RANGER, VET, SEAL and IRON

IETF77
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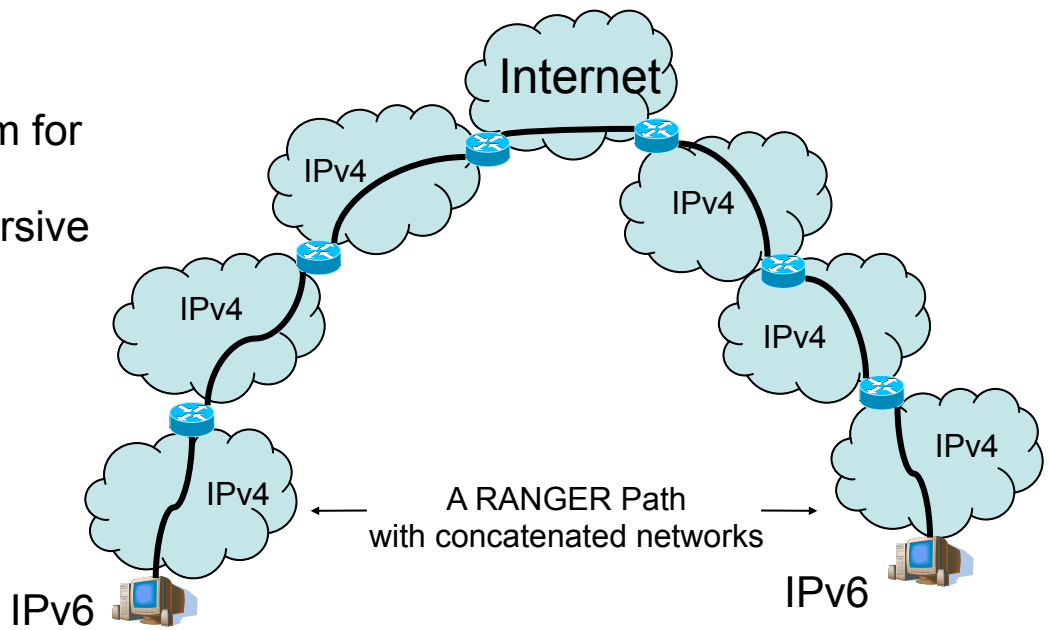
Routing and Addressing in Networks with Global Enterprise Recursion (RANGER) – RFC5720

- Recursively-nested connected local network regions joined by Enterprise Border Routers (EBRs) – a network-of-networks
- each distinct local network region is an “enterprise” unto itself
- PI and PA addressing, multihoming, traffic engineering, etc.
- PI prefixes are *portable* - no need for autoconfiguration
- example use cases:
  - Internet interdomain core
  - large academic campus network
  - corporate enterprise network
  - ISP networks
  - SOHO networks
  - civil aviation networks
  - Mobile Ad-hoc Networks

How RANGER Works

- **RANGER "concatenates" networks with recursive re-encapsulation**
- **Example: IPv4 for local routing and addressing; IPv6 for global routing and addressing (other IPvX/IPvY combinations also supported)**

•Routing scaling through local routing regions (RLOCs) with mapping system for global addresses (EIDs)
•Global communications through recursive re-encapsulation across local routing regions (EIDs)
•VET and SEAL



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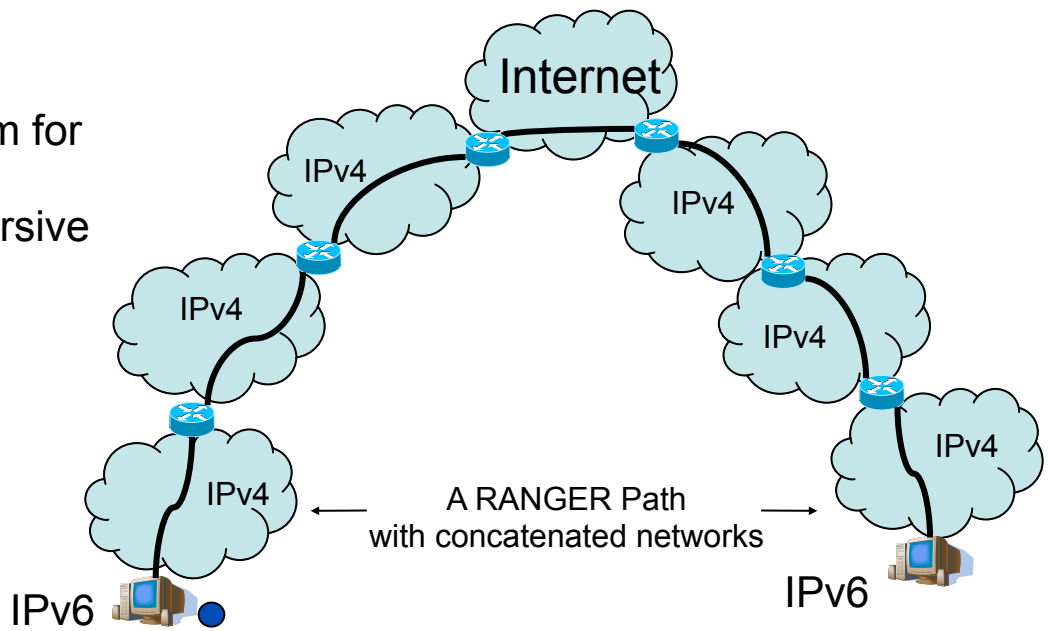

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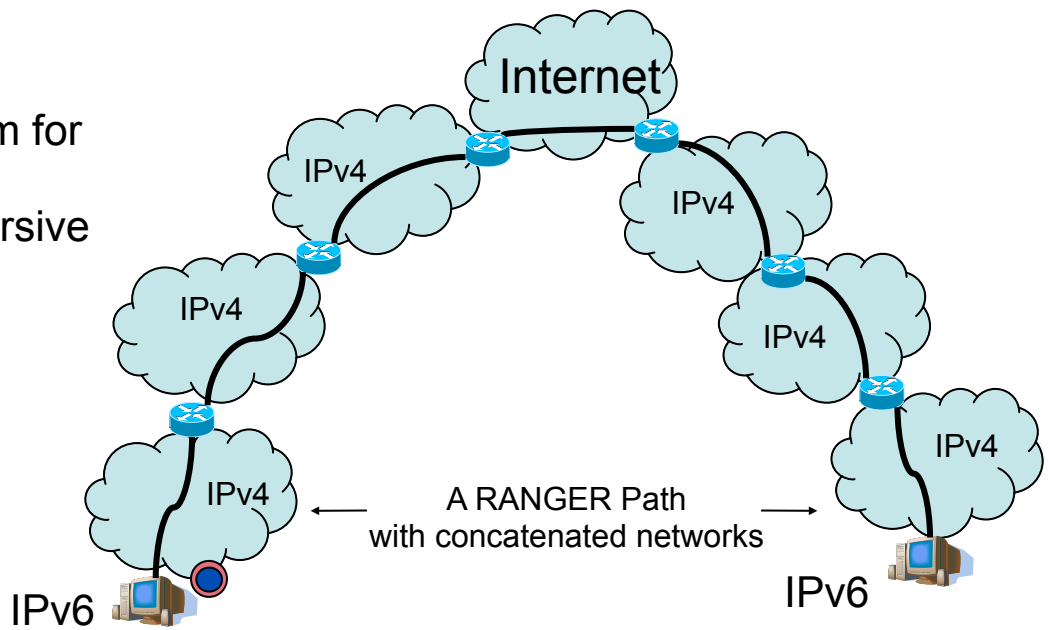

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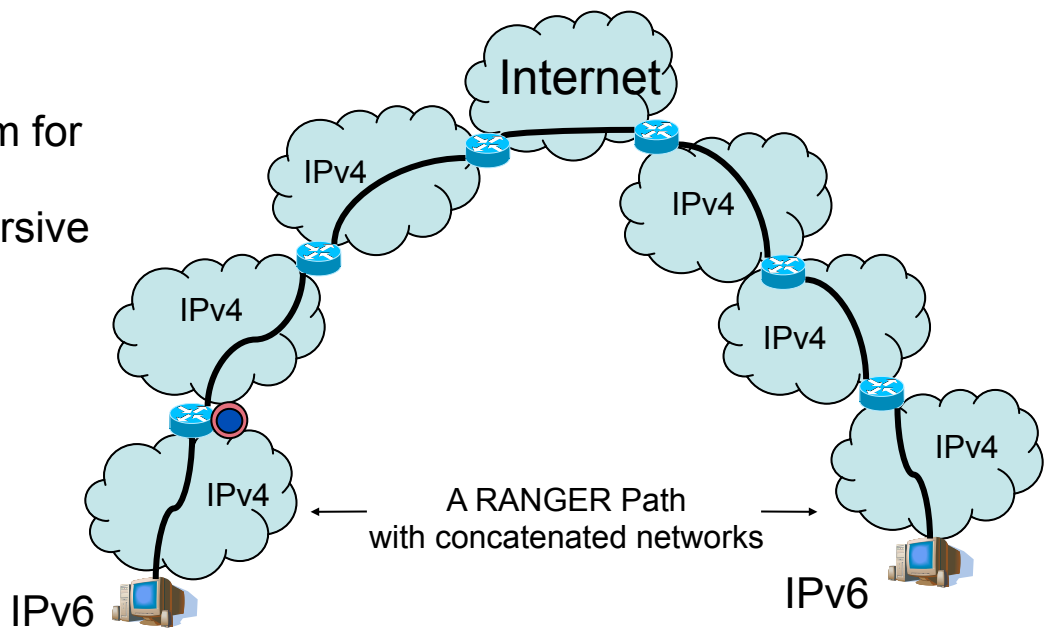

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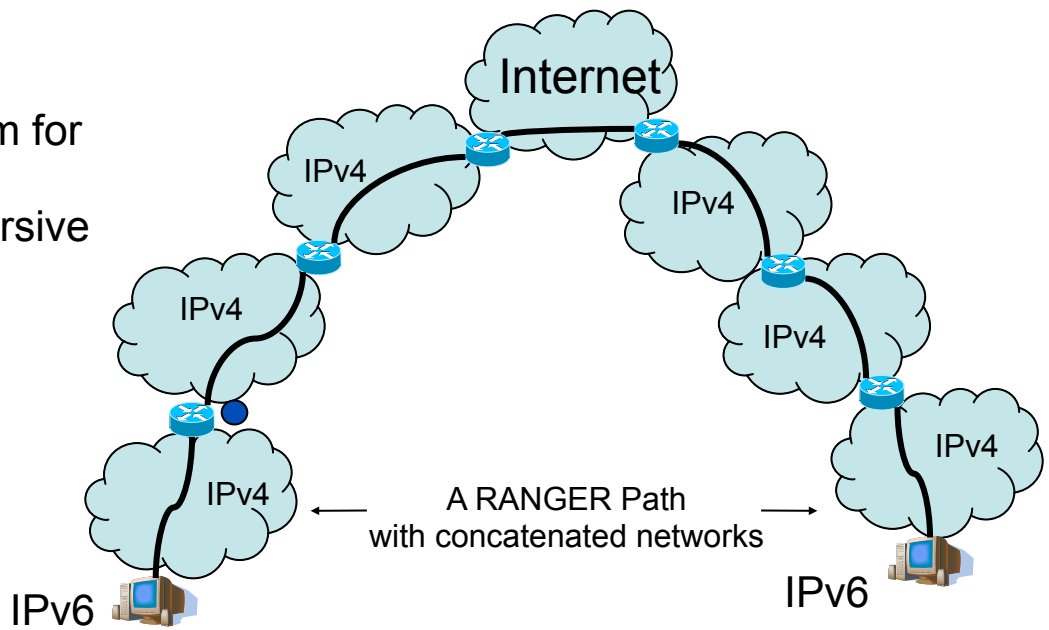

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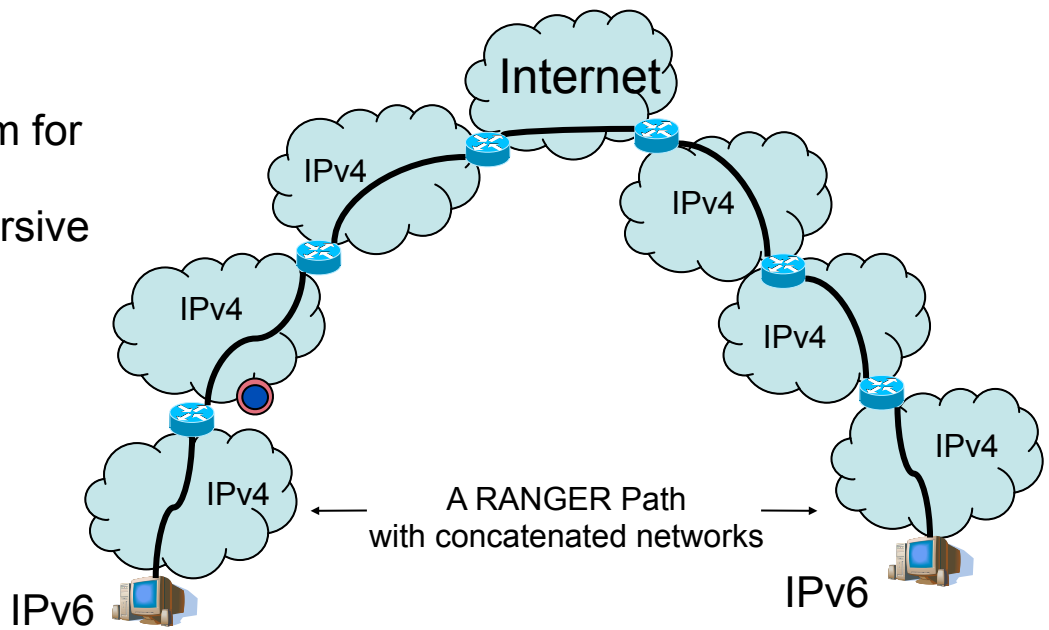

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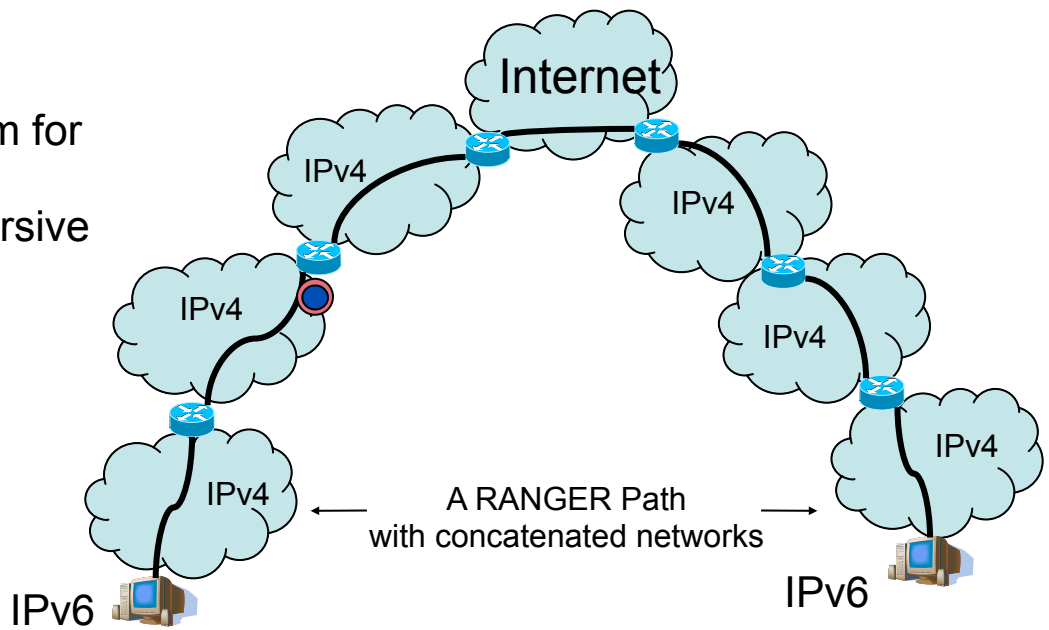

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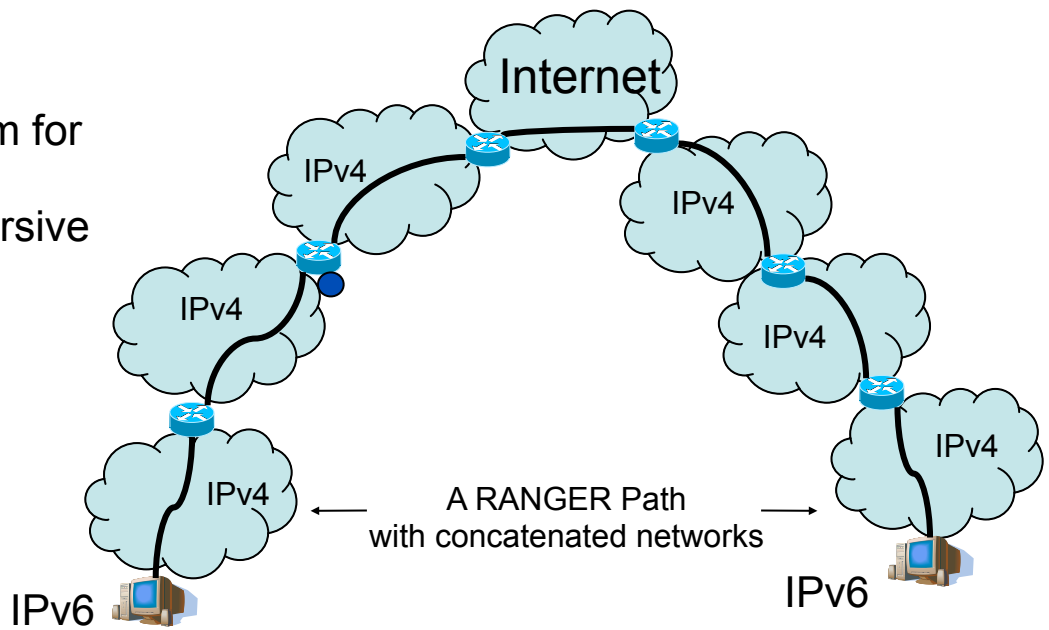

