Enabling and Securing IPv6 in Service Provider Networks

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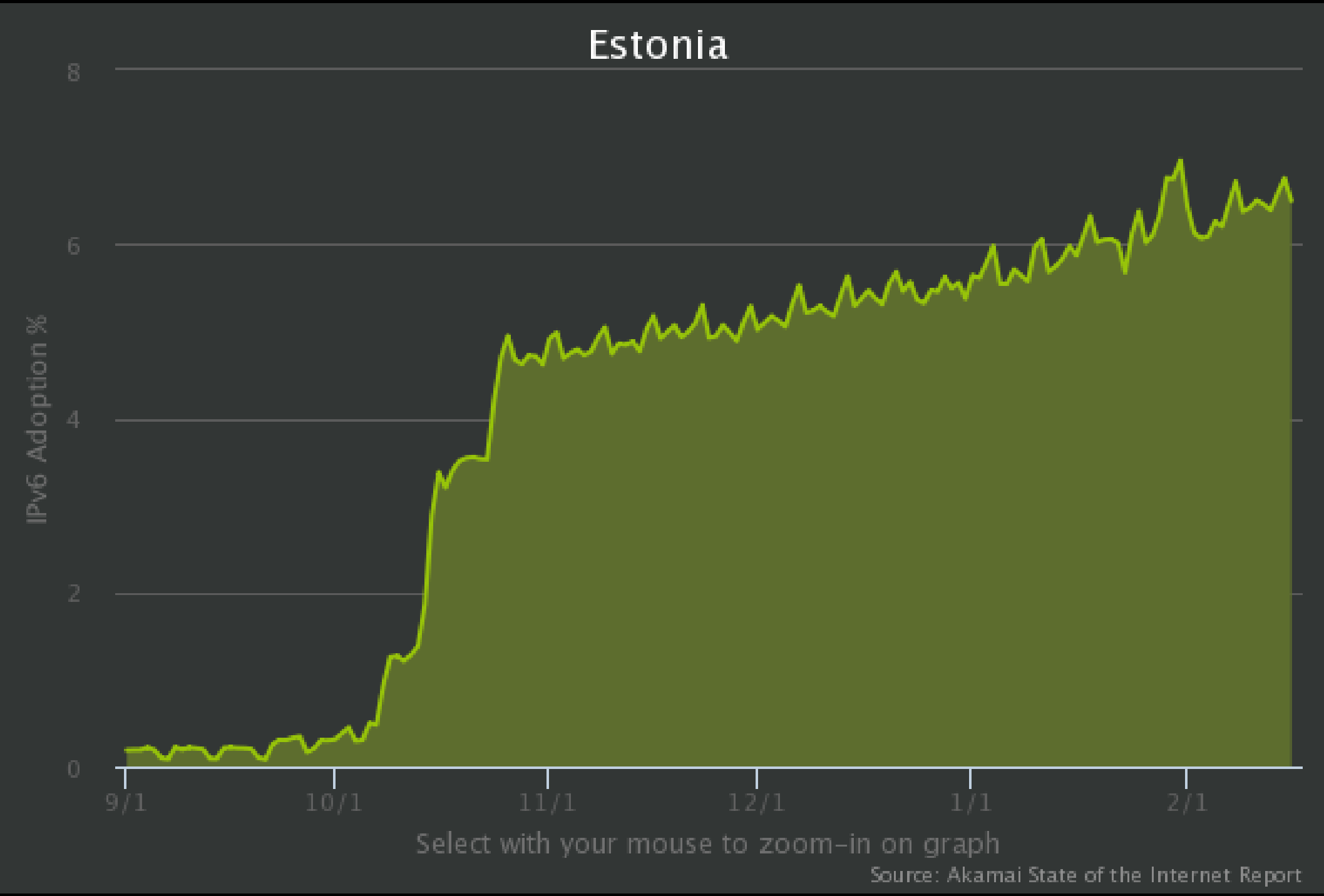
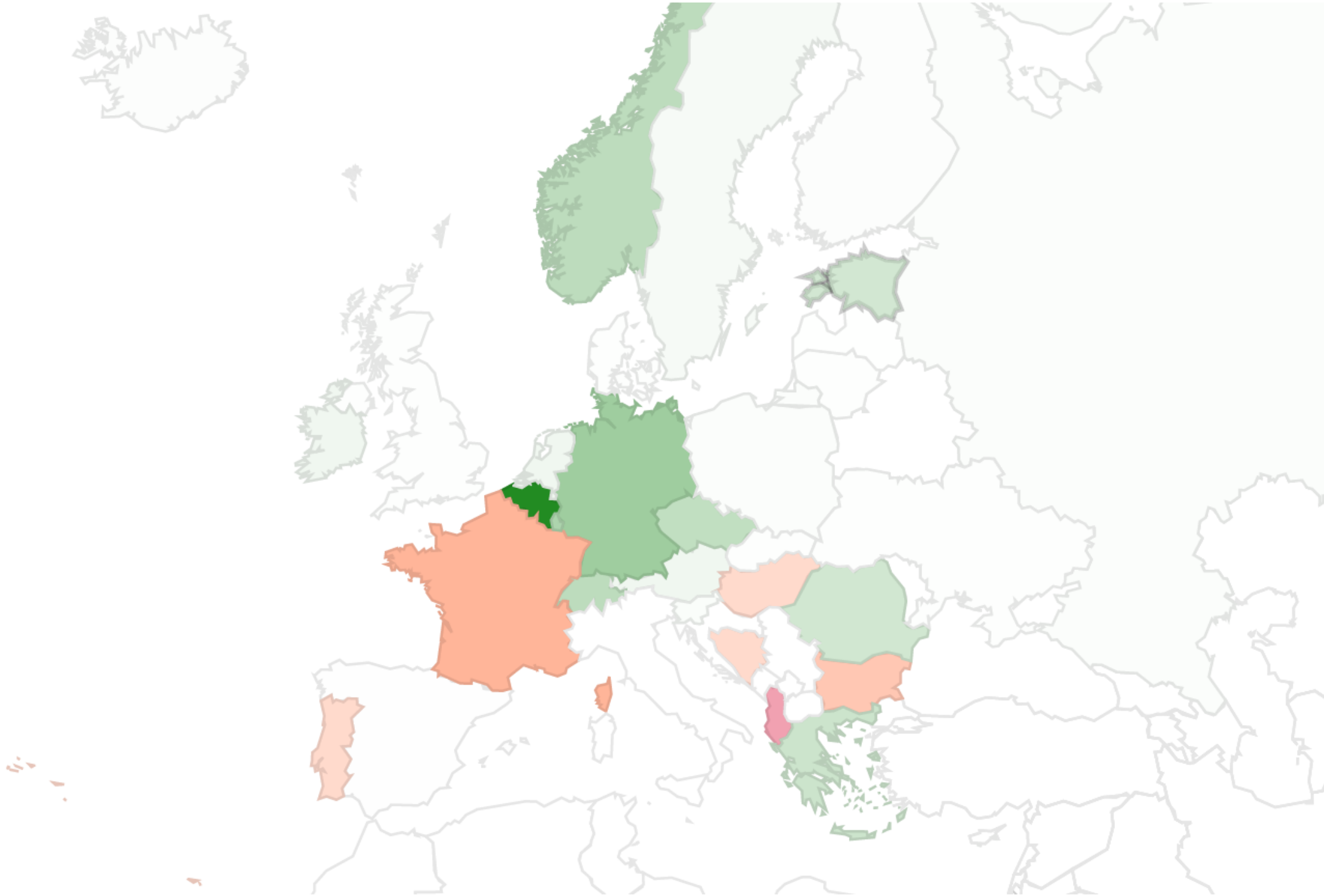
