

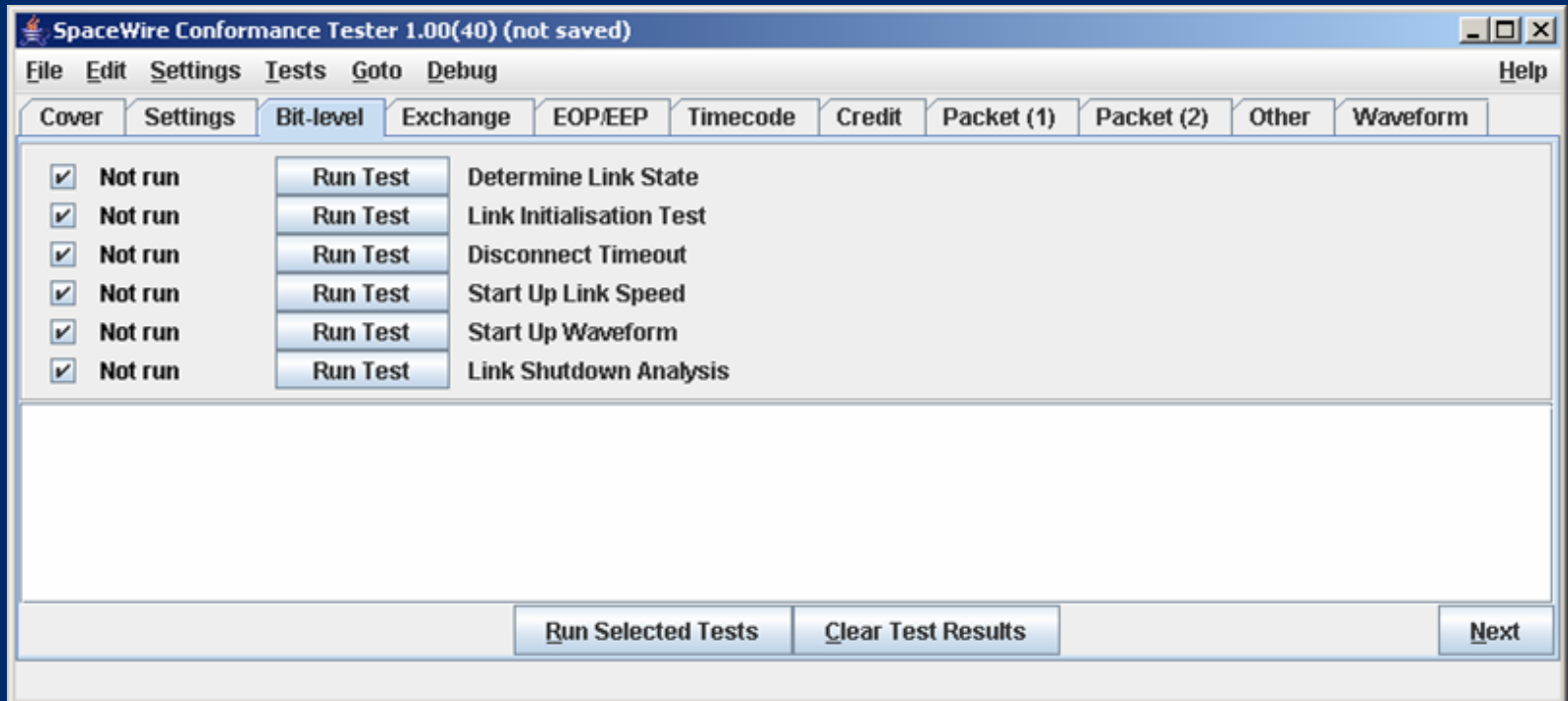


Debugging SpaceWire Devices Using The Conformance Tester

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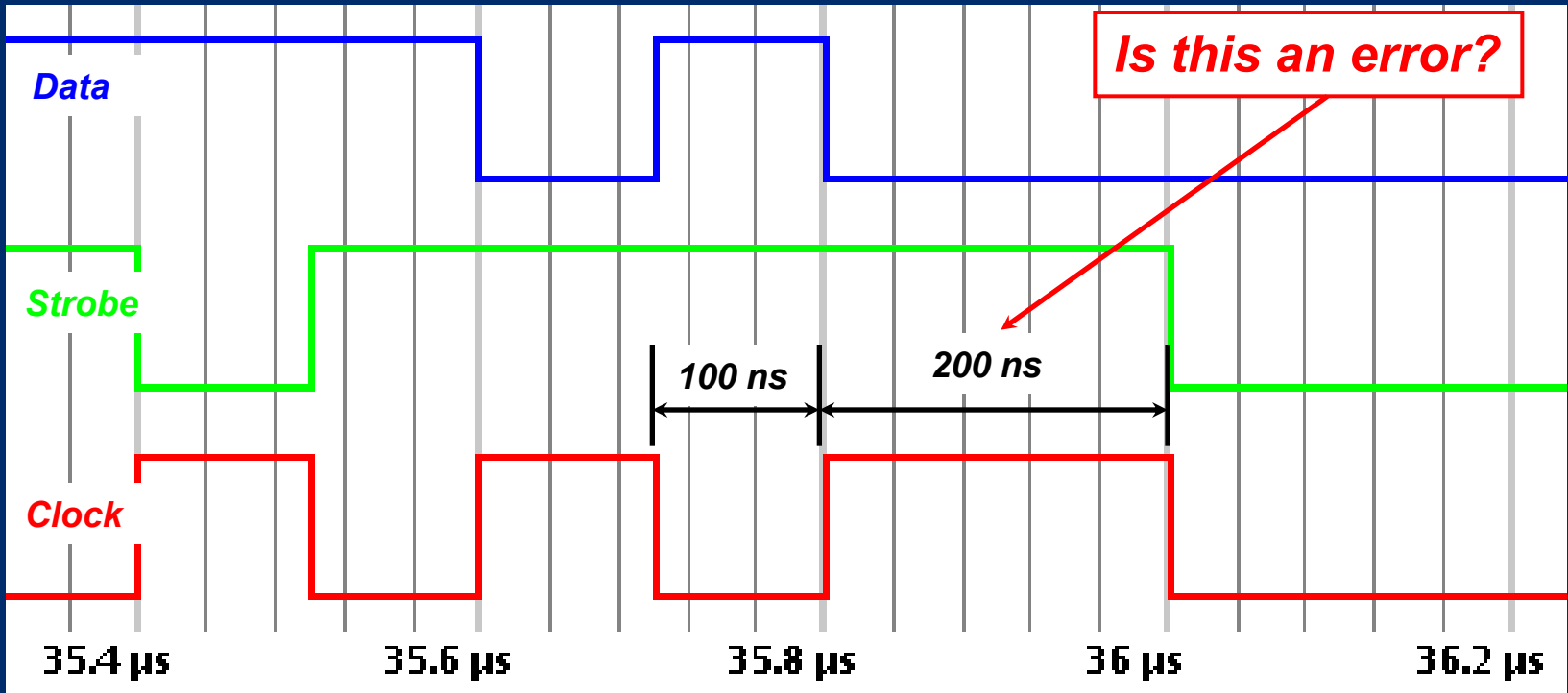
Introduction



- Link initialisation transmit rate:
 - Measurement and issues
- Empty packet credit counting:
 - A surprise interaction between clauses of the standard
- NULL Arrival Timing:
 - A novel probe of the link initialisation state machine

Initial Operating Data Signalling Rate

- §6.6.5: initial signalling rate: (10 ± 1) Mbits/s
- §6.6.6: shall not be changed before *Run*
- Measure: bit width, clock period, average?



Empty Packet Credit Counting

- §8.3.d:
 - Transmit N-Chars only when credit count > 0
 - Decrement credit count for each N-Char transmitted
 - Increment credit count by 8 for each FCT received
- §8.2.1:
 - EOP and EEP are N-Chars (so must be credit counted)
- §8.9.3.2 (14 pages later):
 - Empty packets may be discarded
 - This is not a link error
- **Warning to all *codec* developers:**
 - **Do not discard empty packets before credit counting!**

NULL Arrival Timing

- A new addition to the Conformance Tester:
 - Accessed from the “Other” test group
 - Can be hard to understand even for SpaceWire experts!
 - It has been undocumented until now for this reason
- Novel test:
 - Allows *ErrorReset/ErrorWait* durations to be measured
 - Can discover errors hidden within the UUT *codec*
- Requirements:
 - Fast UUT link recovery time (e.g. ms not seconds)
 - Modified SpaceWire *codec* for tester (not UUT)
 - Violates the SpaceWire standard during operation



