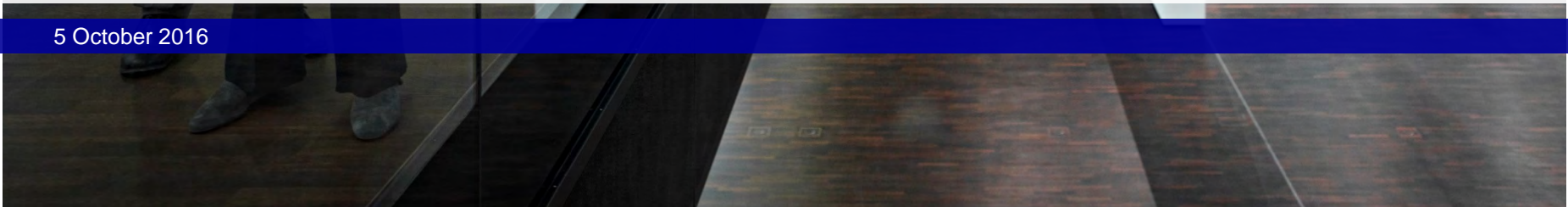




# Open Day 2016

T7<sup>®</sup> latency roadmap  
Sebastian Neusüß

5 October 2016



# Latency: an overview

## Definition

Latency is the delay between signal and response.

## Latency in trading ecosystem

- § Market signal to order generation (trading participants reaction time)
  - § “to trade or not to trade”
  - § “race to zero”, local: sub microsecond, non-local: microwaves, new networks, LEO satellites (?)
- § Exchange round-trip time
  - § Introduces risks while order status unknown
  - § Eurex® T7 median reduced from 200  $\mu$ s to 150  $\mu$ s (2015 to 2016)
  - § Xetra® T7 median roundtrip expected at ~100  $\mu$ s (current Xetra system: 380  $\mu$ s)
- § Order generation to matching engine latency (“Inbound latency”)
  - § Part of round-trip time
  - § Variance introduces non-determinism and incentivises “sender multiplicity”
- § Matching engine to participant latency (“Outbound latency”)
  - § Part of round-trip time
  - § Variance incentivises “receiver multiplicity”

## T7® latency roadmap overview

### **Q4/2016**

§ Upgrade of hardware for matching engines, high-frequency gateways and market data publishers

### **21 November 2016 (T7 4.0)**

§ Merge of matching engine and EOBI market data publisher into a single process to save transportation time ( $t_9 - t_7$ ), stepwise introduction

§ Improved sequencing consistency on the ETI gateways and reduced variance of gateway processing times

§ MassOrderCancel extension reduces complexity and thus latency for liquidity providers

§ Addition of first option product to EOBI (Eurex KOSPI Product OKS2) in December 2016

### **Q2/2017 (before T7 5.0)**

§ Upgrade of 10 Gbit co-location network

### **19 June 2017 (T7 5.0)**

§ FIFO processing per gateway

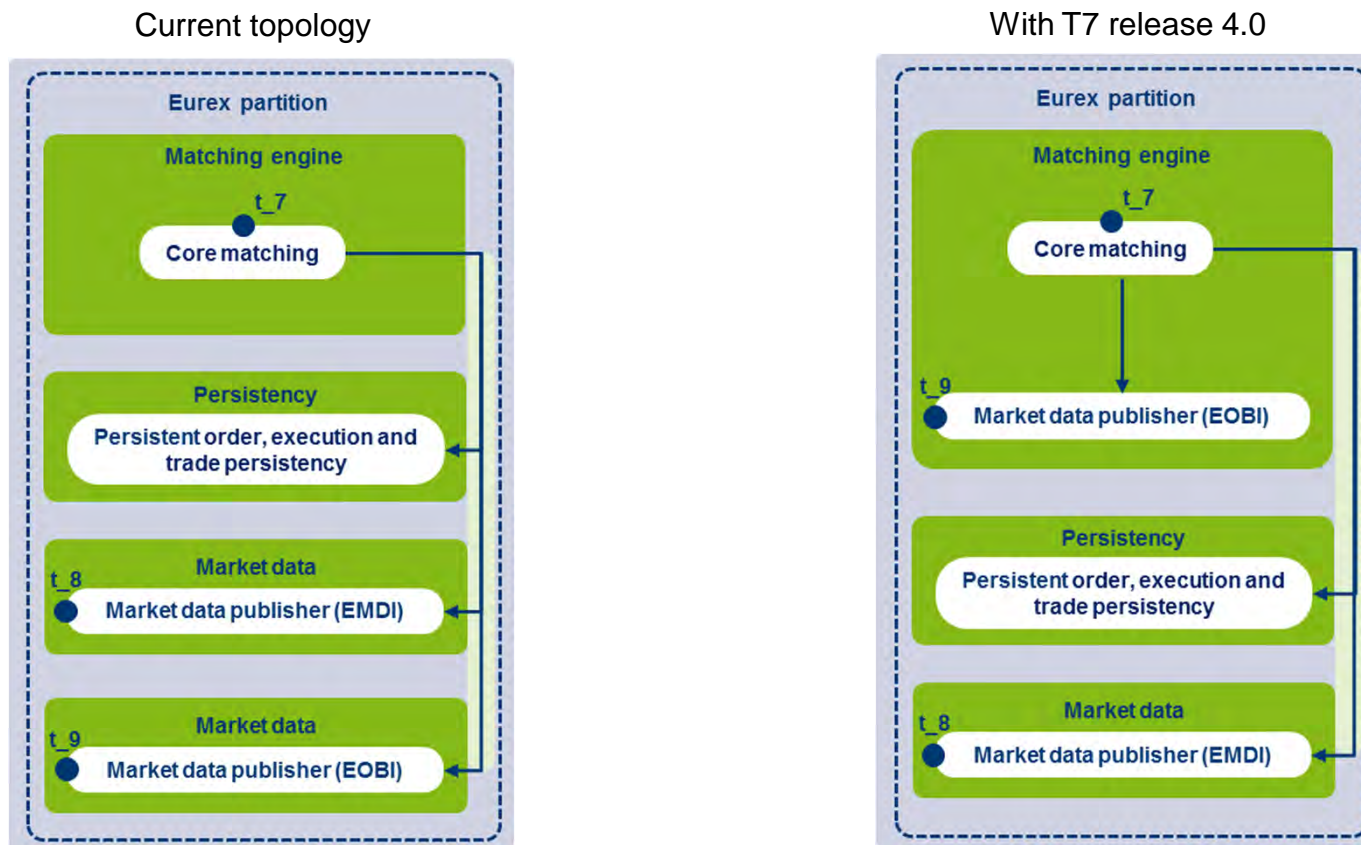
§ Xetra® migration to T7 (26 Jun and 3 Jul)

