

# IPv6 ROLLOUT in GÉANT2 & EUROPE

**Vasilis Maglaris** {[maglaris@mail.ntua.gr](mailto:maglaris@mail.ntua.gr)}

NREN Policy Committee - GÉANT Consortium  
National Technical University of Athens - NTUA

**Athanassios Liakopoulos** {[aliako@grnet.gr](mailto:aliako@grnet.gr)}

Greek Research & Technology Network - GRNET

**Ana Romero** {[ana.romero@dante.org.uk](mailto:ana.romero@dante.org.uk)}

DANTE

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# IPv6 @ a glance

- **IPv6 Address: 128 bits**
  - GÉANT Address Space → 2001:798::/32
  - grnet.gr1.gr.geant.net → 2001:798:2017:10aa::1  
(2001:0798:2017:10aa:0000:0000:0000:0001)
- **Allows for *routable* addresses for “everything”**
  - IP phones, 3G devices, sensors, personal devices, appliances ...
- **Easy way of end-system configuration**
  - IP address auto-configuration: *address\_prefix:f(MAC\_address)*
  - Enhanced DHCP parameter passing: NTP, SMPT, SIP ... servers (in addition to IP address, GW, DNS)
  - DHCP *prefix delegation* – assign multiple addresses to a client
- **Better support of mobility**
  - Multiple IPv6 addresses per interface, associated with multiple networks
- **Multi-homing potential**
- **Security**
  - Mandatory *IPSec* support
  - Might open unknown network security hazards (new technology)
- **Multicasting: Embedded Rendezvous Points** selected at session initiation
- **QoS *Flow Label*** in header allows easy packet differentiation

# GÉANT



- **IPv6 deployment**

- April 2003: First pilots, *Rediris* (SPAIN) and *Renater* (FRANCE)
- May 2003: IPv6 connection to *Abilene*
- June 2003: IPv6 connections to *SINET*
- July 2003: IPv6 Connection to *Canarie*
- Commercial networks: *Telia* (May 2003), *Global Crossing* (July 2003)
- October 2003: Operational support in *GÉANT*
- January 2005: IPv6 Multicast
- **April 2005: 43TBytes incoming / outgoing traffic (triple in a year)**

- **Operational issues**

- Similar policy (peering, AUPs) for IPv4 and IPv6 traffic
- Similar service levels for IPv4 and IPv6
- IPv6 traffic monitoring tools (packet filters, BGP session monitoring ...)

- **Network**

- Dual stack backbone network based on Juniper M160 and M40
- Support of BGP and ISIS

# Current GÉANT IPv6 Connectivity



## - Peering

- **European NRENs**

- **Native:** ARNES, BELNET, CARNET, CERN, CESNET, CYNET, EENET, FCCN, GARR, GRNET, HEAnet, HUNGARNET, IUCC, ISTF, JANET, NORDUnet, PSNC, RedIRIS, RENATER, RESTENA, RoEduNet, SANET, SURFnet, SWITCH, Ulakbim
- **Tunnel:** ACONET, DFN, LITNET, University of Malta
- **Not connected:** LATNET

- **International:** **Native** - Abilene, CANARIE, ESnet, **Tunnel** – SINET, APAN-KR via Renater

- **Commercial:** **Tunnel** - Global Crossing, Telia

## IPv6: GÉANT to non-European NRNEs via Abilene

- **ARIN Region:** *DoD* (ASN 22), *VBNS* (ASN 145), *Univ. of Wisconsin* (ASN 2381), *Univ. of Indiana* (ASN 22398)
- **LACNIC Region:** Brazil - *RNP* (ASN 1916), Argentina - *RETINA* (ASN 3597)
- **APNIC Region:** Taiwan - *TANET2* (ASN 7539), Japan - *WIDE* (ASN 2500), Australia - *AARNET* (ASN 7570), Singapore - *SINGAREN* (ASN 7610), *Thailand Ministry of University Affairs* (ASN 4621), *Chinese Univ. of Hong Kong* (ASN 3662)

