Use of IPREF as a tool for transitioning to IPv6

draft-augustyn-intarea-ipref-02
IETF 118 Prague 2023

Brief Overview of IPREF

- End-to-end address space traversal
  - over NAT/NAT6/filters and cross IPv4/IPv6
  - massively scalable
- IPREF Addresses

context address	reference

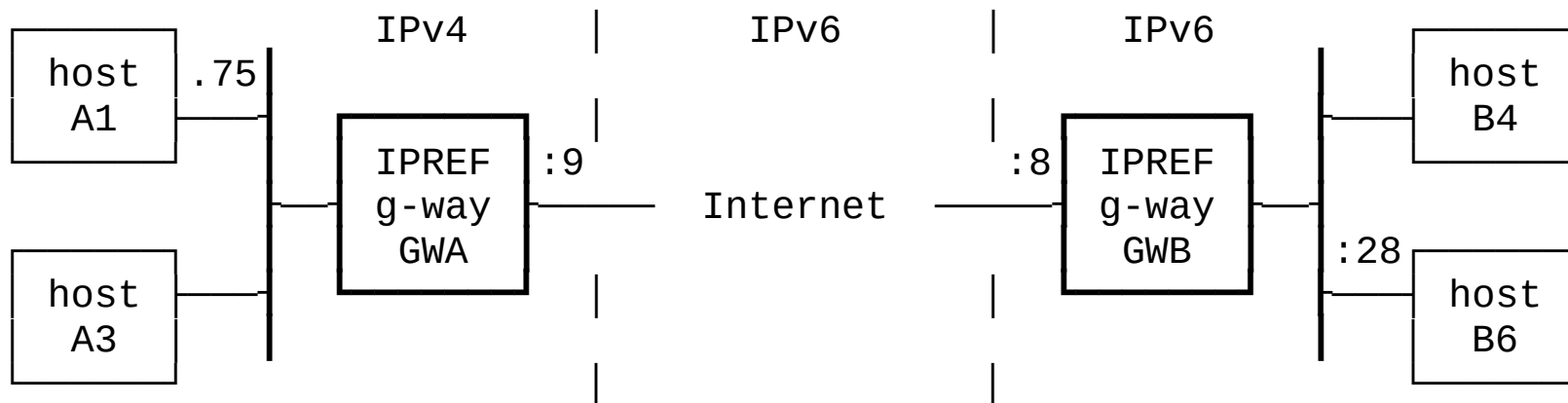192.0.2.123 + 3427
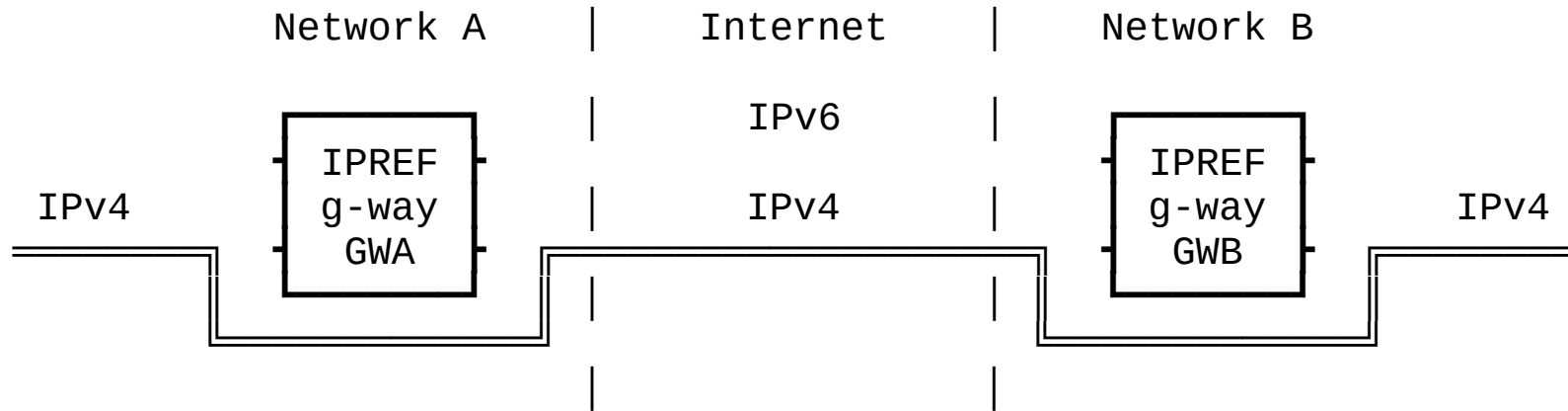
2001:DB8::123 + 2371

