IPv4 Residual Deployments
Unified Packet Format for Stateless solutions
(4rd-U)

draft-despres-softwire-4rd-u-01

4rd-U vs. Translation and Encapsulation vs.

TRANSLATION ENCAPSULATION 4rd-U

- Fragment header always present
- No Transport-layer modification
- Shorter header than encapsulation

```
                       +-------------+
                       |    IPv6     |
   (RFC 6145)          |   Header    |
+-------------+        +-------------+        +-------------+
|    IPv6     |        |  Fragment   |        |    IPv6     |
|   Header    |        |   Header    |        |   Header    |
+-------------+        | (if needed) |        +-------------+
|  Fragment   |        +-------------+        |  Fragment   |
|   Header    |        |    IPv4     |        |   Header    |
| (if needed) |        |   Header    |        |             |
+-------------+        +-------------+        +-------------+
|  Transport- |        |             |        |             |
|   Layer     |        |  IP-layer   |        |  IP-layer   |
|   Header    |        |    Data     |        |    Data     |
+-------------+        |             |        |             |
|             |        |             |        |             |
~    Data     ~        ~             ~        ~             ~
|             |        |             |        |             |
+-------------+        +-------------+        +-------------+
```

Why it is useful?

2. Current O&M tools of IPv6-only domains use port fields of IPv6 packets to do access control (ACLs). Having them ready for encapsulated IPv4 packets MAY take a long time

   ➔ advantage to Double-translation

3. Web redirection in IPv6-only domains MAY require valid TCP checksums in IPv6 payloads

   ➔ advantage to Double-translation

1. IPv4 and IPv6 treat fragmentation differently so that the IPv4 DF bit MAY be lost in Translation

   ➔ advantage to Encapsulation

4. If IPv6-domain traversal by IPv4 packets is subject to its own IPv6 traffic class, the IPv4 TOS MAY be lost

   ➔ advantage to Encapsulation

Why it is possible?

1. IPv6 packets have an optional Fragment header.
2. In this header, the packet ID field has 32 bits more than that of IPv4 headers
3. Only 9 bits of IPv4 headers are missing for end-to-end transparency in case of translation (DF bit and TOS octet)
4. Checksum validity of UDP/TCP can be ensured in 4rd-U packets without any change in IP payload (using for this the 16 last bits of IPv6 addresses)

How it works – (1) From IPv4 to IPv6

HEADER-FIELDS

- **7 are constant**
- **7 are COPIED**

  (DF and TOS in packet ID)
- ***1 is /MODIFIED/ by adding a constant***
- **2 *ADDRESS MAPPINGS***

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Vers=6 |   TrafClass   |             Flow Label = 0            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         /PAYLOAD LENGTH/      |Next Header=44 |   HOP LIMIT   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+                                                               +
|                                                               |
+                    *IPv6 SOURCE ADDRESS*                      +
|                                                               |
+                                                               +
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+                                                               +
|                                                               |
+                 *IPv6 DESTINATION ADDRESS*                    +
|                                                               |
+                                                               +
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  NEXT HEADER  |  Reserved = 0 |     FRAGMENT OFFSET     | 0 |M|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|D|      0      |   IPv4 TOS    |       IPv4 IDENTIFICATION     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                          IP   PAYLOAD                        ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

