IPv6 Transitioning: Considerations for Mobile Operators

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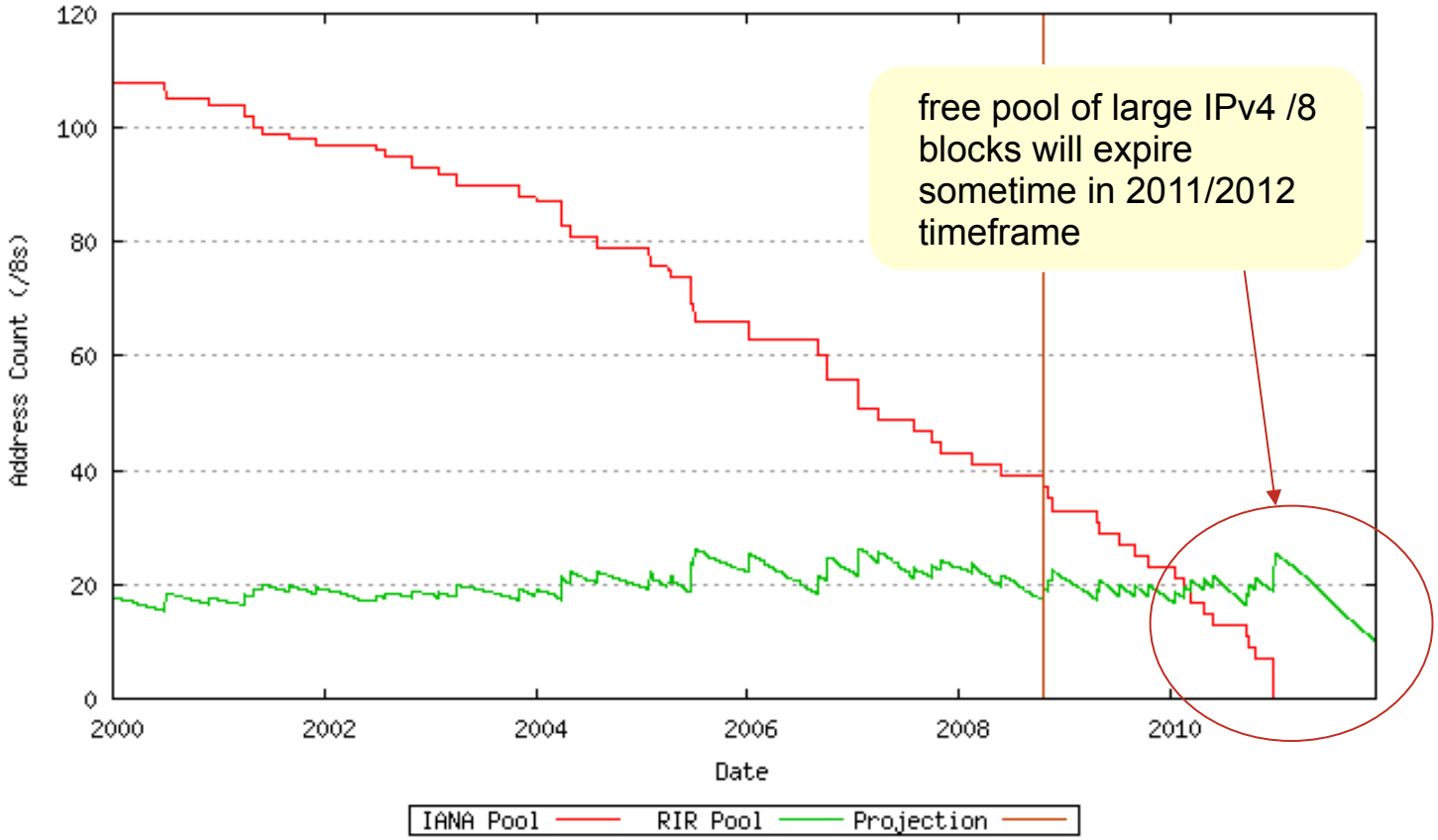
Cisco

IPv4 Address Completion (Run-Out)

