To: T10 Technical Committee
From: Kevin Marks - Dell, Inc.
Date: August 16, 2006
Subject: T10/06-350r0 - SPC-4/SBC-3: Power conditions state machine clarifications

Revision History

Revision 0 (8/16/06) – Initial proposal

Related Documents

SCSI Primary Commands - 4 (T10/1731-D – SPC-4) Rev 6
SCSI Block Commands - 3 (T10/1799-D – SBC-3) Rev 6

New text to be added
~~Text to be deleted~~
<<…Editorial text…>

Overview

Within SPC-4 and SBC-3, mainly in the power conditions state machines there are several transitions that occur, as stated, when the command is received, this is incorrect and should be “processed.” This proposal changes this and also makes some editorial changes.

Suggested Changes to SPC-4:

5.9 Power conditions

5.9.1 Power conditions overview

The optional Power Condition mode page (see 7.4.12) allows an application client to control the power condition of a logical unit in a manner that may reduce power consumption of the SCSI target device. This control is invoked by enabling and setting the idle condition timer and/or the standby condition timer using the mode page. A change in the power condition of any logical unit in a SCSI target device may result in a change in the SCSI target device’s power consumption.

In addition to the Power Condition mode page, the power condition of a logical unit may be controlled by the START STOP UNIT command (see SBC-3 or RBC). If both the Power Condition mode page and the START STOP UNIT command methods are being used to control the power condition of the same logical unit, then any START STOP UNIT command's power condition specification shall override the Power Condition mode page's power control and may disable the idle condition and standby condition timers.

There shall be no notification to the application client that a logical unit has transitioned from one power condition to another. The REQUEST SENSE command (see 6.26) indicates if a logical unit is in the idle power condition or the standby power condition.

Command standards (see 3.1.17) may define for their peripheral device types additional power conditions (e.g., the stopped power condition defined by SBC-3 for direct-access block devices) and extensions to the REQUEST SENSE command for reporting power conditions.

No power condition shall affect the supply of any power required for proper operation of a service delivery subsystem.

Logical units that contain cache memory shall write all cached data to the medium for the logical unit (e.g., as a logical unit would do in response to a SYNCHRONIZE CACHE command as described in SBC-2) prior to entering into any power condition that prevents accessing the media (e.g., before a hard drive stops its spindle motor during transition to the standby power condition).

The power conditions are described in table 39.

Table 39 — Power Conditions

Power Condition	Description
active	While in the active power condition (see 3.1.5): a) A device server is capable of responding to all of its supported commands including media access requests; b) A logical unit completes processing of operations in the shortest time when compared to the time required for completion while in the idle or standby power conditions; and c) The SCSI target device may consume more power than when the logical unit is in the idle power condition (e.g., a disk drive's spindle motor may be active).
idle	While in the idle power condition (see 3.1.46): a) A device server is capable of responding to all of its supported commands including media access requests; b) A logical unit may take longer to complete processing a command than it would while in the active power condition (e.g., the device may have to activate some circuitry before processing a command); and c) The power consumed by the SCSI target device should be less than or equal to the power consumed when the logical unit is in the active power condition and may be greater than the power consumed when the logical unit is in the standby power condition.
standby	While in the standby power condition (see 3.1.108): a) A device server is not capable of processing media access commands; and b) The power consumed by the SCSI target device should be less than or equal to the power consumed when the logical unit is in the idle power condition (e.g., a disk drive's spindle motor is stopped).

5.9.2 Power condition state machine

5.9.2.1 Power condition state machine overview

The PC (power condition) state machine describes the logical unit power states and transitions resulting from Power Condition mode page settings.

The PC states are as follows:

a) PC0:Powered_on (see 5.9.2.2) (initial state);
b) PC1:Active (see 5.9.2.3);
c) PC2:Idle (see 5.9.2.4); and
d) PC3:Standby (see 5.9.2.5).

The PC state machine stall start in the PC0:Powered_on state after power on.

Figure 5 describes the PC state machine.

