6707 **Table 3-46. NIB Attributes**

Attribute	Id	Type	Read Only	Range	Description	Default
nwkMaxRejoinParentAttempts	0xC3	Integer	No	0 – 255	The maximum number of attempts to rejoin to parent devices for the current network.	3
nwkEndDeviceTimeout	0xC4	Integer	No	0 – 14	The enumerated timeout value that the local end device stack will use when negotiating its end device timeout. This value is converted to seconds by referencing Table 3-52 Requested Timeout Enumerated Values. This value is ignored for a router or coordinator device. This value is only used when the local device is an end device.	

6708 3.3 Frame Formats

6709 This section specifies the format of the NWK frame (NPDU). Each NWK frame consists of the following basic com-
6710 ponents:

6711 • A NWK header, which comprises frame control, addressing and sequencing information

6712 • A NWK payload, of variable length, which contains information specific to the frame type

6713 The frames in the NWK layer are described as a sequence of fields in a specific order. All frame formats in this section
6714 are depicted in the order in which they are transmitted by the MAC sub-layer, from left to right, where the leftmost
6715 bit is transmitted first. Bits within each field are numbered from 0 (leftmost and least significant) to k-1 (rightmost
6716 and most significant), where the length of the field is k bits. Fields that are longer than a single octet are sent to the
6717 MAC sub-layer in the order from the octet containing the lowest-numbered bits to the octet containing the highest-
6718 numbered bits.

6719 3.3.1 General NPDU Frame Format

6720 The NWK frame format is composed of a NWK header and a NWK payload. The fields of the NWK header appear
6721 in a fixed order. The NWK frame SHALL be formatted as illustrated in Figure 3-4.

Octets: 2	2	2	1	1	0/8	0/8		Variable	Variable
Frame control	Destination address	Source address	Radius	Sequence number	Destination IEEE Address	Source IEEE Address		Source route subframe	Frame payload
NWK Header									Payload

Figure 3-4. General NWK Frame Format

3.3.1.1 Frame Control Field

The frame control field is 16 bits in length and contains information defining the frame type, addressing and sequencing fields and other control flags. The frame control field SHALL be formatted as illustrated in Figure 3-5.

Bits: 0-1	2-5	6-7	8	9	10	11	12	13	14-15
Frame type	Protocol version	Discover route	Deprecated (Multicast flag)	Security	Source Route	Destination IEEE Address	Source IEEE Address	End Device Initiator	Reserved

Figure 3-5. Frame Control Field

Table 3-47 shows the allowable frame control sub-field configurations for NWK data frames. Note that all frames listed below will have a frame type sub-field equal to 00 indicating data and a protocol version sub-field reflecting the version of the Zigbee specification implemented.

Table 3-47. Allowable Frame Control Sub-Field Configurations

Data Transmission Method	Discover Route	Multicast	Security	Destination IEEE Address	Source IEEE Address
Unicast	00 or 01	0	0 or 1	0 or 1	0 or 1
Broadcast	00	0	0 or 1	0	0 or 1
Source routed	00	0	0 or 1	0 or 1	0 or 1

3.3.1.1.1 Frame Type Sub-Field

The frame type sub-field is 2 bits in length and SHALL be set to one of the non-reserved values listed in Table 3-48.

6733 **Table 3-48. Values of the Frame Type Sub-Field**

Frame Type Value b_1 b_0	Frame Type Name
00	Data
01	NWK command
10	Reserved
11	Inter-PAN

6734 #### 3.3.1.1.2 Protocol Version Sub-Field

6735 The protocol version sub-field is 4 bits in length and SHALL be set to a number reflecting the Zigbee NWK protocol
6736 version in use. The protocol version in use on a particular device SHALL be made available as the value of the NWK
6737 constant *nwkcProtocolVersion*.

6738 #### 3.3.1.1.3 Discover Route Sub-Field

6739 The discover route sub-field MAY be used to control route discovery operations for the transit of this frame (see
6740 section 3.6.4.5).

6741 **Table 3-49. Values of the Discover Route Sub-Field**

Discover Route Field Value	Field Meaning
0x00	Suppress route discovery
0x01	Enable route discovery
0x02, 0x03	Reserved

6742 For NWK layer command frames, the discover route sub-field SHALL be set to 0x00 indicating suppression of route
6743 discovery.

6744 #### 3.3.1.1.4 Security Sub-Field

6745 The security sub-field SHALL have a value of 1 if, and only if, the frame is to have NWK security operations enabled.
6746 If security for this frame is implemented at another layer or disabled entirely, it SHALL have a value of 0.

6747 #### 3.3.1.1.5 Source Route Sub-Field

6748 The source route sub-field SHALL have a value of 1 if and only if a source route subframe is present in the NWK
6749 header. If the source route subframe is not present, the source route sub-field SHALL have a value of 0.

6750 #### 3.3.1.1.6 Destination IEEE Address Sub-Field

6751 The destination IEEE address sub-field SHALL have a value of 1 if, and only if, the NWK header is to include the
6752 full IEEE address of the destination.

6753 #### 3.3.1.1.7 Source IEEE Address Sub-Field

6754 The source IEEE address sub-field SHALL have a value of 1 if, and only if, the NWK header is to include the full
6755 IEEE address of the source device.

3.3.1.1.8 End Device Initiator

If the source of the message is an end device and the *nwkParentInformation* field of the NIB is a value other than 0, then this sub-field SHALL be set to 1. Otherwise this sub-field SHALL be set to 0. After validating the source (see section 3.6.2.2), a router parent device SHALL clear this field when relaying a message sent by one of its end device children.

3.3.1.2 Destination Address Field

The destination address field SHALL always be present and SHALL be 2 octets in length. If the multicast flag sub-field of the frame control field has the value 0, the destination address field SHALL hold the 16-bit network address of the destination device or a broadcast address (see Table 3-76). Note that the network address of a device SHALL be set to the value of the *macShortAddress* attribute of the MAC PIB.

3.3.1.3 Source Address Field

The source address field SHALL always be present. It SHALL always be 2 octets in length and SHALL hold the network address of the source device of the frame. Note that the network address of a device SHALL be set to value of the *macShortAddress* attribute of the MAC PIB.

3.3.1.4 Radius Field

The radius field SHALL always be present. It will be 1 octet in length and specifies the range of a radius-limited transmission. The field SHALL be decremented by 1 by each receiving device.

3.3.1.5 Sequence Number Field

The sequence number field is present in every frame and is 1 octet in length. The sequence number value SHALL be incremented by 1 with each new frame transmitted. The values of the source address and sequence number fields of a frame, taken as a pair, MAY be used to uniquely identify a frame within the constraints imposed by the sequence number's one-octet range. For more details on the use of the sequence number field, see section 3.6.2.

3.3.1.6 Destination IEEE Address Field

The destination IEEE address field, if present, contains the 64-bit IEEE address corresponding to the 16-bit network address contained in the destination address field of the NWK header. Upon receipt of a frame containing a 64-bit IEEE address, the contents of the *nwkAddressMap* and neighbor table SHOULD be checked for consistency, and updated if necessary. Section 3.6.1.10.2 describes the actions to take in detecting address conflicts. If the 16-bit network address is a broadcast or multicast address then the destination IEEE address field SHALL NOT be present.

3.3.1.7 Source IEEE Address Field

The source IEEE address field, if present, contains the 64-bit IEEE address corresponding to the 16-bit network address contained in the source address field of the NWK header. Upon receipt of a frame containing a 64-bit IEEE address, the contents of the *nwkAddressMap* and Neighbor Table SHOULD be checked for consistency, and updated if necessary. Section 3.6.1.10.2 describes the actions to take in detecting address conflicts.

3.3.1.8 Source Route Subframe Field

The source route subframe field SHALL only be present if the source route sub-field of the frame control field has a value of 1. It is divided into three sub-fields as illustrated in Figure 3-6.

Octets: 1	1	Variable
Relay count	Relay index	Relay list

Figure 3-6. Source Route Subframe Format

3.3.1.8.1 Relay Count Sub-Field

The relay count sub-field indicates the number of relays contained in the relay list sub-field of the source route sub-frame.

3.3.1.8.2 Relay Index

The relay index sub-field indicates the index of the next relay in the relay list sub-field to which the packet will be transmitted. This field is initialized to 1 less than the relay count by the originator of the packet, and is decremented by 1 by each receiving relay.

3.3.1.8.3 Relay List Sub-Field

The relay list sub-field SHALL contain the list of relay addresses. The relay closest to the destination SHALL be listed first. The relay closest to the originator SHALL be listed last.

3.3.1.8.4 Frame Payload Field

The frame payload field has a variable length and contains information specific to individual frame types.

3.3.2 Format of Individual Frame Types

There are two defined NWK frame types: data and NWK command. Each of these frame types is discussed in the following sections.

3.3.2.1 Data Frame Format

The data frame SHALL be formatted as illustrated in Figure 3-7.

