Deploying IPv6: 6NET and Euro6IX

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Agenda

- Introduction
  - Why is IPv6 of interest?
  - IPv6 deployment status
  - Getting connectivity
- European projects
  - 6NET
  - Euro6IX
  - Others

IPv6 overview

- Successor to IPv4, with 128-bit addressing
  - e.g. 2001:0630:1fff:0080:dead:beef:baad:cafe
  - Improves scalability, client reachability
- Hierarchical addressing from outset
  - e.g. single route advertised for JANET
- Auto configuration ("plug and ping")
  - Well-suited to ad-hoc networking
- IPsec implementation "mandated"
- Better support for Mobile IP

Why university/HE interest?

- IPv6 is deploying elsewhere, esp. Asia
  - Gain understanding of deployment issues
- Deploy to support research activities
- Next generation application support
  - No NATs, restoration of end to end principle
  - IPv6 may be important for GRID activities
  - Potential for ADSL+802.11b+IPv6 to the home
  - Outreach, home working/learning
- 3G is set to use IPv6, and may be open…

Peer to Peer

- Current Internet has client-server focus
  - Web, e-mail, etc.
  - Clients in homes/SME's, servers on globally addressable Internet
  - NAT generally works in this environment
- Future trend client-client, or p2p
  - VoIP, messaging, file sharing, gaming, GRID, …
  - Implies all devices globally addressable
  - Deployment of servers in the home
    - E.g. multiple web cams, home appliances/data
    - NAT adds significant complexity in this case

But do we really need it…?

- IPv4 is seen to "do everything"
  - But it is being stretched
  - One of the biggest problems is NAT
  - Need to enable Internet growth
  - Provide a NGN development environment
    - Web evolved more than 10 years after IPv4
  - Seek to use IPv6 features
- Universities have address space
  - But many new PDA, embedded devices
  - GÉANT embracing eastern European countries

Introducing 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*

Implementations

- Windows XP/.NET
- *BSD
- Linux
- Solaris 8+
- Symbian OS
- Compaq Tru64
- AIX 4.3+
- HP/UX 11.0+
- Irix
- Cisco IOS
- Juniper
- Hitachi
- *BSD
- Zebra, ZebOS
- Ericsson Telebit
- 6WIND
- 3Com
- +others…

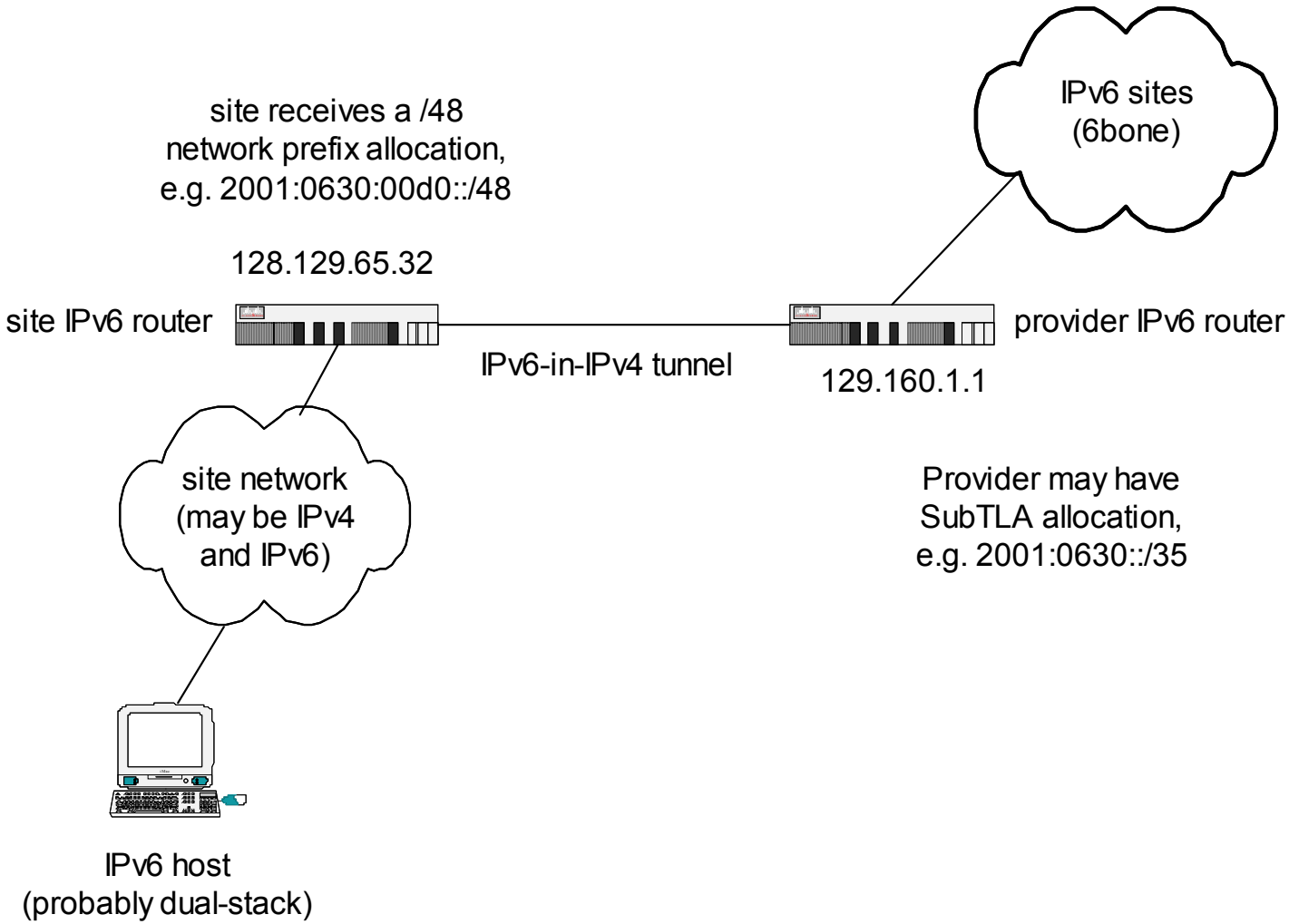
IPv6 integration and transition

- How can IPv4 and IPv6 co-exist?
  - Includes IPv4 and IPv6 systems communicating
- Different transition aspects and tools
  - Site transition
  - ISP (MAN or NREN) transition
  - Need to understand relationships between tools
  - Wide range of proposed tools in IETF
  - IETF now identifying deployment scenarios
- How to deploy IPv6 in an IPv4 network
  - Includes DNS, firewalls, email, ….

