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Or. Eng.

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INTERNET INFRASTRUCTURE INDICATORS

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Or. Eng.

FOREWORD

In September 1998 this report was presented to the Working Party on Telecommunications and Information Services Policy (TISP) and was recommended to be made public by the Committee for Information, Computer and Communications Policy (ICCP).

The report was prepared by Dr. Sam Paltridge of the OECD's Directorate for Science, Technology and Industry. It is published on the responsibility of the Secretary-General of the OECD.

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MAIN POINTS

The Internet stands out as an extremely dynamic medium, even by the standards of rapid change which increasingly characterise the communications sector. In large part, due to this dynamism, Internet governance best lends itself to self-regulatory models. Among OECD governments, there is a strong preference for the private sector to take the lead in developing self-regulatory approaches suited to the new environment. There is increasing recognition that this is a critical requirement for the growth of electronic commerce. At the same time, the trend toward regulatory forbearance in the communications sector, on the part of governments, does not obviate the need for policy makers to better understand how the Internet is evolving and to assess policy implications.

Ready access to available indicators, in areas such as infrastructure development, is fundamental to better understanding the networks which enable electronic commerce. From a policy perspective such indicators are also important. Recent examples, where indicators have been used to inform issues include the management and administration of the domain name system, as well as trying to assess the impact of mergers on the level of competition in Internet backbone markets. Internet indicators may also help to inform issues related to convergence, between different communication platforms, as the Internet develops more multi-media capabilities. In addition new issues may arise where there are tradeoffs between technological limitations and competition questions, such as in IP number portability. As the Internet expands it can be expected that the use of indicators will increase in both the public and private sectors.

Following the discussion at the OECD/OSIPP's Internet workshop in Osaka, held on 10 June 1998, this paper is aimed at providing a discussion, and reference document, of available Internet infrastructure indicators for policy makers and industry self-governance initiatives. Expressed in bullet point form the main objectives are:

- to provide a reference document for policy makers pertaining to available online information generated by online surveys and Internet network co-ordination, such as the Internet's name and addressing system;

- to discuss new indicators of Internet infrastructure development, such as the use of traceroutes or other tools to indicate market position and inform discussion of Internet traffic exchange;

- to provide a discussion of new tools, in the absence of traditional infrastructure indicators, which might help to contribute to a better understanding of emerging patterns of electronic commerce such as indicators of hypertext links between OECD countries;

- to assist in building a better understanding of the importance of infrastructure indicators.

INTERNET INFRASTRUCTURE INDICATORS

Introducing Internet infrastructure and indicators

The subject of Internet indicators is very large and encompasses more than infrastructure. A broader discussion might include, for example, indicators of network pricing, revenue or particular applications such as e-mail. That being said it is not an easy task to categorise Internet infrastructure indicators or draw a line between indicators of infrastructure and usage. Clearly, a number of 'usage indicators' can be used to inform discussion of Internet infrastructure development and performance. The most significant, in this context, are indicators of the most accessed sites on the World Wide Web. Another example is the hyper-text links between different domains that form the pathways for electronic commerce.

Given the inter-related nature of the Internet, infrastructure indicators are vitally important for Internet Service Providers (ISP) and policy makers. For infrastructure providers and users, these indicators play an increasingly important role in underpinning Internet self-governance and self-regulation. *For each of the key reasons expressing why self-regulation is preferred by the Internet community, information to inform that process is essential (Box 1).* If one ISP does the 'wrong thing', in terms of its inter-action with the Internet, it can impair the network and service performance for all ISPs. This can range from problems with day-to-day network quality management right up to, in the worst case, bringing traffic flows on the Internet to a standstill. Just as policy makers have needed indicators for regulation in traditional communication sectors, the Internet industry needs infrastructure indicators for self-regulation.[1]

For policy makers familiarity with Internet infrastructure indicators is important in a number of areas. One aspect is the increasing number of regulatory issues being placed before governments, not only in relatively unfamiliar issues at the core of the Internet (e.g. the debate over domain names) but also in areas where the Internet is converging with other communication platforms (e.g. public switched telecommunication network and broadcasting regulation). Moreover, a better understanding of Internet infrastructures is an important element underpinning wider issues bearing on electronic commerce. They can provide a better understanding of the challenges for the private sector in upgrading infrastructure and of comparative national performance. They also provide an important input into a better understanding of how the Internet is becoming more critical for overall economic and social development in OECD countries.

The main criteria for inclusion of indicators in this document is that the data were generated by network surveys (e.g. queries of Internet Protocol network databases and objects connected to Internet Protocol networks) or by entities that play a role in administering core Internet infrastructure. In respect to the first criteria, online or electronic network measurements would qualify but an off-line survey or e-mail based surveys are not included. The exclusions are not because such surveys may not provide valuable information but rather because the off-line survey methodologies used are generally well known. In addition, their exclusion assists to narrow the scope of this document to a manageable level and to focus on indicators that often rely on the policy maker to bring together data from different sources to generate the indicator. The second criteria includes data that are collected by the managers of core infrastructure surrounding the Domain Name System (DNS), such as second and third level domain registration, Internet Protocol (IP) number assignment, Autonomous System Number (ASN) assignment.

As this document excludes off-line surveys it does not try to answer the question of how many users access the Internet. Some useful Internet Websites on this subject, with the summaries of attempts to draw together the results of official and commercial surveys, are those of HeadCount and NUA (Table 1). How reliable the underlying results are for each country depends on the individual surveys and there is, of course, no harmonisation of methodologies. At the same time some of the Internet's core administrative entities, in some countries, are collecting useful data from among their members. In this context a leading example is KR-NIC, the organisation which administers domain names and IP addresses in Korea, which surveys Korean Internet Service providers (ISPs) to determine their number of business connections and dial-up subscribers. KRNIC is then able to publish national Internet subscriber statistics for Korea.

The structure of this document is as follows. The first section briefly discusses on-line network surveys of Internet hosts and servers. This is progressively followed by discussions of indicators of the Internet's naming and addressing systems including domain names, IP addresses and autonomous system numbers. As appropriate, references are made to governance and regulatory issues where these indicators are being used to inform debate or form a tool used by industry for self-regulation. The final sections discuss the use of tools that can be constructed by policy makers by using some of the Internet tools. Whereas surveys of hosts, servers and so forth are undertaken by the Internet's technical community, tools are available for policy makers to generate infrastructure indicators. These include the use of traceroutes to provide an indicator of market position and a better understanding of traffic exchange in backbone networks. In addition, the use of search engines to provide information on the implementation of webcasting technologies and the topography of Internet hyper-text links to leading electronic commerce sites and between domains is discussed. By way of example, a matrix of all the hyper-text links between domains for the OECD area is made available. Accordingly, it is possible to see the emerging pathways of electronic commerce between OECD countries. Finally, readers may find the references to electronic glossaries at the end of this document a useful aid in respect to Internet terminology.

Box 1: Extract on Internet Self-regulation from Professor Tamar Franklin's Opening Statement at "Toward an Internet Assigned Numbers Entity: Charter Stakeholders Workshop", Reston, 1-2 July 1998. http://www.giaw.org/statement.frankel.htm (Emphasis added)

"Self regulatory organisations usually arise under certain conditions, which in the case of the Internet communities seem to be absent. However, on closer examination, other conditions are present in the Internet context, with similar effects.

First, the members of self regulatory organisations have a homogeneous business (e.g. broker dealers, lawyers, or medical doctors). Members of the Internet do not have a homogenous business. However, they are all inter-connected. **If they do not work in harmony, the whole structure may malfunction.** In this respect the Internet communities are to be viewed as homogenous.

Second, members of a self regulatory organisation deal with each other as part of their businesses: broker dealers trade with each other on behalf of their customers, lawyers refer clients to each other and work on transactions. They establish arbitrations and other mechanisms for solving their disagreements. **Not all members of the Internet communities deal with each other. But various groups deal with others continuously. All members are interested in resolving their disputes effectively and efficiently.** They can be viewed as dealing with each other.

Third, members of a self regulatory organisation usually have a strong interest in maintaining their reputation, for example, stock exchanges. Although reputation is not the strongest driving force for all members of the Internet communities, each group has a high stake in maintaining public trust of a somewhat different kind: **Internet professionals desire reputation as innovators; commercial service providers desire reputation as credible and reliable providers, and so on.**

Fourth, **members of self regulatory organisations would rather be regulated by their competitors (who know the business and are subject to the same rules) than by the government** that is ready to regulate. Even ...[so]... governmental bodies ... may move to regulate the Internet communities if they do not do so for themselves. It seems that most communities of the Internet would prefer self regulation."

Internet infrastructure indicators

Internet hosts and servers

The most common indicators used to measure Internet development are the surveys of Internet hosts undertaken by Network Wizards and RIPE (Reseaux IP Européens) (Table 1). Network Wizards define an Internet host as a domain name that has an associated IP address record. This would be any computer system connected to the Internet (via full or part-time, direct or dial-up connections), such as oecd.org and www.oecd.org.[2]

The Network Wizards survey includes all Top Level Domains (TLDs) and generic Top Level Domains (gTLDs) and is undertaken every six months. The RIPE survey is undertaken monthly but is limited to TLD registrations in their service area.[3] While both surveys are much appreciated by the Internet community the results need to be qualified and have several limitations. The first qualification that needs to be made is that host data do not indicate the total number of users who can access the Internet. The second caveat is that these surveys do not reach every host on the Internet, as access to some hosts is blocked by company fire-walls. Recognising the limitation of this second factor Network Wizards changed their methodology for the survey undertaken in January 1998 to enable access to a greater number of hosts.[4] Notwithstanding this change, surveys of Internet hosts may only be interpreted as the minimum size of the 'public Internet', as it is impossible to determine the number of users accessing services via each host.

The Netcraft Web Server Survey is a survey of web server software usage on computers connected to the Internet.[5] Netcraft collect and collate as many hostnames providing an http-service as their survey can find, and systematically poll each one with an HyperText Transfer Protocol (HTTP) request for the server name. A host name is the first part (before the first dot) of a hosts' domain name (e.g. www). In the July 1998 survey Netcraft received responses from 2 594 622 web servers. The growth rate for the first half of 1998 was 41 per cent. Some 96 per cent of these servers are in the OECD area. By far the largest number of web servers are under **.com** which has 60 per cent of all web servers. As for Internet hosts, it is possible to provide penetration by domain and to weight this by the number of gTLD registrations. The country providing the most responses, on a per capita basis, is Denmark. This is because there are a lot of small virtually hosted sites in Denmark. Netcraft report, that while this is a characteristic of many countries, it is particularly so in Denmark and the Netherlands. TeleDanmark and Cybercity operate two of the largest virtual hosting sites in Denmark.

Internet surveys of hosts and servers provide one indicator of Internet development and may be used as one potential indicator of comparative Internet development between countries. The main limitations are not reaching all hosts or servers, and the structure of the domain name system being such that there is no guarantee that all hosts under a particular domain are located in a certain geographic location. For example, the reachable hosts of a user in France, registering under a gTLD, would appear under domains such as **.com** or **.net** rather than **.fr**. Nor is it necessarily the fact that a host using a second level domain under **.fr** will be physically located in France. That being said the OECD's observations, from an series of traceroutes to Websites under TLDs, are that by far the majority of hosts using TLDs are located in the country concerned.

In 1997, Imperative Inc. published active domains registration under gTLDs for OECD countries (Table 2).[6] The availability of gTLD registrations by country presented the first possibility of redistributing Internet hosts under domain names such as **.com** to individual countries. This was undertaken in the report entitled "Internet Traffic Exchange: Developments and Policy".[7] The most simple option, used to prepare this report, was to weight the number of hosts under gTLDs according to the number of gTLD registrations from a particular country. In other words if 5 per cent of the total gTLD registrations are from a particular country then 5 per cent of the total number of hosts surveyed under gTLDs are reallocated to that country.

This methodology could, no doubt, be subject to a number of caveats. Nevertheless it seems reasonable to assume that this approach gives a more accurate distribution of Internet hosts, in OECD countries, than allocating all hosts under gTLD registrations to the United States. The results of the weighted methodology are most striking in the case of Canada where, for mid 1997, there was a 72 per cent increase in the number of hosts over the number of hosts surveyed solely under **.ca**. Other countries recording significant increases at that time, albeit from smaller base numbers of hosts, were Turkey, Spain, Luxembourg and France. All these countries recorded a relatively large increase in the number of hosts relative to the average OECD increase of 21 per cent. The countries for which this made very little difference are those where users mainly rely on national TLD registrations, such as Iceland, the Czech Republic, New Zealand, Poland and Finland. Figure 1 shows this methodology applied to the Network Wizards survey for July 1998. Figure 2 shows the same methodology applied to the Netcraft web server survey.

The Netcraft Server surveys also provide one of the best available indicators of the growth of electronic commerce on the Internet. Whereas the best known search engines only cover http sites, Netcraft also undertakes a secure socket layer (SSL) survey. The SSL protocol was developed by Netscape for encrypted transmission over TCP/IP networks. It sets up a secure end-to-end link over which http or any other application protocol can operate. The most common application of SSL is https for ssl-encrypted http which enables electronic commerce to take place.

In August 1998, Netcraft received responses from more than 424 000 web sites using encryption. However most of these responses are excluded, in terms of electronic commerce web sites, because they do not have third party certification. Sites without a third party certification are not expected to be engaging in electronic commerce because of the warning message that gets generated. The key element for electronic commerce is third party certification with matching certificate. Netcraft say plausible reasons for the large number of responses, where the name in the certificate did not match the site's domain name, might include web sites run from virtual hosting configurations where the provider sets up all customers with https services, with customers buying certificates when they start to make use of the facilities. A second example is sites using generic test certificates to experiment with SSL. Netcraft adds that sites where the certificate issuer is not a known certificate authority, typically indicate that that site has generated and signed its own certificate, which is acceptable for prototyping, or where trust is not required outside a limited group of people, such as a company, or collaborative project. This is likely to be more commonplace on internal networks than on externally visible Internet sites.

The major electronic commerce uses of secure server software are for encrypted credit card transactions over the Internet. The most common non-retail use of SSL is subscription access to privileged information. For example many of the leading United States investment banks disseminate research over SSL, and there are some applications for virtual private networks or closed access communities.

By excluding sites without third party certification it is possible to get an indication of the number of electronic commerce sites in each OECD country. Unlike the Internet host and general Netcraft web server survey, the SSL survey does not use the domain name system to categorise location but uses the actual address of the business. In August 1998, there were over 22 200 web sites engaged in electronic commerce via SSL in the OECD area. This number had grown by 128 per cent over the previous twelve months. The United States is a clear leader with three quarters of all electronic commerce sites but its overall share is falling as electronic commerce picks up speed in other countries. Albeit starting from smaller bases, the number of electronic commerce sites grew by more than 300 per cent over the previous year in some OECD countries. Australia, Canada, and the United Kingdom have the highest number of electronic commerce Websites after the United States. In relative terms the United States also leads the OECD with more than six electronic commerce sites for every 100 000 inhabitants followed by Iceland, Australia and Canada (Figure 3).

Domain Name System

The Domain Name System (DNS) maps Internet addresses. To function as part of the Internet a host needs a domain name that has an associated Internet Protocol (IP) address record. This includes any computer system connected to the Internet via full or part-time, direct or dial-up connections. DNS servers perform the necessary function of translating back and forth between names and numbers. These servers contain databases of IP addresses and corresponding domain names and they are interrogated each time a user wants to send an e-mail or request data over the World Wide Web.

A top-level domain name (TLD) can either be an ISO country code (for example **.be** stands for Belgium) or one of the generic top level domains (a so-called gTLD such as **.com, .org**, **.net**). To register a second level domain name (e.g. **oecd.org**) or a third level domain name (e.g. **mpt.go.jp**) a user needs to apply to the domain name registry with the delegated authority for the TLD or gTLD. Some registries publish data on the number of registrations on a monthly basis while others publish intermittently (Table 2). The Internet Hosts surveys undertaken by Network Wizards and RIPE also provide, as a by-product, an indicator of the number of registrations under each domain.

The main importance of DNS indicators are that they can be used to inform discussions over the different policies and prices of TLD and gTLD registries. Whether the registration process under a certain domain name is subject to industry self-regulation or government oversight, the availability of DNS data is important to ensure transparency in registration management for service providers, business users and consumers. This is particularly important in those cases where a monopoly or monopoly power exists in the registration of second and third level domain names. The second utilisation is to use registration data to enhance the understanding of host surveys and the structure of hyper-text links (see later section).

Whois?

To determine the person or company to which a domain name, IP address or ASN has been assigned or allocated users can access a number of 'Whois?' databases (Table 2). These tools can provide useful information for constructing certain Internet indicators. Generally a 'Whois?' database entry will provide the name of a registrant (company or an individual with specific function such as billing or technical contact) and address information. While this information is not always reliable, and some users would like to see additional information or functionality included, the various 'Whois?' databases are valuable resources for the Internet community. The United States White Paper "A Proposal to Improve the Technical Management of Internet Domain Names and Addresses Discussion Draft", contained a number of suggestions for the type of information that should be included in domain registration databases and it will be up to the new DNS authority to work through guidelines in this area.[8] Publication of aggregate data, such as the number of gTLD registrations by country, would certainly provide a valuable source of information for constructing Internet indicators.

IP addresses

Internet Protocol (IP) addresses are the numbers used to identify computers, or other devices, on a TCP/IP network.[9] Networks using the TCP/IP protocol route messages based on the IP address of the destination. The format of an IP address is a 32-bit numeric address written as four numbers separated by periods. Each number can be zero to 255. For example, 193.51.65.17 is one IP address used by the OECD.

On a stand alone private TCP/IP network, IP addresses can be assigned at random as long as each one is unique to that network. If that private network connects to the Internet it requires a registered IP address to avoid duplication. The current version of IP (IP version 4 or IPv4), which was standardised in 1981, created a pool of 4 294 967 296 IPv4 addresses.[10] Originally these numbers were assigned under three classes known as Class A, Class B and Class C (Box 2). However, as the Internet expanded, concern arose that the existing numbers would be exhausted and that the size of the global routing tables was in danger of growing faster than the capabilities of the underlying equipment. Given the huge volume increases in the size of the routing tables, concerns were raised that core routers would be forced to drop routes, and portions of the Internet would become unreachable.[11] A further problem was that net blocks, under Classes A, B and C, were often too large or small for differing organisations needs.

To address these concerns the Internet's technical community introduced Classless Inter-Domain Routing (CIDR), a new IP addressing scheme that replaces the older system based on Classes A, B, and C. CIDR enables more efficient allocation of the IPv4 address space allowing for the continued growth of the Internet until a new numbering system (IPv6) is deployed. It is projected that IPv6, which will create a virtually unlimited resource of IP numbers, will be increasingly used from the year 2000, and play a significant role by around 2003 to 2005. Before that time it is envisaged that IPv4 allocations and assignments will be made with an eye to the finite nature of the existing resource and the need to minimise growth in the size of the routing table.

Originally blocks of IP addresses were directly allocated by the Internet Assigned Numbers Authority (IANA).[12] While in some cases the IANA still makes direct assignments to organisations most allocations are now made to three regional bodies -- APNIC (Asia-Pacific Network Information Center), ARIN (American Registry for Internet Numbers) and RIPE NCC (Reseaux IP Européens Network Co-ordination Centre) (Table 2). These organisations subsequently re-allocate or assign IP addresses to individual organisations, such as ISPs or national bodies co-ordinating IP address space for a certain country (e.g. KR-NIC in Korea and JP-NIC in Japan). As a general rule, end users receive IP assignments from their ISP. Notwithstanding this some ISPs receive addresses from upstream or backbone ISPs and some end users receive allocations directly from a registry or directly from the IANA.

The question of the whether the institutions allocating IP addresses at various levels have monopolies, in terms of guiding their self-governance practices, is important. Reform to the IANA is ongoing at the time of writing which takes into account its monopoly position. Whether the three regional registries have a total monopoly position is less clear because ISPs can, and do, apply to different registries (including allocations made to industry sectors such as the Cable Television Network based ISPs). In addition, apart from convention, there may be nothing to stop an entity with a very large net block from reselling this resource in competition to the regional registries.[13] Certainly many entities at the sub-regional registry level 'resell' IP numbers.

The best sources of data on IP addresses are the three regional IP address registries. However, the policies and practices of each organisation mean the dissemination of IP allocation and assignment is carried out in different forms (Table 2). APNIC publishes time series data for assignments in its Annual Report together with a very useful analytical discussion of significant trends.[14] RIPE maintains a database of allocated address space which indicates the date of allocation, the size of allocation, and the type of allocation.[15] These data are grouped by RIPE under country TLDs (and 'EU' representing the European region) and listed by the recipient organisation. By clicking on the IP number assigned to a certain entity, RIPE's database displays contact names and other information. ARIN maintains a 'Whois?' which enables users to query their database of their assignments and those of the IANA.[16] While the ARIN 'Whois' enables a user to look up a particular assignment via an IP address, or all assignments by company name, it is less easy to get an overview of total assignments and trends than at RIPE or APNIC.

A further indicator to assist in the understanding of IP address allocations is work which has been undertaken by the Cooperative Association for Internet Data Analysis (CAIDA) to enable visualisation of IP address occupancy (Table 1).[17] CAIDA says "... analysis and visualisation of the Internet Protocol (IP) v.4 address space reflects how current Internet address space is allocated (to institutions and ISPs) and the degree to which allocated space is actually being advertised and routed across the Internet infrastructure. Such depictions of the address space can also provide inputs for analysis of public policy (equity) issues, as well as information for evaluating engineering and operational aspects of the commercial Internet."[18] The CAIDA visualisation tool is shown in Figure 4. The bands show allocated address space and the specks indicate those parts of the address space which are reachable via the public Internet.

To see individual IP number assignments it is necessary to look at the available information from the regional databases of the three regional registries. The best starting point is ARIN's 'Whois' database which can be used to generate the first level of allocations and reservations made by the IANA (Table 3). The largest individual blocks of IP addresses, formerly called Class A, are between numbers 1 and 127. Given the origins of the Internet many of these blocks were historically allocated to United States military, military contractors and academic institutions. It is possible to generate the individual records of each of these net blocks by placing X.0.0.0 (where X equals the first network number). For example, placing 4.0.0.0 in the ARIN 'Whois?' will produce the record for BBN's allocation. Similarly typing 63.0.0.0 in the search field will reveal this block of IP addresses is allocated to ARIN who then reassigns smaller amounts of address space to applicants. Most of the 'A Class' blocks received directly by individual organisations were assigned by the IANA prior to the creation of ARIN.

The data in Table 4 and Table 5 show the largest assignments by RIPE and APNIC respectively. Many of the organisations with the largest allocations from RIPE and APNIC can, and do, apply for additional allocations from ARIN. The data shown are just reassignments made by RIPE and APNIC from their allocations from the IANA. Notwithstanding this limitation the data reveal a trend towards traditional telecommunication carriers gaining the largest allocations of IP addresses. In Europe telecommunication carriers, or group alliances between carriers, hold the majority of IP addresses. This is due to telecommunication carriers emerging as some of the largest ISPs, in their own right, and by taking over the largest independent ISPs. Several university networks retain large IP address blocks and some government agencies have large allocations, such as the National Health Service in the United Kingdom.

In the Asia/Pacific region data on individual allocations are not always available at the national registry level because of the past or present role of national Network Information Centres (NICs). In Japan JP-NIC publishes a list of IP allocations by company name and KR-NIC publishes a current total of all IP address space allocated to it for Korea. In the APNIC database the largest individual allocation is to Telstra (203/10), which was originally allocated to the Australian Academic Research Network acting as AU-NIC. Telstra inherited this allocation when it purchased AARNet/AUNIC. As such, significant parts of the 203/10 space have been allocated to ISPs in Australia, although Telstra still announces this group of IP addresses to the rest of the Internet. At the same time, individual ISPs from Australia have gone directly to APNIC for address blocks. To show overall allocations by country, the data in Table 6 present the APNIC and RIPE assignments by country rather then entity. However, it needs to be borne in mind that these are just APNIC and RIPE reassignments and that significant IP resources have also been assigned by ARIN and the IANA to entities in these countries. For example, the Department of Social Security in the United Kingdom's historic 'A Class' allocation (51/8) is nearly twice the size of all allocations made to ISPs and other UK users in the United Kingdom via RIPE.

