

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/

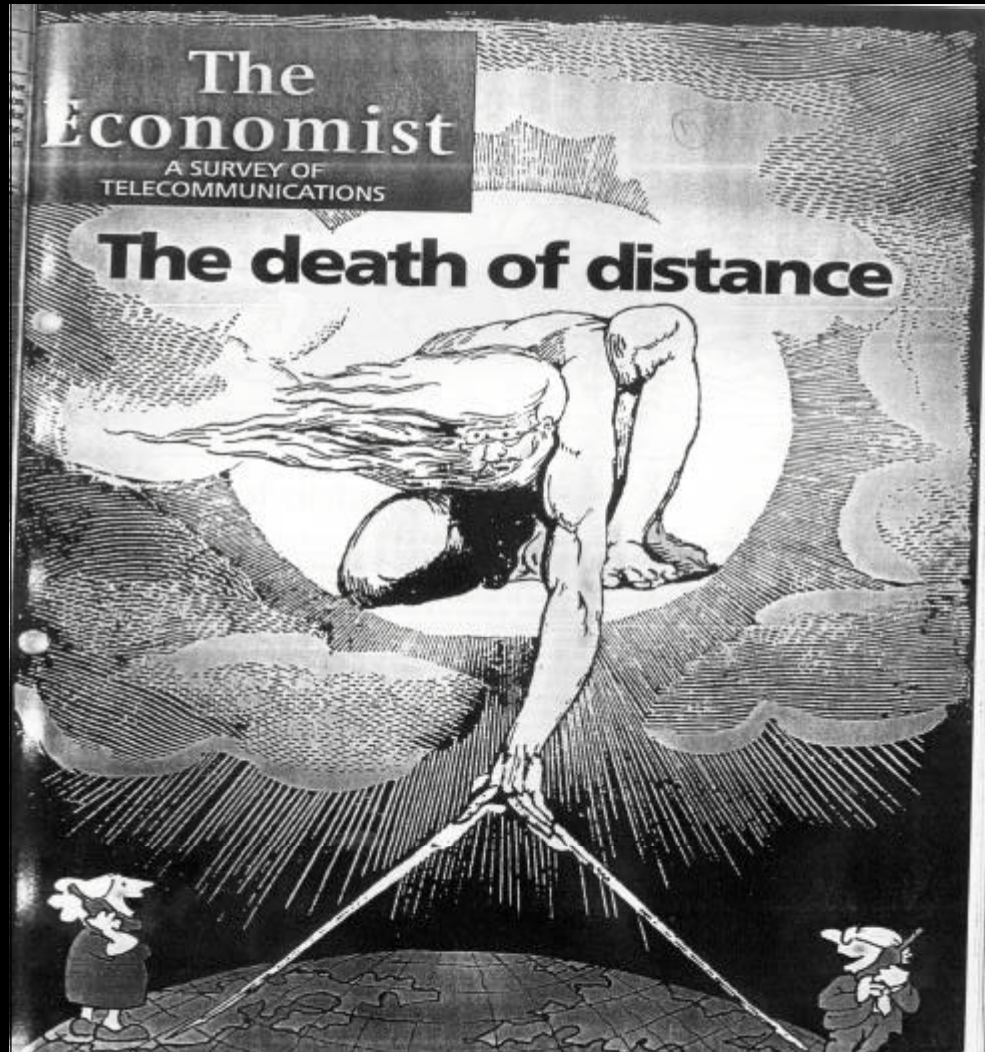
Is there a geography of cyberspace?

Bits, not atoms

Spaceless space

anything,
anytime,
anywhere

End of
Geography



Cyberspace
is everywhere
and nowhere

friction-free
economy

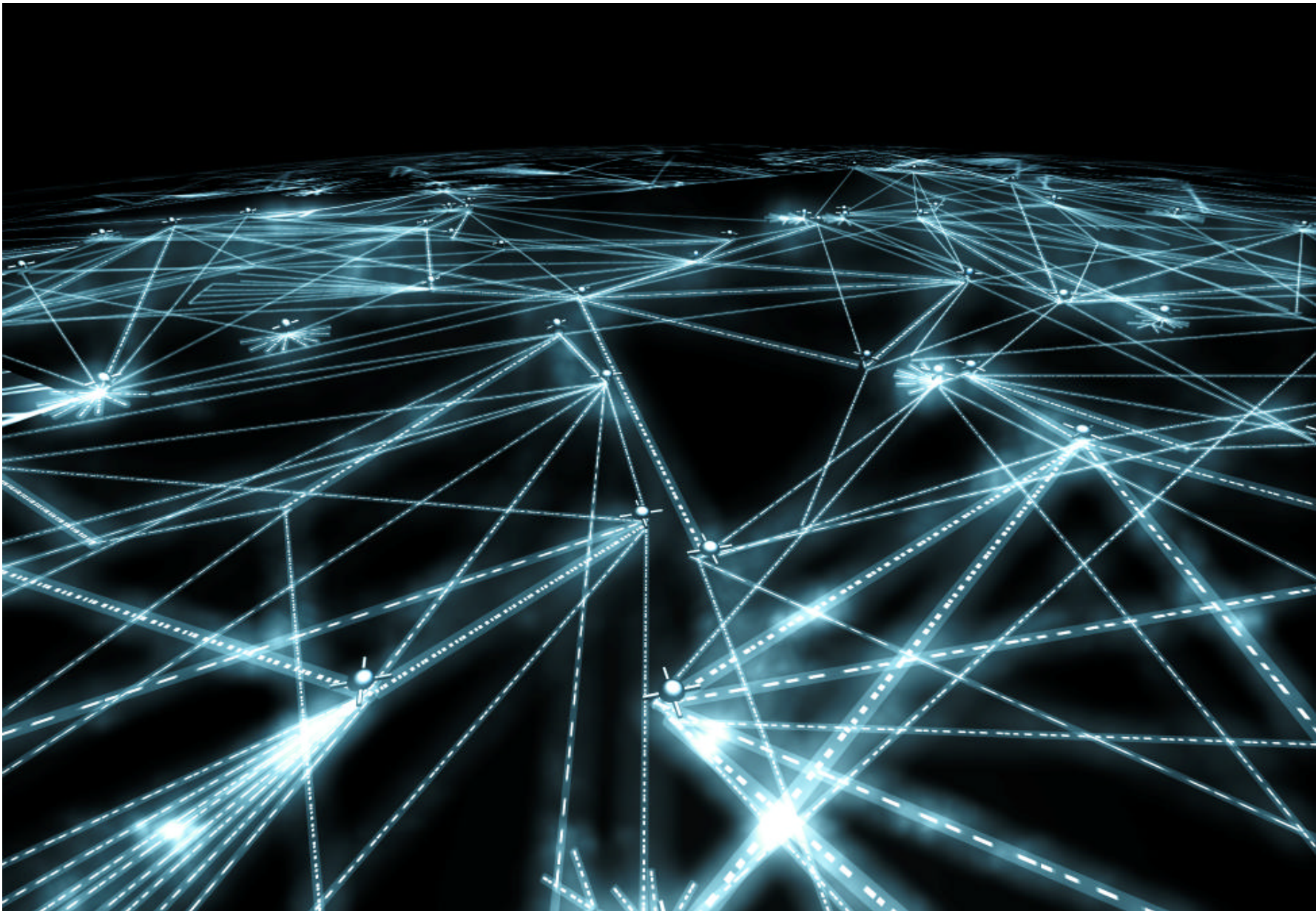
Cities dissolve

*Weightless
World*

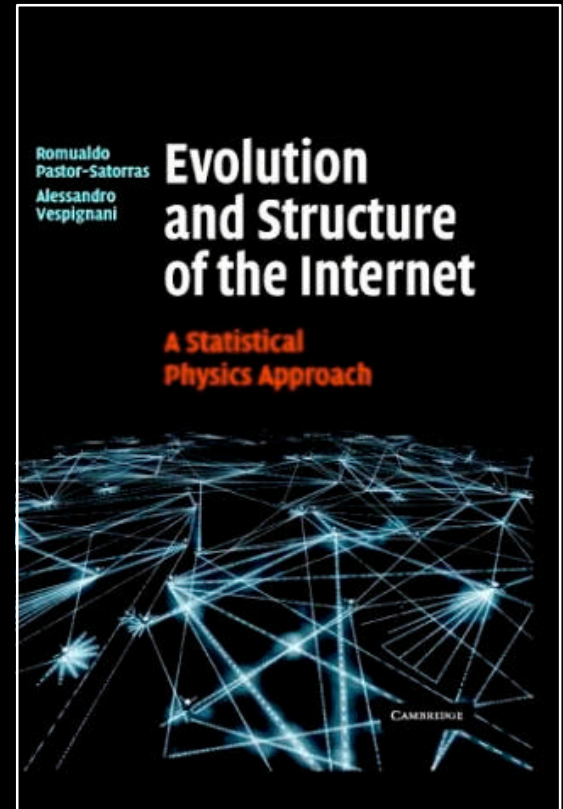
30th September 1995

Aesthetics -> governance -> stories
maps make space

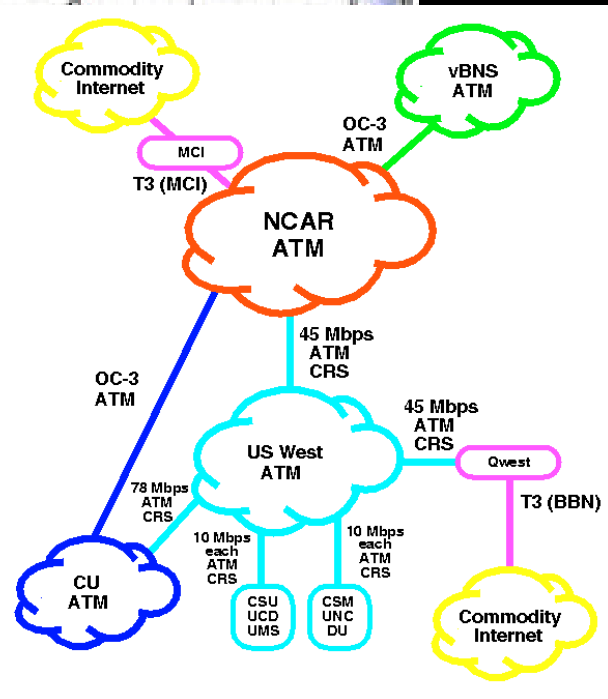
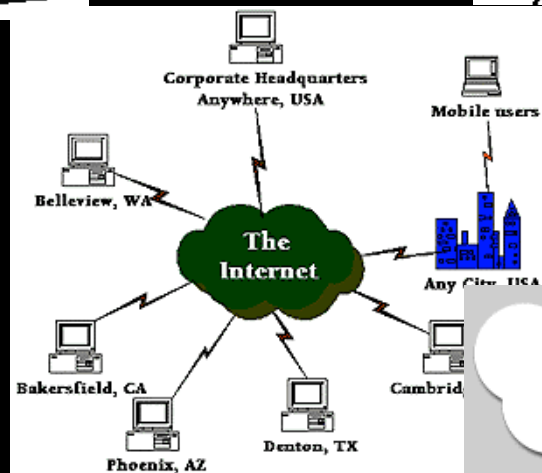
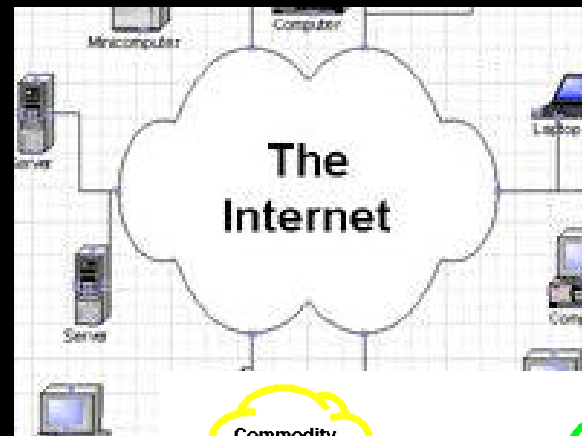
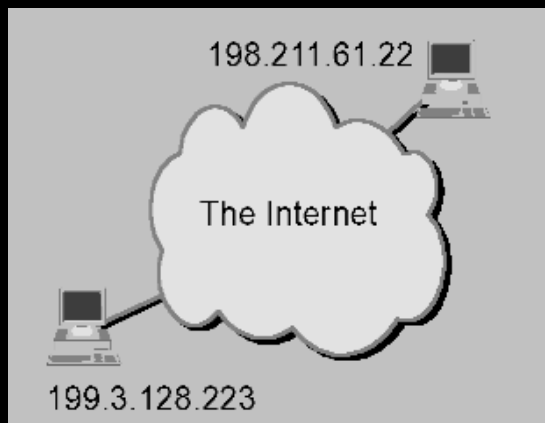


