Configuring IP Routing

This chapter covers these topics:

Introduction to IP routing and interfaces

This chapter describes the following areas of IP routing configuration:

- Local IP network setup

  The Ethernet profile defines the MAX unit's Ethernet IP interface, as well as network services such as DNS, dynamic address assignment for PPP callers, and routing policies. See "Configuring the local IP network setup" .

- WAN IP interfaces

  Connection profiles (or similar profiles on an external authentication server) define a destination across a WAN interface and add a route to the routing table.

- IP routing table

  The IP routing table determines where IP packets are forwarded and which connections are brought up. See "Configuring IP routes and preferences" for details.

IP addresses and netmasks

In the MAX, IP addresses are specified in dotted decimal format (not hexadecimal). If no netmask is specified, the MAX assumes a default netmask based on address "class".

Table 9-1. *IP address classes and default netmasks*

Class	Address range	Network bits
Class A	0.0.0.0 - 127.255.255.255	8
Class B	128.0.0.0 - 191.255.255.255	16
Class C	192.0.0.0 - 223.255.255.255	24

For example, a class C address such as 198.5.248.40 has 24 network bits, which leaves 8 bits for the host portion of the address. So, up to 253 hosts can be supported on one class C network.

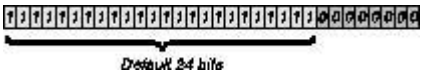

Figure 9-1. *A class C IP address*

To specify a netmask, the MAX includes a netmask modifier that specifies the total number of network bits in the address. For example:

```
ip-address = 198.5.248.40/29
```

In the example address shown above, the /29 specification indicates that 29 bits of the address will be used to specify the network. This is commonly referred to as a 29-bit subnet. The three remaining bits are used to specify unique hosts.

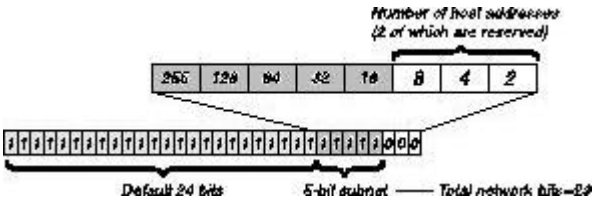

Figure 9-2. *A 29-bit netmask and number of supported hosts*

Eight bit-combinations are possible in 3 bits. Of those 8 possible host addresses, 2 are reserved:

000 - Reserved for the network (base address)
001
010
100
110
101
011
111 - Reserved for the broadcast address of the subnet

Note: Early implementations of TCP/IP did not allow zero subnets. That is, subnets could have the

same base address that a class A, B, or C network would have. For example, the subnet 192.168.8.0/30 was illegal because it had the same base address as the class C network 192.168.8.0/24, while 192.168.8.4/30 was legal. (192.168.8.0/30 is called a zero subnet, because like a class C base address, its last octet is zero.) Modern implementations of TCP/IP allow subnets to have base addresses that might be identical to the class A, B, or C base addresses. Ascend's implementations of RIP 2 and OSPF treat these so-called zero subnetworks the same as any other network. However, it is important that you treat zero subnets consistently throughout your network. Otherwise, you will encounter routing problems!

Table 9-2 shows how the standard subnet address format relates to Ascend notation for a class C network number.

Table 9-2. *Standard netmasks and Ascend netmask notation*

Netmask	Number of host addresses	Ascend notation
255.255.255.0	254 hosts + 1 broadcast, 1 network base	/24
255.255.255.128	126 hosts + 1 broadcast, 1 network base	/25
255.255.255.192	62 hosts + 1 broadcast, 1 network base	/26
255.255.255.224	30 hosts + 1 broadcast, 1 network base	/27
255.255.255.240	14 hosts + 1 broadcast, 1 network base	/28
255.255.255.248	6 hosts + 1 broadcast, 1 network base	/29
255.255.255.252	2 hosts + 1 broadcast, 1 network base	/30
255.255.255.254	invalid netmask (no hosts)	/31
255.255.255.255	1 host - a host route	/32

The broadcast address of any subnet is specified by setting the host portion of the IP address to all ones. The network address (or base address) represents the network itself, because the host portion of the IP address is all zeros. For example, if the MAX configuration assigns this address to a remote router:

```
198.5.248.120/29
```

The Ethernet attached to that router has the following address range:

```
198.5.248.120 - 198.5.248.127
```

Note: A host route is a special case IP address with a subnet mask of /32; for example, 198.5.248.40/32. Host routes are required for a dial-in host.

IP routes

At system startup, the MAX builds an IP routing table that contains configured routes. When the system is up, it may use routing protocols such as RIP or OSPF to learn additional routes dynamically.

For each route, the Destination field specifies a destination network address that may appear in IP packets, and the Gateway field specifies the address of the next-hop router to reach that destination.

How the MAX uses the routing table

The MAX relies on the routing table to forward IP packets.

- If the MAX finds a routing table entry whose Destination field matches the destination address in a packet, it routes the packet to the specified next-hop router, bringing up a WAN connection if necessary.
- If the MAX does not find a matching entry, it looks for the Default route, which is indicated in the routing table with a destination 0.0.0.0. If that route has a specified next-hop router, it forwards the packet to that router.
- If the MAX does not find a matching entry or does not have a valid Default route, it drops the packet.

Static and dynamic routes

A static route is a manually configured path from one network to another, which specifies the destination network and the gateway (router) to use to get to that network.

- Each Static Rtes profile specifies one static route. If a path to a destination must be reliable, the administrator often configures more than one path (a secondary route), in which case the MAX chooses the route based on assigned metrics and availability.
- The Ethernet>Mod Config profile specifies a static connected route, which states "to reach system-A, send packets out this interface to system-A." Connected routes are low cost, because no remote connection is involved.
- Each IP-routing Connection profile specifies a static route that states "to reach system-A, send packets out this interface to system-B," where system-B is another router.

A dynamic route is a path to another network that is "learned" dynamically rather than configured in a profile. Routers that use RIP broadcast their entire routing table every 30 seconds, updating other routers about which routes are usable. Hosts that run ICMP can also send ICMP Redirects to offer a better path to a destination network. OSPF routers propagate link-state changes as they occur. Routing protocols such as RIP and OSPF all use some mechanism to propagate routing information and changes to the routing environment.

Route preferences and metrics

RIP is a distance-vector protocol, which uses a virtual hop count to select the shortest route to a destination network. OSPF is a link-state protocol, which means that OSPF can take into account a variety of link conditions, such as the reliability or speed of the link, when determining the best path to a destination network. Because these two metrics are incompatible, the MAX supports route preferences.

When choosing which routes should be put in the routing table, the router first compares preference values, preferring the lower number. If the preference values are equal, then the router compares the metric field, using the route with the lower metric.

- Connected routes have a default preference of 0
- OSPF routes have a default preference of 10

- ICMP redirects have a default preference of 30
- RIP routes have a default preference of 100
- Static routes have a default preference of 100
- ATMP routes have a default preference of 100

IP interfaces

The MAX must have at least one system-based IP interface (on Ethernet) to support IP routing. It also creates several internal interfaces at system startup.

MAX IP interfaces

At system startup, the MAX creates its Ethernet and internal IP interfaces. When the system is up, it adds IP interfaces as they are created. For each IP interface that is not configured as a private route, the MAX also adds a route to the routing table at system startup.

- The Ethernet IP interface is always active, because it is always connected.

  The Ethernet interface label is ie0. Its IP address is assigned in Ethernet>Mod Config>Ether Options.

- The loopback (lo0) interface is always up.

  The loopback address is 127.0.0.1/32.

- The reject (rj0) interface is always up.

  The reject address is 127.0.0.2. Packets routed to this interface are sent back to the source address with an ICMP "host unreachable" message.

- The black-hole (bh0) interface is always up.

  The black-hole address is 127.0.0.3. Packets routed to this interface are discarded silently.

- The inactive interface is where all routes point when their WAN connections are down.

  The inactive interface label is wanidle0.

WAN IP interfaces

WAN interfaces are created as they are brought up. WAN interfaces are labeled wanN, where N is a number assigned in the order in which the interfaces become active. The WAN IP address may be a local address assigned dynamically when the caller logs in, an address on a subnet of the local network, or a unique IP network address for a remote device.

