Designing LTE with IPv6

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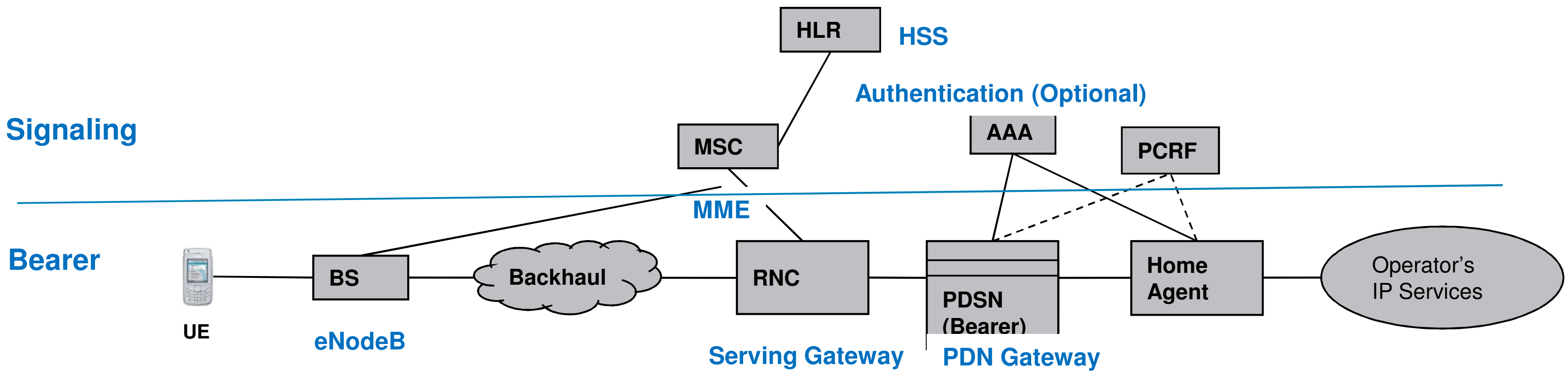
Agenda

- **LTE/EPS support for IPv6**
  - Few LTE Acronyms
  - LTE Traffic - Control & Bearer Traffic
  - Subscriber IP Address Allocations by Gateway
- **Typical Mobile network – IPv6 Touch Points**
  - IPv6 Planning Considerations
  - IPv6 subnetting – Infrastructure & Mobiles
  - DNS considerations
- **IPv6 Transitions Scenarios**
  - Dealing with Public/Private IPv4 Depletion
  - Large Scale NAT Deployments
- **IPv6 Trials/Deployment in Mobile Network**

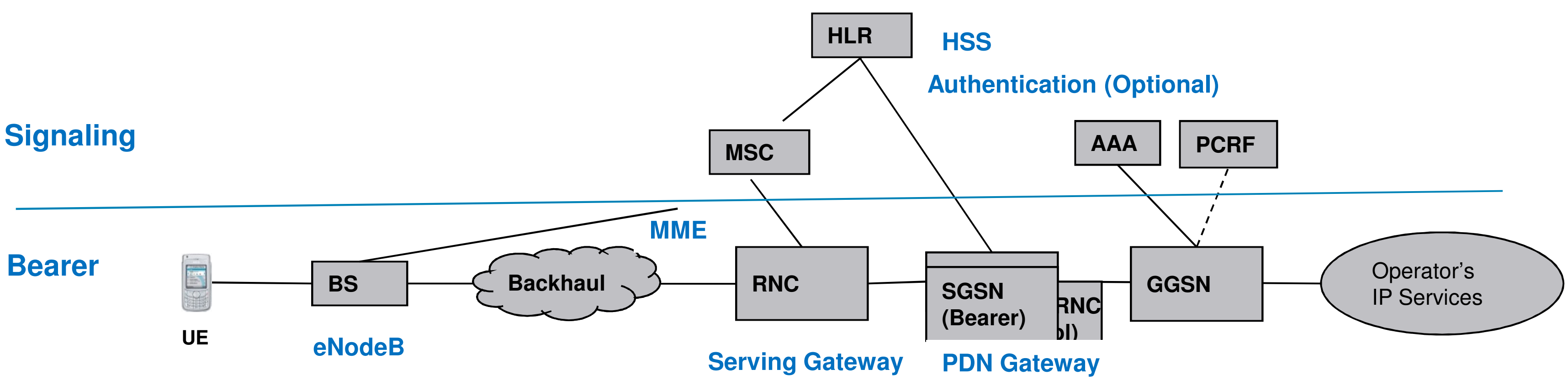
LTE – Long Term Evolution, EPS – Evolved Packet System

LTE Functional Migration from 3G

CDMA to LTE Migration

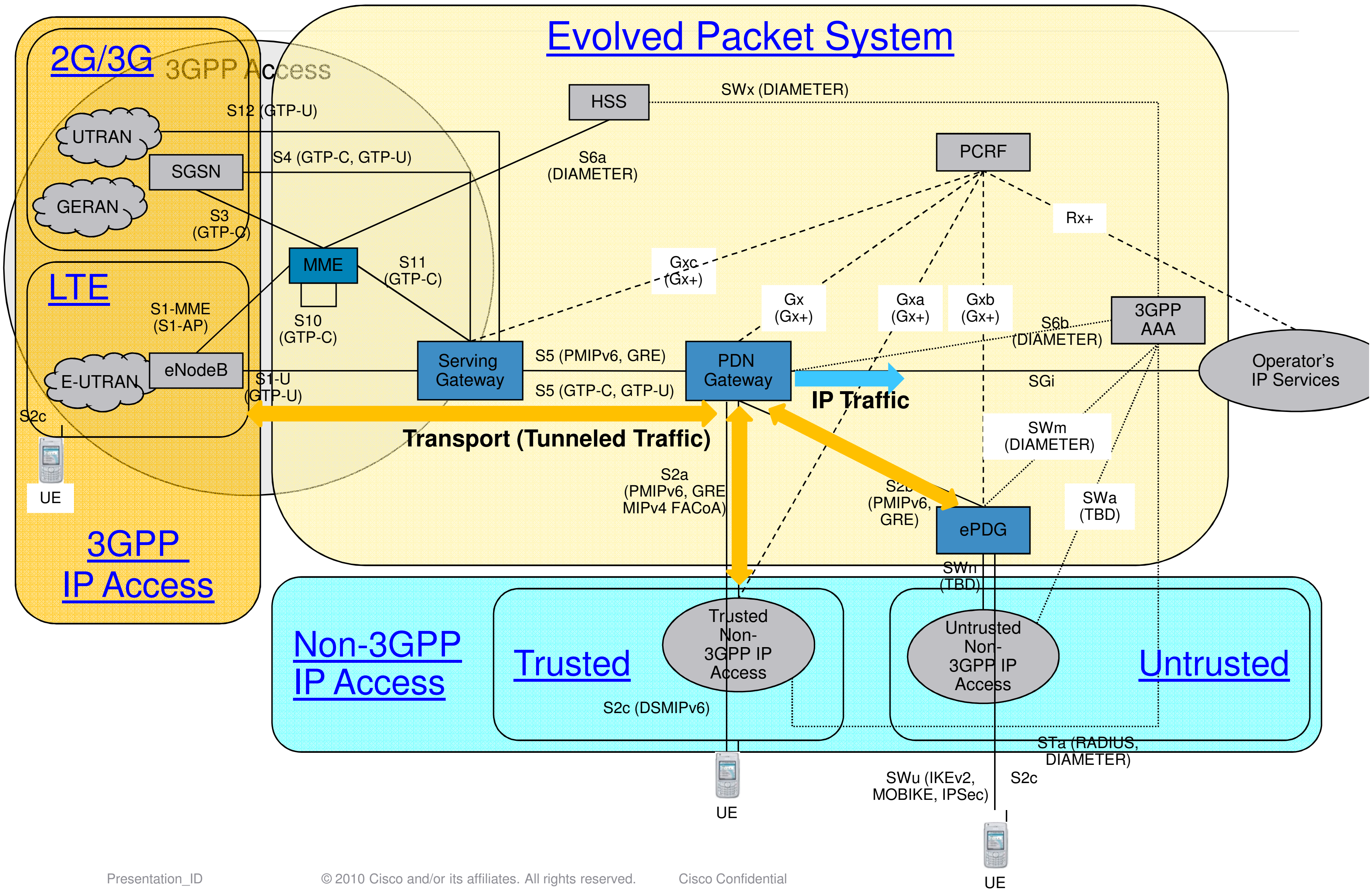


UMTS to LTE Migration



PGW has link to AAA, PCRF

LTE/EPS Reference Architecture
(Ref 3GPP TS23.401, TS23.402)