### **4 December 2017 (T7 6.0)**

§ Partition-specific FIFO gateways, stepwise introduction

## Merge of EOBI and matching engine

- § Merge of matching engine and EOBI market data publisher into a single process will reduce the match to market data and latency ( $t_9 - t_7$ ) significantly
- § Underlines “public data first” principle and makes system ready for gateway latency improvements



## Motivation for 10 Gbit co-location upgrade

The current Eurex / Xetra 10GE network infrastructure in co-location is about five years old and Eurex / Xetra plan to offer an additional improved 10GE connectivity alternative to members.

### Reasons

#### § Ease of access and reduced complexity

§ Current situation:

- one pair of order entry switches per market in each of the six customer rooms<sup>1)</sup>
- one pair of market data switches per market in each of the six customer rooms
- customers can only reach the respective pair of switches in each room

§ Future situation:

- customers may reach any switch from any room without move of equipment
- fewer customer-facing switches

#### § Better consistency

§ Less latency variance by using state-of-the-art equipment

§ Better normalisation of cable lengths (currently +/- 4 m, +/-20 ns)

§ **Better latency:** one-way latency reduction by ~1  $\mu$ s

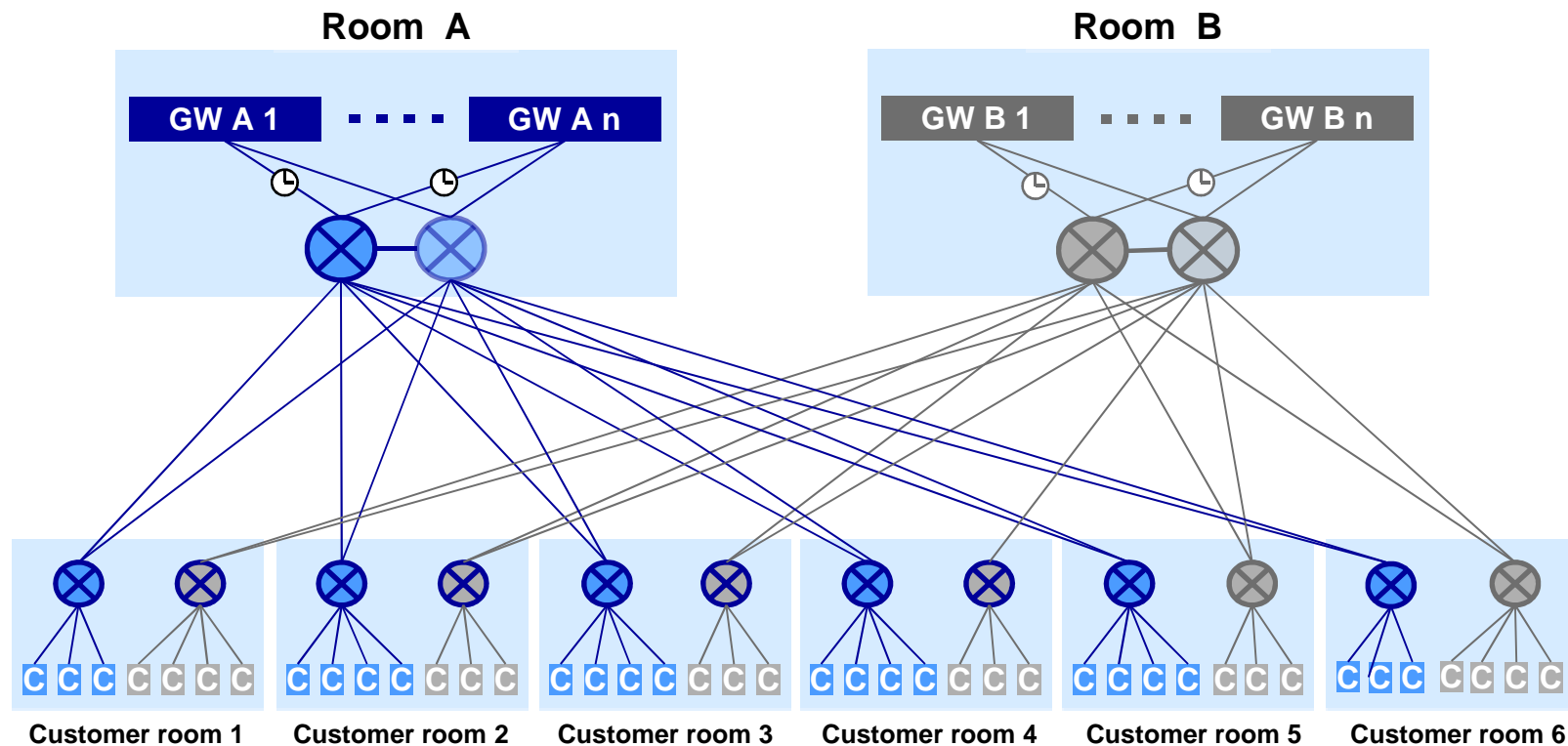
§ **Better monitoring capabilities:** additional time stamp at handover point between customers and exchange