Octets: 2	Variable	Variable
Frame control	Routing fields	Data payload
NWK header		NWK payload

Figure 3-7. Data Frame Format

The order of the fields of the data frame SHALL conform to the order of the general NWK frame format as illustrated in Figure 3-4.

3.3.2.1.1 Data Frame NWK Header Field

The data frame NWK header field SHALL contain the frame control field and an appropriate combination of routing fields as required.

In the frame control field, the frame type sub-field SHALL contain the value that indicates a data frame, as shown in Table 3-48. All other sub-fields shall be set according to the intended use of the data frame.

The routing fields SHALL contain an appropriate combination of address and broadcast fields, depending on the settings in the frame control field (see Figure 3-5).

3.3.2.1.2 Data Payload Field

The data frame data payload field SHALL contain the sequence of octets that the next higher layer has requested the NWK layer to transmit.

3.3.2.2 NWK Command Frame Format

The NWK command frame SHALL be formatted as illustrated in Figure 3-8.

Octets: 2	Variable	1	Variable
Frame control	Routing fields	NWK command identifier	NWK command payload
NWK header		NWK payload	

Figure 3-8. NWK Command Frame Format

The order of the fields of the NWK command frame SHALL conform to the order of the general NWK frame as illustrated in .

3.3.2.2.1 NWK Command Frame NWK Header Field

The NWK header field of a NWK command frame SHALL contain the frame control field and an appropriate combination of routing fields as required.

In the frame control field, the frame type sub-field SHALL contain the value that indicates a NWK command frame, as shown in Table 3-48. All other sub-fields shall be set according to the intended use of the NWK command frame.

The routing fields SHALL contain an appropriate combination of address and broadcast fields, depending on the settings in the frame control field.

3.3.2.2.2 NWK Command Identifier Field

The NWK command identifier field indicates the NWK command being used. This field SHALL be set to one of the non-reserved values listed in Table 3-50.

3.3.2.2.3 NWK Command Payload Field

The NWK command payload field of a NWK command frame SHALL contain the NWK command itself.

3.4 Command Frames

The command frames defined by the NWK layer are listed in Table 3-50. The following sections detail how the NLME SHALL construct the individual commands for transmission.

For each of these commands, the following applies to the NWK header fields unless specifically noted in the section on NWK header in each command:

- The frame type sub-field of the NWK frame control field SHALL be set to indicate that this frame is a NWK command frame.
- The discover route sub-field in the NWK header SHALL be set to suppress route discovery (see Table 3-49).
- The source address field in the NWK header SHALL be set to the address of the originating device.

6850 **Table 3-50. NWK Command Frames**

Command Frame Identifier	Command Name	Network Encryption	Reference
0x01	Route Request	Required	3.4.1
0x02	Route Reply	Required	3.4.2
0x03	Network Status	Required	3.4.3
0x04	Leave	Required	3.4.4
0x05	Route Record	Required	3.4.5
0x06	Rejoin Request	Optional	3.4.6
0x07	Rejoin Response	Optional	3.4.7
0x08	Link Status	Required	3.4.8
0x09	Network Report	Required	
0x0a	Network Update	Required	3.4.10
0x0b	End Device Timeout Request	Required	3.4.11
0x0c	End Device Timeout Response	Required	3.4.12
0x0d	Link Power Delta	Required	3.4.13
0x0e	Network Commissioning Request	Optional	3.4.14
0x0f	Network Commissioning Response	Optional	3.4.15
0x10 – 0xff	Reserved	-	—

6851 ## 3.4.1 Route Request Command

6852 The route request command allows a device to request other devices within radio range to engage in a search for a
6853 particular destination device and establish a state within the network that will allow messages to be routed to that
6854 destination more easily and economically in the future. The payload of a route request command SHALL be formatted
6855 as illustrated in Figure 3-9.

Octets: 1	1	2	1	0/8	Variable
Command options	Route request identifier	Destination address	Path cost	Destination IEEE Address	TLVs
NWK command payload					

Figure 3-9. Route Request Command Frame Format

3.4.1.1 MAC Data Service Requirements

In order to transmit this command using the MAC data service, specified in IEEE Std 802.15.4-2020 [B1], the following information SHALL be included in the MAC frame header:

- The destination PAN identifier SHALL be set to the PAN identifier of the device sending the route request command.
- The destination address SHALL be set to the broadcast address of 0xffff.
- The source address and PAN identifier SHALL be set to the network address and PAN identifier of the device sending the route request command, which MAY or MAY NOT be the device from which the command originated.
- The frame control field SHALL be set to specify that the frame is a MAC data frame with MAC security disabled, since any secured frame originating from the NWK layer SHALL use NWK layer security. Because the frame is broadcast, no acknowledgment request SHALL be specified.
- The addressing mode and intra-PAN flags SHALL be set to support the addressing fields described here.

3.4.1.2 NWK Header Fields

In order for this route request to reach its destination and for the route discovery process to complete correctly, the following information SHALL be provided:

- The destination address in the NWK header SHALL be set to the broadcast address for all routers and the coordinator (see Table 3-76).
- The source IEEE address sub-field of the frame control field SHALL be set to 1 and the source IEEE address field of the NWK header SHALL be present and SHALL contain the 64-bit IEEE address of the originator of the frame.

3.4.1.3 NWK Payload Fields

The NWK frame payload contains a command identifier field, a command options field, the route request identifier field, the address of the intended destination, an up-to-date summation of the path cost, and the destination IEEE address.

The command frame identifier SHALL contain the value indicating a route request command frame.

3.4.1.3.1 Command Options Field

The format of the 8-bit command options field is shown in Figure 3-10.

Bit: 0-2	3-4	5	6	7
Reserved	Many-to-one	Destination IEEE address	Deprecated (Multicast)	Reserved

Figure 3-10. Route Request Command Options Field

3.4.1.3.1.1 Many-to-One

The many-to-one field SHALL have one of the non-reserved values shown in Table 3-51.

Table 3-51. Many-to-One Field Values

Value	Description
0	The route request is not a many-to-one route request.
1	The route request is a many-to-one route request and the sender supports a route record table.
2	The route request is a many-to-one route request and the sender does not support a route record table.
3	Reserved

3.4.1.3.1.2 Destination IEEE Address

The destination IEEE address field is a single-bit field. It SHALL have a value of 1 if, and only if, the command frame contains the destination IEEE address. The Destination IEEE Address field SHOULD always be added if it is known.

3.4.1.3.2 Route Request Identifier

The route request identifier is an 8-bit sequence number for route requests and is incremented by 1 every time the NWK layer on a particular device issues a route request.

3.4.1.3.3 Destination Address

The destination address SHALL be 2 octets in length and represents the intended destination of the route request command frame.

3.4.1.3.4 Path Cost

The path cost field is eight bits in length and is used to accumulate routing cost information as a route request command frame moves through the network (see section 3.6.4.5.2).

3.4.1.3.5 Destination IEEE Address

The destination IEEE address SHALL be 8 octets in length and represents the IEEE address of the destination of the route request command frame. It SHALL be present only if the destination IEEE address sub-field of the command frame options field has a value of 1.

3.4.2 Route Reply Command

The route reply command allows the specified destination device of a route request command to inform the originator of the route request that the request has been received. It also allows Zigbee routers along the path taken by the route request to establish state information that will enable frames sent from the source device to the destination device to travel more efficiently. The payload of the route reply command SHALL be formatted as illustrated in Figure 3-11.

Octets: 1	**1**	**2**	**2**	**1**	**0/8**	**0/8**	**Variable**
Command options	Route request identifier	Originator address	Responder address	Path cost	Originator IEEE address	Responder IEEE address	TLVs
NWK command payload							

Figure 3-11. Route Reply Command Format

3.4.2.1 MAC Data Service Requirements

In order to transmit this command using the MAC data service, specified in IEEE Std 802.15.4-2020 [B1], the following information SHALL be included in the MAC frame header:

The destination MAC address and PAN identifier SHALL be set to the network address and PAN identifier, respectively, of the first hop in the path back to the originator of the corresponding route request command frame. The destination PAN identifier SHALL be the same as the PAN identifier of the originator.

The source MAC address and PAN identifier SHALL be set to the network address and PAN identifier of the device sending the route reply command, which MAY or MAY NOT be the device from which the command originated.

The frame control field SHALL be set to specify that the frame is a MAC data frame with MAC security disabled, since any secured frame originating from the NWK layer SHALL use NWK layer security. The transmission options SHALL be set to require acknowledgment. The addressing mode and intra-PAN flags SHALL be set to support the addressing fields described here.