Some of the main self-governance issues, relating to infrastructure, facing the Internet community are in the management of the existing IPv4 address space. These include:

- co-ordination of the three existing IP address registries;
- proposals to create new regional registries;
- the criteria for allocation of IP addresses;

- the pricing structure used by registries for this resource.

Issues such as these can generate vigorous discussion within the Internet community and raise governance questions of a similar nature to the controversial DNS debate. Perhaps the main differences with IP address issues are that the main players are ISPs, rather than the much larger community which took an interest in DNS, and the absence of intellectual property concerns associated with trademarks and domain registration. Notwithstanding these differences, because the existing allocation of IP addresses are a monopoly, at least in one sense, the IANA and regional registries need to observe standards of *openness*, *transparency* and *public accountability*. An essential part of this process, and *a pre-requisite for self-governance, is the publication of data and indicators in a readily accessible form to the Internet community*.

While the management of IP addresses is best done by the private sector, policy makers need to have an understanding of the IP address system because of its potential to spill over into matters placed before governments. The most significant case in point is the ongoing problem of IP address portability and the competition questions raised. For example, if a relatively small ISP can not get a direct allocation of IP address space from a registry they need to borrow numbers from upstream ISPs. If a small ISP then wishes to change its upstream (i.e. backbone provider), it has to return the borrowed IP numbers to the larger provider. In effect this means the smaller ISP has to renumber its network, which can be expensive and disruptive for its customers, if it wants to change backbone providers. This issue was raised in the context of the proposed merger of Worldcom and MCI which was considered by competition authorities in the United Sates and Europe. The concern voiced by some relatively small ISPs, arguing against this merger, was that if a dominant player in the backbone market abused that position they would face a high cost to shift providers because of the lack of number portability. At the same time, the technical reasons for not encouraging portability for small address assignments and the attendant increase in the size of the routing table this would cause (discussed in the next section) need to be borne in mind. According to some experts the portability problem will not be solved by the introduction of IPv6.[19]

Box 2: Extract from "Understanding IP Addressing: Everything You Ever Wanted To Know", by Chuck Semeria. http://www.3com.com/nsc/501302.html

Class A Networks (/8 Prefixes)
Each Class A network address has an 8-bit network-prefix with the highest order bit set to 0 and a seven-bit network number, followed by a 24-bit host-number. Today, it is no longer considered 'modern' to refer to a Class A network. Class A networks are now referred to as "/8s" (pronounced "slash eight" or just "eights") since they have an 8-bit network-prefix.

A maximum of 126 (2 7 -2) /8 networks can be defined. The calculation requires that the 2 is subtracted because the /8 network 0.0.0.0 is reserved for use as the default route and the /8 network 127.0.0.0 (also written 127/8 or 127.0.0.0/8) has been reserved for the "loopback" function. Each /8 supports a maximum of 16 777 214 (2 24 -2) hosts per network. The host calculation requires that 2 is subtracted because the all-0s ("this network") and all-1s ("broadcast") host-numbers may not be assigned to individual hosts.

Since the /8 address block contains 2 31 (2 147 483 648) individual addresses and the IPv4 address space contains a maximum of 2 32 (4 294 967 296) addresses, the /8 address space is 50 per cent of the total IPv4 unicast address space.

Class B Networks (/16 Prefixes)
Each Class B network address has a 16-bit network-prefix with the two highest order bits set to 1-0 and a 14-bit network number, followed by a 16-bit host-number. Class B networks are now referred to as"/16s" since they have a 16-bit network-prefix.

A maximum of 16 384 (2 14) /16 networks can be defined with up to 65 534 (2 16 -2) hosts per network. Since the entire /16 address block contains 2 30 (1 073 741 824) addresses, it represents 25 per cent of the total IPv4 unicast address space.

Class C Networks (/24 Prefixes)
Each Class C network address has a 24-bit network-prefix with the three highest order bits set to 1-1-0 and a 21-bit network number, followed by an 8-bit host-number. Class C networks are now referred to as "/24s" since they have a 24-bit network-prefix. A maximum of 2 097 152 (2 21) /24 networks can be defined with up to 254 (2 8-2) hosts per network. Since the entire /24 address block contains 2 29 (536 870 912) addresses, it represents 12.5 per cent (or 1/8th) of the total IPv4 unicast address space.

Autonomous systems

Autonomous systems numbers (ASN, ASes or AS numbers) acts as a label for a set of IP addresses and are used by ISPs to specify the global routing policy for those IP addresses.[20] On the Internet packets of data are passed between devices known as routers. Part of this process involves consultation of the routing table to determine the best onward path. A routing policy indicates 'reachability information', and hence enables traffic to pass between the networks of different ISPs. For example, if an ISP has two connections to 'the Internet', it is often useful to spread traffic out over those two links. An ISP's routing policy indicates how the traffic will be sent, e.g. traffic to ISPs X, Y, and Z should go out from Connection One, traffic to ISPs A, B, and C should go out via Connection Two. This policy is then propagated in order to insure that traffic (both incoming and outgoing) flows in the correct direction and that reachability of the addresses of an ISP providing services can be assured.

AS numbers are allocated by APNIC, ARIN and RIPE. These registries apply certain criteria to the assignment of AS numbers for reasons outlined by RIPE:

> "The creation of an AS should be done in a conscious and well coordinated manner to avoid creating ASes for the sake of it, perhaps resulting in the worst case scenario of one AS per routing announcement. It should be noted that there is a limited number of AS numbers available. Also creating an AS may well increase the number of AS paths modern Exterior Routing Protocols will have to keep track of. This aggravates what is known as "the routing table growth problem."[21]

In practice this means that most end users and small ISPs do not receive an individual AS number but instead use their upstream service provider's AS number. If an ISP only has one connection to the Internet (i.e. it is singly homed), it only has one way in which traffic can flow, thus it does not need an AS number (and in fact, the registries will not delegate them in these cases). However, the downstream ISP will still be exchanging traffic with the Internet, albeit under the AS number of their upstream provider. The distinction between being single-homed and multi-homed refers to the number of connections a small ISP, or content provider, has to the Internet via different backbone infrastructure providers. If an organisation is connected to the Internet via one ISP it is single-homed, but if it receives connections from two, or more, ISPs it is multi-homed.

Data on individual AS number allocations are available from ARIN (Table 2) and there are a number of tools which use AS numbers to plot visualisations of Internet routes (Table 1). A related set of tools examines the size of the routing tables between AS numbers (Table 1). These indicators plot the size of the routing table, and provide a guide to the Internet's infrastructure providers of policies aimed at minimising routing table growth. A related tool analyses routing tables to produce a list of possible routes which could be aggregated to reduce the size of the routing table. Indicators such as these perform a very useful function for industry self regulation as they highlight individual ISPs which could do a service to the entire Internet by aggregating routes. In short, this indicator provides an important self-regulatory tool for ISPs, as described below.

While AS numbers are a limited resource, there being only 65 536 of them, the most pressing resource issue is the growth in the number of routes between AS numbers. Internet backbone routers need to maintain the complete routing information for the Internet.[22] As the Internet has expanded, so too have the number of routes between AS numbers. At the close of 1990 there were around 2 200 such routes. By the end of 1992 this had grown to 8 500 routes and by 1995 increased to more than 30 000 routes. In June 1998 there were just over 56 000 routes between AS numbers on what might be termed the core of the Internet (i.e. all routes between AS numbers that have no default route).[23] This rapid growth has been a cause for concern among the Internet's technical community because it was felt that there was a limit to the amount of global routing information able to be accommodated by backbone routers.[24]

In mid-1997 an accident occurred which demonstrated the 'high-watermark' for the 'core Internet' and the fragility of the Internet.[25] This was due to one Autonomous System accidentally re-announcing the entire Internet through itself resulting in a sudden doubling in the number of global routes to just over 80 000. As a result backbone routers around the world were overloaded as they did not have enough memory to cope with the additional routes. As these same routers tried to reboot, and establish peering, they once again received the information for more than 80 000 routes, and again ran out of memory. This problem recurred until filters were manually installed or the originator of the excess routes fixed the source of the problem.

This accident demonstrated both the current upper limit of the routing resource and the need for industry to have information and indicators to assist in self-regulating Internet traffic exchange. For example, one available online indicator lists the "Top 30" ISPs who, if they decided to aggregate their announced 'classful prefixes' at the origin AS level, could make a significant difference in the reduction of the current size of the Internet routing table.[26] Some of the largest and best known ISPs from around the world figure in this list at any one time. Accordingly these data provide one indicator for ISPs to measure each other's performance in taking action to benefit the whole Internet community.

Apart from looking at AS numbers and routing tables for technical reasons, some analysts have recently used these data to inform economic and policy debates. For example, CAIDA note,

> "Analysis of AS data based on information obtained from review of multiple, comprehensive Border Gateway Protocol 4.0 route tables can also provide indications as to the richness of an ISP's peering relationships over time. Analysis of AS data from packet traces can provide information as to the actual paths or networks that traffic traverses as it makes its way through the Internet infrastructure at a select point in time. Yet, while these analyses can serve as indicators of traffic behaviour and relationships among the Internet's providers, they are not exhaustive nor can they be generalised across providers." [27]

One recent application ASN and routing table data has been put to is to try to use it as an indicator of the relative position of different players in the Internet backbone market. For example, by examining ASN and routing table data, Bell Atlantic has sought to indicate how significant the different players are in the United States Internet backbone market (Box 3).[28] One goal of this analysis was to get an indicator of how many connections existed between smaller ISPs and major backbone networks in the United States. The intent of this analysis was to provide the FCC, and other competition authorities, with an indication of the market position of Worldcom and MCI, based on their initial proposal to merge their Internet backbones. A further very useful tool provided by CAIDA is their backbone visualisation tool which enables users to see the major backbone routes on the Internet by ISP and the bandwidth available between various locations (Table 1).

Another potential utilisation of ASN data is to inform discussion on international and regional Internet connectivity and infrastructure development. As described in "Internet Traffic Exchange: Developments and Policy", a number of factors led the United States to be the global hub of the Internet and the country to which virtually all international connectivity was centred.[29] As a result there was little need for AS numbers in regions such as the Asia Pacific because only the largest ISPs or user networks put into place direct infrastructure links. In other words, downstream ISPs, and smaller IP networks, used the AS number of their upstream backbone connection to the United States. However, the recent increase in allocation of AS numbers in the Asia Pacific has drawn some analysts to the conclusion that there is a corresponding increase in intra-national and intra-regional connectivity.[30] In the Asia Pacific this process is believed to have been spurred by the devaluation of a number of currencies (increasing the cost of international bandwidth) and the desire to improve network performance via localised (intra-national and intra-regional) traffic exchange. Further analysis of the policies for the AS numbers in appropriate databases, such those of APNIC and routing registries, could provide a tool for better understanding the amount of intra-national and intra-regional connectivity.

Box 3: Bell Atlantic's Routing Analysis Methodology
(Source: Bell Atlantic, Appendix A, Filing to FCC, CC Doket No 97-211, January 1998)

"Step 1. Download Autonomous System Database

Autonomous System numbers (ASNs) are identifiers used to identify "autonomous networks - networks under the management of a single entity, e.g. a corporation, university, or an ISP/carrier. An entity may own several ASNs, either for several independent networks or as a technical convenience in managing a single large network. ... ASNs, in addition to their administrative function, play an integral role in the exchange and management of traffic routing information between networks; the routing information advertised by a network is tagged with that networks ASN. Thus, at the core of the Internet, the large exchange points the route to a destination unambiguously labelled with the ASN of the destination's ISP/NSP [see Table 2 for ASN file reference].

Step 2. Identify Autonomous Systems Numbers Associated with carrier of Interest

This is a simple search of the ASN database to retrieve all ASNs registered to each carrier/ISP. The result is a simple list of ISPs/carriers and their associated ASNs. For example Bell Atlantic operates and ASN, "AS4390". As a second example, Sprint has registered more than 100 ASNs. Most of these are used internally however, and only a few are used to advertise routes externally. The product of this process is a list of ASNs registered to each carrier.

Step 3. Pull Routing Summary (Number of Routes) for each ASN and each carrier

This step uses a publicly available, neutral (not operated by any ISP/Carrier) service to determine the number of route announcements associated with a given ASN. The service is available on the World Wide Web [see Table 1 for reference]. The service operates by taking a full Internet routing table from MAE West exchange point and associating each routing announcement with its "Autonomous System of Origin", the ASN which originates, or "owns" the route. This step produces a table summarising the number of routes "owned" by each carrier."

Network performance

Due to the nature of the Internet, measurement of performance across different networks can be much more difficult and controversial than the public switched telecommunication network (PSTN).[31] Measuring the performance within one network is relatively straightforward and many ISPs are comfortable enough to place near real-time indicators on the World Wide Web (Table 7). This strikes an immediate contrast to the PSTN where such information was generally reserved for engineering purposes, and only made public in regulatory filings or annual reports. Accordingly, it is possible to see in near real time how, for example, MCI's Internet backbone is performing or the performance of links to Singapore Telecom's Internet exchange point (STIX). Measurements include the latency of round trip times over different parts of networks and the loss of packets during times of congestion. Where the problematic aspect of measurement arises, is in constructing indicators to measure performance across different ISP networks, core Internet infrastructure (such as DNS) and the networks and sites of users. This can, of course, give rise to different interpretations of where the reasons for good and poor performance arise.

There are several motivations for an increasing number of ISPs and Internet exchange points to put performance-related data on their Websites. Publication of such data can be used for marketing purposes and to provide customers with an additional service. At the same time many of these indicators can be constructed by independent entities or by users themselves for their individual connections. As such there are a growing number of Websites that measure the "Internet Weather" from the perspective of their network or their Website (Table 7). These are also companies that specialise in measuring the performance of particular backbone providers and ISPs, as well as services such as e-mail. Two examples are the services of Keynote or Inverse. Keynote's methodology is to measure the time it takes to access and download web pages. The company says the "...measurements are performed every 15 minutes around the clock from each of Keynote's 52 automated measurement locations around the world. This produces over 34 000 discrete measurements of download speeds each week for each of the more than 1000 web sites whose performance Keynote measures for its customers."[32] However, such indicators are not without critics who claim it is not possible to accurately measure one network's performance across many networks. For Internet weather reports, some ISPs argue that they present an unfair portrayal of their performance because the origin of measurement point is in another network. So a strong reason for ISPs to publish their own performance is to counter, with data from their perspective, the measurements undertaken by other entities.

The crux of the debate over measurements is how can it be done in a fair and reasonable way over networks where no-one has end-to-end responsibility and a reluctance to share operational data between networks.[33] The latter problem is one reason CAIDA brings together different network providers to share data in a neutral environment and allow the development of new tools and indicators for the whole Internet industry.[34] In large part initiatives in the area of Internet network performance measures are best done by the private sector, albeit some government funded basic research institutions are currently playing an important role. However if self-governance and industry co-operation evolves as the standard model for Internet traffic exchange, by contrast to the often heavily regulated interconnection in the PSTN, then the availability of performance indicators across different networks is essential.

One issue that may arise for competition authorities or regulators is the claim that if one ISP held a majority share of the backbone market it might downgrade performance (i.e. traffic exchange) to other ISPs to encourage their customers to directly connect to the dominant player's network.[35] Where there is a strongly competitive backbone market this problem should not arise. However, in those countries where this is not the case, perhaps due to the existing or legacy effects of telecommunication monopolies, industry regulators may be called on to arbitrate very complex disputes between ISPs. On the other hand, the more indicators make transparent the relative performance of different networks the less likely such problems are to occur.

Traceroutes

Traceroutes enable users to follow a path taken by packets of data via intermediate routers between IP addresses. A traceroute can be initiated from a user's PC, with a connection to the Internet, to a particular IP address (or a host/domain name such as www.oecd.org). The second option is to use one of the many sites on the World Wide Web which enable a user to traceroute from that web-site to an IP address using their browser (Table 8). *Boardwatch Magazine* has compiled a comprehensive guide to traceroutes and how they work (refer http://www.boardwatch.com/mag/96/dec/bwm38.htm).[36] Essentially traceroutes work by sending packets to an Internet address and getting intermediate routers to send a return message to the source. The return message identifies the IP address of each router and the round trip time, in milliseconds, between the original router and each intermediate router.

The easiest way to understand how a traceroute works is by example. In Table 9, the results of a traceroute from Telstra's IP network in Australia to the OECD in France are shown. Commencing from left to right the first column shows the number of hops (or steps between routers) that the traceroute packets took between Canberra and Paris. The second column shows the name of the router and the third column the IP number of each router. The fourth column shows the round trip time between each hop and the origin of the traceroute (i.e. Telstra's site in Canberra). It is important to note that these times are not cumulative, or otherwise related, but the round trip time for each stage. As an aside some analysts believe traceroutes are not an authoritative guide to network performance because the traceroute packets may receive a low priority.[37]

In terms of networks crossed the first six hops were within Telstra's network via Canberra and Sydney sites. The name of the router at Hop 6 is not shown because of the failure of a reverse domain name look-up. DNS look-ups are conducted automatically within the traceroute programme and according to Bellcore around 4 per cent of queries fail and need to be resent.[38] By manually looking up the IP address, in ARIN's 'Whois?' it is possible to determine that the number is assigned to AT&T Easy Link Services. So the packets may have been passed via an AT&T traffic exchange point directly from Telstra to BBN Planet (a subsidiary of GTE). From Hops 7 to 10 the traffic was carried by BBN, in California, from Palo Alto to San Jose before passing through an address allocated for traffic exchange points (Hop 11). The traffic is then handed from BBN's network to GIP (Global One's IP network) in Stockton, California. As the OECD's Internet connection is provided by Sprint (a member of Global One) GIP carried the traffic across the United States from Stockton to Pensauken, on the United States East Coast (hops 12 to 14) and through to the OECD's web-site in Paris (Hops 15 to 22). If a packet failed to return from any particular stage an asterisk is shown.

While the use of traceroutes as a tool for the Internet technical community to monitor the performance of peer networks is the leading application, traceroutes have also been used by some knowledgeable users to learn more about the performance of their ISP and their backbone provider.[39] Users can learn, for example, how traffic to their nominated Websites traverses the Internet, and the network providers involved, in a much more transparent way than the public switched telecommunication network. For policy makers traceroutes also represent an important tool for better understanding and informing debates on national and international traffic exchange. For example, some traceroutes demonstrate that traffic follows a certain path not because it may be the most efficient but because of the legacy or existence of infrastructure monopolies. In other words traffic may travel a certain route because capacity on a more logical route to provide connectivity is either unavailable or priced at uncompetitive rates. In addition, traceroutes to the most accessed Internet sites in different countries can be used as an indicator to better understand the relative positions of players in backbone markets. Prior to consideration of this application, other interesting technical features, albeit sometimes erratic in terms of success, are:

- Traceroutes can indicate the capacity of a link between two routers either through the ISP incorporating this information (in the name of the router) or via traceroute software that endeavours to identify the capacity of each link (Patchar - refer Table 8).

- Traceroutes can be conducted between any two known hosts on some web sites. For example, by using GIP's traceroute between two known hosts it is possible to follow packets on paths between the Websites of the Whitehouse and the Kremlin Museum[40].

- Some within the Internet community voluntarily incorporate latitude and longitude information in their routers and would like to see this practice generally adopted by all network managers. This proposal is outlined in "Request For Comments - 1876" (Table 8).[41] Software, such as that marketed by NDG, is then available to map the course of a traceroute based on the latitude and longitude of each router. Other programmes seek to do this simply via a domain look-up request, such as Mids-Alexa, but the results are less precise. The URLs for MIDS and NDG are in Table 8.

– Users can employ traceroutes to provide an indication, or 'non-authoritative verification', of whether a Website is actually in the location specified on a Website or implied by a top level domain name or 'Whois? record'. In a number of cases bearing on electronic commerce (e.g. intellectual property disputes) or law enforcement and industry self-regulatory initiatives (e.g. harmful or illegal content) a user's first action is to use tools such as traceroutes to provide additional information about the source of data and possible recourse to ISPs or other authorities.

Measuring IP backbone market positions with traceroutes

In the debate over the initial proposal to merge Worldcom and MCI's Internet backbones, a number of different methodologies were proposed to measure market share.[42] Worldcom and MCI forwarded the view that Internet revenues represented the best available indicator of market share. On the other hand critics of this view held that accurate data were not available either for the total Internet market or by relevant Internet market segment. Similarly, for policy makers considering the competition aspects of the merger, data were not available on Internet traffic such that an assessment of the market shares of various players could be constructed via that avenue. Accordingly players engaged in the merger debate endeavoured to find other indicators that might inform competition authorities. One example was Bell Atlantic's use of ASN data and routing tables to indicate the share of connectivity to different backbone networks (Box 3). For its part Worldcom and MCI pointed to the trend toward multi-homing to counter the implied impact of the ASN connectivity indicator and the problem of portability with IP numbers. However, there was little data available to measure this point or others raised in the debate.

An alternative methodology is to use traceroutes to the most accessed Internet sites to gain a better understanding of backbone markets and Internet traffic exchange. The basic idea is to undertake a series of traceroutes from a Website served by a certain backbone provider to the most sought after content and portals (see following sections). It is then possible to see for how many of these sites a backbone provider can carry the traffic on an end-to-end basis and for how many of those sites they need to hand traffic to another provider. In other words, in Figure 5, the US backbone provider nominated on the left of the scale is the origin of the traceroute to the 100 Websites generating the highest traffic on the World Wide Web. The data corresponding to each backbone provider's name show the number of sites for which they carried the traffic on an end-to-end basis and the number for which they handed traffic to another backbone provider.

For the United States backbone market, Worldcom could carry traffic to 45 of the leading 100 Websites entirely on its own network (Figure5). MCI could carry traffic entirely on its own network for 28 sites, Sprint for 18 sites and so forth. Together, a merger of Worldcom and MCI's backbone networks would have meant the new entity could carry the traffic internally to 62 of the leading 100 sites. Worthy of note is that this market position paralleled many of the market share estimates forwarded by those opposed to the merger of Internet backbones of these companies. Yet, at the same time, the data also showed a high degree of multi-homing by major content providers in the United States with 53 of all sites being multi-homed and 35 of Worldcom customers being multi-homed.

The series of traceroutes for the United States also reveal the relative dependency different backbone providers have on each other to carry traffic to and from high volume Websites. For example, Sprint needs to exchange traffic with Worldcom/MCI for 26 sites whereas in the reverse Worldcom only passed traffic to Sprint for three sites. By illustrating the reliance different backbone networks place on each other it is possible to get an indication of the level of competition they are able to provide for each other. Whereas backbones such as Sprint and GTE are the largest competitors to Worldcom and MCI, a 'tier two' backbone provider such as Savvis appears to primarily rely on Worldcom and MCI to reach leading Websites and other ISPs (Figure 6). In fact Savvis first handed traffic to Worldcom for 71 of the top 100 Websites and to MCI for a further 11 sites. Worldcom and MCI then carried the traffic within their own networks to the Website or passed it to another ISP.