<sup>1)</sup> There are seven co-location rooms in Equinix (out of which one is currently being retired and not supported for new network).



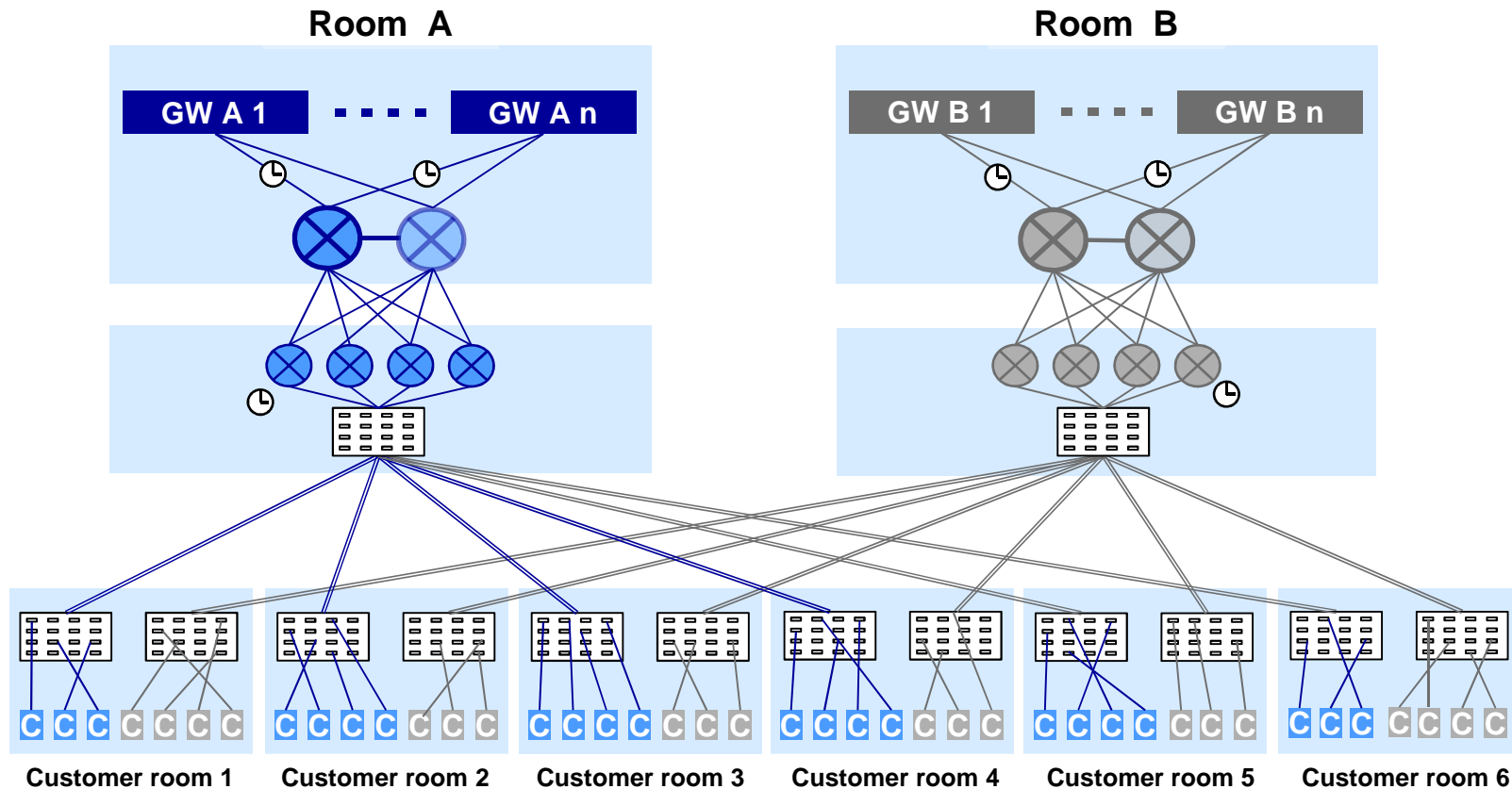
# Current order entry network topology in 10 Gbit co-location

