Trading Monitoring Cockpit : Conceptual Architecture

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ABSTRACT
We are witnessing the rise of robots in the finance industry in which human capabilities are largely surpassed by the capabilities of trading robots, and where solutions to several conundrums should be explored and sought. We describe this domain, explore some fundamental questions and suggest the Trading Monitoring Cockpit as a possible aide to human traders. This is work in progress, and we base our claims on assumptions and theoretical concepts and not on any practical experiments, nor real-world data collections.

Categories and Subject Descriptors
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General Terms
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Keywords
markets, trading, HFT, crisis, emergency, crash

1. PROLOGUE
During the last two decades we observe that the securities and share trading business is undergoing very profound, tectonic changes. The injection of new technologies into trading activities has accelerated the speed of trades by a factor of one million, and has increased the volume of data inflows exponentially.

These changes have created some huge technical challenges and regulatory issues. The Monitoring Cockpit architecture is outlined here as a partial solution to address only some of these challenges. We also provide some topic outlines for further, necessary research.

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We start with an overview of the market, introduce the high-level trading architecture, and provide the layout of the Monitoring Cockpit. We briefly mention social networks and private chat rooms as an area of particular concern for regulators. We conclude with a focus on some technical details of the cockpit which we believe provides a rich area for future research and development.

2. MARKET LANDSCAPE
Developing methods to understand the markets, to model and predict future trends, are well-known, long-standing problems. Scientists, engineers, and practitioners from several fields have tried to address these questions with more or less (mainly less) success for a long time. The latest wave of complex systems science research is likely the biggest, most comprehensive and interdisciplinary attempt. But one cannot say that final, single, agreed and decisive answers have been found.

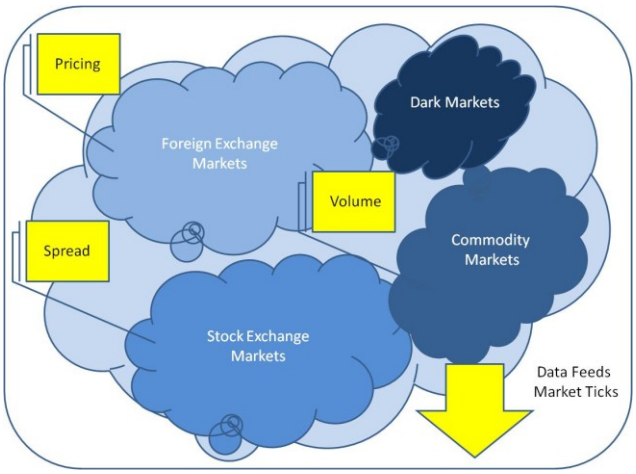

Fig. 1. Markets Landscape

In the simplest sense, markets are meeting places for sellers and buyers - already existing for many centuries. The market participants exchange bids and offers, so establishing a pricing mechanism as the fundamental role of the market. Furthermore, in modern times, markets provide data feeds and market ticks, enabling the expansion of the number of traders, growing the volume of trades, and bringing efficiency into markets. Thus, bigger demand will push prices up (and vice versa), and at much higher speeds than in the past, which in turn improves efficiencies. For our purpose we will consider four well-known

markets (Fig. 1), of which foreign exchange is the biggest (5.3 T$/day), stock exchange markets the fastest (1 M-Trades/Sec), and dark pools the least regulated. Currently, there are 13 public exchanges and 50 alternative trading systems in the U.S alone. Over time, different theories of market mechanisms have been developed, schools of thought established and exhaustive research done by a wide variety of researchers. Consequently in the market theories field, beyond economists we encounter physicists, psychologists, biologists, mathematicians, ecologists and many, many others. Their interest in models ranges from the very simple to hyper-complex systems - to ecology environment or ultra-large scale systems or, in particular, a system-of-systems view. In the broadest sense, efficient market hypothesis dominated theoretical work, and only lately, as a result of finding exceptions and discrepancies, new theories have emerged – such as behavioral finance [1].

For our purposes here, we will use a simplistic view of markets - consisting of human traders, trading some daily average amounts, and represented together as the overall daily turnover of the market. It is obviously a constantly moving, dynamic system which is unpredictable, uncertain, and never fully known. While specialized traders are focused on particular markets, it has been observed recently that the inter-market automatic moves and trades are becoming possible and more feasible than in the past.

