SAND2012-6413C

Creative New Uses for Prediction Markets

Mark Boslough

Complex Adaptive Systems S&T Workshop

National Reconnaissance Office

August 2, 2012

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2012-6413C

Potential applications and uses

1. Intelligence information aggregation
2. Settling scientific controversies
3. Quantification of scientific consensus
4. Counterintelligence
5. Notification of new information
6. “Connecting the dots”
7. Objective evaluation of information quality
8. Decision support
9. Funding allocation

“Wisdom of Crowds”

Four qualities that make a crowd smart

1. Diversity (people have different pieces of information)
2. Decentralization (nobody at top is dictating answer)
3. Independence (people focus on own area of expertise)
4. Method* to generate collective opinion (aggregation)

Aggregation method needs to preserve other 3 qualities!

*Double-auction markets are effective at aggregating distributed and dynamic information into a quantitative collective hypothesis evaluation.

Conceptual mapping

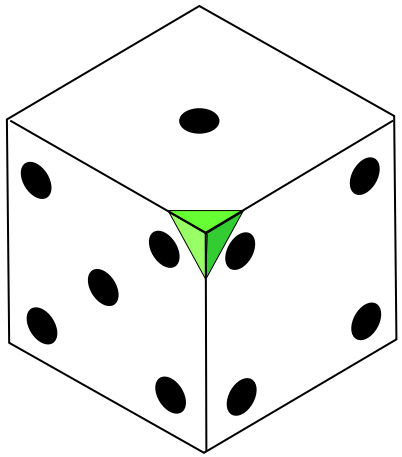
Contract = “Hypothesis”

Price = “Probability”

Example 1: Intelligence information aggregation

Possibility sets can be aggregated

State space Ω



True state = ω_{154}

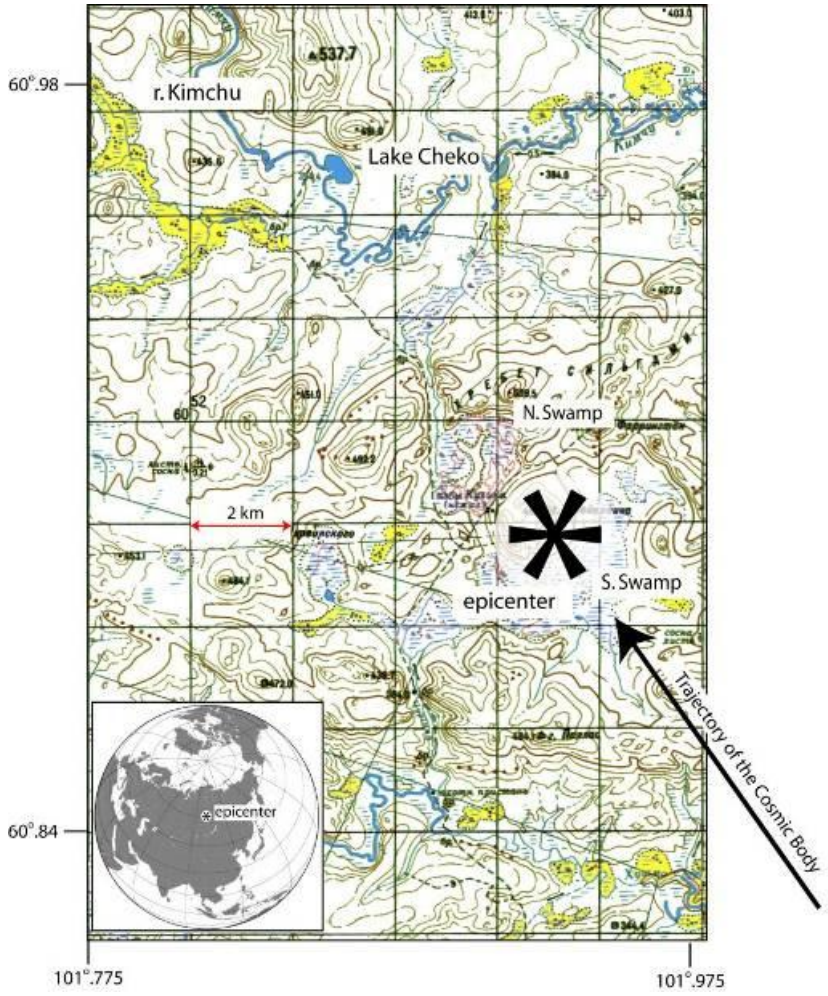
$P_A = \{\omega_{154}, \omega_{564}, \omega_{624}, \omega_{214}\}$

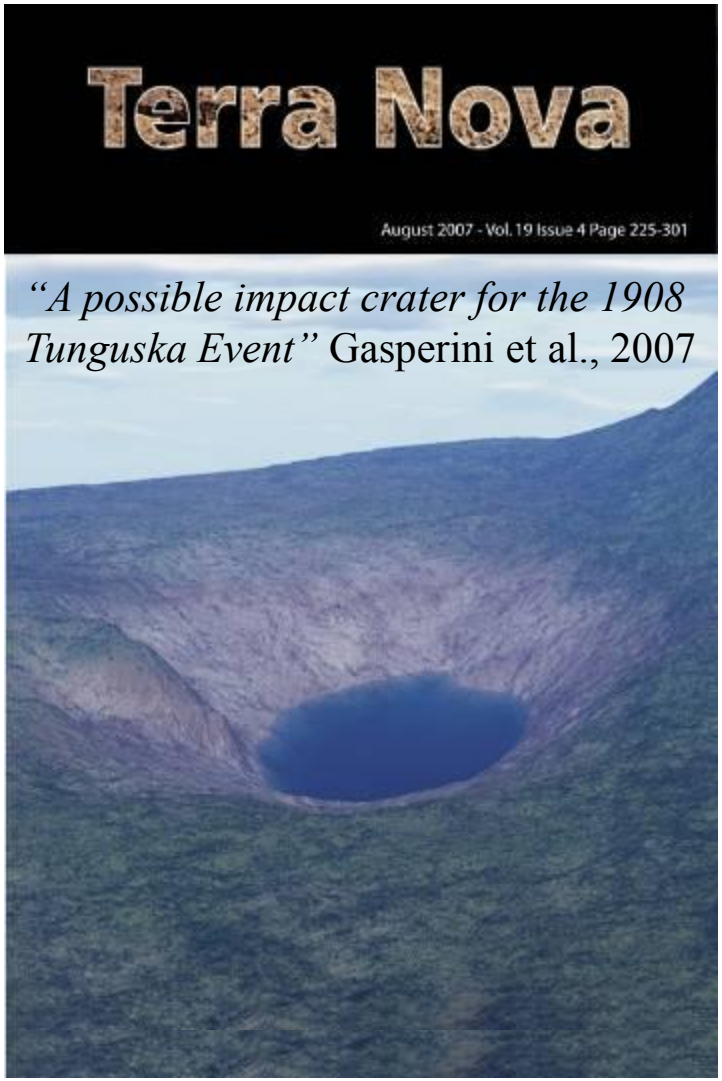
$P_B = \{\omega_{142}, \omega_{154}\}$

$P_C = \{\omega_{415}, \omega_{154}, \omega_{541}\}$

$P_{Aggregate} = \{\omega_{154}\}$

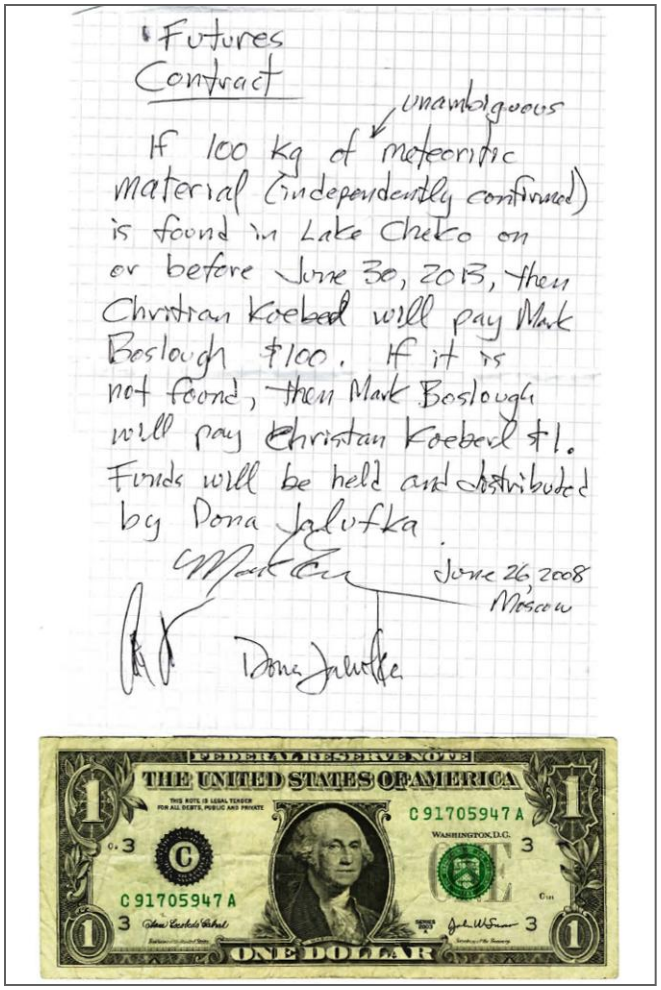
Example 2: Settling Scientific Controversies





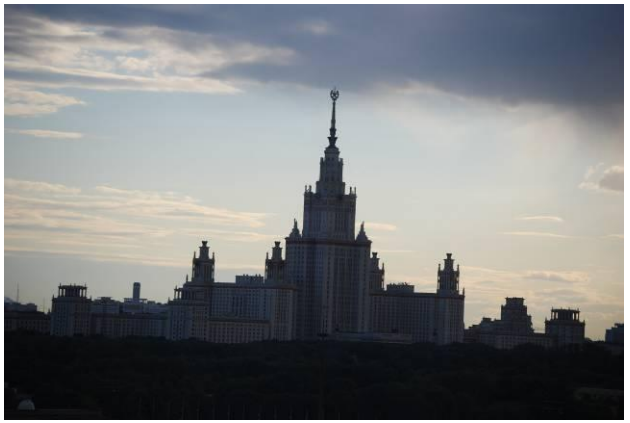
"A possible impact crater for the 1908 Tunguska Event" Gasperini et al., 2007

What is a futures contract?



Futures contract

If 100 kg of unambiguous meteoritic Material (independently confirmed) is found in Lake Cheko on or before June 30, 2013, then Christian Koeberl will pay Mark Boslough $100. If it is not found, then Mark Boslough will pay Christian Koeberl $1. Funds will be held and distributed by Dona Jalufka.



Lake Cheko photography: Discovery Channel

Impact crater or just a lake?

First post-expedition conference: Vanavara

First look: Submersible camera videos!

Another futures contract

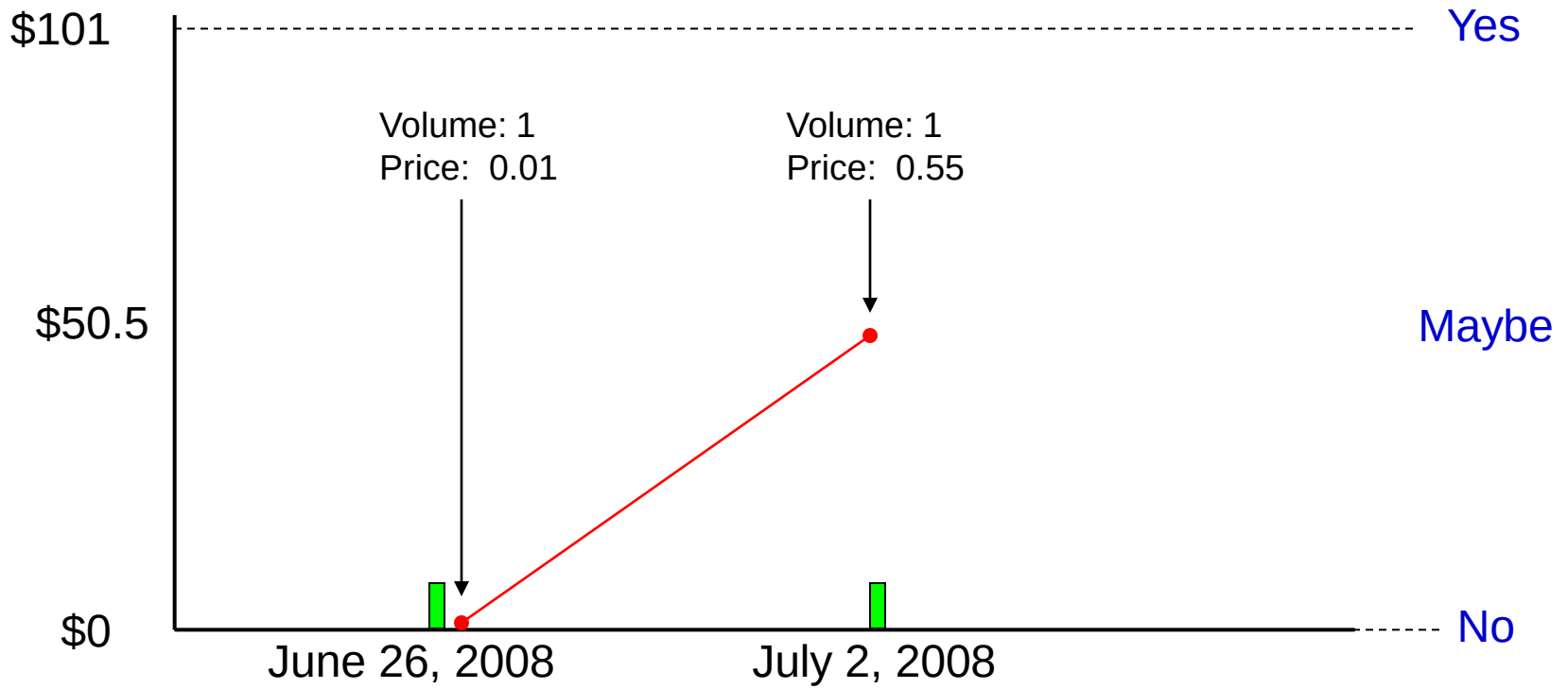
Futures contract

If 100 kg of unambiguous meteoritic Material (independently confirmed) is found in Lake Cheko on or before June 30, 2013, then Mark Boslough will pay Luca Gasperini $50.50. If it is not found, then Luca Gasperini will pay Mark Boslough $50.50. Funds will be held and distributed by Karl Kletetschka.

(Same hypothesis, different odds)

Money can be made (or lost) before maturity

MB bought $101 contract for $1.00.
Sold $101 contract for $50.50.
MB put up $51.50
Locked in $101.
Net profit: $49.50.



