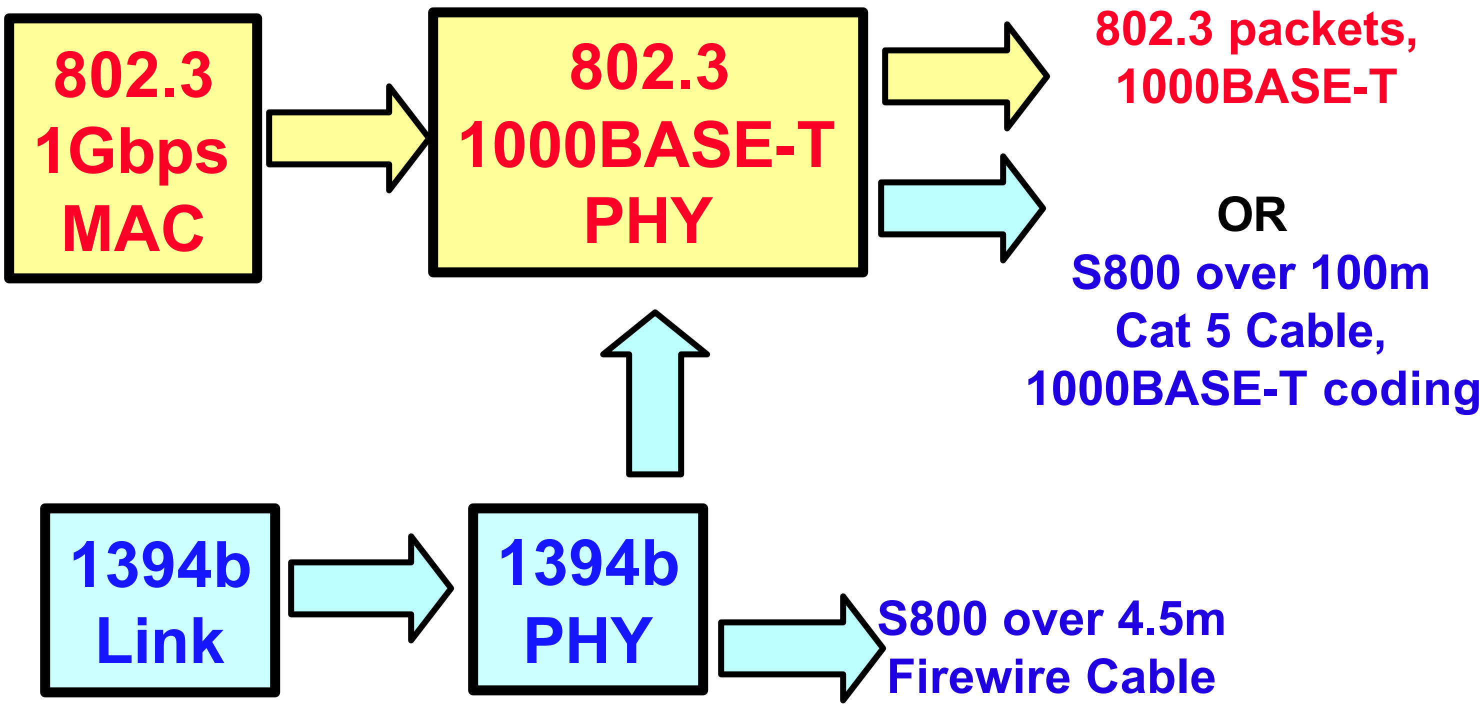
