

What is a High-Speed Trade? Why does a Stock Exchange Speed-Up?



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Takanobu Mizuta

Now, I belong to SPARX Asset Management Co., Ltd. as Fund Manager and Senior Researcher.
I am also a part-time lecturer of the Graduate School of Public Policy, The University of Tokyo.

In SPARX Asset Management, I am responsible for quotative investigate of Japanese stock market and the portfolios, and maintaining system/DB for the investigation, and academic-study regulation/rules using multi-agent simulations.

2014 Ph.D.: School of Engineering, The University of Tokyo (Kiyoshi Izumi Laboratory)

2004 Joined SPARX Asset Management (current affiliation)

2002 Master: School of Science, The university of Tokyo (Space Plasma Physics)

2000 Bachelor: Japan Meteorological College

2016/4-, Vice Chair: Special Interest Group on Financial Informatics
the Japan Society for Artificial Intelligence (JSAI SIG-FIN),

2019-, Technical Committee Member: IEEE Computational Intelligence Society,
Computational Finance and Economics (IEEE CFETC)

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If you are interested in a multi-agent simulation in finance (not Today's Talk)

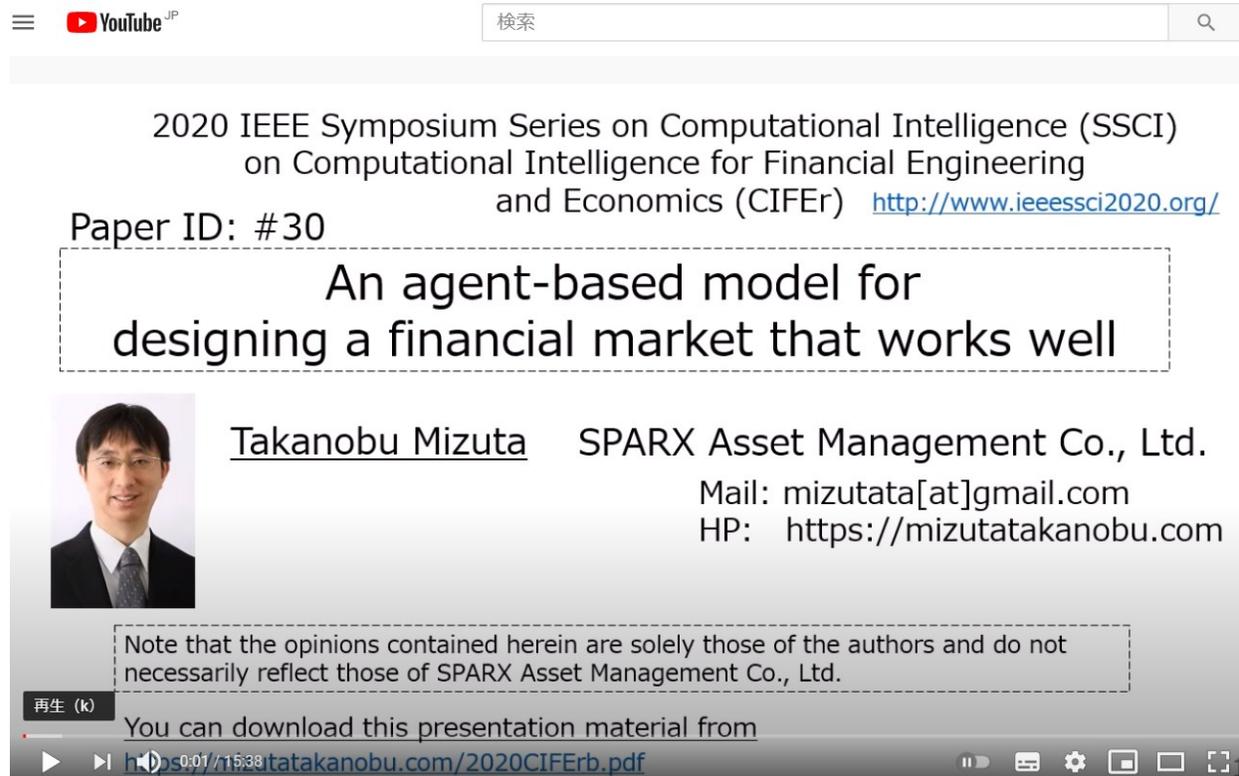
My Review Paper

Mizuta 2020, "An agent-based model for designing a financial market that works well", IEEE Symposium Series on Computational Intelligence, Computational Intelligence for Financial Engineering and Economics (CIFEr), December 1 to 4, 2020, Canberra, Australia(virtual)

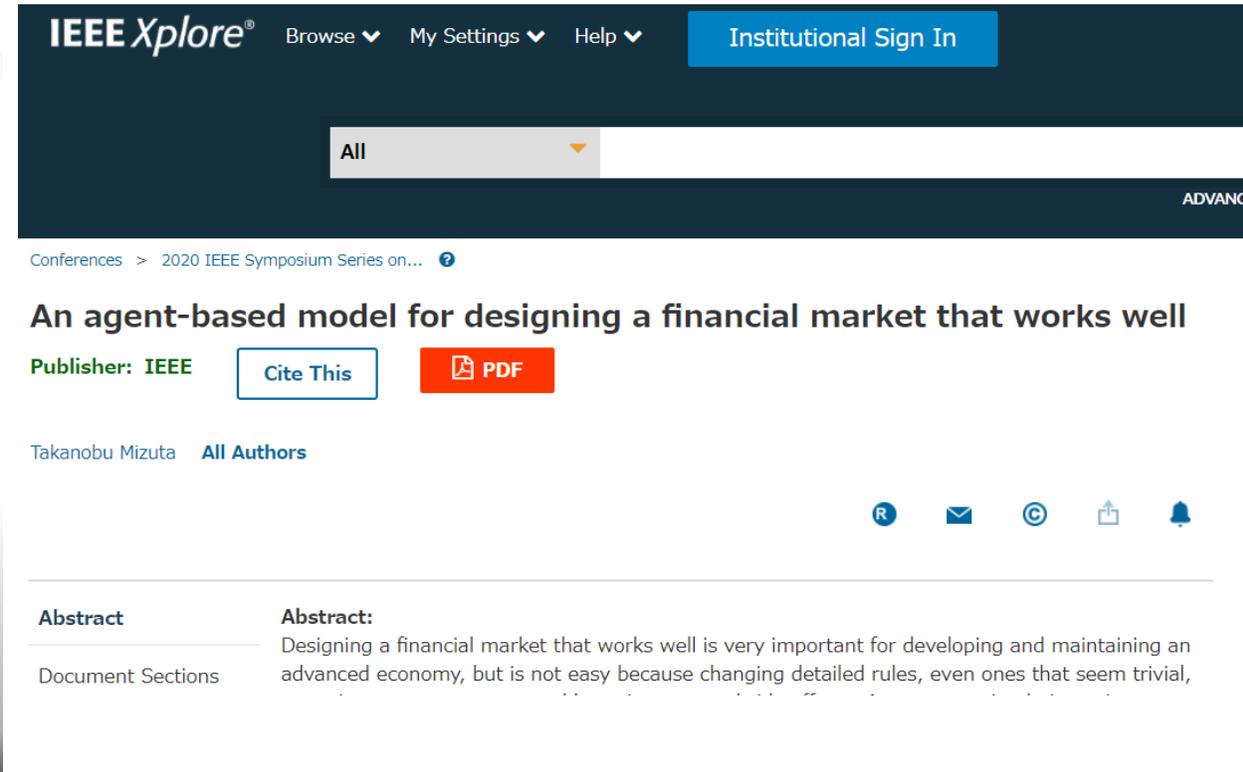
<https://doi.org/10.1109/SSCI47803.2020.9308376>

<https://arxiv.org/abs/1906.06000>

Presentation on YouTube <https://youtu.be/rmlb72ykmlE>



The screenshot shows a YouTube video player interface. At the top, there is a search bar with the text "検索" and a magnifying glass icon. Below the search bar, the video title is "2020 IEEE Symposium Series on Computational Intelligence (SSCI) on Computational Intelligence for Financial Engineering and Economics (CIFEr) <http://www.ieeessci2020.org/>". The paper ID is "#30". The main content of the slide is "An agent-based model for designing a financial market that works well". Below the slide, there is a portrait of Takanobu Mizuta, his name, and his affiliation: "SPARX Asset Management Co., Ltd.". Contact information includes "Mail: mizutata[at]gmail.com" and "HP: https://mizutakanobu.com". A note in a dashed box states: "Note that the opinions contained herein are solely those of the authors and do not necessarily reflect those of SPARX Asset Management Co., Ltd.". At the bottom, there is a text overlay: "You can download this presentation material from <https://mizutakanobu.com/2020CIFEr/p.pdf>". The video player controls at the bottom show a play button, a progress bar at 0:01 / 15:38, and various icons for volume, settings, and full screen.



The screenshot shows the IEEE Xplore digital library page for the paper. The top navigation bar includes "IEEE Xplore", "Browse", "My Settings", "Help", and "Institutional Sign In". Below the navigation bar, there is a search bar with the text "All" and a dropdown arrow. The main content area displays the paper title "An agent-based model for designing a financial market that works well" and the publisher "IEEE". There are buttons for "Cite This" and "PDF". Below the title, the author's name "Takanobu Mizuta" and "All Authors" are listed. At the bottom, there is an "Abstract" section with the text: "Designing a financial market that works well is very important for developing and maintaining an advanced economy, but is not easy because changing detailed rules, even ones that seem trivial, ...". The page also features social media icons for ResearchGate, Email, Creative Commons, and a notification bell.

