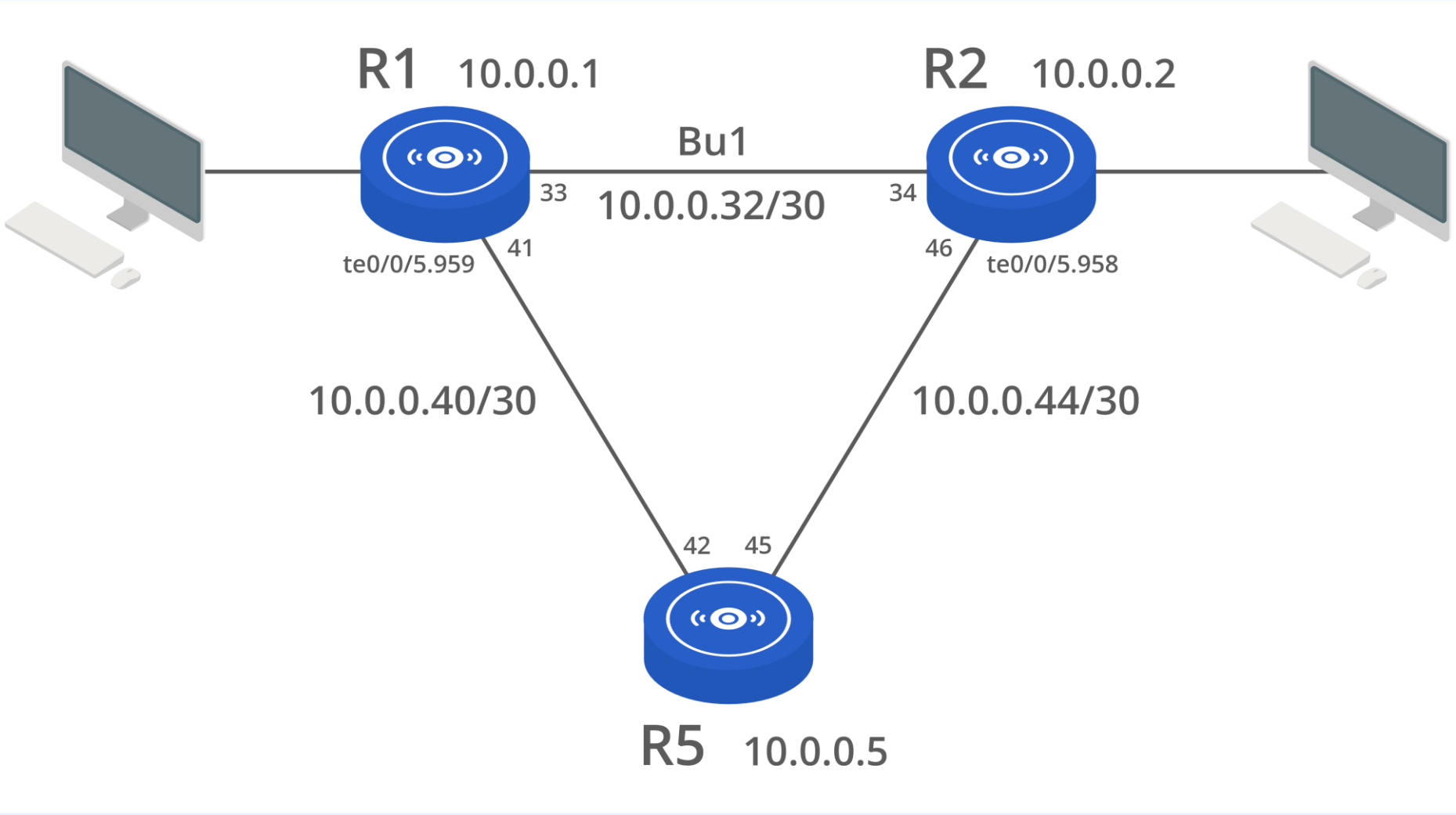
Механизмы минимизации простоев в сети MPLS на магистральных маршрутизаторах серии ME

Топология лабораторного стенда



Конфигурация OSPF, LDP

На примере маршрутизатора R2

```
0/ME5200:R17-180_R2-wbr# sh running-config
router ospfv2 1
Thu Sep 19 17:12:01 2024
! Configuration version 3.9.1.125RC
router ospfv2 1
  area 0.0.0.0
    interface bundle-ether 1
      network point-to-point
    exit
    interface loopback 0
      passive
    exit
    interface tengigabitethernet 0/0/5.958
      network point-to-point
    exit
  exit
  router-id 10.0.0.2
exit
```

```
0/ME5200:R2# sh running-config mpls
Thu Sep 19 17:19:41 2024
! Configuration version 3.9.1.125RC
mpls
  forwarding
    interface bundle-ether 1
    interface loopback 0
    interface tengigabitethernet 0/0/5.958
  exit
  ldp
    discovery interface bundle-ether 1
    exit
    discovery interface tengigabitethernet
0/0/5.958
    exit
    neighbor 10.0.0.1
    exit
  exit
  router-id 10.0.0.2
  transport-address 10.0.0.2
exit
```

Просмотр состояния OSPF, LDP форвардинга

```
0/ME5200:R2# sh ospfv2 neighbors
Sun Sep 22 14:06:39 2024
  Routing Process: 1, ID 10.0.0.2
    Router is not an area border router

  Neighbor ID      Area ID         Pri State     BFD           Dead Time  Last state change  Address      Interface
  ------------  ----------- ---- -------------- ------------- ---------- ------------------ ------------ ----------
  10.0.0.1         0.0.0.0     1  full          not-required  00:00:01   00h06m52s          10.0.0.33    bu1
  10.0.0.5         0.0.0.0     1  full          not-required  00:00:30   01d20h29m          10.0.0.45    te0/0/5.958

0/ME5200:R2#
0/ME5200:R2# sh mpls ldp forwarding
Sun Sep 22 14:06:45 2024
  Codes:
    R = Remote LFA FRR backup
    E = Entropy Label Capability
  Prefix                Label(s) out  Outgoing Interface  Next Hop              flags
  --------------------- ------------ ------------------- --------------------- ------
  10.0.0.1/32           ImpNull       bu1                 10.0.0.33
  10.0.0.5/32           ImpNull       te0/0/5.958         10.0.0.45
0/ME5200:R2#
```