To further demonstrate this indicator the OECD has performed a similar series of traceroutes in Sweden (Figure 7), Germany (Figure 8), the Netherlands (Figure 9) and Australia (Figure 10) by using the leading 100 Websites in each country. One important finding common to each of these markets was that there was much less multi-homing at the leading Websites than in the United States. Of the three countries Sweden had the most sites multi-homed (10) whereas Australia and Germany only had a couple of Websites with multiple providers. This raises the question of why this is the case compared to the proliferation of multi-homing by major content providers in the United States. One explanation could be that it is due to the different levels of competition including the availability or pricing of infrastructure. Another factor could be that the Websites in the United States bear far high traffic flows, than counterparts in other countries, and therefore require a higher degree of multi-homing. It might also be simply a sign that the Internet market in the United States is more mature than in other OECD countries.

One other potential indicator of the commercial maturity of the US Internet market relative to Australia, Germany, Sweden and the Netherlands is the high proportion of university Websites that figure in the top 100 Websites for these countries. In other words, users in universities still account for a high proportion of Internet traffic and accordingly lift the ranking of university Websites relative to commercial Websites. For example, 31 of the leading Dutch Websites are served by SurfNet the University network partly owned and managed by KPN, the incumbent telecommunication carrier.[43] This is not surprising since at end of 1997 half the hosts under the **.nl** domain were covered by SurfNet. Australia, Germany and Sweden have similarly high numbers of university Websites in their top 100 Websites. By way of contrast, Relevant Knowledge ranks just four universities in the US in its top 100.[44] One implication of this might be to bear in mind that academic backbone networks, while continuing to grow and provide important services, will either commercialise to capture mass market growth (as in the US) or form an increasingly smaller part of the total backbone market.

There are also interesting features that apply to the four individual countries, albeit in each market a variation on the methodology has been explored. In Sweden a series of traceroutes was also conducted from CERN in Switzerland to test the market positions from outside the country (Figure 7). The results were that SwipNet, owned by Tele-2 provided carriage for 41 per cent of the commercial sites (i.e. excluding Sunet the University network). Telia and Telenordia provided carriage for a further 39 per cent of commercial sites. One implication of these results is that while there are multiple backbone networks in Sweden, had a discussed merger between Telia and Telenor been consummated early in 1998 then just two entities would have carried traffic on an end-to-end basis to 80 per cent of the leading commercial sites. Telenor is part owner of Telenordia, along with BT and TeleDanmark.

The traceroutes conducted for the leading 100 Websites in Germany also had interesting features (Figure 8). This time one local traceroute site was used (Nacamar) and two foreign sites (TeleDanmark) and Global One (from a Website in the United States). Here the idea was to test to see how traffic was carried between different countries, where there was an obvious network relationship between partners (i.e. Global One in which Deutsche Telekom is a shareholder and the largest telecommunication infrastructure provider in Germany) and a carrier without a financial relationship but a close geographical location to Germany (TeleDanmark). To provide an additional perspective, both the first and second (if applicable) backbone network crossed are shown in Figure 8 for the two foreign originated series of traceroutes.

Putting university Websites to one side, the traceroutes from a Website served by Nacamar revealed a rich diversity of ISP backbone partners and a fairly small share of traffic exchange with Deutsche Telekom. Deutsche Telekom's relatively small share was confirmed by the trace from Global One, where had it provided greater connectivity, there would have been a greater share of end-to-end carriage within Global One. However , the most striking feature of this traceroute series was the amount of traffic between Denmark and Germany that traversed the United States. For one quarter of the traceroutes from TeleDanmark, to the leading sites in Germany, traffic was initially exchanged via MCI's network in the United States and then found its way back to Germany via the Netherlands or other European countries. For a further 68 Websites TeleDanmark passed the traffic to Telenordia (via an exchange point in Stockholm), whence it was mostly carried via other providers through the Netherlands before being passed to Germany.

A further observation is that Global One handed all non-Deutsche Telekom customer traffic, as soon as possible, to the applicable backbone provider, many of whom had facilities connecting these ISPs to exchange points in the United States or further west from Germany in Europe. As such in Figure 8, Global One's pattern of traffic exchange, at the second exchange stage, looks more like Nacamar's series of first exchanges. By way of contrast the series of traceroutes from TeleDanmark are still another one or two steps from a similar series of exchanges. Due to the fact that Websites under **.de** (Germany) link to content under **.dk** (Denmark), second only to **.com**, it would appear that Danish content is popular with German users. This raises the question of whether existing traffic exchange between the two countries is optimal or still influenced by the legacy of past European regulatory policies, in respect to telecommunication monopolies. In other words, does traffic between some European countries travel via the United States because this is the most efficient route or because of the cost or availability of trans-border infrastructure in Europe?

For the Netherlands a series of traceroutes was initiated from one domestic site (Cistron, a Dutch ISP) to the leading 100 sites under **.nl** (Figure 9). For some 96 of these traceroutes, traffic was exchanged wholly within the Netherlands. Some four traceroutes travelled via the United States. Three of these traceroutes eventually found their way back to the Netherlands and one terminated in the United States where the content was located on a server, although bearing a **.nl** top level domain name. In this series the methodology was also varied to count all backbone traffic exchanges (i.e. all networks crossed), instead of just counting the number of initial traffic exchanges (i.e. the second backbone provider).

The series of traceroutes to the leading 100 Websites in Australia is shown in Figure 10. Australia's backbone market, at least until recently, has been characterised by Telstra treating all domestic traffic exchanges as paid transit. This system is different to 'shortest exit routing' which is most commonly the system used to exchange Internet traffic. With shortest exit routing "...data is passed from one network to another at the earliest point where ISPs meet".[45] If the two ISPs (e.g. ISP-A and ISP-B) have not agreed to exchange traffic directly it will be exchanged at the first opportunity with an ISP that does have a relationship with both (i.e. ISP-A passes traffic to ISP-C which then passes traffic to ISP-B).

Whereas most large backbone providers which peer hand off traffic to another backbone network, as soon as the network determines they do not have a direct connection to the Website concerned and another path is available, Telstra's backbone network carries this traffic virtually the whole way (including traffic exchanges with other major Australian backbones). Interestingly, this also leads to incoming international traffic being handed to Telstra, at an international exchange point, even if the ISP concerned has a direct backbone connection to Australia. Consider the series of traceroutes from CWIX (the Cable and Wireless US IP backbone network) which only carries traffic between CWIX and Optus (a Cable and Wireless Australian subsidiary), when it is to an Optus or Ozemail customer's Website

(Table 10). For Telstra customers, which is virtually every ISP in Australia, the CWIX network hands traffic to MCI which then passes it to Telstra.

This international pattern of traffic is interesting in terms of Telstra's position on the financing of international infrastructure. If CWIX (and Optus) carried the traffic from the United States to Australia, Optus would have had to pay Telstra for the domestic traffic exchange to reach the Telstra customer's Website (at least prior to a new traffic exchange agreement signed between Telstra and Optus in June 1998). The interesting point is that it may be less expensive for CWIX to pass the traffic to MCI, than carry it directly to Australia and have it exchanged locally by Optus. In other words because CWIX passes the traffic to MCI (where the financial basis of the exchange may either be fairly low cost domestic transit or 'no settlement' peering) and MCI then passes the traffic to Telstra (where Telstra pays the full transport cost to Australia), then CWIX has not only saved on international bandwidth, but also on domestic exchange costs for local interconnection in Australia with Telstra. *In summary, domestic traffic exchange arrangements may influence international traffic exchange, and are therefore an important element necessary to inform policy and regulatory debates in this area.*

Pathways to electronic commerce

Website ranking

There are a number of companies that seek to rank the most accessed sites on the World Wide Web. Lists of the most accessed web sites are of interest to a variety of different groups. For the companies wanting to advertise on the Internet it is useful to have an indication of the relative popularity of different Websites. For users such rankings are sometimes used as a directory service in different categories. For policy makers the main interest in Website rankings is the indication they might give for the location of the most popular content and as an input to determining the leading players providing access infrastructure to that content. The OECD has used Web21's lists of the most accessed Websites in different categories both to highlight to location of popular content, and its impact on traffic patterns, as well as the benefits being generated for pluralism and cultural diversity at a national and global level.[46] Such lists have also been used to determine which ISPs have the most significant backbone networks in terms of carriage of traffic to these high volume sites.

A number of companies undertake studies endeavouring to rank Websites by the amount of traffic or visits they generate (so called 'hits' or alternatively user sessions). Web21 produces the "Hot100" in different categories (e.g. news, sport, business, overall) and by different countries (e.g. **.au**, **.nl**). Categories of content are useful when policy makers are endeavouring to better understand the location of popular content, such as webcasting radio stations and the potential impact on policy in respect to convergence between different communication platforms. Country categories are useful for examination of traffic exchange, via traceroutes, between major backbone providers in national markets and their relationships with major international backbone markets. By combining tools such as traceroutes and lists of the most popular Websites indications can be constructed for different markets in terms of infrastructure availability, competition policy and the extent of trends such as multi-homing.

While a number of companies use off-line surveys, the two companies highlighted in Table 11 use a combination of on-line and off-line techniques. Web21 collects data from a number of different sources but primarily use the logs from proxy servers and caches. These logs are sent on-line to Web21 on a daily basis and represent the surfing patterns of over 100 000 surfers world-wide. Approximately 60 per cent of these users are in North America and 40 per cent outside the United States.[47] Relevant

Knowledge is another company which ranks web sites by getting users to download proprietary software via the Internet onto all computers they use to access the Web. These user's surfing patterns are then tracked by the company and made available on the net by different demographic categories.[48] RelevantKnowledge reports that, on average, 83 per cent of the 35 000 users they monitor go to 10 or fewer different domain names each week.[49] This is one reason the best known Websites are increasingly valued by advertisers. According to the Internet Advertising Bureau (IAB) the top 10 Websites receive 67 per cent of total Internet advertising expenditures.[50]

Ranking portals

A portal is the term given to that part of a Website which acts as a gateway, or launch point, through which users navigate the World Wide Web. A portal can be the page a user sees each time they log onto the World Wide Web, such as the home page of an ISP or AOL (America Online). Accordingly, one measure of the usage of a portal is the number of subscribers served by a certain ISP, or other online service, although this is not precise as users can create their own portal or set their opening web page to another Website. These latter users will often define portals, such as Yahoo! or Excite, as their default Websites or use the default page of their browser (e.g. Netscape, Microsoft). These portals, which commenced service primary as search engines or directories have since moved to providing multiple applications designed to provide users with a variety of tools in one location (e.g. e-mail, news, personalised news, search engines, directories etc.). Similarly, Netscape and Microsoft have incorporated an increasing number of portal-like functions into their browsers as well as selling hyper-text links and advertising space to other portals.

One way to examine the use of portals is to look at the results of Website ranking, as discussed in the previous section. Accordingly sites such as Yahoo and Excite are amongst the most accessed Websites on the Internet. It is this popularity, and the belief of many analysts that portals will become increasingly important to making the Internet more user friendly for electronic commerce, that has attracted increasing attention. Portals that were fairly recently in the preserve of sophisticated Internet users are now the best known sites on the Internet, a trend not missed by companies engaging in electronic commerce. For example, Yahoo!'s mix of advertisers changed from 85 per cent computer-related in 1995, to approximately 80 per cent consumer brands in 1997.[51] This has led to portals becoming highly valued by stock markets and traditional media companies wanting to own prominent pathways to their content.[52] Examples of the latter trend are Disney Corporation's investment in Infoseek and NBC's investment in Snap.[53] Another approach to investigating portals is to examine the number of hyper-text links to the gateway pages of these Websites and their origin.

Many electronic commerce sites pay search engines, or other portals, a fee for each transaction referral.[54] This can be done with, for example , 'click-through' banner advertising. The search engine "HotBot", itself a portal, provides a tool that enables users to count the number of hyper-text links to a URL (Universal Resource Locator). By putting in a URL such as **http://www.oecd.org/**, and selecting the appropriate setting, "HotBot" shows there were around 19 000 hyper-text links to this URL in June 1998. It is also possible to break this number down by hyper-text links from different domains (e.g. **.com**, **.gov** or **.be** for Belgium) and by region (i.e. combining certain domains to provide a figure for Europe or North America). The usual caveat, that allowance needs to be made for domain registrations under gTLDs coming from different countries, needs to be borne in mind. In addition the total count of hyper-text links includes internal Website hyper-text links to a particular URL (e.g. back to main page hyper-text links, links to the web designer's page and so forth). It is also probable that if this measure became used as an indicator of popularity it would be relatively easy to distort (though probably just as easy to counter and make allowance for in the overall outcomes). That being said an initial look at the number of hyper-text links to a selection of leading portals is worthwhile for a better understanding of the development of electronic commerce.

It should be borne in mind that it is also possible to count hyper-text links to an entire domain, such as **netscape.com**. This would count links to the entire domain (e.g. **www.netscape.com** and **home.netscape.com** etc.) rather than a particular URL (e.g. **http://www.netscape.com**/). This is useful for examining hyper-text links between domains, including TLDs and gTLDs as discussed below, but in the context of an examination of portals it is interesting to link to the main URL of a company rather than its entire domain. It is also possible to net out internal links within a domain so that only the links from other Websites are counted but they are included in Table 12. Nicheworks has an interesting visualisation tool for Websites and links, showing the example of the Chicago Tribune's Website (Table 12).

By most measures 'Yahoo!' emerges as the most accessed Website on the Internet. Accordingly it is not a surprise that a count of the number of hyper-text links to **http://www.yahoo.com/**, reveals that it has the most links directed to it to on the World Wide Web (Table 12). Excite and Lycos are the search engines that have the next highest number of hyper-text links followed by Alta Vista. Netscape and Microsoft also have Websites which attract some of highest numbers of links on the World Wide Web. Apple and IBM make up the remainder of the group of companies with more than 100 000 hyper-text links to their main URLs. Results of other sites have been chosen to give an indication of the very large difference in the number of hyper-text links to 'new media' Websites and those to some traditional media. There is a vast difference in the number of hyper-text links to Websites needed to navigate the Internet (either via search and directory functions such as Yahoo! or equipment and software such as Netscape and Microsoft) for content and services than to the Websites of traditional print media.

As an aside it is also possible to use this tool to get an indication of the amount of 'adult content' relative to all content on the World Wide Web. Here it can be noted that the leading 100 Websites providing adult content make up only around 0.05 per cent of all content on the Internet. The proxy measure for content here is to count the number of outgoing URLs from these Websites relative to the total number of outgoing URLs from all domains. This does of course not deny the importance of using self regulatory tools, such as screening technologies, because of the ease with which adult material can be located intentionally or accidentally by children. However it is interesting to compare this figure with the amount of content under **.edu** (used by institutions of higher education in the United States) which makes up more than 16 per cent of all Internet content. Taken together with the content under **.us** (used by schools in the United States) and the educational content under top level domains, the amount of educational content helps put a more balanced perspective on the different types of content available on the World Wide Web.

It is also interesting to examine the number of hyper-text links to the traditional gatekeepers to the online world (Table 13). Significantly only AT&T and NTT exceed 10 000 hyper-text links to their main URLs. In the not too distant past telecommunication carriers with government mandated monopolies owned every 'portal' from the actual line connection to the PSTN, through to every piece of customer equipment and the cover and contents of telephone directories. From the 1960s onward these monopolies came under increasing pressure for commercial and technological reasons. Today, the majority of these markets have been liberalised in OECD countries, meaning that telecommunication carriers need to compete not only at the level of physical infrastructure but also for portals. Consider, for example, if as Internet telephony is increasingly incorporated into electronic commerce Websites, the additional communication revenue (over and above the local call or access fee) may accrue to the Internet telephony provider nominated by the owner of the portal (e.g. in a similar way to 800 numbers for the PSTN). Even for the telecommunication carrier that becomes an ISP, and therefore has the opportunity to create a portal via the launch point for subscribers, there is no guarantee that these users will not opt for portals like Yahoo! and Netscape.

Comparative World Wide Web development

One indicator of the take up of different audio, video and other software tools on the World Wide Web is to use a search engine to count the number of applications. As Internet searches can be conducted under a particular top level domain name, by using HotBot, it is possible to get an indication of the use of these technologies (Table 14). By including objects found under gTLDs and the TLDs associated with OECD Member countries, there appeared to be around 600 000 audio and more than 200 000 video applications in July 1998.

While the usual caveat applies, as to the allocations under gTLDs not being country specific, the data shown under TLDs might be taken to represent a very large sample for any given country. Accordingly by using search engines, analysts have one indication of the number of webcasting sites under a domain associated with a certain country. In future this may be an important source of information to assist policy makers dealing with convergence issues.

Indicators of domain linkages to and from OECD countries

Charts of the growth in the Internet show a sharp rise in popularity after the development of the World Wide Web. In particular there is a sharp increase after the introduction of ‘browsers’, the initial tools that made it easy to navigate this space by ‘point and click’. This innovation created new pathways for electronic commerce and, by doing so, raised the question of whether indicators of the topography of linkages between domains could be useful for policy makers. While the nature of the Internet’s DNS makes it easier to apply some analytical tools to individual domains (i.e. **yahoo.com**), than to geographical areas (e.g. **.nl** for the Netherlands), it is possible to construct matrices of the linkages between all the TLDs associated with OECD countries and gTLDs (Table 15). These data show the number of hyper-text links embedded in Websites between all TLDs and gTLDs.[55] For example, in July 1998 there were 3 281 links from **.au** (Australia) to **.at** (Austria) and 2 855 links from **.at** to **.au**.

The largest number of hyper-text links between top level domains are intra-domain links. For example some 71.6 per cent of all hyper-text links under **.au** are to other Websites under **.au** (Table 16). The next domains to which there are the most hyper-text links are the gTLDs such as **.com**. One reason for this is that these domains can, at one level, be seen as an extension of intra-domain links because a significant proportion of gTLD registrations are from outside the United States. In other words a large number of **.au** to **.com** hyper-text links would be within Australia. The second and more important reason for the preponderance of links to gTLDs is that much of the most popular content is under **.com.** Accordingly the **.com** share of inter-domain links is by far the largest (Table 17). For example 38 per cent of all the inter-domain links from the **.au** domains are to the **.com** domains followed by **.net** and **.edu**.

It is also possible to look at the bilateral relationships between domains. In Table 18 the data show the percentage of total number of hyper-text links between two domains. For example there were 11 423 hyper-text links from **.ca** to **.fr** and 10 994 links from **.fr** to **.ca.** Accordingly Table 18 shows that 51 per cent of the bilateral links were from **.ca** to **.fr** and 49 per cent from **.fr** to **.ca**. On an overall basis there were 3 254 329 hyper-text links from **.ca** to other domains and 3 072 287 hyper-text links from all other domains to **.ca**. So the balance, including intra-domain links under **.ca**, was 48.7 per cent incoming links and 51.3 per cent outgoing links. By excluding intra-domain links, the balance for **.ca** inter-domain links was 44.2 per cent incoming links and 55.8 per cent outgoing links. One reason for this balance is that Canadians are the greatest users of **.com**, outside users in the United States. To make allowance for this it is possible to exclude **.com**, **.net** and **.org** which then shifts the balance in the opposite direction. Under this equation some 67.7 per cent of links are incoming for **.ca** and 33.3 per cent of links are outgoing from **.ca**.

These matrices raise a very large number of possible research and discussion topics that go well beyond the scope of this document. The reasons that users link from one domain to another no doubt have many social and economic factors including, cultural, linguistic, trade, geography and so forth. However, an important factor is the relative development of the Internet in different countries. Attractive content has to exist under a certain domain, and be accessible (i.e. some users link to the same content under one domain rather than another based on infrastructure performance), before users will link to a URL. Linkages between domains provide a interesting indicator for further analysis of comparative performance even though allowances need to be made for gTLD registrations across different countries.

The most obvious and important question is how closely the relative proportion of hyper-text links between domains resembles Internet traffic flows between those domains. In addition, in the absence of data on Internet traffic flows between countries, might the number of links be taken as an indicator of the importance of content in one domain for users in another domain? If so, might this be a consideration in debates over the financing of international infrastructure? In addition, could this indicator be used to inform decisions to develop more direct traffic exchange between neighbouring countries rather than send traffic via other countries and continents? For example, in the series of traceroutes from Denmark to Germany, the majority of traffic travelled via the United States or via Sweden and the Netherlands. At the same time, the number of links from **.de** (Germany) to **.dk** (Denmark) indicates German users are the second most likely to link to URLs under **.dk** after users from the **.com** domain.

One future topic might be to focus on how closely Internet linkages, from one domain to another, resemble the relative importance of telephony routes. The differences from traditional communication patterns may suggest more about Internet use and how electronic commerce is developing than the similarities. One aspect of this might be to examine the importance of geography in determining linkages. For example, do users link more to distant countries rather than neighbouring countries where there is easier access to traditional media from that country. Another aspect might be language. For example, do users put more content aimed at international consumption under **.com** than under their national domains.

Table 1. Selected Internet infrastructure indicators

	Note	Frequency	URL
Internet Host Surveys			
Network Wizards	Covers all gTLDs and TLDs	Twice yearly	http://www.nw.com/
KRNIC	Covers hosts under .kr	Yearly and latest current.	http://www.krnic.net/english/net/2_93_00.html
RIPE	Covers TLDs within area served by RIPE.	Monthly	http://www.ripe.net/statistics/hostcount.html
Web Server Surveys			
Netcraft	Presents results for Internet on a monthly basis but, with the exception of .com, discloses data for only a selected number of gTLDs and TLDs each survey.	Monthly	http://www.netcraft.co.uk/Survey/
Internet Backbones			
CAIDA's MapNet	Visualisation of Internet backbone networks, mainly United States, by bandwidth and ISP. Some non-United States headquartered ISPs are included, such as Telstra.	Relies on the co-operation of ISPs to keep information accurate.	http://www.caida.org/Tools/Mapnet/Backbones/
Cybergeography	Collection of links, maps and resources for Internet visualisation.	Reference and Links.	http://www.cybergeography.org/
Information for ISPs	Collection of links to backbone maps and undersea cables.	Links to maps and resources.	http://www.clark.net/pub/rbenn/isp.html
Internet Backbone Maps	Links to ISP backbone maps.	Linked directly to ISP maps.	http://navigators.com/isp.html
Internet Backbone maps	Links to Internet backbone maps.	Links to other Websites.	http://www.exploits.org/~rkroll/netmaps.html
Yahoo!	Yahoo's links to Internet maps	Links to backbone maps.	http://www.yahoo.com/Computers_and_Internet/Internet/Maps/
IP Address Occupancy			
CAIDA	Indicator which allows visualisation of IP address occupancy	Intermittent	http://www.caida.org/IPv4space/
Geography of Internet Address Space in UK.	Maps of IP address location in the United Kingdom.	Maps for March 1997	http://www.geog.ucl.ac.uk/casa/martin/internetspace/
Internet Routes and ASNs			
CIDR Report	Plots size of routing table.	Daily	http://www.employees.org:80/~tbates/cidr.plot.html
Gains by aggregating at the origin AS level.	This lists the "Top 30" players who if they decided to aggregate their announced classful prefixes at the origin AS level could make a significant difference in the reduction of the current size of the Internet routing table. Also provides a weekly summary of changes in terms of withdrawn and added routes.	Daily/Weekly	http://www.employees.org:80/~tbates/cidr-report.html#Gains

Table 1. Selected Internet infrastructure indicators *(continued)*

	Note	Frequency	URL
CSELT Routing Information	Graphic display of BGP4+ routing entries for the backbone sites and for all sites running BGP4+	Real time.	http://carmen.cselt.it/ipv6/bgp/index.html
Telstra	Plots size of routing table.	BGP Table plotted for 2 days, 14 days and 1994 to present.	http://www.telstra.net/ops/bgptable.html
NLANR	The form processes BGP routing tables collected from a route server with BGP connections to multiple geographically distributed target operational routers. It allows for constructing interconnection maps by Autonomous System (AS) numbers.	Once daily (at night)	http://rwac.ucsd.edu/ASx/
University of Oregon Route Views Project	The Route Views project seeks to provide information for operators about how their prefixes and ASes are being seen by the global routing system, and to provide researchers with high quality data about the routing system.		http://www.antc.uoregon.edu/route-views/
Estimates/Surveys of Internet Users			
HeadCount	Aggregates official and commercial surveys of on-line use by country.	Ongoing.	http://www.headcount.com/
NUA	Produces estimates from various surveys (global and regional estimates)	Current.	http://www.nua.ie/surveys/how_many_online/index.html
Bellcore	Netsizer (Forecasting)	Current	http://www.netsizer.com/
KRNIC	Publishes survey of Korean ISPs with precise numbers of subscribers.	Current.	http://www.krnic.net/english/net/net.html
Reference			
CAIDA	The best available critical list of infrastructure tools and indicators.	Reference and Links	http://www.caida.org/Tools/taxonomy.html
Merit	Internet Performance Measurement and Analysis (IPMA) project, a joint effort of the U-M Department of Electrical Engineering and Computer Science and Merit Network.	Reference and Links to Merit and other tools.	http://www.merit.edu/ipma/

Source: OECD.

