To: INCITS T10 Membership

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Subject: Proposed frame format for ADT

1. Related Documents

T10/02-233r0 ADT Frame Format Notes (Paul Suhler)
T10/02-274r0 ADI ADT Frame Format Proposal (Rod Wideman)

2. General

This proposal builds upon the documents listed above to create a more complete frame format. Several of the concepts that are described in the proposal are slightly different approaches than these other proposals, while others are simply building on top of them.

3. Assumptions

Several assumptions were used that had not been clearly described in the other documents:

1. The physical interface will be a point-to-point connection.
2. The recipient shall acknowledge every frame except ACK frames.
3. Because ACK frames will be used so often, they should be kept short.
4. Like other serial transport layers used by T10, there will be several different protocols used on this one. I have identified four so far:
   - A link layer protocol that includes the ACK frame mentioned earlier as well as a protocol for port login. The link protocol should also include a method to negotiate link parameters, such as baud rate and maximum frame size.
   - A protocol that allows for encapsulation of SCSI information. The protocol must be capable of supporting simultaneous command threads initiated by both sides.
   - A protocol that allows for quick access to the polling frame defined in T10/02-097r1 without most of the overhead associated with processing SCSI commands.
   - Provisions for supporting vendor specific protocols that can be used to access diagnostic features in the devices.
5. It is acceptable to have multiple layers of header that are dependent on the protocol the frame is hosting. The basic frame header should include everything that is required to validate and route the frame. Other information that is common to frames of a particular protocol can be included in a second layer of header within the frame's payload.

4. Basic Frame Format

Document T10/02-274 describes a basic frame format in it section labeled "ADI ADT Frame Format". This proposal is based on that format.

5. ADT Frame Header

This proposal is based around the concept of layered headers, with the ADT frame header only containing the information needed to validate and route the frame to the proper protocol handler. Table 1 defines the ADT Frame Header.

Table 1 - ADT Frame Header

Byte \ Bit	7	6	5	4	3	2	1	0
0	X_Origin	Protocol			Payload Type			
1	Frame Number							
2 - 3	Exchange ID							
4 - 5	Payload Size							

The first byte in the header is a set of bit fields collectively referred to as the **Frame Type** byte.

X_Origin – Set to zero if the Automation device originates the exchange. Set to one if the Data Transfer Device originates the exchange. This bit remains constant for all frames associated with a given exchange.

Protocol – Indicates the protocol that is carried in the payload.

Table 2 - Protocol field values

Protocol	Description
0	Link Services
1	SCSI
2	ADC Fast Access frame
3	Vendor Specific
4 – 7	Reserved

Payload Type – Specifies the type of data that can be found in the payload of the frame. See the individual protocol sections for a description of the values in this field.

Frame Number – This is a continuously incrementing number assigned by the transmitting port that uniquely identifies a frame from other frames sent by that port over a small period of time. It ranges from 1 to 255, and repeats. ACK frames return the Frame Number field of the frame that they are Acknowledging. All other frame types shall be assigned the next frame number in sequence independent of the traffic the port is receiving.

An ACK frame that contains status indicating bad formatting or bad checksum such that the Frame Number of the frame being acknowledged can not be trusted shall use a Frame Number of 0.

The **Exchange ID** field contains the identifier used to distinguish frames that are part of the same exchange. Some sequences require more than one frame to complete, often involving frames originating in both devices. All frames that are associated in these sequences shall have the same Exchange ID. An originator of an Exchange may not re-use an Exchange ID value until all frames associated with that exchange have been acknowledged, or until an Abort Exchange frame has been acknowledged.

Payload Size – Contains a count of byte in the Payload area of the frame. This count does not include the SOF, EOF, ADT Frame Header, Checksum, or Escape bytes within the payload.

6. Link Service Frames

6.1 Link Service frame overview

Either port may initiate link Service frames. Link Service frames are used to manage the transport layer. Table 3 defines the values for Frame Type field in Link Service protocol frames.

Table 3 - Link Service frame types

Payload Type	Description
0h	ACK
1h	Port Login
2h	Pause
3h	Resume
4h - Fh	Reserved

6.2 ACK

ACK frames are sent by the transport layer to indicate that the port has received a frame. An ACK frame is sent for every frame that is received except another ACK frame.

The Payload of an ACK frame contains 1 byte indicating the status of the receipt of the frame indicated by the Frame Number field in the ADT Header. Table 4 lists the status values.

