MODULE 5

Appendixes

APPENDIX A

Configuring DECnet

Objectives

Upon completion of this chapter, you will be able to perform the following tasks:

- **Describe the DECnet protocol stack**
- **Describe the key features of DECnet**
- **Enable DECnet protocol and configure DECnet interfaces**
- **Monitor DECnet operation in the router**

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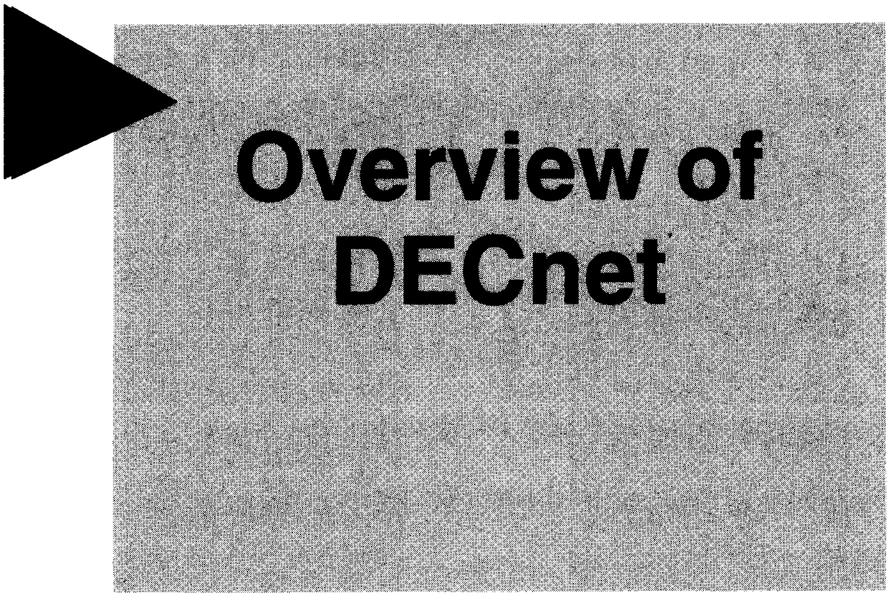
This chapter presents how to configure Cisco routers in DECnet networks.

Sections:

- Overview of DECnet
- Configuring DECnet
- DECnet Access Lists
- Monitoring DECnet



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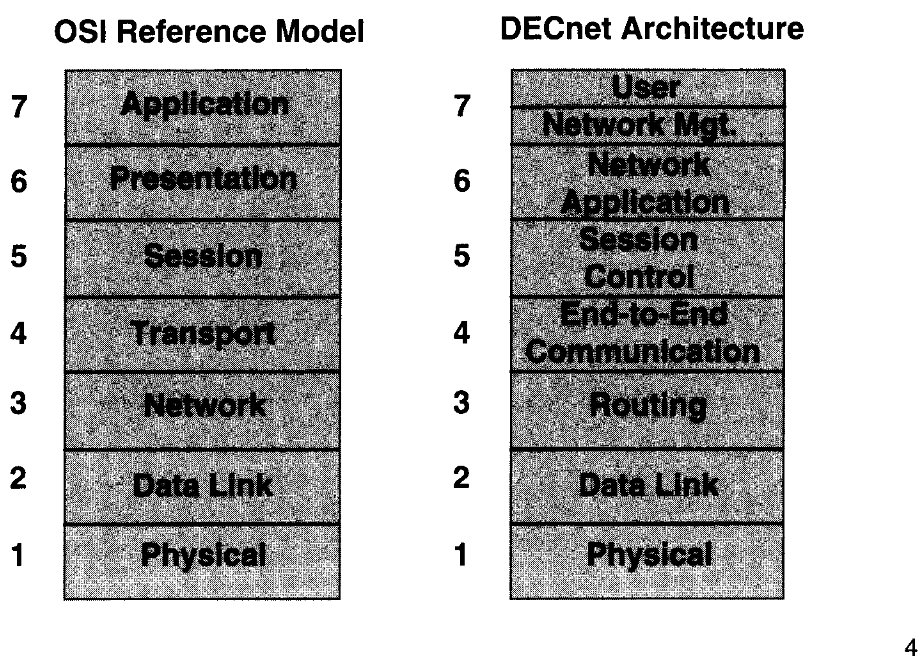
Overview of DECnet

DECnet Protocol Stack



DECnet is a proprietary Digital Equipment Corporation (Digital) protocol.

DECnet has evolved, with each evolution being called a phase. Phase IV is the default; conversion to Phase V is in progress.

DECnet Features

- **Addressing is 16 bits (area.node)**
- **Modifies MAC address to contain node ID**
- **Nodes are grouped into areas**
- **Broadcasts are not propagated**
- **Routing protocol is DECnet**
  - **— Updates sent at 40-second intervals**
  - **— Metric is path cost**

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A DECnet address contains 16 bits: 6 bits for the area and 10 bits for the node.

Each addressable entity is called a node; each node is assigned one address. The area.node address is modified and becomes a software-formatted MAC address used on all interfaces.

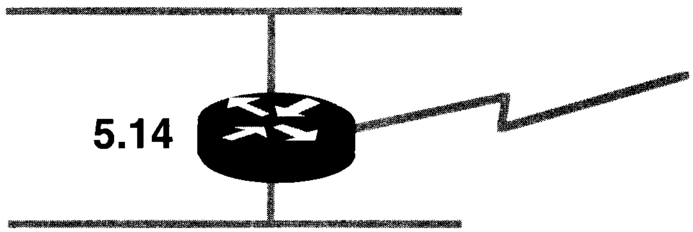
Traffic is localized by placing nodes in logical or physical groupings called areas.

DECnet is a distance vector protocol; path determination is based on the cost of all outgoing interfaces. Routers keep cost calculations for all hosts in their area.

Due to the incorporation of logical addressing into the MAC address, no address resolution is required, as it is in IP.

DECnet Addressing

Area.Node



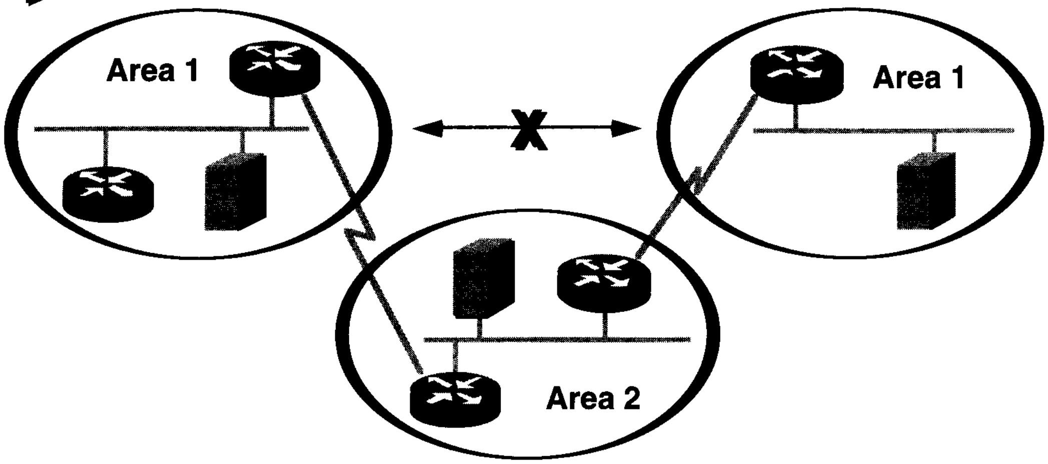
- **One address is assigned to the entire unit**
  - — Each interface has the same logical address
  - — Each "wire" does not require a unique network number

6

DECnet addresses are 16 bits in size. The upper 6 bits represent the area field, and the lower 10 bits represent the node field.

Each device speaking DECnet is a node, and addresses are assigned to the node, not to individual wires or interfaces. Therefore, the entire router, as a node, is assigned one address.

Area Assignments



- Logical grouping of nodes
- Arbitrary topology
- Must be contiguous

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A 6-bit area number allows a maximum of 63 areas.

All nodes in an area must be contiguous.

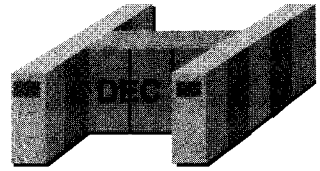
Within a LAN, one router is chosen as the designated router (DR). The DR is always known to end nodes because of periodic DR announcements. All traffic from an end node is initially sent to the designated router for forwarding. Later, as network knowledge is learned, the end nodes use a more direct path.

Several nodes in an area are assigned intra-area router status. These nodes contain knowledge about all nodes within that area in their routing tables.

One or more nodes in an area are assigned to be an interarea router. The task of this router is to forward traffic to a specific router in another area. An interarea router's routing table contains all nodes in an area plus the paths to other areas via interarea routers.

Node Assignments

Area . Node
5 17



- **Concatenate to form 16-bit hex number**

0001010000010001 or 0x1411

- **Swap two lower bytes and add to standardized DEC MAC address header**

AA-00-04-00-11-14

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Using a 10-bit node number allows a maximum of 1023 nodes in each area.

The node address is folded into the MAC address for each interface.

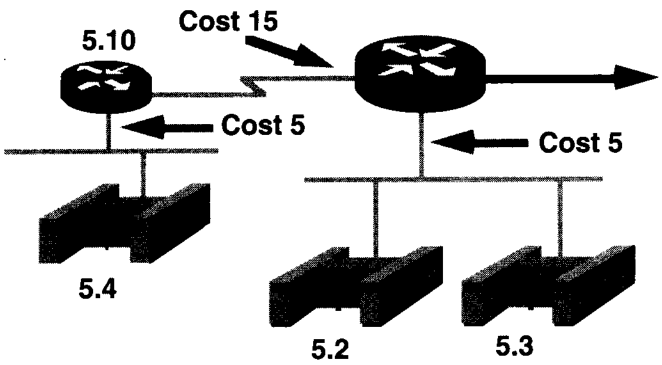
When DECnet initializes, the modified (software-supplied) MAC address is propagated onto each interface.

When a host boots, it advertises its presence. During normal operation, host reachability is advertised to local routers every 15 seconds.

End nodes (nonrouting hosts) have no knowledge of the network after they boot up. Only the designated router is known through its periodic announcements.

All traffic from the end node is forwarded to the designated router. As delivery responses from destination nodes are returned to the end node, addresses are placed in a cache. Traffic destined for nodes already in the cache will not be directed to the designated router.

Routers Pass Information



Routing Table

Host/Cost/Next Dest.

5.2	5	.
5.3	5	.
5.4	20	5.10

- **Routing decisions are based on cost**
- **Routing table contains host and cost information**
- **Routers know about all hosts in their area**

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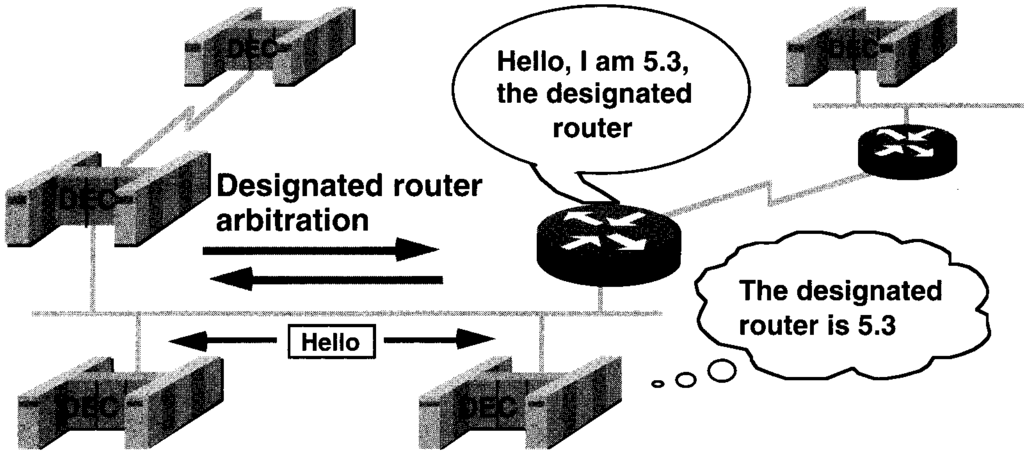
Periodic updates are sent by each router. These updates contain cost information to all reachable nodes within each router's area. Each interface has an outgoing cost associated with it. Routing decisions are based on total path cost.

