



## Open Day 2017

Recent developments in market and reference data interfaces  
EOBI, EMDI, MDI and RDI/RDF

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# Contents

**02** Overview of T7<sup>®</sup> – interface landscape

**03** Market and reference data interfaces – at a glance

**04** Continuous improvement of latency and throughput

**07** Latency characteristics: EMDI vs EOBI

**08** Recent changes and development

**13** Xetra BEST for cash markets

**14** Midpoint trades for cash markets

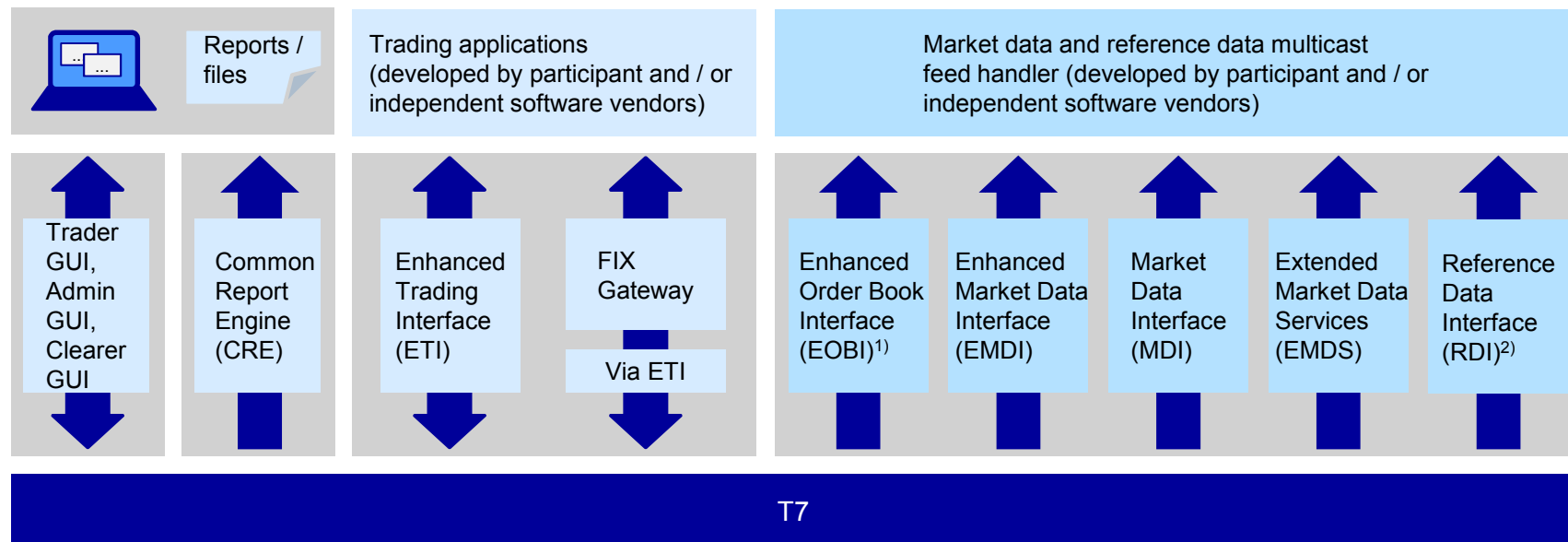
**15** TES enhancements

**16** Appendix

## Overview of T7<sup>®</sup> – interface landscape

Market and reference data interfaces are based on efficient multicast mechanism, i.e. public data dissemination over a UDP-based multicast network.

Common market and reference data interface technology is used for the trading of derivatives and cash products / instruments.



1) Available in co-location only

2) In addition to the multicast-based solution, there will also be a file-based solution for reference data via the Common Report Engine (CRE) and an internet download.

