Hvorfor bare laboratoriemetoder ikke er nok; deteksjon og bekjempelse av matsvindel ved å analysere sporbarhet og registeringer

FoodFraud 2021 konferanse

København 15/09/21

Seniorforsker Petter Olsen, Nofima

About Nofima

Nofima is a private, non-profit research institute owned by the Norwegian government with head office in Tromsø and over 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 2020 was around 65 Million Euros

Food fraud quiz

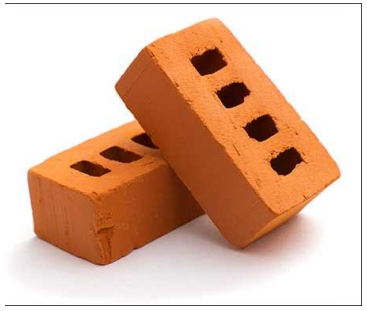
You thought you were buying this:





But instead they gave you (a significant amount of) this:



Connect the foodstuff to the material that was added to it!

Food fraud quiz

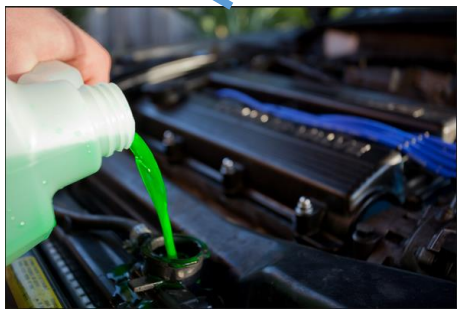
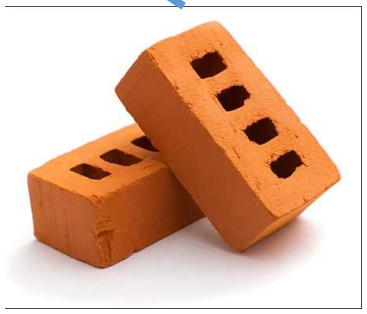
You thought you were buying this:





But instead they gave you (a significant amount of) this:



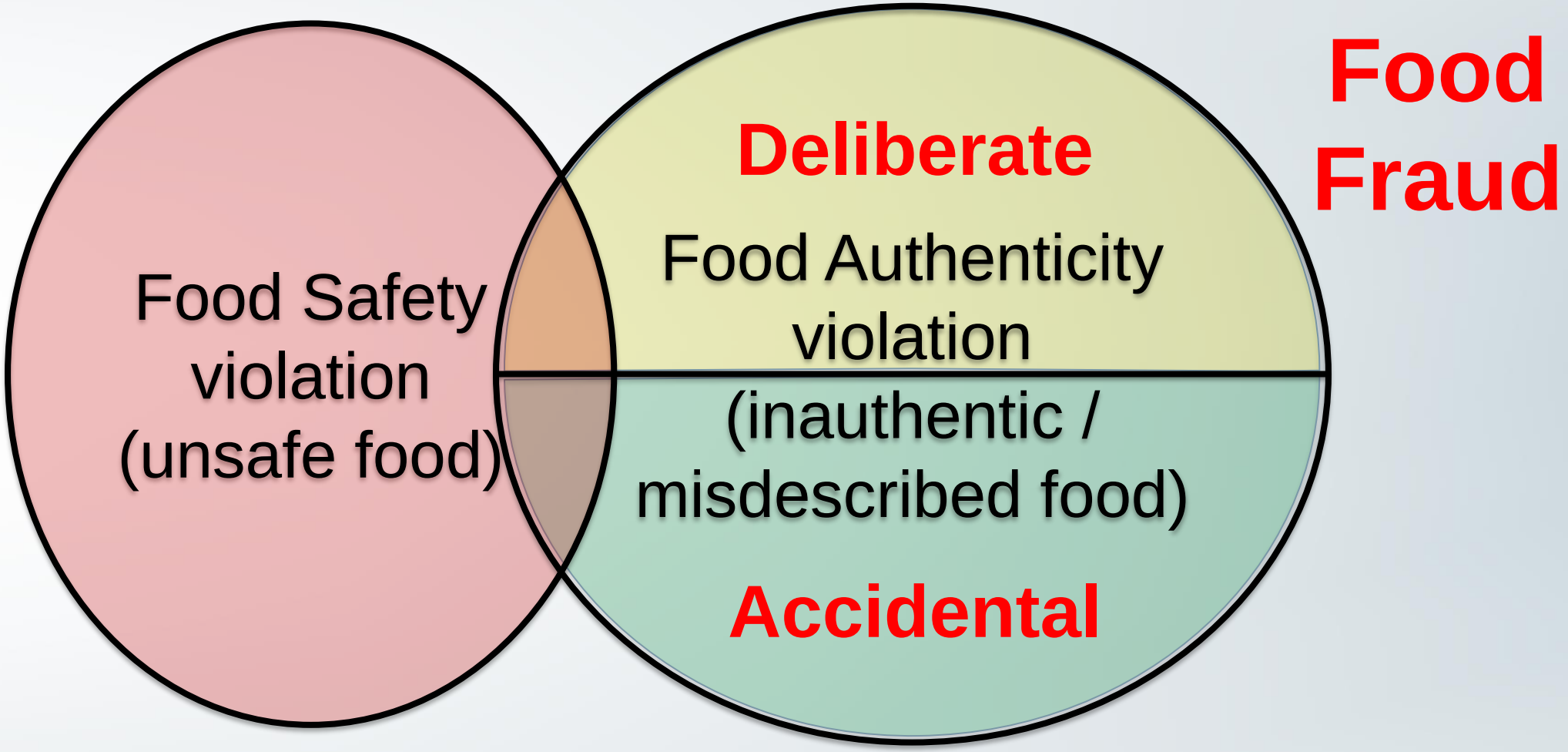



Connect the foodstuff to the material that was added to it!

This presentation

1. Defining food fraud
2. Two different approaches to food authenticity
3. Input-output analysis, mass-balance accounting
4. Components of a traceability system
5. Use of blockchain technology

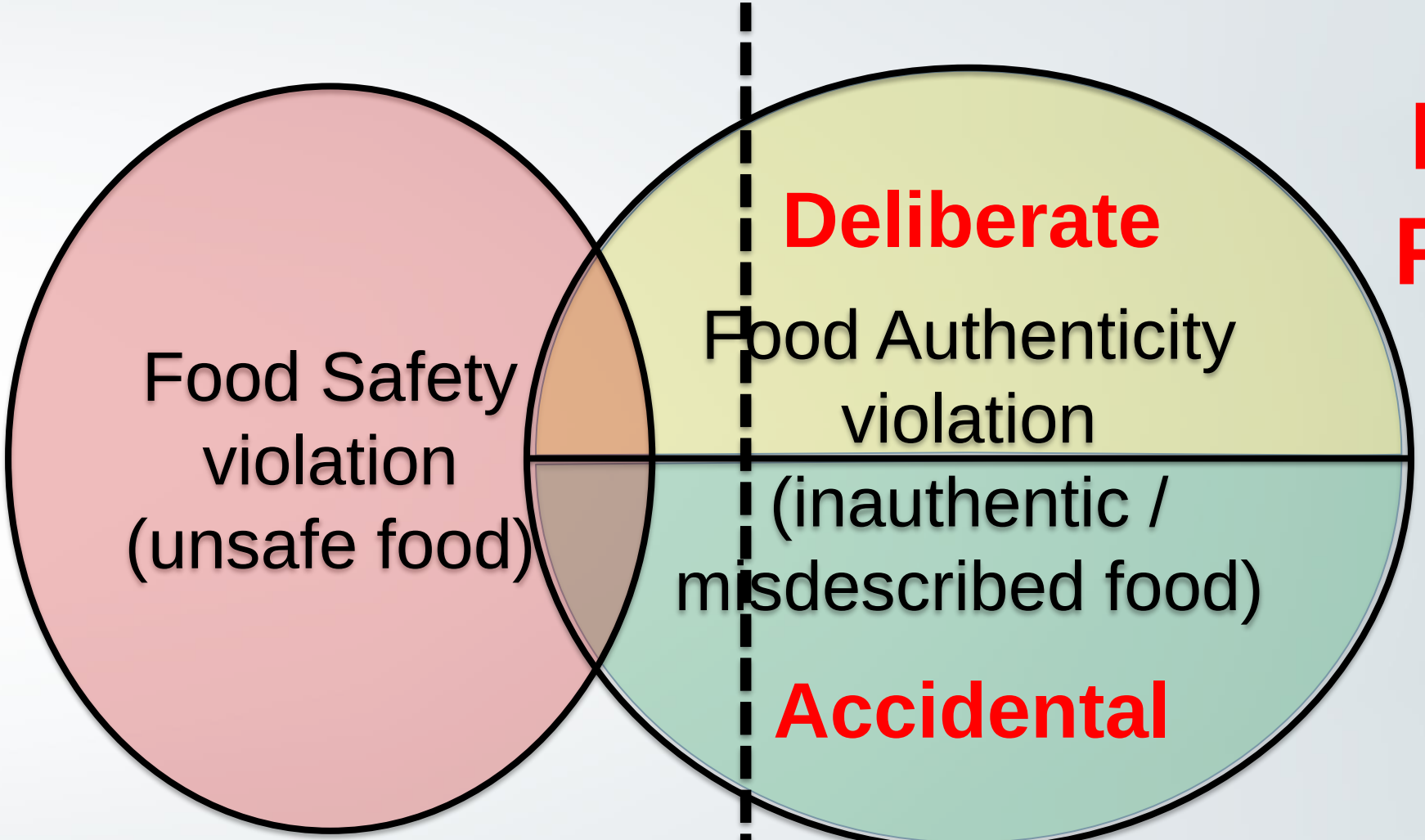
Food safety, food authenticity, and food fraud



