Enabling Grids for E-sciencE

DJRA4.3
Report on implications of IPv6 usage for EGEE Grid

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Objectives

From the EGEE Technical Annex :

- **A study will be made of the features of IPv6, seeking those that are of direct benefit to Grids (Completed).**
- **The availability of IPv6 in the NRENs and Access networks will be monitored (Completed).**
- **Awareness of IPv6 (First survey):**
  - Middleware engineering activities to avoid dependencies that constraint middleware to operate with only IPv4 Grid operations. activities to understand the benefits of IPv6 usage in operating a large-scale Grids.
  - Applications communities, to understand the benefits of IPv6 usage by applications.

IPv6 protocol : features

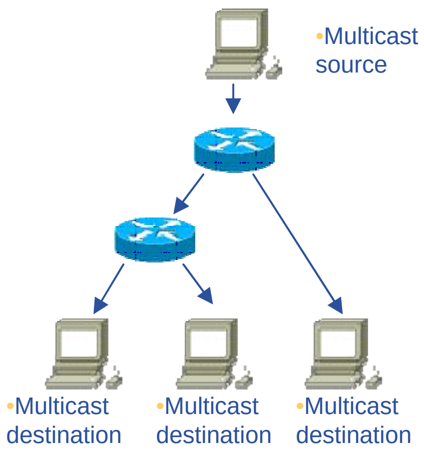
- **IPv6 was defined to solve lack of IPv4 addresses in the mid nineties,**
  - Expanded Address Space (128 bits v.s. 32 bits).

- **Opportunity to review IP Protocol in depth:**
  - Headers,
    - => Header format simplification with clean extensibility.
  - Configuration,
    - => Automatic configuration.
  - Multicast,
    - => No more Broadcast -> Multicast.
  - Quality of Service,
    - => Class of Service support.
  - Security,
    - => IPv6 includes IPSec.
  - Mobility.

In the protocole core specification

IPv6 protocol : Advantages

- **Addressing:**
  - Restoration of end-to-end addressing,
    - no more NAT, security.
  - Enhanced Multicast,
    - Could be useful for File Transfer.



  - Hierarchic Addressing plan,
    - better efficency for routing.

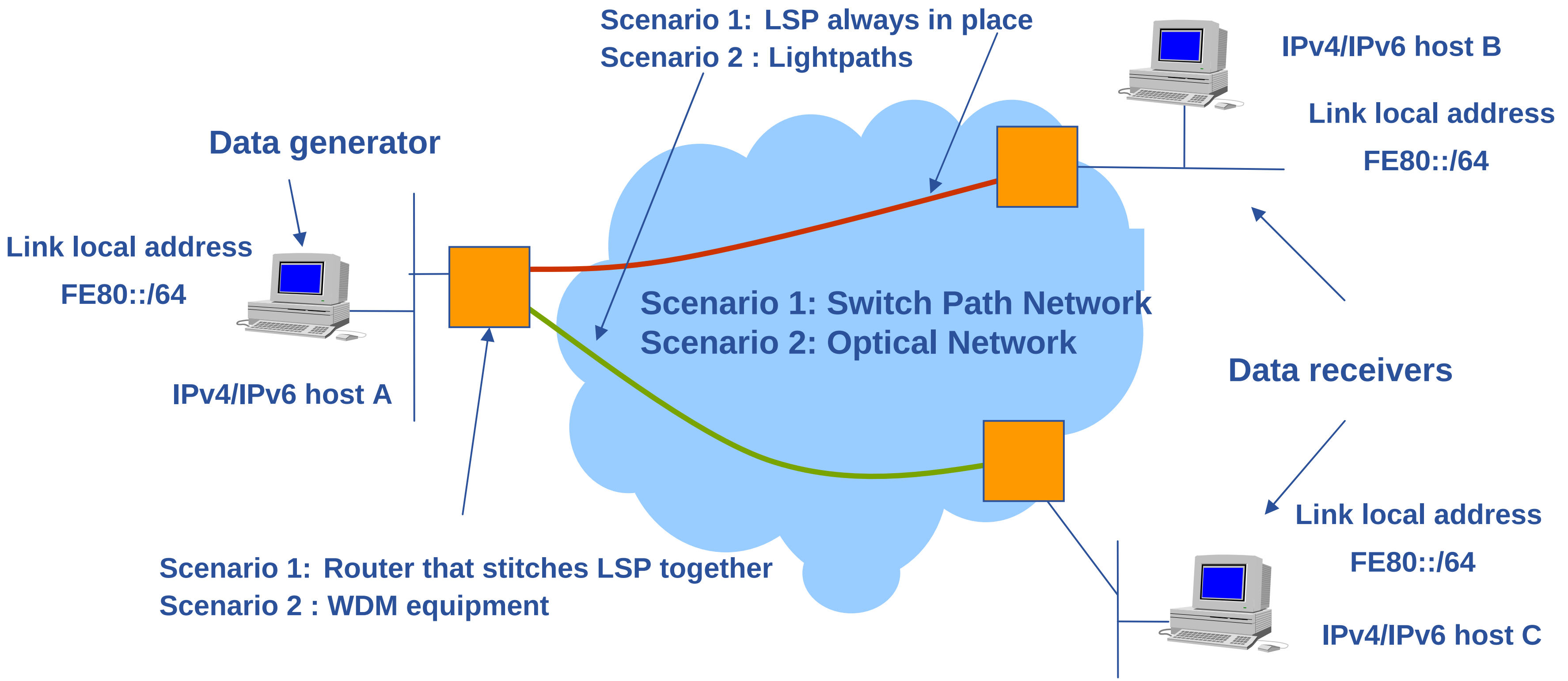
32 bits	8 bits	20 bits	4 bits	Interface ID (64 bis)
Prefix given to NRENs	RENATER (/32)	Univ. of Jussieu (/40)	CNRS/UREC (/60)	