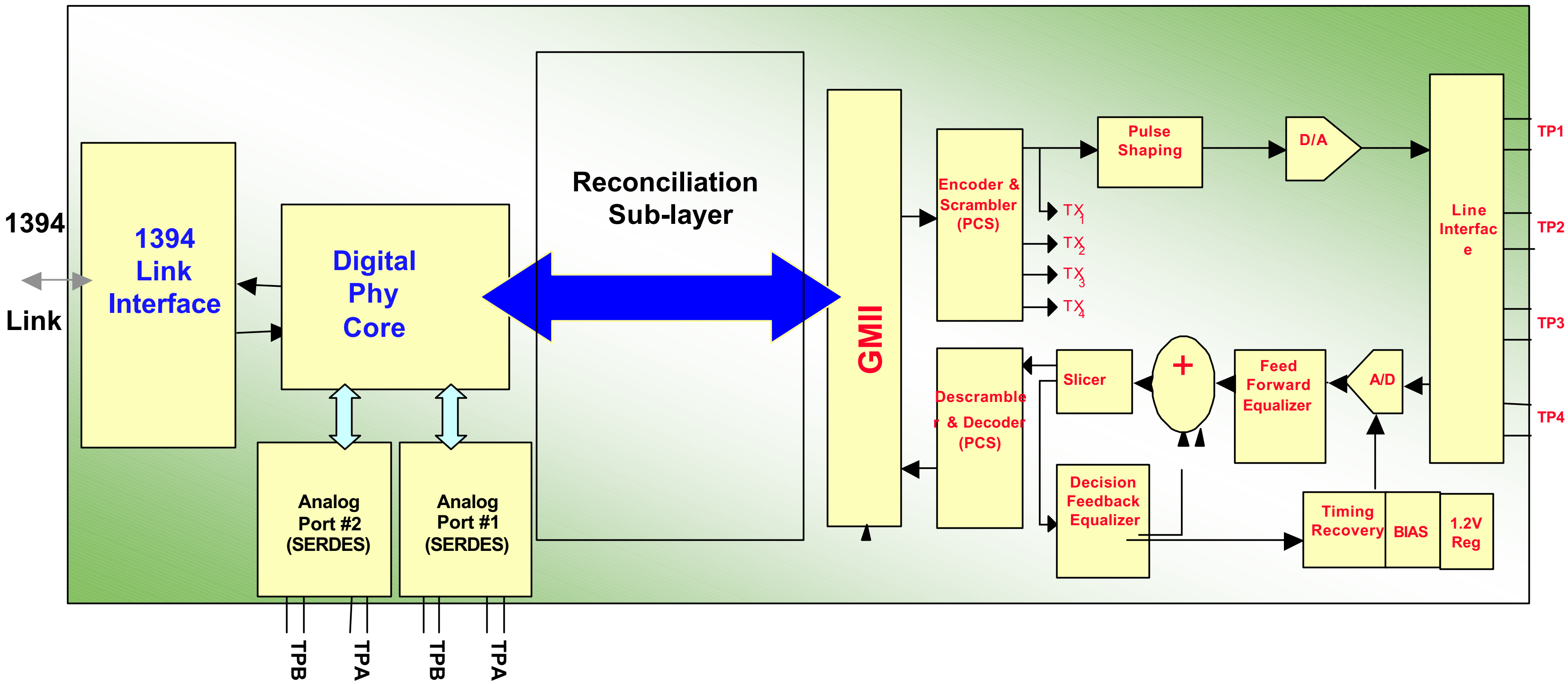
Requirements

