

FoodChain-Lab: an innovative tool to increase food safety through supply chain analyses

11.02.2025, FoodChain-Lab workshop France

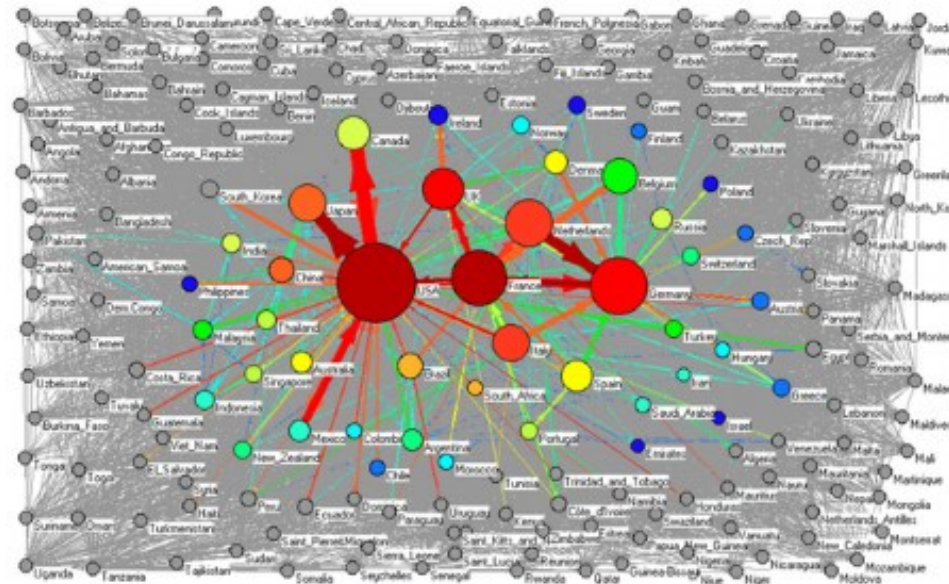
BfR: Marion Gottschald, Alexander Falenski, Marco Rügen, Latife Salih, Arne Zerndt, Hanna Hauck, Marc Lorenzen, Daria Savvateeva, Matthew Salewski, Bernd-Alois Tenhagen

EFSA: Olaf Mosbach-Schulz

FCL was supported by EFSA-BfR Framework Partnership Agreements (FPA) GP/EFSA/AMU/2016/01 and GP/EFSA/AMU/2020/02, and received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 773830 OH EJP COHESIVE.

The challenges of complex global food and feed supply chains

Globalised trade



Long and complex supply chains

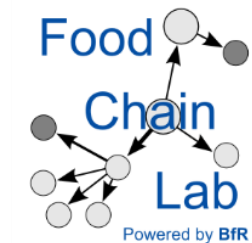
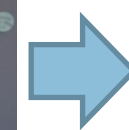
Large amounts of data

Ercsey-Ravasz M et al. (2012) PLoS ONE 7(5): e37810. doi:10.1371/journal.pone.0037810

Increased complexity of risk assessment and outbreak control

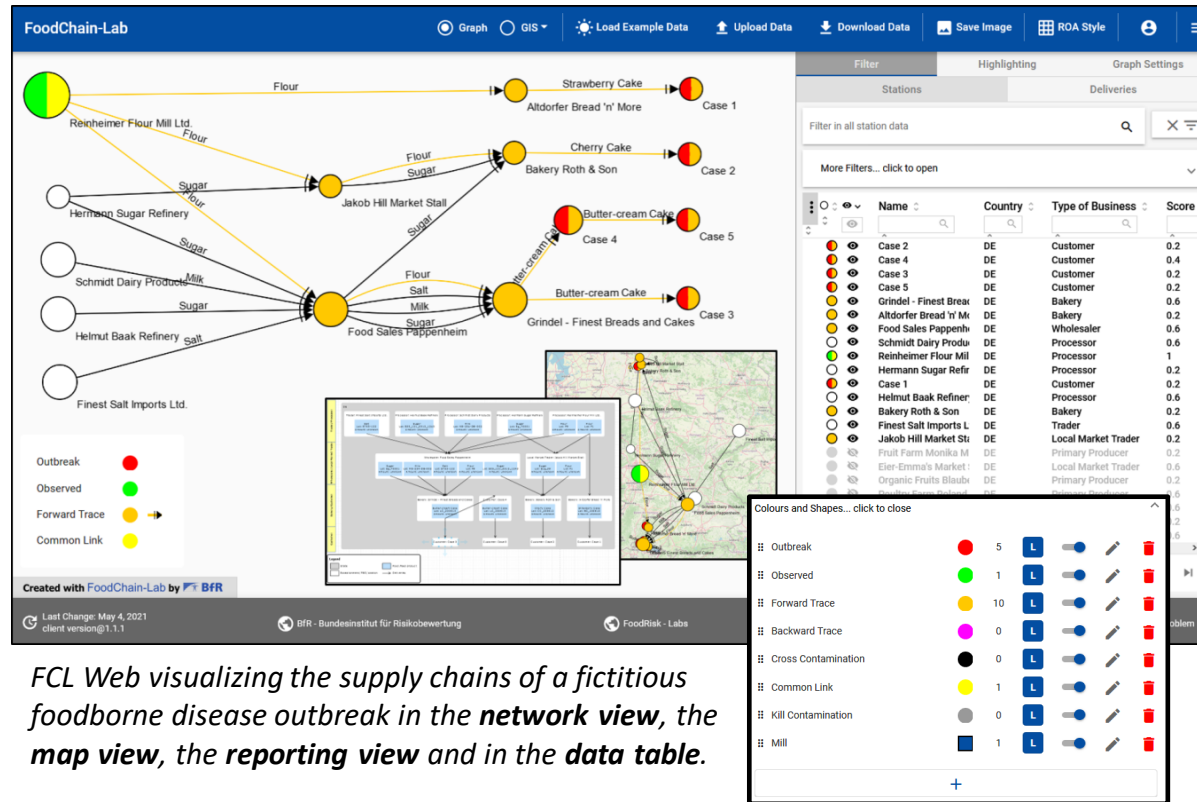


Importance of powerful interoperable software tools e.g. for tracing food and feed



FoodChain-Lab: A tool for supply chain mapping

- Tool to trace back and forward suspicious food items along complex supply chains to help solving foodborne crises (outbreaks, chemical contaminations)



FCL Web visualizing the supply chains of a fictitious foodborne disease outbreak in the **network view**, the **map view**, the **reporting view** and in the **data table**.

Powerful tracing software: What are the needs?

Accessibility

Prioritization

Powerful, digital data collection

Anonymization

Powerful visualization and analysis

Interoperability

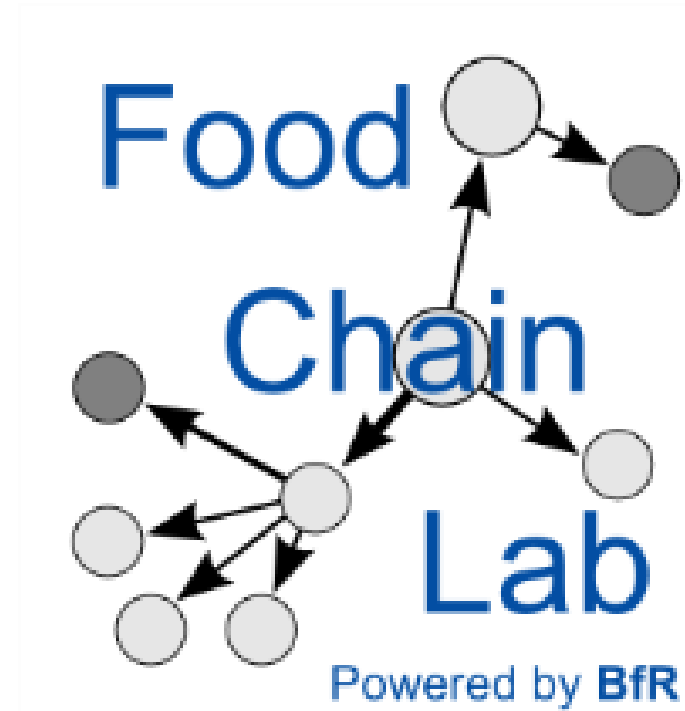
Automated reporting

Data security

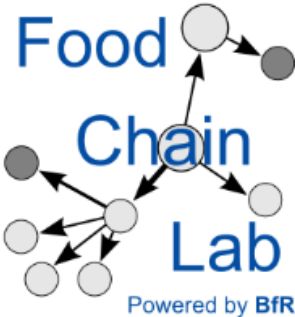
Training

Need: Accessibility

- Free, open access software → **ready-to-use**
- Available as **desktop** and **web application**
<https://foodrisklabs.bfr.bund.de> <https://fcl-portal.bfr.berlin>
- Everybody can register and use it



Need: Digital data in pre-agreed formats



Data collection and data extraction: Structured excel templates as a first step

- Ready to use
- Easy to use and easily accessible
- Machine-readable
- Structured but not much standardised
- Tested and applied in real foodborne incidents

Core part										Flexible part			
Company_ID	Name	Street	Street Number	Postal Code	City	District	State	Country	Type of business	Latitude	Longitude		
1	1	Disease case						DE	Disease case				
2	2	Coffee bar						DE	Coffee bar				
3	3	Oat milk producer						DE	Oat milk producer				
4	4												
5	5												

Core part				Flexible part													
DeliveryID	Station	Product Name	Lot Number	Lot size		Delivery Date Departure			Delivery Date Arrival			Unit weight/vol./pck.		Recipient	Additional Fields ->	Item Number	
				Quantity	Type / Unit	Day	Month	Year	Day	Month	Year	Quantity	Type / Unit				
1	1	5 Coffee ground															
2	2	6 Drinking water															
3	3	3 Oatmilk															
4	4	7 White sugar															
5	5	8 Drinking water															
6	6	9 Oat grain															
7	7	10 Rape seed oil															
8	8	11 Salt															
9	9	12 Vitamin B12															
10	10	13 Regulator (dipotassium phosphate)															
11	11	2 Cappuccino with oat milk and sugar															

