SpaceWire new Standard version comments

Albert Ferrer Florit

Space Technology Centre
University of Dundee

Space Technology Centre
University of Dundee

Signal level

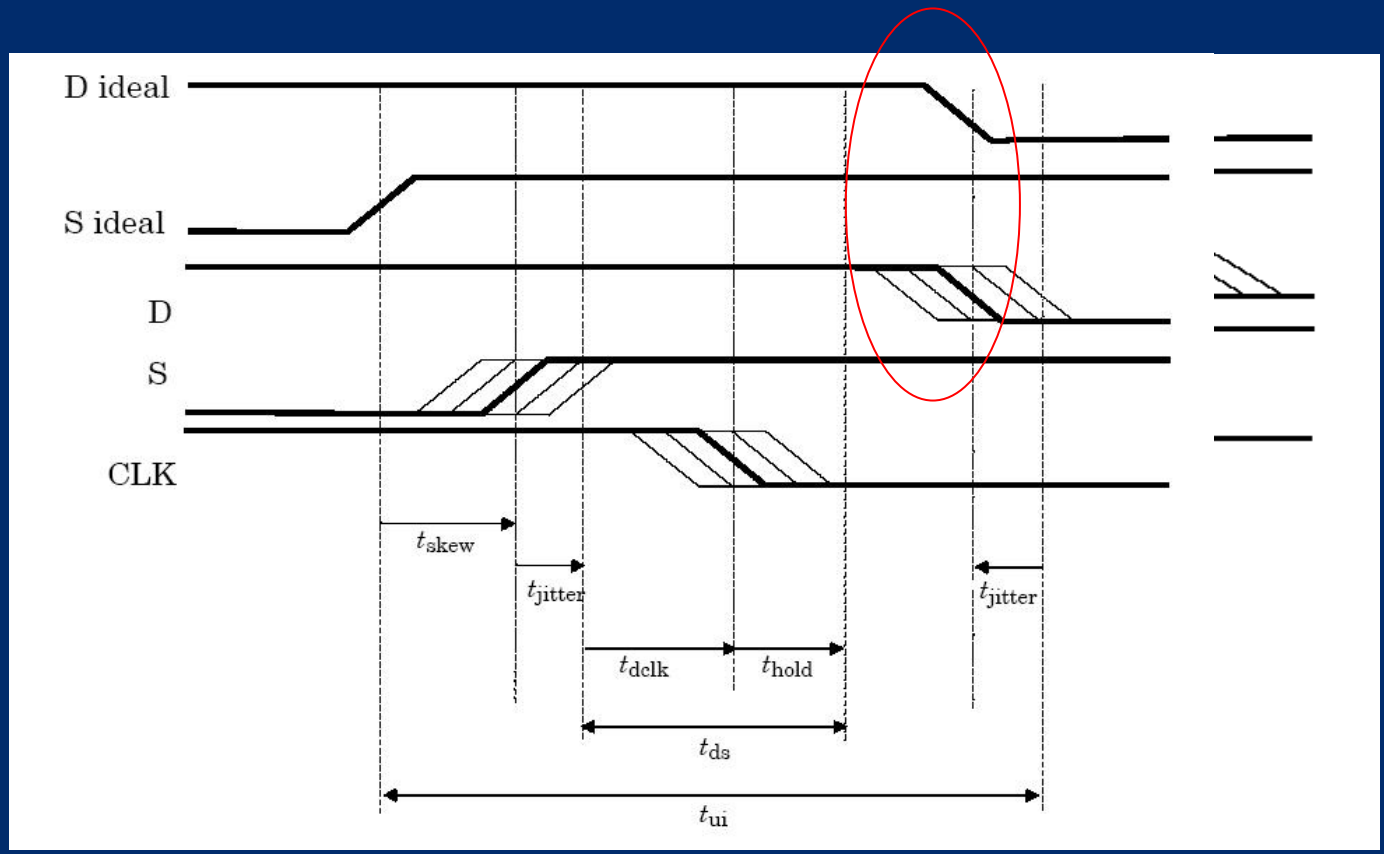
Albert Ferrer Florit

Space Technology Centre
University of Dundee

Figure 13 error

- t_{skew} is the skew between the Data and Strobe signals.

t_{margin} is the available margin. $t_{margin} = t_{ui} - (t_{skew} + 2^{*}t_{jitter} + t_{dclk} + t_{hold})$.