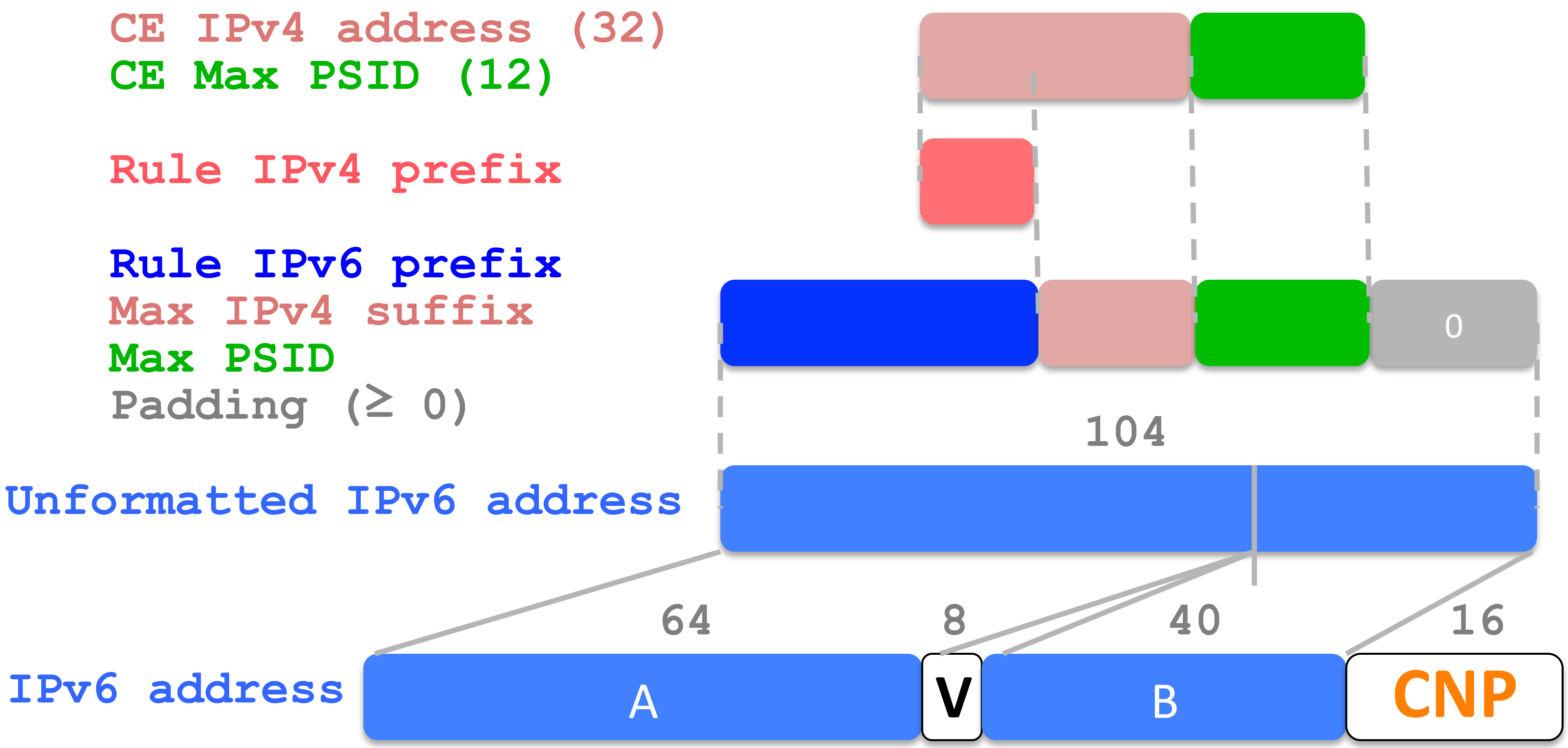
How it works – (2) From IPv6 to IPv4

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Vers=4 |HeadL=5|      TOS      |         /TOTAL LENGTH/        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    IPv4 IDENTIFICATION        |0|D|M|     FRAGMENT OFFSET     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  TIME TO LIVE |    PROTOCOL   |       "HEADER CHECKSUM"       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    *IPv4 SOURCE ADDRESS*                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                 *IPv4 DESTINATION ADDRESS*                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                          IP  PAYLOAD                          ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

HEADER-FIELDS

- **3 are constant**
- **7 are COPIED**
- ***1 is /MODIFIED/ by adding a constant***
- **2 are *ADDRESS MAPPING* derived**
- **1 is *"COMPUTED" (header checksum)***