- IPREF Addresses publishable in DNS

Traversing Address Spaces

```
              Network A        |      Internet        |    Network B

src:   2001:db8::9 + 1579       2001:db8::9 + 1579      2001:db8::9 + 1579
dst:   2001:db8::8 + 2466       2001:db8::8 + 2466      2001:db8::8 + 2466

            ↓                          ↓                       ↓

src:   172.17.1.75              2001:db8::9             fdee:eeee::5951
dst:   10.128.48.62             2001:db8::8             2001:db8:b::28
```

```
                          IPv4      |      IPv6      |      IPv6

 ┌──────┐  .75 │              |                  |            ┌──────┐
 │ host │──────┤           ┌──────────┐          ┌──────────┐ │ host │
 │  A1  │      │           │  IPREF   │:9     :8 │  IPREF   │ │  B4  │
 └──────┘      ├───────────┤  g-way   │─ Internet ─┤  g-way  ├─└──────┘
               │           │   GWA    │          │   GWB    │ :28
 ┌──────┐      │           └──────────┘          └──────────┘ ┌──────┐
 │ host │──────┤              |                  |            │ host │
 │  A3  │                     |                  |            │  B6  │
 └──────┘                     |                  |            └──────┘
```

waldemar@wdmsys.com

Transitioning to IPv6, I

1. Starting point

```
          Network A    |    Internet    |    Network B
                       |                |
                       |      IPv6      |
          ┌─────────┐  |                |  ┌─────────┐
          │  IPREF  │  |                |  │  IPREF  │
IPv4      │  g-way  │  |      IPv4      |  │  g-way  │      IPv4
──────────│   GWA   │──────────────────────│   GWB   │──────────
          └─────────┘  |                |  └─────────┘
                       |                |
                       |                |
```

2. Switching traffic to IPREF

```
          Network A    |    Internet    |    Network B
                       |                |
IPv6                   |      IPv6      |
-- -- -- -- -- --┐ ┌─────────┐  |                |  ┌─────────┐
                 │ │  IPREF  │  |                |  │  IPREF  │
IPv4             │ │  g-way  │  |      IPv4      |  │  g-way  │      IPv4
─────────────────│ │   GWA   │══════════════════════│   GWB   │═══════════
                   └─────────┘  |                |  └─────────┘
                       |                |
                       |                |
```

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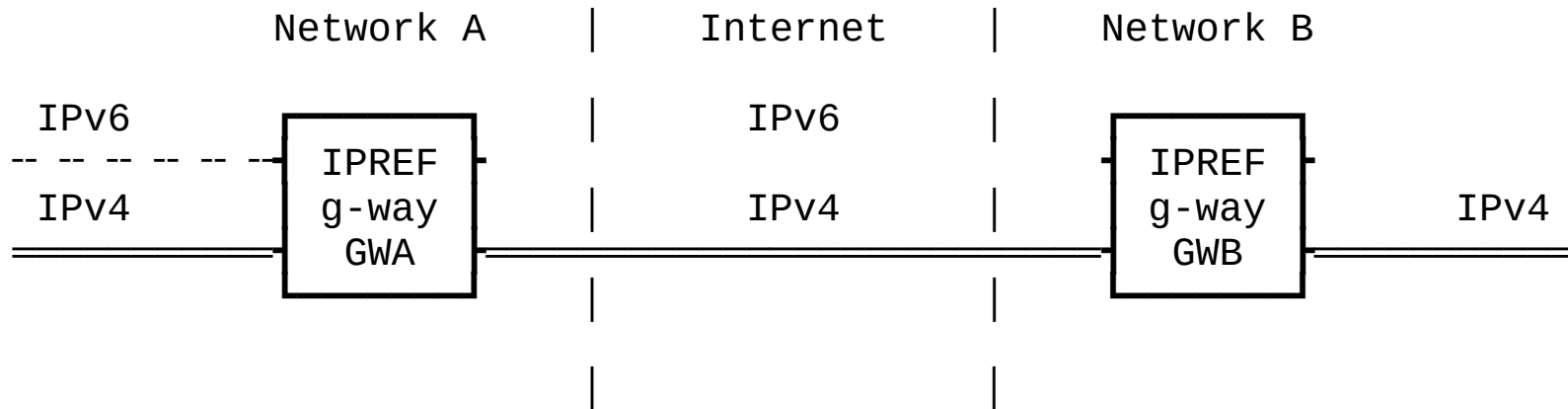
Transitioning to IPv6, II

