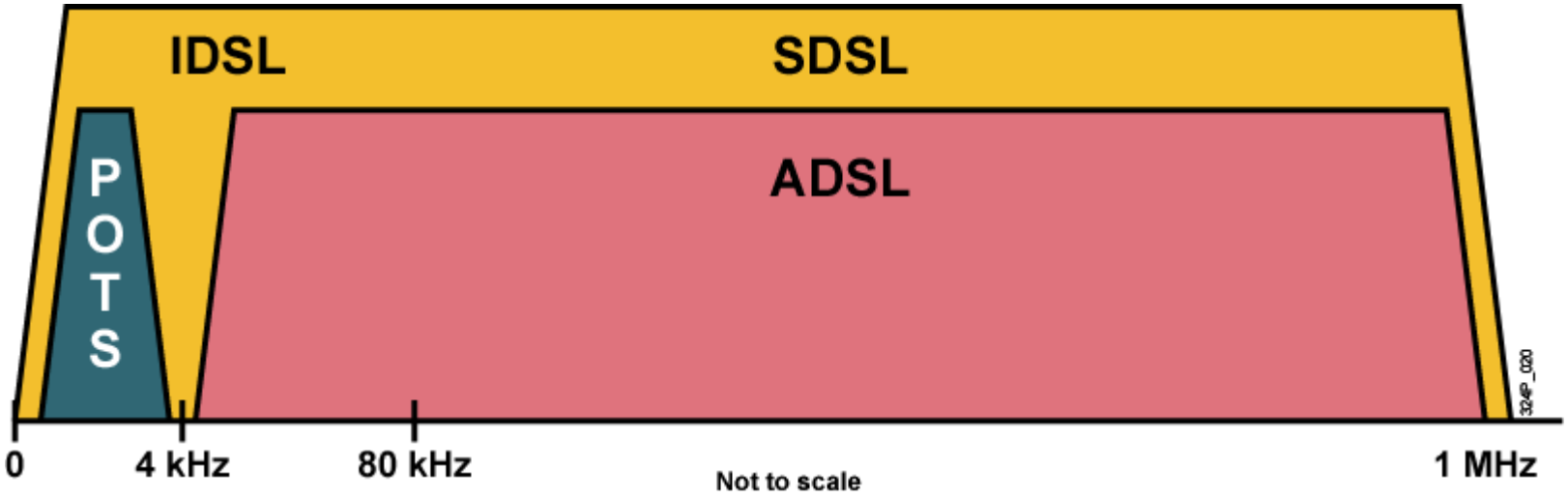
Module 2: Teleworker Connectivity

Lesson 2.4: Describing DSL Technology

Objectives

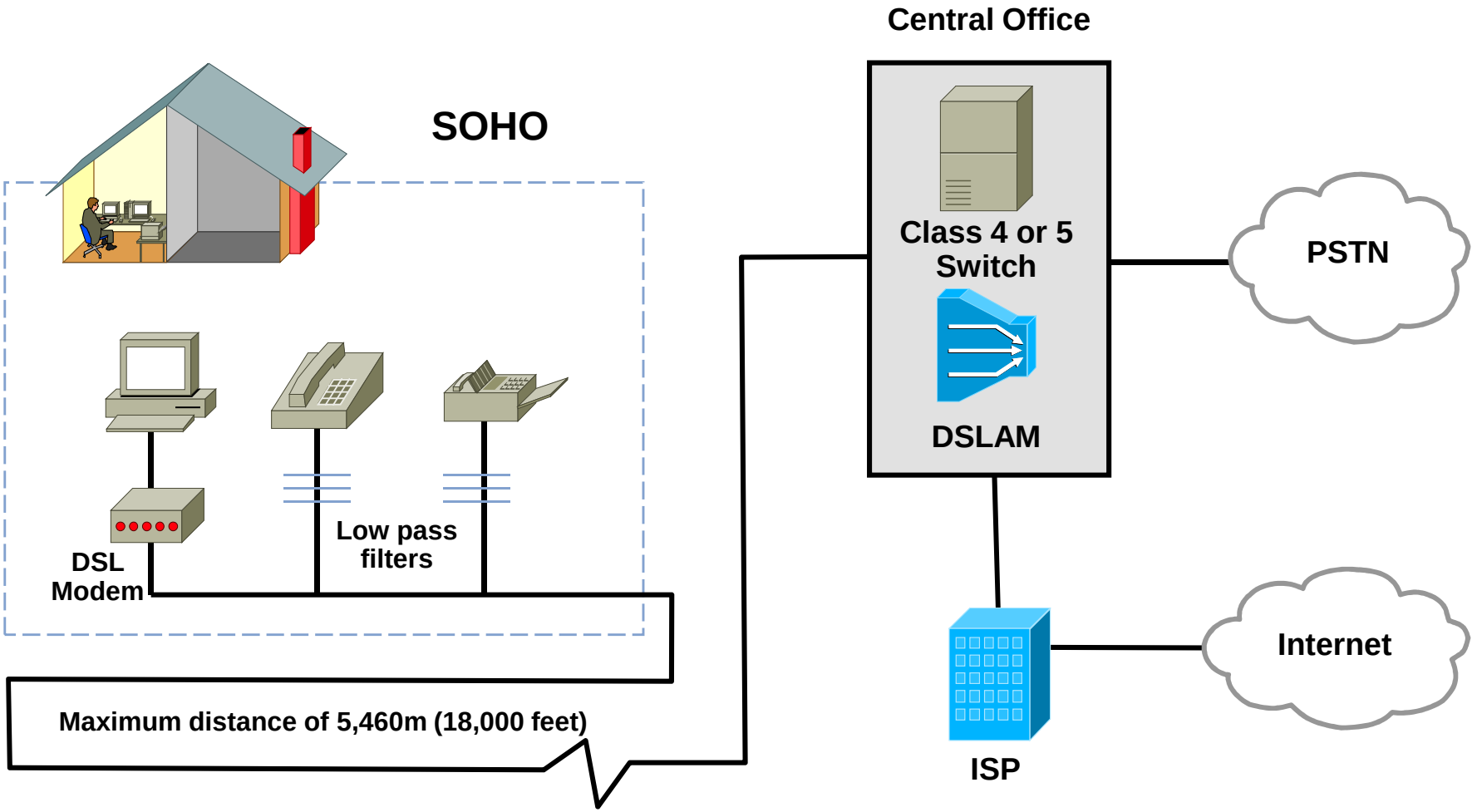
- Describe how DSL works.
- Identify the connections in a DSL network.
- Describe the variants of DSL and factors effecting their performance.
- Identify DSL distance limitations.

What Is a DSL?



- Uses high transmission frequencies (up to 1 MHz)
- Technology for delivering high bandwidth over regular copper lines
- Connection between subscriber and CO

DSL Connections



How Does DSL Work?

- Downstream and upstream transmission
- Symmetrical and asymmetrical services
- Multiple xDSL variations
- Delivers data and voice signals simultaneously and transparently
- Provides an always-on data connection
- Bandwidth varies with distance

DSL Variants

- DSL variants differ in:
  - Nature
  - Maximum data rate
  - Line coding technology
  - Data and voice support
  - Maximum distance

DSL Variants Characteristics

DSL Technology	Nature	Max. Data Rate (Down / Up) [bps]	Data and POTS
ADSL	Asymmetric	8 M / 1 M	Yes
VDSL	Symmetric or Asymmetric	52 M / 13 M	Yes
IDSL	Symmetric	144 k / 144 k	No
SDSL	Symmetric	768 k / 768 k	No
HDSL	Symmetric	2 M / 2 M	No
G.SHDSL	Symmetric	2.3 M / 2.3 M	No

Factors Affecting DSL Performance

- Factors that define maximum distance and speed:
  - Signal attenuation
  - Bridge tap
  - Load coil
  - Wire gauge
  - Impedance mismatch
  - Crosstalk
  - AM radio interference
  - Fiber-optic cable

DSL Distance Limitations

DSL Technology	Max. Data Rate (Down / Up) [bps]	Max. Distance [feet / km]
ADSL	8 M / 1 M	18,000 / 5.5
VDSL	52 M / 13 M	4,500 / 1.4
IDSL	144 k / 144 k	18,000 / 5.5
SDSL	768 k / 768 k	22,000 / 6.7
G.SHDSL	2.3 M / 2.3 M	28,000 / 8.5

- Maximum data rate and distance assume no impairments.
- Maximum data rate is achieved at shortest distance.
- Maximum distance is achieved at lowest data rate.

Summary

- For many years, the telephone networks did not use the bandwidth above 3 kHz. Advances in technology allowed DSL to use the additional bandwidth from 3 kHz up to 1 MHz to deliver high-speed data services over ordinary copper lines.
- The two key components are the DSL transceiver and the DSLAM.
- DSL transmission is either downstream or upstream based on the direction of the transmission. Downstream transmission is from a CO toward a subscriber, and upstream transmission is from a subscriber toward a CO.
- All DSL types are limited in distance and speed. Speed is inversely proportional to distance.

Resources

- Asymmetric Digital Subscriber Line

  http://www.cisco.com/en/US/customer/tech/tk175/tk15/tsd_technology_support_protocol_home.html

- Long Reach Ethernet & Digital Subscriber Line (xDSL)

  http://www.cisco.com/en/US/tech/tk175/tsd_technology_support_category_home.html

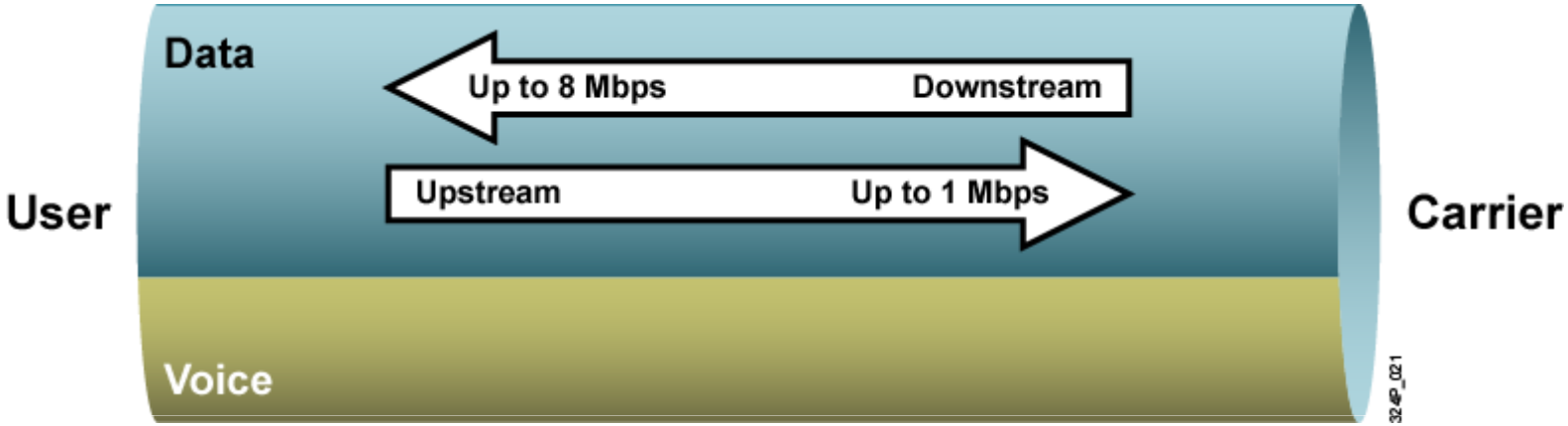
Module 2: Teleworker Connectivity

Lesson 2.5: Deploying ADSL

Objectives

- Describe the operation and characteristics of ADSL.
- Identify the methods used to separate ADSL and POTS signals.
- Describe ADSL modulation techniques.
- Describe three ways to encapsulate IP packets over an ATM and DSL connection.
- Describe PPPoE and PPPoA deployment options.
- Describe PPPoE and PPPoA session establishment.