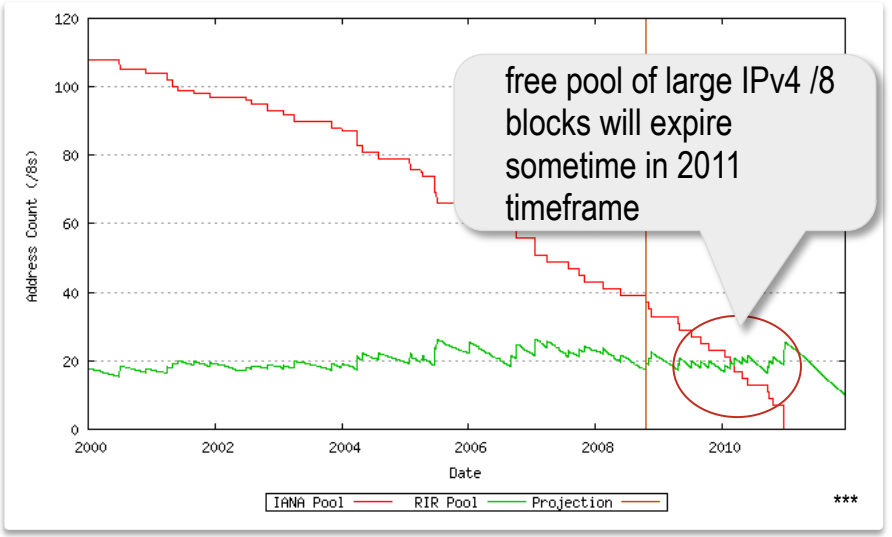


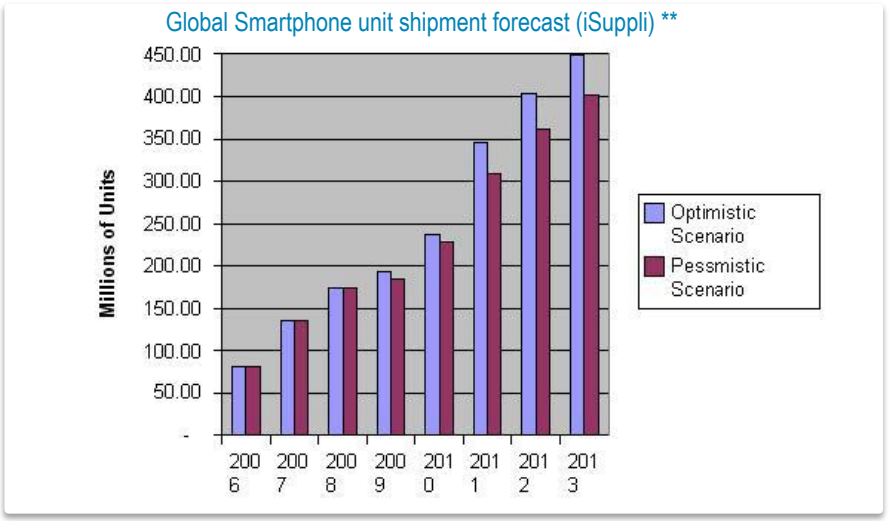
- see http://www.potaroo.net/tools/ipv4/index.html for more details

The Key Challenge

Global IPv4 address completion

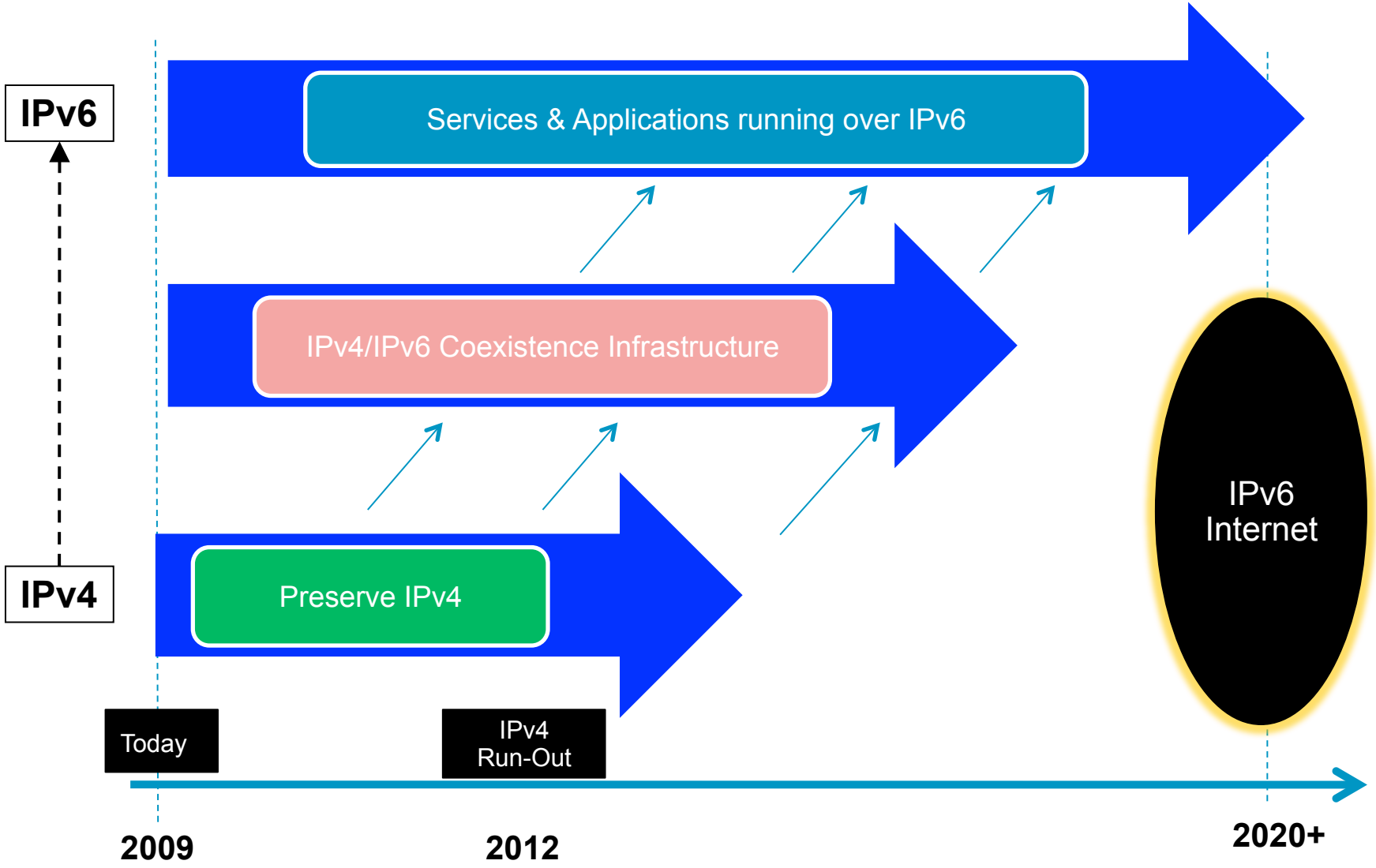
- Urgency
  - 1st Order is IPv4 Address Run-Out: IANA global IP-address pool exhausted by ~2011/12
  - 2nd Order is pragmatic IPv6 Transition Strategy: Moving from v4 to v6
- Smartphones a key driver for IP-endpoint and bandwidth growth
  - Smartphone predicted CAGR: 18.3 (pessimistic) – 21% (optimistic)*
  - 17.4% of all mobile device shipments in 2009*
- Several operators already introduced central NAT devices
  - Rough estimate: Approx. 50% of all mobile operators use NAT on data services
  - Bandwidth growth for data-services (+360%)