Food fraud is not a branch of food safety

- Food safety problems always have a biochemical component that, at least potentially, can be detected by analytical methods and instruments; food fraud cannot necessarily be detected analytically
- Food safety violations are almost always unintentional; food fraud is always intentional
- If someone detects a food safety issue, the food producer will normally cooperate; if a (potential) food fraud issue is detected, the (guilty) food producer will normally not cooperate
- The victim of food safety incidents is the consumer; the main victim of food fraud incidents is the legitimate producer

Food safety, food authenticity, and food fraud



Analytically verifiable properties

- 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

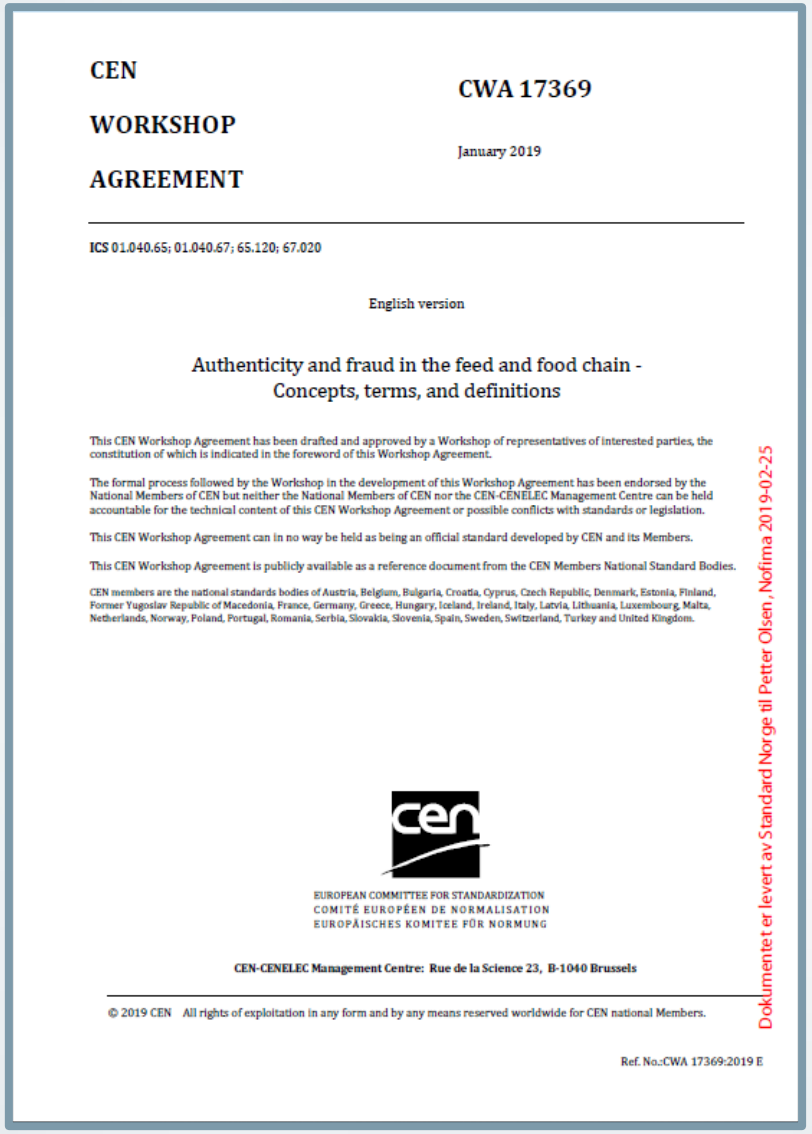
- Dioxin in Belgian chicken feed
- Cadmium in salmon feed
- Sudan Red
- Nitrite in smoked salmon
- Wrong species declaration for sushi fish
- Horsemeat sold as - / mixed with beef

Properties 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

Defining Food Fraud

CWA 17369:2019



CEN

WORKSHOP

AGREEMENT

CWA 17369

January 2019

ICS 01.040.65; 01.040.67; 65.120; 67.020

English version

Authenticity and fraud in the feed and food chain - Concepts, terms, and definitions

This CEN Workshop Agreement has been drafted and approved by a Workshop of representatives of interested parties, the constitution of which is indicated in the foreword of this Workshop Agreement.

The formal process followed by the Workshop in the development of this Workshop Agreement has been endorsed by the National Members of CEN but neither the National Members of CEN nor the CEN-CENELEC Management Centre can be held accountable for the technical content of this CEN Workshop Agreement or possible conflicts with standards or legislation.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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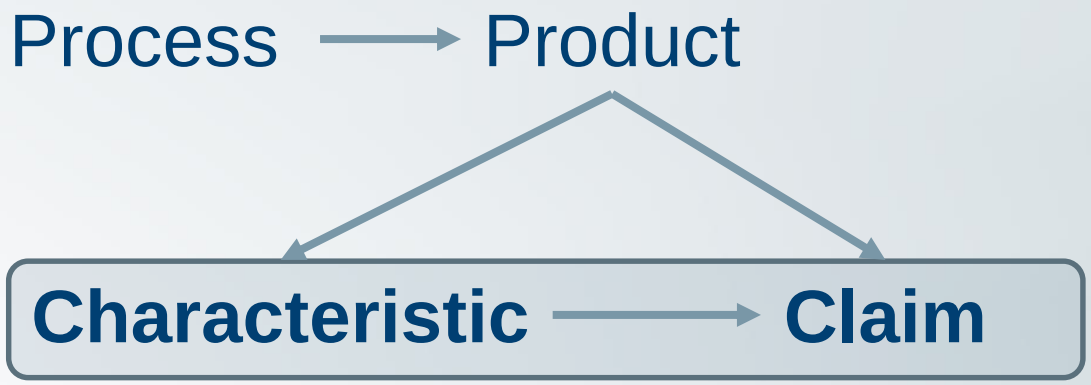
Authenticity and fraud in the feed and food chain – Concepts, terms, and definitions

A hierarchy of food fraud terms



(food product) claim

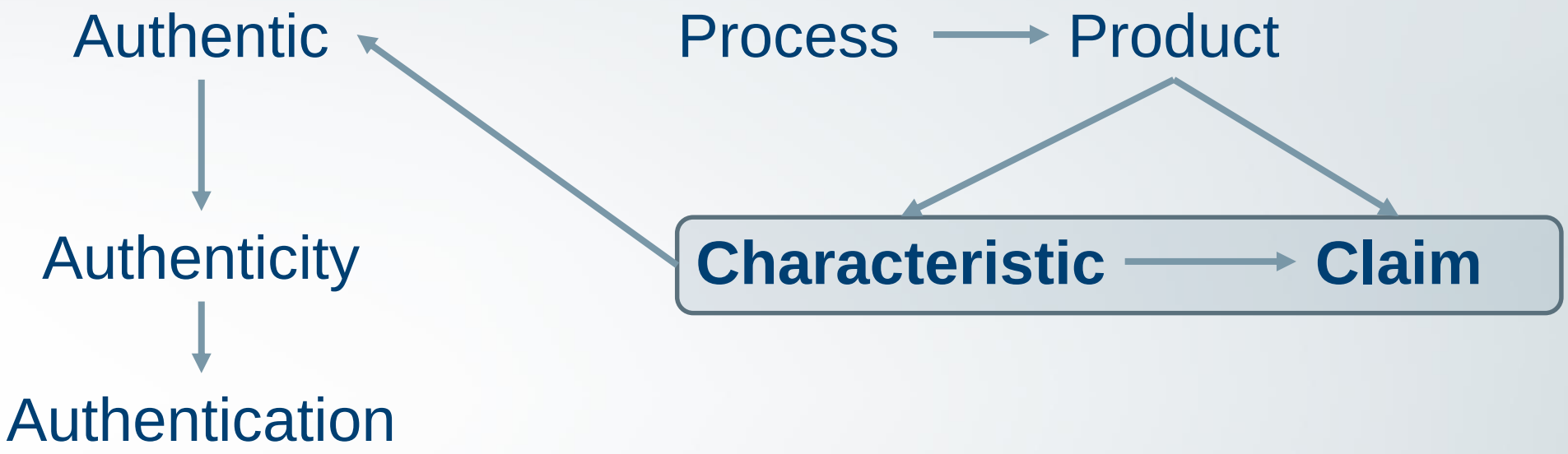
A statement where a **product** is said or implied to have a certain **characteristic**

