High-Level Data Link Control

This configuration and troubleshooting guide will aid in the setup of High-Level Data Link Control (HDLC) for ADTRAN Operating System (AOS) products. An overview of HDLC general concepts combined with detailed command descriptions provide step-by-step assistance for configuration. The troubleshooting section outlines proper use of `show` commands to verify that HDLC has been configured properly on the AOS product(s).

This guide consists of the following sections:

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HDLC Overview

HDLC is one of the oldest Data Link Layer (Layer 2) protocols for a wide area network (WAN); predating even the personal computer (PC). Although it was developed for a mainframe environment containing primary and secondary devices, HDLC has been updated for use in the PC environment. The original HDLC protocol is significant to the world of internetworking because it is the basis of many modern Layer 2 protocols, including point-to-point protocol (PPP), Frame Relay, and Q.921 (LAP-D). Despite its historical significance, the original HDLC protocol is no longer in wide deployment. However, Cisco HDLC (cHDLC), an extension to the original HDLC protocol, is prevalent in today's industry.

The term HDLC in modern day conversation typically refers to the extended version of HDLC or cHDLC. cHDLC enhances the International Organization for Standardization (ISO) HDLC standard by adding multi protocol support and Serial Line Address Resolution Protocol (SLARP). SLARP enables dynamic address assignment and keep alive capability across a serial point-to-point connection.

Following common industry verbiage, this document uses the acronym HDLC in place of cHDLC.

Hardware and Software Requirements and Limitations

HDLC allows for the efficient transport of IP traffic across various transmission mediums, including T1, E1, T3, digital data service (DDS), symmetric high-speed digital subscriber (SHDSL), and synchronous serial circuits. The protocol is simplistic and lacks the more advanced features found in PPP; such as authentication, automatic Layer 3 (IP) addressing, loop detection, and multilink applications. Although HDLC is a very basic protocol, efficient design and ease of configuration make it the preferred protocol of many Internet Service Providers (ISPs) across dedicated circuits to their customer’s premises.

First generation NetVanta 3200/3205 routers do not support the appropriate software for HDLC implementation.
Advanced CLI Configuration

T1, E1, DDS, SHDSL, Serial, T3, and HSSI Interfaces

The physical T1, E1, DDS, SHDSL, serial, T3, and high-speed serial interface (HSSI) interfaces must be set up and activated in addition to configuring the virtual HDLC interface. Table 1 shows the primary physical settings that must be configured for an interface that uses HDLC.

Table 1. Primary Required Physical Settings

<table>
<thead>
<tr>
<th>Interface</th>
<th>Command</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>tdm-group &lt;number&gt; timeslots &lt;range of DS0s&gt;</td>
<td>Defines the number of channels (DS0s) used for the T1 connection.</td>
</tr>
<tr>
<td></td>
<td>coding [ami</td>
<td>b8zs]</td>
</tr>
<tr>
<td></td>
<td>framing [d4</td>
<td>esf]</td>
</tr>
<tr>
<td></td>
<td>clock source [internal</td>
<td>line</td>
</tr>
<tr>
<td></td>
<td>lbo [long</td>
<td>short]</td>
</tr>
<tr>
<td></td>
<td>no shutdown</td>
<td>Activates the interface.</td>
</tr>
<tr>
<td>E1</td>
<td>tdm-group &lt;number&gt; timeslots &lt;value&gt;</td>
<td>Defines the number of channels used for the E1 connection.</td>
</tr>
<tr>
<td></td>
<td>coding [ami</td>
<td>hdb3]</td>
</tr>
<tr>
<td></td>
<td>framing [crc4]</td>
<td>Defines the frame format.</td>
</tr>
<tr>
<td></td>
<td>clock source [internal</td>
<td>line</td>
</tr>
<tr>
<td></td>
<td>no shutdown</td>
<td>Activates the interface.</td>
</tr>
<tr>
<td>DDS</td>
<td>clock source [internal</td>
<td>line]</td>
</tr>
<tr>
<td></td>
<td>clock rate [auto</td>
<td>bps56k</td>
</tr>
<tr>
<td></td>
<td>no shutdown</td>
<td>Activates the interface.</td>
</tr>
<tr>
<td>SHDSL</td>
<td>equipment-type cpe</td>
<td>Specifies this unit as a slave unit that is interfacing directly with a service provider.</td>
</tr>
<tr>
<td></td>
<td>no shutdown</td>
<td>Activates the interface.</td>
</tr>
<tr>
<td>Serial*</td>
<td>serial-mode [EIA530</td>
<td>v35</td>
</tr>
<tr>
<td></td>
<td>et-clock-source [rxclock</td>
<td>txclock]</td>
</tr>
<tr>
<td></td>
<td>no shutdown</td>
<td>Activates the interface.</td>
</tr>
</tbody>
</table>
Basic HDLC Interface Setup

