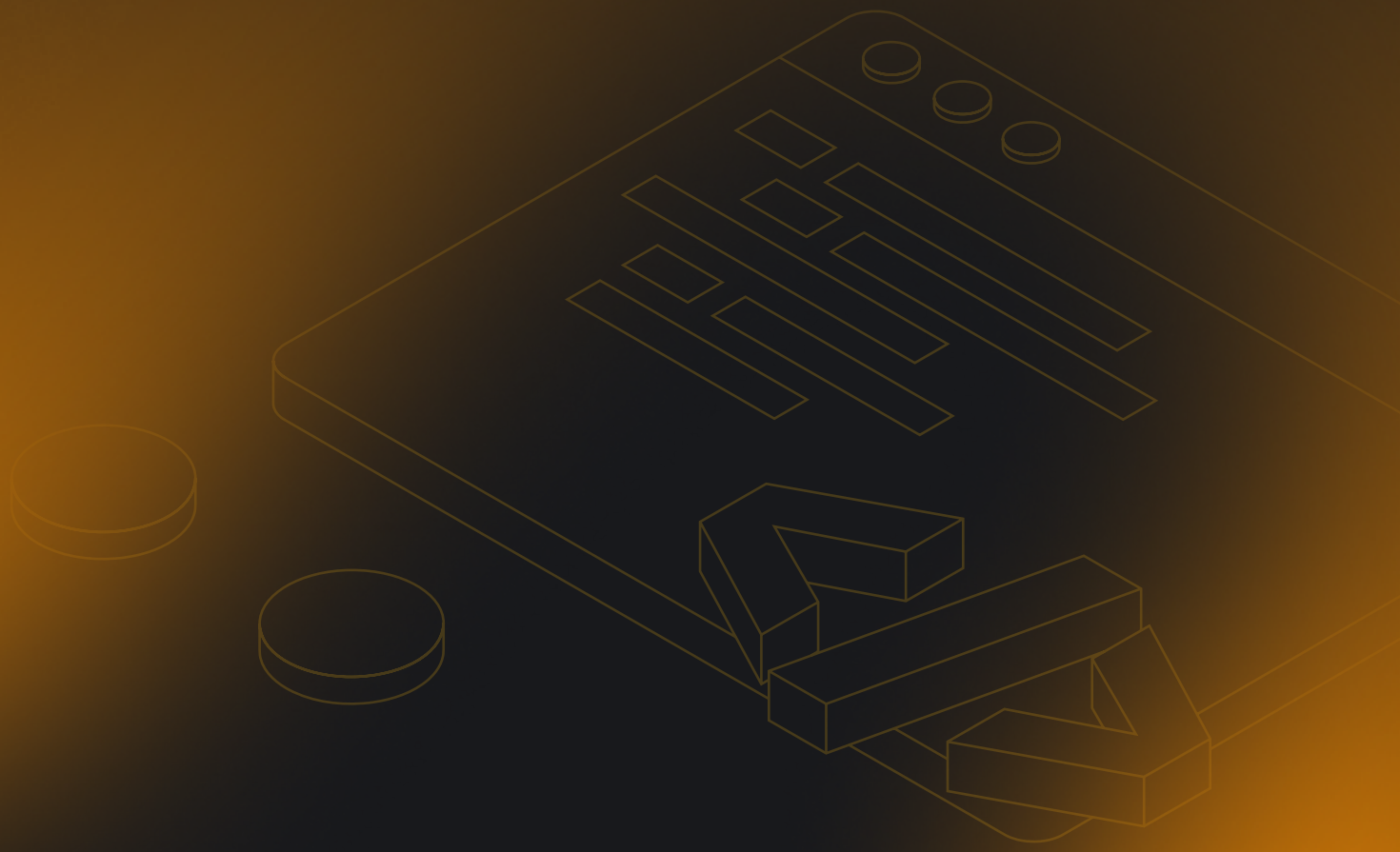
VyOS Networks



Deployment Guide | Technical Doc

BROADBAND NETWORK GATEWAY (BNG)

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Broadband Network Gateway (BNG)

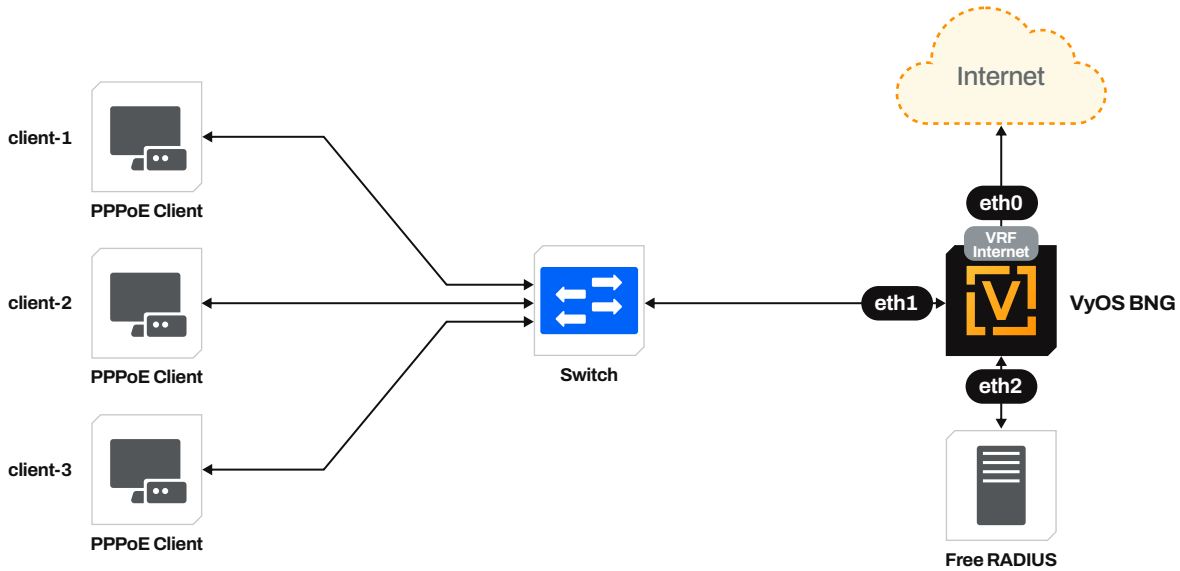
A Broadband Network Gateway (BNG)—also known as a Broadband Remote Access Server (BRAS)—is a critical network function in service provider networks. It acts as the aggregation and termination point for broadband subscriber sessions, managing traffic from residential and enterprise customers accessing the internet or private services. It handles essential functions like establishing sessions, user authentication, IP address assignment, enforcing traffic policies and QoS, and track usage for billing and analytics.

A configurable Broadband Network Gateway (BNG) will help you overcome this need, as you can allow your router to communicate with external devices and servers in order to establish connectivity with your subscribers through logical sessions.

There are two types of logical sessions:

- **PPPoE Subscriber Session**
  The PPP-over-Ethernet (PPPoE) subscriber session is established using the point-to-point protocol (PPP) that runs between the customer-premises equipment (CPE) and the broadband network gateway (BNG). It is designed for managing how data is transmitted over Ethernet, and it allows a single server connection to be divided between multiple clients.
- **IPoE Subscriber Session**
  The IP-over-Ethernet (IPoE) subscriber session is established using the IP connection that runs between the CPE and the BNG; IP addressing is done using the DHCP protocol. IPoE is essentially DHCP triggered subscriber interfaces. Users are “authenticated” through the combination of incoming interface and MAC address. This identifies the physical location of the user based on the queue they are connected to.

Lab Topology



Configuration

⚠ This BNG guide was developed using VyOS 1.5.0-S1 and has been tested and verified.

Configuring PPPoE server

VyOS utilizes accel-ppp to provide PPPoE server functionality. It can be used with local authentication or a connected RADIUS server.