- § two switches per gateway room (for failover reasons)
- § 24 customer-facing switches (four per customer room, Eurex<sup>®</sup> A / B, Xetra<sup>®</sup> A / B, Xetra not shown below)
- § Customers can only connect to switches in the room they are located in



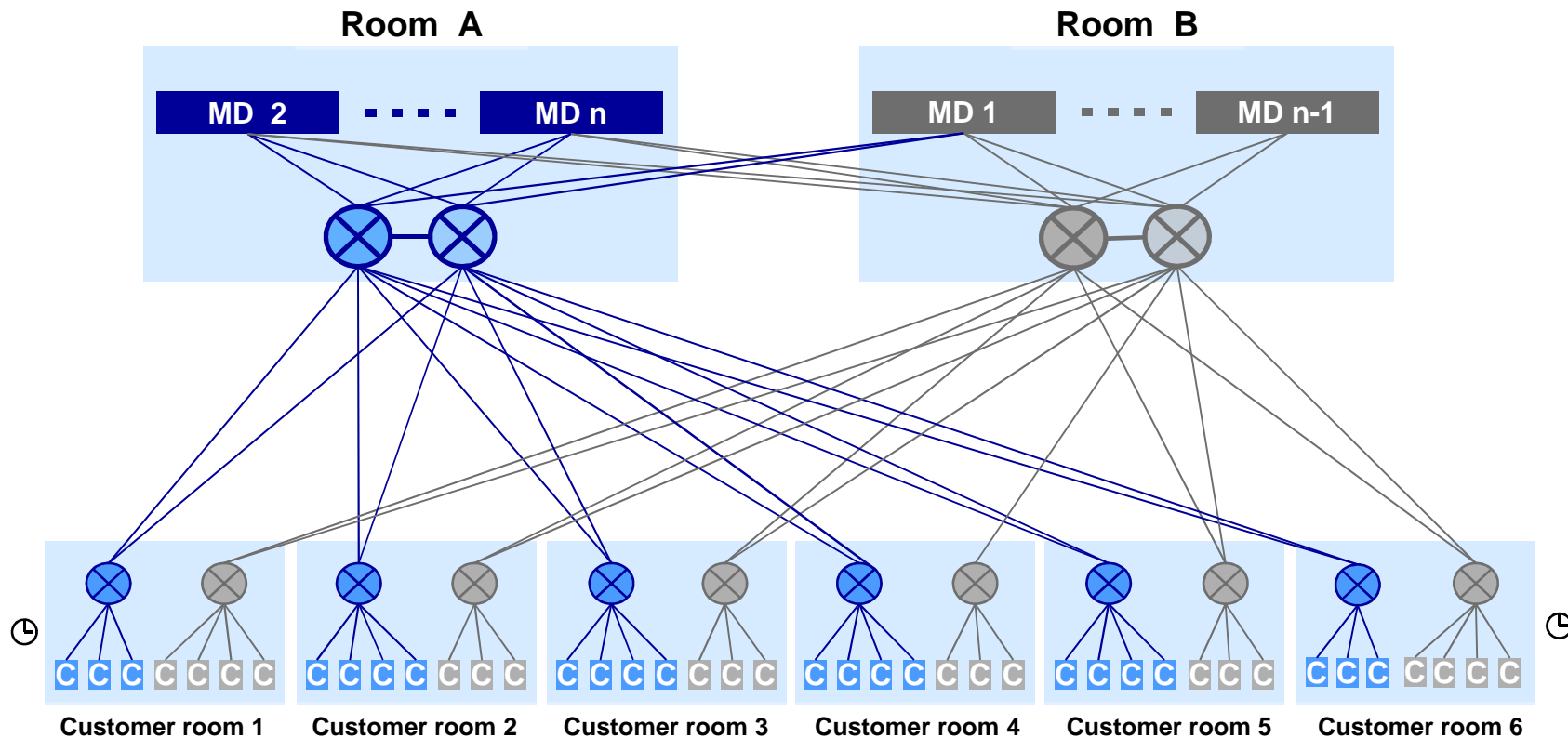
# Future order entry network topology in 10 Gbit co-location

- § two switches per gateway room (for failover reasons) and per market (only one market shown)
- § Eurex®: eight centrally located switches (four per room, A and B)
- § Xetra®: four centrally located switches (two per room, A and B), not shown below
- § Customers can connect to any switch from any of the six co-located rooms