# GÉANT2 Routing Policies

- **sTLA (sub – Top Level Aggregation)**  
2001:0798::/32
- **Prefix lengths accepted**  
in the range /19 to /35 (with exceptions for Root Name Servers)
- **Do NOT accept 6bone prefixes**  
3ffe::/16

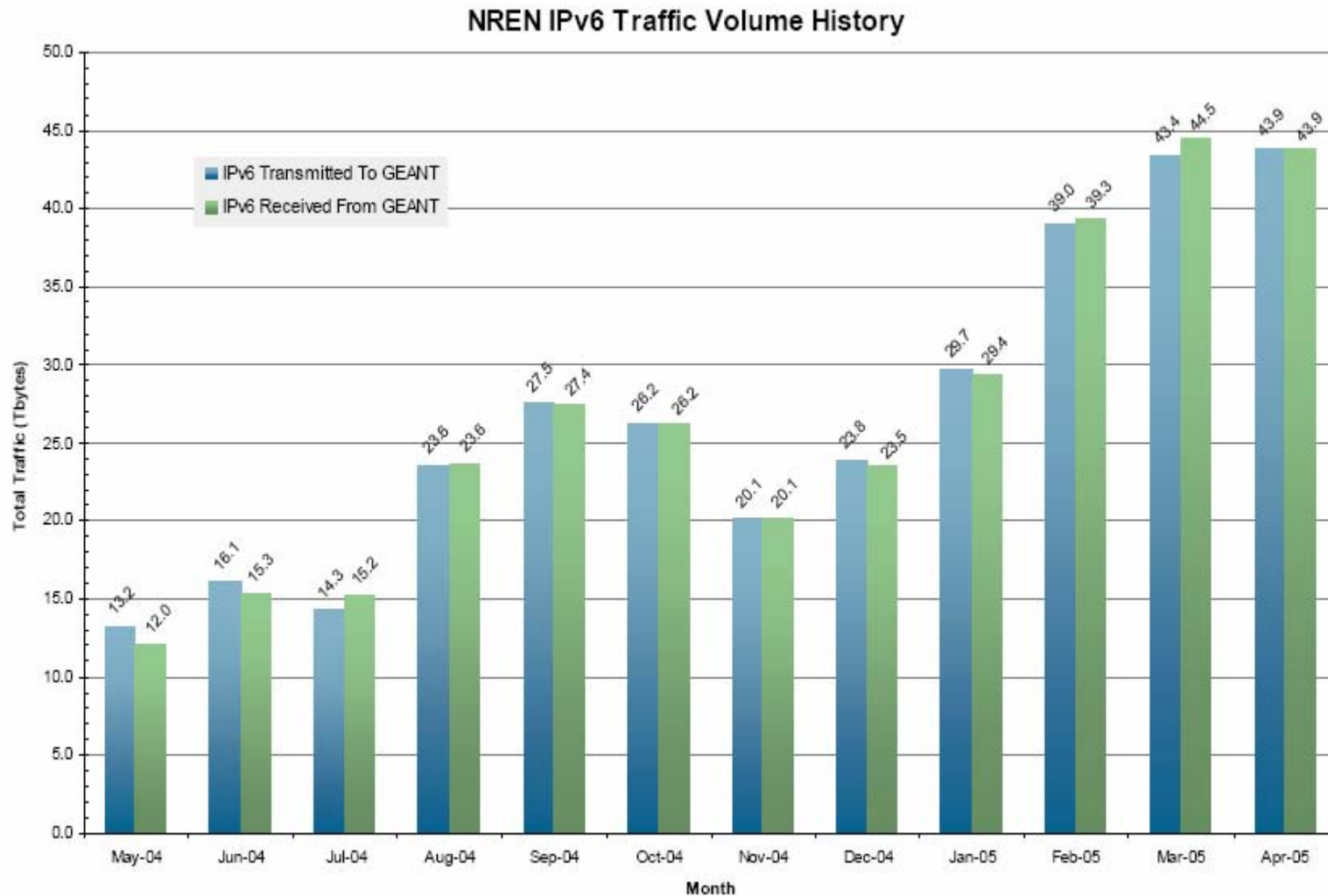
# Multicast IPv6 in GÉANT

- **Native Multicast IPv6 across GÉANT backbone**
  - Pilot service ready since early 2005
  - Tested in 2004 in collaboration with Multicast v6 TF
  - Request for specific *mcast* v6 features to Juniper
- **Several NRENs connected to the multicast IPv6 enabled core**
  - 12 NRENs already connected - 7 in native, rest in tunnels
  - Connectivity to *M6bone* via *Renater*
  - Native connectivity to *Abilene*

