User Defined Data Field using Available Bits in Preamble

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Concept

• Use available bits in preamble to convey user-defined data to link partner(s):
  Can include:
  – Collisions
  – Receiver Status
  – Broad indication of error level/CRC
  – Other information

• Make feature transparent to 10BASE-T1S PHYs which do not support it.
Preamble Structure w/User Defined Data

<table>
<thead>
<tr>
<th>SCRAMBLER SYNC</th>
<th>15 bits user-defined data</th>
<th>7th OCTET</th>
<th>SFD</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 5 5 5 5 5 5 X X X X 5 5 5 5 D</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Standard Preamble w/o User Defined Data: 101010101010101010101010101010..  
Preamble with User-Defined Data Field: 1010101010101010101000101111001110..  

- Based on: [1]  
- User Defined Data: LSB First.  
- Designed for optional implementation.  
  - Would require minor PCS receive changes in standard for all PHYs to regenerate preamble during user defined field.
Proposed User-Defined Data Format

- **UD_EN**:  
  - 0== User defined data field not supported.  
  - Ignore User Defined field for this packet. Default if standard preamble (0x555555555555555D) sent.  
  - 1== User Defined Data Supported.

- **SENDER_ADDR[2:0]**  
  - If Clause148 supported & num_nodes<=8, SENDER_ADDR=node_ID  
  - If Clause 147 point-to-point, can set SENDER_ADDR using Clause 98 autoneg next page exchange or set fixed.  
  - Clause 147 multipoint w/o PLCA can use PLCA register space node ID to define SENDER_ADDR.

- **UD_Data[5:0]**  
  - User-defined data 6 bits in length.

- **CRC-5** with Hamming distance of 4 covering bits B0..B9.
CRC-5

- Polynomial: $x^5 + x^3 + x + 1$ [2,3]
- Hamming distance of 4 for 10 bit length.
- Error events for 10BASE-T1S:
  - Single bit errors, double bit errors, descrambler multiplied errors, bursts < 200ns (impulse noise).

<table>
<thead>
<tr>
<th>Burst/Erasure Length</th>
<th>Error Coverage</th>
<th>Notes</th>
<th>Verified by Sim?</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>100.0%</td>
<td>Needed for differential detection</td>
<td>Yes</td>
</tr>
<tr>
<td>2 bits err, 1 bit ok, 2 bit err</td>
<td>100.0%</td>
<td>Diff. detection w/descrambler</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>100.0%</td>
<td>Covers transient noises w/UTP</td>
<td>Yes</td>
</tr>
<tr>
<td>6</td>
<td>93.7%</td>
<td>$p=1-2^{-4}$</td>
<td>Yes</td>
</tr>
<tr>
<td>8</td>
<td>96.9%</td>
<td>$p=1-2^{-5}$</td>
<td>Yes</td>
</tr>
</tbody>
</table>

- Overall, error detection capability of 96.9% ($p=1-2^{-5}$) of multi-bit errors.
Changes to PCS Receive State Diagram to Support User Defined Data

- For PHYs which do not implement UD Data, counter for preamble regeneration increases to 12.
Changes to PCS Transmit State Diagram to Support User Defined Data
• 15 bits available for user defined data using available overhead in the preamble.

• Optional feature – interoperates with 10BASE-T1S PHYs which don’t support it.

• CRC-5 provides robust error detection capability for channel error events.

• Works with automotive point-to-point and multidrop topologies.

• User-Defined Data field in preamble is feasible with little additional complexity.
References

[1] “IEEE802.3cg TF T1S preamble” P. Beruto and A. Orzelli

    http://users.ece.cmu.edu/~koopman/crc/index.html
