S800BASE-T
Standby Mode

June, 2003

1000BASE-T / S800BASE-T Characteristics

- **When a physical layer “LINK” is established, opposite ends are synchronized in a master / slave relationship**
  - Necessary for proper cancellation of Near End Crosstalk (NEXT) and Far End Crosstalk (FEXT)
  - Link start-up is based on values derived from auto-negotiation Next Pages
  - Link start-up time is significant
    - 1000BASE-T devices are allowed 750ms after completion of autonegotiation to establish lin
- **IDLE pattern is very similar to data**
  - All four pairs transmit and all four pairs receive simultaneously
  - IDLE pattern is a 3 level subset of the PAM5 coding on each of 4 pairs at 125MHz on each line
  - IDLE pattern consumes as much transmit power as data
  - Cessation of IDLE results in link drop
    - Followed by restart of auto-negotiation
    - Several seconds to re-establish link
- **No 1000BASE-T equivalent to “Standby” mode**

S800BASE-T Standby Options

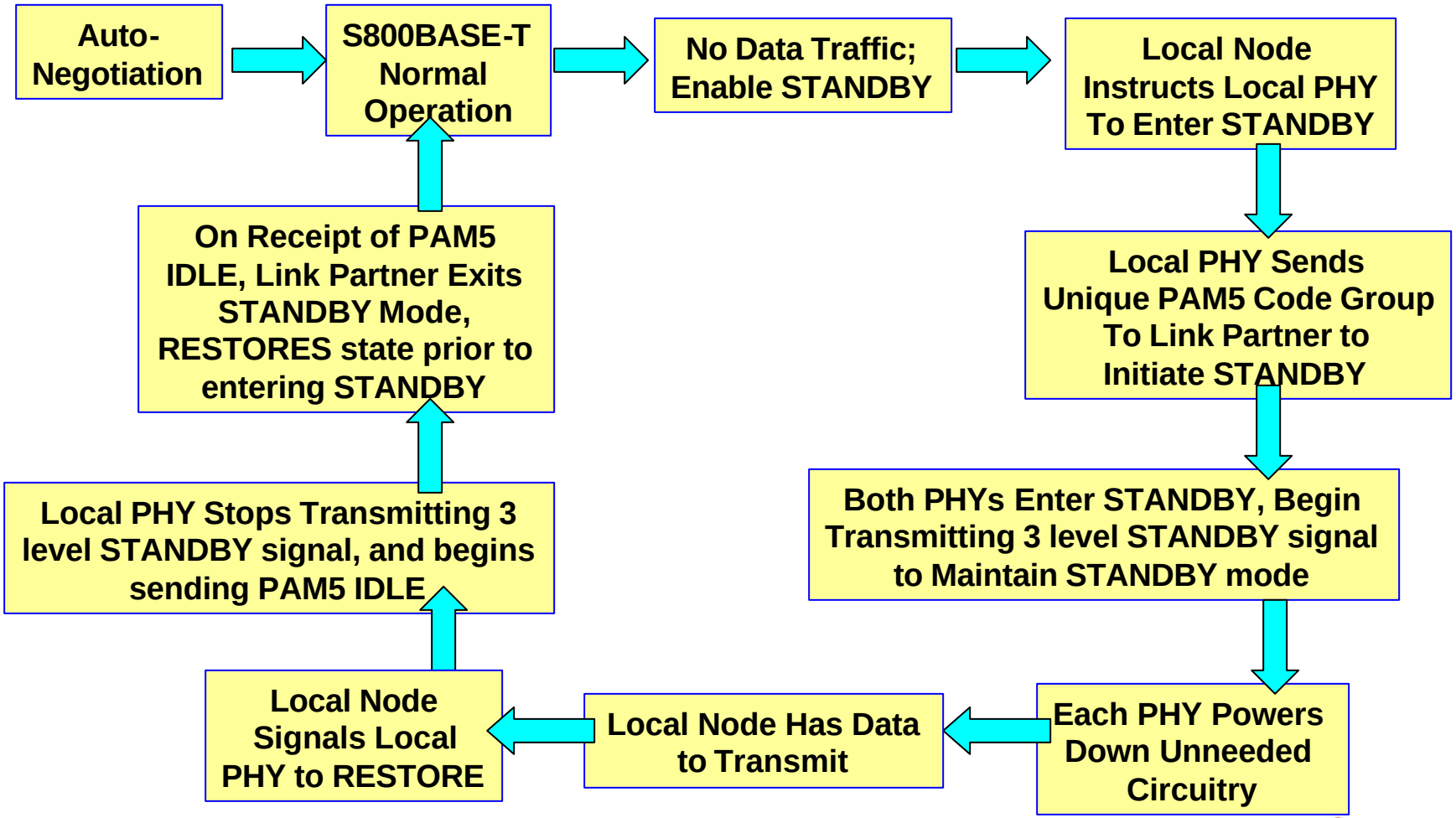
- **Option 1: Preserve end-to-end timing synchronized**
  - Keep enough TX/RX circuitry on to keep PLL's synch'd
  - Significant power reduction from normal idle, but not the lowest possible
    - Likely <100mW
  - Relatively quick time to RESTORE from Standby to normal operation (~10ms)

