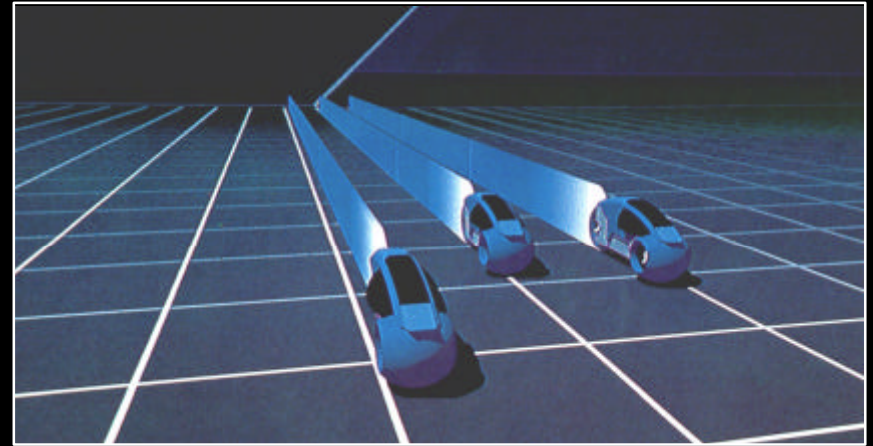


# Information Mapping



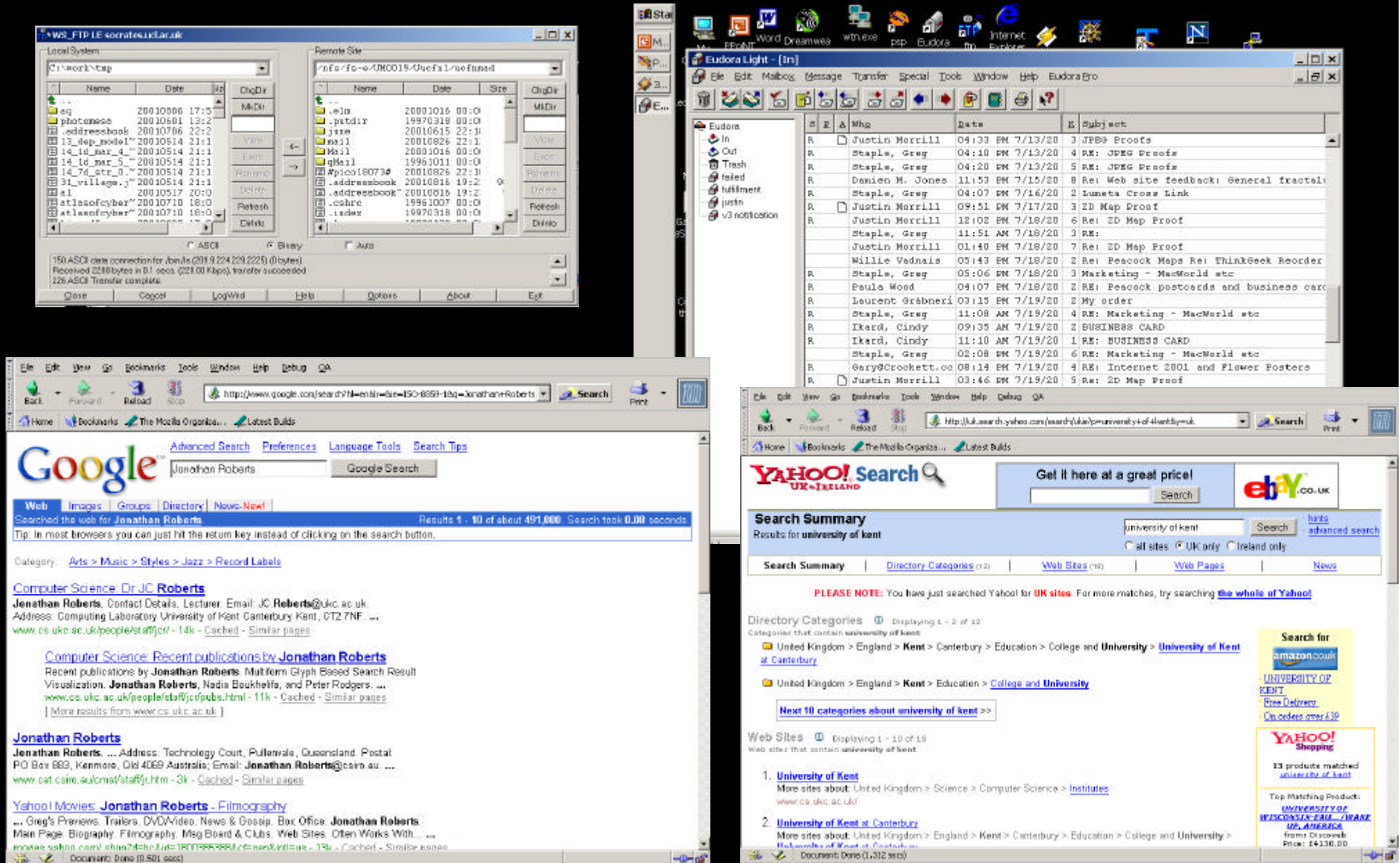


# Visualising information space - Hollywood style





# how we really navigate online content..



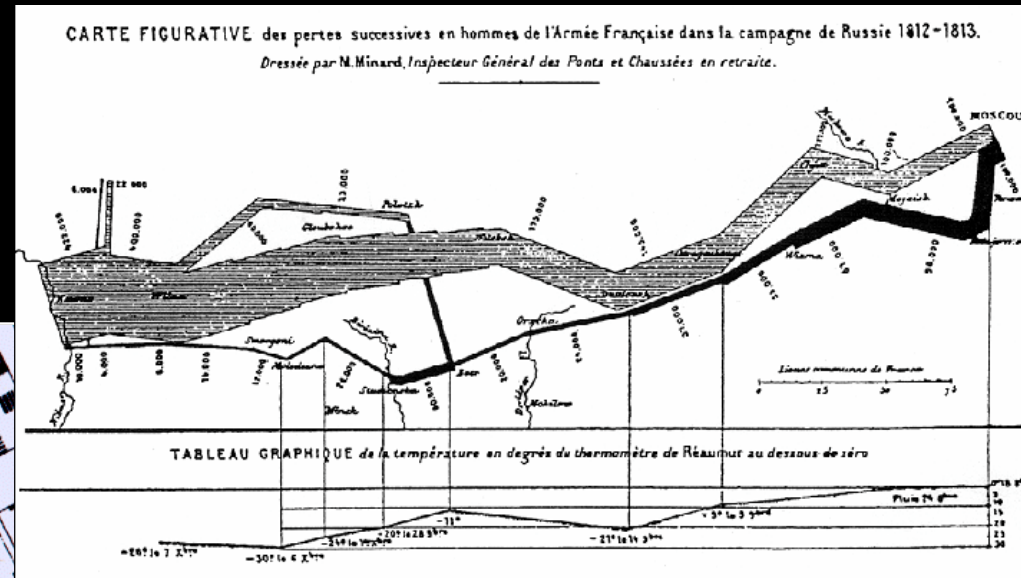
# Navigating cyberspace, 2d maps

- improving ways to navigate online content by appropriate visualisation
- is there a middle ground between current textual / list type interfaces versus the immersive 3d (cool) interfaces of Hollywood?
- from feedback received, it seems like many people are seeking better navigation tools and interfaces
- experience from cartography can help
- examine the potential of information mapping

