

High Precision Timestamps

Unveiling market microstructure

February 2019

Data Services

Deutsche Börse is introducing the High Precision Timestamp (HPT) information product suite

The HPT products:

Provide valuable information on the flow of an order in the T7[®] architecture

Act as a measure to evaluate and optimise participants' investment strategies

Can be used in algorithm backtesting

Are available for all order book updates sent via Co-location 2.0 Service

Are available for Eurex[®] and Xetra[®]

The ETICaptTime timestamp is captured at the outer boundary of the exchange's network and offers valuable insights into trading system dynamics

RequestTime

- **RequestTime** timestamp is captured at the T7 Gateway and is publicly available in EMDI/EOBI for aggressive orders
- Latency is introduced by the Exchange network before the incoming orders enter the Gateway which is not reflected in the RequestTime
- **Using RequestTime to evaluate the reaction time may not be sufficient**

ETICaptTime

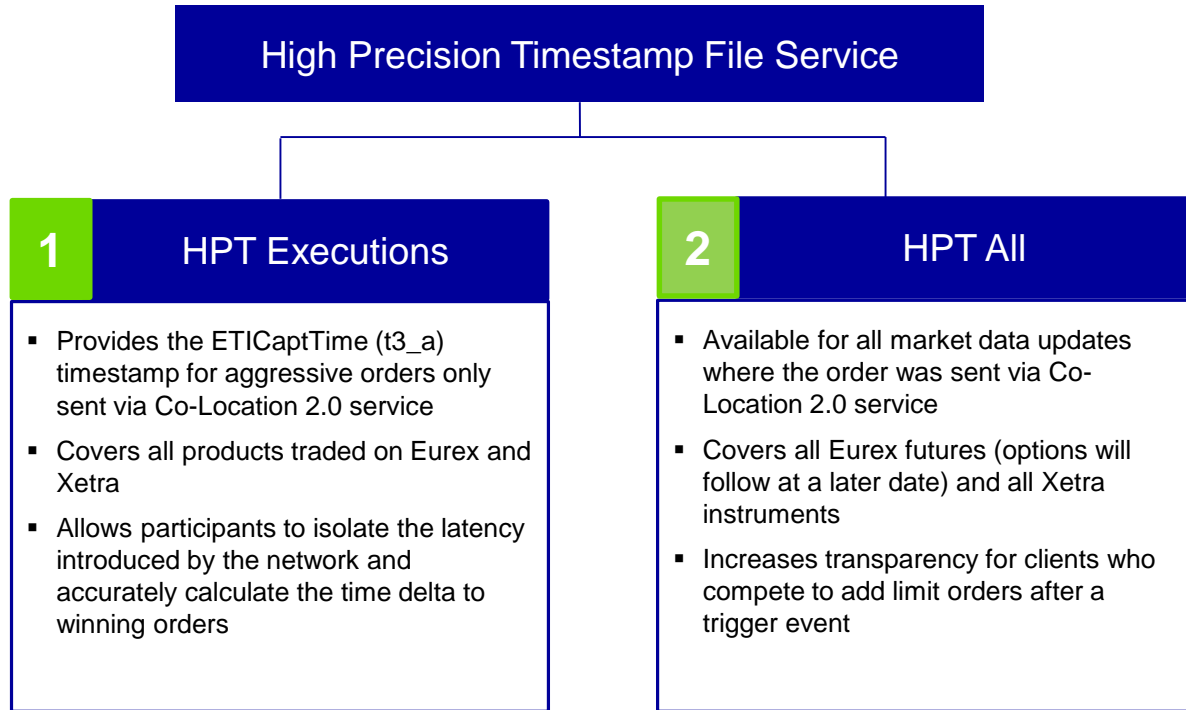
- **ETICaptTime** timestamp is captured as soon as an order arrives at the **outer boundary** of the exchange's network
- It allows participants **to isolate the latency introduced by the network**
- ETICaptTime is made available to subscribers via a daily file service



