EEE
Ultra Low Power Mode

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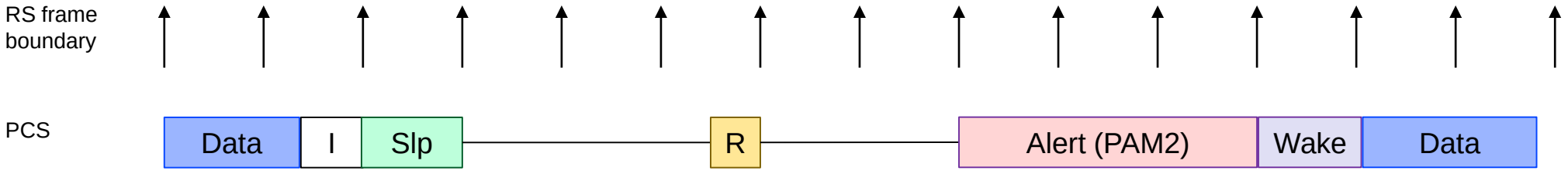
Ultra low speed channel

- A connection between an ECU and a camera in an automobile requires high speed communication in one direction and very sparse data transmission in the opposite
- Some implementations today use high speed LVDS transmission in the direction of camera for image transmission to the ECU and I2C in the opposite for transmission of camera commands. The I2C bus offers a very low power consumption.
- 802.3ch needs an offering of lowest possible power for transmission of occasional data from the ECU to the camera to compete with existing technology.

EEE

- Proposed EEE signaling in Graba/Benyamin presentations was as follows



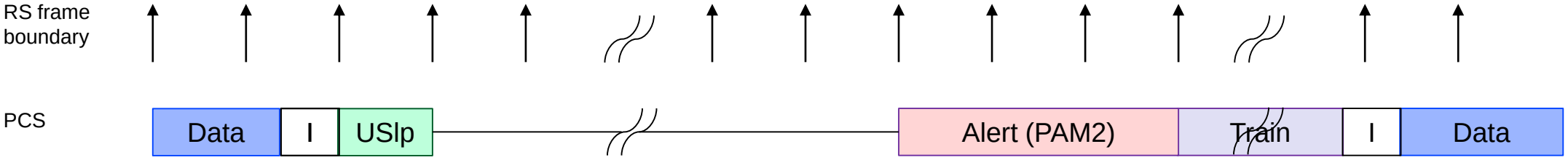
- While the transmission link from the ECU to the camera can use a fraction of normal transmission power, frequent refreshes are required which still consume power and may also prevent parts of the circuit from fully powering down due to time limitation.
- This proposal offers a way to further reduce power for EEE mode of operation when the data to be transmitted is sparse by entering into Ultra Low Power EEE mode.

Caveats

- The following Caveats apply
  - The ULP EEE mode only works in the direction of Slave transmit to Master Receive going quiet. This means that the port receiving quiets is not required to use clock recovery to lock to the link partner’s clock frequency. A master transmitter is not allowed to enter the ultra low power mode.
  - Coming out of Ultra low power may require full training and can take several milliseconds. As such it is only appropriate when data transmission is required very sparsely such as camera commands in an automotive environment (requires camera to be set as master).

Ultra Sleep

- Ultra sleep is required support when the phy supports EEE
- Much like SLEEP, a special code (USleep) is reserved to initiate Ultra Low power mode
- Once this mode is entered the link will go completely quiet (no refresh). Much more extensive circuitry power down can occur when a transmitter or receiver is in EEE Ultra Low Power mode as compared to EEE Low power mode with frequent refreshes.
- Once the transmitter has data to transmit, an alert is transmitted followed by a full training sequence. The training sequence consists of x uS of PAM2 signaling followed by y uS of PAM4 signaling. We have preliminary data that indicates this time may be as high as 30ms but need further study.



Effects on the system

- As mentioned, use of Ultra Sleep is only effective when the data transmission is very sparse. Assuming a refresh period equivalent to 2% of QR cycle, and another 1% for powering up the circuits, and assuming that under worst conditions, no new circuit can be shut down during Ultra sleep given the longer dormant period:
  - normal EEE would use 3% power continuously
  - ULP EEE would use zero, but wake up is 30ms
  - So if we transmit data less than once per 9 seconds, ULP would save power
- Mac changes
  - For Ultra sleep mode, the MAC must use an appropriate wait time before transmitting. Equivalent to EEE $T_{w\_sy\_tx}$ a new parameter will be dfined ($T_{w\_sy\_tx\_ULP}$) with a value of TBD (possibly 30ms). When in Ultra Low Power EEE mode, the MAC must use this new parameter for the delay.

Thank you.