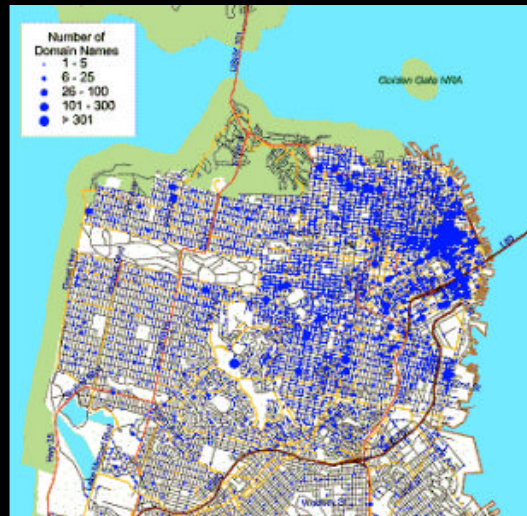


Maps and imagination



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





Maps let us look inside the cloud

My definition of 'map'

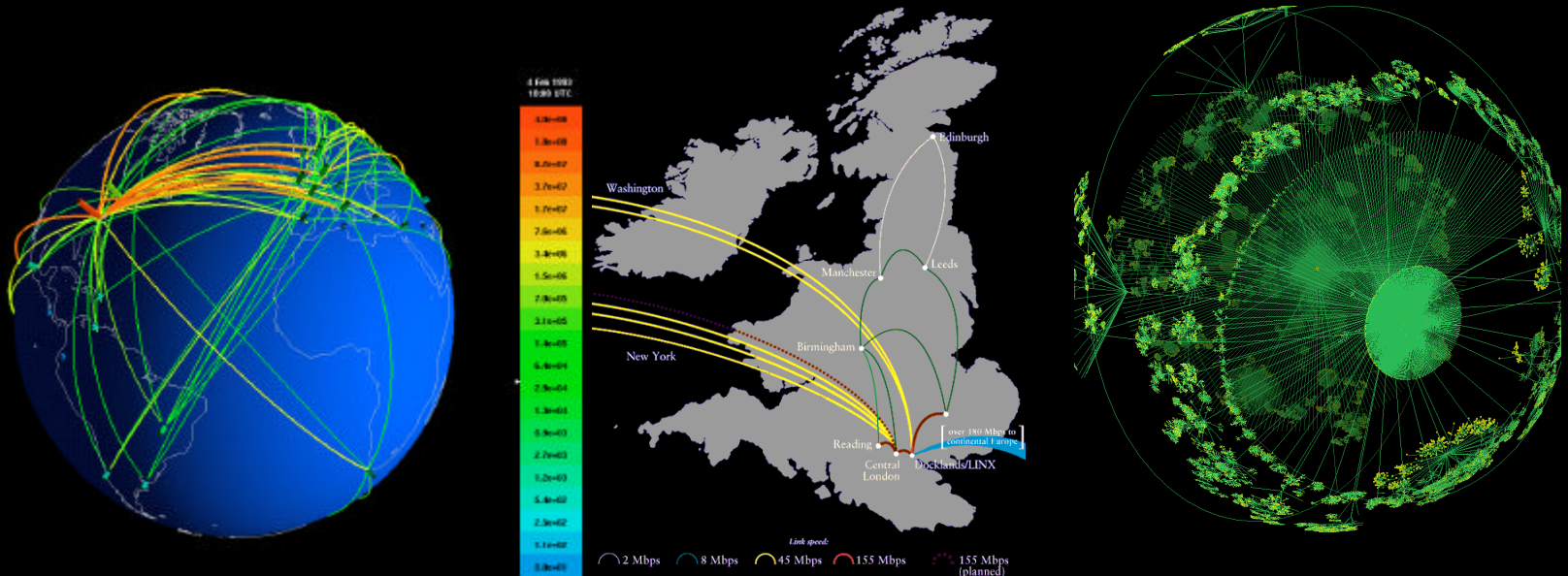
- half of your examples are not even maps!
- "maps are graphic representations that facilitate a spatial understanding of things, concepts, conditions, processes, or events in the human world"

(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!

Ordance 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

cycle for life CANCER RESEARCH UK

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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

Search Results for "map of the internet"

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

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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.

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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'



Save Up To 70%

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AGE	MALE	FEMALE	MALE	FEMALE
35	\$10.22	\$9.14	\$16.10	\$13.92
45	\$18.49	\$15.44	\$32.63	\$26.54

Sample rates as submitted by First Plus Pacific Life Insurance Company

CLICK NOW FOR
THE BEST RATES!

ReliaQuote
A Division of Relia Life Insurance Company

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Sign Up: Free Daily Tech E-letter

Technology Home

WashTech

Tech Policy

- Copyright
- Cybercrime
- E-Taxes
- FCC
- ICANN
- Security

Government IT

Markets

Columnists

Personal Tech

Special Reports

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washingtonpost.com

More News

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Get Mortgage
Rates from over

80

Local Lenders!

Loans Below
\$322,700

Loans Above
\$322,700

Dissertation Could Be Security Threat

Student's Maps Illustrate Concerns About Public Information

By Laura Blumenfeld

Washington Post Staff Writer

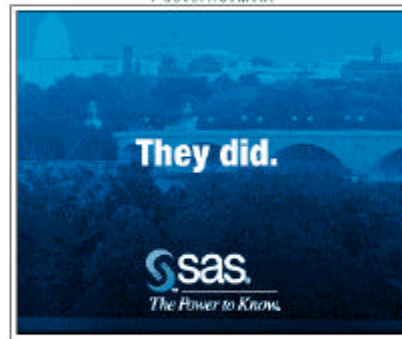
Tuesday, July 8, 2003, Page A01

Sean Gorman's professor called his dissertation "tedious and unimportant." Gorman didn't talk about it when he went on dates because "it was so boring they'd start staring up at the ceiling." But since the Sept. 11, 2001, attacks, Gorman's work has become so compelling that companies want to seize it, government officials want to suppress it, and al Qaeda operatives -- if they could get their hands on it -- would find a terrorist treasure map.

Tinkering on a laptop, wearing a rumpled T-shirt and a soul patch goatee, this George Mason University graduate student has mapped every business and industrial sector in the American economy, layering on top the fiber-optic network that connects them.

He can click on a bank in Manhattan and see who has communication lines running into it and where. He can zoom in on Baltimore and find the choke point for trucking warehouses. He can drill into a

advertisement



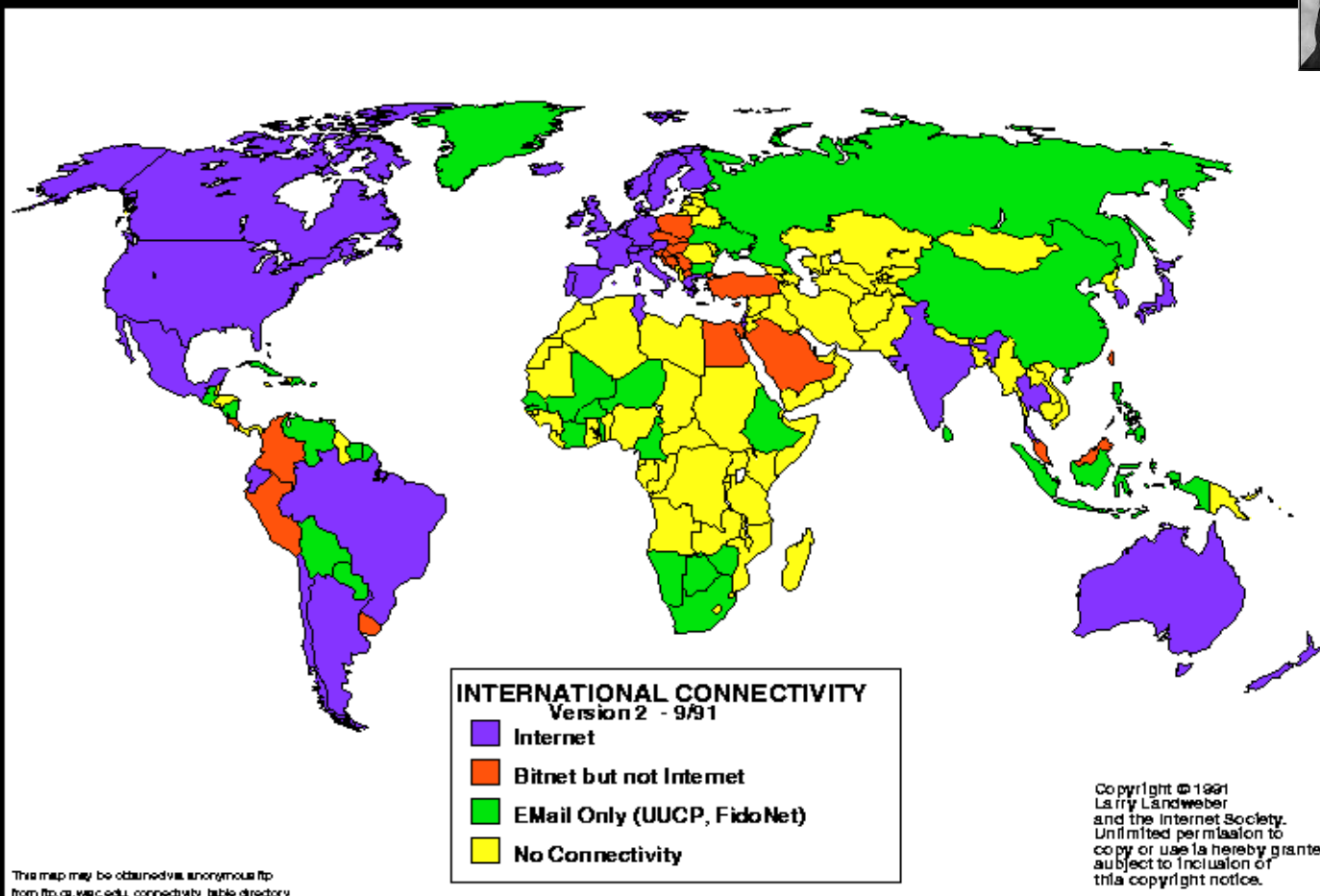
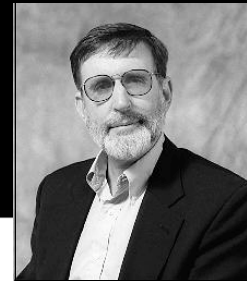
enlarge photo

Sean Gorman's program can map critical infrastructure in cities (Andrea Bruce Woodall - The Washington Post)

Statistical mapping:

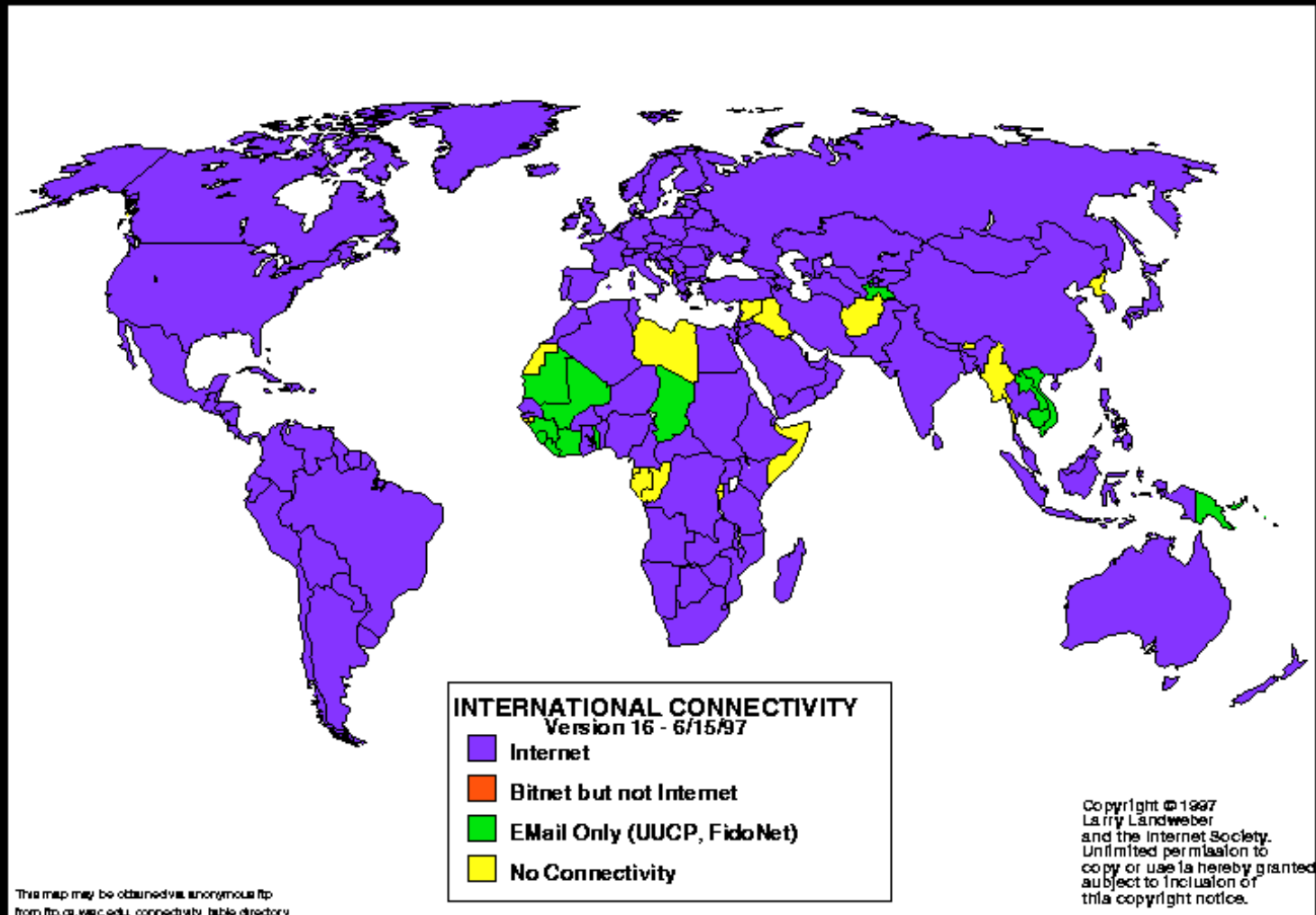
- statistical maps by shading area or continuous grids
- dot mapping and proportional symbols
- line mapping