Designated Routers



- **Routers and end nodes advertise their presence via hello messages**
- **Designated routers are chosen by highest priority**
- **Initial end-node traffic is always sent to the designated router**

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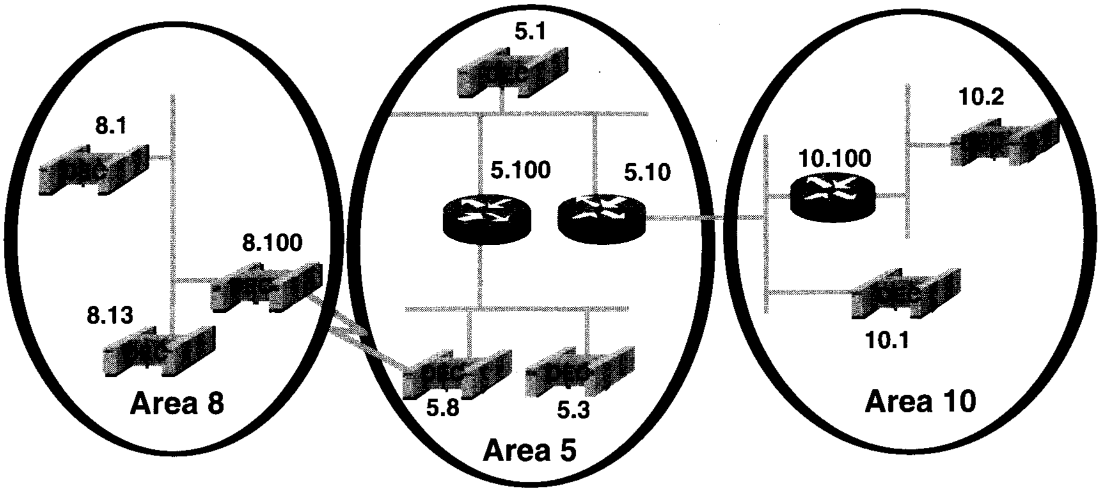
As each node powers up, it advertises its presence using the Hello protocol.

Periodic announcements are sent by each node to advertise their reachability.

The single DR is always known to end nodes because of periodic DR announcements. All traffic from an end node is initially sent to the designated router for forwarding. Later, the end nodes use a more direct path as network knowledge is acquired.

Level 1 and Level 2 Routing



- **Level 1—Inside your area**
- **Level 2—Between areas**

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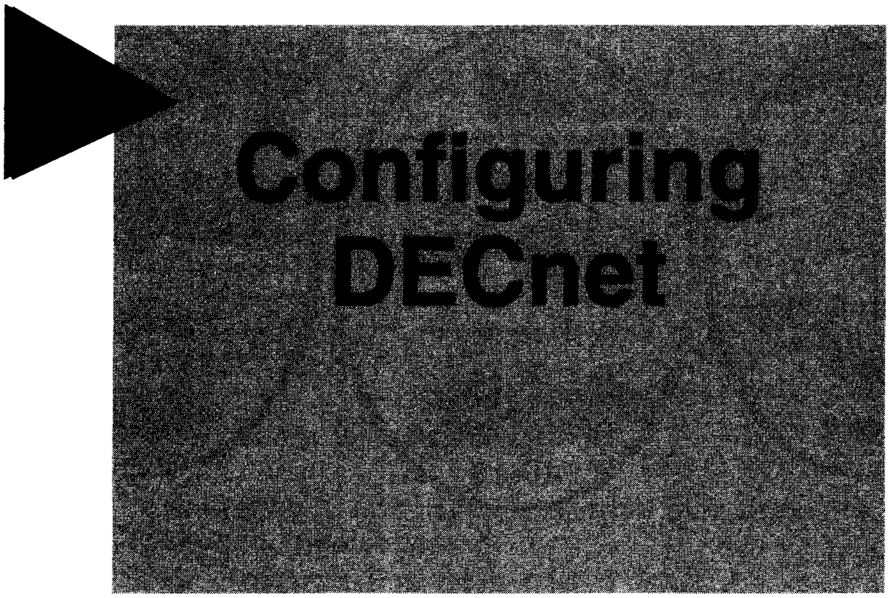
Routers that forward traffic within their own area are referred to as Level 1 routers. These routers have complete knowledge of all nodes within that area. These routers are referred to as routing-iv (a reference to Phase IV DECnet).

Routers that communicate between areas have knowledge of all nodes in their area and of the nodes that provide entry into other areas. These Level 2 routers are configured as area routers.



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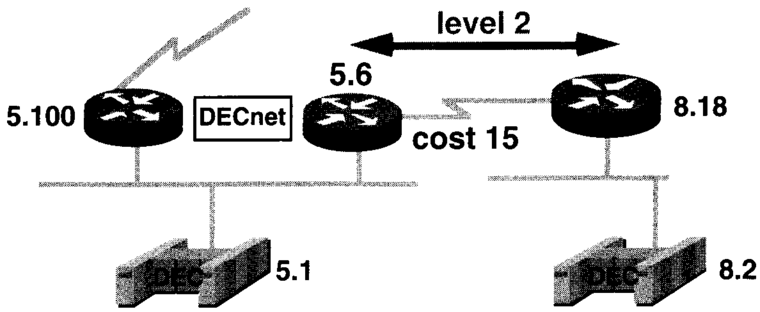
Configuring DECnet

DECnet Configuration Tasks



- **Global configuration**
  - — DECnet routing and address
  - — Routing Level 1 or 2
- **Interface configuration**
  - — Cost

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The activation of DECnet as a routing protocol requires setting global and interface parameters.

Global tasks:

- Start the DECnet routing process and assign a node address.
- Designate the router as a Level 1 or 2.

Interface task: Assign each interface an outgoing cost. There is no default value.

DECnet Configuration

Router (config) #

decnet [***network-number***] **routing [iv-prime]** ***decnet-address***

- **Enables DECnet routing and assigns the area and node address**

Router (config) #

decnet [***network-number***] **node-type** { **area** | **routing-iv** }

- **Assigns Level 1 or Level 2 responsibility**

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The **decnet routing** command starts the routing process and assigns an area.node address to the entire router.

The **decnet iv-prime** command also starts the DECnet routing process, but does not do the MAC address modification. This feature was added to reduce the conflict between other protocols that also modify MAC addresses.

The **decnet node-type** command establishes the routing characteristics of this router.

Routers are referred to as Level 1 routers if they perform the intra-area routing task and as Level 2 routers if they perform the interarea routing task.

Level 1 routing is specified as *routing-iv*, the default.

Level 2 routing is specified as *area*.

DECnet Configuration

Router (config-if) #

decnet cost *cost-value*

- **Assigns an outgoing cost**

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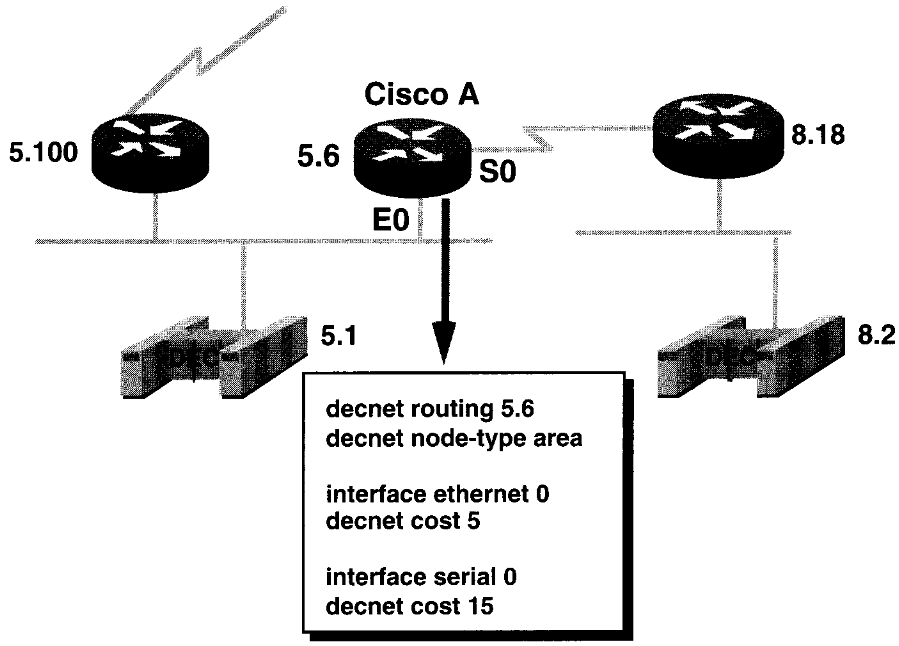
The **decnet cost** command enables DECnet on this interface and assigns a cost (from 1 to 63) to the interface.

There are no default costs. A cost must be assigned to each interface.

The cost assigned should be proportional to the speed of the media; the higher the bandwidth, the lower the cost associated with its use.

Path cost is the total of all outgoing interface costs used in the delivery of the datagram.

DECnet Configuration Example



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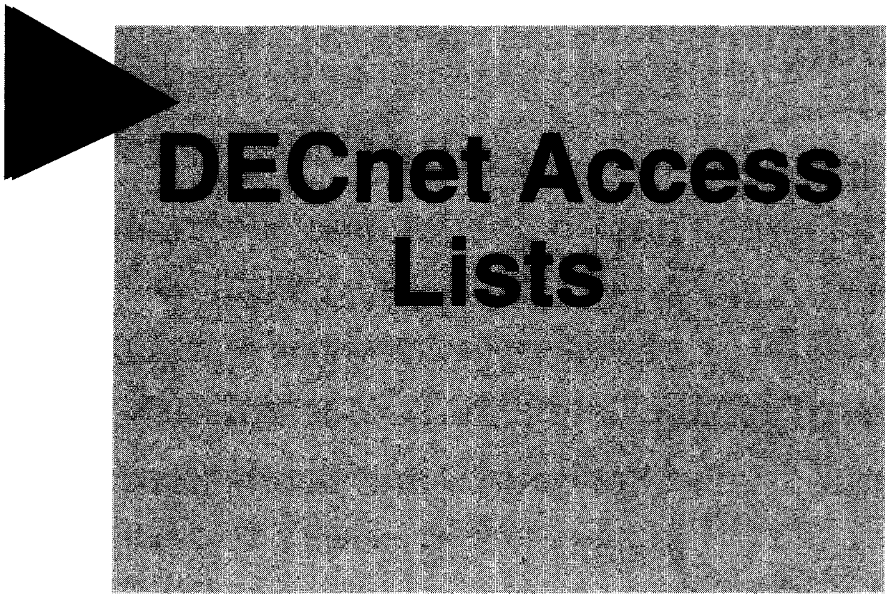
In the example:

Command	Description
decnet routing *5.6*	Enables DECnet routing and assigns the router an address of Area 5, Node 6.
decnet node-type area	Defines the router as a Level 2 interarea node.
decnet cost 15	Assigns an outgoing cost of 15 to the interface serial 0.