End user+site IPv6 connectivity

- The basics for an end user/site…
  - Certainly a host that supports IPv6
  - And ideally a router supporting IPv6
  - Can run IPv6-only, but most likely dual stack
- An IPv6 connection to wider IPv6 Internet
  - Need an upstream provider
  - Link probably tunnelled in IPv4, possibly native
- IPv6 address space
  - Inherited from/allocated by upstream provider

Using tunnelled connectivity



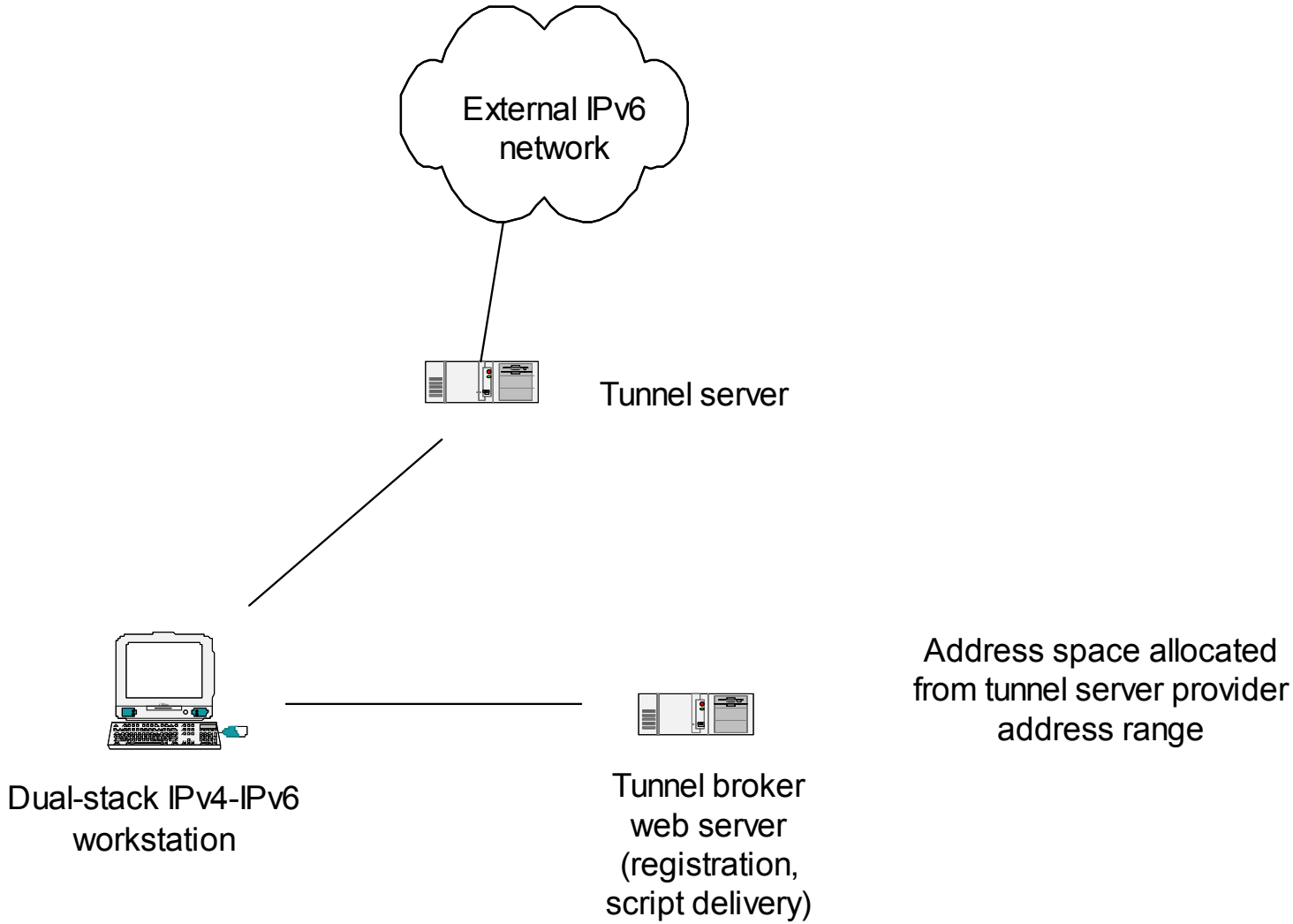
IPv6 addressing and DNS

- Receive a /48 prefix from provider
  - Allows 16 bits of network space with 64 bits of host space, so better than IPv4 Class A prefix.
- Set up DNS for IPv6 addresses
  - Uses "quad A" records, e.g.
    - foo IN AAAA 2001:0630:00d0:20:<host part>
  - Can have A and AAAA for same host
  - Beware what the applications do here!
- Obtain reverse DNS delegation
  - Currently under ip6.int, soon ip6.arpa.

Tunnel brokers for single hosts

- Can connect with one single host using an IPv6 tunnel broker
  - Needs to be dual stack IPv4 and IPv6
  - Freenet6.net is world's most popular
    - But located in Canada!
  - Bypasses site admin, except for IP tunnel…
- Register at web page, receive script
  - Script creates the tunnel from your host to the tunnel server

Tunnel broker



Current IPv6 deployment

- Generally tunnelled IPv6 in IPv4
  - Not structured
  - In many eyes, collaboration = tunnel + peering
  - Tunnel brokers often very remote
  - Lack of regional harmonisation
- Little experience of large-scale native IPv6 network deployment and operation
  - Hence 6NET and Euro6IX
  - IPv6 backed by European Commission
    - But important deployment is market led

European academic deployment

- National initiatives
  - e.g. UNINETT, RENATER, UKERNA
- European Commission funded projects
  - Early IST 5th framework
    - 6INIT, 6WINIT
  - Late IST 5th framework
    - 6NET, Euro6IX, 6LINK
  - GÉANT pan-European deployment
    - Includes IPv6 activity towards production service in GÉANT lifetime