Note 1 to entry: The claim can be explicit, e.g. on the label or in the accompanying documentation

Note 2 to entry: The claim can be implicit, in that if the food product had the characteristic in question, it should have been stated explicitly, or it should not have been put on the market at all. Examples of implicit claims assumed to be true for food products include:

- The product is safe
- The ingredient list is complete
- The product does not contain undeclared allergens
- The food product is produced according to applicable rules and regulations

A hierarchy of food fraud terms



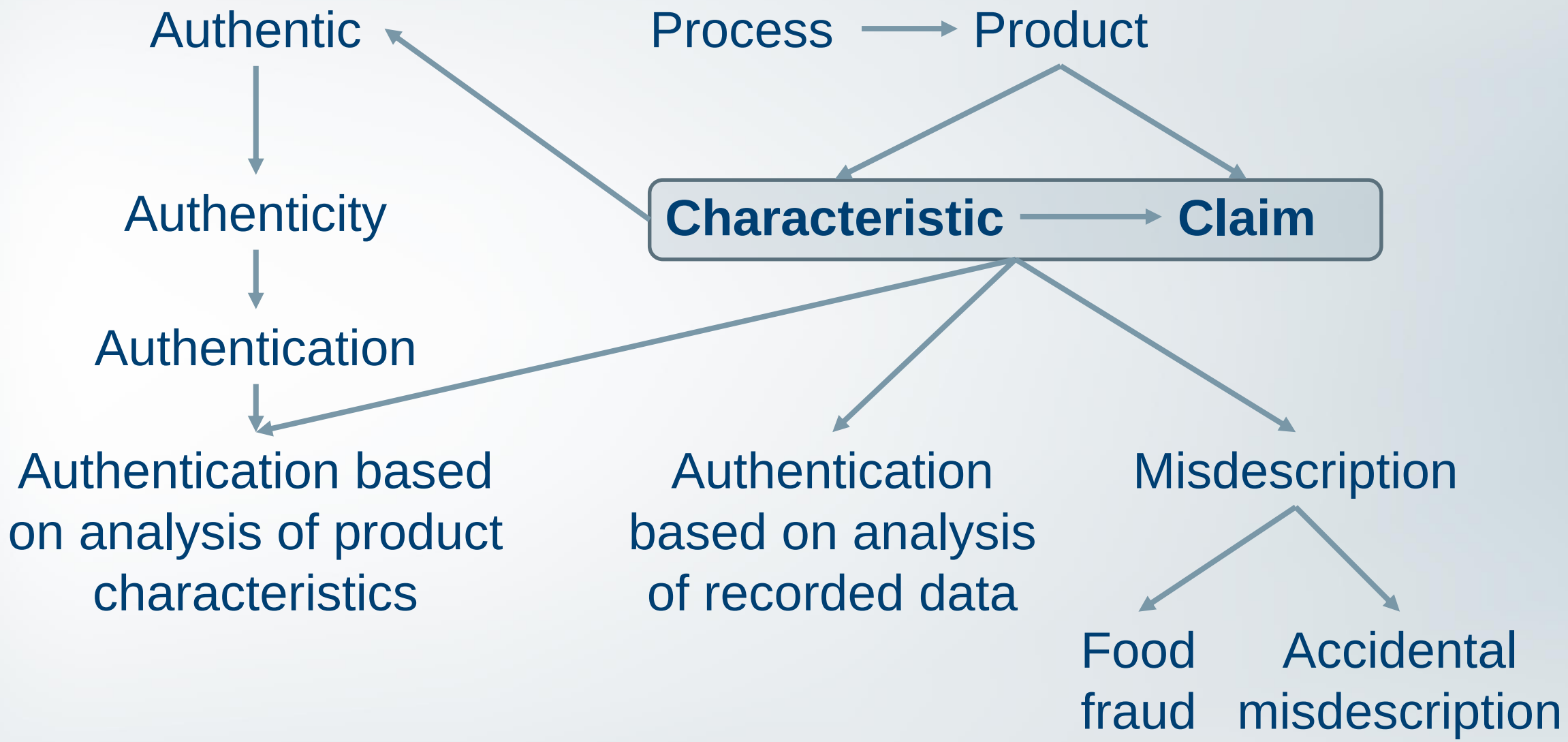
Authentic
Match between the food **product characteristics** and the corresponding food product **claims**

Note 1 to entry: This is a state of being for a food product; either it is authentic, or there is a mismatch between some characteristics and the corresponding claims, and the product is not authentic

Authenticity
State of being **authentic**

Authentication
Process of verifying the **authenticity** of the food product

A hierarchy of food fraud terms



Misdescription

Mismatch between the actual food product **characteristic** and the corresponding food product **claim**

Note 1 to entry: Food product misdescription can be deliberate or accidental
Note 2 to entry: Misdescription on the label of a food product is often referred to as mislabelling, but the term mislabelling is also used to refer to when the label is not in accordance with relevant requirements or regulations.

