The ISP Column
A monthly column on things Internet

January 2010

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Addressing 2009

It's January again, and being the start of another year, it's as good a time as any to look at the last 12 months and see what the Internet has up to in 2009. The Internet's continuing growth can be viewed using many forms of metrics, including number of connected customers, the count of web pages, or selected measures of network traffic.

One perspective comes from an examination of the records of address allocations that were made by the five Regional Internet Registries (RIRs). These records indicate allocations of new address blocks for the Internet, and record the economy where the address allocation was made. New Internet services need IP addresses, and looking at how many addresses have been allocated and to which economy can provide a perspective of where the Internet is growing, and how quickly.

For many years the growth of the Internet has been inexorable. Around a decade ago the confident prediction was made that the annual doubling of the "size" of the Internet would be a constant, akin in some ways to the underlying optimism in technology that sits behind Moore's so-called Law. That particular Internet bubble burst in 2000 and the wildly optimistic predictions of the growth of the Internet were tempered somewhat, but there was the underlying view that the Internet would just continue to grow and just when we thought that the world of humans represented a market space that would reach saturation sometime soon there was the "internet of things" to keep us going for many decades to come. So once again by the late 2000's the Internet was portrayed as a form of economic miracle that would defy conventional cycles of business activity.

The global financial crash of late 2007 and its continuing repercussions have once more shown us that there is no activity that is completely immune from the dismal science of economics. When capital dries up, and investors are more worried about risk levels than maximizing the potential rates of return, then all parts of an economy will slow down and even contract, and the Internet itself is no longer completely immune from such conventional business pressures.

So lets see how the Internet has fared in 2009.

Growth of the Internet

Using address allocations as the metric its possible to observe the impact of the global financial crisis on the expansion of the Internet. The deployment of new services often calls for an associated investment in infrastructure and related services, and the constraints on capital over the past couple of years has had its impacts in the rate of expansion of the Internet.

	2005	2006	2007	2008	2009
Allocated Addresses (IPv4, Millions)	174.5	168.5	206.4	203.8	190.1
Relative Growth	8.0%	7.7%	8.8%	8.0%	6.9%

Table 1 - IPv4 Allocated addresses (Millions of /32s)

During 2009 the total number of IPv4 addresses allocated from the RIRs, supporting the growth of the Internet, was 6% lower than 2008, which itself was 2% lower that the peak 2007 figure. In global terms the Internet continues to expand, but the number of new services has slowed down. In terms of growth over the existing deployed based the period 2005 though to 2008 saw an annual growth rate that averaged 8.1%, while 2009 saw this drop slightly to 6.9%.

Which economies received these addresses? At a regional level its possible to compare the allocations made by each RIR.

RIR IPv4 Allocation	2005	2006	2007	2008	2009
APNIC	31%	31%	34%	44%	46%
RipeNCC	35%	33%	31%	22%	23%
ARIN	27%	28%	26%	28%	22%
LACNIC	6%	7%	7%	6%	6%
AfriNIC	1%	2%	3%	1%	3%

Table 2 - IPv4 Allocated addresses - Distribution by RIR

What is evident in these figures is the decline in the relative volume of IPv4 allocations in the region served by the RIPE NCC, and the strong growth in demand for IPv4 addresses in the Asia Pacific region. As has been widely reported in the financial media, the effects of this financial downturn are not uniformly spread, and some of the Asian economies have shown considerable underlying strength and resilience, and the expansion of Internet services in these economies have continued to grow in the past three years, while many economies in North America and Western Europe have grown at a much reduced rate over the past 2 years. In 2009 almost half of all allocated IPv4 addresses were allocated to economies in the Asia Pacific region.

Which economies are leading this continued growth in IPv4 services?