- **Native Protocols in IPv6:**
  - IPSec security
    - robust end-to-end security.
  - Mobile IP:
    - Host is keeping its IP address when moving.
    - Useful for mobile user.

- **IPv6 and the network:**
  - Extension header,
    - possibility to add information.
  - Class of Service,
    - Diffserv model.
  - Automatic configuration,
    - No need to configure manually.

IPv6 protocol : Grid Layer-2 connectivity

It has been shown that Layer 2 connectivity between remote server farms have some positive effects for the Grid Middleware.



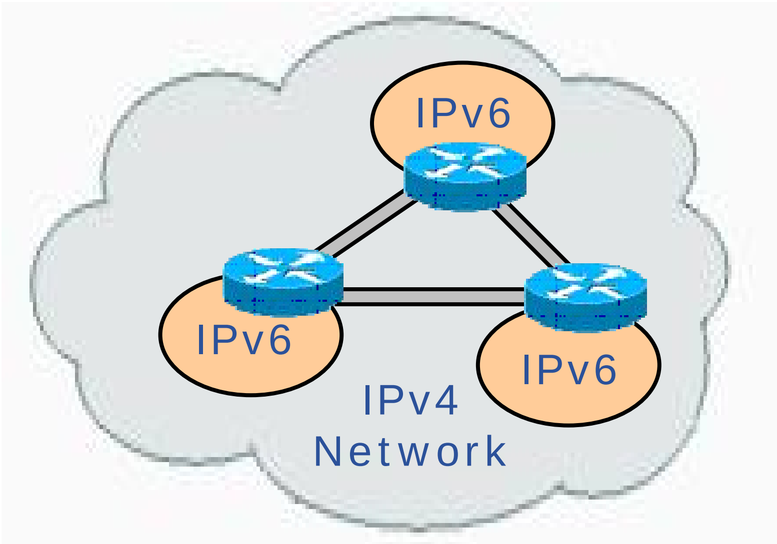
WDM: Wavelength Division Multiplexing

IPv6 Link Local Address and Stateless configuration provide solution that does not require any Layer 3 manual configuration.

IPv6 protocol : Cohabitation IPv4/IPv6

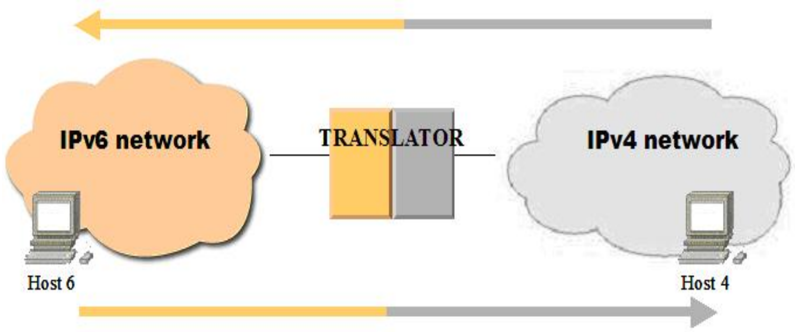
Transition mechanisms:

- Dual Stack,
  - IPv4 and IPv6 stacks on the same host/router.
- IPv6 over IPv4 tunneling,
  - Tunnel Brokers, IPv6 Manually configured tunnel, 6to4, IPv6 over IPv4 GRE, 6PE.



