Chapter 20

DECnet

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Introduction

This chapter describes the main features of Digital Equipment Corporation's (DEC) DECnet routing protocol, support for DECnet on the router, and how to configure and operate the router to act as a wide area DECnet router.

DECnet refers to the software that runs on DEC host computers and allows them to communicate using a range of methods including X.25 and Computer Interconnect (CI). However, it is common practice to refer to DECnet as the protocol that DEC hosts use to transfer data across a network.

Overview of a DECnet Network

DECnet lets software *processes* communicate over a data network. A network consists of two or more computer systems called *nodes* and the *logical links* that connect them. *Adjacent nodes* are connected by physical *lines* over which *circuits* operate. A circuit can support multiple logical links between processes.

A DEC host computer that runs DECnet software is a DECnet node. Frequently such host computers are end nodes, but sometimes they are configured to be routers. Therefore, in this section, when reference is made to a 'router' that router may well be a host computer.

In a network of more than two nodes, *routing* is required to ensure that data messages can be directed between a source process and a destination process. In DECnet, messages are always sent over the most cost effective path. This means that messages can be automatically rerouted if a circuit becomes unavailable and an alternative path is open. A DECnet network consists of either *routing nodes* or *end nodes*. An end node sends or receives a message but cannot forward a message from one node to another node. Routing nodes are further divided into *type 1* and *type 2* (or *area*) *routing* nodes. The remainder of this document explains the two types of routing nodes. In the router's commands and displays, type 1 nodes are referred to as ROUTING-IV routers, while type 2 nodes are referred to as AREA routers.

The router is capable of acting as either type 1 or type 2 (area) routers. The level at which the router supports DECnet is referred to as **Phase IV+.**

A single DECnet area can directly support 1023 nodes, however, most practical networks have no more than 200–300 nodes in any one area. Area routing joins two or more areas and avoids the overhead of passing end node information between areas. Using area routing, the number of nodes that can be supported is greatly increased since there are 63 distinct areas.

Type 1 routers are only aware of the structure of the network within a particular area. An area router joins the areas together. By default, the router acts as a type 1 router. It can be configured as an area router and, in this case, acts as both a type 1 and type 2 router. In other words, it maintains tables of all the end systems (and other routers) within its particular area (as defined by its DECnet address), as well as information about other areas that it has obtained by communicating with other area routers.

To set the router type, use the command:

```
set decnet type={area|routingiv|level1|level2|1|2}
```

To display current settings, use the command:

```
show decnet
```

DECnet Addresses

DECnet addresses are associated with individual nodes within a DECnet network, rather than to interfaces. This is in contrast to a protocol such as TCP/IP where each interface is assigned a unique address. This means that the router has only one DECnet address regardless of the number of interfaces.

DECnet nodes must each have an address of the form *area.node*, where *area* is the area number, and takes a value from 1 to 63, and *node* is the node number and takes a value from 1 to 1023. The numbers are expressed in decimal.

There is no "Assigned Numbers Authority" as with TCP/IP. It is the responsibility of the network administrator to uniquely assign node and area numbers. This lack of central authority is a common cause of problems when two separately administered networks are connected together. Area number '1' is a very popular choice!

For example, to set the DECnet address of a router to node 45 in area 2, use the command:

```
set decnet address=2.45
```

When routing DECnet, a router must use a MAC address determined from the DECnet address assigned to the router, rather than the globally unique address assigned by the router manufacturer. With routers from many manufacturers, when DECnet routing is enabled the router must be rebooted so that the new MAC address can take effect. This can be disruptive to network operation. To avoid this, the router is able to use more than one MAC address simultaneously. This is done without the performance impact of receiving packets for all addresses, through the use of a Content Addressable Memory (CAM) incorporated into the Ethernet interface hardware.

Routing and the Default Router

When several routers are present on an Ethernet segment, one is automatically chosen as the default router. Its purpose is to act as the initial router for local end nodes. When an end node initiates a DECnet transfer with another system (that could be local or remote to this segment), it first sends the packet to the default router. The packet contains the DECnet address of the destination system and the default router uses this information to determine if the end node needs to use the services of a router to send further packets. This would occur, for instance, if the destination system was in a different area. The default router is aware of the presence of any area routers on the local segment and would then send the packet to the area router to forward to the correct area. When a response packet is returned from the area router to the initiating end node, the end node would learn that there is a direct link to the area router.

In many networks the default router is also the area router. In this case the redirect packet would instruct the end node to forward future packets to the default router, rather than redirect them elsewhere.

If the destination system was also on the local segment and the source and destination were in the same area, the default router would forward the packet to the destination node. When the destination system returns a packet to the initiating end node, the end node learns of the direct route to the destination. The end system then sends future packets directly to the destination.

Clearly the default router is very important. It is chosen *automatically* amongst all the routing nodes on the local segments as part of the processing that DECnet performs. The basis of the choice is the router advertising the highest DECnet node number. This can however be modified, since all routers also advertise a *priority*. By default this is set to 64, but it can be changed to ensure that a router with a low DECnet node number becomes the default router. A higher priority is used in preference to a lower one. The priority of a node takes precedence over the DECnet node number.

Routers advertise their presence by using DECnet hello packets.

To modify the priority, use the command:

```
set decnet priority
```

To view the current priority, use the command:

```
show decnet
```

Routes and Routing Tables

The purpose of DECnet is to route data packets between software processes, which generally reside on different host systems. To enable the router to determine where it should direct traffic, it maintains an internal routing table. It gets information about other end nodes and routers by listening to their 'Hello' and 'Routing Update' multicasts. Using these, it constructs the internal routing table that describes the network. To display the DECnet routing table, use the command:

```
show decnet route
```

The meaning of the fields is explained in "Command Reference" on page 20-14.

The router discards a route when the end node does not respond with a 'Hello' packet after an extended period of time. It replaces a route when a better route is provided. The criteria for *better* is primarily the cost for any given interface and the computed cost of all interfaces along the route. For example, if the route update is received from an Ethernet interface, then the Ethernet interface cost is added to the incoming routing packet cost. The issue of costs is examined further in "Managing the Router" on page 20-5.

Filters

The router maintains *inclusion* and *exclusion* lists. If there are DECnet addresses on the exclusion list then data from those sources are discarded by the router and are not forwarded to other areas or received from them. If there are DECnet addresses on the inclusion list then only packets from those sources are routed; all others are discarded. The addresses can refer to individual nodes or entire areas.