Table 2. Domain names, IP addresses, autonomous system numbers and Whois?

	Note	URL
Data on domain registration (gTLDs)		
InterNIC	gTLD statistics periodically released via press release.	http://www.internic.net/
Imperative (Internet.Org)	1997 publication of ‘active’ gTLD registrations by country, but currently just US gTLD registrations and registrations by US city.	http://www.internet.org/
Imperative (Internet.Org)	Domain web hosting market share.	http://www.internet.org/cgi-bin/genobject/hosting/tiga6aD77ZE
Imperative (Internet.Org)	Domain registrations listed by ISP.	http://www.internet.org/cgi-bin/genobject/connectivity/tiga6aD77ZE
Data on domain registration (gTLDs)		
Australia (com.au)		http://www.MelbourneIT.com.au/
Austria (.at)	Host count data is at http://www.aco.net/at-hostcount/at-hostcount.html	http://www.nic.at/
Belgium (.be)	1994 to present.	http://www.DNS.BE/domain-info/statistics.html
Canada (.ca)	Data from 1988 to present presented by province and sub-domain.	http://www.cdnnet.ca/info/statistics
Czech Republic (.cz)		http://www.nic.cz/indexeng.htm
Denmark (.dk)		http://www.dk-hostmaster.dk/
Finland (.fi)		http://www.thk.fi/
France (.fr)	Data from 1991 to present.	http://www.nic.fr/Statistiques/index.html
Germany (.de)	Various data on domains and IP addresses from 1992 to present.	http://www.nic.de/Netcount/netStatOverview.html
Greece (.gr)	Variety of data for .gr	http://www.open.gr/survey/311297/facts-en.html
Hungary (.hu)		http://www.nic.hu/
Iceland (.is)		http://www.isnet.is/nic/
Ireland (.ie)	Data from January 1995 to present.	http://www.ucd.ie/hostmaster/ie-dom.html
Italy (.it)	Data from 1994 to present.	http://www.nic.it/statistics/index.html
Japan (.jp)	Data by number of allocated domains, connected domains and disconnected domains from 1992 to present.	http://www.nic.ad.jp/jpnic-e/stat.html
Korea (.kr)	Data from 1993 to present.	http://www.krnic.net/english/net/net.html
Luxembourg (.lu)		http://www.dns.lu/
Mexico (.mx)	Data from 1997 to present.	http://www.nic.mx/dom/stats.html
Netherlands (.nl)		http://www.domain-registry.nl/
New Zealand (.nz)	Data from 1993 to present.	http://www.domainz.net.nz/newsstand/stats/ga.html
Norway (.no)	Data from January 1995.	http://www.uninett.no/navn/stats/domains.gif
Poland (.pl)		http://www.nask.pl/

Table 2. Domain names, IP addresses, autonomous system numbers and Whois? *(continued)*

	Note	URL
Portugal (.pt)		http://www.dns.pt/evolucao.html
Spain (.es)	Data from 1991 to present.	http://www.nic.es/estadisticas/
Sweden (.se)	Data from 1985 to present.	http://www.nic-se.se/tillvaxt.shtml
Switzerland (.ch)		http://www.nic.ch/newdom-reg.htm
Turkey (.tr)		http://dns.metu.edu.tr/
United Kingdom (.uk)		http://www.nic.uk/
United States (.us)		http://www.isi.edu/us-domain/
IP Number Allocation		
IANA	Information on IP addressing policies and practices.	http://www.iana.org
APNIC	Publication of data in annual report.	http://www.apnic.net
ARIN	http://www.arin.net/whois/arinwhois.html	http://www.arin.net
JPNIC	List of IP numbers allocated for entities in Japan.	http://www.nic.ad.jp/jpnic/ipaddress/ip-list-e.txt
KRNIC	IP Address holdings.	http://www.krnic.net/net/c_class_98.html
RIPE	Database available at http://www.ripe.net/lir/registries/allocs.html	http://www.ripe.net
AS Number Allocation		
APNIC	Publication of data in annual report.	http://www.apnic.net
ARIN	This file contains a list of autonomous system numbers and names of all registered ASNs.	ftp://rs.arin.net/netinfo/asn.txt
RIPE	Search via Whois?	http://www.ripe.net/db/whois.html
Whois?		
InterNIC	Search for second level gTLD registrations.	http://internic.net/cgi-bin/whois
APNIC	Whois? search for the APNIC database	http://www.apnic.net/reg.html
ARIN	ARIN's Whois program searches ARIN's database to locate information on networks, autonomous system numbers (ASNs), network-related handles, and other related Points of Contact (POCs).	http://www.arin.net/whois/arinwhois.html
RIPE	Search via RIPE Whois for European DNS registrations.	http://www.ripe.net/db/whois.html
AllWhois	Enables searches of all available Whois databases including TLD databases.	http://www.allwhois.com/
IP Address Latitude and Longitude	The script searches the whois database at rs.internic.net for location data. US sites are resolved to the city. Canadian sites are resolved to their province. Other Non-US sites are resolved to the country's capital.	http://cello.cs.uiuc.edu/cgi-bin/slamm/ip2ll/

Source: OECD.

Table 3. Leading IP allocations and reservations by IANA, May 1998

	Coordinator		Coordinator		Coordinator
1	IANA	23	IANA	45	Interop Show Network
2	IANA	24	Multiple Cable Companies	46	N/A
3	General Electric Company	25	Royal Signals and Radar Establishment	47	Bell-Northern Research
4	BBN Planet	26	Defense Information Systems Agency	48	Prudential Securities Inc.
5	IANA	27	IANA	49	N/A
6	Army Information Systems Center	28	ARPA DSI JPO	50	Various
7	Defense Information Systems Agency	29	Defense Information Systems Agency	51	Department of Social Security of the United Kingdom
8	IANA	30	Defense Information Systems Agency	52	E.I. duPont de Nemours and Co., Inc.
9	IBM Corporation	31	IANA	53	Cap Debis ccs
10	IANA	32	Norsk Informasjonsteknologi	54	Merck and Co., Inc.
11	DoD Intel Information Systems	33	DLA Systems Automation Center	55	Army National Guard Bureau
12	Various	34	Halliburton Company	56	U.S. Postal Service
13	Xerox Palo Alto Research Center	35	Merit Network Inc.	57	Société Internationale de Télécommunications Aéronautiques (SITA)
14	Public Data Network	36	Stanford University	58	IANA
15	Hewlett-Packard Company	37	IANA	59	IANA
16	Digital Equipment Corporation	38	Performance Systems International	60	IANA
17	Apple Computer, Inc.	39	IANA	61	Asia Pacific Network Information Center (APNIC)
18	Massachusetts Institute of Technology	40	Eli Lilly and Company	62	European Regional Internet Registry (RIPE NCC)
19	Ford Motor Company	41	IANA	63	American Registry for Internet Numbers (ARIN)
20	Computer Sciences Corporation	42	IANA	64	IANA/ARIN
21	DDN-RVN	43	Japan Inet	65-127	IANA
22	Defense Information Systems Agency	44	Amateur Radio Digital Communications	128-212	Various/IANA

1. A maximum of 126 (2 7 -2) /8 networks can be defined. The calculation requires that the 2 is subtracted because the /8 network 0.0.0.0 is reserved for use as the default route and the /8 network 127.0.0.0 (also written 127/8 or 127.0.0.0/8) has been reserved for the "loopback" function. Each /8 supports a maximum of 16 777 214 (2 24 -2) hosts per network. The host calculation requires that 2 is subtracted because the all-0s ("this network") and all-1s ("broadcast") host-numbers may not be assigned to individual hosts.

Source: OECD.

Table 4. Leading IP allocations from RIPE, April 1998

	Recipient organisation	Assignment (host equivalent)	Percent of Total RIPE Assignment	Countries/Region for which assignments were made
0	Last Resort registries and RIPE Archive	7 716 864	16.4	at, ch, cz, de, dk, eu, fi, no, tr, uk.
1	EUnet (Qwest)	3 317 760	7.1	at, be, cz, de, eu, fr, fi, is, ie, lu, no.
2	UUnet (Worldcom)	3 194 880	6.8	de, eu, fr, it, nl, se, uk.
3	France Telecom	1 261 568	2.7	fr, se.
4	Telianet (Telia AB)	1 073 152	2.3	dk,se,no, uk.
5	PSInet (PSINet UK Ltd)	1 040 384	2.2	be,ch,de,es,fr,it,nl, uk.
6	Renater (Renater) GIP Renater	991 232	2.1	fr
7	Unisource ((Unisource Business Networks) (Telia, KPN, Swisscom)	925 696	2.0	at, be,ch, de,it,nl.
8	Datanet (DATANET) Telecom Finland	917 504	2.0	fi
9	Sunet (SUNET/NORDUnet) University/Research	917 504	2.0	se
10	IBM (IBM Global Network Europe)	880 640	1.9	eu
11	HTC (The Helsinki Telephone Ltd.)	737 280	1.6	fi
12	Demon Internet (Scottish Power)	720 896	1.5	uk
13	Janet (JANET NOSC) Research	720 896	1.5	uk
14	TTD (Telefonica Transmision de Datos)	630 784	1.3	es
15	NHS (United Kingdom National Health Service)	589 824	1.3	uk
16	Telenor (Telenor Nextel AS) (Telenor CR)	540 672	1.2	cz, no, se
17	Interbusiness (InterBusiness) Telecom Italia	524 288	1.1	it
18	Global One (France Telecom, Deutsche Telekom, Sprint)	466 944	1.0	eu, uk
19	BT (BT Public Internet Service)	458 752	1.0	uk
20	MAZ (MAZ Internet Services)	401 408	0.9	de
21	DFN (DFN) University/Research	393 216	0.8	de
22	Telekom (Deutsche Telekom AG)	393 216	0.8	de
23	Nacamar (Nacamar Data Communications)	331 776	0.7	de
24	NASK (Research and Academic Networks in Poland)	327 680	0.7	pl
25	TPSA (Polish Telecom)	278 528	0.6	pl

Source: OECD.

Table 5. Leading IP allocations from APNIC, January 1998

	Recipient organisation	Assignment (host equivalent)(1)	Percent of total APNIC Allocation	Countries/Region for which assignments were made
1	JP-NIC	7 668 480	32.0	Japan
2	Telstra	4 194 304	17.5	Australia
3	KR-NIC	3 932 160	16.4	Korea
4	CERNET	2 785 280	11.6	China
5	TW-NIC	1 638 400	6.8	Taiwan
6	Netway (NZ Telecom)	356 352	1.5	New Zealand
7	Jaring	327 680	1.4	Malaysia
8	Chinanet	262 144	1.1	China
9	Inet	197 376	0.8	Thailand
10	Access One/Ozemail	196 608	0.8	Australia
11	NZ-NIC	159 744	0.7	New Zealand
12	PIPL	156 928	0.7	Singapore
13	AUnet	131 072	0.5	Asia Pacific
14	IBM	98 304	0.4	Asia Pacific
15	Linkage	98 304	0.4	Hong Kong
16	Twix	81 920	0.3	Taiwan
17	CN-NIC	73 728	0.3	China
18	Stari	66 560	0.3	Hong Kong
19	Connect	65 536	0.3	Australia
20	Cyberway	65 536	0.3	Singapore
21	Evoserve	65 536	0.3	Philippines
22	Singnet	65 536	0.3	Singapore
23	ERNET	53 248	0.2	India
24	Hong Kong Telecom	49 152	0.2	Hong Kong
25	SIC	49 152	0.2	China
Country level IP Data				
	KRNIC	http://www.nic.ad.jp/jpnic/ipaddress/ip-list-e.txt		
	JPNIC	http://www.krnic.net/net/c_class_98.html		

1. While included here, in practice each allocation block requires that 2 is subtracted because the all-0s ("this network") and all-1s ("broadcast") host-numbers may not be assigned to individual hosts.

Source: OECD.

Table 6. Leading IP Assignments from APNIC and RIPE (by country)

	APNIC Assignment by country	Assignment (host equivalent)(1)	Percent of total APNIC assignment	RIPE assignment by country	Assignment (host equivalent)(1)	Percent of total OECD European assignment
1	Japan	7 726 848	32.24	United Kingdom	8 552 704	18.2
2	Australia	4 637 952	19.35	Germany	8 429 568	17.9
3	Korea	3 932 160	16.41	France	3 170 304	6.7
4	China	3 252 224	13.57	Sweden	2 752 512	5.9
5	Taiwan	1 785 856	7.45	Finland	2 648 064	5.6
6	New Zealand	533 504	2.23	Italy	2 375 680	5.1
7	Hong Kong	416 000	1.74	Switzerland	1 859 584	4.0
8	Malaysia	379 904	1.59	Austria	1 605 632	3.4
9	Singapore	314 112	1.31	Netherlands	1 556 480	3.3
10	Asia Pacific	286 976	1.20	Norway	1 294 336	2.8
11	Thailand	282 368	1.18	Denmark	1 165 312	2.5
12	Indonesia	166 400	0.69	Spain	1 155 072	2.5
13	Philippines	119 296	0.50	Czech Rep.	876 544	1.9
14	India	94 208	0.39	Belgium	811 008	1.7
15	Pakistan	10 240	0.04	Poland	802 816	1.7
16	Mongolia	9 216	0.04	Turkey	729 088	1.6
17	Sri Lanka	7,168	0.03	Hungary	557 056	1.2
18	Macao	4 096	0.02	Portugal	471 552	1.0
19	Fiji	2 048	0.01	Greece	360 448	0.8
20	Vanuatu	2 048	0.01	Ireland	180 224	0.4
21	Maldives	1 024	0.004	Iceland	139 264	0.3
22	Papua New Guinea	1 024	0.004	Luxembourg	122 880	0.3
23	Bangladesh	512	0.002	.eu area	5 353 472	11.4
	.ap area	286 976	1.20			
	Total	23 965 184	100.00	Europe (OECD)	46 969 600	100.00
	Asia Pacific OECD(2)	17 117 440	71.42			

1. While included here, in practice each allocation block requires that 2 is subtracted because the all-0s ("this network") and all-1s ("broadcast") host-numbers may not be assigned to individual hosts.

2. Including Australia, Japan, Korea, New Zealand and Asia Pacific (.ap) assignments.

Source: OECD.

Table 7. Selected network performance measures

	Note	Frequency	URL
Network performance			
Ameritech	Chicago NAP Daily Usage Statistics	Daily	http://nap.aads.net/~nap-stat/
CAIDA	List of infrastructure indicators	Reference	http://www.caida.org/INFO/
Exodus	Exodus Exchange Point Utilization Graphs	Daily	http://www.bengi.exodus.net/inet/
MCI	MCI network performance	Near Real time	http://traffic.mci.com/
NORDUnet	The automatically produced network statistics of NORDUnet.	Daily	http://www.nordu.net/stats/
PSINET	Each cell in the matrix represents the success rate of 100 pings of 100 bytes each from the each source (a regional router) to each destination (usually a nameserver). Ping success rates of 95-100% are colored green, 88-94% are colored yellow, and 0-87% are red.	Every 15 minutes.	http://www.isp.psi.net/nops-eng/matrix/
STIX	Singapore Internet Exchange Point performance.	Near real time	
Internet Performance			
Internet Traffic Report	A test called "ping" is used to measure round-trip travel time along major paths on the Internet from several servers in different areas of the globe performing the same ping at the same time. A regional index is then constructed for different parts of the world.	Every 15 minutes.	http://www.internettrafficreport.com/
Internet Weather	The current Internet weather to TEN's three gaming "Zones."	Daily	http://weather.ten.net/report/index.html
Internet Weather Report	Intended to be an indication of Internet health from the perspective of this site's connection. Significantly this site measures the performance of paths to the Internet's global root servers.	Near real time	http://www.internetweather.com/
MIDS Internet Weather Report	The IWR is presented in geographical maps that show lag, which is round trip time (latency) from Austin, Texas to thousands of Internet domains worldwide, currently every four hours, six times a day, seven days a week, using ICMP ECHO (ping). See also MIDS measurement service at http://www.miq.net/	Daily	http://www4.mids.org/weather/
State of the Internet	Performance measured to selected backbones, ISPs and popular Internet sites.	Current plots.	http://www2.tscnet.com/cgi-bin/netmon/
PING to News Groups	The rating are based on 20 pings with packets of 210 bytes in size between the news server, or nearest upstream pingable host for each network and twin.uoregon.edu.	Current and Daily Plots	http://twin.uoregon.edu/iwr/ping.html
Selected measurement companies			
Inverse	The Inverse ISP Benchmark Report provides ISPs and corporate customers with information on ISP performance and reliability and e-mail performance set against industry averages.	Data published periodically by Inverse and its customers. Some ISPs release their full performance report. See for example IBM's report at: http://www.ibm.net/whatsnew/html/ratings.html	http://www.inversenet.com/
Keynote	Measures performance of selected US backbone providers and popular Websites.	Publishes public comparisons on a daily and monthly basis with 15 minute update service for clients.	http://www.keynote.com/

Source: OECD.

Table 8. Selected traceroute sites

	Note	URL
Traceroute sites		
Beach.net	United States ISP traceroute site.	http://www.beach.net/traceroute.html
CarpeNet	German ISP.	http://www.carpe.net/cgi-bin/trace
Cistron	Dutch ISP site which includes AS numbers if available.	http://www.cistron.nl/cistron/trace/
CERN	CERN's traceroute site in Switzerland.	http://wwwcs.cern.ch/wwwcs/public/ip/traceroute.html
Global One	Enables traceroute between two known hosts.	http://www.gip.net/utilities.html
MIDS-Alexa tracemap service.	Creates a map of traceroute.	http://mids.alexa.com/test/tracemap/
SAVVIS	United States backbone provider.	http://www.savvis.com/cgi-bin/trace
Tama	Japanese ISP site.	http://www.tama.or.jp/~marin/cgi-bin/traceroute.cgi
TeleDanmark	TeleDanmark's Data Division's site.	http://trace.tele.dk/
Telstra	Australian backbone provider.	http://www.telstra.net/cgi-bin/trace
UMEA	Swedish traceroute site.	http://www.it-center.se/cgi-bin/nph-traceroute
Lists of Traceroute sites for companies and countries		
ATMnet	ATMnet's troubleshooters page with list of technical utilities by company and country.	http://www.atmnet.net/Support/troubleshooting.html#TRACEROUTE
Boardwatch	Lists of traceroutes by country.	http://www.boardwatch.com/isp/trace.htm
CWIX	CWIX traceroutes and list of other sites.	http://www.cw-usa.net/internet/traceindex.html
Exodus	List of trace routes by company.	http://www.exodus.net/tech/utilities.html
Sites in France	List of traceroutes in France.	http://hplyot.obspm.fr/cgi-bin/nph-traceroute
Merit	List of traceroutes.	http://www.merit.edu/~ipma/tools/trace.html
Sites in Australia	List of Australian university and ISP traceroutes.	http://www.vrn.edu.au/tracerte.htm and http://auix.esc.net.au/trace.html
Yahoo	List of trace routes by site (www.yahoo.com) and the Yahoo traceroute.	http://net.yahoo.com/cgi-bin/trace.sh
Traceroute software		
Patchar	A traceroute tool which enables user to determine bandwidth of links covered by the trace.	http://www.caida.org/Pathchar/
Neotrace	Traceroute visualisation tool.	http://www.neoworx.com/neotrace/
Visualroute	Traceroute visualisation tool.	http://www.visualroute.com/
NDG	A number of traffic visualisation tools.	http://www.ndg.com/
Reference		
Jack Rickard	"Mapping the Internet with Traceroute"	http://www.boardwatch.com/mag/96/dec/bwm38.htm
Davis et.al.	RFC 1876 Describes a means for expressing location information in the Domain Name System	ftp://ftp.is.co.za/rfc/rfc1876.txt

Source: OECD.

Table 9. Traceroute example (Telstra, Australia to OECD, France)

Hop number	Name of router	IP address	Round trip time for each hop
1.	Ethernet0.dickson.Canberra.telstra.net	(203.50.0.1)	1.527 ms 1.432 ms 1.436 ms
2.	Serial6-5.civ2.Canberra.telstra.net	(139.130.235.1)	2.281 ms 2.166 ms 4.811 ms
3.	Fddi0-0.civ-core1.Canberra.telstra.net	(139.130.235.226)	8.443 ms 2.334 ms 2.354 ms
4.	Hssi0-1-0.pad-core3.Sydney.telstra.net	(139.130.249.33)	6.832 ms 6.728 ms 6.577 ms
5.	Fddi0-0.pad16.Sydney.telstra.net	(139.130.249.235)	6.942 ms 10.756 ms 7.27 ms
6.	205.174.74.185	(205.174.74.185)	318.006 ms 313.69 ms 314.286 ms
7.	paloalto-cr18.bbnplanet.net	(131.119.26.125)	317.614 ms 364.02 ms 315.375 ms
8.	paloalto-nbr2.bbnplanet.net	(4.0.3.85)	314.583 ms 315.394 ms 314.553 ms
9.	sanjose1-nbr1.bbnplanet.net	(4.0.1.2)	316.775 ms 316.244 ms 315.468 ms
10.	sanjose1-br1.bbnplanet.net	(4.0.3.194)	315.848 ms 335.53 ms 317.376 ms
11.	198.32.136.94	(198.32.136.94)	328.571 ms 320.829 ms 317.919 ms
12.	gip-stock-1-hssi4-0.gip.net	(204.59.128.33)	263.302 ms 273.514 ms 264.753 ms
13.	gip-stock-2-fddi1-0.gip.net	(204.59.128.226)	276.001 ms 273.309 ms 272.074 ms
14.	gip-penn-1-hssi4-0.gip.net	(204.59.136.17)	336.509 ms 340.33 ms 332.627 ms
15.	gip-raspail-1-hssi5-0.gip.net	(204.59.18.22)	415.521 ms 427.173 ms 413.905 ms
16.	gip-raspail-2-fastethernet1-0.gip.net	(204.59.18.194)	415.18 ms 419.926 ms 418.115 ms
17.	* gip-paris-2-serial3-0.gip.net	(204.59.18.9)	463.156 ms 446.154 ms
18.	gip-paris-1-fddi1-0.gip.net	(204.59.16.193)	435.752 ms 441.349 ms 485.601 ms
19.	204.59.16.106	(204.59.16.106)	534.106 ms * 467.924 ms
20.	* net-rtgk.oecd.org	(193.51.65.17)	468.81 ms 484.535 ms
21.	net-rtgk.oecd.org	(193.51.65.17)	456.406 ms !N * *
22.	net-rtgk.oecd.org	(193.51.65.17)	1128.16 ms !N 488.126 ms !N 501.672 ms !N

1. Traceroute to cs9-HQ.oecd.org (193.51.65.78), 30 hops max, 40 byte packets from http://www.telstra.net/cgi-bin/trace

Source: OECD.