# Current market data network topology in 10 Gbit co-location

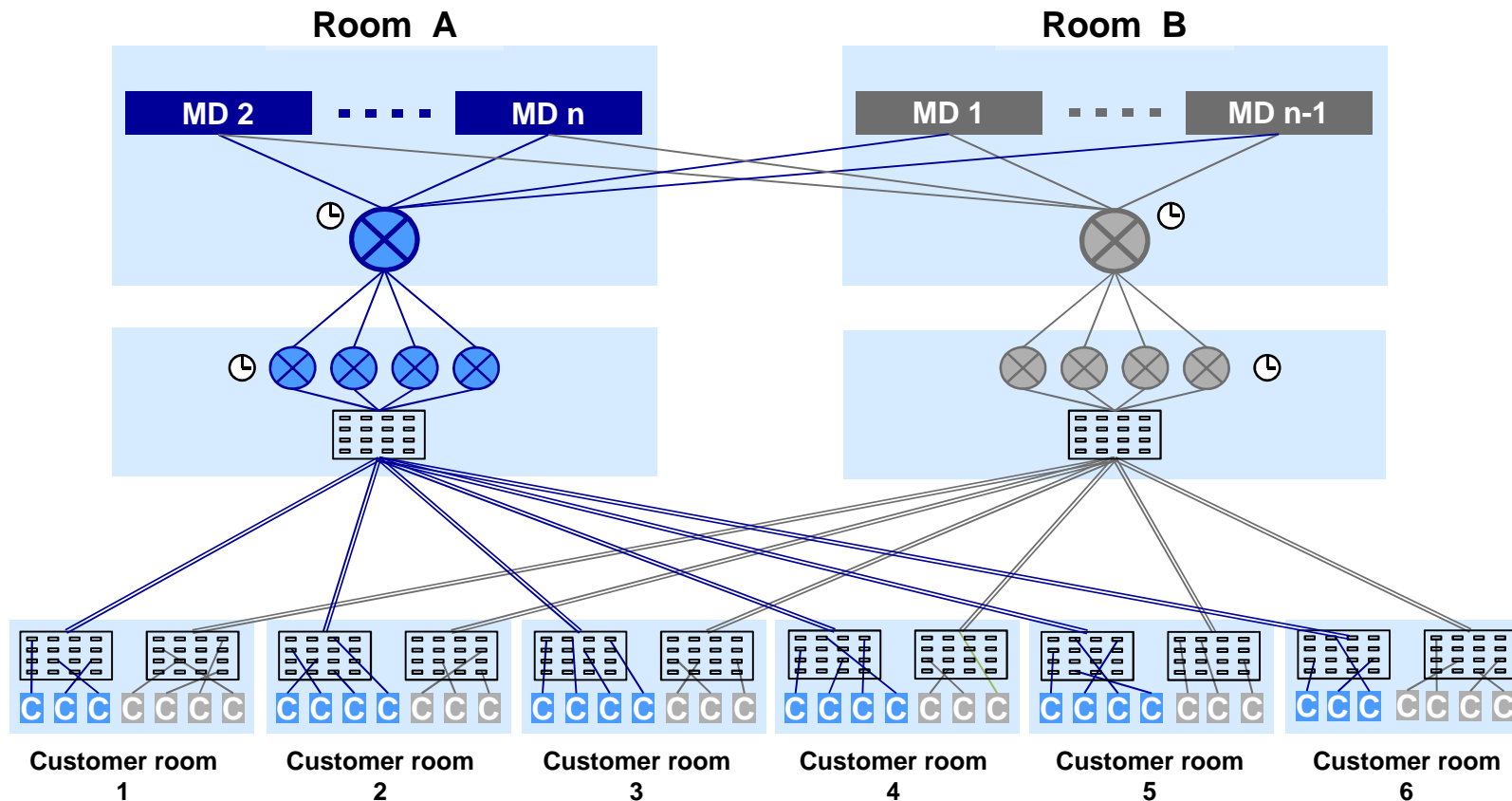
- § four market data distribution layer switches (two A and two B switches)
- § 24 market data customer-facing switches (Eurex<sup>®</sup> A / B and Xetra<sup>®</sup> A / B per room)
- § Customers can only connect to switches in the room they are located in





## Future market data network topology in 10 Gbit co-location

- § two market data distribution layer switches (A / B) per market
- § Eurex®: eight centrally located customer-facing market data switches (four in A, four in B)
- § Xetra®: four centrally located customer-facing market data switches (two in A, two in B), not shown
- § Customers can connect to any switch of any of the six co-located rooms



## Migration plan

- § Co-location 2.0 will be built in parallel to the existing infrastructure
- § It will be offered at a new price that will be published by the end of 2016
- § Legacy network (including 10GE connectivity) will be connected to co-location 2.0 access layer switches
- § Go-live date is set before T7® release 5.0 (June 2017)
- § Orders may be placed as from 20 February 2017
- § Lines will be available on go-live date for orders received until 17 March 2017
- § Orders placed after 17 March 2017 will be processed in first-come, first-served mode

