BfR
German Federal Institute for Risk Assessment

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

11.02.2025, FoodChain-Lab workshop France

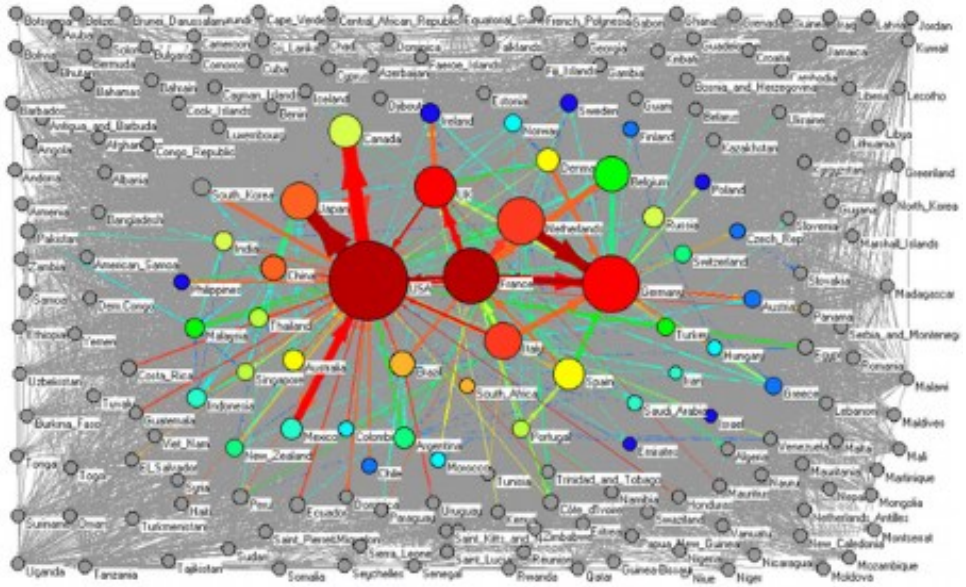
BfR: Marion Gottschald, Alexander Falenski, Marco Rügen, Latife Salih, Arne Zerndt, Hanna Hauck, Marc Lorenzen, Daria Savvateeva, Matthew Salewski, Bernd-Alois Tenhagen
EFSA: Olaf Mosbach-Schulz

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

Long and complex supply chains

Globalised trade



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

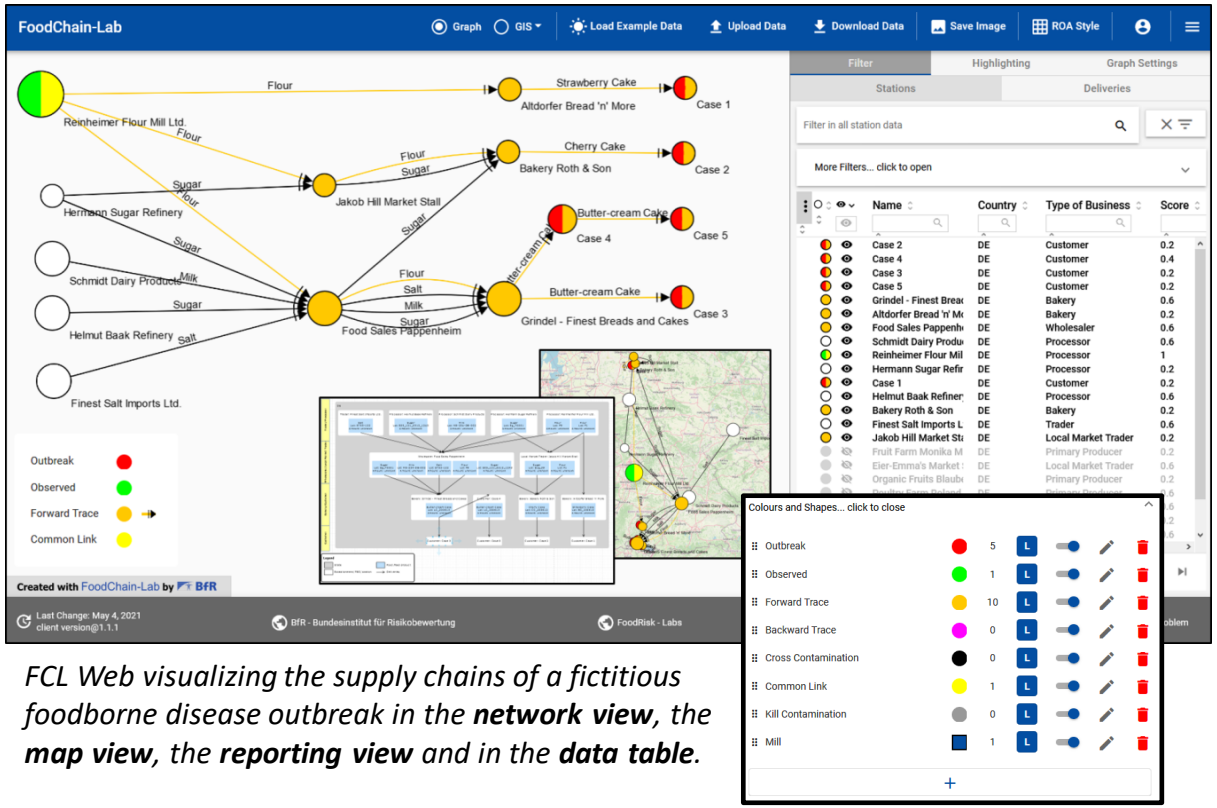
Importance of powerful interoperable software tools e.g. for tracing food and feed

Food Chain Lab
Powered by BfR

BfR

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

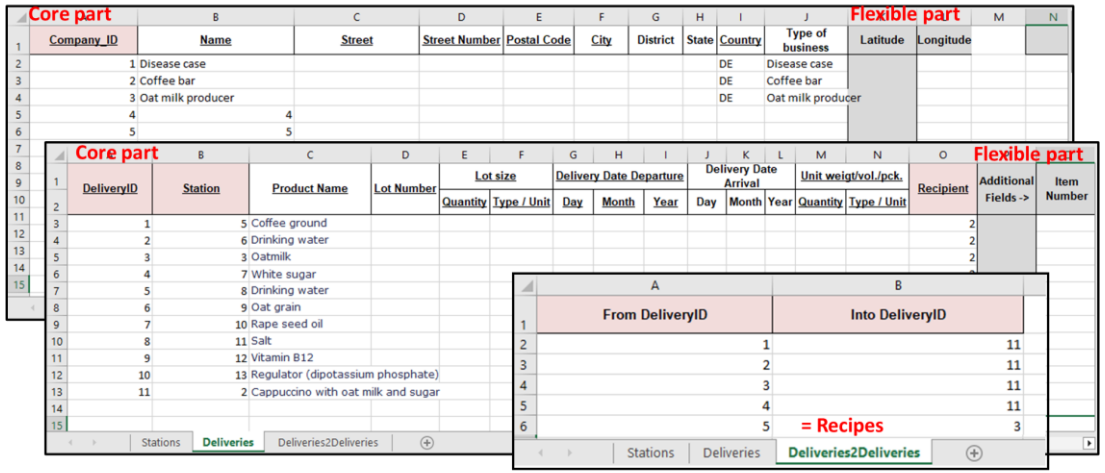
- Free, open access software → **ready-to-use**
- Available as **desktop** and **web application**
  https://foodrisklabs.bfr.bund.de https://fcl-portal.bfr.berlin
- Everybody can register and use it

Need: Digital data in pre-agreed formats

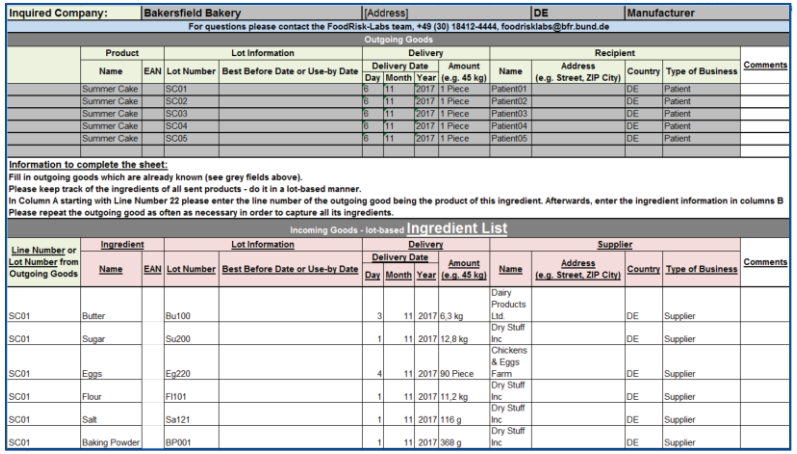
Data collection and data extraction:
Structured excel templates as a first step

- Ready to use
- Easy to use and easily accessible
- Machine-readable
- Structured but not much standardised

- Tested and applied in real foodborne incidents



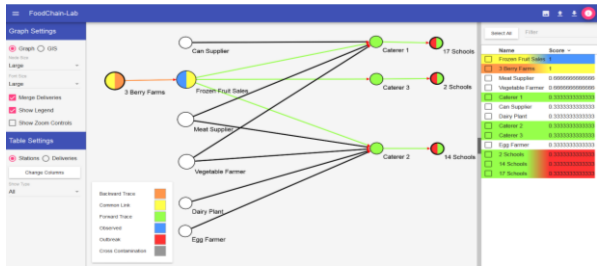
<u>FCL All-in-one template</u>
For data collection + extraction of data of whole incident in one file



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

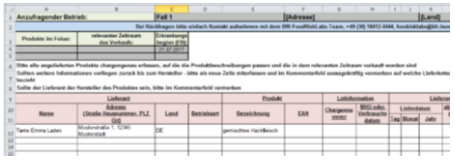
Need: Powerful visualization and analysis

