# Impulse Toolkit for High Frequency Trading Systems

The Most Widely Used Optimizing C-to-FPGA Compiler

## Overview

Hedge funds, banks and other financial services firms use Impulse software to create hardware-based high frequency trading systems. For example, software developers have used Impulse tools to create ITCH, ITCH/OUCH, OPRA and generic UDP systems. These systems show ultra-low latency and consistent processing intervals in even the highest volume market conditions. Impulse tools enable software developers to port existing trade logic and create new algorithms in hardware using standard software programming methods. Using Impulse tools, software engineers can create hardware systems 50% faster than standard hardware design methods and make system improvements 80% faster.

Combining the Impulse ANSI C tool set with feed handler reference designs minimizes time to market and improves quality of results. In the past, using FPGAs meant learning a new programming language and understanding low-level hardware concepts. With Impulse C, you can incorporate FPGAs into your network using familiar C-language programming methods. Impulse C allows you to easily add custom, proprietary strategies into optimized hardware to process and parse market feeds at up to line speeds, perform complex analyses and make quicker trading decisions.

Impulse provides software-to-FPGA tools, training, and intellectual property. Impulse and Impulse Partners provide tested sub-system elements including feed handler IP. These reference designs can be purchased running on the hardware platform of your choice. Impulse enables your team to easily develop and add hardware based algorithms to these platforms, and optimize your trading network.

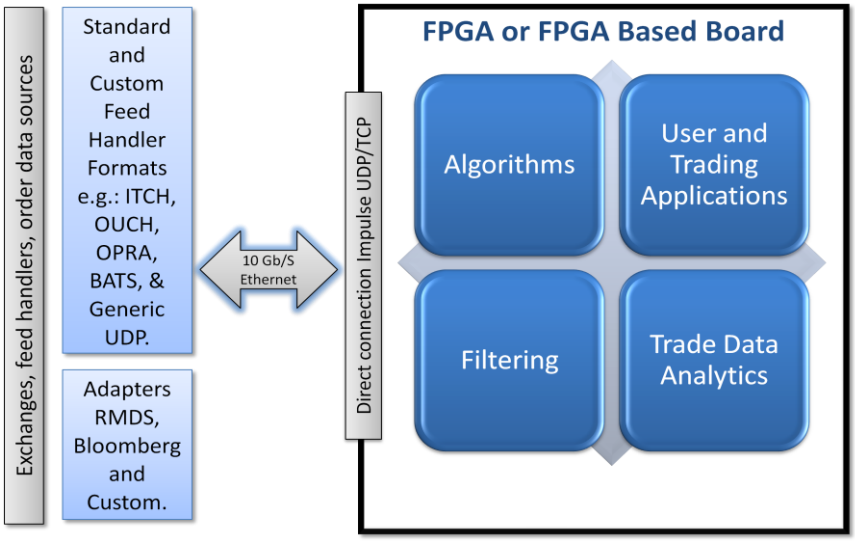
## Available Products and Software Modules

| Product | Part number | Description |
|---|---|---|
| **CoDeveloper™** | CSWIN-XIMBX-ANL-300 | ANSI C to FPGA Optimizing compiler and development toolkit. |
| **CoValidator™** | CVWIN-XIMBX-ANL-200 | Automatic Hardware Test bench generation option for CoDeveloper. Compatible with ModelSim. |
| **ITCH Module** | CSMOD-ITCHX-ANL-100 | Incoming MOLD UDP data packets of ITCH feeds. |
| **OPRA Module** | CSMOD-OPRAX-ANL-100 | OPRA, FIX/FAST Parser |
| **UDP Parser Module** | CSMOD-UDPXX-ANL-100 | 1GigE feed and generic UDP parser outputting via PCIe to host |
| **ARP Responder Module** | CSMOD-ARPRE-ANL-100 | ARP to PCIe |
| **Math.h Library** | CSLIB-MATHH-ANL-200 | Floating point library for Xilinx FPGAs |
| **European Options Monte Carlo Module** | CSMOD-UEOPT-ANL-100 | Stochastic simulation useful for valuations and risk analysis |
| **Asian Options Monte Carlo Module** | CSMOD-ASOPT-ANL-100 | Stochastic simulation useful for valuations and risk analysis |
| **Mersenne Twister Module** | CSMOD-MERSE-ANL-100 | High speed random number generator |

Note: Modules typically include 20-30 hours of Impulse design services to integrate with customer-specific configuration.

## Trading Acceleration:

Impulse CoDeveloper allows software developers to create hardware in an FPGA. Increase speed by consolidating multiple functions on a single device and eliminating inter-device communications lag. Use Impulse software to create complete high frequency trading systems that connect to virtually any feed. Easily add your own trading logic, algorithms or modules.

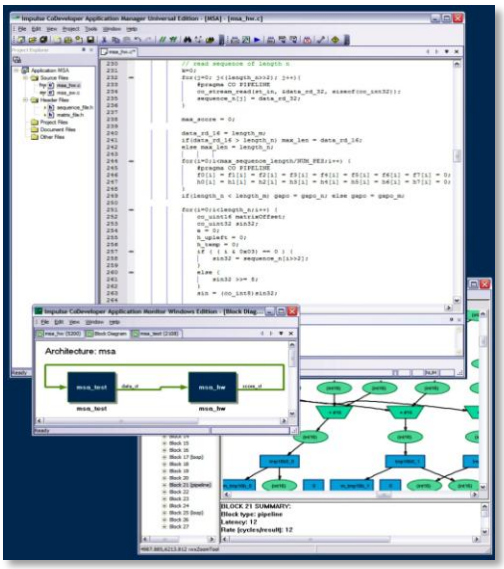



## Basic Steps for C-to-FPGA Implementation:

**Import** - Use CoDeveloper to import, refactor and optimize C-language algorithms for deployment in FPGAs.

**Analyze** - Graphic optimization tools including the Impulse Stage Master Explorer help you to optimize each process in your system, and identify bottlenecks that may require more resources. Imported C code can be quickly ported to an FPGA for prototyping and quick functional verification. The C code can then be refactored and re-optimized for FPGA acceleration.

**Experiment with Stage Delays and Data Dependencies** - Advanced capabilities of Stage Master Explorer provide you with visibility and control over the generated hardware. Use the Dataflow view, shown at right, to view relationships between operators, variables and control flow in your algorithms.



**Select Hardware** – Impulse CoDeveloper supports hardware from multiple third-party partners. Target hardware is selected from a pull down menu. The selected hardware may be a single FPGA with embedded hard and soft processors, or a more powerful board or system with various host communication methods, combinations of FPGAs, different types of memory resources and microprocessors already configured.

**Verify** - At three levels:

1. Run the software in a desktop executable to test functionality prior to creating hardware.
2. Verify your Impulse C generated hardware using a hardware simulator such as Mentor ModelSim.
3. Automatically generate and export text benches to ModelSim to test that the performance of the C and HDL implementations match.

Impulse software, services and FPGA-based platforms are used by banks and trading houses worldwide. Impulse and its partners provide: Automated ticker-plants, ultra low-latency market data feed handling/arbitrage IP and appliances, and real-time risk analysis applications.

*Contact Impulse to discuss your trading technology requirements. Let us help you improve your trading time.*