# ESMv4: PPPoE Hosts

## In This Chapter

This section describes advanced IPv4 Enhanced Subscriber Management (ESM) PPPoE host configurations.

Topics in this section include:

# Applicability

This note is applicable for 7750 SR-C12, SR-7/12 and 7710 on IOM2 and higher and was tested on release 7.0R5 and describes support of PPP termination and aggregation (PTA) hosts. L2TP-hosts are out of scope. Routed CO is supported on 7450 ESS-7 or ESS-12 in mixed-mode since 8.0R1.

This note is related only to the use of IPv4 hosts.

PPPoE has been supported since Release 6.0.

The 7750 SR-c4 is supported from 8.0R4 and higher.

PPPoE hosts are only supported in a Routed CO model (IES or VPRN) using Ethernet SAPs with null, dot1q or QinQ encapsulation.

PPPoE hosts are also supported in external loop/VSM if there is Layer 2 aggregation.

# Summary

The delivery of services to residential customers encompassing voice, video and data is covered by Alcatel-Lucent's Triple Play Service Delivery Architecture (TPSDA).

In the TPSDA, a subscriber is defined as a collection of hosts pertaining to a single access connection (for example, DSL line) and identified by a subscriber identifier. A subscriber host is an end user terminal within the subscriber home (PC, set-top box, home gateway) that is identified in the network with a unique (IP address/MAC address) tuple for IPoE or (PPPoE session ID; MAC address) tuple for PPPoE.

The following host types are distinguished:

Static hosts

- ip-mac
- ip-only

Dynamic hosts

- ARP-host
- DHCP-host
- PPPoE-host

This section provides configuration and troubleshooting commands for PPPoE-hosts and will use a local user database (LUDB) for host authentication and ESM (Enhanced Subscriber Management) string assignments.

The IP information in this note is retrieved from a Local DHCP server.

The authentication, IP information and ESM strings can come all from a LUDB, a RADIUS server, a (local) DHCP server, or any combination of them. These combinations are out of scope.

Knowledge of the Alcatel-Lucent TPSDA concept is assumed throughout this document.

# Overview

## PPPoE Hosts in a Routed CO Environment

The network topology for a Routed CO environment is displayed in Figure 347.

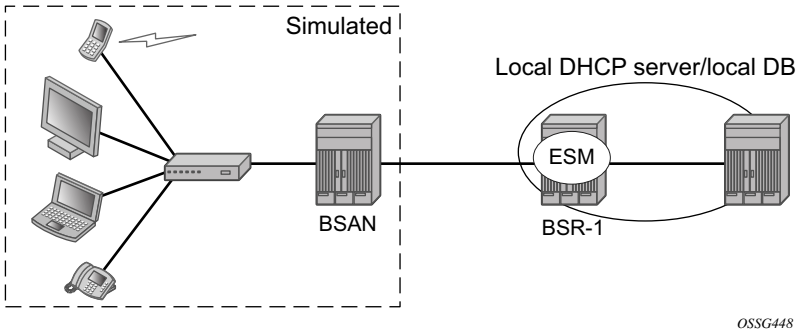


**Figure 347: Routed CO Network Topology**

The following configuration tasks should already be configured and are not detailed or explained in this section. Refer to the appropriate user guide.

- Basic service router configuration (system interface, IGP, MPLS, BGP)
- Routed CO service topology: VPRN or IES service with subscriber- and group-interface on BSR-1
- ESM
- LUDB (Local User Data Base)
- Local (DHCP) Dynamic Host Configuration Protocol) server

This section focuses on PPPoE hosts instantiated in a VPRN service subscriber-interface on BSR-1 (Routed CO). Note that in case of Routed CO, it is also possible to instantiate the PPPoE hosts in the Base routing instance using an IES service.

# Review of the PPPoE Protocol

PPPoE, Point-to-Point Protocol over Ethernet, is a network protocol for encapsulating PPP frames inside Ethernet frames. The protocol is described as an informational RFC 2516, *A Method for Transmitting PPP Over Ethernet (PPPoE)*, and is based on RFC 1661, *The Point-to-Point Protocol (PPP)*,which provides a standard method for transporting multi-protocol data-grams over point-to-point links.

PPP includes three main components:

- A method for encapsulating multi-protocol datagrams.
- A link control protocol (LCP) for establishing, configuring, and testing the data-link connection.
- A family of network control protocols (NCP) for establishing and configuring different network-layer protocols.

Ethernet networks are packet-based and have no concept of a connection or circuit. By using PPPoE, users can virtually dial from one machine to another over an Ethernet network; establish a point to point connection between them and then transport data packets over the connection.

In a typical wire-line solution with broadband access, PPPoE is used between a client (PC or modem) and a Network Access Server (NAS) (also called Broadband Network Gateway (BNG) or Broadband Service Router (BSR)) through an access node, like a Broadband Service Access Node (BSAN).

PPPoE consists of two phases, the Discovery Stage and the Session Stage.

## Discovery Stage

The discovery phase offers a stateless client-server model. When the Discovery Stage completes, both peers know the PPPoE SESSION_ID and the peer's Ethernet address, which together uniquely define the PPPoE session. There are four steps in the Discovery Stage:

**Step 1.** PPPoE Active Discovery Initiation (PADI)

Initiation (Host broadcast) — This broadcast packet is used by the client to search for an active server (BNG/BSR/NAS) providing access to a service.

Note: Additional attributes on the PADI message could be added if a BSAN is situated between the client and the BRAS.

**Step 2.** PPPoE Active Discovery Offer (PADO)

Access concentrator unicast — If the access server can provide the service it will respond with a unicast PADO to signal the client it may request connectivity.

Multiple servers may respond and the client may choose a server to connect.

**Step 3.** PPPoE Active Discovery Request (PADR):

Host unicast — After the client receives a PADO it will send a PADR unicast packet to connect to a server.

**Step 4.** PPPoE Active Discovery Session-Confirmation (PADS)

Access concentrator unicast — A server will respond to the client with this unicast packet to establish the session and provide the session-id. Once the PADS was provided the Session Stage begins.

Note: Discovery PPPoE Ethernet frames have the ETHER_TYPE field set to the value 0x8863.

## PPPoE Tags

IANA has set up a registry of PPPoE tag values (16-bit values). PPPoE tag values already in use are specified as reserved values as shown in Table 26. All other tag values between 0 and 65535 are to be assigned by IANA

**Table 26: Reserved PPPoE Tags**

| Tag Value | | Tag Name |
|---|---|---|
| 0 | 0x0000 | End-Of-List |
| 257 | 0x0101 | Service-Name |
| 258 | 0x0102 | AC-Name |
| 259 | 0x0103 | Host-Uniq |
| 260 | 0x0104 | AC-Cookie |
| 261 | 0x0105 | Vendor-Specific |
| 262 | 0x0106 | Credits |
| 263 | 0x0107 | Metrics |
| 264 | 0x0108 | Sequence Number |
| 272 | 0x0110 | Relay-Session-Id |
| 273 | 0x0111 | HURL |
| 274 | 0x0112 | MOTM |
| 288 | 0x0120 | PPP-Max-Payload |
| 289 | 0x0121 | IP_Route_Add |
| 513 | 0x0201 | Service-Name-Error |
| 514 | 0x0202 | AC-System-Error |
| 515 | 0x0203 | Generic-Error |

Explanations for some PPPoE tags (RFC 2516) are shown in the PPPoE discovery debugs messages.

**0x0101 Service-Names** — This tag indicates that a service name follows. The tag_value is an UTF-8 string that is not null terminated. When the tag_length is zero this tag is used to indicate that any service is acceptable. Examples of the use of the *service-name* tag are to indicate an ISP name or a class or quality of service.

**(0x0102) AC-Names** — This tag indicates that a string follows which uniquely identifies this particular Access Concentrator unit from all others. It may be a combination of trademark, model,

and serial id information, or simply an UTF-8 rendition of the MAC address of the box. It is not null terminated.

(0x0103) Host-Uniq — This tag is used by a host to uniquely associate an access concentrator response (PADO or PADS) to a particular host request (PADI or PADR). The tag_value is binary data of any value and length that the host chooses. It is not interpreted by the Access Concentrator. The host may include a host-uniq tag in a PADI or PADR. If the access concentrator receives this tag, it must include the tag unmodified in the associated PADO or PADS response.

(0x0104) AC-Cookie — This tag is used by the access concentrator to aid in protecting against denial of service attacks. The access concentrator may include this tag in a PADO packet.

If a host receives this tag, it must return the tag unmodified in the following PADR. The tag_value is binary data of any value and length and is not interpreted by the host.

