Mapping of Address and Port Overview

UK IPv6 Council – Transition Technologies Workshop

Kingsman: The Golden Circle

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Why MAP?

- IPv4aaS.
  - IPv6-only Access Layer.
  - Reduce operational overhead.
- Allows IPv4 address sharing, or 1:1.
- No DNS synthesizing required.
- Doesn’t require an agent on end-hosts.
- Can operate in either encapsulation or translation modes.
- **Stateless.**

Stateless

MAP Border Relays (BR) do not have to keep track and state of every flow.

Potential for cheaper and more scalable border relay hardware.

- Predefined mapping rules are configured on both the MAP Border Relay (BR) and the Customer Premise Equipment (CPE).
- IP headers and layer 4 port sets are algorithmically calculated based on these predefined mapping rules.
- No additional accounting records are required.
- No additional ALG or port forwarding techniques required.

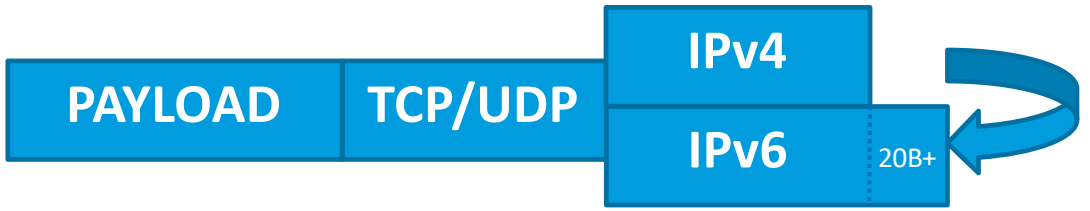
Mapping of Address and Port (MAP)

RFC7597: MAP-E

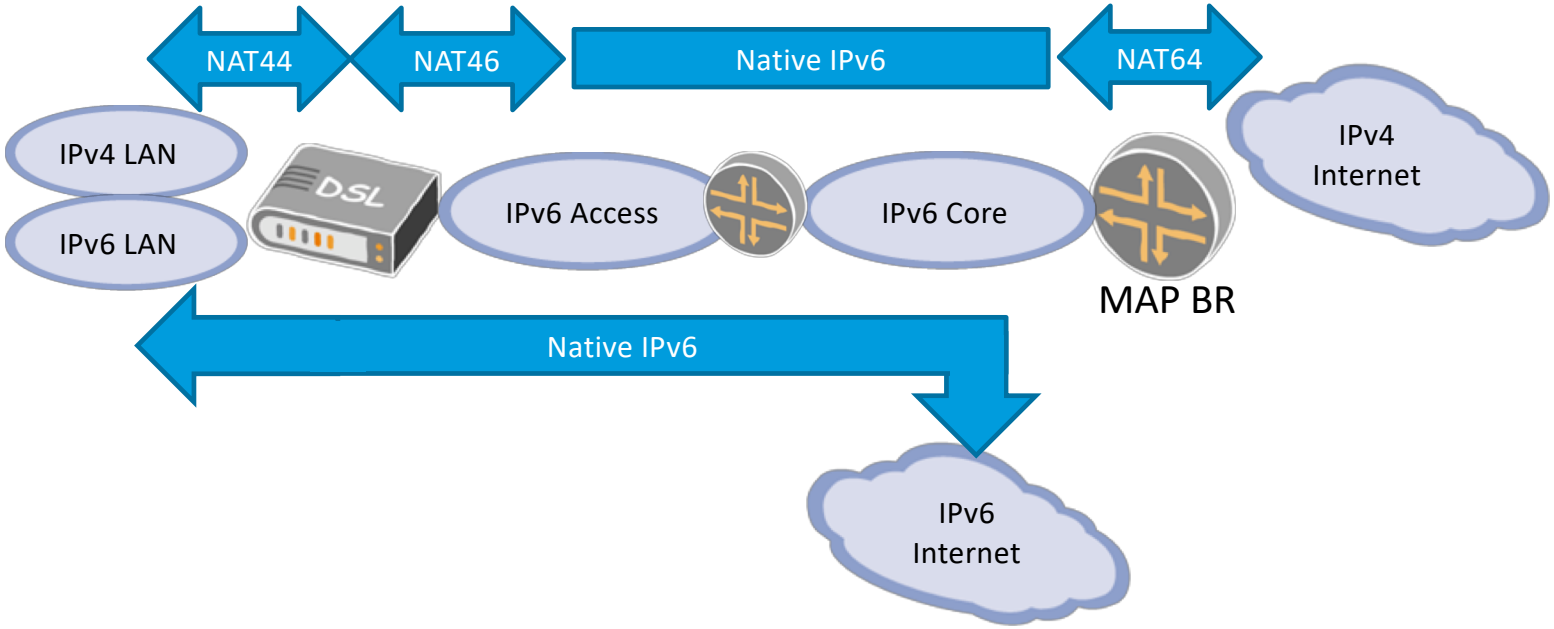
- Encapsulation
  - Larger per-packet overhead.
  - IPv4 header remains intact.