3. Connecting to IPv6 Internet

```
            Network A      |    Internet    |   Network B

    IPv6                   |      IPv6      |
  ══════════╗  ┌───────┐   |                |   ┌───────┐
            ║  │ IPREF ├-- -- -- --         |   │ IPREF │
    IPv4    ║  │ g-way │   |      IPv4      |   │ g-way │     IPv4
  ══════════╩══│  GWA  │══════════════════════════│  GWB  ├══════════
               └───────┘   |                |   └───────┘
                           |                |
                           |                |

                           |                |
```
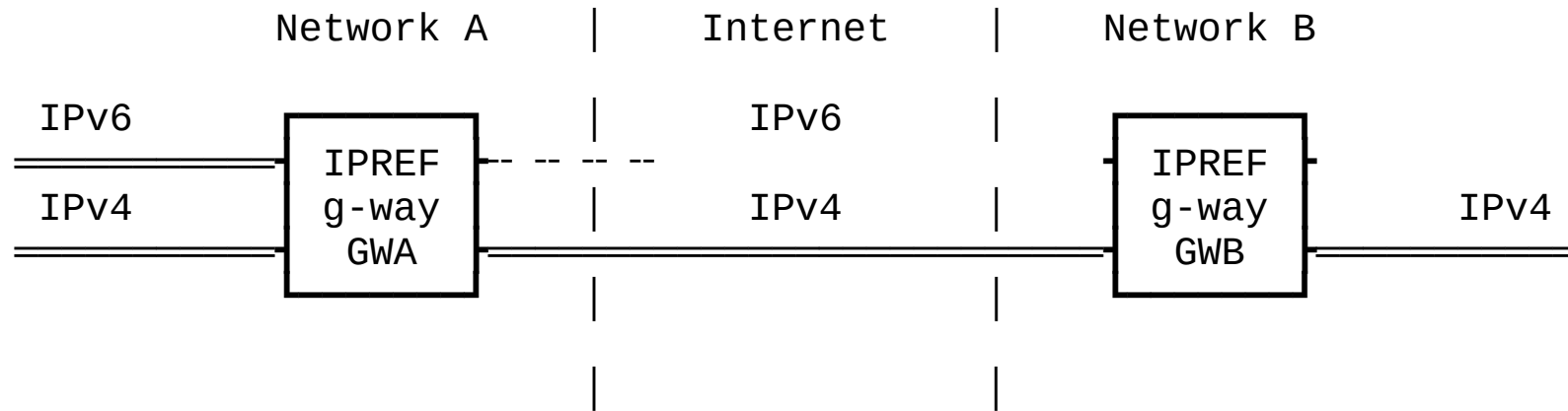
4. Switching gateway traffic to IPv6

```
            Network A      |    Internet    |   Network B

    IPv6                   |      IPv6      |                     IPv6
  ══════════╗  ┌───────┐   |                |   ┌───────┐  -- -- -- -- -- --
            ║  │ IPREF │══════════════════════════│ IPREF │
    IPv4    ║  │ g-way │   |      IPv4      |   │ g-way │     IPv4
  ══════════╩══│  GWA  ├-- -- -- -- -- -- -- -- -- --│  GWB  ╠══════════
               └───────┘   |                |   └───────┘
                           |                |
                           |                |

                           |                |
```

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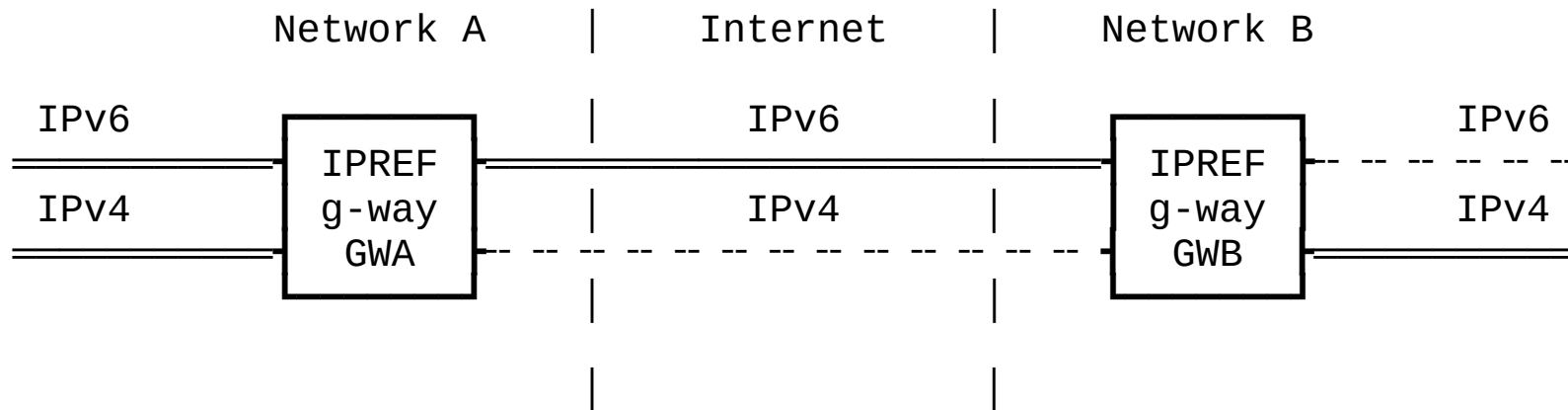
Transitioning to IPv6, III

