4. Adjacencies

Before routers can spread topology and status information throughout a routing area, each router determines that information for the links to which it is directly connected and for the routers to which it can communicate directly (without forwarding) over those links.

This section deals with the *local neighborhood discovery* part of the protocol.

The NLSP™ specification treats two categories of networks differently. In this specification, the terms *LAN* (local area network) and *WAN* (wide area network) are used for these categories. For each medium of interest, it is specified whether NLSP treats it as a LAN or WAN. In most cases, the categorization is obvious, but not always. In general terms, a LAN is capable of broadcast addressing at the Data-Link layer. IEEE 802.3 and IEEE 802.5 are LANs. Because IEEE 802.6 and FDDI support broadcast, they are treated as LANs even though they are not always local networks. In general terms, a WAN is either connection-oriented (requiring a call setup at the Data-link layer) or is a point-to-point network. Examples are PPP (dedicated or dialed links) and X.25.

Section 4.1 deals with WANs, while Section 4.2 deals with LANs.

By exchanging Hello packets on circuits, a router determines the reachability of its neighbors. An *adjacency* is the record that a router keeps about the state of its connectivity with a neighbor, and about the attributes of the neighboring router.

4.1. Maintaining Adjacencies over WANs

Adjacency establishment goes through several stages on a WAN:

- The underlying data-link connection is established. The details depend on the type of medium.
- If a connection is successfully established, the two neighbors use the *IPX WAN version 2* (IW2) protocol to exchange identities and determine certain operational characteristics of the link. Section 3 covers IW2.
- If IW2 concludes successfully, the two neighbors begin to exchange Hello packets and update their Adjacency Databases. Details follow in this section.
- Once the Hello packets establish an adjacency, the routers start exchanging Link State packets. These are defined in Section 5.
- Finally, the routers start forwarding IPX data packets over the link.

4.1.1. Maintaining WAN Links

For each adjacency, the router maintains a state variable that assumes one of three values: “Up,” “Initializing,” or “Down.”

Whenever a circuit is created and the first Hello packet is received, the state initializes to “Down.” Whenever there is a Layer 2 data-link reset of the circuit, an adjacencyStateChange (Down) event is generated and the state is set to “Down.” The same actions are taken if the link (or the entire router) is reset by local management action or by operation of NLSP (for example, detection of a checksum error in the locally stored Link State database).

See Figure 4-1 for the complete state machine.

If a neighbor is not heard from in the time indicated by the holdingTimer recorded when accepting a WAN Hello packet, the router generates an adjacencyStateChange (Down) event and deletes the adjacency.

4.1.2. Sending WAN Hello Packets

Sending WAN Hello packets allows routers on a circuit to discover each other's identity, decide whether they are in the same routing area, and determine whether the other router and the link between them remains operational.

A router sends a WAN Hello packet on a WAN link when

a) The circuit is first enabled and the IW2 protocol exchange is complete

b) The interval nonBcastHelloInt expires

c) The contents of the next Hello to be transmitted would be different from the contents of the previous Hello transmitted by this system, and one or more seconds have elapsed since the previous Hello

Hello packets are sent regardless of the value of the local state, as long as the circuit exists.

The WAN Hello packet is constructed as follows:

d) The Local WAN Circuit ID field is set to the localCircuitID value assigned by this router when the circuit is created. This value must be unique among all WAN circuits attached to this router. (It is recorded in the circuitID entry of the Adjacency database.)

e) The WAN State field is set to this router's current state for this link.

f) The MTU Size field must be included. It indicates the largest packet (in bytes, including the IPX™ header but not the data-link header) that the router is capable of receiving on the circuit; that is, the localMaxPacketSize.

4.1.3. Receiving WAN Hello Packets

Upon receipt of a WAN Hello packet, perform the following acceptance tests:

a) The general packet acceptance tests described in Section 2 under "General Processing of Incoming IPX Packets."

b) If the length of the packet, as described in its header, is greater than the buffer in which it was received, discard the packet and log a packetRxSmall event.

c) If the options in the variable part of the packet are ill-formed, or if they extend beyond the end of the packet, discard the packet and log a malformedOption event.

d) Compare each of the area addresses from the Area Addresses field with the set of manualAreaAddresses configured locally. Consider a match to be detected if the Address and the Mask portion are identical. If no match is detected between any pair (that is, if the local and remote system have no area address in common),

   i) If there is an adjacency and it is not in the "Up" state, generate an areaMismatch.

   ii) If the adjacency is in the "Up" state, delete the adjacency and generate an adjacencyStateChange (Down—Area Mismatch) event.

   iii) Otherwise, ignore the packet.

e) If the Circuit Type field in the received Hello packet is other than 1 or 3,

i) If the adjacency already exists, generate an adjacencyStateChange (Down) event and delete the adjacency.

ii) If the adjacency does not already exist, discard the packet and generate a wrongSystemType event.

f) If the Local MTU option is absent, discard the packet and generate a missingOption event.

g) If the value of the Local MTUfield is less than minMTUAllowed, discard the packet and generate a malformedOption event.

Once the packet has passed the preceding tests, the router invokes a state machine comparing the router's own internal current state for the link with the value of the state field of the received packet. Figure 4-1 illustrates the state machine. Each cell of the table indicates the new state for the router's own state of the link.

