About this Document

This document is aimed at network managers who are responsible for deploying and managing the network infrastructure for their organisation, and want some understanding of the issues involved in enabling IPv6. The appendix at the end outlines the history of IPv6 on JANET to date.

The JANET IPv6 Technical Guide provides a more detailed account, including technical information and case studies that will assist with the implementation of IPv6. It is available at:

http://www.ja.net/services/publications/technical-guides/ipv6-tech-guide-for-web.pdf

IPv6 Across JANET – Recommendations

- IPv4 will not go away; however, IPv6 is also here to stay. It is for this reason that UKERNA has been experimenting with IPv6 services for a number of years and has deployed dual-stack services on the JANET core which has been stable since its deployment. It is felt that the time is now right to consider the introduction of IPv6 into the JANET Service Level Agreement.
- Prior to any production deployment, Regional Networks and JANET-connected sites are advised to gain some early experience of IPv6 connectivity and deployment in the form of some kind of testbed. The IPv6 Technical Guide highlights some basic steps.
- The ultimate recommendation for Regional Networks and JANET-connected sites is to enable dual-stack services (using both IPv4 and IPv6), as deployed on the JANET core, and ensure that future purchases of computer systems and networking equipment are IPv6 capable.

What is IPv6?

IPv6 is the new version of IP (Internet Protocol), the common protocol underpinning all Internet communications. It is expected ultimately to supersede the current version, IPv4, in order to accommodate the rapid growth of the Internet. The transition from IPv4 to IPv6 will take some years, but in the meantime the two protocols can and will coexist and operate together in various ways.

With the growing number of users and electronic devices connecting to the Internet, there is a need to ensure that adequate global address space is available as IPv4 will not be able to accommodate this growth. IPv6 was developed by the IETF (Internet Engineering Task Force) during the 1990s and offers 3.4 x 10^{38} addresses; the IETF document RFC2460[1] defines the IPv6 protocol in detail. The Appendix to this report provides a brief history on IPv6 development within JANET.

1. http://rfc.net/rfc2460.html

Why IPv6?

There are many reasons why IPv6 should be used. Perhaps the two principal reasons are as follows.

The US and Western Europe consume a large proportion of the IPv4 address space. In other parts of the world, such as Asia, perceived difficulties in obtaining large blocks of IPv4 address space have led to an advanced deployment of IPv6.

IPv6 now ships as standard in most if not all common computer systems and network equipment platforms. Therefore there is a good case to be made for experimenting with IPv6 now as the growth of IP services in the future is dependent upon its adoption. For example, developments in Mobile IP[2] are only continuing in the Mobile IPv6 area: work on Mobile IPv4 has decreased.

Why IPv4 is Not Enough

IPv4's lifetime has been extended since 1994 by the deployment of Classless Inter-Domain Routing (CIDR) and Network Address Translation (NAT).

CIDR is a method of allocating and routing IPv4 address space more efficiently than the original specification allowed for, in particular the allocation of address space in blocks other than three fixed sizes ('Classful' addressing at /8, /16 and /24 boundaries).

NAT allows many hosts to share a single public IP address, thereby reducing the number of globally unique addresses an organisation needs. Each host on the network is numbered using a private IP address, which is never visible to the rest of the Internet. When a host makes a connection outside the local organisation's network, a NAT device translates the private address to the public address before packets are transmitted and/or received.

Using CIDR and NAT to extend the use of IPv4 address space has a number of architectural implications. While there are workarounds for these issues, none are clear-cut, and common support for the workarounds across different vendors' equipment is rare. Note: while NAT is viewed as a security measure by some, as it does hide internal hosts from inbound connection attempts by default, it is no substitute for a proper security policy and firewall used in conjunction with global addressing.

Taking into account these factors: decreasing availability of global IPv4 address space, avoiding the issues associated with the extension of IPv4 addresses, and the increase in devices connecting to the global Internet and requiring public IP addresses, the deployment of IPv6 is encouraged.

