Internet Services and Access

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Perceptions of the Internet, its growth, its accessibility, the available services, the community and distribution of users, affect its growth, accessibility, and community. Clear understanding of these issues and the distribution of the community and services, make it easier to both understand the environment and utilize available services. The Internet has grown and changed from a government sponsored entity to one that is as diverse as the global community. This diversification ranges from government, to business, to individuals. Fundamental services like TELNET and FTP remain a basic staple for users of the Internet, however additional services like gopher and WAIS servers make information access and retrieval new primary services and reasons for connecting. We use tables, a scatterplot, and nine maps to explore these aspects of the Internet.

Introduction

The Internet community has been growing at a rapid pace, one that some would call explosive. In some areas, the growth rate is only beginning on the curve, while in others, a significant population is already networked, and yet the seemingly limitless growth continues. Description of the global Internet community, including location and magnitude of the communities in a graphic way gives visual understanding of the community. The community can be described as a whole, that is all connections in a country, state, or region, or described more specifically, for example by exact location and magnitude of all connections in the domain of .edu. These graphic descriptions of the Internet give an intuitive view of how the Internet and its available services are distributed and show the magnitude of the different varieties of connections. Also, since maps are a familiar representation mechanism for most individuals, maps of the Internet community and services help those in non-technical fields understand the scope of the medium. The maps do not just illustrate, they also inform.

Improvements in the availability of data and resolution of the data have improved the clarity of the mappings. We show how data collected last summer was mapped and how current resolution of the data produces clearer, more interesting and meaningful maps of the Internet community. Additionally, comparison of last year's maps with recent data show the areas of current growth and those areas with continued growth potential. This growth is particularly interesting in developing countries and Eastern European countries.

As time passed, we found many interesting things to map in addition to the numbers of connections. Services like anonymous FTP, archie, WAIS, and gopher, provide the Internet community with access to a wealth of information. Online library catalogs index millions of books. Freenet hubs provide access to growing communities of formerly unreachable users. These services are available throughout the world and serve a variety of communities.

In this paper we present: a sketch of factors in the history of the Internet that caused its current exponential growth; an examination of Internet growth and size per country using bar graph maps, tables, and a scatterplot; and an overview of the available servers for four Internet services, using comparative server population maps.

History

The Internet began in the United States, although it has always had international participation. To explain the Internet, we first have to mention the ARPANET, and then we can discuss why the Internet started growing exponentially, and why it continues to do so.

Before the Internet was the ARPANET, which was a project of the Advanced Research Projects Agency (ARPA) to develop networking technology that could survive a nuclear war. ARPA was also cost-conscious and wanted to use the network to provide remote access (remote login and file transfer) to supercomputers it was funding. The first four nodes of the ARPANET were interconnected in 1969. Using the network for communications among people was not in the original plans, but distributed electronic mail was invented within a couple of years (1972 or 1973), and mailing lists followed soon after (about 1977). networked resource sharing and communications together make collaboration much easier than without. The effect is hard to explain to those who haven't used it, but those who have often don't want to work (or sometimes even play) anywhere that does not have good network access.

The ARPANET used the Network Control Protocol (NCP). (ARPANET NCP was unrelated to the current Novell NCP.) In the mid-1970s, other networking technologies, such as Ethernet and packet radio, were being developed. ARPA saw that a technology was needed that could connect various underlying networks of different kinds and make them appear to be one large virtual network. Such a technology is a protocol, and such a virtual network of networks all using the same protocol is an internet. The protocol was called the Internet Protocol (IP). IP is a datagram protocol, that is, each packet of information has an address, is routed through the various networks separately, and can arrive out of order, multiple times, or not at all. Datagrams are useful for survivability (if a link or node goes down, the datagram just gets routed through another one). But application programs and users need reliability. So the Transmission Control Protocol (TCP) was invented to provide reliable transmission from a process on one machine across an internet to a process on another machine, delivering bytes in order and without loss (TCP retransmits lost packets until one arrives) or duplication (TCP detects duplicates and throws them away before the application sees them). TCP is used on top of IP (that is, it uses IP to send datagrams), and the set of protocols (protocol suite) consisting of IP, TCP, and other protocols is usually called TCP/IP.