		1	2	3	4
		Received packet indicates "Down"	Received packet indicates "Initializing"	Received packet indicates "Up"	Link is reset by local action, or a data-link reset is detected.
A	Current state is "Down"	"Initializing"	"Initializing"	"Down"	"Down"
B	Current state is "Initializing"	"Initializing"	"Up"	"Up"	"Down"
C	Current state is "Up"	"Initializing"	"Up"	"Up"	"Down"

Figure 4-1: WAN Adjacency State Machine

Note: The state machine deals with the case where one end of the point-to-point link wants to bring down the adjacency and must ensure that the remote system is aware of this. This could happen in the following scenarios:

1. A circuit is deleted and re-created.

   Although NLSP sends a Hello with zero holding time when the circuit is deleted, there is no guarantee that this will get through. Thus, the remote system might be unaware that the next Hello that is received is from a new adjacency, so it does not attempt to resynchronize its LSP database.

2. When the router is reset, or an LSP with an incorrect checksum is found in memory.

In either case, NLSP attempts to reacquire the information from its neighbors. This can be done simply if the remote system can be forced to bring down and then bring up its adjacency to the local system. Adjacency state procedures are independent of the IW2 protocol, to allow for new types of unreliable data-link media.

Figure 4-2 illustrates a typical startup scenario involving routers *A* and *B*. The notations in square brackets refer to the row and column of Figure 4-1. For example, [A3] refers to a router in the "Down" state receiving a Hello indicating that its neighbor is in the "Up" state.

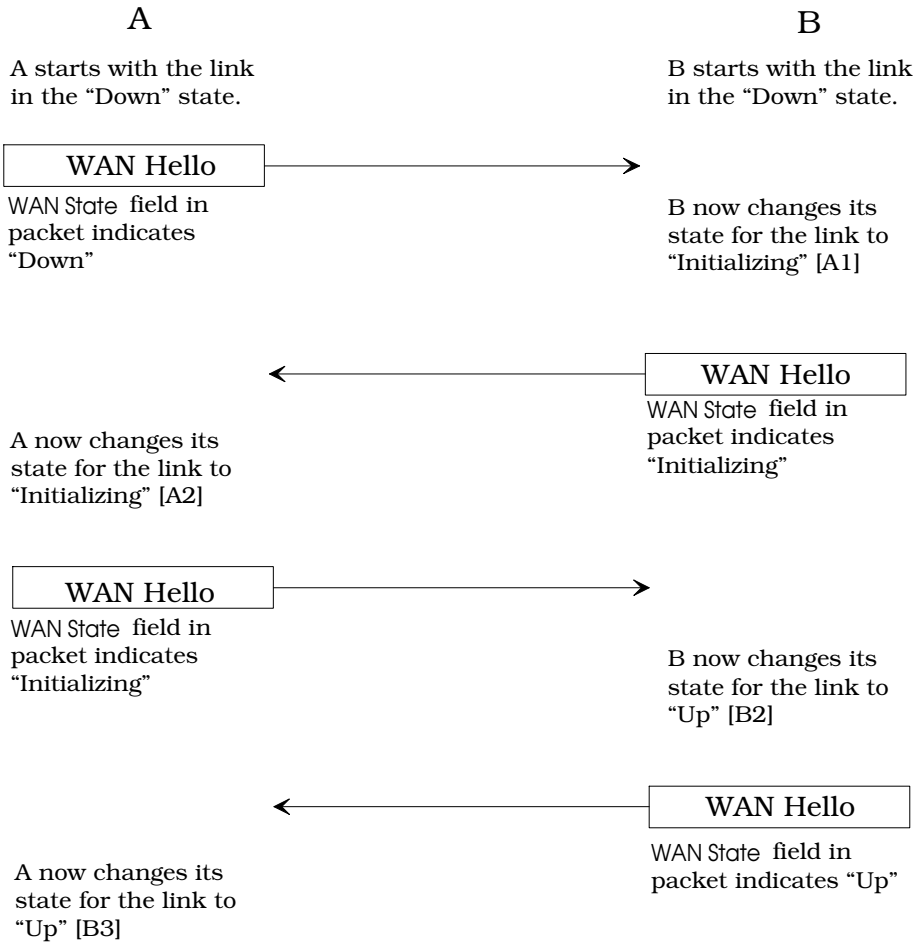


Figure 4-2: New WAN Adjacency

Once a system considers a link to be "Down," it stays "Down" until its neighbor reports that the link goes "Down" then "Up" again. Figure 4-3 illustrates what happens when an adjacency is lost, then recovered. In that figure, note that if B makes the first move rather than A, the sequence is the same except that the first step is absent.