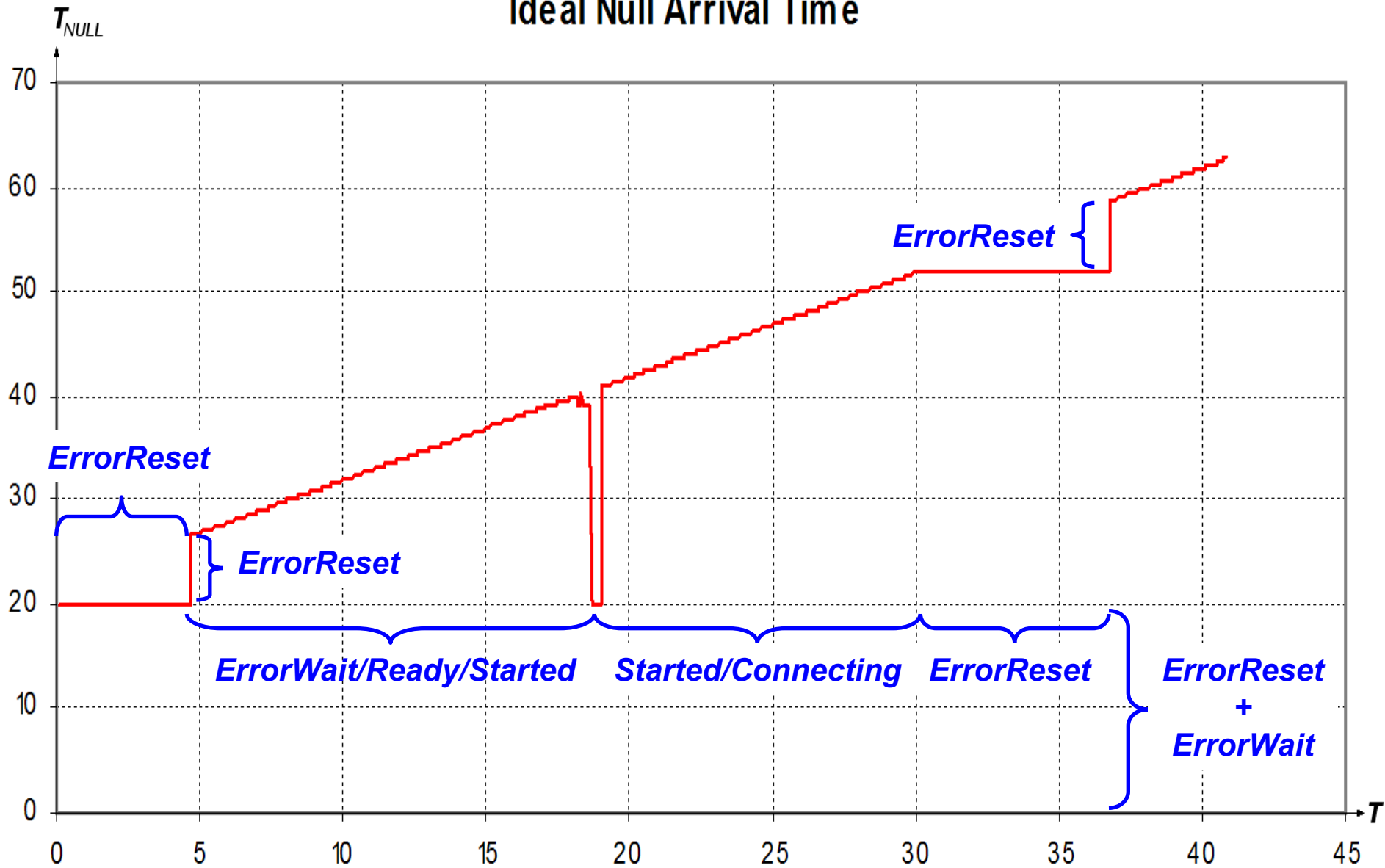
Test Background

- System configuration:
 - Tester TLI connected to UUT with link in the *Run* state
 - TLI transmitting NULLs at **maximum** achievable rate
 - At least 100 Mbits/s; 200 Mbits/s is sufficient
- Basic test operation:
 - At time $T=0$ tester TLI sends a parity error to UUT
 - UUT will move to *ErrorReset* immediately and disconnect
 - TLI **ignores** UUT disconnect and **remains** in *Run* state
 - UUT will detect TLI NULLs when it reaches *ErrorWait*
- Test measurement:
 - UUT sends NULLs at $T = T_{null} = 6.4 \mu\text{s} + 12.8 \mu\text{s} = 19.2 \mu\text{s}$
 - We define T_{null} as the NULL arrival time