* Source: http://www.mobile-tech-today.com/story.xhtml?story_id=65091
** Source: http://www.ciol.com/Biz-Watch/News-Reports/Smartphones-ring-in-healthy-growth-in-2009/5309116823/0/
*** See see http://www.potaroo.net/tools/ipv4/index.html for more details

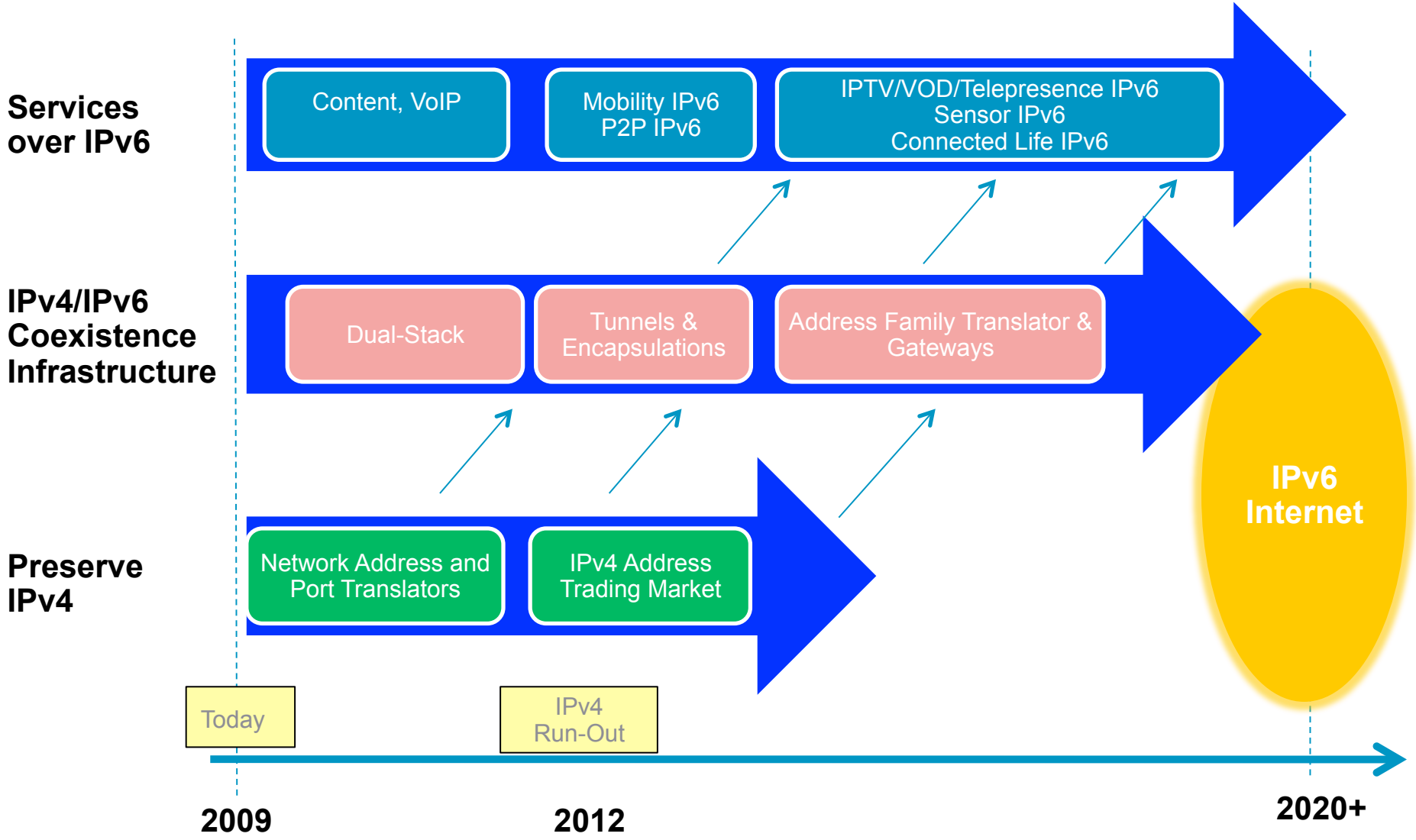
"346": A 3 Tier Transition Framework for Moving from IPv4 to IPv6



