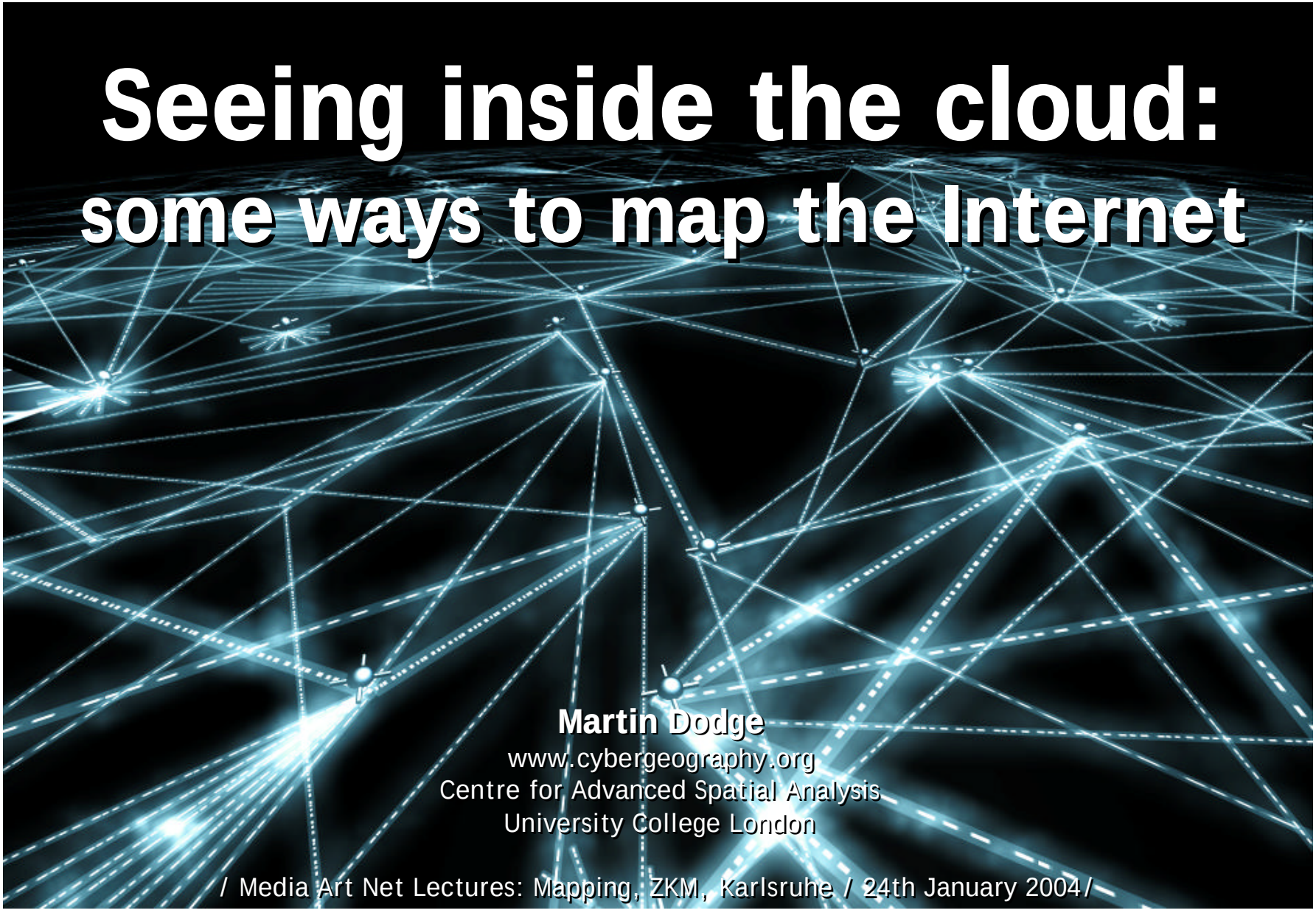


Seeing inside the cloud:
some ways to map the Internet

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

/ Media Art Net Lectures: Mapping, ZKM, Karlsruhe / 24th January 2004 /

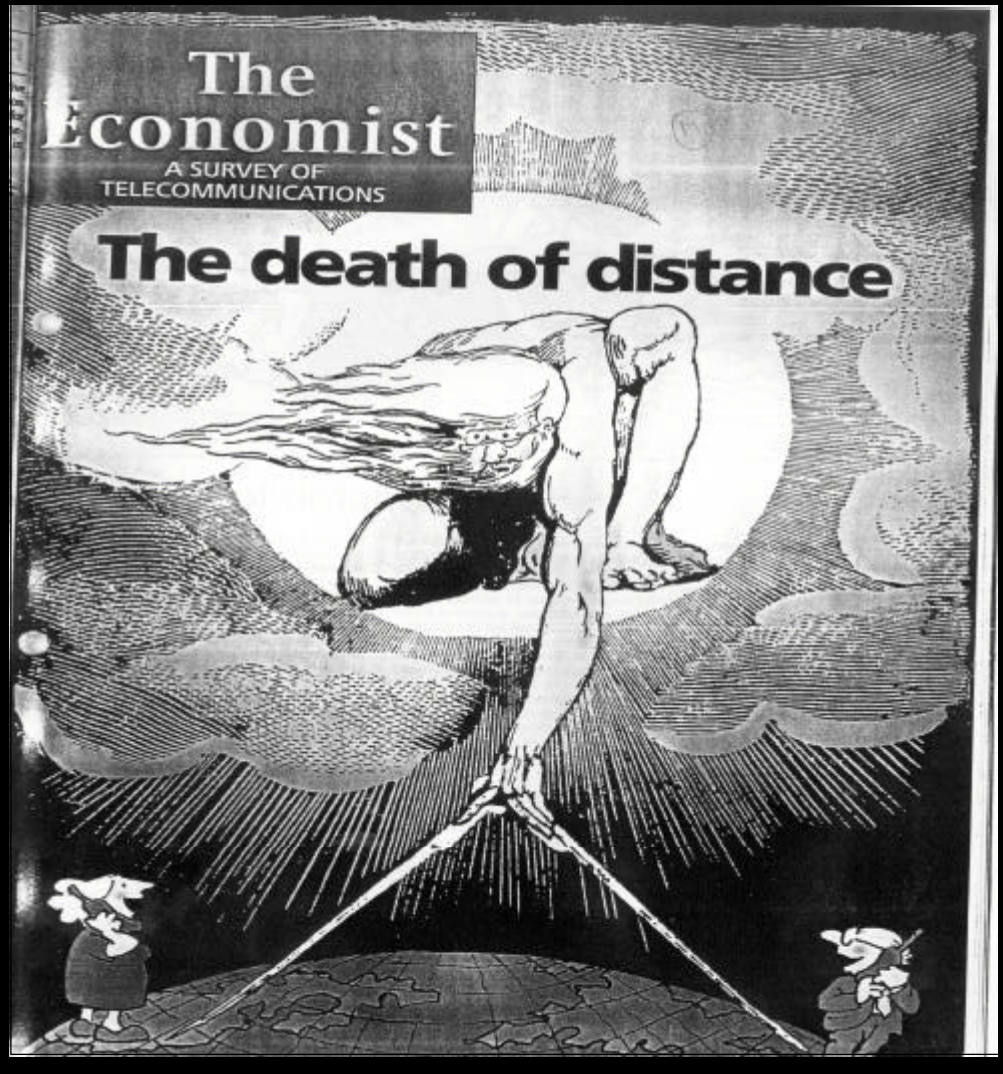
Is there a geography of cyberspace?

Bits, not atoms

Spaceless space

anything, anytime, anywhere

End of Geography



30th September 1995

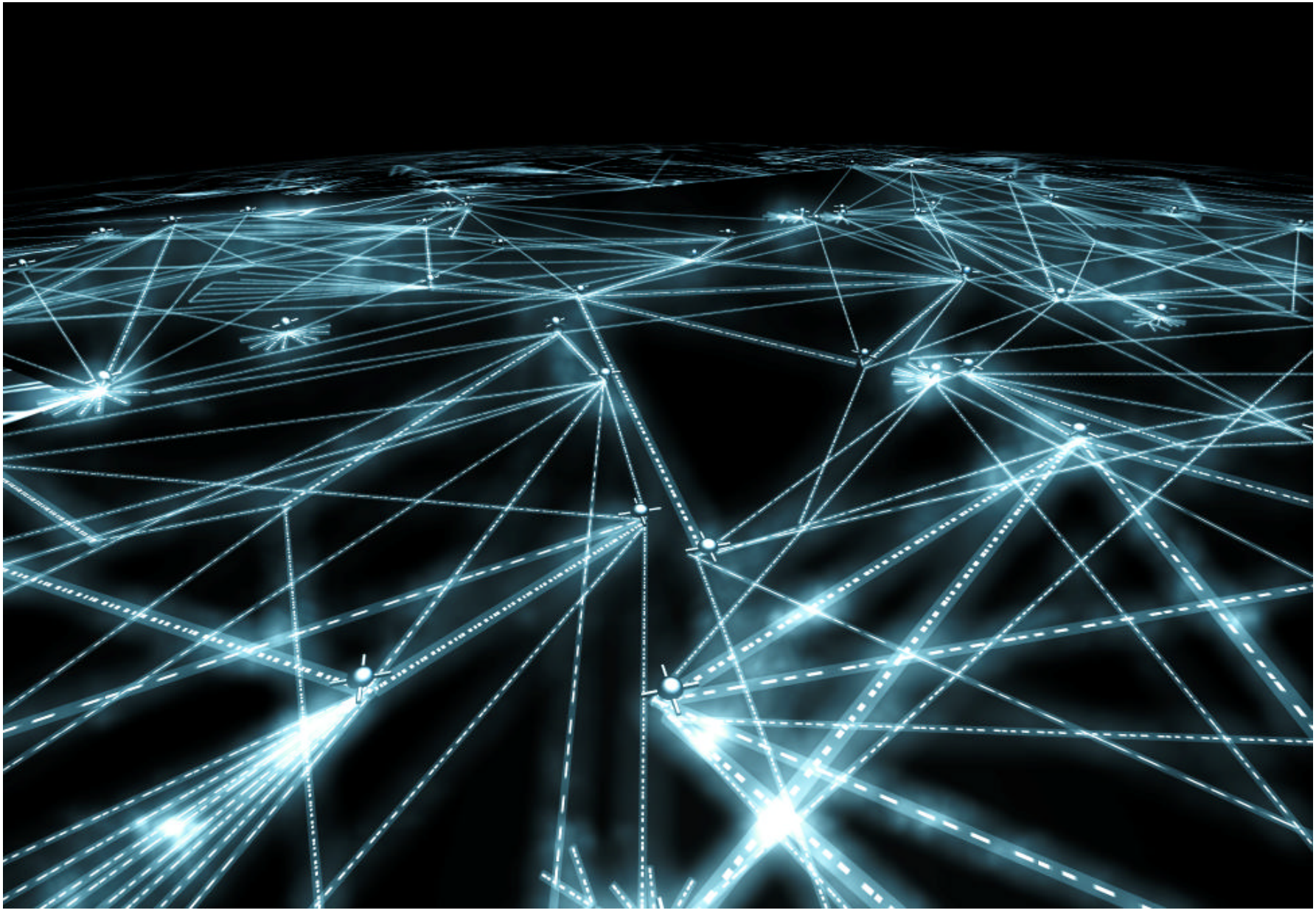
Cyberspace is everywhere and nowhere

friction-free economy

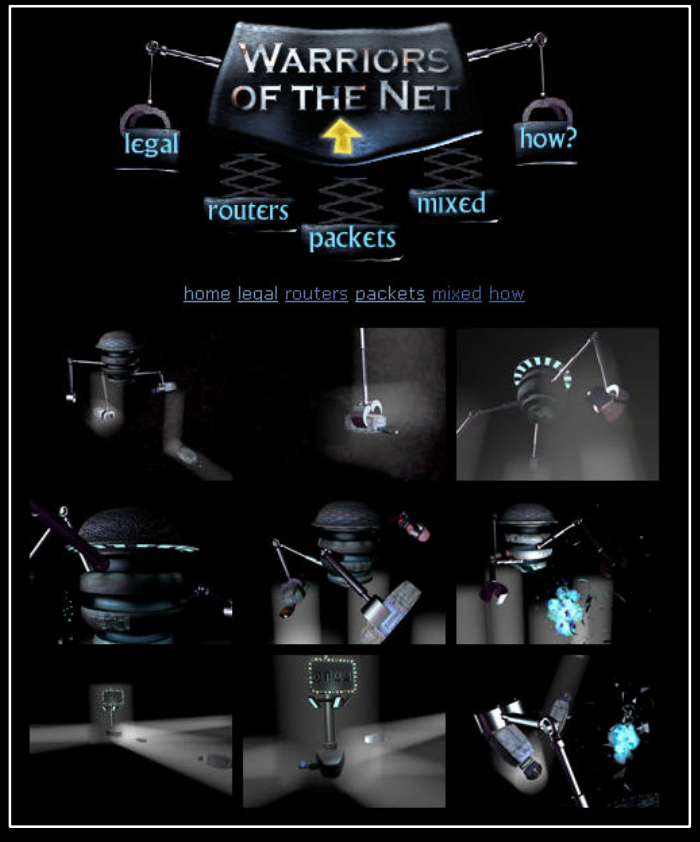
Cities dissolve

Weightless World

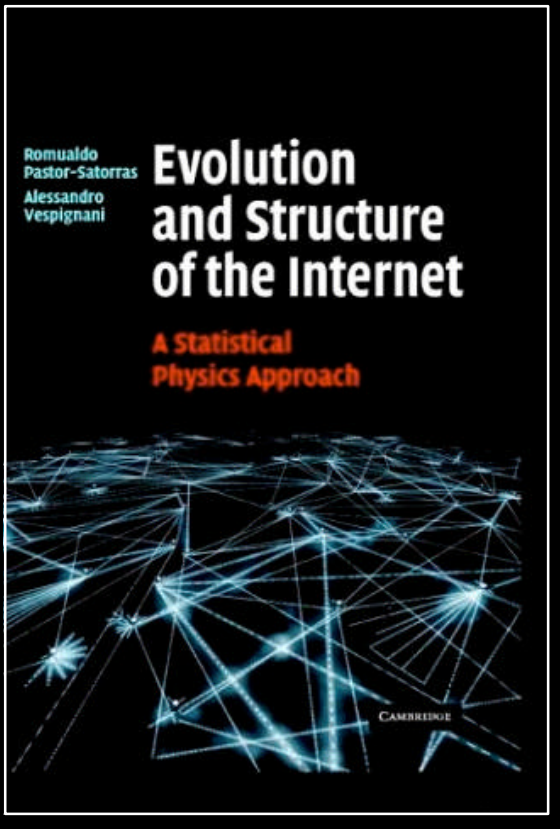
Aesthetics -> governance -> stories
maps make space

