Technical Considerations and Possible Solution Sets for EEE

IEEE 802.3 Energy Efficient Ethernet Study Group
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Switching PHYs and Start-up

- Autonegotiation: 802.3 defines a standard compliant mechanism to switch between copper PHY types
  - Clause 28 autonegotiation
- PHY Control: 802.3 defines standard control actions, timing, and sequencing necessary to establish a link between two PHYs
  - Clause 40.4.2.4 (1000BT), 50.4.2.5 (10GBT)
- Any other means for switching between speeds and establishing a link will require a *enhancements to the standard*

Enhancing the Standard

- General agreement that standard autonegotiation + phy control requires too much switching time to be useful
  - This is the main reason for the existence of EEE
- To what extent is EEE willing to enhance the current standard to save power and reduce switching time ?
  - The answer most likely depends on “how much power” and “how much time”
  - Extent of modifications to the standard does not necessarily relate to extent of modifications to standard compliant PHYs
    - Ex: Reduce transmit voltage – simple tweak to PHY, big change to standard
  - The Task Force needs to solicit presentations which explore the relationship between power, switching time, and extent of enhancements to standard
  - The study group should not create objectives that unnecessarily limit the potential solution space

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Possible Categories of Solutions

1. **Standard Autoneg + startup ("Std Autoneg")**
   - aka, reset and re-establish at the new speed

2. **Skip unnecessary autoneg steps ("Fast AN")**
   - Speed, duplex, M/S resolution, etc are all established on first link up
   - No need to re-negotiate after an EEE speed change

3. **Skip unnecessary start-up steps ("Fast Start")**
   - Power backoff, precoder coefficient exchange, etc (10G)
   - Initialize filters, cancellers, control loops from last known state

4. **Switch between 802.3 PHY and subset PHY ("Subset PHY")**
   - Define lower power PHY as a subset of the higher speed standard PHY

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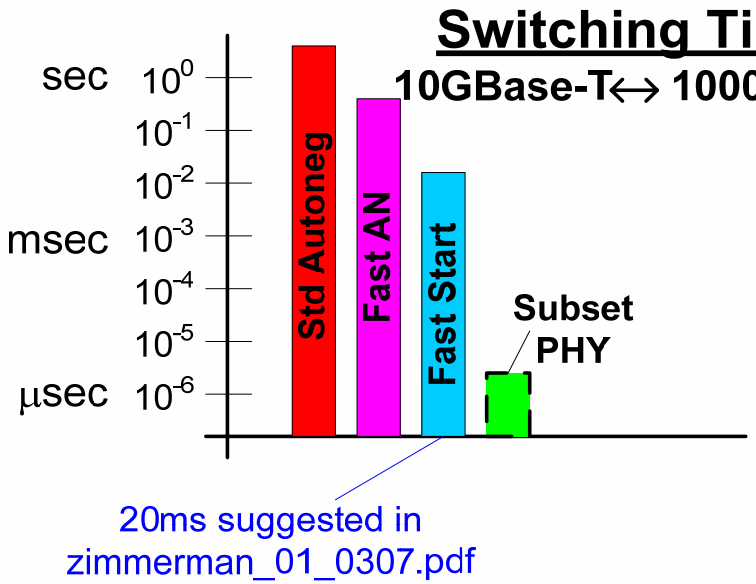
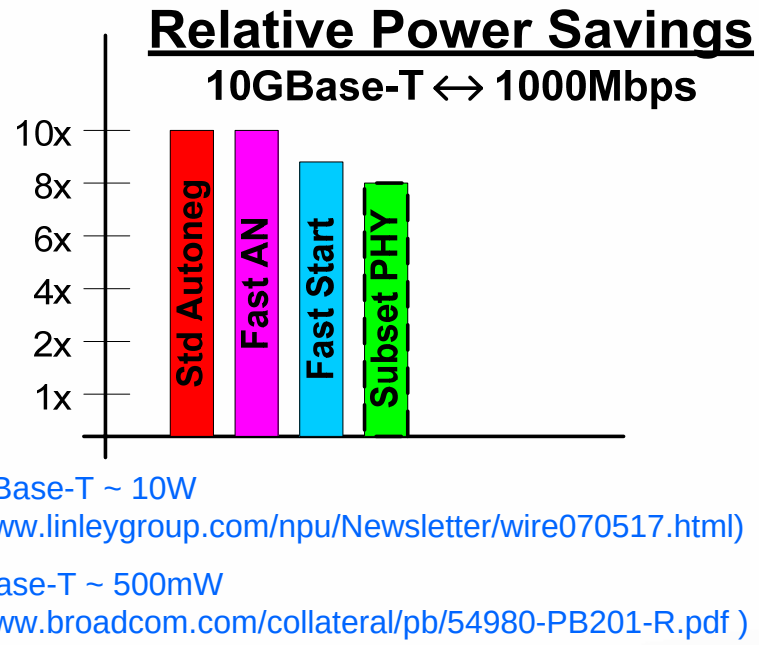
Comparison of Possible Solutions

