

## **1. Reconstructed Limit Order Book Data Derived from NASDAQ's Historical TotalView-ITCH**

### **1.1. Underlying Data:**

- a) Raw Message Data:  
The limit order book data is reconstructed from NASDAQ's historical TotalView-ITCH message data. For more information on NASDAQ's historical TotalView-ITCH please visit <http://www.nasdaqtrader.com/Trader.aspx?id=ITCH>
- b) Database Period:  
LOBSTER's database of raw message data includes the following NASDAQ historical TotalView-ITCH versions:
  - 4.1: April 27-th 2010 until the trading day before yesterday.

### **1.2. Output Structure:**

- a) Description:  
LOBSTER generates a 'message' and an 'orderbook' file for each active trading day. The message file contains indicators for the type of event causing an update of the limit order book time stamped to seconds after midnight with decimal precision of at least milliseconds and up to nanoseconds depending on the requested period. The order book file contains the evolution of the order book up to the requested level.
- b) Message File:
  - o Format: CSV
  - o Size: Matrix of size: (Nx6)
  - o Name:  
TICKER\_Year-Month-Day\_StartTime\_EndTime\_message\_LEVEL.csv  
StartTime and EndTime give the theoretical beginning and end time of the output file in milliseconds after midnight. LEVEL refers to the number of levels of the requested limit order book.
  - o Columns:
    - 1. Time:  
Seconds after midnight with decimal precision of at least milliseconds and up to nanoseconds depending on the requested period.
    - 2. Type:
      - (1) Submission new limit order
      - (2) Cancellation (Partial deletion limit order)
      - (3) Deletion (Total deletion limit order)
      - (4) Execution (Against visible limit order)
      - (5) Execution (Against hidden limit order)
      - (7) Trading halt indicator (Detailed information below)
      - (100) Other (Unknown)
    - 3. Order ID:  
Unique order reference number (Assigned in order flow)
    - 4. Size:  
Number of shares
    - 5. Price:  
Dollar price times 10000 (i.e. a stock price of \$91.14 is given by 911400)
    - 6. Direction:  
-1: Sell limit order; 1: Buy limit order  
Note: Execution of a sell (buy) limit order corresponds to a buyer (seller) initiated trade, i.e. Buy (Sell) trade.

- c) Order Book File:
- o Format: CSV
  - o Size: Matrix of size: (Nx(4xNumberOfLevels))
  - o Name: TICKER\_Year-Month-Day\_StartTime\_EndTime\_orderbook\_LEVEL.csv  
StartTime, EndTime and LEVEL as defined above.
  - o Columns:
    1. Ask price 1: Level 1 ask price (Best ask )
    2. Ask size 1: Level 1 ask volume (Best ask volume)
    3. Bid price 1: Level 1 bid price (Best bid)
    4. Bid size 1: Level 1 bid volume (Best bid volume)
    5. Ask price 2: Level 2 ask price (2<sup>nd</sup> best ask)
    6. ...
- d) Remarks:
- o Ticker:  
The term 'ticker' refers to a ticker symbol used in NASDAQ's TotalView-ITCH message data to uniquely identify publicly traded shares of a particular stock.
  - o Levels:  
The term 'level' refers to occupied price levels. A 1 level order book, hence, contains the best ask and bid prices and their respective volumes. A 2 level order book contains the best and second best ask and bid prices and their respective volumes. This implies that the difference between two levels in LOBSTER's output is not necessarily the minimum tick size.
  - o Unoccupied Price Levels:  
When the selected number of levels exceeds the number of levels available the empty order book positions are filled with dummy information to guarantee a symmetric output. The extra bid and/or ask prices are set to -999999999 and 999999999, respectively. The Corresponding volumes are set to 0.
  - o Trading Halts:  
When trading is halted, a message of type '7' is written into the message file. The corresponding price and trade direction are set to '-1' and all other message properties are set to '0'. Should quoting be allowed during the halt, another message of type '7' with price '0' is added. Again the trade direction is set to '-1' and all other fields are set to '0'. The resuming of trading is indicated by a message of type '7' with price '1' (Trade direction '-1' and all other entries '0'). For messages of type '7' the corresponding order book row contains a duplication of the preceding order book state. The reason for the trading halt is not included in the output.  
  
Please note, that trading halt information is only included in order books that are derived from NASDAQ's historical TotalView-ITCH files version 4.1 which cover the period from 27-th of April 2010 up to now.
  - o Time Window:  
The limit order books provided by LOBSTER give the dynamics during regular trading hours, i.e. the time between 09:30:00 and 16:00:00 EST. Extensions to the pre-trading session will be available in the future.

### 1.3. Remarks:

- a) Ticker and Company Names:  
The request interface for reconstructed limit order book data is based on the tickers used in NASDAQ's historical TotalView-ITCH files. LOBSTER does not provide an interface that allows searching the company ticker based on the company's name or vice versa. Users are asked to identify the ticker of a company of interest relying on third party services.
- b) Compressed Files:  
The limit order book files provided for download are compressed using the open source tool 7-zip to reduce download times. Accessing the data in the .CSV format requires the user to extract the downloaded archives via 7-zip, which must be installed user's computer.