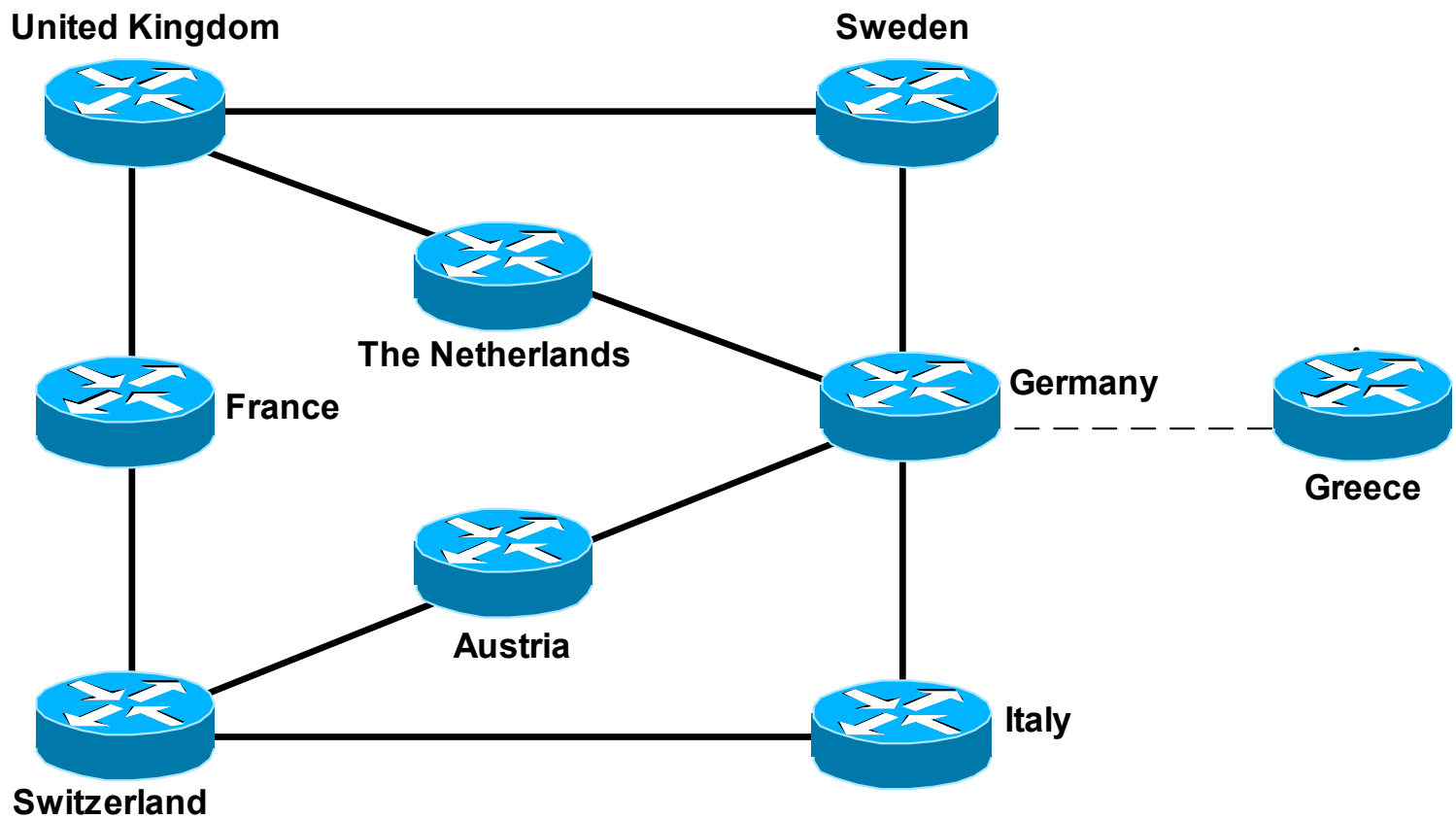
6NET and Euro6IX

- EC IST programme, 5th Framework
- Both projects 3 year duration
  - Both run Jan 1st 2002 – Dec 31st 2004
- 6NET majors on academic networks
  - High capacity native network spans 11 NRENs
- Euro6IX focuses on telcos
  - Coming together at IPv6 exchange points, investigating new business models

6NET

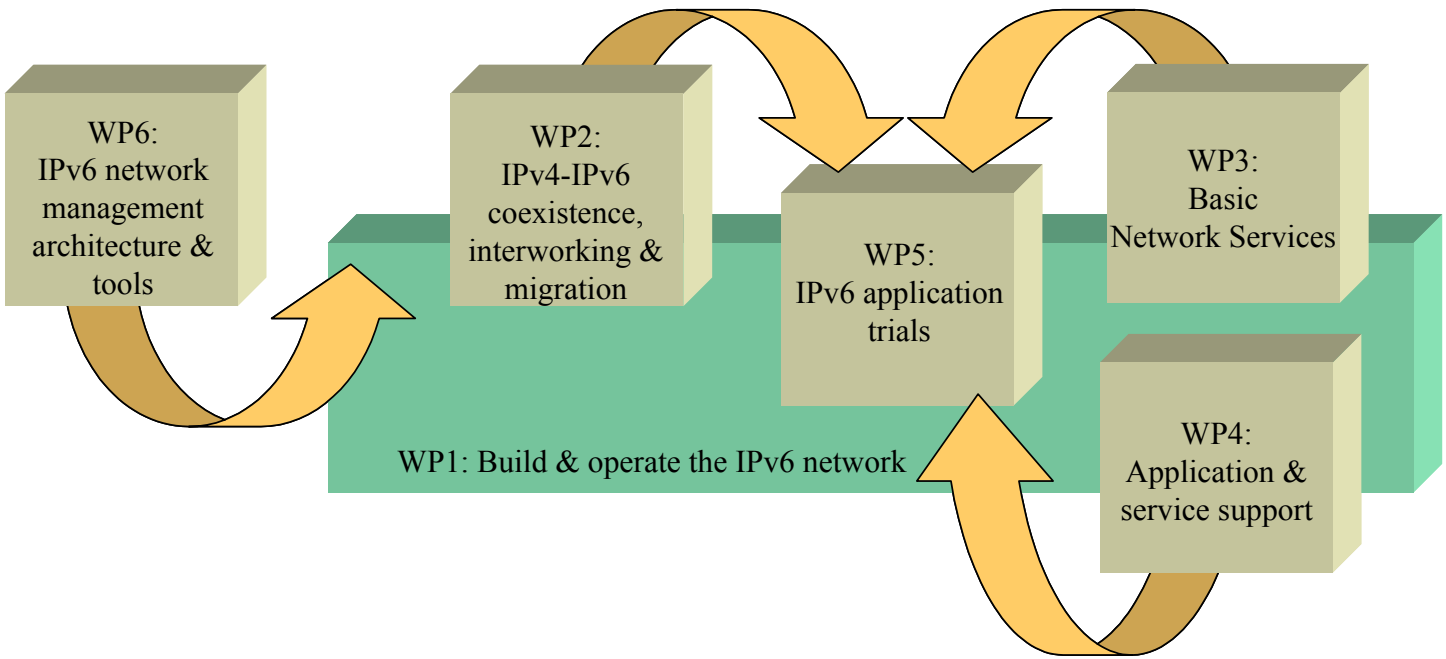
- Major aim is to validate IPv6
- Led by Cisco, with 31 partners
  - 6NET PoPs are 12404-series routers
  - NREN PoPs are 12404 or 7206
- All major NRENs taking part
  - Includes NORDUnet
- Universities providing end users
  - Network will be open to other projects
- Adding Poles, Czechs and Slovenians
  - Under newly associated states scheme

