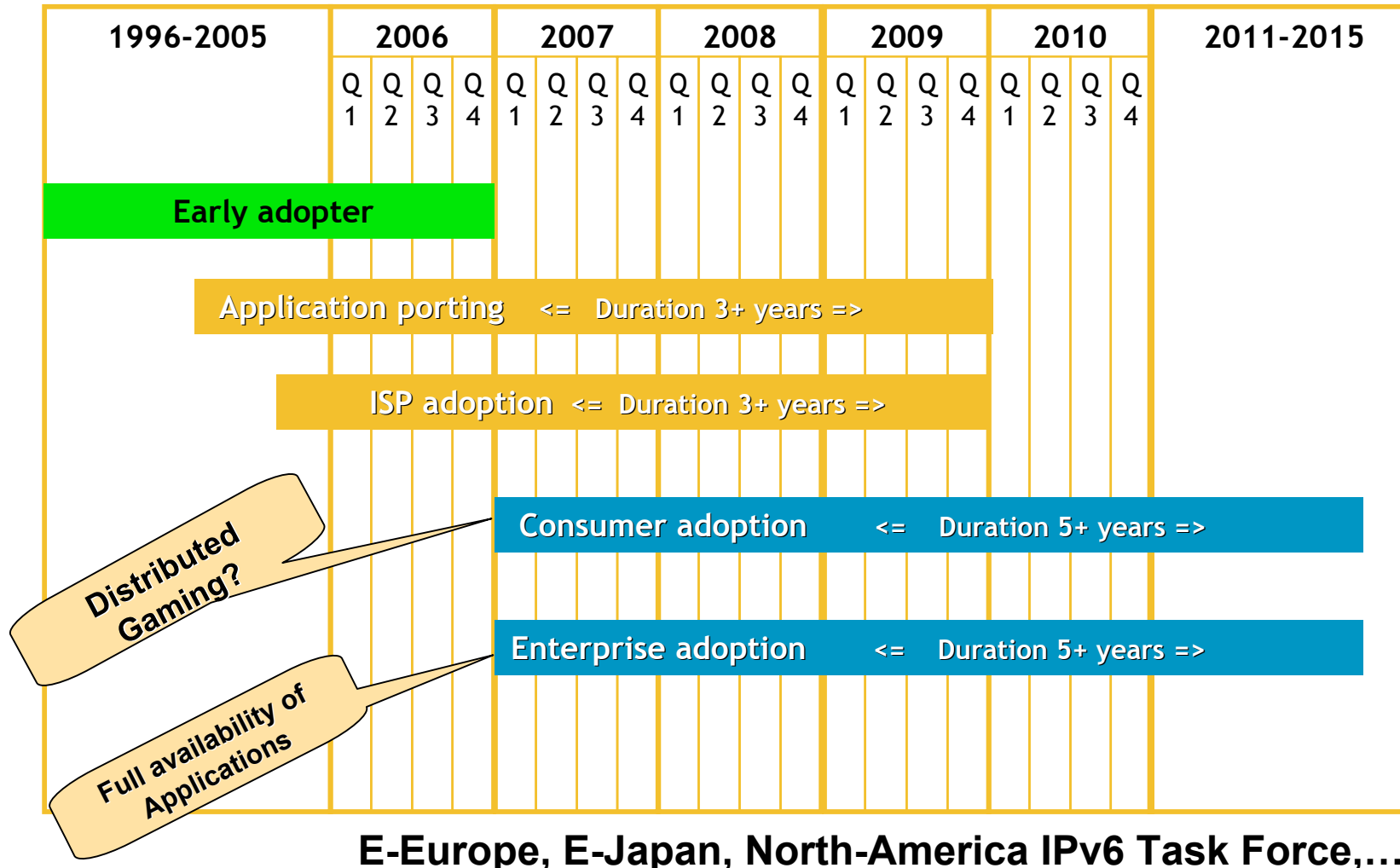




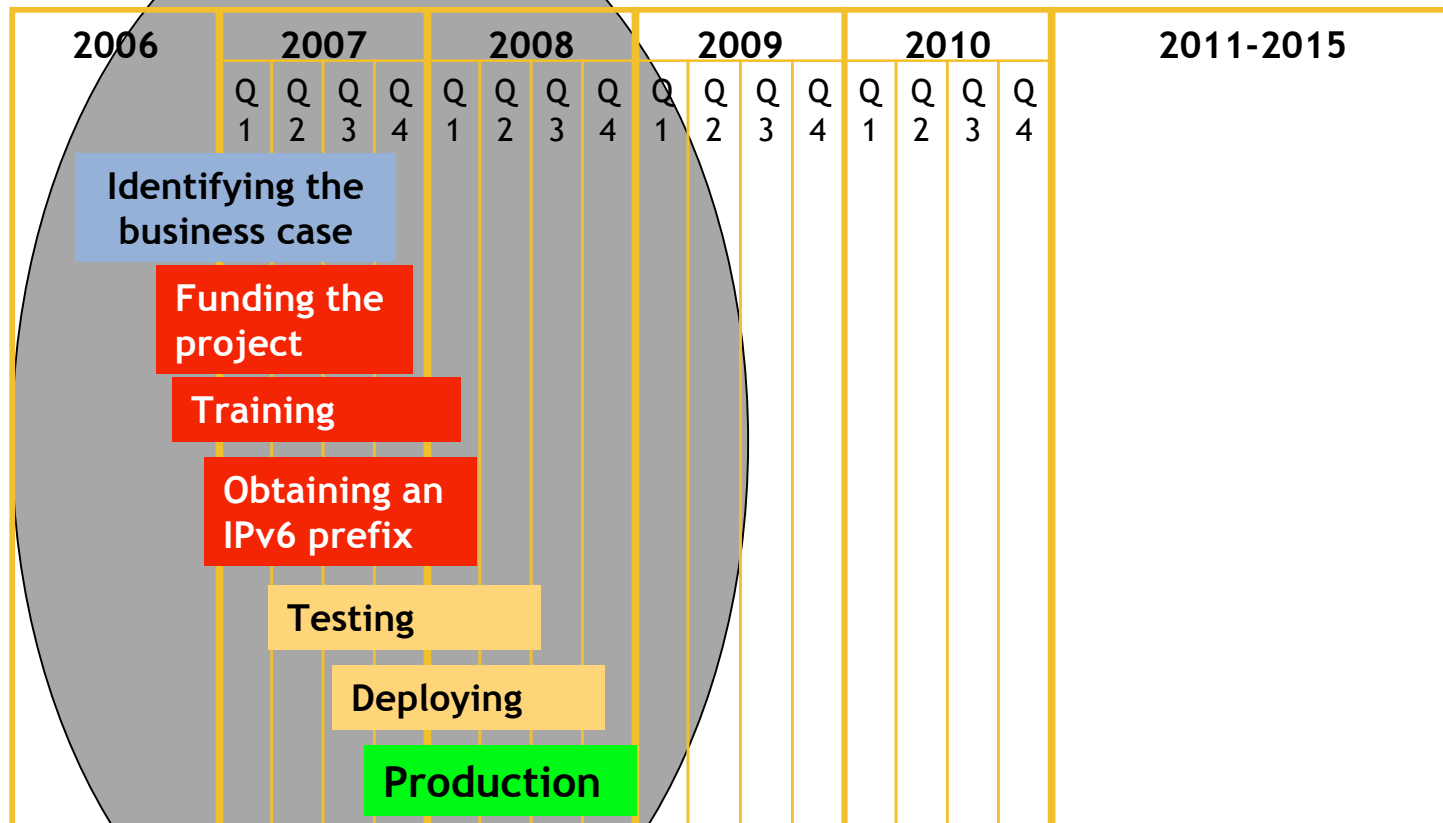
IPv6 Deployment Scenarios

ISP/IXP Workshops

IPv6 – Looking at the Crystal Ball



IPv6 – Working out the Timeline



How long do you need for each phase of an IPv6 deployment project?