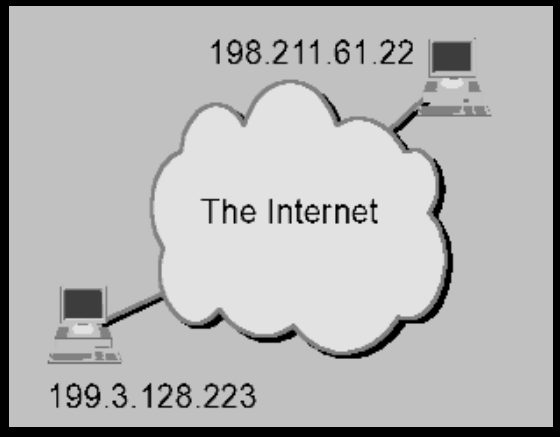


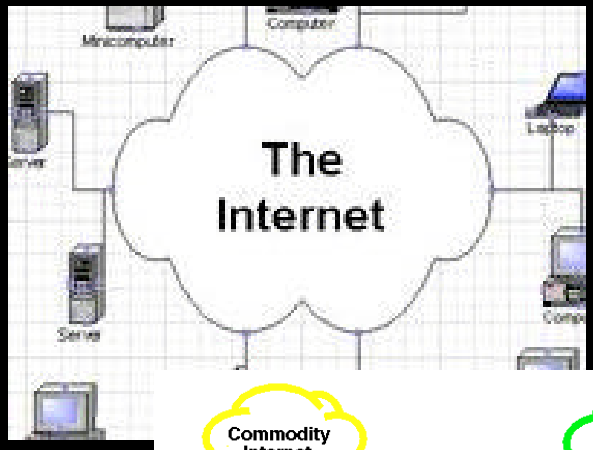
Maps and imagination



(Ericsson MediaLab,
animation by Gunilla Elam
www.warriorsofthe.net)

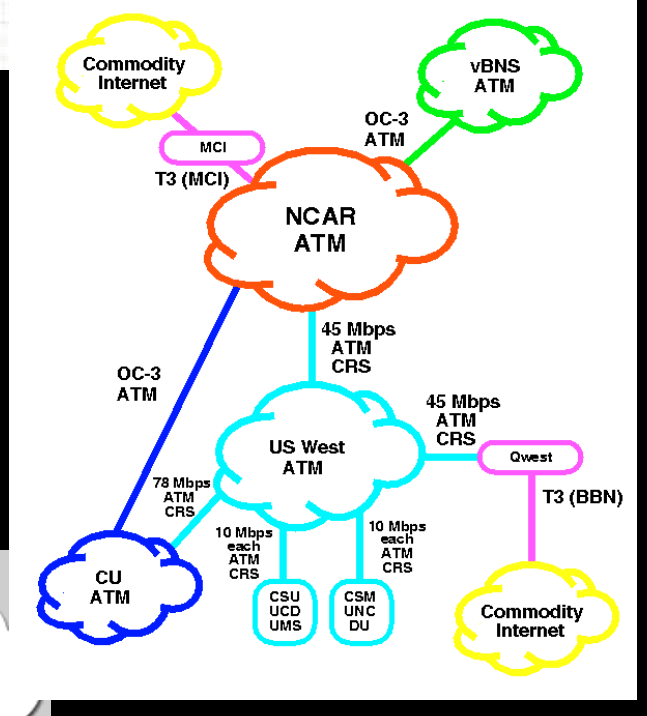


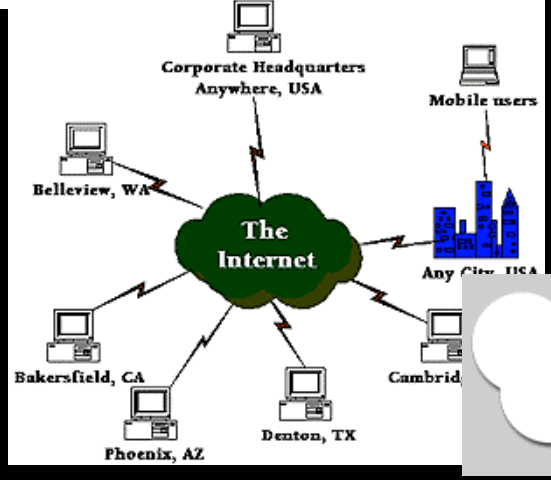

198.211.61.22
The Internet
199.3.128.223


The Internet

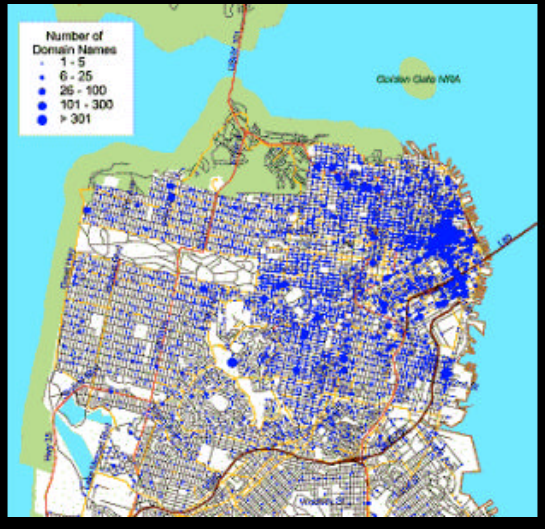

Internet


146.97.112.0


Commodity Internet
vBNS ATM
OC-3 ATM
MCI
T3 (MCI)
NCAR ATM
45 Mbps ATM CRS
OC-3 ATM
45 Mbps ATM CRS
US West ATM
Qwest
T3 (BBN)
78 Mbps ATM CRS
10 Mbps each ATM CRS
10 Mbps each ATM CRS
CU ATM
CSU UCD UMS
CSM UNC DU
Commodity Internet


Corporate Headquarters
Anywhere, USA
Mobile users
Belleview, WA
The Internet
Any City, USA
Bakersfield, CA
Cambrid
Denton, TX
Phoenix, AZ


Internet



Maps let us look inside the cloud

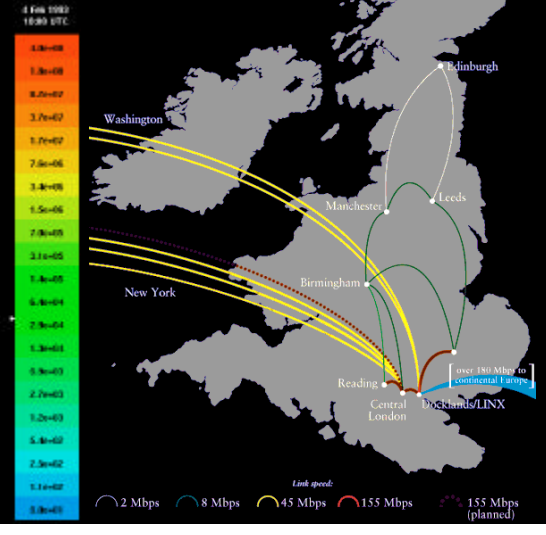
My definition of ‘map’

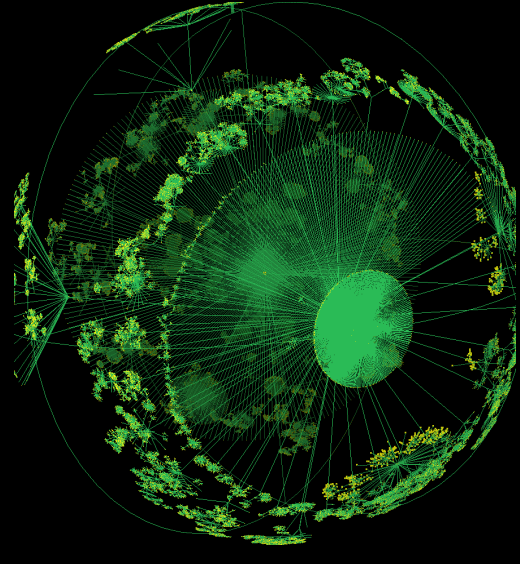
- half of your examples are not even maps!
- “maps are graphic representations that facilitate a spatial understanding of things, concepts, conditions, processes, or events in the human world”

  (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

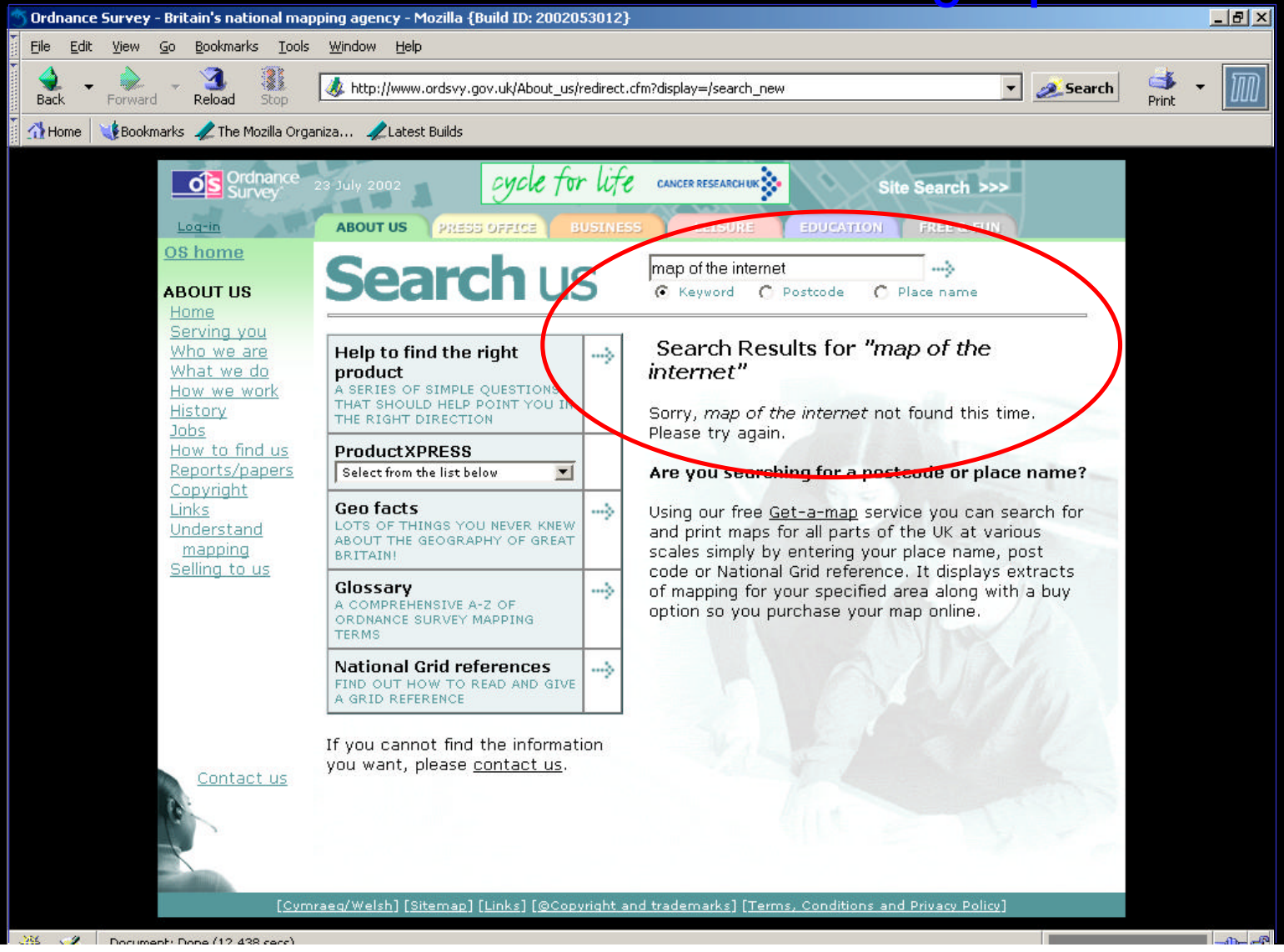




Purpose of Internet maps

- 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?

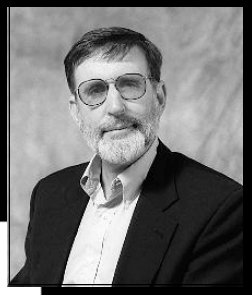
- its new, its fast changing
- complex and fast growing
- diversity of owners, heterogeneous, no one has overall responsibility
- banal, boring, background. Invisible internet
- secrecy - network security and commercial confidentiality
- has not been seen as a vital strategic asset. although this is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

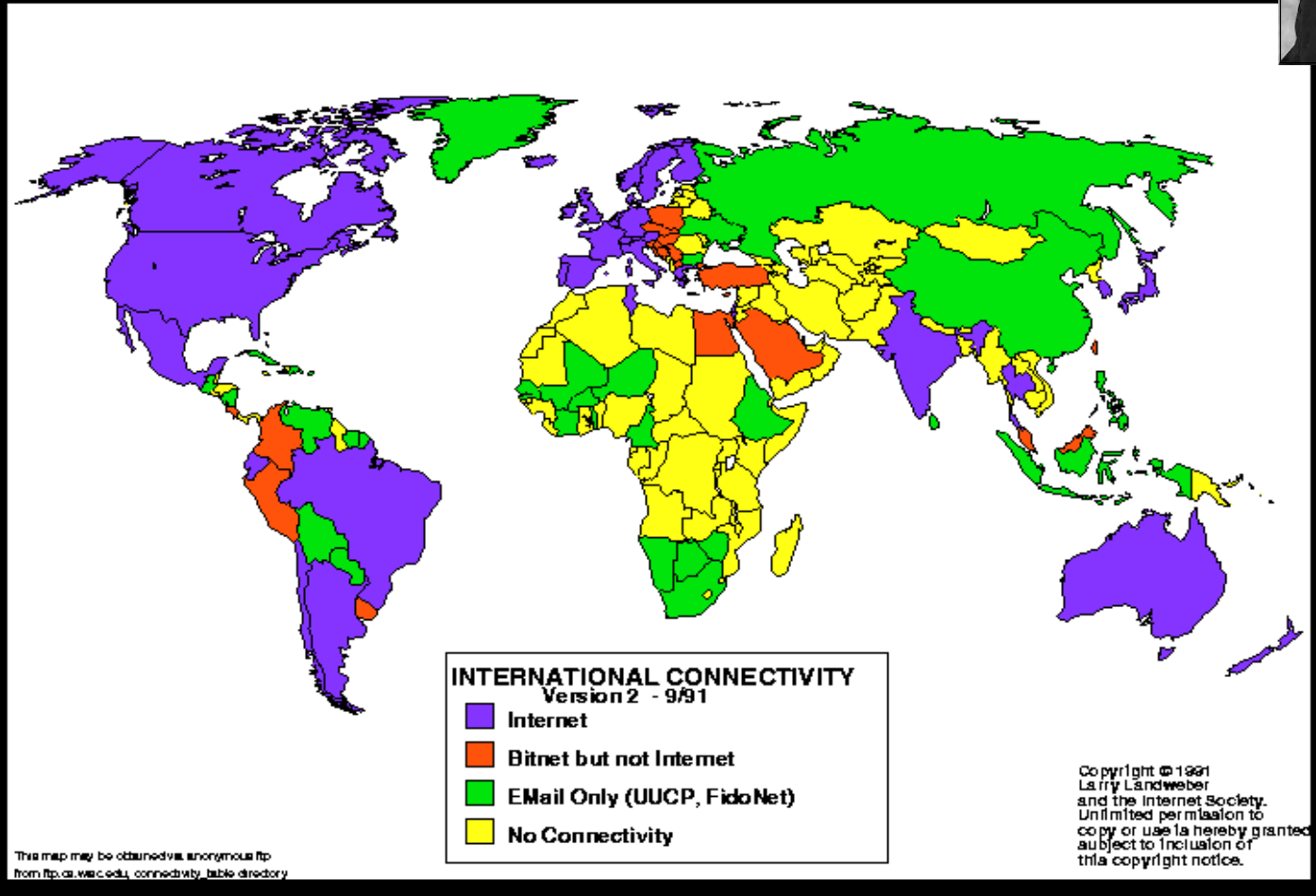
(http://www.washingtonpost.com/ac2/wp-dyn/A23689-2003Jul7)

Statistical mapping:

- statistical maps by shading area or continuous grids
- dot mapping and proportional symbols
- line mapping