3.4.2.2 NWK Header Fields

In order for this route reply to reach its destination and for the route discovery process to complete correctly, the following information SHALL be provided:

- The source address in the NWK header SHALL be set to the 16-bit network address of the device transmitting the frame.
- The destination address field in the NWK header SHALL be set to the network address of the first hop in the path back to the originator of the corresponding route request.
- Since this is a NWK layer command frame, the source IEEE address sub-field of the frame control field SHALL be set to 1 and the source IEEE address field of the NWK header SHALL be present and SHALL contain the 64-bit IEEE address of the originator of the frame. The destination IEEE address sub-field of the frame control field SHALL also have a value of 1 and the destination IEEE address field of the NWK header shall be present and SHALL contain the 64-bit IEEE address of the first hop in the path back to the originator of the corresponding route request.
- The Sequence Number field in the NWK header SHALL be created for every hop during the route reply process. The Radius Field SHALL be set to *nwkcMaxDepth* * 2 by the target of the route request. Every hop during the Route Reply process SHALL decrement the radius by 1. If the value of the radius in the received Route Reply message is 1, the relaying router SHALL set the radius of the message to 1. The Sequence Number SHALL be created as if it were a new frame from the device transmitting the frame replacing the sequence number with

the device's next available sequence number. The Route Reply frame is not a forwarded frame, but is newly created by each hop during the route reply process.

3.4.2.3 NWK Payload Fields

The NWK frame payload contains a command identifier field, a command options field, the route request identifier, originator and responder addresses and an up-to-date summation of the path cost.

The command frame identifier SHALL contain the value indicating a route reply command frame.

3.4.2.3.1 Command Options Field

The format of the 8-bit command options field is shown in Figure 3-12.

Bit: 0 – 3	4	5	6	6-7
Reserved	Originator IEEE address	Responder IEEE address	Deprecated (Multicast)	Reserved

Figure 3-12. Route Reply Command Options Field

3.4.2.3.1.1 Originator IEEE Address

The originator IEEE address sub-field is a single-bit field. It SHALL have a value of 1 if and only if the originator IEEE address field is included in the payload. This bit SHALL always be set.

3.4.2.3.1.2 Responder IEEE Address

The responder IEEE address sub-field is a single-bit field. It SHALL have a value of 1 if, and only if, the responder IEEE address field is included in the payload. This bit SHALL always be set.

3.4.2.3.2 Route Request Identifier

The route request identifier is the 8-bit sequence number of the route request to which this frame is a reply.

3.4.2.3.3 Originator Address

The originator address field SHALL be 2 octets in length and SHALL contain the 16-bit network address of the originator of the route request command frame to which this frame is a reply.

3.4.2.3.4 Responder Address

The responder address field SHALL be 2 octets in length and SHALL always be the same as the value in the destination address field of the corresponding route request command frame.

3.4.2.3.5 Path Cost

The path cost field is used to sum link cost as the route reply command frame transits the network (see section 3.6.4.5.2).

3.4.2.3.6 Originator IEEE Address

The originator IEEE address field SHALL be 8 octets in length and SHALL contain the 64-bit address of the originator of the route request command frame to which this frame is a reply. This field SHALL only be present if the originator IEEE address sub-field of the command options field has a value of 1.

3.4.2.3.7 Responder IEEE Address

The responder IEEE address field SHALL be 8 octets in length and SHALL contain the 64-bit address of the destination of the route request command frame to which this frame is a reply. This field SHALL only be present if the responder IEEE address sub-field of the command options field has a value of 1.

3.4.3 Network Status Command

A device uses the network status command to report errors and other conditions arising in the NWK layer of a particular device to the peer NWK layer entities of other devices in the network. The NWK status command MAY be also used to diagnose network problems, *for example* address conflicts. The payload of a network status command SHALL be formatted as illustrated in Figure 3-13.

Octets: 1	2	Variable
Status code	Target address	TLVs
NWK command payload		

Figure 3-13. Network Status Command Frame Format

3.4.3.1 MAC Data Service Requirements

In order to transmit this command using the MAC data service, specified in IEEE Std 802.15.4-2020 [B1], the following information SHALL be provided:

- The destination MAC address and PAN identifier SHALL be set to the network address and PAN identifier, respectively, of the first hop in the path to the destination of the command frame or to the broadcast address 0xffff in the case where the command frame is being broadcast at the NWK layer.
- The source MAC address and PAN identifier SHALL be set to the network address and PAN identifier of the device sending the network status command.
- The frame control field SHALL be set to specify that the frame is a MAC data frame with MAC security disabled, since any secured frame originating from the NWK layer SHALL use NWK layer security. The transmission options SHALL NOT be set to require acknowledgement if the destination MAC address is the broadcast address 0xffff.
- The addressing mode and intra-PAN flags SHALL be set to support the addressing fields described here.

3.4.3.2 NWK Header Fields

Network status commands MAY be either unicast or broadcast. The fields of the NWK header SHALL be set as follows:

- The source address field SHALL always be set to the 16-bit network address of the device originating the command frame.
- The source IEEE address sub-field of the frame control field SHALL be set to 1 and the source IEEE address field of the NWK header SHALL be present and SHALL contain the 64-bit IEEE address of the originator of the frame.
- When sent in response to a routing error, the destination address field in the NWK header SHALL be set to the same value as the source address field of the data frame that encountered a forwarding failure.
- If and only if, the network status command frame is not broadcast, the destination IEEE address sub-field of the frame control field SHALL have a value of 1 and the destination IEEE address field of the NWK header SHALL be present and SHALL contain the 64-bit IEEE corresponding to the 16-bit network address in the destination address field if this IEEE address is known.

3.4.3.3 NWK Payload Fields

The NWK frame payload of the network status command frame contains a command frame identifier field, a status code field and a destination address field as described below. The command frame identifier SHALL be set to specify the network status command frame as defined in Table 3-52.

3.4.3.3.1 Status Code

The status code SHALL be set to one of the non-reserved values shown in Table 3-52.

Table 3-52. Status Codes for Network Status Command Frame

Value	Status Code	NLME-NWK-STATUS.indication Usage	Sent over-the-air in NWK Status Command	Description
0x00	Legacy No Route Available	No	Yes	This link code indicates a failure to route across a link. This was used in previous specifications. Revision 23 devices SHALL no longer SEND this error code but SHALL accept and act on it. It SHALL be treated the same as 0x02, Link failure.
0x01	Legacy Link Failure	No	Yes	This link code indicates a failure to route across a link. This was used in previous specifications. Revision 23 devices SHALL no longer SEND this error code but SHALL accept and act on it. It SHALL be treated the same as 0x02, Link failure.
0x02	Link failure	No	Yes	This link code indicates a failure to route across a link.
0x03 – 0x08	Deprecated	-	-	These are deprecated error codes and SHOULD NOT be used in a future specification version.
0x09	Parent link failure	Yes	No	The failure occurred as a result of a failure in the RF link to the

Value	Status Code	NLME-NWK-STATUS.indication Usage	Sent over-the-air in NWK Status Command	Description
				device's parent. This status is only used locally on a device to indicate loss of communication with the parent.
0x0A	Deprecated	-	-	These are deprecated error codes and SHOULD NOT be used in a future specification version.
0x0B	Source Route failure	Yes	Yes	Source routing has failed, probably indicating a link failure in one of the source route's links.
0x0C	Many-to-one route failure	Yes	Yes	A route established as a result of a many-to-one route request has failed.
0x0D	Address Conflict	Yes	Yes	The address in the destination address field has been determined to be in use by two or more devices.
0x0E	Deprecated	-	-	These are deprecated error codes and SHOULD NOT be used in a future specification version.
0x0F	PAN Identifier Update	Yes	No	The operational network PAN identifier of the device has been updated.
0x10	Network Address Update	Yes	No	The network address of the local device has been updated.
0x13	Unknown Command	No	Yes	The NWK command ID is not known to the device.

Value	Status Code	NLME-NWK-STATUS.indication Usage	Sent over-the-air in NWK Status Command	Description
0x14	PAN ID Conflict Report	Yes	No	Notification to the local application that a PAN ID Conflict Report has been received by the local Network Manager.
0x15 – 0xFF	Reserved	-	-	Reserved for future use

These status codes are used both as values for the status code field of a network status command frame and as values of the Status parameter of the NLME-NWK-STATUS.indication primitive.

A device receiving a reserved or deprecated status code SHALL ignore it.

3.4.3.3.2 Destination Address

The destination address field SHALL be 2 octets in length and SHALL be present if, and only if, the network status command frame is being sent in response to a routing failure or a network address conflict. In case of a routing failure, it SHALL contain the destination address from the data frame that encountered the failure; in case of an address conflict, it SHALL contain the offending network address.

3.4.4 Leave Command

The leave command is used by the NLME to inform other devices on the network that a device is leaving the network or else to request that a device leave the network. The payload of the leave command SHALL be formatted as shown in Figure 3-14.

1
Command options
NWK command payload

Figure 3-14. Leave Command Frame Format

3.4.4.1 MAC Data Service Requirement

In order to transmit this command using the MAC data service, specified in IEEE Std 802.15.4-2020 [B1], the following information SHALL be provided:

The destination MAC address and PAN identifier SHALL be set to the network address and PAN identifier, respectively, of the neighbor device to which the frame is being sent or else to the MAC broadcast address 0xffff in the case where the NWK header also contains a broadcast address.