ADSL—Data and Voice on the Same Wire



- ADSL coexists with POTS over the same copper wiring.
- Asymmetric data rates:

  High-speed downstream for intensive applications:

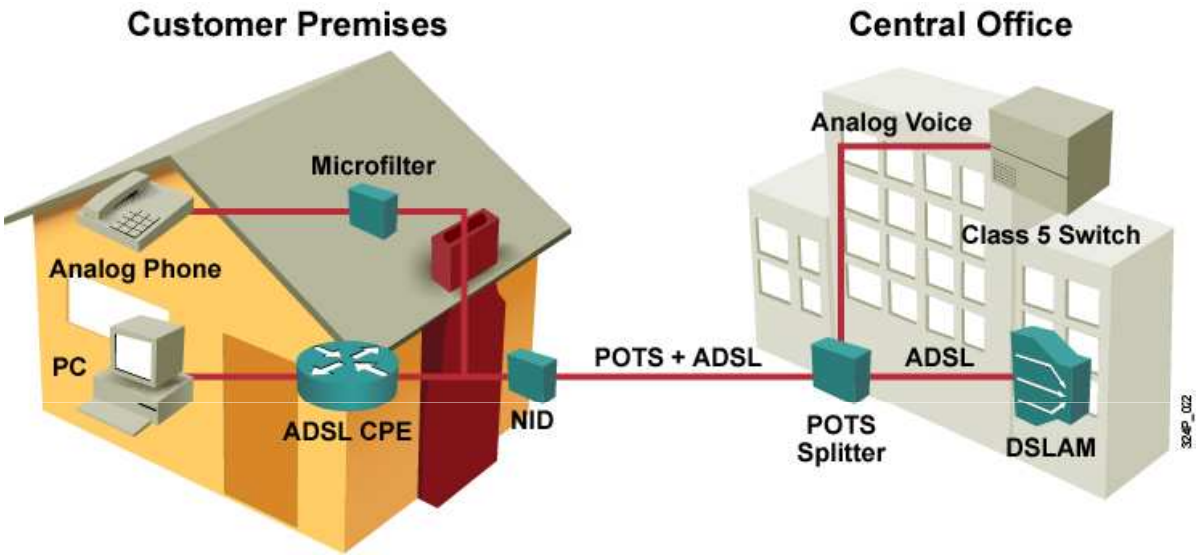
ADSL	8 Mbps for 18,000 feet
ADSL2	12 Mbps for 8000 feet
ADSL2+	24 Mbps for 5,000 feet

  Slower (1 Mbps) upstream for undemanding data requests

ADSL Characteristics

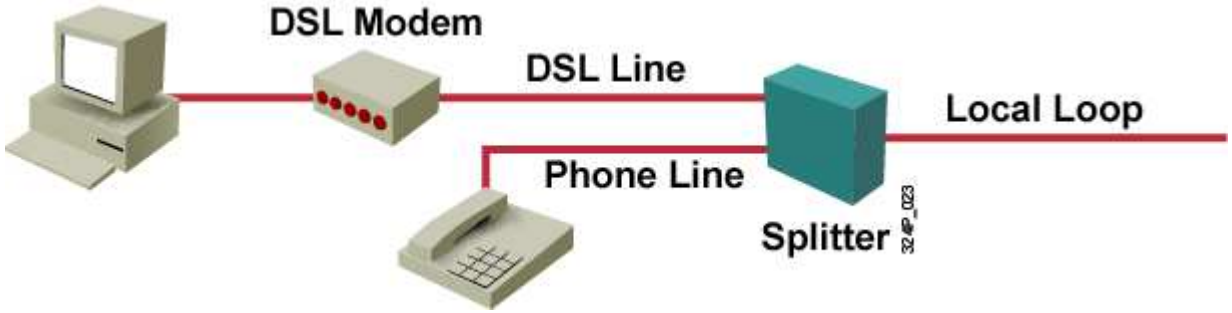
- ADSL equipment:
  - ADSL terminal unit-remote (ATU-R)
  - DSLAM encompassing many ADSL terminal unit-central office (ATU-C)
- ADSL features three basic line-coding techniques:
  - Single carrier—CAP modulation
  - Multicarrier with DMT
  - Multicarrier with G.lite
- ADSL operation and performance are influenced by different impairments.

Separating ADSL and POTS with Microfilters and a CO Splitter



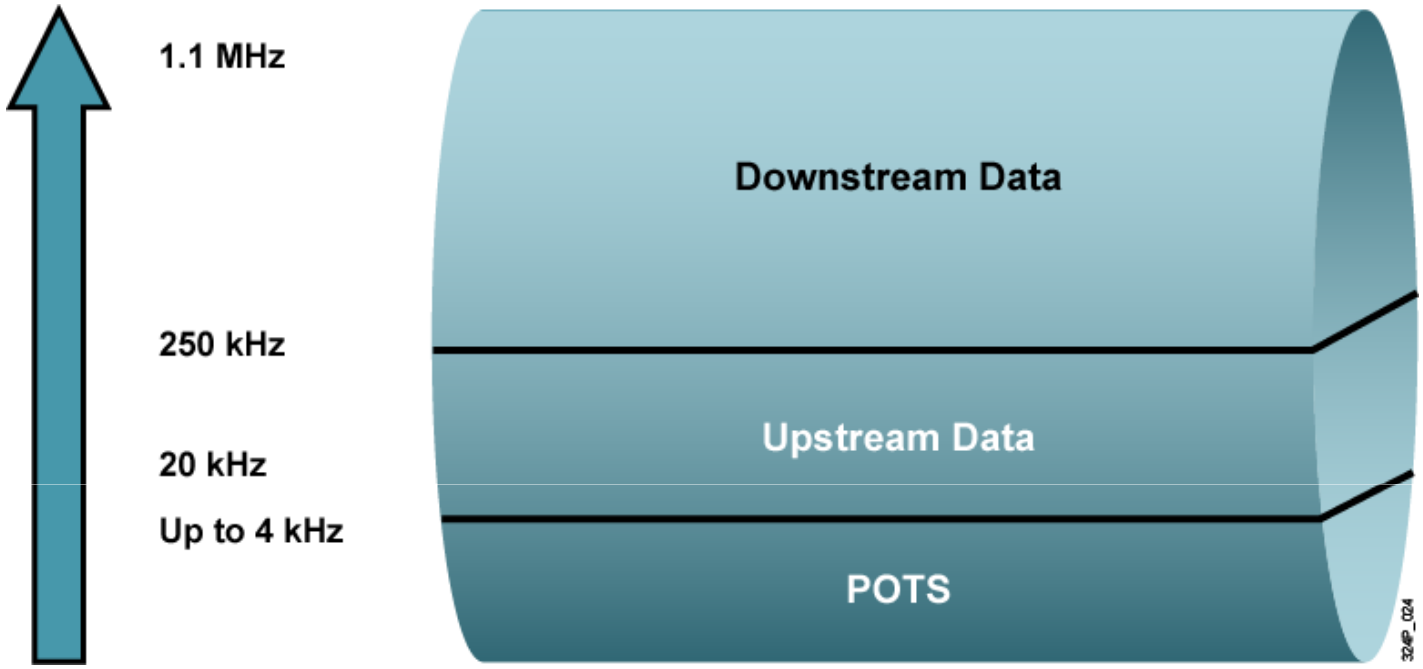
- A key feature of ADSL is coexistence with POTS.
- Transmission of voice and data signals is performed on the same wire pair.
- Data circuits are offloaded from the voice switch.

Separating ADSL and POTS with a CPE Splitter



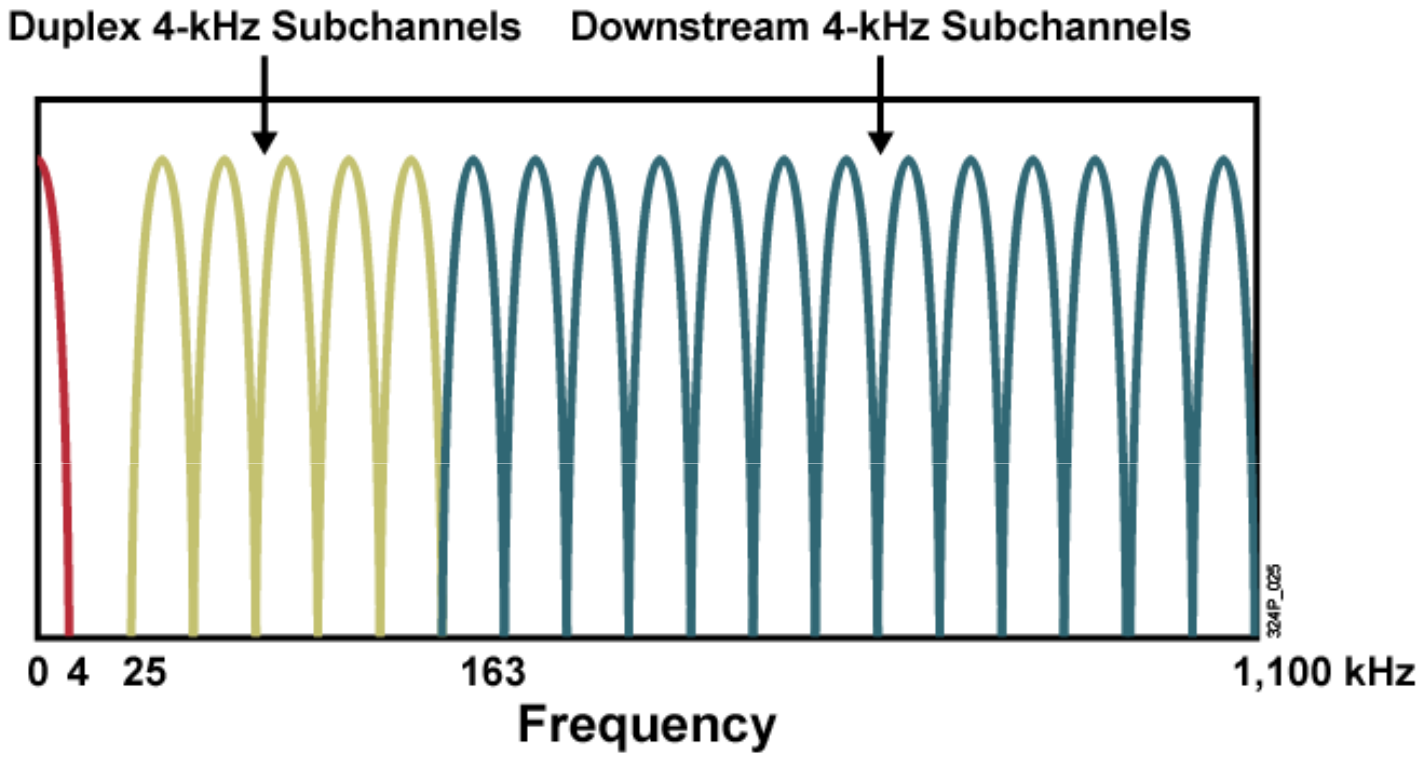
- How are data and POTS channels separated?
  - POTS splitter at CO
  - Microfilters at customer premises

ADSL Channel Separation with CAP Modulation



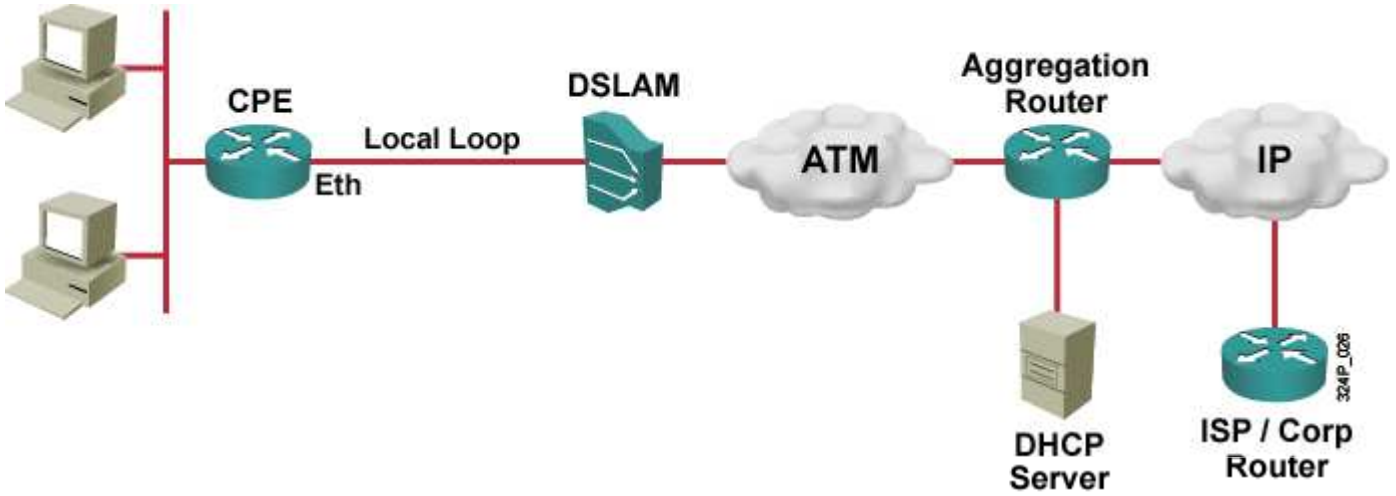
- Single-carrier modulation technique
- CAP (carrierless amplitude/phase modulation)

ADSL Channel Separation with DMT Modulation



- Multiple-carrier modulation technique
- DMT (Discrete Multitone)

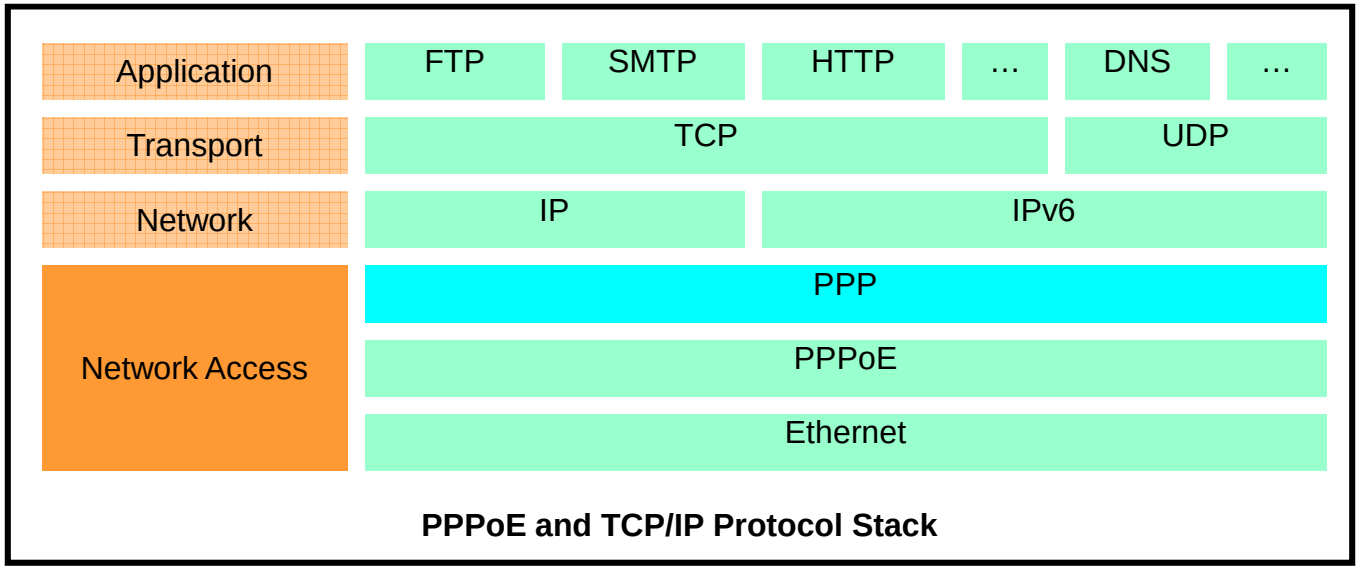
Data over ADSL



- IP packets encapsulated over ATM
- Three common approaches:
  - RFC 1483/2684 Bridged
  - PPPoE
  - PPPoA

