White Rabbit standardization in IEEE1588-20XX

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THU China
IEEE standard lifecycle

- Maintaining the standard
- Gaining final approval
- Initiating the project
- Mobilizing the working group
- Balloting the standard
- Drafting the standard
IEEE1588 standard revision

• Currently: IEEE1588-2008
• Revision started in June 2013
• Enforced by standard life-cycle
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• Revision started in June 2013
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• Performed by **P1588 Working Group** with over 200 members
• Divided into 5 sub-committees
• High Accuracy (**HA**) sub-committee dedicated to White Rabbit
White Rabbit split into 5 parts

1. L1 syntonization
2. Delay asymmetry estimation and correction of PTP calculations for delay asymmetry and hardware delays
3. Calibration procedure
4. Assignment of fixed roles (master/slave) to WR ports
5. WR PTP profile compatible with Delay Request-Response default PTP profile
1. L1 syntonization in WR

- Local PTP clock is the same as L1 clock
1. L1 syntonization in HA

- Flexible and configurable relation between PTP and L1 clocks
- All phase offsets known and pseudo-constant
1. L1 syntonization in HA

- Introduces a new L1 state machine
- Semi-independent from PTP state machine
- Detects if a peer port supports L1Sync
- Handles L1 configuration matching
2. Correction of PTP calculations

• Delay asymmetry estimation:
  • In WR: \( \text{delay}_{ms} = \frac{1+\alpha}{2+\alpha} \delta_{mm} \)
  • In HA: \(< \text{delayAsymmetry} > = \text{constantAsymmetry} + \frac{\alpha}{2+\alpha} < \text{meanDelay} > \)
  \( \text{delay}_{ms} = < \text{delayAsymmetry} > + < \text{meanDelay} > \)
2. Correction of PTP calculations

• Delay asymmetry estimation:
  • In WR: \( \text{delay}_{ms} = \frac{1+\alpha}{2+\alpha} \delta_{mm} \)
  • In HA: \( <\text{delayAsymmetry}> = \text{constantAsymmetry} + \frac{\alpha}{2+\alpha} <\text{meanDelay}> \)
    \( \text{delay}_{ms} = <\text{delayAsymmetry}> + <\text{meanDelay}> \)

• Hardware delays:
  • In WR: only Slave corrects \( of\text{fset}_{ms} \) for \( \Delta_{TXM}, \Delta_{RXM}, \Delta_{TXS}, \Delta_{RXS} \)
  • In HA: both Master and Slave correct timestamps for ingress/egress latencies
3. WR Calibration procedure v1.1

• In HA: “Calibration Procedures”
• Rewritten into informative annex
• Rewritten to use IEEE-1588 terminology and data sets
• Exactly the same step-by-step procedure

• Does not include
  • Mathematical proofs
  • Measurement errors estimation
4. Assignment of fixed roles

- **MasterOnly PTP Ports**
  - Best Master Clock Algorithm running
  - Some ports disallowed from becoming PTP Slaves
4. Assignment of fixed roles

• MasterOnly PTP Ports
  • Best Master Clock Algorithm running
  • Some ports disallowed from becoming PTP Slaves

• Mechanism for external role configuration
  • Best Master Clock Algorithm disabled
  • External mechanism to configure PTP port state
5. WR PTP Profile

- “High Accuracy Delay Request-Response Default PTP Profile”
- Extends Delay Req-Resp Default PTP Profile
- Mandates support of optional features required by High Accuracy
- Defines default and allowed values for the optional features
- Interoperates with Delay Req-Resp Default Profile
- Defines High Accuracy Clock Model
  - Syntonization through Layer-1
  - Synchronization through PTP
Where is WR in IEEE1588-20XX?

- L1 syntonization – Annex O
- Correction of PTP calculations – Clause 16.7 / 16.8
- Calibration procedure – Annex Q
- Assignment of fixed roles – Clause 9.2.2.2 / 8.2.15.5.2 / 17.6
- HA PTP Profile – Annex J.5
- Sub-ns implementation – Annex P

- Changes to core parts of the standard:
  https://www.ohwr.org/projects/wr-std/wiki/wrin1588
Where is WR in IEEE1588-20XX?

**HA-specific optional features**
- L1 Sync
- Calculation of the delayAsymmetry
- Configurable correction of timestamps

**Changes to the main clause of IEEE1588**
- HA features require changes to 1588 clauses

**Generic optional features**
- Mechanism for external configuration
- Master Only mode

**HA Profile uses and requires support of the HA and other optional features**

**High Accuracy Default PTP Profile**
(Addition to Annex J)

**Informative annex describes HA Profile implementation that provides sub-ns accuracy of synchronization**

**Sub-ns synchronization using High Accuracy Default Profile**
(Annex P)
IEEE1588-20XX standardization process

2013 Jun: start

Project Authorization Request (PAR)

The protocol enhances support for synchronization to better than 1 nanosecond.
IEEE1588-20XX standardization process

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IEEE1588-HA implementation

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IEEE1588-HA implementation

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Now:
- Automated compliance tests delivered by Veryx
- Ongoing work on HA implementation

Greg Daniluk, WR standardization in IEEE1588, 28/06/2018
Summary

• White Rabbit becomes High Accuracy profile of IEEE1588-20XX
• Standard drafted
• Now going through a Balloting phase
• We’re working on first HA implementation
• Compliance tests developed independently

• New IEEE-1588 standard to be published mid-2019