Price can be plotted as ticker, but individual wagers are not necessarily correlated

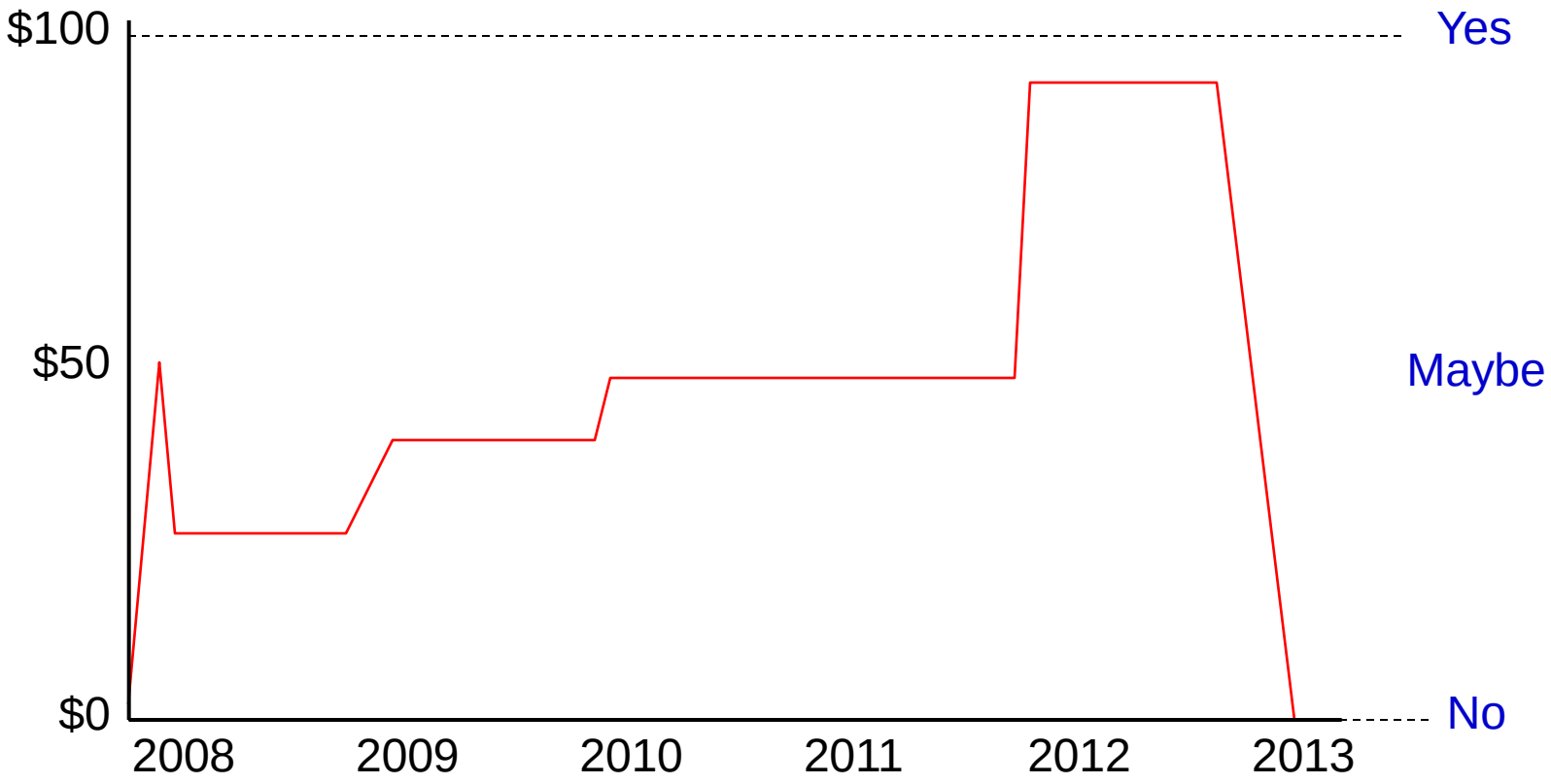
What is a futures market?

Futures contract

If 100 kg of unambiguous meteoritic Material (independently confirmed) is found in Lake Cheko on or before June 30, 2013, then the holder of this contract collects $101. If it is not found, then the contract is void. Funds will be held and distributed by the World Scientific Hypothesis Exchange.

Generalized contract allows exchange trading

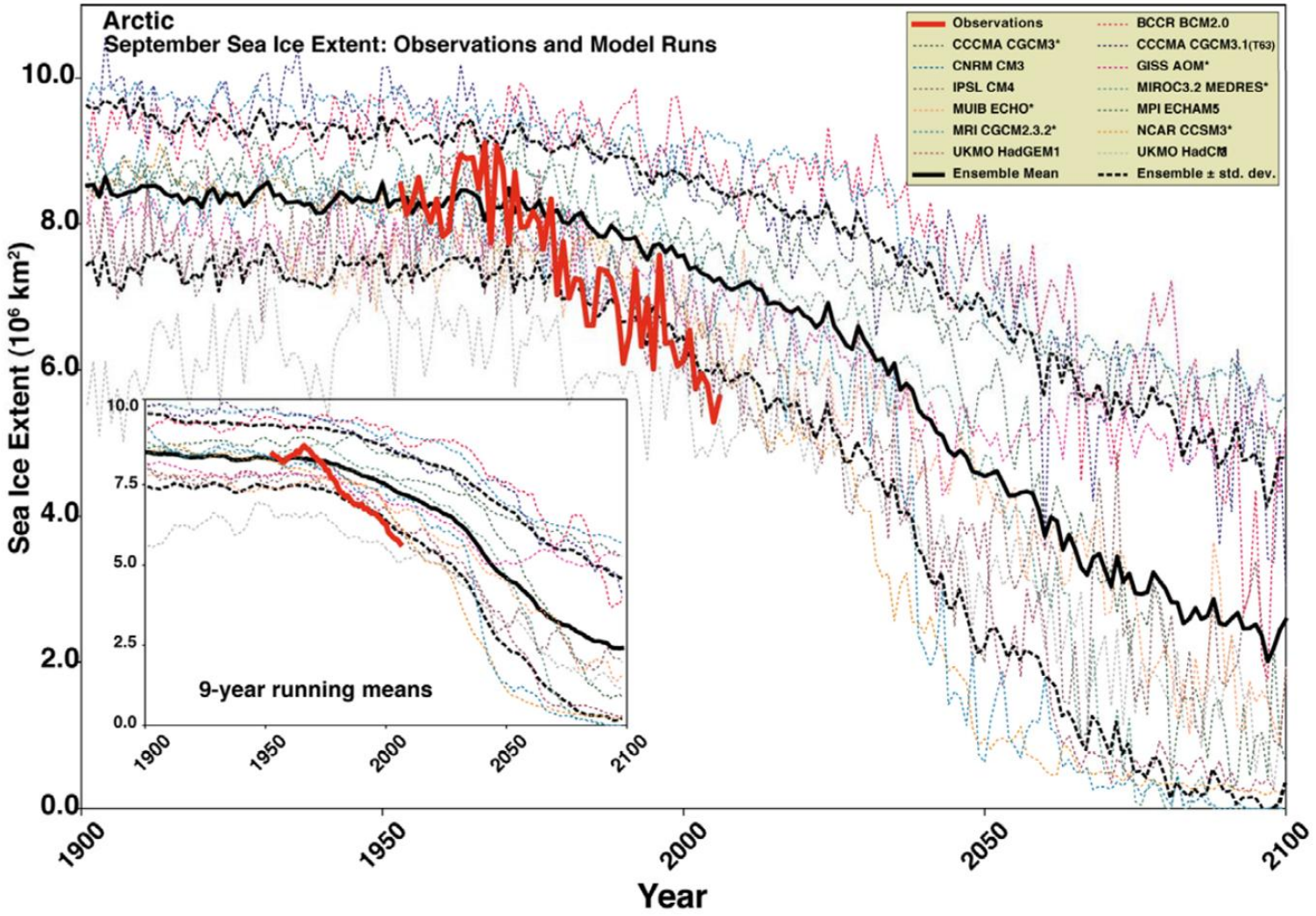
Is Lake Cheko an impact crater?



Price is the consensus probability of hypothesis being correct

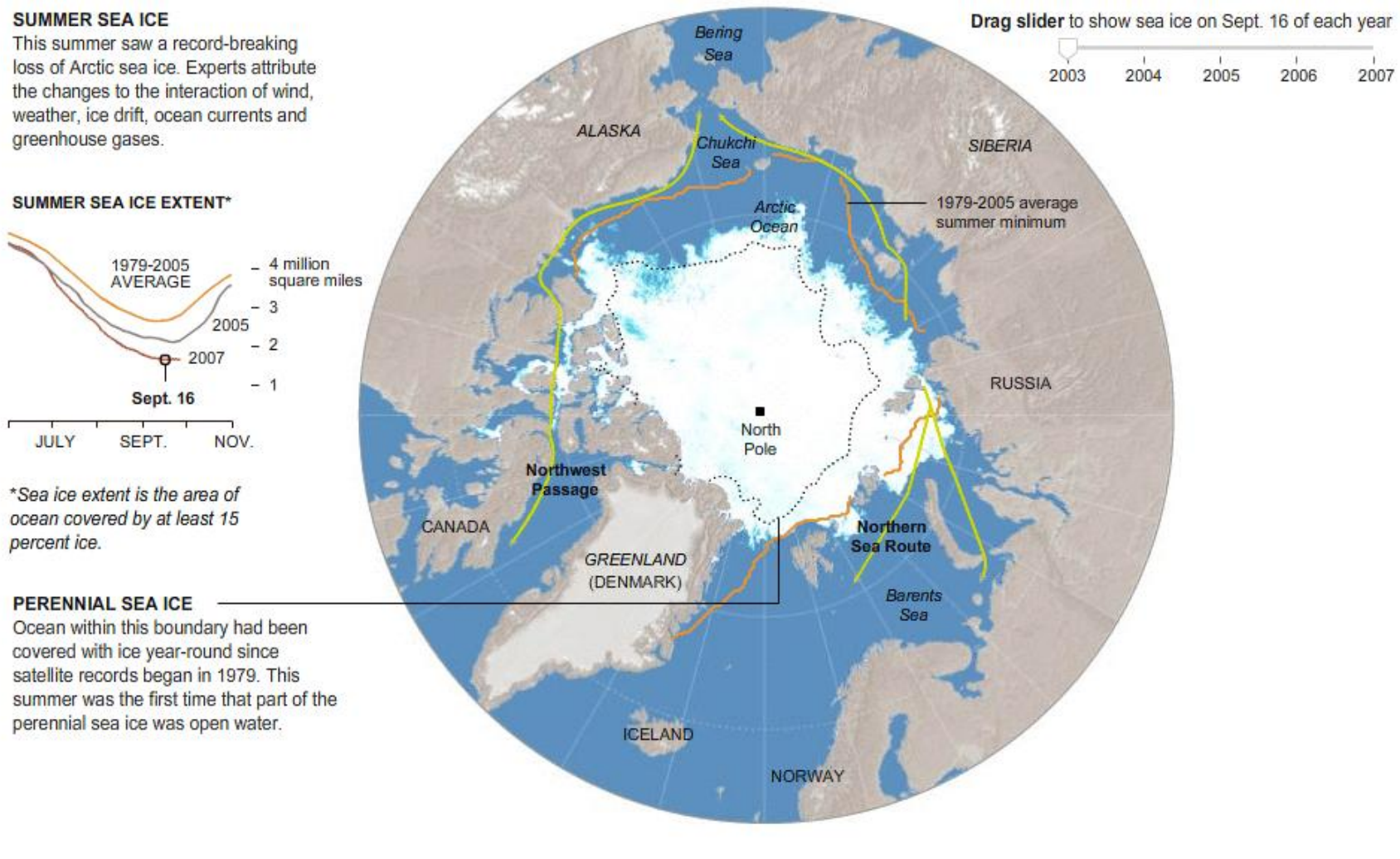
Example 3: Quantification of scientific consensus