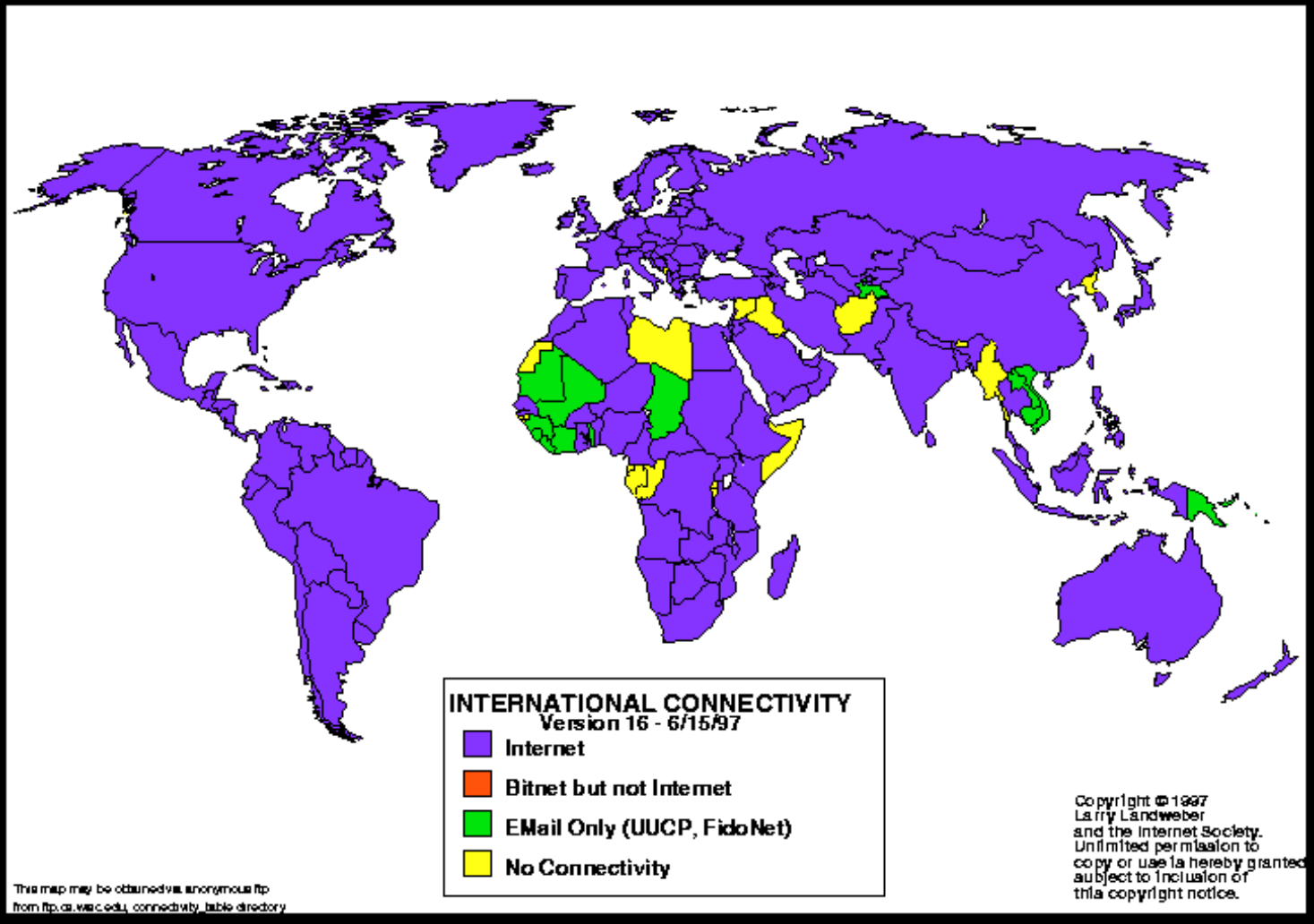
Larry Landweber & ISOC national level network connectivity maps from 1990s





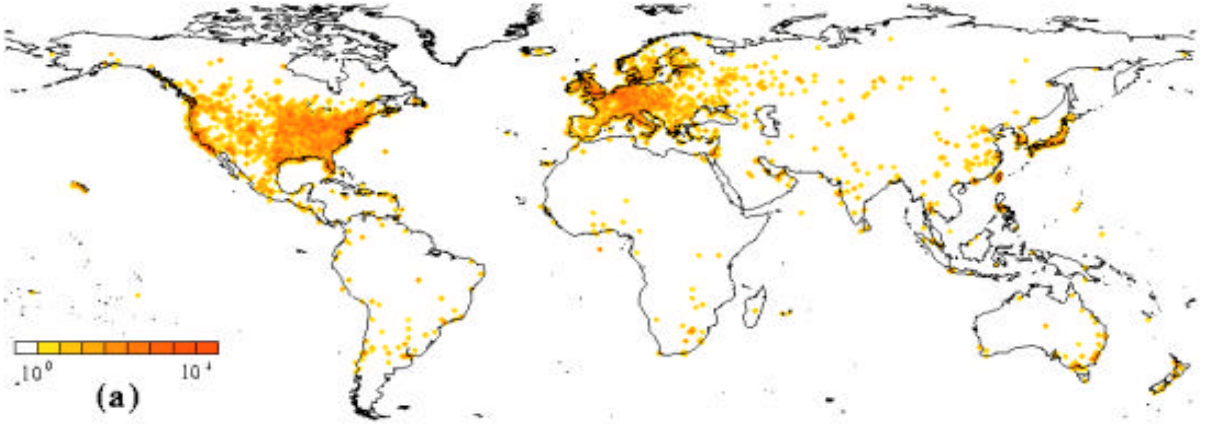
(http://www.cs.wisc.edu/~lhl/maps/)

the whole world now pretty much wired??

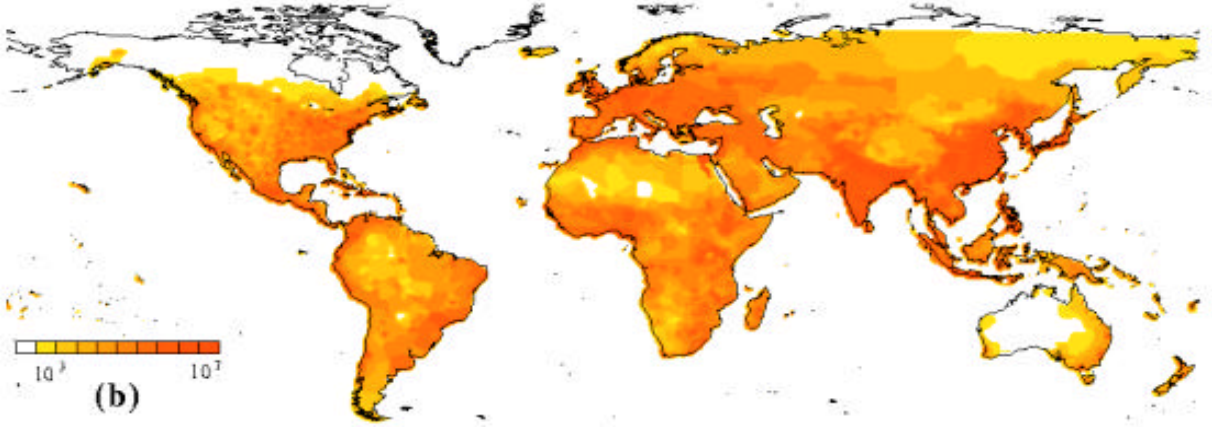


Geographic density of Internet routers

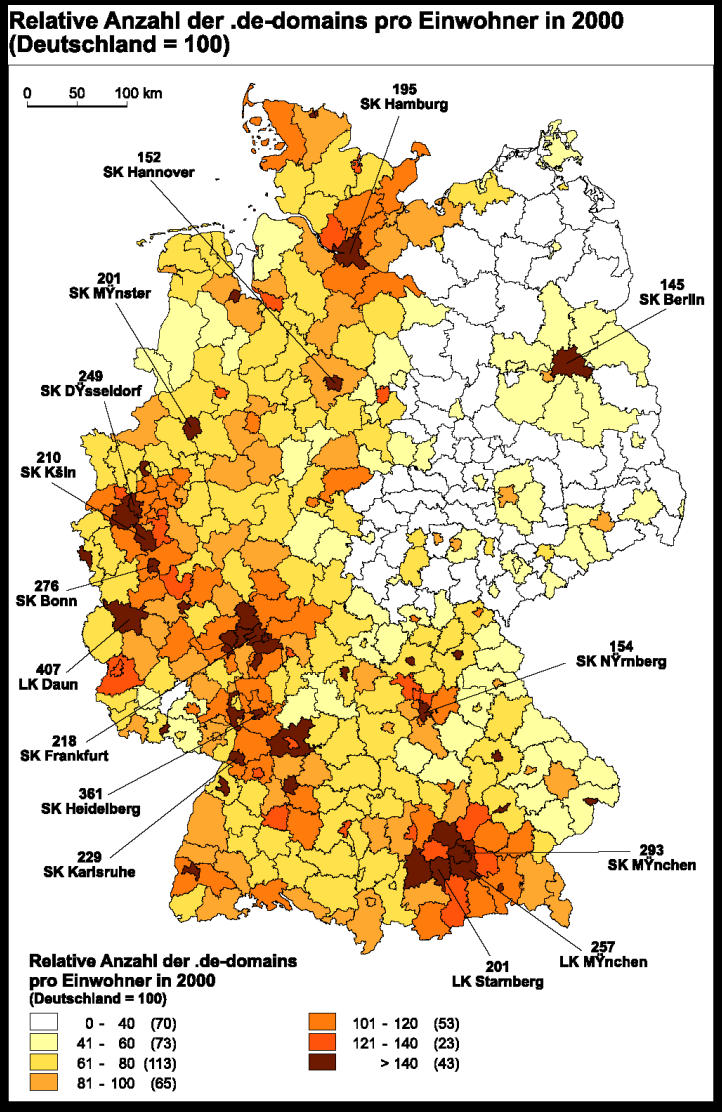
Router density



Population density



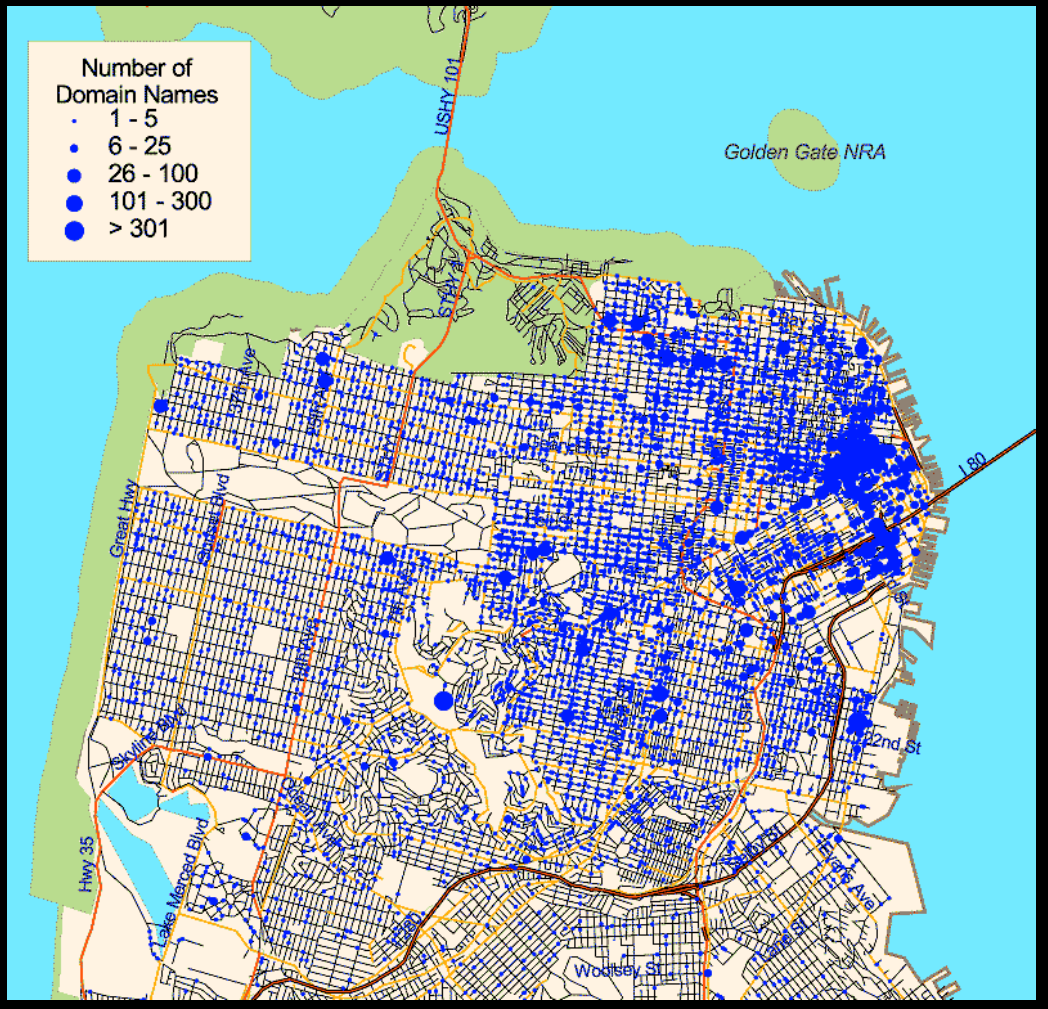
(source: Modeling the internet 's large-scale topology, http://xxx.lanl.gov/abs/cond-mat/0107417)



Domain name geography analysis by Mark Krymalowski

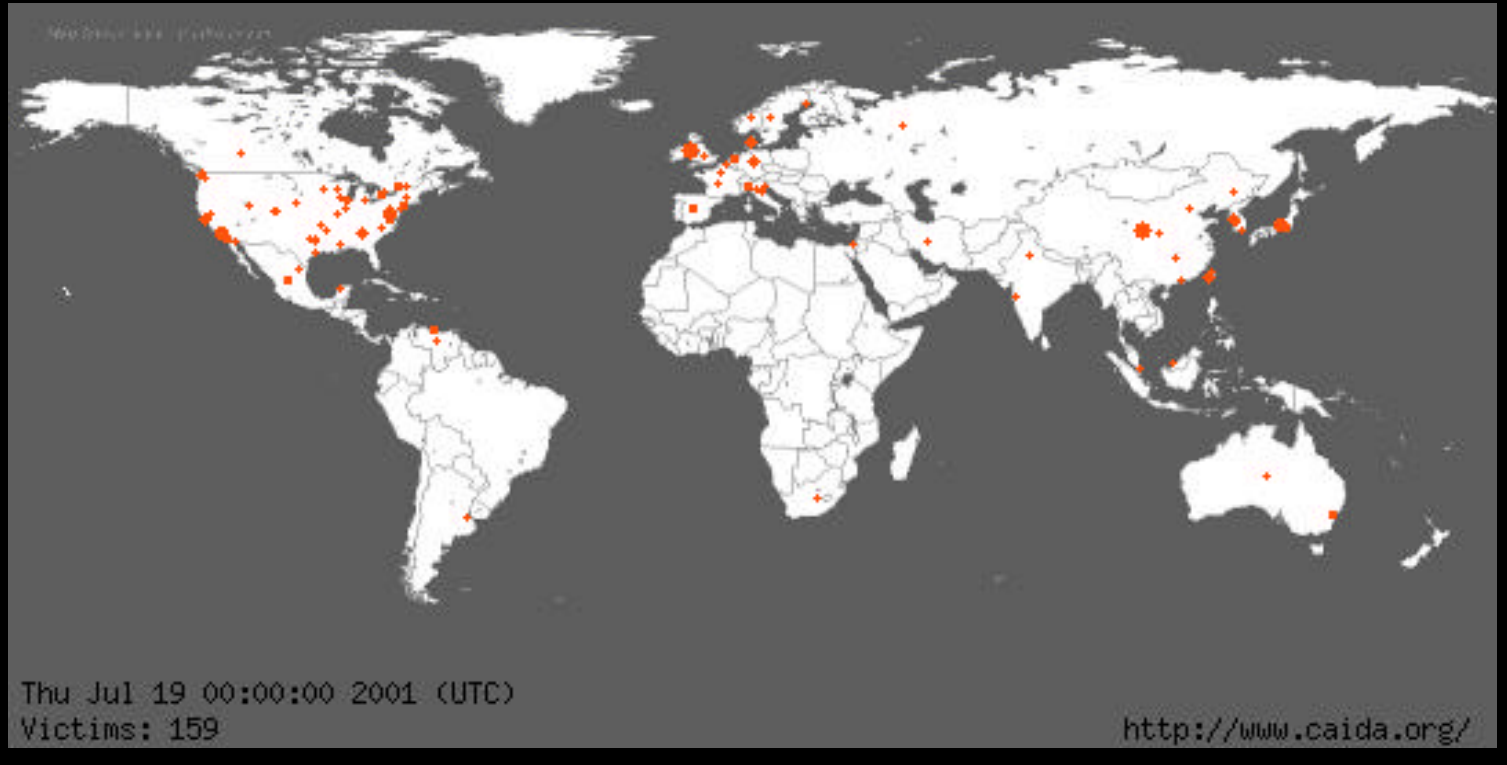
(source: www.denic.de/doc/DENIC/presse/stats2000.en.html)