The first experimental TCP/IP internet was established in 1977. By 1982 the ARPANET was so successful that ARPA had given operational control of it to the Defense Communciations Agency (DCA, now called DISA, for Defense Information Systems Agency). DCA mandated that all hosts and networks connected to the ARPANET must use TCP/IP (rather than NCP) by 1 January 1983, which is the usual start date given for the Internet (note the definite article and the capital I), which is the largest TCP/IP internet. The Internet was originally called the ARPA Internet, but various other U.S. federal agencies took increasing roles, and the Internet spread to other countries and even to businesses, so it came to be called just the Internet. The ARPANET acted as a backbone network in the Internet for many years, but was retired in 1990, and no longer exists. The Internet is now a multi-protocol network, since other protocols are also used over it, but TCP/IP is by far the most prevalent protocol suite in it.

Also in 1983, the 4.2BSD version of the UNIX timesharing system was distributed. UNIX was originally developed by AT&T, but lacked networking capabilities. 4.2BSD was developed by the Computer Systems Research Group (CSRG) of the University of California at Berkeley (UCB) and funded by ARPA, which wanted a standard research operating system for use by its researchers. As part of the project, ARPA wanted a good implementation of the TCP/IP protocols, and CSRG delivered. Delivered for cost of distribution, actually, and to anyone who wanted it (and had the appropriate AT&T UNIX license), since 4.2BSD was funded by tax money.

Also around 1983, new companies such as Sun Microsystems and older ones such as Digital were developing networked workstations to take advantage of new inexpensive microprocessors, such as the

Motorola 68000 and the Intel i286. The specifications for the TCP/IP protocols have always been freely available in their entirety, both over the Internet itself, and on paper. This alone gave TCP/IP an advantage over proprietary protocol suites. But implementation still takes time. These companies needed a good implementation of TCP/IP quickly, not to mention a working operating system to use it, and 4.2BSD was available. 4.2BSD became the reference implementation of TCP/IP. Many computer vendors adopted it, bugs and all, as their baseline system. The 4.2BSD TCP/IP code was used by many companies that did not use the entire operating system, and was even adapted to entirely different operating systems, such as VMS.

In the early years, the U.S. federal government, especially DCA (now DISA) promoted the implementation and use of TCP/IP both by buying systems that had it, and by requiring any system they bought to have it. This provided an early market for TCP/IP, and promoted implementation of it. TCP/IP quickly became the most implemented of all protocol suites, and thus gained an advantage in interoperabilty that it still maintains.

In the mid-1980s fiber optic links were laid across the United States and elsewhere in unprecedented quantities. This made T-1 (1.544Mbps) speed cost-effective for wide area network links, and made the old ARPANET DS-0 (56Mbps) speed obsolete. Meanwhile, the National Science Foundation (NSF) formed an office to promote an NSFNET backbone network, which ran at first DS-0 (1986), then T-1 (1988), and since about 1991 almost T-3 (45Mbps) speed. NSF also gave seed money to start a few dozen NSFNET mid-level (mostly regional) networks, on condition that they become self-funding within three years.

Finally, the Internet Domain Name Services (DNS) was specified in 1984 and widely deployed around 1986-1988. DNS permits an organization to control its own host name space, while still interacting as an integral part of the overall Internet domain name system. DNS destroyed the limitations of the old ARPANET host table, which had required all hosts to be listed in a single file, kept by a single central organization.

All these factors (the 4.2BSD and later 4.3BSD reference implementation of TCP/IP; inexpensive microprocessors; workstation startups; fiber optics; government promotion by ARPA, DCA, and NSF; and DNS) came together around 1988, and growth of the Internet worldwide went exponential. The Internet has been approximately doubling in size (numbers of networks, almost certainly hosts, and probably users) every year since.

Why are we seeing worldwide exponential growth now of a technology that was originally funded as a U.S. military Cold War project? In addition to the factors already described, the basic nature of the technology is also a major advantage. Survivability meant decentralization and distribution, which turn out to be very useful features in a fast-growing international internetwork. There's no single technological or administrative point of failure to restrain growth. The Internet has long outgrown the control of the U.S. government or any government or other organization. Any country, company, university, or other organization can implement its own internet and connect it to the Internet, retaining control over its own facilities while participating in the global community.

The Maps

The heart of this paper is the nine included maps. These maps are not of a traditional node and link variety. They present services that users actually use, not the underlying physical links between computers. It is important for most users to know where information is available, not how it became available or how it travels from one point to another. Maps of services available to the Internet community, and of the community itself, provide a better understanding of each. We provide a variety of representations of the Internet to help broaden and clarify views of the network.

