IPv6 Integration Case Study: Portuguese Academic Network

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Abstract— **The IPv6 has experienced a slow progress. However the inexistence of studies in this area does not aid in the understanding of its true evolution. Without the necessary measuring tools it is not possible to assess IPv6's dissemination and ultimately its success or failure. In this paper an initial study of the IPv6 integration in the Portuguese academic network is provided. This study is part of a joining effort developed between the Fundação para a Computação Científica Nacional and the University of Coimbra to discover the current integration of IPv6 and its impact, at national level. The results are encouraging since when comparing the results of 2004 and 2005 it is possible to observe a significant increase in the traffic that is transmitted and received (towards GEANT) by the Rede Ciência, Tecnologia e Sociedade members.**

Keywords-ipv6; transition;

I. INTRODUCTION

IPv6 is the result of many years of research activities by the international Internet community, providing a larger address space, improving routing, security and supporting new applications. The IPv6 integration is being held mainly in academic networks. This slow integration is the result of the increase of some IPv6 testbeds that are now gaining influence in current IPv4 networks, due to the characteristics provided by the new version of IP. The IPv6 rollout is inevitable and it will have impact in all organizations that maintain, implement or use IP networks. Ultimately, the force of that impact will depend on the transition time frame, mostly on the existence (or not) of an emergency push towards the use of IPv6.

The work presented in this document is part of a join effort between the Portuguese NREN (National Research and Education Network) and the University of Coimbra, to study the evolution, the integration and the influence of IPv6 in the Portuguese academic community. The Fundação para a Computação Científica Nacional (FCCN) [1], the Portuguese NREN, is a private entity that provides support to portuguese universities and research institutions. FCCN is responsible to manage the Rede Ciência, Tecnologia e Sociedade (RCTS), which is a high performance network that provides a communication platform between academic, science and technology institutions. Currently, FCCN is aiming to be a driving force in this area by its participation on the 6NET [2], 6DISS [3] and IPv6-TF-SC [4] projects, and working on the dissemination of IPv6's potential on its own network. At the same time, FCCN from its neutral position also aims to help Internet Service Providers to enter into the IPv6 world. This set of efforts may contribute to prepare Portugal in a timely way for the Next Internet Generation.

The remainder of this paper is organized as follows: section 2 presents the IPv6 Portuguese Academic Network within GEANT, and a comparative study regarding traffic is performed between FCCN and other NRENs. Section 3 is divided in 3 sub-sections: in the first it is provided an overview of the IPv6 integration and evolution in the academic network. Secondly, the results of a survey about the use of IPv6 in academy are discussed. Finally, FCCN's current addressing scheme to re-delegate its /32 prefix is detailed. Conclusion is presented in last Section.

II. THE IPV6 PORTUGUESE ACADEMIC NETWORK WITHIN GÉANT

This section provides an overview of the integration of FCCN with the GÉANT network [5], which is a multi-gigabit data communications network designed specifically for research and education use. GEANT's transformation in a dual-stack infrastructure (April 2003) was the key push for the portuguese academic network to go on the same path. Before the transition to GEANT2 (January 2006), almost all NRENs connected to the most advanced pan-continental network were using both IPv4 and IPv6. However, the trend even today inside any NREN's network is that only few universities and research labs are making a real use of IPv6 connectivity.

Figure 1 presents the volume of traffic exchanged within GEANT in the last year. This graph illustrates the average of traffic (per month) from and to the current 30 NRENs that belong to GEANT. The amount of traffic exchanged per year is 424.1 TBytes and 442.1 TBytes, with 38.5 and 40.2 TBytes, of average per month of traffic received and transmitted, respectively. These numbers, when compared to 2004's analog period, represent an increase of proximally 269% (output) and 272% (input) in volume of traffic exchanged.

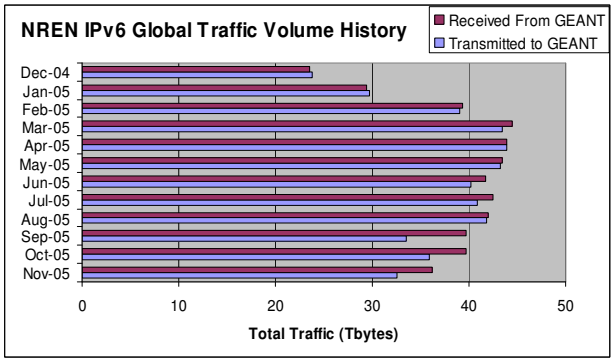

Figure 1. NREN IPv6 traffic volume in the last year

FCCN represents less than 1% of the total traffic exchanged inside the GEANT network, as can be observed from Table 1. This table presents the most 12 representative NRENs belonging to this network.