The first step to configuring HDLC for an E1, T1, DDS, SHDSL, serial, T3, or HSSI interface is to create a virtual interface. Start from the Global Configuration mode:

**Step 1: Create an HDLC Interface on the AOS Product**

Create the virtual HDLC interface and assign it a number. Every HDLC interface must have a unique number.

```
(config)# interface hdlc <interface id>
```

* <interface id> Specifies the HDLC interface number. Range is 1 to 1024. This value is only locally significant and does not need to match an identifier of the HDLC interface on the other end of the point-to-point circuit.

**Step 2: Configure an IP Address for the WAN Connection**

The IP address for the E1, T1, or DDS WAN connection is configured on the HDLC interface rather than on the physical interface. There are two ways to assign an IP address to the HDLC interface:

- Assign a static IP address
- Configure the HDLC interface as an unnumbered interface
**Static IP Address**

The static IP address is a fixed address assigned to the HDLC interface by a user.

```
(config-hdlc 1)#ip address <ip address> <subnet mask>
```

- `<ip address>` Specifies a valid IP address. IP addresses should be expressed in dotted decimal notation.
- `<subnet mask>` Specifies the subnet mask that corresponds to a range of IP addresses (network) or a specific host. Subnet masks can be expressed in dotted decimal notation or as a prefix length following a forward slash (/).

For example, the IP address 192.168.0.1, assuming a 24-bit subnet mask, could be entered in either of the following ways:

```
(config-hdlc 1)#ip address 192.168.0.1 255.255.255.0
```

**Unnumbered Interface**

To conserve IP addresses on a network, users can create an HDLC interface as an unnumbered interface. When a logical interface on the router is assigned an IP address, the address cannot overlap with the IP addresses assigned to other logical interfaces on the network. As a result, each interface that has an IP address represents an entire subnet. Depending on the subnetting scheme used, this could use more IP addresses than a network can spare.

By configuring an HDLC interface as an unnumbered interface, the IP address of another interface (specified by the user) will also be used for the HDLC interface. AOS then uses the IP address of the specified interface when routing updates are sent over the HDLC interface.

```
(config-hdlc 1)#ip unnumbered <interface>
```

- `<interface>` Specifies the interface that contains the IP address to use as the source address for all packets transmitted on this interface. For example, for an Ethernet interface, `eth 0/1` might be specified. Valid interface types include asynchronous transfer mode (ATM), bridged virtual interface (BVI), demand, Ethernet, Frame Relay, HDLC, loopback, and PPP. Virtual local area network (VLAN) interfaces are also an option on integrated switch-router products. Type `ip unnumbered ?` for a list of valid interfaces on a specific product.

Unnumbered interfaces allow better conservation of IP addresses, but there is a caveat associated with this IP addressing method. If the source interface is down for any reason (for example, an Ethernet interface is unplugged), the HDLC interface will also lose IP connectivity. Logical interfaces, such as Loopback or VLAN, are the best choice for an unnumbered interface because they do not go down unless they are administratively disabled.

**Step 3: (Optional) Configure Secondary IP Addresses**

Depending on the network setup, secondary address configuration may or may not be needed. If secondary addresses are not needed for this HDLC connection, go to Step 4.
Additional IP addresses may be configured on HDLC interfaces, as needed. The most common reason for adding secondary addresses to WAN interfaces is for configuring port forwarding or one-to-one NAT. Port forwarding and one-to-one NAT allow users to make servers on a private network available to the Internet via public IP addresses. The configuration requires the publicly available IP addresses to be added to the router’s WAN interface, usually as secondary addresses.

```
(config-hdlc 1)#ip address <ip address> <subnet mask> secondary
```

<i>ip address</i> Specifies a valid IP address. IP addresses should be expressed in dotted decimal notation (for example, 208.61.209.2).

<i>subnet mask</i> Specifies the subnet mask that corresponds to a range of IP addresses (network) or a specific host. Subnet masks can be expressed in dotted decimal notation or prefix length.

**Step 4: Activating the HDLC Interface**

Although this command activates the HDLC interface, the interface will not change until it is bound to the physical interface (refer to Step 5).

```
(config-hdlc 1)#no shutdown
```

**Step 5: Cross Connect the Physical Interface to the Virtual Interface**

Next, associate the appropriate physical interface to the HDLC interface, using the <tt>cross-connect</tt> command. The physical interface must be cross connected to the virtual interface so that the AOS device knows which data link layer protocol to use for that WAN connection. When a physical interface is cross connected to a virtual interface, the two are considered a single interface cross connect group. This guide assumes that the physical interface has already been configured.

```
(config-hdlc 1)#cross-connect <number> <from interface> <group number> <to interface>
```

<i>number</i> Identifies the cross connect using a number descriptor. Each cross connect within an AOS device must have a unique number. Range is 1 to 1024.