6NET network topology

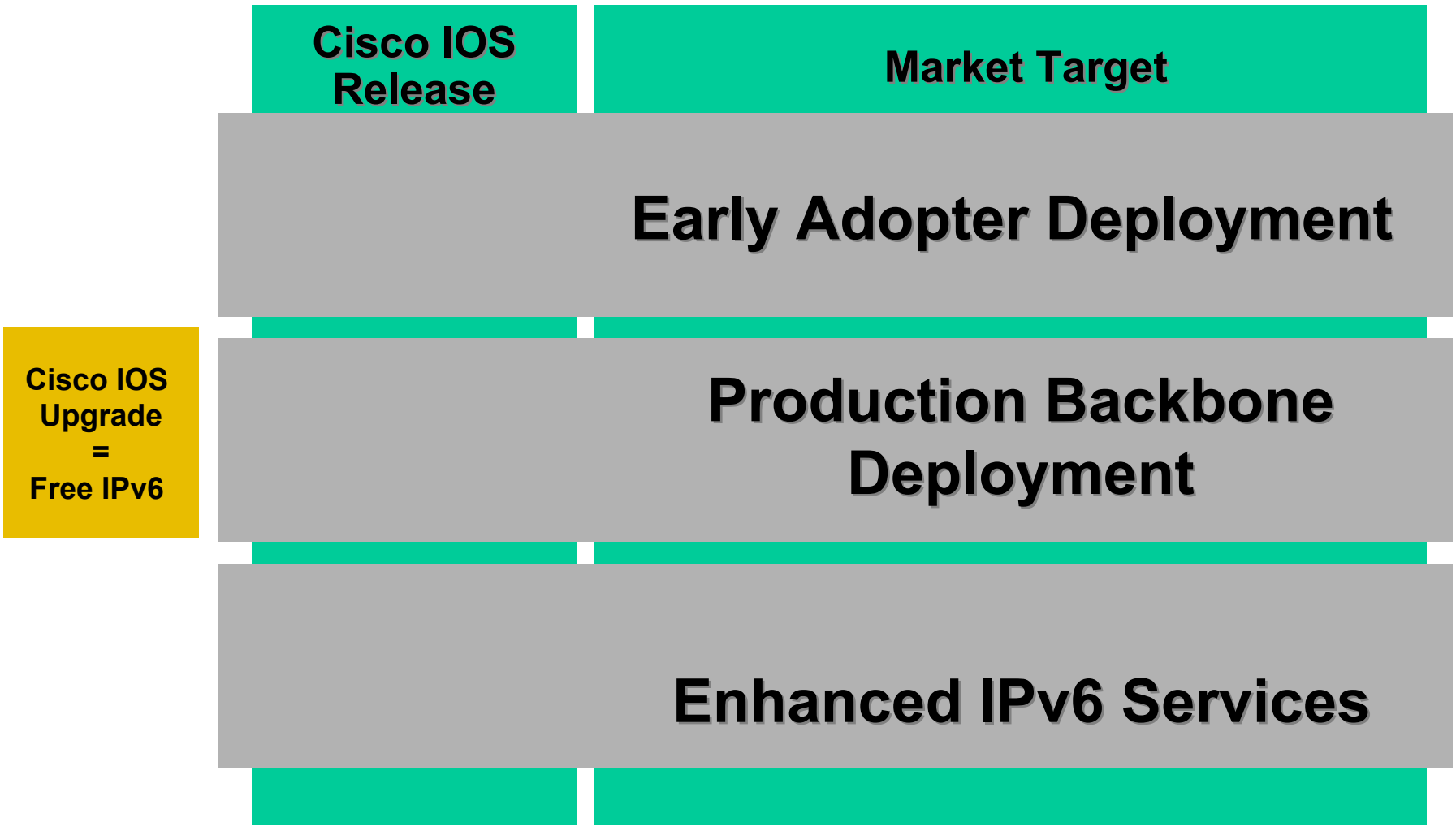


6NET work packages

- WP1 specifies network
  - deployment due for April/May 2002.