Stroeve et al. (2007) Arctic Sea Ice Decline: Faster than Forecast, GRL

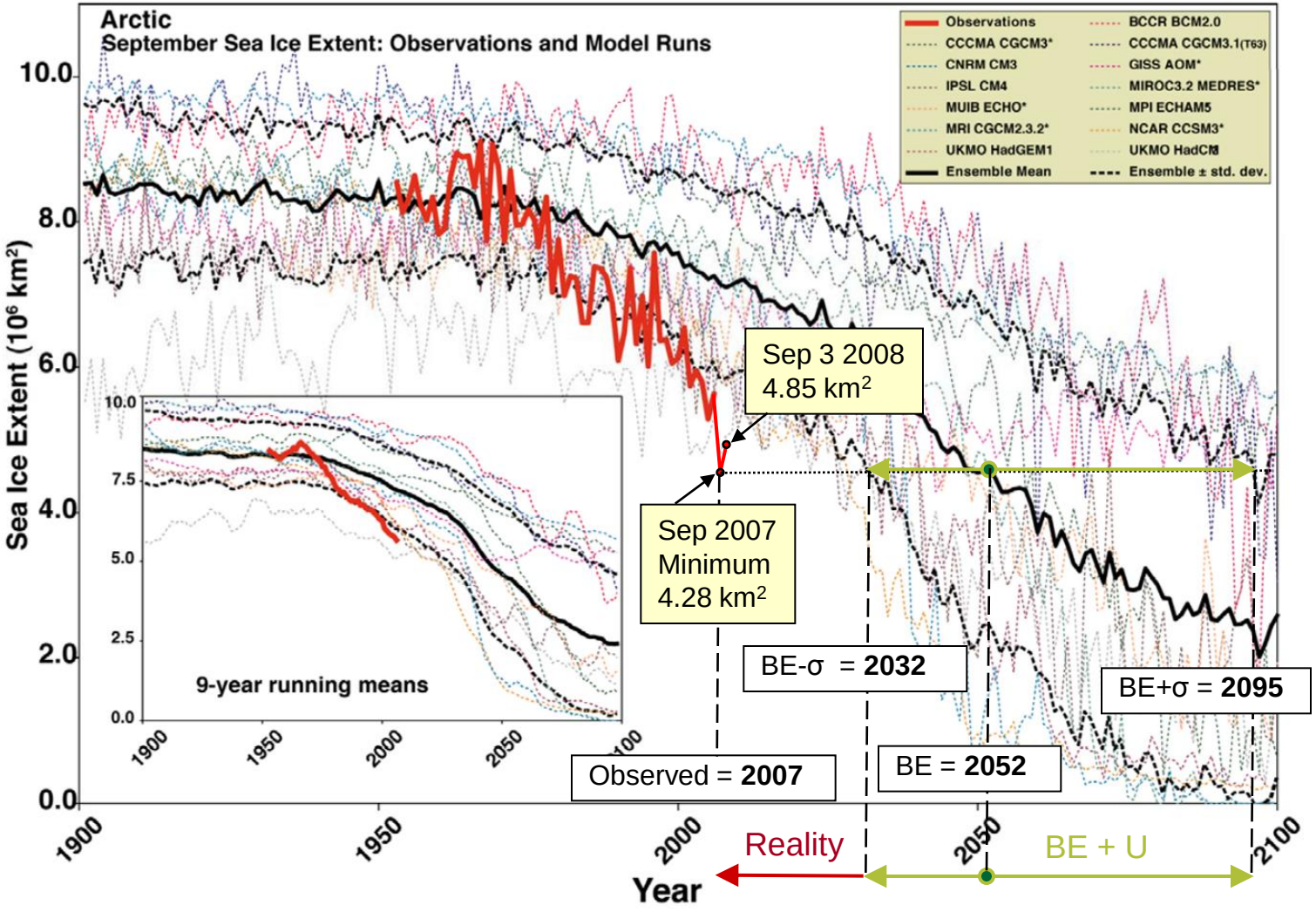


Recent History of Arctic Sea Ice

Hypothesis: Arctic will be ice-free by 2013

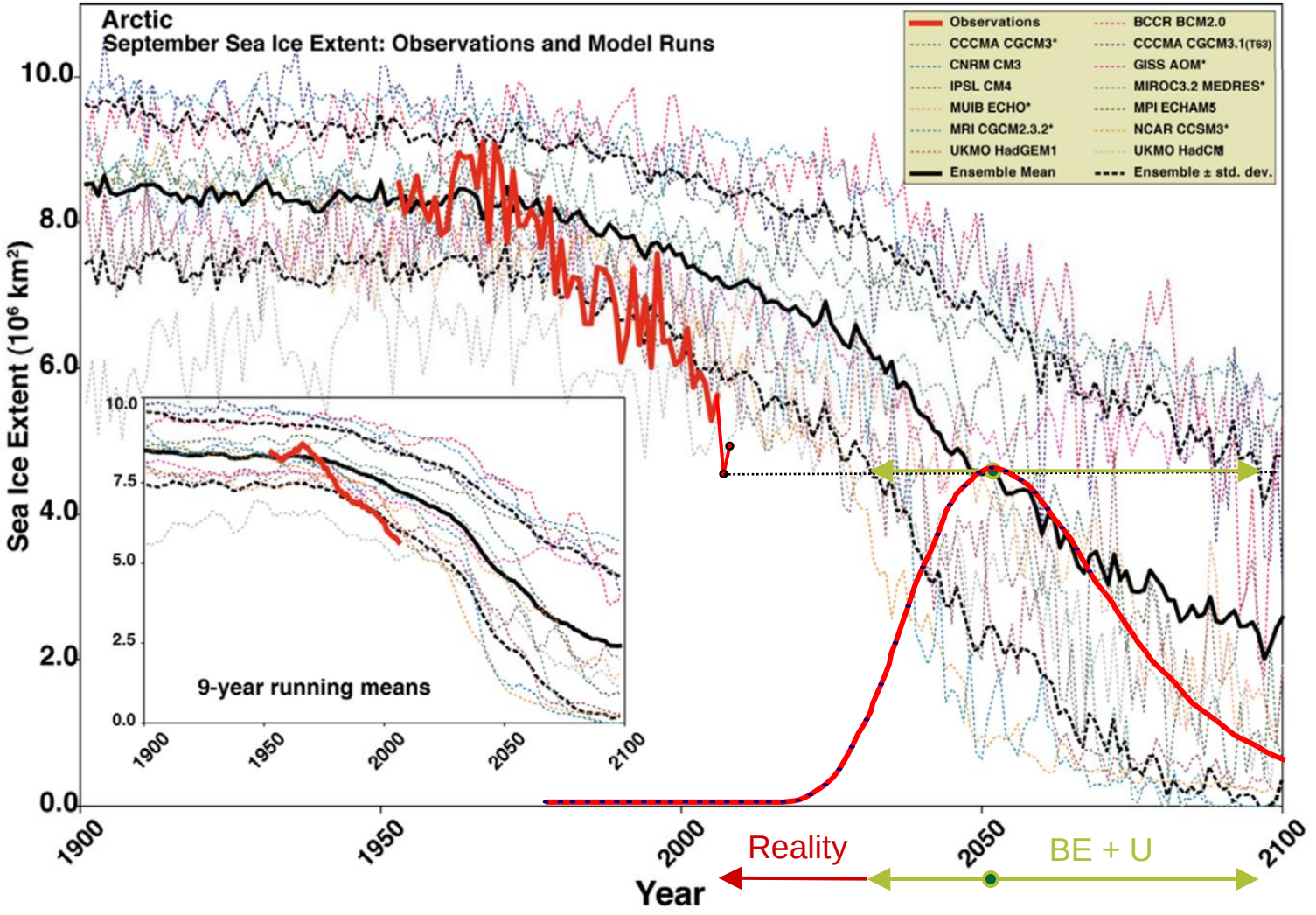


Example 3: Quantification of scientific consensus



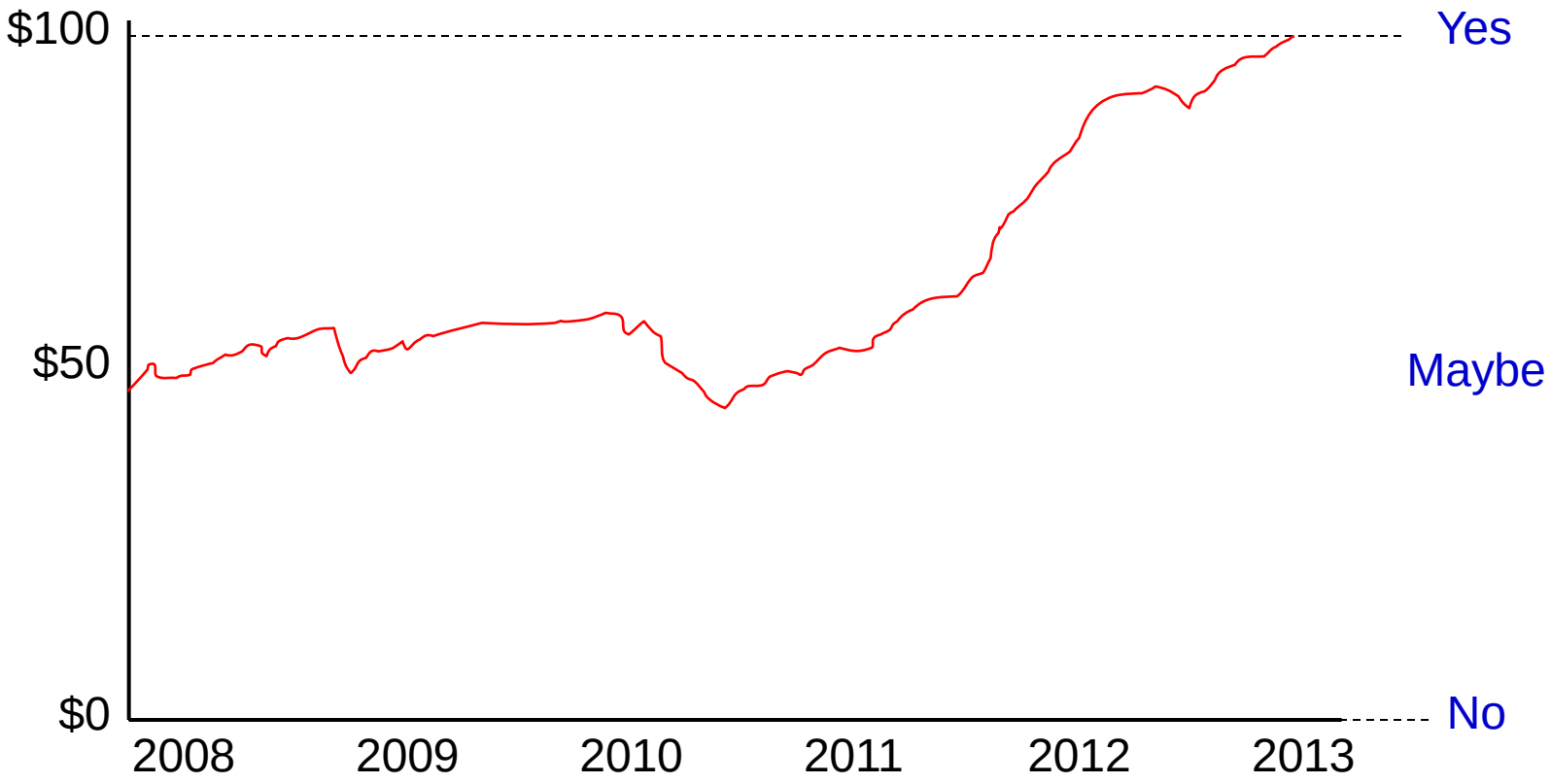
Contracts can be used to determine best estimates and uncertainties

Example 3: Quantification of scientific consensus



Contracts can be used to build probability distribution functions

Will Arctic be ice free in September 2013?



Price is the consensus probability of hypothesis being correct…
…but now the market has liquidity because of hedging investments!

Example 4: Counterintelligence

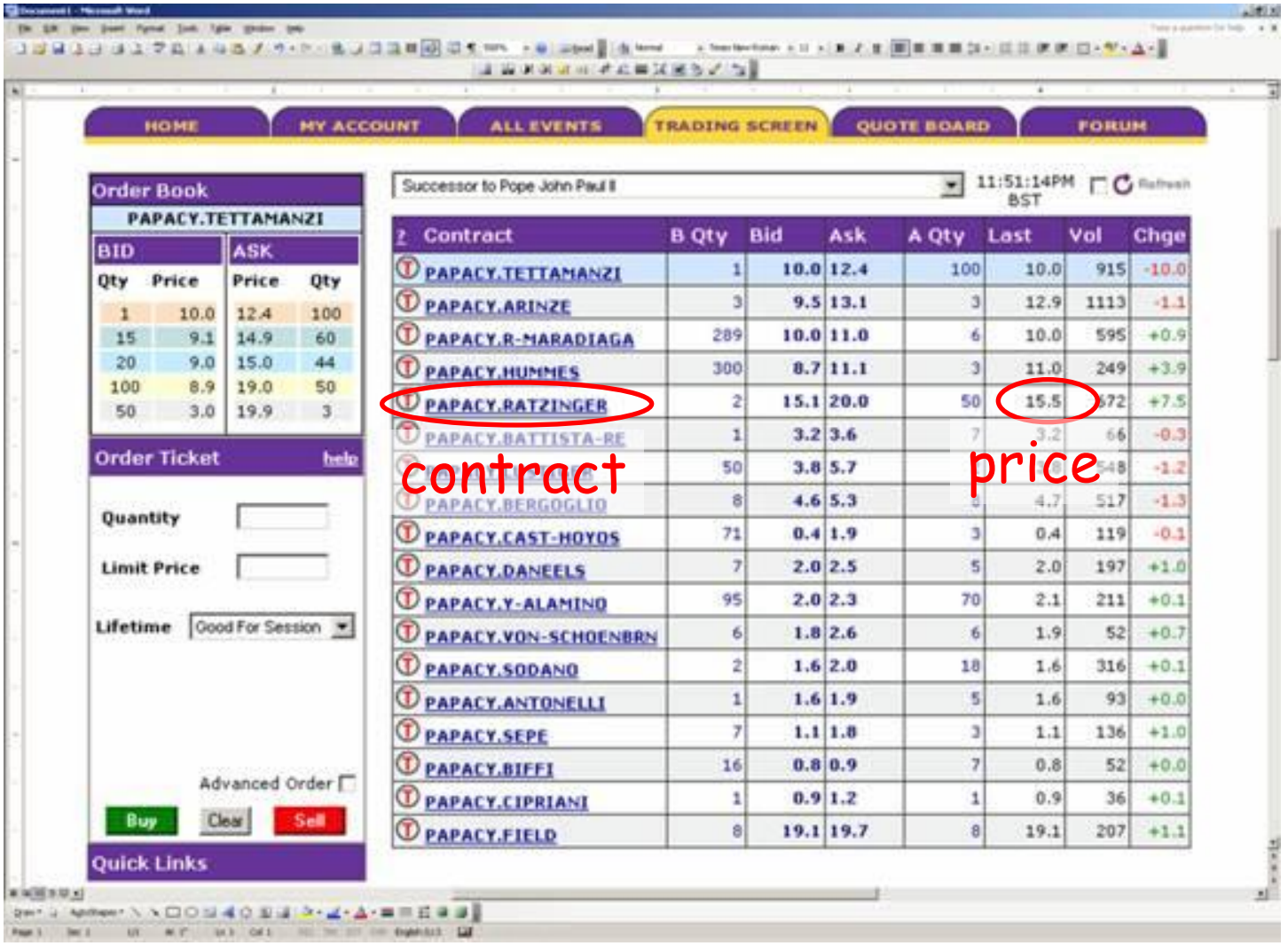
Vatican on lookout for eavesdroppers

Spies may be out to penetrate secret conclave of cardinals

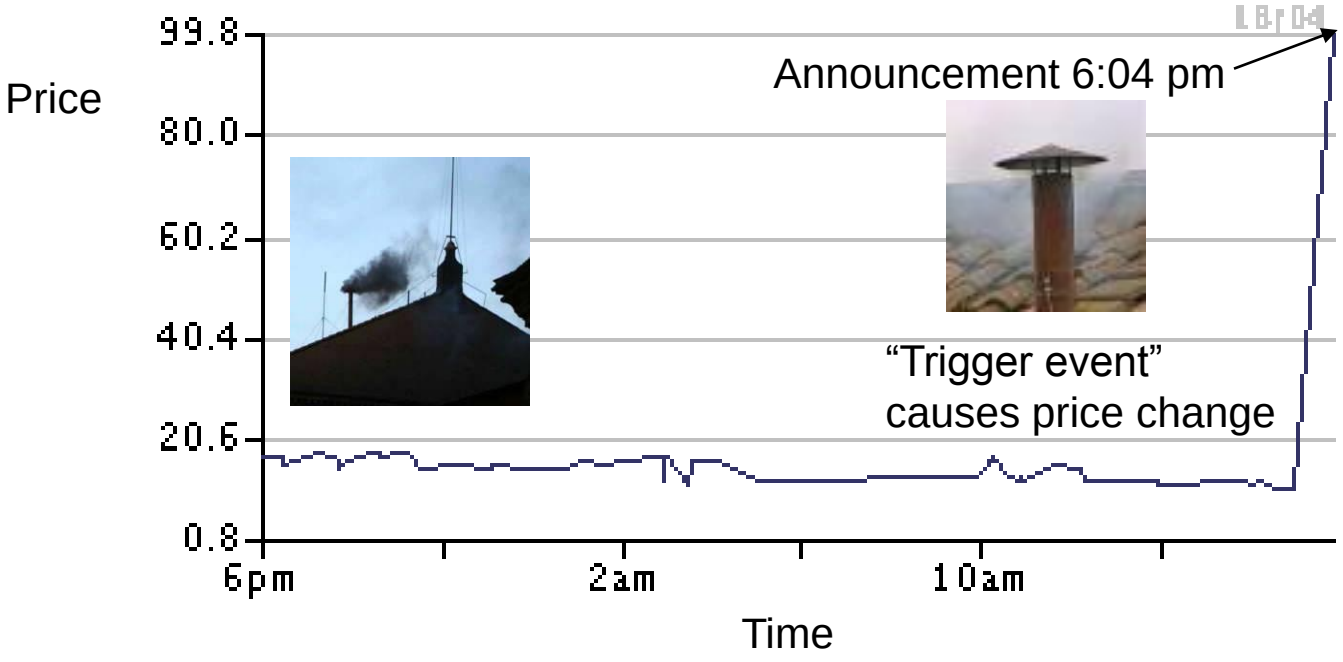
Friday, April 15, 2005

VATICAN CITY (CNN):
"Surely many intelligence agencies in the world are trying to penetrate inside the Holy See. They will do with special aircraft, for example, spy planes with… lasers." **Andrea Margelletti,** of the Center for International Studies in Rome.