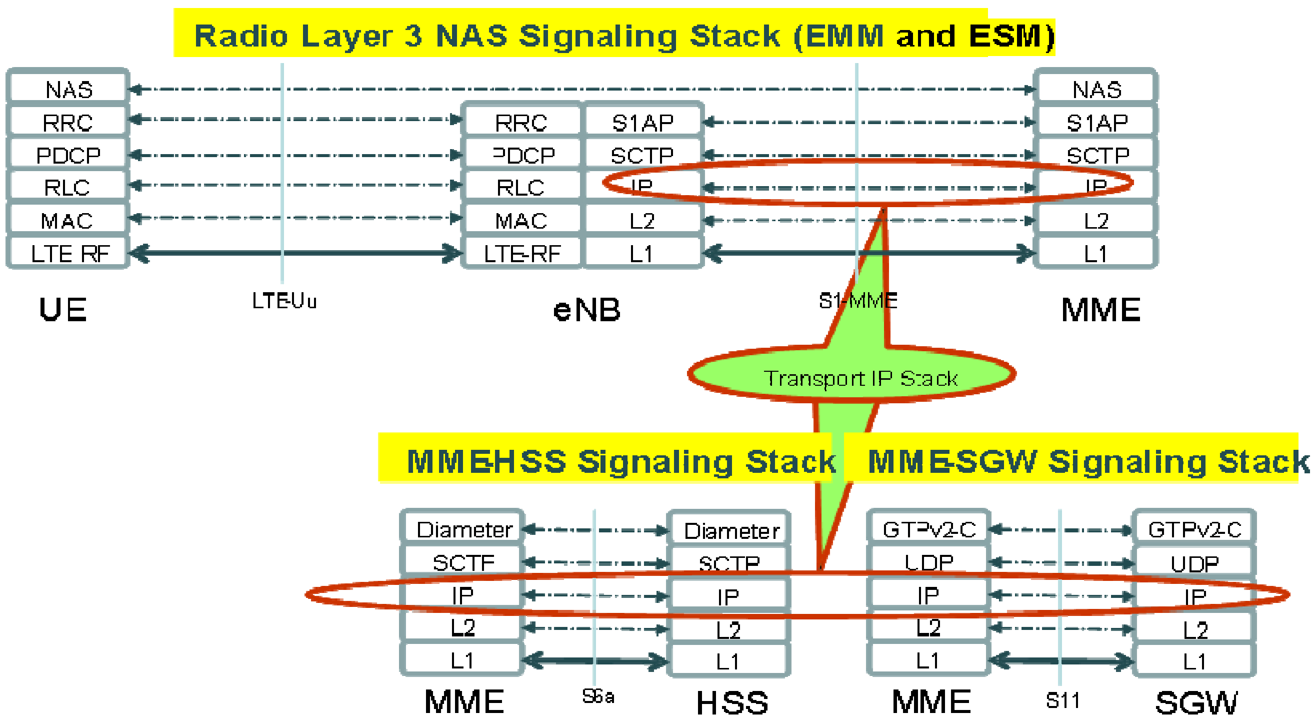
Few LTE Acronyms

LTE Acronyms	Meaning
Access Point Name (APN)	Identifies an IP packet data network (PDN) and service type provided by the PDN to that user's session.
PDN Connection	The Association between an mobile user and PDN (APN). This is represented by one IPv4 Address and/or one IPv6 Prefix
GPRS Tunneling Protocol (GTP)	Signaling and Tunneling protocol for data (between eNB, SGW, and PGW)
EPS Bearer	An EPS bearer uniquely identifies traffic flows that receive a common QoS treatment between UE and PDN-GW
Default Bearer	First one to get established and remains established throughout the lifetime of PDN Connection.
Dedicated Bearer	Additional bearer(other than default), created for a PDN connection to provide specific QoS treatment for Apps

Transport Traffic – Control

- Provide user authentication, establish data sessions
- Network Layer - IPv4, Dual stack or native IPv6
- Transport - Radio Access Network & Mobile Backhaul

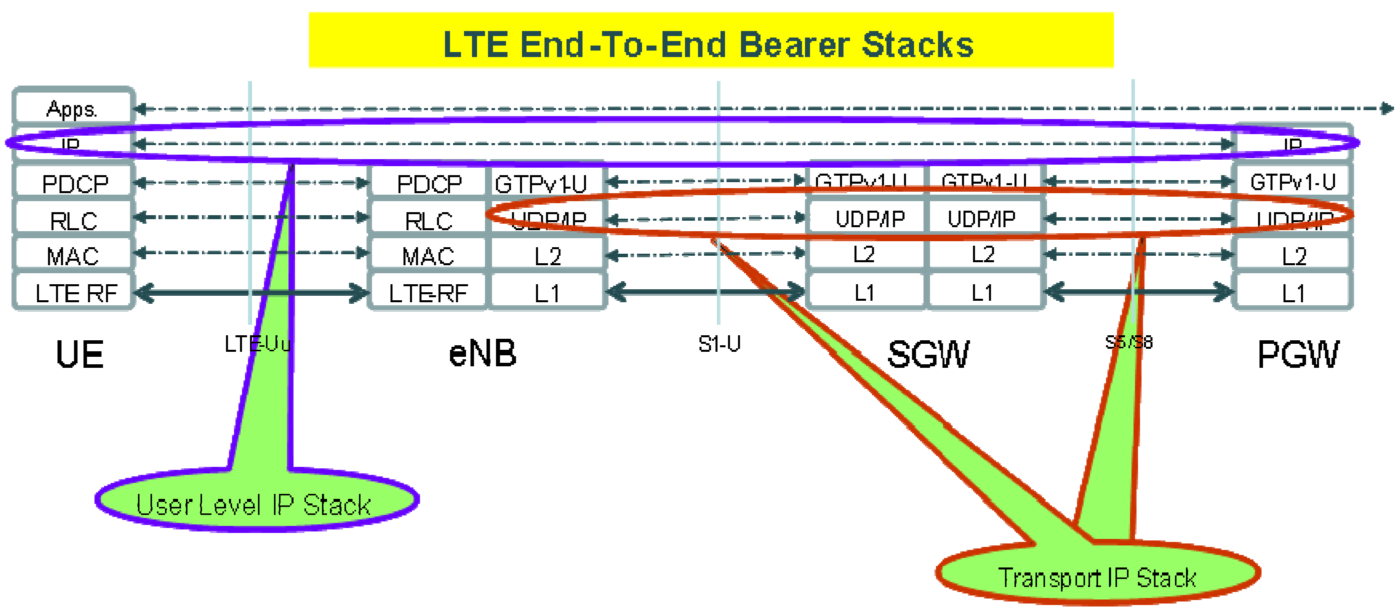
LTE Control Plane Stacks



Transport Traffic - Bearer

- Two way user traffic between **Users** and **Applications**
- Encapsulated in tunnel (GTP)
- Default Bearer and Dedicated Bearer(s) <u>if Required</u>
- Service Level QoS

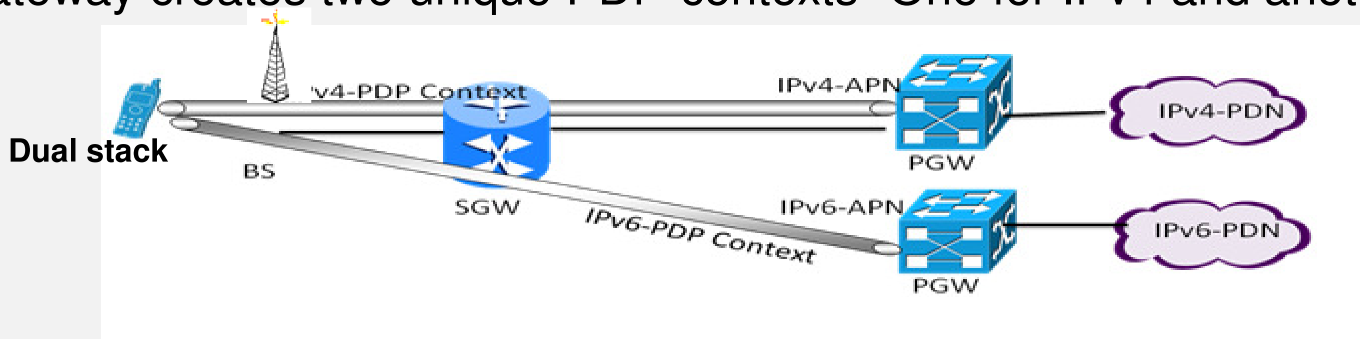
LTE Bearer Plane Stacks



Transport Traffic - Bearer setup for Subscriber

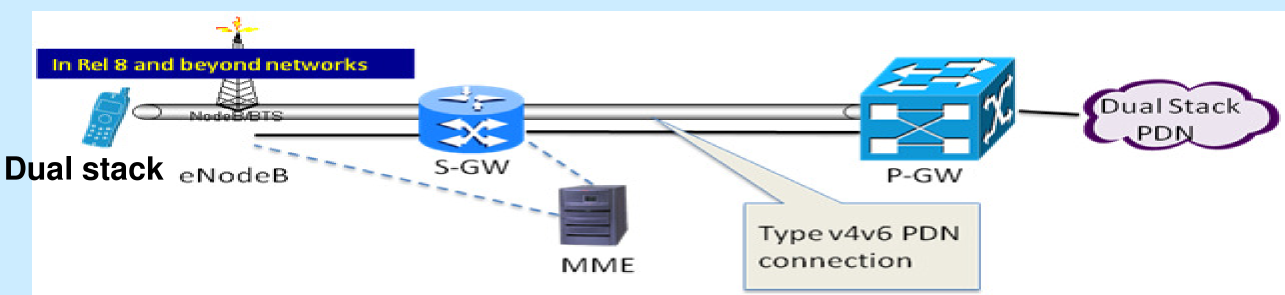
Prior to 3GPP Rel-8 (LTE introduced from Rel-8 onward)

- Dual-stack User sends two PDP requests- One of for IPv4 and another for IPv6
- Gateway creates two unique PDP-contexts- One for IPv4 and another for IPv6.



