IPv6 in Service Provider Networks

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Agenda

- IPv6 preliminaries
- IPv6 ready technologies and services (L1, L2, L3)
- Building IPv6 networks
  - Native IPv6, Dual-stack, MPLS
  - Access, Aggregation, Core
- Focus on xDSL
  - DSLAMs, ATM vs. Ethernet-aggregation
  - PPPoE vs IPoE
  - Home network
- Creating IPv6 services
  - Native, Dual-stack, 6VPE
- Case study: IPv6 services (Made in Japan)
- Conclusion

IPV6 preliminaries
IPv4, IPv5 ...

Wikipedia

- IPv4: Internet Protocol version 4 is the fourth iteration of the Internet Protocol (IP) and it is the first version of the protocol to be widely deployed.

- IPv5: Internet Protocol version 5 was assigned to an experimental protocol called ST (Internet Stream Protocol) ... ST was envisioned to be the connection oriented complement to IPv4, but it has never been introduced for public usage.

- IPv6: Internet Protocol version 6 is a network layer protocol for packet-switched internetworks. It is designated as the successor of IPv4, the current version of the Internet Protocol, for general use on the Internet.

IPV6 preliminaries
Promises and facts (IPv4 vs. IPv6)

Larger address space

- Avoids the potential exhaustion of address space
- No need for NAT and other devices that break end-to-end ”visiblity”.
- For corporate nets simplifying subnetting

Stateless autoconfiguration of hosts

- IPv6 hosts can be configured automatically when connected to a routed IPv6 network.
- Only suitable for hosts: routers must be configured manually or by other means.

Multicast

- Multicast is part of the base protocol suite in IPv6.
(In IPv4 multicast is optional!)
- Most nets currently not configured to route multicast
(link-scoped aspect of multicast will work BUT the site-scope, organization-scope and global-scope multicast not)

Faster routing

- By using a simpler and more systematic header structure, IPv6 was supposed to improve the performance of routing.
(Recent advances in router technology, however, may have made this improvement obsolete.)

Jumbograms

- Payload can be up to 64KB in size in standard mode (size field = 16 bit), or larger with a "jumbo payload" option.
(IPv4: packets are limited to 64 KB of payload)
- The use of jumbograms improves performance over high-throughput networks.

Network-layer security

- IPsec, the protocol for IP network-layer encryption and authentication, is an integral part of the base protocol suite
(IPv4: IPSec is optional, but usually implemented)
- IPsec is not widely deployed except for securing traffic between IPv6 BGP routers.

Mobility

- Mobile IPv6 (MIPv6) avoids triangular routing and is therefore as efficient as normal IPv6.
(IPv4: home-agent, foreign agent, ...)
- This advantage is mostly hypothetical, as neither MIP nor MIPv6 are widely deployed today.

IPV6 preliminaries
Mythos and Realities about IPv6

Mythos: QoS is natively supported in IPv6
Reality:
No QoS functions are built into IPv6, BUT but there are mechanisms allowing QoS related protocols to work with IPv6 (Traffic flow = 20 bit: special handling of certain traffic flows, Traffic Class = 8 bit: priorities for DS field [same for IPv4/IPv6])

Mythos: Multicast is natively supported in IPv6.
Reality:
Multicast is part of the base protocol suite in IPv6, BUT MC routing have to be configured in the internetwork. There is support for scoped-addresses (node-local, link-local, site-local, organization-local, global-scope).
Remark: IPv4 support only TTL-scoping and Administrative-scoping.

Mythos: There is no BroadCast in IPv6.
Reality:
IPv6 does not have a link-local broadcast facility, BUT the same effect can be achieved by multicasting to the all-hosts group (FF02::1). IPv6 has built-in mechanism to eliminate the frequent use of BC-like traffic.

Mythos: Multihoming is solved in IPv6
Reality:
Not yet standardized! No NAT is defined in IPv6. PI (Provider Independent) addresses have been made available in IPv6, but several cons. Research in progress ...
Remark: Multihoming = Connecting multiple ISPs to ensure redundant access to Internet. Multihoming in IPv4 through PI address or NAT.