## Market and reference data interfaces – at a glance

- **Price level aggregated** public market data interfaces for derivatives and cash markets
  - EMDI – market data interface for **unnetted** market data
  - MDI – market data interface for **netted** market data

### FAST encoded messages and FAST compression

- **Order-by-order** public market data interface for derivatives and cash markets
  - EOBI – market data interface for **unnetted** market data

### Fixed-length binary messages and **no** data compression

- Public **reference data** interfaces for derivatives and cash markets
  - RDI – reference data interface for reference data
  - RDF – reference data file in xml format
- FAST encoded messages and FAST compression
- FIXML messages and no compression

 **Common message layouts for all markets**

## Continuous improvement of latency and throughput (1/3)

Achievement of **latency and throughput improvements** along with the cash markets, Xetra, Vienna and Dublin, integration into T7<sup>®</sup> system of the last T7 releases

Continuous improvement of latency and throughput is accomplished with:

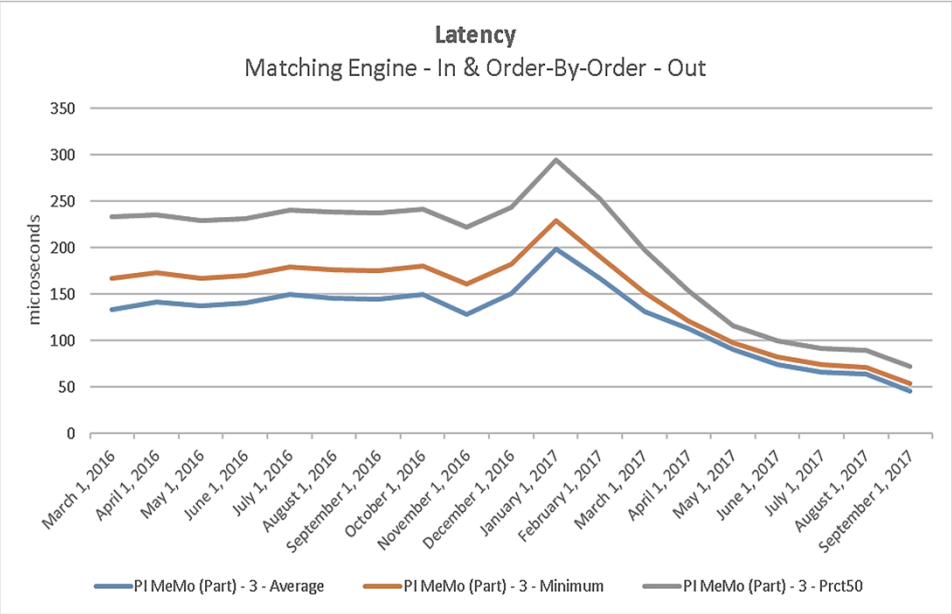
- Hardware refresh
  - Intel Xeon E5-2667 v3 CPUs (Haswell) on all servers hosting core services (matching engines, unnetted market data publishers)
  - Intel Xeon E5-2690 CPUs (Sandy Bridge) on all other servers
- Co-location 2.0: upgrade of the co-location network infrastructure (completed on 29 May 2017)
- Software improvements during last T7 releases
  - Introduction of new gateway architecture: high-frequency gateways to “first in, first out” (FIFO) principle (will be followed with introduction of partition-specific gateways)
  - Integration of EOBI (Order by Order publisher) into matching engine
    - Reduced resource usage
    - Avoidance of machine-to-machine communication
    - Gain of overall latency and throughput improvements and reduction of outliers

➡ Reducing the latency for EOBI market data by more than 30  $\mu$ s

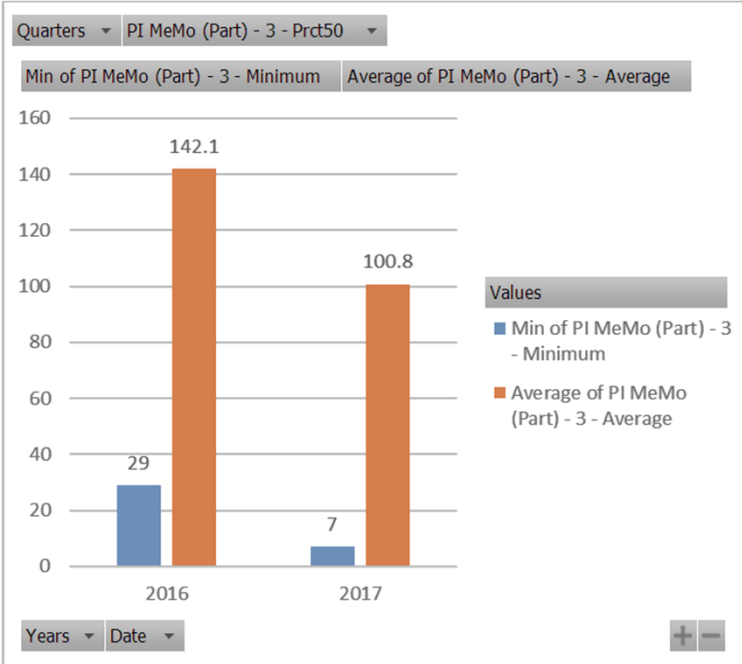
➡ Median round-trip time has been reduced by 50  $\mu$ s to below 85  $\mu$ s; the average daily round-trip time is now below 250  $\mu$ s.