Example for local authentication:

Set a name for this PPPoE-server access concentrator.

```
set service pppoe-server access-concentrator <name>
```

Set authentication backend as local.

```
set service pppoe-server authentication mode local
```

Create user/pass for local authentication.

```
set service pppoe-server authentication local-users username <name> password
<password>
```

Use this command to define the first IP address of a pool of addresses to be given to pppoe clients.

```
set service pppoe-server client-ip-pool <POOL-NAME> range <x.x.x.x-x.x.x.x |
x.x.x.x/x>
```

Define a default address pool name.

```
set service pppoe-server default-pool <POOL-NAME>
```

Define the interface the PPPoE server will use to listen for PPPoE clients.

```
set service pppoe-server interface <interface>
```

Specifies single <gateway> IP address to be used as local address of PPP interfaces.

```
set service pppoe-server gateway-address <address>
```

```
set service pppoe-server access-concentrator 'PPPoE-Server'
set service pppoe-server authentication local-users username client1 password '1234'
set service pppoe-server authentication local-users username client2 password 'abcd'
set service pppoe-server authentication mode 'local'
set service pppoe-server client-ip-pool PPPoE-POOL range '192.168.10.10-192.168.10.50'
set service pppoe-server default-pool 'PPPoE-POOL'
set service pppoe-server gateway-address '192.168.10.1'
set service pppoe-server interface eth1
```

```
vyos@BNG-1# show service pppoe-server
 access-concentrator PPPoE-Server
 authentication {
     local-users {
         username client1 {
             password 1234
         }
         username client2 {
             password abcd
         }
     }
     mode local
 }
 client-ip-pool PPPoE-POOL {
     range 192.168.10.10-192.168.10.50
 }
 default-pool PPPoE-POOL
 gateway-address 192.168.10.1
 interface eth1 {
 }
```

RADIUS Authentication

To enable RADIUS based authentication, the authentication mode needs to be changed within the configuration. Previous settings like the local users, still exist within the configuration, however they are not used if the mode has been changed from local to radius. Once changed back to local, it will use all local accounts again.

Configure RADIUS <server> and its required shared <secret> for communicating with the RADIUS server. Since the RADIUS server would be a single point of failure, multiple RADIUS servers can be set up and will be used subsequently.

```
set service pppoe-server authentication radius server 172.16.0.2 key 'vyos'
```

Allocation clients ip addresses by RADIUS

If the RADIUS server sends the attribute **Framed-IP-Address** then this IP address will be allocated to the client and the option **default-pool** within the CLI config is being ignored.

If the RADIUS server sends the attribute **Framed-Pool**, IP address will be allocated from a predefined IP pool whose name equals the attribute value.

User interface can be put to VRF context via RADIUS Access-Accept packet, or change it via RADIUS CoA. **Accel-VRF-Name** is used for these purposes. It is a custom ACCEL-PPP attribute. Define it in your RADIUS server.

Renaming clients interfaces by RADIUS

If the RADIUS server uses the attribute NAS-Port-Id, ppp tunnels will be renamed.

> ⚠ The value of the attribute **NAS-Port-Id** must be less than 16 characters, otherwise the interface won't be renamed.

Automatic VLAN Creation

VLAN's can be created by Accel-ppp on the fly via the use of a Kernel module named **vlan_mon,** which is monitoring incoming vlans and creates the necessary VLAN if required and allowed. VyOS supports the use of either VLAN ID's or entire ranges; both values can be defined at the same time for an interface.

When configured, PPPoE will create the necessary VLANs when required. Once the user session has been cancelled and the VLAN is not needed anymore, VyOS will remove it again.

```
set service pppoe-server interface <interface> vlan <id | range>
```

Bandwidth Shaping

Bandwidth rate limits can be set for local users or RADIUS based attributes.

- **For Local Users**

  Download bandwidth limit in kbit/s for <user>.

  ```
  set service pppoe-server authentication local-users username <user> rate-limit
  download <bandwidth>
  ```

  Upload bandwidth limit in kbit/s for <user>.

  ```
  set service pppoe-server authentication local-users username <user> rate-limit
  upload <bandwidth>
  ```

  Once the user is connected, the user session is using the set limits and can be displayed via **show pppoe-server sessions**.

- **For RADIUS users**

  The current attribute Filter-Id is being used as default and can be setup within RADIUS:
  Filter-Id = 2000/3000 (means 2000Kbit down-stream rate and 3000Kbit up-stream rate)
  The command below enables it, assuming the RADIUS connection has been set up and is working.

  Use this command to enable bandwidth shaping via RADIUS.

  ```
  set service pppoe-server authentication radius rate-limit enable
  ```

Other attributes can be used, but they have to be in one of the dictionaries in **/usr/share/accel-ppp/radius.**

> ⚠ If you set a custom RADIUS attribute you must define it on both dictionaries at RADIUS server and client.

Specifies which RADIUS server attribute contains the rate limit information.

```
set service pppoe-server authentication radius rate-limit attribute <attribute>
```

Specifies the vendor dictionary, dictionary needs to be in **/usr/share/accel-ppp/radius.**

```
set service pppoe-server authentication radius rate-limit vendor
```

Received RADIUS attributes have a higher priority than parameters defined within the CLI configuration.

Monitoring

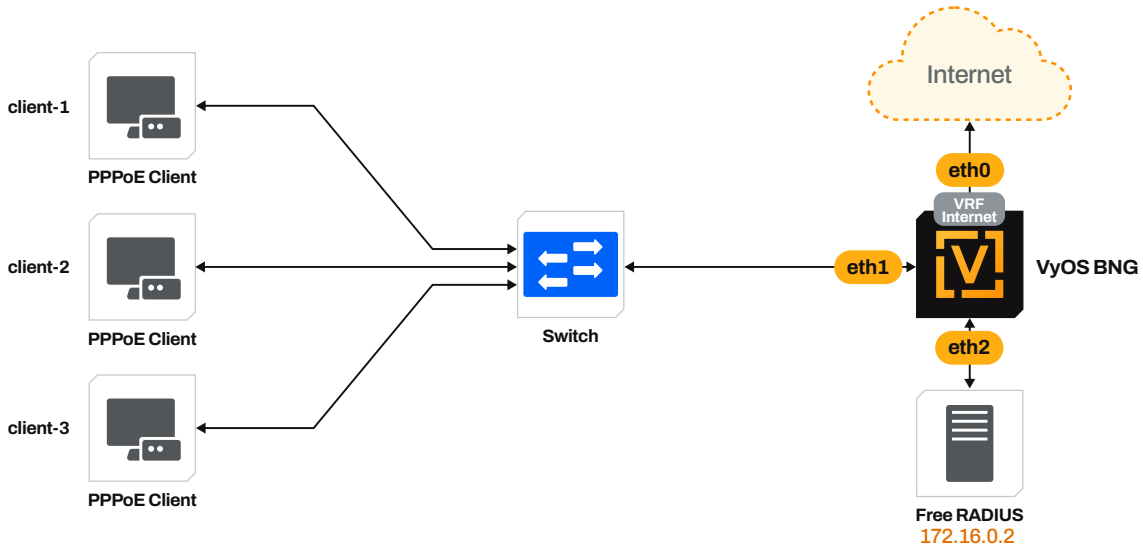
Use these commands to check the active sessions, statistics and logs in the PPPoE server.

```
show pppoe-server sessions
```

```
show pppoe-server statistics
```

```
show log pppoe-server
```

Example for RADIUS Authentication



This configuration sets up a **PPPoE server on VyOS (listening on eth1)** that authenticates users via **RADIUS (172.16.0.2)**, supports **rate-limit attributes from RADIUS**, and assigns IP addresses from the defined pools (**192.168.10.x and 10.0.0.x**).

client-1

- Static IP address defined in the user configuration in FreeRADIUS will be assigned.
- VSA **Accel-VRF-Name** is used to indicate which VRF the PPPoE session should be assigned to. VRF “internet” in this example.
- **NAS-Port-Id** attribute is used to rename the PPP session as bng-1-client1
- **Filter-Id** attribute is used to define bandwidth shaping.

client-2

- Assigns IP dynamically from pool **PPPoE-POOL-2** (defined in pppoe-server)
- VSA **Accel-VRF-Name** is used to indicate which VRF the PPPoE session should be assigned to. VRF internet in this example.
- **NAS-Port-Id** attribute is used to rename the PPP session as bng-1-client2
- **Filter-Id** attribute is used to define bandwidth shaping.

client-3

- Assigns IP dynamically from pool **PPPoE-POOL-1** (defined in pppoe-server)
- VSA **Accel-VRF-Name** is used to indicate which VRF the PPPoE session should be assigned to. VRF internet in this example.
- **NAS-Port-Id** attribute is used to rename the PPP session as bng-1-client2
- **Filter-Id** attribute is used to define bandwidth shaping.

```
# interfaces configuration
set interfaces ethernet eth0 address '192.0.2.1/30'
set interfaces ethernet eth0 description 'WAN'
set interfaces ethernet eth0 vrf 'internet'
set interfaces ethernet eth1 description 'PPPoE-Access'
set interfaces ethernet eth2 address '172.16.0.1/30'
set interfaces ethernet eth2 description 'to_RADIUS'
set interfaces loopback lo address '100.0.0.1/32'
```

```
# pppoe-server configuration

set service pppoe-server access-concentrator 'PPPoE-Server'
set service pppoe-server authentication mode 'radius'
set service pppoe-server authentication radius dynamic-author key 'vyos'
set service pppoe-server authentication radius dynamic-author port '3799'
set service pppoe-server authentication radius dynamic-author server '0.0.0.0'
set service pppoe-server authentication radius nas-identifier 'BNG-1'
set service pppoe-server authentication radius nas-ip-address '100.0.0.1'
set service pppoe-server authentication radius rate-limit enable
set service pppoe-server authentication radius server 172.16.0.2 key 'vyos'
```

```
set service pppoe-server authentication radius source-address '172.16.0.1'
set service pppoe-server client-ip-pool PPPoE-POOL range '192.168.10.10-192.168.10.50'
set service pppoe-server client-ip-pool PPPoE-POOL-2 range '10.0.0.10-10.0.0.20'
set service pppoe-server default-pool 'PPPoE-POOL'
set service pppoe-server gateway-address '100.0.0.1'
set service pppoe-server interface eth1

# vrf configuration
set vrf name internet description 'VRF internet'
set vrf name internet protocols static route 0.0.0.0/0 next-hop 192.0.2.2
set vrf name internet table '1000'
```