One cannot find many business domains in which the predominant operating parameter (as trading speed) has improved ***one million*** times in only one short decade. This can be largely attributed to technology improvements and trading system design advances [3][4].

In an abstract sense, contemporary markets can be seen as the combination of ultra-fast technical systems with human players and traders; producing endless streams of data and facing strict regulatory compliance. Thus, this is an extremely complex field posing several technical and legal challenges.

This paper will point out some of these challenges, suggest possible solutions, and outline some tentative research plans in the conclusion. Two schools of thought are currently present: one postulating that high frequency trading (HFT) improves market efficiency and brings necessary liquidity into markets, and another, totally opposite, claiming that all HFT activities are greed-driven financial speculation. The reality of the market is that all big banks, hedge funds, retirement funds and others are players. A regulatory approach that would tend to equalize the chances of all players would be something like:

+ separate human trading from HFT

+ give differentiated time in markets in turns

+ intentionally delay some activities so as to give advantage to human traders against HFT [8] etc.

The key objective for the authorities, beyond ensuring fair trades, is to prevent crises and crashes, which seems to be happening on a small scale on daily basis in all markets. Furthermore, more profound research is necessary to understand those hyper-fast, hybrid, ultra-complex systems. Observing some other phenomena, perhaps natural phenomena such as schools of fish, may provide some surprising analogies and useful insights [5].

3. TRADING SYSTEMS ARCHITECTURE

Trading is traditionally done either in trading pits (on the exchange floor), or on a trading platform (in-house room) especially fitted with computing, communication and collaboration systems. As human traders are getting information from markets via various channels, they quickly grasp and make sense of that endless chain of events and execute their sell/buy orders. In modern times, HFT is driven by proprietary algorithms which are typically well-guarded secrets of financial institutions, making difference between profit and loss and bringing competitive advantage.

Comparing human-driven trade with the speed of HFT systems is challenging. In an blink of an eye (0.4 secs), HFT can push several hundred thousand sell/buy orders into a trading queue. Humans cannot fully grasp such speed, let alone hope to match it. Latency differences become very dramatic at such speeds – HFT is a million times faster than human trades (Fig. 2). Furthermore, HFT systems have advanced data and information feeds [7] which give them an opportunity to apply some clever strategies of buying/selling/cancelling orders to confuse competing HFT systems, and thereby make profits. They also have the capability to get early insights into market moves, and see the future before humans can even grasp it.

Some researchers have postulated that power system monitoring is a good analogy/concept to be applied to financial markets [6]. A precondition for this is to have trustworthy, timely and clear information provided in real-time, which is not always possible in financial markets. On the other hand, the volume of data and speed is probably much more challenging than in energy systems. Energy systems are typically hierarchical, self-regulating systems with several embedded loops of self-control, regulation and self-protection – attributes that might well be useful to emulate in financial markets.

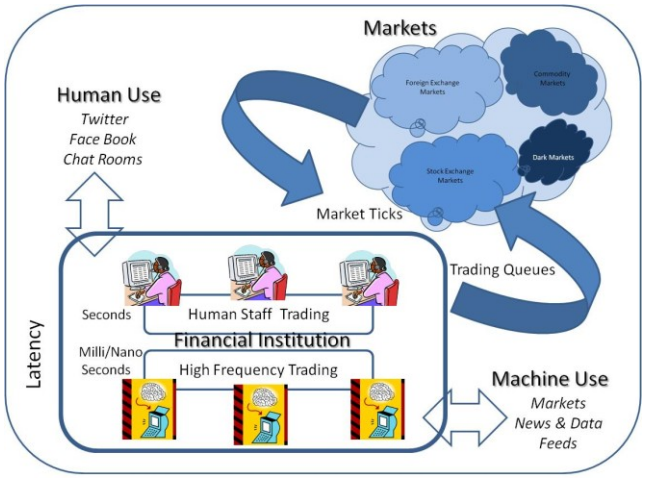

Fig. 2. Trading Systems Platform: Conceptual View

We are only pointing out important problems here, as it would be beyond the scope (and aim) of this paper to propose the real solution to this extremely delicate area. However, we believe that the Trading Monitoring Cockpit may help relieve the situation by providing support to both human traders and regulatory institutions. We suggest some possible usage scenarios in our conclusion.