# Continuous improvement of latency and throughput (2/3)

Processing time of the public market data relevant transactions, i.e. t<sub>9</sub>-t<sub>5</sub>, were reduced significantly during the last T7<sup>®</sup> releases.

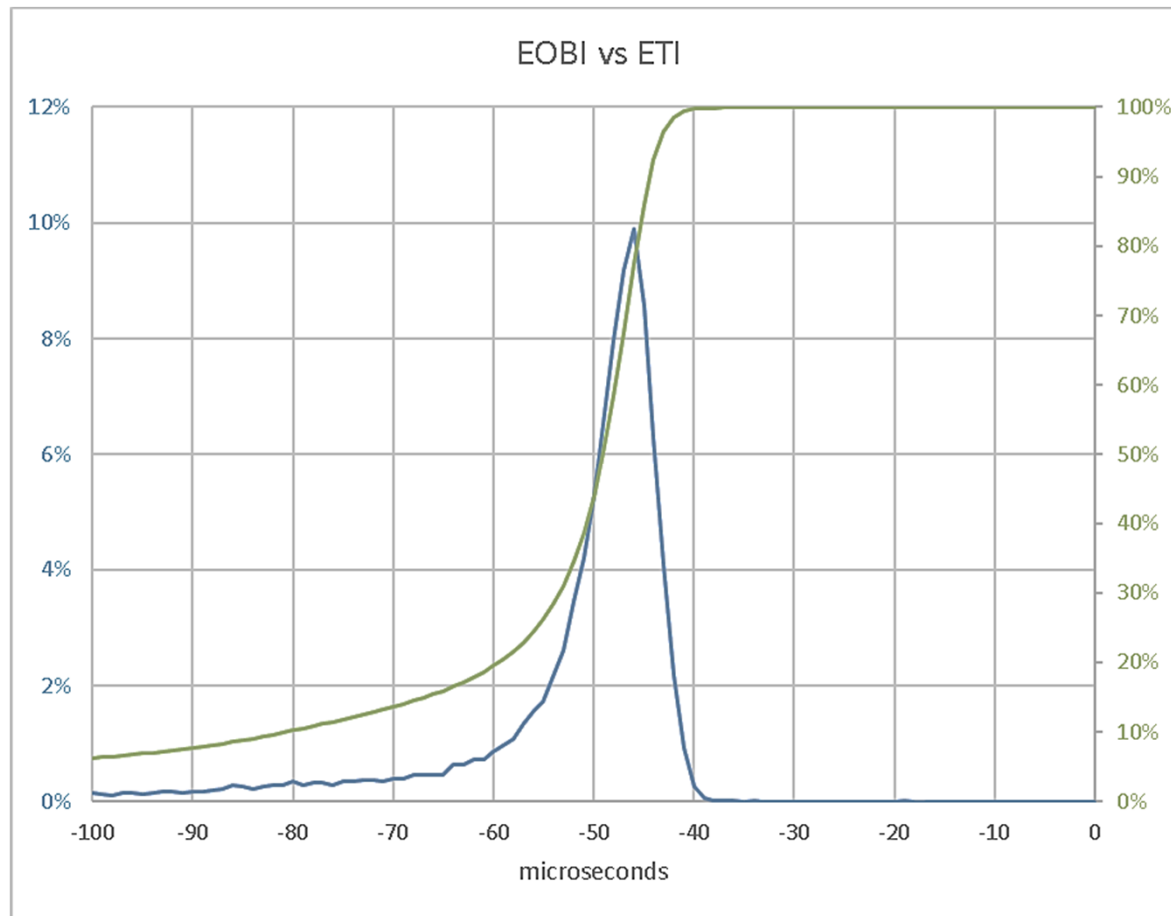


Latency comparison between 2016 and 2017 for average and minimum process time



## Continuous improvement of latency and throughput (3/3)

The market data updates provided via EOBI are almost always faster than ETI, i.e.  $t_9-t_4$ , although the design of the T7<sup>®</sup> system does not guarantee this.