<i>from interface</i> Specifies the physical interface on one end of the cross connect. Specify an interface in the format <tt><interface type [slot/port | interface id]></tt>. To set up the HDLC cross connect as outlined in this guide, it is likely that a T1, E1, DDS, serial, or SHDSL WAN interface will be specified as the from interface. For example, for a T1 interface, use <tt>t1 1/1</tt>. Enter <tt>cross-connect 1 ?</tt> for a list of all valid interfaces.

<i>group number</i> Optional. Specifies which configured time division multiplex (TDM) group to use for this cross connect. This subcommand only applies to T1 or E1 physical interfaces. To set up the HDLC cross connect as outlined in this guide, use the same TDM group number previously assigned to the physical interface (see Table 2 for more details).

<i>to interface</i> Specifies the virtual interface on the other end of the cross connect. Specify an interface in the format <tt><interface type [slot/port | slot/port.subinterface id | interface id | interface id.subinterface id]</tt>. To set up the HDLC cross connect as outlined in this guide, the interface number placed here should match the number assigned to the HDLC interface in Step 1. For example, for <tt>hdlc 1</tt>, use the ? to display a list of all valid interfaces.
The **cross-connect** command binds the virtual HDLC interface to the physical WAN interface in the AOS product. The HDLC interface can now attempt to negotiate an HDLC session with its peer, and if that negotiation is successful, the status of the HDLC interface will change to up. To view the status of or troubleshoot an HDLC interface, refer to *Troubleshooting* on page 29 of this guide.

**Step 6: Exit the HDLC Interface Configuration Menu and Save the Configuration**

Issue the **exit** command once to leave the HDLC Interface Configuration mode and return to the Global Configuration mode. Issue the **exit** command a second time to return to Enable mode, which is where the **copy running-config startup-config** command is issued to save the configuration.

```
(config-hdlc 1)#exit
(config)#exit
#copy running-config startup-config
```

**Additional Settings**

Depending on the user's WAN environment, other settings may need to be configured on the HDLC interface.

**Bridging**

Generally, routing should always be used across WAN links. However, some legacy equipment, such as point-of-sale devices and older medical equipment, do not support IP networking. AOS offers bridging as an option available for legacy applications that do not support IP routing.

Use the **bridge-group** command to assign an interface to the specified bridge group. This command is supported on all Ethernet interfaces, HDLC and PPP virtual interfaces, and Frame Relay virtual subinterfaces. Use the **no** form of this command to remove an interface. Any two IP interfaces can be bridged (Ethernet to PPP virtual interface, VLAN to PPP virtual interface, etc.).

```
(config-hdlc 1)#bridge-group <number>
```

*<number>* Specifies the bridge group (by number) to which to assign this interface. Range is 1 to 255.
Description

A description may be added to the HDLC interface to provide additional information about it. For example, if multiple HDLC interfaces at the corporate office have been configured toward different remote locations, a description can be used to identify the location of the connection at the far end of each HDLC link.

(config-hdlc 1)#description <text>

<text> Identifies the specified interface using up to 80 alphanumeric characters.

This description is displayed in the output when either the show running-config or the show interface hdlc commands are issued from Enable mode.

Keepalive

Use the keepalive command to enable the transmission of keepalive packets on the HDLC interface and specify the time interval (in seconds) between transmitted packets. By default, the keepalive interval in AOS for HDLC interfaces is 10 seconds.

(config-hdlc 1)#keepalive <value>

<value> Defines the time interval (in seconds) between transmitted keepalive packets. Valid range is 0 to 32,767 seconds.

The keepalive interval must be set to the same value on devices at both ends of the HDLC link. The shorter the keepalive interval, the faster an interface failure will be detected. The keepalive signal may be disabled by issuing the command keepalive 0 on the HDLC interface. However, this should only be done if the keepalive has been disabled on the device at the other side of the point-to-point connection.

When an HDLC interface is enabled, it is normal for the interface line protocol to initially alternate between up and down status a few times. This will occur until the devices at both ends of the HDLC link have received each other’s keep alive signal.
Maximum Transmission Unit (MTU)

The MTU defines the largest size that an HDLC frame can be. If a frame exceeds this size, it must be fragmented. By default, the MTU for HDLC interfaces is 1500 bytes.

