IPv6 Services over xDSL Networks

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Presentation Outline

- The Greek Schools Network
- Why to move to IPv6?
- Deployment Strategies
- Address Delegation
- Cooperation
- Experiences

GSN Organization Profile

- The Greek School Network (GSN) is the educational intranet of the Ministry for National Education and Religious Affairs of Greece
- Objectives:
  - Provision of IP connectivity and IT services to the vast majority of primary/secondary schools in Greece
  - Facilitate the integration of new technologies in the educational process

Network Architecture

Backbone:

8 major PoPs, interconnected via GRNET

Distribution Network:

51 nodes

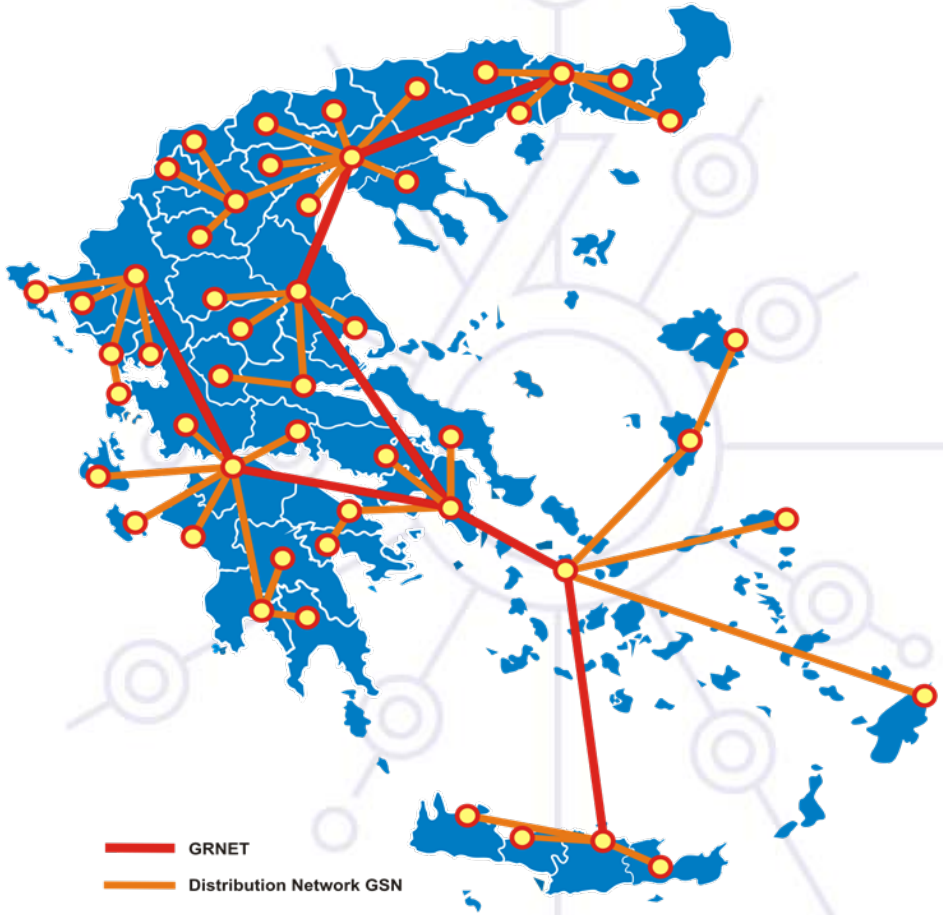
(8 main, 43 secondary)

Access Network technology:

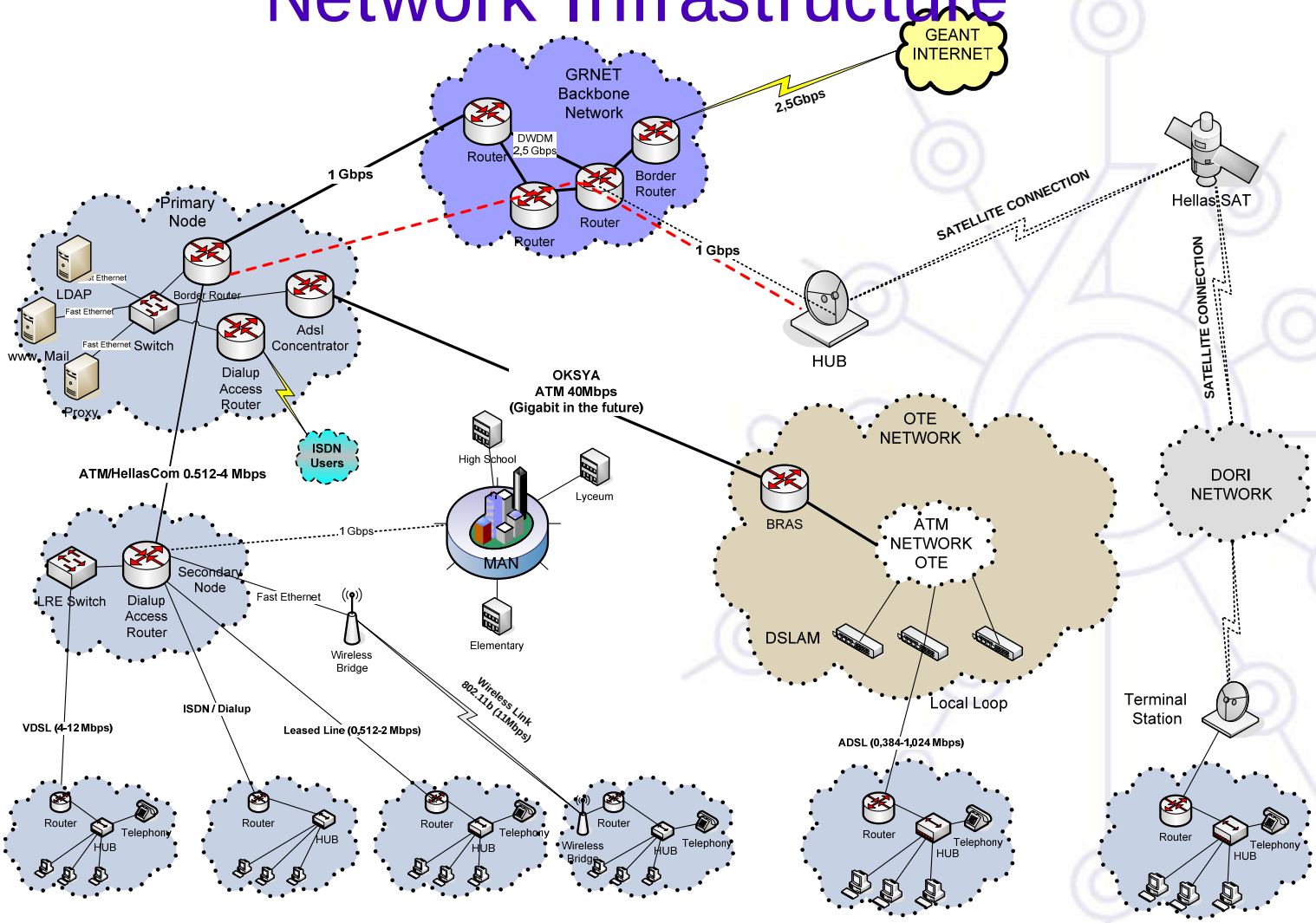
- Dialup (ISDN, PSTN)
- ADSL
- Leased Lines (SDSL, VDSL),
- Wireless

Number of connected schools:

- 14.200 primary & secondary
- schools (~100%)
- 2.862 administration offices



Network Infrastructure



GSN Services

- **Basic Services**
  - Broadband / dial-up access
  - E-mail, Mailing lists
  - Forums, instant messaging, blogs
  - Portal (www.sch.gr)
  - Web-Hosting / Creation
  - Web-Filtering, Proxy/Cache
  - E-cards, E-News
  - Security - CERT
- **Advanced Services**
  - E-learning
  - Real time services, VoD
  - Secure Content Delivery
  - Teleconference, Voice over IP

GSN Services (#2)

- **Infrastructure Services**
  - Directory Service (LDAP)
  - Public Key Infrastructure - AAI
  - User registration service
  - Statistics
  - Helpdesk
  - QoS Monitoring
  - DNS
  - GIS, Remote control

Why to move to IPv6?

- IPv6 removes the limitations imposed by the IPv4 address shortage
  - Every school has a NAT / PAT gateway due to address shortage
  - Difficult to debug interconnection problems
  - IPv6 provides enough address space for every school and pupil!
- P2P applications do not work with servers behind NAT/PAT
  - Multimedia e-learning and peer-to-peer virtual collaboration applications
  - Development of P2P applications becomes easier

Why to move to IPv6?

