05-427r0  SAS2 Training Sequence

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Adaptive equalization is desirable for 6G speeds.

Adaptive equalization will require a training sequence to optimize the channel.

Equalizer convergence time is TBD.
  - Dependent on equalizer implementation & channel model
  - May require many milliseconds to adapt to a channel.

Channel adaptation must occur prior to speed negotiation.

There is not enough time allotted in the current speed negotiation time for channel adaptation.

Maintain backward compatibility with SAS1.1 and SATA.
Modify speed negotiation phase for 6G only to provide for training sequence

- Only 250 us is proposed.
- This time cannot be extended much because it must be contained within the RCDT (Rate Change Delay Time) in order to maintain compatibility with SAS1.1
- 250 us is probably not enough to adapt to corner case channels.
- Known training sequence proposed to speed convergence
  - Training sequence based equalizers are more costly than blind equalizers.
Modify OOB sequence to provide for detection of a SAS2 adaptive device.

- Allows complete freedom to define a new training + speed negotiation sequence that will satisfy the needs for adaptive equalizers.
- Allows 6G vendors that do not use adaptive equalizers to not carry the extra baggage of training sequences and additional time required to link up.
  - Non adaptive phy’s would use current SAS 1.1 speed negotiation sequence.
- Allows for reasonable training sequence length.
- Use a PRBS pattern as a training sequence.
- Maintains backward compatibility with SAS1.1 and SATA.
- Allows for adaptation at both 1.5G and 3.0G rates. This should allow operation with much longer cable lengths at the lower rates!
Define a new OOB symbol COMSAS2. COMSAS2 symbol has 4320 OOB idle time and 7200 negation time.

Modify SP state machine to allow sending/detection of COMSAS2 symbol.
  - May cause SAS1.1 PHY’s to incorrectly believe a SAS2 adaptive PHY is SATA, Must be handled by SAS2 adaptive PHY by re-issuing COMINIT after receiving COMSAS.
  - Branch SP state machine to new SP states (SPxx) that will handle new SAS2 training and speed negotiation.
  - SATA is handled the same as SAS1.1
**Proposed SAS2 OOB Sequence**

**SAS2 to SAS2 OOB sequence**

- Phy A Tx/Phy B Rx
  - COMINIT
  - COMSAS2
- Phy A Rx/Phy B Tx
  - COMINIT
  - COMSAS2
  - **Proceed to SAS2 Adaptive Speed Negotiation**

**SAS2 to SAS OOB sequence**

- Phy A Tx/Phy B Rx
  - COMINIT
  - COMSAS2
  - COMINIT
  - COMSAS
  - **Proceed to SAS1 Speed Negotiation**
- Phy A Rx/Phy B Tx
  - COMINIT
  - COMSAS
  - COMWAKE
  - COMINIT
  - COMSAS
  - **Proceed to SAS1 Speed Negotiation**

Comwake may be absent if SAS device implements spinup hold.
Proposed SAS2 training + speed negotiation sequence

- Training Sequence
- ALIGN(0)s
- ALIGN(1)s
- Long time
- Rate change delay time (RCDT2) TBD ms
- Speed negotiation window time
- Speed negotiation lock time (SNLT)
- Speed negotiation transmittime (SNTT)
Adaptive Equalizers may need much longer than 250 us to adapt to some channels.

The current speed negotiation timing does not allow for enough time to adapt to the channel.

A way to distinguish between SAS1.1 and a new speed negotiation sequence is necessary.

The proposed method is backwards compatible with SAS1.1 but allows for ultimate flexibility for SAS 2.