SINTEF REPORT

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TITLE

Norwegian Traceability Project 2004
Subproject: Demonstration of electronic chain traceability

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ABSTRACT

The aim of this project has been to aid the *traceability* implementation process in the Norwegian fishing industry by testing and demonstrating existing solutions for electronic food chain traceability.

The demonstration activities have covered the following tests:

1. Electronic data capture technology (RFID tags).
2. A new method for food chain process mapping.
3. Exchange of structured electronic information.

As a whole, demonstration activities have been successfully performed and experiences made in this project found a good basis for further work on implementation of electronic chain traceability systems, as well as international standardization on the area.

KEYWORDS	ENGLISH	NORWEGIAN
GROUP 1	Food traceability	Matsporing
GROUP 2	Electronic traceability	Elektronisk sporing
SELECTED BY AUTHOR	Traceability implementation	Innføring av sporing

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1 Introduction

The aim of this project has been to aid the *traceability* implementation process in the Norwegian fishing industry by testing and demonstrating existing solutions for electronic food chain traceability.

The demonstration activities have covered the following tests:

1. Electronic data capture technology (RFID tags).
2. A new method for food chain process mapping.
3. Exchange of structured electronic information.

This project has been carried out in close co-operation with other related national, Nordic and European traceability implementation projects like:

- SEAFOODPlus (www.seafoodplus.org)
- TELOPTrace (www.tracetracker.com)
- IFSAT (www.ifsat.no)
- TRACE (www.trace.eu.org)

Together with the TELOPTrace project, we have developed a recommendation for:

- Unique identification of traceable units.
- Labelling of units.
- Information content in electronic messages.

Together with the SEAFOODPlus project, we have conducted a survey of available RFID technology and made functional specifications for a RFID-based data capture system.

Important traceability standardization work is being done both in the SEAFOODPlus project and especially in the TRACE project. A standard electronic language (TraceCore XML) and sector specific standards developed in these projects found the basis for new implementation projects. In Norway, the implementation and demonstration work is presently continued in the TRAINS and e-Traceability projects.

2 Internal traceability implementation process

An internal *food traceability implementation process* consists of the following 8 steps:

1. **Start-up meeting.**

   Presentation of objectives and tasks, discuss expectations, and prepare next steps. Decide on scope of implementation, which ingredients to trace, and which products.

2. **Document internal material and accompanying information flow, from reception of raw materials and ingredients, through production to shipping of finished products.**

   The purpose of the survey is to identify critical traceability points where information is lost, and look out for complex mixing of raw material and ingredients.

3. **Make a decision with respect to how traceable units should be identified.**

   For trade units going out (finished products, units that go to the next company in the supply chain, units out in the world) identification must be meaningful also for those who receive the product. In the TraceFood framework, it is a requirement that these units are identified by GTIN+ codes (see GTIN+ definition). If a company is not already a member of GS1 (or more precisely, if it does not already have access to GS1 codes), GS1 membership is strongly recommended. GS1 membership will mean that a company gets a globally unique company code and can thus start the process of constructing and generating globally unique product codes (GTIN+). For trade units coming in (shipments of raw materials and ingredients from other company, units that come from a previous link in supply chain), the existing product label and accompanying documentation received must be examined to identify potential codes that can be systematically recorded, thus ensuring that links to production of raw material or ingredients are not lost. If no such codes exist, a request can be sent to the supplier to be added, or your own internal codes upon reception can be generated. For internal batches, both raw material and production batches, internal codes may be used (or globally unique codes of course), but whatever internal batch identification is used, the raw material batch code must be linked explicitly to the corresponding incoming trade units, and the production batch code must be linked explicitly to the corresponding outgoing trade units.

4. **Plan re-engineering of software systems.**

   The software that shall keep track of raw materials and ingredients, must most likely be changed in three ways: *a)* data recordings should be keyed to the Trade Unit ID (directly linked to the GTIN+ or indirectly linked to the GTIN+ through the internal batch identifiers); *b)* internal traceability should be implemented by keeping track of transformations (for each raw material batch, record what production batches it went into, preferably what amount or proportion of the raw material batch that went into each batch; similarly for each production batch, record what raw material batches that went into it, preferably (if possible and relevant) what proportion of the production batch that came from each raw material type and batch); and *c)* there should be developed modules for dispatch and reception of traceability messages using TraceCore XML and accompanying sector-specific XML.

5. **Plan re-engineering of manual routines.**

   The manual routines must be changed to enable systematic identification and associated data recording as indicated above, both with respect to data recording and accessing, as well as the physical linkage between products and accompanying information (labels, freight forms, certificates, etc).

6. **Plan re-engineering of material flow and production routines.**

   Material flow should preferably be designed in a traceability friendly manner, with a minimum of mixing of raw materials with different origins.

7. **Implement the changes in software systems according to point 4.**

   Here ICT companies must be involved and a standard development cycle is expected (requirement specification, software design, database design, coding, testing, teaching, etc).

8. **Implement changes in manual routines.**

   Motivate, train, and start using the new software systems. Implement changes in material flow and production routines. Implement changes relating to raw material and ingredient reception (logging received identifiers, link to internal raw material/ingredient batches), production (logging transformation of raw material/ingredients batches into production batches as indicated above) and shipment (providing and logging dispatched identifiers, link to internal production batch).

3 Data capture technology

3.1 Introduction

The purpose of introducing RFID tags on the packaging and carriers is to improve several functions such as:

- More accurate identification of cargo units.
- Conduct faster data capture.
- Being able to sort the cargo more easily.
- Record historical data through the food chain (e.g., food safety related information such as temperature).

Supermarkets like Wal-Mart, Metro, Sainsbury’s, and Marks & Spencer have had their own RFID projects and shown great interest in implementing this new technology in their supply chains.

The main focus of this activity is the testing of equipment for automatic identification and data capture (AIDC) using state-of-the-art RF technology. One major goal is to evaluate technical and economical advantages/disadvantages in the distribution chain for farmed fish compared to the use of bar codes and traditional temperature loggers. The testing includes transfer of data between equipment for data capture and information systems.

3.2 Survey of available data capture technology

3.2.1 Introduction

This part recommends technology and equipment for initial tests based on the status in 2004 for standards, technology, and functional specifications for selected steps in the salmon distribution chain. The salmon value chain was the first chain to be investigated in the SEAFOODPlus and TELOPTrace projects.

Note that this survey was carried out in the beginning of the project period in 2004, meaning that the findings are not necessarily up-to-date.

3.2.2 Methodology

Information and views on the current status and future developments have been gathered by reviewing material from international standards organizations, research organizations, major technology suppliers, and major companies in important supply chains.

To conclude the information gathering phases, SINTEF hosted the workshop 'Technology in chain traceability' in Trondheim in June 2004, with selected lecturers representing both technology users and providers.

Following this workshop, functional requirements for AIDC equipment for the fish distribution chain were discussed with selected companies. This forms the basis for recommending equipment for the initial tests.

3.2.3 Status and trends

3.2.3.1 Technology and market

The dominating technology used for identification of logistic units and trade units is bar codes. The use of EAN-UCC (now GS1) barcode standards is recommended by the TraceFish standard major producers, wholesalers, and retailers (for example in ECR D-A-CH, ECR France & ECR Spain, 2004).

However, EAN-UCC (GS1), government bodies, and major companies in manufacturing and retail are looking at RFID technology to replace or supplement the use of bar codes. The major reasons for looking into this technology are:

- Several RFID tags can be read at the same time.
- Line of sight is not required for reading.
- Possibly less exposed to mechanical damage than barcode labels (dependent of placement).
- Smaller in size than barcode labels.
- Possible to store more information, and also add/update information.
- Possible to combine identification with environmental data (e.g. RFID tags with temperature sensors).
- Possibility for reuse in returnable assets.

There are, however, some obstacles:

- Costs of tags and readers (expected to decrease with increasing volumes).
- Work on international standards is still in progress.
- Physical constraints related to reading distance, type of goods (metal, liquids), interference, environmental conditions etc.

The technology has been on the market for several years, and products are developed with functionality for a wide range of applications. Naturally, increasing functionality corresponds to a higher price per tag (see Figure 1).

The current focus for use in the consumer goods supply chains is on passive tags in the HF and UHF frequency range. The vision of item-level tagging using low cost, read-only tags with a fixed Electronic Product Code (EPC) was developed by MIT Auto-ID Centre. Further developments based on the proposals by Auto-ID are now coordinated by EPCGlobal, established by EAN-UCC (GS1).

In supply chain applications it is common that a lot of tags (hundreds) are in the same area, this means that functionality for anti-collision is important.

Tags with writable memory are more expensive, but can be more flexible:

- The need for online database access is reduced (more information can be stored in the tag).
- Information can be added to the tag on selected stages in the distribution chain.

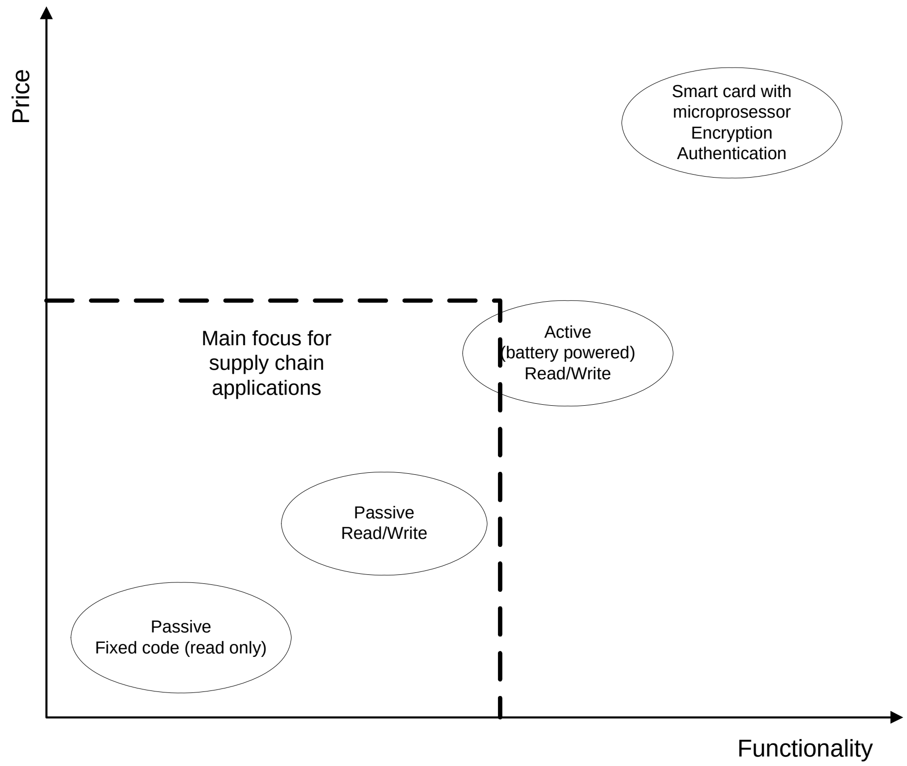

Figure 1 Tag categories

Active tags (battery powered) also have some important applications, especially where a higher read range is required (for example tracking of containers in large yards) or where tags are combined with sensors (temperature, pressure etc).