<< Insert Figure 5 >>

Figure 5 — Power condition state machine

5.9.2.2 PC0:Powered_on state

5.9.2.2.1 PC0:Powered_on state description

The logical unit shall enter this state upon power on. This state consumes zero time.

5.9.2.2.2 Transition PC0:Powered_on to PC1:Active

This transition shall occur after the logical unit is ready to begin its power on initialization.

5.9.2.3 PC1:Active state

5.9.2.3.1 PC1:Active state description

While in this state, if power on initialization is not complete, then the logical unit shall complete its power on initialization.

While in this state, if power on initialization is complete, then:

a) The logical unit is in the active power condition (see table 39);
b) If the idle condition timer is active, then the idle condition timer is running; and
c) If the standby condition timer is active, then the standby condition timer is running.

5.9.2.3.2 Transition PC1:Active to PC2:Idle

This transition shall occur after:

a) The idle condition timer is active; and
b) The idle condition timer is zero.

5.9.2.3.3 Transition PC1:Active to PC3:Standby

This transition shall occur after:

a) The standby condition timer is active; and
b) The standby condition timer is zero.

5.9.2.4 PC2:Idle state

5.9.2.4.1 PC2:Idle state description

While in this state:

a) The logical unit is in the idle power condition (see table 39);
b) The device server processes the REQUEST SENSE command as described in 6.27; and
c) If the standby condition timer is active, then the standby condition timer is running.

5.9.2.4.2 Transition PC2:Idle to PC1:Active

This transition shall occur after the device server processes ~~receives~~ a command that requires the logical unit to be in the PC1:Active state to process the command.

5.9.2.4.3 Transition PC2:Idle to PC3:Standby

This transition shall occur after:

a) The standby condition timer is active; and
b) The standby condition timer is zero.

5.9.2.5 PC3:Standby state

5.9.2.5.1 PC3:Standby state description

While in this state:

a) The logical unit is in the standby power condition (see table 39); and
b) The device server processes the REQUEST SENSE command as described in 6.27.

5.9.2.5.2 Transition PC3:Standby to PC1:Active

This transition shall occur after the device server processes ~~receives~~ a command that requires the logical unit to be in the PC1:Active state to process the command.

5.9.2.5.3 PC3:Standby to PC2:Idle

This transition shall occur after the device server processes ~~receives~~ a command that requires the logical unit to be in the PC2:Idle state to process the command.

Suggested Changes to SBC-3:

4.15.1 START STOP UNIT and power conditions overview

The START STOP UNIT command (see 5.18) allows an application client to control the power condition of a logical unit. This method includes specifying that the logical unit transition to a power condition.

In addition to the START STOP UNIT command, the power condition of a logical unit may be controlled by the Power Condition mode page (see SPC-4). If both the START STOP UNIT command and the Power Condition mode page methods are being used to control the power condition of the same logical unit, then the power condition specified by any START STOP UNIT command shall override the Power Condition mode page's power control.

There shall be no notification to the application client that a logical unit has transitioned from one power condition to another. The REQUEST SENSE command (see 6.27) indicates if a logical unit is in the idle power condition or the standby power condition and may indicate if a logical unit is in the ~~standby~~ stopped power condition.

If the logical unit is in the idle power condition, the device server shall process a REQUEST SENSE command by:

1) returning parameter data containing sense data with the sense key set to NO SENSE and the additional sense code set to:

A) LOW POWER CONDITION ON if the reason for entry into the idle power condition is unknown;
B) IDLE CONDITION ACTIVATED BY TIMER if the logical unit entered the idle power condition due to the idle condition timer (see SPC-4); and

C) IDLE CONDITION ACTIVATED BY COMMAND if the logical unit entered the idle power condition due to a START STOP UNIT command or receipt of a command requiring the idle power condition while it was in the standby power condition;

and

2) returning GOOD status for the REQUEST SENSE command.