Use Case

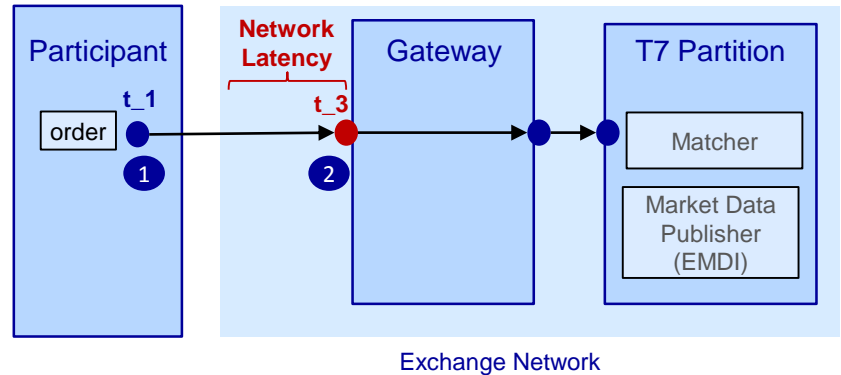
- Two orders are sent to T7 and compete for the same price
- The first order is matched, the second order loses
- Using the ETICaptTimestamp participants can calculate how long the 2nd order lagged behind the 1st one and use this information to improve their strategies

The HPT offering includes the HPT Executions and HPT All information products



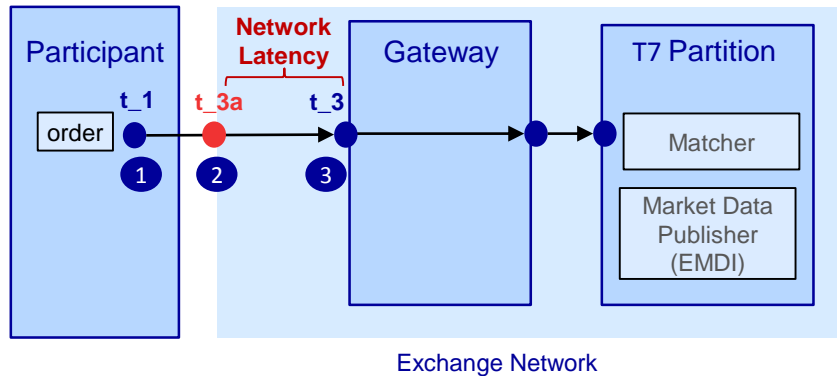
Currently RequestTime is captured at the Gateway and is used to estimate the time delta to the winning order

Step	Description
1	Participant sends order from their system at t_1 (t_1 is captured by client)
2	Order arrives at the Gateway at RequestTime (t_3). t_3 is captured and published in EMDI/EOBI in field RequestTime for aggressive orders only

