2.2.4.5.5.3 Effect on Receipt

If, on receipt of this primitive, the Endpoint parameter has a value which is out of range or else enumerates an endpoint that is not implemented on the current device the APSME will issue the APSME-REMOVE-ALL-GROUPS.confirm primitive with a Status of INVALID_PARAMETER.

After checking the Endpoint parameter as described above, the APSME will remove all entries related to this endpoint from the group table. Then, the APSME issues the APSME-REMOVE-ALL-GROUPS.confirm primitive to the next higher layer with a status value of SUCCESS.

2.2.4.5.6 APSME-REMOVE-ALL-GROUPS.confirm

This primitive allows the next higher layer to be informed of the results of its request to remove all groups from an endpoint.

2.2.4.5.6.1 Semantics of the Service Primitive

The semantics of the service primitive are as follows:

```
APSME-REMOVE-ALL-GROUPS.confirm      {
                                     Status,
                                     Endpoint
                                     }
```

Table 2-19 specifies the parameters for this primitive.

Table 2-19. APSME-REMOVE-ALL-GROUPS.confirm Parameters

Name	Type	Valid Range	Description
Status	Enumeration	SUCCESS or INVALID_PARAMETER	The status of the request to remove all groups.
Endpoint	Integer	0x01 - 0xfe	The endpoint which is to be removed from all groups.

2.2.4.5.6.2 When Generated

This primitive is generated by the APSME and issued to the next higher layer in response to an APSME-REMOVE-ALL-GROUPS.request primitive. If the APSME-REMOVE-ALL-GROUPS.request was successful, then the Status parameter value will be SUCCESS. If the Endpoint parameter of the APSME-REMOVE-ALL-GROUPS.request primitive had an invalid value, then the status value will be INVALID_PARAMETER.

2.2.4.5.6.3 Effect on Receipt

On receipt of this primitive, the next higher layer is informed of the status of its request to remove all groups from an endpoint. The Status parameter values will be as described above.

2.2.5 Frame Formats

This section specifies the format of the APS frame (APDU). Each APS frame consists of the following basic components:

- An APS header, which comprises frame control and addressing information.
- An APS payload, of variable length, which contains information specific to the frame type.

The frames in the APS sub-layer are described as a sequence of fields in a specific order. All frame formats in this section are depicted in the order in which they are transmitted by the NWK layer, from left to right, where the leftmost

bit is transmitted first in time. Bits within each field are numbered from 0 (leftmost and least significant) to k-1 (rightmost and most significant), where the length of the field is k bits. Fields that are longer than a single octet are sent to the NWK layer in order from the octet containing the lowest-numbered bits to the octet containing the highest-numbered bits.

On transmission, all fields marked as reserved SHALL be set to zero. On reception, all fields marked as reserved in this version of the specification SHALL be checked for being equal to zero. If such a reserved field is not equal to zero, no further processing SHALL be applied to the frame and the frame SHALL be discarded.

2.2.5.1 General APDU Frame Format

The APS frame format is composed of an APS header and an APS payload. The fields of the APS header appear in a fixed order, however, the addressing fields may not be included in all frames. The general APS frame SHALL be formatted as illustrated in Figure 2-3.

<table>
<tr><th>Octets: 1</th><th>0/1</th><th>0/2</th><th>0/2</th><th>0/2</th><th>0/1</th><th>1</th><th>0/
Variable</th><th>Variable</th></tr>
<tr><td rowspan="2">Frame control</td><td>Destination endpoint</td><td>Group address</td><td>Cluster identifier</td><td>Profile identifier</td><td>Source endpoint</td><td rowspan="2">APS counter</td><td rowspan="2">Extended header</td><td rowspan="2">Frame payload</td></tr>
<tr><td colspan="5">Addressing fields</td></tr>
<tr><td colspan="8">APS header</td><td>APS payload</td></tr>
</table>

Figure 2-3. General APS Frame Format

2.2.5.1.1 Frame Control Field

The frame control field is 8 bits in length and contains information defining the frame type, addressing fields, and other control flags. The frame control field SHALL be formatted as illustrated in Figure 2-4.

Bits: 0-1	2-3	4	5	6	7
Frame type	Delivery mode	ACK. format	Security	ACK. request	Extended header present

Figure 2-4. Format of the Frame Control Field

2.2.5.1.1.1 Frame Type Sub-Field

The frame type sub-field is two bits in length and SHALL be set to one of the non-reserved values listed in Table 2-20.

