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# Auto-Negotiation of Voltage Level

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# 10/100BASE-T1L Technology Ability Bits in Draft 2.0

- The 10/100BASE-T1L technology ability field bit assignments are shown in the table below
  - The 10BASE-T1L technology bits are as specified in Table 98B-1
  - The 100BASE-T1L technology bits are as proposed in IEEE P802.3dg/D2.0

| Bit | Selector Description |
|---|---|
| A9 | 10BASE-T1L capability |
| A10 | 100BASE-T1L ability |
| A21 | 100BASE-T1L increased transmit/receive level ability |
| A23 | 10BASE-T1L increased transmit level request |
| A24 | 10BASE-T1L increased transmit/receive level ability |
| A25 | 10BASE-T1L EEE ability |

  - The 100BASE-T1L technology bits are not independent
    - To bring up a 100BASE-T1L link at 2 Vpp level both link partners needs to set both A10 and A21
    - If either link partner does not set bit A21, then the link comes up at 1 Vpp

# Why 100BASE-T1L is Different from 10BASE-T1L

- 10BASE-T1L used too many (4) technology ability bits
  - The technology ability field is shared by all PHYs that use clause 98 auto-negotiation
    - This includes all T1 PHYs, all T1L PHYs, all T1S PHYs and all asymmetric T1 / V1 PHYs
    - There are only 27 technology ability bits available in the base page
    - We are rapidly approaching the point of requiring additional next page exchange during auto-negotiation
  - The consensus in the 802.3dg working group is that we should not use technology ability bits unnecessarily
- 10BASE-T1L is inconsistent with every other 802.3 PHY in having both an ability bit and a request bit (for the higher voltage level)
  - For every ability in every other PHY the ability bit is set to indicate that the PHY has that ability
  - The link settings are then determined by a specified priority resolution process
- 10BASE-T1L is inconsistent with all of the recent 802.3 PHYs in auto-negotiating EEE
  - All recent 802.3 PHYs except 10BASE-T1L negotiate support for EEE during training
  - There is no need for this ability to be known prior to link establishment

# Proposal for Further Changes in Technology Bits

- We propose to use 3 technology bits to specify a category
  - For example, BASE-T1L would be a separate category
  - Within a category the 12 currently unassigned technology bits would be category-specific
  - This proposal is described in detail in a separate presentation
- In IEEE P802.3dg/D2.0 auto-negotiation of the voltage level for 100BASE-T1L operates as follows:
  - To bring up a 100BASE-T1L link at 2 Vpp level both link partners needs to set both A10 and A21
  - If either link partner does not set bit A21, then the link comes up at 1 Vpp
  - Setting bit A21 without setting bit A10 is not allowed
- We propose to make the two 100BASE-T1L technology bits independent
  - A 100BASE-T1L PHY may support 1 Vpp only, 2 Vpp only or both 1 Vpp and 2 Vpp
  - If a PHY supporting 1 Vpp only is connected to a PHY supporting 2 Vpp only, then the link will not come up
  - If two PHYs that support both 1 Vpp and 2 Vpp are connected then 2 Vpp will be resolved
  - If a PHY supporting both 1 Vpp and 2 Vpp is connected to a PHY supporting 2 Vpp only, then the link will come up at 2 Vpp
  - If a PHY supporting both 1 Vpp and 2 Vpp is connected to a PHY supporting 1 Vpp only, then the link will come up at 1 Vpp

# Proposed 10/100BASE-T1L Technology Ability Bits

- The proposed 10/100BASE-T1L technology ability field bit assignments are shown in the table below:

| Bit | Selector Description |
|---|---|
| A7, A8, A26 | Category selection.<br>000 NULL category is used by existing PHYs including 10BASE-T1L PHYs<br>010 BASE-T1L category can be used by 10/100BASE-T1L PHYs |
| A9 | 10BASE-T1L capability |
| A10 | 100BASE-T1L standard transmit/receive level ability |
| A11 | 100BASE-T1L increased transmit/receive level ability |
| A23 | 10BASE-T1L increased transmit level request |
| A24 | 10BASE-T1L increased transmit/receive level ability |
| A25 | 10BASE-T1L EEE ability |

- Existing 10BASE-T1L PHYs will ignore the category selection and the 100BASE-T1L abilities
  - New 10/100BASE-T1L PHYs will advertise their 10BASE-T1L abilities exactly as before