Translation mechanisms:

- For communication between an only IPv6 host and an only IPv4 host.
- Several mechanisms.
- Introduce NAT mechanism for IPv6.



All these mechanisms are used in the deployed netwoks.

IPv6 deployments : In the world

- In Europe:
  - 2000 European Pv6 introduction with 6INIT.
  - 2002 Broad European deployments with 6NET and Euro6IX (2200 pm).
  - 2005 6DISS, Europe promotes now IPv6 deployments in developing regions.

- In Asia,
  - Main priority for Japan since 2000 to upgrade both public and private networks.
  - China : IPv6 backbones have been already deploy because of huge need of addresses.

- In the United States,
  - North American IPv6 Task Force (2001), Moonv6 Project (2003).

- ISPs:
  - Several deployments: MCI, Telia, NTT, Global Crossing.
  - In Japan, ISPs propose IPv6 access to their clients and specific services (free-video on demand).

Many deployments, the interconnection is provided by GIXs.

GIX : Global Internet eXchange node.

IPv6 deployments : GEANT and NRENs

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Name	Country	Connection date
IUCC	Israel	April 03
LITNET	Lituania	May 03
NORDUnet	Nordic countries	August 03
PIONER	Poland	May 03
Rbnet/RUNnet	Russia	September 03
RedIRIS	Spain	April 03
RENATER	France	April 03
RESTENA	Luxembourg	June 003
RoEduNet	Romania	May 03
SANET	Solvakia	October 04
SURFnet	Netherland	April 03
SWITCH	Switzerland	May 03
UKERNA	UK	June 03
ULAKBIM	Turkey	May 03

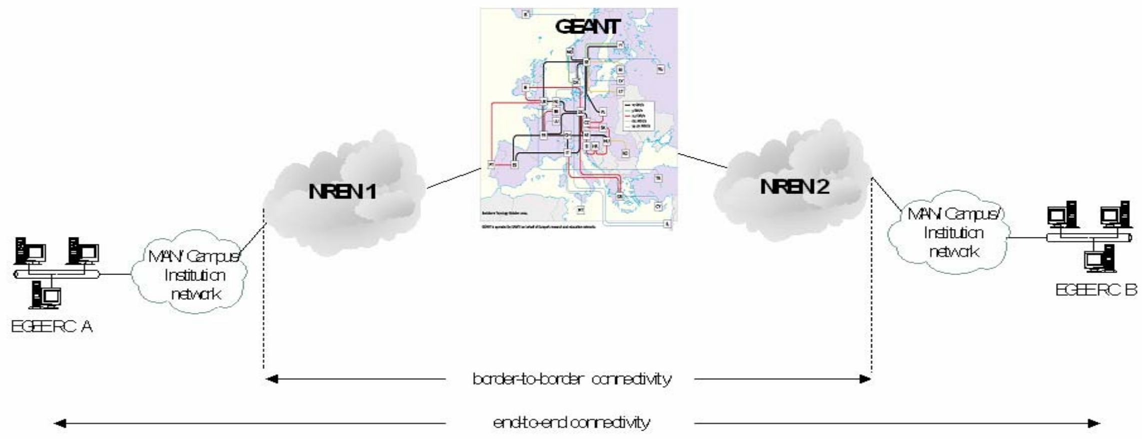
Name	Country	Connection date
ACOnet	Austria	May 03
ARNES	Slovenia	July 03
BELNET	Belgium	July 03
CARNet	Croatia	March 03
CESNET	Czech Republic	July 03
CYNET	Cyprus	December 04
DFN	Germany	September 03
EENet	Estonia	May 03
FCCN	Portugal	April 03
GARR	Italy	April 03
GRNET	Greece	July 03
HEAnet	Ireland	April 03
HUNGARNET	Hungary	June 03
ISTF	Bulgaria	May 05

Although not a NREN, CERN is directly connected to GEANT since May 2003. GEANT has an internationnal peering with Abilene and CANARIE since the middle of 2003 with a native connection type.

