Deploying 464XLAT in 12 Steps for 25.000.000 Subscribers

RIPE NCC Open House: IPv6-Only Networks

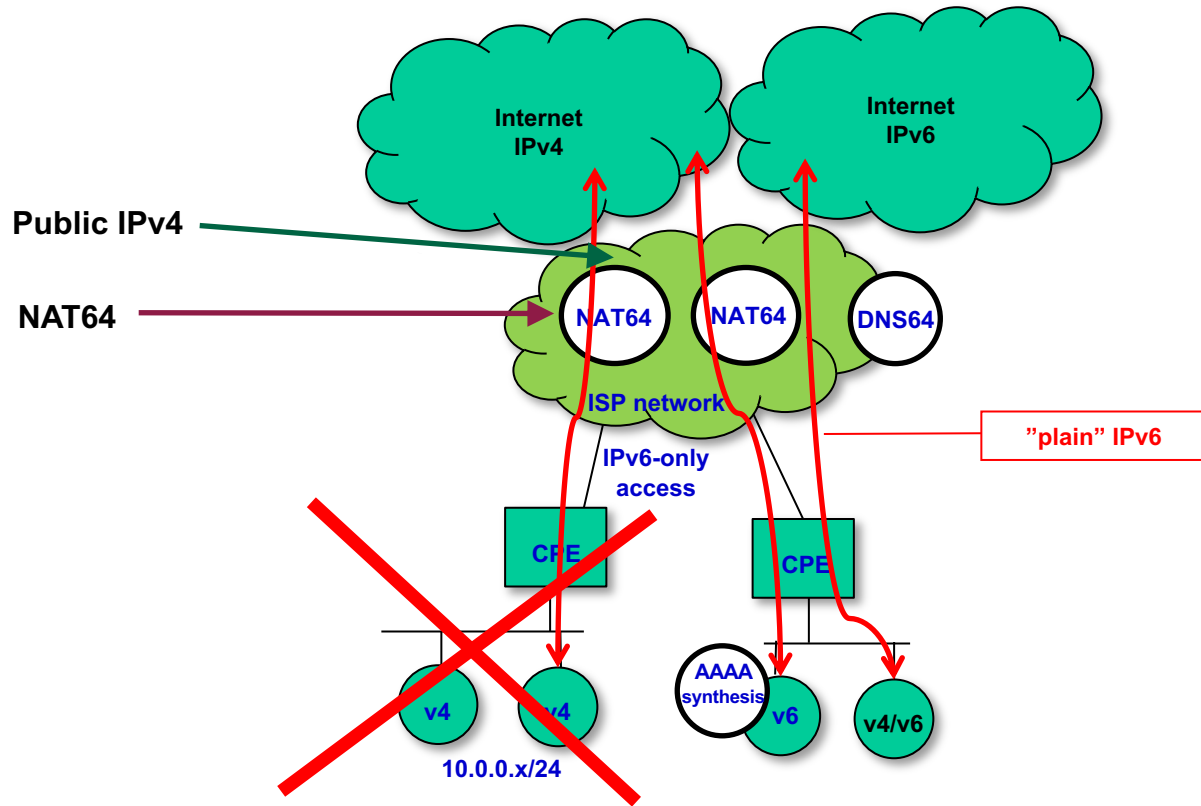**May, 2021**

@JordiPalet

(jordi.palet@theipv6company.com)

