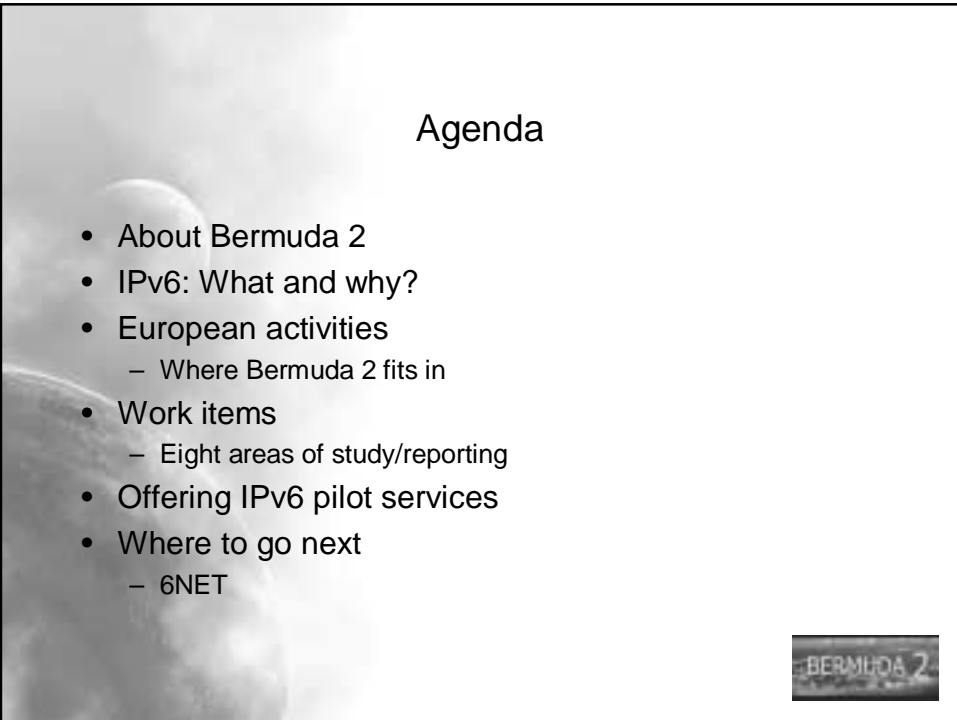



Bermuda 2: an IPv6 deployment study


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Agenda

- About Bermuda 2
- IPv6: What and why?
- European activities
 - Where Bermuda 2 fits in
- Work items
 - Eight areas of study/reporting
- Offering IPv6 pilot services
- Where to go next
 - 6NET



About Bermuda 2

- A one-year project
 - Funding ends 31st October 2001
 - Managed by UKERNA, funded by the JISC
- Southampton, UCL, Lancaster
 - Half a person each
- Includes collaboration with Internet 2
 - But also GÉANT (Europe), WIDE (Japan) and BT
- Eight work items
 - Not offering answers and solutions to all questions
- Recommendations for deployment
 - And further study



What is IPv6?

- Next version of Internet Protocol
 - IPv6 addresses are 128-bit, IPv4 has 32-bit, *allowing more devices to be globally addressable*
 - Aggregated address allocation from day one, *reducing the number of route entries* on the Internet backbone
 - Improved support for Mobile IPv6, which is now required for 3G implementations
 - Streamlined but extensible IPv6 header, including 8-bit type of service and 20-bit flow label fields
 - Offers some mechanisms for *autoconfiguration* (plug and play, ad-hoc networking) and network renumbering
- Key feature is *scalability*



Why run IPv6 pilots?

- Deployment momentum is growing
 - 3G mobile community has *adopted IPv6 for 3GPP Release 5*
 - Growth of “*always on*”, globally addressable IP devices
 - *Peer-to-peer computing*
 - e.g. ICQ, Napster, video/VoIP (H.323), unified messaging
 - Home network appliances, pervasive computing devices
 - GRID computing, e.g. Globus toolkit
- European Commission wants IPv6 deployed
 - Attempt to keep pace with Japanese initiatives
 - Has led to the formation of the EU IPv6 Task Force
 - GÉANT academic network is *mandated to introduce IPv6*



Do we really need IPv6?