IPv4 Addresses (/32's Millions)						
Rank		**2007**		**2008**		**2009**
1	USA	48.47	USA	53.79	China	50.67
2	China	37.29	China	46.49	USA	38.55
3	France	13.38	Japan	10.06	Japan	11.04
4	Germany	11.22	Rep. Korea	7.96	Rep. Korea	10.95
5	Rep. Korea	7.73	Germany	7.29	Russia	5.46
6	Japan	7.14	Brazil	6.29	Brazil	4.19
7	UK	6.41	Russia	6.12	UK	4.19
8	India	5.61	Italy	5.85	Italy	4.16
9	Mexico	5.24	India	4.23	France	3.85
10	Italy	5.09	Taiwan	4.18	Germany	3.6

Table 3 - IPv4 Allocated addresses - Top 10 Economies

Within the Asia Pacific region China received almost 51 million IPv4 addresses in 2009, which represents more than one quarter of the total IPv4 address allocations performed in 2009. This appears to point to the strong pace of internet expansion in both broadband and wireless services in 2009 within China. Japan and the Republic of Korea both received 11 million addresses in 2009, and Taiwan and Australia both received some 3 million IPv4 addresses.

Some economies were visibly impacted by the change in economic conditions, and the rate of growth of Internet service deployment declined in 2009. Germany's IPv4 address allocations declined from 11.2 million addresses in 2007 to 7.29 in 2008 and 3.6 million in 2009. A similar picture was seen in India, where in 2007 some 5.6 million addresses were allocated, while in 2008 this fell to 4.2 million addresses and in 2009 this fell further to 1.5 million addresses.

Impact of Mobile Services

The USA was allocated 38 million addresses in 2009. Considering that the country is already well connected with wired services, with some 74% of the population using Internet services, the continued consumption of IPv4 addresses points to the continuing strength of new Internet service markets in this country. A similar picture exists in Japan, which already had 165 million IPv4 addresses allocated at the start of the year, with a population of some 127 million. The 11.5 million addresses allocated in 2009 point to a similar profile of growth of new service markets in this economy. A similar picture of the strong growth in mobile Internet services is evident in Australia (2.6 million IPv4 addresses in 2009) Canada (2 Million) and the Netherlands (2 Million), where these economies already have a mature wired broadband market with between 70% to 85% of their populations already listed as Internet users.

These new service markets appear to be complementing the existing wired Internet infrastructure, and are being lead by mobile internet services, headlined by technologies such as Apple's iPhone and Google's Android platforms. Even with a conservative projection of some 90 - 100 million mobile IP devices to be sold in 2010, this would represent a significant proportion of the Internet's service growth for the coming year. Given that mobile services represent a higher potential average revenue per used over wired broadband services, it may be the case that the future direction of the mass market Internet will be determined by the architectural and technical choices taken by mobile services in the coming years.

> As a timely illustration of this trend to use of mobile services, the situation in the Australian market was reported as follows:
>
> "Use of wireless broadband services mushroomed during the past year [2009] to reach more than 2 million subscribers, driven by the popularity of wireless modems and mobile devices such as the iPhone. The Australian Communications and Media Authority's communications report [for 2009] revealed the use of wireless broadband services jumped by 162 per cent in 2008-2009. … Wireless broadband subscribers accounted for 25 percent of the number of Internet subscribers, up from 11 per cent in 2008."
>
> The Australian, Wednesday 13 January 2010

Address Distribution

Another way to look at the address distribution is in terms of "skew". If the Internet is populated by a largely homogenous population then the distribution of address allocations would be relatively uniform, such that the group of largest allocations would not be vastly larger than the group of smallest allocations. One way to look at the level of skew is to use a cumulative distribution plot, comparing the number of allocations to the amount of address space, shown below.