Numbered interfaces

The MAX can operate as a both a system-based router and interface-based router. Some applications require numbered interfaces, and some sites use them for trouble-shooting leased point-to-point connections and forcing routing decisions between two links going to the same final destination. More

generally, interface-based routing allows the MAX to operate more nearly the way a multi-homed Internet host behaves.

Interface-based routing means that in addition to the system-wide IP configuration, the MAX and the far end of the link have link-specific IP addresses, which are specified in these parameters:

- Connections>IP Options>IF Adrs (the link-specific address for the MAX)
- Connections>IP Options>WAN Alias (the far end link-specific address)

It is also permissible to omit the remote side's system-based IP address from the Connection profile and use interface-based routing exclusively. This is an appropriate mechanism, for example, if the remote system is on a backbone net which may be periodically reconfigured by its administrators, and you want to refer to the remote system only by its mutually agreed-upon interface address. In this case, the link-specific IP addresses are specified in these parameters:

- Connections>IP Options>IF Adrs (the near end numbered interface)
- Connections>IP Options>LAN Adrs (the far end numbered interface)

Note that LAN Adrs must always be filled in, so if the only known address is the interface address, it must be placed in the Lan Adrs parameter rather than the WAN Alias parameter. In this case, a host route is created to the LAN Adrs (interface) address, a net route is created to the subnet of the remote interface, and incoming calls must report their IP addresses as the LAN Adrs address.

It is also possible, although not recommended, to specify the local numbered interface (IF Adrs) and use the far end device's system-wide IP address (LAN Adrs). In this case, the remote interface must have an address on the same subnet as the local, numbered interface.

If a MAX is using a numbered interface, the following differences in operation should be noted, compared to unnumbered (system-based) routing:

- IP packets generated in the MAX and sent to the remote address will have an IP source address corresponding to the numbered interface, not the system-wide (Ethernet) address.
- During authentication of an outbound call using a numbered interface, the MAX reports the address of the interface as its IP address.
- The MAX adds all numbered interfaces to its routing table as host routes.
- The MAX accepts IP packets addressed to the a numbered interface, considering them to be destined for the MAX itself. (The packet may actually arrive over any interface, and the numbered interface corresponding to the packet's destination address need not be active.)

Configuring the local IP network setup

The Ethernet profile configures system-global parameters that affect all IP interfaces in the MAX. These are the related parameters:

```
Ethernet
      Mod Config
            Ether options
                  IP Adrs=10.2.3.1/24
                  2nd Adrs=0.0.0.0/0
```

```
        RIP=Off
        Ignore Def Rt=Yes
        Proxy Mode=Off

  WAN options...
        Pool#1 start=100.1.2.3
        Pool#1 count=128
        Pool#2 start=0.0.0.0
        Pool#2 count=0
        Pool#3 start=10.2.3.4
        Pool#3 count=254
        Pool#4 start=0.0.0.0
        Pool#4 count=0
        Pool#5 start=0.0.0.0
        Pool#5 count=0
        Pool#6 start=0.0.0.0
        Pool#6 count=0
        Pool#7 start=0.0.0.0
        Pool#7 count=0
        Pool#8 start=0.0.0.0
        Pool#8 count=0
        Pool#9 start=0.0.0.0
        Pool#9 count=0
        Pool#A start=0.0.0.0
        Pool#A count=0
        Pool only=No
        Pool Summary=No

  Shared Prof=No
  Telnet PW=Ascend

  BOOTP Relay...
        BOOTP Relay Enable=No
        Server=N/A
        Server=N/A

  DNS...
        Domain Name=abc.com
        Sec Domain Name=
        Pri DNS=10.65.212.10
        Sec DNS=12.20 7.23.51
        Allow As Client DNS=Yes
        Pri WINS=0.0.0.0
        Sec WINS=0.0.0.0
        List Attempt=No
        List Size=N/A
        Client Pri DNS=0.0.0.0
        Client Sec DNS=0.0.0.0

  SNTP Server...
        SNTP Enabled=Yes
        Time zone-UTC+0000
        SNTP host#1=0.0.0.0
        SNTP host#2=0.0.0.0
        SNTP host#3=0.0.0.0

  UDP Cksum=No
  Adv Dialout Routes=Always
```

For details on each parameter, see the MAX Reference Guide.

Understanding the IP network parameters

This section provides some background information on the IP network configuration. These parameters are divided into areas of functionality in the subsections below.

- The MAX unit's local IP address

  The IP Adrs parameter specifies the MAX unit's IP address on the local Ethernet. It may be a subnet or network (class) address. This is a required setting for the MAX to operate as an IP router.

- A second IP address for the Ethernet interface

  The MAX can assign two unique IP addresses to its single physical Ethernet port and route between them-a feature referred to as "dual IP." This gives the MAX a logical interface on two networks or subnets on the same backbone.

  Usually, devices connected to the same physical wire all belong to the same IP network. With dual IP, a single wire can support two separate IP networks, with devices on the wire assigned to one network or the other and communicating by routing through the MAX.

  Dual IP is also used to distribute the load of routing traffic to a large subnet by assigning IP addresses on that subnet to two or more routers on the backbone. When the routers have a direct connection to the subnet as well as to the backbone network, they route packets to that subnet and include the route in their routing table updates.

  Dual IP also allows you to make a smooth transition when changing IP addresses. That is, a second IP address can act as a placeholder while you are making the transition in other network equipment.

- Enabling RIP on the Ethernet interface

  You can configure an IP interface to send RIP updates (informing other local routers of its routes), receive RIP updates (learning about networks that can be reached via other routers on the Ethernet), or both.

  Note: Ascend recommends that you run RIP version 2 (RIP-v2) if possible. Ascend does not recommend running RIP-v2 and RIP-v1 on the same network in such a way that the routers receive each other's advertisements. RIP-v1 does not propagate subnet mask information, and the default class network mask is assumed, while RIP-v2 handles subnet masks explicitly. Running the two versions on the same network can result in RIP-v1 "guesses" overriding accurate subnet information obtained via RIP-v2.

- Ignoring the default route

  You can configure the MAX to ignore default routes advertised by routing protocols. This configuration is recommended, because you typically do not want the default route to be changed by a RIP update. The default route specifies a static route to another IP router, which is often a local router such as a Cisco router or another kind of LAN router. When the MAX is configured to ignore the default route, RIP updates will not modify the default route in the MAX routing table.

- Proxy ARP and inverse ARP

  The MAX can be configured to respond to ARP requests for remote devices that have been assigned an address dynamically. It responds to the ARP request with its own MAC address while bringing up the connection to the remote device. This feature is referred to as Proxy ARP (see "Understanding the IP network parameters").

The MAX also supports Inverse Address Resolution Protocol (Inverse ARP). Inverse ARP allows the MAX to resolve the protocol address of another device when the hardware address is known. The MAX does not issue any Inverse ARP requests, but it does respond to Inverse ARP requests that have the protocol type of IP (0x8000) or in which the hardware address type is the 2 byte Q.922 address (Frame Relay). All other types are discarded. The Inverse ARP response packet sent by the MAX has the following information:

- ARP source protocol address is the MAX unit's IP address on Ethernet.
- ARP source hardware address is the Q.922 address of the local DLCI.

See RFCs 1293 and 1490 for details on Inverse ARP.

- Specifying address pools

  You can define up to 10 address pools in the Ethernet profile, with each pool supporting up to 254 addresses. The Pool#N start parameter specifies the first address in a block of contiguous addresses on the local network or subnet. The Pool#N count parameter specifies how many addresses are in the pool (up to 255). Addresses in a pool do not accept a netmask modifier, because they are advertised as host routes. If you allocate IP addresses on a separate IP network or subnet, make sure you inform other IP routers about the route to that network or subnet, either by statically configuring those routes or configuring the MAX to dynamically send updates.

- Forcing callers configured for a pool address to accept the dynamic assignment

  During PPP negotiation, a caller may reject the IP address offered by the MAX and present its own IP address for consideration. Connection profiles compare IP addresses as part of authentication, so the MAX would automatically reject such a request if the caller has a Connection profile. However, Name-password profiles have no such authentication mechanism, and could potentially allow a caller to spoof a local address. The Pool Only parameter instructs the MAX to hang up if a caller rejects the dynamic assignment.

