Networking
For everyone

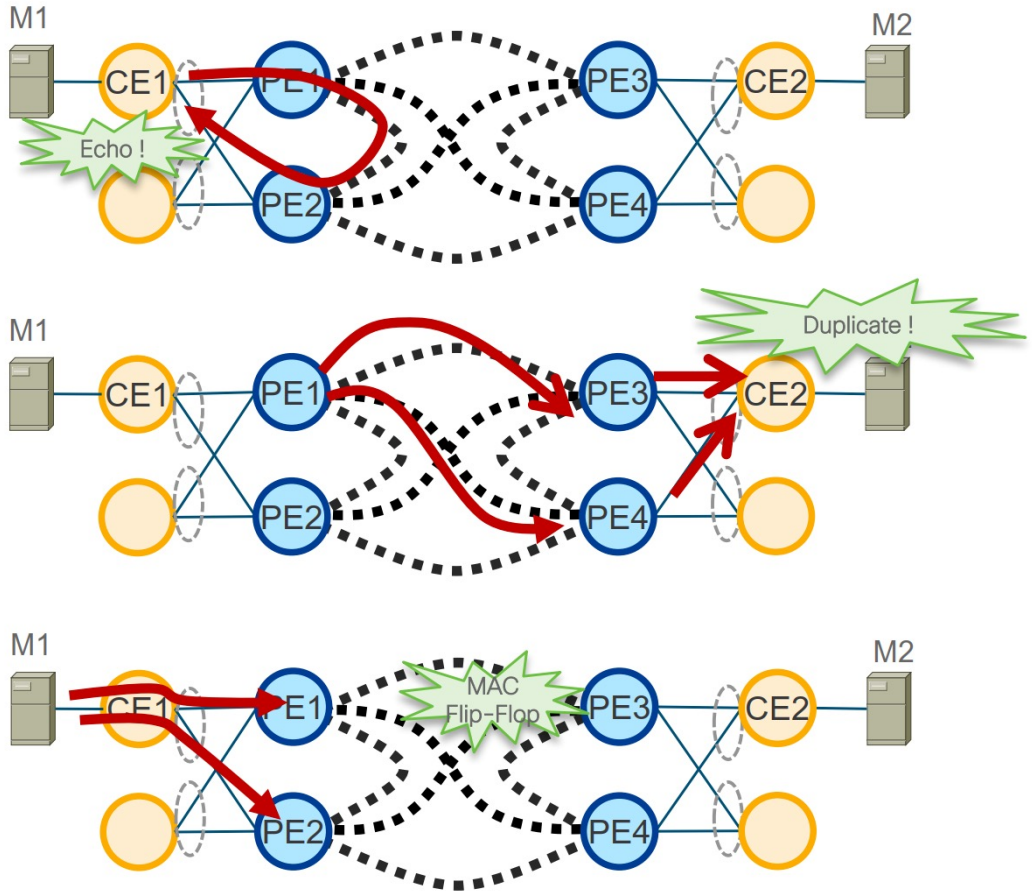
Ethernet VPN

Networking
For everyone

Основные принципы EVPN

Проблемы организации L2VPN

- VPLS не позволяет строить топологии Active-Active
- Существуют проблемы флуда и дубликатов
- MAC Flipping



Основные преимущества EVPN

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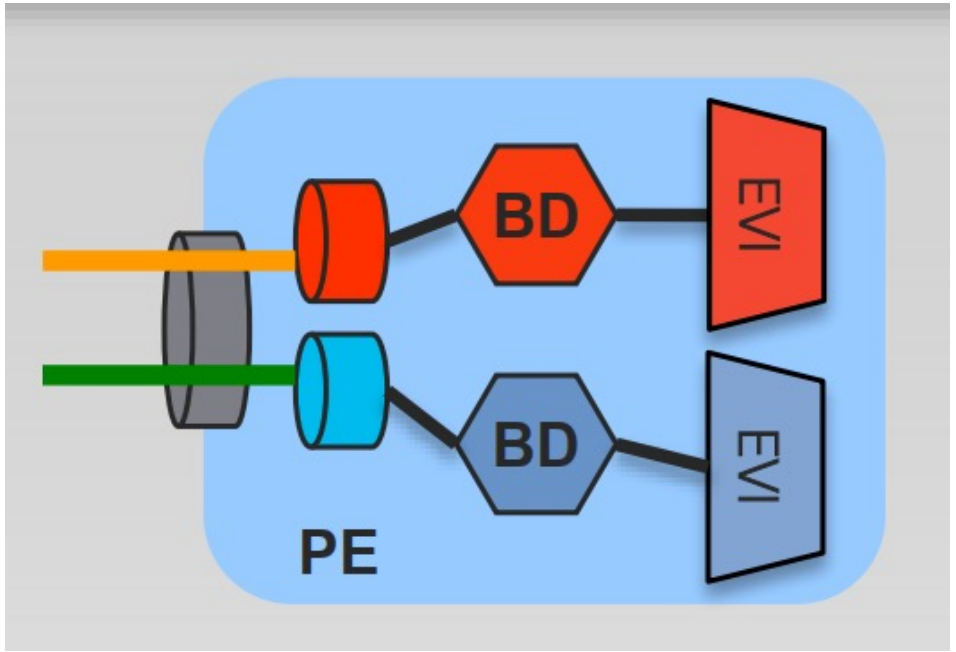
- Интеграция L2 и L3 сервисов
- L3-like подход для организации L2
- Active-active топологии
- Fast Convergence
- Изучение маршрутов (MAC) на уровне Control Plane

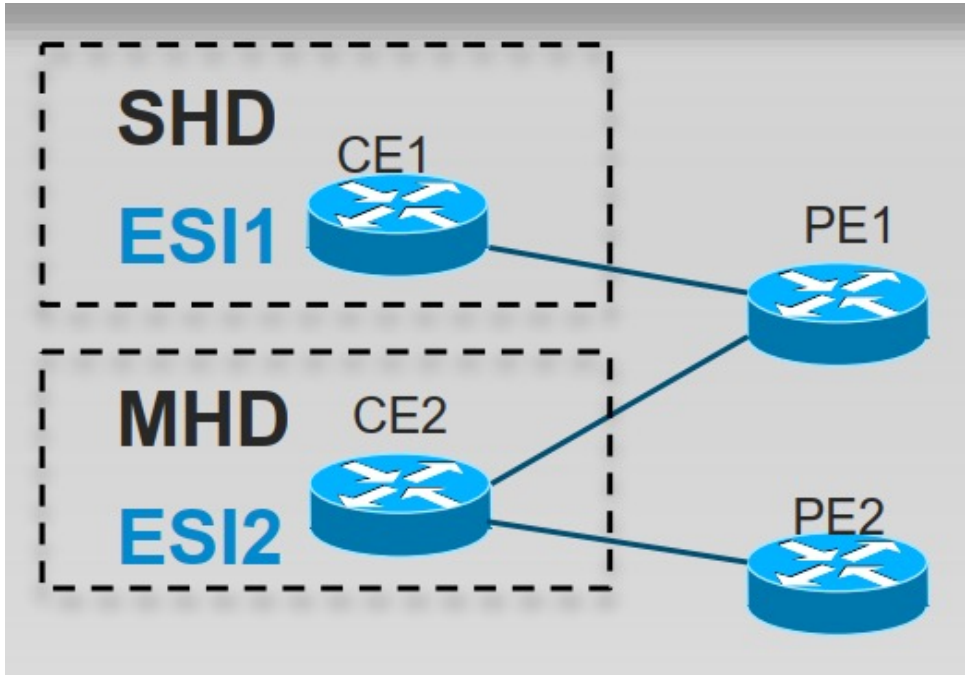
Концепты EVPN

- EVPN Instance (EVI)
  - идентицифирует VPN
  - относится к одному или более Bridge-Domain
    - port-based
    - vlan-based



Ethernet Segment (ES)

- Характеризует сайт, подключенный к одному или более PE
- Идентифицируется посредством ESI
  - Single-homed Device (SHD)
  - Multi-homed Device (SHD)



BGP маршруты

- Новое SAFI (70)
- Новые маршруты
  - [1] Ethernet Auto-Discovery
  - [2] MAC/IP
  - [3] Inclusive Multicast
  - [4] Ethernet Segment
  - [5] IP Prefix

BGP аттрибуты

- Новые community
  - ESI MPLS Label
  - ES-Import
  - MAC Mobility
  - Default Gateway
  - Encapsulation
- Новые возможности
  - MAC moves
  - Redundancy
  - Split-horizon label

Балансировка

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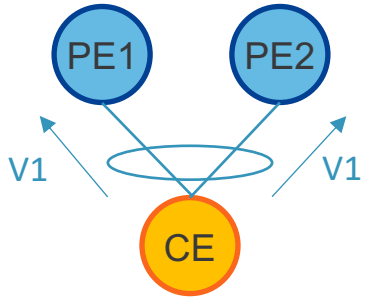
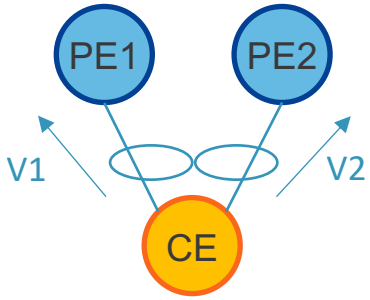
All-Active (per flow)