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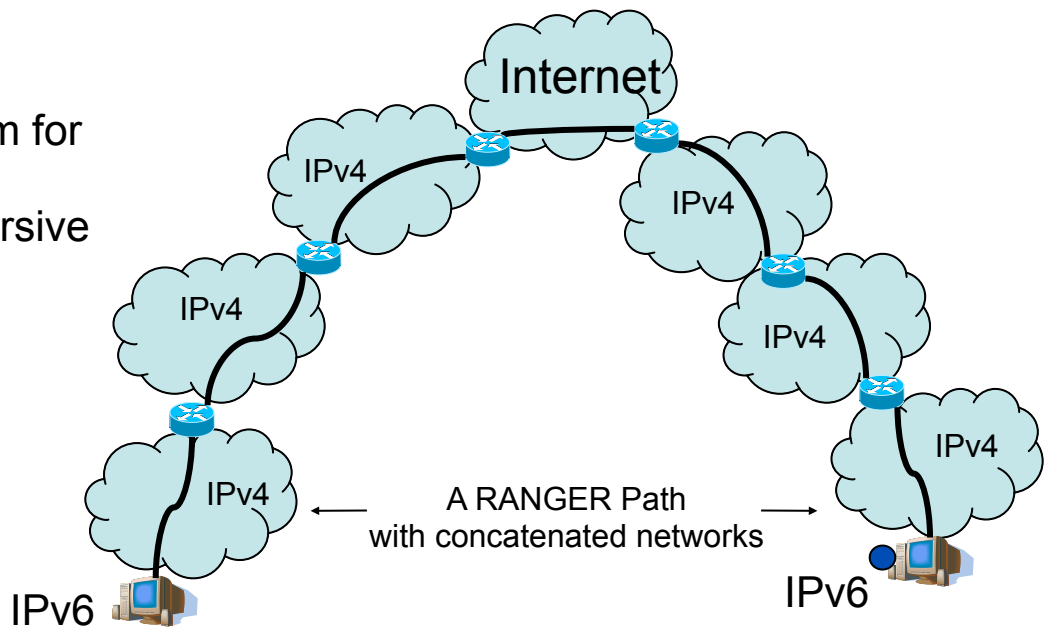
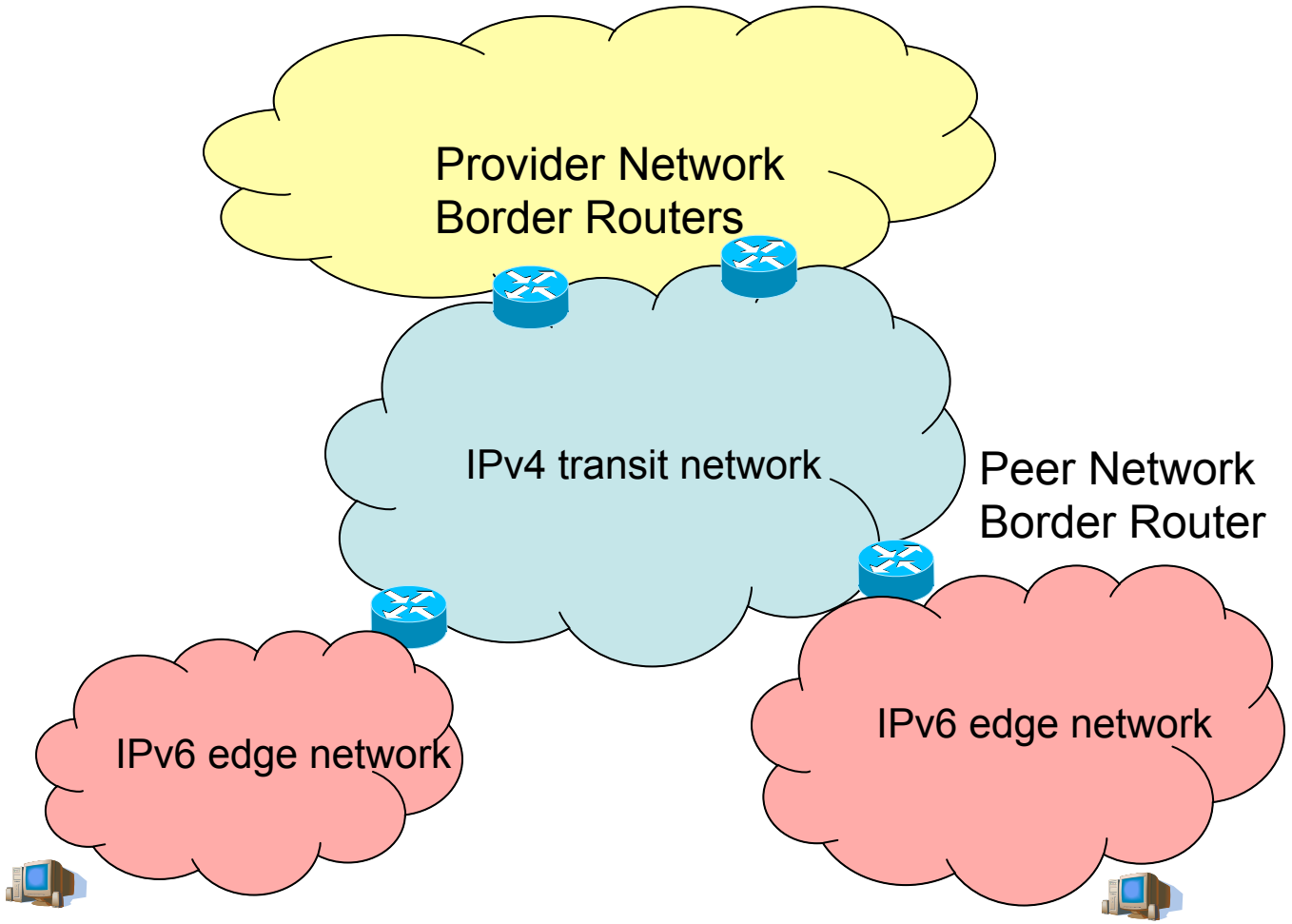


Virtual Enterprise Traversal (VET) – RFC5558

- Traversal of a single network within the recursive nesting
- Automatic point-to-multipoint tunneling (NBMA)
- Discover enterprise network exit routers:
  - default routes through border routers on provider networks
  - more-specific routes through border routers on peer networks
  - Secure Redirection
- Router-to-router tunneling
- Only border routers are modified
- Version 2 of ISATAP

How VET Works



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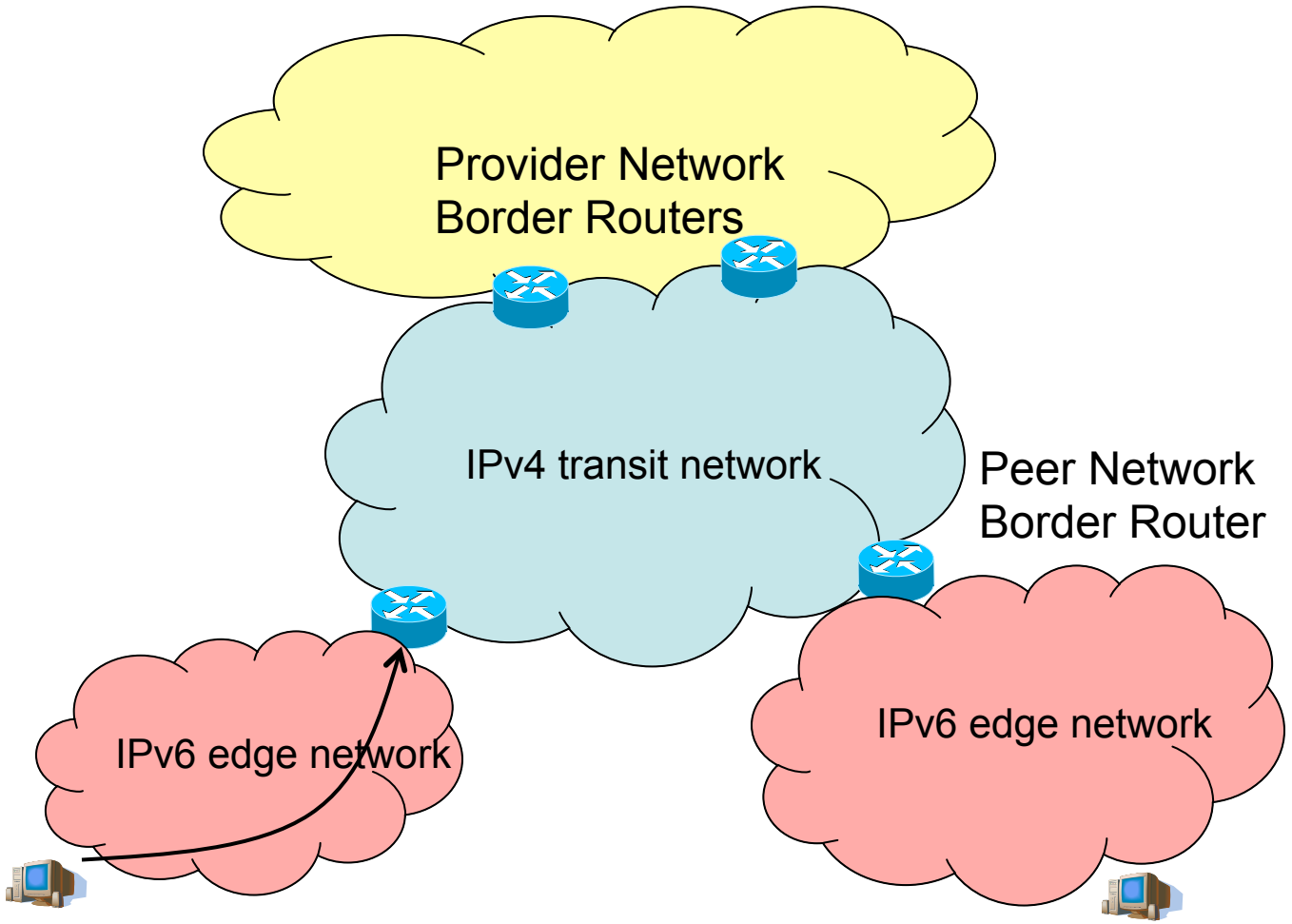

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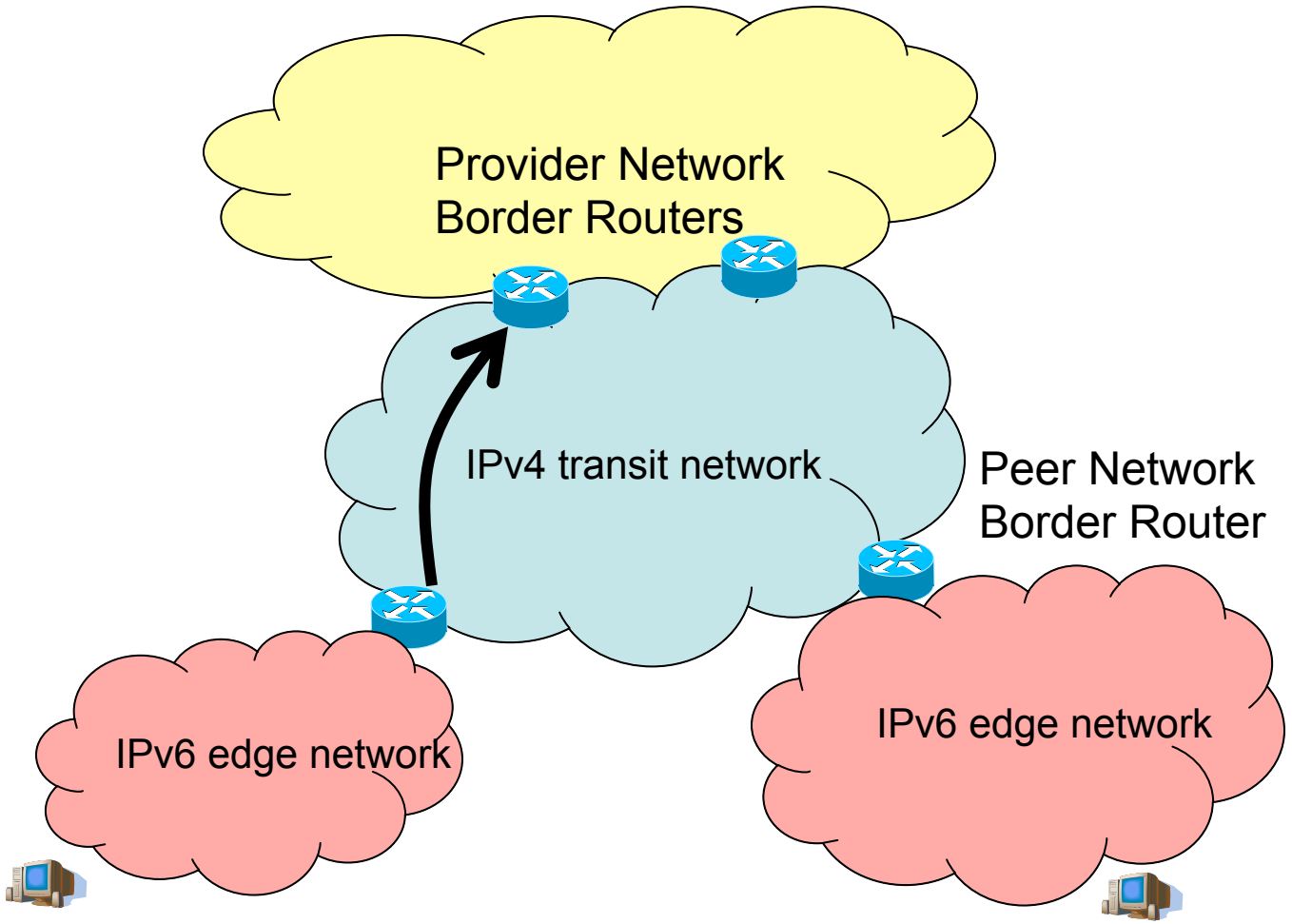

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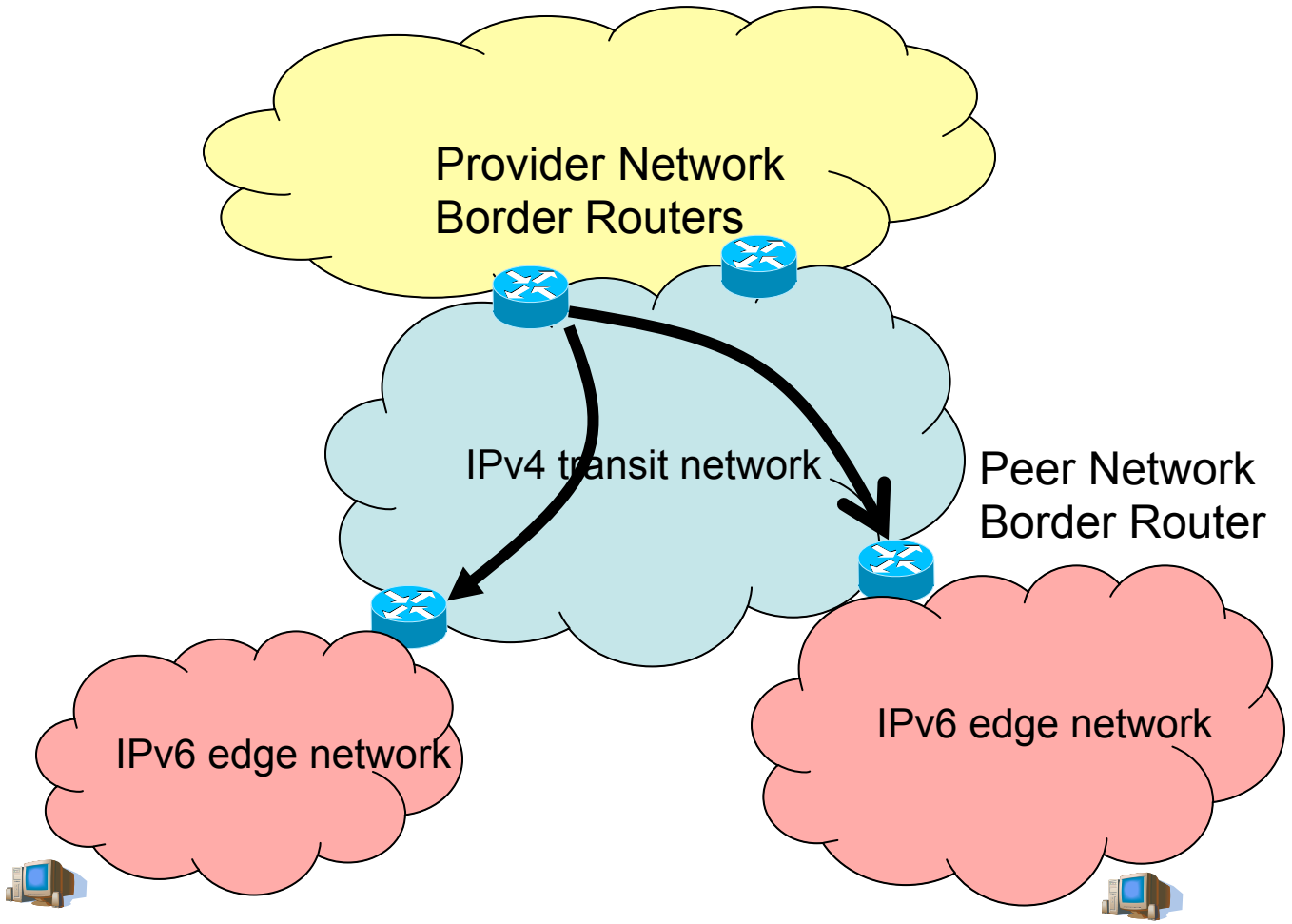

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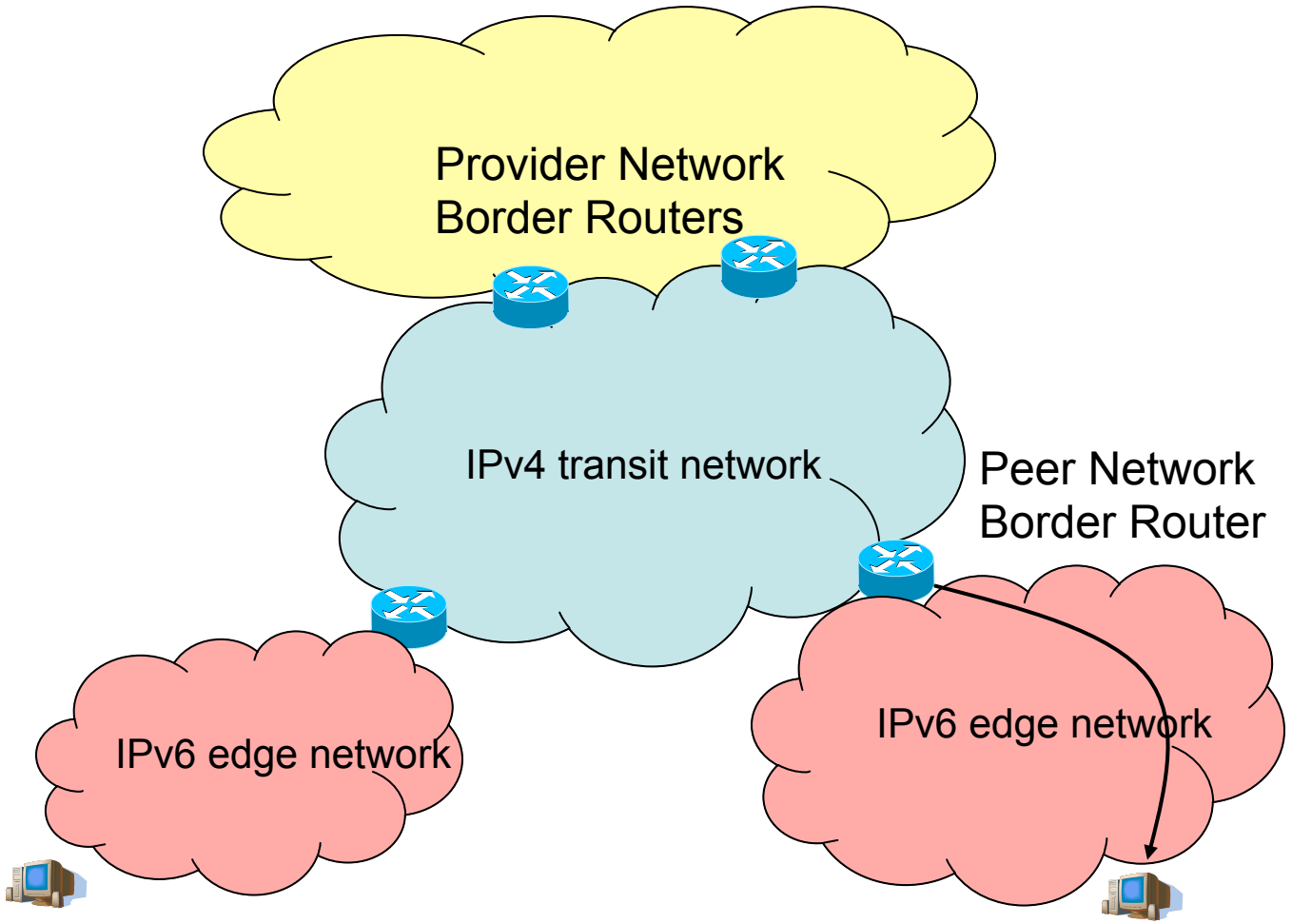