Просмотр LDP форвардинга

```
0/ME5200:R2# sh mpls ldp bindings local
Sun Sep 22 14:07:07 2024
  10.0.0.1/32
    local binding: 10.0.0.1:0, label 165
    State: mapping-established, type: prefix
    Interface:
  10.0.0.1/32
    local binding: 10.0.0.5:0, label 165
    State: mapping-established, type: prefix
    Interface:
  10.0.0.2/32
    local binding: 10.0.0.1:0, label 3
    State: mapping-established, type: prefix
    Interface:
  10.0.0.2/32
    local binding: 10.0.0.5:0, label 3
    State: mapping-established, type: prefix
    Interface:
  10.0.0.5/32
    local binding: 10.0.0.1:0, label 184
    State: mapping-established, type: prefix
    Interface:
0/ME5200:R2#
```

```
0/ME5200:R2# sh mpls ldp bindings remote
Sun Sep 22 14:08:14 2024
  10.0.0.1/32
    local binding: 10.0.0.1:0, label 3
    State: mapping-established, type: prefix
    Interface: Bundle-ether1
  10.0.0.1/32
    local binding: 10.0.0.5:0, label 28
    State: mapping-liberally-retained, type: prefix
    Interface:
  10.0.0.2/32
    local binding: 10.0.0.1:0, label 140
    State: mapping-liberally-retained, type: prefix
    Interface:
  10.0.0.5/32
    local binding: 10.0.0.1:0, label 179
    State: mapping-liberally-retained, type: prefix
    Interface:
  10.0.0.5/32
    local binding: 10.0.0.5:0, label 3
    State: mapping-established, type: prefix
    Interface: Tengigabitethernet0/0/5.958
0/ME5200:R2#
```

Конфигурация сервиса и его состояние

```
0/ME5200:R2# sh l2vpn bridge-domain service
Error: Syntax error on line "sh l2vpn bridge-
domain service": Illegal command line

0/ME5200:R2# sh running-config l2vpn bridge-
domain service
Sun Sep 22 12:48:50 2024
! Configuration version 3.9.1.125RC
l2vpn
  bridge-domain service
    interface tengigabitethernet 0/0/5.1952
    exit
    pw 10.0.0.1 33
      pw-class LDP-transport
    exit
  exit
exit
```

```
0/ME5200:R2#
0/ME5200:R2# sh l2vpn bridge-domain bd-name service
Sun Sep 22 12:49:10 2024
  MM -- mtu mismatch              Up -- up          GUp -- going up
  CM -- control-word mismatch     Dn -- down        GDn -- going down
  OL -- no outgoing label         ST -- standby     Lld -- lower layer down
  BK -- backup connection         Fl -- failed      Drm -- dormant
  SP -- static pseudowire         SW -- switchover

  Bridge domain: service, state: up, bridge type: vpls
    MAC learning: enabled
    Local switching: enabled
    Flood replication point: egress
    Flooding Multicast: enabled
      Unknown unicast: enabled
    MAC aging time: 300 s, MAC limit: 4000, Action: enabled, MTU: 1500
    Oper-status: up
    ACs: 1 (1 up)
    PWs: 1 (1 up)
```

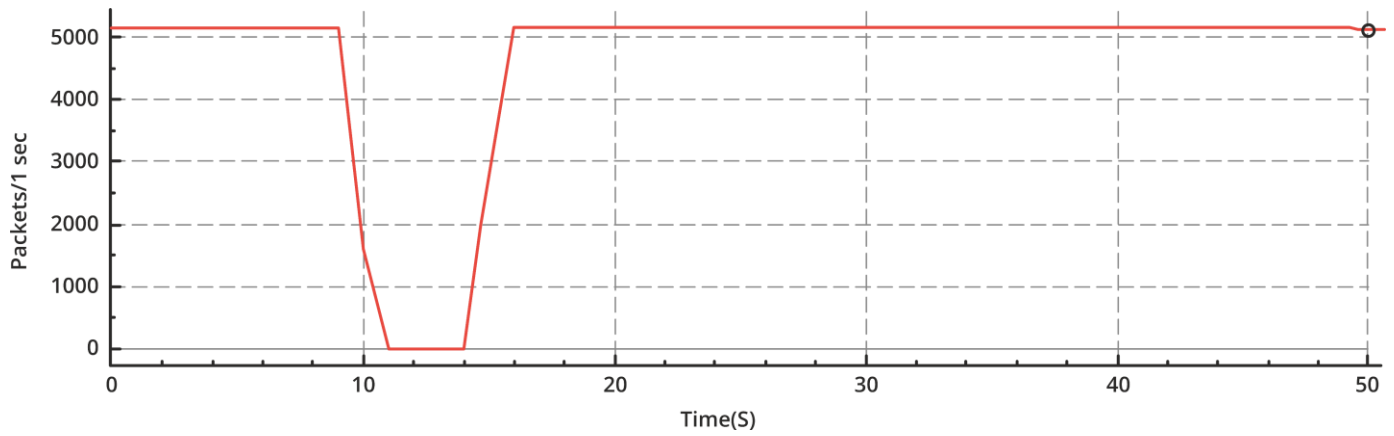
Конфигурация сервиса и его состояние

```
List of ACs:

      AC: Tengigabitethernet0/0/5.1952
        AC binding status: up, Interface
oper state: up

    List of PWs:

      PW: Neighbor 10.0.0.1, pw-id 33, admin
Up, oper Up
      Status codes:
        PW class: LDP-transport, type:
ethernet, signaling: pseudowire-id-fec-
signaling
        PSN type: mpls, encapsulation: MPLS,
control word: control-word-not-present
        Redundancy state active
        Vpn index: 4, type: ls
        Created: 2024-09-12 18:42:11, last
state change: 01d19h49m ago
```

```
                                        Local          Remote
Label                                   164            171
Group ID                                0              0
MTU                                     1500           1500
Forwarding                              true           true
Customer-facing (ingress) recv fault    false          false
Customer-facing (egress) send fault     false          false
Local PSN-facing (ingress) recv fault   false          false
Local PSN-facing (egress) send fault    false          false
Switchover                              false          false
Interface description string rcv: none
Remote capabilities:
VC status can be signaled: true
VCCV ID can be signaled  : false
Remote node capability:
Manually set PW: false
Protocol has not yet finished cap. determination: false
Signaling the pseudowire: true
Sending the pseudowire: false

List of VFIs:

List of Autodiscovery PWs:

0/ME5200:R2#
```

