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How Linux took over the World of Finance

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Linux and the Finance

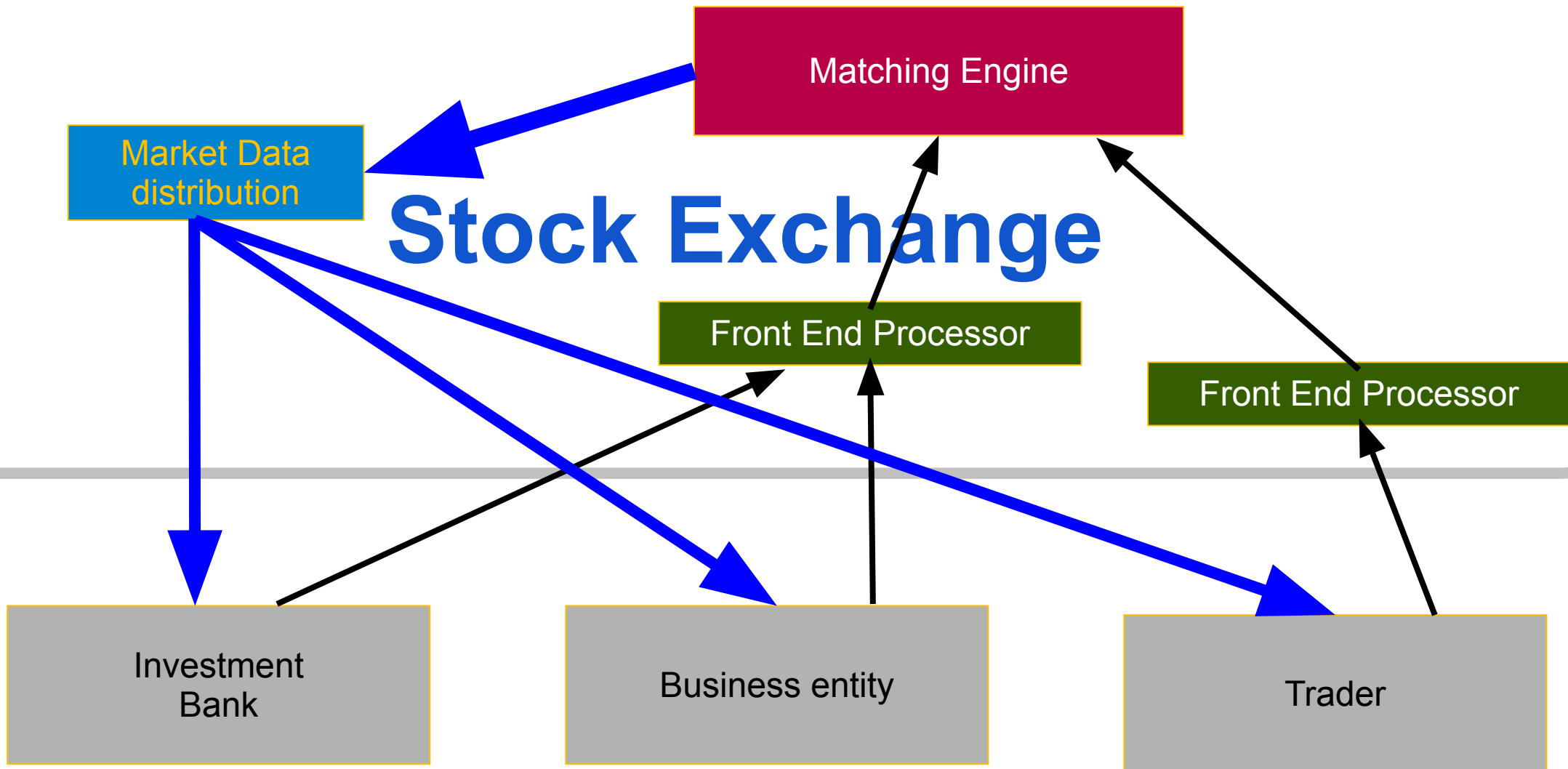
Linux has become a dominant operating system not only in high performance computing and on handhelds. It also runs the world of finance these days.

In the area of financial markets we have use of Linux by the Stock Exchanges, Investment banks as well as by "Quants" that use Linux to implement complex trading strategies.