3.2.3.2 International standards

A more detailed summary of technology issues and status on relevant standards can be found in a separate SINTEF report (ref. Forås et. al 2004).

Table 1 shows the topics addressed in the ISO standards most relevant to the use of RFID tags in the distribution chain for fish.

Table 1 Overview of the most relevant ISO standards

ISO Standards	Description
ISO-IEC 15693.1-3	The standards are developed for the use of vicinity cards, but the technology has also been used extensively for logistics applications. The standard defines physical properties, radio communication requirements, anti-collision handling, and data transfer protocols.
ISO-IEC 15961 ISO-IEC 15962 ISO-IEC 15963 In process	The standards respectively describe the protocols for transfer and storage of data on RFID tags used for identification of physical items: • The instruction set and the data syntax for exchange of information between an application and the RFID tag • Data storage formats in the RFID tag memory • Numbering system for tags with permanent unique ID The standards are independent of the radio communication interfaces described in the ISO-IEC 18000 series.
ISO-IEC 18000.1 ISO-IEC 18000.2-n	The standards describe the communication interfaces between RFID tag and RF interrogator (reader). 18000.1 describe the functionality and parameters to be defined for each of the

In process	frequencies to be used for RFID tags. The standards 18000.2-n describe how the functionality should be implemented for the different frequency ranges. Frequency ranges currently in process: • 18000.2: 135 kHz and below • 18000.3: 13.56 MHz • 18000.4: 2.45 GHz • 18000.5: 5.8 GHz (currently withdrawn) • 18000.6: 860-930 MHz • 18000.7: 433 MHz

In parallel with the work in ISO, there is a lot of effort on technology and standards development for simple RFID tags used in the supply chains for consumer goods. This work is driven by large retail chains, their suppliers, and leading electronics equipment manufacturers. ECPGlobal was established by EAN-UCC (GS1) to coordinate this work, which was started by the MIT Auto-ID Centre. The specifications currently published from EPCGlobal are:

- EPC Tag Data Specification Version 1.1.
- 900 MHz Class 0 Radio Frequency (RF) Identification Tag Interface Specification.
- 13.56 MHz ISM Band Class 1 Radio Frequency (RF) Identification Tag Interface.
- 860MHz – 930 MHz Class 1 Radio Frequency (RF) Identification Tag Radio Frequency & Logical Communication Interface Specification.
- Physical Markup Language (PML) Core Specification, Extensible Markup Language (XML) Schema and Instance Files.

The main difference between Class 0 and Class 1 tags is that it is possible to write to a Class 1 tag, while Class 0 tags are factory programmed with a unique ID. Version 2 of the Class 1 specification will soon be published.

EAN-UCC has also developed guidelines (GTAG) for implementing the EAN-UCC (GS1) barcode standard data elements on read/write RFID tags (for example GTIN – Global Trade Item Number, SSCC – Serial Shipping Container Code etc).

So far, the EPCGlobal and the ISO SC31 WG4 standards proposals have some differences. However, the need for common global standards is evident, and efforts to coordinate this work have already been started. Another challenge for worldwide use of the technology is the use of common radio frequencies and signal strengths. For example, in some parts of the world the UHF frequency range is reserved for other purposes. Work has also been started to resolve these issues.

3.2.4 Functional specifications

3.2.4.1 Introduction

The functional specifications are based on the TraceFish standard. In addition to identification of trade and logistics units, food safety-related information like temperature data is important elements in the standard. These data must be captured, linked to the relevant trade units, and be available on request.

3.2.4.2 Identification of trade/logistical units

Introduction
The initial testing should involve at least three businesses in the distribution chain for farmed salmon:

- Processing plant for farmed salmon;
- Transport company (including both truck transport and terminal handling); and
- Retailer.

Fresh and frozen salmon are shipped in boxes stacked on EUR pallets. Boxes with fresh salmon are filled with ice. The use of passive RFID tags should be tested on both individual boxes and on whole pallets. In an operational situation, RFID tags are expected to supplement the existing labels. For the tests, RFID inlays can be integrated in existing labels or attached in addition to existing labels.

Details on the parameters to be included in the tests will be discussed with participating companies.

Data captured automatically, using either bar code or RFID technology will later be exchanged electronically, using the Tracefish Technical standard.

Processing plant for farmed salmon
The salmon is slaughtered, and fresh salmon is packed in boxes with ice. Some of the salmon are frozen, stored, and then packed in boxes before shipping to customers. The packaging is done according to customer orders, and labels with text and barcodes are attached to each of the boxes.

There are two main alternatives for information content in the RFID tags:

- Only a unique ID
- The same information content as in the existing labels (existing labels follow the recommendations in the Tracefish standard and the corresponding EAN.UCC guidelines).

It is desirable to test both these types of RFID tags at the following stages in the internal flow:

- Single cases on a conveyor belt (simulate a sorting operation between packing in boxes and palletizing).
- Pallet truck transport of stacked boxes on a pallet from the palletizing area to the load staging area (simulate control of pallet content, routing information to the pallet truck driver etc.).

Fixed readers should be used for both these test cases. For the pallet truck transport, a gate or portal might be necessary.

Transport
The salmon is loaded on trucks for transport either directly to the customer or via a distribution terminal. The truck driver needs to verify that the correct pallets are loaded on the truck.

To simulate this verification, the pallet RFID tags should be read using a handheld reader. This means that the reader must be able to distinguish between the pallet and box tags.

Customer or distribution terminal
In principle the same operations are carried out at the receiving docks of a distribution terminal and at a customer site: The truck is unloaded and the load content is verified. Verification is normally based on electronically transferred information from the previous step in the distribution chain (for example in the form of an ASN – Advanced Shipping Notice).

It could be argued that testing at a customer site or distribution terminal is comparable to the testing in the processing plant. However, it is considered important to verify that the tags 'survive' the truck transport (they are still attached to pallets/boxes and there is no physical damage).

The RFID tags should be read during pallet truck transport from the dock to the receiving area (simulate verification of pallet content). Fixed readers should be used for this test.

3.2.4.3 Temperature data

Introduction
The initial testing should involve at least three businesses in the distribution chain for farmed salmon:

- Processing plant for farmed salmon.
- Transport company (including both truck transport and terminal handling).
- Customer.

The TraceFish standard describes in detail the recommended temperature checks for each business involved in the distribution chain. In the standard, there are different methods for recording temperature data:

1. Temperature information for the product holding areas is recorded by each business in the chain (processing plant, terminal, transport company, etc).
2. The temperature is recorded by data loggers following the product (for example placed in the box with the product).
3. Spot checks on the product temperature (for example on receiving a logistic unit).

The technical solutions for internal data communications and exchange of data can vary between the different businesses in the chain, and will be defined as part of detailed test descriptions for data exchange.

Table 2 Examples of Tracefish data elements for temperature logging.

Food business	Unit or area to control	Tracefish data element	Method for logging (example)	Data transfer and storage (example)
Processor, for each unit received	Logistic or trade unit	CPR08 Temperature check	Spot check on surface temperature	Manual entry in local database
Processor, for each unit received	Logistic or trade unit	CPR09 Temperature record	Affixed recording device in one trade unit (box) or logistic unit (pallet)	Read recording device, store temperature/time log in local database
Processor, for each unit received	Product holding area	CPR12 Temperature record	Selected temperature sensors in the building logged by the local SCADA[1] system	Automatic storage in local database
Processor, for each new unit created	Production area	CPR30 Temperature record	Selected temperature sensors in the building logged by the local SCADA system	Automatic storage in local database
Processor, for each new unit dispatched	Product holding area	CPR37 Temperature record	Selected temperature sensors in the building logged by the local SCADA system	Automatic storage in local database

Processing plant for farmed salmon

Table 2 shows the Tracefish data elements and the corresponding method of logging temperature data for this part of the distribution chain for farmed fish.

Temperature loggers should be attached to trade units or logistic units during packaging. Exact location for the loggers must be discussed in detail (placed inside boxes, on top of a pallet etc.). For test purposes, the loggers will be read in the product holding area (load staging area). This will also make it possible to compare data from building sensors with data from the temperature loggers. Both fixed and handheld readers should be used.

Logging by building sensors will be tested by checking the status of the devices and by extracting temperature logs for a suitable time period.

The temperature data elements must be linked to the appropriate trade/logistic units. The principle of internal data flow for temperature data for a processor business is shown in Figure 2.

