

To: INCITS T10 Committee  
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Subject: Modify ADT ACK and NAK to differentiate Initiate Recovery acknowledgements

## 1 Revision History

Revision 0:  
Posted to the T10 web site 29 June 2004.

## 2 General

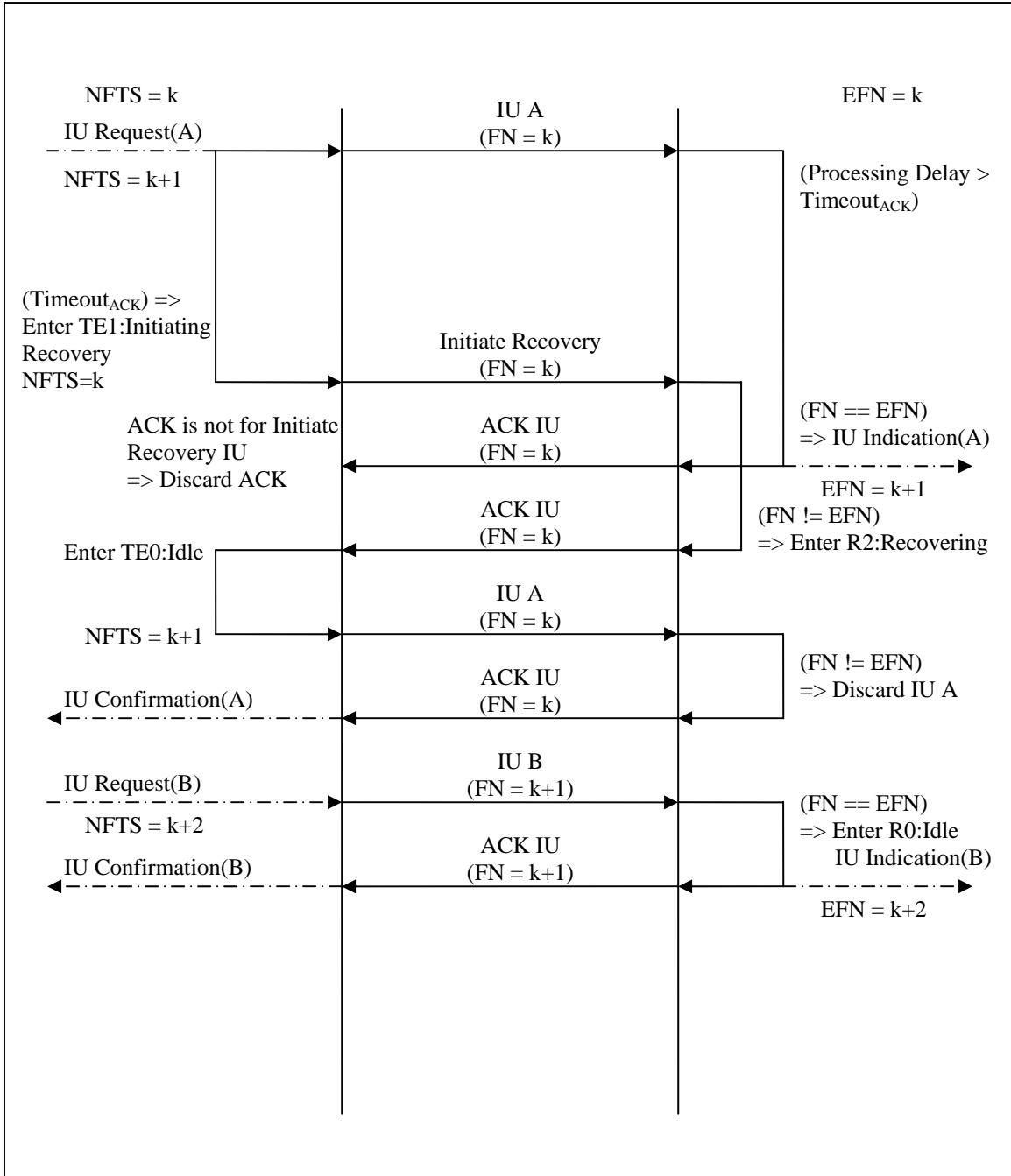
When handling recovery for an acknowledgement time-out, there is a possibility for confusion because the ACK for the Initiate Recovery IU cannot be distinguished from the ACK for the original frame. If the ACK for the original frame is received after the Initiate Recovery IU is sent, it will be interpreted as an ACK for the Initiate Recovery IU. When the actual ACK for the Initiate Recovery IU is received, the port will no longer be expecting it. Another situation that is currently possible is for a similar sequence as mentioned above to occur, but for the Initiate Recovery IU to be corrupted. In this case, the port initiating recovery will think that the other port is in the R2:Recovering state, but when the frame is resent, a NAK for an unexpected frame number will be sent. After resolving these issues, an error recovery scenario would proceed as shown in section 3 below. In order to address these issues, a couple of different proposals are discussed below along with pros and cons of each solution.