IPv6 Deployments

Many national and international networks have successfully deployed IPv6 alongside their IPv4 infrastructure through dual-stack services where IPv4 and IPv6 coexist on the same routing equipment and network links. This is the infrastructure currently deployed on the JANET core. Note that the deployment of dual-stack networking services does not impact the IPv4 service.

2. http://www.cisco.com/en/US/tech/tk827/tk369/tk425/tsd_technology_support_sub-protocol_home.html

Enabling dual-stack on a network will allow the basic network capability of both IPv4 and IPv6. Once the basic network transmission capability is in place, the next step is to make services available over IPv6. JANET currently makes its main web server, **www.ja.net,** available via IPv6 and the core nameservers are also reachable using IPv6. Much of this work is straightforward as most server operating systems now provide IPv6 support as standard, and built-in support for IPv6 is commonplace in most network service software such as web, DNS and e-mail.

An interesting situation is where a service is deployed using IPv6 only, which an IPv4-only host has a requirement to use. The IETF has done much work on transition tools to aid this situation; so far there have been no reports of any major issues encountered.

Points to Consider by JANET-Connected Organisations and Regional Networks

As with any emerging technology, a number of issues need to be considered prior to the deployment of IPv6 on a production network. These include:

- Understanding the differences between IPv4 and IPv6
- Managing the use of both IPv4 and IPv6 addresses within the same organisation
- Educating and training technical staff, including acquiring technical expertise and knowledge for the staff within the organisation who will be responsible for maintaining the service
- Prepare an IPv6 transition plan for your organisation.

Bear in mind that:

- Production scale rollout needs to be managed appropriately and carried out during the maintenance period
- Equipment (including software) needs to be able to support IPv4 and IPv6 simultaneously
- IPv6 security policy should be the same as IPv4. Although IPv6 addresses look different visually when compared to IPv4 addresses, there is not much difference between the two where security is concerned. Network security is a function of the security policies that are in place and the way they are applied to a particular network.

UKERNA has published a JANET IPv6 Technical Guide and holds a number of IPv6 training activities. Further details about these activities can be found on the JANET website at:
http://www.ja.net/development/ipv6/

References

- IPv6 – Extinction, Evolution or Revolution? January 2006, Geoff Huston
  http://www.potaroo.net/ispcol/2006-01/ipv6revolution.html
- IPv6 and the Future of the Internet, July 2001, Brian Carpenter
  http://www.isoc.org/briefings/001/
- JANET IPv6 website
  http://www.ja.net/development/ipv6/
- The Bermuda Project
  http://www.ipv6.ac.uk/bermuda2

Appendix: JANET IPv6 History

In May 1997, UKERNA connected to the global 6bone IPv6 experimental network and obtained 6bone test IPv6 address space for use by JANET sites. The 6bone was an overlay network, tunnelling IPv6 packets over the IPv4 Internet, which operated in an informal co-operative way between interested networks and equipment vendors. Several JANET sites, or departments within sites, established tunnels to the 6bone via the JANET router, giving them very early experience of IPv6.

In 1999, UKERNA made an application to the RIPE NCC for a /32 prefix for JANET in order to carry out experimental work in the IPv6 area, and also to allow Regional Networks and JANET-connected organisations to be allocated globally recognised IPv6 address space so that they can in turn carry out any IPv6 related activities. The allocation to Regional Networks and JANET sites was a /48 prefix which allows a potential 65,000 subnets.

IPv6 technology trials were carried out as part of the Bermuda Project, led by the University of Southampton, the University of Lancaster and University College London. In 2001, UKERNA participated in the three-year European Commission-funded 6NET project, which was led by Cisco®. In parallel, a JANET IPv6 experimental service was established where JANET-connected organisations could formally apply for IPv6 address space for their organisation and experiment with IPv6/IPv4 tunnels.