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



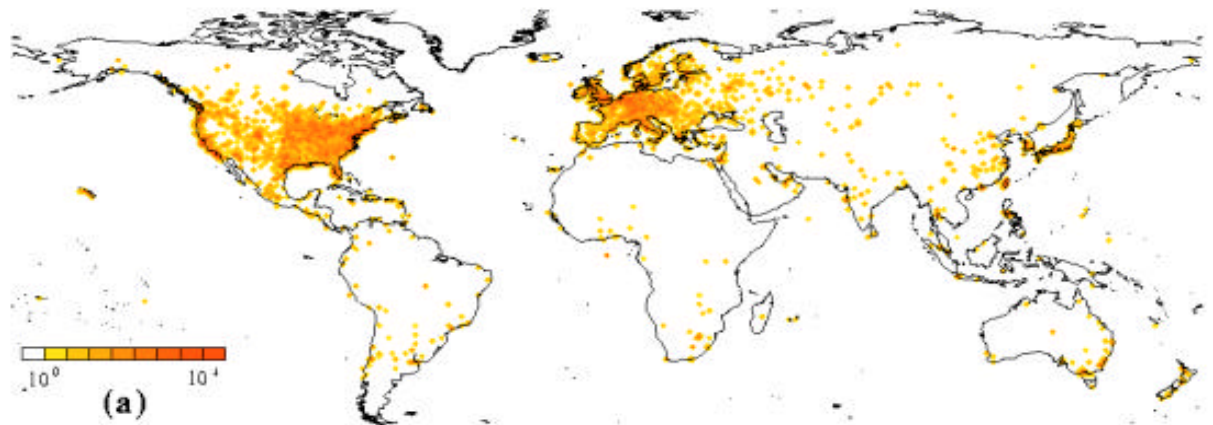
(<http://www.cs.wisc.edu/~lhl/maps/>)

the whole world now pretty much wired??

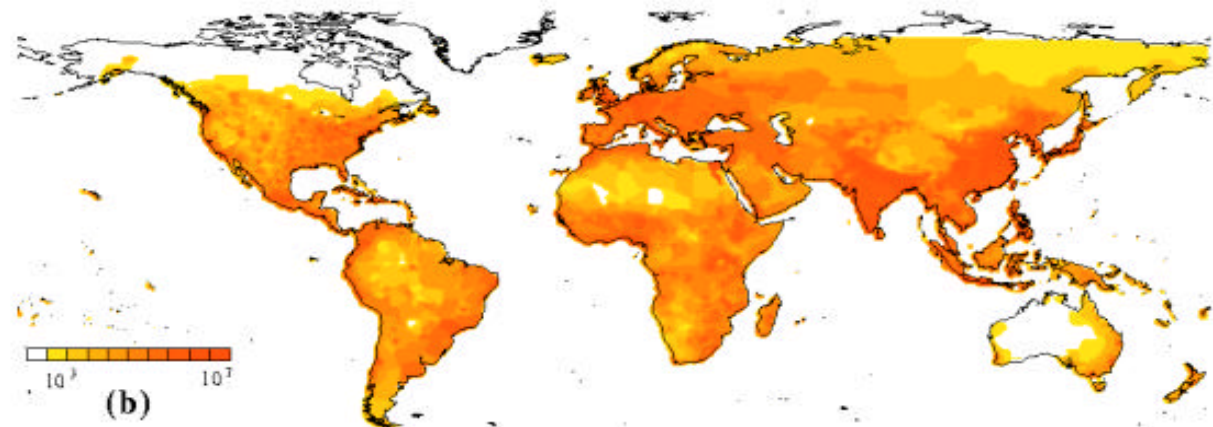


Geographic density of Internet routers

Router
density

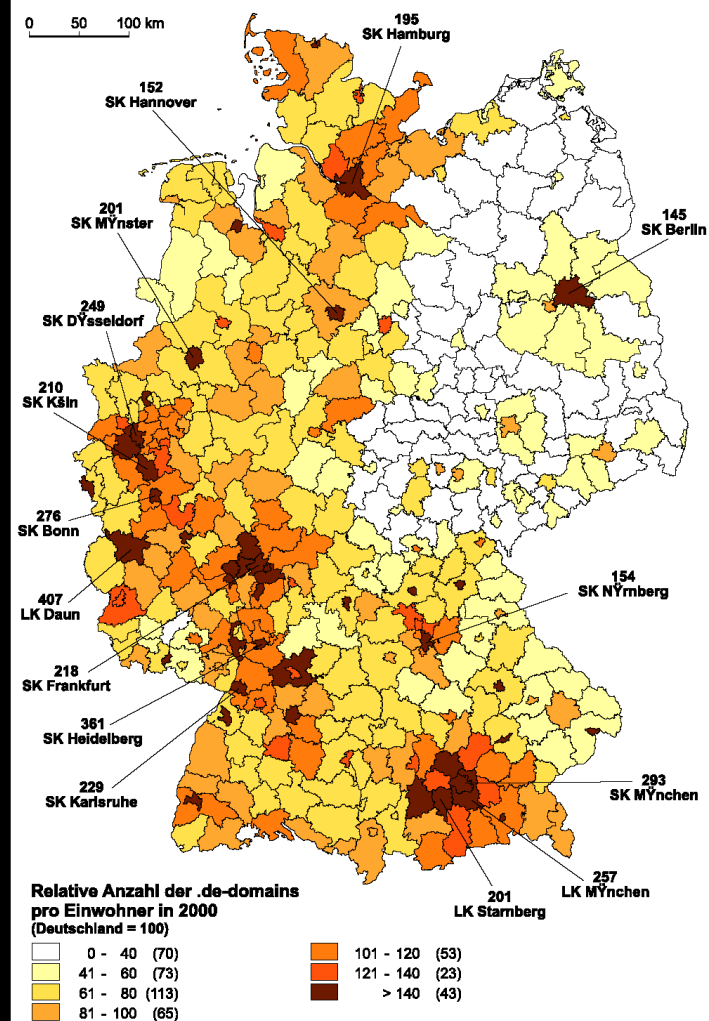


Population
density



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

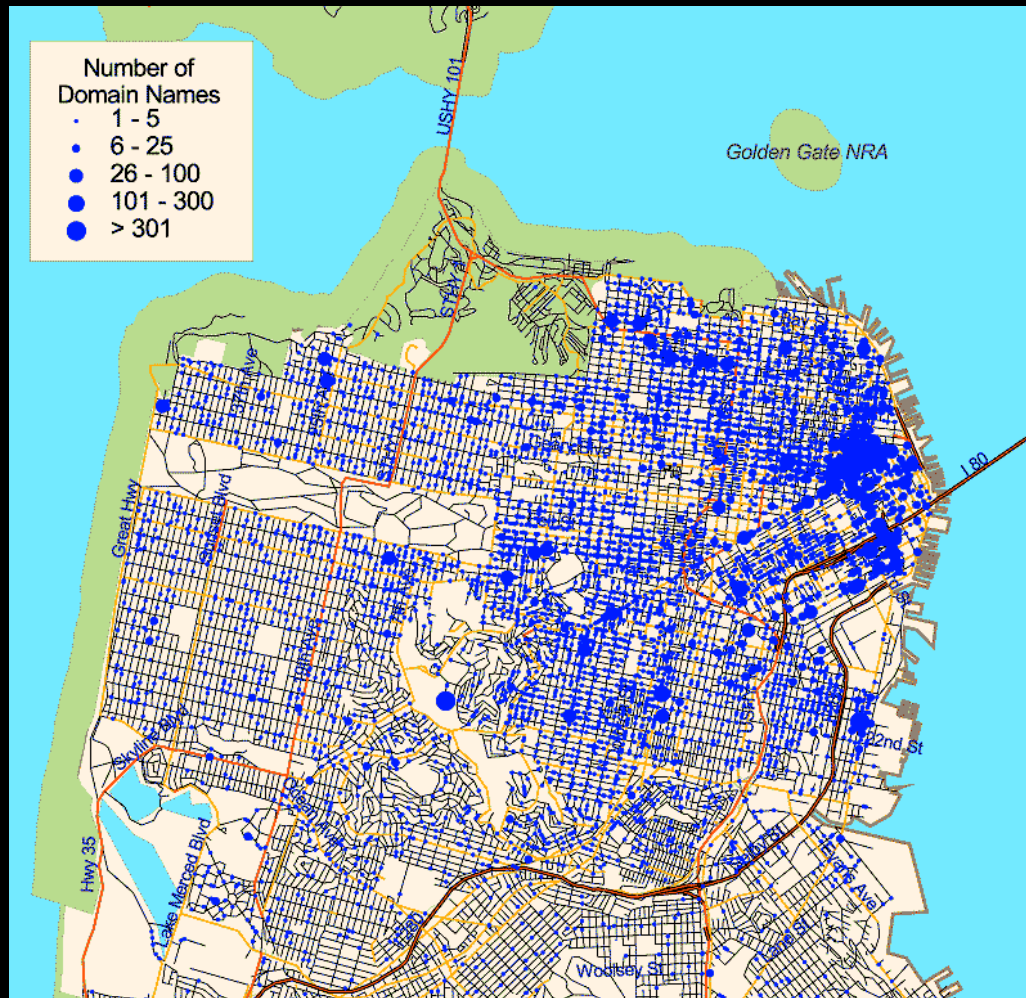
**Relative Anzahl der .de-domains pro Einwohner in 2000
(Deutschland = 100)**



Domain name geography
analysis by Mark Krymalowski

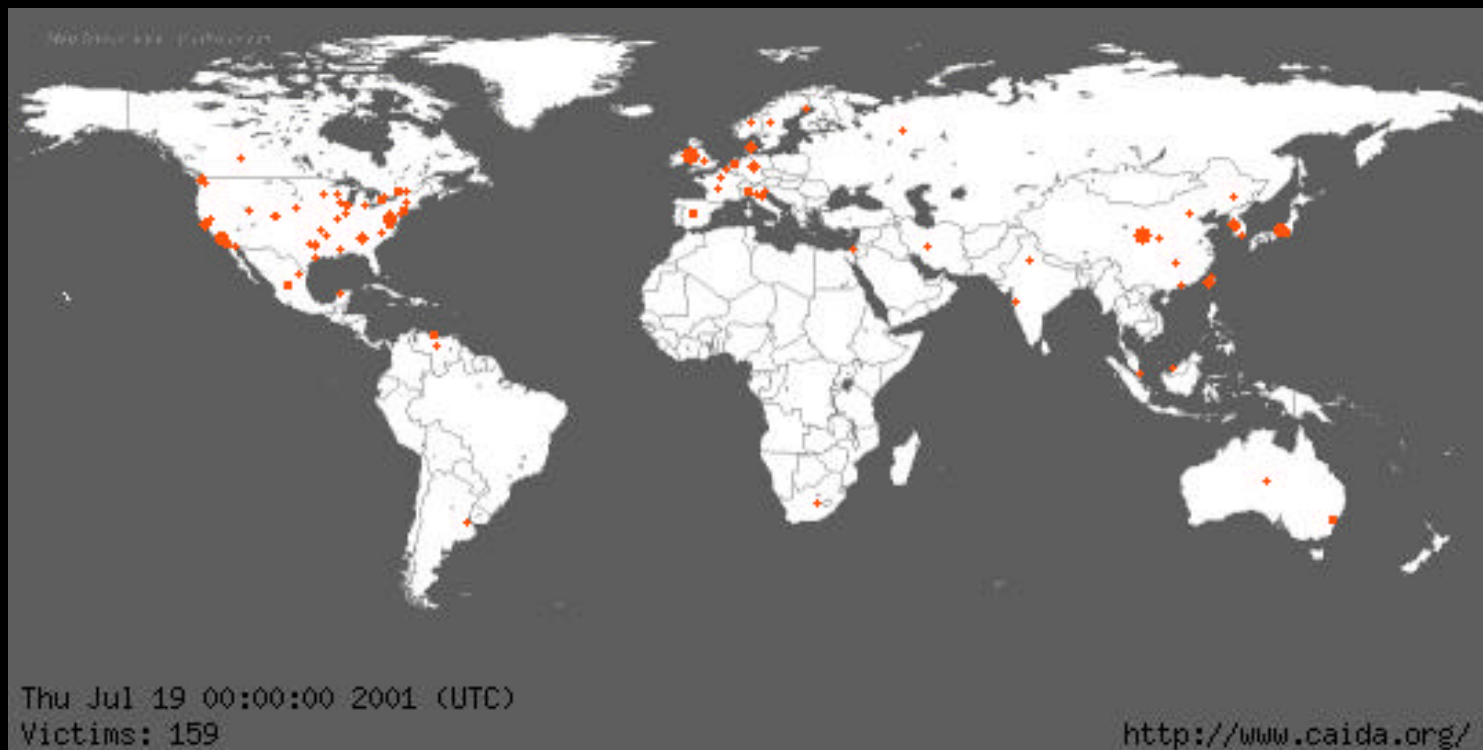
(source: www.denic.de/doc/DENIC/presse/stats2000.en.html)