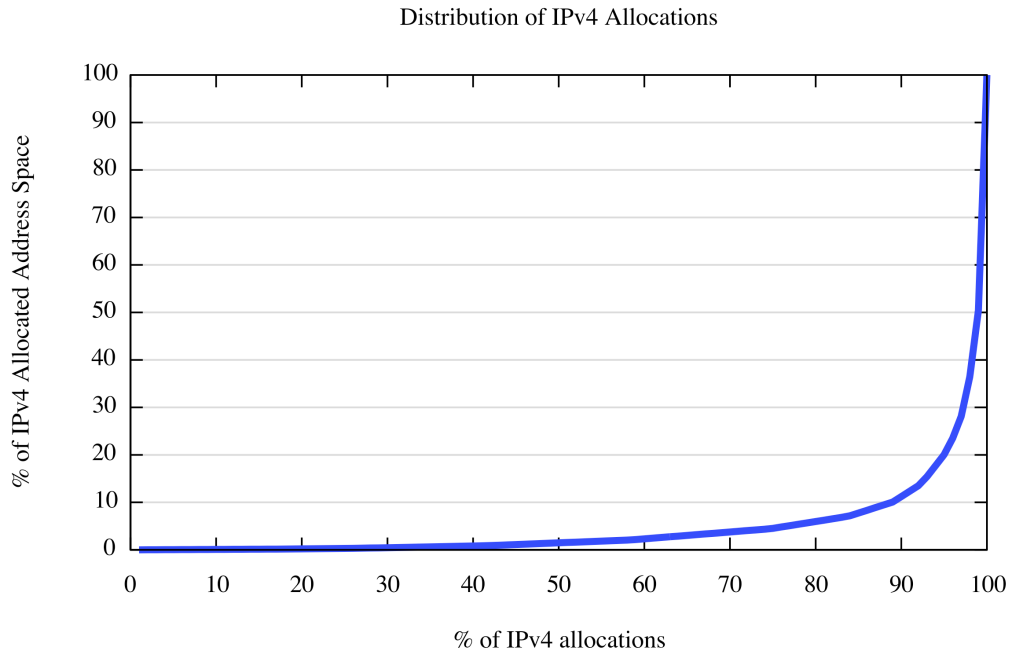

Figure 1 - IPv4 Allocation Distribution

What this distribution is showing is that of the 6,701 individual IPv4 allocations that were made in 2009, just 68 allocations that accounted for 50% to the total amount of allocated address space, or 95 million IPv4 addresses. There were 3 such allocations in AfriNIC and LACNIC, 13 in the RIPE NCC region, 18 in ARIN and 31 in APNIC. Drilling down a little deeper on the largest allocations in this set, there were 4 allocations of 4 million addresses (/10), and 20 allocations of between 1 and 4 million addresses (/10 to /11). These 24 allocations in 2009 went to 16 distinct entities, as listed in table 4.

Rank	Economy	Organization	/32's (M)
1	CN	China Mobile Communications Corporation	8.39
2	US	AT&T Internet Services	6.82
3	CN	China TieTong Telecommunications Corporation	4.19
4	CN	Chinanet Guandong Province Network	4.19
5	BR	Comite Gestor da Internet no Brasil	4.19
6	KR	Korea Telecom	4.19
7	CN	North Star Information Hi.tech Ltd. Co.	4.19
8	JP	NTT Communications Corporation	4.19
9	US	Verizon Internet Services Inc.	3.78
10	US	Sprint Wireless	3.54
11	CN	China Unicom Shandong Province Network	2.10
12	CN	Chinanet Jiangsu Province Network	2.10
13	CN	Chinanet Zhejiang Province Network	2.10
14	FR	LDCOM Networks (SFR)	2.10
15	IT	Telecom Italia Wireline Services	2.10
16	US	Comcast	1.90

Table 4 - IPv4 Allocated addresses - Top 16 allocations for 2009

This "heavy tail" distribution of the largest allocations has not always been the case. In looking at the distribution of IPv4 allocations over the past decade the following table shows the percentage of address space that were allocated to the 1% largest individual allocations and the lower half of the individual allocations.

