DEUTSCHE BÖRSE GROUP

High Precision Timestamps File Service

A new data services product for EUREX and XETRA

August 2018

Deutsche Boerse is introducing a new timestamp to help clients accurately calculate the time delta to winning orders

The new timestamp:

- Provides more information on the flow of an order in the T7 ® architecture
- Acts as a measure to evaluate and optimise participants' investment strategy
- Can be used in algorithm backtesting
- Available for all aggressive orders sent via Co-location 2.0 Service

The new timestamp will allow to calculate the time delta to winning orders with higher accuracy

Current Timestamp

- Currently, **RequestTime**[1] of an incoming order is captured at the T7 Gateway and is used to calculate the time delta to the winning order
- Latency is introduced by the Exchange network before the incoming orders enter the Gateway which is not reflected in the RequestTime
- **Using RequestTime to calculate the time lag to the winning order may not be sufficient**

New Timestamp

- The new timestamp ETICaptTime is captured **as soon as an aggressive order arrives at the outer boundary of the Exchange's network** and has much higher accuracy than RequestTime
- It will allow participants **to isolate the latency introduced by the network** and calculate the real time delta to the winning order
- The new timestamp will be published daily in a file

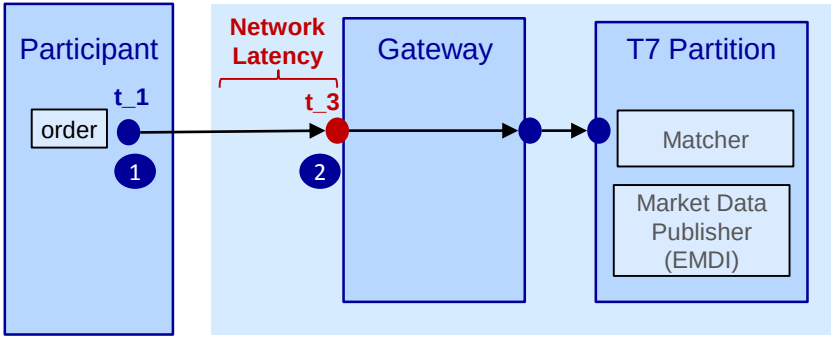
Use Case

- Two market orders are sent to T7. First order is matched against the best price and second order is matched against the second best price
- Currently, participants use RequestTime at Gateway to calculate how long the 2nd order lagged behind the 1st one
- **Using the new timestamp allows to calculate the time lag with higher precision**

[1] **RequestTime** timestamp is publicly available in EMDI/EOBI for aggressive orders. Aggressive is the order that triggered the trade. It is an incoming order that matches one of the orders sitting on the order book and pulls liquidity out of the order book.

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

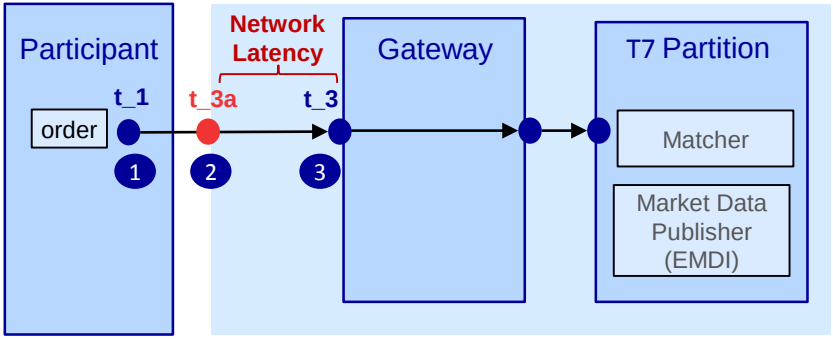
Step	Description
1	Participant sends order from their terminal at t_1 (t_1 is captured by client)
2	Order arrives at the Gateway at t_3. t_3 is captured and published in EMDI/EOBI in field **RequestTime** for aggressive orders only



[1] More information on the T7 architecture and T7 timestamps can be found in Appendix 1.