Today's Talk: What is a High-Speed Trade? Why does a Stock Exchange Speed-Up?

- As you know, I am not a technology engineer. So, I do not know about technology, especially hardware, so much.
- I am not a High-Speed Trader nor Stock Exchange people. This is not only weak point, but strong point that my talk is not position talk. (They tend to emphasize their benefits too much. On the other hand, my talk will be fair.)
- The goal of my talk showing the abstract what is High-Speed Trade and the reason why Stock Exchanges try to speed up their matching system.

Today's Talk's Contents

- (1) Stock Markets and Liquidity Providers
- (2) Trading Strategies of High-Speed Trades
- (3) High-Speed Trades Companies
- (4) Speed up of Stock Exchanges



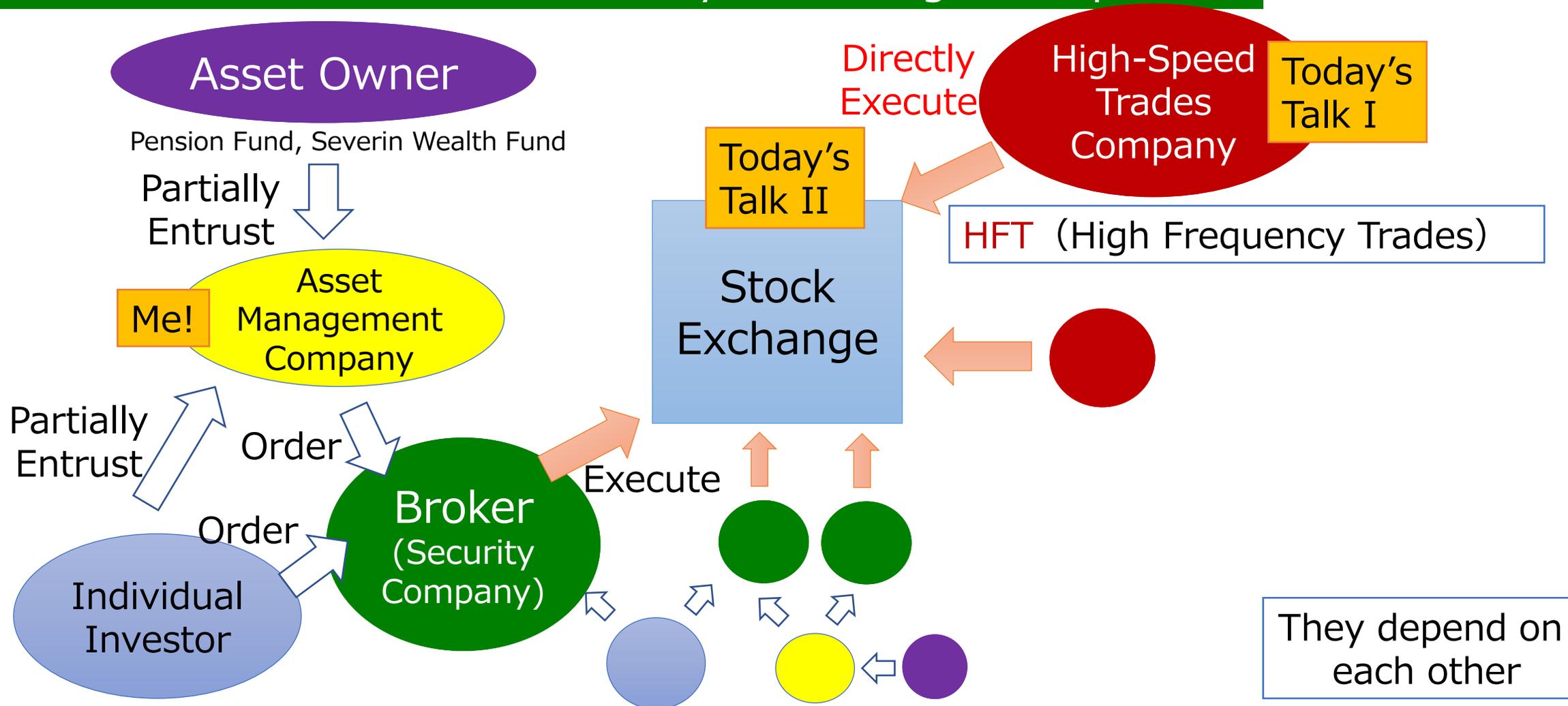
(1) Stock Markets and Liquidity Providers

(2) Trading Strategies of High-Speed Trades

(3) High-Speed Trades Companies

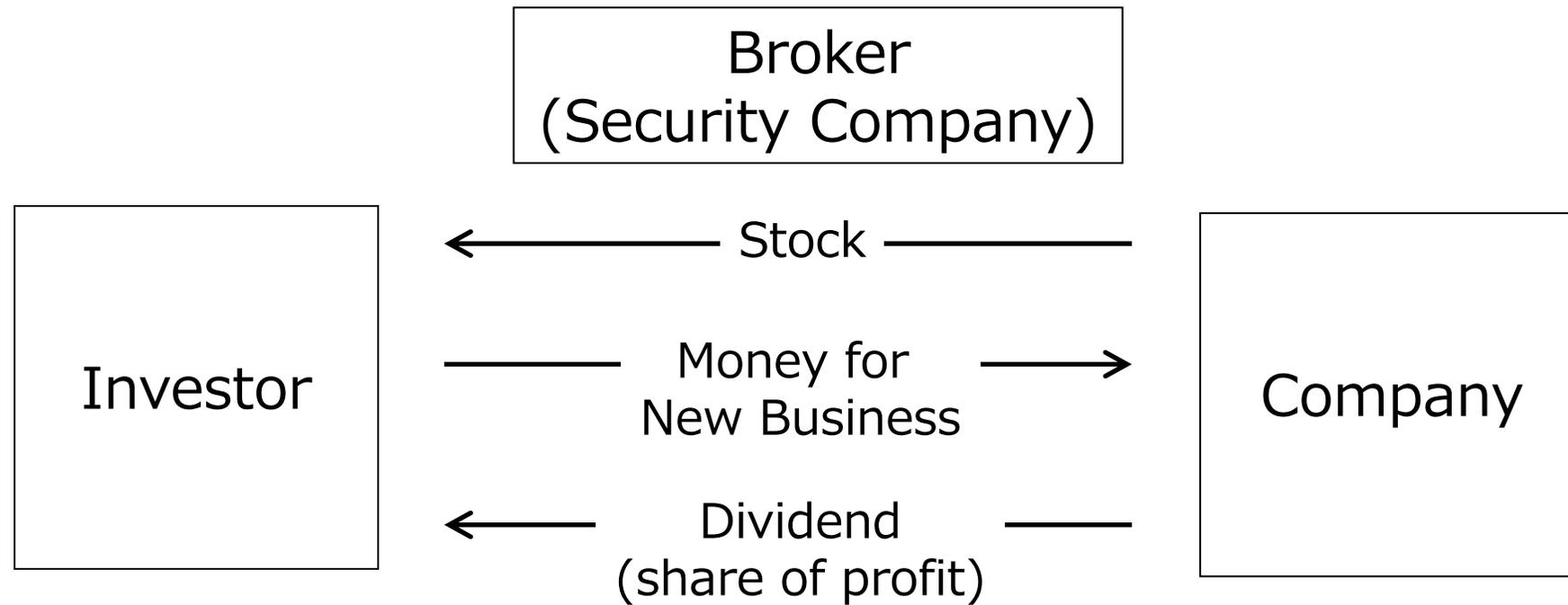
(4) Speed up of Stock Exchanges

Stock Market works well with a variety of Trading Participants



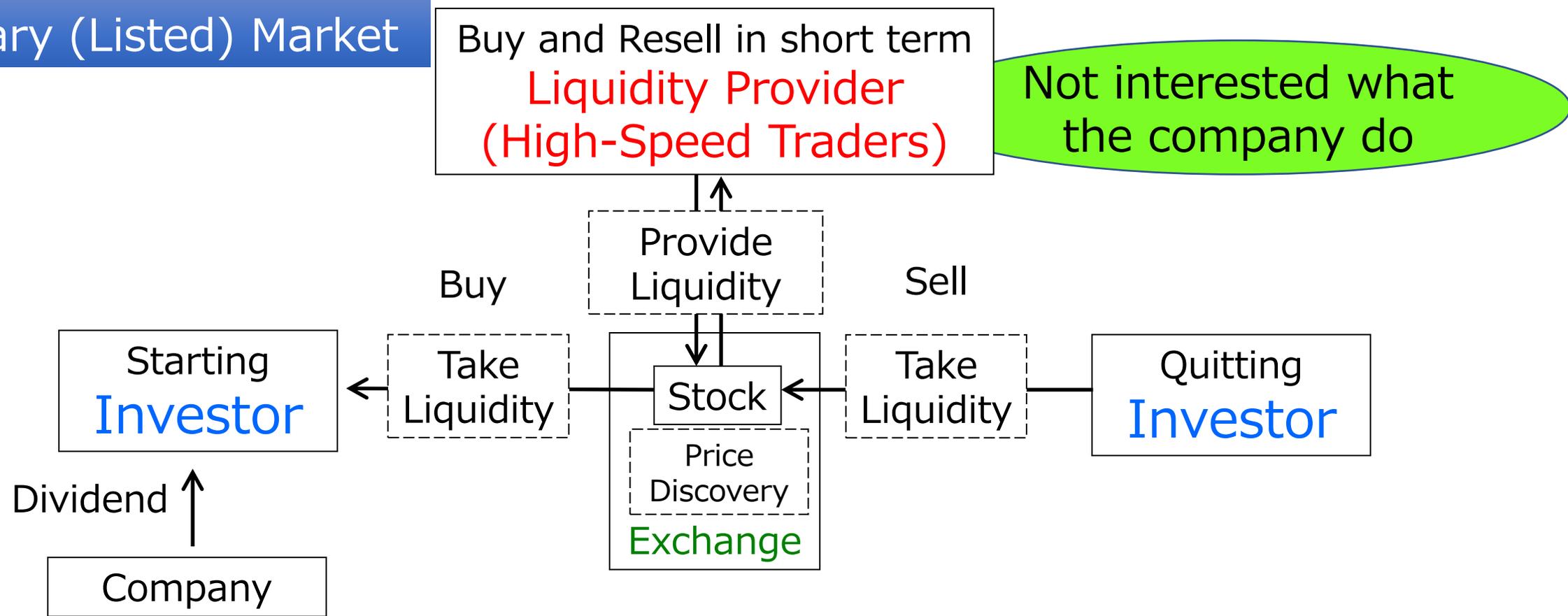
High-Speed Trades Company earns margin by reselling stocks like as a used bookstore
Asset Owner and Investor hold a company like as a book reader