Table 2-20. Values of the Frame Type Sub-Field

Frame Type Value b_1 b_0	Frame Type Name
00	Data
01	Command
10	Acknowledgement
11	Inter-PAN APS

2.2.5.1.1.2 Delivery Mode Sub-Field

The delivery mode sub-field is two bits in length and SHALL be set to one of the non-reserved values from Table 2-21.

Table 2-21. Values of the Delivery Mode Sub-Field

Delivery Mode Value b_1 b_0	Delivery Mode Name
00	Normal unicast delivery
01	Reserved
10	Broadcast
11	Group addressing

If the value is 0b00, the frame will be delivered to a given endpoint on the receiving device.

If the value is 0b10, the message is a broadcast. In this case, the message will go to all devices defined for the selected broadcast address in use as defined in section 3.6.6. The destination endpoint field SHALL be set to a value between 0x01-0xfe (for broadcasts to specific endpoints) or to 0xff (for broadcasts to all active endpoints).

If the value is 0b11, then group addressing is in use and that frame will only be delivered to device endpoints that express group membership in the group identified by the group address field in the APS header. Note that other end-points on the source device MAY be members of the group addressed by the outgoing frame. The frame SHALL be delivered to any member of the group, including other endpoints on the source device that are members of the specified group.

2.2.5.1.1.3 ACK Format Field

This bit indicates if the destination endpoint, cluster identifier, profile identifier and source endpoint fields SHALL be present in the acknowledgement frame. This is set to 0 for data frame acknowledgement and 1 for APS command frame acknowledgement.

2.2.5.1.1.4 Security Sub-Field

The Security Services Provider (see Chapter 4) manages the security sub-field.

2.2.5.1.1.5 Acknowledgement Request Sub-Field

The acknowledgement request sub-field is one bit in length and specifies whether the current transmission requires an acknowledgement frame to be sent to the originator on receipt of the frame. If this sub-field is set to 1, the recipient

SHALL construct and send an acknowledgement frame back to the originator after determining that the frame is valid. If this sub-field is set to 0, the recipient SHALL NOT send an acknowledgement frame back to the originator.

This sub-field SHALL be set to 0 for all frames that are broadcast or multicast.

2.2.5.1.1.6 Extended Header Present

The extended header present sub-field is one bit in length and specifies whether the extended header SHALL be included in the frame. If this sub-field is set to 1, then the extended header SHALL be included in the frame. Otherwise, it SHALL NOT be included in the frame.

2.2.5.1.2 Destination Endpoint Field

The destination endpoint field is 8-bits in length and specifies the endpoint of the final recipient of the frame. This frame SHALL be included in the frame only if the delivery mode subfield is set to 0b00 (normal unicast delivery), or 0b10 (broadcast delivery). In the case of broadcast delivery, the frame SHALL be delivered to the destination endpoint specified within the range 0x01-0xfe or to all active endpoints if specified as 0xff.

A destination endpoint value of 0x00 addresses the frame to the Zigbee device object (ZDO), resident in each device. A destination endpoint value of 0x01-0xfe addresses the frame to an application operating on that endpoint. A destination endpoint value of 0xff addresses the frame to all active endpoints except endpoint 0x00.

2.2.5.1.3 Group Address Field

The group address field is 16 bits in length and will only be present if the delivery mode sub-field of the frame control has a value of 0b11. In this case, the destination endpoint SHALL NOT be present. If the APS header of a frame contains a group address field, the frame will be delivered to all endpoints for which the group table in the device contains an association between that endpoint and the group identified by the contents of the group address field.

2.2.5.1.4 Cluster Identifier Field

The cluster identifier field is 16 bits in length and specifies the identifier of the cluster to which the frame relates and which SHALL be made available for filtering and interpretation of messages at each device that takes delivery of the frame. This field SHALL be present only for data or acknowledgement frames.

2.2.5.1.5 Profile Identifier Field

The profile identifier is two octets in length and specifies the Zigbee profile identifier for which the frame is intended and SHALL be used during the filtering of messages at each device that takes delivery of the frame. This field SHALL be present only for data or acknowledgement frames.

