

#### Francisco Girela @ WSTS 2021

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## At the core of electronic trading networks

- Latency
  - Optimization
  - Network visibility
- Data quality
  - Timestamping
    precision
  - Distributed strategies
- Regulations
- Resiliency





- **Traceable time synchronization** is the capability to maintain a shared notion of time related to an official time reference between different devices located in the same or different locations.
  - Generation: is the capability to obtain a notion of time.
    - GPS, atomic clocks
  - Distribution: is the capability to propagate a notion of time to a different device.
    NTP, PTP, WR, PPS





## How does the market work?

#### Large Investors:

- Seek Investment opportunities and/or Insurance
- Have a price opinion
- Technology needs: Execute orders quickly Market-makers:
- Continuously provide liquidity to the market
- No opinion: both Buy and Sell prices
- Technology needs: limit the Risk of having stale prices

#### **Exchanges:**

- Continuously sort orders by best price, then best time
- Technology needs: ensure a Deterministic service





Ref: Clock Synchronization for the Low-latency Financial sectors, Pedro Estrela, ISPCS 2019 keynote https://www.euronext.com/en/technology/optiq-tech-solutions-for-exchanges-and-venue-operators

## How does a stock exchange network look like?

## • Participant

- Buy/sell stocks
- Access Network
  - Recover data from participants
- Matching engine
  - Order book
- Market Data Network
  - Provide data to participants



🚫 Cisco 3548X Switch

Optical tap (capture and time measurement)



Ref: https://www.eurex.com/resource/blob/48918/74e70365580415639ea4628ec25a6b72/data/presentation\_insights-into-trading-systemdynamics\_en.pdf





Ref: https://navisp.esa.int/opportunity/details/55/show https://www.pinclipart.com/maxpin/xJmwRx/



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 Latency measurement: Absolute reaction times to market events oscillates between 15 and 70 nanoseconds. Main wave: 20 ± 10 ns.

5 ns peak-to-peak time error means 50% uncertainty in the measurement.

 Data quality: Training AI with incorrect latency values affects the fidelity of the outcome. Even when not interested on running the "lowlatency" race, time sync and capturing are important tools to improve your profitability.





## Network resiliency and regulations

#### **FINRA CAT:**

- Each Participant shall synchronize its Business Clocks, (...), at a minimum to within **100 microseconds** of the time maintained by the atomic clock of the NIST.
- Each Industry Member shall synchronize its Business Clocks, (...), at a minimum to within a **50 millisecond** tolerance of the time maintained by the atomic clock of the NIST, and maintain such synchronization

#### **MIFID II:**

• The maximum divergence from UTC for activity using high frequency algorithmic trading techniques is **100 microseconds**.

FINCE CET CAT Alert – 2020-02, Updated Publish Date: 05/08/2020

#### STANDARDS FOR SELF REPORTING DEVIATIONS OF CLOCK SYNCHRONIZATION STANDARDS TO FINRA CAT

EFFECTIVE DATE: THE COMPLIANCE ENFORCEMENT DATE FOR INDUSTRY MEMBER REPORTING



Regulatory technical and implementing standards – Annex I MIFID II / MIFIR



## Network resiliency best practices

What to avoid?

- **GNSS dependency:** Affected by jamming, spoofing and unintended interferences.
- Single time source: Just a single time source doesn't ensure that the time is correct and risks your network.

What to seek?

- Network redundancy: Single points of failure increase the probability of major failures.
- **Traceability:** Time synchronization must be validated, especially when working with purely software solutions.
- **Profitability:** Deploying synchronization backups can be an opportunity to improve and boost your trading capabilities.



Segal's law "A man with a watch knows what time it is. A man with two watches is never sure."



White Rabbit Technology



# White Rabbit technology

## White Rabbit (WR) is an ultra-accurate IEEE 1588 (PTP) implementation that achieves sub-nanosecond accuracy.



Easy to integrate in **Ethernet** networks



Avoid calibration and



NTP, PTPv2, PPS and subnanosecond WR





Scalable to thousands of nodes in metro areas



**Resilient** to GNSS disruption



**PTPv2.1 High Accuracy** profile



## White Rabbit Hardware

# White Rabbit hardware

- Multi-port synchronization fan-out.
- WR, HATI, IEEE 1588 PTPv2 and NTP interoperability on all optical interfaces.
- Multi-source time references.
- Failover mechanisms.
  - Automatic switchover.
  - Holdover.
- Time traceability for regulatory purposes.
- Extended monitoring and management tools (Authentication, SNMP, security...).
- Redundant power supply and fans.
- Serial and Ethernet RJ45 ports.
- White Rabbit timing monitoring.







## White Rabbit Software

# **FPGA** IP core

- WR-PTP timing using **FPGA** (Xilinx) IP Core.
- Sub-nanosecond time accuracy on L1 switches and 3rd party NICs.
- No need for expensive oscillators/clocks.
- No added latency to the data path.







## Spanish stock market use case

- Sub-nanosecond synchronization over a 44 km fiber link (27 miles).
- ± 15 nanoseconds traceability to UTC using a GNSS
  Disciplined Oscillator WR device.
- Holdover capabilities if the link is lost.

	2 h	6 h	12 h	24 h	36 h
2019-09-06	8 ns	58 ns	53 ns	729 ns	1252 ns
2019-10-26	17 ns	95 ns	270 ns	474 ns	609 ns
2019-11-02	80 ns	336 ns	529 ns	881 ns	1649 ns
2019-11-09	34 ns	46 ns	40 ns	38 ns	272 ns
2019-11-16	28 ns	5 ns	52 ns	73 ns	53 ns
Worst observed case	80 ns	336 ns	529 ns	881 ns	1649 ns







## White Rabbit Technology

## A present technology designed for the future



#### Best-in-class synchronization accuracy for the next electronic trading generation.

- Deutsche Börse: <u>https://stacresearch.com/STAC-Summit-6-Jun-2019-deutsche-boerse</u>
- Optiver: <a href="https://www.youtube.com/watch?v=pe6Gh\_fi3Wc&t=2s">https://www.youtube.com/watch?v=pe6Gh\_fi3Wc&t=2s</a>
- Spanish stock market: <u>https://ieeexplore.ieee.org/document/9071992</u>



Basis for the Standard IEEE 1588-2019 High Accuracy profile.



Alternative to GNSS synchronization in several segments.

- USA Department of Transportation demonstration as Global Positioning GPS backup: <u>https://insidegnss.com/seven-solutions-to-demo-alternate-precision-time-keeping-for-dot/</u>
- European GNSS Agency: <u>https://www.gsc-europa.eu/sites/default/files/sites/all/files/</u> <u>Report on User Needs and Requirements Timing Synchronisation.pdf</u>
- Leader technology in science.
- 5G telecom evaluations: Deutsche Telekom, Orange...



## Contact 7 Solutions

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  - Available during the whole show!



# Thank you for your attention!

