



# **IPv6 on European Academic Networks: GEANT, Bermuda 2**

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(see <http://www.ipv6.ac.uk/gtpv6/> for slides)

# 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

# IPv6 status

- Deployment momentum is growing
  - 3G mobile community adopting 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, ngtrans
  - Host: Solaris 8, Windows 2000, FreeBSD, Linux, ...
  - Router: Cisco, Hitachi, 3Com, Ericsson Telebit, FreeBSD,...
  - Applications: apache, sendmail, openldap, ... Java...

# 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 to the limit
  - IPv6 offers a scalable solution, e.g. via aggregated addressing
  - Cost of migration/integration is a big issue

# European academic IPv6 initiatives

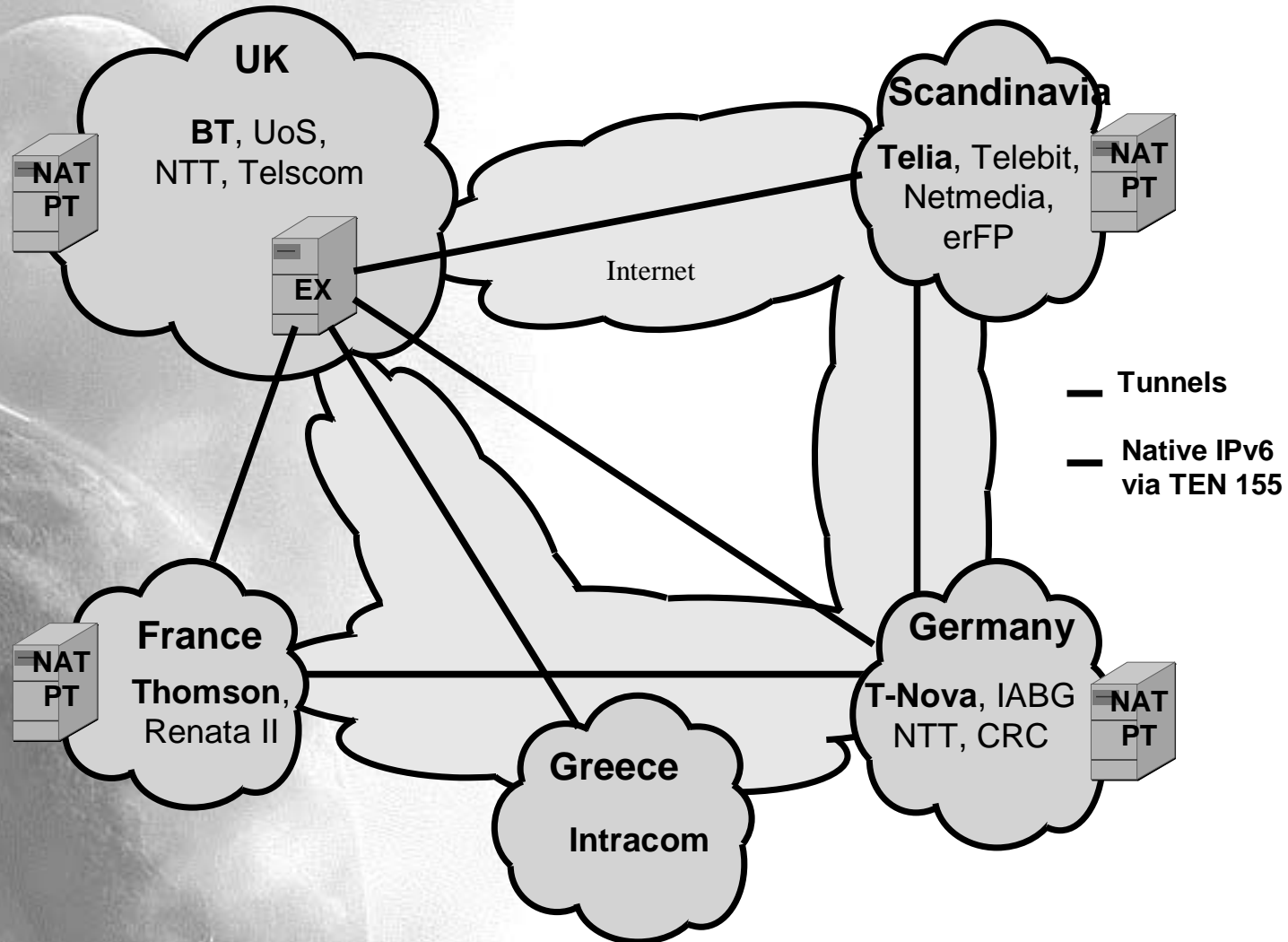
- Happening at three levels
- European Commission funded projects
  - 6INIT, 6WINIT
  - WINE, BRAIN, Armstrong, LONG, NGNI, ...
- National Research Network (NRN) IPv6 projects:
  - JOIN (DFN, Germany)
  - Bermuda 2 (UKERNA, UK)
- Inter-NRN IPv6 projects
  - Quantum IPv6 Test Programme: QTPv6 (up to Oct'2000)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



