

IPv6 on UK and European Academic Networks: Bermuda 2 and GTPv6

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IPv6: Bermuda 2 and GEANT



Today's talk

- Overview IPv6 status and drivers
- Where Bermuda 2 fits in to European initiatives
- 6INIT
- Bermuda 2
- GEANT: GTPv6
- Deployment
- Work item descriptions
- Where next?

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Why run IPv6 trial/services?

- European Commission wants IPv6 deployed
 - Attempt to keep pace with Internet 2 and Japanese initiatives
- National Research Networks (NRNs) want experience
 - To be better prepared for production deployment
 - To be seen to be leading and assisting research activities
 - In UK, there are 5,000,000 people in higher education (10%)
- End-site research uses IPv6
 - So desirable to carry traffic over academic network backbones

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IPv6 status

- Deployment momentum is growing
 - 3G mobile community need to adopt IPv6
 - Growing number of "always on", globally addressable IP devices
 - Peer-to-peer computing, e.g. ICQ, Napster, video/VoIP
 - Home networking appliances, pervasive computing devices
- Standards and implementations hardening
 - IETF ipng, ngrans, multi6
 - Host: Solaris 8, Windows 2000, FreeBSD, Linux, ...
 - Router: Cisco, Hitachi, 3Com, Ericsson Telebit, FreeBSD, ...
 - Applications: Apache, Sendmail, OpenLDAP, ... Java...

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Do we want IPv6?

- UK Universities have adequate IPv4 addresses
 - But some sites run NAT
 - IP subnets limited at the University Department level
 - New Eastern European countries have IPv4 shortage
- IPv4 does everything already
 - But it is “patched” heavily, and reliant on NAT/etc.
 - IPv6 offers a scalable solution
 - Cost of migration/integration is a big issue

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EU academic IPv6 initiatives

- Happening at three levels
- European Commission funded projects
 - 6INIT, 6WIND
 - WINE, BRAIN, Armstrong, LONG, NGNI, ...
- National Research Network (NRN) IPv6 projects:
 - JOIN (DFN, Germany)
 - Bermuda 2 (UKERNA, UK)
- Inter-NRN IPv6 projects
 - Quantum IPv6 Test Programme: QTPv6 (up to Oct'2000)
 - GEANT IPv6 Test Programme: GTPv6 (Nov'2000 onwards)

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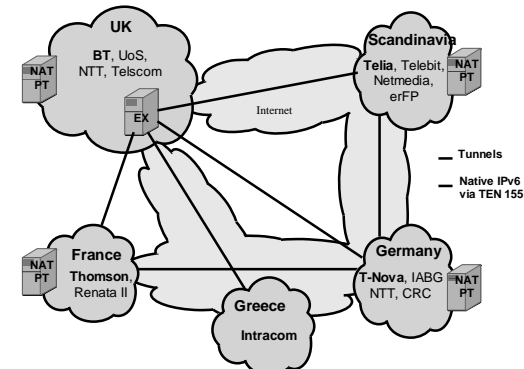


6INIT



- EU 5th Framework Project, ~ 4.5M euros, 16 months
- 12 partners including BT, Berkcom, 6WIND, Ericsson, Telebit, Telscom, Telia, Netmedia, Intracom, er, UoS
- Focus on deployment of pan-European IPv6 testbed
 - Five interconnected national clusters
- Study and deploy transition tools
 - Using NAT-PT, SIP ALG
- Develop and port multimedia applications
 - Includes VoIP, online stock trading, videoconferencing, news-on-demand, streamed audio, agent communications.

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Management and DNS

- Management and monitoring tools
 - SNMP
 - Traffic flow measurement
 - Understand applications being used
- DNS
 - Look up IPv6 IP addresses via AAAA or A6 records instead of A records
 - Need IPv6 transport DNS (available in BIND9)
 - Need IPv6 root name server(s)
 - Ability to register domain names with IPv6 DNS IPs

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IPv6 production address space