[1] SCADA – Supervisory Control And Data Aquisition

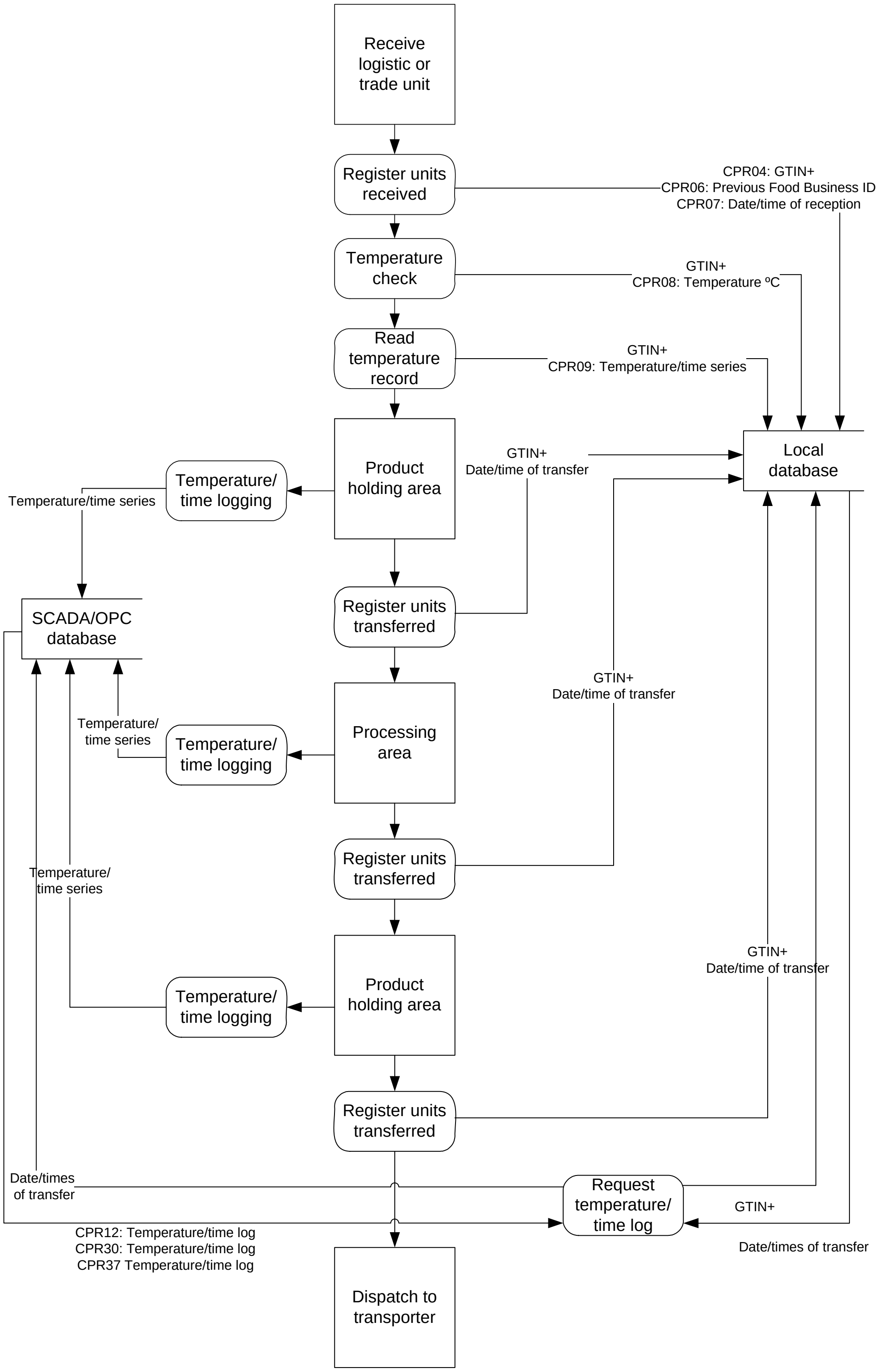

Figure 2 Temperature data flow for business type processor, Tracefish data elements.

The figure shows GTIN+ as the ID for linking temperature data to trade units; in some cases it can be more appropriate to link the data to logistic units (for example pallets, using the SSCC number). This will be discussed in more detail before the tests start.

Transport
Table 3 shows the TraceFish data elements and the corresponding method of logging for this part of the distribution chain for farmed fish.

Table 3 Examples of Tracefish data elements for temperature logging

Food business	Unit or area to control	Tracefish data element	Method for logging (example)	Data transfer and storage (example)
Transporter, for each unit received	Logistic or trade unit	CTS09 Temperature check	Spot check on affixed recording device	Automatic storage in local database
Transporter, for each unit dispatched	Product holding area	CTS14 Temperature record	Truck transport: Logging of temperature sensors in the truck, with transfer to the transporters main office	Automatic storage in local database

The salmon is loaded on trucks for transport to customers, and the truck driver needs to verify the temperature of the cargo. To simulate this operation, temperature loggers on trade/logistic units should be read using a handheld reader.

Customer (wholesaler) or distribution terminal
Table 4 shows the Tracefish data elements and the corresponding method of logging for this part of the distribution chain for farmed fish.

Table 4 Examples of Tracefish data elements for temperature logging

Food business	Unit or area to control	Tracefish data element	Method for logging (example)	Data transfer and storage (example)
Wholesaler, for each unit received	Logistic or trade unit	CTW09 Temperature record	Affixed recording device in one trade unit (box) or logistic unit (pallet)	Read recording device, store temperature/time log in local database
Wholesaler, for each unit dispatched	Product holding area	CTW20 Temperature record	Selected temperature sensors in the building logged by the local SCADA system	Automatic storage in local database

The truck is unloaded and the temperature loggers are read by the customer to verify the quality of the load. The temperature loggers should be read during pallet truck transport from the dock to the receiving area. Fixed readers should be used for this test.

3.2.5 Choice of technology/equipment

3.2.5.1 Introduction

Ideally, several types of equipment should be tested. This would allow comparisons between different solutions (standards) for technology and data communication interfaces, as well as measuring the performance of different types of equipment/technology. This should be done incrementally, using a limited number of products for the initial testing to make sure that the technology is suitable for the demanding environments in the fish industry.

When selecting suppliers for participation, several criteria have been considered. Among these are:

- Available RFID technology (for example frequency range).
- Relevant experience (also from other industries).
- General background in the AIDC industry (including barcode equipment, traditional temperature loggers).
- Participation in standardization work and policy on conformance to standards.

Essential is of course that the suppliers are willing to commit resources (equipment, personnel) to the project.

3.2.5.2 Identification of trade/logistic units

Barcode technology
The EAN-UCC (GS1) barcode standards will be the basis for comparison with the use of RFID technology. Barcode technology is well proven, and the EAN-UCC standards are well known. The emphasis on barcodes in this project will be more on whether the potential for improving traceability is realized, not technical tests.

The use of 2D barcodes is quite limited in supply chain operations compared to traditional barcodes, and will not be considered in this project.

RFID technology
International standardization efforts and product developments are currently focused on the UHF (860-960 MHz) and HF (13.56 MHz) frequency ranges. Different products have different characteristics, which make them more or less suitable for the demanding environments in the distribution chain for fish. Because of this, it is important to test equipment for both these frequency areas, and ideally also products from several suppliers.
The alternatives for equipment in the suggested steps in the distribution chain are shown in Table 5.

Table 5 Alternatives for ID capture equipment

Food business	Tracefish data element	Equipment category	Supplier
Processor	CPR14 Unit ID	RFID passive R tag RFID passive R/W tag Stationary reader UHF frequency range (ISO 18000.6)	Willett/Sato, Intermec
		RFID passive R tag RFID passive R/W tag Stationary reader HF frequency range (ISO 18000.3)	Willett/Sato
	CPR33 Unit ID	RFID passive R tag RFID passive R/W tag Stationary reader UHF frequency range (ISO 18000.6)	Willett/Sato, Intermec
Transporter	CTS04 Unit ID	RFID passive R tag Stationary reader UHF frequency range (ISO 18000.6)	Willett/Sato, Intermec
Customer or distribution terminal	CTW04 Unit ID	RFID passive R tag RFID passive R/W tag Stationary reader UHF frequency range (ISO 18000.6)	Willett/Sato, Intermec
		RFID passive R tag RFID passive R/W tag Stationary reader HF frequency range (ISO 18000.3)	Willett/Sato

Detailed configurations and installation plans must be worked out in cooperation with the suppliers as part of detailed test plans.

3.2.5.3 Temperature logging

The tests will be based on a combination of existing equipment (building sensors, truck sensors) and RF temperature loggers from cooperating suppliers. RF technology is chosen because of the potential for reducing the manual labour needed for reading data.

The alternatives for equipment in the suggested links in the distribution chain are shown inTable 6.

Table 6 Alternatives for temperature logging equipment

Food business	Tracefish data element	Equipment category	Supplier/model
Processor	CPR09 Temperature record	Affixed recording device in one trade unit (box)	Elpro/Hamster R
			KSW Microtec /TempSens
	CPR37 Temperature record	Selected temperature sensors in the building logged by the local SCADA system	Depending on the current infrastructure of the business. Interface via OPC[2] server is desirable.
Transporter	CTS09 Temperature check	Spot check on affixed recording device	Elpro/Hamster R
			KSW Microtec /TempSens
	CTS14 Temperature record	Truck transport: Logging of temperature sensors in the truck, with transfer to the transporters main office	Depending on the equipment currently installed in the trucks
Customer or distribution terminal	CPR09 Temperature record	Affixed recording device in one trade unit (box)	Elpro/Hamster R
			KSW Microtec /TempSens
	CPR37 Temperature record	Selected temperature sensors in the building logged by the local SCADA system	Depending on the current infrastructure of the business. Interface via OPC server is desirable.

The Elpro/Hamster R logger operates on 868 MHz (Europe), while KSW Microtec/TempSens operates on 13.56 MHz.

Detailed configurations and installation plans must be worked out in cooperation with the suppliers as part of detailed test plans.

[2] OPC – Open Connectivity, standards in industrial automation

3.2.6 Test of RF temperature loggers in the Norwegian Salmon industry

This memo contains a description of the test for an initial evaluation of the use of RF temperature loggers in the farmed salmon chain. The tests are done as a part of two research projects:

- SeafoodPlus
- Telop Trace

The loggers were placed inside cases with salmon on ice. The loggers can in theory be identified and the log transferred to a computer by using radio frequency (RF) readers. This will be an advantage over current systems, because loggers placed inside cases can be read or monitored at critical points in the distribution chain without breaking the pallets/cases.

The tests were done at the Fjord Seafood production plant at Herøy in Norway, and aimed to confirm whether current technology can be used like this in a real life environment.

Two different products are tested:

- Elpro Hamster R loggers, with reader/antenna from Elpro, 868 MHz
- KSW Microtec TempSens loggers, with reader/antenna from Scemtec, 13.56 MHz

More detailed specifications are shown at www.elpro.com and www.ksw-microtec.de.

3.2.6.1 Functionality to be tested

The basis for the tests is the Tracefish standards, where two types of temperature data are defined:

- Temperature check
- Temperature record

Typically, the temperature check is performed when goods is received, while a temperature record can include data from several links in the distribution chain.

The time used for data transfer is an important parameter, and the tests include both the readout of current temperature (a single value with a timestamp) and the complete log.

For all tests, the amount of data transferred is the maximum storage capacity for the loggers:

- Elpro Hamster R: 32 kBytes, corresponding to about 13 000 registrations
- KSW Microtec TempSens: 1 kByte, corresponding to about 64 registrations

3.2.6.2 Parameters expected to influence the results

In general, the use of RF technology is subject to influence from a large number of parameters. Some parameters relevant for these tests are:

- The location of the logger inside a case
- The location of the case with logger on the pallet
- The orientation of the logger relative to the reader antenna
- Number of loggers in the reader field at the same time
- Distance from logger to reader antenna
- Direction of travel relative to the reader antenna

- Speed past the reader antenna
- Environment (building material, technical installations, moving objects, radio noise sources, etc.)

The initial tests did focus on the influence of a few of these parameters, while the others were kept constant. The parameters that were investigated are described in section 2.4.4.

The results can also vary if other types of equipment are used, this can be investigated further at a later stage.

