The White Rabbit Story at Deutsche Börse

13th White Rabbit Workshop
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The Big Picture

Colo 2.0 Topology

- Distribution Layer Switch
- Access Layer Switch
- Optical TAP (for capture and timestamping)
Timestamping Overview

NB: network TAP ~= Terminal Access Point (backronym)
Timestamping Overview

- For monitoring, all network traffic is captured
- Each captured packet is timestamped, i.e. a timestamp is attached
- Timestamps have sub-nanosecond resolution
Timestamp Trailer

Enhanced Trading Interface 11.0, ModifyOrderNRResponse (10108), BodyLen: 136

Metamako ethernet trailer, Timestamp: 13:05:00.000151592, Source Device: 66, Source Port: 11

Original FCS: 0xb0aa5c32

Trailer Extensions, Sequence No: 680
Sequence Number: 680

Time Stamp: Jan 17, 2023 13:05:00.000151592 CET
[Time Difference: -0.000010408 seconds]

Flags: 0x03, Original FCS Valid, Has Trailer Extensions
.... ...1 = Original FCS Valid: Valid
.... ..1. = Has Trailer Extensions: True
0000 00.. = Reserved: 0x00

Source Device ID: 66
Source Port: 11

00d0 43 0a b0 aa 5c 32 00 02 a8 20 63 c6 8e ec 00 02 C...\2...
00e0 50 28 03 00 42 0b P(\8...
White Rabbit – A perfect match

- White Rabbit synchronizes clocks with sub-nanosecond precision and accuracy
- When monitoring participants competing over single nanoseconds, this performance is required
- More and more devices support it natively
White Rabbit Sub-Nanosecond Performance

Offsets between two White Rabbit switches, over 2.5 days:
Deutsche Börse Services built around White Rabbit

- Monitoring that integrates high-precisions timestamps extensively (network/applications)
  - Troubleshooting
  - Verification that our trading system stays fair
  - Performance analyses
  - …

- White Rabbit Network Access
  - Co-located participants can connect to our White Rabbit network

- High Precision Timestamp (HPT) Service
  - Provide transparency to participants
White Rabbit Access – Participant Point of View
Customer Feedback

- ‘DB even sells extra timestamps taken out of band for more insight.’
- ‘Very interesting!’
- ‘Great business model!’
- ‘Ultimate expression of time is money.’
- ‘Publishing internal timestamps is great for transparency.’
Outlook

Use White Rabbit for all the things?

- Use White Rabbit for measuring the lengths of cables
- Why not just connect also all the server to the WR network?
  - => to increase accuracy/precision of server generated timestamps
  - status quo: servers are connected to dedicated PTP network
Cable Length Measurement

Since White Rabbit devices are very good at measuring delays …

- … why not use a White Rabbit device for measuring the length of cables
- => insert the cable into the path somehow, query the delay, convert delay to length
Connecting servers to White Rabbit

Possible approaches:

1. Hybrid – White Rabbit into a rack and the last meters:
   1. 1PPS
   2. PTP / SyncE

2. Find a Network Interface Card (NIC) that supports White Rabbit
Hybrid: 1PPS

WR endpoint + 1PPS splitter

1PPS splitter that directly connects to WR
Hybrid: 1PPS

Advantages:
- Good network cards (NIC) with 1PPS input are easy to find

Disadvantages:
- Requires NIC with high quality oscillator
- Easy to introduce errors in the 1PPS cabling
- Operationally challenging
Network card with native White Rabbit

Arguably, having a good network card with native White Rabbit would be the best solution.

- For hardware timestamping on the NIC
- Next step: PTM to better synchronize the system clock to the NIC clock
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Where to get more Information

- Insights into Trading System Dynamics (Deutsche Börse’s T7), May 2023
  https://www.xetra.com/resource/blob/2419076/e8d4df56f75c9a96fb0f6fff6b18a14f/data/Deutsche%20B%C3%B6rse%E2%80%99s%20T7%20-%20Insights%20into%20trading%20system%20dynamics.pdf

- HPT Analysis Example Notebook (2018-12-10)
  https://www.mds.deutsche-boerse.com/resource/blob/1486254/682c971319c8233513fe9a046db85c6c/data/High-Precision-Timestamps-hpt.zip.html

- Follow Stefan Schlamp on LinkedIn for market (micro) structure analyses snippets