- At PHY/Link interface must appear to be standard 1394b PHY
- At GMII must appear to be standard 1000BASE-T PHY
- When network port negotiates to be 1394, must appear to be standard 1394b port connection to 1394 management software
  - Looks like network unconnected to Ethernet software
- When a network port negotiates to be Ethernet, must appear to be standard Ethernet connection to Ethernet management software
  - Looks like unconnected port to 1394 software
- Must support 1394b S100 as defined, and S800 using 1000BASE-T modulation
- Must support 10BASE-T, 100BASE-T, 1000BASE-T (full and half duplex) Ethernet
- Negotiation preference set at device endpoint (NOT at hub/switch/bridge) … e.g., Apple would prefer FireWire for Mac OS X, others may prefer alternate connections.

Ethernet and Firewire



S800BASE-T Block Diagram



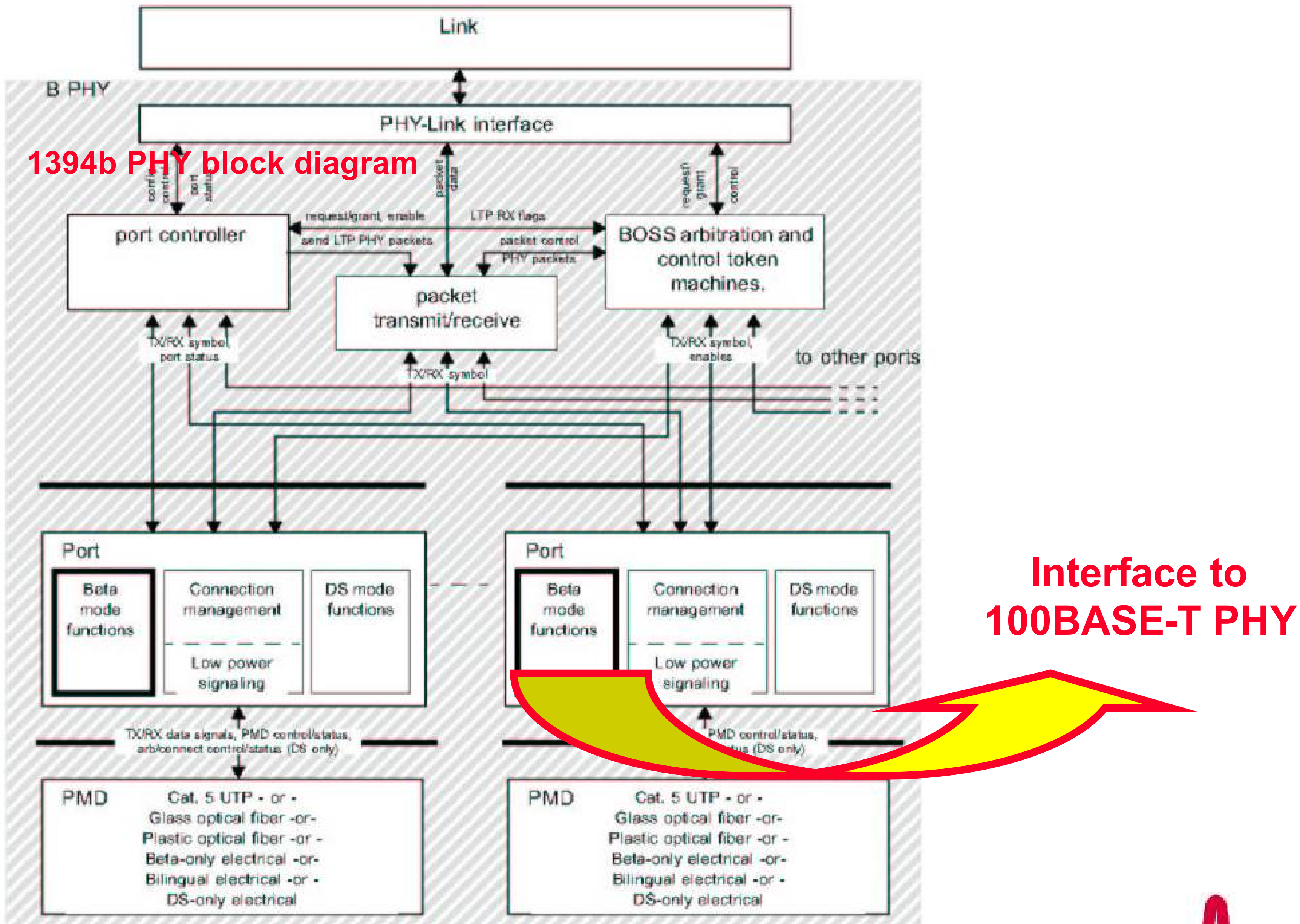
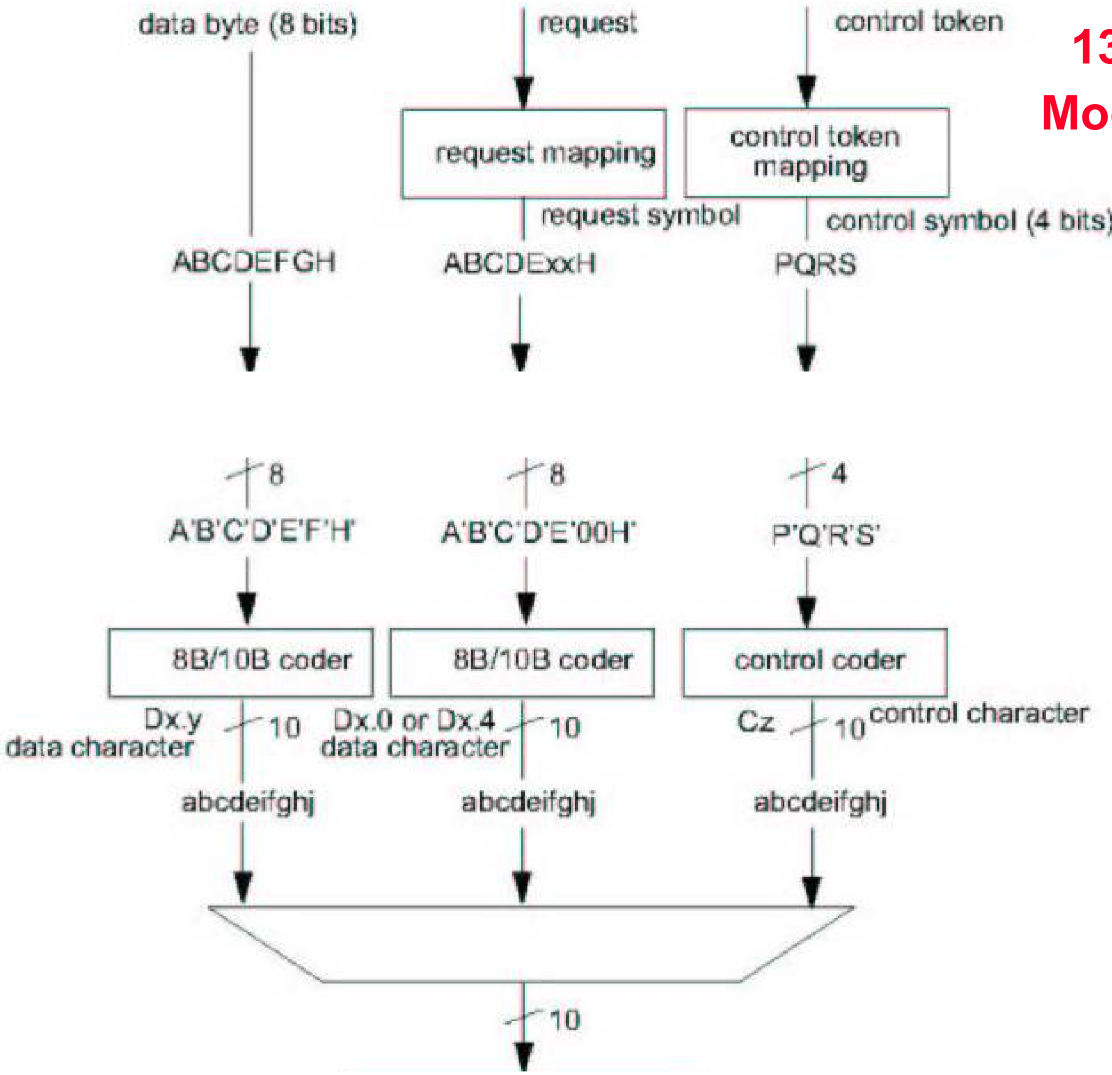


