

Internet Economics and Financial Technology
Computer Science COMSM0019

Lecture I: Introduction, and The Big Picture

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University of
BRISTOL

Your Lecturers



John Cartlidge
MVB 3.39

Refinitiv Lecturer in Financial Informatics and
Data Analytics



Professor Dave Cliff
Professor of Computer Science

Dave Cliff
MVB 5.16

Foresight Lead Expert Group,
FCA Academic Advisory Council

Your Lectures

Lectures:

Tuesday 15:00-15:50 & 16:00-16:50, QB1.15

What happens in this unit?

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REVISION WEEK

But there is more...

Flipped Sessions: watch video lecture, then interact

Week 4: live market-trading experiment

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Week 6: robot traders on Bristol Stock Exchange

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REVISION WEEK

Lab Sessions: Explore Refinitiv's Eikon

- Week 3: intro** L01:The Big Picture (DC)
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- REVISION WEEK**

the big picture

Business Books

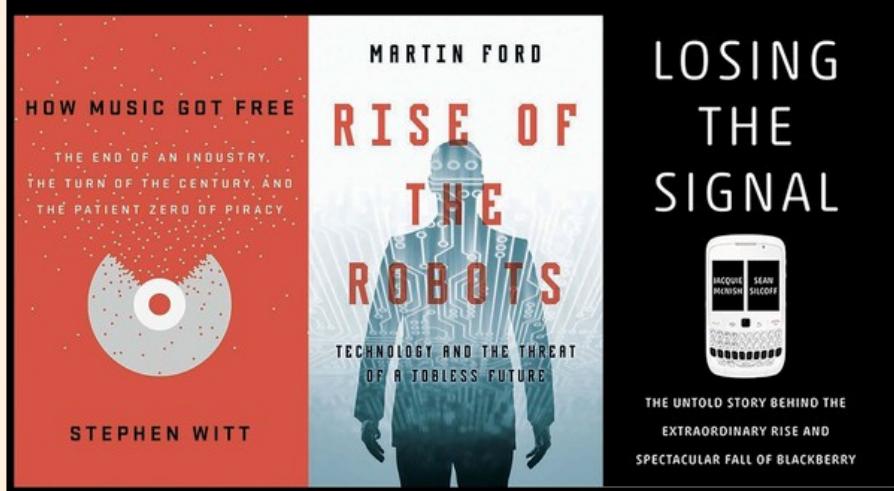
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FT & MCKINSEY BUSINESS BOOK OF THE YEAR AWARD September 22, 2015 2:02 pm

Tech titles dominate shortlist for FT business book of the year

Andrew Hill in London

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Three of the six finalists in the 2015 Financial Times and McKinsey Business Book of the Year Award

Four books on the causes and consequences of technological disruption have made it to the six-strong shortlist of this year's Financial Times and McKinsey Business Book of the Year Award.

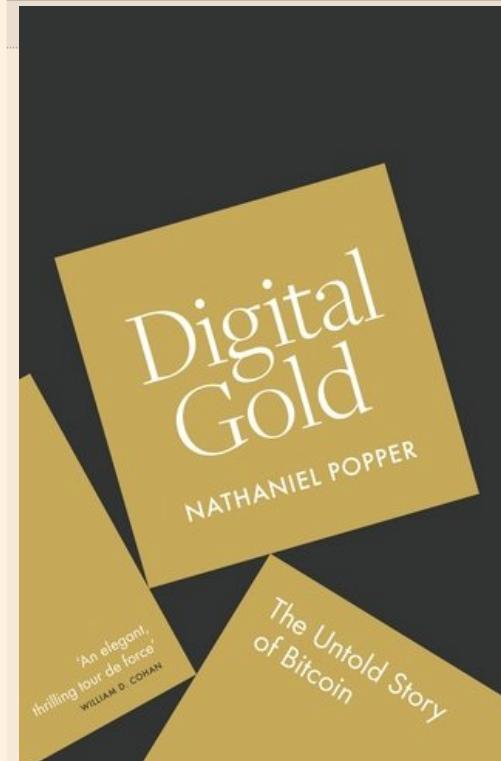


More

ON THIS STORY

The World FT & McKinsey

The six finalists for the £30,000 prize include: *The Rise of the Robots*, by Martin Ford, which analyses the future of employment and automation; *Losing the Signal*, by Jacque McNish and Sean Silcoff, who look at how BlackBerry went off course; *Digital Gold*, Nathaniel Popper's examination of the rise of bitcoin,



HIGHLIGHTS

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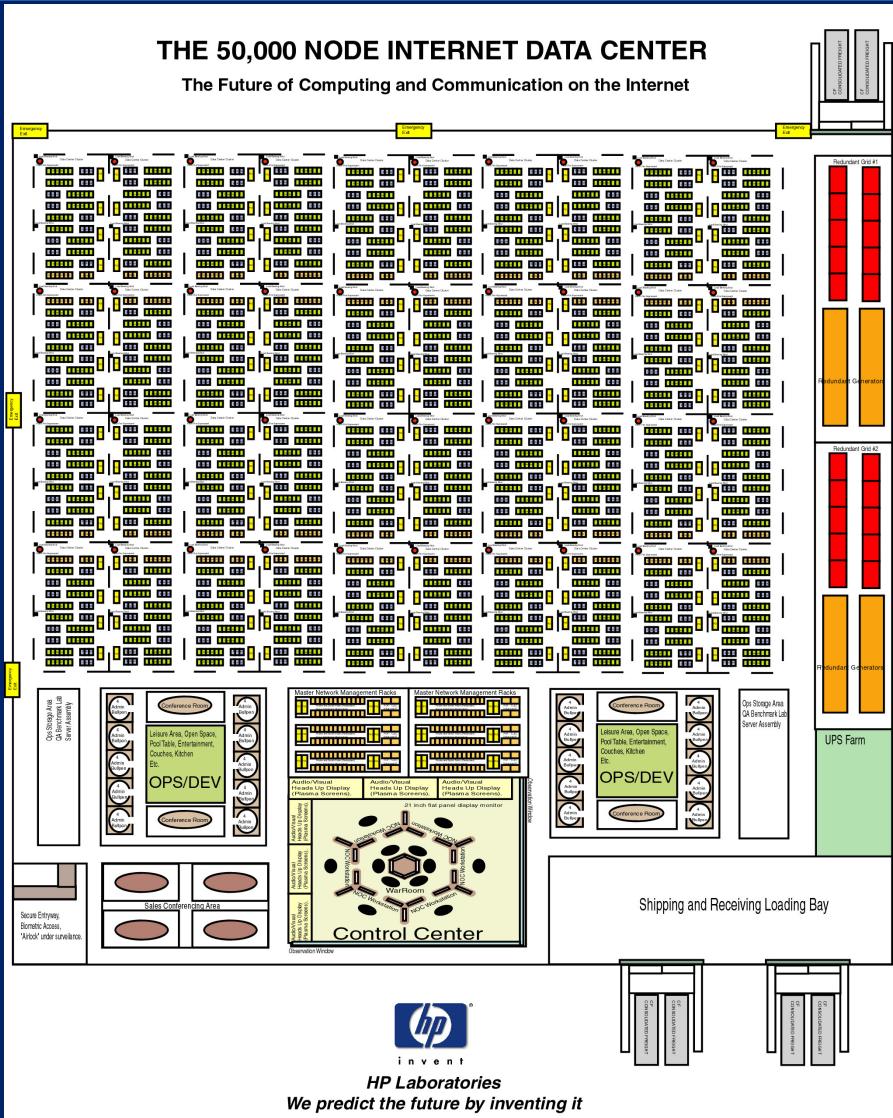
It's a once-a-decade kind of thing

- Mainframes
- Minicomputers
- Micros/PCs
- LAN/Distributed
- Internet/Web
- Utility/Service...



