

Editorial

Dear Reader,

After three and a half years of hard work, we have reached the (successful) end of the 6NET project so here is the eighth and last issue of the 6NET Newsletter with some conclusive views, more scientific results and reports of recent events.

Let us also mention as a last piece of news that Gunter Van de Velde (CISCO) presented some lessons and achievements of the 6NET project during an international conference on Next Generation Networks organized at ULB on June 2, in collaboration with projects EUROLABS and EGEE; the event attracted nearly 80 attendees.

Happy reading,

The Editorial Team

“The 6NET Story” by Jane Butler, CISCO

Preparing 6NET

When we began thinking about preparing 6NET in the Spring of 2001, none of us knew quite how big, how influential and how much fun it was going to be. Of course our ideas didn't have the name 6NET and it took us more than 6 months to shape up our ideas into a project. Those of us from Cisco had never submitted a project to the IST programme before so it was a steep learning curve and a very intense period of preparation. We had many friends and supporters in the scientific and academic community who worked with us, sometimes we agreed and sometimes we argued but I think we all shared a common vision of putting together a project that would influence the future of the Internet, particularly supporting those around the globe who were yet to experience the joys and power of the Internet.

Everyone involved felt that the European Commission IST programme was a perfect platform and structure in which to develop this type of project. So after many months of intense work we were all rewarded with a funded IST project which became named 6NET. But that was just the start.....

6NET – the journey

As we began the journey of 6NET we found it naturally fell into several distinct parts, first we had to get the testbed up and running and plan in more detail who was going to do what and when.

Inevitably our budget was cut down in the negotiations so we had to make some adjustments from the original plan. Then we had to concentrate on developing the IPv6 protocol itself.



Jane Butler is seen here with Theo de Jongh; they were definitely some of the powerful CISCO driving forces of the project together with colleagues Graca Carvalho, Patrick Grossetete and Gunter Van de Velde. to name iust a few.

When we began 6NET, IPv6 code was in early betas from most commercial companies, 6BONE had been built but was only using tunnels.

Much of the natural functionality of IPv4 had not been developed in IPv6.

The original dream of IPv6 was to solve many of the problems of IPv4, however in reality enhancements to IPv4 had negated the need for IPv6 for many years. So no-one had focussed on adding features and functionality to IPv6 to make it a full deployable protocol, not just a replacement to IPv4 but more a protocol that would be used as the basis for the growth of the Internet – both geographically and for a wider range of hosts. One thing we strived for in the early days of 6NET was a testbed that had as much native connectivity as was affordable.

This we believed would give everyone involved the chance to really exercise the IPv6 protocol developments we planned without the added complexity of tunnels that might detract from the real work.

The final stages of the project moved into exploiting the protocol and providing demonstrations that IPv6 was ready for full production service. This work is still going on – we were lucky enough to be able to extend 6NET for an extra 6 months.

6NET – the highlights and the fun parts

The 6NET Consortium was and is a very friendly and collaborative Forum for everyone who is committed to IPv6 to work together. The dynamics have always been extremely good allowing real work to prevail. All partners have gone the extra mile with their contribution and support as and when necessary. This has fostered and encouraged much more to be achieved than we could have dreamed of in the early days.

In January 2004 for example, the European Commission, 6NET and Euro6IX co-hosted in Brussels an IPv6 Service Launch event where over 50 CEOs drawn from not only academia but industry announced their plans to launch an IPv6 service.

IPv6 Fora have been established in many European countries where larger groups of those committed to IPv6 make plans and discuss ideas. Many contributions to standards bodies such as the IETF have emerged from the Consortium showing technical leadership in many areas of IPv6 development.