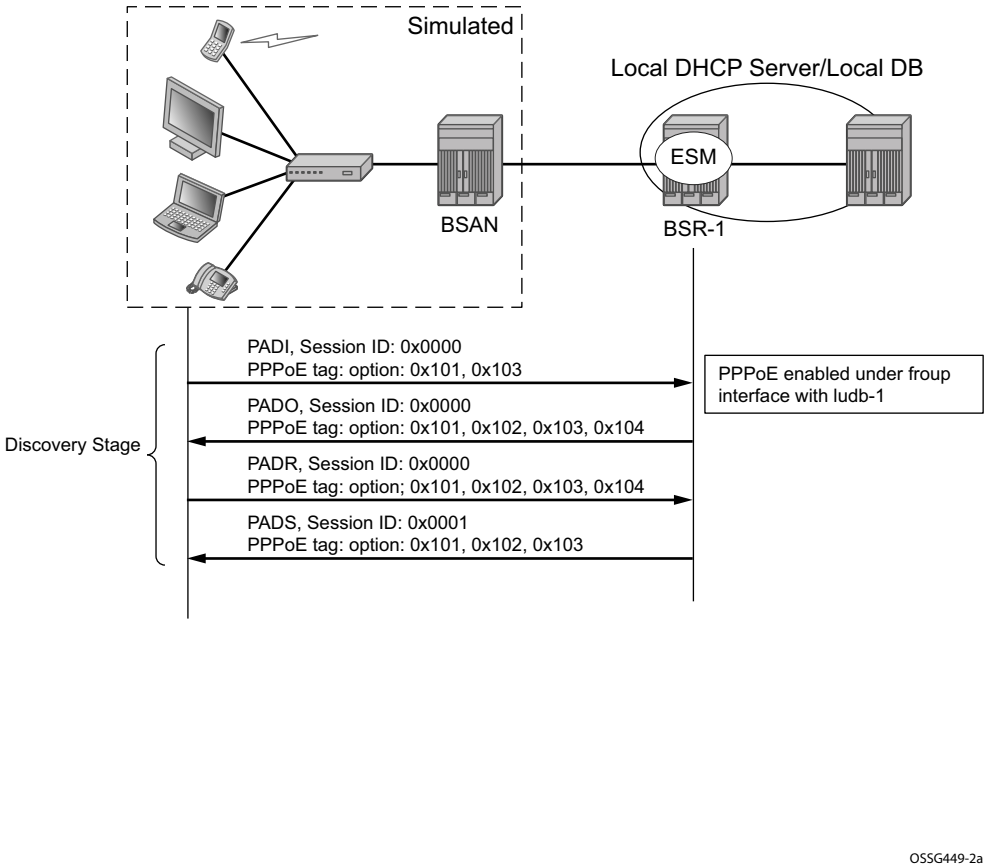


**Figure 348: Discovery Stage Messages**

# Session Stage

This next stage after Discovery is called the Session Stage. Once the MAC address of the peer is known and a session-id is exchanged, the two end points have all the information needed to start building a point-to-point connection over Ethernet and exchange packets over the connection.

This stage can be divided into to the following sections:


- Setup on page 2221
- Maintenance on page 2227
- Termination on page 2228


## Setup

### PPP Link Control Protocol (LCP)

Both the NAS and the user open the PPP session based on LCP packets. All post-discovery PPPoE Ethernet frames have the ETHER_TYPE field set to the value 0x8864.

Authentication method and the MRU are negotiated during this phase.

RFC 2516 mandates a maximum negotiated Maximum Receive Unit (MRU) of 1492.

RFC 4638, *Accommodating a Maximum Transit Unit/Maximum Receive Unit (MTU/MRU) Greater Than 1492 in the Point-to-Point Protocol over Ethernet (PPPoE),* relaxes this restriction and allows a maximum negotiated MRU greater than 1492 to minimize fragmentation in next-generation broadband networks.

The 7750 implementation follows RFC 4638 when the client implements these extensions.

LCP uses config_request and config_ack/nack to negotiate parameters:

- LCP goes to final state opened when configure-ack is send & received.
- The own options are proposed in configure request.

There are three cases for the LCP negations parameters:

- Peer supports the options and his content.
  → Peer will agree and send config-ack.
- Peer does not support an option
  → Peer will send configure-reject with the option that is not supported.
  → Resend of configure-request without that option.
  → Peer agrees and sends config-ack.
- Peer does support the option but not the content.
  → Peer will send config-nack with the option and his new content.
  → Resend of configure-request with same options but new content.
  → Peer agrees and sends config-ack.

**Table 27: LCP and IPCP Code**

| Code | Packet Type |
|---|---|
| 1 | Configure-Request |
| 2 | Configure-Ack |
| 3 | Configure-Nak |
| 4 | Configure-Reject |
| 5 | Terminate-Request |
| 6 | Terminate-Ack |
| 7 | Code-Reject |
| 8 | Protocol-Reject |
| 9 | Echo-Request |
| 10 | Echo-Reply |
| 11 | Discard-Request |
| 12 | Identification |
| 13 | Time-Remaining |
| 14 | Reset-request CCP |
| 15 | Reset-Ack CCP |

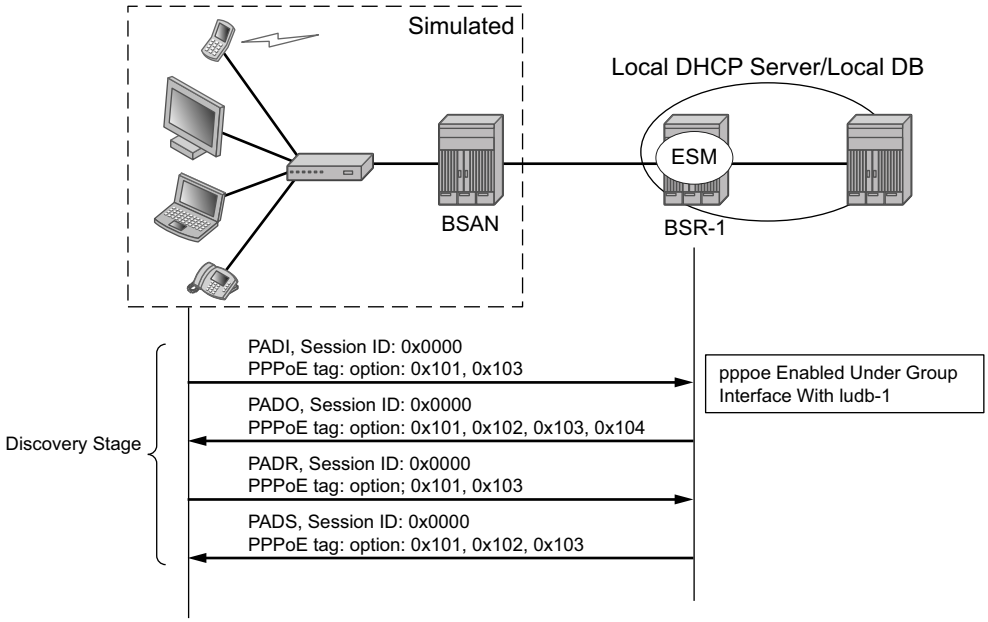


**Figure 349: LCP Phase Messages**

## Authentication Phase

The client authenticates itself through PAP (PPP Password Authentication Protocol) or CHAP (Challenge Handshake Authentication Protocol) to check for access permission.For the CHAP authentication, the BSR initiates the authentication as shown in Figure 350.

Note: The password as a hashed output on the link and plain text in a RADIUS Access-Request message.

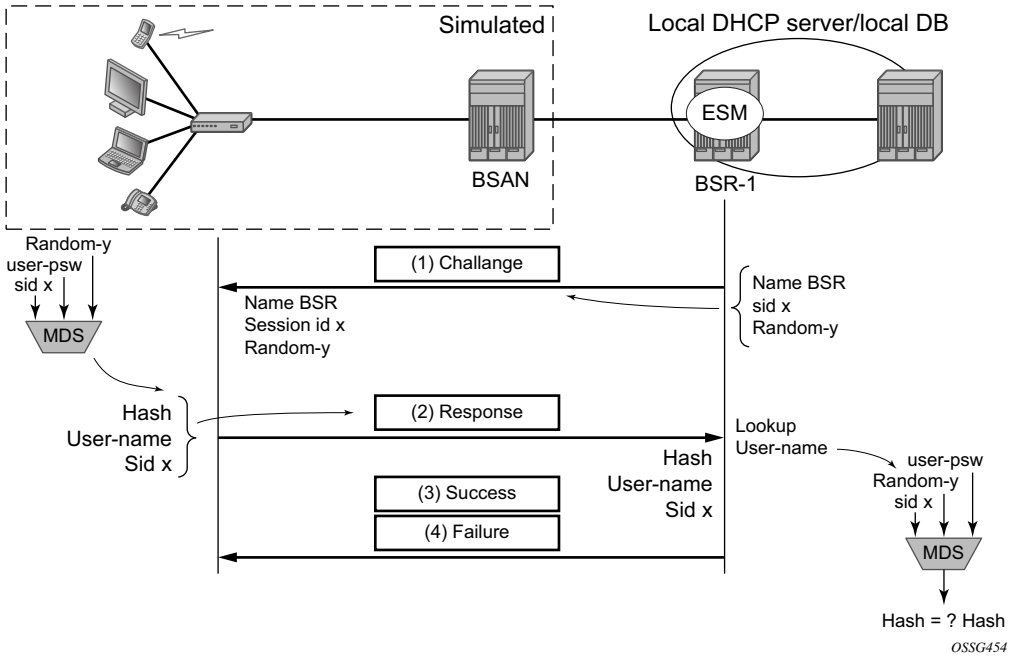


**Figure 350: CHAP Handshaking Overview Process**

For PAP the client initiates the authentication as shown in Figure 351.

Note: The password is sent as plain text on the link and hashed in a RADIUS Access-Request message.

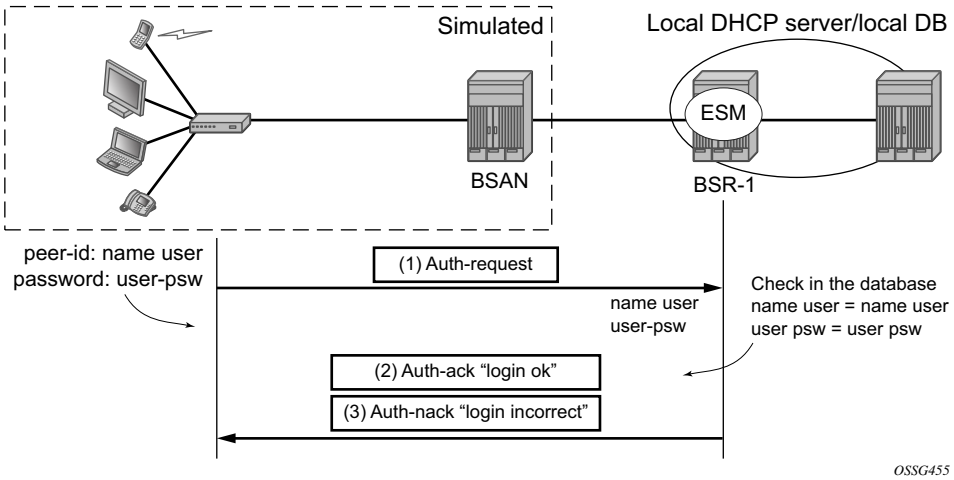


**Figure 351: PAP Overview Process**

## Network-Layer Protocol Phase (PPP IPCP Opening Phase)

At this stage the user requests an IP address to be used for data transmission. During this negotiation the client will also receive a Domain Name Server (DNS), NBNS (Netbios Name Server) address, etc. if they are requested.