# Support for Advanced Physical Layer (APL)

- APL bring the benefits of Ethernet to the field of process automation
  - APL applications were some of the earliest adopters of 10BASE-T1L
  - Any changes that we propose for 100BASE-T1L must continue to support the requirements of APL applications
  - APL has its own 10 Mb/s standard that is based on IEEE Std802.3 but imposes certain restrictions to support the intended applications
    - We will paraphrase here - see IEC TS 63444 for the exact requirements
    - A “trunk port” can only operate at 2.4 Vpp
    - A “spur port” can only operate at 1 Vpp
    - A trunk port should not enable communication when connected to a PHY that specifies 1 Vpp operation – but it can still bring up a link
    - A spur port should not enable communication when connected to a PHY that requests 2.4 Vpp operation – but it can still bring up a link
  - We expect similar restrictions for APL at 100 Mb/s

# 10/100BASE-T1L Ability Advertisement for APL

- The following table shows the proposed ability advertisement settings for PHYs supporting both 10BASE-T1L and 100BASE-T1L

| Technology Ability bits | | Segment class | | | |
|---|---|---|---|---|---|
| | | Trunk Port | | Spur Port | |
| | | 10BASE-T1L | 100BASE-T1L | 10BASE-T1L | 100BASE-T1L |
| A9 | 10BASE-T1L capability | 1 | | 1 | |
| A10 | 100BASE-T1L standard transmit/receive level ability | | 0 | | 1 |
| A11 | 100BASE-T1L increased transmit/receive level ability | | 1 | | 0 |
| A23 | 10BASE-T1L increased transmit level request | 1 | | 0 | |
| A24 | 10BASE-T1L increased transmit/receive level ability | 1 | | 0 | |
| A25 | 10BASE-T1L EEE ability | 0 | | 0 | |

- Note that a 100BASE-T1L link will not be established between a trunk port and a spur port

# Other Applications May Require Operation at 2 Vpp

- The requirement to have certain ports decline to communicate at 1 Vpp is not unique to APL
  - Many industrial communication links are subject to high levels of interference
  - Applications in areas such as heating and air conditioning, elevators, trains, and so on may have similar characteristics
  - In all these cases it may be desirable to support 2 Vpp only operation
  - The approach adopted in 10BASE-T1L of bringing up the link at 1 Vpp even in cases where the application would prefer to specify 2 Vpp only operation is very burdensome
    - Links in APL are actively managed - every time the link comes up the resolved voltage is checked, and communication is disabled if the voltage is incompatible with the application requirements
    - Do we really want to place the burden of active management on every application where 2 Vpp only operation is required?
  - The proposed technology ability bit assignments allow applications to specify 2 Vpp only operation without the need for active management
    - The link will simply not come up if the link partner does not support 2 Vpp

# Priority Resolution

- It is proposed that when both link partners support both 1 Vpp and 2 Vpp, 2 Vpp will have priority
  - It would seem illogical to prioritize 1 Vpp operation since this PHY is primarily targeting longer reach

# Handling of Voltage Mismatch

- We need to decide about how to handle cases like the one shown in the following table

| Technology Ability bits | | Local PHY | | Remote PHY | |
|---|---|---|---|---|---|
| | | 10BASE-T1L | 100BASE-T1L | 10BASE-T1L | 100BASE-T1L |
| A9 | 10BASE-T1L capability | 1 | | 1 | |
| A10 | 100BASE-T1L standard transmit/receive level ability | | 0 | | 1 |
| A11 | 100BASE-T1L increased transmit/receive level ability | | 1 | | 0 |
| A23 | 10BASE-T1L increased transmit level request | 1 | | 0 | |
| A24 | 10BASE-T1L increased transmit/receive level ability | 1 | | 0 | |
| A25 | 10BASE-T1L EEE ability | 0 | | 0 | |

- In this case a 100BASE-T1L link cannot be established but it would be possible to bring up a 10BASE-T1L link at 1 Vpp

# Options for Handling of Voltage Mismatch

- One option is to treat 100BASE-T1L at 2 Vpp and 100BASE-T1L at 1 Vpp as if they are two different technologies
  - In that case the highest common denominator (HCD) technology associated with the table on the previous slide is 10BASE-T1L and the link will come up at 1 Vpp
- Another option is to treat 100BASE-T1L at 2 Vpp and 100BASE-T1L at 1 Vpp as two different configurations of the same technology in a similar way to the way we handle LEADER / FOLLOWER configuration
  - In that case the HCD technology associated with the table on the previous slide is 100BASE-T1L
  - The clause 98 Arbitration sequencer of Figure 98-7 will enter the AN GOOD CHECK state, but the variable incompatible_link will be set true, as would be the case if both PHYs are forced to be LEADER, for example
  - Auto-negotiation will restart repeatedly until management intervenes or downshift handles the situation