- **Option 2: Lowest power, drop synchronization**
  - Power off all Rx circuitry except a simple signal detect
  - Reduce TX to a low frequency "link pulse" equivalent
  - Potentially <50mW of power
  - RESTORE time may be perceptible (~ second)

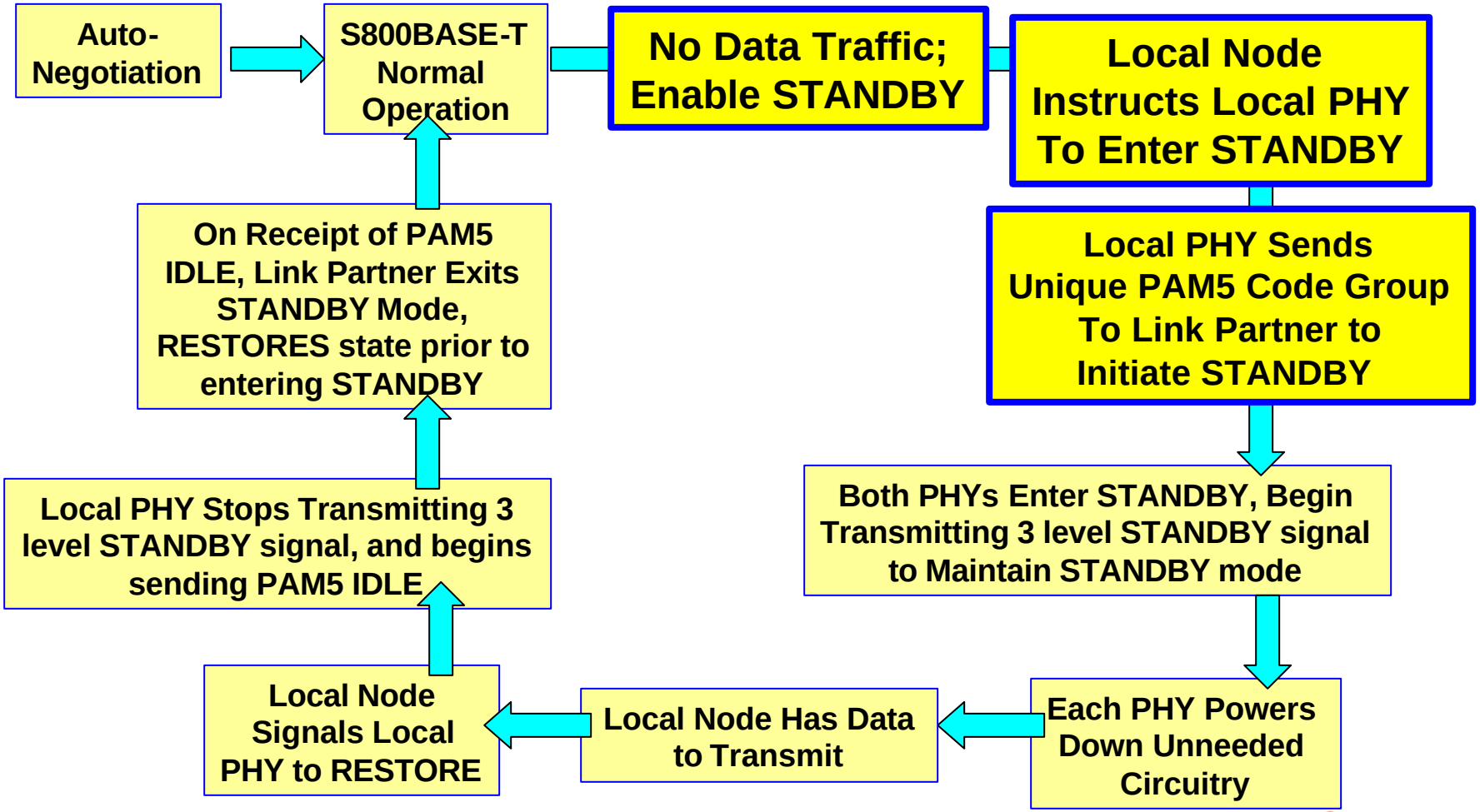
Option 1: Standby Mode Basic Functions

- **Initiation**
  - Command from local node
    - E.g., local node 1394b PHY layer receives a standby packet and instructs S800BASE-T sublayer to enter standby
  - Standby Initiation Signal on the wire
    - Unique PAM5 Constellation symbols, currently unused
- **Standby**
  - Lower power mode
  - Some form of “link” must be maintained
    - Timing information and adaptive filter states maintained to bring up full operation quickly
    - Auto-negotiation parameters maintained
    - Ability to detect a cable disconnect
- **Restore**
  - Resume previous S800BASE-T operation
  - No repeat of auto-negotiation

