



Project APAN Keynote – July 5, 2004



The 6NET project

An IPv6 testbed for the European Research Community

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Nature of IST IPv6 Projects

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- All these projects are joint between industry, universities and research institutions
- Most are 50% funded by EC for industries and major research institutions; university 100%
- EC has funded some 30 projects with IPv6 area
 - 6NET & Euro6IX are the largest at 10ME each from EC
 - The whole EC programme will be discussed tomorrow
- This talk represents the efforts of 150 researchers on 6NET – and many more in other projects
- EC has spent at least 100ME over last five years
 - Nationally even more spent

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Other IPv6 IST Projects

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- 6INIT 1/00 – 4/01, 4ME Set up IPv6 Pilot
- 6WINIT 1/01 – 1/03 3.5ME Explore IPv6 wireless applications
- Euro6IX 1/02 – 12/04 10ME Pilot IXs with Carriers
- 6LINK – 1/02 – 12/04 Organise IPv6 Cluster
- NGNLAB – 1/02 – 1/03 1 ME QoS, security, testbed
- 6POWER – 2.1ME IPv6/Power Line Carrier
- 6QM – Measurement and QoS
- ATHENA – 1-04 Digital Transition for TV, DVB-T
- SEINIT – 12/03 – 11/04 8.0 ME IPv6 Heterogeneous Security
- Cadenus, Nomad, MUSE, Eurov6, Torrent

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6NET & Euro6IX Project Objectives

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- To build and operate a dedicated international IPv6 network, and use this network to validate that the demands for the continuous growth of the global Internet can be met with the new IPv6 technology.
- To help European research and industry to play a leading role in defining the next generation of networking and application technologies that go beyond the current state of the art.

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Euro6IX

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- Concentrate on seven large Telcos
 - Also some universities and research institutes
 - Contrast with 6NET concentration on NRENs
- Build a large, scalable and native set of IPv6 traffic exchanges with connectivity to each other
- Gain real IPv6 experience ISPs, Telcos, ASPs
- Put in a production transit service
- Include fixed and cellular carriers
- Relatively modest network
 - Contrast with 6NET higher speed

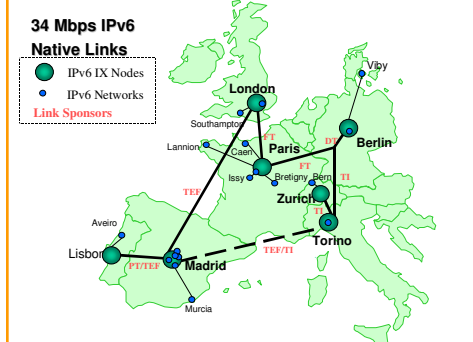
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Euro6IX Topology

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6NET Partners and Links

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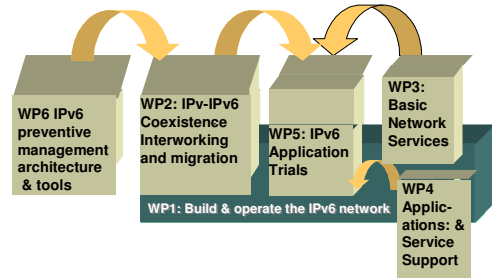
- Cisco, Dante, IBM, (Sony), TERENA
- 13 NRENs (AT, CH, CZ, DE, FR, GR, PL, P, HU, IT, NO, Nordunet, UK)
- 15 Research Institutes and Universities
 - Usually one per country with an NREN
- ETRI, NTT
- Links with many other projects strong, e.g.
 - Euro6IX strong in Telcos
 - GEANT strong in provision of research networks
 - EGEE in grid work

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Project Workflow

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WP0 - Project management and technical management
WP7 - Dissemination and exploitation