(config-hdlc 1)#mtu <size>

<size> Specifies the window size (in bytes) for transmitted packets. The valid range for HDLC interfaces is 64 to 2100 except in the NetVanta 5305. The valid range for HDLC interfaces in the NetVanta 5305 is 64 to 4600.

The valid MTU range for HDLC interfaces to all interfaces was 64 to 1520 prior to AOS 14.1.

The MTU should be left at 1500 bytes for most network environments. However, in some cases the MTU size may need to be adjusted. If the peer router uses a different MTU size across the HDLC connection, transmissions and routing can be affected. For example, if the HDLC peer is set to an MTU less than 1500 and the host router sends a frame that is 1500 bytes, the HDLC peer will have to fragment the frame. Furthermore, if the frame is tagged with the do not fragment field, then the peer router cannot forward the frame at all.

If open shortest path first (OSPF) routing has been enabled on the AOS product, the MTU setting should be verified on all adjacent devices. OSPF routers cannot become adjacent if their MTU sizes do not match.
GUI Configuration

The Web-based graphical user interface (GUI) is an especially useful tool for those who are less familiar with command line interface (CLI) configuration. AOS products ship standard with a user-friendly GUI that can be used to perform many basic management and configuration functions on the AOS product. Some advanced options are configurable via the GUI as well.

Open a GUI session. If you need assistance, refer to the quick start guide specific to your AOS product available on the AOS Documentation CD shipped with your unit or online at www.adtran.com.

Figure 1. System Summary Menu

Once a successful connection to the GUI has been established, the main landing page appears.

A setup wizard option is available in the NetVanta 340, 3200, 3430, and 3448. Select Setup Wizard from the left-hand menu in the GUI. The same wizard is available in the Total Access 900(e) Series and NetVanta 6355, but it is called a Configuration Wizard. The wizard will guide a system administrator through setup of the most common HDLC configurations. However, if the system administrator prefers to configure HDLC without going through the wizard, the following step-by-step process mimics the configuration outlined in Advanced CLI Configuration on page 3 of this document.

While navigating the GUI you will notice question mark symbols that indicate additional information is available. Simply place your cursor over the symbol to view the additional information.
Step 1

Select **Physical Interfaces** from the left-hand **System** menu in the GUI. A list of all the physical interfaces on the AOS product will appear. Select the interface to be configured for HDLC by selecting its name (See Figure 2). As an example, this tutorial demonstrates the configuration of the interface **t1 1/1**.

*NOTE*

A virtual interface (i.e., **HDLC 1**) that has already been created will appear as a hyperlink listed under the **Logical Interface** heading. This hyperlink allows direct access to configuration menus for the virtual interface.

![Physical Interfaces Menu](image)

Select the interface to be configured for HDLC by selecting its name.

*Figure 2. Physical Interfaces Menu*
Step 2

The **Physical Interfaces Configuration** menu in the Total Access 900(e) Series, NetVanta 6355, and NetVanta 7000 Series is different than the NetVanta 3200 menu shown below. Refer to the Total Access 900(e) Series, NetVanta 6355, and NetVanta 7000 Series GUI on page 13 to find information applicable to the GUI in those products.

The GUI now displays the **Physical Interfaces Configuration** options for **t1 1/1** (See Figure 3). Select the number of data DS0s on this T1 that are to be mapped to the router. All DS0s or a contiguous fraction of DS0s can be activated for data. Select the button next to **HDLC** to set the **Encapsulation** type. To enable the interface, ensure that a check mark appears in the box next to **Enable**.

This page is a good place to double check all other physical parameters (e.g., **Clocking**, **Framing**, **Coding**, etc.) for the interface.

Select **Apply** to proceed to the **HDLC Configuration Menu**.

![Figure 3. T1 Configuration Menu (NetVanta 3200)]
The Physical Interfaces Configuration options are displayed for t1 0/1 (see Figure 4). The top part of the page lists various physical parameters that already should have been configured for the T1 interface. However, it is always recommended to double check the settings.

The next section contains options for configuring HDLC. Select HDLC from the Connect To drop-down menu. Next, select the number of data DS0s on this T1 that are to be mapped to the router. All DS0s or a contiguous fraction of DS0s can be activated for data.

Select Add to proceed to the HDLC Configuration menu.
Step 3

The **HDLC Configuration** menu (see Figure 5) contains basic HDLC control settings, such as whether or not the interface is enabled, choice of queuing method, MTU size, etc. An optional description of this HDLC link can be entered.

