



Open Day 2018

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

27 September 2018 8



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T7[®] Technology Roadmap

Deutsche Börse is pursuing its Technology Roadmap to deliver innovative and superior trading technology.

Recent developments and Outlook:

- Introduction of partition-specific gateways in HY1 2018
- Reduction of median request-response latency by 8 μ s to 52 μ s for partition specific gateways
- Reduction of median request-market data out latency by 8 μ s to 33 μ s for order-by-order public market data

T7 Release 7.0 on 3 December 2018:

- Further optimisation of partition-specific gateways inbound and outbound processing, i.e. median request-market data out latency will be reduced very small further
- Support for passive liquidity protection for options
- Support for client liquidity improvement process
- Equity and Basket Total Return Futures
- Trade Entry Service (TES) for cash markets

Launch of EOBI for all Eurex products in February 2019

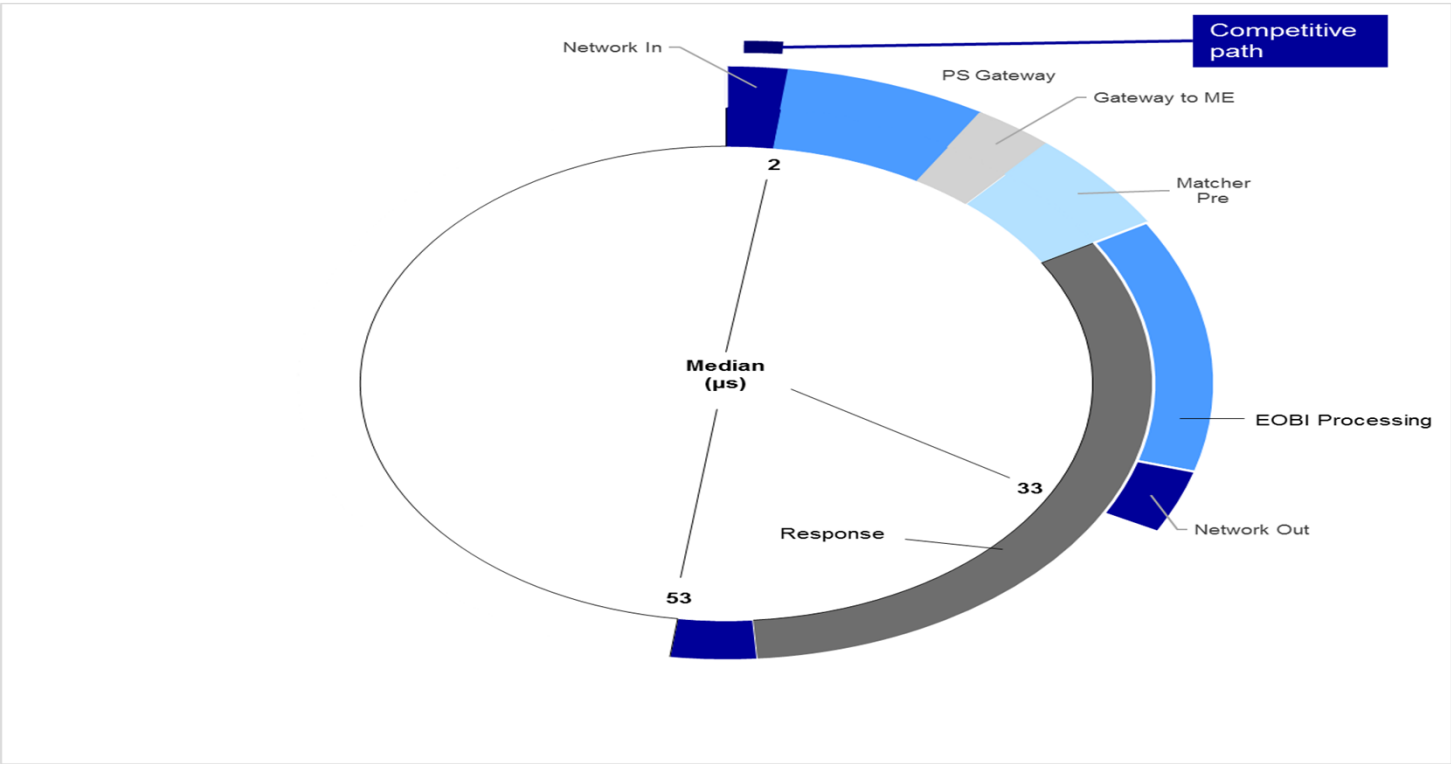
For further details about T7 please visit our websites:

www.eurexchange.com/t7 and www.xetra.com/xetra-en/technology/t7

T7[®] Latency Composition

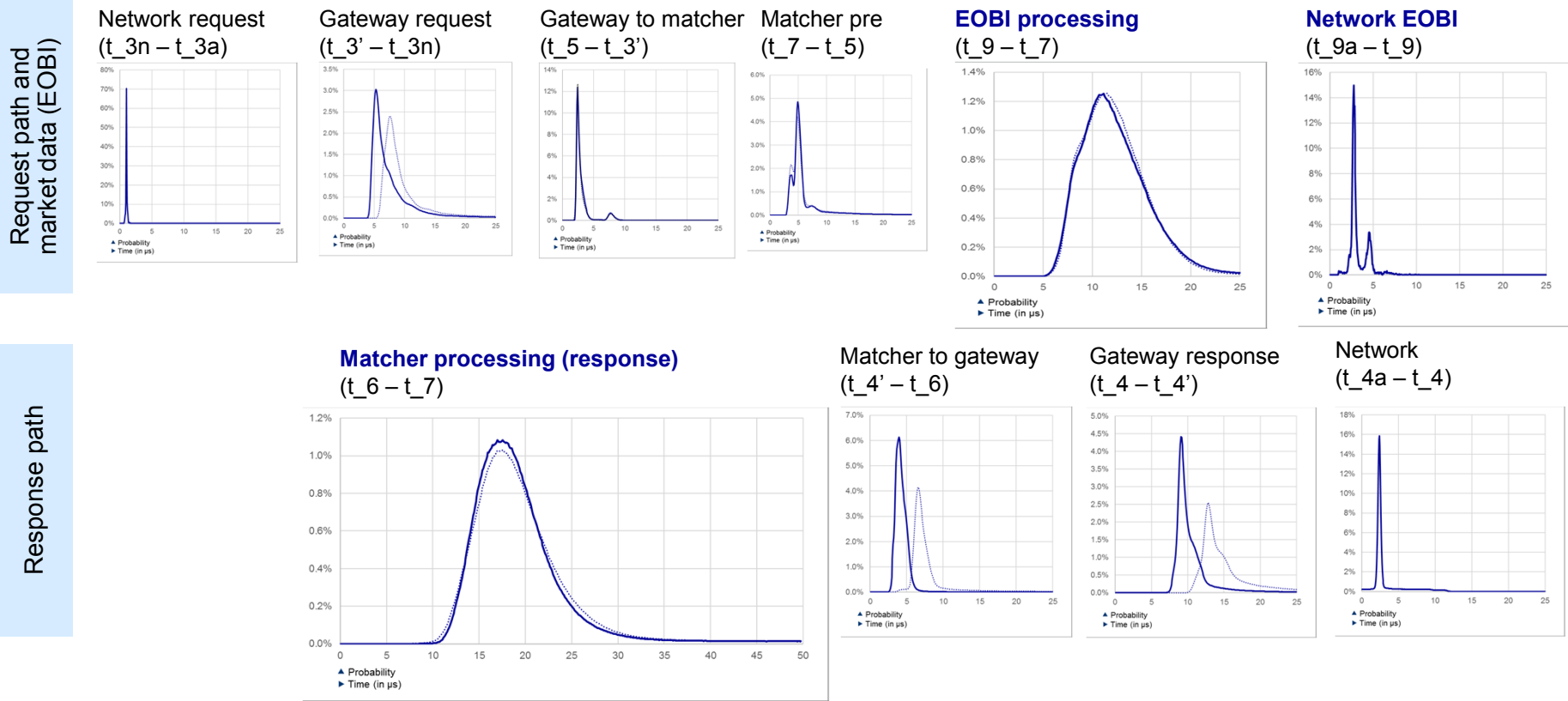
The diagram below outlines the composition of latency for Eurex Futures transactions for T7[®] release 6.1. The full circle represents 100 μ s. The latency in the request and response path has dropped significantly. Note the latency difference between order book updates sent on the public path via EOBI and the private response.

Median latencies Release 6.1



T7[®] Latency Composition

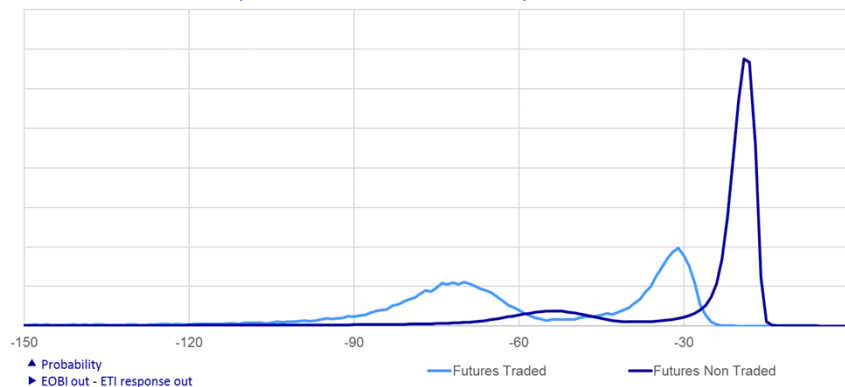
The below charts show a comparison of latencies since the last update (March 2018) for Eurex futures sent via PS gateways. Tuning measures for the PS gateway lead to significantly reduced processing times for requests and responses. Other latencies are stable since the introduction of PS gateways. Network response and market data include TCP / UDP stack on the server. Dotted lines represent data from 19 March 2018 (T7 Release 6.0) and solid lines data from 19 June 2018 (T7 Release 6.1).



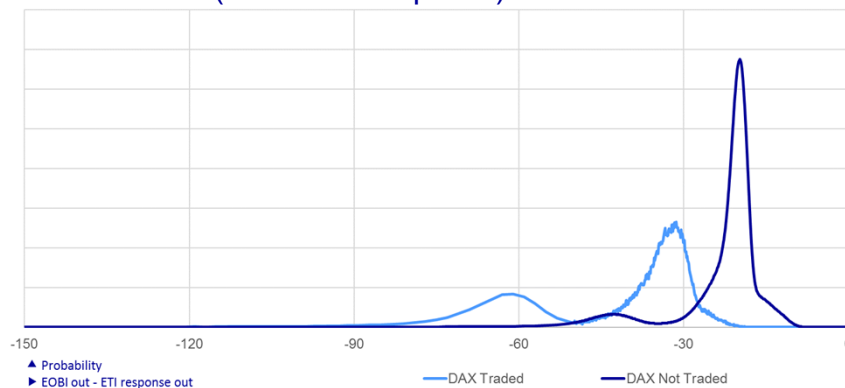
T7[®] Latency

Latency characteristics of EOBI versus ETI

EOBI vs ETI (Eurex FESX Future)



EOBI vs ETI (Xetra DAX equities)



T7 is designed to publish order book updates first on its public data feed.