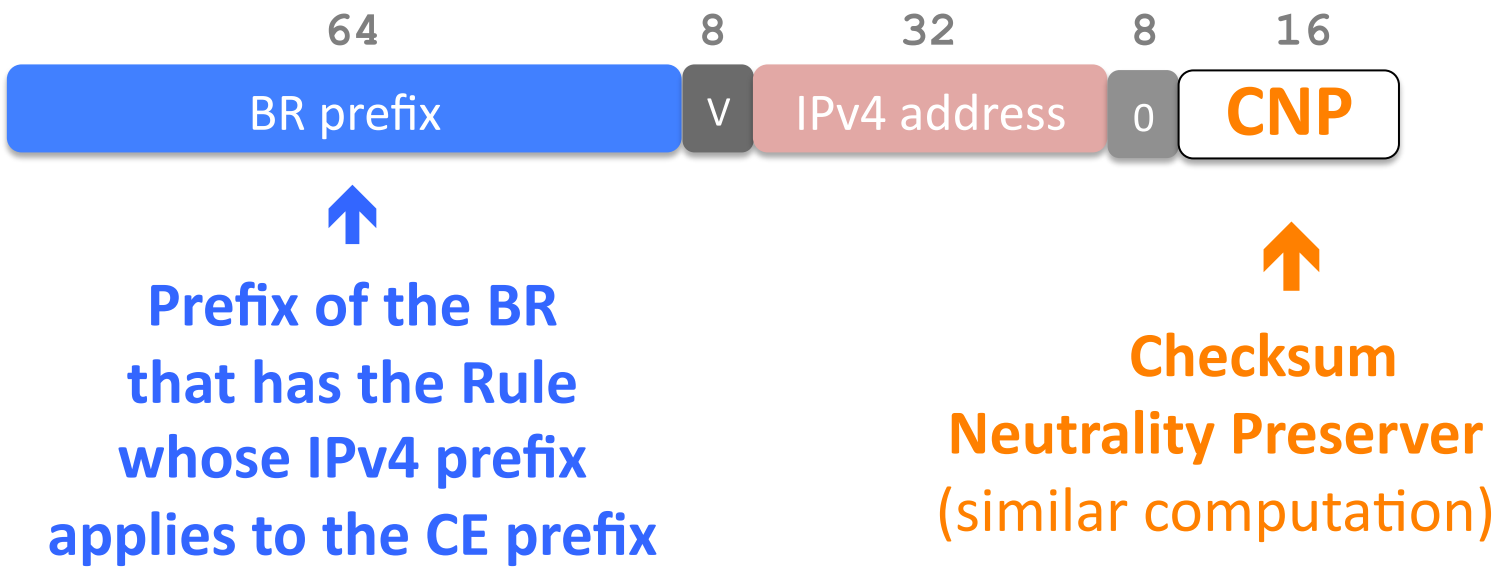
A checksum-neutral Address-Mapping (CE address)



V: 4rd mark
(permits to use the CE IPv6 prefix for 4rd without possible conflict with any valid IPv6 address)

CNP: Checksum Neutrality Preserver
(computed from IPv4 address + A.V.B)

A checksum-neutral Address-Mapping (BR address)



4rd-U in the global picture

	Possibility of :	MAP Trans	MAP Encap	Stateless DS-lite	4rd-U
1	Direct CE-CE routes	Y	Y	N	Y
2	Full IPv4 Transparency	N	Y	Y	Y
3	Use of IPv6 O&M tools and Web redirect	Y	N	N	Y
4	Changing IPv4 pool and/or sharing ratio without IPv6 renumbering	Y (TBD)	Y (TBD)	Y (TBD)	Y (TBD)
5	Operation on IPv4-only networks of the NAT444 model	Y (4rd-T /6rd)	Y (4rd-E /6rd)	Y (*) (SDNAT /RFC1918)	Y (4rd-U /6rd)

(*) No IPv6 service

Additional feature (not in draft)

Avoid fragment processing in BR from non-shared-address CEs

- In BRs, fragmented packets from shared-address CEs need some reassembly processing to check ports of all fragments
- If BRs don't know whether source CEs have a shared address or not, they do this processing even if not needed
- CE sources can indicate whether they have shared or non-shared addresses in one of the 7 remaining free bits in IPv6 fragment headers.

Conclusion

The 4rd-U design is a proposed
for stateless IPv4 residual deployments
across IPv6-capable domains
as basis of a **unique standard**