If the logical unit is in the standby power condition, the device server shall process a REQUEST SENSE command by:

1) returning parameter data containing sense data with the sense key set to NO SENSE and the additional sense code set to:

A) LOW POWER CONDITION ON if the reason for entry into the standby power condition is unknown;
B) STANDBY CONDITION ACTIVATED BY TIMER if the logical unit entered the standby power condition due to the standby condition timer (see SPC-4); and
C) STANDBY CONDITION ACTIVATED BY COMMAND if the logical unit entered the idle power condition due to a START STOP UNIT command;

and

2) returning GOOD status for the REQUEST SENSE command.

If the logical unit is in the stopped power condition, the device server shall process a REQUEST SENSE command by:

1) returning parameter data containing sense data with:

A) the sense key set to NO SENSE and the additional sense code set to NO ADDITIONAL SENSE INFORMATION; or
B) the sense key set to NOT READY and the additional sense code set to LOGICAL UNIT NOT READY, INITIALIZING COMMAND REQUIRED;

and

2) returning GOOD status for the REQUEST SENSE command.

No power condition shall affect the supply of any power required for proper operation of the service delivery subsystem.

4.15.2 START STOP UNIT and power conditions state machine

4.15.2.1 START STOP UNIT and power conditions state machine overview

The SSU_PC (start stop unit power condition) state machine for logical units implementing the START STOP UNIT command describes the logical unit power states and transitions resulting from settings by the START STOP UNIT command and settings in the Power Condition mode page (see SPC-4).

The SSU_PC states are as follows:

a) SSU_PC0:Powered_on (see 4.15.2.2) (initial state);
b) SSU_PC1:Active (see 4.15.2.3);
c) SSU_PC2:Idle (see 4.15.2.4);

d) SSU_PC3:Standby (see 4.15.2.5); and
e) SSU_PC4:Stopped (see 4.15.2.6).

The SSU_PC state machine shall start in the SSU_PC0:Powered_on state after power on.

NOTE 6 - The SSU_PC state machine is an enhanced version of the Power Condition state machine described in SPC-4.

Figure 2 describes the SSU_PC state machine.

<< Insert Figure 2 >>

Figure 2 — Power condition state machine for logical units implementing the START STOP UNIT command

4.15.2.2 SSU_PC0:Powered_on state

4.15.2.2.1 SSU_PC0:Powered_on state description

The logical unit shall enter this state upon power on. This state consumes zero time.

4.15.2.2.2 Transition SSU_PC0:Powered_on to SSU_PC1:Active

This transition shall occur if:

a) the logical unit has been configured to transition to the SSU_PC1:Active state.

4.15.2.2.3 Transition SSU_PC0:Powered_on to SSU_PC4:Stopped

This transition shall occur if:

a) the logical unit has been configured to transition to the SSU_PC4:Stopped state.

4.15.2.3 SSU_PC1:Active state

4.15.2.3.1 SSU_PC1:Active state description

While in this state, if power on initialization is not complete, then the logical unit completes its power on initialization.

While in this state, after power on initialization is complete, then:

a) the logical unit is in the active power condition (see SPC-4);
b) if the idle condition timer is active (see SPC-4) and not disabled (see 5.18), then the idle condition timer is running; and
c) if the standby condition timer is active (see SPC-4) and not disabled (see 5.18), then the standby condition timer is running.

4.15.2.3.2 Transition SSU_PC1:Active to SSU_PC2:Idle

This transition shall occur after:

a) the device server processes ~~receives~~ a START STOP UNIT command with the POWER CONDITION field set to IDLE;
b) the device server processes ~~receives~~ a START STOP UNIT command with the POWER CONDITION field set to FORCE_IDLE_0; or
c) the idle condition timer is active (see SPC-4), enabled (see 5.18), and zero.

4.15.2.3.3 Transition SSU_PC1:Active to SSU_PC3:Standby

This transition shall occur after:

a) the device server processes ~~receives~~ a START STOP UNIT command with the POWER CONDITION field set to STANDBY;
b) the device server processes ~~receives~~ a START STOP UNIT command with the POWER CONDITION field set to FORCE_STANDBY_0; or
c) the standby condition timer is active (see SPC-4), enabled (see 5.18), and zero.