"346": A 3 Tier Transition Framework for Moving from IPv4 to IPv6

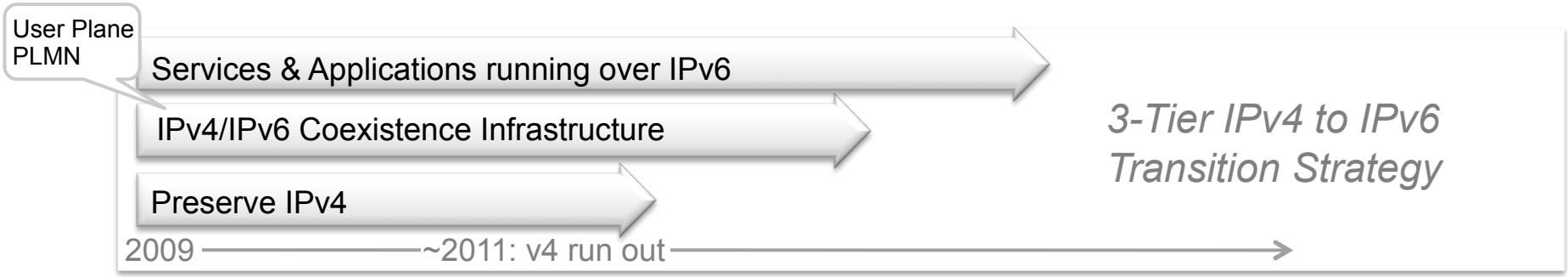
- Native IPv6 Internet is years away
- IPv4 Run-Out is here now
- Entering a period of IPv4/IPv6 Coexistence
- Legacy (IPv4) and new (IPv6) apps and services can only function over an IPv4/IPv6 Coexistence Infrastructure
  - They will likely need more time to implement dual-stack and/or native IPv6
- Thus we need tools, methods, products and solutions that
  - Help address IPv4 run-out
  - Offer incremental means to build out IPv4/IPv6 coexistence infrastructure
- Not one size fits all

346 Technology Buckets



Evolution towards IPv6

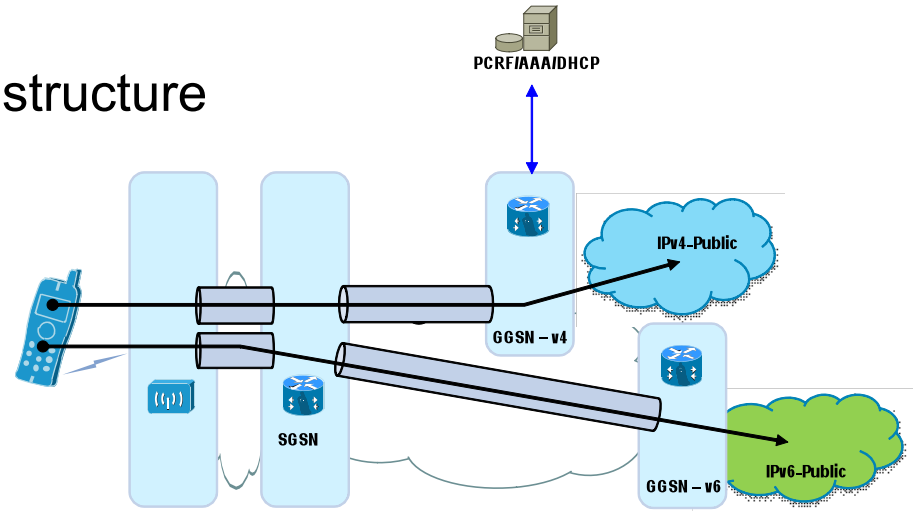
Transition Tiers and Technologies



v4 User	v4 Server	v4 Transport	v6 User	v6 Server	v6 Transport	Transition Technology
■	■	■				NAT 44
■	■	■				A+P
		■	■	■		6rd
■	■	■	■	■	■	Dual-Stack
■	■		■	■	■	Dual-Stack lite
■	■	■	■	■	■	Gateway-Initiated Dual-Stack lite
■	■		■	■	■	Prefix-NAT (PNAT)
	■		■	■	■	AFT: Stateless NAT64
	■	■		■	■	AFT: Stateful NAT64

