

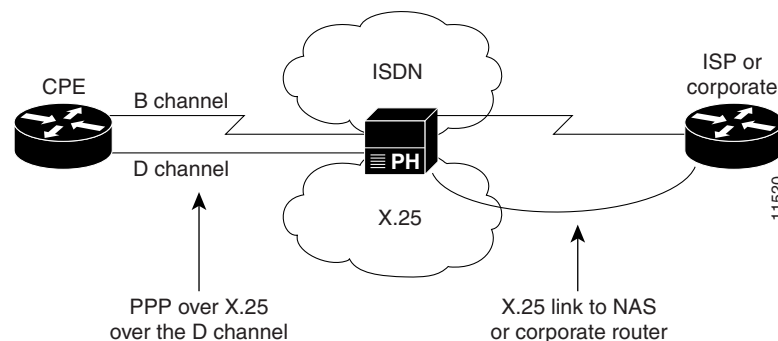
Configuring X.25 on ISDN using Always On/Dynamic ISDN (AO/DI)

Always On/Dynamic ISDN (AO/DI) is an on-demand service that is designed to optimize the use of an existing Integrated Services Digital Network (ISDN) signaling channel (D channel) to transport X.25 traffic. The X.25 D channel call is placed from the subscriber to the packet data service provider. The use of PPP allows protocols to be encapsulated within the X.25 logical circuit carried by the D channel. The bearer channels (B channels) use the Multilink protocol without the standard Q.922 and X.25 encapsulations, and invoke additional bandwidth as needed. Optionally, the Bandwidth Allocation Control Protocol (BACP) and the Bandwidth Allocation Protocol (BAP) can be used to negotiate bandwidth allocation as required.

AO/DI takes full advantage of existing packet handlers at the central office by using an existing D channel to transport the X.25 traffic. The link associated with the X.25 D channel packet connection is used as the primary link of the Multilink bundle. The D channel is a connectionless, packet-oriented link between the Customer Premise Equipment (CPE) and the central office. Since the D channel is always available, it is possible to in turn offer “always available” services. On-demand functionality is achieved by using the B channels to temporarily boost data throughput and are disconnected after use. Figure 315 shows the AO/DI environment and how ISDN and X.25 resources are implemented.

Note On the client side the X.25 SVC can only be terminated on an ISDN D channel; however, on the server side, the SVC can be terminated on an ISDN Basic Rate Interface (BRI) using a D channel, a Primary Rate Interface (PRI) using specific timeslots, or a high-speed serial link.

Figure 315 AO/DI Environment



AO/DI provides the following benefits:

- ISDN telecommuting cost savings. Low-speed, D channel services are typically more cost efficient than the time-based tariffs applied to the B channels, which usually carry user data.

- Reduces the amount of data traffic from service provider voice networks. The D channel X.25 packets are handled at the central office by the X.25 packet handler thereby routing these packets bypassing the switch, which reduces impact on the telephony network.
- Network access server (NAS) cost reductions. AO/DI can reduce service provider NAS costs by increasing port efficiencies. Initial use of the “always on” D channel connection lowers the contention ratio on standard circuit switched dial ports.

How AO/DI Works

AO/DI functionality is based on the following technology modules:

- PPP over X.25 Encapsulation
- Multilink PPP Bundle
- BACP/BAP

PPP over X.25 Encapsulation

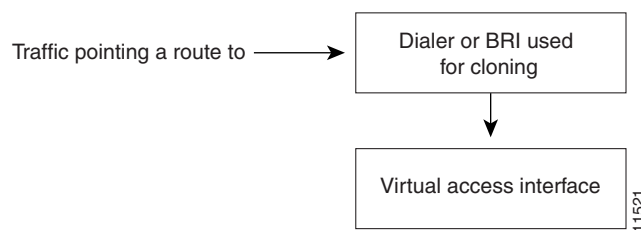
PPP over X.25 is

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omplished through the
following process:

- 1 The X25 map statement on the client side, creates a virtual access interface. A virtual access interface is dynamically created and configured by cloning the configuration from a dialer interface (dialer interface 1, for example).
- 2 The dialer interface goes into “spoofing” mode and stays in this mode until interesting traffic is seen.
- 3 When interesting traffic is seen, the dialer interface activates the virtual access interface, which creates the X.25 SVC. Once the SVC is established, PPP negotiation begins in order to bring up the line protocol. The client will initiate a call to the remote end server, per the **x25 map ppp** command.
- 4 When the AO/DI server receives a call intended for its X.25 map statement, the call is accepted and an event is queued to the X.25 encapsulation manager. The encapsulation manager is an X.25 process that authenticates incoming X.25 calls and AO/DI events, and creates a virtual access interface that clones the configuration from the dialer or BRI interface. Figure 316 shows the virtual interface creation process.