Easy and intuitive data visualization in FCL Web

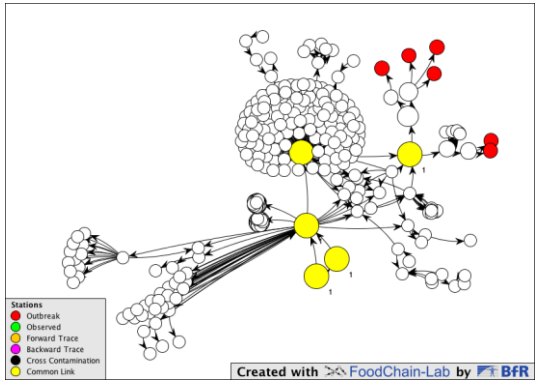


JSON based data exchange

Data collection

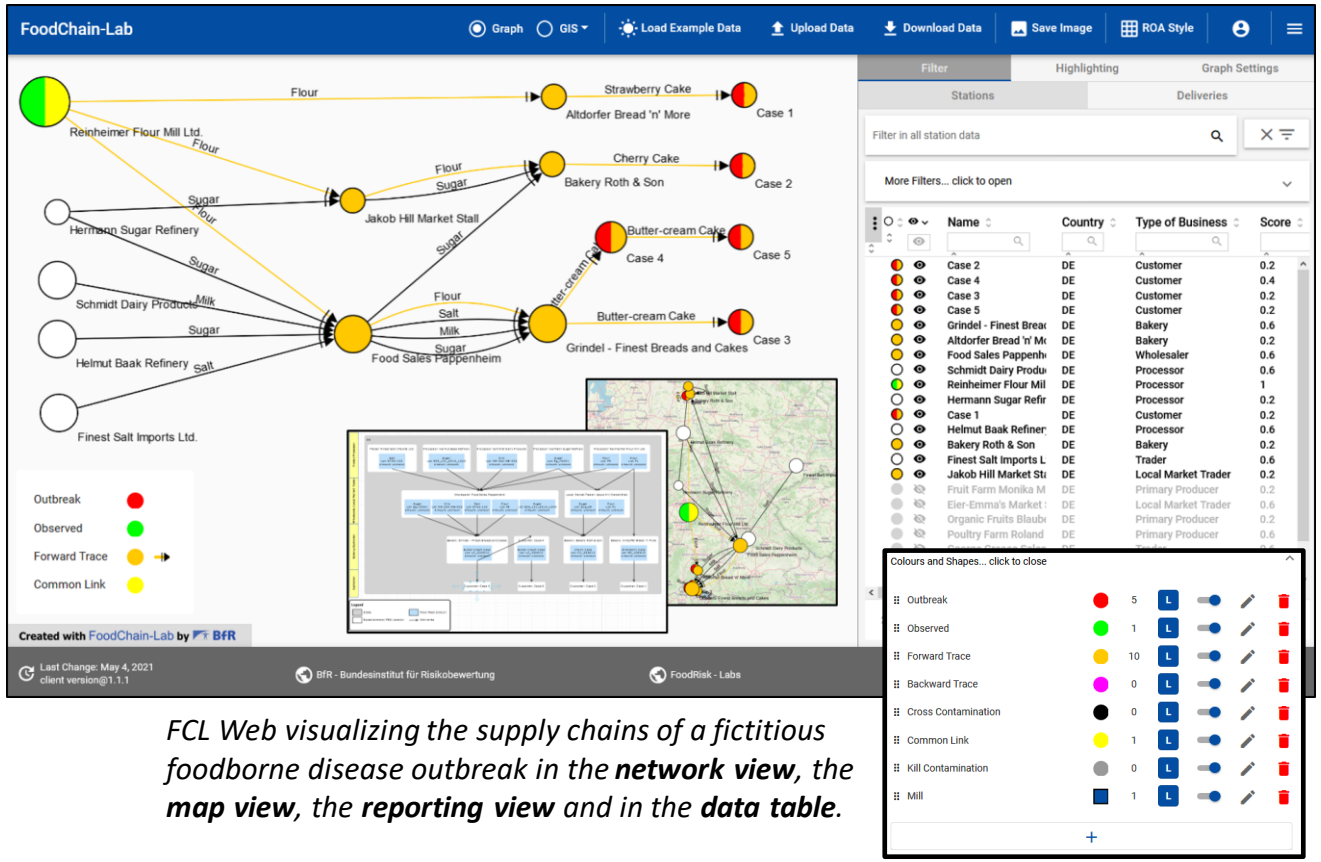


Advanced data analysis within FCL Desktop



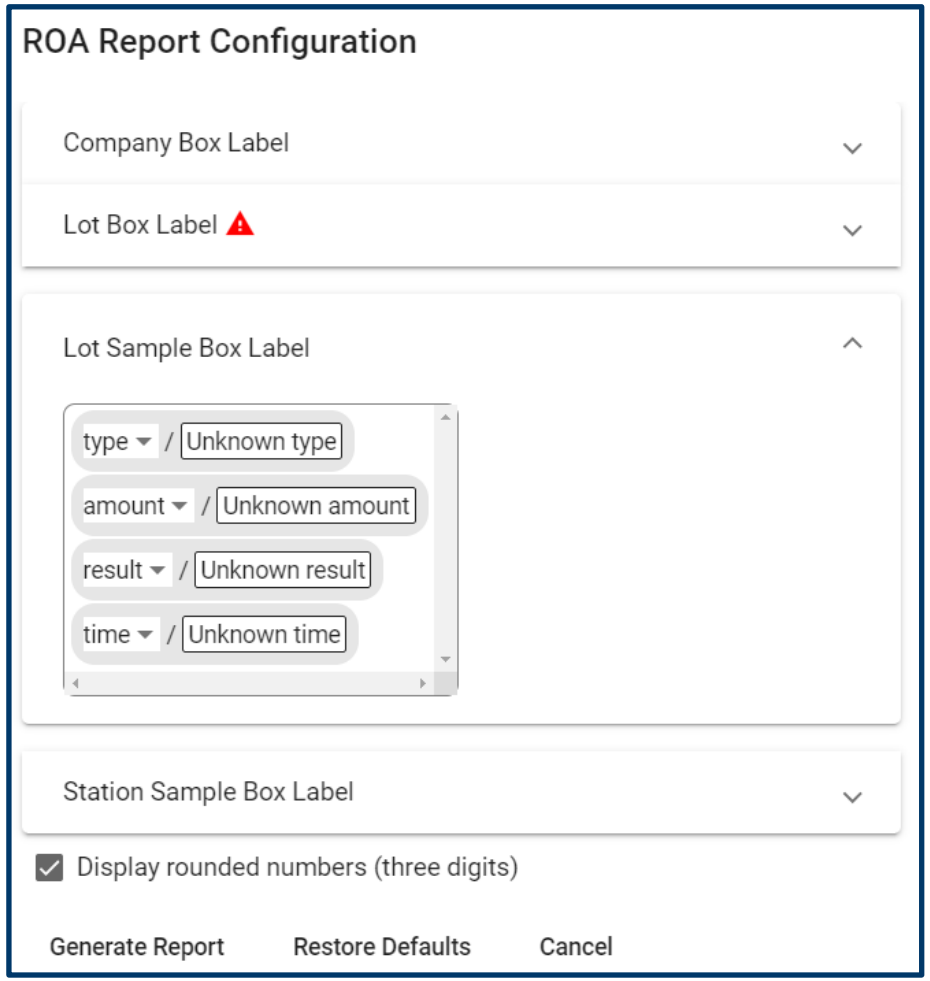
Need: Powerful visualization and analysis

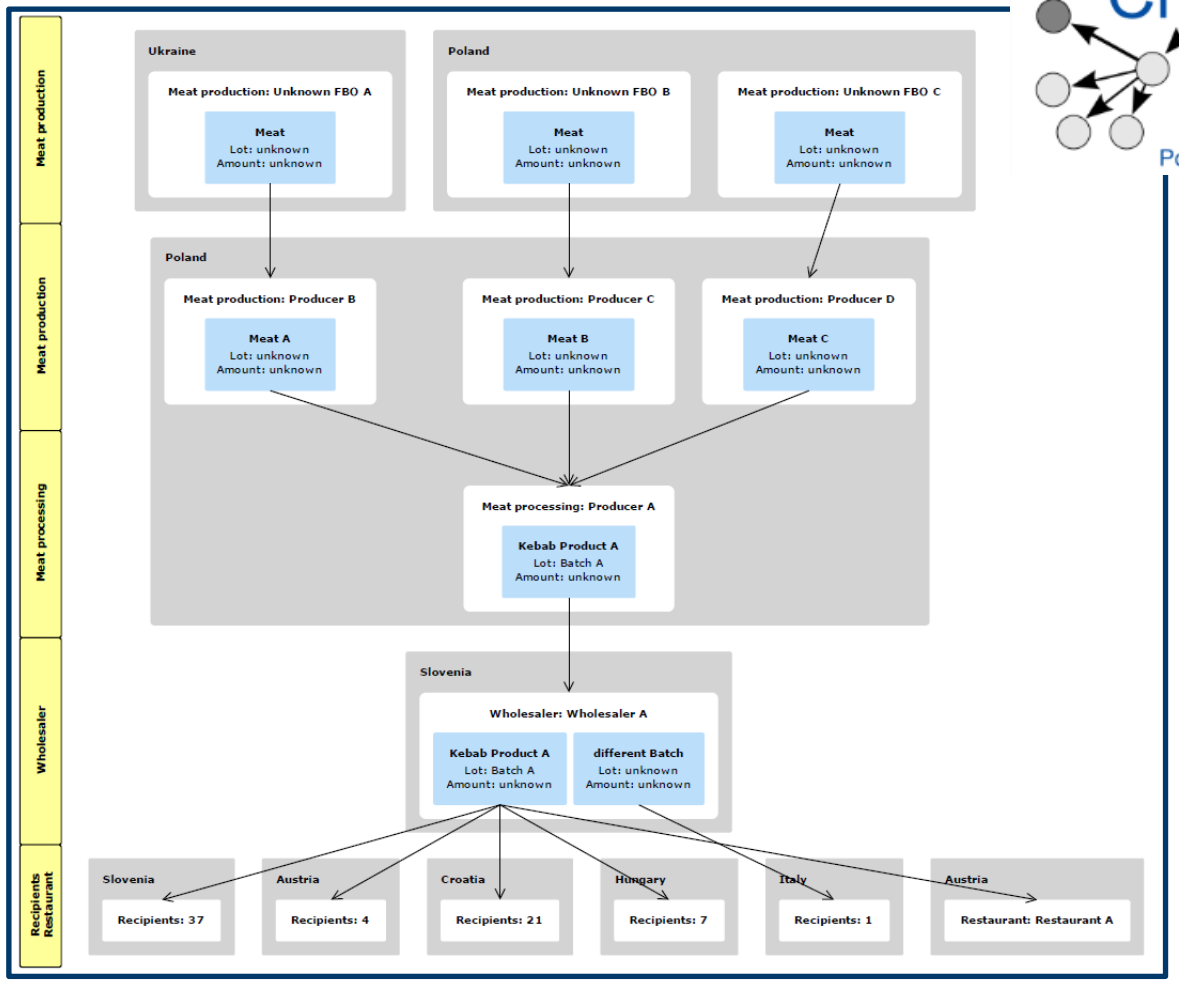
- Automated visualisation of food business operators ◯ and deliveries ↗ as network and on a map
- Visualizations customizable if needed (different layouts, hiding/merging FBOs and deliveries)
- Automated analysis of supply chain network to identify potential common source ● of pathogen/contamination 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**.*