Table 4 - ACK Frame status code values

Status	Description	Frame Number
00h	Good Receipt	Valid
01h	Bad checksum	0
02h	Over-length (more bytes received than Payload Size indicate)	0
03h	Under-length (more bytes received than Payload Size indicate)	0
04h	Unsupported protocol	Valid
05h	Out of resources	Valid
06h	Aborted, login in progress	Valid
07h	Invalid or illegal Pause frame received	Valid
08h	Illegal operation is Special state	Valid
09h - FFh	Reserved	

6.3 Port Login

Port Login frames are used to establish link parameters. The login process is a negotiation between the ports that shall result in the determination of a set of operating parameters that are acceptable to both ports. A port shall discard any frame type other than Link Service frames until the login process has completed. The login process consists of the following steps:

1. One of the ports on the link sends a Port Login frame containing parameters that are acceptable to that port. The Parameters Changed field shall be one and the Accept field shall be zero. Any frames received by the port shall be discarded and the ACK frame returned shall contain a Status of “Aborted, login in progress”.
2. Upon receiving a Port Login frame, all open exchanges shall be aborted and an ACK frame is sent. If the parameters in the Port Login frame are acceptable, a Port Login frame is sent back with the Parameters Changed bit set to zero and the Accept bit set to one. Skip to step 4. If one or more parameter is unacceptable, the values are adjusted down and a Port Login frame is sent with the adjusted values. The Parameters Changed bit shall be set to one and the Accept bit set to zero.
3. Upon receiving a Port Login frame, the login originator shall send an ACK frame. If the parameters in the Port Login frame are acceptable, a Port Login frame is sent back with the Parameters Changed bit set to zero and the Accept bit set to one. Skip to step 4. If the values are unacceptable, they are adjusted down and a Port Login is sent with the adjusted values. The Parameters Changed bit shall be set to one and the Accept bit set to zero. Skip to step 2.

4. Once negotiations have reached a point where a port receives a Port Login frame with acceptable parameters, it shall set the Accept bit to one and the Parameters Changed bit to zero and send it back. Upon receiving a Port Login frame with the Accept bit set to one, a port shall send an ACK. If the port has not yet sent a Port Login frame with the Accept bit set to one, it shall do so in response to this frame. The login parameters shall take affect after both ports have acknowledged a Port Login frame with identical parameters that have the Accept bit set to one and the Parameters Changed bit set to zero.

Editors Note: Add a state transition table here so this stuff makes some sense.

Table 5 defines the payload of the Port Login Frame.

Table 5 - Port Login frame payload contents

Bit Byte	7	6	5	4	3	2	1	0
0	PC	Accept	Reserved					Special
1	Maximum ACK Offset							
2 - 3	Maximum Payload Size							
4 - 5	Baud Rate							

The Parameters Changed (PC) bit is set to one on the first frame of a negotiation sequence, and for all subsequence frames if a negotiated parameter in the frame is different than was last received. The PC bit is set to zero if the Port Login frame is identical to the last one received, with the exception of the PC and Accept bits.

The Accept bit is set to zero on the first frame of a negotiation sequence and all subsequent Port Login frames sent by a port until the frame it is sending matches the last one it received, except for the PC and Accept bits.

The Special bit is set to one if the port is negotiating parameters for a special operation. Each device may place limitations on the operations that can be performed while operating in Special mode. The intention of this mode is to improve transfer rates for special operations such as Firmware Updates and remote diagnostics. Devices may offer higher baud rates, larger frames, or larger offsets in this mode.

The Maximum ACK Offset field indicates the number of frames that may be sent to the port without receiving ACK frames in response. The offset count is incremented for each frame sent by a port and decremented for each ACK frame received. Link Service frames are not counted in the offset. A value of zero indicates the port is disabled for all but Link Service traffic.

The Maximum Frame Size value indicates the maximum number of bytes in the payload of a frame that the port can accommodate. A port must be capable of supporting a frame payload size of at least 270 bytes to support this transport layer.

The Baud Rate indicates the speed that the physical interface shall run. The Baud Rate field contains the actual Baud rate divided by 100. All port shall default to 9600 Baud at power-up and following error conditions that require re-establishment of the link.

6.4 Pause

A Pause Link Service frame may be sent by either device to temporarily stop traffic on the link. When a port receives a Pause frame, it shall acknowledge the frame and then temporarily discontinue sending any more frames on the Link. Once in the paused state, receipt of any valid frame other than an acknowledge frame shall place the port back into active state. The paused state is not non-volatile, so a power cycle or other hard reset condition in the paused device may cause the port to become active again. A Pause frame shall not be sent until the ports have successfully negotiated the link parameters with a Port Login exchange. The paused state only affects the sending of frames, a port must always be capable of receiving frames unless it has placed the opposite port into paused state.

The Pause frame has no data in its payload.

Editors note: We need to include link state definitions in the model section.

6.5 Resume

A Resume frame may be sent by a port to re-activate the other device's port after it has been paused.

