IPv4 to IPv6 Transition Approaches Discussion

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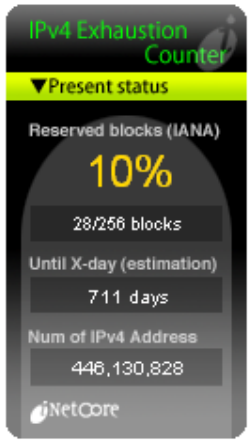
1 Driver

IPv4 address depletion

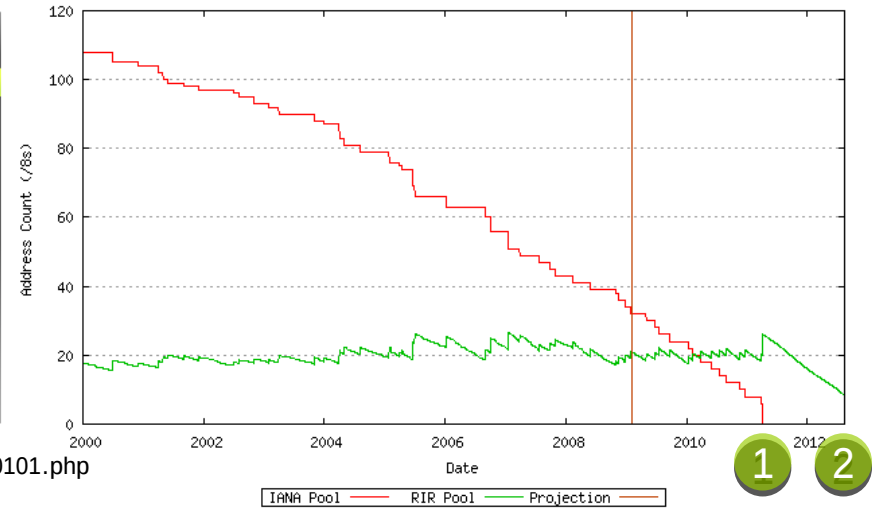
Current Projections:

- IANA unallocated address pool exhaustion: **2011**
- RIR unallocated address pool exhaustion: **2012**
- All IPv4@ in use: 2015-16



http://entne.jp/tool/toollist/000101.php

Source: http://www.potaroo.net/tools/ipv4



Remarks:

- IANA may release additional reserved IPv4 blocks
- Service providers may deploy NAT
- 4G wireless and machine-to-machine traffic may boost demand for addresses

1 IANA Exhaustion
2 RIR Exhaustion

Back where we were 20 years ago but the problem is bigger and there's no easy fix

Observations:

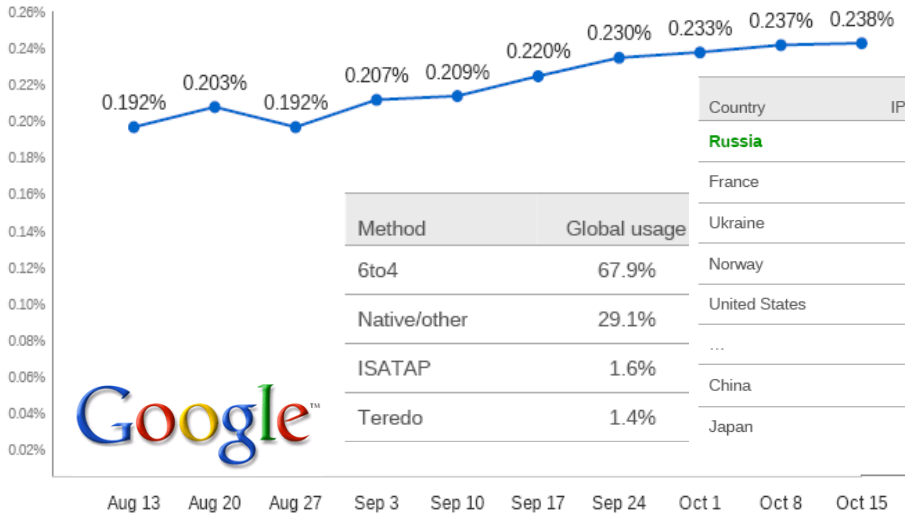
IPv6 prevalence is still low, but growing by the week

