Can Traceability Systems and Blockchain Technology Ensure Authenticity and Detect Food Fraud?

Petter Olsen

Senior Scientist, Nofima, Tromsø

Hong Kong / Tromsø / online, January 28th 2021

About Nofima

Nofima is a private, non-profit research institute owned by the Norwegian government with head office in Tromsø and around 390 employees in six different locations around Norway.

Nofima was founded in 2008 when four former public food research institutes merged:

- Norconserv – canned and preserved foods, Stavanger
- Matforsk – food from agriculture, Ås
- Akvaforsk – aquaculture related research, Sunndalsøra
- Fiskeriforskning – seafood and processing, Tromsø

Main areas of work:

- Aquaculture and fisheries – raw materials
- Food from agriculture and aquaculture – processes and products
- Consumer and market research, which includes:
  - Consumer research, buying behaviour, food and context
  - Innovation and product development
  - Traceability, sustainability, environmental accounting

Turnover in 2018 was 623 Million NOK

Traceability definition – ISO 8402

Traceability:

The ability to trace the history, application or location of an entity by means of recorded identifications.

For products this includes

- origin of - and properties of all raw materials and ingredients
- complete process history
- location at any time

Traceability misconceptions

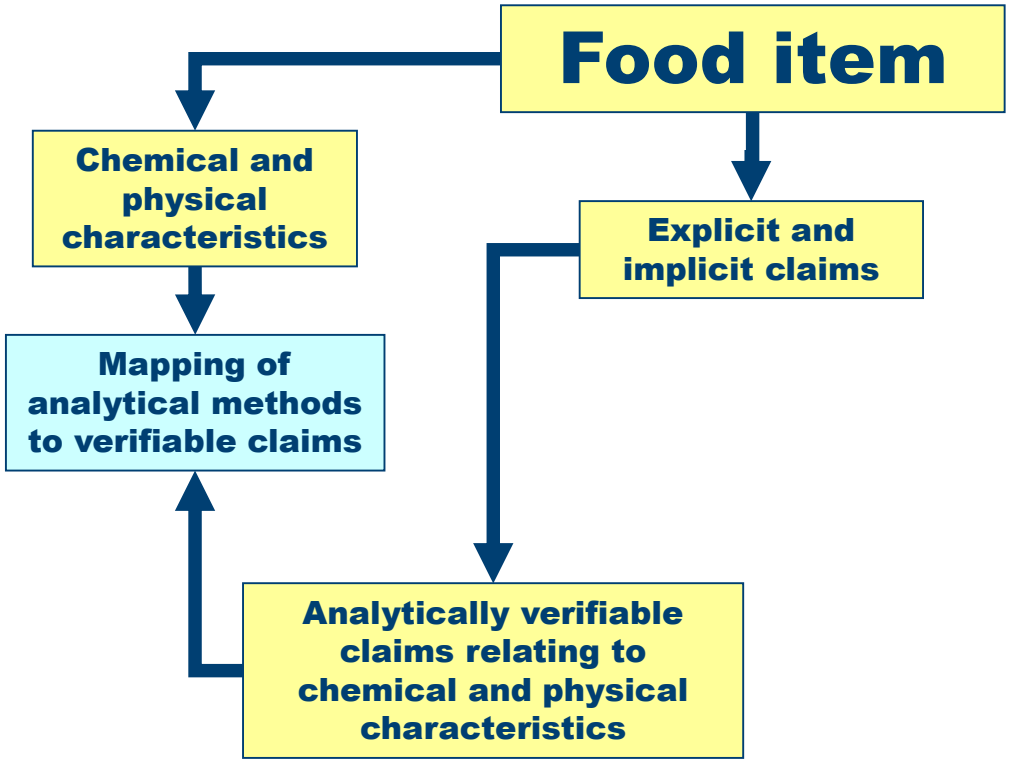
… by means of recorded identifications

This means that the job of a traceability system is to keep track of recorded identifications, recorded data. The recorded data value may be true or false (error, fraud, etc.); it constitutes an (unsubstantiated) claim relating to the product / unit in question. Machines, instruments, and methods that provide us with objective measurements of food items do not provide traceability, but they can be very useful when trying to verify the claim (the veracity of the data); this includes DNA, LC, GC, NMR, NIR, and other analytical methods.