2008

Example: HP Utility Data Centre, c.2001...



50,000 blade-servers
in a very big shed
with a very big air-conditioning system
Utility Data Center (UDC)

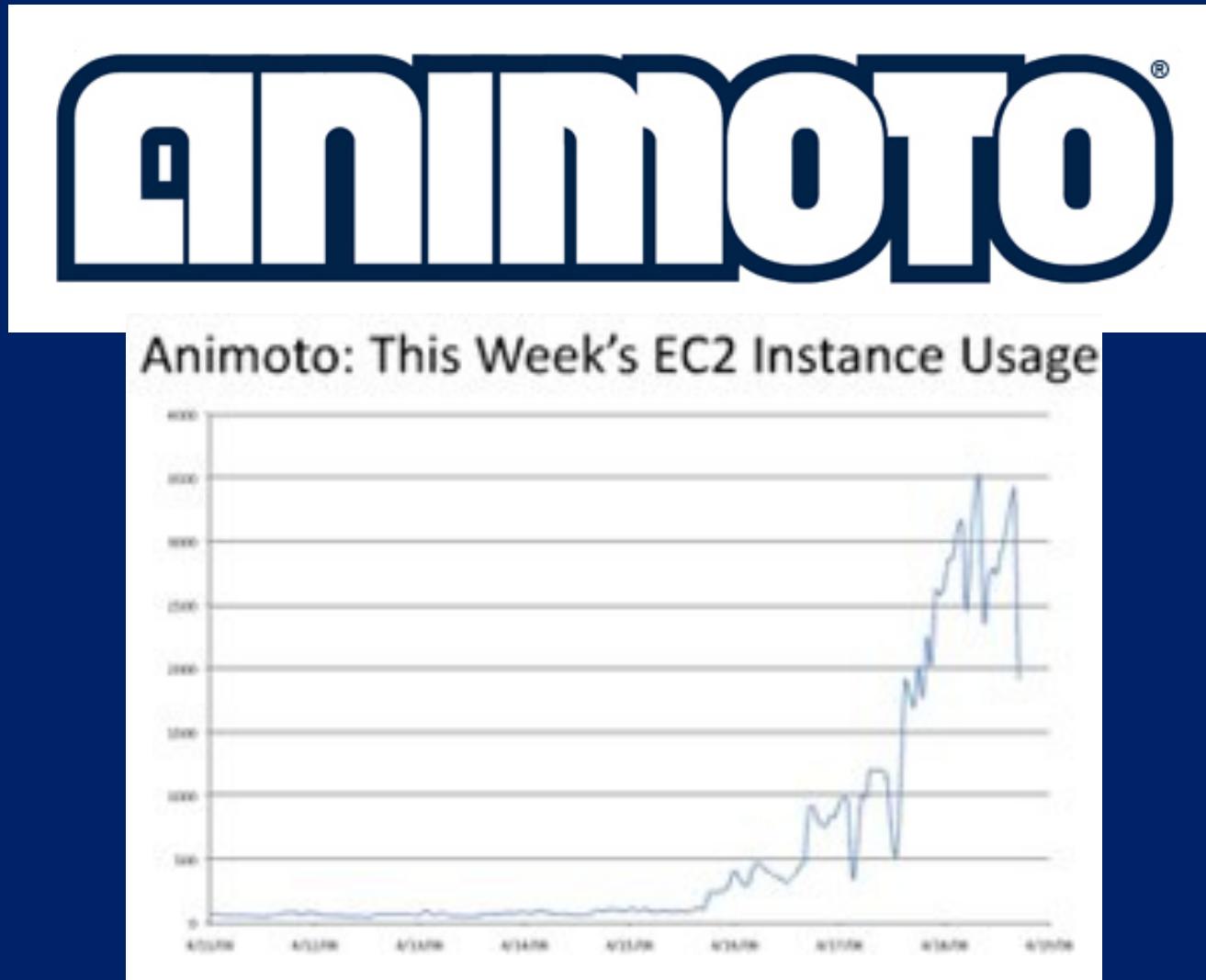
Just one shed in a global network...



Modular Data Centres In Big Steel Boxes



Don't try this at home: Animoto



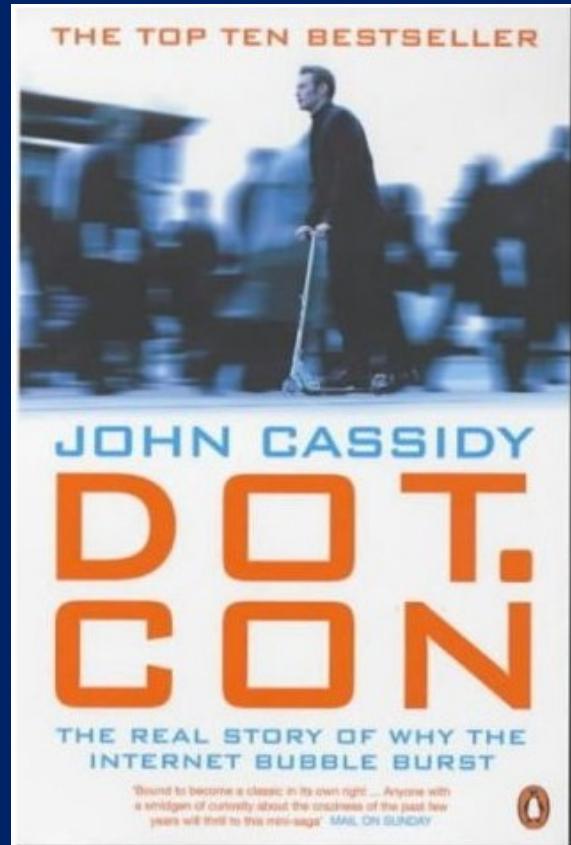
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Major bubbles form and burst less frequently...