## T7<sup>®</sup> order entry enhancements

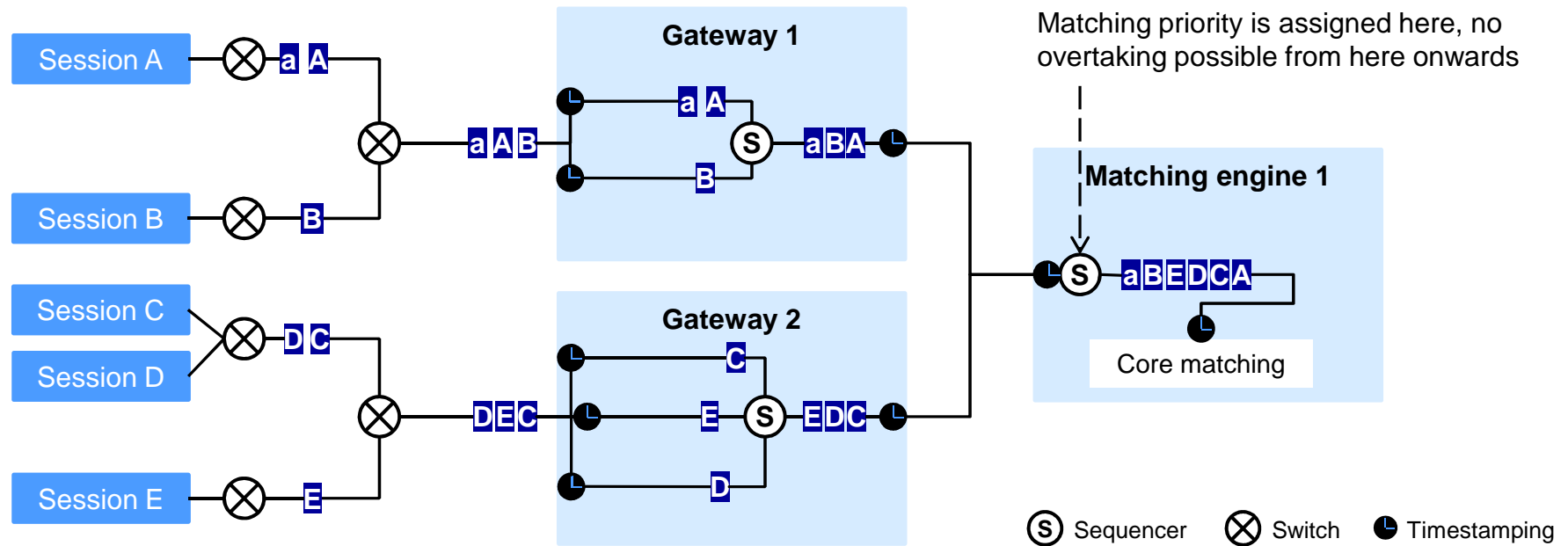
**Current situation:** parallel inbound paths with latency jitter

- § 14 customer-facing switches with connection constraints
- § 16 HF gateways (Eurex<sup>®</sup>) with processing jitter of ~10 µs

**Future situation:** fewer inbound paths with reduced jitter

- § Upgraded 10 Gbit network with eight (four) customer-facing switches for Eurex (Xetra<sup>®</sup>)
- § Rel 4.0: 16 HF gateways with less processing jitter and reduced overtaking
- § Rel 5.0: FIFO processing on each HF gateway
- § Rel 6.0: introduction partition-specific FIFO gateways

# T7® order entry – current situation



Request sequencing takes place ...

§ on the network in front of the trading gateways.

§ in the gateway for messages of all sessions routed to one matching engine (partition).

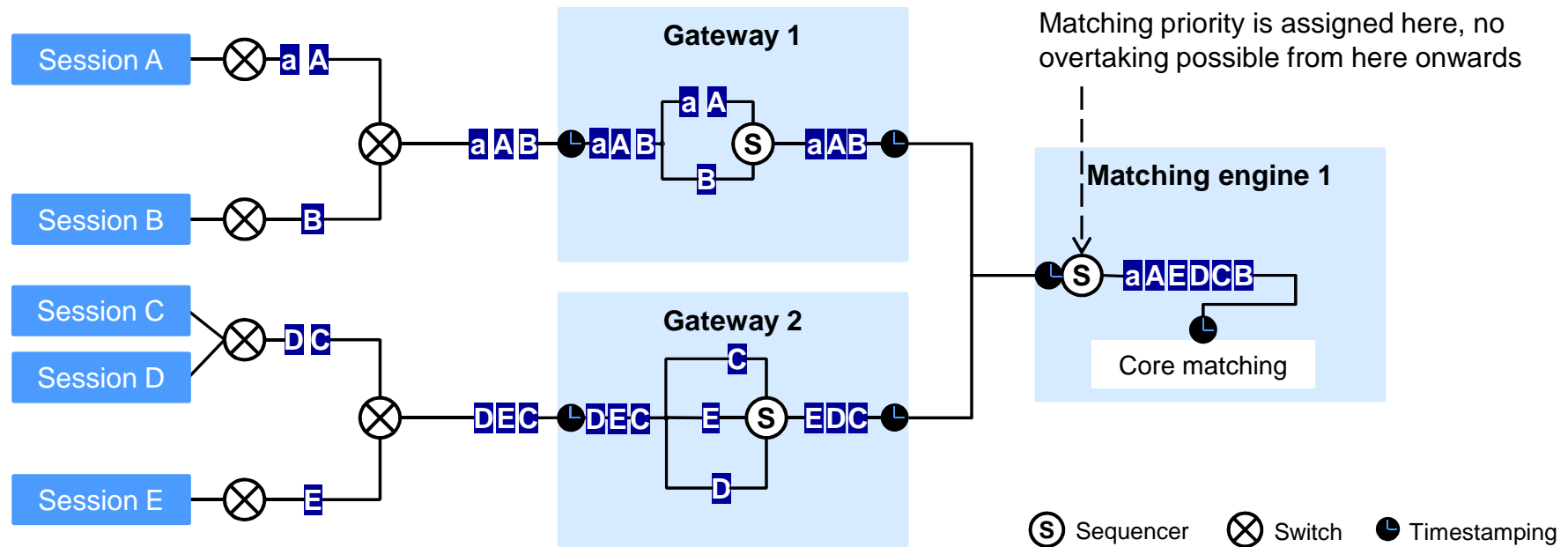
§ in the matching engine for messages of all sessions.

Request ordering is preserved ...