IPv6 Deployment Scenarios

- Many ways to deliver IPv6 services to End Users
 - End-to-end IPv6 traffic forwarding is the Key feature
 - Minimize operational upgrade costs
- Service Providers and Enterprises may have different deployment needs
 - Incremental Upgrade/Deployment
 - ISP's differentiate Core and Edge infrastructures upgrade
 - Enterprise Campus and WAN may have separate upgrade paths
- IPv6 over IPv4 tunnels
- Dedicated Data Link layers for native IPv6
- Dual stack Networks
 - IPv6 over MPLS or IPv4-IPv6 Dual Stack Routers



IPv6 over IPv4 Tunnels

- Several Tunnelling mechanisms defined by IETF

Apply to ISP and Enterprise WAN networks

GRE, Configured Tunnels, 6to4

Apply to Campus

ISATAP

- Leverages 6Bone experience
- No impact on Core infrastructure
Either IPv4 or MPLS



Native IPv6 over Dedicated Data Links

- Native IPv6 links over dedicated infrastructures
 - ATM PVC, dWDM Lambda, Frame Relay PVC, Serial, Sonet/SDH, Ethernet
- No impact on existing IPv4 infrastructures
 - Only upgrade the appropriate network paths
 - IPv4 traffic (and revenues) can be separated from IPv6
- Network Management done through IPv4

IPv6 Tunnels & Native Case Study

- ISP scenario

Configured Tunnels or Native IPv6 between IPv6 Core Routers

Configured Tunnels or Native IPv6 to IPv6 Enterprise's Customers

Tunnels for specific access technologies, e.g. Cable

MP-BGP4 Peering with other IPv6 ISPs

Connection to an IPv6 IX

6to4 relay service

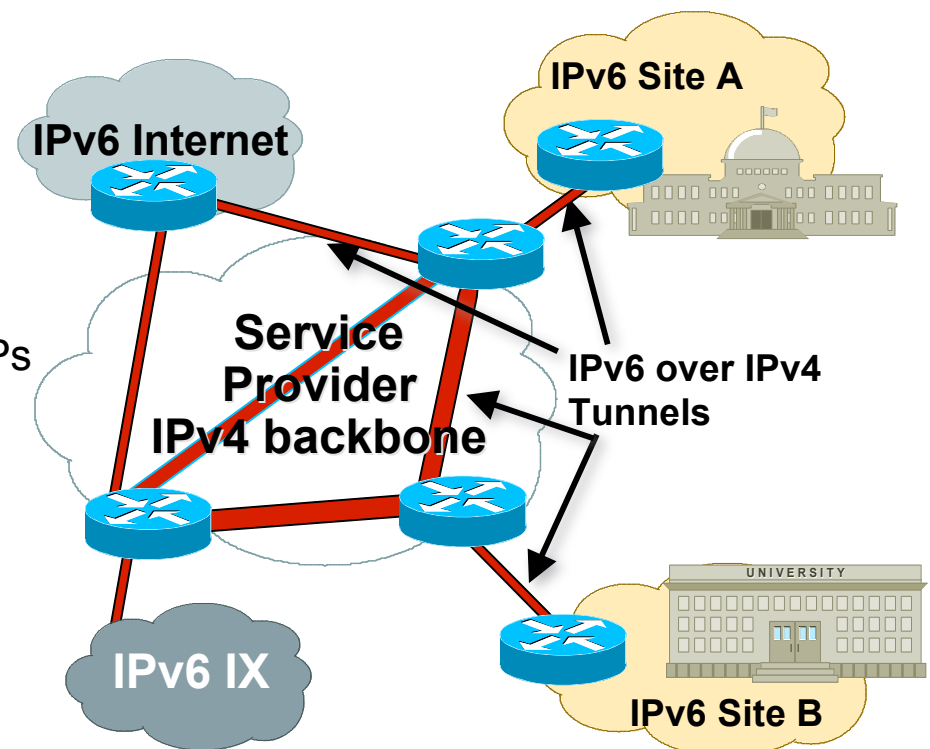
- Enterprise/Home scenario

6to4 tunnels between sites, use 6to4 Relay to connect to the IPv6 Internet

Configured tunnels between sites

ISATAP tunnels or Native IPv6 on a Campus

Use the most appropriate



Dual Stack IPv4-IPv6 Infrastructure

- It is generally a long term goal when IPv6 traffic and users will be rapidly increasing
- May be easier on network's portion such as Campus or Access networks
- Theoretically possible but the network design phase has to be well planned