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The 6NET & GEANT Networks

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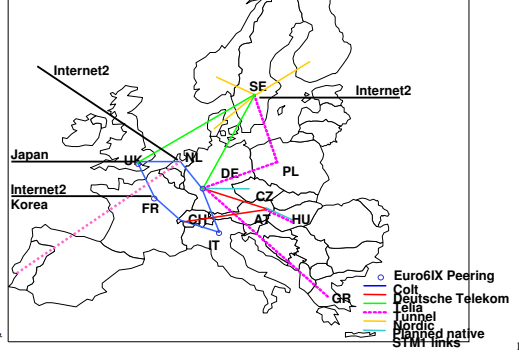
- 6NET aim was native IPv6 network initially 155 Mbps, going up to 2.5 Gbps after 12-18 months
 - No real large native IPv6 network was available
- Dante acquired and managed the IPv6 network
 - Upgrade depended on GEANT production plan
 - Separate from 6NET, as GEANT uses Junipers
- In practice 6NET became operational 7/02
 - Success encouraged GEANT to go into production
- Currently GEANT running dual-stack U/c
 - Will run M/c by end 2004

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6NET Map

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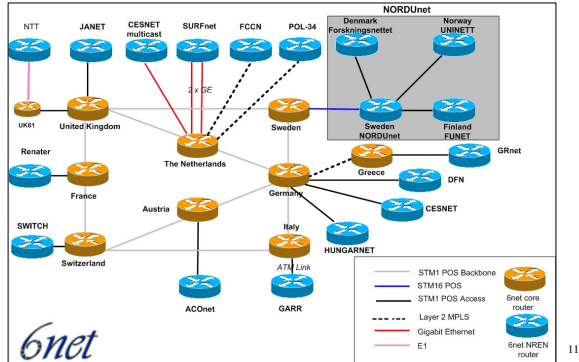


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6NET Topology

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6NET Characteristics

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- Most 6NET speeds are STM-1
 - Some STM-16
 - Some Gigabit Ethernet
 - E1 to Japan
- 6NET runs advanced services
 - Both M/c and U/c supported
 - QoS implemented on the core and edges
 - Planning to introduce Mobility support

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GÉANT v6 Transition

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- GEANT Schedule**
 - Core Configuration – February 2003
 - First Connections – April 2003
 - Pilot service – June 2003
 - IPv6 U/c production service – October 2003
 - IPv6 M/c production – Expected November 2004
- GEANT Impact on 6NET**
 - Most ordinary 6NET traffic already via GEANT
 - Not ones needing QoS, M/c or Mobility support
 - From end-2004, hope all 6NET traffic via GEANT

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Major Network Problems

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- Difficulty coordinating tests over core network**
 - Many entities involved in each particular test
- Monitoring IPv6 enabled networks**
 - 6NET core managed via SNMP v4 at NOC
 - MIBs for IPv6 traffic missing

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6NET Traffic Load - I

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Janet access Weekly graph

Max In: 443.2 kb/s (0.3%) Average In: 28.1 kb/s (0.0%) Current In: 24.0 kb/s (0.0%)
 Max Out: 276.1 kb/s (0.2%) Average Out: 127.7 kb/s (0.1%) Current Out: 116.0 kb/s (0.1%)

Renater access Weekly graph

Max In: 134.3 kb/s (0.1%) Average In: 26.4 kb/s (0.0%) Current In: 17.2 kb/s (0.0%)
 Max Out: 787.5 kb/s (0.5%) Average Out: 121.3 kb/s (0.1%) Current Out: 125.7 kb/s (0.1%)

30 min average graphs taken from 6net weathermap

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6NET Traffic Load -III

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Nordunet access Weekly graph

Max In: 360.2 kb/s (0.0%) Average In: 113.5 kb/s (0.0%) Current In: 113.4 kb/s (0.0%)
 Max Out: 35.2 Mb/s (1.4%) Average Out: 25.5 Mb/s (1.0%) Current Out: 27.4 Mb/s (1.1%)

Surfnet access Weekly graph

Max In: 57.8 Mb/s (5.8%) Average In: 36.8 Mb/s (3.7%) Current In: 26.6 Mb/s (2.7%)
 Max Out: 980.4 kb/s (0.1%) Average Out: 95.9 kb/s (0.0%) Current Out: 64.1 kb/s (0.0%)