**IP Settings**

The **IP Settings** configuration is located toward the bottom of the **HDLC Configuration** menu. Choose the type of IP address for the AOS device: **None**, **Static**, or **Unnumbered**. The **Address Type** should be set to **None** when connecting to a bridge with IP routing disabled. The **Address Type** should be set to **Static** when assigning a fixed IP address to the interface (see Figure 5). Secondary IP addresses may be entered after the static IP address has been assigned.

---

*The option to add secondary IP addresses does not appear until you have configured the initial IP Settings and selected Apply.*

---

**Figure 5. HDLC Configuration and Static IP Address Type**
The **Address Type Unnumbered** allows the IP address of another interface on the AOS device to also be used as the IP address of the HDLC interface (see Figure 6). See *Unnumbered Interface* on page 5 for more information on the use of unnumbered interfaces.

Figure 6. HDLC Configuration, Unnumbered IP Address Type, and Media Gateway
**Media Gateway**

The option to designate the HDLC interface as a **Media Gateway** is available in the **IP Settings** menu for voice products as well as a number of data products (see Figure 6 on page 15). Refer to the AOS Feature Matrix, article #2272, found at http://kb.adtran.com for the most current listing of products that support this option.

The Media Gateway option is used in conjunction with the SIP Transparent Proxy feature. If the HDLC interface is the outbound interface used to connect to the Session Initiation Protocol (SIP) server, then the media gateway option should be set to **primary**. This setting should be enabled for all interfaces on the unit where voice traffic sourcing is desired. Refer to *Configuring SIP Transparent Proxy in AOS*, article #2183, found at http://kb.adtran.com for more information on SIP Transparent Proxy.
Step 4

Upon completing all applicable fields for the HDLC Interface and IP Settings, select Apply. Basic HDLC interface configuration should now be complete. The GUI menu will refresh itself. Scroll to the bottom of the menu to view the status of the HDLC interface (See Figure 7 on page 17). If the peer end of the HDLC connection has been properly configured, the HDLC interface's Line Status should change to Up.

![Status Menu](image)

**Figure 7. Status Menu**
Upon completion of HDLC configuration in the GUI, be sure to save all changes to nonvolatile random access memory (NVRAM). This is accomplished by selecting the word **Save** in the upper right-hand corner of the menu.

**Figure 8. Save the Configuration**
Example Configurations

The example scenarios contained within this section are designed to enhance understanding of HDLC configurations on AOS products.

Some commands shown in the example configurations in this guide are already enabled as the default setting in the unit. These commands will not appear in the output when the `show running-config` command is issued. Keep this in mind when comparing the configuration in your unit to the configurations shown in this guide. Issue the `show run verbose` command to see all commands (including those that do not appear when the `show running-config` command is issued).

Integrated Switch/Router Versus Nonintegrated Switch/Router Configuration

Configuration of the IP address and firewall access policies on the private Local Area Network (LAN) interface differs slightly depending on the type of AOS product. The IP address and firewall commands are placed on the private LAN Ethernet interface on nonintegrated switch/router products, such as the NetVanta 3200 and 3430. The Advanced CLI Configuration outlined in this guide on page 3, as well as the majority of the examples provided in this section, applies to nonintegrated switch/router products. Configuration of the IP address and firewall access policies on integrated switch/router products, such as the NetVanta 6355, varies in that the commands are issued on the appropriate VLAN interface(s) as opposed to the private Ethernet interface. An additional step is required to associate switch port interfaces to the appropriate VLAN that corresponds with the physical setup of the network. The example configuration below assigns the switch port 0/1 interface to VLAN 1.

```plaintext
! interface vlan 1
  ip address 192.168.0.1 255.255.255.0
  access-policy Private
  no shutdown
! interface switchport 0/1
  switchport access vlan 1
  no shutdown
!
```

Some switch/router AOS products, such as the NetVanta 1224R Series, label the switch port interfaces `interface ethernet 0/x` instead of `interface switchport 0/x`, where x is a variable from 1 to 24 depending on the product.

Refer to Example 2 on page 22 to see an integrated switch/router product example configuration for the NetVanta 3448.
Example 1: HDLC to an ISP with AOS Device and External Firewall

HDLC is sometimes used across a T1 connection between an ISP and its customer. The following configuration example has an external firewall that is connected to Ethernet 0/1 on the AOS product. The external firewall will perform all security functions, including network address port translation (NAPT) and port forwarding. A virtual interface, HDLC 1, defines the IP address assignment for the HDLC connection. The customer's WAN IP address (65.162.109.202 /30) is statically assigned and 24 DS0s on the WAN interface will be used for this HDLC connection. One public IP address (208.61.209.1 /29) will be assigned to Ethernet 0/1 on the AOS product. Another public IP address from the public block (208.61.209.2 /29) will be assigned to the external firewall. A default route that points to interface HDLC 1 is added to the route table in the AOS product. The external firewall needs to have its default route pointing to the public IP address assigned to the AOS product's Ethernet 0/1 interface (208.61.209.1 /29).