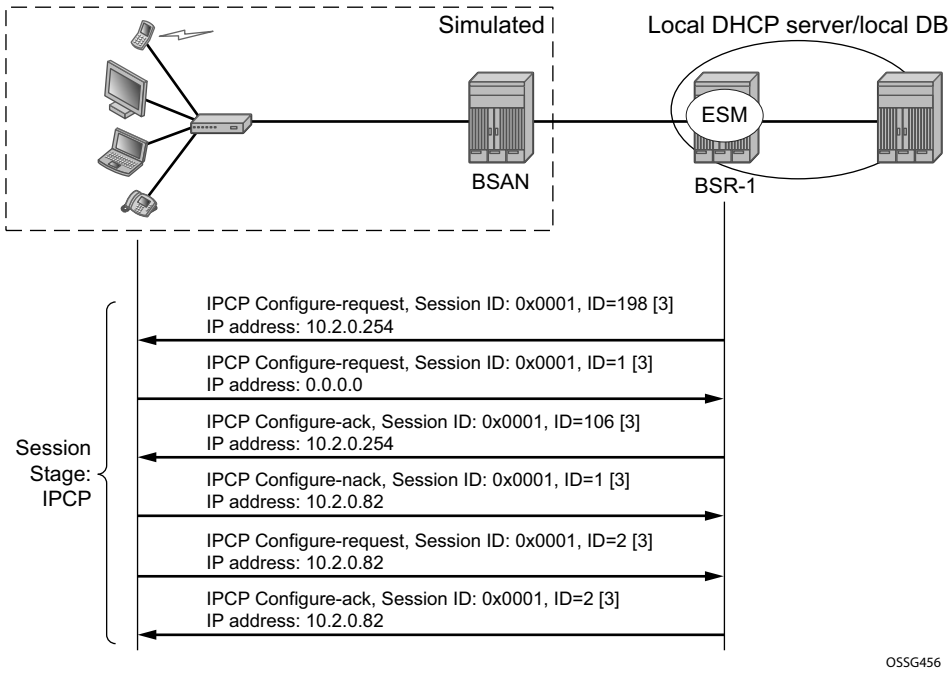


**Figure 352: IPCP Phase Messages**

## Maintenance

PPP uses keepalives in order to maintain the integrity of the connection. This keepalive mechanism uses an echo-request that is sent to remote PPP peer, following which the remote PPP peer should respond with an echo-reply. The connection is considered down if x-numbers of echo-reply are missed. Both sides can initiate keepalives which run independently.

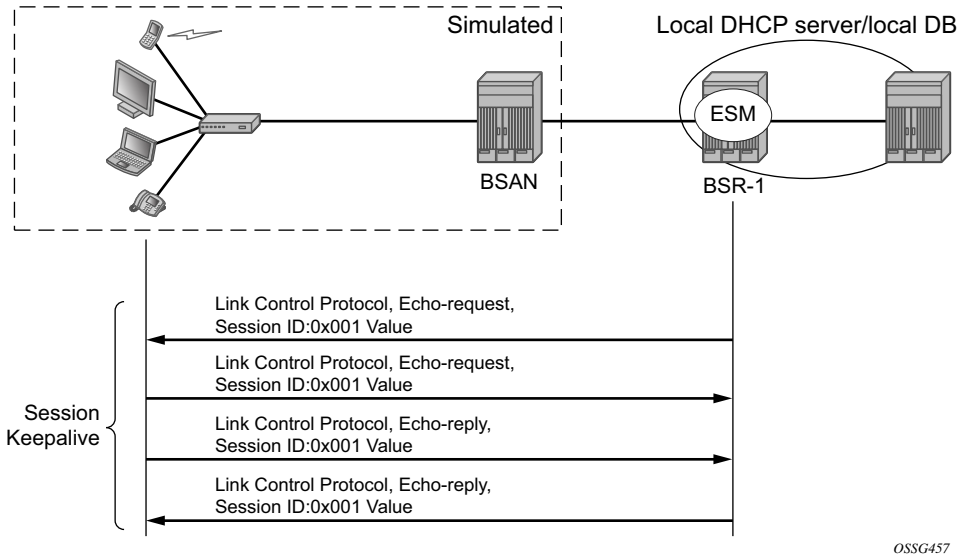


**Figure 353: Keepalive Messages**

# Termination

## Link Termination Phase

A PPPoE session can be terminated by either the client or by the BRAS and consists of a Terminate-request followed by a PADT.

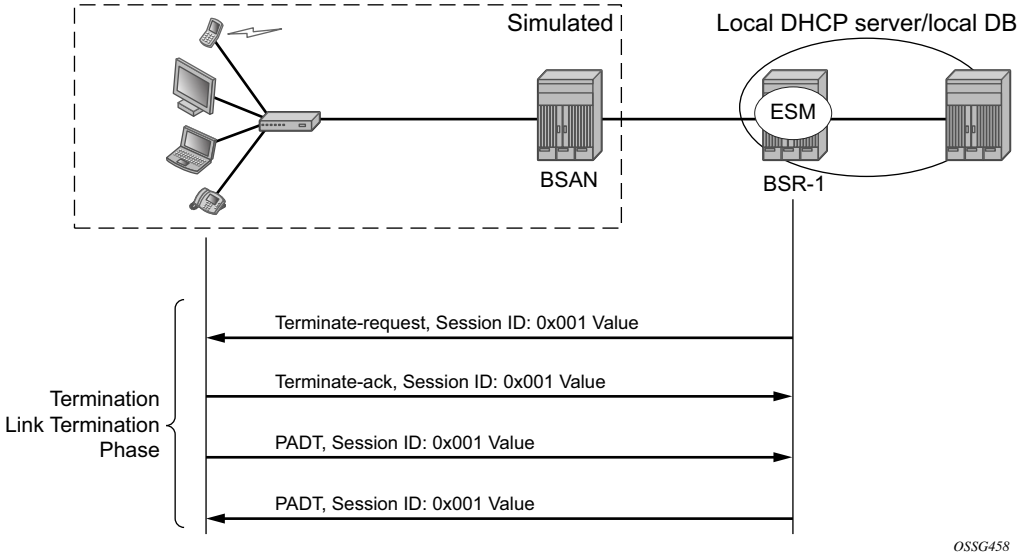


**Figure 354: Link Termination Phase**

# Configuration

## PPPoE Host Session: Set-Up, Operation and Release

Enable PPPoE termination under the group-interface context.

Enable the local user database under the PPPoE node of the group-interface.

```
B:BSR-1# configure service vprn 1
            subscriber-interface "sub-int-1" create
                address 10.2.0.254/16
                group-interface "group-int-1" create
                    sap 1/1/3:1 create
                        sub-sla-mgmt
                            sub-ident-policy "sub-id-default"
                            no shutdown
                        exit
                    exit
                    pppoe
                        user-db "ludb-1"
                        no shutdown
                    exit
                exit
            exit
            no shutdown
```

The local user database is configured with the following parameters.

```
*A:BSR-1>config>subscr-mgmt# info
----------------------------------------------
        local-user-db "ludb-1" create
            pppoe
                match-list username
                host "user1" create
                    host-identification
                        username "user1@domain1"
                    exit
                    address pool "pool-1"
                    password chap "KG35KPbV/9zoZpmco.h0nXFfa0QqZdsT" hash2
                    identification-strings 254 create
                        subscriber-id "PPPoE-host-user1@domain1"
                        sla-profile-string "sla-profile-1"
                        sub-profile-string "sub-profile-1"
                    exit
                    no shutdown
                exit
```

A local DHCP server will be used as a source for the IP addressing of the PPPoE host.

```
*A:BSR-1>config>service>vprn# info
----------------------------------------------
            dhcp
                local-dhcp-server "server-1" create
                    use-gi-address
                    pool "pool-1" create
                         subnet 10.2.0.0/16 create
                            exclude-addresses 10.2.0.254 10.2.0.255
                            address-range 10.2.0.1 10.2.0.253
                        exit
                    exit
                    no shutdown
                exit
            exit
```

- The PPPoE policy configuration.

```
A:BSR-1# configure subscriber-mgmt pppoe-policy "pppoe-policy-1" create
*A:BSR-1>config>subscr-mgmt>pppoe-policy$ info detail
----------------------------------------------
            no description
            no disable-cookies
            keepalive 30 hold-up-multiplier 3
            no pado-delay
            no ppp-initial-delay
            no ppp-mtu
            max-sessions-per-mac 1
            no reply-on-padt
            ppp-authentication pref-chap
            ppp-chap-challenge-length min 32 max 64
            ppp-options
            exit
```

The PPPoE policy defines the parameters which are used in the establishment of the PPPoE session such as:

- Disable-cookies — This parameter disables the use of cookies.
- Keepalive — This command defines the keepalive interval and the number of keepalives that can be missed before the session is declared down for this PPPoE policy.
  - → [10 — 300] seconds: Specifies the keepalive interval in seconds.
  - → hold-up-multiplier [1 — 5]: Specifies the number of keepalives that can be missed.
- PADO-delay — This parameter configures the delay timeout before sending a PPPoE Active Discovery Offer (PADO) packet.
  - → [1 — 30] deciseconds
- PPP-mtu — This parameter configures the maximum PPP MTU size.
  - → [512 — 9212]: possible values for MTU size.