The inclusion list is checked first. If the packet passes this test then the exclusion list is checked. The packet is routed only if it passes both tests. This method allows an inclusion to be set for an entire area, but individual nodes in that area can still be excluded. To set inclusions or exclusions, use the commands:

```
add decnet inclusion=dntadd
add decnet exclusion=dntadd
```

To delete them, use the commands:

```
delete decnet inclusion=dntadd
delete decnet exclusion=dntadd
```

To display the lists, use the commands:

```
show decnet inclusion
show decnet exclusion
```

Managing the Router

The router maintains a Management Information Base (MIB) holds various counters and parameters that configure the DECnet router module. Although the MIB is structured after MIB II, it cannot currently be accessed through SNMP. This will be added in a future release. However, access to the MIB can be gained through standard management commands.

Counters

To display the DECnet counter, use the command:

```
show decnet counter
```

This displays all the counters. To selectively display the MIB, use the command:

```
show decnet counter=option
```

Specify either the GATEWAY, INTERFACE or ROUTE option. The functions of the counters are described in detail in "Command Reference" on page 20-14.

To clear the counters by a system reboot or when the DECnet routing module is reset, use the command:

```
reset decnet
```

Resetting the DECnet routing module causes all DECnet routes to be lost. The router cannot accept DECnet traffic until the routing timers on other nodes expire, or until it gets a response to its initial 'Hello' packets. It has no effect on the other routing modules or on the rest of the router system in general.

Timers

The DECnet routing module maintains several timers that control when various DECnet events occur. Three of these – the Hello, Broadcast and Routing timers – are user-configurable. To display current settings, use the command:

```
show decnet
```

If a change occurs to the routing table in the router, then the new routing table is sent immediately to other adjacent nodes and the routing timer is restarted.

To set timers, use the command:

```
set decnet [broadcasttimer=1..65535] [hellotimer=1..8191]
   [routingtimer=1..65535]
```

Costs

The DECnet routing module allows costs to be set for DECnet interfaces, using the COST parameter of the **add decnet interface** command on page 20-16 and the **set decnet interface** command on page 20-26, to influence the way that DECnet routes packets. An interface with a lower cost is chosen over an interface with a higher cost when it comes to making routing choices among several candidate interfaces. The default costs used by the router are 1 for Ethernet interfaces and 10 for Point-to-Point Protocol (PPP) and Frame Relay interfaces. The maximum cost is 25.

The costs should be set according to the network administration policy, to ensure that they are used consistently across the whole network. It is recommended that a uniform circuit cost standard be established across the entire network. The following algorithm is based on one suggested by Digital Equipment Corporation (from "*Guide to Networking on VMS*") to determine appropriate circuit costs (see figure below). The algorithm is based on circuit delay. Delay is based on circuit bandwidth.

Figure 20-1: Determining appropriate circuit costs.

Cost	For circuits...
1	Where the bandwidth is greater than 100 Kbits per second.
x	Where the bandwidth is greater than 4K bits per second but less than 100 Kbits per second. x is approximately equal to 100,000 divided by the bandwidth.
25	Where the bandwidth is less than 4K bits per second.

However, this algorithm does not account very well for modern circuit bandwidths. For example, in a large network that has grown over a number of years, there may be a range of circuit bandwidths – 9600 bits/s links to remote offices; 64 Kbits/s to 2 Mbit/s regional links, and 10 Mbits/s LANs. Using the above algorithm, the 9600 bits/s links would be assigned a cost of ~10, 64 Kbits/s links would be assigned a cost of ~2, and all other links would be

assigned a cost of 1. As a result, there is no differentiation between, for example, 128 Kbits/s and 10 Mbits/s links.

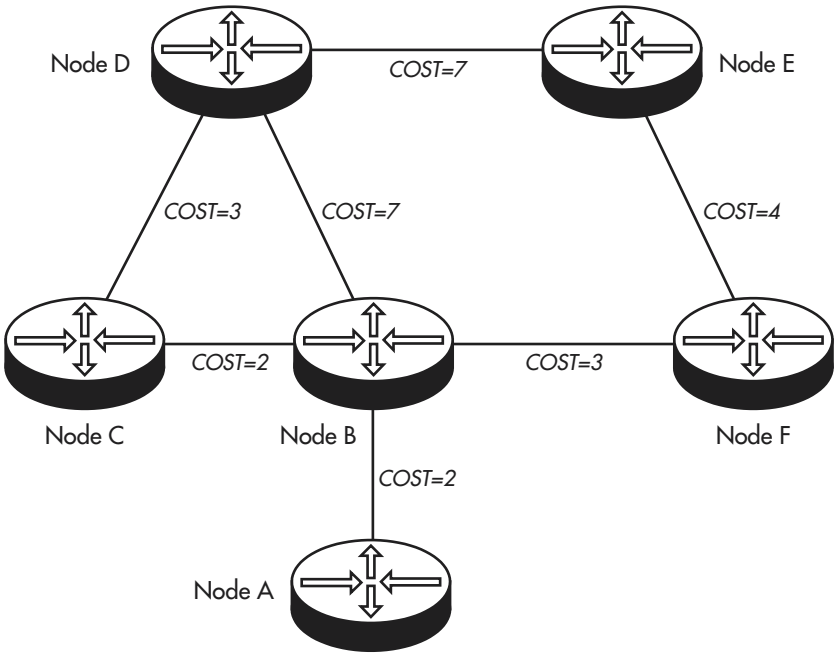
An alternative approach is to develop a costing algorithm that is unique to the particular network and its range of bandwidths. A starting point is to assign an arbitrary cost to each link based on bandwidth (see Figure 20-2 on page 20-7).

Figure 20-2: Assigning an arbitrary cost to each link based on bandwidth.

Cost	For circuits...
1	With a bandwidth of 10 Mbits/s.
5	With a bandwidth of 2 Mbits/s.
10	With a bandwidth of 512 Kbits/s.
15	With a bandwidth of 128 Kbits/s.
20	With a bandwidth of 64 Kbits/s.
25	With a bandwidth of 9600 bits/s.

The above can then be skewed to take account of link congestion and preferred path by adjusting the costs of particular network links. For example, Figure 20-3 on page 20-8 shows a simple network consisting of a single area, and how the COST parameter can be used to establish a favoured route between nodes A and D. The lowest path cost is seven (A—B, B—C, C—D), so node A routes packets to node D via that path.

Figure 20-3: Using interface costs to establish preferred routes between nodes in a DECnet network.



Node A transmits a packet to Node D. There are three possible routes. Node A routes the packet via nodes B and C because this route has the lowest path cost (7).