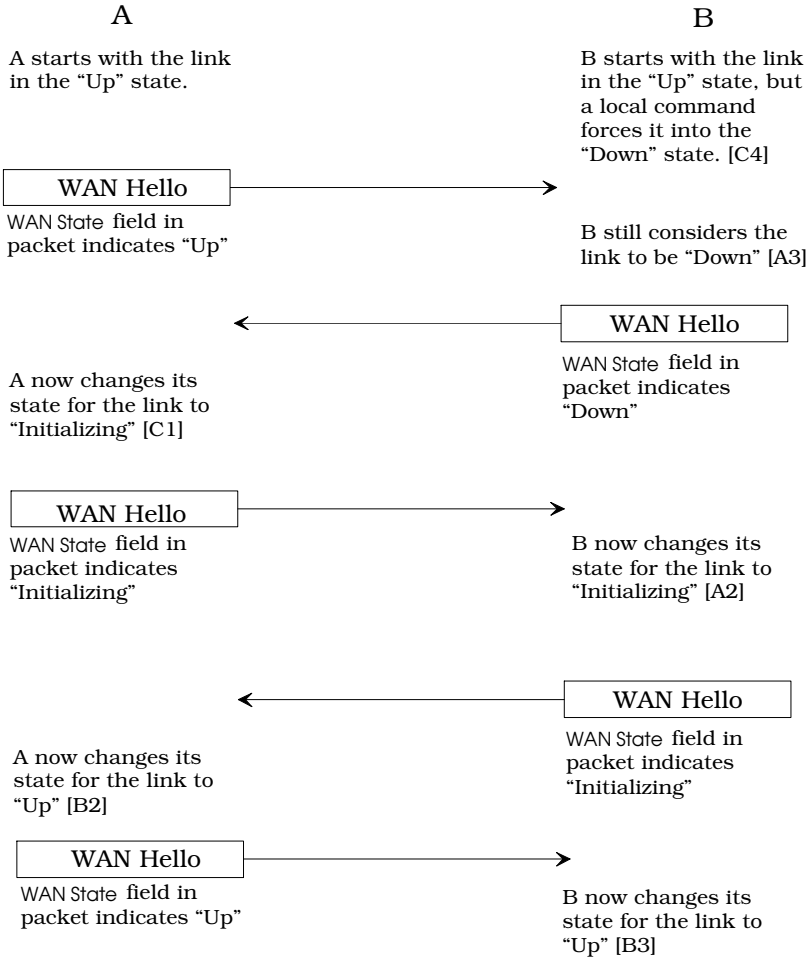


Figure 4-3: Recovering a WAN Adjacency

If the state changes from "Up" to a different state, generate an adjacencyStateChange (Down) event.

If it is a new adjacency, that is, if the state machine changes from "Initializing" to "Up," then

a) Generate an adjacencyStateChange (Up) event.

b) Transmit a WAN Hello packet.

c) Compare the Source ID field (call it *x*) of the received packet with the local systemID (call it *y*). The numeric comparison is done by considering each byte as an unsigned integer, and the first byte as most significant.

   i) If $x < y$, set the circuit's circuitID to the concatenation of the local systemID and the localCircuitID of this circuit (as in the Local Circuit ID field of WAN Hello packets sent by this router on this link).

ii) If $x > y$, set the circuit's circuitID to the concatenation of the Source ID field of the received packet and the Local Circuit ID field of the received packet.

Note: Do not change the value included in the Local Circuit ID field of Hello packets transmitted by this router. That value is assigned once when the circuit is created and is not subsequently changed.

iii) If $x = y$, the local systemID and local localCircuitID are used.

Note: The two values would be equal if it is some form of loopback circuit.

d) Note that the packet was accepted.

If the adjacency already exists in the "Up" state and remains "Up," compute a CircuitID as in item c) immediately prior. Then,

e) If the computed circuitID is the same as the one previously recorded for the link, simply note that the packet was accepted.

f) If the computed circuitID differs from the one previously recorded for the link, generate an adjacencyStateChange (Down) event, and delete the adjacency.

If, in the above steps, you note that the packet was accepted,

g) Copy the adjacency areaAddressesOfNeighbor entries from the Area Addresses field of the packet.

h) Set the holdingTimer to the value of the Holding Timer field of the packet.

i) Set the neighborSystemID to the value of the Source ID field of the packet.

j) From the MTU Size field in the packet, update the actualMaxPacketSize value for the circuit; it is the lowest value of the MTU size field received on the circuit (this allows packets exceeding minMTU bytes to be transmitted confidently).

4.2. Maintaining Adjacencies over LANs

Multipoint networks with broadcast capabilities include LANs, some Metropolitan Area Networks (MANs), such as Switched Multimegabit Data Service (SMDS), and other emerging technologies. For simplicity, the term LAN refers to broadcast networks of all types.

At various places, packet fields contain the six-byte IEEE MAC address. Sometimes decisions are made based on the six-byte IEEE MAC address reported for an incoming packet by the Data-link layer. When the medium is an IEEE 802.3, 802.4, or 802.5 LAN, the value used is an actual six-byte IEEE address. If a medium has a smaller address (for example, Omninet), it is right-justified and zero-padded. If a medium has a larger data-link address (for example, SMDS), a specification is needed for that medium to resolve values between data-link addresses and IEEE addresses.

4.2.1. Enabling LAN Circuits

When a broadcast circuit is enabled on a router, the router takes the following actions:

a) Begin sending Hello packets (page 4-7)

b) Begin accepting Hello packets from other routers on the LAN (page 4-8)

c) After waiting for a determined time interval, run the Designated Router election process (page 4-10).

