A Note to the Reader

The organization for which this document is intended has been anonymised and is referred to throughout the document as "The Firm". Additional anonymisation has been undertaken on the exact names of the trade teams and the associates involved in interviews.

Proposed Technology Strategy Plan

The Firm's technology is fundamental to the success of the company; it is a key differentiator in the market place and a major source of competitive advantage. The current operating environment is highly competitive, extremely complex and increasingly diverse, a problem that is compounded by the global nature of The Firm's main business units. In order for the company to remain competitive in the High frequency Market Making (HFMM) arena whilst expanding into new venues and trade types a particular focus must be given to the organisation of technology within The Firm.

Strategic Aims

In order to be competitive The Firm must foster a technology capability with the following key attributes:

- Delivers the highest levels of system performance
- Delivers highly reliable fundamental technology and systems
- Promotes innovation and is open to collaboration
- Is agile and able to respond to rapid market changes
- Enables the highest level of performance from its associates

This document outlines the initial people, process and technology requirements for achieving these aims. In order to remain focused enough for an implementation plan to be formed the document is targeted at the first 12-18 months of the firm wide 3 year business plan. Assessment of implementation progress should be scheduled regularly and to coincide with the quarterly business strategy review.

Strategy Overview

The Strategic Aims contain a number of inherent polarities that are indicative of the competitive nature of HFMM. The polarities stem from the conflict between high performance and high reliability on one side, and innovation and agility on the other. The capabilities required to deliver high quality and rapid innovation are not complimentary and so designing a delivery model to achieve both requires particular attention.

Typically a delivery model will be designed to either:

- Make the long term technical investments in the architecture, development and testing required to achieve consistently high performance and / or high reliability, or
- Support rapid prototyping and fast time to market to enable innovation and agility

In each case the people, processes and technology are focused on different fundamental aims and the basic timeframes for delivery are not aligned (Figure 1).

Model	People	Process	Technology
Reliability & Performance	Experts with deep knowledge of chosen platforms and languages	Well understood mid to long term specifications in planned release cycles	Specified and restricted to allow for extreme levels of performance
Innovation & Agility	Generalist with broad knowledge of multiple technology fields	Multiple short term releases with loosely defined specifications	Flexible use of multiple platforms and languages

<div align="right">**Figure 1 - Different requirements of the delivery models**</div>

Impact on Associates

It is also important to recognise the impact of innovation and agility within the HFMM domain on the associates within the technology capability. In any given domain of sufficient complexity there comes a point when it becomes difficult to both understand the full domain sufficiently enough to approach it strategically, and to have intimate enough knowledge of the details to be effective in implementation of that strategy. In order to allow individual associates to perform maximally they must be allowed to focus on subsets of complexity for a suitable period of time, thus allowing for both overview and detail level expertise to coexist.

This strategy plan attempts to address the aforementioned conflicts by targeting a core technology capability on the demands of a high performance and highly reliable trading services platform whilst deploying a consulting style set of platform experts to work closely and innovatively with the business units. It also recognises the need for associates to achieve focus within the overall organisational complexity by establishing areas of domain expertise within the wider technology capability.

Operational Structure

Figure 2 depicts the high level operational structure as three broad operation areas (Core Technology, Business Units and Implementation Teams) consisting of multiple domains of expertise. Overarching responsibilities like project management, administration and leadership are omitted for clarity. The structure is designed to allow for focus within both the business and core technology teams whilst providing a specific structure for collaboration and innovation at the point of final implementation.

Core Technology

The role of Core Technology is to design and deliver the fundamental technology platform required to compete in the HFMM industry. It consists of five areas of domain expertise:

- Core Connectivity – Responsible for the software development required to achieve the lowest latency possible within the core connectivity technology stack. This includes work on the software, compiler optimisations and any relevant optimisations to bypass unnecessary network stack layers. Extensible frameworks for all the main counterparty (i.e. exchanges, data providers and regulators) connectivity options should be provided and supported. The software should enable specialist development by the Implementation Teams for specific counterparty connections.
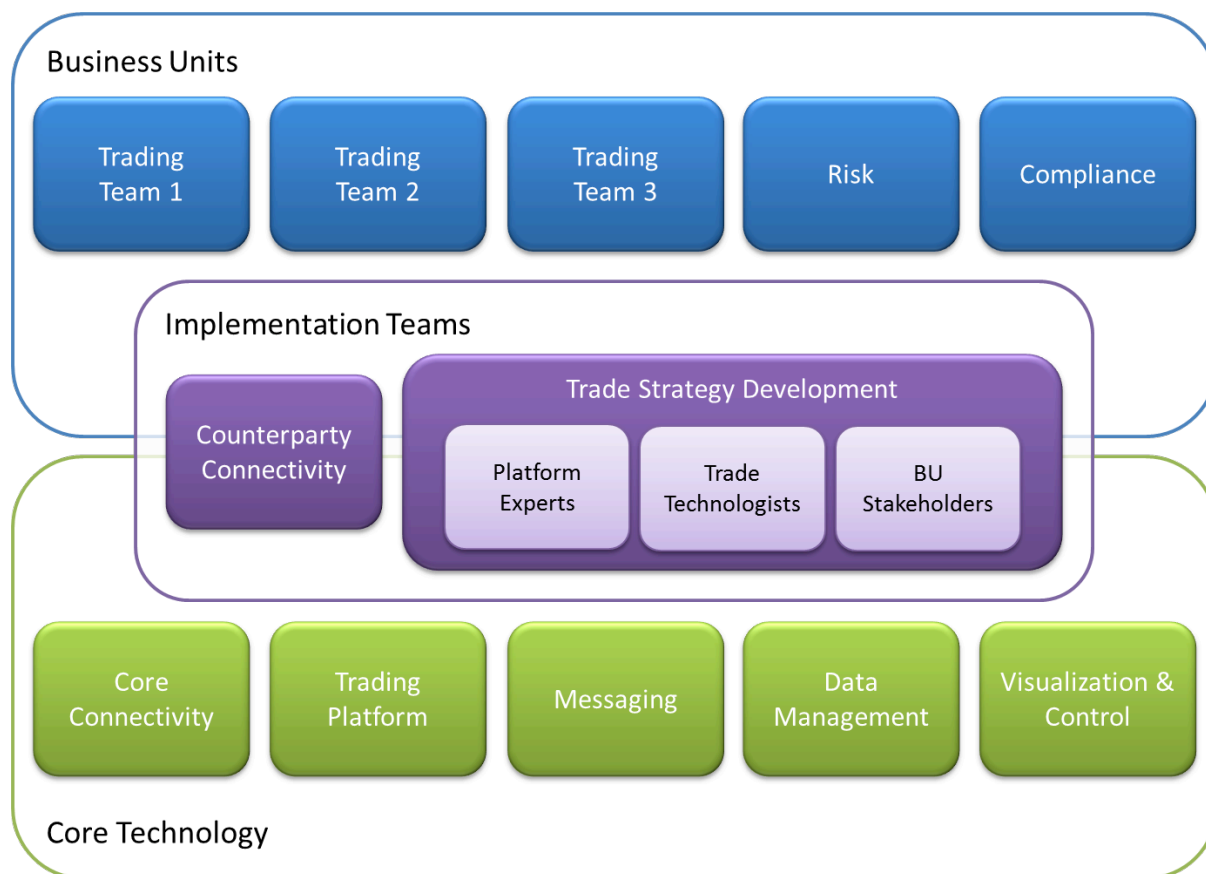
- Trading Platform – Responsible for development of the primary valuation and order placement technology components required to execute the trading algorithms in the marketplace. Components are designed for low latency with high reliability guarantees. The domain is also responsible for development of an open API into the technology to allow for multiple front end technologies to connect and interoperate with the trading platform.
- Messaging – Responsible for development of the firm wide persistent messaging technology that allows distributed components of the trading platform to communicate and interoperate. The technology is designed to be persistent, replay-able and optionally transactional.
- Data Management – Responsible for all aspects of processing, storing and distributing the large amounts of data created and used by the trading activities each day. This includes external market data from exchanges and other data providers, internal trading data such as order streams and internally calculated trading metrics and statistics about system performance.
- Visualization & Control – Responsible for developing the interface with the main trading platform that enables the Business Units and Implementation Teams to create, manage and terminate trading algorithms. The software is designed to provide a highly reliable interface with flexible front end options around visualisation (grids, charts, reports, etc.) and platform control (a combination of static buttons and a scripted interface into the Trading Platform open API).

Business Units

A full discussion of the role of the Business Units within the company is outside of the scope of this document. For the purposes of the Technology Strategy Plan the Business Units represent the traders and other essential trade functions that utilize the Core Technology platform in order to create and execute trading algorithms in the market in a way that is competitive, within acceptable risk parameters and conformant to regulatory requirements.

