
Title: 2nd Bang Hold-Off Implementation Approach

Subject:

The 2nd Bang Hold-Off mechanism shall be added to the TTP/C protocol implementation 2.04 using the available C2NF hardware with a minimum of software re-design.

Although the C2NF hardware was not designed to support this mechanism (lack of independent timers) an approach for a “software” solution is found.

Implementation Description:

For the 2nd Bang Hold-Off it must be ensured that between 2 received cold start frames at least one TDMA round is passed. Because no extra timer is available following algorithm shall be implemented in the listen state:

- 1) At reception of each correct cold start frame (that means syntactically and semantically correct and agreement between the channels in case of receptions on both channels) the C-state time of that frame shall be latched (this is obsolete if the C-state time of the frame is always 0x0) and the global time shall be adjusted to that frame independently from a positive integration or not.
- 2) At reception of the next cold start frame the controller shall check if the global time exceeds the latched C-state time of the last cold start plus the duration of the TDMA round in macroticks (this shall be a MEDL parameter). If this is the case the frame is suitable for integration. In the other case the frame shall be processed as described in 1 and the listen timeout is restarted.
- 3) During the listen state the controller shall permanently check an overflow of the global time: if the global time exceeds $\max(\text{global_time})/2 = 0x8000$ an overflow flag shall be set which signals the algorithm in 2 that the condition of the passed TDMA round between two received cold start frames is fulfilled. As a precondition for that algorithm the global time field in the C-state of a cold start frame shall be set to 0x0.

The behavior of the cold-starting node shall be changed in following way:

- 4) Cold start frames shall be sent with 0x0 in their C-state global time field (the startup time field is obsolete) – the action time shall not be asserted.
- 5) After having sent the cold start frame the controller goes back to the listen state with a timeout of “listen timeout + 1 TDMA round”¹; the observed channel shall be reset to “no observed channel”.
- 6) The point in time of sending the cold start frame shall be the new base for the TDMA round interval check in 2.

¹ Only in Honeywell Hub configuration

Impact:

The listen state shall be changed in following way:

- Integration-synchronization of the global time (not of the delta counter) shall be moved to the end of the integration routine, that means if the frame is syntactically and semantically 100% correct.
- A register to store the TDMA round duration in macroticks shall be allocated.
- A controller shall check if the global time in the cold start frame is 0x0. If this is not the case the frame shall be rejected.
- A register (flag) to store a global time overflow according to 3 shall be allocated. The overflow flag shall be reset (at start of the listen state and) after the big bang.

The cold start state shall be changed in following way:

- The startup time field shall be ignored – each cold starting node shall set its global time to 0x0.
- The schedule synchronous TDMA scheme in the current cold start state shall be substitute with the asynchronous reception of the listen state (temporal agreement between own sent frame and a received frame cannot be checked with the C2NF).
- The intervall of sending cold start frames is changed from “1 TDMA round + startup timeout” to “3 TDMA rounds + node individual startup timeout” because the “listen timeout” is defined as “2 TDMA rounds + node individual startup timeout”.

Following problem may occur on bus systems:

- Due to the new cold start sending interval being longer than the listen timeout a system may startup on a bus architecture in the worst case after (most likely) $n-1$ collisions if n is the number of nodes with cold start permission.

As a solution an interval of “listen timeout – 1 TDMA round” shall be used between two cold starts in bus architectures (the same interval as used in the current implementation). This cold start interval therefore shall be defined in the MEDL calculated in a different way for bus and hub solutions.