Large variations among countries, due to single deployments (eg. free.fr)

Most IPv6 connectivity through tunneling (Windows: Teredo; MAC: 6to4 [Airport Extreme], …)

Over 50% of allocated IPv6 prefixes are not visible

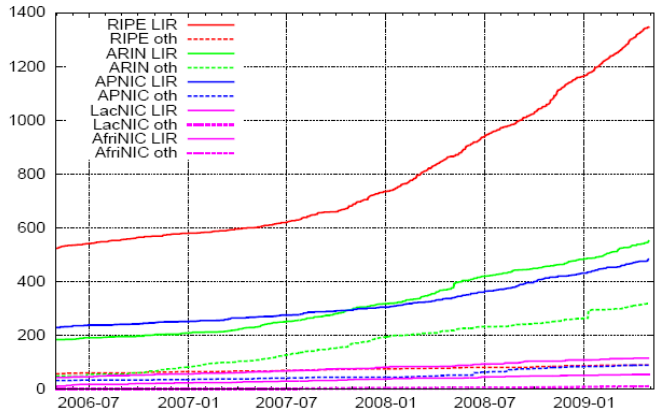
%IPv6 requests to all google subdomains



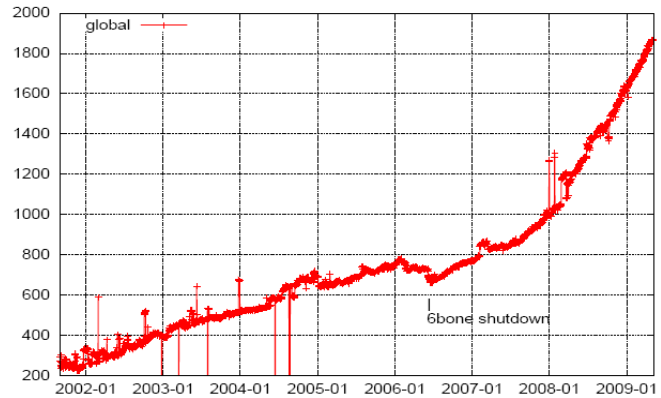
Method	Global usage
6to4	67.9%
Native/other	29.1%
ISATAP	1.6%
Teredo	1.4%

Country	IPv6 penetration
Russia	**0.76%**
France	0.65%
Ukraine	0.64%
Norway	0.49%
United States	0.45%
…	
China	0.24%
Japan	0.15%

Graphics: Allocations over Time



Graphics: Total Prefixes - 7 years



Source: RIPE-58

Problems

- End User doesn't care/know about IPv4/IPv6
- Content provide doesn't have same pressure as the service provider
- So IPv4-only content will still be around for quite some time
- How do we ensure IPv4 content access continuity in during ipv4-ipv6 transition?

2 Solution 1: Temporary Address Assignment

Temporary address assignment

Mechanism:

- The UE requests an IPv4 address whenever the user starts an application that requires IPv4 communication
- Some time after the application terminates (to be determined by the UE), the associated default bearer and IPv4 address are released

Advantages:

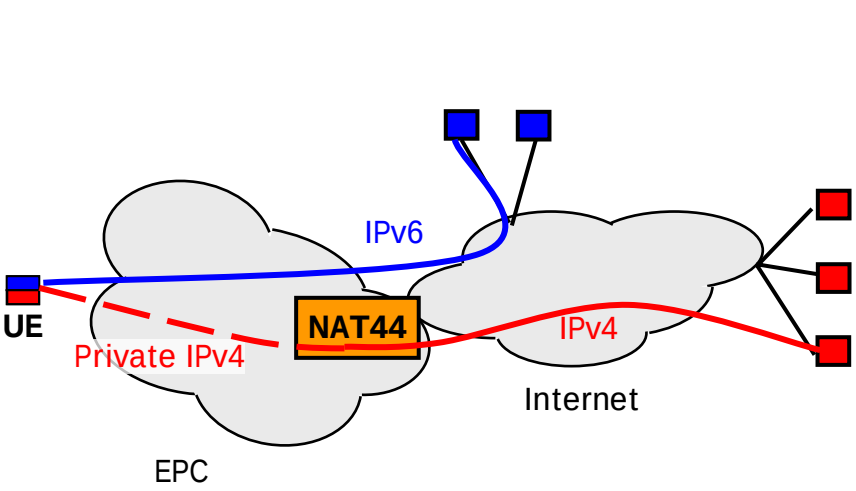
- Does not require NAT

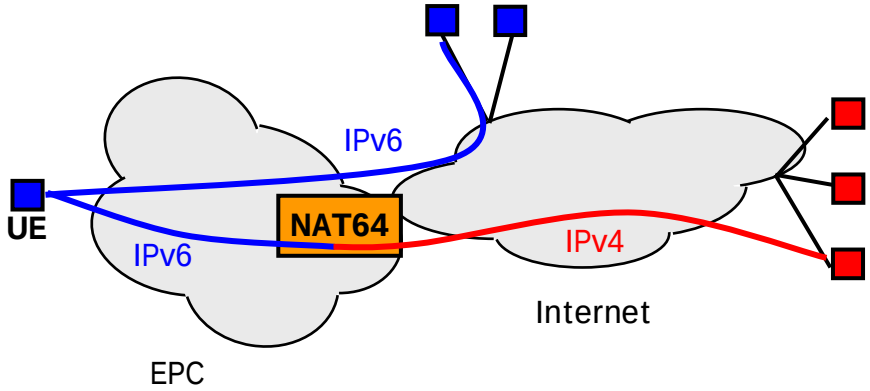
Disadvantages:

- Need extension to OS/APP
- Significant increase of signaling load (bearer set up plus registration for relevant applications)
- Can not support IPv4 “always-on” or “server-like” application.
- May have issue during busy hour

3 Solution 2: Network Address Translation

Network Address Translation (NAT)





There are two solutions that involve NAT:

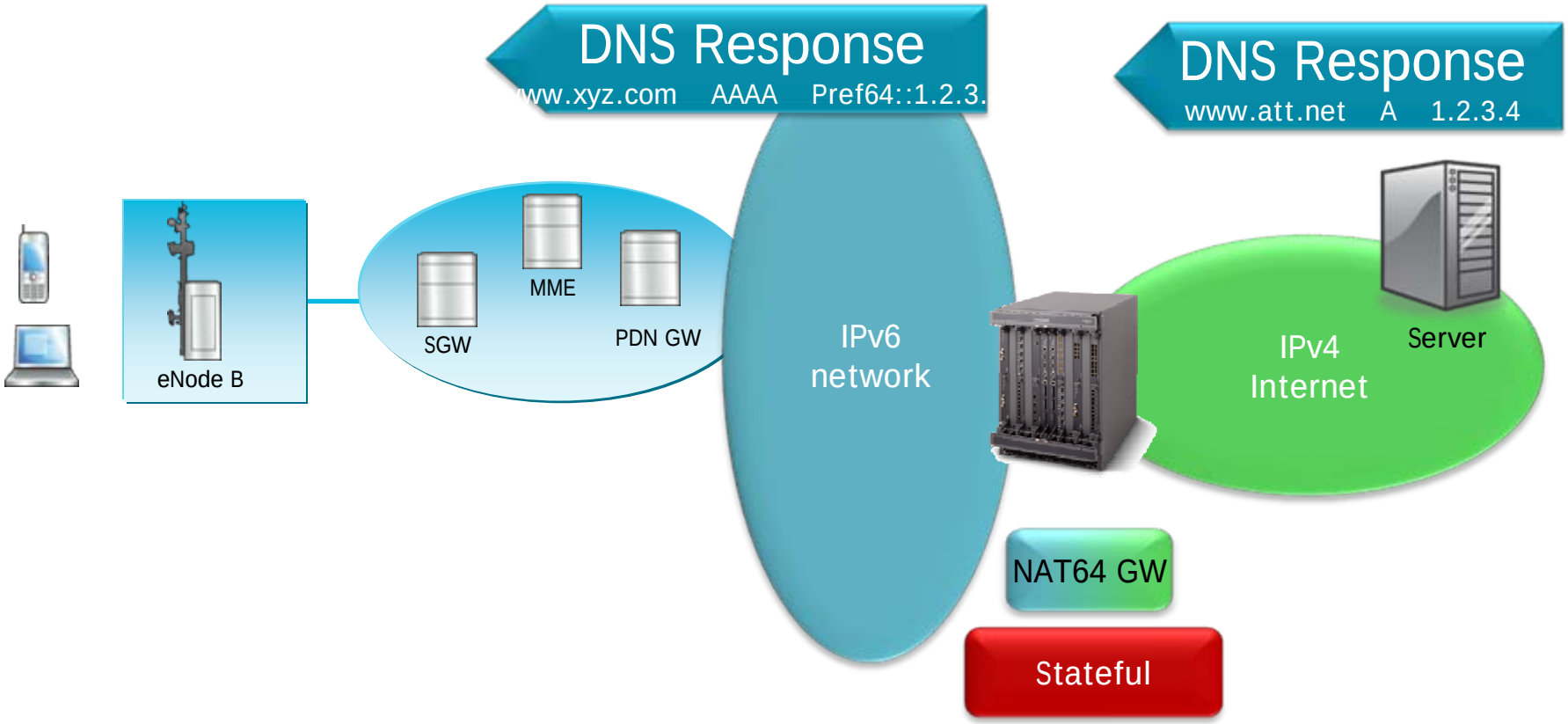
2a: use IPv6-only devices; requires v6-v4 NAT (NAT64)

2b: assign private IPv4 addresses; requires v4-v4 NAT (NAT44)

In both cases:

- End-to-end IPv6 is used when the UE communicates with IPv6-enabled hosts
- NAT is used when the UE communicates with IPv4-only hosts