The source MAC address and PAN identifier SHALL be set to the network address and PAN identifier of the device sending the leave command.

The frame control field SHALL be set to specify that the frame is a MAC data frame with MAC security disabled, since any secured frame originating from the NWK layer SHALL use NWK layer security. Acknowledgment SHALL be requested.

The addressing mode and intra-PAN flags SHALL be set to support the addressing fields described here.

3.4.4.2 NWK Header Fields

The NWK header fields of the leave command frame SHALL be set as follows:

- The source IEEE address sub-field of the frame control field SHALL be set to 1 and the source IEEE address field of the NWK header SHALL be present and SHALL contain the 64-bit IEEE address of the originator of the frame.
- If the request sub-field of the command options field is set to 1 then the destination address field in the NWK header SHALL be set to the network address of the child device being requested to leave.
- If the request sub-field is set to 0 then the destination address field in the NWK header SHALL be set to 0xfffd so that the indication is received by devices with *macRxOnWhenIdle* equal to TRUE.
- The destination address sub-field of the frame control MAY be set to 0 or 1. The choice SHALL be based on whether the local device has knowledge of the IEEE address for the device being requested to leave. If the local device knows the IEEE address then the field SHALL be set to 1 and the destination IEEE address field SHALL be present..
- The radius field SHALL be set to 1.

3.4.4.3 NWK Payload Fields

The NWK payload of the leave command frame contains a command frame identifier field and a command options field. The command frame identifier field SHALL be set to specify the leave command frame as described in Table 3-50.

3.4.4.3.1 Command Options Field

The format of the 8-bit Command Options field is shown in Figure 3-15.

Bit: 0 – 4	5	6	7
Reserved	Rejoin	Request	Remove children

Figure 3-15. Leave Command Options Field

3.4.4.3.1.1 Rejoin Sub-Field

The Rejoin sub-field is a single-bit field. If the value of this sub-field is 1, the device that is leaving from its current parent will rejoin the network. If the value of this sub-field is 0, the device will not rejoin the network.

3.4.4.3.1.2 Request Sub-Field

The request sub-field is a single-bit field. If the value of this sub-field is 1, then the leave command frame is a request for another device to leave the network. If the value of this sub-field is 0, then the leave command frame is an indication that the sending device plans to leave the network.

3.4.4.3.1.3 Remove Children Sub-Field

The remove children sub-field is a single-bit field. If this sub-field has a value of 1, then the children of the device that is leaving the network will also be removed. If this sub-field has a value of 0, then the children of the device leaving the network will not be removed.

3.4.5 Route Record Command

The route record command allows the route taken by a unicast packet through the network to be recorded in the command payload and delivered to the destination device. The payload of the route record command SHALL be formatted as illustrated in Figure 3-16.

Octets: 1	Variable
Relay count	Relay list
NWK command payload	

Figure 3-16. Route Record Command Format

3.4.5.1 MAC Data Service Requirements

In order to transmit this command using the MAC data service, specified in IEEE Std 802.15.4-2020 [B1], the following information SHALL be provided:

- The destination MAC address and PAN identifier SHALL be set to the network address and PAN identifier, respectively, of the neighbor device to which the frame is being sent.
- The source MAC address and PAN identifier SHALL be set to the network address and PAN identifier of the device sending the route record command.
- The frame control field SHALL be set to specify that the frame is a MAC data frame with MAC security disabled, since any secured frame originating from the NWK layer SHALL use NWK layer security. Acknowledgment SHALL be requested.
- The addressing mode and intra-PAN flags SHALL be set to support the addressing fields described here.

3.4.5.2 NWK Header Fields

The NWK header fields of the route record command frame SHALL be set as follows:

- If the route record is being initiated as the result of a NLDE-DATA.request primitive from the next higher layer, the source address field SHALL be set to the 16-bit network address of the originator of the frame. If the route record is being initiated as a result of the relaying of a data frame on behalf of one of the device's end device children, the source address field SHALL contain the 16-bit network address of that end device child.
- The source IEEE address sub-field of the frame control field SHALL be set to 1 and the source IEEE address field of the NWK header SHALL be present and SHALL contain the 64-bit IEEE address corresponding to the 16-bit network address contained in the source address field.
- The destination address field in the NWK header SHALL be set to the 16-bit network address of the concentrator device that is the destination of the frame.
- The destination IEEE address sub-field of the frame control field SHALL be set to 1, and the destination IEEE address field SHALL be set to the IEEE address of the concentrator device that is the destination of the frame, if this address is known.
- The Source Route sub-field of the frame control field SHALL be set to 0.

3.4.5.3 NWK Payload

The NWK frame payload contains a command identifier field, a relay count field, and a relay list field. The command frame identifier SHALL contain the value indicating a route record command frame.

3.4.5.3.1 Relay Count Field

This field contains the number of relays in the relay list field of the route record command. If the route record is being initiated as the result of a NLDE-DATA.request primitive from the next higher layer, the relay count field is initialized to 0. If the route record is being initiated as a result of the relaying of a data frame on behalf of one of the device's end device children, the relay count field is initialized to 1. In either case, it is incremented by each receiving relay.

3.4.5.3.2 Relay List Field

The relay list field is a list of the 16-bit network addresses of the nodes that have relayed the packet. If the route record is being initiated as a result of the relaying of a data frame on behalf of one of the device's end device children, the initiating device will initialize this field with its own 16-bit network address. Receiving relay nodes append their network address to the list before forwarding the packet.

3.4.6 Rejoin Request Command

The rejoin request command allows a device to rejoin its network. This is normally done in response to a communication failure, such as when an end device can no longer communicate with its original parent. The rejoin request command SHALL be formatted as shown in Figure 3-17.

Octets: 1
Capability Information
NWK command payload

Figure 3-17. Rejoin Request Command Frame Format

3.4.6.1 MAC Data Service Requirements

In order to transmit this command using the MAC data service, specified in IEEE Std 802.15.4.-2015, [B1], the following information SHALL be provided:

- The destination address and PAN identifier SHALL be set to the network address and PAN identifier, respectively, of the prospective parent.
- The source MAC address and PAN identifier SHALL be set to the network address and PAN identifier of the device transmitting the rejoin command frame.
- The transmission options SHALL be set to require acknowledgement.
- The addressing mode and intra-PAN flags SHALL be set to support the addressing fields described here.

3.4.6.2 NWK Header Fields

The NWK header fields of the rejoin request command frame SHALL be set as follows:

- The source address field of the NWK header to the 16-bit network address SHALL be as follows. If the value of the *nwkNetworkAddress* in the NIB is within the valid range, then it SHALL use that value. If the value of the *nwkNetworkAddress* in the NIB is not within the valid range, then it SHALL randomly generate a value within the valid range, excluding the value of 0x0000, and use that.
- The source IEEE address sub-field of the frame control field SHALL be set to 1, and the source IEEE address field SHALL be set to the IEEE address of the device issuing the request.
- The destination address field in the NWK header SHALL be set to the 16-bit network address of the prospective parent.

- The destination IEEE address sub-field of the frame control field SHALL be set to 1, and the destination IEEE address field SHALL be set to the IEEE address of the prospective parent, if this address is known.
- The radius field SHALL be set to 1.

3.4.6.3 NWK Payload Fields

The NWK frame payload contains a command identifier field and a capability information field. The command frame identifier SHALL contain the value indicating a rejoin request command frame.

3.4.6.3.1 Capability Information Field

This one-octet field has the format of the capability information field in the association request command in [B1], which is also described in Table 3-67.

3.4.7 Rejoin Response Command

The rejoin response command is sent by a device to inform a child of its network address and rejoin status. The rejoin request command SHALL be formatted as shown in Figure 3-18.

Octets: 2	**1**
Network address	Rejoin status
NWK command payload	

Figure 3-18. Rejoin Response Command Frame Format

3.4.7.1 MAC Data Service Requirements

In order to transmit this command using the MAC data service, specified in [B1], the following information SHALL be provided:

- The destination MAC address and PAN identifier SHALL be set to the network address and PAN identifier, respectively, of the device that sent the rejoin request to which this frame is a response.
- The source MAC address and PAN identifier SHALL be set to the network address and PAN identifier of the device that received and processed the rejoin request command frame.
- Acknowledgment SHALL be requested.
- The addressing mode and intra-PAN flags SHALL be set to support the addressing fields described here. The TXOptions SHALL request ‘indirect transmission’ to be used if the *Receiver on when idle* bit of the *nwkCapabilityInformation* contained in the corresponding rejoin request command is equal to 0x00. Otherwise, ‘direct transmission’ SHALL be used.