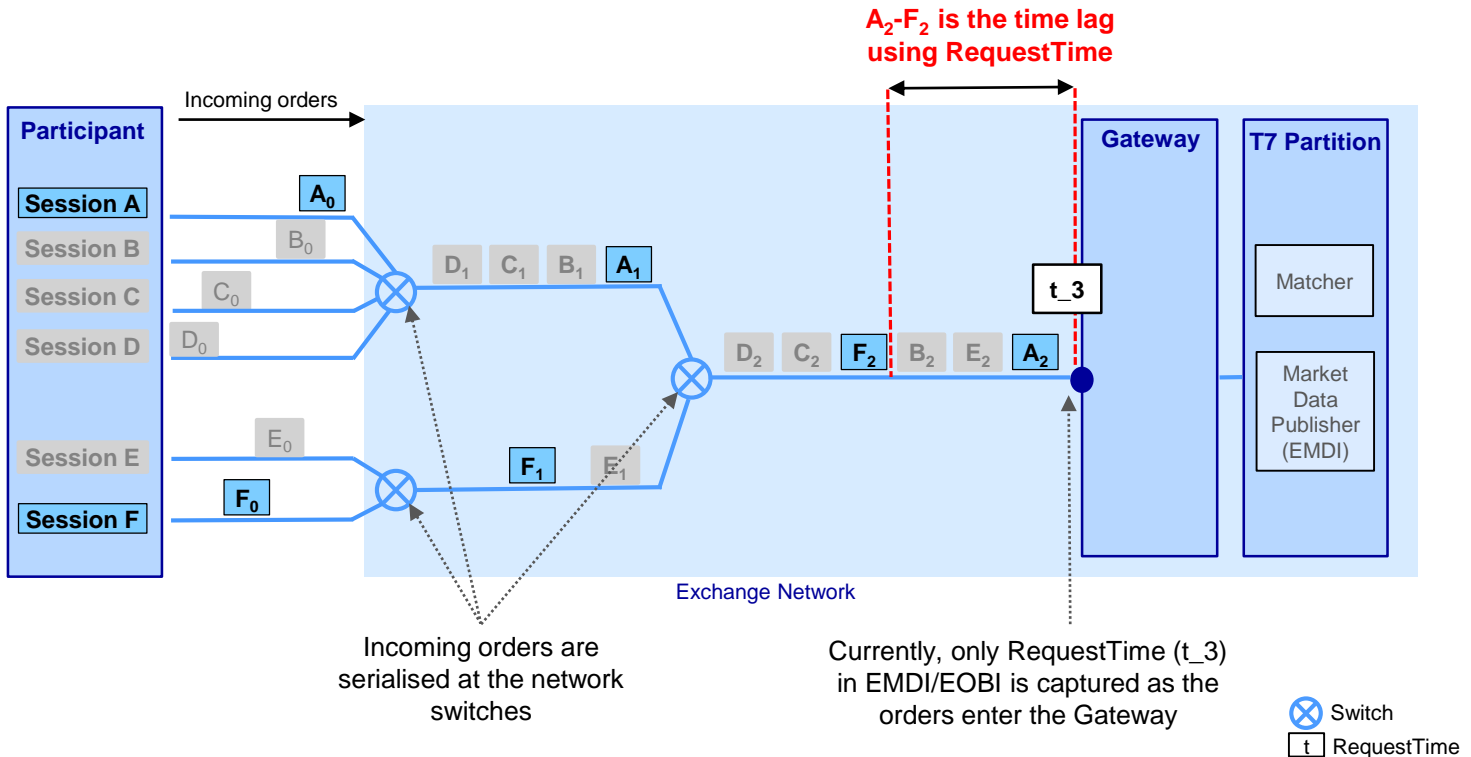


The ETICaptTime timestamp is captured at the outer bounds of the Exchange Network and allows to determine network latency

Step	Description
1	Participant sends order from their system at t_1 (captured by client)
2	The network timestamp ETICaptTime (t_{3a}) is captured at the outer boundaries of the Exchange's network. ETICaptTime is published daily for all market updates in a CSV file
3	Order arrives at the Gateway at t_3 . t_3 is captured and published in EMDI/EOBI in field RequestTime for aggressive orders only