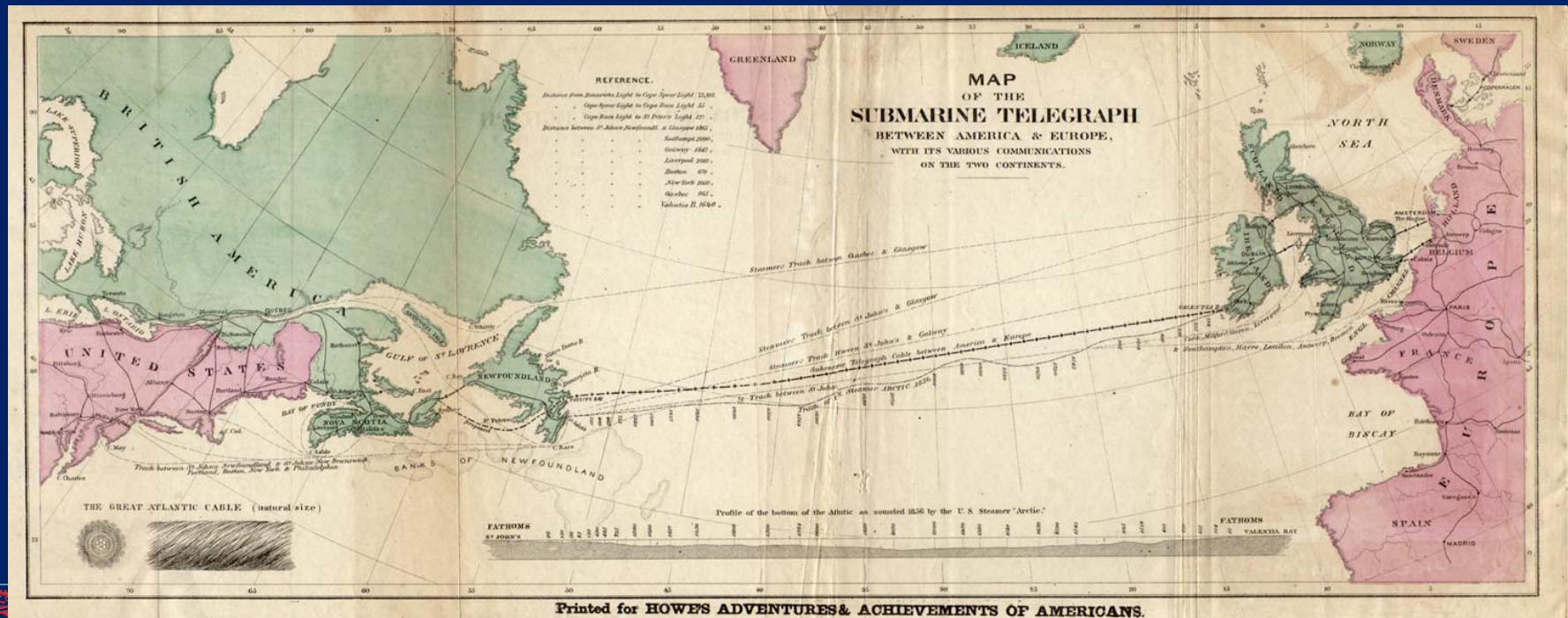
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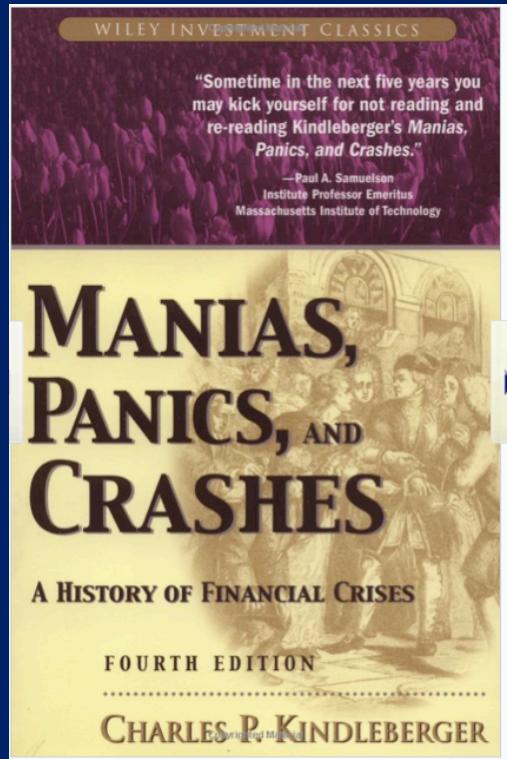
But there are precedents for the dotcom bubble...

The first global communications tech revolution

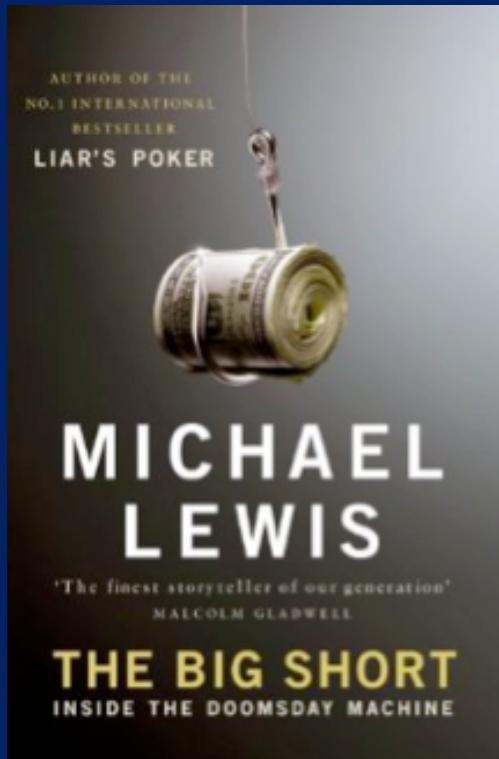
- For an entertaining version of the history of transoceanic telecomms cables (yes, really: that's what the internet is based on) see:
- N. Stephenson (1996) “Mother Earth Mother Board.” *Wired* 4.12
 - <http://www.wired.com/wired/archive/4.12/ffglass.html>



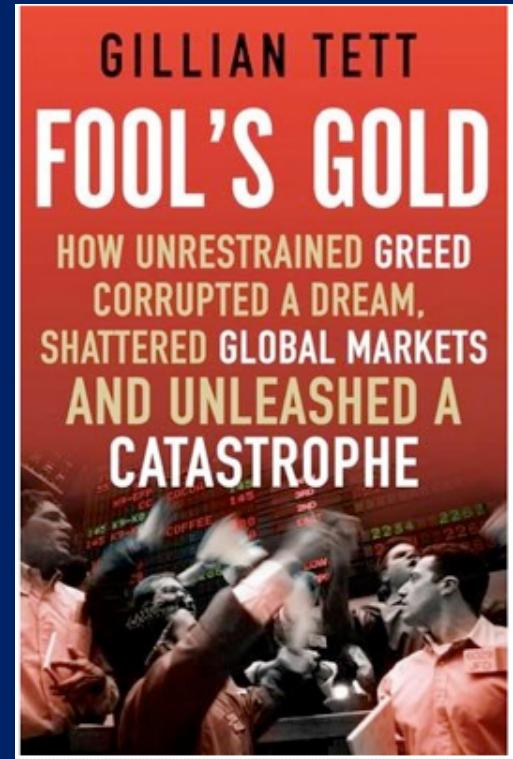
Another recent bubble-type phenomena



1978, 89, 96,
& 2000



2010



2009

New Scientist June 2nd, 2007

Where have all the traders gone?



Time is running out for Wall Street's high rollers. A new breed of traders is muscling in, says Robert Matthews

BRAD BAILEY was visiting the trading floor of an investment bank in New York City when he first noticed it. As a former Wall Street trader, he should have felt at home amid all the screens, phones and bustle of billions of dollars in trades. But that was just it: there wasn't any bustle. In fact, there were hardly any traders. "You could hear a pin drop," he recalls. Then it sank in: machines had taken over the role of people and computer servers don't make any noise.