Dotcom domain names



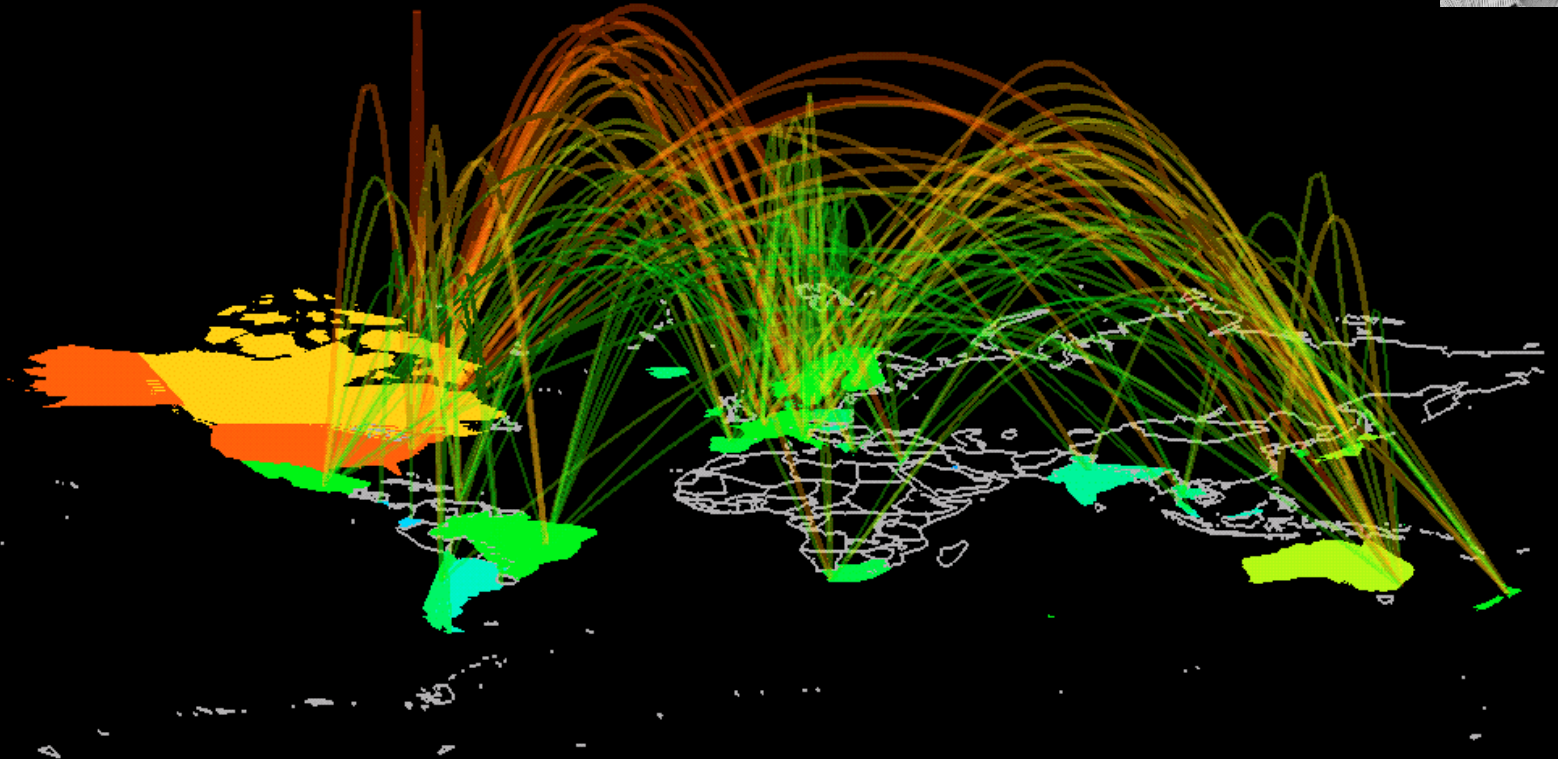
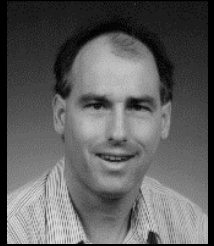
(source: Matthew Zook, www.zooknic.com)

Mapping virus diffusion - Code-Red

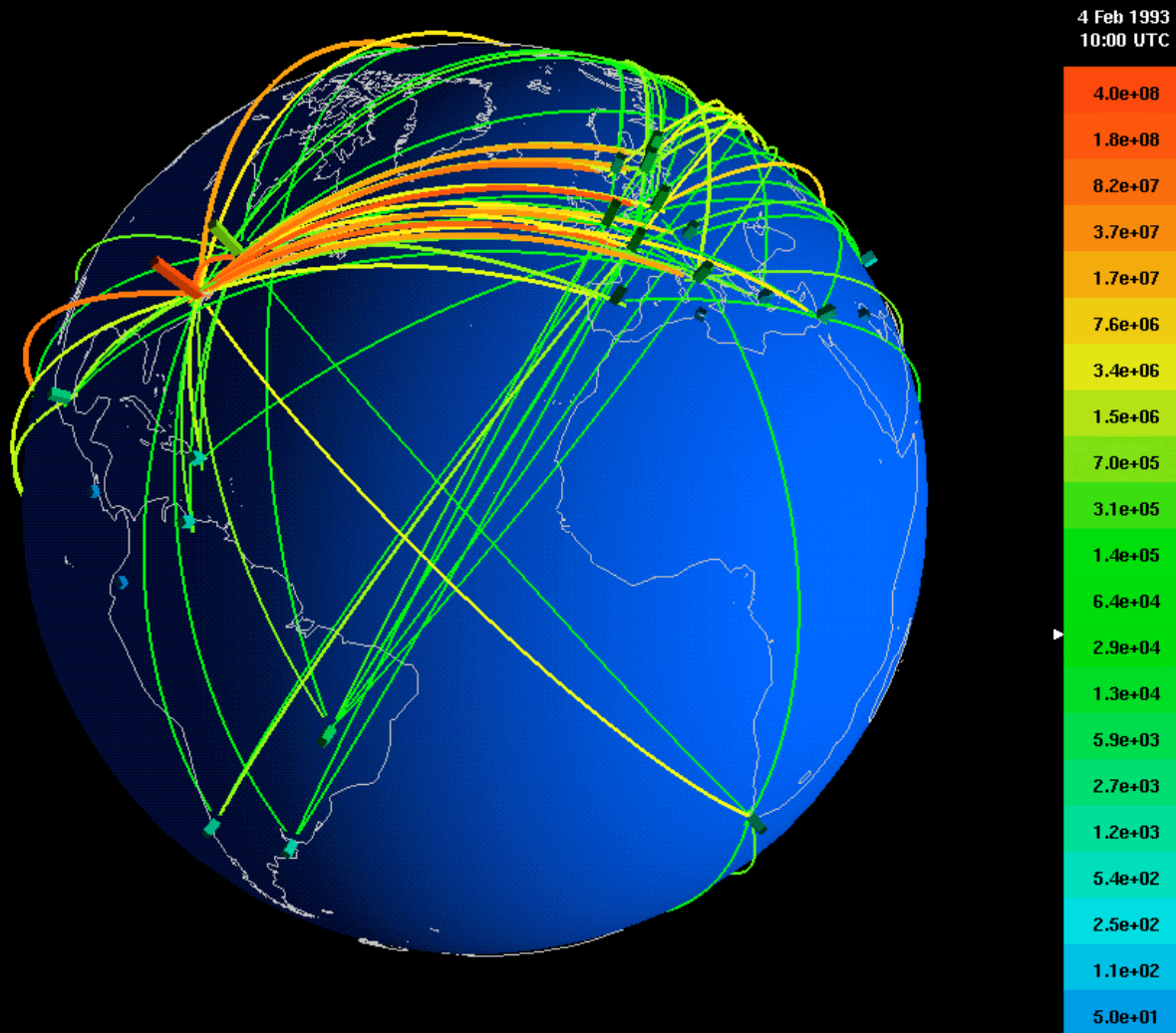


(source: Caida, www.caida.org/analysis/security/code-red/)

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?