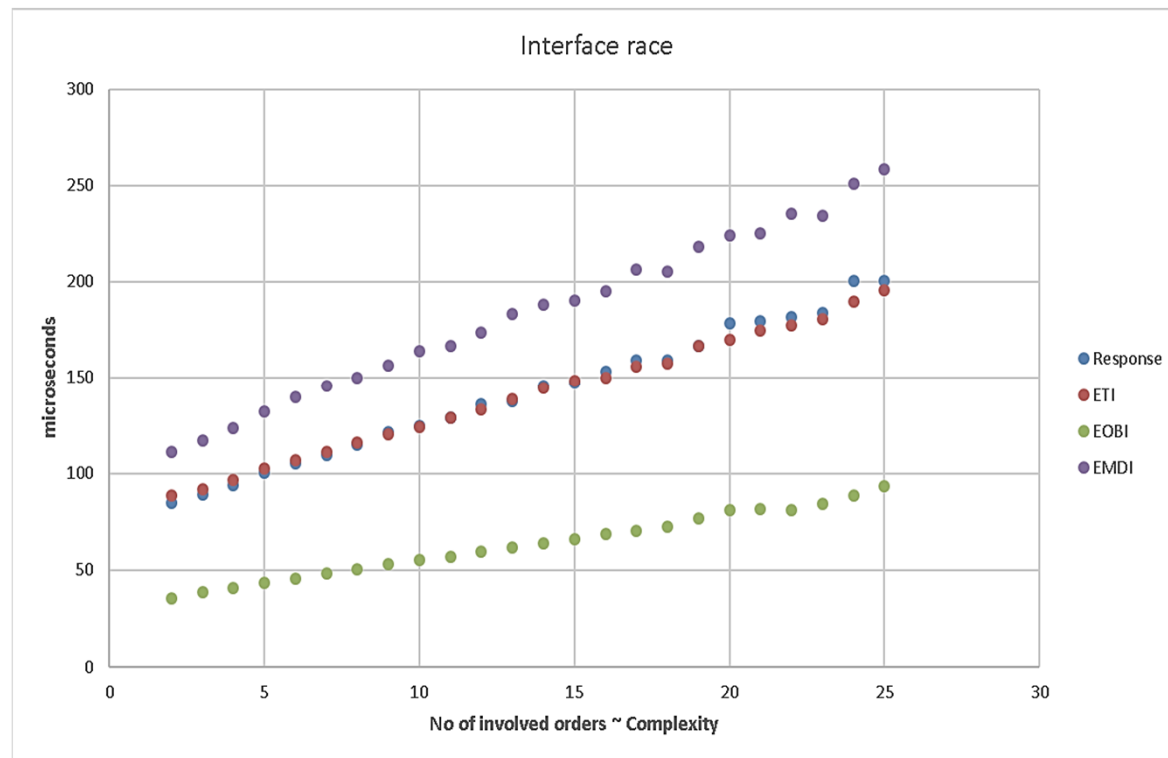


The distribution diagram shows that EOBI is approx. 40  $\mu$ s faster than ETI.

## Latency characteristics: EMDI vs EOBI

The public market data updates provided via EOBI are almost always faster than EMDI.

### Latency characteristics of T7<sup>®</sup>'s interfaces in August 2017





## Recent changes and development (1/4)

### Functional enhancements

In order to satisfy the regulatory MiFID II / MiFIR requirements and extend functionality, T7<sup>®</sup> will introduce several enhancements with T7 Release 6.0.