IOS roadmap


Cisco IOS Release
Market Target
Early Adopter Deployment
Production Backbone Deployment
Enhanced IPv6 Services
Cisco IOS Upgrade = Free IPv6

Phase I

Cisco IOS Upgrade = Free IPv6

Cisco IOS Release	IPv6 Features Supported
Phase I **Early Adopters** Cisco IOS 12.2(2)T, (4)T Any router able to run 12.2T, from Cisco 800 to Cisco 7500 IP Plus, Enterprise and SP images	IPv6 Basic specification (RFC 2460) ICMPv6, Neighbor Discovery Stateless auto-configuration RIPv6 (RFC 2080) Multi-Protocol extensions for BGP4 (RFC 2545 & 2858) Configured and Automatic Tunnels 6to4 Tunnel Standard Access List IPv6 over Ethernet (10/100/1000Mb/s), FDDI, Cisco HDLC, ATM and FR PVC, PPP (Serial, POS, ISDN) Ping, Traceroute, Telnet, TFTP

Done

Phase 2

Cisco IOS Release	IPv6 Features Under Development
	i/IS-ISv6 CEFv6/dCEFv6 AAA/Dialer Pool, NAT-PT Extended Access Control List IPv6 over IPv4 GRE Tunnels IPv6 Provider Edge router (6PE) over MPLS DNS AAAA client Link-Local BGP Peering CDP, SSH, IPv6 MIB Phase I Sustaining

Phase III

Cisco IOS Release	Evaluation of IPv6 Phase III Features
Phase III Enhanced Protocols **Target date: CY 2002 And Later**	**Routing:** OSPFv3 & E-IGRP **Enhanced Services:** Mobile IPv6, IPSec, IPv6 Multicast, IPv6 QoS **Management:** Netflow IPv6 record, SNMP over IPv6, MIB's enhancements **Tunnels**: IPv6 over IPv6, IPv4 over IPv6 tunnels, ISATAP **IETF IPv6 Enhancements**: eg. R.A. extensions, ICMPv6 prefix delegation, **Hardware Acceleration**: in-progress **Encapsulation**: Add enhanced support for DPT, Cable and DSL

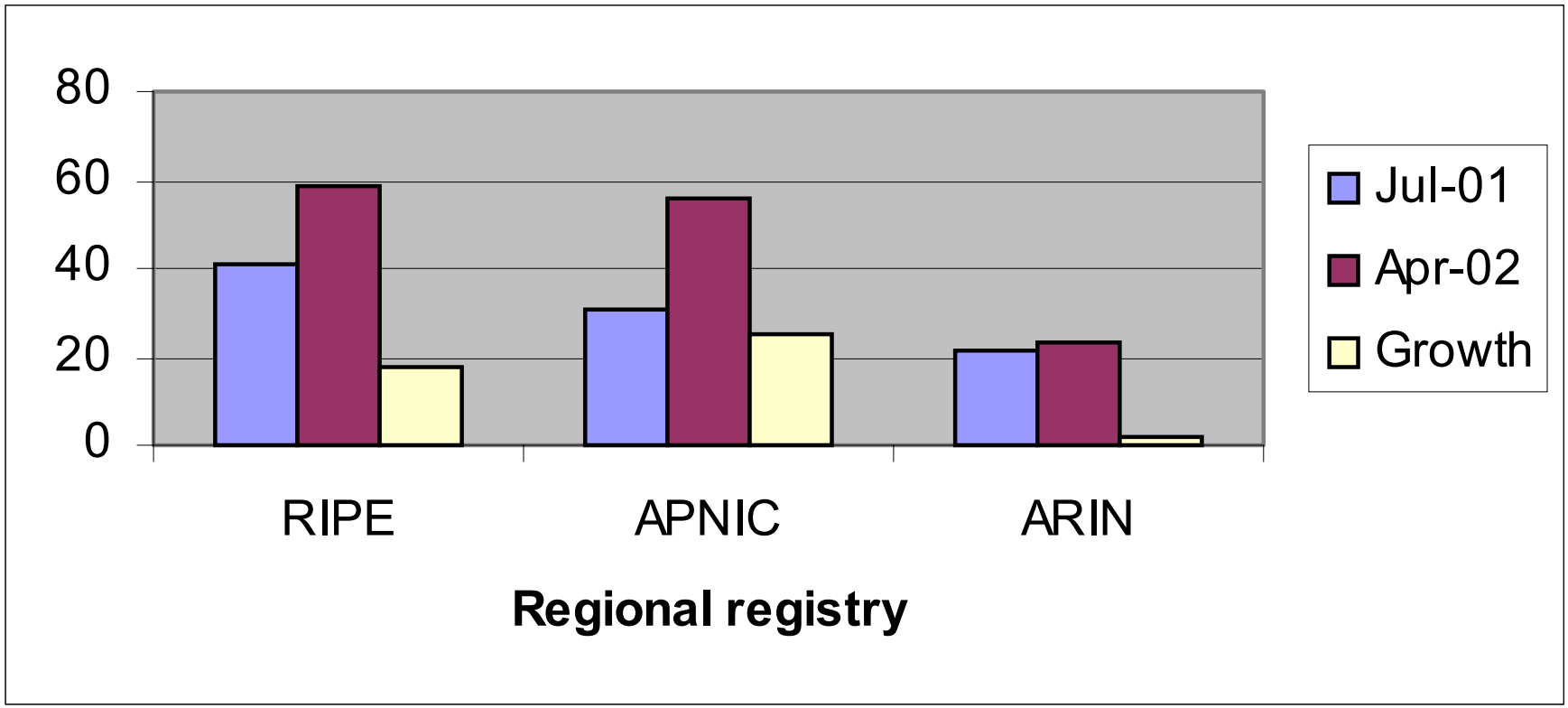
Technical aspects

- Routing
  - IS-IS internal, BGP4+ external
- Addressing
  - Core takes uses DANTE address space
    - 2001:0798::/40
  - Point to point links use /64 prefix
  - NREN networks use own address space
    - RIPE NCC assigned production prefixes

RIPE-NCC SubTLA allocations

- Top level address space under 2001::/16
  - APNIC 56, ARIN 23, RIPE 59 as of April 2002
  - See http://www.ripe.net/cgi-bin/ipv6allocs
  - APNIC allocations growing the fastest
  - Common regional registry policies
- European NRENs with SubTLAs include:
  - CH-SWITCH-19990903 2001:0620::/35
  - NO-UNINETT-20010406 2001:0700::/35
  - AT-ACONET-19990920 2001:0628::/35
  - UK-JANET-19991019 2001:0630::/35
  - DE-DFN-19991102 2001:0638::/35