3.4.7.2 NWK Header Fields

The NWK header fields of the rejoin response command frame SHALL be set as follows:

- The source address field SHALL be set to the 16-bit network address of the device that is sending the response.
- The source IEEE address sub-field of the frame control field SHALL be set to 1 and the source IEEE address field of the NWK header SHALL be present and SHALL contain the 64-bit IEEE address of the parent device that is sending the response.
- The destination address field of the NWK header SHALL be set to the current network address of the rejoining device, *i.e.* the device that sent the join request to which this frame is a response.

- The destination IEEE address sub-field of the frame control field SHALL have a value of 1 and the destination IEEE address field of the NWK header SHALL be present and SHALL contain the 64-bit IEEE address of the child device that is source of the rejoin request command to which this frame is a response.
- The NWK layer will set the security of the Network Rejoin Response command frame to the same level as that of the received rejoin request command frame to which it is a response.

3.4.7.3 NWK Payload Fields

3.4.7.3.1 Network Address Field

If the rejoin was successful, this two-octet field contains the new network address assigned to the rejoining device. If the rejoin was not successful, this field contains the broadcast address (0xffff).

3.4.7.3.2 Rejoin Status Field

This field SHALL contain one of the non-reserved association status values specified in [B1].

3.4.8 Link Status Command

The link status command frame allows neighboring routers to communicate their incoming link costs to each other as described in section 3.6.4.4. Link status frames are transmitted as one-hop broadcasts without retries.

3.4.8.1 MAC Data Service Requirements

In order to transmit this command using the MAC data service, specified in IEEE Std 802.15.4-2020 [B1], the following information SHALL be included in the MAC frame header:

- The destination PAN identifier SHALL be set to the PAN identifier of the device sending the link status command.
- The destination address SHALL be set to the broadcast address of 0xffff.
- The source MAC address and PAN identifier SHALL be set to the network. address and PAN identifier of the device sending the link status command.
- The frame control field SHALL be set to specify that the frame is a MAC data frame with MAC security disabled, since any secured frame originating from the NWK layer SHALL use NWK layer security. Because the frame is broadcast, no acknowledgment request SHALL be specified.
- The addressing mode and intra-PAN flags SHALL be set to support the addressing fields described here.

3.4.8.2 NWK Header Fields

The NWK header field of the link status command frame SHALL be set as follows:

- The source IEEE address sub-field of the frame control field SHALL be set to 1 and the source IEEE address field of the NWK header SHALL be present and SHALL contain the 64-bit IEEE address of the originator of the frame.
- The destination address in the NWK header SHALL be set to the router-only broadcast address (see Table 3-76).
- The destination IEEE address sub-field of the frame control field SHALL have a value of 0 and the destination IEEE address field of the NWK header SHALL NOT be present.
- The radius field SHALL be set to 1.

3.4.8.3 NWK Payload Fields

The NWK command payload of the link status command SHALL be formatted as illustrated in Figure 3-19.

Octets: 1	Variable
Command options	Link status list
NWK command payload	

Figure 3-19. Link Status Command Format

3.4.8.3.1 Command Options Field

The format of the 8-bit command options field is shown in Figure 3-20.

Bit: 0 – 4	5	6	7
Entry count	First frame	Last frame	Reserved

Figure 3-20. Link Status Command Options Field

The entry count sub-field of the command options field indicates the number of link status entries present in the link status list. The first frame sub-field is set to 1 if this is the first frame of the sender's link status. The last frame sub-field is set to 1 if this is the last frame of the sender's link status. If the sender's link status fits into a single frame, the first frame and last frame bits SHALL both be set to 1.

3.4.8.3.2 Link Status List Field

An entry in the link status list is formatted as shown in Figure 3-21.

Octets: 2	1
Neighbor network address	Link status

Figure 3-21. Link Status Entry

Link status commands SHALL be transmitted on every active MAC interface in the MAC Interface table where the state is TRUE (active) and RoutersAllowed is also TRUE. The set of link status entries in the link status command derived from the neighbor table SHALL be specific to the interface that the command is to be transmitted on. Link status entries are sorted in ascending order by network address. If all router neighbors do not fit in a single frame, multiple frames are sent. When sending multiple frames, the last network address in the link status list for frame N is equal to the first network address in the link status list for frame N+1.

Each link status entry contains the network address of a router neighbor, least significant octet first, followed by the link status octet. The incoming cost field contains the device's estimate of the link cost for the neighbor, which is a value between 1 and 7. The outgoing cost field contains the value of the outgoing cost field from the neighbor table.

The link status field in a link status entry is formatted as in Figure 3-22.

Bits: 0-2	3	4-6	7
Incoming cost	Reserved	Outgoing cost	Reserved

Figure 3-22. Link Status Entry Format

3.4.9 Network Report Command

The network report command allows a device to report network events to the device identified by the address contained in the *nwkManagerAddr* in the NIB in an unsolicited way. Such events are radio channel condition and PAN ID conflicts. The payload of a network report command SHALL be formatted as illustrated in Figure 3-23.

Starting with Revision 23 of this specification this is considered a legacy command. Revision 23 devices SHALL NOT generate this command. Generating unsolicited messages on the network due to unencrypted traffic must be limited to avoid introducing security problems. Statistics on PAN ID conflicts are collected by the device and reported via the higher layer (such as ZDO).

Octets: 1	8	Variable
Command options (see Figure 3-24)	EPID	Report information
NWK command payload		

Figure 3-23. Network Report Command Frame Format

3.4.9.1 MAC Data Service Requirements

In order to transmit this command using the MAC data service, specified in [B1], the following information SHALL be included in the MAC frame header:

- The destination PAN identifier SHALL be set to the PAN identifier of the device sending the network report command.
- The destination address SHALL be set to the value of the next-hop address field in the routing table entry for which the destination address field has the same value as the *nwkManagerAddr* field in the NIB. If no such routing table entry exists, then the NWK MAY attempt route discovery as described in section 3.6.4.5.
- The source MAC address and PAN identifier SHALL be set to the network address and PAN identifier of the device sending the network report command, which MAY or MAY NOT be the device from which the command originated.
- The frame control field SHALL be set to specify that the frame is a MAC data frame with MAC security disabled, since any secured frame originating from the NWK layer SHALL use NWK layer security. The transmission options SHALL be set to require acknowledgment.

3.4.9.2 NWK Header Fields

The NWK header fields of the network report command frame SHALL be set as follows:

- The source IEEE address sub-field of the frame control field SHALL be set to 1 and the source IEEE address field of the NWK header SHALL be present and SHALL contain the 64-bit IEEE address of the originator of the frame.

- The destination address field in the NWK header SHALL be set to the 16-bit network address contained in the *nwkManagerAddr* attribute of the NIB.
- The destination IEEE address sub-field of the frame control field SHALL have a value of 1 and the destination IEEE address field of the NWK header SHALL be present and SHALL contain the 64-bit IEEE address of the corresponding to the 16-bit network address contained in the *nwkManagerAddr* attribute of the NIB, if this IEEE address is known.

3.4.9.3 NWK Payload Fields

The NWK frame payload contains a command identifier field, a command options field, an EPID field, and a report information payload.

The command frame identifier SHALL contain the value indicating a network report command frame.

3.4.9.3.1 Command Options Field

The format of the 8-bit command options field is shown in Figure 3-24.

Bits 0 - 4	5 - 7
Report information count	Report command identifier (see Figure 3-25)

Figure 3-24. Network Report Command Options Field

3.4.9.3.1.1 Report Information Count Sub-Field

The report information count sub-field contains an integer indicating the number of records contained within the Report Information field. The size of a record depends in the value of the Report Command Identifier.

3.4.9.3.1.2 Report Command Identifier Sub-Field

The report command identifier sub-field contains an integer indicating the type of report information command. Figure 3-25 contains the values that can be inserted into this field.

Report Command Identifier Value	Report Type
0x00	PAN identifier conflict
0x01 - 0x07	Reserved

Figure 3-25. Report Command Identifier Sub-Field

3.4.9.3.2 EPID Field

The EPID field SHALL contain the 64-bit EPID that identifies the network that the reporting device is a member of.

3.4.9.3.3 Report Information

The report information field provides the information being reported, the format of this field depends upon the value of the Report Command Identifier sub-field.

3.4.9.3.3.1 PAN Identifier Conflict Report

If the value of the Report Command Identifier sub-field indicates a PAN identifier conflict report then the Report Information field will have the format shown in Figure 3-26.

Octets: 2	2	2
1st PAN ID	...	nth PAN ID

Figure 3-26. PAN Identifier Conflict Report

The PAN ID conflict report SHALL be made up of a list of 16-bit PAN identifiers that are operating in the neighborhood of the reporting device. The number of PAN identifiers in the PAN ID conflict report SHALL be equal to the value of the report information count sub-field of the command options field.

3.4.10 Network Update Command

The network update command allows the device identified by the *nwkManagerAddr* attribute of the NIB to broadcast the change of configuration information to all devices in the network. For example, broadcasting the fact that the network is about to change its short PAN identifier.