FreeRadius user definition

```
client1  Cleartext-Password := "test"
         Framed-IP-Address = 172.16.3.1
         Accel-VRF-Name = "internet"
         Framed-IP-Netmask = 255.255.255.255
         NAS-Port-Id = "bng-1-%{User-Name}"
         Filter-Id := "1000/2000"

client2  Cleartext-Password := "test"
         Framed-Pool = PPPoE-POOL-2
         Accel-VRF-Name = "internet"
         NAS-Port-Id = "bng-1-%{User-Name}"
         Filter-Id := "2000/3000"

client3  Cleartext-Password := "test"
         Framed-Pool = PPPoE-POOL-1,
         Accel-VRF-Name = "internet",
         NAS-Port-Id = "bng-1-%{User-Name}",
         Filter-Id = "2000/2000"
```

Verification

- Display the list of network interfaces that are currently configured to listen for PPPoE client connections, along with their status and session-related details.

```
vyos@BNG-1# run show pppoe-server interfaces
 interface:   connections:    state:
-----------------------------------
     eth1             3    active
```

- Check the active sessions in the PPPoE server, along with their ifname assigned, username, assigned IP address and rate-limit defined by RADIUS.

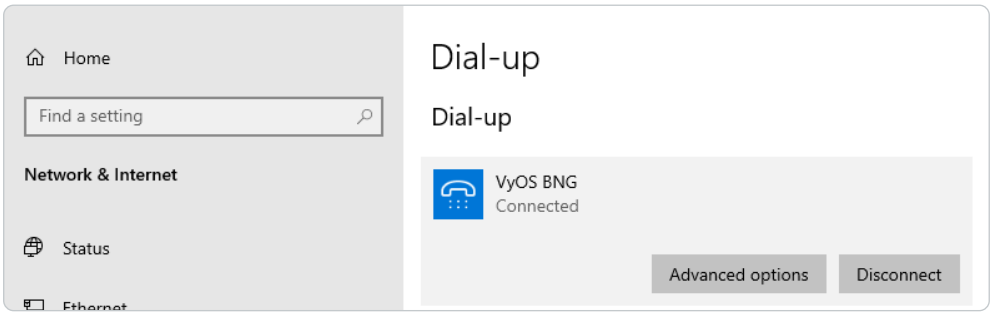
```
vyos@BNG-1# run show pppoe-server sessions
 ifname     | username |      ip       | ip6 | ip6-dp |    calling-sid    | rate-limit | state  |  uptime  | rx-bytes | tx-bytes
--------------+----------+---------------+-----+--------+-------------------+------------+--------+----------+----------+----------
 bng-1-client1 | client1  | 172.16.3.1    |     |        | 0c:7a:e7:4e:00:00 | 1000/2000  | active | 03:33:50 | 2.2 KiB  | 2.1 KiB
 bng-1-client2 | client2  | 10.0.0.10     |     |        | 0c:0d:9f:67:00:00 | 2000/3000  | active | 03:33:46 | 854 B    | 572 B
 bng-1-client3 | client3  | 192.168.10.11 |     |        | 0c:3c:a5:b7:00:00 | 2000/2000  | active | 00:05:06 | 1.4 KiB  | 220 B
```

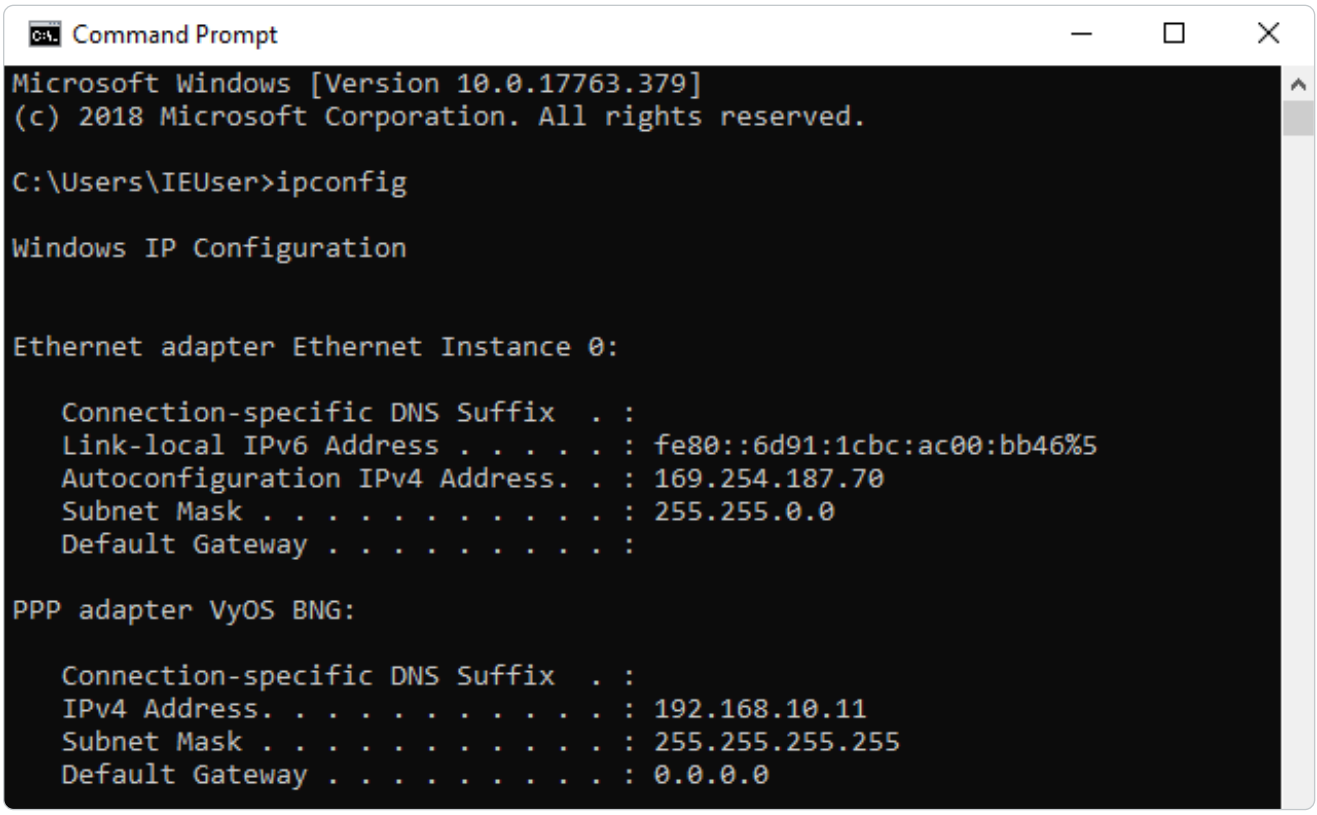
- Verify routes for VRF “internet”