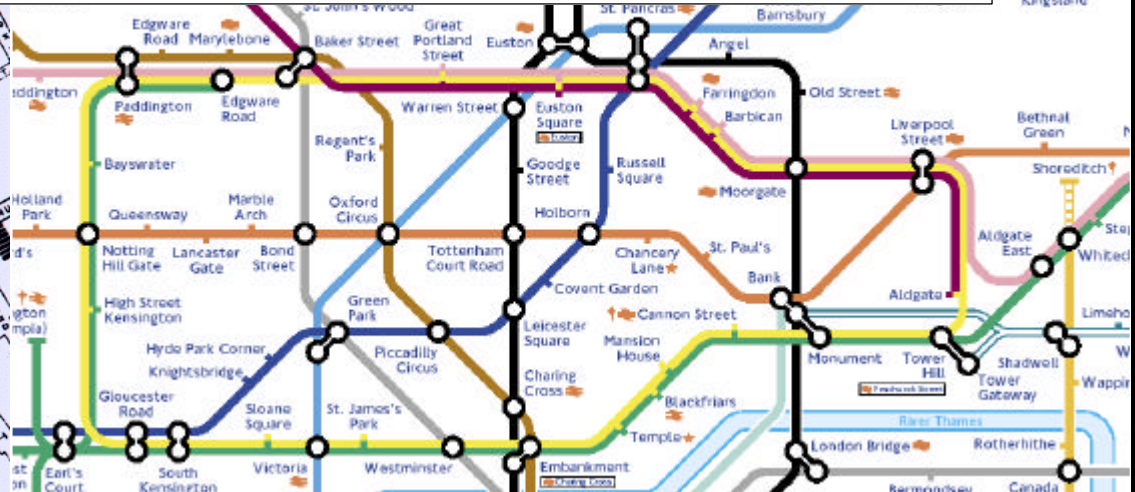


# Information maps - the 'classics'

Charles Minard's  
'Napoleon' map, from 1861



John Snow's 'Cholera' Map, 1854



London Tube map, based on the design  
Of Harry Beck in 1930s



# The power of information maps

- the missing 'up button' on the browser
- intelligent summarisation and generalisation
- 3 key advantages:
  - a sense of the whole (the birds eye view / big picture)  
What is there around here?
  - revealing hidden connections / structure
  - support interactive browsing

*Where is the wisdom we have lost in knowledge?  
Where is the knowledge that we have lost in information.*

T.S. Elliot, The Rock (1934)

There are a lot of bad information  
maps and many more interesting but  
noble failures

Here are a few of the best examples

# ODP - typical hierarchical directory of websites

The screenshot shows a Netscape browser window titled "Open Directory - Regional: Europe: Switzerland - Netscape". The address bar displays "http://dmoz.org/Regional/Europe/Switzerland/". The browser's menu bar includes File, Edit, View, Go, Communicator, and Help. Below the menu bar is a toolbar with buttons for Back, Forward, Reload, Home, Search, Netscape, Print, Security, Shop, and Stop. A green banner at the top of the page features the "dmoz" logo and the text "open directory project". To the right of the banner are links for "about dmoz", "become an editor", and "help". Below the banner is a search bar with a "Search" button and a dropdown menu set to "the entire directory". The main content area displays the category "Top: Regional: Europe: Switzerland (885)" with a "Description" link. A list of subcategories follows, each with a count in parentheses:

- [Cantons](#) (349)
- [Localities](#) (0)
- [Regions](#) (0)
- [Guides and Directories](#) (16)
- [Arts and Entertainment](#) (104)
- [Business and Economy](#) (146)
- [Education](#) (14)
- [Government](#) (41)
- [Health](#) (1)
- [Maps and Views](#) (53)
- [News and Media](#) (12)
- [Recreation and Sports](#) (8)
- [Science and Environment](#) (28)
- [Society and Culture](#) (64)
- [Transportation](#) (12)
- [Travel and Tourism](#) (28)
- [Weather](#) (9)

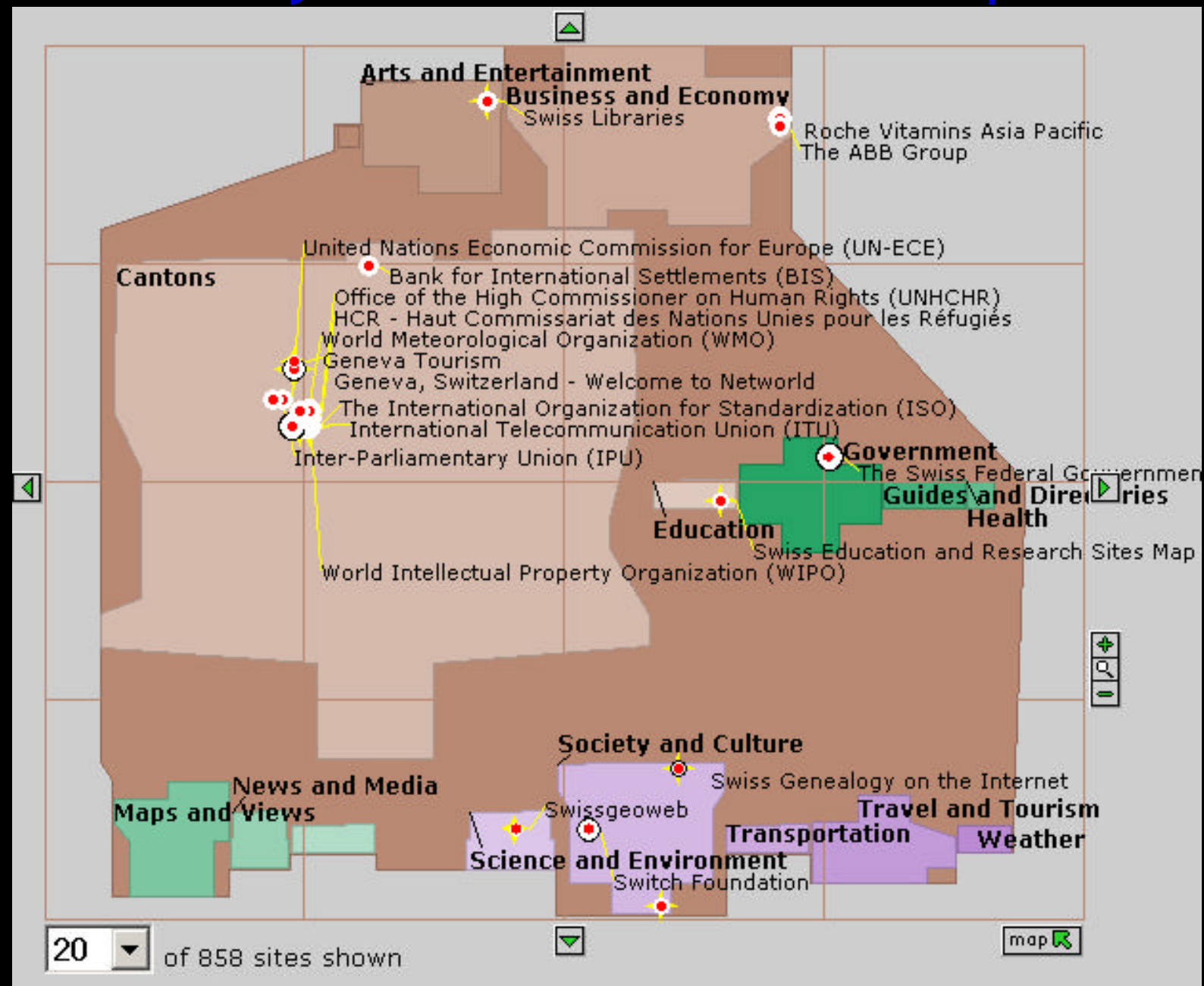
Below the list, it says "See also:" followed by:

- [World: Rumantsch](#) (26)

The browser's status bar at the bottom shows "Document: Done".