The top diagram shows the time difference distribution between public and private data for the Eurex FESX future (EOBI first datagram vs ETI responses, $t_9 - t_4$), the graph below shows the same for Xetra DAX equities.

The data is a production sample from 19 June 2018.

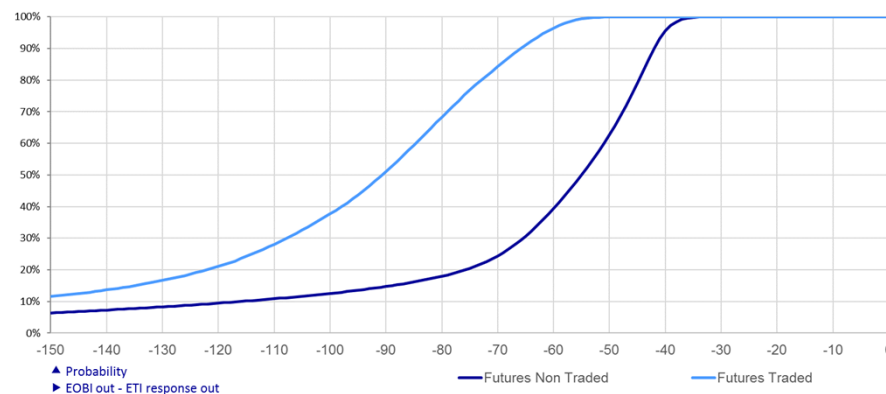
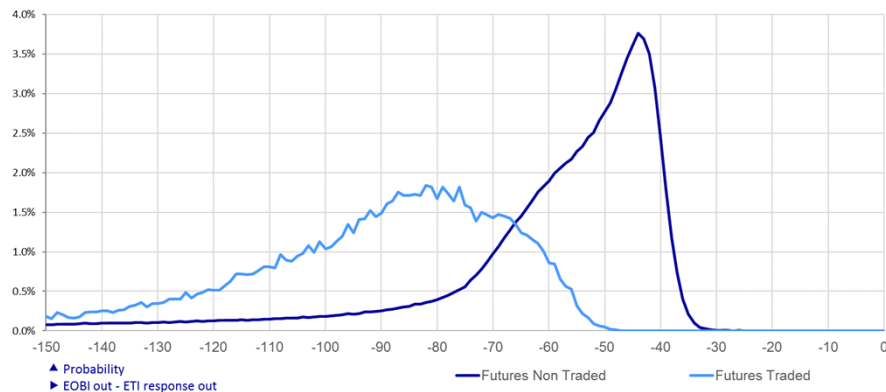
T7 Release 6.1 has reduced the median latency of responses via PS gateways by 5 μs , but **EOBI market data is still 20 μs faster for order book updates and 35 μs faster for executions**. Note that the slower mode of the distribution is caused by responses via low frequency gateways typically being more than 30 μs slower.

The first EOBI datagram was faster in approximately 99.9 percent of the cases compared to the ETI response and also the first passive ETI book order notification (not shown).

T7[®] Latency

Latency characteristics of EOBI versus EMDI

Latency characteristics of EMDI versus EOBI



Market data updates provided via EOBI are almost always faster than EMDI updates.

The top diagram shows the distribution of t_9 minus t_8 , i.e. EOBI first datagram versus EMDI sending time, the bottom diagram shows the cumulative distribution.

The graphs show data of EURO STOXX 50[®] Index Futures (FESX) for 19 June 2018 (after introduction of T7 Release 6.1).

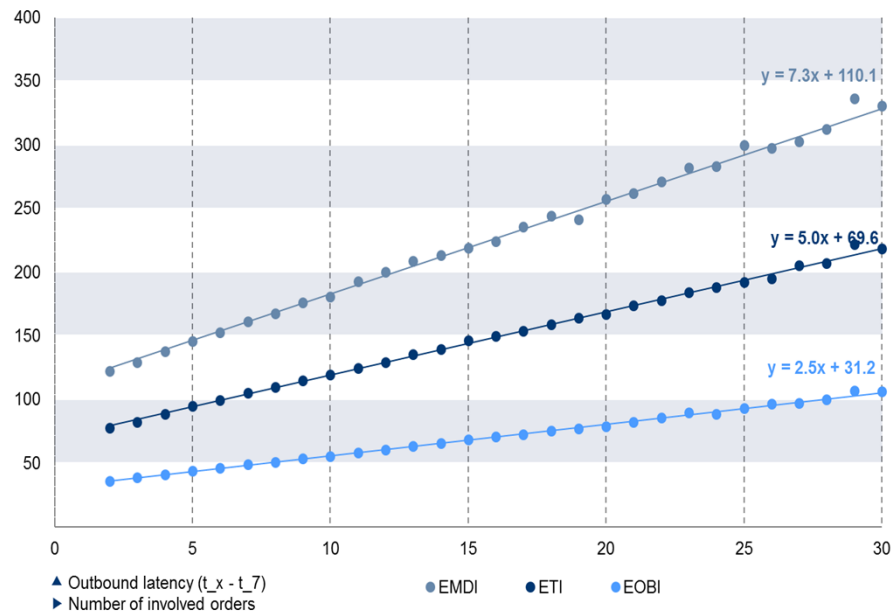
EOBI was faster for more than 99.99% of all order book updates.

A very similar latency characteristic applies to Xetra[®].

T7[®] Latency

Latency characteristics of ETI vs EOBI vs EMDI

Outbound latency for FESX trades (19 Jun 2018)



This diagram displays the dependency of the median latency on the **complexity of a trade** for ETI (t₄ - t₇), EMDI (t₈ - t₇) and EOBI (t₉ - t₇). Note that for ETI we display the gateway sending time of the first passive notification and for EOBI the sending time of the UDP datagram containing the Execution Summary message.