www.tradesports.com

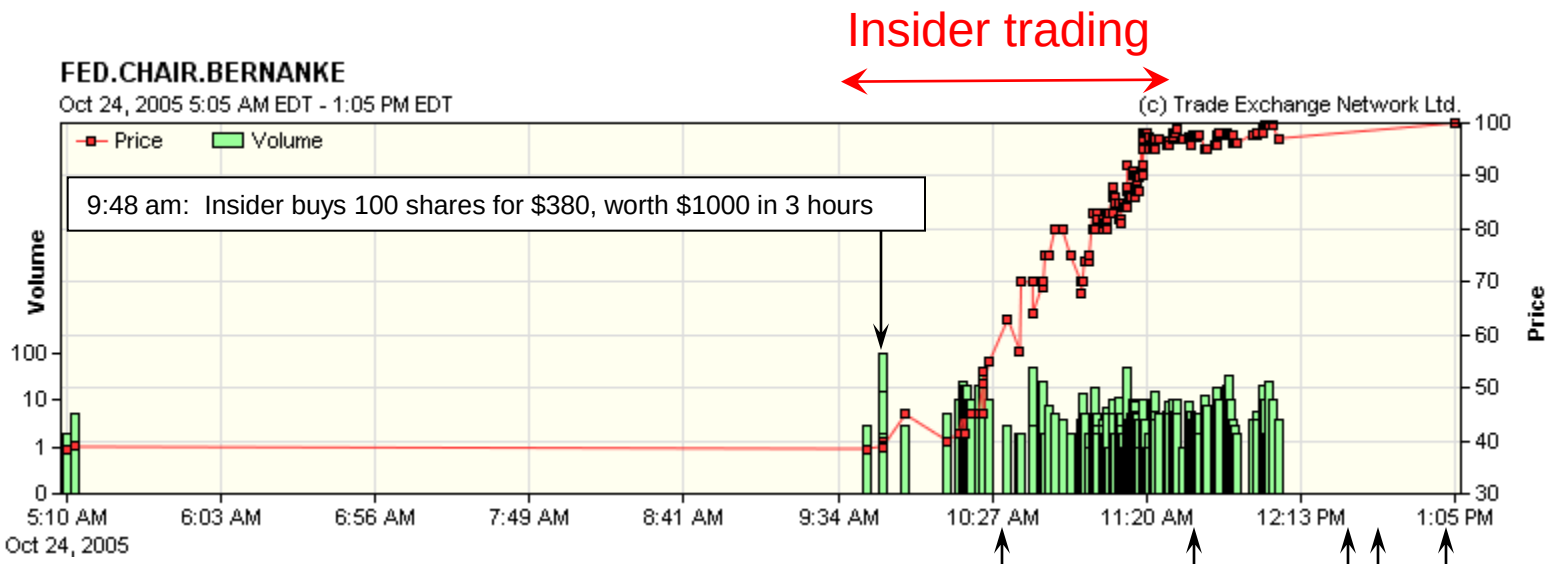


Pope contract ticker confirms no leaks



Cardinal Ratzinger contract "ticker"

Fed chair contract ticker reveals leaks



10:30 am: (Drudge) FLASH: New Fed chairman will be announced at 1PM ET... Developing…

11:36 am: (Drudge) WSJ: President Bush to name Ben Bernanke, the current chairman of his Council of Economic Advisers, to succeed Alan Greenspan as chairman of the Federal Reserve... Developing…

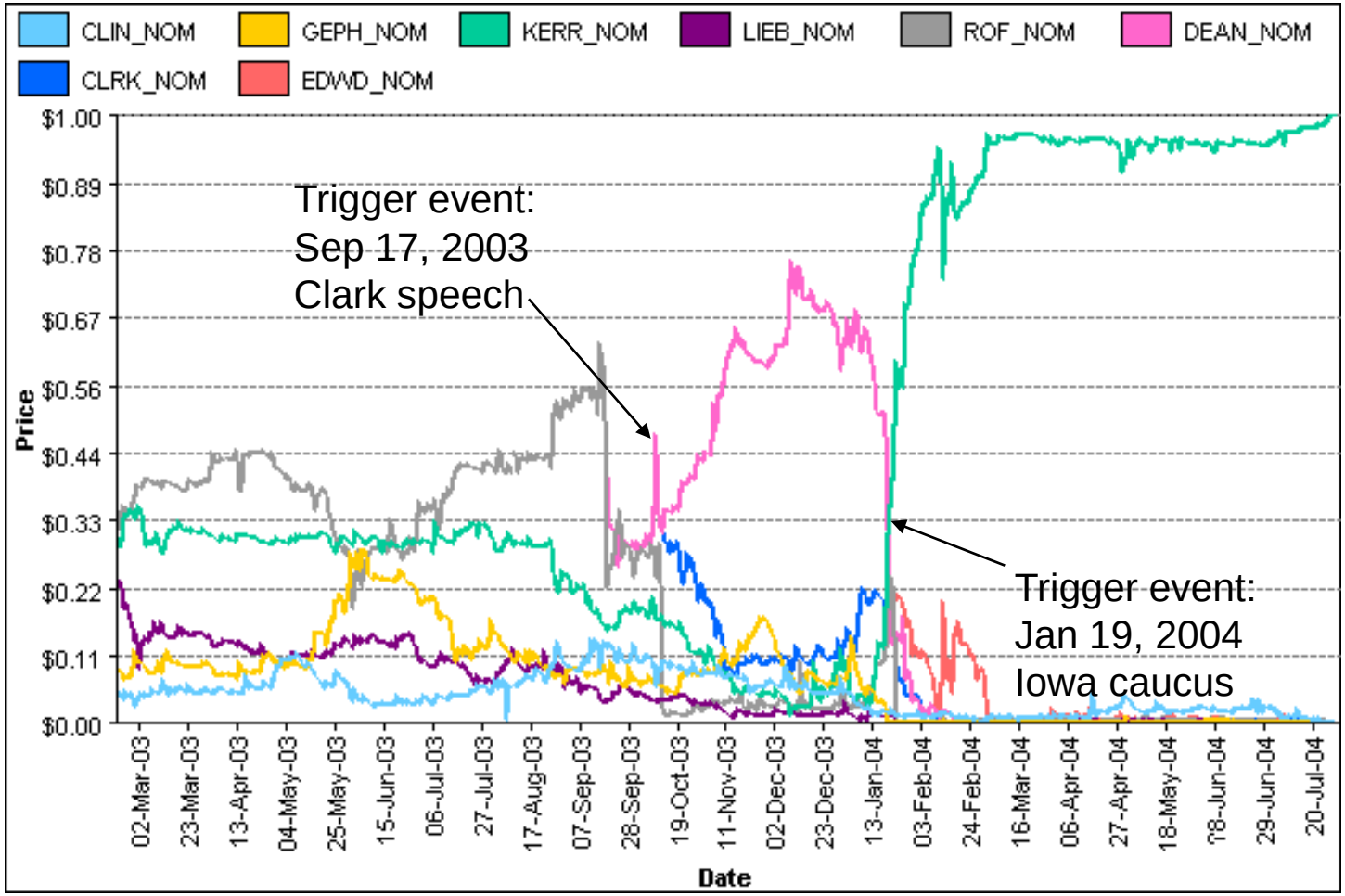
12:29 pm (CNN): President Bush was expected to announce Monday that he has picked top economic adviser Ben Bernanke..

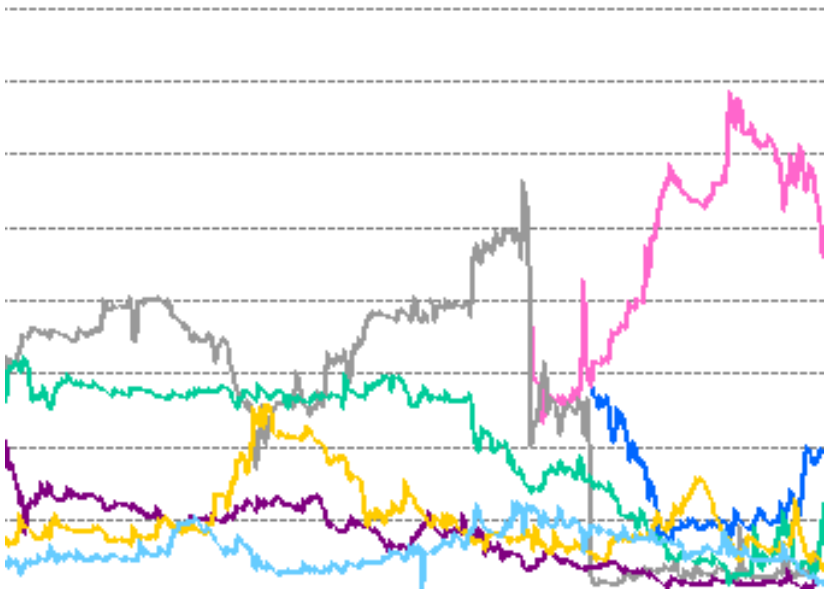
12:29 pm (Drudge): Bush picks Bernanke to Replace Greenspan…

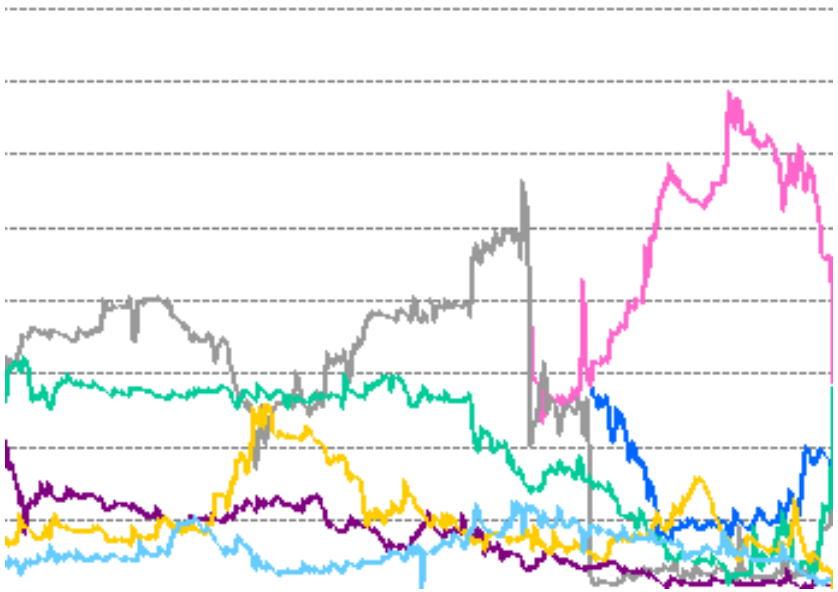
(White House) President Appoints Dr. Ben Bernanke for Chairman of the Federal Reserve

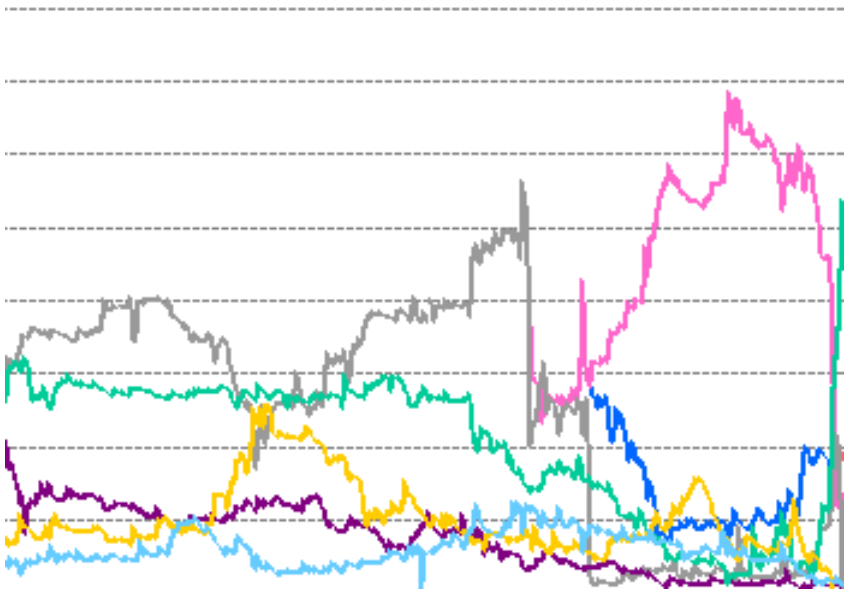
Example 5: Notification of new information