Path	Path Cost	Path Length
A—B, B—C, C—D	2+2+3=7	3 hops
A—B, B—D	2+7=9	2 hops
A—B, B—F, F—E, E—D	2+3+4+2=11	4 hops

DNT1_R

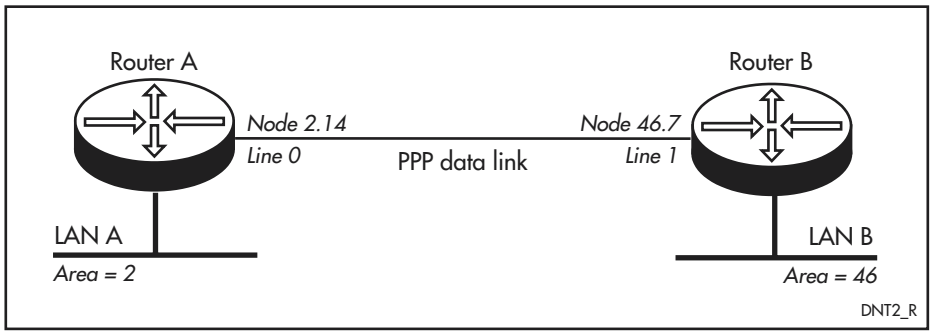
Configuration Examples

The following examples illustrate the steps required to configure DECnet routing.

A Basic DECnet Setup

This example illustrates how to set up the router to provide a wide area DECnet network between two LANs in different DECnet areas (see figure below).

Figure 20-4: Example configuration for a basic DECnet network.



This example, like most others, may rely on configurations performed as part of other examples. In particular, see "Privilege Levels" on page 1-9 of Chapter 1, Operation and "Configuring a PPP link" on page 9-33 of Chapter 9, Point-to-Point Protocol (PPP). If remote or local management using Telnet is required, see "A Basic TCP/IP Setup" on page 14-53 of Chapter 14, Internet Protocol (IP).

To configure a basic DECnet network

1. **Configure the PPP link.**

   Step-by-step examples of how to establish manager level access and to use this to set up a PPP link are in "Privilege Levels" on page 1-9 of Chapter 1, Operation and "Configuring a PPP link" on page 9-33 of Chapter 9, Point-to-Point Protocol (PPP).

   If management of either router using Telnet is required, then TCP/IP must be configured first. See "A Basic TCP/IP Setup" on page 14-53 of Chapter 14, Internet Protocol (IP).

2. **Enable the DECnet routing module.**

   Turn on the DECnet routing module, purge the static database, and restore the DECnet defaults by using the following commands on each router:

   ```
   enable decnet
   purge decnet
   ```

3. **Set the DECnet node address and routing type.**

   On router A, set the DECnet node address and configure it as an area router (type 2) by using the commands:

   ```
   enable decnet
   set decnet address=2.14 type=area
   ```

Do the same for router B by using the commands:

```
enable decnet
set decnet address=46.7 type=are
```

4. Create the DECnet interfaces.

On router A, assign the interfaces by using the commands:

```
add decnet interface=pp0
add decnet interface=eth0
```

On router B, assign the interfaces by using the commands:

```
add decnet interface=ppp0
add decnet interface=eth0
```

When routing DECnet, a router must use a MAC address determined from the DECnet address assigned to the router, rather than the globally unique address assigned by the router manufacturer. Because routers come from many manufacturers, when DECnet routing is enabled the router must be rebooted so that the new MAC address can take effect. This can be disruptive to network operation. To avoid this, the router is able to use more than one MAC address simultaneously. This is done without the performance impact of receiving packets for all addresses, through the use of a Content Addressable Memory (CAM) incorporated into the Ethernet interface hardware.

5. Test the configuration.

The routing table quickly fills with all the nodes visible to the routers. Check this against your knowledge of each DECnet area. To display the routing table, use the command:

```
show decnet route
```

Figure 20-5: Example output from the **show decnet route** command for a basic DECnet network.

```
DECnet route information

Area routes:

Address   NextHop   Interface   Cost    Hops   Age
-----------------------------------------------------
2.0       local      none         0       0   86711
46.0      2.14       ppp0        30       2    1173
-----------------------------------------------------

Routing-IV routes:

Address   NextHop   Interface   Cost    Hops   Age
-----------------------------------------------------
2.14      local      none         0       0   86711
2.2       local      eth0         1       1     240
2.5       local      eth0         1       1     393
2.48      local      eth0         1       1     392
-----------------------------------------------------
```

Nodes 2.2, 2.5 and 2.7 are hosts on LAN A. The section of the display showing the areas that can be seen by this router should be checked to ensure that area 46 can be reached.

Check that a user on a host in area 2 can access a host in area 46 and vice versa.

Troubleshooting

Areas are not Visible

1. The most likely cause is a link problem. Review "Configuring a PPP link" on page 9-33 of Chapter 9, Point-to-Point Protocol (PPP) to ensure that the PPP link is open.

   To display information about the network, use the command:

   ```
   show ppp
   ```

Figure 20-6: Example output from the **show ppp** command for a basic DECnet network.

```
Name      Enabled  ifIndex  Over      CP       State
-----------------------------------------------------------
ppp0        YES      04               DCP      OPENED
                             syn0     LCP      OPENED
-----------------------------------------------------------
```

2. The remote router has not yet sent the full routing update. Do a warm restart of both the router modules by using the command:

   ```
   reset decnet
   ```

3. One or other of the routers is not configured as an area router. Check this on both routers by using the command:

   ```
   show decnet
   ```

Figure 20-7: Example output from Switch A with the **show decnet gateway** command.

```
DECnet general configuration

Module status ................... Enabled
Module activity ................. Active
Module version .................. 1.3
Node ............................ [ZF1]
Address ......................... 2.14
Router type ..................... area
Priority ........................ 64
Maximum address ................. 1023
Hello timer ..................... 15
Routing Timer ................... 600
Broadcast timer ................. 40
```

   If either router does not produce a display similar to this, repeat step 4 or step 5.

4. Contact your authorised distributor or reseller for assistance.

No Nodes in the Route Table

1. Verify that there are hosts on each LAN that are running DECnet. Attempt to connect from one local host to another local host.
2. Contact your authorised distributor or reseller for assistance.

Refining the DECnet Setup

This example builds on the previous example, by adding filters and adjusting parameters to improve performance.

General Filters

General filters are added to the configuration to restrict packets being routed around the network. A common application could be to prevent all packets from a remote area from being passed to the local LAN, or to prevent a certain local host from being accessed from any remote site. There are two basic types of filters: exclusions and inclusions. Both work on either specific host DECnet numbers or on area numbers. Multiple filters can be specified.