5. Dropping IPv4 Internet

```
                Network A     |    Internet    |    Network B

  IPv6                        |      IPv6      |                       IPv6
══════════╗    ┌─────────┐    |                |    ┌─────────┐    ╔── ── ── ── ── ──
          ║    │  IPREF  │════════════════════════════│  IPREF  │
  IPv4    ║    │  g-way  │    |                |    │  g-way  │    ║   IPv4
══════════╝    │   GWA   │    |                |    │   GWB   │    ╚════════════════
               └─────────┘    |                |    └─────────┘
                              |                |
                              |                |
```

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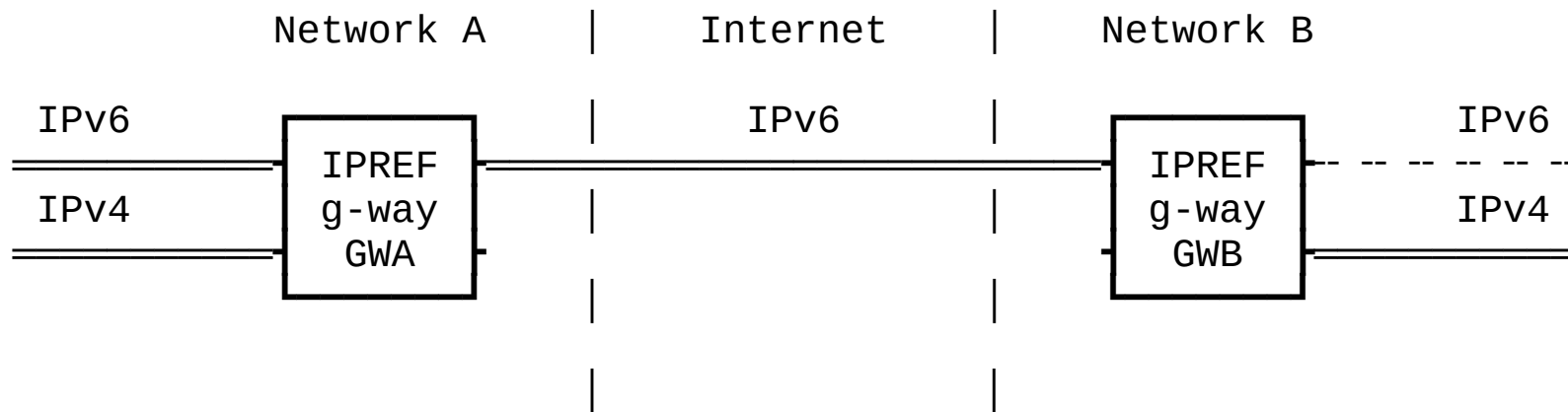
Transitioning to IPv6, IV