Access Ports	Speed Mbps	IPv6 Transmitted To GEANT			IPv6 Received From GEANT			Traffic Asymmetry	Max. Load
		Average Mbps	Peak Mbps	Volume Gbytes	Average Mbps	Peak Mbps	Volume Gbytes	See Appendix	See Appendix
ACONET ↔ AT	622	0.05	1.19	15.13	0.04	5.20	12.05	0.11	0.01%
ARNES ↔ SI	1,240	0.00	0.07	0.13	0.00	1.53	0.52	-0.60	0.00%
BELNET ↔ BE	2,500	39.38	49.99	12759.44	6.22	10.85	2015.34	0.73	1.58%
CARNET ↔ HR	1,240								
CESNET ↔ CZ	2,500	0.00	0.18	1.10	0.11	14.15	36.58	-0.94	0.00%
CYNET ↔ GR	155								
DFN ↔ DE	10,000	0.27	14.62	88.35	0.24	17.77	78.76	0.06	0.00%
EENET ↔ SE	622	0.00	15.29	1.04	0.01	3.89	3.66	-0.56	0.00%
FCCN ↔ PT	1,240	0.01	10.87	4.50	0.16	16.16	51.90	-0.84	0.01%
GARR ↔ IT	10,000	0.03	4.53	9.88	0.15	18.07	47.30	-0.65	0.00%
GRNET ↔ GR	2,500	0.01	0.41	2.75	0.11	11.59	35.32	-0.86	0.00%
HEANET ↔ IE	2,500	3.68	14.30	1193.16	0.00	0.00	0.06	1.00	0.15%
HUNGARNET ↔ HU	10,000	0.01	0.61	2.56	0.02	11.13	5.28	-0.35	0.00%
ISTF ↔ HU	155	0.00	0.01	0.10	0.00	0.17	0.19	-0.33	0.00%
IUCC ↔ IL	310	0.00	0.01	0.00	0.00	0.37	0.10	-1.00	0.00%
JANET ↔ UK	2,500	0.07	1.71	23.91	0.02	3.14	7.58	0.52	0.00%
LATNET ↔ SE	155								
LITNET ↔ SE	622	0.10	3.05	31.82	0.18	34.29	58.06	-0.29	0.03%
MALTA ↔ IT	20	0.00	0.00	0.00	0.00	0.04	0.03	-1.00	0.00%
NORDUNET ↔ SE	10,000	9.77	32.42	3166.65	42.36	50.00	13725.68	-0.63	0.42%
PSNC ↔ PL	10,000	2.14	4.15	693.07	16.59	25.65	5375.16	-0.77	0.17%
RBNET ↔ SE	155	0.01	17.66	2.49	0.00	0.46	0.42	0.71	0.00%
REDIRIS ↔ ES	10,000	0.14	14.41	45.88	0.04	14.82	12.96	0.56	0.00%
RENATER ↔ FR	10,000	0.46	10.97	147.97	0.30	19.79	97.52	0.21	0.00%
RESTENA ↔ LU	155	0.00	0.01	0.06	0.00	0.01	0.06	0.00	0.00%
ROEDUNET ↔ HU	622	0.00	0.25	0.45	0.02	8.14	5.02	-0.83	0.00%
SANET ↔ SK	200	0.00	0.06	0.10	0.00	2.51	0.32	-0.54	0.00%
SURFNET ↔ NL	10,000	45.53	50.00	14750.52	31.34	49.99	10155.72	0.18	0.46%
SWITCH ↔ CH	2,500	33.84	49.98	10962.60	37.42	49.96	12123.50	-0.05	1.50%
ULAKBIM ↔ GR	622	0.00	0.03	0.16	0.01	0.94	4.31	-0.93	0.00%



