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To: T10 Committee (SCSI)

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Subject: SAS: SP_DWS Wording Changes

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 be 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 Stop DWS message from the SP state machine.

This state machine receives the following messages from the SP state machine (see 1.7):

a) Start DWS; and
b) Stop DWS.

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

a) DWS Lost; and
b) DWS Reset.

The SP_DWS state machines shall maintain the timers listed in table 1.

Table 1 — SP_DWS timers

Timer	Initial value
DWS reset timeout timer	1 ms

Figure 1 shows the SP_DWS state machine.

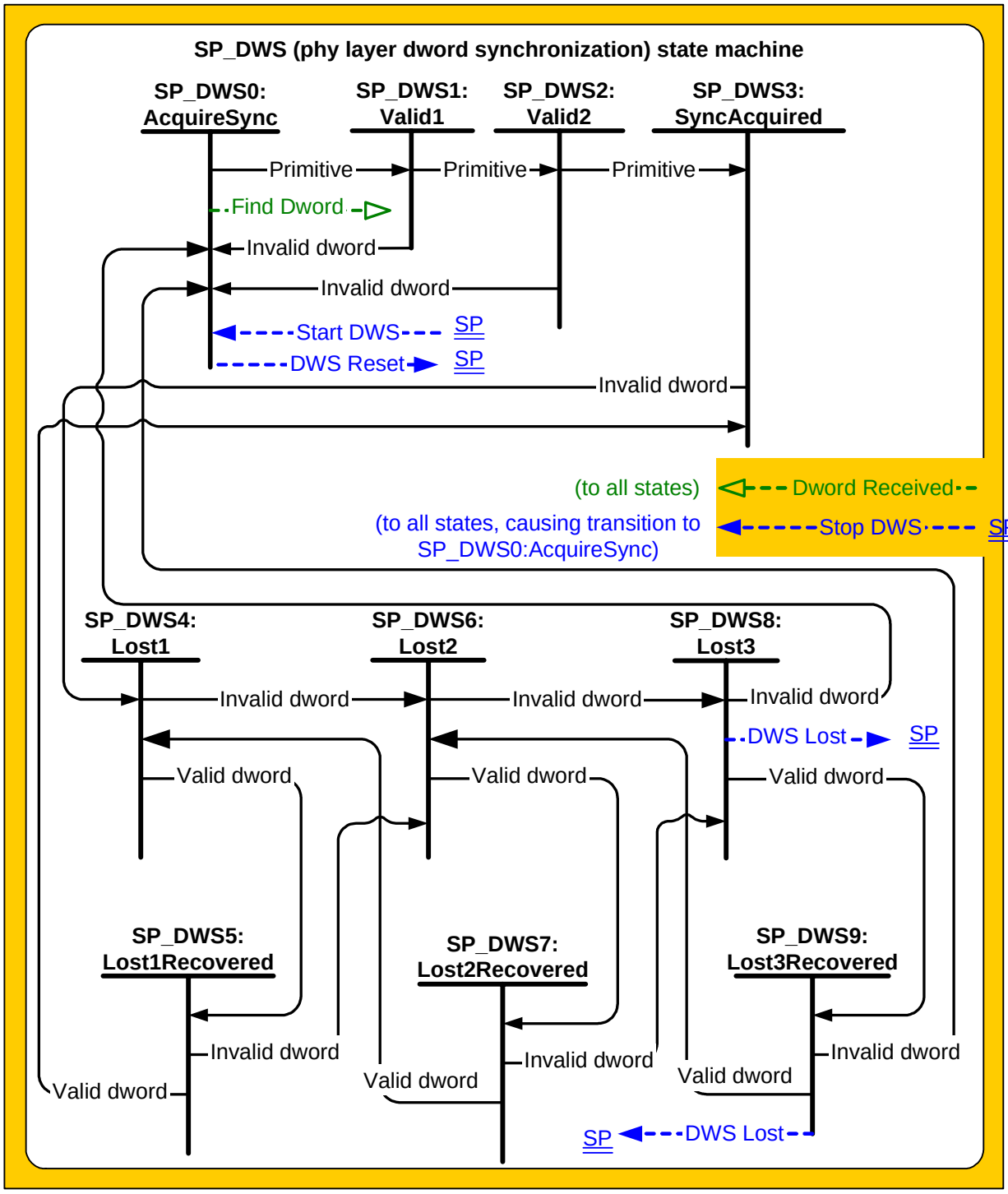

Figure 1 — SP_DWS (phy layer dword synchronization) state machine

0.1.2 SP_DWS receiver

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

a) Find Dword.