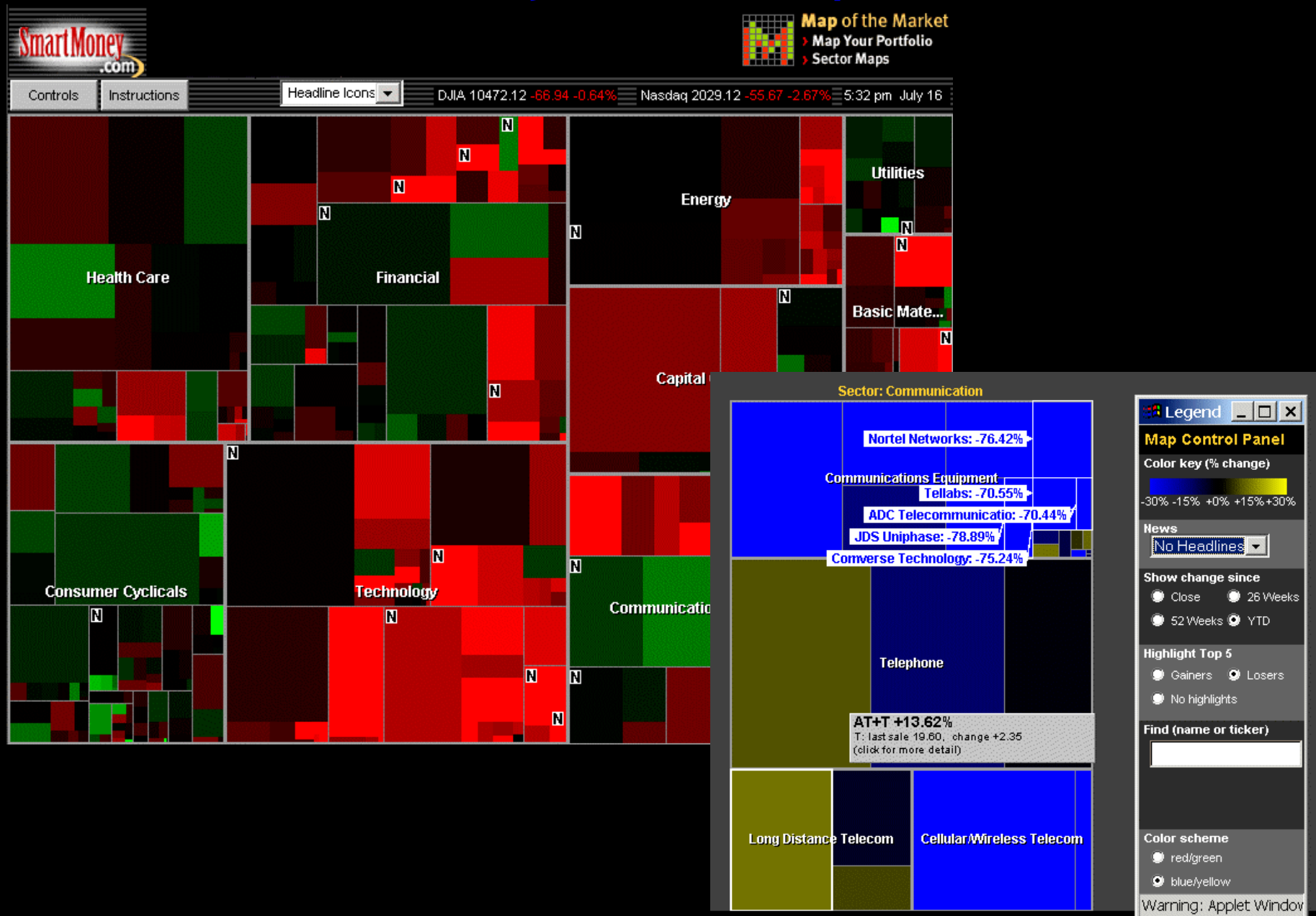


# Antarctica Systems' Visual Net : Map.net demo



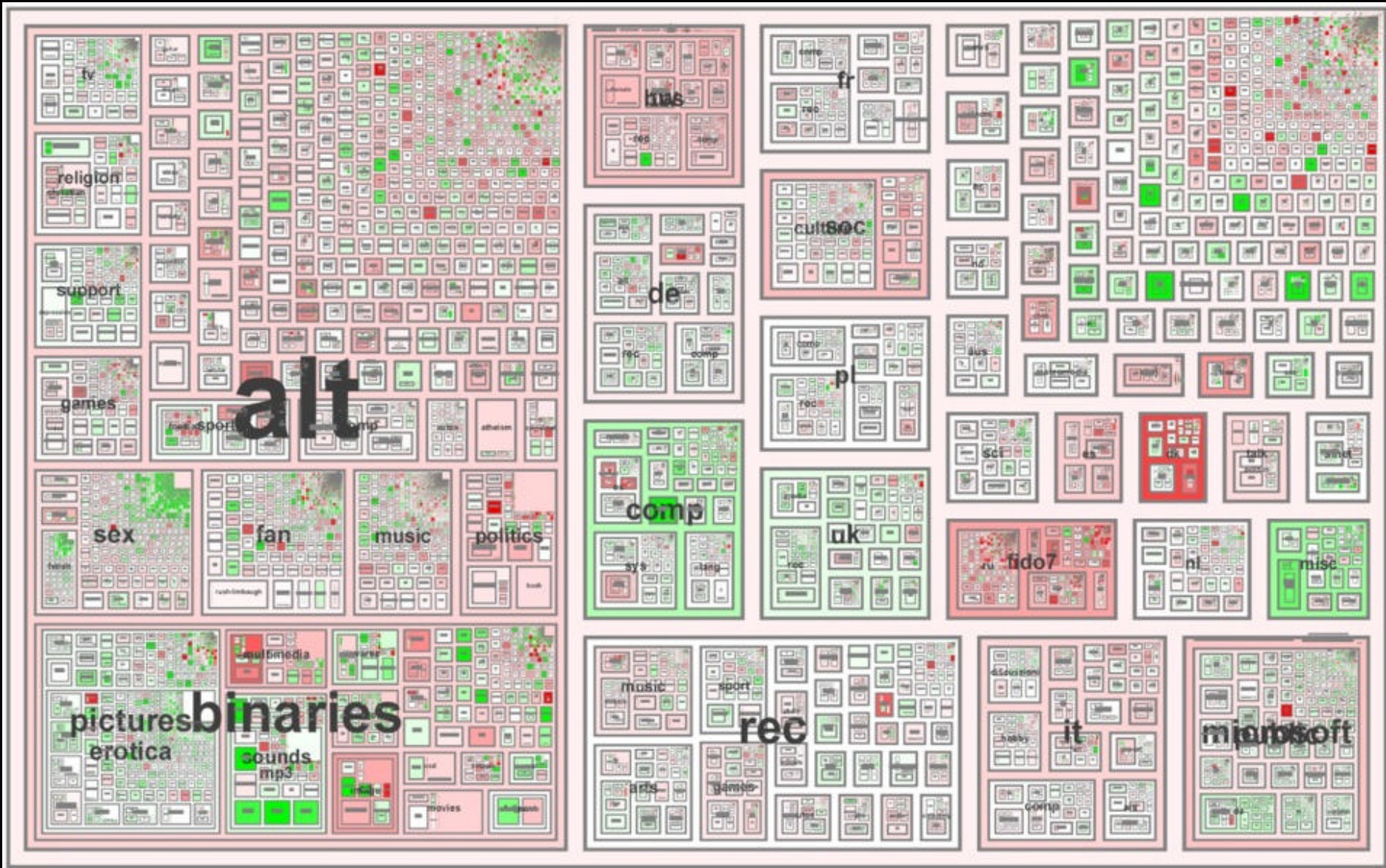
<http://www.map.net/>

# SmartMoney.com - Map of the Market





Netscan project by Marc Smith & Andrew Fiore, Microsoft Research

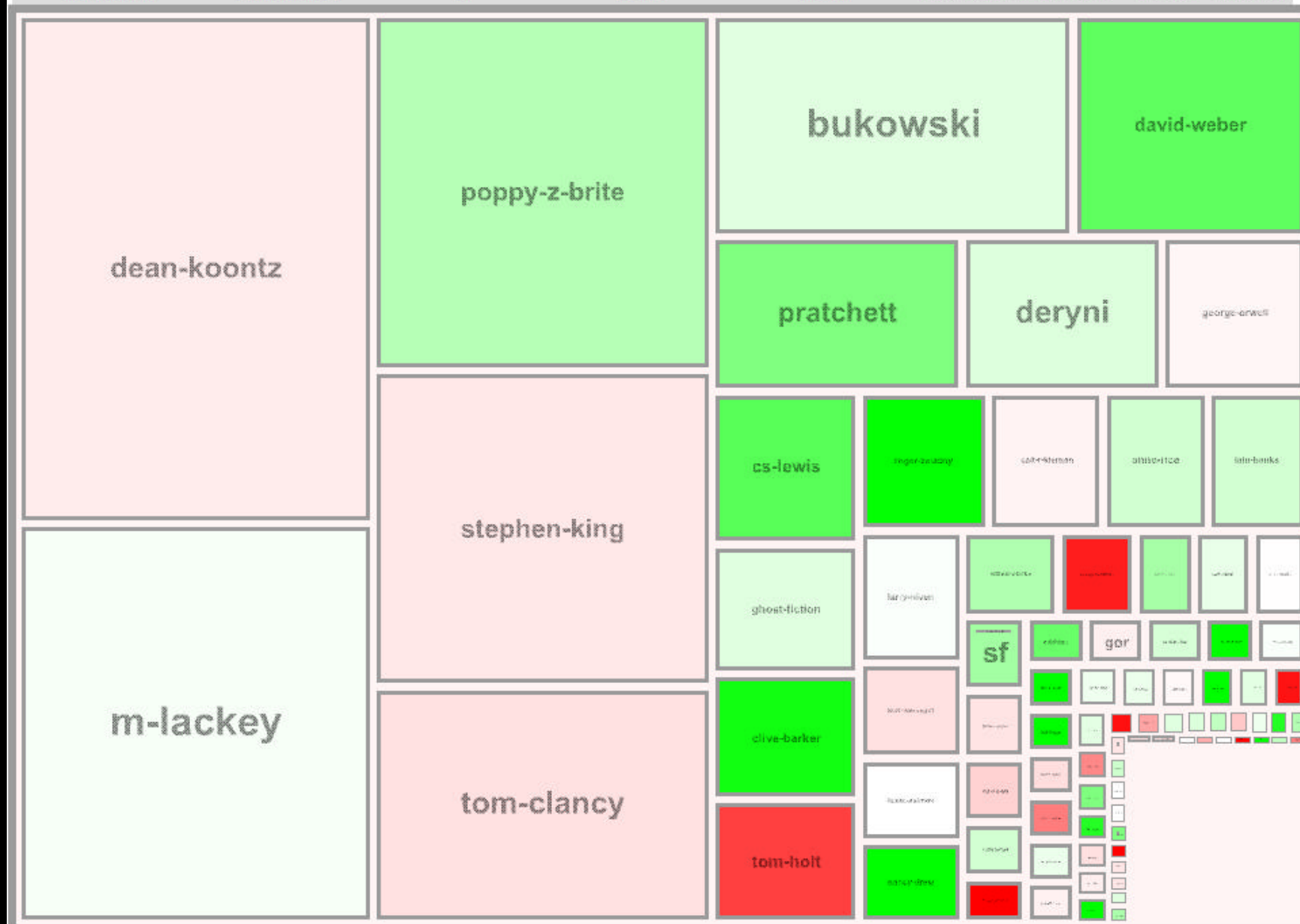


<http://netscan.research.microsoft.com/>



## books

Newsgroup Name	Date	Total Groups	Total Messages	Total Posters	Deep red means - 300% change
alt.books	01/01/2001	87	19567	3264	Deep green means + 300% change



# Music

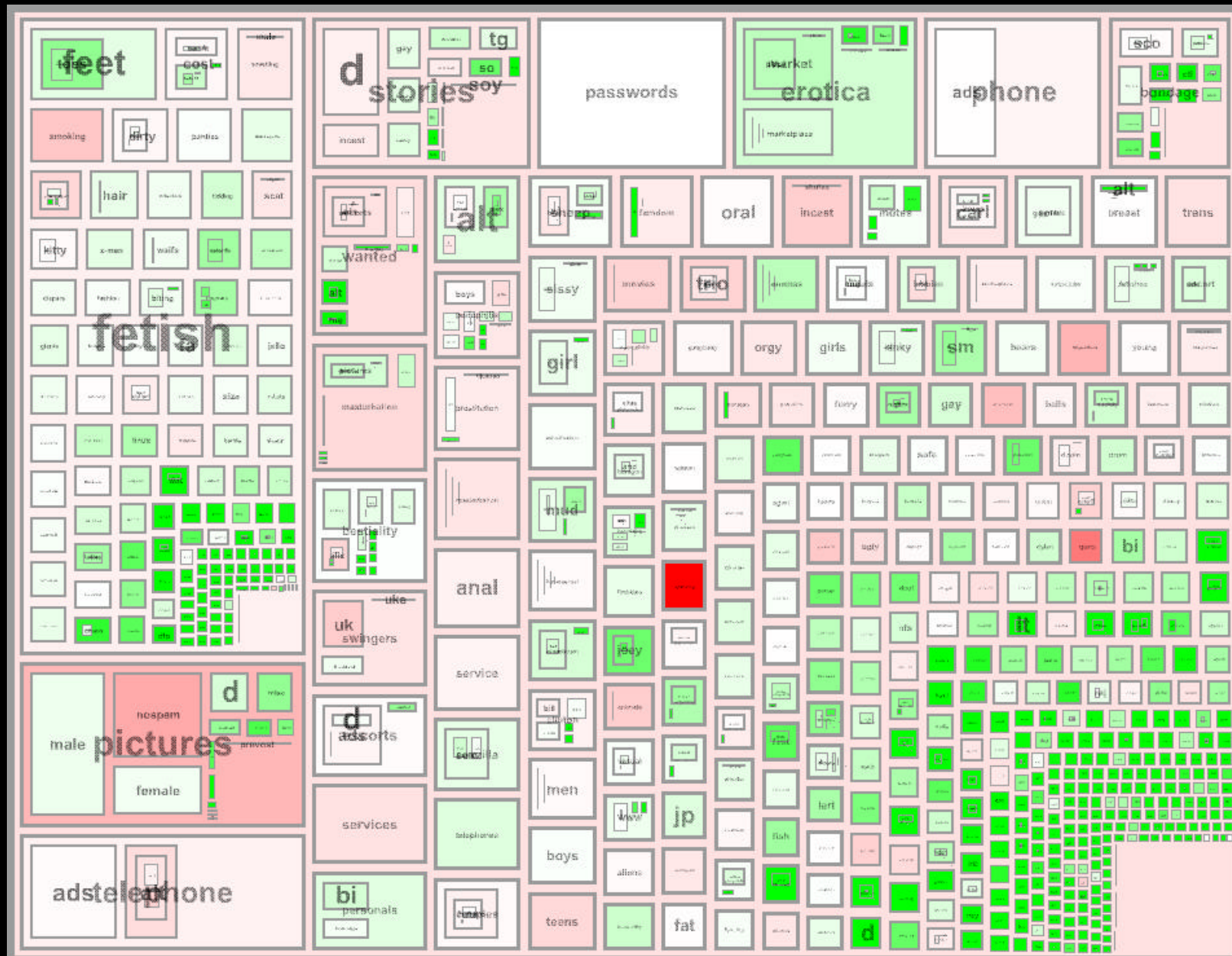
Newsgroup Name	Date	Total Groups	Total Messages	Total Posters	Deep red means - 300% change Deep green means + 300% change
alt.music	01/01/2001	807	197736	43757	
napster mp3					
oasis					
rush					
pearl-jam					
prince					
yes					
u2					
placebo					
trance					
weird-al					
blur					
nirvana					
mariah					
weezer					
blink-182					
drillkore					
ween					
country					
ska					
kom					
dio					
blues					
back					
ash					
nin					
bjork					
abba					
quincy					
herbie					
... (many more small tiles) ...					