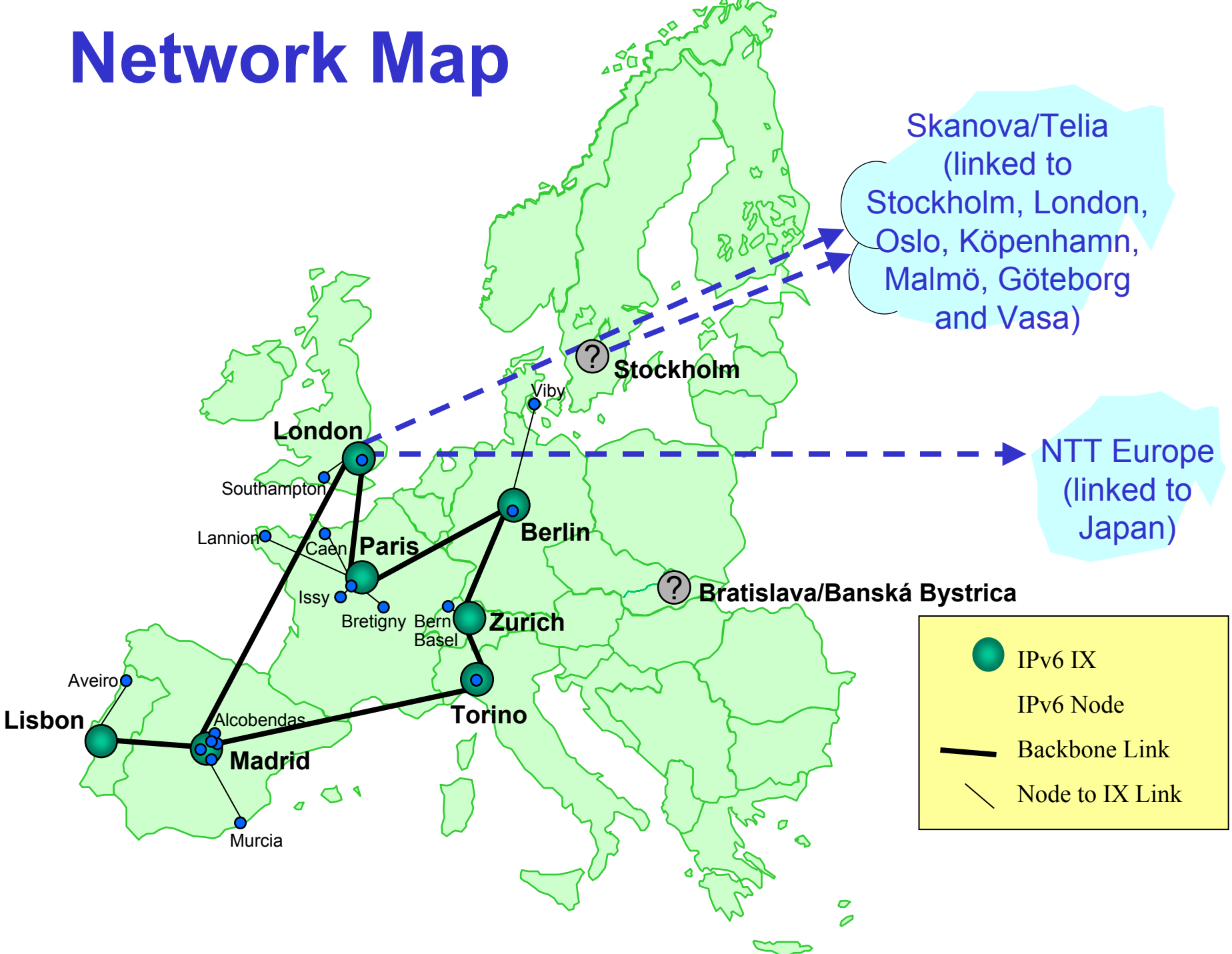
SubTLA allocation growth



Euro6IX

- Led by Telefonica/Consulintel
  - 18 partners, mainly telcos
  - Wide variety of router platforms
  - Hitachi is a primary sponsor
- Validating IPv6 for NGN
  - Investigating IPv6 business models
  - How telcos mutually benefit from IX's
  - Includes application development
  - Open to ISP's for trials

Network Map


Skanova/Telia
(linked to
Stockholm, London,
Oslo, Köpenhamn,
Malmö, Göteborg
and Vasa)
NTT Europe
(linked to
Japan)
Stockholm
Viby
London
Southampton
Lannion
Caen
Paris
Berlin
Issy
Bretigny
Bern
Basel
Zurich
Bratislava/Banská Bystrica
Aveiro
Lisbon
Alcobendas
Madrid
Torino
Murcia
IPv6 IX
IPv6 Node
Backbone Link
Node to IX Link

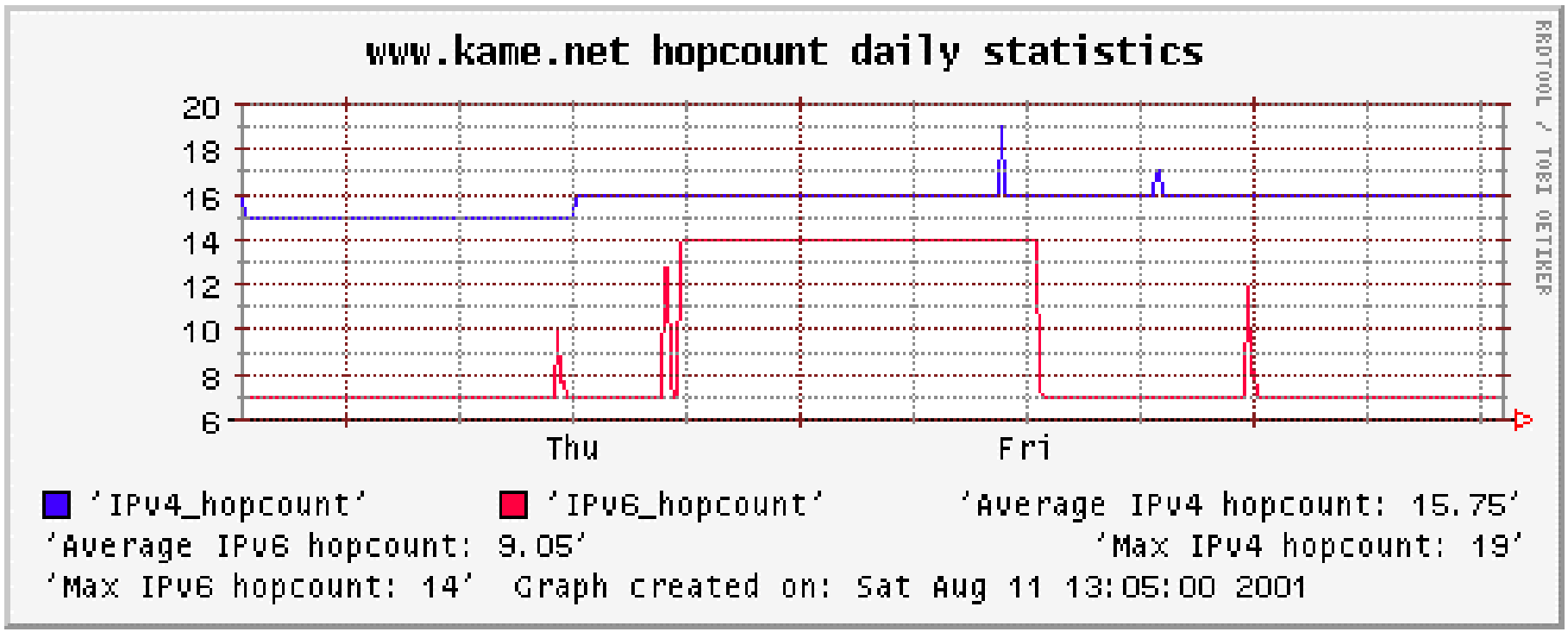
GÉANT IPv6 WG (GTPv6)