… location at any time

Keeping track of the location does not only mean knowing where the raw materials and ingredients came from, but also where the product went. Traceability is not only looking backward in the chain; it also means looking forward (and ‘traceability’ is not a synonym for ‘provenance’ or ‘origin’).

In a traceability system we find claims, not facts



A food product is **authentic** when there is a match between the food **product characteristics** and the corresponding food product **claims**

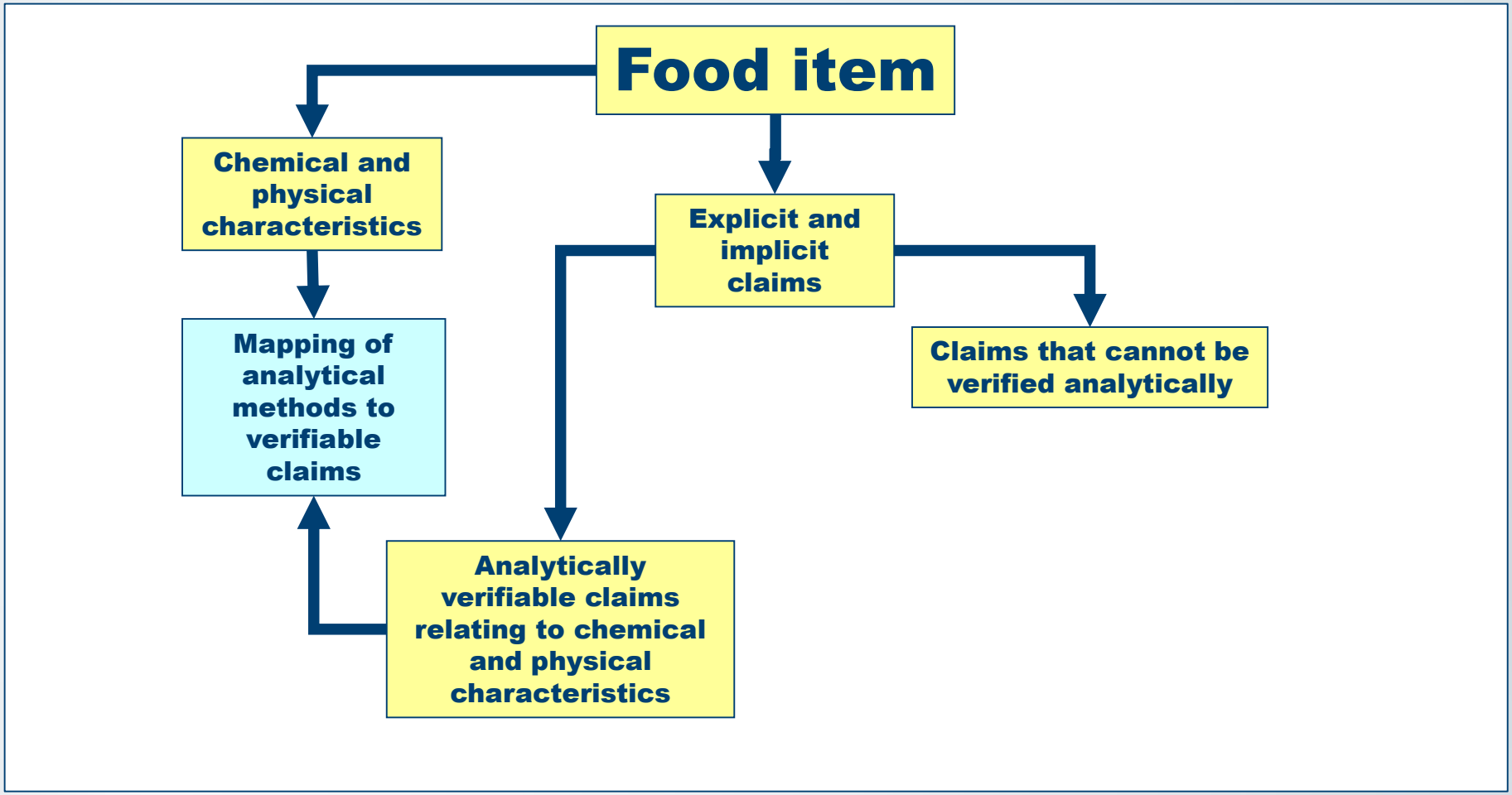
Analytically verifiable characteristics

- Species, Geographical origin
- Farmed or wild (for salmon, typically)
- Fresh or frozen, then thawed
- Presence of bioactive compounds, pathogens
- Presence of undeclared / unwanted additives