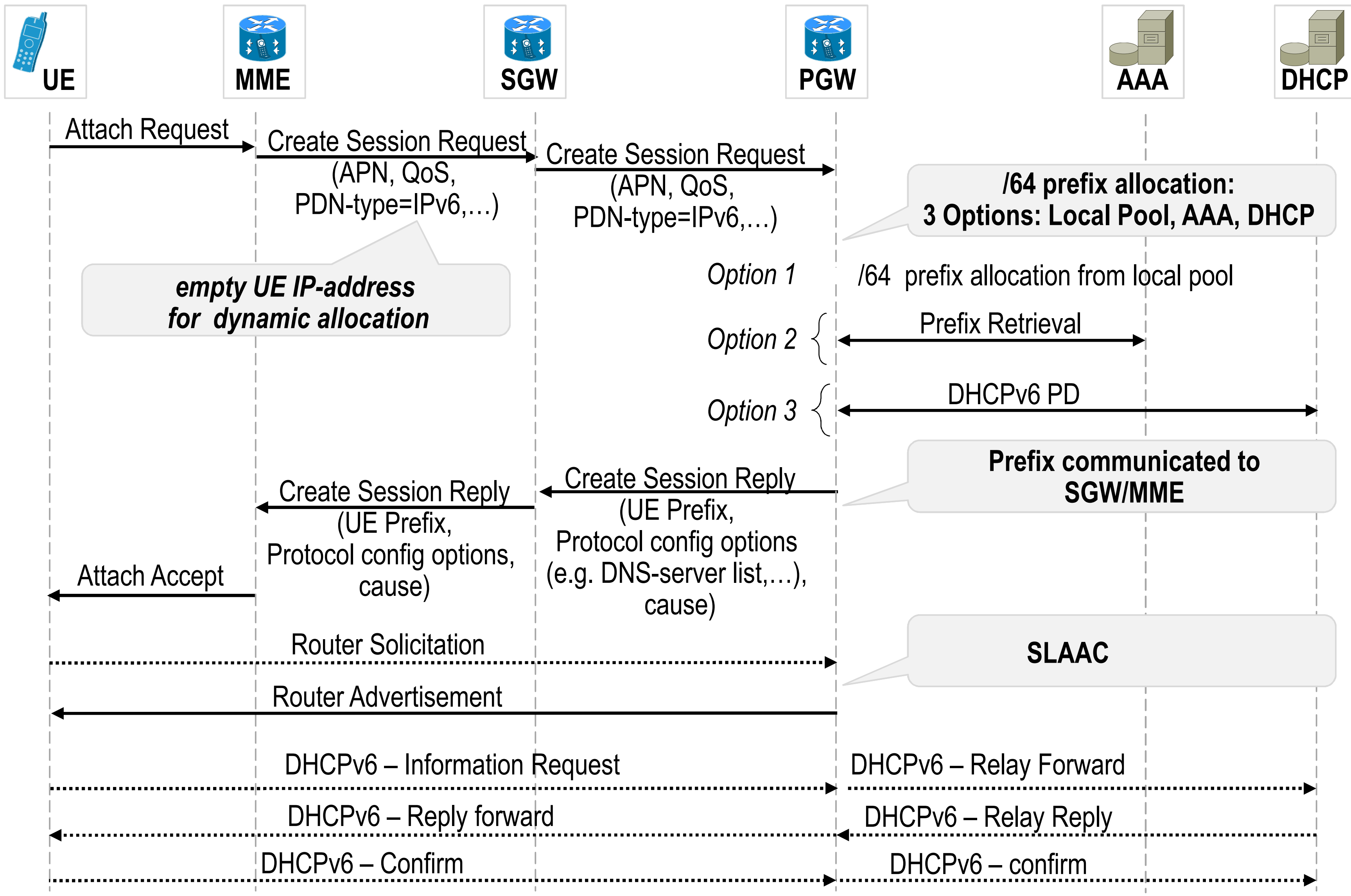
3GPP Rel-8 onward

- Dual stack User send one PDP request "IPv4v6"
- Gateway will create bearer; Allocate IPv4 & IPv6 to same bearer
- For GPRS network single bearer is applicable from 3GPP Rel-9 onward



Subscriber IPv6 Address Allocation

For your reference

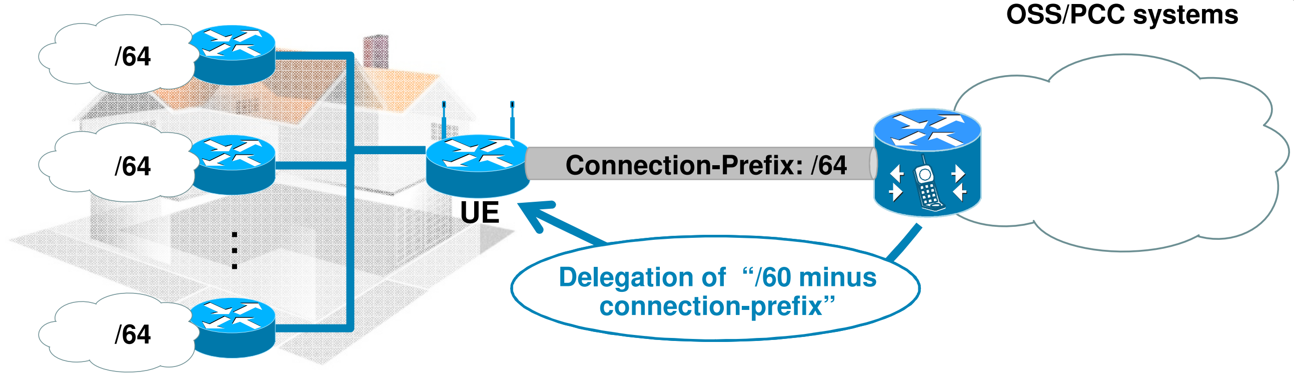


Mobile Router (3GPP Rel-10)

For your reference

FUTURE

UE represented by single prefix (here "/60") - in routing and OSS/PCC systems



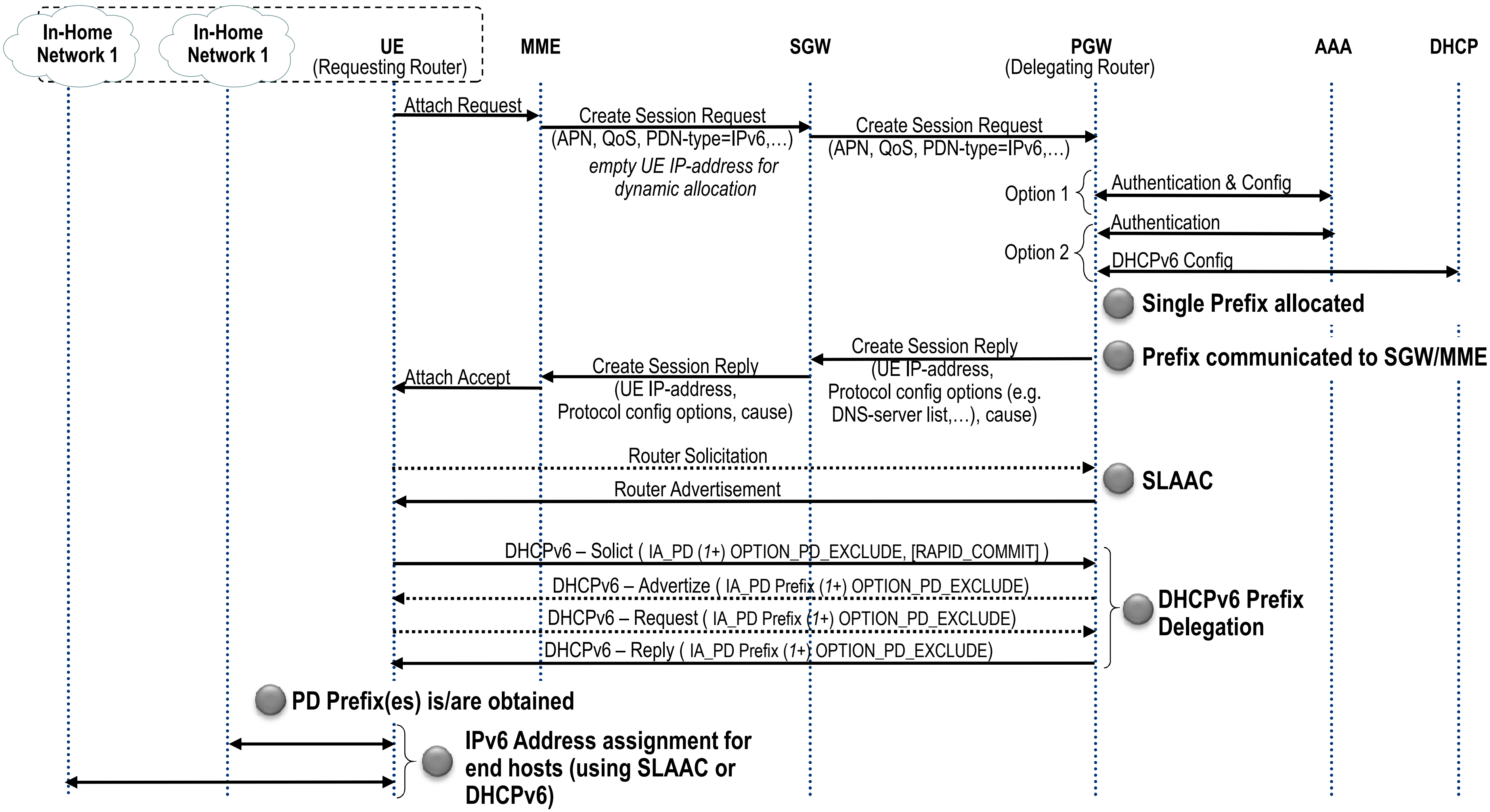
- Enable LTE UE to work as Mobile router (/60) & Each client get /64
- Prefix Delegation w/ DHCPv6 PD (RFC3633) on top of existing address
- LTE UE request DHCPv6 Prefix delegation
- DHCPv6 allocate prefix (e.g. /60) "prefix minus connection-prefix" delegated using Prefix-Exclude option (see draft-korhonen-dhc-pd-exclude)
- LTE UE further allocate /64 to clients minus connection-prefix

IPv6 Prefix Delegation in 3GPP Network

3GPP TS 23.060 & 23.401 (Rel-10)