IPv4/IPv6 Coexistence: Native IPv6 / Dual Stack
IPv6 Hosts & Dual Stack Hosts

- Dual-Stack Implementation
  - Consumer-Service – User plane (Dual-Stack Handset)
  - Transport (PLMN & OSS/BSS)
- IPv4 and IPv6 across all the infrastructure
  - Routing protocols handle IPv4 & IPv6
  - Content, application, and services available on IPv4 and IPv6
  - OSS/BSS challenges
  - Handsets might require upgrades*
- End-users can use dual-stack network transparently:
  - If DNS returns IPv6 address for domain name query, IPv6 transport is used
  - If no IPv6 address returned, DNS is queried for IPv4 address, and IPv4 transport is used instead



*Note: Several handset vendors already support v6 (e.g. Symbian)

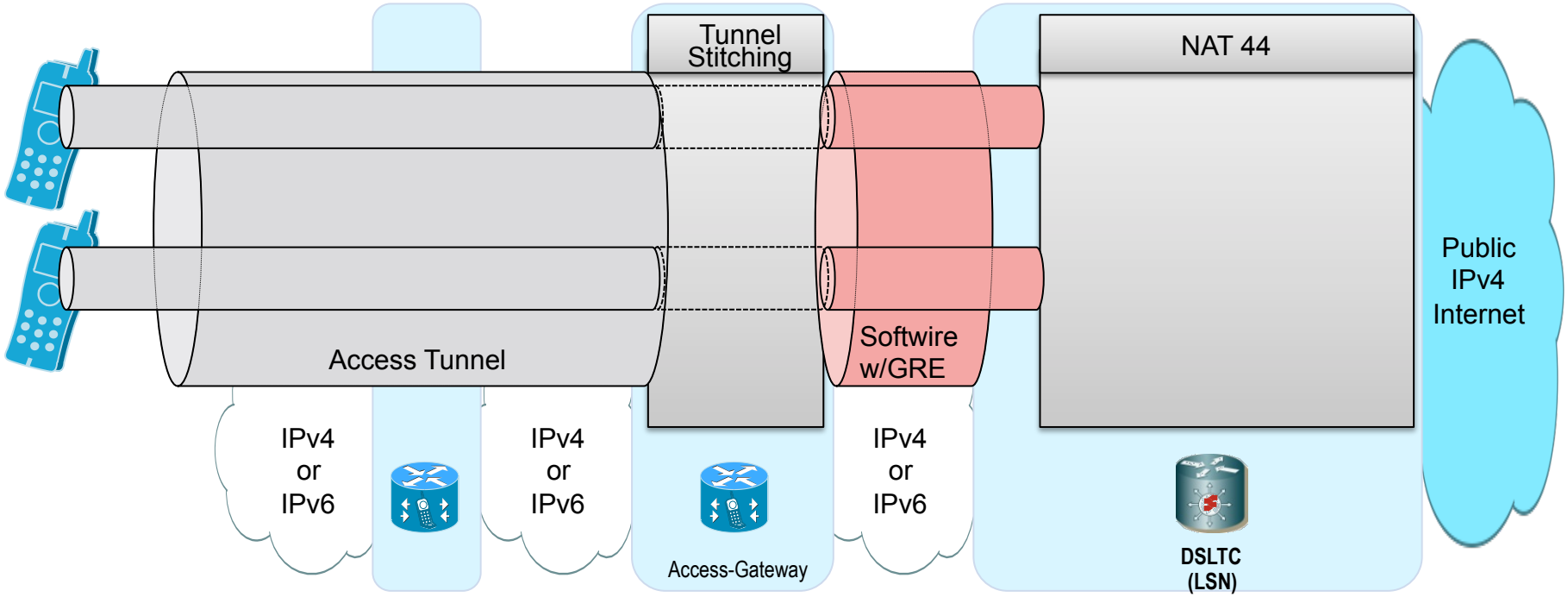
Dual-Stack Migration & IPv4 Exhaust
Deployment Options & Requirements

