

To: X3T10 Committee (SCSI)

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Subject: Addressing Model for SAM-2

## **1 Overview**

### **1.1 Example of hierarchical system**

A system that is composed of many layers appears as a tree. For example, a driver may connect to multiple HBAs, which in turn may connect to multiple SCSI devices, etc. See figure 1 for an example of a system that consists of:

- a) One initiator that has three SCSI devices attached on a single SCSI bus that is not expandable. One of the SCSI devices is a dual ported SCSI bridge controller.
- b) One initiator has two SCSI devices attached on a single SCSI bus that is expandable. One of the SCSI devices contains a dual ported SCSI bridge controller.
- c) The SCSI bridge controller has three SCSI buses with SCSI devices attached and is capable of driving more SCSI buses.
  - a) Two of the SCSI buses contain two SCSI devices each and these SCSI buses are not expandable. One of the SCSI devices contains a SCSI bridge controller.
  - b) One of the SCSI buses contains two SCSI devices and is expandable.
  - c) The SCSI bridge controller has three SCSI buses with SCSI devices attached and is capable of driving more SCSI buses.
    - a) Two of the SCSI buses contain two SCSI devices each and these SCSI buses are not expandable.
    - b) One of the SCSI buses contains two SCSI devices and is expandable.

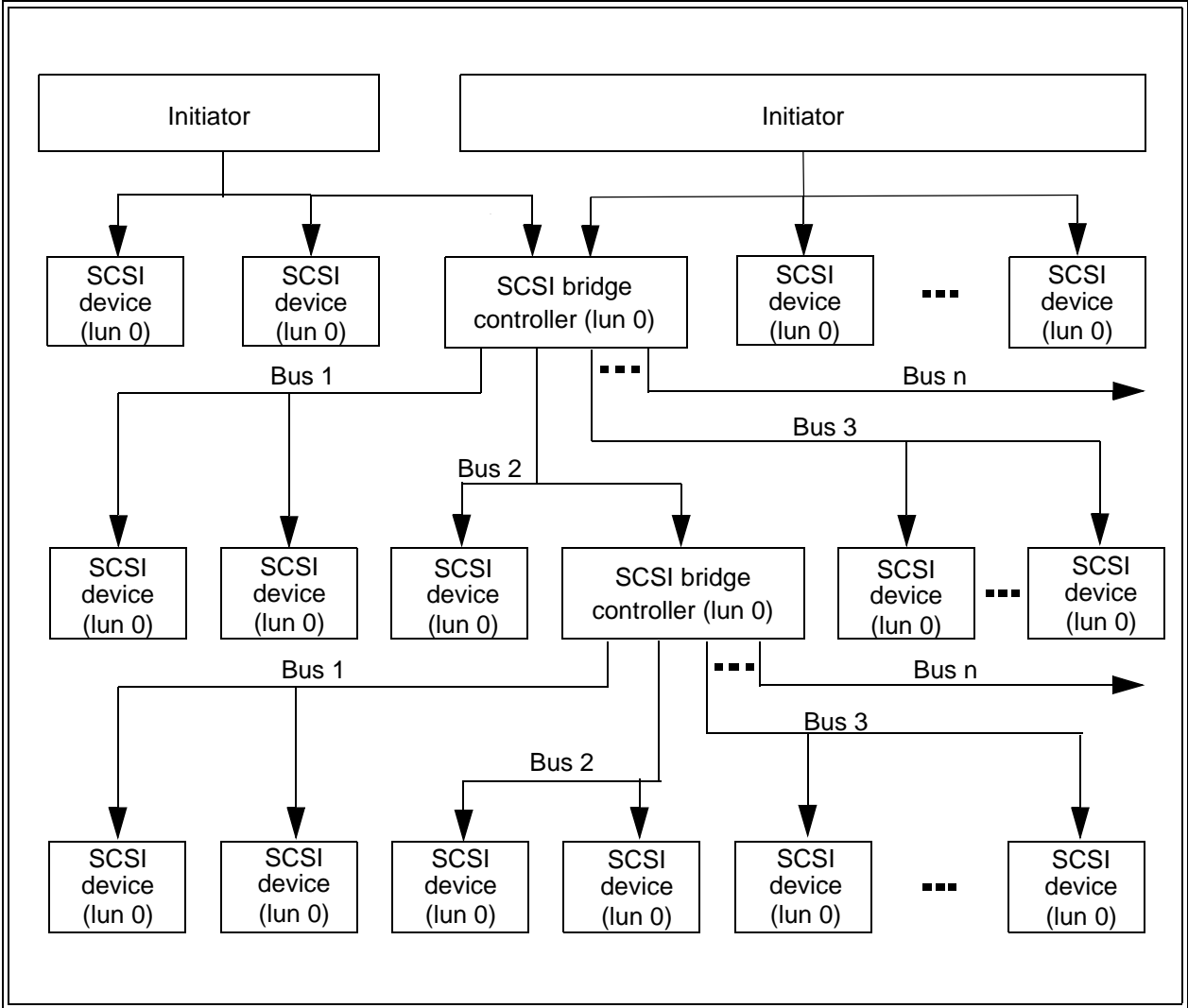


Figure 1 - Example of hierarchical system diagram

2 Addressing Model

All peripheral device addresses, except LUN 0, default to vendor specific values. All addressable objects may default to vendor specific values or may be defined by an application client during configuration.

2.1 LUN 0 address

All SCSI devices shall accept LUN 0 as a valid address. For SCSI devices that support the hierarchical addressing model the LUN 0 shall be the logical unit that an application client addresses to determine information about the target and the logical units contained within the target.

To address the LUN 0 of an SCSI device the peripheral device address method shall be used.

2.2 Buses

Within the hierarchical system there may be target devices that have multiple logical units that are connected through separate physical interconnects. Within the addressing model these physical interconnects are referred to as buses. A target device that has SCSI devices attached to these buses