3.2.6.3 Test procedures

The tests were done using a pallet of fresh salmon on ice in cases of expanded polyester, with dimensions 800x400x200 mm (LxWxH). The pallet had 9 layers of 3 cases each, i.e. a total 27 cases. The net weight of salmon in each case is about 20 kg, there is about 4-5 kg of ice in each case.

Tag location on pallet and orientation relative to reader antenna

Initial laboratory tests using the Elpro loggers have shown that the loggers can be read when placed inside a case, but they should be placed adjacent to a sidewall. The reason for this is of course that the absorption rate for radio communication in the UHF range is higher when passing through organic materials. Another issue is that the loggers should be reused due to the cost, and it will be easier to spot them when they are placed at a sidewall.

As shown in Figure 3, placing the logger at the centre of a sidewall gives 4 possible locations. This does not seem to be a lot of alternatives, but there are three cases for each layer on a pallet (see Figure 4).

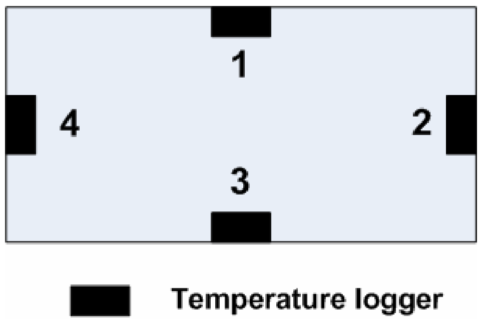

Figure 3 Possible locations inside a case (top view)

Within a pallet layer we have 12 possible locations. If we multiply this with 9 layers of cases on each pallet, the number of possible locations on a pallet is 108. Note also that the layers are stacked in alternating patterns (see Figure 5).

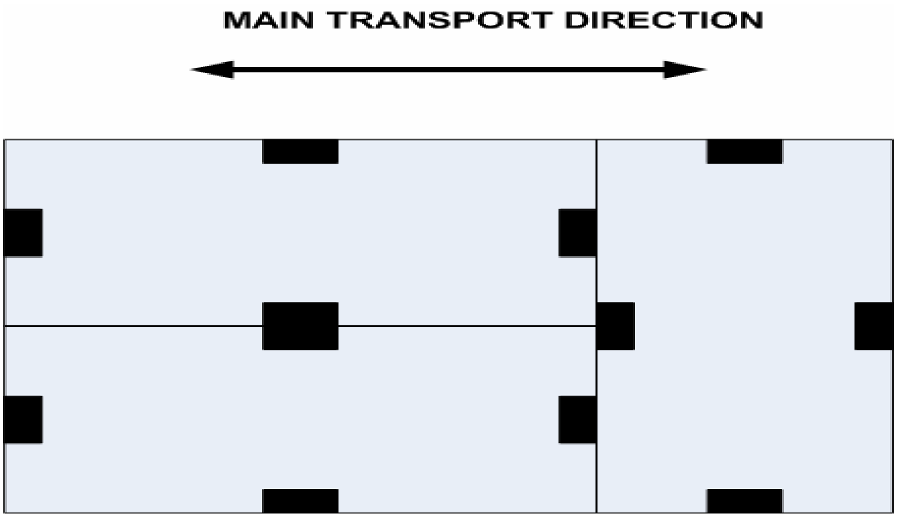

Figure 4 Possible locations on a pallet layer (top view)

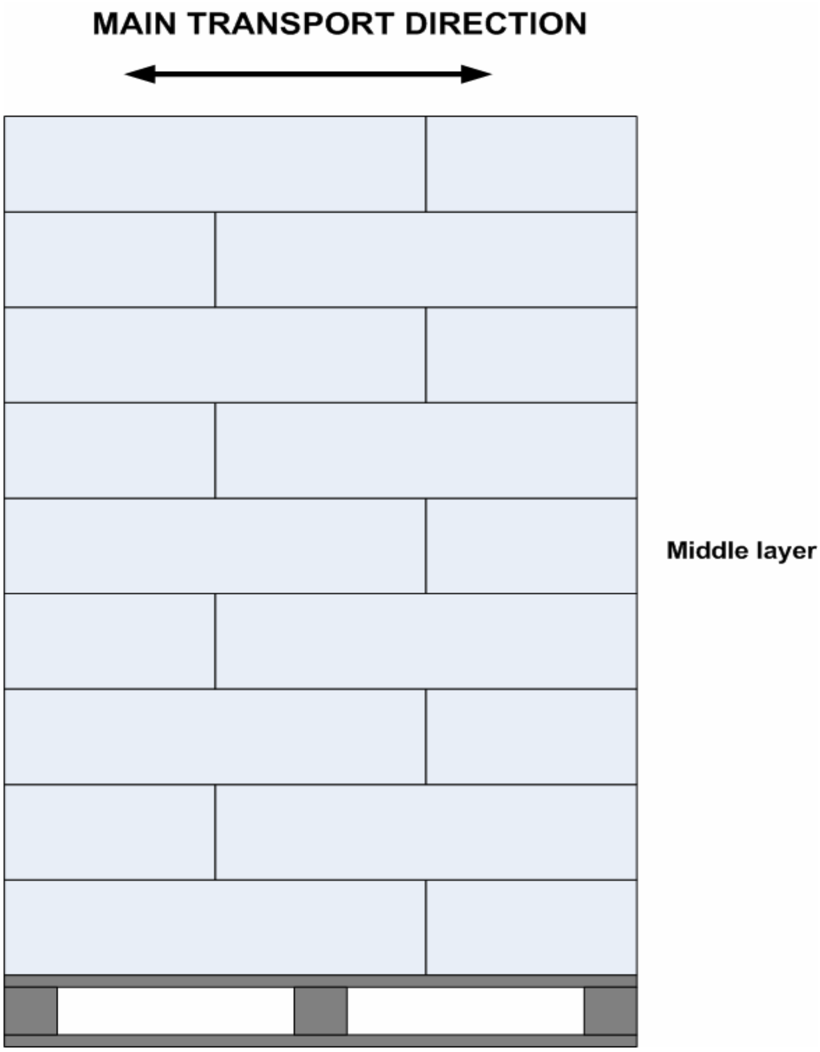

Figure 5 Pallet side view

For practical purposes, the number of alternatives had to be reduced for these initial tests. Placing the loggers in the middle layer of the pallet should give representative temperature recordings. Within this layer, the tests included a total of 6 different logger locations relative to the antenna (see Figure 6).

In an operational environment, it is expected that the current cost levels of loggers will allow for a maximum of one logger on each pallet. Thus, all the tests are done with only one logger on the pallet. If several loggers are in the reader field simultaneously, the total time for reading each logger will increase. This needs to be investigated further.

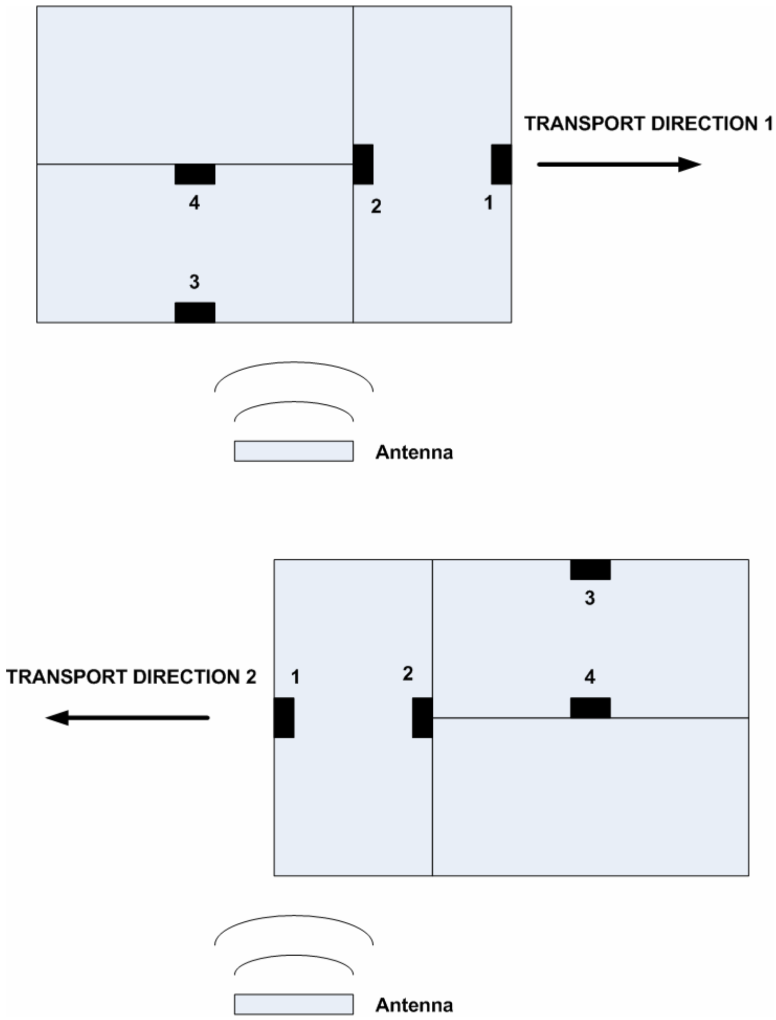

Figure 6 Tag locations used for testing

Distance from logger to reader antenna

The two types of loggers used for these tests have quite different characteristics. The Elpro logger operates on the frequency 868 MHz (UHF) and is active, i.e. the power supply in the logger is also used for transmitting to the reader. The theoretical maximum distance is stated as 100 meters.

The KSW Microtec logger operates on the 13.56 MHz frequency (HF) and is passive, i.e. depends on generating power for return transmissions from the reader radio signals. The theoretical maximum distance is in the area of 1 meter.

Because of the difference in performance, the Elpro loggers are tested for a larger number of distances.

Speed past the reader antenna

The amount of time the loggers are in the reader field is important for a successful communication. In a terminal area, pallets are usually transported using a pallet jack or rider pallet truck. The tests are carried out with rider pallet truck that had a speed of 0,8 – 1 meter per second.

3.2.6.4 Results

Apart from the frequencies, there was one major technical distinction between the loggers: The Elpro logger used active communication, while the KSW logger was semi-passive. This means that the Elpro logger used internal battery power for communication with the reader, while the KSW logger depended on power generated from the radio waves emitted from the reader. This naturally influence the reading distances obtained.

The ID of the Elpro logger was readable at all box/pallet positions (see Figure 7). The temperature log was only readable from stationary pallets up to a distance of 20 metres.