- Assume 10GBase-T is the highest negotiated speed
- Speed and power of subset PHY are an early estimate of what's possible





- Power savings for various options is comparable
- Subset PHY offers potential to improve transition time by over 3 orders of magnitude
  - µS instead of mS

Comparison of Possible Solutions

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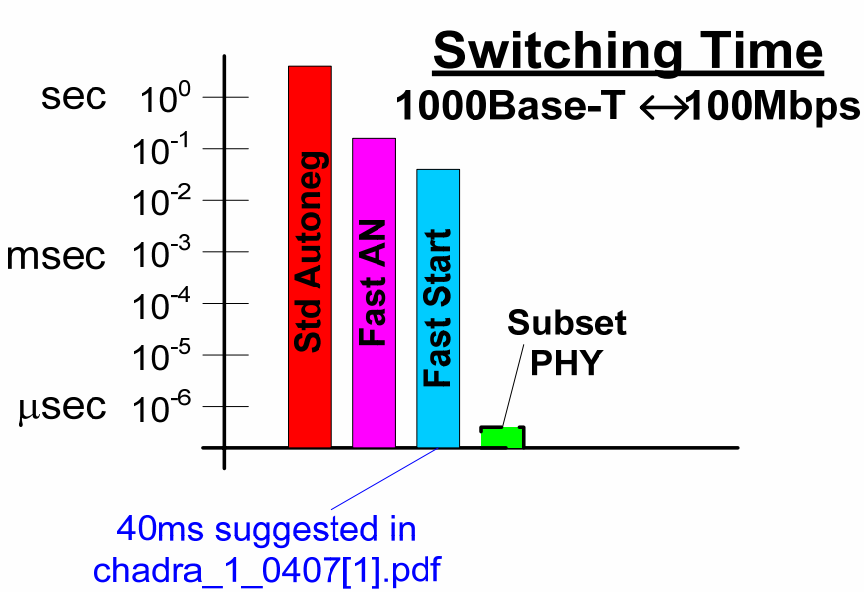

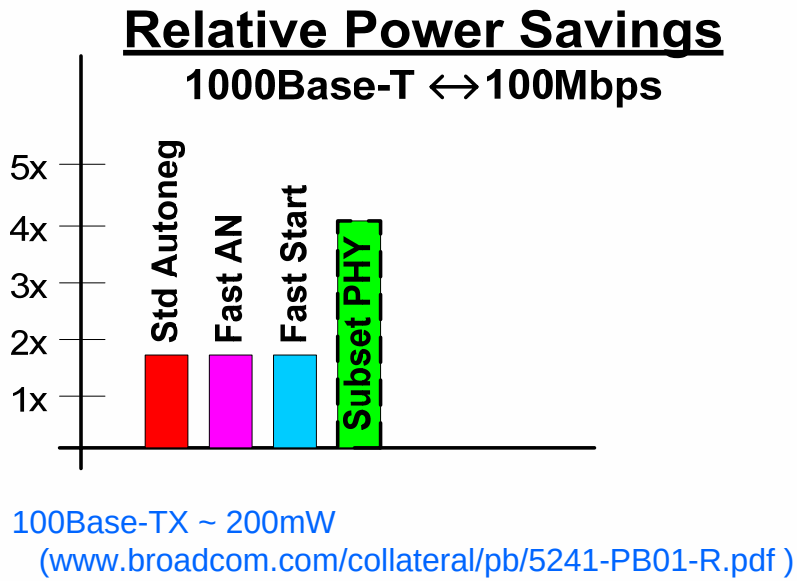

- Subset PHY is ~2x lower power
- Subset PHY offers potential to improve transition time by over 4 orders of magnitude
  - nS instead of mS

Summary

- **The currently defined standard method for changing data rates is too slow to be useful for EEE**
  - **The standard must be enhanced to allow for a more rapid change**
- **The best solution for EEE *may* be Rapid PHY Selection but …**
  - **The study group is not tasked with finding the best solution**
  - **RPS is only a subset of a larger potential solution space**
    - **At least three dimensional: speed, power, change**
- **The EEE objectives should be robust enough to encourage innovative solutions to be presented to the task force**
  - **Task force can always choose to reject proposals that are too far "out of the box"**

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