But also in the rest of the industry financial operations rely on Linux technology in many ways. This includes classic accounting, CRM (Customer Relations Management, SCM (Supply Chain Management) and so on. This often not visible because the business machines on the edge may still run Microsoft Windows.

- Stock Exchanges
- Banks (Investment banks)
- Corporate Giants interacting with Markets
- Small investors with software on their machines at home (wannabe Quants)
- Professional Quants
- Where?
 - Chicago (CME), New York (multiple Exchanges), London, Frankfurt, Shanghai?

Data Flow in and out of Stock Exchanges



- Intelligence and Speed
 - Powerful and fast processors
 - High capacity and fast LAN
 - High capacity and fast WAN
 - Powerful but stripped down code
- Need for tuning
 - Therefore a lot of Linux hotrodding

How did it happen?

- 70s: Paper trading
- 80s, 90s: MS-DOS, Novell, Sun, proprietary Unixes
- Tandem Systems from the 90s are still in use!!
- 90s Microsoft develops kernel extensions for messaging layers needed for trading.
- ~2000 a lot of Sun systems and other proprietary Unixes. Linux at the fringes. Fierce discussions if Windows is better or Linux.
- 2007-9 Widespread adoption of Linux as the trading OS of choice.
- > 2010 Linux is the standard OS for trading systems. Windows on the desktop and for specialized services.



Players in the Game

- Exchanges (NYSE, NASDAQ, CME, LSE etc)
- Banks (Investment banks like Goldman Sachs)
- Funds (Various investment funds)
- Individual Traders (via specialized brokerage companies)
- Brokers focusing on electronic trading.

- Kernel optimizations
- Fast RDMA APIs
- Realtime kernels
- Optimization of binaries
- Fast C++ code
- Networking enhancements
- Tendency to do bare metal coding



The Speed of Light Problem

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- Machines are extremely fast these days.
- However it takes hundred of milliseconds to send a signal around the world or to a satellite.
- Relativity sets limits on signaling speed (and therefore in the world of finance one constantly runs against the limitation of physics).
- Things must be close together. One person in Los Angeles will have a tremendous disadvantage against the person in New York if they are trading at the NYSE.

Transition from Manual to Automated Trading

- Manual takes hours to arrange
- Human reviews data
- Human decides
- 30-60 trades per min max
- Mostly a backup mechanism
- Dying out
- Milliseconds
- Computer analyses
- Trading algo decides
- Thousands of trades per sec
- Fast reactions
- Taking over the world

- Speed dependency. Whoever gets there first wins. You must be able to control your tech.
- Differentiation: How can you beat the other guy? Hot rod-ding Linux maybe.
- Problems with high latencies of windows network stack.
- Linux is highly customizable
- Most internet servers use Linux. Logical choice to also use that for financial markets.
- Major stock exchanges are all on Linux these days.
- Commercial solutions vendors focus on Linux. Products for Windows are rare in this market.
- Sun's Solaris OS was present for the longest time but gradually diminished after the acquisition by Oracle in 2009. Trend was there before but it accelerated.
- Some minor use of AIX and some of BSD remains



Distributions in use

- Predominantly Redhat Enterprise Linux (mostly older releases)
- SUSE Novell (mostly in Europe / Germany)
- Realtime versions of the above
- Gentoo (extremely customizable)
- Ubuntu / Debian

Challenges for Linux in Finance

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- Open source contributors are rare
- Trading companies want to keep competitive advantage and therefore involvement in upstream development is limited.
- Constant unnerving regressions in kernel components that cause high latencies. People stick to old kernels.
- Operating system is in the way
 - Direct Hardware interaction (OS bypass) are seen as a path to better performance.
 - OS overhead impinging in uncontrollable ways on the applications which can cause unforeseen delays at unfortunate points in time.



Final comments

- Linux dominates for the foreseeable future
- We need to find a way to encourage contributions from the financial world.

Content Title

Linux has become the dominant operating system not only in high performance computing but also in the world of finance. Stock exchanges, Banks, Investment funds and "Quants" use Linux to implement complex trading strategies. This talk presents the history of how it happened and what key technology issues drove the adoption of Linux in the Industry and are driving it today.

Competition in the industry leads to technology innovation and causes technology to be taken to extreme ends. Now the industry approaches the limitations of physics. The speed of light is limiting trading latencies. The hardware has been optimized to extremes but it is still running Linux. Calculations and deep learning dominate the landscape and the machines get ever intelligent. And its still all Linux.