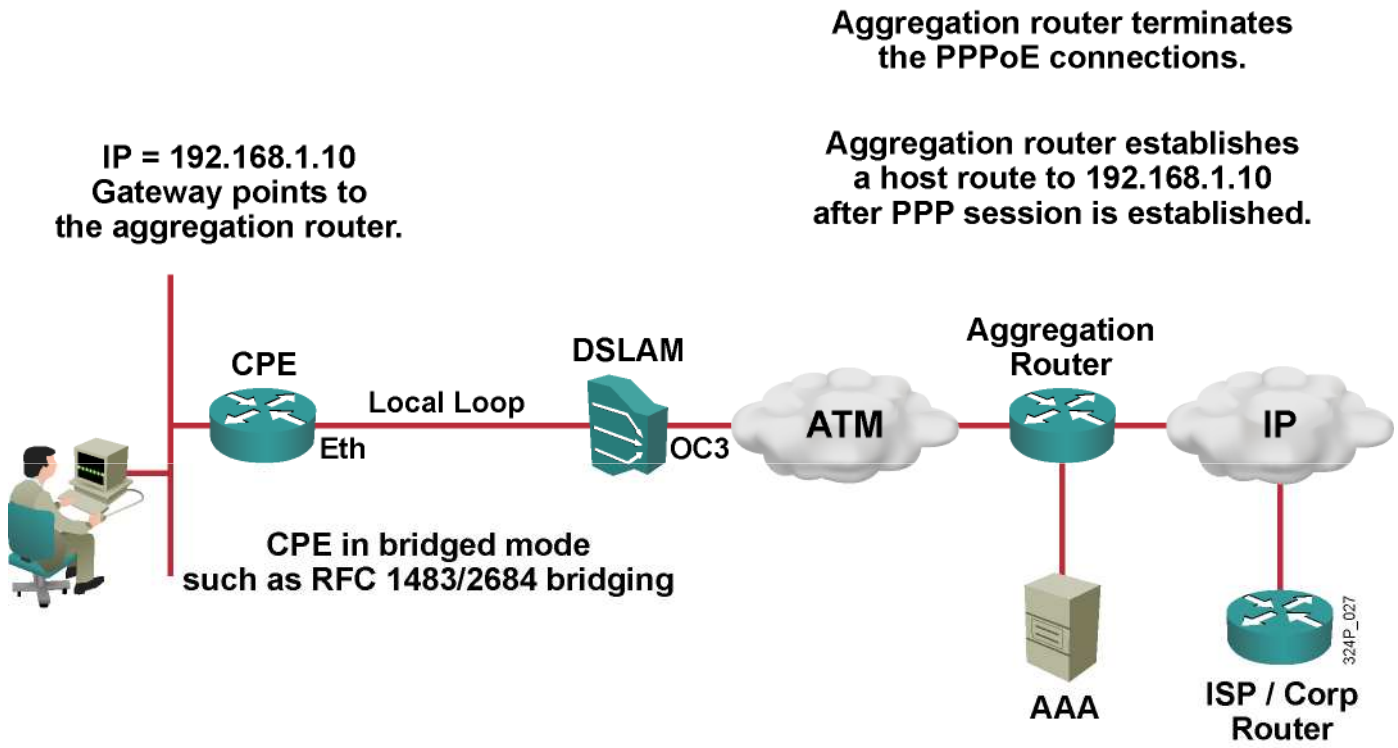
PPP over Ethernet

- An Ethernet frame carries the PPP frame.
- Service provider end:
  - DSLAM for DSL connection termination
  - Aggregation router for PPP session termination
- Subscriber end:
  - DSL modem for DSL connection termination
  - PPPoE client for PPP session termination
- The client device is the PC or the router at the CPE.



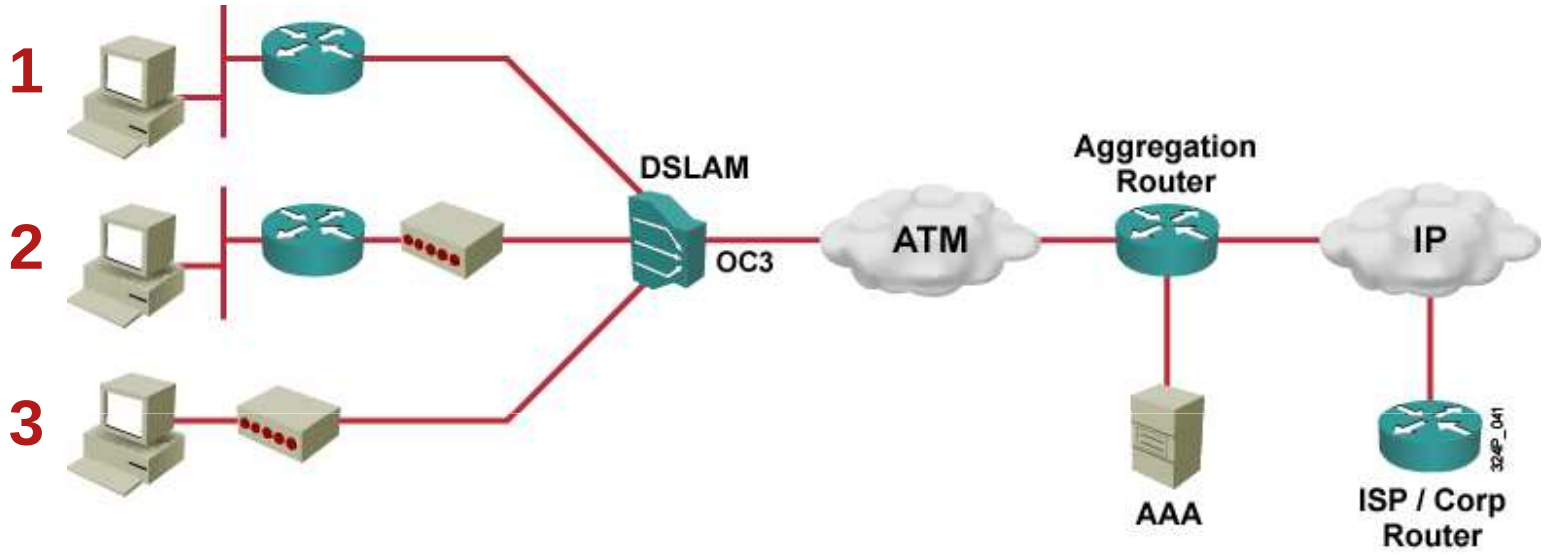
PPPoE and TCP/IP Protocol Stack

PPPoE in Operation



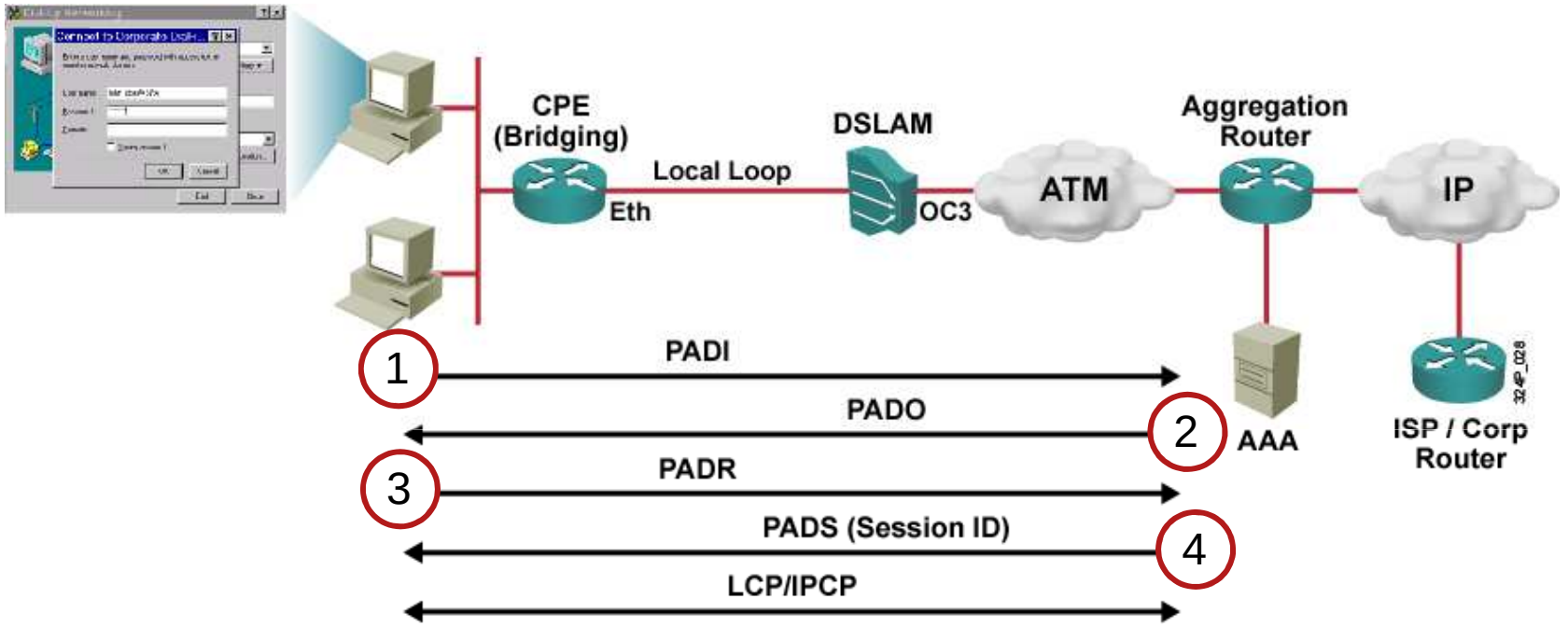
- IP is assigned to PPPoE client functioning device.
- A CPE router can connect multiple users via a single ADSL connection using NAT/PAT and DHCP.

DSL and PPPoE Deployment Options



- DSL and PPPoE deployment types:
  - Router terminating DSL and with PPPoE client
  - Modem terminating DSL and router with PPPoE client
  - Modem terminating DSL and end-user PC with PPPoE client

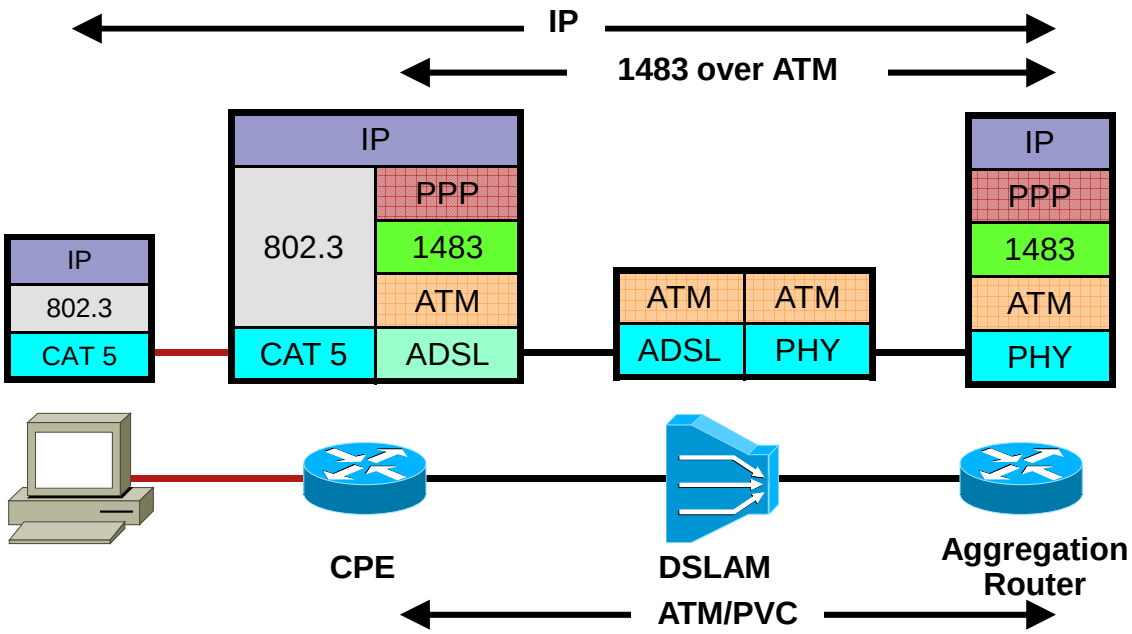
PPPoE Session Establishment



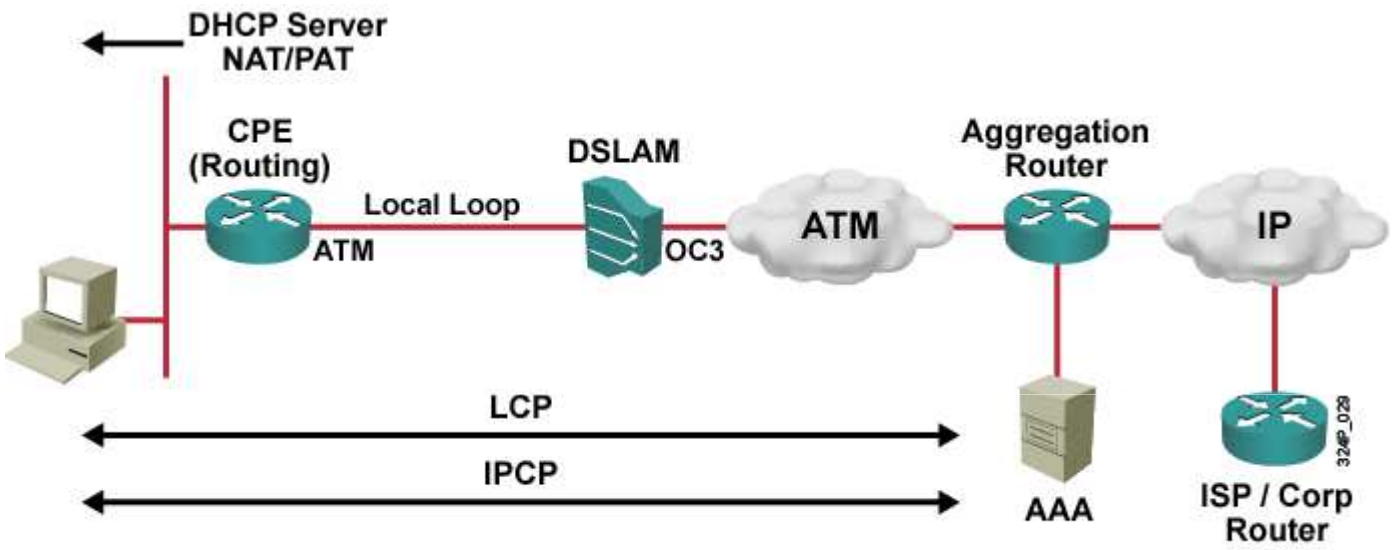
- PPP session is from PPPoE client to the aggregation router.
- Subscriber IP address is assigned by the aggregation router via IPCP.