Dotcom domain names



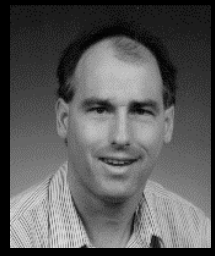
(source: Matthew Zook, www.zooknic.com)

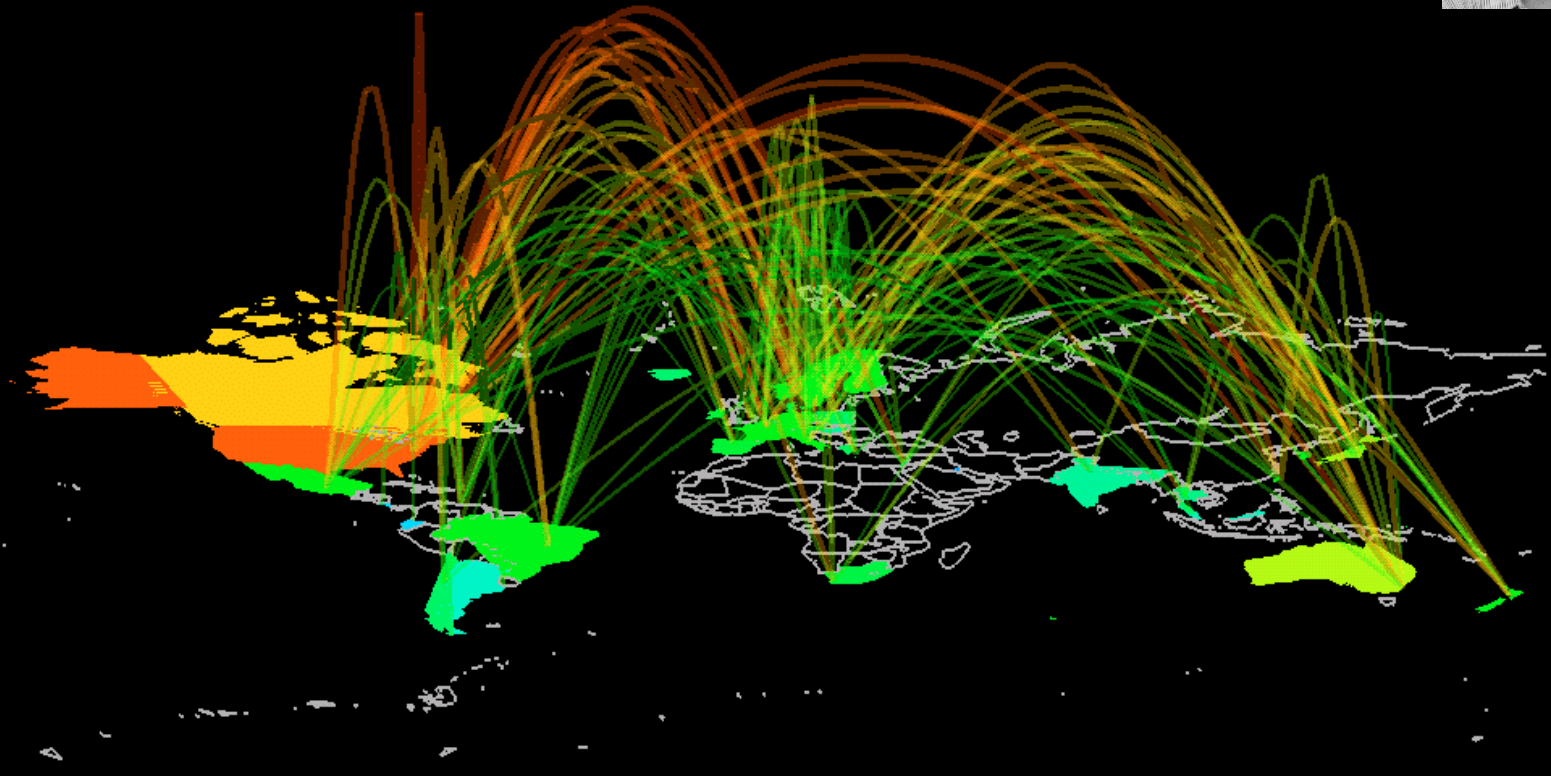
Mapping virus diffusion - Code-Red



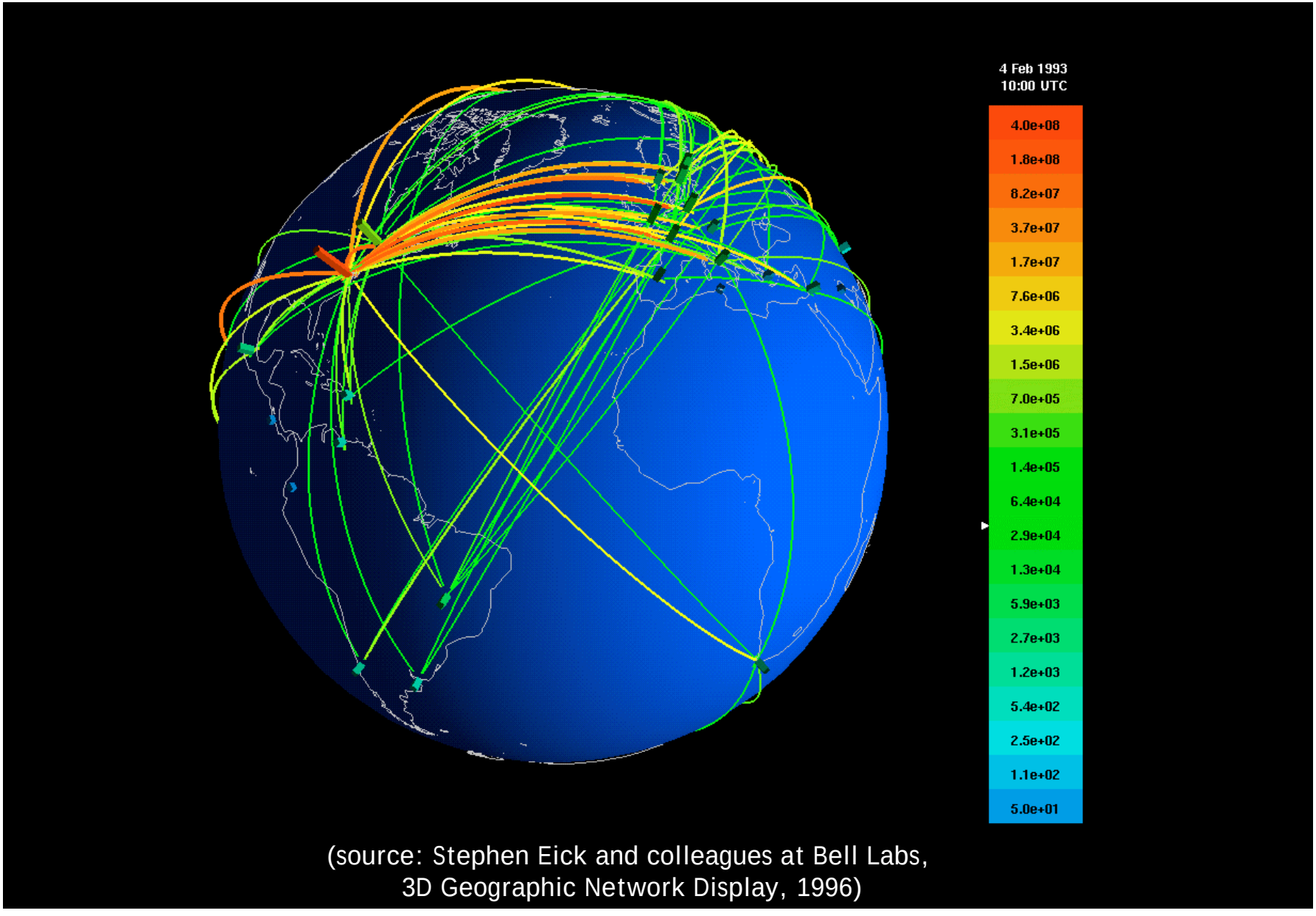
(source: Caida, www.caida.org/analysis/security/code-red/)

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)

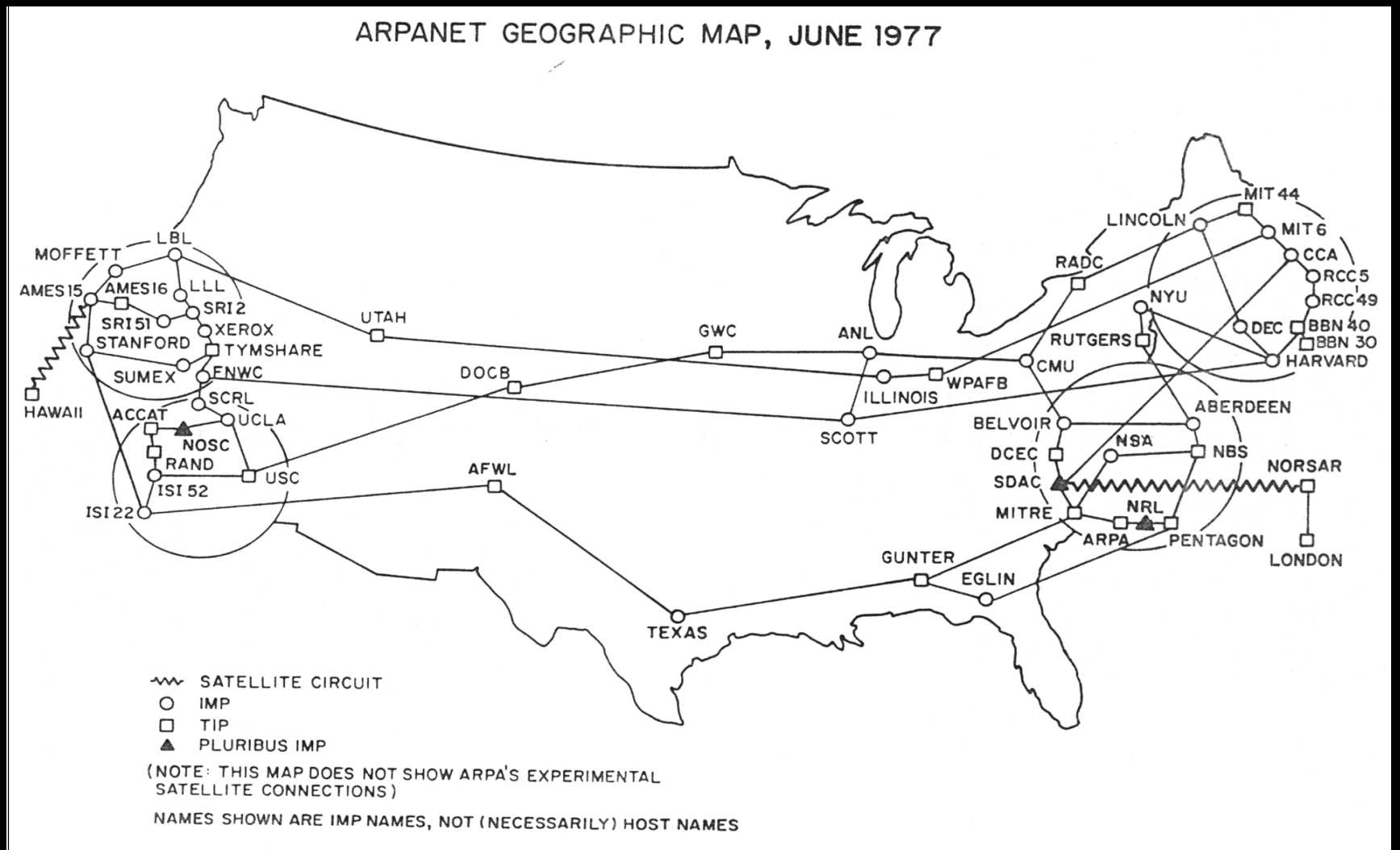
Where do the cables go?

Geographic link-node mapping, physical or logical?