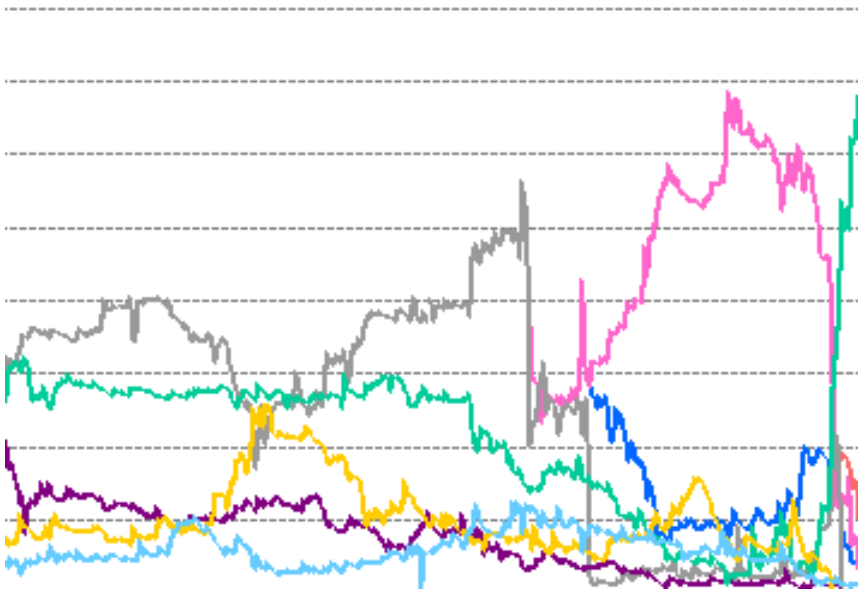
Iowa Electronic Market data

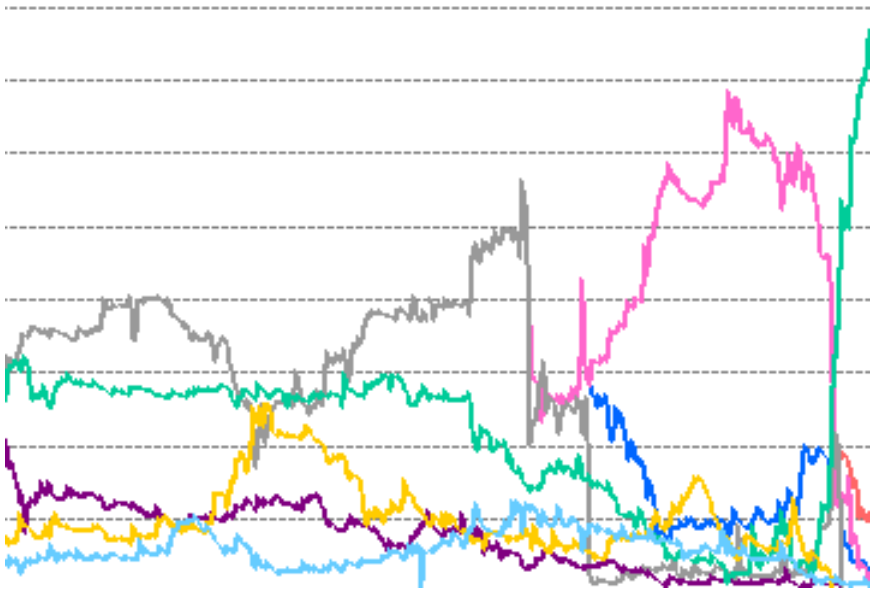


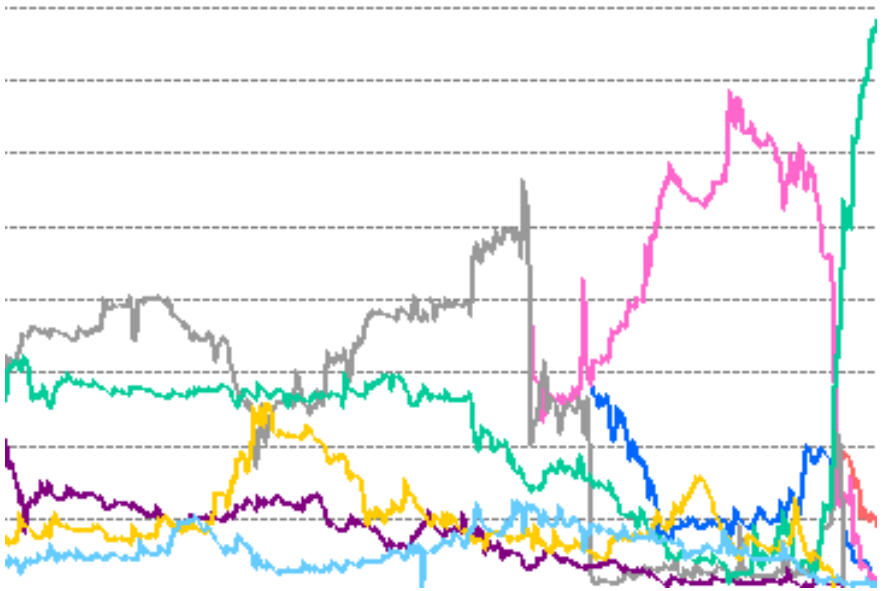


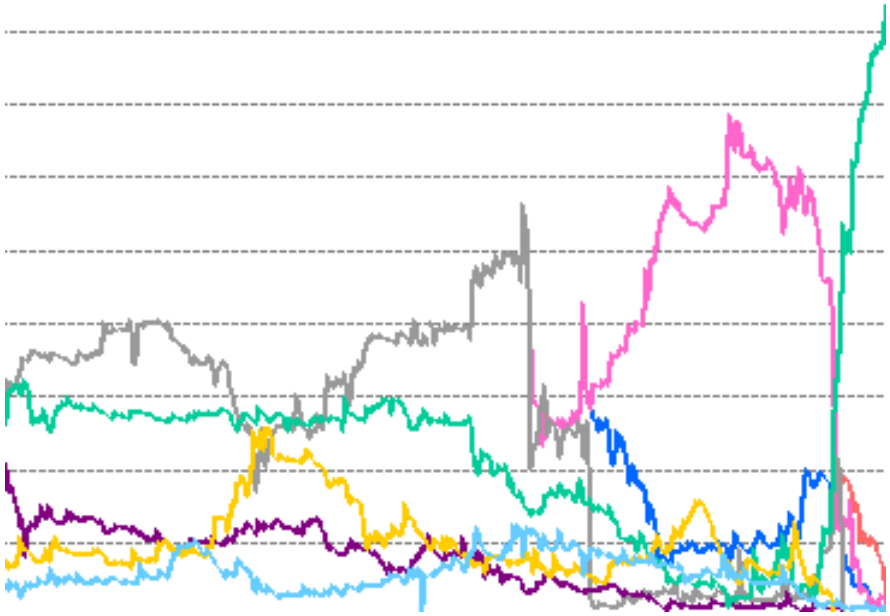


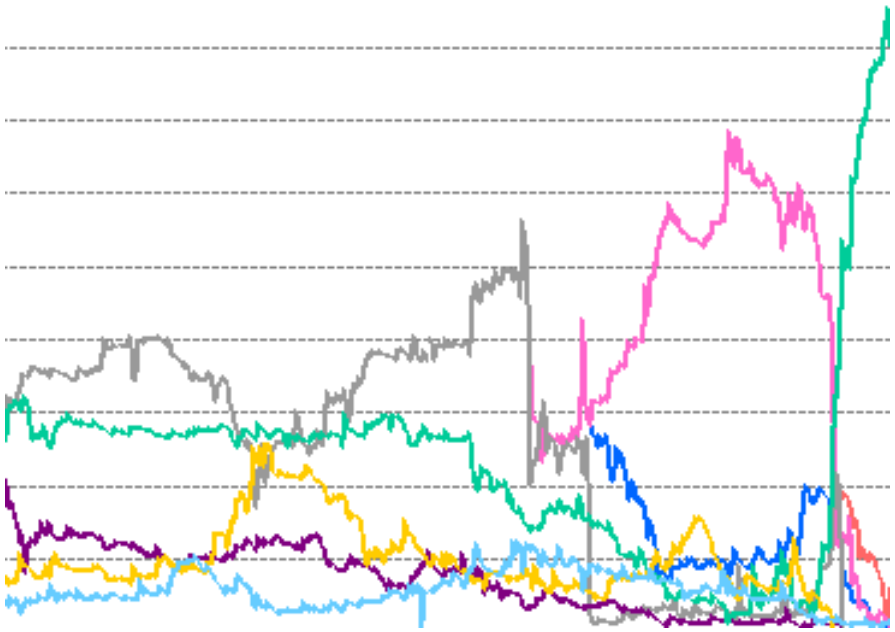


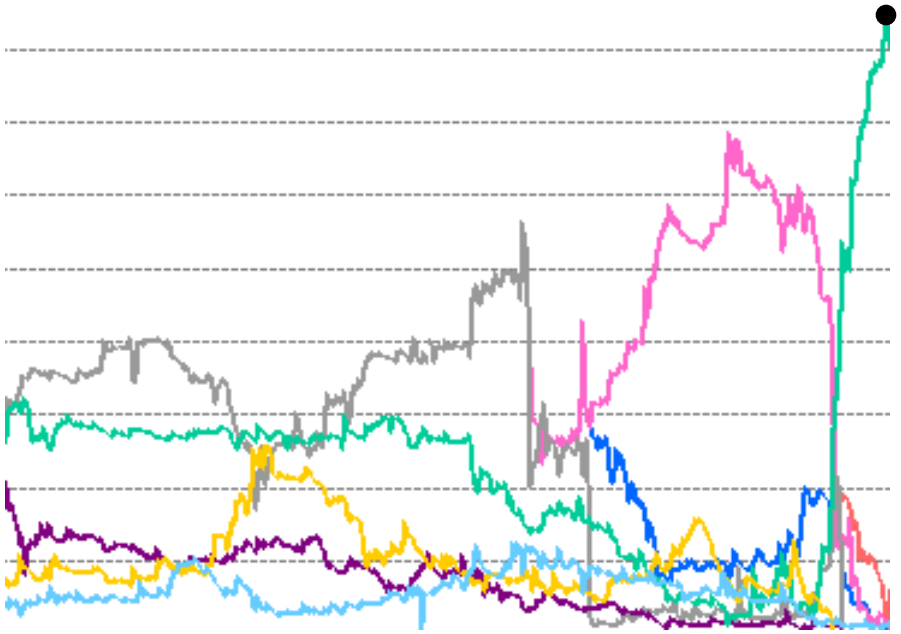






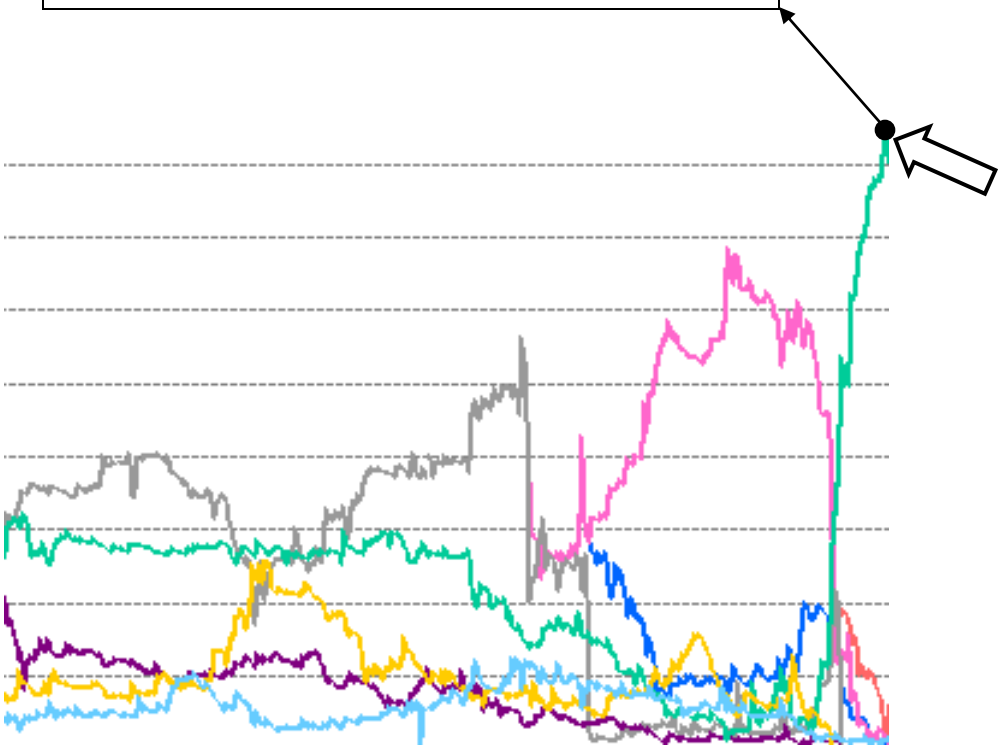




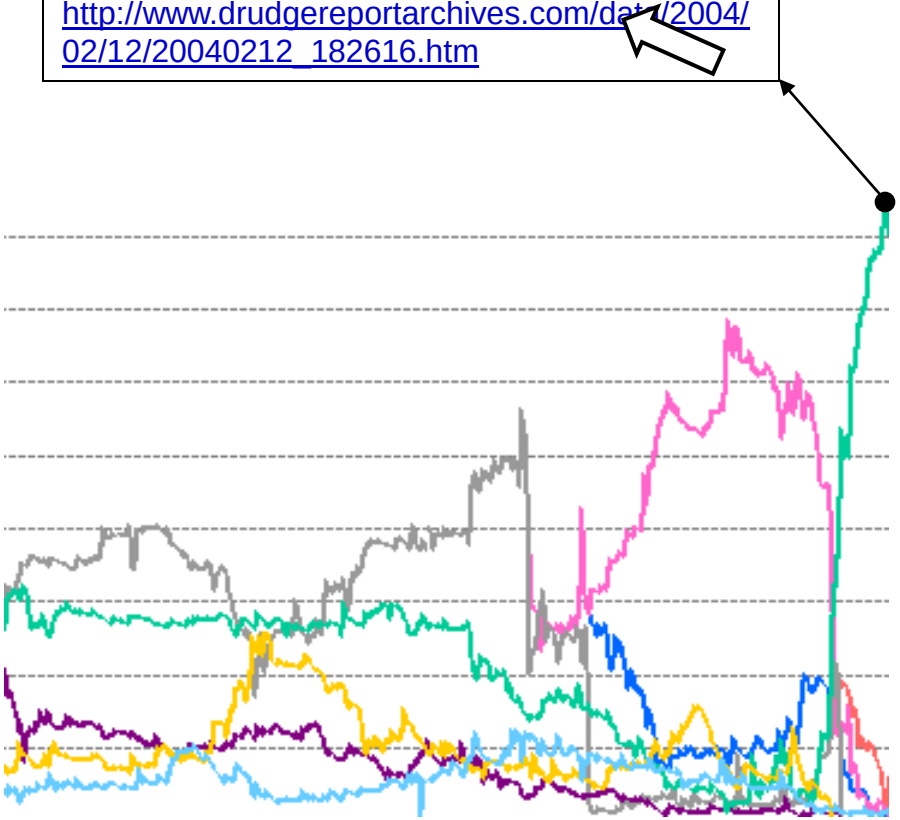


Trigger event:
Feb. 12, 2004
18:26:16

http://www.drudgereportarchives.com/data/2004/02/12/20040212_182616.htm



http://www.drudgereportarchives.com/data/2004/02/12/20040212_182616.htm



A frantic behind-the-scenes drama is unfolding around Sen. John Kerry and his quest to lockup the Democratic nomination for president, the DRUDGE REPORT can reveal...