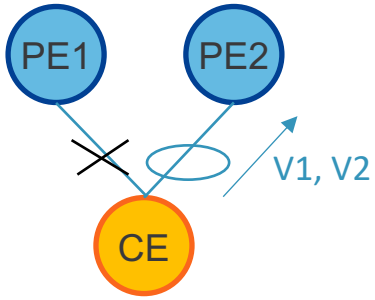
Single LAG at the CE
VLAN goes to both PE
Traffic hashed per flow
Benefits: Bandwidth, Convergence

Single-Active (per VLAN)



Multiple LAGs at the CE
VLAN active on single PE
Traffic hashed per VLAN
Benefits: Billing, Policing

Port-Active (per port)

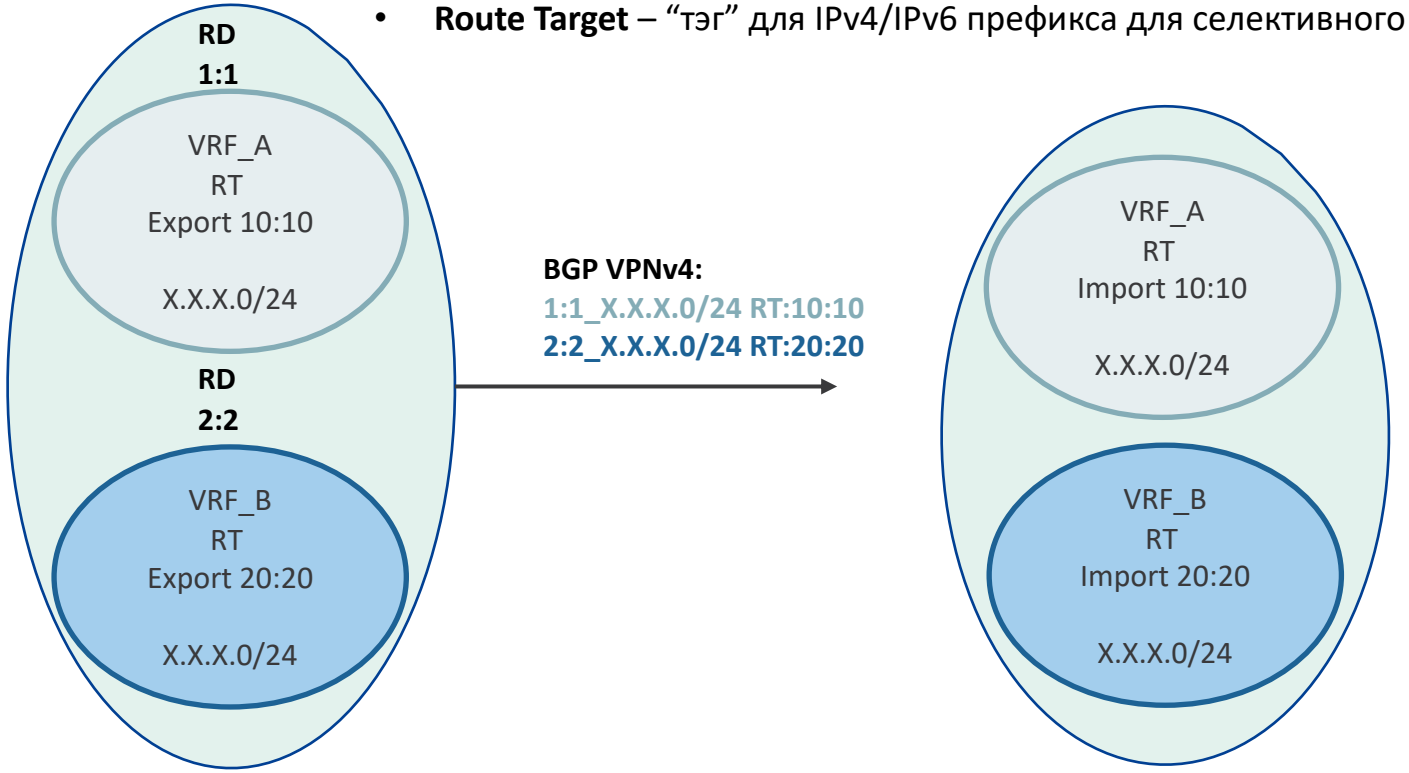


Single/Multiple LAGs at the CE
Port active on single PE
Traffic hashed per port
Benefits: Protocol Simplification

Вспомним про RD и RT

Networking For everyone

- **Route Distinguisher** - делает IPv4/IPv6 префикс глобально уникальным
- **Route Target** – “тэг” для IPv4/IPv6 префикса для селективного import/export

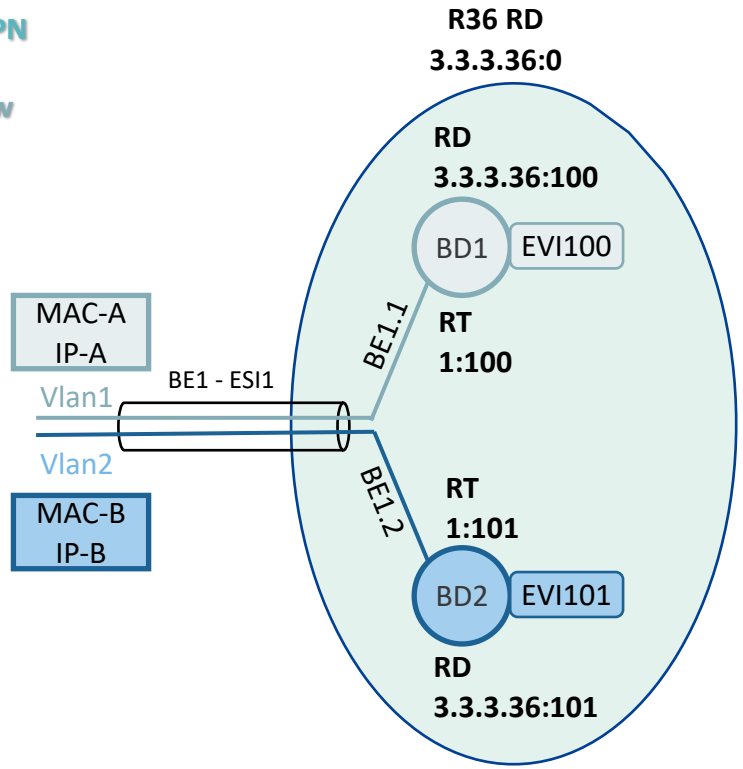


RD и RT в EVPN

Networking For everyone

Per-Node/Per-EVI RD - [BGP-RouterID]:[EVI-ID] -> **Similar to VRF RD in L3VPN**
EVPN RT1, RT2, RT3
Per-Node/Per-EVI RT - [BGP-AS]:[EVI-ID] -> **Similar to VRF RT in L3VPN**

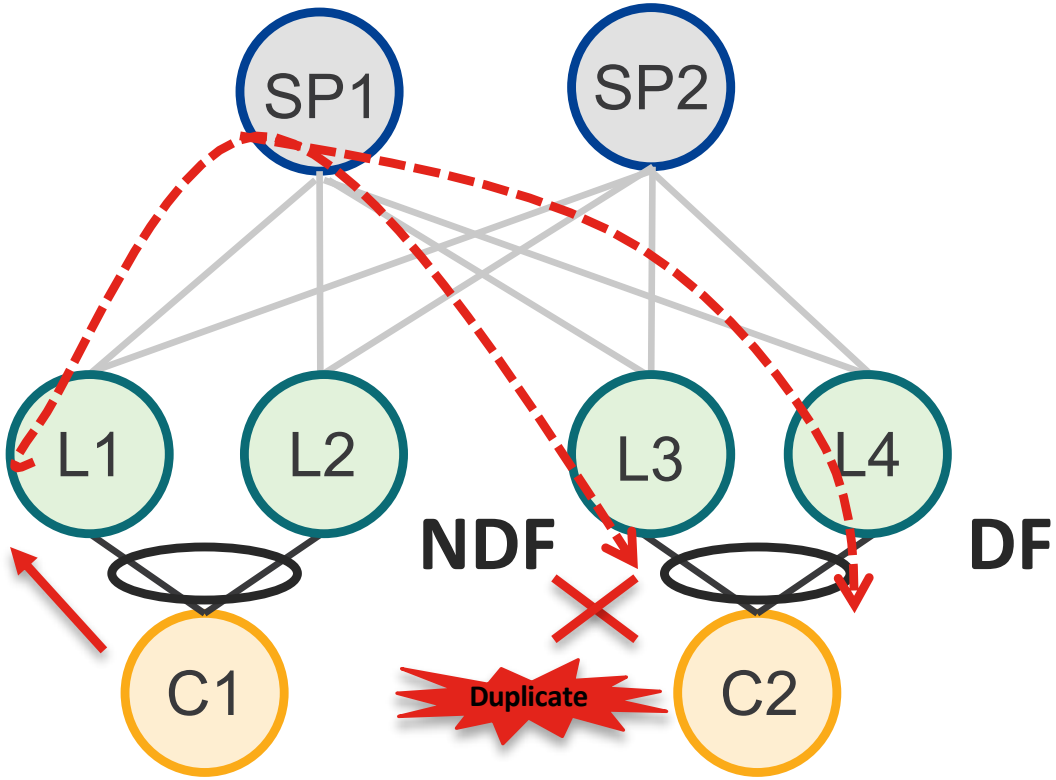
Per-Node RD - [BGP-routerid]:0,1,2,…. -> **DF Election, Mass-Withdraw**
EVPN RT1, RT4
R36 example BGP RouterID 3.3.3.36, BGP-AS: 1, EVI 100:
Per-Node RD: 3.3.3.36:0,1,2
Per-Node/Per-EVI RD: 3.3.3.36:100
Per-Node/Per-EVI RT: 1:100