Figure 316 Creating a Virtual Access Interface

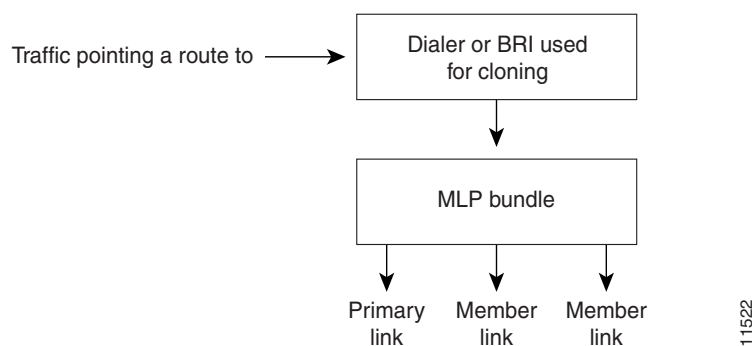


Multilink PPP Bundle

Multilink offers load balancing, packet fragmentation, and the bandwidth allocation functionality that is key to AO/DI structure. The Multilink PPP bundle process is achieved through the following process:

- 1 The **ppp multilink bap** command initiates Multilink PPP and, subsequently, BAP. The virtual access interface that is created above the X.25 virtual circuit (over the D channel) becomes the first member link of the Multilink PPP bundle.
- 2 The **ppp multilink idle-link** command works in conjunction with the **dialer load-threshold** command in order to add additional B channels as needed to boost traffic throughput. When an additional B channel is added, the first member link enters “receive only” mode, allowing the link additions. When the higher throughput is no longer needed, the additional B channels are disconnected and the primary link is the only link in the bundle, it disengages “receive only” mode. The X.25 SVC stays active. Figure 317 shows the MLP bundle sequence.

Figure 317 MLP Bundle Creation Sequence



BACP/BAP

Bandwidth resources are provided by BACP, described in RFC 2125. Once the MLP peers have successfully negotiated BACP, BAP negotiates bandwidth resources in order to support traffic throughput. BAP is a subset of BACP, and it defines the methods and governing rules for adding and removing links from the bundle for MLP. BACP/BAP negotiations are achieved through the following process:

- 1 Once the MLP session is initiated and BACP is negotiated over the MLP bundle, the AO/DI client issues a BAP call request for additional bandwidth.

- 2 The AO/DI server responds with the BAP call response, which contains the phone number of the B channel to add. B channels are added, as needed, to support the demand for increased traffic throughput.
- 3 B channels are disconnected as the traffic load decreases.

AO/DI Terminology

Basic Rate Interface (BRI)—An ISDN interface composed of two B channels and one D channel for circuit-switched communication of voice, video, and data.

bearer channel (B Channel)—A channel that carries data on the ISDN interface.

cloning—A virtual interface created and configured by applying a specific virtual template interface. The template is the source of the generic user information and router-dependent information. The result of cloning is a virtual access interface configured with all the commands in the template.

customer premise equipment (CPE)—Terminating equipment installed at customer sites.

dialer interface—A logical interface that includes settings needed to make calls in order to reach specific remote destinations (subnetworks).

E.164—ITU-T recommendation for international telecommunication numbering, especially in ISDN, BISDN, and SMDS.

Integrated Services Digital Network (ISDN)—Communication protocols offered by telephone companies that permit telephone networks to carry data, voice, and other source traffic.

Multilink PPP (MLP)—A protocol that provides the capability of splitting and recombining packets to a single end system across a logical pipe (also called a bundle) formed by multiple links. Multilink PPP provides bandwidth on demand and reduces transmission latency across WAN links.