For your reference

FUTURE



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  - Large Scale NAT
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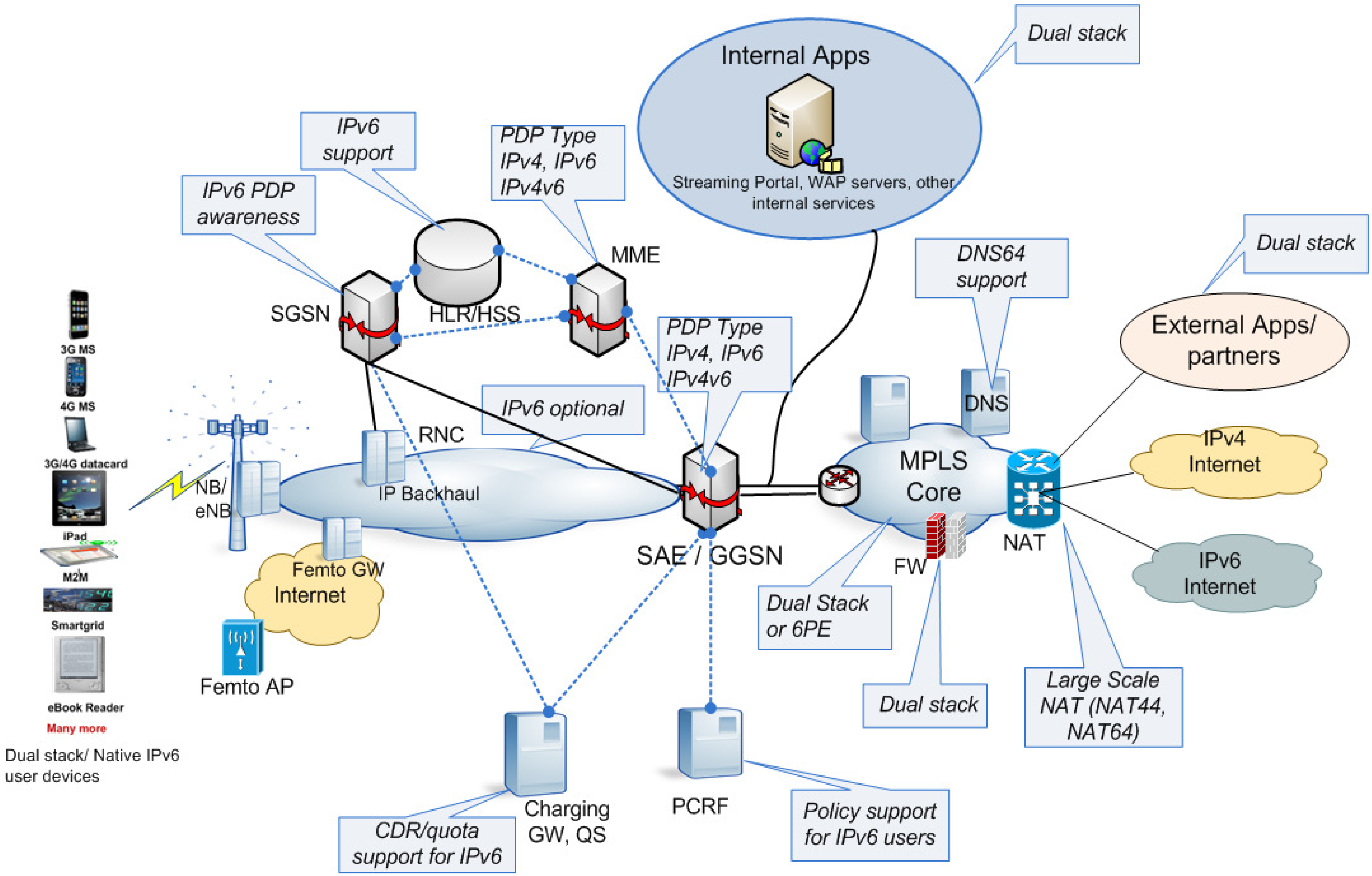
LTE – Long Term Evolution, EPC – Evolved Packet Core

Typical Mobile Network – IPv6 Touch Points



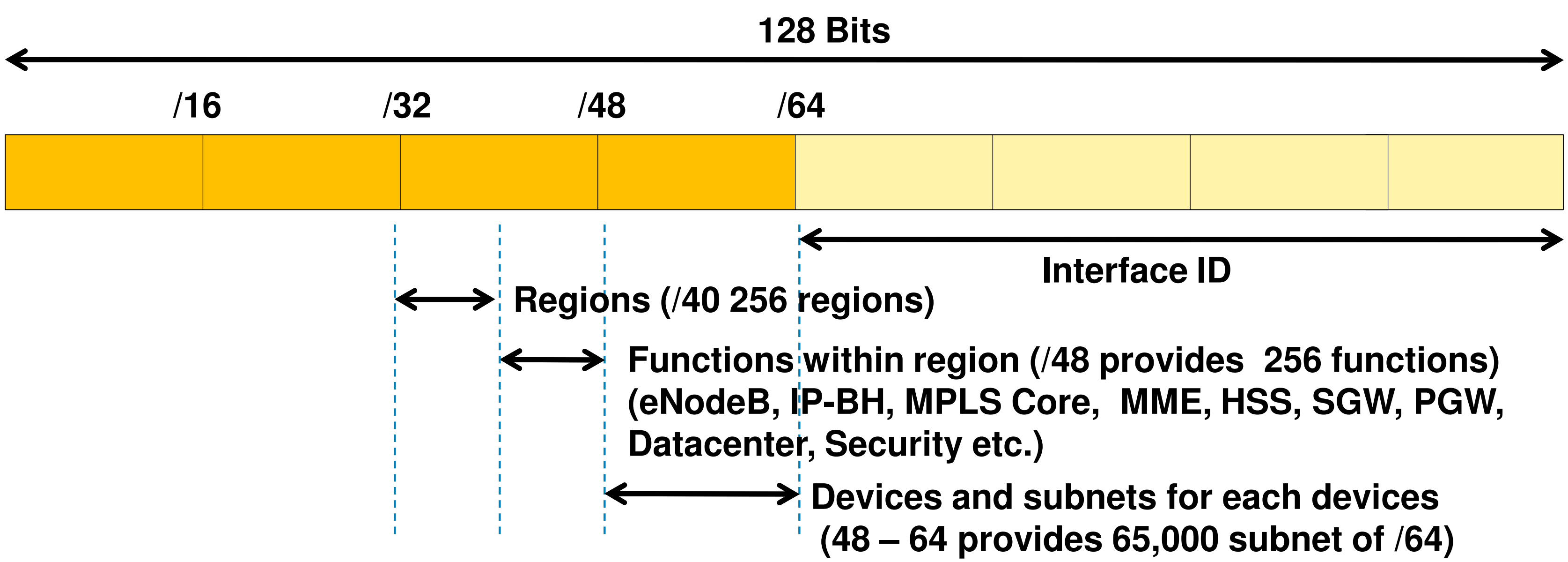
IPv6 Planning Design Considerations

- **Greenfield LTE deployments should be IPv6**
  - Dual Stack Users. Chose IPv6 as preferred
  - Transport – Dual stack (Preference) or 6PE, 6VPE
  - All LTE Gateway interfaces should be IPv6
  - Internal Apps (i.e. IMS, Video etc.) should be IPv6
  - NAT64 for IPv4 internet
- **Deploying LTE in existing network**
  - Build LTE/EPS architecture with dual stack
  - Integrate with existing 2.5/3G network on IPv4
  - Dual stack UE, Gateway supporting dual stack
  - Transport – 6PE, 6VPE or dual stack (without adverse impact)
  - Create Services islands- served by IPv4, IPv6
  - NAT64 for IPv4 internet

IPv6 Subnet Considerations for Infrastructure

- Infrastructure subnets <u>typically not</u> announced to internet
- Summarization – optimize routing and easy to scale
- Interface address- Choices - /126, /127, /64
- Loopback /128

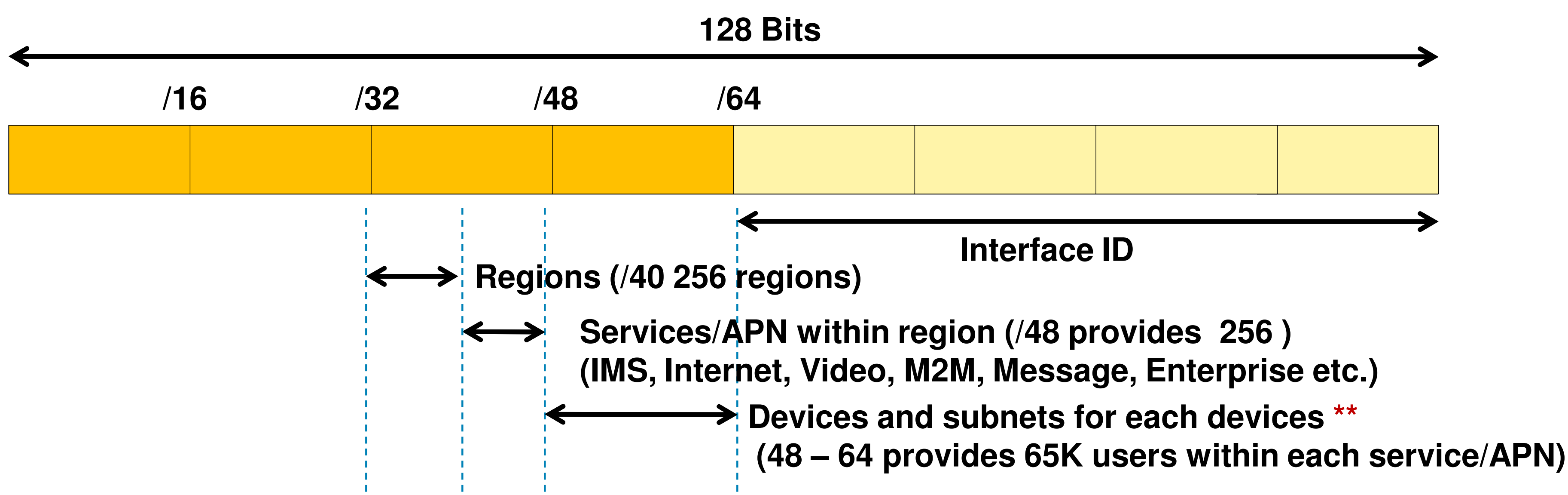
Subnetting Example (Assuming - /32 for Infrastructure)