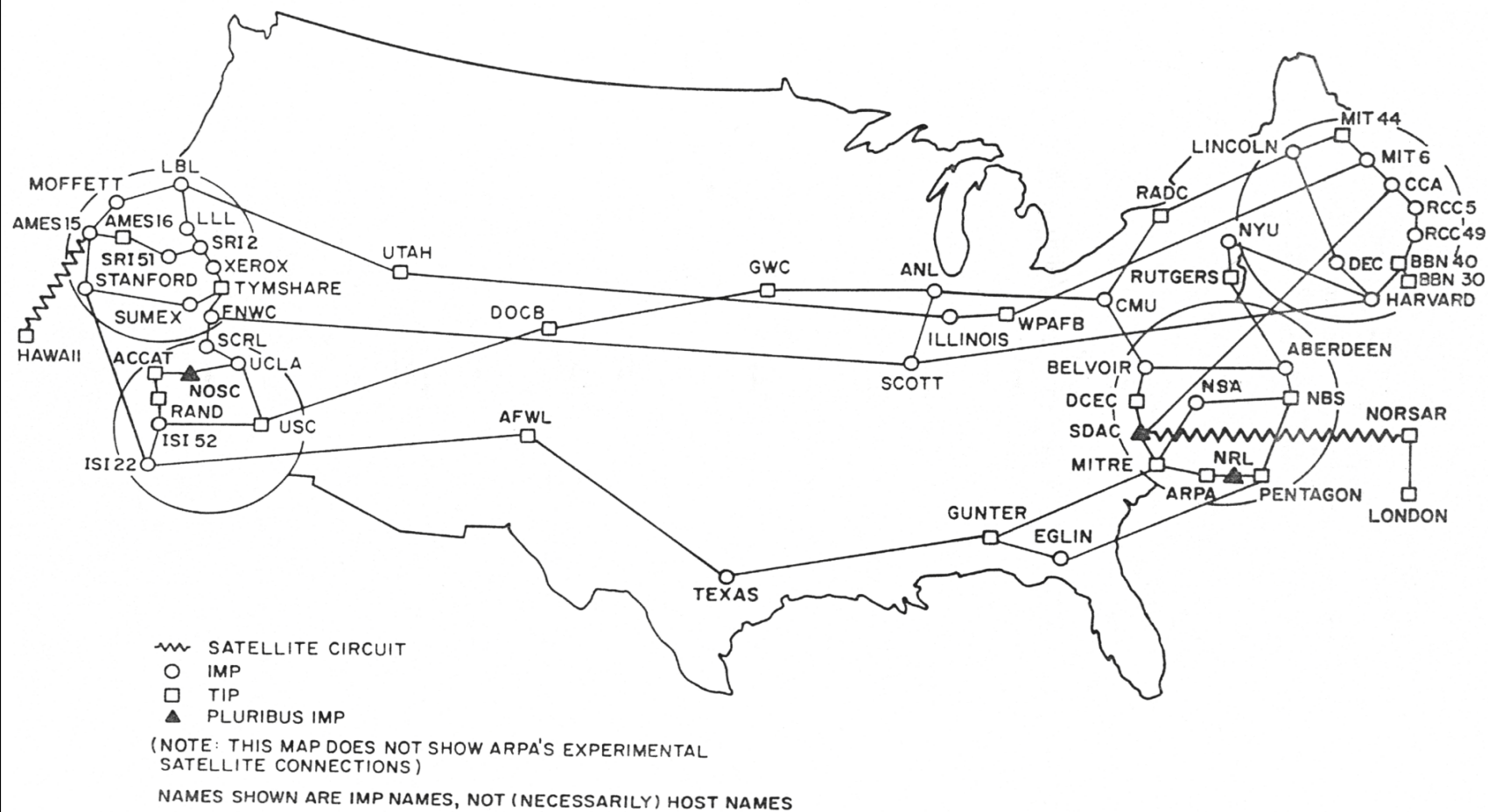
Just nodes and links





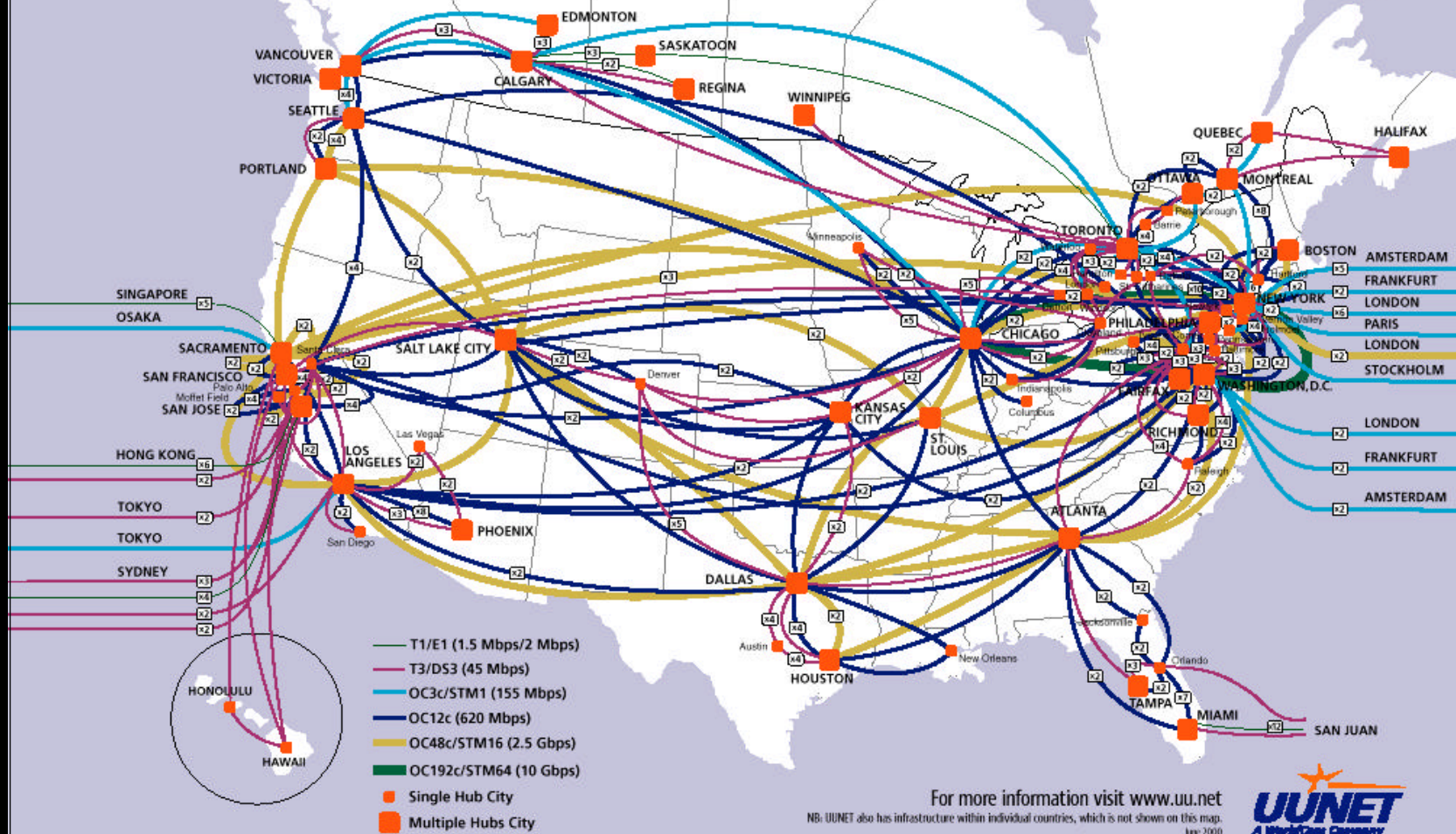
(source: Library of Congress, <http://hdl.loc.gov/loc.gmd/g3701p.ct000084>)

ARPANET GEOGRAPHIC MAP, JUNE 1977



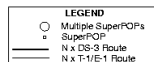
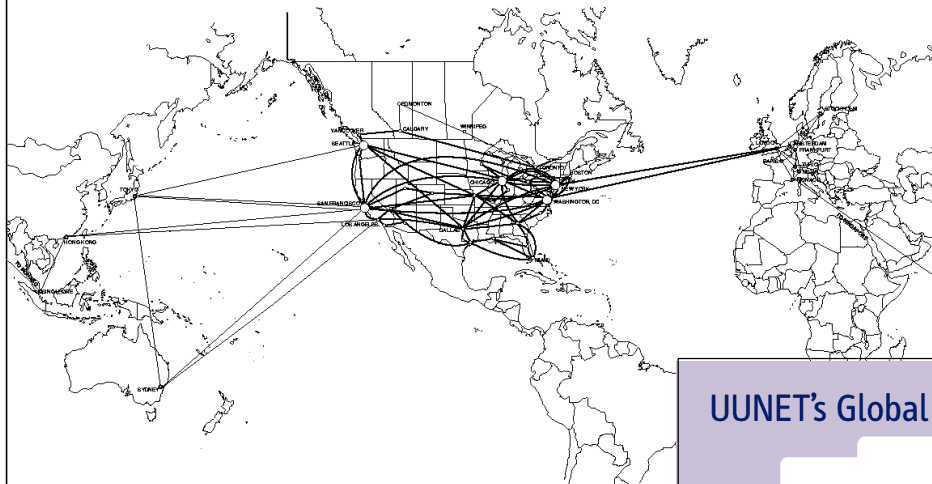
(source: Internet Archive, ARPANET documents)

UUNET's North America Internet network



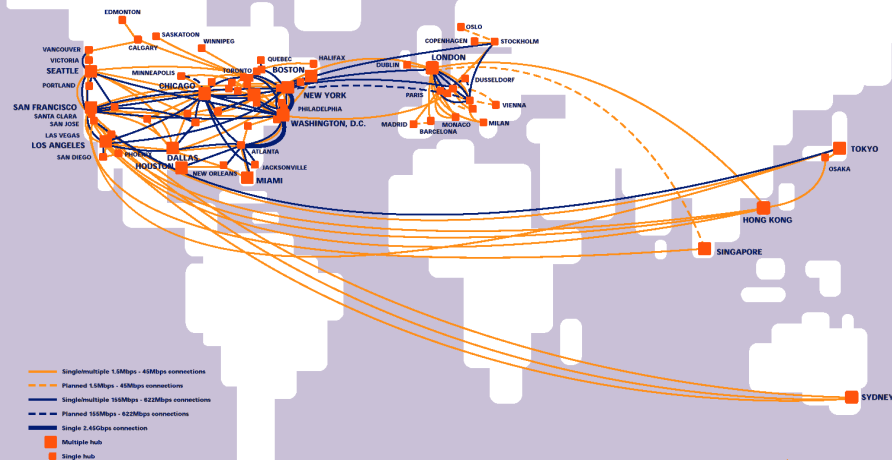


UUNET Global Network



Backbone marketing maps

UUNET's Global Internet Backbone



For more information visit www.uu.net

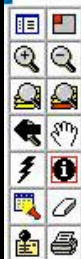
ND: With the exception of North America, Spain & Germany, all major "in-country" links have been excluded from this map. "In-state" links within the USA have also been excluded.

This does not constitute a solicitation of any form. UUNET's services are provided under license to UUNET's customers. UUNET's services are provided under license to UUNET's customers. UUNET's services are provided under license to UUNET's customers.



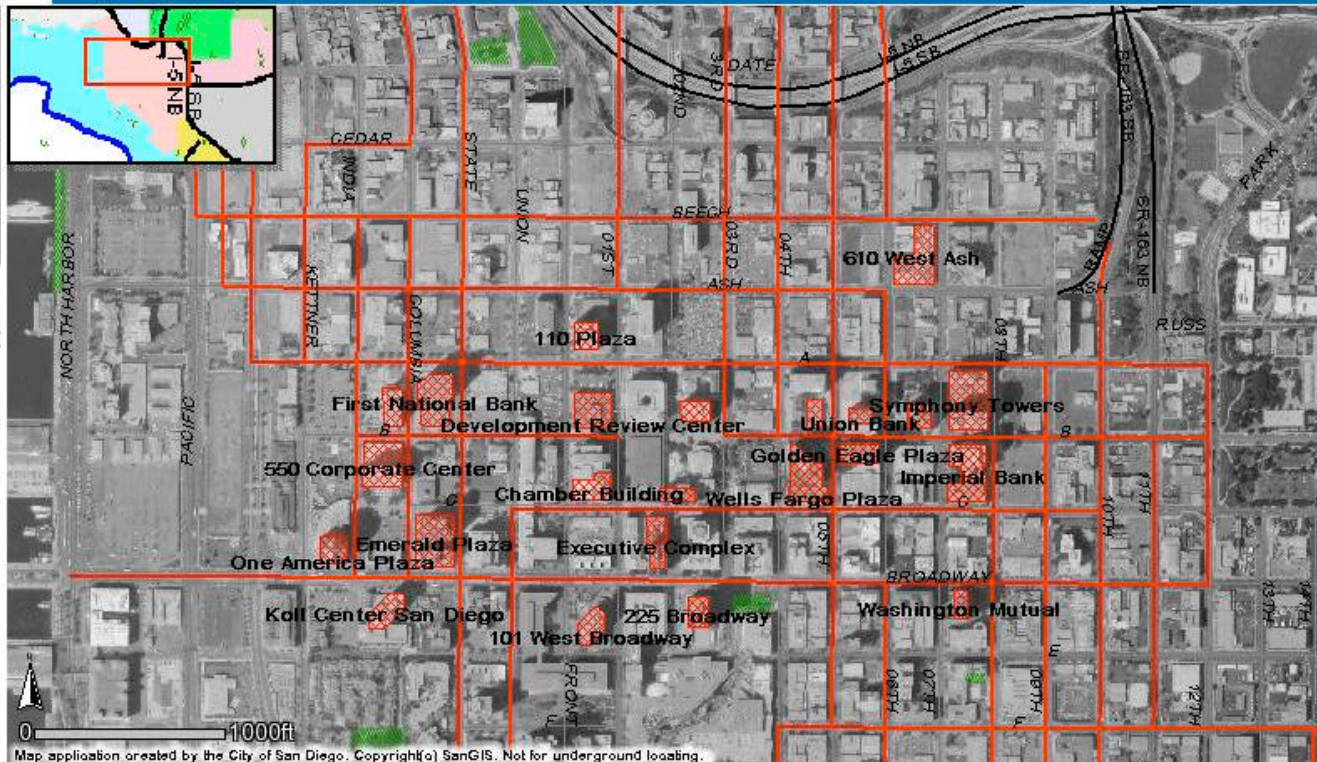
MapQuest 2000 2nd edition

(source: www.uu.net)



[Click Here for Help](#)

[Tour the Map](#)



Map application created by the City of San Diego. Copyright(s) SanGIS. Not for underground locating.

Fiber Network

Rec	Road Name	Suffix	Service Provider
1	STATE	ST	Level (3),NextLink,TCG/AT&T Local
2	A	ST	ICG,MFS,TCG/AT&T Local
3	STATE	ST	ICG,Level (3),NextLink
4	A	ST	ICG,MFS

Layers

- | Visible on Map | Active for Details | Layer Name |
|-------------------------------------|----------------------------------|--|
| <input checked="" type="checkbox"/> | <input type="radio"/> | Building Names |
| <input checked="" type="checkbox"/> | <input type="radio"/> | Wired Buildings |
| <input checked="" type="checkbox"/> | <input checked="" type="radio"/> | Fiber Network |
| <input type="checkbox"/> | <input type="radio"/> | Service Provider Homepages |
| <input checked="" type="checkbox"/> | <input type="radio"/> | Freeways |
| <input checked="" type="checkbox"/> | <input type="radio"/> | Roads |
| <input checked="" type="checkbox"/> | <input type="radio"/> | City Boundary |
| <input type="checkbox"/> | <input type="radio"/> | Property Boundaries |
| <input checked="" type="checkbox"/> | <input type="radio"/> | Parks |
| <input type="checkbox"/> | <input type="radio"/> | Centre City Development Corporation Area |
| <input checked="" type="checkbox"/> | <input type="radio"/> | Aerial Orthophoto |

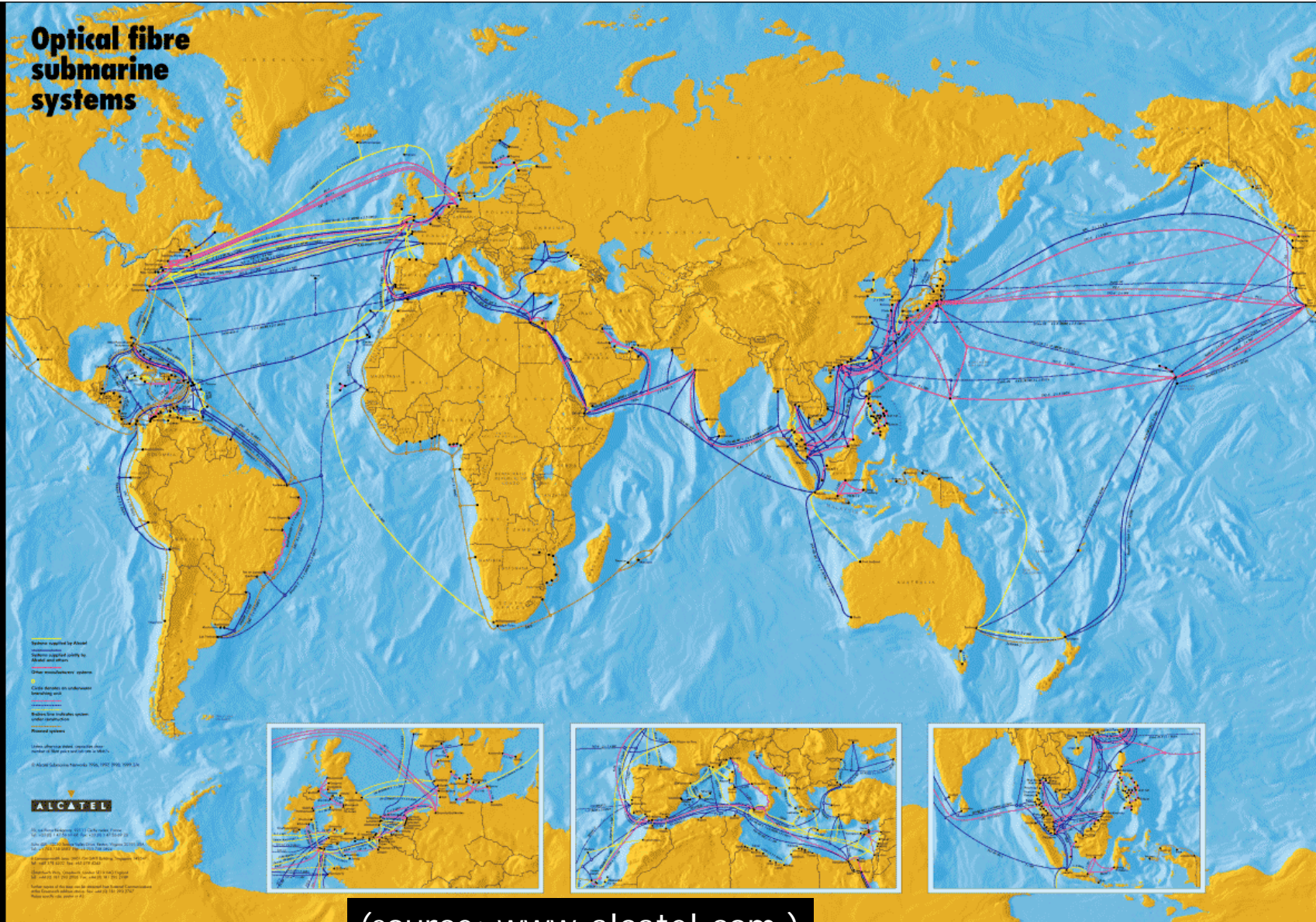
Identify

This information should not be used for underground cable location. Network information, current through 1999, is a partial listing of providers for Downtown only.

