Interface classifications

Howard Frazier
Broadcom Corporation
IEEE 802.3ba Task Force
March 18, 2008
Orlando, FL
Supporters

• Joel Goergen, Subi Krishnamurthy – Force10
• Gary Nicholl – Cisco
• Ilango Ganga – Intel
• Brad Booth – AMCC
• Shimon Muller – Sun Microsystems
Interface classifications

- **Abstract:**
  - Service primitives (function calls, pseudo code)
  - Clause 2 (MAC service interface), Clause 6 (MAC/PLS service interface)

- **Logical:**
  - Signals, code-points, syntax, sequences, true/false
  - Clauses 22 (MII), 35 (GMII), 46 (XGMII), etc

- **Electrical:**
  - AC/DC parameters
  - Clauses 22 (MII), 54 (CX4)

- **Optical:**
  - Active output/active input parameters
  - Clauses 38, 52, 58-60, etc

- **Physical:**
  - Mechanical inter-matebility
  - Clause 38 (by reference to duplex SC in 38.11.3)
  - Clause 54 (by reference to 61076-3-113 in 54.8.1)
Abstract interfaces

- Formally defined using service primitives
  - MA_DATA.request (DA, SA, MSDU, FCS)
  - MA_DATA.indication (DA, SA, MSDU, FCS, Status)

- May be defined in pseudo-code
  - TransmitBit, ReceiveBit, Wait, transmitting, receiveDataValid, carrierSense

- Described from the perspective of the subordinate layer (or sub-layer)
Abstract interfaces

- Can be mapped to logical interfaces
  - MAC/PLS service interface mapped to MII, GMII, XGMII in Clauses 22, 35, 46

- Provides consistent behavior across many generations of implementation
Abstract interfaces

• Advantages
  • implementation independent
  • long-lived
  • brief specification

• Disadvantages
  • intangible
  • do not ensure interoperability
    – no conformance test points
Logical interfaces

- The behavioral specification of an abstract interface, plus

- Signals, code-points, syntax, sequences, etc
  - TXD<31:0>, RXD<31:0>, TXC<3:0>, RXC<3:0>, TX_CLK, RX_CLK

Figure 46-5—Normal frame transmission
Logical interfaces

• Advantages
  • easy to map to Register Transfer Level (RTL) hardware descriptive languages (HDL)
  • more rigorous than abstract interfaces

• Disadvantages
  • do not ensure interoperability
    – since there is no definition of the logic levels
  • take longer to specify than abstract interfaces
  • not as long-lived as abstract interfaces
Electrical interfaces

- The specification of a logical interface, plus

- DC characteristics
  - $V_{OH}$, $V_{OL}$, $V_{IH}$, $V_{IL}$, $I_{OH}$, $I_{OL}$, $I_{IH}$, $I_{IL}$, etc

- AC characteristics
  - $T_r$, $T_f$, $T_{SU}$, $T_{HD}$, etc

**Table 35-7—DC specifications**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{OH}$</td>
<td>Output High Voltage</td>
<td>$I_{OH} = -1.0 \text{ mA}$</td>
<td>$V_{CC} = \text{Min}$</td>
<td>2.10</td>
<td>3.60</td>
</tr>
<tr>
<td>$V_{OL}$</td>
<td>Output Low Voltage</td>
<td>$I_{OL} = 1.0 \text{ mA}$</td>
<td>$V_{CC} = \text{Min}$</td>
<td>GND</td>
<td>0.50</td>
</tr>
<tr>
<td>$V_{IH}$</td>
<td>Input High Voltage</td>
<td></td>
<td></td>
<td>1.70</td>
<td>—</td>
</tr>
<tr>
<td>$V_{IL}$</td>
<td>Input Low Voltage</td>
<td></td>
<td></td>
<td>—</td>
<td>0.90</td>
</tr>
<tr>
<td>$I_{IH}$</td>
<td>Input High Current</td>
<td>$V_{CC} = \text{Max}$</td>
<td>$V_{IN} = 2.1 \text{ V}$</td>
<td>—</td>
<td>40</td>
</tr>
<tr>
<td>$I_{IL}$</td>
<td>Input Low Current</td>
<td>$V_{CC} = \text{Max}$</td>
<td>$V_{IN} = 0.5 \text{ V}$</td>
<td>-600</td>
<td>—</td>
</tr>
</tbody>
</table>
Electrical interfaces

• Advantages
  • very rigorous
  • high degree of interoperability
    – since it can be probed and measured

• Disadvantages
  • take longer to specify than logical interfaces
  • not as long-lived as logical or abstract interfaces
Optical interfaces

- Specify transmit characteristics
  - Wavelength, spectral width, launch power, optical modulation amplitude, return loss, etc
- Specify receive characteristics
  - Wavelength, receive sensitivity, overload, etc