2.2.5.1.6 Source Endpoint Field

The source endpoint field is eight-bits in length and specifies the endpoint of the initial originator of the frame. A source endpoint value of 0x00 indicates that the frame originated from the ZDO resident in each device. A source endpoint value of 0x01-0xfe indicates that the frame originated from an application operating on that endpoint.

2.2.5.1.7 APS Counter

This field is eight bits in length and is used as described in section 2.2.8.4.2 to prevent the reception of duplicate frames. This value SHALL be incremented by one for each new transmission.

2.2.5.1.8 Extended Header Sub-Frame

The extended header sub-frame contains further sub-fields and SHALL be formatted as illustrated in Figure 2-5.

Octets: 1	0/1	0/1
Extended frame control	Block number	ACK bitfield

Figure 2-5. Format of the Extended Header Sub-Frame

2.2.5.1.8.1 Extended Frame Control Field

The extended frame control field is eight bits in length and contains information defining the use of fragmentation. The extended frame control field SHALL be formatted as illustrated in Figure 2-6.

Bits: 0-1	2-7
Fragmentation	Reserved

Figure 2-6. Format of the Extended Frame Control Field

The fragmentation sub-field is two bits in length and SHALL be set to one of the non-reserved values listed in Table 2-22.

Table 2-22. Values of the Fragmentation Sub-Field

Fragmentation Value b_1 b_0	Description
00	Transmission is not fragmented.
01	Frame is first fragment of a fragmented transmission.
10	Frame is part of a fragmented transmission but not the first part.
11	Reserved

2.2.5.1.8.2 Block Number

The block number field is one octet in length and is used for fragmentation control as follows: If the fragmentation sub-field is set to indicate that the transmission is not fragmented then the block number field SHALL NOT be included in the sub-frame. If the fragmentation sub-field is set to 01, then the block number field SHALL be included in the sub-frame and SHALL indicate the number of blocks in the fragmented transmission. If the fragmentation sub-field is set to 10, then the block number field SHALL be included in the sub-frame and SHALL indicate which block number of the transmission the current frame represents, taking the value 0x01 for the second fragment, 0x02 for the third, etc.

2.2.5.1.8.3 ACK Bitfield

The ACK bitfield field is one octet in length and is used in an APS acknowledgement as described in section 2.2.8.4.3 to indicate which blocks of a fragmented ASDU have been successfully received. This field is only present if the frame type sub-field indicates an acknowledgement and the fragmentation sub-field indicates a fragmented transmission.

2.2.5.1.9 Frame Payload Field

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

2.2.5.2 Format of Individual Frame Types

There are three defined frame types: data, APS command, and acknowledgement. Each of these frame types is discussed in the following sections.

2.2.5.2.1 Data Frame Format

The data frame SHALL be formatted as illustrated in Figure 2-7.

<table>
<tr><th>Octets: 1</th><th>0/1</th><th>0/2</th><th>2</th><th>2</th><th>1</th><th>1</th><th>0/
Variable</th><th>Variable</th></tr>
<tr><td rowspan="2">Frame control</td><td>Destination endpoint</td><td>Group address</td><td>Cluster identifier</td><td>Profile Identifier</td><td>Source endpoint</td><td rowspan="2">APS counter</td><td rowspan="2">Extended header</td><td rowspan="2">Frame payload</td></tr>
<tr><td colspan="5">Addressing fields</td></tr>
<tr><td colspan="8">APS header</td><td>APS payload</td></tr>
</table>

Figure 2-7. Data Frame Format

The order of the fields of the data frame SHALL conform to the order of the general APS frame as illustrated in Figure 2-8.

The APS header field for a data frame SHALL contain the frame control, cluster identifier, profile identifier, source endpoint and APS counter fields. The destination endpoint, group address and extended header fields SHALL be included in a data frame according to the values of the delivery mode and extended header present sub-fields of the frame control field.

In the frame control field, the frame type sub-field SHALL contain the value that indicates a data frame, as shown in Table 2-20. All other sub-fields SHALL be set appropriately according to the intended use of the data frame.

2.2.5.2.1.1 Data Payload Field

For an outgoing data frame, the data payload field SHALL contain part or all of the sequence of octets that the next higher layer has requested the APS data service to transmit. For an incoming data frame, the data payload field SHALL contain all or part of the sequence of octets that has been received by the APS data service and that is to be delivered to the next higher layer.