- Max-sessions-per-mac — This parameter sets the maximum PPPoE sessions that can be opened for the given MAC address.

  → [1 — 63]: possible PPPoE sessions per MAC address.

- Reply-on-PADT — Some of the PPPoE clients expect reply on PPPoE Active Discovery Terminate (PADT) message before the context of the session is cleared up. To support such client, a command enabling reply to PADT is provided.

  → [Default] **no reply-on-padt**

- PPP-options — This parameter enables the context to configure PPP options which is not supported by default

These parameters will be explained later in details according to its existence in which PPPoE phase.

Notes:

- The default policy cannot be modified nor deleted.
- Multiple PPPoE policies may be configured.

```
* The PPPoE policy is defined within the PPPoE context under the group interface.
*A:BSR-1>config>service>vprn# info
----------------------------------------------
---snip---
            subscriber-interface "sub-int-1" create
                address 10.2.0.254/16
                group-interface "group-int-1" create
--snip---
                    pppoe
                        pppoe-policy "pppoe-policy-1"
---snip---
```

Troubleshooting the PPPoE discovery messages (PADI, PADO, PADR, PADS and PADT) is done with PPPoE debugging:

```
*A:BSR-1# debug service id 1 pppoe packet discovery ?
  - discovery [padi] [pado] [padr] [pads] [padt]
  - no discovery

 <padi>               : keyword - debug PADI packets
 <pado>               : keyword - debug PADO packets
 <padr>               : keyword - debug PADR packets
 <pads>               : keyword - debug PADS packets
 <padt>               : keyword - debug PADT packets
```

For example:

```
*A:BSR-1# show debug
debug
    service
        id 1
            pppoe
                packet
                    mode egr-ingr-and-dropped
                    detail-level medium
                    discovery
                    ppp
                    dhcp-client
                exit
```

To display the debugging information, a dedicated log should be created:

```
*A:BSR-1# configure log
        log-id 1
           from debug-trace
            to session
        exit
```

## Discovery Stage

The following is an example of PPPoE (PADI discovery packet) debug log output:

```
"PPPoE: RX Packet
   VPRN 1, SAP 1/1/3:1
   DMAC: ff:ff:ff:ff:ff:ff
   SMAC: 00:00:67:14:01:02
   Ether Type: 0x8863 (Discovery)

   PPPoE Header:
   Version: 1                 Type      : 1
   Code   : 0x09 (PADI)       Session-Id: 0x0000 (0)
   Length : 65
   PPPoE Tags:
   [0x0101] Service-Name: "AGILENT"
   [0x0103] Host-Uniq: len = 4, value = 00 14 00 00
   [0x0105] Vendor-Specific: vendor-id = 0x0de9 (ADSL Forum)
      [0x01] Agent-Circuit-Id: "circuit10"
      [0x02] Agent-Remote-Id: "remote10"
      [0x81] Actual-Upstream: 64
      [0x82] Actual-Downstream: 64
      [0x90] Access-Loop-Encap: 01 01 00
```

---

### PPPoE Policy Parameters

Service name — The client can ask a particular service. Empty means that any service is acceptable. The service name can indicate an ISP name, class, QoS.

```
PPPoE: RX Packet
   VPRN 1, SAP 1/1/3:1

   DMAC: ff:ff:ff:ff:ff:ff
   SMAC: 00:00:67:14:01:02
   Ether Type: 0x8863 (Discovery)

   PPPoE Header:
   Version: 1                 Type      : 1
   Code   : 0x09 (PADI)       Session-Id: 0x0000 (0)
   Length : 65

   PPPoE Tags:
   [0x0101] Service-Name: "AGILENT"
```

The BSR echoes the service name from the PADI message. Empty means that any service is acceptable.

```
112 2010/01/07 17:29:32.07 UTC MINOR: DEBUG #2001 vprn1 PPPoE
"PPPoE: TX Packet
   VPRN 1, SAP 1/1/3:1

   DMAC: 00:00:67:14:01:02
   SMAC: 00:03:fa:90:f8:6a
   Ether Type: 0x8863 (Discovery)

   PPPoE Header:
   Version: 1                 Type      : 1
   Code   : 0x07 (PADO)       Session-Id: 0x0000 (0)
   Length : 48

   PPPoE Tags:
   [0x0101] Service-Name: "AGILENT"
```

Host-Uniq — The host can include a unique tag of any length inserted In PADI or PADR.The AC should echo back this tag in the PADO or PADS.

```
"PPPoE: RX Packet
   VPRN 1, SAP 1/1/3:1

   DMAC: ff:ff:ff:ff:ff:ff
   SMAC: 00:00:67:14:01:02
   Ether Type: 0x8863 (Discovery)

   PPPoE Header:
   Version: 1                 Type      : 1
   Code   : 0x09 (PADI)       Session-Id: 0x0000 (0)
   Length : 65
   PPPoE Tags:
   [0x0101] Service-Name: "AGILENT"
   [0x0103] Host-Uniq: len = 4, value = 00 14 00 00
```

The following parameters can optionally be added to the PADI by the PPPoE intermediate agent (BSAN):

Vendor-specific information

- Agent-Circuit-Id
- Agent-Remote-Id
- Access-loop-Encapsulation
- Access loop characteristics (actual-upstream, actual-downstream)

The debug output:

```
111 2010/01/07 17:29:32.07 UTC MINOR: DEBUG #2001 vprn1 PPPoE
"PPPoE: RX Packet
   VPRN 1, SAP 1/1/3:1
   DMAC: ff:ff:ff:ff:ff:ff
   SMAC: 00:00:67:14:01:02
   Ether Type: 0x8863 (Discovery)

   PPPoE Header:
   Version: 1                 Type      : 1
   Code   : 0x09 (PADI)       Session-Id: 0x0000 (0)
   Length : 53

   PPPoE Tags:
   [0x0101] Service-Name: "AGILENT"
   [0x0103] Host-Uniq: len = 4, value = 00 14 00 00
   [0x0105] Vendor-Specific: vendor-id = 0x0de9 (ADSL Forum)
      [0x01] Agent-Circuit-Id: "circuit10"
      [0x02] Agent-Remote-Id: "remote10"
      [0x81] Actual-Upstream: 64
      [0x82] Actual-Downstream: 64
      [0x90] Access-Loop-Encap: 01 01 00
```

The cookies can be displayed in the PADO message. This tag of any value and length may be included by the AC and is echoed back by the client to the AC in the next PADR .

```
112 2010/01/07 17:29:32.07 UTC MINOR: DEBUG #2001 vprn1 PPPoE
"PPPoE: TX Packet
   VPRN 1, SAP 1/1/3:1

   DMAC: 00:00:67:14:01:02
   SMAC: 00:03:fa:90:f8:6a
   Ether Type: 0x8863 (Discovery)

   PPPoE Header:
   Version: 1                 Type      : 1
   Code   : 0x07 (PADO)       Session-Id: 0x0000 (0)
   Length : 48

   PPPoE Tags:
   [0x0101] Service-Name: "AGILENT"
   [0x0102] AC-Name: "BSR-1"
   [0x0103] Host-Uniq: len = 4, value = 00 14 00 00
   [0x0104] AC-Cookie: len = 16, value = d7 91 cd b7 3e 51 76 d6 03 0a f2 68 8c
da ba 74
```

- AC-name — Identifies the string that uniquely identifies the access concentrator (AC).

```
112 2010/01/07 17:29:32.07 UTC MINOR: DEBUG #2001 vprn1 PPPoE
"PPPoE: TX Packet
   VPRN 1, SAP 1/1/3:1

   DMAC: 00:00:67:14:01:02
   SMAC: 00:03:fa:90:f8:6a
   Ether Type: 0x8863 (Discovery)

   PPPoE Header:
   Version: 1                Type      : 1
   Code   : 0x07 (PADO)      Session-Id: 0x0000 (0)
   Length : 48

   PPPoE Tags:
   [0x0101] Service-Name: "AGILENT"
   [0x0102] AC-Name: "BSR-1"
```

When **disable-cookies** is configured, the use of cookies will be disabled, when omitted the **no-disable-cookies** will be used.

```
*A:BSR-1>config>subscr-mgmt>pppoe-policy# info
----------------------------------------------
            disable-cookies
```

The cookies are encoded back by the client in the next PADR message.

PPPoE hosts are authenticated based on username-password information (PAP/CHAP authentication) or on information embedded in the PADI message PADI authentication).

```
ppp-chap-challenge length
```

The **min** and **max** values for the **ppp-chap-challenge** are defined when enabling **ppp-chap-challenge length**. When omitted, a **min** of 32 and **max** of 64 are used.

```
*A:BSR-1# configure subscriber-mgmt pppoe-policy "pppoe-policy-1" ppp-chap-challenge-
length ?
  - ppp-chap-challenge-length min <minimum-length> max <maximum-length>
  - no ppp-chap-challenge-length
 <minimum-length>     : [8..64]
 <maximum-length>     : [8..64]
```

## Local User Database Authentication

With this authentication method, the client's PPPoE session is authenticated locally on the BRAS without any constraint of an external radius server.

The local user database is configured with the following parameters.

```
*A:BSR-1>config>subscr-mgmt# info
----------------------------------------------
        local-user-db "ludb-1" create
            pppoe
                match-list username
                host "user1" create
                    host-identification
                        username "user1@domain1"
                    exit
                    address pool "pool-1"
                    password chap "KG35KPbV/9zoZpmco.h0nXFfa0QqZdsT" hash2
                    identification-strings 254 create
                        subscriber-id "PPPoE-host-user1@domain1"
                        sla-profile-string "sla-profile-1"
                        sub-profile-string "sub-profile-1"
                    exit
                    no shutdown
                exit
```

Example: PADI authentication through LUDB.

```
*A:BSR-1# configure subscriber-mgmt local-user-db "ludb-1" pppoe match-list ?
  - no match-list
  - match-list <pppoe-match-type-1> [<pppoe-match-type-2>...(up to 3 max)]

 <pppoe-match-type>   : circuit-id|mac|remote-id|service-name|username
```

To complete the discovery phase, the server must provide a session-id to the client and we allocate always session-id 1 for different MACs.