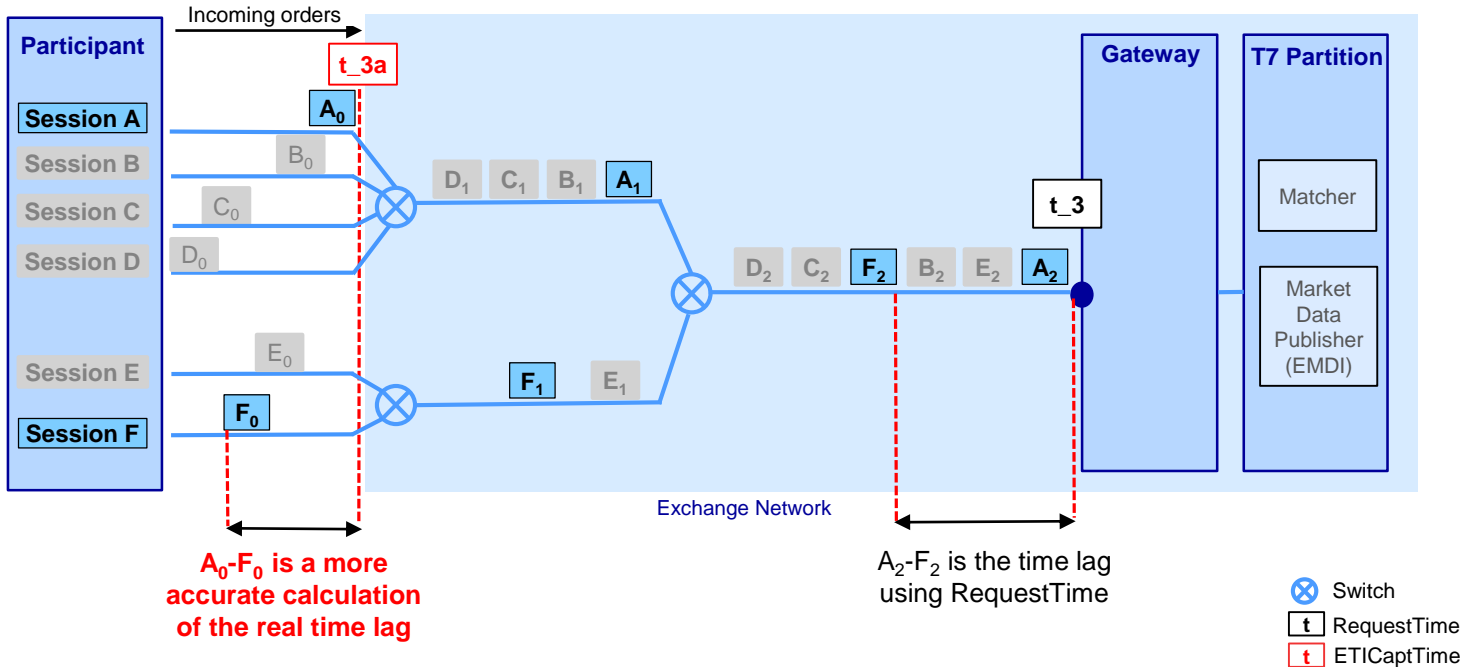


Example: Orders A to F are submitted at different times. The time lag between A and F is currently calculated based on Gateway timestamps



Example (cont.): The new timestamp ETICaptTime allows the calculation of the time lag between orders A and F with higher precision

t_{3a} is captured at the outer boundaries of the network allowing for a highly accurate calculation of the time delta between A and F



High Precision Timestamp Subscription Details

Product Scope

1. **HPT Executions File Service:** Available for all Eurex and Xetra instruments
2. **HPT All File Service:** Available for all Eurex futures and all Xetra instruments. Eurex options will be made available at a later release.

Data Availability

- The file is available T+1 in **CSV** format via the Deutsche Börse Data Shop subscription service at datashop.deutsche-boerse.com
- For a full description of the information in the files please check the next slides

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HPT Executions File: Field Description

Field	Description
MarketSegmentID	Product identifier, extracted from EOBI/EMDI ¹ Packet Header
SecurityID	Unique instrument identifier, extracted from EOBI Execution Summary (ES)/EMDI DepthIncremental (DI)
ExecID	Matching timestamp, extracted from EOBI ES/EMDI MDEntryTime
ApplSeqNum	Message sequence number, extracted from EOBI Packet Header / EMDI DI MsgSeqNum
PartitionID	Grouping of T7 products, extracted from EOBI / EMDI Packet Header
CompletionIndicator	Indicates whether a unit of work fits into a single datagram, extracted from EOBI Packet Header (empty for EMDI)
TradeCondition	1 = Implied Trade, extracted from EOBI ES (empty for EMDI)
AggressorSide	1= Triggered by the buy side, 2= triggered by the sell side, extracted from EOBI ES / EMDI DI
LastQty	Total quantity of this match, extracted from EOBI ES / EMDI MDEntrySize
LastPx	Worst price of this match, extracted from EOBI ES / EMDI MDEntryPx
RestingHiddenQty	Quantity of matched passive orders that is not displayed to the market, extracted from EOBI ES (empty for EMDI)
RestingCxlQty	Extracted from EOBI ES (empty for EMDI)
RequestTime	Gateway request in timestamp of aggressing order, extracted from EOBI ES / EMDI DI
AggressorTime	Matching Engine In timestamp of aggressing order, extracted from EOBI ES / EMDI DI
TransactTime	Time when market data feed handler writes packet on the wire, extracted from EOBI/EMDI Packet Header
EOBICaptTime/EMDICaptTime	Time when market data feed packet is captured by distribution layer tap (t_9d)
ETICaptTime	Time when aggressing order packet is captured by access layer tap (t_3a)