The payload of a network update command SHALL be formatted as illustrated in Figure 3-27.

Octets: 1	8	1	Variable
Command Options (see Figure 3-28)	EPID	Update Id	Update Information
NWK command payload			

Figure 3-27. Network Update Command Frame Format

3.4.10.1 MAC Data Service Requirements

In order to transmit this command using the MAC data service specified in [B1], the following information SHALL be included in the MAC frame header:

- The destination PAN identifier SHALL be set to the old PAN identifier of the Zigbee coordinator in order for the command frame to reach network devices which have not received this update. The destination address SHALL be set according to the procedures for broadcast transmission outlined in section 3.6.6.
- The source MAC address and PAN identifier SHALL be set to the network address and the old PAN identifier of the device sending the network report command, which MAY or MAY NOT be the device from which the command originated.
- The frame control field SHALL be set to specify that the frame is a MAC data frame with MAC security disabled, since any secured frame originating from the NWK layer SHALL use NWK layer security.

3.4.10.2 NWK Header Fields

The NWK header fields of the network update command frame SHALL be set as follows:

- The source IEEE address sub-field of the frame control field SHALL be set to 1 and the source IEEE address field of the NWK header SHALL be present and SHALL contain the 64-bit IEEE address of the originator of the frame.
- The destination address in the NWK header SHALL be set to the broadcast address 0xffff.
- The destination IEEE address sub-field of the frame control field SHALL have a value of 0 and the destination IEEE address field SHALL NOT be present in the NWK header.

3.4.10.3 NWK Payload Fields

The NWK frame payload contains a command identifier field, a command options field, an EPID field and an Update Information variable field.

The command frame identifier SHALL contain the value indicating a network update command frame.

3.4.10.3.1 Command Options Field

The format of the 8-bit command options field is shown in Figure 3-28.

Bits 0 - 4	5 - 7
Update Information Count	Update Command Identifier (see Figure 3-29)

Figure 3-28. Network Update Command Options Field

3.4.10.3.1.1 Update Information Count Sub-Field

The update information count sub-field contains an integer indicating the number of records contained within the Update Information field. The size of a record depends on the value of the Update Command Identifier sub-field.

3.4.10.3.1.2 Update Command Identifier Sub-Field

The update command identifier sub-field contains an integer indicating the type of update information command. Figure 3-29 contains the values that can be inserted into this field.

Update Command Identifier Value	Report Type
0x00	PAN Identifier Update
0x01 – 0x07	Reserved

Figure 3-29. Update Command Identifier Sub-Field

3.4.10.3.2 EPID Field

The EPID field SHALL contain the 64bit EPID that identifies the network that is to be updated.

3.4.10.3.3 Update Id Field

The update Id field will reflect the current value of the *nwkUpdateId* attribute of the device sending the frame.

3.4.10.3.4 Update Information

The update information field provides the information being updated, the format of this field depends upon the value of the Update Command Identifier sub-field.

3.4.10.3.4.1 PAN Identifier Update

If the value of the Update Command Identifier sub-field indicates a PAN identifier update, then the Update Information field SHALL have the format shown in Figure 3-30.

Octets: 2
New PAN ID

Figure 3-30. PAN Identifier Update

The PAN identifier update SHALL be made up of a single 16-bit PAN identifier that is the new PAN identifier for this network to use. The Update Information count sub field SHALL be set equal to 1 as there is only a single PAN identifier contained within the Update Information field.

3.4.11 End Device Timeout Request Command

The End Device Timeout Request command is sent by an end device informing its parent of its timeout requirements. This allows the parent the ability to delete the child entry from the neighbor table if the child has not communicated with the parent in the specified amount of time.

The payload of an End Device Timeout Request command SHALL be formatted as illustrated in Figure 3-31.

Octets: 1	1
Request Timeout Enumeration	End Device Configuration

Figure 3-31. Format of the End Device Timeout Request Command

3.4.11.1 MAC Data Service Requirements

In order to transmit this command using the MAC data service, specified in [B1], the following information SHALL be provided:

- The destination address and PAN identifier SHALL be set to the network address and PAN identifier, respectively, of the end device's parent.
- The source MAC address and PAN identifier SHALL be set to the network address and PAN identifier of the device transmitting the End Device Timeout Request command.
- The transmission options SHALL be set to require acknowledgement.
- The address mode and intra-PAN flags SHALL be set to support the addressing fields described here.

3.4.11.2 NWK Header fields

The NWK header fields of the End Device Timeout Request command frame SHALL be set as follows:

- The source address field of the NWK header SHALL be set to the 16-bit network address.
- The source IEEE address sub-field of the frame control field SHALL be set to 1, and the source IEEE address field SHALL be set to the IEEE address of the device issuing the request.
- The destination address field in the NWK header SHALL be set to the 16-bit network address of the parent.
- The destination IEEE address sub-field of the frame control field SHALL be set to 1, and the destination IEEE address field SHALL be set to the IEEE address of the parent.
- The radius field SHALL be set to 1.

3.4.11.3 NWK Payload Fields

The NWK frame payload contains a command identifier field and the payload of the End Device Timeout Request as described in Table 3-53.

Table 3-53. Fields of the End Device Timeout Request

Name	Type	Valid Range	Description
Requested Timeout Enumeration	Enumerated type	0 – 14	The requested timeout enumeration. This will be converted into

			actual timeout value based on Table 2-54.
End Device Configuration	Bitmask	0x00 – 0x00	This is an enumeration of the child's requested configuration.

3.4.11.3.1 Requested Timeout Field

The valid values for the requested timeout will be an enumerated type between 0 and 14. This will be converted to an actual timeout value according to Table 3-54.

Table 3-54. Requested Timeout Enumerated Values

Requested Timeout Enumeration Value	Actual Timeout Value
0	10 seconds
1	2 minutes
2	4 minutes
3	8 minutes
4	16 minutes
5	32 minutes
6	64 minutes
7	128 minutes
8	256 minutes
9	512 minutes
10	1024 minutes
11	2048 minutes
12	4096 minutes
13	8192 minutes
14	16384 minutes

This allows for an actual timeout value between 10 seconds and 16384 minutes (~ 11 days).

3.4.11.3.2 End Device Configuration Field

Table 3-55. End Device Configuration Field Values

Bit	Description
0 – 15	Reserved for future use

This is a bitmask indicating the end device's requested configuration. At this time there are no enumerated bits in the configuration field. Devices adhering to this standard SHALL set the field to 0. To allow for future compatibility this field is left in place. Devices that receive the End Device Timeout Request message with an End Device Configuration field set to anything other than 0 SHALL reject the message.

This will allow parents to correctly report their lack of support for unknown end device features. The receiving device SHALL reject the request by sending an End Device Timeout Response with a status of 0x01 (UNSUPPORTED_FEATURE).

3.4.12 End Device Timeout Response Command

The End Device Timeout Response is sent by a router parent informing the end device whether it has accepted the timeout value that it was previously sent, and what its capabilities are.

Octets: 1	1
Status	Parent Information

Figure 3-32. Format of the End Device Timeout Response Command

3.4.12.1 MAC Data Service Requirements

In order to transmit this command using the MAC data service, specified in reference [B1], the following information SHALL be provided:

- The destination address and PAN identifier SHALL be set to the network address and PAN identifier, respectively, of the end device.
- The source MAC address and PAN identifier SHALL be set to the network address and PAN identifier of the device transmitting the End Device Timeout Response command.
- The transmission options SHALL be set to require acknowledgement.
- The address mode and intra-PAN flags SHALL be set to support the addressing fields described here.

3.4.12.2 NWK Header fields

The NWK header fields of the End Device Timeout Response command frame SHALL be set as follows:

- The source address field of the NWK header SHALL be set to the 16-bit network address.
- The source IEEE address sub-field of the frame control field SHALL be set to 1, and the source IEEE address field SHALL be set to the IEEE address of the device issuing the command.
- The destination address field in the NWK header SHALL be set to the 16-bit network address of the end device.
- The destination IEEE address sub-field of the frame control field SHALL be set to 1, and the destination IEEE address field SHALL be set to the IEEE address of the end device.
- The radius field SHALL be set to 1.

3.4.12.2.1 NWK Payload Fields

The NWK frame payload contains a command identifier field and a capability information field. The payload of the End Device Timeout Response is described in Table 3-56.

Table 3-56. Payload fields of the End Device Timeout Response

Name	Type	Valid Range	Description
Status	Enumeration	0 – 0xFF	The success or failure result of the previously received End Device Timeout Request command. See Table 3-57 for an enumeration of the status codes.
Parent Information	Bitmask	0 – 0xFF	This bitmask indicates the parent router's support information to the child device. The bitmask's values are described in Table 3-58.