The inclusion list is checked first. If the packet passes this test, then the exclusion list is checked. The packet is routed only if it passes both tests. This method allows an inclusion to be set for an entire network but individual hosts on that network can still be excluded.

For the purposes of this example, assume that remote area 23.0 is to be entirely excluded from the local LAN, and that local host 2.3 is to be available for local access only. The steps required to do this are:

1. Add the area exclusion for area 23.0 by using the command:

```
add decnet exclusion=23.0
```

2. Add the local host exclusion by using the command:

```
add decnet exclusion=2.3
```

Performance Tuning

The default settings for the DECnet router module works for most situations, however it is possible to change these to improve the performance.

DECnet relies on regular broadcasts of routing tables. These can be large because details of all possible hosts within an area are sent in each update. This means that they contain 1023 entries, even if the area contains a few hosts. This situation can be improved by:

1. Allocating host numbers consecutively from 1, and
2. Setting the MAXADDRESS parameter to reflect the actual number of hosts.

   To reduce the size of the update table to include only those hosts that are actually allocated (assume there are 34 hosts), use:

   ```
   set decnet maxaddress=40
   ```

   If you add hosts with addresses beyond the setting for this parameter, they are ignored by the router. To rectify this, simply put in a new value.

   In addition to reducing the size of the table, the frequency where it is sent can also be changed. To change from the 40 seconds default on a serial line to 120 seconds, use the command:

   ```
   set decnet broadcasttimer=120
   ```

Command Reference

This section describes the commands available on the router to enable, configure, control, and monitor the DECnet module.

The shortest valid command is denoted by capital letters in the Syntax section. See "Conventions" on page xcv of Preface in the front of this manual for details of the conventions used to describe command syntax. See Appendix A, Messages for a complete list of messages and their meanings.

add decnet exclusion

Syntax `ADD DECnet EXclusion=`*`dntadd`*

where *dntadd* is a DECnet address in the format *area.node* . *Area* is the area number from 1 to 63 and *node* is the node number from 1 to 1023.

Description This command adds an entry to the exclusion list for a DECnet node or nodes. A single node or an entire area can be excluded. Any packets received from a node that is on the exclusion list are discarded by the router. An address of *area*.0 excludes all nodes within the specified area. A maximum of 32 entries can be defined. Exclusions of the form 0.0 and 0.*node* are illegal.

The EXCLUSION parameter specifies the DECnet address to be added to the exclusion list. The address must be a valid DECnet address and the exclusion must not already exist.

When a DECnet packet is received, the inclusion list is checked first. If the DECnet node that transmitted the packet is not on the inclusion list the packet is discarded immediately, otherwise the exclusion list is checked. If the node is on the exclusion list the packet is discarded. The packet is routed only if it passes both filters. This method allows an inclusion filter to be set for an entire area while excluding individual nodes within the area.

If the command is successful, information about the exclusion that has been added to the exclusion list is displayed (see figure below).

Figure 20-8: Example output from the **add decnet exclusion** command.

```
DECnet exclusion information

Exclusion
-------------------------------------------------------------
45.678
-------------------------------------------------------------
```

Examples To exclude packets from node 678 in area 45, use the command:

```
add dec ex=45.678
```

To exclude packets from any node in area 2, use the command:

```
add dec ex=2.0
```

Related Commands

add decnet inclusion
delete decnet exclusion
delete decnet inclusion
show decnet exclusion
show decnet inclusion

add decnet inclusion

Syntax

```
ADD DECnet INclusion=dntadd
```

where *dntadd* is a DECnet address in the format *area.node*. *Area* is the area number from 1 to 63 and *node* is the node number from 1 to 1023.

Description

This command adds an entry to the inclusion list for a DECnet node or nodes. A single node or an entire area can be included. The router discards packets received from a node that are not on the inclusion list router. An address of *area*.0 includes all nodes within the specified area. A maximum of 32 inclusions can be defined. Inclusions of the form 0.0 and 0.*node* are illegal.

The INCLUSION parameter specifies the DECnet address to be added to the inclusion list. The address must be a valid DECnet address and the inclusion must not already exist.

The inclusion value of 0.0 is the default and does not need to be entered. That is, if there are no entries, then all nodes in all areas are included by default. When a DECnet packet is received, the inclusion list is checked first. If the node that transmitted the packet is not on the inclusion list the packet is discarded immediately, otherwise the exclusion list is checked. If the node is on the exclusion list the packet is discarded. The packet is routed only if it passes both filters. This method allows an inclusion filter to be set for an entire area while excluding individual nodes within the area.

If the command is successful, information about the inclusion that has been added to the inclusion list is displayed (see figure below).

Figure 20-9: Example output from the **add decnet inclusion** command.

```
DECnet inclusion information

Inclusion
-------------------------------------------------------------
34.23
-------------------------------------------------------------
```

Examples

To include packets from node 23 in area 34, use the command:

```
add dec in=34.23
```

To include packets from any node in area 45 except node 23, use the command:

```
add dec in=45.0
add dec ex=45.23
```

Related Commands

add decnet exclusion
delete decnet exclusion
delete decnet inclusion
show decnet exclusion
show decnet inclusion

add decnet interface

Syntax

```
ADD DECnet INTerface=interface [COSt=1..25]
```

where *interface* is a valid interface name formed by concatenating an interface type and an interface instance

Description

This command adds an interface to the list of interfaces used by the DECnet routing module. The interface must exist and must not already be in use by the DECnet module. The DECnet module is reset when this command is executed.

Executing this command disrupts communications until the internal routing tables are rebuilt. A file transfer fails if it is in progress through the router when the command is executed.

The INTERFACE parameter specifies the interface to be added. Valid interfaces are:

- eth (e.g. eth0)
- PPP (e.g. ppp0)
- FR (e.g. fr0)

The interface must already exist. To see a list of all currently available interfaces, use the command SHOW INTERFACE.

The COST parameter specifies the cost added to any route information received over the interface. The default cost for an interface is 1 for Ethernet, and 10 for a PPP link or Frame Relay.

The maximum number of hops supported by the router's DECnet implementation is 30. The maximum route cost (the sum of all interface costs on a route) supported by the router's DECnet implementation is 254.

If the command is successful, information about the interface that has been added is displayed (see figure below).