IPv4 Allocations	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Top 1%	26%	30%	39%	38%	38%	51%	45%	51%	47%	50%
Lower 50%	7%	5%	5%	4%	3%	1%	2%	1%	1%	1%

Table 5 - IPv4 Allocated addresses

What appears to have happened across the period 2000 - 2005 was a marked phase of aggregation in this industry, where the economies of scale in a mass market for Internet services started to exercise significant influence over the deployment of services on the Internet. This picture has remained relatively consistent since 2005, and the largest 100 Internet enterprises across the world appear to undertake at least one half of the volume of deployment of new Internet services. To the extent that the internet on the 1990's was a poster child of a strongly competitive environment and highly diverse supply industry in the communications sector, the 2000's has seen the Internet progress into an environment which has strong components of economies of scale and marked homogeneity across the larger suppliers. A marketplace that is strongly influenced by a small number of larger enterprises is often not as agile in areas of technical and service innovation, and competitive pressures are not as strong a factor when one or two providers assume a dominant market position.

The distribution of addresses in the IPv4 Internet tends to paint a picture of an industry that has now completed a process of aggregation, and the pressures that will lead to further evolution of the Internet in the coming years will probably be different to those that drove the Internet of some years ago.

IPv4 Address Exhaustion

The Internet continues to rely heavily, if not solely, on IPv4, and the consumption of a further 190 million addresses in 2009 leaves a pool of some 352 million address in the central IANA pool for further normal allocation. Assuming a continuation of the current allocation rates of an average of some 520,000 addresses per day, and allowing for a slight upward movement in that average rate over time, then IANA will allocate its last IPv4 address block in October 2011, and the first RIR to exhaust its entire pool of unallocated IPv4 addresses is projected to occur in November 2012 (http://ipv4.potaroo.net).

The slowdown in the allocation rate of addresses has impacted this predicted exhaustion date through 2009. At the start of 2009 the projected IANA exhaustion date was April 20011, and in line with the slowdown of address allocations in the year, the projected exhaustion date has dropped back by some 6 months (http://www.potaroo.net/tools/ipv4/predict.png).

Conventionally, news of impending exhaustion of addresses would motivate some form of a last minute rush for addresses. Somewhat surprisingly, this is not evident so far, and if could be said that the industry has been acting in a somewhat calm and considered manner in terms of total address demands being placed on the dwindling pool of remaining IPv4 addresses. This reticence in terms of demand for more addresses may have been further reinforced by the continuing impacts of the financial situation and its effects in terms of dampened growth of Internet markets in many economies. It is also the case, however, that there is evidence of industry attention switching to IPv6 in 2009, so lets now look at the figures for iPv6 address allocation.

IPv6

IPv6 uses a somewhat different address allocation methodology than IPv4, and it is a matter of choice for a service provider as to how large an Ipv6 address prefix is assigned to each customer.

The original recommendations published by the IAB and IESG in 20012 (RFC3177) envisaged the general use of a /48 as an end site prefix. Subsequent consideration saw a more flexible approach being taken with the choice of the end site prefix size being left to the service provider, and today's IPv6 environment has some providers using a /56 end site allocation unit, while other providers use a /48. This variation makes a comparison of the count IPv6 addresses somewhat misleading, as an ISP using /48's for end sites will require 256 times more address space to accommodate the same customer base as a provider who uses a /56 end site prefix.

In order to allow for a comparison using comparable units, we'll use the number of allocations of IPv6 address blocks are the basis of the comparative statistics.

In the period 2008 to 2009 the number of individual allocations of IPv4 address space, as distinct from the number of allocated addresses, fell by 5% from some 6,969 individual allocations in 2008 to 6,701 in 2009. In comparison the number of IPv6 allocations rose by 45%, from 886 in 2008 to some 1,281 in 2009.

Allocations	2005	2006	2007	2008	2009
IPv6	245	243	492	886	1281
IPv4	4774	5646	6312	6969	6701

Table 6 - Number of individual Address Allocations, 2005 - 2009

The uptake of IPv6 is most evident in 2009 in the more mature internet markets of Europe, North America and Asia, showing that where there is a mature IP infrastructure in an economy, the local industry has turned its attention to the infrastructure deployment of IPv6 in 2009.