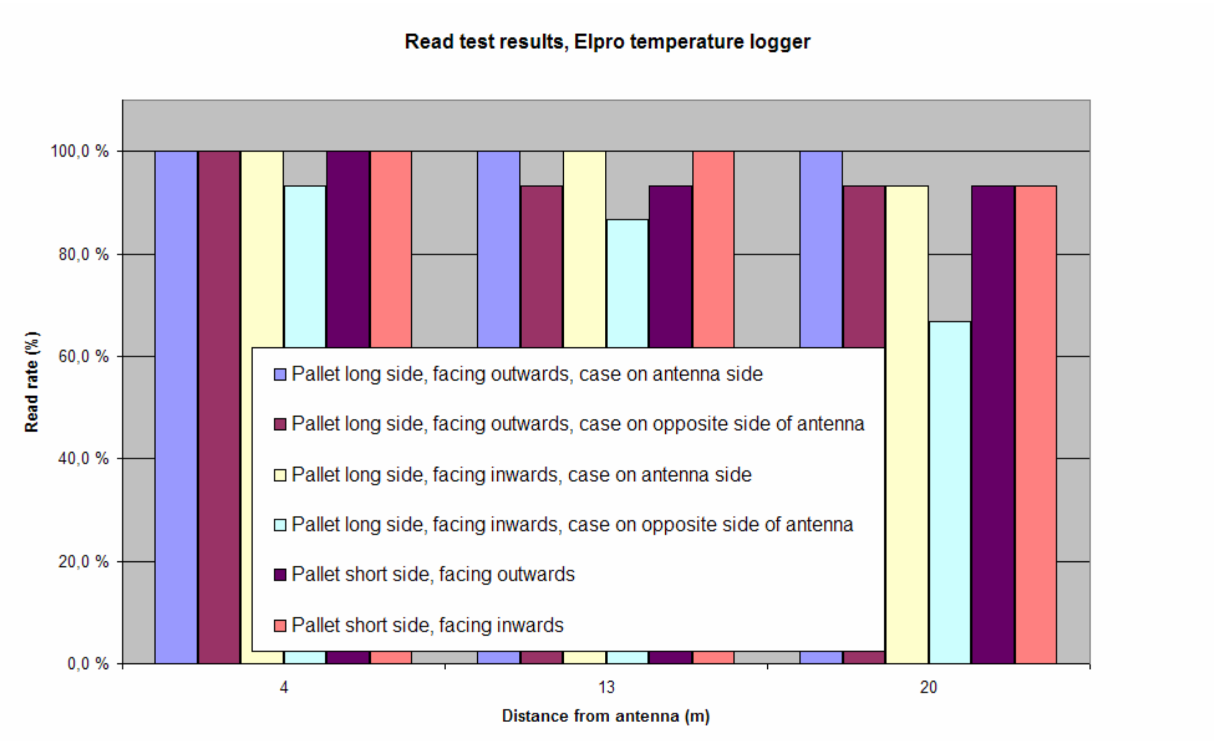

Figure 7 Test results from testing the Elpro tag at all locations

The KSW TempSens reader had no contact with the tag when the pallet was moving. The logger could only be read when the pallet was stationary in front of the antenna, at a distance of about 20-25 cm.

3.2.6.5 Conclusion

The results were very good for the Elpro logger. This type of logger can be used in real life conditions for monitoring temperatures inside a case of salmon.

The reading range of the semi-passive KSW TempSens was too short to be used in the actual industrial environment.
In the SeafoodPlus project we are doing more RFID testing, especially testing tags with sensors. Our aim is to develop guidelines for good data capture practice, by the end of 2008.

4 Process mapping

4.1 Introduction

Before implementing internal traceability, a survey analyzing material flow and production processes should be conducted, as well as information flow through the food business. The material flow entails both raw materials and ingredients going into the production, and products created. Investigation of the information flow should cover data recording related to the material flow.

4.2 Process mapping method

The objective of the process mapping is to analyze the material flow and the information flow, and in particular to identify systematic information loss.

The overall steps for process mapping are outlined in Figure 8.

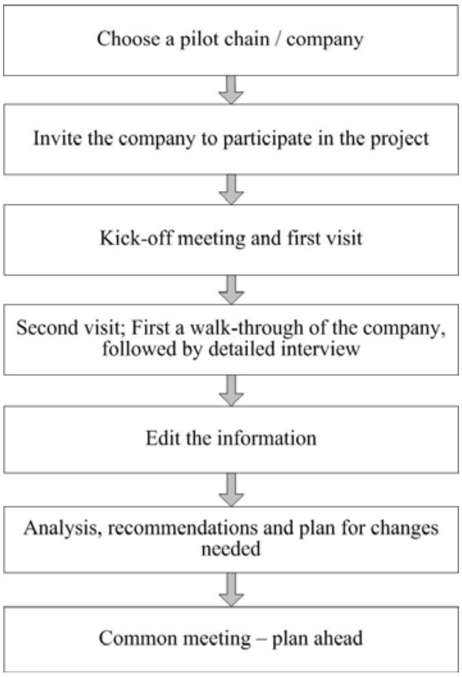

Figure 8 Overview of the steps in the process mapping

Companies in a pelagic supply chain in Denmark, a tuna supply chain in Spain, and a farmed salmon supply chain in Norway were chosen to be pilot companies in SEAFOODPlus. These companies were visited in 2004 and 2005, and the process mapping study was carried out.

A walk-through of the each company was followed by detailed interviews of the staff. The first step in process mapping of this type was to identify the end product.

The method “Analysis of traceability in food supply chains - Standard method” was used (Olsen, 2007). This method was developed for exactly this type of analysis.

The principle and sequence of events can be illustrated as follows:

When performing process studies to document material and information flow of food, each of the 9 steps in Figure 9 can be converted to a form to be used in the mapping or interview. The tables with questions (see Olsen, 2007) are quite extensive, and not all questions will apply to all steps. In addition, some products or steps may have special attributes that are relevant to record in addition. These may easily be appended to the respective forms.

Note that the steps 2, 4, 6, and 8 deal with the transformation information, i.e., the documentation of what happens exactly at the point and time when the product moves from one context to the next.

The steps 1, 3, 5, 7, and 9 deal with durations, i.e., what happens or what is the state during transportation, pre-processing, production, and packaging of the product.

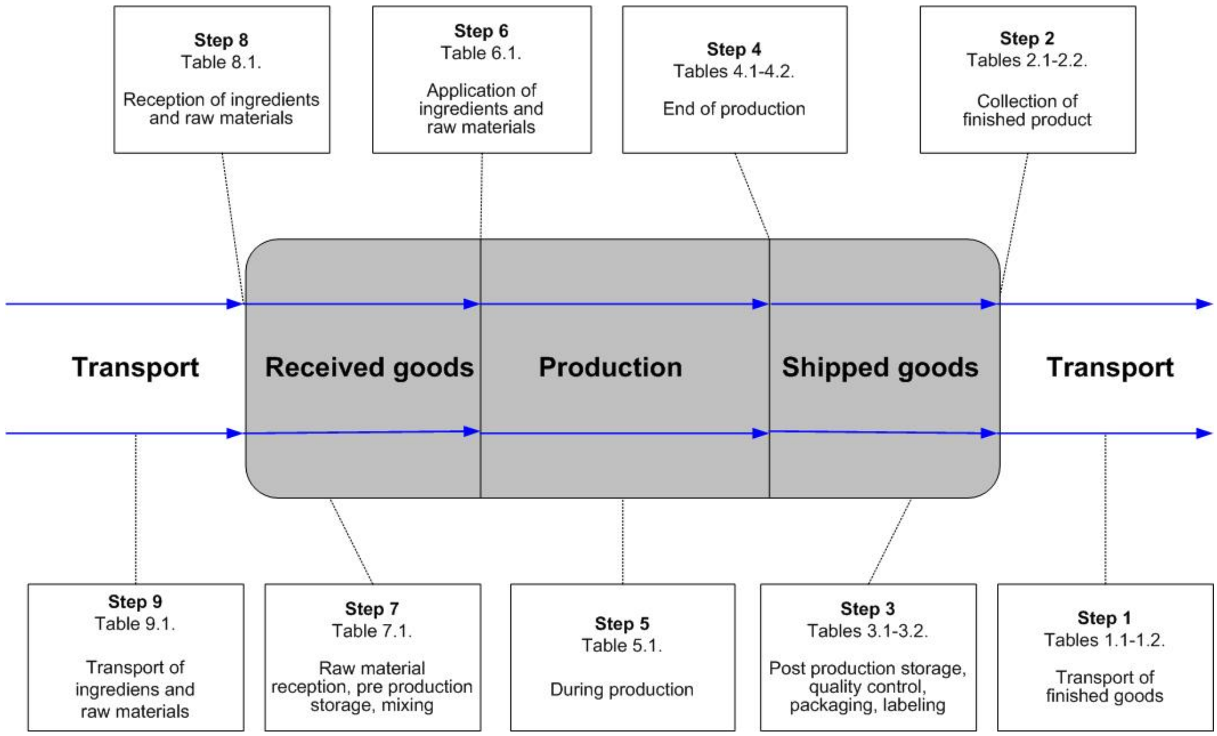

Figure 9 Overview of the method in process mapping to analyze the material flow and the information flow. The tables referred to are in Olsen (2007)

The diagram above and the tables with questions show how to map one product, starting with a form or table where the information about the transportation of it to the next step is recorded. As the process mapping moves against the material flow, it is likely that multiple tables or forms will be needed. In particular, this is true when moving from mapping the process parameters (step 5) to mapping the application of raw materials and ingredients (step 6). If only one product, process, and transportation route is documented, there will be only one set of questions to ask (one form or table) in steps 1, 2, 3, 4, and 5. If multiple raw materials or ingredients are used, then each of these will be documented on a separate form 6, and each of these forms will then have to be traced through steps 7, 8, and 9.

4.3 Process mapping in the farmed salmon chain

4.3.1 Material flow and identification

A salmon supply chain from breeding to production of salmon fillets in Norway has been studied (Figure 10), including production of vitamins and pigment colour and production of salmon feed. The grey steps in the supply chain have been analyzed by using the analysis schemes in (Olsen, 2007).