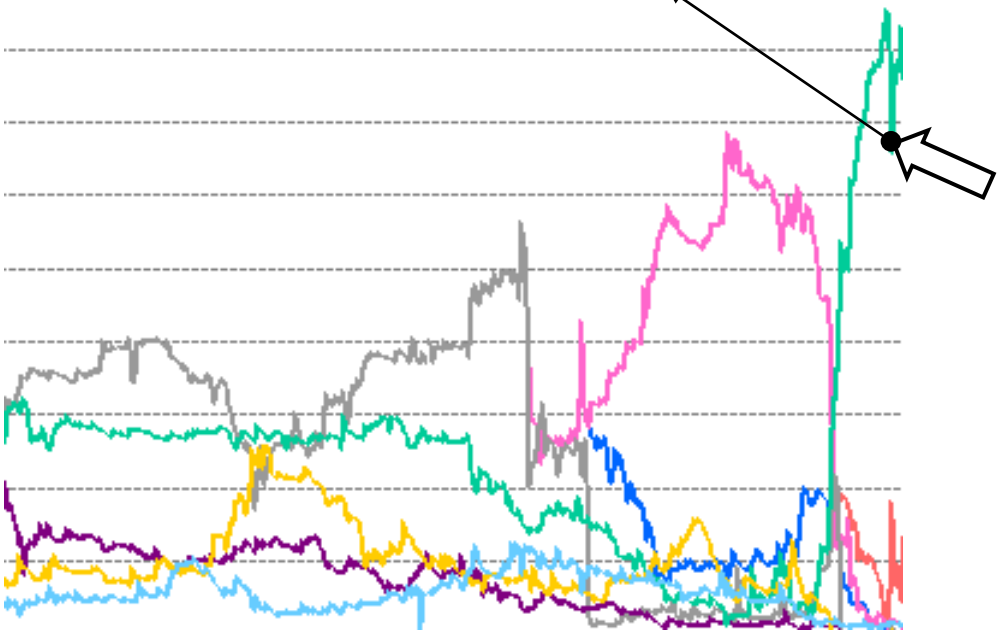
CAMPAIGN DRAMA ROCKS DEMOCRATS: KERRY FIGHTS OFF MEDIA PROBE OF RECENT ALLEGED INFIDELITY, RIVALS PREDICT RUIN

DRUDGE REPORT

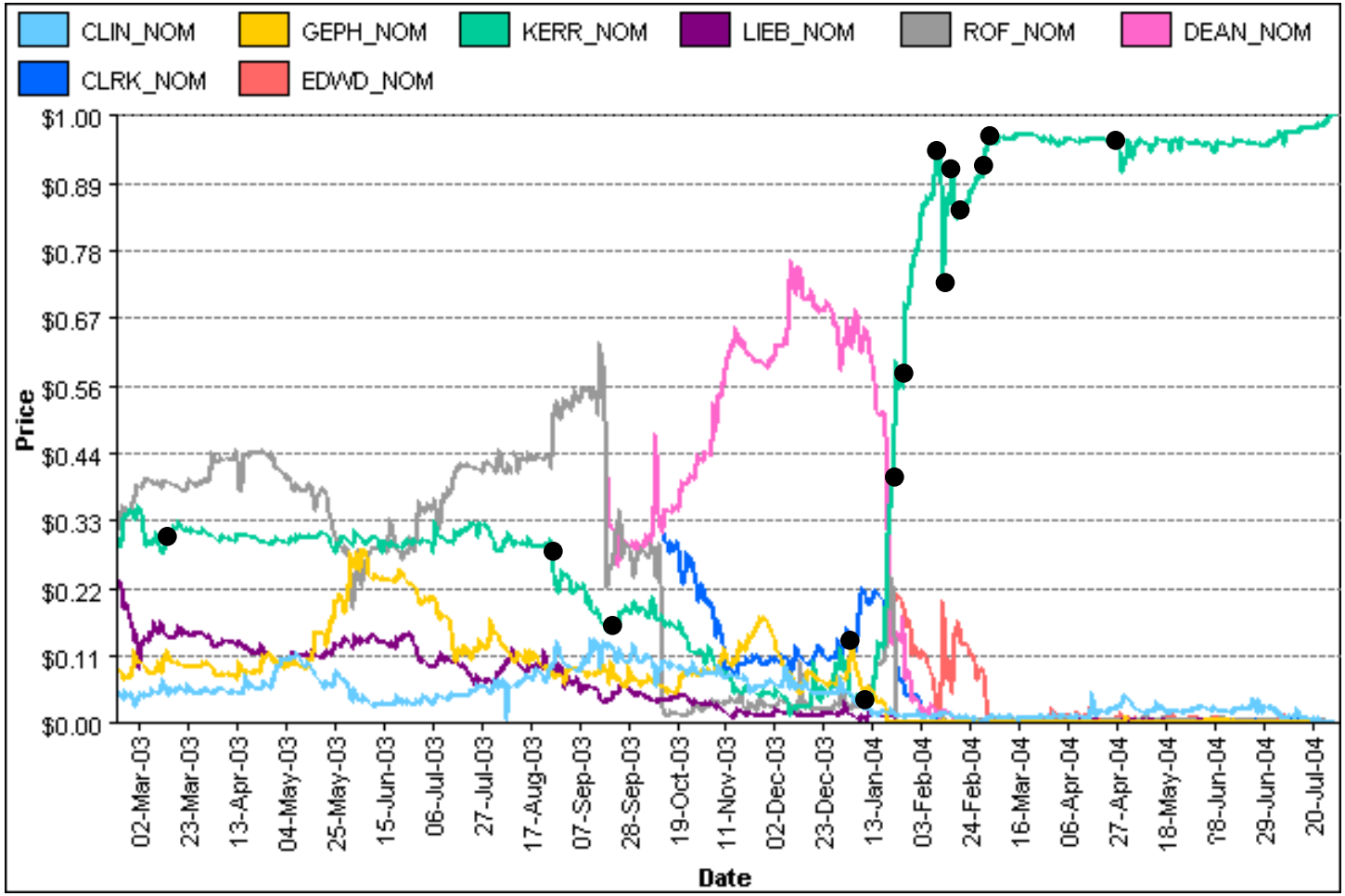
http://www.drudgereportarchives.com/data/2004/02/12/20040212_182616.htm

Statement from woman and parents about rumors linking her to Sen. John Kerry
The Associated Press
Monday, February 16, 2004

http://sfgate.com/cgibin/article.cgi?file=/news/archive/2004/02/16/politics1300EST0543.DTL

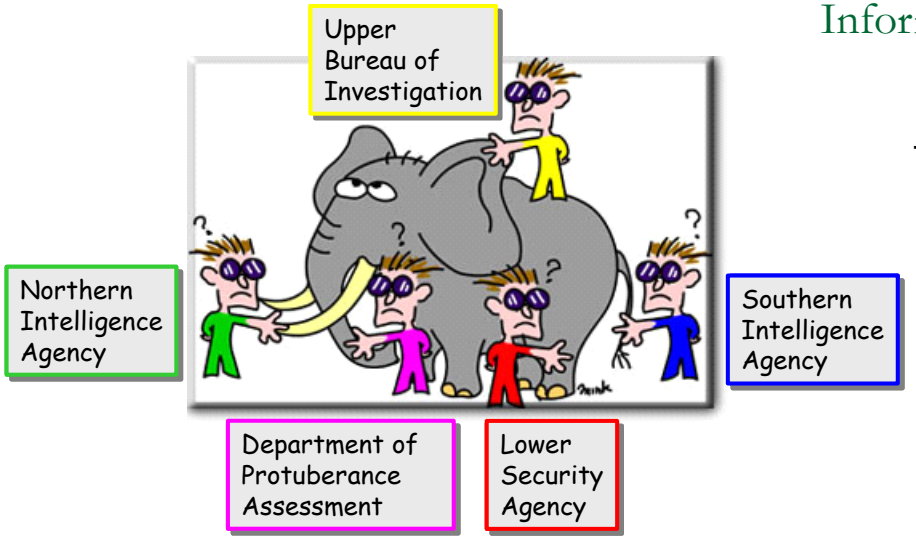


Annotated ticker can provide a self-organized dynamic data structure



Example 6: “Connecting the dots”

How markets aggregate information

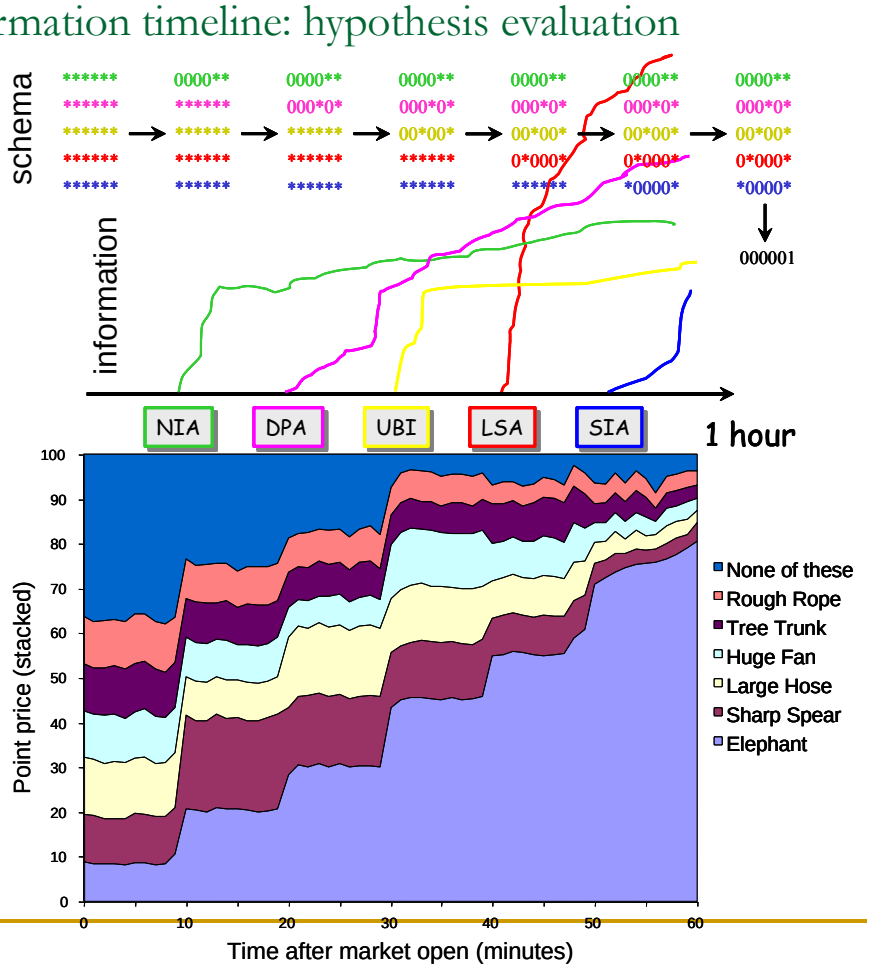


IAM contract

The lights will be turned on at 1:00 pm. If a(n) **Sharp Spear** is seen, this contract is redeemable for 100 tokens. Otherwise, it is void. Sold at **51 minutes** for **9** tokens.

IAM contract

The lights will be turned on at 1:00 pm. If a(n) **Elephant** is seen, this contract is redeemable for 100 tokens. Otherwise, it is void. Sold at **51 minutes** for **61** tokens.

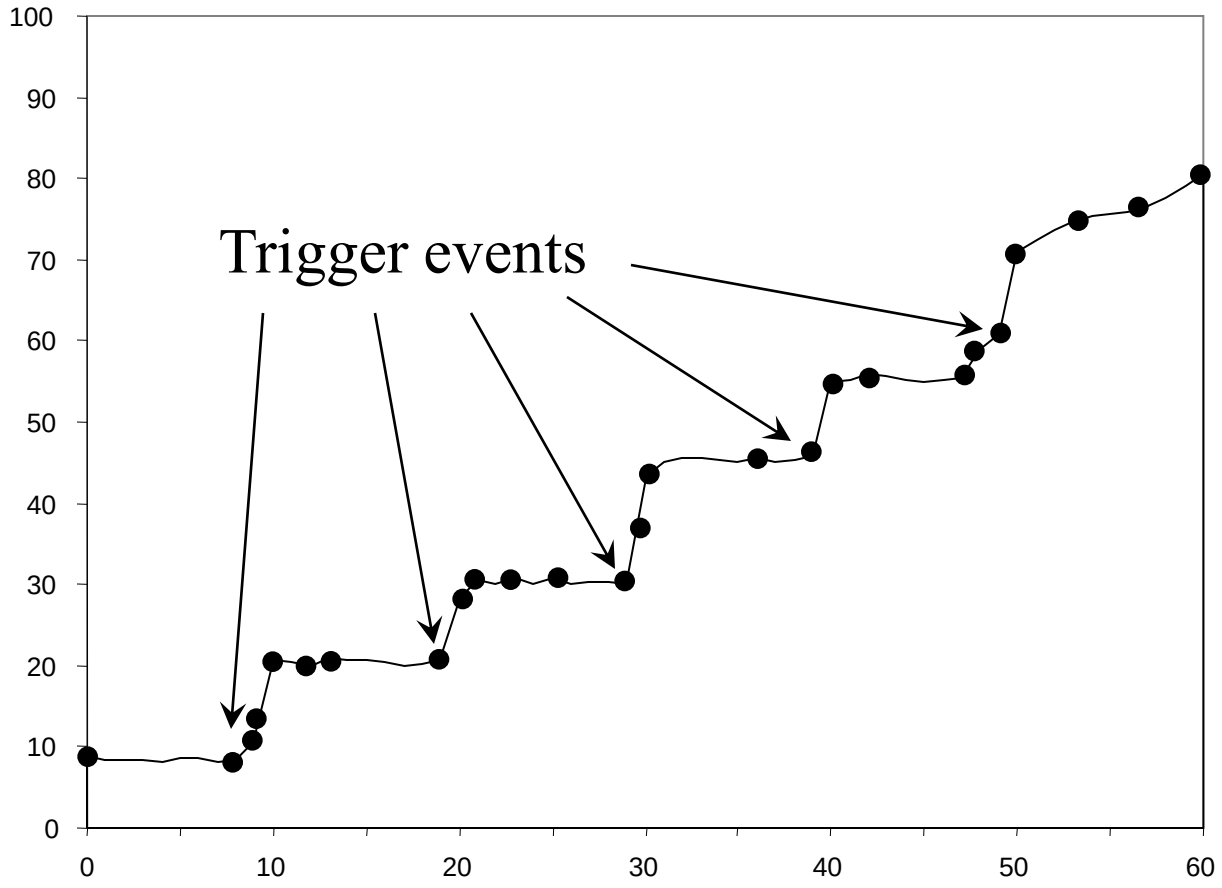


Closed Market Institution

- Traders can have eligibility requirements (e.g. analysts only)
- Traders can have security requirements (clearance level)
- Tracking points can be proxy for money
- Protocol for information disclosure can be implemented