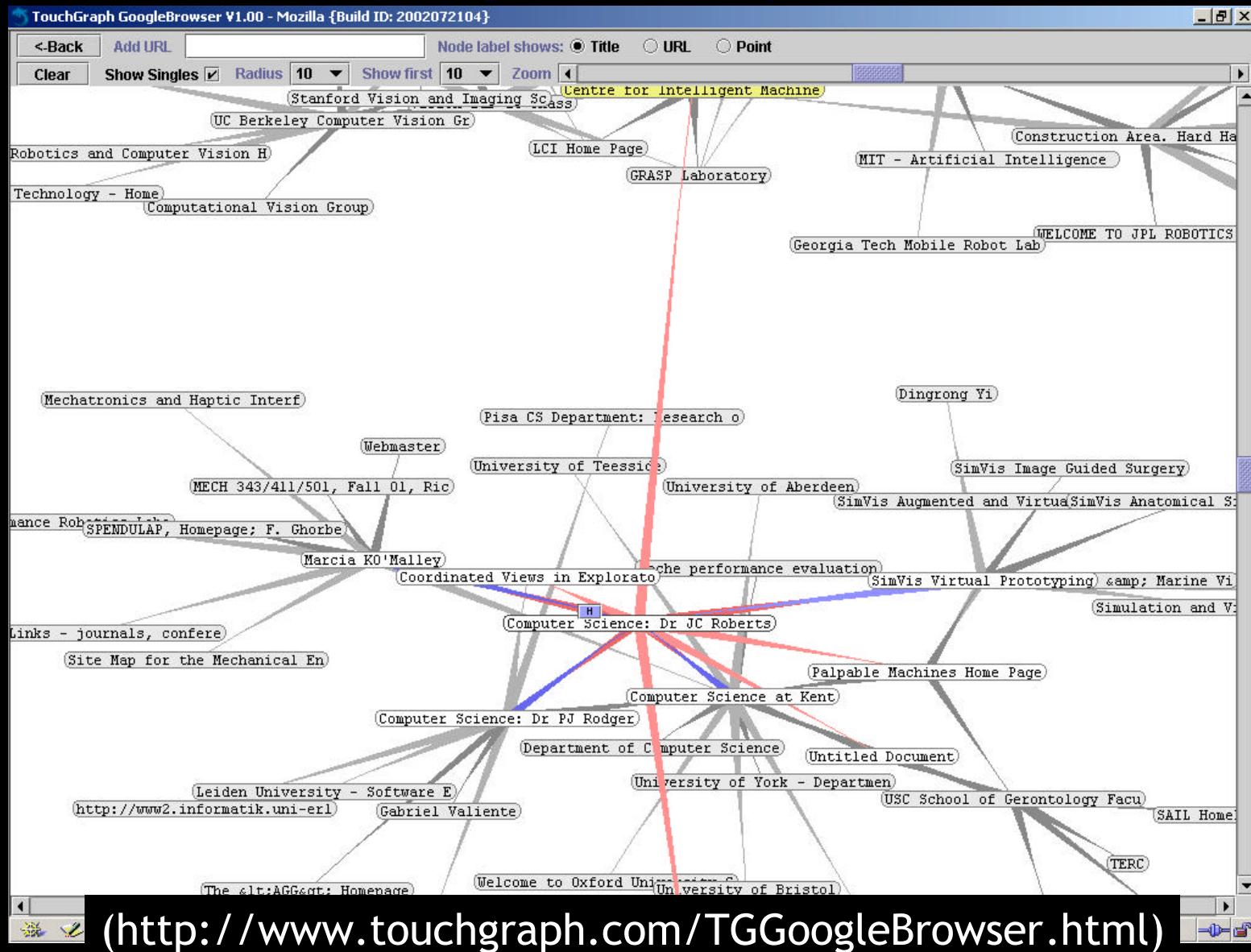
## TV

Newsgroup Name	Date	Total Groups	Total Messages	Total Posters	Deep red means - 300% change Deep green means + 300% change
alt.tv	01/01/2001	381	134859	19222	



# And of course Sex (the alt.sex newsgroups)





# critical cartography: the new nature of the map

- the power of maps
- maps are not simply about communicating geographic information or representing the landscape
- maps express power; maps create power
- maps are not neutral or objective
- maps are systems of power-knowledge
- maps are subjective, selective distortions
- maps serve the interests of those that make them



# critical cartography: the new nature of the map

- maps can be 'read' as texts, concerned for the 2nd text, the marginal, the unsaid
- we should worry less about map design, accuracy standards, theories of information transfer, etc, etc (that's a smoke screen)
- examine more the social implications
- what are the ethics of the maps, the map-maker and their mapping practices
- is it ethical to record and map someone's web surfing and email interactions?