Figure 10-1—PHY master architecture (Data routing, arbitration and control interfaces in context)

1394b PHY beta mode functions
Modifications for 1000BASE-T PHY

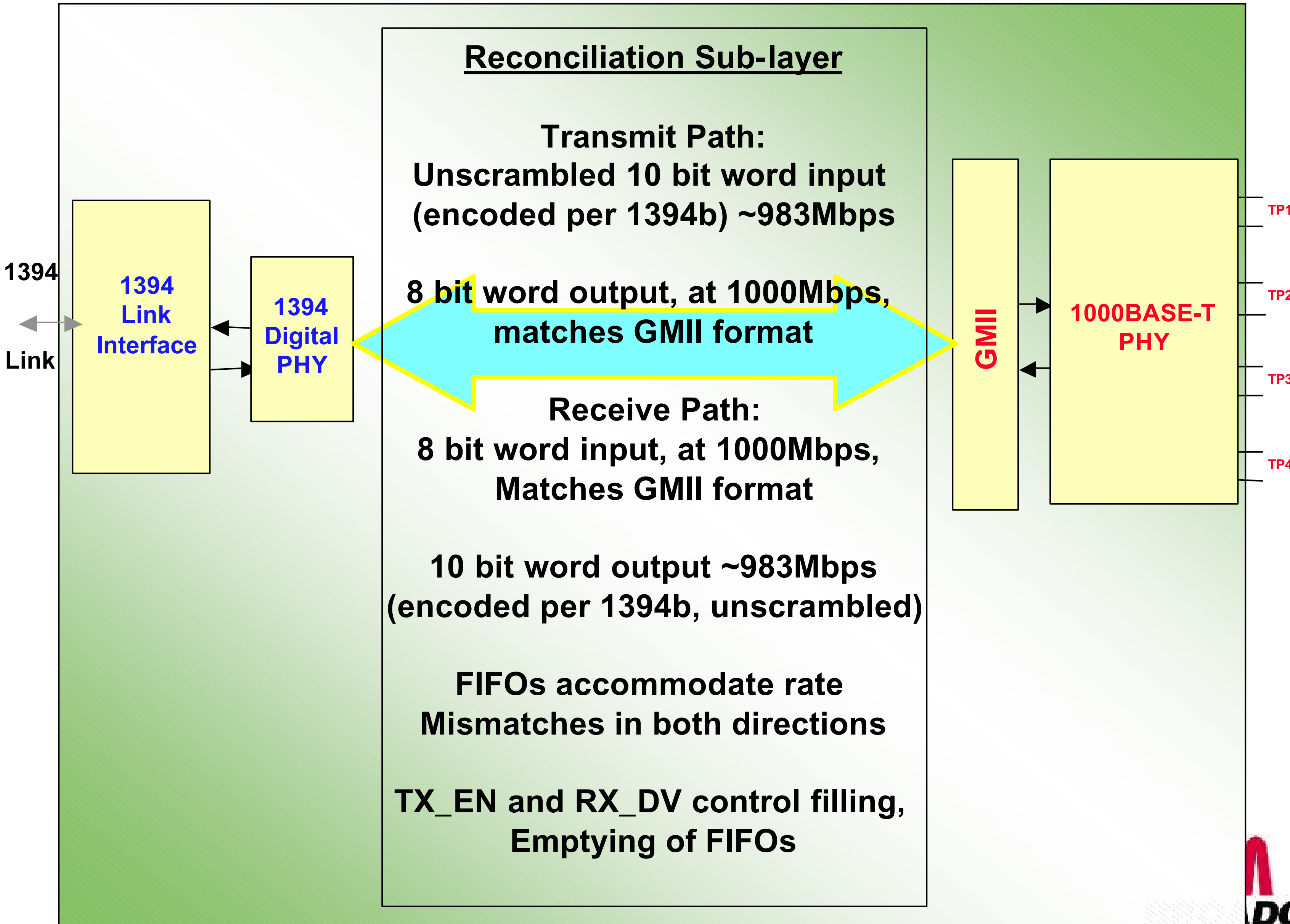


Scrambler is Bypassed

Serializer is Bypassed

Interface to Ethernet PHY is 10 bits parallel data, encoded

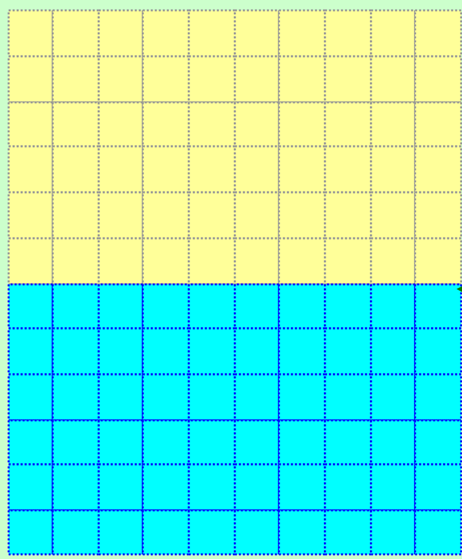
S800BASE-T Block Diagram



Reconciliation Sublayer: Transmitter

Encoded S800 data stream:
8B/10B encoded data + valid 1394b control symbols

Shift 10 bit word at 98.3MHz into FIFO



120 bit deep FIFO

Pointer

<u>Transmit Enable</u>

When pointer indicates FIFO reach FULL state, TX_EN goes HIGH

When pointer indicates FIFO reached EMPTY state, TX_EN goes LOW

TX_EN

8 bit bytes go directly to 1000BASE-T GMII

Reconciliation Sublayer: Transmitter

Transmit Sequence:

1. 1394b PHY begins transmitting to FIFO at 983Mbps
2. FIFO takes 80-88ns to reach FULL state
3. TX_EN goes HIGH, 1000BASE-T PHY begins transmitting data
4. FIFO empties while 1000BASE-T PHY transmits at 1000Mbps (faster than the incoming data)
5. When FIFO reaches EMPTY state, TX_EN goes LOW
6. 1000BASE-T PHY sends IDLE while FIFO is re-filling
7. After 80-88ns, FIFO is FULL, TX_EN goes HIGH, data transmission resumes

1394b PHY sends data + control symbols continuously at 983Mbps

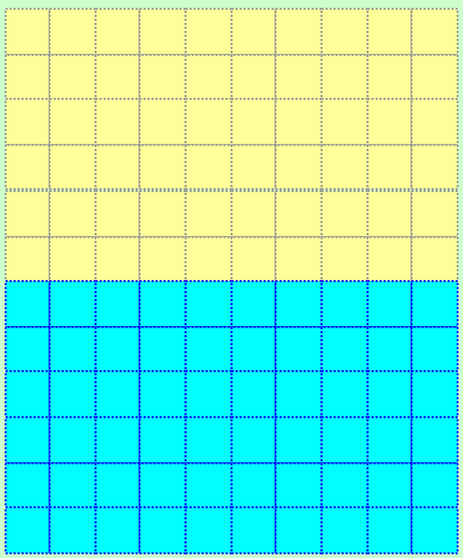
1000BASE-T PHY alternates between bursts of data and IDLE symbols

Reconciliation Sublayer: Receiver

8 bit bytes come directly to 1000BASE-T GMII

RX_DV

120 bit deep FIFO



Receive Data Valid

When RX_DV is LOW (IDLE) no data is loaded into FIFO

When RX_DV is HIGH, valid data is loaded into FIFO

Encoded S800 data stream:
8B/10B encoded data + valid 1394b control symbols

Shift 10 bit word at 98.3MHz out of FIFO

Reconciliation Sublayer: Receiver

Receive Sequence:

1. 1000BASE-T receives IDLE, no data is loaded into FIFO
2. When 1000BASE-T receives data, RX_DV goes high
3. FIFO fills with data from 1000BASE-T at 1000Mbps
4. FIFO empties data to 1394b PHY at 983Mbps
5. Periodic IDLE patterns allow FIFO to empty, in order to prevent overflowing

1000BASE-T PHY alternates between bursts of data and no data (no input to FIFO)

1394b PHY receives data + control symbols continuously at 983Mbps

Added Delay Times

Approximate latencies	ns
Transmit Reconciliation Sublayer	90
1000BASE-T transmitter (GMII to RJ-45)	85
100 meters UTP prop delay	550
1000BASE-T receiver (RJ-45 to GMII)	245
Receive Reconciliation Sublayer	30
Total added latency	1,000

- Total delay is ~1us
- Added device latency ≃ 100m cable propagation delay

Supporting 1394b S100 on UTP as defined

4.4.2 CAT-5 UTP (ISO/IEC 11801 ch. 7)

CAT-5 is low cost, easily installed and the materials are readily available. CAT-5 is well known because of its use in the Ethernet standard.

This standard uses CAT-5 in a way that is compatible with typical 100BASE-T2 Ethernet cable plant. Data are transmitted out on pins 1 and 2 and received on pins 7 and 8. This wiring matrix avoids erroneous connection to Ethernet equipment. Inputs and outputs to CAT-5 are transformer isolated. This standard supports auto-crossover for UTP. The electrical specifications are as other standards using CAT-5 (e.g., 1 V peak-peak binary signaling). By requiring adaptive equalization in the receiver, this standard achieves a maximum CAT-5 operating length of 100 meters at S100. Higher speeds are not defined by this standard.