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

a) Dword Received (Valid Primitive);

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

Upon receiving a Find Dword message, the SP_DWS receiver shall monitor the input data stream and 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) message to the SP_DWS state machine. Until it receives another Find Dword message, it ~~shall send a Dword Received (Valid) or Dword Received (Invalid) message to the SP_DWS state machine for every four characters it receives.~~shall:

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 Data 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.

Upon entry into this state, this state shall send an Phy Layer Not Ready confirmation to the link layer.

After receiving a Start DWS message, this state shall:

a) ~~After receiving a Start DWS message, this state shall~~ send a Find Dword message to the SP_DWS receiver, and wait for a Dword Received (~~Valid~~Valid Primitive) message~~.~~; and
b) initialize and start the DWS reset timeout timer;

If this state is entered from SP_DWS1 or SP_DWS2 the DWS reset timeout timer shall continue running.

~~At any time after receiving a Start~~ If this state is entered from SP_DWS1 or SP_DWS2 the DWS ~~message,~~ and the reset timeout timer is expired then this state may send a DWS Reset message to the SP state machine (e.g., if the phy chooses to initiate a new link reset sequence because dword synchronization has been lost for too long).

This state shall not send a DWS Reset message to the SP until the DWS reset timeout timer expires.

If the DWS reset timeout timer expires this state may send a DWS Reset message to the SP state machine.

0.1.3.2 Transition SP_DWS0:AcquireSync to SP_DWS1:Valid1

This transition shall occur ~~when~~ after a Start DWS message has been received and a Dword Received (~~Valid~~Valid Primitive) 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.

The DWS reset timeout timer shall continue timing.

0.1.4.2 Transition SP_DWS1:Valid1 to SP_DWS0:AcquireSync

This transition shall occur after ~~receiving~~ a Dword Received (Invalid) ~~message~~message is received or the DWS timeout timer expires.

0.1.4.3 Transition SP_DWS1:Valid1 to SP_DWS2:Valid2

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

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.

The DWS reset timeout timer shall continue timing.

0.1.5.2 Transition SP_DWS2:Valid2 to SP_DWS0:AcquireSync

This transition shall occur after ~~receiving~~ a Dword Received (Invalid) ~~message~~message is received or the DWS timeout timer expires.

0.1.5.3 Transition SP_DWS2:Valid2 to SP_DWS3:SyncAcquired

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

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.

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) 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 Received (Invalid) message.

0.1.7 SP_DWS4:Lost1 state

0.1.7.1 State description

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

0.1.7.2 Transition SP_DWS4:Lost1 to SP_DWS5:Lost1Recovered

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

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

0.1.8 SP_DWS5:Lost1Recovered state

0.1.8.1 State description

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

0.1.8.2 Transition SP_DWS5:Lost1Recovered to SP_DWS3:SyncAcquired

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

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

0.1.9 SP_DWS6:Lost2 state

0.1.9.1 State description

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

0.1.9.2 Transition SP_DWS6:Lost2 to SP_DWS7:Lost2Recovered

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

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

0.1.10 SP_DWS7:Lost2Recovered state

0.1.10.1 State description

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

0.1.10.2 Transition SP_DWS7:Lost2Recovered to SP_DWS4:Lost1

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

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

0.1.11 SP_DWS8:Lost3 state

0.1.11.1 State description

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

If a Dword Received (Invalid) message is received (i.e., the fourth non-nullified invalid dword is received), this state shall send a DWS Lost 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 Data Dword) message or a Dword Received (Valid Primitive) message.

0.1.11.3 Transition SP_DWS8:Lost3 to ~~SP_DWS9~~SP_DWS0:~~Lost3Recovered~~AcquireSync

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

~~0.1.11.4 Transition SP_DWS8:Lost3 to SP_DWS0:AcquireSync~~

a) ~~This transition shall occur after~~ sending a DWS Lost message~~.~~; and
b) shall initialize the DWS reset timeout timer.

0.1.12 SP_DWS9:Lost3Recovered state

0.1.12.1 State description

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

If a Dword Received (Invalid) message is received (i.e., the fourth non-nullified invalid dword is received), this state shall send a DWS Lost 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 Data Dword) message or a Dword Received (Valid Primitive) message.

0.1.12.3 Transition SP_DWS9:Lost3Recovered to ~~SP_DWS6~~SP_DWS0:~~Lost2~~AcquireSync

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

~~0.1.12.4 Transition SP_DWS9:Lost3Recovered to SP_DWS0:AcquireSync~~

a) ~~This transition shall occur after~~ sending a DWS Lost message~~.~~; and
b) shall initialize the DWS reset timeout timer.