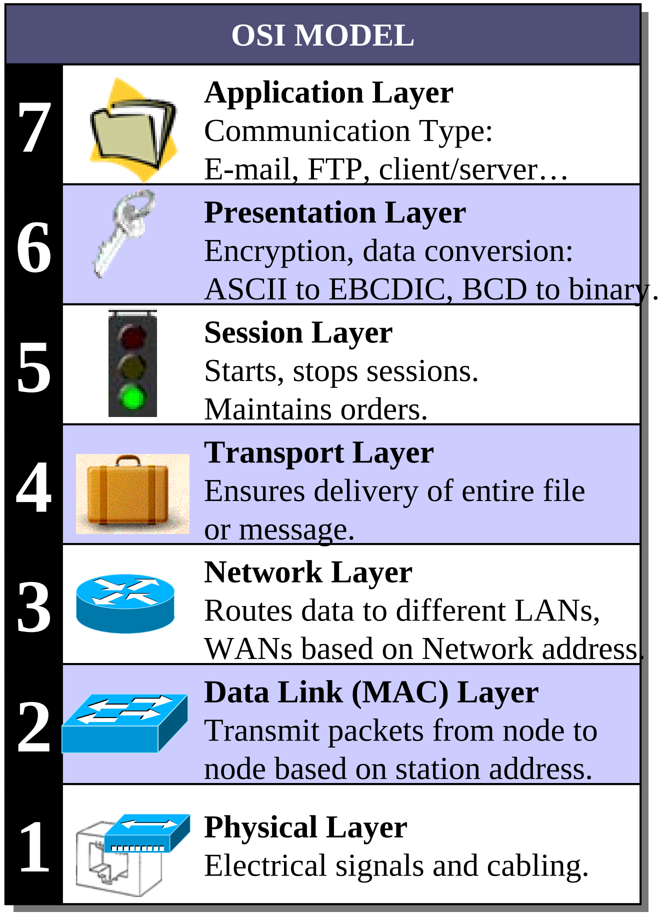
”IPv6-ready” technologies and services
L1 and L2: Technologies and services

- IP(v4/v6) is a network layer protocol and is encapsulated in a data link layer protocol (e.g., Ethernet).

Generally speaking:
All L1 and L2 technologies/services are ”IPv6-ready”
- WDM, LL, FR, ATM, Ethernet, etc.
- IPv6 network can be built by the customer

BUT what about ???
- MC: Efficient transport (e.g. MLD)
- OAM: DCN, management, counters, etc.
- L2+ features: L2 manipulation based on L3/L4 information (e.g. Filtering, ACL, Matching, etc.)

Problem No.1: Ethernet
- IPv6 is transparent on L2 switches except for multicast → additional support needed for MLD snooping
- IPv6 management Telnet/SSH/HTTP/SNMP
- L2+: ACLs, features (e.g. MC VLAN Reg), Mixing L2/L3 traffic (e.g. Layer 3 IPv6 packets are treated as non-IP packets and are bridged by the switch)



”IPv6-ready” technologies and services

L3: Native IPv6 services

	Environment	Scenario
Core	Core is IPv6 aware – Native IP	Dual Stack
	Core is IPv6 unaware – MPLS	6PE/6VPE
Access	Few customers, no native IPv6 service form the PoP or Data link is not (yet) native IPv6 capable	Tunnels
	Native IPv4-IPv6 services between aggregation and end-users	Dual Stack
	Dedicated circuits – IPv4 – IPv6	Dual Stack

MPLS – Layer 2.5

- Multiprotocol by default ☺ even if not used up-to now
- 6PE, 6VPE technologies

Native IPv6

- Tunneling (does not scale)
- Dual stack
- IPv6 only

- Problems if mixed IPv4/IPv6
  - Devices should be hardware based for both
  - Features should work for both protocol (feature parity)
  - Differences of routing protocols
    - RIP2/RIPng (IPv6 only, not backward compatible),
    - OSPFv2/OSPFv3 (focuses on links rather than subnets),
    - IS-IS (Multi-protocol)
    - BGP-4 (MP-BGP already well-known by SPs)
  - Bandwidth allocation
    - Different header size
    - Additional control plane traffic
  - IPv4 and IPv6 control planes and data planes must not impact each other