- Summarizing host routes in routing table advertisements

  IP addresses assigned dynamically from a pool are added to the routing table as individual host routes. You can summarize this network (the entire pool), cutting down significantly on route flappage and the size of routing table advertisements.

  Pool Summary indicates the route summarization is in use; that is, a series of host routes will be summarized into a network route advertisement. Packets destined for a valid host address on that network are routed to the host, and packets destined for an invalid host address are rejected with an ICMP "host unreachable" message.

  To use the pool summary feature, create a network-aligned pool and set the Pool Summary parameter to Yes. To be network-aligned, the Pool Start address must be the first host address. Subtract one from the Pool Start address to determine the network address (the zero address on the subnet). Since the first and last address of a subnet are reserved, you must set the Pool Count to a value that is 2 less than a power of 2. For example, you may use values 2, 6, 14, 30, 62, 126 or 253. The netmask will be deduced from a value that is 2 greater than Pool Count. For example, with this configuration:

```
Pool Summary=Yes
Pool#1 start=10.12.253.1
Pool#1 count=126
```

The network alignment address is Pool Start address -1: 10.12.253.0 and the netmask is Pool Count +2 addresses: 255.255.255.128. The resulting address pool network is:

```
10.12.253.0/25
```

For an example configuration that shows route summarization, see "Configuring DNS" .

- Sharing Connection profiles

  The Shared Prof parameter specifies whether the MAX will allow more than one incoming call to share the same Connection profile. This feature is related to IP routing because sharing profiles cannot result in two IP addresses reached through the same profile.

  In low-security situations, more than one dial-in user can share a name and password for accessing the local network. This would require sharing a single Connection profile that specifies bridging only, or dynamic IP address assignment. Each call would be a separate connection. The name and password would be shared, and a separate IP address would be assigned dynamically to each caller.

  If a shared profile uses an IP address, it must be assigned dynamically, because multiple hosts cannot share a single IP address.

- Telnet password

  The Telnet password is required from all users attempting to access the MAX unit via Telnet. Users are allowed three tries to enter the correct password, after which the connection attempt fails.

- BOOTP relay

  By default, a MAX does not relay BOOTP (Bootstrap Protocol) requests to other networks. If BOOTP is enabled, the MAX can relay BOOTP requests to another network. However, SLIP BOOTP must be disabled in Ethernet>Mod Config>TServ Options. SLIP BOOTP makes it possible for a computer connecting to the MAX over a SLIP connection to use the Bootstrap Protocol. A MAX can support BOOTP on only one connection. If both SLIP BOOTP and BOOTP relay are enabled, you will receive an error message.

  You can specify the IP address of one or two BOOTP servers. You are not required to specify a second BOOTP server.

  Note: If you specify two BOOTP servers, the MAX that relays the BOOTP request determines when each server is used. The order of the BOOTP servers in the BOOTP Relay menu does not necessarily determine which server is tried first.

- Local domain name

  The Domain Name is used for DNS lookups. When the MAX is given a hostname to look up, it tries various combinations including appending the configured domain name. The secondary domain name (Sec Domain Name) can specify another domain name that the MAX can search using DNS. The MAX searches the secondary domain only after the domain specified in the

Domain Name parameter.

- DNS or WINS name servers

  When the MAX is informed about DNS (or WINS), Telnet and Rlogin users can specify hostnames instead of IP addresses. If you configure a primary and secondary name server, the secondary server is accessed only if the primary one is inaccessible.

- DNS lists

  DNS can return multiple addresses for a hostname in response to a DNS query, but it does not include information about availability of those hosts. Users typically attempt to access the first address in the list. If that host is unavailable, the user must try the next host, and so forth. However, if the access attempt occurs automatically as part of immediate services, the physical connection is torn down when the initial connection fails. To avoid tearing down physical links when a host is unavailable, you can use the List Attempt parameter to enable the user to try one entry in the DNS list of hosts, and if that connection fails, to try the next entry, and so on, without losing the WAN session. The List Size parameter specifies the maximum number of hosts listed (up to 35).

- Client DNS

  Client DNS configurations define DNS server addresses that will be presented to WAN connections during IPCP negotiation. They provide a way to protect your local DNS information from WAN users. Client DNS has two levels: a global configuration that applies to all PPP connections (defined in the Ethernet profile), and a connection-specific configuration that applies only to the WAN connection defined in the Connection profile. The global client addresses are used only if none are specified in the Connection profile.

- SNTP service

  The MAX can use SNTP (Simple Network Time Protocol-RFC 1305) to set and maintain its system time by communicating with an SNTP server. SNTP must be enabled for the MAX to communicate using that protocol. In addition, you must specify your time zone as an offset from the UTC (Universal Time Configuration). UTC is in the same time zone as Greenwich Mean Time (GMT), and the offset is specified in hours using a 24-hour clock. Because some time zones, such as Newfoundland, cannot use an even hour boundary, the offset includes four digits and is stated in half-hour increments. For example, in Newfoundland the time is 1.5 hours ahead of UTC, which is represented as follows:

  ```
  UTC +0130
  ```

  For San Francisco, which is 8 hours ahead of UTC:

  ```
  UTC +0800
  ```

  For Frankfurt, which is 1 hour behind UTC:

  ```
  UTC -0100
  ```

- Specifying SNTP server addresses

  The host parameter lets you specify up to three server addresses. The MAX will attempt to communicate with the first address. It will attempt the second only if the first is inaccessible,

and the third only if the second is inaccessible.

- UDP checksums

  If data integrity is of the highest concern for your network and having redundant checks is important, you can turn on UDP checksums to generate a checksum whenever a UDP packet is transmitted. UDP packets are transmitted for queries and responses related to ATMP, SYSLOG, DNS, ECHOSERV, RADIUS, TACACS, RIP, SNTP, and TFTP.

  Note: Setting UDP checksums to Yes could cause a slight decrease in performance, but in most environments the decrease is not noticeable.

- Poisoning dialout routes in a redundant configuration

  If you have another Ascend unit backing up the MAX in a redundant configuration on the same network, you can use the Adv Dialout Routes parameter to instruct the MAX to stop advertising IP routes that use dial services if its trunks are in the alarm condition. Otherwise, it continues to advertise its dialout routes, which prevents the redundant unit from taking over the routing responsibility.

Example IP network configurations

This section shows some example Ethernet profile IP configurations. For a more complete example that shows an Ethernet profile, Route profile, and Connection profile configuration that work together, see "Configuring DNS" .

Configuring the MAX IP interface on a subnet

On a large corporate backbone, many sites configure subnets to increase the network address space, segment a complex network, and control routing in the local environment. For example, suppose the main backbone IP network is 10.0.0.0, and supports a Cisco router at 10.0.0.17.

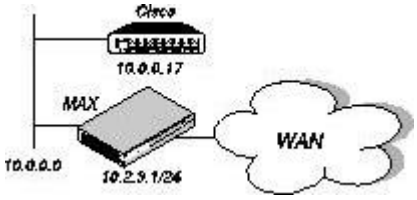

Figure 9-3. *Creating a subnet for the MAX*

You can place the MAX on a subnet of that network by entering a subnet mask in its IP address specification, for example:

1. Open Ethernet>Mod Config>Ether Options.
2. Specify the IP subnet address for the MAX on Ethernet. For example:

```
Ethernet
      Mod Config
            Ether options
                  IP Adrs=10.2.3.1/24
```

3. Configure the MAX to receive RIP updates from the local Cisco router (optional).

```
                  RIP=Recv=v2
```

4. Close the Ethernet profile.

With this subnet address, the MAX requires a static route to the backbone router on the main network; otherwise, it can only communicate with devices on the subnets to which it is directly connected. To create the static route and make the backbone router the default route:

1. Open the Default IP Route profile.

2. Specify the IP address of a backbone router in the Gateway parameter. For example:

```
Ethernet
      Static Rtes
            Name=Default
            Active=Yes
            Dest=0.0.0.0/0
            Gateway=10.0.0.17
            Metric=1
            Preference=100
            Private=Yes
```

3. Close the Default IP Route profile.

See "Configuring IP routes and preferences" for more information about IP Route profiles. To verify that the MAX is up on the local network, invoke the terminal server interface and enter the Ping command to a local IP address or hostname. For example:

```
ascend% ping 10.1.2.3
```

You can terminate the Ping exchange at any time by typing Ctrl-C.