Standby Mode: Proposed Method



Standby Mode: Proposed Method

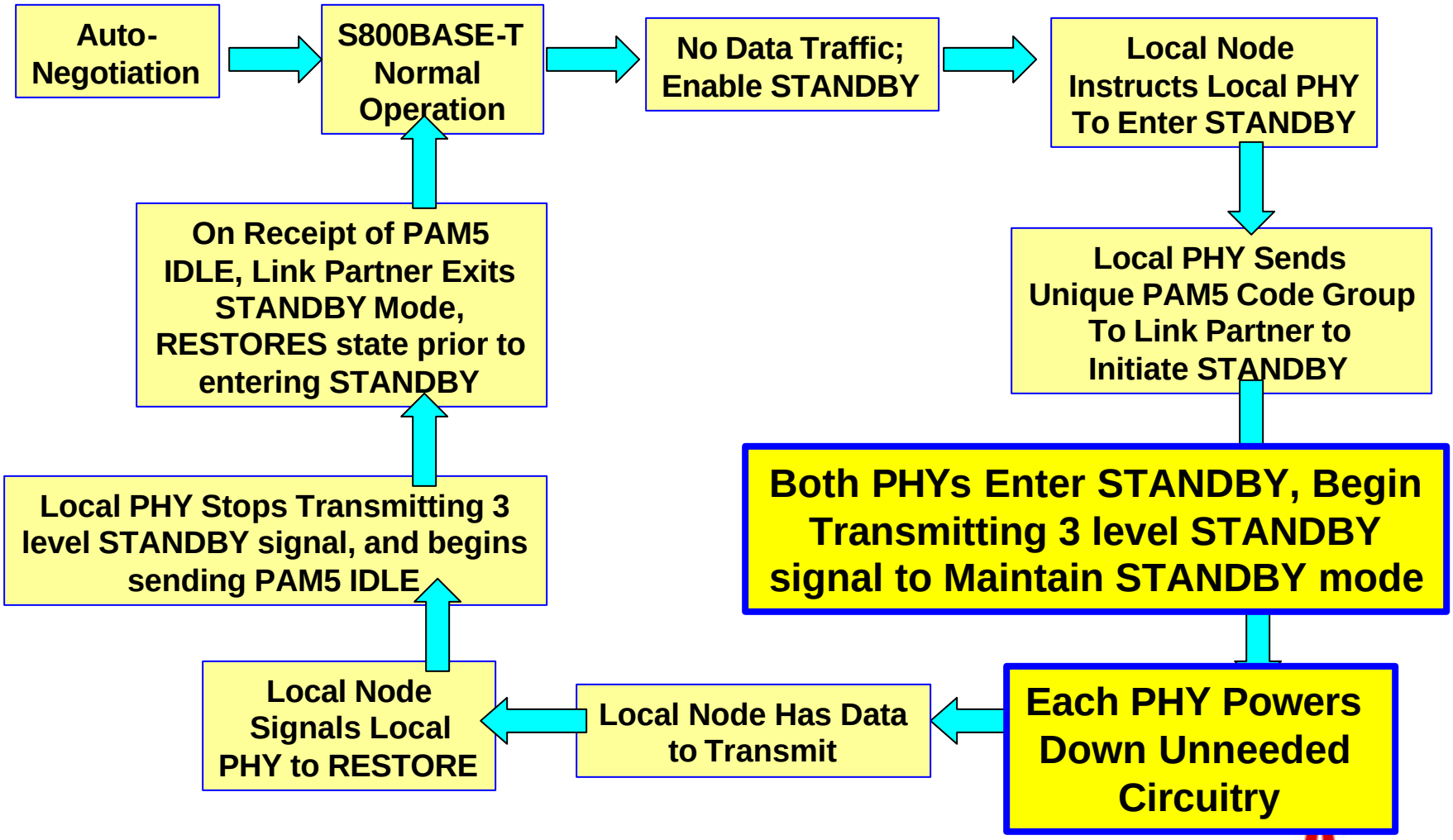


INITIATION

Local PHY Sends Unique PAM5 Code Group To Link Partner to Initiate STANDBY

- 1000BASE-T PAM5 Constellation code space includes ~500 symbols defined for data, IDLE, and ~100 “unused” symbols