Figure 9. An HDLC Connection to an ISP with an External Firewall on the Customer’s LAN
The following configuration applies to Example 1:

```plaintext
interface eth 0/1
    ip address 208.61.209.1 255.255.255.248
    no shutdown

interface t1 1/1
    clock source line
    tdm-group 1 timeslots 1-24 speed 64
    no shutdown

interface hdlc 1
    ip address 65.162.109.202 255.255.255.252
    no shutdown
    cross-connect 1 t1 1/1 1 hdlc 1

ip route 0.0.0.0 0.0.0.0 hdlc 1
```
Example 2: HDLC to an ISP with AOS Device (Using the Internal Firewall Capabilities)

HDLC is sometimes used across a T1 connection between an ISP and its customer. The following configuration example uses the built-in firewall capabilities of the AOS product to perform security functions, including NAPT, 1:1 (NAT), and port forwarding. The customer's WAN IP address (65.162.109.202 /30) is statically assigned and all 24 DS0s on the WAN interface will be used for the HDLC connection. Through the internal firewall, 1:1 NAT or port forwarding is used for any public IP addresses that are assigned to servers and public devices that sit on the private side of the AOS product. This example shows a Hypertext Transfer Protocol (HTTP) server with a private IP address (192.168.0.2 /24) receiving port forwards from public IP address 208.61.209.1 /29. The public IP address is entered as a secondary IP address on the WAN HDLC interface. NAPT is also used to provide Internet access to devices on the LAN.

Sample configurations for this example are provided for both the NetVanta 3430, a nonintegrated switch/router product and NetVanta 3448, an integrated switch/router product. Refer to the beginning of this section for more information on the configuration differences between these two types of products.

Refer to the Port Forwarding Quick Configuration Guide, article #2154 found at http://kb.adtran.com, for information on port forwarding, 1:1 NAT, and other firewall features.

Summary of IP Addresses:
ISP Serial/WAN IP - 65.162.109.201 255.255.255.252
Customer Serial/WAN IP - 65.162.109.202 255.255.255.252
Public Block/Customer Range of IP addresses - 208.61.209.1-208.61.209.6 255.255.255.248

Figure 10. A HDLC Connection to an ISP with the Built-in Firewall of the AOS Device
The following configuration applies to Example 2:

**NetVanta 3430**

```
! ip firewall
ip firewall nat-preserve-source-port
! interface eth 0/1
    ip address 192.168.0.1 255.255.255.0
    access-policy Private
    no shutdown
!
interface t1 1/1
    clock source line
    tdm-group 1 timeslots 1-24 speed 64
    no shutdown
!
interface hdlc 1
    ip address 65.162.109.202 255.255.255.252
    ip address 208.61.209.1 255.255.255.248 secondary
    access-policy Public
    no shutdown
    cross-connect 1 t1 1/1 1 hdlc 1
!
ip access-list standard MATCHALL
    permit any
!
ip access-list extended WEB-IN
    permit tcp any host 208.61.209.1 eq www
!
ip access-list extended WEB-OUT
    permit ip host 192.168.0.2 any
!
ip policy-class Private
    allow list MATCHALL self
    nat source list WEB-OUT address 208.61.209.1 overload
    nat source list MATCHALL interface hdlc 1 overload
!
ip policy-class Public
    nat destination list WEB-IN address 192.168.0.2
!
ip route 0.0.0.0 0.0.0.0 hdlc 1
!
```

*NOTE*

The commands `ip firewall nat-preserve-source-port` and `clock source line` are enabled by default. Therefore, these commands will not appear in the output when the `show running-config` command is issued.
A default route directing all traffic from the LAN to the HDLC 1 interface is needed.

NetVanta 3448

interface t1 1/1
  clock source line
  tdm-group 1 timeslots 1-24 speed 64
  no shutdown

interface vlan 1
  ip address 192.168.0.1 255.255.255.0
  access-policy Private
  no shutdown

interface hdlc 1
  ip address 65.162.109.202 255.255.255.252
  ip address 208.61.209.1 255.255.255.248 secondary
  access-policy Public
  no shutdown
  cross-connect 1 t1 1/1 1 hdlc 1

ip access-list standard MATCHALL
  permit any

ip access-list extended WEB-IN
  permit tcp any host 208.61.209.1 eq www

ip access-list extended WEB-OUT
  permit ip host 192.168.0.2 any

ip policy-class Private
  allow list MATCHALL self
  nat source list WEB-OUT address 208.61.209.1 overload
  nat source list MATCHALL interface hdlc 1 overload

ip policy-class Public
nat destination list WEB-IN address 192.168.0.2
!
ip route 0.0.0.0 0.0.0.0 hdlc 1
!

