IPv6 in Mobile Networks

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Introduction

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Agenda

1. Why IPv6 in Mobile Networks?
2. IPv6 – it's here. Really.
3. Wireless Network Architectures
4. 464XLAT – Saviour? Or the devil in disguise?
5. Solution Testing and Results
6. Conclusion
7. Q&A

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Why IPv6 in Mobile Networks?

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Why IPv6 in Mobile Networks?

- Exponential Growth in mobile data traffic and user equipment
- Network readiness for Internet-of-Things
- IPv4 public address depletion
- IPv4 private address depletion
- Offload the NAT44 architecture
- VoLTE/IMS

Remember – IPv6 should be invisible to the end-user

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IPv6
It’s Here. Really.

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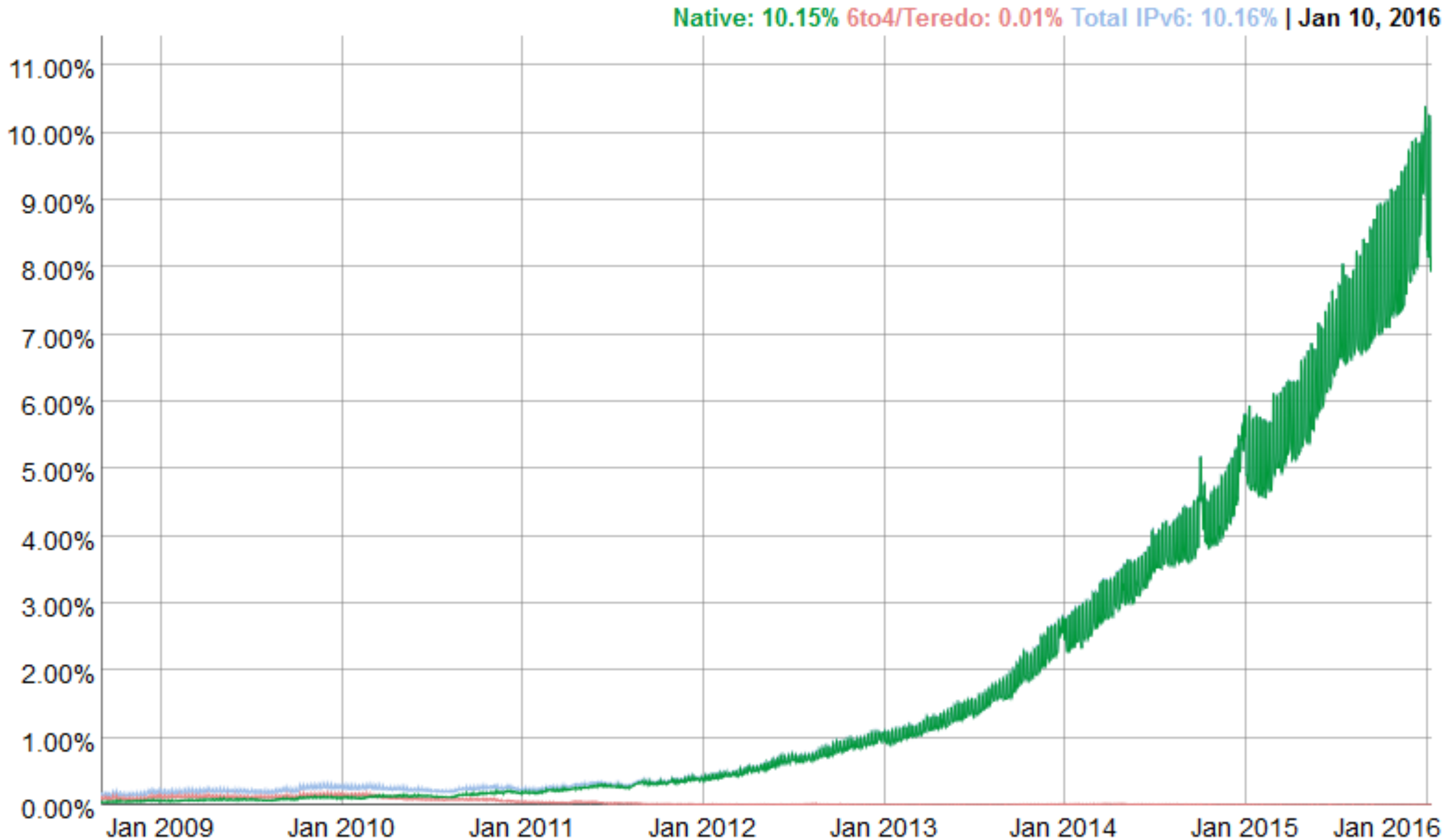
IPv6 Global Traffic



The world according to Google

Source - https://www.google.com/intl/en/ipv6/statistics.html

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Carrier Examples

SP1	SP2 / SP3	SP4
Dual-Stack +CLAT	SS+NAT64+DNS64+CLAT	SS/DS+NAT64+DNS-HD

1. Every carrier will have a unique set of circumstances that dictates which transition method they will use. There is no standard way of doing this.
2. You must determine which is the best method for your network.

In any method, remember to ensure you have a long-term strategy for the eventual deployment of native Single Stack IPv6!

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IPv4 reality – from a business perspective

1. Vendors know about IPv4 address depletion – and are prepared to charge you for NAT44 sessions traversing through your CGNAT. **The more sessions there are, the more money they will make!**

- Translations are unavoidable in Wireless Networks today. How do you reduce expenditure and future CAPEX and OPEX as your network takeup grows?
- There is NO EXCEPTION – ALL your traffic will be translated!

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IPv4 reality – from a business perspective

2. IPv4 public address runout is a reality – but so is **private address runout**! Many businesses reuse IPv4 private addresses in different areas of the network, isolating it in different VPNs.

- What if one region needed to communicate with another region internally?
- Have you considered how much licensing fees and development fees are for NAT444 ALGs?

3. Some websites or services in the very near future will have no IPv4 destination address (or NATed on their end). Your customers, stuck on IPv4 only, will either not be able to reach these website or services, or will be able to reach them but with inefficiencies.

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IPv4 reality – from a business perspective

Business justification to stay on IPv4 only

"IPv4 is working today for my customers. Service availability is key to customer retention and customer spend. If I want to maintain IPv4 only, I will need to maintain my CGNAT spend on licences to increase session count, hardware to handle NAT44 translations, purchase more IPv4 public addressing, or perform expensive regionalization exercises with NAT444 ALG development. But the expense is worth it to maintain service availability for my customers knowing that it will work for existing services."