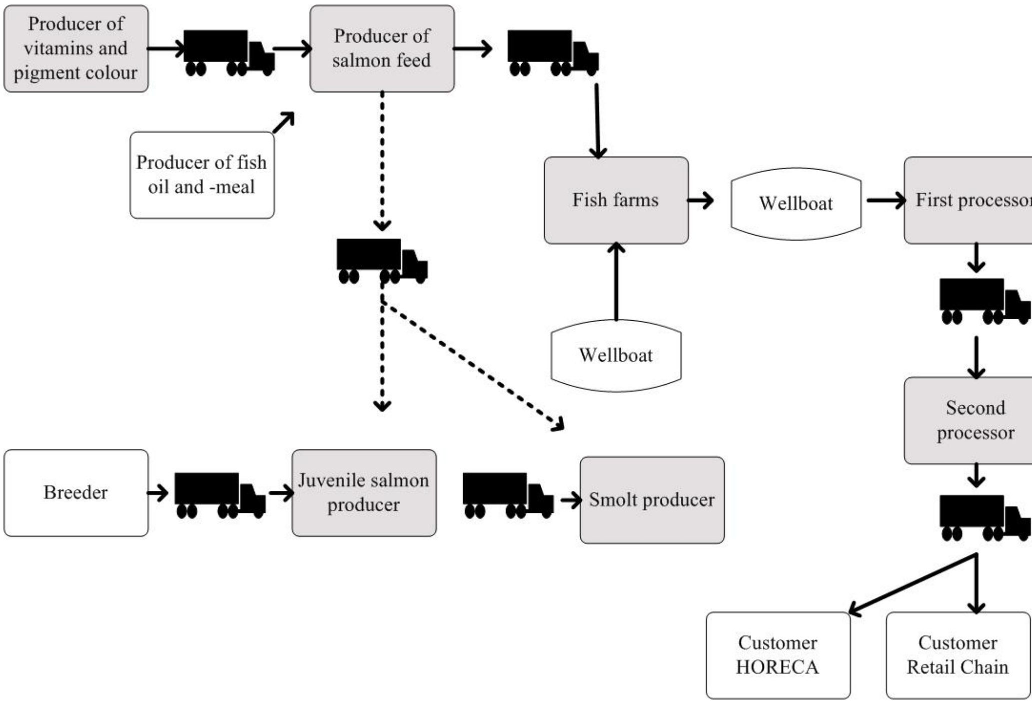

Figure 10 Overview of the salmon supply chain in Norway

The first step in process mapping of this type is to identify the end product. The product chosen to be mapped was salmon fillets.

Producer of vitamins and pigment colour

The producer of vitamins and pigment colour supplied vitamins to the producer of salmon feed. The vitamins were based on chemical products. All the steps, including the natural gas supply, were internal in the company. The internal traceability of the vitamin-producing company was not evaluated in this study. This evaluation will only focus on chain traceability starting from the producer of vitamins and pigment colour. The transformation information in the Enterprise Resource Planning system (ERP) between producerID, production batchID, and customerID, indicated that the producer of vitamins and pigment colour had the possibility to trace each batch of an article to a defined number of customers. A barcode labelling and reading system was implemented and running. The system was based on the EAN-128 code, which is the preferable system for global unique identification.

Producer of salmon feed

The producer of salmon feed received raw materials from more than 100 different suppliers. The sizes of the received batches could vary between a few kilos in a single box of vitamins to several tons in a bulk cargo of fishmeal. The study focused on the methods and systems for receiving raw materials from the producer of vitamins and pigment colour. Traceability between the producer of vitamins and pigment colour and producer of salmon feed was based on manual recordings of identifications and additional traceability information. The identifications used were only partly based on an internationally standardised system.

Breeder

The breeder produced salmon roe and delivered it to the juvenile salmon producer. This step was not analyzed in this study.

Juvenile salmon producer

The juvenile salmon producer received salmon roe. Feed, water, and oxygen were added to make the salmon grow into juveniles, and temperature and light were controlled to optimize the growing conditions. During the production, only splitting of the original fish groups was done. The identification of trade units was unique both for reception and dispatch of fish groups. Input factors, such as feed, were not recorded with unique trade unit (TU)/logistic unit (LU) IDs. Traceability of feed was therefore only possible at the feed type level. For the salmon itself, developing from roe to juvenile, the information loss was not significant. Salmon of one origin/generation were kept separate from other salmon in all stages through this step, from roe to juvenile. The roe could be distributed across numerous cylinders, and the juveniles in many tanks, but the splitting, mixing and joining that happened did not cause significant information loss as the fish was uniform. There is a concern, however, that relevant information pertaining to the feed could be lost unnecessarily; if a recall based on feed batch ID should occur, it might be problematic for the juvenile salmon producer to prove that the fault is not to be found in his company.

Smolt producer

The smolt producer received salmon juveniles. Feed and water was added to make the salmon grow from juveniles to smolt (ready for salt water), temperature and light was controlled to optimize the growing conditions, and the fish was vaccinated against disease. Salmon smolt was delivered to fish farms either in September/October of the same year as when received (0 yearlings) or in April/May the following year (1 yearlings). Traceability of the fish TUs were considered to be good. During the production, only splitting of the original fish groups was made. The IDs of the TUs were unique both for reception and dispatch of fish groups. The input factor feed was not recorded with unique TU/LU IDs at reception. At consumption, feed name and batch ID were linked to the actual fish groups. Traceability of feed was therefore possible at feed batch level per fish group. The software was, however, not capable of reporting these references. Because of this, the traceability was not electronic. The input factor vaccine was recorded with unique TU/LU IDs. Traceability of vaccine was possible at the TU/LU level per fish group.

Fish farms

The fish farms received smolt. Feed was added to make the salmon grow from smolt to 4-6 kg salmon. Temperature and light was controlled to optimize the growing conditions, and the fish was chemically treated against lice. Salmon smolt was received at fish farms either in September/October or in April/May. It took 10-18 months to grow from smolt to 4-6 kg. Traceability of the fish TUs were considered to be good. During the production, only splitting of the original fish groups was made. The IDs of TUs were unique both for reception of smolt and dispatch of salmon for harvesting. These IDs were internal and proprietary and were not used as a link by the live fish transporters. Input factors such as feed were not recorded with unique TU/LU IDs. Traceability of feed was therefore only possible for feed type per fish group.

Well boat

Well boats transported live salmon from the fish farms to the first processor. This step was not analyzed in this study.

First processor
Live salmon was received from well boats and placed in waiting cages. The salmon in each cage was assigned a production batch ID and processed one cage at a time. Salmon from the cages were pumped one cage at a time to a cooling tank. The production lines were emptied between batches to make sure that batches were not mixed. To keep the salmon calm, CO_2 was added in the cooling tank. From the cooling tank, the salmon was pumped to a station for 'throat cutting', and then on to a bleeding tank. The salmon was then sent through a grader for sorting by size, and sent to the appropriate gutting line.

Gutted fresh flow:
The packaging of fresh salmon in boxes was done automatically according to customer orders. The boxes were then filled with ice, labeled and strapped. Palletizing was done by a robot, sorting the boxes by quality and size. Pallets were transferred to the terminal area by pallet truck.

Fresh fillet flow:
Filleting was done by customer order, and the required size/quality was sent to a manual fillet line. Fillets were manually packed in boxes, labeled and strapped. The boxes were stacked on pallets and transferred by pallet truck to the terminal area.

Gutted frozen flow:
From the grader, the salmon was transported by pallet truck in 400 kg containers. After stacking in racks, the salmon was placed in freeze tunnels. Frozen salmon was packed in boxes, labeled and strapped. After palletizing, pallets were transported to freeze storage. Selecting from storage was done by customer order, using the first in, first out (FIFO) principle as much as possible. The process of loading onto trucks was common for all the product flows. The pallet labels were placed on top of the pallets. This made it possible to find errors discovered after loading by crawling on top of the cargo. The transport to customers either went directly or via terminal/other transport modes.

The salmon in each waiting cage was treated as one separate batch. When a new batch was started, the production plant information system assigned a batch ID. The operator chose a supplier (fish farm) from a list, and could also enter the fish farm cage number. The batch number assigned to the salmon from each waiting cage was kept through the production plant, and was printed on both box labels and pallet labels.

Transport
The transport company transported salmon from the first processor to the second processor. The loading of each customer order at the second processor was recorded on a freight manifest printed from the plant information technology (IT) system. This was a standardized document with basic information about the transport, and each manifest had a unique consignment number. This number was also printed on the document as a barcode. The processing plant printed the customer order number on the freight manifest as a reference between the transport and the customer order. The document was signed by sender, transporter and receiver, and each party kept their own copy. For each transport order, the transport company assigned a transport order number. This was used as the internal reference in the transport company for tracing the transport. As an external reference, the transport company normally linked the second processor’s customer order number to each transport order number. The invoice number was also linked to the transport order number. One transport (transport order) consisted of one or several trips, identified by a unique trip number. The trip numbers were linked to the transport order number. The information stored for each trip was origin and destination, date/time of start and arrival, truck registration number, etc. For international transports, the transport company issued an international freight manifest. In addition to the name of the receiver, the reference to the second processor’s customer order on

this document was the transport company's transport order number. When the transport company stored salmon in the terminals, the transport company kept track of pallets/boxes by assigning a physical area for each client. The location of individual pallets/boxes was not managed by a Warehouse Management System (WMS). When a sale was made, the transport company received an order with a packing list with reference to individual boxes.

Secondary processor
Fresh salmon was received from first processor (above) in 20 kg styrofoam boxes on pallets. The transport was made by refrigerated trucks. The outgoing products could vary between a few kilos to several tons of smoked salmon in 10 kg styrofoam boxes.

The level of external traceability was poor, as they missed traceability links at both ends of their internal chain – that is, the reception of raw materials and the dispatch of outgoing products. At the reception of raw materials, there is no scanning of box or pallet labels. But some data from the box labels are entered manually into paper forms. However, nothing that can be used as unique backward links (to the slaughtering plant or to the transporter) is entered.

The situation is similar at the dispatch of products. Production lot numbers are stamped on the boxes using ink-stampers, but the numbers are not globally unique, and not even internally unique. The boxes receive printed labels from the Marel system too, but the labels only identify the customer and transporter at a generic level (name only), and does not contain the production lot number (as this is being stamped on the box).

4.3.2 Conclusion

In general, traceability is good along the production chain. Internal traceability is acceptable in all steps. The methods and systems of chain traceability are, however, more insecure and partly missing.

4.3.3 Recommendations

General recommendations for the salmon supply chain

1. For each unit received from the fish farms and other suppliers, the SSCC, supplier ID (GLN; Global Location Number), and transporter ID should be recorded and linked to the internal production batch ID.

2. For each unit dispatched to customer, an SSCC should be used as an ID and linked to an internal production batch ID, customer ID (GLN), and transporter ID.

3. For recording SSCC numbers on pallets when loading trucks, a logistic unit ID data capture system should be in place at the plant. The data capture system must be integrated with the company's ERP system.

General comments
It is assumed that the ERP systems for each step in the chain have functionality for linking logistic units (SSCC) and trade units (GTIN+) to customer orders.