Why more Per-Node RD?
Maximum Route-Targets (RTs) per route is 400

Designated Forwarder

- Как предотвратить дубликаты пакетов в multi-homed ES?

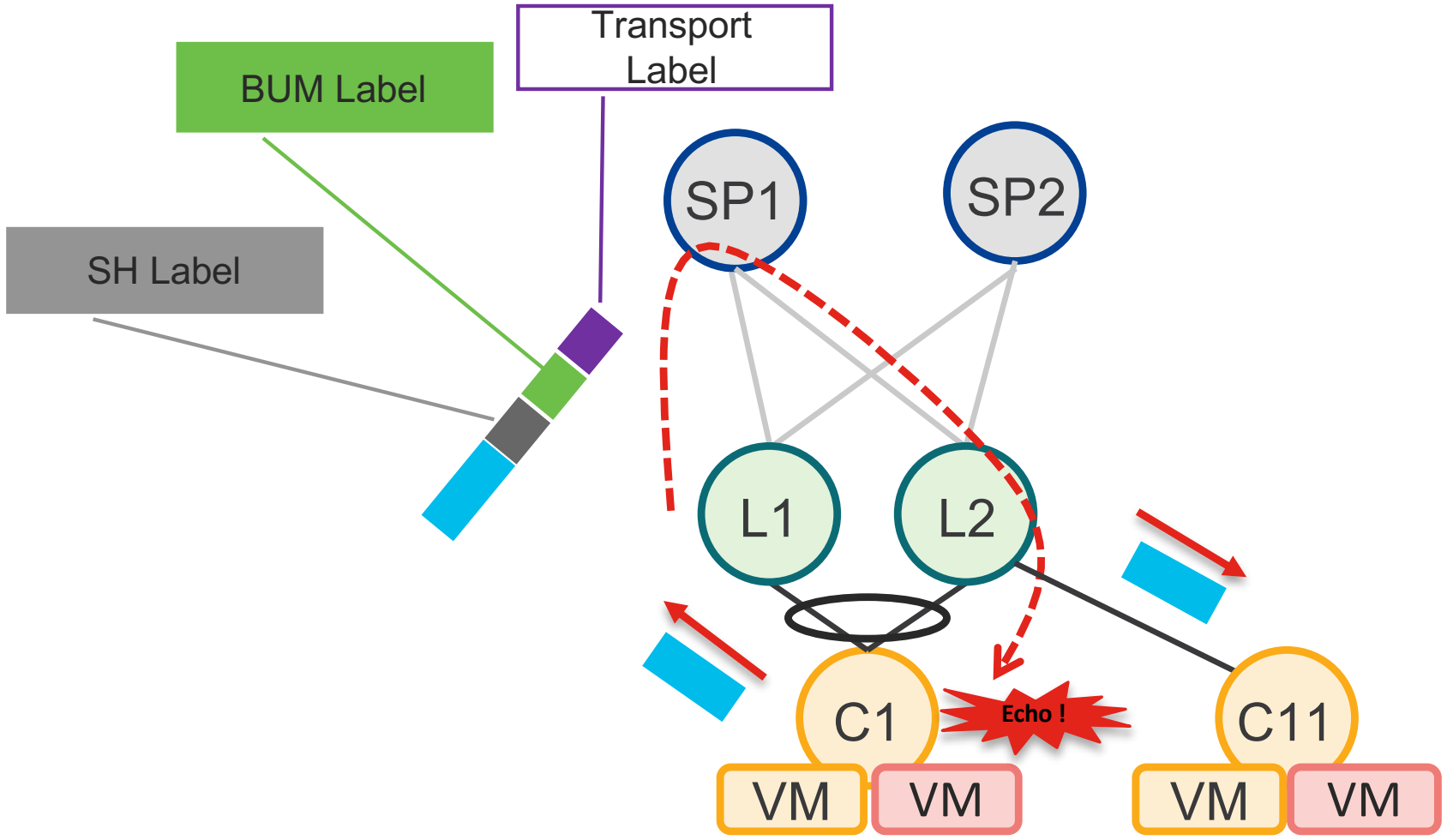


Выбор Designated Forwarder

- Один DF для каждого ES
- Выбор на основе BGP Route Type-4

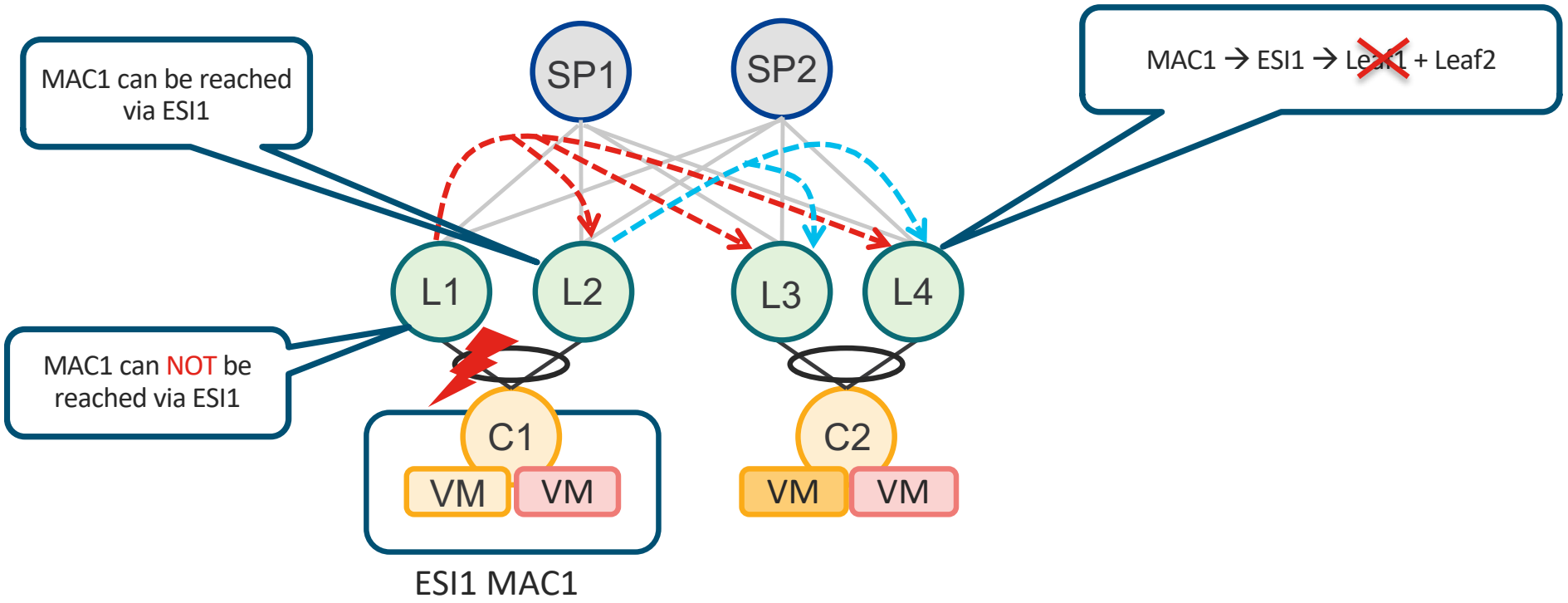
```
R36#show evpn ethernet-segment esi 0036.3700.0000.0000.1100 carving detail
……
Ethernet Segment Id     Interface                         Nexthops
----------------------- --------------------------------- --------------------
0036.3700.0000.0000.1100 BE100                             3.3.3.36
                                                           3.3.3.37
 ES to BGP Gates : Ready
 ES to L2FIB Gates : Ready
 Main port       :
    Interface name : Bundle-Ether100
    Interface MAC : 008a.9644.d8dd
    IfHandle     : 0x0800001c
    State        : Up
    Redundancy   : Not Defined
 ESI type         : 0
    Value         : 36.3700.0000.0000.1100
 ES Import RT     : 3637.0000.0000 (from ESI)
 Source MAC       : 0000.0000.0000 (N/A)
 Topology         :
    Operational   : MH, All-active
    Configured    : All-active (AApF) (default)
 Service Carving : Auto-selection
 Peering Details : 3.3.3.36[MOD:P:00] 3.3.3.37[MOD:P:00]
 Service Carving Results:
    Forwarders   : 1
    Permanent    : 0
    Elected      : 1
           EVI E :     100
    Not Elected  : 0
 MAC Flushing mode : STP-TCN
 Peering timer    : 3 sec [not running]
 Recovery timer   : 30 sec [not running]
 Carving timer    : 0 sec [not running]
 Local SHG label : 64005
 Remote SHG labels : 1
             64005 : nexthop 3.3.3.37
```

Split Horizon



Mass MAC Withdraw

- Как проинформировать другие PE об аварии, которая затрагивает большое количество MAC адресов?