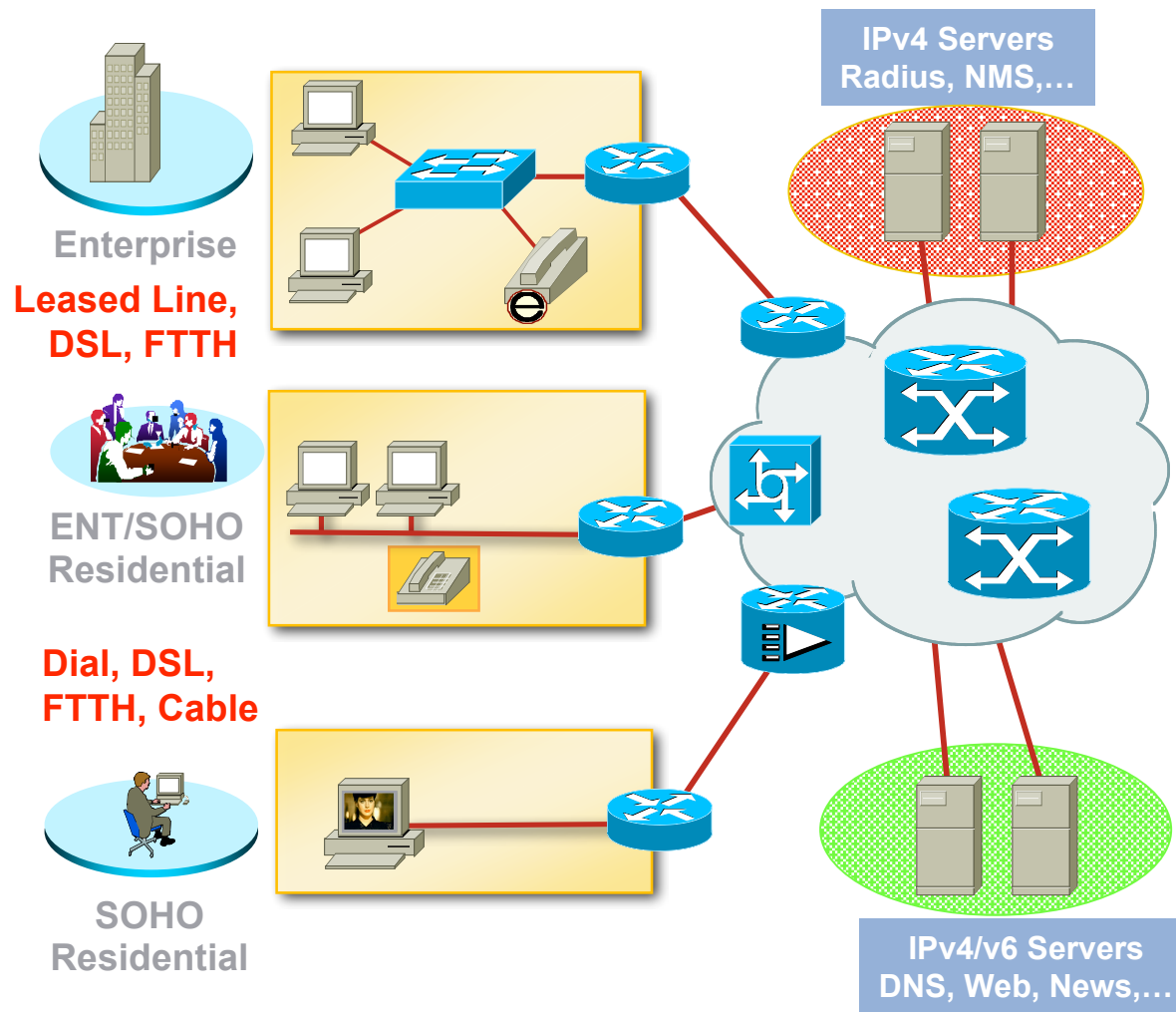
Memory size to handle the growth for both IPv4 & IPv6 routing tables

IGP options & its management: Integrated versus "Ships in the Night"

Full network upgrade impact

- IPv4 and IPv6 Control & Data planes should not impact each other
Feedback, requirements & experiments are welcome

Dual Stack IPv4-IPv6 Case Study



- **Campus scenario**

Upgrade all layer 3 devices to allow IPv6 hosts deployment anywhere, similar to IPX/IP environment