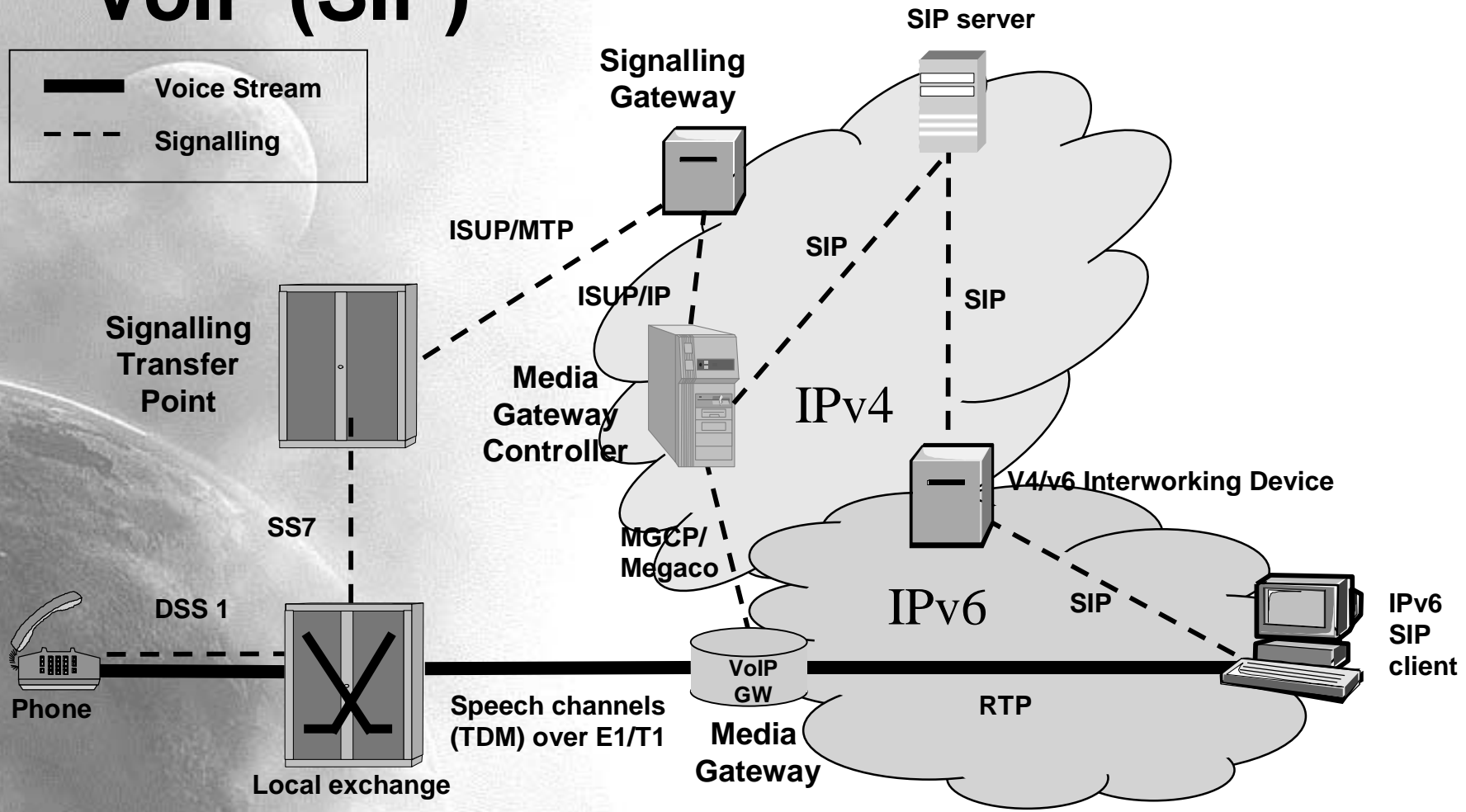
# 6INIT

- EU 5<sup>th</sup> Framework Project, ~ 4.5M euros, 16 months
- 12 partners including BT, Berkom, 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.