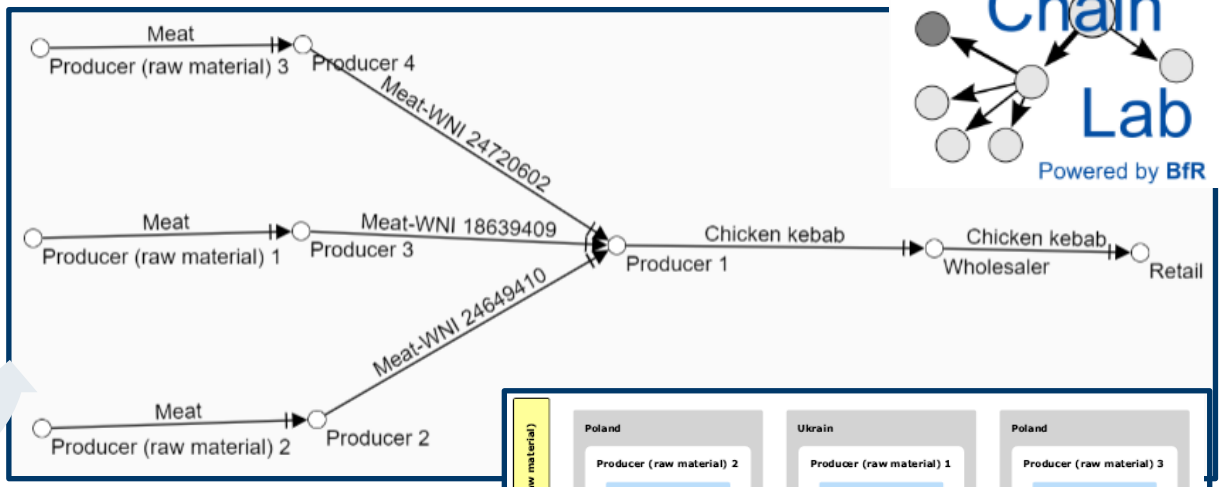
Need: Automated reporting

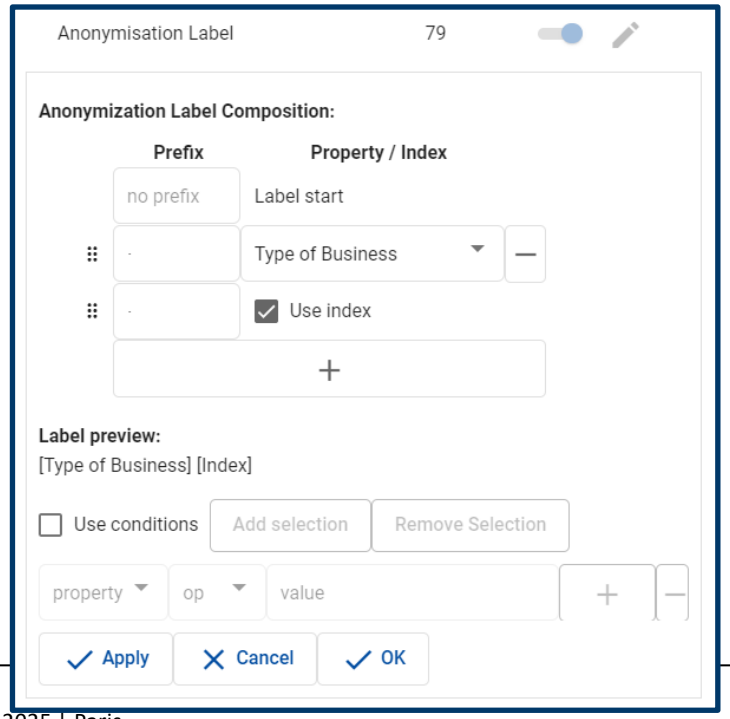


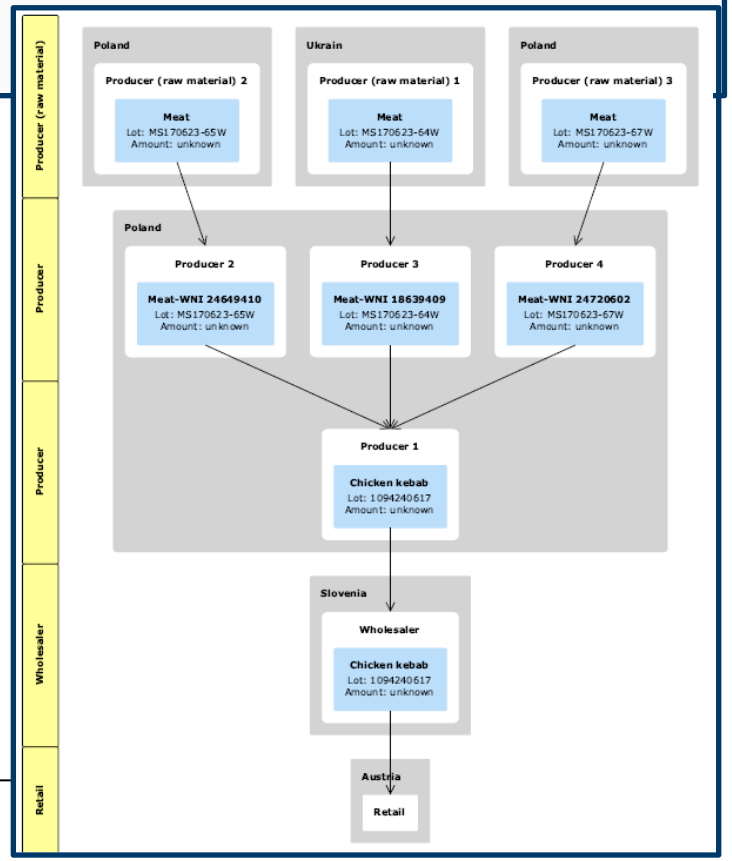


- Automated summary tables → planned
- Statistics on outbreaks (dashboards) → planned

Need: Unique anonymity code







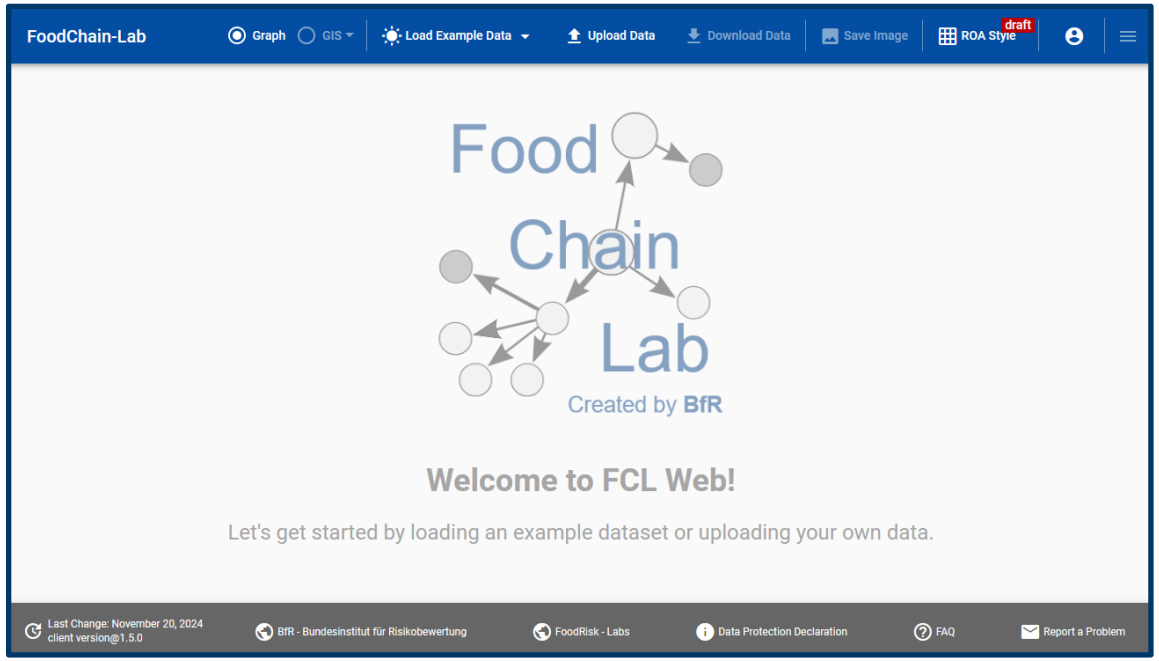
Anonymity code:

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

Need: Data security

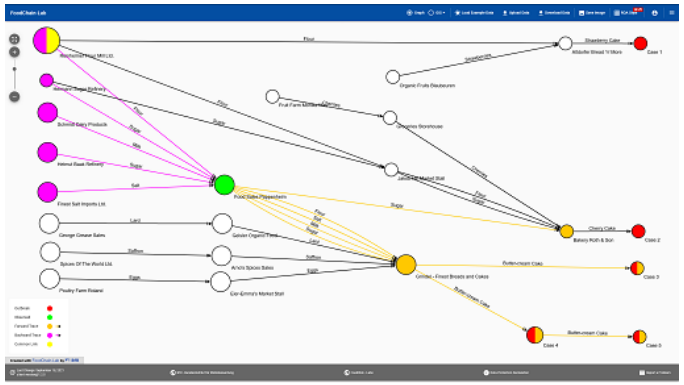
In FCL Desktop and in FCL Web, data always stay on user side!