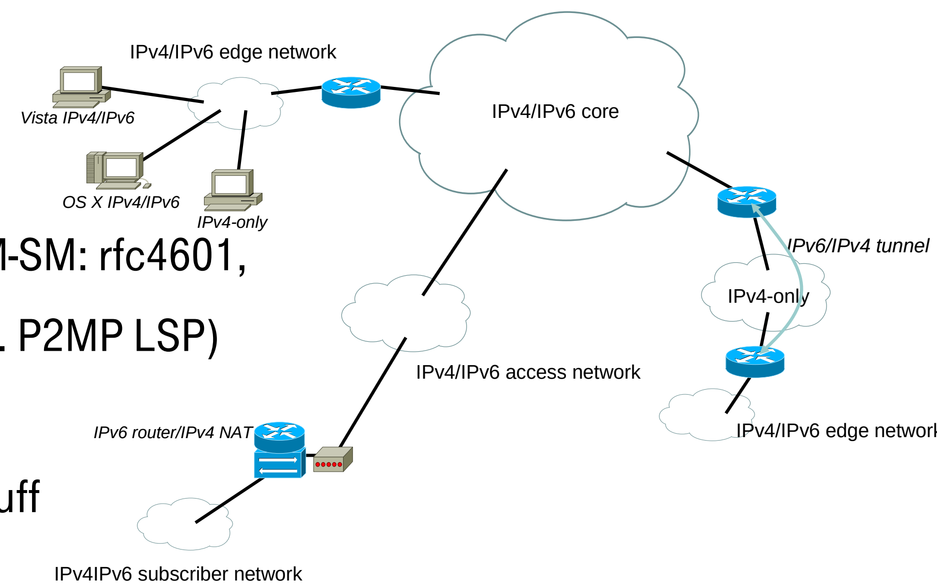
Building IPv6 networks
Challenges for SPs

- Building IPv6 networks
  - Greenfield/Overlay scenario
  - Expanding existing networks
  - Different methods used for Access, Aggregation and Core
- Methods:
  - Tunneling, Native IPv6, Dual-stack, MPLS

Major challenges for L2:
- Many IPv6-friendly technologies: WDM, TDM, SDH, FR, ATM
- Ethernet based services
- Providing access over Eth-xDSL

Major challenge for L3:
- IPv6 Unicast routing (peering included)
- IPv6 Multicast transport
  - Good news: PIM works for IPv6 (PIM-SM: rfc4601, PIM-SSM: rfc3569, etc.)
  - Bad news: MPLS (GRE tunneling vs. P2MP LSP)
- Feature parity (IPv4 vs. IPv6)
- OAM, Troubleshooting

- Layer 8 problem: available networking stuff



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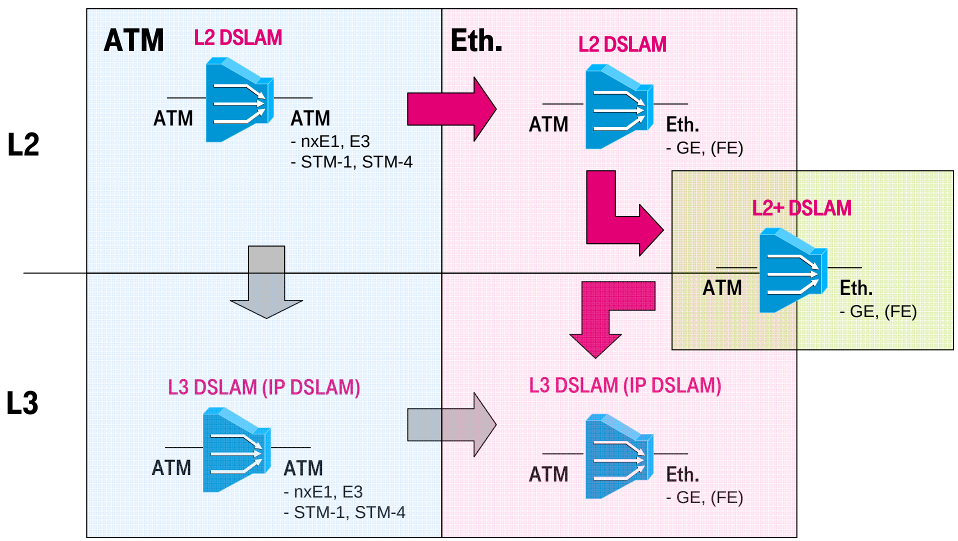
Focus on xDSL
Supporting IPv6 in DSL equipment (standards)

DSLAMs:
- ATM aggregation
  - More simple: ATM totally transparent
  - IPv6 support req. only in RG and BNG
- Ethernet aggregation
  - More problematic: L2+ features on Ethernet
  - IPv6 support req. on all elements



Status of standards (DSLForum):