Note: in VLAN per service model (N: 1 VLAN) where the MACs are the same and the PPPoE interworking will be done at the BSAN.

```
*A:BSR-1# show service id 1 pppoe session
===============================================================================
PPPoE sessions for svc-id 1
===============================================================================
Sap Id              Mac Address       Sid  Up Time        IP/L2TP-Id      Type
-------------------------------------------------------------------------------
1/1/3:1             00:00:67:14:01:02  1   0d 23:05:40    10.2.0.46       Local
-------------------------------------------------------------------------------
Number of sessions : 1
```

The 7750 has the possibility to delay the sending of the PADO message to the client. This feature could be used if the client is dual homed to 2 BSRs and is explained later in the document.

When PADO-delay is configured, the configured value equals the delay timeout before sending PADO, when omitted the PADO-delay value of 0 msec will be used.

```
*A:BSR-1>config>subscr-mgmt>pppoe-policy# pado-delay ?
  - no pado-delay
  - pado-delay <deci-seconds>

 <deci-seconds>       : [1..30]
```

## Session Stage

### lcp

During the link establishment phase client and server negotiate options and need to come to an agreement on these options. Options that are unknown by the peer are rejected whereas known options with unknown content are nack'd. In the later case the peer needs to resend the same option but with another content. In case of a reject the peer should remove that option. An Ack will be send if there is a full agreement.

One of the more important options that is exchanged is the maximum receive unit (MRU) and the authentication protocol that will be used later in the authentication phase. The first option, the MRU value (minus overhead) is sent from the BSR towards the client and is the lowest value between the port MTU and the optional configured ppp-mtu in the ppp-policy.

RFC 2516 mandates a maximum negotiated Maximum Receive Unit (MRU) of 1492 but RFC 4638 relaxes this restriction and allows a maximum negotiated MRU greater than 1492 to minimize fragmentation in next-generation broadband networks. The 7750 SR and 7710 SR implementation follows RFC 4638 when the client implements these extensions.

If a PPPoE client wants to use MRU>1492 in the LCP-config request it should include the **ppp-max-payload** tag with the higher MTU value in the initial PADI message.

```
*A:BSR-1# configure subscriber-mgmt pppoe-policy "pppoe-policy-1" ppp-mtu ?
  - no ppp-mtu
  - ppp-mtu <mtu-bytes>

 <mtu-bytes>          : [512..9212]

PPPoE debug output.
134 2010/01/07 21:04:10.30 UTC MINOR: DEBUG #2001 vprn1 PPPoE
"PPPoE: TX Packet
   VPRN 1, SAP 1/1/3:1

   DMAC: 00:00:67:13:01:02
   SMAC: 00:03:fa:90:f8:6a
   Ether Type: 0x8864 (Session)

   PPPoE Header:
   Version: 1                Type      : 1
   Code   : 0x00             Session-Id: 0x0001 (1)
   Length : 21

   PPP:
   Protocol  : 0xc021 (LCP)
   Code      : 1 (Configure-Request)
   Identifier: 5             Length    : 19

   Options:
   [1] MRU: 1492
---snip--
```

The second important option, the authentication method used in the authentication phase is exchanged between client and server and can be PAP or CHAP authentication. The authentication method is not exchanged when PADI authentication is done. PADI authentication means that the BSR will authenticate the user based on parameters in the PADI message. Authentication based on PADI and PAP/CHAP is possible.

```
Debug output example for CHAP authentication protocol.
137 2010/01/07 21:04:10.30 UTC MINOR: DEBUG #2001 vprn1 PPPoE
"PPPoE: RX Packet
   VPRN 1, SAP 1/1/3:1

   DMAC: 00:03:fa:90:f8:6a
   SMAC: 00:00:67:13:01:02
   Ether Type: 0x8864 (Session)

   PPPoE Header:
   Version: 1                Type      : 1
   Code   : 0x00             Session-Id: 0x0001 (1)
   Length : 21

   PPP:
   Protocol  : 0xc021 (LCP)
   Code      : 2 (Configure-Ack)
   Identifier: 5             Length    : 19

   Options:
      [3] Authentication-Protocol: 0xc223 (CHAP), Algorithm = 5 (MD5)
      [5] Magic-Number: 0x60363318
```

Debug output example for PAP authentication protocol.

```
46 2010/01/13 10:59:45.71 UTC MINOR: DEBUG #2001 vprn1 PPPoE
"PPPoE: RX Packet
   VPRN 1, SAP 1/1/3:1

   DMAC: 00:03:fa:90:f8:6a
   SMAC: 00:00:67:13:01:02
   Ether Type: 0x8864 (Session)

   PPPoE Header:
   Version: 1                Type      : 1
   Code   : 0x00             Session-Id: 0x0001 (1)
   Length : 20

   PPP:
   Protocol  : 0xc021 (LCP)
   Code      : 2 (Configure-Ack)
   Identifier: 160           Length    : 18

   Options:
   [1] MRU: 1492
   [3] Authentication-Protocol: 0xc023 (PAP)
   [5] Magic-Number: 0x37df4db2
"
```

- Fallback case chap->pap

For user authentication, with pap-chap-access, always try CHAP first; if that doesn't succeed, try PAP.

The option to be used first (CHAP/PAP) is defined when enabling the ppp-authentication. When omitted, CHAP is preferred always.

```
*A:BSR-1# configure subscriber-mgmt pppoe-policy "pppoe-policy-1" ppp-authentication ?
  - no ppp-authentication
  - ppp-authentication {pap|chap|pref-chap}

 <pap|chap|pref-chap> : keywords
```

PPPoE clients that implement undocumented options also require an agreement on those unknown options. By default, the 7750 SR will reject unknown options but the **ppp-option** feature in the **pppoe-policy** allows for support of undocumented client LCP or IPCP options. If the received LCP or IPCP option matches the configured options in the pppoe-policy an ack will be send instead of a reject.

```
*A:BSR-1# configure subscriber-mgmt pppoe-policy "pppoe-policy-1" ppp-options custom-
option  ?
  - custom-option <protocol> <option-number> address <ip-address>
  - custom-option <protocol> <option-number> hex <hex-string>
  - custom-option <protocol> <option-number> string <ascii-string>
  - no custom-option <protocol> <option-number>

 <protocol>           : lcp|ipcp
 <option-number>      : [0..255]
 <ip-address>         : a.b.c.d
 <ascii-string>       : [127 chars max]
 <hex-string>         : [0x0..0xFFFFFF...(max 254 hex nibbles)]
```

Troubleshooting the PPPoE LCP session messages is done with PPPoE debugging:

```
*A:BSR-1>debug>service>id>pppoe>packet# ppp ?
  - no ppp
  - ppp [lcp] [pap] [chap] [ipcp]

 <lcp>                : keyword - debug LCP packets
 <pap>                : keyword - debug PAP packets
 <chap>               : keyword - debug CHAP packets
 <ipcp>               : keyword - debug IPCP packets
```

- Authentication

The 7750/7710 BSR supports three main methods for PPPoE authentication.

- PADI or PAP/CHAP authentication through RADIUS
- PADI or PAP/CHAP authentication through a LUDB
- PADI authentication via LUDB then PAP/CHAP pre-authentication through RADIUS

DHCP server authentication will not be explained in this section because this is more authorization than authentication

The flow chart of the PPPoE host authentication process is shown in Figure 355.