Время перерыва сервиса

При падении линка без дополнительных настроек



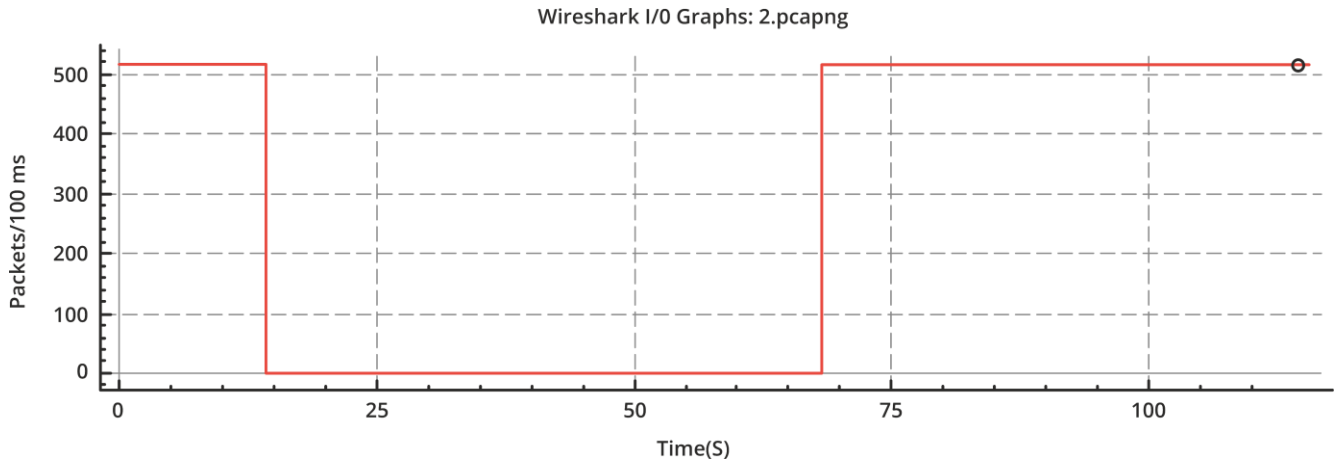
No.	Time	Source	Destination	Protocol	Length	Info
53223	10.312088137	10.200.200.10	10.10.10.101	UDP	247	14354 → 1604 Len=201
53224	10.312285275	10.200.200.10	10.10.10.101	UDP	247	14355 → 1605 Len=201
53225	10.312477404	10.200.200.10	10.10.10.101	UDP	247	14356 → 1606 Len=201
53226	10.312672773	10.200.200.10	10.10.10.102	UDP	247	14308 → 1610 Len=201
53227	10.312863946	10.200.200.10	10.10.10.102	UDP	247	14318 → 1620 Len=201
53228	10.313058640	10.200.200.10	10.10.10.102	UDP	247	14328 → 1630 Len=201
53244	15.448001909	10.200.200.10	10.10.10.103	UDP	247	15358 → 1700 Len=201
53245	15.448183098	10.200.200.10	10.10.10.103	UDP	247	16358 → 1800 Len=201
53246	15.448366397	10.200.200.10	10.10.10.101	UDP	247	14351 → 1601 Len=201

```
router ospfv2 1
  area 0.0.0.0
    interface bundle-ether 1
      network point-to-point
    exit
    interface loopback 0
      passive
    exit
    interface tengigabitethernet 0/0/5.958
      network point-to-point
    exit
  exit
  auto-cost reference-bandwidth 100000000
  router-id 10.0.0.2
exit
```

Время перерыва 5,11 сек.

Время перерыва сервиса

Без падения линка без дополнительных настроек



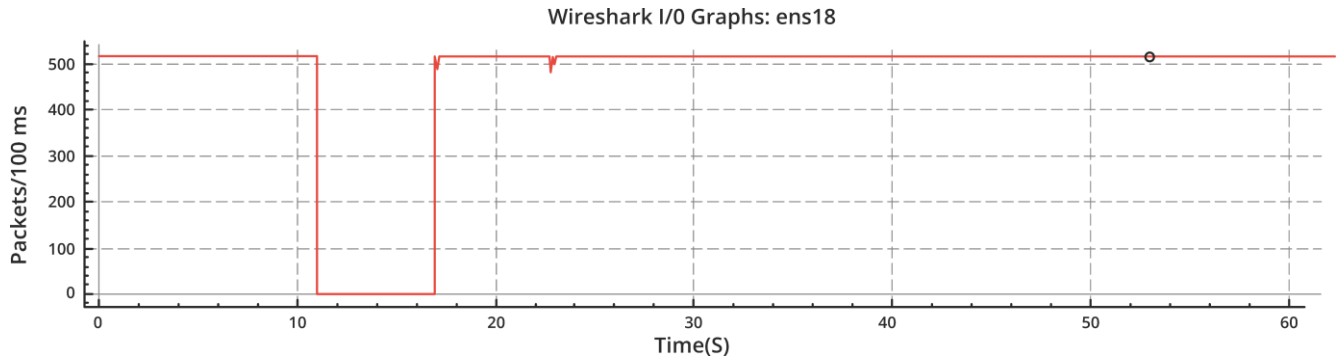
No.	Time	Source	Destination	Protocol	Length	Info
74207	14.414901892	10.200.200.10	10.10.10.101	UDP	247	14355 → 1605 Len=201
74208	14.415093497	10.200.200.10	10.10.10.101	UDP	247	14356 → 1606 Len=201
74209	14.415289097	10.200.200.10	10.10.10.102	UDP	247	14308 → 1610 Len=201
74788	68.323963667	10.200.200.10	10.10.10.102	UDP	247	14308 → 1610 Len=201
74789	68.324106099	10.200.200.10	10.10.10.102	UDP	247	14318 → 1620 Len=201
74790	68.324304175	10.200.200.10	10.10.10.102	UDP	247	14328 → 1630 Len=201
74791	68.324498583	10.200.200.10	10.10.10.102	UDP	247	14338 → 1640 Len=201
74792	68.324705389	10.200.200.10	10.10.10.102	UDP	247	14348 → 1650 Len=201
74793	68.324889417	10.200.200.10	10.10.10.102	UDP	247	14358 → 1660 Len=201

```
router ospfv2 1
  area 0.0.0.0
    interface bundle-ether 1
      network point-to-point
    exit
    interface loopback 0
      passive
    exit
    interface tengigabitethernet 0/0/5.952
      network point-to-point
    exit
    interface tengigabitethernet 0/0/5.958
      network point-to-point
    exit
  exit
  auto-cost reference-bandwidth 100000000
  router-id 10.0.0.2
exit
```

Время перерыва 54 сек!

Время перерыва сервиса

Без падения линка с уменьшенными hello и dead интервалами



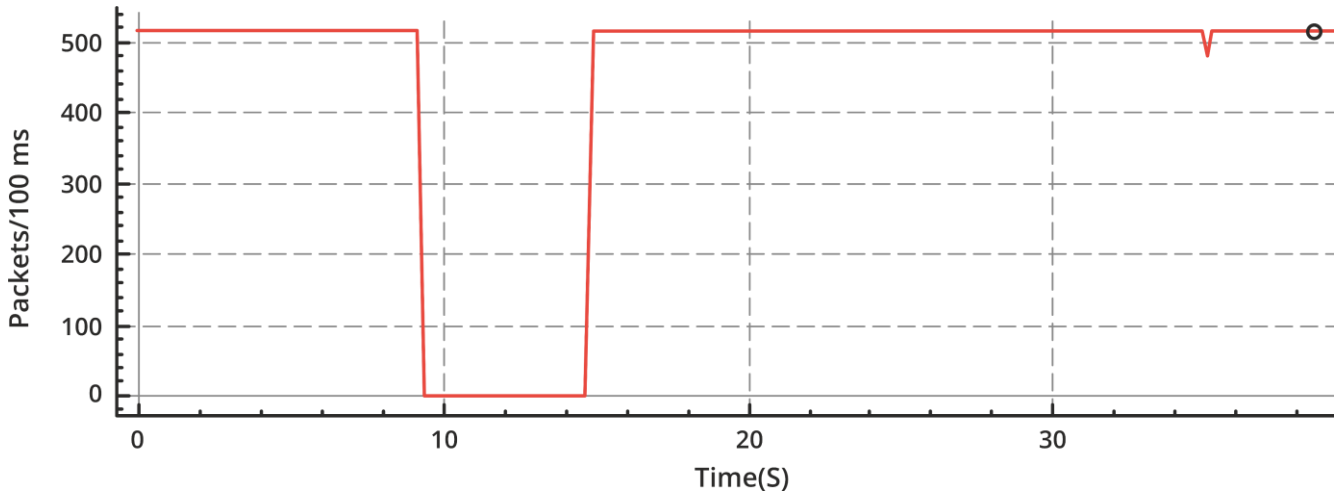
No.	Time	Source	Destination	Protocol	Length	Info
56795	11.025806030	10.200.200.10	10.10.10.102	UDP	247	14308 → 1610 Len=201
56796	11.026003922	10.200.200.10	10.10.10.102	UDP	247	14318 → 1620 Len=201
56797	11.026160743	10.200.200.10	10.10.10.102	UDP	247	14328 → 1630 Len=201
56798	11.026355315	10.200.200.10	10.10.10.102	UDP	247	14338 → 1640 Len=201
56910	16.886821570	10.200.200.10	10.10.10.101	UDP	247	14356 → 1606 Len=201
56911	16.886998177	10.200.200.10	10.10.10.102	UDP	247	14308 → 1610 Len=201
56912	16.887191754	10.200.200.10	10.10.10.102	UDP	247	14318 → 1620 Len=201
56913	16.887385530	10.200.200.10	10.10.10.102	UDP	247	14328 → 1630 Len=201
56914	16.887582422	10.200.200.10	10.10.10.102	UDP	247	14338 → 1640 Len=201
56915	16.887776525	10.200.200.10	10.10.10.102	UDP	247	14348 → 1650 Len=201
56916	16.887970685	10.200.200.10	10.10.10.102	UDP	247	14358 → 1660 Len=201

```
router ospfv2 1
  area 0.0.0.0
    interface bundle-ether 1
      dead-interval minimal
      fast-hello-multiplier 3
      network point-to-point
    exit
    interface loopback 0
      passive
    exit
    interface tengigabitethernet 0/0/5.958
      network point-to-point
    exit
  exit
  auto-cost reference-bandwidth 100000000
  router-id 10.0.0.2
exit
```