IPv6 Subnet Considerations for Subscribers

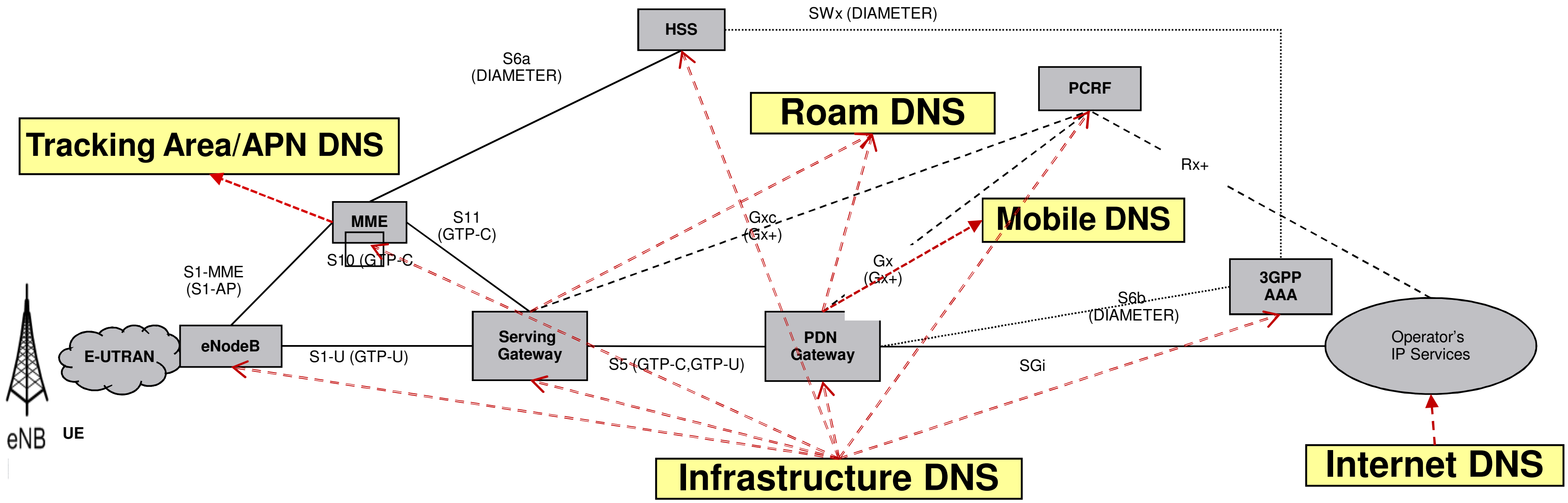
- LTE Users IPv6 subnets are announced to internet
- Separate block for each service i.e. APN/virtual APN
- Allocation strategy – Local Pool, AAA, DHCPv6
- Subnet strategy – Ability to identify services, easy growth

Subnetting Example (Assuming /32 for LTE Users)



**** For wireless routers gateway allocated smaller block i.e. /60, /56 etc.**

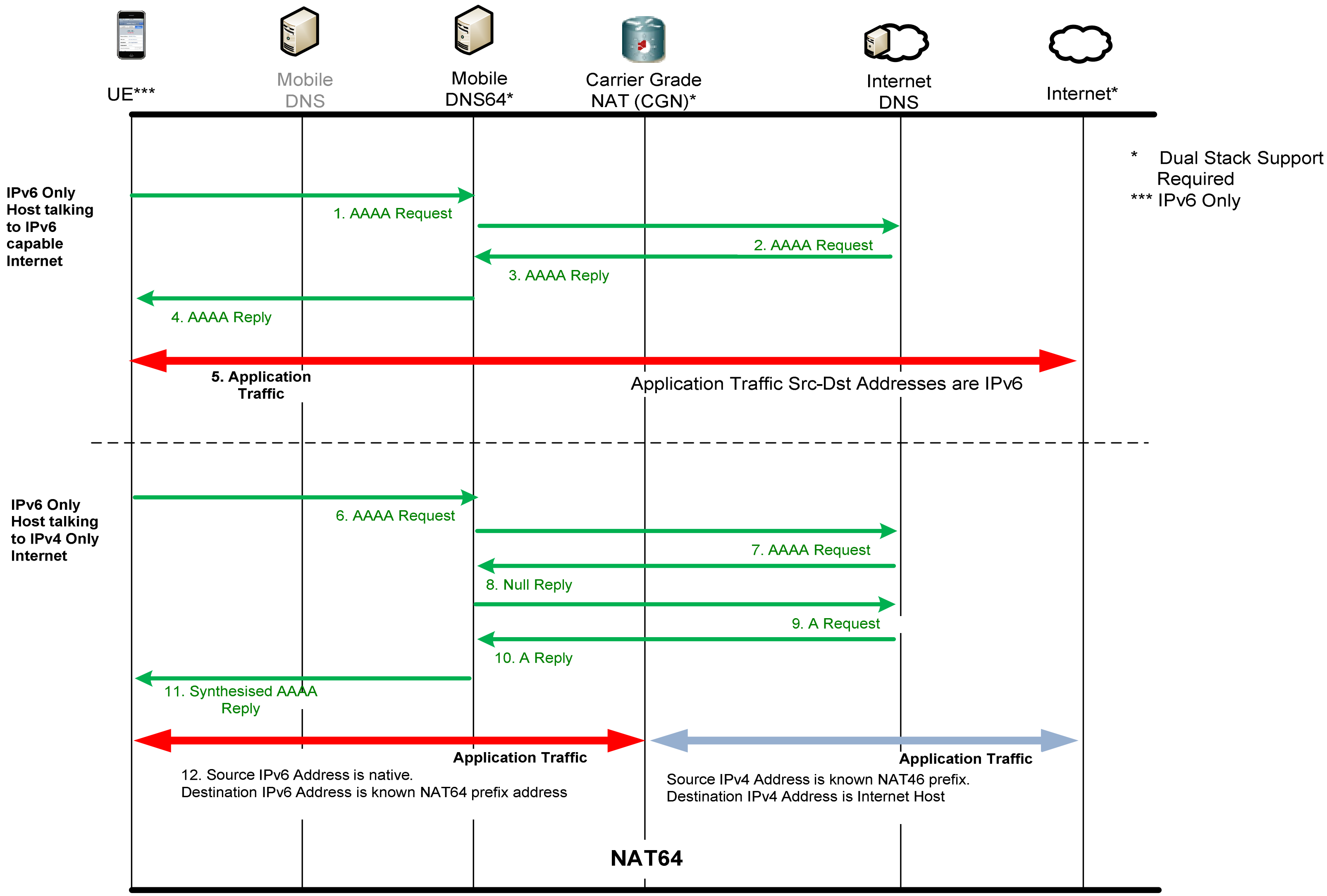
IPv6 Impact on DNS Architectures



Tracking Area/APN DNS - Used by MME during handover, tracking area updates	IPv6 capable if LTE interfaces are IPv6
Mobile DNS – Used mobile to resolve Apps/internet	Need DNS44 and DNS64 capability
Internet DNS - Root DNS for service provider	Need DNS44 and DNS64 capability
Infrastructure DNS – Used by OAM network	Only if OAM is IPv6
Roam DNS- Used by gateways for roaming traffic	Only if IPv6 roaming supported

For your reference

DNS64 Traffic Flow



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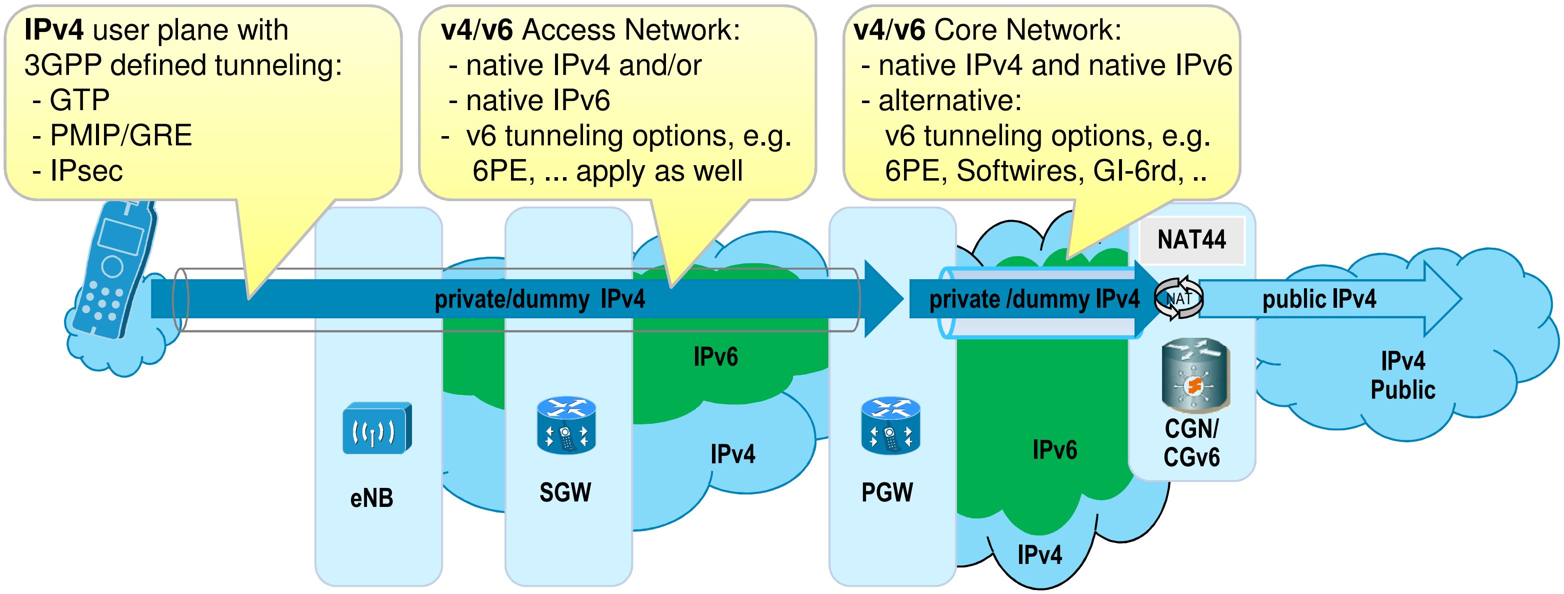
LTE – Long Term Evolution, EPC – Evolved Packet Core

