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Large-scale International IPv6 Pilot Network

Editorial

Dear Reader,

After a successful Review in the summer, the 6NET consortium would like to present to you another extended issue of the 6NET Newletter.

Meanwhile, it has been decided to extend the project until June 2005 to include some extra activities. You can read about this and many other things in this Newsletter.

Happy reading!

Interview with Patrick Grossetete

IPv6 Product Manager for Cisco Systems IOS Technologies segment

Introduction

IPv6, the IETF-designed protocol set dubbed the 'next generation' of IP, is designed as an update of the current version, IPv4, which - it is said - is beginning to show its age. Much of the vaunted improvement over IPv4 is attributable to the simple fact that IPv6 offers a virtually infinite number of Internet addresses - from approximately 200 million assignable IPv4 addresses to countless trillions of assignable IPv6 addresses. At the same time, the policy of the Registries (RIPE-NCC, ARIN, APNIC, LACNIC) of allocating prefixes and enabling a hierarchy of routes facilitated by IPv6, is also seen as a significant benefit compared to the previous incarnation. Also, IPv6 is said to add many improvements in areas such as network auto-configuration and mobility.

It seems that big business is also behind the initiative. Sony, for one, has announced that all its products will be IPv6-enabled by 2005. According to Boeing[1] the average home contains 250 devices (toasters, electric toothbrushes, etc.. that could at some future time be connected to the Internet via IPv6. Therefore, level of opportunity for makers of such products such as consoles, sensors, controls and fixtures - once these products are IPv6-enabled - must look enticingly high.

Deployment

Certainly, deployment of IPv6 is now seen as having gained a certain momentum and it can also to be increasingly regarded as both easier and cheaper to implement than had once been feared, not the least because the protocol is being integrated into many networking products. For example, all of the major router manufacturers now support IPv6. At the same time, all major operating systems (Apple, BSD, HP, IBM, Linux, Microsoft, SUN, etc...) embed an IPv6 stack.

Also, given the fact that IPv6 is already being bundled in much of the hardware and software that carriers and corporate network managers are already purchasing as part of their normal infrastructure upgrades, emerging demand for IPv6 is being quite easily met.

To those who do suggest that the upgrade process to IPv6 is both time consuming and expensive, Cisco agrees merely to the degree that there is a "cost", though Grossetete suggests that it is one that is hard to evaluate as such costs vary on a case-by-case basis.

"For some networks," says Grossetete, "it is more a human cost - such as training, configuration, testing and management - while for others, it is the cost of software and possibly hardware upgrades."

What is more important, believes Cisco, is the selection of a deployment scenario that enables IPv6 services at the lowest cost possible. According to Grossetete, "This is one of the reasons Cisco designed the 6PE approach to allow carriers and operators who run MPLS today to add IPv6 services in the locations where it is needed, thereby reducing costs."

Scaling the Internet

In one respect, however, according to Grossetete, the difference between IPv4 and IPv6 is not that great. "IPv6 is IP," says Grossetete, "And if a carrier is getting revenue from IPv4, there is no reason he can't generate revenues for IPv6 in a similar way."

Notwithstanding this fact, Grossetete asserts that the main benefit of IPv6 is its ability to scale the Internet and reach a mass-market size, defined as 20% or more of a given population. Cisco's spokesperson points out that the current level of 600 million Internet users represents less than 10% of the planet's population.

Also, it is stressed, as the number of end users increases and global addressing is restored, there is a high level of opportunity to push new services to the edge of the network, with IPv6 increasingly becoming associated with broadband access, mobile wireless technologies and a large set of new appliances. "This" suggests Grossetete, "is where innovations and new services and revenues should be expected, considering that today IPv6 only reaches parity with IPv4."

Impact on vendors

In terms of the impact of IPv6 on major networking vendors, Cisco believes this comes down primarily to the requirement that vendors support a multi-protocol environment for the next few years, as it is apparent that IPv4 will not disappear overnight.

With this in mind, manufacturers such as Cisco have delivered multi-protocol software on their products since day one.

Clearly, the optical networking sector will be affected by the level of IPv6 uptake. So, if the Internet grows, then the amount of traffic generated will increase accordingly, thereby requiring additional capacity in the core of the network where optical technology is crucial.

