IEEE p1394c:
1394 with 1000BASE-T PHY Technology

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IEEE Working Group 1394c Charter

Bob Davis, Chair of the Microcomputer Standards Committee of the IEEE approved the formation of the 1394c study group on March 5, 2003, with the following statement:

"The group is chartered to investigate methods of running IEEE 1394 over up to 100 meters of UTP-5 by leveraging existing gigabit Ethernet PHY technology."

The 1394c working group was formally created by the IEEE NESCOM in September, 2003.

1394c Overview

What it is:

- A PHYsical layer addition to IEEE 1394
- “S800” data rates (~800Mbps)
- 100 meters of Category 5 UTP
- RJ-45, standard pinout
- Negotiation capabilities

What it is NOT:

- “1394 over Ethernet”
- “Ethernet over 1394
- Any packet encapsulation

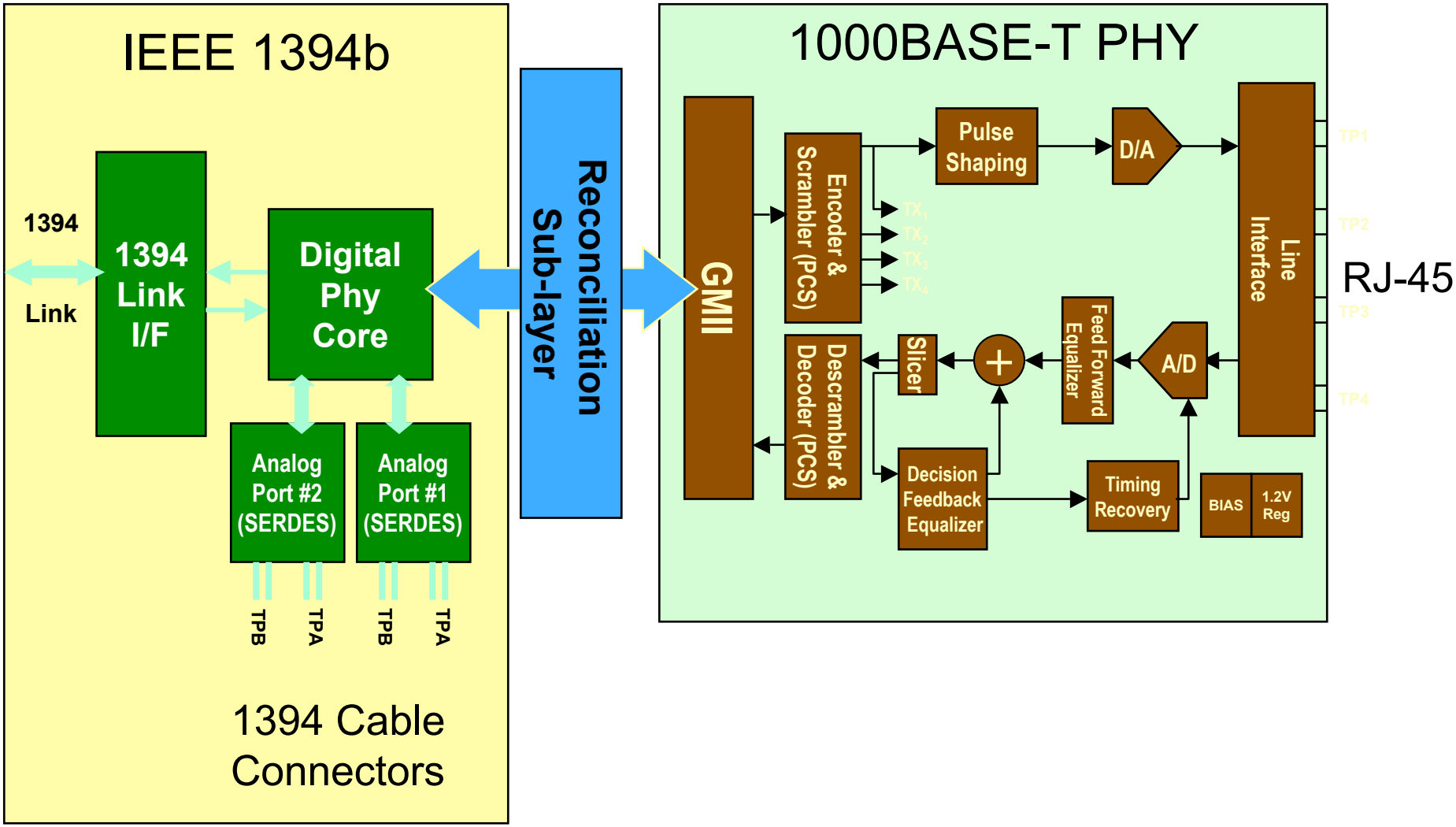
1394c Goals

- Leverage 1000BASE-T technogy to use Category 5 unshielded twisted pair cabling for S800 transport 1394b links
- Allow appropriate negotiation to be done so that the endpoints can select which protocols to be used:
  - 10BASE-T Ethernet
  - 100BASE-TX Ethernet
  - S100 1394b
  - 1000BASE-T Ethernet
  - S800 1394c
- Not interfere with any legacy 802.3 device