Figure 20-10: Example output from the **add decnet interface** command.

```
DECnet interface information

Interface    Cost
-------------------------------------------------------------
fr0           20
-------------------------------------------------------------
```

Examples To add frame relay interface 0, with a baud rate of 40000 bits per second, and assign a cost of 20 (using the second cost algorithm), use the command:

```
add dec int=fr0 cos=20
```

If the network is 50% congested, use a cost of 23 instead:

```
add dec int=fr0 cos=23
```

Related Commands
delete decnet interface
set decnet
set decnet interface
show decnet
show decnet interface

add decnet lpn

Syntax `ADD DECNET LPN=`*`dntadd`*

where *dntadd* is a DECnet address in the format *area.node*. *Area* is the area number from 1 to 63 and *node* is the node number from 1 to 1023.

Description This command adds a DECnet node to the list of low priority nodes. Normally, all DECnet nodes in a network have the same priority. Traffic to an LPN is processed at a lower priority than traffic to other nodes. A lower priority can be assigned to nodes that are normally used for non-interactive traffic to enable traffic prioritisation over congested WAN links.

If the command is successful, information about the LPN that has been added is displayed (see figure below).

Figure 20-11: Example output from the **add decnet lpn** command.

```
DECnet low priority node information

Node
-------------------------------------------------------------
2.512
-------------------------------------------------------------
```

Examples To add node 2.512 to the list of low priority nodes, use the command:

```
ADD DECNET LPN=2.512
```

Related Commands
delete decnet lpn
show decnet lpn

delete decnet exclusion

Syntax

```
DELete DECnet EXclusion={dntadd|ALL}
```

where *dntadd* is a DECnet address in the format *area.node*. A*rea* is the area number from 1 to 63 and *node* is the node number from 1 to 1023.

Description This command deletes an entry from the exclusion list for a DECnet node or nodes. A single node or an entire area can be excluded. Any packets received from a node that is on the exclusion list are discarded by the router. An address of *area*.0 excludes all nodes within the specified area. A maximum of 32 entries can be defined. Exclusions of the form 0.0 and 0.*node* are illegal.

The EXCLUSION parameter specifies the DECnet address to be deleted from the exclusion list. If a DECnet node address is specified, the address must be a valid DECnet address and the exclusion must exist. If ALL is specified, all entries are removed from the exclusion list.

When a DECnet packet is received, the inclusion list is checked first. If the DECnet node that transmitted the packet is not on the inclusion list the packet is discarded immediately, otherwise the exclusion list is checked. If the node is on the exclusion list the packet is discarded. The packet is routed only if it passes both filters. This method allows an inclusion filter to be set for an entire area while excluding individual nodes within the area.

Examples To delete the exclusion list entry for node 2.45, use the command:

```
del dec ex=2.45
```

To delete the exclusion list entry for all nodes within area 2, use the command:

```
del dec ex=2.0
```

To delete all entries from the exclusion list, use the command:

```
del dec ex=all
```

Related Commands
add decnet exclusion
add decnet inclusion
delete decnet inclusion
show decnet exclusion
show decnet inclusion

delete decnet inclusion

Syntax

```
DELete DECnet INclusion={dntadd|ALL}
```

where *dntadd* is a DECnet address of the form *area.node*. A*rea* is the area number from 1to 63 and *node* is the node number from 1 to 1023.

Description

This command deletes an entry from the inclusion list for a DECnet node or nodes. A single node or an entire area can be included. The router discards packets from a node that are not on the inclusion list. An address of *area*.0 includes all nodes within the specified area. A maximum of 32 inclusions can be defined. Inclusions of the form 0.0 and 0.*node* are illegal.

The INCLUSION parameter specifies the DECnet address to be deleted from the inclusion list. If a DECnet node address is specified, the address must be a valid DECnet address and the inclusion must exist. If ALL is specified, all entries are removed from the inclusion list.

When a DECnet packet is received, the inclusion value of 0.0 is the default and does not need to be entered. That is, if there are no entries, then all nodes in all areas are included by default. The inclusion list is checked first. If the node that transmitted the packet is not on the inclusion list the packet is discarded immediately, otherwise the exclusion list is checked. If the node is on the exclusion list the packet is discarded. The packet is routed only if it passes both filters. This method allows an inclusion filter to be set for an entire area while excluding individual nodes within the area.

Examples

To delete the inclusion list entry for node 2.45, use the command:

```
del dec in=2.45
```

To delete the inclusion list entry for all nodes within area 2, use the command:

```
del dec in=2.0
```

To delete all entries from the inclusion list, use the command:

```
del dec in=all
```

Related Commands

add decnet exclusion
add decnet inclusion
delete decnet exclusion
show decnet exclusion
show decnet inclusion

delete decnet interface

Syntax `DELete DECnet INTerface=`*`interface`*

where *interface* is a valid interface name formed by concatenating an interface type and an interface instance

Description This command removes an interface from the list of interfaces used by the DECnet routing module. This command resets the DECnet routing module.

Executing this command disrupts communications until the internal routing tables are rebuilt. A file transfer fails if it is in progress through the router when the command is executed.

Valid interfaces are:

- eth (e.g. eth0)
- PPP (e.g. ppp0)
- FR (e.g. fr0)

The specified interface must exist and currently be in use by the DECnet routing module. To see a list of current valid interfaces, use the **show decnet interface** command on page 20-33 or the **show interface** command on page 7-66 of Chapter 7, Interfaces

Examples To remove frame relay interface 0, use the command:

```
del dec int=fr0
```

Related Commands
add decnet interface
set decnet
set decnet interface
show decnet
show decnet interface

delete decnet lpn

Syntax `DELete DECnet LPN={`*`dntadd`*`|ALL}`

where *dntadd* is a DECnet address of the form *area.node*. *Area* is the area number from 1 to 63 and *node* is the node number from 1 to 1023.

Description This command removes a DECnet node from the list of low priority nodes and restores it to normal priority. Normally, all DECnet nodes in a network have the same priority. Traffic to an LPN is processed at a lower priority than traffic to other nodes. A lower priority can be assigned to nodes that are normally used for non-interactive traffic to enable traffic prioritisation over congested WAN links.

The LPN parameter specifies the DECnet address to be deleted from the low priority list. If a DECnet node address is specified, the address must be a valid DECnet address and the entry must exist in the list. If ALL is specified, all entries are removed from the list.

Examples To remove the entry for node 2.52 from the low priority list, use the command:

```
del dec lpn=2.52
```

To remove all entries from the low priority list, use the command:

```
del dec lpn=all
```

Related Commands
add decnet lpn
show decnet lpn

disable decnet

Syntax `DISable DECnet`

Description This command disables the DECnet routing module. The DECnet routing module must currently be enabled. The change takes effect immediately. The current DECnet static configuration is retained but the dynamic DECnet routing tables are deleted; DECnet packets are no longer forwarded by the router and the router ceases to act as a DECnet node.