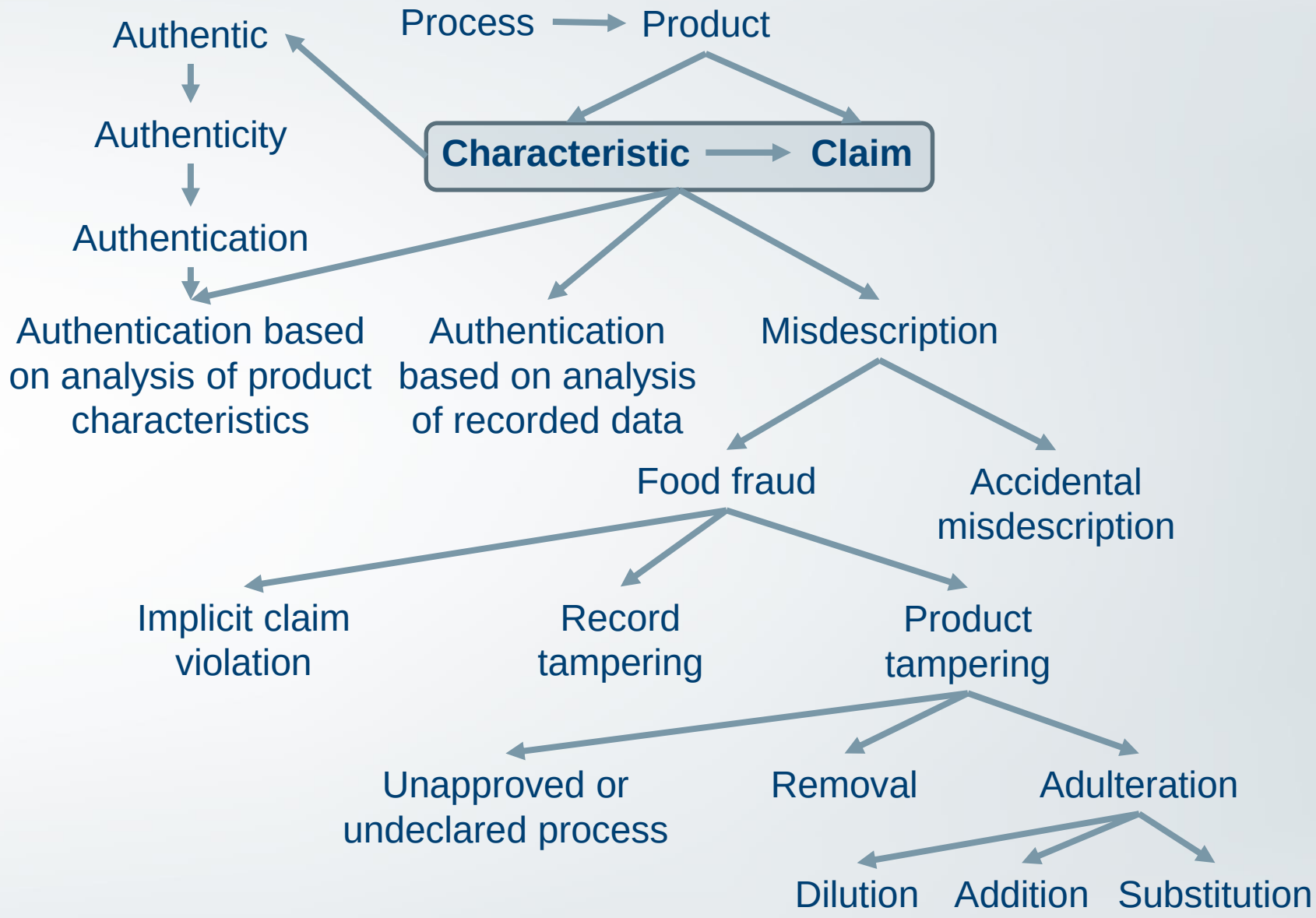
Accidental misdescription

Unintentionally causing a mismatch between food product **claims** and food product **characteristics**

Food fraud

Intentionally causing a mismatch between food product **claims** and food product **characteristics**

The whole hierarchy of terms in the CWA



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

Authentication methods for food products

For claims/characteristics that have a biochemical component:

- DNA-based analyses, Stable isotope and trace element analyses, Liquid chromatography (LC), Gas chromatography (GC), Nuclear magnetic resonance (NMR) spectroscopy, Vibrational spectroscopy, Mass spectrometry, Microscopy, General food chemistry analysis, Sensory analysis, …

For claims/characteristics without a biochemical component:

- Input-Output analysis
- Mass-balance accounting

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?

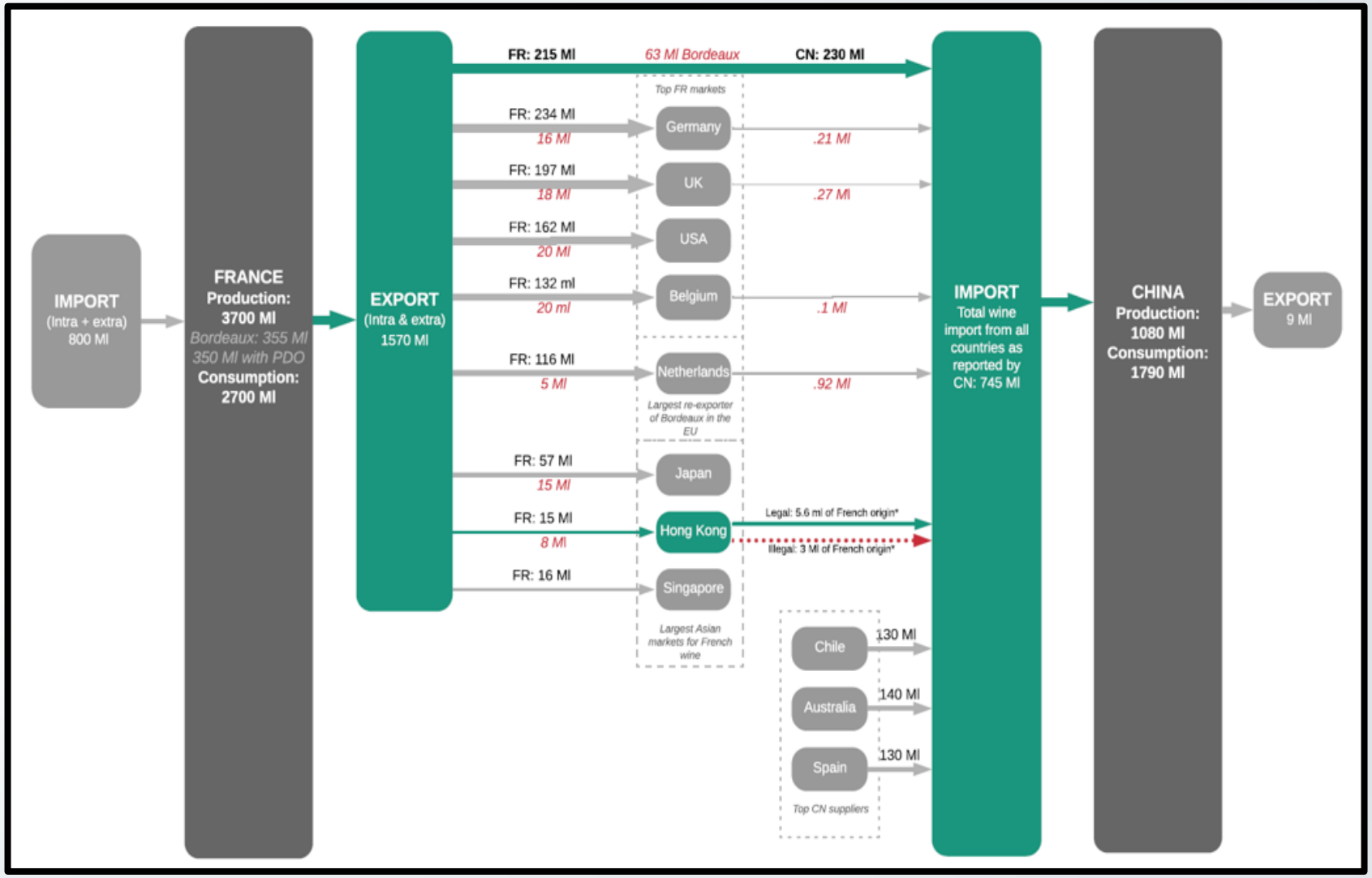
	Reported amount fish / product landet into region:					
1000 tons	Landed	Finn-mark	Troms	Nord-land	Other	Sum
Finnmark	61254		1439	0	217	62910
Troms	70853	163		513	0	71529
Nordland	88188	0	128		85	88401
Andre	49005	0	0	212		49217
Sum	269300	163	1567	725	302	272057

	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?

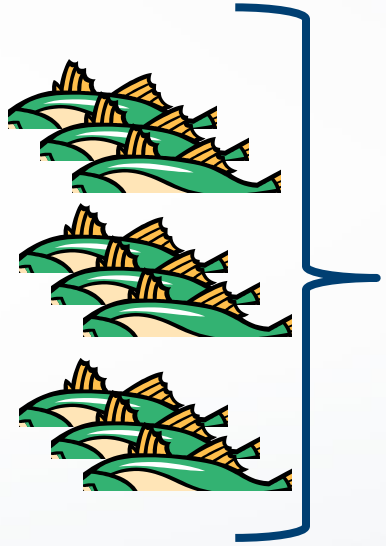
Input-Output analysis for wine exported from France to China



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.