30 min average graphs taken from 6net weathermap

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GEANT Topology, May 2004

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Backbone Topology May 2004

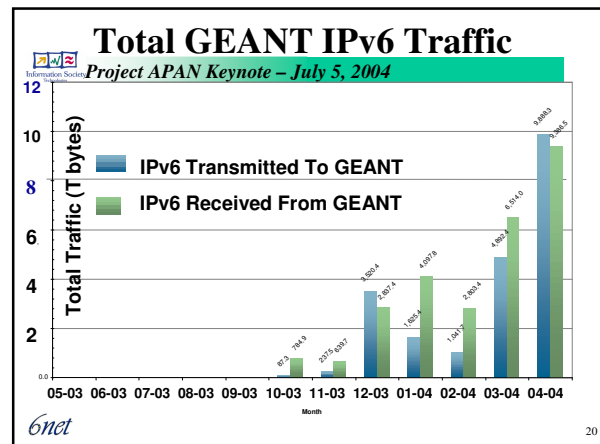
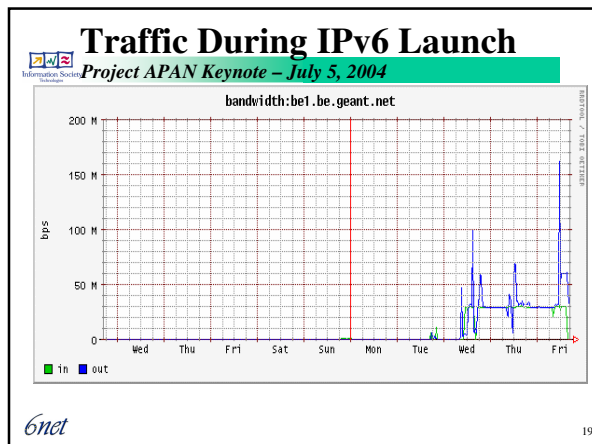
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GEANT Connectivity

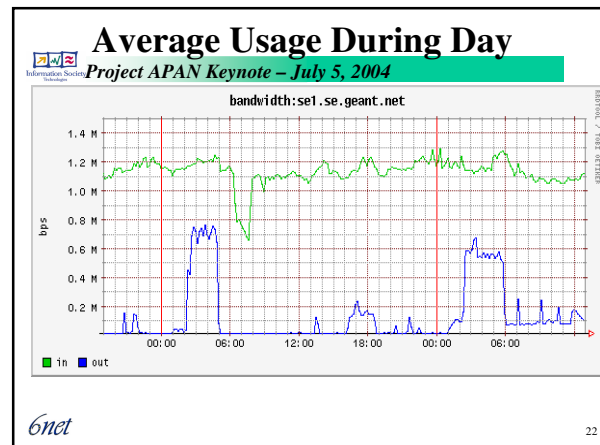
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- Connecting 30 NRENs in 35 countries**
 - Extra 8 in Silk at lower capacity
 - Extra 5 in SEEREN at lower capacity
 - Extra 4 in EUMED-Connect
- Backbone capacity 34 – 10,000 Mbps**
 - 26 NRNs connected at IPv6, 22 native, 4 tunnels
 - 356 IPv6 routes announced to them (not 6NET!)
 - Some extra countries going to IPv6 dual-stack

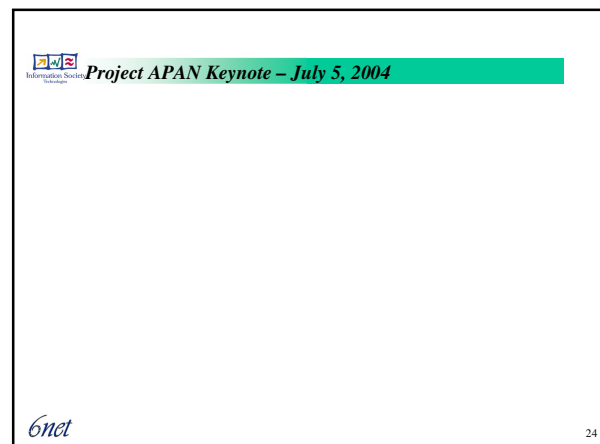
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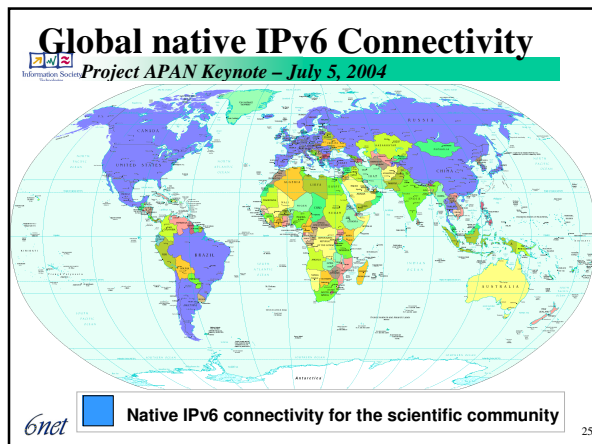


