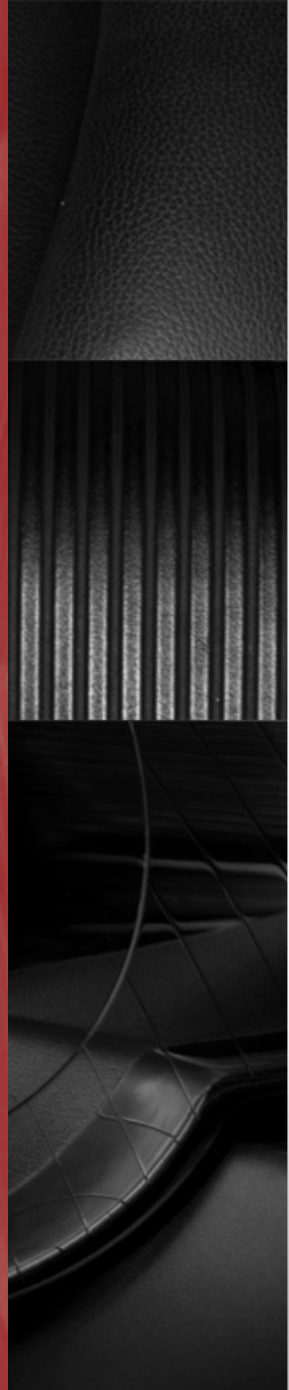# Deployment of IPv6 protocol in broadband networks

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IPv6 over MPLS transport network

Two technologies exist for IPv6 implementation over MPLS network:

- **6PE, RFC 4798**

6PE technology enabled IPv6 traffic transit over MPLS network, thus, IPv6 support is required only on PE-routers. Core layer (P-routers) still rely on IPv4, IGPv4. In most implementations IPv6 traffic is sent with 2 MPLS labels. Routing information is stored in GRT.

- **6VPE, RFC 4659 (IPv6 VPN)**

6VPE technology allows IPv6 VPN implementation in MPLS network. IPv6 traffic is sent with c 2 MPLS labels (same as for IPv4 VPN). IPv6 support is required only on PE-routers.

All advantages of MPLS are applicable to IPv6 – FRR, TE, QoS.

What should be upgraded on the TN

- All modern MPLS routers (Cisco, Juniper, ALU, Huawei, Ericsson and others) support both technologies.

- What can be required to implement IPv6 on transport network:

  - Purchase new software for routers (ask for recommended software versions, based on you business demands from vendor or system intergator!)

  - Purchase licenses for IPv6 support (or for specific features)

  - Line card upgrade/swap (check FIB/LFIB capacity, depends on forwarding model: centralized or distributed)

  - Memory upgrade for routers

  - IPv6 address-plan design (infrastructure, customer)