7416 **Table 3-57. Enumeration of the End Device Timeout Response Status**

Status	Value	Description
SUCCESS	0x00	The End Device Timeout Request message was accepted by the parent.
INCORRECT_VALUE	0x01	The received timeout value in the End Device Timeout Request command was outside the allowed range.
UNSUPPORTED_FEATURE	0x02	The requested feature is not supported by the parent router.
Reserved	0x03 – 0xFF	Reserved for future use.

7417

7418 **Table 3-58. Values of the Parent Information Bitmask**

Bits	Description
0	MAC Data Poll Keepalive Supported
1	End Device Timeout Request Keepalive Supported
2	Power Negotiation Support
3 – 15	Reserved for future use

7419 3.4.13 Link Power Delta Command

7420 The Link Power Delta command frame allows neighboring devices to communicate the value of the difference in dB
7421 between its optimal receive power level and the actual received power level (*ΔP)* of the last packet received with
7422 each other as described in section 3.4.13.7.

7423 The Link power delta notification command frame also allows end devices to exchange the value of the difference in
7424 dB between its optimal receive power level and the actual received power level (*ΔP)* of the last packet received
7425 frame with its parent device as described in section 3.4.13.7.

7426 3.4.13.1 MAC Data Service Requirements

7427 Before any power negotiation has been performed, all transmissions SHALL be at the maximum transmit power. Once
7428 power levels have been negotiated as described in this section, all communications SHALL be at the last set power
7429 level. If the channel is changed or a rejoin performed, the joining SHALL be performed at the maximum power level.

7430 The data transmission is done using the MAC data service, specified in [B1], the following information SHALL be
7431 included in the MAC frame header:

7432 • The destination PAN identifier SHALL be set to the PAN identifier of the device sending the Link Power Delta
7433 command.

7434 • The source MAC address and PAN identifier SHALL be set to the network address and PAN identifier of the
7435 device sending the Link Power Delta command.

7436 • The destination address SHALL be set to the broadcast address of 0xffff when the Command Options field is
7437 set to Notification

7438 • The destination address SHALL be set to the unicast destination address when the Command Options field is
7439 set to Request or Response.

- The frame control field SHALL be set to specify that the frame is a MAC data frame with MAC security disabled, since any secured frame originating from the NWK layer SHALL use NWK layer security.
- If the destination address of the frame is broadcast, no acknowledgment request SHALL be specified.
- If the destination address of the frame is a unicast network address, acknowledgment request SHALL be specified.
- The addressing mode and intra-PAN flags SHALL be set to support the addressing fields described here. The TxOptions SHALL request 'indirect transmission' to be used if the *Receiver on when idle* bit of the *nwkCapabilityInformation* contained in the NIB is 0x00. Otherwise, 'direct transmission' SHALL be used.

3.4.13.2 NWK Header Fields

The NWK header fields of the link power delta notification command frame SHALL be set as follows:

- The source address field of the NWK header SHALL be set to the 16-bit network address.
- The source IEEE address sub-field of the frame control field SHALL be set to 1, and the source IEEE address field SHALL be set to the IEEE address of the device issuing the request.
- If the sender is an end device, or responding to a request, the destination address field in the NWK header SHALL be set to the 16-bit network address of the parent. The destination IEEE address sub-field of the NWK frame control field SHALL be set to 1.
- If it is communicating power delta values for neighboring devices that have macRxOnWhenIdle = TRUE, the destination address in the NWK header SHALL be set to the macRxOnWhenIdle = TRUE broadcast address (see Table 3-64). In this case the destination IEEE address sub-field of the frame control field SHALL have a value of 0 and the destination IEEE address field of the NWK header SHALL NOT be present.
- The radius field SHALL be set to 1.

3.4.13.3 NWK Payload Fields

1 Octet	1 Octet	Variable
Command Options	List Count	Power List

Figure 3-33. NWK Payload Fields

3.4.13.4 Command Options Field

Bit: 0-1	2-7
Type	Reserved

Figure 3-34. Command Options Fields

Table 3-59. Command Options: Type Values

Value	Type	Description
0	Notification	An unsolicited notification. These frames are typically sent periodically from an RxOn device. If the device is a FFD, it is broadcast to all RxOn devices (0xfffd), and includes power information for all neighboring RxOn devices. If the device is an RFD with RxOn, it is sent unicast to its Parent, and includes only power information for the Parent device.
1	Request	Typically used by sleepy RFD devices that do not receive the periodic Notifications from their Parent. The sleepy RFD will wake up periodically to send this frame to its Parent, including only the Parent's power information in its payload. Upon receipt, the Parent sends a Response (Type = 2) as an indirect transmission, with only the RFD's power information in its payload. After macResponseWaitTime, the RFD polls its Parent for the Response, before going back to sleep. Request commands are sent as unicast. Note: any device MAY send a Request to solicit a Response from another device. These commands SHALL be sent as unicast and contain only the power information for the destination device. If this command is received as a broadcast, it SHALL be discarded with no action.
2	Response	This command is sent in response to a Request. Response commands are sent as unicast to the sender of the Request. The response includes only the power information for the requesting device.
3	Reserved	

3.4.13.5 List Count

Number of power delta records in the power list.

3.4.13.6 Power List

2 Octets	1 Octet
Device Address	Power Delta

Figure 3-35. Power List

3.4.13.6.1 Device Address

Network address of the device whose power delta is conveyed in this notification.

3.4.13.6.2 Delta Power

Delta power (ΔP) calculated as *Popt* – *Prx*. This is the value of the difference in dB between its optimal receive power level (*Popt*) and the actual received power level (*Prx*) of the last packet received.

3.4.13.7 Link Power Delta command behavior

When joined to a network, a Zigbee router or coordinator that supports Power Control SHALL periodically send a Link Power Delta command with Type = Notification (0), every nwkLinkPowerDeltaTransmitRate seconds plus a one off random jitter of between 0 and 10 seconds, as a one-hop broadcast (0xfffd) without retries. A value of 0 for nwkLinkPowerDeltaTransmitRate indicates that Link Power Delta commands are never sent. It is allowed for End Devices to use a value other than the default rate to reduce the transmission rate and save battery life.

An end device that supports Power Control SHALL generate a Link Power Delta message only if the nwkParentInformation in the NIB indicates bit 2 is set to 1, meaning the parent supports Power Negotiation. The Link Power Delta SHALL be sent as follows:

1. The message SHALL be unicast to the router parent of the end device.
2. The message SHALL only contain the router parent information in the Link Power Delta message.

The Power List SHALL contain all active devices in its neighbor table with macRxOnWhenIdle = TRUE. Multiple Link Power Delta commands MAY be sent if not all the devices from the neighbor table can fit within a single frame. Subsequent commands SHOULD have additional random jitter applied.

When joined to a network, a Zigbee end device with macRxOnWhenIdle = TRUE and that supports Power Control , SHALL periodically send a Link Power Delta command with Type = Notification (0) as a unicast its Parent, every *nwkLinkPowerDeltaTransmitRate* seconds plus a one off random jitter of between 0 and 10 seconds. The Power List SHALL contain only the Parent.

When joined to a network, a Zigbee end device with macRxOnWhenIdle = FALSE and that supports Power Control, SHALL periodically wake up and send a Link Power Delta command with Type = Request (1) as a unicast to its Parent, every *nwkLinkPowerDeltaTransmitRate* seconds plus a one off random jitter of between 0 and 10 seconds. The Power List SHALL contain only the Parent device. The end device SHALL wait *macResponseWaitTime* before polling its Parent for the link power delta command with Type = Response (2). The Power List in the Response SHALL contain only the end device.

The Power Delta to be included for each device in the Power List SHALL be the difference in dBm between the optimal level (defined as 20 dB above the sensitivity requirement, see Annex D.9.2.4.2) and the last available RSSI for that device.

Upon receipt of a Link Power Delta command, a device that supports Power Control SHALL do the following.

1. Find an entry in the *nwkNeighborTable* where the NWK Source Address of the Link Power Delta command corresponds to the Network Address value of the entry. If no entry is found, the message SHALL be dropped and no further processing SHALL be done.
2. Examine Link Power Delta command and find the Device Address in the payload of the message that matches the *nwkNetworkAddress* value in its NIB. If no match is found and the receiving device is an End Device, then the message SHALL be dropped and no further processing SHALL be done.

3. Using the MLME of the MAC interface that the message arrived on, execute a MLME-SET-POWER-INFORMATION-TABLE.request with the following parameters.
   a. Set the Short address to the NWK Source of the Link Power Delta Command.
   b. Set the IEEE address to the Source IEEE of the Link Power Delta Command.
   c. Set the TX Power level as described from section D.11.2.
   d. Set the last RSSI level according to the RSSI parameter of the MCPS-DATA.indication.
4. If the receiving device is an end device, processing is complete. No further processing SHALL be done.
5. If the receiving device is a router, it SHALL do the following.
   a. If the entry in the *nwkNeighborTable* indicates a Device Type value other than 0x02 (Zigbee End Device), processing is complete. No further processing SHALL be done.
   b. Otherwise this message is from an End Device child of the router. The router SHALL generate a response Link Power Delta Command accordingly:
   c. The NWK destination SHALL be the NWK Source of the received Link Power Delta Command, not a broadcast address.