Examples To stop the router from routing DECnet packets, use the command:

```
dis dec
```

Related Commands
enable decnet
purge decnet
reset decnet
show decnet

enable decnet

Syntax `ENAble DECnet`

Description This command enables the DECnet routing module. The DECnet routing module must currently be disabled. The change takes effect immediately. Any existing static configuration is restored, the dynamic DECnet routing tables are rebuilt from routing and Hello messages, and the router becomes an active DECnet node, forwarding packets for which it has a route.

Examples To enable the DECnet routing, use the command:

```
ena dec
```

Related Commands
disable decnet
purge decnet
reset decnet
show decnet

purge decnet

Syntax `PURge DECnet`

Description This command removes configuration information (except the enabled/disabled status), restores defaults, and resets the DECnet routing module. Static DECnet configuration information is removed from non-volatile memory. The command should be issued when the router is first enabled or when major changes to configuration data are required. This command ensures that a new configuration does not inherit "forgotten" parameters from previous configurations.

Executing this command disrupts communications until the correct configuration data is re-entered. A file transfer fails if it is in progress through the router when the command is executed. All configuration information related to the DECnet routing module is removed or restored to the default.

A log message is sent to the logging facility if one has been defined. The internal log is also updated with the message:

```
DECNET, static DNT database has been initialized
```

Examples To remove all previous static DECnet routing configurations, use the command:

```
pur dec
```

Related Commands
disable decnet
enable decnet
reset decnet
show decnet
show log in Chapter 33, Logging Facility

reset decnet

Syntax `RESET DECnet`

Description This command resets and reinitialises the DECnet routing module. The router rebuilds dynamic routing tables. As far as other routers are concerned, the effect is the same as if the router had been turned off and on. The DECnet routing module must currently be enabled.

Executing this command disrupts communications until the internal routing tables are rebuilt. A file transfer fails if it is in progress through the router when the command is executed.

Examples To reset the DECnet routing module and rebuild all dynamic routing tables, use the command:

```
reset dec
```

Related Commands

disable decnet
enable decnet
purge decnet
show decnet
show log in Chapter 33, Logging Facility

set decnet

Syntax

```
SET DECnet [Address=dntadd] [BROadcasttimer=1..65535]
   [HEllotimer=1..8191] [MAXADdress=1..1023]
   [PRIOrity=1..127] [ROUtingtimer=1..65535] [TYpe={AREa|
   ROUtingiv|LEVEL1|LEVEL2|1|2}]
```

where *dntadd* is a DECnet address of the form `area.node`. *Area* is the area number from 1–63 and *node* is the node number from 1–1023

Description

This command is used to change global configuration parameters for the DECnet routing module. If specified, the TYPE, ADDRESS, and MAXADDRESS parameters resets the DECnet module if it is enabled.

Executing this command disrupts communications until the internal routing tables are rebuilt. A file transfer fails if it is in progress through the router when the command is executed.

The ADDRESS parameter specifies the DECnet node address of the router and resets the DECnet routing module if it is enabled. Each node in a DECnet network must be assigned a unique number. The number refers to both the *area* that the node is in, and the *number* of the node within that area. Because DECnet uses this number as the basis of all routing, unique numbers are essential.

DECnet nodes determine the “preferred router” on the basis (provided the priority of each node is the same) of the highest address.

There is no central authority that assigns DECnet numbers. Each organisation should carefully assign numbers. If you intend to connect to other organisations, you should also ensure that the area number is uniquely chosen for each organisation.

Since routing update packets contain information about all DECnet node addresses up to the highest address currently assigned, node addresses should be assigned consecutively if possible. This limits the size of routing tables and improves performance. To improve manageability of a DECnet network, it is normal to assign nodes to different areas when the number of nodes within an area exceeds 250–300. This is done to help reduce the size of routing updates that must be exchanged between nodes and hence helps to improve performance.

When routing DECnet, a router must use a MAC address determined from the DECnet address assigned to the router, rather than the globally unique address assigned by the router manufacturer. With routers from many manufacturers, when DECnet routing is enabled the router must be rebooted so that the new MAC address can take effect. This can be disruptive to network operation. To avoid this, the router is able to use more than one MAC address simultaneously. This is done without the performance impact of receiving packets for all addresses, through the use of a Content Addressable Memory (CAM) incorporated into the Ethernet interface hardware.

DECnet associates the node address with a particular node within a DECnet network rather than an interface. This is in contrast to a protocol like TCP/IP. Therefore each DECnet node has only one address, regardless of the number of interfaces.

The BROADCASTTIMER parameter specifies the interval, in seconds, where the router sends routing messages on Ethernet or other broadcast media. The default is 40 seconds. Routing messages list all the hosts that can be reached by this router. If the router is configured as an *area* router, then area routing information about other areas is also broadcast. Other routers or hosts configured as routers use the information in the routing update to build local routing tables. Changing this parameter affects the frequency where the routing tables can be refreshed.

The HELLOTIMER parameter affects only the Ethernet interfaces and specifies the time, in seconds, between hello packets. By default, the router sends DECnet hello packets every 15 seconds over each Ethernet interface where it is attached. Hosts and other routers use the "Hello" packet to identify one another and to determine which hosts can be communicated with directly.

The MAXADDRESS parameter specifies the maximum number of DECnet addresses within an area. The default is 1023. This means that, by default, the router routes traffic for areas that can have up to 1023 nodes. Setting this parameter to a lower number enhances performance by restricting the size of routing updates. All routers within an area should have the same value of MAXADDRESS. This parameter can also be used to reduce the size of routing update packets.

The PRIORITY parameter specifies the DECnet router priority of the router. The priority applies to the HELLO broadcast packets sent out over the Ethernet interface since it is relevant in a broadcast environment. It is used by DECnet to establish the *preferred router* on a particular Ethernet LAN. The router with the highest priority is used as the preferred router by other DECnet nodes on the LAN. The default is 64.

The priority does not have any effect on the rate that traffic is forwarded. Since DEC also use a default priority of 64, increasing this parameter often selects this router as the preferred router.