  - IT-systems upgrade (billing/mediation, inventory systems, monitoring systems)
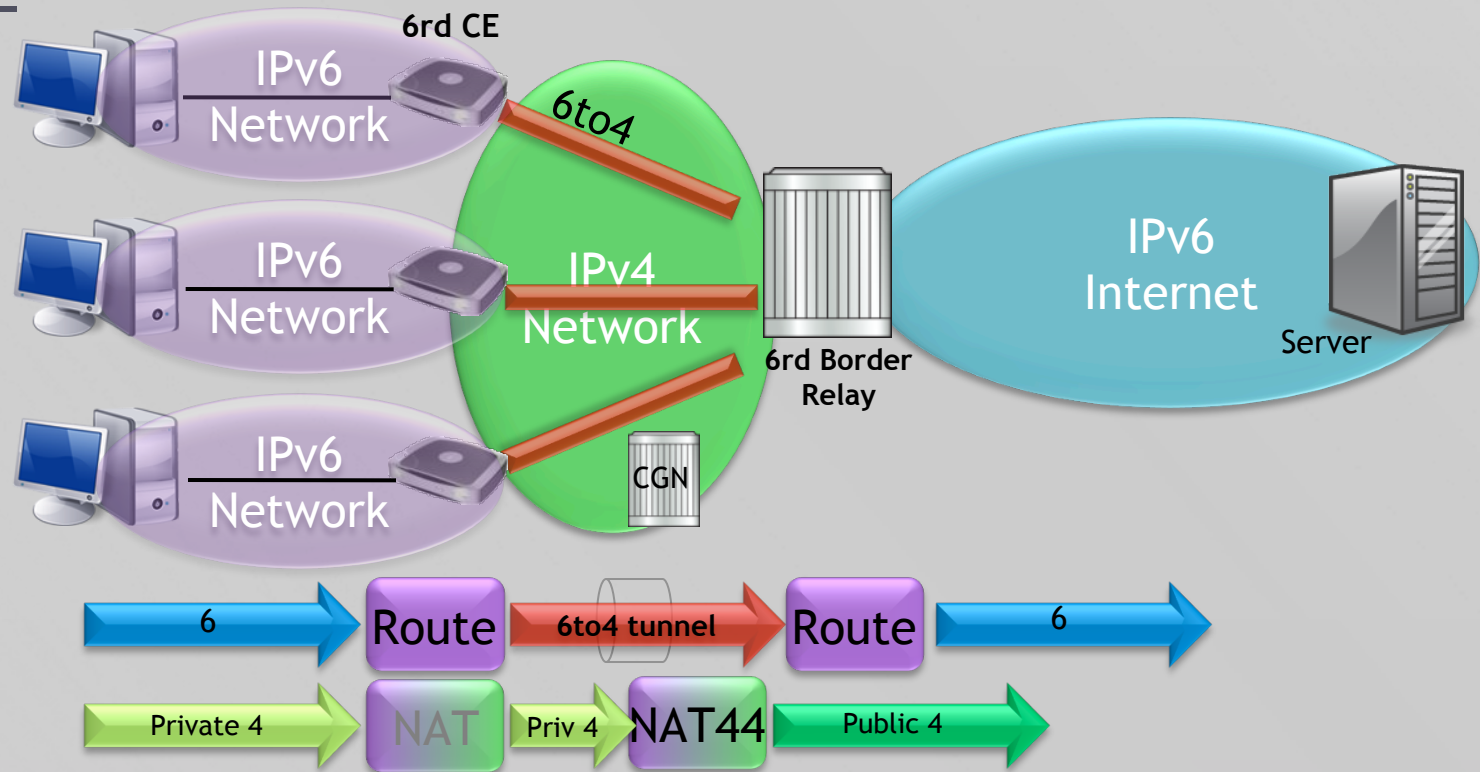
IPv6 in wireline Broadband networks – implementation cases

Four main implementation schemes are available for IPv6:

- 6RD

- Dualstack (IPv4 + IPv6 + CGN)

- Dualstack lite, RFC 6333

- Single stack IPv6 (+ NAT 64)

6RD

- Allows launch IPv6 over IPv4-infrastructure, quick launch scenario.
- Requires special CPE and 6rd Border Relay
- CPE (6rd CE router) encapsulates IPv6 packets into 6to4 tunnel (RFC3056)
- CGN is recommended for solving IPv4 shortage problem
- Problems with MTU may occur