There's a quiet revolution happening all over the financial world. Gone are the days of Gordon Gekko-likeokliabilities screening obscenities and dumping a loss-making stock onto an unsuspecting market. Investors have realised that the processing speed and sheer volume of trades a computer can make can help them to outwit the sharpest of dealers, they are investing heavily in what has fast become an arms race between investors. Their goal is to develop the best "algorithmic trading" systems - software that helps decide which trades are the most profitable, and the does the deals. Ten years ago, algo trading was almost non-existent, but according to a recent report by Baily, now the Boston-based consulting firm Alte Group, one-third of all trading decisions in US markets are now made by machines. He predicts that by 2010 more than half will be done this way. At Deutsche Bank in London, over 70 per cent of a category of foreign currency trades, called "spot trades", are now carried out without human intervention every day. All this will have an

As a result, investment houses are becoming increasingly tech-savvy. Eavesdrop on traders today and you are more likely to hear talk of "low latency access" (which we'll get to later) than of what they'd like to do to a rival's neck.

"Anyone who's been on Wall Street since the early 1990s will have had to retrain themselves," says Bailey. Back then, success as a trader hinged on an instinct for what the market was "thinking," plus reactions fast enough to make the most of the opportunities the market presented. In the early years of computerized trading, when machines were simply communication tools, hitting a key a few tenths of a second faster than a competitor could make a real difference to your profit margin. Nowadays human traders struggle to keep up. "Silicon is taking over from carbon on Wall Street," says Bailey, as hedge funds proliferate across trading floors. "Everyone who has a desk now has a laptop."

Computers have the edge over humans in many ways. Take something as simple as reading a chart. When a human trader sees a stock change by one-half a percent in just a few hundred milliseconds, a computerized trader is at least 10 times faster, depending on how much you are willing to fork out to speed things up. A few hundred milliseconds might seem insignificant, but if the price changes by a fraction of a per cent in the split-second before a trade worth many millions, it could mean a swing of tens of thousands of dollars. The key for any trader is "low latency" market access — that is, minimal delay between placing an order and seeing it fulfilled.

"70 per cent of foreign currency trades are carried out without human intervention"

impact on more than just high-rolling investors. Even if you don't own any shares you can bet that millions of those owned by your pension fund are already being bought and sold using "algo" trading techniques.

It's not hard to see why algorithmic trading

is so attractive. Machines can make multiple trades, monitor thousands of stocks and do all at breakneck speed. Crucially, they can do without anyone noticing. There are big profits to be made in buying and selling shares that other traders haven't yet realised are being lucratively traded. The more discreet you can do this by - spreading the deal over lots of small trades, for example - the less likely other traders are to wake up to the opportunity and dilute your profit potential. Such discretion is near impossible for a human, as it requires constant monitoring of the market to make sure your trades don't alter stock prices in an unfavourable direction.

To achieve this, traders naturally have ultra-fast software, running on top of the-line computers with the very best processes and memory capacity. But there is a more direct, and perhaps less obvious, way to speed things up: moving closer to the source. Trading companies pay top dollar to snuggle their servers as close as possible to those of the stock exchange. With access to such "proximity servers", their electrons can beat those of their rivals to the punch. Last year one of the biggest hitters in the algo-based trading world, Deutsche Börse, paid an undisclosed sum to proximity server supplier BT Radian to allow microseconds off its trading times.

Stealth-trading is another area in which machines have the upper hand. For example, many of the leading brokerage firms now have computers running so-called volume-weighted average price (VWAP) algorithms. These allow stock brokers to execute their trades more efficiently by spreading them out over time.

May 2010						
Mon	Tue	Wed	Thu	Fri	Sat	Sun
26	27	28	29	30	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	1	2	3	4	5	6







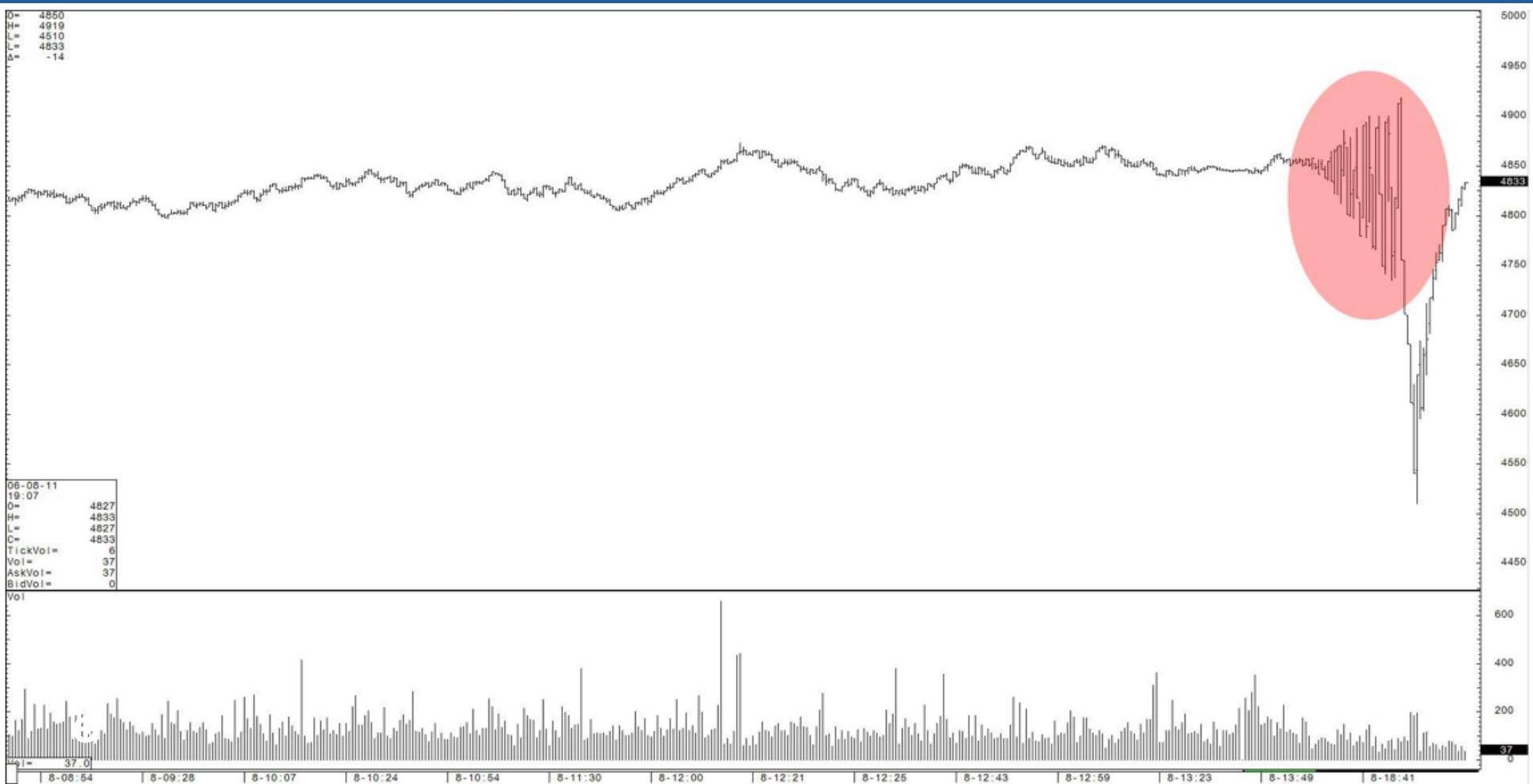




A calendar for June 2011 is displayed. The days of the week are labeled at the top: Mon, Tue, Wed, Thu, Fri, Sat, Sun. The dates are arranged in a grid. The date June 8 is highlighted with a red circle. The calendar shows the following dates:

June 2011						
Mon	Tue	Wed	Thu	Fri	Sat	Sun
30	31	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	1	2	3
4	5	6	7	8	9	10

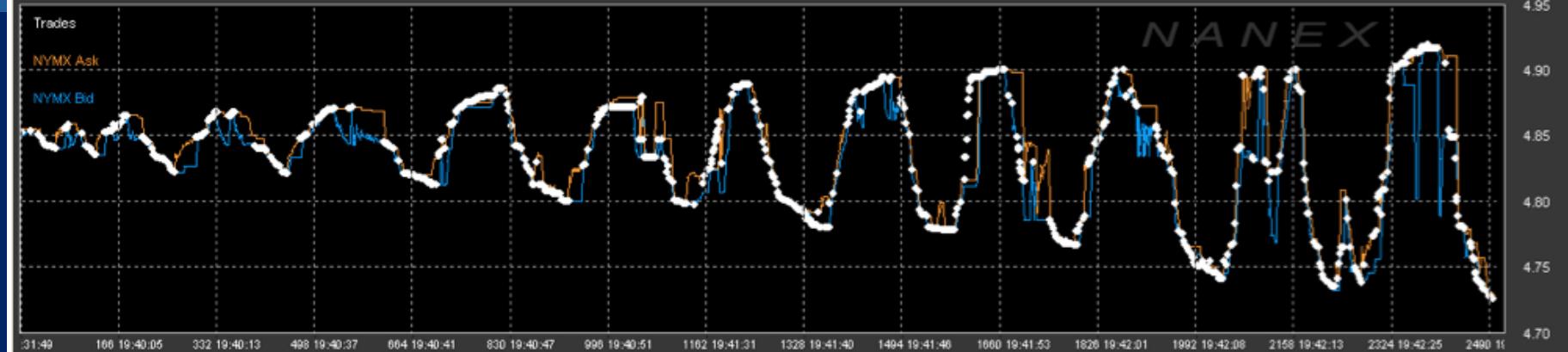




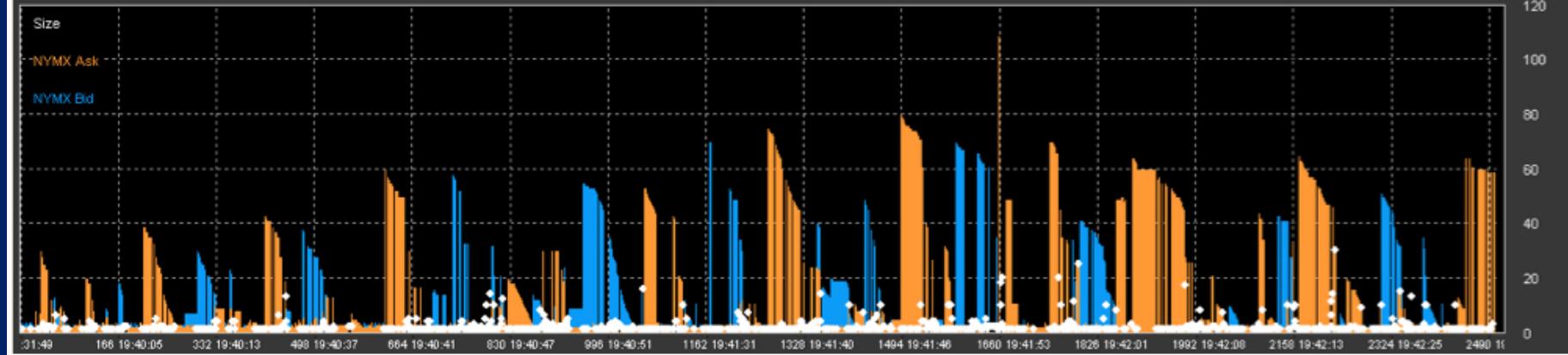
<http://www.zerohedge.com/article/presenting-natgas-fractal-algo>

Activity before the drop, prices and size:

Prices for tNG.N11 on 06/08/2011



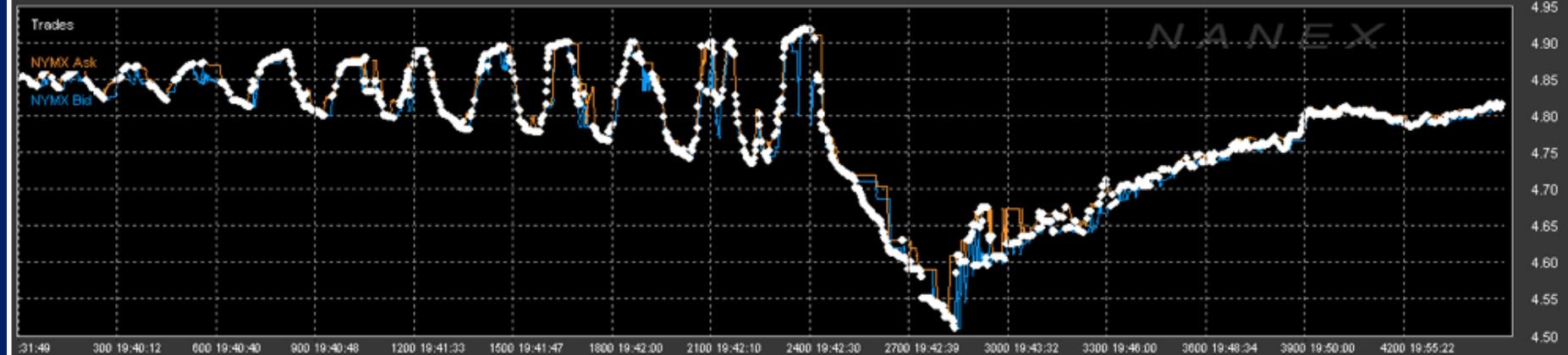
Sizes for tNG.N11 on 06/08/2011



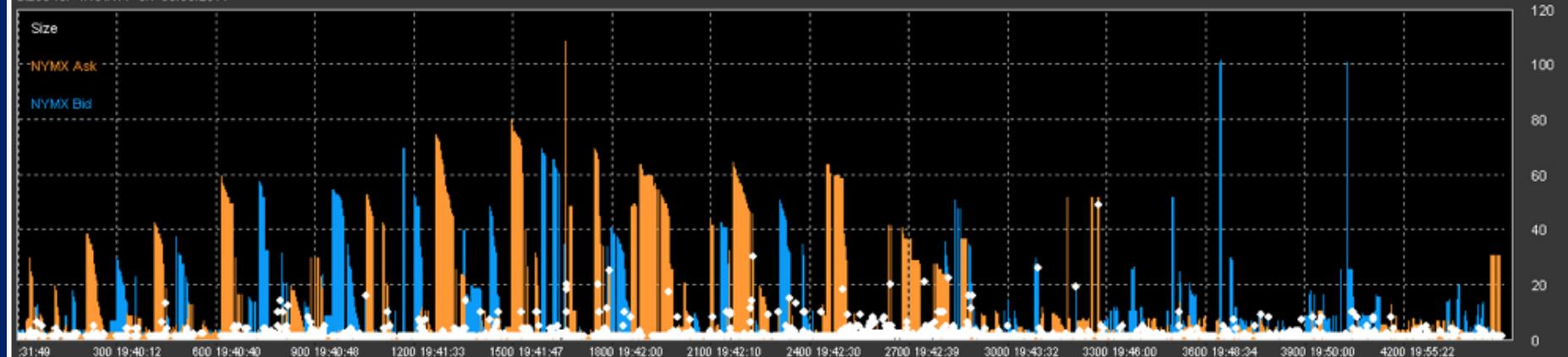
<http://www.nanex.net/StrangeDays/06082011.html>