Время перерыва 5,9 сек.

Время перерыва сервиса

При падении линка с уменьшенными hello и dead интервалами



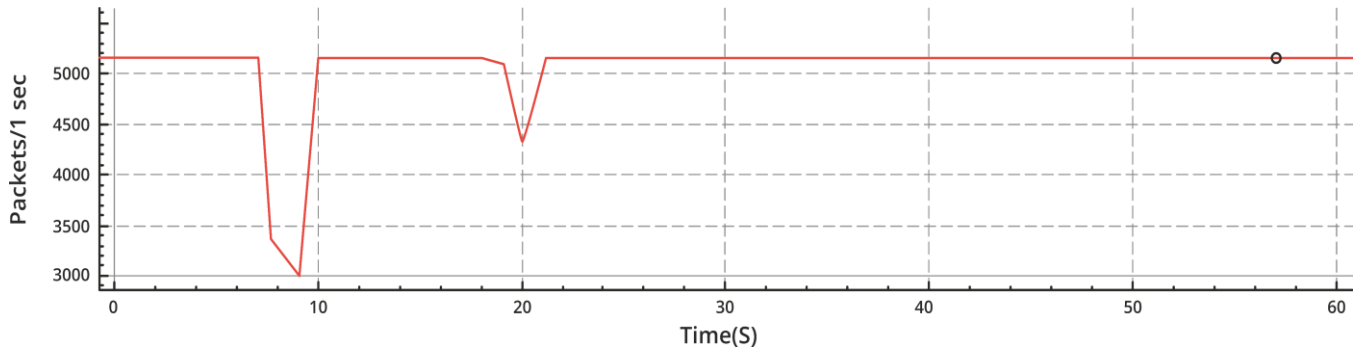
No.	Time	Source	Destination	Protocol	Length	Info
48678	9.453076061	10.200.200.10	10.10.10.103	UDP	247	16358 → 1800 Len=201
48679	9.453270032	10.200.200.10	10.10.10.101	UDP	247	14351 → 1601 Len=201
48680	9.453464293	10.200.200.10	10.10.10.101	UDP	247	14352 → 1602 Len=201
48681	9.453658980	10.200.200.10	10.10.10.101	UDP	247	14353 → 1603 Len=201
48682	9.453853810	10.200.200.10	10.10.10.101	UDP	247	14354 → 1604 Len=201
48683	9.454049594	10.200.200.10	10.10.10.101	UDP	247	14355 → 1605 Len=201
48839	14.557516724	10.200.200.10	10.10.10.103	UDP	247	11358 → 1300 Len=201
48840	14.557705783	10.200.200.10	10.10.10.103	UDP	247	12358 → 1400 Len=201
48841	14.557899443	10.200.200.10	10.10.10.103	UDP	247	13358 → 1500 Len=201

```
router ospfv2 1
  area 0.0.0.0
    interface bundle-ether 1
      dead-interval minimal
      fast-hello-multiplier 3
      network point-to-point
    exit
    interface loopback 0
      passive
    exit
    interface tengigabitethernet 0/0/5.958
      network point-to-point
    exit
  exit
  auto-cost reference-bandwidth 100000000
  router-id 10.0.0.2
exit
```

Время перерыва 5,10 сек.

Время перерыва сервиса

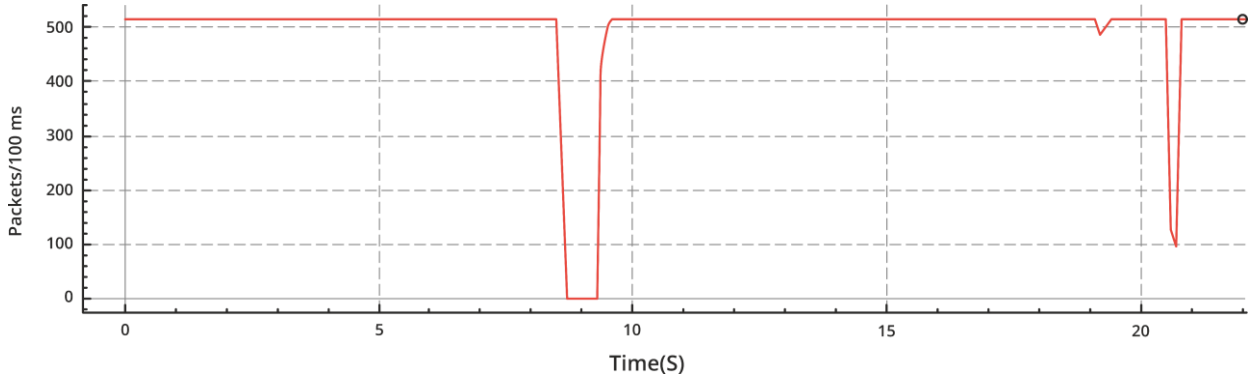
С уменьшенным таймером route-calculation