In 2003 UKERNA initiated a comprehensive programme to deploy dual-stack, supporting both IPv4 and IPv6 connectivity, on the JANET core. This was completed successfully within a short timescale. The pan-European network GÉANT and other national research networks have taken a similar approach and currently support dual-stack IPv4/IPv6 on their networks.

After many years of operation, the 6bone was formally shut down on 6 June 2006. By this time, JANET's IPv6 interconnectivity and experience had improved drastically.

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UKERNA manages the networking programme on behalf of the higher and further education and research community in the United Kingdom. JANET, the United Kingdom's academic and research network, is funded by the Joint Information Systems Committee (JISC).

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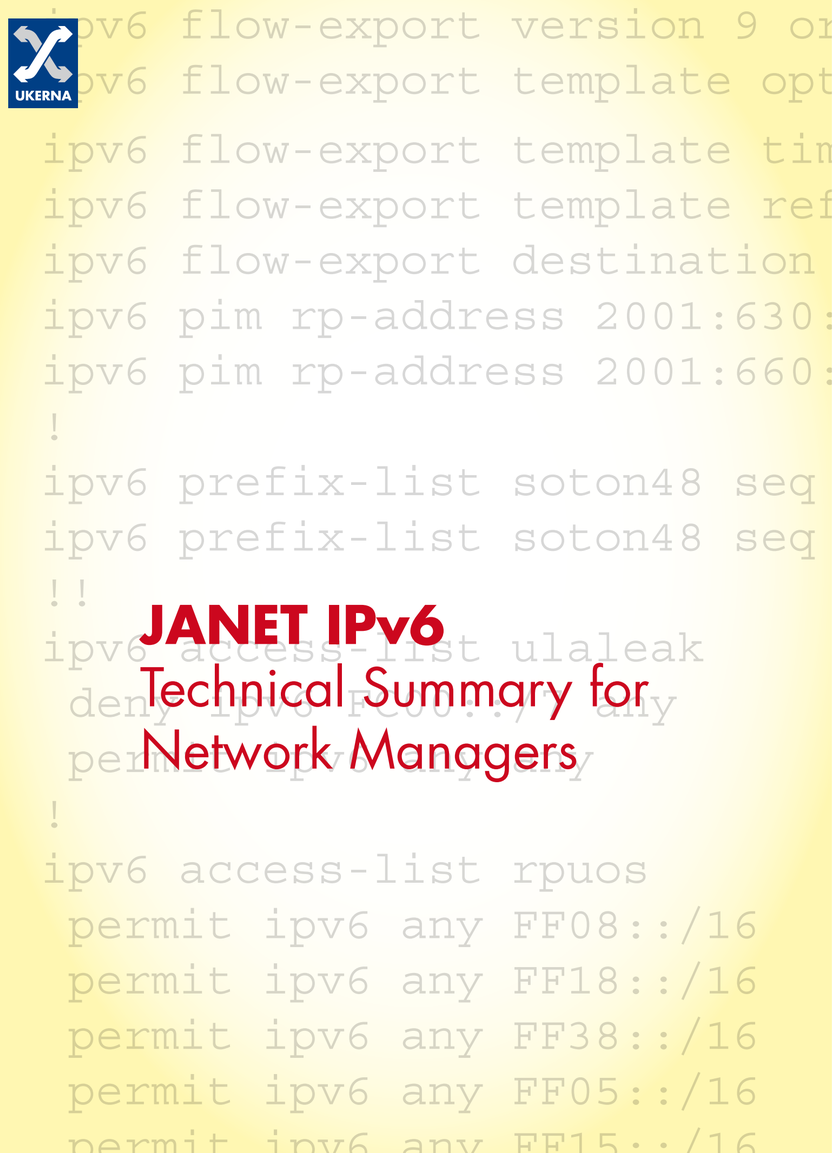

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JANET IPv6
Technical Summary for Network Managers