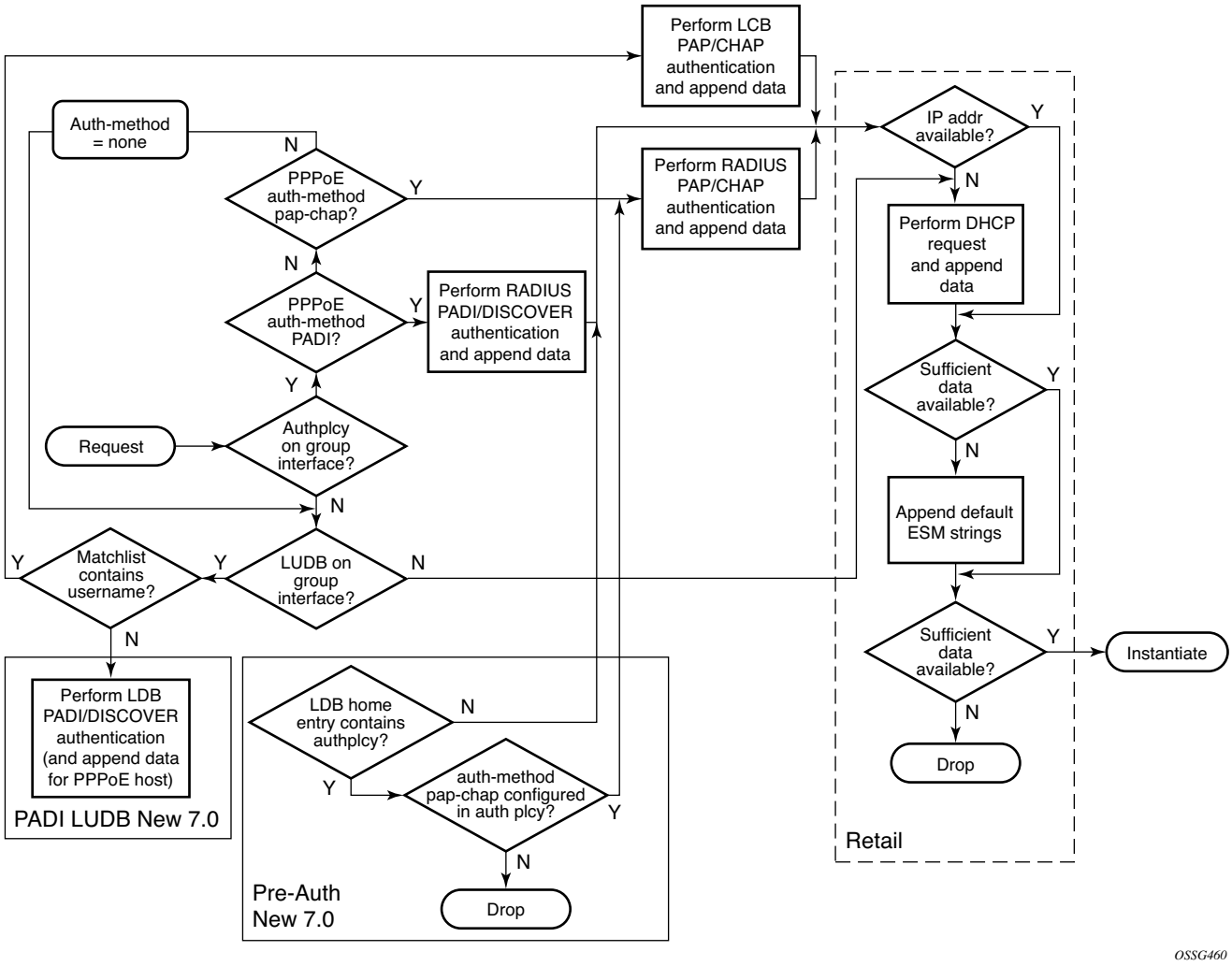


**Figure 355: Authentication Flow Chart**

- PPPoE users get authenticated via the LUDB if this LUDB is configured under the group-interface.

```
*A:BSR-1>config>service>vprn>sub-if>grp-if>pppoe# info
----------------------------------------------
                        user-db "ludb-1"
```

- Users get authenticated via RADIUS if we have an authentication-policy under the same group-interface. RADIUS has precedence if both are configured.

```
*A:BSR-1>config>service>vprn>sub-if>grp-if# info
----------------------------------------------
                    authentication-policy "auth-1"
                    pppoe
                        user-db "ludb-1"
                    exit
```

- Users that get authenticated via the LUDB can still go to RADIUS if we move the authentication-policy from the group-interface to the LUDB.

```
A:BSR-1>config>subscr-mgmt>loc-user-db>pppoe>host# info
----------------------------------------------
---snip---
                    auth-policy "auth-1"
                    no shutdown
```

This last mechanism is called pre-authentication and could be used to pick up parameters like **pado-delay** or checking some variables such as **circuit-id**, **remote-id** from the LUDB during discovery phase but use RADIUS for PAP/CHAP authentication.

```
*A:BSR-1>config>subscr-mgmt>loc-user-db>pppoe>host# host-identification ?

 [no] circuit-id      - Configure the circuit id of this host
 [no] mac             - Configure the MAC address of this host
 [no] remote-id       - Configure the remote id of this host
 [no] service-name    - Configure the service name of this host
 [no] username        - Configure the user name of this host
```

- Both RADIUS and LUDB support PADI or PAP/CHAP authentication.
- PPPoE users that are authenticated through the LUDB and have in the LUDB a match-list other than **username** will get authenticated based on PADI parameters like mac, circuit-id, remote-id.

```
*A:BSR-1>config>subscr-mgmt>loc-user-db>pppoe# match-list ?
  - no match-list
  - match-list <pppoe-match-type-1> [<pppoe-match-type-2>...(up to 3 max)]

 <pppoe-match-type>   : circuit-id|mac|remote-id|service-name|username
```

- PPPoE users that have in the LUDB a match-list equal to **username** will use the PAP/CHAP authentication method.

```
*A:BSR-1>config>subscr-mgmt# info
----------------------------------------------
        local-user-db "ludb-1" create
            pppoe
                match-list username
                host "user1" create
                    host-identification
                        username "user1@domain1"
                    exit
                    address pool "pool-1"
                    password chap "KG35KPbV/9zoZpmco.h0nXFfa0QqZdsT" hash2
---snip---
```

- PPPoE users that are authenticated through RADIUS and have in the authentication policy, a pppoe-access-method equal to PADI will use the **mac** or **circuit-id** information from the PADI in their request to RADIUS.

```
*A:BSR-1>config>subscr-mgmt>auth-plcy$ pppoe-access-method ?
  - pppoe-access-method {none|padi|pap-chap}
  - no pppoe-access-method
```

- The selection for mac or circuit-id can be altered via the parameter user-name-format.

```
*A:BSR-1>config>subscr-mgmt>auth-plcy$ user-name-format ?
  - user-name-format <format> [append domain-name]
  - no user-name-format

 <format>             : mac|circuit-id|tuple|ascii-converted-circuit-id|
                        ascii-converted-tuple
```

PPPoE users that are authenticated through RADIUS and have in the authentication policy a pppoe-access-method equal to pap-chap use the username from the authentication phase in their request to RADIUS. The parameter user-name-format is irrelevant in this last case.

## RADIUS Authentication

When authentication is provided through RADIUS, two methods can be used to authenticate the PPPoE session.

- PADI authentication
- PAP/CHAP authentication

The RADIUS policy specifies what parameters are provided in the RADIUS access-request message.

The following parameters can be configured:

- Circuit-id: Provided through the PADI/PADR PPPoE relay vendor specific tag as specified in TR-101 of the DSL Forum.
- Remote-id: Provided through the PADI/PADR PPPoE relay vendor specific tag as specified in TR-101 of the DSL Forum.
- NAS-port-id: SAP ID on which the PPPoE session terminates (e.g. 1/1/3:1).
- NAS-identifier: System name of the NAS or BNG.
- PPPoE-service-name: Provided through the PPPoE PADI packet.
- access-loop-options: Provided through the PAD/PADR PPPoE extensions as specified in TR-101 of the DSL Forum.

The option to use PADI authentication or PAP/CHAP authentication is selected with the following configuration in the RADIUS policy:

```
*A:BSR>config>subscr-mgmt>auth-plcy# pppoe-access-method ?
  - pppoe-access-method {none|padi|pap-chap}
  - no pppoe-access-method
```

When PADI authentication is used for PPPoE termination the MAC address or the PPPoE relay tag (Circuit-ID) or a combination of MAC address and circuit ID can be used to identify the subscriber in the RADIUS server.

To determine the iinformation to use in the RADIUS Access-Request message is configured in the RADIUS policy using the following command:

```
*A:BSR >config>subscr-mgmt>auth-plcy# user-name-format ?
  - user-name-format <format>
  - no user-name-format

 <format>            : mac|circuit-id|tuple|ascii-converted-circuit-id|ascii-converted-
tuple
```

## Local User Database Authentication

A second authentication option for PPPoE termination is to use the local user database of the BSR 7750/ 7710 for PAP/CHAP authentication (this option will be used in this note). With this authentication method the client's PPPoE session is authenticated locally on the BSR without any constraint of an external radius server.

The local user database is configured with the following parameters:

```
*A:BSR-1>config>subscr-mgmt# info
----------------------------------------------
        local-user-db "ludb-1" create
            pppoe
                match-list username
                host "user1" create
                    host-identification
                        username "user1@domain1"
                    exit
                    address pool "pool-1"
                    password chap "KG35KPbV/9zoZpmco.h0nXFfa0QqZdsT" hash2
                    identification-strings 254 create
                        subscriber-id "PPPoE-host-user1@domain1"
                        sla-profile-string "sla-profile-1"
                        sub-profile-string "sub-profile-1"
                    exit
                    no shutdown
```

With this authentication method, authentication can be provided by the username/password.

To enable the local authentication method, the local user database is configured under the PPPoE node of the group-interface as shown below.

```
*A:BSR-1>config>service>vprn>sub-if>grp-if# info
----------------------------------------------
---snip---
                  pppoe
---snip--
                       user-db "ludb-1"
                       no shutdown
```

To check LUDB parameters for the PPPoE hosts.

```
*A:BSR-1# show subscriber-mgmt local-user-db ludb-1 pppoe-host user1
===============================================================================
PPPoE Host "user1"
===============================================================================
Admin State          : Up
---snip---
 User Name           : user1@domain1

Matched Objects      : userName
```

```
Address              : pool "pool-1"
Password Type        : CHAP
---snip---
Identification Strings (option 254)
 Subscriber Id       : PPPoE-host-user1@domain1
 SLA Profile String  : sla-profile-1
 Sub Profile String  : sub-profile-1
---snip--
```

To debug the LUDB.

```
*A:BSR-1# debug subscriber-mgmt local-user-db "ludb-1" detail
  - detail {all|failed}
  - no detail
```

## DHCP Client Authentication

A third authentication method for PPPoE termination is to perform PPPoE to DHCP transformation (where the 7750 SR acts as a DHCP client on behalf of the PPP session) and to use a DHCP server for session authentication. This method is useful when a similar authentication is used for DHCP based clients.

The PPPoE to DHCP authentication method can provide authentication on the basis of MAC address, circuit ID or remote ID.

- ipcp

IP and DNS information can be obtained from different sources like LUDB and RADIUS for fixed IP addressing or (local) DHCP for dynamic ip-pool management.

DNS and IP-addressing should come from the same source and are ipcp rejected if they are not .

If IP information is returned from a DHCP server. PPPoE options such as the DNS name are retrieved from the DHCP ACK and provided to the PPPoE client.