# IPv6 volume history



# International Traffic

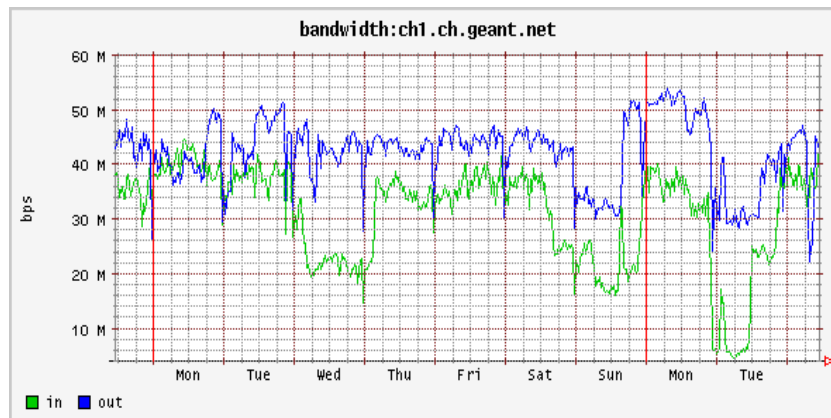


Interconnect Circuits	Speed <i>Mbps</i>	IPv6 Transmitted To GEANT			IPv6 Received From GEANT			Traffic Asymmetry	Max. Load
		Average	Peak	Volume	Average	Peak	Volume	See	See
		<i>Mbps</i>	<i>Mbps</i>	<i>Gbytes</i>	<i>Mbps</i>	<i>Mbps</i>	<i>Gbytes</i>	<i>Appendix</i>	<i>Appendix</i>
ABILENE ⇄ DE	2,500	0.00	0.43	0.36	0.02	0.97	5.90	-0.89	0.0%
ABILENE ⇄ NL	2,500	0.08	4.44	24.72	0.06	1.51	18.05	0.16	0.0%
ABILENE ⇄ NY	1,000	0.00	0.32	0.13	0.21	7.14	68.46	-1.00	0.0%
CANARIE ⇄ NL	1,000								
CANARIE (MAN) ⇄ NY	1,000								
CANARIE ⇄ NY	1,000	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.0%
CLARA ⇄ ES	622								
EUMED ⇄ IT	155								
ESNET ⇄ NY	2,500	0.00	0.03	0.13	0.00	0.99	0.78	-0.71	0.0%
SINET ⇄ NY	2,500								
TENET ⇄ UK	155								
INFONET ⇄ UK	155								
<b>TOTAL</b>		<b>25.4</b>			<b>93.2</b>				

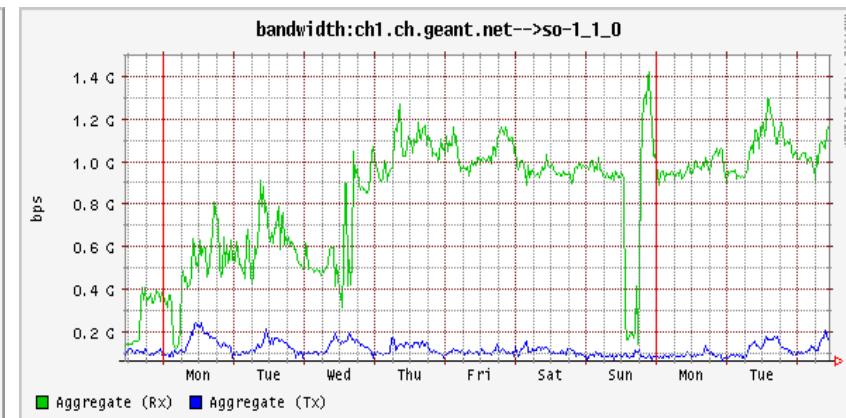
Other Interconnections	Speed <i>Mbps</i>	IPv6 Transmitted To GEANT			IPv6 Received From GEANT			Traffic Asymmetry	Max. Load
		Average	Peak	Volume	Average	Peak	Volume	See	See
		<i>Mbps</i>	<i>Mbps</i>	<i>Gbytes</i>	<i>Mbps</i>	<i>Mbps</i>	<i>Gbytes</i>	<i>Appendix</i>	<i>Appendix</i>
Global Cross. ⇄ DE	2,500	0.40	5.92	130.02	1.64	15.74	529.77	-0.61	0.1%
Telia ⇄ UK	2,500	0.07	2.60	21.16	0.37	6.39	119.49	-0.70	0.0%
<b>TOTAL</b>		<b>176.5</b>			<b>742.5</b>				