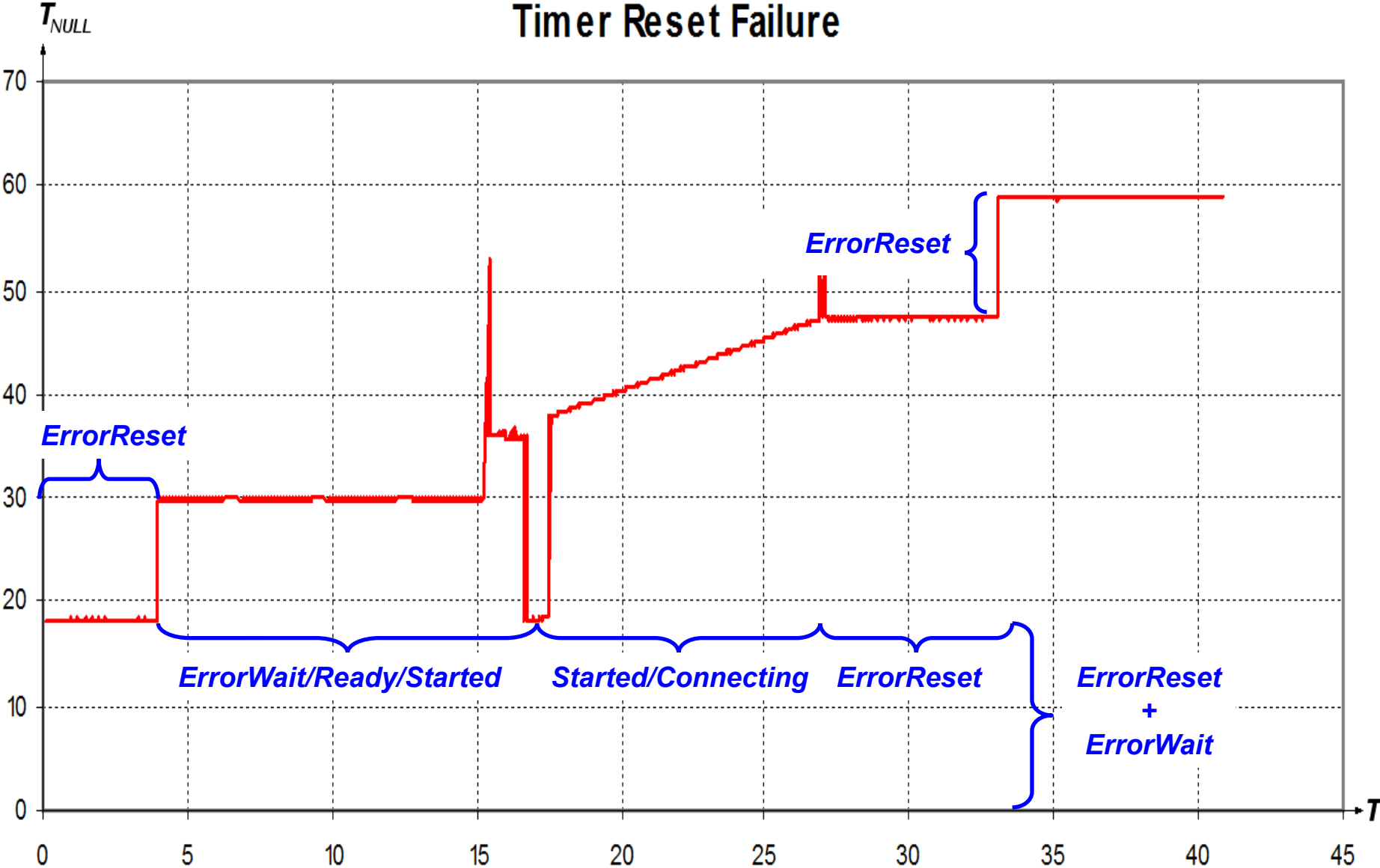
Test Iteration

- Full test operation:
 - Wait until the link is in the *Run* state
 - Generate a first link error at $T = 0$
 - Generate a second link error at time $T_{err} > 0$
 - How does T_{err} affect T_{null} ? (normal $T_{null} = 19.8 \mu\text{s}$)
- *ErrorReset* behaviour:
 - If $T_{err} < 6.4 \mu\text{s}$ then UUT must ignore the second error
 - So the second error will not affect T_{null}
- *ErrorWait/Ready/Started/Connecting*:
 - UUT must return to *ErrorReset* on second error
 - This will increase T_{null} by at least T_{err}

Ideal Null Arrival Time



Timer Reset Failure





Summary

- **Conformance Tester:**
 - Effective at detecting bugs in SpaceWire devices
- **Initial data signalling rate:**
 - Standard does not say how the rate shall be measured
 - Single bit rate? Recovered clock rate? Average rate?
 - Should shutdown be excluded from start-up rate?
- **Credit counting empty packets:**
 - Consequences of two parts of the SpaceWire standard ...
 - ... can be a surprise which leads to incorrect behaviour
- **NULL Arrival Test:**
 - A novel procedure for probing SpaceWire devices
 - Permits measurement of *ErrorReset* duration *etc.*