¹ [T7 Enhanced Order Book Interface \(EOBI\) manual](#)

[T7 Enhanced Market Data Interface \(EMDI\) manual](#)

HPT All File: Field Description

Field	Description
ApplSeqNum	Application sequence number, extracted from EOBI Packet Header
MsgSeqNum	Message sequence number, extracted from EOBI Message Header.
Message	TemplateID, extracted from EOBI Message Header. See next page for details.
CompletionIndicator	Indicates whether a unit of work fits into a single datagram, extracted from EOBI Packet Header
PartitionID	Grouping of T7 products, extracted from EOBI / EMDI Packet Header
MarketSegmentID	Product identifier, extracted from EOBI/EMDI ¹ Packet Header
SecurityID	Unique instrument identifier, extracted from EOBI Execution Summary (ES)/EMDI DepthIncremental (DI)
Side	1= buy side, 2= sell side, in case of executions: triggering side
Price	Price, in case of executions: worst price of this match
Qty	Quantity, in case of executions: Total quantity of this match
TradeCondition	1 = Implied Trade, extracted from EOBI Execution Summary
RestingHiddenQty	Quantity of matched passive orders that is not displayed to the market, extracted from EOBI ES (empty otherwise)
RestingCxlQty	Extracted from EOBI ES (empty otherwise)
ExecID	Matchier central timestamp, extracted from EOBI
TrdRegTSTimePriority	Priority time, extracted from EOBI
RequestTime	Gateway request in timestamp of aggressing order, extracted from EOBI ES or ETI packet
AggressorTime	Matching Engine In timestamp of aggressing order, extracted from EOBI ES
TransactTime	Time when market data feed handler writes packet on the wire, extracted from EOBI Packet Header
EOBICaptTime	Time when market data feed packet is captured by distribution layer tap (t_9d)
ETICaptTime	Time when triggering ETI packet is captured by access layer tap (t_3a), network entry time of an order in case of an Instrument State Change message

¹ [T7 Enhanced Order Book Interface \(EOBI\) manual](#)

[T7 Enhanced Market Data Interface \(EMDI\) manual](#)