Dual-Stack is NOT the Future

- We can't anymore think in dual-stack across an entire network: IPv6-only with IPv4aaS (IPv4-as-a-Service)
- Remove IPv4 as much as you can (access, even core) and keep dual-stack in "client" VLANs
  - As we are used to: Private IPv4 behind NAT
  - Add IPv6 GUA
  - Ensures that old apps and devices will keep working
- You can keep also dual-stack in a DC, but not really needed
  - Many organizations can't do that anymore
    - IPv6-only comes to the DC: SIIT-DC (RFC7755)
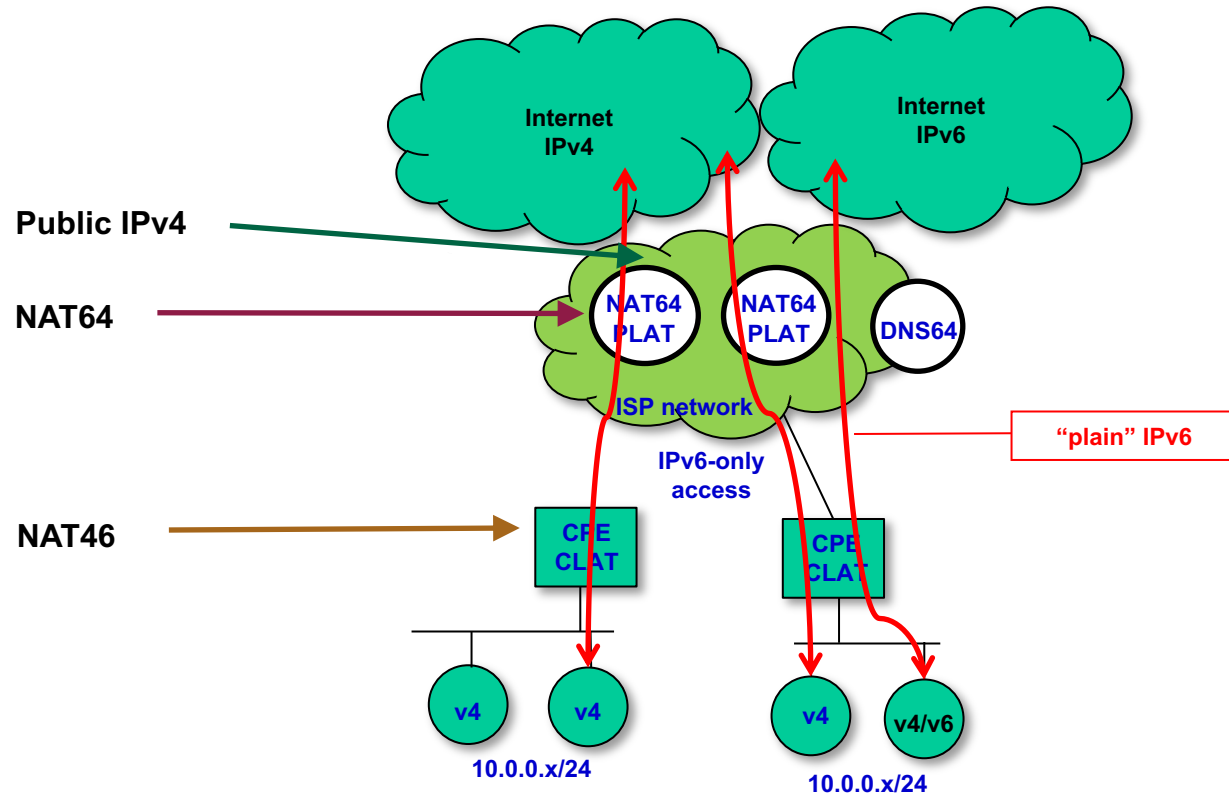   - Other choices, including SIIT-DC-DTM (RFC7756)

NAT64 is NOT a Valid Solution

- IPv4-only devices or apps will not work

- Some apps will don't work:
 - Peer-to-peer using IPv4 "references"
  - Literal addresses
  - Socket APIs

Internet IPv4

Internet IPv6

Public IPv4

NAT64

NAT64   NAT64   DNS64

ISP network

"plain" IPv6

IPv6-only access

CPE   CPE

v4   v4   AAAA synthesis   v6   v4/v6

10.0.0.x/24

464XLAT is the Solution

- ONLY valid solution for cellular networks
- Best solution for broadband:
  - Wired
  - Wireless

