User Defined Data Field using Available Bits in Preamble

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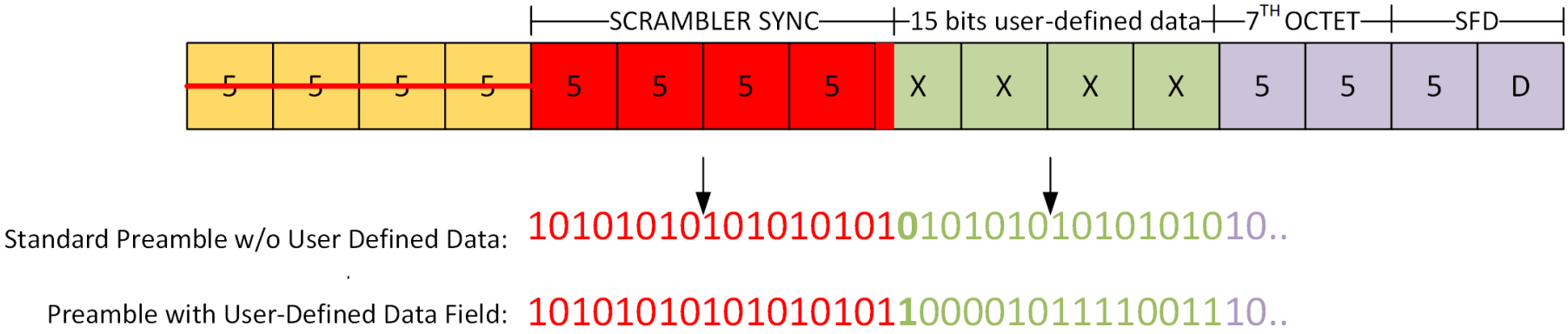
Concept

- 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



- 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

B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
CRC5 [S4:S0]					UD_DATA[5:0]						SENDER_ADDR[2:0]			UD_EN

SENT LSB FIRST

- 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.

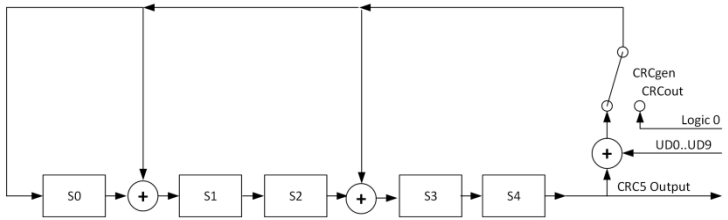
- SENDER_ADDR[2:0]
  - If Clause148 supported & num_nodes<=8, SENDER_ADDR=node_ID
  - If Clause 147 point-to-point, can set SENDER_ADDR using Clause 98 autoneg next page exchange or set fixed.
  - Clause 147 multipoint w/o PLCA can use PLCA register space node ID to define SENDER_ADDR.

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

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

CRC-5

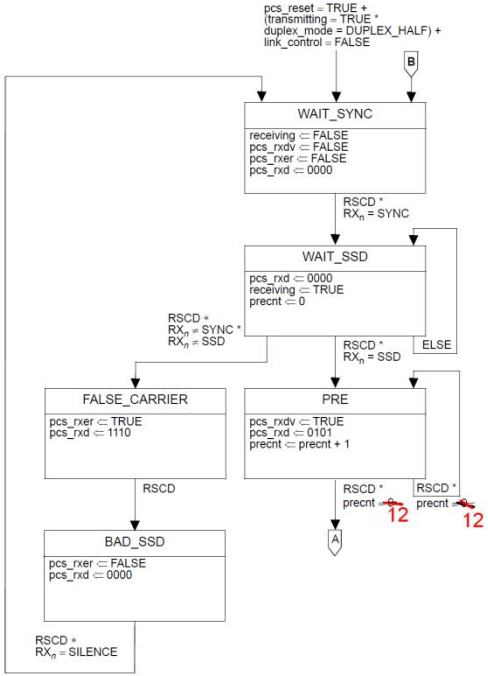
- Polynomial: x^5+x^3+x+1 [2,3]
- Hamming distance of 4 for 10 bit length.
- Error events for 10BASE-T1S:
  - Single bit errors, double bit errors, descrambler multiplied errors, bursts < 200ns (impulse noise).



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

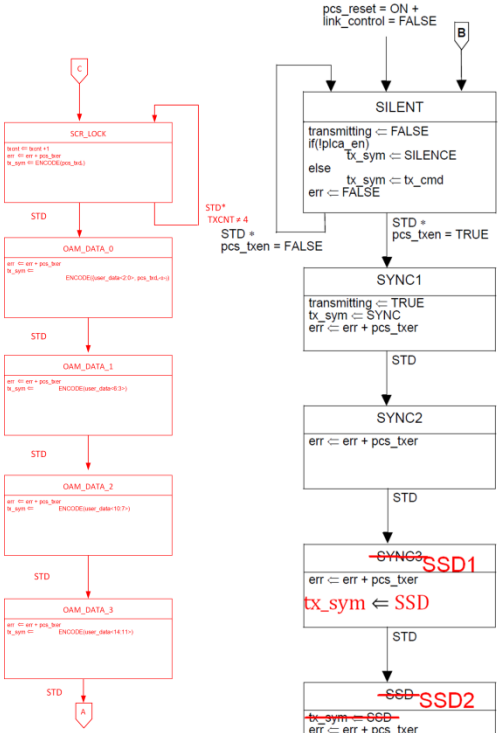
- Overall, error detection capability of 96.9% ($p=1-2^{-5}$) of multi-bit errors.

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



Summary

- 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://www.ieee802.org/3/cg/public/May2018/beruto_3cg_04_0518.pdf

[2] “Best CRC Polynomials.” P. Koopman
http://users.ece.cmu.edu/~koopman/crc/index.html

[3] S.B. Wicker, *Error Control Systems for Digital Communication and Storage*, Prentice Hall, 1994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