Buying books needs used bookstores, but book readers want to buy cheaper as possible
Investors welcome High Speed Trades Company, but want them not to earn so much



- For new business, at first money for investment is needed, then after that, company get a profit.
- So, investors seeking share of profit with company pay very important role to build innovative company.
- For example, people were going to an unknown world to get treasures back in the Age of Exploration. Whether the ship return or not is very uncertain, but, if so, big money will be come. So, starting the exploration is depend on investors and aiming big money taking large risk .

Secondary (Listed) Market

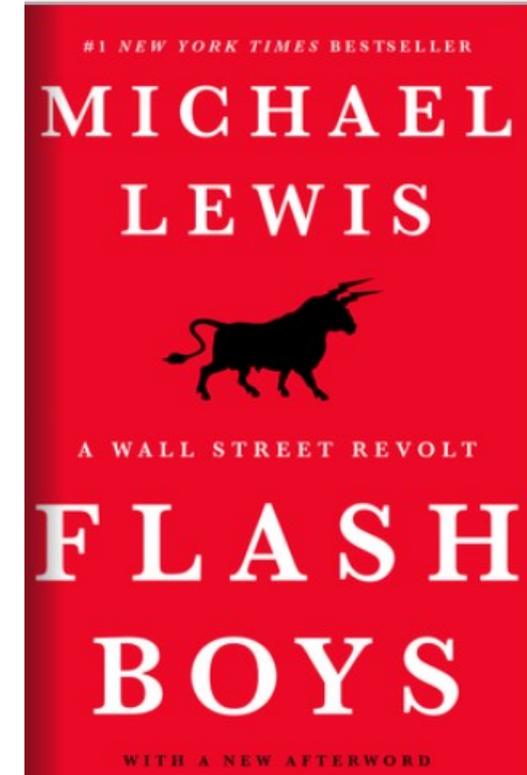


There comes a time when any investor will quit investment and sell stock. (No one lives forever, there comes a time anyone want to use the money.) So, easy to sell (liquidity) is important for the investors. If not easy, this leads hesitation to buy stock and providing new money to an innovative company in primary market.

Liquidity providers indirectly help innovative company to get new money.

What do you feel "High-Speed trades" ?

- ✓ Some people may recall the book "Flash Boys" by Michael Lewis, or the movie based on the book, "the Hummingbird Project"
- ✓ They are overdramatic, but the atmosphere of High-Speed trades industry is like this, especially hardware battle. They are good "fantasy" to know what is High-Speed trades.
- ✓ However, there are many wrong descriptions intending to create image that High-Speed trades are evils.
- ✓ Please remember that in real financial markets there are no heroes, no heroines, no devils and no villains. There are just investors keeping rules and not keeping rules.
- ✓ The book (not the movie) described one person as a hero to build the stock exchange excluding High-Speed trades (IEX), however, actual IEX has not provided liquidity so much even now.
- ✓ Actual high-Speed traders can not earn so much like as in the movie at least now. (The stories are around 2009?)
- ✓ However, the atmosphere, hardware battle, is like this.



The film opens as stockbroker Vincent Zaleski pitches Bryan Taylor on investing in **a fiberoptic cable** from Kansas electronic exchange to the New York Stock Exchange in order to front run orders in a new high-frequency trading (HFT) operation. // Any deviation in the shape of the tunnel will create delays in the trade. Anton is hard at work trying to **shave 1 millisecond off** the time it takes to front-run orders to NYC. Currently, his software will do it in 17 milliseconds, which is not fast enough to be competitive. It needs to be at least 16 milliseconds to be a viable enterprise for Taylor's firm. // Eva (villain? rival of the hero in the movie) finds an NYU student who has written a paper about microwave pulses to effect HFT. She hires him, and starts the process of building **a series of towers to make trades with microwaves.**



Overdramatic and “fantasy”, but, actual HFTs also battle using very very large and expensive hardware each other

(Wikipedia) https://en.wikipedia.org/wiki/The_Hummingbird_Project

(Trailer) <https://youtu.be/3-IlhKbakFA>

The series of towers is real



Sorry for my talking about the important part of the movie, villain's towers won to hellos' straight fiberoptic cable that is slower some millisecond.

In the real, the towers have been remained and the straight cable have not.

December 31, 2014

2014 TOP STORY: No, Michael Lewis, the US Equities Market Is Not Rigged



Larry Tabb

Bloomberg

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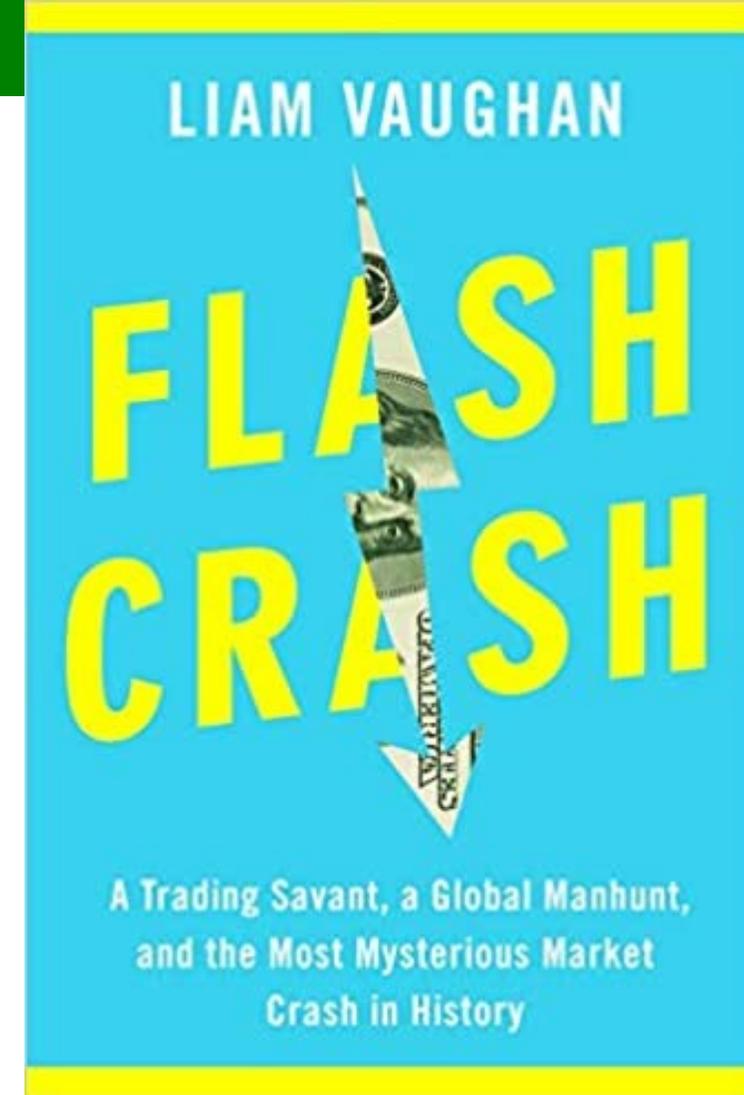


While 'Flash Boys' (and 'the hummingbird project') may capture the complex execution framework of the US equities market, Michael Lewis does not portray the full story. The market may not be perfect, but it's not rigged.

<https://tabbforum.com/opinions/no-michael-lewis-the-us-equities-market-is-not-rigged/>

(Reference) the book "Flash Crash"

- ✓ On the other hand, the book "Flash Crash" is recommendable to be well written as a non-fiction, very objective, no labeling heroes or villains to investors.
- ✓ However, the main character is just criminal manipulating the e-mini S&P 500 future market with placing spoofing orders, and he is just individual investors and not High-Speed trades.
- ✓ Moreover, his trades were not related with the flash crash in May 2010, however, when he was arrested the mass media not understanding the flash crash just reported "he is a flash crash trader".
- ✓ The movie "Flash Crash" will also be released, but I am concern that the movie will be dramatized more excessively and lose objectively.