RFC7599: MAP-T

- Translation
  - Less per-packet overhead (not zero!)
  - Loses IPv4-only header attributes.
  - 5-tuple hashing.
  - Border relay-bypass.



Packet Flow (MAP-T)



Mapping Rules

Basic Mapping Rule (BMR)

When combined with the CPE's Prefix Delegation, defines the IPv4 address and port sets the CPE is allowed to use.

Default Mapping Rule (DMR) [MAP-T]

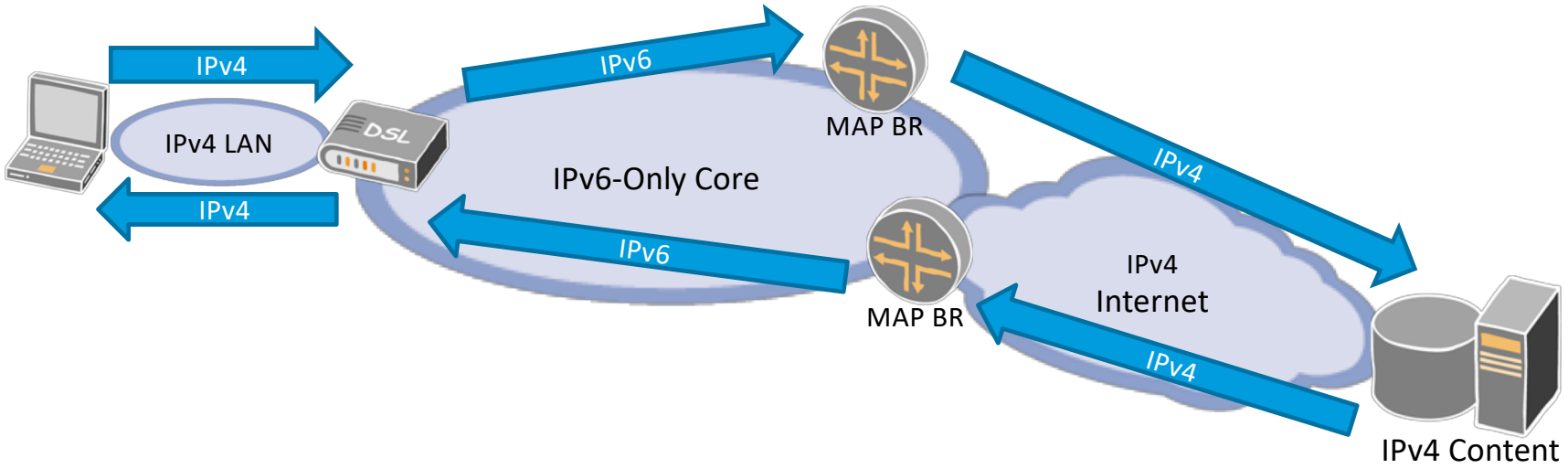
Specifies an IPv6 prefix from which to map external IPv4 addresses. (RFC6052)

Forward Mapping Rule (FMR) **[Optional]**

Allows IPv6 packets to flow between CPE <-> CPE without hair-pinning via a MAP BR.