The router is assigned an address of 5.6 with area responsibility. Interface costs are assigned. There are no defaults.



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DECnet Access Lists

Key Concepts of DECnet Access Lists

- **DECnet address is area.node**
- **16-bit address has 10 bits for area, 6 bits for node**
- **Level 1 router is intra-area; Level 2 router is interarea**
- **Standard access lists filter source address**
- **Extended lists filter source and destination**

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The DECnet Phase IV suite of protocols designates an area.node for its addressing—16 bits decimal. Up to ten bits refer to the area. An area defines a Level 1 subnetwork containing nodes. Nodes refer to addresses having up to 6 bits.

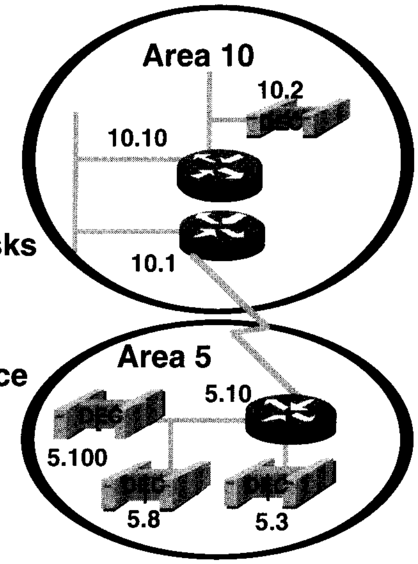
Traffic inside an area is referred to as intra-area. Routers for this type of traffic are configured as Level 1 routers. If traffic has a destination outside the area, a Level 2 router provides interarea links.

Standard access lists require the minimum of a source area and node address. A mask discussed in the next page can further express portions of the address to match for access testing purposes.

Extended access lists enable checking for destination addresses. Again, the optional mask can further refine the portion of the address to check with the access list.

DECnet Access List Procedures

- **Access list configuration**
  - **— Access list numbers: 300-399**
  - **— Enter source area addresses**
  - **— Optional: destination, wildcard masks**
- **Access group configuration**
  - **— Apply access list number to interface**
  - **— Use Level 2 routers between areas**



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To configure for both standard and extended access lists for DECnet, the access list number an administrator chooses must be within the range of 300-399.

The source address can be an entire area or an area.node.

The optional wildcard masks match bit-for-bit with the DECnet area.node address. As with other protocols, a zero in the wildcard mask indicates the corresponding bit in the DECnet address will be checked; a one in a wildcard mask bit position means the corresponding bit position in the DECnet address can be ignored during the access list test.

However, because the DECnet addressing uses decimal numbers, wildcard masking differs from masking used with IP addresses. For example, to mask all bits in a DECnet area address, express the "all-ones" mask as 1023 (1111111111).

Apply the access list to one or more interfaces using the **access-group** command.

If the traffic to control has its destination on another DECnet area, it must cross a Level 2 router. An access list specifying only source address must be placed near the destination. Depending on the specific controls and masking required, this may be at the appropriate Level 2 interface.

Controlling DECnet Access

Router (config) #

access-list ***access-list-number*** **{ permit | deny }**
source source-mask **[** ***destination destination-mask*** **]**

- **Traffic filter using access lists**

Router (config-if) #

decnet access-group ***access-list-number***

- **Links filter list to outgoing interface**

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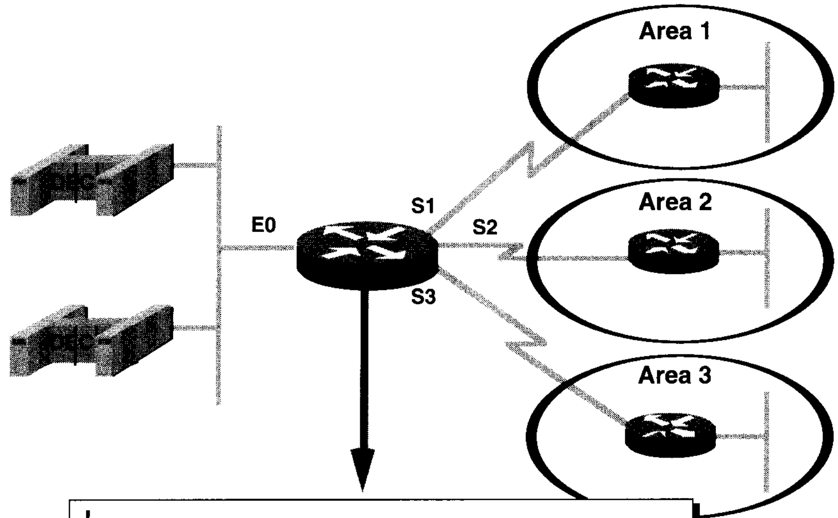
The **access-list** command is used to make an entry in a traffic filter list.

access-list field descriptions:

Command	Description
access-list-number	Integer you choose from 300 to 399 that uniquely identifies the access list.
permit	Permits access when there is an address match.
deny	Denies access when there is an address match.
source	Source address. DECnet addresses are written in the form area.node. For example, 50.4 is node 4 in area 50. All addresses are in decimal.
source-mask	Mask to be applied to the address of the source node. All masks are in decimal.
destination (optional)	Destination node's DECnet address in decimal format. DECnet addresses are written in the form area.node. For example, 50.4 is node 4 in area 50.
destination-mask (optional)	Mask to be applied to the address of the destination node. All masks are in decimal.

The **decnet access-group** command is used to link an access list to the selected interface.

Controlling DECnet Example




```
!
access-list 301 permit 1.0  0.1023  0.0  63.1023
access-list 301 permit 3.0  0.1023  0.0  63.1023
!
interface ethernet 0
decnet access-group 301
```

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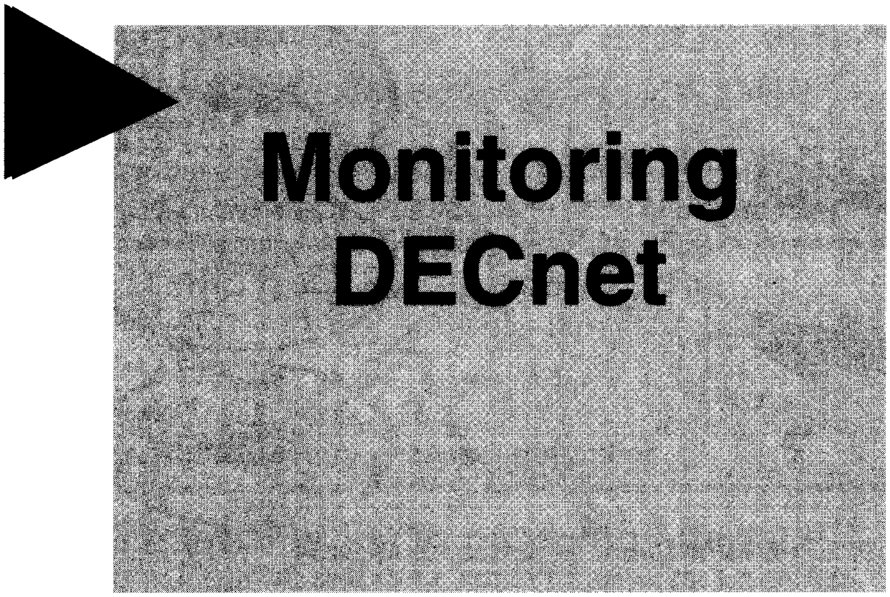
In the example:

access-list 301 permit 1.0 0.1023 0.0 63.1023 Command	**Description**
301	Access list number in the range indicating a DECnet list.
permit	Traffic that matches selected parameters will be forwarded.
1.0	Source address, area 1.
0.1023	Source address mask; the 0 indicates that the area number must match. The 1023 is the node number mask; all ones indicates a don't care condition.
0.0	Destination address; all zeros is a placeholder.
63.1023	Destination address mask; all ones in both the area and node portions indicate a don't care condition.
decnet access-group 301 Command	Links the access list to interface Ethernet 0.

Access list 301 is configured to allow traffic from any node in areas 1 and 3 to be forwarded out interface Ethernet 0. It implies that no other traffic will be permitted. (The end of a list contains an implicit deny all else statement.)



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Monitoring DECnet

Monitoring DECnet

```
Router# show decnet interface
Global DECnet parameters for network 0:
  Local address is 33.22, node type is area
  Level-2 'Attached' flag is FALSE
  Maximum node is 1023, maximum area is 63, maximum visits is 63
  Maximum paths is 2, path split mode is normal
  Local maximum cost is 1022, maximum hops is 30
  Area maximum cost is 1022, maximum hops is 30
 --More--
Ethernet0 is up, line protocol is up, encapsulation is ARPA
  Interface cost is 5, priority is 64, DECnet network: 0
  We are the designated router
  Sending HELLOs every 15 seconds, routing updates 40 seconds
  Smallest router blocksize seen is 1498 bytes
  Routing input list is not set, output list is not set
  Access list is not set
  DECnet fast switching is enabled
  Number of L1 router adjacencies is : 1
  Number of non-PhaseIV+ router adjacencies is : 1
  Number of PhaseIV+ router adjacencies is : 0
 --More--
```

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Use the **show decnet interface** command to display status about all DECnet interfaces, including line status, timers, and access lists assigned.

Monitoring DECnet (cont.)

```
Router# show decnet route
  Area        Cost  Hops   Next Hop to Node       Expires  Prio
*33            0     0      (Local) -> 33.22
*63            5     1    Ethernet1 -> 63.50        37      64     A
  Node        Cost  Hops   Next Hop to Node       Expires  Prio
*(Area)        0     0      (Local) -> 33.22
*33.1          5     1    Ethernet0 -> 33.1         43      64     V
*33.3         25     2      Serial1 -> 33.4
 33.3         25     2      Serial0 -> 33.4
 33.4         20     1      Serial1 -> 33.4         39      64     V
*33.4         20     1      Serial0 -> 33.4         33      64     V
*33.22         0     0      (Local) -> 33.22
```

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Use the **show decnet route** command to display the contents of the DECnet routing table.

Monitoring DECnet (cont.)

```
Router# show decnet traffic
Total: 403781 received, 0 format errors, 0 unimplemented
       0 not a gateway, 0 no memory, 3 no routing vector
       0 congestion encountered
Hellos: 239348 received, 0 bad, 0 other area, 399223 sent
Level 1 routing: 149429 received, 0 bad, 0 other area, 104915 sent
Level 2 routing: 15004 received, 0 not primary router, 119909 sent
Data: 0 received, 0 not long format, 0 too many visits
      0 forwarded, 0 returned, 0 converted, 0 local destination
      0 access control failed, 0 no route, 617 encapsulation failed
      0 inactive network, 0 incomplete map
```

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The **show decnet traffic** command is used to show different forms of traffic that have arrived at the router.