A plan to improve the traceability at the producer of vitamins and pigment colour could be as follows:

1. Redefine the barcode on the trade unit labels to include the following EAN-128 AI's:
   a. AI (01) GTIN
   b. AI (10) Lotnumber
   c. AI (21) Serial number or (8008) Date and time of production

2. If trade units are assembled into a logistic unit:
   a. Labelling and identification of the logistic units including EAN-UCC's SSCC in a barcode
   b. Links between ID of each trade unit in the logistic unit (1a, b and c) and the SSCC
   c. Link between SSCC and order number in software such as SAP

3. Labelling and identification by the producer of trade units and logistic units by using the EAN-UCC Global Identification Number (GLN) AI 410-415 in barcode.

A plan to improve the traceability at the producer of salmon feed could be as follows:

1. Scanning of SSCC and GLN at raw material reception. Automatic data capture may be the most efficient improvement to improve traceability in the raw material reception. This is only possible through the use of standardised company and batch IDs from suppliers according to the TraceFish standard for identification of company and batch/trade units.

2. Use the GTIN article numbers instead of proprietary raw material numbers.

3. Apply GLN in product labels using EAN-UCC 128 coding at all production sites.

4. Identification of small bags with GTIN (AI 01), batch number (AI 10), and Serial number (AI 21) or date and time of production (AI 8008).

5. Links between ID of each trade unit on the logistic unit (ref. 4. above) and the SSCC.

6. If small bags are dispatched as single bags, they should be labelled as a logistic unit with an SSCC.

7. To ensure the link between trade unit/logistic unit and customer (fish farmer), a logistic unit ID data capture system should be in place at the transporter or alternatively at the fish farm.

A plan to improve the traceability at the juvenile salmon producer, the smolt producer, the fish farms and the first processor could be as follows:

1. For each unit received from the suppliers (previous step, feed, chemicals, etc), the SSCC, transporter ID, and supplier ID (GLN) should be recorded and linked to the internal fish group I.

2. For recording SSCC numbers, a logistic unit ID data capture system should be in place at the fish farm. The data capture system must be integrated with the company's ERP system.

3. For each unit dispatched to customer, an SSCC should be used as an ID and linked to an internal fish group number, customer ID (GLN), and transporter ID.

A plan to improve the traceability at the transport company could be as follows:

1. Loading: For each unit received from the first processor, the SSCC, supplier ID (GLN) and freight manifest ID should be recorded and linked to the internal transport company order number.

2. For recording SSCC numbers during loading, a logistic unit ID data capture system should be in place at the first processor /the transport company vehicle.

3. Unloading: For each unit unloaded at a distribution terminal or at the customer site, the SSCC of the logistic unit, and the GLN of the destination should be recorded.

A plan to improve the traceability at the second producer could be as follows:

1. For each unit received from the suppliers, the SSCC, transporter ID, and supplier ID (GLN) should be recorded and linked to the internal production batch ID. This also includes the received SSCC or other appropriate ID for packaging.

2. For recording SSCC numbers, a logistic unit ID data capture system should be in place at the fish farm. The data capture system must be integrated with the salmon fillet producer's ERP system.

3. For each unit dispatched to customer, an SSCC should be used as an ID and linked to an internal production batch ID, customer ID (GLN), and transporter ID.

4.3.4 Changes and reengineering of production practice in the Norwegian farmed fish industry

The production practice in the Norwegian farming of Atlantic salmon was until the first few years after the millennium not influenced by traceability principles. A traceability survey conducted in 2002 (Forås, Storøy et al. 2004) revealed the following shortcomings:

- Not standardised and unstructured identification of generations of fish groups.

- Insufficient labelling of batch ID on trade units.

- Absence of recording of feed ID when used.

- A high degree of mixing of different fish groups from diverse suppliers and with different genetic characteristics.

- No data is recorded at the live fish carriers between farm sites and harvesting sites.

Recommendations to the case chain were to:

- Reengineer production processes in order to reduce the size of their traceable units. Reduce the number of size grading and mixing of fish groups in the smolt, ongrowing, and live fish carrying steps.

- Implement global unique identification keys for the traceable units.

- Implement recording routines of IDs of raw materials and input factors at reception, production, and delivery.

- Develop integration modules for traceability information exchange between software applications.

- Develop a software application for recording of traceability.

In the period of 2003-2004, many of the fish farmers experienced challenges that required improved product traceability. Examples of problems that occurred were inexplicable mortality, customers complaining on product quality caused by factors early in the supply chain, etc. Tracing back to the causal factors and tracing forward to all the batches that were influenced, were described as problematical by many of the farmers.

A new traceability survey in 2004 in the same case chain as in 2002, displayed a change in practice (Forås, Fremme et al. 2006). The new production practices gave smaller traceability units in the chain from smolt to harvesting due to:

- Substantial reengineering in production practices in order to avoid mixing of different fish groups in the smolt, ongrowing, and live fish carrying steps

- Improved records on reception and use of input factors such as vaccines and feed

- Improved traceability records documenting transformation information between steps in the chain

The same process reengineering as mentioned above has been adapted by the majority of the fish farming industry during the period 2003-2005.

During the same period of time the actual feed producer implemented globally unique identification on their trade units. They also started keeping records of which batch numbers were delivered to which customer.

Despite these improvements, the 2004 survey revealed that the reengineering only to a certain degree reduced the traceable units. The feeding records per fish group did not include the unique ID on the feed bags or the feed batch numbers. This gave complex relations between feed and fish groups, which again gave a high traceability granularity.

Regarding globally unique IDs, none of the fish farmers had implemented such on the fish groups.

The live fish carriers still had minimal recording of traceability information and none of this were available electronically.

4.4 Conclusion

There has been substantial reengineering of production processing in the salmon farming industry in Norway between 2002 and 2004. This reengineering has led to an improved granularity of traceability. At the same time, there are still multiple challenges towards optimal chain traceability. Further focus should be made on implementing globally unique IDs and an improved solution for the live fish carrier.

5 Electronic exchange of traceability information

5.1 Introduction

Standard identification of traceable units, standard naming of data elements, and a standard language for coding and transmission of messages is a premise for enabling structured electronic exchange of information between random partners. However, when information is exchanged between a fixed number of partners, the information may as well be exchanged in an agreed electronic format (as it was in these trials).

In this test project, the following model was chosen;

1. Use of EAN number system (now GS1) for unique identification of traceable units.
2. Use of data elements standardized in the TraceFish standard.
3. Use of agreed format for exchange of electronic messages.

All tests have been carried out in close co-operation with the TELOPTrace project.

5.2 Use of EAN number system in the TELOPTrace project

5.2.1 Introduction

One of the main challenges in traceability projects has been the issue of unique identification keys on the traceable entities in the chain and information exchange between partners. This document intends to settle doubts that have arisen about the use of standards, coding, and information exchange.

Section 5.2.2 describes the unique identification keys and the use of the EAN-standards, giving short definitions of the essential terms and expressions. This has been written by Knut Vala and Kjell Arne Myren at EAN Norway.

Chapter 5.3 proposes specific guidelines for labelling and logistics exchange of information for each link in a traceability chain, and has been prepared by Eskil Forås from SINTEF.

5.2.2 Relevant EAN Standards

This chapter gives short definitions for the essential terms and expressions.
Then the different identification numbers in the EAN-system are described and short examples are given:

- the unique reference key for trade items (products) – GTIN + batch number + serial number
- the unique reference key for locations (legal entities and delivery addresses) – GLN
- the unique reference key for logistic units (e.g. pallets) – SSCC-code

The chapter also gives recommendations for bar-coding of the unique reference keys on trade items and logistic units with EAN/UCC 128. The unique reference key for locations is not recommended to barcode on labels, but to be kept in the ERP-systems of the parties and transferred electronically by EDI messages.

How the unique reference keys are structured in an electronic despatch advice is also described.

At last there is given a short description of requirements for the internal ERP-systems of the parties in the supply chain. This includes the different databases and how the different unique reference keys are linked together in the ERP-system.

5.2.2.1 Definitions

AI	Abbreviation for Application Identifier
Application Identifier	The field of two or more characters at the beginning of an Element String encoded in an UCC/EAN-128 Symbol, which defines uniquely its format and meaning.
Batch/lot number	A number allocated by the manufacturer related to the production of a product.
Check digit	A digit calculated from the other digits of an GTIN, GLN or SSCC-code, used to check that the data has been correctly composed.
EAN.UCC Company Prefix	Part of the international EAN.UCC Data Structures consisting of an EAN.UCC Prefix and a Company Number, both of which are allocated by an EAN International Numbering Organisation.
EAN/UCC-128 Bar Code Symbol	A subset of the Code 128 Bar Code Symbol that is utilized exclusively for EAN.UCC defined data structures.
EAN Member Organisation	A member of EAN International that is responsible for administering the EAN.UCC System in its country (or assigned area) and for managing the correct use of the EAN.UCC System by its member companies.
ERP-system	Enterprise Resource Planning system
Extension Digit	A digit, allocated by the user, used to increase the capacity of the Serial Reference within the SSCC.
GLN	Shorthand term for the EAN.UCC Global Location Number using the EAN/UCC-13 Data Structure to identify physical, functional, or legal entities.
GTIN	Shorthand term for the EAN.UCC Global Trade Item Number. A GTIN may use the EAN/UCC-8, UCC-12, EAN/UCC-13 or EAN/UCC-14 Data Structure
GTIN+	The combination of GTIN, batch number and serial number. Used for unique identification of trade unit.
Indicator	The first digit of a EAN/UCC 14 number where 1 to 8 is used for extension of numbering capacity for fixed weight items and 9 is used exclusively for variable weight items
Location Number	See GLN.
Logistic unit	An item of any composition established for transport and/or storage that needs to be managed through the supply chain.
Serial number	A serial number allocated by the manufacturer of a trade item that is unique within a given batch or lot of trade items
Serial Shipping Container Code	See SSCC.
SSCC	The unique identification of a logistic unit using an 18-digit data structure.
Trade item	Any item (product or service) upon which there is a need to retrieve pre-defined information and that may be priced or ordered or invoiced at any point in any supply chain. In the TELOP project Trade Items are also referred to as Trade Units.

5.2.2.2 Trade items (products)

The traceability key for trade items (products) consists of the following identification numbers:

a) GTIN (Global Trade Item Number)
b) Batch/lot-number
c) Serial number

a) *GTIN* – GTIN (Global Trade Item Number) can be encoded by one of the following EAN numbering schemes:

- EAN/UCC 13
- EAN/UCC 14
- UCC-12
- EAN/UCC 8

For use in the TRACE project we recommend use of either EAN/UCC-14 or EAN/UCC-13. In the internal ERP-system, GTIN must be represented by a 14 digit numeric string with the following structure:

EAN/UCC-14 Data Structure

Indicator	EAN.UCC Company Prefix Article Reference	Check Digit
N_1	N_2 N_3 N_4 N_5 N_6 N_7 N_8 N_9 N_{10} N_{11} N_{12} N_{13}	N_{14}

N1 Indicator may range from 0 to 9. Indicator 9 is used for variable weight goods.
N2 – N13 Consist of Country prefix, company prefix and article reference
N14 Check digit

The GTIN is allocated by the manufacturer or brand owner of the product, but the company first needs to contact the national EAN body to be assigned a GTIN scheme.