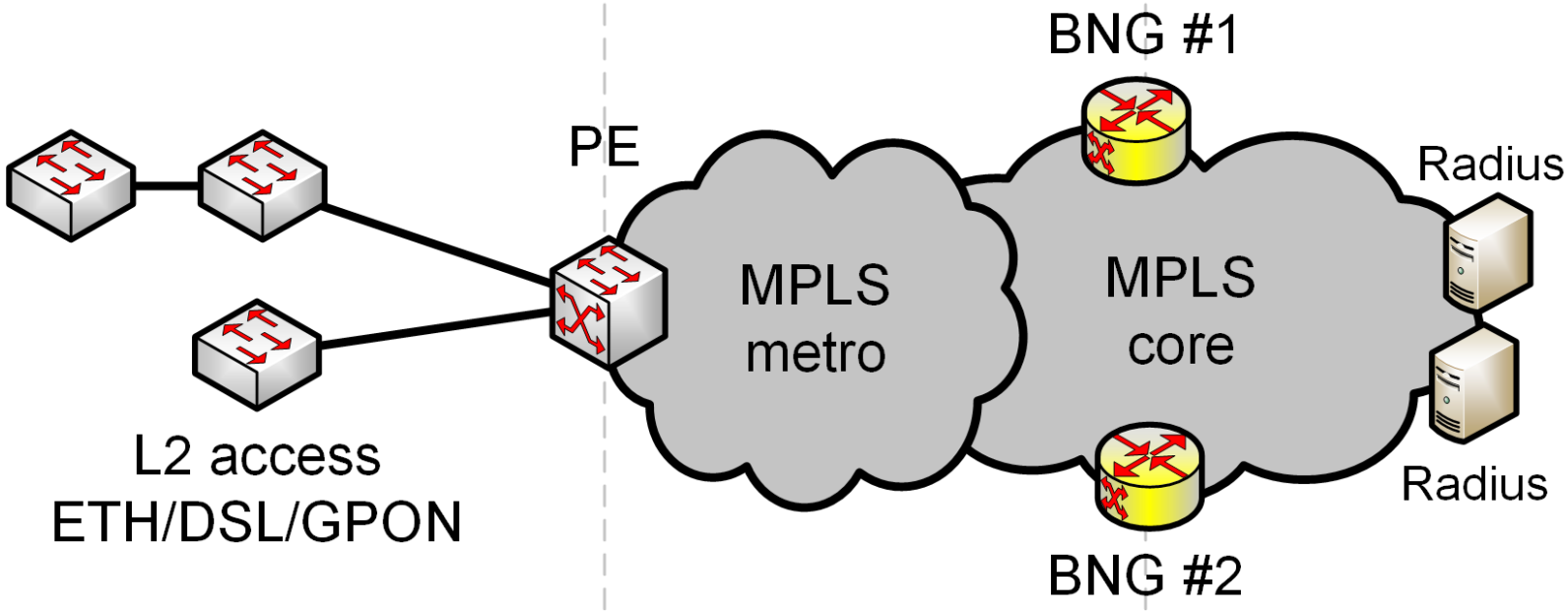
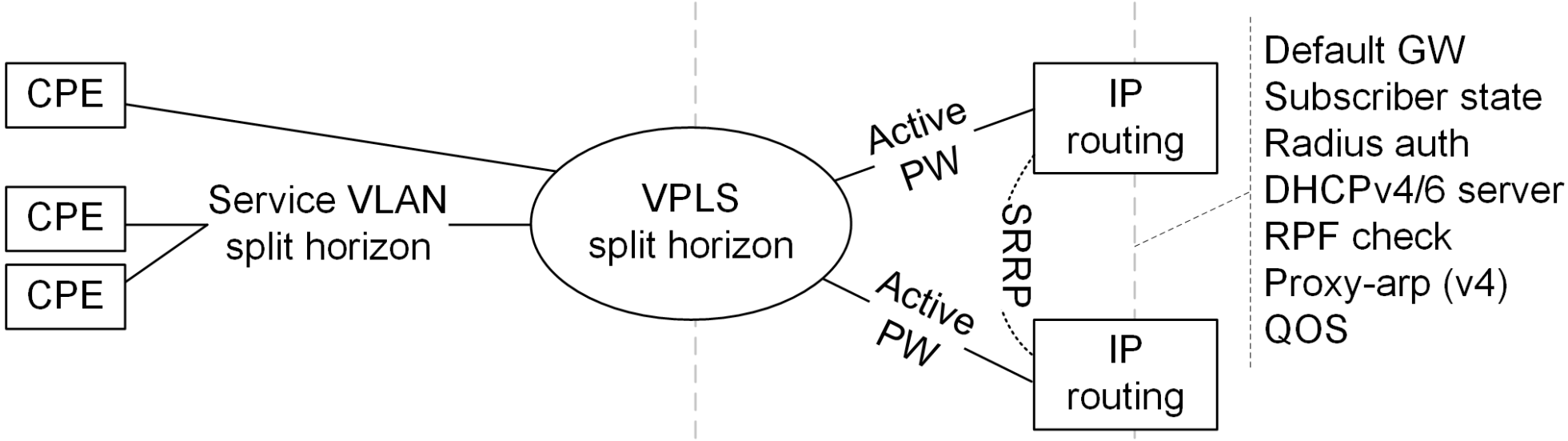