Monitoring DECnet (cont.)

```
Router# debug decnet routing
DECnet routing debugging is on
Router#
DNET-RT: Received level 1 routing from 33.1 on Ethernet0 at 22:39:09
DNET-RT: Received level 1 routing from 33.1 on Ethernet0 at 22:39:09
DNET-RT: Received level 2 routing from 63.50 on Ethernet1 at 22:39:09
DNET-RT: Sending routes
DNET-RT: Sending periodic L1 routing updates on Ethernet0
DNET-RT: Sending periodic L2 routing updates to PhaseIV+ multicast on Ethernet0
DNET-RT: Sending periodic L2 routing updates to old PhaseIV multicast on Ethernet0
DNET-RT: Sending periodic L1 routing updates on Ethernet1
DNET-RT: Sending periodic L2 routing updates to PhaseIV+ multicast on Ethernet1
DNET-RT: Sending periodic L2 routing updates to old PhaseIV multicast on Ethernet1
DNET-RT: Sending periodic L1 routing updates on Serial0
DNET-RT: Sending periodic L2 routing updates to PhaseIV+ multicast on Serial0
DNET-RT: Sending periodic L2 routing updates to old PhaseIV multicast on Serial0
DNET-RT: Sending periodic L1 routing updates on Serial1
DNET-RT: Sending periodic L2 routing updates to PhaseIV+ multicast on Serial1
DNET-RT: Sending periodic L2 routing updates to old PhaseIV multicast on Serial1
DNET-RT: Received level 1 routing from 33.4 on Serial1 at 22:39:29
DNET-RT: Received level 1 routing from 33.4 on Serial1 at 22:39:30
```

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Use the **debug decnet routing** command to display routing update messages.

Summary

DECnet addressing is area.node

One address is assigned to the entire router

DECnet modifies MAC addresses on all interfaces

Routers function within or between areas

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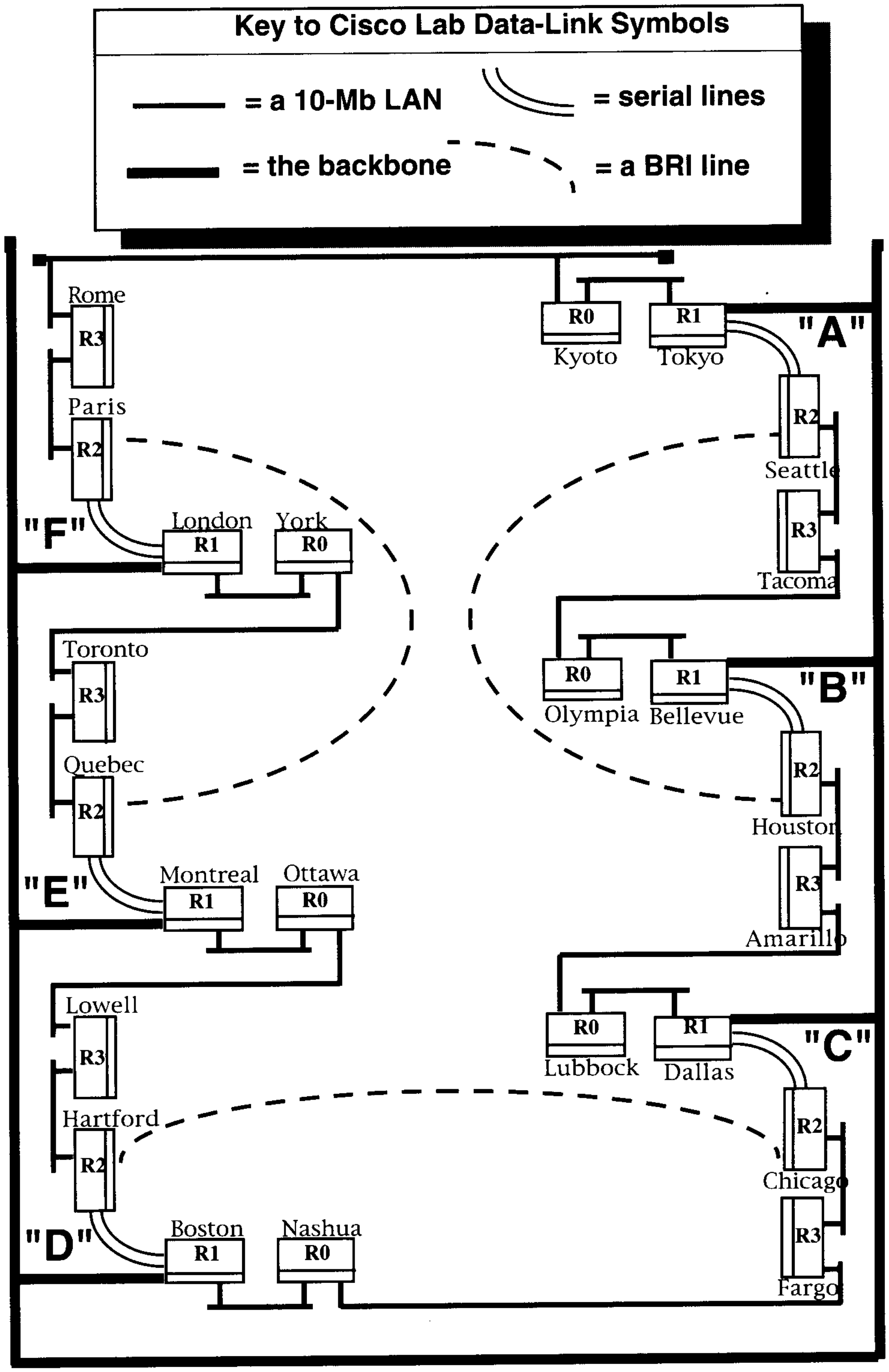
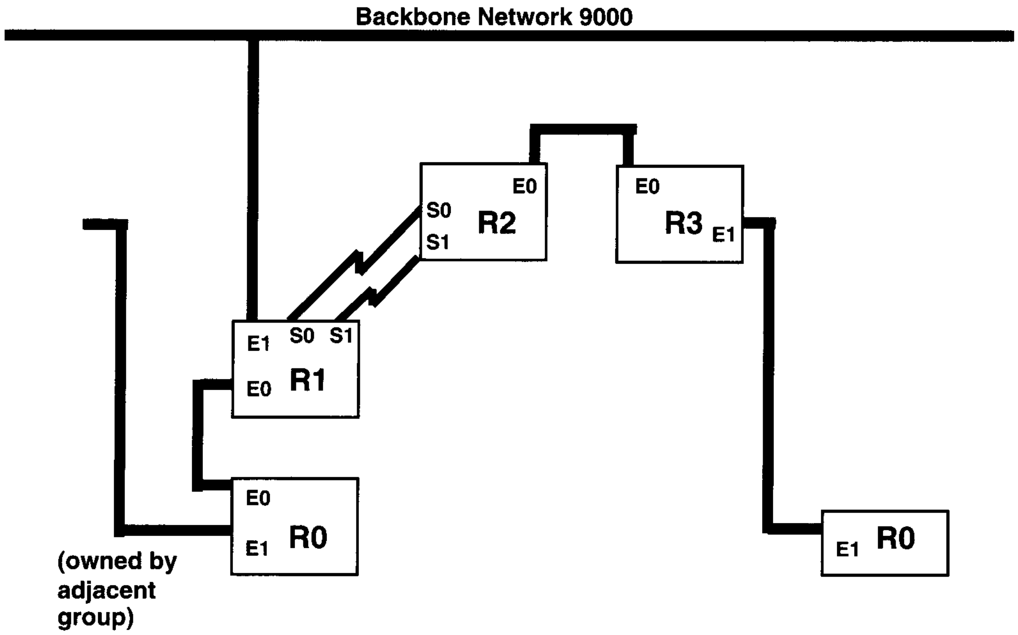
Lab: DECnet Implementation

Map of the Classroom/Lab Internetwork





Workgroup	Area
A	21
B	22
C	23
D	24
E	25
F	26

Media Type	Cost
Token Ring	3
Ethernet	5
Serial 56 Kb	20

Routing Type	Usage	Keyword
Level 1	Within an area	*routing-iv*
Level 2	Between areas	*area*

Lab: DECnet Planning Worksheet

Objective: Enable DECnet protocol and configure DECnet interfaces.

Objective: Monitor DECnet operation in the router.

Step 1 Given the area for your group, assign a unique area.node combination to each router within the group.

Step 2 Determine whether the router requires a Level 1 or Level 2 configuration.

Group: __________ Area:_______________

Router	DECnet Area	Level
R0		
R1		
R2		
R3		

Step 3 Record the MAC addresses for your router prior to DECnet configuration using the **show interface** command.

Router Name:____________________ Router Number:__________

Interface	MAC Address

DECnet Implementation

Instructions: Using the work from the previous lab, we will form a DECnet internetwork within the training lab. Configure DECnet and establish connectivity within your workgroup. Next, expand your network connectivity to incorporate the rest of the groups in the room.

Step 1 Shut down all E1 interfaces that connect your network to other groups.

Step 2 Using the **configure** command, start DECnet routing of the appropriate type (Level 1 or Level 2).

Step 3 Assign the DECnet network and node number to the router.

Step 4 Use the **show decnet interface** command to verify address assignment.

Step 5 Use the **show decnet route** command to verify entries in the routing table.

Step 6 Reactivate E1 interfaces and expand your network to incorporate the room.

Step 7 Use the IP addresses of the E0 interface to **telnet** to routers in your workgroup.

Step 8 Use the **show interface** command to discover the MAC address after DECnet configuration on all interfaces on routers in your workgroup and record them on the DECnet Implementation Worksheet on the next page.

Step 9 Save the configuration of your router in nonvolatile memory.

DECnet Implementation Worksheet

Instructions: Discover and record the MAC address after DECnet configuration.

Router R0 host name:

Interface	MAC Address	DECnet Cost
E0		
E1		

Router R1 host name:

Interface	MAC Address	DECnet Cost
E0		
E1		
S0		
S1		

Router R2 host name:

Interface	MAC Address	DECnet Cost
E0		
S0		
S1		

Router R3 host name:

Interface	MAC Address	DECnet Cost
E0		
E1		

APPENDIX B

Configuring Banyan VINES

▶Objectives

Upon completion of this chapter, you will be able to perform the following tasks:

Describe the VINES protocol stack

Describe key features of VINES

Enable VINES protocol and configure VINES interfaces

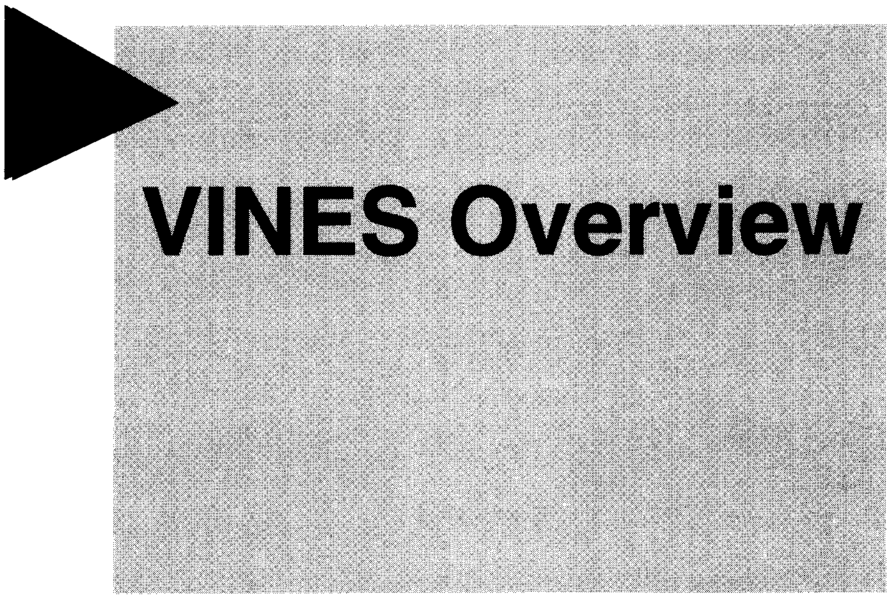
Monitor VINES operation in the router

2

This chapter explains how to configure Banyan VINES routing on Cisco routers.