The TYPE parameter specifies the type of DECnet routing functionality the DECnet module provides. If ROUTER-IV is specified (LEVEL1 and 1 are equivalents), the router acts as a DECnet Type 1 router only. It has no knowledge of any areas other than the one to which it belongs. It is not able to route packets between different areas. The area is set on the basis of the DECnet node address by using the command:

```
set decnet address=area.node
```

If AREA is specified (LEVEL2 and 2 are equivalents), the router is able to participate in routing between areas. In general, the AREA parameter is selected for routers that link two different areas. The ROUTING-IV parameter could be considered more common, especially within a single organisation. The default is ROUTING-IV. With this setting, packets addressed to a node outside the area are passed to the nearest area router, which forwards them between areas. This parameter alters the output of some SHOW commands, which includes extra information on other areas if the router is an area router.

The ROUTINGTIMER parameter specifies the interval, in seconds, between routing messages transmitted over non-Ethernet media. The default is 600 seconds. Routing messages list all the hosts that can be reached by this router. If the router is configured as an *area* router, then area routing information about other areas is also broadcast. In some cases these updates can be rather large. This can be a problem for slow speed serial links, and in this case, the routing timer should be increased to reduce the effect of the update on link performance.

Other routers, or hosts configured as routers, use the information in the routing update to build local routing tables. Therefore changing this parameter affects the frequency where the tables can be altered.

If the command is successful, the DECnet module configuration is displayed (see figure below).

Figure 20-12: Example output from the **set decnet** command.

```
DECnet general configuration

Module status ................... Disabled
Module activity ................. Uninitialised
Module version .................. 1.3
Node ............................ [dnt3]
Address ......................... 2.1
Router type ..................... routing-iv
Priority ........................ 64
Maximum address ................. 1023
Hello timer ..................... 15
Routing Timer ................... 600
Broadcast timer ................. 40L
```

Examples To set the node address to be area 2, node 45, use the command:

```
set dec a=2.45
```

To set the router up as an area router, use the command:

```
set dec ty=are
```

Alternatively, to set several options, use the command:

```
set dec a=2.45 maxad=400 prio=100 ty=are
```

Related Commands **show decnet**

set decnet interface

Syntax `SET DECnet INTerface=`*`interface`* `COSt=1..25`

where *interface* is a valid interface name formed by concatenating an interface type and an interface instance

Description This command sets the cost added to any routing information received over the interface. The default cost is 1 for Ethernet interfaces and 10 for a PPP or Frame Relay link. We recommend that a uniform circuit cost standard be established across the entire network. See "Costs" on page 20-6 for a discussion of costing algorithms.

Executing this command disrupts communications until the internal routing tables are rebuilt. A file transfer fails if it is in progress through the router at the time the command is executed.

Valid interfaces are:

- eth (e.g. eth0)
- PPP (e.g. ppp0)
- FR (e.g. fr0)

The specified interface must exist and currently be in use by the DECnet routing module. To see a list of current valid interfaces, use the **show decnet interface** command on page 20-33 or the **show interface** command on page 7-66 of Chapter 7, Interfaces

The maximum number of hops supported by the router's DECnet implementation is 30. The maximum route cost (the sum of all interface costs on a route) supported by the router's DECnet implementation is 254.

If the command is successful, information about the interface that has been modified is displayed (Figure 20-13 on page 20-27).

Figure 20-13: Example output from the **add decnet interface** command.

```
DECnet interface information

Interface    Cost
-------------------------------------------------------------
fr0           20
-------------------------------------------------------------
```

Examples To set the cost associated with frame relay interface 0, use the command:

```
set dec int=FR0 cos=20
```

Related Commands

add decnet interface
delete decnet interface
set decnet
show decnet
show decnet interface

show decnet

Syntax `SHow DECnet`

Description This command displays global configuration information for the DECnet module (Figure 20-14, Table 20-1 on page 20-28).

Figure 20-14: Example output from the **show decnet** command.

```
DECnet general configuration

Module status ................... Disabled
Module activity ................. Uninitialised
Module version .................. 1.3
Node ............................ [dnt3]
Address ......................... 0.0
Router type ..................... routing-iv
Priority ........................ 64
Maximum address ................. 1023
Hello timer ..................... 15
Routing Timer ................... 600
Broadcast timer ................. 40
```

Table 20-1: Parameters in the output of the **show decnet** command.

Parameter	Meaning
Module status	Whether the DECnet module is enabled or disabled.
Module activity	Whether the current state of the DECnet module is active, initialised, or uninitialised. The normal operational state is active.
Module version	The version of DECnet software currently running.
Node	The name of the router node, assigned with the **set system name** command on page 1-124 of Chapter 1, Operation.
Address	The DECnet address for the router. This gives both the area and node address.
Router type	Whether the type of router is area or routing-iv.
Priority	The router priority on the Ethernet LAN.
Maximum address	The largest address allowed in the area.
Hello timer	The hello timer period on the Ethernet.
Routing timer	The routing timer period on non-broadcast media.
Broadcast timer	The routing broadcast timer on the Ethernet.

Examples To display the configuration of the DECnet routing module, use the command:

```
sh dec
```

Related Commands

disable decnet
enable decnet
set decnet

show decnet counter

Syntax `SHow DECnet COUnter[={GLobal|INTerface|ROUte}]`

Description This command displays the values of the counters and parameters in the Management Information Base (MIB) that the router maintains. These values are reset when the router is rebooted and when the **reset decnet** command on page 20-23 is executed. If no option is specified all counters are displayed. The MIB can be selectively displayed by specifying one of the options GLOBAL, INTERFACE or ROUTE.

If GLOBAL is specified, general counters for the entire module are displayed (Figure 20-15 on page 20-29, Table 20-2 on page 20-29).

If INTERFACE is specified, interface counters are displayed (Figure 20-16 on page 20-30, Table 20-3 on page 20-30).

If ROUTE is specified, route counters are displayed (Figure 20-17 on page 20-30, Table 20-4 on page 20-31).

Figure 20-15: Example output from the **show decnet counter=global** command.

```
DECnet counter information

Global counter:
  inReceives ..................... 24
  inDiscards ..................... 0
  forwDatagrams .................. 0
  localDatagrams ................. 24
  outInvalidDest ................. 0
  outNoRoute ..................... 0
```

Table 20-2: Parameters in the output of the **show decnet counter=global** command.

Parameter	Meaning
inReceives	The number of packets received by the router.
inDiscards	The number of packets discarded by the router as a result of filters.
forwDatagrams	The number of packets forwarded by the router.
localDatagrams	The number of packets received for the router itself.
outInvalidDest	The number of packets dumped because of an invalid destination
outNoRoute	The number of packets dropped because no route existed to the destination.