Flash Crash(book)

<https://www.amazon.com/dp/0385543654>

Plan of Flash Crash(Movie)

<https://www.hollywoodreporter.com/news/dev-patel-star-flash-crash-new-regency-see-saw-1280039>

- (1) Stock Markets and Liquidity Providers
- (2) Trading Strategies of High-Speed Trades**
- (3) High-Speed Trades Companies
- (4) Speed up of Stock Exchanges

Market Making Strategy

A trader always places both buy and sell order with a little different price. The trader earns by the difference when buy and sell investors come.

-> like as a used book-store

Arbitrage trades

Even though two assets have exactly same economic value, sometimes they have different prices. Then, a trader buys cheaper one and immediately sell more expensive one.

-> like as a resail broker

Both strategies have been there since long ago, and recently was automated.

Market Making Strategy

Order Book of continuous double auction

places both buy and sell order

	Shares Sell	Price	Shares Buy	
Place Waiting Sell Order	84	1.01		
	176	1.00		
		0.99	204	Place Waiting Buy Order
		0.98	77	

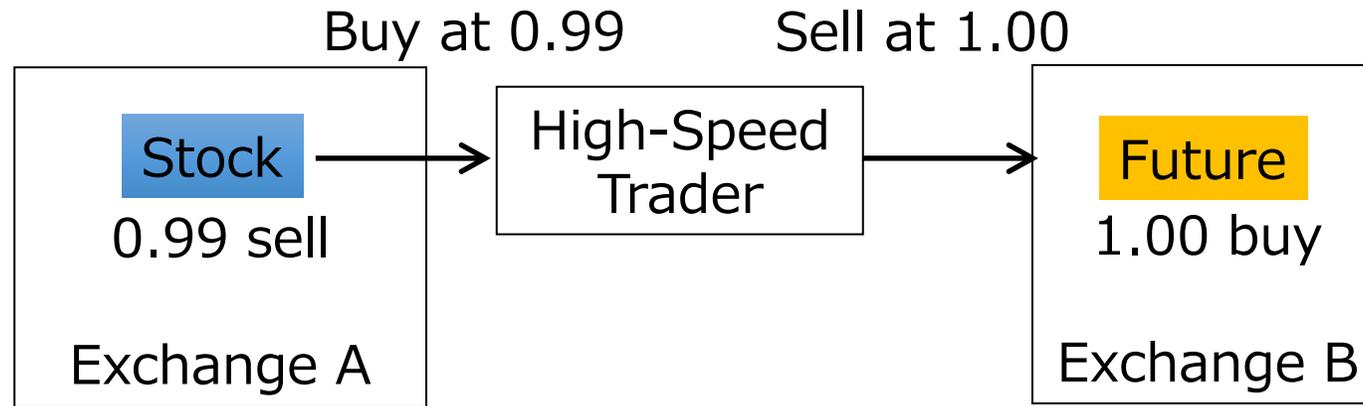
Multiple buyers and sellers compete to buy and sell stocks in the market, and transactions can occur at any time whenever an offer to buy and an offer to sell match.

For example, when someone sells at 0.99 the waiting buy order is immediately executed and someone buys at 1.00 the waiting sell order is immediately. So, the trader earns by the price difference. However, when the prices fall down, the trader should sell super quickly, because after some milliseconds the trader can only sell very lower price the trader bought.

So, the trader needs a high-speed trade.

Arbitrage trades

Even though two assets have exactly same economic value (stock, future, option, ETF, etc.), sometimes they have different prices. Then, a trader buys cheaper one and immediately sell more expensive one.



Only Fastest trader earns

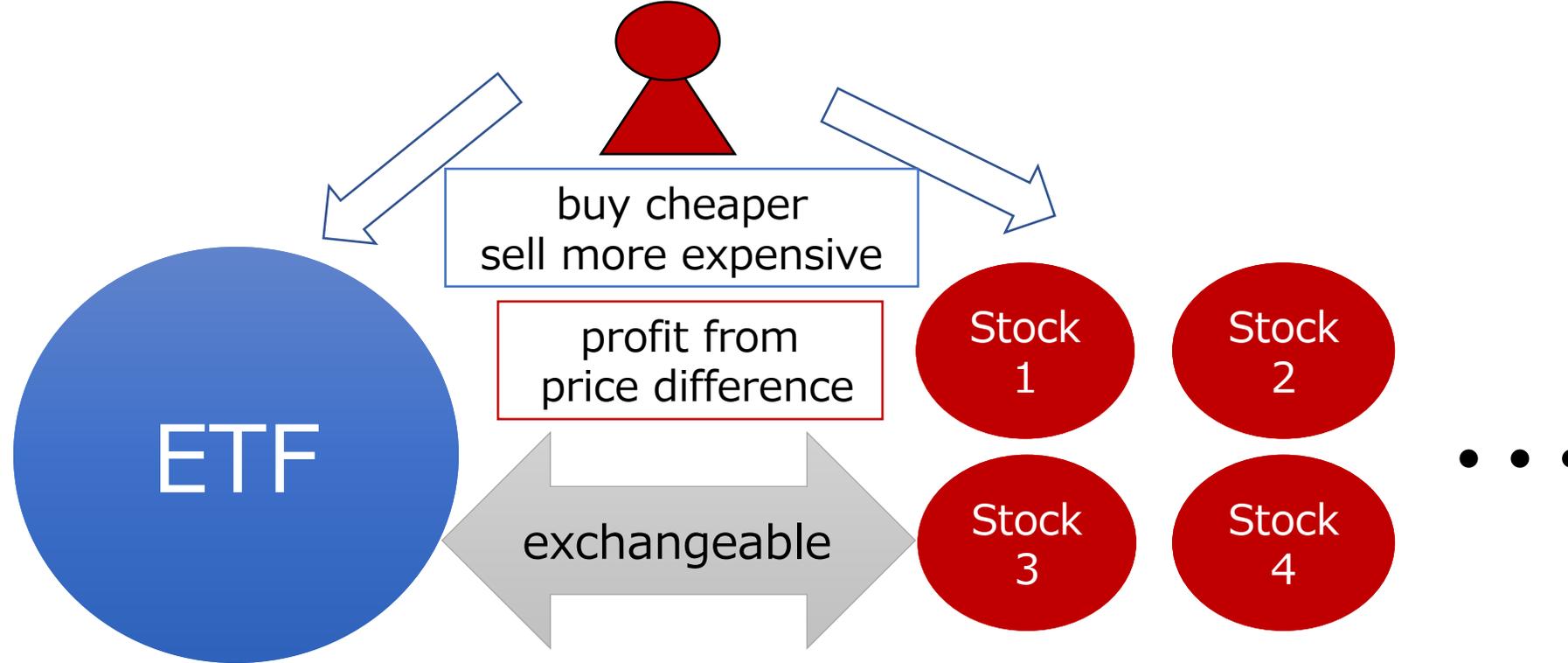
Other Traders earn ZERO, even though the speed is a nanosecond slower

Trading Speed is only needed

In the movie "the Hummingbird Project", the traders do arbitrage trades

(Reference) Actual Arbitrage between ETF and stocks

High-Speed trader



An ETF is exchangeable with all stocks held by the ETF.

When the price of the ETF and the total value of the stocks held by the ETF differ, a trader can buy the cheaper asset, exchange, sell the more expensive asset, and thus earn a profit from the price difference.

The trader arbitrage-trades with Market Making, very complex trades

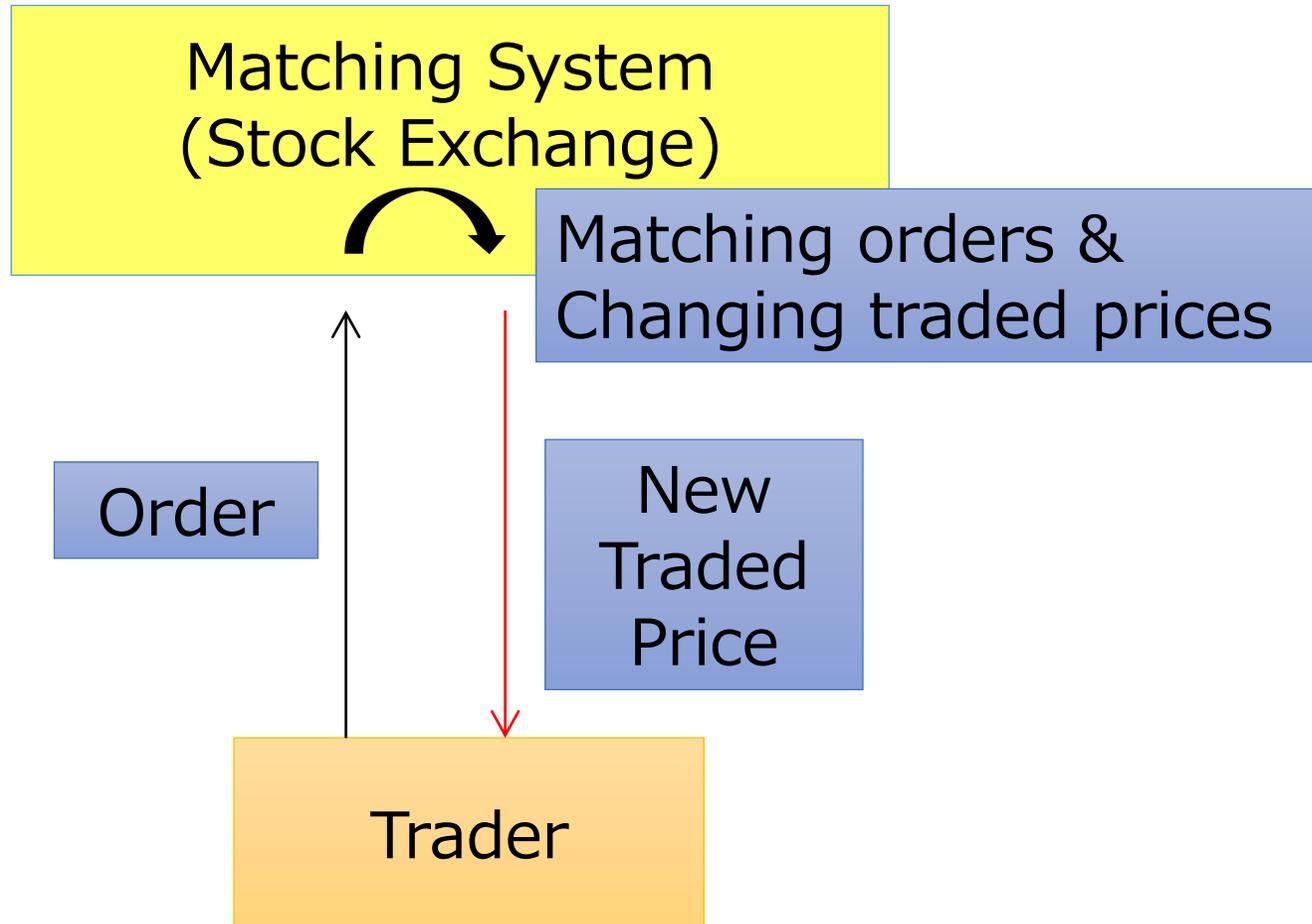
Which type of "speed" is needed?