UE	SP-Network	Large-Scale NAT Function	Problem targeted/Notes
Public IPv4	IPv4	n/a	
Public IPv4, IPv6	IPv4, IPv6	n/a	IPv4, IPv6 parallel network operation; (no solution to IPv4-exhaustion)
Private IPv4	IPv4	NAT 44	Public IPv4 exhaust
Non-meaningful IPv4,	IPv4	Extended NAT44	Public & Private IPv4 exhaust , or private 1918 addressing not desired
Non-meaningful or private IPv4	IPv6, (IPv4)	Extended NAT44	Migrate Core to IPv6, Public/Private IPv4 exhaust
Non-meaningful or private IPv4, IPv6	IPv6, (IPv4)	Extended NAT44	Migrate Core to IPv6, Offer native v6 services (e.g. IMS), Public/Private IPv4 exhaust

- Smooth/Incremental transition solution towards IPv6 – while keeping IPv4 support for existing services
  - No changes to UE (continue to support installed base)
  - Minimal changes to existing access architectures
  - IPv4 and/or IPv6 SP transport networks supported

Gateway-initiated Dual-Stack lite

Concept (draft-gundavelli-softwire-gateway-init-ds-lite*)

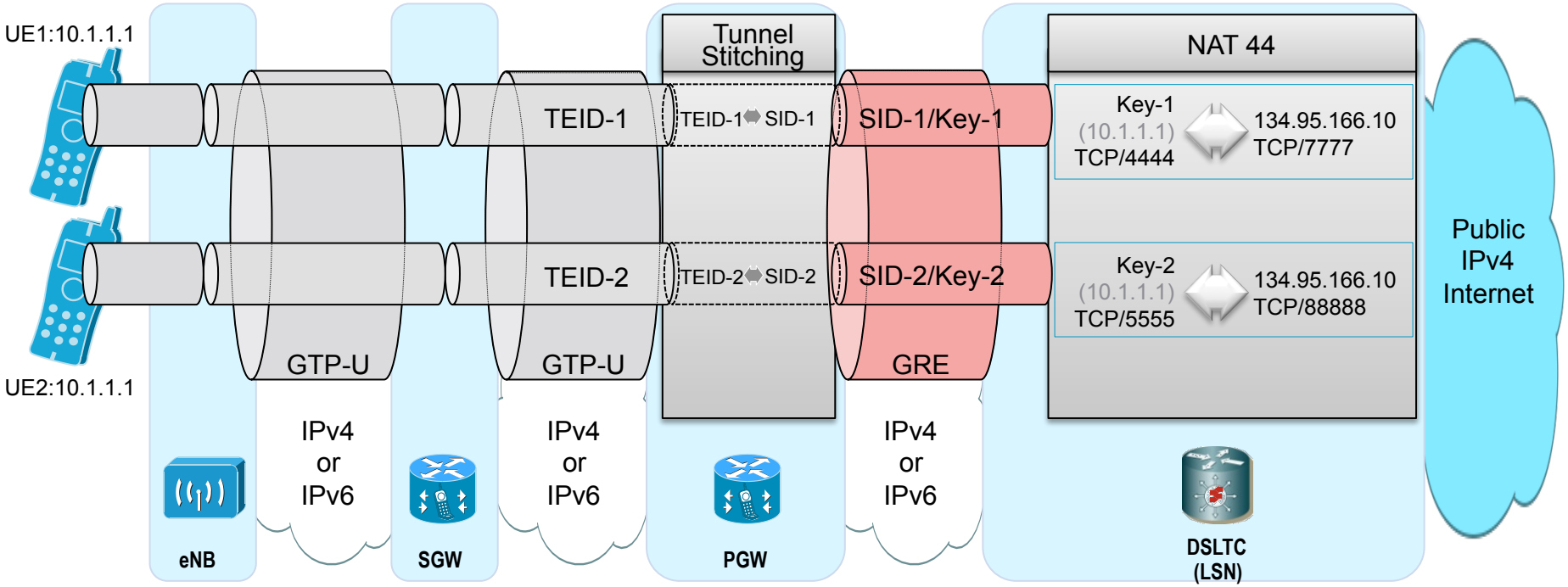


- UE & Access Architecture remains unchanged; no impact on roaming operations
- Point-to-Point tunnel between UE and NAT44-box (DSLTC): IPv4 address on UE is not used for packet forwarding (allows all UEs to have the same address)
- SP network can be IPv4 or IPv6

* http://tools.ietf.org/html/draft-gundavelli-softwire-gateway-init-ds-lite-00

Gateway-initiated Dual-Stack lite

Details – EPC w/ GTP example



- Example uses same IP-address for both Ues
- PGW stitches PDP-Contexts/EPC-bearers to Softwire-Tunnel (Softwire-ID/GRE-key identifies individual flows)
- DSLTC performs NAT44:
  Maps Softwire-ID/Port to public IP-address/Port