### 3 Error Handling Scenario

The following sequence shows how the error scenario posed in the statement above would be handled after implementing one of the solutions discussed below. This scenario could be added to appendix B as follows:

#### B.11 Delayed response with recovery driven by timeout

Figure B.11 shows a scenario in which the recipient of a frame is delayed in processing the frame by some other factor in the device. It is the timeout on the ACK which begins the error recovery sequence.



## 4 Proposal #1

### 4.1 Add an additional field to ACK/NAK which contains Protocol/Frame Type from frame being acknowledged

#### 4.1.1 Change section 6.5.3.2 to the following:

##### 6.5.3.2 ACK information unit

An ACK IU shall be sent by a port that has received a frame without error. Except for acknowledgement IUs, a port shall send an ACK IU for every frame that it receives without error. The Payload of the ACK IU is shown in Table 13. The values for PROTOCOL and FRAME TYPE are those from the frame that is being acknowledged.

Table 13 — ACK IU payload contents

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved	PROTOCOL			FRAME TYPE			

#### 4.1.2 Change the beginning of section 6.5.3.3 to the following:

##### 6.5.3.3 NAK information unit

A NAK IU is sent by the transport layer to indicate that the port has detected an error during the reception of a frame. Except for acknowledgement IUs, a port shall send a NAK IU for every frame that it receives in error. The FRAME NUMBER field in the ADT frame header of the NAK IU shall be set to the value in the Expected Frame Number counter (see 4.5.3). The Payload of the NAK IU is shown in Table 14. The values for PROTOCOL and FRAME TYPE are those from the frame that is being acknowledged.

Table 14 — NAK IU payload contents

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved	PROTOCOL			FRAME TYPE			
1	PR	STATUS CODE						

#### 4.1.3 Add the following statement to 4.3.5.3.1 and 4.3.5.4.1:

Any ACK IU or NAK IU for frames other than those mentioned above shall be discarded.

### 4.2 Pros of Proposal #1

1. Can easily determine whether ACK is for original frame or Initiate Recovery IU.
2. Has additional benefit of providing validation of ACK for link service frames which use frame number 0.

### 4.3 Cons of Proposal #1

1. Has a larger impact because it affects every ACK/NAK that is sent rather than just the recovery path.

## 5 Proposal #2

### 5.1 *Provide ACK/NAK for use with Initiate Recovery*

#### 5.1.1 Add the following entries to Table 12:

Frame Type	Description
7h	Initiate Recovery ACK (acknowledge)
8h	Initiate Recovery NAK (negative acknowledge)
9h-Fh	Reserved

#### 5.1.2 Add the following sections to describe the IUs added above:

##### 6.5.9 Initiate Recovery ACK information unit

This information unit is identical to the ACK information unit, but it is used exclusively as a response to the Initiate Recovery information unit.

##### 6.5.10 Initiate Recovery NAK information unit

This information unit is identical to the NAK information unit, but it is used exclusively as a response to the Initiate Recovery information unit.

#### 5.1.3 Add the following statement to 4.3.5.3.1 and 4.3.5.4.1:

Any ACK IU or NAK IU for frames other than those mentioned above shall be discarded.

5.1.4 In 4.3.5.3.2, replace ACK IU with Initiate Recovery ACK IU

5.1.5 In 4.3.5.3.3, replace NAK IU with Initiate Recovery NAK IU

5.1.6 In 4.3.5.4.2, replace ACK IU with Initiate Recovery ACK IU

5.1.7 In 4.3.5.4.2, replace NAK IU with Initiate Recovery NAK IU

5.1.8 In 4.6.2.3.a, replace ACK IU with Initiate Recovery ACK IU

5.1.9 In 4.6.2.4.4, replace ACK IU with Initiate Recovery ACK IU

5.1.10 In 4.6.2.4.4, replace NAK IU with Initiate Recovery NAK IU

5.1.11 Remove references to Initiate Recovery in 4.6.2.5.2 and add following section:

##### 4.6.2.5.3 Initiate Recovery IU

If a protocol error is detected on an Initiate Recovery, the port shall send an Initiate Recovery NAK IU with PR bit set to zero and appropriate status code (see table 14) then discard the frame.