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

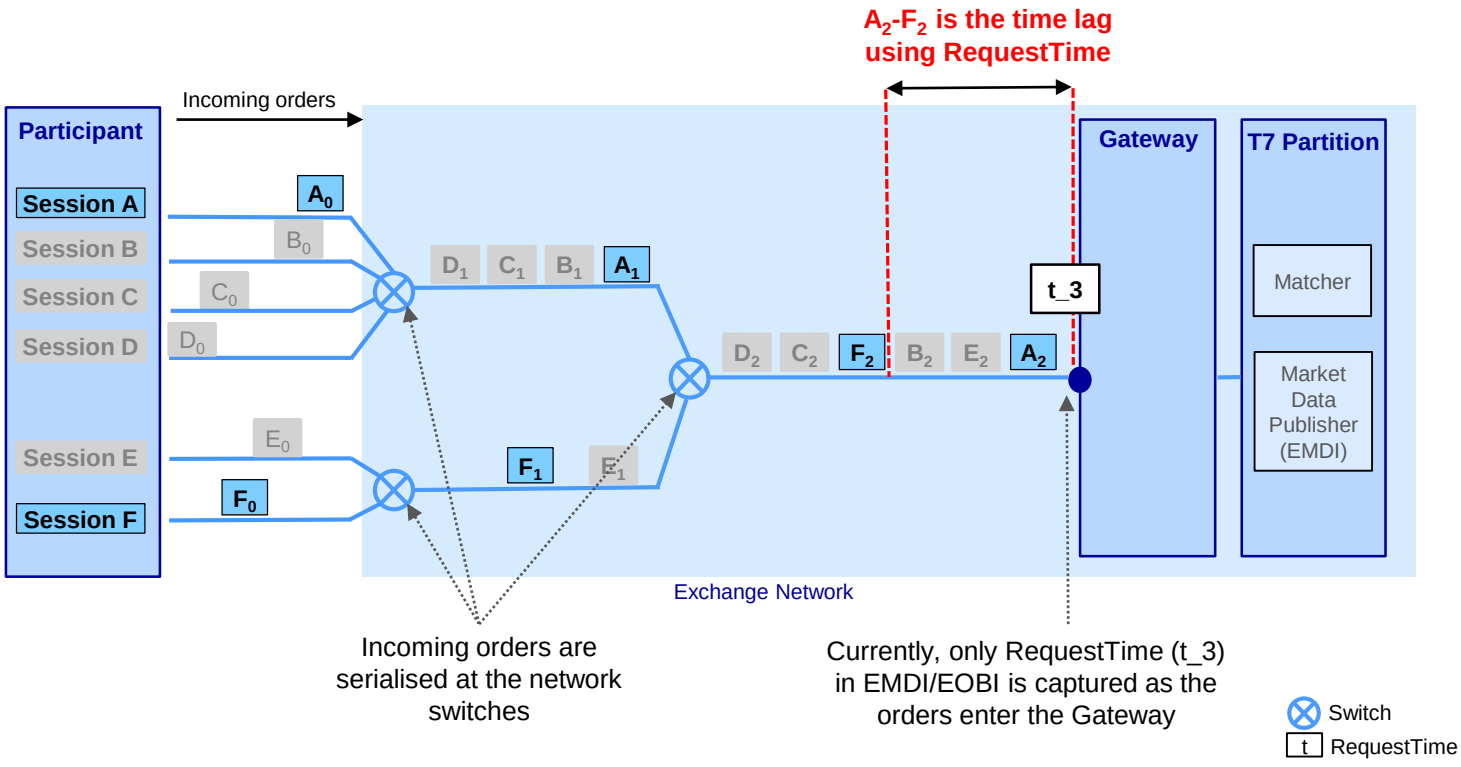
Step	Description
1	Participant sends order from their terminal at t_1 (captured by client)
2	The new timestamp **ETICaptTime** (t_3a) is captured at the outer boundaries of the Exchange's network. ETICaptTime is published for aggressive orders only in PCAP/CSV file.
3	Order arrives at the Gateway at t_3. t_3 is captured and published in EMDI/EOBI in field RequestTime for aggressive orders only



