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To: T10 Committee (SCSI)

From: George Penokie (IBM/Tivoli)

Subject: SAS: SP_DWS Wording Changes

Overview

There has been confusion about how primitives and data dwords are handled in the SP_DWS state machine. This proposal fixes that.

0.1 SP_DWS (phy layer dword synchronization) state machine

0.1.1 SP_DWS state machine overview

Each phy includes an SP_DWS state machine.

This state machine establishes the same dword boundaries at the receiver as at the attached transmitter by searching for control characters. A receiver in the phy monitors and decodes the incoming data stream and forces K28.5 characters into the first byte position to effectively perform dword ~~alignment~~alignment when requested by the SP_DWS state machine. The receiver continues to reestablish dword alignment by forcing received K28.5 characters into the first byte position until a valid primitive is detected. The resultant primitives, dwords and valid dword indicators (e.g., encoding error indicators) are sent to this state machine to enable it to determine the dword synchronization policy.

After dword synchronization has been achieved, this state machine monitors invalid dwords that are received. When an invalid dword is detected, it requires two valid dwords to nullify its effect. When four invalid dwords are detected without nullification, dword synchronization is considered lost.

While dword synchronization is lost, the data stream received is invalid and dwords shall not be passed to the link layer.

This state machine consists of the following states:

a) SP_DWS0:AcquireSync (see 0.1.3)(initial state);
b) SP_DWS1:Valid1 (see 0.1.4);
c) SP_DWS2:Valid2 (see 0.1.5);
d) SP_DWS3:SyncAcquired (see 0.1.6);
e) SP_DWS4:Lost1 (see 0.1.7);
f) SP_DWS5:Lost1Recovered (see 0.1.8);
g) SP_DWS6:Lost2 (see 0.1.9);
h) SP_DWS7:Lost2Recovered (see 0.1.10);
i) SP_DWS8:Lost3 (see 0.1.11); and
j) SP_DWS9:Lost3Recovered (see 0.1.12).

This state machine shall start in the SP_DWS0:AcquireSync state after:

a) power on;
b) hard reset; or
c) receiving a Phy Not Ready ~~parameter~~ message from the SP state machine.

This state machine receives the following ~~parameters~~ messages from the SP state machine (see 6.7):

a) Phy Not Ready;
b) Phy Ready (SAS); and
c) Phy Ready (SATA).

This state machine sends the following ~~parameters~~ messages to the SP state machine:

a) DWS Reset.

Figure 1 shows the SP_DWS state machine.