From DeliveryID		Into DeliveryID	
1			11
2			11
3			11
4			11
5			11
6			3

= Recipes

FCL All-in-one template
For data collection + extraction of data of whole incident in one file





Inquired Company:		Bakersfield Bakery		[Address]		DE		Manufacturer						
For questions please contact the FoodRisk-Labs team, +49 (30) 18412-4444, foodrisklabs@bfr.bund.de														
Outgoing Goods														
Product	Lot Information			Delivery			Recipient							
	Name	EAN	Lot Number	Best Before Date or Use-by Date	Day	Month	Year	Amount (e.g. 45 kg)	Name	Address (e.g. Street, ZIP City)	Country	Type of Business	Comments	
Summer Cake	SC01			6	11	2017	1 Piece	Patient01		DE	Patient			
Summer Cake	SC02			6	11	2017	1 Piece	Patient02		DE	Patient			
Summer Cake	SC03			6	11	2017	1 Piece	Patient03		DE	Patient			
Summer Cake	SC04			6	11	2017	1 Piece	Patient04		DE	Patient			
Summer Cake	SC05			6	11	2017	1 Piece	Patient05		DE	Patient			
Information to complete the sheet:														
Fill in outgoing goods which are already known (see grey fields above). Please keep track of the ingredients of all sent products - do it in a lot-based manner. In Column A starting with Line Number 22 please enter the line number of the outgoing good being the product of this ingredient. Afterwards, enter the ingredient information in columns B. Please repeat the outgoing good as often as necessary in order to capture all its ingredients.														
Incoming Goods - lot-based Ingredient List														
Line Number or Lot Number from Outgoing Goods	Ingredient	Lot Information			Delivery			Supplier						
		Name	EAN	Lot Number	Best Before Date or Use-by Date	Day	Month	Year	Amount (e.g. 45 kg)	Name	Address (e.g. Street, ZIP City)	Country	Type of Business	Comments
SC01	Butter			Bu100			3	11	2017	6.3 kg	Dairy Products Ltd	DE	Supplier	
SC01	Sugar			Su200			1	11	2017	12.8 kg	Dry Stuff Inc	DE	Supplier	
SC01	Eggs			Eg220			4	11	2017	90 Piece	Chickens & Eggs Farm	DE	Supplier	
SC01	Flour			Fl101			1	11	2017	11.2 kg	Dry Stuff Inc	DE	Supplier	
SC01	Salt			Sal121			1	11	2017	116 g	Dry Stuff Inc	DE	Supplier	
SC01	Baking Powder			BP001			1	11	2017	368 g	Dry Stuff Inc	DE	Supplier	

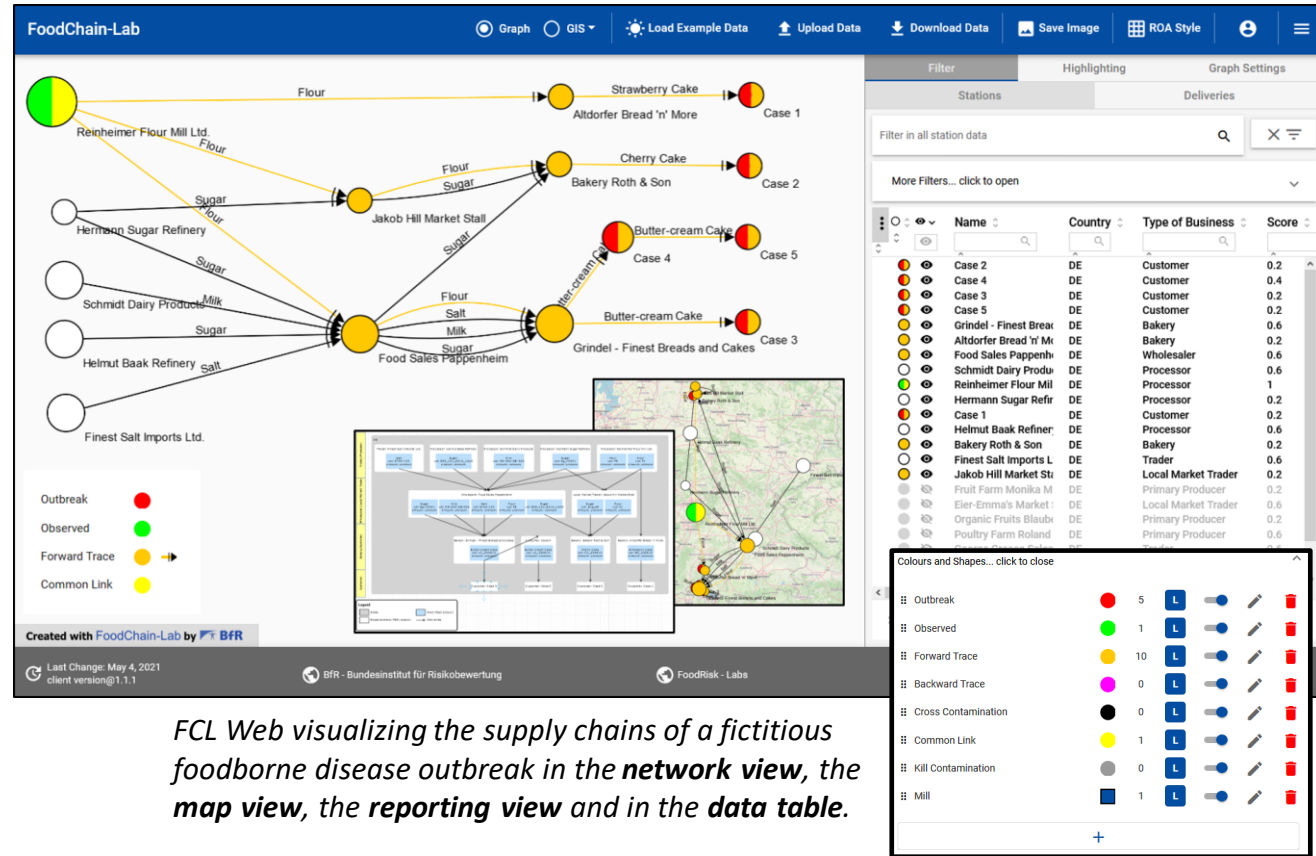
FCL backward + forward tracing template
For stepwise data collection e.g. done by inspectors on site



Need: Powerful visualization and analysis



- Automated visualisation of food business operators  and deliveries  as network and on a map
- Visualizations customizable if needed (different layouts, hiding/merging FBOs and deliveries)
- Automated analysis of supply chain network to identify potential common source  of pathogen/contamination and disease cases  via scoring algorithm; displaying the trace of a product
- Interactive analysis/reasoning, simulation of hypotheses (e.g. cross contamination)
- Helps prioritizing next investigation steps



FCL Web visualizing the supply chains of a fictitious foodborne disease outbreak in the **network view**, the **map view**, the **reporting view** and in the **data table**.

Need: Automated reporting

ROA Report Configuration

Company Box Label ▼

Lot Box Label ▲ ▼

Lot Sample Box Label ▲

type ▼ / Unknown type

amount ▼ / Unknown amount

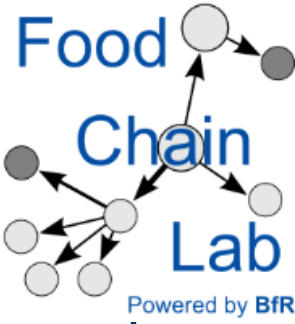
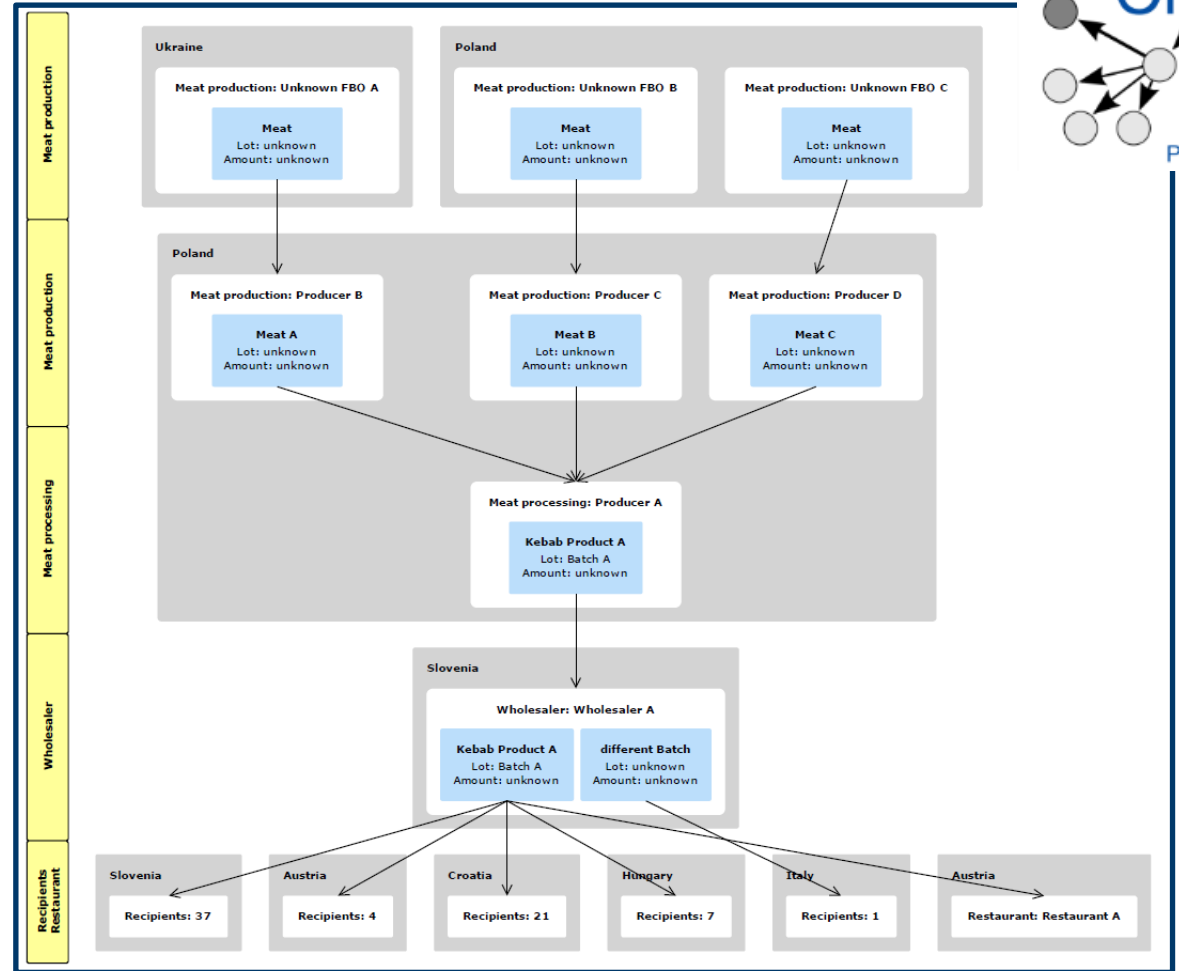
result ▼ / Unknown result