- ### Nature of GEANT IPv6 Traffic
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- Much traffic still artificial from forcing information traffic via IPv6
 - Do not support M/c yet
 - Many NRENs supporting IPv6, but some regional nets do not yet
 - Still few IPv6 Hosts
 - Some peering arrangements still problematic
 - No symmetric peering with 6NET
 - Assumed clear distinction between “production” via GEANT and “experimental” via 6NET
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- ### Foreign Networks and GEANT
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- Have connections to Commercial IPv6 Internet
 - Have IPv6 peering with Abilene, ES-NET, CA-Net, Koren; Dante figures of connections:
 - **ARIN Region:** DoD (22), VBNS (145), Univ.Wisconsin (2381), Univ.Indiana (22398)
 - **LACNIC Region:** RNP (1916), Reuna (11340), Mexico (278), Retina (3597)
 - **APNIC Region:** Taiwan RN(7539), Wide (2500), Australia NREN (7570), Singapore NREN (7610), Thailand Ministry (4621), Chinese Univ. of Hong Kong (3662)
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IPv6 Network Set-Up Conclusions

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- Move to dual-stack technically straightforward in new homogeneous networks like 6NET & GEANT
 - Must monitor IPv6 data for performance & stability
 - Even OK when operational with major services
 - More difficult with older NRENs needing upgrades
 - Slower process still with universities which need broader upgrade of heterogeneous equipment
 - Needs investment for hardware, management, staff
 - For normal IPv6/satellite little problem, however for IPv6/DVB there are needs for new en/decoders
- Significantly more difficult in older, heterogeneous nets

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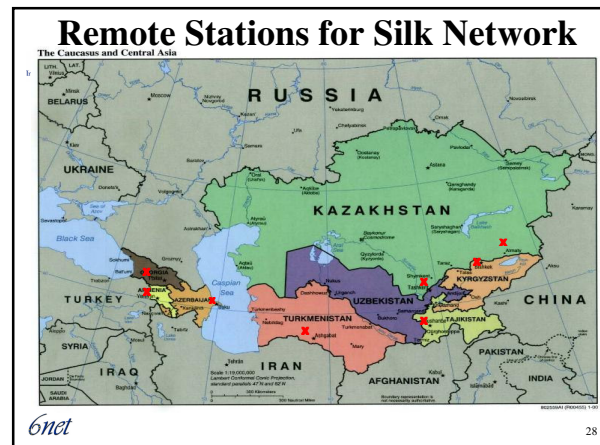
IPv6 over Satellite

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- As part of network and dissemination, testing IPv6/satellite
 - Hardware developed by IABG/ESA for IPv6/DVB-S
 - Will be tested over Silk VSAT Network in Southern Caucasus and Central Asia
 - Will put in small IPv6 infrastructure as part of test
 - Will mount IPv6 Workshop there
- EC/6NET and ESA providing small bandwidth
- ESA/IABG providing boards

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Transition Objectives

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- Goal: study and deploy IPv6 transition solutions:
 - NREN (ISP) networks
 - University (site) networks
- Also studying
 - IPv6 deployment issues (ongoing)
 - IPv6-specific issues for WLANs (complete)
- Has linkages with all other WPs, strongly with WP5

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Key Achievements in Transition