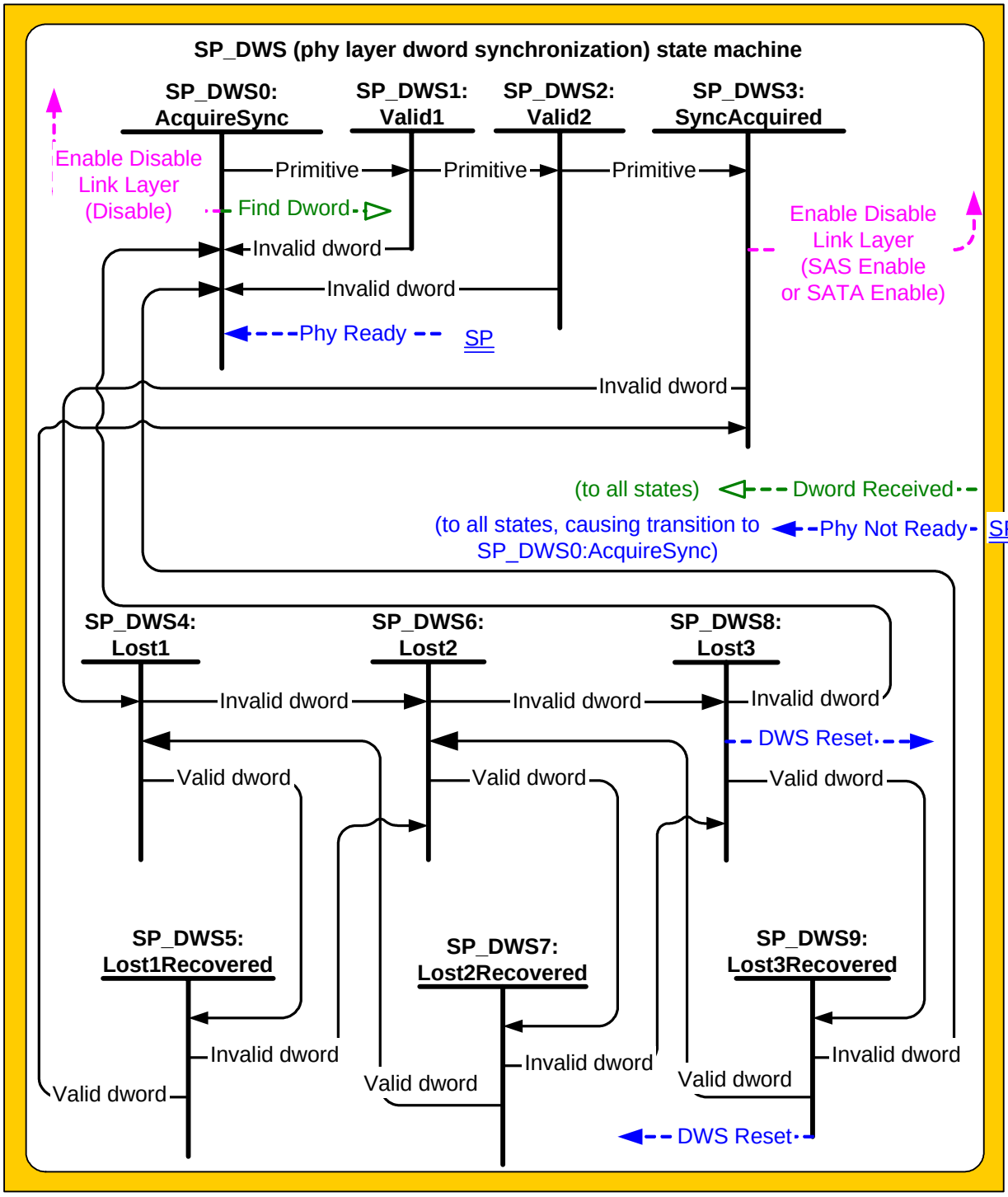

Figure 1 — SP_DWS (phy layer dword synchronization) state machine

0.1.2 ~~SP_DWS~~ Receiver

The ~~SP_DWS~~ receiver receives the following ~~parameters~~ messages from the SP_DWS state machine:

a) Find Dword.

The ~~SP_DWS~~ receiver sends the following ~~parameters~~ messages to the SP_DWS state machine:

a) Dword Received (~~Valid~~Valid Primitive); ~~and~~

b) Dword Received (~~Invalid~~Valid Dword)~~.~~; and
c) Dword Received (Invalid).

Upon receiving a Find Dword ~~parameter~~message, the ~~SP_DWS~~ receiver shall ~~monitors~~ monitor the input data stream and ~~forces~~ force each K28.5 character detected into the first byte position as a possible dword. If the next three characters are data characters, it shall send the dword as a Dword Received (~~Valid~~Valid Primitive) ~~parameter~~ message to the SP_DWS state machine. Until it receives another Find Dword ~~parameter~~message, it ~~shall send a Dword Received (Valid) or Dword Received (Invalid) parameter to the SP_DWS state machine for every four characters it receives.~~shall:

~~Editor's Note 1: fill in this section. Define better what an invalid dword means.~~

a) send a Dword Received (Valid Primitive) message to the SP_DWS state machine anytime a dword is received that contains a K28.5 character in the first byte position followed by three data characters;
b) send a Dword Received (Invalid) message to the SP_DWS state machine anytime an invalid dword (see 3.1.61xx) is received; or
c) send a Dword Received (Valid Dword) message to the SP_DWS state machine anytime a data dword is received.