Table 10. Traceroutes between Telstra, CWIX and Optus

	Telstra to CWIX (1)	CWIX to Telstra(2)	CWIX to Optus	Optus to CWIX
Hop number	Name of router (IP address)	Name of router (IP Address)	Name of router (IP address)	Name of Router (IP Address)
1.	Ethernet0.dickson.Canberra.telstra.net (203.50.0.1)	tip-7513-1-f5-0 (206.142.240.1)	tip-7513-1-f5-0 (206.142.240.1)	nswrno2-eth2-0-ultimo.nswrno.net.au (203.15.123.113)
2.	2 139.130.204.241 (139.130.204.241)	cpe3-fddi-0.Washington.mci.net (192.41.177.180)	dcb-7513-3-f12-0.cwi.net (207.124.104.117)	nswrno1-fasteth1-0-0-ultimo.nswrno.net.au (203.15.123.97)
3.	3 Serial6-0.civ2.Canberra.telstra.net (139.130.235.5)	core1-hssi3-0.Washington.mci.net (204.70.1.221)	nyd-7513-1-a12-0 (207.124.105.162)	atm11-0-3.ia3.optus.net.au (192.65.88.213)
4.	Fddi0-0.civ-core1.Canberra.telstra.net (139.130.235.226	core2.Bloomington.mci.net (204.70.4.65)	sfd-7513-1-a11-0-2 (207.124.107.74)	atm11-0-3.ia3.optus.net.au (192.65.88.213)
5.	Fddi0-0.civ-core1.Canberra.telstra.net (139.130.235.226)	borderx2-fddi-1.Bloomington.mci.net (204.70.208.68)	cwi-optus (207.124.109.58)	202.139.7.150 (202.139.7.150) h21-3.sf1.optus.net.au (202.139.7.138)
6.	Hssi6-0-0.lon-core2.Melbourne.telstra.net (139.130.239.173)	telstra-internet.Bloomington.mci.net (204.70.208.122)	h21-4. ia2.optus.net.au (202.139.7.137)	sfd-7513-1-f12-0.cwix.net (207.124.109.57)
7.	Fddi0-0.lon5.Melbourne.telstra.net (139.130.239.231) borderx2-hssi3-0.Bloomington.mci.net (204.70.208.121)	Fddi0-0.lon7.Melbourne.telstra.net (139.130.239.228)	192.65.89.53 (192.65.89.53)	nyd-7513-1-a1-0-2.cwix.net (207.124.107.73) sfd-7513-1-f12-0.cwix.net (207.124.109.57)
8.	core2-fddi-1.Bloomington.mci.net (204.70.208.65)	telstra-corp.gw.au (139.130.181.2)	ntp1.optus.net.au (192.65.91.101)	nyd-7513-2-f5-0.cwix.net (206.142.243.2) nyd-7513-1-a1-0-2.cwix.net (207.124.107.73)
9.	core2.SanFrancisco.mci.net (204.70.4.201)	www.telstra.com.au (192.148.160.100)		phy-7513-1-h4-0.cwix.net (207.124.108.42)
10.	mae-west2-nap.SanFrancisco.mci.net (204.70.10.254)			blb-7513-1-h9-0.cwix.net (207.124.117.6)
11.	198.32.136.68 (198.32.136.68)			blb-7513-1-h9-0.cwix.net (207.124.117.6) tip-7513-2-h1-0.cwi.net (207.124.105.77) blb-7513-1-h9-0.cwix.net (207.124.117.6)
12.	207.124.107.73 (207.124.107.73) 352.835 ms 353.397 ms 360.774 ms			12 tip-7513-2-h1-0.cwi.net (207.124.105.77) 206.142.248.46 (206.142.248.46)
13.	207.124.105.161 (207.124.105.161)			
14.	tip-7513-2-f2-0.cwix.net (207.124.104.114)			
15.	206.142.248.46 (206.142.248.46)			

1. Traceroute from Telstra to www-apache.cwix.net (206.142.248.46)
2. Traceroute from cwix to www.telstra.com.au (192.148.160.100)
3. Traceroute from CWIX to www.optus.com.au (192.65.91.65)
4. Traceroute from http://www.nswrno.net.au/cgi-bin/trace to CWIX.

Source: OECD.

Table 11. Selected Web site ranking

	Note	Frequency	URL
Companies listing sites listed by Access			
Relevant Knowledge	Ranks Top 171 Websites and other categories by monitoring a panel of users.	Monthly	http://www.relevantknowledge.com/Press/sdindex.html
Web21	Ranks Top 100 Websites in different categories from proxy servers and caches.	Depends on Category.	http://www.100hot.com/
Indications of links to a Website			
HotBot	Search engine which enables user to get an indication of the number of links to a certain site in total or from different domains. It is also possible to count links from one top level domain to another top level domain	Always available.	http://www.HotBot.com/
Website measurement and capability service			
HotBot	Search engine which enables users to count the number of outgoing URLs and suffix domains under a particular domain name. For example it is possible to compare these categories under .fr for France to .be for Belgium. It is also possible to determine how many domains have capabilities such as video and audio	Always available.	http://www.HotBot.com/
Website link visualisation			
Nicheworks	Website and link visualisation tool.	Example: The Chicago Tribune Website.	http://www.bell-labs.com/user/gwills/NICHEguide/trib.html
Ptolomaeus	A Website cartography tool.		http://www.inf.uniroma3.it/~vernacot/ptolpage.htm

Source: OECD.

Table 12. Links to the URLs of selected sites (June 1998)

		Links found by HotBot under:						
URL	Website Name	Total	.com	.edu (1)	gtlds (2)	Europe (3)	Asia/India (4)	Oceania (5)
www.yahoo.com	Yahoo!	690 532	465611	39395	555 746	39 404	9 265	5 666
www.excite.com	Excite	233 980	165120	12574	205 919	15 277	2 280	1 869
www.netscape.com	Netscape	221 525	67295	52145	155 436	49 100	3 229	4 190
www.lycos.com	Lycos	212 787	136999	15683	212 787	18 870	4 008	2 579
www.microsoft.com	Microsoft	187 665	80235	14615	132 547	35 448	5 053	4 209
home.netscape.com	Netscape (home)	158 336	69555	14601	110 448	33 023	4 880	2 767
altavista.digital.com	Alta Vista	111 002	71 436	9 958	90 529	13 473	1 867	1 159
www.apple.com	Apple	109 789	60 459	11 713	84 530	11 618	2 302	8 286
www.ibm.com	IBM	106 478	65 023	6 547	80 570	14 603	3 077	1 141
www.cnn.com	CNN	77 372	36 172	13 264	61 279	9 667	1 957	1 086
www.disney.com	Disney	62 752	42 375	4 251	54 193	4 775	967	750
www.geocities.com	Geocities	60 338	41 222	1 266	46 640	4 536	1 052	449
www.infoseek.com	Infoseek	57 179	20 681	7 023	39 027	10 512	3 291	1 437
www.HotBot.com	HotBot	56 088	18 842	6 715	38 623	12 823	1 307	1 224
www.nasa.gov	NASA	47 501	7 390	6 086	38 853	5 435	1 444	491
www.dejanews.com	DejaNews	38 621	11 069	5 475	24 701	9 089	1 697	1 018
www.usatoday.com	USA Today	38 410	13 564	8 115	29 575	2 818	1 231	352
www.cnet.com	CNET	32 868	17 667	3 798	27 704	2 472	593	471
www.nytimes.com	NY Times	29 219	10 283	7 972	24 239	2 743	679	288
www.amazon.com	Amazon	26 786	11 498	4 416	21 025	3 277	685	525
www.whowhere.com	WhoWhere	26 051	11 191	3 022	18 817	5 245	579	509
www.washingtonpost.com	Washington Post	14 729	5 057	3 571	12 456	1 241	278	148
www.ft.com	Financial Times	11 552	1 952	636	3 764	3 426	221	168
www.playboy.com	Playboy	11 000	3 990	915	5 794	3 730	618	150
www.wired.com	Wired	9 135	2 497	1 689	6 057	2 033	331	212
www.economist.com	The Economist	8 814	2 272	1 820	5 643	2 005	258	185
www.smh.com.au	Sydney Morning Herald	7 917	544	189	1 079	349	91	6 053
www.spiegel.de	Spiegel Online	5 474	396	308	973	4 270	78	25
www.lemonde.fr	Le Monde	4 874	685	350	1 759	2 449	104	44
www.nikkei.co.jp	Nikkei	1 831	116	19	209	53	1 503	14

1. .edu includes only institutions in the United States. All educational institutions outside the United States register under TLDs.
2. This includes .com, .net, .org, ..edu, .mil and .gov. The first three would include registrations from users anywhere in the world while the last three are only used by the United States.
3. European TLDs as defined by HotBot.
4. This category includes Japan and Korea among others.
5. This category includes Australia and New Zealand among others.

Source: OECD.

Table 13. Links to the URLs of leading telecommunications carriers' Websites (July 1998)

		Links under:		
URL	Name of telecommunications carrier	Applicable TLDs (1)	.com	total
att.com	AT&T	164	12622	18890
ntt.jp	NTT	14271	170	15141
sprint.com	Sprint	32	5161	6728
mci.com	MCI	65	2469	5449
telefonica.es	Telefonica	4228	220	4959
gte.com	GTE	27	3563	4737
telstra.com.au	Telstra	2463	1071	4167
bellsouth.com	Bell South	27	2187	3713
bt.com	British Telecom	406	1744	2724
ameritech.com	Ameritech	50	1483	2617
uswest.com	US West	39	1105	2182
bell.ca	Bell Canada	624	867	2142
pacbell.com	Pacbell	32	763	1995
bell-atl.com	Bell Atlantic	22	1009	1900
francetelecom.fr	France Telecom	184	1177	1777
dtag.de	Deutsche Telekom	804	427	1644
wcom.com	Worldcom	5	597	1602
telia.se	Telia	1088	147	1498
telecom.co.nz	Telecom NZ	1109	60	1260
nynex.com	Nynex	10	761	1247
telenor.no	Telenor	768	42	1202
sbc.com	SBC	17	458	1099
ntt.co.jp	NTT	567	119	982
cwplc.com	Cable & Wireless	65	711	869
francetelecom.com	France Telecom	33	487	814
tele2.se	Tele2	652	48	747
minitel.fr	France Telecom (Minitel)	85	119	574
ptt-telecom.nl.	KPN	332	46	530
telecomitalia.it	Telecom Italia	292	37	475
telecom.ie	Telecom Eireann	46	290	421
swisscom.ch	Swisscom	258	51	384
teledanmark.dk	TeleDanmark	175	61	373
bt.co.uk	British Telecom	175	69	357
belgacom.be	Belgacom	147	50	343
hpy.fi	Helsinki Telephone Company	184	23	338
kdd.co.jp	KDD	199	70	309
tpsa.pl	Telecom Poland	254	8	298
bctel.com	BC-Tel	69	137	257
pt.lu	PT Luxembourg	69	25	184
telecom.pt	Portugal Telecom	94	19	179
simi.is	P&T Iceland	61	13	146

Table 13. Links to the URLs of leading telecommunications carriers' Websites (July 1998) *(continued)*

		Links under:		
URL	Telecommunication carrier	Applicable	.com	total
kpn.com	KPN	78	11	143
telia.com	Telia	27	76	138
pta.at	PTA Austria	98	12	132
swisscom.com	Swisscom	66	16	130
sonera.fi	Sonera (Telecom Finland)	110	8	127
spt.cz	SPT Telecom	90	4	123
matav.hu	Matav	84	18	122
cwcom.co.uk	Cable & Wireless	54	29	106
clear.co.nz	Clear	18	9	49
telmex.com.mx	Telmex	15	20	46
optus.com.au	Optus	32	4	43
kpn.nl	KPN	26	2	33
ntt.com	NTT	2	6	22
ote.gr	OTE	11	0	20

1. e.g. .jp for NTT and .be for Belgacom.

Source: OECD.

Table 14. Comparative World Wide Web development (June 1998)

Domain	Top Level Domain	Under Origin Domain Suffix	Share of Total OECD	Audio	Video
.com	COM	34382 090	40.7	269809	70265
.edu	EDU	13815 908	16.4	66757	72634
.org	ORG	5099 979	6.0	37147	7140
.net	NET	5056 226	6.0	44693	6830
.de	Germany	4098 814	4.9	15393	8228
.ca	Canada	2832 673	3.4	12215	3245
.uk	United Kingdom	2789 408	3.3	53129	4706
.jp	Japan	2247 215	2.7	22341	7705
.au	Australia	1657 438	1.8	13301	2733
.us	United States	1341 568	1.6	5983	1808
.se	Sweden	1147 532	1.4	7806	4373
.it	Italy	1142 622	1.4	5415	7602
.fr	France	1012 372	1.2	6738	3610
.nl	Netherlands	913 586	1.1	5378	2042
.ch	Switzerland	820 348	1.0	2838	1113
.fi	Finland	735 468	0.9	3137	923
.at	Austria	645 005	0.8	2383	872
.no	Norway	582 982	0.7	2690	1304
.es	Spain	569 020	0.7	3343	1928
.kr	Korea	436 619	0.5	3886	1591
.cz	Czech Republic	427 569	0.5	1067	468
.dk	Denmark	391 685	0.5	1929	598
.pl	Poland	349 900	0.4	1540	404
.be	Belgium	295 036	0.3	1463	485
.mil	MIL	293 634	0.3	455	557
.mx	Mexico	280 834	0.3	846	169
.hu	Hungary	236 429	0.3	640	294
.nz	New Zealand	201 499	0.2	1065	290
.gr	Greece	159 591	0.2	600	253
.pt	Portugal	135 924	0.2	573	144
.ie	Ireland	130 975	0.2	727	161
.tr	Turkey	113 766	0.1	266	126
.int	INT	97 464	0.1	14	12
.is	Iceland	52 311	0.1	327	100
.lu	Luxembourg	31 886	0.0	135	28
	OECD (1)	84 525 376		596029	214741

1. OECD represents approximately 96 per cent of world total however this includes domains found under non-OECD country gTLDs.

Source: OECD.

Table 15. World Wide Web links between TLDs and gTLDs (July 1998)

	To	Australia	Austria	Belgium	Canada	Czech Republic	Denmark	Finland	France	Germany	Greece	Hungary	Iceland	Ireland	Italy	Japan	Korea	Luxem-bourg	Mexico
From		.au	.at	.be	.ca	.cz	.dk	.fi	.fr	.de	.gr	.hu	.is	.ie	.it	.jp	.kr	.lu	.mx
Australia	.au	**1583158**	3281	2810	18728	778	2393	5793	6155	12931	1234	804	566	2587	5625	7100	1090	464	848
Austria	.at	2855	**547653**	1295	2957	529	1007	5757	2770	17077	376	543	141	563	3706	1629	307	703	226
Belgium	.be	1841	896	**245743**	2304	232	743	1087	3557	3486	326	225	147	584	1555	905	229	900	164
Canada	.ca	20484	3369	3804	**2372498**	1303	3059	5355	11423	14061	1069	909	632	3491	5557	7094	1139	752	1516
Czech Republic	.cz	1664	1238	578	2455	**374124**	630	1277	1464	4794	212	443	109	347	1436	977	217	274	198
Denmark	.dk	2047	822	783	2323	256	**349218**	10331	1900	3762	231	246	353	434	1352	922	225	428	126
Finland	.fi	4804	1935	1698	5291	538	2396	**603110**	2940	24913	454	563	538	1054	2818	2295	334	1011	248
France	.fr	5449	1916	5842	10994	532	2496	2337	**965890**	10189	589	445	187	1032	4478	2847	397	1630	398
Germany	.de	17878	28891	6454	18212	2325	13474	10271	18260	**3284644**	1743	2046	871	3996	14077	9062	1575	5027	1257
Greece	.gr	826	332	368	771	94	269	420	917	2083	**134105**	113	57	153	670	475	171	490	75
Hungary	.hu	2250	674	280	1013	283	250	697	914	2091	141	**201874**	47	173	761	462	135	103	117
Iceland	.is	344	238	110	517	48	383	266	168	370	45	35	**45387**	93	168	155	29	56	27
Ireland	.ie	2621	489	558	1526	80	344	1698	1712	2216	288	71	49	**113600**	1367	1262	53	168	44
Italy	.it	5732	2562	2261	5748	659	1785	3011	7419	10684	830	911	431	1293	**1040151**	2917	520	1376	727
Japan	.jp	10949	2530	1907	11551	837	2015	18403	9980	10914	587	712	315	1182	4625	**1915213**	1931	291	532
Korea	.kr	2944	842	803	3382	296	3356	997	1689	5537	261	303	151	617	1287	2613	**381919**	226	263
Luxembourg	.lu	84	122	482	208	23	91	95	336	699	46	14	24	60	194	46	11	**25327**	10
Mexico	.mx	470	145	129	905	56	132	270	367	623	30	64	20	87	312	255	44	31	**240524**
Netherlands	.nl	6904	2776	6059	7195	825	2230	4356	5274	12299	732	746	521	1416	5070	7699	593	1234	431
New Zealand	.nz	6587	211	237	1624	56	223	374	429	986	81	60	62	309	409	541	141	40	90
Norway	.no	3018	1133	928	3217	352	4502	2591	2681	5196	343	269	505	752	1534	1326	271	417	181
Poland	.pl	1788	693	505	1583	484	633	968	1279	3803	199	319	100	321	2357	1138	222	729	131
Portugal	.pt	1443	362	467	1019	138	325	658	949	3567	371	115	56	222	850	518	138	203	105
Spain	.es	2901	1246	1560	1560	390	1089	1722	3422	5026	536	360	185	683	2908	1544	377	1229	1890
Sweden	.se	7686	2814	2367	8274	803	7338	7726	4601	11585	741	622	838	1687	29570	3436	708	1008	406
Switzerland	.ch	3212	3301	1797	4010	481	1142	1741	7944	16752	334	472	116	689	3531	3310	352	552	223
Turkey	.tr	1417	456	356	1834	162	316	572	922	1616	147	184	53	288	610	759	205	168	118
UK	.uk	20582	5038	5796	20902	1298	5650	7391	11576	31564	1969	1327	914	7020	9788	22691	1646	2604	996
US	.us	4992	647	721	9744	122	462	1105	1551	2243	236	171	125	733	1323	1841	226	104	548
COM	.com	180774	33271	36040	310326	12407	30041	45191	90025	190754	12002	7637	7350	29689	75127	94609	20036	6109	17217
ORG	.org	29594	5921	7035	60979	3013	5920	8261	22046	29944	14497	1530	931	3460	10995	13102	2125	2033	2481
NET	.net	40555	9016	8212	66886	2700	7650	13736	19496	36433	2653	1966	1784	6306	16826	18267	6495	1102	3270
EDU	.edu	77921	14505	11044	107593	4430	10728	20137	30091	76554	4235	5453	1878	11287	21846	45090	38010	2022	6444
GOV	.gov	2928	587	446	4032	164	740	773	1707	3942	142	171	64	334	1535	1887	289	103	384
INT	.int	56	62	233	126	43	100	75	173	218	67	26	21	44	209	70	22	187	18
Total		2058758	679974	359708	3072287	410861	463130	788552	1242027	3843556	181852	231749	65528	196586	1274627	2174057	462182	59101	282233

Source: OECD

Table 15. World Wide Web links between TLDs and gTLDs (July 1998) *(continued)*

	To	Netherlands	New Zealand	Norway	Poland	Portugal	Spain	Sweden	Switzerland	Turkey	United Kingdom	United States	COM	ORG	NET	EDU	GOV	INT	Total
From		.nl	.nz	.no	.pl	.pt	.es	.se	.ch	.tr	.uk	.us	.com	.org	.net	.edu	.gov	.int	
Australia	.au	9030	5656	5203	2021	2364	2511	12546	9141	258	37367	8044	238734	50599	90690	64636	15307	379	2210831
Austria	.at	3433	422	1595	457	424	994	2558	4954	114	7037	620	50818	24546	11550	16687	7527	1048	724878
Belgium	.be	6274	281	1084	286	309	714	1628	2067	67	5009	478	33062	7713	7880	9118	1933	895	343722
Canada	.ca	12059	3479	5096	1696	860	2542	8368	9584	221	60197	9380	351879	105811	90402	105867	28271	1102	3254329
Czech Republic	.cz	2368	318	1136	541	310	466	1508	2064	49	5199	626	38685	9906	7233	12502	2609	270	478227
Denmark	.dk	2525	981	16812	299	259	561	5947	1538	46	6190	543	77915	21613	8497	8528	2385	587	530985
Finland	.fi	5153	640	4047	476	517	1095	8801	3326	117	11858	1273	52976	15123	14512	21594	14772	18780	832000
France	.fr	6262	549	3496	638	810	2024	4163	9172	108	13169	1113	90126	33362	18038	24174	7740	834	1233426
Germany	.de	29203	3573	10413	2789	2162	5184	16769	32172	602	57031	3864	315941	119105	94495	108479	28593	2805	4273243
Greece	.gr	1255	130	405	148	299	194	824	612	33	3250	253	25190	5246	2617	4357	1105	1555	189862
Hungary	.hu	1252	129	613	277	114	252	731	1378	49	2662	255	20495	4260	3409	6890	1306	95	256432
Iceland	.is	422	65	410	43	38	69	468	218	11	2579	138	4527	1557	1217	1501	337	60	62099
Ireland	.ie	1722	116	1565	1301	1584	1242	4907	758	14	9652	216	31921	4367	4703	12635	708	164	205721
Italy	.it	9454	1028	2870	790	774	2553	6030	6152	173	17216	1655	122857	22778	25851	22266	8559	1339	1341362
Japan	.jp	7847	3078	3233	1957	644	1630	5293	7666	324	28221	2175	163406	34974	32681	68726	52377	259	2408965
Korea	.kr	2019	589	1173	398	320	521	1718	2216	125	6095	957	44985	9361	14798	11923	3549	88	508321
Luxembourg	.lu	271	21	54	36	80	143	143	221	3	484	33	3413	504	433	420	138	508	34777
Mexico	.mx	380	61	224	71	47	795	275	328	23	947	183	10344	2344	2631	3569	712	25	267423
Netherlands	.nl	**802538**	1302	3981	1051	831	1895	6882	4964	175	19828	1563	99347	27284	32321	23914	6242	1122	1101600
New Zealand	.nz	838	**166723**	353	99	73	181	632	936	12	4047	438	28412	5451	5980	4371	1060	45	232111
Norway	.no	3622	481	**505274**	385	296	573	7210	2401	91	12535	766	47173	11973	10155	13224	3241	354	648970
Poland	.pl	1612	271	1221	**273198**	203	366	1638	1712	71	3802	430	33840	6450	8380	7343	1866	145	359800
Portugal	.pt	880	149	494	435	**118017**	577	2356	1577	78	6719	267	18267	3967	3034	4604	880	185	173992
Spain	.es	3250	498	1687	468	928	**500216**	2487	3329	132	8370	917	45862	13105	16847	15262	3709	1037	646732
Sweden	.se	8759	1185	9912	1043	901	1711	**1006346**	5889	165	20465	1941	124698	29451	35683	32152	7586	1279	1381376
Switzerland	.ch	4626	498	1797	439	540	1024	2962	**727850**	95	9483	698	77663	18843	12974	17859	4849	1274	933433
Turkey	.tr	1055	264	531	266	115	214	727	1019	**43512**	2674	547	12394	5245	3759	6879	1486	74	90944
UK	.uk	17775	5319	7584	1674	1752	4624	12690	17926	460	**2399150**	5057	381320	75512	74247	89601	55009	3157	3311609
US	.us	2711	615	1091	255	162	488	2005	2261	72	9010	**1134816**	125880	60718	38256	62596	38335	138	1506303
COM	.com	123408	39167	53072	18213	11039	39236	130564	80451	1582	419724	204608	**28131921**	1235643	2498323	860632	331087	14790	35392065
ORG	.org	20399	3698	8600	1815	1960	6073	14579	55985	1194	53139	46658	730815	**4084047**	173701	215323	94265	4179	5740297
NET	.net	34957	6556	16362	4363	2111	7452	23205	20204	614	70410	49692	1377625	242527	**4128522**	259464	57868	1011	6566296
EDU	.edu	45931	10379	20590	4920	3377	9349	34270	43769	2355	170081	97530	1052173	454143	270774	**9162329**	223030	2750	12097018
GOV	.gov	2103	379	735	251	178	433	1123	8060	110	33015	9497	55536	25926	10161	63582	**1245236**	272	1476825
INT	.int	224	20	57	17	63	87	110	1832	2	263	15	944	955	281	215	272	**84521**	91628
Total		1175617	258620	692770	323116	154461	597989	1332463	1073732	53057	3516878	1587246	34021144	6774409	7755035	11343222	2253949	147126	