This, however, cannot be achieved without the success of broadband access and mobile wireless services at the edge of the network, as it is these key areas that represent the essential drivers required to bring traffic to the core.

"Accordingly", says Grossetete, "Areas such as bandwidth, global addressing and always-on connectivity are keys for new services that will generate the traffic absorbed by core optical."

IPv6 networks

Among non-US IPv6 deployments, the China Next Generation Internet (CNGI) project has attracted particular attention. The largest IPv6 network initiative in China, the CNGI project was announced in November 2003 and is led by China's State Council, also encompassing eight other Government ministries initiated and approved by China's State Council in 2003.

Five key Chinese carriers, including China Telecom, China Unicom, China Netcom/CSTNET, China Mobile, China RailCom and CERNET (China Education and Research Network), are slated to join CNGI, building their own national IPv6 backbone independently, while interconnecting with at least two IPv6 IX.

And late last year, a spokesman for China's Ministry of Information Industry claimed, for China at least, that "IPv6 is more important than 3G" as a result of the impact on additional economic growth and the promotion of application, service, media, content and manufacturing industries from IPv6 deployment. Some claim that China will have one of the biggest IPv6 networks in the world by the end of 2005 and that China will be the one of the world's leading IPv6 nations.

For Cisco, however, this misses the point, "China selected IPv6 as mandatory for CNGI" says Grossetete, "but it was not the only one. All national and research networks throughout the world have IPv6 services."

It was pointed out that several Japanese ISPs currently offer IPv6 over broadband, while in the US the Department of Defence called for IPv6 in June 2003, specifying that all products bought from October 2003 should be IPv6-capable.

A number of other high-profile IPv6 networks have been announced in recent months, amongst them the following:

- In October 2003, the North American IPv6 Task Force (NAv6TF) announced that North America's largest IPv6 pilot network, Moonv6, had been deployed.
  The North American IPv6 Task Force has joined the military and university communities in building the largest-ever network based on IPv6.
  The network connects more than 80 servers, switches and nodes in eight states.
- In December 2003, NTT East Corp, a regional unit of Nippon Telegraph & Telephone, said it would launch a commercial service based on IPv6 in the Tokyo metropolitan area in January 2004.
  The IPv6 service would be available to subscribers to NTT East's FTTH Internet access service or ADSL service.
- In December 2003, Verio launched a commercial IPv6 gateway in North America that features native, tunnelling and dual-stack services.
  The gateway allows US customers to connect to parent company NTT Communications' global tier-one IPv6 backbone operating in Asia, Europe, North America and Australia. Subsequently, Verio offers commercial IPv6 service at every location in the US where it offers Internet access.
  Verio's IPv6 Gateway Services offer customers many of the same features as IPv4 connectivity.
  However, additional future enhancements would allow customers to benefit from many IPv6-exclusive features, including VPN product offerings as the enhanced IPv6 capabilities allow for full integration of the IPsec framework in IPv6, which enables end-to-end secure communications.

Internet connectivity

There is another aspect also worth considering. The combination of IPv6 and cheap, always-on Internet connectivity is expected to enable many products - from refrigerators to digital cameras, sensors, and other electronic devices - to become Internet hosts.

As a result, in Cisco's opinion[2], "The Internet will be used to connect whole new classes of device for which networking was not previously cost-effective, and will replace the existing means of communication for many existing devices".

The evolution of the Internet has seen the 'global network' model shifting to what might be termed a largely 'client/server' model - with servers running users' applications being owned either by an ISP or a corporation.

IPv6, however, with its 'global address for everybody' philosophy, goes some way to returning the Internet to something like its original mission, since IPv6 enables end-users who have a global address space to set up their own server if they so wish. This clearly signals new opportunities for both users and service providers.

Sanyo in Japan, for example, offers a digital camera with a WiFi interface. After taking a picture, users can go to any 802.11 hotspot and download photos to their home server.

"If you look at this kind of application as well as distributed computing" says Grossetete, "I can see a lot of opportunities for the service providers to generate new services and revenues. One example might be an on-line backup centre as users wish to protect their data if they're running their own servers."

([1]) - According to Connexion by Boeing, the average home contains 250 devices that someday could be connected to the Internet via IPv6.