Six of the maps show numbers of hosts on the Internet per region, displaying a bar of the appropriate size over each region. The regions are countries in the whole world, countries in Europe, and states in the United States. These six maps are in pairs, using data from July 1992 and January 1993. The source of the data is Mark Lottor's domain walk; see RFC 1296 [Lottor 1992]. The innovation here is the presentation of the data in geographic map form.

Two maps are of Internet services, that is, of computers acting as servers for certain Internet services. The service maps use both shape and color to distinguish the various services down to the city level, rather than the country or state level that is used in the bar graph maps. So far as we know, this service data (for anonymous FTP, archie, WAIS, and gopher) has never been presented together. It certainly has never been presented in this graphical form.

Additionally, a bar graph map showing the growth rates of the Internet connections from July 1992 until January 1993 is provided. Each bar represents the percentage growth during the period. The dark bars represent countries that appear for the first time in the January data.

Let's examine each map type in more detail, starting with the bar graph host maps and continuing with the iconic service maps. In between, we also include several tables and a scatterplot.

The Bar Maps

The bar graph maps come in three pairs, showing two time periods (July 1992 and January 1993) across three regions (the world, Europe, and the United States). These maps give a quick impression of the global distribution of hosts on the Internet. A glance tells you that most hosts are in North America, Western Europe, Japan, and Australia, but that regions like South Africa and Latin America are catching up quickly. The four dragons of the Far East, Singapore, Hong Kong, Taiwan, and South Korea, clearly visible.

The scale has been carefully chosen to be useful in all three regions and two time periods depicted. This way, you can compare pairs of maps across time in a region, or even compare maps across regions. The scale is logarithmic. The next larger bar generally indicates twice as many hosts. The largest category, of more than 128,000 hosts, is only needed for the United States on the world maps and California on the United States maps. You can see Germany move up into the next category, of 64,001−128,000 hosts, between July 1992 and January 1993. On the world map, Europe is a jumble, which is why world maps should be used for the global view, and larger scale maps for more detail.

On the European maps, it is clear Germany has the most hosts, followed by various countries in the west of Europe, namely the United Kingdom, Sweden, the Netherlands, France, Switzerland, Norway, Finland, Austria, Italy, Spain, and Denmark, followed by the smaller countries of the Atlantic.

The east lags behind, and the farther east, the fewer hosts. Hungary only recently connected to the Internet, and Romania and Albania remain unconnected. However, Poland and Czechoslovakia have passed Greece in total number of hosts each.

Changes in host counts can be observed by comparing the pair of European maps. Hungary moved above 10 hosts, Ireland, Poland and Czechoslovakia above 1,000, Belgium above 2,000, and Spain and Denmark above 4,000, Austria above 8,000, Norway and Finland above 16,000, and Germany above 64,000 hosts during the six month interval shown.

Since these maps were drawn with SAS/Graph, and SAS, Inc. has not yet updated their political boundary database, these maps do not, unfortunately, show the Baltics or the CIS countries separately, nor do they account for the dissolution of Yugoslavia or the partition of Czechoslovakia. We haven't separated the Czech Republic and Slovakia in the data, for that matter. We have, however, reunited Germany, both in the data and in the maps.

The United States maps show the clear size advantage of California, followed by Massachusetts, Maryland, and Texas. Every state of the United States is on the Internet, plus the District of Columbia, Puerto Rico, and the U.S. Virgin Islands. Guam apparently is not yet, but McMurdo Station in Antarctica is.

Even though California has the most hosts by far of any state, most Internet hosts in the United States are actually on the east coast, because there are more states and people there. Growth can be seen in many places. In the west, Washington, Utah, and Arizona each passed 8,000 hosts, joining Oregon's category (which is also Austria's category). North Dakota passed 1,000 to join South Dakota (and Portugal, Singapore, and New Zealand). Oklahoma and Nebraska passed 2,000 to join Idaho (and Belgium and Hong Kong). Texas, Minnesota, Ohio, and Virginia passed 32,000 to join Massachusetts (and the United Kingdom, Canada, and Australia). We'll leave further state comparisons to the reader.