Need: Easy and intuitive handling



Functionalities in FoodChain-Lab

FCL Web



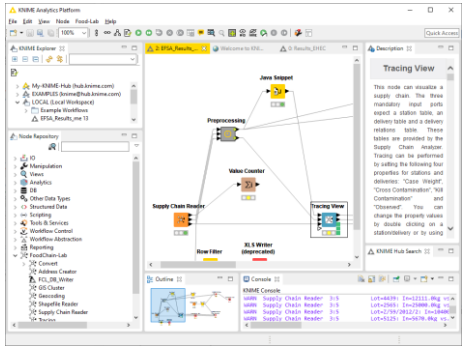
+ live demo on how FCL was applied in tracing investigations

- 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

FCL Desktop



- 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
- -

FoodChain-Lab – successful applications and impact

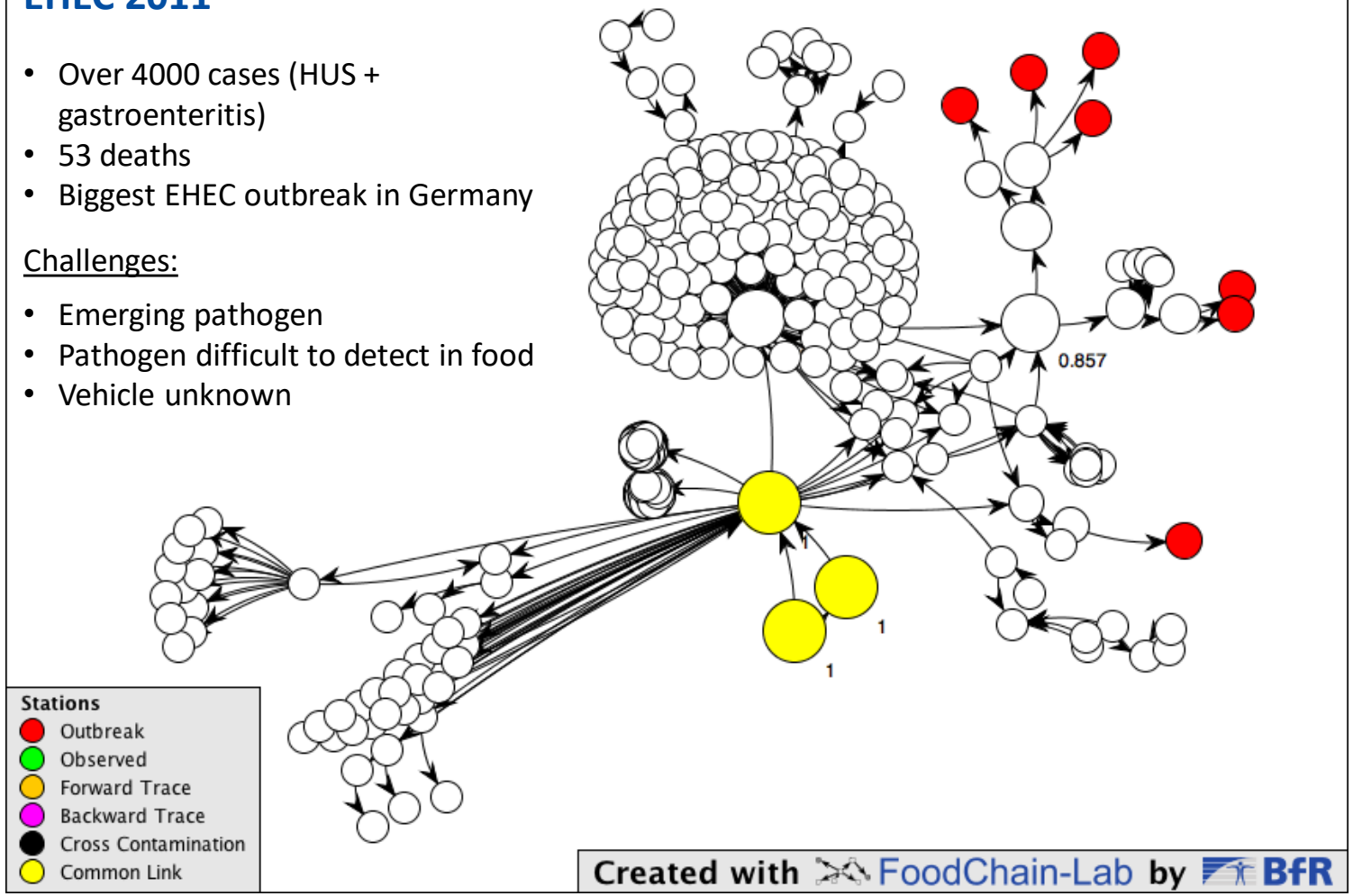
+ crisis exercises

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



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)

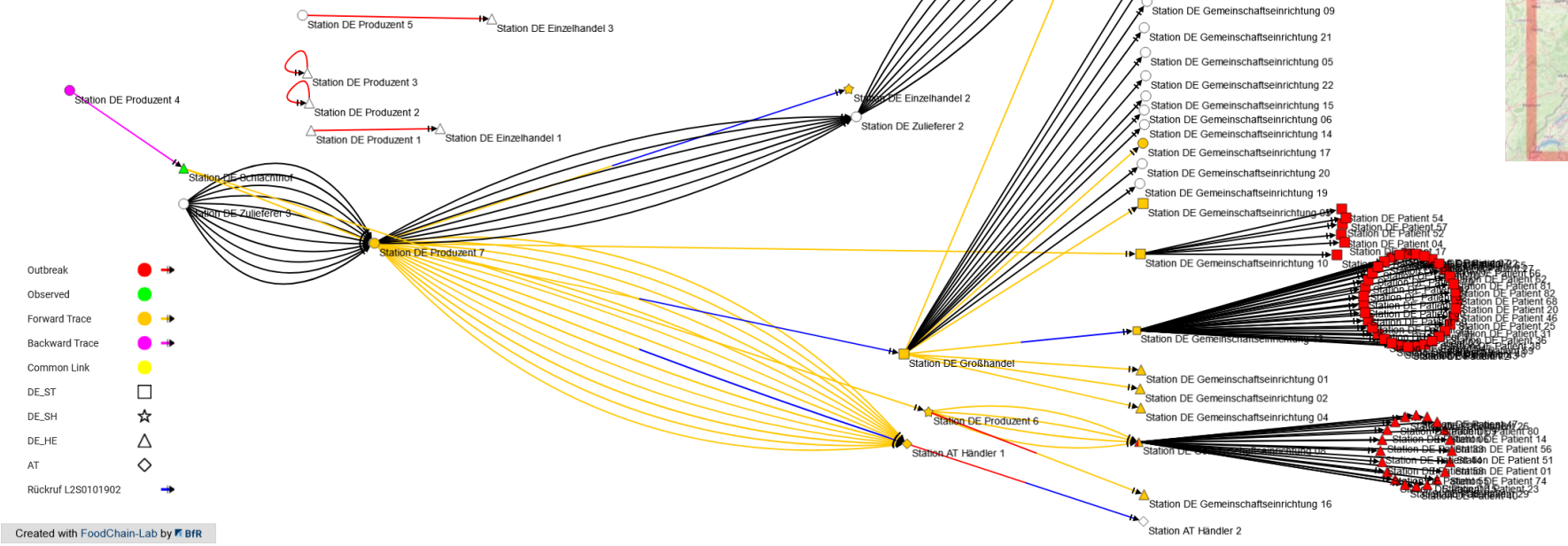
U.S. FDA implemented FCL and FCL Web in data analysis workflow