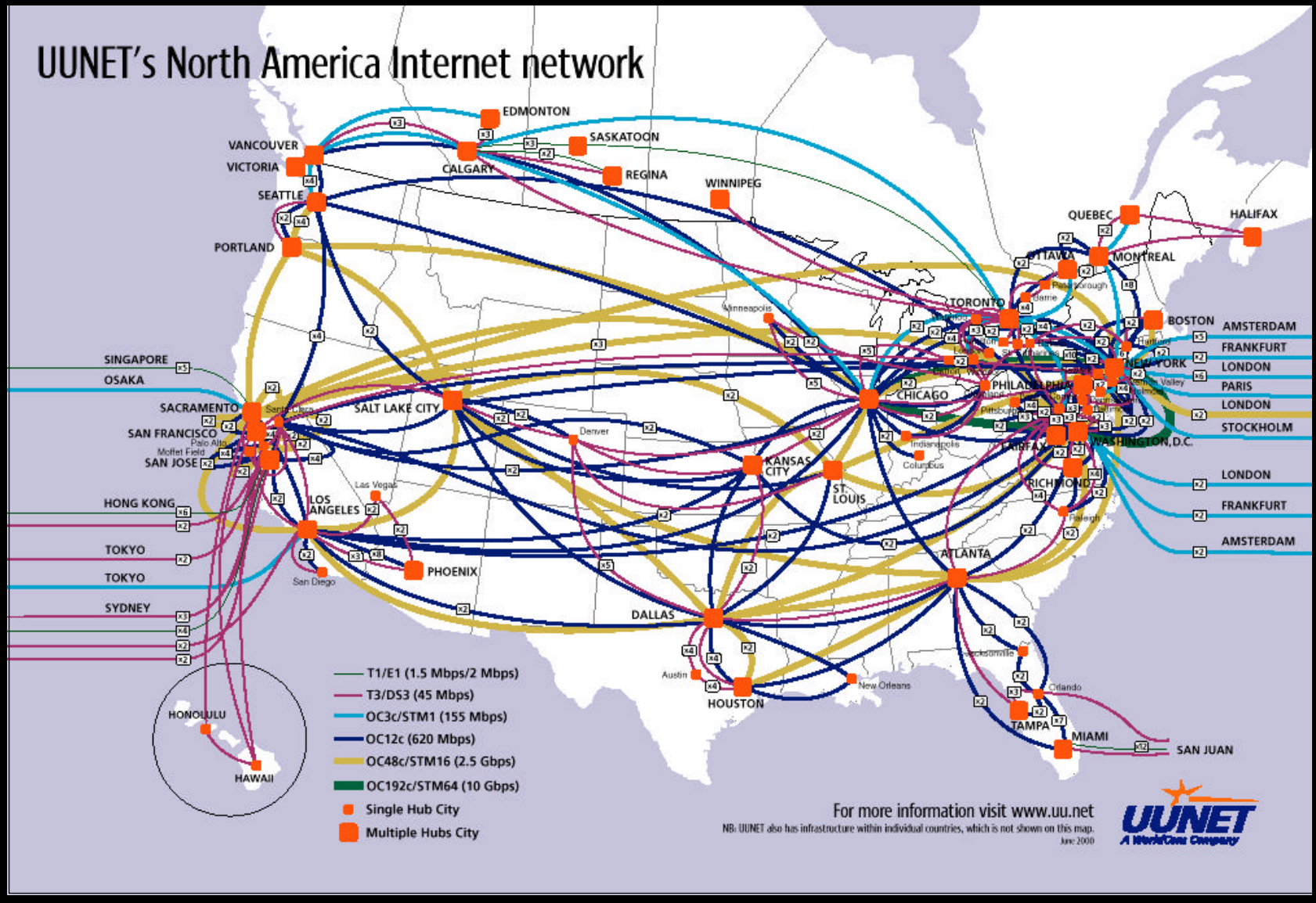
Just nodes and links

Victorian internet, circa 1853

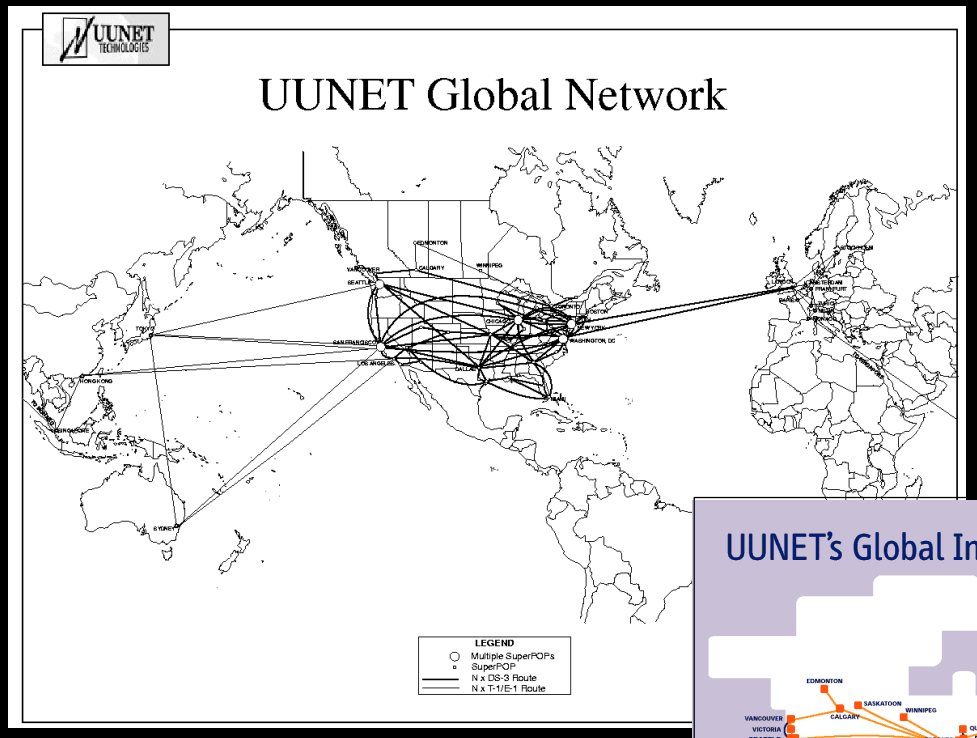
(source: Library of Congress, http://hdl.loc.gov/loc.gmd/g3701p.ct000084)

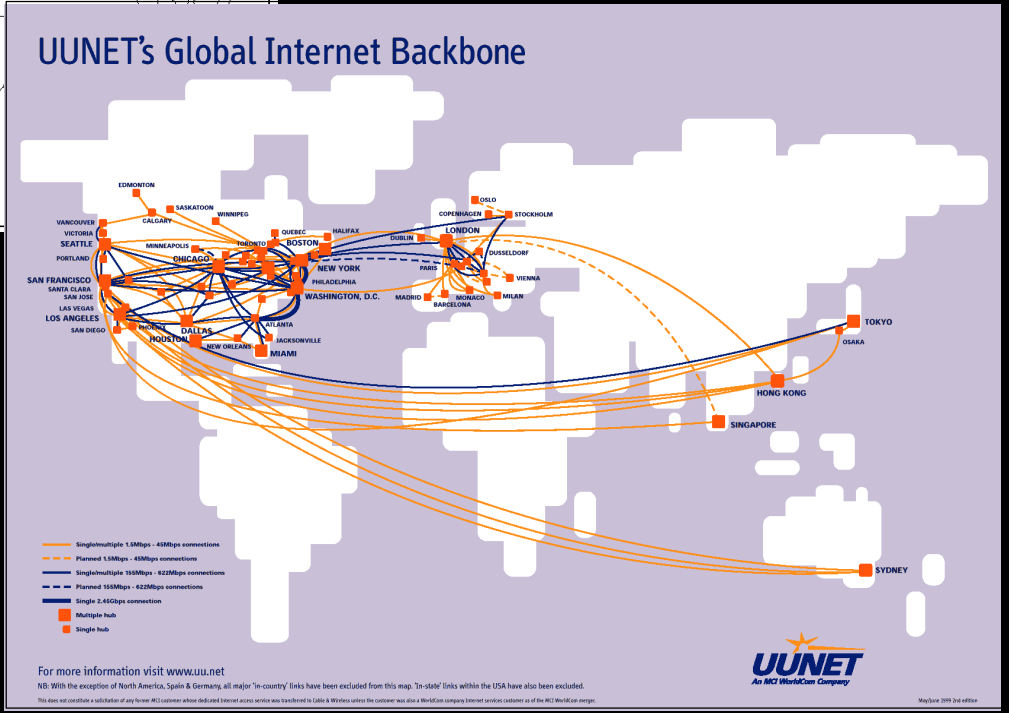


(source: Internet Archive, ARPANET documents)

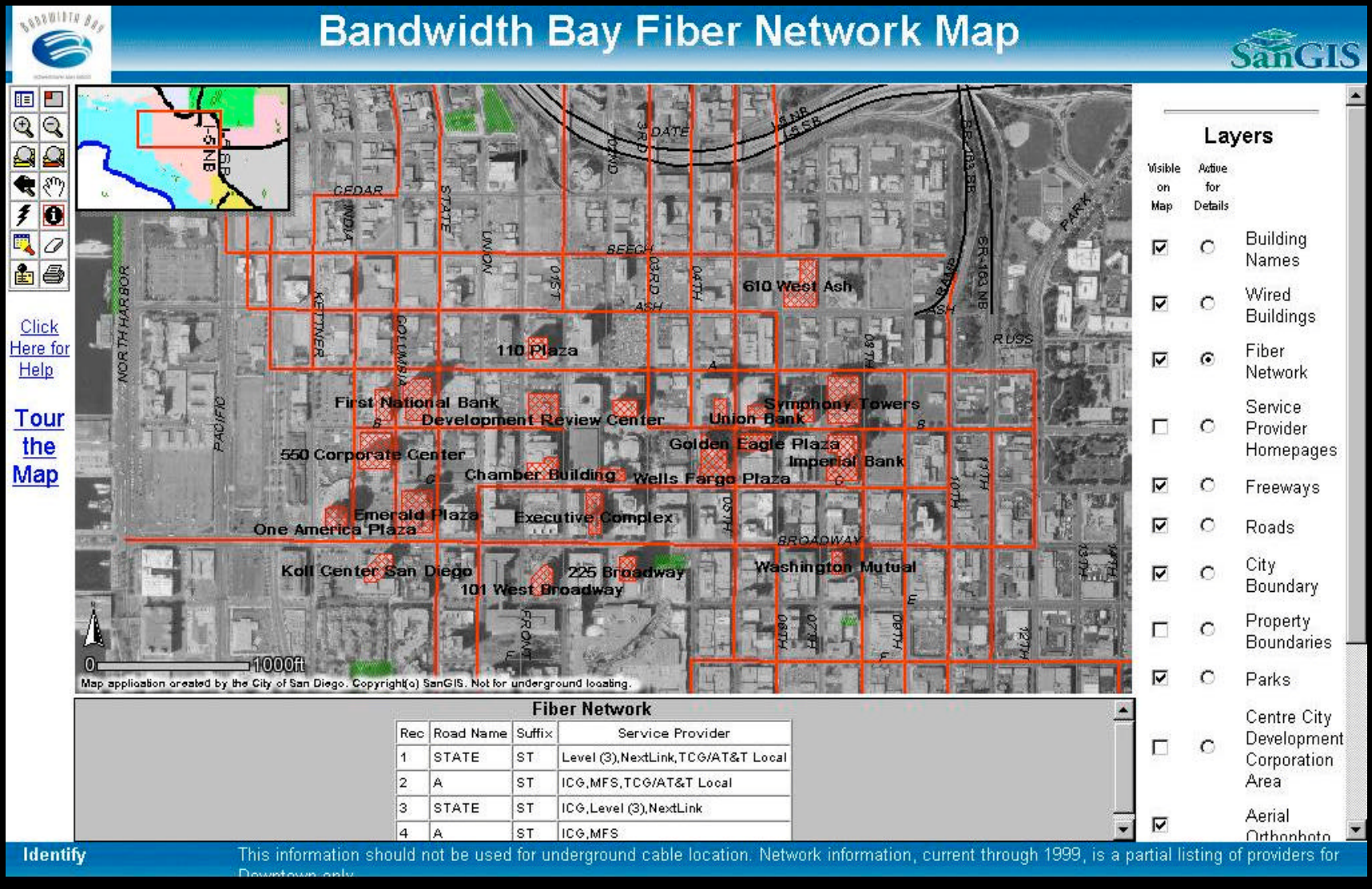

UUNET's North America Internet network
EDMONTON
VANCOUVER
VICTORIA
SASKATOON
CALGARY
REGINA
WINNIPEG
SEATTLE
PORTLAND
QUEBEC
HALIFAX
OTTAWA
MONTREAL
TORONTO
BOSTON
NEW YORK
PHILADELPHIA
CHICAGO
WASHINGTON, D.C.
SINGAPORE
OSAKA
SACRAMENTO
SAN FRANCISCO
SAN JOSE
SALT LAKE CITY
Denver
KANSAS CITY
ST. LOUIS
Indianapolis
Columbus
FAIRFAX
RICHMOND
Raleigh
HONG KONG
LOS ANGELES
Las Vegas
TOKYO
TOKYO
SYDNEY
San Diego
PHOENIX
ATLANTA
DALLAS
Austin
HOUSTON
New Orleans
Jacksonville
Orlando
TAMPA
MIAMI
SAN JUAN
HONOLULU
HAWAII
AMSTERDAM
FRANKFURT
LONDON
PARIS
LONDON
STOCKHOLM
LONDON
FRANKFURT
AMSTERDAM
T1/E1 (1.5 Mbps/2 Mbps)
T3/DS3 (45 Mbps)
OC3c/STM1 (155 Mbps)
OC12c (620 Mbps)
OC48c/STM16 (2.5 Gbps)
OC192c/STM64 (10 Gbps)
Single Hub City
Multiple Hubs City
For more information visit www.uu.net
NB: UUNET also has infrastructure within individual countries, which is not shown on this map.
June 2000
UUNET
A WorldCom Company