- Propose assigning a sequence of one or more unused symbols to have the meaning “STANDBY INITIATION”
- On receipt of STANDBY INITIATION symbol (from the UTP wire), the link partner will enter STANDBY mode

Standby Mode: Proposed Method

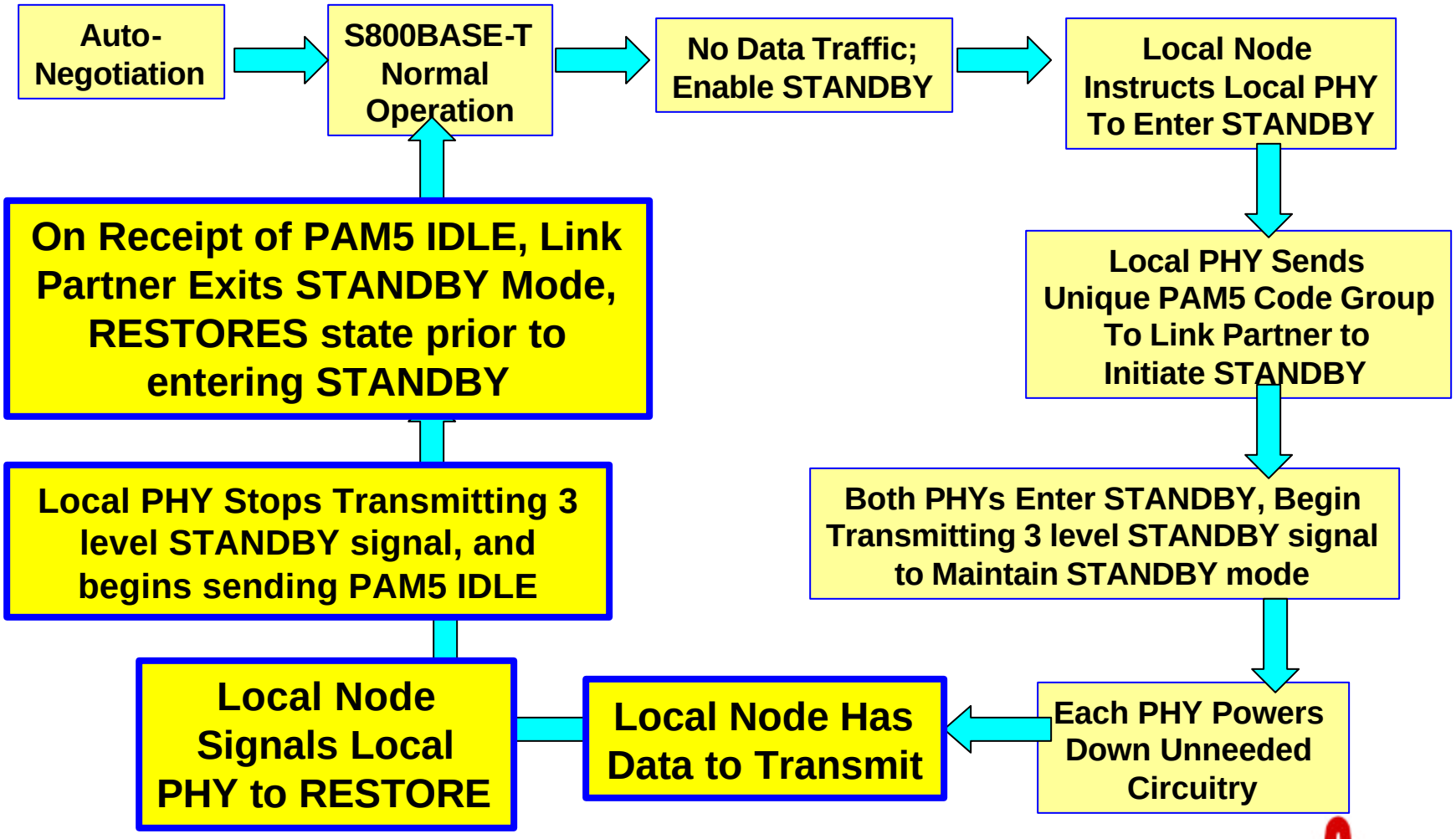


STANDBY MODE

Both PHYs Enter STANDBY, Begin Transmitting 3 level STANDBY signal to Maintain STANDBY mode