4.2.2. Sending LAN Hello Packets

Sending Hello packets allows for routers on the broadcast circuit to discover the identity of other Level 1 routers of the same routing area on that circuit.

The LAN ID field of the Hello packet is the concatenation of a router's System ID and a one-byte Local LAN Circuit ID assigned by that router, to be unique among all the LAN circuits directly attached to that router. If the router sending a LAN Hello believes that another router is the Designated Router for that LAN, it puts in the LAN ID field the value of the LAN ID observed in the other router's LAN Hello. Otherwise (either it believes itself to be Designated Router or perhaps it has seen no Hello packets yet), the router sending a LAN Hello uses its own systemID in the System ID field and a Local LAN Circuit ID it assigns when filling in the LAN ID field. It uses the circuitID entry to keep track of the assigned values for different circuits.

The priority is a manually configured value. It comes into play with Designated Router election.

The No Multicast bit is set to zero if the router is capable of receiving packets addressed to the selective link-level multicast addresses. Otherwise, the bit is set to one.

The variable-length fields include the following:

a) The area addresses with which the router has been configured (manualAreaAddresses).

b) The LAN addresses of the adjacencies on this circuit. The adjacency list includes only Level 1 routers within the same area. Only those adjacencies in the "Initializing" or "Up" states are included. The states are described in section 4.2.5.

c) The MTU Size field must be included. It indicates the largest packet (in bytes, including the IPX header but not data-link header) that the router can receive on the circuit.

A router transmits a LAN Level 1 Hello packet immediately when any circuit has been enabled. Hello packets are transmitted to the multidestination address allL1Routers. Routers listen on this address for arriving Hello packets.

A router also transmits a LAN Level 1 Hello packet when at least one second has elapsed since the last such transmission on this circuit by this router, and

- bcastHelloInt seconds have elapsed[1] since the last periodic LAN Level 1 Hello transmission:

  The Holding Time is set to holdingTimeMultiplier × bcastHelloInt. For a Designated Router, the value of drBcastHelloInt is used instead of bcastHelloInt[1]. The Holding Time for this packet is therefore set to holdingTimeMultiplier × drBcastHelloInt seconds. This permits a failed Designated Router to be detected more rapidly.

  There is an exception. When a system resigns as Designated Router, it sends the first holdingTimeMultiplier Hello packets at the interval of drBcastHelloInt, with a holding time of holdingTimeMultiplier × bcastHelloInt. This prevents other systems from timing out the adjacency if a Hello is dropped. The same rule applies for router implementations that permit timers to be

[1] Jitter is applied, as described in Section 2.

changed dynamically, in the case that the hello interval is increased.

Or

- The contents of the next Hello to be transmitted would differ from the contents of the previous Hello transmitted by this system.

  Or

- The system has determined that it is to become or resign as Level 1 Designated Router.

When a router transmits a Hello packet, it must not exceed the actualMaxPacketSize. If the number of adjacencies is so large that actualMaxPacketSize would be exceeded, the router generates a tooManyAdjacencies event and transmits a Hello packet with as many Neighbors as fit.

Note: For example, with a circuit having an actualMaxPacketSize of 1500 bytes, and with a router having three manual area addresses, a Hello packet can report at most 233 neighbors.

	Bytes	
IPX header	30	
LAN Hello header	27	
Three Area Addresses	26	= 3 × 8 + 2
Local MTU Option	6	
Neighbors	1270	= 5 options containing 42 neighbors each = 5 × (6 × 42 + 2)
Neighbors	140	= 1 option containing 23 neighbors = 6 × 23 + 2
Total Bytes	1499	
Total Neighbors	233	= (5 × 42) + 23

To minimize the possibility of the Hello transmissions of all routers on the LAN becoming synchronized, the hello timer is only reset when a Hello is transmitted as a result of timer expiration, or on becoming or resigning as Designated Router. It is not reset if the Designated Router changes from one remote system to another.

4.2.3. Receiving LAN Hello Packets

Upon receipt of a LAN Hello packet, perform the following acceptance tests:

a) The general packet acceptance tests described in Section 2 under “General Processing of Incoming IPX Packets.”

b) If the source network number in the IPX header differs from this router’s view of the circuit’s network number, discard the packet and log a mismatchedNetworkNumber event.

c) If the source node number in the IPX header differs from the six-byte IEEE MAC address reported by the data-link layer, discard the packet and log a mismatchedNodeAddress event.

d) If the length of the packet as described in its header is greater than the buffer in which it was received, discard the packet and log a packetRxSmall event.

e) If the options in the variable part of the packet are ill-formed, or if they extend beyond the end of the packet, discard the packet and log a malformedOption event.

f) If the Circuit Type field is other than 1 or 3, discard the packet.

g) Compare each of the area addresses from the Area Addresses field with the set of manualAreaAddresses configured locally. Consider a match to be detected if the Address and the Mask portions are identical. If a match is not found between any pair (that is, if the local and remote system have no area in common), reject the adjacency and generate an areaMismatch event.

h) If the Local MTU option is absent, discard the packet and generate a missingOption event.

i) If the value of the Local MTUfield is less than minMTUAllowed, discard the packet and generate a malformedOption event.