4. MONITORING COCKPIT LAYOUT

During the last ten years or so, HFT has advanced from a curiosity in the markets to an absolute winner in some. By some recent estimates, 2/3 of all transactions on major stock exchanges are performed by HFT players, and possibly as many as half. As an illustrative example, in the space of one second HFTs can launch/cancel up to million trades, which no human can match. Thus, HFT players have became the dominant trading force, in which some have made profit in each and every day except one in a five year period! No human trader could match these performances. Consequently, all financial players have started using HFT as the strategic operational tool and system. Recently, however, profits started to decline sharply and regulatory bodies have become well aware of this human traders-robo-traders harsh competition problem [2].

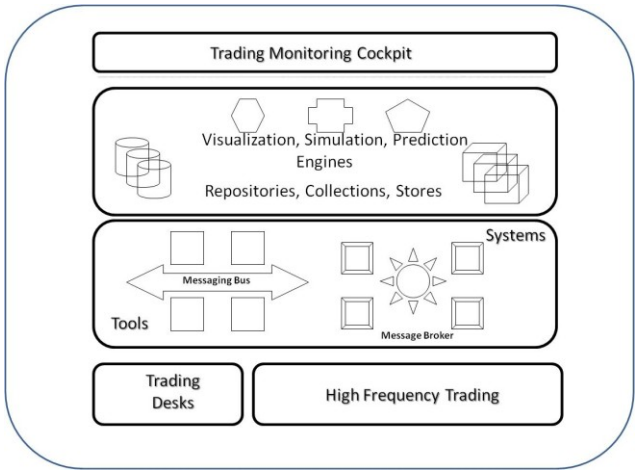

Fig. 3. Trading Monitoring Cockpit : Conceptual View

As trade monitoring represents an important part of regulation, we envisage the Trading Monitoring Cockpit, which will enable human traders participation, in such a way that machine will monitor and track machines while providing signals, hints and predictions about ongoing trading. For that purpose, we sketch the structure of monitoring cockpit (Fig. 3) bringing machine-to-machine trades to the attention and control of human traders.

Monitoring instrumentation captures all key parameters from trading desks, and streams them into separate transactional (messaging bus) or real-time (message brokering) streams. They are transformed into constantly evolving analytics which drive the Trading Monitoring Cockpit screens and parameters. It also provides commands, of course, but we will skip that description for the sake of simplicity. The architectural stack describes high-level components, while detailed design can be made only during practical experiments and practical deployments.

Regulators enabled the appearance of yet another type of exchange - one not obliged to give too much information (dark pools) - and thought about increasing competition among exchanges (around 50 in US right now). These exchanges are now under the close scrutiny of regulating bodies. The new practice of colocation has become apparent - servers are placed in the closest possible place to the trading platform, while ensuring that no advantage is created for any players.

Other attempts at gaining advantages are the move towards network edge, where trading algorithms are placed directly into network edge, enabling best positioning against competitors, and the move from fiber optics versus proprietary (expensive) microwave links covering greater distances, involving more traders and offering very competitive latencies.

Arrivals of yet other data and information feeds into this domain have created yet another layer of complexity and concern for market regulators.

5. SOCIAL NETWORKS AND PRIVATE CHATROOMS

The recent rise in use of social networks and public and private chartrooms has brought yet another headache for finance industry regulators. Namely, it turns out that HFT systems are listening carefully to those media, and react instantly with changed strategies. For example, the recent (false) rumors alluding to the US President being wounded created an immediate effect on markets and a subsequent change in trading strategies. We may surmise that regulators will need to issue precise legislation about this new domain of possible manipulation.

This will be a very delicate domain, as privacy needs to be ensured, and secrecy guaranteed - but in a regulated manner. So far, social networks are used for various social, marketing and entertainment purposes, while their entry into the business domain will inevitably change the nature of the entire domain and so will need new technologies. We observe right now that technology is constantly providing new, wider and faster inter-connectivity, leading to a constantly rising amount of data and information flowing in and out of markets, while creating a huge amplification effect.