- GEANT committed to deploy IPv6
  - By end of project 2004
  - Backbone uses Juniper platform
- Variety of testbed routers
  - Centred around Juniper M5 at RENATER
  - Also Ericsson Telebit, FreeBSD, Cisco
  - Covers work items not in 6NET
  - Includes NREN partners not in 6NET
- See www.ipv6.ac.uk/gtpv6

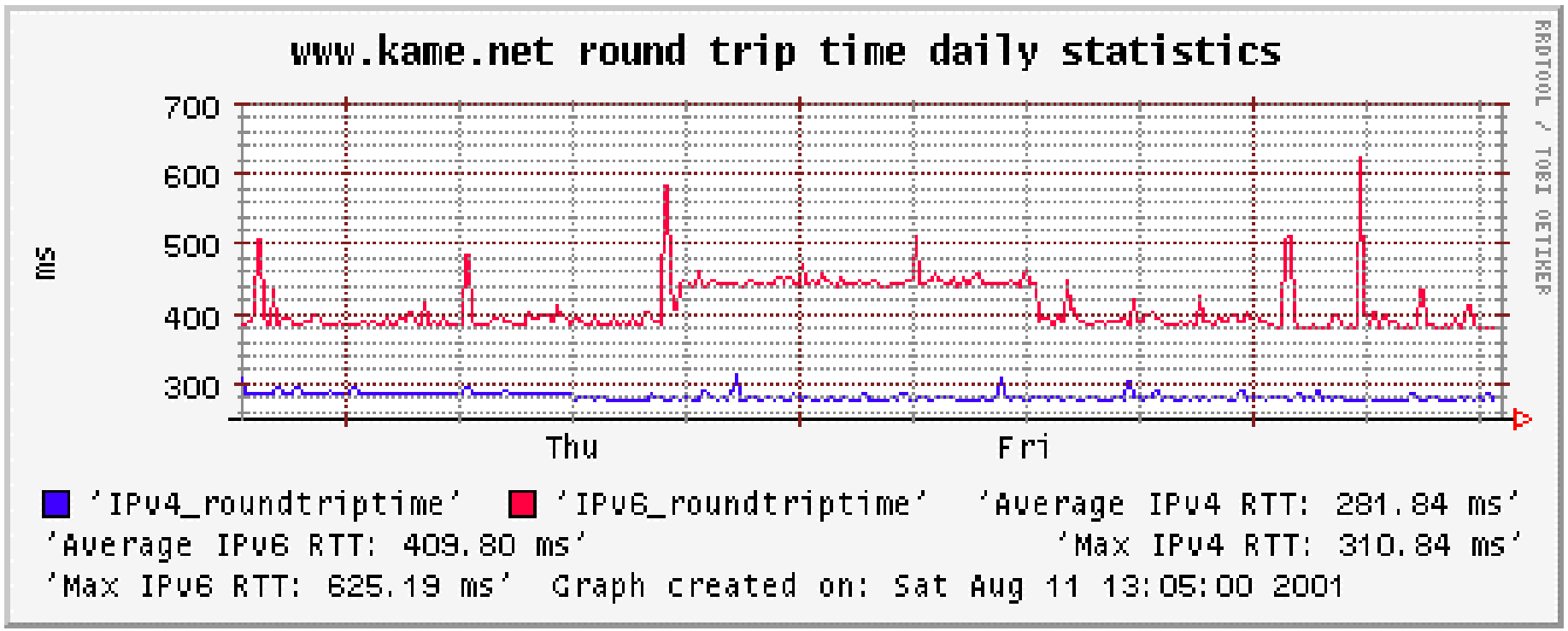
IPv6 monitoring tools

- Desirable to monitor network
- Tools include
  - Basic ping and traceroute
  - IPv6 looking glass
  - BGP AS path viewers (ASpathTree)
  - Custom tools, e.g. trout6 – developed in GTPv6
- 6NET is porting and deploying more tools
  - Includes RIPE Test Traffic servers
  - Part of full IPv6 NOC for 6NET

trout6: hop count



trout6: round trip time



6WINIT

- Focus on mobile, clinical applications
  - Uses IPv6 with GPRS/UMTS
  - Includes MIPv6, IPsec
  - Three clinical sites
- Also general non-clinical applications
  - Ad-hoc networking, service discovery
  - Sensor applications
  - Conferencing and collaboration
- See www.6winit.org

You want to run IPv6 only?

- Certainly possible
  - Many routers can run IPv6-only
    - But may need IPv4 if you want, e.g., SNMP.
  - Many hosts can run IPv6-only
    - But issues like DNS lookups over IPv6
- Need mechanisms to access IPv4-only sites
  - e.g. NAT-PT or DSTM
- Want IPv4 sites to be able to reach you?