A. Enable IPv6 Transport: Dual Stack Network

IPv4/IPv6 Coexist in Transport Network

IPv4/IPv6 Coexistence: Transport Network

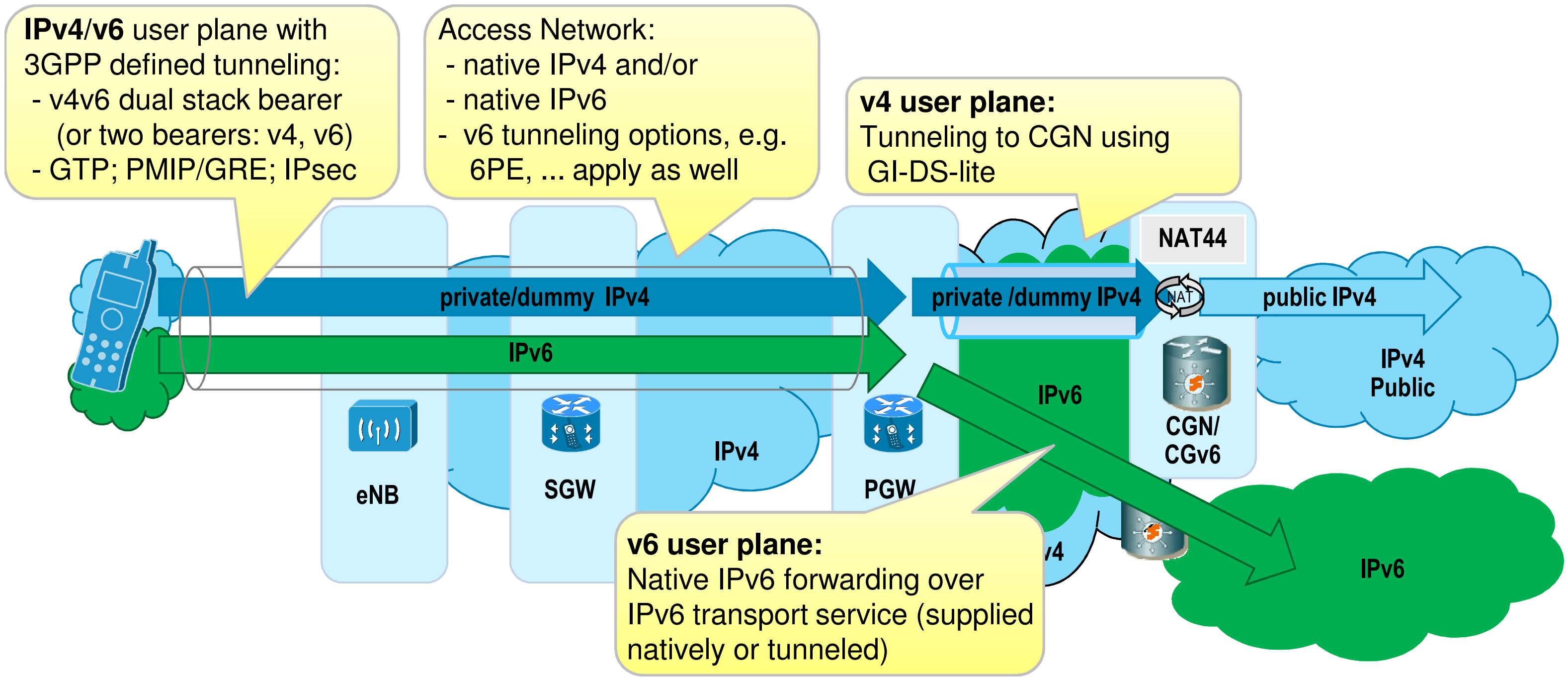


- Enable Dual-Stack IPv4/IPv6 Transport Network
  - Access Network: 3GPP standards already support dual-stack (GTP/PMIP/IPsec tunneling)
  - Routing Protocols handle IPv4 / IPv6
- Core needs to support IPv6 transport (in parallel with IPv4): Options
  - Native IPv6 (in parallel to IPv4 forwarding)
  - IPv6-over-IPv4: Manually Configured Tunnels (IPinIP/GRE); Gateway-Initiated 6rd
  - IPv6-over-MPLSv4: 6PE, (6VPE)

B. Enable IPv6 Services: Dual-Stack Handset

IPv4/IPv6 services available to user

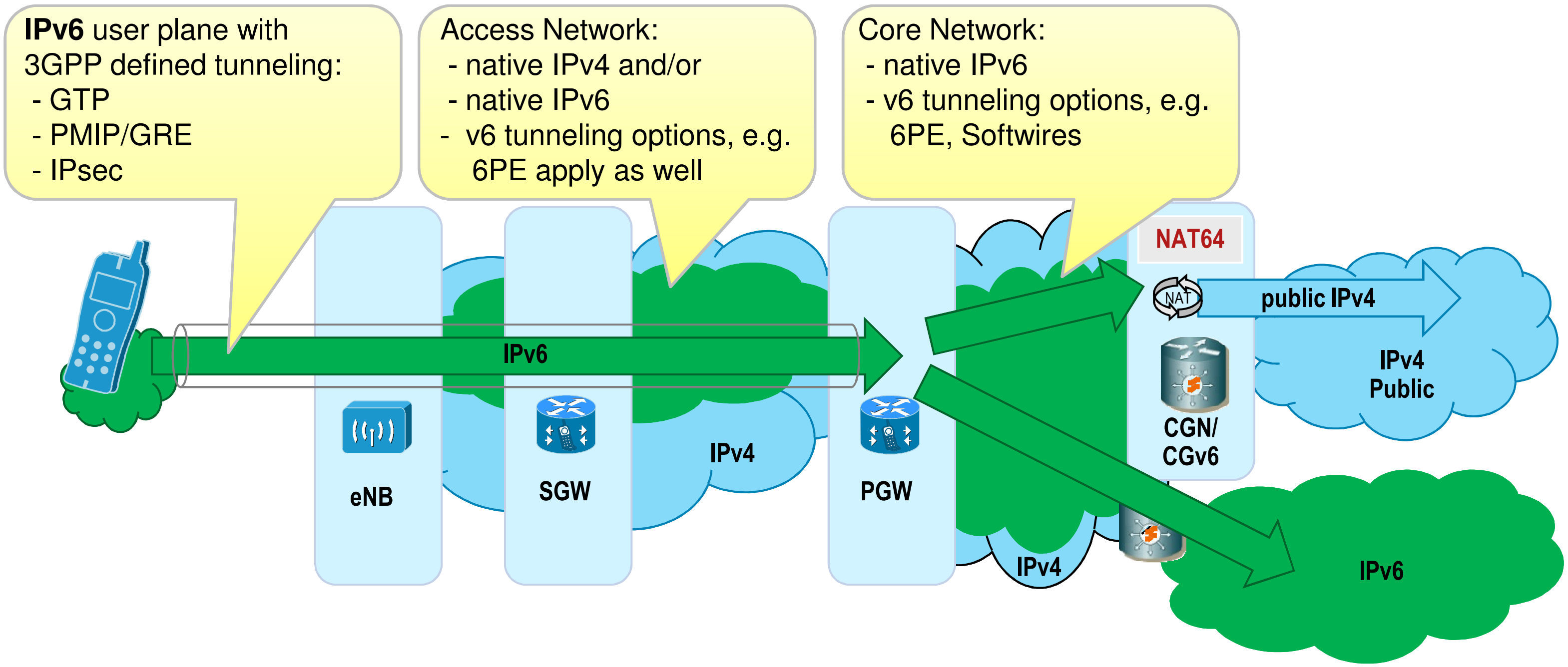
IPv4/IPv6 Coexistence: Handset



- IPv6 support on handset added (establishes v4/v6 bearer)
- Both IP Stacks available to the user, enable Dual-Stack IPv4/IPv6 Transport Network
  - 3GPP standards already support dual-stack access network (GTP/PMIP/IPsec tunneling)
- User Plane traffic transport over core network:
  - IPv4 User Plane: Gateway Initiated DS-Lite – tunneling between PGW and CGN
  - IPv6 User Plane: Native IPv6 forwarding (v6 transport supplied as native or tunneled service)

Simplify Handset: IPv6-only handset

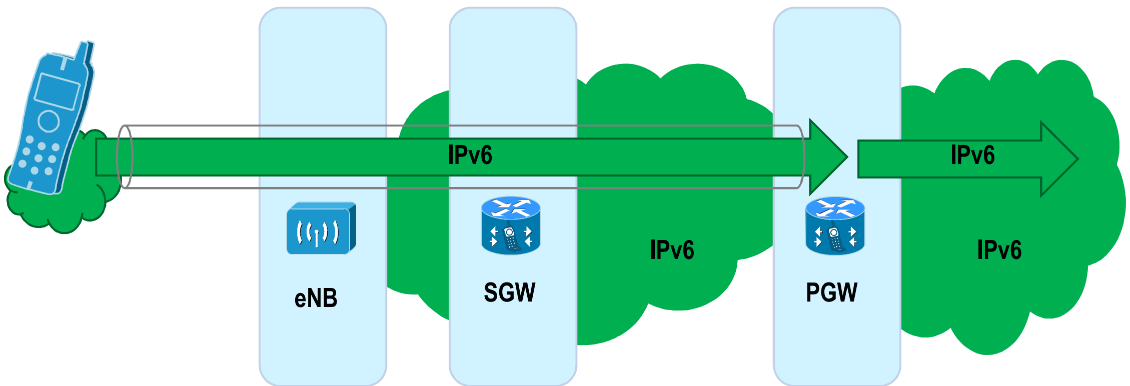
NAT64 to allow access to legacy IPv4 services



- Handset: IPv6 only as default service
  - Simplify Operations, Optimize Resource Usage
  - IPv4 only kept as backup – in case IPv6 service not avalable (e.g. Roaming scenarios)
- Stateful NAT64 as natural evolution from NAT44

The Far Future: IPv6 only

A Dream Has Come True ☺



- All services delivered via v6
- IPv4 discontinued on Handset and Transport Network

IPv6 Transition Scenarios **

Running out of Public IPv4

- Converting some mobile pools from public to RFC1918
- Introduce dual stack mobiles
- Convert internal Apps (e.g. IMS etc.) to native IPv6
- Repurpose freed public IPv4 for other use
- Create multiple islands of private RFC1918 pools (L3VPN)

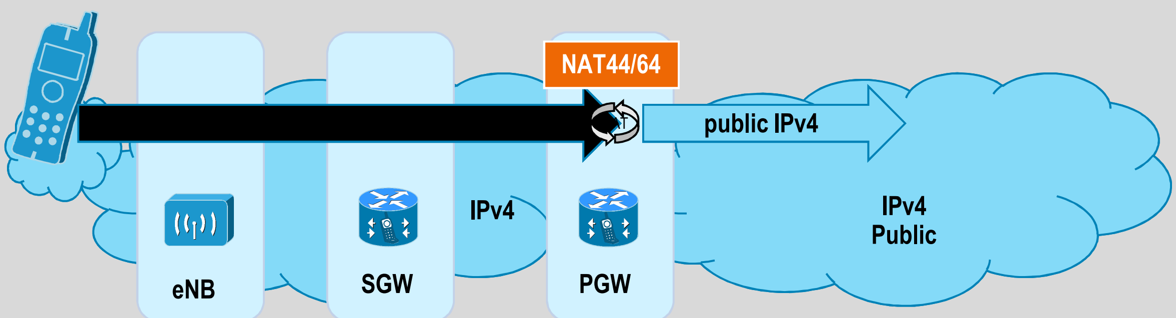
Running out of Private IPv4

- Creating multiple islands of private RFC1918 pools (L3VPN)
- Possibly implement Gateway Initiated Dual Stack Lite
- Introduce dual stack mobiles
- Convert internal Apps (e.g. IMS etc.) to native IPv6

** 3GPP TR23.975 IPv6 migration strategies

Large Scale NAT -Where to Place the NAT Function?