Internet IPv4

Internet IPv6

Public IPv4

NAT64

NAT64 PLAT

NAT64 PLAT

DNS64

ISP network

"plain" IPv6

IPv6-only access

NAT46

CPE CLAT

CPE CLAT

v4

v4

v4

v4/v6

10.0.0.x/24

10.0.0.x/24

464XLAT Traffic Flows

- Dual-stack support in user LANs, cellular apps and tethered devices
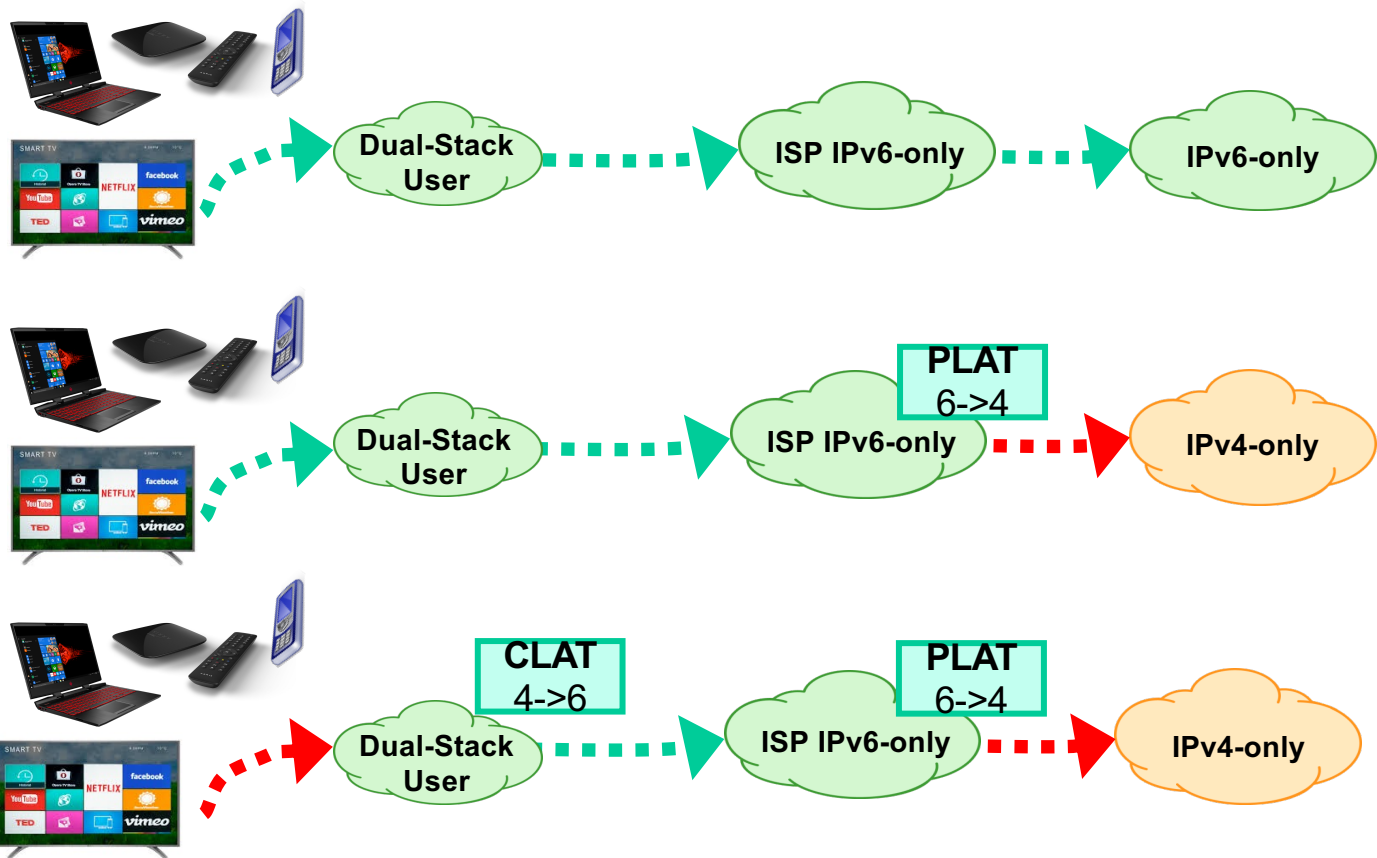
- Typically
  - >85% IPv6
  - 14% NAT64
  - 1% CLAT+NAT64