# 6INIT clusters

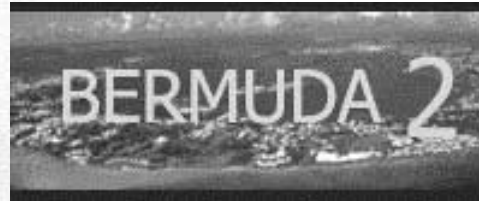


# VoIP (SIP)



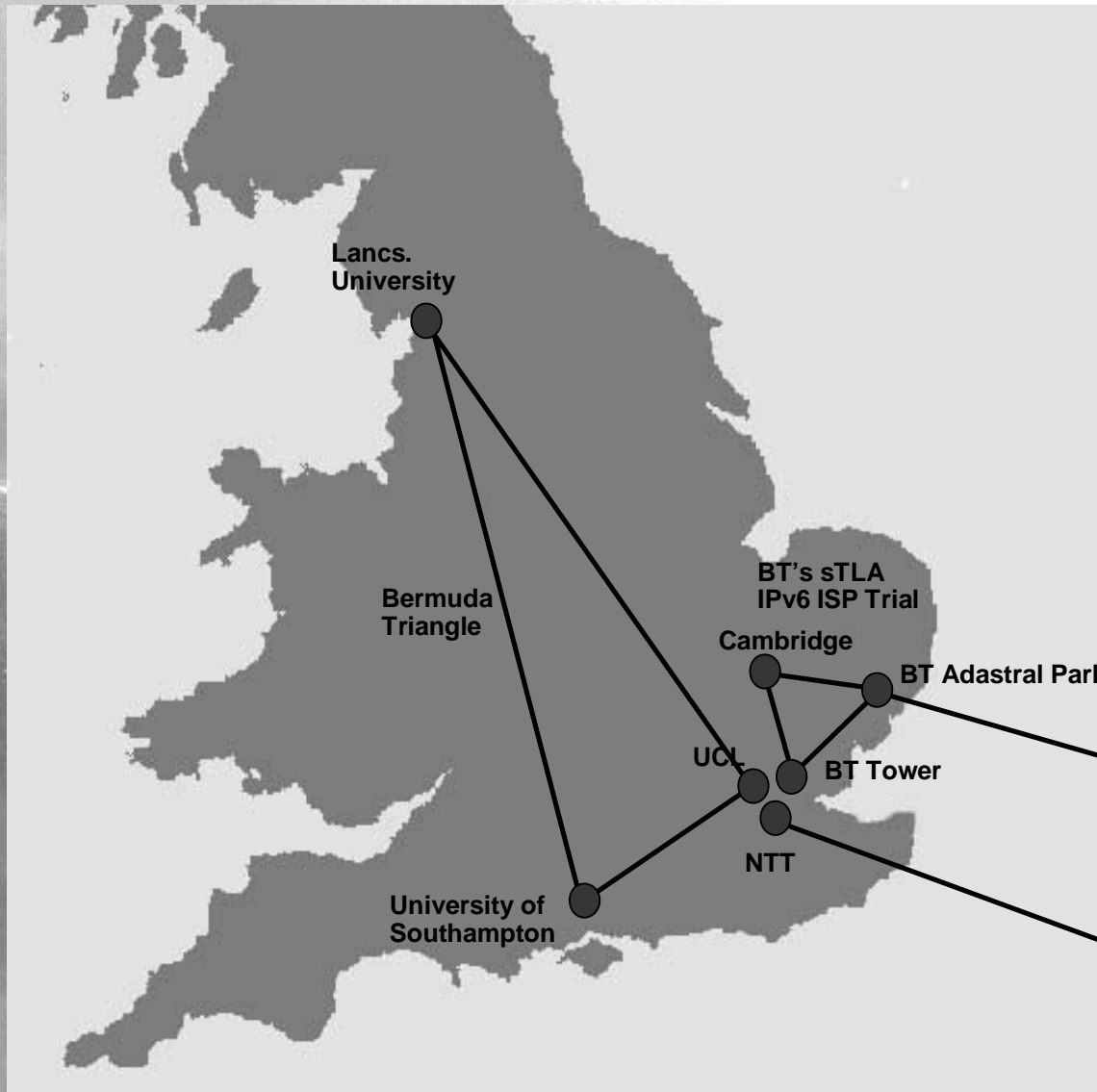
# 6INIT lessons

- How to deploy an IPv6 network
  - But native IPv6 links over ATM, which is being removed
  - Need a successor European academic IPv6 backbone
- IPv4-IPv6 interworking experience
  - NAT-PT works
  - But not without some DNS headaches
- Applications/environments developed/tested
  - SIP for VoIP, FreeSWAN for IPsec, ipfw filtering
  - Core services: web, mail, ...
  - KAME PIM-SM for multicast, 6WIND IPv6 QoS/VPN



- UKERNA (UK) academic IPv6 deployment study
- Jointly by Southampton, UCL, Lancaster
  - Management, DNS and address assignment issues
  - QoS-enabling multicast services (vic/rat)
  - Transition tools study: how to migrate a University
  - IPsec and VPNs
  - Wireless access methods, ad hoc networks, Mobile IPv6
  - Policy management (QoS and VPN)
- 12 months, runs to October 2001
- Seeking US (Internet 2) collaborations