Examples

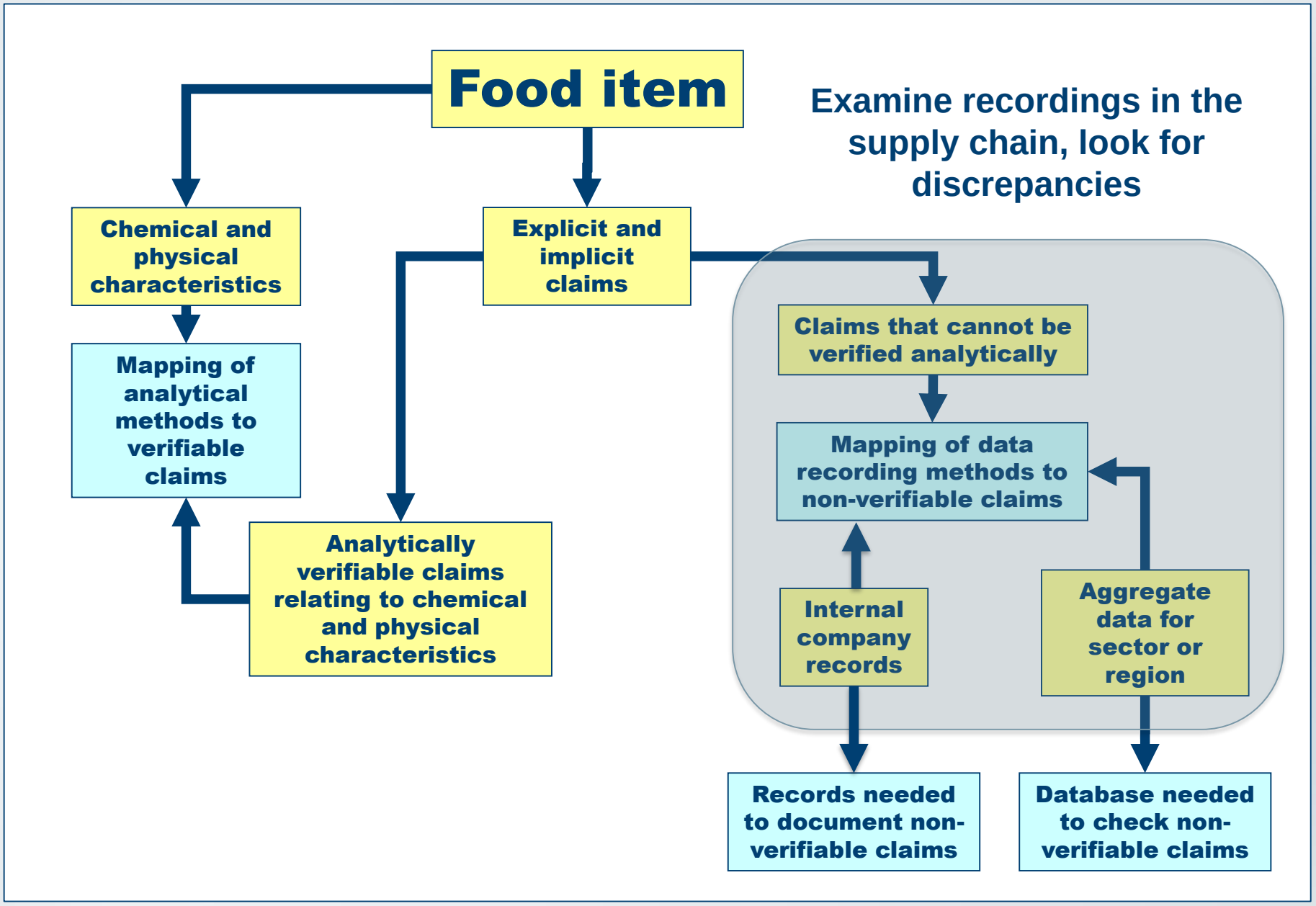
- Dioxin in Belgian chicken feed
- Cadmium in salmon feed
- Sudan Red
- Nitrite in smoked salmon
- Wrong species declaration for sushi fish
- Horsemeat sold as - / mixed with beef