RFC8585 and RFC8683

- Starting points:
  - RFC8585 tells your CE providers what you need
  - RFC8683 is about considerations for your network
  - Pros and Cons of IPv6 Transition Technologies for IPv4aaS
    - draft-ietf-v6ops-transition-comparison
- However … every network is a different (and special) animal
- This presentation shows 12 steps used for a **real case deployment, done for an operator with 25 million subscribers** (production deployment "work in progress")
  - Cellular, DSL & GPON

1. Training and Network Review

- Train the operator staff
  - Needs to work with you, with the same level of knowledge
  - They need to understand the steps, how it works
  - They need to be able to complete the deployment
  - They need to be able to resolve issues
  - Experience demonstrates that training is always needed
    - Lot's of IPv6 "bad" knowledge, play against the deployment
- Review the actual network
  - Lot's of misconfigurations and security issues
    - IPv6 is NOT like IPv4
      - Example: assign prefixes (/48), not addresses

2. Addressing Plan and Routing

- Do you have already a good addressing plan?
  - Rule of thumb:
    - /48 per broadband subscriber
      - approx. 50.000 subscribers per each /32
    - /64 per cellular subscriber
- Have you got the right prefix size from the RIR?
  - You can use existing policies to extend it
- Do you have already your BGP ready?
- What about internal routing?
- Is all working? Sure?

3. Broadband Access

- Typical elements that need to be re-configured:
  - BRAS/BNG/MSAN/DSLAM/OLT
  - Radius
  - Provisioning systems
  - Billing apps
  - Monitoring
- Do they work well if IPv6-only is provided?

- Do you have control on all the devices, or need to rely on vendors?

4. CEs

- Do they fully support RFC8585 or only 464XLAT?

- NAT64 prefix configuration:
  - RFC7050 (heuristic)
  - RFC7225 (via PCP)
  - RFC8781 (via RAs)
  - Manually pre-configured (WKP 64:ff9b::/96)

- How to handle the existing CEs
  - Reflash?
  - Replace?
  - Marketing operation to upgrade customers?

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5. Packet Switched Network

- Will your cellular network behave as expected?

- Are the HLR/HSS able to deliver IPv6-only?

- Can you configure a single APN to cover all the cases?
  - IPv6, IPv4v6 and IPv4 PDP contexts?
  - You need to support all kind of UEs!
    - Gradual transition to IPv6-only with OTA updates

- Do you have control on all the elements or need to coordinate with vendors?

6. Cellular Clients

- Android, iOS and Windows
- Don't even consider other platforms
- Android supports IPv6-only and CLAT by default
- iOS requires the operator's Apple liaison support
  - Apple will enable the right APN, IPv6 and CLAT or HEv2
- Since Windows 10 CLAT support is available

- You can "hack" a few iOS devices with your own profile to override the standard config
  - Useful for a test-bed

7. Preview the Impact

- Before deploying 464XLAT, assess the impact in your network

- Look at DPI and other relevant data:
  - What apps
  - How much traffic each
  - How much traffic into CDNs/caches
  - Usage of DNSSEC

- Allowed failure rate?
  - Can we have some customer groups with dual-stack?

8. Deploy a Testbed

- Make a realistic testbed of your possible deployment
  - It must be as close as possible to the production network or even part of it

- Possible manual provisioning at this stage

- You need to be able to test different combinations of:
  - NAT64
  - DNS64
  - UEs
  - CEs (with different access technologies)

9. Test Apps/Services

- With data gathered from DPI and other sources, choose the top "n" apps/services
  - May be around 20 is a good number, but it depends on traffic %

- Test each in every possible scenario:
  - NAT64+DNS64: iOS
  - 464XLAT: iOS, Android, DSL, GPON, DOCSIS, etc.