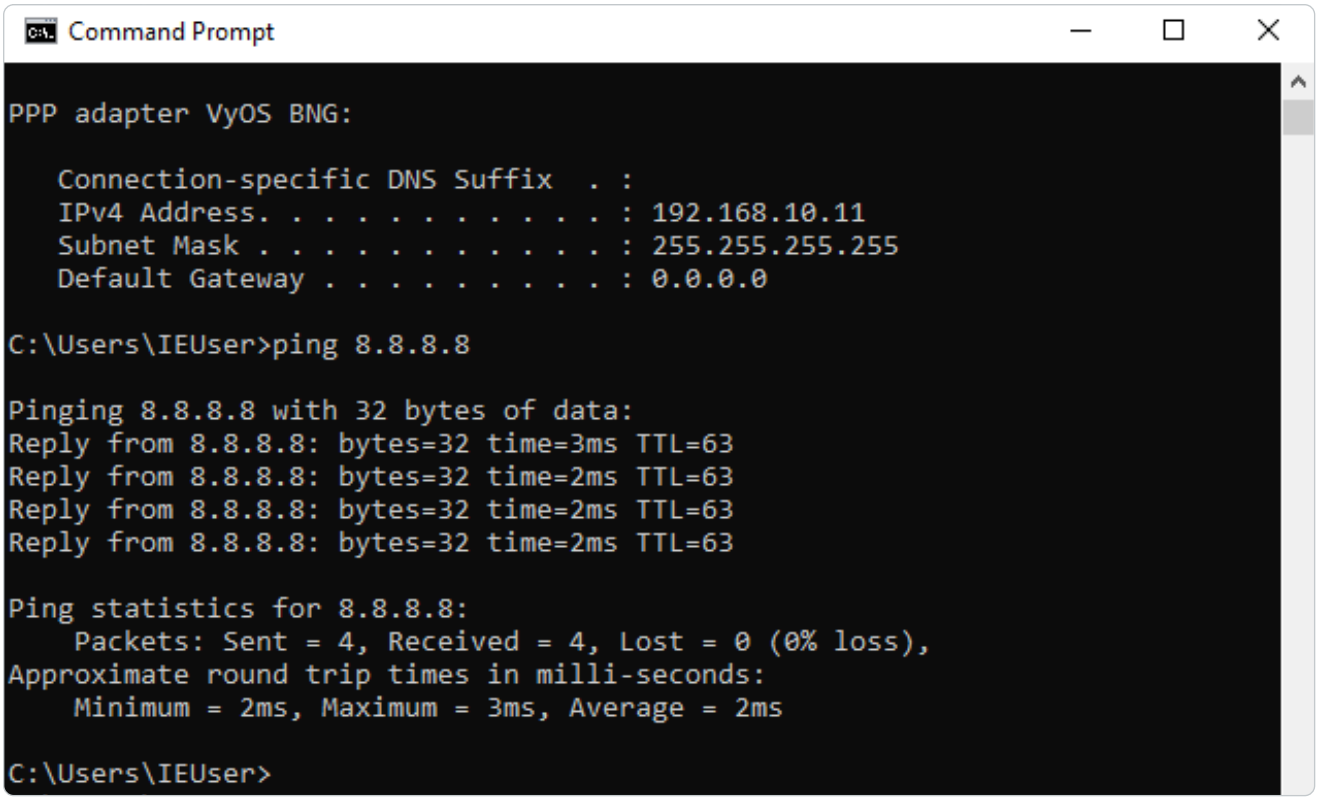
```
vyos@BNG-1# run show ip route vrf internet
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, F - PBR,
       f - OpenFabric,
       > - selected route, * - FIB route, q - queued, r - rejected, b - backup
       t - trapped, o - offload failure

VRF internet:
S>* 0.0.0.0/0 [1/0] via 192.0.2.2, eth0, weight 1, 01:11:20
C>* 10.0.0.10/32 is directly connected, bng-1-client2, 03:34:20
C>* 172.16.3.1/32 is directly connected, bng-1-client1, 03:34:24
C>* 192.0.2.0/30 is directly connected, eth0, 03:37:11
C>* 192.168.10.11/32 is directly connected, bng-1-client3, 00:05:43
```

- Check from the client side (**client3** is a windows machine).







- RADIUS Packet captures

Access-Request client1:

```
▸ Frame 1: 158 bytes on wire (1264 bits), 158 bytes captured (1264 bits) on interface -, id 0
▸ Ethernet II, Src: 0c:43:74:71:00:02 (0c:43:74:71:00:02), Dst: 02:42:dd:e3:32:00 (02:42:dd:e3:32:00)
▸ Internet Protocol Version 4, Src: 172.16.0.1, Dst: 172.16.0.2
▸ User Datagram Protocol, Src Port: 38907, Dst Port: 1812
▾ RADIUS Protocol
    Code: Access-Request (1)
    Packet identifier: 0x1 (1)
    Length: 116
    Authenticator: 96bf2c8e9bc1ccac0ee3106d70033b94
    [The response to this request is in frame 2]
  ▾ Attribute Value Pairs
    ▸ AVP: t=User-Name(1) l=9 val=client1
    ▸ AVP: t=NAS-Identifier(32) l=7 val=BNG-1
    ▸ AVP: t=NAS-IP-Address(4) l=6 val=100.0.0.1
    ▸ AVP: t=NAS-Port-Type(61) l=6 val=Virtual(5)
    ▸ AVP: t=Service-Type(6) l=6 val=Framed(2)
    ▸ AVP: t=Framed-Protocol(7) l=6 val=PPP(1)
    ▸ AVP: t=Calling-Station-Id(31) l=19 val=0c:7a:e7:4e:00:00
    ▸ AVP: t=Called-Station-Id(30) l=19 val=0c:43:74:71:00:01
    ▸ AVP: t=User-Password(2) l=18 val=Encrypted
```

Access-Accept client1:

```
Frame 2: 116 bytes on wire (928 bits), 116 bytes captured (928 bits) on interface -, id 0
Ethernet II, Src: 02:42:dd:e3:32:00 (02:42:dd:e3:32:00), Dst: 0c:43:74:71:00:02 (0c:43:74:71:00:02)
Internet Protocol Version 4, Src: 172.16.0.2, Dst: 172.16.0.1
User Datagram Protocol, Src Port: 1812, Dst Port: 38907
RADIUS Protocol
  Code: Access-Accept (2)
  Packet identifier: 0x1 (1)
  Length: 74
  Authenticator: 48b291691e9c2b329cbd54bc12807663
  [This is a response to a request in frame 1]
  [Time from request: 0.000317000 seconds]
▾ Attribute Value Pairs
  ▸ AVP: t=Framed-IP-Address(8) l=6 val=172.16.3.1
  ▾ AVP: t=Vendor-Specific(26) l=16 vnd=accel-ppp(55999)
      Type: 26
      Length: 16
      Vendor ID: accel-ppp (55999)
    ▾ VSA: t=Unknown-Attribute(1) l=10 val=696e7465726e6574   <-- Accel-VRF-Name Attribute
        Type: 1
        Length: 10
        Unknown-Attribute: 696e7465726e6574   <-- ASCII hexa-coded "internet" string
  ▸ AVP: t=Framed-IP-Netmask(9) l=6 val=255.255.255.255
  ▸ AVP: t=NAS-Port-Id(87) l=15 val=bng-1-client1
  ▸ AVP: t=Filter-Id(11) l=11 val=1000/2000
```

Dynamic Authorization Extensions to RADIUS

Extensions to the RADIUS protocol (defined in RFC 5176) that allow a RADIUS server to dynamically change or terminate subscriber sessions already authorized by a NAS/BNG. These mechanisms include:

1. **Disconnect-Message (DM):** terminates an active session.

   Examples of use:

   - When the user exceeds their data quota.
   - When an administrator manually disconnects the session from the OSS/BSS.
   - When fraud or policy violations are detected.

   The RADIUS server sends a DM to the BNG, and the BNG immediately disconnects the subscriber.

2. **Change of Authorization (CoA):** updates session attributes without requiring the user to reconnect.

   Examples of use:

   - Changing the user's speed plan (e.g., from 10 Mbps to 50 Mbps) in real time.
   - Moving the user to another VRF/pool.
   - Applying or removing firewall/QoS policies.

   The RADIUS server sends a CoA-Request, and the BNG responds with a CoA-ACK if the change is accepted.

Configuration:

`set service pppoe-server authentication radius dynamic-author server <address>`

Activates the Dynamic Authorization feature on the VyOS PPPoE server and specifies the IP address of the RADIUS server allowed to send these messages (DM/CoA) to the VyOS BNG/PPPoE server.

With this configuration, VyOS listens on **UDP port 3799** (default) to receive and apply DM/CoA requests from that RADIUS server.

In case you want to listen to on another port:

`set service pppoe-server authentication radius dynamic-author port <port>`

Secret for Dynamic Authorization Extension server (DM/CoA)

`set service pppoe-server authentication radius dynamic-author key <secret>`

```
set service pppoe-server authentication radius dynamic-author key 'vyos'
set service pppoe-server authentication radius dynamic-author port '3799'
```

Example of Change of Authorization (CoA)

Modifies attributes of an active session (e.g., updating bandwidth).

```
echo "User-Name = client1
Filter-Id := \"500/500\"" | radclient -x 172.16.0.1:3799 coa vyos -s 172.16.0.2
```

Explanation:

- **coa** — indicates a CoA-Request.
- **Filter-Id** — applies new bandwidth shaping.
- **-s 172.16.0.2** — forces the source IP address.