Configuring DNS

The DNS configuration enables the MAX to use local DNS or WINS servers for lookups. In this example DNS configuration, client DNS is not in use. Note that you can protect your DNS servers from callers by defining connection-specific ("client") DNS servers and specifying that Connection profiles use those client servers. To configure the local DNS service:

1. Open Ethernet>Mod Config>DNS.

2. Specify the local domain name.

3. If appropriate, specify a secondary domain name.

4. Specify the IP addresses of a primary and secondary DNS server, and turn on the DNS list attempt feature.

```
Ethernet
      Mod Config
            DNS...
                  Domain Name=abc.com
                  Sec Domain Name=
                  Pri DNS=10.65.212.10
                  Sec DNS=12.20 7.23.51
                  Allow As Client DNS=Yes
                  Pri WINS=0.0.0.0
                  Sec WINS=0.0.0.0
                  List Attempt=Yes
```

```
List Size=35
Client Pri DNS=0.0.0.0
Client Sec DNS=0.0.0.0
```

5. Close the Ethernet profile.

Setting up address pools with route summarization

The address pool parameters enable the MAX to assign an IP address to incoming calls that are configured for dynamic assignment. These addresses are assigned on a first-come first-served basis. After a connection has been terminated, its address is freed up and returned to the pool for reassignment to another connection. Figure 9-4 shows a host using PPP dial-in software to connect to the MAX.

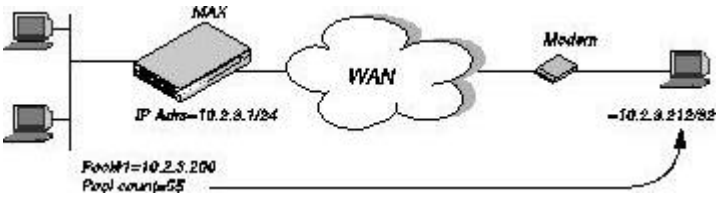

Figure 9-4. *Address assigned dynamically from a pool*

This example shows how to set up network-aligned address pools and use route summarization. It also shows how to enter a static route for the pool subnet and make Connection profile route private, which are requirements when using route summarization.

These are the rules for network-aligned address pools:

- The Pool Count must be two less than the total number of addresses in the pool.

  Add two to Pool Count for the total number of addresses in the subnet, and calculate the netmask for the subnet based on this total.

- The Pool Start address must be the first host address.

  Subtract 1 from the Pool Start address for the base address for the subnet.

For example, the following configuration is network aligned:

```
Ethernet
      Mod Config
            WAN options...
                  Pool#1 start=10.12.253.1
                  Pool#1 count=62
                  Pool Summary=Yes
```

Pool Start is set to 10.12.253.1. When you subtract one from this address, you get 10.12.253.0, which is a valid base address for the 255.255.255.192 netmask. Note that 10.12.253.64, 10.12.253.128, and 10.12.253.192 are also valid zero addresses for the same netmask. The resulting address pool network is 10.12.253.0/26.

Pool Count is set to 62. When you add two to the Pool Count, you get 64. The netmask for 64 addresses is 255.255.255.192 (256-64 = 192). The Ascend subnet notation for a 255.255.255.192 netmask is /26.

After verifying that *every one* of the configured address pools is network-aligned, you must enter a static route for them. These static routes handle all IP address that have not been given to users by routing them to the reject interface or the blackhole interface. (See "MAX IP interfaces" .)

Note: The MAX creates a host route for every assigned address from the pools and host routes override subnet routes. So, packets whose destination matches an assigned IP address from the pool are properly routed and not discarded or bounced. Because the MAX advertises the entire pool as a route, and only privately knows which IP addresses in the pool are active, a remote network might improperly send the MAX a packet to an inactive IP address. Depending on the static route specification, these packets are either bounced with an ICMP unreachable or silently discarded.

For example, the following static route specifies the blackhole interface, so it silently discards all packets whose destination falls in the pool's subnet. In addition to the Dest and Gateway parameters that define the pool, be sure you have set the Metric, Preference, Cost, and Private parameters as shown.

```
Ethernet
      Static Rtes
            Name=pool-net
            Active=Yes
            Dest=10.12.253.0/26
            Gateway=127.0.0.3
            Metric=0
            Preference=0
            Cost=0
            Private=No
```

The routing table will contain the following lines:

```
Destination         Gateway    IF      Flg       Pref   Met     Use    Age

10.12.253.0/26      -          bh0     C         0      0       0   172162

127.0.0.1/32        -          lo0     CP        0      0       0   172163

127.0.0.2/32        -          rj0     CP        0      0       0   172163

127.0.0.3/32        -          bh0     CP        0      0       0   172163
```

When you configure Connection profiles that assign IP addresses from the pool, make sure the Private parameter is set to Yes. For example:

```
Ethernet
      Connections
            Ip options...
                  LAN Adrs=0.0.0.0/0
                  WAN Alias=0.0.0.0
                  IF Adrs=0.0.0.0/0
                  Preference=100
                  Cost=0
                  Private=Yes
                  RIP=Off
                  Pool=1
```

Configuring IP routing connections

When IP routing is enabled and addresses are specified in a Connection profile, it defines an IP WAN interface. These are the related options:

```
Ethernet
      Answer
```

```
                Assign Adrs=Yes
                PPP options...
                      Route IP=Yes

                Session options...
                      RIP=Off

    Ethernet
          Connections
                Station=remote-device

                Route IP=Yes
                IP options...
                      LAN Adrs=0.0.0.0/0
                      WAN Alias=0.0.0.0/0
                      IF Adrs=0.0.0.0/0
                      Metric=7
                      Preference=100
                      Private=No
                      RIP=Off
                      Pool=0

                Session options...
                      IP Direct=0.0.0.0
```

For details on each parameter, see the MAX Reference Guide.

Understanding the IP routing connection parameters

This section provides some background information about enabling IP routing in the Answer profile and Connection profiles.

- Enabling dynamic address assignment for answered calls

  Assign Adrs must be set to Yes in the Answer profile to enable the MAX to allocate IP addresses dynamically from a pool of designated addresses on the local network. The caller's PPP software must be configured to accept an address dynamically. If the Pools Only parameter is set to Yes in the Ethernet profile, the MAX terminates connections that reject the assigned address during PPP negotiation. See "Configuring dynamic address assignment to a dial-in host" for related information.

- Enabling IP routing for WAN connections

  Route IP in Answer>PPP Options must be set to Yes to enable the MAX to negotiate a routing connection.

- Enabling IP routing for a WAN interface

  To enable IP packets to be routed for this connection, set the Route IP parameter to Yes in the Connection profile. When IP routing is enabled, IP packets are always routed, they are never bridged.

- Configuring the remote IP address

  The LAN parameter specifies the IP address of the remote device. Before accepting a call from the far end, the MAX matches this address to the source IP address presented by the calling device. It may be one of the following values:

  - IP address of a router

If the remote device is an IP router, specify its address including its netmask modifier. (See "IP addresses and netmasks" for background information.) If you omit the netmask, the MAX inserts a default netmask which makes the entire far-end network accessible.

- IP address of a dial-in host

  If the remote device is a dial-in host running PPP software, specify its address including a netmask modifier of /32; for example, 10.2.3.4/32.

- The null address (0.0.0.0)

  If the remote device is a dial-in host that will accept dynamic address assignment, leave the remote-address parameter blank.

Note: The most common cause of trouble in initially establishing an IP connection is incorrect configuration of the IP address or subnet specification for the remote host or calling device.

- A WAN alias

  This is another IP address for the remote device, used for numbered interface routing. The WAN Alias will be listed in the routing table as a gateway (next hop) to the Lan Adrs. The caller must be using a numbered interface, and its interface address must agree with the WAN Alias setting.

