# CMC Development Task.



Prior to your technical interview at CMC, we would like you to implement a small test application.

Reviewing your implementation and discussing how it can be enhanced will form part of the interview.

The task is to build order books from a stream of orders and print out the ‘By Level’ order book(s) at the end. A detailed specification of a ‘By Level’ order book is provided below.

A simple task framework and skeleton Visual Studio Project have been provided for your convenience. You need to implement the IOrderConsumer class in OrderConsumer.cs.

You should:

1. Initialise your structures in startProcessing(Log log)
2. Build the ‘By Level’ Order Books by processing the order events in handleEvent(Action action, Order order).
3. Write the ‘By Level’ Order Books to the Log interface in finishProcessing().

A couple of points:

1. Separate OrderBooks are maintained for each different instrument.
2. You **must** maintain the By Level Order Books in **real time** and not wait until the finishProcessing() event to build them.
3. It is not required that the candidate ‘match’ bid orders to asks. The requirement is merely to aggregate the orders for each level.

We would expect candidates to spend no more than 90 minutes on their submission.

The source code includes some hard coded test data to help you get started but also includes some order streams as XML files. Your submission should process data from any of these sources and the output will be checked.

# Order Book Definition



Many markets are order driven, which is to say that traders submit orders to buy and sell instruments for a given price and volume.

This exercise assumes a market in which you are only notified of market orders. These are a firm request to buy or sell a certain quantity of the instrument (stock or option or future) for no more than the given 'limit price'.

For example an order to buy 100 Microsoft shares for 28.70 means that the trader wants to buy 100 MSFT shares and will not pay more than $28.70. Multiple traders place individual orders at different prices and sizes, leading to the build-up of an order book. The 'By Level' order book shows the number of orders and their total volumes (i.e. the cumulative quantity) at a given price level.

Orders may be removed (either because a trader has cancelled an order or because it has traded) and the price and/or volume of an order may be edited.

The following example may help clarify the concept:

Definitions:

- Bid Price - The highest price that a trader is willing to pay to buy an instrument
- Bid Size - The number of contracts (or shares) that are available at the bid price.

- Ask Price - The lowest price that a trader is willing to accept to sell an instrument
- Ask Size - The number of contracts (or shares) that are available at the ask price.

- Order book level - a tuple containing a price, size and order count.

The order book should include all buy and sell orders currently pending for an instrument. It contains two 'sides' - bid and ask. Each side consists of multiple levels, and is sorted so the level that has highest bid is on the top of the bid side, and the lowest ask is on the top of the ask side. An order book representation can be:

By order: each level represents a single order (buy/sell) that was placed e.g.

| Order Id | Ask Size | Ask Price |
|---|---|---|
| s1 | 10 | 19.00 |
| s2 | 2 | 19.00 |
| s3 | 9 | 21.00 |
| s4 | 8 | 21.00 |
| s5 | 7 | 22.00 |

| Order Id | Bid Size | Bid Price |
|---|---|---|
| b1 | 10 | 15.14 |
| b2 | 21 | 10.40 |
| b3 | 5 | 10.40 |

By level/by price: orders that have the same price are aggregated – each level has the price, the total size of all orders at that price and the number of orders at that price.

| Ask Price | Ask Size | Order Count |
|---|---|---|
| 19.00 | 12 | 2 |
| 21.00 | 17 | 2 |
| 22.00 | 7 | 1 |

| Bid Price | Bid Size | Order Count |
|---|---|---|
| 15.14 | 10 | 1 |
| 10.40 | 26 | 2 |

## *A few important notes:*

1. Order Books are built for each individual Instrument. It is a mistake to aggregate orders for different Instruments in the same order book
2. A typical order book might have anywhere from 5 to 500 price levels at any time
3. It is common for new price levels to be created during the day as the stock price moves
4. A typical order might have 4 or more modification events applied to it before being removed