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- Deployment of 6PE/MPLS in SURFnet
- Development of OpenVPN tunnelling
- Initial campus transition analysis (Soton/Lanc/WWU)
- Multicast gateway: <http://www.uninett.no/testnet/multicast/mcgw/>
- IETF contributions in v6ops, dhc WGs
- Applications workshop:
 - led to cross-WP activity, e.g. OpenMCU
- Surveyed NRENs/sites
 - for deployment, lessons learnt, etc
- Security analysis of transition tools

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Current Transition Aims

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- **Work on ISP/NREN transition**
 - including 6PE/MPLS deployment
- **Work on site/university transition**
 - including joint campus transition case studies
 - with Euro6IX collaboration
- **Continue tracking IPv6 deployment issues**
 - not just “IPv6-only” issues
- **Develop transition aspect of demonstrators**
 - including home networking & OpenVPN solution

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Advanced Network Services

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- **Key Achievements**
 - Operational Multicast, DHCP and RPSLNg
 - Two automatic routing information mechanisms are in place: RIS & GRH
 - Active cooperation with other WPs
 - FLUTE, Multimedia Conferencing
- **Major difficulties:**
 - missing standards for DNS-SEC
 - missing products DHCP and RPSLNg
- **Major new work on large-scale renumbering**

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Applications & Services Support

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- **Key Recent Objectives**
 - MIPv6 deployment and testing
 - VPN deployment and testing
 - QoS activity
 - Very limited multi-homing work
- **Key Recent Achievements**
 - 6NET now QoS enabled
 - Multiple MIPv6 Home Agents deployed
 - Microsoft, Cisco, Linux, BSD all deployed
 - Two IPv6-capable VPN technologies tested
 - DVC & Xbone with Euro6IX, small deployment

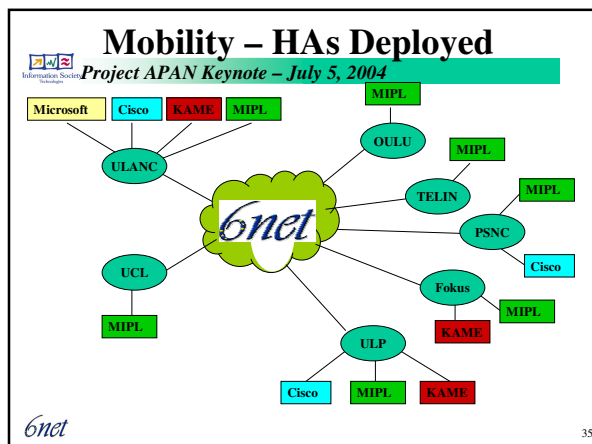
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Recent Mobility Work

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- **MLD proxy implementation**
 - Beta now available
 - Supports multiple mobile nodes and multiple multicast groups
- **MIPv6 deployment**
 - 7 testing partners
 - Many HAs - Cisco, MIPL, KAME, Microsoft

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IPv6 Wireless LANs

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- **Studied use of 3 access control mechanisms for IPv6**
 - 802.1x, Outbound VPN, Web-based redirection
- **Collaboration with TF-Mobility, UK WAG**
- **Implemented Linux VPN access control protocol**

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VPN Work

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- Got ISI (US) to port Xbone to IPv6
 - Hierarchical VPN, policies implicit
- Got DRDC (Canada) to port DVC to IPv6
 - Coalition network with each site defining VPN policy
 - Link to Euro6IX PKI
- Showed VoIP & VIC/RAT tools operate on both VPNs
- Started Deploying DVC between Euro6IX, DRDC and 6NET
- Started Deploying Xbone between Euro6IX, ISI and 6NET

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QoS Activity

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- EF, BE and LBE supported initially
 - AF classes to follow if required for app support
- QoS Models
 - Ingress DSCP trusted and DSCP non-trusted
 - Policed and non-policed at ingress
 - 5% of access link reserved for BE, 1% LBE
- Chose to wait for new Cisco IOS 12.0(28)S
 - Allows 6NET to run embedded RP M/c with QoS
 - Cisco GSR still some concerns for QoS configuration

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QoS Current Status

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Task	Config Status	Test Status
Backbone edge configuration	Complete	Partial / In progress
Backbone queueing	Complete	In progress
Partner edge configuration	In progress	In progress
Install detailed monitoring system	Starting	
Application testing	ASAP	