Table 16. Percentage of all World Wide Web links between TLDs and gTLDs (July 1998)

	To	Australia	Austria	Belgium	Canada	Czech Republic	Denmark	Finland	France	Germany	Greece	Hungary	Iceland	Ireland	Italy	Japan	Korea	Luxem-bourg	Mexico
From		.au	.at	.be	.ca	.cz	.dk	.fi	.fr	.de	.gr	.hu	.is	.ie	.it	.jp	.kr	.lu	.mx
Australia	.au	**71.6**	0.1	0.1	0.8	0.0	0.1	0.3	0.3	0.6	0.1	0.0	0.0	0.1	0.3	0.3	0.0	0.0	0.0
Austria	.at	0.4	**75.6**	0.2	0.4	0.1	0.1	0.8	0.4	2.4	0.1	0.1	0.0	0.1	0.5	0.2	0.0	0.1	0.0
Belgium	.be	0.5	0.3	**71.5**	0.7	0.1	0.2	0.3	1.0	1.0	0.1	0.1	0.0	0.2	0.5	0.3	0.1	0.3	0.0
Canada	.ca	0.6	0.1	0.1	**72.9**	0.0	0.1	0.2	0.4	0.4	0.0	0.0	0.0	0.1	0.2	0.2	0.0	0.0	0.0
Czech Republic	.cz	0.3	0.3	0.1	0.5	**78.2**	0.1	0.3	0.3	1.0	0.0	0.1	0.0	0.1	0.3	0.2	0.0	0.1	0.0
Denmark	.dk	0.4	0.2	0.1	0.4	0.0	**65.8**	1.9	0.4	0.7	0.0	0.0	0.1	0.1	0.3	0.2	0.0	0.1	0.0
Finland	.fi	0.6	0.2	0.2	0.6	0.1	0.3	**72.5**	0.4	3.0	0.1	0.1	0.1	0.1	0.3	0.3	0.0	0.1	0.0
France	.fr	0.4	0.2	0.5	0.9	0.0	0.2	0.2	**78.3**	0.8	0.0	0.0	0.0	0.1	0.4	0.2	0.0	0.1	0.0
Germany	.de	0.4	0.7	0.2	0.4	0.1	0.3	0.2	0.4	**76.9**	0.0	0.0	0.0	0.1	0.3	0.2	0.0	0.1	0.0
Greece	.gr	0.4	0.2	0.2	0.4	0.0	0.1	0.2	0.5	1.1	**70.6**	0.1	0.0	0.1	0.4	0.3	0.1	0.3	0.0
Hungary	.hu	0.9	0.3	0.1	0.4	0.1	0.1	0.3	0.4	0.8	0.1	**78.7**	0.0	0.1	0.3	0.2	0.1	0.0	0.0
Iceland	.is	0.6	0.4	0.2	0.8	0.1	0.6	0.4	0.3	0.6	0.1	0.1	**73.1**	0.1	0.3	0.2	0.0	0.1	0.0
Ireland	.ie	1.3	0.2	0.3	0.7	0.0	0.2	0.8	0.8	1.1	0.1	0.0	0.0	**55.2**	0.7	0.6	0.0	0.1	0.0
Italy	.it	0.4	0.2	0.2	0.4	0.0	0.1	0.2	0.6	0.8	0.1	0.1	0.0	0.1	**77.5**	0.2	0.0	0.1	0.1
Japan	.jp	0.5	0.1	0.1	0.5	0.0	0.1	0.8	0.4	0.5	0.0	0.0	0.0	0.0	0.2	**79.5**	0.1	0.0	0.0
Korea	.kr	0.6	0.2	0.2	0.7	0.1	0.7	0.2	0.3	1.1	0.1	0.1	0.0	0.1	0.3	0.5	**75.1**	0.0	0.1
Luxembourg	.lu	0.2	0.4	1.4	0.6	0.1	0.3	0.3	1.0	2.0	0.1	0.0	0.1	0.2	0.6	0.1	0.0	**72.8**	0.0
Mexico	.mx	0.2	0.1	0.0	0.3	0.0	0.0	0.1	0.1	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	**89.9**
Netherlands	.nl	0.6	0.3	0.6	0.7	0.1	0.2	0.4	0.5	1.1	0.1	0.1	0.0	0.1	0.5	0.7	0.1	0.1	0.0
New Zealand	.nz	2.8	0.1	0.1	0.7	0.0	0.1	0.2	0.2	0.4	0.0	0.0	0.0	0.1	0.2	0.2	0.1	0.0	0.0
Norway	.no	0.5	0.2	0.1	0.5	0.1	0.7	0.4	0.4	0.8	0.1	0.0	0.1	0.1	0.2	0.2	0.0	0.1	0.0
Poland	.pl	0.5	0.2	0.1	0.4	0.1	0.2	0.3	0.4	1.1	0.1	0.1	0.0	0.1	0.7	0.3	0.1	0.2	0.0
Portugal	.pt	0.8	0.2	0.3	0.6	0.1	0.2	0.4	0.5	2.1	0.2	0.1	0.0	0.1	0.5	0.3	0.1	0.1	0.1
Spain	.es	0.4	0.2	0.2	0.2	0.1	0.2	0.3	0.5	0.8	0.1	0.1	0.0	0.1	0.4	0.2	0.1	0.2	0.3
Sweden	.se	0.6	0.2	0.2	0.6	0.1	0.5	0.6	0.3	0.8	0.1	0.0	0.1	0.1	2.1	0.2	0.1	0.1	0.0
Switzerland	.ch	0.3	0.4	0.2	0.4	0.1	0.1	0.2	0.9	1.8	0.0	0.1	0.0	0.1	0.4	0.4	0.0	0.1	0.0
Turkey	.tr	1.6	0.5	0.4	2.0	0.2	0.3	0.6	1.0	1.8	0.2	0.2	0.1	0.3	0.7	0.8	0.2	0.2	0.1
UK	.uk	0.6	0.2	0.2	0.6	0.0	0.2	0.2	0.3	1.0	0.1	0.0	0.0	0.2	0.3	0.7	0.0	0.1	0.0
US	.us	0.3	0.0	0.0	0.6	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0
COM	.com	0.5	0.1	0.1	0.9	0.0	0.1	0.1	0.3	0.5	0.0	0.0	0.0	0.1	0.2	0.3	0.1	0.0	0.0
ORG	.org	0.5	0.1	0.1	1.1	0.1	0.1	0.1	0.4	0.5	0.3	0.0	0.0	0.1	0.2	0.2	0.0	0.0	0.0
NET	.net	0.6	0.1	0.1	1.0	0.0	0.1	0.2	0.3	0.6	0.0	0.0	0.0	0.1	0.3	0.3	0.1	0.0	0.0
EDU	.edu	0.6	0.1	0.1	0.9	0.0	0.1	0.2	0.2	0.6	0.0	0.0	0.0	0.1	0.2	0.4	0.3	0.0	0.1
GOV	.gov	0.2	0.0	0.0	0.3	0.0	0.1	0.1	0.1	0.3	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0
INT	.int	0.1	0.1	0.3	0.1	0.0	0.1	0.1	0.2	0.2	0.1	0.0	0.0	0.0	0.2	0.1	0.0	0.2	0.0

Source: OECD

Table 16. Percentage of all World Wide Web links between TLDs and gTLDs (July 1998) *(continued)*

	To	Netherlands	New Zealand	Norway	Poland	Portugal	Spain	Sweden	Switzerland	Turkey	United Kingdom	United States	COM	ORG	NET	EDU	GOV	INT	Total
From		.nl	.nz	.no	.pl	.pt	.es	.se	.ch	.tr	.uk	.us	.com	.org	.net	.edu	.gov	.int	
Australia	.au	0.4	0.3	0.2	0.1	0.1	0.1	0.6	0.4	0.0	1.7	0.4	10.8	2.3	4.1	2.9	0.7	0.0	100
Austria	.at	0.5	0.1	0.2	0.1	0.1	0.1	0.4	0.7	0.0	1.0	0.1	7.0	3.4	1.6	2.3	1.0	0.1	100
Belgium	.be	1.8	0.1	0.3	0.1	0.1	0.2	0.5	0.6	0.0	1.5	0.1	9.6	2.2	2.3	2.7	0.6	0.3	100
Canada	.ca	0.4	0.1	0.2	0.1	0.0	0.1	0.3	0.3	0.0	1.8	0.3	10.8	3.3	2.8	3.3	0.9	0.0	100
Czech Republic	.cz	0.5	0.1	0.2	0.1	0.1	0.1	0.3	0.4	0.0	1.1	0.1	8.1	2.1	1.5	2.6	0.5	0.1	100
Denmark	.dk	0.5	0.2	3.2	0.1	0.0	0.1	1.1	0.3	0.0	1.2	0.1	14.7	4.1	1.6	1.6	0.4	0.1	100
Finland	.fi	0.6	0.1	0.5	0.1	0.1	0.1	1.1	0.4	0.0	1.4	0.2	6.4	1.8	1.7	2.6	1.8	2.3	100
France	.fr	0.5	0.0	0.3	0.1	0.1	0.2	0.3	0.7	0.0	1.1	0.1	7.3	2.7	1.5	2.0	0.6	0.1	100
Germany	.de	0.7	0.1	0.2	0.1	0.1	0.1	0.4	0.8	0.0	1.3	0.1	7.4	2.8	2.2	2.5	0.7	0.1	100
Greece	.gr	0.7	0.1	0.2	0.1	0.2	0.1	0.4	0.3	0.0	1.7	0.1	13.3	2.8	1.4	2.3	0.6	0.8	100
Hungary	.hu	0.5	0.1	0.2	0.1	0.0	0.1	0.3	0.5	0.0	1.0	0.1	8.0	1.7	1.3	2.7	0.5	0.0	100
Iceland	.is	0.7	0.1	0.7	0.1	0.1	0.1	0.8	0.4	0.0	4.2	0.2	7.3	2.5	2.0	2.4	0.5	0.1	100
Ireland	.ie	0.8	0.1	0.8	0.6	0.8	0.6	2.4	0.4	0.0	4.7	0.1	15.5	2.1	2.3	6.1	0.3	0.1	100
Italy	.it	0.7	0.1	0.2	0.1	0.1	0.2	0.4	0.5	0.0	1.3	0.1	9.2	1.7	1.9	1.7	0.6	0.1	100
Japan	.jp	0.3	0.1	0.1	0.1	0.0	0.1	0.2	0.3	0.0	1.2	0.1	6.8	1.5	1.4	2.9	2.2	0.0	100
Korea	.kr	0.4	0.1	0.2	0.1	0.1	0.1	0.3	0.4	0.0	1.2	0.2	8.8	1.8	2.9	2.3	0.7	0.0	100
Luxembourg	.lu	0.8	0.1	0.2	0.1	0.2	0.4	0.4	0.6	0.0	1.4	0.1	9.8	1.4	1.2	1.2	0.4	1.5	100
Mexico	.mx	0.1	0.0	0.1	0.0	0.0	0.3	0.1	0.1	0.0	0.4	0.1	3.9	0.9	1.0	1.3	0.3	0.0	100
Netherlands	.nl	**72.9**	0.1	0.4	0.1	0.1	0.2	0.6	0.5	0.0	1.8	0.1	9.0	2.5	2.9	2.2	0.6	0.1	100
New Zealand	.nz	0.4	**71.8**	0.2	0.0	0.0	0.1	0.3	0.4	0.0	1.7	0.2	12.2	2.3	2.6	1.9	0.5	0.0	100
Norway	.no	0.6	0.1	**77.9**	0.1	0.0	0.1	1.1	0.4	0.0	1.9	0.1	7.3	1.8	1.6	2.0	0.5	0.1	100
Poland	.pl	0.4	0.1	0.3	**75.9**	0.1	0.1	0.5	0.5	0.0	1.1	0.1	9.4	1.8	2.3	2.0	0.5	0.0	100
Portugal	.pt	0.5	0.1	0.3	0.3	**67.8**	0.3	1.4	0.9	0.0	3.9	0.2	10.5	2.3	1.7	2.6	0.5	0.1	100
Spain	.es	0.5	0.1	0.3	0.1	0.1	**77.3**	0.4	0.5	0.0	1.3	0.1	7.1	2.0	2.6	2.4	0.6	0.2	100
Sweden	.se	0.6	0.1	0.7	0.1	0.1	0.1	**72.9**	0.4	0.0	1.5	0.1	9.0	2.1	2.6	2.3	0.5	0.1	100
Switzerland	.ch	0.5	0.1	0.2	0.0	0.1	0.1	0.3	**78.0**	0.0	1.0	0.1	8.3	2.0	1.4	1.9	0.5	0.1	100
Turkey	.tr	1.2	0.3	0.6	0.3	0.1	0.2	0.8	1.1	**47.8**	2.9	0.6	13.6	5.8	4.1	7.6	1.6	0.1	100
UK	.uk	0.5	0.2	0.2	0.1	0.1	0.1	0.4	0.5	0.0	**72.4**	0.2	11.5	2.3	2.2	2.7	1.7	0.1	100
US	.us	0.2	0.0	0.1	0.0	0.0	0.0	0.1	0.2	0.0	0.6	**75.3**	8.4	4.0	2.5	4.2	2.5	0.0	100
COM	.com	0.3	0.1	0.1	0.1	0.0	0.1	0.4	0.2	0.0	1.2	0.6	**79.5**	3.5	7.1	2.4	0.9	0.0	100
ORG	.org	0.4	0.1	0.1	0.0	0.0	0.1	0.3	1.0	0.0	0.9	0.8	12.7	**71.1**	3.0	3.8	1.6	0.1	100
NET	.net	0.5	0.1	0.2	0.1	0.0	0.1	0.4	0.3	0.0	1.1	0.8	21.0	3.7	**62.9**	4.0	0.9	0.0	100
EDU	.edu	0.4	0.1	0.2	0.0	0.0	0.1	0.3	0.4	0.0	1.4	0.8	8.7	3.8	2.2	**75.7**	1.8	0.0	100
GOV	.gov	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.0	2.2	0.6	3.8	1.8	0.7	4.3	**84.3**	0.0	100
INT	.int	0.2	0.0	0.1	0.0	0.1	0.1	0.1	2.0	0.0	0.3	0.0	1.0	1.0	0.3	0.2	0.3	**92.2**	100

Table 17. Percentage of World Wide Web links between TLDs and gTLDs (excluding Intra-domains) (July 1998)

	To	Australia	Austria	Belgium	Canada	Czech Republic	Denmark	Finland	France	Germany	Greece	Hungary	Iceland	Ireland	Italy	Japan	Korea	Luxem-bourg	Mexico
From		.au	.at	.be	.ca	.cz	.dk	.fi	.fr	.de	.gr	.hu	.is	.ie	.it	.jp	.kr	.lu	.mx
Australia	.au		0.5	0.4	3.0	0.1	0.4	0.9	1.0	2.1	0.2	0.1	0.1	0.4	0.9	1.1	0.2	0.1	0.1
Austria	.at	1.6		0.7	1.7	0.3	0.6	3.2	1.6	9.6	0.2	0.3	0.1	0.3	2.1	0.9	0.2	0.4	0.1
Belgium	.be	1.9	0.9		2.4	0.2	0.8	1.1	3.6	3.6	0.3	0.2	0.2	0.6	1.6	0.9	0.2	0.9	0.2
Canada	.ca	2.3	0.4	0.4		0.1	0.3	0.6	1.3	1.6	0.1	0.1	0.1	0.4	0.6	0.8	0.1	0.1	0.2
Czech Republic	.cz	1.6	1.2	0.6	2.4		0.6	1.2	1.4	4.6	0.2	0.4	0.1	0.3	1.4	0.9	0.2	0.3	0.2
Denmark	.dk	1.1	0.5	0.4	1.3	0.1		5.7	1.0	2.1	0.1	0.1	0.2	0.2	0.7	0.5	0.1	0.2	0.1
Finland	.fi	2.1	0.8	0.7	2.3	0.2	1.0		1.3	10.9	0.2	0.2	0.2	0.5	1.2	1.0	0.1	0.4	0.1
France	.fr	2.0	0.7	2.2	4.1	0.2	0.9	0.9		3.8	0.2	0.2	0.1	0.4	1.7	1.1	0.1	0.6	0.1
Germany	.de	1.8	2.9	0.7	1.8	0.2	1.4	1.0	1.8		0.2	0.2	0.1	0.4	1.4	0.9	0.2	0.5	0.1
Greece	.gr	1.5	0.6	0.7	1.4	0.2	0.5	0.8	1.6	3.7		0.2	0.1	0.3	1.2	0.9	0.3	0.9	0.1
Hungary	.hu	4.1	1.2	0.5	1.9	0.5	0.5	1.3	1.7	3.8	0.3		0.1	0.3	1.4	0.8	0.2	0.2	0.2
Iceland	.is	2.1	1.4	0.7	3.1	0.3	2.3	1.6	1.0	2.2	0.3	0.2		0.6	1.0	0.9	0.2	0.3	0.2
Ireland	.ie	2.8	0.5	0.6	1.7	0.1	0.4	1.8	1.9	2.4	0.3	0.1	0.1		1.5	1.4	0.1	0.2	0.0
Italy	.it	1.9	0.9	0.8	1.9	0.2	0.6	1.0	2.5	3.5	0.3	0.3	0.1	0.4		1.0	0.2	0.5	0.2
Japan	.jp	2.2	0.5	0.4	2.3	0.2	0.4	3.7	2.0	2.2	0.1	0.1	0.1	0.2	0.9		0.4	0.1	0.1
Korea	.kr	2.3	0.7	0.6	2.7	0.2	2.7	0.8	1.3	4.4	0.2	0.2	0.1	0.5	1.0	2.1		0.2	0.2
Luxembourg	.lu	0.9	1.3	5.1	2.2	0.2	1.0	1.0	3.6	7.4	0.5	0.1	0.3	0.6	2.1	0.5	0.1		0.1
Mexico	.mx	1.7	0.5	0.5	3.4	0.2	0.5	1.0	1.4	2.3	0.1	0.2	0.1	0.3	1.2	0.9	0.2	0.1	
Netherlands	.nl	2.3	0.9	2.0	2.4	0.3	0.7	1.5	1.8	4.1	0.2	0.2	0.2	0.5	1.7	2.6	0.2	0.4	0.1
New Zealand	.nz	10.1	0.3	0.4	2.5	0.1	0.3	0.6	0.7	1.5	0.1	0.1	0.1	0.5	0.6	0.8	0.2	0.1	0.1
Norway	.no	2.1	0.8	0.6	2.2	0.2	3.1	1.8	1.9	3.6	0.2	0.2	0.4	0.5	1.1	0.9	0.2	0.3	0.1
Poland	.pl	2.1	0.8	0.6	1.8	0.6	0.7	1.1	1.5	4.4	0.2	0.4	0.1	0.4	2.7	1.3	0.3	0.8	0.2
Portugal	.pt	2.6	0.6	0.8	1.8	0.2	0.6	1.2	1.7	6.4	0.7	0.2	0.1	0.4	1.5	0.9	0.2	0.4	0.2
Spain	.es	2.0	0.9	1.1	1.1	0.3	0.7	1.2	2.3	3.4	0.4	0.2	0.1	0.5	2.0	1.1	0.3	0.8	1.3
Sweden	.se	2.0	0.8	0.6	2.2	0.2	2.0	2.1	1.2	3.1	0.2	0.2	0.2	0.4	7.9	0.9	0.2	0.3	0.1
Switzerland	.ch	1.6	1.6	0.9	2.0	0.2	0.6	0.8	3.9	8.1	0.2	0.2	0.1	0.3	1.7	1.6	0.2	0.3	0.1
Turkey	.tr	3.0	1.0	0.8	3.9	0.3	0.7	1.2	1.9	3.4	0.3	0.4	0.1	0.6	1.3	1.6	0.4	0.4	0.2
UK	.uk	2.3	0.6	0.6	2.3	0.1	0.6	0.8	1.3	3.5	0.2	0.1	0.1	0.8	1.1	2.5	0.2	0.3	0.1
US	.us	1.3	0.2	0.2	2.6	0.0	0.1	0.3	0.4	0.6	0.1	0.0	0.0	0.2	0.4	0.5	0.1	0.0	0.1
COM	.com	2.5	0.5	0.5	4.3	0.2	0.4	0.6	1.2	2.6	0.2	0.1	0.1	0.4	1.0	1.3	0.3	0.1	0.2
ORG	.org	1.8	0.4	0.4	3.7	0.2	0.4	0.5	1.3	1.8	0.9	0.1	0.1	0.2	0.7	0.8	0.1	0.1	0.1
NET	.net	1.7	0.4	0.3	2.7	0.1	0.3	0.6	0.8	1.5	0.1	0.1	0.1	0.3	0.7	0.7	0.3	0.0	0.1
EDU	.edu	2.7	0.5	0.4	3.7	0.2	0.4	0.7	1.0	2.6	0.1	0.2	0.1	0.4	0.7	1.5	1.3	0.1	0.2
GOV	.gov	1.3	0.3	0.2	1.7	0.1	0.3	0.3	0.7	1.7	0.1	0.1	0.0	0.1	0.7	0.8	0.1	0.0	0.2
INT	.int	0.8	0.9	3.3	1.8	0.6	1.4	1.1	2.4	3.1	0.9	0.4	0.3	0.6	2.9	1.0	0.3	2.6	0.3

Source: OECD

Table 17. Percentage of World Wide Web links between TLDs and gTLDs (excluding Intra-domains) (July 1998) *(continued)*