Auto-Discovery (маршрут 0x1)

- Анонс Split-Horizon Label внутри ES
- Mass MAC Withdraw

```
R36#show bgp l2vpn evpn rd 3.3.3.36:0 [1][3.3.3.36:1][0036.3700.0000.0000.1100][4294967295]/184
Sun Oct 14 20:56:59.687 UTC
BGP routing table entry for [1][3.3.3.36:1][0036.3700.0000.0000.1100][4294967295]/184, Route Distinguisher: 3.3.3.36:0
Versions:
 Process          bRIB/RIB SendTblVer
 Speaker              76372     76372
   Local Label: 0
Last Modified: Sep 18 23:02:40.399 for 3w4d
Paths: (1 available, best #1)
 Advertised to update-groups (with more than one peer):
   0.2
 Path #1: Received by speaker 0
 Advertised to update-groups (with more than one peer):
   0.2
 Local
   0.0.0.0 from 0.0.0.0 (3.3.3.36)
     Origin IGP, localpref 100, valid, redistributed, best, group-best, import-candidate, rib-install
     Received Path ID 0, Local Path ID 1, version 76372
     Extended community: EVPN ESI Label:0x00:64005 RT:1:100
```

RT-1

RD - unique per advertising node (R36 unique)

Ethernet Segment Identifier (ESI)

EVI(s) Route-Target
All EVI(s) which use this ESI

Redundancy mode
All-Active: 0x00
Single-Active: 0x01

Split-Horizon Label

MAC Advertisement (маршрут 0x2)

Networking For everyone

```
R36#show bgp l2vpn evpn rd 3.3.3.36:100 [2][0][48][0062.ec71.fbd7][0]/104
Mon Oct 15 04:33:39.527 UTC
BGP routing table entry for [2][0][48][0062.ec71.fbd7][0]/104, Route Distinguisher: 3.3.3.36:100
Versions:
 Process          bRIB/RIB SendTblVer
 Speaker              83317     83317
   Local Label: 64004
Last Modified: Oct 15 04:32:31.399 for 00:01:08
Paths: (2 available, best #1)
 Advertised to update-groups (with more than one peer):
   0.2
 Path #1: Received by speaker 0
 Advertised to update-groups (with more than one peer):
   0.2
 Local
   0.0.0.0 from 0.0.0.0 (3.3.3.36)
     Origin IGP, localpref 100, valid, redistributed, best, group-best, import-candidate, rib-install
     Received Path ID 0, Local Path ID 1, version 83317
     Extended community: SoO:3.3.3.37:100 RT:1:100
     EVPN ESI: 0036.3700.0000.0000.1100
 Path #2: Received by speaker 0
 Not advertised to any peer
 Local
   3.3.3.37 (metric 30) from 3.3.3.103 (3.3.3.37)
     Received Label 64004
     Origin IGP, localpref 100, valid, internal, import-candidate, imported, rib-install
     Received Path ID 0, Local Path ID 0, version 0
     Extended community: SoO:3.3.3.37:100 RT:1:100
     Originator: 3.3.3.37, Cluster list: 3.3.3.103
     EVPN ESI: 0036.3700.0000.0000.1100
     Source AFI: L2VPN EVPN, Source VRF: default, Source Route Distinguisher: 3.3.3.37:100
```

RT-2

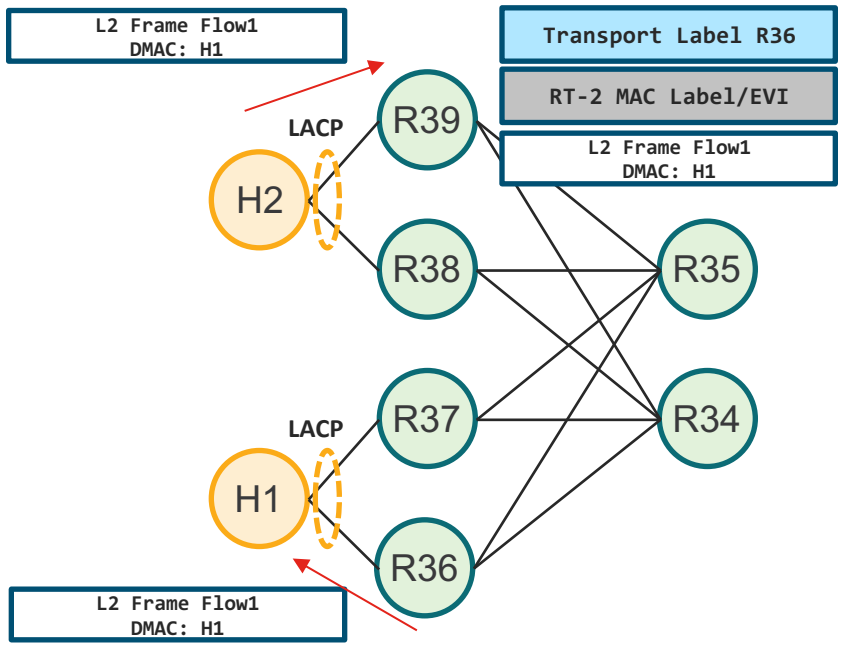
Advertised MAC

R36 Re-Advertised

R37 MAC DP Learned and Advertised

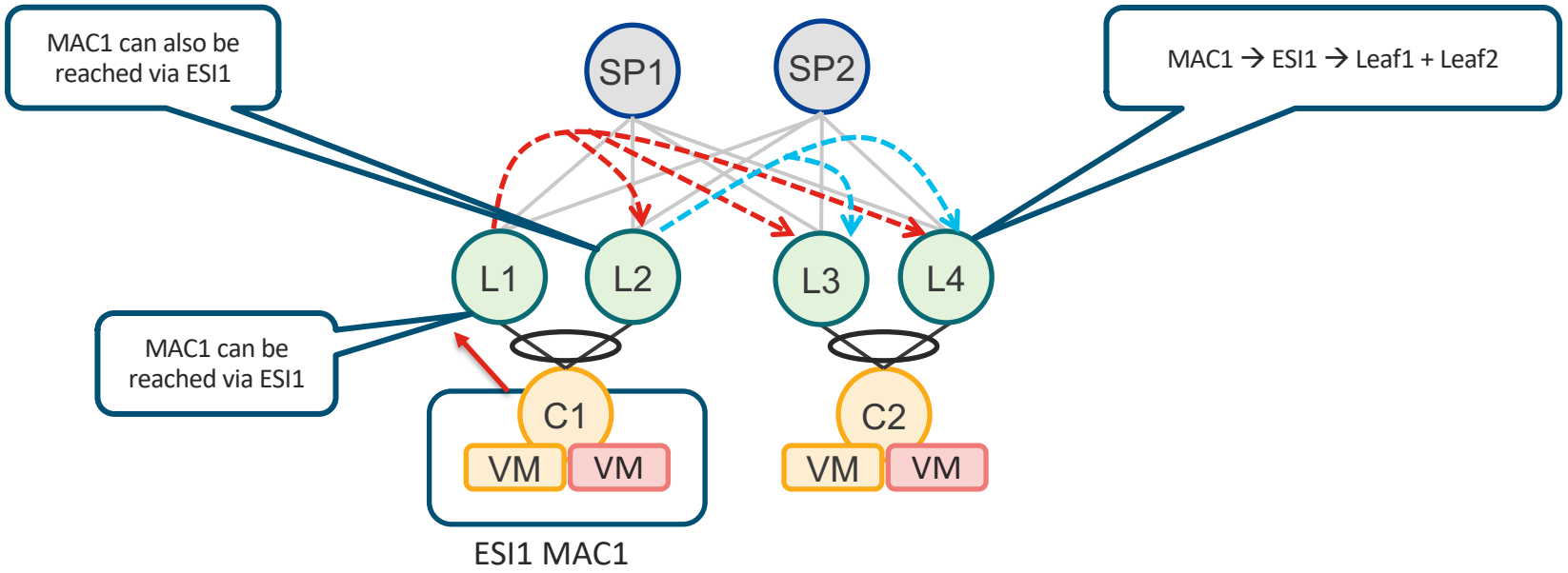
Передача Unicast трафика

- 1. DF Election и MHS Auto-Discovery
- 2. ESI Auto-Discovery (Split-Horizon, mass withdraw)
- 3. Inclusive Multicast
- 4. MAC Advertisement