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Addressing those IPv4 business concerns…

1. Vendors can **only make money from you once when you deploy IPv6 Single-Stack** – to perform **NAT64.**

- The only sessions that require translations for IPv6 will be IPv6 to IPv4 traffic for NAT64
- NAT64 ALG development is still a problem but is only a problem if you don't know which vendor to deal with.
- Majority of traffic (Youtube, Google, Facebook) will be IPv6 only.
- IPv4 destination translations will deplete over time thereby reducing CAPEX and OPEX.

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Addressing those IPv4 business concerns…

2. You don't need IPv6 private addresses for your customers and no translations are required. No regionalisation is required to isolate identical subnets because all IPv6 subnets are different!

- Regions can communicate between each other using IPv6 public addresses
- No NAT required unless communicating with IPv4 destinations

3. Your customers, with **IPv6 Single-Stack with NAT64** to reach IPv4 destinations, should be able to **reach all current and future IPv4 and IPv6 websites or services with minimal issues.**

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IPv6 reality – from a business perspective

Business justification to move to IPv6

"IPv4 is working today for my customers. Service availability is key to customer retention and customer spend. If I want to maintain IPv4 only, I will need to maintain my CGNAT spend on licences to increase session count, hardware to handle NAT44 translations, purchase more IPv4 public addressing, or perform expensive regionalization exercises with NAT444 ALG development.

But I could direct spending instead, on introducing IPv6 services as it solves IPv4 address depletion problems and reduces my CAPEX and OPEX expenditure over time. It also allows the company to begin looking at new innovative future technologies without worrying about regionalization, translation, or tunneling issues that are associated with IPv4. The expense is worth it to maintain service availability for my customers knowing that it will work for existing services and for new IPv6 only services into the future."

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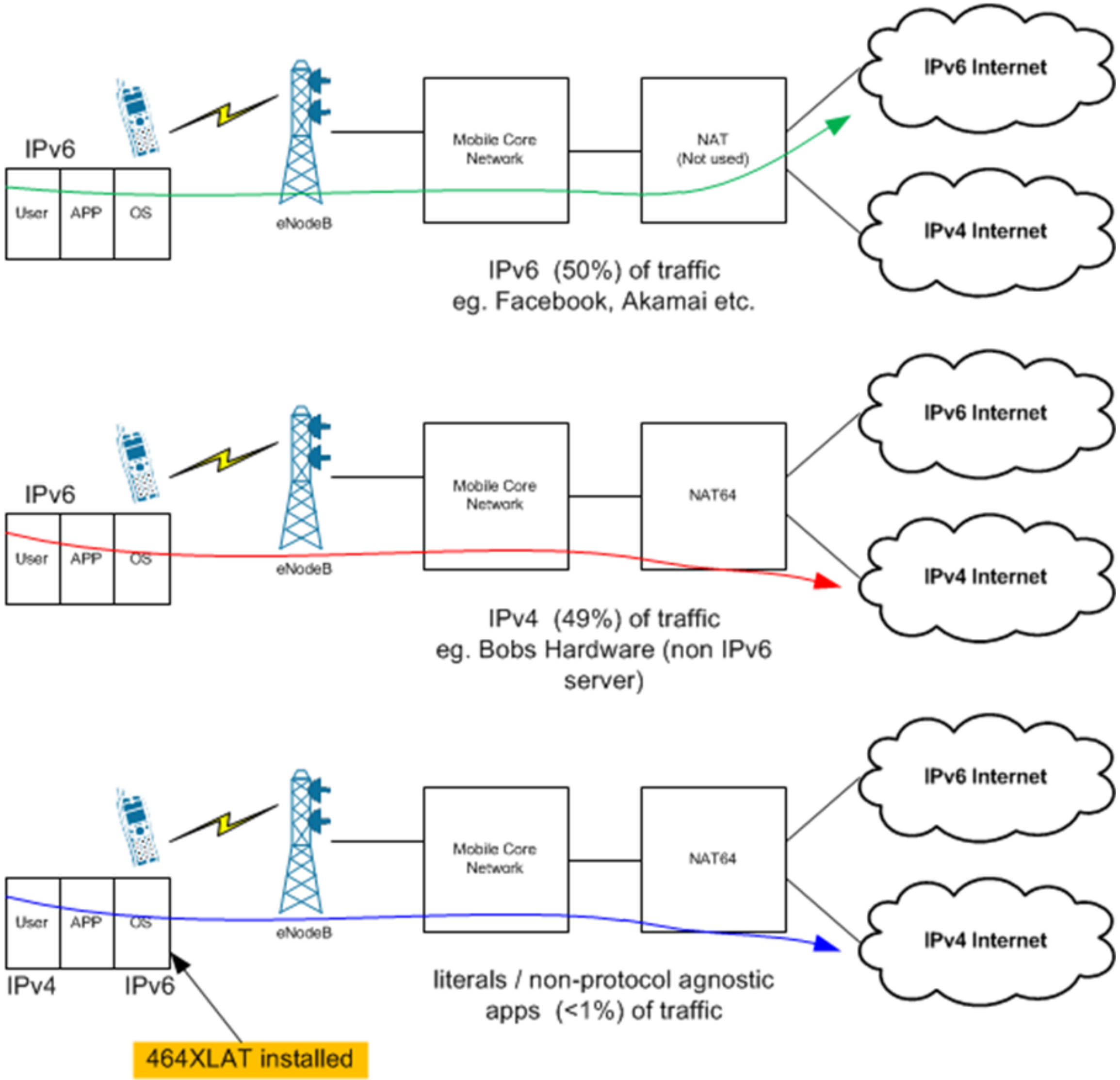
How much traffic will use IPv6?



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Wireless Network Architectures

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Wireless Internet Access
Quick 3GPP terminology refresher

SGSN/MME – Provides Signaling information

GGSN/EPG – Gateway to IP environment.
Allocates IP addresses to UEs via PDP requests.