	To	Netherlands	New Zealand	Norway	Poland	Portugal	Spain	Sweden	Switzerland	Turkey	United Kingdom	United States	COM	ORG	NET	EDU	GOV	INT	Total
From		.nl	.nz	.no	.pl	.pt	.es	.se	.ch	.tr	.uk	.us	.com	.org	.net	.edu	.gov	.int	
Australia	.au	1.4	0.9	0.8	0.3	0.4	0.4	2.0	1.5	0.0	6.0	1.3	38.0	8.1	14.4	10.3	2.4	0.1	100
Austria	.at	1.9	0.2	0.9	0.3	0.2	0.6	1.4	2.8	0.1	4.0	0.3	28.7	13.9	6.5	9.4	4.2	0.6	100
Belgium	.be	6.4	0.3	1.1	0.3	0.3	0.7	1.7	2.1	0.1	5.1	0.5	33.7	7.9	8.0	9.3	2.0	0.9	100
Canada	.ca	1.4	0.4	0.6	0.2	0.1	0.3	0.9	1.1	0.0	6.8	1.1	39.9	12.0	10.3	12.0	3.2	0.1	100
Czech Republic	.cz	2.3	0.3	1.1	0.5	0.3	0.4	1.4	2.0	0.0	5.0	0.6	37.2	9.5	6.9	12.0	2.5	0.3	100
Denmark	.dk	1.4	0.5	9.2	0.2	0.1	0.3	3.3	0.8	0.0	3.4	0.3	42.9	11.9	4.7	4.7	1.3	0.3	100
Finland	.fi	2.3	0.3	1.8	0.2	0.2	0.5	3.8	1.5	0.1	5.2	0.6	23.1	6.6	6.3	9.4	6.5	8.2	100
France	.fr	2.3	0.2	1.3	0.2	0.3	0.8	1.6	3.4	0.0	4.9	0.4	33.7	12.5	6.7	9.0	2.9	0.3	100
Germany	.de	3.0	0.4	1.1	0.3	0.2	0.5	1.7	3.3	0.1	5.8	0.4	32.0	12.0	9.6	11.0	2.9	0.3	100
Greece	.gr	2.3	0.2	0.7	0.3	0.5	0.3	1.5	1.1	0.1	5.8	0.5	45.2	9.4	4.7	7.8	2.0	2.8	100
Hungary	.hu	2.3	0.2	1.1	0.5	0.2	0.5	1.3	2.5	0.1	4.9	0.5	37.6	7.8	6.2	12.6	2.4	0.2	100
Iceland	.is	2.5	0.4	2.5	0.3	0.2	0.4	2.8	1.3	0.1	15.4	0.8	27.1	9.3	7.3	9.0	2.0	0.4	100
Ireland	.ie	1.9	0.1	1.7	1.4	1.7	1.3	5.3	0.8	0.0	10.5	0.2	34.7	4.7	5.1	13.7	0.8	0.2	100
Italy	.it	3.1	0.3	1.0	0.3	0.3	0.8	2.0	2.0	0.1	5.7	0.5	40.8	7.6	8.6	7.4	2.8	0.4	100
Japan	.jp	1.6	0.6	0.7	0.4	0.1	0.3	1.1	1.6	0.1	5.7	0.4	33.1	7.1	6.6	13.9	10.6	0.1	100
Korea	.kr	1.6	0.5	0.9	0.3	0.3	0.4	1.4	1.8	0.1	4.8	0.8	35.6	7.4	11.7	9.4	2.8	0.1	100
Luxembourg	.lu	2.9	0.2	0.6	0.4	0.8	1.5	1.5	2.3	0.0	5.1	0.3	36.1	5.3	4.6	4.4	1.5	5.4	100
Mexico	.mx	1.4	0.2	0.8	0.3	0.2	3.0	1.0	1.2	0.1	3.5	0.7	38.5	8.7	9.8	13.3	2.6	0.1	100
Netherlands	.nl		0.4	1.3	0.4	0.3	0.6	2.3	1.7	0.1	6.6	0.5	33.2	9.1	10.8	8.0	2.1	0.4	100
New Zealand	.nz	1.3		0.5	0.2	0.1	0.3	1.0	1.4	0.0	6.2	0.7	43.5	8.3	9.1	6.7	1.6	0.1	100
Norway	.no	2.5	0.3		0.3	0.2	0.4	5.0	1.7	0.1	8.7	0.5	32.8	8.3	7.1	9.2	2.3	0.2	100
Poland	.pl	1.9	0.3	1.4		0.2	0.4	1.9	2.0	0.1	4.4	0.5	39.1	7.4	9.7	8.5	2.2	0.2	100
Portugal	.pt	1.6	0.3	0.9	0.8		1.0	4.2	2.8	0.1	12.0	0.5	32.6	7.1	5.4	8.2	1.6	0.3	100
Spain	.es	2.2	0.3	1.2	0.3	0.6		1.7	2.3	0.1	5.7	0.6	31.3	8.9	11.5	10.4	2.5	0.7	100
Sweden	.se	2.3	0.3	2.6	0.3	0.2	0.5		1.6	0.0	5.5	0.5	33.3	7.9	9.5	8.6	2.0	0.3	100
Switzerland	.ch	2.3	0.2	0.9	0.2	0.3	0.5	1.4		0.0	4.6	0.3	37.8	9.2	6.3	8.7	2.4	0.6	100
Turkey	.tr	2.2	0.6	1.1	0.6	0.2	0.5	1.5	2.1		5.6	1.2	26.1	11.1	7.9	14.5	3.1	0.2	100
UK	.uk	1.9	0.6	0.8	0.2	0.2	0.5	1.4	2.0	0.1		0.6	41.8	8.3	8.1	9.8	6.0	0.3	100
US	.us	0.7	0.2	0.3	0.1	0.0	0.1	0.5	0.6	0.0	2.4		33.9	16.3	10.3	16.9	10.3	0.0	100
COM	.com	1.7	0.5	0.7	0.3	0.2	0.5	1.8	1.1	0.0	5.8	2.8		17.0	34.4	11.9	4.6	0.2	100
ORG	.org	1.2	0.2	0.5	0.1	0.1	0.4	0.9	3.4	0.1	3.2	2.8	44.1		10.5	13.0	5.7	0.3	100
NET	.net	1.4	0.3	0.7	0.2	0.1	0.3	1.0	0.8	0.0	2.9	2.0	56.5	9.9		10.6	2.4	0.0	100
EDU	.edu	1.6	0.4	0.7	0.2	0.1	0.3	1.2	1.5	0.1	5.8	3.3	35.9	15.5	9.2		7.6	0.1	100
GOV	.gov	0.9	0.2	0.3	0.1	0.1	0.2	0.5	3.5	0.0	14.3	4.1	24.0	11.2	4.4	27.5		0.1	100
INT	.int	3.2	0.3	0.8	0.2	0.9	1.2	1.5	25.8	0.0	3.7	0.2	13.3	13.4	4.0	3.0	3.8		100

Table 18. Balance of World Wide Web links between TLDs and gTLDs (July 1998)

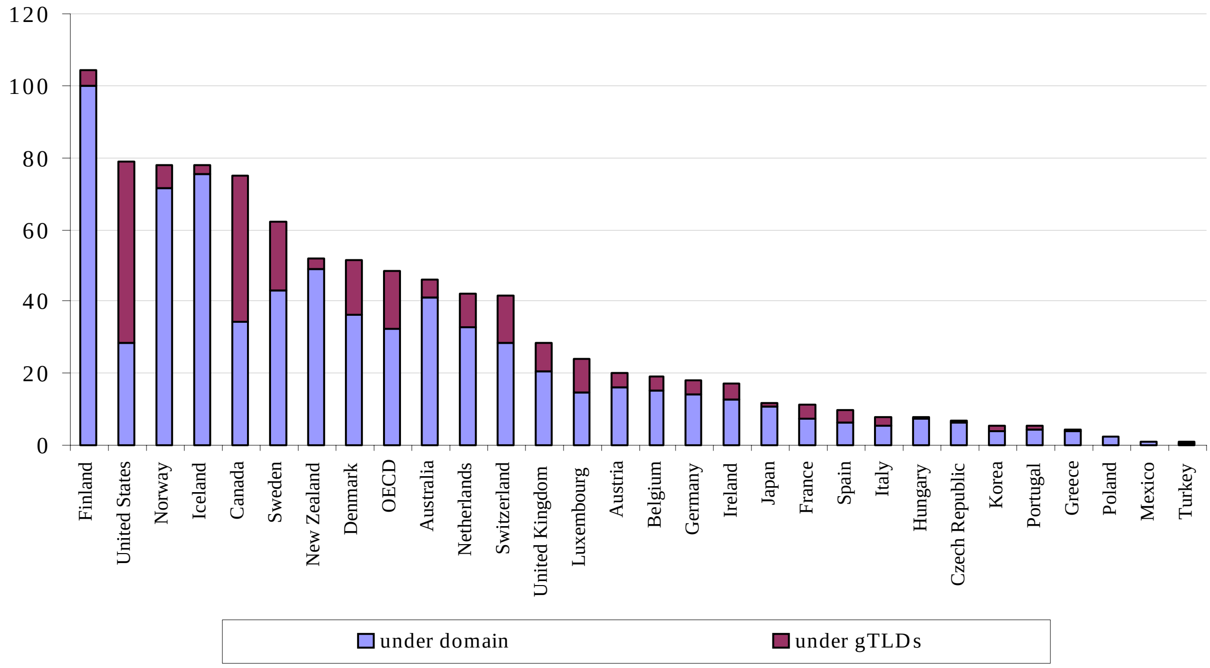
	To	Australia	Austria	Belgium	Canada	Czech Republic	Denmark	Finland	France	Germany	Greece	Hungary	Iceland	Ireland	Italy	Japan	Korea	Luxem-bourg	Mexico
From		.au	.at	.be	.ca	.cz	.dk	.fi	.fr	.de	.gr	.hu	.is	.ie	.it	.jp	.kr	.lu	.mx
Australia	.au	**100.0**	53.5	60.4	47.8	31.9	53.9	54.7	53.0	42.0	59.9	26.3	62.2	49.7	49.5	39.3	27.0	84.7	10.9
Austria	.at	46.5	**100.0**	59.1	46.7	29.9	55.1	74.8	59.1	37.1	53.1	44.6	37.2	53.5	59.1	39.2	26.7	85.2	7.5
Belgium	.be	39.6	40.9	**100.0**	37.7	28.6	48.7	39.0	37.8	35.1	47.0	44.6	57.2	51.1	40.7	32.2	22.2	65.1	2.6
Canada	.ca	52.2	53.3	62.3	**100.0**	34.7	56.8	50.3	51.0	43.6	58.1	47.3	55.0	69.6	49.2	38.0	25.2	78.3	17.4
Czech Republic	.cz	68.1	70.1	71.4	65.3	**100.0**	71.1	70.4	73.3	67.3	69.3	61.0	69.4	81.3	68.5	53.9	42.3	92.3	19.4
Denmark	.dk	46.1	44.9	51.3	43.2	28.9	**100.0**	81.2	43.2	21.8	46.2	49.6	48.0	55.8	43.1	31.4	6.3	82.5	5.3
Finland	.fi	45.3	25.2	61.0	49.7	29.6	18.8	**100.0**	55.7	70.8	51.9	44.7	66.9	38.3	48.3	11.1	25.1	91.4	5.4
France	.fr	47.0	40.9	62.2	49.0	26.7	56.8	44.3	**100.0**	35.8	39.1	32.7	52.7	37.6	37.6	22.2	19.0	82.9	7.0
Germany	.de	58.0	62.9	64.9	56.4	32.7	78.2	29.2	64.2	**100.0**	45.6	49.5	70.2	64.3	56.9	45.4	22.1	87.8	9.3
Greece	.gr	40.1	46.9	53.0	41.9	30.7	53.8	48.1	60.9	54.4	**100.0**	44.5	55.9	34.7	44.7	44.7	39.6	91.4	9.3
Hungary	.hu	73.7	55.4	55.4	52.7	39.0	50.4	55.3	67.3	50.5	55.5	**100.0**	57.3	70.9	45.5	39.4	30.8	88.0	13.6
Iceland	.is	37.8	62.8	42.8	45.0	30.6	52.0	33.1	47.3	29.8	44.1	42.7	**100.0**	65.5	28.0	33.0	16.1	70.0	4.9
Ireland	.ie	50.3	46.5	48.9	30.4	18.7	44.2	61.7	62.4	35.7	65.3	29.1	34.5	**100.0**	51.4	51.6	7.9	73.7	3.0
Italy	.it	50.5	40.9	59.3	50.8	31.5	56.9	51.7	62.4	43.1	55.3	54.5	72.0	48.6	**100.0**	38.7	28.8	87.6	12.5
Japan	.jp	60.7	60.8	67.8	62.0	46.1	68.6	88.9	77.8	54.6	55.3	60.6	67.0	48.4	61.3	**100.0**	42.5	86.4	6.5
Korea	.kr	73.0	73.3	77.8	74.8	57.7	93.7	74.9	81.0	77.9	60.4	69.2	83.9	92.1	71.2	57.5	**100.0**	95.4	30.7
Luxembourg	.lu	15.3	14.8	34.9	21.7	7.7	17.5	8.6	17.1	12.2	8.6	12.0	30.0	26.3	12.4	13.6	4.6	**100.0**	0.8
Mexico	.mx	35.7	39.1	44.0	37.4	22.0	51.2	52.1	48.0	33.1	28.6	35.4	42.6	66.4	30.0	32.4	14.3	75.6	**100.0**
Netherlands	.nl	43.3	44.7	49.1	37.4	25.8	46.9	45.8	45.7	29.6	36.8	37.3	55.2	45.1	34.9	49.5	22.7	82.0	0.1
New Zealand	.nz	53.8	33.3	45.8	31.8	15.0	18.5	36.9	43.9	21.6	38.4	31.7	48.8	72.7	28.5	14.9	19.3	65.6	6.5
Norway	.no	36.7	41.5	46.1	38.7	23.7	21.1	39.0	43.4	33.3	45.9	30.5	55.2	32.5	34.8	29.1	18.8	88.5	4.3
Poland	.pl	46.9	60.3	63.8	48.3	47.2	67.9	67.0	66.7	57.7	57.3	53.5	69.9	19.8	74.9	36.8	35.8	95.3	11.1
Portugal	.pt	37.9	46.1	60.2	54.2	30.8	55.7	56.0	54.0	62.3	55.4	50.2	59.6	12.3	52.3	44.6	30.1	71.7	11.2
Spain	.es	53.6	55.6	68.6	38.0	45.6	66.0	61.1	62.8	49.2	73.4	58.8	72.8	35.5	53.3	48.6	42.0	89.6	49.9
Sweden	.se	38.0	52.4	59.2	49.7	34.7	55.2	46.7	52.5	40.9	47.3	46.0	64.2	25.6	83.1	39.4	29.2	87.6	5.6
Switzerland	.ch	26.0	40.0	46.5	29.5	18.9	42.6	34.4	46.4	34.2	35.3	25.5	34.7	47.6	36.5	30.2	13.7	71.4	4.3
Turkey	.tr	84.6	80.0	84.2	89.2	76.8	87.3	83.0	89.5	72.9	81.7	79.0	82.8	95.4	77.9	70.1	62.1	98.2	40.3
UK	.uk	35.5	41.7	53.6	25.8	20.0	47.7	38.4	46.8	35.6	37.7	33.3	26.2	42.1	36.2	44.6	21.3	84.3	4.8
US	.us	38.3	51.1	60.1	51.0	16.3	46.0	46.5	58.2	36.7	48.3	40.1	47.5	77.2	44.4	45.8	19.1	75.9	26.0
COM	.com	43.1	39.6	52.2	46.9	24.3	27.8	46.0	50.0	37.6	32.3	27.1	61.9	48.2	37.9	36.7	30.8	64.2	14.8
ORG	.org	36.9	19.4	47.7	36.6	23.3	21.5	35.3	39.8	20.1	73.4	26.4	37.4	44.2	32.6	27.3	18.5	80.1	8.3
NET	.net	30.9	43.8	51.0	42.5	27.2	47.4	48.6	51.9	27.8	50.3	36.6	59.4	57.3	39.4	35.9	30.5	71.8	9.2
EDU	.edu	54.7	46.5	54.8	50.4	26.2	55.7	48.3	55.5	41.4	49.3	44.2	55.6	47.2	49.5	39.6	76.1	82.8	21.2
GOV	.gov	16.1	7.2	18.7	12.5	5.9	23.7	5.0	18.1	12.1	11.4	11.6	16.0	32.1	15.2	3.5	7.5	42.7	5.8
INT	.int	12.9	5.6	20.7	10.3	13.7	14.6	0.4	17.2	7.2	4.1	21.5	25.9	21.2	13.5	21.3	20.0	26.9	1.6
Total		48.2	48.4	51.1	48.6	46.2	46.6	48.7	50.2	47.4	48.9	47.5	51.3	48.9	48.7	47.4	47.6	63.0	20.4
Inter-domain (ie. excluding intra-domain)		43.1	42.7	53.8	44.2	26.1	38.5	44.8	50.8	36.1	46.1	35.4	54.7	47.4	43.8	34.4	38.8	78.1	60.8
Inter-domain TLD (excluding intra and .com., .net, .org.)		65.8	59.4	69.8	67.7	43.2	60.7	55.9	68.7	54.9	67.8	53.1	68.2	61.9	64.4	49.6	58.4	86.9	78.3

Source: OECD

Table 18. Balance of World Wide Web links between TLDs and gTLDs (July 1998) *(continued)*

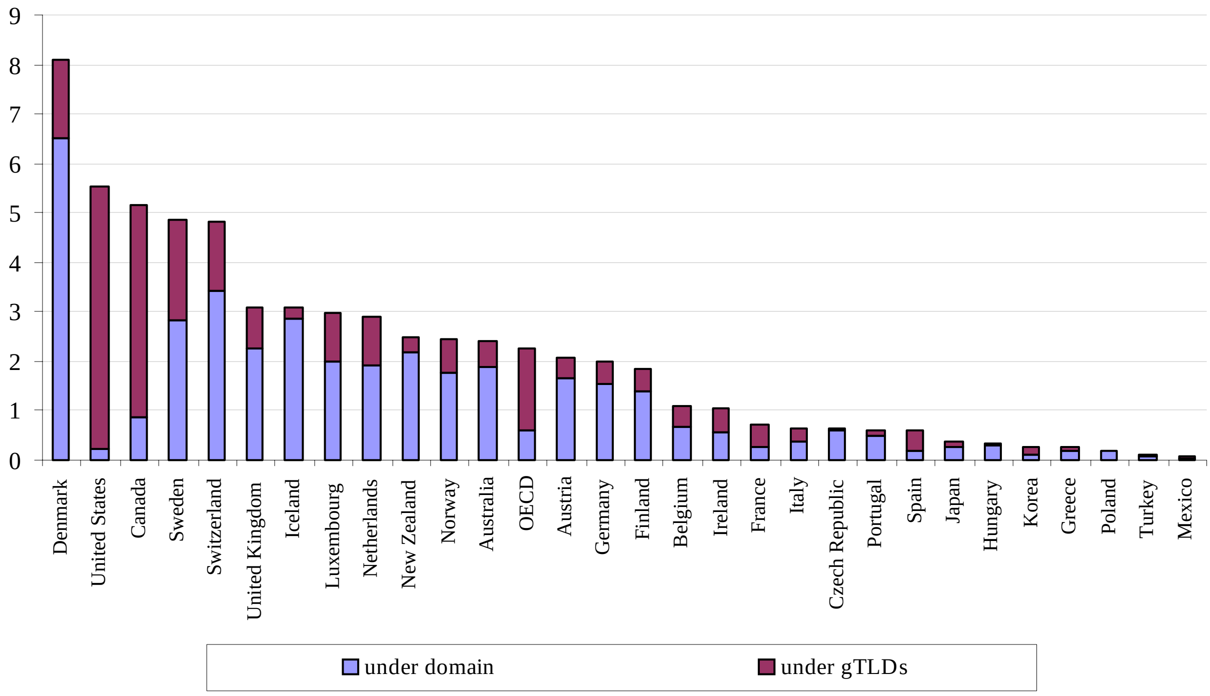
	To	Netherlands	New Zealand	Norway	Poland	Portugal	Spain	Sweden	Switzerland	Turkey	United Kingdom	United States	COM	ORG	NET	EDU	GOV	INT
From		.nl	.nz	.no	.pl	.pt	.es	.se	.ch	.tr	.uk	.us	.com	.org	.net	.edu	.gov	.int
Australia	.au	57.8	65.2	74.4	58.3	44.9	24.6	79.6	86.6	1.2	88.2	4.3	89.0	55.5	53.8	95.7	99.6	0.0
Austria	.at	94.2	27.1	69.7	55.8	25.4	26.1	43.7	91.6	2.2	91.6	1.8	89.6	73.1	44.3	96.6	99.2	0.2
Belgium	.be	96.4	23.2	68.2	38.0	16.5	23.2	47.5	85.3	1.1	87.4	1.3	82.5	48.4	41.6	95.3	89.2	0.2
Canada	.ca	88.1	52.0	76.3	62.5	35.5	23.5	67.6	83.9	1.0	86.1	2.9	85.2	61.3	45.7	96.3	99.6	0.0
Czech Republic	.cz	97.7	47.5	70.1	79.7	44.3	36.7	75.8	92.7	3.6	97.7	4.8	92.8	78.6	62.0	98.7	98.4	0.1
Denmark	.dk	91.9	17.9	96.4	47.9	19.2	7.1	83.9	83.0	0.8	93.1	1.8	92.9	73.9	44.2	92.0	96.0	0.1
Finland	.fi	93.2	19.8	80.7	42.0	23.1	12.4	83.5	85.3	1.6	91.5	2.7	86.5	52.4	41.9	96.5	99.5	2.3
France	.fr	93.6	17.0	73.2	40.2	19.1	30.6	34.4	90.9	0.9	89.5	1.2	80.3	63.1	37.5	93.4	97.8	0.1
Germany	.de	96.7	40.7	73.2	43.9	30.1	30.9	50.0	95.2	1.9	96.2	2.0	91.3	76.6	55.2	96.5	99.2	0.1
Greece	.gr	93.9	27.5	67.1	28.5	35.8	20.7	71.2	80.6	1.6	93.2	2.1	63.5	66.4	38.2	96.8	94.3	0.8
Hungary	.hu	95.4	32.4	65.8	70.7	24.1	28.8	60.8	88.2	3.6	94.0	3.2	93.1	68.4	38.5	97.6	98.0	0.0
Iceland	.is	87.2	11.4	80.4	43.4	17.0	7.6	80.1	80.4	1.2	95.4	1.8	82.9	46.6	39.3	95.9	94.1	0.1
Ireland	.ie	84.8	13.4	83.0	85.4	69.9	42.4	87.7	72.5	0.2	92.9	0.7	90.2	40.9	29.4	97.4	94.1	0.1
Italy	.it	95.9	40.1	54.9	48.2	21.0	7.9	63.1	91.0	1.7	92.9	2.2	91.8	57.5	54.2	93.6	97.6	0.1
Japan	.jp	93.6	69.9	74.0	79.1	29.4	32.2	61.5	91.0	1.4	93.9	2.2	92.6	65.7	42.0	97.3	99.9	0.0
Korea	.kr	93.5	68.5	84.1	74.3	45.9	42.4	83.0	91.5	7.1	96.4	4.6	95.5	59.0	28.0	97.6	99.4	0.0
Luxembourg	.lu	87.1	4.8	6.9	15.1	6.1	12.4	20.6	56.8	0.1	82.3	0.5	62.7	31.4	17.6	80.3	42.5	0.9
Mexico	.mx	80.9	25.2	63.1	40.3	2.4	66.2	55.2	73.5	2.3	63.3	1.1	80.7	41.8	29.0	90.3	97.5	0.0
Netherlands	.nl	**100.0**	26.4	71.2	54.4	20.4	17.8	59.8	82.5	1.0	88.0	1.3	83.0	43.8	41.3	91.9	96.5	0.1
New Zealand	.nz	0.5	**100.0**	56.6	39.9	12.8	13.3	55.9	78.0	0.2	86.8	1.1	88.5	45.4	36.6	92.0	98.1	0.0
Norway	.no	91.1	0.1	**100.0**	43.8	14.9	5.5	80.0	81.9	1.2	92.0	1.4	84.6	42.3	33.0	94.7	98.3	0.1
Poland	.pl	94.2	41.3	0.4	**100.0**	30.3	26.0	78.9	86.6	4.1	93.7	2.3	94.9	59.7	63.0	96.7	99.1	0.0
Portugal	.pt	92.3	33.5	70.9	0.4	**100.0**	39.0	81.4	93.2	4.3	97.6	2.4	90.3	65.3	47.3	96.3	93.3	0.1
Spain	.es	94.7	46.5	82.2	44.8	0.2	**100.0**	70.8	94.0	2.8	94.5	2.3	88.3	63.7	64.3	97.2	97.7	0.2
Sweden	.se	93.3	14.1	85.8	30.7	26.6	0.2	**100.0**	89.0	1.3	91.1	1.5	89.5	55.9	51.0	96.6	98.6	0.1
Switzerland	.ch	83.2	17.2	51.2	21.8	14.0	14.8	0.4	**100.0**	0.5	80.7	0.9	58.1	48.3	22.9	68.9	72.6	0.1
Turkey	.tr	98.9	74.4	88.2	77.3	46.6	56.5	88.4	2.3	**100.0**	97.4	25.7	91.2	89.5	61.5	98.4	99.9	0.1
UK	.uk	81.5	29.8	66.6	19.9	17.3	18.4	57.2	87.0	0.0	**100.0**	1.2	87.8	51.7	30.4	73.1	99.5	0.1
US	.us	86.1	44.5	71.7	48.9	15.0	20.1	74.2	80.5	1.4	0.8	**100.0**	73.0	55.0	28.2	86.8	100.0	0.0
COM	.com	81.3	45.4	61.1	49.9	19.4	23.9	62.7	86.7	0.4	76.9	0.7	**100.0**	47.3	70.4	93.9	99.7	0.0
ORG	.org	78.9	23.6	57.1	31.4	13.0	17.1	43.6	91.4	1.6	46.7	3.6	15.2	**100.0**	27.7	89.3	99.0	0.1
NET	.net	85.4	39.2	66.1	59.0	11.1	17.3	64.1	84.3	0.8	64.8	2.0	88.8	5.5	**100.0**	96.2	99.5	0.0
EDU	.edu	91.3	44.0	73.7	51.7	18.1	22.5	65.7	86.4	2.6	73.1	10.2	83.0	63.6	2.9	**100.0**	99.9	0.0
GOV	.gov	66.5	10.5	28.3	22.2	4.6	5.4	18.8	84.4	0.2	46.3	2.8	37.1	30.9	4.4	4.9	**100.0**	0.0
INT	.int	83.3	5.3	28.2	8.4	5.7	6.4	7.9	96.1	0.1	65.6	0.1	18.4	48.6	9.3	44.1	0.3	**100.0**
Total		83.5	28.5	65.8	65.0	19.3	30.2	58.8	92.2	1.6	70.0	4.3	85.6	50.8	39.1	88.5	96.1	100.0
Inter-domain (ie. excluding intra-domain)		55.5	58.4	56.6	36.6	39.4	40.0	46.5	62.7	16.8	55.1	54.9	44.8	61.9	59.8	42.6	81.3	89.8
Inter-domain TLD (excluding intra and .com., .net, .org.)		72.7	78.2	71.6	56.8	54.3	58.0	63.8	78.3	26.8	74.6	75.5	0.0	0.0	0.0	65.3	87.8	92.7