- **ISP**

Access technologies may have IPv4 dependencies, eg. for User's management

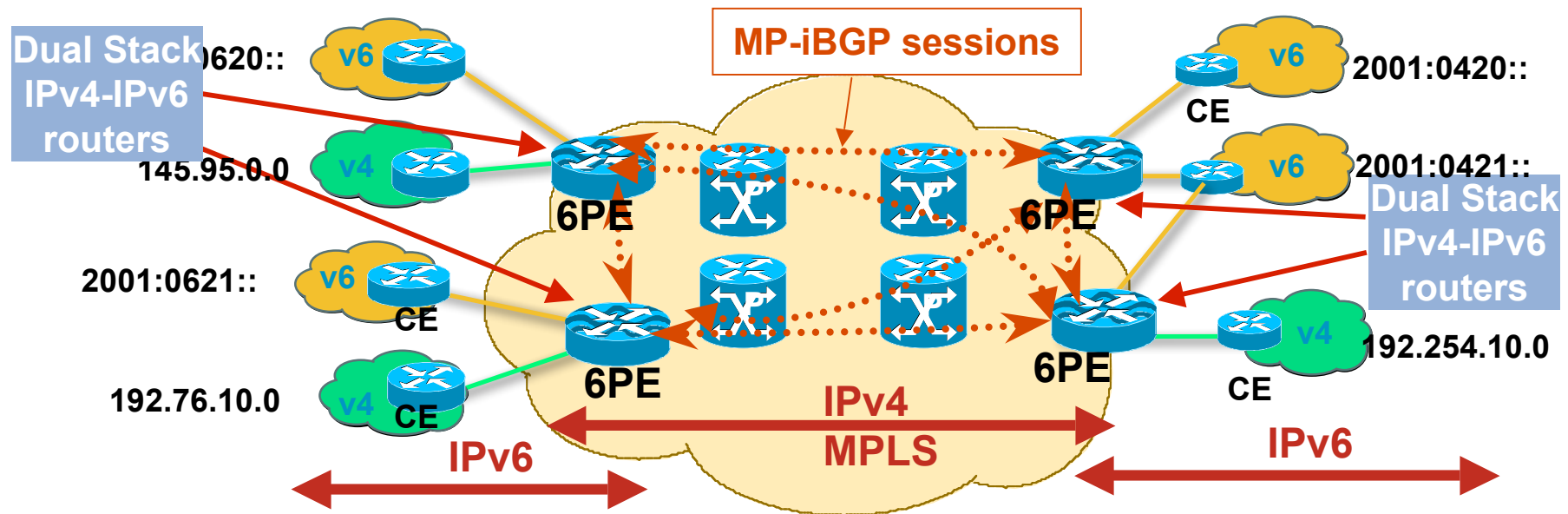
Transparent IPv4-IPv6 access services

Core may not go dual-stack before sometimes to avoid a full network upgrade

IPv6 over MPLS Infrastructure

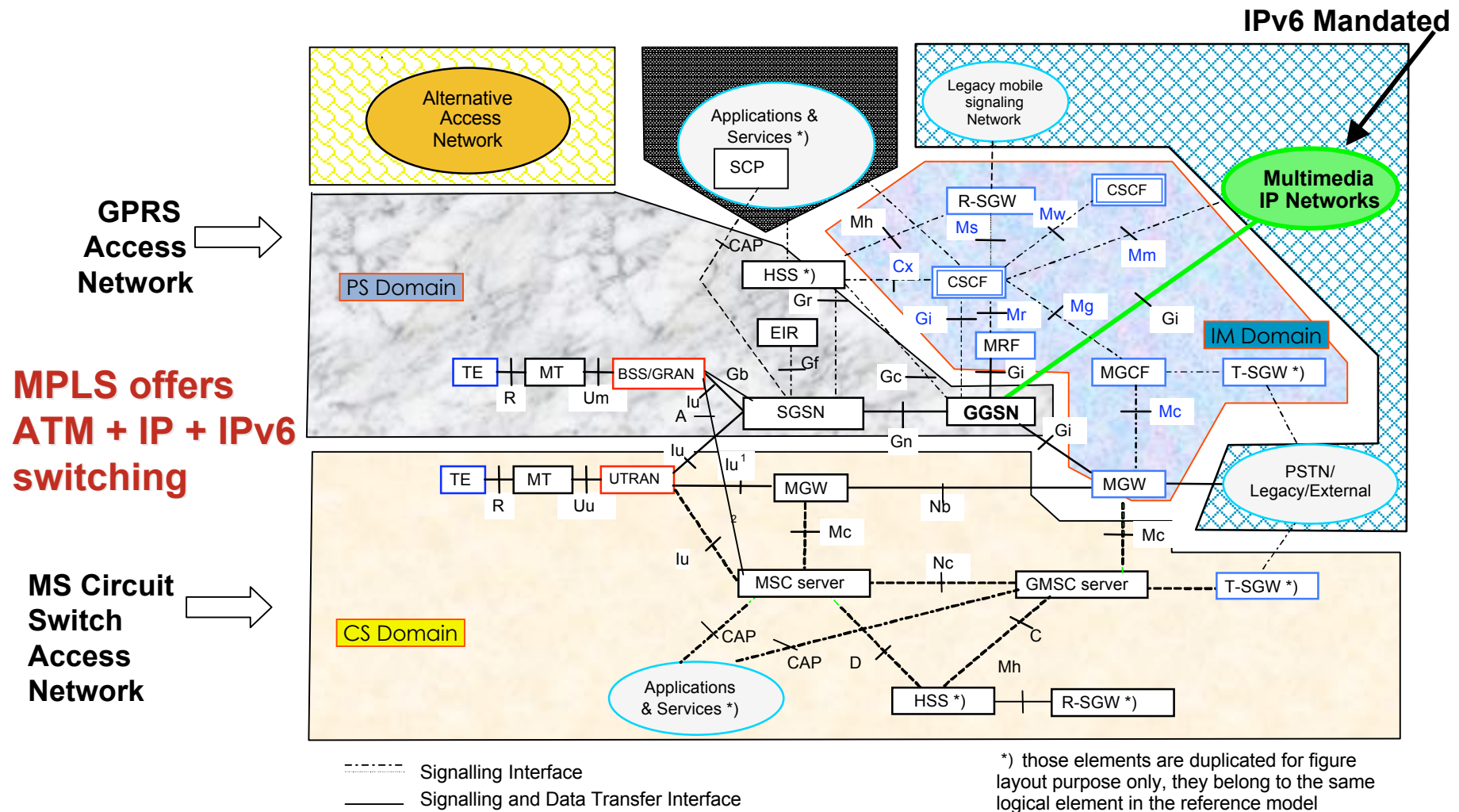
- Service Providers have already deployed MPLS in their IPv4 backbone for various reasons
 - MPLS/VPN, MPLS/QoS, MPLS/TE, ATM + IP switching
- Several IPv6 over MPLS scenarios
 - IPv6 Tunnels configured on CE (no impact on MPLS)
 - IPv6 over Circuit_over_MPLS (no impact on IPv6)
 - IPv6 Provider Edge Router (6PE) over MPLS (no impact on MPLS core)
 - Native IPv6 MPLS (require full network upgrade)
- Upgrading software to IPv6 Provider Edge Router (6PE)
 - Low cost and risk as only the required Edge routers are upgraded or installed
 - Allows IPv6 Prefix delegation by ISP

IPv6 Provider Edge Router (6PE) over MPLS



- IPv4 or MPLS core infrastructure is IPv6-unaware
- PEs are updated to support Dual Stack/6PE
- IPv6 reachability exchanged among 6PEs via iBGP
- IPv6 packets transported from 6PE to 6PE inside MPLS