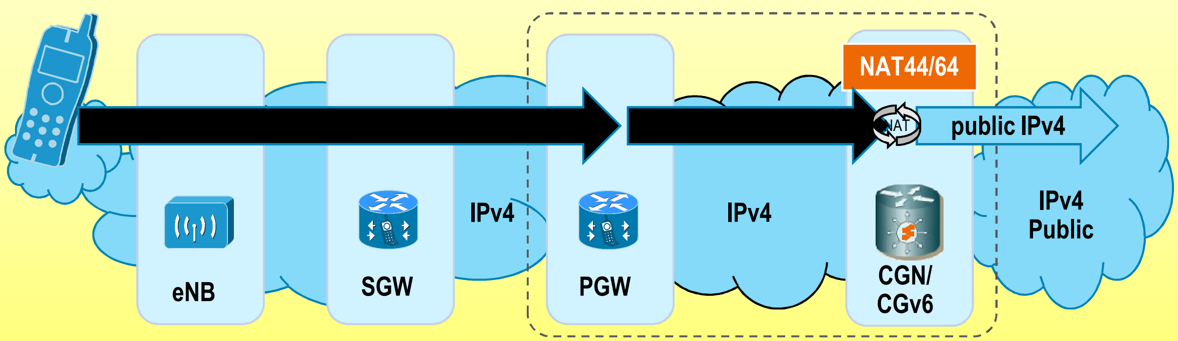
Option 1: NAT on Mobile Gateway (Distributed)



Key Benefits:

- Subscriber aware NAT
  - per subscriber control
  - per subscriber accounting
- Large Scale (further enhanced by distribution)
- Highly available (incl. geo-redundancy)

Option 2: NAT on Router (Centralized)



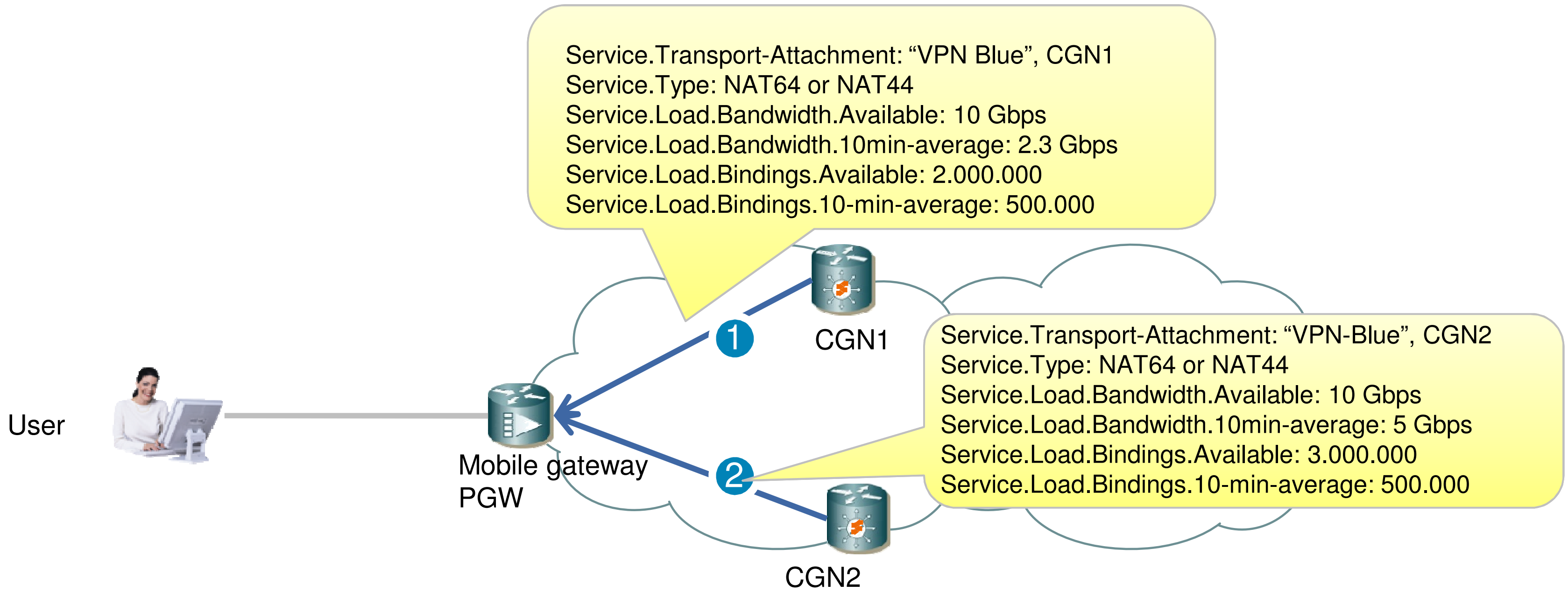
Key Benefits:

- Integrated NAT for multiple administrative domains (operational separation)
- Large Scale
- Overlapping private IPv4 domains (e.g. w/ VPNs)
- Intelligent routing to LSN

Routing to Multiple CGN Gateways

For your reference

FUTURE



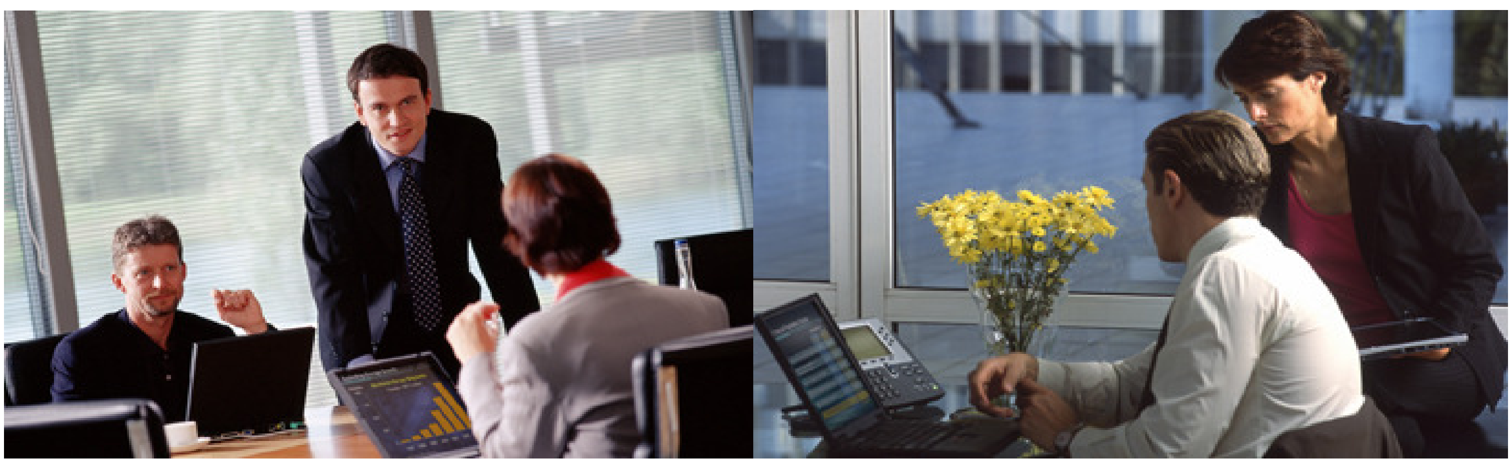
- CGN announce their availability with dynamic state
- Mobile Gateway select the best route and forward traffic

IPv6 Trials/Deployments in Mobile Networks

Regions	LTE with IPv6 Experience
North America	Existing 3G operators, introducing LTE LTE network operational with IPv6 Users - dual stack, IPv6 for internal Apps (IMS) IPv6 Infrastructure – eNB, IP-backhaul, gateways Large Scale NAT44/64
Asia Pacific	Multiple networks designed with IPv6 (Greenfield as wells as existing 3G networks integrating LTE) Most networks at testing stage Key drivers - IPv4 depletion, Infrastructure
Europe	LTE network operational with IPv6 Users - dual stack Infrastructure – IPv4, tunnels Large Scale NAT44/64

Key Take Away ….