In a traceability system we find claims, not facts



Characteristics not or only partly verifiable by analytical methods

- Volume, Weight, Amount, Value
- Batch / lot number, Owner
- Origin, country of origin
- Eco-label, other value adding labels
- Organic production (also has some analytical components)
- Halal, Kosher (also has some analytical components)
- Most properties relating to sustainability or ethics



  Nofima

Input-Output analysis

For companies, sectors or regions: Compare outputs from previous link in the supply chain with inputs to next link in the chain; identify discrepancies.

Where does the fish come from?

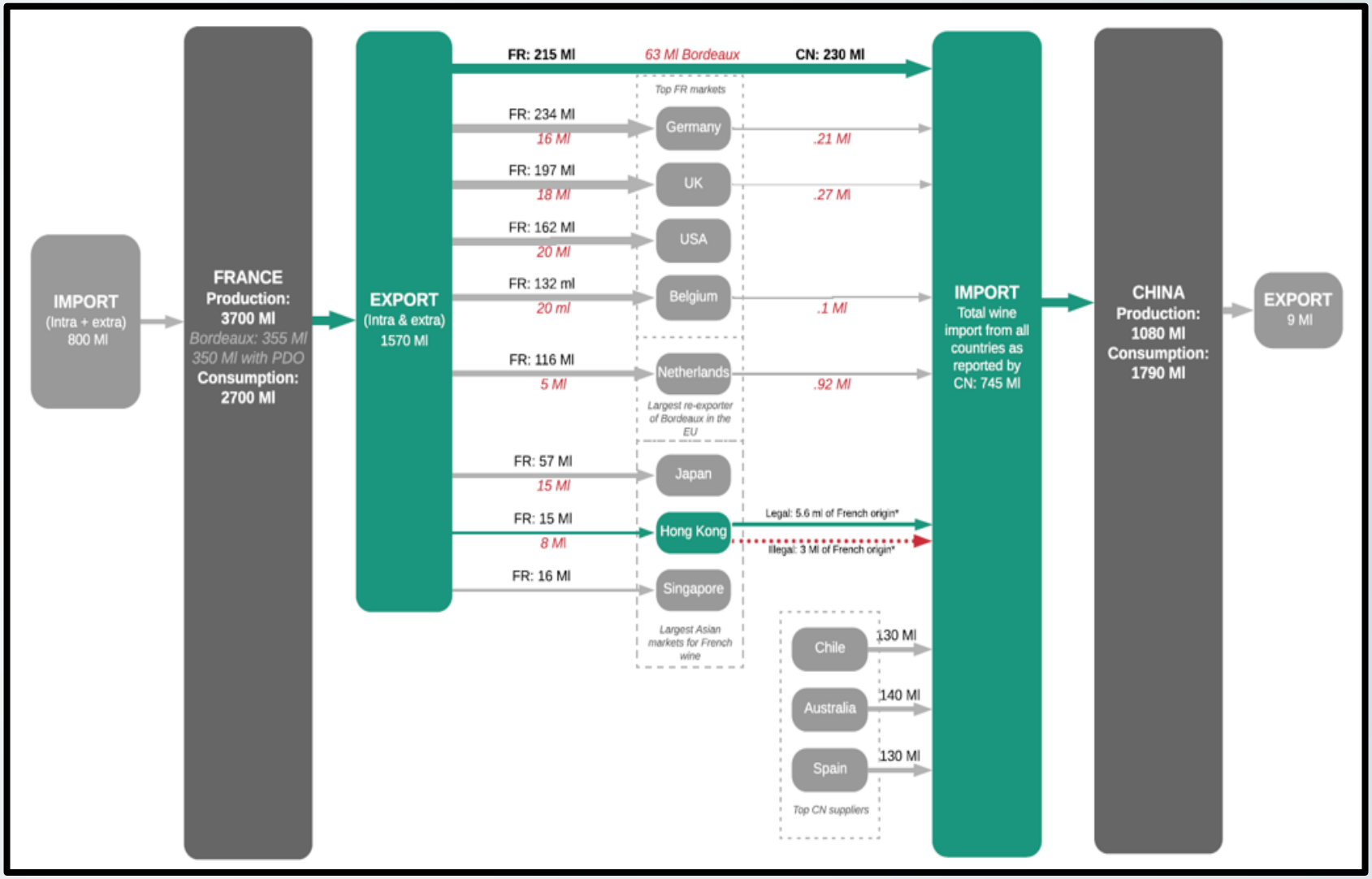
	Reported amount fish / product landet into region:					
1000 tons	Landed	Finn-mark	Troms	Nord-land	Other	Sum
Finnmark	61254		1439	0	217	62910
Troms	70853	163		513	0	71529
Nordland	88188	0	128		85	88401
Andre	49005	0	0	212		49217
Sum	269300	163	1567	725	302	272057