- Do UK Universities have sufficient IPv4 addresses?
 - Sites beginning to run Network Address Translation (NAT)
 - *NAT will cause problems* for peer-to-peer applications
 - NAT is “OK” when running client-server
 - IP subnets limited at the University Department level
 - Trend to more IP-enabled devices per person
 - Project servers, clusters, laptops, handhelds,...
 - New Eastern European countries have IPv4 shortage
 - These are becoming part of the GÉANT community



Deploying IPv6...

- All we need to do is...
 - Develop new stacks and (commercial) support for hosts (OS software and APIs) and routers (in hardware)
 - Check standards compliance and interoperability for and between IPv6 systems
 - Devise methods for IPv4 and IPv6 systems to co-exist and communicate with each other
 - Port and update everything needed for day-to-day use by end users, network operators, remote access,
- And then we might...
 - ...*enable and evolve innovative new applications*



IPv6 status

- Standards and implementation development:
- IETF
 - ipng, ngtrans, multi6, dnsex, mobileip, zeroconf, dhc, ...
- Hosts:
 - Solaris 8, Windows 2000/XP, FreeBSD, Linux, Tru64, ...
- Routers:
 - Cisco, Hitachi, Juniper, 3Com, Ericsson Telebit, FreeBSD,...
- Applications:
 - Apache 2, BIND 9, Sendmail 8.10, OpenLDAP...
 - Java JDK1.4 has (limited) IPv6 support



European academic IPv6 initiatives

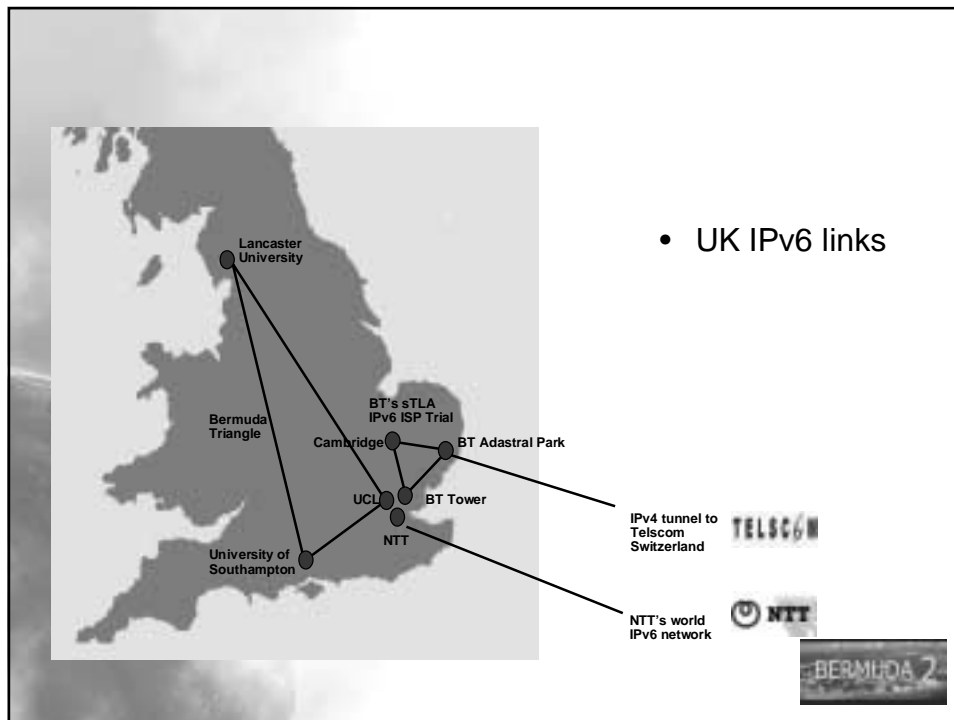
- Happening at three levels
- European Commission funded projects
 - 6INIT, 6WINIT (Fifth Framework IST projects)
 - WINE, BRAIN, Armstrong, LONG, NGNI, ...
- NREN projects, for example:
 - JOIN project (DFN, Germany)
 - Bermuda 2 project (UKERNA, UK)
- Inter-NREN IPv6 projects
 - GÉANT IPv6 Test Programme: GTPv6 (Nov'2000 onwards)
 - 6NET (from January 2002)



