

## Description

Equities, futures, and options exchanges; market makers; hedge funds; and traders require real-time knowledge of the best bid and ask prices for the instruments that they trade. Algo-Logic Systems' Coherent Accelerator Processor Interface (CAPI) enabled Order Book is an FPGA hardware accelerator that processes market data while running on the Nallatech P385 card in an IBM® POWER8™ server. By implementing the entire feed processing module and Order Book in logic, the system enables software to directly receive market data snapshots in the coherent shared memory with the least possible latency. Tracking the open orders by all participants ensures that the market is fair and liquid, trades are profitable, and jitter is avoided during bursts of market activity.

The L-3 Order Book provides traders the best opportunity to receive real-time information about the trading activity on their exchange by taking advantage of the exchange's market data feeds that offer the highest level of transparency. The Order Book works on incremental L-3 update messages that come in as part of the market data feed over UDP/IP Multicast.

By using the IBM POWER8 server, algorithms can run on the highest number of cores and seamlessly integrate with the Order Book hardware accelerator by means of the coherent shared memory. Through simple memory-mapped IO (MMIO) address space, all the parameters are configurable and statistics can be easily read from software.

IBM POWER8 dual-socket system allows trading firms to optimally leverage heterogeneous computing. Trading algorithms can run on up to 96 CPU threads, bulk analytics can utilize high-throughput vector processing from GPU cores, and latency sensitive operations provided by FPGA logic to implement a truly heterogeneous solution that achieves better performance than could be achieved only in software.

## Applications

- High frequency market makers
- Algorithmic trading systems requiring both complexity and speed
- Exchanges needing jitter-free matching engines
- Advertising bidding technology
- Highest performance tick-to-trade systems
- Low latency feed distributions needing to minimize bandwidth utilization
- Arbitrage opportunity discovery in the nanosecond timescale

## Key Features and Use-cases

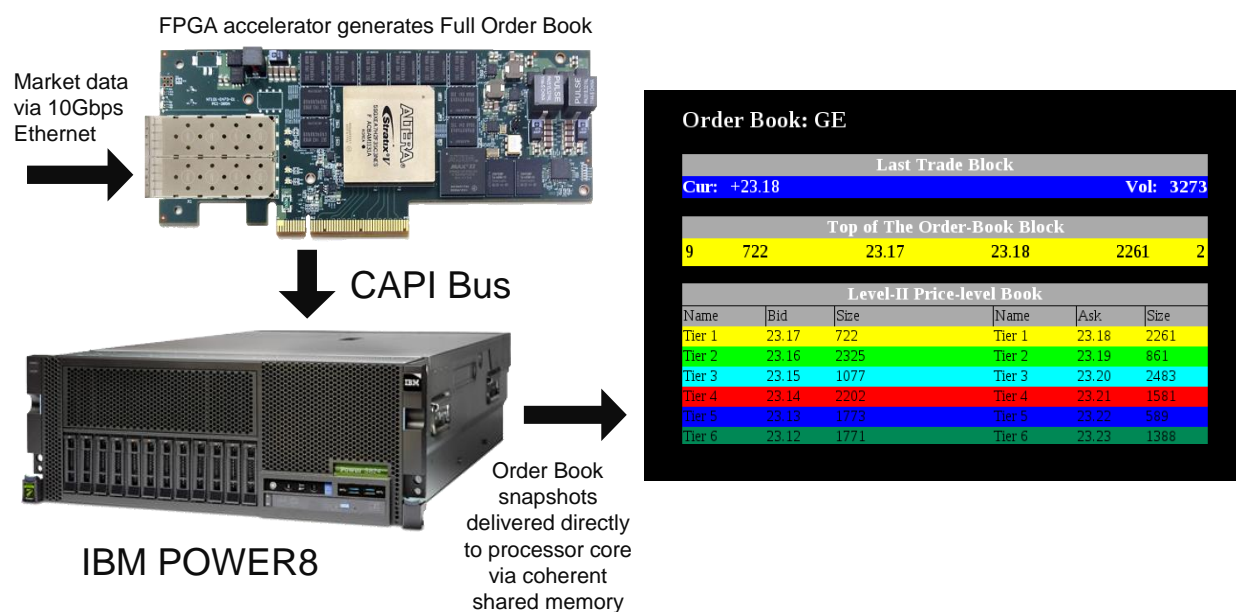
- Accelerator Function Unit (AFU) is implemented on FPGA under CAPI
- Full Order Book with a L-2 default size of 6 price-levels per symbol, fully scalable to larger sizes
- By default L-2 snapshots are generated for each symbol. The number of symbols in use and their respective snapshots are user configurable. L-2 snapshot generation frequency is also user configurable
- Full Order Book output logic seamlessly connects to customer's proprietary algorithmic trading strategies
- Trader has access to the latest market depth (L-2 snapshots) in coherent shared memory
- Full Order Book building process includes
  - I. Receiving parsed market data feed messages
  - II. Building and maintaining L-3 order level replica of the exchange's displayable book
  - III. Building L-2 books for each symbol with the market depth and weight summary of all open orders
  - IV. Reporting locally generated copy of the top-of-book with configurable amount of market depth (L-2 snapshots) as well as the last trade information when orders execute

## Full Order Book Metrics

L-2 Snapshot Generation	On change of top levels of book, peak rate user configurable
L-2 Price Levels	Provided in snapshot from 1 to 6 levels, user configurable
Maximum L-3 Table Depth	3k (default), scalable to 48k
Order Book Update Message Rate	4 million add/delete incremental order book update messages per second
Number of Symbols	12 (default), scalable to 24
Market Data Filtering Latency	180 nanoseconds
L-2 Book Processing Time	Under 120 nanoseconds
L-3 Book Processing Time	Under 230 nanoseconds
Complete Tick-to-Trade Latency	Under NDA

## CAPI Enabled Full Order Book on POWER8 Application with Level-II sample screenshot

The Algo-Logic Systems' Order Book Application Level-II sample screenshot is illustrated below. In this reference design the symbols filtered by the Market Data Filter application are used to generate the Level-II Order Book.



## Ordering Codes

AL-OB – (Market) (# Symbols) (L3 depth) (Platform) → Example:

- Market (e.g.: NASDAQ ITCH 5.0)
- Number of symbols to monitor = 12, 24, 48, 80+
- Level 3 depth (# of Open Orders) = 3k and 48k on-chip; 100k+ off-chip
- Platform: Nallatech P385