([2]) - An IPv6 Business Model Proposal - Community of Interest by Patrick Grossetete and Kevin Miles.

Liberouter

Ladislav Lhotka and Jiří Novotný

Open source software has always been an attractive option for system software development. The highly regarded KAME stack certainly played an important role in the early stages of IPv6 deployment. The main routing platform of the 6NET testbed – Cisco Systems routers – found a natural complement in PC-based routers that can more easily accommodate to the still rapidly changing landscape of IPv6 protocols.

This is especially true for IPv6 multicast, where the 6NET team contributed several novel ideas and gained considerable operating experience.

The *Liberouter* project, which is a part of 6NET work package 3, aims at improving the PC router platform in three directions:

- performance
- consistent configuration and management interface
- routing daemons

COMBO IPv6 forwarding/filtering accelerator

The performance issue is addressed by the development of a hardware accelerator capable of handling most data plane functions (packet forwarding and filtering) and thus increasing the overall throughput of a PC router up to approximately 10 Gbit/s.

The Liberouter hardware is a set of cards known as the COMBO family (COMmunication BOards). All boards are based on a combination of modern programmable chips (FPGA, CPLD, CAM) with standard electronic components (SRAM, DRAM, PCI interface controllers, power supplies etc.).

The main COMBO6 card (See Figure 1) is, in fact, a generic programmable device. With different firmware it could be turned into a high-end sound or video card or even a number-crunching node. For networking applications, the COMBO6 card must be complemented by a daughter card with interfaces. Both cards are interconnected through a pair of connectors and thus form a “sandwich” that still fits into a single PCI slot.

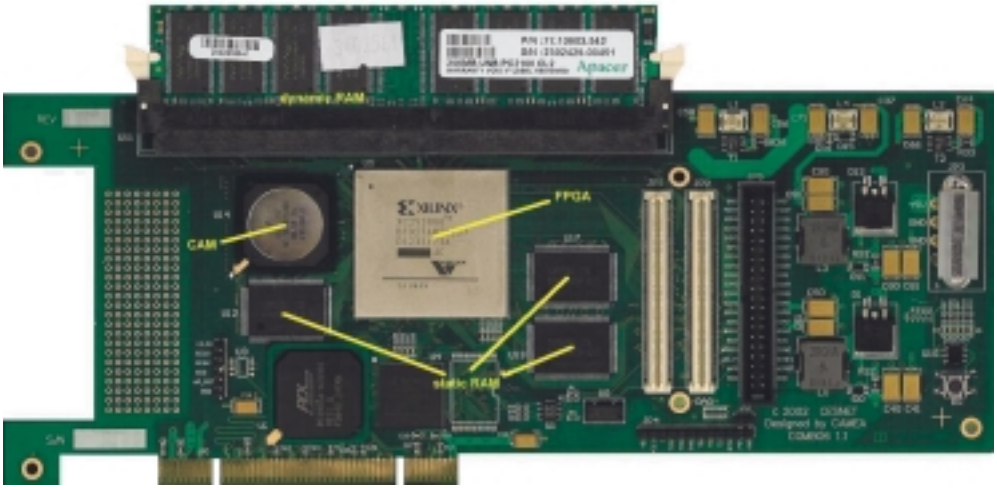

Figure 1

Interface cards typically contain additional FPGA chips that provide additional processing power. The following interface cards are currently available:

1) COMBO-4MTX – 4 metallic ports of Gigabit Ethernet
2) COMBO-4SFP – 4 ports of Gigabit Ethernet in SFP cages
3) COMBO-2XFP – 2 ports of 10-Gigabit Ethernet in XFP cages (see Figure 2).

Most of the data plane functionality of an IPv6 router is or will be implemented in the VHDL language as firmware for the FPGAs on the COMBO6 and interface boards. In the spirit of so-called hardware-software codesign, the host operating system handles transparently those functions and exceptions that are not (yet) supported by the hardware, for example obsolete protocols like AppleTalk or IPv4, less frequent IPv6 header options etc.

Figure 2

The COMBO hardware is currently supported under NetBSD and Linux. Our goal is to integrate it seamlessly into the operating system environment so that utilities like ifconfig, tcpdump, routing daemons etc. work without changes as on a standard software-only PC router. To this end, the card drivers, apart from servicing special interactions with the COMBO hardware (downloading the firmware etc.), present the hardware accelerator as an ordinary multi-port Ethernet adapter.