4.15.2.3.4 Transition SSU_PC1:Active to SSU_PC4:Stopped

This transition shall occur after the device server processes ~~receives~~ a START STOP UNIT command with the START bit set to zero and the POWER CONDITION field set to START_VALID.

4.15.2.4 SSU_PC2:Idle state

4.15.2.4.1 SSU_PC2:Idle state description

While in this state:

a) the logical unit is in the idle power condition (see SPC-4);
b) the device server processes the REQUEST SENSE command as described in 4.15.1; and
c) if the standby condition timer is active (see SPC-4) and not disabled (see 5.18), then the standby condition timer is running.

4.15.2.4.2 Transition SSU_PC2:Idle to SSU_PC1:Active

This transition shall occur after:

a) the device server processes ~~receives~~ a START STOP UNIT command with the START bit set to one;
b) the device server processes ~~receives~~ a START STOP UNIT command with the POWER CONDITION field set to ACTIVE; or
c) the device server processes ~~receives~~ a command that requires the logical unit to be in the SSU_PC1:Active state to process the command.

4.15.2.4.3 Transition SSU_PC2:Idle to SSU_PC3:Standby

This transition shall occur after:

a) the device server processes ~~receives~~ a START STOP UNIT command with the POWER CONDITION field set to STANDBY;
b) the device server processes ~~receives~~ a START STOP UNIT command with the POWER CONDITION field set to FORCE_STANDBY_0; or
c) the standby condition timer is active (see SPC-4), enabled (see 5.18), and zero.

4.15.2.4.4 Transition SSU_PC2:Idle to SSU_PC4:Stopped

This transition shall occur after the device server processes ~~receives~~ a START STOP UNIT command with the START bit set to zero.

4.15.2.5 SSU_PC3:Standby state

4.15.2.5.1 SSU_PC3:Standby state description

While in this state:

a) the logical unit is in the standby power condition (see SPC-4); and
b) the device server processes the REQUEST SENSE command as described in 4.15.1.

4.15.2.5.2 Transition SSU_PC3:Standby to SSU_PC1:Active

This transition shall occur after:

a) the device server processes ~~receives~~ a START STOP UNIT command with the START bit set to one;
b) the device server processes ~~receives~~ a START STOP UNIT command with the POWER CONDITION field set to ACTIVE; or
c) the device server processes ~~receives~~ a command that requires the logical unit to be in the SSU_PC1:Active state to process the command.

4.15.2.5.3 Transition SSU_PC3:Standby to SSU_PC2:Idle

This transition shall occur after:

a) the device server processes ~~receives~~ a START STOP UNIT command with the POWER CONDITION field set to IDLE;
b) the device server processes ~~receives~~ a START STOP UNIT command with the POWER CONDITION field set to FORCE_IDLE_0; or
c) the device server processes ~~receives~~ a command that requires the logical unit to be in the SSU_PC2:Idle state to process the command.

4.15.2.5.4 Transition SSU_PC3:Standby to SSU_PC4:Stopped

This transition shall occur after the device server processes ~~receives~~ a START STOP UNIT command with the START bit set to zero.

4.15.2.6 SSU_PC4:Stopped state

4.15.2.6.1 SSU_PC4:Stopped state description

While in this state:

a) the logical unit is in the stopped power condition;
b) the device server is not capable of processing medium access commands. The device server shall terminate each medium access command or TEST UNIT READY command processed ~~received~~ while in this state with CHECK CONDITION status with the sense key set to NOT READY and the additional sense code set to LOGICAL UNIT NOT READY, INITIALIZING COMMAND REQUIRED;
c) the device server processes the REQUEST SENSE command as described in 4.15.1; and
d) the power consumed by the SCSI target device should be less than or equal to that consumed than when the logical unit is in the SSU_PC1:Active, SSU_PC2:Idle, or SSU_PC3:Standby states.

4.15.2.6.2 Transition SSU_PC4:Stopped to SSU_PC1:Active

This transition shall occur after:

a) the device server processes ~~receives~~ a START STOP UNIT command with the START bit set to one; or

b) the device server processes ~~receives~~ a START STOP UNIT command with the POWER CONDITION field set to ACTIVE.