## Local DHCP Server

In this note, a local DHCP server will be used as a source for the IP addressing of the PPPoE host.

```
*A:BSR-1>config>service>vprn# info
----------------------------------------------
            dhcp
                local-dhcp-server "server-1" create
                    use-gi-address
                    pool "pool-1" create
                         subnet 10.2.0.0/16 create
                            exclude-addresses 10.2.0.254 10.2.0.255
                            address-range 10.2.0.1 10.2.0.253
                         exit
                    exit
                    no shutdown
                exit
```

To check the DHCP server summary:

```
*A:BSR-1# show router 1 dhcp local-dhcp-server server-1 summary
===============================================================================
DHCP server server-1  router 1
===============================================================================
Admin State            : inService
Operational State      : inService
---snip---
-------------------------------------------------------------------------------
Pool name : pool-1
-------------------------------------------------------------------------------
Subnet                 Free       Stable     Declined   Offered    Rem-pend
-------------------------------------------------------------------------------
10.2.0.0/16            252        1          0          0          0

Totals for pool        252        1          0          0          0
-------------------------------------------------------------------------------

Totals for server      252        1          0          0          0

-------------------------------------------------------------------------------
Associations                    Admin
-------------------------------------------------------------------------------
local-dhcp-server-1             Up
===============================================================================
*A:BSR-1#
```

To debug the DHCP server:

```
*A:BSR-1# show debug
debug
    router "1"
        ip
            dhcp
                detail-level medium
                mode egr-ingr-and-dropped
            exit
```

- Keepalive

The keepalive timer (defined in seconds) and the hold-up-multiplier are defined when enabling keepalives. When omitted, a 30 sec keepalvie timer and 3 hold-up-multipliers are used.

```
*A:BSR-1# configure subscriber-mgmt pppoe-policy "pppoe-policy-1"  keepalive ?
  - keepalive <seconds> [hold-up-multiplier <multiplier>]
  - no keepalive
 <seconds>            : [10..300]
 <multiplier>         : [1..5]

 [10-300] seconds: interval between LCP Echo Requests
 hold-up-multiplier [1-5] : Number of missed replies before the PPPoE session is consid-
ered dead.
```

To check the keepalive statistics:

```
*A:BSR-1# show service id 1 pppoe session session-id 1 mac 00:00:67:14:01:02  statis-
tics
===============================================================================
PPPoE sessions for svc-id 1
===============================================================================
Sap Id              Mac Address       Sid Up Time        IP/L2TP-Id      Type
-------------------------------------------------------------------------------
1/1/3:1             00:00:67:14:01:02 1   0d 04:31:37    10.2.0.37       Local

Packet Type               Received        Transmitted
-------------------------------------------------------------------------------
--snip--
LCP Echo-Request          543             1086
LCP Echo-Reply            1086            543
```

The 7750/7710 BSR supports an optimised implementation of keepalive mechanism; this is a mechanism where client and/or server can check the aliveness of the peer. This LCP echo-request is sent on expiration of a timer, derived from the configured **pppoe-policy keepalive** value.

An LCP echo reply is returned to the client after a LCP echo request is received and the above timer on the BSR is reset to the initial keepalive value.

The above mechanism results in an optimised mechanism if the keepalive timers from the client are smaller than the configured values on the BSR.

The client or BSR will terminate the session with a PADT if no LCP echo-reply is received within the time specified by the hold-up-multiplier.

Example for Echo Request from BSR and Echo Reply from the PPPoE host.

```
Ethernet II, Src: TimetraN_90:f8:6a (00:03:fa:90:f8:6a), Dst: Soft*Rit_14:01:02
(00:00:67:14:01:02)
802.1Q Virtual LAN, PRI: 5, CFI: 0, ID: 1
PPP-over-Ethernet Session
Point-to-Point Protocol
PPP Link Control Protocol
    Code: Echo Request (0x09)
    Identifier: 0x01
    Length: 8
    Magic number: 0x2e538af6

No.     Time        Source                Destination           Protocol Info
      4 30.000280   TimetraN_90:f8:6a     Soft*Rit_14:01:02     PPP LCP  Echo Reply

Ethernet II, Src: TimetraN_90:f8:6a (00:03:fa:90:f8:6a), Dst: Soft*Rit_14:01:02
(00:00:67:14:01:02)
802.1Q Virtual LAN, PRI: 5, CFI: 0, ID: 1
PPP-over-Ethernet Session
Point-to-Point Protocol
PPP Link Control Protocol
    Code: Echo Reply (0x0a)
```

```
Identifier: 0x0b
Length: 8
Magic number: 0x2e538af6
```

To check the PPPoE session for a particular service, use the **show service id <service-id> pppoe session** command. Detailed output as well as additional output filtering is available:

```
*A:BSR-1# show service id 1 pppoe session  ?
  - session [interface <ip-int-name|ip-address> | sap <sap-id>] [type
    <pppoe-session-type>] [session-id <session-id>] [mac <ieee-address>]
    [ip-address <ip-address[/mask]>] [port <port-id>] [no-inter-dest-id |
    inter-dest-id <intermediate-destination-id>] [detail|statistics]

*A:BSR-1# show service id 1 pppoe session detail
===============================================================================
PPPoE sessions for svc-id 1
===============================================================================
Sap Id              Mac Address       Sid Up Time        IP/L2TP-Id      Type
-------------------------------------------------------------------------------
1/1/3:1             00:00:67:14:01:02 1   0d 04:34:44    10.2.0.37       Local

LCP State            : Opened
IPCP State           : Opened
PPP MTU              : 1492
PPP Auth-Protocol    : CHAP
PPP User-Name        : user2@domain1

Subscriber-interface : sub-int-1
Group-interface      : group-int-1

Subscriber Origin    : Local-User-Db
Strings Origin       : Local-User-Db
IPCP Info Origin     : DHCP

Subscriber           : "PPPoE-host-user2@domain1"
Sub-Profile-String   : "sub-profile-1"
SLA-Profile-String   : "sla-profile-1"
ANCP-String          : ""
Int-Dest-Id          : ""
App-Profile-String   : ""
Category-Map-Name    : ""

Primary DNS          : N/A
Secondary DNS        : N/A
Primary NBNS         : N/A
Secondary NBNS       : N/A
Address-Pool         : "pool-1"

Circuit-Id           : circuit10
Remote-Id            : remote10
Service-Name         : AGILENT

Session-Timeout      : N/A
Radius Class         :
Radius User-Name     :
-------------------------------------------------------------------------------
Number of sessions : 1
```

An event will be generated when a PPPoE host has been created in the system.

```
424 2010/01/07 15:28:37.64 UTC WARNING: SVCMGR #2500 Base Subscriber created
"Subscriber PPPoE-host-user1@domain1 has been created in the system"
```

The PPPoE host will appear in the subscriber-host table for the service with origin set to PPPoE.

```
B:BSR-1# show service  id 1 subscriber-hosts
===============================================================================
Subscriber Host table
===============================================================================
Sap                    IP Address      MAC Address       PPPoE-SID Origin
  Subscriber                             Fwding state
-------------------------------------------------------------------------------
1/1/3:1                10.2.0.52       00:00:64:02:01:02 1         PPPoE
  PPPoE-host-user1@do*                   Fwding
-------------------------------------------------------------------------------
Number of subscriber hosts : 1
```

A host route (/32) for its IP address is inserted in the routing table towards the appropriate group-interface.

```
*A:BSR-1# show router 1 route-table
===============================================================================
Route Table (Service: 1)
===============================================================================
Dest Prefix                                     Type    Proto    Age         Pref
       Next Hop[Interface Name]                                        Metric
-------------------------------------------------------------------------------
10.2.0.0/16                                     Local   Local    03d06h17m   0
       sub-int-1                                                       0
10.2.0.37/32                                    Remote  Sub Mgmt 04h35m43s   0
       [group-int-1]                                                   0
13.13.13.0/24                                   Remote  BGP VPN  01d22h40m   170
       192.0.2.3                                                       0
172.16.0.1/32                                   Local   Local    11d00h19m   0
       local-dhcp-server-1                                             0
-------------------------------------------------------------------------------
No. of Routes: 4
===============================================================================
*A:BSR-1#
```

To advertise the PPPoE host subnets to other protocol/network, a policy statement should be defined with using **from protocol direct**.

```
*A:BSR-1>config>router>policy-options# info
----------------------------------------------
            policy-statement "policy-1"
                entry 10
                    from
                        protocol direct
---snip---
```

- Terminate

Some of the PPPoE clients expect reply on PADT message before the context of the session is cleared up. To support such client, a command enabling reply to PADT is configured.