- Top level address space under 2001::/16
 - APNIC 26, ARIN 14, RIPE 28
 - See <http://www.dfn.de/service/ipv6/ipv6aggis.html>
- European entries include academic NRNs, including:
 - CH-SWITCH-19990903 2001:0620::/35
 - AT-ACONET-19990920 2001:0628::/35
 - UK-JANET-19991019 2001:0630::/35
 - DE-DFN-19991102 2001:0638::/35
 - NL-SURFNET-19990819 2001:0610::/35
 - FR-RENATER-20000321 2001:0660::/35

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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?
- How should an NRN allocate addresses?
 - Is a /35 enough?
 - Should a /29 be allocated from the outset?
- No real hard experience of these issues yet
 - Required for production JANET deployment

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QoS-enabling applications

- IPv6 IP header has
 - Type/Class of Service field: geared to DiffServ
 - Flow label field: geared to IntServ
- Modify existing IPv6 software
 - UCL vic/rat tools already work with IPv6
 - Add packet classifying for ToS field
- Operate over network supporting DiffServ
 - e.g. FreeBSD 4.2 with IPv6 ALTQ

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Transition tools study

- Many tools for IPv6-IPv4 interworking
 - e.g. NAT/PT, 6to4, DSTM, IPv6-in-IPv4, dual stack,...
- No “best tool” for all environments
- Trial the tools
 - NAT-PT
 - IPv6 tunnel broker
- Theoretical study of other tools

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IPv6 IPsec

- In theory IPv6 mandates Ipsec
 - AH and ESP headers
- In practice, implementations limited:
 - FreeBSD 4.2 with Racoon daemon
 - FreeS/WAN for Linux
- Trial both methods
 - Consider performance issues
 - Key-sharing methods important – same IPv4 problems

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Wireless IPv6

- 3G is a significant driver for IPv6
 - Mobile device needs home and care-of IP address
- Focus of Bermuda study is wireless LAN
 - Run Orinoco 802.11b access points
 - Run IPv6 on hosts (laptops) with 802.11b cards
 - “It just works” – but access point management by IPv4
- Handoff from fixed to wireless network
 - Includes consideration of bandwidth changes

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Mobility...

- Interesting area is mobility within network
 - Run access points on routed, not flat, IPv6 network
 - Need to detect movement between IPv6 subnets
 - Need smooth handoff
 - Desirable to be addressable via home domain name
- IPv6 has strong mobility support
 - Option to autoconfigure in remote network
 - Improved direct communication to mobile node.
 - Useful in ad-hoc networking environment

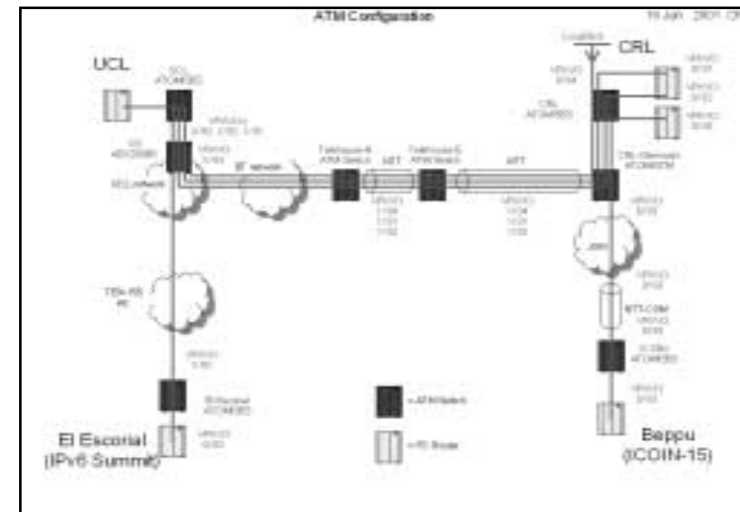
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Bermuda 2 collaborations

- Have some Internet 2 contacts and links
 - e.g. ISI, CRC, some PVCs from UCL to US/Canada.
- Seeking new collaborations
 - For IPv6 network connectivity
 - To share experiences in particular areas of study
 - Attended and presented at Internet 2 Spring Meeting
- Building other international relationships
 - E.g. 45 Mbit/s IPv6 link from UCL to Japan
 - Built on ATM connectivity – lifetime limited
 - Used for videoconference session at Spanish IPv6 Forum meeting