IBR – Internet Border Router

UE – User Equipment (Handset)

HLR – Home Location Register

APN – Access Point Name (VLAN). Can have local and real. Think of it as an SVI (Logical VLAN) or an SSID

PDP – Packet Data Protocol (IP / Mobile No / Tunnel information to GGSN/SGSN

Pref64::/n – an IPv6 prefix used for IPV6 address synthesis (RFC6416). Typically, n=96. (WKP/ WKN)

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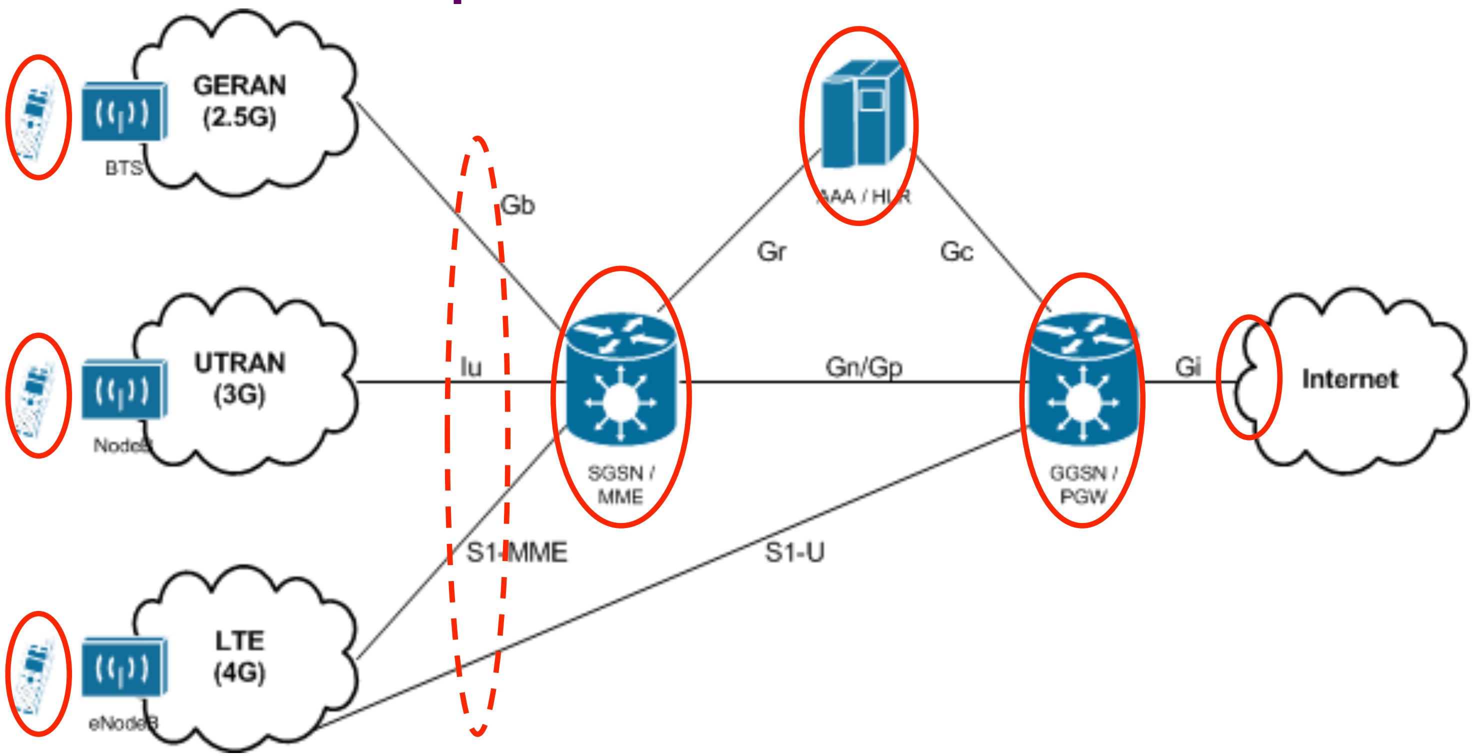
Wireless Internet Access
Basic IPv6 requirements



Dual-Stack / Native IPv6 UE

Backhaul – IPv6 optional

SGSN – IPv6 PDP aware

HLR/HSS – Full IPv6 support

Radius AAA – Full IPv6 support

DNS – Full IPv6 support

GGSN – Full IPv6 support

MPLS Core – 6VPE

CGNAT – NAT44/NAT64

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Wireless Internet Access
Basic IPv6 requirements

SGSN/MME – Needs to be 3GPP-R9+

GGSN/EPG – do IPv6 only and IPv4v6 single bearer PDP contexts

HLR/HSS – Support IPv6 and/or IPv4v6 PDP contexts

APN – Can specify IPv6 subnet ranges for handsets, and DNS NameServer addresses.

DNS – Full IPv6 connectivity and support, with DNS-HD configuration if required

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Wireless Internet Access
Basic IPv6 requirements

IBR – NAT64 translations with NAT64 ALGs

UE – 464XLAT enabled for IPv6 SS, and can support IPv6, or IPv4v6 PDP contexts

WKP/WPN – use the default, or use an address which is optimized.