Primary Rate Interface (PRI)—An ISDN interface to primary rate access. Primary rate access consists of a single 64-kpbs D channel plus 23 (T1) or 30 (E1) B channels.

signaling channel (D Channel)—A channel used to carry control signals on the ISDN interface.

virtual access interface—A unique virtual interface that is created dynamically and exists temporarily. Virtual access interfaces can be created and configured differently by different applications, such as virtual profiles and virtual private dialup networks.

virtual circuit—A logical circuit created to ensure reliable communication between two network devices. A virtual circuit can be either permanent (a PVC) or switched (an SVC).

X.121—ITU-T standard describing an addressing scheme used in X.25 networks. X.121 addresses are sometimes called International Data Numbers (IDNs).

X.25—An ITU-T standard that defines how connections between DTE and DCE are maintained for remote terminal access and computer communications in public data networks (PDNs). X.25 specifies LAPD, a data-link layer protocol, and PLP, a network layer protocol.

Restrictions

AO/DI supports PPP encapsulation on switched X.25 virtual circuits (VCs) only.

The X.25 encapsulation (per RFC 1356), PPP, BAP, and BACP modules must be present in both the AO/DI client and server.

Prerequisites

AO/DI relies on features from X.25, PPP, and BACP modules and must be configured on both the AO/DI client and server. BAP, if negotiated, is a subset of BACP, which is responsible for bandwidth allocation for the Multilink PPP peers. It is recommended you configure PPP multilink with the BAP option due to the differences between the ISDN (E.164) and X.25 (X.121) numbering formats.

In order to implement AO/DI you must configure the AO/DI client and server for PPP, incorporating BAP and X.25 module commands. This involves configuring the BRI or PRI interfaces with the appropriate X.25 commands and the dialer interfaces with the necessary PPP or BAP commands.

The following tasks are required before you can configure specific commands required to run AO/DI:

- Configure PPP and BAP on the Client
- Configure X.25 Parameters on the Client
- Configure PPP and BAP on the Server
- Configure X.25 Parameters on the Server

Configure PPP and BAP on the Client

Use the following commands in interface configuration mode, to configure PPP and BAP under the dialer interface on the AO/DI client:

Command	Purpose
ppp multilink bap	Enable PPP BACP bandwidth allocation negotiation.
encapsulation ppp	Enable PPP on the interface.
dialer in-band	Enable DDR on the interface.
dialer load-threshold <i>load</i>	Set the dialer load threshold.
dialer-group <i>group-number</i>	Control access to this interface by adding it to a dialer access group.
ppp bap callback accept	Enable the interface to initiate additional links upon peer request (optional).
ppp bap call request	Enable the interface to initiate additional links.
dialer map <i>protocol next-hop-address</i> [name <i>hostname</i>] [spc] [speed 56 64] [broadcast] [modem-script <i>modem-regexp</i>] system-script <i>system-regexp</i>	Enable a serial interface or an ISDN interface to initiate and receive calls, to or from, remote sites.
or	
dialer string <i>dial-string</i> [<i>:isdn-subaddress</i>] dialer string <i>dial-string</i> [class <i>class-name</i>]	Specify the destination string (telephone number) for calling: <ul style="list-style-type: none"> • A single site (using legacy DDR) • Multiple sites (using dialer profiles)

Configure X.25 Parameters on the Client

The AO/DI client interface must be configured to run PPP over X.25. In order to configure the interface for the X.25 parameters, use the following commands in interface configuration mode:

Command	Purpose
x25 address <i>address</i>	Configure the X.25 address.
x25 htc <i>circuit-number</i>	Set the highest two-way circuit number. For X.25 the default is 1024.
x25 win <i>packets</i>	Set the default virtual circuit receive window size. The default is 2 packets. ¹
x25 wout <i>packets</i>	Set the default virtual circuit transmit window size. The default is 2 packets. ¹

1. The default input and output window sizes are typically defined by your network administrator. Cisco IOS- configured window sizes must be set to match that of the network.

For details and usage guidelines for X.25 configuration parameters, refer to Cisco IOS Release 11.3 *Wide-Area Networking Configuration Guide* and *Command Reference*.

Configure PPP and BAP on the Server

Use the following commands in interface configuration mode to configure PPP and BAP under the dialer interface on the AO/DI server:

Command	Purpose
ppp multilink bap	Enable PPP BACP bandwidth allocation negotiation.
encapsulation ppp	Enable PPP on the interface.
dialer in-band	Enable DDR on the interface.
dialer load-threshold <i>load</i>	Set the dialer load threshold.
dialer-group <i>group-number</i>	Control access to this interface by adding it to a dialer access group.
ppp bap call accept	Enable the interface to accept additional links upon peer request.
ppp bap callback request	Enable the interface to initiate additional links (optional).