- Trade Teams 1, 2 and 3 – Trading teams consist of traders and trade technologists working with the Core Technology Trade Platform and other bespoke solutions to place orders in the markets.
- Risk – Responsible for the technology and processes required to define and enforce risk controls on behalf of the company.
- Compliance – Responsible for the technology and processes required to ensure the company's trading activities remain in conformance with the regulatory requirements or the markets.

Implementation Teams

Unlike Core Technology and the Business Units, the Implementation Teams are not permanent organisational structures. These teams are fluid; they are formed and deployed to address specific business agility requirements and as agents of innovation within the business. Typically the teams will comprise of representatives from both Core Technology and the Business Unit that is the end user of any team output. The teams should be small (2 – 5 associates), short lived (project cycles < 1 month) and contain experts from the relevant business or technology domains.

In general the teams will form for one of two purposes:

1. Counterparty Connectivity – Using the extensible frameworks from Core Technology, these small teams are formed to address the specific implementation details of actual connectivity to counterparties such as exchanges, market data providers and regulators. They are required for new counterparty connectivity, to meet upgrade and migration schedules for existing counterparties and to realise improvements in the frameworks undertaken by the Core Connectivity team.
2. Trade Strategy Development – These teams perform the bulk of the trade specific implementations, making heavy use of the Core Technology platform to address the requirements of requesting Business Units or to facilitate innovative Proof of Concept (PoC) releases. The teams should consist of Platform Experts (generalist developers from Core Technology with knowledge of the trade platform API's and experience developing other trade specific implementations), Trade Technologists (generalist developers from the requesting Business Units) and, where appropriate, non-technical Business Unit Stakeholders (responsible for ensuring the developments meet the business requirements of the requesting team).

Communication Processes

The plans for inter group communication processes account for two key factors prevalent in the internal organisation of The Firm:

1. The organisational areas do not operate and deliver value at the same speed, so cross area orchestration is required
2. The need for the business to be agile is as important as long term planning

A high level view of the process interactions can be found in Figure 3. The firm wide strategic themes are contained in three year strategy plans underpinned by matching three year operating plans for strategy implementation. Strategic themes and operating plans are formally reviewed in six month intervals, although informal assessments of suitability and success are constantly being performed. The Business Units work from this timescale and are responsible for setting and delivering the six month team level goals. Core Technology has significant input into the strategic themes and also participates in the six month team level goal setting.
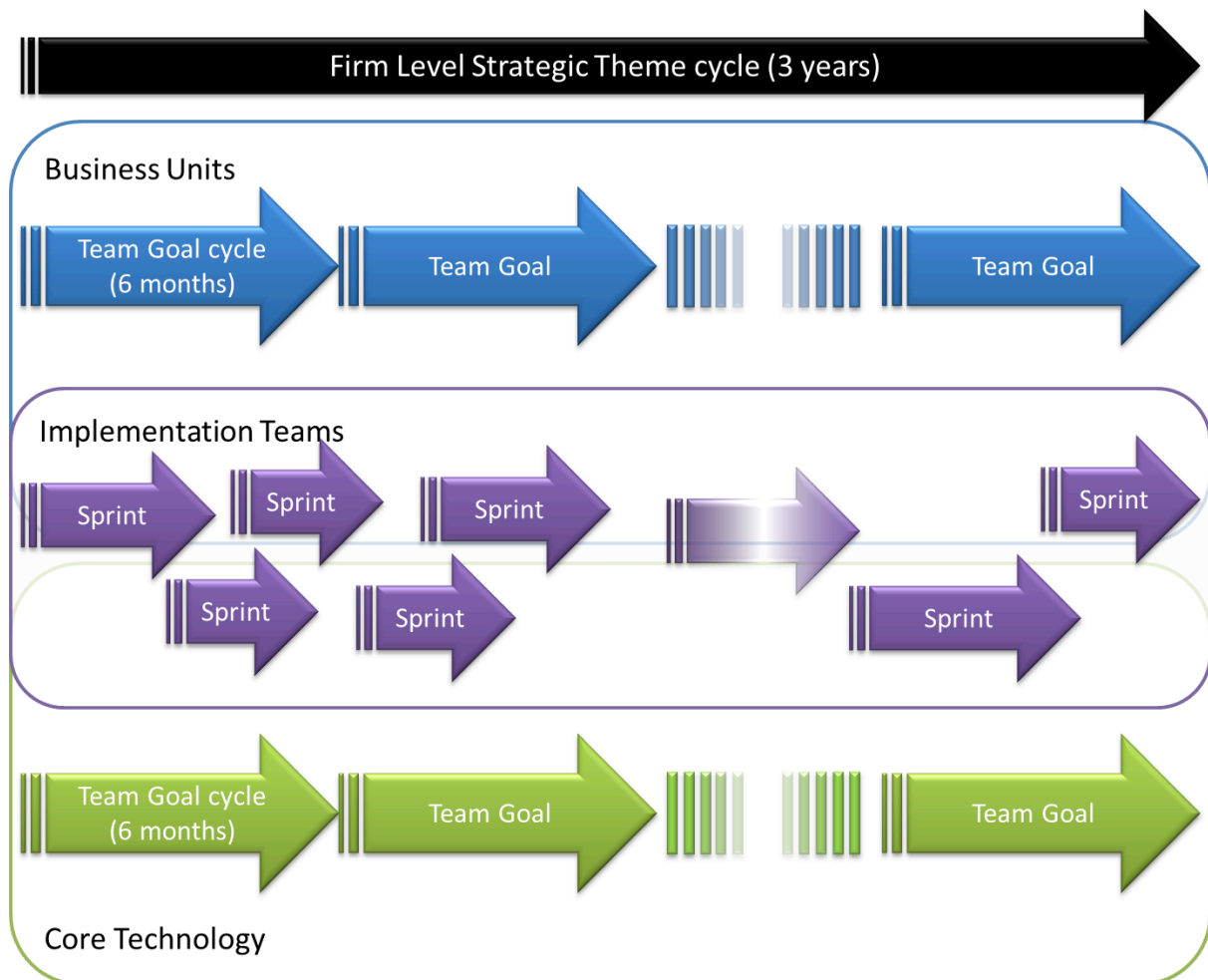