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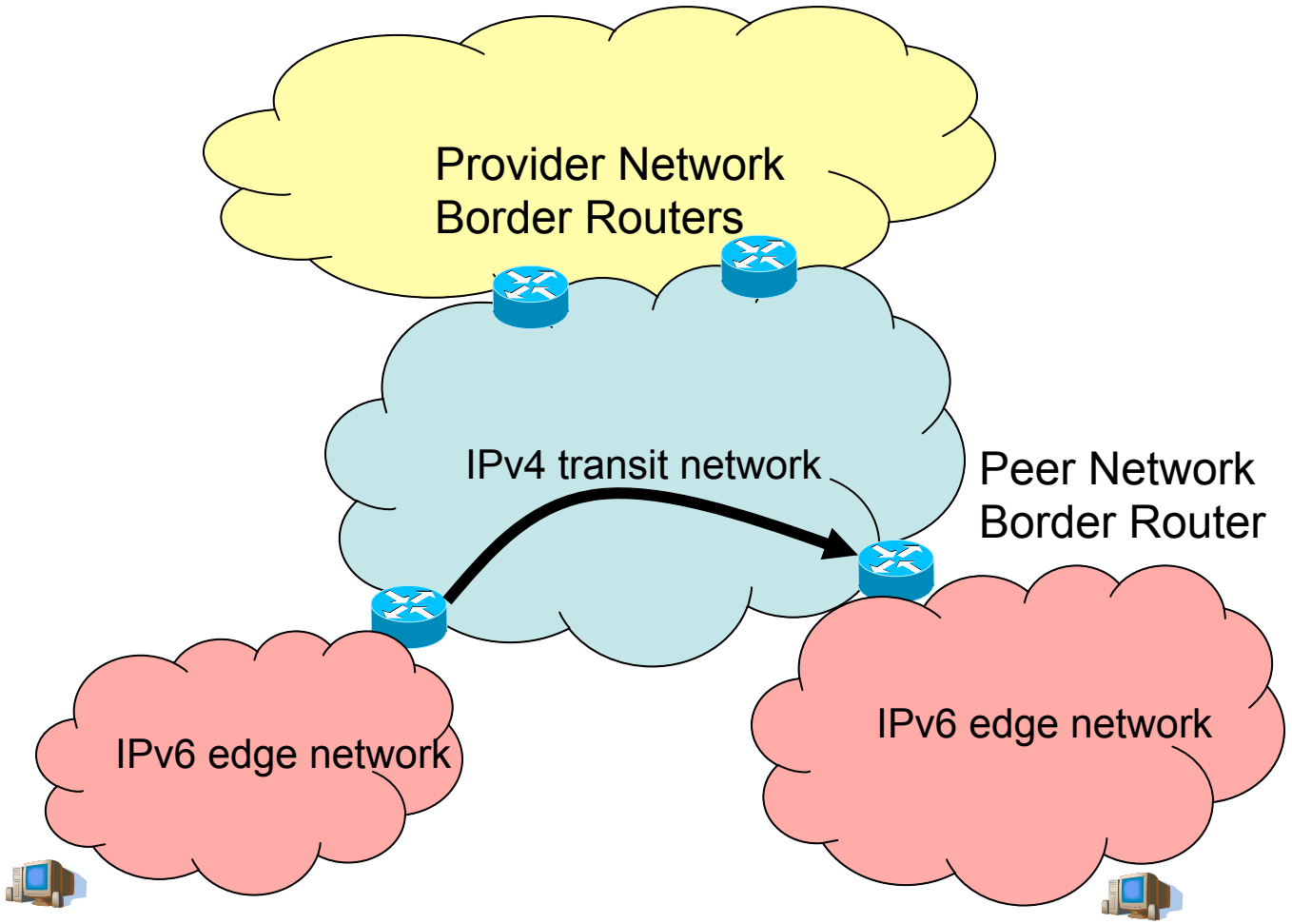

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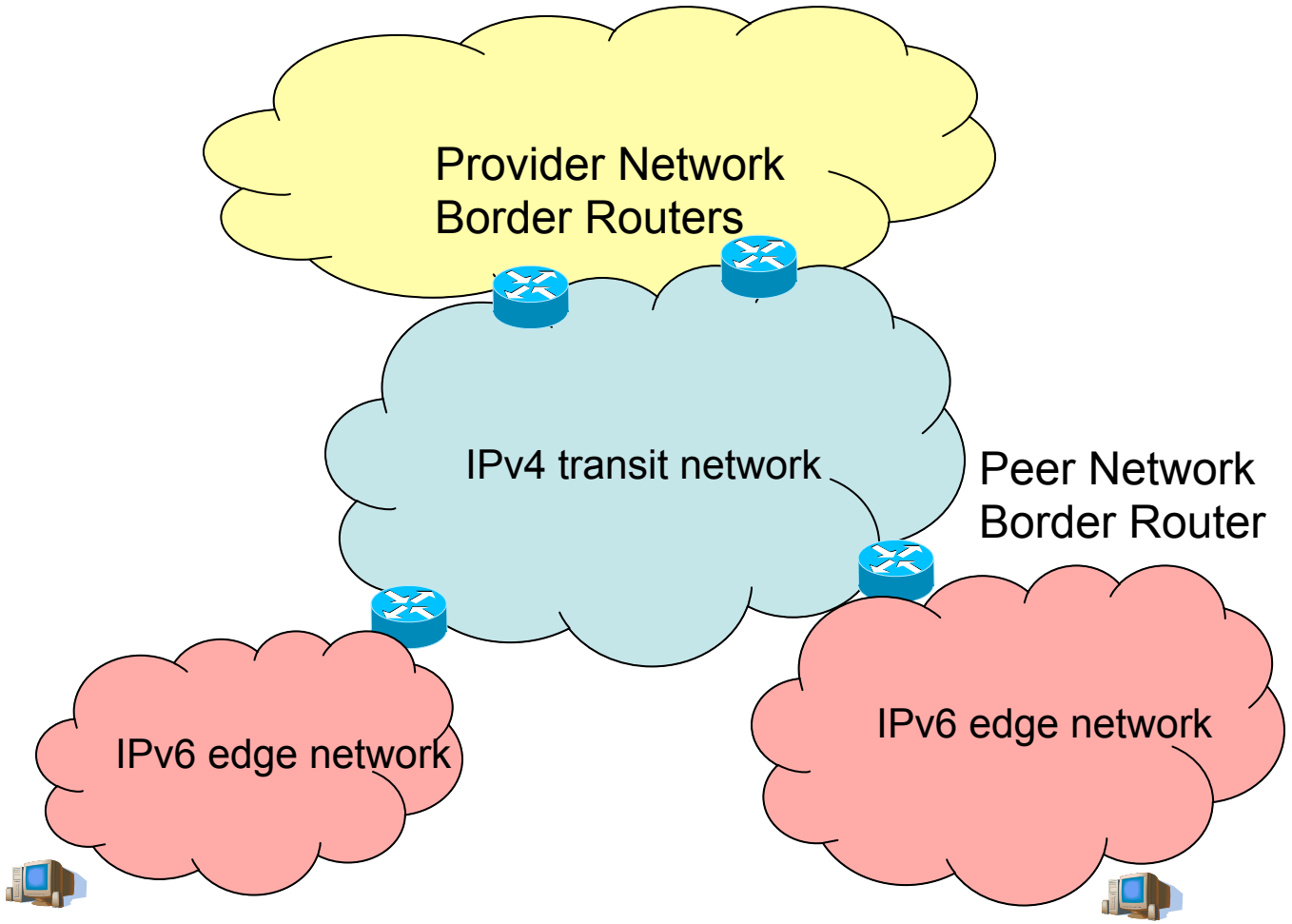
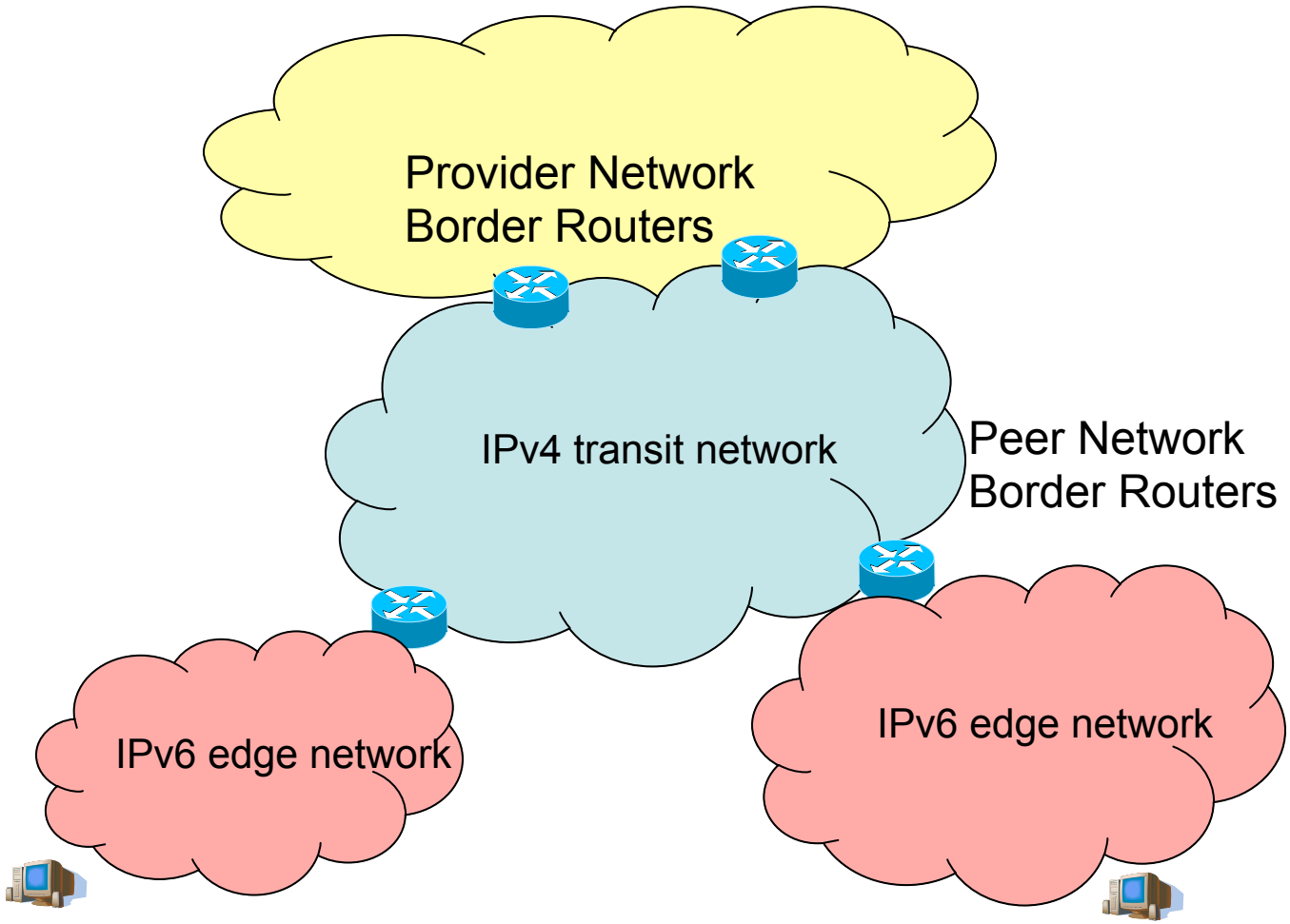


Subnetwork Encapsulation and Adaptation Layer (SEAL) – RFC5320

- tunnel encapsulation overhead reduces path MTU
- avoid path MTU discovery if possible due to unnecessary packet loss; black-holing due to ICMP filtering
- have the tunnel do transparent link-layer adaptation
- tunnel ingress discovers MRU of tunnel egress
- end result is 1500 and larger gets through

- SEAL supports synchronization between tunnel endpoints, so off-path DOS attacks are prevented
- SEAL also supports “semi-stateless” mode with no fragmentation/reassembly but robust MTU discovery

How SEAL Works



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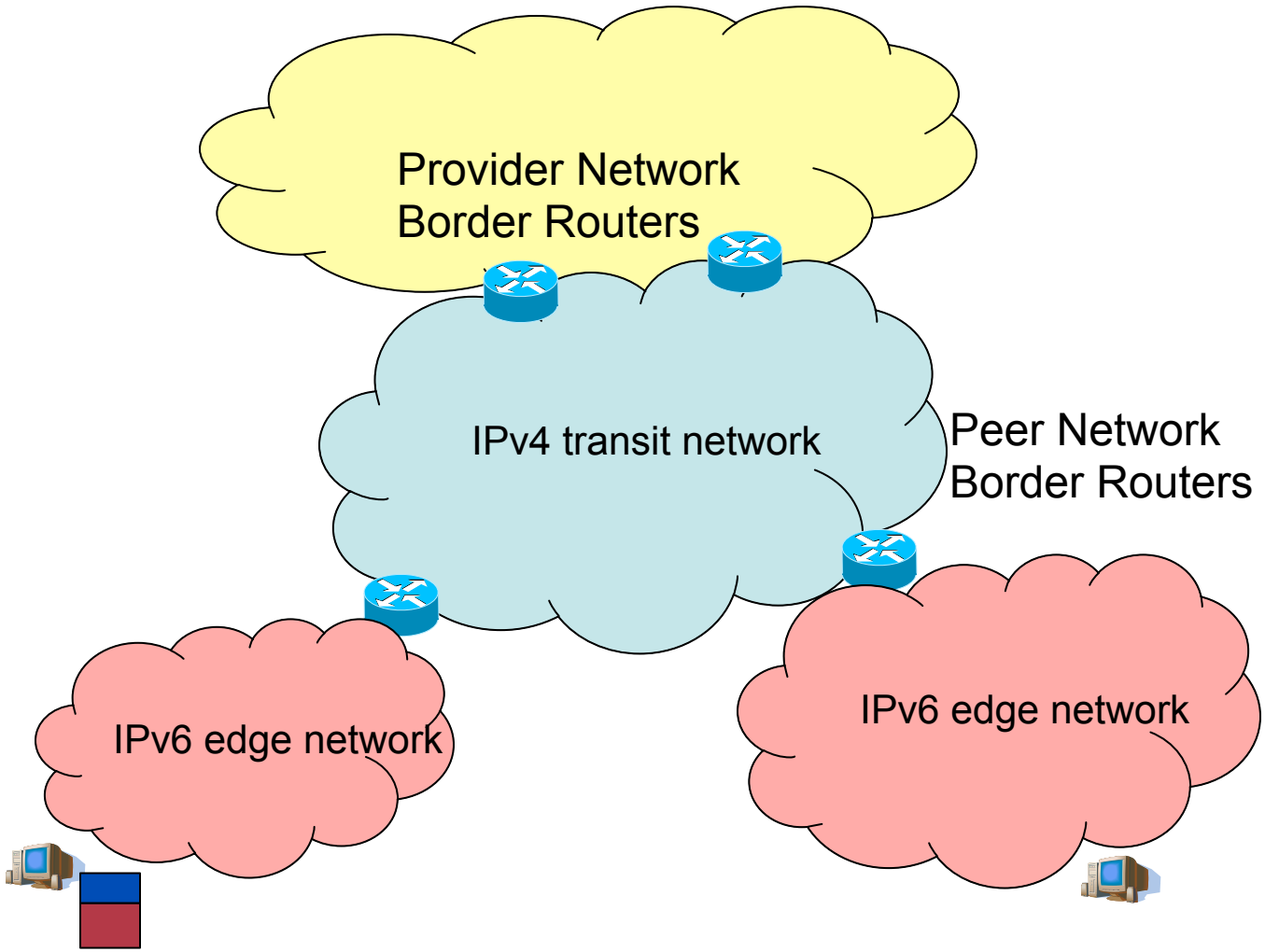

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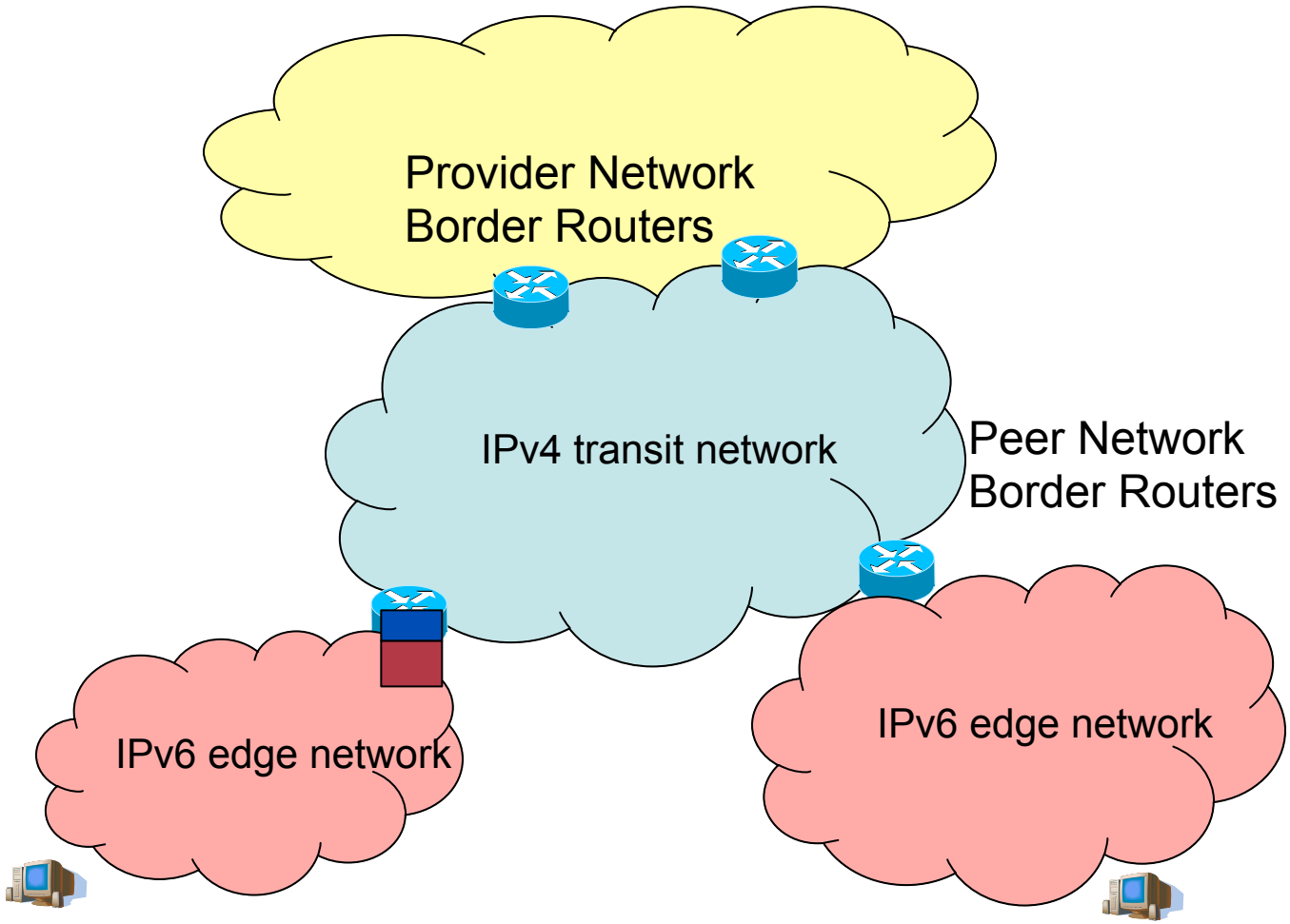

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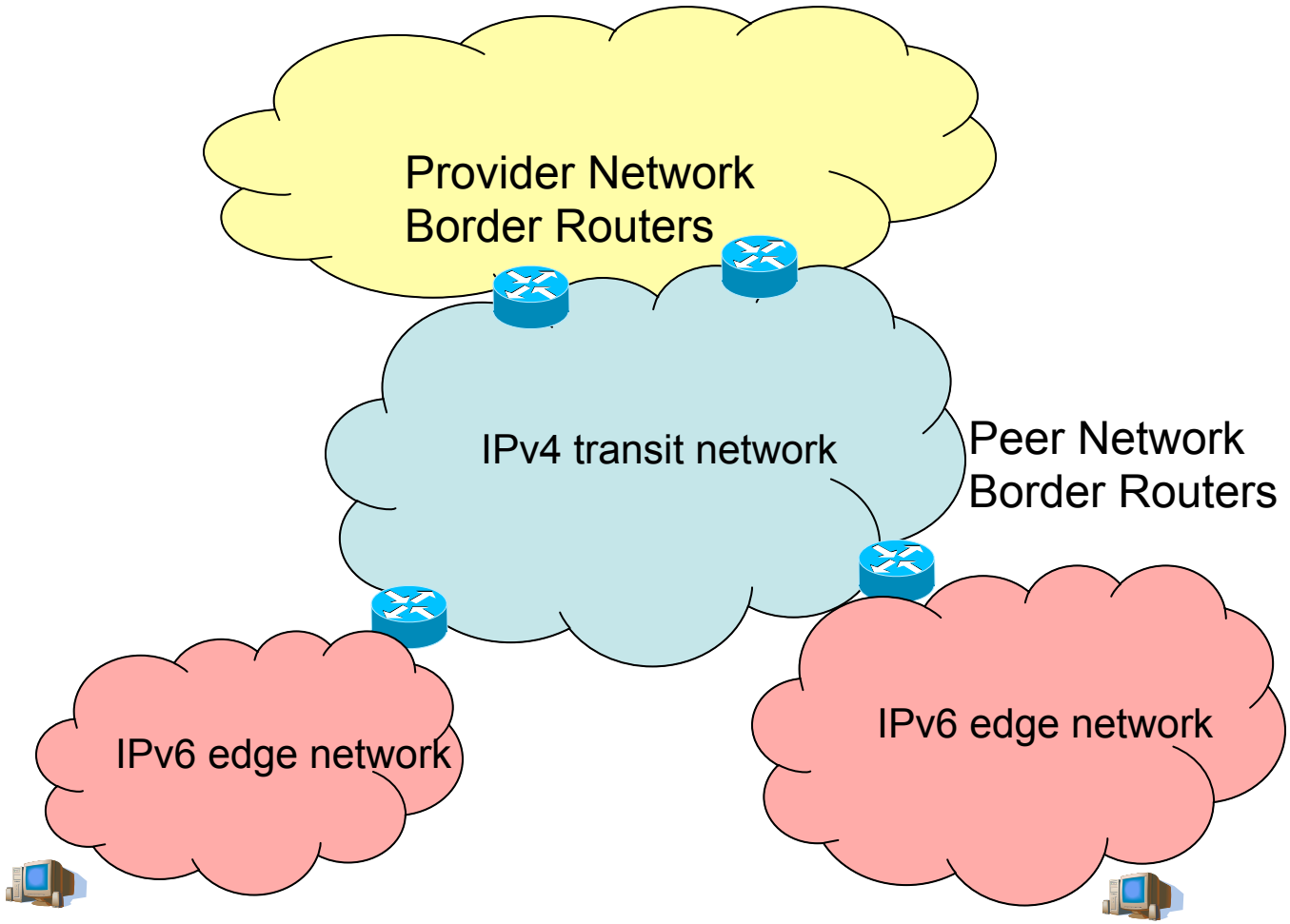