Backhaul – IPv6 optional

MPLS Core – 6VPE

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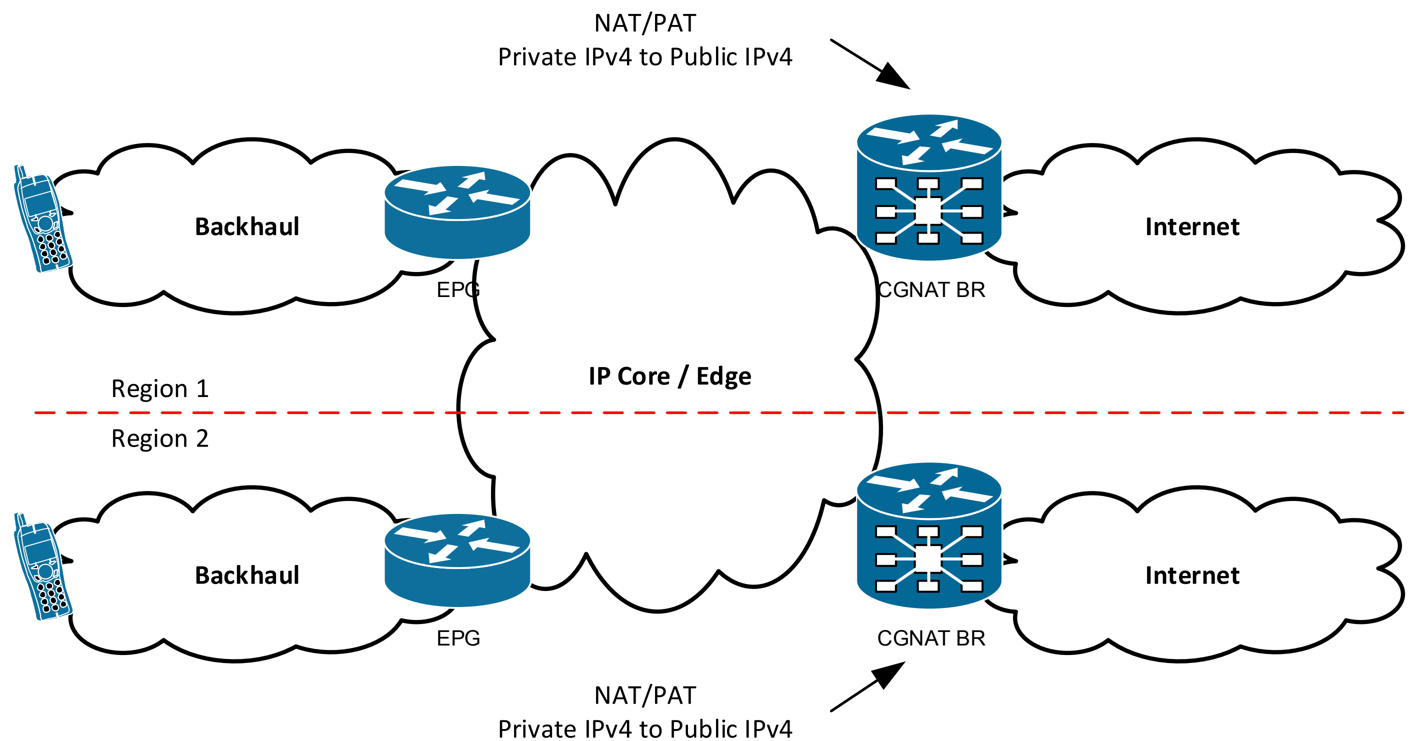
Current IPv4 Implementation Centralised CGN



- RFC1918 IPv4 Private Address space used for UE assignment for each APN.

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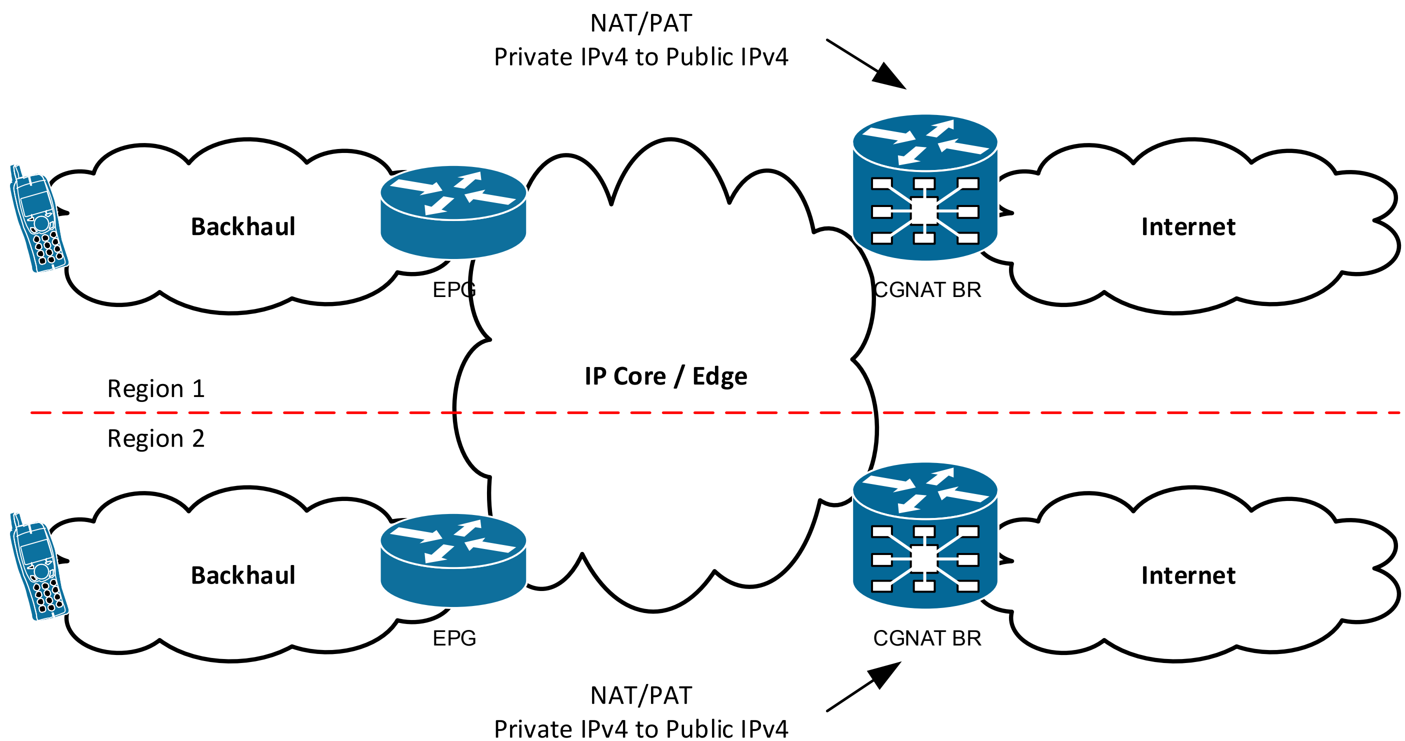
Current IPv4 Implementation
Centralised CGN



- CGN performs NAT/PAT 44

  PAT substantially reduces Public and Private IPv4 address demand, but does not prevent IPv4 address depletion.

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Bearer Types

IPv4 Only Bearer

– The link is “IPv4 only” – 1x private IPv4 address allocated by the GGSN via PDP context request.