If the preceding tests succeed, the router accepts the adjacency and sets the neighborSystemType to "L1 Router."

Use the MTU size field in the packet to update the actualMaxPacketSize value for the circuit; it is the lowest value of the MTU size field received on the circuit.

If a Level 1 LAN Hello is received with the No Multicast bit set to one, the router sends future NLSP packets for that network segment to the broadcast address, where it would otherwise use the multicast address. There is no provision for returning to the multicast address.

4.2.4. Maintaining Existing LAN Adjacencies

When a Level 1 LAN Hello is received from a router for which there is already an adjacency with

a) The adjacency neighborNICAddress equal to the six-byte IEEE MAC source address of the packet

b) The adjacency neighborSystemID equal to the Source ID field of the packet

c) The adjacency neighborSystemType equal to "L1 Router"

the router updates the adjacency's holdingTimer, priorityOfNeighbor, and areaAddressofNeighbor according to the values in the packet.

4.2.5. Detecting New LAN Adjacencies and Updating Adjacency States

When

a) A LAN Level 1 Hello is received (from router *R*)

b) There is no adjacency for which

   i) The adjacency neighborNICAddress is equal to the six-byte IEEE MAC source address of the packet

   ii) The adjacency neighborSystemID is equal to the Source ID field of the packet

   iii) The adjacency neighborSystemType is equal to "L1 Router"

the router creates a new adjacency. However, if the Adjacency database has insufficient space to allow creating a new adjacency, the router instead merely ignores the Hello packet.

In the new adjacency, the router sets the following:

c) The neighborSystemType to "L1 Router"

d) The holdingTimer, neighborPriority, and areaAddressOfNeighbor according to the values in the packet

e) The neighborNICAddress equal to the six-byte IEEE MAC source address of the packet

The router sets the state of the adjacency to "Initializing" until it is known that the communication between this system and *R* (the source of the Hello packet) is two-way. However, R is included in future LAN Level 1 Hello packets transmitted by this system.

When R reports this router's LAN Address in its LAN Level 1 Hello packet, this router

f) Sets the adjacency's state to "Up"

g) Generates an adjacencyStateChange (Up) event

Figure 4-4 illustrates a typical scenario. In the figure, router B is already running and router A comes on line.

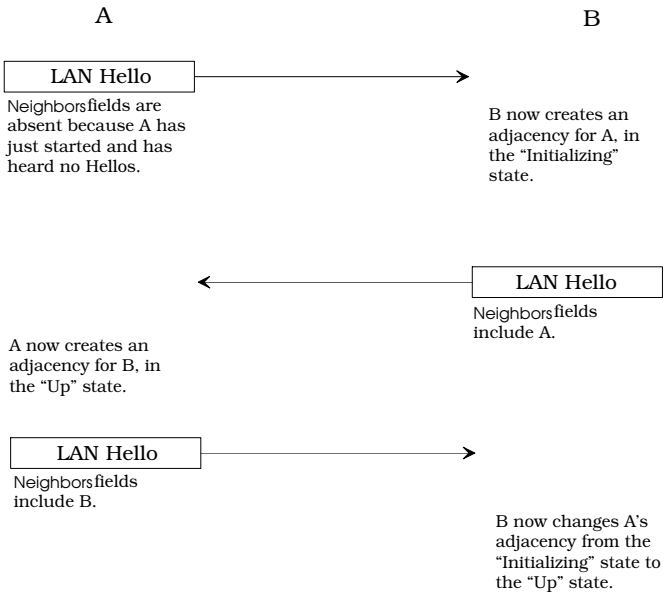


Figure 4-4: New LAN Adjacency

4.2.6. Detecting Obsolete LAN Adjacencies

The router keeps a separate holding timer (adjacency holdingTimer) for each Level 1 adjacency. The value of holdingTimer is initialized to the holding time, as reported in the Holding Time field of the LAN Level 1 Hello packet. If a neighbor is not heard from in that time, the router

a) Purges it from the Adjacency database

b) Generates an adjacencyStateChange (Down) event

If a LAN Level 1 Hello packet is received from neighbor *N*, and this system's LAN Address is no longer in *N*'s Hello packet, this router

c) Sets the adjacency's adjacencyState to "Initializing"

d) Generates an adjacencyStateChange (Down) event

4.2.7. Designated Router Election

The Level 1 Designated Router is the highest priority Level 1 router on a LAN. In case of a tie, the numerically highest MAC address wins, from among the routers having highest priority.

The numeric comparison is done by considering each byte as an unsigned integer, and the first byte as most significant.

When a LAN circuit changes state to "Up," a system waits 2 × drBcastHelloInt before electing a Designated Router on that circuit. However, if in this time an adjacency is formed (reaching the "Up" state) to a system on that LAN, and that system reports that it is the Designated Router itself, the Designated Router election process is run at once.

The priority to become Designated Router on a LAN is configurable, per router per LAN attachment. The default is 44. If a system elects itself Designated Router, it raises its priority by 20. The purpose is to avoid unnecessary area-wide traffic in LSPs as Designated Router roles change for a LAN with routers that can go up and down from time to time.