Netopeer configuration system

Instead of merely creating a new command-line shell for PC routers, we decided to develop a more general configuration system named Netopeer that will be useful for other router platforms and heterogeneous networks. It is based on the idea of a (mostly) platform-independent description of router configurations, which is in our case expressed in XML.

The configurations are stored in a central repository with version control and secured remote access. It is based on the Subversion software. Users (network administrators) can create or modify the configurations by means of a front-end representing a specific router configuration language and/or user interface. We are working on three types of front-ends:

- "Native" command-line interface
- Web user interface
- Batch translators from other configuration languages (currently under development are versions for Cisco IOS and JUNOS).

On the opposite end of the data-processing chain are back-ends, which perform the inverse translation from XML into the specific router configuration languages and, if possible, install the resulting configurations in the target device. We are currently working on Unix and Cisco IOS back-ends.

An interesting extension of the Netopeer system is the metaconfiguration application. Instead of individual routers, it is oriented towards the configuration of entire networks. It uses another XML vocabulary for expressing the configuration at this level and uses automated procedures for translating these "metaconfigurations" into the Netopeer XML configurations of all routers in the network.

BIRD routing daemon

As the most, popular routing daemons for Unix systems – GateD and Zebra – are either not being actively developed or have restrictive licenses, we decided to support another promising open source routing daemon, BIRD (http://bird.network.cz), and contribute to its development. After porting BIRD to NetBSD, we started the development of a PIM module for IPv4/IPv6 source specific multicast.

One of the main virtues of the Liberouter project can be seen in its openness. Therefore, we use open source licenses for all our software and firmware and even hardware schematics are available on the Web. As a result, other projects and activities outside 6NET expressed interest in the Liberouter hardware. The SCAMPI project is developing another firmware for the COMBO6 card oriented to high-speed network monitoring and the CzechLight project integrated the COMBO-4SFP card into a two-channel optical repeater and a similar 10 Gbps repeater is now under development. Further applications of the Liberouter hardware are proposed for the FP6 projects GN2 and LOBSTER.

For more information about the Liberouter project, visit our web pages at http://www.liberouter.org.

Collaboration between 6NET and SEEREN

The collaboration between the two IST projects 6NET and SEEREN became effective on September 1st 2004. The Memorandum of Understanding, defining the terms of the collaboration, has the purpose to:

- facilitate the dissemination and promotion of the best practices from the 6NET project to the SEEREN network of countries and partners,
- help the main SEEREN beneficiary countries to experiment and become familiar with IPv6,
- produce joint reports on the results of the 6NET-SEEREN cooperation.

The South Eastern European Research & Educational Networking (SEEREN) initiative (http://www.seeren.org), funded by the European Commission under the Information Society Technologies (IST) Programme (IST-2001-38830), has expanded research networking in SE Europe by providing connections between the National Research and Education Networks (NRENs) in eligible countries and GEANT. The eligible countries are Albania, Bosnia-Herzegovina, Bulgaria, FYR of Macedonia, Greece, Hungary, Romania and Serbia-Montenegro. The project has designed and implemented - and is currently operating - the SEEREN 2-34Mbps network infrastructure links. The SEEREN infrastructure was launched and entered its stable operation on January 2004. SEEREN partners are currently setting-up and exploiting a range of new services and current “best practices” in their network. Of high priority is to experiment with IPv6 technology and get familiar with IPv6 "peculiarities" and constraints.

The 6NET project has built - and now operates - a dedicated international IPv6 network, which is being used to validate that the demands for the continuous growth of the global Internet can be met with the new IPv6 technology. Aimed at the research network community in Western Europe, Poland, the Czech Republic and Hungary, the network comprises 155Mbps and GE links. Topics being addressed are transition strategies (from IPv4 - IPv6), Routing, DNS, DHCP, Multicast, Renumbering, Mobile IP, VPNs, Grid-related activities, Management and Monitoring tools, and Applications. The SEEREN project terminates on December 31st 2004, whereas 6NET continues until the 30th of June 2005. The collaborations are therefore foreseen to be performed within both SEEREN and 6NET in the 2nd half of 2004, and within 6NET during the 1st half of 2005. The work will be carried out by the common SEEREN/6NET partners (GRnet, DANTE, TERENA, HUNGARnet) in collaboration with the 6NET coordinator (Cisco).