VyOS will respond with a CoA-ACK if it accepts the changes without disconnecting the user.

```
root@AAA-1:/etc/freeradius/3.0# echo "User-Name = client1
> Filter-Id := \"500/500\"" | radclient -x 172.16.0.1:3799 coa vyos -s 172.16.0.2
Sent CoA-Request Id 150 from 0.0.0.0:50951 to 172.16.0.1:3799 length 38
 User-Name = "client1"
 Filter-Id := "500/500"
Received CoA-ACK Id 150 from 172.16.0.1:3799 to 0.0.0.0:0 length 20
Packet summary:
 Accepted      : 1
 Rejected      : 0
 Lost          : 0
 Passed filter : 1
 Failed filter : 0
root@AAA-1:/etc/freeradius/3.0#
```

```
vyos@BNG-1# run show pppoe-server sessions
 ifname     | username |      ip       | ip6 | ip6-dp |    calling-sid    | rate-limit | state  |  uptime  | rx-bytes | tx-bytes
--------------+----------+---------------+-----+--------+-------------------+------------+--------+----------+----------+----------
 bng-1-client2 | client2  | 10.0.0.10     |     |        | 0c:0d:9f:67:00:00 | 2000/3000  | active | 00:06:55 | 450 B    | 216 B
 bng-1-client1 | client1  | 172.16.3.1    |     |        | 0c:7a:e7:4e:00:00 | 1000/2000  | active | 00:06:55 | 450 B    | 216 B
 bng-1-client3 | client3  | 192.168.10.10 |     |        | 0c:3c:a5:b7:00:00 | 2000/2000  | active | 00:03:27 | 1.3 KiB  | 220 B
[edit]
vyos@BNG-1#
[edit]
vyos@BNG-1# run show pppoe-server sessions
 ifname     | username |      ip       | ip6 | ip6-dp |    calling-sid    | rate-limit | state  |  uptime  | rx-bytes | tx-bytes
--------------+----------+---------------+-----+--------+-------------------+------------+--------+----------+----------+----------
 bng-1-client2 | client2  | 10.0.0.10     |     |        | 0c:0d:9f:67:00:00 | 2000/3000  | active | 00:08:02 | 450 B    | 216 B
 bng-1-client1 | client1  | 172.16.3.1    |     |        | 0c:7a:e7:4e:00:00 | 500/500    | active | 00:08:02 | 450 B    | 216 B
 bng-1-client3 | client3  | 192.168.10.10 |     |        | 0c:3c:a5:b7:00:00 | 2000/2000  | active | 00:04:34 | 1.3 KiB  | 220 B
[edit]
vyos@BNG-1#
```

Example of Disconnect-Message (DM)

```
vyos@BNG-1# run show pppoe-server sessions
 ifname     | username |      ip       | ip6 | ip6-dp |    calling-sid    | rate-limit | state  |  uptime  | rx-bytes | tx-bytes
--------------+----------+---------------+-----+--------+-------------------+------------+--------+----------+----------+----------
 bng-1-client2 | client2  | 10.0.0.10     |     |        | 0c:0d:9f:67:00:00 | 2000/3000  | active | 00:00:26 | 450 B    | 216 B
 bng-1-client1 | client1  | 172.16.3.1    |     |        | 0c:7a:e7:4e:00:00 | 1000/2000  | active | 00:00:26 | 450 B    | 216 B
 bng-1-client3 | client3  | 192.168.10.10 |     |        | 0c:3c:a5:b7:00:00 | 2000/2000  | active | 00:00:03 | 1.3 KiB  | 220 B
[edit]
vyos@BNG-1#
```

Terminates an active PPPoE session (client1) on the BNG.

```
echo "User-Name = client1" | radclient -x 172.16.0.1:3799 disconnect vyos -s 172.16.0.2
```

- **User-Name = client1** — identifies the session to be terminated.
- **172.16.0.1:3799** — IP address and UDP port where the BNG listens for (CoA/DM) messages. Default port is **3799** (RFC 5176).
- **disconnect** — message type (Disconnect-Request).
- **vyos** — the shared secret defined on the BNG for CoA/DM.
- **-x** — enables debug output in the console.

```
root@AAA-1:/etc/freeradius/3.0# echo "User-Name = client1" | radclient -x 172.16.0.1:3799 disconnect vyos
-s 172.16.0.2
Sent Disconnect-Request Id 73 from 0.0.0.0:55779 to 172.16.0.1:3799 length 29
 User-Name = "client1"
Received Disconnect-ACK Id 73 from 172.16.0.1:3799 to 0.0.0.0:0 length 20
Packet summary:
 Accepted      : 1
 Rejected      : 0
```

```
 Lost          : 0
 Passed filter : 1
 Failed filter : 0
root@AAA-1:/etc/freeradius/3.0#
```

```
vyos@BNG-1# run show pppoe-server sessions
 ifname     | username |      ip       | ip6 | ip6-dp |    calling-sid    | rate-limit | state  |  uptime  | rx-bytes | tx-bytes
---------------+----------+---------------+-----+--------+-------------------+------------+--------+----------+----------
+----------
 bng-1-client2 | client2  | 10.0.0.10     |     |        | 0c:0d:9f:67:00:00 | 2000/3000  | active | 00:15:15 | 450 B    | 216
B
 bng-1-client3 | client3  | 192.168.10.10 |     |        | 0c:3c:a5:b7:00:00 | 2000/2000  | active | 00:11:47 | 1.3 KiB  | 220
B
 bng-1-client1 | client1  | 172.16.3.1    |     |        | 0c:7a:e7:4e:00:00 | 1000/2000  | active | 00:00:56 | 450 B    | 216 B
[edit]
vyos@BNG-1#
[edit]
vyos@BNG-1# run show pppoe-server sessions
 ifname     | username |      ip       | ip6 | ip6-dp |    calling-sid    | rate-limit | state  |  uptime  | rx-bytes | tx-bytes
---------------+----------+---------------+-----+--------+-------------------+------------+--------+----------+----------
+----------
 bng-1-client2 | client2  | 10.0.0.10     |     |        | 0c:0d:9f:67:00:00 | 2000/3000  | active | 00:15:37 | 450 B    | 216
B
 bng-1-client3 | client3  | 192.168.10.10 |     |        | 0c:3c:a5:b7:00:00 | 2000/2000  | active | 00:12:09 | 1.3 KiB  | 220 B
```

Typical Flow

1. The client connects via PPPoE - the BNG requests authentication from the RADIUS server.
2. The session is created with initial attributes (IP pool, VRF, speed, etc.).
3. Later, the OSS/BSS decides to make changes:
   - Sends a **CoA** - the new parameters are applied live.
   - Sends a **DM** - the session is terminated, and the client must reconnect.

Accounting-Interim-Update

The **Accounting-Interim-Update** is a message in the RADIUS protocol used to **send periodic accounting updates** from the PPPoE server to a RADIUS server while a user session is active. Its main purpose is to maintain a real-time record of resource usage.

To enable **Accounting-Interim-Update** messages, you must configure the sending interval for these packets to the RADIUS server. This function is disabled by default, so periodic updates are not sent.

```
set service pppoe-server authentication radius accounting-interim-interval
<seconds>
```

The set `service` `set service pppoe-server authentication radius acct-timeout` command in VyOS defines the **timeout** that the PPPoE server will wait for a response from the RADIUS server after

sending an accounting update packet. If VyOS does not receive a response from the RADIUS server within the time specified by **acct-timeout**, it will consider the message to have failed.

The **set service pppoe-server authentication radius acct-interim-jitter** command in VyOS adds a random "**jitter**" value to the sending interval of **Accounting-Interim-Update** messages to the RADIUS server. The main goal of this feature is to prevent **overloading the RADIUS server** when there are a large number of connected clients.

```
set service pppoe-server authentication radius accounting-interim-interval '5'
set service pppoe-server authentication radius acct-interim-jitter '1'
set service pppoe-server authentication radius acct-timeout '3'
```

Interim-update packet capture

```
Frame 54: 239 bytes on wire (1912 bits), 239 bytes captured (1912 bits) on interface -, id 0
Ethernet II, Src: 0c:43:74:71:00:02 (0c:43:74:71:00:02), Dst: 02:42:dd:e3:32:00 (02:42:dd:e3:32:00)
Internet Protocol Version 4, Src: 172.16.0.1, Dst: 172.16.0.2
User Datagram Protocol, Src Port: 40711, Dst Port: 1813
RADIUS Protocol
  Code: Accounting-Request (4)
  Packet identifier: 0x5 (5)
  Length: 197
  Authenticator: e0ae86ba3212f1877616e06c4ca12d8c
  [The response to this request is in frame 55]
▾ Attribute Value Pairs
  ▸ AVP: t=User-Name(1) l=9 val=client1
  ▸ AVP: t=NAS-Identifier(32) l=7 val=BNG-1
  ▸ AVP: t=NAS-IP-Address(4) l=6 val=100.0.0.1
  ▸ AVP: t=NAS-Port(5) l=6 val=1
  ▸ AVP: t=NAS-Port-Id(87) l=15 val=bng-1-client1
  ▸ AVP: t=NAS-Port-Type(61) l=6 val=Virtual(5)
  ▸ AVP: t=Service-Type(6) l=6 val=Framed(2)
  ▸ AVP: t=Framed-Protocol(7) l=6 val=PPP(1)
  ▸ AVP: t=Calling-Station-Id(31) l=19 val=0c:7a:e7:4e:00:00
  ▸ AVP: t=Called-Station-Id(30) l=19 val=0c:43:74:71:00:01
  ▸ AVP: t=Acct-Status-Type(40) l=6 val=Interim-Update(3)
  ▸ AVP: t=Acct-Authentic(45) l=6 val=RADIUS(1)
  ▸ AVP: t=Acct-Session-Id(44) l=18 val=79d91f910e46e989
  ▸ AVP: t=Acct-Session-Time(46) l=6 val=22
  ▸ AVP: t=Acct-Input-Octets(42) l=6 val=2058
  ▸ AVP: t=Acct-Output-Octets(43) l=6 val=1818
  ▸ AVP: t=Acct-Input-Packets(47) l=6 val=31
  ▸ AVP: t=Acct-Output-Packets(48) l=6 val=28
  ▸ AVP: t=Acct-Input-Gigawords(52) l=6 val=0
  ▸ AVP: t=Acct-Output-Gigawords(53) l=6 val=0
  ▸ AVP: t=Framed-IP-Address(8) l=6 val=172.16.3.1
```