PPP over ATM

- Routed solution
- User packets routed over ATM
- Service provider end:
  - DSLAM for DSL connection termination
  - Aggregation router for PPP session termination
- Subscriber end: CPE for DSL connection and PPP session termination



Establishing a PPP Session with PPPoA



- CPE receives an IP address via IPCP like in the dial model.

Summary

- ADSL exists on the same twisted-pair telephone line as the POTS.
- ADSL uses two types of modulation techniques: a single-carrier CAP, which is proprietary, and multicarrier standardized DMT.
- ADSL has asymmetric data rates, with higher data rates toward the user (downstream) and lower data rates toward the carrier (upstream).
- There are three ways to encapsulate IP packets over an ATM and DSL connection:
  - RFC 1483/2684 Bridged
  - PPP over Ethernet (PPPoE)
  - PPP over ATM (PPPoA)
- Point-to-Point Protocol over Ethernet (PPPoE) is a network protocol for encapsulating PPP frames in Ethernet frames.
- Point-to-Point Protocol over ATM (PPPoA), is a network protocol for encapsulating PPP frames in ATM AAL5.

Resources

- DSL Glossary

  http://whatis.techtarget.com/definition/0,,sid9_gci748453,00.html

- Asymmetric Digital Subscriber Line

  http://www.cisco.com/en/US/customer/tech/tk175/tk15/tsd_technology_support_protocol_home.html

- Long Reach Ethernet & Digital Subscriber Line (xDSL)

  http://www.cisco.com/en/US/tech/tk175/tsd_technology_support_category_home.html

Module 2: Teleworker Connectivity

Lesson 2.6: Configuring the CPE as the PPPoE or PPPoA Client

Objectives

- Describe the steps necessary to configure the Customer Premises Equipment (CPE) as a PPPoE client over Ethernet and ATM interfaces.
- Explain why maximum segment size (MSS) and maximum transmission unit (MTU) settings must be adjusted in PPPoE configurations.
- Describe methods to verify and troubleshoot PPPoE connections.

Configuring the CPE as the PPPoE Client over the Ethernet Interface

Configuration tasks:

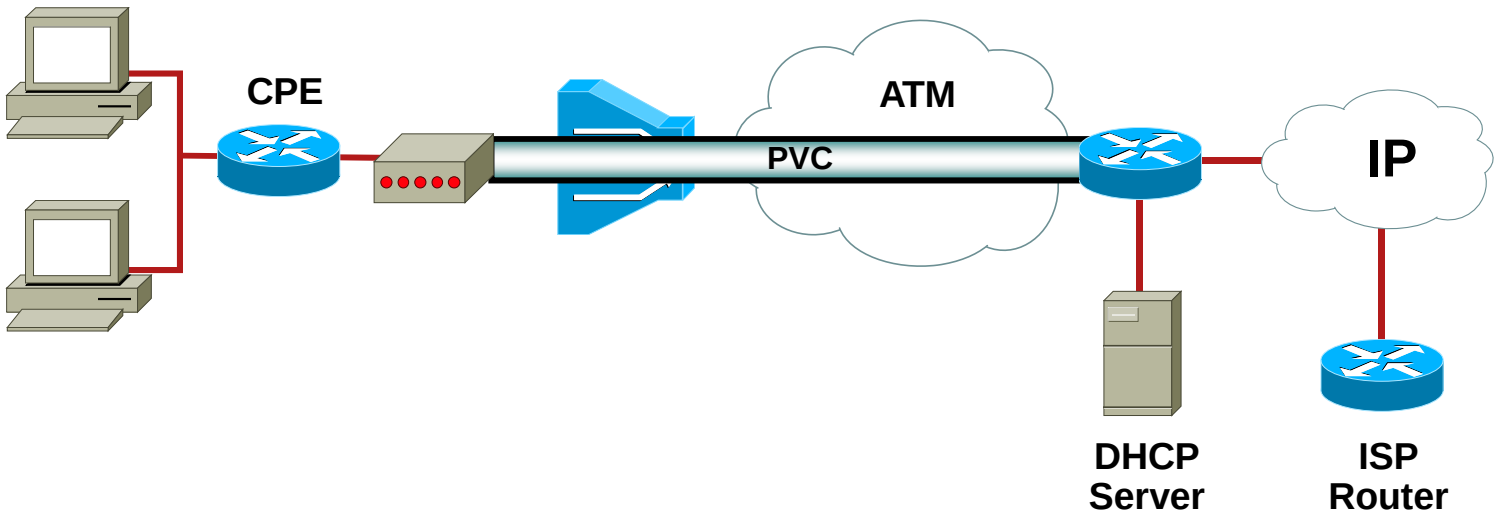
Step 1: Configure an Ethernet interface.

Step 2: Configure a dialer interface.

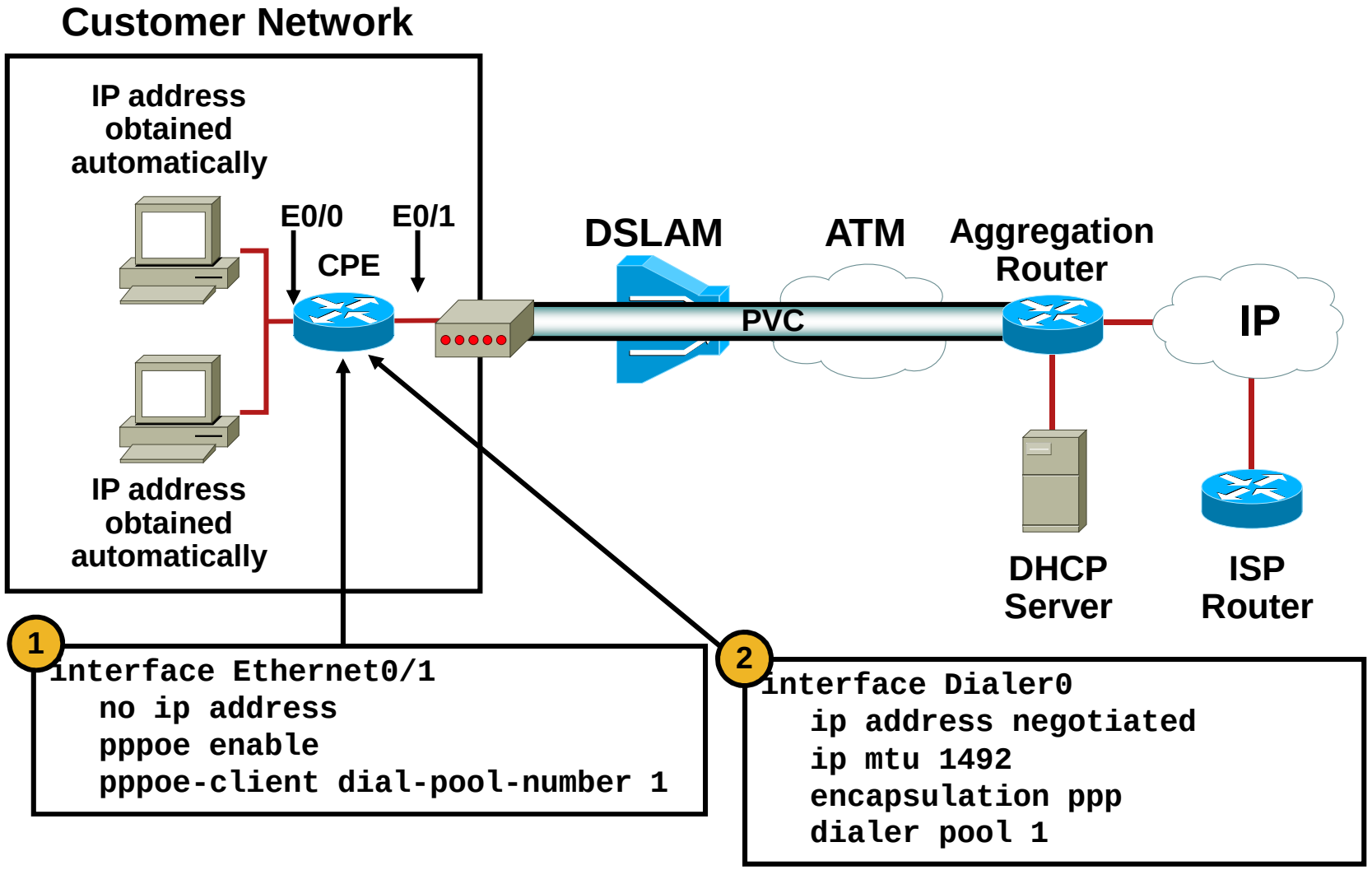
Step 3: Configure PAT.

Step 4: Configure DHCP server.

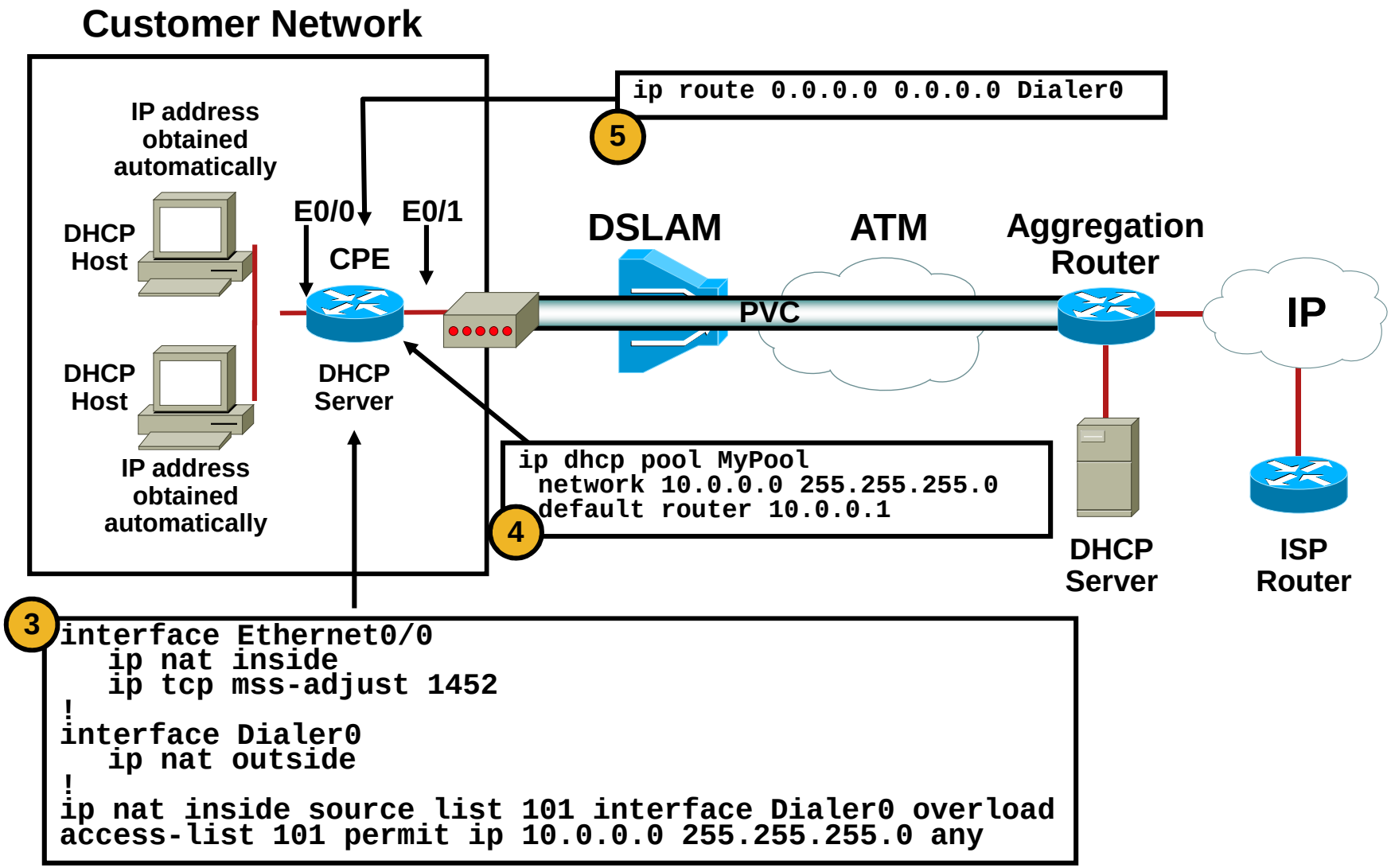
Step 5: Configure a static default route.