Figure 20-16: Example output from the **show decnet counter=interface** command.

```
DECnet counter information

Interface counter:
  eth0:
    Input:                          Output:
      inOctets ......... 2756         outOctets ....... 14472
      inDiscards ........... 0        outDiscards ......... 0
      inUcastPkts ......... 0
      inNUcastPkts ....... 12

  ppp0:
    Input:                          Output:
      inOctets ......... 6106         outOctets ........... 0
      inDiscards ........... 0        outDiscards ......... 0
      inUcastPkts ......... 0
      inNUcastPkts ....... 12
```

Table 20-3: Parameters in the output of the **show decnet counter=interface** command.

Parameter	Meaning
inOctets	The number of input bytes received by the interface.
inDiscards	The number of input packets discarded due to lack of resources.
inUcastPks	The number of input unicast packets received (i.e. those addressed to this router).
inNUcastPkts	The number of input multicast or broadcast packets received.
outOctets	The number of output bytes sent by the interface.
outDiscards	The number of packets discarded at the interface level due to lack of resources.

Figure 20-17: Example output from the **show decnet counter=route** command.

```
DECnet counter information

Area route counter:

Address    NextHop    Interface    Cost    Hops    Octets rcvd   Octets sent
-------------------------------------------------------------------------------
2.0        local       none          0       0              0             0
23.0       23.1        ppp0         10       1              0             0
34.0       local       eth0          1       1              0             0
-------------------------------------------------------------------------------

Routing-IV route counter:

Address    NextHop    Interface    Cost    Hops    Octets rcvd   Octets sent
-------------------------------------------------------------------------------
2.1        local       none          0       0              0             0
2.48       local       eth0          1       1              0             0
-------------------------------------------------------------------------------
```

Table 20-4: Parameters in the output of the **show decnet counter=route** command.

Parameter	Meaning
Address	The remote DECnet address.
NextHop	The address of the next router on the route to the remote network.
Interface	The interface the destination network can be reached on.
Cost	The cost to reach the remote network.
Hops	The number of hops (routers) to reach the remote network.
Octets rcvd	The number of bytes received from the network.
Octets sent	The number of bytes sent to the network.

Examples To display the DECnet interface counters, use the command:

```
sh dec cou=int
```

Related Commands **show decnet route**

show decnet exclusion

Syntax `SHow DECnet EXclusion`

Description This command displays the DECnet node exclusion list (Figure 20-18 on page 20-31). DECnet exclusions provide a means for filtering incoming packets. The router ignores packets from hosts or areas on the exclusion list.

Figure 20-18: Example output from the **show decnet exclusion** command.

```
DECnet exclusion information

Exclusion
------------------------------------------------------------
3.4
45.1
------------------------------------------------------------
```

Examples To display the list of DECnet exclusions, use the command:

```
sh dec ex
```

Related Commands **add decnet exclusion**
add decnet inclusion
delete decnet exclusion
delete decnet inclusion
show decnet inclusion

show decnet inclusion

Syntax `SHow DECnet INclusion`

Description This command displays the DECnet node inclusion list (Figure 20-19 on page 20-32). The inclusion list provides a means of filtering incoming packets. If area or host addresses are added to the inclusion list, then only packets from those areas and hosts are accepted by the router. All other packets are discarded.

The inclusion value of 0.0 is the default and does not need to be entered. That is, if there are no entries, then all nodes in all areas are included by default. When a DECnet packet is received, the inclusion list is checked first. If the node that transmitted the packet is not on the inclusion list the packet is discarded immediately, otherwise the exclusion list is checked. If the node is on the exclusion list the packet is discarded. The packet is routed only if it passes both filters. This method allows an inclusion filter to be set for an entire area while excluding individual nodes within the area.

Figure 20-19: Example output from the **show decnet inclusion** command.

```
DECnet inclusion information

Inclusion
-------------------------------------------------------------
3.4
34.23
2.0
-------------------------------------------------------------
```

Examples To display the list of DECnet inclusions, use the command:

```
sh dec in
```

Related Commands

add decnet exclusion
add decnet inclusion
delete decnet exclusion
delete decnet inclusion
show decnet exclusion

show decnet interface

Syntax `SHow DECnet INTerface`

Description This command displays the interfaces that are currently assigned to the DECnet routing module (Figure 20-20 on page 20-33, Table 20-5 on page 20-33).

Figure 20-20: Example output from the **show decnet interface** command.

```
DECnet interface information

Interface    Cost
-------------------------------------------------------------
eth0           1
ppp0          10
-------------------------------------------------------------
```

Table 20-5: Parameters in the output of the **show decnet interface** command.

Parameter	Meaning
Interface	The DECnet interface.
Cost	The cost of crossing the DECnet interface.

Examples To display the configuration of all DECnet interfaces, use the command:

```
sh dec int
```

Related Commands

add decnet interface
delete decnet interface
set decnet
set decnet interface
show decnet

show decnet lpn

Syntax `SHow DECnet LPN`

Description This command displays the list of low priority nodes where packets are forwarded at a low priority (Figure 20-21 on page 20-34).

Figure 20-21: Example output from the **show decnet lpn** command.

```
DECnet low priority node information

Node
------------------------------------------------------------
34.5
34.6
7.8
------------------------------------------------------------
```

Examples To display the list of low priority nodes, use the command:

```
sh dec lpn
```

Related Commands **add decnet lpn**
delete decnet lpn

show decnet route

Syntax `SHow DECnet ROUte`

Description This command displays the DECnet routing table (Figure 20-22 on page 20-35, Table 20-6 on page 20-35). The DECnet routing module maintains a routing table that lets it determine the route from source node to destination node for traffic that passes through it. If the router is an area router, the area routing table is displayed first.

Figure 20-22: Example output from the **show decnet route** command.

```
DECnet route information

Area routes:

Address    NextHop    Interface    Cost     Hops      Age
-------------------------------------------------------
2.0        local       none          0        0        33
23.0       23.1        ppp0         10        1        30
34.0       local       eth0          1        1        30
-------------------------------------------------------

Routing-IV routes:

Address    NextHop    Interface    Cost     Hops      Age
-------------------------------------------------------
2.1        local       none          0        0        33
2.48       local       eth0          1        1        25
-------------------------------------------------------
```

Table 20-6: Parameters in the output of the **show decnet route** command.

Parameter	Meaning
Address	The destination DECnet host address.
NextHop	The DECnet address of the next router on the route to the destination network.
Interface	The interface where the destination network can be reached.
Cost	The cost to reach the destination network.
Hops	The number of hops to the destination network.
Age	The time in seconds that the route has been known.

Examples To display the DECnet routing table, use the command:

```
sh dec rou
```

Related Commands

set decnet
show decnet
show decnet counter