time ▼ / Unknown time

Station Sample Box Label ▼

Display rounded numbers (three digits)

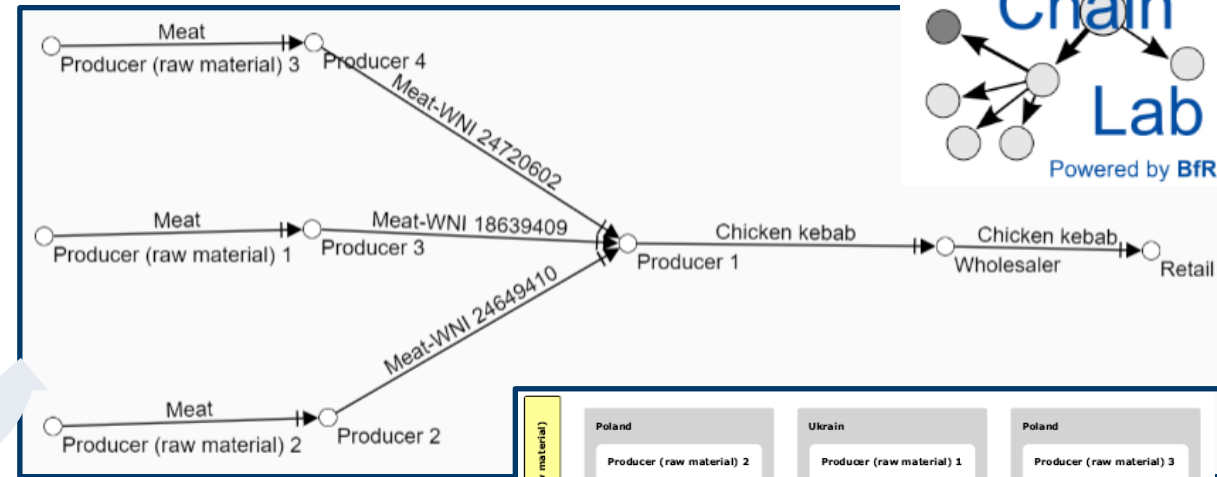
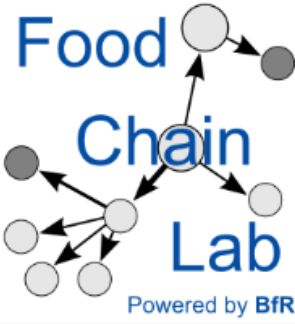
Generate Report
Restore Defaults
Cancel



- Automated summary tables → planned
- Statistics on outbreaks (dashboards) → planned



Need: Unique anonymity code



Anonymisation Label 79

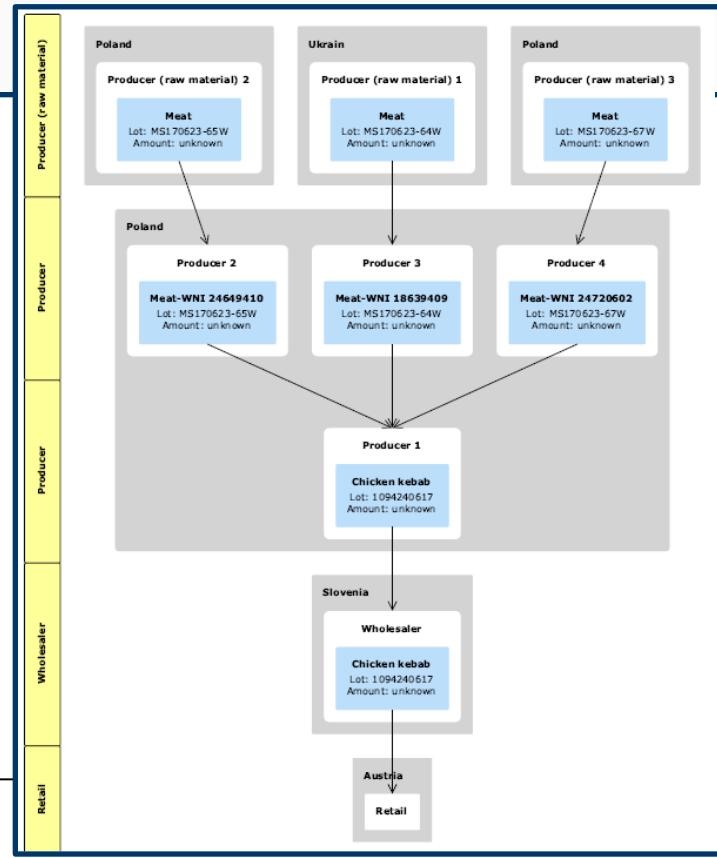
Anonymization Label Composition:

Prefix	Property / Index
no prefix	Label start
::	Type of Business
::	<input checked="" type="checkbox"/> Use index
+	

Label preview:
[Type of Business] [Index]

Use conditions Add selection Remove Selection

property op value + -



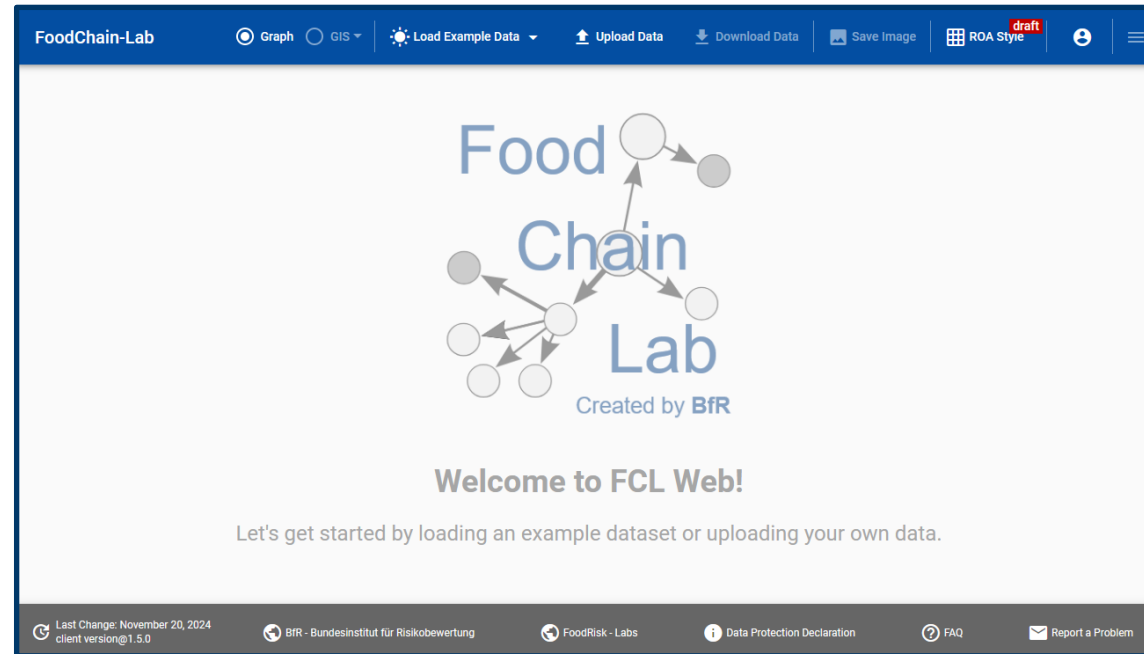
- Anonymity code:
- Customisable!
 - Switch on/off
 - Available in graph/map/reporting view

Need: Data security

In FCL Desktop and in FCL Web, data always stay on user side!