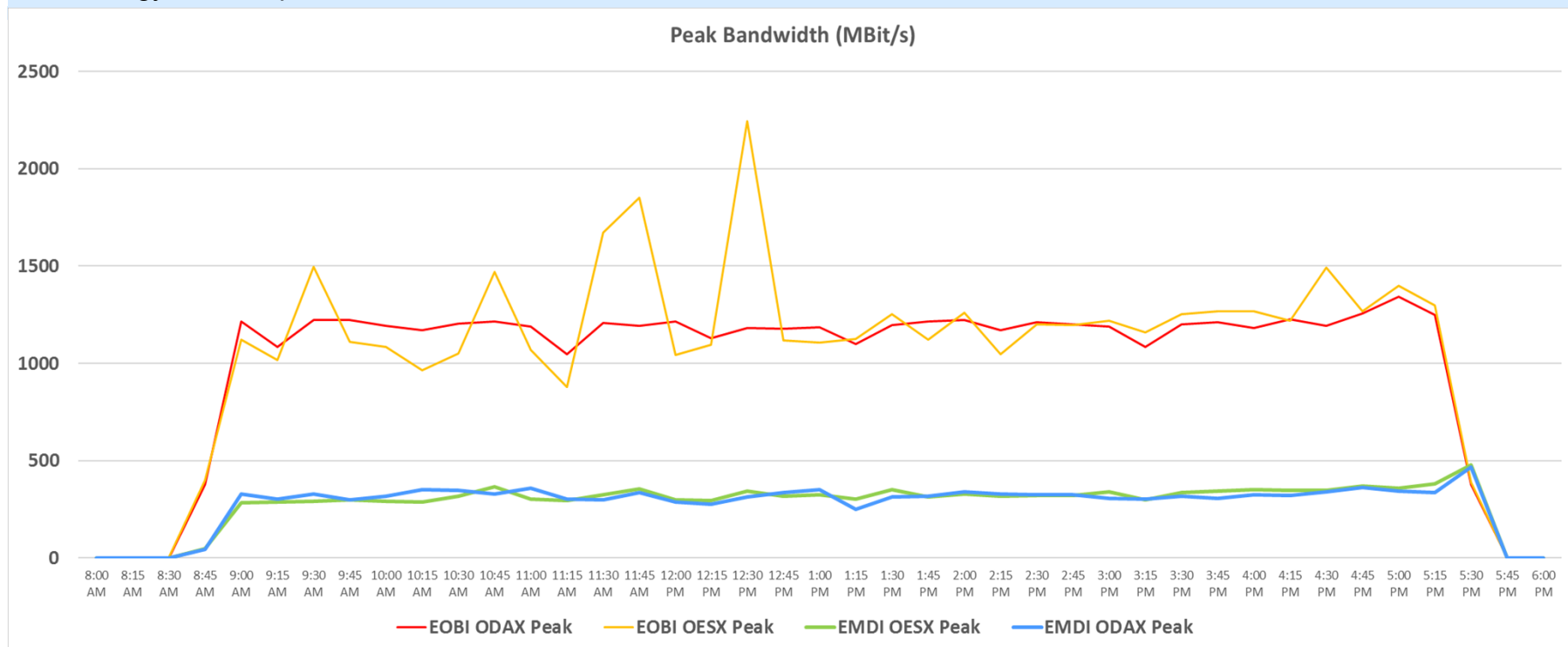
In about 99.95% of all trades, we disseminate order book data on EOBI first (even true for larger trades).

ETI response latency has slightly increased since the migration to PS gateways.

Launch of EOBI for all Eurex options (1/2)

Peak bandwidth utilisation EOBI vs EMDI

Deutsche Börse will start publishing all Eurex products via EOBI interface starting from February 2019 as announced in our Technology Roadmap.