Configuring IPoE server

VyOS utilizes accel-ppp to provide IPoE server functionality. It can be used with local authentication (mac-address) or a connected RADIUS server.

Typically, IPoE uses Dynamic Host Configuration Protocol (DHCP) and Extensible Authentication Protocol (EAP) to provide the same functionality as PPPoE, but in a less robust manner.

IPoE can be configured on different interfaces, it will depend on each specific situation which interface will provide IPoE to clients. The client's mac address and the incoming interface is being used as a control parameter, to authenticate a client.

Creates local IPoE user with username=**<interface>** and password=**<MAC>** (mac-address)

```
set service ipoe-server authentication interface <interface> mac <MAC>
```

Set authentication backend.

```
set service ipoe-server authentication mode <local | radius>
```

Use this command to define the first IP address of a pool of addresses to be given to IPoE clients. If notation **x.x.x.x-x.x.x.x,** it must be within a /24 subnet. If notation **x.x.x.x/x** is used there is a possibility to set host/netmask.

```
set service ipoe-server client-ip-pool <POOL-NAME> range <x.x.x.x-x.x.x.x |
x.x.x.x/x>
```

Use this command to define the default address pool name.

```
set service ipoe-server default-pool <POOL-NAME>
```

Specifies address to be used as server ip address if radius can assign only client address. In such a case if the client address is matched network and mask then specified address and mask will be used. You can specify multiple such options.

```
set service ipoe-server gateway-address <x.x.x.x/x>
```

Specifies the client connectivity mode.

- **l2:** It means that clients are on the same network where the interface is.**(default)**
- **l3:** It means that clients are behind some router.

```
set service ipoe-server interface <interface> mode <l2 | l3>
```

Specify where the interface is shared by multiple users or it is vlan-per-user.

- **shared:** Multiple clients share the same network. (default)
- **vlan:** One VLAN per client.

```
set service ipoe-server interface <interface> network <shared | vlan>
```

Example for local authentication

The example configuration below will assign an IP to the clients on the incoming interface eth1 with the client mac address 0c:52:73:2c:00:00 and 0c:21:df:2c:00:00. Other DHCP discovery requests will be ignored, unless the client mac has been enabled in the configuration.

```
set interfaces ethernet eth1 address '192.168.0.1/24'
set service ipoe-server authentication interface eth1.100 mac 0c:52:73:2c:00:00
set service ipoe-server authentication interface eth1.101 mac 0c:21:df:2c:00:00
set service ipoe-server authentication mode 'local'
set service ipoe-server client-ip-pool IPOE-POOL range '192.168.0.100-192.168.0.200'
set service ipoe-server default-pool 'IPOE-POOL'
set service ipoe-server gateway-address '192.168.0.10/24'
set service ipoe-server interface eth1 mode 'l2'
set service ipoe-server interface eth1 network 'vlan'
set service ipoe-server interface eth1 vlan '100-200'
```

RADIUS authentication

To enable RADIUS based authentication, the authentication mode needs to be changed within the configuration. Previous settings like the local users, still exist within the configuration, however they are not used if the mode has been changed from local to radius. Once changed back to local, it will use all local accounts again.

```
set service ipoe-server authentication radius server <server> key <secret>
```

Configure RADIUS <server> and its required shared <secret> for communicating with the RADIUS server. Since the RADIUS server would be a single point of failure, multiple RADIUS servers can be set up and will be used subsequentlyally.

```
set service ipoe-server authentication radius source-address <address>
```

Source IPv4 address used in all RADIUS server queries.

> The **source-address** must be configured on one of VyOS interface. Best practice would be a loopback or dummy interface.

Allocation clients ip addresses by RADIUS

If the RADIUS server sends the attribute **Framed-IP-Address** then this IP address will be allocated to the client and the option **default-pool** within the CLI config is being ignored.

If the RADIUS server sends the attribute **Framed-Pool**, IP address will be allocated from a predefined IP pool whose name equals the attribute value.

User interface can be put to VRF context via RADIUS Access-Accept packet, or change it via RADIUS CoA. **Accel-VRF-Name** is used for these purposes. It is a custom ACCEL-PPP attribute. Define it in your RADIUS server.

Monitoring

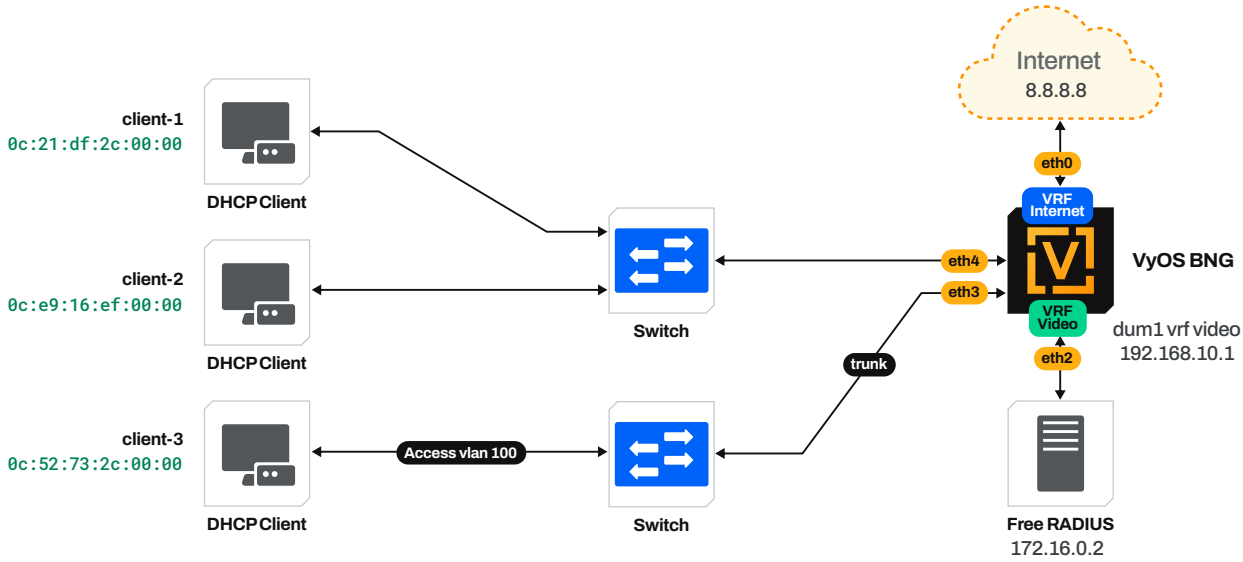
Use these commands to check the active sessions, statistics and logs in the IPoE server.

```
show ipoe-server sessions
```

```
show ipoe-server statistics
```

```
show log ipoe-server
```

Example for RADIUS authentication



This configuration sets up an IPoE server on VyOS (listening on **eth3** and **eth4**) that authenticates users via RADIUS (**172.16.0.2**), supports rate-limit attributes from RADIUS, and assigns IP addresses from the defined pools.

client-1

- Static IP address (**192.168.0.10**) defined in the user configuration in FreeRADIUS will be assigned.
- VSA **Accel-VRF-Name** is used to indicate which VRF the IPoE session should be assigned to, VRF **"internet"**.
- **Filter-Id** attribute is used to define bandwidth shaping.

client-2

- Assigns IP dynamically from pool **IPoE-POOL-1** (defined in ipoe-server)
- VSA **Accel-VRF-Name** is used to indicate which VRF the IPoE session should be assigned to, VRF **"internet"**.
- **Filter-Id** attribute is used to define bandwidth shaping.

client-3

- Assigns IP dynamically from pool **IPoE-POOL-2** (defined in ipoe-server)
- VSA **Accel-VRF-Name** is used to indicate which VRF the IPoE session should be assigned to, VRF **"video"**.
- **Filter-Id** attribute is used to define bandwidth shaping.