No.	Time	Source	Destination	Protocol	Length	Info
44540	8.655040202	10.200.200.10	10.10.10.101	UDP	247	14355 → 1605 Len=201
44541	8.655236490	10.200.200.10	10.10.10.101	UDP	247	14356 → 1606 Len=201
44542	8.655429092	10.200.200.10	10.10.10.102	UDP	247	14308 → 1610 Len=201
44543	8.655623267	10.200.200.10	10.10.10.102	UDP	247	14318 → 1620 Len=201
44544	8.655818384	10.200.200.10	10.10.10.102	UDP	247	14328 → 1630 Len=201
44545	8.656010941	10.200.200.10	10.10.10.102	UDP	247	14338 → 1640 Len=201
44548	9.417024082	10.200.200.10	10.10.10.103	UDP	247	16358 → 1800 Len=201
44549	9.417164478	10.200.200.10	10.10.10.101	UDP	247	14351 → 1601 Len=201
44550	9.417352691	10.200.200.10	10.10.10.101	UDP	247	14352 → 1602 Len=201
44551	9.417577891	10.200.200.10	10.10.10.101	UDP	247	14353 → 1603 Len=201
44552	9.417747048	10.200.200.10	10.10.10.101	UDP	247	14354 → 1604 Len=201

```
router ospfv2 1
  area 0.0.0.0
    interface bundle-ether 1
      dead-interval minimal
      fast-hello-multiplier 3
      network point-to-point
    exit
    interface loopback 0
      passive
    exit
    interface tengigabitethernet 0/0/5.958
      network point-to-point
    exit
  exit
  auto-cost reference-bandwidth 100000000
  route-calculation max-delay 0
  router-id 10.0.0.2
exit
```

Падение LDP при восстановлении канала

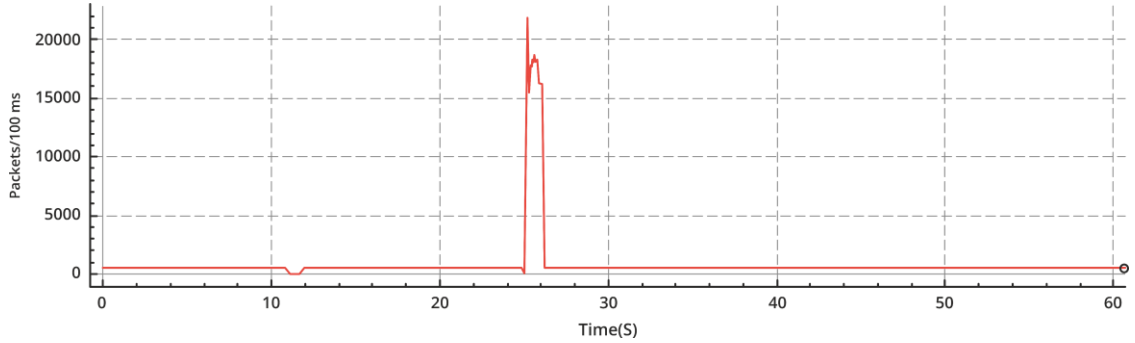



```
2024-09-22T14:28:31.520105+07:00 dcsi[758][758]: %OSPF_V2-W-ADJCHANGE: Router 10.0.0.2: Nbr 10.0.0.1 at 10.0.0.33,
interface bu1 changed state to DOWN
2024-09-22T14:28:41.270241+07:00 dcsi[758][758]: %OSPF_V2-W-ADJCHANGE: Router 10.0.0.2: Nbr 10.0.0.1 at 10.0.0.33,
interface bu1 changed state to INIT
2024-09-22T14:28:41.323080+07:00 dcsi[758][758]: %OSPF_V2-W-ADJCHANGE: Router 10.0.0.2: Nbr 10.0.0.1 at 10.0.0.33,
interface bu1 changed state to TWO WAY
2024-09-22T14:28:41.325046+07:00 dcsi[758][758]: %OSPF_V2-W-ADJCHANGE: Router 10.0.0.2: Nbr 10.0.0.1 at 10.0.0.33,
interface bu1 changed state to EXCHANGE
2024-09-22T14:28:41.329822+07:00 dcsi[758][758]: %OSPF_V2-W-ADJCHANGE: Router 10.0.0.2: Nbr 10.0.0.1 at 10.0.0.33,
interface bu1 changed state to FULL
2024-09-22T14:28:42.859160+07:00 if-manager[690][690]: %IF_MGR-N-LINK_DOWN: PW 33 peer 10.0.0.1
2024-09-22T14:28:42.863919+07:00 if-manager[690][690]: %IF_MGR-N-LINK_UP: PW 33 peer 10.0.0.1 (active)
```