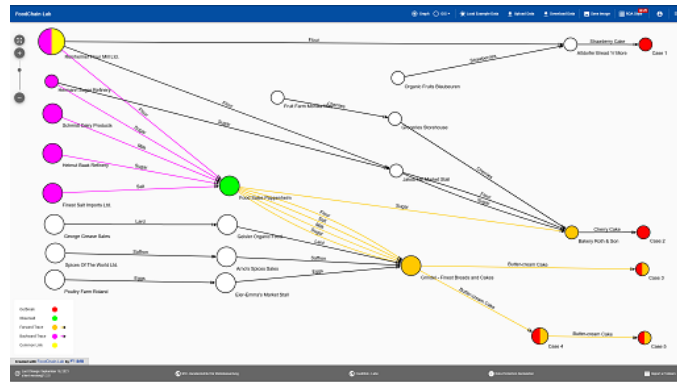
Need: Easy and intuitive handling



Functionalities in FoodChain-Lab

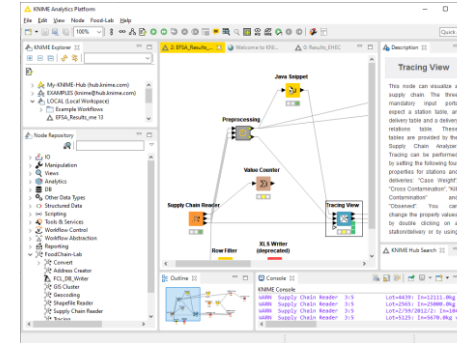


FCL Web



+ live demo on how FCL was applied in tracing investigations

FCL Desktop



- In a web browser (no installation)
- Data stays local, browser is only for visualisation
- Intuitive handling

Features

- Import of the All-in-One (AiO) Template
- -
- -
- (only via AiO template)
- -
- -
- Graph view and GIS view
- Tracing
- Hypothesis generation
- ROA style for reports

- In KNIME (~ 1 GB installation)
- Data is stored locally
- Using KNIME needs to be learned

Features

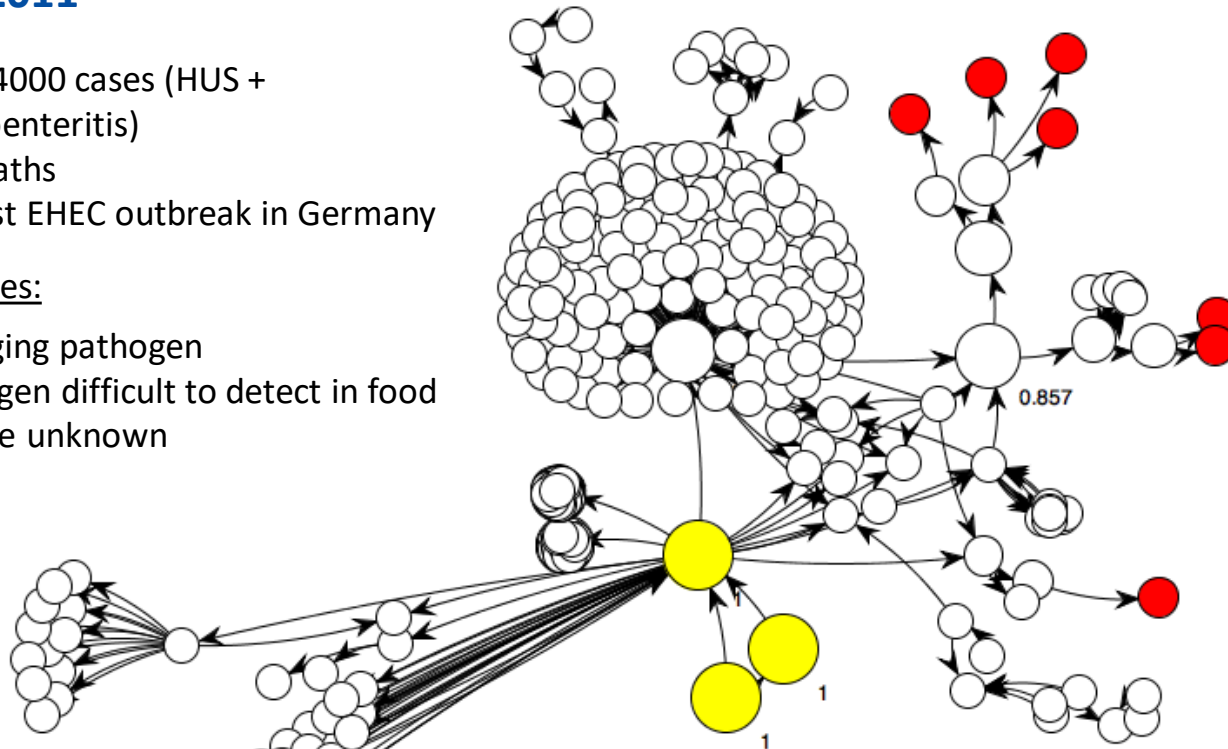
- Template import (Forward, backward, All-in-One)
- Tracing template generation
- Database with plausibility checks
- Geocoding
- Clustering
- KNIME Data analytics functionalities
- Graph view and GIS view
- Tracing
- Hypothesis generation
- -

EHEC 2011

- Over 4000 cases (HUS + gastroenteritis)
- 53 deaths
- Biggest EHEC outbreak in Germany

Challenges:

- Emerging pathogen
- Pathogen difficult to detect in food
- Vehicle unknown



Stations

- Outbreak
- Observed
- Forward Trace
- Backward Trace
- Cross Contamination
- Common Link

Created with  FoodChain-Lab by 

Other applications:

DE:

Norovirus 2012, Salm M. 2015,
EHEC 2017, Fipronil 2017

EU:

HAV 2013/14, C. Bot. 2017 (roach), Salm 2017 (sesame)

Autonomous applications:

UK, AT, ES, HU, PL

Free support by FCL team

Interested?



Please contact foodrisklabs@bfr.bund.de

Impact:

FAO/WHO/OIE: FCL part of Tripartite Tool Box (SISOT)

U.S. FDA implemented FCL and FCL Web in data analysis workflow

The power of digital tracing data: automated visualization + analysis

Some examples of recent FCL activities and how they could help in daily work on tracing data collection, visualization/analysis and reporting

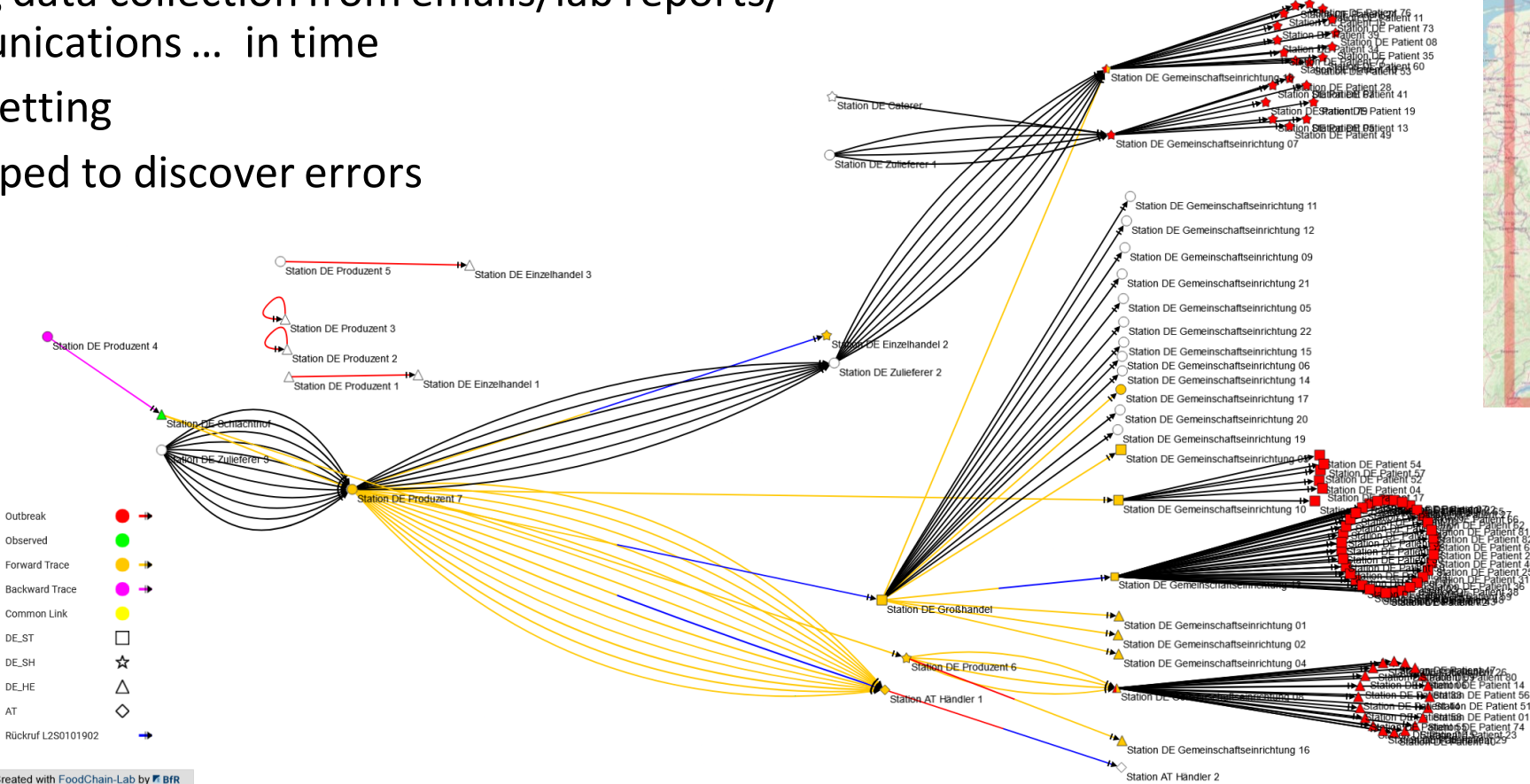
Case studies – Crisis exercise in real time with German federal + federal state authorities (2023)

Realistic crisis setting

Tracing data collection from emails/lab reports/communications ... in time

Team setting

FCL helped to discover errors



Created with FoodChain-Lab by BfR



Case studies – non-dioxin-like polychlorinated biphenyls (ndl-PCB) contamination in feed in 2018