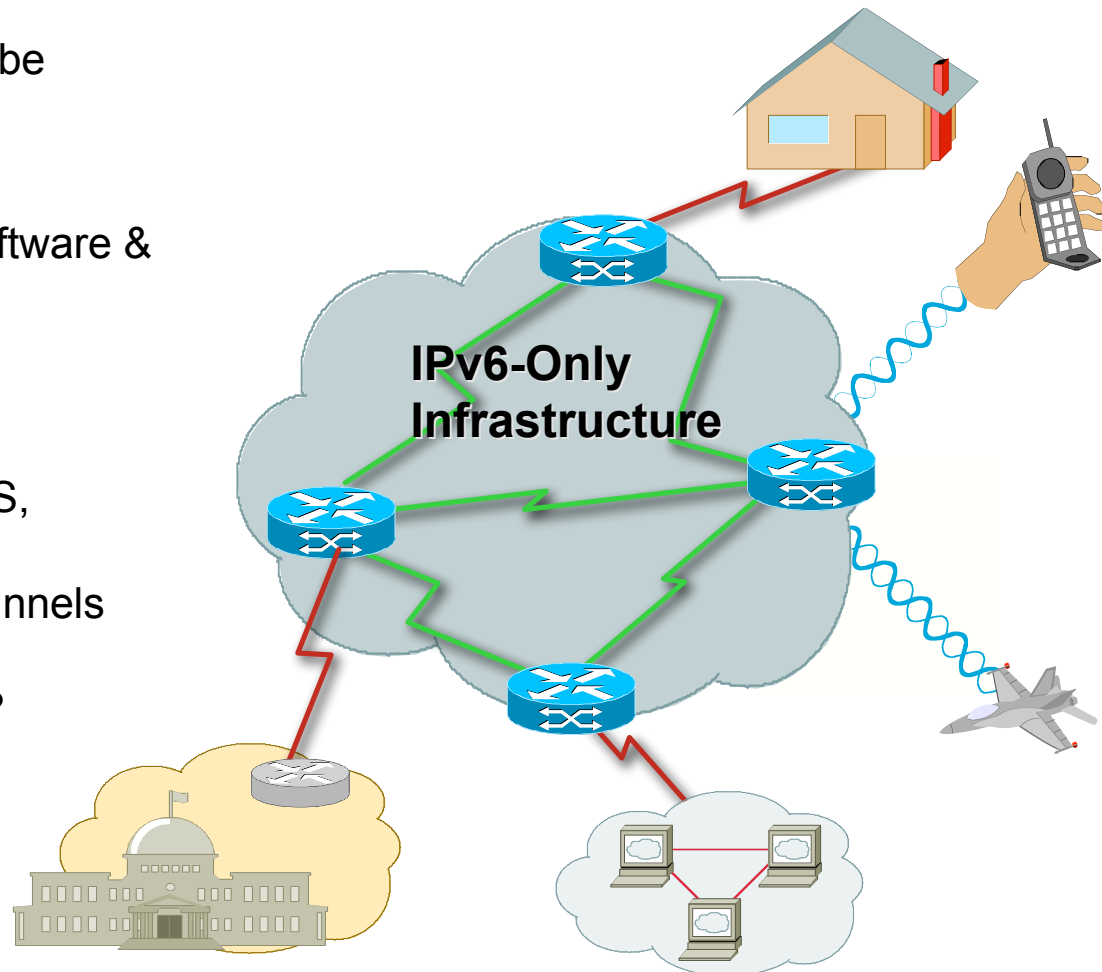
3GPP/UMTS Release 5: a 6PE Application



IM Domain is now a sub-set of the PS Domain

Native IPv6-only Infrastructure?