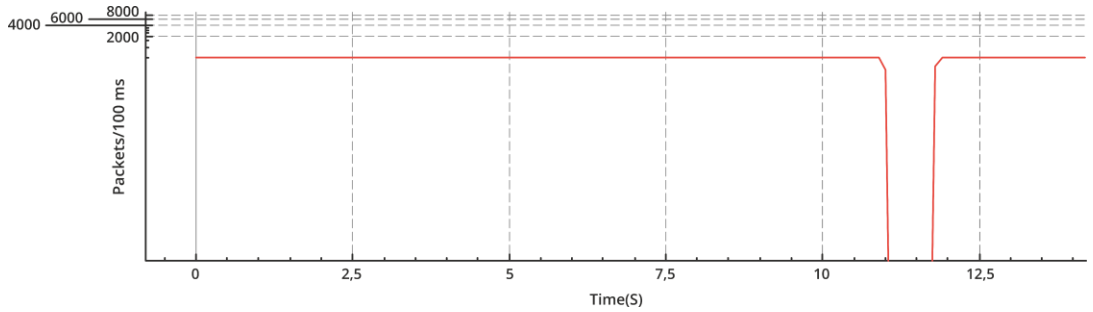
Время перерыва сервиса

С уменьшенным таймером route-calculation и включенной синхронизацией IGP-LDP

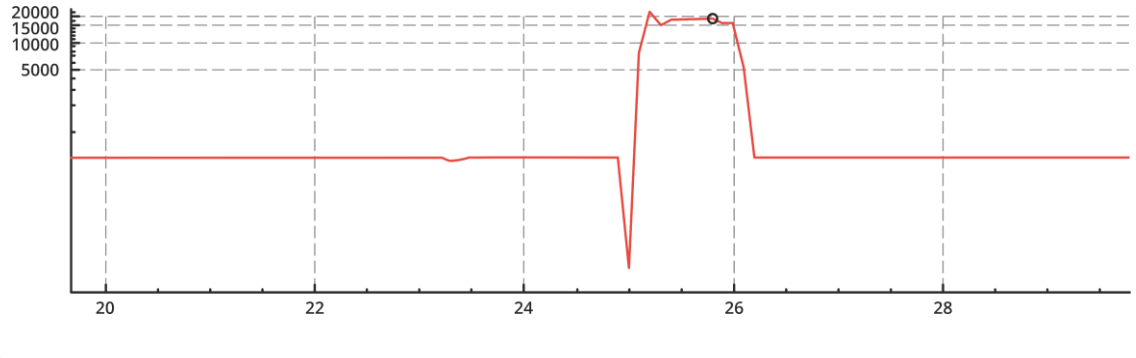
Видно возникновение петли маршрутизации



Перерыв при основном переключении составил 799 ms

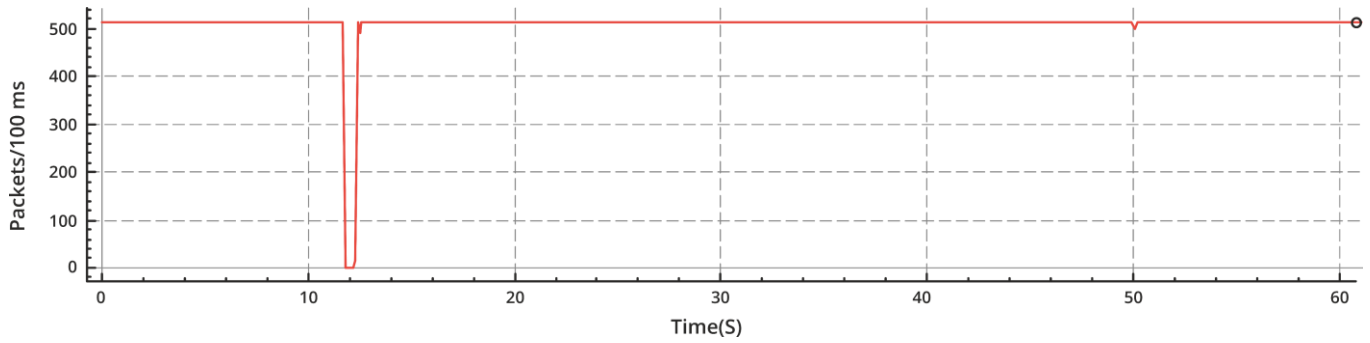


Продолжительность всплеска трафика превышает даже время перерыва при первом обрыве



Время перерыва сервиса

С учетом всех настроек лишь немного меньше 1 секунды



No.	Time	Source	Destination	Protocol	Length	Info
59091	11.479129607	10.200.200.10	10.10.10.103	UDP	247	16358 → 1800 Len=201
59092	11.479320665	10.200.200.10	10.10.10.101	UDP	247	14351 → 1601 Len=201
59093	11.479515014	10.200.200.10	10.10.10.101	UDP	247	14352 → 1602 Len=201
59094	11.479708211	10.200.200.10	10.10.10.101	UDP	247	14353 → 1603 Len=201
59095	11.479905277	10.200.200.10	10.10.10.101	UDP	247	14354 → 1604 Len=201
59098	12.397168276	10.200.200.10	10.10.10.101	UDP	247	14356 → 1606 Len=201
59099	12.397349586	10.200.200.10	10.10.10.102	UDP	247	14308 → 1610 Len=201
59100	12.397532055	10.200.200.10	10.10.10.102	UDP	247	14318 → 1620 Len=201
59101	12.397726332	10.200.200.10	10.10.10.102	UDP	247	14328 → 1630 Len=201
59102	12.397922069	10.200.200.10	10.10.10.102	UDP	247	14338 → 1640 Len=201
59103	12.398125860	10.200.200.10	10.10.10.102	UDP	247	14348 → 1650 Len=201

```
router ospfv2 1
  area 0.0.0.0
    interface bundle-ether 1
      dead-interval minimal
      fast-hello-multiplier 3
      ldp-igp-synchronization hold-time 20
      network point-to-point
    exit
    interface loopback 0
      passive
    exit
    interface tengigabitethernet 0/0/5.958
      network point-to-point
    exit
  exit
  auto-cost reference-bandwidth 100000000
  microloop-avoidance rib-update-delay 100
  route-calculation max-delay 50
  router-id 10.0.0.2
exit

Время перерыва 918 ms.
```

Настройка и просмотр параметров BFD сессий

```
0/ME5200:R2# sh running-config bfd
Sun Sep 22 17:34:38 2024
! Configuration version 3.9.1.125RC
bfd
  rx-interval 50
  session ospf
    address-family ipv4 local-address 10.0.0.34
    address-family ipv4 neighbor 10.0.0.33
    rx-interval 25
    tx-interval 25
  exit
  tx-interval 50
exit
0/ME5200:R2#
0/ME5200:R2# sh bfd neighbors
Sun Sep 22 17:34:54 2024
  IPv4
  Neighbor address  Local address    Discriminator  State       Code             Protocols      ession name
  ----------------- ---------------- -------------- ----------- ---------------- -------------- ------------
  10.0.0.33         10.0.0.34        1              up          no-diagnostic    ospf           ospf
There are no BFD neighbors over IPv6
```

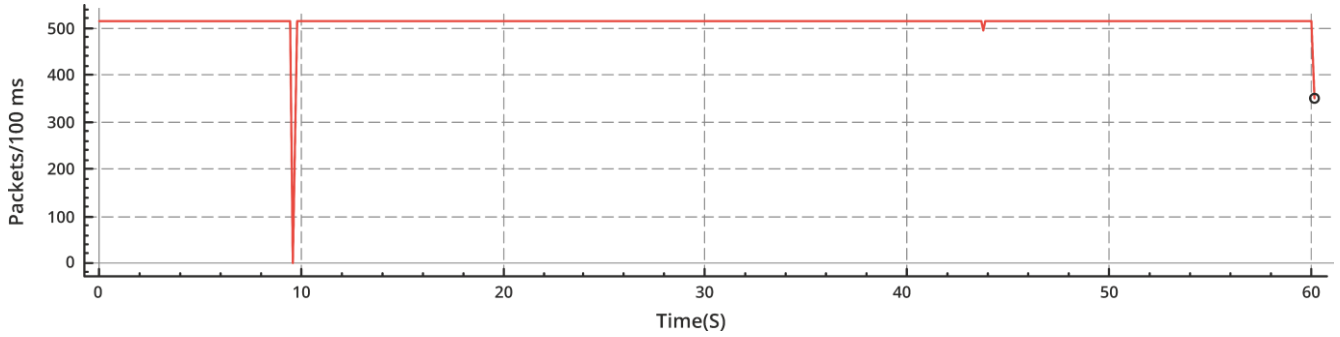
Настройка и просмотр параметров BFD сессий

```
0/ME5200:R2# sh bfd neighbors ipv4 10.0.0.33
Sun Sep 22 17:35:38 2024

  Neighbor Address: 10.0.0.33
  Local address: 10.0.0.34
  Session state is up
  Diagnostic: no-diagnostic
  Interface: bu1
  Applied session profile: ospf
  LocalDiscriminator: 1
  RemoteDiscriminator: 1
  Registered protocols: ospf
  MinTxInt: 25 ms, MinRxInt: 25 ms, Multiplier: 3
  Received MinTxInt: 25 ms, Received Multiplier: 3
  Actual TxInt: 25 ms
  Actual Detection Interval: 75 ms
  Peer path is single-hop
  BFD is hardware
  Uptime: 00h14m40s
```

```
 Elapsed time since the last change: 00h14m40s
  Last received packet:
    Version: 1
    Diagnostic: no-diagnostic
    State bit: up
    Multiplier: 3
    Length: 24
    My Discriminator: 1
    Your Discriminator: 1
    Desired Min Tx Interval: 25 ms
    Required Min Rx Interval: 25 ms
    Required Min Echo Rx Interval: 0 ms
    Flags:
      Poll:                          0
      Final:                         0
      Control Plane Independent:     1
      Authentication Present:        0
      Demand:                        0
      Multipoint:                    0

0/ME5200:R2#
```