IPv6 Allocations	2005	2006	2007	2008	2009
RipeNCC	98	94	164	439	642
ARIN	59	71	218	235	396
APNIC	54	43	63	163	194
LACNIC	31	16	27	31	35
AfriNIC	3	19	20	18	14

Table 7 - IPv6 allocations by RIR

IPv6 Allocations by Economy 2007 - 2009

Rank	2007		2008		2009
1	USA	197	USA	218	USA	366
2	UK	29	Germany	70	Germany	90
3	Germany	27	UK	36	UK	67
4	Canada	20	Netherlands	35	Netherlands	60
5	Russia	11	Russia	33	Australia	52
6	South Africa	10	Switzerland	33	Russia	48
7	Netherlands	10	Australia	28	Japan	32
8	France	8	Japan	28	France	30
9	Australia	8	Italy	22	Czech Republic	30
10	Japan	7	Vietnam	22	Sweden	28

Table 8 - IPv6 allocations by Economy

Notably, the United States has increased its level of IPv6 allocation in 2009. Within the Asia Pacific region the economies of Australia and Japan show the highest level of activity in 2009, with Australia receiving 52 IPv6 allocations and Japan 32.

To illustrate the point about the difference between allocations and addresses, Table 9 y shows IP address allocations by address count for the period 2007 - 2009.

IPv6 addresses (/48's Millions)						
Rank		**2007**		**2008**		**2009**
1	Australia	268.89	Brazil	4307.55	USA	15.28
2	UK	68.75	USA	948.83	Germany	9.44
3	Japan	67.44	Sweden	9.37	UK	4.06
4	USA	8.19	France	5.37	Netherlands	3.01
5	Germany	5.77	Germany	4.52	Australia	2.88
6	Taiwan	4.26	UK	2.36	Russia	2.88
7	Poland	1.18	Netherlands	2.23	Japan	2.22
8	Uruguay	1.05	Russia	2.16	France	1.64
9	Canada	0.85	Switzerland	2.16	Czech Republic	1.44
10	Russia	0.72	China	1.7	Sweden	1.44

Table 9 - IPv6 address allocations by Economy

The 2007 allocation to Australia was dominated by the allocation of a single large address block (2401:6000::/20) to the Australian Government Department of Defence, and the 2008 allocation by LACNIC of 2804::/16 was to the "Comite Gestor da Internet no Brasil". A large allocation was also made by ARIN to the US Department of Defence in the same year.

The Outlook

The past three years has shown that the Internet is now an integral part of the portfolio of conventional business activity across the world, and the deployment of internet services and the opening up of markets through deployment of Internet services is subject to the same economic opportunities and constraints as any other business activity. Those economies that were adversely impacted by the global financial situation saw a drop in the expansion of new Internet services and a drop in their demands for IP address allocations across 2009, while other economies that managed to avoid the worst impacts of a financial recession continued to see growth in new Internet markets across the year.

Undoubtedly the next three years will see a change in the Internet. With a rebuilding of local economies we will see a return to a greater level of pressure for further growth in the Internet, particularly in mobile services and the emergence of ubiquitous Internet environments. However it will not be possible to sustain this growth using IPv4. As the Internet expands in the coming years we should expect to see the transition to IPv6 take a prominent role, and it may be possible that in 2010 the number of IPv6 allocations exceed the number of IPv4 address allocations for the first time.

At the same time we are witnessing an industry that is no longer using technical innovation, openness and diversification as its primary means of propulsion. Today's internet is serviced by a far smaller number of very large players, each of whom appear to be assuming a very strong position within their respective markets. The drivers for such larger players tend towards risk aversion, conservatism and increased levels of control across their scope of operation.

This changing makeup of the Internet industry also has quite profound implications in terms of network neutrality, the separation of functions of carriage and service provision, investment profiles and expectations of risk and returns on infrastructure investments, and on the openness of the Internet itself. 2010 promises to be an interesting year.

Disclaimer

The above views do not necessarily represent the views or positions of the Asia Pacific Network Information Centre.

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