> **Note:** In a router implementation, the increment by which the priority is raised when a system elects itself Designated Router can be configurable. The default value of the increment should still be 20.

The set of routers considered as candidates include the local router, together with routers from which LAN Level 1 Hello packets have been received and to which Level 1 adjacencies exist in adjacencyState "Up."

A router runs the election process whenever a LAN Level 1 Hello packet is received or transmitted. (For these purposes, transmission of one's own Hello is equivalent to receiving it.) If there has been no change to the information on which the election is performed since the last time it was run, the previous result can be assumed. The relevant information is

a) The set of router adjacency states

b) The set of router priorities (including this system's)

The LAN ID field in the LAN Level 1 Hello packets transmitted by this system is set to the value of the LAN ID field reported in the LAN Level 1 Hello packet received from the system that this system considers to be the Designated Router. The value is also used as the pseudonode ID, to enable LSPs to be issued for this system claiming connectivity to the pseudonode.

If this system determines by the election process that it is itself the Designated Router, it sets the LAN ID field to be the concatenation of the system's own ID and the locally assigned one-byte Local LAN Circuit ID.

If the system determines that it is the Designated Router for a LAN circuit, it should allocate memory and other resources sufficient to generate the pseudonode LSPs for the circuit. If sufficient resources are unavailable, the router takes the following steps:

c) Enter the LSP database overload state, as described in Section 5.

d) As described in Section 5, part of entering the LSP database overload state is lowering the router's priority for the circuit in question. This likely causes the overloaded router to no longer be elected Designated Router for the circuit. However, it is still possible for it to be elected the Designated Router.

4.3. Adjacency Database

4.3.1. Constant Values

allL1Routers
: The LAN data-link address used to send multicast packets. The value is specific to a particular medium. A list is included in Section 2.

minMTUAllowed
: The smallest packet size to support NLSP. If a router cannot send and receive packets of at least this size, NLSP and IPX cannot operate on the circuit. The value is 576 bytes, including the IPX header but not the data-link header.

4.3.2. Configured Values of the Local System

manualAreaAddresses
: One to three IPX routing area addresses. Each is a 32-bit IPX network number, paired with a 32-bit mask of leading one bits. The mask indicates how many bits of the network number identify the area. All the manualAreaAddresses of the routers in a routing area are synonymous in identifying the area. The default area address is (area = 0, mask = 0), meaning that all networks in the reachable internetwork are in one area.

systemID
: A six-byte value assigned to a router. It must be unique in the entire internetwork.

nonBcastHelloInt
: The interval, in seconds, between NLSP Hello packets sent on WAN circuits. Default is 5 seconds.

bcastHelloInt
: The interval, in seconds, between NLSP Hello packets sent on a LAN circuit by systems other than the circuit's Designated Router. Default is 10 seconds.

drBcastHelloInt
: The interval, in seconds, between NLSP Hello packets sent on a LAN circuit by the circuit's Designated Router. Default is 3 seconds.

holdingTimeMultiplier
: The multiplier used to specify the holding time for NLSP neighbor entries as a function of the NLSP Hello interval. Default is 5.

4.3.3. Configured Values per Circuit

localMaxPacketSize
: The maximum size, in bytes, that the system supports locally on this circuit. The IPX header is included, but not the data-link header or trailer.

localHoldingTimer
: This router's holding time, in seconds, sent in an NLSP Hello packet.

priority
: The priority of this router to become the NLSP LAN Level 1 Designated Router on a broadcast circuit. The default is 44. If a system elects itself Designated Router, it raises its priority by 20.

4.3.4. Dynamic Values per Circuit

localCircuitID
: A local one-byte identifier assigned to a circuit by the local system. The value across all directly attached WANs must be unique, and the value across all directly attached LANs must be unique.

circuitID
: A seven-byte value identifying a circuit. It is derived by combining a router's systemID with that router's localCircuitID for the circuit.

actualMaxPacketSize
: The maximum size, in bytes, that are sent and received on this circuit. The IPX header is included, but not the data-link header or trailer.

noMulticast
: A bit recording whether a Hello packet has been received indicating that another router on a LAN circuit is incapable of receiving multicast packets. If set, packets are sent by broadcast instead of multicast.

4.3.5. Dynamic Values per Adjacency

state
: A variable with three values: "Up," "Initializing," and "Down." There is a WAN state machine for the steps in establishing an adjacency, and a different state machine for LANs.

holdingTimer
: The initial holding time, in seconds, for this NLSP neighbor entry as specified in the NLSP Hello packet.

neighborSystemID
: The six-byte systemID of the neighboring router.

neighborNICAddress
: The six-byte IEEE MAC address of the neighbor's network interface point of attachment to a LAN circuit shared with this router.

neighborSystemType
: The types are "L1 router" and "L1 and L2 router." This version of the NLSP specification covers L1 operation. Provision for L2 is to ensure forward compatibility.

areaAddressesOfNeighbor
: The neighbor's manual area addresses.

neighborPriority
: The priority of the neighboring NLSP router for becoming the LAN Level 1 Designated Router.