shall assign numbers, other than zero, to those buses. The bus numbers shall be used when assigning LUN's to the logical units attached to those buses.

Target devices shall assign a bus number of zero to all the target devices logical units not connected through a separate physical interconnect.

## 2.3 Eight byte LUN structure

The eight byte LUN structure (see table 2) allows up to four levels of devices to be addressed under a single target. Each level shall use bytes 0-1 to define the address and/or location of the SCSI device to be addressed on that level.

If the LUN indicates that the command is to be relayed to the next layer then the current layer shall use bytes 0-1 of the eight byte LUN structure to determine the address of the device to which the command is to be sent. When the command is sent to the target the eight byte LUN structure that was received shall be adjusted to create a new eight byte LUN structure (see table 1).

Devices shall keep track of the necessary addressing information to allow reconnection to the correct task during reselection.

**Table 1 - Eight byte LUN structure adjustments**

| Byte position |           |          |
|---------------|-----------|----------|
| Old           |           | New      |
| 0 - 1         | Moves to  | Not used |
| 2 - 3         | Moves to  | 0 - 1    |
| 4 - 5         | Moves to  | 2 - 3    |
| 6 - 7         | Moves to  | 4 - 5    |
| N/A           | zero fill | 6 - 7    |

The eight byte LUN structure requirements as viewed from the application client are shown in table 2.

Table 2 - Eight byte LUN structure

| Bit Byte | 7                       | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|-------------------------|---|---|---|---|---|---|---|
| 0        | FIRST LEVEL ADDRESSING  |   |   |   |   |   |   |   |
| 1        |                         |   |   |   |   |   |   |   |
| 2        | SECOND LEVEL ADDRESSING |   |   |   |   |   |   |   |
| 3        |                         |   |   |   |   |   |   |   |
| 4        | THIRD LEVEL ADDRESSING  |   |   |   |   |   |   |   |
| 5        |                         |   |   |   |   |   |   |   |
| 6        | FOURTH LEVEL ADDRESSING |   |   |   |   |   |   |   |
| 7        |                         |   |   |   |   |   |   |   |

The FIRST LEVEL ADDRESSING field indicates the first level address of a device. See table 3 for a definition of the FIRST LEVEL ADDRESSING field.