Figure 3 – Alignment of cross discipline strategic goals

Delivery styles differ between Business Units and Core Technology; the Business Units perform classical project management where scheduling of multiple internal disciplines (technology, trade skills, certifications etc.) and external arrangements (exchange and regulator documentation) is required to enable trade development, Core Technology delivers strategic technical advances through focused internal software development methodologies (see the Technology Capability section). Synchronisation of the six month goals between Business Units and Core Technology is vital to ensure the effectiveness of the Implementation Teams.

At the interface of Business Units and Core Technology, the Implementation Teams do not participate in goal setting beyond the immediate delivery cycles (sprints) for which they are formed. The success of an Implementation Team is solely defined by the ability to deliver to the requesting team's requirements in a timeframe suitable for ensuring the developments can be effective in the marketplace. These sprints vary in length and team composition, the scheduling is defined by a combination of the readiness of the Business Unit and Core Technology capabilities combined with the availability of resources required for team formation. Since an effective sprint requires a combination of appropriate base capability and availability of suitable resources from both main organisational areas, the importance of intra-cycle coordination between Business Units and Core Technology cannot be underestimated.

Required Meeting Types

Effective internal communication does not happen solely on a schedule, it requires constant informal discussions based on a joint understanding of strategy. However, when synchronisation of disciplines is required there are some important types of meeting that should be scheduled. In order, from least to most frequent:

- Annual Strategic Progress Review – A large scale cross discipline review of progress toward the current three year strategy based on completed targets from the three year operating plans. Provides a formal opportunity to assess effectiveness of the business plans and appropriateness of the strategy.
- Six Month Goal Review – A cross discipline review of progress in the previous goal period. Provides an opportunity to assess the effectiveness of synchronisation and to determine if the sprints have been successful in progression towards the three year operating plan. Each review forms the transition point between periods, one of the results of assessing the previous periods goals should be a revised set of goals for the forthcoming period. Priorities should be carefully considered based on both requirements and current capability levels.
- Monthly Status Updates – A cross discipline review of the progress towards the current set of six month goals. Focused on addressing the effectiveness of completed and in flight sprints and on ensuring effective cross-discipline synchronisation. Leads to a list of sprints expected to be started in the forthcoming month.
- Sprint Planning Sessions – Based on the continual prioritisation enabled by the monthly status updates each sprint planning session brings together representatives from the requesting Business Unit and the owners of each Core Technology domain required for delivery of the required technology. Decisions are made on appropriateness of commencing the sprint as well as composition of the team and any other requirements for successful execution of the sprint.
- Sprint Review Sessions – A sprint review occurs either at completion of the sprint or if the sprint is determined to be in difficulty of meeting the requirements or the delivery schedule. At completion the goal of the meeting is to ensure all requirements are complete or accounted for and that progress toward the six month goal cycle is properly tracked. For sprints that are in difficulty the goal of the meeting is to determine if the sprint can continue in its current form or if it must be terminated. In both accounts the impact on the six month goals should be assessed and recorded.