Exchange Network[1]

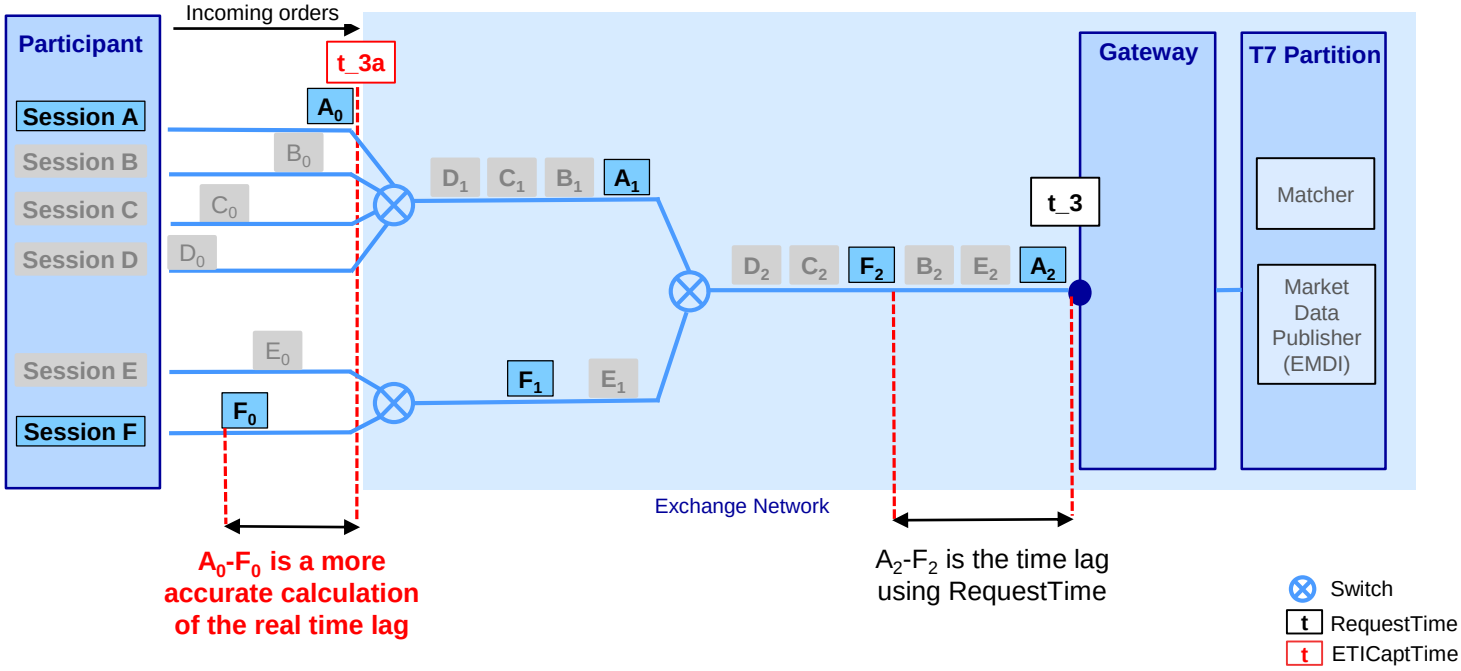
[1] More information on the T7 architecture and T7 timestamps can be found in Appendix 1.