## two key ideas

- maps are subjective
- maps are frames

# maps are subjective

- we all know the huge number of subjective decisions we take when making maps
- just think of the last time you did some analysis (manipulation) and visualising in xxxxx package. trace out the number of subjective, and often arbitrary, decisions you make
- plus all the arbitrary defaults set by software designers and programmers
- these all effect the end result. what comes out is your social construction



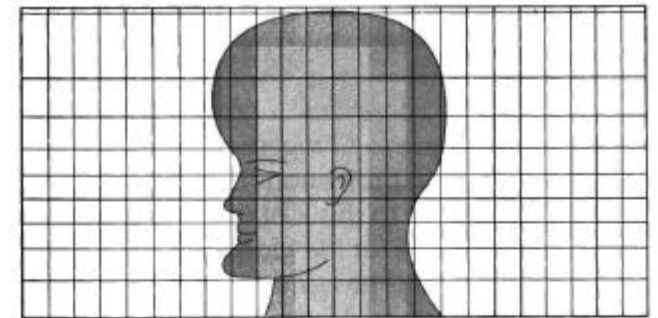
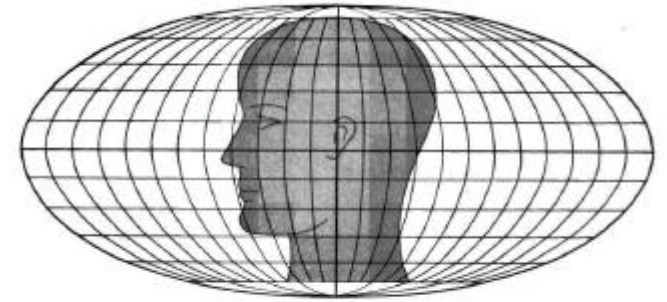
- this is the same for even the most fancy 3d immersive cyberspace map
- this applies to all visualisations

# maps are subjective

- subjectivity is inherent
- subjectivity is not wrong. you are not a 'bad' person for making subjective maps. not a personal criticism
- the problem is :
  - passing off the map as objective and neutral
  - denying the subjectivity
  - naïve belief that the map is just a mirror of reality
  - this is enhanced with the 'scientific' sophistication and hiding behind layers gee whiz tech
  - maps are then used and applied on the assumption that they are objective

# distortion and deception “how to lie with maps”

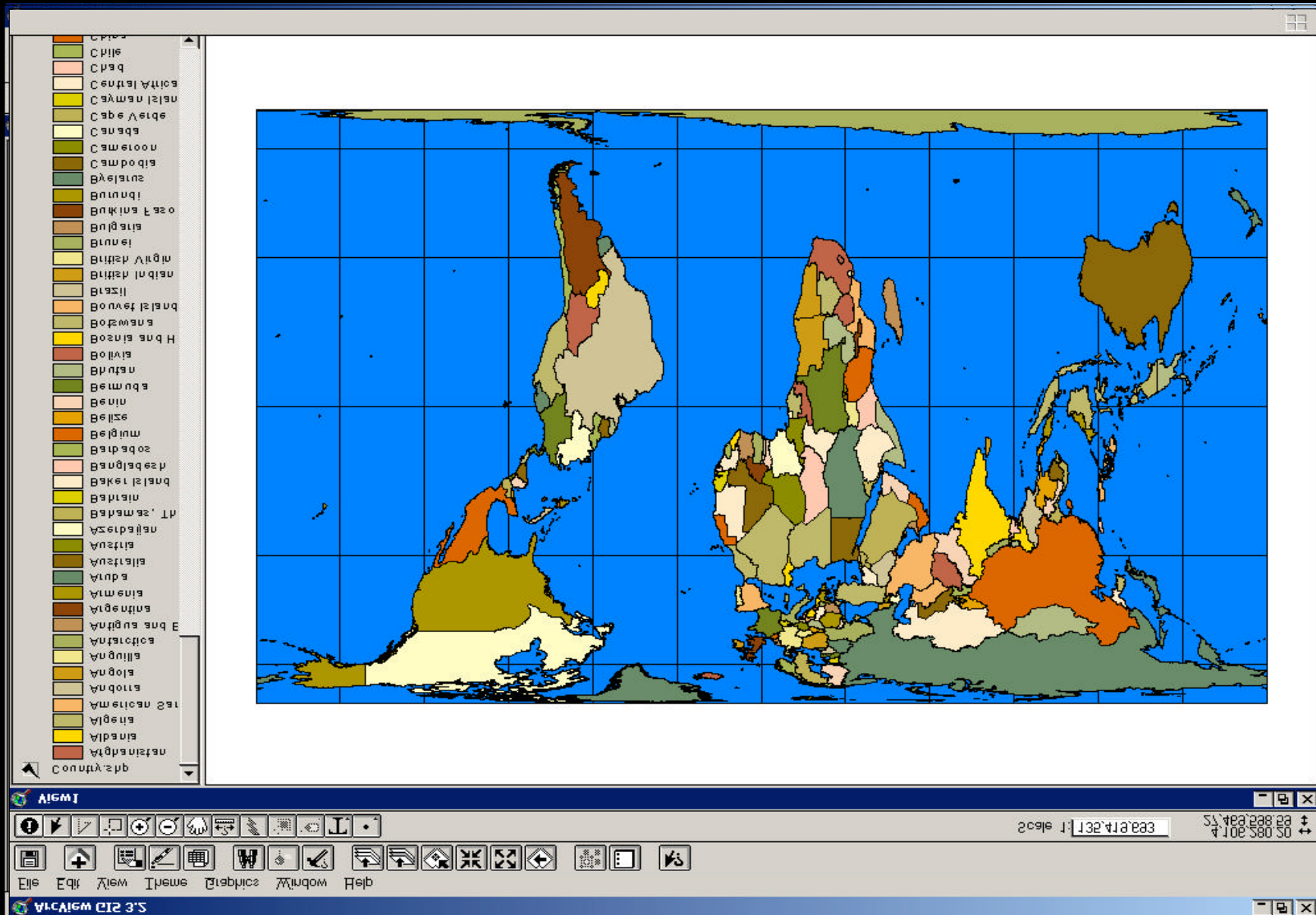
- most obvious being through
  - data selection/omission
  - projections
- how are maps of cyberspace deceiving?
- clearly there are many ways to project cyberspace onto a map



