www.6net.org

Large-scale International IPv6 Pilot Network

Introduction

6NET is a European project to demonstrate that continued growth of the Internet can be met using new IPv6 (Internet Protocol Version 6) technology. It also aims to help European research and industry play a leading role in defining and developing the next generation of networking technologies.

6NET involves thirty-six partners from the commercial, research and academic sectors and represents a total investment of EUR 18 million; 43% of which comes from the project partners themselves, and 57% from the Information Society Technologies (IST) Programme of the European Commission. The project started on 1 January 2002 and was due to run until 31 December 2004. However, it is likely to be extended until the end of June 2005.

The main objective of the project is to understand and address all the issues to be encountered in the introduction and deployment of IPv6 services. One important activity was to install and operate a pan-European pilot IPv6 network in order to gain a better understanding of IPv6 deployment issues. This allowed practical operational experience to be gained, and provided the possibility to test migration strategies which are important considering that IPv4 and IPv6 technologies will need to coexist for several years.

A network also requires services and applications in order to be fully validated, so the project is developing and porting applications to work with IPv6. In conjunction with this, it is investigating how legacy applications can operate on IPv6 infrastructure.

Last but not least, the project has been collaborating with other IPv6 activities such as Euro6IX and the IPv6 Cluster, and is contributing to standardisation bodies such as the IETF (Internet Engineering Task Force) and GGF (Global Grid Forum). It also plays an important role in promoting IPv6 technology at both the national and international level.

Project Activities

6NET aims to encourage the adoption of IPv6 by resolving the two major hurdles that are considered to be hindering its widespread acceptance. These were to demonstrate that IPv6 is fully functional and stable, and to demonstrate that IPv6 offers distinct advantages over IPv4.

TESTBED

To this end, a backbone IPv6 network connecting fifteen countries and running at 155 Mbps was established in 2002. This runs IPv6 over dedicated links, although for cost reasons, four links (to Greece, Hungary, Poland and Portugal) are provided by POS (Packet-over-SONET/SDH) over a Layer 2 VPN infrastructure.

Local access is provided through national IPv6 testbeds operated by partner NRENs (National Research and Education Networks) such as JANET (UK), RENATER (France) and SWITCH (Switzerland). Connectivity to the non-European 6NET partners in Japan and South Korea is provided via connections to London and RENATER respectively, and there are also connections to Abilene in the US (via SURFnet), Euro6IX (via the JANET- UK6X, GARR-TILab and SWITCH-Swisscom exchange points) and to the 6Bone (which is an overlay network).

The 6NET backbone and interconnected national testbeds, collectively form the largest native IPv6 network in the world. This provided plenty of scope for trialling the new technology, testing interoperability with existing networks, and demonstrating services and applications. In fact, it demonstrated that the IS-IS and BGP4+ routing protocols, IPv6 over IPv4 tunnelling, and DNS support were stable and usable. In addition, a multicast overlay network (M6Bone) was established and has been utilised for conferencing and radio broadcasting (e.g., Trondheim Underground Radio).

SERVICES

The success of the testbed spurred the existing GÉANT and NORDUnet networks to move to dual-stack operation earlier than anticipated, and in turn, encouraged many NRENs to offer IPv6 services as well. Having served its purpose, and with 6NET partners now having IPv6 access via GÉANT, the testbed will be terminated in January 2004.

The project has also successfully tested IPv6 over MPLS and undertaken QoS trials. IPv6 has been deployed in a campus environment at Southampton, whilst large-scale wireless trials are currently being held in Lancaster, Southampton and Tromsø. Other components important to widespread IPv6 deployment such as DHCPv6, DNSSEC, autoconfiguration, multihoming, renumbering, mobile IPv6 and IPsec, have been evaluated and feedback provided to developers. The aim is determine which elements are missing, and to ensure that any problems are identified and fixed.

APPLICATIONS

A number of middleware and user applications are being developed or ported by the project. This includes the SIP-based telephony system (including PSTN gateway), the AccessGrid conferencing tool (including IPv4-IPv6 gateway), IPv6 versions of the IBM WebSphere e-business applications, an IPv6 version of the FLUTE multicast file transfer tool, and MIPv6-based video streaming for PDAs. The project has also created IPv6 versions of the Globus Toolkit (GT3.x) which is used to develop Grid-aware applications (e.g., IPv6 WeatherStation and eProtein), and the Open H.323 Toolkit, used to develop an IPv6-version of GnomeMeeting. Other network management tools such as NetSNMP, MRTG, OpenEye, Smokeping and Weathermap have been developed or ported for traffic measurement and visualisation purposes.

To complement this work, the project is developing low-cost hardware solutions such as the Liberouter card that allows a low-cost PC to be turned into a high performance IPv6 router. Another card allows IPv6-enabled DVB (Digital Video Broadcasting) to be deployed over a satellite network.