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



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

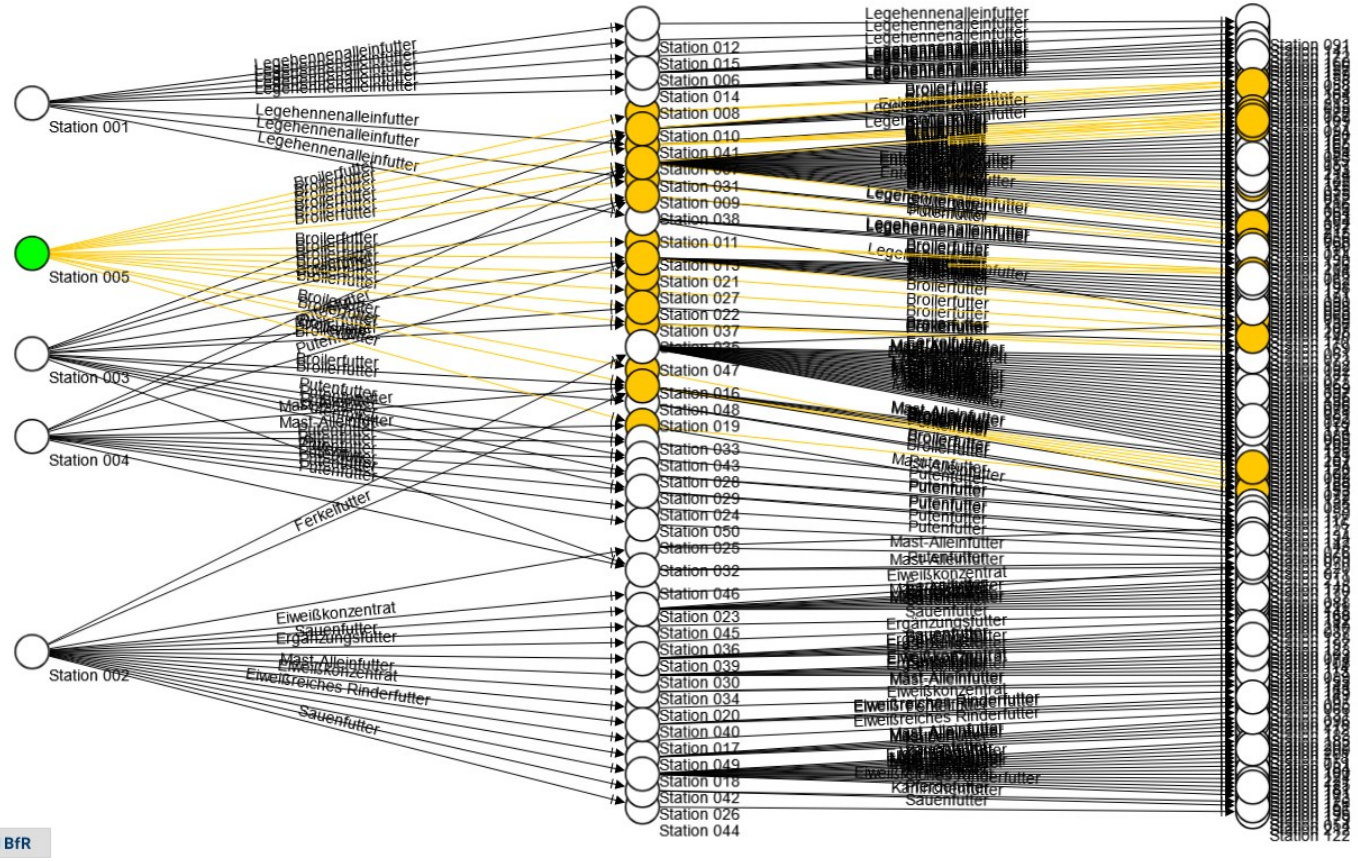
5 Excel tables with suppliers

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

More than 1300 deliveries to >220 stations

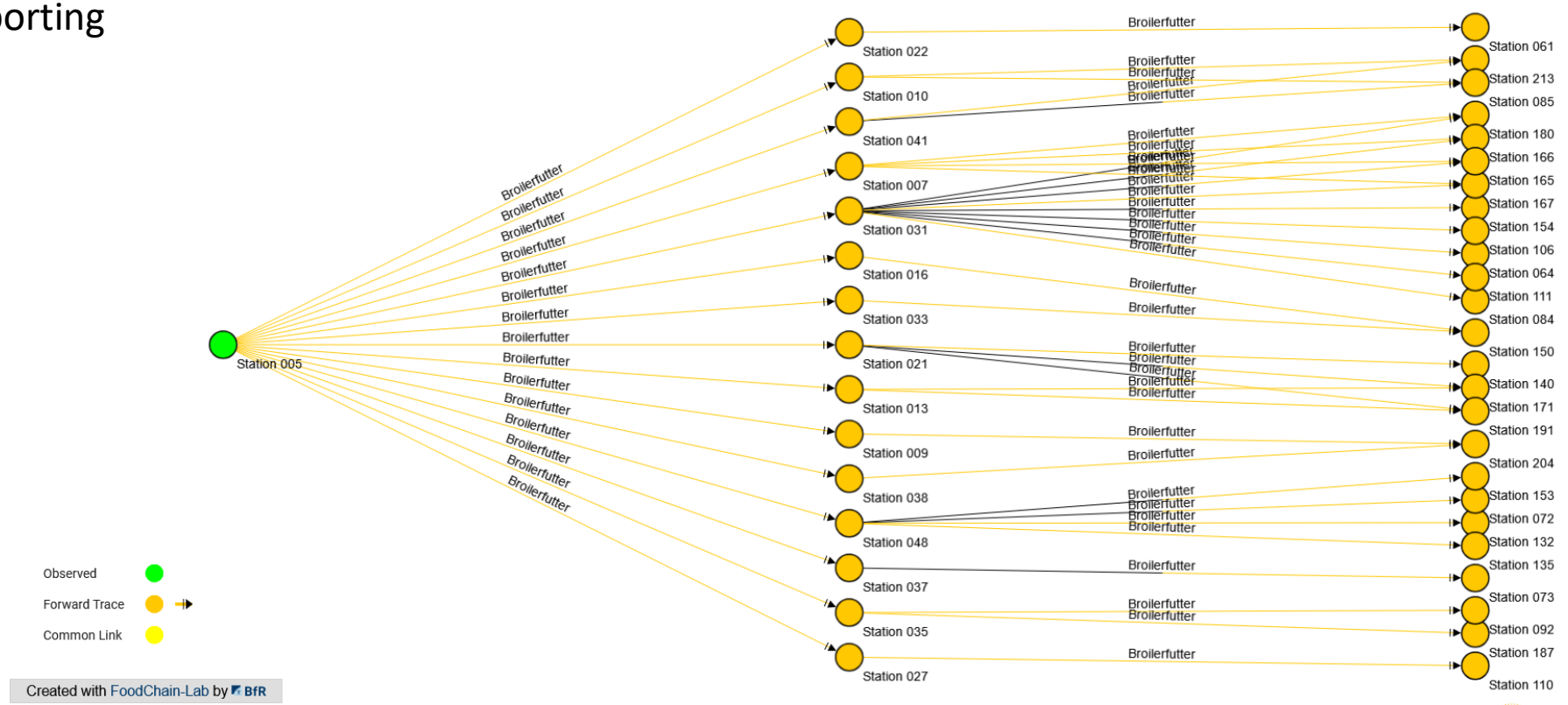
- Easy visualization + analysis of whole picture in FCL
- Easy filtering and condensing the view in FCL (see next slide → reduction to only one feed storage cell in FCL)

34 Visio sheets in situation reports



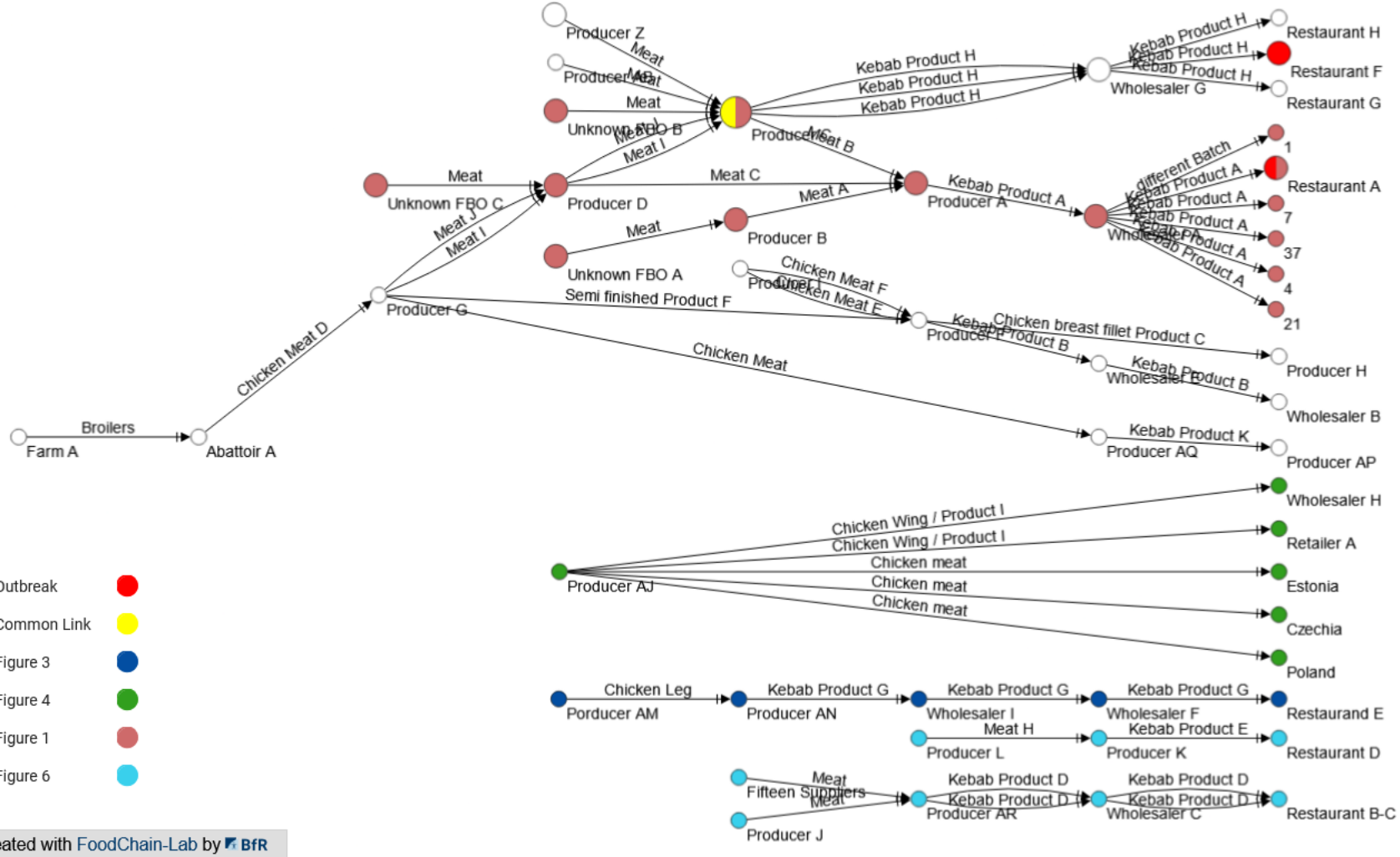
Case studies – ndl-PCB contamination in feed in 2018