The main services offered are DNS, FTP mirroring, video-streaming.

IPv6 becomes a true service for NRENs.

IPv6 deployments : The last mile



- Not all regional, metropolitan and campus networks support IPv6:
  - Last mile is often a source of problems in end-to-end approach networks (QoS, monitoring, troubleshooting, SLA).
  - Same situation for IPv6.
- To prove the opportunity to go deeper into IPv6 in EGEE, a testbed involving all the connectivity models in an IPv4/IPv6 cohabitation world could be very interesting for the Grid,
  - By testing deployment, scalability and performance of some transition scenarios.

IPv6 & Grids: Efforts for Grids

- **Stantardization authority : GGF IPv6 - Working Group**
  – Study of IP version dependencies in GGF specifications.
  – Guidelines for IP independence in GGF specifications.
  – Status for Java Developers Kit API for IPv6.
- **Projects:**
  – 6NET => European project porting and testing Globus on IPv6:
    - Targeting Globus Toolkit 3.
    - Deployed GT3 IPv6 testbeds at UCL and UoS.
    - Collaboration with Argonne National Laboratory development team.
  – 6Grid => Japanese project working on IPv6 and Grid:
    - Aim to use benefits of the IPv6 protocol (end-to-end, IPSec, automatic configuration).
    - Development of IPv6-enabled Globus Toolkit 2.

IPv6 & Grids : Applications

- **Network programming**
  - Applications interact with the network through network interfaces
    - Sockets, Remote Procedure Calls, Streams
  - APIs are IPv6 compliant
    - The Sockets programming interface has been extented
  - Avoid Hard-coded IPv4 addresses in code.

  An application which does not use a network programming interface or hard coded IPv4 address is not IP dependent by itself
    - If it calls a file transfer program with host name.

- **Languages (C, Java, Perl, Python),**
  - Last versions support IPv6.
  - As Java support IPv6, there are no reason to consider that deployment of Web Services in an IPv6 environment is not possible.

- **Operating Systems,**
  - Scientific Linux 3, Linux RedHat 7.1 and more.

First survey of the IP dependencies:

gLite Services	Observations	Comments
Workload Management System	Suspected possible dependencies in the relations between the WM elements (Match Maker, Information Supermarket, Job Submission & Monitoring).	Detailed code survey is necessary to find the IP dependencies.
Data Management	Use of URI, there are no obvious IPv4-dependencies.	
Computing Element	Use of URI, there are no obvious IPv4-dependencies.	
Data Access	GridFTP is not IPv6-enabled.	ANL developed a globus_eXtensible Input Output library (XIO), which may be used to implement a IPv6-enabled GridFTP.
	NFS is IPv6-enabled.	
Information & Monitoring	Some libraries are not IPv6-enabled.	
Logging & Bookkeeping	Suspected dependencies.	Detailed code survey is necessary to find the IP dependencies.
Accounting	Use of URI, there are no obvious IPv4-dependencies.	

IPv6 & Grids: Equipments

- **Clusters**
  - At first sight, a cluster with an appropriate OS becomes IPv6 compliant.
  - Today the best way is certainly the Dual Stack mecanism
    - The cluster can support IPv4 and IPv6 applications.
- **Routers**
  - Recent network equipments are dual-stack with an implementation conforming to IETF standards.
  - Features and some transition/translation mechanisms are supported.
    - SSH, Telnet, TFTP for management purpose.
- **Network Administration**
  - Automatic configuration mechanisms.
  - For managing network: SNMP, like in IPv4, with IPv6 MIBs.
  - Monitoring tools available.

IPv4/IPv6 cohabitation involves a competence in two protocols from system and network administrators.

But keep in mind that there is no reason for network and system administrators to face twice the amount of work.

Conclusion : Impact on EGEE

- **gLite is not IPv6-enabled yet.**
- **Both IP protocols will coexist for many years**
  - Applications and middleware will have to live in the resulting « Dual stack » worldwide network.
  - Regarding the emergence of new countries (India, China and Latin American) may accelerate IPv6 arrival.
    - They are interested by Grid computing and perhaps gLite.
- **From a network point of view, including infrastructure deployment, services and programming, there is no obstacle to tackle an integration of IPv6 in EGEE.**
  - Existing recommendations from international bodies (IETF, GGF) must be followed.
- **Resources and experience from various activities need to team up.**
  - Development, integration, testing, operations.