Aliasing

- Как балансировать трафик в сторону MHD через несколько PE, в случае если MAC изучен только через один PE из пары?



```
RP/0/RP0/CPU0:R36#show bgp l2vpn evpn rd 3.3.3.36:100 [1][0036.3700.0000.0000.1100][0]/120
Mon Oct 15 03:35:13.604 UTC
BGP routing table entry for [1][0036.3700.0000.0000.1100][0]/120, Route Distinguisher: 3.3.3.36:100
Versions:
 Process          bRIB/RIB SendTblVer
 Speaker              79640     7964
Last Modified: Oct 12 17:40:06.399 for 2d09h
Paths: (2 available, best #1)
 Advertised to update-groups (with more than one peer):
   0.2
 Path #1: Received by speaker 0
 Advertised to update-groups (with more than one peer):
   0.2
 Local
   0.0.0.0 from 0.0.0.0 (3.3.3.36)
     Origin IGP, localpref 100, valid, redistributed, best, group-best, import-candidate, rib-install
     Received Path ID 0, Local Path ID 1, version 39769
 Path #2: Received by speaker 0
 Not advertised to any peer
 Local
   3.3.3.37 (metric 30) from 3.3.3.103 (3.3.3.37)
     Received Label 64004
     Origin IGP, localpref 100, valid, internal, import-candidate, imported, rib-install
     Received Path ID 0, Local Path ID 0, version 0
     Extended community: RT:1:100
     Originator: 3.3.3.37, Cluster list: 3.3.3.103
     Source AFI: L2VPN EVPN, Source VRF: default, Source Route Distinguisher: 3.3.3.37:100
```

RT-1

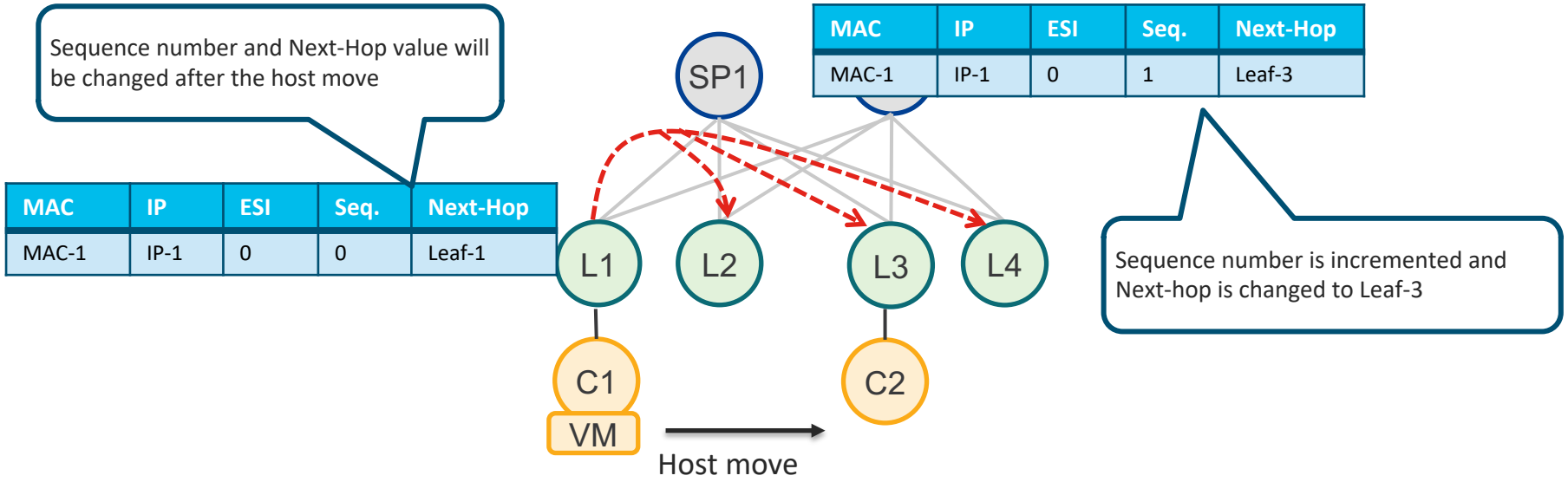
Ethernet Segment Identifier (ESI)

Aliasing Label allocated by R37 for EVI 100

EVI 100 Route-Target

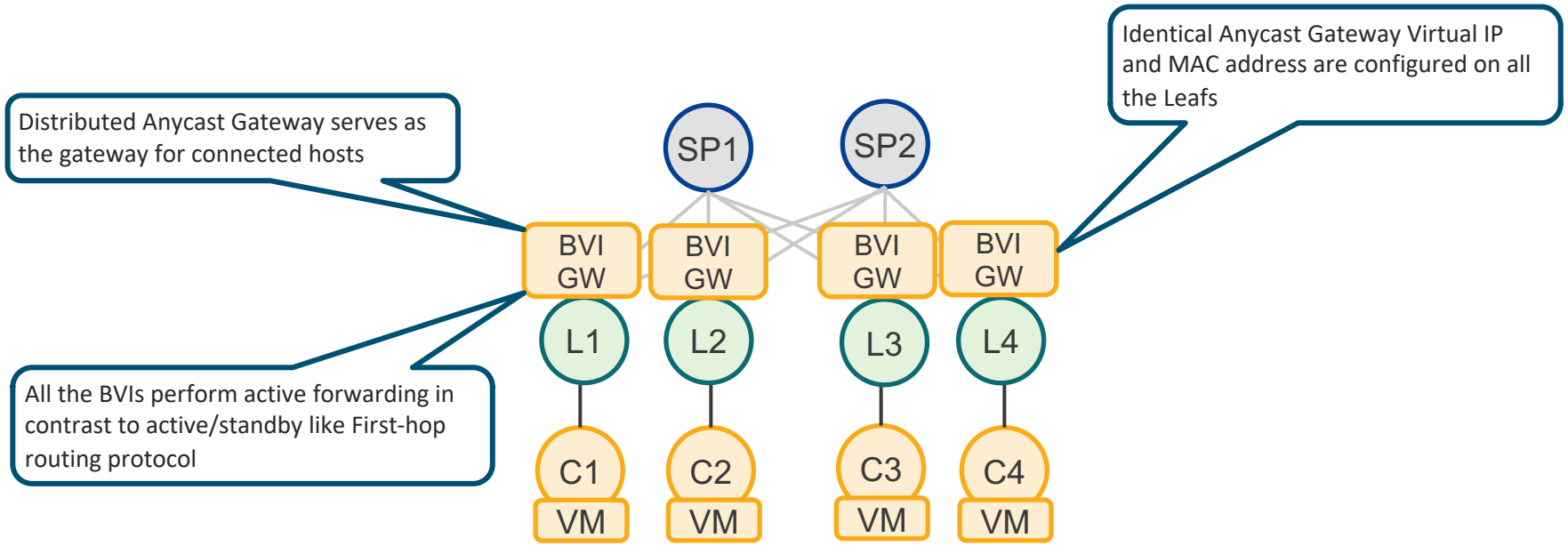
MAC Mobility

- Как детектировать перемещение MAC адреса?



Распределённый шлюз

- Цель – оптимизация маршрутизируемого трафика



Networking
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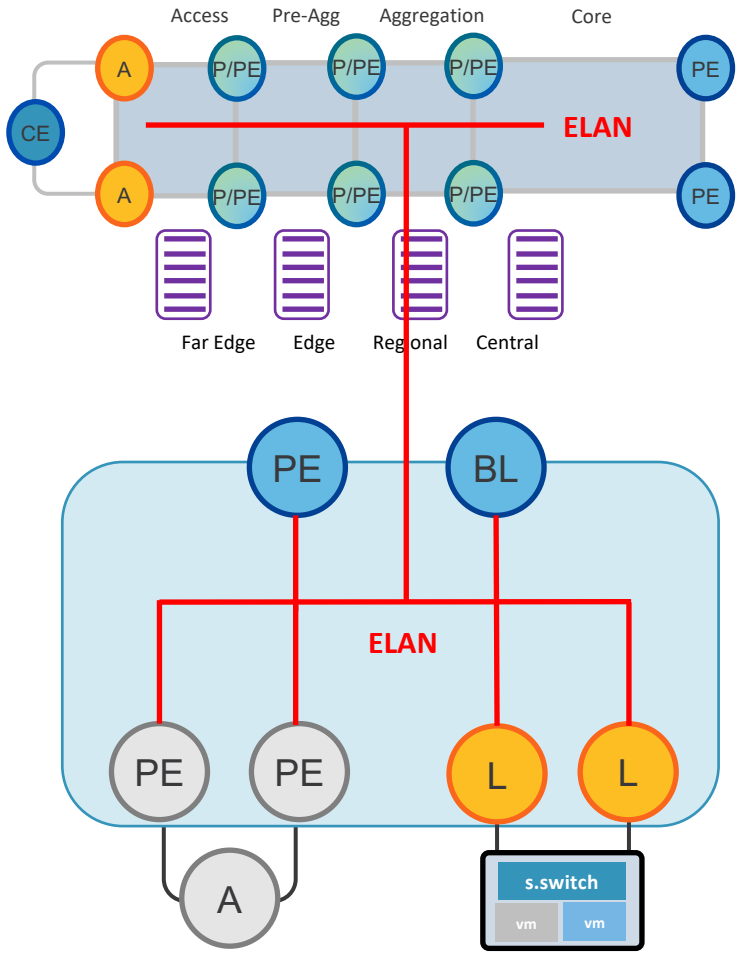
Предоставляемые сервисы