- **Each PHY powers down critical circuitry**
  - 3 of 4 Transmitters are powered off
  - 3 of 4 Receivers are powered off almost completely
    - NEXT / FEXT cancellers, adaptive filters, ADCs are powered off
      - Pads and signal detect functions remain powered
  - Code is changed from PAM5 constellation to a single pair, 3 level code:
    - **STANDBY SIGNAL** similar to IDLE code, but on 1 pair instead of 4
    - Allows phases of each channel's phase recovery circuit to remain locked
  - Power reduced by >80%, to <100mW (implementation specific)
- **STANDBY SIGNAL allows:**
  - Detection of physical disconnect
    - e.g., cable pulled out of connector, link partner loses power
  - Synchronization to allow quick restore to S800BASE-T IDLE /data

Standby Mode: Proposed Method



RESTORE

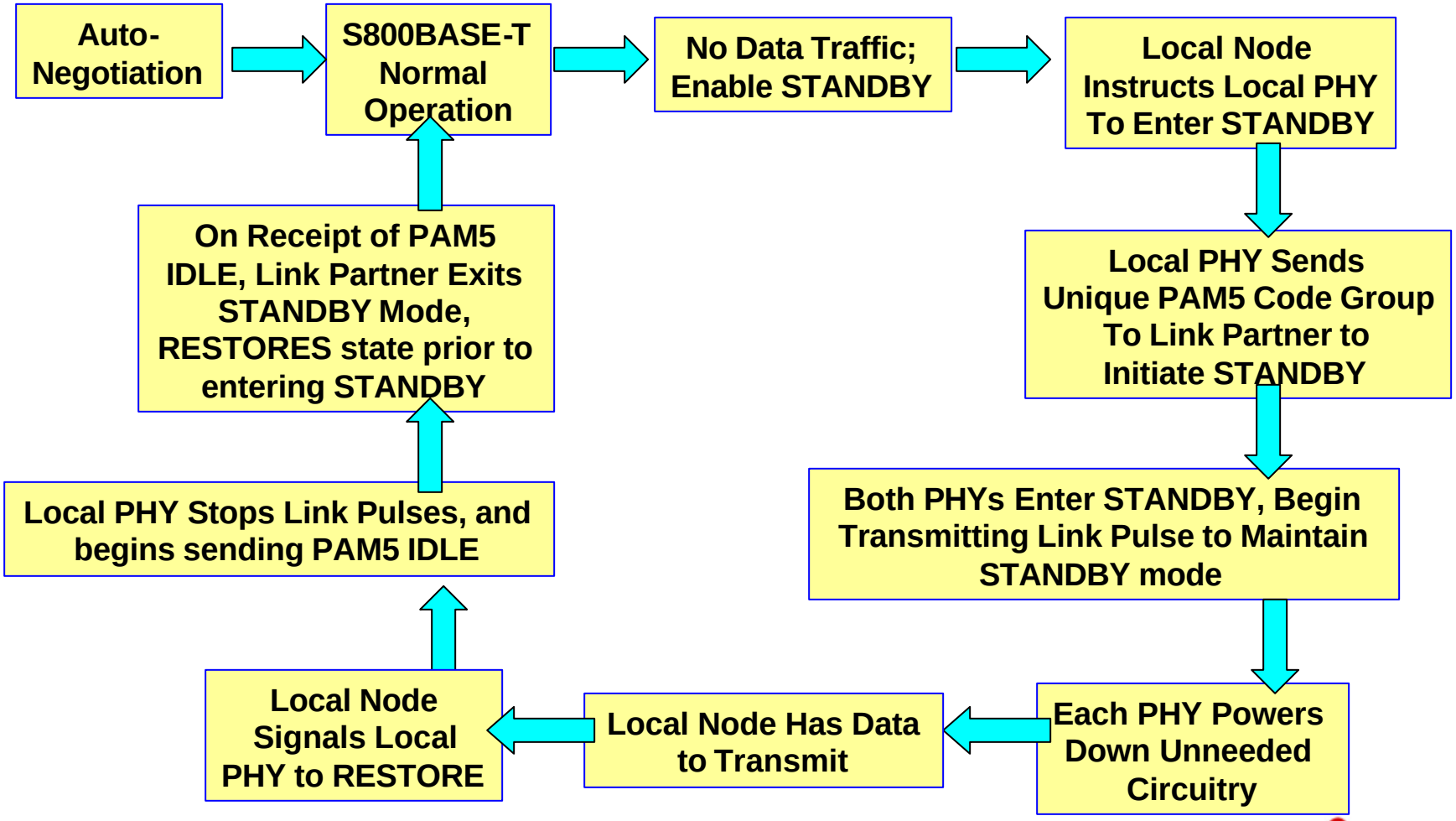
- Local Node Has Data to Transmit
- Local Node Signals Local PHY to RESTORE
- Local PHY Stops Transmitting 3 level STANDBY signal, and begins sending PAM5 IDLE
- On Receipt of PAM5 IDLE, Link Partner Exits STANDBY Mode, RESTORES state prior to entering STANDBY