Activity after the drop, prices and size:

Prices for fNG.N11 on 06/08/2011



Sizes for fNG.N11 on 06/08/2011



<http://www.nanex.net/StrangeDays/06082011.html>

Amazon's \$23,698,655.93 book about flies

http://www.michaeleisen.org/blog/?p=358

Most Visited - Egg for SocioTech Calendar Weather MultiMap Proactis DaveCliff National Rail Import to Mendeley BBC-Radio4

Amazon's \$23,698,655.93 book a... +

it is NOT junk

a blog about genomes, DNA, evolution, open science, baseball and other important things

Amazon's \$23,698,655.93 book about flies

By Michael Eisen | April 22, 2011

A few weeks ago a postdoc in my lab logged on to Amazon to buy the lab an extra copy of Peter Lawrence's *The Making of a Fly* – a classic work in developmental biology that we – and most other *Drosophila* developmental biologists – consult regularly. The book, published in 1992, is out of print. But Amazon listed 17 copies for sale: 15 used from \$35.54, and 2 new from \$1,730,045.91 (+\$3.99 shipping).



Price at a Glance	
List:	\$70.00
Price:	\$70.00
Used:	from \$35.54
New:	from \$1,730,045.91
Have one to sell? Sell yours here	

All New (2 from \$1,730,045.91) Used (15 from \$35.54)

Show New Prime offers only (0)

Sorted by [Price + Shipping](#)

New 1-2 of 2 offers

Price + Shipping	Condition	Seller Information	Buying Options
\$1,730,045.91	New	Seller: profnath Seller Rating: ★★★★☆ 93% positive over the past 12 months. (8,193 total ratings) In Stock. Ships from NJ, United States. Domestic shipping rates and return policy.	Add to Cart or Sign in to turn on 1-Click ordering.

[Subscribe](#)

Michael Eisen



I'm an evolutionary biologist at UC Berkeley and an Investigator of the Howard Hughes Medical Institute. My research focuses on the evolution and population genomics of gene regulation in flies, and on the ways that microbes control animal behavior. I am a strong proponent of open science, and a co-founder of the Public Library of Science. And most importantly, I am a Red Sox fan.

I can be reached at:
mbeisen at berkeley.edu

**Demand Public Access
To Scientific Knowledge**

a A



Any words
 All words
 Exact phrase

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You are here: [Home](#) > [Our work](#) > [Foresight projects](#) > [Current projects](#) > Future of Computer Trading in Financial Markets

The Future of Computer Trading in Financial Markets

[Our work](#)[Foresight projects](#)[Current projects](#)

▼ Future of Computer Trading in Financial Markets

▶ Lead Expert Group

▶ Computer Trading in Financial Markets - press notice

Advances in technology continue to transform how our financial markets operate. The volume of financial products traded through computer automated trading taking place at high speed and with little human involvement has increased dramatically in the past few years.

For example, today, over one third of United Kingdom equity trading volume is generated through high frequency automated computer trading while in the US this figure is closer to three-quarters.

Current projects

■ [Global Food and Farming Futures](#)

■ [International Dimensions of Climate Change](#)

■ [Global Environmental Migration](#)

■ [The Future of Computer Trading in Financial Markets](#)

Published projects

■ [Technology and Innovation Futures](#)

■ [Land Use Futures](#)

■ [Mental Capital and Wellbeing](#)

The screenshot shows a web browser displaying the Foresight website. The URL in the address bar is <http://www.bis.gov.uk/foresight/our-work/projects/current-projects>. The page title is "Working paper and driver reviews | Our work | BIS". The main content area features the Foresight logo and a search bar. A sidebar on the left lists various work areas, with "Future of Computer Trading in Financial Markets" highlighted. The main content discusses a working paper published to inform the Foresight project, reviewing evidence from the first year of the two-year project. It mentions 20 countries involved and three papers to be read together. A quote from Sir John Beddington is provided, emphasizing the need for better understanding of critical issues. The working paper itself is described as an expert, independent review of the emerging evidence base on computer trading. A large orange callout box points to the "Working paper" section, which links to a PDF file (874 Kb). Below this, there are sections for "Supporting evidence" with links to four documents (DR1, DR2, DR3, DR4) and a "Done" button at the bottom.

Working paper and driver reviews | Our work | BIS

http://www.bis.gov.uk/foresight/our-work/projects/current-projects

Most Visited ▾ Egg for SocioTech Calendar Weather MultiMap Proactis DaveCliff National Rail Import to Mendeley BBC-Radio4

Working paper and driver reviews... +

Foresight

Any words All words Exact phrase Search

Home About Foresight Our work Our impact Publications Media centre Contact us

You are here: Home > Our work > Foresight projects > Current projects > Future of Computer Trading in Financial Markets > Working paper and driver reviews

Working paper and driver reviews

This working paper was published to inform the Foresight project. It reviews evidence directly commissioned by Foresight as well as the wider evidence base from the first year of this two year project. Leading experts from 20 countries have been involved in writing and peer reviewing this material.

The working paper brings together three papers which should be read together to provide an overall picture of the impact of computer trading on financial stability and market quality, as well as how computer trading has evolved to date and how it might evolve from a technology angle.

Commenting on the papers, Sir John Beddington said:

"With financial markets evolving at a rapid pace, it is essential we develop a better understanding of the critical issues which affect the health of this sector and the wider economies it serves.

"I believe these papers will be valuable to policy makers and regulators wanting to maximise the opportunities from computer-based trading while managing the risks. This kind of evidence-based analysis is vital if a resilient regulatory framework is to be put in place."

The working paper provides an expert, independent review of the emerging evidence base on computer trading, rather than being Foresight's findings or conclusions on these issues. The findings do not represent the position of the UK or any other government.

Working paper

- [The future of computer trading in financial markets working paper \(PDF, 874 Kb\)](#)

Supporting evidence

- [DR1 What has happened to UK equity market quality in the last decade \(PDF, 1.4 Mb\)](#)
- [DR2 Feedback effects and changes in the diversity of trading strategies \(PDF, 3.6 Mb\)](#)
- [DR3 Technology trends in the financial markets \(PDF, 897 Kb\)](#)
- [DR4 The global financial markets \(PDF, 475 Kb\)](#)

Done

COMSM0019 Lecture 1 — Copyright © 2019 Dave Cliff

Working Paper

<https://www.gov.uk/government/collections/future-of-computer-trading>

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Working paper

16 review documents

Working paper and driver reviews

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<https://www.gov.uk/government/publications/computer-trading-technology-trends>

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/289029/11-1222-dr3-technology-trends-in-financial-markets.pdf

Foresight Driver Review DR3

Technology Trends in the Financial Markets: A 2020 Vision

Prof Dave Cliff, UK LSCITS Initiative, Computer Science, University of Bristol.

Dr Dan Brown, Computer Science, University College London.

Prof Philip Treleaven, Computer Science, University College London.