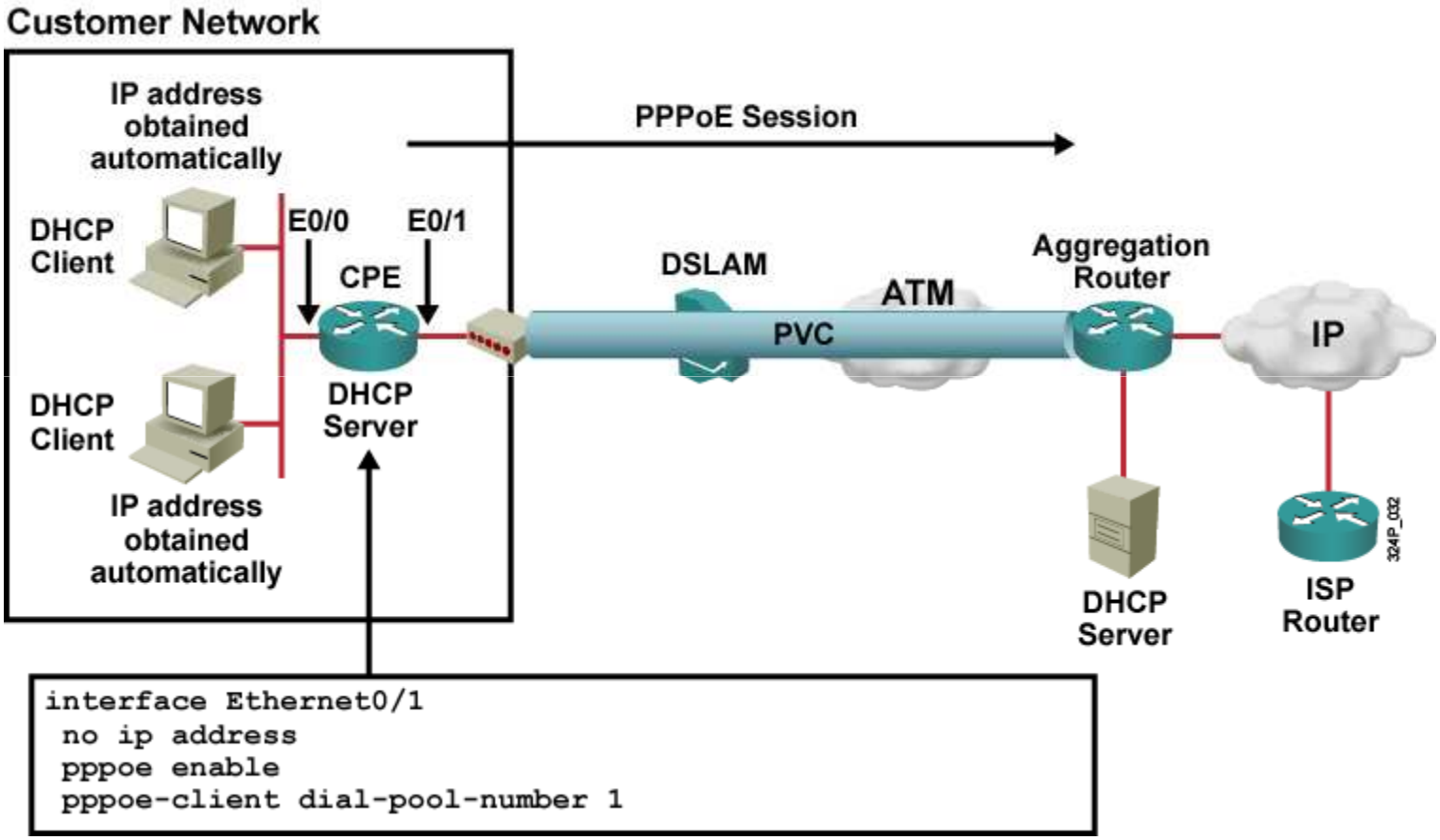
CPE as the PPPoE Client over the Ethernet Interface



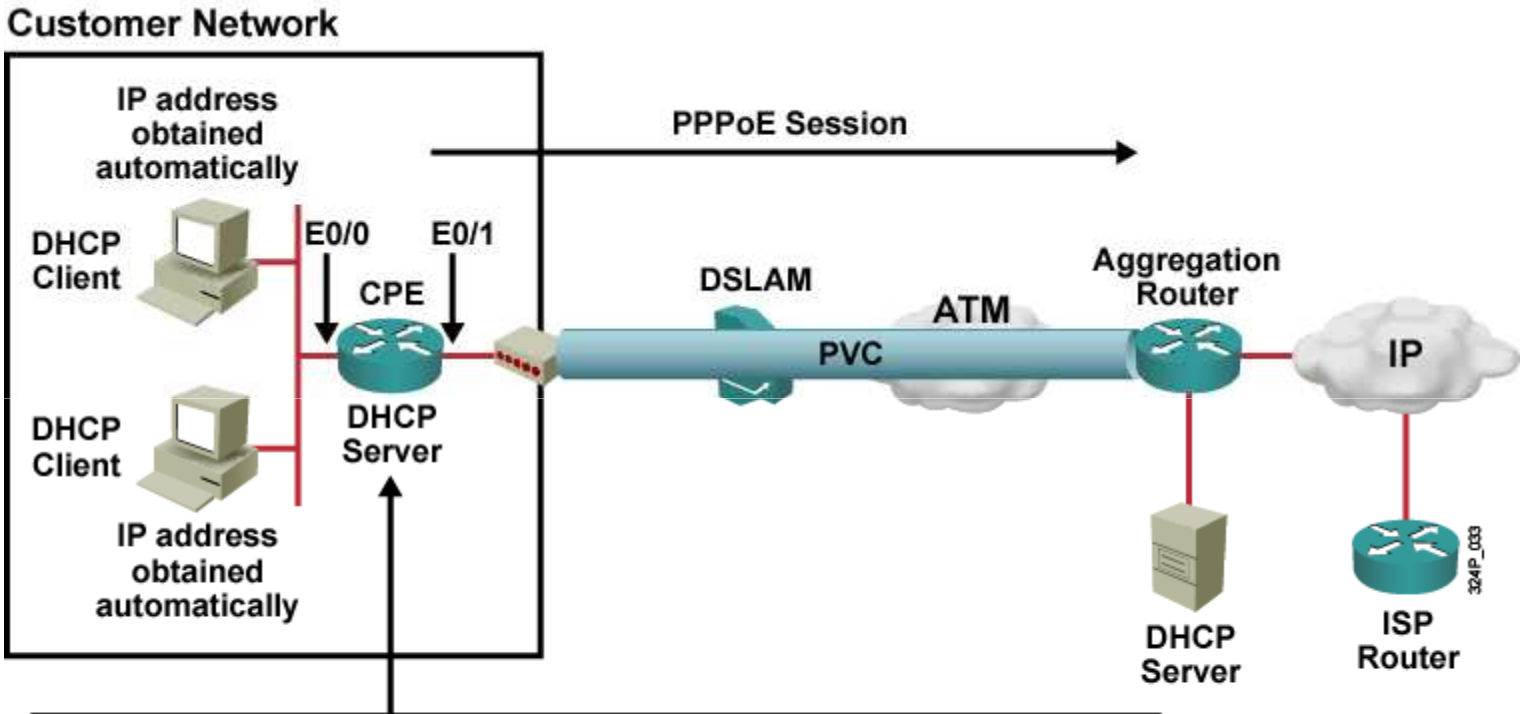
CPE as the PPPoE Client over the Ethernet Interface (Cont.)



Example: Configuring a PPPoE Client

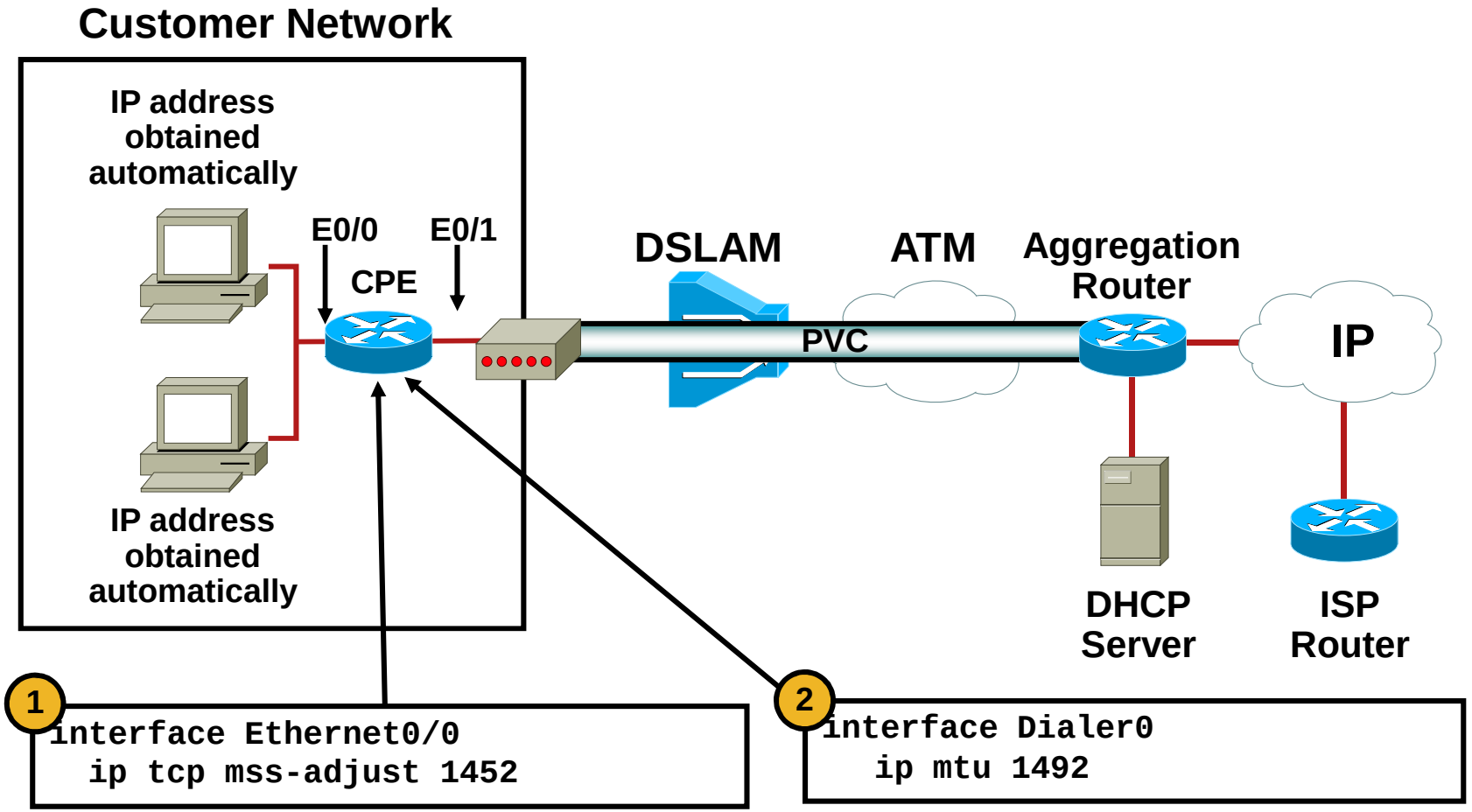


Example: Configuring the PPPoE Dialer Interface




```
interface Dialer0
 ip address negotiated
 encapsulation ppp
 dialer pool 1
 ip mtu 1492
 ip nat outside
 ppp authentication chap callin
 ppp chap password mysecret
```