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



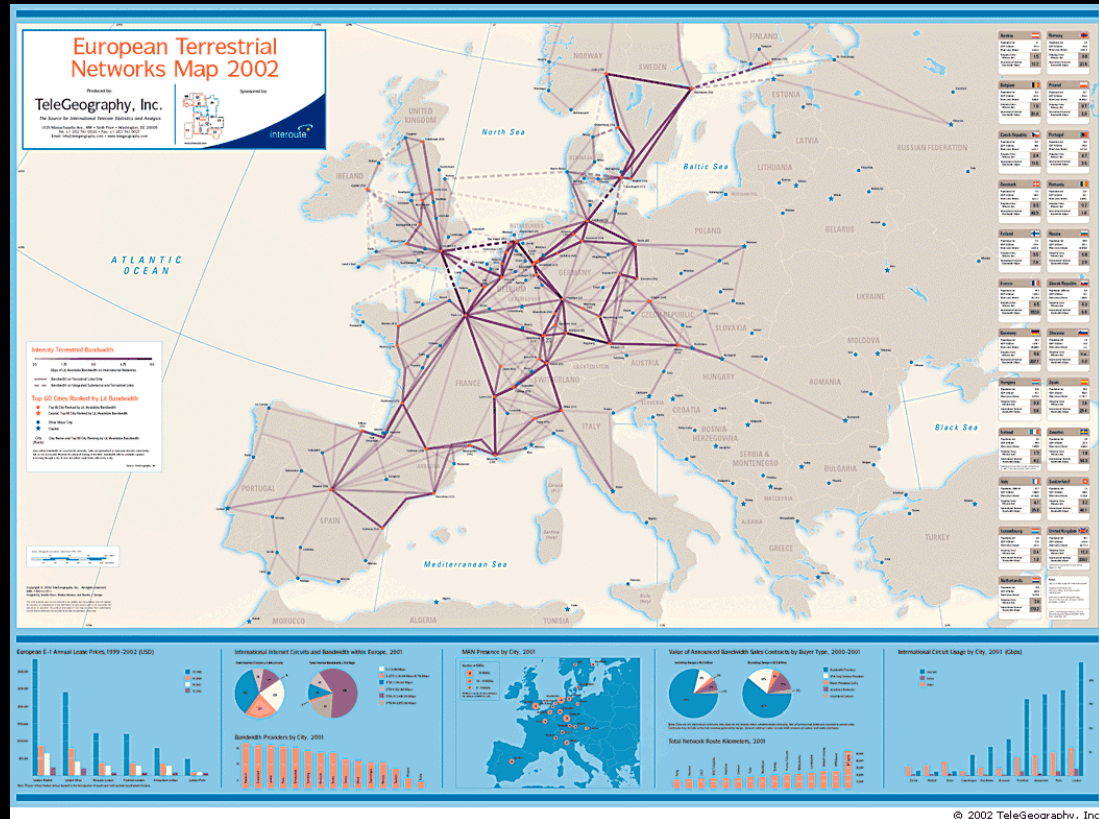
Optical fibre submarine systems



Maps for market research

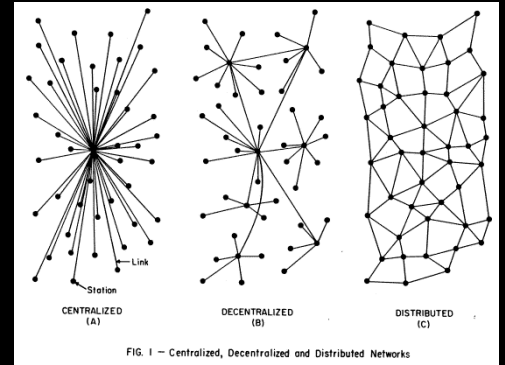


www.kmicorp.com



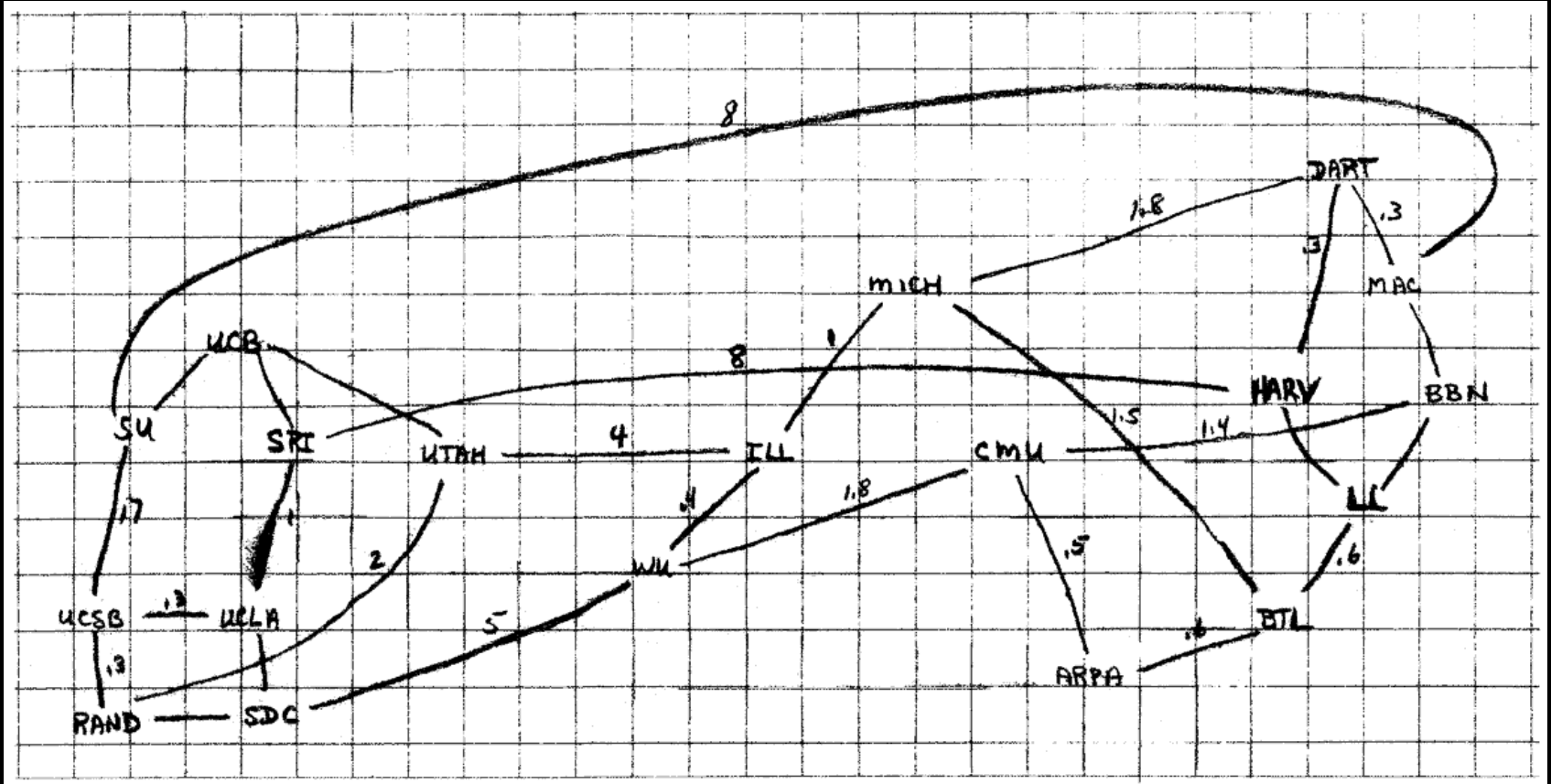
www.telegeography.com

Bye, bye to the geographic world



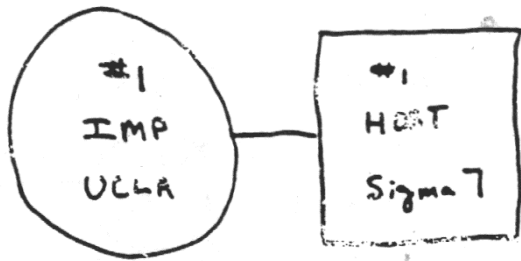
- focus is on topology, not geography
- Internet engineers don't care about where things are, but how they are logically connected
- wiring diagrams rather than maps

Sketch maps for net planners



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

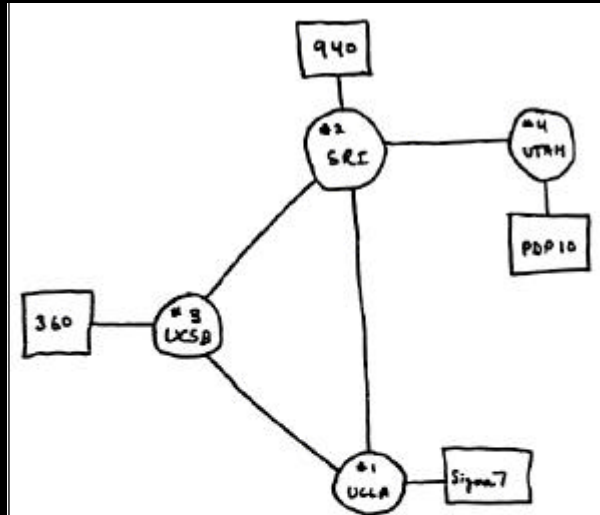
Birth of the net on the back of the envelope