0.1.3 SP_DWS0:AcquireSync state

0.1.3.1 State description

This is the initial state of this state machine. On entry into this state, this state shall send an Enable Disable Link Layer (Disable) confirmation to the link layer, send a Find Dword ~~parameter~~ message to the ~~SP_DWS~~ receiver, and wait for a Dword Received (~~Valid~~Valid Primitive) ~~parameter~~message.

0.1.3.2 Transition SP_DWS0:AcquireSync to SP_DWS1:Valid1

This transition shall occur when a Phy Ready ~~parameter~~ message has been received and a Dword Received (~~Valid~~Valid Primitive) ~~parameter~~ message has been received.

0.1.4 SP_DWS1:Valid1 state

0.1.4.1 State description

This state is reached after one valid primitive has been received. This state waits for a second valid primitive or an invalid dword.

0.1.4.2 Transition SP_DWS1:Valid1 to SP_DWS0:AcquireSync

This transition shall occur after receiving a Dword Received (Invalid) ~~parameter~~message.

0.1.4.3 Transition SP_DWS1:Valid1 to SP_DWS2:Valid2

This transition shall occur after receiving a Dword Received (~~Valid~~Valid Primitive) ~~parameter that contains a defined primitive~~message.

0.1.5 SP_DWS2:Valid2 state

0.1.5.1 State description

This state is reached after two valid primitives have been received without adjusting the dword synchronization. This state waits for a third valid primitive or an invalid dword.

0.1.5.2 Transition SP_DWS2:Valid2 to SP_DWS0:AcquireSync

This transition shall occur after receiving a Dword Received (Invalid) ~~parameter~~message.

0.1.5.3 Transition SP_DWS2:Valid2 to SP_DWS3:SyncAcquired

This transition shall occur after receiving a Dword Received (~~Valid~~Valid Primitive) ~~parameter that contains a defined primitive~~message.

0.1.6 SP_DWS3:SyncAcquired state

0.1.6.1 State description

This state is reached after three valid primitives have been received without adjusting the dword synchronization. This state shall send one of the following confirmations to the link layer:

a) an Enable Disable Link Layer (SAS Enable) confirmation if this state machine has received a Phy Ready (SAS) ~~parameter~~message; or
b) an Enable Disable Link Layer (SATA Enable) confirmation if this state machine has received a Phy Ready (SATA) ~~parameter~~message.

The most recently received primitive and all subsequent dwords shall be forwarded for processing by the link layer.

This state waits for a Dword Received (Invalid) ~~parameter~~message, which indicates that dword synchronization might be lost.

0.1.6.2 Transition SP_DWS3:SyncAcquired to SP_DWS4:Lost1

This transition shall occur after receiving a Dword Receive (Invalid) ~~parameter~~message. An expander forwarding the dword to another phy shall replace the invalid dword with ERROR for a SAS physical link or SATA_ERROR for a SATA physical link.

0.1.7 SP_DWS4:Lost1 state

0.1.7.1 State description

This state is reached when one invalid dword has been received and not nullified. This state waits for a Dword Received ~~parameter~~message.

0.1.7.2 Transition SP_DWS4:Lost1 to SP_DWS5:Lost1Recovered

~~This transition shall occur after receiving a Dword Received (Valid) parameter.~~

This transition shall occur after receiving a Dword Received (Valid Dword) message or a Dword Received (Valid Primitive) message.

0.1.7.3 Transition SP_DWS4:Lost1 to SP_DWS6:Lost2

This transition shall occur after receiving a Dword Received (Invalid) ~~parameter~~message. An expander forwarding the dword to another phy shall replace the invalid dword with ERROR for a SAS physical link or SATA_ERROR for a SATA physical link.

0.1.8 SP_DWS5:Lost1Recovered state

0.1.8.1 State description

This state is reached when a valid dword has been received after one invalid dword had been received. This state waits for a Dword Received ~~parameter~~message.