Backbone marketing maps

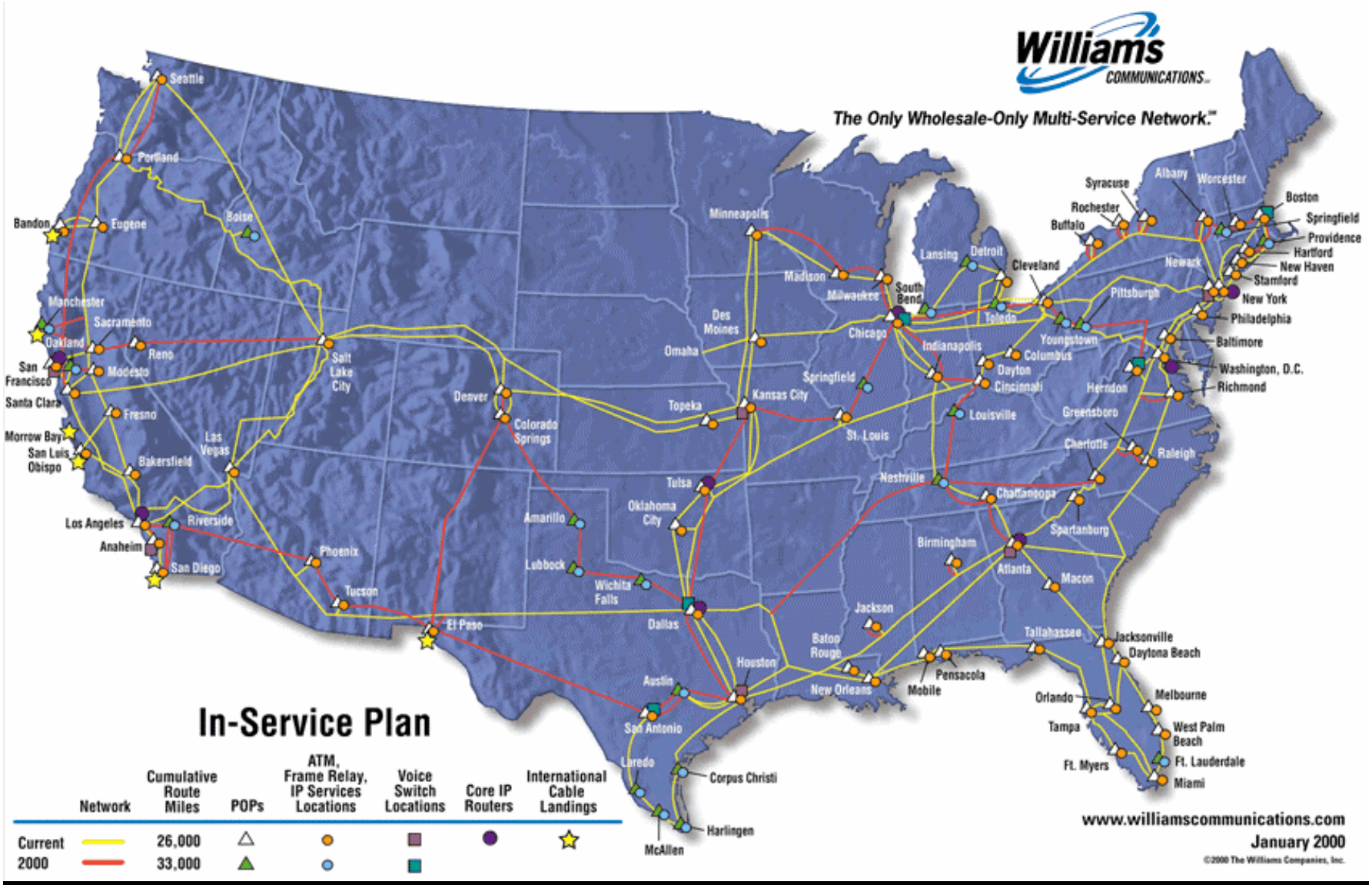




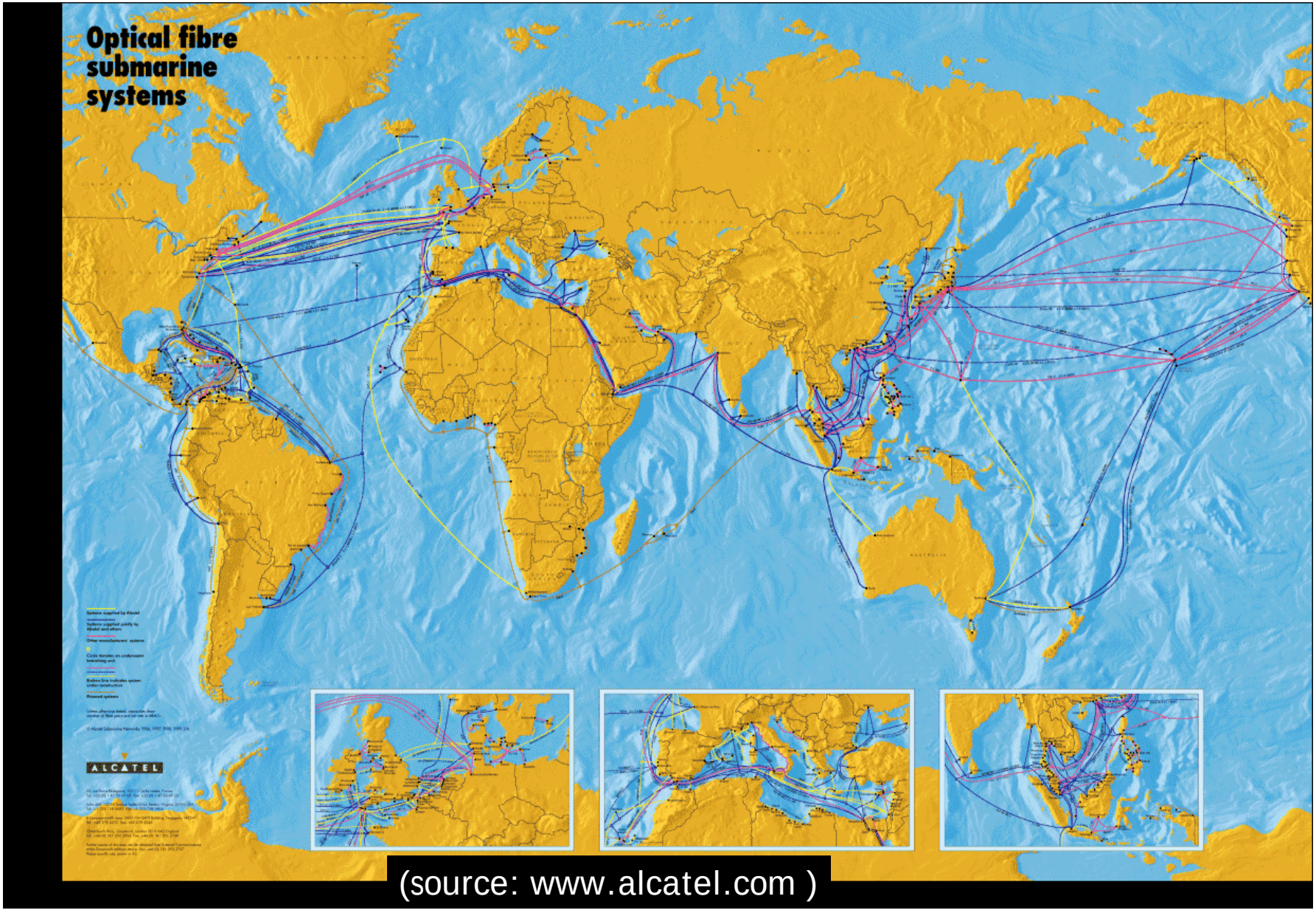
(source: www.uu.net)



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

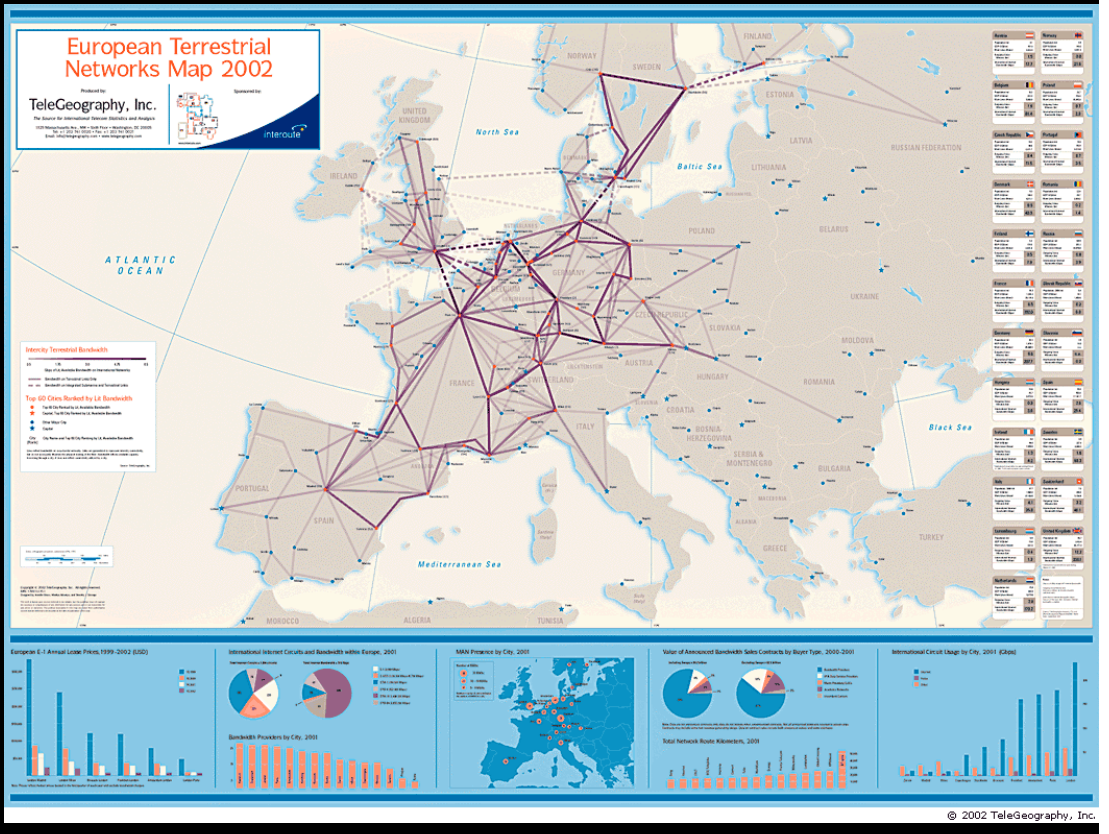


(source: www.williamscommunications.com)


Optical fibre submarine systems
ALCATEL
(source: www.alcatel.com)

Maps for market research

www.kmicorp.com



www.telegeography.com

Bye, bye to the geographic world

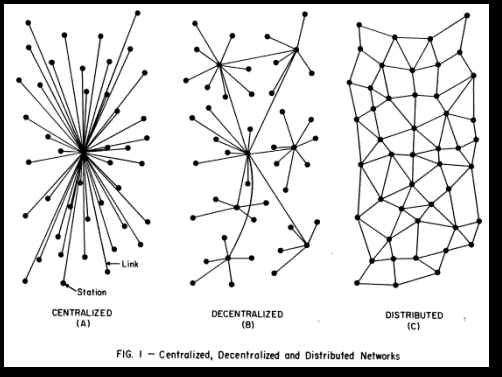
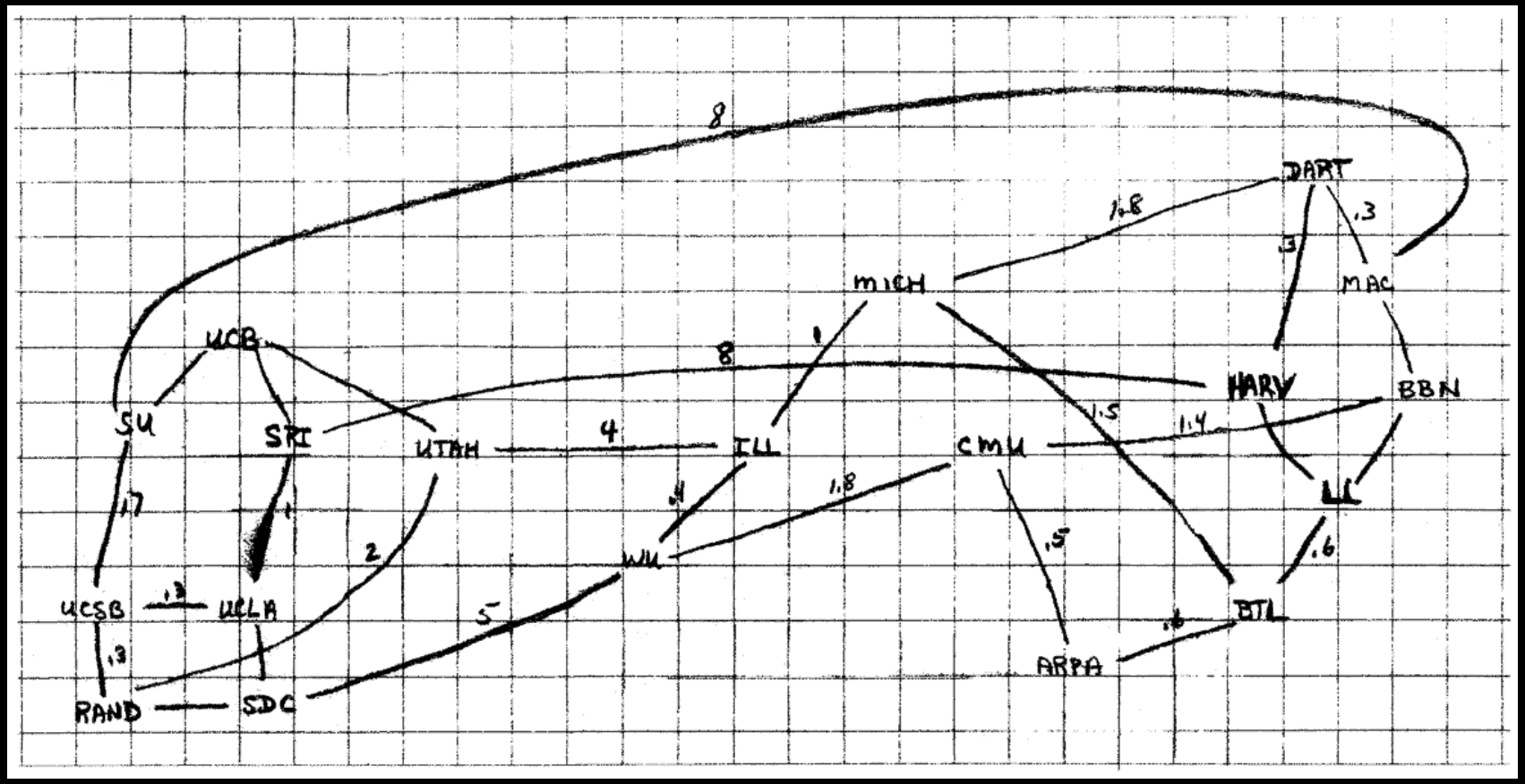


FIG. 1 — Centralized, Decentralized and Distributed Networks

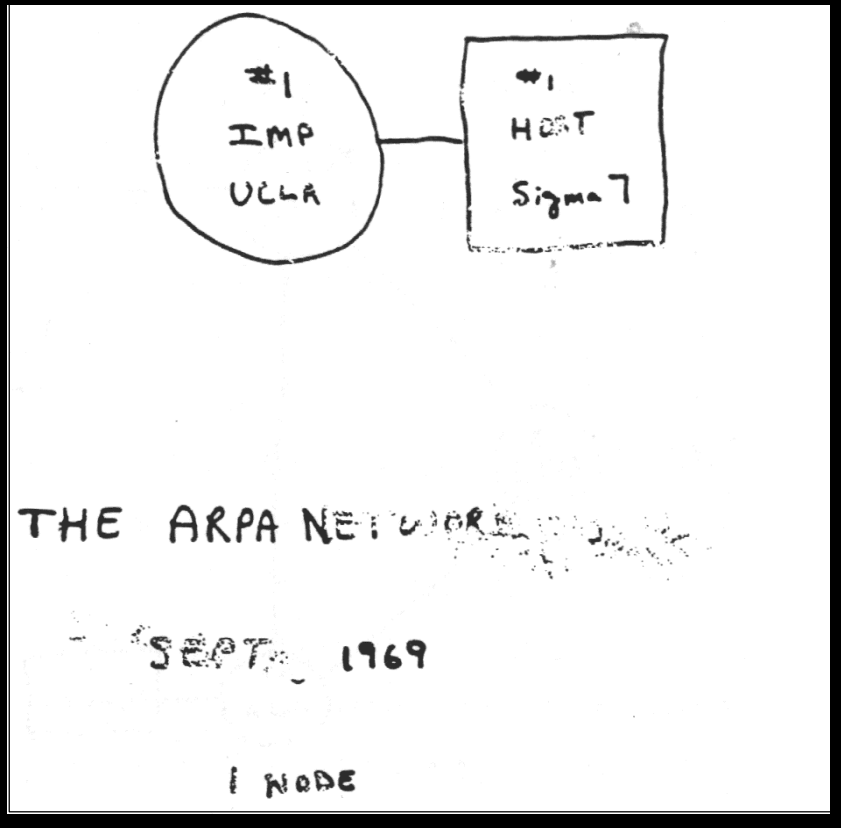
- focus is on topology, not geography
- Internet engineers don't care about where things are, but how they are logically connected
- wiring diagrams rather than maps