{Paste in the map ‘‘The Internet’’ here.}

{Paste in the map ‘‘The Internet in Europe’’ here.}

{Paste in the map ‘‘The Internet in the United States’’ here.}

Growth Differences

Comparing the bar graph maps across time, some changes are visible, and some are not. Many countries appear in the January 1993 data that were not present in the July 1992 data. Here they are, with their actual host counts:

country	hosts
Bulgaria	1
Costa Rica	3
Croatia	6
Cyprus	29
Ecuador	38
Greenland	1
Latvia	7
Malaysia	14
Russia	48
Slovenia	10
Yugoslavia	13

You can't actually see Croatia and Slovenia separately from Yugoslavia, nor can you see Latvia, because of the SAS/Graph problem mentioned previously, but the other countries are directly visible on the 1993 maps. Greenland may have been on the net earlier, but we only discovered it in the data recently. It is a host on the NASA Science Network, pointed out to us by Larry Landweber [Landweber 1993]. Russia is a bit problematical, since it is accessible through CIX (Commercial Internet Exchange) and other commercial IP connectivity providers, but it is not accessible through the NSFNET backbone yet. We can TELNET to it, so we list it and map it. The recent connections of countries such as Bulgaria, Costa Rica, and Ecuador illustrate the continuing global spreading of the Internet.

Looking more closely at the data, we find three countries actually show a decrease in number of hosts. Sometimes this happens. Sometimes it merely appears to happen. The usual reason for apparent but not real decreases is increased use of the domain name system (DNS). That is, widespread deployment of subdomains may result in more hosts being hidden under subdomains. Such subdomains are sometimes firewalled so that only the subdomain and not hosts within it are visible, even to domain walks. Sometimes the apparent decrease is due to more direct measurement problems, such as a network connectivity outage while the data is being collected.

Here are the countries showing decreased counts:

country	July 1992	January 1993	increase
Italy	7458	7395	-0.845%
Korea	4223	3324	-21.28%
Tunisia	25	13	-48%

Most of the other countries showed increases in their numbers of hosts. Some of these increases could be a result of increased use of DNS, that is, shifts from use of other name to host mapping techniques, such as static host tables, which would not register in a domain walk. Most of these increases are however, quite plausibly real.

Some countries grew more rapidly than others. Here we make a few observations and generalizations, which are at least supported by the data, and may even be correct.

These countries showed an increase of more than 100% over the six month interval we mapped:

country	July 1992	January 1993	percent
Argentina	2	93	4550%
Venezuela	5	108	2060%
India	6	77	1183%
Hungary	72	595	726%
Antarctica	4	32	700%
Thailand	1	5	400%
Czechoslovakia	547	1748	220%
Poland	612	1625	166%
Chile	146	321	120%
South Africa	2010	4228	110%
Ireland	621	1297	109%
Denmark	2652	5328	101%

The fastest growing countries on the Internet are not the long-established ones, such as the United States, Canada, or the Netherlands. They are relatively newly-connected countries with relatively few hosts, such as Venezuela and Hungary. Some countries that have been connected for a few years, such as Argentina and India, are now showing growth spurts. The increase in Antarctica is mostly at the U.S. McMurdo station.

On the lower end of this list we see a few old countries, such as Ireland and Denmark. They grew at only around 100%, unlike the multiple thousand percent growth of India, Argentina, and Venezuela.

These countries showed increases of 75% to 100% over the mapped six month period:

country	July 1992	January 1993	increase
Iceland	392	763	94.6429%
Brazil	935	1812	93.7968%
Taiwan	1940	3739	92.732%
Estonia	38	69	81.5789%

Here we have an interesting mix of recent connections and old ones. Brazil and Estonia connected to the Internet relatively recently. But Taiwan and Iceland have been connected for a long time. And Iceland is one of the most densely networked countries in the world, in hosts per person. This would seem to mean that even the most densely networked countries still have much room for growth.

These countries showed increases of 50% to 75%:

country	July 1992	January 1993	increase
Spain	3490	5770	65.3295%
United Kingdom	32843	53420	62.6526%
Belgium	1431	2257	57.7219%
Mexico	776	1215	56.5722%
Denmark	42486	65138	53.3164%

There are no newly connected countries in this list.