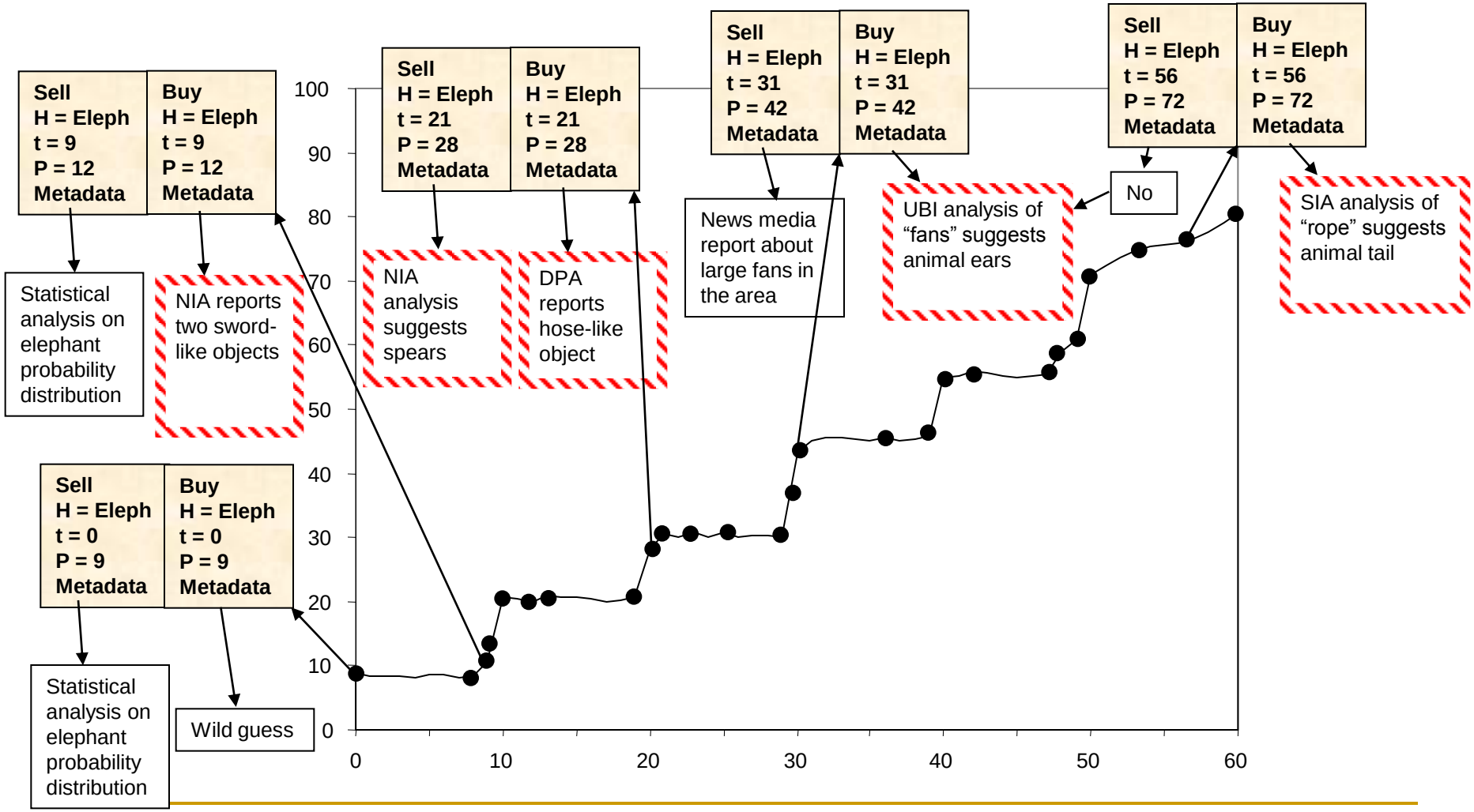
Innovation: linked metadata

Market trading creates the dots



Innovation: linked metadata

Disclosure rule connects the dots



Example 7: Objective evaluation of information quality

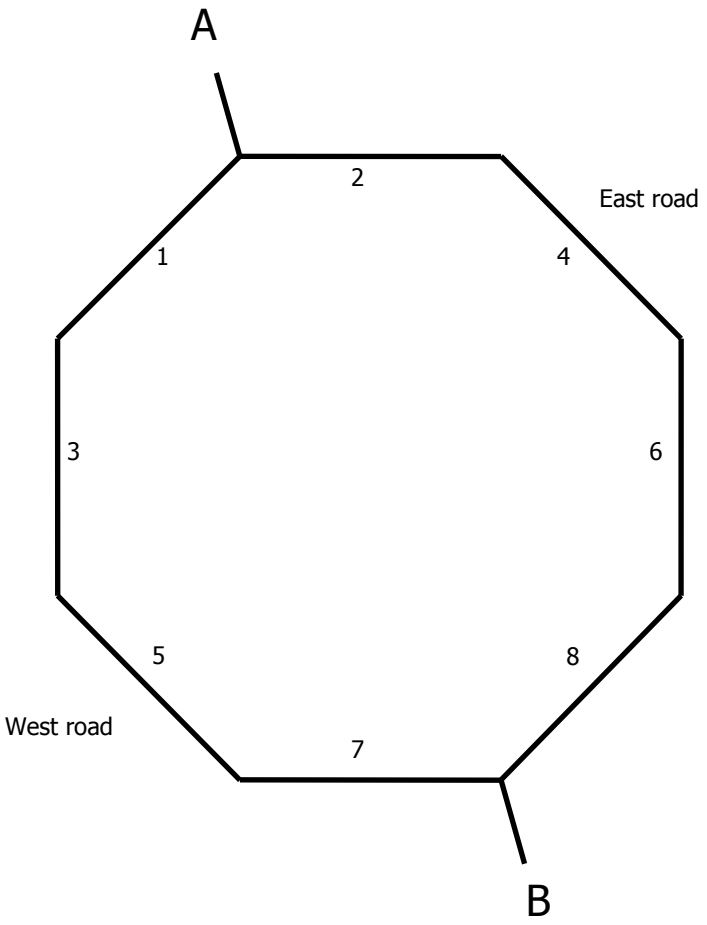
Simulated IED field test

Eight-way aggregation market
(one contract for each road segment)

Futures contract

The contract will expire at midnight. If the mock IED is found on segment 4 this contract is redeemable for 100 points.

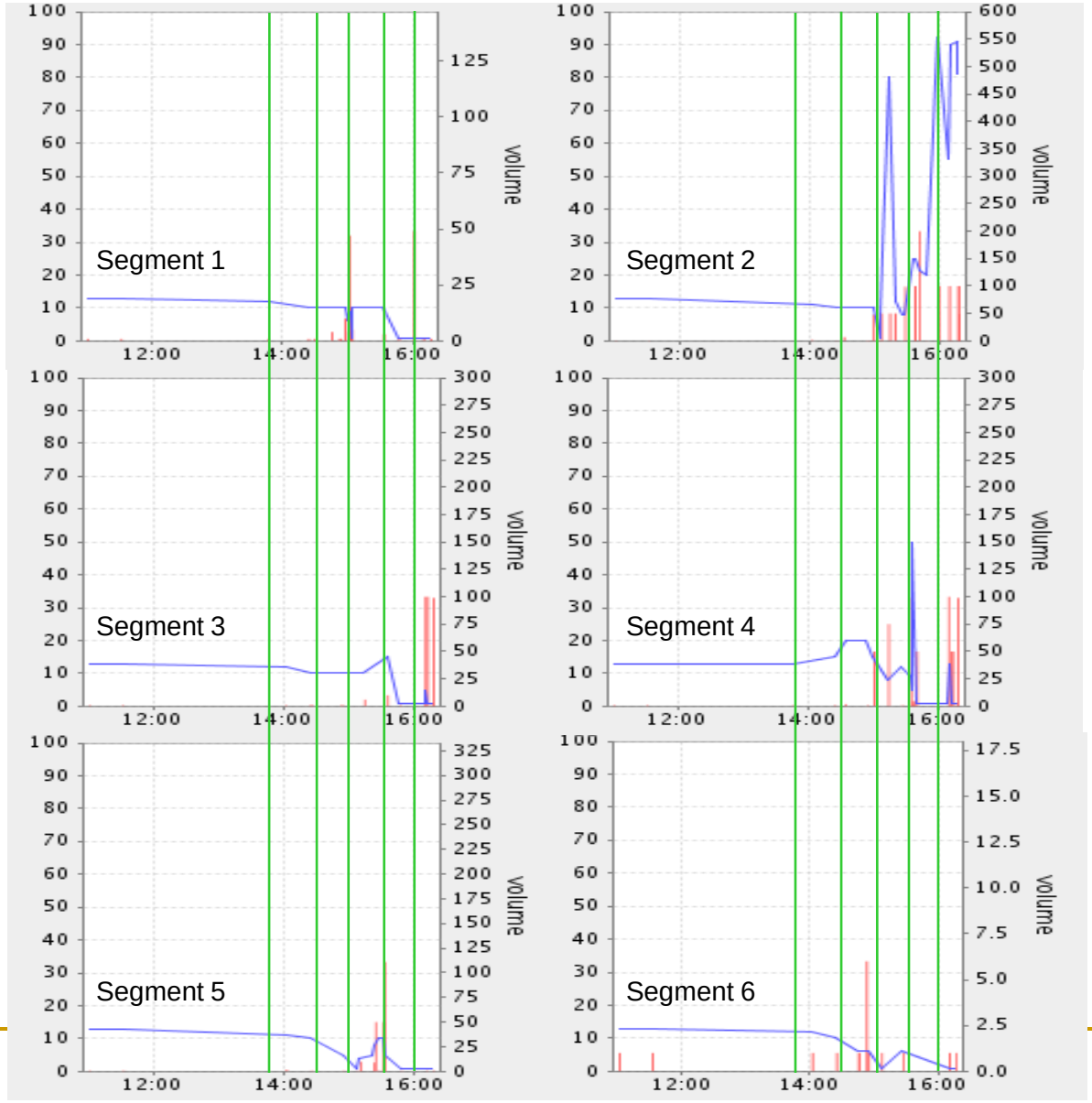
Otherwise, it is void.



Seven technologies ranked by market

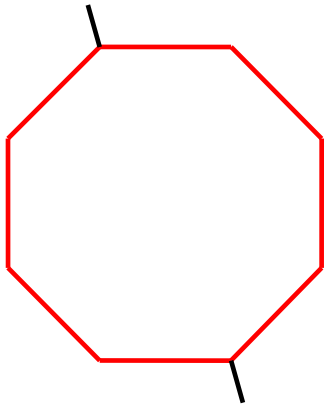
	False pos. rate	False neg. rate	Round 1 t=13:45	Round 2 t=14:31	Round 3 t=15:00	Round 4 t=15:32	Round 5 T=15:57	Win (Loss)
NUT	0%	0%	7 0	6 0	4 0	2 1	7 0	$489
JIG	3.125%	6.25%	8 0	5 0	2 1	5 0	7 0	$144
BAT	6.25%	12.5%	8 0	1 0	8 0	1 0	5 0	($8)
LOG	6.25%	25%	1 0	2 1	3 0	4 0	5 0	$32
OAK	6.25%	50%	8 0	3 0	4 0	1 0	1 0	$1
CAT	12.5%	12.5%	7 0	8 0	1 1	4 1	3 0	($7)
FIR	12.5%	25%	4 1	4 1	3 1	6 0	5 0	($649)

Time-resolved tickers for six segments

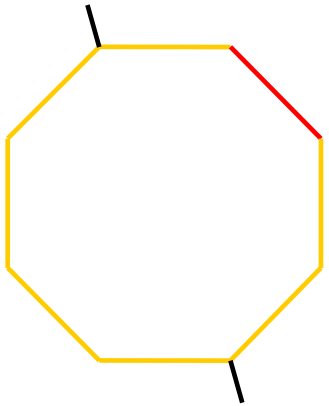


Example 8: Decision support

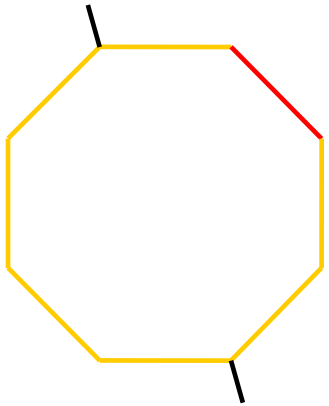
Information can be distilled to its essence for decision makers



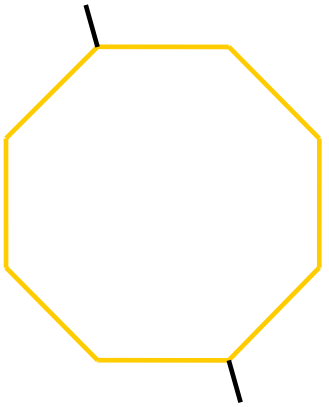
Initial state



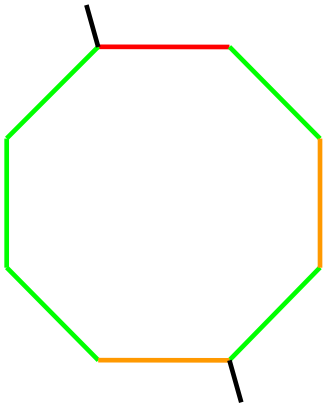
Round 1



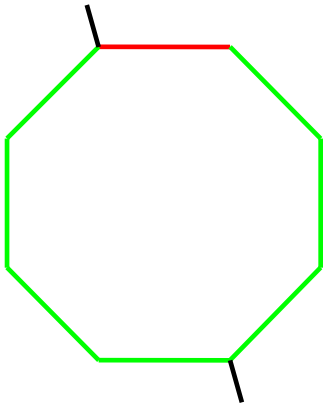
Round 2



Round 3



Round 4



Round 5

Example 9: Funding allocation

	False pos. rate	False neg. rate	Round 1 t=13:45	Round 2 t=14:31	Round 3 t=15:00	Round 4 t=15:32	Round 5 T=15:57	Win (Loss)
NUT	0%	0%	7 0	6 0	4 0	2 1	7 0	$489
JIG	3.125%	6.25%	8 0	5 0	2 1	5 0	7 0	$144
BAT	6.25%	12.5%	8 0	1 0	8 0	1 0	5 0	($8)
LOG	6.25%	25%	1 0	2 1	3 0	4 0	5 0	$32
OAK	6.25%	50%	8 0	3 0	4 0	1 0	1 0	$1
CAT	12.5%	12.5%	7 0	8 0	1 1	4 1	3 0	($7)
FIR	12.5%	25%	4 1	4 1	3 1	6 0	5 0	($649)