Gateway-Initiated Dual-Stack lite

Benefits compared to plain NAT44 and DS-lite

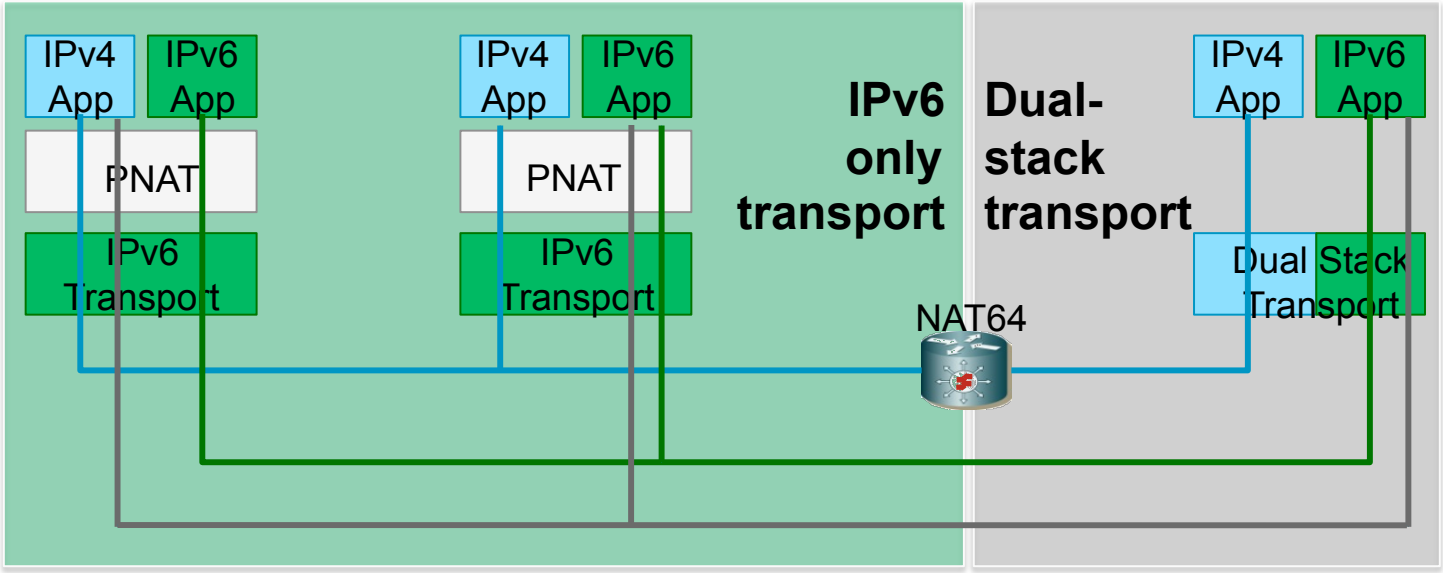
Requirement	GI-DS-lite	Plain NAT44	DS-lite
Changes to UE/Handset	no	no	yes
Changes to the 3GPP architecture	minimal (PGW changes)	no	yes
Changes to OSS/BSS	minimal (due to NAT)	minimal	yes
Added overhead on airlink	no	no	yes
SP network: IPv4	yes	yes	no
SP network: IPv6	yes	n/a	yes
SP network: IPv4, IPv6	yes	n/a	no
UE: private IPv4	yes	yes	yes
UE: non-meaningful IPv4	yes	no	yes
UE: (any) IPv4, IPv6	yes	n/a	yes
UE: Evolution to IPv6 only	option	n/a	yes
Roaming	yes, no changes	n/a	v6 support in visited network (SGSN/SGW)

Prefix NAT (PNAT)
Host Based Translation

"There are legacy applications which cannot be upgraded to use IPv6 transport, but those applications have to be supported for backward compatibility reasons."

"The core network is migrated to IPv6-only transport for operational simplicity. Native IPv4 transport is not available to the end hosts."

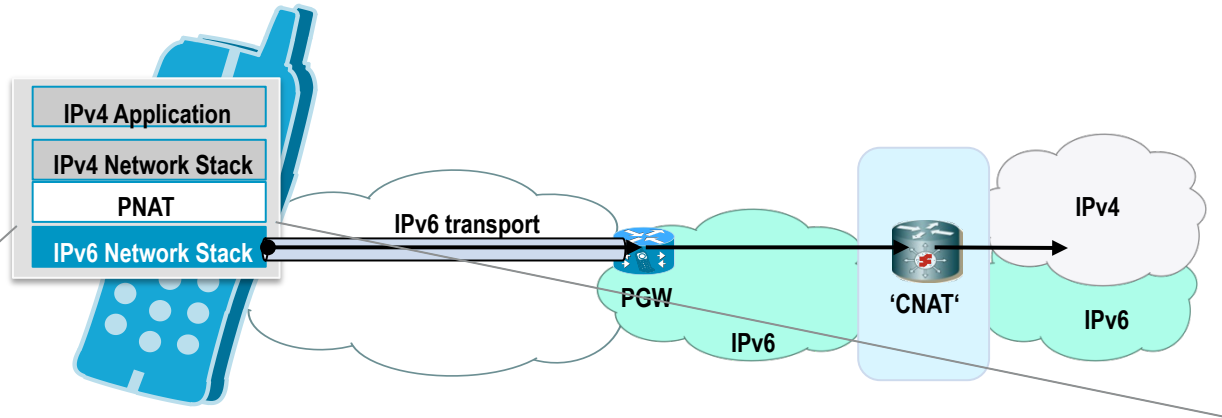
"Modification of the host stack is allowed and is not difficult."