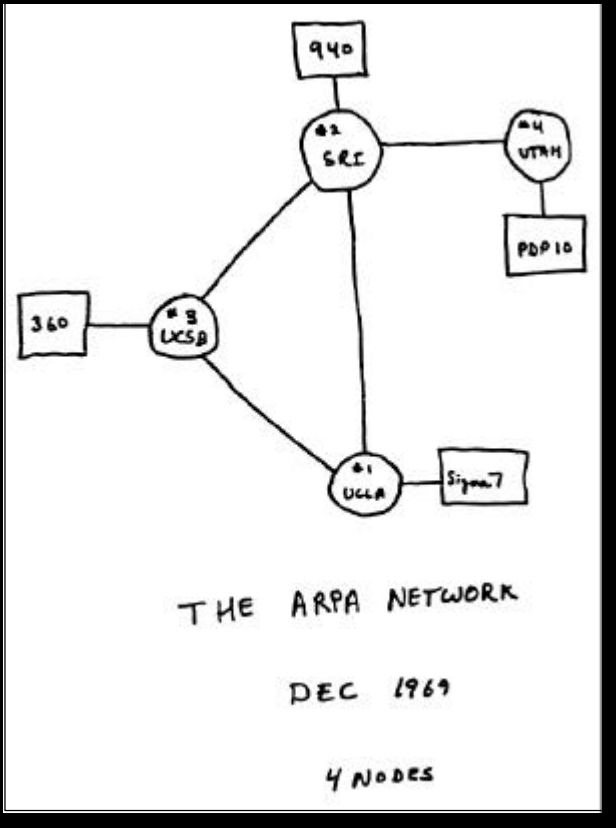
Sketch maps for net planners



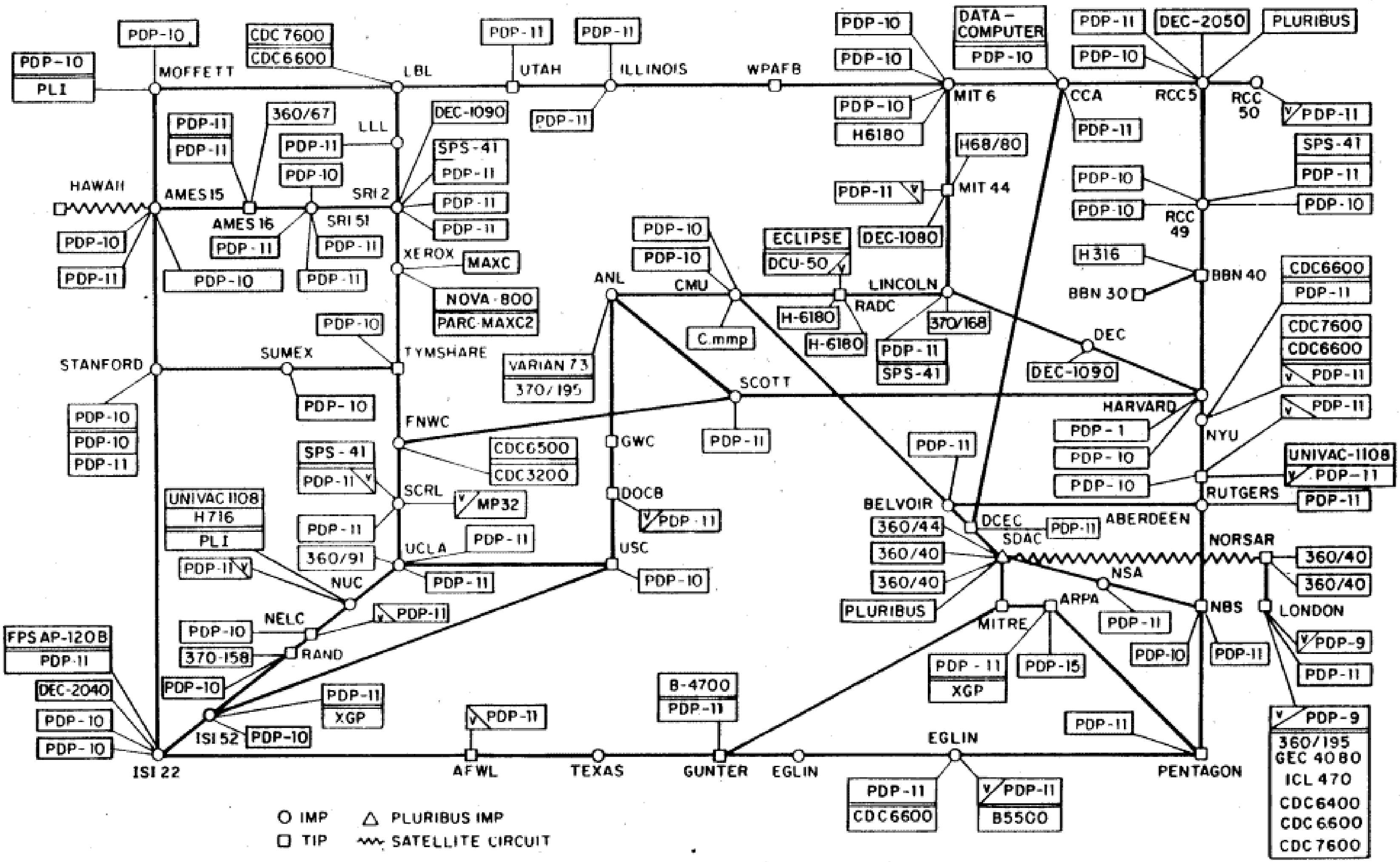
Larry Roberts (source: from ‘Where Wizards Stay up Late’ book)

Birth of the net on the back of the envelope





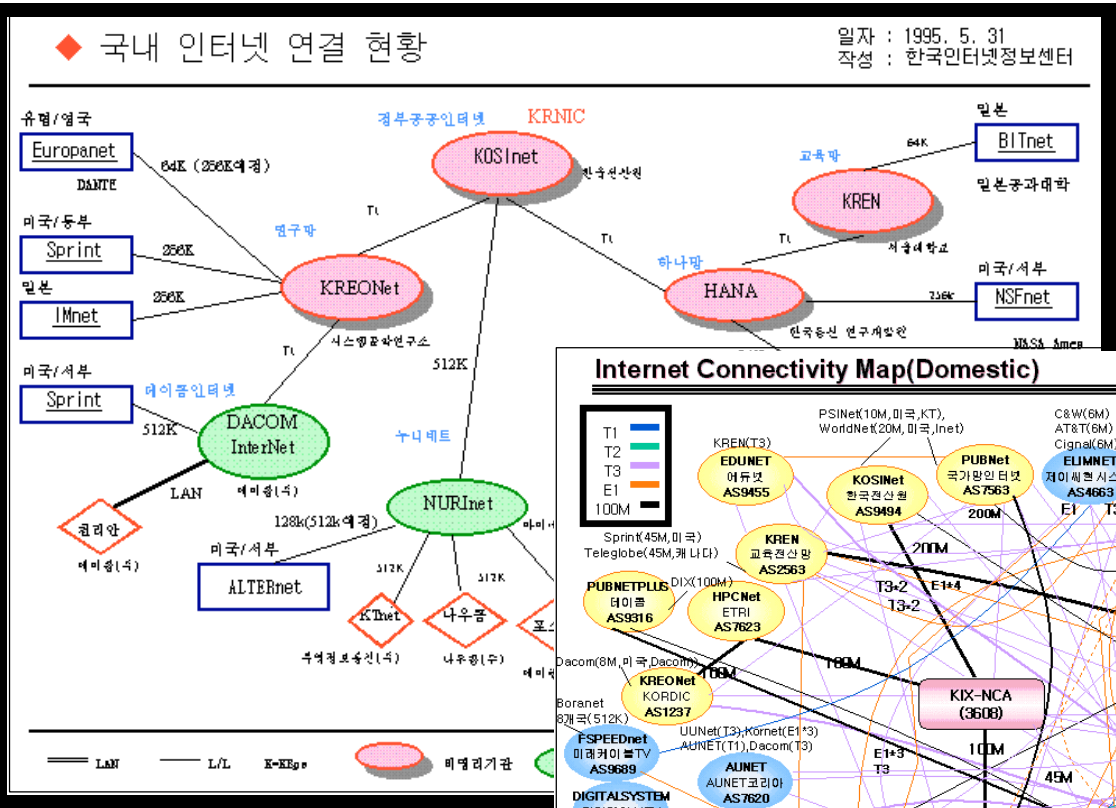
ARPANET LOGICAL MAP, MARCH 1977

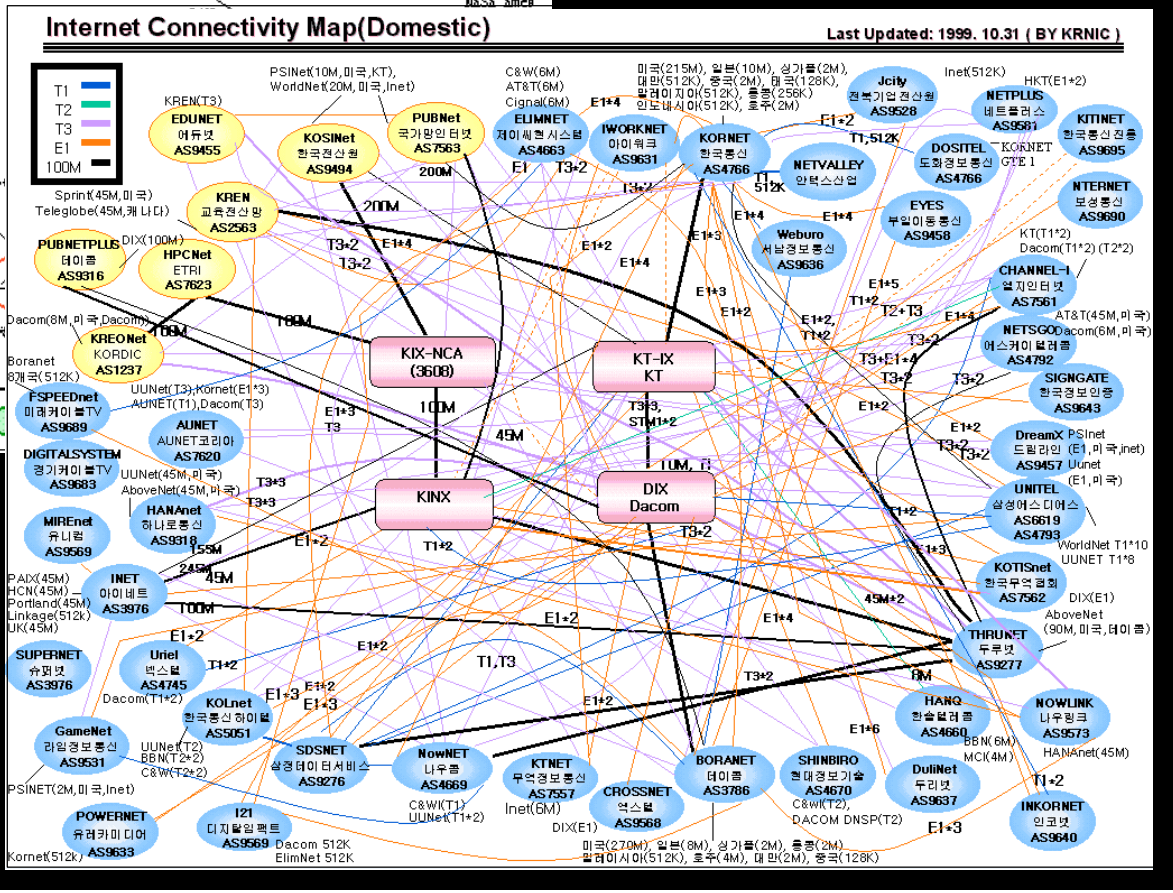


(PLEASE NOTE THAT WHILE THIS MAP SHOWS THE HOST POPULATION OF THE NETWORK ACCORDING TO THE BEST INFORMATION OBTAINABLE, NO CLAIM CAN BE MADE FOR ITS ACCURACY)