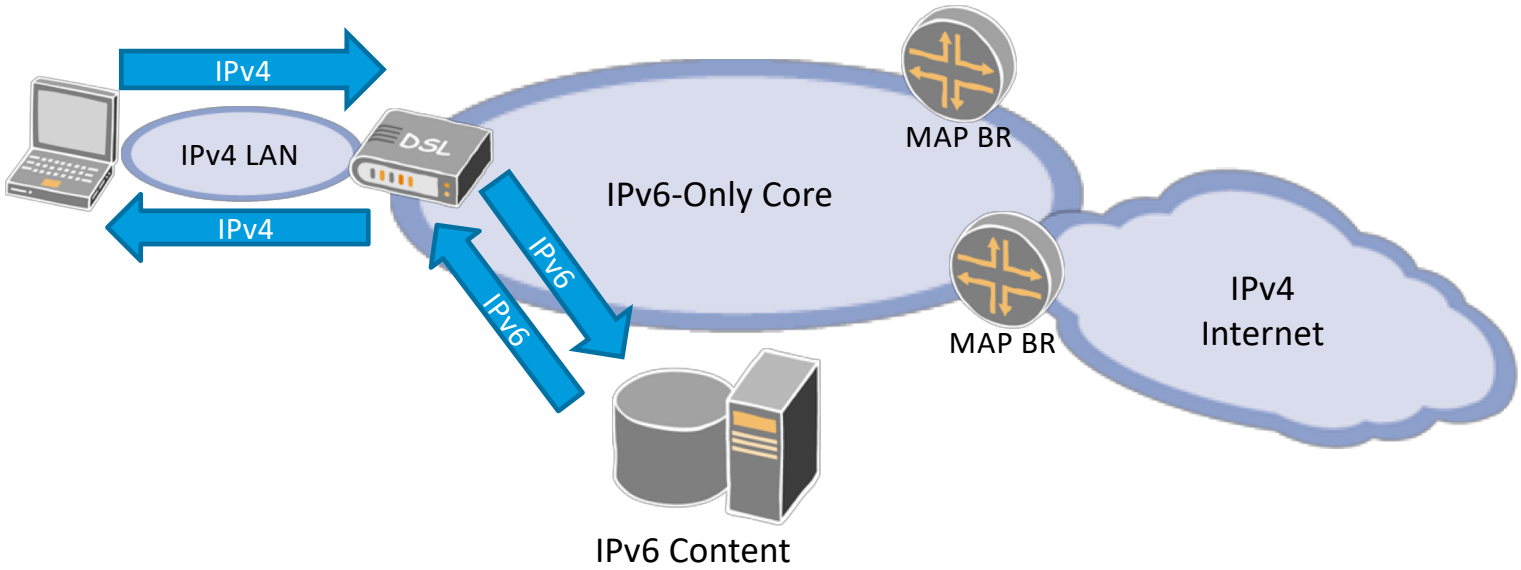
Anycasting

- DMR IPv6 prefixes can be anycasted internally
- Public IPv4 prefixes can be anycasted externally.
- Stateless translation/encapsulation allows for asymmetric packet flows.