§ within the messages of a session routed to one matching engine (partition).

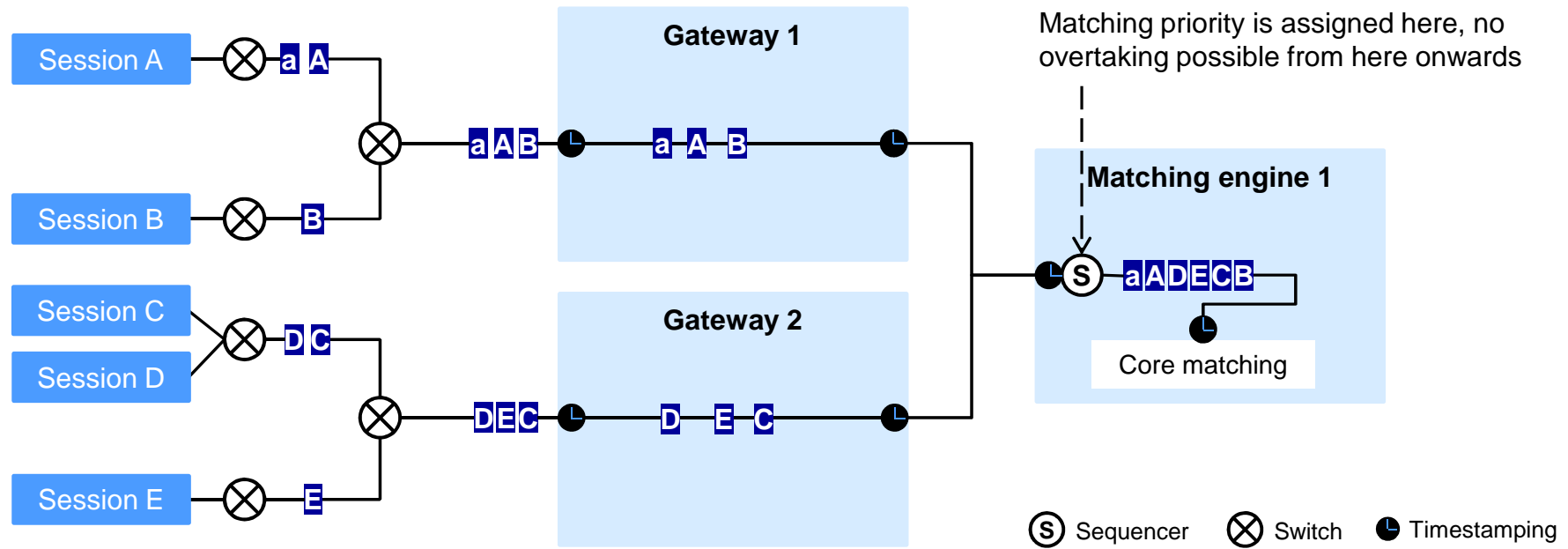
§ within the messages sent from one gateway to a matching engine (partition).

# T7<sup>®</sup> order entry – release 4.0



- § Same sequencing points as before
- § Reduced reordering probability within each gateway, e.g. in case of a burst of ten messages in one microsecond, the probability of the first message leaving the gateway first is raised from currently ~50% to > 90% (lab results).
- § Fewer and newer order entry switches (Co-location 2.0)

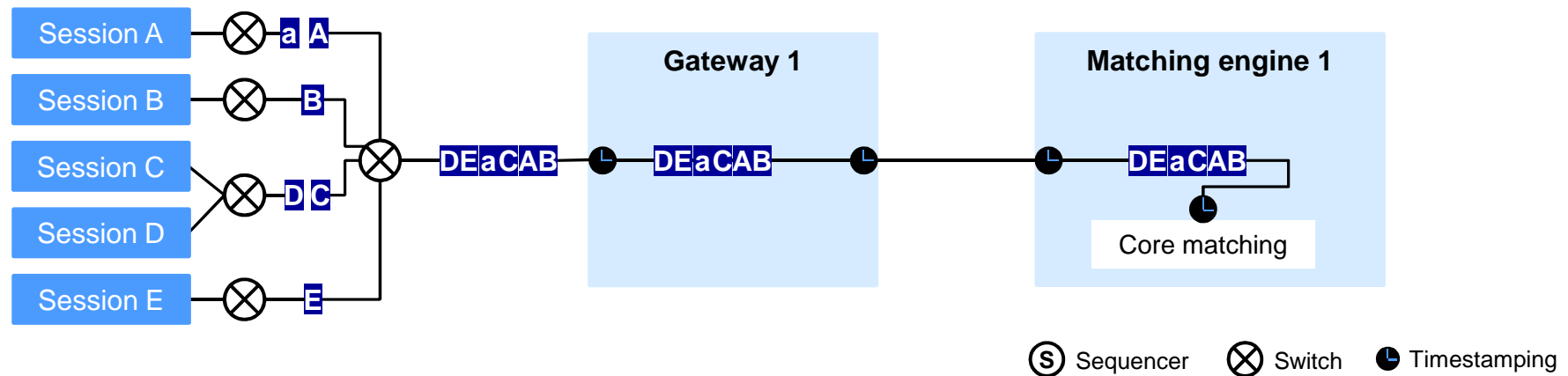
# T7® order entry – release 5.0



- § Wire order delivery to each gateway
- § FIFO processing within each gateway



# T7<sup>®</sup> order entry – release 6.0



- § One FIFO gateway per matching engine (partition)
- § LF and FIX sessions will still be able to access all partitions
- § Stepwise introduction
- § Implementation details not yet finalised