TABLE I. AVERAGE TRAFFIC EXCHANGED PER NRENS

	IPv6 Transmitted To GEANT (Gbytes)	IPv6 Transmitted From GEANT (Gbytes)
NORDUnet	2 518.25	13 048.27
SWITCH	10 045.05	10 894.74
SURFNET	13 830.06	7 568.09
PSNC	781.62	4 597.44
BELNET	10 048.05	2 087.55
HEAnet	800.76	400.37
FCCN	11.61	233.36
RENATER	85.23	103.94
DFN	182.84	69.94
GRNET	8.91	63.39
EENET	0.72	12.59
REDIRIS	135.75	4.84

In an effort supported also by European Commission Framework programs, several NRENs (including the Portuguese) have initiated the IPv6 deployment in their basic and secondary school networks. The relevance of this effort is huge, as these types of networks are composed by thousands of nodes, touching the Internet experience of a wider set of people - and most important, the next generation which is still in school today.

In the scope of GEANT2, IPv6 multicast is a new available feature. Unfortunately, multicast over different administrative domains is still in an early development stage, which results in a few NRENs establishing sessions with GEANT2 to exchange IPv6 multicast routes. FCCN is also cooperating with some of GEANT2's Joint Research Activities and Service Activities, namely the Performance Enhancement and Response Team where IPv6 requests/events are taken care of in the same way IPv4 related situations. In terms of traffic, monitor mechanisms present a small growth. The most perceived application/service making use of IPv6 inside GEANT2 is Netnews.

III. THE IPV6 PORTUGUESE ACADEMIC NETWORK INTEGRATION

This section presents some of the existing information regarding the evolution and current situation of the IPv6 integration in the IPv6 Portuguese Academic Network.

A. *IPv6 evolution*

Since April 2003, FCCN is responsible to delegate IPv6 network prefixes to all of the RCTS members, and since then only 9 organizations requested native IPv6. In the starting year 5 organizations became IPv6 native, 3 in 2004, 1 in 2005 and 1 in 2006 (Table II). Mainly to technical issues, such as unsupported IPv6 hardware, some of the organizations had to connect to RCTS' IPv6 backbone through tunnel mechanisms.

TABLE II. EVOLUTION OF IPV6 CONNECTION

	2003	2004	2005	2006
Native IPv6	5	3	1	1
Tunnel IPv4/IPv6	8	7	4	4

B. *IPv6 Current state*

Recently, FCCN made a survey about some of the internal networks of RCTS members. The sample at stake was built on 4 universities, which already have native IPv6, and 4 others which only connect to the Portuguese academic network using IPv4. Regarding IPv4, these 8 universities are using about 9258 public addresses (/19 prefix, and both a /22 and a /27). In the IPv6 world, all of them have already a /48 prefix each, but as described before, only half of them are currently using it. From these, some already established an IPv6 addressing plan, in order to distribute their /48 block throughout their several organic units. A common point to all is the fact they are using private IPv4 addressing.

One of the strategic elements in each network context is the layer 3 equipment (router) used to connect the institution to RCTS. From the gathered data, we clearly see that some equipment replacement is in order for some universities to enter the IPv6 path. In terms of bandwidth, the sum of this RCTS members' set is about 152 Mbps. All of these universities have opted for a 50/50 bandwidth model. This model is based on providing the same amount of bandwidth for global/commercial networks and for academic/research networks. The 8 cases may be divided in 3 categories: those connected at 3Mbps/3Mbps; at 10Mbps/10Mbps; and at 15Mbps/15Mbps. For those who already use IPv6, the connection model may vary, if they requested a separate connection interface for IPv6, or if the IPv6 connectivity is provided on the same physical interface than IPv4.

One different observed trend was the usage of Traffic Shapping - the most popular equipment seems to be the Packeteer 6500 [6]. This can probably be a barrier for real and complete IPv6 deployment in their networks, if IPv6 is not integrated in this products' feature set.

Only one of the inquired universities is currently doing multihoming, using their own autonomous system identifier, but only for IPv4. It happens that their secondary/commercial

ISP has only undergone an IPv6 test phase, and currently it does not have a commercial offer for IPv6 services.

In terms of services, one university has already its DNS, E-MAIL and FTP services with IPv6 - the 128-bit addresses are already inserted in the DNS tree and being used. A second university has its DNS, WEB and FTP services with IPv6 support. There is still a third university running its WEB service in a dual-stack fashion. The lack of IPv6 support in the majority of services is reported to be mostly due to lack of human resources.