Whole user communities are being introduced to IPv6 technology via pilot projects. Two of these are work with schools in Greece and a satellite-based Caucausas/Central Asian community. It is also expected that a set of mobile demonstrators will be made available in the last phases of the project.

Project Structure

6NET is comprised of seven technical work packages that focus on various aspects of IPv6 technology:

WP1 Build and Operate Network. This defines and implements the core network infrastructure, addressing and naming schemes, routing architecture and peering policy. It is responsible for running the NOC (Network Operations Centre), and facilitating interconnection with other IPv6 networks (e.g. Euro6IX, Abilene, NTT Japan and KOREN).

WP2 IPv4-IPv6 Co-existence, Interworking and Migration. This is investigating how to transition IPv4-based networks to IPv6 at backbone, regional and campus levels.

WP3 Basic Network Services. This designs, implements and tests IPv6-enabled network services such as routing (both inter-domain and intra-domain), DNS, DHCP (Dynamic Host Control Protocol), renumbering, registry procedures, and multicasting. It is also focusing on interoperability between IPv6 and IPv4 network services.

WP4 Application and Service Support. This is investigating the new features introduced in IPv6, such as mobility, multihoming, quality-of-service (QoS), and security.

WP5 IPv6 Middleware and User Applications. This is developing, porting and testing IPv6-enabled applications, including videoconferencing, media streaming, web services, transaction processing and grid computing.

WP6 Network Management Architecture and Tools. This is considering configuration, fault reporting and security issues related to IPv6, as well as developing and installing appropriate management tools.

WP7 Dissemination and Exploitation of Results. This organises workshops, presents papers at conferences and other events, liaises with other IPv6 activities and standardisation bodies, provides training, and is developing business models. It is also helping to introduce the new technology into new communities.

Dissemination and Training

6NET organises annual informational workshops and a number of training events on IPv6. It also issues quarterly newsletters with updates on the project, which are available in both electronic and paper formats.

The experience gained during the project has been turned into a number of 'cookbooks' aimed at network administrators. Cookbooks on migrating backbone and campus networks from IPv4 to IPv6, implementing IPv6 services, and IPv6 network management have already been published, and others are currently being produced.

All project documentation and information about forthcoming events can be found on the 6NET website.

During the project extension, 6NET will establish a virtual helpdesk to support research and education networks who wish to make the transition to IPv6. The project will also summarise its knowledge and experiences by producing a book on IPv6 deployment which should be available around May 2005.

Standards Contributions

6NET actively contributes to the IETF, particularly to the ipv6, v6ops (formerly ngtrans), multi6 and dhc working groups. Indeed, 6NET participants co-chair v6ops and multi6.

A number of Internet Drafts (in excess of fifty) have been submitted in the areas of site-local addressing, multicasting, 6to4 security, SNMP over IPv6, application porting, campus transition scenarios, renumbering, dual-stack issues, 3GPP and DNSSEC. These are areas which were previously poorly defined, and 6NET has been able to provide input based on its operational experiences.

6NET has also worked with the GGF to produce guidelines for IP version independence in Grid specifications, and to determine the IPv4 dependencies in current specifications. In addition, it has contributed to the IEEE (Institute of Electrical and Electronics Engineers) in the areas of IPv6 transition and mobile source-specific multicasting, whilst regularly providing updates to RIPE (Réseaux IP Européens), a collaborative forum of European ISPs.

The 6NET project is co-ordinated by Cisco Systems and comprises:

ACOnet (Austria)
CESNET (Czech Republic),
DANTE
DFN (Germany)
ETRI (South Korea)
FCCN (Portugal)
GRNET (Greece)
HUNGARNET (Hungary)
IBM
GARR (Italy)
Lancaster University (UK)
NORDUnet
NTT (Japan),
PSNC (Poland)
RENATER (France)
SURFnet (Netherlands)
SWITCH (Switzerland)
Telematica Instituut (Netherlands)
TERENA
UKERNA (UK)
ULB (Belgium),
UCL (UK)
University of Southampton (UK)
CSC (Finland),
CTI (Greece),
DTU (Denmark)
Fraunhofer FOKUS (Germany)
INRIA (France)
Invenia (Norway)
Oulu Polytechnic (Finland)
ULP (France)
Uninett (Norway)
University of Oulu (Finland)
WWU-JOIN (Germany)

Summary

6NET has demonstrated that IPv6 is deployable in a production environment. Not only does it solve the shortage of addresses, but it also promises a number of enhanced features which are not an integral part of IPv4. It was a major factor in accelerating the rollout of dual-stack operation on the GÉANT and NORDUnet networks, as well as many NRENs. The 6NET network itself has been used to provide IPv6 connectivity to a number of worldwide events, including IST 2002 (November 2002), IETF 57 (July 2003), IST 2003 (November 2003) and the Global IPv6 Service Launch (January 2004), showing that it is ready for full deployment.

Information Society Technologies

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