2.2.5.2.2 APS Command Frame Format

The APS command frame SHALL be formatted as illustrated in Figure 2-8.

Octets: 1	1	1	Variable
Frame control	APS counter	APS command identifier	APS command payload
APS header		APS payload	

Figure 2-8. APS Command Frame Format

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

2.2.5.2.2.1 APS Command Frame APS Header Fields

The APS header field for an APS command frame SHALL contain the frame control and APS counter fields. In this version of the specification, the APS command frame SHALL NOT be fragmented and the extended header field SHALL NOT be present.

In the frame control field, the frame type sub-field SHALL contain the value that indicates an APS command frame, as shown in Table 2-20. The APS Command Payload SHALL be set appropriately according to the intended use of the APS command frame.

2.2.5.2.2.2 APS Command Identifier Field

The APS command identifier field identifies the APS command being used.

2.2.5.2.2.3 APS Command Payload Field

The APS command payload field of an APS command frame SHALL contain the APS command itself.

2.2.5.2.3 Acknowledgement Frame Format

The acknowledgement frame SHALL be formatted as illustrated in Figure 2-9.

Octets: 1	0/1	0/2	0/2	0/1	1	0/Variable
Frame control	Destination endpoint	Cluster identifier	Profile identifier	Source endpoint	APS counter	Extended header
APS header						

Figure 2-9. Acknowledgement Frame Format

The order of the fields of the acknowledgement frame SHALL conform to the order of the general APS frame as illustrated in Figure 2-3.

2.2.5.2.3.1 Acknowledgement Frame APS Header Fields

If the ACK format field is not set in the frame control field, the destination endpoint, cluster identifier, profile identifier and source endpoint SHALL be present. This is not set for data frame acknowledgement. The extended header field SHALL be included in a data frame according to the value of the extended header present sub-field of the frame control field.

In the frame control field, the frame type sub-field SHALL contain the value that indicates an acknowledgement frame, as shown in Table 2-20. The extended header present sub-field SHALL contain the same value as in the frame to which this frame is an acknowledgement. All other sub-fields shall be set appropriately according to the intended use of the acknowledgement frame.

If the ACK format field is set in the frame control field, the frame is an APS command frame acknowledgement and the destination endpoint, cluster identifier, profile identifier and source endpoint fields SHALL NOT be included. Alternatively, if an APS data frame is being acknowledged, the source endpoint field SHALL reflect the value in the destination endpoint field of the frame that is being acknowledged. Similarly, the destination endpoint field SHALL reflect the value in the source endpoint field of the frame that is being acknowledged. And the Cluster identifier and Profile identifier fields SHALL contain the same values as in the frame to which this frame is an acknowledgement.

The APS counter field SHALL contain the same value as the frame to which this frame is an acknowledgment.

Where the extended header is present, the fragmentation sub-field of the extended frame control field SHALL contain the same value as in the frame to which this frame is an acknowledgement. If fragmentation is in use for this frame, then the block number and ACK bitfield fields SHALL be present. Where present, the block number field SHALL contain block number to which this frame is an acknowledgement. If fragmentation is in use, the acknowledgement frames SHALL be issued according to section 2.2.8.4.5.4 and not for each received frame unless the transmission window size is set to request acknowledgement of each frame.

2.2.6 Command Frames

This specification defines no command frames. Refer to section 4.4.11 for a thorough description of the APS command frames and primitives related to security.

2.2.7 Constants and PIB Attributes

2.2.7.1 APS Constants

The constants that define the characteristics of the APS sub-layer are presented in Table 2-23.

Table 2-23. APS Sub-Layer Constants

Constant	Description	Value
apscMaxDescriptorSize	The maximum number of octets contained in a non-complex descriptor.	64
apscMaxFrameRetries	The maximum number of retries allowed after a transmission failure.	3
apscAckWaitDuration	The maximum number of seconds to wait for an acknowledgement to a transmitted frame.	1.6 seconds 0.05 * (2* *nwkcMaxDepth*) + (security encrypt/decrypt delay) where the (security encrypt/decrypt delay) = 0.1 (assume 0.05 per encrypt or decrypt cycle)
apscMinDuplicateRejectionTableSize	The minimum required size of the APS duplicate rejection table.	1