0.1.8.2 Transition SP_DWS5:Lost1Recovered to SP_DWS3:SyncAcquired

~~This transition shall occur after receiving a Dword Received (Valid) parameter.~~

This transition shall occur after receiving a Dword Received (Valid Dword) message or a Dword Received (Valid Primitive) message.

0.1.8.3 Transition SP_DWS5:Lost1Recovered to SP_DWS6:Lost2

This transition shall occur after receiving a Dword Received (Invalid) ~~parameter~~message. An expander forwarding the dword to another phy shall replace the invalid dword with ERROR for a SAS physical link or SATA_ERROR for a SATA physical link.

0.1.9 SP_DWS6:Lost2 state

0.1.9.1 State description

This state is reached when two invalid dwords ~~has~~ have been received and not nullified. This state waits for a Dword Received ~~parameter~~message.

0.1.9.2 Transition SP_DWS6:Lost2 to SP_DWS7:Lost2Recovered

~~This transition shall occur after receiving a Dword Received (Valid) parameter.~~

This transition shall occur after receiving a Dword Received (Valid Dword) message or a Dword Received (Valid Primitive) message.

0.1.9.3 Transition SP_DWS6:Lost2 to SP_DWS8:Lost3

This transition shall occur after receiving a Dword Received (Invalid) ~~parameter~~message. An expander forwarding the dword to another phy shall replace the invalid dword with ERROR for a SAS physical link or SATA_ERROR for a SATA physical link.

0.1.10 SP_DWS7:Lost2Recovered state

0.1.10.1 State description

This state is reached when a valid dword has been received after two invalid dwords had been received. This state waits for a Dword Received ~~parameter~~message.

0.1.10.2 Transition SP_DWS7:Lost2Recovered to SP_DWS4:Lost1

~~This transition shall occur after receiving a Dword Received (Valid) parameter.~~

This transition shall occur after receiving a Dword Received (Valid Dword) message or a Dword Received (Valid Primitive) message.

0.1.10.3 Transition SP_DWS7:Lost2Recovered to SP_DWS8:Lost3

This transition shall occur after receiving a Dword Received (Invalid) ~~parameter~~message. An expander forwarding the dword to another phy shall replace the invalid dword with ERROR for a SAS physical link or SATA_ERROR for a SATA physical link.

0.1.11 SP_DWS8:Lost3 state

0.1.11.1 State description

This state is reached when three invalid dwords ~~has~~ have been received and not nullified. This state waits for a Dword Received ~~parameter~~message.

If a Dword Received (Invalid) ~~parameter~~ message is received (i.e., the fourth non-nullified invalid dword is received), this state shall send a DWS Reset ~~parameter~~ message to the SP state machine.

0.1.11.2 Transition SP_DWS8:Lost3 to SP_DWS9:Lost3Recovered

~~This transition shall occur after receiving a Dword Received (Valid) parameter.~~

This transition shall occur after receiving a Dword Received (Valid Dword) message or a Dword Received (Valid Primitive) message.

0.1.11.3 Transition SP_DWS8:Lost3 to SP_DWS0:AcquireSync

This transition shall occur after sending a DWS Reset ~~parameter~~message.

0.1.12 SP_DWS9:Lost3Recovered state

0.1.12.1 State description

This state is reached when a valid dword has been received after three invalid dwords had been received. This state waits for a Dword Received ~~parameter~~message.

If a Dword Received (Invalid) ~~parameter~~ message is received (i.e., the fourth non-nullified invalid dword is received), this state shall send a DWS Reset ~~parameter~~ message to the SP state machine.

0.1.12.2 Transition SP_DWS9:Lost3Recovered to SP_DWS6:Lost2

~~This transition shall occur after receiving a Dword Received (Valid) parameter.~~

This transition shall occur after receiving a Dword Received (Valid Dword) message or a Dword Received (Valid Primitive) message.

0.1.12.3 Transition SP_DWS9:Lost3Recovered to SP_DWS0:AcquireSync

This transition shall occur after sending a DWS Reset ~~parameter~~message.