Process



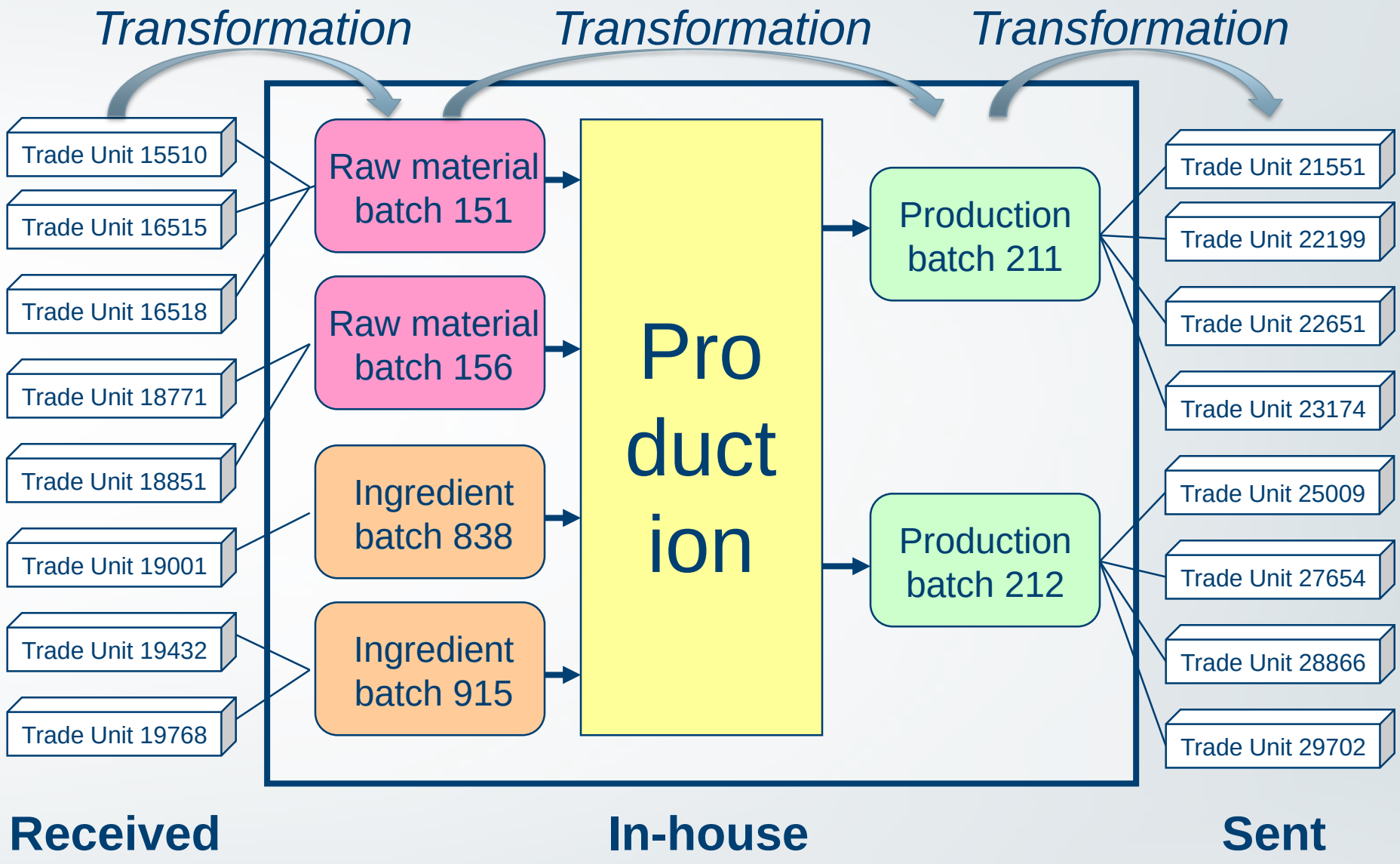
Batch 112
Batch 112
Batch 112
Batch 112
Batch 112
Batch 112
Batch 112
Batch 112
Batch 112

Raw material used to produce Batch 112: **10t**

Significant discrepancy!