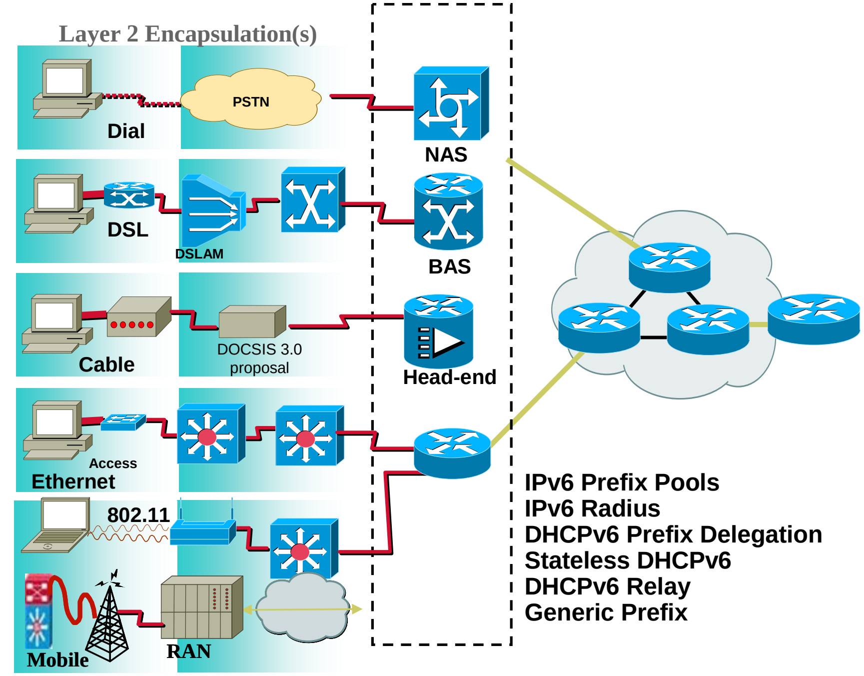
RG:
- TR-124 Func. Req. for BB Residential GW Devices
  GEN.NET.3: IPv6-ready hardware
- WT-107 Internet GW Device Data Model for TR-069
  IP address field = IPv4/IPv6

BNG:
- TR-092 BB Remote Access Server (BRAS) Req.
  PPPv6, DHCP-PD, DSCP classification for QoS, Routing protocols (OSPF, ISIS, MP-BGP)

Technology
- TR-101: Migration to Eth-based DSL Aggregation
  No IPv6 related stuff! (e.g. R-26 Ethertype filter: PPPoE, IPoE, ARP)

→ IPv6 in DSL-standards very poor

Focus on xDSL ...
Supporting IPv6 in DSL equipment (issues)



Some issues with native-IPv6 transport on E-DSLAM:

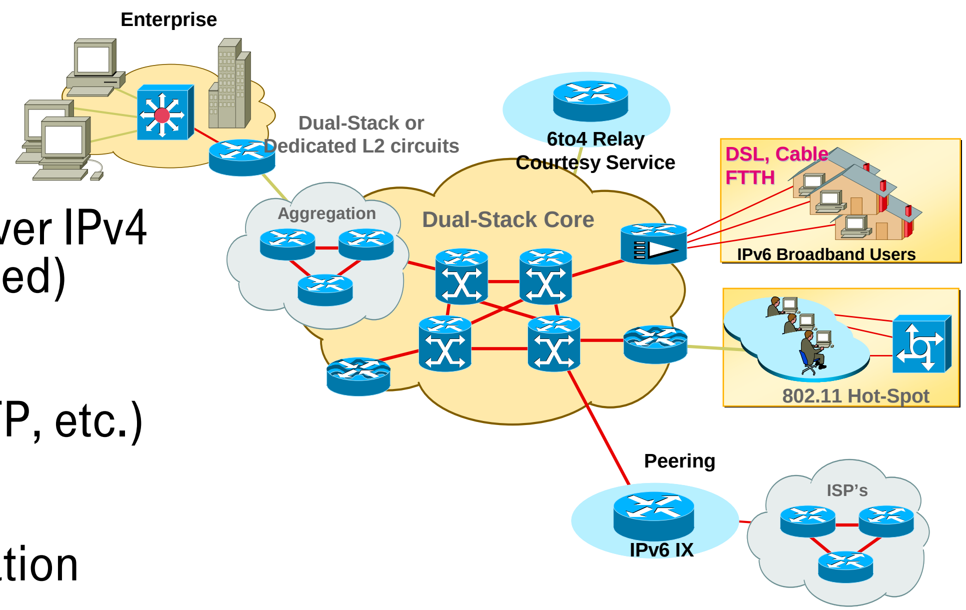
- Unicast traffic forwarding
  - PPPv6: same solutions as for PPPv4 ☺
  - Native IPv6: many problems
    - IPoA (rfc2492), IPoA IWF implementation
    - IPoE (rfc2464), different Ethertype for IPv6 (0x86dd)
    - Different ARP-like functions of IPv6 ND (DA=MC address)
      (today on DSLAMs MC upstream traffic is filtered)
    - DHCP relay agent should support IPv6