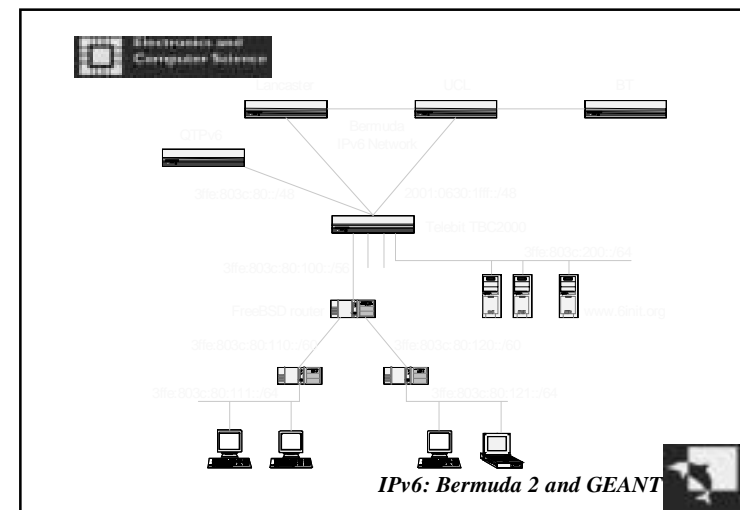
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IPv6 deployment at Southampton

- Host platforms
 - Solaris 8, Win2K Tech Preview, FreeBSD 3.5/4.2, Redhat Linux 6.2, Compaq Tru64 5.1
- Router Platforms
 - Cisco IOS12.x, Ericsson Telebit TBC2000, FreeBSD 3.5/4.2, Zebra, 3Com NetBuilder II
- IPv6 Connectivity
 - Bermuda 2, GTPv6, UUNet UK

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6INIT/Bermuda activities

- New multimedia applications
 - MP3 audio “jukebox” multicast IPv6 streaming software, “cradio”
 - Linux IPv6 audio device driver, used for MIDI
- Deploying core services
 - IPv6 firewall (FreeBSD IP filter)
 - E-mail transport/access (sendmail, fetchmail)
 - Web applications (Mozilla, MS IE5, Apache)
- Local network
 - External native IPv6 connection via Telebit TBC2000
 - Internal unicast/multicast routing on FreeBSD 3.5 PC routers
 - Linux, Windows 2000, Solaris 8, FreeBSD 3.5 IPv6 clients

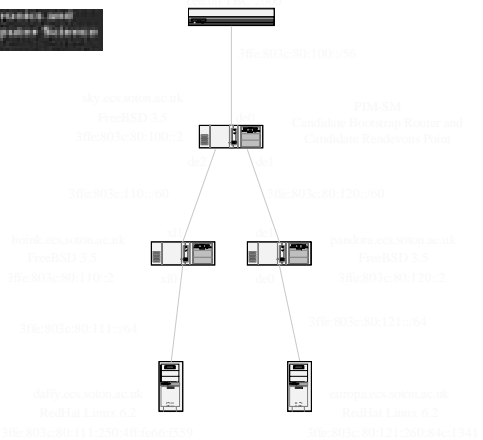
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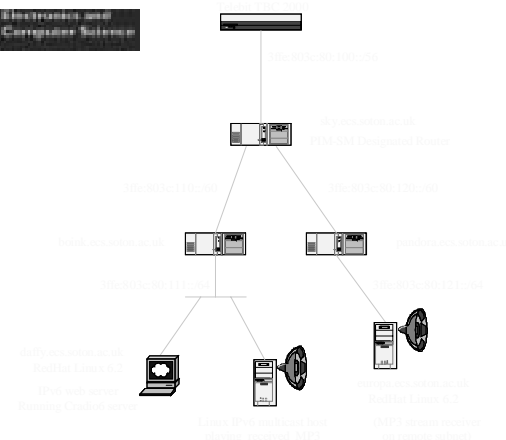
IPv6 multicast

- Protocol Independent Multicast (PIM)
 - FreeBSD (KAME) has IPv6 implementation
 - Run in Sparse Mode (PIM-SM)
- Deployed network of FreeBSD routers
 - Testing PIM-SM in hierarchical network topology
 - Will progress to more “interesting” topologies
 - Using vic, rat, and own multicast applications