Время перерыва сервиса

Со стандартными таймерами и поднятым функционалом BFD

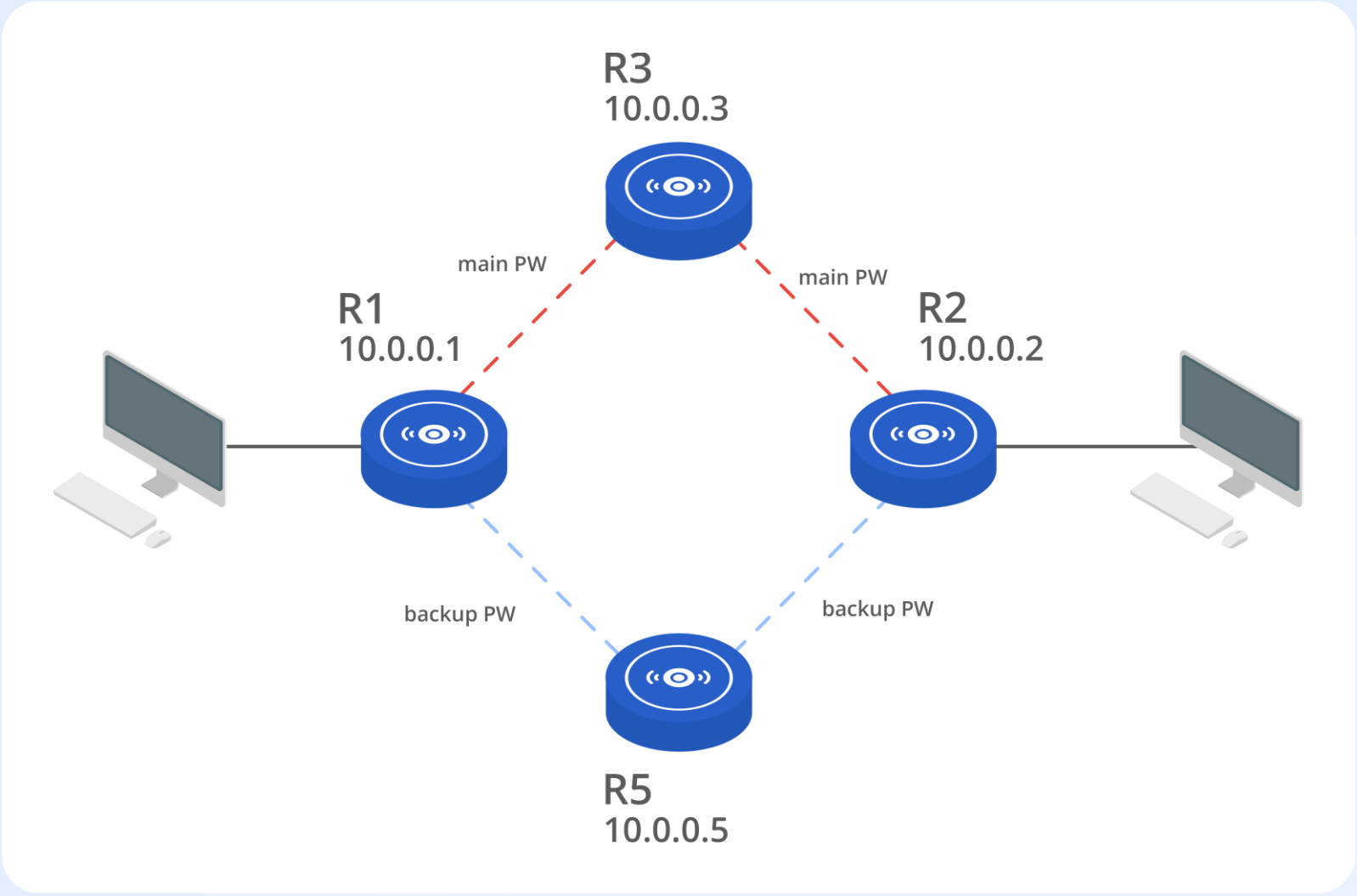


No.	Time	Source	Destination	Protocol	Length	Info
47759	9.280645440	10.200.200.10	10.10.10.101	UDP	247	14351 → 1601 Len=201
47760	9.280839799	10.200.200.10	10.10.10.101	UDP	247	14352 → 1602 Len=201
47761	9.281033707	10.200.200.10	10.10.10.101	UDP	247	14353 → 1603 Len=201
47762	9.281228238	10.200.200.10	10.10.10.101	UDP	247	14354 → 1604 Len=201
47763	9.281423557	10.200.200.10	10.10.10.101	UDP	247	14355 → 1605 Len=201
47764	9.281617345	10.200.200.10	10.10.10.101	UDP	247	14356 → 1606 Len=201
47766	9.511310032	10.200.200.10	10.10.10.103	UDP	247	15358 → 1700 Len=201
47767	9.511459742	10.200.200.10	10.10.10.103	UDP	247	16358 → 1800 Len=201
47768	9.511652381	10.200.200.10	10.10.10.101	UDP	247	14351 → 1601 Len=201
47769	9.511846172	10.200.200.10	10.10.10.101	UDP	247	14352 → 1602 Len=201
47770	9.512043485	10.200.200.10	10.10.10.101	UDP	247	14353 → 1603 Len=201

```
router ospfv2 1
  area 0.0.0.0
    interface bundle-ether 1
      bfd fast-detect
      ldp-igp-synchronization hold-time 20
      network point-to-point
    exit
    interface loopback 0
      passive
    exit
    interface tengigabitethernet 0/0/5.958
      network point-to-point
    exit
  exit
  auto-cost reference-bandwidth 100000000
  microloop-avoidance rib-update-delay 100
  route-calculation max-delay 50
  router-id 10.0.0.2
exit
```

Время перерыва 230 ms.

Схема стенда для проверки времени переключения при использовании backup PW



Конфигурация сервиса

На устройствах стенда R1

```
0/ME5100revX:R1# sh run l2
Tue Sep 24 11:20:41 2024
! Configuration version 3.9.1.131R
l2vpn
  pw-class LDP-transport
    encapsulation mpls signaling-type pseudowire-
    id-fec-signaling
  exit
  xconnect-group service
    p2p service
      interface tengigabitethernet 0/0/5.1951
      pw 10.0.0.3 33
        backup
          pw 10.0.0.5 35
            pw-class LDP-transport
          exit
        exit
        pw-class LDP-transport
      exit
    exit
  exit
exit
```

```
0/ME5100revX:R1#  sh run mpls
Tue Sep 24 11:21:52 2024
! Configuration version 3.9.1.131R
mpls
  forwarding
    interface loopback 0
    interface tengigabitethernet 0/0/5.951
    interface tengigabitethernet 0/0/5.959
  exit
  ldpt
    discovery interface tengigabitethernet 0/0/5.951
    exit
    discovery interface tengigabitethernet 0/0/5.959
    exit
    neighbor 10.0.0.3
      bfd fast-detect
    exit
    neighbor 10.0.0.5
      bfd fast-detect
    exit
    reroute-optimization
  exit
  router-id 10.0.0.1
  transport-address 10.0.0.1
exit
```