4.3.6. NLSP Events

packetRxSmall
: A truncated packet was received, containing only a portion of the information sent.

mismatchedNodeAddress
: The source node number is incorrect in a received packet.

malformedOption
A syntax check failed for a received packet, or an option's value is outside the legal range for the option.

missingOption
A Hello packet was received in which a mandatory option (for example, Local MTU) was absent.

areaMismatch
Another router reported a set of area addresses disjoint from manualAreaAddresses.

wrongSystemType
Attempt by another router to communicate outside the realm of the Level 1 routing.

mismatchedNetworkNumber
A neighbor disagrees with this router on the IPX network number assigned to a circuit.

tooManyAdjacencies
This system has more NLSP adjacencies on a LAN circuit than fit into a LAN Hello packet.

adjacencyStateChange
Indicates that the state variable has changed in value for a circuit.

4.4. Packet Structures

The following packet types are relevant to maintaining the Adjacency Database.

- WAN Hello (page 4-16)
- LAN Level 1 Hello (page 4-17)

These packets ride in the data portion of IPX packets. The IPX header fields are encoded as follows:

	WAN Hello	LAN Level 1 Hello
Destination Network	zero	zero
Destination Node	0xFFFFFFFFFFFF	0xFFFFFFFFFFFF
Destination Socket	0x9001	0x9001
Source Network	internalNetworkNumber of the router sending the packet	Network number of the LAN on which the packet is being transmitted
Source Node	Node number of the router sending the packet on its internalNetworkNumber (0x000000000001)	IEEE MAC address of the LAN interface through which the packet is being transmitted
Source Socket	0x9001	0x9001
Packet Type	0	0

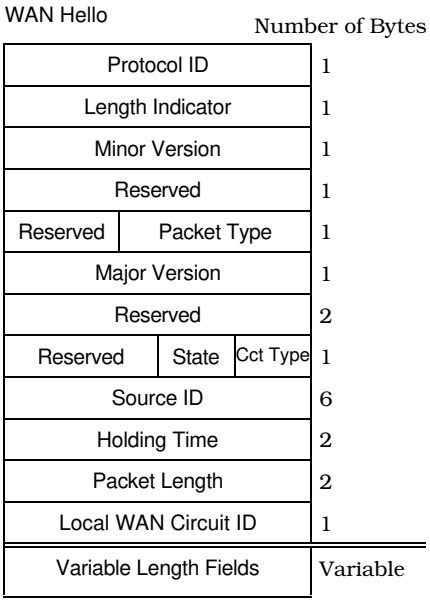
The maximum size of Hello packets on any circuit is determined by the media type and the buffer sizes used by neighbors on that circuit. Each Hello packet includes the Local MTU option, containing the sender's localMaxPacketSize for the circuit. This is the way routers communicate the packet size they are able to receive on that circuit. Every router calculates the minimal value of Local MTU for active adjacencies on each circuit. It then takes the smaller of that value and its own localMaxPacketSize for that circuit. The result is the actualMaxPacketSize value for that circuit. Hello packets can be as large as that value, but no larger.

Note: In practice, the actualMaxPacketSize value for a circuit is the circuit's maximum data-link user data payload size in most situations. There are, however, certain situations where the value is smaller. For example:

a) A bridged LAN that includes LAN segments of different media

b) A circuit on which one router uses a smaller buffer size than the circuit's maximally supported size, owing to resource limitations or misconfiguration

4.4.1. WAN Hello



Protocol ID: 0x83, identifies the NLSP routing layer.

Length indicator: The number of bytes in the fixed portion of the header (up to and including the LAN ID field).

Minor Version: 1, ignored on receipt.

Reserved: 0, ignored on receipt.

Reserved (3 bits): 0, ignored on receipt.

Packet Type (5 bits): 17.

Major Version: 1.

Reserved: 0, ignored on receipt.

Reserved (4 bits): 0, ignored on receipt.

State (2 bits): The sending router's state associated with this link:

0 = "Up"
1 = "Initializing"
2 = "Down"

Circuit Type, abbreviated Cct Type in the diagram (2 bits):

0 = Reserved value, ignore entire packet.

1 = Level 1 routing only.

2 = Level 2 routing only (sender uses this link for Level 2 routing only).

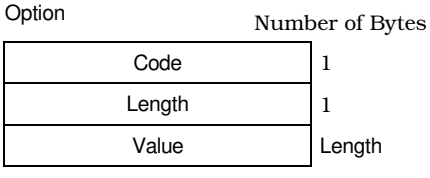
3 = Both Level 1 and Level 2 (sender is a Level 2 router and uses this link for Level 1 and Level 2 traffic).

Source ID: The system ID of the sending router.

Holding Time: Holding Timer, in seconds, to be used for the sending router.

Packet Length: The entire length of this packet, in bytes, including the NLSP header.

Local WAN Circuit ID: A unique identifier assigned to this circuit when it is created by this router.



Variable Length fields: A series of optional fields, each of which has the following three-part code/length/value Option form.

Currently defined codes, and the corresponding values, are as follows:

- Area Addresses: The set of Manual Area Addresses of the sending router. This field must be present.

  Code = 0xC0. Length = Total length of the value field, in bytes; either 8, 16, or 24.