- PHY PLLs aligned by STANDBY SIGNAL to allow quick return to S800BASE-T IDLE
  - Receive pairs Signal Detect function will sense activity on pairs 2, 3, 4, and power up full receive functions
- All parameters from initial auto-negotiation are preserved
- ~10ms to transition from STANDBY to IDLE, and be ready for data transmission and reception

Option 2: Standby Mode Basic Functions

- **Initiation**
  - Command from local node
    - E.g., local node 1394b PHY layer receives a standby packet and instructs S800BASE-T sublayer to enter standby
  - Standby Initiation Signal on the wire
    - Simple link pulses: 100ns pulse, ~16ms spacing
      - Low frequency
- **Standby**
  - Lower power mode
  - Some form of "link" must be maintained
    - Timing information lost, adaptive filter states lost
    - Auto-negotiation parameters maintained
    - Ability to detect a cable disconnect
- **Restore**
  - Resume previous S800BASE-T operation
  - No repeat of auto-negotiation
  - Must re-synch clocks

Standby Mode: Proposed Method 2



STANDBY MODE Option 2

Both PHYs Enter STANDBY, Begin Transmitting Link Pulses to Maintain STANDBY mode

- **Each PHY powers down critical circuitry**
  - 3 of 4 Transmitters are powered off
  - **4** of 4 Receivers are powered off almost completely
    - NEXT / FEXT cancellers, adaptive filters, ADCs are powered off
      - Pads and signal detect functions remain powered
  - Code is changed from PAM5 constellation to a single pair, 2 level low frequency code:
    - **STANDBY SIGNAL** similar to 10BASE-T IDLE code, on 1 pair
      - **100ns pulses, ~16ms spacing**
    - Clocks lose synchronization
  - Power reduced by >90%, to <100mW (implementation specific)
- **STANDBY SIGNAL allows:**
  - Detection of physical disconnect
    - e.g., cable pulled out of connector, link partner loses power

RESTORE

- Local Node Has Data to Transmit
- Local Node Signals Local PHY to RESTORE
- Local PHY Stops Transmitting 3 level STANDBY signal, and begins sending normal link pulses

- On Receipt of NLPs, Link Partner Exits STANDBY Mode, RESTORES state prior to entering STANDBY

- Receive pairs Signal Detect function will sense activity on pairs 2, 3, 4, and power up full receive functions
- All parameters from initial auto-negotiation are preserved
- 750ms to transition from STANDBY to IDLE, and be ready for data transmission and reception

Note: 1000BASE-T link start-up assumes somes coordination based on the conclusion of autonegotiation. When exiting Standby, some additional synchronization handshake may be necessary

S800BASE-T Standby Options

- **Option 1: Preserve end-to-end timing synchronization**
  - Keep enough TX/RX circuitry on to keep PLL's synch'd
  - Significant power reduction from normal idle, but not the lowest possible
  - Relatively quick time to RESTORE from Standby to normal operation (~10ms)

- **Option 2: Lowest power, drop synchronization**
  - Power off all Rx circuitry except a simple signal detect
  - Reduce TX to a low frequency "link pulse" equivalent
  - Potentially <50mW of power
  - RESTORE time may be perceptible (~ second)

- **Trade-offs:**

Power consumption of Standby

vs.

Time required to exit Standby and Restore data transmission