Bermuda 2 work items

- Network deployment (initially over ATM PVCs)
- Network management, monitoring and addressing
- Transition methods (site and NREN)
- Quality of service
- Security (X-Bone style network overlays)
- Wireless LANs
- Policies (QoS and security)
- Web resources, HOWTOs, sample configs, etc...
- An exit strategy...





Management and DNS

- Management and monitoring tools
 - Traffic flow measurement, reachability, response times
 - Desire to understand the applications being used
 - *Monitor applications as well as the network*
 - We will need SNMP for IPv6
- DNS
 - Use of AAAA or A6 records instead of IPv4's A records
 - IETF appears to be moving A6 to experimental status
 - Using IPv6 transport DNS (available in BIND9)
 - Currently no IPv6 transport root name server(s)
 - No ability to register domain names with IPv6 DNS IPs



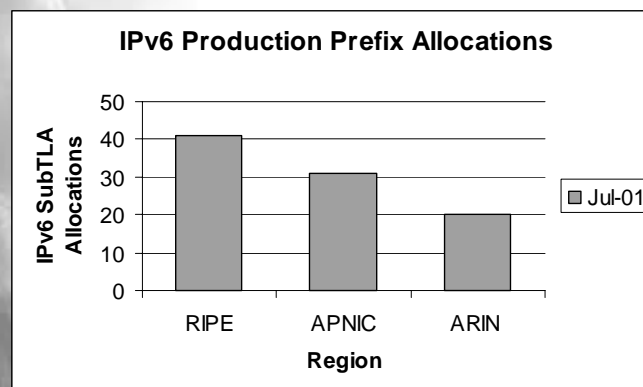
IPv6 production address space

- Top level address space under 2001::/16
 - APNIC 31, ARIN 21, RIPE 41 as of July 2001
 - See <http://www.ripe.net/cgi-bin/ipv6allocs>
 - IPv6 looks like 2001:0630:1fff:0080:dead:beef:baad:café
 - Usually has 8 byte network part, 8 byte host part
- European NRENs with SubTLAs include:

• CH-SWITCH-19990903	2001:0620::/35
• AT-ACONET-19990920	2001:0628::/35
• UK-JANET-19991019	2001:0630::/35
• DE-DFN-19991102	2001:0638::/35



IPv6 SubTLA allocations, July 2001



Addressing issues

- *Common policy* agreed by ARIN, APNIC and RIPE
- End sites to get a /48 allocation
 - But *what is an end site?*
 - A student household? A university?
 - What is best practice for end site address allocation?
- How should an NREN allocate addresses?
 - *Is a /35 enough for JANET?* This is a slow start method...
 - Should a /29 be allocated from the outset? Or /28? /24?
- No real hard experience of these issues yet
 - Required for production JANET deployment



QoS-enabling applications

- IPv6 IP header has
 - Type/Class of Service field: geared to DiffServ
 - Flow label field: identifies unique flows (IntServ oriented)
 - Definition of *flow label use is a hot IETF topic*
- Modifying existing IPv6-enabled software
 - *UCL videoconferencing tools (vic/rat) are IPv6-enabled*
 - In unicast or multicast mode
 - UCL is adding packet marking for the IPv6 Type of Service field
- Operate over network supporting DiffServ
 - e.g. FreeBSD 4.3 with IPv6 ALTQ methods
 - *Can't trial to US* because no native IPv6 link or available Expedited Forwarding for IPv6-in-IPv4 traffic.