The commands switchport access vlan 1, ip firewall nat-preserve-source-port, and
clock source line are enabled by default. Therefore, these commands will not appear in the
output when the show running-config command is issued.

A default route directing all traffic from the LAN to the HDLC 1 interface is needed.
Example 3: HDLC from Central Corporate to a Branch Office

HDLC can be used across the connection between a central corporate office and a remote branch office. The distance between the two locations is transparent, with clients on the remote LAN operating seamlessly with clients and resources on the corporate LAN. Internet access for the remote office is also funneled through the corporate office and across the HDLC connection. The following configuration example uses private static IP addresses at each end of the HDLC link (10.0.0.1 /30 at corporate and 10.0.0.2 /30 at the branch office). Clocking on the T1 interface is provided by the AOS product at the corporate location. Each LAN is assigned a different subnet (192.168.1.0 /24 at corporate and 192.168.2.0 /24 at the branch office). The remote office is programmed with a default route that points to the HDLC interface. This route ensures that Internet and other traffic destined for the corporate LAN is directed to the proper place. The default route programmed into the corporate AOS product points toward the corporate Internet router connected to the ISP (192.168.1.254 /24). A static route programmed into the corporate router ensures that traffic destined for the remote LAN (192.168.2.0 /24) is directed towards the HDLC interface on the remote router (10.0.0.2 /30).

![An HDLC Connection from Central Corporate to a Branch Office](image_url)
The following configuration applies to Example 3:

**Central Office:**

```plaintext
! interface eth 0/1
   ip address 192.168.1.1 255.255.255.0
   no shutdown
!
interface t1 1/1
   clock source internal
   tdm-group 1 timeslots 1-24 speed 64
   no shutdown
!
interface hdlc 1
   ip address 10.0.0.1 255.255.255.252
   no shutdown
   cross-connect 1 t1 1/1 1 hdlc 1
!
ip route 0.0.0.0 0.0.0.0 192.168.1.254
ip route 192.168.2.0 255.255.255.0 hdlc 1
!
```

**Remote Office:**

```plaintext
!
interface eth 0/1
   ip address 192.168.2.1 255.255.255.0
   no shutdown
!
interface t1 1/1
   clock source line
   tdm-group 1 timeslots 1-24 speed 64
   no shutdown
!
interface hdlc 1
   ip address 10.0.0.2 255.255.255.252
   no shutdown
   cross-connect 1 t1 1/1 1 hdlc 1
!
ip route 0.0.0.0 0.0.0.0 hdlc 1
!
```

The corporate Internet router (192.168.1.254) must be configured with the following routes:

```plaintext
ip route 192.168.2.0 255.255.255.0 192.168.1.1
ip route 10.0.0.0 255.255.255.252 192.168.1.1
```

*NOTE: The command clock source line is enabled by default. Therefore, this command will not appear in the output when the show running-config command is issued.*
Quick Configuration Guide

Table 2. HDLC Configuration Command Summary

<table>
<thead>
<tr>
<th>Step</th>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(config)#interface hdlc &lt;interface id&gt;</td>
<td>Create a virtual HDLC interface.</td>
</tr>
<tr>
<td>2</td>
<td>(config-hdlc 1)#ip address &lt;ip address&gt;</td>
<td>Configure the HDLC interface with a static IP address.</td>
</tr>
<tr>
<td></td>
<td>&lt;subnet mask&gt;</td>
<td></td>
</tr>
<tr>
<td>(or)</td>
<td>(config-hdlc 1)#ip unnumbered &lt;interface&gt;</td>
<td>Configure the HDLC interface as an unnumbered interface.</td>
</tr>
<tr>
<td>3</td>
<td>(config-hdlc 1)#ip address &lt;ip address&gt;</td>
<td>Configure secondary IP addresses on the HDLC interface.</td>
</tr>
<tr>
<td></td>
<td>&lt;subnet mask&gt; secondary</td>
<td></td>
</tr>
<tr>
<td>(Optional)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(config-hdlc 1)#no shutdown</td>
<td>Activate the HDLC interface.</td>
</tr>
<tr>
<td>5</td>
<td>(config-hdlc 1)#cross-connect &lt;number&gt;</td>
<td>Cross connect the physical WAN interface to the virtual HDLC interface.</td>
</tr>
<tr>
<td></td>
<td>&lt;from interface&gt; &lt;group number&gt; &lt;to interface&gt;</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>(config-hdlc 1)#exit</td>
<td>Exit the HDLC Interface Configuration mode.</td>
</tr>
<tr>
<td></td>
<td>(config)#exit</td>
<td>Exit the Configuration mode.</td>
</tr>
<tr>
<td></td>
<td>#copy running-config startup-config</td>
<td>Save the configuration.</td>
</tr>
</tbody>
</table>