Amount of fillet in Batch 112: **8t**

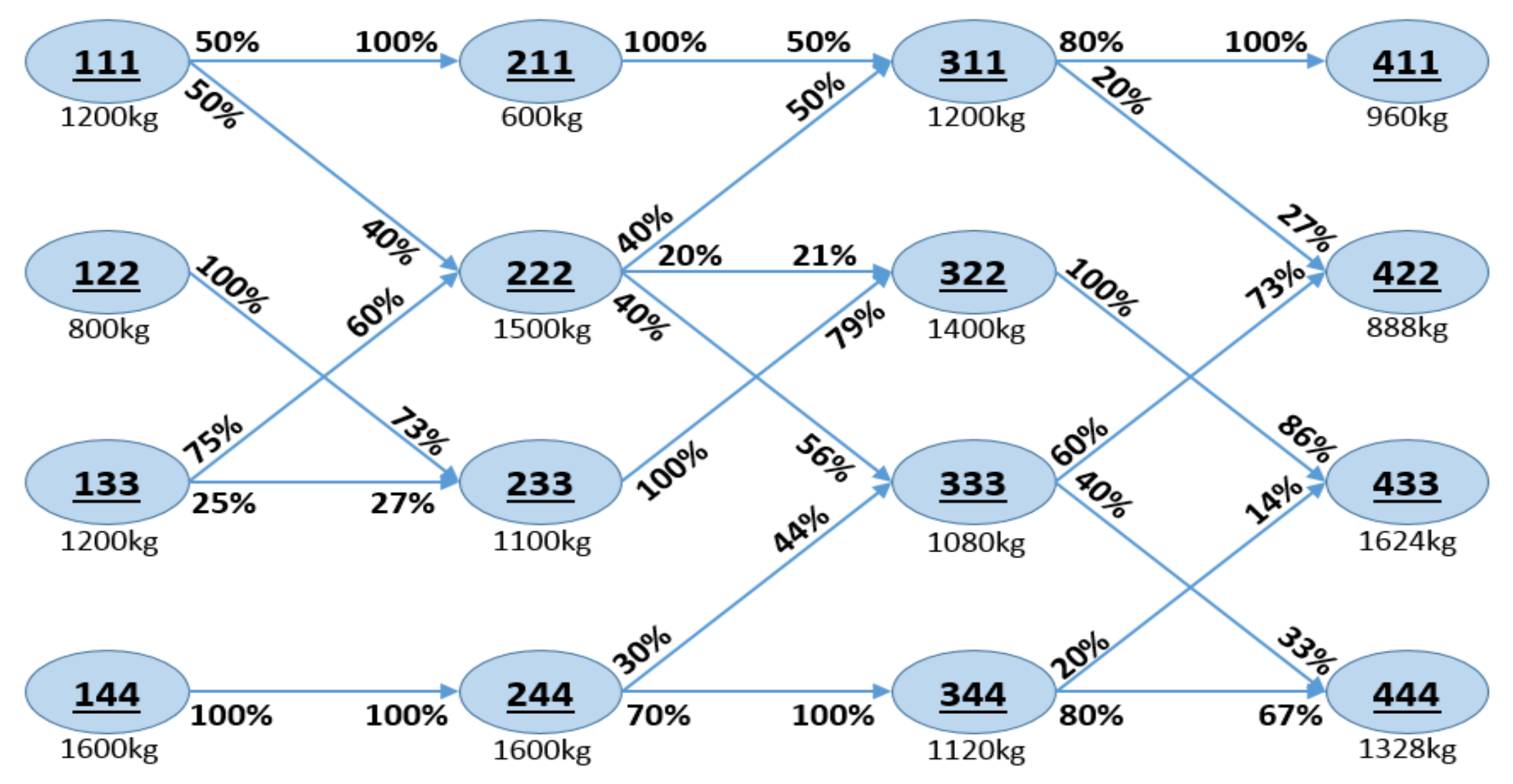
Keeping track of transformations



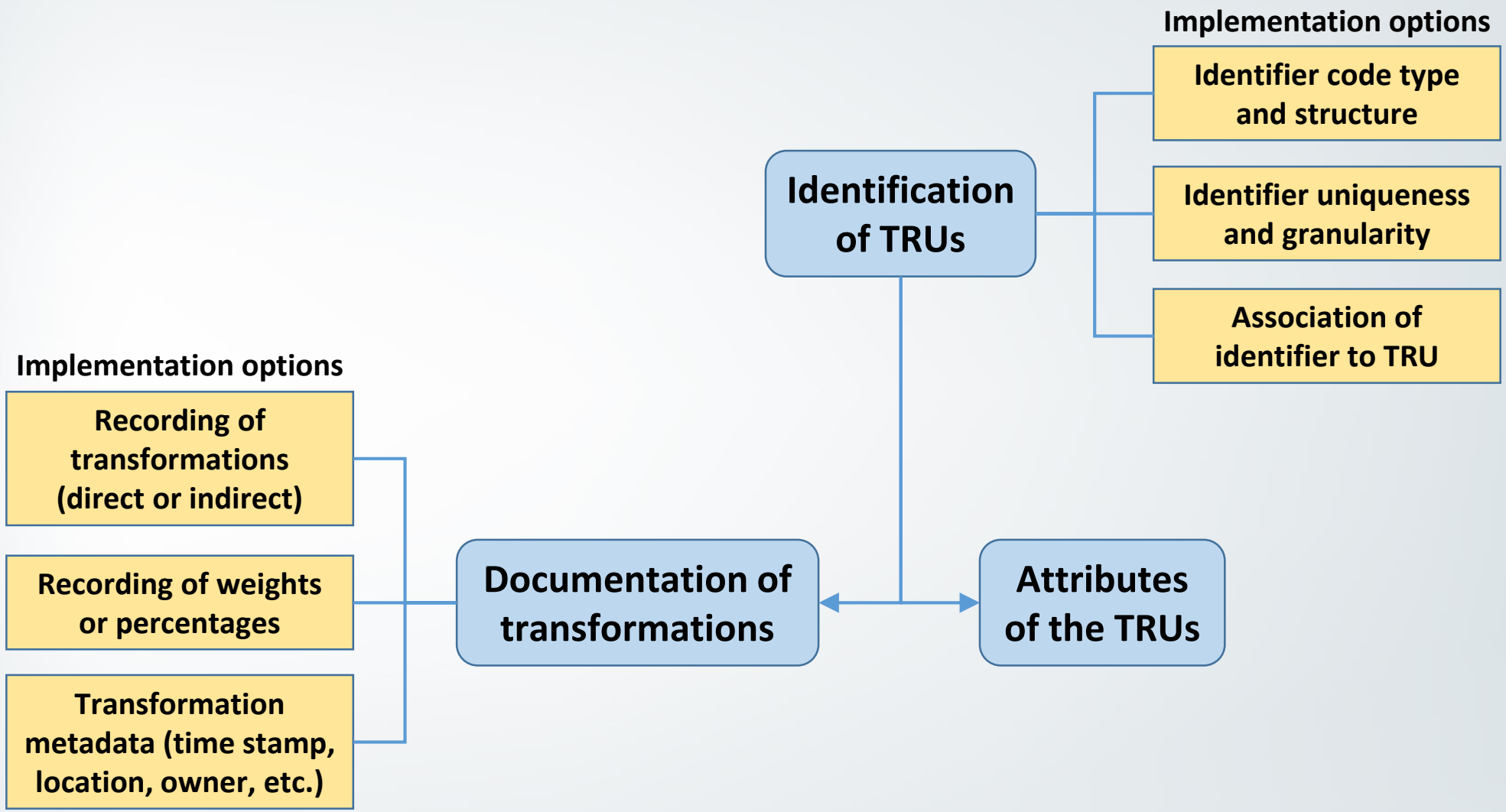
Components of a traceability system

Identification of TRUs

Complicated supply chains with transformations



Components of a traceability system

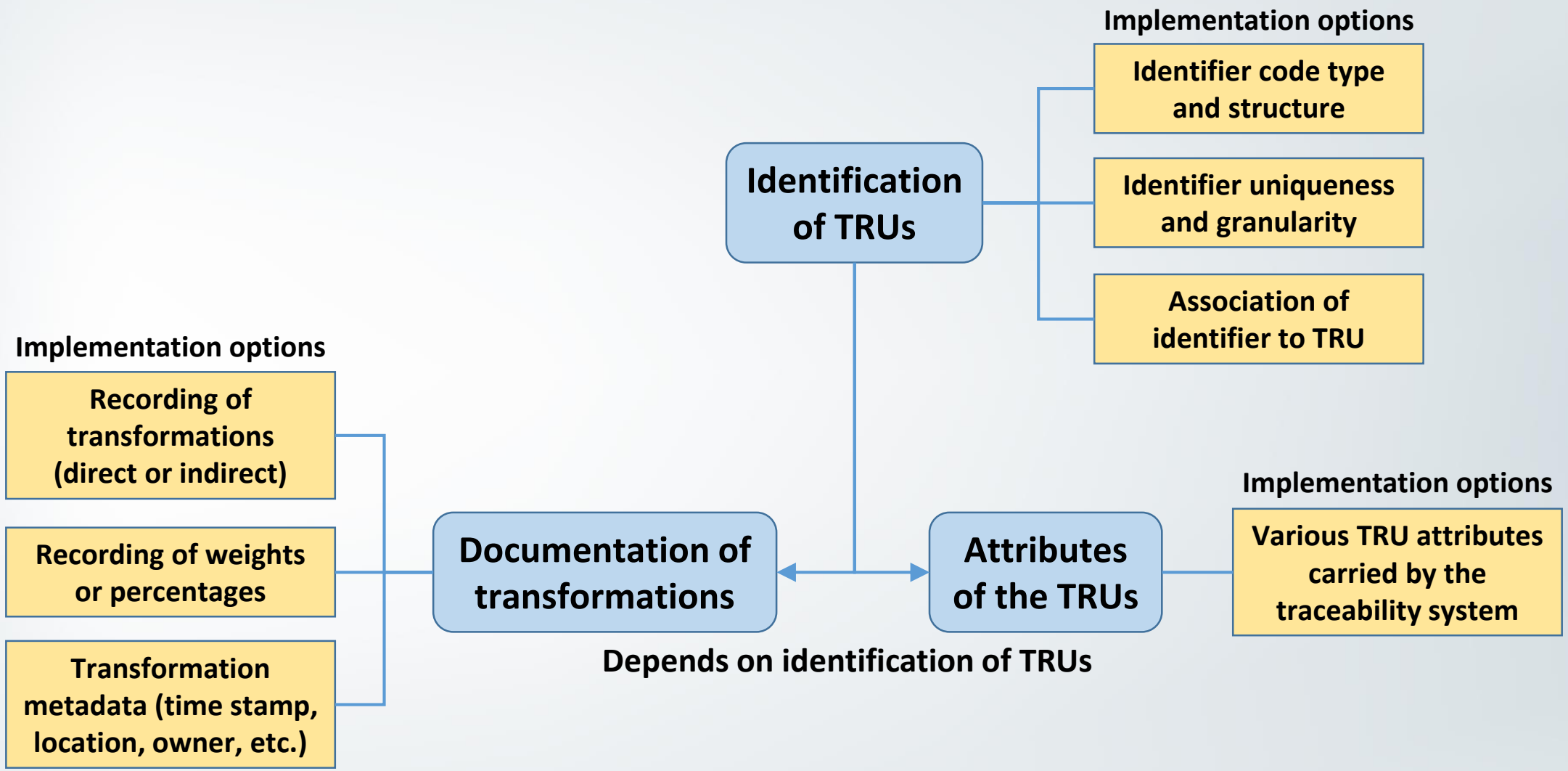


Example: Attributes in a captured fish supply chain

- Species Common Name
- Species Scientific Name
- Location/Catch Area Common Name
- Location/Catch Area FAO Map Number
- Location/Catch Area Latitude
- Location/Catch Area Longitude
- Landing location
- Landing location
- Receiving station name/ID
- Date of Catch/Date of Sailing
- Date of landing
- Vessel Type
- Vessel Name
- Vessel Unique ID/Call Sign
- Vessel Flag State
- Gear Type
- Fishing Method
- Onboard storage method
- Producer Information
- Production location
- Business name/ID
- Date of Production
- Date of durability
- Date of shipment
- Type of product
- Preservation/processing method
- Storage
- Storage method
- Unit Weight
- Packaging
- Method of packaging
- Labelling scheme
- Eco-label scheme
- …

FoodIntegrity project – Deliverable 6.1 Seafood Claims Ontology

Components of a traceability system



September 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

urs 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
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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, announci

October 2008

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 unknown

Blockchain news articles …

"It is estima … products are adulterate … blockchain] tampered p … entified and isolated, pr … duct recalls."

"In [a Wal … it took 2.2 seconds to … rm. Without blockchain, t … r six days, 18 hours and 26 … original farm."

What is blockchain?