7. SCSI Frames

7.1 SCSI frame overview

SCSI frames contain information required to implement the SCSI protocol. Each SCSI frame shall include a payload header at the start of the Payload to carry other information that is required to perform the selected function. All SCSI commands use the simple queue model described in SAM-2. The X_Orign bit in the ADT Frame Header implies the Initiator and Target identities. . The Exchange ID value from the ADT Frame Header takes on the roll of the Queue Tag from SAM-2. The LUN is included in the SCSI Command frame payload header.

SCSI frames support the Payload Type values defined in Table 6.

Table 6 – SCSI protocol Frame Types

Payload Type	Description
0h	Command
1h	Response
2h	Transfer Ready
3h	Data
4h- Fh	Reserved

7.2 SCSI Command frame

The SCSI Command frame payload shall contain information described in Table 7

Table 7 - SCSI Command frame payload contents

Bit Byte	7	6	5	4	3	2	1	0
0 – 1	LUN							
2	Task Management Flags							
3	Reserved							
4 - 19	CDB							
20 – 23	Buffer Allocation Length							

The LUN field indicates the Logical Unit Number that the command or task management function shall be routed to within the target device. If the logical unit does not exist within the device, the device shall return a Check Condition status with a Sense Key of Illegal Request and addition sense code of Invalid Logical Unit.

The Task Management Flags indicated the type of action that is to be performed by the target logical unit or device. The values for this field are defined in Table 8.

Table 8 – Task Management Flags values

TMF	Description
00h	Frame contains a SCSI Command
01h	Abort Task Set
02h – 0Fh	Reserved
10h	Reset Logical Unit
11h – 1Fh	Reserved
20h	Target Reset
21h - FFh	Reserved

If the Task Management Flags contain 00h, the CDB field contains a SCSI Command Descriptor Block. Otherwise, the CDB field shall be ignored by the target. See SAM-2 for a definition of the task management functions provided.

The Buffer Allocation Length field shall contain the number of bytes of buffer space provided by the initiator.

7.3 SCSI Response frame

A SCSI Response frame shall be returned to the Exchange Initiator for every SCSI Command frame that is sent. Table 9 defines the payload of a SCSI Response frame.

Table 9 – SCSI Response frame contents

Bit Byte	7	6	5	4	3	2	1	0
0	Response Code							
1	SCSI Status							
2 - 3	Sense Length							
4 - N	SCSI autosense Data							

The Response Code field indicates the results of the operation as an extension to the SCSI Status code. Table 10 defines the values for this field.

Table 10 – Response code values

Response Code	Description
00h	No failure or Task Management function complete
01h	More data transferred than requested by XFER_RDY
02h	Invalid field in SCSI Command frame
03h	Incorrect relative offset in data frame
04h	Task Management function not supported
05h	Task Management function failed
06h - FFh	Reserved

The SCSI Status field contains SCSI Status as defined in SAM-2. This is only valid if the Response Code field is set to 00h and the SCSI Command frame for the Exchange was a SCSI command containing a CDB.

The Sense Length field indicates how many bytes of sense data can be found in the frame. This field shall be set to 0 if the Response Code is not 00h, and no sense data shall be included in the frame. If the Response code is 00h and the SCSI Status field contains Check Condition, autosense data shall be included in the frame as defined in SPC-2 and the Sense Length field shall be set to indicate how much sense data is included.

7.4 SCSI Xfer_Rdy frame

A SCSI Xfer_Rdy frame shall be sent by a target of an exchange to inform the Exchange initiator that it is ready to receive data associated with the command. The target port may request all of the data associated with a command with a single SCSI Xfer_Rdy, or it may use multiple SCSI Xfer_Rdy frames within the exchange context to request the data a little bit at a time. The contents of the SCSI Xfer_Rdy frame payload are described in Table 11.

Table 11 – SCSI Xfer_Rdy frame payload contents

Bit Byte	7	6	5	4	3	2	1	0
0 – 3	Buffer Offset							
4 – 7	Burst Length							

The Buffer Offset field indicates the offset from the beginning of the buffer associated with the first byte sent shall be sent. Data shall not be requested out of order. This field can be used to recover from an error detected in transmission by allowing the target device to request re-transmission of the previous burst of data.

The Burst Length indicates the size of the buffer that has been allocated to receive data within the target device. The initiator shall transmit Burst Length bytes of data using a SCSI Data frame or sequence of frames to satisfy the request.

7.5 SCSI Data frame

The SCSI Data frame is used to send data associated with SCSI Data In and Data Out operations. Table 12 describes the contents of a SCSI Data frame.

Table 12 – SCSI Data frame payload contents

Bit Byte	7	6	5	4	3	2	1	0
0 – 3	Buffer Offset							
4 – 7	Data Length							
8 – N	Data							

The Buffer Offset field indicates the offset from the beginning of the buffer associated with the first byte sent shall be sent. Data shall not be sent out of order, however, a port may re-send a data burst should it detect an error in transmission.