Figure 1. Internet hosts per 1 000 inhabitants, July 1998 (including: com, net, org)



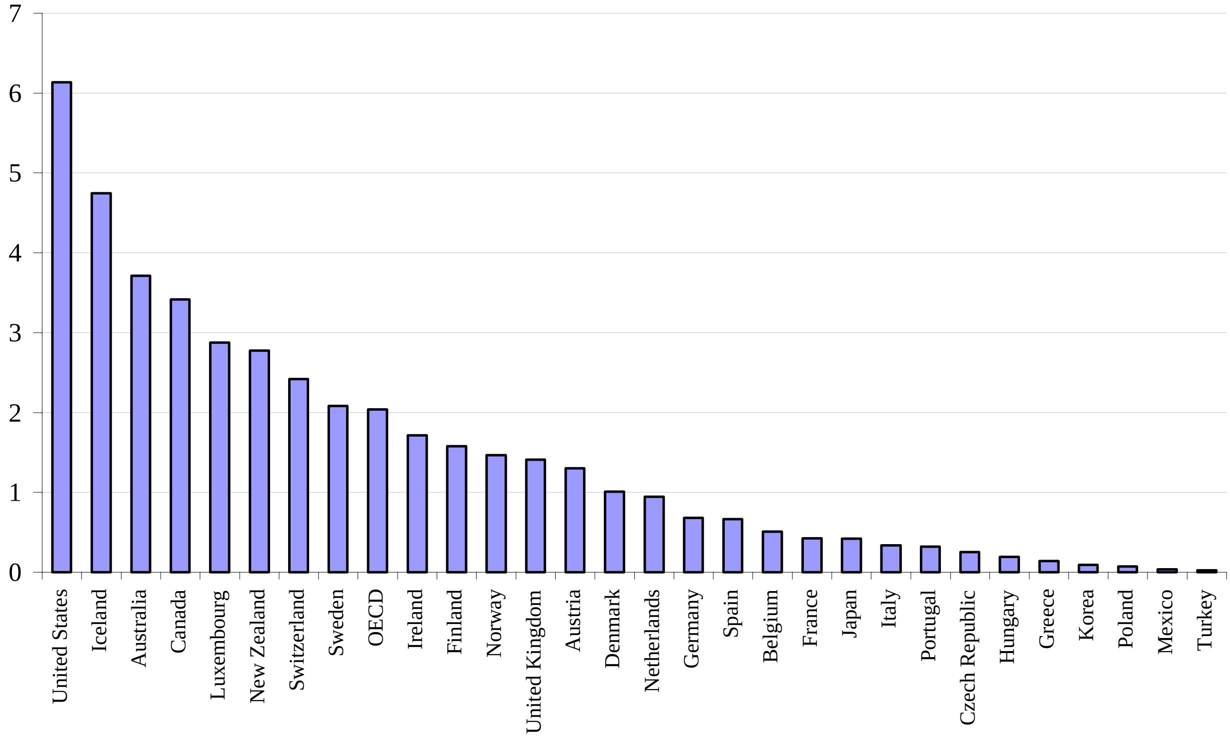
Source: OECD from Network Wizards and Imperative Data

Figure 2. Web server sites per 1 000 inhabitants, July 1998 (including: com, net, org)



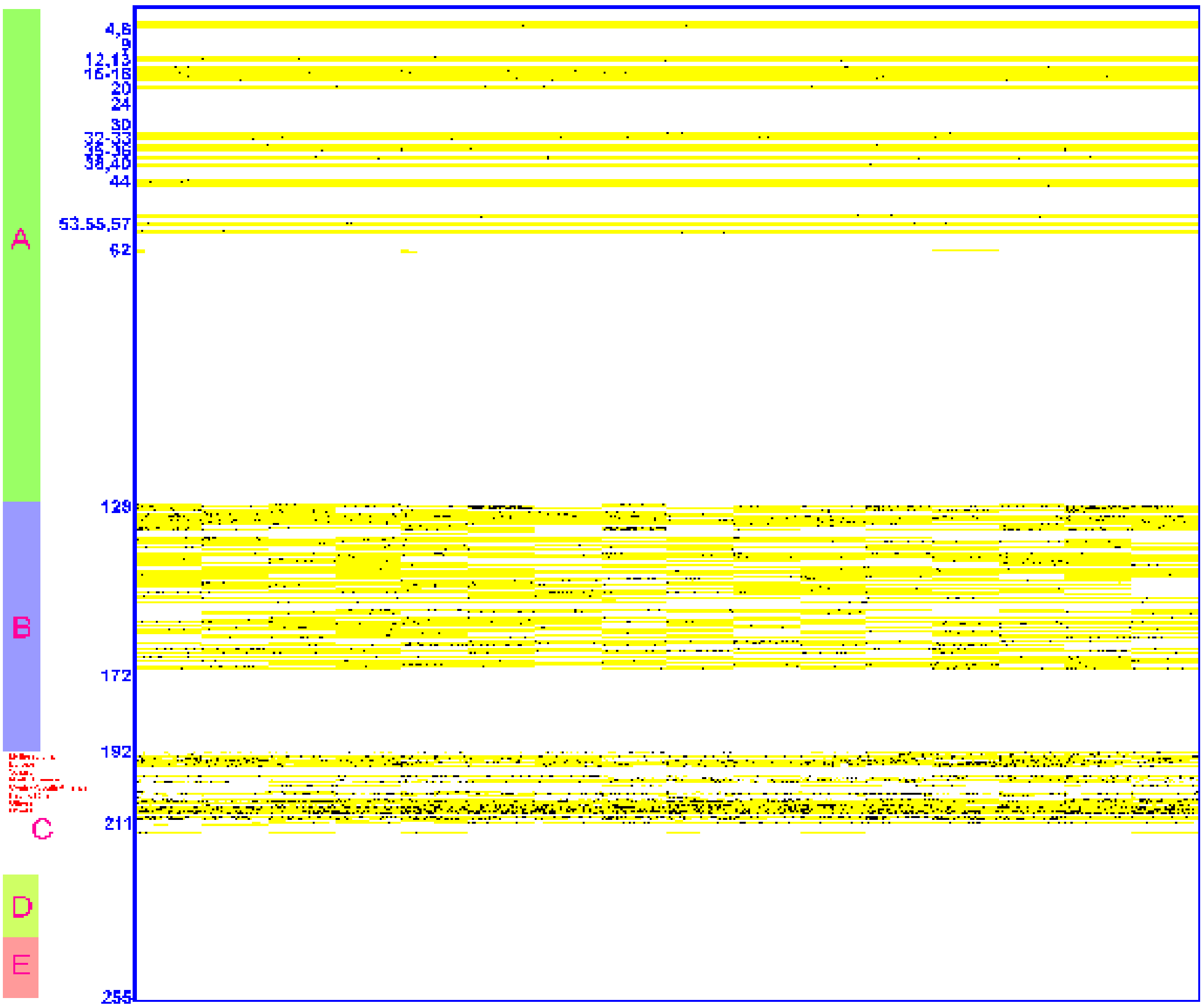
Source: OECD from Netcraft Data (www.netcraft.co.uk)

Figure 3. Secure Web servers for electronic commerce per 100 000 inhabitants, August 1998



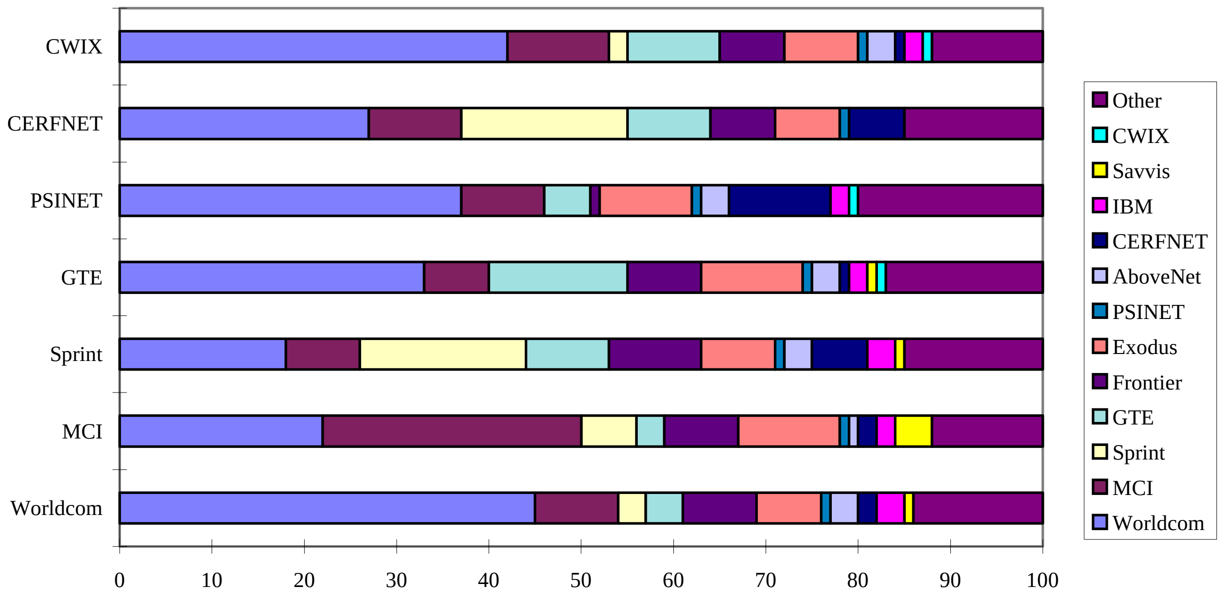
Source: OECD from Netcraft Data.

Figure 4: IP address occupancy



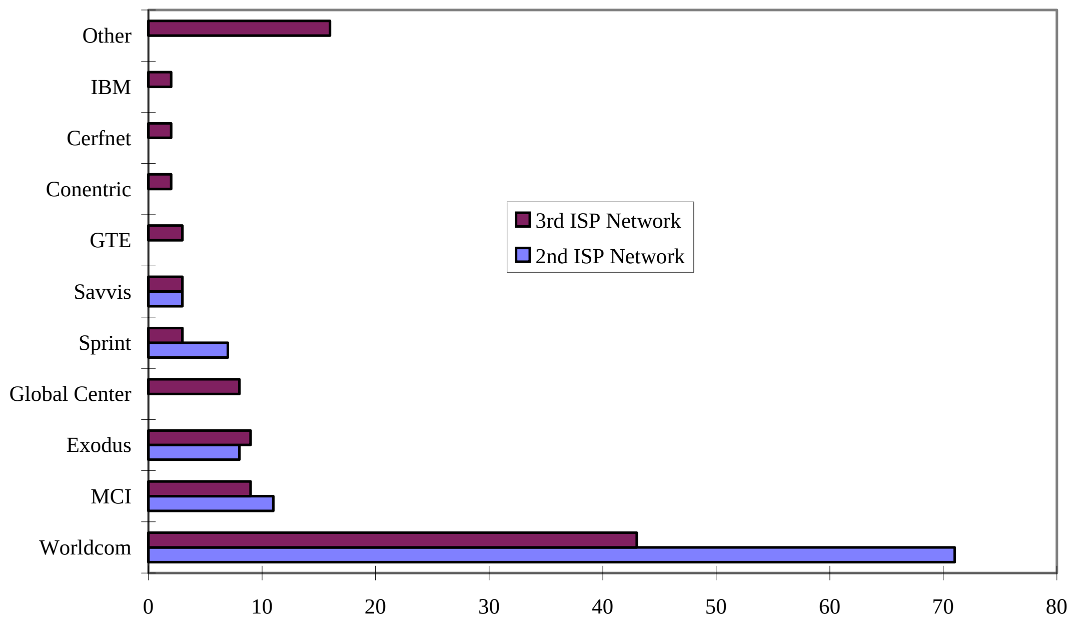
Source: CAIDA: http//www.caida.org/IPv4space/

Figure 5. Traceroutes to the leading 100 Internet sites across United States backbones (May 1998)



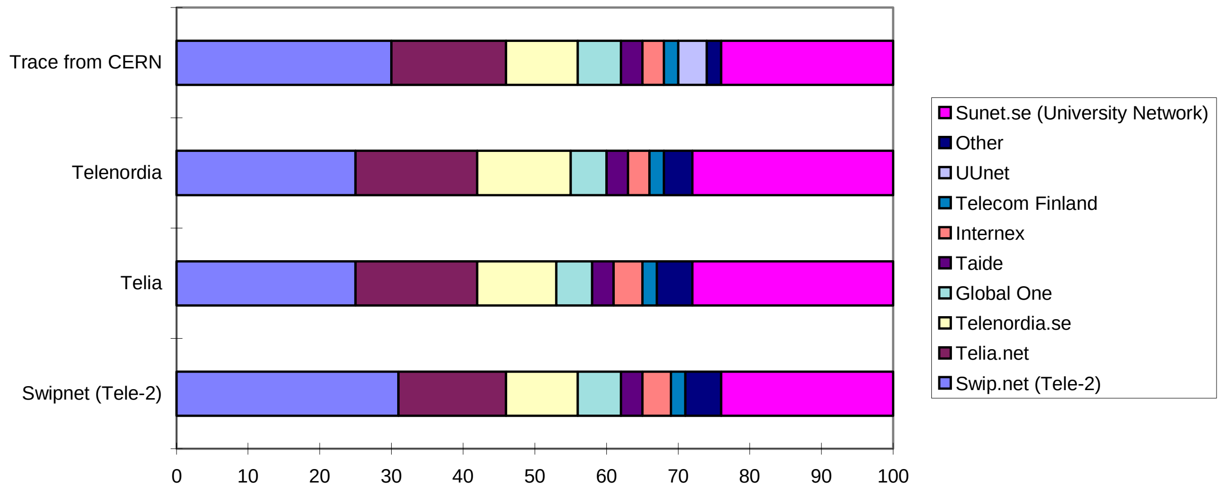
Source: OECD

Figure 6. Traceroutes to the leading 100 Internet sites across United States backbones, from Savvis (May 1998)



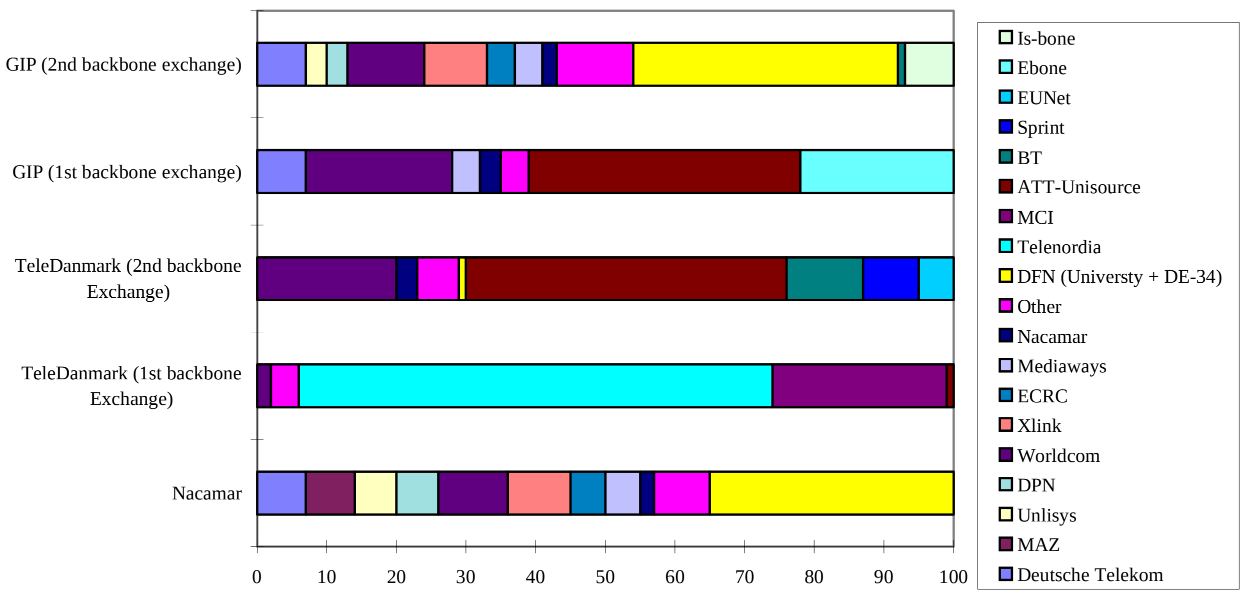
Source: OECD

Figure 7. Traceroutes to the leading 100 Internet sites in Sweden across Swedish backbones (May 1998)



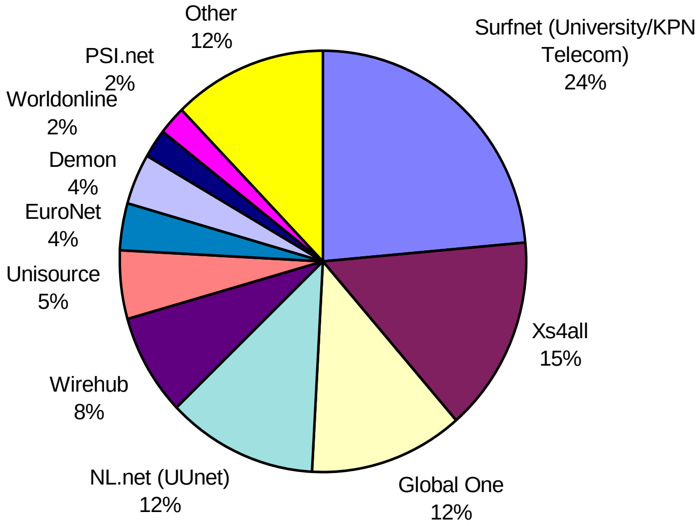
Source: OECD

Figure 8. Traceroutes to the leading 100 Internet sites in Germany across German and foreign backbones (May 1998)



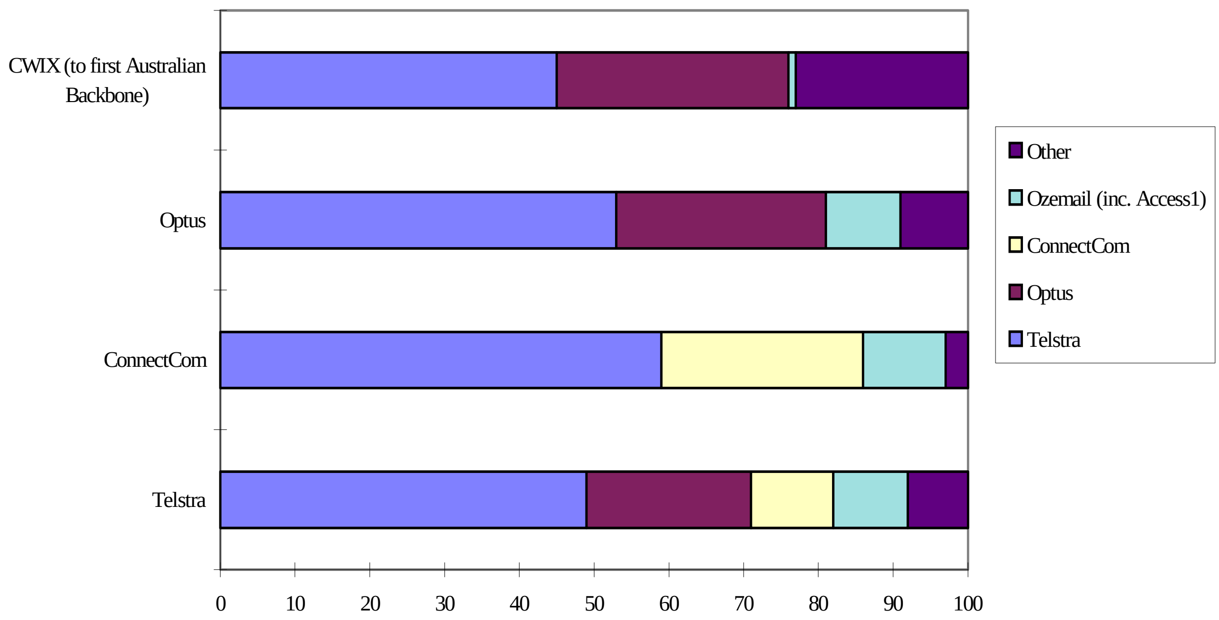
Source: OECD

Figure 9. Traceroute from Cistron to the Leading 100 Internet sites in the Netherlands (May 1998)



Source: OECD

Figure 10. Traceroutes to the leading 100 Internet sites in Australia across Australian backbones (June 1998)



Source: OECD

ELECTRONIC GLOSSARY

In keeping with the subject of this document, rather than provide a textual glossary, this section has the URLs of several Websites which can define technical terms and provide definitions on an ongoing basis.

Glossary

	Note	URL
PC Webomedia	An online encyclopedia and search engine dedicated to computer technology.	http://www.pcwebopaedia.com/
ILC	ILC Glossary of Internet Terms	http://www.matisse.net/files/glossary.html#P
McGraw-Hill	The McGraw-Hill Internet Training Manual	http://www.marketing-coach.com/mh-guide/glossary.htm
Netdictionary	Netdictionary is an alphabetical reference guide to Internet terms.	http://www.netdictionary.com/html/index.html
Yahoo!	Collection of links to On-line Glossaries.	http://www.yahoo.com/Computers_and_Internet/Internet/Information_and_Documentation/Internet_Glossaries/

Source: OECD.

NOTES

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