- Specifying a local IP interface address

  This is another local IP interface address, to be used as the local numbered interface instead of the default (the Ethernet IP Adrs).

- Metrics and preferences

  Connection profiles often represent switched connections, which have an initial cost that can be avoided if a nailed-up link to the same destination can be used. To favor nailed-up links, you can assign a higher metric to switched connections than any of the nailed-up links that can go to the same place.

  Each connection represents a static route, which has a default preference of 100. (See "Route preferences and metrics" .) For each connection, you can fine-tune the route preference and assign a different preference.

- Private routes

  The Private parameter specifies whether the MAX will disclose the existence of this route when queried by RIP or another routing protocol. Private routes are used internally but are not advertised.

- Assigning the IP address dynamically

  The Pool parameter specifies an IP address pool from which the caller will be assigned an IP address. If the Pool parameter is null but all other configuration settings enable dynamic assignment, the MAX gets IP addresses from the first defined address pool. See "Configuring DNS" .

- IP direct configuration

  An IP Direct configuration bypasses routing and bridging tables for all incoming packets and sends each packet received to the specified IP address. All outgoing packets are treated as normal IP traffic. They are not affected by the IP Direct configuration.

  Note: IP Direct connections are typically configured with RIP turned off. If you set the IP Direct configuration with RIP set to receive, all RIP updates will be forwarded to the specified address. This is typically not desirable since RIP updates are designed to be stored locally by the IP router (the MAX, in this case).

- Configuring RIP on this interface

  You can configure an IP interface to send RIP updates (informing other routers on that interface of its routes), receive RIP updates (learning about distant networks from other routers on that interface), or both.

  Ascend recommends that you run RIP version 2 (RIP-v2) if possible. Ascend does not recommend running RIP-v2 and RIP-v1 on the same network in such a way that the routers receive each other's advertisements. RIP-v1 does not propagate subnet mask information, and the default class network mask is assumed, while RIP-v2 handles subnet masks explicitly. Running the two versions on the same network can result in RIP-v1 "guesses" overriding accurate subnet information obtained via RIP-v2.

Checking remote host requirements

IP hosts, such as UNIX systems, Windows or OS/2 PCs, or Macintosh systems, must have appropriately configured TCP/IP software. A remote host calling into the local IP network must also have PPP software.

- UNIX

  UNIX systems typically include a TCP/IP stack, DNS software, and other software, files, and utilities used for Internet communication. UNIX network administration documentation describes how to configure these programs and files.

- PC-compatibles

  PCs running Windows or OS/2 need the TCP/IP networking software. The software is included with Windows 95, but the user may need to purchase and install it separately if the computer has a previous version of Windows or OS/2.

- Macintosh

  Macintosh computers need MacTCP or Open Transport software for TCP/IP connectivity. MacTCP is included with all Apple system software including and after Version 7.1. To see if a Macintosh has the software, the user should open the Control Panels folder and look for MacTCP or MacTCP Admin.

For any platform, the TCP/IP software must be configured with the host's IP address and subnet mask. If the host will obtain its IP address dynamically from the MAX, the TCP/IP software must be configured to allow dynamic allocation. If a DNS server is supported on your local network, you

should also configure the host software with the DNS server's address.

Typically, the host software is configured with the MAX as its default router.

Example IP routing connections

This section provides example Connection profile configurations for IP routing. These examples all presume that the Ethernet profile has been configured correctly, as described in "Configuring the local IP network setup" .

Configuring dynamic address assignment to a dial-in host

In this example, the dial-in host is a PC that will accept an IP address assignment from the MAX dynamically. Figure 9-5 shows an example network.

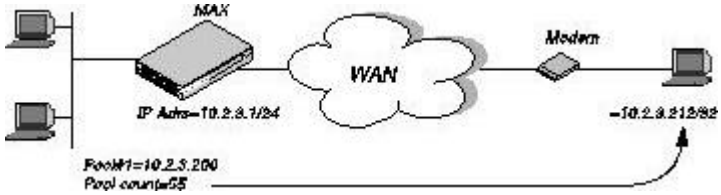

Figure 9-5. *A dial-in user requiring dynamic IP address assignment*

In this example, site A is a backbone network and site B is a single dial-in host with a modem, TCP/IP stack, and PPP software. The PPP software running on the PC at site B must be configured to acquire its IP address dynamically. For example, this example software configuration presumes that the PC has a modem connection to the MAX:

```
Username=victor
Accept Assigned IP=Yes
IP address=Dynamic (or Assigned or N/A)
Netmask=255.255.255.255 (or None or N/A)
Default Gateway=None or N/A
Name Server=10.2.3.55
Domain suffix=abc.com
Baud rate=38400
Hardware handshaking ON
VAN Jacobsen compression ON
```

To configure the MAX to accept dial-in connections from site B and assign an IP address:

1. Open Ethernet>Mod Config>WAN Options.

2. Type the start address of the pool and the number of contiguous addresses it includes. For example:

```
Ethernet
      Mod Config
            WAN options
                  Pool Summary=Yes
                  Pool#1 start=10.12.253.1
                  Pool#1 count=126
                  Pool only=Yes
```

3. Open the Ether Options subprofile and turn on Proxy Mode.

```
                  Ether options
```

```
                        Proxy Mode=Yes
```

4. Close the Ethernet profile.

5. Open the Answer profile and enable both IP routing and dynamic address assignment.

```
Ethernet
      Answer
            Assign Adrs=Yes
            PPP options
                  Route IP=Yes
```

6. Close the Answer profile.

7. Open a Connection profile for the dial-in user.

8. Specify the user's name, activate the profile, and set encapsulation options.

```
Ethernet
      Connections
            Station=victor
            Active=Yes
            Encaps=PPP
            Encaps options...
                  Send Auth=CHAP
                  Recv PW=*SECURE*
```

9. Configure IP routing and address assignment.

```
            Route IP=Yes
            IP options
                  LAN Adrs=0.0.0.0/0
                  RIP=Off
                  Pool=1
```

10. Close the Connection profile.

Configuring a host connection with a static address

This type of connection enables the dial-in host to keep its own IP address when logging into the MAX IP network. For example, if a PC user telecommutes to one IP network and uses an ISP on another IP network, one of those connections can assign an IP address dynamically and the other can configure a host route to the PC. This example shows how to configure a host connection with a static address. See "IP addresses and netmasks" for details on the /32 netmask.

Figure 9-6. *A dial-in user requiring a static IP address (a host route)*

In this example, the PC at site B is running PPP software that includes settings like these:

```
Username=patti
Accept Assigned IP=N/A (or No)
IP address=10.8.9.10
Netmask=255.255.255.255
Default Gateway=N/A (or None)
```

```
Name Server=10.7.7.1
Domain suffix=abc.com
VAN Jacobsen compression ON
```

To configure the MAX to accept dial-in connections from site B:

1. Open the Answer profile and enable IP routing.

```
Ethernet
      Answer
            PPP options
                  Route IP=Yes
```

2. Close the Answer profile.

3. Open a Connection profile for the dial-in user.

4. Specify the user's name, activate the profile, and set encapsulation options.

```
Ethernet
      Connections
            Station=patti
            Active=Yes
            Encaps=PPP
            Encaps options...
                  Send Auth=CHAP
                  Recv PW=*SECURE*
```

5. Configure IP routing.

```
            Route IP=Yes
            IP options
                  LAN Adrs=10.8.9.10/32
                  RIP=Off
```

6. Close the Connection profile.

Configuring an IP Direct connection

You can configure a Connection profile to automatically redirect incoming IP packets to a specified host on the local IP network without having the packets pass through the routing engine on the MAX.

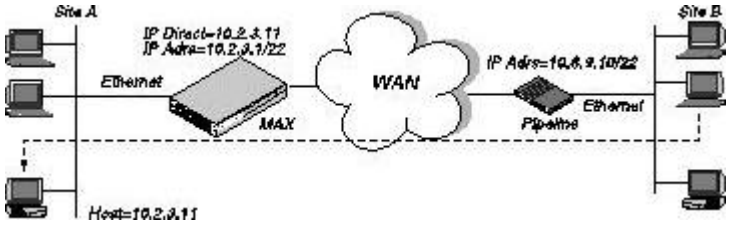

Figure 9-7. *Directing incoming IP packets to one local host*

Note: IP Direct connections typically turn off RIP. If the connection is configured to receive RIP, all RIP packets from the far side are kept locally and forwarded to the IP address you specify for IP Direct.