Dualstack (IPv4 + IPv6 + CGN)
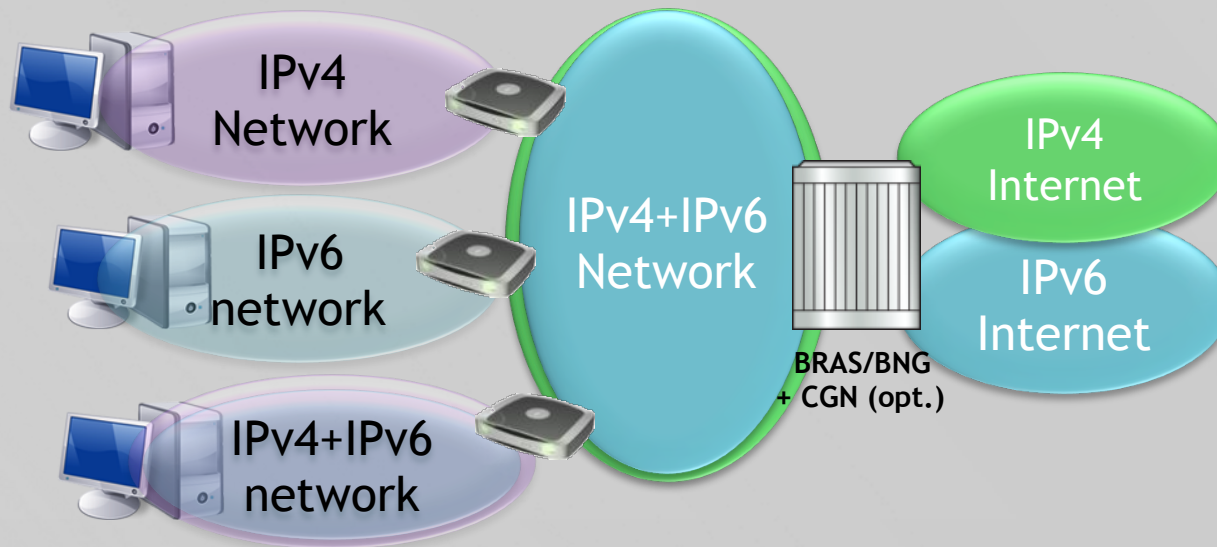
- Daulstack required (IPv4 and IPv6 support) on all network elements.

- CPE gets 2 addresses.

- CGN is recommended for solving IPv4 shortage problem

- NAT64 is required for "pure IPv6" clients

Dualstack (IPv4 + IPv6 over tunnel + CGN)
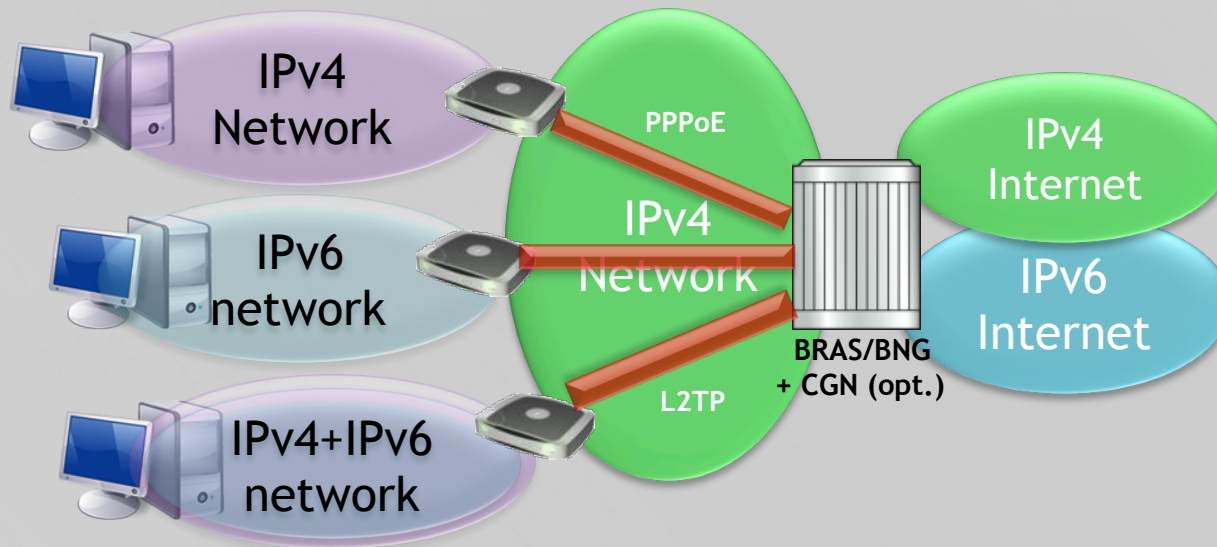
- Необходима поддержка Daulstack (т.е. IPv4 и IPv6) только на CPE и BRAS/BNG.
- CPE получает сразу 2 адреса внутри туннеля.
- CGN is recommended for solving IPv4 shortage problem
- Для чистых IPv6 клиентов потребуется применение NAT64