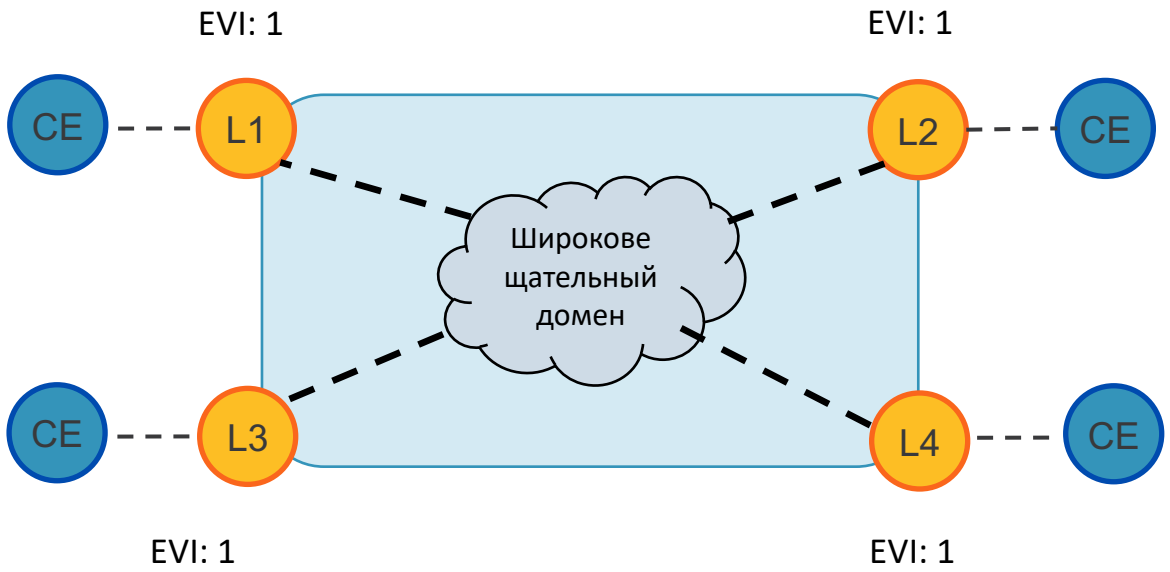
EVPN - Brdiging

Networking
For everyone

- L2 E-LAN E2E Service
- East-West In Fabric
- MAC advertisement
- Multi-homing
- Legacy access protocols
- VPLS seamless interop
- MAC mobility
- On-Demand Nexthop
- Convergence



Bridging - пример

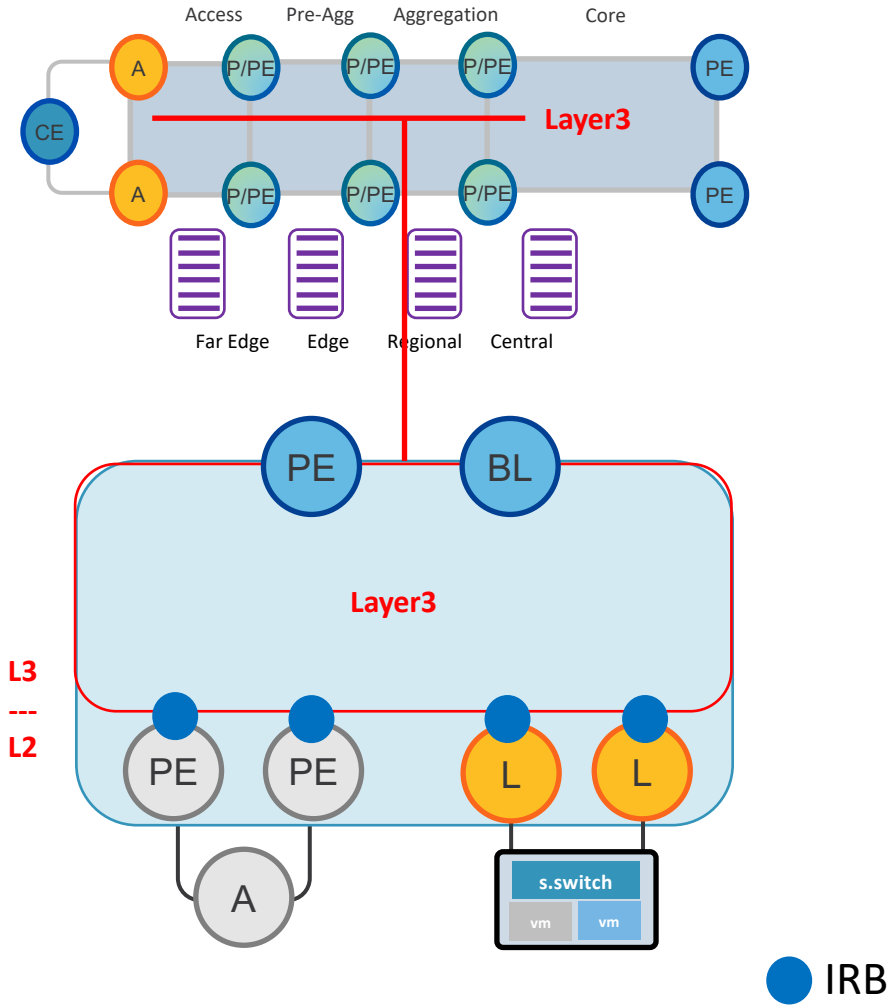


EVI = EVPN instance

EVPN - IRB

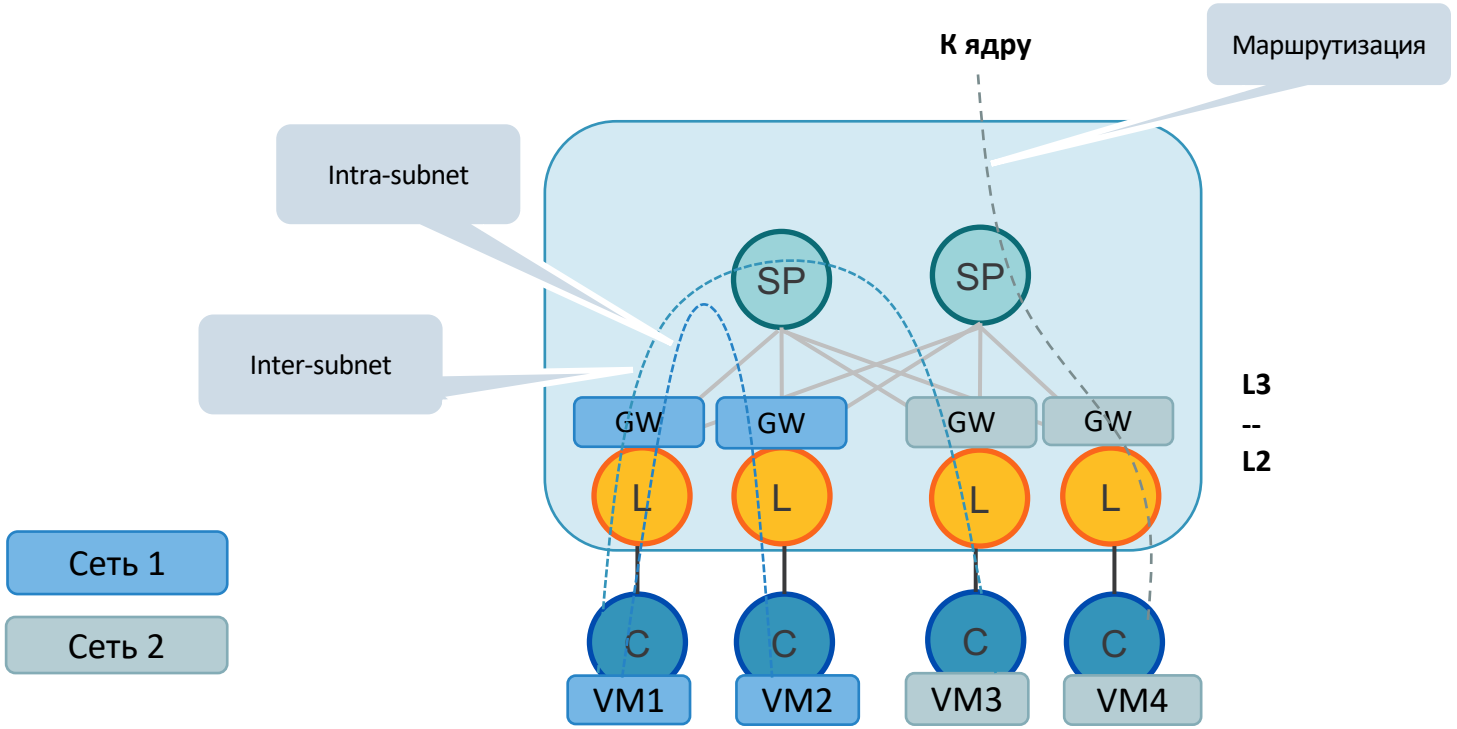
Networking For everyone

- Virtualization and Compute
- L2 Legacy to L3VPN
- Distributed Anycast Gateway
- Symmetric IRB
- Multi-homing
- Host Routing & Mobility
- Optimal Forwarding
- Summarization
- L2 / L3 integration