# IPv6 Vs IPv4 Traffic volume

**GÉANT v6 traffic volume: 2% IPv6 of the total traffic**



IPv6 daily traffic stats for SWITCH access to GÉANT



Daily total traffic stats for SWITCH access into GÉANT

Daily statistics from one of the most IPv6 users in GÉANT: SWITCH with 5% IPv6 traffic volume of the total traffic in the access

# Case Study: GRNET

- **GRNET dual stack IPv6 network**
  - GRNET2 (Cisco GSR12400) since December 2003 - GRNET1 (Cisco 7500) since March 2004.
  - Basic networking services, e.g. DNS, and monitoring.
  - Gradual increase of IPv6 traffic towards GEANT, e.g. 52GByte in Feb2005.
- **IPv6-only test network since 2002 – 6NET**
  - Connect Athens, Thessaloniki, Patra and Heraklion (Crete)
  - Validate protocols and routers functionality.
- **IPv6 support in Universities**
  - 10 Universities with *native IPv6* connections
  - Services: Address allocation, native connectivity, servers, multicast, etc
- **IPv6 deployment in Greek School Network**
  - Dual stack core network + ADSL *native IPv6* access for 150 schools
  - Plan smooth migration IPv6.
- **IPv6 Forum**
  - ISPs, Mobile Operators, Telcos, Vendors, Software developers, Government

# Other Regions

- **SEEREN (South Eastern Europe)**
  - 6PE services over Carrier Supporting Carrier (CsC).
  - Basic interconnection services achieved – Monitoring infrastructure deployed.
  - Extend IPv6 services in SEEREN2 (phase 2)
- **EumedConnect**
  - Plans for deployment
- **ALICE**
- **SILK**
  - IPv6 Streaming over Satellite

# IPv6 IST Projects

- **6NET** ([www.sixnet.org](http://www.sixnet.org))
  - Objectives: Operate a large scale native IPv6 network and validate / gain experience with protocols, applications and new services.
  - Services: DNS (DNSSec), Multicast, DHCPv6, Routing (policies & specification language), Security, IPv6 QoS, Mobile IPv6, VPNs, etc.
  - Applications, e.g. Videoconferencing, Streaming, Online Games, etc.
  - Management, e.g. ASPath, Looking Glass, Weathermap, IRRToolSet, MRTG, Nagios, rancid, etc.
- **EURO6IX** ([www.euro6ix.org](http://www.euro6ix.org))
  - Set IPv6 Regional Exchanges
  - European TELCOs
- **6DISS** ([www.6diss.org](http://www.6diss.org))
  - Know-how transfer from European IPv6 projects (6NET, Euro6IX, GEANT), TERENA, European NRENs to research network operators, universities, commercial organizations, governments and regulators in various regions in the world.
  - Target areas: Balkans (e.g. Bulgaria, Rumania, Moldova & Turkey), Mediterranean countries, Newly-Independent States, Sub-Saharan Africa, Southern Africa, The Caribbean, Asia-Pacific region, South and Central America . . . + exchange with organisations in India & China

# Next Steps

- **Increase awareness to end users**
- **Increase IPv6 deployment to schools, libraries**
- **Mobility – Security – QoS support**
- **Inter-domain multicast IPv6**
  - Implementing embedded RP (Rendezvous Points) selection when setting a session
  - Available in JUNOS 7.0R2, other vendors e.g. Cisco also support it
  - Needs to be deployed in all the domains
- **New applications – Services – Integrate**
- **Migration of commercial networks**
- **Broadband, Wireless and 3G networks**
  - Always on, mobile users (ubiquity)