Конфигурация сервиса

На устройствах стенда R2

```
0/ME5200:R2# sh run l2
! Configuration version 3.9.1.131R
l2vpn
  pw-class LDP-transport
    encapsulation mpls signaling-type pseudowire-
id-fec-signaling
  exit
  xconnect-group test
    p2p test
      interface tengigabitethernet 0/0/5.1952
      pw 10.0.0.3 23
        backup
          pw 10.0.0.5 25
            pw-class LDP-transport
          exit
        exit
        pw-class LDP-transport
      exit
    exit
  exit
exit
```

```
0/ME5200:R2# sh run mpls
Tue Sep 24 11:26:26 2024
! Configuration version 3.9.1.131R
mpls
  forwarding
    interface loopback 0
    interface tengigabitethernet 0/0/5.952
    interface tengigabitethernet 0/0/5.958
  exit
  ldp
    discovery interface tengigabitethernet 0/0/5.952
    exit
    discovery interface tengigabitethernet 0/0/5.958
    exit
    neighbor 10.0.0.3
      bfd fast-detect
    exit
    neighbor 10.0.0.5
      bfd fast-detect
    exit
    reroute-optimization
  exit
  router-id 10.0.0.2
  transport-address 10.0.0.2
exit
```

Конфигурация сервиса

На устройствах стенда R3

```
0/ME5100:R3# sh run l2
Tue Sep 24 04:30:38 2024
! Configuration version 3.7.2.29R
l2vpn
  bridge-domain service
    pw 10.0.0.1 33
      pw-class LDP-transport
    exit
    pw 10.0.0.2 23
      pw-class LDP-transport
    exit
  exit
  pw-class LDP-transport
    encapsulation mpls signaling-type pseudowire-
id-fec-signaling
  exit
exit
```

```
0/ME5100:R2# sh run mpls
Tue Sep 24 04:31:12 2024
! Configuration version 3.7.2.29R
mpls
  forwarding
    interface loopback 1
    interface tengigabitethernet 0/0/1.951
    interface tengigabitethernet 0/0/1.952
  exit
  ldp
    discovery interface tengigabitethernet 0/0/1.951
    exit
    discovery interface tengigabitethernet 0/0/1.952
    exit
    neighbor 10.0.0.1
      bfd fast-detect
    exit
    neighbor 10.0.0.2
      bfd fast-detect
    exit
    reroute-optimization
  exit
  router-id 10.0.0.3
  transport-address 10.0.0.3
exit
```

Конфигурация сервиса

На устройствах стенда R5

```
0/FMC0:R5# sh running-config l2vpn
Tue Sep 24 04:34:08 2024
! Configuration version 3.9.1.125RC
l2vpn
  bridge-domain service
    pw 10.0.0.1 35
      pw-class LDP-transport
    exit
    pw 10.0.0.2 25
      pw-class LDP-transport
    exit
  exit
  pw-class LDP-transport
    encapsulation mpls signaling-type pseudowire-
id-fec-signaling
  exit
exit
```

```
0/FMC0:R5# sh run mpls
Tue Sep 24 04:35:14 2024
! Configuration version 3.9.1.125RC
mpls
  forwarding
    interface loopback 1
    interface tengigabitethernet 0/0/10.958
    interface tengigabitethernet 0/0/10.959
  exit
  ldp
    discovery interface tengigabitethernet 0/0/10.958
    exit
    discovery interface tengigabitethernet 0/0/10.959
    exit
    neighbor 10.0.0.1
      bfd fast-detect
    exit
    neighbor 10.0.0.2
      bfd fast-detect
    exit
    reroute-optimization
  exit
  router-id 10.0.0.5
  transport-address 10.0.0.5
exit
```

Просмотр состояния сервиса

```
0/ME5200:R2# sh l2vpn xconnect
Tue Sep 24 11:40:33 2024
  Up  -- up             Dn  -- down              ADn -- admin down
  GUp -- going up       GDn -- going down        ST  -- standby
  Fl  -- failed         Drm -- dormant           SW -- switchover
  Lld -- lower layer down

  Group: test
  XC Name            ST   Side A                      ST   Side B                      ST
  ------------------ ---- --------------------------- ---- --------------------------- ----
  test               Up   te0/0/5.1952                Up   pw 10.0.0.3 23              Up
                                                           pw 10.0.0.5 25              ST
  Total entries: 1 Up: 1
0/ME5200:R2# sh mpls ldp forwarding
Tue Sep 24 12:06:22 2024
  Codes:
    R = Remote LFA FRR backup
    E = Entropy Label Capability
  Prefix                Label(s) out  Outgoing Interface  Next Hop              flags
  --------------------- ------------- ------------------- --------------------- ------
  10.0.0.3/32           ImpNull       te0/0/5.952         10.0.0.49
  10.0.0.5/32           ImpNull       te0/0/5.958         10.0.0.45
0/ME5200:R2#
0/ME5200:R2#
0/ME5200:R2# sh mpls ldp neighbors
Tue Sep 24 12:06:34 2024
  Peer                   Up/Down time  Expires    Adjcs  Addrs  Labels  GR
  ---------------------- ------------- ---------- ------ ------ ------- ---
  10.0.0.3:0             00h58m56s     37s        2      3      3       N
  10.0.0.5:0             17h57m56s     37s        2      3      2       N
```

Время переключения сервиса менее 100 ms

No.	Time	Source	Destination	Protocol	Length	Info
16607	3.227025936	10.200.200.10	10.10.10.103	UDP	247	13358 → 1500 Len=201
16608	3.227219325	10.200.200.10	10.10.10.103	UDP	247	14358 → 1600 Len=201
16609	3.227414456	10.200.200.10	10.10.10.103	UDP	247	15358 → 1700 Len=201
16610	3.227608551	10.200.200.10	10.10.10.103	UDP	247	16358 → 1800 Len=201
16611	3.227802764	10.200.200.10	10.10.10.101	UDP	247	14351 → 1601 Len=201
16612	3.228000927	10.200.200.10	10.10.10.101	UDP	247	14352 → 1602 Len=201
16613	3.228192848	10.200.200.10	10.10.10.101	UDP	247	14353 → 1603 Len=201
16614	3.304317795	10.200.200.10	10.10.10.103	UDP	247	14358 → 1600 Len=201
16615	3.304460742	10.200.200.10	10.10.10.103	UDP	247	15358 → 1700 Len=201
16616	3.304658002	10.200.200.10	10.10.10.103	UDP	247	16358 → 1800 Len=201
16617	3.304849514	10.200.200.10	10.10.10.101	UDP	247	14351 → 1601 Len=201
16618	3.305045118	10.200.200.10	10.10.10.101	UDP	247	14352 → 1602 Len=201
16619	3.305239183	10.200.200.10	10.10.10.101	UDP	247	14353 → 1603 Len=201
16620	3.305432462	10.200.200.10	10.10.10.101	UDP	247	14354 → 1604 Len=201

Мы всегда готовы к диалогу, разработке и доработке решений под ваше техническое задание

630020, г. Новосибирск, ул. Окружная 29В
09:00 — 18:00 (GMT+7)
Понедельник - пятница

+7 (383) 274-10-01, 274-48-48
eltex@eltex-co.ru; eltex-co.ru