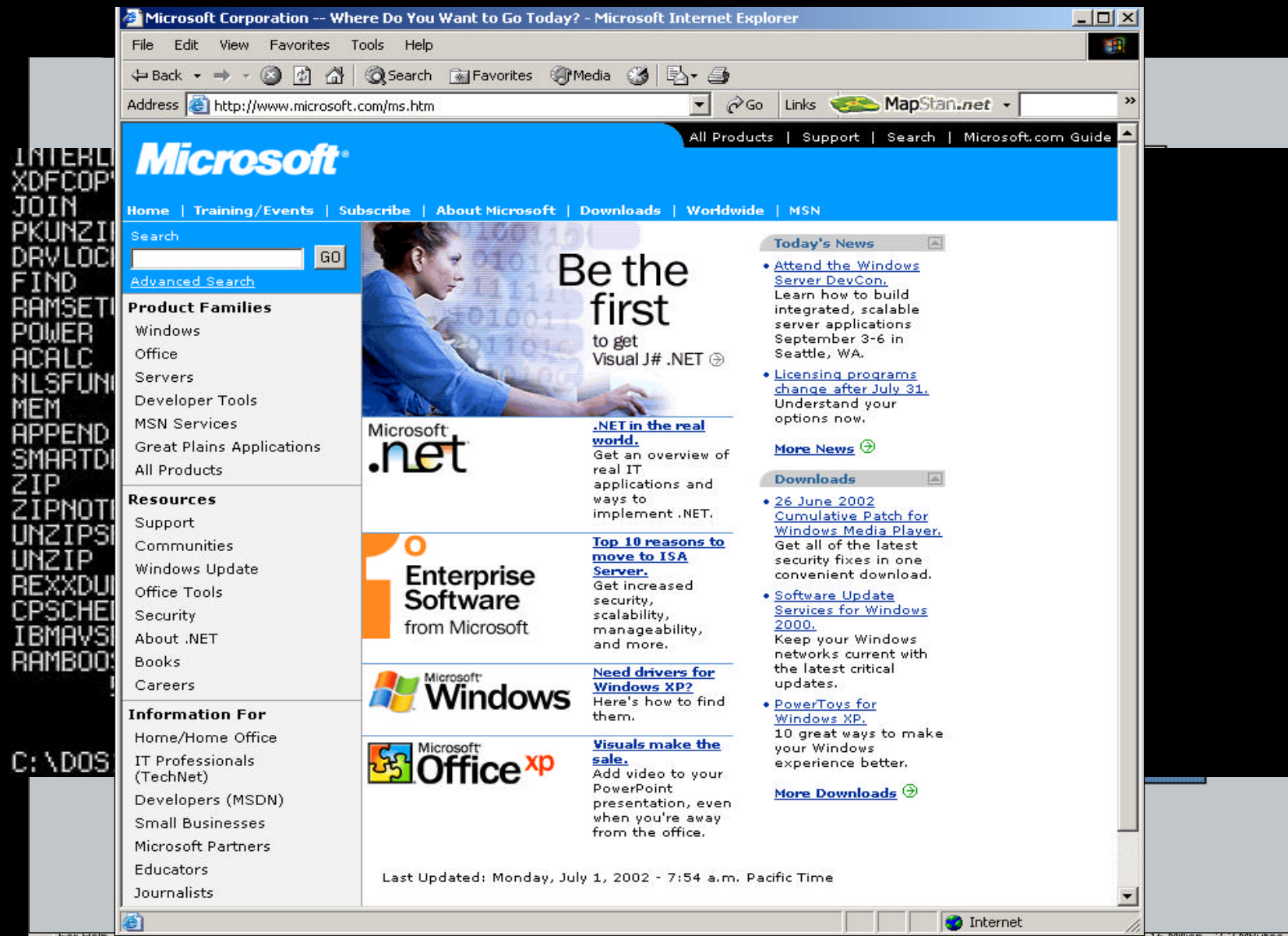
A head drawn on the Mollweide projection (top) has been transferred to Mercator's projection (center) and to the cylindrical equal-area projection with standard parallels at  $30^\circ$  (bottom). Just because the profile looks most natural on Mollweide's projection, that projection is not necessarily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