- Detailed documentation of what works/what fails is key for success

9. Test Apps/Services (2)

Test No. Setup -------------------- App->	1 WWW	2 email	3 VPN	4 WhatsApp	5 WhatsApp video	6 WhatsApp voice	7 Snapchat	8 YouTube	9 Apple Music	10 NetFlix	11 Windows Media Player	12 SopCast	13 GooglePlay, AppleUpdate, WindowsUpda	14 RDP, TeamViewer	15 GoogleDrive, iCloud	16 FileTransfer	17 BitTorrent	18 PlayStation
A. Open Source NAT64+DNS64																		
A.1. Internal VM CLAT+Windows	✓							✓					✓	✓	✓	✓		
A.2. DSL NAT64+DNS64	✓	✓	X	✓			✓	✓	✓	X	✓		✓	X	✓	✓	✓	X
A.3. DSL 464XLAT	✓	✓	✓	✓			✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
A.4. GPON NAT64+DNS64	✓	✓	X	✓			✓	✓	✓	X	✓		✓	X	✓	✓	✓	X
A.5. GPON 464XLAT	✓	✓	✓	✓			✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
A.6. iOS	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓		✓	✓
A.7. Android	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓		✓	✓	
B. ASA NAT64+DNS64																		
B.1. Internal VM CLAT+Windows	✓							✓					✓	✓	✓	✓		
B.2. DSL NAT64+DNS64	✓	✓	X	✓			✓	✓	✓	X	✓		✓	X	✓	✓	✓	X
B.3. DSL 464XLAT	✓	✓	✓	✓			✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
B.4. GPON NAT64+DNS64	✓	✓	X	✓			✓	✓	✓	X	✓		✓	X	✓	✓	✓	X
B.5. GPON 464XLAT	✓	✓	✓	✓			✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
B.6. iOS	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓		✓	
B.7. Android	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓		✓	✓	

Legend

✓	Works
X	Doesn't work (see note for that specific test)
✓	Works if client+app are IPv6-enabled and not using literals (as expected)
	Not Tested - not available in OS

Notes for FAILED tests

1. VPN fails with NAT64+DNS64. This is because the available VPN apps/servers/clients being used for the test don't work with IPv6-only. Alternative apps could work.
2. RDP fails with NAT64+DNS64. This is because the available RDP apps/servers/clients being used for the test don't work with IPv6-only. Alternative apps could work.
3. PlayStation fails with NAT64+DNS64. This is a very well-known issue, because PlayStation is IPv4-only.

10. Choose the NAT64 (DNS64)

- Previous testing is only the starting point
- Are you ok with Open Source?
  - What vendors if not
- How much traffic will pass thru?
  - Typically only 20% (and going lower)
- Need to ensure HA
- Need to support ALGs?
- Logging as required by LEA
- Do you need a DNS64?
  - Similar considerations as for the NAT64

11. NAT64 Deployment Model

- Where you place the NAT64's?

- Single location vs distributed?

- If distributed, HA in each location?

- How you balance the subscribers?

- WKP or NSP?

12. Plan Massive Deployment

- How much time we expected it will take vs how much is taking in reality …

- Following testing phases, with groups of "beta" customers

- Progressive global deployment
  - All customers, one region, one BRAS, opt-in only, per CE features?
  - All customers or only residential?
  - How you keep business customers as dual-stack or with EAM for using specific NAT64 addresses/ports
  - How you approach the cellular network?

