Requirements October 6, 2016

Team Name: Pythia

# Team Members:

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| **Name** |
| Clement Cole |
| Christopher Roche |
| Elijah Adedapo |
| Enrique Torres |

1. **PROJECT DRIVERS**

**A1. Purpose of the Project**

**A1a. Background of Project Effort**

The document details the functionality required for the design of a trading system using Field Programmable Gate Arrays (FPGAs).

Financial traders buy and sell financial data instruments (shares in companies) for their respective clients. As a result, they will anticipate to

buy stocks at lower prices and sell them when the stock is worth significantly higher than the current price.

In order to accomplish such task, financial traders will use several quantitative methods to evaluate current and historic values for the respective stock’s parameters and historical data streams to help predict

the future values of such parameters.

The type of data streams for stock values is of stochastic in nature. In order to correctly predict the daily average highs and lows, certain algorithms will have to be implemented on a software based system (Von Neumann based architectures) or hardware based system (reconfigurable logic circuit architectures).

In order to latencies accounted for in software based systems that impedes the process of buying and selling of stocks by stock brokers, the group will design a project implementing certain algorithms for predicting stock prices (daily average high and lows) using both FPGA components and software based software based systems.

Hence create a product that produces low latency prediction of daily average highs and lows of a specified stock that will assist stock brokers and or special interest groups in forecasting future daily highs and lows for the specified stock.

**A1b. High Level Goals of Project**

**FPGA trading Infrastructures provides:**

* Reduce latencies between computations as compared to other computer based architectures.
* Provide high computational speeds compared to other processes.
* Predict stock prices (Daily Average High and Daily Average Lows).
* Use a web server or repository to feed the specified stock parameters to enable further computations in real time.
* Identify and implement a stock prediction algorithm on both FPGA and software based system.
* As a test measure for proof of concept, measure the performance in terms of speed for both FPGA and software based systems.
* The development of this project will enable stock traders to save time and money when investing in certain commodities for their specified clients.

**A2. The Stakeholders**

**A2a. Executive Sponsor**

**Dr. Robin Pottathuparambil**

**A2b. Customer**

**Dr. Robin Pottathuparambil**

**A2c. Team Members**

**Clement Cole – Engineer/Programmer**

**Christopher Roche – Engineer/Programmer**

**Elijah Adedapo – Engineer/Programmer**

**Enrique Torres – Engineer/Programmer**

**A2d. Typical Technical (Hands-On) Actors and Roles**

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| --- | --- |
| **Actors** | **Roles** |
| **Arbitragers and Swing Traders** | Identifies and executes simultaneous sale and purchase of stocks to profit from a difference in prices. |
| **Floor Traders** | An exchange member who executes transactions from the floor of the exchange for their own account. |
| **Options Trader** | Actors who buy and sell options in the capital market. |
| **Agent/Security Lenders** | Agents or group of commissioned agents responsible for lending exchange-traded funds for transactional purposes by other traders or clients. |
| **Investment Dealers** | May act as a broker or dealer depending on the customer’s request of whether to buy or sell the stock of a commodity. |

**A2e. Personas (Actor-Product Use Case Scenario)**

**Setting:** On a given day, the price of yahoo stocks rose from $50.20 per share

for the daily high to $40.10 per share the next daily high.

Simultaneously, the stock price for Xilinx Inc. went from $42.10 per

share for the current day to $54.34 per share the next day.

The current day is September 02, 2016.

**Actor:** On September 02 2016, Sam Bigfoot, a daily arbitrager and trader at the

New York stock exchange currently owns 400 shares of yahoo stock and 0 shares of the Xilinx stock in his portfolio.

**Solution:** Using the Pythia box (Our Final Product), Sam was able to predict the

value of the yahoo stock and Xilinx simultaneously to $39.20 and $52.10 respectively per share for the next day’s daily high.

On September 02 2016, Sam sells 400 shares of yahoo stock for

$20080.00.

Then buys 400 shares of Xilinx stocks Sam is able to sell 400

shares of his yahoo stock at $20080.00 and buy 400 shares of Xilinx

stocks for a total of $16840.00**.**

**Benefit:** Sam’s account now contains 400 shares of Xilinx stocks that will be

worth total of $21736.00 for the close of September 03, 2016.

**A2f. Example of Stock Brokers**

* Yahoo stock brokers
* Facebook stock brokers
* Twitter stock brokers
* Apple stock brokers
* Coke stock brokers
* Tesla stock brokers
* Google stock brokers
* Microsoft stock brokers
* Xilinx stock brokers
* Intel stock brokers
* AMD stock brokers

**A2g. Stakeholders Map**

Internet of Stock Databases

The Outside World.

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General Consultants.

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Customers and

Potential clients

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Stock Exchange

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Core Team

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FPGA BASED ALGORIRITHM TRADING SYSTEM

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Stock Specific Consultants.

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Stock Brokers

Ordinary Citizens

Core Team

**Lead:** Clement Cole

**Reporter:** Christopher Roach

**GUI Programmer:** Elijah Adedapo

**Intermediate Parsers:** Enrique Torres

**Technical Consultant**

Dr. Robin Pottathuparambil

**A2h. Technical Consultants to Project**

**Dr. Robin Pottathuparambil**

1. **Constraints**

**B1. Solutions Constraints**

**B1a. Network Media**

Premise:

The product will use the current internet provider service for the University Of North Texas to retrieve data from the internet using its respective internet service provider.