THE ARPA NETWORK

SEPT. 1969

1 NODE

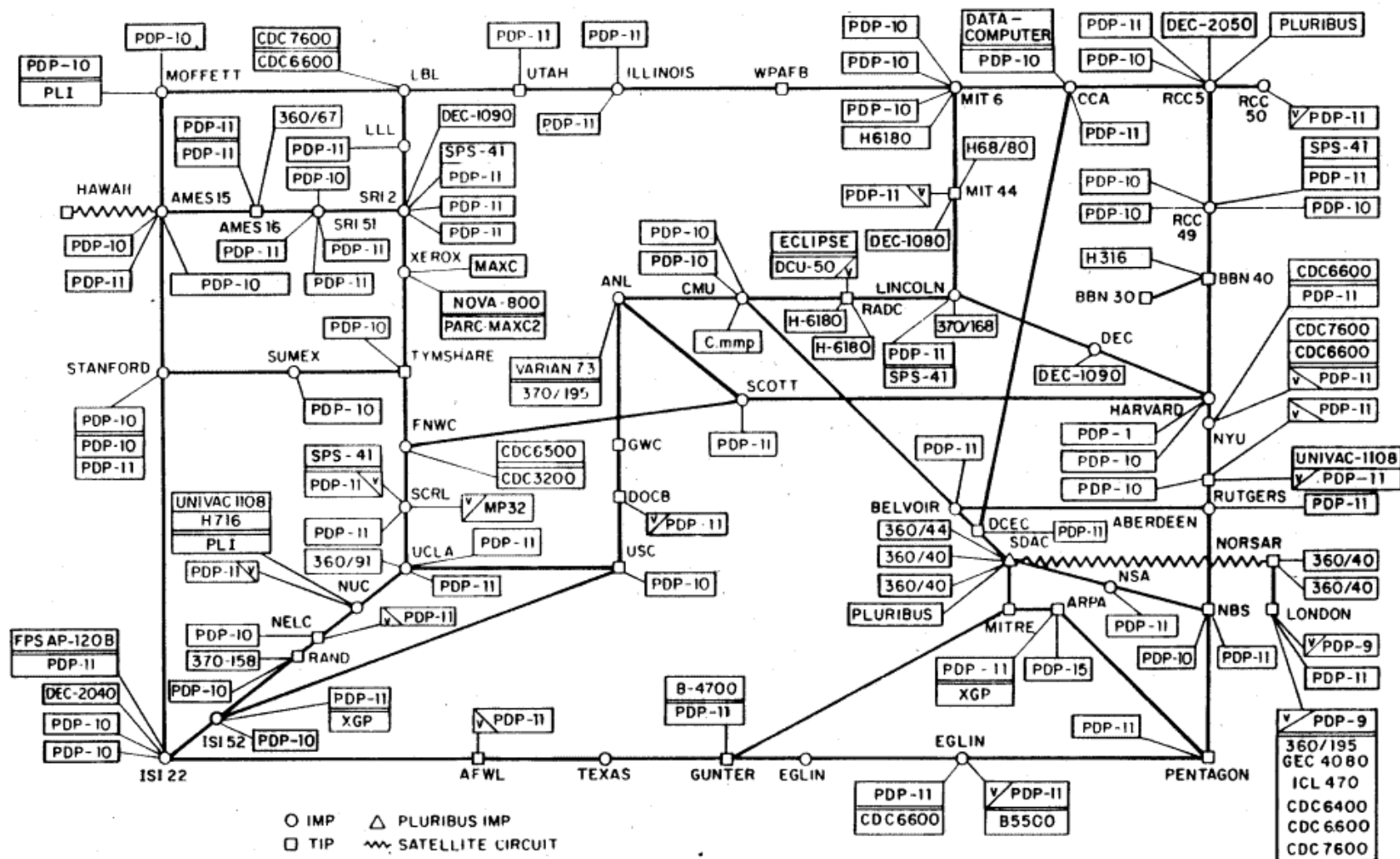


THE ARPA NETWORK

DEC 1969

4 NODES

ARPANET LOGICAL MAP, MARCH 1977

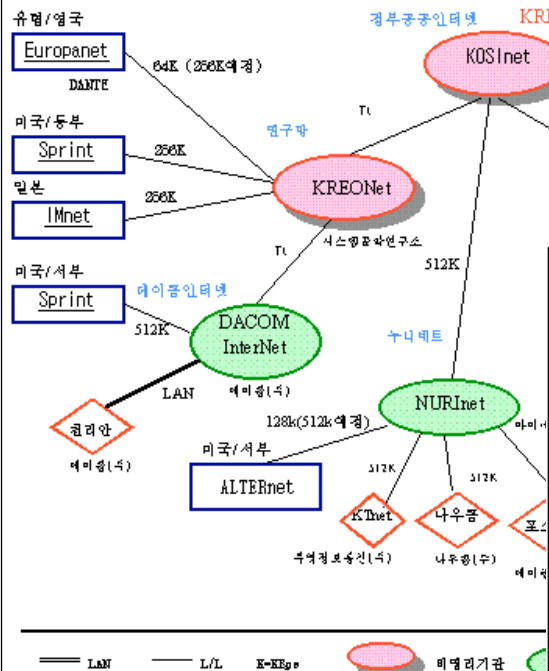


(PLEASE NOTE THAT WHILE THIS MAP SHOWS THE HOST POPULATION OF THE NETWORK ACCORDING TO THE BEST INFORMATION OBTAINABLE, NO CLAIM CAN BE MADE FOR ITS ACCURACY)

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

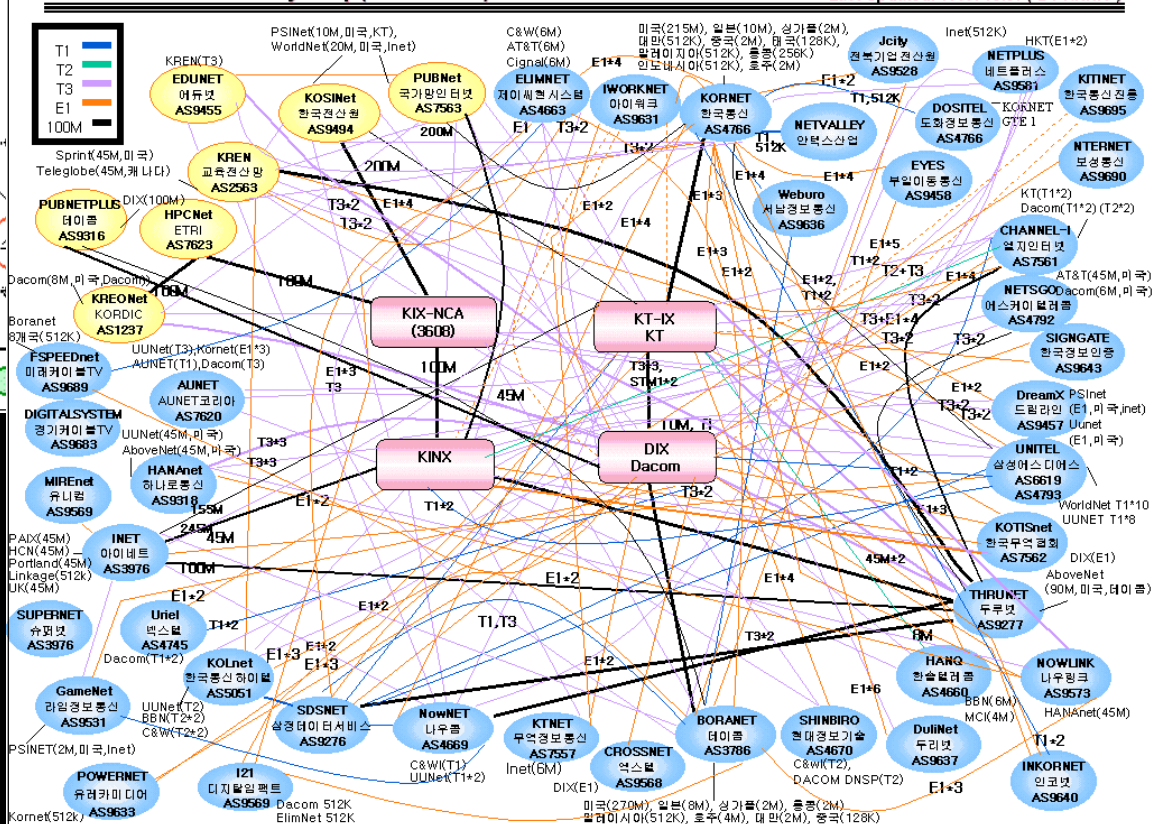
◆ 국내 인터넷 연결 현황

일자 : 1995. 5. 31
작성 : 한국인터넷정보센터



Internet Connectivity Map(Domestic)

Last Updated: 1999. 10.31 (BY KRNIC)

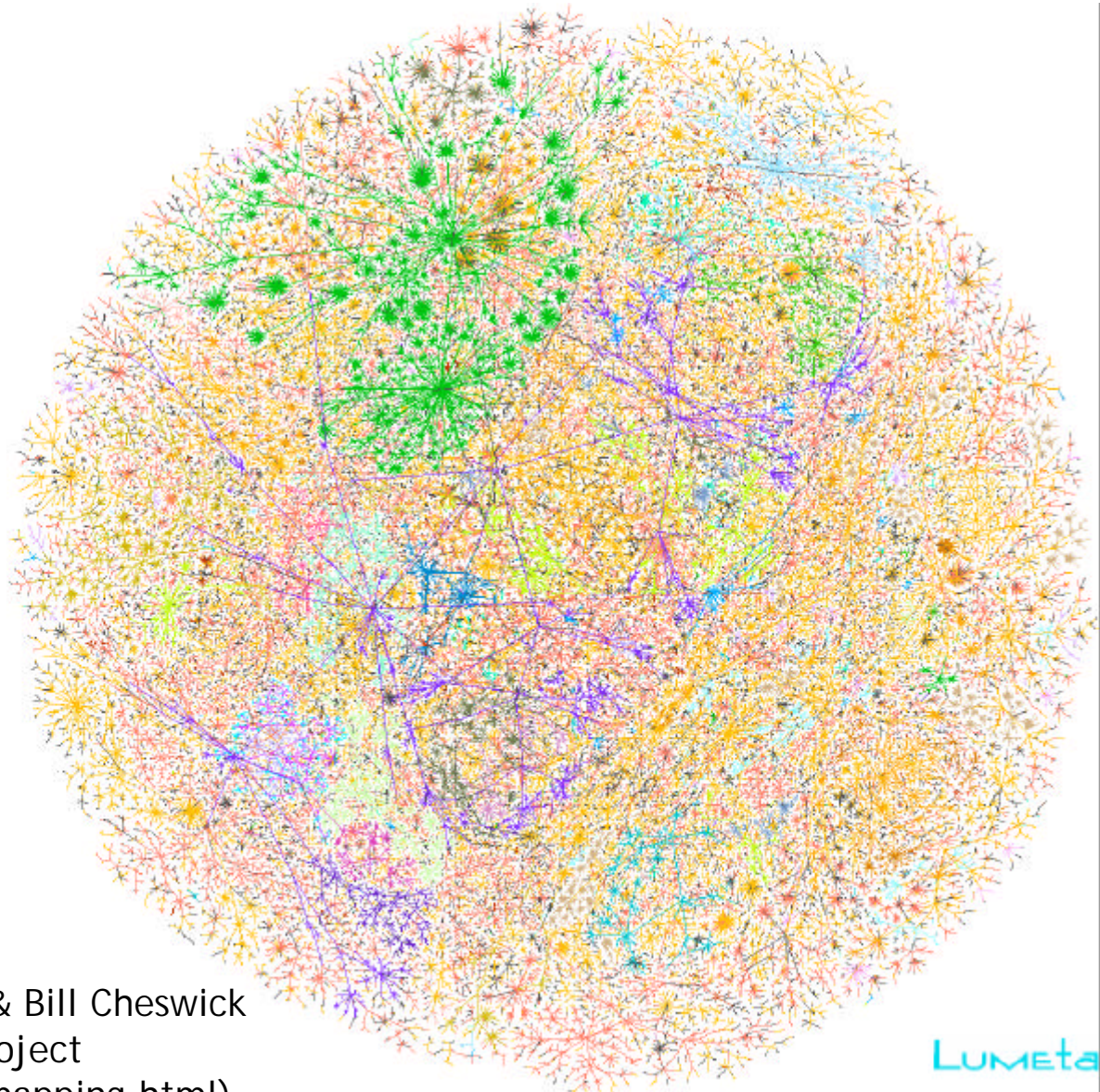


(Source: KR-NIC
<http://stat.nic.or.kr>)

Korean internet
topology

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
krnic.net	897
bellsouth.net	866
gbix.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	



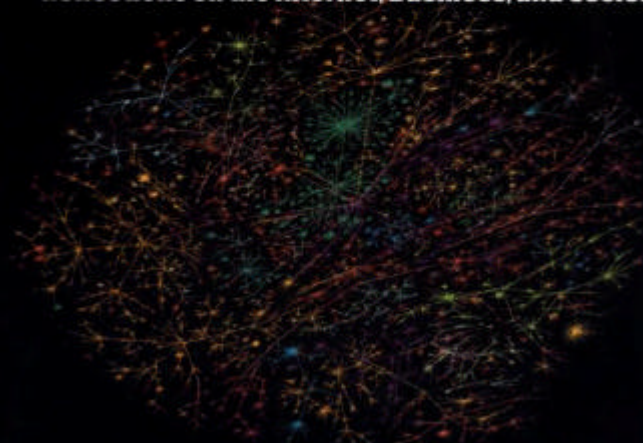
(Source: Hal Burch & Bill Cheswick
Internet Mapping Project
www.lumeta.com/mapping.html)

