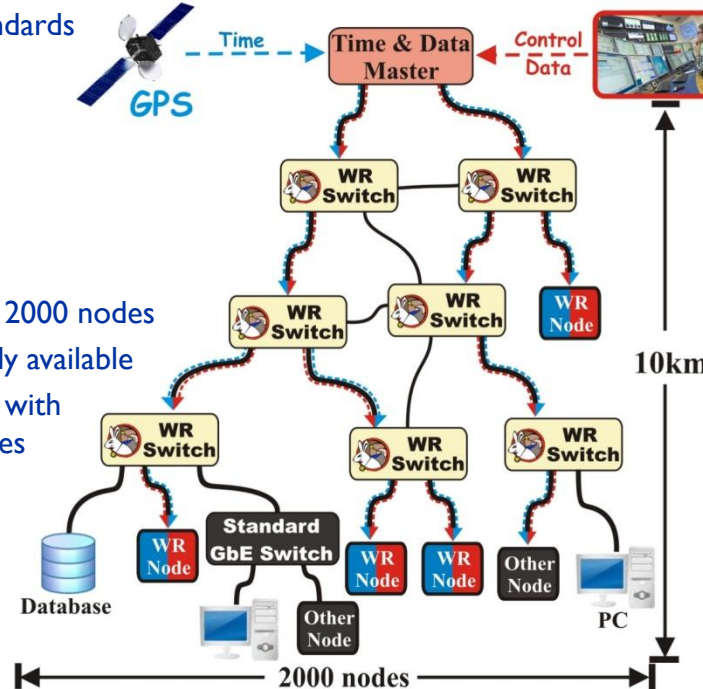




White Rabbit in a nutshell

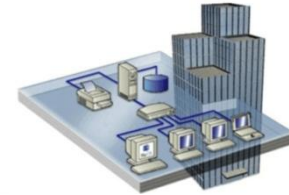
White Rabbit technology is based on, and extends if necessary, well-established standards

- Initiated by CERN and GSI for control & timing
- Based on well-established standards
 - Ethernet
 - Bridged Local Area Network
 - Precision Time Protocol
- Extends standards to provide
 - Sub-ns synchronisation
 - Deterministic data transfer
- Initial specs: links $\leq 10\text{km}$ & ≤ 2000 nodes
- Open Source and commercially available
- Many applications world-wide with links $\leq 1000\text{km}$ & ≤ 6800 nodes



Institute of Electrical and Electronics Engineers

IEEE 802.3 & IEEE 802.1Q
Ethernet Local Area Networks



IEEE 1588
Precision Time Protocol

Motivation to base WR on standards:

- Off-the-shelf standard gear to minimise costs
- Off-the-shelf standard existing tools
- More likely to be implemented by companies
- Evolves with the standard allowing long-term support
- Might make it into the base standard

Towards WR standardisation

WR standardisation to bring longevity, maturity, stability and easier collaboration with companies

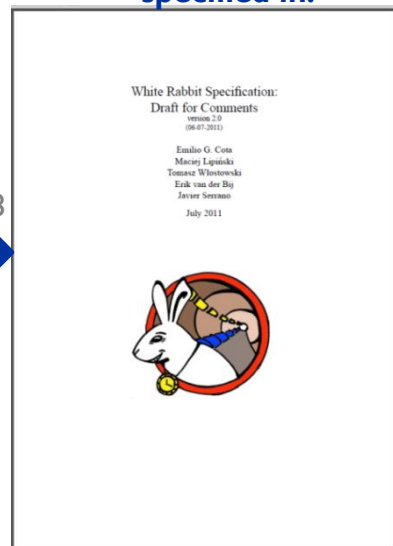
Jul. 2011
WR Spec
published

Apr. 2012
Start project to
standardise WR

Sept. 2012
IEEE1588
Lifecycle initiated

May. 2013
PI588 project
initiated

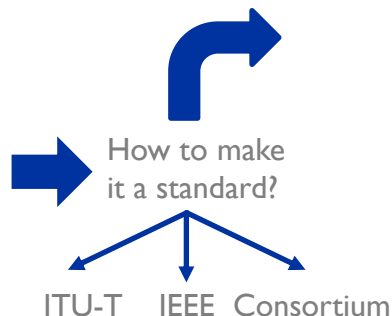
White Rabbit synchronisation specified in:



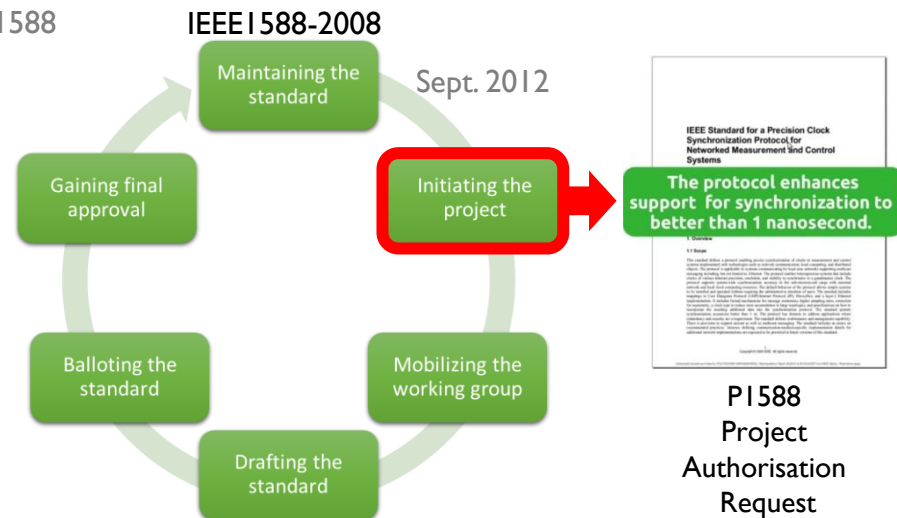
WR-PTP Profile

WR extension of IEEE1588-2008

Best standardisation path:
Include in new a edition of IEEE1588



IEEE standard lifecycle enforced to ensure new edition every 10 years



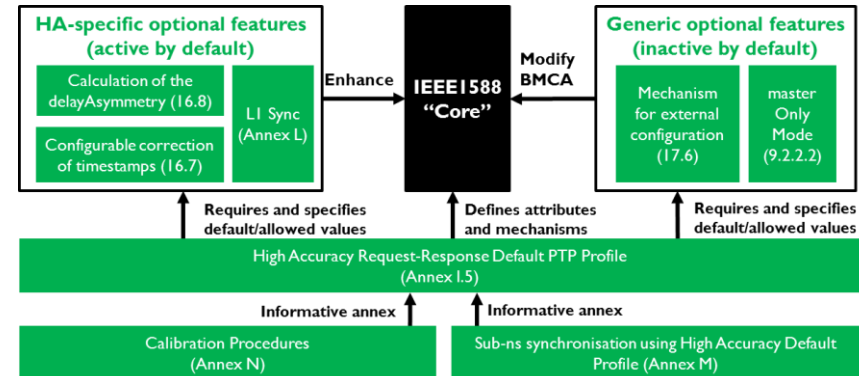
WR Standardisation in IEEE1588

WR standardisation into the base standard was the best path which took 7 years



- IEEE1588 standard revised by **PI588 Working Group** with 200 members
- Divided into 5 sub-committees
- **High Accuracy (HA) sub-committee**
 - Focused on White Rabbit
 - Experts from industry and academia
 - Division of WR into self-contained parts, useful separately
 - Definition of **Optional Features** and **High Accuracy Profile** that allows WR implementation and performance
- Ballot review of the revised standard
 - Internal WR Ballot: 5605 comments
 - Worldwide Sponsor Ballot: 358 comments

White Rabbit included in IEEE1588-2019 on 55 pages as
High Accuracy Default PTP Profile



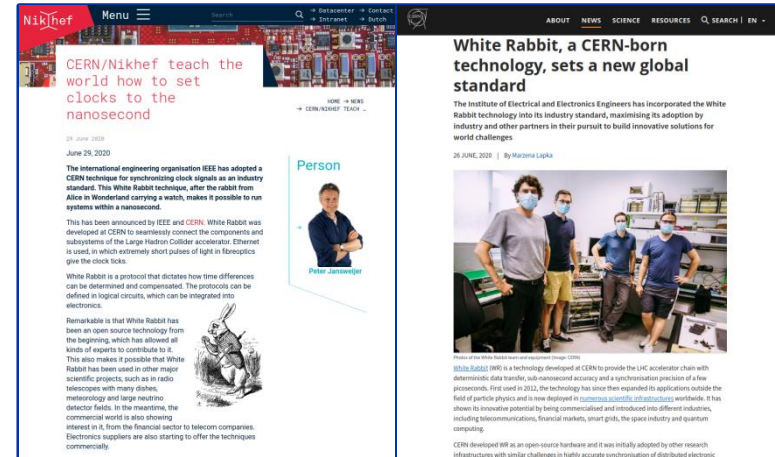
<https://ohwr.org/projects/wr-std/wiki/wrin1588>

Costs, benefits and conclusion

A process requiring a mature technical solution and flexibility to reach consensus



- The author's involvement on behalf of CERN included:
 - Leading the High Accuracy SC and contributing to other SCs
 - Resolving the ballot comments resolution
 - Editing with the IEEE Editor in the final stage
- Indicative costs: 2.25 person-years and 26 kCHF spread over 7 years
- Benefits
 - **For WR technology:**
known shortcomings fixed, more generic and flexible, scrutinised, future-proof
 - **For users/vendors:**
mature and stable solution, more applications/vendors, increased competition
 - **For IEEE I588:**
increased popularity and user base, PTP ready for ever-growing industry requirements
 - **For CERN:**
longevity and lower cost of technology, knowledge transfer, key player in IEEE I588
- For technologies which are meant to last for decades and be deployed in thousands of units, the benefits of standardisation clearly out-weigh the efforts



<https://www.nikhef.nl/en/news/cern-nikhef-teach-the-world-how-to-set-clocks-to-the-nanosecond/>
<https://home.cern/news/news/knowledge-sharing/white-rabbit-cern-born-technology-sets-new-global-standard>