"Low Latency"

Needed time from submitting order to receiving new information

Sending many data per a time that is speed of internet as we usually said, does not effect (e.g. "Mbps")

One trade data is a very few



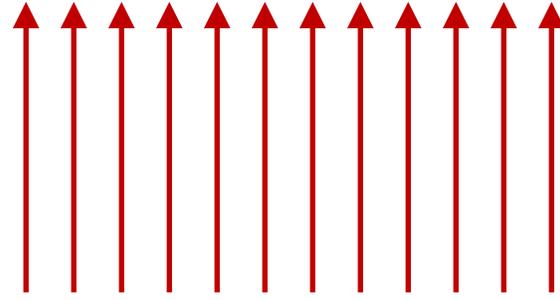
(Reference) Directional Strategy (betting price up-down) exists a few

Monetary Policy Announcement
text publication



Web site of the Bank of Japan

Very frequently
Pinging whether the
text exists or not



Getting the
text



High-Speed Trader

If the text is longer
it buys USD



FX market (USD/JPY)

The text longer means changing monetary policy.
These trades were usual around 2015-2017

(Reference) Latency Arbitrage

The book (not the movie) described "latency arbitrage", but this is exactly not "Arbitrage" because it needs a prediction.

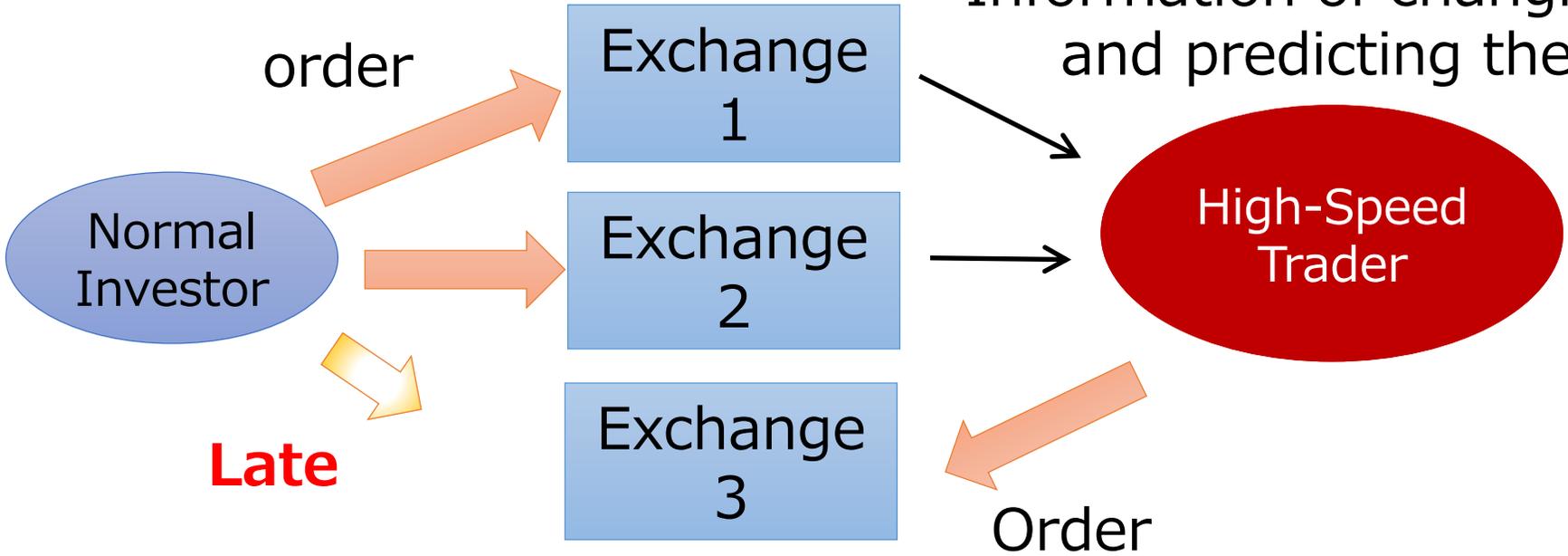
Modern Day Latency Arbitrage: Predicting Price Changes

The prediction is Uncertainty
Not easy strategy

Eric Stockland Follow
Apr 10, 2017 · 8 min read



Information of changing order book,
and predicting the Late Order



Maybe advance the Late Order
(Need Predicting the existence)

- (1) Stock Markets and Liquidity Providers
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High-Speed Trades Companies “to” Tokyo Market

They should be registered to the Japanese regulator from 2018

高速取引行為者登録一覧

令和3年1月7日現在

高速取引行為者名	法人番号	本店所在地
Citadel Securities (Hong Kong) Limited	—	16th Floor Two International Finance Centre, 8 Finance Street, Central, Hong Kong
Susquehanna Pacific Pty Ltd	—	Level 48, Tower One, International Towers, 100 Barangaroo Avenue, Barangaroo, NSW 2000, AUSTRALIA
<u>Virtu Financial Singapore Pte. Ltd.</u>	—	20 Anson Road, #20-01 Twenty Anson, Singapore, 079912
Flow Traders Asia Pte. Ltd.	—	8 Marina View, #39-03 Asia Square Tower 1, Singapore 018960
Grasshopper Pte.Ltd.	—	18 Cross Street, #07-02/03 Cross Street Exchange, Singapore 048423
Optiver Australia Pty Limited	—	33-39 Hunter Street, SYDNEY NSW, Australia 2000
Vivienne Court Trading Pty Ltd	—	Level 1, 188 Oxford Street, PADDINGTON NSW 2021, Australia
<u>ダルマ・キャピタル株式会社</u>	4011101074671	東京都千代田区神田須田町一丁目3番地9 PMO神田万世橋5F
Jane Street Asia Trading Limited	—	15/F Chater House, 8 Connaught Road Central, Central, Hong Kong
XTX Markets Limited	—	R7, 14-18 Handyside Street, London, N1C 4DN, United Kingdom
DRW Singapore Pte. Ltd.	—	8 Marina View, 32-05, Asia Square Tower 1, Singapore 018960
Fenix One Asia Pte. Ltd.	—	8 Marina View, #41-03, Asia Square Tower One, Singapore 018960
Flow Traders B.V.	—	Bank Postbus 9, 1018 HJ Amsterdam, The Netherlands

<https://www.fsa.go.jp/menkyo/menkyoj/kousoku>

Only one company of all 56 is in Tokyo (January 7, 2021)

(Reference) If you want to High-Speed Trades “to” Tokyo Market, PLEASE read the document very carefully



▼ Link to Body | S

Site Search



[HOME](#) > [Regulated Institutions](#)

[Japanese](#)

For those engaging in High Speed Trading

From April 1, 2018, a new system was introduced in relation to High Speed Trading (“HST”) of shares and other types of financial instruments, and those engaging in HST are required to register.

We provide the following information regarding HST registration, etc.

<https://www.fsa.go.jp/en/regulated/hst/index.htm>

(i) whether the overview of trading strategies includes items (a) to (c) of Article 328 (iv) of the FIB Cabinet Ordinance, noting that the following classifications shall be used for matters stipulated in Article 328 (iv)(a)

A. Market-making strategy

A trading strategy where traders create orders for both sell and buy, become the counterparty to other investors, and take the bid/offer spread as their earned income

B. Arbitrage strategy

A trading strategy to purchase and resell to exploit the difference in prices of two positively correlated stocks (e.g. Nikkei 225 Futures and Nikkei 225 ETF) and of a single stock in different markets and make profits

C. Directional strategy

A trading strategy to generate profits based on the assessment of the direction of prices in the near future

D. Other strategies

Strategies that do not fall under market-making, arbitrage, or directional strategies above

The Japanese regulator (Japan Financial Services Agency) also lists up market-making strategy and arbitrage trade as a main strategy of high-speed trades.