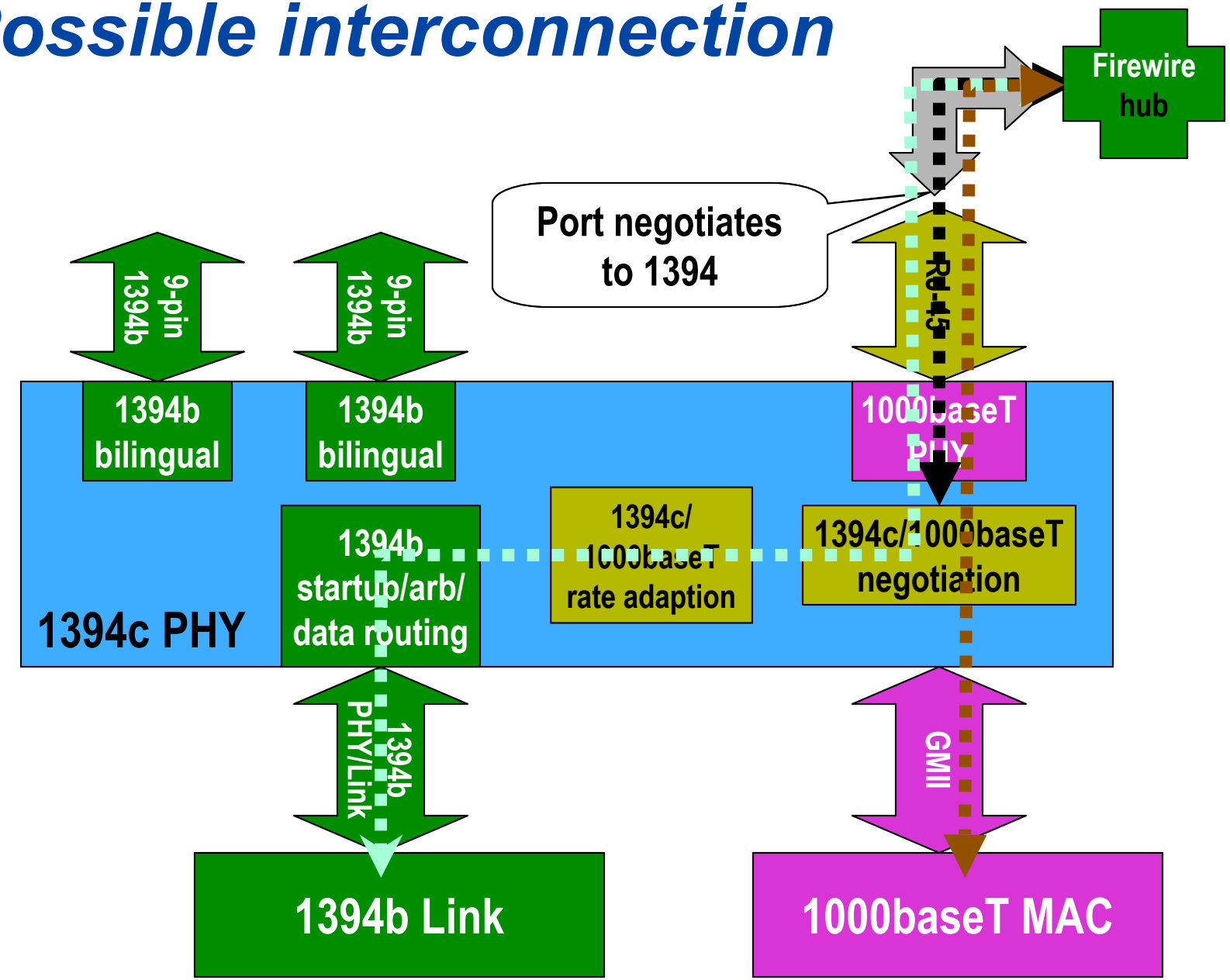
Goals (continued)

- Allow a simple hub-like-thing to be built that:
  - Connects all endpoints that negotiate to Ethernet using standard hub or switch technology
  - Connects all endpoints that negotiate to 1394 using standard PHY or 1394.1 technology
  - Bridges IP data between the two network domains
- For the end user, the objective is to have a single RJ-45 socket that is labeled “network”, and works for any kind of connection.