- Management and security issues
  - Deployment procedures in large numbers (auto-configuration of CPE routers and PCs)
  - Address fragmentation resolved – Simplify routing
  - Easier aggregation of classes of users
  - Security policies can be simplified using the IPv6 addressing schema which identifies various types or user groups and services

Why to move to IPv6?

- Innovation – Expose to new technologies
  - Access to new technologies is now a reality for young students
  - Today's school pupils are the future citizens (or engineers)
  - National programs target today for school laptops per child - Complementary programs to OLPC initatives
  - IPv6 allows the development of new advanced services that exploit features unique to IPv6 environments, such as enhanced security, multicast or mobility
  - Multiply the impact of other IPv6-enabled networks in Greece

Deployment Phases

- Phase 1 (2004-2005) Design studies & Preparation
  - Acquire address space, lab trials, upgrade core network, upgrade basic operational services , network monitoring
- Phase 2 (2006-2007) Pilot - Limited size network
  - Limited size trials, acquire operational experience, define specifications for long term hardware and software upgrades
- Phase 3 (2007-2008) – IPv6 & Broadband access
  - Large deployment of IPv6 access routers and servers, studies related to PC-labs (management, security, etc)
- Phase 4 (2009 -) - Applications
  - Large scale PC-lab upgrades, development of new services

Deployment Strategy for *Core network*

- All major PoPs have been upgraded (dual-stack) to IPv6
  - First part of the network to enable IPv6
  - Established IPv6 BGP peering with GRNET
  - Internal routing fully supports IPv6

Deployment Strategy for *Core network*

- Secondary distribution nodes still do not support IPv6
  - Distribution nodes today aggregate dialup connections from (obsolete) ISDN access routers – Limitations in memory and CPU capabilities
  - GSN decided to shift interconnection model from dial-up/ISDN to broadband (xDSL, wireless, etc).
  - New (broadband) access model resulted to revise network upgrade path and hardware specifications for new equipment
  - Plans to connect schools via (metro) Ethernet services to new distribution nodes. Public metropolitan area networks (MANs) are currently deployed.

Deployment Strategy for *Access Network*

- Started with on site trials at 50 schools
  - Create multiple CPE configuration files based on different interconnection models
  - Validate IPv6 address assignment scheme
    - Easy IPv6 address management and dynamic assignment for every school CPE (using DHCP prefix delegation)
- Moving to ~500 schools
  - Deploy IPv6 up to the access router in each school
  - PC labs still lacking IPv6-enabled OS due to administrative (&not technical) reasons
- Enable IPv6 to ~3000 schools in a large deployment program
  - All schools will be connected via broadband access uplinks
  - Deployment still in progress – Complete in 2008

Deployment Strategy for *Infrastructure Servers*

- Upgrade all servers to become dual-stack
- Second upgrade services to support IPv6
  - Email (SMTP, IMAP, POP3)
  - Web hosting
  - GSN Web portal (www.sch.gr)
  - Web proxy / web filtering – The most difficult task!
  - AAA (Radius software and attributes)
  - Instant Messaging
  - Directory service (LDAP)
- Upgrade DNS service and update DNS entries
- New datacenters are equipped with IPv6-capable (aka OS and software) server farms

Deployment Strategy for *School PC labs*

- The most demanding challenge today
  - Administrative difficulties due to the large number (aka thousands) of PCs deployed in ~15K end sites
  - Management model of PC labs has changed the last years. Today, the administration of the labs is delegated to each school – Lack of central control / coordination
  - PC labs are based on (obsolete) operating systems, such as M$ W2K
  - Large costs for IPv6 upgrades combined with software upgrades and hardware lifecycles
- Pilot tests to remotely enable IPv6 inside school labs (PCs and servers)
  - A limited number of schools already have commercial remote management software
  - Also working on open source remote management tools
  - Work still in progress