Sections:

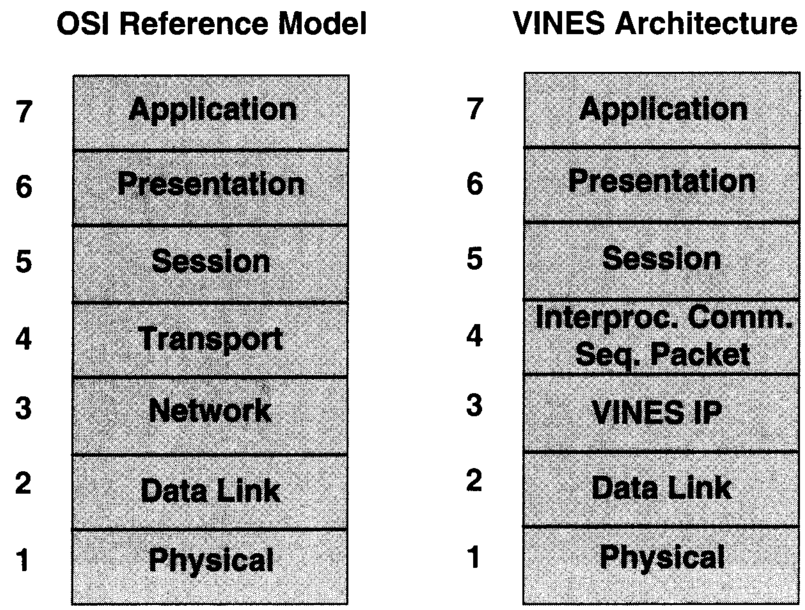
- VINES Overview
- Configuring VINES
- VINES Access Lists
- Monitoring VINES Operation



3

VINES Overview

VINES Protocol Stack



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Banyan Virtual Integrated Network Service (VINES) is a proprietary protocol of Banyan Systems.

The VINES protocol stack has seven layers, as does the OSI reference model. The VINES implementation changes occur at Layers 3 and 4.

Layer 3 contains VINES Internet Protocol (IP) as a connectionless datagram delivery protocol. This protocol is similar to the IP in TCP/IP and it can interoperate in a TCP/IP environment.

Layer 4 transport protocols are the Interprocess Communications Protocol (IPC) and the Sequenced Packet Protocol (SPP). These VINES-specific protocols provide a connection-oriented, reliable transport mechanism. IPC also supports unreliable datagram service.

VINES Features

- Address is 48 bits (network:subnet)
- Dynamic address assignment
- Multiple virtual networks per wire
- Client/server based
- Routing protocol is Routing Update Protocol (RTP)
  - Updates sent at 90-second intervals
  - Metric is delay
- Cisco also supports Sequenced RTP

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Routing Update Protocol (RTP) is the network-layer protocol responsible for propagating routing updates. Routing decisions are based on a "delay" metric. The administrator can assign the delay metric to each interface. If not defined statically, a delay metric based on bandwidth is assigned to the interface. The delay metric is multiplied by 200 ms to represent it in a usable "time interval" format. Time interval values from different interfaces can then be compared more easily.

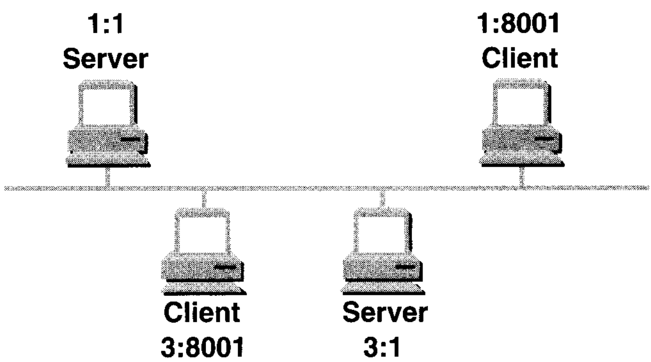
VINES messages are generated at 90-second intervals:

- Clients send hellos
- Servers send hellos and updates
- Routers send routing updates

Cisco also supports the Sequenced Routing Update Protocol (SRTP). This more recent routing protocol uses an update-based scheme for routers and servers to communicate routing changes.

▶VINES Addressing

Network:Subnet



- **Each server has a unique network number**
- **Clients use the addressing space of their server**

6

A VINES address has 48 bits.

Network—32 bits

- A network number is a unique value assigned to each server.
- Banyan servers have a hardware key that provides their addresses.
- The network number is used to assign the client to one of several possible virtual networks.

Subnet—16 bits

- This value is equivalent to a host number.
- Values are hexadecimal.
- Values are assigned by function; 1 is used for a server, 8001-FFFF is used for clients.
- Client numbers are usually assigned incrementally beginning at 8001.

Cisco VINES Network Numbers

0000.0c01.58b4	0 1 5 8 b 4
	21 bits of MAC address
300	3 0 0
	Cisco's block range
	3 0 0 1 5 8 b 4

3 0 0 1 5 8 b 4: 1 — Router takes subnet value of a server

7

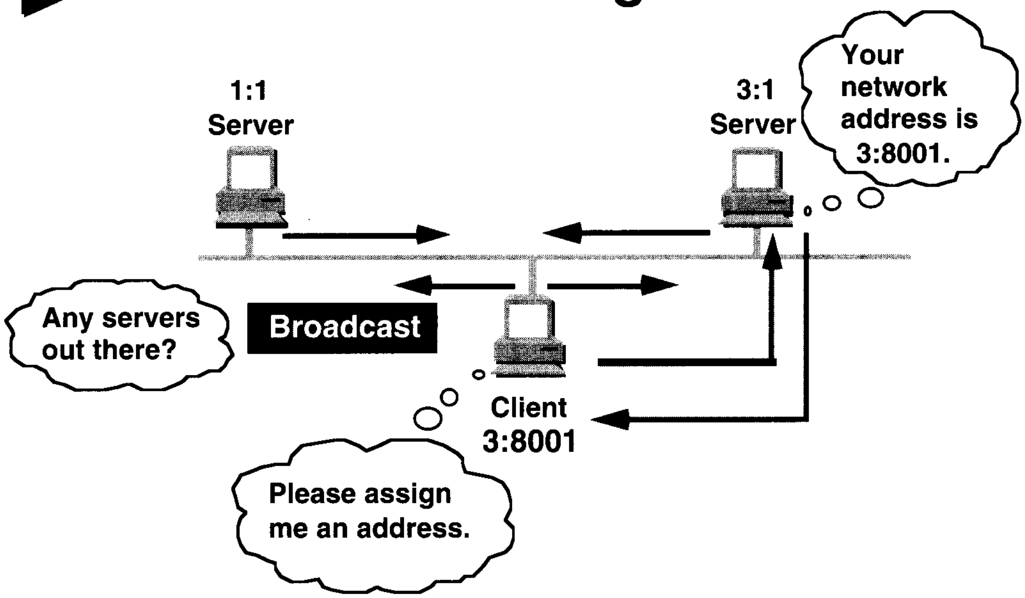
Assignment of the network number is optional.

Cisco's assigned address block is hexadecimal 300.

Cisco addresses are created from the lower 21 bits of the Ethernet or Token Ring interface Media Access Control (MAC) address. These bits are placed behind a block address of 300. The resulting value is used by the router as its network number.

- Given: 0000.0c01.58b4 (Ethernet 0 MAC address).
- The Cisco router takes the Banyan server number of 300158b4:1. The server subnet value of 1 is assigned to routers.

Host Address Assignment



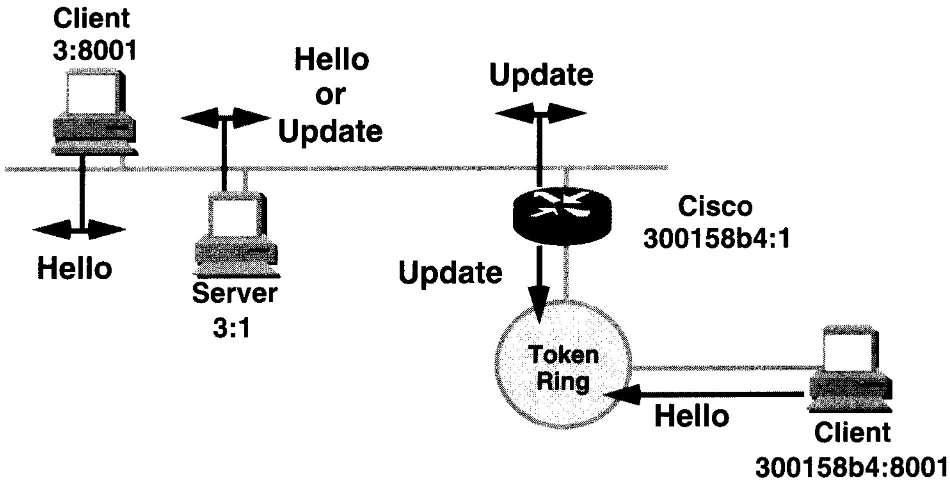
8

A VINES client has no address on startup.

A broadcast message, using the VINES Address Resolution Protocol (ARP), is sent to notify servers that a new client requires address assignment.

The first server to respond to the request assigns the client address based on that server's network number and the next available subnet number.

▶Hello Messages



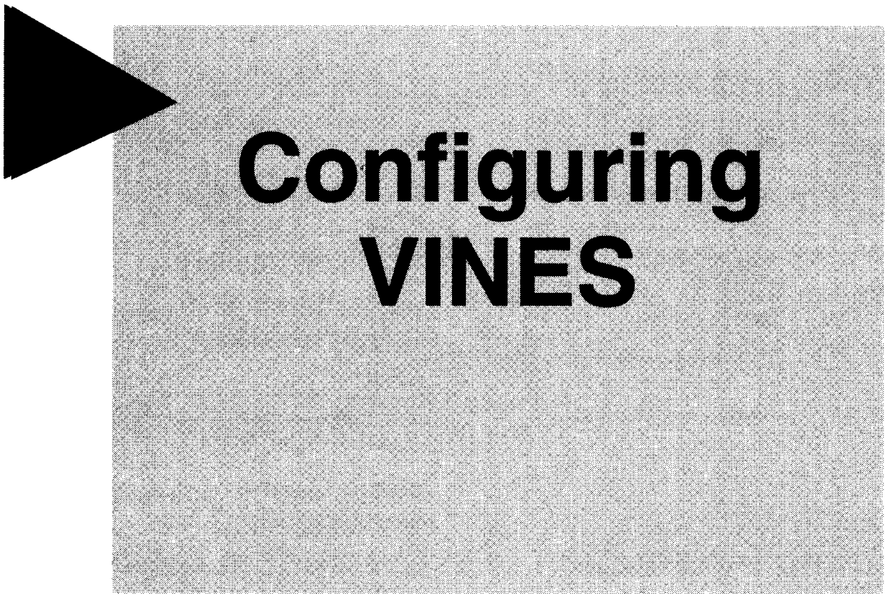
- **Routing information is in the update message**

9

Clients send hellos at 90-second intervals.

Servers send hello and update messages at 90-second intervals.

Cisco routers send update messages at 90-second intervals. Routing information is included in the periodic updates.