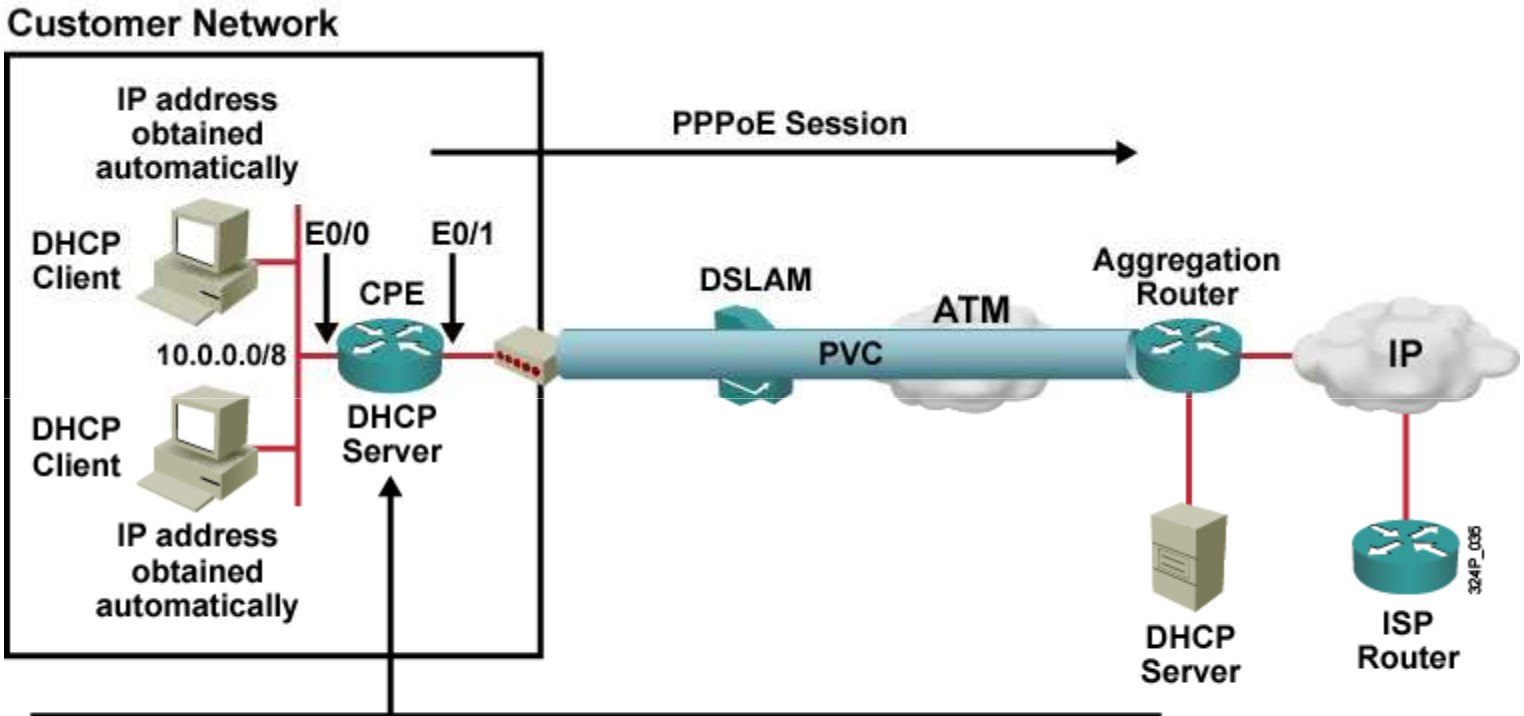
Example: Adjusting MSS and MTU Size



MSS and MTU Adjustments

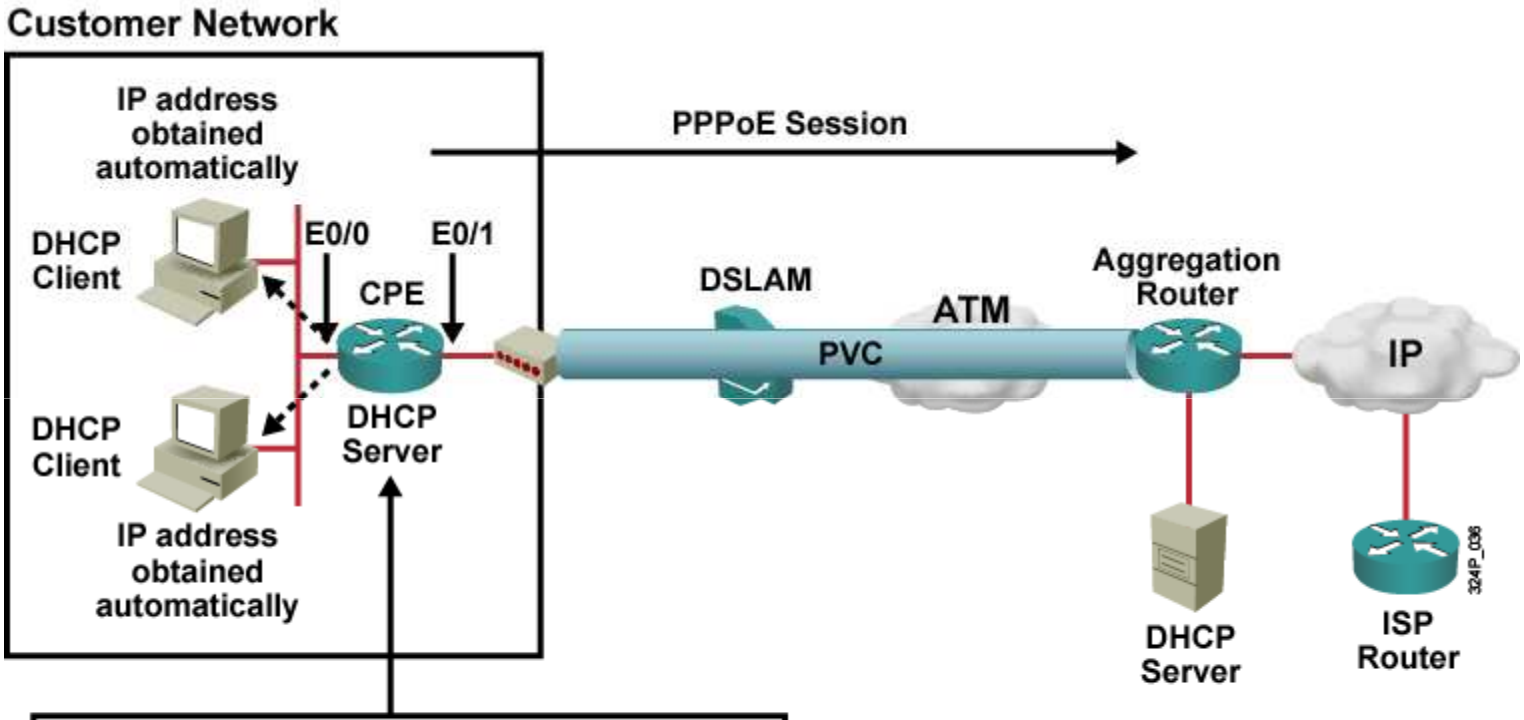
- The default MSS value for a PC is 1500 bytes.
- PPPoE standard only supports an MTU of 1492 bytes
- In most cases, the optimum value for the max-segment-size argument is 1452 bytes.
- Disparities between the host and PPPoE MTU size cause the router in between the host and the server to drop 1500-byte packets and terminate TCP sessions.
- It is necessary to limit the packet sizes going in either direction. On the in-facing interface, you just need to set the MSS to a lower value, but on the out-facing interface, you need to set the MTU to lower values:

Example: PAT Configuration



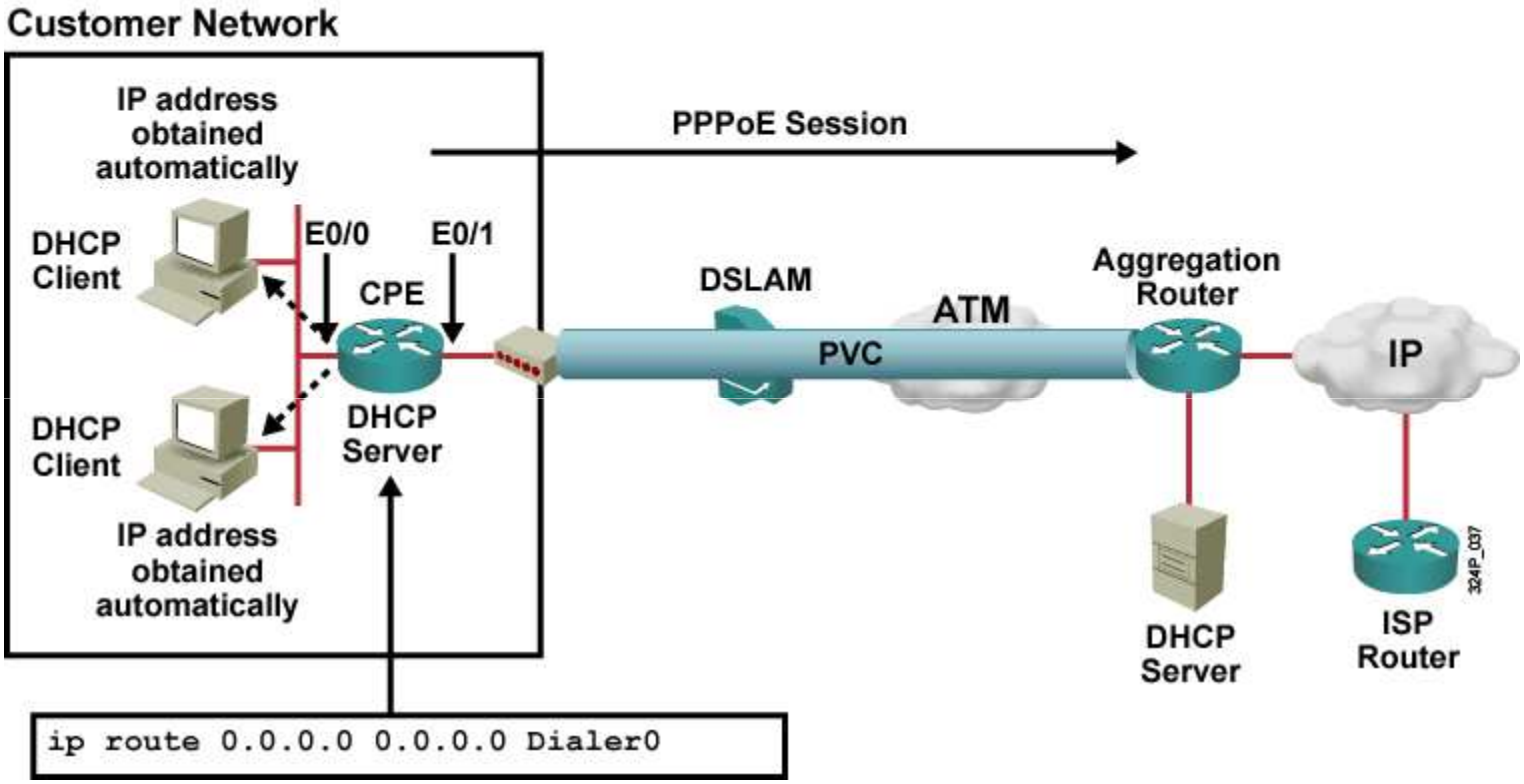

```
interface Ethernet0/0
 ip nat inside
!
interface Dialer0
 ip nat outside
!
ip nat inside source list 101 interface Dialer0 overload
access-list 101 permit ip 10.0.0.0 0.255.255.255 any
```

Example: DHCP Server Configuration




```
ip dhcp pool MyPool
 import all
 network 10.0.0.0 255.0.0.0
 default-router 10.0.0.1
!
interface Ethernet0/0
 ip address 10.0.0.1 255.0.0.0
```

Example: Static Default Route



PPPoE Sample Configuration

```
hostname CPE
!
ip dhcp pool MyPool
 network 10.0.0.0 255.0.0.0
 default-router 10.0.0.1
!
interface Ethernet0/1
 no ip address
 pppoe enable
 pppoe-client dial-pool-number 1
!
interface Ethernet0/0
 ip address 10.0.0.1 255.0.0.0
 ip nat inside ip
 ip tcp adjust-mss 1452
!
interface Dialer0
 ip address negotiated
 ip mtu 1492
 encapsulation ppp
 dialer pool 1
 ip nat outside
 ppp authentication chap callin
 ppp chap password mysecret
!
ip nat inside source list 101 interface Dialer0 overload
access-list 101 permit ip 10.0.0.0 0.255.255.255 any
!
ip route 0.0.0.0 0.0.0.0 Dialer0
```

PPPoA Configuration

Configuring the CPE as the PPPoE Client over the ATM Interface

Configuration tasks:

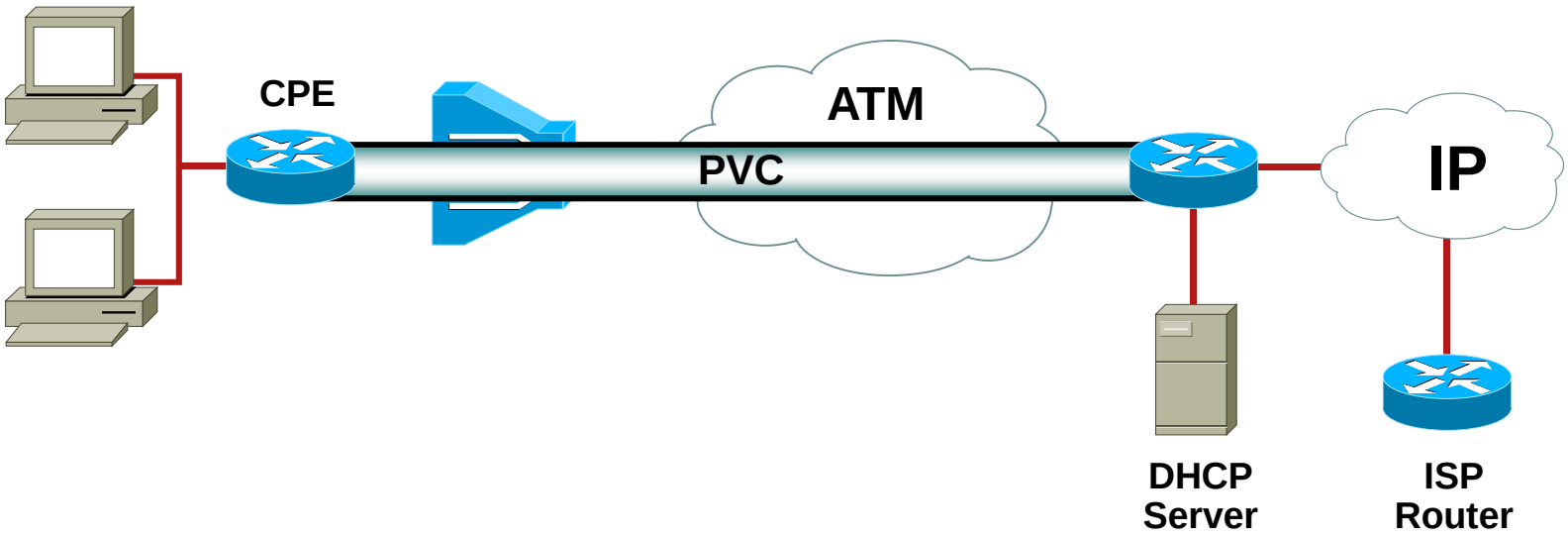
Step 1: Configure an ATM interface.

Step 2: Configure a dialer interface.