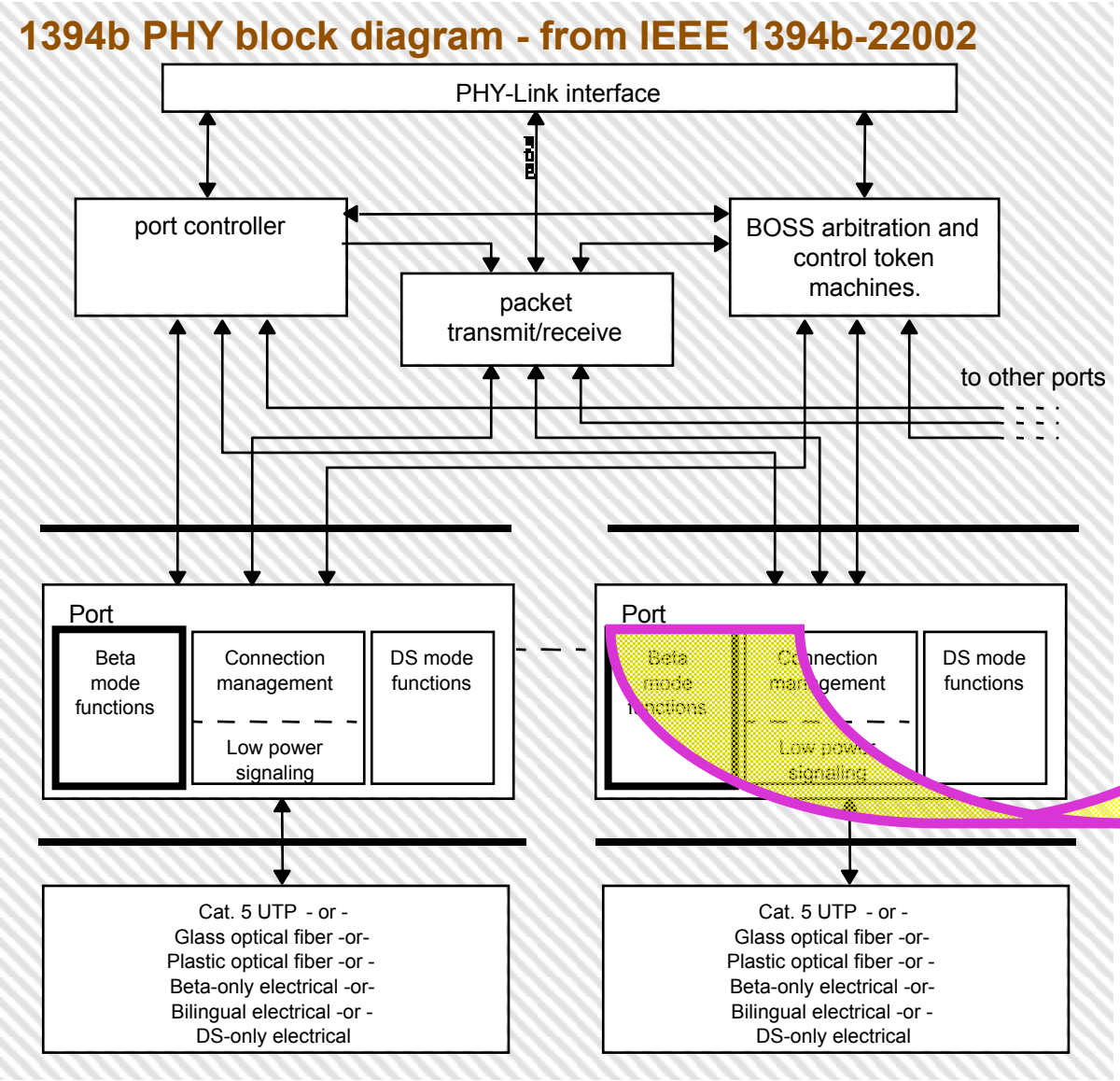
1394c
Conceptual Architectural



Possible interconnection

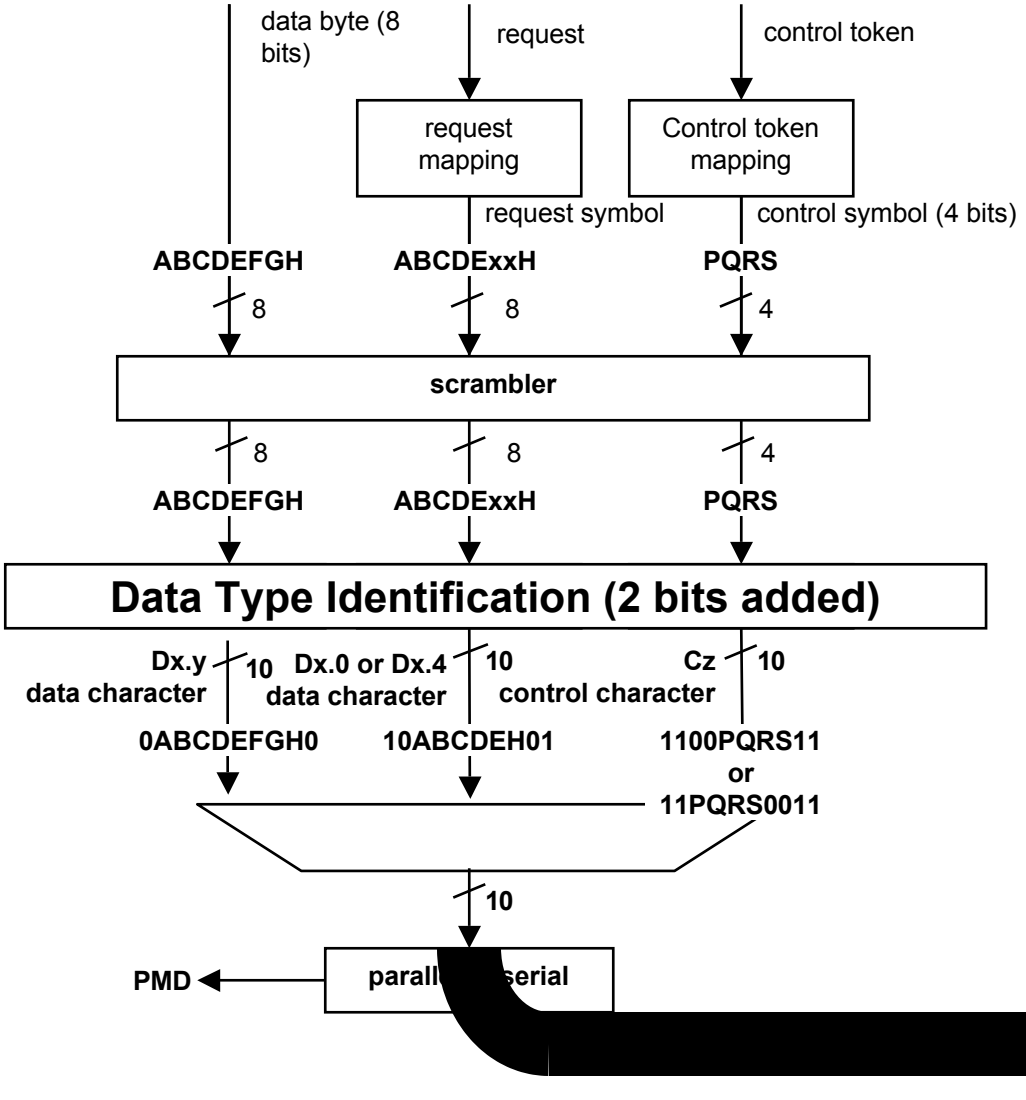


Where 1394c fits



Interface to 100BASE-T PHY

1394c modifications to 1394b PHY



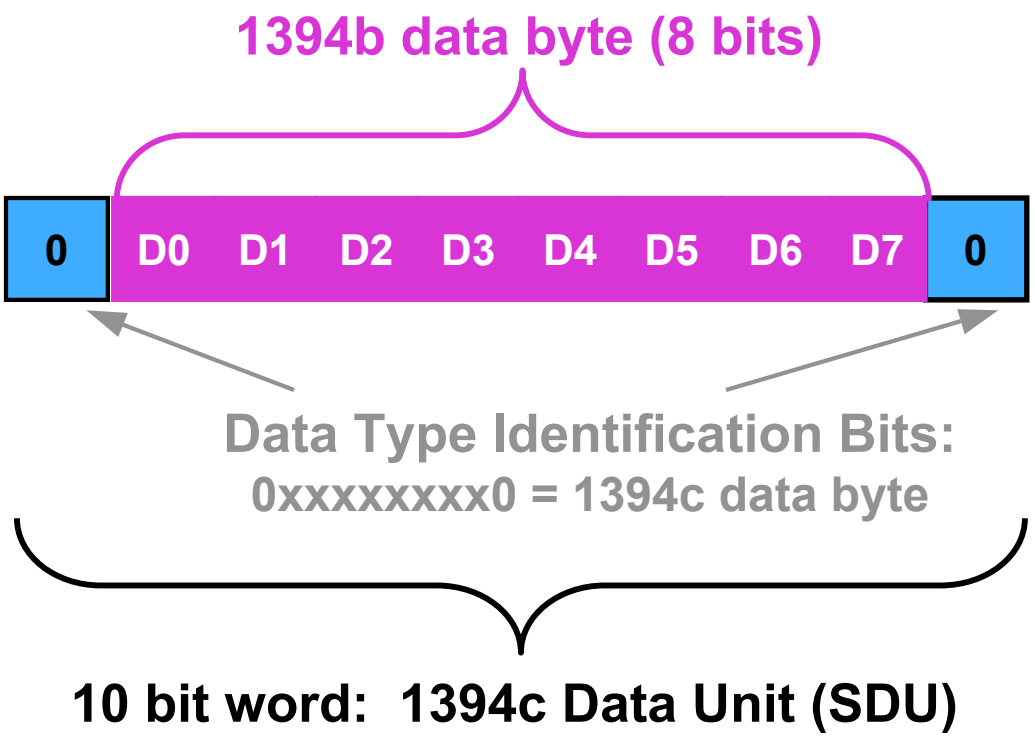
Scrambler is bypassed