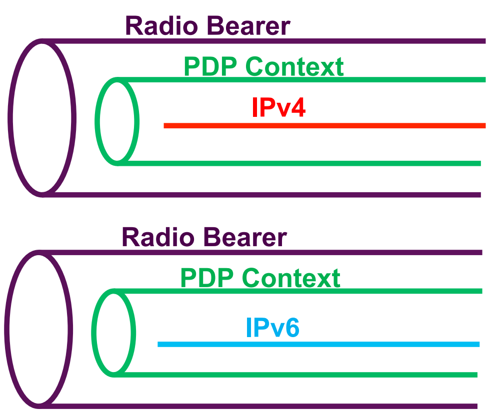
IPv6 Only Bearer

– The link is “IPv6 only” – 1x /64 prefix per bearer, and 1x IPv6 address on UE

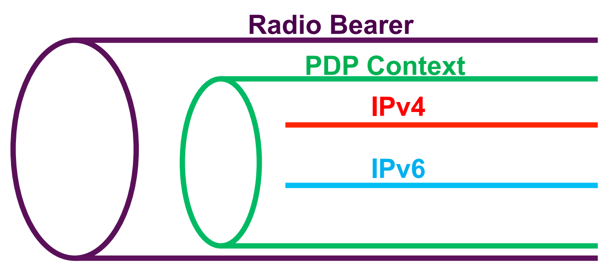
IPv4v6 Bearer

– The link is “dual-stack”. The bearer is configured with both an IPv4 address and 1x /64 prefix.

× Dual Stack – 3GPP Release 8



✓ Dual Stack – 3GPP Release 9



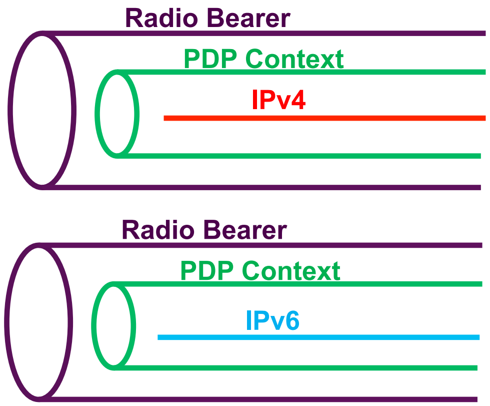
Bearer Types

Dual Stack Implications

3GPP Release 8 : An IPv4 only + IPv6 only bearer is used, resulting in 2x bearers = significant licensing costs to the carrier.

3GPP Release 9 : A single PDP context/bearer IPv4v6 is used as standard. Only 1 interface is used on the GGSN/PGW.

× Dual Stack – 3GPP Release 8



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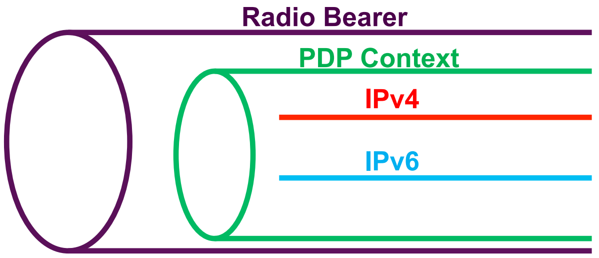

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EPC Configuration

HSS Configuration

PDP Context id = IPv4v6

MME Configuration

DAF = set

EPG Configuration

PDPTYPE = IPv4v6

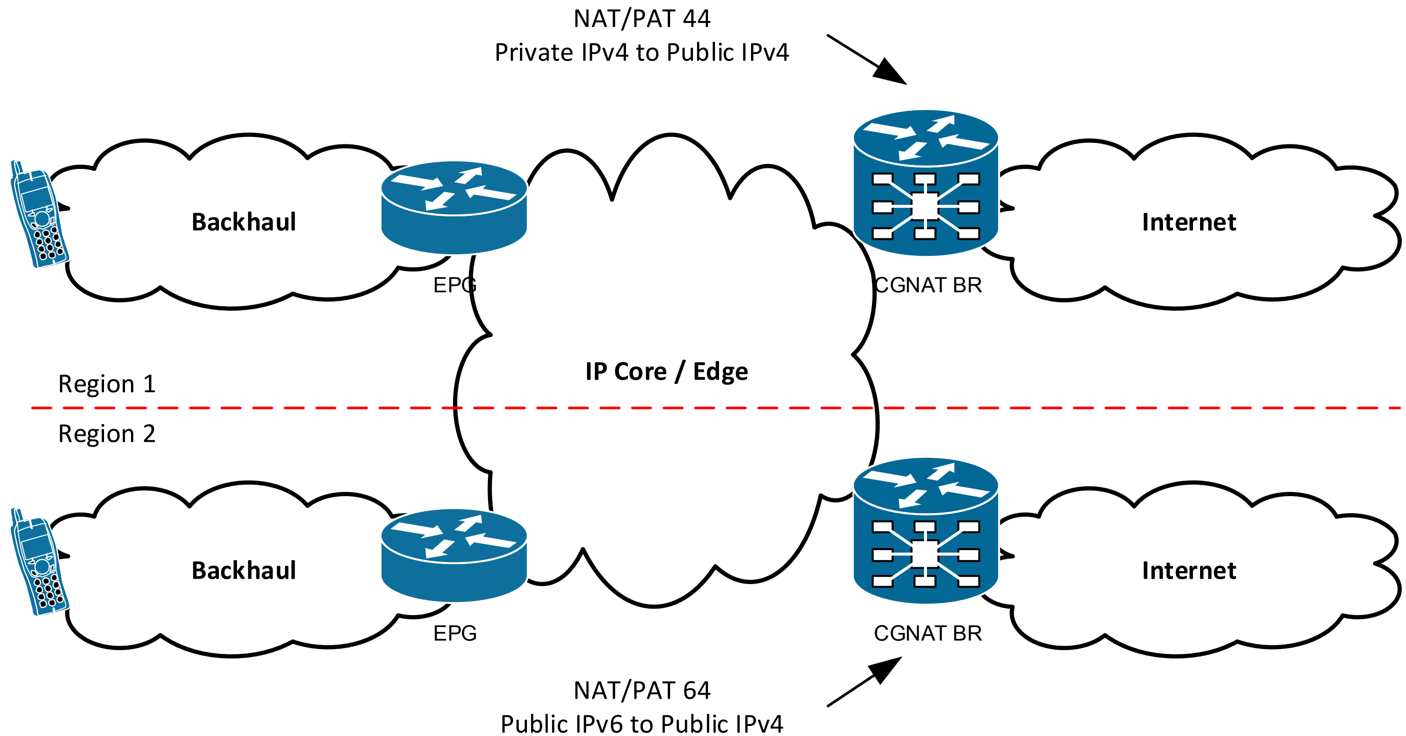
EPG will then also have the following as a minimum within each APN:

-IPv6 Handset Range

-IPv4 Handset Range

-2x IPv4 DNS Name Servers, 2x IPv6 DNS Name Servers

IPv6 Implementation Centralised CGN



- CGN performs NAT/PAT 44 and NAT/PAT 64

  PAT substantially reduces Public and Private IPv4 address demand, but does not prevent IPv4 address depletion.