<b>Markets</b>	
<b>Derivatives</b>	<b>Cash</b>
<b>MiFID II / MiFIR</b> Pre-trade transparency provision Post-trade transparency provision Market making handling Stressed Market Conditions (SMC)	
<b>TES enhancements</b> Entry of leg trade prices for TES trades in complex instruments	<b>BEST execution orders</b> Flow Providers could route their order flow to BEST Executors.
	<b>Volume Discovery Orders (VDO)</b> So-called midpoint orders

## Recent changes and development (2/4)

### MiFID II / MiFIR regulatory requirements

- In order to satisfy the regulatory **MiFID II / MiFIR** requirements, T7®'s market and reference data interfaces are enhanced with upcoming T7 Release 6.0.
- **Pre-trade transparency provision** – the aggregated order book information needs to be published for at least the **five best bid and offer price levels**. Thus, the **market depth** for derivatives products is enhanced to five for all products and will be provided via **netted** and **unnetted** market data.
- **Post-trade transparency provision** – for equity, ETF, ETC and ETN products. T7 system is enhanced to flag trades in these products as **algorithmic** in the new field “**Algorithmic trade indicator**”, if at least one order or quote with an algorithmic identifier flag participates in the execution event.
- **Market making regulations** – new instrument trading parameters are published in RDI and RDF as well as in the product and instrument files on the webpages.
- **Regulatory trading conditions** – **Stressed Market Conditions (SMC)** will be published via T7's EOBI, EMDI and MDI.

The following messages will be enhanced to indicate stressed market conditions:

- **(Mass) instrument state change**
- **Product state change**
- **Snapshot message(s)**

## Recent changes and development (3/4)

### MiFID II regulatory requirements

- In T7<sup>®</sup> RDI and RDF, **product** and **instrument snapshot** messages are enhanced according to the **market making**, **Stressed Market Conditions (SMC)** and **post-trade transparency**:
  - **Market making obligation flag**: indicates whether a product is subject to incentives for quotation during SMC
  - **SMC eligibility flag**: indicates whether a product supports automated stressed market conditions
  - **Illiquid as defined by exchange** denotes that a product is considered to defer trades because of illiquidity in the context of post-trade transparency (resulting from TES Enhancements).

InstrumentAttribType (FIX Tag 871)	
Derivatives markets – product level	Cash markets – instrument level
112 - Illiquid as defined by exchange	114 - Liquid as defined by regulator
113 - Market making obligation	
115 - Eligible for Stressed Market Conditions	

- **Applicable minimum quote quantity** (bid and offer in quote size rules) in SMC
- **Applicable price range tables** for the validation of quote spreads in mass quote request in SMC
- Please note that, applicable price range tables for the price reasonability check and the market order matching range only in SMC on derivatives fast market.

# Recent changes and development (4/4)

## SMC – MiFID II regulatory requirements

Stressed Market Conditions (SMC) are published via all public market data interfaces.

### Product level for derivatives markets

Derivatives markets		
FastMarket Indicator (FIX Tag 2447)	MarketCondition (FIX Tag 2705)	
No	Normal	
No	Stressed	No Fast Market; stressed market automatically triggered
Yes	Stressed	Fast Market triggered by market supervision, optionally automatically triggered stressed market

### Instrument level for cash markets

Cash markets		
FastMarket Indicator (FIX Tag 2447)	MarketCondition (FIX Tag 2705)	
No	Normal	
Yes	Normal	Fast Market
No	Stressed	No Fast Market; stressed market automatically triggered
Yes	Stressed	Fast Market triggered by market supervision, optionally automatically triggered stressed market

Exceptional market conditions will be published via news messages to the markets.

## Recent changes and development

### PTT – MiFID II regulatory requirements

- In order to support the **post-trade transparency provision** regulatory requirement for **equity, ETF, ETC** and **ETN products** of cash markets:
  - A new flag “**AlgorithmicTradeIndicator (2667)**” is introduced in T7<sup>®</sup> EOBI and EMDI to indicate an **algorithmic trade**, i.e. at least one matching order was submitted by a trading algorithm instead of a person.
  - So, all orders executed at the same price level (match step) on which an order from a trading algorithm was involved, are reported with “**AlgorithmicTradeIndicator (2667)**” set to “1 = Algorithmic Trade”.
  - Following messages contain the **algorithmic trade** information:

EOBI messages	EMDI message
Trade Report	Depth Incremental with MDEntryType = 2 (=Trade)
Full Order Execution	
Partial Order Execution	

- If an order from a trading algorithm is involved in an auction trade, then the corresponding market data messages for the auction trade will also be reported with “**AlgorithmicTradeIndicator (2667)**” by setting to “1 = Algorithmic Trade”.