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Applications and Trials

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- Five main areas
 - VoIP and Conferencing
 - (Gaming)
 - Web Services
 - Grid Services
 - Mobile Services
- Initially regarded as separate activity. Now combining vertically with other WPs as complete demonstrators

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VoIP and Conferencing

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- Looked at many existing tools
 - Conferencing RAT, VIC, DVTS, SCS, SPAR
 - Showed normal demo of IPv6 version in 10/03
- SIP-based VoIP
 - SER, VOCAL, Gateways, MCUs
- H.323 Tools
 - OpenH323, GNOME Meeting
- Decided to concentrate on major integrated demos, needing help from other WPs

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VoIP Recent Demo Components

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- KPhone – IPv6 User Agent
- Cisco IP Phone 7960 – IPv4 User Agent
- SER – SIP Exchange Router (IPv6 & IPv4)
- MSP – IPv6-to-IPv4 Gateway
- Asterisk – Multi-Party Communication Gateway
- PSTN Gateway – IP-to-PSTN Gateway
- DVC – Defence R&D Canada, Dynamic VPN Controller

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VoIP SIP Demo Scenarios

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- **Point-to-point Communication**
 - **IPv6-to-IPv6 Communication**
 - Between IPv6 KPhone User Agents
 - **IPv6-to-IPv4 Communication**
 - Between IPv6 Kphone UAs and IPv4 Cisco 7960 UAs
- **Multi-Party IPv6 & IPv4 Communication**
 - **Between IPv6 Kphone UAs & IPv4 Cisco 7960 UAs**
- **IPv6-to-PSTN Communication**
 - **Between IPv6 KPhone UA and PSTN Telephone**
- **Showed that they work over one of the VPN techs**

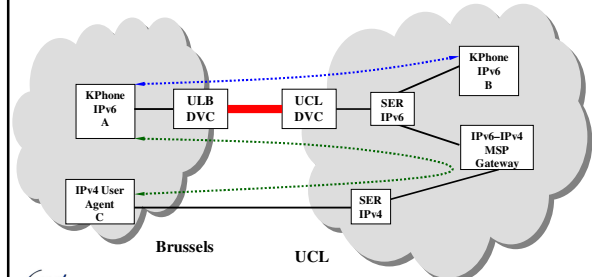
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SIP VoIP Demo

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- **IPv6-IPv6 Call**
 - **IPv6-IPv4 Call (Via MSP)**
- Point-to-Point Communication Across VPN

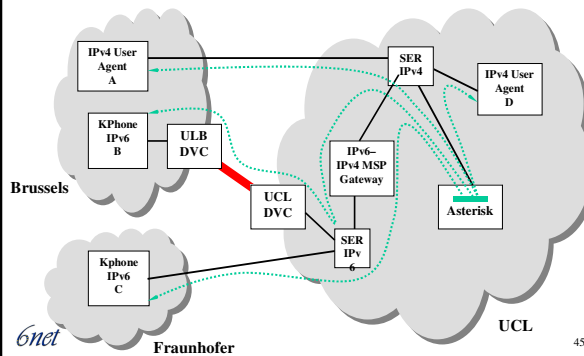


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VoIP Multi-Party over VPN Demo

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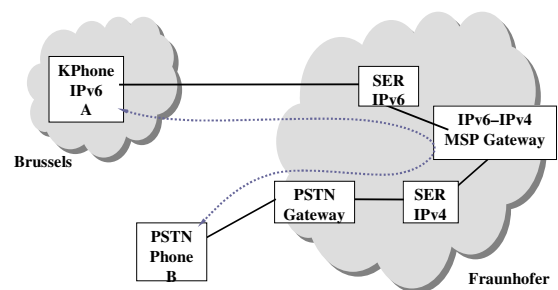


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Point-Point IPv6-PSTN Demo

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VoIP Future Activity

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- **Improve UAs**
- **Ensure that all the gateways shown in the demos work well in an operational sense**
- **Ensure that we really use the tools for everyday work**
 - for instance multi-person conferencing
- **Ensure that the tools work also in the mobile environment with VPN technology**
- **Help general deployment**
- **Expect major stable demonstrator of all components at end of year with VPNs**

