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To: T10 Technical Committee
From: John Lohmeyer, LSI Logic Principal Member of T10
Subj: Proposed Domain Validation Annex for SPI-3

The proposals received by T10 so far on domain validation have only addressed enhancements to the READ BUFFER and WRITE BUFFER commands in the SPC-2 draft standard. SPI-3 is completely silent on this important feature. I think this omission needs to be corrected.

I have drafted an informative annex on domain validation. Since it is informative, it contains no actual requirements. However, it does define several terms and it provides some minimal guidance on performing domain validation. Please review this proposed annex.

Revision 1 incorporates suggestions received during the November '98 T10 meeting week plus some additional changes as a result of the UBF proposal (99-102r0).

Revision 2 incorporates suggestions received during the January '99 SPI-3 working group meeting.

# Domain Validation

(Informative)

## 1. Introduction

'Domain validation' is the act of verifying that the ~~cable plant~~domain is ~~sufficient~~ able to ~~support~~ transfer test data at the negotiated speed and width between the initiator and target. ~~The cable plant includes any cables, printed circuit cards, and expanders that are present between the two SCSI devices.~~ For example, two wide devices connected with a narrow cable will discover that the cable ~~plant~~ does not support wide transfers during domain validation testing. These devices will then ~~revert~~ re-negotiate to narrow transfers.

'Fall back' is the act of re-negotiating to a set of physical parameters that are less demanding ~~of the cable plant~~. After falling back, domain validation is again performed to verify the new parameters. This cycle may be repeated until an acceptable set of physical parameters is found.

~~While the concepts of domain validation and fall back have always been supported in SCSI protocol, they have gained increased attention because higher data rates put increasing demands on the cable plant. It is unacceptable for two SCSI devices to negotiate a set of physical parameters that then fail to achieve reliable operation.~~

This annex defines ~~some terminology related to~~ domain validation and fall back terminology. ~~It also points to various tools available to support these concepts. Key tools~~ Tools used to perform domain validation include:

a) ~~(all documented in SPC-2) are~~ the INQUIRY command,
b) enhancements to the READ BUFFER and WRITE BUFFER commands, and
c) the Unexpected Bus Free timer in the Control Mode Page.

## 2. Domain validation ~~levels~~ methods

~~Three optional levels of domain validation are described.~~

### 2.1 Basic Domain Validation ~~(Level 1)~~

The basic domain validation test consists of issuing an INQUIRY command to a device ~~twice~~three times; ~~once~~ twice with the physical parameters set to asynchronous, narrow mode and once with the physical parameters set to the highest supported values. The first 36 bytes of returned data is compared and any detected transfer errors are noted. Should the data be equal with no errors detected, then the basic domain validation test passes. Should the data not compare but no detected errors occur, then the test should be repeated (this could be due to the target changing the INQUIRY data during device initialization). Otherwise, this test fails and fall back should be attempted.

This test ~~is sufficient to~~ detects most ~~cable plant~~basic problems including:

1) Path width errors (i.e., narrow cable used with wide devices)
2) Down-revision expanders (e.g., expanders not capable of the negotiated data rate)
3) Gross cable errors (e.g., broken wire)
4) Incorrect termination (e.g., missing or bad terminator)~~.~~
5) Damaged transceiver.

### 2.2 Enhanced Domain Validation ~~(Level 2)~~

Enhanced Domain Validation consists of sending and receiving known data patterns.

~~Since most legacy SCSI devices support the READ BUFFER and WRITE BUFFER commands, these commands are used for the enhanced domain validation tests. It is important that~~ During these tests, the application client should prevent ~~test routines insure that no~~ other processes from ~~is~~ using the target device~~. to avoid unwanted side effects. If there is any possibility that there may be multiple initiators present on the same SCSI bus, the RESERVE command should be used to lock out other initiators while doing the test.~~ The application client should use the RESERVE command to prevent other initiators from altering the data buffer in the target.

Some data patterns are more stressful on the physical layer~~. and should be used during the enhanced domain validation tests to assist in detecting certain failure modes. In particular, four data patterns are identified that may be useful in detecting various failures:~~ At a minimum, the application client shall use all of the following data patterns:

1) Counting (0001h, 0203h, 0405h, …)
2) Alternating ones and zeros (0000h, FFFFh, 0000h, FFFFh, …)
3) Crosstalk (5555h, AAAAh, 5555h, AAAAh, …)
4) ~~Walking ones and zeros~~Shifting bit (0000h, FFFEh, 0000h, FFFDh, … then FFFFh, 0001h, FFFFh, 0002h, …)

~~These data patterns are defined in greater detail in 98-228r0. [This reference should be replaced with the WRITE BUFFER and READ BUFFER commands in SPC-2 after 98-228 is accepted.]~~

This test ~~The enhanced domain validation tests~~ may detect additional ~~cable plant~~ problems including:

1) Wrong impedance cables
2) Bad device spacing
3) Poor termination.