6. MONITORING COCKPIT DESIGN LAYOUT

Humans cannot keep-up with the speed and efficiency of computer trading, but they can look at the summaries, trends, projections and warnings, trying to prevent the onset of any crisis which may evolve into an emergency and market crash. Thus, humans can issue the order of slowing down - or stopping entirely - all trading until the market gets back to stability. To that end, we outline in Fig. 4 the layout of the cockpit for the human trader, who will get some assistance via the sophisticated functionality of the monitoring cockpit which is able to digest, analyze and warn about incoming problems.

For illustrative purposes, we show the mapping of the continuous stream of data into facial expressions, passing an early warning to human operators (patent granted 2005: EP 1526679 A1) and representing important capability of the cockpit. This functionality will certainly capture trading signals but also digest rumors from social media and news outlets.

Other key cockpit functionalities as trading parameters tuning, trading books management and trade recordings (for auditing and compliance purposes) will not be described due to the short nature of this paper, but we also point at those as the innovative elements requiring further research, development and engineering. To deal with several unresolved problems, they will certainly contain

important intellectual property and trade secrets, and thus will be closely guarded as the precious property. It is thus understandable that we will not describe any details of this part in the public paper.

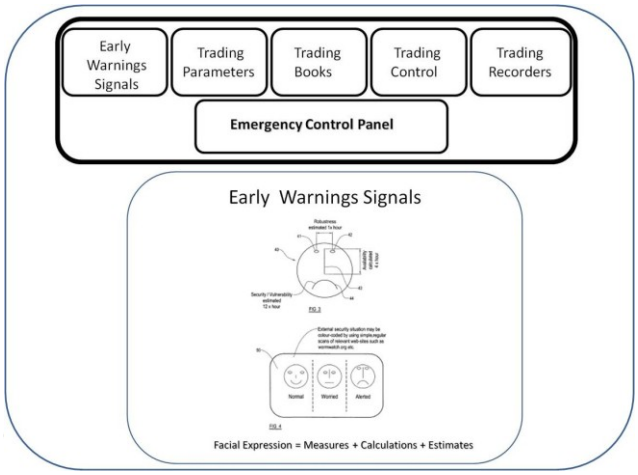

Fig. 4. Trading Cockpit : Design Detail (Patent Granted)

To give an idea of further developments, it is logical to expect that the monitoring cockpit will have at least 3 operational modes – manual, automatic, simulation. Depending on the context, a human trader will activate automatic HFT for some time and then (eventually) switch into manual mode when appropriate. Very much as the automatic pilot in airplane cockpits taking care of routine flight operations, with manual mode deployed in surprising, unseen circumstances. All activities will, of course, have recorders for post analysis and regulatory inquiries.

While normal operations can be ensured, somehow, we believe that the crisis, emergency and crash are so expensive that they could easily deplete all profits gained and remove efficiencies. This is the 3rd mode of cockpit operations – enabling human traders to practice and gain experience on simulators so that they can have some insights before crises emerge or a crash happen.

We will conclude with the strong assumption that the solution to technology-caused problems will be resolved by technological means, but followed by timely and appropriate regulation rules. For this, new regulation should be brought - and innovative ways of digesting and transforming huge data sets and rapid information inflows into actionable analytics need to be developed. This will be an entirely new set of technologies.

7. EPILOGUE: NEXT FIVE YEARS

A long obsession of researchers in this field was 'market efficiency' and how to improve it. It seems to be improved via technological means, such as HFT (shortest latency possible), but at the same time, regulation was not timely set nor properly adapted to those new, hyper-fast players. In recent weeks we have noticed a lot of news about regulating HFT and the decision of the authorities to address this problem. Thus, we observe that the regulators are re-entering into this game again.

We sketched here the Trading Minitoring Cockpit, which could be a potential departing point for the technical solution in which human traders abilities will be augmented via machine capabilities, up to the level that the final decision will always fall upon human traders. Still, this would be just one possible step forward and not a complete or satisfactory solution for this future, exciting field of developments. They can be ultimately transferred into other domains, in which they will give a real, not speculative, advantage. It is important to note that this field represents a leading edge mix of technologies, regulation and ongoing research. As such, it deserves more attention from academic circles.

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