These countries showed an increase of 25% to 50%:

country	July 1992	January 1993	increase
Israel	2724	4056	48.8987%
Luxembourg	76	111	46.0526%
Greece	475	692	45.6842%
Singapore	923	1344	45.6121%
Japan	14753	21472	45.5433%
Norway	13636	19649	44.0965%
Hong Kong	2401	3434	43.0237%
Portugal	1291	1819	40.8985%
Austria	6364	8892	39.7234%
Switzerland	16825	23144	37.5572%
Canada	37021	50741	37.06%
France	18508	24951	34.812%
Australia	43262	54970	27.063%

Here we see most of the most networked countries, whether measured by total hosts or hosts per person. All these countries have been connected to the Internet for many years. Though their growth was slower than for some of the newer countries, the absolute numbers of hosts added in these established countries is still large. Australia added more than 10,000 hosts, for example, which is more than the total number of hosts in any of the more recently connected countries.

Increase of 25% or less:

country	July 1992	January 1993	increase
Sweden	20321	25400	25%
Netherlands	20255	24751	22%
Puerto Rico	157	188	20%
New Zealand	1741	1955	12%
United States	683470	759568	11%
Finland	15633	16197	3.6%
Virgin Islands	1	1	0%

Here we see the rest of the countries with the most hosts and with the most hosts per population, including the United States, which still has more hosts than the rest of the world combined.

A Growth Map

Finally, we have appended a map showing these growth rates. This map gives a visual depiction of these rates and clearly indicates the newly connected countries and those with the dramatic growth. North America, Western Europe, and Australia were the most prominent places on the host count maps, but they are the least prominent places on this growth map. Simple pairs of bars ordered by growth rate would have obscured this geographic difference.

The map would also look significantly different if we had chosen to map absolute number of new hosts connected rather than percentage change. As previously noted, the United States has the greatest absolute growth and countries like Finland with only 3.6% growth added over 500 hosts in this period, far more than any of the newly connected countries.

{Paste in the map ‘‘Growth Rates of the Internet’’ here.}

Speculations on Growth

In the early days, internetworking was an expensive proposition, also requiring much technical expertise. This alone is enough to explain why the Internet first spread in the United States, Canada, Western Europe, Australia, New Zealand, and Japan.

The United States has about 60% of all hosts on the Internet worldwide. To some extent, this is not surprising, since it was not only the first country on the Internet, but also has a large population. But Japan has had Internet connectivity for many years, has no lack of technical expertise or money, and has a population about 50% the size of the U.S. population. Yet Japan has only 3% as many Internet hosts as does the United States. The state of Texas alone has twice as many hosts as Japan. The precise reason for this Japanese discrepency is not clear. However, Japan has had no equivalent of ARPA, DCA, NSF, or other government agency funding or promoting networking in Japan, and this would seem to be one reason for lack of networking in Japan. The U.S. has also seen the growth in the past six years of commercial IP network connectivity, provided by companies such as Advanced Network and Services (ANS), CO+RE (Commercial plus Research and Education), and the CIX (Commericial Internet Exchange) members, such as AlterNet, PSINet, CERFnet, and Sprintnet. There are also at least two CIX members in Europe, Pipex, and EUnet. But the first commercial Japanese IP carriers are only forming this year.

Perhaps Europe, which has countries with large populations, technical expertise, and money, is ahead in networking, after correcting for hosts per population. Yes, the most networked (in Internet hosts per capita) countries in the world are in Europe: Norway, Switzerland, and Finland. These are followed by Australia and the United States, and then more European countries: Iceland and Sweden. Then there is Canada, and four more European countries: Netherlands, Austria, Denmark, and the United Kingdom. Following those, we have Israel, Denmark, Hong Kong, New Zealand, Singapore, France, Ireland, Luxemmbourg, Belgium, Taiwan, Japan, Portugal, Spain, Italy, South Africa, Czechoslovakia, and South Korea. Those are the top 30 by hosts per capita of the 54 countries or regions in the world.

It is interesting that all five of the Nordic countries (Norway, Finland, Iceland, Sweden, and Denmark) appear at the top of the list. We could make an argument for government assistance here, since these countries are participants in NORDUNET, which has funding from their governments. But more study would be needed to make such a case for Switzerland, Netherlands, and Austria. The United Kingdom has a long history of government funding of networking, but until recently most of it was not going to TCP/IP networking. And I could be mistaken, but I don't think the Internet in Australia had much government funding. So it appears the government funding argument can only be stretched so far.