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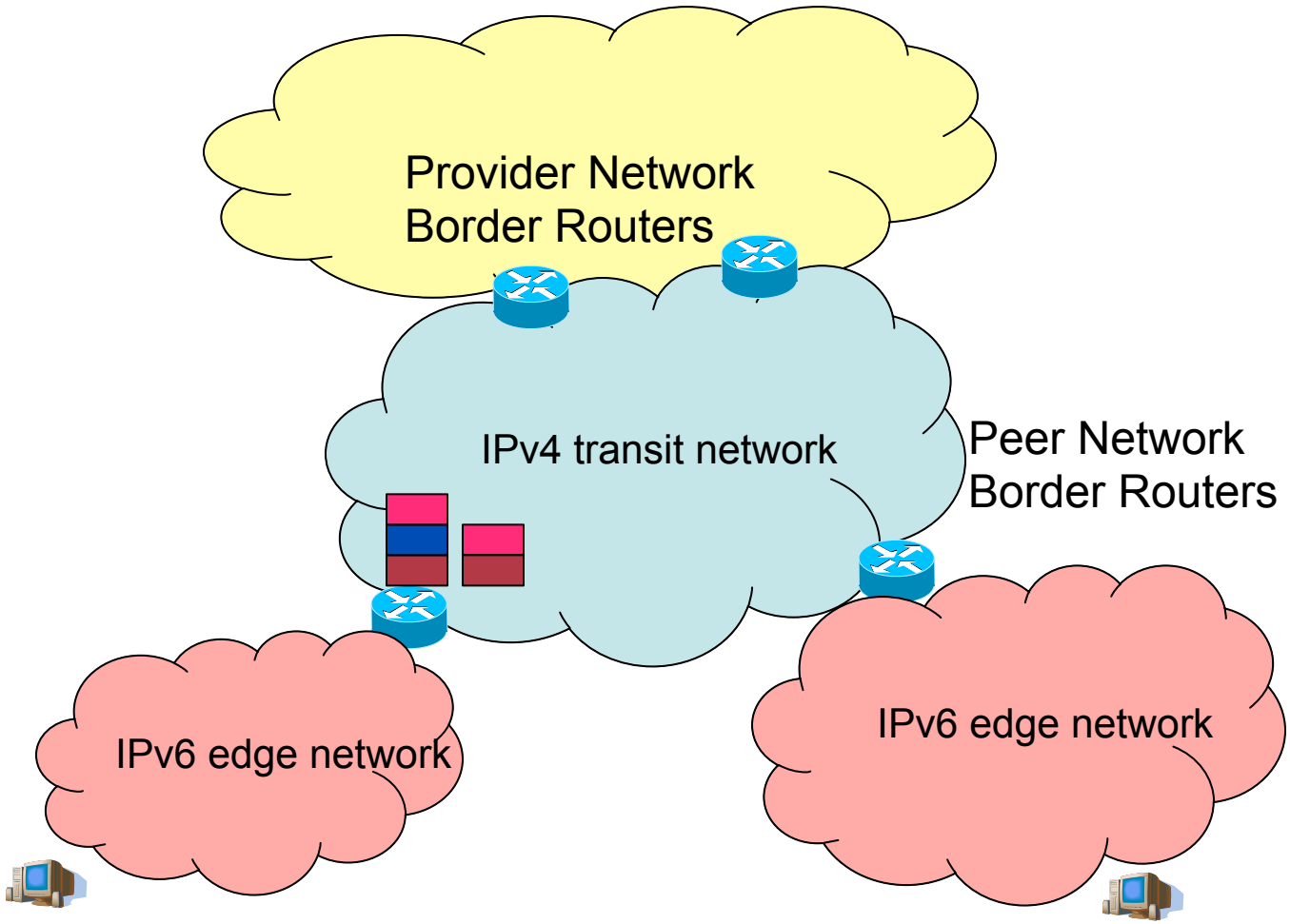

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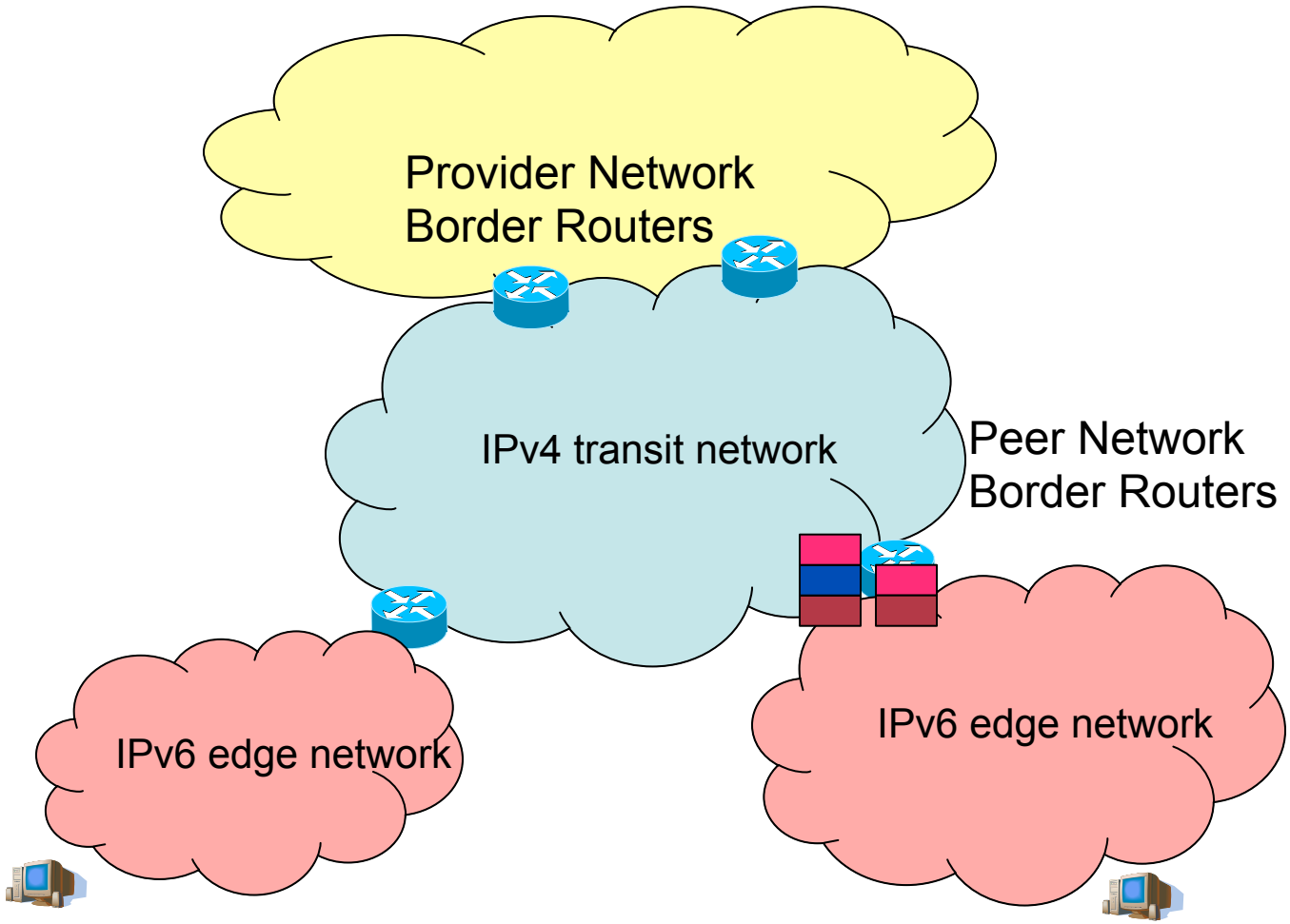

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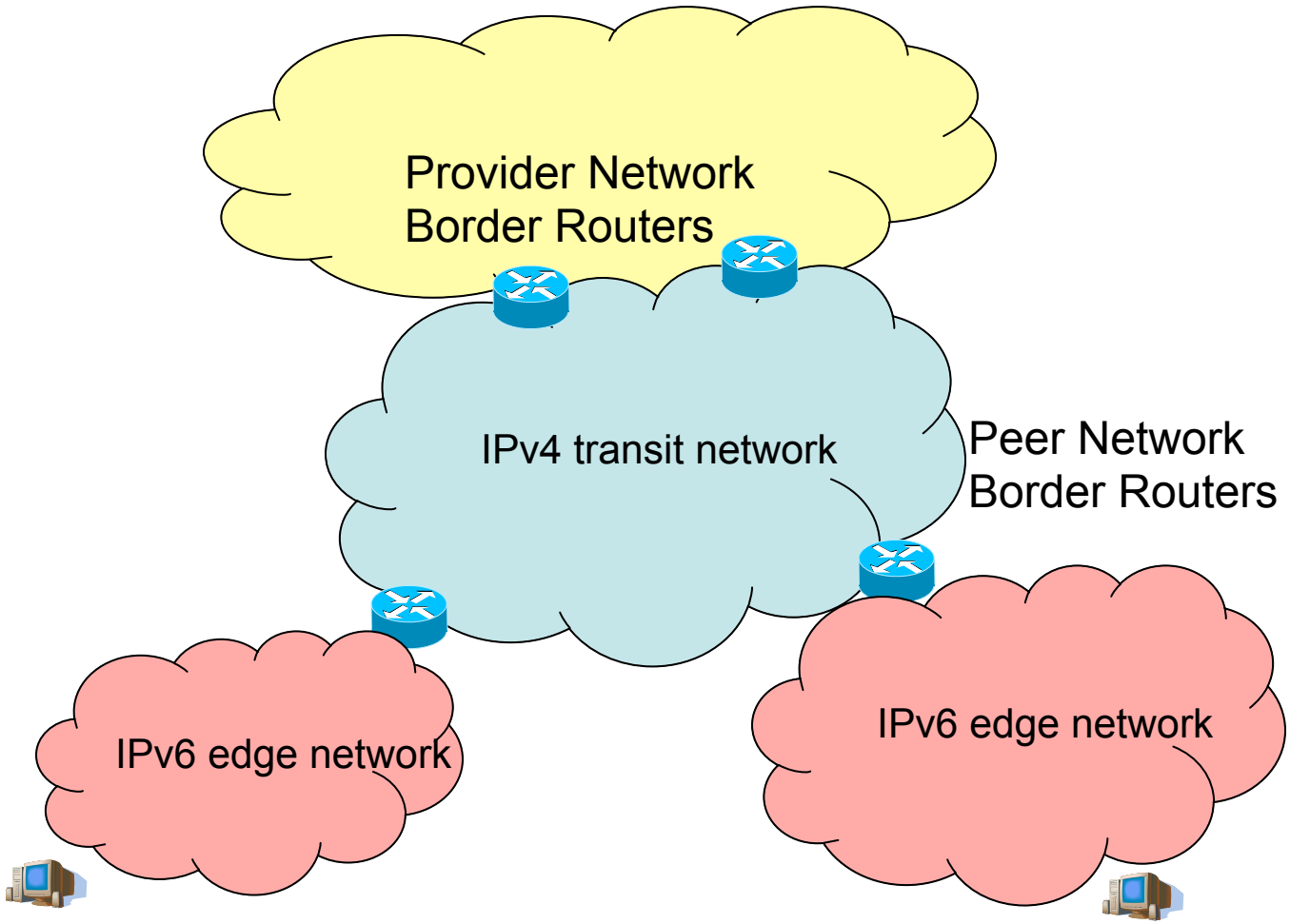

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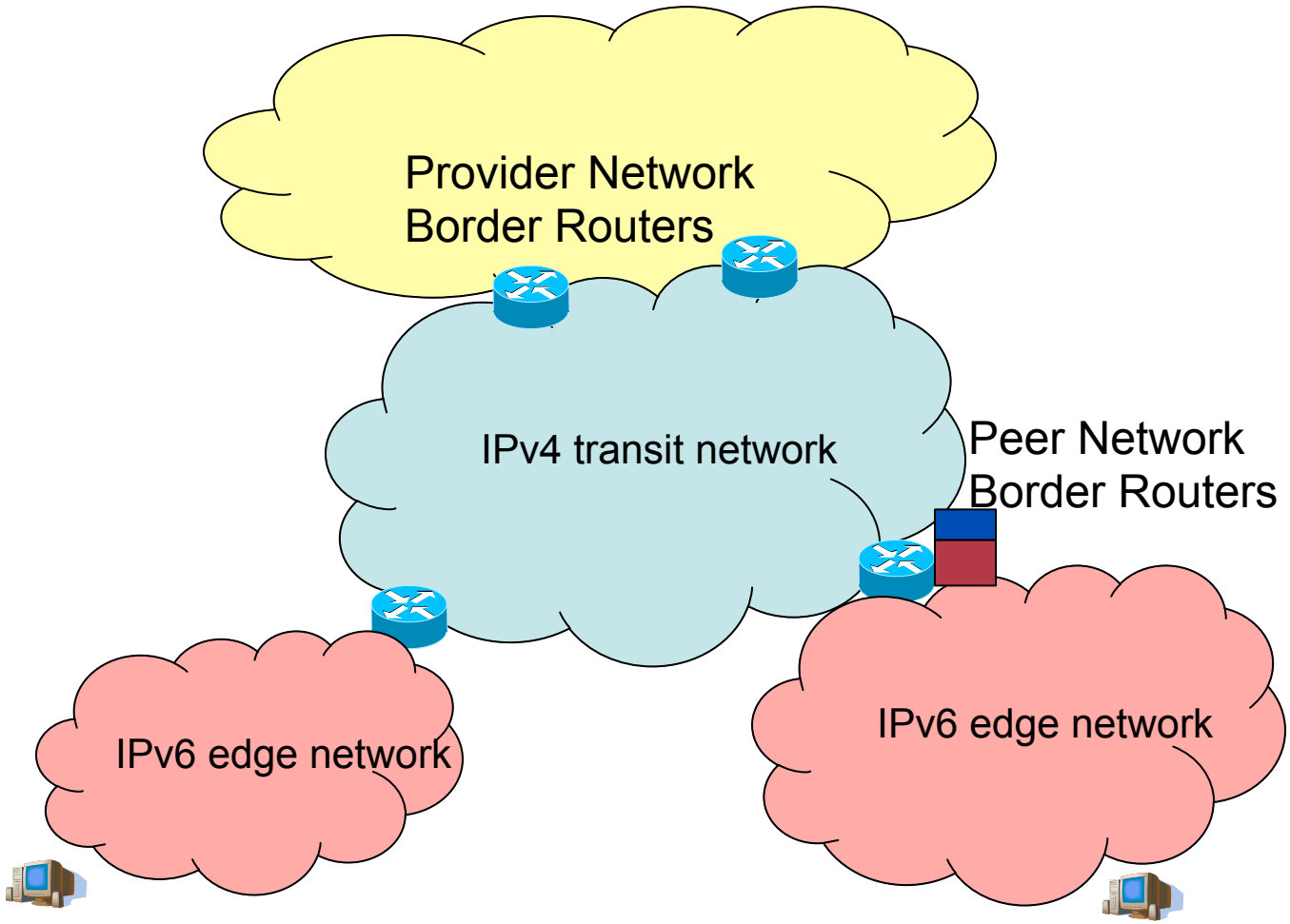

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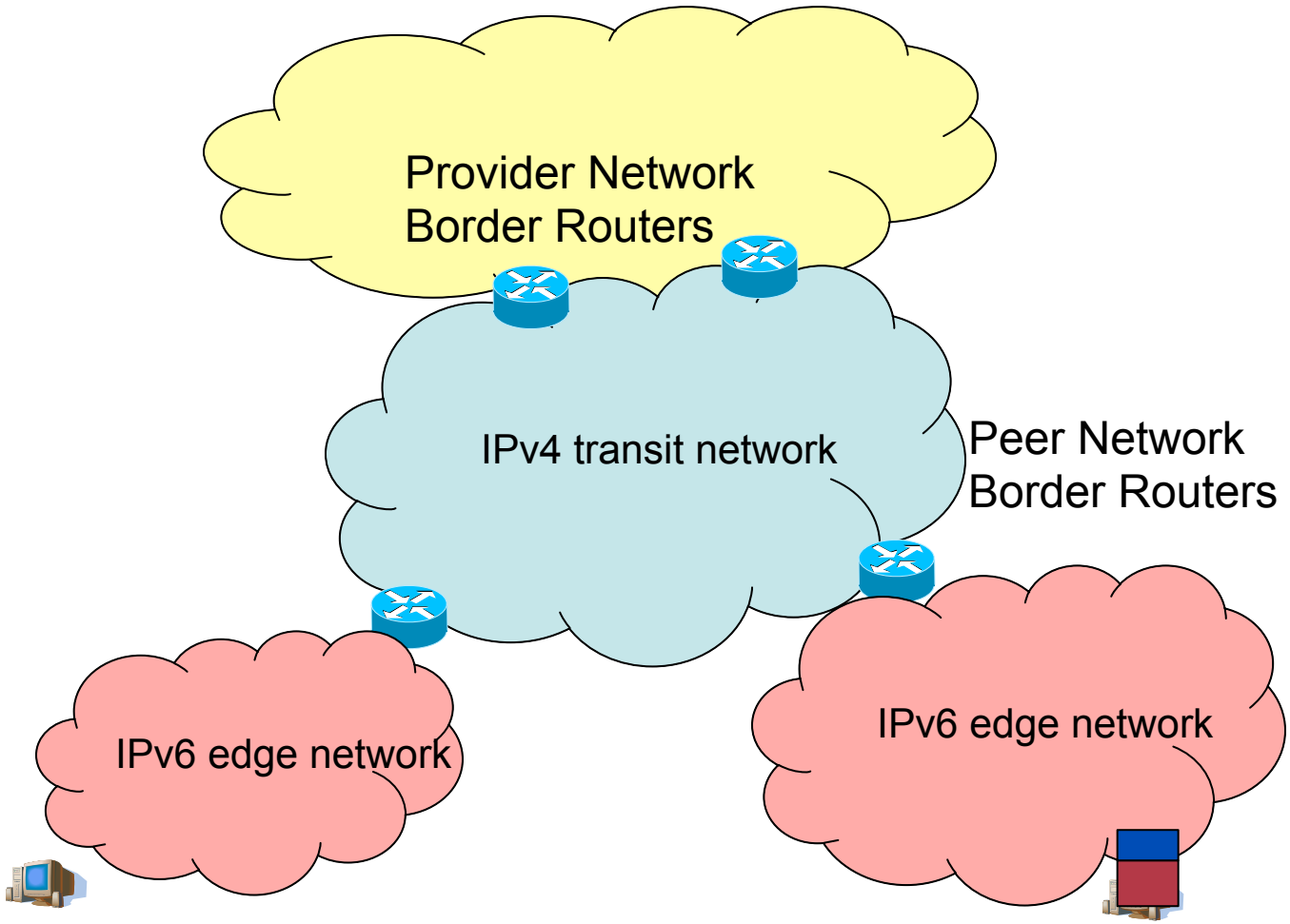