Figure 2 presents the evolution regarding the traffic from and to RCTS members in the year 2005. At this date no data could be collected regarding December 2005. The figure presents an abnormal value: in July the transmitted traffic achieved the 1456 GB, which represents an increase of 1300 GB compared with the previous month. This can be explained by the use of some kind of traffic generator application, or the extensive use of heavy traffic applications such as FTP.

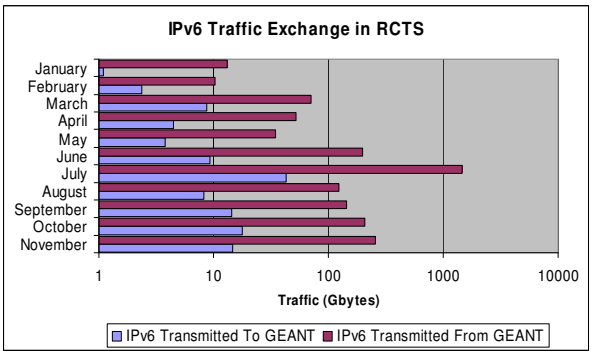

Figure 2. IPv6 traffic exchange in RCTS

Comparing the values regarding the last quarter of 2005 and the same period of 2004, the increase of traffic was exponential, from 3.44 GB to 67.87 GB of transmitted traffic, and from 54.98 GB to 730.39 GB of received traffic.

Several projects are being performed in portuguese organizations, which are involved some how with the study of the new IP protocol in Portugal. One of the main projects is the IPv6 Portuguese TaskForce [7], which aims to contribute in preparing Portugal to the next generation Internet, by joining several agents such as: govern entities, enterprises, telecommunication operators, universities and no less important end users.

C. IPv6 Addressing Scheme

FCCN, as one of RIPE [8] region's LIRs, has received a /32 IPv6 prefix upon request. From that addressing space, FCCN has already preemptively assigned a /48 prefix for each of the members of its network, from the 2001:690:2000::/40 block. Those assignments are already visible using WHOIS at whois.ripe.net. This means that from the total 65536 /48 prefixes only 166 were delegated, which represents about 0,25% of the available address space. These 166 prefixes were sub-divided in:

- 63 prefixes addressed to undergraduate schools, elementary schools and high schools. Each entity received a /56 network prefix;
- 102 prefixes addressed to Universities, Polytechnics and governmental organisms. Each institution received a /48 prefix;
- 1 prefix to be used by FCCN on its backbone, where the fundamental services are allocated, such as DNS, FTP, NTP, and news.

From the 166 delegated prefixes only 9 are currently in use: 4 by Universities, 4 by Polytechnics and the other is used by FCCN in its backbone.

In Portugal, several other LIRs (mainly network operators) have already received a /32 IPv6 prefix (Vodafone, Telepac, CPRM, Oni, NFSi, Via.Networks, Novis, KPNQwestPT). Most of these allocations were performed during 2003. In the previous year (2005) only one allocation was made. The majority of these /32 prefixes are already visible at the Gigapix - the Portuguese Internet Exchange 0.

IV. CONCLUSION

The IPv6 integration is an issue that is not fully studied. Using the information produced by surveys and log files the authors tried, in this paper, to answer questions such as: what is the percent integration of IPv6 when compared to existing IPv4 networks; what are the main problems regarding the IPv6 integration; is the IPv6 traffic increasing when compared to IPv4 traffic. The results showed that there is an increase in the traffic exchanged, transmitted and received from the portuguese academic network in the past two years. However, the number of IPv6 native organizations did not increase as expected. These two conclusions mean that the use of IPv6 is increasing but only where it is already supported, and it is not gaining the desired momentum, especially if compared to IPv4.

ACKNOWLEDGMENT

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REFERENCES

[1] Fundação para a Computação Científica Nacional, http://www.fccn.pt/, January, 2006.

[2] 6NET project, http://www.6net.org/, January 2006.

[3] 6DISS project, http://www.6diss.org/, January 2006.

[4] IPv6-TF-SC project, http://www.european-ipv6-tf.org/, January 2006.

[5] GÉANT, http://www.geant.net/, January 2006.

[6] ShaperWorks, http://www.shaperworks.com/PacketSeeker6500.asp, January 2006.

[7] IPv6 Portugal TaskForce, http://www.pt.ipv6tf.org/, January 2006.

[8] Reseaux IP Europeens, http://www.ripe.net/, January 2006.

[9] Gigapix, http://www.gigapix.pt/, January 2006.