Hosts and GNP

The 30 countries just listed are also many of the richest countries in the world. So perhaps per capita Gross National Production (GNP), or personal income, would be a good predictor of hosts per capita. This turns out to be more or less true, as you can see in the scatterplot [Quarterman Carl-Mitchell 1993].

{Paste in the map ‘‘scatterplot’’ here.}

The per capita GNP and population figures come from the *Oxford Atlas of the World* [Oxford 1992]. and are from 1989-1991. Also, a few figures have been filled in from the *Economist* newspaper, and others, from *The World Factbook 1993-1994* [CIA 1993].

The x axis of the scatterplot is per capita GNP (personal income). The y axis is hosts per 1,000,000 population. Both axes are logarithmic. The points on the scatterplot are ISO 3166 two letter country codes (a table of them appears later in this paper). These are the same codes that are used for top level DNS domains (except the DNS domain for the United Kingdom is uk, not gb). The host counts per country do not depend on top level domains, however. The size of each code as printed on the plot indicates the size of the country. The meanings of the type sizes are indicated by the numbers in the lower right corner of the scatterplot. The largest size, of a billion people or more, applies only to China (cn), which is not on the Internet and thus not on the scatterplot.

The next size down applies only to India (in), which is visible towards the lower left of the plot. The United States (us) fits the third size, and is towards the upper right. There appears to be some correlation towards an axis running approximately from India to the U.S., passing between Ecuador (ec) and Tunisia (tn), through Mexico (mx), Korea (kr), Singapore (sg), Hong Kong (hk), near Germany (de), Netherlands (nl), and Canada(ca). Poland (pl), South Africa (za), and Czhechoslovakia (cs) are noticably above the axis. Most of the rich countries below the line are small. Of the large rich countries, France (fr) and Italy (it) are low, and Japan (jp) is markedly below the axis.

The anomaly in the upper left is Antarctica (aq), shown with its winter (smallest) population of about 1,000 people, which makes even the 32 hosts counted for it show a very high host/population number. We have no reliable source for GNP for the former Soviet republics, so the three xUSSR countries on the Internet, Estonia (ee), Latvia (lv), and Russia (ru) are shown, like Antarctica, with an arbitrary low per capita GNP so that they will appear out of the way on the left of the scatterplot. We could guess from their hosts/population placement that the Baltics are richer than Russia.

The correlation of hosts per capita with personal income shown in this scatterplot is not as strong as we would have expected. But there is a noticeable correlation. All the most networked countries are also rich countries, for example. Does this mean that lesser developed countries (LDCs) will not gain many hosts per capita until they become wealthier? Poland (pl), Chile (cl), Hungary (hu), Czechoslovakia (cs) and Portugal (pt) appear to have already disproven this speculation, as can be seen in the scatterplot. The growth map shows even more clearly that the LDCs are the fastest growing countries on the Internet. Internetworking used to be a difficult and expensive endeavor, but costs are dropping and vendors are cleaning up code and interfaces. Meanwhile, much more can be done with inexpensive existing hardware and software than is usually done in the richer countries. The rest of the world is joining the Internet, and catching up.

Here is a table of ISO 3166 country codes and corresponding country names.