Table 40-12—Assignment of PMA signal to MDI and MDI-X pin-outs

1000BASE-T Pin-out At RJ-45

Contact	MDI	MDI-X
1	BI_DA+	BI_DB+
2	BI_DA–	BI_DB–
3	BI_DB+	BI_DA+
4	BI_DC+	BI_DD+
5	BI_DC–	BI_DD–
6	BI_DB–	BI_DA–
7	BI_DD+	BI_DC+
8	BI_DD–	BI_DC–

10/100 uses pairs 1,2 and 3,6. Cross-over cable for 802.3 will not support S100

Full compatibility may require Re-specifying S800 pinout

Auto-Negotiating to S800BASE-T

- **Use existing 802.3 defined auto-negotiation (clause 28)**
- **1394 link partner could be identified by use of Next Page**
  - Other alternatives are possible, e.g., use of Technology Ability Field in first page of Fast Link Pulse.
- **Requires coordination with IEEE 802.3 working group**

Auto-Negotiating to S800BASE-T

Next Page Message Code Field definitions

The Message Code Field of a message page used in Next Page exchange shall be used to identify the meaning of a message. The following table identifies the types of messages that may be sent. As new messages are developed, this table will be updated accordingly.

The Message Code Field uses an 11-bit binary encoding that allows 2048 messages to be defined. All Message Codes not specified shall be reserved for IEEE use or allocation.

Table 28C–1—Message code field values

Message Code #	M 10	M 9	M 8	M 7	M 6	M 5	M 4	M 3	M 2	M 1	M 0	Message Code Description
0	0	0	0	0	0	0	0	0	0	0	0	Reserved for future Auto-Negotiation use
1	0	0	0	0	0	0	0	0	0	0	1	Null Message
2	0	0	0	0	0	0	0	0	0	1	0	One UP with Technology Ability Field follows
3	0	0	0	0	0	0	0	0	0	1	1	Two UPs with Technology Ability Field follow
4	0	0	0	0	0	0	0	0	1	0	0	One UP with Binary coded Remote fault follows
5	0	0	0	0	0	0	0	0	1	0	1	Organizationally Unique Identifier Tagged Message
6	0	0	0	0	0	0	0	0	1	1	0	PHY Identifier Tag Code
7	0	0	0	0	0	0	0	0	1	1	1	100BASE-T2 Technology Message Code. 100BASE-T2 Ability Page to follow using Unformatted Next Page
8	0	0	0	0	0	0	0	1	0	0	0	1000BASE-T Technology Message Code. Two 1000BASE-T Ability Pages to follow using Unformatted Next Pages.
9.....	0	0	0	0	0	0	0	1	0	0	1	Reserved for future Auto-Negotiation use
......2047	1	1	1	1	1	1	1	1	1	1	1	Reserved for future Auto-Negotiation use

Requirements vs. Proposal

- At PHY/Link interface must appear to be standard 1394b PHY
- At GMII must appear to be standard 1000BASE-T PHY
- When network port negotiates to be 1394, must appear to be standard 1394b port connection to 1394 management software
  - Looks like network unconnected to Ethernet software
- When a network port negotiates to be Ethernet, must appear to be standard Ethernet connection to Ethernet management software
  - Looks like unconnected port to 1394 software

- Connection to 1000BASE-T goes thru 1394b PHY, is invisible to PHY/Link interface
- GMII interface is preserved. Practically, it may be an embedded interface
- Invisible to 1349b PHY/Link and above
- Meets requirements; Next Page can identify 1394 link partner

Requirements vs. Proposal

- Must support 1394b S100 as defined, and S800 using 1000BASE-T modulation
- Must support 10BASE-T, 100BASE-T, 1000BASE-T (full and half duplex) Ethernet
- Negotiation preference set at device endpoint (NOT at hub/switch/bridge) … e.g., Apple would prefer FireWire for Mac OS X, others may prefer alternate connections.
  - Or do we always prefer 1394?

- **S100 over UTP has different pair connection to RJ-45, which is incompatible with 802.3 cross-over. Compatibility may require re-spec'ing.**
- **Meets requirements**
- **Advertised ability (802.3 vs. 1394) can be set at either endpoint. 802.3 auto-negotiation allows nodes to select advertised abilities, but not "preference". Software can set the PHY to advertise the preferred technology first, then fall back to 2nd choice if no match on 1st choice.**