# UK IPv6



Bermuda Triangle

BT's sTLA IPv6 ISP Trial  
Cambridge  
BT Adastral Park  
UCL  
BT Tower  
NTT

IPv4 tunnel to Telscom Switzerland



NTT's world IPv6 network

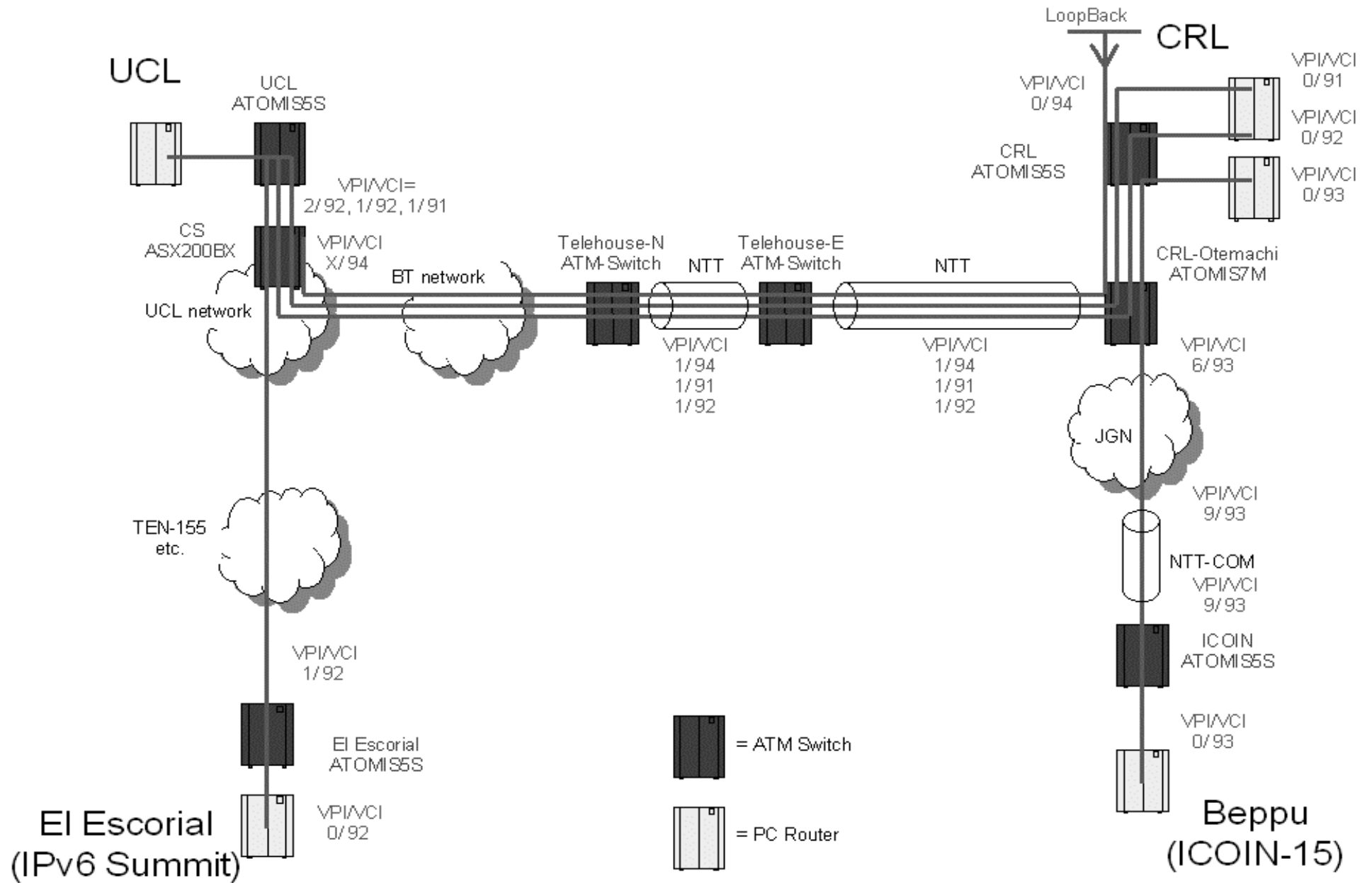


# Bermuda 2 collaborations

- Have some Internet 2 contacts and links
  - e.g. ISI, CRC
  - New IPv6 link (ATM PVC) from CERN to 6TAP
- Seeking new collaborations
  - For IPv6 network connectivity
  - To share experiences in particular areas of study
- 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