(\$mm)	3Q 2019	4Q 2019	1Q 2020	2Q 2020	3Q 2020	YTD 2020
Adjusted Net Trading Income¹	\$250	\$257	\$784	\$669	\$362	\$1,815
<i>Daily Average Adj. NTI</i>	<i>\$3.90</i>	<i>\$4.08</i>	<i>\$12.65</i>	<i>\$10.61</i>	<i>\$5.66</i>	<i>\$9.61</i>
Market Making Adj. NTI	\$142	\$151	\$652	\$552	\$257	\$1,462
<i>Market Making Daily Average Adj. NTI</i>	<i>\$2.21</i>	<i>\$2.40</i>	<i>\$10.52</i>	<i>\$8.76</i>	<i>\$4.02</i>	<i>\$7.73</i>
Execution Services Adj. NTI	\$108	\$106	\$132	\$117	\$105	\$354
<i>Execution Services Daily Average Adj. NTI</i>	<i>\$1.69</i>	<i>\$1.68</i>	<i>\$2.13</i>	<i>\$1.85</i>	<i>\$1.64</i>	<i>\$1.87</i>
Normalized Adjusted EPS¹	\$0.21	\$0.27	\$2.05	\$1.73	\$0.81	\$4.58
Adjusted EBITDA ¹	\$104	\$115	\$570	\$486	\$249	\$1,304
<i>Adjusted EBITDA Margin¹</i>	<i>41.6%</i>	<i>44.6%</i>	<i>72.6%</i>	<i>72.6%</i>	<i>68.7%</i>	<i>71.8%</i>
Adjusted Operating Expenses ¹	\$164	\$159	\$232	\$200	\$130	\$562
Long Term Debt (at end of period)	\$1,957	\$1,957	\$1,957	\$1,769	\$1,669	\$1,669
<i>Debt / LTM Adjusted EBITDA</i>	<i>3.4x</i>	<i>4.0x</i>	<i>2.2x</i>	<i>1.4x</i>	<i>1.2x</i>	<i>1.2x</i>

https://s21.q4cdn.com/422114427/files/doc_financials/2020/q3/2020.Q3-Earnings-Supplement-vFINAL.pdf

VIRTU is listed company, so components of revenue is opened. All High-Speed Trades are described as “Market Making”. I think this includes “Arbitrage trades” for market making, but at least I can say definitely that other strategies are not main.



<https://www.dharmacapital.co.jp/>



自社開発のプログラムについて説明する塩谷代表

<https://archive.is/L34Ih> (archive.is)

The firm was introduced on TV news of NHK, which is Japan's public broadcaster. In the show, the head of the firm said that our main strategies are market-making and arbitrage trades, and speed is most important and need heavy cost for the speed, heavily hardware battle.

THE WALL STREET JOURNAL.

English Edition | Print Edition | Video | Podcasts | Latest Headlines

Financial-technology startups are arming traders with devices that shave precious nanoseconds off stock-market bets.

Speeding up the trading world: Metamako co-founders Scott Newham (left) and David Snowden inspect one of **the ultrafast network switches** that they produce in a factory near Sydney and ship to traders and exchanges world-wide.

Metamako and xCelor said they complete the entire messaging job, including the more complicated task of shooting orders back to the exchange, in around **85 nanoseconds**. The equivalent time for **Cisco's fastest switch is at least 240 nanoseconds**, according to the company's website.

Cisco declined to comment.

<https://www.wsj.com/articles/trading-tech-accelerates-toward-speed-of-light-1470559173>



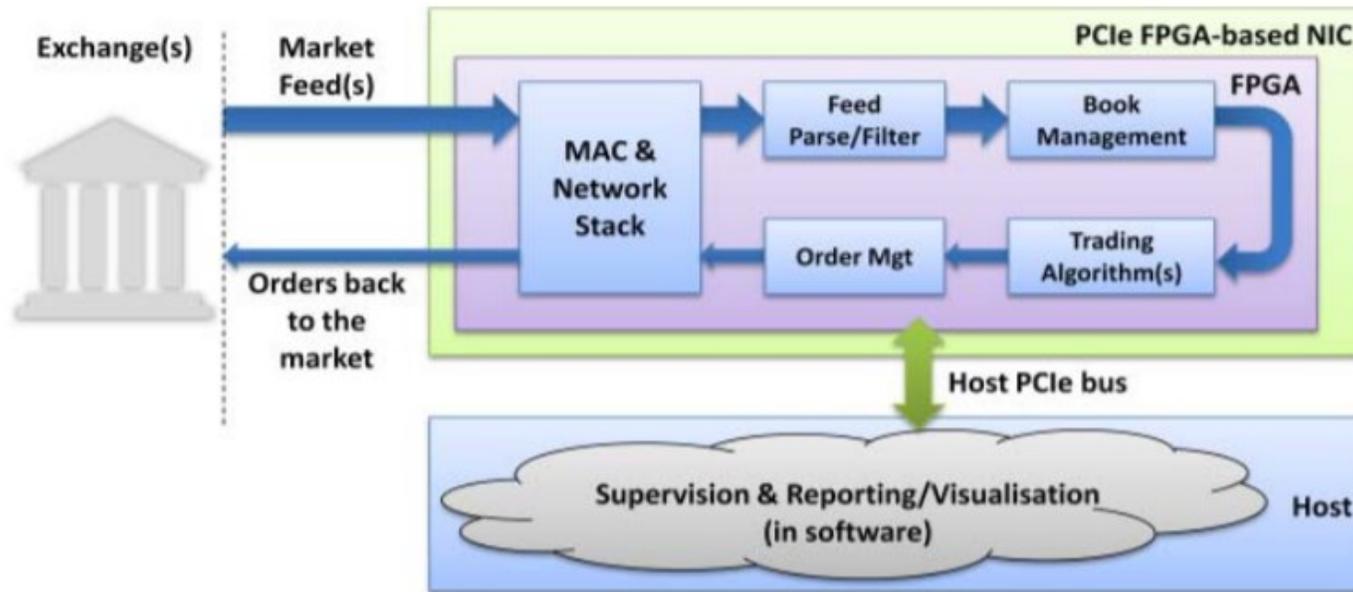


Figure 2 Typical Smart NIC in a supervised financial trading application

Replacing CPU for FPGA(Field Programmable Gate Array).
We can input the algorithm program to FPGA as an integrated circuit.

Declining earnings

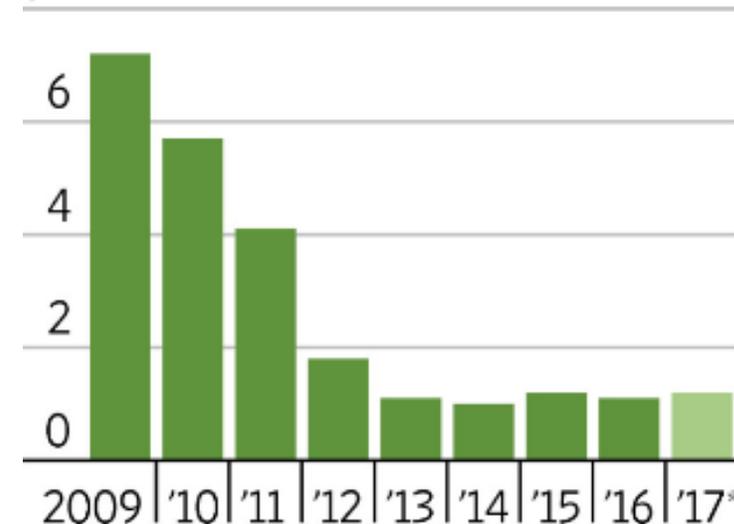


Revenues at HFT firms from U.S. equities trading were an estimated **\$1.1 billion last year, down from \$7.2 billion in 2009**, according to research firm Tabb Group.

High-frequency trading firms' revenue from U.S. equities trading has sunk as volatility dropped.

Industry Revenues

\$8 billion



That is the backdrop behind last week's news that **Virtu Financial Inc. had made a bid to buy rival KCG Holdings Inc.**, a proposed deal that would **unite two of the biggest U.S. electronic trading firms**. Virtu's stock has shed about a fourth of its value since the company went public in 2015, while **KCG's key market-making business has lost money** for the last two quarters.

Other industry heavyweights are exiting altogether. Thomas Peterffy, chairman and chief executive of Interactive Brokers Group Inc., said this month he would end his firm's options market-making activities, a business he helped pioneer in the 1980s. Misha Malyshev, who once led global HFT for hedge fund giant Citadel LLC and left to start Teza Technologies, said in November that Teza would exit its proprietary trading business.

<https://www.wsj.com/articles/high-frequency-traders-fall-on-hard-times-1490092200>

A few companies will survive like as the airflight industry

I do not know whether more high-speed provides more liquidity or not

Markets

Traders Discuss Data Superhighway From Chicago to Japan

By [Brian Louis](#) and [Annie Massa](#)

2016年8月30日 8:00 JST Updated on 2016年8月31日 1:01 JST

Rival high-frequency trading firms are in talks to **jointly build** a Chicago-to-Japan communications link that would accelerate trading across the Pacific Ocean, according to people familiar with the discussions.