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Short-term plans

- IPv6 offered to all IPv4 VNETs demanding it
 - Investigate / trial IPv6 network monitoring tools
- Teaching clusters
 - Win2K / Linux, offering IPv6 for courses
- Research
 - Areas where IPv6 offers new methods
 - Mobility, ad hoc networks, pervasive, gunk...
 - Java 1.4 IPv6 SDK beta very near release
 - Promote use

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Longer term plans

- Need understanding of “what’s missing” in IPv6
 - Includes operational features
 - e.g. root IPv6 name server, full SNMP.
- Need end users to run native IPv6
 - Requires day-to-day tools to use IPv6
 - May be on an IPv6 “island” accessing IPv4 networks via a transition tool like NAT-PT
- Need to seed activity via backbone deployment
 - Happening at European/NRN level

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GEANT

- Successor to QUANTUM
 - Commenced November 2000
- Pan-European academic backbone
 - Initial connections 2.5Gbit
 - Inclusion of Eastern European nations (with limited IPv4 space)
 - Will not be ATM, thus PVCs cannot be used for “native” IPv6.
- Includes TF-NGN working group
 - Task Force for Next Generation Networks
- <http://www.dante.org.uk/geant/>

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GEANT IPv6 Working Group

- Gathering of European NRNs
- Hold “TF-NGN” meetings 4-5 times a year
 - <http://www.dante.org.uk/tf-ngn/>
- Includes TF-NGN technology study groups, e.g.
 - IP Premium
 - IP Multicast
 - Network Monitoring
 - IPv6

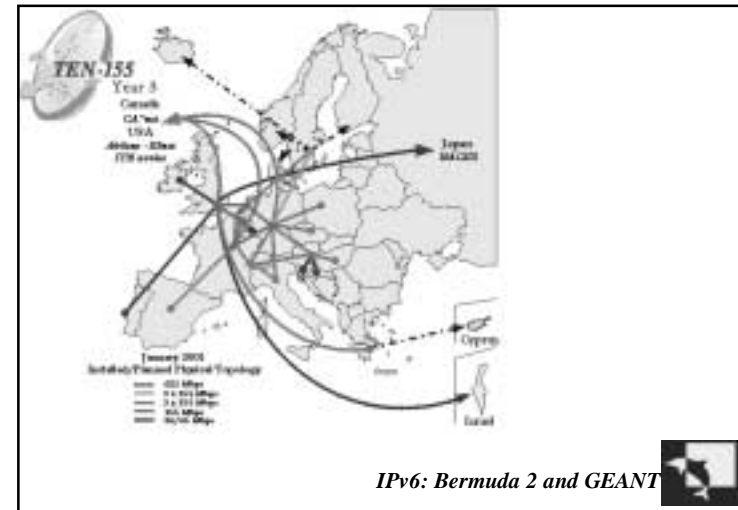
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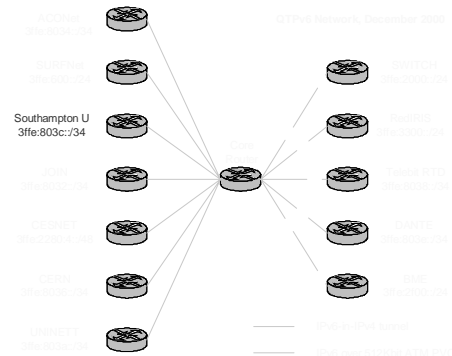
Previous work under QTPv6

- Single core router, star topology, 12 participants
 - Mixture of low-specification Cisco and Telebit routers
- Native 512Kbit ATM PVCs or IPv6-in-IPv4 tunnels
 - Using managed bandwidth service (MBS)
- A /48 address space allocated from QTPv6 prefix
- BGP4+ use for routing
- Areas of study (set in 1998):
 - interoperability, DNS, multihoming, applications
- Initial network gave useful IPv6 insight

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GEANT Test Programme GTPv6

- Understand deployment issues
 - Routing, DNS, registries, address allocation, ...
- Gain operational experience of IPv4/IPv6 backbone
- Insight into IPv6 impact down to site level
- Deployment of “production quality” IPv6 network
- Encourage additional NRN and site participation
- Seek collaborations with other networks/projects
- Study primary and secondary work items
 - 8 work item leaders from around Europe, report July & Oct 2001