Table 3. Additional Settings

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>bridge-group</td>
<td>Assign an interface to a specified bridge group. Any two interfaces may be bridged together.</td>
</tr>
<tr>
<td>description</td>
<td>Add a text description that describes this HDLC interface.</td>
</tr>
<tr>
<td>keepalive</td>
<td>Enable the transmission of keepalive packets on the interface and specify the time interval between transmitted packets.</td>
</tr>
<tr>
<td>mtu</td>
<td>Specify the MTU for this HDLC connection.</td>
</tr>
</tbody>
</table>
Troubleshooting

Network issues observed across an HDLC connection are commonly caused by problems on the physical transmission medium. Therefore, troubleshooting should begin by examining the status of the Layer 1 interface to which the HDLC interface is bound. T1 is the physical layer used for the troubleshooting examples that follow. The output below shows that the physical layer is up and there are no alarms:

```
#show interfaces t1 1/1

 t1 1/1 is UP
  Receiver has no alarms
  T1 coding is B8ZS, framing is ESF
  Clock source is line, FDL type is ANSI
  Line build-out is 0dB
  No remote loopbacks, No network loopbacks
  Acceptance of remote loopback requests enabled
  Tx Alarm Enable: rai
  Last clearing of counters 00:01:08
    loss of frame : 0
    loss of signal : 0
    AIS alarm : 0
    Remote alarm : 0

DS0 Status: 123456789012345678901234
       NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
Status Legend: '-' = DS0 is unallocated
      'N' = DS0 is dedicated (nailed)

Line Status: -- No Alarms --

5 minute input rate 56 bits/sec, 0 packets/sec
5 minute output rate 72 bits/sec, 0 packets/sec
Current Performance Statistics:
  0 Errored Seconds, 0 Bursty Errored Seconds
  0 Severely Errored Seconds, 0 Severely Errored Frame Seconds
  0 Unavailable Seconds, 0 Path Code Violations
  0 Line Code Violations, 0 Controlled Slip Seconds
  0 Line Errored Seconds, 0 Degraded Minutes

TDM group 1, line protocol is UP
Encapsulation HDLC (hdlc 1)
  9 packets input, 522 bytes, 0 no buffer
  0 runts, 0 giants, 0 throttles
  0 input errors, 0 CRC, 0 frame
  0 abort, 0 discards, 0 overruns
  10 packets output, 715 bytes, 0 underruns
```
The statistics listed under the TDM group 1 section all pertain to the HDLC interface. Ideally, all error indicators (runts, giants, throttles, input errors, CRC, frame, abort, discards, overruns, and underruns) should be 0. It is normal to have a few errors if the interface has been active for an extended period of time. A rapidly increasing error value is a good indicator that there are Layer 1 problems on the transmission medium.

If Layer 1 is up and transmitting properly, the next step is to check the status of the HDLC link using the `show interface hdlc` command. The AOS CLI output shows the interface status as UP or DOWN, the local HDLC interface configuration, and the traffic and queuing statistics. This information is vital in identifying the HDLC problem.

Below is sample output of the `show interface hdlc` command. The output shows that interface HDLC 1 is up and transmitting and receiving data with no errors.

```
# show interface hdlc 1

hdlc 1 is UP
Configuration:
  Keep-alive is set (10 sec.)
  IP is configured
    65.162.109.202  255.255.255.252
Link information:
  Receive: bytes=3658, pkts=73, errors=0, broadcast=54
  Transmit: bytes=4763, pkts=74, errors=0, broadcast=55
  5 minute input rate 56 bits/sec, 0 packets/sec
  5 minute output rate 72 bits/sec, 0 packets/sec
  Port BW 1536 Kbps
Queueing method: weighted fair
Output queue: 0/1/460/64/0 (size/highest/max total/threshold/drops)
  Conversations 0/1/256 (active/max active/max total)
  Available Bandwidth 1152 kilobits/sec
  IP is UP     Address=65.162.109.202 Mask=255.255.255.252
                IP MTU=1500, Bandwidth=1536 Kbps
```

If there are no Layer 1 errors and the HDLC interface is DOWN, several settings should be checked:

- Verify the data DSOs on each end of the connection to ensure that they match (for T1 and E1)
- Verify the cross-connect statement to ensure it is present and accurate in the configuration
- Verify that each end of the connection has been setup for HDLC encapsulation