The project, dubbed **“Go West,”** would install **a line of microwave towers** from the **Chicago** area to the U.S. west coast, possibly ending near Seattle, and then connect to an undersea cable that stretches to **Asia**, according to the people, who asked not to be identified because the talks, which started months ago, are confidential. The cast of companies involved in the talks has included Citadel LLC, Virtu Financial Inc. and Jump Trading LLC, though the final roster isn’t set and the talks aren’t final, the people said. Those three firms declined to comment.

<https://www.bloomberg.com/news/articles/2016-08-29/traders-said-to-discuss-data-superhighway-from-chicago-to-japan>

I do not know the high-speed cables that rival can also use are benefitable

(Reference) How do long-term investors feel about high-speed trades?

日本経済新聞

高速取引は「生かさず殺さず」 市場の設計、道半ば

編集委員 松崎雄典

2019/2/4 5:30

スパークス・アセット・マネジメントの水田孝信ファンドマネージャー兼上席研究員は「彼らもうけすぎていると、他の投資家が高く買わされていることになるから、今ぐらいがちょうどいいのでは」と指摘する//、「生かさず殺さず」ということだろう。

I am asked this question by a press person. I answered that “Recently they do not earn not so much. It is good for us. What they earn very much means we are charged heavy trading costs. But we need liquidity they provide. So, we should not make them live nor kill them.”

4 February 2019 Newspaper NIKKEI

<https://www.nikkei.com/article/DGXMZO40796210R00C19A2000000/>

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What do you feel "Stock Exchange" ?

== long ago (-1999 in Tokyo) ==
Physically Gathering traders
like as "Market"



<https://www.jpx.co.jp/corporate/events-pr/140years/index.html>

== Now ==
"Servers" in racks
in the data-center



Fused Fiber Optics for Lowest Latency

<https://www.jpx.co.jp/english/systems/connectivity/>

(The location of the data-center for Tokyo
Stock Exchange is top secret)

(Reference) What is this in Tokyo Stock Exchange?



You may image this place as Tokyo Stock Exchange. However, this is just a decoration for tourists. There is no server of exchange and the data-center locates at definitely different place. People in this are not traders but workers of the exchange (inspecting unfair trades?).

(Reference) What is this in Tokyo Stock Exchange?

In the New York Stock Exchange, even now, there are physically traders who market-make called "Specialist", however, they trade not so much and off course electric trades are very very more then by them.



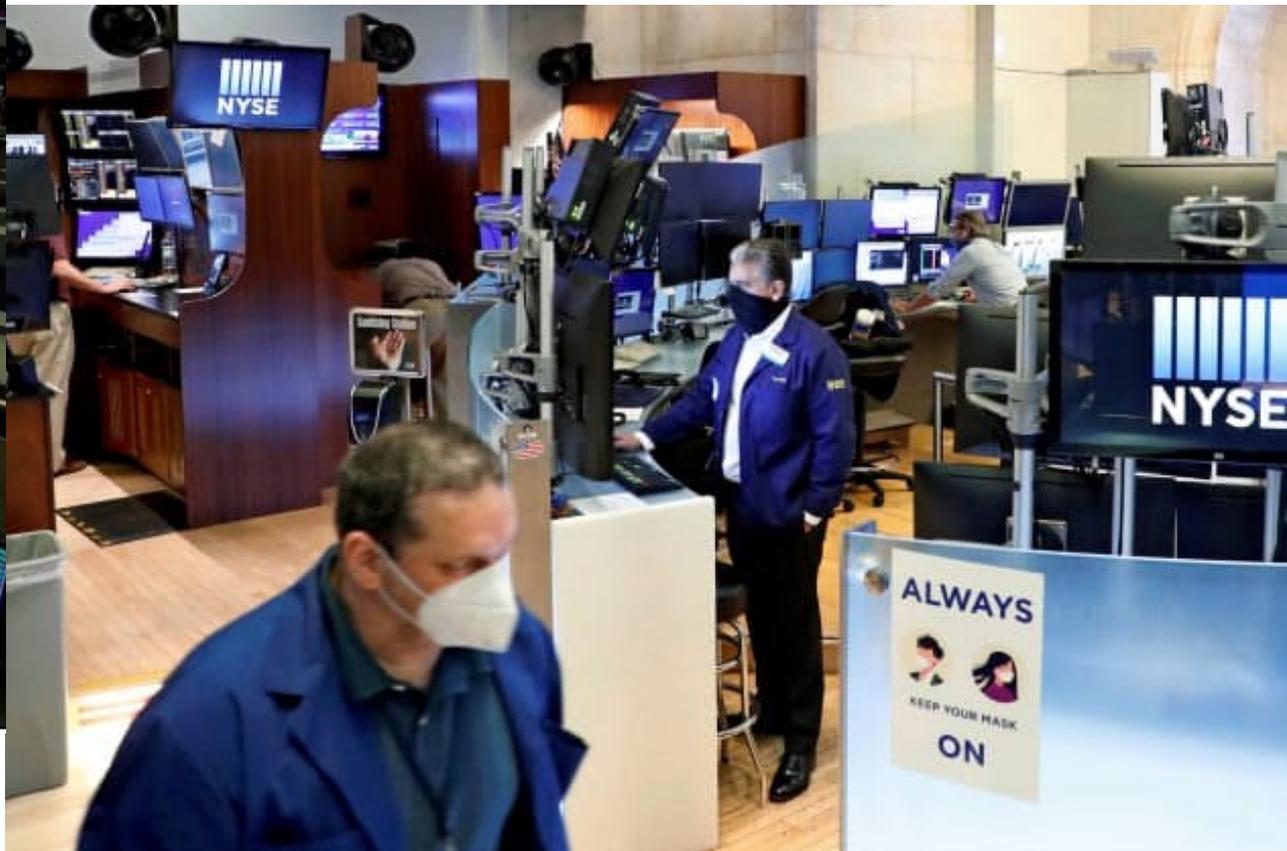
(picture) <https://toyokeizai.net/articles/-/145694> (9 November 2016, Donald Trump won the election)

(detail of specialists) <https://www.sec.gov/fast-answers/answersspecialisthtm.html>

(Left) From 23 March 2020, the floor closed due to tow traders getting COVID-19

(picture) <https://jp.reuters.com/article/health-coronavirus-usa-markets-idJPKBN2172PB>

(NEWS) <https://www.reuters.com/article/us-health-coronavirus-nyse-idUSKBN21B3I7>



(Right) From 26 May, gradually open

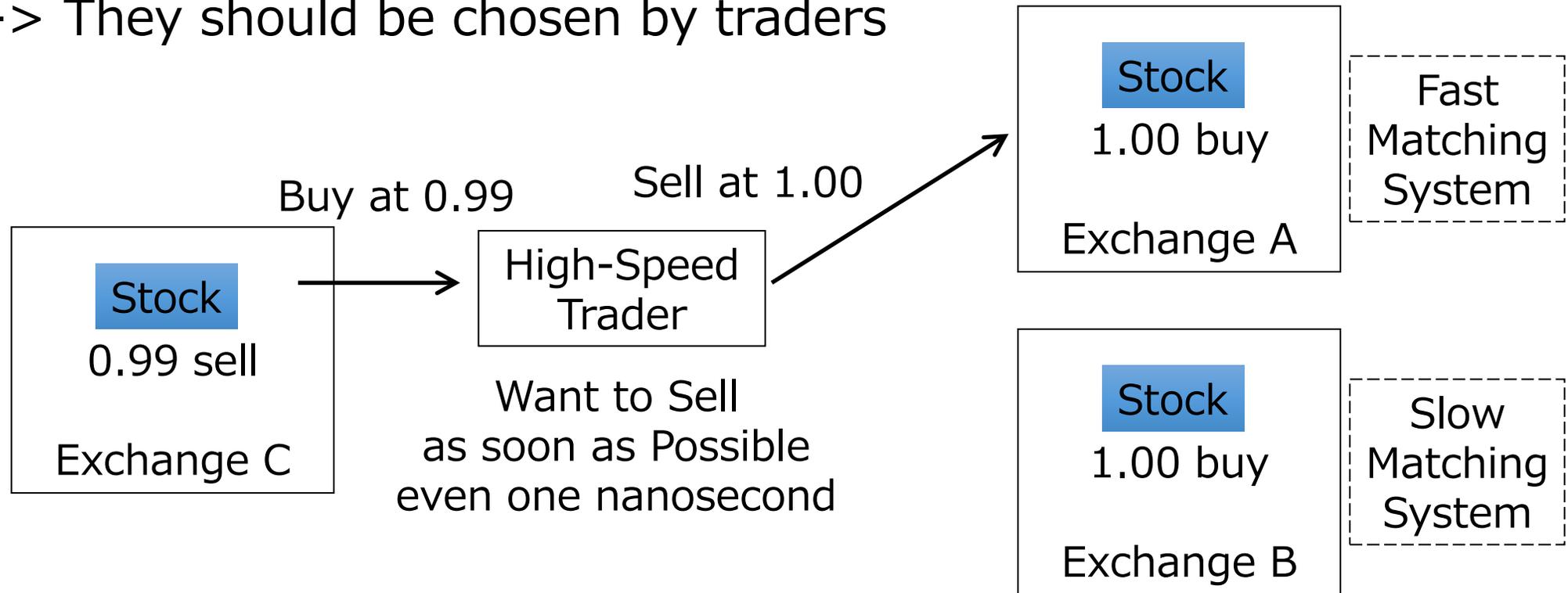
<https://www.cnbc.com/2020/05/26/nyse-floor-reopens-after-coronavirus-shuts-historic-big-board-for-two-months.html>

Some researches showed liquidity was not changed even though open or close.