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signaling speed (range)</td>
<td>1.25 ± 100 ppm</td>
<td>GBd</td>
</tr>
<tr>
<td>Wavelength (range)</td>
<td>1260 to 1360</td>
<td>nm</td>
</tr>
<tr>
<td>Average receive power (max)</td>
<td>−3</td>
<td>dBm</td>
</tr>
<tr>
<td>Receive sensitivity (max)</td>
<td>−19.5</td>
<td>dBm</td>
</tr>
<tr>
<td>Receiver sensitivity as OMA (max)</td>
<td>−18.7 (13.4)</td>
<td>dBm (μW)</td>
</tr>
<tr>
<td>Bit error ratio (max)</td>
<td>10⁻¹²</td>
<td></td>
</tr>
<tr>
<td>Receiver reflectance (max)</td>
<td>−12</td>
<td>dB</td>
</tr>
<tr>
<td>Stressed receive sensitivity (max)</td>
<td>−15.4</td>
<td>dBm</td>
</tr>
<tr>
<td>Stressed receiver sensitivity as OMA (max)</td>
<td>−14.6 (35)</td>
<td>dBm (μW)</td>
</tr>
<tr>
<td>Vertical eye-closure penalty (min)</td>
<td>3.6</td>
<td>dB</td>
</tr>
</tbody>
</table>
Optical interfaces

• Advantages
  • most rigorous
  • highest degree of interoperability

• Disadvantages
  • take a loooooooong time to specify
  • specification methods constantly evolve
Physical interfaces

- Specify mechanical inter-matebility
  - dimensions, clearances, etc. usually defined by reference to an IEC standard
- Specify contact assignments

<table>
<thead>
<tr>
<th>Rx lane</th>
<th>MDI Connector pin</th>
<th>Tx lane</th>
<th>MDI Connector pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>DL0&lt;p&gt;</td>
<td>S1</td>
<td>SL0&lt;p&gt;</td>
<td>S16</td>
</tr>
<tr>
<td>DL0&lt;n&gt;</td>
<td>S2</td>
<td>SL0&lt;n&gt;</td>
<td>S15</td>
</tr>
<tr>
<td>DL1&lt;p&gt;</td>
<td>S3</td>
<td>SL1&lt;p&gt;</td>
<td>S14</td>
</tr>
<tr>
<td>DL1&lt;n&gt;</td>
<td>S4</td>
<td>SL1&lt;n&gt;</td>
<td>S13</td>
</tr>
<tr>
<td>DL2&lt;p&gt;</td>
<td>S5</td>
<td>SL2&lt;p&gt;</td>
<td>S12</td>
</tr>
<tr>
<td>DL2&lt;n&gt;</td>
<td>S6</td>
<td>SL2&lt;n&gt;</td>
<td>S11</td>
</tr>
<tr>
<td>DL3&lt;p&gt;</td>
<td>S7</td>
<td>SL3&lt;p&gt;</td>
<td>S10</td>
</tr>
<tr>
<td>DL3&lt;n&gt;</td>
<td>S8</td>
<td>SL3&lt;n&gt;</td>
<td>S9</td>
</tr>
<tr>
<td>Signal Shield</td>
<td>G1</td>
<td>Signal Shield</td>
<td>G5</td>
</tr>
<tr>
<td>Signal Shield</td>
<td>G2</td>
<td>Signal Shield</td>
<td>G6</td>
</tr>
<tr>
<td>Signal Shield</td>
<td>G3</td>
<td>Signal Shield</td>
<td>G7</td>
</tr>
<tr>
<td>Signal Shield</td>
<td>G4</td>
<td>Signal Shield</td>
<td>G8</td>
</tr>
<tr>
<td>—</td>
<td>—</td>
<td>Link Shield</td>
<td>G9</td>
</tr>
</tbody>
</table>
Physical interfaces

• Advantages
  • most rigorous
  • highest degree of interoperability
  • free food!

• Disadvantages
  • connector wars!
Proposal for 40G and 100G interface classes
Comparison

<table>
<thead>
<tr>
<th>Abstract</th>
<th>Logical</th>
<th>Optical/Electrical</th>
<th>Physical</th>
</tr>
</thead>
</table>

- Longevity: greater (Abstract) to lesser (Physical)
- Interoperability: lesser (Logical) to greater (Optical/Electrical)
- Level of effort: lesser (Optical/Electrical) to greater (Physical)
40 G sub-layers & interfaces

- MAC
- RS
- PCS
- PMA (4:4)
- PMA (4:1)
- PMD
- MDI
- medium
100 G sub-layers & interfaces

- MAC/PLS
  - MAC
  - RS
  - PCS
  - PMA (20:10)
  - PMA (10:4)
  - PMA (4:1)
  - PMD

- MII

- PCS/PMA

- PMA/PMD

- MDI

- medium
Summary

• There are several different classes of interfaces employed in IEEE 802.3
  – Abstract, Logical, Electrical, Optical, Physical

• Each has advantages and disadvantages
  – Longevity, interoperability, level of effort

• We should strive to minimize the number of interfaces, and strive to obtain the most benefit from the effort