The Internet Routing Overlay Network (IRON)

- RANGER overlay network over the Internet DFZ
- RLOC addresses in underlying network; EID addresses in overlay
- IRON router RIB has EID Virtual Prefix (VP)-to-RLOC mappings
- RIB includes manageable number of coarse-grained EID VPs (e.g., 100k ::/32's)
- More-specific EID prefixes added to router FIBs on-demand
- More-specific EIDs added only on routers that need them

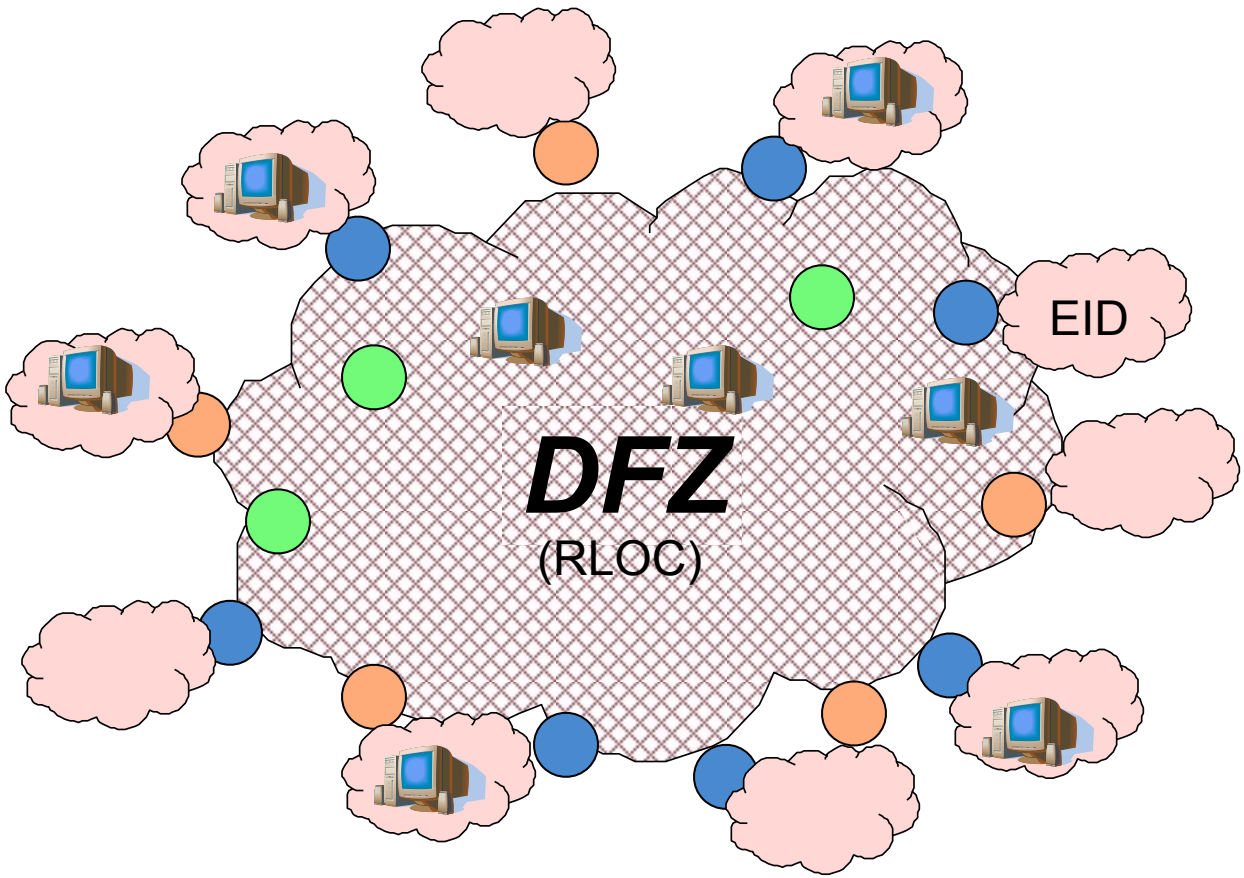
➢ **RIB loaded from centrally-managed file; no dynamic routing protocol needed**

➢ **Excellent scaling properties**

IRON Routers

- IRON Routers (IRs) are tunnel endpoint routers
- IRs form the borders of the IRON; encapsulate inner EID-addressed packets in outer RLOC-addressed headers
- Different IR roles:
  - IR(VP) – an IRON router that holds a Virtual Prefix
  - IR(EID) – an IRON router that connects an EID-based enterprise network to the IRON
  - IR(GW) – an IRON router that relays packets between EID- based endpoints and DFZ-based endpoints
- A single IR can serve multiple roles

The IRON – IRON Routers Connected to the DFZ



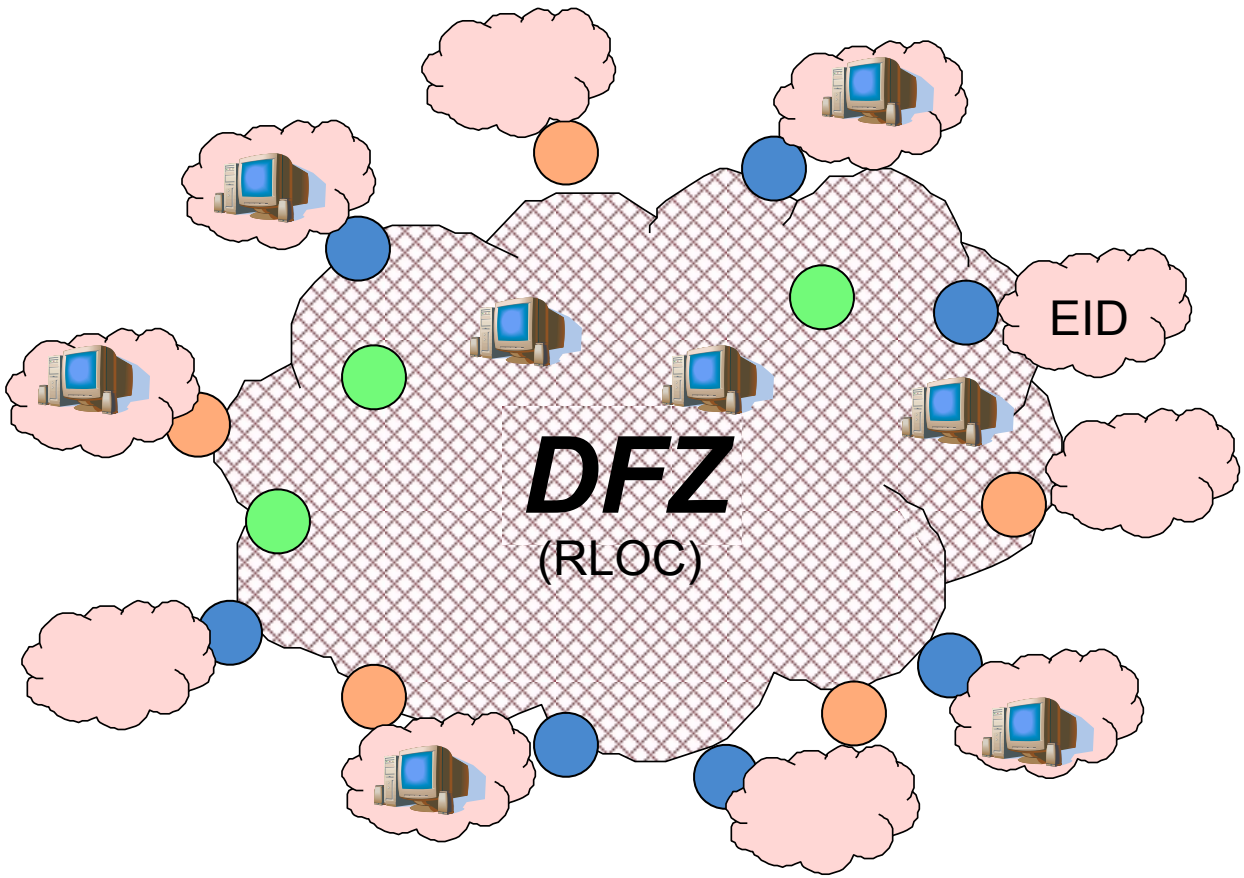
IR(VP):

IR(EID):

IR(DFZ):

Host:

EID End System to EID End System Example



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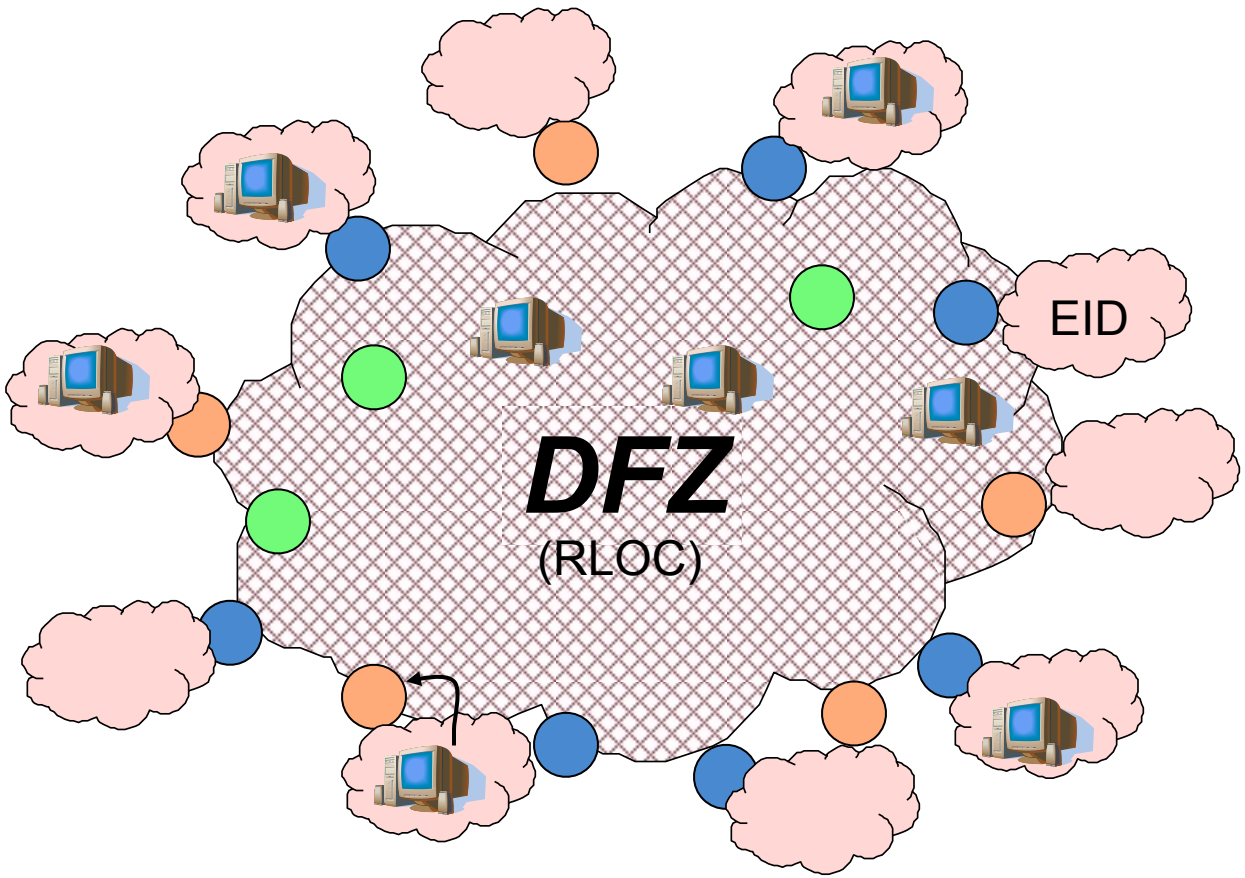

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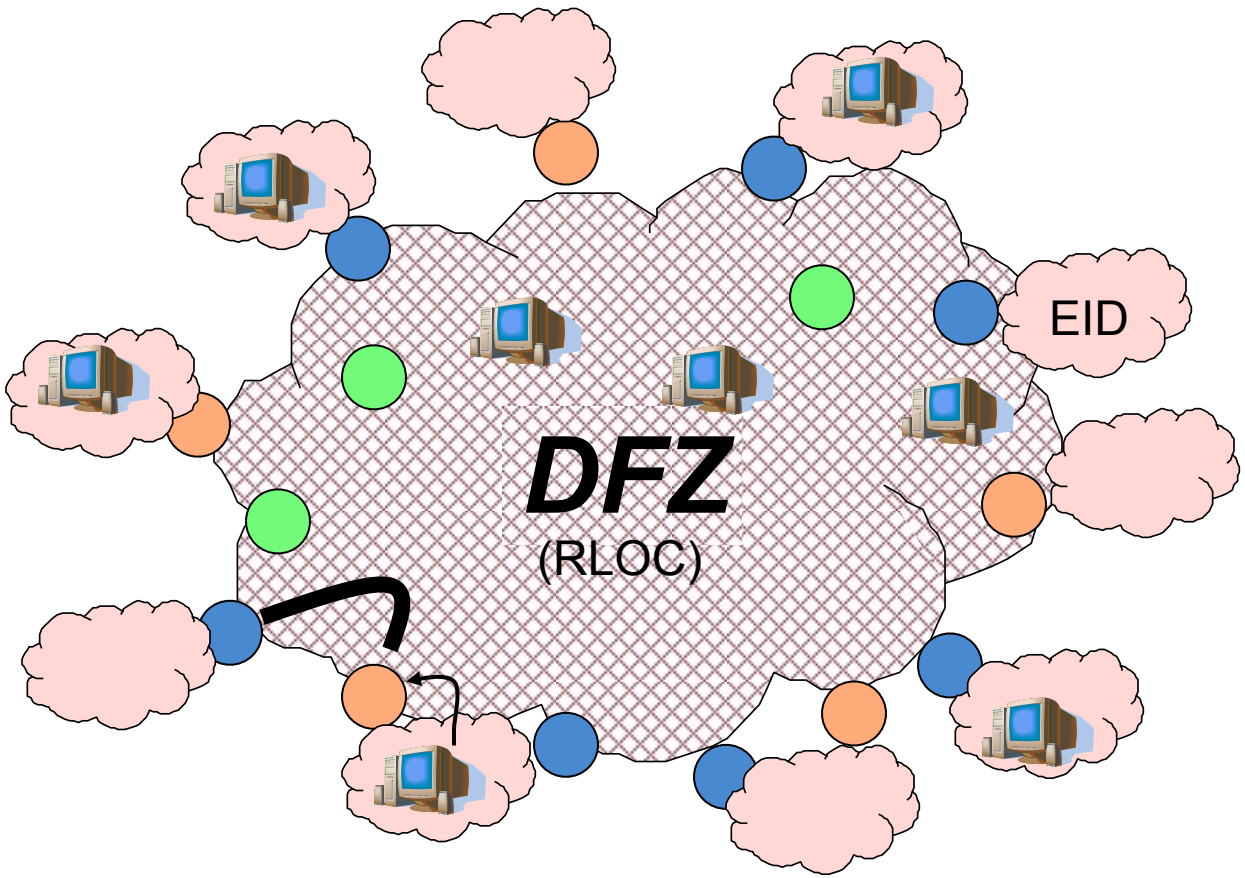

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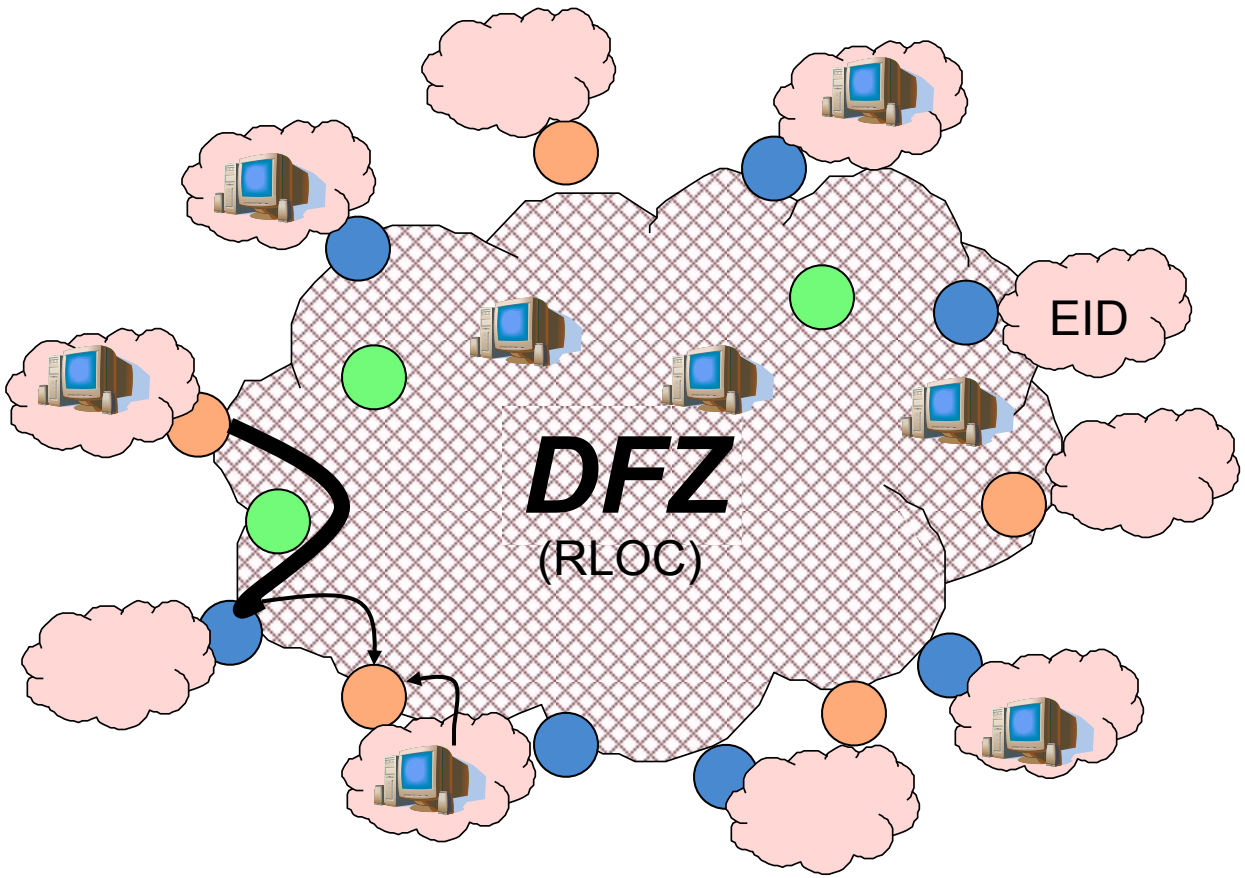

