To: T10 Technical Committee
From: Rob Elliott, HP (elliott@hp.com)
Date: 14 September 2004
Subject: 04-246r1 SAS-1.1 Send AIP multiple times

Revision history
Revision 0 (28 July 2004) First revision
Revision 1 (14 September 2004) Incorporated comments from September 2004 SAS protocol WG.

Related documents
sas1r05 - Serial Attached SCSI 1.1 revision 5

Overview
SAS is generally designed to tolerate single-bit errors. Single-bit errors inside a connection can result in the connection being closed, but another connection can be opened afterwards.

Unfortunately, the AIP primitive appears outside connections yet is involved in a crucial rule for establishing connections when a phy sends an OPEN:

a) if it receives an OPEN not preceded by an AIP, it compares the two OPEN's AWTs and source SAS addresses to determine the winner. The other phy performs the same comparison and must come to the same decision;
b) if it receives an AIP followed by an OPEN, the incoming OPEN is the winner. The other phy makes the same assumption.

If the AIP was only sent one time, however, and encountered a single-bit error, the phy might get confused about which connection request is the winner, resulting in both phys issuing OPEN_ACCEPTs and possibly leading to deadlocks.

Missing AIPs between expanders could also confuse the deadlock detection algorithms.

To avoid this, expanders should be encouraged (though not yet mandated) to send AIP three times rather than one time. In SAS-2, it might be upgraded to a shall. This is slightly different than the "Triple" primitive sequence, which is send-3 receive-3. This is send-3 receive-1.

Suggested changes

7.2.5.1 AIP (Arbitration in progress)

AIP is sent by an expander device after a connection request to indicate that the connection request is being processed and indicate the status of the connection request.

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See 7.12 for details on connections.

7.12.5 Expander devices and connection requests

7.12.5.1 All expander devices

Before an expander device transmits AIP, it may have transmitted an OPEN address frame on the same physical link. Arbitration fairness dictates which OPEN address frame wins (see 7.12.3).

After an expander device transmits an AIP, it shall not transmit an OPEN address frame unless it has higher arbitration priority than the incoming connection request.

Expander devices shall transmit no more than three consecutive AIPs without transmitting an idle dword. Expander devices may transmit three consecutive AIPs to provide better tolerance of errors. Expander devices shall transmit at least one AIP every 128 dwords while transmitting AIP (NORMAL), AIP (WAITING ON PARTIAL), or AIP (WAITING ON CONNECTION).

NOTE 1 Future versions of this standard may require that expander devices transmit three consecutive AIPs.

Expander devices shall transmit an AIP (e.g., an AIP (NORMAL)) within 128 dwords of receiving an OPEN address frame.