## Xetra BEST for cash markets

- BEST quotes can be entered only by participants acting as BEST Executor. They are **not** shown in the public order book.
- Whenever a trade results from BEST executions, participants will be informed by a [Trade Report \(EOBI\)](#) / [Depth Incremental \(EMDI\)](#) message.
- Whenever a trade resulting from BEST is [reversed](#) by market supervision, participants will be informed by a [Trade Reversal](#) / [Depth Incremental](#) message.
- Xetra BEST trades are reported with the indicator “TradeCondition(277)” with the valid value “[153 = Systematic Internalizer \(AZ\)](#)”.
- Trade statistics for book trades, Xetra BEST trades are calculated and reported separately. In the snapshot stream, there are separate trade volume and (last) trade entries for book trades and Xetra BEST trades.
- An [Instrument Summary \(EOBI\)](#) message will be published for each instrument in one snapshot cycle and will contain instrument state information and trade statistics for one instrument.

## Midpoint trades for cash markets

- The new **Volume Discovery Service** combines the execution of an **iceberg order** in the open order book with the execution of the **hidden part of the iceberg order** at the **midpoint** against other orders of this type.
- Whenever a trade results from Volume Discovery Order (midpoint) executions, participants will be informed by a **Trade Report (EOBI) / Depth Incremental (EMDI)** message.
- Whenever a trade resulting from midpoint is **reversed** by market supervision, participants will be informed by a **Trade Reversal / Depth Incremental** message.
- Trades resulting from Volume Discovery Orders are reported with the “TradeCondition (277)” with the value “**155 = Midpoint price (BB)**”.
- Trade statistics for book trades and midpoint executions at midpoint are calculated and reported separately. In the snapshot stream, there are separate trade volume and (last) trade entries for book trades and midpoint trades.
- An **Instrument Summary (EOBI)** message will be published for each instrument in one snapshot cycle and will contain instrument state information and trade statistics for one instrument.

## TES enhancements

- With T7<sup>®</sup> Release 6.0, Eurex will **allow** the initiating user of a TES trade to **enter** leg trade prices, so-called decomposition prices.
- In order to distinguish between **user-entered** TES leg trade price and **T7-calculated** decomposition price and publish them appropriately, the **Depth Incremental** and **Depth Snapshot** messages are enhanced as follows:
  - **MultiLegPriceModel (28750)** is used to indicate the origin of TES trade leg price with values:
    - 1 = User-defined     Used to report TES leg trade prices **entered by user**
    - 0 = Standard         Used to report TES leg trade prices **calculated by T7**
  - **MultiLegReportingType (442)** is used to indicate the instrument type:
    - 1 = Single instrument
    - 2 = Individual leg of a multi-leg security
    - 3 = Complex instrument



## Further information

- Eurex and Xetra website  
<http://www.eurexchange.com/exchange-en/technology/t7/>  
<http://www.xetra.com/xetra-de/technologie/t7/>
- System documentation: public market and reference data manuals  
<http://www.eurexchange.com/exchange-en/technology/t7/Release-6.0/>  
<http://www.xetra.com/xetra-de/technologie/t7/publikationen/>
- Information in the context of trading system dynamics and high-frequency trading  
<http://www.eurexchange.com> > Technology > High-frequency trading
- Some insights into the details that matter for high-frequency trading  
<http://www.eurexchange.com/exchange-en/resources/publications/>

## Benefits of common interface platform

A common public market and reference data interface platform for the trading of securities and derivatives, as a truly state-of-the-art multi-exchange trading system



1

### Synergies

Xetra® and Eurex® trading participants benefit from **synergies** resulting from the alignment on a **common** market and reference data interface technology for the trading of cash and derivative products, i.e. harmonised interface landscape.



2

### Low barriers

**Lower barriers** for trading participants are already active on the cash market to get access to the derivative market and vice versa.