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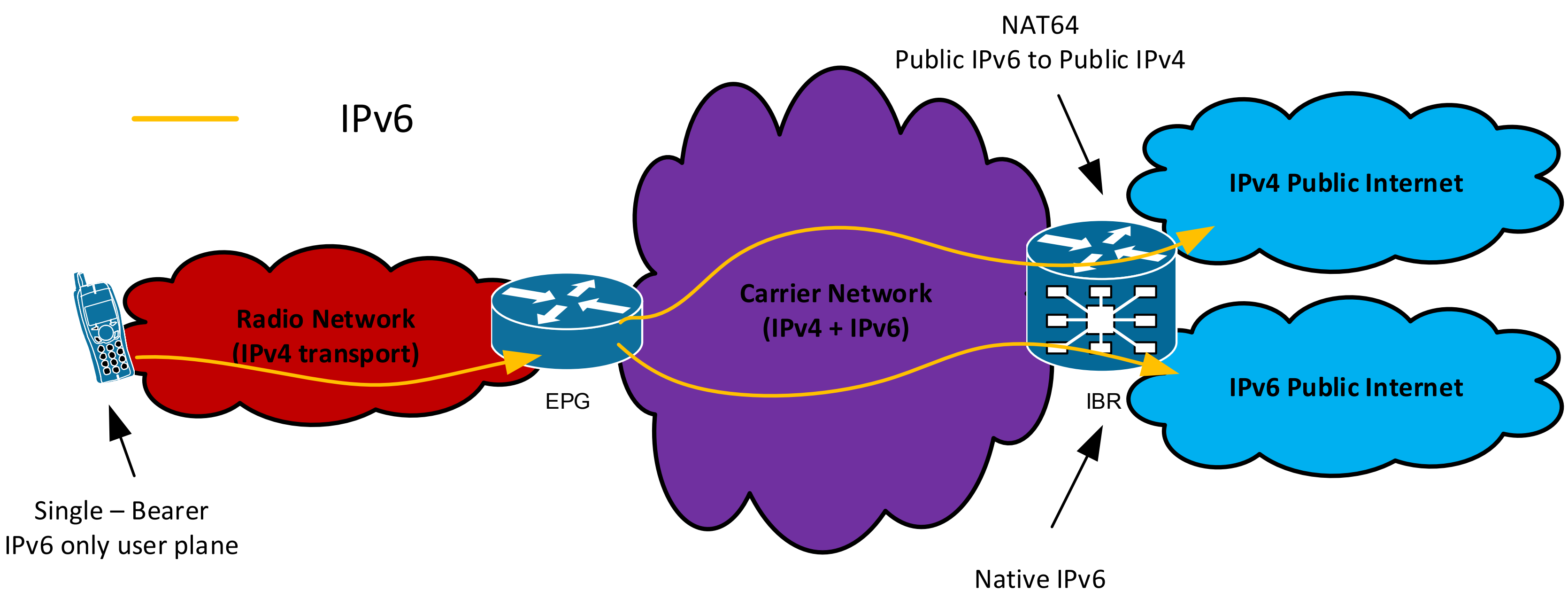
IPv6 Implementation Traffic Flow



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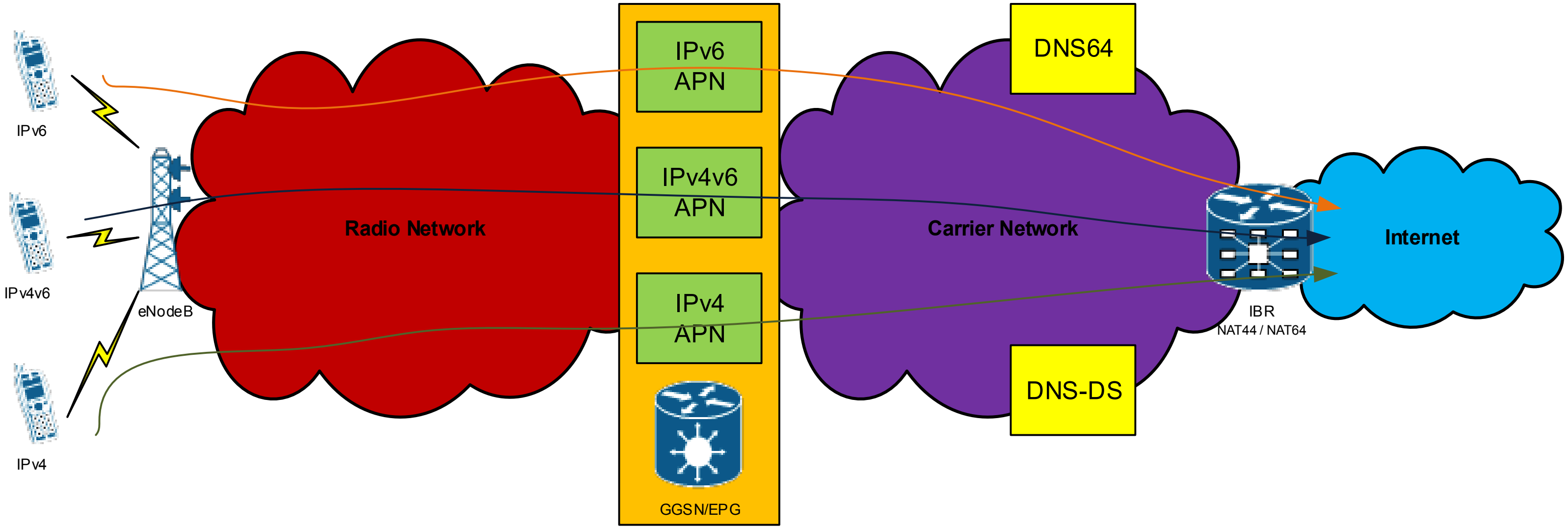
Running multiple APNs