- Multicast traffic forwarding
  - General problem:
    - MC arch. on DSL based on IGMP snooping
    - MLD snooping requiredfor IPv6
  - PPPv6: Missing MLD snooping inside PPP
  - Native IPv6:
    - MLD snooping
    - Different MC address architecture for IPv6
      IPv4 MC 0100.5Exx.xxxx (DA 23 LSbit)
      IPv6 MC 3333.xxxx.xxxx (DA 32 LSbit)

- Loop identification
  - PPPv6: same as for IPv4 = Intermed. Agent ☺
  - Native IPv6:
    - DHCPv6: option-82 can be used ☺
    - Usage of stateless autoconfiguration generates problem
    - IP Session detection support: additional tool = NDP based (Neighbor Unreachability Detection)
      (for IPv4 ARP ping, ICMP ping, Hints from upper layers (there is traffic)
  - Possibility for per End-Point tracking (no NAT)

- L2 security issues should be reconsidered

Creating IPv6 services
Technology independent service portfolio

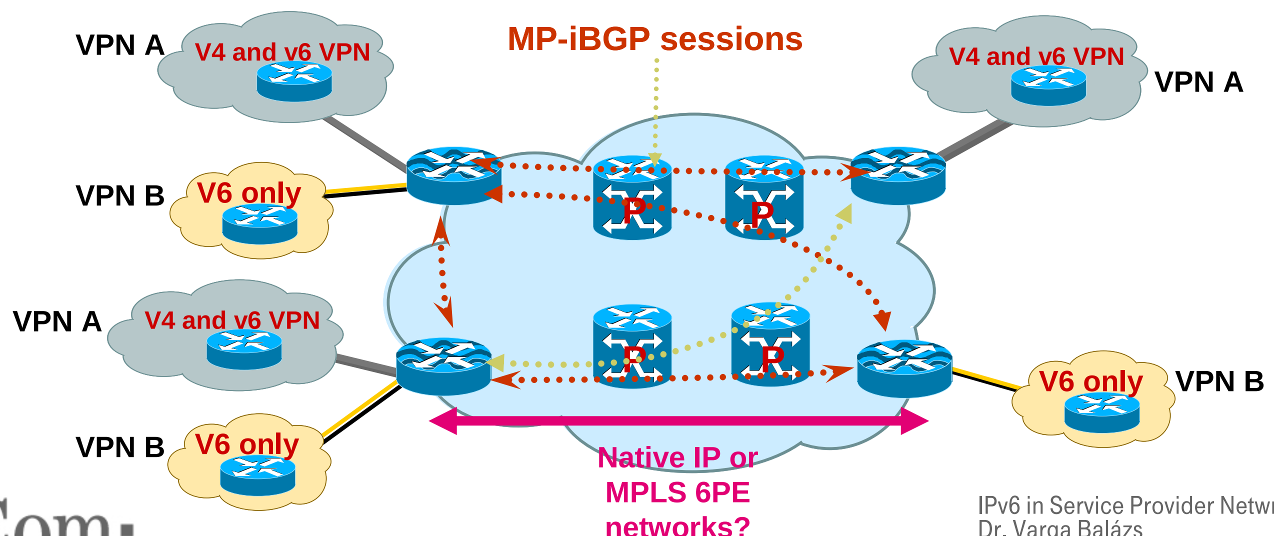


Internet access (ISP perspective):

- Over-the-Top service: Using IPv6 over IPv4
- Dual-stack (both IPv4 & IPv6 provided)
- IPv6 multicast for streaming (IPTV)
- All ISP related issues & services (Address allocation, AAA, DNS, NTP, etc.)