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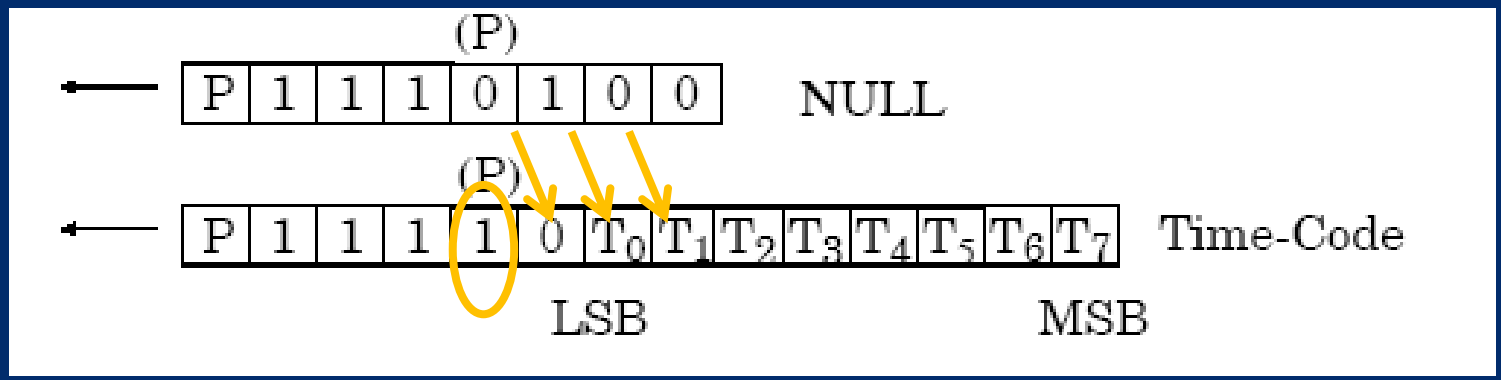
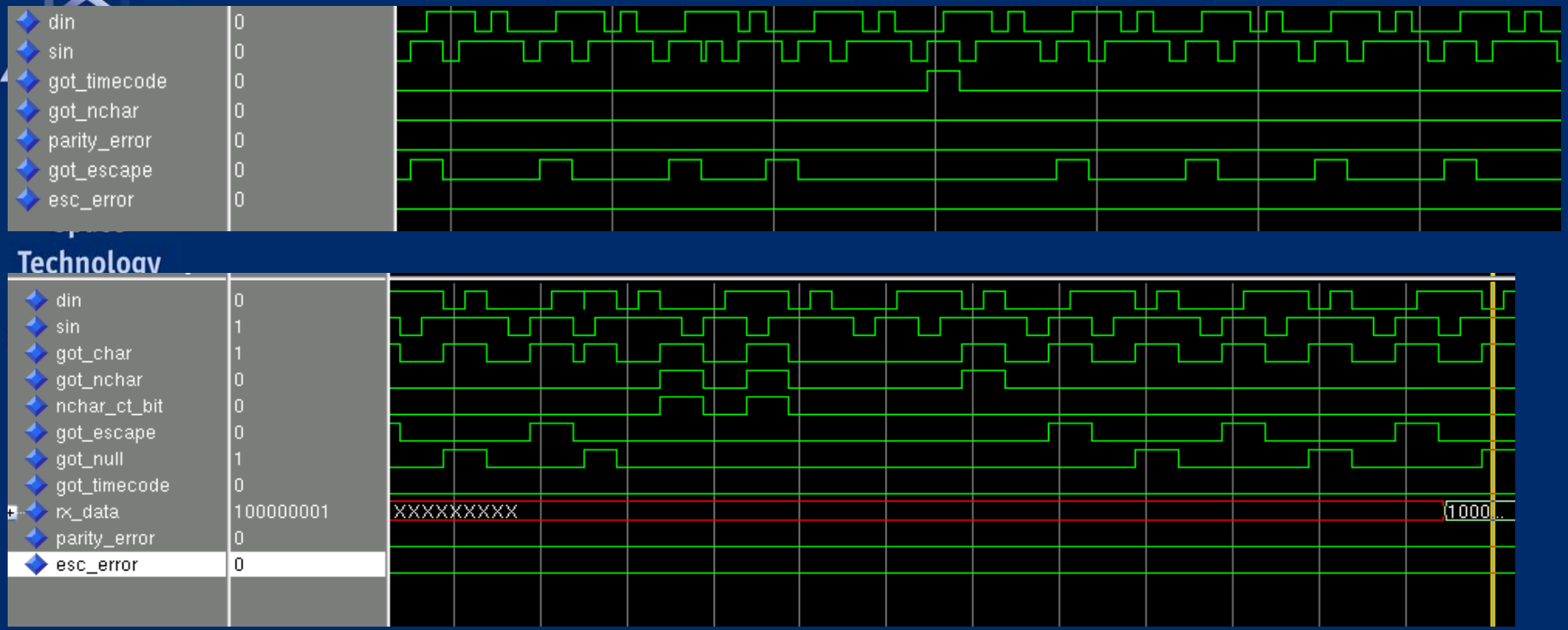
Link error detection