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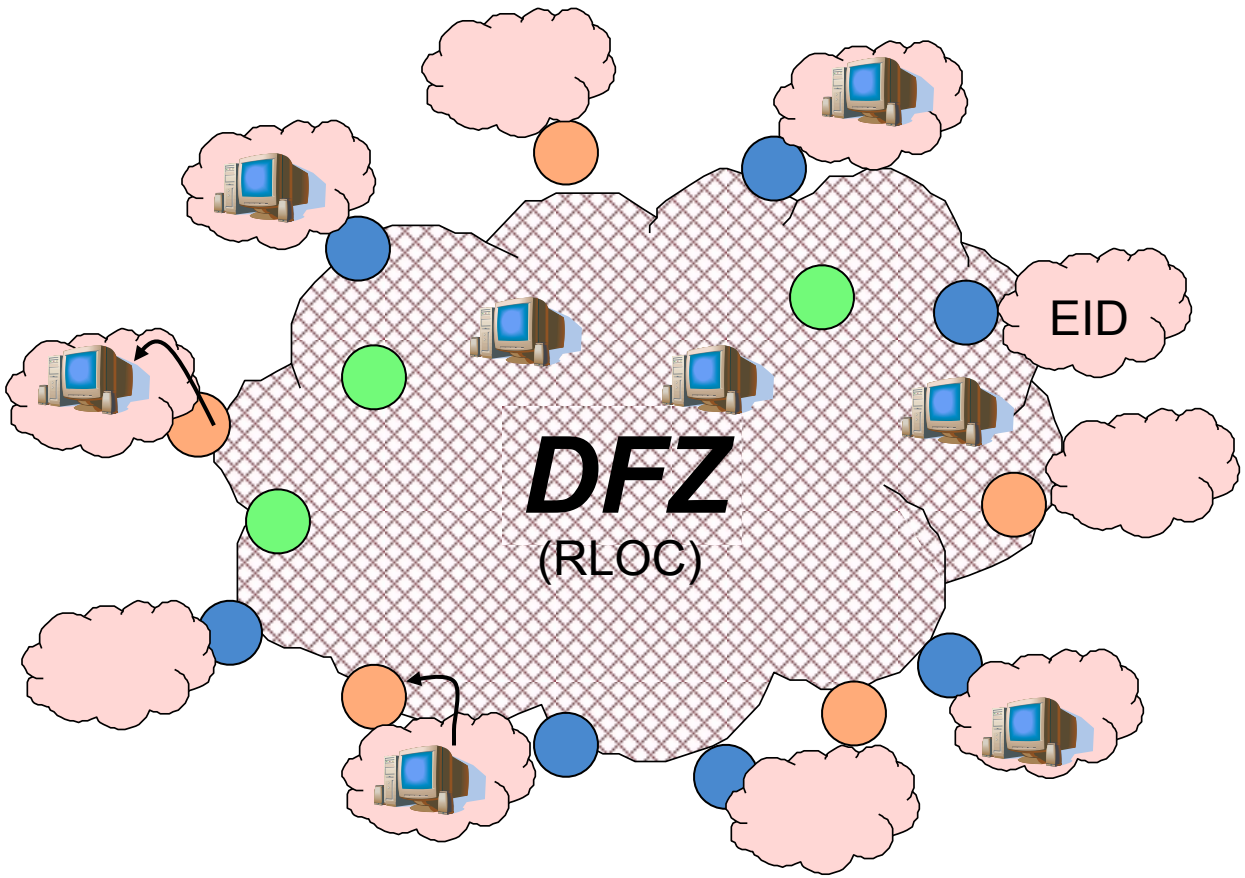

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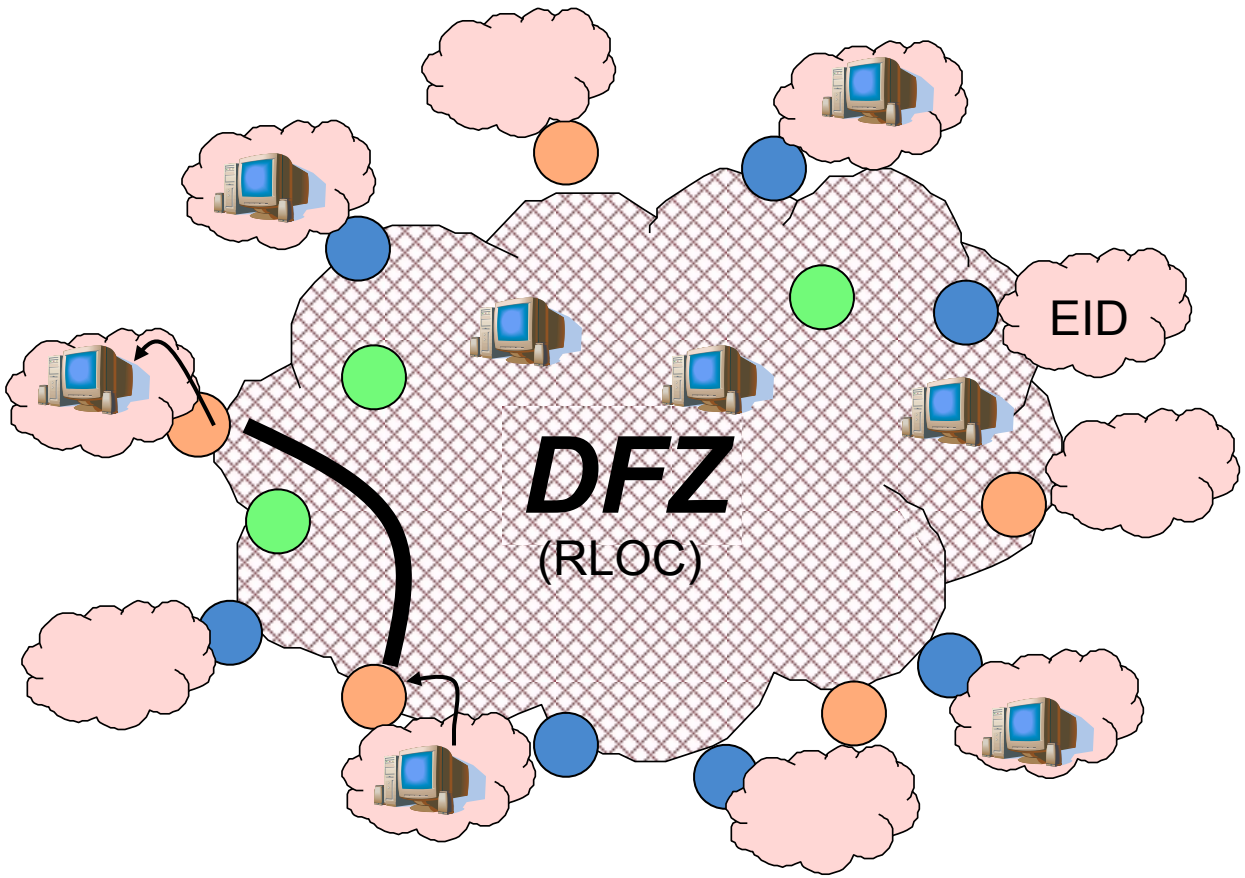

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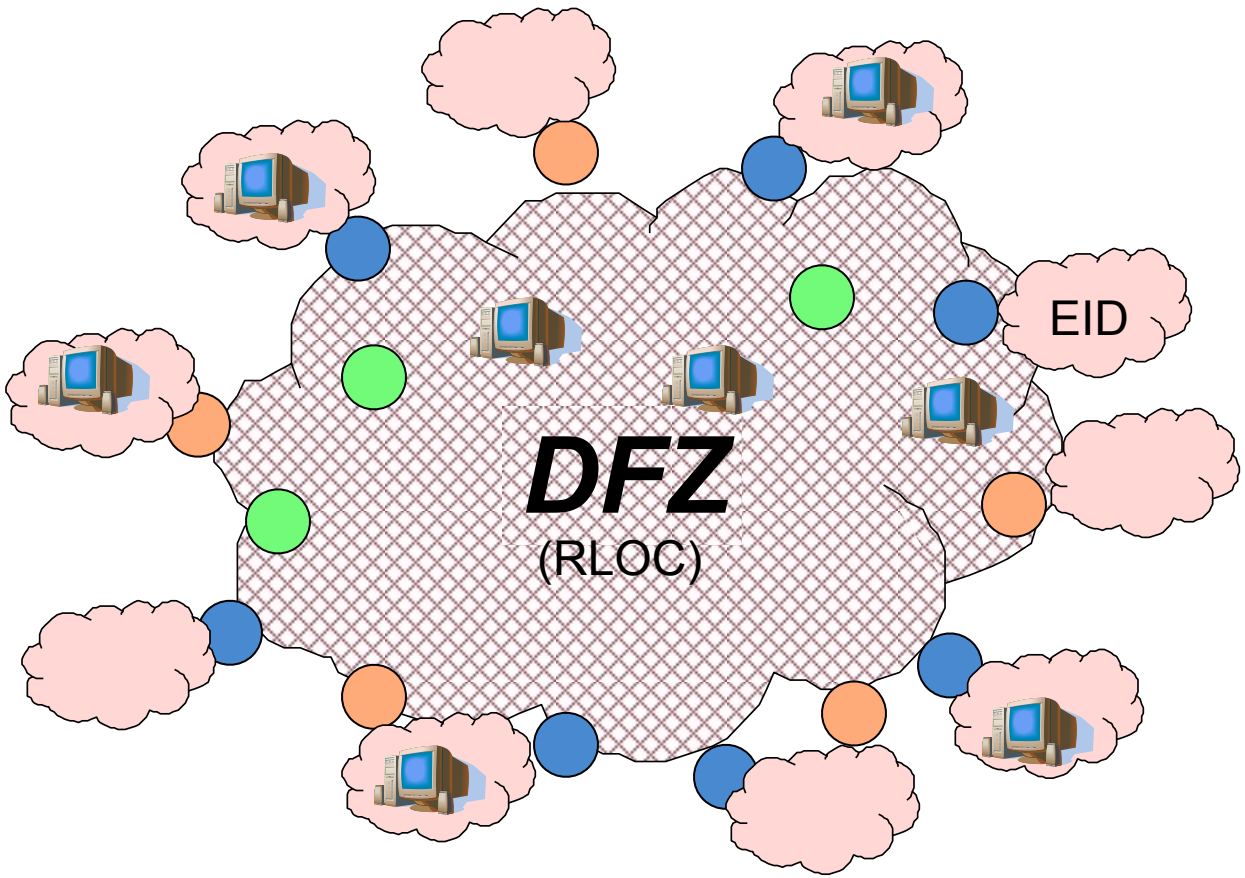

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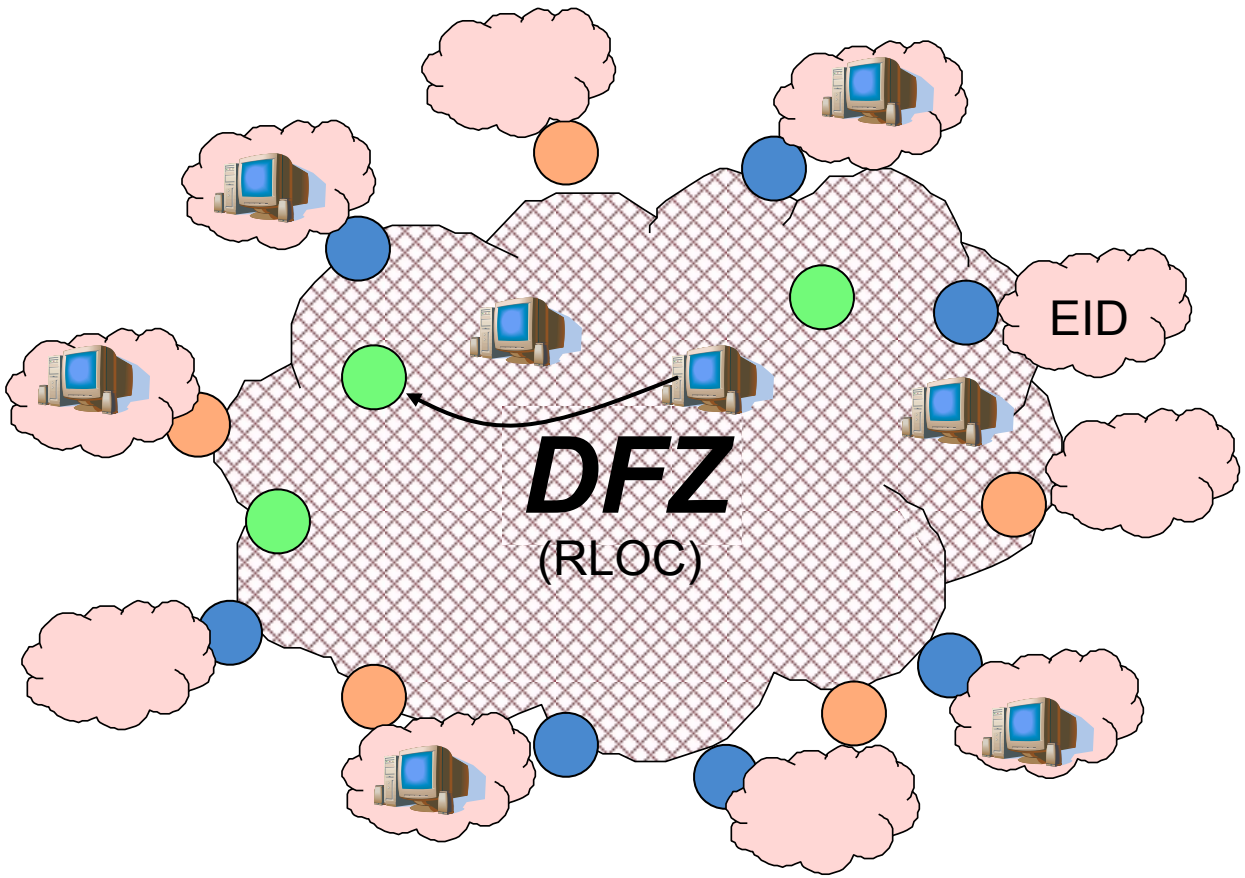

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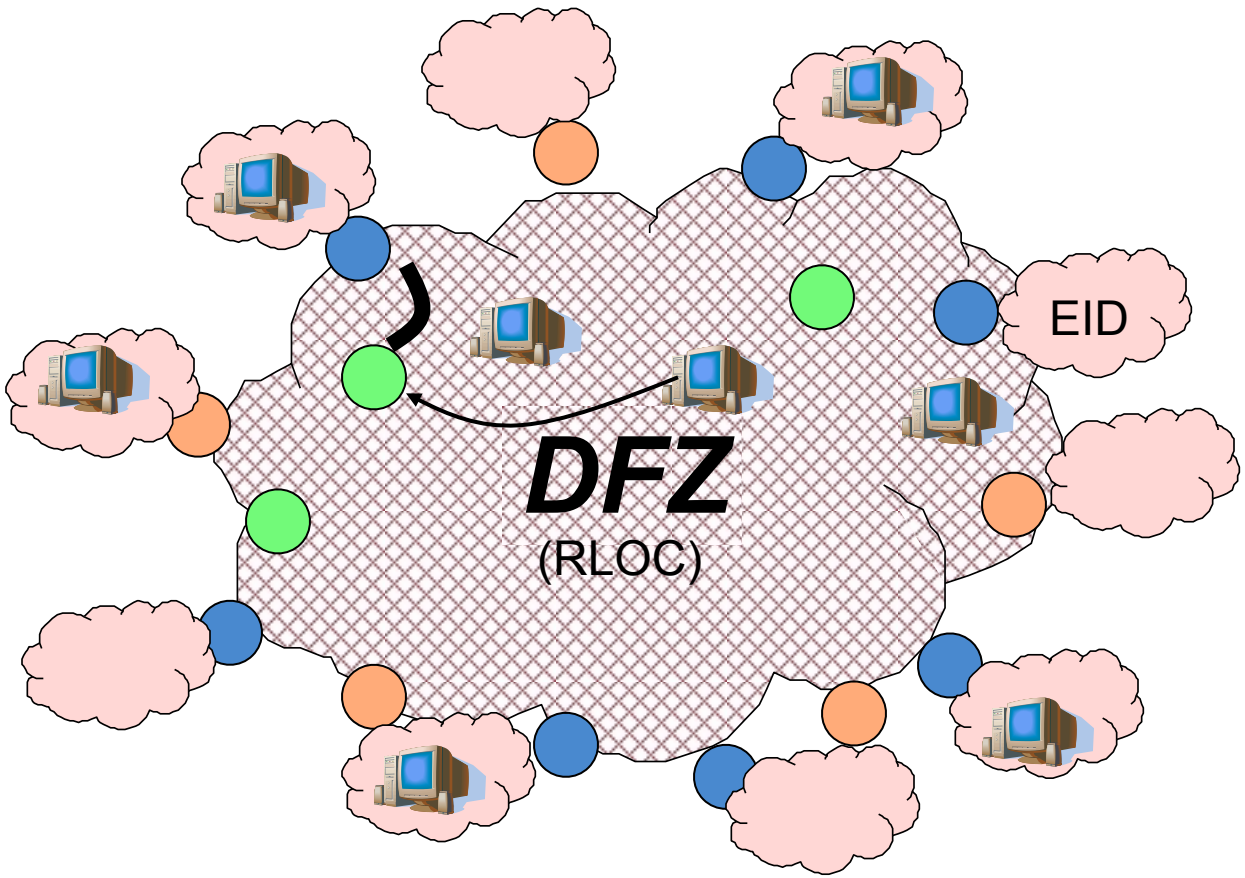

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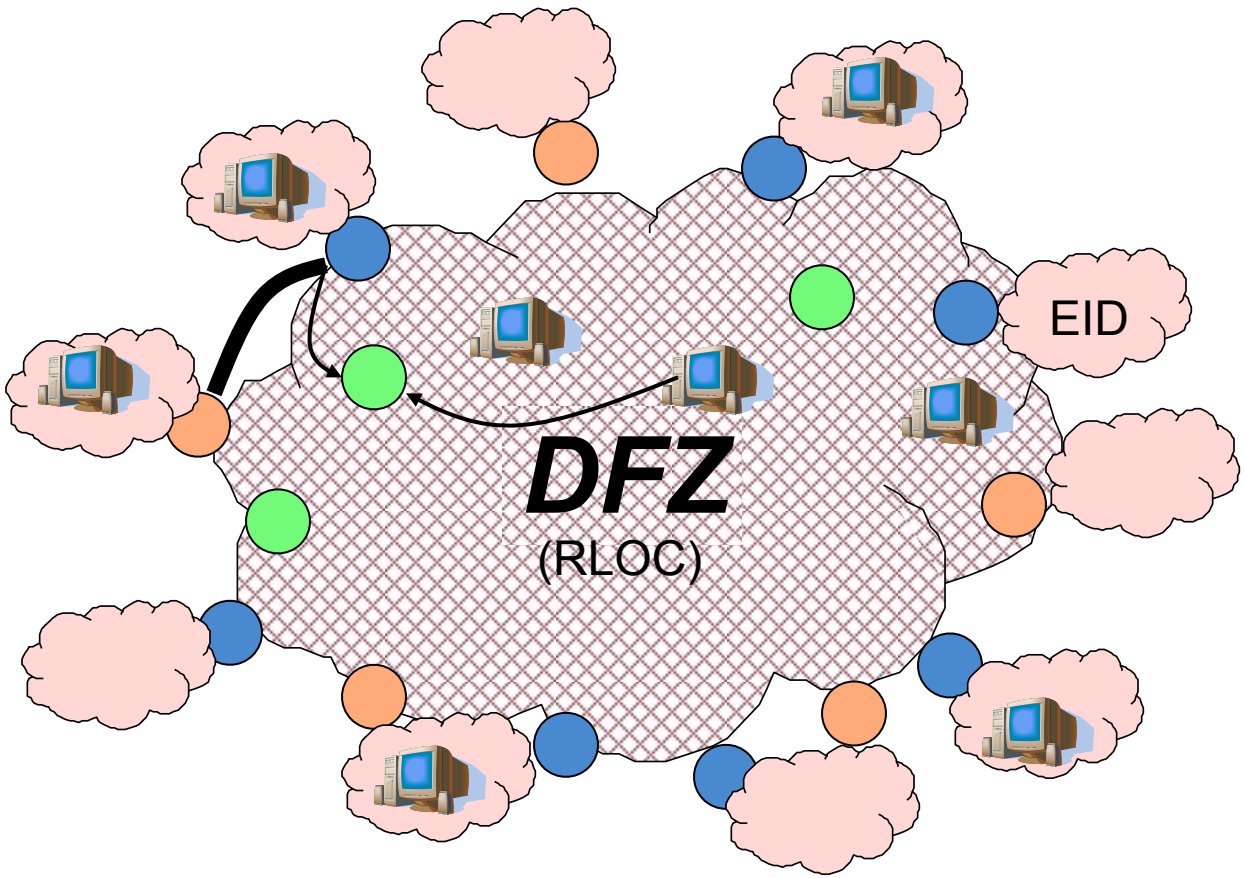