Estonia
IPv6 Adoption %
8
6
4
2
0
9/1
10/1
11/1
12/1
1/1
2/1
Select with your mouse to zoom-in on graph
Source: Akamai State of the Internet Report



- Have been working on it for 3+ years
- BNG replacement was the main driver
  - Proper, native, IPv6
- No replacements in aggregation or access
  - $$$ and more importantly time
  - No tradeoffs in security
- New Linux (OpenWrt) based CPE
- Happy Eyeballs
- Deprecated PPPoE


BNG #1
PE
Radius
MPLS
metro
MPLS
core
Radius
L2 access
ETH/DSL/GPON
BNG #2


CPE
CPE
CPE
Service VLAN
split horizon
VPLS
split horizon
Active
PW
Active
PW
SRRP
IP
routing
IP
routing
Default GW
Subscriber state
Radius auth
DHCPv4/6 server
RPF check
Proxy-arp (v4)
QOS

Enablers

- MPLS
  - You get “free” L2 redundancy with EoMPLS
  - 6PE core (boring) (LDPv6/SR is finally shipping)
- BNG (aka subscriber management)
  - Centralised subscriber state
  - BringYourOwnRadius (SDN!)
  - Address usage logging
  - Unicast RA hack

Enablers

- Split horizon (aka private-vlan)
  - No traffic sent directly between subscribers
- Still need to protect against L2 threats
  - Limit number of MACs per AN port
  - Make sure BNG MACs couldn't be learned from AN ports
  - Limit unknown unicast, multicast, broadcast
- Need proxy-ARP for v4
  - No hacks needed for v6, routed via BNG

Bootup

- DHCPv4 & ARP
  - Authenticated by DHCP option 82
- RAs starting, unicasted to CPE MAC
  - Unsolicited
  - Horrible but required hack for ::/0
  - No on-link prefixes, only M-bit
  - Virtual link-local address at BNG
  - CPE still sends to multicast but only reaches BNG

Bootup

- DHCPv6
  - Delayed, IA_PD only, no IA_NA
  - ND info learned from Solicit
  - No LDRA support in ANs
  - Authenticated using cached v4 data from radius DB
    - Linked using MAC + port (L2 domain)
  - Radius req. rejected if v4 session not found
    - Possible DOS vector
- Shared shapers with v4
- V6 DNS information in DHCPv6

CPE

- /56 per subscriber
  - Cached for up to 24h
  - Take care to sync RA and DHCP lifetimes
- Divided to:
  - 1st /64 – loopback for CPE management
  - 2nd /64 – LAN (RA on-link, RDNSS, stateless DHCPv6)
  - 3rd /64 – public WIFI (if enabled)
- Ingress firewall configurable by customer
- ND logging for helpdesk

Can you do separate v6 BNG?

- Absolutely
- Shapers will not be shared
- But radius database will be
- Have to protect two sets of BNG MACs
- Can you do normal v4 and v6 BNG?
  - Probably but I wouldn't
  - BNG is not for everyone

What about the 4 weeks?

- We cheated
  - Deployed all v6 config during BNG change
  - Filter all 0x86DD at BNG
  - Waited until all CPE bugs are fixed
  - Replaced filter with one that allows v6 for certain MACs
  - Monitor carefully (IPFIX)
- **0** customer-affecting problems

Future

- Support other CPEs
- Static prefix from radius
- Static routes in LAN
  - address hints needed
- Hierarchical DHCPv6 PD
- VOIP and IPTV to IPv6

- Mobile network (VoLTE)

Stats

- 38000+ v6 enabled subscribers
- 81% of them have have at least one IPv6 enabled device in the LAN (70% have more than one)
- Content:
  - Zone.ee
  - Google + Youtube + GA
  - Akamai, Cloudflare, Limelight, Edgecast
  - Facebook
  - VKontakte, Yandex
  - Torrent & Hamachi

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