- Parity bit covers SpW character
  - Can detect a change on a single bit
- Errors can be produced by unexpected jitter, noise or interferences
  - Simultaneous Data/Strobe transitions may occur
  - One or more bits may be added
  - Parity error may not detect these errors
  - Behaviour depends on SpW Codec implementation



Link error detection (2)



- Time-Codes and Data characters may be correctly generated
  - Spurious Time-Codes are not usually forwarded because their value must be one more than the last one sent.
  - Data could be protected by a CRC and data length field.

Link error detection (3)

Protocol	Error detection	Retries	Redundancy	Scheduled
SpaceWire	Parity bit	No	No	No
Can bus	CRC	Yes	No	No
TCP	CRC	Yes	No	No
TTP	CRC	No	Yes	Yes
Flexray	CRC	No/Yes?	Yes	Yes/Asynch
1553	Parity	No/Yes?	Yes	Yes
SpW-RT	CRC	Yes	Yes	Yes/Asynch

- A Bit Error Rate (BER) of 10exp(12) implies an error every 2.78 hours in a single 100Mbit/s link. (GOES-R NASA project)

Character level

Albert Ferrer Florit

Space Technology Centre
University of Dundee

Time-Code definition

- Current definition states:

  "The Time-Code is used to distribute system time information and control flags isochronous with the time-code distribution."

- If Time-Codes are going to be used for other purposes the definition must be changed.
  - Proposal to define Time-Codes as a type of ESC+Data character sequence. This special sequence can be called "escape data characters" or "signalling codes" or "escape codes".

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Time-Codes with different control codes

- They are very important because they can bypass the flow control mechanism.
  - In case of packet blocking they can still be sent
- They have minimum latency and jitter.
- They can contain minimum information
- They are limited
  - If possible, some values should be reserved for future SpW development
- If possible, same control code should imply same behaviour.
- Mandatory functions of theses codes should be very simple to implement in hardware.

Exchange level

Albert Ferrer Florit

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University of Dundee

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Robust distributed signalling

- Proposed interrupt codes use Escape+data characters to broadcast a value to the network.
- Two problems must be solved
  1. Avoid a spurious value to be broadcasted
  2. Avoid infinite transmission due to loops
     - Timeout requires configuration and a counter in the routers for each possible value .
     - Proposal: A different control codes (or any other bit change) must be received each time to enable the value to be broadcasted. (requires 64 bits per port)
- Interrupts distribution could be designed so that its implementation supports other uses.
  (rename to signalling codes)

Network level

Albert Ferrer Florit

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University of Dundee

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Standard inconsistencies

- last paragraph of section 10.2.9.6:

  “In the event of several packets competing for a set of links, subclause 10.3.5 specifies the means of arbitration when an output port becomes available, giving access to the newly freed output port to the packet with the highest priority destination address”

- Section 10.3.5

  “SpaceWire routing switches shall provide a means of arbitrating between input ports requesting the same output port.

  – Does not oblige the use of a specific arbitration algorithm

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Wormhole switching term

- In literature the term Wormhole switching is widely used as a synonymous of wormhole routing.
  - A reference to this other term could be included.

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Spilling packets on blockage (1)

- Packet blocking is produced when the destination stalls.
  - Cascade effect can affect other packets of the network
  - A single fault (sw/hw) may affect the whole network
  - Resetting the link attached to the source node does not solve the problem
- SpW-10X tackles the problem by implementing timeouts in the router
  - Packets are spilled in the input port if data is not being sent during a specific time. An EEP marker is added at the output port
  - Suggest to include this method in the Standard as an informative section.