Justification:

This above premise is due to the easy access to several mediums (wired/Wi-Fi) University’s network via student user name and password.

Fit criterion:

The product shall be compatible to any medium for internet access (Wi-Fi / wireless).

**B1b. Hardware Board (FPGA)**

* Premise:

Algorithms will be implemented on both FPGAs and von- Neumann/Harvard based architectures.

Justification:

The algorithms been implemented can be very complex and causes increase in latencies that affects higher execution time. Implementing both schemas on the FPGA and another computer architecture will serve as proof of concept, in that FPGAs provide lower latencies for computations compared to other architectures.

Fit criterion:

The overall purpose of the project is also to improve High Frequency Trading Systems. This constraint will enable this advantage over other systems other than that of FPGAs.

* Premise:

Configuration of Hardware (FPGA Board) will be in VHDL.

Justification:

VHDL has the advantage of having a lot of constraints in terms of typing which will aid in high-level modeling of more complex algorithms to include a lot of functional parts from packages. Such features are not available in Verilog where all packages have to be actual components.

Fit Criterion:

The FPGA design portion will allow user defined types that will allow flexibility of algorithm implementations.

**B1c. Operating Systems for Software Based Systems**

* Premise:

The group will utilize windows or Linux based operating systems.

Justification:

Both hardware and software system development aspects can be

done on Linux or Windows architectures.

Fit Criterion:

Most users/customers in stock traders use analytic tools that are compatible with Linux and Windows based architectures.

* Premise:

Simulation of hardware component will be done on Windows OS.

Justification:

This is because Modelsim from Mentor Graphics only works with Xilinx ISE with coregen on Windows systems.

Fit Criterion:

Most implementations of stock trading algorithms work directly on Windows based platforms.

**B2. Naming Conventions and Terminology**

**B2a. Field programmable gate arrays (FPGA):**

An integrated circuit designed to be configured by hardware designer.

**B2b. High Frequency Trading (HFT):**

A type of algorithmic trading characterized by high speeds, high turnover rates, and high order-to-trad ratios that leverages high-frequency financial data and electronic trading tools.

**B2c. Stochastic events:**

An event or system that is unpredictable individually by collectively implies a trend due to random variables.

**B3. Relevant Facts, Assumptions and Dependencies**

**B3a. Unable to Access Real Time Data on Physical layer**

* Due to inability for our internal system to access data from stock market in the physical layer, the assumption is that part of our historical data will serve as our real time data stream.

**B3b. Structure of Data Source**

* Data source will be in CSV (comma separated values) format for parsers to the designated units (FPGA and Software Based Systems).
* Data source for User Interface will be handled by the SQL lite API.

**B3c. Types of Possible Algorithms to Implement**

* Genetic Algorithm
* Mean Reversion Algorithm
* Ornstein-Uhlenbeck Process

**B3d. Programming Paradigm**

* For heavy computations, the group will implement a more functional programming paradigm.
* For Software development in the User Interface Blocks, applications will be developed in a more object based programming paradigm.
* Programs and codes developed will be heavily documented for reusability and code update.

**B3e. External Interface Requirements**

* User Interface
* Hardware Interface
* Software Interface
* Communication Interface

**B3f. Hardware Dependencies**

* Implementations of algorithm for FPGA will be on the Xilinx Virtex-7 board.
* Implementations of algorithm on software based system will be on a 64 bit Windows 7 or higher platform.
* Xilinx Corelib tools will be used extensively to generate pre-compiled codes for mathematical function units embedded in respective algorithm.
* Network server application SQL lite will be installed on a Windows 7 or higher platform.

**B3g. Software Dependencies**

* Raw data translation to FPGA design will be handled by an intermediate parser.
* Raw data translation to User Interface will be handled by an intermediate parser.
* Communication between yahoo data streams and components will be handled by the Yahoo Finance API.
* Repository of Project Development will be handled by a private repository on https://github.com.
* Analysis plugins will be handled by system a generic programming language.

1. **Functional Requirements**

C1. Ability to access internet to retrieve data

Team Member: All

C2. Transmit historical stock data to the software system

Team Member: Christopher Roche

C3. Transmit historical stock data to the hardware system

Team Member: Clement Cole

C4. Utilize software model implementation of the prediction algorithm for

given historical data

Team Member: Christopher Roche

C5. Utilize hardware model implementation of the prediction algorithm for

Given historical data

Team Member: Clement Cole

C6. Predict daily high and low stock values

Team Member: Clement Cole & Christopher Roche

C7. Generate stock prediction output report

Team Member: Enrique Torres

1. **Non-Functional Requirements**

D1. Implement a graphic user interface to select (up to) ten stocks

Team Member: Elijah Adedapo

D2. Display a generated stock prediction report via graphic user interface

Team Member: Elijah Adedapo

D3. Compare the performance of hardware and software systems

Team Member: Enrique Torres & Elijah Adedapo

D4. Develop a standalone system that contains all hardware and software

Team Member: All