# ATM Configuration

19 Jan. 2001 CRL

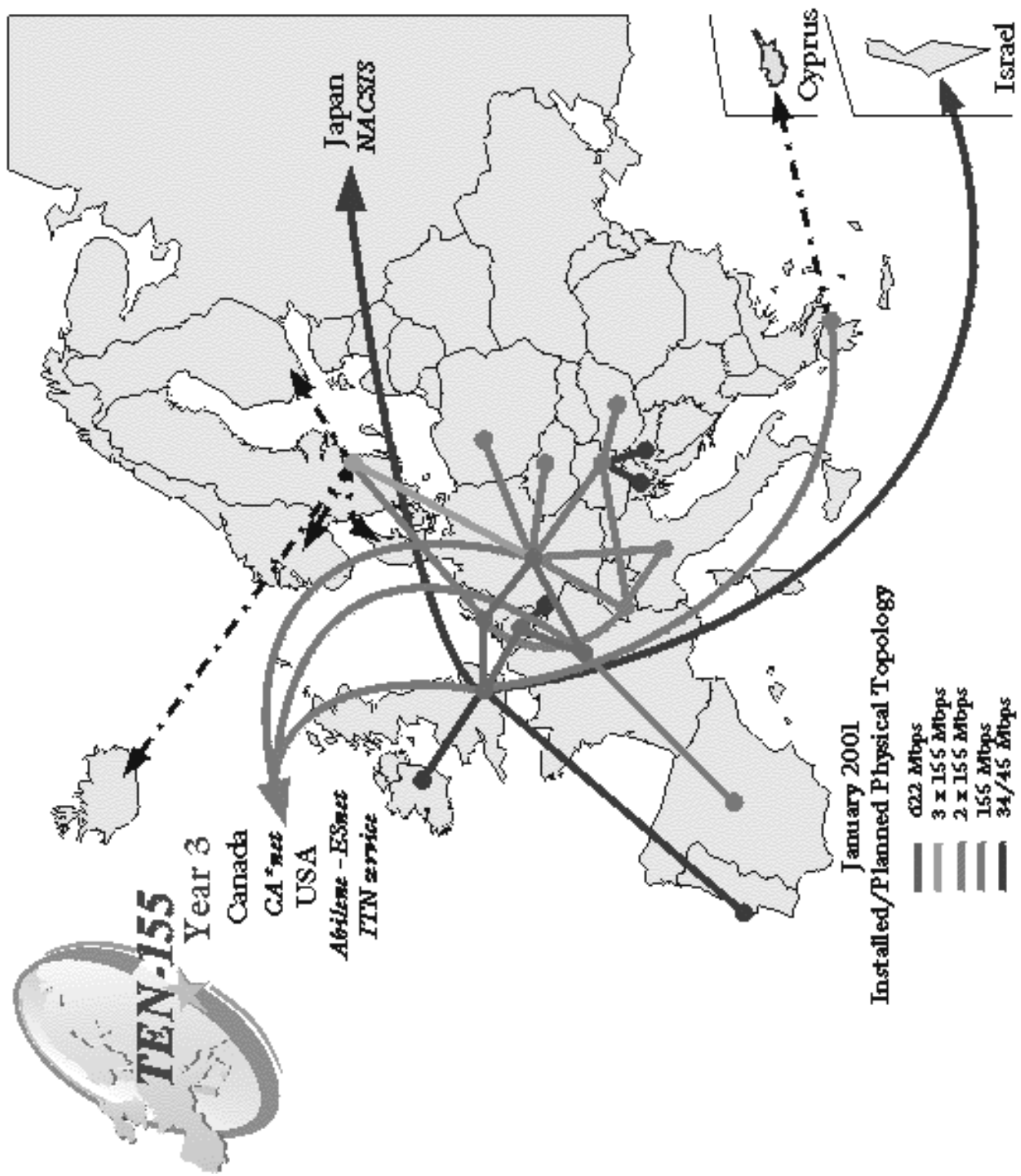


# GEANT IPv6 Working Group

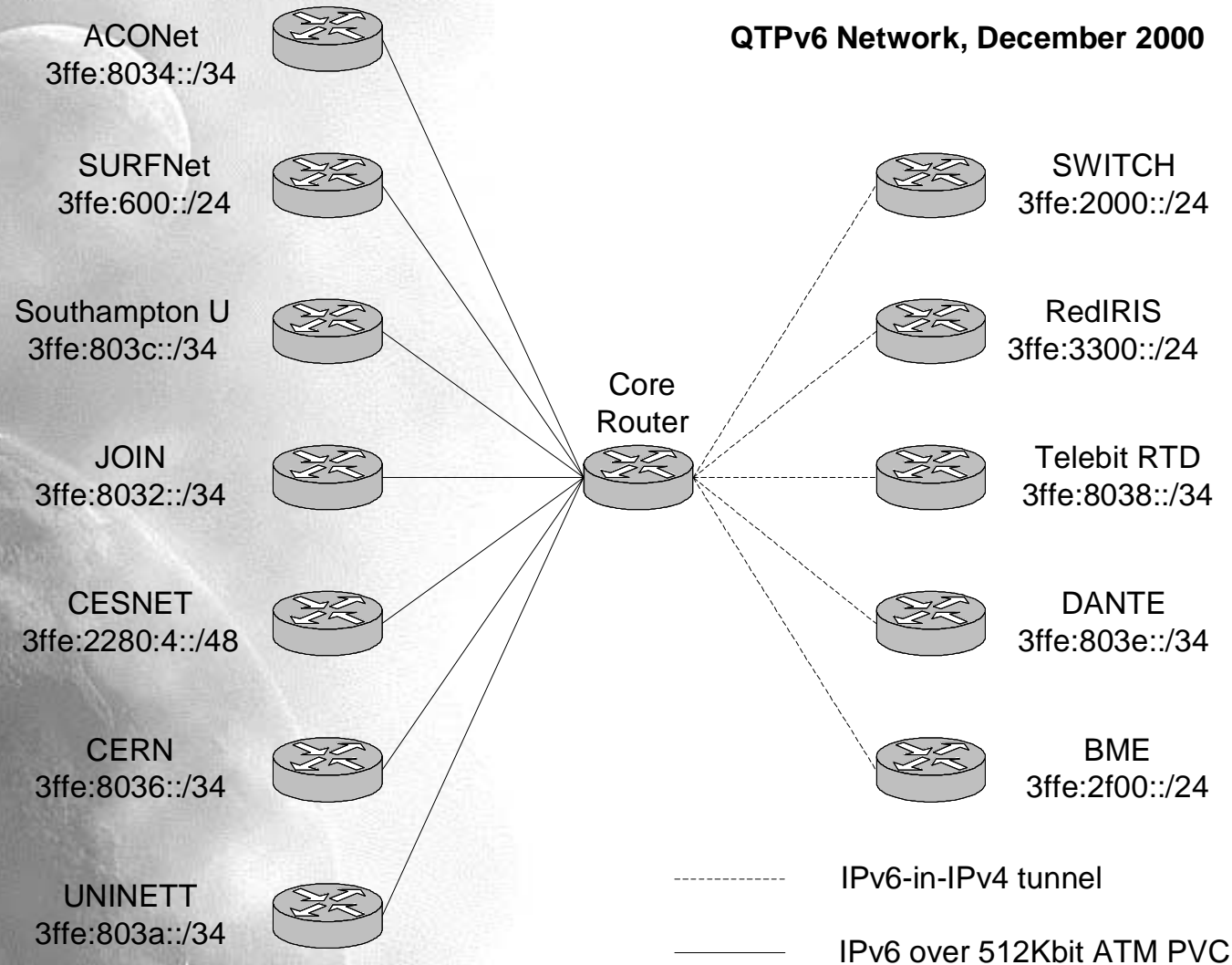
- Gathering of European NRENs
- Successor to Quantum (and its TEN-155 network)
- New multi-gigabit GEANT backbone to replace TEN-155
- GEANT includes network technology study groups, e.g.:
  - Differentiated Services
  - IP Multicast
  - Network Monitoring
  - IPv6
- Hold “TF-NGN” meetings 4-5 times a year
  - <http://www.dante.org.uk/tf-ngn/>

# 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



# QTPv6 overview



# GEANT

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

# 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

# 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

# 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

# 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

# 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)

# 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
• GR-GRNET-19991208	2001:0648::/35
• FR-RENATER-20000321	2001:0660::/35

# 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

# 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? GTPv6 is running trials.
- 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?

# 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,...
- Many studying similar issues
  - But the more operational experience, the better
- Internet 2 collaboration highly desirable
  - Establish network links
  - Share experiences

## Sites to visit

- GTPv6 (GEANT)
  - <http://www.ipv6.ac.uk/gtpv6/>
- Bermuda 2 (UKERNA)
  - <http://www.ipv6.ac.uk/bermuda2/>
- University of Southampton
  - <http://www.ipv6.ecs.soton.ac.uk/>
- UK IPv6 sites
  - <http://www.ipv6.org.uk/>
- 6INIT
  - <http://www.6init.org/>