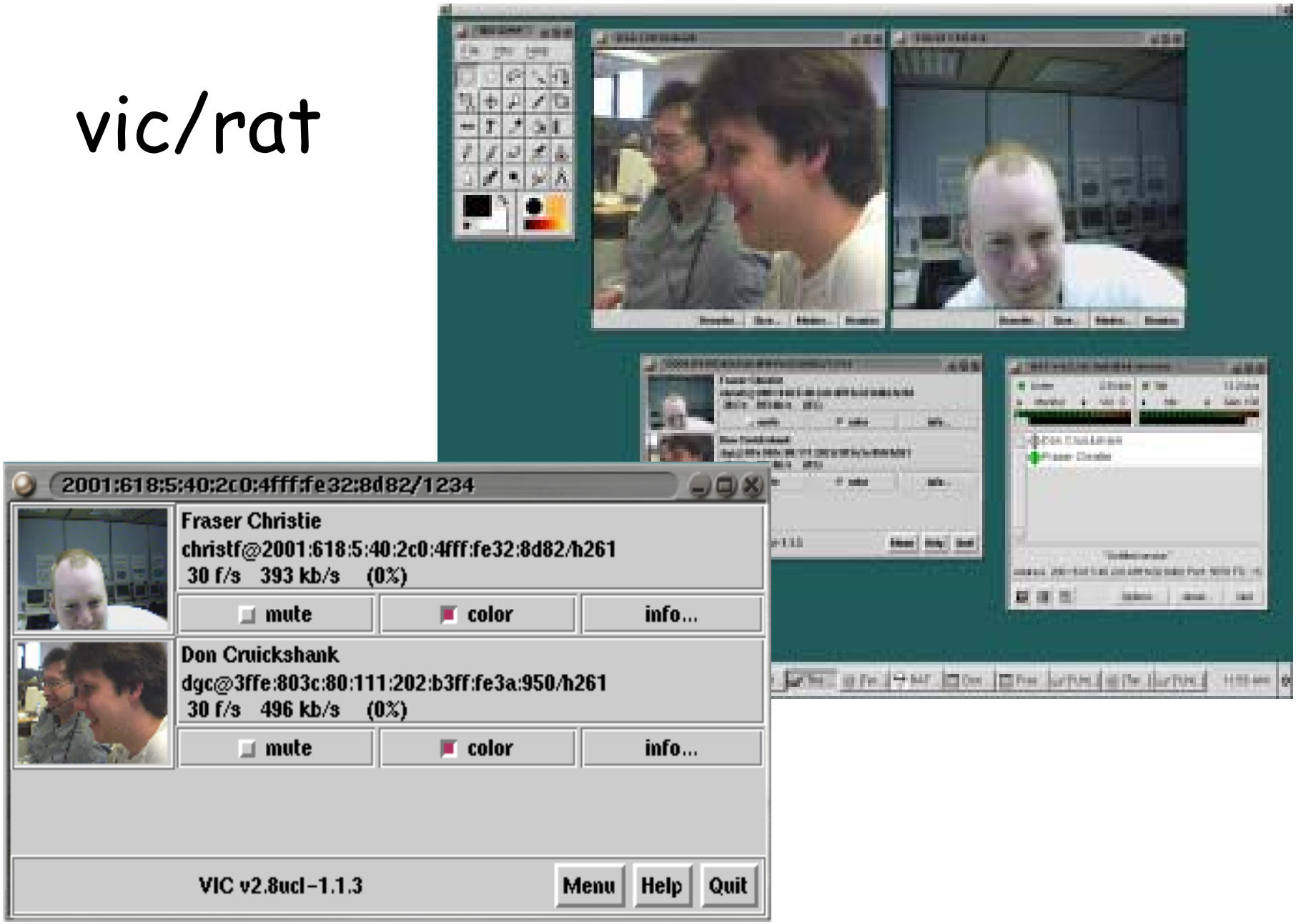
Combining dual-stack/IPv6 only

- Place public services on dual-stack servers
  - e.g. web, DNS, FTP, e-mail
- Use IPv6-only for new applications
  - Aimed at allowing peer-to-peer between IPv6 clients: IPv6 enables the client-server paradigm to be replaced by peer-to-peer.
- Take care with firewalling
  - Don't let IPv6 testbed be a back door!
  - Put dual stack servers in your IPv4 DMZ

IPv6 applications

- Basic applications/services available
  - BIND9, sendmail, Apache, OpenLDAP
  - Most Linux/BSD commands enabled out of box
- Media applications include
  - rat for videoconferencing
  - ollaborative working suite
  - N: MPEG-2 streaming (DVDs)
- the Globus toolkit to IPv6

vic/rat


2001:618:5:40:2c0:4fff:fe32:8d82/1234
Fraser Christie
christf@2001:618:5:40:2c0:4fff:fe32:8d82/h261
30 f/s 393 kb/s (0%)
mute
color
info...
Don Cruickshank
dgc@3ffe:803c:80:111:202:b3ff:fe3a:950/h261
30 f/s 496 kb/s (0%)
mute
color
info...
VIC v2.8ucl-1.1.3
Menu
Help
Quit

Challenges…

- Numerous, including
  - Determining appropriate IPv4-IPv6 transition and interworking schemes
  - Delivering broadband access so home and SME services can benefit from IPv6
  - Attracting IPv6 end users, who probably will not know they are using IPv6
  - Delivering native IPv6 network services and applications

The near future

- IPv6 support hardening further
  - Hardware support in router platforms
  - OS support - .NET, Symbian OS, Java
- IPv6 on NREN networks and GÉANT
  - By 2003/04 - major benefit from 6NET
  - Will be dual stack (already on SURFnet)
- Application introduction still slow
  - May be accelerated, e.g. by 3G
  - Led by deployment in Japan and Asia region
  - IPv4 will be around for a long time

More info

- 6NET
  - http://www.6net.org/
- Euro6IX
  - http://www.euro6ix.org/
- 6LINK
  - http://www.6link.org/
- UK IPv6
  - http://www.ipv6.ac.uk/
  - http://www.ipv6.org.uk/