Increase Funding

Reduce Funding

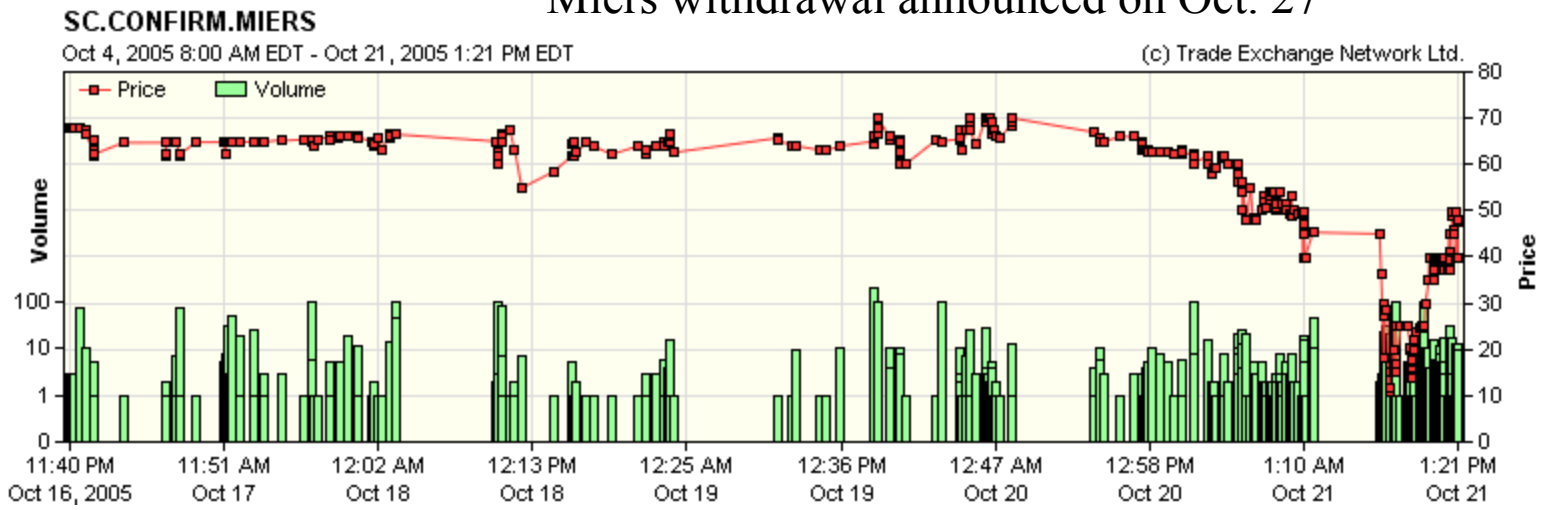
Eliminate

Summary: Intelligence aggregation method

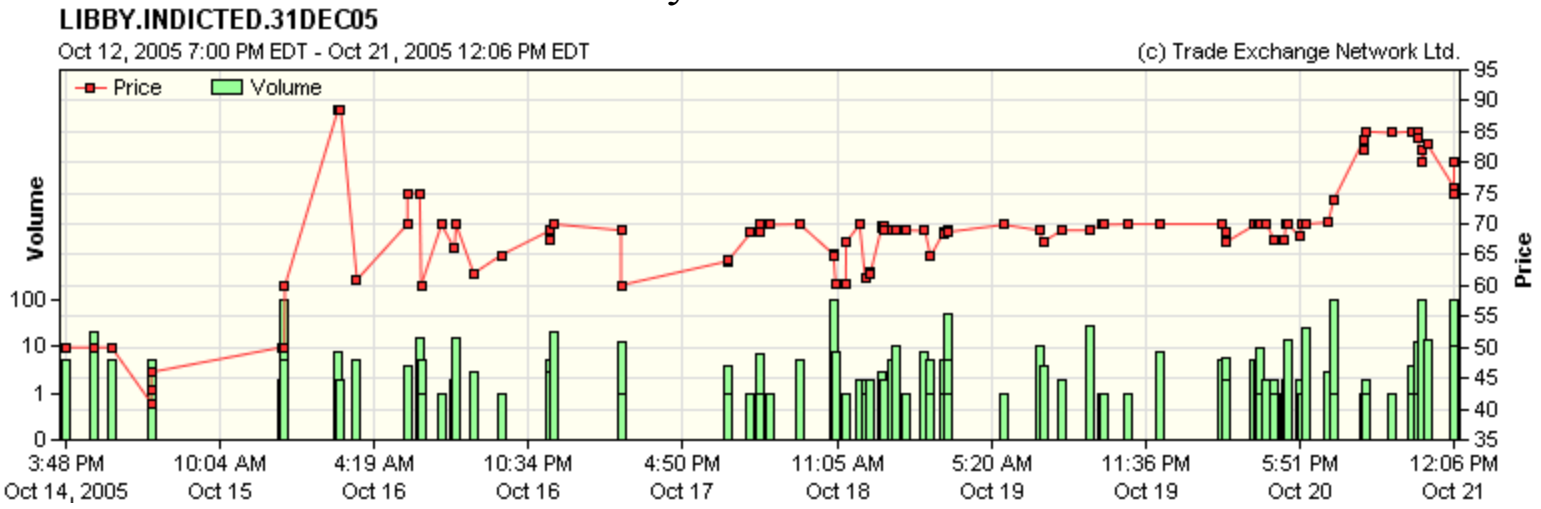
- Overcomes horizontal information barrier (stovepipe effect)
- Overcomes vertical information barrier due to hierarchy and inertia
- Promotes (rather than *inhibits*) information exchange through competition
- Preserves compartmentalization of classified information
- Evolutionary method rewards accurate, relevant and consistent knowledge
- Exhibits rapid time response
- Allows asynchronous information exchange
- Permits insulation from politics and turf battles
- Yields self-assembly of information structures
- Is scalable (massively parallel people and data distribution)

More examples

Miers withdrawal announced on Oct. 27

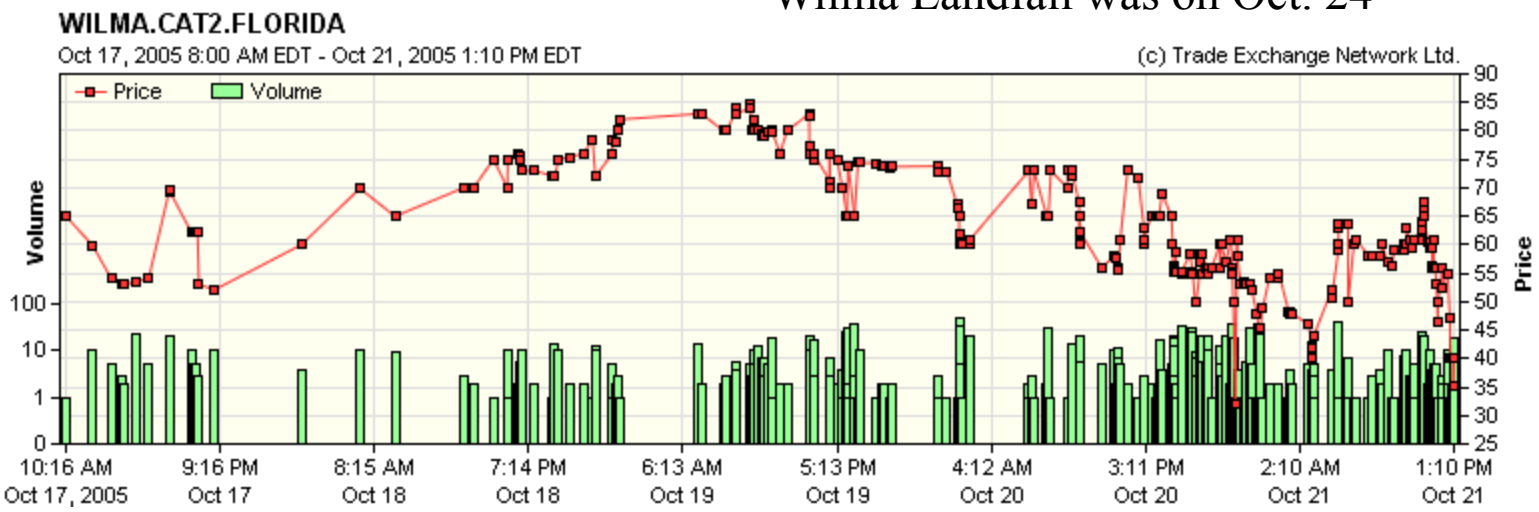


Libby indictment announced on Oct. 28

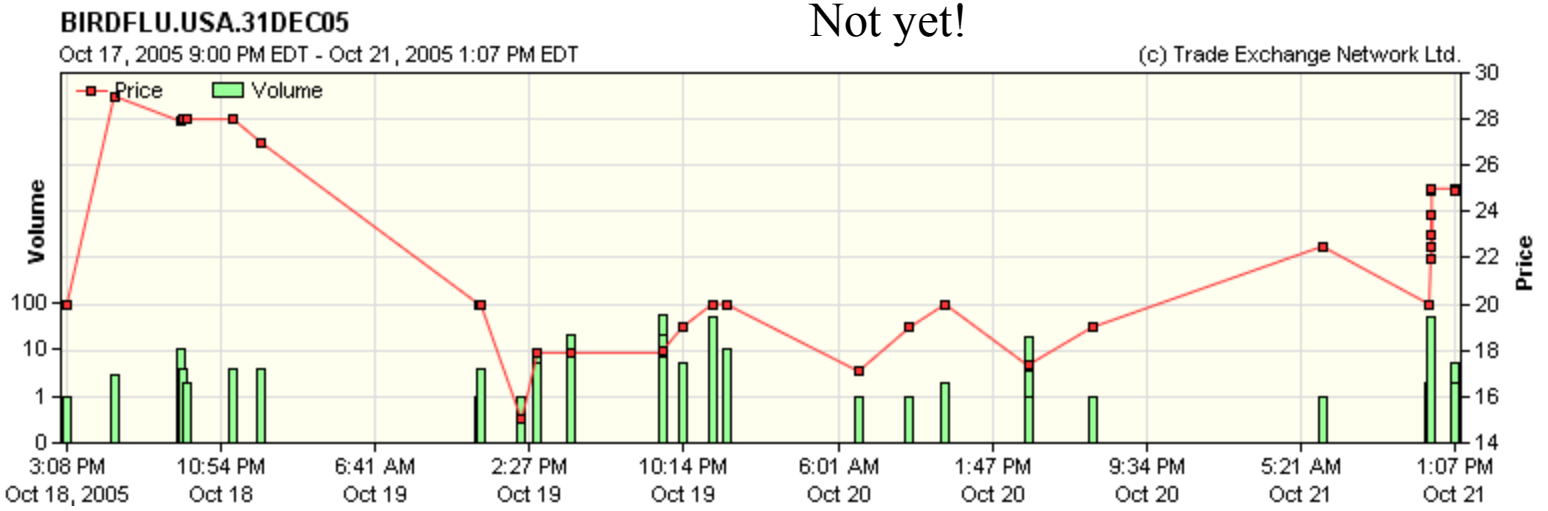


More examples

Wilma Landfall was on Oct. 24



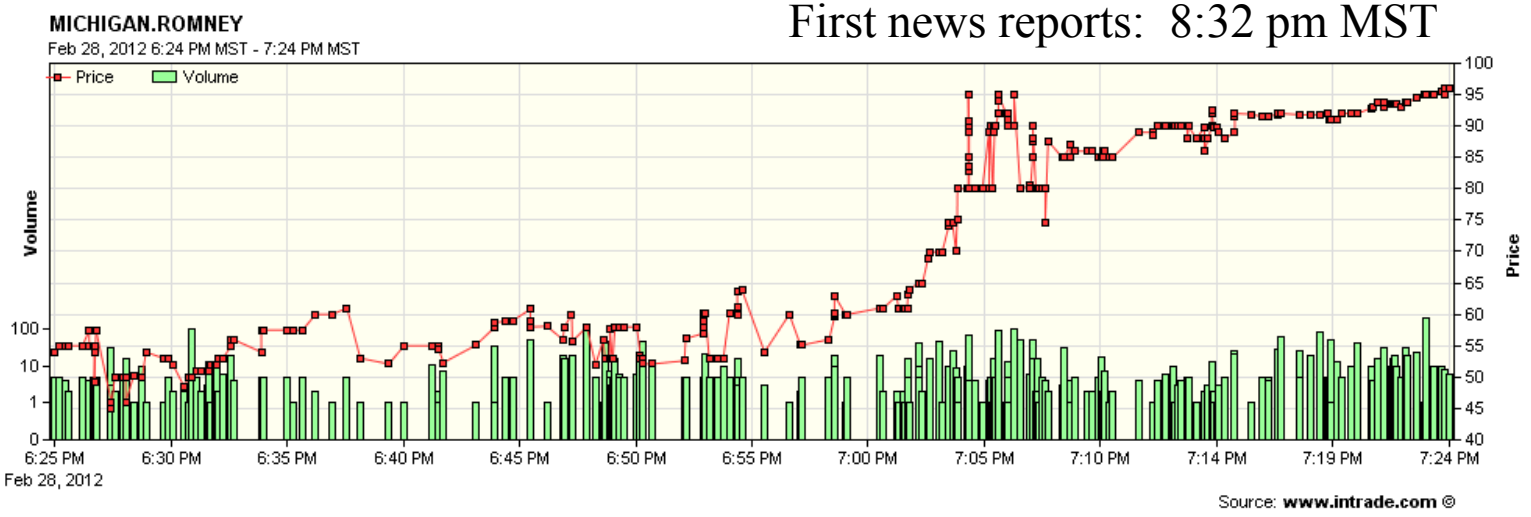
Not yet!



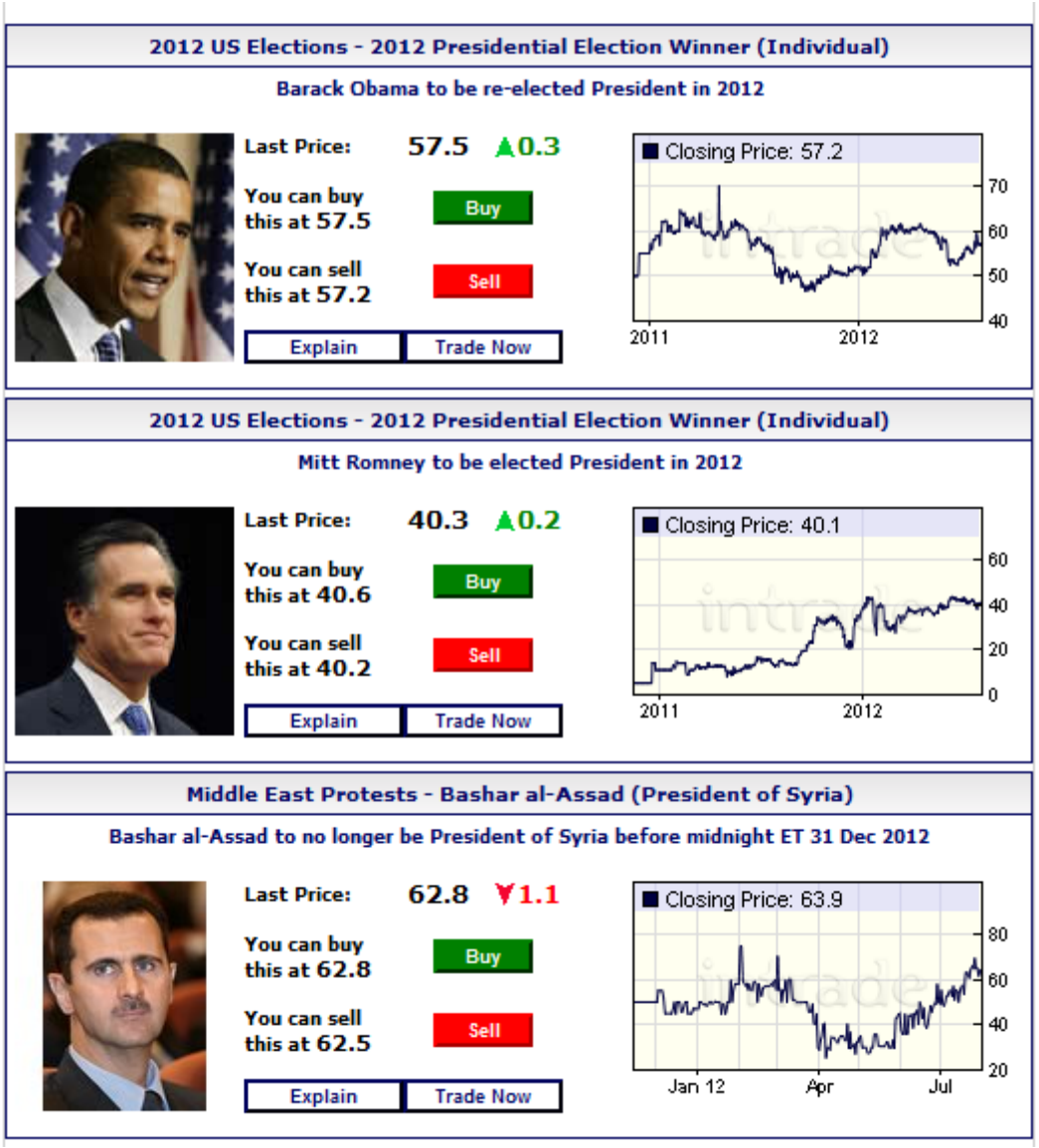
More examples

Announced at 8:29 am MDT

First news reports: 8:32 pm MST



www.intrade.com



Screen shot July 31, 2012