Summary

The global financial markets have been proactive early-adopters of new technologies for most of their history. In the past quarter of a century, since the instigation of the “big bang” switch to paperless electronic trading, the City of London has led the world in the adoption of new information and communications technology (ICT) for the provision of electronic trading facilities, and the associated distribution of data and news feeds. This hunger for new technologies looks unlikely to be diminished in future.

As well as many opportunities, ICT development has additionally brought risks (some of which are non obvious and even counter intuitive) for which there is an immediate requirement for careful and thorough evaluation.

New technologies may come in the form of new hardware, new software (including algorithms), or (most likely) combinations of the two. As new technologies become available and more widely adopted, they may significantly alter what market actions and activities are possible, and in the longer term they may significantly alter the socio-economics of the financial markets, and hence also the necessary regulatory and political frameworks that financial institutions operate in.

<https://www.gov.uk/government/publications/computer-trading-global-financial-markets>

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/289012/11-1223-dr4-global-financial-markets-systems-perspective.pdf

The Global Financial Markets: an Ultra-Large-Scale Systems Perspective

Dave Cliff

Director, UK Large-Scale Complex IT Systems Research & Training Initiative

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Linda Northrop

Director, Research, Technology, and System Solutions Program

Software Engineering Institute, Carnegie-Mellon University, Pittsburgh PA 15213, USA.

+1 412 268 7638; lmn@sei.cmu.edu

Abstract

We argue here that, in recent years, the global financial markets have become a complex adaptive ultra-large-scale socio-technical system-of-systems, and that this has important consequences for how market systems should be engineered and managed in future. The very high degree of interconnectedness in the global markets means that entire trading systems, implemented and managed separately by independent organizations, can rightfully be considered as significant constituent entities in the larger global super-system: that is, the global markets are an instance of what is known in the engineering literature as a *system-of-systems* (SoS). The sheer number of human agents and computer systems connected within the global financial-markets SoS is so large that it is an instance of an *ultra-large-scale system*; and that largeness-of-scale has significant effects on the



BANK OF ENGLAND

Speech

The race to zero

Speech given by

Andrew G Haldane, Executive Director, Financial Stability and member of the interim
Financial Policy Committee

International Economic Association Sixteenth World Congress, Beijing, China

8 July 2011

Foresight FCTFM Project Video

https://www.youtube.com/watch?time_continue=188&v=aJg10eiNQXw

A screenshot of a YouTube video player. The video thumbnail shows a glowing blue Earth with a network of lines representing global connectivity against a dark background with floating numbers. The title of the video is "The Future of Computer Trading in Financial Markets: An International Perspective". Below the title, it says "FINAL PROJECT REPORT". The video player interface includes a play button, volume control, timestamp (0:00 / 3:10), closed captioning (CC), settings, share, save, and more options buttons. The video has 1,062 views and was published on Dec 14, 2012. The channel is GO-Science, Government Office for Science. A red "SUBSCRIBE 1.7K" button is visible in the bottom right corner.

The Really Really Big Picture

Carlota Perez (2002)

Last 250 years of technology “surges”

Do the first 4 surges have clues for the 5th?

Installation>[Crash]>Deployment

- S1: Industrial Revolution 1770-1829 (59yr)
- S2: Steam & Railways 1829-1873 (44yr)
- S3: Steel, Electricity 1875-1918 (43yr)
- S4: Oil, Car, Mass Production 1908-1974 (66yr)
- S5: IT & Telecoms 1971-20?? (nb: 1971+53=2024)

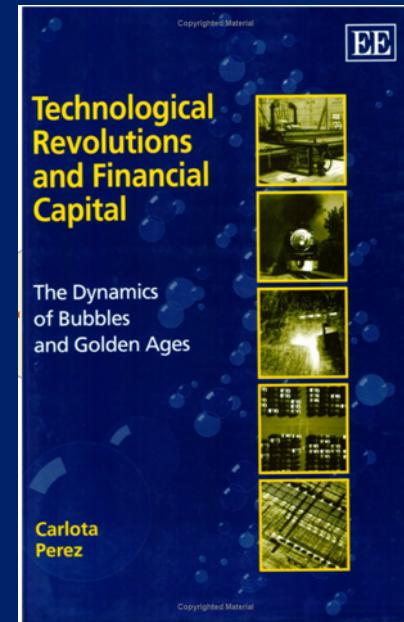


Figure 1. The social assimilation of technological revolutions breaks each great surge of development in half