3

### State-of-the-art technology

T7® is a powerful **state-of-the-art** trading platform. Cutting-edge technology delivers ultra-low latency, robustness and safe handling of very high throughput.



4

### Low footprint

German equities and ETFs are available via a **low-footprint** solution, reducing participant time and effort for release updates.

## A comparison of market data interfaces

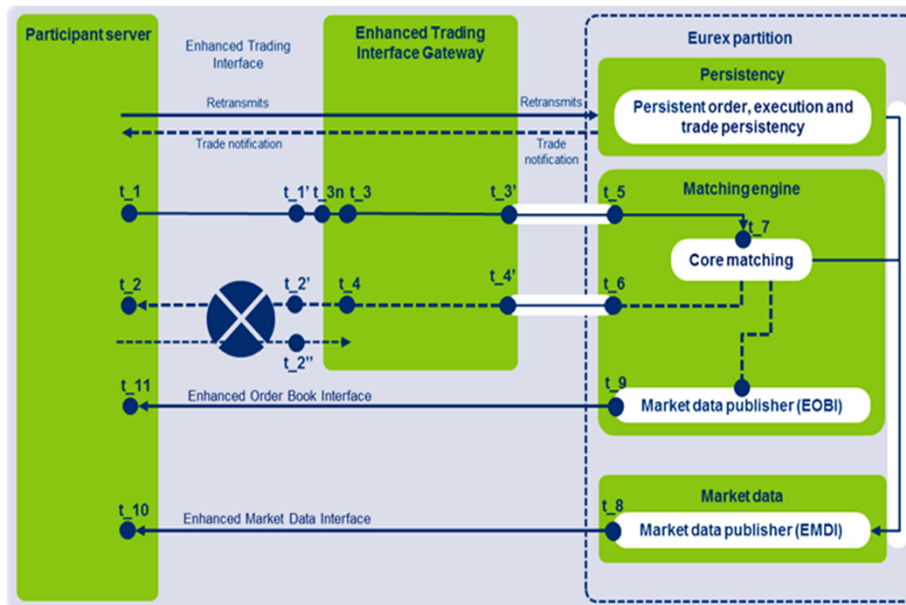
Enhanced Order Book Interface (EOBI)	Enhanced Market Data Interface (EMDI)	Market Data Interface (MDI)
<ul style="list-style-type: none"> <li>▪ Provides <b>entire visible order book</b> by publishing information on each individual order and quote <b>on-exchange</b> market data during continuous trading</li> <li>▪ For selected benchmark products for derivatives market; for all instruments for cash markets</li> <li>▪ Market depth: no restriction</li> <li>▪ <b>No</b> information about synthetic prices</li> <li>▪ Trade statistics only available in snapshot messages</li> <li>▪ Entire order book published incrementally when order book is open and via snapshots periodically</li> <li>▪ Snapshots and incremental market-data messages delivered via separate channels (<b>out-of-band</b>)</li> <li>▪ <b>High bandwidth</b> requirements (available via 10 GB network)</li> <li>▪ <b>Execution summary</b> messages for fast trading decisions</li> </ul>	<ul style="list-style-type: none"> <li>▪ Provides <b>unnetted, price-level aggregated on-exchange and off-exchange</b> market data</li> <li>▪ For all products / instruments of all markets</li> <li>▪ Market depth: configurable per product</li> <li>▪ Provide BBO and synthetic prices</li> <li>▪ Trade statistics available in incrementals and snapshot messages</li> <li>▪ Price-level aggregated snapshots periodically</li> <li>▪ Snapshots and incremental market data messages delivered via separate channels (<b>out-of-band</b>)</li> <li>▪ <b>High bandwidth</b> requirements</li> <li>▪ Trades published on aggregate by price level</li> </ul>	<ul style="list-style-type: none"> <li>▪ Provides <b>netted, price-level aggregated on-exchange and off-exchange</b> market data</li> <li>▪ For all products / instruments of all markets</li> <li>▪ <b>At least five best bid and offer</b> for options and futures</li> <li>▪ Only <b>statistical</b>, daily high / low price and last trade information is provided</li> <li>▪ Snapshots and incremental market data messages delivered via one channel (<b>in-band</b>)</li> <li>▪ <b>Low bandwidth</b> requirements</li> <li>▪ Trades published in <b>statistical</b> fashion</li> </ul>