Dualstack lite

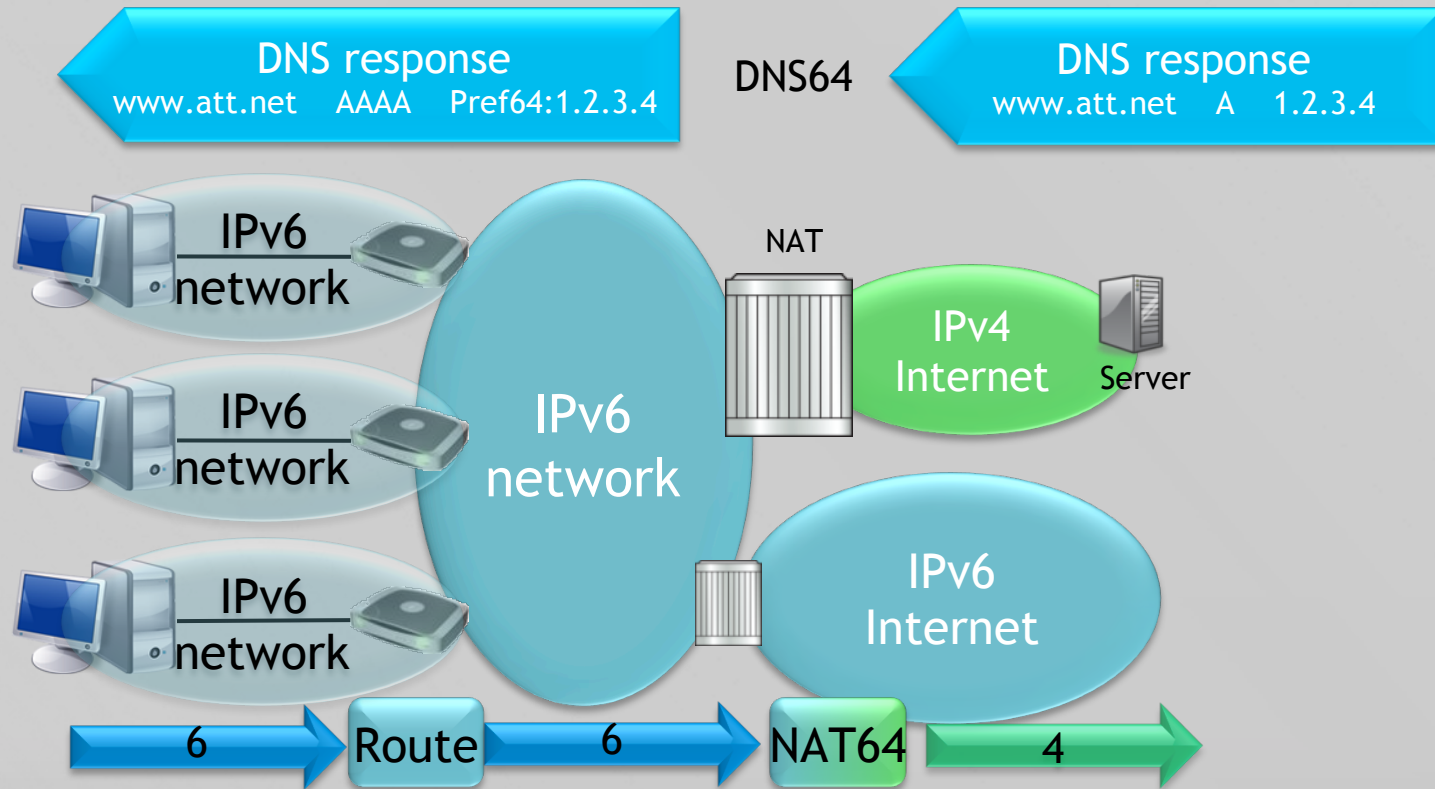| Priv. IPv4	Route	IPv4-in-IPv6	NAT44	Public IPv4
		TUNNELED		ROUTED
IPv6	Route	IPv6	Route	IPv6
		ROUTED		ROUTED
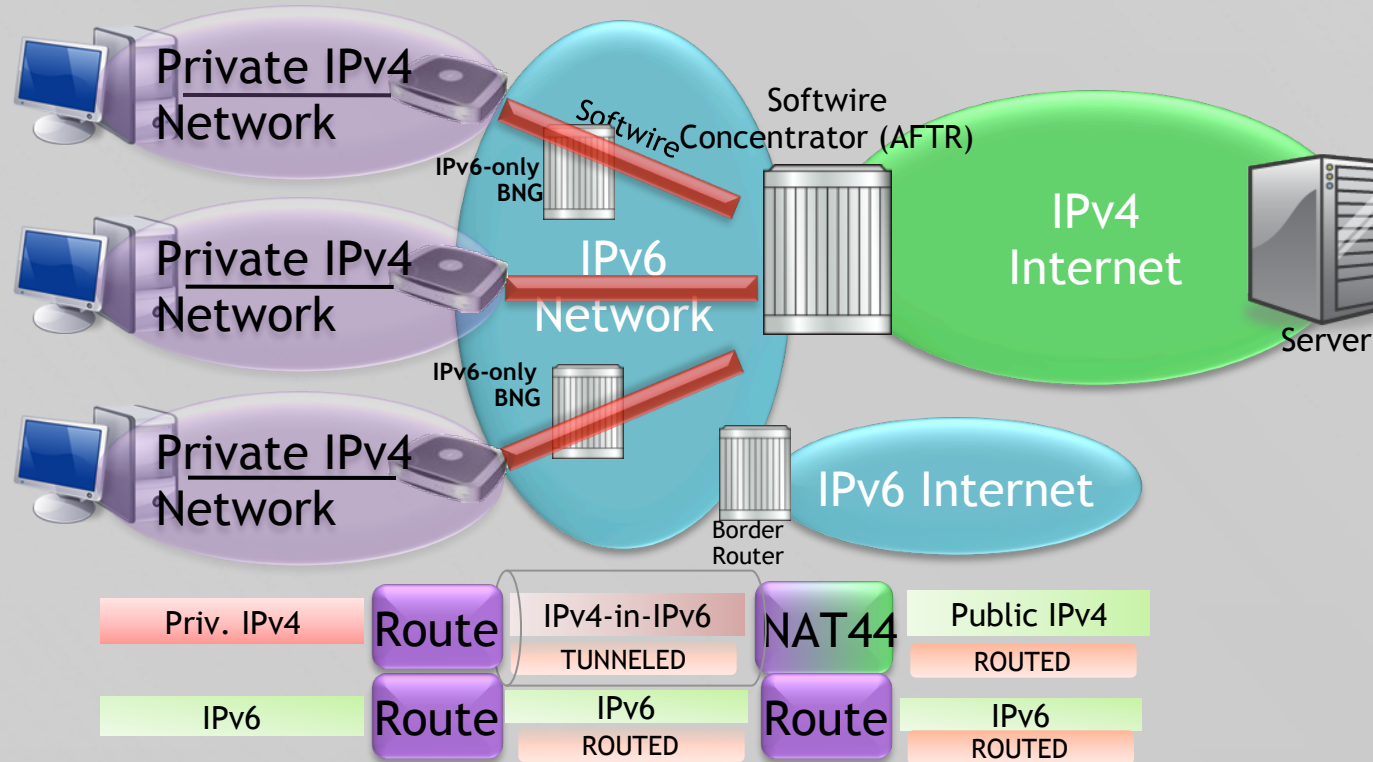
- IPv4 traffic is encapsulated on CPE into IPv4-in-IPv6 tunnel according to RFC2473
- Softwire concentrator decapsulate IPv4 packets and perform NAT44 using unique IPv6 transport address to create NAT(CGN) translation
- IPv4 is routed into 4-in-6 tunnel on CPE and pass through NAT on softwire concentrator (AFTR, Address Family Transition Router)
- IPv6 is routed on CPE and BNG without any modifications