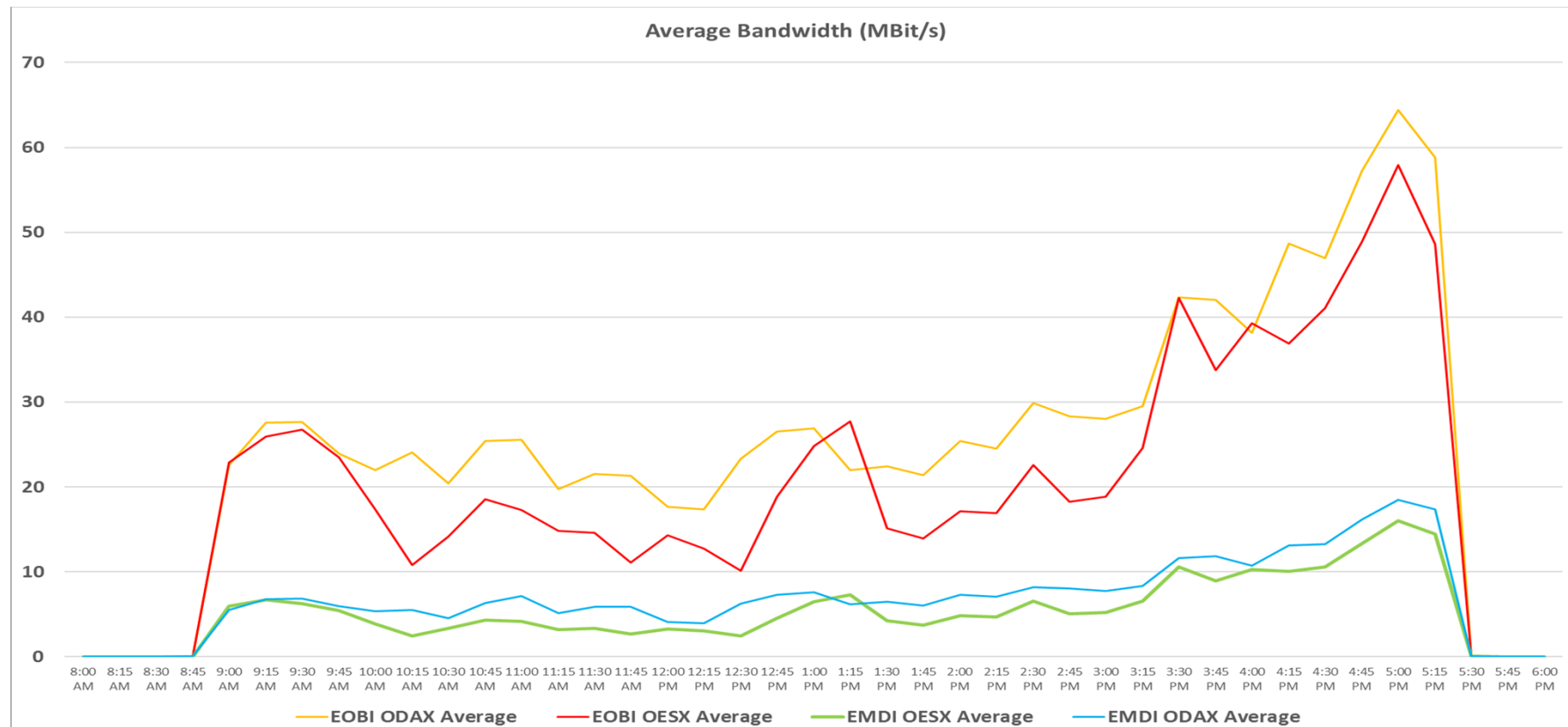


This diagram shows sent **peak bandwidth** utilisation in [Mbit/s] via EOBI and EMDI for options products **OESX** and **ODAX** on 28 February 2018.

EOBI sends approx. **5–6 times more** incremental market data than EMDI for options products.

Launch of EOBI for all Eurex options (2/2)

Average bandwidth utilisation EOBI vs EMDI



This diagram shows sent **average bandwidth** utilisation in [Mbit/s] via EOBI and EMDI for options products OESX and ODAX on 28 February 2018.

EOBI sends approx. **5-6 times more** incremental market data than EMDI for options products.

Extension of Quantity field (1/2)

With T7® Release 7.0 introduction, the format of the data type **Quantity** will be changed from a **4-byte integer** to an **8-byte integer field with four decimals**.

The enhancement will support bonds and warrants trading.

The Quantity format change will affect all market and reference data interfaces, i.e. EOBI, EMDI, MDI and RDI.

Fix field (Tag)	Data type changed from to	Message	Interface
DisplayQty, LastQty, PrevDisplayQty, ImbalanceQty, RestingHiddenQty, RestingCxlQuantity BidSize and OfferSize	Int32_t -> Int64_t	Execution Summary, Order Add, Order Modify, Order Modify Same Priority, Order Delete, Partial Order Execution, Full Order Execution, Quote Request, Cross Request, Trade Report, Trade Reversal, Auction Clearing Price, Auction BBO, Top Of Book	EOBI
MDEntrySize (271), RestingCxlQuantity (28869), OrderQty(38), NonDisclosedTradeVolume (28873) MinBidSize(647) MinOfferSize(648)	uInt32 -> decimal	Depth Incremental, Depth Snapshot	EMDI, MDI, RDI

Please note that the T7 EOBI, EMDI and MDI and RDI/RDF interfaces do not provide backwards compatibility.

Extension of Quantity field (2/2)

The Quantity format change implies that the T7[®] multicast client applications must consider:

- message size of EOBI interface is increased.
- accessing of successor quantity fields by an **offset** for EOBI fields increased by **4-byte integer**.

FAST Templates for EMDI and MDI are changed from

```
<uint32 name="MDEntrySize" id="271" presence="optional"> <delta/> </uint32>
```

to

```
<decimal name="MDEntrySize" id="271" presence="optional"><delta/></decimal>
```

In FAST, a quantity is represented as a Signed Integer exponent (with base-10 power) followed by a Signed Integer mantissa:

$$quantity = mantisse * 10^{exponent}$$

- In all cases expect Bonds and Warrants related messages the “exponent” is zero(=0), i.e., message size of EMDI and MDI interface is increased for all Bonds and Warrants related messages only.

Input value	Decomposed input value		FAST hex/binary	
Ascii	Exponent	Mantissa	Exponent	Mantissa
94.2755	-4	942755	0xfc 1 1111100	0x46 0x3a 0xdd 0 <u>1</u> 000110 0 <u>0</u> 111010 1 1011101
				Stop bits indicated in bold Sign bits indicated by underline

Recent changes and development (1/6)

Functional enhancements

T7[®] introduces several functional enhancements with upcoming T7 Release 7.0

Markets	
Derivatives	Cash
Functional enhancements for MiFID II / MiFIR incl. the individual transaction identification code (TVTIC)	
Client liquidity improvement process (CLIP) Secured execution of customer flow at best price levels in the central order book	Trade Entry Services (TES) The consolidation of all trading activities (on-book / off-book) will result in a single state-of-the-art trading platform
Passive liquidity protection (PLP) Concept of passive liquidity protection for specific products to strengthen order book trading	Bonds and warrants trading / continuous auction for market maker for PEX Introduction of the continuous auction for market maker trading model and supporting of Bonds trading functionality
Equity and basket total return futures Extension of total return futures portfolio by introducing equity total return futures and basket total return futures	

Recent changes and development (2/6)

CLIP – Client Liquidity Improvement Process

Eurex offers a [client flow facilitation service](#) enabling the [execution of customer flow at best prices](#) in the order book. CLIP will [supplement](#) the existing [request-for-cross](#) functionality.