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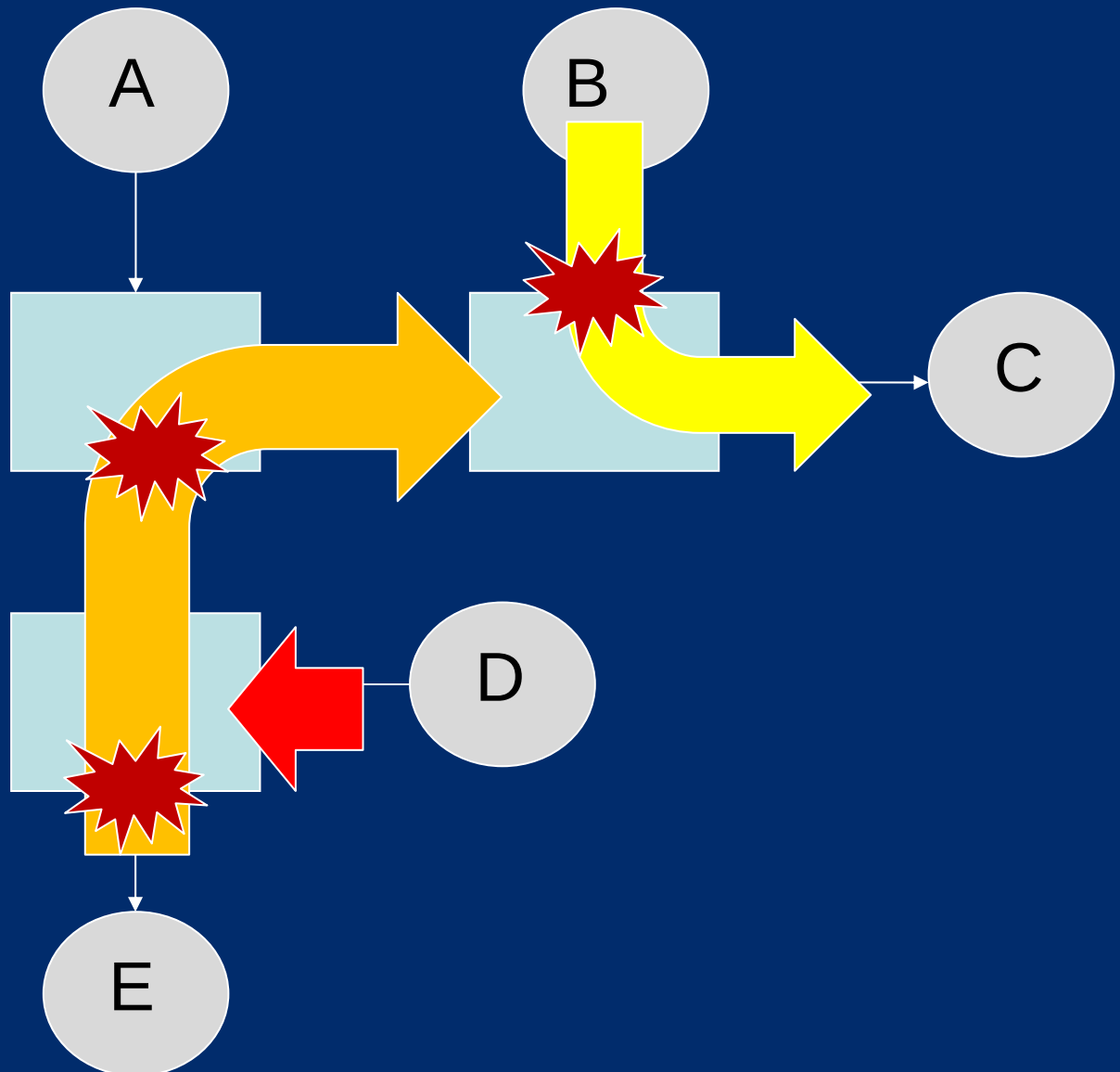
Spilling packets on blockage (2)

- Timeout mechanism requires the sender to wait a predefined time.
  - Minimum time is restricted by the slowest network node
  - Maximum Blocking time depends on other packets of the network.
    - A very slow destination node may block other packets until the transfer is completed
- End to end flow control tackles packet spilling due to congestion
  - However packet spilling can still occur in any part of the network due to an error in any part of the network

Spilling packets on blockage (3)