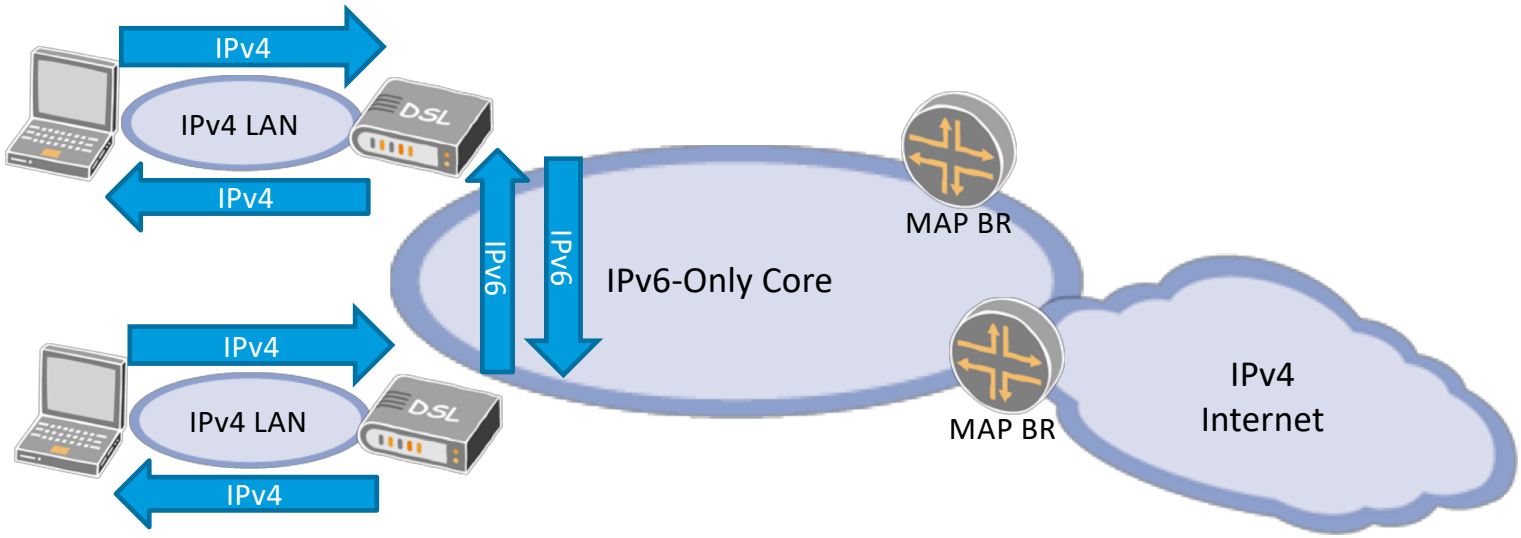
BR Bypass for CDN

- On-net content servers can be numbered from within the IPv6 DMR prefix, allowing for Border Relay-bypass, using more specific destination-based routing.
- Allows for serving of IPv4-only clients from IPv6-capable CDNs.



Forward Mapping Rule

- Allows direct CPE <-> CPE communication, bypassing Border Relays.



Summary

Benefits

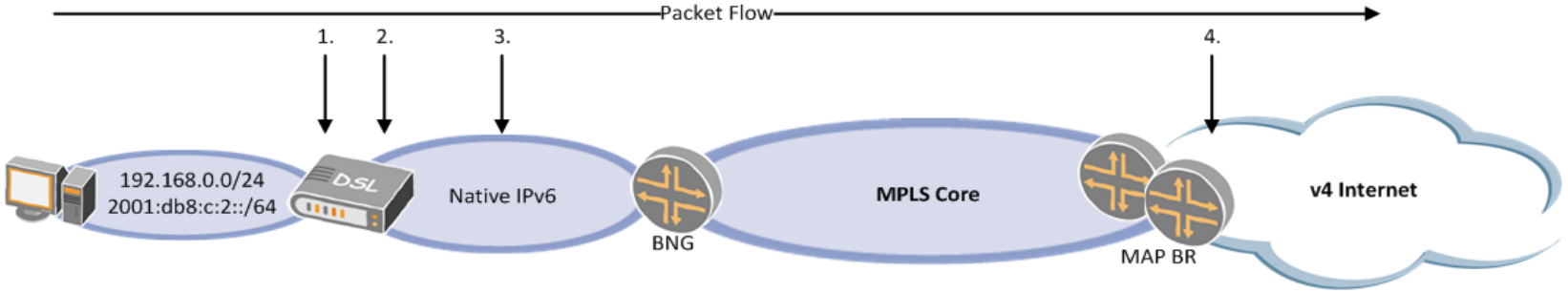
- Stateless.
  - Cheaper & more scalable Border Relay hardware.
- Border Relay Bypass.
- Simpler logging / Compliance.
  - Although some jurisdictions require 5-tuple per-flow logging.