The SECOND LEVEL ADDRESSING field indicates the second level address of a device. See table 3 for a definition of the SECOND LEVEL ADDRESSING field.

The THIRD LEVEL ADDRESSING field indicates the third level address of a device. See table 3 for a definition of the THIRD LEVEL ADDRESSING field.

The FOURTH LEVEL ADDRESSING field indicates the fourth level address of a device. See table 3 for a definition of the FOURTH LEVEL ADDRESSING field.

The device pointed to in the FIRST LEVEL ADDRESSING field, SECOND LEVEL ADDRESSING field, THIRD LEVEL ADDRESSING field, and FOURTH LEVEL ADDRESSING fields may be any physical or logical device addressable by an application client.

Table 3 - FIRST LEVEL ADDRESSING field, SECOND LEVEL ADDRESSING field, THIRD LEVEL ADDRESSING field, and FOURTH LEVEL ADDRESSING field

| Bit Byte | 7              | 6 | 5                       | 4 | 3 | 2 | 1 | 0 |
|----------|----------------|---|-------------------------|---|---|---|---|---|
| n-1      | address method |   | ADDRESS METHOD SPECIFIC |   |   |   |   |   |
| n        |                |   |                         |   |   |   |   |   |

The ADDRESS METHOD field defines the contents of the ADDRESS METHOD SPECIFIC field. See table 4 for the address methods defined for the ADDRESS METHOD field. The ADDRESS METHOD field only defines address methods for objects that are directly addressable by an application client.

**Table 4 - ADDRESS METHOD**

| Codes | Description                         | Clause |
|-------|-------------------------------------|--------|
| 10b   | Logical unit addressing method      | 2.3.1  |
| 00b   | Peripheral device addressing method | 2.3.2  |
| 01b   | Virtual device addressing method    | 2.3.3  |
| 11b   | Reserved                            |        |

### 2.3.1 Logical unit address method

All SCSI commands are allowed when the logical unit address method is selected, however logical units are only required to support mandatory SCSI commands. Devices are not required to relay commands, from the application client, to a lower layer. Any command that is not supported or relayed to a lower layer shall be terminated with a CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID COMMAND OPERATION CODE.

If the logical unit addressing method is selected the device shall relay the received command, if not filtered, to the addressed logical unit.

NOTE 1 - A SCSI device may filter commands to prevent an application client from issuing, for example, a write command to a specific logical unit. A reason for doing this would be to prevent an application client from bypassing configuration requirements at an intermediate level of the hierarchy.

See table 5 for the definition of the ADDRESS METHOD SPECIFIC field used when the logical unit addressing method is selected.

**Table 5 - Logical unit addressing**

| Bit<br>Byte | 7   | 6 | 5      | 4   | 3 | 2 | 1 | 0 |
|-------------|-----|---|--------|-----|---|---|---|---|
| n-1         | 1   | 0 | TARGET |     |   |   |   |   |
| n           | BUS |   |        | LUN |   |   |   |   |

The TARGET field, BUS NUMBER field, and LUN field address the logical unit to which the received command shall be relayed. The command shall be relayed to the logical unit (LUN field value) within the target (TARGET field value) located on the SCSI bus (BUS NUMBER field value).

NOTE 2 - The value of targets within the TARGET field are defined by individual standards. (e.g., SCSI-3 Parallel Interface Standard defines targets to be in the range 0-7, 0-15, and 0-31).

### 2.3.2 Peripheral device address method

All SCSI commands are allowed when the peripheral device address method is selected, however peripheral devices are only required to support mandatory SCSI commands. Devices are not required to relay commands, from the application client, to a lower layer. Any command that is not supported or relayed shall be terminated with a CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID COMMAND OPERATION CODE.

If the peripheral device addressing method is selected the device shall relay the received command, if not filtered, to the addressed peripheral device.