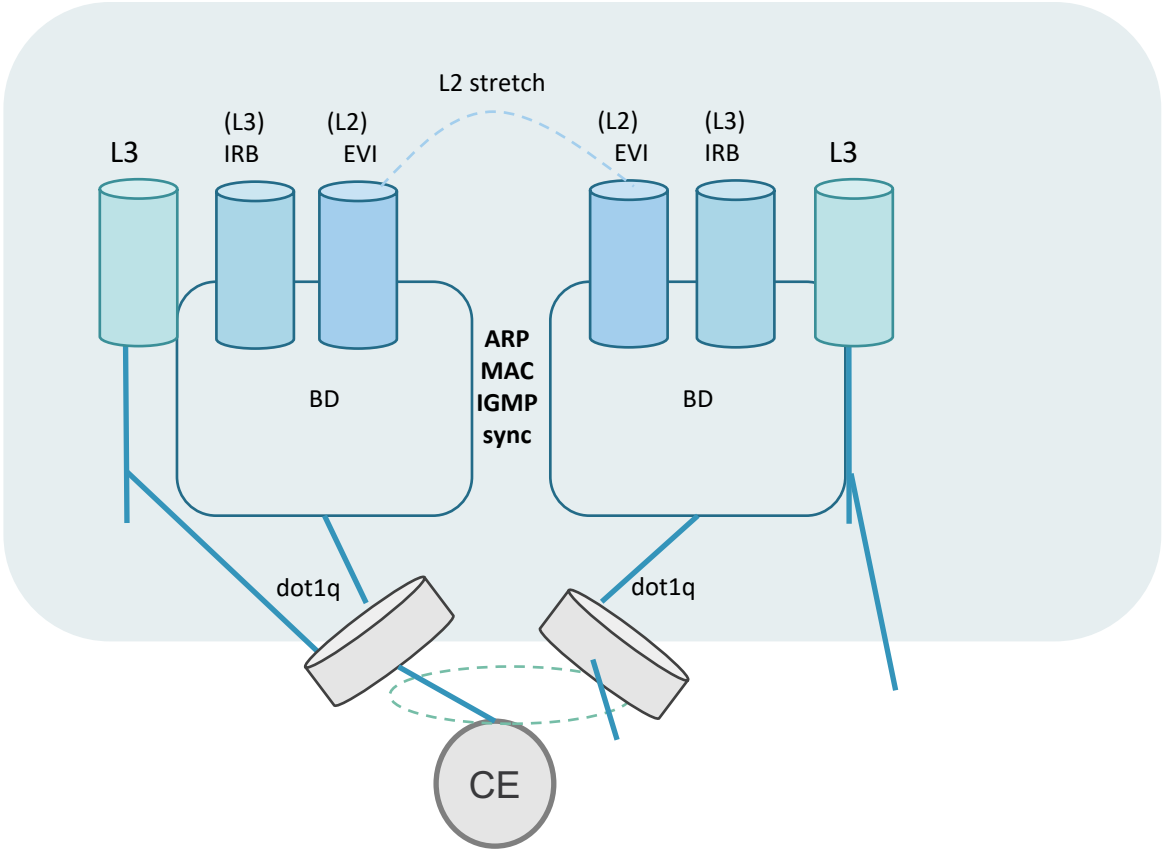
IRB - пример

Networking
For everyone



IP Gateway Multihoming

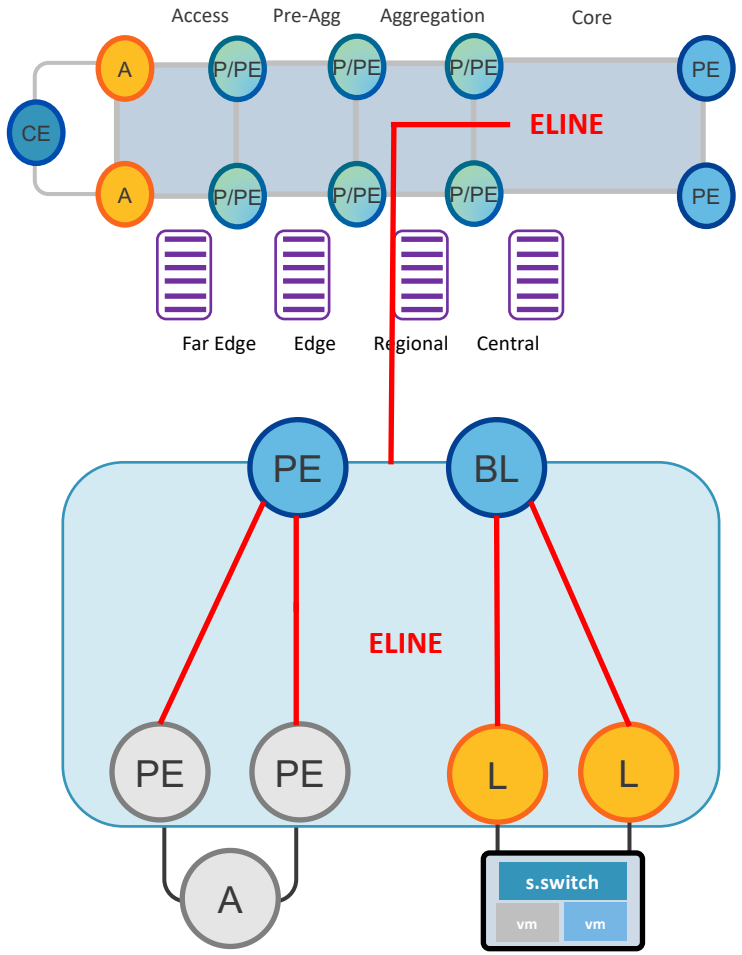
Networking
For everyone



Организация VPWS

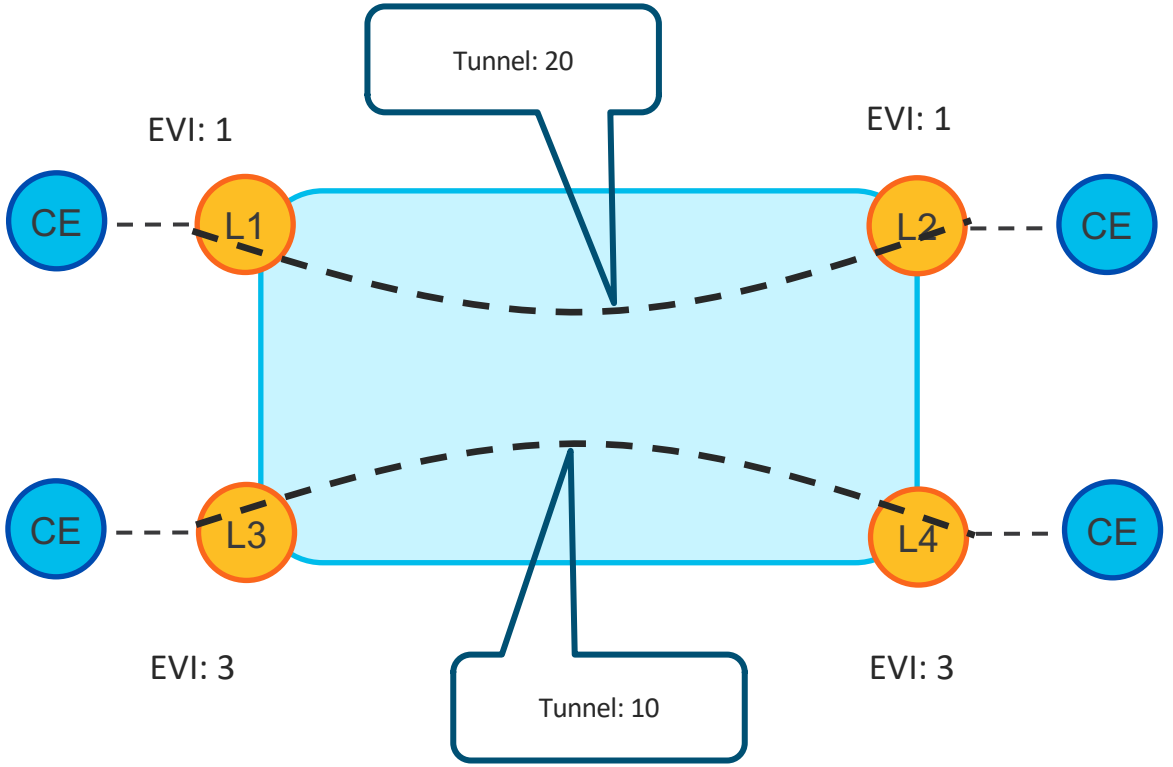
Networking
For everyone

- L2 E-LINE E2E Service
- Access Services to Fabric
- VLAN-unaware
- MPLS / SRv6 dataplane
- Multi-homing
- On-Demand Nexthop