By default, VyOS sends the interface name where the DHCP request is received as the **User-Name** attribute in the RADIUS Access-Request. To change this default behavior and use the client's MAC address as the **User-Name** for authentication on the RADIUS server, you need to create a **Lua script**.

```
vyos@BNG-1# cat /config/scripts/ipoe.lua
#!lua
function username_func(pkt)
    local username=pkt:hwaddr()
    return username
end
```

This script will then be referenced from the **IPoE server configuration**. The IPoE server executes the script for each new session. The script receives client information (the MAC address in this example) and returns the string that will be used as the **User-Name** in the Access-Request sent to RADIUS.

```
# interfaces configuration

set interfaces dummy dum1 address '192.168.10.1/32'
set interfaces dummy dum1 description 'DG for IPOE-POOL-2'
set interfaces dummy dum1 vrf 'video'
set interfaces ethernet eth0 address '192.0.2.1/30'
set interfaces ethernet eth0 description 'WAN'
set interfaces ethernet eth0 vrf 'internet'
set interfaces ethernet eth2 address '172.16.0.1/30'
set interfaces ethernet eth2 description 'to_RADIUS'
set interfaces ethernet eth3 description 'IPoE_Access_vlan'
set interfaces ethernet eth4 address '192.168.0.1/24'
set interfaces ethernet eth4 description 'IPoE-Access_shared'
set interfaces ethernet eth4 vrf 'internet'
set interfaces loopback lo address '100.0.0.1/32'


# ipoe-server configuration

set service ipoe-server authentication mode 'radius'
```

```
set service ipoe-server authentication radius dynamic-author key 'vyos'
set service ipoe-server authentication radius dynamic-author port '3799'
set service ipoe-server authentication radius dynamic-author server '0.0.0.0'
set service ipoe-server authentication radius nas-identifier 'BNG-1'
set service ipoe-server authentication radius nas-ip-address '100.0.0.1'
set service ipoe-server authentication radius preallocate-vif
set service ipoe-server authentication radius rate-limit enable
set service ipoe-server authentication radius server 172.16.0.2 key 'vyos'
set service ipoe-server authentication radius source-address '172.16.0.1'
set service ipoe-server client-ip-pool IPOE-POOL-1 range '192.168.0.100-192.168.0.200'
set service ipoe-server client-ip-pool IPOE-POOL-2 range '192.168.10.100-192.168.10.200'
set service ipoe-server default-pool 'IPOE-POOL-1'
set service ipoe-server gateway-address '192.168.0.1/24'
set service ipoe-server gateway-address '192.168.10.254/24'
set service ipoe-server interface eth3 lua-username 'username_func'
set service ipoe-server interface eth3 mode 'l2'
set service ipoe-server interface eth3 network 'vlan'
set service ipoe-server interface eth3 start-session 'dhcp'
set service ipoe-server interface eth3 vlan '100-200'
set service ipoe-server interface eth3 vlan-mon
set service ipoe-server interface eth4 lua-username 'username_func'
```

```
set service ipoe-server interface eth4 mode 'l2'
set service ipoe-server interface eth4 network 'shared'
set service ipoe-server interface eth4 start-session 'dhcp'
set service ipoe-server lua-file '/config/scripts/ipoe.lua'
set service ipoe-server name-server '8.8.8.8'

# vrf configuration

set vrf name internet description 'VRF internet'
set vrf name internet protocols static route 0.0.0.0/0 next-hop 192.0.2.2
set vrf name internet table '1000'
set vrf name video description 'VRF video'
set vrf name video table '100'
```

FreeRadius user definition

```
0c:21:df:2c:00:00  Cleartext-Password := "0c:21:df:2c:00:00"
        Framed-IP-Address = 192.168.0.10,
        Framed-IP-Netmask := 255.255.255.0,
        Accel-VRF-Name = "internet",
        Filter-Id = "1000/2000"
0c:e9:16:ef:00:00  Cleartext-Password := "0c:e9:16:ef:00:00"
        Framed-Pool = IPOE-POOL-1,
        Accel-VRF-Name = "internet",
        Filter-Id = "2000/3000"
0c:52:73:2c:00:00  Cleartext-Password := "0c:52:73:2c:00:00"
        Framed-Pool = IPOE-POOL-2,
        Accel-VRF-Name = "video",
        Filter-Id = "3000/3000"
```

Verification

- **Check the active sessions in the IPoE server.**

```
vyos@BNG-1# run show ipoe-server sessions
ifname  |     username      |    calling-sid    |       ip       | ip6 | ip6-dp | rate-limit | type | comp | state  |  uptime
----------+-------------------+-------------------+----------------+-----+--------+------------+------+------+--------+----------
 ipoe0    | 0c:e9:16:ef:00:00 | 0c:e9:16:ef:00:00 | 192.168.0.100  |     |        | 2000/3000  | ipoe |      | active | 00:31:14
 ipoe1    | 0c:21:df:2c:00:00 | 0c:21:df:2c:00:00 | 192.168.0.10   |     |        | 1000/2000  | ipoe |      | active | 00:31:03
 eth3.100 | 0c:52:73:2c:00:00 | 0c:52:73:2c:00:00 | 192.168.10.100 |     |        | 3000/3000  | ipoe |      | active | 00:26:52
```

- **Verify routes for VRF “internet”**

```
vyos@BNG-1# run show ip route vrf internet
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, F - PBR,
       f - OpenFabric,
       > - selected route, * - FIB route, q - queued, r - rejected, b - backup
       t - trapped, o - offload failure

VRF internet:
S>* 0.0.0.0/0 [1/0] via 192.0.2.2, eth0, weight 1, 02:12:34
C>* 192.0.2.0/30 is directly connected, eth0, 02:12:37
C>* 192.168.0.0/24 is directly connected, eth4, 01:10:52
C>* 192.168.0.10/32 is directly connected, ipoe1, 00:31:50
C>* 192.168.0.100/32 is directly connected, ipoe0, 00:32:01
```

- **Verify routes for VRF “video”**

```
vyos@vyos# run show ip route vrf video
Codes: K - kernel route, C - connected, L - local, S - static,
       R - RIP, O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, F - PBR,
       f - OpenFabric, t - Table-Direct,
       > - selected route, * - FIB route, q - queued, r - rejected, b - backup
       t - trapped, o - offload failure

IPv4 unicast VRF video:
L * 192.168.10.1/32 is directly connected, dum1, weight 1, 00:19:31
C>* 192.168.10.1/32 is directly connected, dum1, weight 1, 00:19:31
C>* 192.168.10.100/32 is directly connected, eth3.100, weight 1, 00:00:29
L>* 192.168.10.254/32 is directly connected, eth3.100, weight 1, 00:00:29
```

- **Verify client-1 interface, lease and routes assignment**

```
vyos@client-dhcp-1# run show dhcp client leases
Interface    eth0
IP address   192.168.0.10                  [Active]
Subnet Mask  255.255.255.0
Domain Name
Router       192.168.0.1
Name Server  8.8.8.8
DHCP Server  192.168.0.1
DHCP Server  600
```

```
VRF          default
Last Update  Tue Sep 30 16:12:42 UTC 2025
Expiry       Tue Sep 30 16:22:42 UTC 2025
```

```
vyos@client-dhcp-1# run sho interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface    IP Address       MAC                VRF        MTU  S/L    Description
-----------  ---------------  -----------------  -------  -----  -----  -------------
eth0         192.168.0.10/24  0c:21:df:2c:00:00  default   1500  u/u    to_BNG
eth1         -                0c:21:df:2c:00:01  default   1500  u/D    to_BNG
eth2         -                0c:21:df:2c:00:02  default   1500  u/D
eth3         -                0c:21:df:2c:00:03  default   1500  u/D
eth4         -                0c:21:df:2c:00:04  default   1500  u/D
lo           127.0.0.1/8      00:00:00:00:00:00  default  65536  u/u


vyos@client-dhcp-1# run show ip route
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, F - PBR,
       f - OpenFabric,
       > - selected route, * - FIB route, q - queued, r - rejected, b - backup
       t - trapped, o - offload failure

S>* 0.0.0.0/0 [210/0] via 192.168.0.1, eth0, weight 1, 00:40:53
C>* 192.168.0.0/24 is directly connected, eth0, 00:40:53
```