Transition tools study

- There are many tools for IPv6-IPv4 interworking
 - *At backbone/NREN:*
 - IPv6-in-IPv4 tunnels, 6to4, IPv6 over MPLS, tunnel brokers,...
 - *At end sites:*
 - NAT/PT, 6over4, ISATAP, ALGs, DSTM, dual stack,...
- No “best tool” for all environments
- We are running some of the tools within the Bermuda network:
 - NAT-PT
 - Application layer gateways (web cache, SMTP, irc,...)
 - IPv6 tunnel broker
- Theoretical study of other tools

BERMUDA 2

Wireless IPv6

- Becoming highly popular
 - *May steal some of the 3G thunder* both in metropolitan areas, airport lounges and home network access (*ADSL+802.11b to the neighbourhood*)
- Focus of Bermuda wireless study is wireless LANs
 - Running Orinoco 802.11b access points (up to 11Mbit/s)
 - “It just works”
 - Run IPv6 on hosts (laptops) with 802.11b cards
 - *Can run IPv6 on an iPAQ* (e.g. Familiar Linux distribution)
- Desire smooth, fast handoff between access media
 - Includes consideration of billing and bandwidth changes
 - Campus roaming



Mobile (and ad-ho) IPv6 networking

- Interesting area is mobility within network
 - Can run a *routed* or a *flat IPv6 network* for wireless access
 - If routed, need to detect movement between IPv6 subnets
 - Desirable to be addressable via home address (and domain)
- IPv6 has improved mobility support
 - Ability to autoconfigure in remote network
 - Improved direct communication to mobile node
 - But *authentication of binding update* is an issue
 - As is (location) privacy if privacy extensions not used
 - Useful in ad-hoc networking environment
 - Where two “mobile” users are in the same room
 - Desire *service location protocols*, and zeroconf



Bermuda 2 collaborations

- Have some Internet 2 contacts and links
 - e.g. ISI, CRC, NASA, SLAC.
- Still seeking new collaborations
 - For *native IPv6 network connectivity and peerings*
 - To share experiences in particular areas of study
 - Will present at the Internet 2 Fall Meeting in Austin, 1-5 Oct.
- Building other international relationships
 - e.g. *45 Mbit/s IPv6-only link from UCL to Japan (WIDE)*
 - Built on ATM connectivity – lifetime limited
 - Used for IPv6 videoconferencing