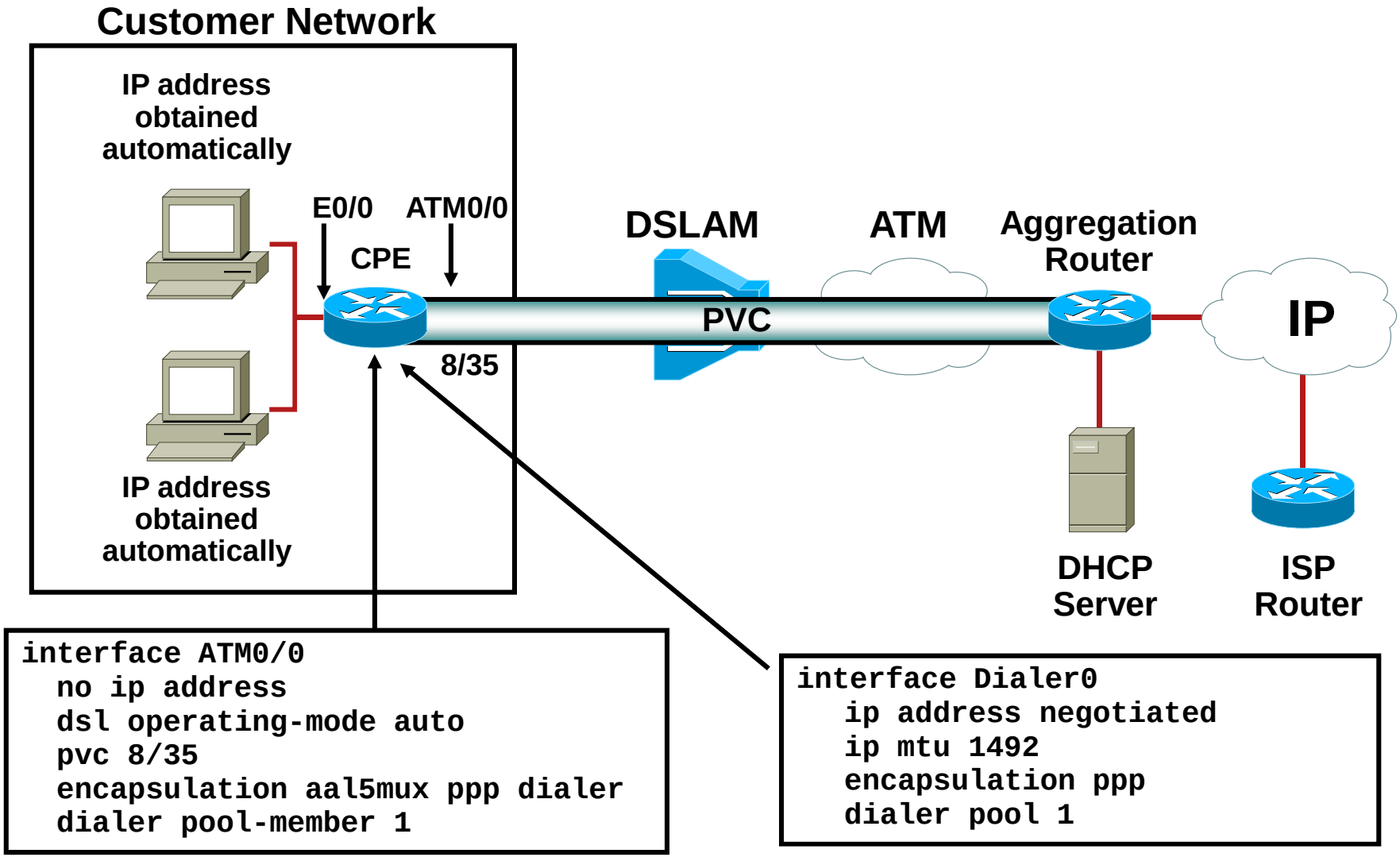
Step 3: Configure PAT.

Step 4: Configure DHCP server.

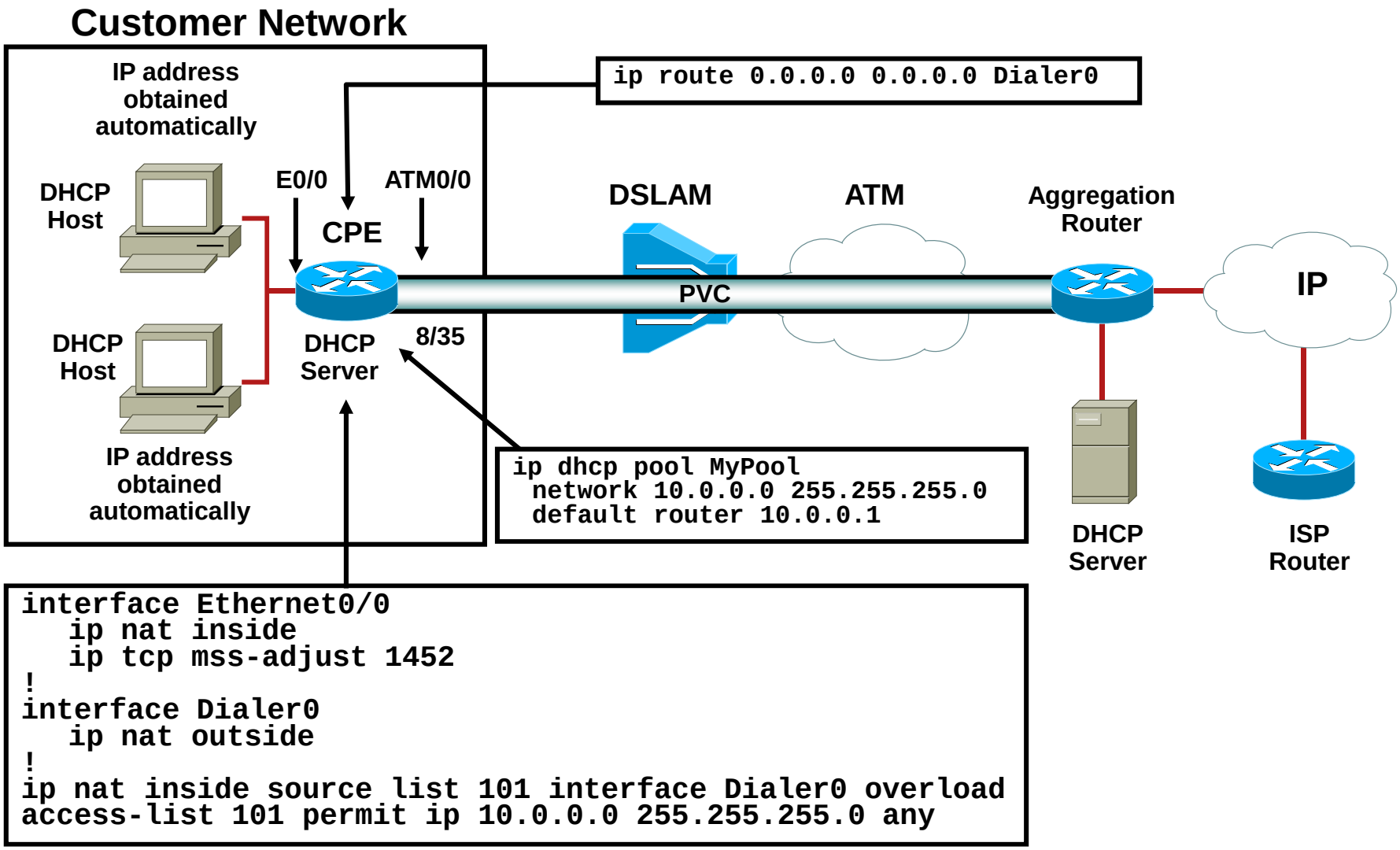
Step 5: Configure a static default route.



CPE as the PPPoE Client over the ATM Interface



CPE as the PPPoE Client over the ATM Interface (Cont.)



PPPoA Sample Configuration

```
hostname CPE
!
ip dhcp pool MyPool
  network 10.0.0.0 255.0.0.0
  default-router 10.0.0.1
!
interface ATM0/0
  no ip address
  dsl operating-mode auto
   pvc 8/35
   encapsulation aal5mux ppp dialer
   dialer pool-member 1
!
interface Ethernet0/0
  ip address 10.0.0.1 255.0.0.0
  ip nat inside
!
interface Dialer0
  ip address negotiated
  encapsulation ppp
  dialer pool 1
  ip nat outside
  ppp authentication chap callin
  ppp chap password mysecret
!
ip nat inside source list 101 interface Dialer0 overload
access-list 101 permit ip 10.0.0.0 0.255.255.255 any
!
ip route 0.0.0.0 0.0.0.0 Dialer0
```

PPPoE Versus PPPoA

- In the PPPoE configuration, you must bind the Ethernet interface to the dialer interface and reduce the maximum Ethernet payload size from 1500 to 1492.
- In the PPPoA configuration, you must configure the proper encapsulation on the ATM interface and associate the interface with the dialer pool.

PPPoE

```
interface Ethernet0/1
 no ip address
 pppoe enable
 pppoe-client dial-pool-number 1
!
interface Dialer0
 ip mtu 1492
```

PPPoA

```
interface ATM0/0
 no ip address
 dsl operating-mode auto
 pvc 1/32
  encapsulation aal5mux ppp dialer
  dialer pool-member 1
```

PPPoE Verification

Verifying a PPPoE Configuration

- Step 1: Debug PPPoE events.
- Step 2: Debug PPPoE authentication.
- Step 3: Verify DHCP Clients.
- Step 4: Verify DHCP Server.
- Step 5: Verify PAT.

Step 1: Debug VPDN PPPoE Events

```
CPE#debug pppoe events
15:13:41.991:  Sending PADI: Interface = Ethernet1
15:13:42.083: PPPoE 0: I PADO
15:13:44.091:  PPPOE: we've got our pado and the pado timer went off
15:13:44.091: OUT PADR from PPPoE Session
15:13:44.187: PPPoE 5989: I PADS
15:13:44.187: IN PADS from PPPoE Session
```

- Determine if the PPPoE connect phase is successful.

```
CPE#show pppoe session
Total PPPoE sessions 1

PPPoE Session Information
UID    SID    RemMAC          Intf          Intf      Session
              LocMAC                        VASt      state
0      5989   0090.1a41.1a83 Et1           Vi2       N/A
              000b.46e2.eb36                UP
```

- Review the status of the PPPoE session.

Step 2: Debug PPP Authentication

```
CPE#debug ppp authentication
CPE#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
CPE(config)#interface ATM 0/0
CPE(config-if)#no shutdown
00:19:05: %LINK-3-UPDOWN: Interface ATM 0/0, changed state to up
00:19:06: %LINEPROTO-5-UPDOWN: Line protocol on Interface ATM0/0,
  changed state to up
00:19:29: %DIALER-6-BIND: Interface Vi2 bound to profile Di1
00:19:29: Vi2 PPP: Using dialer call direction
00:19:29: Vi2 PPP: Treating connection as a callout
00:19:29: Vi2 PPP: Authorization required
00:19:29: Vi2 PPP: No remote authentication for call-out
00:19:29: %LINK-3-UPDOWN: Interface Virtual-Access2, changed state to up
00:19:31: Vi2 CHAP: I CHALLENGE id 1 len 24 from "ISP"
00:19:31: Vi2 CHAP: Using hostname from interface CHAP
00:19:31: Vi2 CHAP: Using password from AAA
00:19:31: Vi2 CHAP: O RESPONSE id 1 len 25 from "CPE"
00:19:32: Vi2 CHAP: I SUCCESS id 1 len 4
00:19:33: %LINEPROTO-5-UPDOWN: Line protocol on Interface Virtual-
  Access2, changed state to up
```

- Enable debugging for PPP authentication to verify authentication success.

Step 3: Verify DHCP Clients

```
C:\Documents and Settings\User>ipconfig /all

Windows 2000 IP Configuration

Ethernet adapter LAB:

        Connection-specific DNS Suffix  . : lab.com
        Description . . . . . . . . . . . : Intel(R) PRO/1000 MT Mobile
  Connection
        Physical Address. . . . . . . . . : 00-11-25-AF-40-9B
        Dhcp Enabled. . . . . . . . . . . : Yes
        Autoconfiguration Enabled . . . . : Yes
        IP Address. . . . . . . . . . . . : 10.0.0.2
        Subnet Mask . . . . . . . . . . . : 255.0.0.0
        Default Gateway . . . . . . . . . : 10.0.0.1
        DHCP Server . . . . . . . . . . . : 10.0.0.1
        DNS Servers . . . . . . . . . . . : 192.168.1.1
                                            192.168.1.2
        Primary WINS Server . . . . . . . : 192.168.1.3
        Lease Obtained. . . . . . . . . . : 6. April 2006 16:36:31
        Lease Expires . . . . . . . . . . : 7. April 2006 0:36:31
```

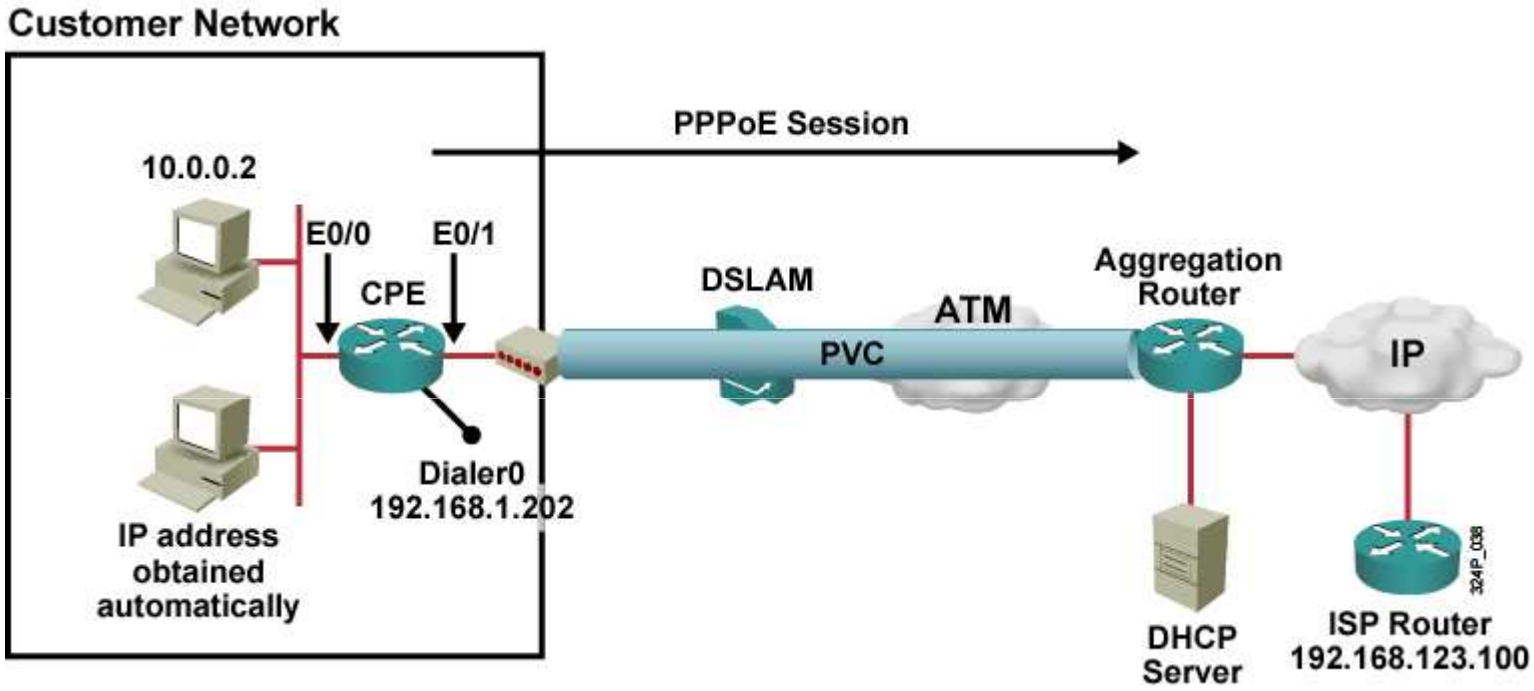
- Verify how the IP address is assigned on the PC.