To configure an IP Direct connection:

1. Open the Answer profile and enable IP routing.

```
Ethernet
      Answer
            PPP options
                  Route IP=Yes
```

2. Close the Answer profile.

3. Open a Connection profile for the dial-in connection.

4. Specify the remote device's name, activate the profile, and set encapsulation options.

```
Ethernet
      Connections
            Station=Pipeline1
            Active=Yes
            Encaps=MPP
            Encaps options...
                  Send Auth=CHAP
                  Recv PW=localpw
                  Send PW=remotepw
```

5. Configure IP routing.

```
            Route IP=Yes
            IP options
                  LAN Adrs=10.8.9.10/22
                  RIP=Off
```

6. Open the Session Options subprofile and specify the IP Direct host.

```
            Session options
                  IP Direct=10.2.3.11
```

7. Close the Connection profile.

Note: The IP Direct address you specify in Connections>Session Options is the address to which all incoming packets on this connection will be directed. When you use the IP Direct feature, a user cannot Telnet directly to the MAX from the far side. All incoming IP traffic is directed to the specified address on the local IP network.

Configuring a router-to-router connection

In this example, the MAX is connected to a corporate IP network and needs a switched connection to another company that has its own IP configuration. Figure 9-8 shows an example network diagram.

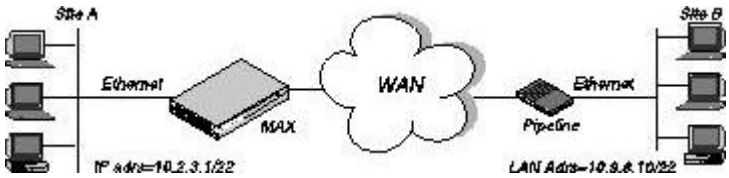

Figure 9-8. *A router-to-router IP connection*

This example assumes that the Answer profile in both devices enable IP routing. To configure the site A MAX for a connection to site B:

1. Open a Connection profile for the site B device.

2. Specify the remote device's name, activate the profile, and set encapsulation options.

```
Ethernet
      Connections
            Station=PipelineB
            Active=Yes
            Encaps=MPP
            Encaps options...
                  Send Auth=CHAP
                  Recv PW=localpw
                  Send PW=remotepw
```

3. Configure IP routing.

```
            Route IP=Yes
            IP options
                  LAN Adrs=10.9.8.10/22
                  RIP=Off
```

4. Close the Connection profile.

To configure the site B Pipeline:

1. Open the Connection profile for the site A MAX.

2. Specify the site A MAX unit's name, activate the profile, and set encapsulation options.

```
Ethernet
      Connections
            Station=MAXA
            Active=Yes
            Encaps=MPP
            Encaps options...
                  Send Auth=CHAP
                  Recv PW=localpw
                  Send PW=remotepw
```

3. Configure IP routing.

```
            Route IP=Yes
            IP options
                  LAN Adrs=10.2.3.1/22
                  RIP=Off
```

4. Close the Connection profile.

Configuring a router-to-router connection on a subnet

In this example network, the MAX is used to connect telecommuters with their own Ethernet networks to the corporate backbone. The MAX is on a subnet, and assigns subnet addresses to the telecommuters' networks.

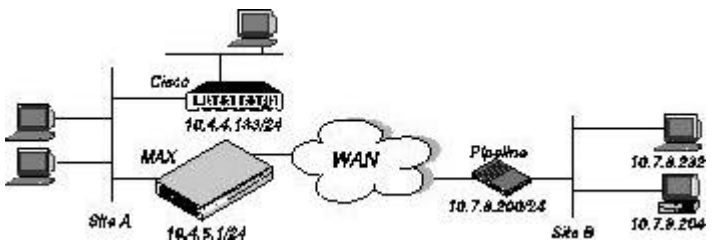

Figure 9-9. *A connection between local and remote subnets*

This example assumes that the Answer profile in both devices enables IP routing. Because the MAX specifies a netmask as part of its own IP address, the MAX must use other routers to reach IP addresses outside that subnet. To forward packets to other parts of the corporate network, the MAX must either have a default route configuration to a router in its own subnet (such as the Cisco router in Figure 5-12) or it must enable RIP on Ethernet.

To configure the MAX at site A with an IP routing connection to site B:

1. Open a Connection profile for the site B device.

2. Specify the remote device's name, activate the profile, and set encapsulation options.

```
Ethernet
      Connections
            Station=PipelineB
            Active=Yes
            Encaps=MPP
            Encaps options...
                  Send Auth=CHAP
                  Recv PW=localpw
                  Send PW=remotepw
```

3. Configure IP routing.

```
            Route IP=Yes
            IP options
                  LAN Adrs=10.7.8.200/24
                  RIP=Off
```

4. Close the Connection profile.

To specify the local Cisco router as the MAX unit's default route:

1. Open the Default IP Route profile.

2. Specify the Cisco router's address as the gateway address.

```
Ethernet
      Static Rtes
            Name=Default
            Active=Yes
            Dest=0.0.0/0
            Gateway=10.4.4.133
            Metric=1
            Preference=10
            Private=Yes
```

3. Close the IP Route profile.

To configure the site B Pipeline unit for a connection to site A:

1. Open the Connection profile in the Pipeline unit for the site A MAX.

2. Specify the site A MAX unit's name, activate the profile, and set encapsulation options.

```
Ethernet
      Connections
```

```
Station=MAXA
Active=Yes
Encaps=MPP
Encaps options...
      Send Auth=CHAP
      Recv PW=localpw
      Send PW=remotepw
```

3. Configure IP routing.

```
Route IP=Yes
IP options
      LAN Adrs=10.4.5.1/24
      RIP=Off
```

To make the MAX the default route for the site B Pipeline unit:

1. Open the Default IP Route profile in the site B Pipeline.

2. Specify the MAX unit at the far end of the WAN connection as the gateway address.

```
Ethernet
      Static Rtes
            Name=Default
            Active=Yes
            Dest=0.0.0/0
            Gateway=10.4.5.1
            Metric=1
            Preference=100
            Private=Yes
```

3. Close the IP Route profile.

Configuring a numbered interface

If you are not familiar with numbered interfaces, see "Numbered interfaces" . In the following example, the MAX is a system-based router but supports a numbered interface for one of its connections. The arrow in Figure 9-10 indicates the numbered interfaces for this connection:

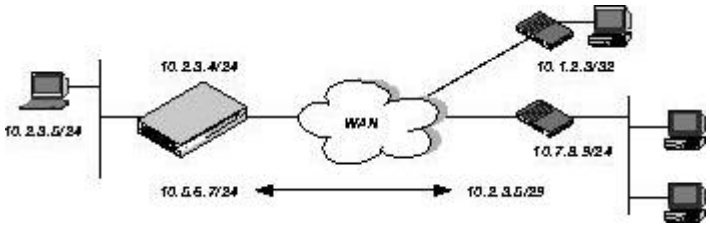

Figure 9-10. *Example numbered interface*

The numbered interface addresses are:

- IF Adrs=10.5.6.7/24
- WAN Alias=10.7.8.9/24

An unnumbered interface is also shown in Figure 9-10. The 10.1.2.3/32 connection uses a single system-based address for both the MAX itself and the dial-in user. To configure the numbered interface:

1. Open Ethernet>Mod Config>Ether Options and verify that the IP Adrs parameter is set correctly.

```
Ethernet
      Mod Config
            Ether options...
                  IP Adrs=10.2.3.4/24
```

2. Close the Ethernet profile.

3. Open the Connection profile and configure the required parameters, then open the IP Options subprofile.

4. Specify the IP address of the remote device in the LAN Adrs parameter.

```
Ethernet
            Connections
            IP options...
                  LAN Adrs=10.3.4.5/24
```

5. Specify the numbered interface address for the remote device in the WAN Alias parameter.

```
            IP options...
                  WAN Alias=10.7.8.9/24
```