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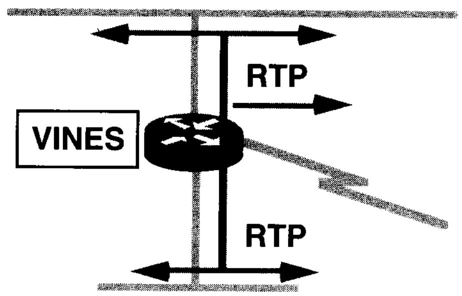
Configuring VINES

VINES Configuration Tasks

- **Global configuration**
  - **VINES routing**
- **Interface configuration**
  - **Assign metric**
  - **Serverless environment**



11

Selecting VINES as a routed protocol requires configuring both global and interface parameters.

Global task: Start the VINES routing process.

Interface tasks:

- Assign a VINES metric on each interface. A default metric is selected if none is specified by the network administrator. The metric value is based on the bandwidth capability of each media.
- On segments where there is no VINES server, the router assigns client addresses and propagates client service broadcasts to the nearest server.

VINES Configuration

Router (config) #

vines routing [***address*** | **recompute**]

- **Enables VINES routing**

Router (config-if) #

vines metric [***whole*** [***fractional***]]

- **Enables interface to participate in VINES network**

12

The **vines routing** command starts the VINES routing process.

Cisco maps to a reserved server network address based on a block of addresses assigned by Banyan. The address created contains 21 bits from the MAC address of an Ethernet or Fiber Distributed Data Interface (FDDI). Use the optional **address** field if you do not have an Ethernet or FDDI (no MAC address) present in the router.

If two routers on the same media have the same address because the addresses were not hard coded, use the optional **recompute** keyword to force random address selection.

The **vines metric** command turns on VINES processing in this interface. This configuration statement is required for each interface. Specify the optional integer value for *whole* to assign a value for interface usage.

If no metric is specified, the Cisco router uses a default metric based on the bandwidth of the link.

Interface Type	Delay Metric Value
Ethernet	2
16-Mb Token Ring	2
4-Mb Token Ring	4
56-Kb Serial	45
9600 Serial	90

VINES Configuration (cont.)

Router (config-if) #

vines arp-enable [**dynamic**]

- **Allows router to assign client addresses**

Router (config-if) #

vines serverless [**dynamic** | **broadcast**]

- **Propagates certain broadcasts to nearest server**

13

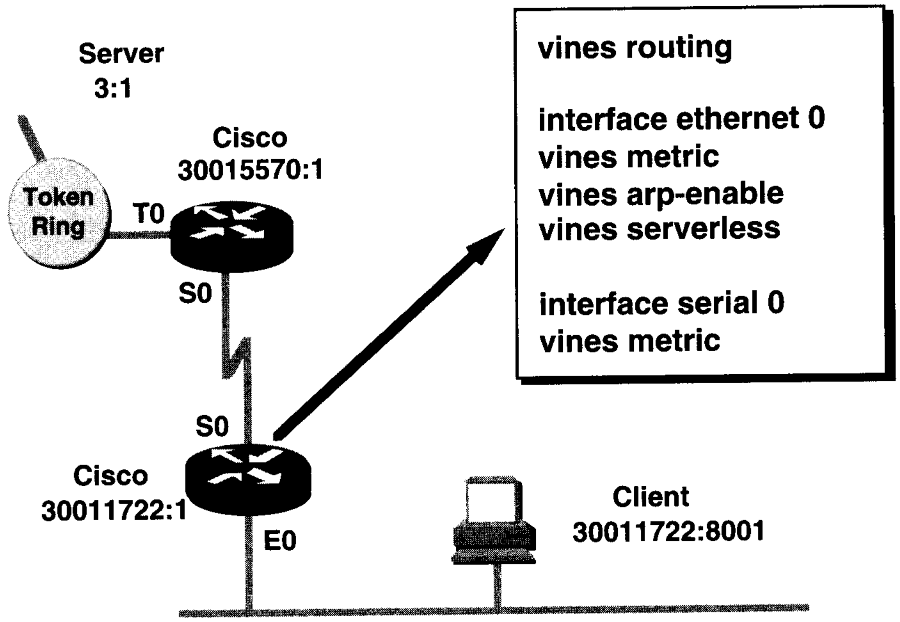
The **vines arp-enable** command allows the router to assign client addresses. The optional keyword **dynamic** should be used on segments that have no VINES server present. If no option is specified, the router responds to all ARP requests, even if a VINES server is present on this network.

The **vines serverless** command allows the propagation of certain broadcast packets by the router. These broadcast packets will be forwarded to the nearest server.

vines serverless Command	Description
dynamic	Forward the broadcast packet to one server.
broadcast	Forward the broadcast to all servers available on all outgoing interfaces.

The use of the **vines serverless** command is limited to segments that do not have servers.

VINES Configuration Example



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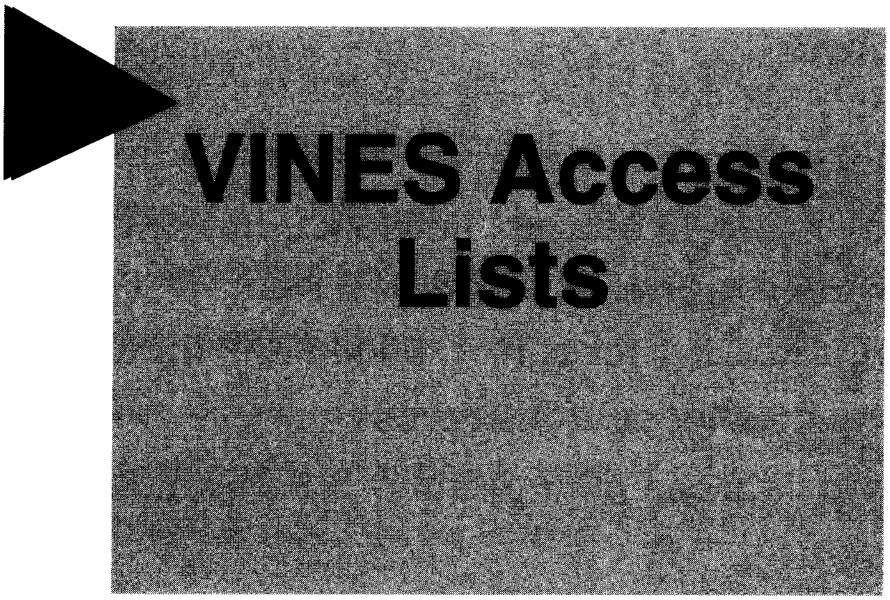
In the example:

Command	Description
vines routing	Starts the VINES routing process.
vines metric	Enables Ethernet 0 for VINES packet processing. A default metric will be used on the interface.
vines arp-enable	Enables the router to respond to VINES ARP requests. ARP requests are issued when the client requires address assignment at startup.
vines serverless	Enables the router to forward service broadcasts to the nearest VINES server.

With these commands, the VINES routing process is enabled. The router responds to address assignment requests and forwards broadcast service requests that arrive on interface Ethernet 0.



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VINES Access Lists

Key Concepts for VINES Access Lists

- **A VINES network is the server itself**
- **Addresses are 48 bits hex network:subnetwork**
  - **8 numbers for net and 4 numbers for subnet**
- **Subnet is node: 1 for server; 8000-FFFF for host**
- **Simple lists filter source address**
- **Standard lists can filter protocol, source, destination**

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Unlike other networking protocols, the VINES network number refers to a device: The VINES network refers to the server itself, rather than the link between devices. This reference also applies to a Cisco router configured to route VINES.

The VINES network address is 32 bits long, expressed as 8 hexadecimal numbers; the subnetwork numbers refer to hosts or clients connecting to the server. The subnet number is 16 bits long expressed as a 4-bit hex number. A colon separates the VINES network and subnetwork numbers.

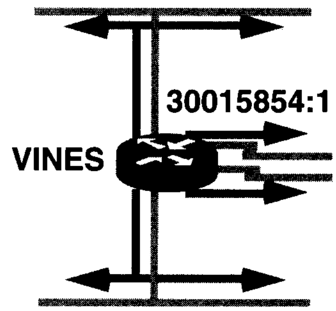
Subnets (nodes or hosts) use the number 1 if they are servers; or if clients, they use a dynamically assigned number from a hexadecimal range beginning at 8000 and ending at FFFF.

The minimal form of VINES access lists is the simple access list. For this filter enter a source VINES address only. The router permits or denies All VINES packets using this type of access list.

Administrators using a standard VINES access list can also filter on a specific VINES protocol as well as the source and destination addresses.

VINES Access List Procedures

- **Access list configuration**
  - **Standard list numbers: 1-100**
  - **Specify VINES protocol or ID**
  - **Enter source and destination**
- **Access group configuration**
  - **Apply access list number to interface**
  - **Only one access list per interface**



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With VINES, the global command for a standard access list includes the word "vines" in the command itself. It uses an access list number range of 1-100.

With standard access lists, the administrator also specifies a protocol by name or by number. For more details on VINES protocol keyword or ID numbers, refer to the information in the command reference document.

VINES source and destination address arguments for access list statements point to the network. The administrator uses these to control packet traffic between systems. The number shown on the graphic is representative of a network number used by Cisco routers.

Once the administrator applies a VINES access list to a router interface, it will permit or deny outgoing traffic matching the access list statements. Packets generated by the router itself are not subject to the access list controls.

Controlling VINES Access

Router (config) #

vines access-list ***access-list-number*** **{ deny | permit }** ***protocol source-address source-mask*** **[** ***source-port*** **]** ***destination-address destination-mask*** **[** ***destination-port*** **]**

- **Establishes parameters in a list entry**

Router (config-if) #

vines access-group ***access-list-number***

- **Links traffic filter to an interface**

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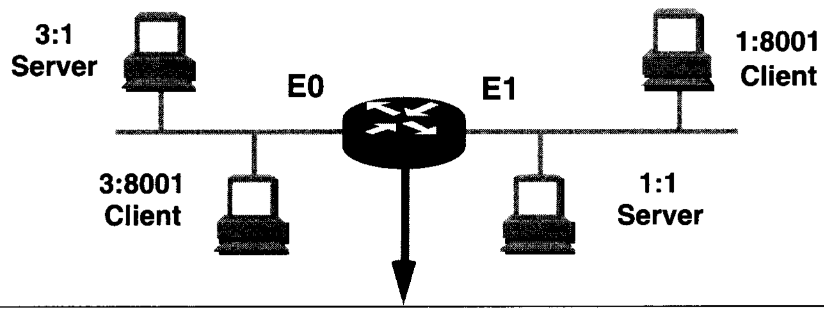
The **vines access-list** command is used to create an entry in the traffic filter list.

vines access-list Command	Description
access-list-number	Number of the access list; a decimal number from 1 to 300.
deny	Denies access if the conditions are matched.
permit	Allows access if the conditions are matched.
protocol	VINES protocol ID number or name; can be a value from 1 to 255 or one of the following protocol keywords: • ICP—Internet Control Protocol • IP—VINES Internet Protocol • IPC—Interprocess Communications • SPP—Sequenced Packet Protocol
source-address	Address of the network from which the packet is being sent. This is a 6-byte hexadecimal number in the format network:host, where network is 4 bytes and host is 2 bytes.
source-mask	Mask to be applied to source-address. This is a 6-byte hexadecimal value. Place ones in the bit positions you want to mask. These bits correspond to the bit in the address that should be ignored.