VPWS - пример

Networking For everyone

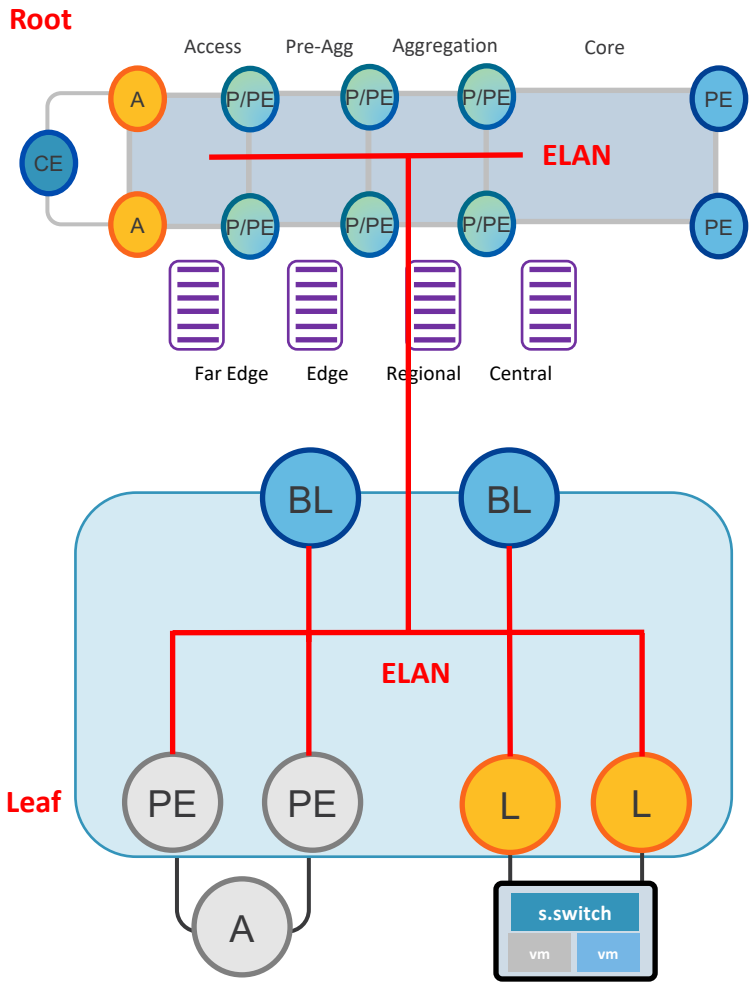


EVI = EVPN instance

EVPN - ETREE

Networking For everyone

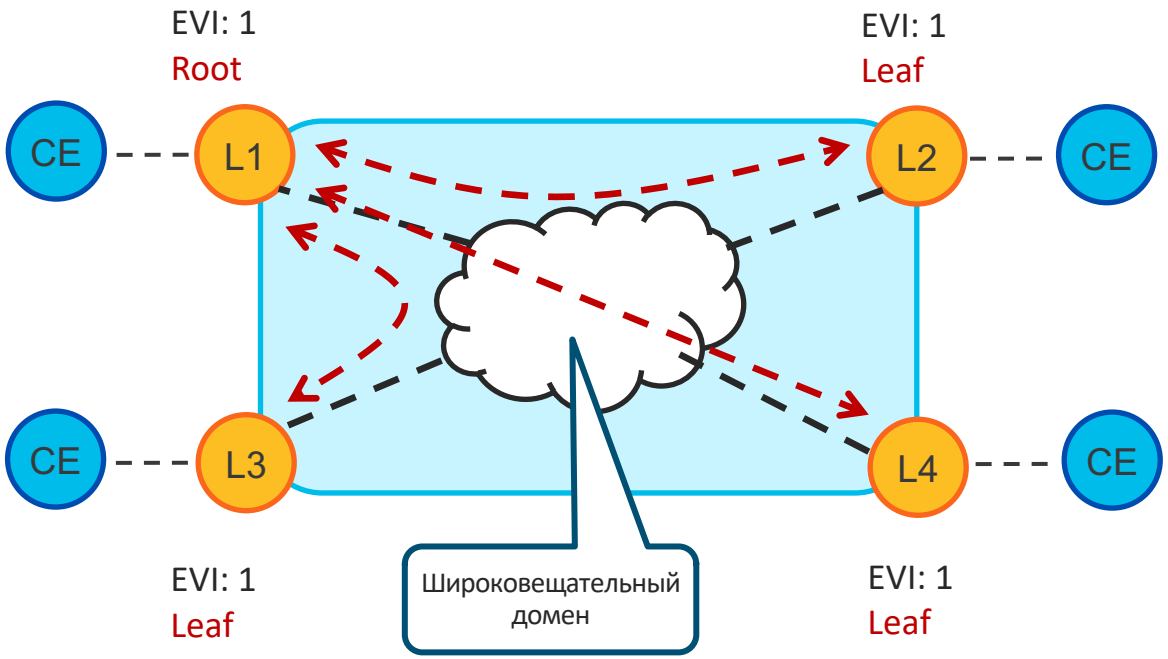
- Residential Services
- BNG applications
- Access Aggregator
- Root/Leaf per router
- Root/Leaf per Bridge Domain
- IRB (as root)
- Multi-homing
- VLAN segmentation



ETREE - пример

Networking For everyone

- ✓ Root to leaf разрешено
- ✓ Leaf to leaf запрещено



EVI = EVPN instance

Networking
For everyone

Примеры конфигурации

```
lacp system mac 3637.3637.3637

interface Bundle-Ether100
 l2transport
 !
!

evpn
 evi 100
  advertise-mac
 !
 group 1
 core interface TenGigE0/0/0/38
 core interface TenGigE0/0/0/39
 !
 interface Bundle-Ether100
 ethernet-segment
  identifier type 0 36.37.00.00.00.00.00.11.00
 !
 core-isolation-group 1
 !
!
```

CE has to receive same lacp system MAC

RT-2 MAC advertise

Core Isolation

```
l2vpn
 bridge group 100
 bridge-domain 100
  interface Bundle-Ether100
  !
  evi 100
  !
 !
 !
!
```

```
router bgp 1
 bgp router-id 3.3.3.36
 address-family l2vpn evpn
 !
 neighbor-group rr
 remote-as 1
 update-source Loopback0
 address-family l2vpn evpn
 !
 neighbor 3.3.3.103
 use neighbor-group rr
 !
 neighbor 3.3.3.104
 use neighbor-group rr
 !
!
```

BGP EVPN CP

IRB

Networking For everyone

```
cef adjacency route override rib


evpn
 no evi 100
  no advertise-mac
 !

vrf a
 address-family ipv4 unicast
 import route-target
  100:100
 !
 export route-target
  100:100
 !
 !
!

interface BVI100
 host-routing
 vrf a
 ipv4 address 192.168.1.1 255.255.255.0
 mac-address 3637.3637.3637
!
```

prefer adjacency /32 (ARP) route over RIB

IOS-XR 6.0+
AIB has the lowest priority by default (LSD>RIB>AIB)

Not needed! We need MAC/IP RT-2

VRF configuration

MAC/IP RT2

Anycast Distributed IRB: Same IP and MAC R36,R37

BGP VRF

Networking For everyone

```
router bgp 1
 bgp router-id 3.3.3.36
 address-family vpnv4 unicast
 !
 address-family l2vpn evpn
 !
 neighbor-group rr
 remote-as 1
 update-source Loopback0
 address-family l2vpn evpn
 !
 neighbor 3.3.3.103
 use neighbor-group rr
 !
 neighbor 3.3.3.104
 use neighbor-group rr
 !
 vrf a
 rd auto
 address-family ipv4 unicast
  additional-paths receive
  maximum-paths ibgp 2
  redistribute connected
 !
!
```

BGP Multi-Path for Inter-subnet forwarding

Networking For everyone