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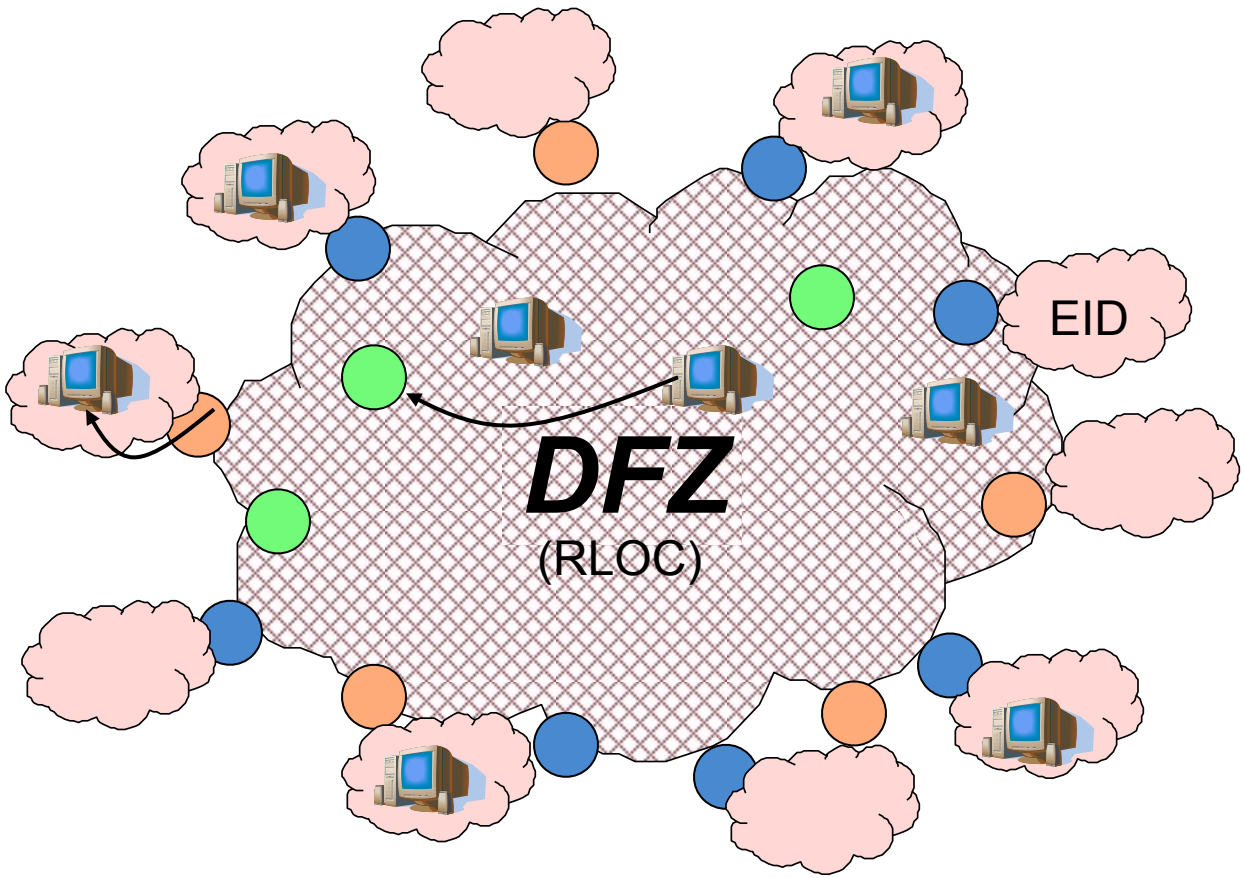

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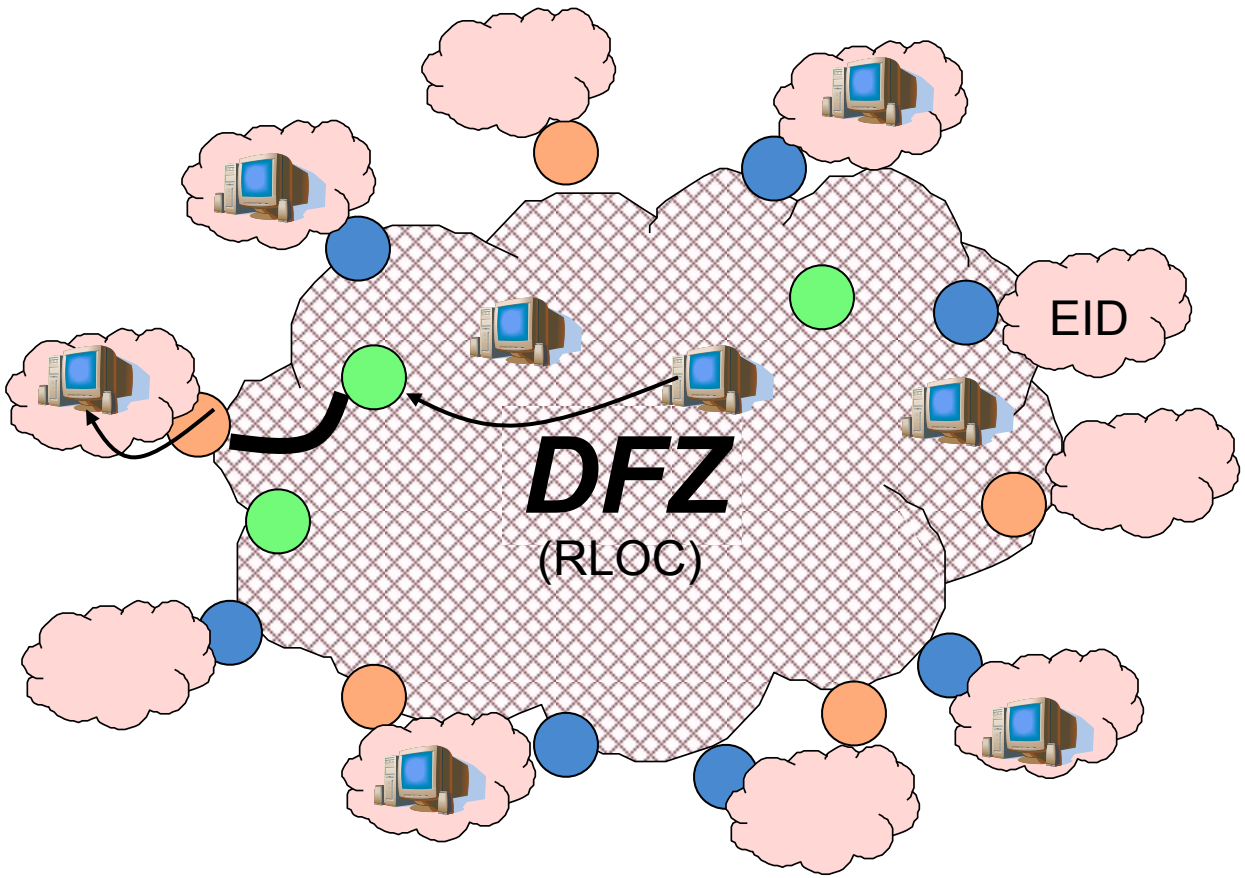

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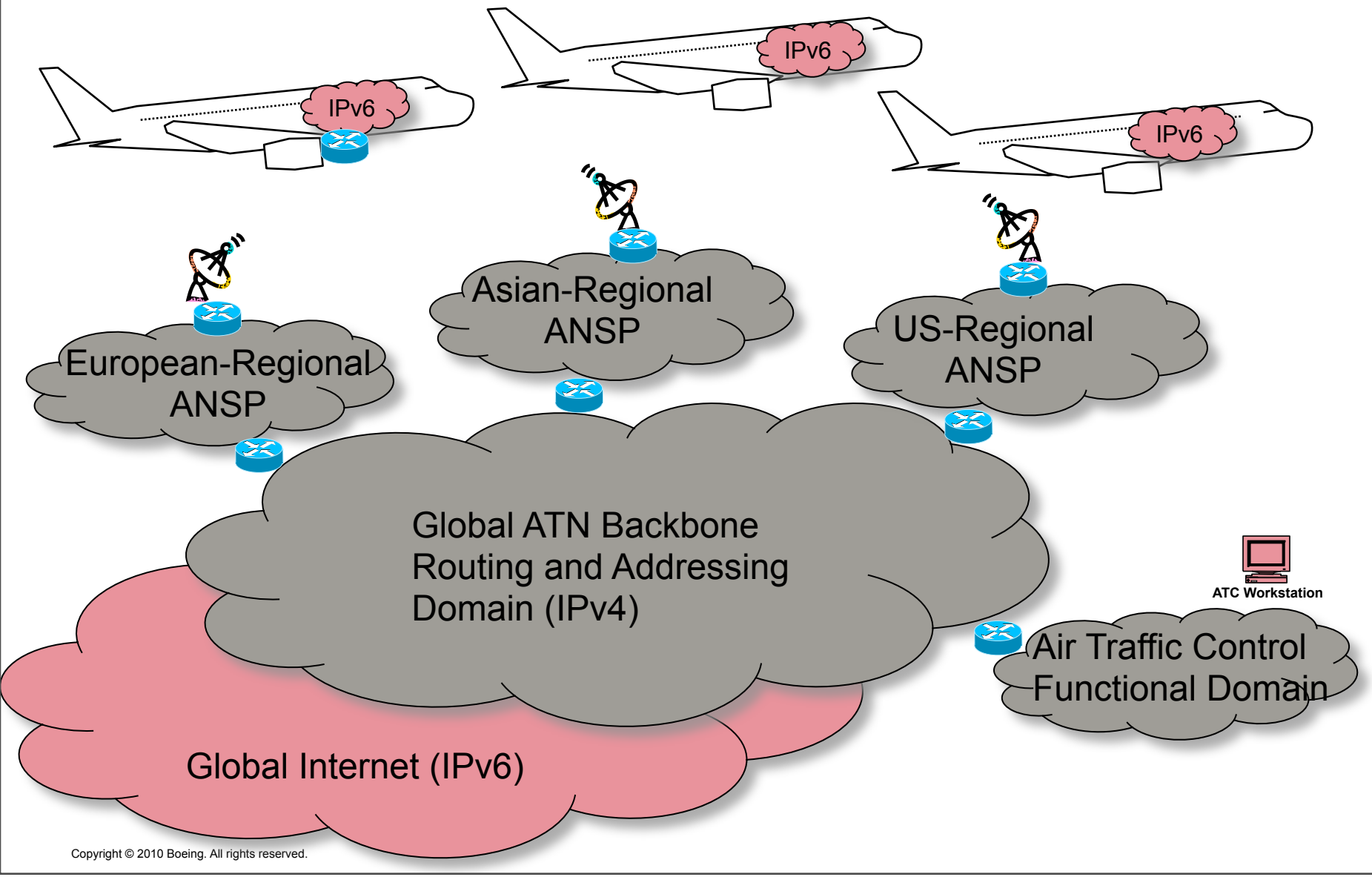
IRON Scaling

- **VPs:**
  - **Assume O(100K) VPs (e.g., ::/32s)**
  - **Assume IRON RIB changes only very rarely**
  - **RIB size is 100K entries – fully populated in each IR**
- **EIDs:**
  - **Assume O(100K) EID prefixes per VP**
  - **Yields 10^{10} EID prefixes in the IRON**
  - **Populated to IR FIBs on-demand**
- **RIB Size: 100K VPs in each IR**
- **FIB Size: 100K EID prefixes + 100K VPs = 200K**

Civil Aviation Example



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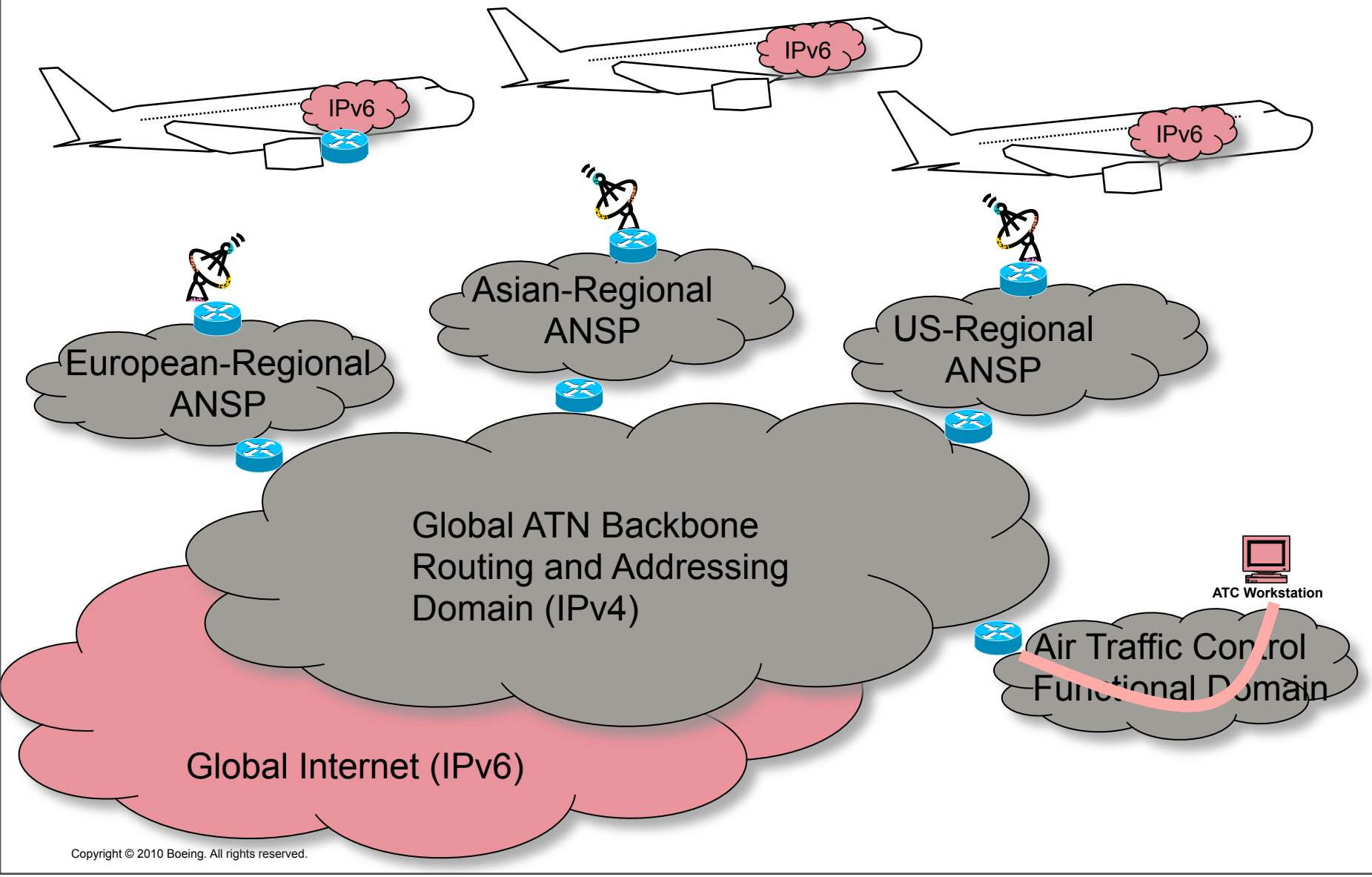

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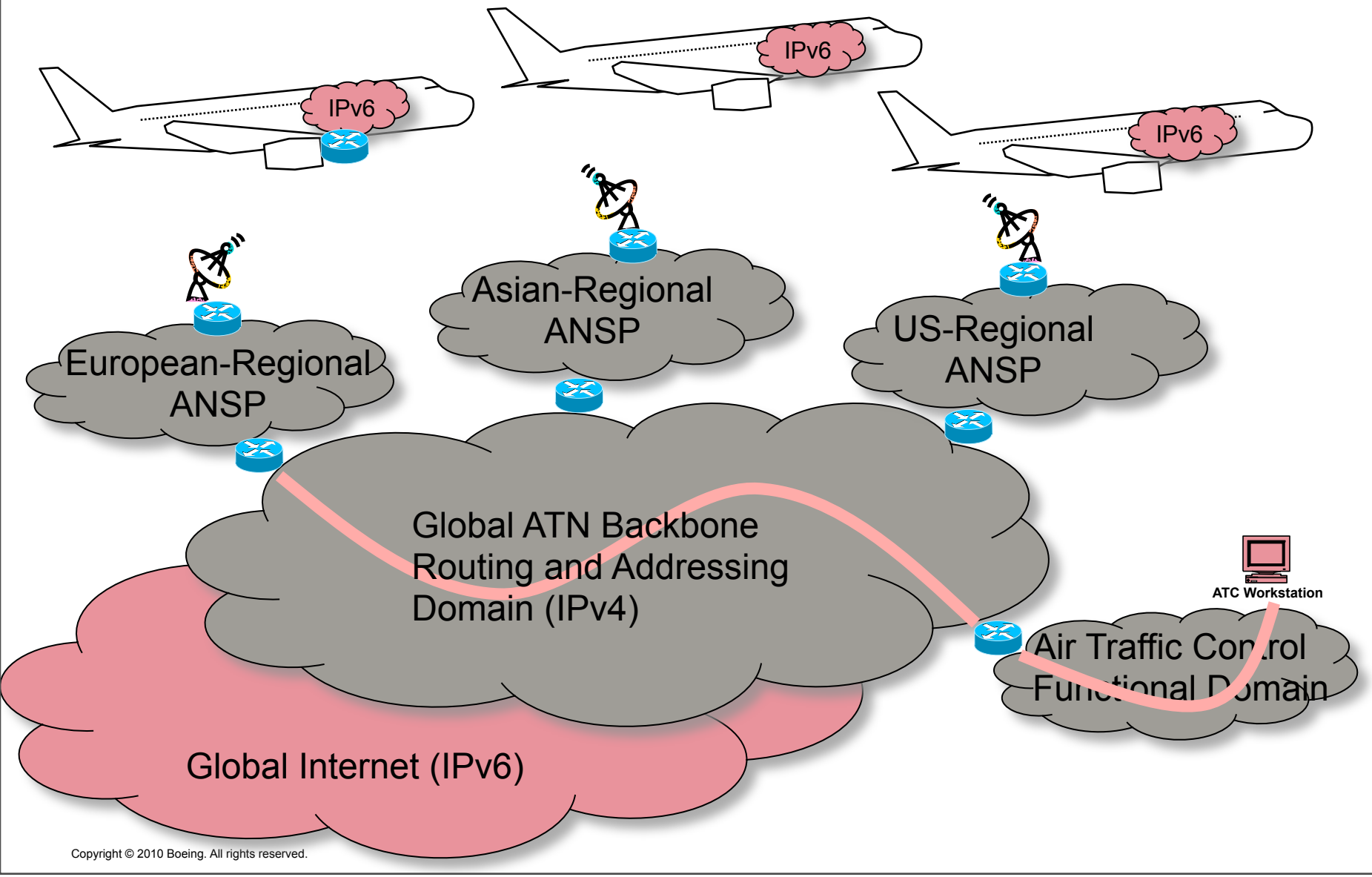

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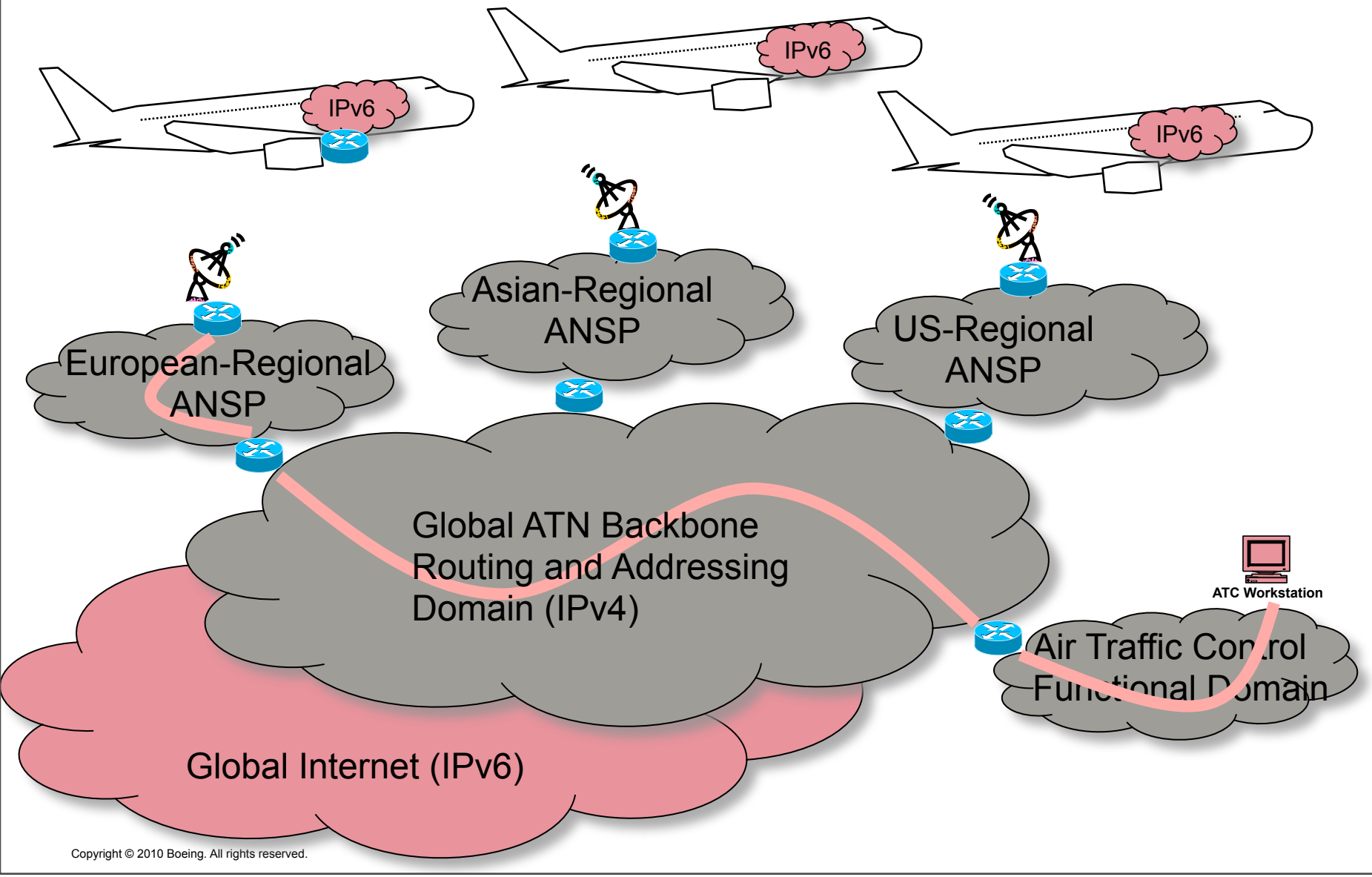