VINES Access Example




```
vines access-list 1 deny   IPC 0:0  ffffffff:ffff  0xf  0:0  ffffffff:ffff  0xf
vines access-list 1 permit  IP  0:0  ffffffff:ffff   0:0  ffffffff:ffff
(implicit deny all)

interface ethernet 1
vines metric
vines access-group 1
```

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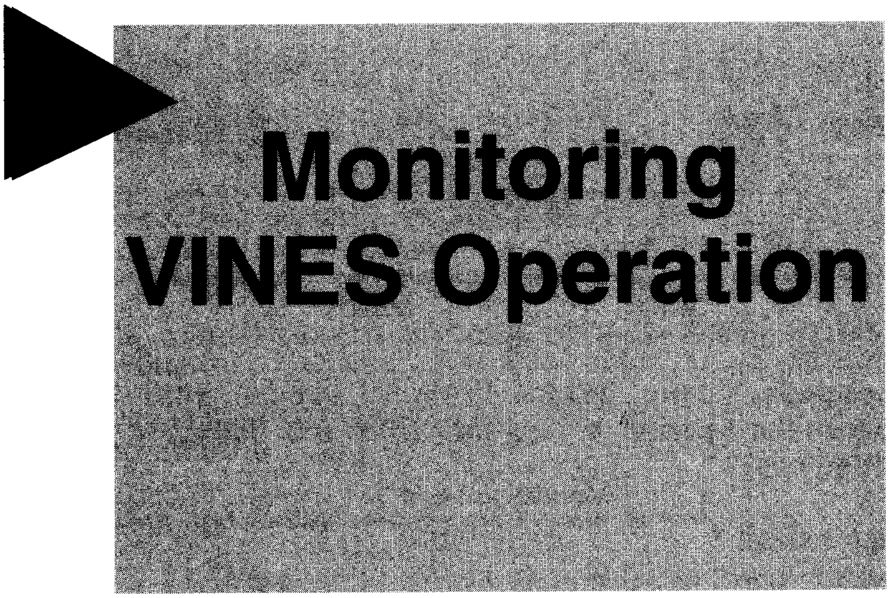
In the example:

vines access-list 1 deny IPC 0:0 ffffffff:ffff 0xf 0:0 ffffffff:ffff 0xf

Command	Description
1	VINES access list number.
deny	Traffic matching selected parameters will be blocked.
IPC	Protocol keyword, transport layer.
0:0	Source address, a placeholder.
ffffffff.ffff	Source address mask; all ones means no match required.
0xf	Source port number, specifies the StreetTalk application.
0:0	Destination address, a placeholder
ffffffff:ffff	Destination address mask; all ones means no match required.
0xf	Destination port, the StreetTalk application.

vines access-list 1 permit IP 0:0 ffffffff:ffff 0:0 ffffffff.ffff

Command	Description
IP	Protocol keyword, network layer.
0:0	Source address, a placeholder.
ffffffff:ffff	Source address mask; all ones means don't care.



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Monitoring VINES Operation

Monitoring VINES

```
Router# show vines interface
VINES address is 300314D8:0001
  Next client will be 300314D8:8001
  Addresses are displayed in hexadecimal format.
  Slowest update interval is 90 seconds
  Roll Call timer queue:
    Neighbor 300313D3:0001-Se0-311087654321 in 00:59:57.
    Neighbor 300313D3:0001-Se1-HDLC in 00:59:57.
Ethernet0 is up, line protocol is up
  VINES broadcast encapsulation is ARPA
  Interface metric is 0020 [2] (0.4000 seconds)
  Split horizon is enabled
  ARP processing is dynamic, state is service
  Serverless is dynamic
  Special propagation of broadcasts is dynamic
  Outgoing access list is not set
  Fast switching is enabled
  Routing updates every 90 seconds.  Next in 28 seconds.
  Nodes present: 0 5.5x servers, 0 5.5x routers, 0 5.5x clients
                 0 4.11 servers, 1 4.11 routers, 0 4.11 clients
  Neighbors:
    0 30023000:0001
Ethernet1 is up, line protocol is up
  VINES broadcast encapsulation is ARPA
 --More--
```

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Use the **show vines interface** command to display the status of the interface. The status information includes addresses, update timers, and presence of access lists.

Monitoring VINES (cont.)

```
Router# show vines route
5 servers, 5 routes, version 29, next update 12 seconds

Network          Neighbor          Flags    Age    Metric    Uses

3000A3C2         3000A3C2:0001     R0*        4      0020       0
30023000         30023000:0001     R0*       48      0020       0
30025166         300313D3:0001     R0*       20      02F0       0
300313D3         300313D3:0001     R0*       20      02D0       0
300314D8         -                 C1         -         -       -
```

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Use the **show vines route** command to display the contents of the VINES routing table.

Monitoring VINES (cont.)

```
Router# show vines neighbor
4 neighbors, 5 paths, version 19, next update 88 seconds

Address          Hardware Address    Type  Int     Flag Age  Metric   Uses

3000A3C2:0001    aa00.0400.32fc      ARPA  Et1     R0*   18   0020      0
30023000:0001    aa00.0400.0184      ARPA  Et0     R0*   62   0020      0
300313D3:0001    311087654321        X25   Se0     R0*   34   02D0      0
300313D3:0001    HDLC                HDLC  Se1     R0.   34   02D0      0
300314D8:0001    -                   -     -       C     -    -         -
```

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Use the **show vines neighbor** command to display the content of the neighbor table. This table contains host names, MAC addresses, encapsulation type, and interface port information.

Monitoring VINES (cont.)

```
Router# debug vines routing verbose
Vines routing verbose debugging is on
Vines routing debugging is on
Router#
VRTP: received update from 300313D3:0001 on Serial0
    network 300313D3 from the server
    network 30025166, metric 20 (0.4000 seconds)
VRTP: received update from 300313D3:0001 on Serial1
    network 300313D3 from the server
    network 30025166, metric 20 (0.4000 seconds)
VRTP: received update from 3000A3C2:0001 on Ethernet1
    network 3000A3C2 from the server
VRTP: generating update for Broadcast on Ethernet0
    network 3000A3C2, metric 20 (0.4000 seconds)
    network 30025166, metric 2F0 (9.4000 seconds)
    network 300313D3, metric 2D0 (9.0000 seconds)
VRTP: sent update to Broadcast on Ethernet0
VRTP: generating update for Broadcast on Ethernet1
    network 30023000, metric 20 (0.4000 seconds)
    network 30025166, metric 2F0 (9.4000 seconds)
    network 300313D3, metric 2D0 (9.0000 seconds)
```

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Use the **debug vines routing** command to display the contents of the periodic routing updates.

Summary

- VINES adressing is network:subnet
- Client addresses are dynamically acquired
- Routers can supply client addresses in a serverless environment
- Multiple virtual networks allowed for each media
- Provides a connection-oriented, reliable transport layer

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Lab: Banyan VINES Implementation

Objective: Enable VINES protocol and configure VINES interfaces.

Objective: Monitor VINES operation in the router.

Instructions: Banyan VINES requires little network address planning because the addresses are dynamically assigned. Configure Banyan VINES and establish connectivity within your workgroup. Next, expand your network connectivity to incorporate the rest of the groups in the room.

Step 1 Shut down all E1 interfaces that connect your network to other groups.

Step 2 Using the **configure** command, start VINES routing.

Step 3 Assign a VINES metric to each interface.

What is the default vines metric for Ethernet? For serial lines?

Step 4 Use the **show vines interface** command to verify address assignment.

Step 5 Use the **show vines route** command to verify entries in the routing table.

Step 6 Use the **ping** command to verify connectivity across your workgroup.

Step 7 Reactivate E1 interfaces and expand your network to incorporate the room.

Step 8 Use the IP addresses of the E0 interface to **telnet** to routers in other groups in the network.

Step 9 Use the **show vines interface** command to discover the VINES address on the remote router.

Step 10 Use the **ping** command to verify VINES connectivity across all workgroups.

Step 11 Once you have confirmed that connectivity has been established, save the configuration of your router in nonvolatile memory.

VINES Investigation

Step 1 Use the **telnet** command to establish a remote session with each router in your group.

Step 2 Use the **show vines interface** command to discover the dynamically assigned VINES addresses for each interface and record them in the following table.

Step 3 What do all of the VINES interfaces within a router have in common?

Group: __________

Router R0 host name:

Interface	VINES Address
E0	
E1	

Router R1 host name:

Interface	VINES Address
E0	
E1	
S0	
S1	

Router R2 host name:

Interface	VINES Address
E0	
S0	
S1	

Router R3 host name:

Interface	VINES Address
E0	
E1	

APPENDIX C

Sample Configurations

After all the labs have been completed in the "Introduction to Cisco Router Configuration" course, the Cisco router configuration should look something like the following:

```
! In a configuration file, all comment lines begin with an "!"
! These comment lines are stripped off by the cisco equipment when loaded to preserve memory space.
!
! Set up name of cisco router.
hostname Tokyo
!
! This command sets the password for enable level access.
enable-password san-fran
!
!
! This command enables DEC routing. This cisco router is Area 7, Node number 1023.
decnet routing 7.1023
!
! This command designates this router as a Level 2 or Area router.
decnet node area
!
!
! This command enables XNS routing. XNS will use the hardware address of the first
! Ethernet, Token Ring or FDDI interface found. If no hardware addresses are
! available, an optional address can be configured.
xns routing
!
!
! This command enables Novell IPX routing. Novell IPX will use the hardware address
! of the first Ethernet, Token Ring, or FDDI interface found. If no hardware addresses
! are available, an optional address can be configured.
novell routing
!
!
! This command enables AppleTalk Phase 1 and Phase 2 routing.
appletalk routing
!
!
! This command enables Banyan VINES routing.
vines routing
!
!
! Each interface must be configured for each of the specific protocols.
!
interface Ethernet 0                ! Major command to designate interface.
ip address 138.100.13.2 255.255.252.0     ! Assign IP address and subnet mask.
decnet cost 5                       ! Enable DEC processing and assign cost.
xns network 200                     ! Enable XNS processing and assign network number.
ipx network 200                     ! Enable Novell processing and assign network number.

appletalk cable-range 10-20         ! Enable AppleTalk Phase 2. Network and node
                                    ! number is dynamically assigned within range.
appletalk zone Planet 10            ! Assign AppleTalk zone name.
vines metric                        ! Enable Banyan VINES processing. A VVINES metric is
                                    ! automatically assigned.
vines arp-enable                    ! Enables interface to respond to VINES ARP requests.
bridge-group 1                      ! Enables bridging on interface as part of bridge
                                    ! group #1.
interface Serial 0                  ! Major command to designate interface.
ip address 138.100.5.1 255.255.252.0      ! Assign IP address and subnet mask.

decnet cost 20                      ! Enable DEC processing and assign cost.
xns network 300                     ! Enable XNS processing and assign network number.
ipx network 300                     ! Enable Novell processing and assign network number.
appletalk address 8.8               ! Enable AppleTalk Phase 1. A network and node
```

```
                                    ! number
                                    ! must be explicitly assigned for serial lines.
appletalk zone Eighth Dimension     ! Assign AppleTalk zone name.
vines metric                        ! Enable Banyan VINES processing. A VINES metric is
                                    ! automatically assigned.
bridge-group 1                      ! Enables bridging on interface as part of bridge group #1.
bridge-group 1 circuit 3            ! Within bridge group #1, enable load balancing
                                    ! over multiple serial lines.
priority-group 1                    ! Enable priority queuing using priority list #1.
!
!
interface Ethernet 1                ! Major command to designate interface.
ip address 131.108.2.200 255.255.255.0    ! Assign IP address and subnet mask.
decnet cost 5                       ! Enable DEC processing and assign cost.
xns network 2000                    ! Enable XNS processing and assign network number.
ipx network 2000                    ! Enable Novell processing and assign network number.
appletalk cable-range 2000-2005     ! Enable AppleTalk Phase 2. Network and
                                    ! node number is dynamically assigned.
appletalk zone Ozone                ! Assign AppleTalk zone name.
vines metric                        ! Enable Banyan VINES processing. A VINES metric is
                                    ! automatically assigned.
bridge-group 1                      ! Enables bridging on interface as part of bridge group #1.
!
!
interface Serial 1                  ! Major command to designate interface.
ip address 138.100.10.1 255.255.252.0    ! Assign IP address and subnet mask.
bridge-group 1                      ! Enables bridging on interface as part of bridge group #1.
bridge-group 1 circuit 3            ! Within bridge group #1, enable load balancing
                                    ! over multiple serial lines.
priority-group 1                    ! Enable priority queuing using priority list #1.
!
!
! Configure IGRP with autonomous system #200.
router igrp 200
! Used by IGRP, list all networks directly connected to the router.
network 131.108.0.0
network 138.100.0.0
!
!
! Define 131.108.0.0 as a "smart" network.
! If an IP packet destination is unknown, send it to this network.
ip default-network 131.108.0.0
!
! This defines the host at 131.108.2.155 as the domain name server
ip name-server 131.108.2.155
!
!
! Map names to IP addresses for ease of use.
ip host BELLEVUE 153.50.65.1 153.50.33.1 153.50.193.2 131.108.2.201
ip host BOSTON 201.222.5.33 201.222.5.129 201.222.5.65 131.108.2.203
ip host DALLAS 180.5.128.129 180.5.128.2 180.5.64.129 131.108.2.202
ip host KYOTO 138.100.13.1 15.16.193.6
ip host LONDON 218.100.100.129 218.100.100.34 218.100.100.65 131.108.2.205
ip host MONTREAL 210.5.43.65 210.5.43.18 210.5.43.129 131.108.2.204
ip host SEATTLE 138.100.5.2 138.100.18.2 138.100.10.2
ip host TACOMA 138.100.18.1 138.100.64.2
ip host TOKYO 138.100.5.1 138.100.13.2 138.100.10.1 131.108.2.200
!
!
! Turn on IEEE 802.1d spanning tree algorithm for bridging.
bridge 1 protocol ieee
!
! Configure SNMP, get commands only, with a community string of public
snmp-server community public RO
```

```
!
! Set up list of protocols and define their priority.
priority-list 1 protocol appletalk high
priority-list 1 protocol ip medium
priority-list 1 protocol xns medium
priority-list 1 default   low
!
!
! Banner displayed when connecting to the cisco router.
banner motd #
                            Welcome to Tokyo!

#
!
!
! Define console connection for local access.
line con 0
login
!
! Define virtual terminals for remote access.
line vty 0 4
login
!
line con 0                         ! Set up console port parameters.
password cisco                     ! Set up console password.
!
line aux 0                         ! Set up auxiliary port parameters.
no exec
!
line vty 0                         ! Set up virtual terminal parameters, one line command
                                   ! for each virtual terminal configured.
password cisco                     ! Set up virtual terminal password.
line vty 1
password cisco                     ! Set up virtual terminal password.
line vty 2
password cisco                     ! Set up virtual terminal password.
line vty 3
password cisco                     ! Set up virtual terminal password.
line vty 4
password cisco                     ! Set up virtual terminal password.
```

APPENDIX D

Decimal to Binary Conversion Table

Decimal 0 to 127—Binary Conversion

	0000		0001		0010		0011
0	0000 0000	16	0001 0000	32	0010 0000	48	0011 0000
1	0000 0001	17	0001 0001	33	0010 0001	49	0011 0001
2	0000 0010	18	0001 0010	34	0010 0010	50	0011 0010
3	0000 0011	19	0001 0011	35	0010 0011	51	0011 0011
4	0000 0100	20	0001 0100	36	0010 0100	52	0011 0100
5	0000 0101	21	0001 0101	37	0010 0101	53	0011 0101
6	0000 0110	22	0001 0110	38	0010 0110	54	0011 0110
7	0000 0111	23	0001 0111	39	0010 0111	55	0011 0111
8	0000 1000	24	0001 1000	40	0010 1000	56	0011 1000
9	0000 1001	25	0001 1001	41	0010 1001	57	0011 1001
10	0000 1010	26	0001 1010	42	0010 1010	58	0011 1010
11	0000 1011	27	0001 1011	43	0010 1011	59	0011 1011
12	0000 1100	28	0001 1100	44	0010 1100	60	0011 1100
13	0000 1101	29	0001 1101	45	0010 1101	61	0011 1101
14	0000 1110	30	0001 1110	46	0010 1110	62	0011 1110
15	0000 1111	31	0001 1111	47	0010 1111	63	0011 1111

0100		0101		0110		0111	
64	0100 0000	80	0101 0000	96	0110 0000	112	0111 0000
65	0100 0001	81	0101 0001	97	0110 0001	113	0111 0001
66	0100 0010	82	0101 0010	98	0110 0010	114	0111 0010
67	0100 0011	83	0101 0011	99	0110 0011	115	0111 0011
68	0100 0100	84	0101 0100	100	0110 0100	116	0111 0100
69	0100 0101	85	0101 0101	101	0110 0101	117	0111 0101
70	0100 0110	86	0101 0110	102	0110 0110	118	0111 0110
71	0100 0111	87	0101 0111	103	0110 0111	119	0111 0111
72	0100 1000	88	0101 1000	104	0110 1000	120	0111 1000
73	0100 1001	89	0101 1001	105	0110 1001	121	0111 1001
74	0100 1010	90	0101 1010	106	0110 1010	122	0111 1010
75	0100 1011	91	0101 1011	107	0110 1011	123	0111 1011
76	0100 1100	92	0101 1100	108	0110 1100	124	0111 1100
77	0100 1101	93	0101 1101	109	0110 1101	125	0111 1101
78	0100 1110	94	0101 1110	110	0110 1110	126	0111 1110
79	0100 1111	95	0101 1111	111	0110 1111	127	0111 1111

Decimal 128 to 255—Binary Conversion

	1000		1001		1010		1011
128	1000 0000	144	1001 0000	160	1010 0000	176	1011 0000
129	1000 0001	145	1001 0001	161	1010 0001	177	1011 0001
130	1000 0010	146	1001 0010	162	1010 0010	178	1011 0010
131	1000 0011	147	1001 0011	163	1010 0011	179	1011 0011
132	1000 0100	148	1001 0100	164	1010 0100	180	1011 0100
133	1000 0101	149	1001 0101	165	1010 0101	181	1011 0101
134	1000 0110	150	1001 0110	166	1010 0110	182	1011 0110
135	1000 0111	151	1001 0111	167	1010 0111	183	1011 0111
136	1000 1000	152	1001 1000	168	1010 1000	184	1011 1000
137	1000 1001	153	1001 1001	169	1010 1001	185	1011 1001
138	1000 1010	154	1001 1010	170	1010 1010	186	1011 1010
139	1000 1011	155	1001 1011	171	1010 1011	187	1011 1011
140	1000 1100	156	1001 1100	172	1010 1100	188	1011 1100
141	1000 1101	157	1001 1101	173	1010 1101	189	1011 1101
142	1000 1110	158	1001 1110	174	1010 1110	190	1011 1110
143	1000 1111	159	1001 1111	175	1010 1111	191	1011 1111

	1100		1101		1110		1111
192	1100 0000	208	1101 0000	224	1110 0000	240	1111 0000
193	1100 0001	209	1101 0001	225	1110 0001	241	1111 0001
194	1100 0010	210	1101 0010	226	1110 0010	242	1111 0010
195	1100 0011	211	1101 0011	227	1110 0011	243	1111 0011
196	1100 0100	212	1101 0100	228	1110 0100	244	1111 0100
197	1100 0101	213	1101 0101	229	1110 0101	245	1111 0101
198	1100 0110	214	1101 0110	230	1110 0110	246	1111 0110
199	1100 0111	215	1101 0111	231	1110 0111	247	1111 0111
200	1100 1000	216	1101 1000	232	1110 1000	248	1111 1000
201	1100 1001	217	1101 1001	233	1110 1001	249	1111 1001
202	1100 1010	218	1101 1010	234	1110 1010	250	1111 1010
203	1100 1011	219	1101 1011	235	1110 1011	251	1111 1011
204	1100 1100	220	1101 1100	236	1110 1100	252	1111 1100
205	1100 1101	221	1101 1101	237	1110 1101	253	1111 1101
206	1100 1110	222	1101 1110	238	1110 1110	254	1111 1110
207	1100 1111	223	1101 1111	239	1110 1111	255	1111 1111

APPENDIX E

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Obtaining Technical Information

Many of the references cited in this list can be obtained from bookstores or ordered directly from the publisher or company that produced the reference. In the world of data communication, however, there are numerous standards that are kept by various companies and agencies. This section provides some tips on obtaining this type information.

Obtaining RFCs

Information about the Internet suite of protocols is contained in documents called Requests for Comments or RFCs. These documents are maintained by Government Systems, Inc. (GSI). You can obtain copies by

- Going to URL: http://info.internet.isi.edu:80/in-notes/rfc

- Contacting GSI directly

  Government Systems, Inc.
  Attn: Network Information Center
  14200 Park Meadow Drive, Suite 200
  Chantilly, Virginia 22021

  1-800-365-3642
  (703) 802-4535
  (703) 802-8376 (FAX)

  `NIC@NIC.DDN.MIL`
  Network address: 192.112.36.5
  Root domain server: 192.112.36.4

Obtaining Technical Standards

Following are some places from which you can obtain technical standards:

- Omnicom at 1-800-OMNICOM.
- Global Engineering Documents, 2805 McGraw Avenue, Irvine, California 92714. Telephone: 800 854-7179.
- American National Standards Institute, 1430 Broadway, New York, New York 10018. Telephone: 212 642-4932 and 212 302-1286.
- IEEE Computer Society Press, Customer Service Center, 10662 Los Vaqueros Circle, P.O. Box 3014, Los Alamitos, CA 90720-1264. Telephone: 714 821-8380.

APPENDIX F

Password Recovery

Password Recovery Procedure

This procedure works for all routers running Cisco IOS Release 10.0 and later. It also works for all routers that have a software configuration register, regardless of IOS version

Step 1 Enter ROM Monitor mode. Power cycle the router and within 60 seconds after the router comes up, press the break key.

Step 2 Enter the ***o*** command in order to "read" the configuration registers original value.

Example: **> o**

Or you can use: **e/s 2000002**

Step 3 Set bit 6 (along with the original bit settings) in order to ignore NVRAM on boot up.

Example: **> o/r 0x*****

Step 4 Initialize and reboot the router.

Example: **> i**

Step 5 In SETUP mode, answer No to all questions. (Just say NO!!)

Step 6 Enter privileged mode.

Example: **Router> enable**

Step 7 Load NVRAM to active memory.

Example: **Router# configure memory**

Step 8 Restore the original configuration register value and enable all interfaces.

Example: **hostname# configure terminal**

hostname(config)# config-register 0x value

hostname(config)# interface xx

hostname(config-if)# no shutdown

Step 9 Recover/record lost passwords.

Example: **hostname# show configure**

or

Change passwords and save to NVRAM.

example:*hostname#* **configure terminal**

hostname(config)# **line console 0**

hostname(config-line)# **login**

hostname(config-line)# **password xxxxxxxxx**

hostname(config-line)# **Cntrl-Z**

hostname# **write memory**