Savings

- CapEx and OpEx

- Avoid paying for IPv4 addresses

- If you replace CEs, reduce your investment in NAT64

- You can "sell" the CEs to customers because new "features"
  - Better WiFi coverage and security
  - New functions: opportunity for triple-play or 4K/8K IPTV
  - More bandwidth
  - Move customers from DSL to GPON and analog voice to VoIP
  - IoT offering
  - Upgraded warrantee

Multiservice Network

NAT64
+
DNS64

464XLAT

Cellular network

464XLAT Residential network

Corporate network
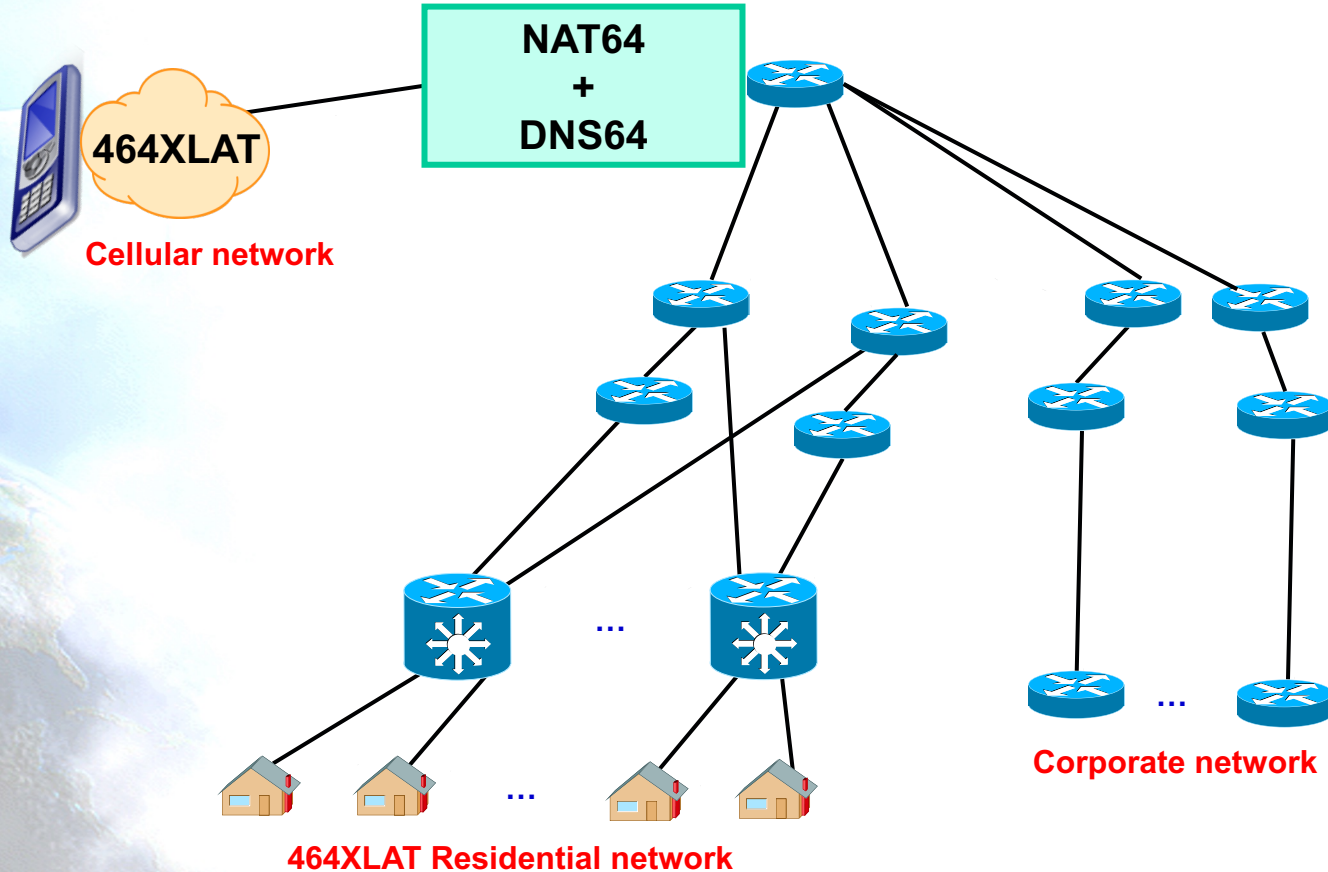
Thanks!

Contact:

@JordiPalet
jordi.palet@theipv6company.com