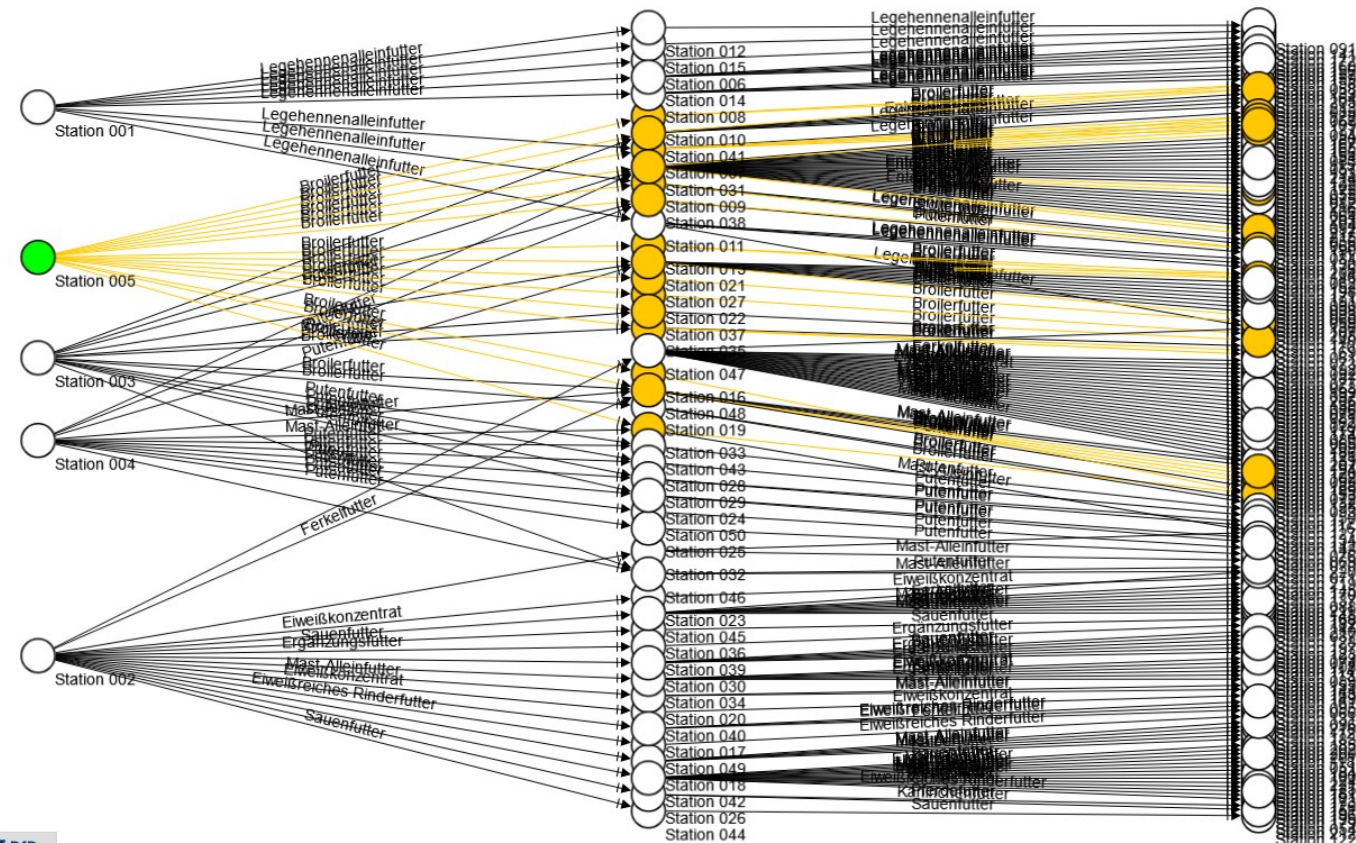
5 Excel tables with suppliers

- Same structure → easily readable by FCL, no need to extract manually

More than 1300 deliveries to >220 stations

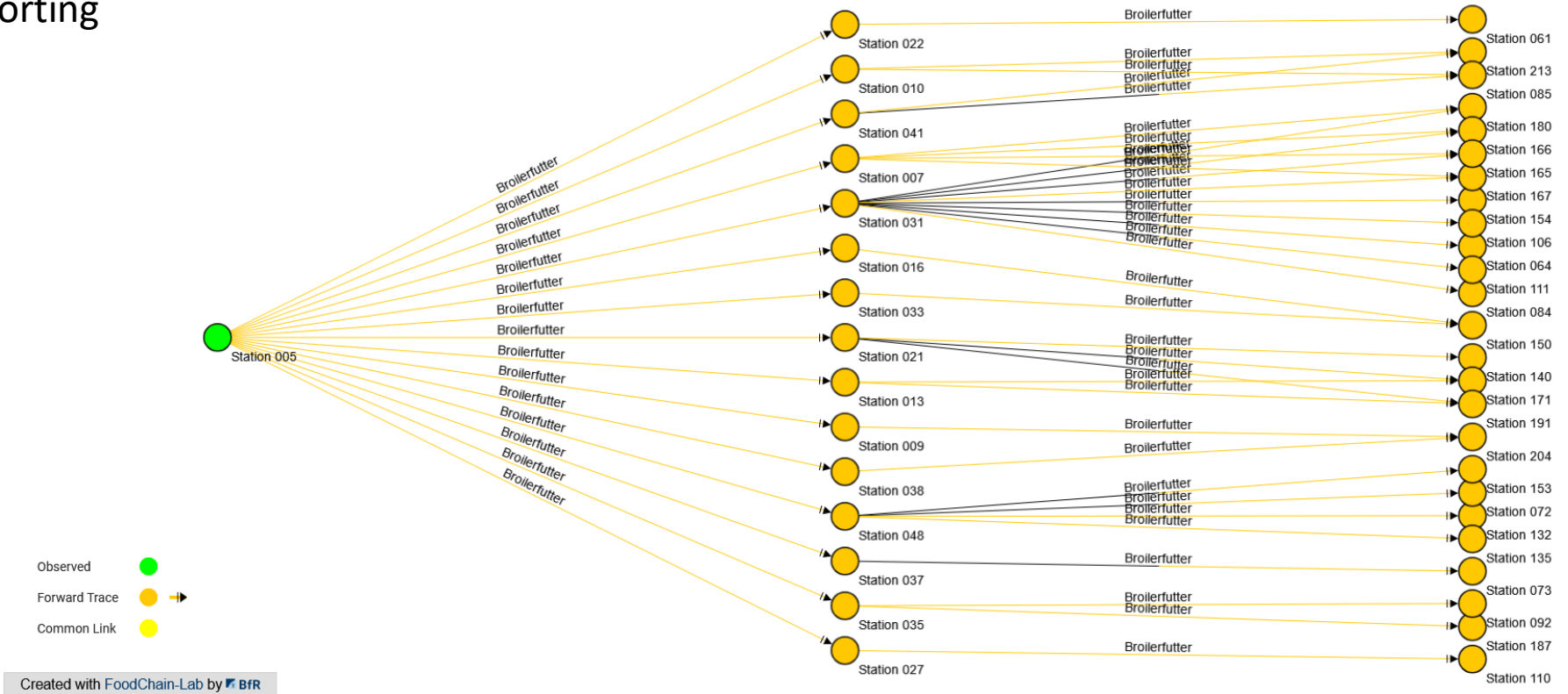
- Easy visualization + analysis of whole picture in FCL
- Easy filtering and condensing the view in FCL (see next slide → reduction to only one feed storage cell in FCL)

34 Visio sheets in situation reports



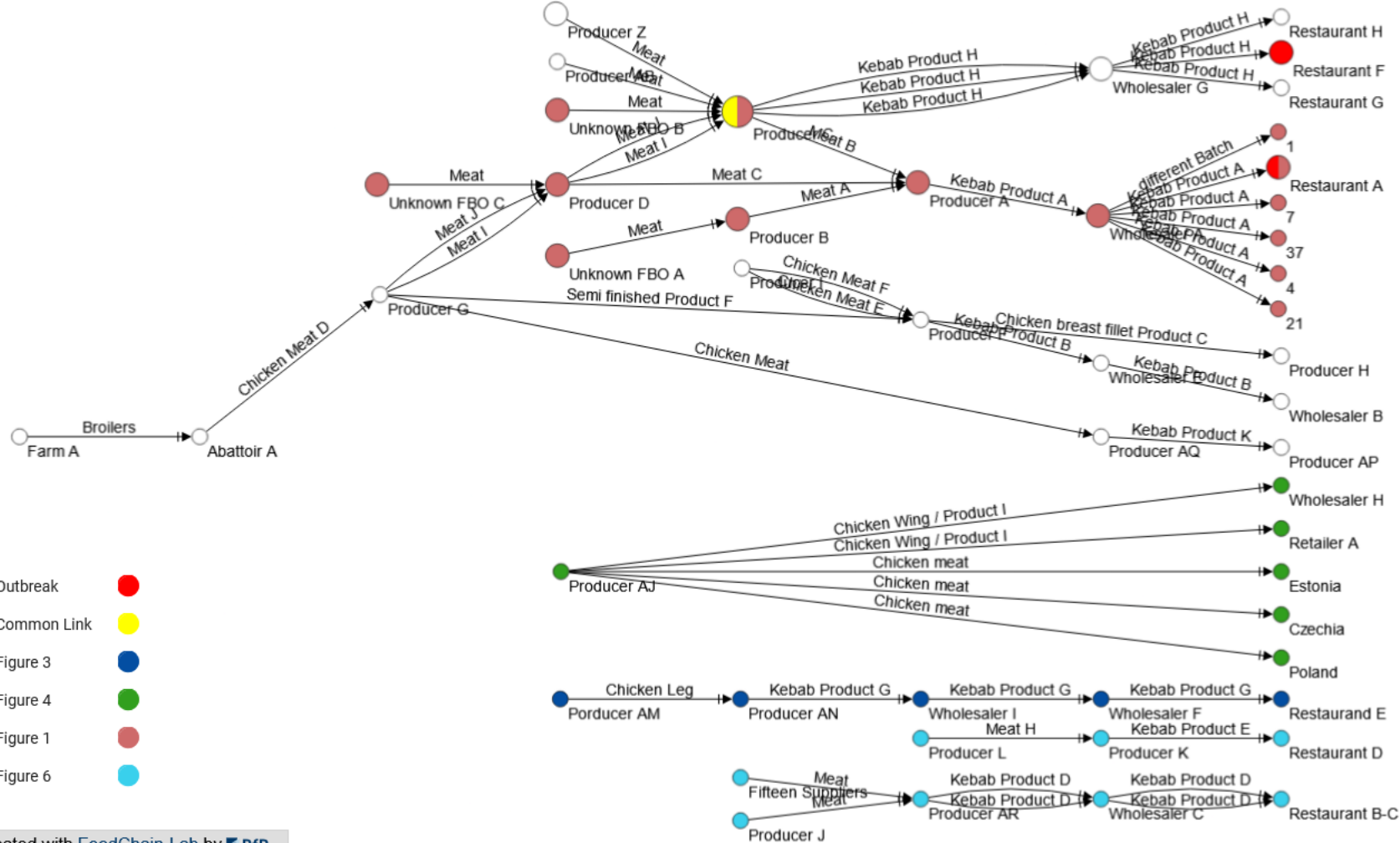
Case studies – ndl-PCB contamination in feed in 2018