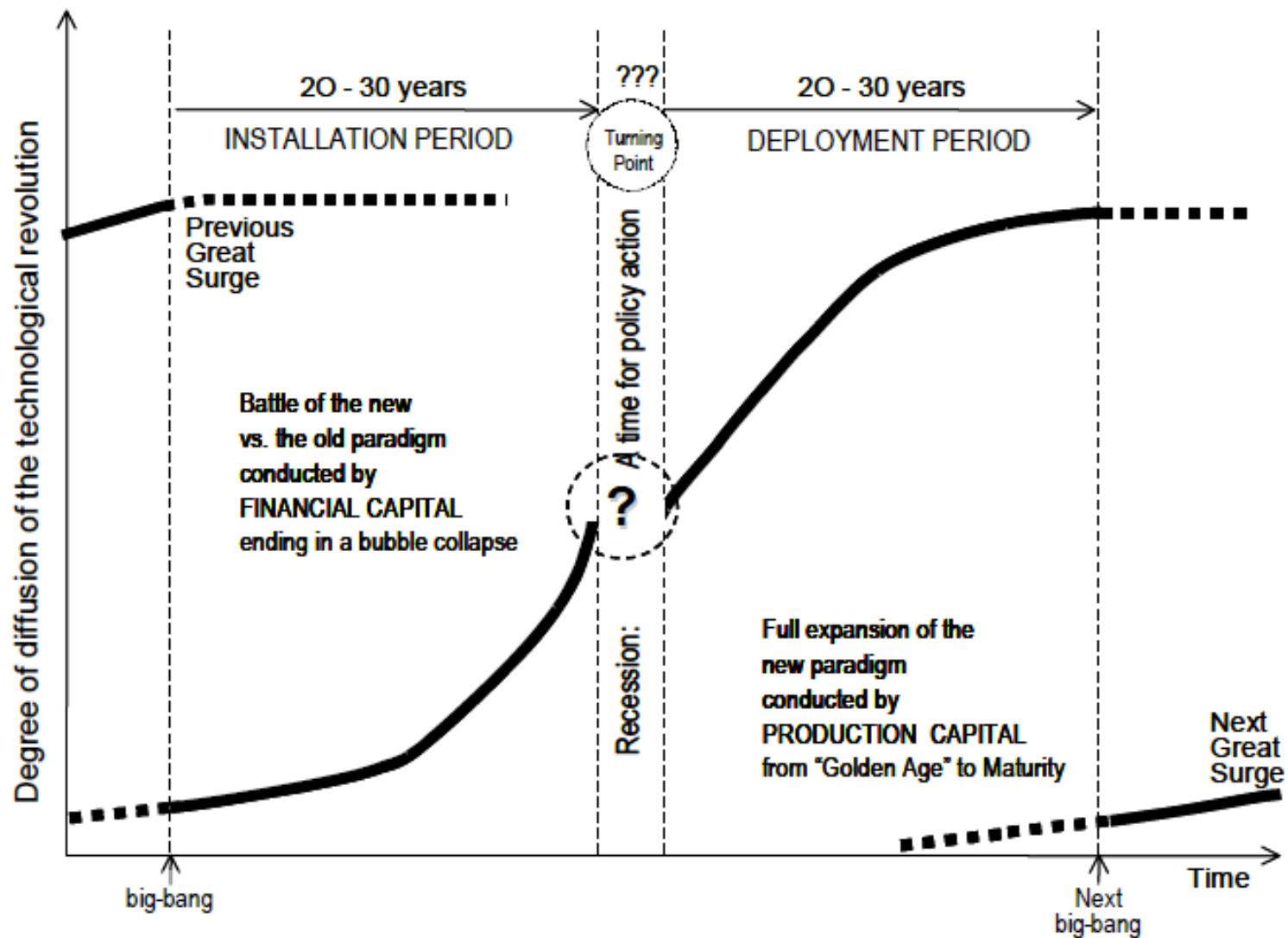
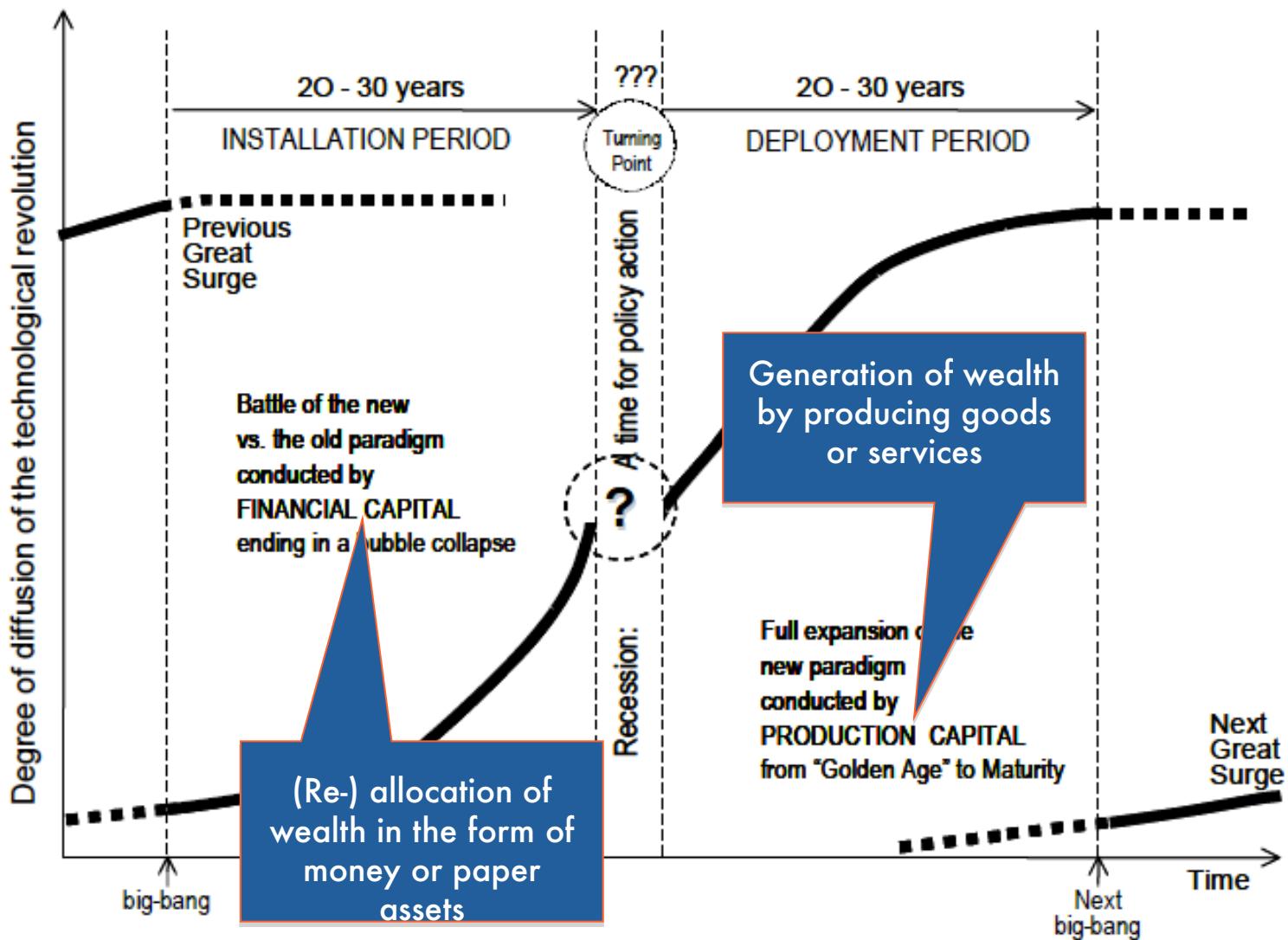


Figure 1.

The social assimilation of technological revolutions breaks each great surge of development in half



Don't read that, but do read these!

- C. Perez (2007) *Respecialisation and the Deployment of the ICT Paradigm: An essay on the present challenges of globalisation*. IPTS FISTERA Project Paper
- <http://www.carlotaperez.org/pubs?s=tf&l=en&a=wprespecialisationandthedeployment>
 - this is more recent than her book, and shorter, too
- Note: Anything written before the 2007/08 global financial crisis might be looking quite dated now – but Perez has written on that topic too, see:
- 2010: “The financial crisis and the future of innovation: a view of technical change with the aid of history” in Van Tilburg et al. (eds) *Let Finance follow and Flow: Essays on finance and innovation*. The Hague: AWT. <http://www.carlotaperez.org/pubs?s=tf&l=en&a=thefinancialcrisisandfutureofinnovation>
- 2013: “Unleashing a golden age after the financial collapse: drawing lessons from history” *Environmental Innovations and Societal Transitions* 6:9-23.
<http://www.carlotaperez.org/pubs?s=tf&l=en&a=unleashingagoldenageafterthefinancialcollapse>

We're not in Kansas anymore, Toto

- Chances are, the language and concepts of various things we ask/expect you to read on this unit are way outside your comfort zone

(That's the plan, at least)

- A lot of this unit could be taught on masters-degree in economics/finance/management – e.g. MBA
- You'll need to look stuff up and follow references (Google Scholar)

Assessment

2007-2014: 50% exam, 50% coursework

2015-now: 100% exam

Mock exams as feedback assessments.

Illustrative Exam Question: January 2014

Question 1

1(a): Carlotta Perez argues that there have been five major technology surges since industrialization started. Give the name of each technology surge, and its start and end dates (to within 20 years of the dates given by Perez, as cited in the lecture slides).

[10 marks]

1(b): Perez argues that each great technology surge occurs in two phases, punctuated by a significant turning point. Describe these two phases and the nature of the turning point.

[5 marks]

1(c): If Perez is correct, then the current technology surge is in its final phase, and will draw to a close in coming years. Do you agree with that? Give evidence to support your argument, whether you agree or disagree.

[3 marks]

1(d): If Perez's argument is correct, then we can expect that the next great technology surge will be starting soon: what technology or technologies do you think are most likely to be involved in that surge, if it was to happen?

[2 marks]

The bottom line

Understanding the wider historical, social, and economic contexts of technology developments allows us to better understand the current situation, and possible/likely futures.

Perez is a leading thinker on these topics, widely held in high regard.

There have been exam questions on these big-picture issues

- Next: Who wants to be a Billionaire? (DC)