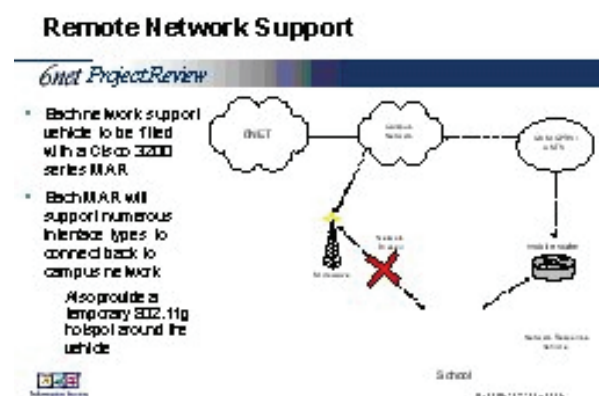
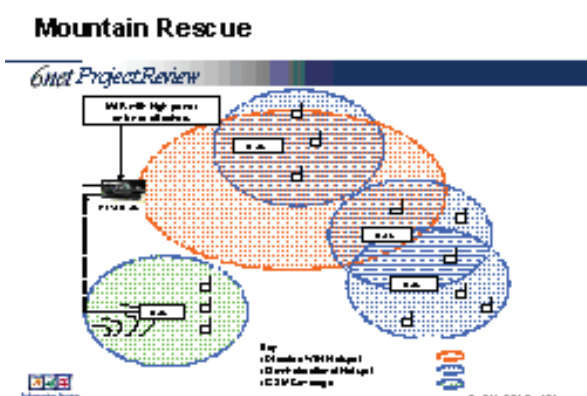
Every 6 months the 6NET Consortium has met to discuss project plans and listen to external speakers contributing to new ideas, and hear about what is happening in the commercial world and other IPv6 related activities. Plus we have always had a very active set of individual and joint Work Package meetings happening throughout the project lifetime.

There have been regular Reviews with the EC and industrial review panel. These Reviews have been tough but stimulating for the Consortium as they should be. As a result the 6NETer's have often had to extend their ideas and thoughts to satisfy the Reviewers.

Finally at the last Review, much of the good work and achievements of the project were recognised as being significant and I think the Consortium members representing 6NET at the Review felt a great sense of achievement after hearing the extremely positive feedback.

Some fun things have been happening too. Every quarter there is an award of a new Captain Kirk who is a Consortium member who has made a recognised and exceptional contribution over the previous 3 months. The person receiving this Award is selected by the previous Captain Kirk and there is a gift of a bottle of fine Italian or French wine or something similar. The Captain Kirk's are now a very select and special group of 6NETer's.

The final thing I wanted to mention here is the tremendous success 6NET has had in developing extra project work almost over and above the original scope of 6NET itself. We have a thriving IPv6 mobility project underway between Cisco and Lancaster University/UCL.



We have a new project called 6DISS which is EC funded and whose primary objective is to disseminate the IPv6 work of 6NET around the world, particularly in places where IPv6 is a necessity – Far East, Africa, South America and also Central Asia/Caucasia by working with the Silk project.

IPv6 in Virtual SILK Road Project

6net Project Review

Bringing affordable Internet connections to 3 Southern Caucasian and 5 Central Asian countries for use by the scientific and academic communities

- IPv6 over Satellite
- Added extra IPv6/DVB engine at DESY hub and five sites – using IABG boards
ESA provided BW for testing their boards
- Configured all main routers dual mode
Ran broadcast ID on DVB channel
- Configured RATIC hosts at five sites
Running IPv6 Multicast (MC) locally
- Put in IPv6 Multicast – Unicast reflectors
Allowed multiplexing without MCUs
- Demonstrated Real-time VIC/RAT conf
Ran VIC and RAT at 3 sites & ES A in Sept
Main: Video streaming at IST-2004 in Nov



Busset, 10-11 Feb 2005

The 6NET team are also writing a book which will probably be published after the end of the project and will act as a lasting reminder of the work of this outstanding Consortium. I am sure signed copies of this book will fetch a high price at an auction one day in the distant future!

6NET – the influence

As I think I have tried to relay in this article, the influence that 6NET has had over the insertion of IPv6 in the networks of the future, both the public Internet and private networks has been clear to see and demonstrate. The experience of the project for everyone has been really excellent and personally it has been a great privilege for me to be able to participate and to some extent guide the project over its lifetime. In my view this is a perfect example of how industry can collaborate with academia with the full support of the EC IST programme.

6net

Contacts

6NET project Website: <http://www.6net.org>
E-mail: info@6net.org

Project Coordinator

Theo de Jongh

tdejongh@cisco.com

6NET Newsletter editorial team

Manuela Profili - Paul Van Binst - Rosette Vandebroucke

paul.vanbinst@helios.ihe.ac.be

6NET Quality of Service

The goal of the IPv6 QoS activity is the investigation of the QoS service's migration to the IPv6 environment. At the first phase of the project several QoS mechanisms were examined in local testbeds. It was demonstrated that QoS mechanisms in IPv6 routers perform as expected and, hence, they can be taken as basis for wide-scale deployment of QoS services. The next step was, inevitably, the deployment of QoS services in the actual 6NET network. It had to be validated that adequate QoS support could be realized in the 6NET network and the special requirements of various applications, e.g. real time applications, could be fulfilled with the available mechanisms supported in the 6NET core routers.