- A CLIP announcement is immediately published via *Cross Request Message* after the creation of a CLIP trading indication.
 - The announcement caters information about the side, quantity and price along with cross request type with **2 = Liquidity Improvement Cross**
- EOBI and EMDI / MDI publishes the update of the public order book and execution of orders which are involved in the CLIP matching process. The execution of a CLIP trade side is not reported. So, CLIP trade sides are not published.
 - CLIP trades will be considered as *on-book* trades with respect to the **MDOriginType = 0 (=Book)** (on-exchange) in EMDI. Matches from CLIP trading are reported with the new valid value for the trade type.
 - Trades from CLIP matching are included in the trade volume reporting and trade statistics.

The following public market data messages are enhanced to support CLIP announcements and trading:

- **Cross request message** is enhanced with:

FIX field (Tag)	Valid values
Price(44)	
CrossRequestType(28771)	1 = Cross announcement 2 = Liquidity improvement cross

- **Depth incremental message** is enhanced with:

FIX field (Tag)	Valid values
TrdType(828)	1108 = Liquidity improvement cross

Recent changes and development (3/6)

PLP – Passive Liquidity Protection

- Eurex introduces a **concept of passive liquidity protection** for specific products to strengthen order book trading.
- PLP aims to reduce the number of liquidity provider trades and to increase the number of aggressive client trades by count and by volume. It is intended to motivate passive liquidity providers to display larger bid – ask volumes and/or tighter bid – ask spreads.
 - Participants who provide liquidity should be able to properly update their quotes upon new information. The **reaction time** for updating quotes fits into a time-window that is deemed large enough for updating non-aggressive orders or quotes, but small enough to continue to allow information into the market in an efficient manner.
 - **Aggressive order** transactions will be **deferred by a time interval Δt** in the order of milliseconds or even lower, before they are able to interact with the order book.
 - **Quote** transactions are assumed to be **passive** by default and, consequently, will be treated like a Book-or-Cancel transactions with the consequence that a quote side executable upon entry will be deleted.

T7[®] RDI and RDF, **instrument snapshot** message, is enhanced accordingly:

Fix field (Tag)	Valid value	
InstrumentAttribType (871)	123 = hasPLP 124 = PLPDeferralTime	Support for Matching Engine base PLP Defines Deferred time interval

Recent changes and development (4/6)

Equity basket total return futures

Eurex extends its portfolio of Total Return Futures by introducing Equity Total Return Futures (ETRF) and Basket Total Return Futures (BTRF).

- RDI / RDF will publish the available BTRF Buckets.
 - BTRF Buckets determine, which products can be **grouped** together in a specific BTRF.
 - The ID of the BTRF Bucket must be stated in all ETI requests regarding a BTRF that refers to that BTRF Bucket.
- **Trade prices** of TES trades that have been executed as part of a basket will be flagged as such.
- T7[®] RDI and RDF, **product** and **instrument snapshot** messages, are enhanced accordingly:
 - new valid values for **MarketSegmentRelationship (2547)** and **MarketSegmentSubType (2544)** fields to provide the **BTRF Bucket** information

Fix field (Tag)	Valid values
MarketSegmentRelationship (2547)	102 = BTRF Bucket
MarketSegmentSubType (2544)	2 = BTRF Bucket

- T7 EMDI and MDI, **Depth Incremental**, message is enhanced accordingly:
 - **TradeCondition = k (= Out Of Sequence)** with **MDOriginType = 2 (= Off-book)** fields to provide the **BTRF trade** information.

Recent changes and development (5/6)

TES – T7 Entry Service for cash markets

T7[®] Entry Service (TES) is already integrated into public T7's market and reference interfaces, T7 EMDI, MDI and EMDS since T7 Release 5.0 for derivatives market.

- New valid values for [TrdType \(828\)](#) are introduced in order to support publishing of TES trades for cash market Frankfurt and our partner exchanges:

Cash market	TrdType	Valid values for TrdType	Interface
Frankfurt	LIS (Large-In-Scale) OTC	1 = Block Trade 54 = OTC	EMDS
Partner exchanges	LIS OTC	1 = Block Trade 54 = OTC	EMDI, MDI

- Distribution of TES Trades may be deferred according to MiFID / MiFIR requirements.
- TES Instrument status will be published via RDI / RDF.

Recent changes and development (6/6)

Continuous Auction for Market Maker for cash markets

T7® is enhanced to support the migration of partner exchange cash markets from Xetra Classic to T7. This requires the implementation of the [Continuous Auction for Market Maker \(CAMM\)](#) trading model and supporting of [Bonds](#) and [Warrants](#) trading functionality.

Key aspects of the [CAMM](#) model for public market and reference data are:

- [Pre Call](#) instrument state for [CAMM](#) trading model,
- instrument state transitions according to [CAMM](#) trading model,
- [knock-out](#) and [sold-out](#) processing.

T7 RDI and RDF, [instrument snapshot](#) message, is enhanced to support the [CAMM model](#) requirement for the migration of partner exchanges:

- new security types such as [Warrant](#), [Federal Note](#), [Federal Treasury Note](#), [Covered Bond](#) etc.
- new Bond specific fields for [Issuer \(106\)](#) and [IssueDate \(225\)](#) and all [Coupon](#) information.
- new valid values for
 - [TradingSessionSubID \(625\)](#) field to provide whether a security supports [CAMM](#).
 - [InstAttribType\(871\)](#) field to provide the [issuer name](#), [issuer number](#), [business unit](#), [allow knocked out](#) etc. information.
 - [SecurityType \(167\)](#) field to provide Bond and Warrant information.
- new [Bond](#) specific fields for [Issuer \(106\)](#) and [IssueDate \(225\)](#) and all [Coupon](#) information

T7 EMDI and MDI, [Instrument](#) and [Mass instrument state change](#) messages, are enhanced accordingly:

- new valid values for [SecurityStatus\(955\)](#) and [SecurityTradingStatus\(326\)](#) provide the [Pre Call \(=214\)](#) and [Call \(=215\)](#) instrument states.