3.4.14 Network Commissioning Request Command

The Network Commissioning Request command allows a device to request joining or rejoining to the network. This MAY be used for negotiating a dynamic link key prior to joining or rejoining, or it can be used to join or rejoin and receive a transport key sent by the trust center using the device's existing link key [PICS-NWK-ASSOCIATE-REQUEST.1].

This command SHALL be the preferred mechanism to join or rejoin when both sender and receiver support it.

If the nwkNetworkAddress value of the NIB is unset, the device SHALL generate a random short address. That value SHALL be used for sending this command frame.

The Network Commissioning Request Command SHALL be formatted as shown in Figure 3-36.

Octets: 1	1	Variable
Network Commissioning Type	Capability Information	Zigbee TLVs
Network Command Payload		

Figure 3-36. Network Commissioning Request Command Format

3.4.14.1 MAC Data Service Requirements

In order to transmit this command using the MAC data service, specified in IEEE-Std 802.15.4-2020, [B1], the following information SHALL be provided [PICS-NWK-ASSOCIATE-REQUEST.2]:

- The destination address and PAN identifier SHALL be set to the network address and PAN identifier, respectively, of the prospective parent.
- The source MAC address and PAN identifier SHALL be set to the network address and PAN identifier of the device transmitting the rejoin command frame.
- The destination and source address modes SHALL be set to short.
- The transmission options SHALL be set to require acknowledgement.
- The address mode and intra-PAN flags SHALL be set to support the addressing fields described above.

3.4.14.2 NWK Header Fields

The NWK header fields of the rejoin request command frame SHALL be set as follows:

The source address field of the NWK header to the 16-bit network address SHALL be as follows. If the value of the *nwkNetworkAddress* in the NIB is within the valid range, then it SHALL use that value. If the value of the *nwkNetworkAddress* in the NIB is not within the valid range, then it SHALL randomly generate a value within the valid range, excluding the value of 0x0000, and use that.

- The source IEEE address sub-field of the frame control field SHALL be set to 1, and the source IEEE address field SHALL be set to the IEEE address of the device issuing the request.
- The destination address field in the NWK header SHALL be set to the 16-bit network address of the prospective parent.
- The destination IEEE address sub-field of the frame control field SHALL be set to 1, and the destination IEEE address field SHALL be set to the IEEE address of the prospective parent, if this address is known.
    - The radius field SHALL be set to 1.

3.4.14.3 NWK Payload Fields

The NWK frame payload contains a command identifier field, a capability information field, and one or more TLVs. The command frame identifier SHALL contain the value indicating a network associate command frame.

3.4.14.3.1 Network Commissioning Type

Table 3-60 defines the Commissioning Types that can be used.

Table 3-60. Network Commissioning Types

ID	Description
0x00	Initial Join
0x01	Rejoin

3.4.14.3.2 Capability Information Field

This one-octet field has the format of the capability information field in the association request command in [B1], which is also described in Table 3-67.

3.4.14.3.3 TLVs

The remainder of this message MAY contain one or more TLVs as defined by Zigbee. The total size of the TLVs SHALL NOT exceed *capsJoinerTLVsUnfragmentedMaxSize* bytes. This allows for the APS Update Device message sent by the parent router to fit the TLV data without fragmentation.

The device sending the Network Commissioning Request command communicates information to the parent device by including TLVs directly in the message. The device SHALL include the Joiner Encapsulation Global TLV. The remainder of this message MAY contain other TLVs as defined by Zigbee. In a multi-hop joining scenario the Trust Center and parent device will not be the same entity. Information about the sending device is communicated to the Trust Center through the Joiner Encapsulation Global TLV, which will be relayed in its entirety. To avoid fragmentation when forwarding TLV data to the Trust Center via APS UpdateDevice message from a parent router, the total size of TLVs SHALL NOT exceed apscJoinerTlvsUnfragmentedMaxSize bytes.

When a device creates the Joiner Encapsulation Global TLV it SHALL contain the following TLVs inside it:

- Fragmentation Parameters Global TLV
- If the device is not rejoining: Supported Key Negotiation Methods Global TLV

At this time this Revision of the specification does not support negotiating a new link key during rejoin. Therefore, devices certified to this Revision SHALL not include the Supported Key Negotiation Methods Global TLV inside

the Joiner Encapsulation TLV so it is clear to the Trust Center that the device does not support this behavior. Future revisions of this specification that support this would include this TLV as a clear sign the rejoining device supports this new functionality.

Additional TLVs MAY be included inside the Joiner Encapsulation Global TLV to be relayed to the Trust Center or MAY be included outside the Joiner Encapsulation Global TLV to be communicated only to the parent router.

The General TLV Processing rules in section I.4.8 SHALL be executed on receipt of the Network Commissioning Request Command frame.

3.4.15 Network Commissioning Response Command

The Network Commissioning Response command is sent by a device to inform a requesting device of its network address and network commissioning request status. The Network Commissioning Response command SHALL be formatted as shown in Figure 3-37.

Octets: 2	1
Network address	Status
NWK Command payload	

Figure 3-37. Network Commissioning Response Format

3.4.15.1 MAC Data Service Requirements

In order to transmit this command using the MAC data service, specified in [B1], the following information SHALL be provided:

- The destination MAC address and PAN identifier SHALL be set to the network address and PAN identifier, respectively, of the device that sent the Network Commissioning Response to which this frame is a response.
- The source MAC address and PAN identifier SHALL be set to the network address and PAN identifier of the device that received and processed the Network Commissioning Response command frame.
- Acknowledgment SHALL be requested.
- The addressing mode and intra-PAN flags SHALL be set to support the addressing fields described here. The TXOptions SHALL request ‘indirect transmission’ to be used if the Receiver on when idle bit of the *nwkCapabilityInformation* contained in the corresponding Network Commissioning Request command is equal to 0x00. Otherwise, ‘direct transmission’ SHALL be used.

3.4.15.2 NWK Header Fields

The NWK header fields of the rejoin response command frame SHALL be set as follows:

- The source address field SHALL be set to the 16-bit network address of the device that is sending the response.
- The source IEEE address sub-field of the frame control field SHALL be set to 1 and the source IEEE ad-dress field of the NWK header SHALL be present and SHALL contain the 64-bit IEEE address of the parent device that is sending the response.
- The destination address field of the NWK header SHALL be set to the current network address of the device that sent the NWK Commissioning Request frame, i.e. the device that sent the join request to which this frame is a response.
- The destination IEEE address sub-field of the frame control field SHALL have a value of 1 and the destination IEEE address field of the NWK header SHALL be present and SHALL contain the 64-bit IEEE address of the child device that is source of the Network Commissioning Request frame.
- The NWK layer will set the security of the Network Commissioning Response frame to the same level as that of the received Network Commissioning Request frame.

3.4.15.2.1 NWK Payload Fields

3.4.15.2.1.1 Network Address Field

If the network commissioning request was successful, this two-octet field contains the network address assigned to the device and will be the same as the value used in the Network Commissioning Request. This address could be different than the value used for the Network & MAC Destination header fields if the requesting device's address is already being used on the network. In that case, the Status field will also contain value of 0xF0, indicating that the commissioning request has not succeeded due to address conflict, but the device should retry the operation with the new address. If the network commissioning was not successful and should not be retried, this field contains the broadcast address (0xffff).

3.4.15.2.1.2 Status Field

In the special case of an address conflict the status SHALL be the value 0xF0, which is normally a reserved value for the association status in [B1]. In this context it indicates a short address conflict. The receiving device can retry the operation using the new short address specified in the Network Address field. Otherwise, this field SHALL contain one of the non-reserved association status values specified in [B1]. Refer to section 3.6.1.6.1.3 for further clarification on selecting a status value.

3.5 Constants and NIB Attributes

3.5.1 NWK Constants

The constants that define the characteristics of the NWK layer are presented in Table 3-61.

Table 3-61. NWK Layer Constants

Constant	Description	Value
nwkcCoordinatorCapable	A Boolean flag indicating whether the device is capable of becoming the Zigbee coordinator. A value of 0x00 indicates that the device is not capable of becoming a coordinator while a value of 0x01 indicates that the device is capable of becoming a coordinator.	Configuration dependent
nwkcMinHeaderOverhead	The minimum number of octets added by the NWK layer to an NSDU.	0x08
nwkcProtocolVersion	The version of the Zigbee NWK protocol in the device.	0x02
nwkcRouteDiscoveryTime	The number of OctetDurations until a route discovery expires.	0x4c4b4 (0x2710 msec on 2.4GHz)
nwkcMaxBroadcastJitter	The maximum broadcast jitter time measured in OctetDurations.	0x7d0 (0x40 msec on 2.4GHz)