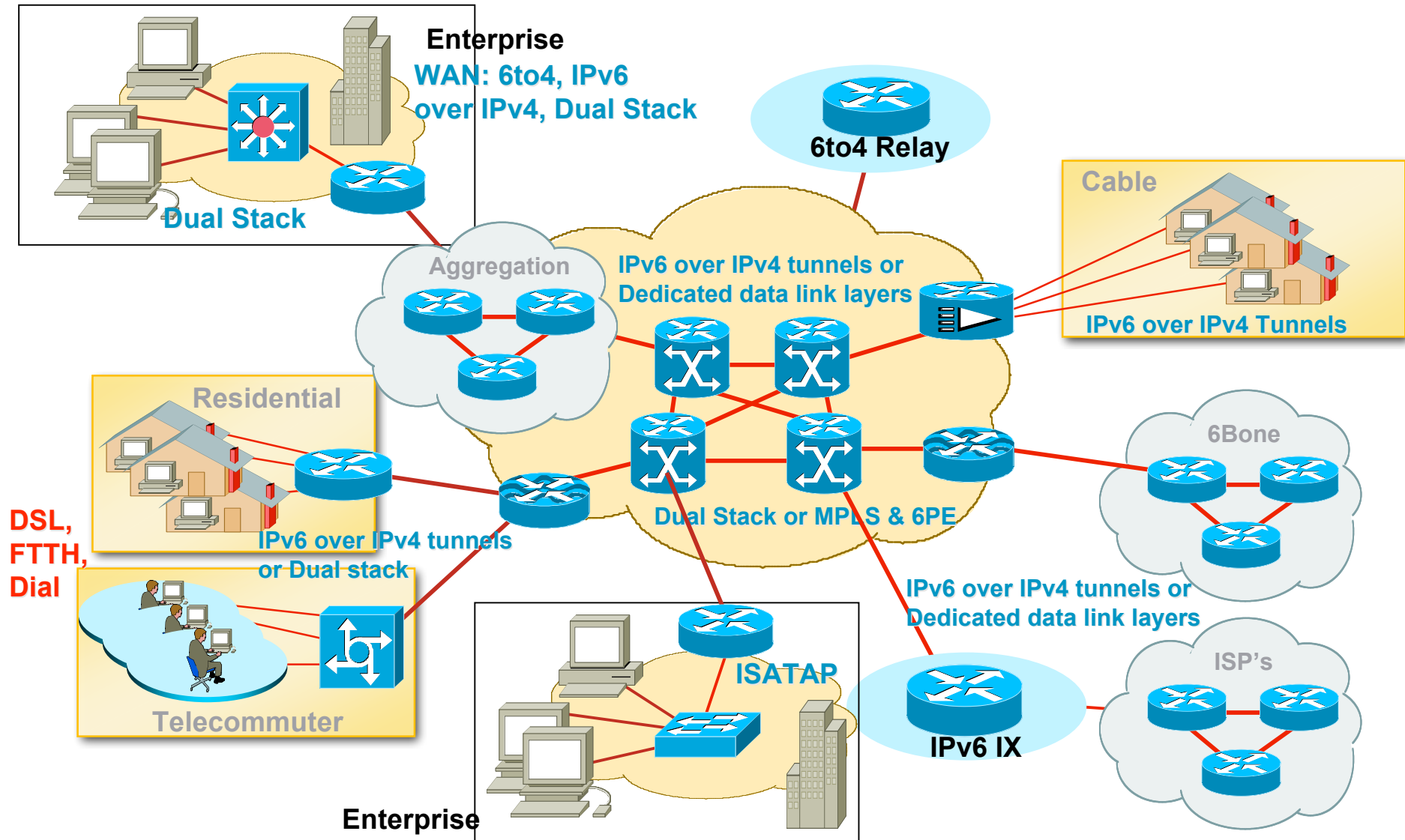
- Application's focus
 - When will the IPv6 traffic be important enough?
- Requires
 - Full Network upgrade (software & potentially hardware)
 - Native IPv6 Network Management Solutions
 - Enhanced IPv6 services availability Multicast, QoS, security,...
 - Transport IPv4 through tunnels over IPv6
 - IPv4 traffic requirements?



IPv6 Deployment Phases

Phases	Benefits
IPv6 Tunnels over IPv4	Low cost, low risk to offer IPv6 services. No infrastructure change. Has to evolve when many IPv6 clients get connected
Dedicated Data Link layers for Native IPv6	Natural evolution when connecting many IPv6 customers. Require a physical infrastructure to share between IPv4 and IPv6 but allow separate operations
MPLS 6PE	Low cost, low risk , it requires MPLS and MP-BGP4. No need to upgrade the Core devices , keep all MPLS features (TE, IPv4-VPN)
Dual stack	Requires a major upgrade. Valid on Campus or Access networks as IPv6 hosts may be located anywhere
IPv6-Only	Requires upgrading all devices. Valid when IPv6 traffic will become predominant

Moving IPv6 to Production



Still a lot to do...

- Though IPv6 has all the functional capability of IPv4 today:

Implementations are not as advanced (e.g., with respect to performance, multicast support, compactness, instrumentation, etc.)

Deployment has only just begun

Much work to be done moving application, middleware, and management software to IPv6

Much training work to be done (application developers, network administrators, sales staff,...)

Some of the advanced features of IPv6 still need specification, implementation, and deployment work

IPv6 Implementations

- Most Operating Systems now deliver an IPv6 stack
- Internetworking vendors are committed on IPv6 support
Interoperability events, e.g. TAHI, UNH, ETSI,...
- For an update status, please check on
www.ipv6-to-standard.org
- Applications IPv6 awareness
Net Utilities (ping, finger,...etc), NFS, Routing Daemons
FTP, TELNET, WWW Server & Browser, Sendmail, SMTP

IPv6 – Conclusion

IPv6 Ready for Production Deployment?

- Evaluate IPv6 products and services, as available
 - Major O.S., applications and infrastructure for the IT industry
 - New IP appliances, e.g...3G (NTT DoCoMo,...), gaming,...
 - IPv6 services from ISP
- Plan for IPv6 integration and IPv4-IPv6 co-existence
 - Training, applications inventory, and IPv6 deployment planning
- Upgrade your router with IPv6 ready software



IPv6 Deployment Scenarios

ISP/IXP Workshops