Create multiple real APNs that supports IPv4, IPv6, and IPv4v6 individually

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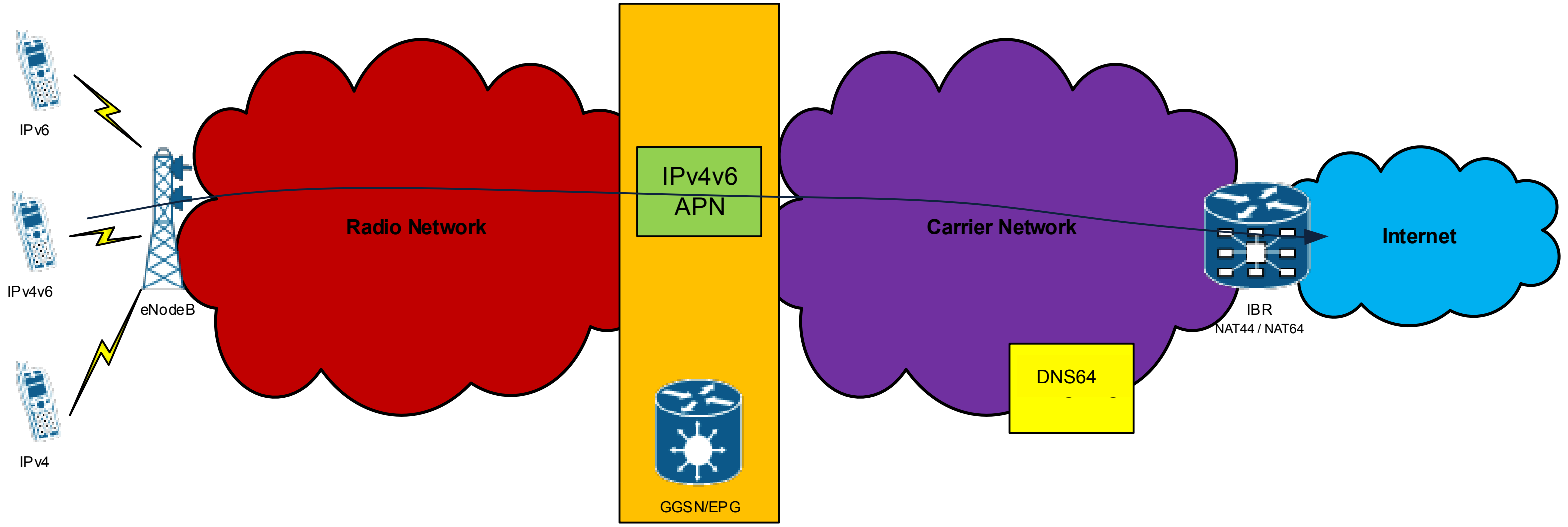
Running a Single APN



Create a single real APN that supports both DS and SS and choose to use a RFC7050 DNS configuration

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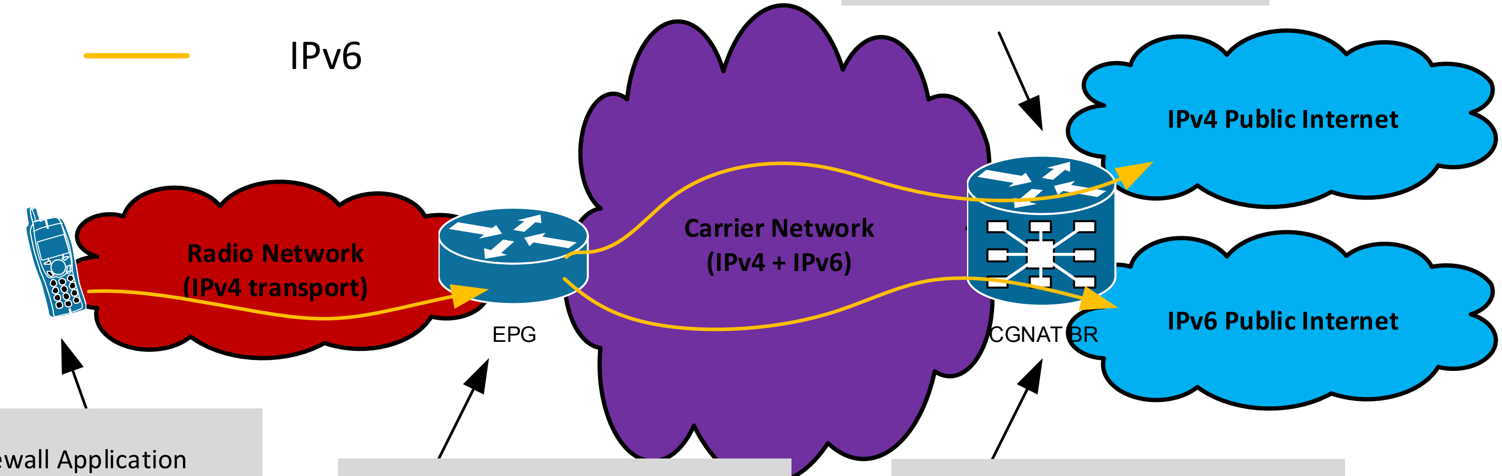
IPv6 Implementation Security

NAT44/64 Translation
Stateful firewall

Untrust to Trust
Block all traffic originating from internet

Trust to Untrust
Allow all traffic



Firewall Application

APN ACL

Advertise only handset ranges to Carrier Network
Block traffic with IP ranges not configured on the EPG

IPv6 Native
Stateful firewall

Untrust to Trust
Block all traffic originating from Internet

Trust to Untrust
Allow all traffic originating from IPv6 handset ranges only
Allow DNS traffic
Block all infrastructure ranges
Block all VoLTE ranges

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UE Requirements and Settings

Android 4.3+ supports 464XLAT. We recommend using anything that is 4.4.4+ or 5.1+

Depending on your setup, either PDP selection is based on the UE or the Network.

International Roaming over IPv6 works today! But we recommend the APN Roaming Protocol to be set to IPv4 only for the next two years.