Encoder is replaced by Data Type ID

Serializer is bypassed

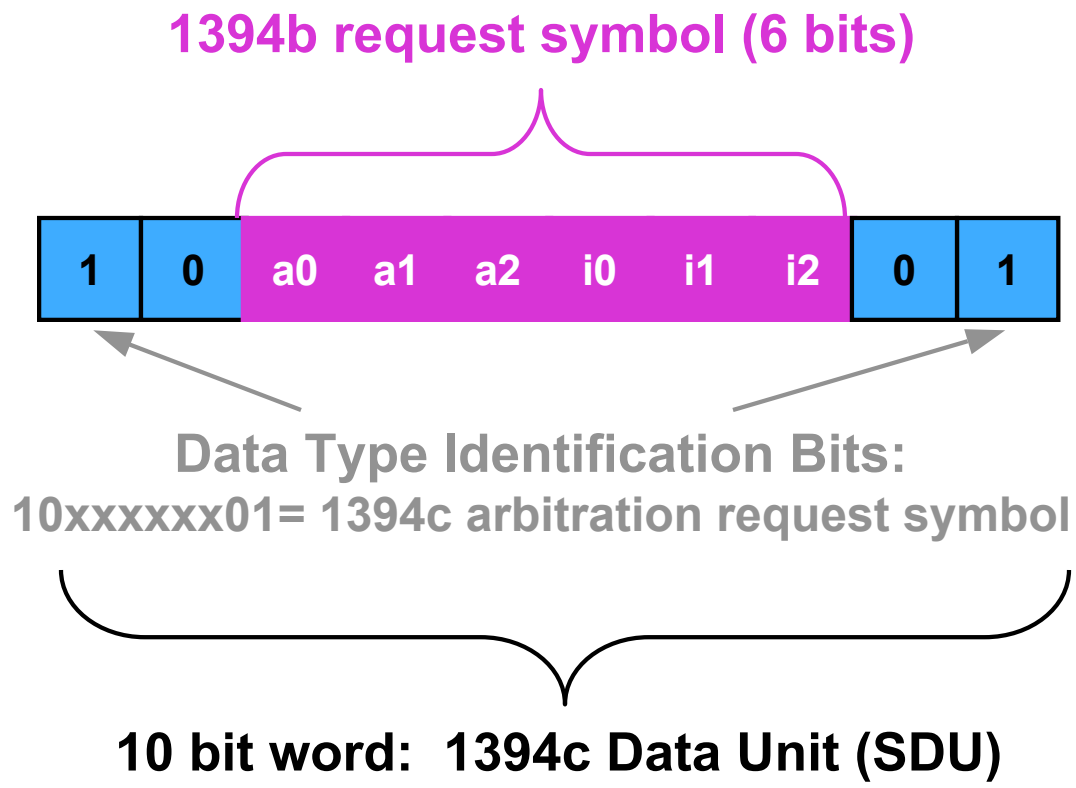
Data Type Identification

Data byte



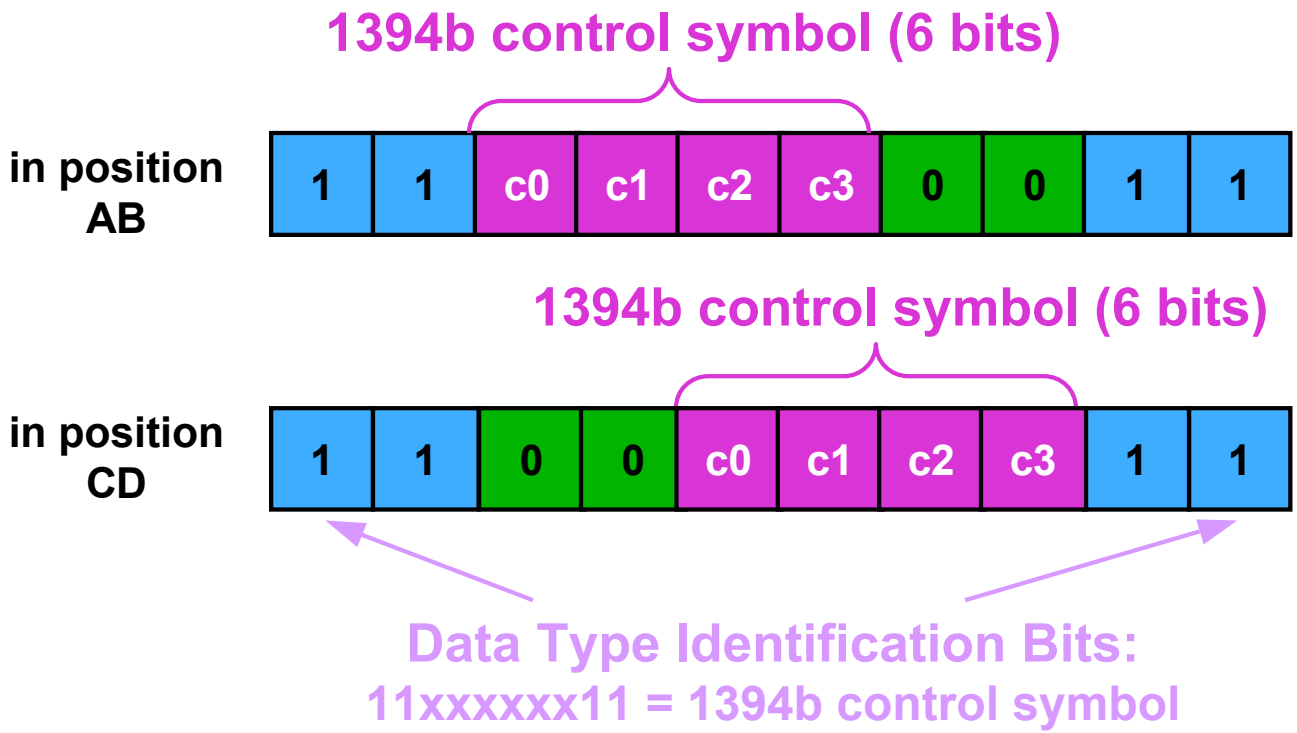
Data Type Identification

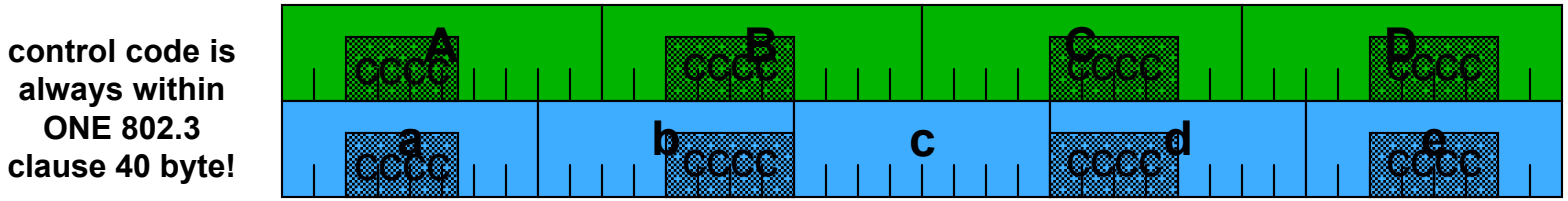
Request symbol



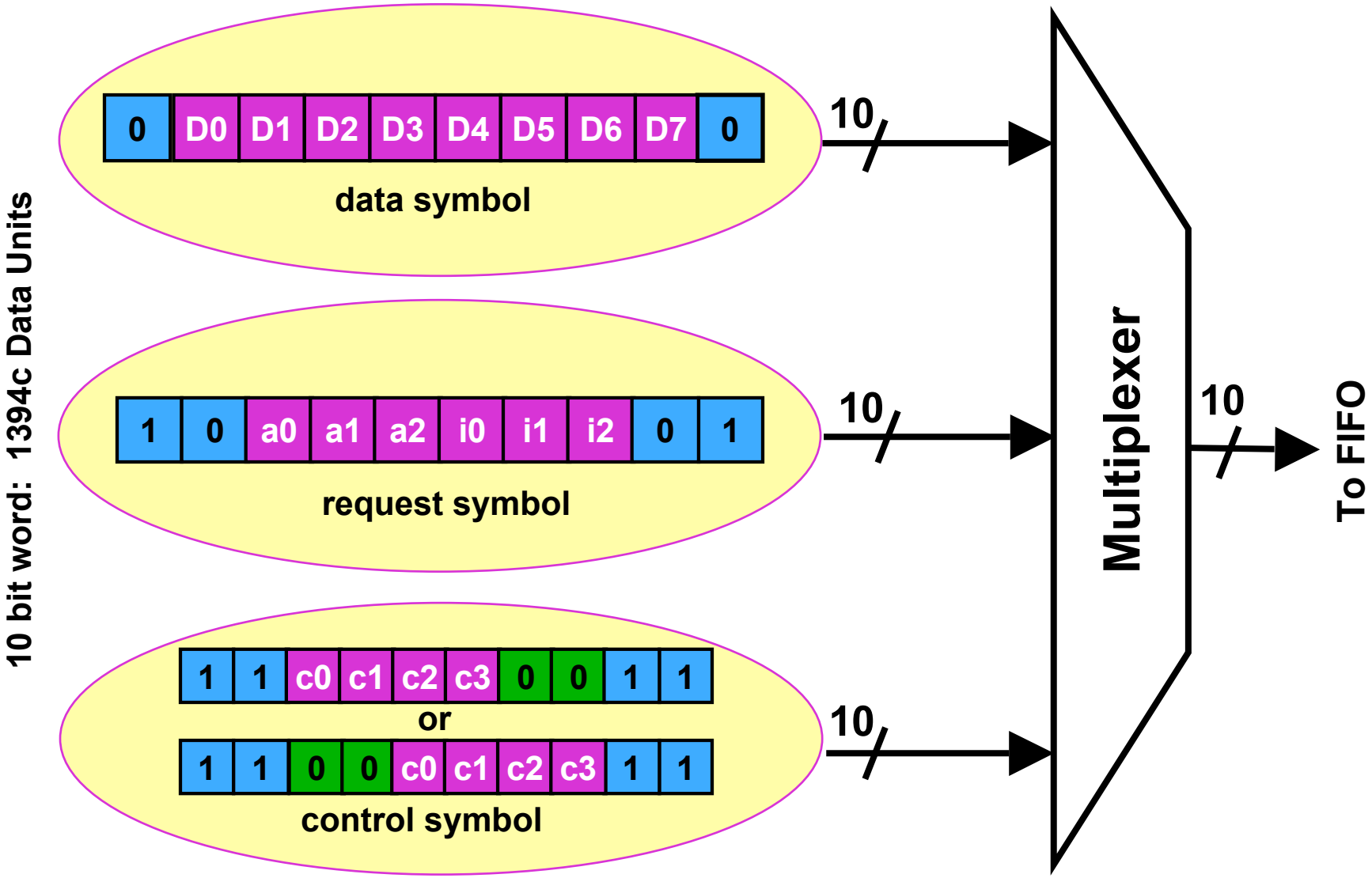