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

The new timestamp 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 Timestamps File Service Subscription Details

Product Coverage	• The new timestamp file covers all products / instruments traded on Eurex and Xetra • Available for all aggressive orders sent via Co-Location 2.0 Service
Data Availability	▪ The file is available daily in **CSV** format per market (Xetra, Eurex) ▪ For a full description of the headers in the files check the next slide
Contact	**Deutsche Boerse Market Data + Services Sales** **EMEA** Maria Boutsikou +44 (0) 207 862 7524 **US** Chris DeMaso +1 212 309 9305

High Precision Timestamps File Description

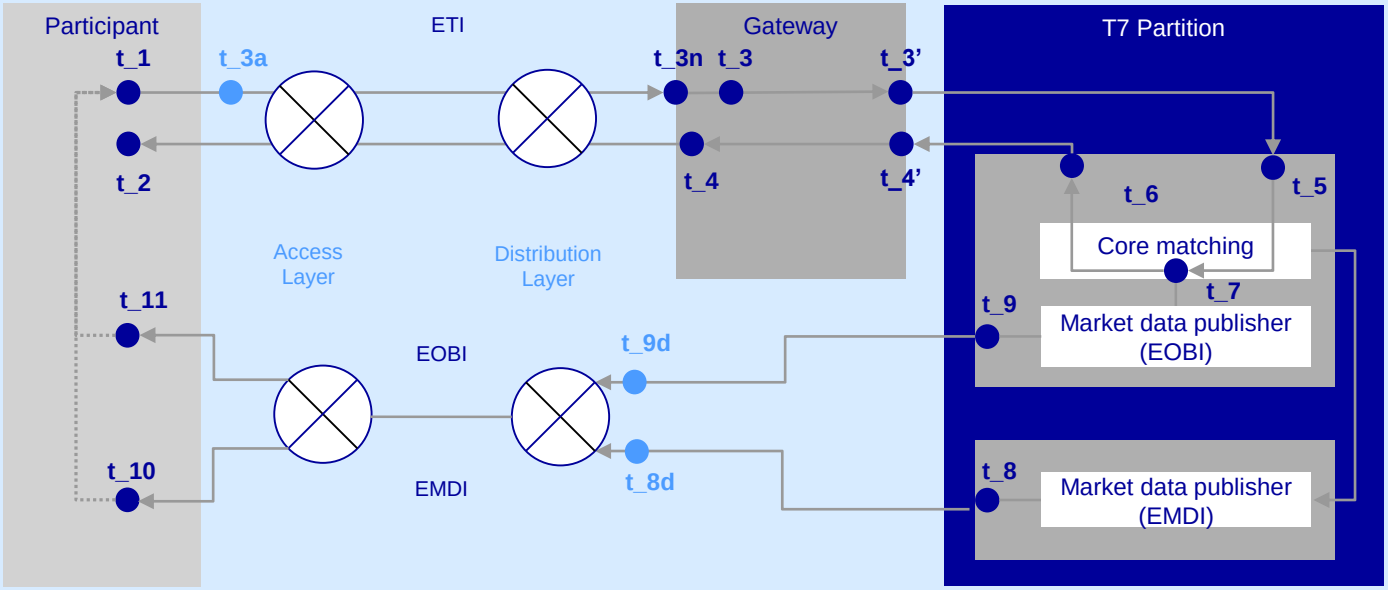
Field	Description
MarketSegmentID	Product identifier, extracted from EOBI/EMDI[1] Packet Header
SecurityID	Unique instrument identifier, extracted from EOBI Execution Summary (ES)/EMDI DepthIncremental (DI)
ExecID	Matching timestamp, extracted from EOBI ES/EMDI MDEntryTime
ApplSeqNum	Message sequence 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

Appendix 1

T7 Architecture and Timestamps

T7® Architecture and Timestamps[1]



The above T7 architecture reflects the new timestamp t_3a. Network timestamps shown in light blue.

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

Description of Timestamps

Definition[1]

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 the T7 Enhanced Order Book Interface (EOBI) manual and the T7 Enhanced Market Data Interface (EMDI) manual

T7 ® Timestamp Reference[1]

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 the T7 Enhanced Order Book Interface (EOBI) manual and the T7 Enhanced Market Data Interface (EMDI) manual

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