- 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



Created with FoodChain-Lab by BfR

Research questions:

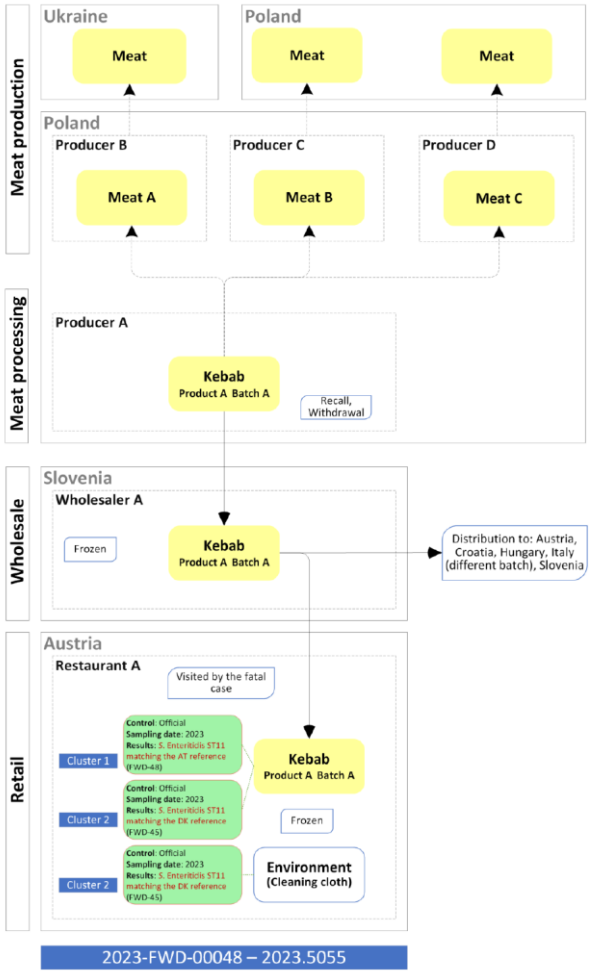
Can FCL Web reproduce ROA figures?

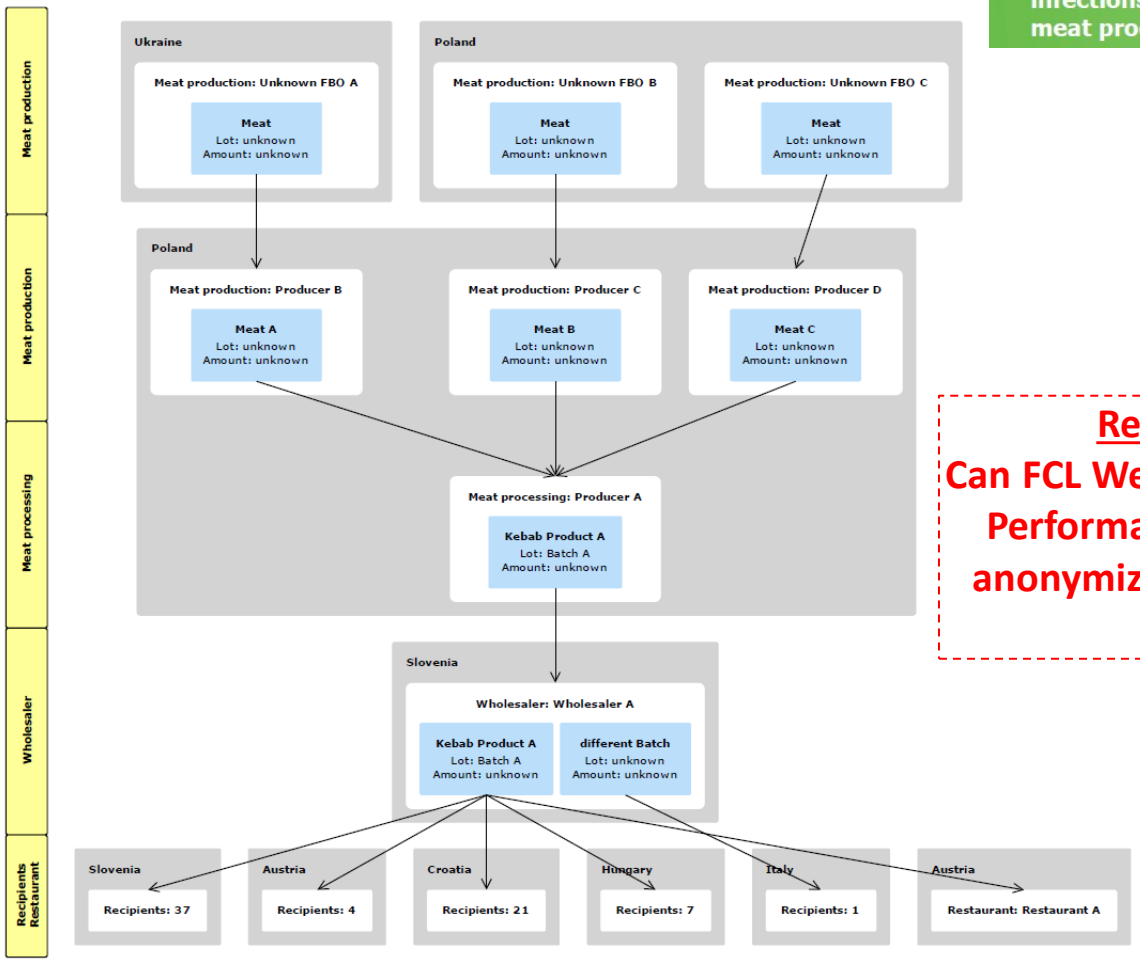
Performance of the automatized anonymization feature in FCL Web

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*)





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. MIKHAIL[1], C. JENKINS[1]*, T. J. DALLMAN[1], T. INNS[2,3], A. DOUGLAS[1], A. I. C. MARTÍN[4], A. FOX[1], P. CLEARY[2,3], R. ELSON[1] AND J. HAWKER[2,3]

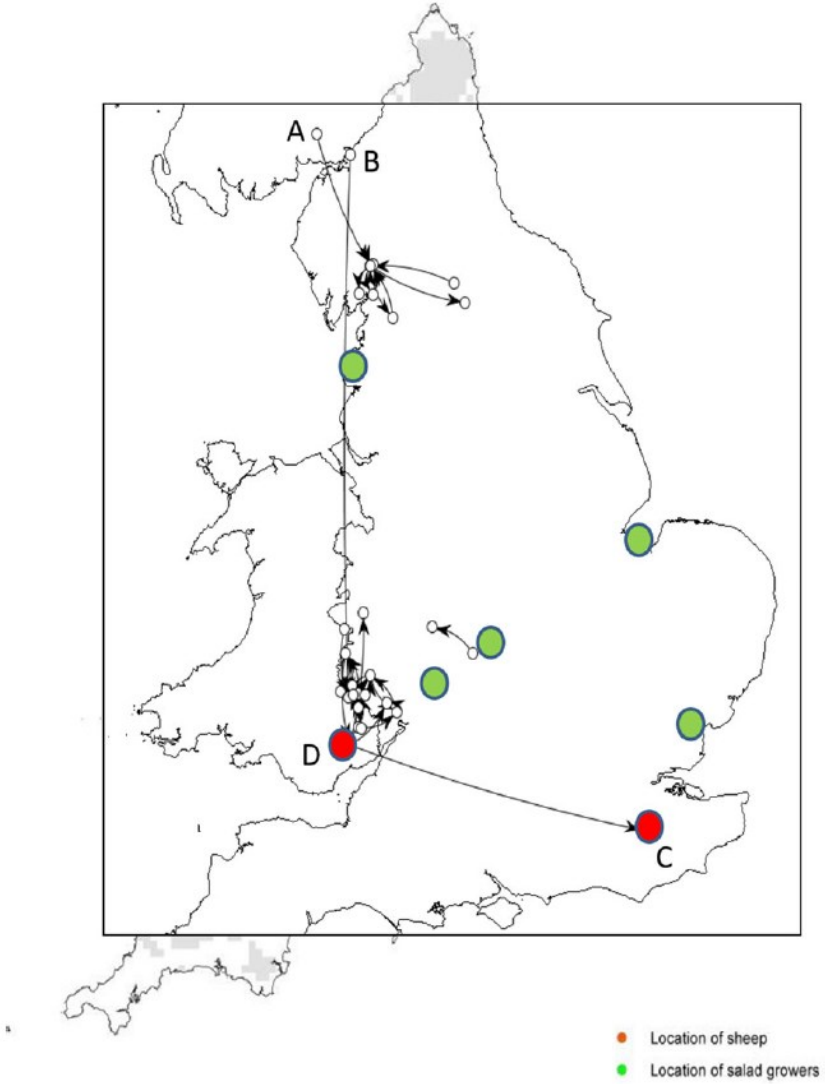
→ Mapping the recent movement of sheep and lambs across the United Kingdom

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[1,4], Sarah Foulkes[1], Ashley Sharp[5], Lara Utsi[1], Chris McBrien[5], Rehman Teagle[1], Alison Waldram[1], Chris Williams[6], Cathy McCann[1], Rob Smith[6], Sepeedeh Saleh[5], Noel McCarthy[3,7], Roberto Vivancos[1,3,8], Jeremy Hawker[1,3], Valerie Decraene[1]