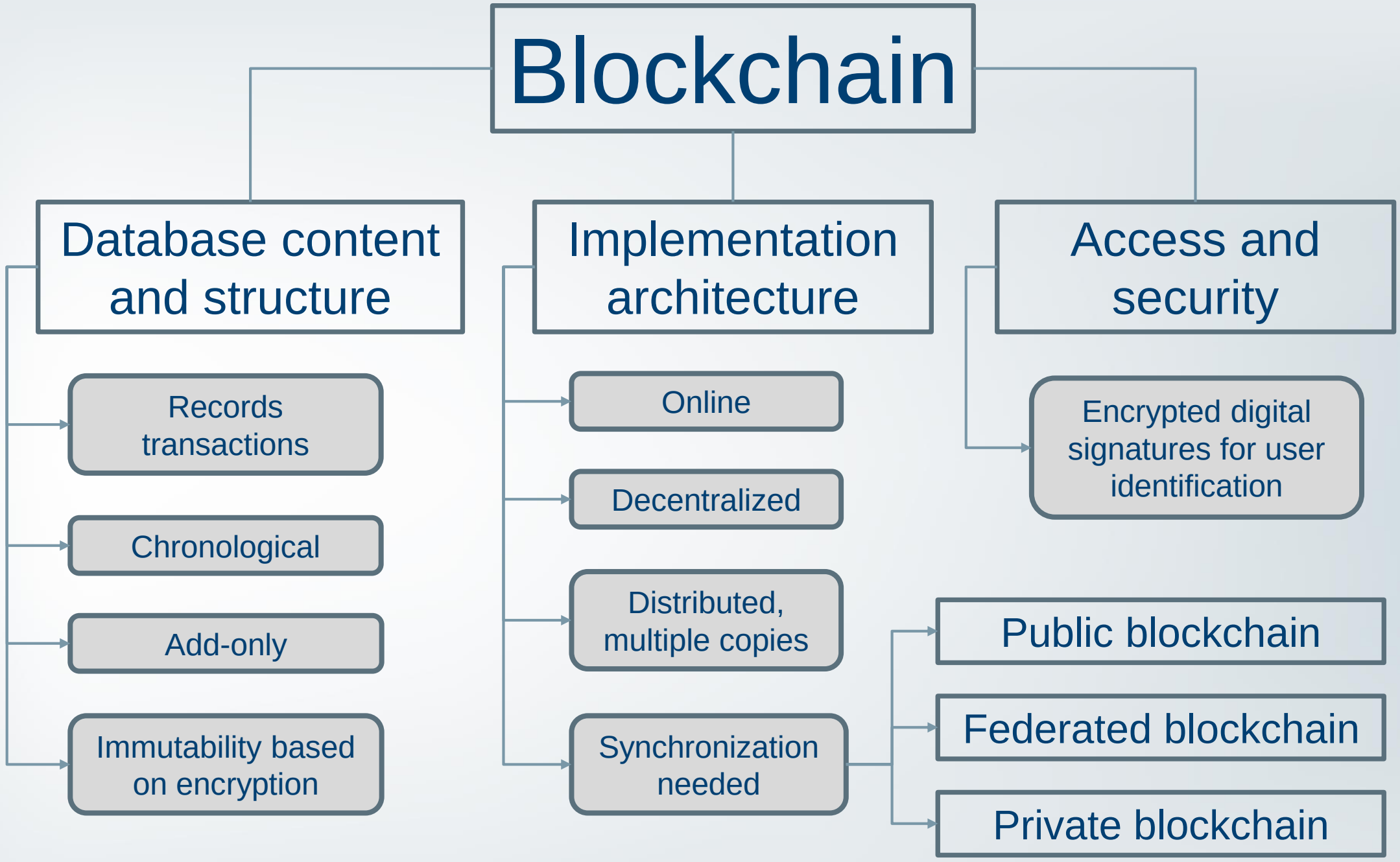
The blockchain is an incorruptible digital ledger of (economic) transactions that can be programmed to record not just financial transactions, but virtually everything (of value)

Don & Alex Tapscott, Blockchain Revolution (2016)

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

What does this mean?

- A block is a set of transactions; normally all transactions reported the last 10 minutes
- The blockchain is a database of blocks
- The users add new blocks to the database every 10 minutes; the database is always growing
- There are thousands of (normally identical) copies of the database, all over the world
- Designed to prevent double spending of digital currency


Blockchain
Database content and structure
Records transactions
Chronological
Add-only
Immutability based on encryption
Implementation architecture
Online
Decentralized
Distributed, multiple copies
Synchronization needed
Public blockchain
Federated blockchain
Private blockchain
Access and security
Encrypted digital signatures for user identification

Verifying recorded data means…

1. Verifying the integrity of the TRU identifier, i.e. that the identifier has not been changed, tampered with, or re-used beyond the intended scope
2. Verifying that the stated transformations are correct, i.e. that the stated input TRUs were used only to produce the stated output TRUs, and that the stated output TRUs came only from the stated input TRUs
3. Verifying that the stated attributes are correct, i.e. that the attribute recorded in the traceability system matches the actual attribute of the TRU

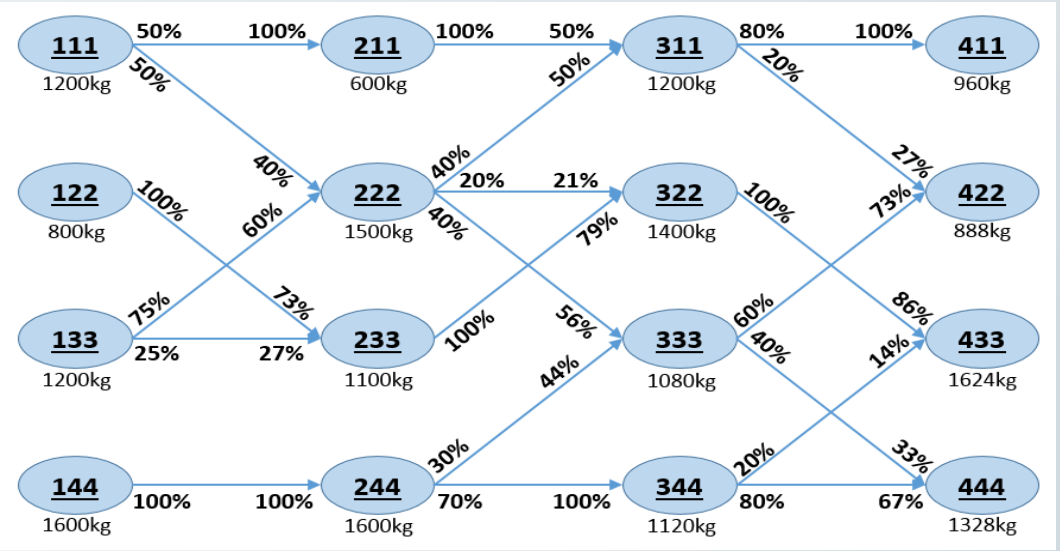
1) Verifying the integrity of the identifier

In general, this cannot be done within the traceability system; the product and label may look exactly as it should, but how do we know that it actually is the TRU that we assigned this identifier to? If the TRU identifier is supposed to be unique, we might be able to identify that a single TRU appears in more than one place at a time.

There are of course various physical (as opposed to virtual) technologies that can make copying of identifiers and labels more difficult; these will not be covered here.

2) Verifying the transformations

This is an area where blockchain can really help with verification, as every transaction (which in a food traceability system means ‘transformation’) is recorded, not just the final value.



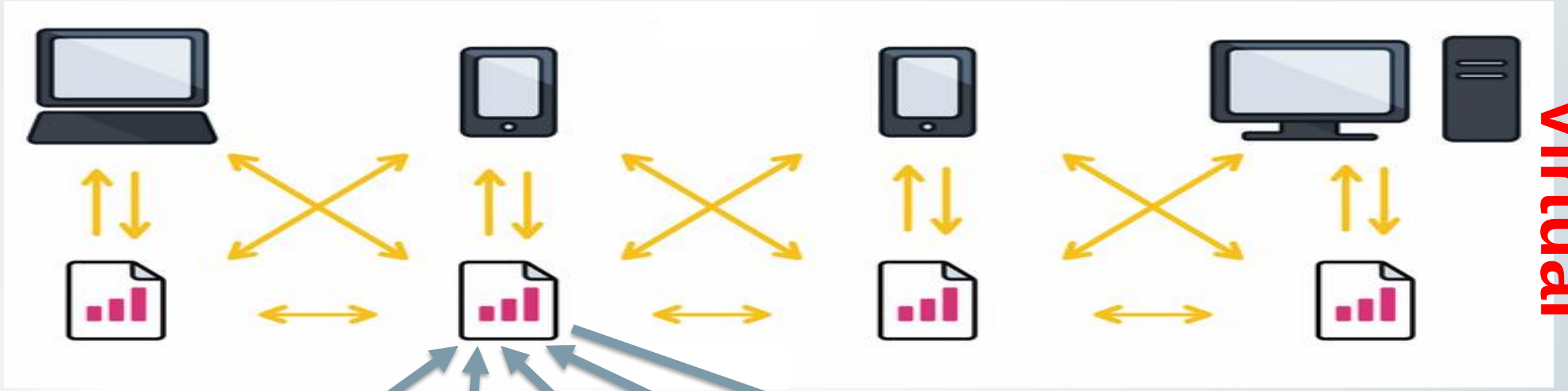
If all the previous transformations are recorded using blockchain technology, new transformations will be added without overwriting the previous ones, and all transformations will be available.

In a traditional traceability system, normally only the inputs and outputs at a given process are recorded, which means that there is no automatic access to the chain of transformations.

3) Verifying the attribute values

- Blockchain suffers from the ‘garbage in, garbage out’ problem, same as in a traditional traceability system.

