InterPacket Gap and Start of Packet Lane Alignment

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Inter Packet Gap

- Frazier et. al. proposal for XGMII:
 - Minimum transmit IPG of 12 byte times (specified by MAC)
 - Minimum receive IPG of 4 byte times
 - Lane alignment: All packets start on lane 0.
- MAC constraints:
 - MAC transmitter is specified as a byte wide device
 - Technically specified as a bit wide device, but never transmits partial octets.
 - Has no knowledge of 4 byte lane alignment restrictions.
 - Therefore will not generate a packet stream where all packets naturally begin on lane 0 of the XGMII.



Options for Maintaining Lane Alignment

• 1) Change the MAC

- Make it aware of physical layer packet alignment restrictions.
- Round each IPG up to get 4 byte alignment for next packet.
- 2) Allow preamble compression
 - When a frame from the MAC transmitter would "naturally" begin on a lane other than lane 0, delete preamble bytes until the packet can begin on lane 0.
- 3) Allow variation in the minimum IPG at the XGMII
 - Allow packets to be held back until the next lane 0 alignment, and make up by shrinking a subsequent IPG. The minimum IPG observed at the XGMII would "dither" between 9 and 15 bytes, but would average 12. The minimum IPG "observed" at the MAC would always be 12.

Precedent from Gigabit Ethernet

- Same issue arose because the two symbol 8B/10B idle sequence imposed a two byte alignment restriction.
- Decision was made not to modify the MAC.
- Preamble compression was chosen over IPG variation:
 - The IPG variation, combined with potential IPG shrinkage in repeaters, could result in a IPG short enough to affect fairness in half-duplex operation.
 - This is not a concern in 10 Gigabit Ethernet, so either preamble compression or IPG variation could be chosen.



Recommendation for 10 Gigabit Ethernet

No change to the MAC

- Making the MAC aware of 4 byte alignment restriction at a particular speed is contrary to the goal of a speed independent MAC.
- Makes 10GE < 10 * GE packet rates for odd packet sizes.

No preamble compression

 Preamble compression would allow SOP to be aligned to lane 0, but SFD would not be. This eliminates any simplicity achieved by the lane alignment restriction in the first place.

Pick IPG variation

 MAC always generates 12 byte minimum IPG. The packet can "slide" forward or backward to meet lane alignment while maintaining 12 byte average.

Impact

- Impact on specification:
 - No change to MAC, min IPG remains 12 bytes (96 bits)
 - XGMII specs minimum of two full columns of Idle following the "T" column (min IPG of 9 bytes at XGMII while MAC assures an avg min of 12 bytes).
- No impact on implementations:
 - No change to required tolerance on received IPG.
 - Transmitters allowed to always round up minimum IPG to next lane alignment if simpler for wide MAC implementations.



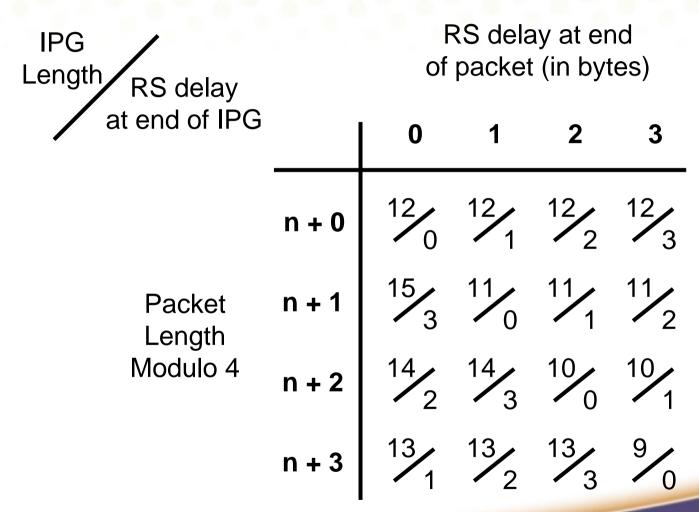
Example

 Packet flow from MAC with 12 byte IPG and no knowledge of 4 byte alignment restrictions:

 RS Aligns by "sliding" packet forward within the window between previous and subsequent packets:



IPG Length Table





Thank you!



IPG cases

• 2 column cases (9-12 byte IPG):

```
      d T A R S
      d d A R S
      d d A R S
      d d A R S

      d K A R d
      d T A R d
      d d A R d
      d d A R d

      d K A R d
      d K A R d
      d T A R d
      d d A R d

      d K A R d
      d K A R d
      d K A R d
      d T A R d
      d T A R d
```

• 3 column cases (13-16 byte IPG):

```
      d T A R K S
      d d A R K S
      d d A R K S
      d d A R K S

      d K A R K d
      d T A R K d
      d d A R K d
      d d A R K d

      d K A R K d
      d K A R K d
      d T A R K d
      d d A R K d

      d K A R K d
      d K A R K d
      d K A R K d
      d T A R K d
      d T A R K d
```

