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IEEE 802.1AS-Rev

Performance Requirements on Time Synchronization for Industrial Automation (Updated Version)

IEEE 802 Plenary Meeting
Feng Chen, Franz-Josef Goetz, Albert Tretter
Siemens AG
Nov. 2015, Dallas

Overview

- This presentation shows a updated list of AS parameters as industrial requirements on time synchronization for Universal Time and Working clocks. [1]

- The intention is also to present the reasons why those parameters are chosen for industrial applications.

[1] The original version was presented at the March Plenary in Berlin and can be found in http://www.ieee802.org/1/files/public/docs2015/as-chen-goetz-industrial-requirments-sync-forward-0315-v01.pdf

Requirements of Industrial Applications

Parameters	Universal Time	Working Clock
Hop count	up to 128	up to 64
Sync accuracy between Sync-master and Sync-slave at last hop	< 100 µs	< 1 µs
Sync accuracy between any two Sync-slaves	< 200 µs	< 2 µs

The parameters in the above table represents the requirements from the industrial applications for time synchronization in terms of the sync accuracy based on the given hop count.

These requirements shall be fulfilled in all operations, e.g. GM changes

Constraints to Meet Industrial Requirements

- In order to achieve the accuracy goals, certain constrains are placed on the accuracy and responsiveness of **Local clock** and **Time-aware systems** for Universal time and Working Clocks respectively.

- These constraint parameters are derived from our test, analytical model and simulation of PROFINET.[1]

[1] http://mediatum.ub.tum.de/doc/811576/811576.pdf

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LocalClock Constraints for Industrial Applications

Parameters	For Universal Time	For Working Clock
Frequency accuracy [1]	<= ± 100 ppm	<= ± 100 ppm
Max. frequency drift rate [2]	< 3 ppm/sec	< 3 ppm/sec
Time measurement granularity	<= 10 ns	<= 10 ns

[1] This requirement shall be fulfilled taking into account the frequency drift caused by temperature changes, shock, vibration, voltage variation and aging.

[2] due to temperature changes, shock, vibration, voltage variation and aging, @SyncMaster, modelled as sine curve. The 3 ppm/sec is derived from Transportation Norm: EN 50155, Rapid external ambient temperature variations resulting from running through tunnels shall be taken into account. For this purpose the rate of change of external temperature shall be assumed to be 3 K/sec.

Time-aware System Constraints for Industrial Applications

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Parameters	For Universal Time	For Working Clock
Sync Residence time	<= 10 ms[2]	<= 1 ms [1]
Sync interval	125 ms[2]	31.25 ms [1]
Pdelay turnaround time	<= 10 ms	<= 10 ms

[1] These parameters for working clock are derived from our test, mathematic model and simulation of PROFINET to guarantee the sync accuracy of 1µs especially during sync-master hold-over (200 ms), in case of GM change, where the cold-standby GM is preselected and synchronized to the primary GM.

For working clock: 64hops*1ms + 31.25ms*3 + switch-over-time < 200 ms (after three successive sync loss, then switch to the cold-standby GM)

[2] for universal time already described in .1AS-2011

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Thank you for your attention!

Feng Chen

Siemens AG

Process Industries and Drives Division

Technology and Innovations

Gleiwitzer Str. 555

90475 Nürnberg

Phone: +49 (911) 895-4955

Fax: +49 (911) 895-3762

E-Mail: chen.feng@siemens.com

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