Blockchain and supply chain



Online
Virtual

Getting accurate data into the blockchain is the challenge

Physical

3) Verifying the attribute values

- Blockchain suffers from the ‘garbage in, garbage out’ problem, same as in a traditional traceability system.
- The access to all previous transformations in the chain means that we already know some of the attribute values; they are ‘inherited’ from previous TRUs (species, origin, etc.).
- As the identity of who made the transaction is recorded, it is less tempting to deliberately falsify data. In a traditional database system, it might be more difficult to find out who recorded erroneous data.
- The access to the entire history of recordings in the whole supply chain will make it easier to use other data recording based methods for checking authenticity, like input-output analysis and mass-balance accounting.

Desired quality of the system	Does blockchain offer an advantage?
Data quality and veracity	
Trust and transparency	
Data confidentiality, ability to provide tiered data access	
Performance and efficiency	
Robustness, fault tolerance	
Interoperability	

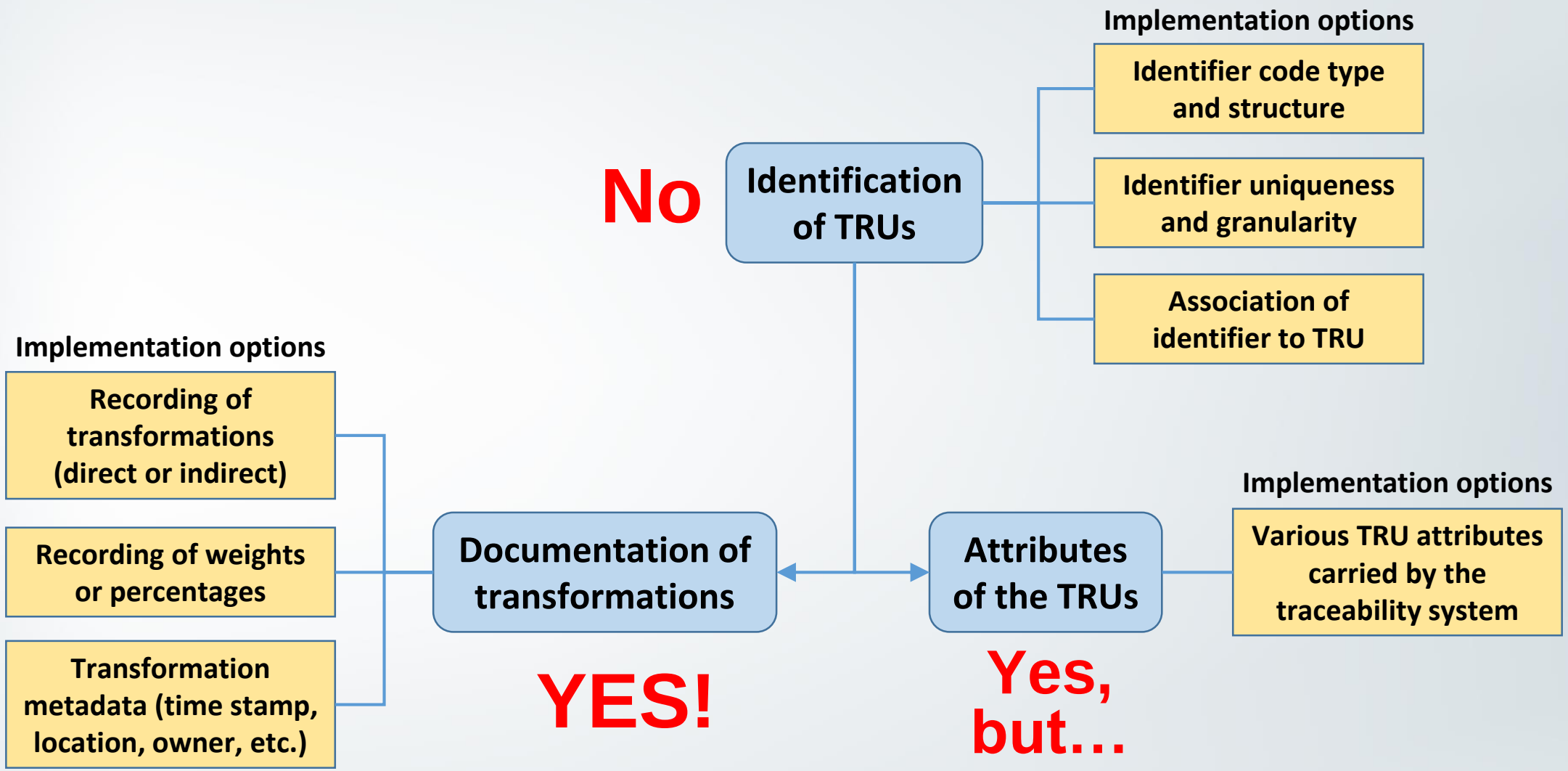
Can blockchain prevent food fraud?

- Blockchain depends on TRU identification, and TRUs can be wrongly identified, or the TRU ID reported is not the actual ID of the TRU in question
- Transformations happen in the physical world, and the information provided about the transformation, the TRUs involved, or the amounts might be wrong
- TRU attributes are determined in the physical world, and the TRU attribute recorded in the blockchain might not match the actual TRU attribute

However…

- Data on transformations will have to refer to TRUs already in the blockchain
- It will forever be clear who recorded claims relating to transformations or TRU attributes
- Some TRU attributes will be inherited from the predecessors in the supply chain (e.g. species)
- The recordings in the blockchain will make it easier to do input-output analysis

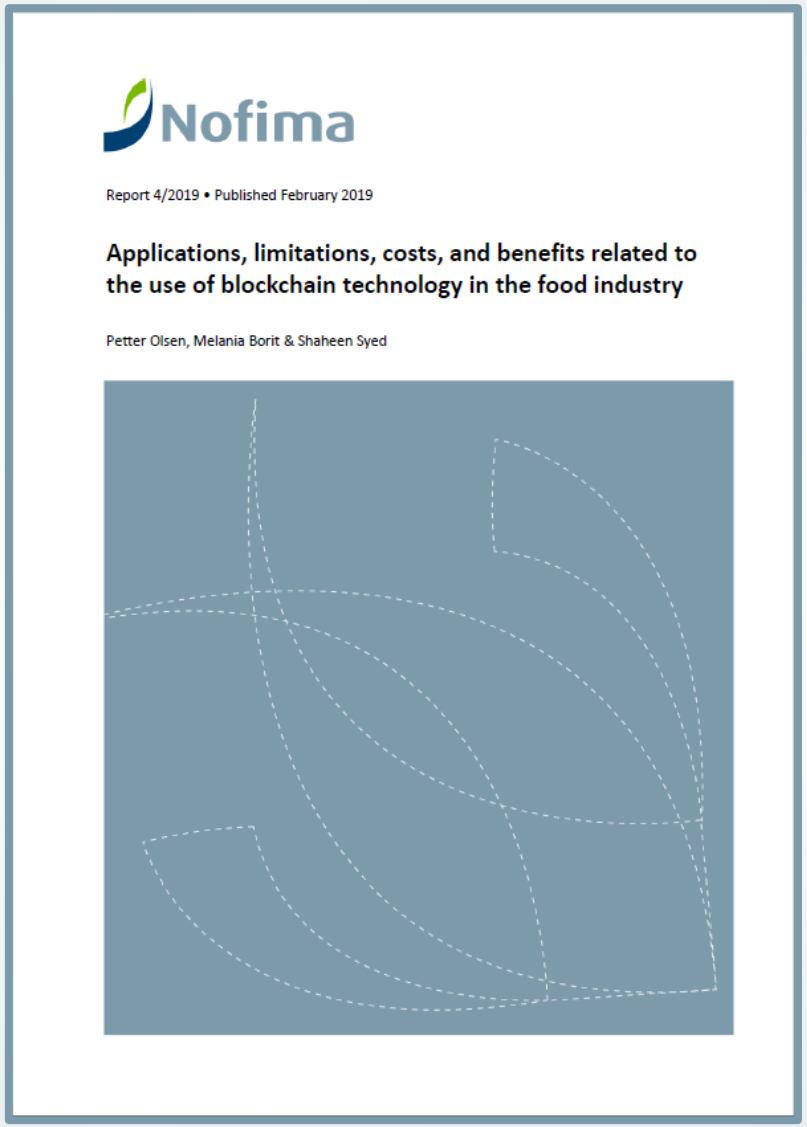
Can blockchain improve the traceability system?



Summary

- Blockchain is an exciting technology that has the potential to underlie a major technological paradigm shift
- Solution providers are currently overselling the benefits of systems based on blockchain technology
- 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
- For traceability in the supply chain, blockchain can remedy some potential problems because while claims that are recorded in the blockchain might still be wrong, it will be quite clear who made these claims, and we will know that these claims have not been tampered with

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

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