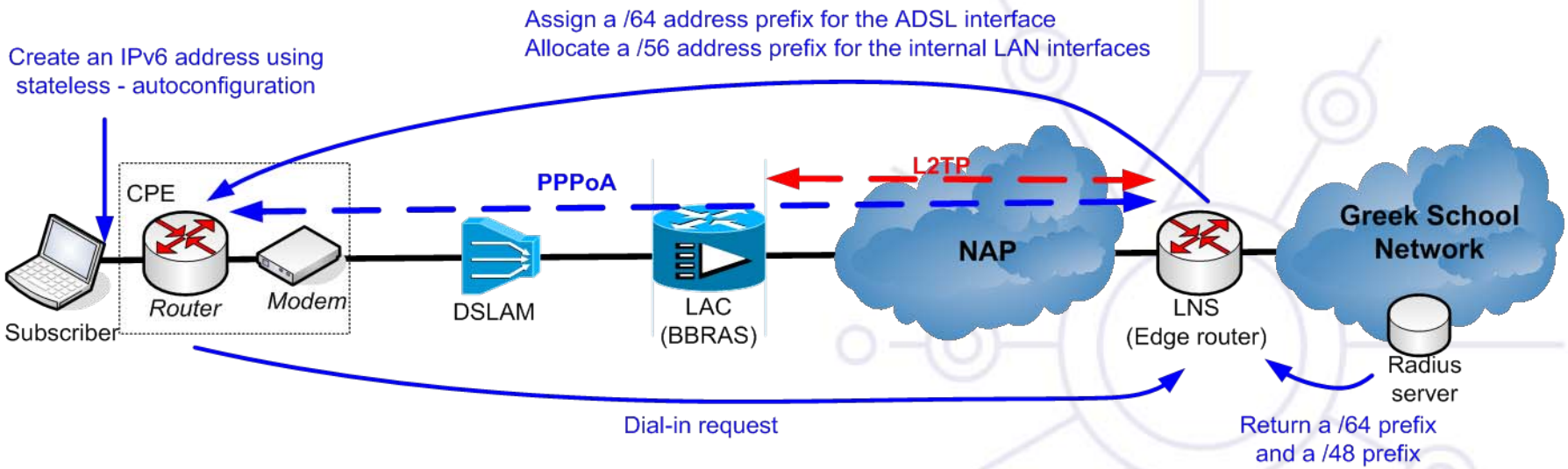
Address Delegation in School GW

- Delegating IPv4/6 addresses in GSN is a two-step process
  - Delegate an IPv6 prefix to the WAN interface and then assign an IPv6 prefix for the LAN interfaces.
  - Use another -different and independent- process for delegating IPv4 addresses.
- Scenario A – *Simple*
  - WAN interface gets an /128 IPv6 address via IPCPv6 or IPv6 loopback is statically configured.
  - LAN interface(s) is manually configured.
  - Statically set a static route at the LNS towards the CPE
  - Easy to deploy to IPv6-enabled routers but difficult to manage the access network! No means to provide extra configuration parameters to the local PCs, e.g. NTP servers.

Address Delegation in School GWs (#2)

- Scenario B – *Using DHCP-PD*
  - WAN interface gets an /64 prefix -instead of specific IPv6 address- by using IPCPv6. If there is a need for a static address assignment to the school router, the *Frame-Interface-ID** should also be provided.
  - Internal LAN interfaces are automatically configured using DHCP-PD (prefix delegation). This process takes place in IP layer, aka independent of the PPP session.
  - Automatically, a static route towards the CPE is set at the LNS.
  - This scenario allows full automated interface configuration while it is possible to provide extra configuration parameters to the local PCs.

Address Delegation in School GWs (#3)



Cooperation

- GSN has successfully cooperated the last years with other organizations, research projects, and companies to leverage results
  - Greek Research Network – GRNET (www.grnet.
    - Long term knowledge transfer between NOCs
  - 6NET (www.6net.org)
    - Project participated to the design phases and first trials
  - Cisco Systems
    - Provide technical expertise and support at pilot phase
  - 6DISS (www.6diss.org)
    - Training of GSN engineers in 6DISS IPv6 workshops
  - 6DEPLOY (www.6deploy.org)

GSN Experiences

- IPv6 deployment in a large and complicated network is achievable with reasonable cost in terms of equipment and man power effort
- IPv6 technology is mature and can be deployed without the fear of network collapse
- Open source software allowed quicker upgrade of GSN services

GSN Experiences (#2)

- BUT, IPv6 transitions should start cautiously in order to:
  - Gain technical experience and become familiar with IPv6
  - Locate and diagnose possible problems
  - Decide beforehand to long term deployment strategies to avoid unnecessary costs
  - It is important IPv6 deployment to be planned with equipment upgrades

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