- ✓ Alignment of Business Goals and Technical Architecture
- ✓ Test & Validation is Key - Feature Certification & Interoperability Testing
- ✓ Governance Plan – Operator, network vendors, Apps partners
- ✓ Use open standards (3GPP, IETF, ITU,NGMN, LTESi)
- ✓ IPv6 Transition/Integration = Business Continuity



Cisco Live 2011 @ Vegas 10 – 14 July

Technical sessions on LTE & IPv6

Session	Topics
BRKRST-3300	Deploying IPv6 in Service Provider Networks
BRKSPM-5127	3G/4G Femtocell Architecture and Design
BRKSPM-2483	Deploying Timing Services in Packet based Networks
BRKSPM-5143	Transitioning to IPv6 for Mobile Operators
BRKSPM-5149	Next-Gen Datacenter for Mobile Operators
BRKSPM-5226	Service and Policy Control Architectures for Mobile Operators
BRKSPM-5244	Mobile Video Optimization and Delivery
BRKSPM-5288	LTE Design and Deployment Strategies
BRKSPM-5293	Mobile Multimedia, Messaging and Voice over LTE
BRKSPM-5327	Mobile Offload Architectures and Fixed Mobile Convergence
TECSPM-2188	Seminar on “Next Generation Mobile Network”
TECSPM-3040	Seminar on “Enabling an Intelligent Mobile Network”

References

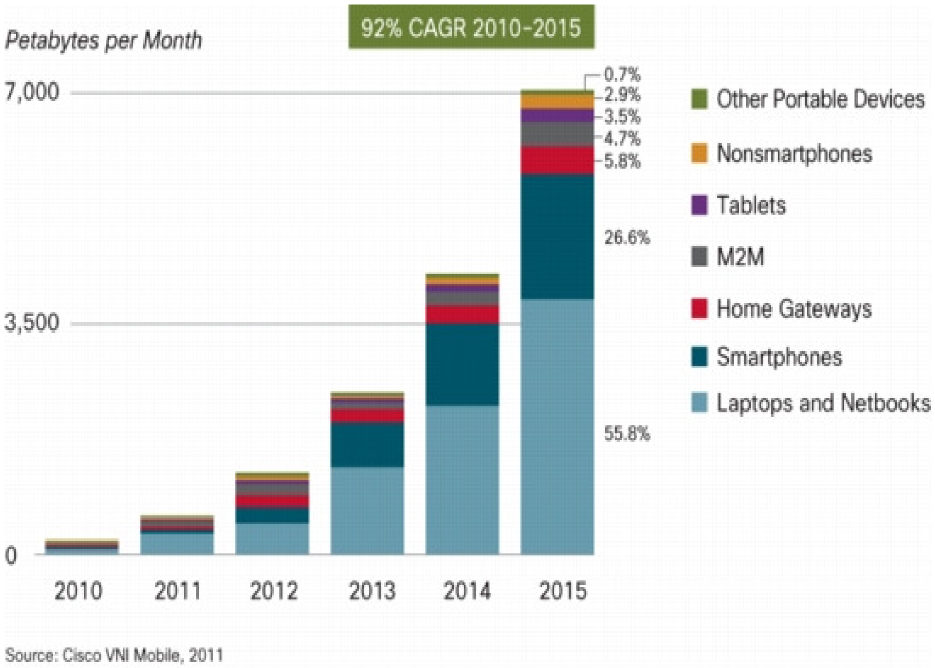
1. NGMN http://www.ngmn.org (White paper on Gateways, backhaul, security)
2. 4G Americas http://www.4gamericas.org (Whitepapers)
    - 3GPP Release 10 and beyond
    - IPv6 integration
    - GSN-UMTS migration to 4G
3. 3GPP http://www.3gpp.org (Standards)
    - 3GPP TR 34.401 For 3GPP Network
    - 3GPP TR 34.401 For Non-3GPP Network
    - 3GPP TR 36.913 Requirement for E-UTRA and E-UTRAN
    - 3GPP TR 35.913 Requirement for further enhancement of E-UTRA (LTE-Advanced)
    - 3GPP TR23.975 IPv6 Migration Guidelines (R10)
4. ETSI Studies on latency requirements for M2M applications
http://docbox.etsi.org/Workshop/2010/201010_M2MWORKSHOP/
1. Global Certification Forum – Testing mobile devices
http://www.globalcertificationforum.org/WebSite/public/home_public.aspx

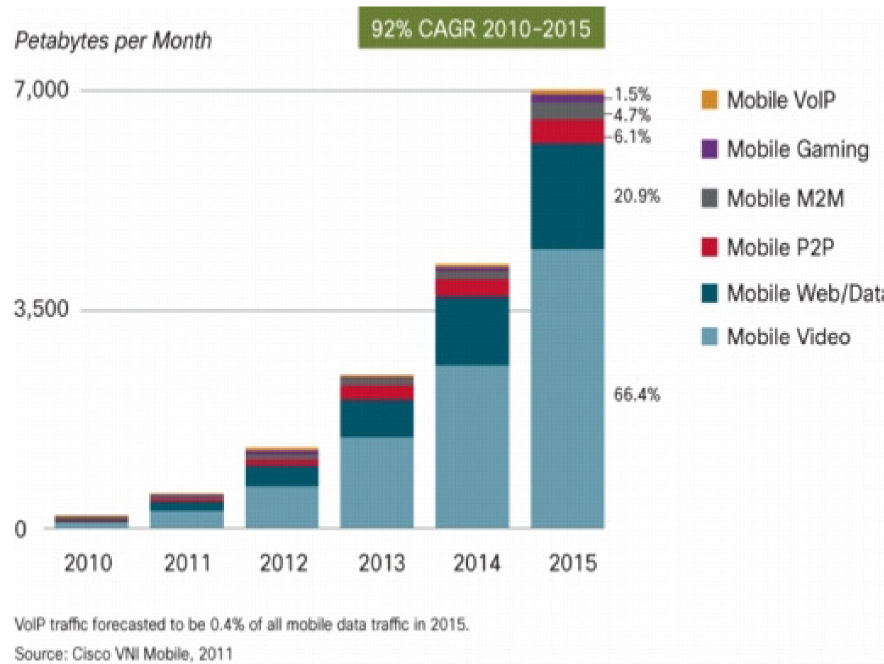
Thank you.

There Are Services Better on IPv6

Characteristic	Reason	Example
Infrequent Use	Maintaining NAT bindings for rare occurrence events is inefficient	▪ Earthquake Warning service NTT IPv6 ▪ Smoke detectors: 6LoWPAN
Universal Connectivity	Reachability of devices in the home	▪ Dozens of IPv6 Tunnel brokers = unconstrained Peer-to-peer
Green Network	A PC with many networked applications sends many keep-alives. Each needs Δ power across network.	▪ Skype for iPhone drains batteries from application via data plane keep-alive
Scalable/Green Data Center	Persistent client/server transport connection is needed to keep NAT open	▪ Facebook IM long polling
High bit Rate+NAT	Smaller SP margin per bit for AFT vs competitors without that cost	▪ Netflix On-Demand supports IPv6. Check path before stream ▪ Google 1/10th Internet traffic

Mobile Broadband Devices and What they Do?



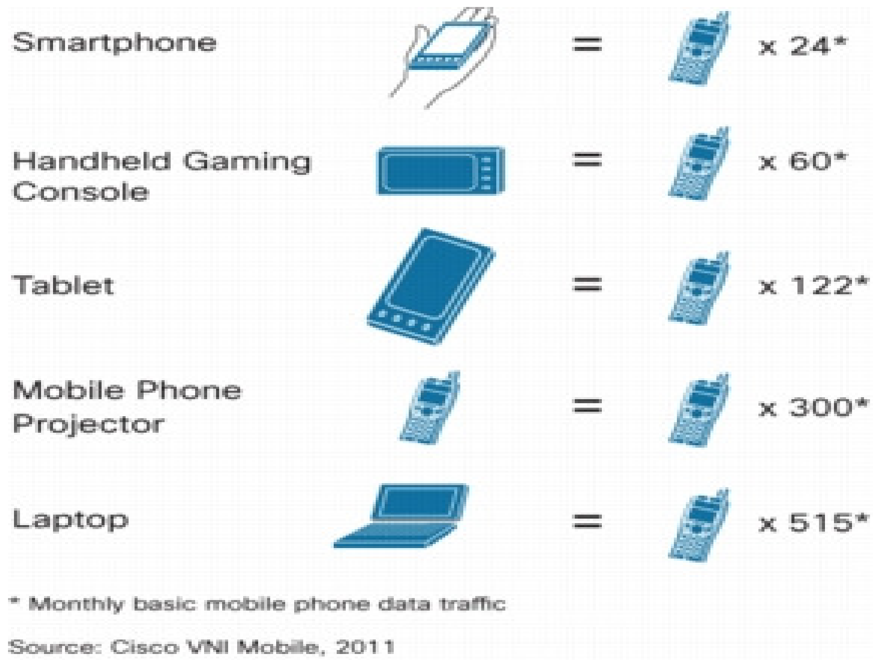


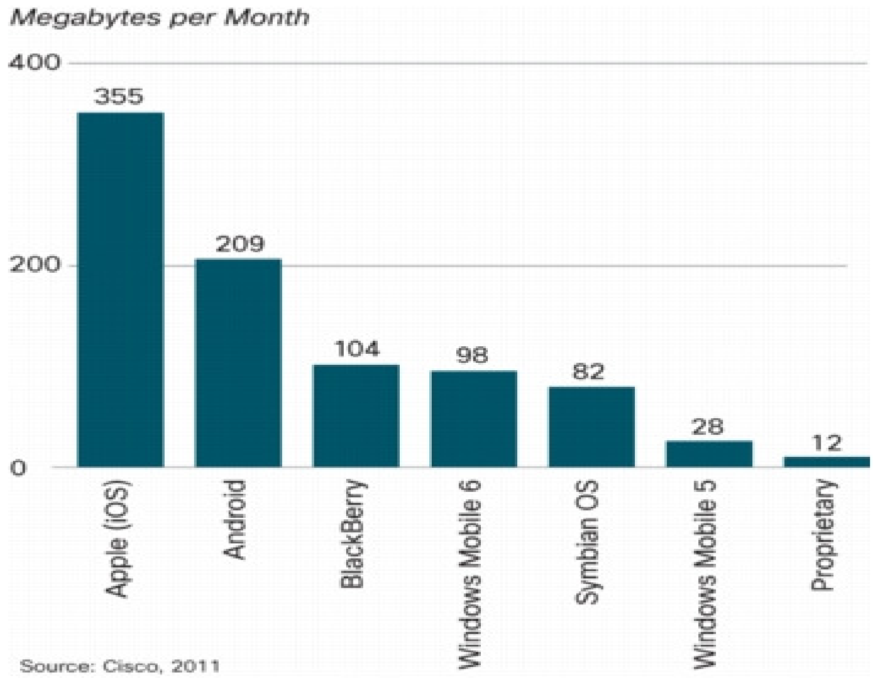
- Dongle (Notepad/netbooks) & Smartphone ~80% of total traffic
- Video(66%), Mobile Web/data(20%). P2P (6%)

Key issue

- Managing OTT video including other Apps efficiently
- Contents caching, local breakout using Mobile Edge Gateway

Device Comparisons





- Top 10% Devices generate 60% of total traffic ** VNI 2010-2015**
- Android is catching fast iOS with iPhone for usage
- Device OS & installed Apps will have unique characteristics

Challenge of Smartphone

- Radio signaling overload, simultaneous device updates
- Bandwidth hogging, Concurrent flows, NAT pin holes
- Malware (DOS/DDoS) attack