LUMETA

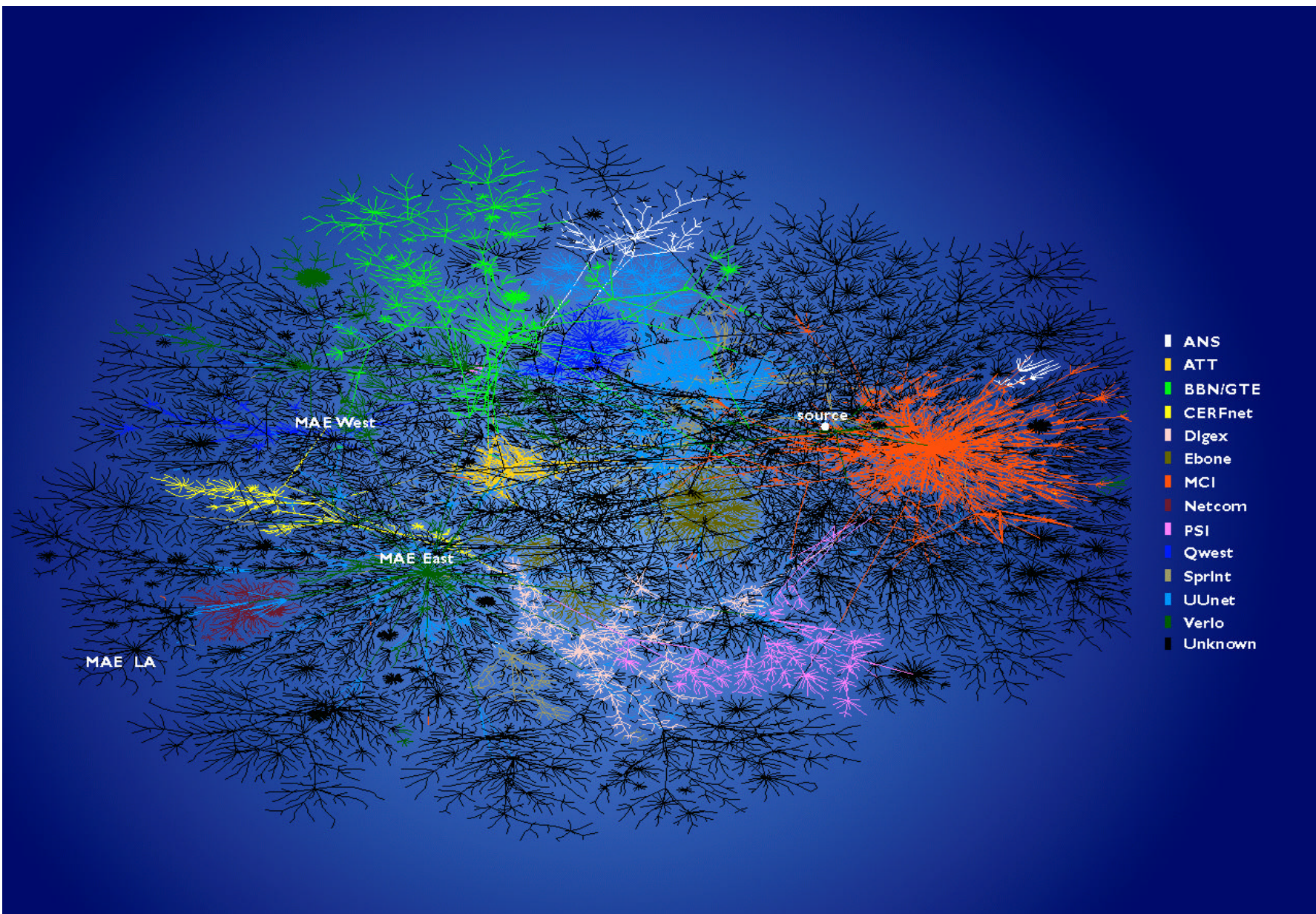
OXFORD

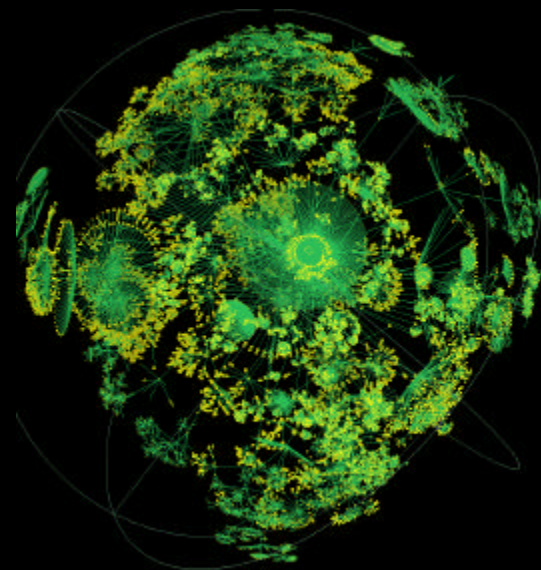
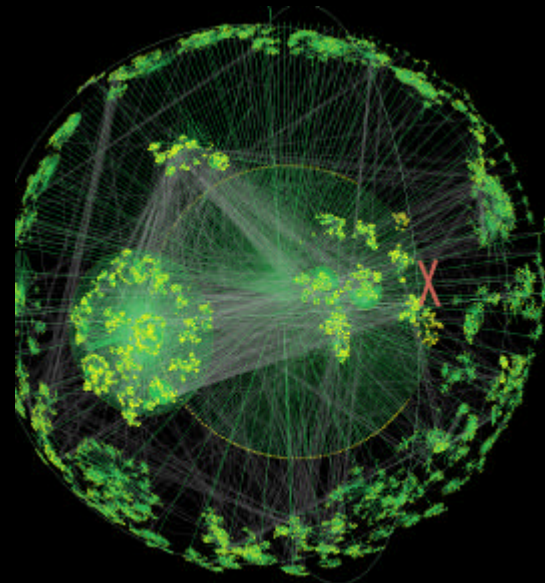
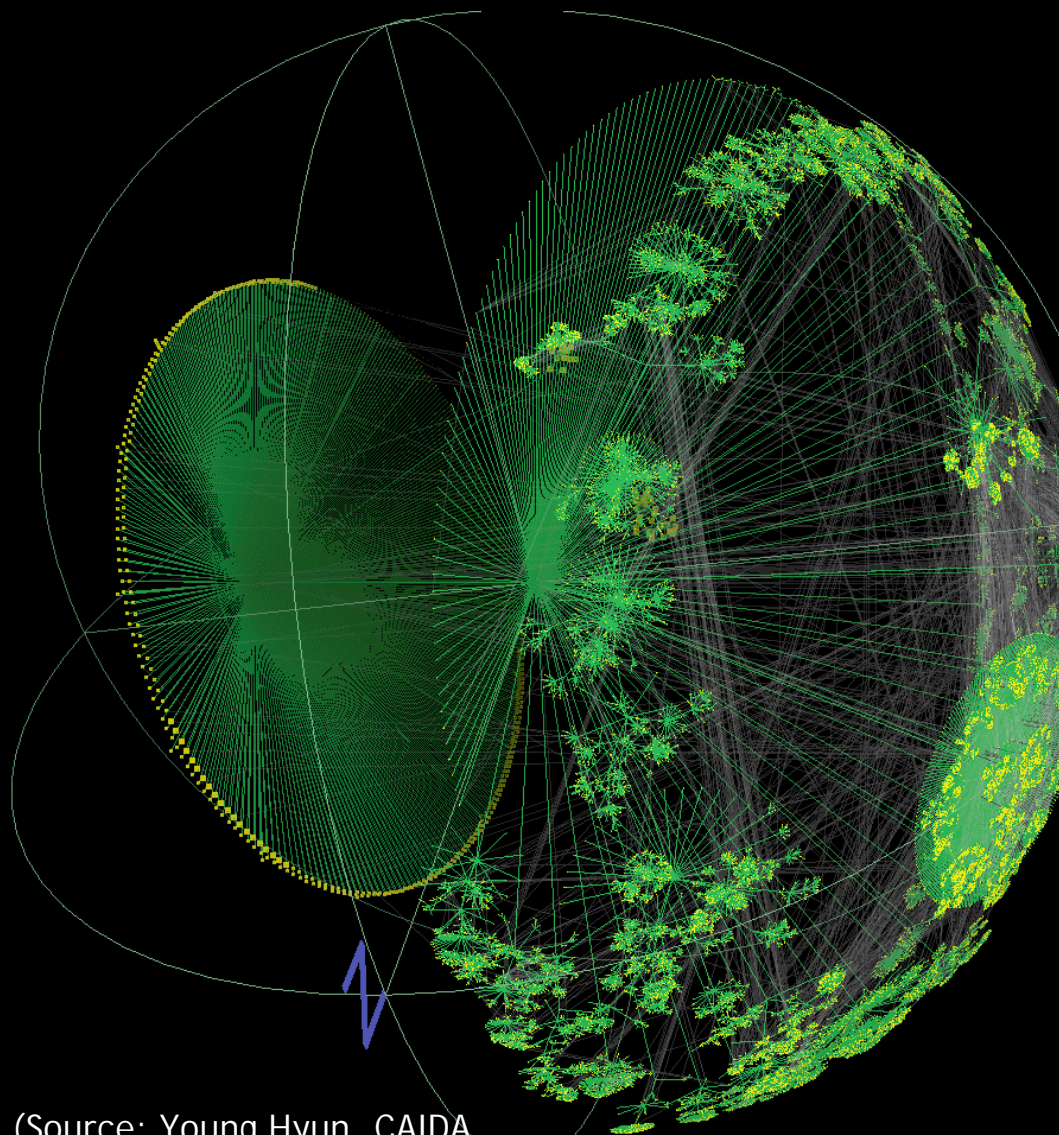
The Internet Galaxy

Reflections on the Internet, Business, and Society

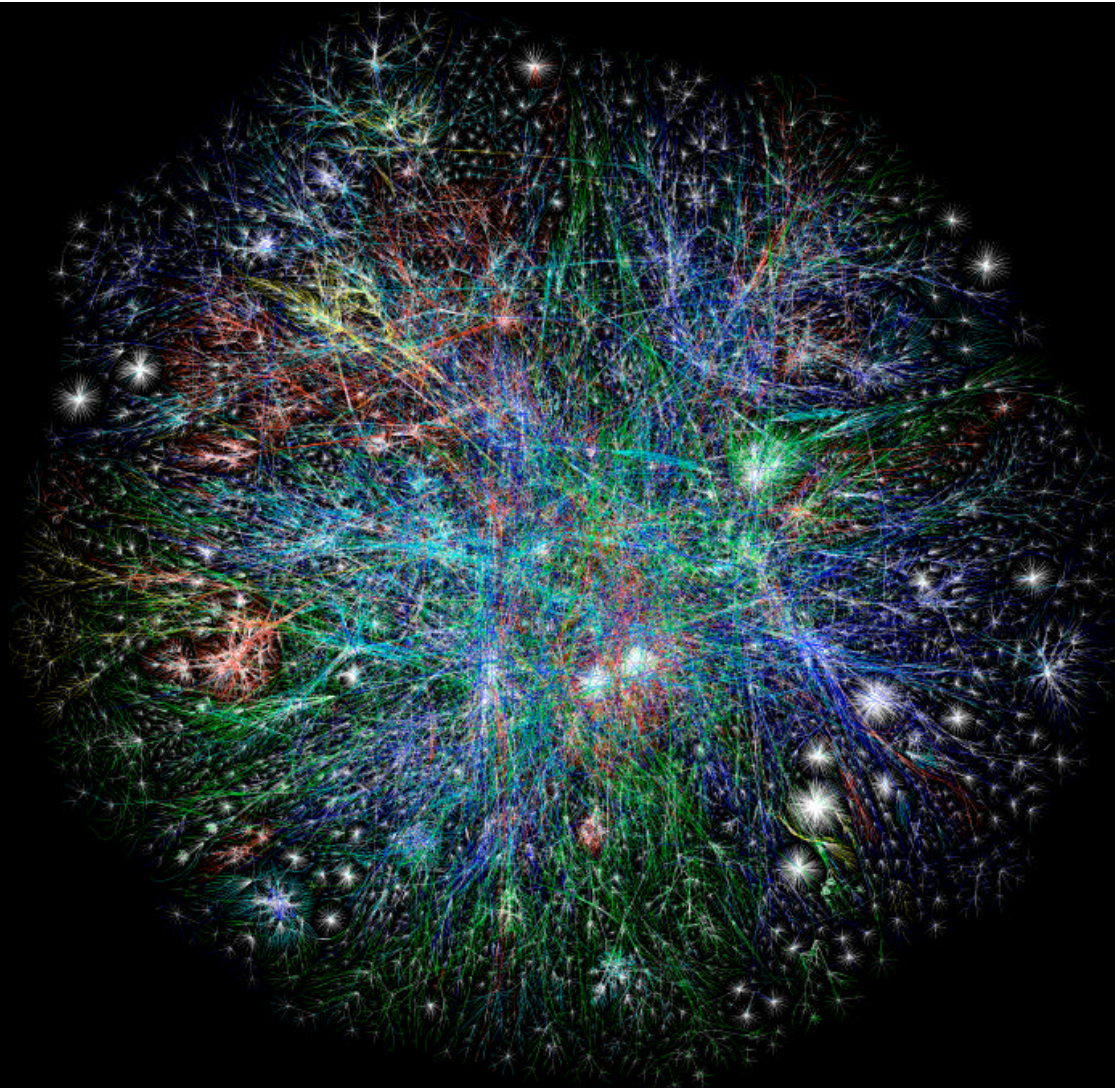


MANUEL CASTELLS





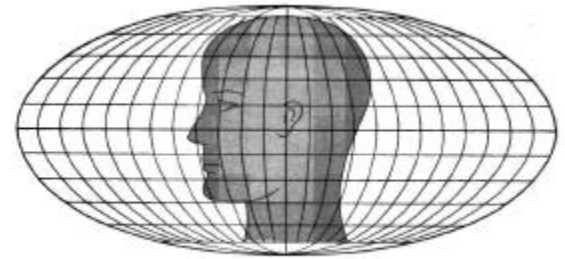
(Source: Young Hyun, CAIDA
www.caida.org/tools/visualization/walrus/)



The Opte Project, www.opte.org

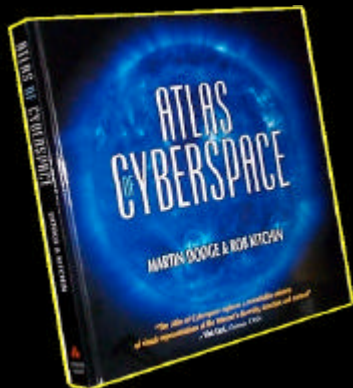
Distortion and deception “how to lie with maps”

- 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