6. Switching to IPv6 independently

```
           Network A    |    Internet    |    Network B

 IPv6                    |      IPv6      |                     IPv6
=======     ┌─────────┐  |               |  ┌─────────┐     =======
            │  IPREF  │══╪═══════════════╪══│  IPREF  │
 IPv4       │  g-way  │  |               |  │  g-way  │
=======     │   GWA   │  |               |  │   GWB   │
            └─────────┘  |               |  └─────────┘
                         |               |
                         |               |
```
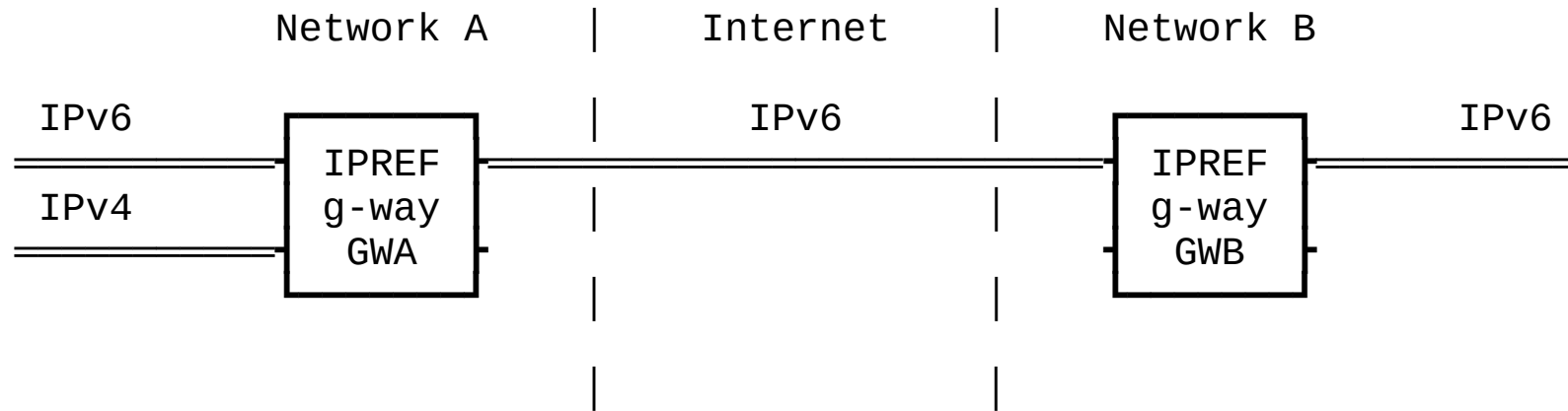
7. Completing transition

```
           Network A    |    Internet    |    Network B

 IPv6                    |      IPv6      |                     IPv6
=======     ┌─────────┐  |               |  ┌─────────┐     =======
            │  IPREF  │══╪═══════════════╪══│  IPREF  │
            │  g-way  │  |               |  │  g-way  │
            │   GWA   │  |               |  │   GWB   │
            └─────────┘  |               |  └─────────┘
                         |               |
                         |               |
```

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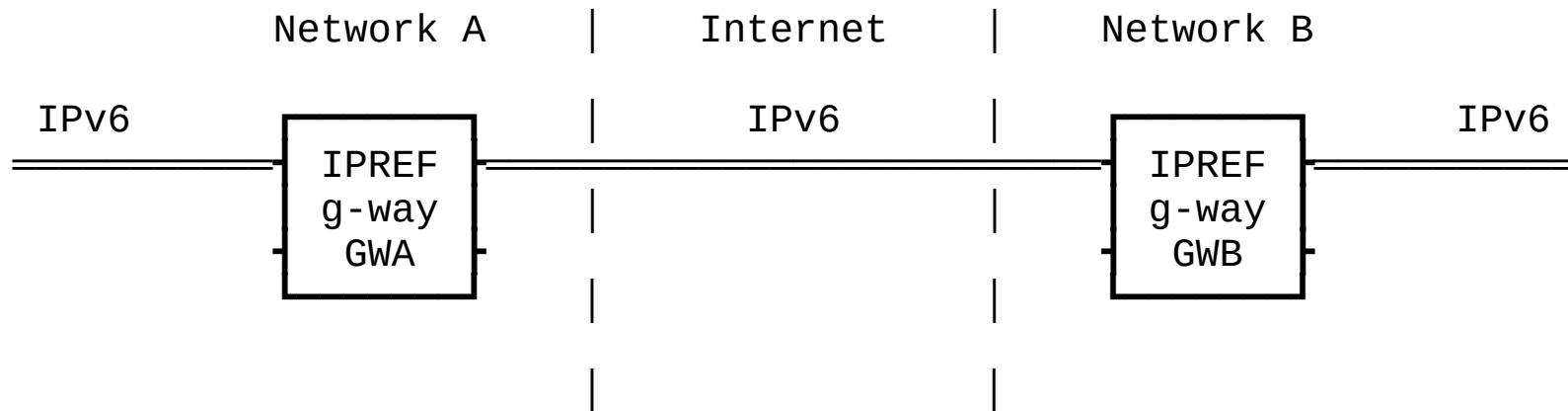
IPREF Succeeds Where Others Fail

- Taking down IPv4 Internet
  - no need for IPv4 addresses
  - dropping IPv4 early

- Enterprises
  - decoupling transition effort from peers
  - work at own pace, lower cost, lower risk
  - pure IPv6

- Procrastinators
  - lower threshold for transition

Transitioning with IPREF, Highlights

- Needs only pure IPv6 Internet

- Transitions directly to pure IPv6

- No need for global IPv4 addresses

- Allows to drop IPv4 Internet early

- Allows to transition at own pace

- Massively scalable

- Huge cost savings

The End