Competition between stock exchanges

There are many stock exchanges

-> They should be chosen by traders



If other conditions are same, the trader should place the order on the exchange using faster matching system.

do not want to lose the chance, and more frequently trades

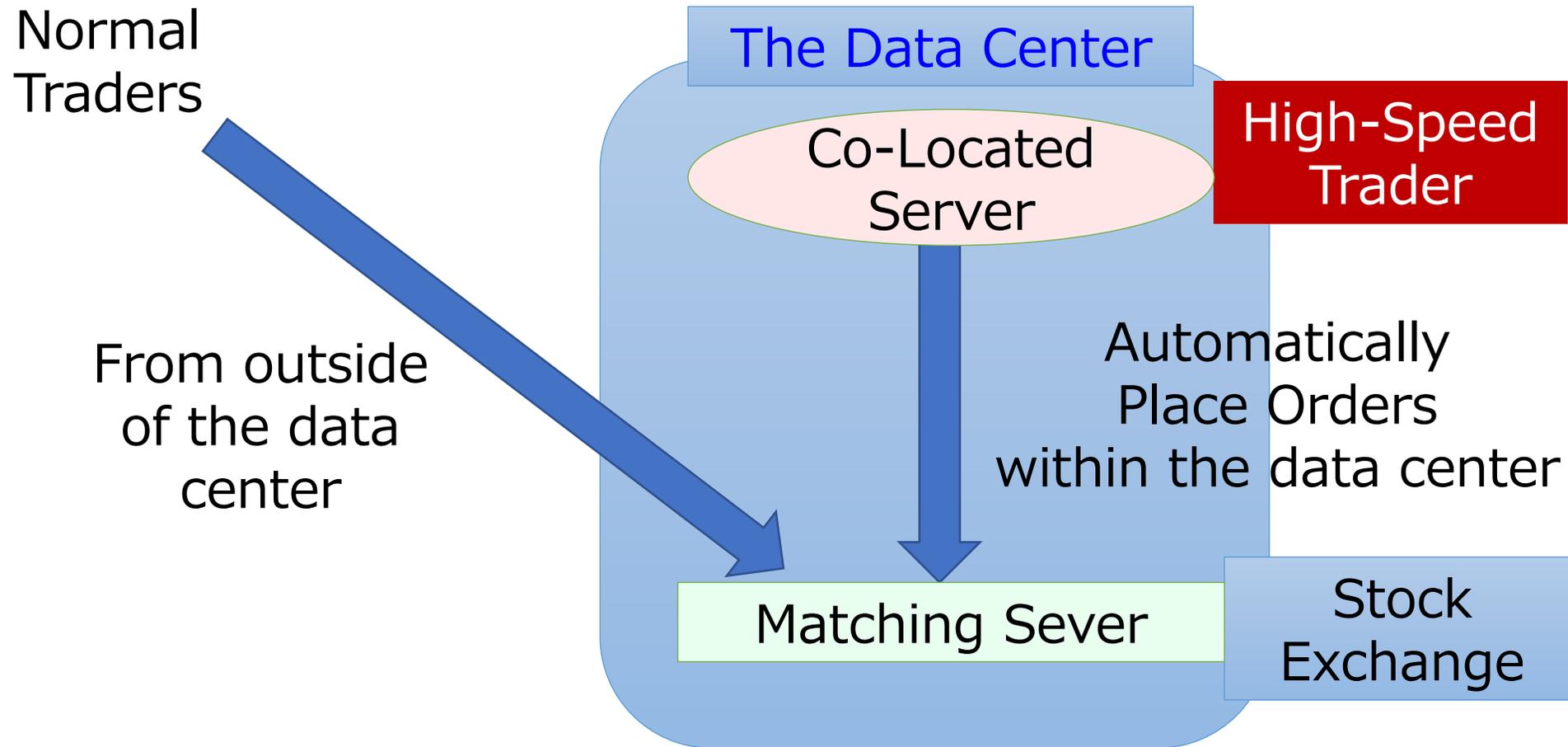
Faster than other exchanges
Is very very important



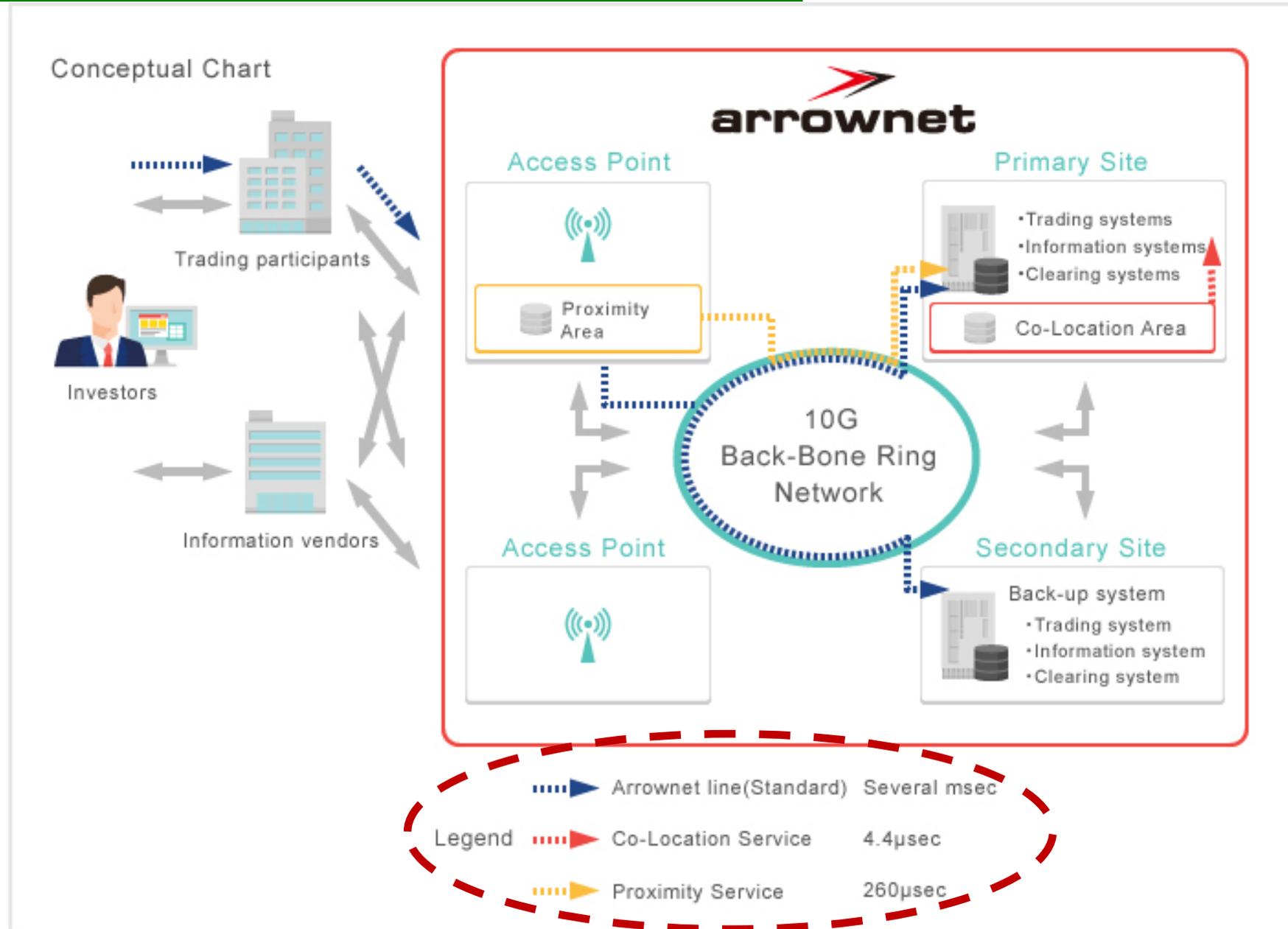
Hardware Battelle

Co-Location Service

Many exchanges provide Co-Location Service to High-Speed Traders to get lowest latency. High-Speed Traders can use co-located server just next matching server.



Co-Location Service by Tokyo Stock Exchange



(Reference) Movie Introducing Co-Location Service of Tokyo Stock Exchange



<https://youtu.be/boTtC3GoT6Y>

About cables (Around 2.36)

About Server redundancy, power and air conditioning (Around 2.30 to 4.00) 41

Summary

- ✓ I presented what is a High-Speed Trade, and why does a Stock Exchange Speed-Up.
- ✓ High-Speed Trades help society by providing liquidity of stocks like as a used bookstore.
- ✓ High-Speed Trades need “Low Latency”. Other types of speed, e. g. “bpm”, are not needed.
- ✓ Market Making Strategy and Arbitrage trades are main strategies of High-Speed Trades. Both strategies have been there since long ago, and recently was automated.
- ✓ Their earnings are declining. A few companies will survive like as the airflight industry because they need heavy cost for the speed, hardware battle.
- ✓ I do not know whether more high-speed provides more liquidity or not.
- ✓ Stock exchanges should be chosen by traders, faster than other exchanges is very important, They are also in Hardware Battle.
- ✓ The book “Flash Boys” by Michael Lewis, and the movie based on the book, “the Hummingbird Project” are good “fantasy” to know what is High-Speed trades.