6. Specify the numbered interface address for the 42 in the IF Adrs parameter.

```
            IP options...
                  IF Adrs=10.5.6.7/24
```

7. Close the Connection profile.

Configuring IP routes and preferences

The IP routing table contains routes that are configured (static routes) and routes that are learned dynamically from routing protocols such as RIP or OSPF. These are the parameters for configuring static routes:

```
Ethernet
      Static Rtes
            Name=route-name
            Active=Yes
            Dest=10.2.3.0/24
            Gateway=10.2.3.4
            Metric=2
            Preference=100
            Private=No
            Ospf=Cost=1
            ASE-type=Type1
            ASE=tag=c0000000

Ethernet
      Connections
            Route IP=Yes
            IP options...
                  LAN Adrs=10.2.3.4/24
                  WAN Alias=10.5.6.7/24
                  IF Adrs=10.7.8.9/24
                  Metric=7
                  Preference=100
                  Private=No
```

```
Ethernet
      Mod Config
            Ether options
                  IP Adrs=10.2.3.1/24
                  2nd Adrs=0.0.0.0/0
                  RIP=Off

            Route Pref
                  Static Preference=100
                  Rip Preference-100
                  RipAseType-Type2
                  Rip Tag=c8000000
                  OSPF Preference=10
                  OSPF ASE Preference=150
```

For details on each parameter, see the MAX Reference Guide.

Understanding the static route parameters

This section provides some background information on static routes.

- Route names

  IP Route profiles are indexed by name. You can assign any name less than 31 characters.

- Activating a route

  A route must be active to affect packet routing. An inactive route is ignored.

- The route's destination address

  The destination address of a route is the target network-the destination address in a packet. Packets destined for that host will use this static route to bring up the right connection. The zero address 0.0.0.0 represents the default route (the destination to which packets are forwarded when there is no route to the packet's destination).

- The route's gateway address

  The gateway-address parameter specifies the IP address of the router or interface to use to reach the target network.

- Metrics, costs, and preferences

  The metric parameter is a hop count for this route (a number between 1 to 15). When RIP was originally developed, the hop count was a number that showed how many routers needed to be crossed to reach the destination. For example, a destination with a hop count of 10 meant that to get a packet there requires crossing 10 routers. A route with a shorter hop count to a destination is more desirable than one with a larger hop count, since it most likely is a shorter, faster route.

  The hop count can also be manually configured to give a route a "virtual" hop count. In this way you can manually configure which routes are more desirable than others in your environment. The higher the metric, the less likely that the MAX will use a route.

  The cost parameter specifies the cost of an OSPF link. The cost is a configurable metric that can be used to take into account the speed of the link and other issues. The lower the cost, the

more likely the interface will be used to forward data traffic. For details, see Chapter 10, "Configuring OSPF Routing."

The preference parameter specifies a route preference. Zero is the default for connected routes (such as the Ethernet). When choosing which route to use, the router first compares the preference values, preferring the lower number. If the preference values are equal, the router compares the metric values, using the route with the lower metric. The value of 255 means "Don't use this route." See "Route preferences and metrics" .

- Tagging routes learned from RIP

  The rip-tag field is "attached" to all routes learned from RIP in OSPF updates. The tag is a hexadecimal number that can be used by border routers to filter the record.

- Type-1 or type-2 metrics for routes learned from RIP

  The rip-ase-type parameter can be set to 1 or 2. Type-1 is a metric expressed in the same units as the link-state metric (the same units as interface cost). Type-2 is considered larger than any link-state path. It assumes that routing between autonomous systems is the major cost of routing a packet, and eliminates the need for conversion of external costs to internal link-state metrics.

- Making a route private

  Private routes are used internally but are not advertised.

- Routes for Connection profile interfaces

  When an IP routing connection is brought up, the MAX activates the route for that WAN interface. The Destination for the route is the remote device's address (LAN Adrs), and the metric and preference values are specified in the Connection profile. If the profile uses numbered interface, an additional route is created for that interface.

- A connected route for the Ethernet IP interface

  The IP Adrs parameter specifies the MAX unit's IP address on the local Ethernet. The MAX creates a route for this address at system startup.

- Static route preferences

  By default, static routes and RIP routes have the same preference, so they compete equally. ICMP redirects take precedence over both and OSPF take precedence over everything. If a dynamic route's preference is lower than that of the static route, the dynamic route can overwrite or "hide" a static route to the same network. This can be seen in the IP routing table: there will be two routes to the same destination. The static route has an "h" flag, indicating that it is hidden and inactive. The active, dynamically learned route is also in the routing table. However, dynamic routes age and if no updates are received, they eventually expire. In that case, the hidden static route reappears in the routing table.

- RIP and OSPF preferences

  Because OSPF typically involves a complex environment, its router configuration is described in a separate chapter. See Chapter 10, "Configuring OSPF Routing."

- Tagging routes learned from RIP

  The RIP Tag field is "attached" to all routes learned from RIP in OSPF updates. The tag is a hexadecimal number that can be used by border routers to filter the record.

- Metrics for routes learned from RIP

  The RipAseTag parameter can be type 1 or 2. Type-1 is a metric expressed in the same units as the link-state metric (the same units as interface cost). Type-2 is considered larger than any link-state path. It assumes that routing between autonomous systems is the major cost of routing a packet, and eliminates the need for conversion of external costs to internal link-state metrics.

Example static route configurations

For example Connection profile configurations, see "Configuring IP routing connections" . Each of these results in a static route. For an example of the Ethernet profile configuration of the MAX unit's local IP interface, see "Configuring the MAX IP interface on a subnet" .

Configuring the default route

If no routes exist for the destination address of a packet, the MAX forwards the packet to the default route. Most sites use the default route to specify a local IP router (such as a Cisco router or a UNIX host running the route daemon) to offload routing tasks to other devices.

Note: If the MAX does not have a default route, it drops packets for which it has no route.

The name of the default IP Route profile is always Default, and its destination is always 0.0.0.0. To configure the default route:

1. Open the first IP Route profile (the route named Default) and activate it.

```
Ethernet
      Static Rtes
            Name=Default
            Active=Yes
            Dest=0.0.0.0/0
```

   Note: The name of the first IP Route profile is always Default, and its destination is always 0.0.0.0 (you cannot change these values).

2. Specify the router to use for packets with unknown destinations; for example:

```
            Gateway=10.9.8.10
```

3. Specify a metric for this route, the route's preference, and whether the route is private. For example:

```
            Metric=1
            Preference=100
            Private=Yes
```

4. Close the IP Route profile.

Defining a static route to a remote subnet

If the connection does not enable RIP, the MAX does not learn about other networks or subnets that are reachable through the remote device, such as the remote network shown in Figure 9-11.

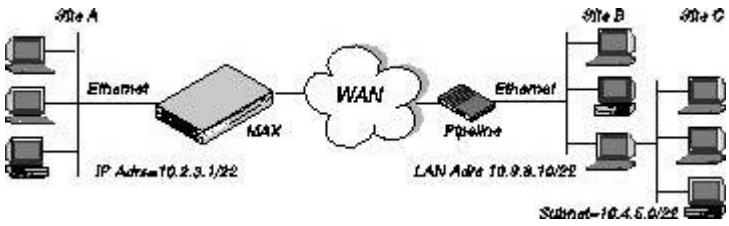

Figure 9-11. *Two-hop connection that requires a static route when RIP is off*

To enable the MAX to route to site C without using RIP, you must configure an IP Route profile like this:

```
Ethernet
      Static Rtes
            Name=SITEBGW
            Active=Yes
            Dest=10.4.5.0/22
            Gateway=10.9.8.10
            Metric=2
            Preference=100
            Private=Yes
            Ospf=Cost=1
            ASE-type=Type1
            ASE=tag=c0000000
```

Example route preferences configuration

This example increases the preference value of RIP routes, instructing the router to use static routes first if one exists.

1. Open Ethernet>Mod Config>Route Pref.
2. Set Rip Preference to 150.

```
Ethernet
      Mod Config
            Route Pref
                  Rip Preference=150
```

3. Close the Ethernet profile.

Configuring the MAX for dynamic route updates

Each active interface may be configured to send or receive RIP or OSPF updates. The Ethernet interface can also be configured to accept or ignore ICMP redirects. All of these routing mechanisms modify the IP routing table dynamically.