Step 4: Verify DHCP Server

```
CPE# show ip dhcp binding
IP address      Client-ID/              Lease expiration        Type
                Hardware address
10.0.0.2        0100.5056.4000.59       Jan 21 2006 12:50 AM    Automatic
10.0.0.3        0100.5056.4000.60       Jan 21 2006 12:50 AM    Automatic
```

- Verify the existing DHCP bindings on the router (DHCP server).

Step 5: Verify PAT




```
CPE# show ip nat translations
Pro   Inside global       Inside local   Outside local          Outside global
icmp  192.168.1.202:512   10.0.0.2:512   192.168.123.100:512    192.168.123.100:512
```

- Verify how IP addresses are translated on the router.

Summary

- Configuration of PPPoE and PPPoA connections require 5 basic steps:
  - Configure interface.
  - Create and configure the dialer interface.
  - Configure PAT.
  - Configure DHCP server.
  - Configure a static default route.
- Various show and debug commands can be used to verify and troubleshoot the configuration.

Resources

- PPPoE/PPPoA Configuration Examples

  http://www.cisco.com/en/US/partner/tech/tk175/tk819/tech_configuration_examples_list.html

- ATM PVC, SVC, Soft-PVC, and PVP Frequently Asked Questions

  http://www.cisco.com/en/US/partner/tech/tk39/tk48/technologies_q_and_a_item09186a008011a901.shtml

- Long Reach Ethernet (LRE) and Digital Subscriber Line (xDSL) Technology Page

  http://www.cisco.com/en/US/partner/tech/tk175/tsd_technology_support_category_home.html

- Cisco DSL Router Configuration and Troubleshooting Guide - PPPoE Online Form

  http://www.cisco.com/en/US/partner/tech/tk175/tk15/technologies_configuration_example09186a008071a7d1.shtml

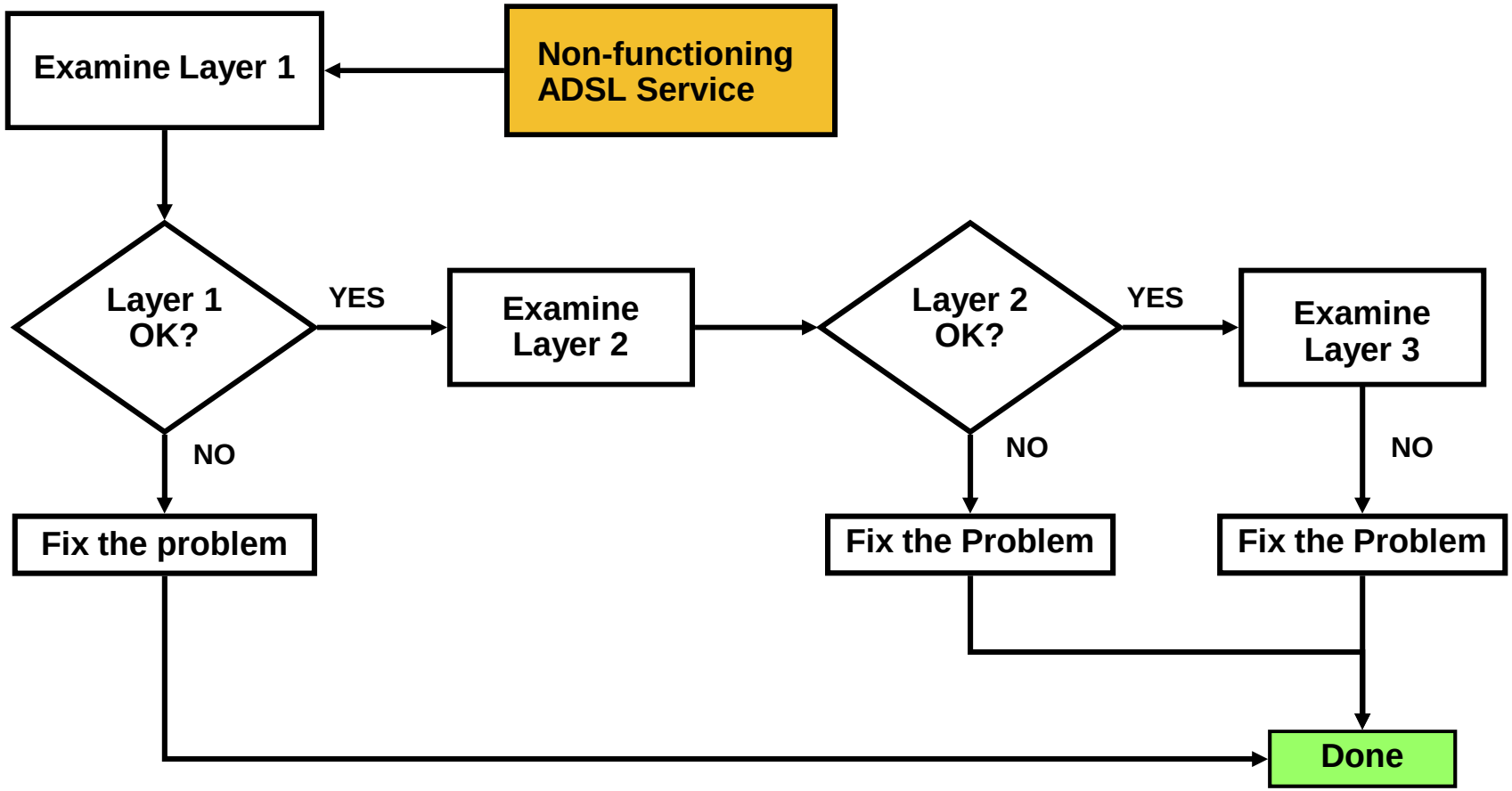
Module 2: Teleworker Connectivity

Lesson 2.7: Verifying Broadband ASDL Configurations

Objectives

- Describe and implement a bottom up troubleshooting technique for ADSL.

Determining the Layer to Troubleshoot



Determine Whether the Router Is Properly Trained to the DSLAM

router#

show dsl interface atm *number*

- Displays information specific to the ADSL for a specified ATM interface

```
Router#show dsl interface atm 0

                    ATU-R (DS)                      ATU-C (US)
Modem Status:       Showtime (DMTDSL_SHOWTIME)
DSL Mode:           ITU G.992.1 (G.DMT)
ITU STD NUM:        0x01                            0x1
Vendor ID:          'ALCB'                          'GSPN'
Vendor Specific:    0x0000                          0x0002
Vendor Country:     0x00                            0x00
Capacity Used:      97%                             100%
Noise Margin:       5.0 dB                          6.0 dB
Output Power:       9.5 dBm                         12.0 dBm
<...part of the output omitted...>

                  Interleave      Fast      Interleave      Fast
Speed (kbps):     7616            0         896             0
<...rest of the output omitted...>
```

Troubleshooting Layer 1 Issues

- Router is not properly trained.
- Check the ADSL_CD light:

  ADSL_CD light is on: Proceed to Layer 2 troubleshooting

  ADSL_CD light is off: Continue with Layer 1 troubleshooting
- Check whether the DSL (ATM) port on the Cisco router is plugged into the wall jack; if not, connect the port to the wall jack with a standard telephone cable (4-pin or 6-pin RJ-11 cable).
- Check if cable pinouts are correct.
- Replace any faulty cable.
- Verify with your service provider that DSL service has been enabled.

Troubleshooting Layer 1: Is the ATM Interface in an Administratively Down State?

- ATM interface is administratively disabled.

```
router#show interfaces atm 0
ATM0 is administratively down, line protocol is down
<...rest of the output omitted...>
```

- Enable administratively disabled interface.

```
router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
router(config)#interface atm 0
router(config-if)#no shutdown
router(config-if)#end
router#copy running-config startup-config
```

Troubleshooting Layer 1: Is the DSL Operating Mode Correct?

- Check the DSL modulation type used with the service provider.
- If modulation is not known, use the default auto operating mode for autodetection.

```
router(config-if)#
dsl operating-mode {auto | ansi-dmt | itu-dmt |
splitterless}
```

- Modifies the operating mode of the DSL for an ATM interface

Troubleshooting Layer 2 Issues

- Verify that a PVC is in use with the **ping atm interface atm** command.

```
router#ping atm interface atm 0 2 32 seg-loopback
Type escape sequence to abort.
Sending 5, 53-byte segment OAM echoes, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 58/58/58 ms
```

- Check the VPI/VCI settings with the **debug atm events** command.

```
router#debug atm events
2d16h: Data Cell received on vpi = 2 vci =32 PPPoA MUX
2d16h: Data Cell received on vpi = 2 vci =32 PPPoA MUX
2d16h: Data Cell received on vpi = 2 vci =32 PPPoA MUX
```

Layer 2 Troubleshooting: Is Data Being Received from the ISP?

```
router#show interfaces atm 0
ATM0 is up, line protocol is up
  Hardware is DSLSAR (with Alcatel ADSL Module)
  MTU 4470 bytes, sub MTU 4470, BW 128 Kbit, DLY 1600 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ATM, loopback not set
  Keepalive not supported
  Encapsulation(s):AAL5, PVC mode
  24 maximum active VCs, 256 VCS per VP, 1 current VCCs
  VC idle disconnect time:300 seconds
  Last input 01:16:31, output 01:16:31, output hang never
  Last clearing of "show interface" counters never
  Input queue:0/75/0 (size/max/drops); Total output drops:0
  Queueing strategy:fifo
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     512 packets input, 59780 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     426 packets output, 46282 bytes, 0 underruns
     0 output errors, 0 collisions, 2 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

Troubleshooting Layer 2: PPP Negotiation

- PPP stages:
  - LCP phase
  - Authentication phase
  - NCP phase
- Use the `debug ppp negotiation` command to verify the PPP negotiation process.
- Use the `debug ppp authentication` command to verify PPP authentication.

Troubleshooting Layer 2: Is PPP Negotiating Successfully?

```
06:36:03: Vi1 PPP: Treating connection as a callout
06:36:03: Vi1 PPP: Phase is ESTABLISHING, Active Open [0 sess, 1 load]
06:36:03: Vi1 PPP: No remote authentication for call-out
06:36:03: Vi1 LCP: O CONFREQ [Closed] id 1 len 10
06:36:03: Vi1 LCP:    MagicNumber 0x03013D43 (0x050603013D43)
<...part of the output omitted...>
06:36:05: Vi1 LCP: State is Open
06:36:05: Vi1 PPP: Phase is AUTHENTICATING, by the peer [0 sess, 1 load]
06:36:05: Vi1 CHAP: I CHALLENGE id 9 len 26 from "nrp-b"
06:36:05: Vi1 CHAP: Using alternate hostname client1
<...part of the output omitted...>
06:36:05: Vi1 CHAP: I SUCCESS id 9 len 4
06:36:05: Vi1 PPP: Phase is FORWARDING [0 sess, 1 load]
06:36:05: Vi1 PPP: Phase is AUTHENTICATING [0 sess, 1 load]
06:36:05: Vi1 PPP: Phase is UP [0 sess, 1 load]
06:36:05: Vi1 IPCP: I CONFREQ [REQsent] id 1 len 10
06:36:05: Vi1 IPCP:    Address 8.8.8.1 (0x030608080801)
06:36:05: Vi1 IPCP:    Address 9.9.9.2 (0x030609090902)
<...part of the output omitted...>
06:36:05: Vi1 IPCP: State is Open
06:36:05: Di1 IPCP: Install negotiated IP interface address 9.9.9.2
06:36:05: Di1 IPCP: Install route to 8.8.8.1
06:36:06: %LINEPROTO-5-UPDOWN: Line protocol on Interface Virtual-Access1,
changed state to up
```

Summary

- ADSL service problems can reside at Layer 1, Layer 2, or Layer 3. Troubleshooting should start by determining which ADSL service layer is failing. To determine which layer has a problem start troubleshooting at Layer 1 and move to subsequent layers as required.

Resources

- RFC2516 A Method for Transmitting PPP over Ethernet (PPPoE)

  http://www.faqs.org/rfcs/rfc2516.html

- PPoE

  http://www.cisco.com/en/US/customer/tech/tk175/tk819/tsd_technology_support_protocol_home.html

- RFC1483 Multiprotocol Encapsulation Over ATM Adaptation Layer 5

  http://www.faqs.org/rfcs/rfc1483.html

- PPPoE / PPPoA

  http://www.cisco.com/en/US/customer/tech/tk175/tk819/tsd_technology_support_protocol_home.html