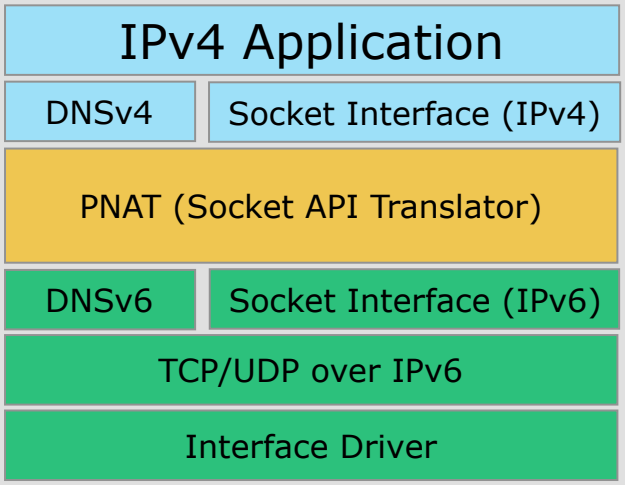
- Modified Host Stack, including NAT46/64 function
- IPv6 transport network; In-network NAT64 for access to v4 domain

Prefix NAT (PNAT)

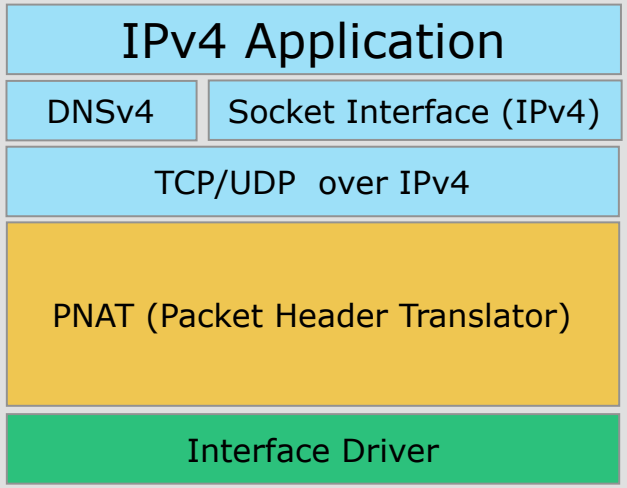
PNAT enabled Host Stack – 2 Implementation Options



PNAT function makes the needed "Bump-in-the-API (BIA)" and the "Bump-in-the-Stack (BIS)" changes



PNAT Socket Translator Module



PNAT Header Translator Module

Prefix NAT
Evaluation

Requirement	PNAT
Changes to UE/Handset	yes (NAT46/64 & ALGs)
Changes to the 3GPP architecture	yes
Changes to OSS/BSS	yes
Added overhead on airlink	yes
SP network: IPv4	no
SP network: IPv6	yes
SP network: IPv4, IPv6	no
UE: private IPv4	yes
UE: non-meaningful IPv4	yes
UE: (any) IPv4, IPv6	yes
UE: Evolution to IPv6 only	yes
Roaming	v6 support in visited network (SGSN/SGW)

- Doubts about claim that IPv4 applications cannot be changed to IPv6
- Increased complexity of host architecture:
  - AFT w/ Application specific ALGs (troubleshooting issues, ALG changes/upgrades to support new applications)
- PNAT performs NAT: Accounting requirements
- OSS/BSS to support v6
- PNAT requires an IPv6 bearer, even for IPv4 applications: Increased overhead due to v6 header
- PNAT requires an IPv6 transport network
- PNAT requires ubiquitous v6 support (potential issues w/ legacy equipment/roaming)

Note: NAT464 was earlier considered by IETF (initially for DS-lite), though later on deprecated in favor tunnel/softwire-based approaches

See also: draft-wing-behave-v4app-v6server

Dual-Stack Transition & IPv4-Exhaust

Evaluation of different mechanisms

Requirement	GI-DS-lite	A+P	PNAT
Changes to UE/Handset	no	yes	yes (NAT46/64 & ALGs)
Changes to the 3GPP architecture	minimal	yes	yes
Changes to OSS/BSS	minimal	yes	yes
Added overhead on airlink	no	no	yes
SP network: IPv4	yes	yes	no
SP network: IPv6	yes	no	yes
SP network: IPv4, IPv6	yes	no	no
UE: private IPv4	yes	option	yes
UE: non-meaningful IPv4	yes	no	yes
UE: (any) IPv4, IPv6	yes	no	yes
UE: Evolution to IPv6 only	option	no	yes
Roaming	yes, no changes	PCO for A+P support on SGSN	v6 support in visited network (SGSN/SGW)