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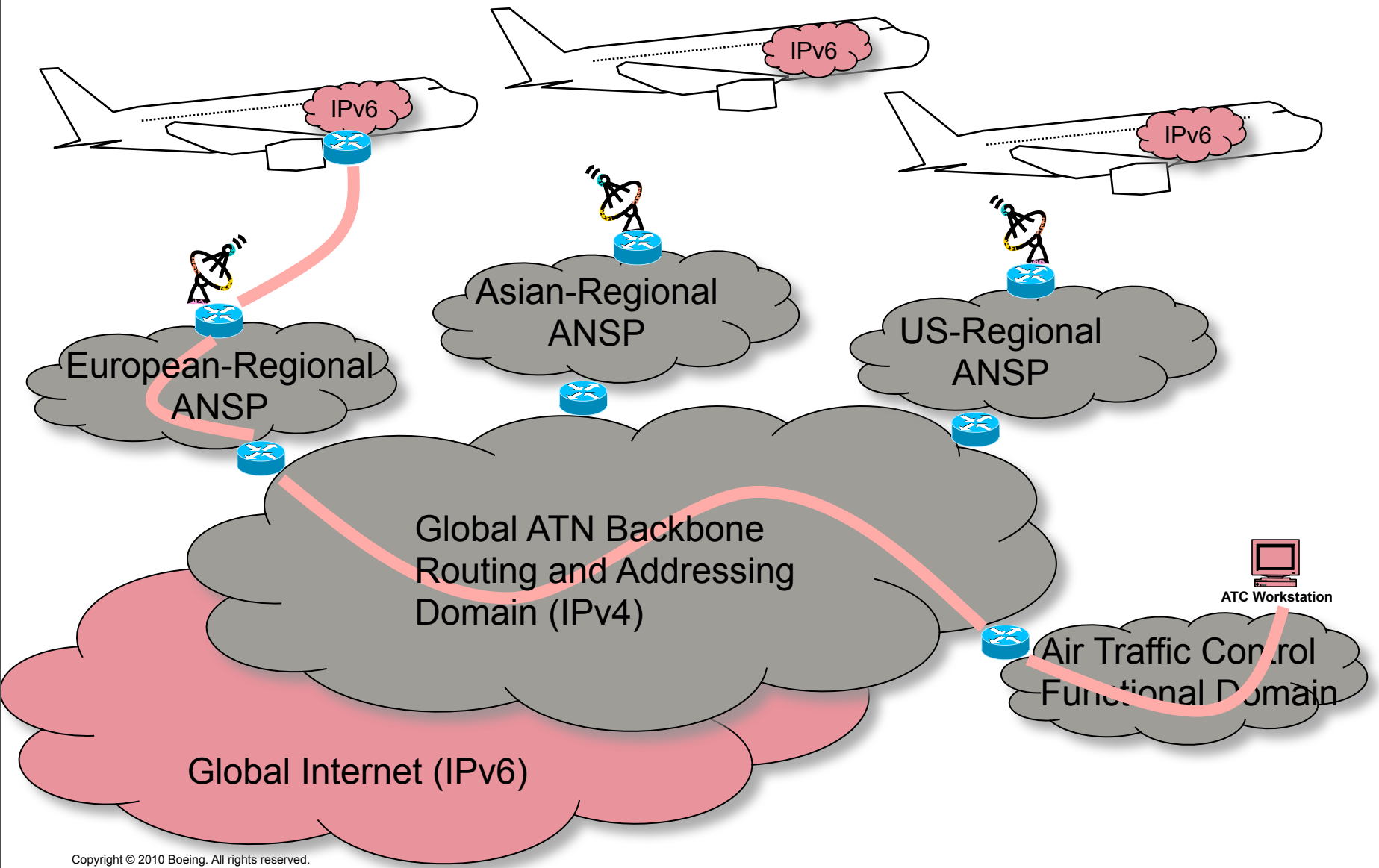
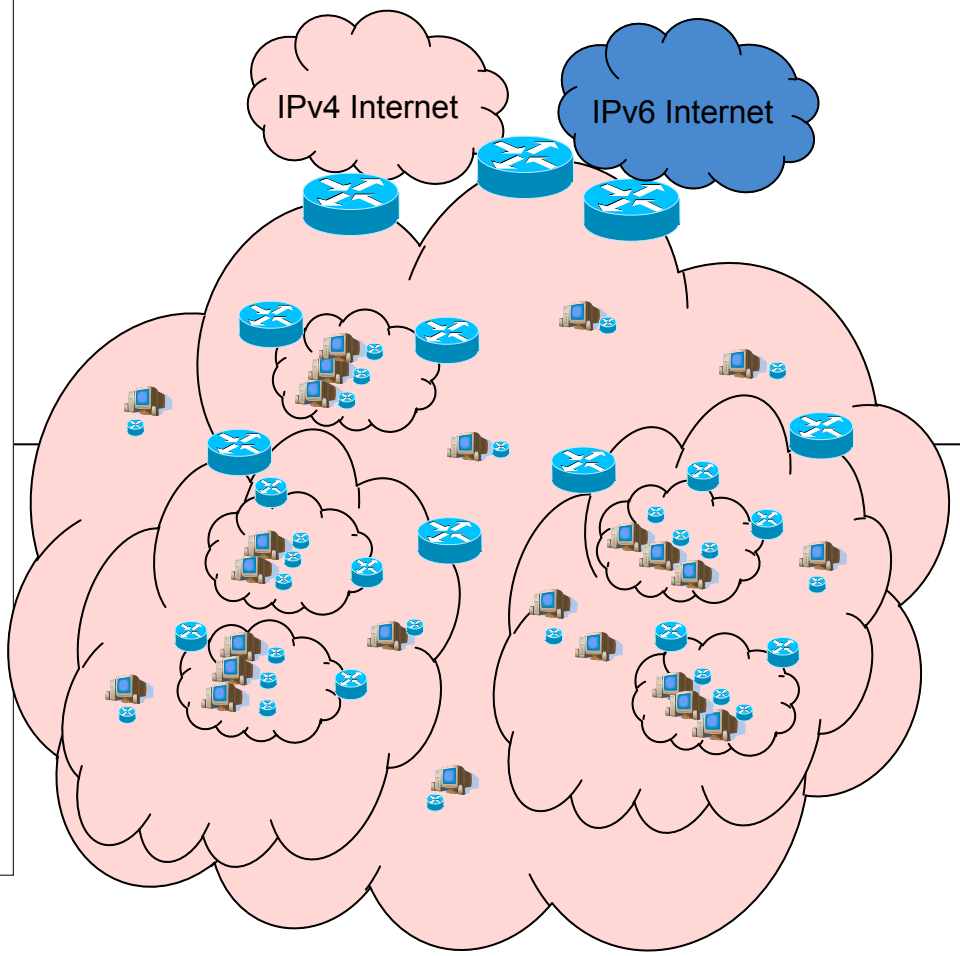


Enterprise Network Example

- Routing & Addressing in Next Generation EnteRprises (RANGER)
  - **Network-of-networks architecture**
  - **Minimal touch-points (border routers only)**
  - **No changes to most hosts and routers**
  - **Fully-provisioned IP services; balanced blend of tunneling, translation and native**
- Gradual integration of IPv6
  - **Customer-driven requirements lead policy and strategy**
  - **IPv6 and IPv4 in peaceful co-existence**
  - **It's not an "either-or" decision**
- Tangible Benefits
  - **Secure Mobile Architecture (SMA)**
  - **simplified management**
  - **logical partitioning**
  - **traffic engineering**
  - **end-to-end addressing**
  - **mobility and multihoming**



Enterprise Network
IPv4-Only

Enterprise Network Example

- Routing & Addressing in Next Generation EnteRprises (RANGER)
  - **Network-of-networks architecture**
  - **Minimal touch-points (border routers only)**
  - **No changes to most hosts and routers**
  - **Fully-provisioned IP services; balanced blend of tunneling, translation and native**
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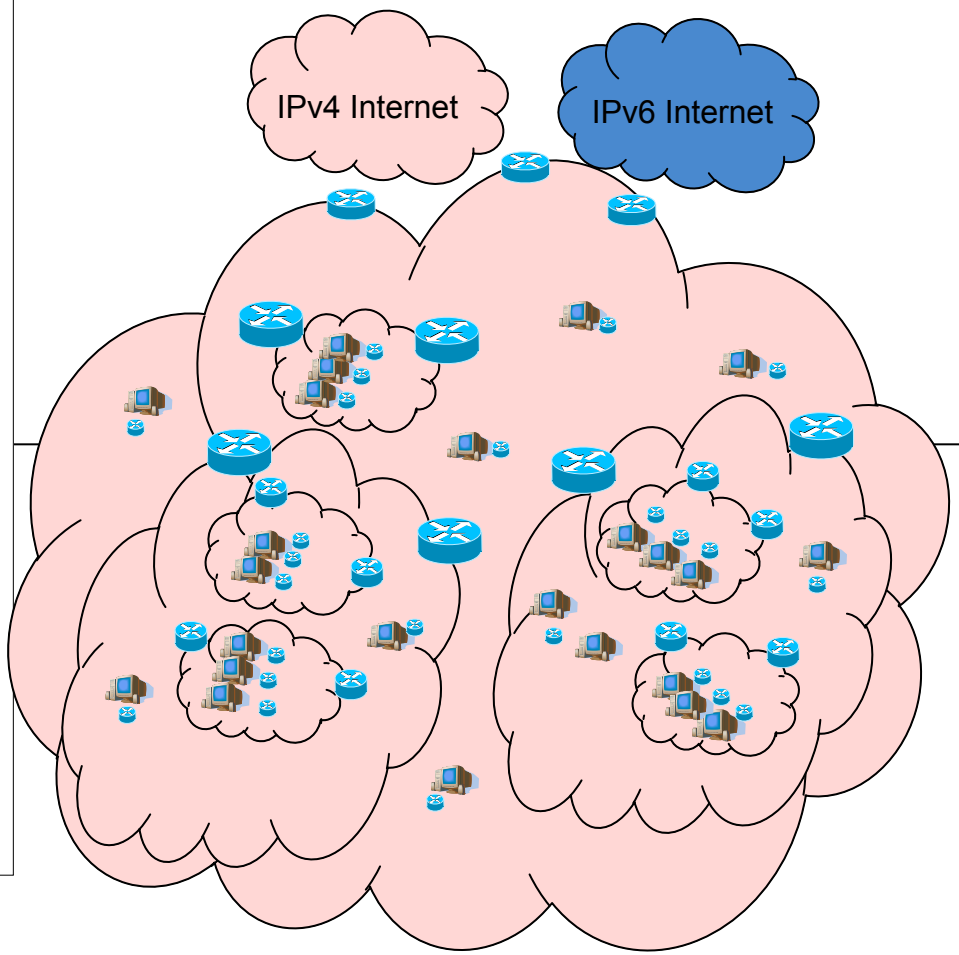

Enterprise Network
Initial IPv6 Deployment

Enterprise Network Example

- Routing & Addressing in Next Generation EnteRprises (RANGER)
  - **Network-of-networks architecture**
  - **Minimal touch-points (border routers only)**
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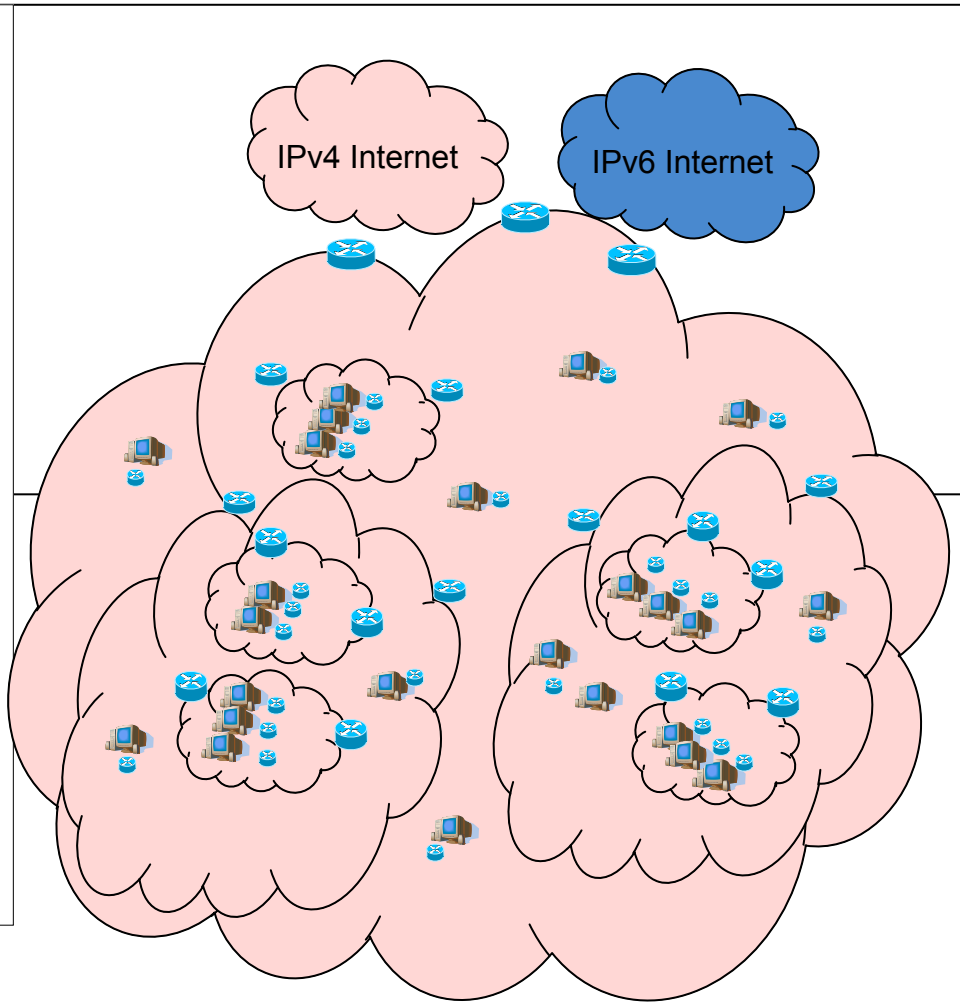
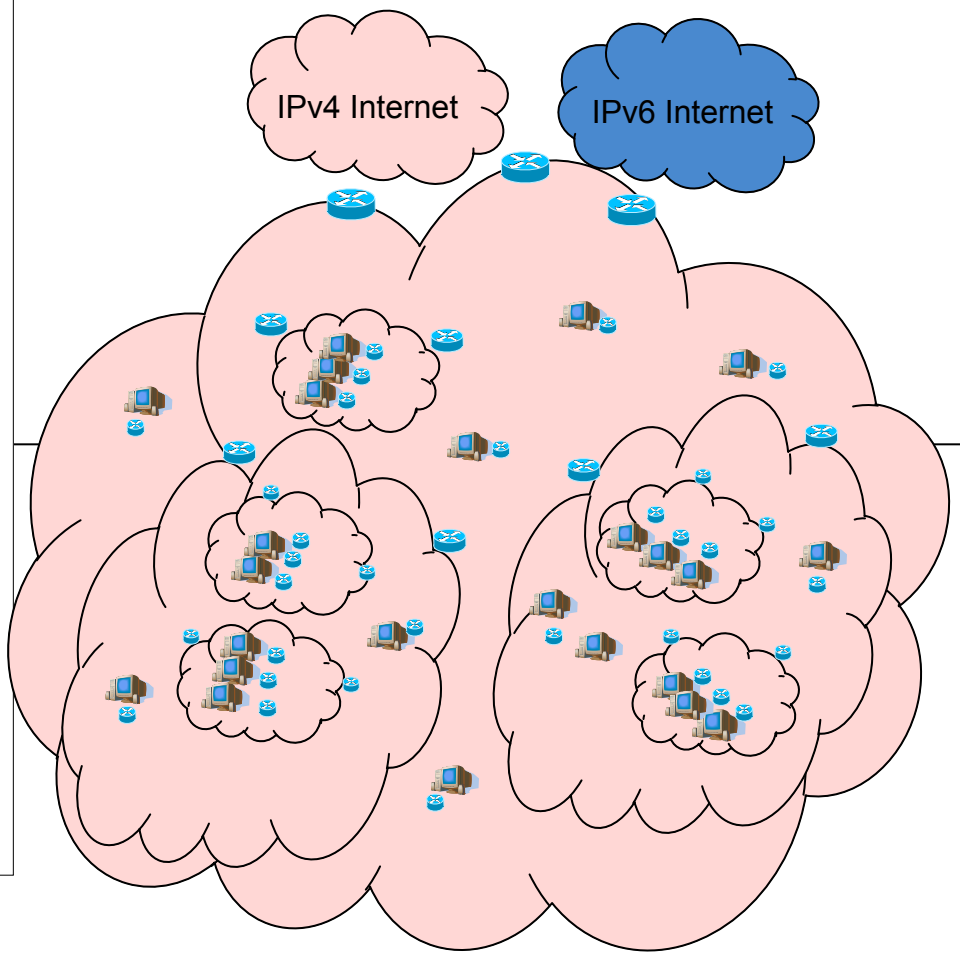
  - **Secure Mobile Architecture (SMA)**
  - **simplified management**
  - **logical partitioning**
  - **traffic engineering**
  - **end-to-end addressing**
  - **mobility and multihoming**



Enterprise Network
Advanced IPv6 Deployment

Enterprise Network Example

- Routing & Addressing in Next Generation EnteRprises (RANGER)
  - **Network-of-networks architecture**
  - **Minimal touch-points (border routers only)**
  - **No changes to most hosts and routers**
  - **Fully-provisioned IP services; balanced blend of tunneling, translation and native**
- Gradual integration of IPv6
  - **Customer-driven requirements lead policy and strategy**
  - **IPv6 and IPv4 in peaceful co-existence**
  - **It's not an "either-or" decision**
- Tangible Benefits
  - **Secure Mobile Architecture (SMA)**
  - **simplified management**
  - **logical partitioning**
  - **traffic engineering**
  - **end-to-end addressing**
  - **mobility and multihoming**



Enterprise Network
Fully Provisioned IP Services

- **Intra-Site Automatic Tunnel Addressing Protocol (ISATAP)**
  http://www.ietf.org/rfc/rfc5214.txt
- **Routing and Addressing in Networks with Global Enterprise Recursion (RANGER)**
  http://www.ietf.org/rfc/rfc5720.txt
- **RANGER Scenarios**
  http://tools.ietf.org/html/draft-russert-rangers
- **Virtual Enterprise Traversal (VET)**
  http://www.ietf.org/rfc/rfc5558.txt
  http://tools.ietf.org/html/draft-templin-intarea-vet
- **Subnetwork Encapsulation and Adaptation Layer (SEAL)**
  http://www.ietf.org/rfc/rfc5320.txt
  http://tools.ietf.org/html/draft-templin-intarea-seal
- **The Internet Routing Overlay Network (IRON)**
  http://tools.ietf.org/html/draft-templin-iron