NOTE 3 - A SCSI device may filter commands to prevent an application client from issuing, for example, a write command to a specific peripheral device. A reason for doing this would be to prevent an application client from bypassing configuration requirements at an intermediate level of the hierarchy.

See table 6 for the definition of the ADDRESS METHOD SPECIFIC field used when the peripheral device addressing method is selected.

**Table 6 - Peripheral device addressing**

| Bit<br>Byte | 7          | 6 | 5              | 4 | 3 | 2 | 1 | 0 |
|-------------|------------|---|----------------|---|---|---|---|---|
| n-1         | 0          | 0 | BUS IDENTIFIER |   |   |   |   |   |
| n           | TARGET/LUN |   |                |   |   |   |   |   |

The BUS IDENTIFIER field identifies the bus or path that the SCSI device shall use to relay the received command. The BUS IDENTIFIER field may use the same value encoding as the BUS NUMBER field (see 2.3.1). However, bus identifier zero shall indicate that the command is to be relayed to a logical unit within the current level of the SCSI device.

The TARGET/LUN field indicates the address of the peripheral device to which the SCSI device shall relay the received command. If the BUS IDENTIFIER field is not zero the TARGET/LUN field indicates the address of the target on the bus indicated by the BUS IDENTIFIER field to which the received command shall be relayed. The received command to shall be relayed to LUN zero.

A BUS IDENTIFIER field of zero represents a logical interconnection logical units. This representation of the logical units may be used for logical units when the SCSI device either does not use hierarchical addressing when assigning LUNs to objects or the SCSI device has objects that need LUNs and are not attached to actual buses (e.g, fans, cache, controllers, etc.).

A BUS IDENTIFIER field greater than zero represent physical interconnects that connect a group of SCSI devices. Each of the buses shall be assigned a number from 1 to n by the SCSI device. The bus identifiers shall be used in the BUS IDENTIFIER field by the SCSI device when assigning addresses to peripheral devices attached to those buses.

NOTE 4 - The value of targets within the TARGET/LUN field are defined by individual standards. (e.g., SCSI-3 Parallel Interface Standard defines targets to be in the range 0-7, 0-15, and 0-31).

The SCSI device located within the current level shall be addressed by a BUS IDENTIFIER field and a TARGET/LUN field of all zeros, also known as LUN 0(see 2.1).

### 2.3.3 Virtual device address method

The virtual device address method points to a virtual device that executes command(s) using the algorithms defined by a configuration.

NOTE 5 - The virtual device might not be under the control of the addressed SCSI device. It is allowed to be in an SCSI device lower in the hierarchy.

All SCSI commands are allowed when the virtual device address method is used, however virtual devices are not required to support all SCSI commands. Any command that is not supported shall be terminated with a CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID COMMAND OPERATION CODE.

In the response to an INQUIRY command the addressed virtual device shall return a valid SCSI peripheral device type.(e.g., direct access device, streaming device, etc.)

When the virtual device addressing method is selected the SCSI device at the current level addresses peripheral devices as required to execute the received command. See table 7 for the definition of the ADDRESS METHOD SPECIFIC field used when the virtual device addressing method is selected.

**Table 7 - Virtual device addressing**

| Bit<br>Byte | 7   | 6 | 5     | 4 | 3 | 2 | 1 | 0     |
|-------------|-----|---|-------|---|---|---|---|-------|
| n-1         | 0   | 1 | (MSB) |   |   |   |   |       |
| n           | LUN |   |       |   |   |   |   | (LSB) |

The LUN field indicates the address of the virtual device the current level shall direct the received command to.

### 3 SPC-2 additions

#### 3.1 Inquiry command additions

A bit needs to be added to the inquiry data to indicate when a device uses the addressing model to assigned LUNs to logical units. The bit would be as follows:

A hierarchical support (HISUPPORT) bit of zero indicates the target does not use the hierarchical addressing model to assign LUNs to logical units. A HISUPPORT bit of one indicates the target uses the hierarchical addressing model to assign LUNs to logical units.

#### 3.2 Command requirements

For SCSI devices that support hierarchical addressing the REPORT LUNS command shall be mandatory.