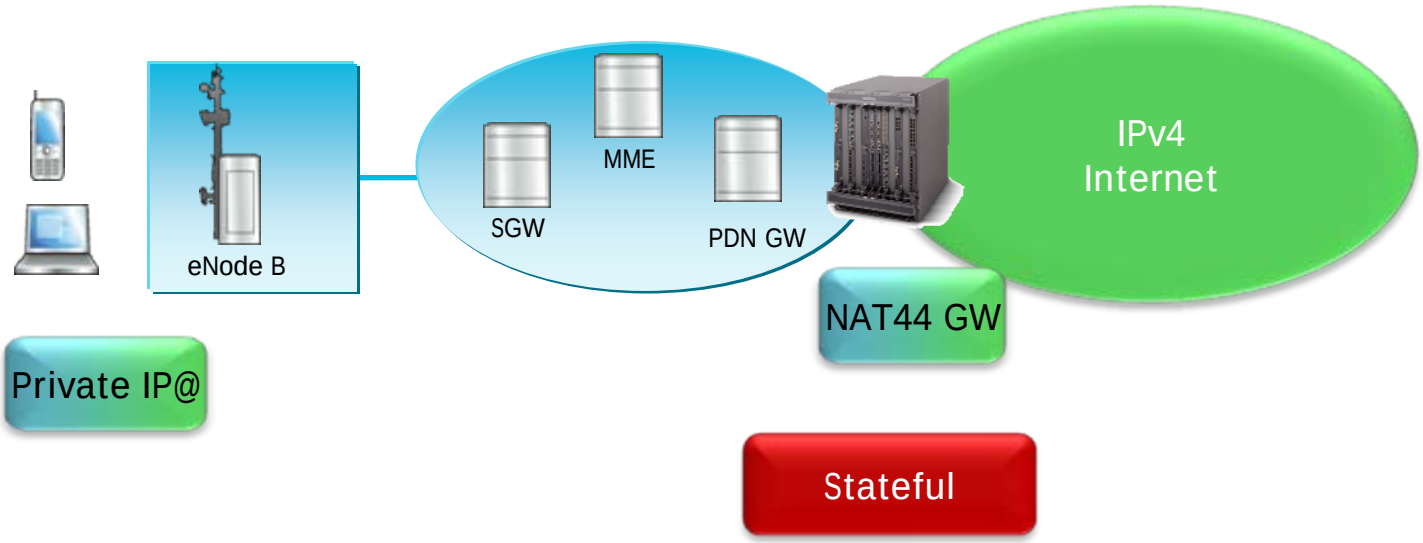
NAT64 & DNS64



NAT64 & DNS64 (Continued)

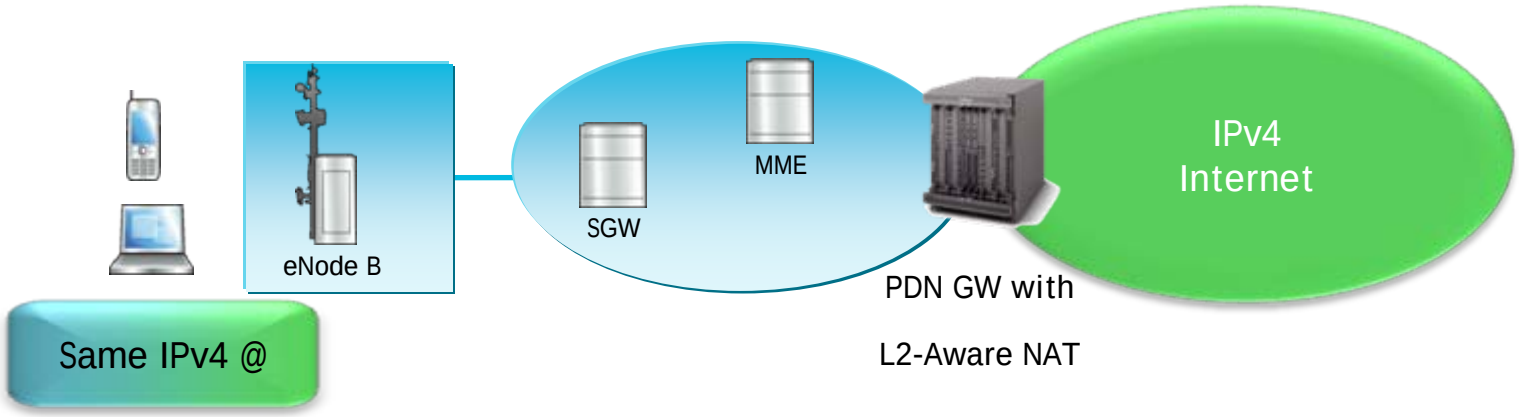
- Addresses IPv6-only hosts communicating with IPv4-only servers
- Does not cater to IPv4-only hosts (such as Windows 98, or non-enabled IPv6 hosts)
- Requires a complementary DNS function (DNS64).
- As transport is IPv6 *Windows XP is not supported! (Windows XP only supports v4 DNS)*
- Uses synthetic AAAA records in the DNS64 function
- IPv4 address overloading (or sharing) still occurs with source NAPT

NAT44



- Each UE will be assigned a private IPv4 address
- UE's private IPv4 address will be translate into public address in NAT44 GW
- Today deployed technology