The QoS mechanisms that are applied in the 6NET backbone adhere to the Differentiated Services (DiffServ) architecture, which ensures both the scalability and efficiency required in this portion of the network. DiffServ operates on a per-hop basis, with each router examining the IPv6 Traffic Class bits in each packet header to obtain the DiffServ code point (DSCP) for that packet. DSCP is defined as the 6 most significant bits of the Traffic Class field that has the same semantics with the "Type of Service" (ToS) field in the IPv4 packet header. When the packet is ready to be queued for transmission, the router places the packet into an appropriate queue according to the DSCP value.

6NET QoS activity proposes a suitable QoS framework, which defines a small set of QoS classes (3) that are deployed in the core network. A high priority service IP Premium, which is based on the EF-PHB (expedited forwarding – per hop behavior), is provided to a small portion of network traffic, especially for traffic generated with real time applications. The BE (best effort) and LBE (less than best effort) services can be used by elastic applications that do not require delay or bandwidth guarantees. All 3 services are defined by different DSCP values (46, 0 and 8 respectively). Figure 1 shows the actions that are defined for the core and access interfaces by 6NET's QoS framework.

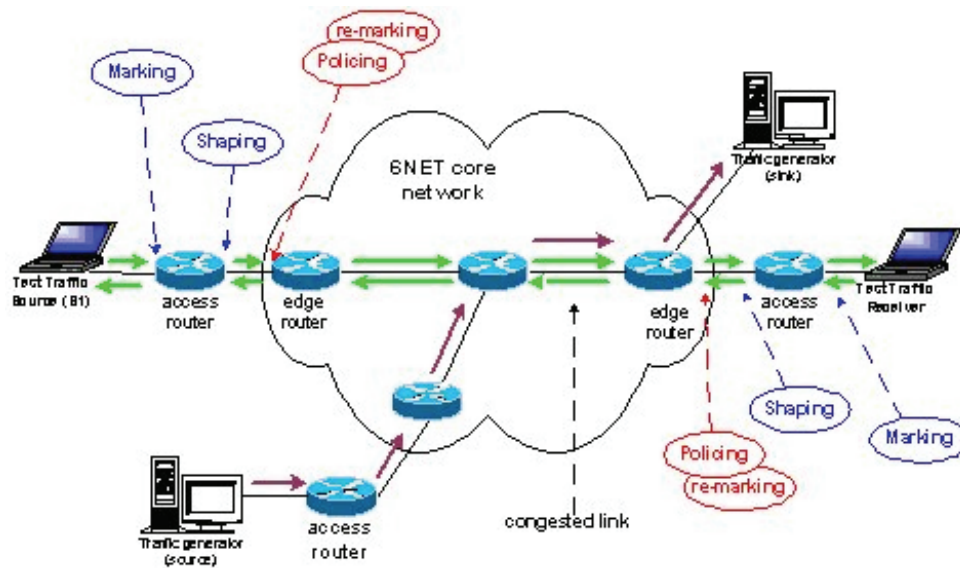


Figure 1: QoS framework's actions

The 6NET network became IPv6 QoS enabled and remained operational for about 8 months (until the network's decommission). In this period, a number of tests were defined that aimed to evaluate the performance of the QoS service. These tests were performed successfully, verifying several mechanisms in various network conditions and especially under heavy congestion.

The testing results demonstrated that the implemented IPv6 IP Premium QoS service properly prioritizes the "Premium" authorized traffic and therefore this traffic remains unaffected under congestion, experiencing zero packet loss as well as minimum delay and jitter. The tests also showed that applying QoS on the 6NET environment actually gave no performance degradation on the core network's devices (routers), as well as no conflicts with other network services. Finally, the successful completion of these experiments clearly demonstrates that such QoS services are mature enough in order to be deployed in a production IPv6 network.

In the near future, as the adoption of IPv6 increases, such QoS services will be widely provided by ISPs. Also, the IPv6 Flow Label (a new field in IPv6 header) will be widely used as it has been recently standardized (RFC 3697), providing extended capabilities for per flow treatment instead of aggregation only.