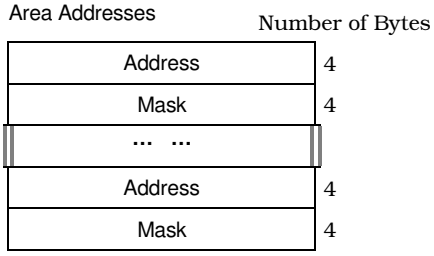
  Value = Up to three area addresses. Each area address consists of a four-byte network number, followed by a four-byte address mask. The mask contains from zero to 32 (inclusive) most-significant one bits to indicate which bits of the network number make

up the address prefix identifying the routing area. The remaining bits are zero. The bit-wise AND of an Address and Mask pair must be equal to Address. For example, it would be a mistake to send Address = 0x84300000 paired with Mask = 0xFF000000.

- Local MTU: indicates how large a packet the sender can transmit. This field must be present.

  Code = 0xC5. Length = 4.

  Value = The maximum number of bytes that the sending router can transmit on this interface. The count includes the IPX header, but not the data-link header.



4.4.2. LAN Level 1 Hello

LAN Level 1 Hello

	Number of Bytes
Protocol ID	1
Length Indicator	1
Minor Version	1
Reserved	1
Reserved | Packet Type	1
Major Version	1
Reserved	2
Reserved | NM | Res | Cct Type	1
Source ID	6
Holding Time	2
Packet Length	2
R | Priority	1
LAN ID	7
Variable Length Fields	Variable

Protocol ID: 0x83, identifies the NLSP routing layer.

Length indicator: The number of bytes in the fixed portion of the header (up to and including the LAN ID field.

Minor Version: 1, ignored on receipt.

Reserved: 0, ignored on receipt.

Reserved (3 bits): 0, ignored on receipt.

Packet Type (5 bits): 15.

Major Version: 1.

Reserved: 0, ignored on receipt.

Reserved (3 bits): 0, ignored on receipt.

No Multicast, abbreviated NM in the diagram (1 bit): When set to one, indicates that the sender of the packet cannot receive traffic addressed to a multicast address; future packets on this LAN (which would otherwise be transmitted multicast) must be sent to the broadcast address.

Res (2 bits): 0, ignored on receipt.

Circuit Type, abbreviated Cct Type in the diagram (2 bits):

0 = Reserved value, ignore entire packet.

1 = Level 1 routing only.

2 = Level 2 routing only (sender uses this link for Level 2 routing only).

3 = Both Level 1 and Level 2 (sender is a Level 2 router and uses this link for Level 1 and Level 2 traffic).

Source ID: The system ID of the sending router.

Holding Time: The Holding Timer, in seconds, to be used for the sending router.

Packet Length: The entire length of this packet, in bytes, including the NLSP header.

R (1 bit): 0, ignored on receipt.

Priority (7 bits): The priority for being the LAN Level 1 Designated Router. Higher numbers have higher priority. An unsigned integer.

LAN ID

	Number of Bytes
System ID	6
Pseudonode ID	1

LAN ID: A field composed of the system ID (6 bytes) of the LAN Level 1 Designated Router, followed by a low-order Pseudonode ID byte assigned by that Designated Router. This field is copied from the Designated Router's Hello packet.

Option

	Number of Bytes
Code	1
Length	1
Value	Length

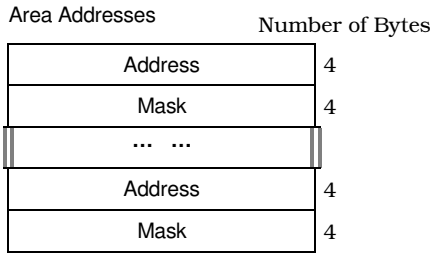
Variable Length fields: A series of optional fields, each of which has the following three-part code/length/value Option form:

Currently defined codes, and the corresponding values, are as follows:

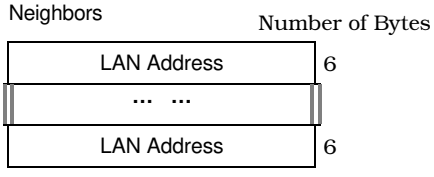
- Area Addresses: The set of Manual Area Addresses of the sending router. This field must be present.

  Code = 0xC0. Length = Total length of the value field, in bytes; either 8, 16, or 24.

  Value = Up to three area addresses. Each area address consists of a four-byte network number, followed by a four-byte address mask. The mask contains from zero to 32 (inclusive) most-significant one bits to indicate which bits of the network number make up the address prefix identifying the routing area. The remaining bits are zero. The bit-wise AND of an Address and Mask pair must be equal to Address; for example, it would be a mistake to send Address = 0x84300000 paired with Mask = 0xFF000000.



- Neighbors: The set of routers on this LAN to which adjacencies of type "Level 1 Router" exist in state "Up" or "Initializing"; that is, those from which Level 1 Hello packets have been heard. This field can occur more than once



  Code = 6. Length = A multiple of six.

  Value = Each six-byte field is the IEEE 802 MAC address of the neighbor router's point of attachment to this LAN segment

- Local MTU: Indicates how large a packet the sender can transmit. This field must be present.

  Code = 0xC5. Length = 4.

  Value = The maximum number of bytes that the sending router can transmit on this interface. The count includes the IPX header, but not the data-link header.