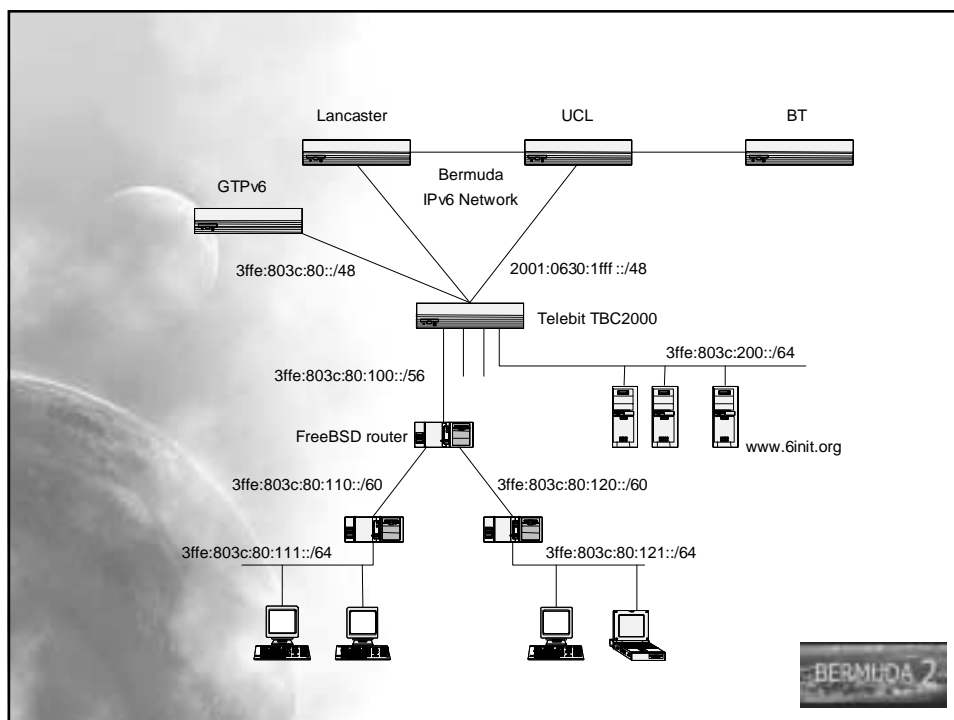
ISI and X-Bone

- UCL working closely with ISI
- Has X-Bone virtual network overlay tools for IPv4
 - Active networking components
 - Downloaded and enabled on demand
- Porting to IPv6
 - Need IPv6 Perl
 - Need IPv6 anycast and multicast to be used
 - Problems with virtual interfaces with KAME (FreeBSD)
 - *No native IPv6 link to Internet 2*
- Need to identify missing IPv6 components
 - ... a general requirement in all areas



IPv6 deployment at Southampton

- Running IPv6 since December 1996
 - Native (X.21) connectivity to UUNet since July 1997
- Host platforms
 - Solaris 8, Win2K Tech Preview, Windows XP, FreeBSD 4.3, Redhat Linux 6.2+, SuSE 7.1+, Compaq Tru64 5.1
- Router Platforms
 - Cisco IOS12.x, Ericsson Telebit TBC2000, FreeBSD 4.3, Zebra, 3Com NetBuilder II
- IPv6 “native” connectivity
 - Bermuda 2 and GTPv6 (ATM PVC)
- Using protocol-based VLANs to switch IPv6 to desktop
 - IPv6 routing done off the IPv4 network