Specific co-operations to be enabled between the 2 projects will be:

1. Dissemination and promotion of the best practices from the 6NET project to the SEEREN network of countries and partners via a workshop to be held in the 2nd half of 2004. The 6NET Cookbooks will form the central part of this workshop.
2. Help the main SEEREN beneficiary countries to experiment and get familiar with IPv6. 6NET is currently performing a number of experiments and making demonstrations. The common organisations (GRnet, DANTE, TERENA, HUNGARnet) will make these activities known to organizations in the SEEREN countries.

Joint reports will be written on the results of all 6NET-SEEREN cooperation.

2nd 6NET Workshop

On the 9th of June 2004,the 6NET project organised a workshop on IPv6 co-located with the TERENA Networking Conference 2004 in Rhodes (Greece).

The workshop discussed the current status of the 6NET project, drawing on the experiences of 6NET and other IPv6 projects.

Several speakers presented the main subjects analysed by the 6NET project, in particular: “IPv6 Multicast” (Jerôme Durand, RENATER), “IPv6 transition: moving into the campus” (Tim Chown, University of Southampton), “Mobile IPv6 in 6NET: An Overview” (Chris Edwards, Lancaster University), “IPv6 Prospects” (Patrick Grosstete, Cisco), “6POWER, IPv6 and PLC for home automation” (Jordi Palet Martinez, Consulintel), “IPv6 Development in China” (Xing Li, CERNET), “Managed IPv6 Transitioning Architectures” (Michael Mackay, Lancaster University), “Performance Analysis of Multicast Mobility in a H-MIP Proxy Environment” (Thomas Schmidt, FHTW Berlin), “IPv6 Security from point of view of firewalls” (Janos Mohasci, Hungarnet), “A test-bed investigation of QoS mechanisms for supporting SLAs in IPv6” (Vasilios Siris, University of Crete & FORTH).

6NET Spring 2004 Conference

The 6NET 2004 Spring Conference took place in Brussels on May 18th and 19th, coupled with demonstrations of IPv6 applications and services, as well as a "showcase" prepared in collaboration with the Eurov6 project.

This two-day event drew about 80 people to ULB in Brussels: 15 speakers, more than 50 attendees and about 15 engineers, researchers and staff involved in the demonstrations and organisation.

After the very successful Global IPv6 Service Launch event in January, this shows that interest remains high in IPv6 matters.

3rd 6NET Project Review

6NET held a successful 3rd Project Review on June 3rd - 4th in Brussels. One result from this process is that the project will be extended until the end of June 2005. Activities in the extension period will focus primarily on disseminating the results and supporting IPv6 deployments.

Dissemination will include a book based on 6NET's *how-to* Cookbooks, support for workshops in the Balkan States, the Newly-Independent States and Brazil, collaboration with the similar IPv6 testbed in the US (Moonv6), and larger-scale application demonstrators (e.g. mountain rescue, mobile library, car-to-car). First demonstrations of VoIP, video-conferencing and mobility were already shown in the Review.

New deployment-related work being considered includes a network connecting 5'000 schools in Greece, and the specification of renumbering procedures through an IETF rfc. So-called "Tiger Teams" will also be established to offer a help-desk type of service to would-be deployers.

The demonstrations associated with the 3rd 6NET Review were successfully conducted in the ULB/VUB EuroDemo facility.

3rd Joint 6NET/Euro6IX meeting

The 3rd Joint 6NET/Euro6IX meeting took place on the 8th of June 2004 at the University of the Aegean, Rhodes (Greece).

Several IPv6 related issues were discussed during the meeting, presenting the main achievements of both the 6NET and Euro6IX projects, and describing the synergies aiming to accomplish the full implementation of the IPv6 features.

The main subjects debated during the joint meeting were: multicasting, RPSL, multihoming, transitioning, security, QoS, monitoring tools, applications and demonstrations.

Attendees agreed to increase the collaboration between the 6NET and Euro6IX projects.

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