ae	United Arab Emirates	gf	French Guiana	nz	New Zealand
am	Armenia	gl	Greenland	pa	Panama
aq	Antarctica	gp	Guadeloupe	pe	Peru
ar	Argentina	gr	Greece	pf	French Polynesia
at	Austria	gu	Guam	pg	Papua New Guinea
au	Australia	hk	Hong Kong	ph	Philippines
az	Azerbaijan	hn	Honduras	pk	Pakistan
ba	Bosnia Hercegovina	hr	Croatia (Hrvatska)	pl	Poland
be	Belgium	hu	Hungary	pr	Puerto Rico
bf	Burkina Faso	id	Indonesia	pt	Portugal
bg	Bulgaria	ie	Ireland	py	Paraguay
bh	Bahrain	il	Israel	qa	Qatar
bo	Bolivia	in	India	re	Reunion
br	Brazil	ir	Iran	ro	Romania
bw	Botswana	is	Iceland	ru	Russia
by	Belarus	it	Italy	sa	Saudi Arabia
ca	Canada	jm	Jamaica	sc	Seychelles
cg	Congo	jp	Japan	se	Sweden
ch	Switzerland	ke	Kenya	sg	Singapore
ci	Cote D'Ivoire	kg	Kyrgyzstan	si	Slovenia
cl	Chile	kr	South Korea	sn	Senegal
cm	Cameroon	kz	Kazakhstan	sr	Suriname
cn	China	li	Liechtenstein	tg	Togo
co	Colombia	lk	Sri Lanka	th	Thailand
cr	Costa Rica	lt	Lithuania	tj	Tajikistan
cs	Czechoslovakia	lu	Luxembourg	tm	Turkmenistan
cu	Cuba	lv	Latvia	tn	Tunisia
cy	Cyprus	md	Moldova	tr	Turkey
de	Germany	ml	Mali	tt	Trinidad and Tobago
dk	Denmark	mn	Mongolia	tw	Taiwan
do	Dominican Republic	mo	Macau	ua	Ukraine
ec	Ecuador	mu	Mauritius	ug	Uganda
ee	Estonia	mw	Malawi	us	United States
eg	Egypt	mx	Mexico	uy	Uruguay
es	Spain	my	Malaysia	uz	Uzbekistan
et	Ethiopia	mz	Mozambique	ve	Venezuela
fi	Finland	na	Namibia	vi	Virgin Islands (U.S.)
fj	Fiji	nc	New Caledonia	vu	Vanuatu
fr	France	ne	Niger	yu	Yugoslavia
gb	United Kingdom	ni	Nicaragua	za	South Africa
gd	Grenada	nl	Netherlands	zm	Zambia
ge	Georgia	no	Norway	zw	Zimbabwe

The Service Maps

A simple Internet connection brings benefits to the connecting site. But maturity in Internet participation is indicated by a site providing services as well as using them, and by providing the more recent and sophisticated services.

The two maps of services show data to the city level, rather than to the country or state level. The services mapped are anonymous FTP, archie, gopher, and WAIS. The data for anonymous FTP and archie come from the public lists kept by archie, and the gopher and WAIS data from their respective public top level lists. These service maps distinguish the services by both shape and color. The number of servers for a given service in a specific locality is shown by the size of the icon for that service. The scales used here are also exponential. Each larger icon in the legend represents ten times as many servers. The sizes shown in the legend are representative, not exclusive, and the icons in the maps are not limited to those sizes; an icon in a map can be any size representing an integer.

The archies shown are only those in the public archie list. There are actually quite a few more archies out there, in many European countries, in Korea, and elsewhere. Austria even has two. But those other archies are in some sense private, at least to their countries, so we do not show them here.

We show WAIS servers, with no weighting for number of WAIS database per server. WAIS databases would also be interesting to map.

You can see at a glance that most of these services are limited to North America, western Europe, Australia, and Japan. The data is for January 1993, but is already out of date. There are gopher services in Chile, Brazil, and Mexico, for example. The gopher in Mexico is not in the top level gopher list, and would not show up anyway. It would be interesting to map a more exhaustive gopher list.

Differences in geographical distribution among the services are visible in the maps. Anonymous FTP is the most widespread, followed by gopher, WAIS, and archie, in that order. However, archie servers appear in a few places WAIS does not. The need for geographic distribution is somewhat different for archie and WAIS. Having a local archie server reduces traffic over a country's links to the rest of the world, since archie indexes anonymous FTP sites, and having those indexes more locally available saves having to transfer them over more distant links. Adding a local WAIS server probably does the opposite effect, since people elsewhere in the world will now be using that WAIS server.

Gopher seems to be somewhat more widely distributed than WAIS. Exactly why is not clear. Perhaps gopher is easier to install? Maybe because the gopher user interface is more general, permitting access to more types of services? Maybe gopher is less constrained to English? We don't know, but these maps raise such questions.

{Paste in the map “Services Worldwide” here.}

{Paste in the map ‘‘Services in North America’’ here.}

Summary

We find geographic maps are convenient for giving overall impressions of data, and for some detailed comparisons. For especially detailed comparisons, tables of precise numbers may still be necessary. But data can be much more visible in maps than in tables, since maps are ordered in two or three dimensions, unlike the linear alphabetic or numerical order of tables. Data in maps can motivate using tables to find out more about what is seen in the maps. Maps alone are often not enough, but maps add value that other graphical techniques for depiction of numerical data do not. We expect to produce more maps as we obtain more current and more detailed data.

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