- reduction to only one feed storage cell in FCL in only a few clicks → this view is more feasible for reporting



Case studies

ECDC-EFSA ROA 2023: Salmonella in chicken meat products



Research questions:
 Can FCL Web reproduce ROA figures?
 Performance of the automatized anonymization feature in FCL Web

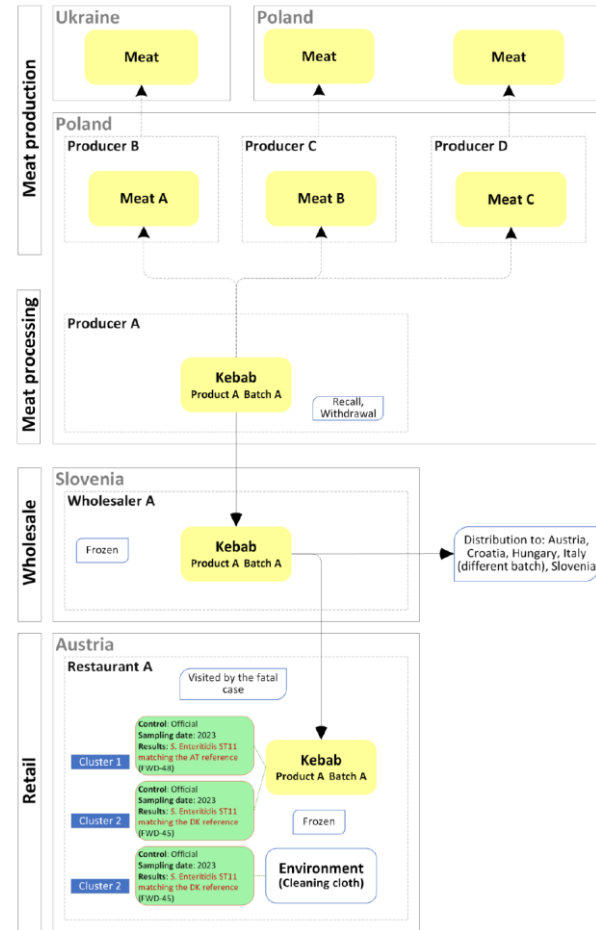
Created with FoodChain-Lab by BfR



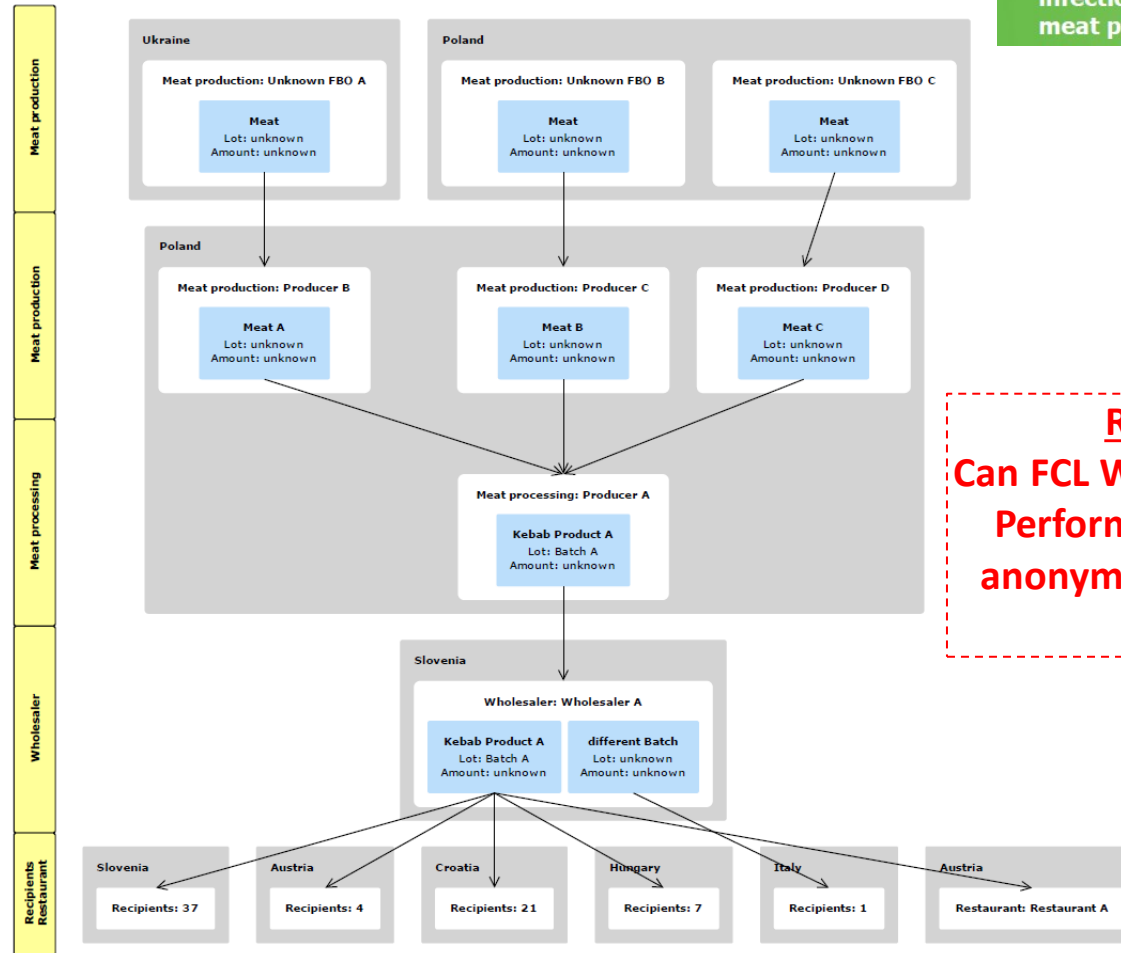
Case studies

ECDC-EFSA ROA 2023: Salmonella in chicken meat products

Figure 1. Graphical representation of traceability and microbiological analysis of the *Salmonella*-positive food (Kebab Product A), as reported by the countries involved under RASFF notification 2023.5055 (as of 3 October 2023, fup22)



2023-FWD-00048 – 2023.5055



Research questions:
Can FCL Web reproduce ROA figures?
Performance of the automatized anonymization feature in FCL Web

An outbreak of Shiga toxin-producing *Escherichia coli* O157:H7 associated with contaminated salad leaves: epidemiological, genomic and food trace back investigations[‡]

A. F. W. MIKHAIL¹, C. JENKINS^{1*}, T. J. DALLMAN¹, T. INNS^{2,3}, A. DOUGLAS¹, A. I. C. MARTÍN⁴, A. FOX¹, P. CLEARY^{2,3}, R. ELSON¹ AND J. HAWKER^{2,3}

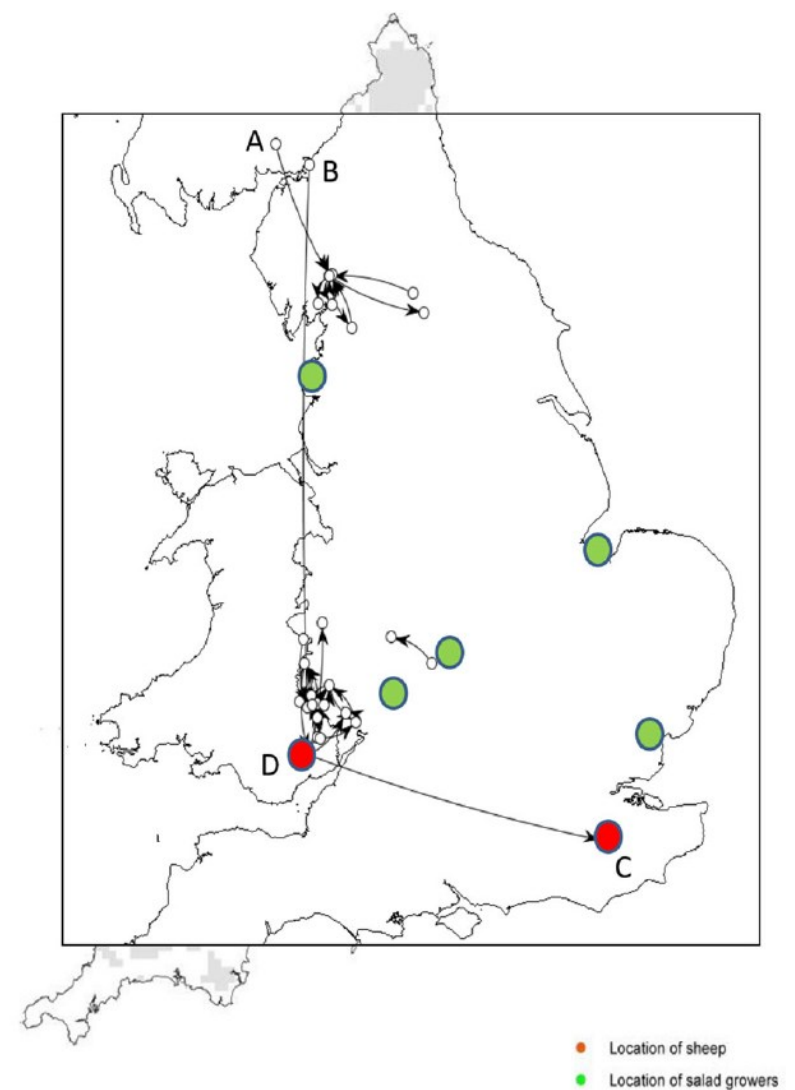
→ Mapping the recent movement of sheep and lambs across the United Kingdom