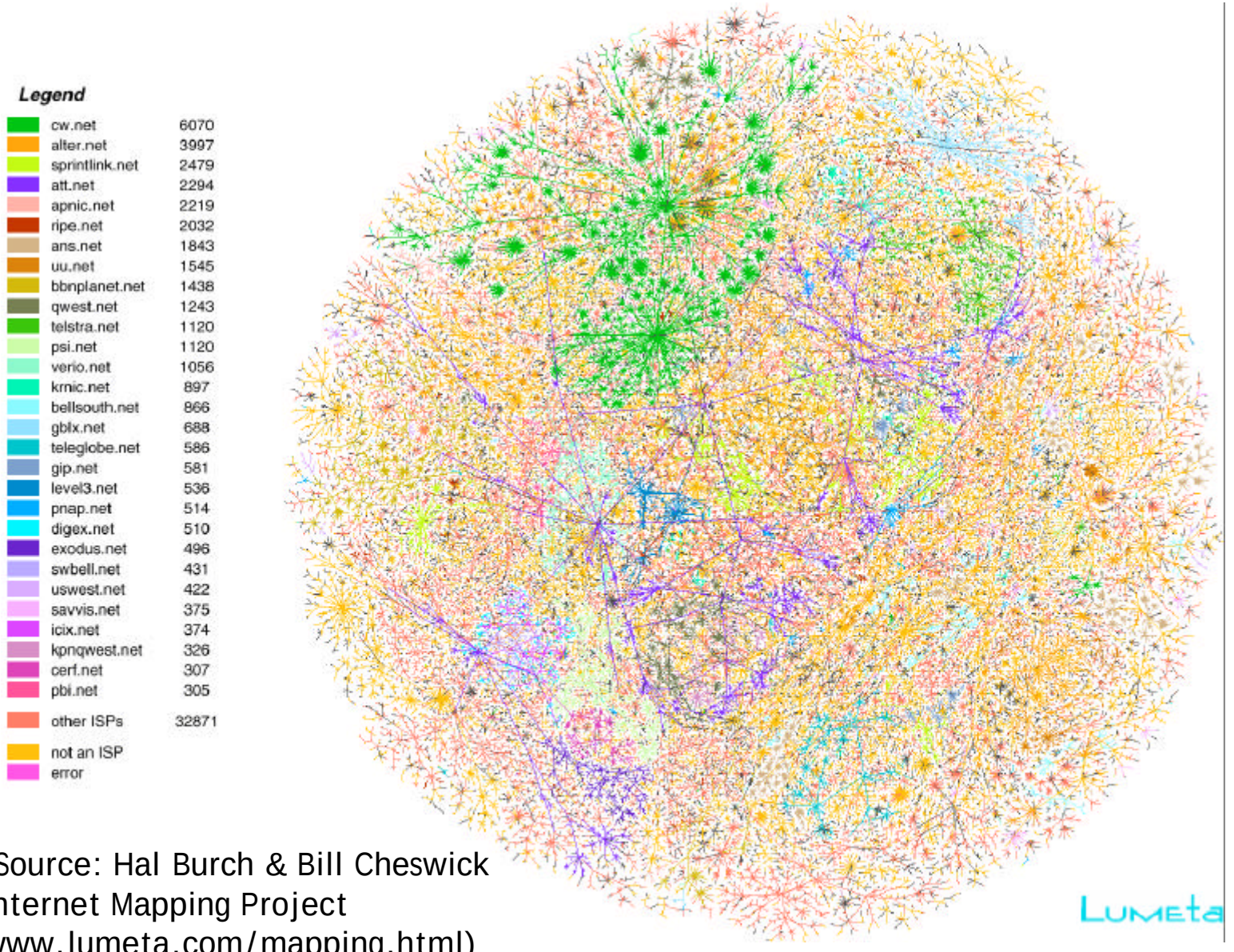
NAMES SHOWN ARE IMP NAMES, NOT (NECESSARILY) HOST NAMES

Korean internet topology

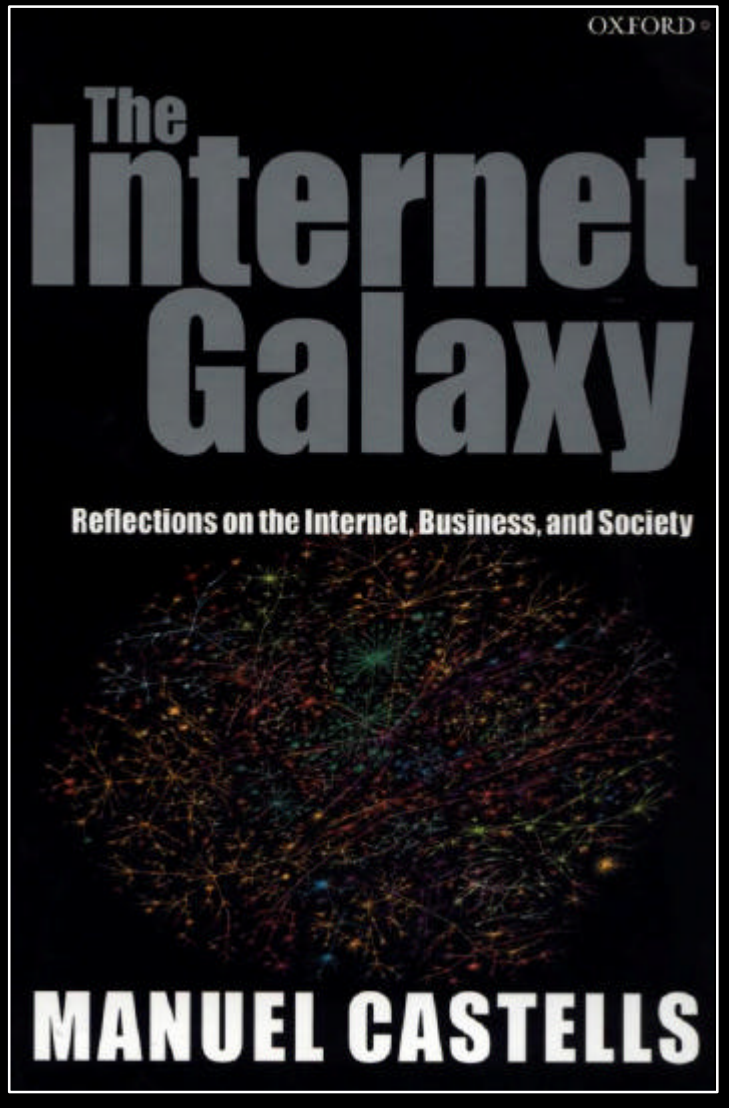


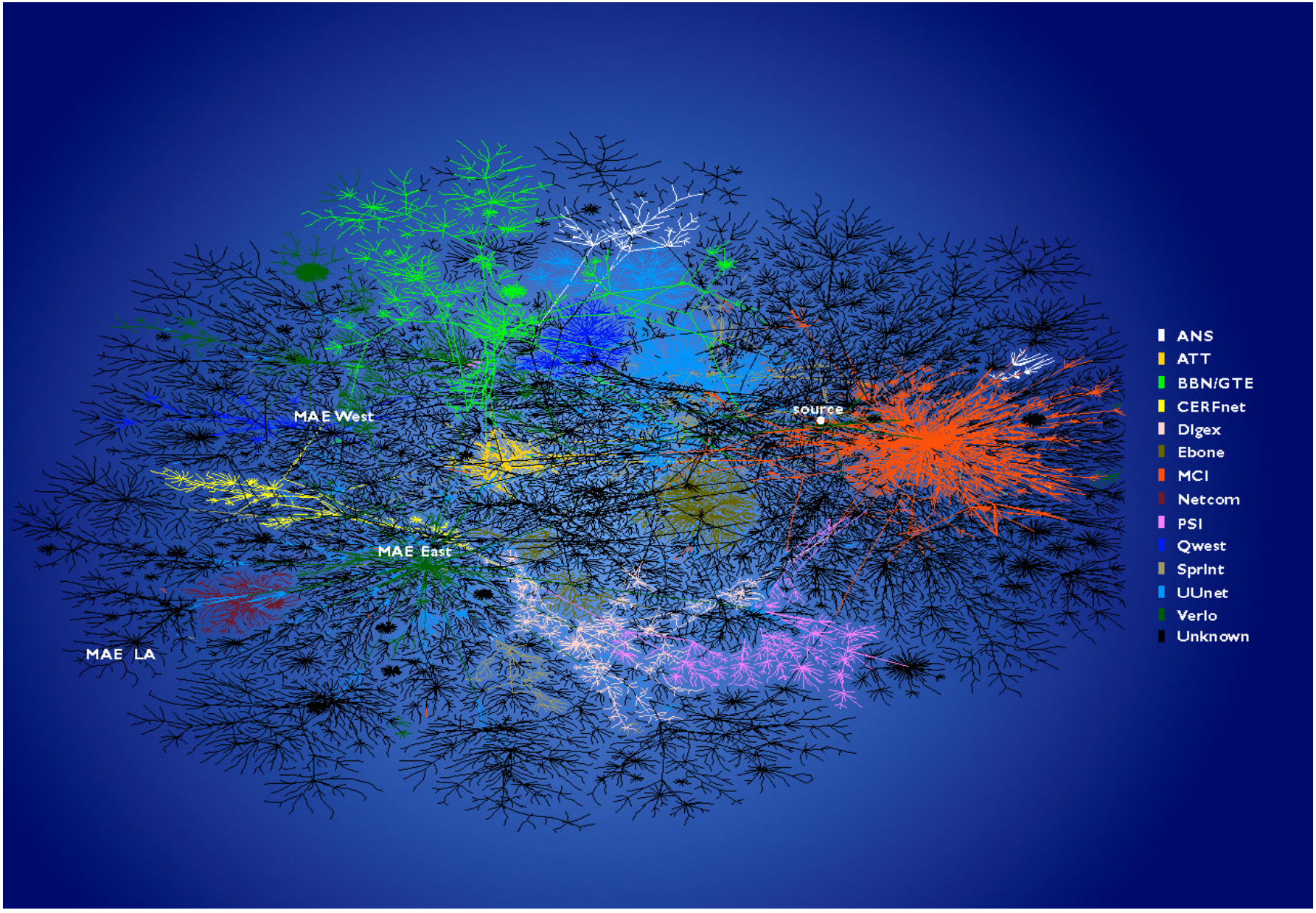


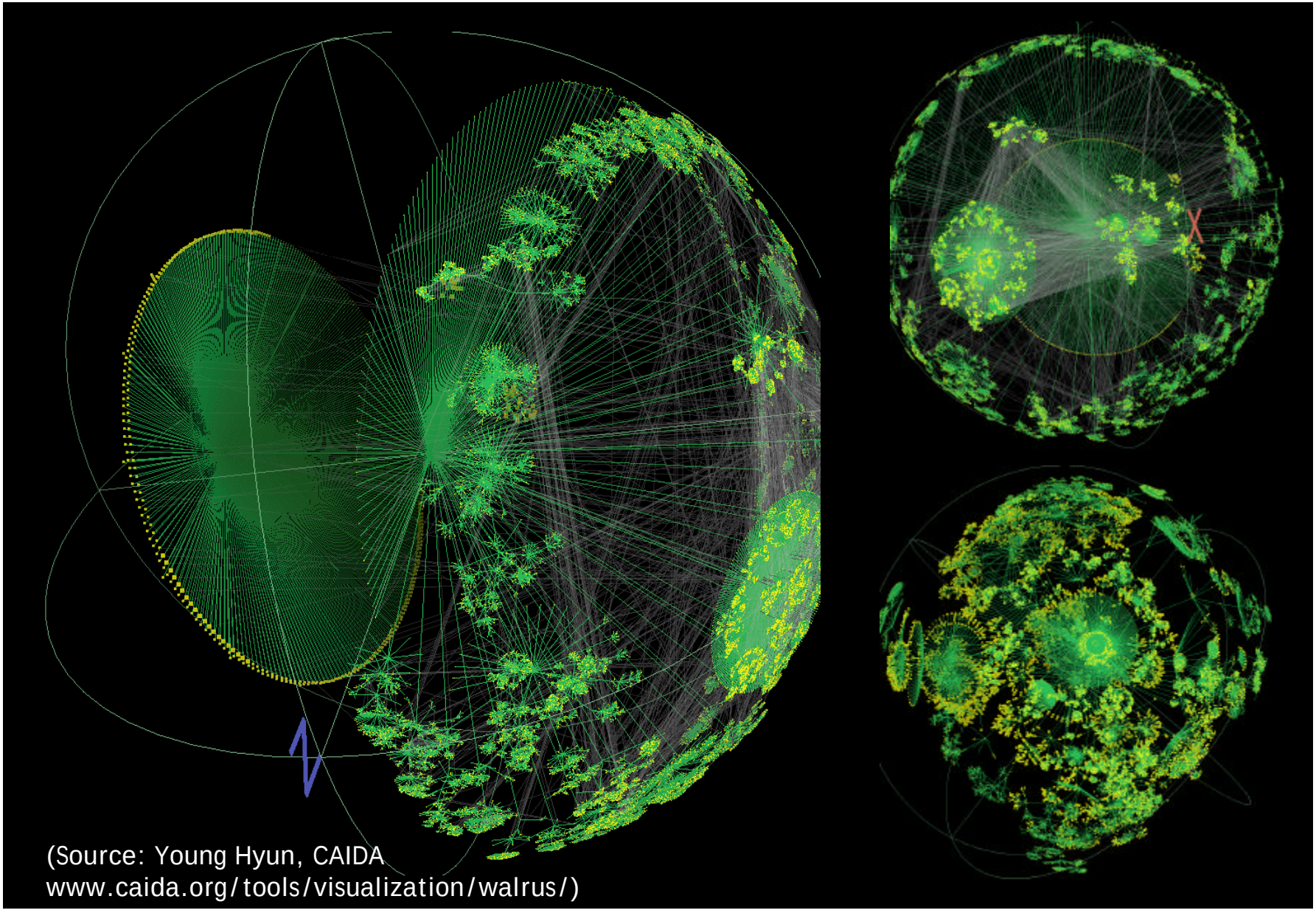
(Source: KR-NIC
http://stat.nic.or.kr)



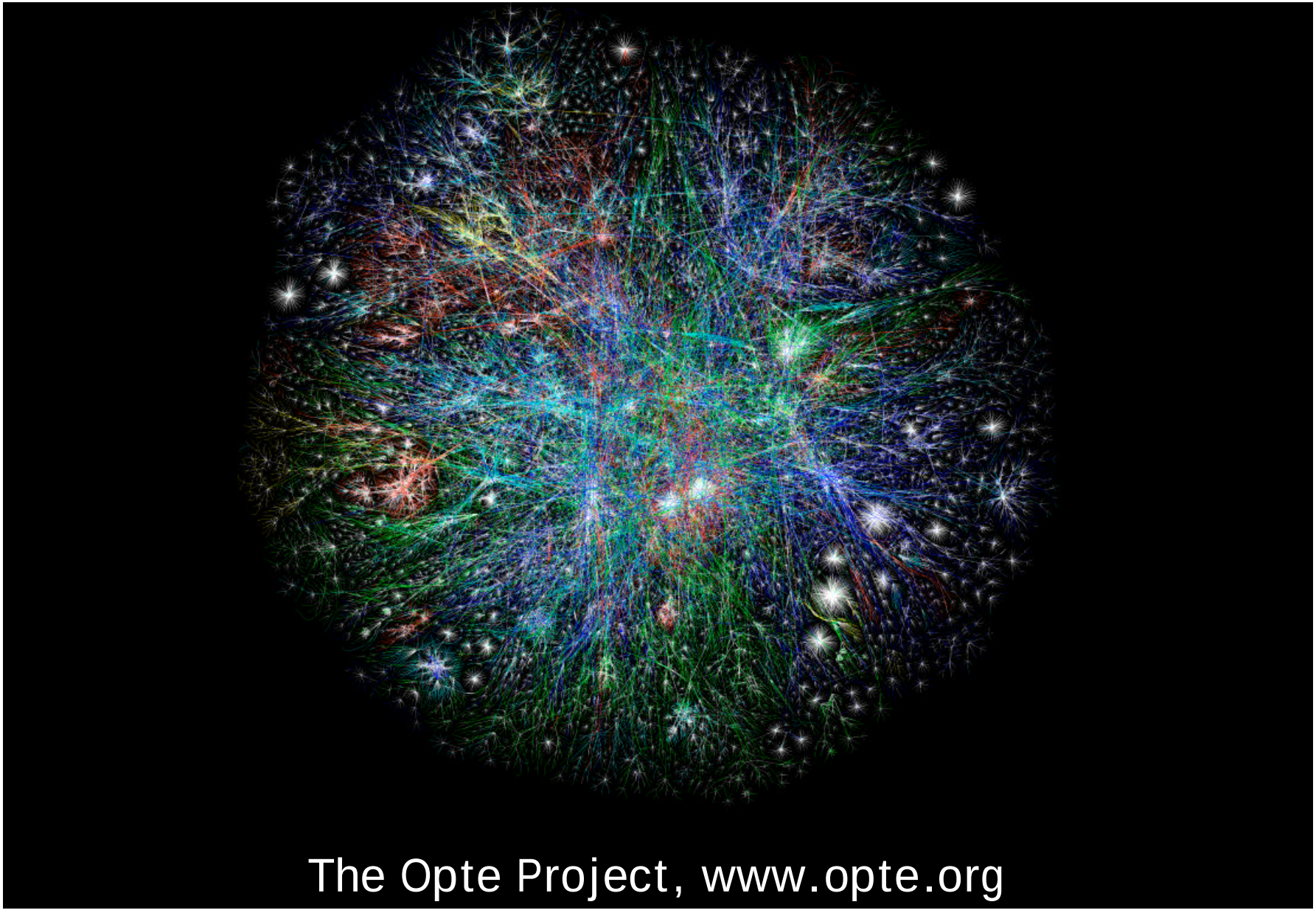
(Source: Hal Burch & Bill Cheswick
Internet Mapping Project
www.lumeta.com/mapping.html)


OXFORD
The Internet Galaxy
Reflections on the Internet, Business, and Society
MANUEL CASTELLS


MAE West
MAE East
MAE LA
source
ANS
ATT
BBN/GTE
CERFnet
Digex
Ebone
MCI
Netcom
PSI
Qwest
Sprint
UUnet
Verio
Unknown

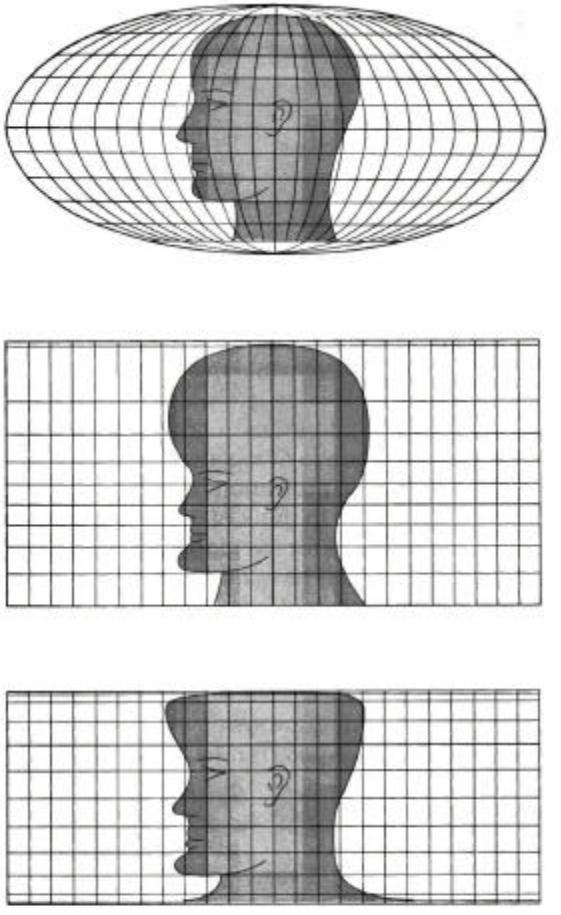


(Source: Young Hyun, CAIDA
www.caida.org/tools/visualization/walrus/)


The Opte Project, www.opte.org

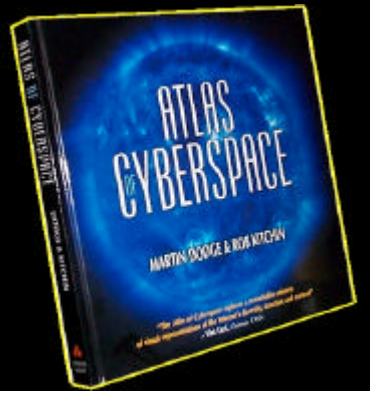
Distortion and deception "how to lie with maps"

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



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