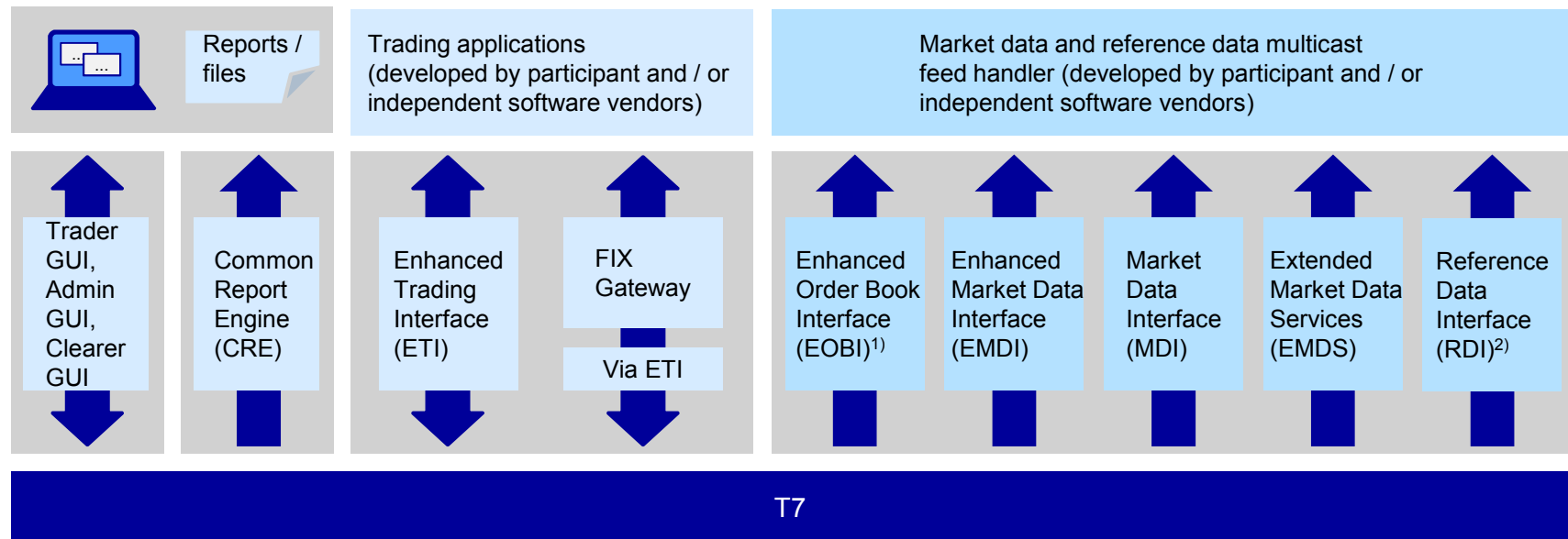
Further information

- 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-7.0/>
<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

Overview of T7[®] – 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 is also a file-based solution for reference data via the Common Report Engine (CRE) and an internet download.