## Publishing of orders in cash markets

- **Market orders** are not published for derivative markets, i.e. for Eurex and EEX, as stated in rules and regulations.
  - However, **market orders** are published for cash markets, i.e. Xetra, Vienna and Dublin markets.
  - In order to publish the **market orders** for cash markets via all market data interfaces:
    - Order type information wiping out price and quantity is published. That means:
      - Depth incremental message with order type, i.e. “MDEntryType = b (Market Bid)” or “c (Market Offer)” and setting of “MDEntryPx” and “MDEntrySize” fields to “NO\_VALUE”
- **Iceberg orders** are supported for cash markets only. They are published via all market data interfaces:
    - Iceberg order price and peak quantity information is published as regular limit order. Obviously, the hidden quantity is not published.
    - In case of a partial match, the new peak quantity is reported as regular limit order. However, the matched order quantity might be greater than reported peak quantity.
    - In case of full match, the matched order is reported as regular limit order.
      - Order type, i.e. “MDEntryType = 0 (Bid)”, “1 (Offer)” or “2 (Trade)” in Depth Incremental and Execution Summary, Partial and Full Order Execution messages

# Time stamps

## Time stamp overview



Detailed timestamp explanation in appendix  
 ■ Represents one physical server  
 ■ Messaging: WLLM using RDMA via Infiniband

- **Matching engine:**
  - Order book maintenance and execution
  - Creation of direct responses as well as execution messages all for passive orders / quotes
- **Market data (EMDI):**
  - Creation of order book delta messages
  - Creation of order book snapshot messages
- **Market data (EOBI):**
  - Creation of order book messages
  - Creation of order book snapshot messages

Eurex EOBI market data is disseminated directly from the matching engine with a configuration update since 13 March 2017.

# Appendix

## Time stamps

### The time stamps are available via the following fields:

t_3, t_3n:	tag	5979	("RequestTime")	in the Eurex ETI Response in the Eurex EMDI Depth Incremental Message, in case a trade is reported in the Eurex EOBI Execution Summary message
t_3':	tag	7764	("RequestOut")	in the Eurex ETI Response (from the matching engine)
t_4':	tag	7765	("ResponseIn")	in the Eurex ETI Response (from the matching engine)
	tag	25043	("NotificationIn")	in the Eurex ETI Notification (from the matching engine)
t_4:	tag	52	("SendingTime")	in the Eurex ETI Response and Notification
t_5:	tag	21002	("TrdRegTSTimeIn")	in the Eurex ETI Response (from the matching engine)
	tag	21002	("TrdRegTSTimeIn")	in the Eurex EOBI Order Add, Order Modify, Order Modify Same Priority and Order Delete messages
	tag	28820	("AggressorTimestamp")	in the Eurex EMDI Depth Incremental message, in case a trade is reported
	tag	28820	("AggressorTimestamp")	in the Eurex EOBI Execution Summary message
t_6:	tag	21003	("TrdRegTSTimeOut")	in the Eurex ETI Response and Notification (from the matching engine)
t_7:	tag	17	("ExecID")	in the Eurex ETI Response (from the matching engine) in the Eurex EOBI Execution Summary message
	tag	273	("MDEntryTime")	in the Eurex EMDI Depth Incremental message
	tag	21008	("TrdRegTSTimePriority")	in the Eurex EOBI Order Add and Order Modify messages
	tag	60	("TransactTime")	in the Eurex EOBI Order Modify Same Priority and Order Delete messages
t_8:	no tag		("SendingTime")	in the Eurex EMDI UDP packet header
t_9:	tag	60	("TransactTime")	in the Eurex EOBI packet header
(t_8-t_5):	no tag		("PerformanceIndicator")	in the Eurex EMDI UDP packet header of the Eurex EMDI Depth Incremental stream

#### Notes on time stamps:

All time stamps provided are 8 byte integers (in nanoseconds after Unix epoch).

The "PerformanceIndicator" is a 4 byte integer (in nanoseconds as well).



Thank you for your attention.

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