## Further information

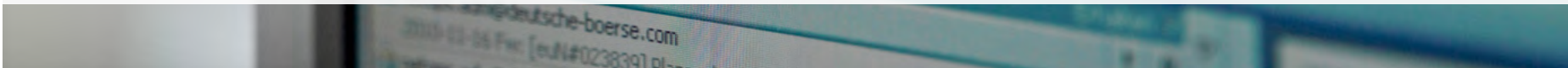
§ More details and regular updates are available in the “Insights into Trading System Dynamics” presentation at [eurexchange.com](http://eurexchange.com) > Technology > HFT

§ For further questions contact us via [monitoring@deutsche-boerse.com](mailto:monitoring@deutsche-boerse.com)

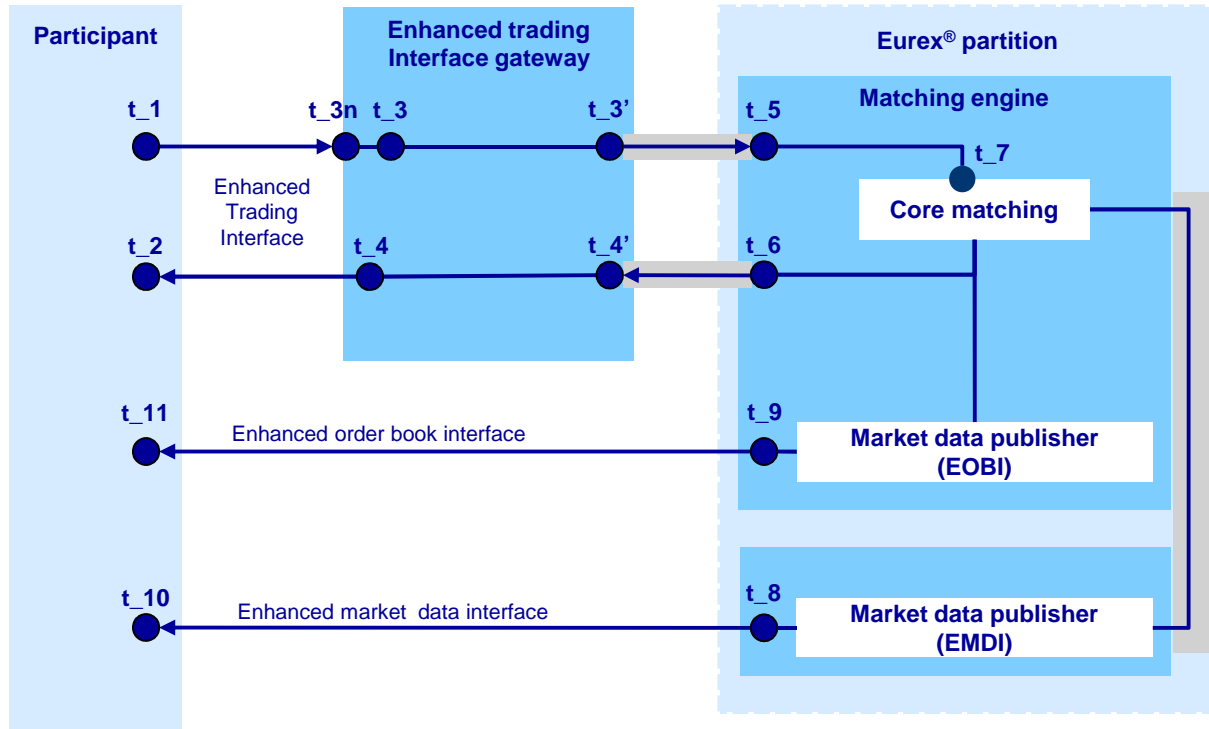


Thank you for your attention!

**Contact**  
[monitoring@deutsche-boerse.com](mailto:monitoring@deutsche-boerse.com)



# Backup: T7<sup>®</sup> system overview (release 4.0)



### Request / inbound

- § t<sub>3n</sub>: GW in (RequestTime, for HF gateways only)
- § t<sub>3</sub>: GW application in (RequestTime, for LF gateways only)
- § t<sub>3'</sub>: GW out (RequestOut)
- § t<sub>5</sub>: Matcher in (TrdRegTSTimeIn)
- § t<sub>7</sub>: Core matching in (ExecID, MDEntryTime, TransactTime, TrdRegTSTimePriority)

### Response / outbound

- § t<sub>6</sub>: Matcher out (TrdRegTSTimeOut)
- § t<sub>4'</sub>: GW in (ResponseIn)
- § t<sub>4</sub>: GW out (SendingTime)
- § t<sub>8</sub>: EMDI out (header SendingTime)
- § t<sub>9</sub>: EOBI out (header TransactTime)

■ Represents one physical server  
 ■ Messaging: WLLM using RDMA via Infiniband

Further information and regular updates are available in the 'Insights into Trading System Dynamics' presentation at [www.eurexchange.com/exchange-en/technology/high-frequency-trading](http://www.eurexchange.com/exchange-en/technology/high-frequency-trading)