	Reported amount fish / product used or sold					
1000 tons	Processed	Norway	EU	Russia	Other	Sum
Finnmark	20131	11324	18244	10695	7549	67943
Troms	20028	10014	17167	12160	10014	69383
Nordland	26520	14144	25636	12376	9724	88401
Andre	15257	8367	14273	8859	4430	51186
Sum	81937	43849	75320	44090	31717	276913

Significant discrepancy!

Where does it go?

Input-Output analysis for wine exported from France to China



Mass-balance accounting

For processes: Using our knowledge of the raw material and the process type to establish typical or optimum conversion / yield factors, and then comparing process input with process output.

September 2008 Oktober 2008

THE

Max 18C, min 5C

Tuesday September 16 2008 timesonline.co.uk No 69430

Lehman collapse se
shockwave round w

hares and oil prices plunge, thousands lose jobs

ry Duncan Economics Editor

ars of a global financial meltdown w yesterday as the world's biggest nkruptcy plunged markets into noil.

nvestors were left reeling as the pt demise of the Lehman Broth- investment bank sparked the est shake-up on Wall Street in ades.

nother of US capitalism's biggest tutions, Merrill Lynch, is to be lowed by Bank of America in a billion takeover to save it from se.

res fell as fear spread through ancial system. Central banks un- urgent measures amid concerns e world economy was entering erous new phase. The Bank of d injected £5 billion of emer- lending into money markets. 5,000 Lehman staff in Britain

are now
uestionably in
vorst financial
s since the
t Depression'

aletsky, page 24

rticle page 2
ker page 5

Dow Jones industrial average was down 300 points, or 2.6 per cent. Sentiment was also bolstered by steep falls in oil prices, which dropped by more than $5 a barrel to $96, closing under $100 for the first time in six months and raising hopes that cheaper fuel would ease economic stresses on Western nations.

However, by close of trading the Dow had fallen by more than 500 points — its biggest one-day drop since the reopening after the September 11 attacks — as concerns mounted over the world's largest insurer. Shares in American International Group (AIG), which sponsors Manchester United, fell by 45 per cent after it made an unprecedented approach to the US Federal Reserve for $40 billion in emergency funding.

Last night the Fed asked Goldman Sachs and J P Morgan Chase, two of Wall Street's remaining big banks, to head a $75 billion emergency package to keep AIG afloat.

As central banks battled to stabilise the system, the Fed eased its rules for emergency lending further. It announced that it would accept company shares in return for crisis loans for the first time. In Frankfurt, the European Central Bank injected €30 billion in emergency funds into eurozone markets.