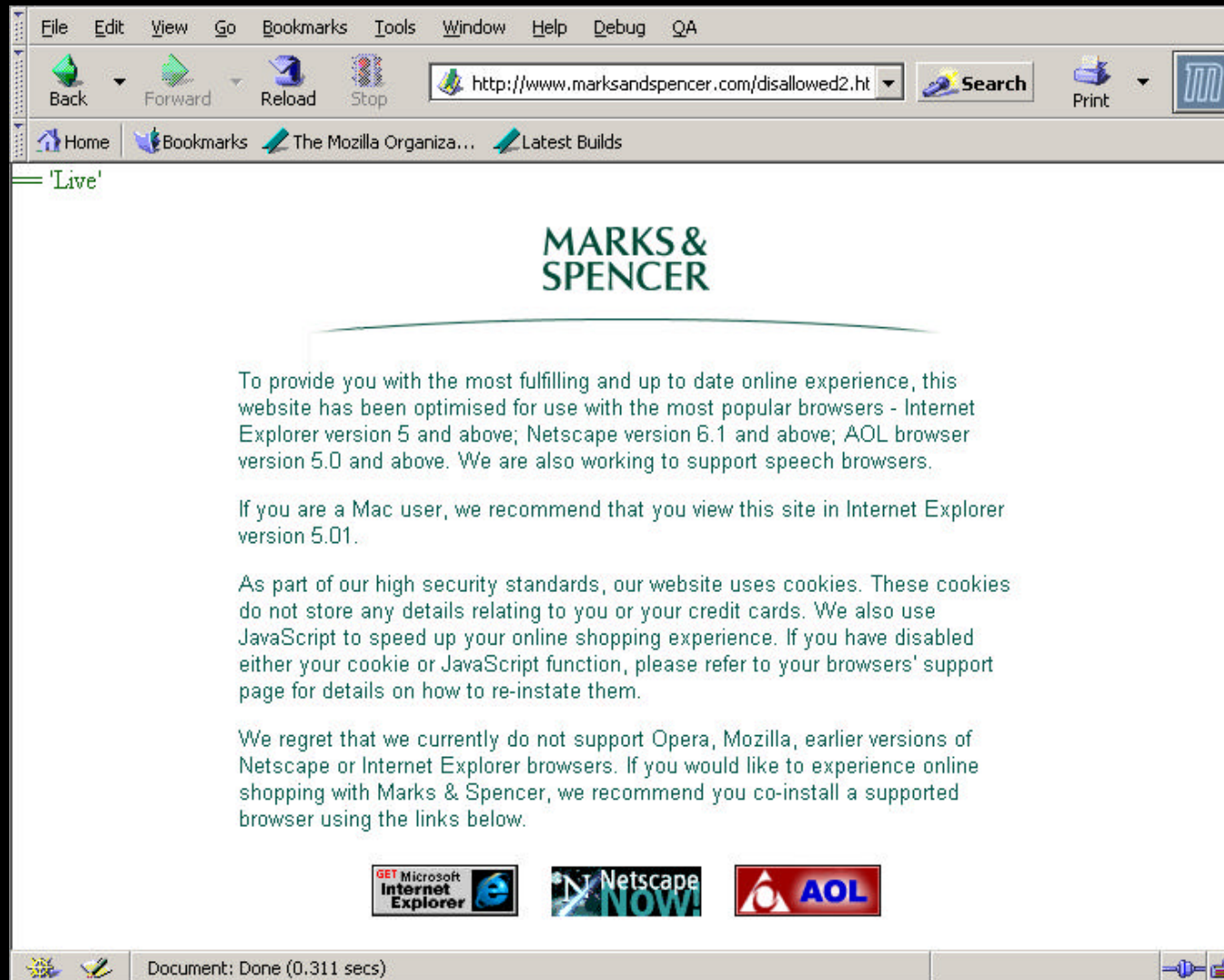
# maps as frames of space



# interfaces as frames of virtual space



# We don't like your browser, you can't come in



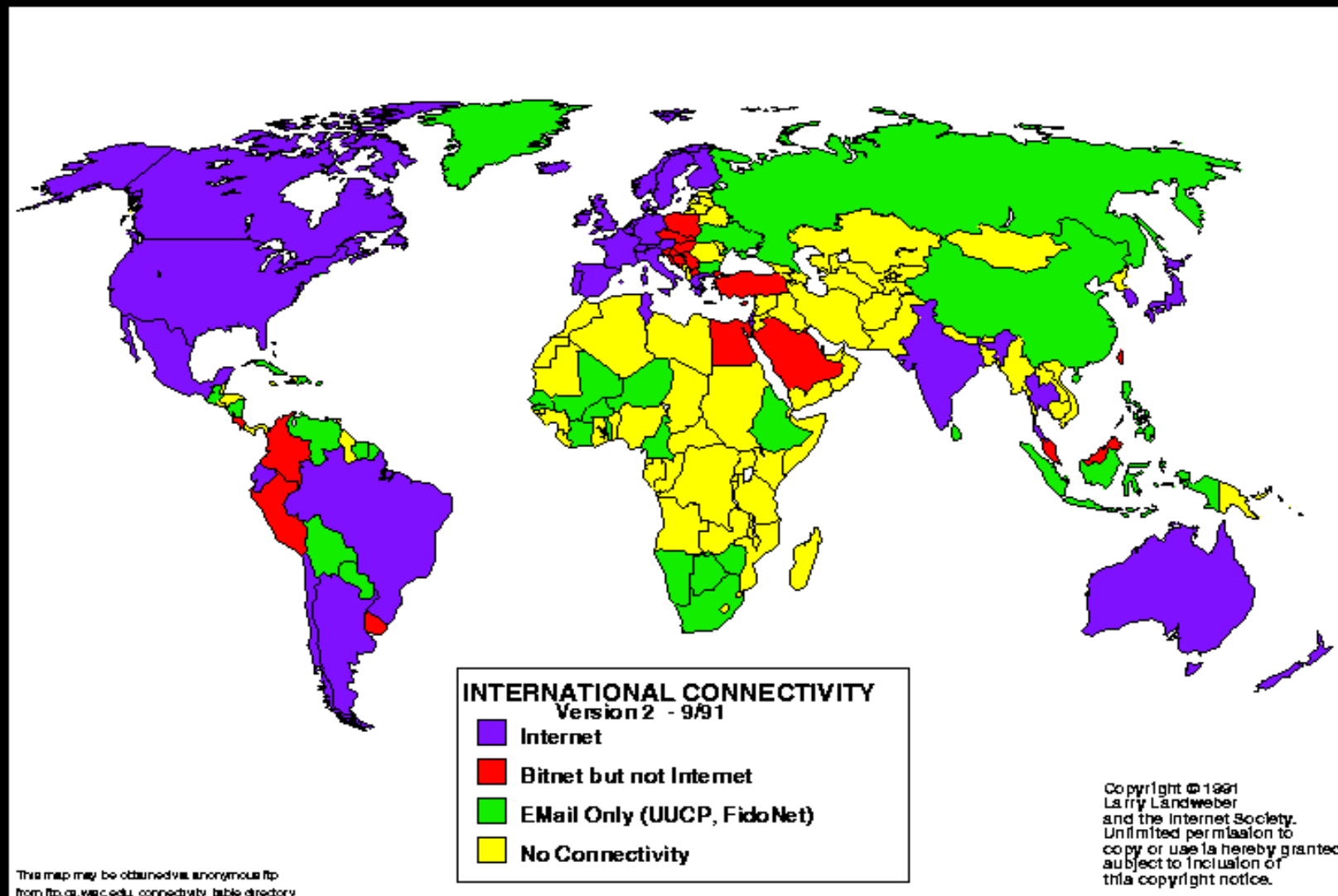
“Exclusively for Everyone (except mozilla users)”



# virtual maps make virtual space

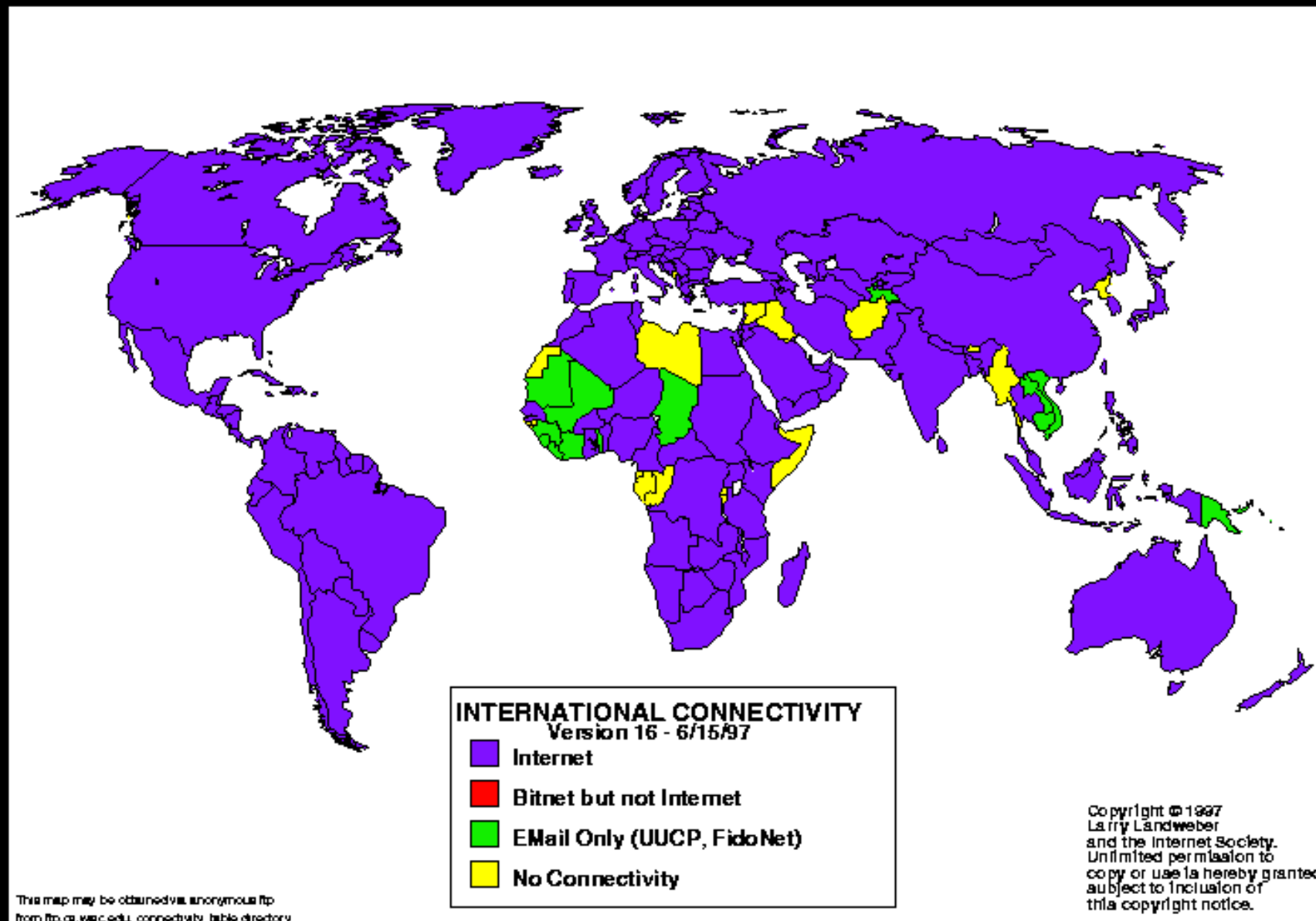
- the map affects what we see and what we can do
- we never know virtual space for 'real'
- the interface is the space
- map and the territory are one
- those who make the interface, make the space...
- and of course the map they make is subjective and serves their interests
- its easy to take the interface for granted, assuming it is natural and a given. do not recognise its artificiality

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



([ftp://ftp.cs.wisc.edu/connectivity\\_table/](ftp://ftp.cs.wisc.edu/connectivity_table/))

# the whole world now pretty much wired??





- questions ?? I would welcome feedback to [m.dodge@ucl.ac.uk](mailto:m.dodge@ucl.ac.uk)
- <http://www.cybergeography.org> for more info
- the slides of this presentation are available at [http://www.casa.ucl.ac.uk/martin/ukc\\_talk.pdf](http://www.casa.ucl.ac.uk/martin/ukc_talk.pdf)