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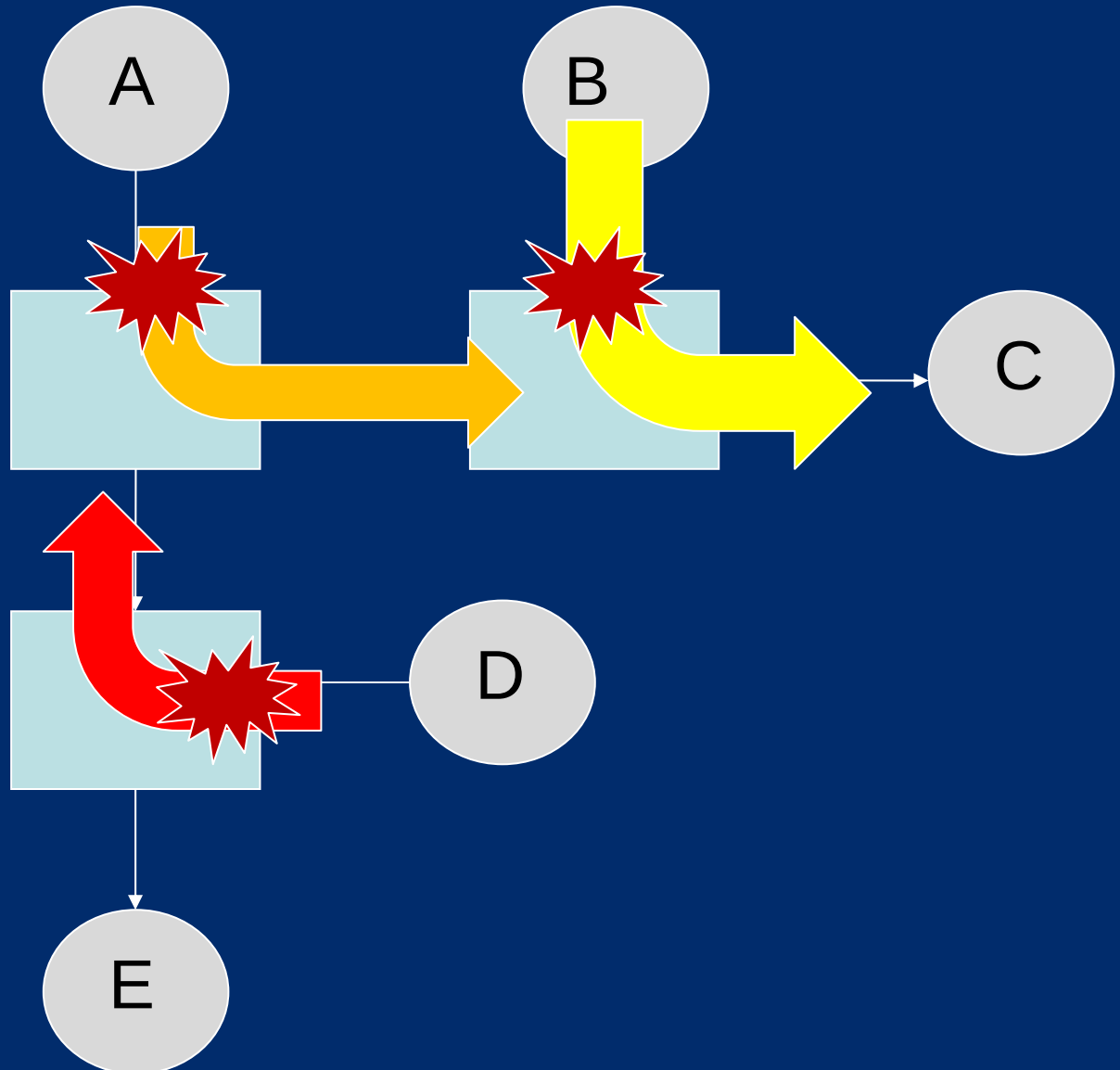
Spilling packets on blockage (4)



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Fault tolerant Time distribution

- Current Standard promotes the use of time-codes to distribute time information
  - Only one master.
  - If master fails time distribution is lost or corrupted until an FDIR mechanism recovers from the error.
- Multiple time-Code distribution has been suggested.
  - Requires 64 escape codes per master.
  - Requires 3 Masters for single-fault safe distribution and 4 masters for built-in clock synchronization.

Fault tolerant Time distribution (2)

- A time-code provides:
  1. A tick signal (the instant a time-code is received)
  2. An initial state value (the value received must be incremented each time)
- Time-Code information can be provided using two different interrupt codes (or signalling codes) for Time master used
  1. Reset state counter
  2. Increase state counter

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Fault tolerant Time distribution (3)

- TTP bus requires 4 master clocks:
  - Time value is periodically sent
  - Lowest and highest value are discarded. “Correct” value is the average between the other two. (Welch-Lynch)
  - The “correct” value is used to synchronize the master clocks.
- SpW networks could apply the same method
  - Nodes that are master clocks apply the Welch-Lynch on the period of each master clock
  - Other nodes may apply a simpler algorithm