### 2.3 Margined Domain Validation ~~(Level 3)~~

Margin testing verifies that the ~~agreed upon~~negotiated physical parameters have some degree of margin. ~~That is, known~~Known data patterns are transferred with slightly 'altered' signals to verify that no errors occur on the transfers. The ~~presumption~~ assumption is that if no errors occur with the 'altered' signals, then transfers with normal signals should have ~~sufficient~~ some margin~~s~~ to ~~ensure reliable operation~~accommodate noise not present during the testing. Should errors occur with the altered signals, then the initiator should fall back to a lower transmission speed.

~~There are several techniques under investigation for altering signals. These include:~~
~~a) altering the driver strength (slightly changed current or voltage level)~~
~~b) moving the timing window of the data signals with respect to the REQ or ACK signal~~
~~c) changing the rise and fall times~~
~~d) changing the receiver sensitivity.~~

~~Other techniques may be feasible and are permitted.~~
This annex does not specify which techniques to use to alter signals.

Margined domain validation testing is done using the techniques described in 2.2 except that the signals are altered~~margined as described above~~.

~~The WRITE BUFFER and READ BUFFER commands include a margin adjustment field to specify the vendor-specific margin setting used for each transfer. Legacy devices do not support this field, so it is not possible to do complete signal-margining tests with legacy devices. Nonetheless, if either device supports this field, it is possible to do partial testing (i.e., inbound or outbound testing).~~

~~The m~~Margined domain validation may give added confidence that the ~~cable plant~~domain is sufficient to support the negotiated physical parameters.

## 3. Signal calibration

Signal calibration adjusts signal line drivers (and possibly receivers) to improve signal transmission characteristics during normal data transfers. Parameters that may be adjusted include driver strength, receiver sensitivity, and timing parameters such as setup time and hold time.

This annex does not address signal calibration beyond defining the term.

## 4. Fall back

Fall back is the act of re-negotiating to a ~~lower (or~~ less-demanding~~)~~ set of physical parameters for example transfer mode reduction or bus width reduction. ~~(e.g., Fast-40 instead of Fast-80).~~ It is accomplished by either ~~by~~ a ~~new~~ PPR negotiation ~~(assuming both devices support the PPR message)~~ or ~~by~~ a ~~new~~ WDTR/SDTR negotiation ~~for older devices~~.

~~The fall back procedure can introduce some complexities since message-based negotiations are often handled at a lower level of the operating system than the portion that deals with command delivery. Thus the routine that performs domain validation testing may need a service from a lower layer that was previously not provided. Extensions to several operating system interfaces are being proposed to support fall back. These include the Desktop Management Interface (DMI), Advanced SCSI Programming Interface (ASPI), and others.~~

## 4. System considerations

~~The READ BUFFER and WRITE BUFFER commands were first defined in SCSI-2.~~ Devices that do not implement the READ BUFFER and WRITE BUFFER commands~~implemented prior to SCSI-2~~ should report CHECK CONDITION status and ILLEGAL REQUEST sense key in response to attempts to issue these commands. It may be impractical to perform certain domain validation tests with these devices. ~~This is not a significant issue since very few of the devices are still in service and these devices only support lower transfer rates that should not stress the cable plant.~~

### 4.1 Buffer Corruption

~~SCSI-2 defined the~~ The READ BUFFER and WRITE BUFFER commands ~~as~~ access~~ing~~ physical buffers in the target. Many implementations do not protect the buffer contents if there is an intervening command from any other process. Therefore, ~~domain validation software~~the application client should ensure that no other SCSI processes are active while performing tests.

The RESERVE command may be used~~ful~~ ~~in~~to block~~ing~~ commands from other initiators. However, using the RESERVE command is not sufficient to prevent commands from the same initiator (possibly issued by other processes) from corrupting the buffer contents. Also, targets with multiple logical units may corrupt the buffer if commands are processed on other logical units.

~~A proposal for SPC-2 (98-184r2) defines an enhancement to the~~ The READ BUFFER and WRITE BUFFER commands include an echo buffer option that ~~helps with this problem. The proposal defines an 'echo buffer' that is protected from corruption by other commands. This echo buffer~~ may be especially valuable when performing these tests ~~during normal operation of the system~~.

### 4.2 Failure Modes during Domain Validation Testing

Domain validation testing may cause several kinds of error conditions ~~on cable plants that are inadequate for the negotiated set of physical parameters~~:

a) Parity or CRC errors - detected error
b) Data comparison mismatches - undetected error
c) Bus hangs. - requires special handling

~~These error conditions usually result in falling back to a less demanding set of physical parameters. The first error condition is a detected error. The second error condition is an~~

~~undetected error. The third error condition may require special handling as described in the next paragraph.~~

Bus hangs occur when the target fails to detect an ACK pulse from the initiator (possibly as a result of the initiator failing to detect a REQ pulse from the target). This is a frequent failure mode on marginal ~~cable plants~~domains. It is recommended that initiators include provisions to avoid extended bus hangs. Two recovery actions are possible:

a) Assert the RST signal

b) Use the ~~Unexpected Bus Free timer function documented in 99-102r0~~Synchronous Transfer Timeout (STT) function in the SCSI Port Control Mode page..