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H.323 Conferencing

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- **H.323 Conferencing is the most commonly used technology for this activity**
 - **Usable at work, at home, and even on the move**
- **Use a typical example of the technology**
 - **A mixture of Open Source and 6NET-development**
- **Gnome Meeting is IPv4 & IPv6 capable**
- **OpenMCU allows 4-way U/c MM conferencing**
 - **IPv4 and IPv6 users can connect in at same time**
- **Adding gatekeepers, multiple MCUs, scheduler**

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Media Streaming

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- General feeling that mobile video streaming will be an important commercial application
- Showed a combination of real-time streaming, multiple destinations, PDAs, and MIP – with both classical and IPv6-optimised routing
 - **Showed impact of MIPv6**

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MIPv6 Streaming Demonstrator

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Future Mobility Activity

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- This basic technology will be developed further in some major mobile demonstrators
 - Will work with some important agencies
- Both the devices and the underlying computer processing will be able to be mobile
- Both routing and delay should be optimised
- Will include the multi-media conferencing, QoS, Grid, streaming and security in the applications pursued

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E-Commerce Activity

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- IBM has deployed Web Services platforms
 - Putting some applications onto Web Sphere
 - Are developing a management portal
 - Security study underway
- Application Performances
 - Provide an end to end migration performance evaluator
- Network storage added
 - Provide infrastructure distributed depot
 - Release user presence constraints for tests
- Edge Services
 - Testing new HTTP proxy and application level gateway

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Grid Activity

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- Set up IPv6 and Grid WG in GGF
- Ensure Globus was IPv6 Enabled
- Show Grid applications run over mixed IPv6/IPv4 environments
- Show Access Grid can operate in mixed IPv6/IPv4 environments

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Activities in GGF IPv6 WG

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- Set-up & co-chaired by 6NET:IBM and UCL
- Global Grid Forum (IPv6-Working Group)

<http://forge.gridforum.org/projects/ipv6-wg/>

 - IP version dependencies in GGF specifications
 - Guidelines for IP independence in GGF specifications
 - Status for Java Developers Kit API for IPv6

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Results of GGF-IPv6 WG

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- Guidelines for IP independence in GGF specs
- Out of 88 documents surveyed 24 had some form of dependency
 - 60% failed to reference IPv6 URL RFC2732
 - e.g. [http://\[2001:0DB8::CAFE\]/sofia/](http://[2001:0DB8::CAFE]/sofia/)
 - 24% IP dependent textual material
 - The rest contained other dependencies
 - IP independence in specifications, Implementation
 - Implications for new features
- Status for Java Developers Kit API for IPv6
 - Add support for Flow Label and IPv4-mapped

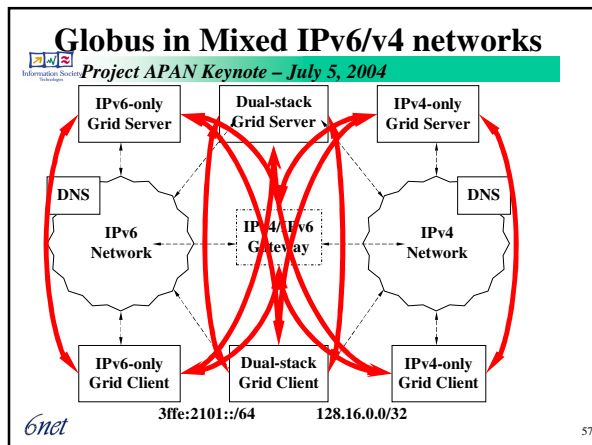
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Ongoing activity with Globus v3

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- A few protocols need to be modified to suit IPv6 protocols
 - For example, Grid-FTP
- Correspondingly, the specific implementation needs modification
 - UCL has contributed to code changes in Globus core for IPv6
 - ANL developing XIO architecture for GridFTP with IPv6 capability