When reply-on-padt is configured, the BSR will reply with PADT message, when omitted no PADT will be sent from the BSR as a reply on the client's PADT.

```
*A:BSR-1#configure subscriber-mgmt pppoe-policy "pppoe-policy-1"
                reply-on-padt
```

The pppoe debug output:

```
77 2010/01/07 20:31:50.32 UTC MINOR: DEBUG #2001 vprn1 PPPoE
"PPPoE: TX Packet
   VPRN 1, SAP 1/1/3:1

   DMAC: 00:00:67:13:01:02
   SMAC: 00:03:fa:90:f8:6a
   Ether Type: 0x8863 (Discovery)

   PPPoE Header:
   Version: 1                Type      : 1
   Code   : 0xa7 (PADT)      Session-Id: 0x0001 (1)
   Lengt
```

A PPPoE host can be manually deleted from the system using following clear command:

```
*A:BSR-1# clear service id 1 pppoe session
  - session all [no-padt]
  - session interface <ip-int-name|ip-address> [mac <ieee-address> [session-id
    <session-id>]] [type <pppoe-session-type>][ip-address <ip-address[/mask]>]
    [port <port-id>] [no-inter-dest-id | inter-dest-id
    <intermediate-destination-id>] [no-padt]
  - session sap-id <sap-id> [mac <ieee-address> [session-id <session-id>]]
    [type <pppoe-session-type>] [ip-address <ip-address[/mask]>] [port
    <port-id>] [no-inter-dest-id | inter-dest-id
    <intermediate-destination-id>] [no-padt]

*A:BSR-1# clear service id 1 pppoe session sap-id 1/1/3:1 mac 00:00:67:14:01:02
```

Several examples are displayed:

- **Admin Reset** — Use the **clear** command or a RADIUS Disconnect Request.

  ```
  TERMINATE CAUSE [49] 4 Admin Reset(6)
  ```

- **User Request** — User disconnects the session.

  ```
  TERMINATE CAUSE [49] 4 User Request(1)
  ```

- **Accounting OFF**
  - → When accounting policy has been removed from sap/interface/sub-profile.
  - → vprn service which is transporting accounting information has been shutdown.
  - → The last RADIUS accounting server has been removed from already applied accounting policy.

  ```
  TERMINATE CAUSE [49] 4 NAS Request(10)
  ```

- **PPPoE keepalive timeout**

  ```
  TERMINATE CAUSE [49] 4 Lost Carrier(2)
  ```

- **RADIUS session timeout**

# PPPoE Hosts Advanced Topics

## QoS Aspects

VLAN based downstream PPPoE control traffic is generated by default with dot1p value 7 .This value can be overruled with the following commands:

In case of the PPPoE hosts instantiated in the Base routing instance using an IES service.

```
*B:BSR-1#configure router sgt-qos application pppoe dot1p 5 [0..7]
```

In case of the PPPoE hosts instantiated in a VPRN service subscriber-interface.

```
*B:BSR-1#configure service vprn 1 sgt-qos application pppoe dot1p 5  [0..7]
```

The **show router sgt-qos** command displays the configured and default DSCP and default dot1p values per application. Since PPPoE is a Layer 2 protocol we will see only the dot1p settings. The default dot1p value **none** corresponds with value 7.

```
*A:BSR-1# show router 1 sgt-qos application pppoe
===============================================================================
Dot1p Application Values
===============================================================================
Application         Dot1p Value                   Default Dot1p Value
-------------------------------------------------------------------------------
pppoe                7                             none
===============================================================
*A:BSR-1#
```

## Limiting the Number of PPPoE Hosts

The maximum number of PPPoE sessions can be controlled by the parameters session-limit, sap-session-limit, host-limit, multi-sub-sap limit and max-sessions-per mac.

**session-limit** — The maximum number of PPPoE sessions for an IES/VPRN group-interface is defined when enabling session-limit. When omitted, a single PPPoE session is allowed.

```
B:BSR-1> configure service vprn 1
                        ---snip--
                            group-interface group-int-1
                                 pppoe
                                      session-limit 1
                                 exit
```

A trap is generated when trying to instantiate a new pppoe session while the configured number of sessions is reached. Note that the discovery phase is completed before the check on the session-limit is performed.

```
"PPPoE session failure on SAP 1/1/3:1 in service 1 - Reached the interface session limit
(1) for "group-int-1""

PPPoE debug output:
"PPPoE: Dropped Packet
   VPRN 1, SAP 1/1/3:1

   Problem: Reached the interface session limit (1) for "group-int-1"sap-session-limit
:
```

The maximum number of pppoe sessions per SAP for an IES/VPRN group-interface is defined when enabling sap-session-limit. When omitted, a single pppoe session per SAP is allowed:

```
B:BSR-1> configure service vprn 1
                        ---snip--
                            group-interface group-int-1
                                 pppoe
                                      sap-session-limit 1
                                 exit
```

A trap is generated when trying to instantiate a new PPPoE session while the configured number of the sessions per sap is reached.

```
"PPPoE session failure on SAP 1/1/3:1 in service 1 - Reached the per-SAP session limit
(1) for "group-int-1""


PPPoE debug output:
"PPPoE: Dropped Packet
   VPRN 1, SAP 1/1/3:1

   Problem: Reached the per-SAP session limit (1) for "group-int-1"
```

- max-sessions-per-mac

The BSR 7750/7710 implementation defines a unique PPPoE session based on the PPPoE SESSION_ID and the client's MAC address.

The maximum number of PPPoE sessions per mac is defined when enabling max-sessions-per-mac. When omitted, a single PPPoE session per mac is allowed.

```
*B:BSR-1> configure
             subscriber-mgmt
                pppoe-policy "pppoe-policy-1"
                  max-sessions-per-mac 63
              exit
```

Although the command is max-session-per-mac, actually it means the maximum number of supported sessions-per-MAC-per-SAP especially in N: 1 VLAN model.

A trap is generated when trying to instantiate a new PPPoE session per the same mac while the configured number of max-sessions-per-mac is reached.

```
"PPPoE session failure on SAP 1/1/3:1 in service 1 - Reached the maximum number (1) of
PPPoE sessions for MAC 00:00:67:13:01:02"
```

- Host-limit

The maximum number of PPPoE hosts is defined when enabling host-limit. When omitted, a single host is allowed.

```
*B:BSR-1> configure
             subscr-mgmt
                   sla-profile "sla-profile-1"
                       host-limit 10
                   exit
             exit
```

If the configured host-limit is reached for a subscriber, access is denied for a new host, and an event is generated.

```
"PPPoE session failure on SAP 1/1/3:1 in service 1 - subscriber PPPoE-host-
user1@domain1 sla-profile sla-profile-1, host-limit (1) exceeded"
```

Note: An optional parameter **remove-oldest**can be specified behind the host-limit. In this case the new host is accepted and the old one will be removed.

```
B:BSR-1> configure
             subscr-mgmt
                   sla-profile "sla-profile-1"
                       host-limit 10 remove-oldest
                   exit
             exit
```

- multi-sub-sap

This parameter defines the maximum number of subscribers (dynamic and static) that can be simultaneously active on this SAP.

When omitted, a single PPPoE session per sap is allowed (no multi-sub-sap).

```
*B:BSR-1> configure service vprn 1
          ---snip---
                group-interface "group-int-1" create
                    sap 1/1/3:1 create
                        sub-sla-mgmt
                            multi-sub-sap 100
                        exit
```

A trap is generated when trying to instantiate a new PPPoE session while the configured number of the multi-sub-sap is reached.

"PPPoE session failure on SAP 1/1/3:1 in service 1 - Number of subscribers exceeds the configured multi-sub-sap limit (1)"

## Redundancy

Redundancy for PPPoE sessions can be used for load balancing the sessions between the 2 BSRs. PADO-delays (which can come from RADIUS, LUDB, and policy) is using to achieve that.

The redundant BSRs need different IP subnets, and upon failure the PPP sessions will need to be re-established.

Because PADI messages are broadcast on a multi-access network, all BSRs on that network will reply with a PADO to the initiator.

The PADR and PADS are sent in unicast to the MAC address from the first received PADO message.

In order to allow control over the NAS/BSR selection for a given PPPoE session the 7750 and 7710 offer the ability to delay the PADO message. Due to the fact that PPPoE clients select the NAS/BSR for further communication based on the first PADO message that arrives, this functionality provides control over the NAS/BSR who gets selected for a given PPPoE session.

On top if for some reason a NAS/BSR, without PADO delay configured in the PPPoE policy, does not reply on PADI messages to the client another NAS/BSR with a PADO delay configured will reply based on the time configured and ultimately the PPPoE session will be established with the PADO delayed NAS/BSR.

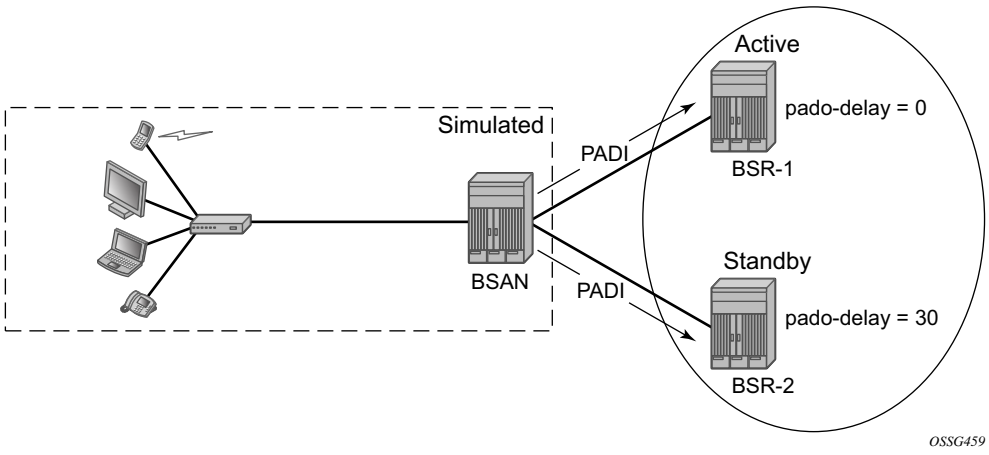


**Figure 356: Pado-Delay Scenario**

To check the pado-delay value.

```
*A:BSR-1# show subscriber-mgmt pppoe-policy pppoe-policy-1
===============================================================================
PPPoE Policy "pppoe-policy-1"
===============================================================================
Description          : (Not Specified)
Last Mgmt Change     : 01/11/2010 11:21:01     PPP-mtu              : N/A
Keepalive Interval   : 10s                     Keepalive Multiplier : 1
Disable AC-Cookies   : No                      PADO Delay           : 3000msec
Max Sessions-Per-Mac : 63                      Reply-On-PADT        : No
PPP-Authentication   : pref-CHAP               PPP-CHAP Challenge   : 32 - 64
---snip---
```

## High Availability

The PPPoE session state is HA: the session state is synchronised to the standby CPM. When the active CPM fails, all PPPoE hosts stay active without service interruption.

# Conclusion

This section provides configuration and troubleshooting commands for PPPoE hosts in a Layer 3 Routed CO (IES/VPRN subscriber interface) context.