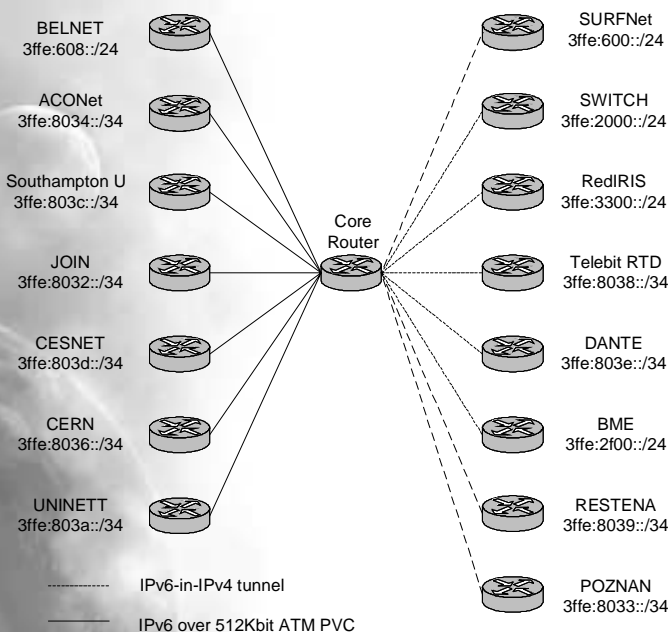


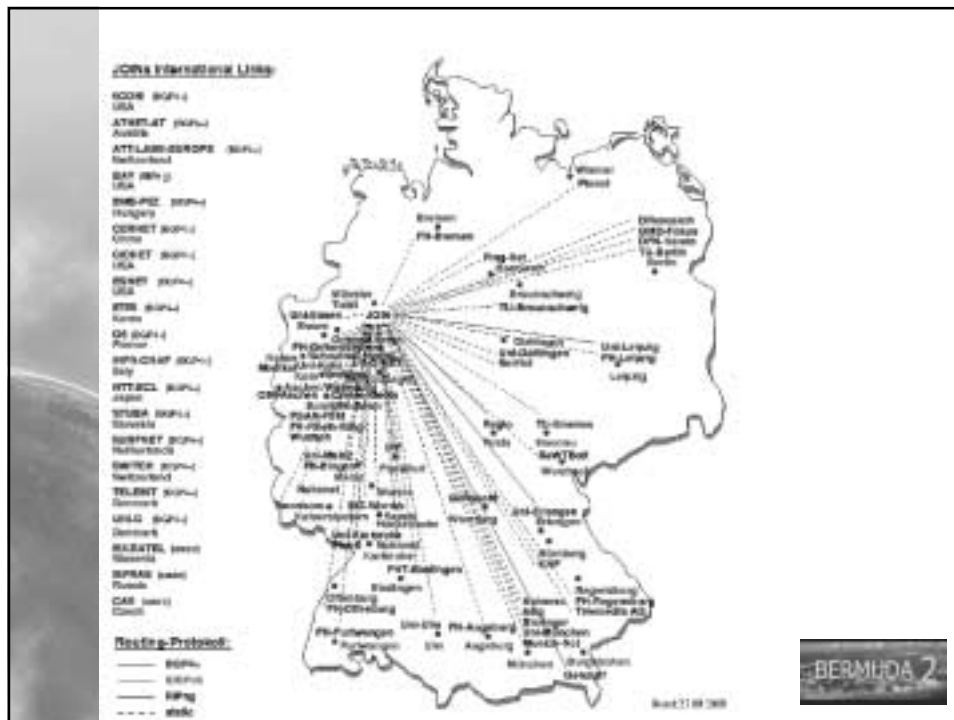
GÉANT

- Successor to QUANTUM
 - Project and planning commenced November 2000
- Pan-European academic backbone
 - Initial connections 2.5 to 10 Gbit/s
 - *Will go live in November 2001*
 - Inclusion of Eastern European nations (with limited IPv4 space)
 - *Will not be ATM, thus PVCs cannot be used for “native” IPv6.*
- Includes TF-NGN activity
 - Task Force for Next Generation Networks
 - One Working Group is IPv6
 - *GÉANT IPv6 Test Programme: GTPv6*