ALU Proposal:Layer2-Aware NAT



TEID	Inside IP	Inside Port	Outside IP	Outside Port	Protocol
0x11111111	1.2.3.4	100	202.96.202.100	100	TCP
0x22222222	1.2.3.4	200	202.96.202.100	200	TCP
0x33333333	1.2.3.4	100	202.96.202.100	300	TCP

- Each UE can have same IPv4 address
- L2-aware NAT will use session identification (TEID) for NAT map entry and downstream routing
- Greatly simplify the address management

NAT44 is preferable to NAT64

NAT44 and NAT64 have the same disadvantages:

- Break application experience

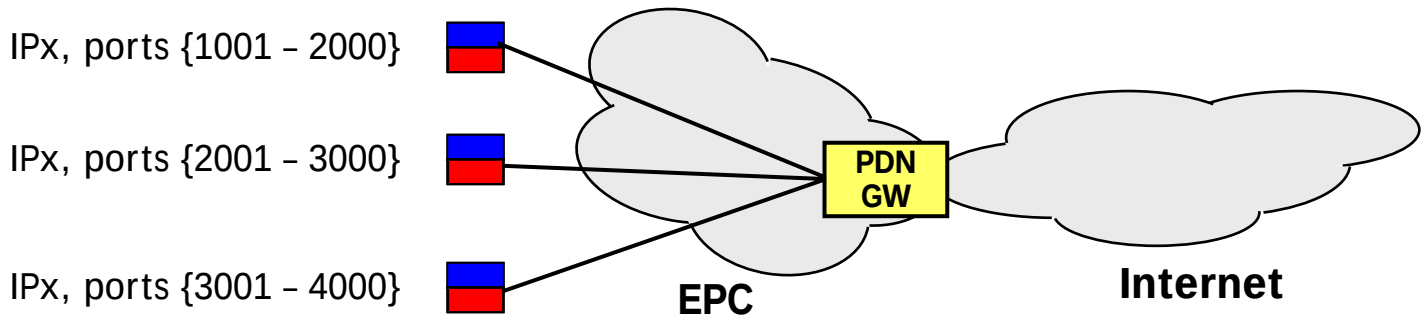
Both have essentially the same implementation complexity

However, NAT44 is preferable to NAT64:

- NAT44 is widely deployed; NAT64 is still being standardized
- NAT44 only requires modification of IP address and port numbers; NAT64 requires a mapping between different header formats NAT64 requires alignment with mapping performed by DNS servers; NAT44 has no such dependency

4 Solution 3: Address + Port (A+P)

Address + Port (A+P)



Mechanism:

- At attachment, the PGW assigns a (public) IPv4 address plus a range of port numbers to a UE
  - The same IP address is used for multiple UEs; port ranges are chosen so that they don't overlap
- The UE uses a port number from the assigned range for traffic it generates
- When routing Internet traffic to one of the UEs, the PDN Gateway must make a forwarding decision based on IP address *and* port number

The term A+P comes from Internet Draft draft-ymbk-aplusp, which proposes this technique in a slightly different context

Address + Port (A+P) – cont'd

Advantages:

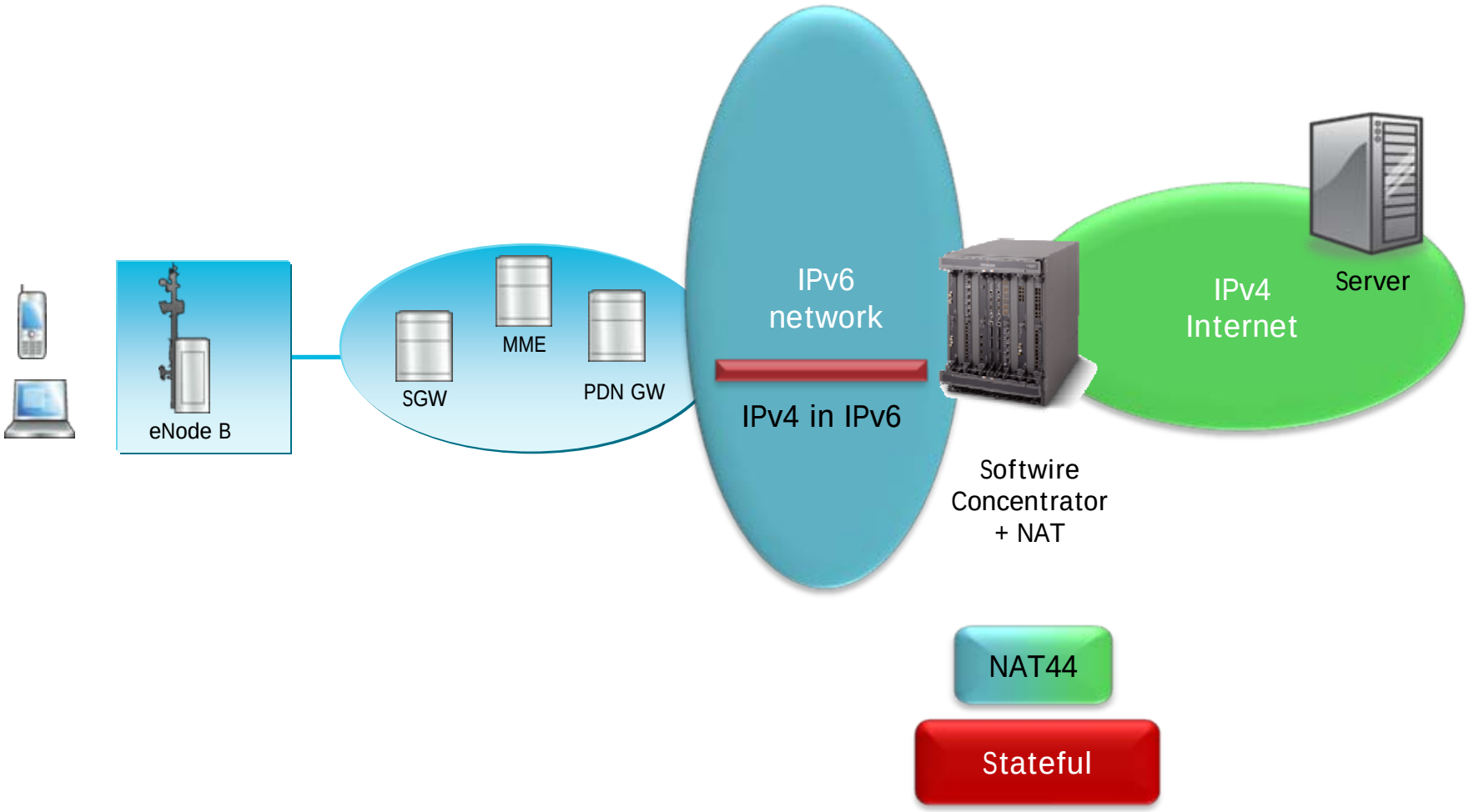
- Compared to the use of private v4 addresses with NAT44, the A+P approach is much more transparent

Disadvantages:

- To benefit from the A+P approach, the method must be supported by PDN GWs and UE devices
  - Private IP addresses could be assigned to UEs that don't support this method

5 Solution 4: Dual-Stack Lite

Dual-Stack lite



Dual-Stack Lite (Continued)

- Addresses mobile operators who want IPv6-only core networks
- Tunnels IPv4 in a IP tunnel using IPv6 transport (a Softwire)
- NAP44 can be performed in the Softwire Concentrator or use A+P
- Be aware about obfuscation of the IPv4 traffic as a result of tunnelling

6 Summary

Summary

1. Transition to IPv6 is mainly driven by technical, not business, so it tend to cost money instead of bring in revenue.
2. IPv6 is the ultimate solution, internet community should move to IPv6 end-to-end ASAP!
3. However before that, current transition solutions all have limitations, so why don’t we start with cheapest one: Dual-Stack+NAT44