Data Type Identification

Control symbol

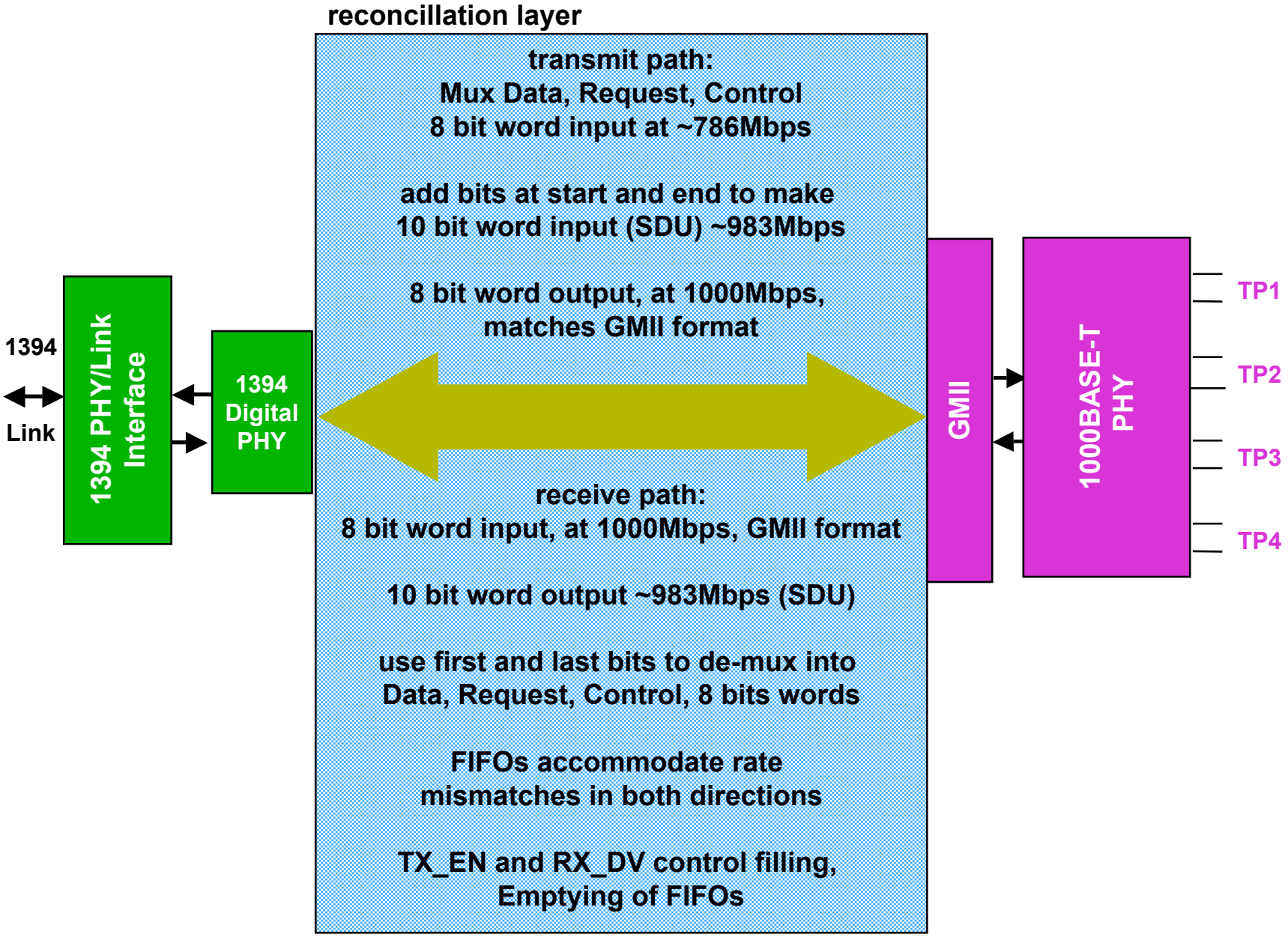




Mux SDUs into single stream



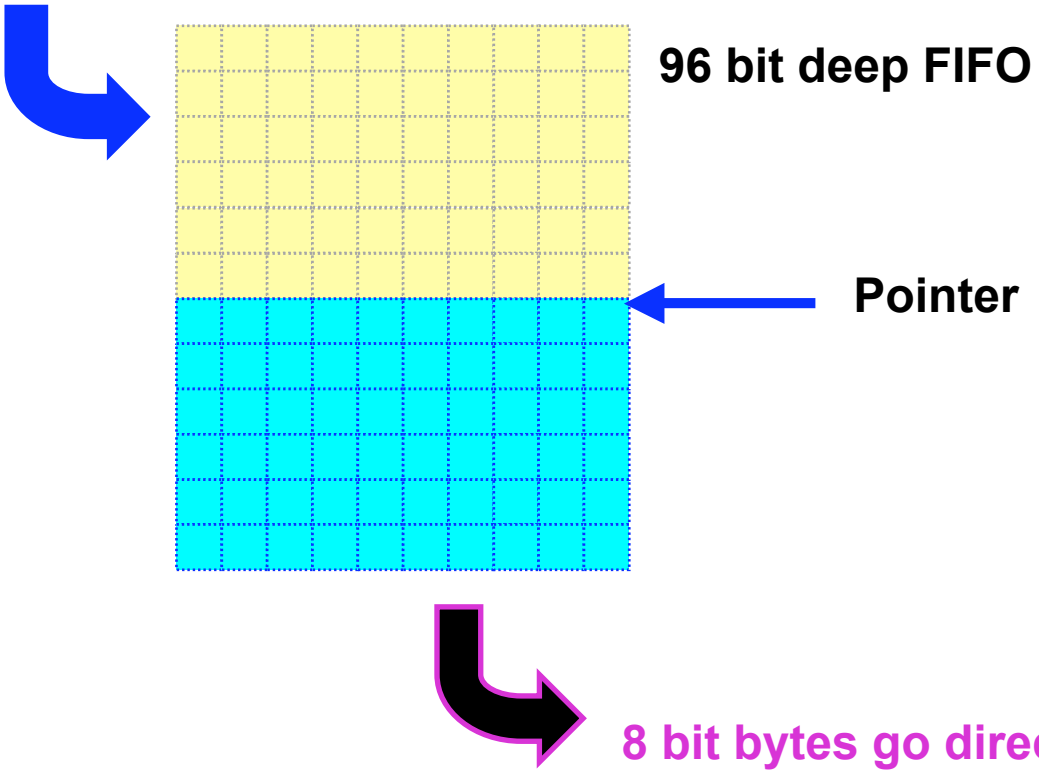
1394c Block Diagram



Reconciliation sublayer: transmitter

Encoded S800 data stream:
10 bit word SDU (1394c Data Unit)

Shift 10 bit word at 98.3MHz into FIFO



Transmit Enable

On startup, TX_EN goes HIGH when the pointer indicates the FIFO is full,

When pointer indicates FIFO is empty, TX_EN goes LOW

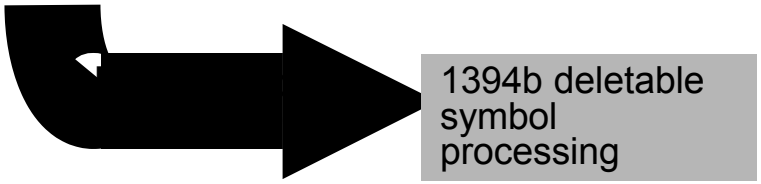
after startup, TX_EN goes HIGH when 11 IDLE symbols have been sent by 802 PHY