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GTPv6 Work Items

- **Primary:**
 - Platforms, Routing and Interoperability (JOIN)
 - Addressing and registries (ACONET)
 - DNS (DANTE)
 - Transition tools (UNINETT)
 - Applications (UKERNA)
- **Secondary:**
 - Network monitoring (SWITCH)
 - IPv6 multicast (UKERNA)
 - Multihoming
 - Firewalls (BME)
 - IPsec (RESTENA)
 - Wireless access

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GTPv6 characteristics (vs QTPv6)

- More “realistic” topology, but not full mesh
 - Focus on 7-8 main participant sites
- Acquire high specification routers
 - Seek to obtain and use a variety of higher-end equipment
- Initial connections most likely to be tunnelled
- Use RIPE production address space under 2001::/16
 - But not mandated
- Use BGP4+ for routing
- Encourage use of applications
- Promote use by and within NRNs

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Inter-NRN IPv6 network

- Too early to run IPv6 on production routers
 - Cisco commercial code is close
- Use IPv6-purposed routers on “parallel” infrastructure
 - Likely to co-locate with GEANT backbone routers
- Should links be native or tunnelled?
 - Native is more interesting, but may be relatively low bandwidth
 - May get “test” infrastructure (E3) as part of GEANT procurement
- Should tunnels be manually configured or 6to4?
 - Manual tunnels can give some “structure” to the network
 - 6to4 can leverage existing IPv4 routing

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Connectivity to end-users

- To NRNs outside GTPv6 core participants
 - Most likely to be tunnelled for short term
 - Many links may be tunnelled for medium term
- Within NRNs
 - Most European NRNs are removing ATM, e.g. SuperJANET4
 - So will likely use tunnels
- To end-user
 - If no native or other link to site, use tunnel broker (eg.freenet6.net)
 - But broker reduces pressure on site administrator
 - Also requires a firewall “hole” to work (protocol 41, IP in IP)

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Some other current issues

- Native IPv6 after removal of ATM PVCs
 - But how “native” is/was IPv6 over ATM? Run MPLS?
- Native or tunnelled?
 - Do we want performance now, or experience for the future?
 - Native connectivity is a small part of the big picture.
- DNS issues
 - Is A6 the way to go?
- Support in end-user applications
 - What are the new “killer” IPv6 applications? Peer-to-peer?
 - How can porting be encouraged, and integrated officially?
- What are the viable transition scenarios?

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But.... when?

- Production service requires commercial code
 - Stable, reliable, hardware-enabled, well-understood
 - And with associated management/policy/addressing
- Backbone, native IPv6 possible in 12-18 months
 - Research networks should be keen to lead
 - But are increasingly market-driven & service-oriented
 - Less demand where IPv4 address space perceived as sufficient
- Need 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

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Summary

- Many European IPv6 initiatives
 - At inter-NRN level: GTPv6 as part of GEANT
 - At NRN level: e.g. Bermuda 2 (UKERNA), JOIN (DFN)
 - Funded by the Commission, e.g. 6INIT, 6WINIT, WINE,...
- UKERNA supporting IPv6 studies
- Many studying similar issues
 - But the more operational experience, the better
- Internet 2 collaboration highly desirable
 - Establish network link, share experiences

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What can I do?

- Start running IPv6 on host/router systems
 - Cisco/FreeBSD/Solaris/Win2K good places to start
- Get IPv6 connectivity
 - Tunnel to Bermuda, or 6bone, or GTPv6
 - Or tunnel broker, e.g. to www.freenet6.net
- Check web resources
- Join JISCMail mailing list (and others...)
 - ipv6-users@jiscmail.ac.uk

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Sites to visit

- Bermuda 2 (UKERNA)
 - <http://www.ipv6.ac.uk/bermuda2/>
- GTPv6 (GEANT)
 - <http://www.ipv6.ac.uk/gtpv6/>
- University of Southampton
 - <http://www.ipv6.ecs.soton.ac.uk/>
- UK IPv6 sites
 - <http://www.ipv6.org.uk/>

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