GTPv6 Network, July 2001

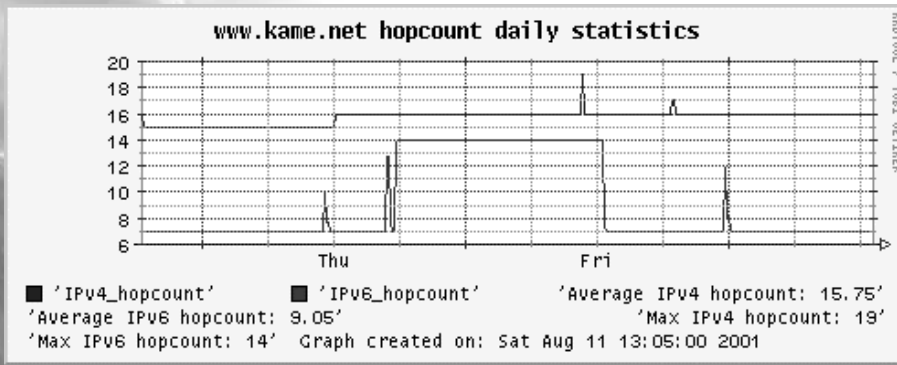




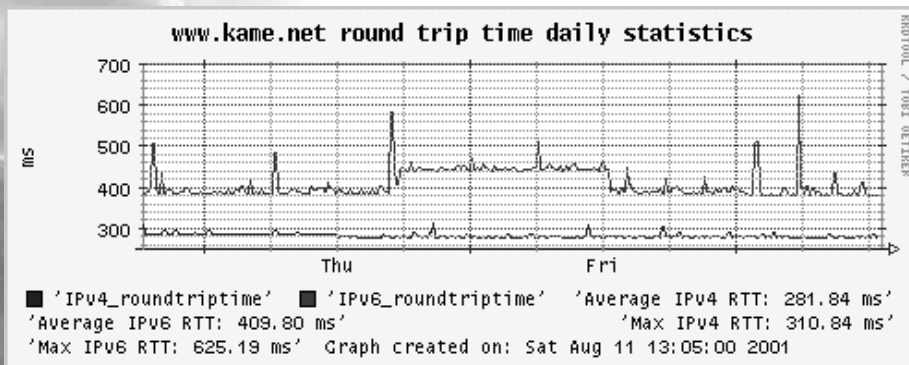
Network monitoring

- Network monitoring
 - Link utilisation visualisation via MRTG
 - Visual autonomous system (AS) path info (AS path-tree)
 - IPv6 looking glasses (viewing your site remotely)
 - IPv6 reachability (e.g. ping6)
 - Traffic routing information tool: trout6:
<http://tipster6.ik.bme.hu/trout6/>
 - Monitor applications, relate to user experiences
 - Investigating building an IPv6 version of the RIPE Test Traffic servers that use IP Performance Metrics (IPPM) to measure one-way network performance

Trout6: hops to www.kame.net



...and RTT stats:



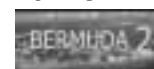
Bermuda 2 next steps

- UKERNA position statement on IPv6
 - *Align with GÉANT position*
 - Offer (embracing) pilot service to UK universities
 - *Peering and native link to Internet 2 (6TAP)*
- Expansion of Internet 2 collaboration
- Link to and collaboration with WIDE
- E-Science linkage
 - Managed Bandwidth Next Generation (MPLS, UTI)
 - GRID Network Team (GNT)
- 6NET, and collaboration with Euro6IX



Connectivity for UK universities

- Desirable to
 - Encourage *hierarchical connectivity/addressing*
 - rather than each university getting its own 6bone connections
 - Set up appropriate *IPv6 router(s) infrastructure*
 - Use UKERNA's *production IPv6 prefix*
 - Offer various transition methods to universities
 - e.g. manual tunnels, 6to4, tunnel broker
 - Offer open network monitoring
 - Pass on Bermuda 2 lessons learnt to wider community
 - Offer IPv6 *workshops and training* as per Internet 2 IPv6 WG



But.... when a full service?

- Production service requires commercial IPv6 code
 - Stable, reliable, *hardware-enabled*, well-understood
 - And with associated management/policy/addressing
- On backbone, native IPv6 possible in 12-18 months
 - Research networks should be keen to lead
 - But are increasingly market-driven & service-oriented
 - Run *dual-stack routers, IPv4 and Ipv6 on same links*
 - Less demand where IPv4 address space perceived as sufficient
- Desirable to seed IPv6 activity
 - But *need day-to-day use to be possible for end users*
 - Full Microsoft support in applications may be 2-4 years



6NET: a Pan-European IPv6 initiative

- A Fifth Framework proposal, ~20M Euros
 - Features Cisco, DANTE, TERENA, ~10 NRENs (including *UKERNA*), many universities, IBM and Sony, *all Bermuda partners*
 - A 3-year project, considering wide range of aspects of deployment, management and transition
 - Provides resources to build on the previous GTPv6 work
 - Initially nine 155Mbit/s native IPv6 SDH links
 - Expansion to native 2.5Gbit/s in year 2
 - Aiming for *full production quality*, academic-purposed
 - Inclusion of mobility, IPsec, multicast, and GRID aspects
 - If EC negotiations successful, starts January 2002
 - Parallel commercial (ISP) project: Euro6IX



Sites to visit for more info...

- Bermuda 2: www.ipv6.ac.uk/bermuda2
- GTPv6 (GÉANT): www.ipv6.ac.uk/gtpv6
- UoS IPv6: www.ipv6.ecs.soton.ac.uk
- UK IPv6 sites: www.ipv6.org.uk
- IPv6 Forum: www.ipv6forum.com
- European IPv6 Task Force: www.ipv6tf.org
- GÉANT: www.dante.org.uk/geant