BAP configuration commands are optional. For information on how to configure BACP/BAP refer to the Cisco IOS Release 11.3 *Dial Solutions Configuration Guide*.

Configure X.25 Parameters on the Server

The AO/DI server BRI, PRI, or serial interface must be configured for the X.25 parameters necessary to run PPP over X.25. Use the following commands in interface configuration mode to configure the interface for X.25 parameters:

Command	Purpose
x25 address <i>address</i>	Configure the X.25 address.
x25 htc <i>circuit-number</i>	Set the highest two-way circuit number. For X.25 the default is 1024.

Command	Purpose
<code>x25 win packets</code>	Set the default virtual circuit receive window size. The default is 2 packets. ¹
<code>x25 wout packets</code>	Set the default virtual circuit transmit window size. The default is 2 packets. ¹

1. The default input and output window sizes are typically defined by your network administrator. Cisco IOS-configured window sizes must be set to match that of the network.

For details and usage guidelines for X.25 configuration parameters, refer to Cisco IOS Release 11.3 *Wide-Area Networking Configuration Guide* and *Command reference*.

AO/DI Configuration Tasks

Once the AO/DI client and server is configured with the necessary PPP, BAP, and X.25 commands, you can configure the routers to perform AO/DI. In order to configure AO/DI, perform the following tasks:

- Configure the AO/DI Client
- Configure the AO/DI Server

Configure the AO/DI Client

To configure AO/DI, you must complete the tasks in the following section. The last task, to define local number peer characteristics, is optional.

- Enable AO/DI on the Interface
- Enable the AO/DI Interface to Initiate Client Calls
- Enable the MLP Bundle to Add Multiple Links
- Modify BACP Default Settings (optional)

Enable AO/DI on the Interface

To enable an interface to run the AO/DI client, use the following command in interface configuration mode:

Command	Purpose
<code>x25 aodi</code>	Enable the AO/DI client on an interface.

Enable the AO/DI Interface to Initiate Client Calls

You must enable the interface to establish a PPP session over the X.25 protocol. The cloning interface will hold the PPP configuration, which will be cloned by the virtual access interface that is created and attached to the X.25 virtual circuit (VC). The cloning interface must also hold the MLP

configuration that is needed to run AO/DI. To add the X.25 map statement that will enable the PPP session over X.25, identify the cloning interface, and configure the interface to initiate AO/DI calls, use the following command in interface configuration mode:

Command	Purpose
x25 map ppp <i>x121-address</i> interface <i>cloning-interface</i>	Enable the interface to initiate a PPP session over the X.25 protocol and remote end mapping.

Enable the MLP Bundle to Add Multiple Links

Once Multilink PPP is enabled and the primary traffic load is reached (based on the **dialer load-threshold** value), the MLP bundle will add additional member links (B channels). The addition of another B channel places the first link member into “receive-only” mode and subsequent links are added, as needed. To configure the dialer interface or BRI interface used for cloning purposes and to place the first link member into receive only mode, use the following command in interface configuration mode:

Command	Purpose
ppp multilink idle-link	Configure the interface to enter “receive-only” mode so that MLP links are added as needed.

Modify BACP Default Settings

During BACP negotiation between peers, the called party indicates the number to call for BACP. This number may be in either a national or subscriber format. A national format indicates that the phone number returned from the server to the client should contain 10 digits. A subscriber number format contains 7 digits. To assign a prefix to the phone number that is to be returned, use the optional command in interface configuration mode:

Command	Purpose
ppp bap number prefix <i>prefix-number</i>	Specify a primary telephone number prefix for a peer to call for PPP BACP negotiation (optional).

Note The **ppp bap number prefix** command is not typically required on the server side, as the server usually does not initiate calls to the client. This command would only be used on the server in a scenario where both sides are configured to act as both client and server.