VoLTE / IMS IPv6 RAVEL (VoLTE International Roaming over IPv6)

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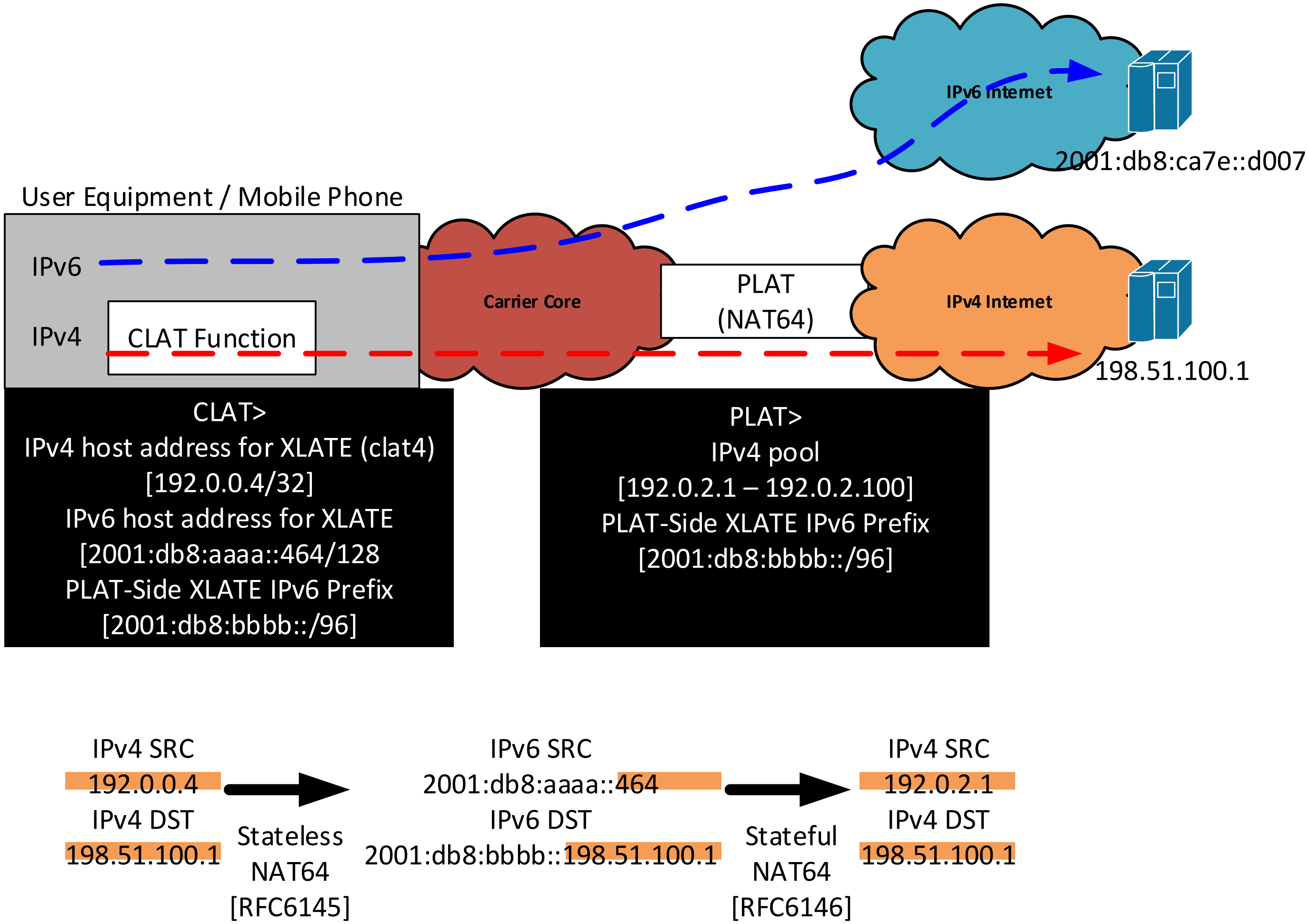
464XLAT – Saviour? or the devil in disguise?

464XLAT Architecture for Mobiles



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CGNAT Configuration

NAT44

Private IPv4 to Public IPv4 address pool

NAT64

Public IPv6 to Public IPv4 address pool

The IPv4 address pool should be different to ensure the return traffic is correct

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Saviour…?

Google has embraced the informational RFC and has deployed it to everything Android 4.3+. Vendors have embraced it and enabled the code on all devices running this OS.

Forbidden Fruit has gone down a different path, and have requested all IOS9 apps to support IPv6 in the long term and have provided the developers IPv6 dev kits to prepare applications to support IPv6. Their devices support IPv4, IPv6, and IPv4v6 only with no 464XLAT.

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Saviour…?

It will solve reachability issues for non-protocol agnostic applications such as Skype, or websites and applications still using IPv4 literals in their URL/Code.

It allows the industry to slowly migrate to IPv6 services without impacting existing legacy applications and websites.

We expect, the lifetime of 464XLAT to be required in devices to assist in the transition period to be 10 years, and not required after.

BUT…

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… or the devil in disguise?

The primary device type in most carriers today may very well be from the Forbidden Fruit company. You are stuck on Single-Stack IPv6 with no 464XLAT, or worse yet – Dual-Stack.

It will solve reachability issues for non-protocol agnostic applications such as Skype, or websites and applications still using IPv4 literals in their URL/Code. But you are reliant on the application developers to improve their code instead of being reliant on 464XLAT.

It allows the industry to slowly migrate to IPv6 services without impacting existing legacy applications and websites. What if the industry decides to use the technology to prolong IPv4 allocations to devices instead of going to native IPv6?

A standardised way of deployment

Some ground rules need to be placed across the entire industry today, if we are to successfully convince businesses, vendors, manufacturers, and engineers, that a unified standardized transition method is the right way to proceed. This provides certainty to engineers who are writing businesses cases for management, on a clear path to move to IPv6.

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Solution Testing and Results

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Solution Testing and Results

APN – IPv4v6, HLR/HSS – IPv4v6

Legacy devices configured with IPv4 only are not impacted

New devices configured with IPv4v6 obtains both addresses

New devices configured with IPv6 only obtains IPv6 only

CGNAT

NAT64 ALGs: ftp, sip, pptp, rtsp, h323

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IPv4 vs IPv6

Some applications fail with IPv6 – even with 464XLAT

VPNs are a real problem – but is it a carrier problem or an application / server problem?

HTTP / HTTPS works very well

SSH is not a major problem

IPv6 is faster in some cases – smaller BGP table, no NAT etc.

Major apps work very well – especially from the major content providers

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Conclusion

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Conclusion

There are operators who have launched commercial IPv6 services already. Each operator must decide their own path – there is no single universal answer on how this can be done.

Q&A

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CONTACT

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References

464XLAT Tutorial – Masataka Mawatari (JPIX) – Slide 33

https://conference.apnic.net/data/40/20150903_apnic40_464xlat_tutorial_mawatari_1441333278.pdf

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