**5.1.12 Remove references to Initiate Recovery in 4.6.2.6.2 and add following section:**

**4.6.2.6.2 Initiate Recovery IU**

If a resource limitation error is detected on an Initiate Recovery IU, the port shall send an Initiate Recovery NAK IU with the appropriate status code (see table 14) and PR bit set to zero then discard the frame.

If the port is unable to send an acknowledgment IU due to a resource limitation, it shall discard the frame.

**5.1.13 Change first sentence of 6.5.3.1 to the following:**

An acknowledgement IU is an ACK IU, NAK IU, Initiate Recovery ACK IU, or Initiate Recovery NAK IU.

**5.2 *Pros of Proposal #2***

1. Makes a clear distinction between the ACK for the original frame and the ACK for the Initiate Recovery IU.
2. Has little impact on anything but the recovery path.

**5.3 *Cons of Proposal #2***

1. Requires two new link service frame types.

## 6 Proposal #3

### 6.1 *Reserve exchange ID 0 for Initiate Recovery IU and require ACK/NAK to use exchange ID from the frame they are acknowledging*

#### 6.1.1 **Add the following to the end of the EXCHANGE ID description in section 6.3:**

The EXCHANGE ID value of 0 is reserved for use in Initiate Recovery IUs to facilitate ACK/NAK identification.

#### 6.1.2 **Change the description in section 6.5.3.2 to the following:**

##### 6.5.3.2 ACK information unit

An ACK IU shall be sent by a port that has received a frame without error. Except for acknowledgement IUs, a port shall send an ACK IU for every frame that it receives without error. The x\_ORIGIN field is undefined and shall be ignored. The EXCHANGE ID and FRAME NUMBER fields shall match those of the frame being acknowledged. An ACK IU shall contain zero bytes of payload.

#### 6.1.3 **Change the description in section 6.5.3.3 to the following:**

##### 6.5.3.3 NAK information unit

A NAK IU is sent by the transport layer to indicate that the port has detected an error during the reception of a frame. Except for acknowledgement IUs, a port shall send a NAK IU for every frame that it receives in error. The x\_ORIGIN field is undefined and shall be ignored. The EXCHANGE ID field shall match that of the frame being acknowledged. The FRAME NUMBER field in the ADT frame header of the NAK IU shall be set to the value in the Expected Frame Number counter (see 4.5.3). The Payload of the NAK IU is shown in Table 13.

#### 6.1.4 **Change the description in section 6.5.8 to the following:**

##### 6.5.8 Initiate Recovery information unit

An initiate Recovery IU shall be sent by a port when it detects an error has occurred with a frame that it sent. The FRAME NUMBER field in the ADT Frame Header shall contain the frame number of the frame in error. The x\_ORIGIN field is undefined and shall be ignored. The EXCHANGE ID field shall be 0. An Initiate Recovery IU shall contain zero bytes of payload. See 4.6 for a full explanation of the error recovery process.

#### 6.1.5 **Change following entry in Table C.2:**

Field	Value	Description
EXCHANGE ID	1	New Exchange.

#### 6.1.6 **Change following entry in Table C.3:**

Field	Value	Description
EXCHANGE ID	2	New Exchange.

#### 6.1.7 **Change following entry in Table C.4:**

Field	Value	Description
EXCHANGE ID	1	New Exchange.

### 6.1.8 Change following entry in Table C.5:

Field	Value	Description
EXCHANGE ID	1	Exchange ID assigned by the automation device.

### 6.1.9 Change following entry in Table C.6:

Field	Value	Description
EXCHANGE ID	1	Exchange ID assigned by the automation device.

### 6.1.10 Change following entry in Table C.7:

Field	Value	Description
EXCHANGE ID	1	Exchange ID assigned by the automation device.

### 6.1.11 Change following entry in Table C.8:

Field	Value	Description
EXCHANGE ID	1	Exchange ID assigned by the automation device.

### 6.1.12 Change following entry in Table C.9:

Field	Value	Description
EXCHANGE ID	1	Exchange ID assigned by the automation device.

## 6.2 Pros of Proposal #3

1. Provides a unique way of identifying ACK for Initiate Recovery IU.

## 6.3 Cons of Proposal #3

1. Limits the number of possible outstanding exchanges to 7.
2. Affects every ACK/NAK that is sent rather than just the recovery path.