Technology Capability

The technology capability required to support HFMM is split into a number of main areas designed to interoperate via well-defined APIs allowing specialisation of development choices for each area whilst ensuring the system is capable of integrated operation (see Figure 4).
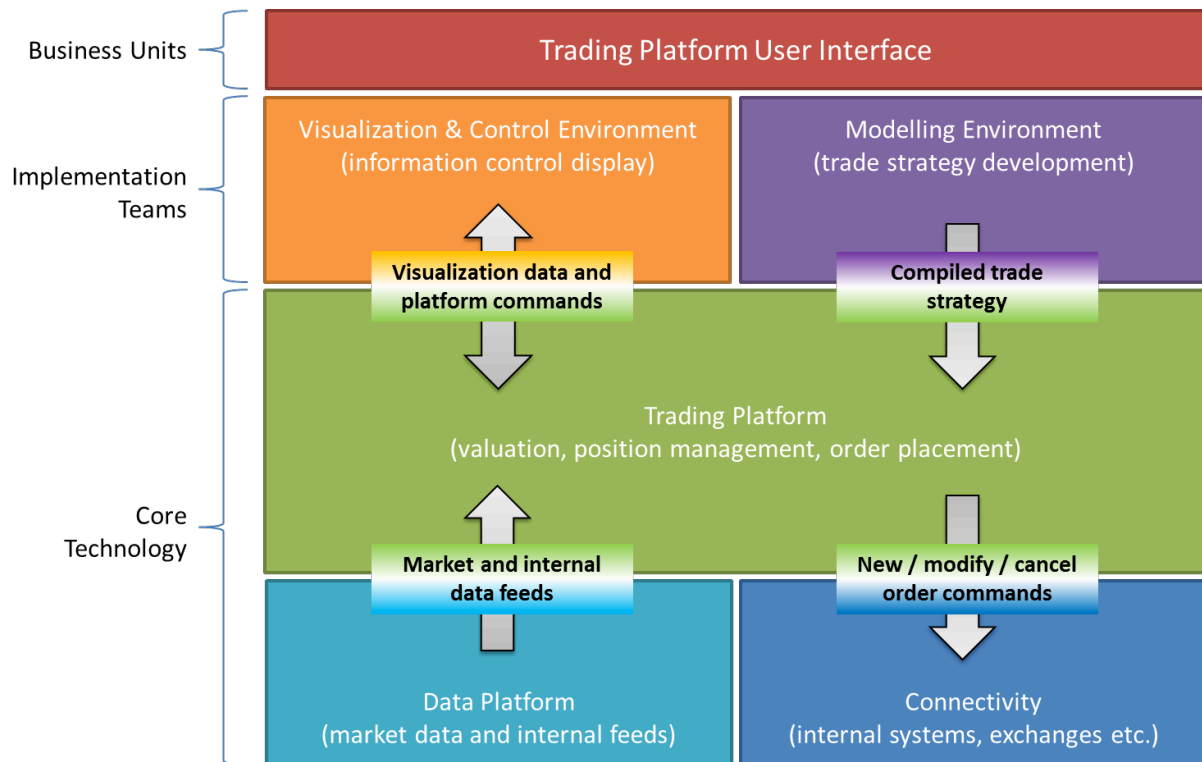
Figure 4 – Interaction of technology areas in the overall technology capability

The system is layered to allow for the differing focus of the Business Units and Core Technology teams, and the specific aims of the Implementation Teams. The Data Platform, Connectivity and Trading Platform areas are built using languages capable of highest performance (C++ with low level compiler optimisations) and which allow for variability of deployments to be minimised. The Trading Platform exposes API's and protocols to the Visualization & Control and Modelling Environments, these areas are developed using a dynamic scripting language (python) which enables a tight code-test-deploy cycle designed to support innovation within the Implementation Teams. The front end Trading Platform User Interface provides the primary interface to the system as a whole and is developed using technologies designed for desktop deployment (WPF and C#) of a graphical user interface.

Software Delivery Lifecycle

Delivery methodologies inside Core Technology teams will remain the choice of those teams, enabling the owners of a domain to choose how to deliver technology. The Implementation Teams will use an Agile development methodology: Scrum. Scrum is an iterative and incremental agile software development method for managing software projects and product or application development. It focuses on bringing together teams of business experts and technologists for short, rapid iteration projects called "sprints". Connectivity projects often work to fixed specs and Scrum may not be the best approach, but quick delivery of effective software to traders will benefit from the agility supported by Scrum.