Business Customers (SP perspective)

- L1/L2 services for access/aggregation
- IP-VPN service (6VPE)



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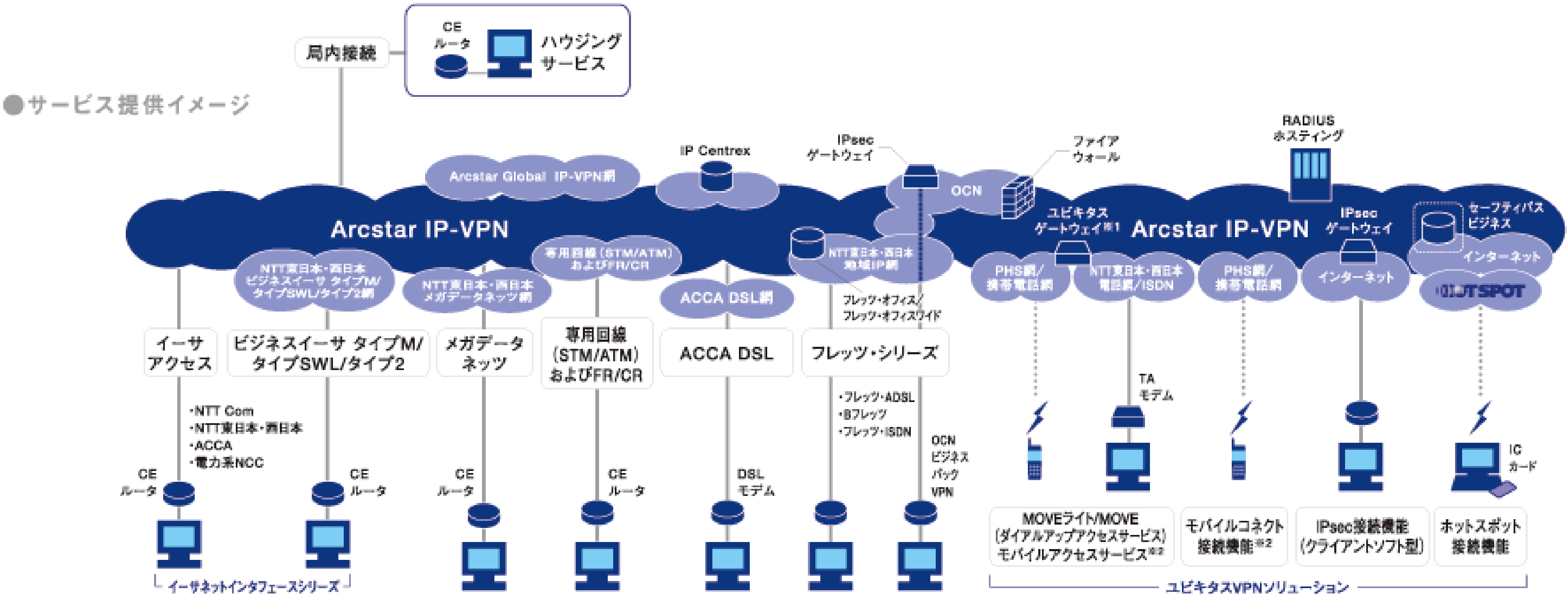
Case study
IPv6 services: Made in Japan



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Case study
IPv6 networking in Japan

Core network
- SP uses mainly MPLS → 6PE, 6VPE
- Only a few dual-stack networks
- Separate network used for
  - business and residential customers
  - recently some SP merges the sep. networks

Aggregation/Access
- Mainly switched (L2) networks
  → native IPv6 transport
- For users on IPv4-only access
  → Over-the-Top model: IPv6 over IPv4 tunneling

Home network for residential:
- IPv4 and IPv6 is mixed (/32 for IPv4) (/64 for IPv6)
- IPv4: PPPoE (rfc2516), IPv6: IPoE+NDP (rfc2461)
- Scenarios
  - No HGW: L2 bridging
    (PPPoE IPv4, native IPv6)
  - IPv4-HGW: no IPv6 support
    routing (PPPoE-IPv4) and bridging (IPoE-IPv6)
  - IPv4/IPv6-HGW: IPv6 support
    PPPoE (IPv4), Proxy-RA (router advertisement)