Novel application of the matched case–control design to compare food supply chains during an *Escherichia coli* O157 outbreak, United Kingdom, 2016

Thomas Inns^{1,2,3}, Paul Cleary^{1,3}, Nick Bundle^{4,4}, Sarah Foulkes¹, Ashley Sharp⁵, Lara Utsi¹, Chris McBrien⁵, Rehman Teagle¹, Alison Waldram¹, Chris Williams⁶, Cathy McCann¹, Rob Smith⁶, Sepeedeh Saleh⁵, Noel McCarthy^{3,7}, Roberto Vivancos^{1,3,8}, Jeremy Hawker^{1,3}, Valerie Decraene¹

National outbreak of Shiga toxin-producing *Escherichia coli* O157:H7 linked to mixed salad leaves, United Kingdom, 2016

Maya Gobin¹, Jeremy Hawker^{1,2}, Paul Cleary^{1,2}, Thomas Inns^{1,2}, Daniel Gardiner^{1,3}, Amy Mikhail⁴, Jacquelyn McCormick⁴, Richard Elson^{2,4}, Derren Ready⁴, Tim Dallman^{2,4}, Iain Roddick¹, Ian Hall⁵, Caroline Willis⁶, Paul Crook¹, Gauri Godbole³, Drazenka Tubin-Delic⁷, Isabel Oliver^{1,8}

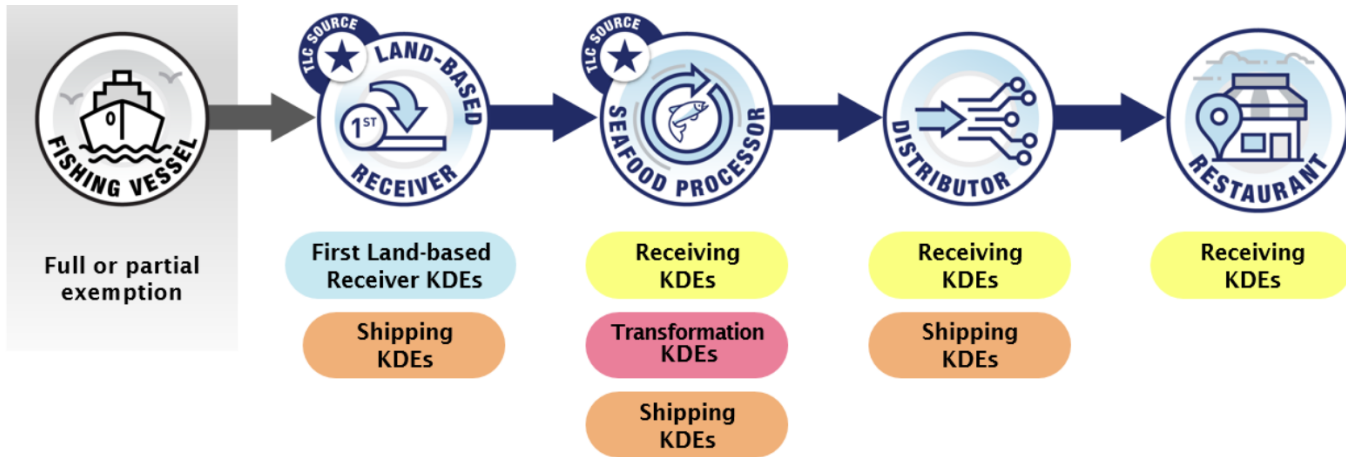


Case study on Salmonella outbreak associated with eggs

Mapping of movements of hospital staff

FDA's New Era of Smarter Food Safety

„Food Traceability Rule“ for harmonized data and data sharing



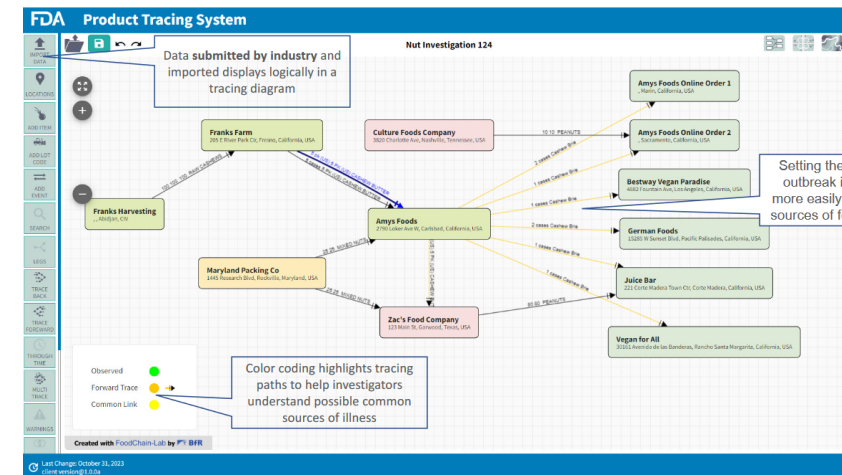
Demo video of PTS + FCL in action

<https://www.fda.gov/food/new-era-smarter-food-safety/product-tracing-system>



Product Tracing System

- Receive, process and visualize traceability data
- Improve traceback and traceforward analysis
- Government and industry collaboration
- FCL integrated in FDA system



Collaboration between FDA and BfR

Looking ahead: Powerful tracing tools are interoperable

The current situation: Fipronil incident as example

NL collects data

DE collects data

...

1 Sender, name, address, and telephone number, fax number
Name, address of the company arranging the transport

2 Receiver, name, address, and telephone number, fax number
Receiving company

3 Local consignment note
Local consignment note number
Local consignment note date

4 Consignment
Description of the goods
Quantity

5 Consignment
Description of the goods
Quantity

6 Invoice number

7 Date of receipt

8 Date of delivery

9 Date of receipt

10 Date of receipt

11 Date of receipt

12 Date of receipt

13 Remarks not readable

14 Signature of the sender

15 Signature of the transporter

16 Name, address of the logistics provider with ID number

17 International consignment note number

18 Amount of interest on transportation

19 Date of receipt

20 Date of receipt

21 Date of receipt

22 Signature initiator

23 Signature transporter

Signature receiver: 02/08/2012

REMARKS:
INVOICE 29
Reklamazione: Paletti no sono europalet!!! Problem con temperatura e -10!!! Merce con foglie verde.

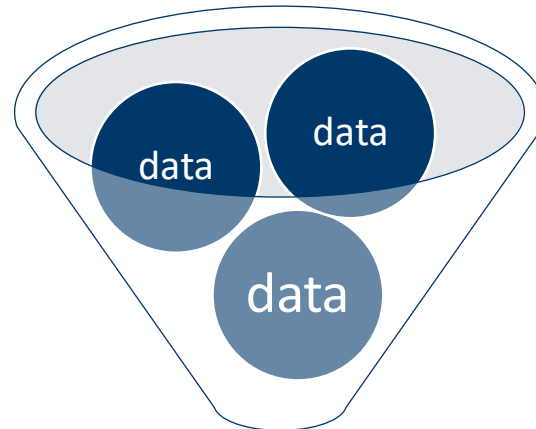
Example for data exchanged between European authorities

The current situation: Fipronil incident as example

NL collects data

DE collects data

...



RASFF system



Details of the RASFF alert shown in the screenshot:

- Operation type: Service
- Name: Egg product 1
- Applicant: EFSA/EFSA
- Address: Europa Drive Bldg 11
- Location: Bonn
- Postal code: 53174
- Country: Germany
- Distribution: Germany
- Attachment(s):
- Operation type: Service Egg Storage 1
- Name: EFSA/EFSA
- Applicant: EFSA/EFSA
- Address: Mühlenstr. 101
- Location: Bonn
- Postal code: 53117
- Country: Germany
- Distribution: Germany
- Attachment(s):
- Operation type: Service Egg Transport 1
- Name: EFSA/EFSA
- Applicant: EFSA/EFSA
- Address: Mühlenstr. 101
- Location: Bonn
- Postal code: 53117
- Country: Germany
- Distribution: Germany
- Attachment(s):

Example for data exchanged between European authorities

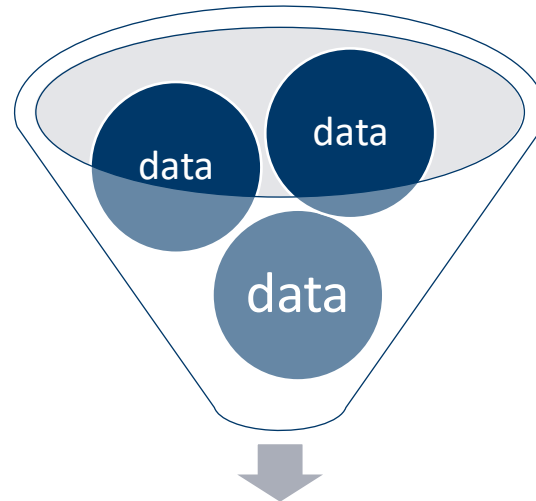
The current situation: Fipronil incident as example

NL collects data

DE collects data

...