TX_EN

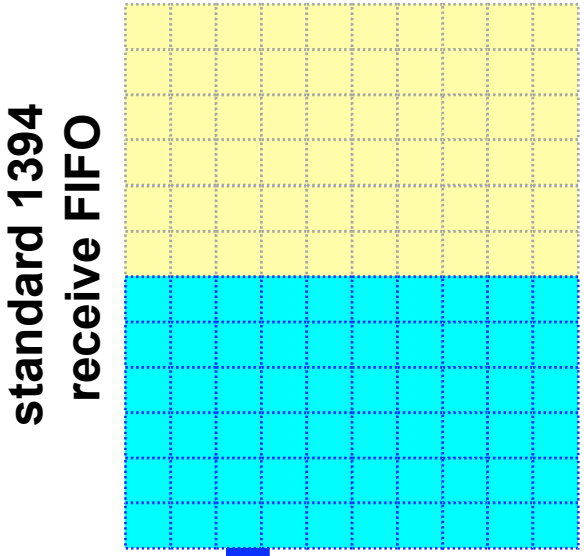
8 bit bytes go directly to 1000BASE-T GMII

Reconciliation Sublayer: Receiver

8 bit bytes come directly to 1000BASE-T GMII



RX_DV



Receive Data Valid

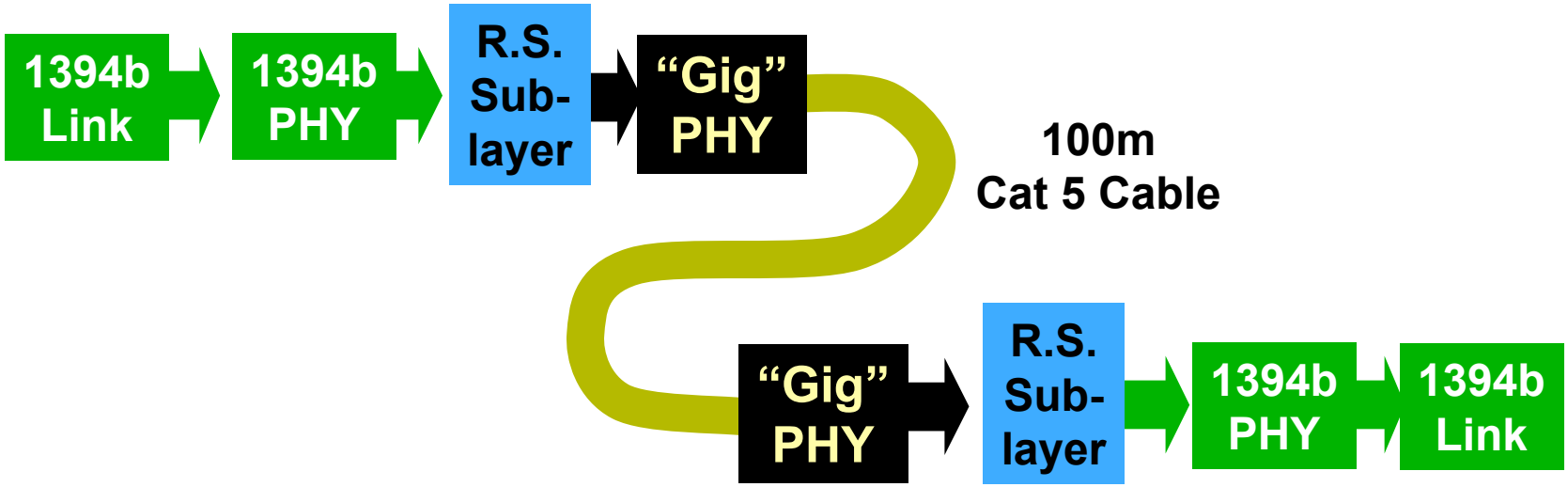
When RX_DV is LOW no data is loaded into FIFO… will happen when the standard burst of 11 IDLE symbols arrive

When RX_DV is HIGH, valid data is loaded into FIFO

Encoded S800 data stream:
10 bit word SDU (1394c Data Unit)

Shift 10 bit word at 98.3MHz out of FIFO

Link Equivalence



Reconciliation layer summary

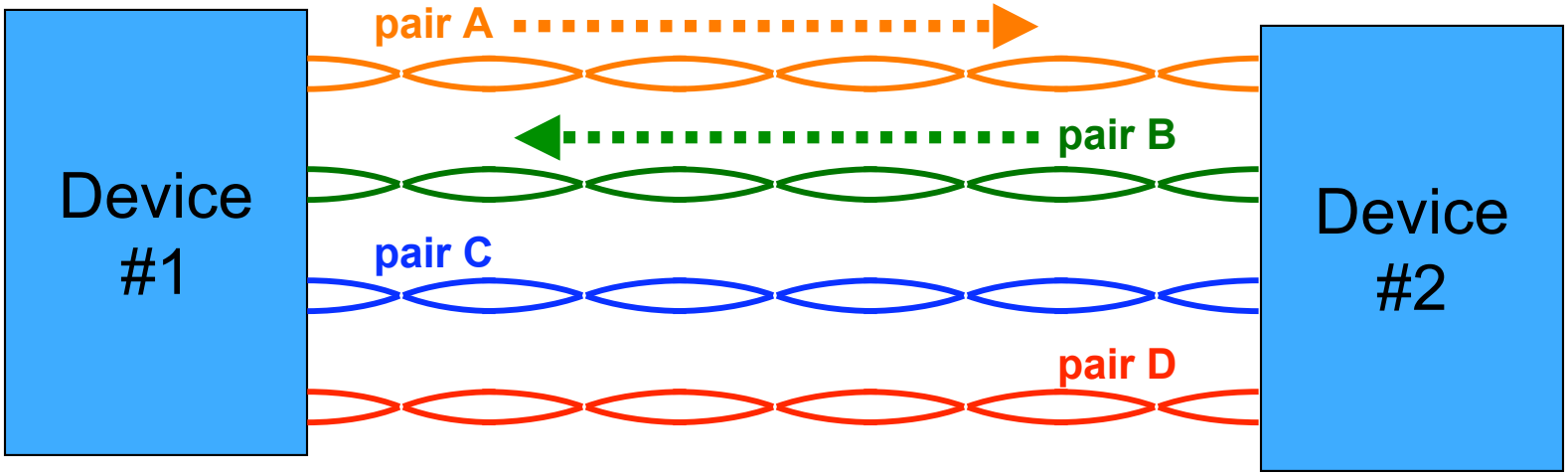
- Straight-forward design
- No exotic technology
- Actually simpler than standard 1394b beta port
  - No scrambler/descrambler
  - Minimal data encode/decode
- Some extra latency due to 1000base-T PHY encoding/decoding