These are the parameters that enable the MAX to receive updates from RIP or ICMP. (For information on OSPF updates, see Chapter 10, "Configuring OSPF Routing.")

```
Ethernet
      Mod Config
            Ether options
                  RIP=On
```

```
                  Ignore Def Rt=Yes
            RIP Policy=Poison Rvrs
            RIP Summary=Yes
            ICMP Redirects=Accept

Ethernet
      Answer
            Session options...
                  RIP=On

Ethernet
      Connections
            IP options...
                  Private=No
                  RIP=On
```

Understanding the dynamic routing parameters

This section provides some background information about the dynamic routing options.

- RIP (Routing Information Protocol)

  You can configure the router to send or receive RIP updates (or both) on the Ethernet interface and on each WAN interface. The Answer profile setting applies to Name profiles and profiles retrieved from RADIUS. You can also choose between RIP-v1 and RIP-v2 on any interface. Many sites turn off RIP on WAN connections to keep their routing tables from becoming very large.

  Note: The IETF has voted to move RIP-v1 into the "historic" category and its use is no longer recommended. Ascend recommends that you upgrade all routers and hosts to RIP-v2. If you must maintain RIP-v1, Ascend recommends that you create a separate subnet and place all RIP-v1 routers and hosts on that subnet.

- Ignoring the default route

  You can configure the MAX to ignore default routes advertised by routing protocols. This configuration is recommended, because you typically do not want the default route to be changed by a RIP update. The default route specifies a static route to another IP router, which is often a local router such as a Cisco router or another kind of LAN router. When the MAX is configured to ignore the default route, RIP updates will not modify the default route in the MAX routing table.

- RIP policy and RIP summary

  The RIP Policy and RIP Summary parameters have no effect on RIP-v2.

  If the MAX is running RIP-v1, the RIP Policy parameter specifies a split horizon or poison reverse policy to handle update packets that include routes that were received on the same interface on which the update is sent. Split-horizon means that the MAX does not propagate routes back to the subnet from which they were received. Poison-reverse means that it propagates routes back to the subnet from which they were received with a metric of 16.

  The RIP Summary parameter specifies whether to summarize subnet information when advertising routes. If the MAX summarizes RIP routes, it advertises a route to all the subnets in a network of the same class; for example, the route to 200.5.8.13/28 (a class C address subnetted to 28 bits) would be advertised as a route to 200.5.8.0. When the MAX does not summarize information, it advertises each route in its routing table "as-is;" in our example, the

MAX advertises a route only to 200.5.8.13.

- Ignoring ICMP redirects

  ICMP was designed to dynamically find the most efficient IP route to a destination. ICMP redirect packets are one of the oldest route discovery methods on the Internet and one of the least secure, because it is possible to counterfeit ICMP redirects and change the way a device routes packets.

- Private routes

  If you configure a profile with Private=Yes, the router will not disclose its route in response to queries from routing protocols.

Example RIP and ICMP configurations

This example configuration instructs the router to ignore ICMP redirect packets, to receive (but not send) RIP updates on Ethernet, and to send (but not receive) RIP updates on a WAN connection.

1. Open Ethernet>Mod Config>Ether Options.

2. Configure the router to receive (but not send) RIP updates on Ethernet.

```
Ethernet
      Mod Config
            Ether options
                  RIP=Recv-v2
```

   Receiving RIP updates on Ethernet means that the router will learn about networks that are reachable via other local routers. However, it will not propagate information about all of its remote connections to the local routers.

3. Close the Ether Options subprofile, and set ICMP Redirects to Ignore.

```
            ICMP Redirects=Ignore
```

4. Close the Ethernet profile.

5. Open Connections>IP Options, and configure the router to send (but not receive) RIP updates on this link.

```
Ethernet
      Connections
            IP options...
                  RIP=Send-v2
```

   Sending RIP on a WAN connection means that the remote devices will be able to access networks that are reachable via other local routers. However, the MAX will not receive information about networks that are reachable through the remote router.

6. Close the Connection profile.

Managing IP routes and connections

This section describes how to monitor TCP/IP/UDP and related information in the terminal server

command-line interface. To invoke the terminal-server interface, select System>Sys Diag>Term Serv and press Enter.

Working with the IP routing table

The terminal-server IProute commands display the routing table and enable you to add or delete routes. The changes you make to the routing table using the IProute command last only until the MAX unit resets. To view the IProute commands:

```
ascend% iproute ?

iproute ?           Display help information
iproute add         iproute add <destination/size> <gateway> [ pref ] [ m
iproute delete      iproute delete <destination/size> <gateway> [ proto ]
iproute show        displays IP routes (same as "show ip routes" command)
```

Displaying the routing table

Note that the IProute Show command and the Show IP Routes command have identical output. To view the IP routing table:

```
ascend% iproute show

Destination        Gateway        IF       Flg Pref  Met   Use   Age
0.0.0.0/0          10.0.0.100     wan0     SG   1     1     0     20887
10.207.76.0/24     10.207.76.1    wanidle0 SG   100   7     0     20887
10.207.77.0/24     10.207.76.1    wanidle0 SG   100   8     0     20887
127.0.0.1/32       -              lo0      CP   0     0     0     20887
10.0.0.0/24        10.0.0.100     wan0     SG   100   1     21387 20887
10.1.2.0/24        -              ie0      C    0     0     19775 20887
10.1.2.1/32        -              lo0      CP   0     0     389   20887
255.255.255.255/32 -              ie0      CP   0     0     0     20887
```

The columns in the table display the following information:

- Destination

  The Destination column indicates the target address of a route. To send a packet to this address, the MAX will use this route. Note that the router will use the most specific route (having the largest netmask) that matches a given destination.

- Gateway

  The Gateway column specifies the address of the next hop router that can forward packets to the given destination. Direct routes (without a gateway) no longer show a gateway address in the gateway column.

- IF

  The Interface column shows the name of the interface through which a packet addressed to this destination will be sent.

  ie0 is the Ethernet interface

  lo0 is the loopback interface

  wanN specifies each of the active WAN interfaces

wanidle0 is the inactive interface (the special interface for any route whose WAN connection is down).

- Flg

  The Flg column can contain the following flag values:

  - C (A directly connected route such as Ethernet)
  - I (ICMP Redirect dynamic route)
  - N (Placed in the table via SNMP MIB II)
  - O (A route learned from OSPF)
  - R (A route learned from RIP)
  - r (A RADIUS route)
  - S (A static route)
  - ? (A route of unknown origin, which indicates an error)
  - G (An indirect route via a gateway)
  - P (A private route)
  - T (A temporary route)
  - * (A hidden route that will not be used unless another better route to the same destination goes down)

- Pref

  The Preference column contains the preference value of the route. Note that all routes that come from RIP will have a preference value of 100, while the preference value of each individual static route may be set independently.

- Metric

  The Metric column shows the RIP-style metric for the route, with a valid range of 0-16. Routes learned from OSPF show a RIP metric of 10. OSPF Cost infinity routes show a RIP metric of 16.

- Use

  This is a count of the number of times the route was referenced since it was created. (Many of these references are internal, so this is not a count of the number of packets sent using this route.)

- Age

This is the age of the route in seconds. It is used for troubleshooting, to determine when routes are changing rapidly or flapping.

The first route in the default route (destination 0.0.0.0/0), which is pointing through the active Connection profile.

```
0.0.0.0/0          10.0.0.100     wan0      SG   1     1     0     20887
```

In this example, the IP Route profile for the default route specifies a Preference of 1, so this route is preferred over dynamically learned routes. The next route is specified in a Connection profile that is inactive.

```
10.207.76.0/24     10.207.76.1    wanidle0 SG   100   7     0     20887
```

The next route in the table is a static route that points through an inactive gateway:

```
10.207.77.0/24     10.207.76.1    wanidle0 SG   100   8     0     20887
```

The static route is followed by the loopback route:

```
127.0.0.1/32       -              lo0      CP   0     0     0     20887
```

The loopback route says that packets sent to this special address will be handled internally. The C flag indica