Single stack IPv6

DNS response
www.att.net   AAAA   Pref64:1.2.3.4

DNS64

DNS response
www.att.net   A   1.2.3.4

IPv6 network

IPv6 network

IPv6 network

IPv6 network

NAT

IPv4 Internet

Server

IPv6 Internet

6 → Route → 6 → NAT64 → 4

- No support for IPv4-only hosts (Windows 98 or hosts with disabled IPv6 protocol);
- Not all applications (IM, games, etc.) still support IPv6;
- DNS64 implementation is required;
- Some problems exist with connections initiated by IPv4-servers

Where IPv6 support is required

- Access/aggregation layer devices

- Core & IP routers (ASBR)

- Security devices (Firewall, IDS/IPS)

- Service layer (BRAS/BNG, DPI, IPTV platform, VoIP)

- CPE

- OS

- Application layer

- SORM equipment

IPv6 support in OS

Functional	Windows 98	Windows XP	Windows Vista/7	MacOS	Linux
IPv6 capable	No	Yes	Yes	Yes	Yes
IPv6 by default	No	No	Yes	Yes	Yes
DHCPv6	No	No	Yes	No	Yes
DNS over IPv6	No	No	Yes	Yes	Yes
IPv6 over PPP	No	No	Yes	Yes	Yes
Routed IPv6 RG support	No	No	Yes	No	Yes

Open questions

- Do IPv6 solve problem of address space shortage?

- What will service provider gain form IPv6 implementation?

- Which new VAS can be launched with IPv6 implementation?

- VoIP over IPv6?

- IPTV over IPv6?

Implementation costs

What is in the cost of implementing IPv6 on broadband networks :

- Access/aggregation layer devices modernization (swap)

- BRAS/BNG modernization, purchase software and licenses

- DNS and DHCP services modernization (upgrade)

- Модернизация AAA и Billing

- BRAS/BNG and AAA/Billing integration

- Maintenance department staff training

- Technical support staff training and development of new troubleshooting scenarios

- Equipment reconfiguration

Don't forget about tests (never) ☺

BRAS/BNG, CGN, AFTR (although access/aggregation switches with enhanced IPv6 security are not so simple) are the most complex devices in broadband network, that's why it's necessary to precisely define the technical requirements for equipment selection.

Most vendors claim to support all that is specified in your requirements…

That's why as said ~~Vladimir Lenin~~: «Test, test and test again!»

Individual functions may work properly, but their combination, or, more correctly, device with all required functions configured usually does not work.

Before you install the device on the network, always perform stress test (throughput including IPv6, protection from flood and storm, control plane protection and maximum client sessions with traffic) with traffic generator!

IPv6 requirements for network equipment

- List of requirements depends strongly on IPv6 implementation scheme chosen.

- What can help you in requirements definition process:

http://www.ripe.net/ripe/docs/current-ripe-documents/ripe-554

How to encourage customers to use IPv6

- Offer higher access speed for IPv6 services (ex.: 15 Mbit/s in IPv6 and 10 Mbit/s in IPv4) or implement service based tariffs with benefits for IPv6 usage .

- In cooperation with content providers offer bonuses for IPv6 active users (premium accounts, more space on storage, etc)

- Offer IPv6 ready CPE for lease (maybe cheaper)

Thank you!!!

Questions?