T7[®] 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

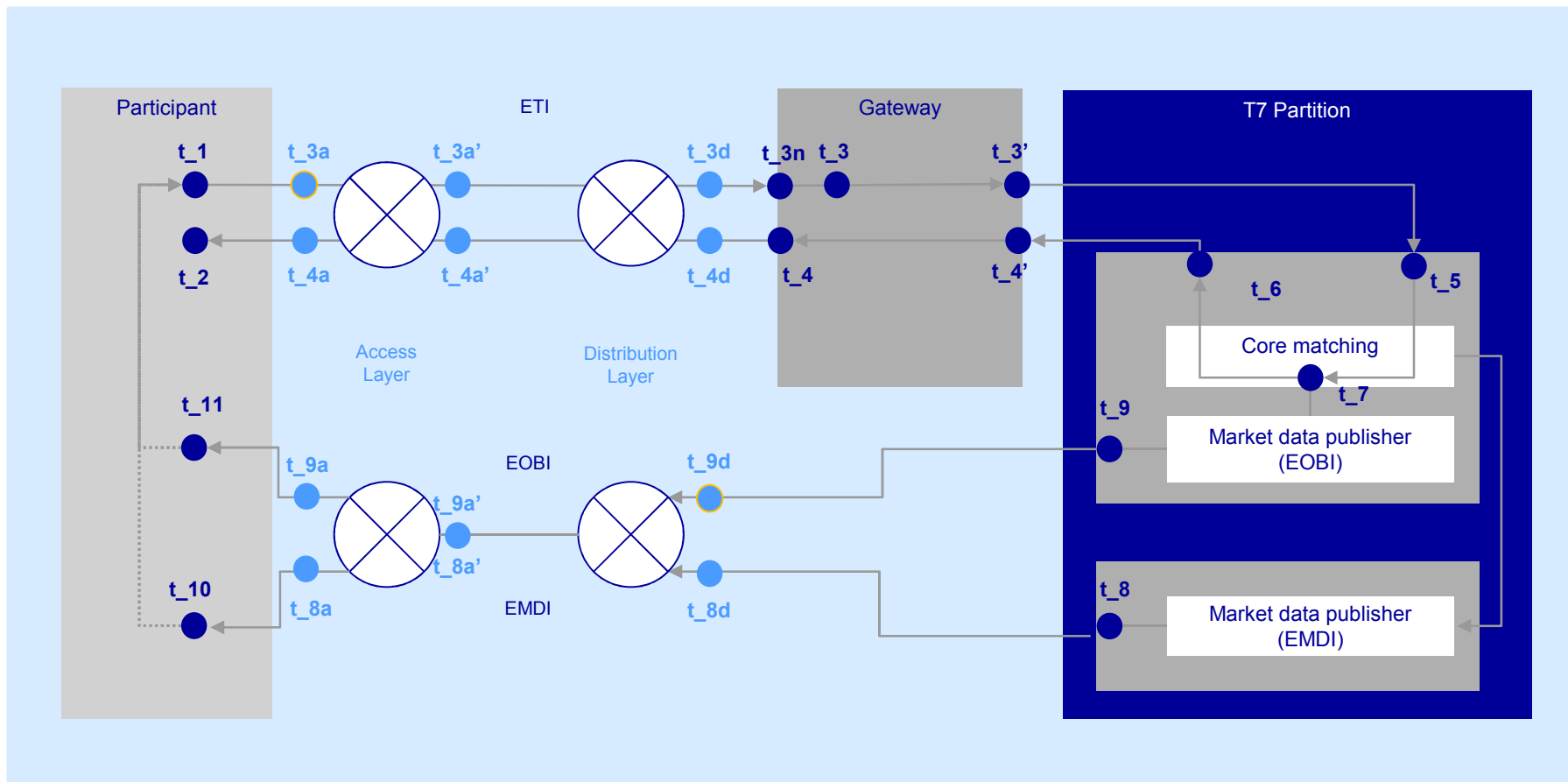
FIXML messages and no compression

 Common message layouts for all markets

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

T7[®] timestamps



Network time-stamps shown in light blue, t_{3a} and t_{9d} are available via the high precision timestamp file service, see <https://datashop.deutsche-boerse.com/High-precision-timestamp>

Description of timestamps

Definition

t_1,t_2: can be taken by a Participant (e.g. via a network capture) when a request / response is read from/written to the socket.

t_4: taken by the ETI gateway when a response / notification is written to the socket on the participant's side of the gateway; contained in (private) ETI response / notification.

t_3n: taken by the ETI gateway when the first bit of a request arrives on the PS gateway NIC; contained in (private) ETI response for transactions sent via PS gateways. Consecutive messages via the same session might be assigned to the same t_3n in rare cases.

t_3: taken by the ETI gateway application when a request is read from the socket on the participant's side of the gateway; contained in (private) ETI response for transactions sent via LF gateways.

t_3': taken by the ETI gateway right before a request is sent towards the matching engine; contained in (private) ETI response.

t_4': taken by the ETI gateway when a response / notification is received by the ETI gateway from the matching engine; contained in (private) ETI response / notification.

t_5, t_6: taken by the matching engine when a request / response is read / written; contained in (private) ETI response.

t_7: time at which the matching engine maintains the order book.

t_8: time taken by EMDI publisher just before the first respective UDP datagram is written to the UDP socket.

t_9: time taken by EOBI publisher just before the first respective UDP datagram is written to the UDP socket.

t_10, t_11: can be taken by a participant (e.g. via a network capture) when a UDP datagram is read from the UDP socket.

t_?a, t_?a', t_?d: taken by network capture devices in the access and distribution layers.

T7[®] timestamp reference

The timestamps t_3,...,t_9 are available via the following fields:

t_3, t_3n:	Tag	5979	("RequestTime")	in the T7 ETI Response in the T7 EMDI Depth Incremental message, in case a trade is reported in the T7 EOBI Execution Summary message
t_3':	Tag	7764	("RequestOut")	in the T7 ETI Response (from the matching engine)
t_4':	Tag	7765	("ResponseIn")	in the T7 ETI Response (from the matching engine)
	Tag	25043	("NotificationIn")	in the T7 ETI Notification (from the matching engine)
t_4:	Tag	52	("SendingTime")	in the T7 ETI Response and Notification
t_5:	Tag	21002	("TrdRegTSTimeIn")	in the T7 ETI Response (from the matching engine)
	Tag	21002	("TrdRegTSTimeIn")	in the T7 EOBI Order Add, Order Modify, Order Modify Same Priority and Order Delete messages
	Tag	28820	("AggressorTimestamp")	in the T7 EMDI Depth Incremental message, in case a trade is reported in the T7 EOBI Execution Summary message
t_6:	Tag	21003	("TrdRegTSTimeOut")	in the T7 ETI Response and Notification (from the matching engine)
t_7:	Tag	17	("ExecID")	in the T7 ETI Response (from the matching engine)
				in the T7 EOBI Execution Summary message
	Tag	273	("MDEntryTime")	in the T7 EMDI Depth Incremental message
	Tag	21008	("TrdRegTSTimePriority")	in the T7 EOBI Order Add and Order Modify messages
	Tag	60	("TransactTime")	in the T7 EOBI Order Modify Same Priority and Order Delete messages
t_8:	no Tag		("SendingTime")	in the T7 EMDI UDP packet header
t_9:	Tag	60	("TransactTime")	in the T7 EOBI packet header
(t_8-t_5):	no Tag		("PerformanceIndicator")	in the T7 EMDI UDP packet header of the T7 EMDI Depth Incremental stream

Notes on timestamps:

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

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

The Network timestamps (t_?a, t_?a', and t_?d are not available in any field.



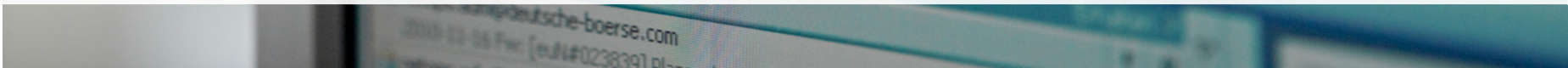
Thank you for your attention.

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