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

Maya Gobin[1], Jeremy Hawker[1,2], Paul Cleary[1,2], Thomas Inns[1,2], Daniel Gardiner[1,3], Amy Mikhail[4], Jacquelyn McCormick[4], Richard Elson[2,4], Derren Ready[4], Tim Dallman[2,4], Iain Roddick[1], Ian Hall[5], Caroline Willis[6], Paul Crook[1], Gauri Godbole[3], Drazenka Tubin-Delic[7], Isabel Oliver[1,8]

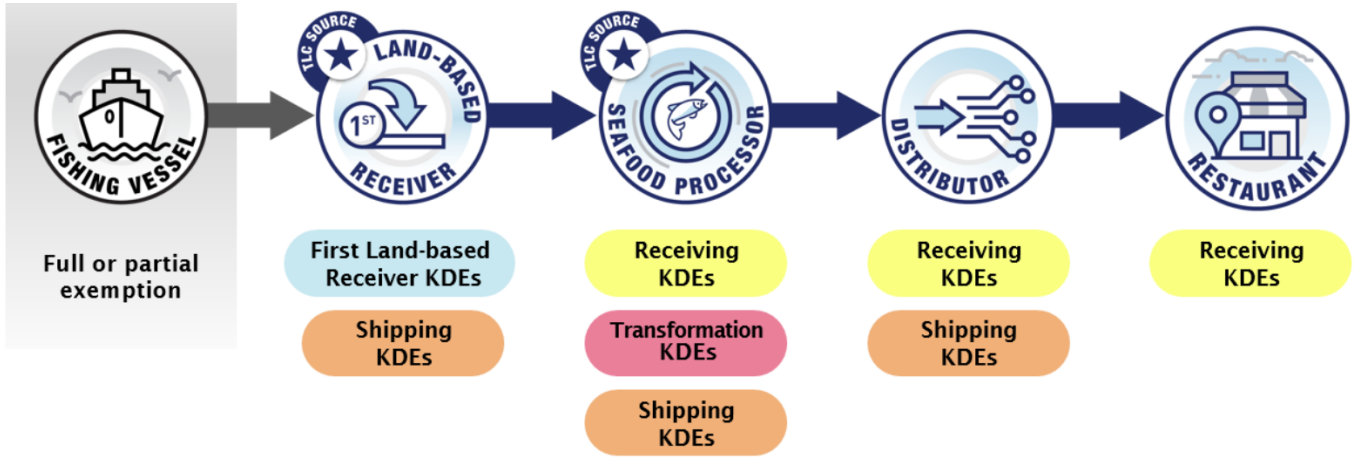


Case study on Salmonella outbreak associated with eggs

Mapping of movements of hospital staff

FDA´s New Era of Smarter Food Safety

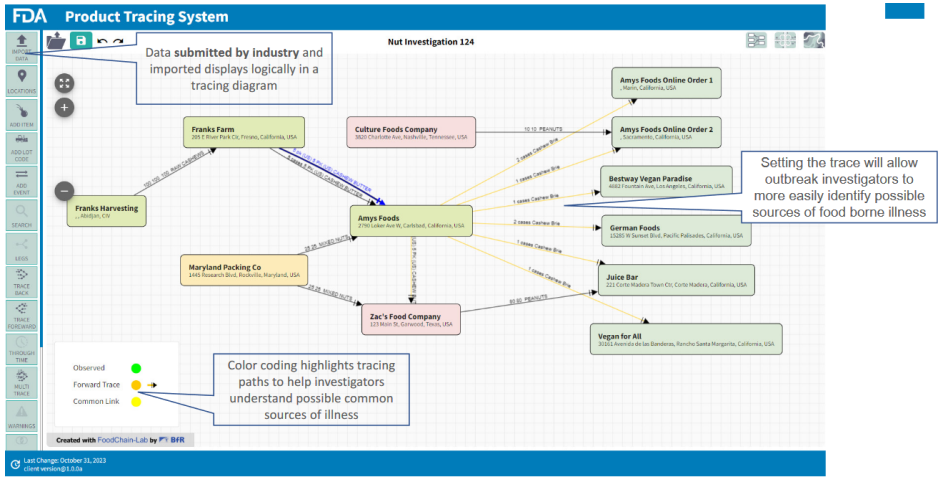
„Food Traceability Rule“ for harmonized data and data sharing



Product Tracing System

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

FDA Product Tracing System + Food Chain Lab Powered by BfR



Demo video of PTS + FCL in action

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

Collaboration between FDA and BfR

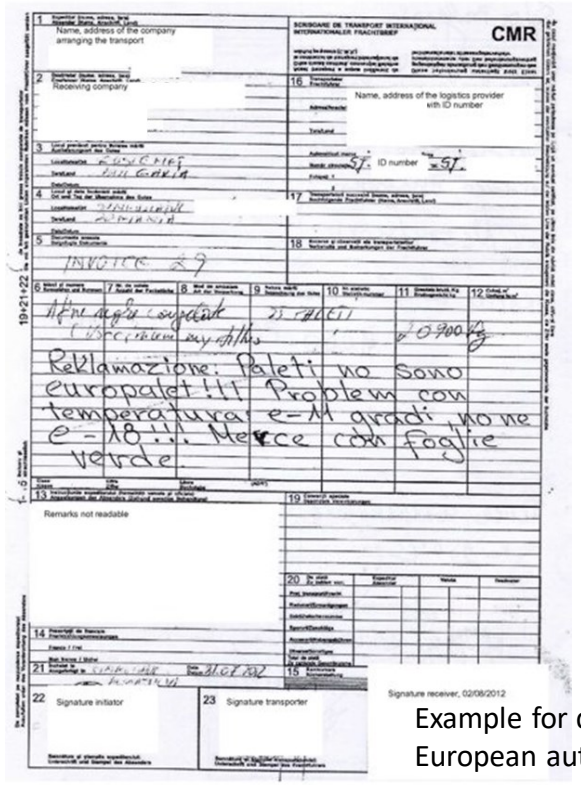
Looking ahead: Powerful tracing tools are interoperable

The current situation: Fipronil incident as example

NL collects data

DE collects data

…



Example for data exchanged between European authorities

The current situation: Fipronil incident as example

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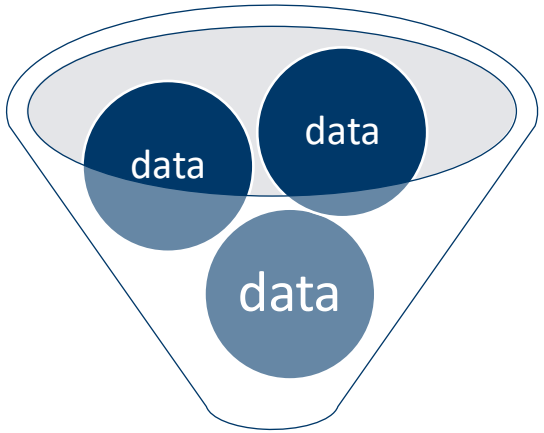
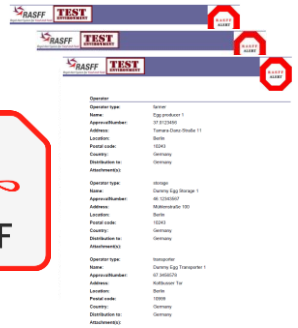
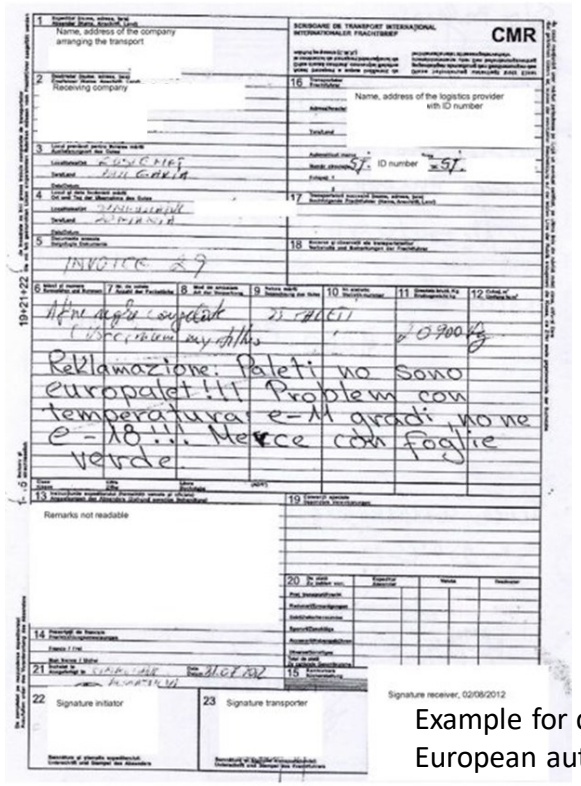


RASFF system





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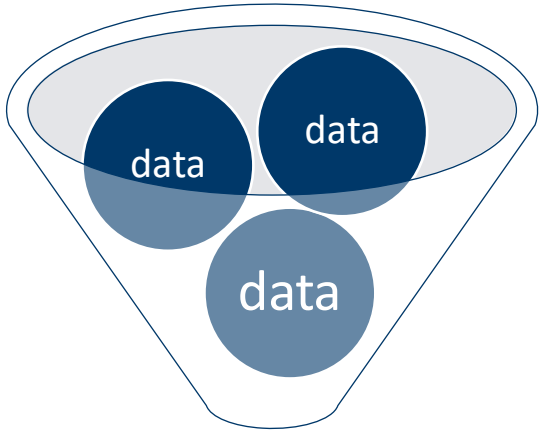
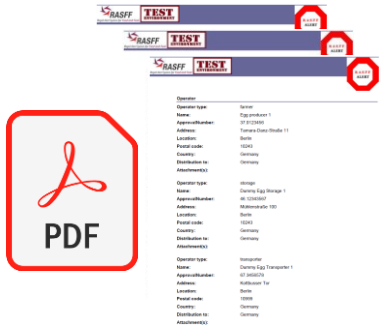