- **Verify client-3 assignment**

```
vyos@client-dhcp-3# run show dhcp client leases
Interface    eth0
IP address   192.168.10.100               [Active]
Subnet Mask  255.255.255.0
Domain Name
Router       192.168.10.1
Name Server  8.8.8.8
DHCP Server  192.168.10.1
DHCP Server  600
VRF          default
Last Update  Tue Sep 30 16:18:57 UTC 2025
Expiry       Tue Sep 30 16:28:56 UTC 2025

vyos@client-dhcp-3# run show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface    IP Address         MAC                VRF        MTU  S/L    Description
-----------  -----------------  -----------------  -------  -----  -----  -------------
eth0         -                  0c:52:73:2c:00:00  default   1500  u/u    to_BNG
eth1         -                  0c:52:73:2c:00:01  default   1500  u/D    to_BNG
eth2         -                  0c:52:73:2c:00:02  default   1500  u/D
eth3         -                  0c:52:73:2c:00:03  default   1500  u/D
eth4         -                  0c:52:73:2c:00:04  default   1500  u/D
lo           127.0.0.1/8        00:00:00:00:00:00  default  65536  u/u
             ::1/128
vyos@client-dhcp-3# run show ip route
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, F - PBR,
       f - OpenFabric,
```

```
       > - selected route, * - FIB route, q - queued, r - rejected, b - backup
       t - trapped, o - offload failure

S>* 0.0.0.0/0 [210/0] via 192.168.10.1, eth0.100, weight 1, 00:37:55
C>* 192.168.10.0/24 is directly connected, eth0.100, 00:37:55
```

Ping test from clients

```
vyos@client-dhcp-1# run ping 8.8.8.8
PING 8.8.8.8 (8.8.8.8) 56(84) bytes of data.
64 bytes from 8.8.8.8: icmp_seq=1 ttl=63 time=3.41 ms
64 bytes from 8.8.8.8: icmp_seq=2 ttl=63 time=2.66 ms
64 bytes from 8.8.8.8: icmp_seq=3 ttl=63 time=2.05 ms
64 bytes from 8.8.8.8: icmp_seq=4 ttl=63 time=2.89 ms
64 bytes from 8.8.8.8: icmp_seq=5 ttl=63 time=3.06 ms
^C
--- 8.8.8.8 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4007ms
rtt min/avg/max/mdev = 2.046/2.813/3.412/0.455 ms
[edit]
vyos@client-dhcp-1#
```

```
vyos@client-dhcp-3# run ping 192.168.10.1
PING 192.168.10.1 (192.168.10.1) 56(84) bytes of data.
64 bytes from 192.168.10.1: icmp_seq=1 ttl=64 time=2.12 ms
64 bytes from 192.168.10.1: icmp_seq=2 ttl=64 time=1.51 ms
64 bytes from 192.168.10.1: icmp_seq=3 ttl=64 time=1.41 ms
64 bytes from 192.168.10.1: icmp_seq=4 ttl=64 time=1.51 ms
64 bytes from 192.168.10.1: icmp_seq=5 ttl=64 time=1.60 ms
64 bytes from 192.168.10.1: icmp_seq=6 ttl=64 time=1.57 ms
^C
--- 192.168.10.1 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5010ms
rtt min/avg/max/mdev = 1.406/1.620/2.123/0.233 ms
[edit]
vyos@client-dhcp-3#
```

RADIUS Packet capture

Client-1 Access-Request

```
Frame 13: 172 bytes on wire (1376 bits), 172 bytes captured (1376 bits) on interface -, id 0
Ethernet II, Src: 0c:b5:8f:43:00:02 (0c:b5:8f:43:00:02), Dst: 02:42:dd:e3:32:00 (02:42:dd:e3:32:00)
Internet Protocol Version 4, Src: 172.16.0.1, Dst: 172.16.0.2
User Datagram Protocol, Src Port: 56057, Dst Port: 1812
RADIUS Protocol
   Code: Access-Request (1)
   Packet identifier: 0x1 (1)
   Length: 130
   Authenticator: d9f049286456bbf4c22fc2e0892aa4eb
   [The response to this request is in frame 14]
   Attribute Value Pairs
      AVP: t=User-Name(1) l=19 val=0c:21:df:2c:00:00
      AVP: t=NAS-Identifier(32) l=7 val=BNG-1
      AVP: t=NAS-IP-Address(4) l=6 val=100.0.0.1
      AVP: t=NAS-Port(5) l=6 val=17
      AVP: t=NAS-Port-Id(87) l=7 val=ipoe0
      AVP: t=NAS-Port-Type(61) l=6 val=Ethernet(15)
      AVP: t=Calling-Station-Id(31) l=19 val=0c:21:df:2c:00:00
      AVP: t=Called-Station-Id(30) l=6 val=eth4
      AVP: t=User-Password(2) l=34 val=Encrypted
```

Client-1 Access-Accept

```
Frame 14: 102 bytes on wire (992 bits), 124 bytes captured (992 bits) on interface -, id 0
Ethernet II, Src: 02:42:dd:e3:32:00 (02:42:dd:e3:32:00), Dst: 0c:b5:8f:43:00:02 (0c:b5:8f:43:00:02)
Internet Protocol Version 4, Src: 172.16.0.2, Dst: 172.16.0.1
User Datagram Protocol, Src Port: 1812, Dst Port: 56057
RADIUS Protocol
   Code: Access-Accept (2)
   Packet identifier: 0x1 (1)
   Length: 59
   Authenticator: 174d98f684ae27187229721a00703f13
   [This is a response to a request in frame 13]
   [Time from request: 0.000697000 seconds]
   Attribute Value Pairs
      AVP: t=Framed-IP-Address(8) l=6 val=192.168.0.10
      AVP: t=Framed-IP-Netmask(9) l=6 val=255.255.255.0
      AVP: t=Vendor-Specific(26) l=16 vnd=accel-ppp(55999)
         Type: 26
         Length: 16
         Vendor ID: accel-ppp (55999)
         VSA: t=Unknown-Attribute(1) l=10 val=696e7465726e6574
      AVP: t=Filter-Id(11) l=11 val=1000/2000
```

ASCII hexa-coded “internet” string in Accel-VRF-Name Attribute

Client-3 Access-Request

```
Frame 9: 179 bytes on wire (1432 bits), 179 bytes captured (1432 bits) on interface -, id 0
Ethernet II, Src: 0c:b5:8f:43:00:02 (0c:b5:8f:43:00:02), Dst: 02:42:dd:e3:32:00 (02:42:dd:e3:32:00)
Internet Protocol Version 4, Src: 172.16.0.1, Dst: 172.16.0.2
User Datagram Protocol, Src Port: 56409, Dst Port: 1812
RADIUS Protocol
   Code: Access-Request (1)
   Packet identifier: 0x1 (1)
   Length: 137
   Authenticator: 251d25824baff4c6c6f237412a5baec9
   [The response to this request is in frame 10]
   Attribute Value Pairs
      AVP: t=User-Name(1) l=19 val=0c:52:73:2c:00:00
      AVP: t=NAS-Identifier(32) l=7 val=BNG-1
      AVP: t=NAS-IP-Address(4) l=6 val=100.0.0.1
      AVP: t=NAS-Port(5) l=6 val=15
      AVP: t=NAS-Port-Id(87) l=10 val=eth3.100
      AVP: t=NAS-Port-Type(61) l=6 val=Ethernet(15)
      AVP: t=Calling-Station-Id(31) l=19 val=0c:52:73:2c:00:00
      AVP: t=Called-Station-Id(30) l=10 val=eth3.100
      AVP: t=User-Password(2) l=34 val=Encrypted
```

Client-3 Access-Accept

```
▸ Frame 10: 99 bytes on wire (1032 bits), 129 bytes captured (1032 bits) on interface -, id 0
▸ Ethernet II, Src: 02:42:dd:e3:32:00 (02:42:dd:e3:32:00), Dst: 0c:b5:8f:43:00:02 (0c:b5:8f:43:00:02)
▸ Internet Protocol Version 4, Src: 172.16.0.2, Dst: 172.16.0.1
▸ User Datagram Protocol, Src Port: 1812, Dst Port: 56409
▾ RADIUS Protocol
    Code: Access-Accept (2)
    Packet identifier: 0x1 (1)
    Length: 57
    Authenticator: aa9ecf2e1e5bb325062210d2f81efdc9
    [This is a response to a request in frame 9]
    [Time from request: 0.000530000 seconds]
  ▾ Attribute Value Pairs
    ▸ AVP: t=Framed-Pool(88) l=13 val=IPOE-POOL-2
    ▾ AVP: t=Vendor-Specific(26) l=13 vnd=accel-ppp(55999)
        Type: 26
        Length: 13
        Vendor ID: accel-ppp (55999)
      ▸ VSA: t=Unknown-Attribute(1) l=7 val=766964656f
    ▸ AVP: t=Filter-Id(11) l=11 val=3000/3000
```

ASCII hexa-coded “video” string in Accel-VRF-Name Attribute