1394c Negotiation

- 1394c uses the same physical cable at 1000BASE-T, 100BASE-TX, 10BASE-T
  - Same connector and pin-out
- Negotiation is required to allow 1394c devices to recognize each other, without interfering with 802.3 devices
- 1394c method allows a single RJ-45 to be used for both 802.3 or 1394c, depending on outcome of negotiation

802.3 clause 28 Auto-Negotiation

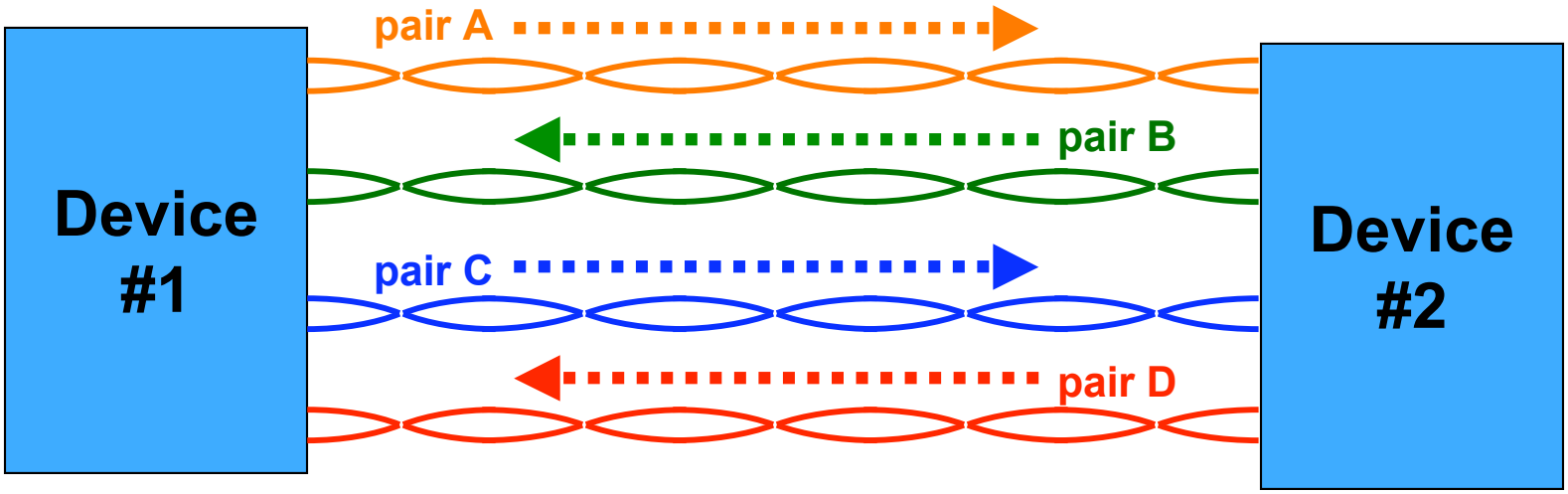
Pair A: RJ-45 positions 1 and 2
Pair B: RJ-45 positions 3 and 6



- Auto-Negotiation on Pairs A & B can establish 802.3 capabilities
- Pairs C & D are silent (no signal)
  - No traffic for 10BASE-T, 100BASE-TX
  - In 1000BASE-T, are used only after Auto-Neg is successful

1394c Negotiation

Pair C: RJ-45 positions 4 and 5
Pair D: RJ-45 positions 7 and 8



- Auto-Negotiation on Pairs A & B can establish 802.3 capabilities
- Pairs C & D are used in parallel to signal other capabilities

Maximum compatibility:
parallel negotiation

- 1394c gets a unique “selector code”
- 802.3 auto-negotiation does not allow more than one Selector Field to be advertised at one time
- 802.3 Auto-Negotiation is specified on wire pairs A & B
  - the state of pairs C & D is undefined in 802.3 Auto-Negotiation
- Run 1394c negotiation on pairs C & D in parallel with 802.3 AutoNegotiation

Summary of 1394c parallel negotiation

- run 1394c negotiation on pairs C & D
  - use unique 1394c Selector Field in Base Page
  - Set 10/100 values to zero (no capability)
    - **no possible confusion for any legacy device on pairs C & D**
  - **no** interaction with any 802.3 AutoNegotiation
- a device with only 1394c capability will only run negotiation on pairs C & D
- a device with both 802.3 and 1394c capability will run two negotiations in parallel on both pairs of wire
  - if Link Partner does not respond on pairs C & D, then 802.3 Auto-Negotiation will link successfully
  - if Link Partner also has 1394c advertised on pairs C & D, the 1394c will override results of 802.3 negotiation
  - both ends can see capabilities for both 802.3 and 1394c, and store for use by management

priority resolution Table 28B.3

- Insert 1394 S800 at top of table due to Isochronous capabilities at nearly the same speed
- New Table
  - 1394c
  - 1000Base-T full duplex
  - 1000Base-T half duplex
  - 100Base-T2 full duplex
  - 100Base-TX full duplex
  - 100Base-T2 half duplex
  - 100Base-T4 half duplex
  - 100Base-TX half duplex
  - 10Base-T full duplex
  - 10Base-T half duplex

1394c negotiation summary

- Implementing parallel negotiation for 1394c will allow easy interoperability with 1000Base-T and slower Ethernet devices
- there are no technical hurdles to implementing negotiation for 1394c
- The IEEE standards possibilities are well understood

1394c Status

- Working group meeting regularly since last summer
- Chair is Michael Johas Teener
  - mike@teener.com
  - Secretary is Les Baxter
    - les@baxter-enterprises.com
- working group website is http://grouper.ieee.org/groups/1394/c
- Draft 0.2 posted in April, 2004
  - Draft review in two weeks during 1394TA in San Francisco
- working group uses main 1394 email list:
  - Send “subscribe stds-1394” to majordomo@ieee.org
- 802.3 interested parties invited to participate