The Data Length indicates the number of bytes of data included in this frame.

The Data field contains data.

8. ADC Fast Access Frames

8.1 ADC Fast Access overview

This protocol is intended to provide a feature set beyond what is provided by SCSI to both take advantage of the features of the transport layer and work around the slower speed of it. The ADC Fast Access protocol provides:

- A simple method for accessing the Very High Frequency Polling frame define in ADC,
- a method for device to report asynchronous activity, and
- a method to control these asynchronous reports.

SCSI frames support the Payload Type codes listed in Table 13.

Table 13 – ADC Fast Access frame types

Payload Type	Description
0h	Request for Polling Frame
1h	Polling Frame
2h	AER Frame
3h	AER Control Frame
4h - Fh	Reserved

8.2 Request for Polling Frame

Only Automation devices may initiate a Request for Polling Frame. The payload of this frame is described in Table 14.

Table 14 – Request For Polling frame payload contents

Bit Byte	7	6	5	4	3	2	1	0
0	Polling Frame Type							

Table 15 shows the values for the Polling Frame Type field.

Table 15 - Polling Frame Types

Polling Frame Type	Description
0h	Very High Frequency Data
1h	High Frequency Data
2h	Tape Alert Flags
3h	Low Frequency Data
4h	Media Information Data
5h	Polling Control Data
6h - Fh	Reserved

8.3 Polling Frame

Only Data Transfer devices may initiate a Polling frame. The payload of this frame is described in ADC.

8.4 AER Frame

Asynchronous Event Report frames may optionally be used to report that an event has occurred that may be of interest. Only a Data Transport device may initiate AER frames. The payload of an AER frame is defined by Table 16

Table 16– AER frame payload contents

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved						UAG	VHF

The VHF bit shall be set to one if the Very High Frequency Polling data has changed since the last time it was read by the Automation device.

The UAP bit shall be set to one of a Unit Attention condition has been generated for the ADC device. The UA bit shall be set to zero if no Unit Attention conditions are present for the ADC device.

8.5 AER Control Frame

The AER Control frame may optionally be sent by an Automation device to a Data Transfer device to enable or disable AER reporting. The Data Transfer device shall respond to the AER Control frame by enabling the selected AER events that it supports, and sending the updated frame back to the Automation device. Any AER events that are not supported by the Data Transfer device shall have their enable bits set to zero in the response frame. The default setting for all AER event in a Data Transfer device shall be zero. Table 17 describes the payload of an AER Control frame.

Table 17– AER Control frame payload contents

Bit / Byte	7	6	5	4	3	2	1	0
0	UA	Reserved			TMS	Byte1	ClnS	DIS
1	Reserved					ESC	ISC	TAC

The Drive Initialized Status (DIS) bit shall be set to one to indicate that the device shall send an AER report with the VHF bit set to one if the Drive Initialized status changes in the VHF Polling frame data. The DIS bit shall be set to zero to disable AER reports on changes in the Drive Initialized status.

The Cleaning Status (ClnS) bit shall be set to one to indicate that the device shall send an AER report with the VHF bit set to one if the Cleaning Requested or Cleaning Required status changes in the VHF Polling frame data. The ClnS bit shall be set to zero to disable AER reports on changes in the Cleaning status.

The Byte1 bit shall be set to one to indicate that the device shall send an AER report with the VHF bit set to one if any of the status bits in byte 1 of the VHF Polling frame data changes states. The Byte1 bit shall be set to zero to disable AER reports on changes in these bits.

The Tape Motion Status (TMS) bit shall be set to one to indicate that the device shall send an AER report with the VHF bit set to one if the Tape Motion Status changes in the VHF Polling frame data. The TMS bit shall be set to zero to disable AER reports on changes in the Tape Motion Status.

The Unit Attention (UA) bit shall be set to one to indicate that Unit Attention conditions generated for the ADC device shall cause an AER report with the UAG bit set to one. If the UA bit is set to zero, Unit Attention conditions shall not cause an AER frame to be sent.

The Tape Alert Changed (TAC) bit shall be set to one to indicate that the device shall send an AER report with the VHF bit set to one if the Tape Alert Changed status in the VHF Polling frame data has been set to one. The DIS bit shall be set to zero to disable AER reports on setting Tape Alert Changed.

The Interface Status Changed (ISC) bit shall be set to one to indicate that the device shall send an AER report with the VHF bit set to one if the Interface Status Changed status in the VHF Polling frame data has been set to one. The DIS bit shall be set to zero to disable AER reports on setting Interface Status Changed.

The Error Status Changed (ESC) bit shall be set to one to indicate that the device shall send an AER report with the VHF bit set to one if the Error Status Changed status in the VHF Polling frame data has been set to one. The DIS bit shall be set to zero to disable AER reports on setting Error Status Changed.