4.15.2.6.3 Transition SSU_PC4:Stopped to SSU_PC2:Idle

This transition shall occur after:

a) the device server processes ~~receives~~ a START STOP UNIT command with the POWER CONDITION field set to IDLE; or
b) the device server processes ~~receives~~ a START STOP UNIT command with the POWER CONDITION field set to FORCE_IDLE_0.

4.15.2.6.4 Transition SSU_PC4:Stopped to SSU_PC3:Standby

This transition shall occur after:

a) the device server processes ~~receives~~ a START STOP UNIT command with the POWER CONDITION field set to STANDBY; or
b) the device server processes ~~receives~~ a START STOP UNIT command with the POWER CONDITION field set to FORCE_STANDBY_0.

<<...>>

5.18 START STOP UNIT command

The START STOP UNIT command (see table 55) requests that the device server change the power condition of the logical unit (see 4.15) or load or eject the medium. This includes specifying that the device server enable or disable the direct-access block device for medium access operations by controlling power conditions and timers.

Logical units that contain cache shall write all cached logical blocks to the medium (e.g., as they would do in response to a SYNCHRONIZE CACHE command (see 5.19 and 5.20) with the SYNC_NV bit set to zero, the LOGICAL BLOCK ADDRESS field set to zero, and the NUMBER OF BLOCKS field set to zero) prior to entering into any power condition that prevents accessing the medium (e.g., before the rotating media spindle motor is stopped during transition to the stopped power condition).

If any deferred downloaded code has been received as a result of a WRITE BUFFER command (see SPC-4), then that deferred downloaded code shall replace the current operational code.

Table 55 — START STOP UNIT command

<< Insert Table 55 >>

If the immediate (IMMED) bit is set to zero, then the device server shall return status after the operation is completed. If the IMMED bit set to one, then the device server shall return status as soon as the CDB has been validated.

The POWER CONDITION field is used to specify that the logical unit be placed into a power condition or to adjust a timer as defined in table 56. If this field is supported and is set to a value other than 0h, then the START and LOEJ bits shall be ignored.

Table 56 — POWER CONDITION field

<< Insert Table 56 >>

If the START STOP UNIT command is ~~received~~ processed with the POWER CONDITION field set to ACTIVE, IDLE, or STANDBY, then:

a) the logical unit shall transition to the specified power condition;
b) the logical unit shall change power conditions only after receipt of another START STOP UNIT command or a logical unit reset;
c) the device server shall disable the idle condition timer if it is active (see SPC-4) and disable the standby condition timer if it is active (see SPC-4) until another START STOP UNIT command is ~~received~~ processed that returns control of the power condition to the logical unit, or a logical unit reset occurs.

If the START STOP UNIT command is ~~received~~ processed with the POWER CONDITION field set to LU_CONTROL, then the device server shall enable the idle condition timer if it is active (see SPC-4) and disable the standby condition timer if it is active (see SPC-4).

If the START STOP UNIT command is ~~received~~ processed with the POWER CONDITION field set to FORCE_IDLE_0 or FORCE_STANDBY_0, then the device server shall:

a) force the specified timer to zero, cause the logical unit to transition to the specified power condition, and return control of the power condition to the device server; or
b) terminate a START STOP UNIT command that selects a timer that is not supported by the device server or a timer that is not active. The command shall be terminated with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.

It is not an error to specify that the logical unit transition to its current power condition.

If the load eject (LOEJ) bit is set to zero, then the logical unit shall take no action regarding loading or ejecting the medium. If the LOEJ bit is set to one, then the logical unit shall unload the medium if the START bit is set to zero. If the LOEJ bit is set to one, then the logical unit shall load the medium if the START bit is set to one.

If the START bit is set to zero, then the logical unit shall transition to the stopped power condition, disable the idle condition timer if it is active (see SPC-4), and disable the standby condition timer if it is active (see SPC-4). If the START bit set to one, then the logical unit shall transition to the active power condition, enable the idle condition timer if it is active, and enable the standby condition timer if it is active.