The 6NET Cookbooks

The 6NET project has gained a great deal of experience of IPv6 implementation and deployment issues and has documented this in a number of cookbooks. These are aimed at network and system administrators and are easy-to-follow guides on migrating backbone networks from IPv4 to IPv6, migrating campus networks from IPv4 to IPv6, implementing IPv6 services, and IPv6 network management...

IPv4 to IPv6 transition cookbook for organisational/ISP and backbone networks - The early focus of the 6NET project was to deploy a native IPv6-only network connecting fifteen National Research and Education Networks (NRENs), but provision of end-to-end IPv6 services between universities and other sites requires IPv6 support within these NRENs. These NRENs will have existing production IPv4 networks which cannot be disrupted, which means that methods of introducing IPv6 that do not adversely impact performance are necessary. The methods described in this cookbook are applicable to most ISPs, although not to all of their operations as NRENs generally do not deliver IP services to home users. The transitional mechanisms investigated include the dual-stack approach, tunnelling, IPv6 over MPLS, IPv6 over ATM, deployment of parallel networks, tunnel brokers and 6to4 relays. It also includes case studies covering GÉANT and several NRENs. IPv4 to IPv6 transition cookbook for end site networks/universities - As IPv6 grows in maturity and as an understanding of its benefits grow, deployments will also increase in number. Within the 6NET project, many of the participants have made a significant investment in deploying IPv6 services, mainly dual-stack, but a small number of IPv6-only. This cookbook therefore presents both theory and practice for IPv6 site deployment, including examples using popular operating systems such as FreeBSD, Linux, Solaris and Windows, as well as router platforms such as Cisco IOS, Juniper JunOS and Zebra. It covers the various tunnelling and translation methods, and provides case studies of the University of Münster, the University of Southampton and in the Tromsø metropolitan area.

IPv6 cookbook for routing, DNS, intra-domain multicast, inter-domain multicast, and security - This provides information on how to implement routing (RIP, IS-IS, OSPF and BGP protocols), DNS (AAAA, A6 and DNAME records), inter- and intra-domain multicasting (address formats and routing protocols), and security features (IPSec, SSH and ACLs) on IPv6 networks. It includes configuration examples, and evaluates various multicast implementations from Cisco, Juniper, 6WIND and KAME. Some transitional problems such as the ipv6.int v ipv6.arpa issue are also covered.

IPv6 Network Management cookbook - Network management and monitoring is a critical part of operating any production-quality network, and if IPv6 networks are not subject to the same or improved standards as existing networks, the existing IPv4 user base will be unwilling to migrate. This cookbook covers straightforward monitoring of link status to gathering and analysis of traffic statistics, both for network planning, and for early detection of denial-of-service attacks. It suggests appropriate tools that can be used to support this, and identifies weaknesses and missing components.

The last 6NET review



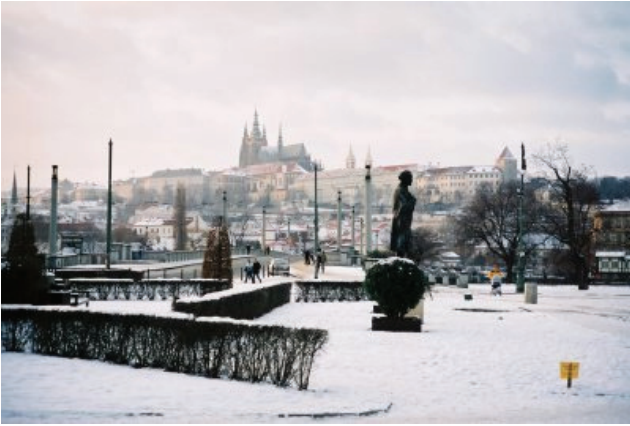
Part of the final phase of the 6NET project has been oriented towards the building of demonstrators that combine the results from the IPv6 Network Services workpackages (WP3 and WP4) with applications developed or adapted by WP5. Scenarios have been selected that especially show the advantages of using IPv6. The following demonstrators were shown at the GARR IPv6 Event in Pisa (May 10-12):

- AccessGrid conferencing tool
- Mobile Access Routers
- eProtein Analysis (Globus)
- IPv6 Mobility
- Multicast (Mad-FLUTE/SSM)

In the final review (Lisbon, June 23-24) the partners will reflect on all the successful achievements that 6NET has made in terms of first validating, then encouraging and supporting the deployment of IPv6.