Detriments

- Additional complexity on the CPE.
  - 👍 OpenWRT: Almost out of the box, need to ‘opkg install’ the MAP package. (Andrew Yourtchenko’s implementation)
  - 🆗 Broadcom SDK: Requires additional development. (CERNET’s implementation)
- Complexity in the mapping algorithm and address planning.
  - IPv6 Address planning becomes important and inflexible.
  - OK for greenfield deployments.
- Lack of real-world deployments.

Appendix.

Packet Flow Example (MAP-T)



1.

TCP/UDP Header		IP Header	
SPORT: 6783	DPORT: 80	SOURCE: 192.168.0.123	DEST: 8.8.8.8

Stateful NAPT on CPE translates both source IPv4 address and source port (when oversubscribing) based on the BMR

2.

TCP/UDP Header		IP Header	
SPORT: 1200	DPORT: 80	SOURCE: 151.230.60.51	DEST: 8.8.8.8

MAP-T agent on CPE translates source IP address to v6 based on the BMR, and destination IP address to v6 based on the DMR (and RFC6052)

3.

TCP/UDP Header		IP Header	
SPORT: 1200	DPORT: 80	SOURCE: 2001:db8:c:2:97:e63c:3300:0000	DEST: 2001:db8:ffff:0:8:808:800:0000

MAP-T Border Router translates source IP address back to IPv4 based on the BMR, and destination IP based on DMR (and RFC6052)

4.

TCP/UDP Header		IP Header	
SPORT: 1200	DPORT: 80	SOURCE: 151.230.60.51	DEST: 8.8.8.8

Note: Source address translation is BMR-dependent, it would not use RFC6052 as shown in this example.

Mapping Rules

- The same mapping rules are applied to both CPEs and Border Relays alike; no custom per-CPE configuration is required.
- Mapping rules can be communicated to the CPE via DHCPv6 options within the lease (RFC7598), or via TR.069 or other means.
- The bits between the IPv6 supernet, and the IPv6 Prefix Delegation, tell the CPE which IPv4 address and layer 4 ports are available.

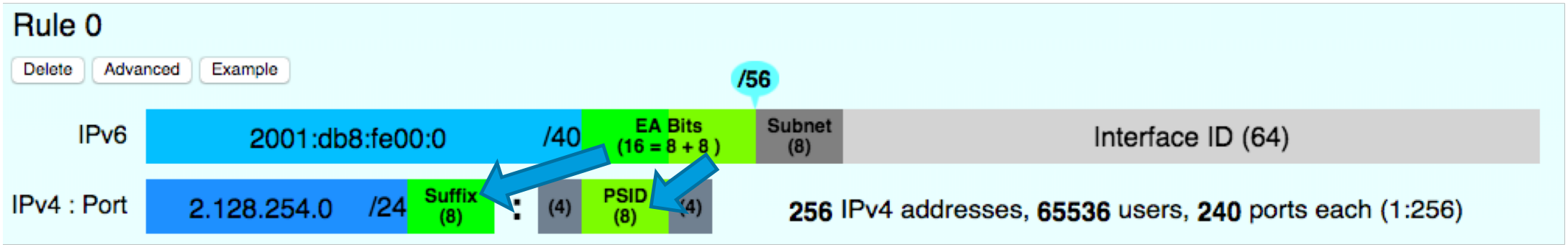


Image Source: Generated at http://6lab.cisco.com/map/