A group of ten global banks also attempted to foster calm, announc-

Bitcoin: A Peer-to-Peer Electronic Cash System

Satoshi Nakamoto
satoshin@gmx.com
www.bitcoin.org

Abstract. A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. Digital signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double-spending. We propose a solution to the double-spending problem using a peer-to-peer network. The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work. The longest chain not only serves as proof of the sequence of events witnessed, but proof that it came from the largest pool of CPU power. As long as a majority of CPU power is controlled by nodes that are not cooperating to attack the network, they'll generate the longest chain and outpace attackers. The network itself requires minimal structure. Messages are broadcast on a best effort basis, and nodes can leave and rejoin the network at will, accepting the longest proof-of-work chain as proof of what happened while they were gone.

1. Introduction

Commerce on the Internet has come to rely almost exclusively on financial institutions serving as trusted third parties to process electronic payments. While the system works well enough for

The identity of Satoshi Nakamoto is still not known

  Nofima

What is blockchain?

The blockchain is an incorruptible digital ledger of (economic) transactions that can be programmed to record not just financial transactions, but virtually everything (of value)

Don & Alex Tapscott, Blockchain Revolution (2016)

Sample transaction: From account: 1234, To account: 5678, Amount: 1 BTC

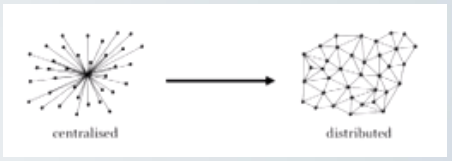
Innumerable news articles on blockchain

"It is es… roducts are …With blockch… e easily identifie… pensive

"In [a W… took 2.2 seco… farm. Witho… e the retailer … nutes to

Blockchain is a special type of database that contains transactions

Online
(many users)



Distributed
(many copies)

Database

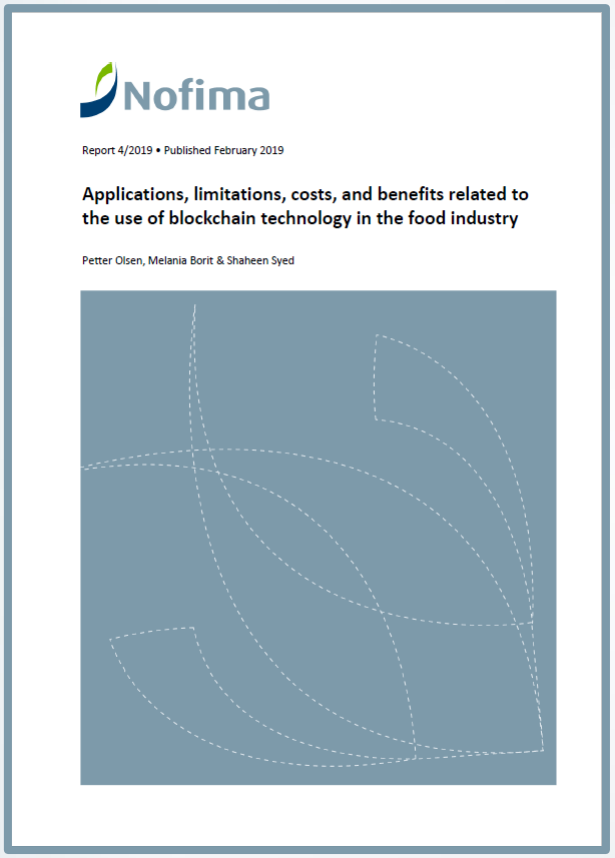
Synchronised
(every 10 minutes)

Encrypted,
Immutable

Conclusion

- Confidentiality and speed can be a challenge for traceability systems based on blockchain technology, but otherwise the technology is well suited for the purpose, and interoperability will be simpler
- It is a challenge that many blockchain technology solution providers promise more than they can deliver
- Blockchain will not prevent food fraud, but we will always know who recorded data, we will know that the data has not subsequently been changed, and it will be more difficult to introduce undeclared ingredients and products into the supply chain

For more details…



Nofima Report 4/2019

Applications, limitations, costs, and benefits related to the use of blockchain technology in the food industry

Thanks for your attention

Petter Olsen
petter.olsen@nofima.no

www.nofima.no

The research leading to these results has received funding from the European Union's Framework Programmes under grant agreement n° 727864 ***EU-China-Safe*** *(H2020), n° 818173* ***AquaVitae*** *(H2020), and Northern Periphery and Arctic Programme Project n° 401* ***DisruptAqua*** *.*