The project will then take a look forward to the many national and international IPv6 projects that are just beginning (for example in school networks) which have often been initiated through 6NET partners. 6NET has been a very successful project, and instrumental in the deployment of IPv6. Its impact and influence will not end with the final review, but will continue through 6DISS, the extensive public archive of practical "Cookbooks" and the relationships that have been built between the partners.

6NET Consortium meeting



The last full size meeting of the 6NET Consortium took place in Prague in January 2005, hosted by the Czech NREN CSNET, with most of the 36 partners attending.

The participants prepared the final review of the project and discussed the details of the program of work for the last months of activities.



IPv6 and e-business

IBM, pioneer of e-business and On Demand Business trends, has enabled the IPv6 support into its operating systems and is progressively enabling its other software products.

The first IBM product fully IPv6-enabled is WebSphere Application Server (WAS) v6. "e-business" is a concept that represents the execution of real-time business processes with the assistance of Internet technologies. The application server is the main piece of an e-business infrastructure. It provides the execution environment for the applications and handles the network connectivity. This means that most e-business applications can be developed without specific consideration of the network infrastructure.

IBM has used the 6Net infrastructure and a beta version of WAS v6 to verify the above assumption. IBM has migrated three applications: a Web Service for the automatic documentation of web services, an application of end-to-end purchase of electronic components and a service of bank account management and has also developed a new web service based on the MPing tool initially developed by Uninett to collect statistics about packet delay and loss in a TCP/IP network (see figure).

The results confirm the central role of the middleware: applications should be ready for IPv6 as soon as their underlying middleware, such as Java, is ready. Some difficulties have been encountered with the second application designed on a client-server architecture using an applet. In this case, the migration required an adaptation of the applet code to manage IPv6 connectivity. This problem has highlighted the importance of designing applications respecting standards. Another lesson learned is the possibility for an application to work well with a mixed IP architecture in which some nodes are accessed in IPv6 and others in IPv4.

The bottom line is that e-business applications are not limited by the network infrastructure. If developed in compliance with the standards, they can transparently interact with the same service provided by two different service providers on two different IP protocol versions.

3rd final 6NET workshop

The 3rd and final 6NET Open Workshop was held on the 11th and 12th of June 2005 in conjunction with the GARR Conference 2005 in Pisa, Italy.

It was organised as a plenary session on general IPv6 topics within the main conference, a parallel session dedicated to the newer features offered by IPv6, followed by another parallel session focusing on IPv6 issues of specific relevance to the Italian research networking community.

The main objective of the workshop was to publicise the experiences of the 6NET project and those of other related IPv6 developments. The focus was on making the case for using IPv6, drawing on the real-world experiences of the 6NET and Euro6IX projects amongst others.

The workshop opened with an address from Latif Ladid, President of the IPv6 Forum, who stated that IPv6 had reached a state of technical maturity where it was realistic to deploy it in production networks. The challenge now was a political and logistical one to persuade service providers and end-users to adopt it. Patrick Grossetete of Cisco Systems continued this message by stating that most of the barriers to widespread usage of IPv6 were no longer technical. However, the benefits of IPv6 were increasingly being recognised in environments such as homes and schools, as well as the automotive industry. The session concluded with a panel (question and answer) discussion about where IPv6 was headed in the coming years.

The next session featured Jean-Pierre Rombeaut of Alcatel discussing the use of Mobile IPv6 for converging consumer technologies such as GSM and DECT with VoIP. This was followed by presentations from Gunter Van de Velde of Cisco Systems and Janos Mohacsi of NIIF that provided an appraisal of the security issues that needed to be considered when using IPv6. Finally, Mario Morelli of Telecom Italia Labs gave an overview of the IPv6-enabled Internet Exchanges that been developed by the Euro6IX project.

The final session focused on the IPv6 deployment experiences of GARR (the Italian NREN), with presentations from Gabriella Paolini and Marco Sommani. Stefano Lucetti also presented the mobile IPv6 demonstrator developed at the University of Pisa, whilst Renzo Davoli outlined the IPv6 testbed facilities available at the University of Bologna.

The full proceedings of the workshop can be found on the 6NET website at:
<http://www.6net.org/events/workshop-2005/>

6NET Partners