RASFF system



NL extracts data manually

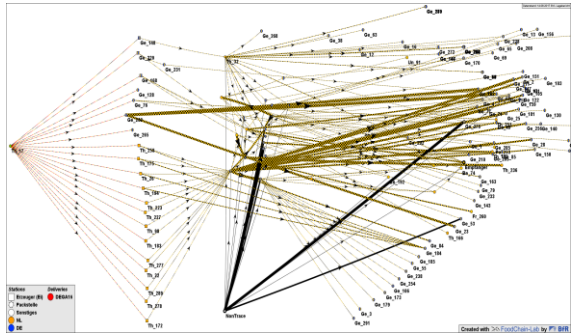
DE (BVL + BfR) extracts data manually

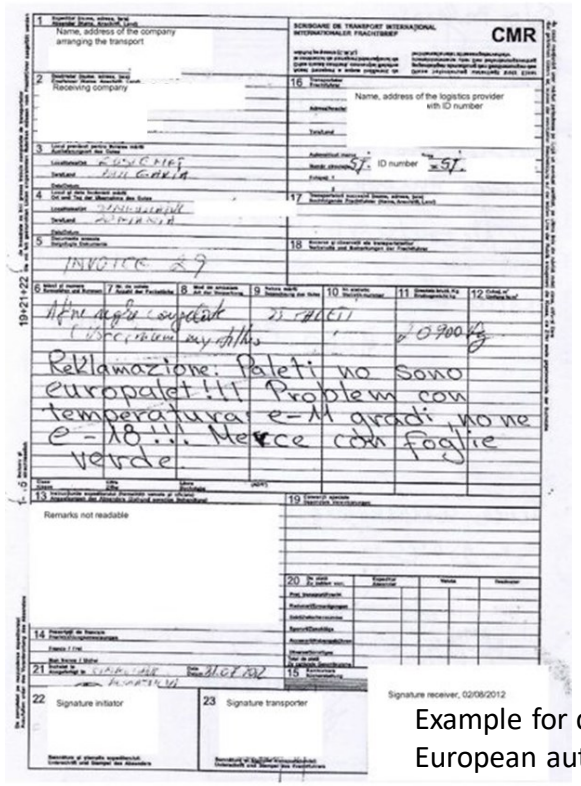
NRW extracts data manually

Duplication of work!

The challenge: Getting an overview on situation

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



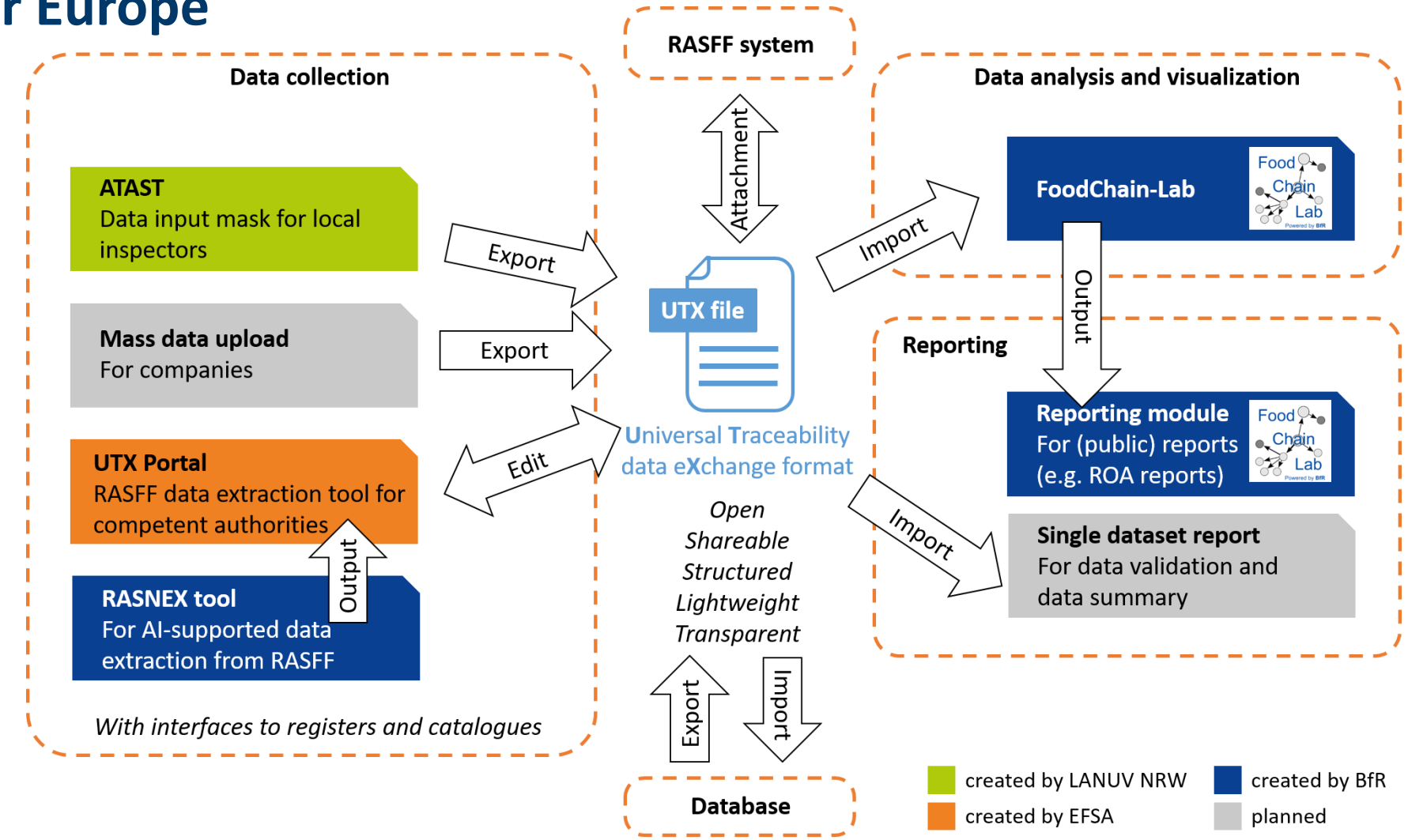


Example for data exchanged between European authorities

EUROPEAN FOOD SAFETY AUTHORITY

BfR

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



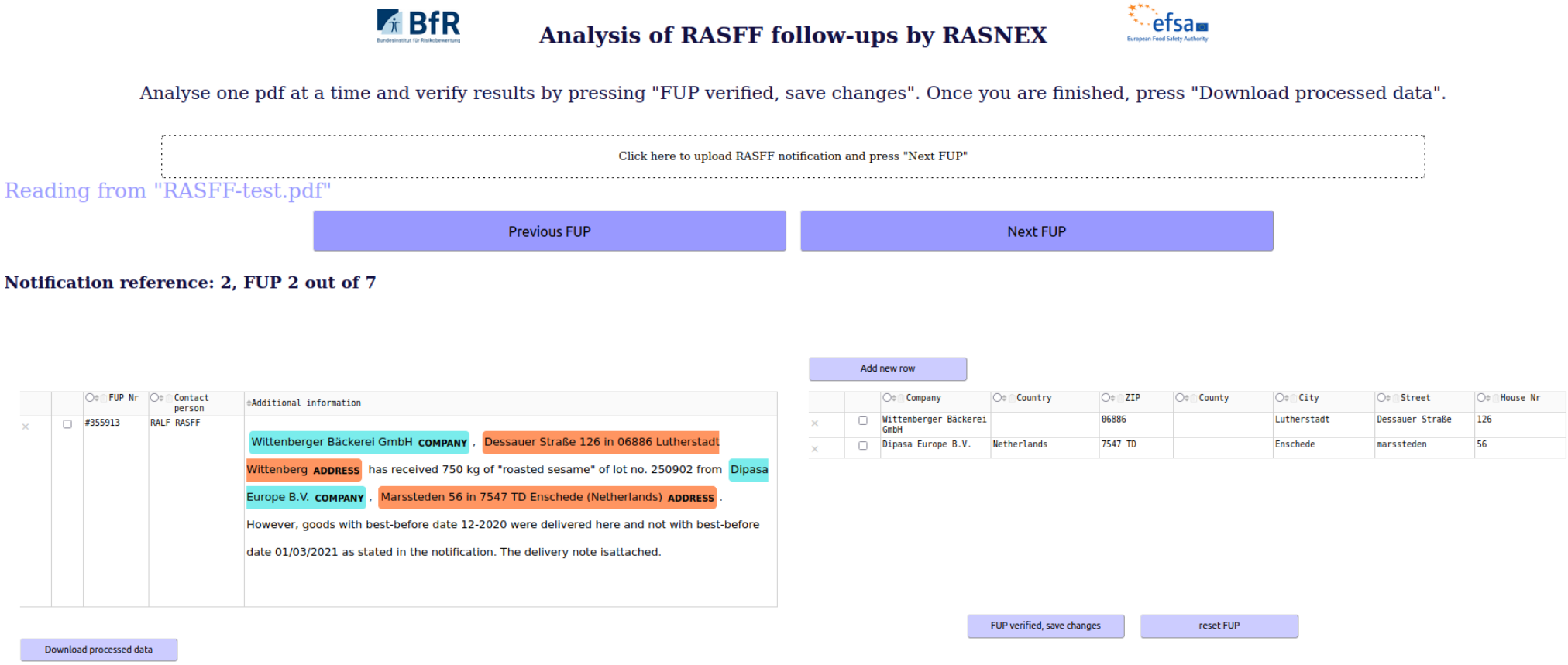
Benefits:

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



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

Thank you for your attention!

BfR
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

Marion Gottschald

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