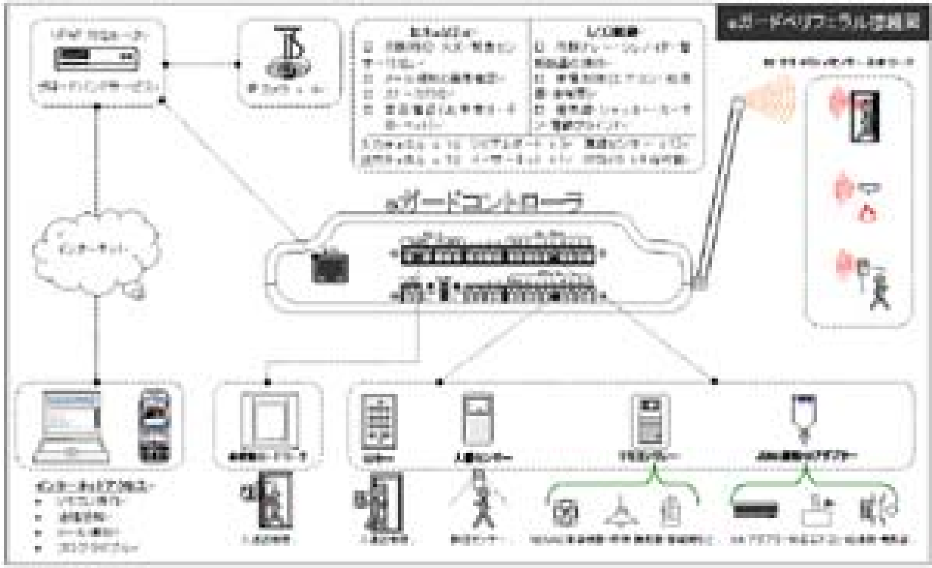
Devices
- IPv4: PC for Internet access
- IPv6: STB video IPv6, SIP-TV phone (High Quality Video Phone), TV-Set (TV with RJ-45 = embedded IPv6 STB), PC with IPv4/IPv6 OS, Home Control Systems, etc.



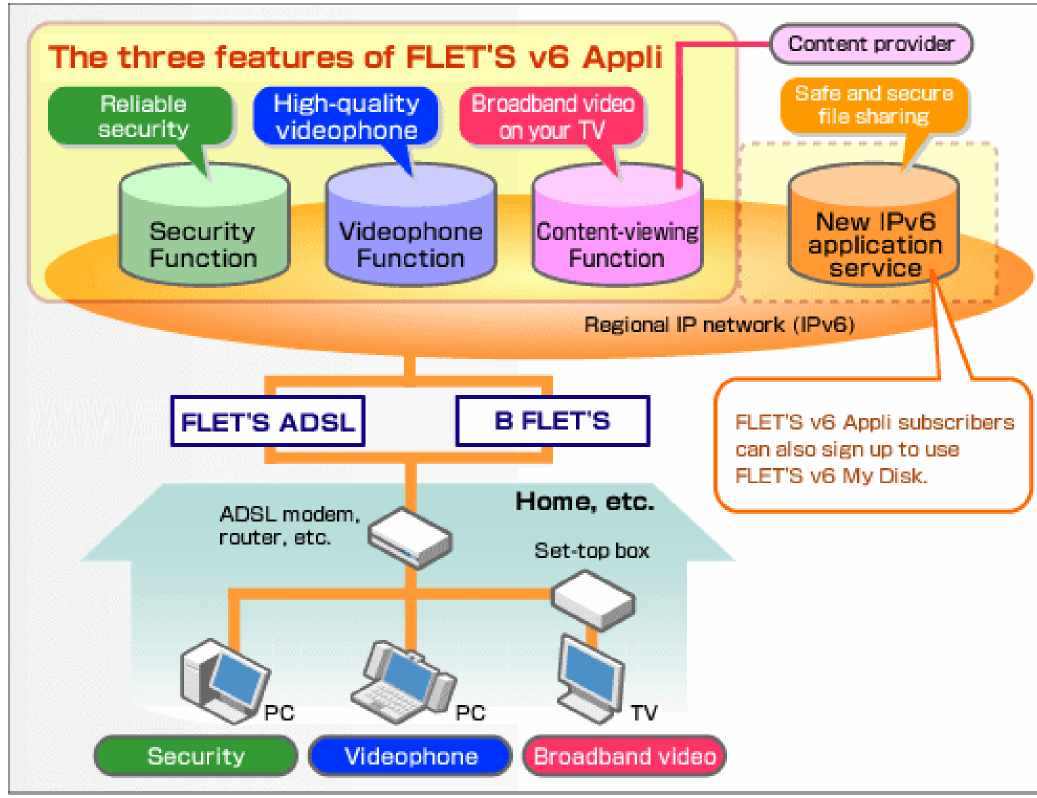
ARGYLE HOME TECH
HOME AUTOMATION SYSTEMS