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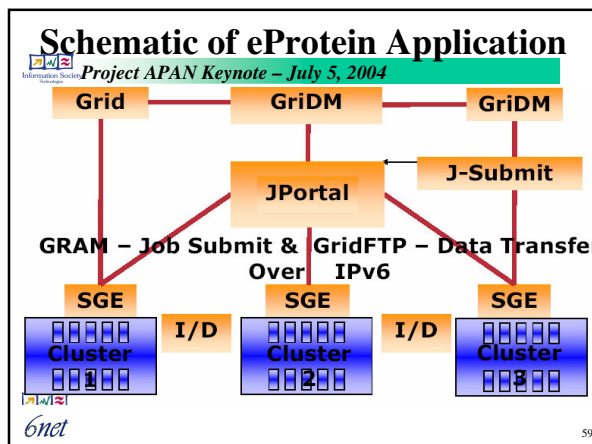


Grid Application Demonstrators

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- Setting up to normal Grid applications
 - eProtein and Weather Sensor
- Showing that both can run in a mixed IPv4/IPv6 environment
 - Both IPv4 and IPv6 Grid Globus nodes
 - Both IPv4 and IPv6 Grid Globus clients
- Expect to look at impacts when both Grid node and Grid client are mobile with IPv6

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IPv6 Network Manage Arch & Tools

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- Key Objective is to provide tools to configure, manage and monitor IPv6 networks
 - Also spread information about IPv6 management
- Mechanisms include
 - Testing and listing info on the relevant tools
 - Have the relevant protocols in PS RFC status (IETF)
 - Organise the pressure on the vendors to get the missing bits and the unified MIBs implemented
 - Documentation of tools and training

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Important Management Tools



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- Netflow for IPv6 – based on Netflow v9 record
 - Available on Cisco IOS 12.3(7)T, Still required on Cisco 12000 series
 - Export and collection still done over IPv
- SNMP over an IPv6 transport
 - Available on Cisco 12000 series from IOS 12.0(27)S, Still required on other Cisco series
- Cisco Campus Manager beta is under tests
- HP OpenView is available for IPv6 (09/2003)

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Network Management Dissem



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- Another Objective is to disseminate information about the tools
 - Write cookbooks
 - Help deploy toolset
 - Provide Web stores on relevant tools

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Unfinished Business



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- Complete QoS tests on 6NET network
- Help GEANT put up QoS and M/c
- Refine and Publish IPv6 transition cookbooks for NRENs and Universities
- Publish case study of transition of whole Univs
- Setup DNSSEC service in 6Net.
- Provide a complete case study on re-numbering

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Remaining work with VPNs



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- Ensure smooth use of both VPN technologies with realistic policies
- Ensure that the technologies work with VoIP and multimedia conferencing
- Ensure that the technologies work in a mobile scenario with MIPv6 and Mobile Routers
- Investigate the use of the VPNs with Grid and Mobile use of Grids

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Demonstrators being Considered



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- Technical Demonstrators using Mobile IPv6
 - Car-to-car
 - Mobile library
 - Mobile ambulance
 - Mountain rescue
- Usage Demonstrators
 - Schools deployment
 - Voice/IP
- All in specific locations

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Main Future Activity



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- Do serious transition of whole universities
- Carry out serious vertical trials of mobile demonstrators like ambulance, home network or tele-consultation
 - GEANT plus mobile nets
 - Using transition tools of WP2
 - M/c and SSM of WP3
 - Mobility and VPNs of WP4
 - Application technology including some of WP5

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Contributions to Standards

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- **Co-Chairs of Multi6 and v6ops IETF WGs.**
 - In last 7 months, co-authored or contributed to 32 Internet Drafts on DHCPv6, NAT replacement, transition mechanisms, VLAN usage, fire walling, deprecation of site-local addressing, multi-homing and renumbering.
- **Both Co-Chairs of GGF IPv6 WG**
 - 3 drafts on IP version independence, survey of IPv4 dependencies and Java APIs

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Conclusions

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- **6NET has shown in Europe the feasibility of running IPv6**
 - GEANT is taking over, so network being phased out
- **6NET has tackled a number of areas that needed technical investigation**
 - Transition, Routing, M/c, SSM, VPN, QoS, Mobility, monitoring and management
 - Has provided needed real data and experience
 - Has pioneered a few important applications
- **Allowed Europe to join the international community of Internet2, WIDE and Koren**

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