Example for data exchanged between European authorities



RASFF system



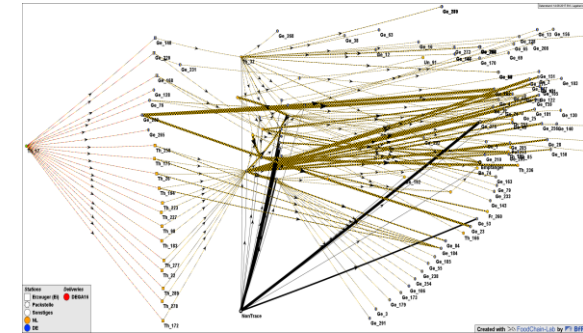

NL extracts data manually

DE (BVL + BfR) extracts data manually

NRW extracts data manually

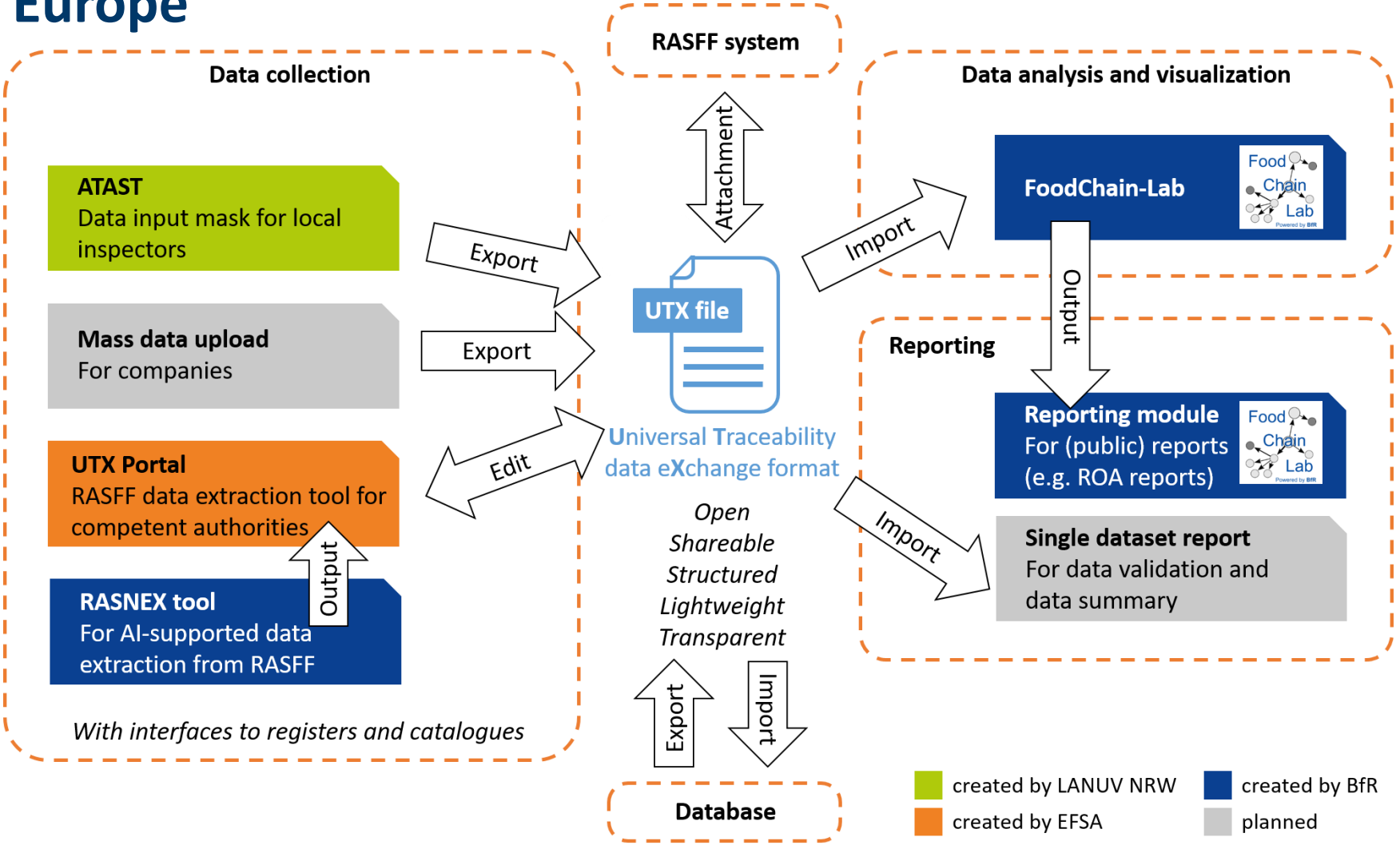
The challenge: Getting an overview on situation

Unstructured data, not machine-readable/paper-based, distributed across several follow-up notifications → limited usability of data



Duplication of work!

The future: An interoperable multiactor food tracing software ecosystem for Europe



Benefits:

- Facilitate data exchange
- Avoid double work
- Easy visualisation + analysis

*Your tool?
Feedback on UTX?*

Please contact
foodrisklabs@bfr.bund.de

The future: AI-based tools to automatize data extraction



Analysis of RASFF follow-ups by RASNEX



Analyse one pdf at a time and verify results by pressing "FUP verified, save changes". Once you are finished, press "Download processed data".

Click here to upload RASFF notification and press "Next FUP"

Reading from "RASFF-test.pdf"

Previous FUP

Next FUP

Notification reference: 2, FUP 2 out of 7

FUP Nr	Contact person	Additional information
#355913	RALF RASFF	<p>Wittenberger Bäckerei GmbH COMPANY, Dessauer Straße 126 in 06886 Lutherstadt</p> <p>Wittenberg ADDRESS has received 750 kg of "roasted sesame" of lot no. 250902 from Dipasa</p> <p>Europe B.V. COMPANY, Marssteden 56 in 7547 TD Enschede (Netherlands) ADDRESS.</p> <p>However, goods with best-before date 12-2020 were delivered here and not with best-before date 01/03/2021 as stated in the notification. The delivery note is attached.</p>

Download processed data

Add new row

Company	Country	ZIP	County	City	Street	House Nr
<input checked="" type="checkbox"/> Wittenberger Bäckerei GmbH		06886		Lutherstadt	Dessauer Straße	126
<input checked="" type="checkbox"/> Dipasa Europe B.V.	Netherlands	7547 TD		Enschede	Marssteden	56

FUP verified, save changes

reset FUP



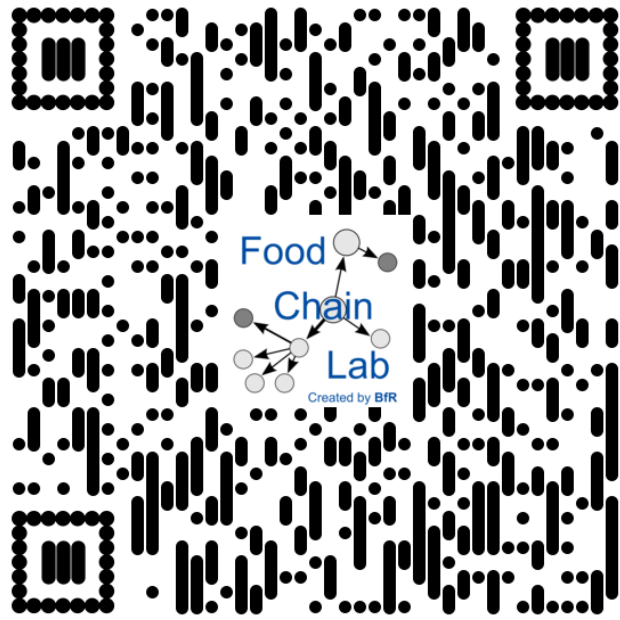
Benefits of using FoodChain-Lab for MS/EU authorities

- Free and open-access software
- Combines stepwise tracing information in one visualization
- All steps of a tracing investigation integrated in one modular framework
 - *Data Management, Data Cleaning, Data Analysis (automated, calculation of scores)*
- Helps during Outbreak Investigation
 - *Identify potential common source of contamination by tracing back and forward suspicious food items*
 - *Assists in brainstorming → test hypotheses and generate new ones*
 - *Helps prioritizing next steps*
 - *Identifies missing data*
- Free support and free trainings in FCL
- Harmonization with/integration of other tools and initiatives

***“Progress is impossible
without change [...]”
George Bernard Shaw***



Fast and reliable investigation of foodborne incidents



Marion Gottschald

**German Federal Institute for
Risk Assessment**

Tel. +49 30 - 184 12 - 88888
foodrisklabs@bfr.bund.de
<https://foodrisklabs.bfr.bund.de>

Thank you for your attention!



German Federal Institute for Risk Assessment

EFSA-BfR tracing team

BfR: Marion Gottschald, Alexander Falenski, Matthew Salewski, Daria Savvateeva,
Marc Lorenzen, Latife Salih, Marco Rügen, not in picture: Arne Zerndt + Hanna Hauck
EFSA: Olaf Mosbach-Schulz



FCL was supported by EFSA-BfR Framework Partnership Agreements (FPA) GP/EFSA/AMU/2016/01 and GP/EFSA/AMU/2020/02, and received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 773830 OH EJP COHESIVE.