Case Study
IPv6 services in Japan



Services

- Business customers
  - Internet connection
  - VPNv6 service
- Residential customers
  - IPv6 based applications
  - Video-Phone
  - Video (TV and VoD)
  - Security

Data Centers:

- IPv6 enabled (up-to 10G)

Main drivers for IPv6

- Government push
- Single billing and tracking systems to build across STB, PC, Cellar phones
  - Moving inside the home of the customer
- Billing per Content is Primary Objective for Service Providers and Carriers
  - Price of telecommunication has dropped to one of the worlds cheapest
- Cell phones based application
  - Number portability, 95% for entertainment and 5% for business

Conclusion
Many perspectives on IPv6

Markets Perspective

- IPv6 enables innovation, scalability and simplicity

Software Developer Perspective

- Applications must be “IP agnostic”

Network Manager Perspective

- Infrastructure must be deliver IPv6 up to the edge/access layer

The End-User Perspective

- IP version needs to be transparent

SixXS - IPv6 Deployment & Tunnel Broker :: Ghost Route Hunter : IPv6 DFP visibility : All - Mozilla Firefox

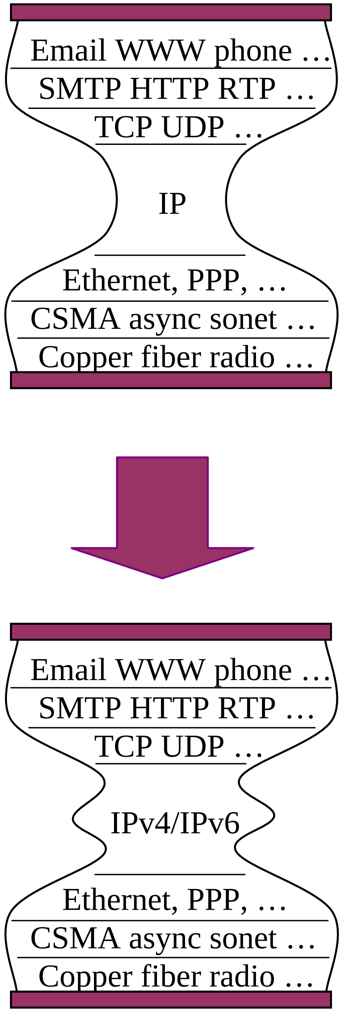
File Edit View Go Bookmarks Tools Help

http://www.sixxs.net/tools/grh/dfp/all/?country=hu Go

LG	Prefix	tld	NetName	Owner	AS	S	Allocated	First seen	Seen by	Last se
LG	2001:738::/32		HU-HUNGARNET-2001071...	HungarNet	1955	A	2001-07-17		98%	2007-02
LG	2001:7f8:35::/48		BIX-20050905	Council of Hungarian Inte...		A	2005-09-05		0%	
LG	2001:1aa0::/32		HU-PANTEL-20040317	PanTel Telecommunications...	12301	A	2004-03-17		0%	
LG	2001:4c48::/32		HU-HTC-20050420	Hungarian Telecom MATAV		A	2005-04-20		0%	
LG	2001:4d18::/32		HU-ELENDER-20050815	Euroweb Internet Service ...	5561	A	2005-08-15	2005-12-13 09:47:22	0%	2007-01
LG	2a01:1f0::/32		HU-COVYSOFT-20060927	CovySoft Networks Co.		A	2006-08-27		0%	
LG	2a01:270::/32		HU-ATW-20061219	ATW Internet Kft.	41075	A	2006-12-19	2006-12-21 11:32:22	90%	2007-02
LG	3ffe:2f00::/24		BME-FSZ/HU		2547	C	1998-09-08		0%	2006-06
LG	3ffe:401c::/32		T-NET	T-NET IPv6 Project	29657	C	2001-11-24	2003-11-25 12:11:22	0%	2006-06

The database currently holds 9 IPv6 DFP's.
Of which 2 (22.22%) are reclaimed, 0 (0.00%) are returned to the pool and 5 (55.56%) IPv6 DFP's didn't have a routing entry.

Conclusion
IPv6 will change our life ...



"With the notable exception of stateless autoconfiguration, most of the features of IPv6 have been ported to IPv4 in a more or less elegant manner. This makes deployment of IPv6 dependent on address space exhaustion."

" It is expected that IPv4 will be supported alongside IPv6 for the foreseeable future"

"IPv6 nodes need to communicate with IPv4 nodes, at least initially, and more likely, indefinitely"

"IPv6 no more IPng, because it's today network"