Configure the AO/DI Server

The AO/DI server will receive calls from the remote end interface running AO/DI client and likewise, must be configured to initiate a PPP session over X.25, allow interface cloning, and be capable of adding additional links to the MLP bundle. The interface configured for AO/DI server relies on the **no-outgoing** option for the **x25 map** command to ensure calls are not originated by the interface. Use the following command to configure the AO/DI server:

- Enable the Interface to Receive AO/DI Client Calls
- Enable the MLP Bundle to Add Multiple Links
- Modify BACP Default Settings (optional)

Enable the Interface to Receive AO/DI Client Calls

Configure the **x25 map** command with the calling client's X.121 address. This enables the AO/DI server interface to run a PPP over X.25 session with the configured client. The **no-outgoing** option must be set in order to ensure calls do not originate from this interface. To configure an interface for AO/DI server, use the following command in interface configuration mode:

Command	Purpose
x25 map ppp <i>x121-address</i> interface <i>cloning-interface</i> no-outgoing	Enable the interface to initiate a PPP session over the X.25 protocol and remote end mapping.

Enable the MLP Bundle to Add Multiple Links

Once Multilink PPP is enabled and the primary traffic load is reached (based on the **dialer load-threshold** value), the MLP bundle will add additional member links (B channels). The addition of another B channel places the first link member into "receive-only" mode and subsequent links are added, as needed. To configure the dialer interface or BRI interface used for cloning purposes and to place the first link member into receive only mode, use the following command in interface configuration mode:

Command	Purpose
ppp multilink idle-link	Configure the interface to enter "receive-only" mode so that MLP links are added as needed.

Modify BACP Default Settings

During BACP negotiation between peers, the called party indicates the number to call for BACP. This number may be in either a national or subscriber format. A national format indicates that the phone number returned from the server to the client should contain 10 digits. A subscriber number format contains 7 digits. To assign a prefix to the phone number that is to be returned, use the optional command in interface configuration mode:

Command	Purpose
ppp bacp number { format national subscriber }	Specify that the primary telephone number for a peer to call is in either a national or subscriber number format (optional).

Note The **ppp bacp number prefix** command is not typically required on the server side, as the server usually does not initiate calls to the client. This command would only be used on the server in a scenario where both sides are configured to act as both client and server.

AO/DI Configuration Examples

This section provides the following configuration examples:

- AO/DI Client Configuration Example
- AO/DI Server Configuration Example

AO/DI Client Configuration Example

The following example shows BRI interface 0 configured with the necessary PPP, multilink, and X.25 commands necessary for the AO/DI client:

```
hostname Router_client
!
ip address-pool local
isdn switch-type basic-5ess
x25 routing
!
interface Ethernet0
 ip address 172.21.71.99 255.255.255.0
!
interface BRI0
 isdn switch-type basic-5ess
 ip address 6.1.1.9 255.0.0.0
 encaps ppp
 dialer in-band
 dialer load-threshold 1 either
 dialer-group 1
 no fair-queue
 ppp authentication chap
 ppp multilink bap
 ppp bap callback accept
 ppp bap call request
 ppp bap number prefix 91
 ppp multilink idle-link
 isdn x25 static-tei 23
 isdn x25 dchannel
 dialer rotary-group 1
!
interface BRI0:0
 no ip address
 x25 address 12135551234
 x25 aodi
 x25 htc 4
 x25 win 3
 x25 wout 3
 x25 map ppp 12135556789 interface bri0
!
dialer-list 1 protocol ip permit
```

AO/DI Server Configuration Example

The following example shows the configuration for the AO/DI server, which is configured to only receive calls from the AO/DI client. The configuration uses the command **x25 aodi**, **x25 map ppp** with the **no-outgoing** option, and **ppp bap number format**, which implements the **national** format.

```
hostname Router_server
!
ip address-pool local
isdn switch-type basic-5ess
x25 routing
!
interface Ethernet0
 ip address 172.21.71.100 255.255.255.0
!
interface BRI0
 isdn switch-type basic-5ess
 ip address 6.1.1.10 255.0.0.0
 encaps ppp
 dialer in-band
```

```
no fair-queue
dialer load-threshold 1 either
dialer-group 1
ppp authentication pap
ppp multilink bap
ppp multilink idle-link
ppp bap number default 2135550904
ppp bap number format national
ppp bap call accept
ppp bap timeout pending 20
isdn x25 static-tei 23
isdn x25 dchannel
dialer rotary-group 1
!
interface BRI0:0
no ip address
x25 address 12135556789
x25 htc 4
x25 win 3
x25 wout 3
x25 map ppp 12135551234 interface bri0 no-outgoing
!!
dialer-list 1 protocol ip permit
```