HPT All File: Message Types Covered

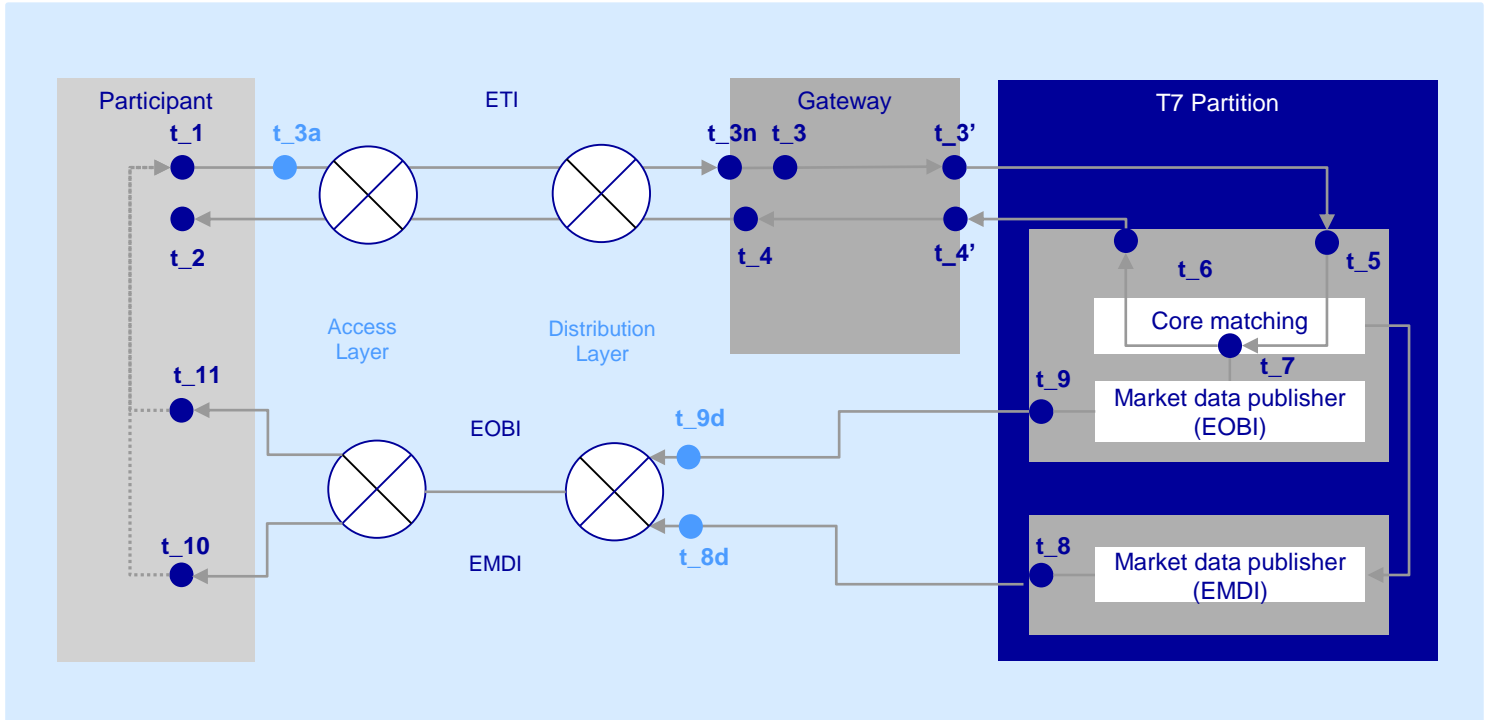
Message	Description
13100	Order add
13101	Order modify
13102	Order delete
13106	Order modify same priority
13202	Execution summary
13104	Full order execution
13105	Partial order execution

Appendix 1

T7 Architecture and Timestamps



T7 Architecture and Timestamps¹



The above T7 architecture reflects the new timestamp t_{3a} . Network timestamps shown in **light blue**.

¹ More details can be found in [T7 Enhanced Order Book Interface \(EOBI\) manual](#) and [T7 Enhanced Market Data Interface \(EMDI\) manual](#)

T7 Timestamp Reference¹

The time stamps **t_3** to **t_9** are available via the following **EMDI/EOBI** 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
	Tag	28820	("AggressorTimestamp")	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 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).

¹ More details can be found in [T7 Enhanced Order Book Interface \(EOBI\) manual](#) and [T7 Enhanced Market Data Interface \(EMDI\) manual](#)

Description of Timestamps

Definition¹

Timestamp	Description
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
t_3n	taken by the ETI gateway when the first bit of a request arrives on the HF gateway NIC
t_3	taken by the ETI gateway application when a request is read from the socket on the Participant´s side of the gateway
t_3'	taken by the ETI gateway right before a request is sent towards the matching engine
t_4'	taken by the ETI gateway when a response/ notification is received by the ETI gateway from the matching engine
t_5, t_6	taken by the matching engine when a request/response is read/written
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.

¹ More details can be found in [T7 Enhanced Order Book Interface \(EOBI\) manual](#) and [T7 Enhanced Market Data Interface \(EMDI\) manual](#)



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