For more information, see General EAN.UCC Specification Chapter 2.1 (www.gs1.no)

E.g. on EAN/UCC 13 and 14:

- EAN 13 = **7030640000019**
- EAN 14 = **17030640000016**

The number before country prefix in EAN 14 number is an indicator that can be used from 0 to 9 in trade items.

E.g. bar-coded with EAN 128:

- EAN 13 = (01)07030640000019
- EAN 14 = (01)17030640000016

b) *Batch/lot number* – The batch/lot number is an internal identification number allocated by the manufacturer.

The batch/lot number is an alphanumeric string from 1 to 20 characters.

E.g. bar-coded with EAN 128:

- (10)1234567cc01dd4kk7890

For more information, see General EAN.UCC Specification Chapter 3.6.6 (www.gs1.no)

c) *Serial number* – The serial number combined with the GTIN and batch/lot number of a product identify each individual item stemming out from that specific batch of the given product.

The serial number field is alphanumeric and may contain from 1 to 20 characters. The serial number is allocated by the producer of the GTIN and batch. This will make the trade item keys globally unique.

E.g. bar-coded with EAN 128:

- (21)01234567891011121314

For more information, see General EAN.UCC Specification Chapter 3.6.13 (www.gs1.no)

5.2.2.3 Locations

Locations are identified with the GLN (Global Location Number). In an internal ERP-system, the GLN must be represented by a 13 digit numeric string with the following structure:

EAN.UCC Company Prefix	Location Reference	Check Digit
N_1 N_2 N_3 N_4 N_5 N_6 N_7 N_8	N_9 N_{10} N_{11} N_{12}	N_{13}

N1 – N12 Consist of Country prefix, company prefix and location number
N13 Check digit

In the TRACE project it is recommended to identify legal entities, companies, delivery addresses etc. by GLN (Global Location Numbers).

WARNING!
In some countries GLN numbers are allocated from separate pools (e.g., in Norway) – different numbers for each of them. Therefore, to avoid confusion and number clash, it is strongly advised to always contact a respective MO (EAN Member Organisation, e.g., GS1 Norway) before making any decision to use a Company Prefix to create GLNs.

For more information, see General EAN.UCC Specification Chapter 2.4 (www.gs1.no)

5.2.2.4 Logistic units

Logistic units (e.g. pallets, big bags) are identified by the Serial Shipping Container Code. The SSCC-code has the following structure

Extension Digit	EAN.UCC Company Prefix	Serial Reference	Check Digit
N_1	N_2 N_3 N_4 N_5 N_6 N_7 N_8 N_9 N_{10}	N_{11} N_{12} N_{13} N_{14} N_{15} N_{16} N_{17}	N_{18}

N1 Extension digit from 1-9
N2 – N17 Consist of Country prefix, company prefix and article reference
N18 Check digit

In the TRACE project it is recommended to identify logistic units by the SSCC-code.

For more information, see General EAN.UCC Specification Chapter 3.6.1 (www.gs1.no)
E.g. bar-coded with EAN 128:

- (00)370306400000000003

The SSCC codes are normally generated by the manufacturer or brand owner of the product.

5.2.2.5 Labels

For bar-coding of products and logistic units in the TRACE project, EAN/UCC 128 should be used. Below, you will find the recommendations for bar-coding of trading units and logistic units. It is assumed that the trading partners transfer all other information by EDI or any suitable electronic information exchange (i.e., e-mails in simple cases).

a) Bar-coding of trading units

The table below shows the mandatory information to be bar-coded for trading units.

Information	Application Identifier (AI)	Format
GTIN	01 or 02	n2 + n14
Batch/lot number	10	n2 + an..20
Serial number	21	n2 + an..20

Example:

GTIN: 07030640000019

Batch: 123F55

Serial number: 1234567

(01)07030640000019(10)123F55(21)1234567

b) Bar-coding of logistic units

The following table shows the mandatory information to be bar-coded for logistic units.

Information	Application Identifier (AI)	Format
SSCC	00	n2+n18

Example:

Sender:	Skretting AS Bjønkleiva 4 4000 Stavanger	**GLN:**
Receiver:	Fjord Seafood Toresvei 15 Bergen	**GLN:**

(00) 370306400000000010

In the case when trading unit and logistic unit is the same physical unit, all information is bar-coded on the same label, or on two separate labels.
For more information about EAN/UCC 128, see General EAN.UCC Specification Chapter 5.3 (www.gs1.no).

5.2.2.6 EDI Messages

Each party in the supply chain of the TRACE project should ideally be able to transmit and/or receive EANCOM Despatch Advice level 3, alternatively similar XML messages). It is recommended to send one EANCOM DESADV per delivery address. The following information is mandatory

Information	Format
Despatch level	
GLN of Supplier	n13
GLN of Buyer	n13
GLN of Delivery Party if other than address of Buyer	n13
Logistic units	
SSCC	n18
Product within the logistic unit	
GTIN	n14
Batch/lot number	an..20
Serial number	an..20

5.2.2.7 The ERP-system

Each party in the supply chain of the TRACE project should have an ERP-system with information on:

- locations (legal entities, companies, delivery addresses etc.) identified with GLN and containing complete master data about each entity
- products (consumer units, trading units (cartons, fish boxes), despatch units (pallets, big bags, containers etc)
- traceability information handling
    - incoming logistic units and product batches from suppliers
    - internal production process with merges, splits and creation of production batches
    - transmitted logistic units and product batches to customers

5.3 Applying the Standards: Labelling and Information Exchange between partners.

Based on findings in traceability surveys and general traceability guidelines, the following chapter will present proposals for improved traceability through labelling, record keeping and electronically sent and received information. The recommendations are presented for each step in a typical traceability chain described in Figure 11.

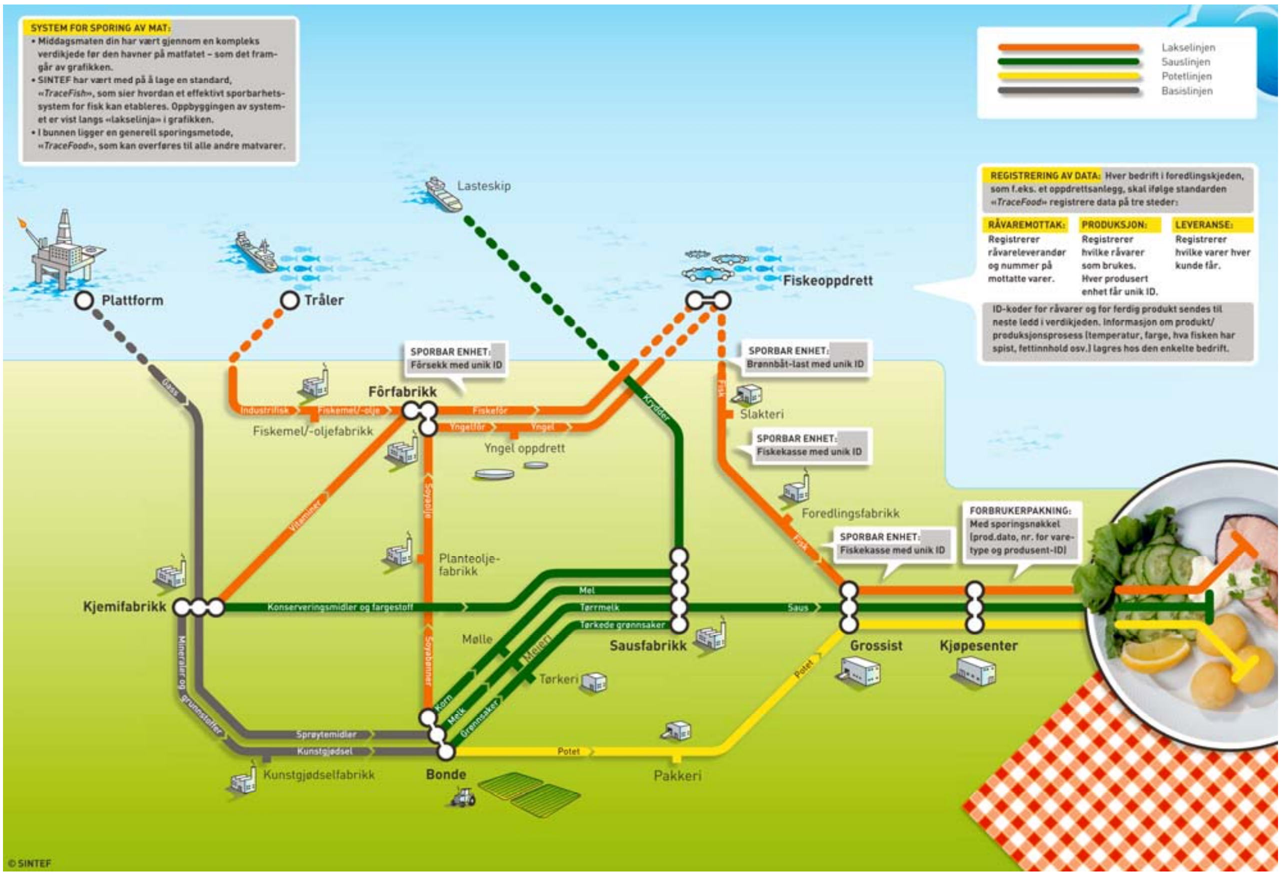

Figure 11 A typical traceability chain in the food industry

The AI numbers are shown in the tables as reference. When messages are electronic, it is not common to send the AI in the message.

5.3.1 Raw material/additive producer

This recommendation applies to all products sold to a feed producer.

5.3.1.1 Identification and labelling

All trade and logistic units that are produced should be bar-coded according to Table 7.

Table 7 Barcode labelling and identification of Raw material producers trade units

Description	EAN identifications	EAN AI	Example
Logistic unit	SSCC	AI (00)	(00)370306400000000003
Trade unit	GTIN Batch number Serial number	AI (01) AI (10) AI (21)	(01)17030640000016 (10)1234567cc01dd4kk7890 (21)01234567891011121314

5.3.1.2 Receiving orders

The ID of place of delivery should be received as electronically transferred information from Feed producer.

Table 8 Electronically transferred information received from Feed producer

Description	EAN identifications	EAN AI	Example
Feed producer establishment ID	GLN	AI (414)	(414)703064001532
Other order information			

5.3.1.3 Dispatch

The electronic data, sent to *Feed producer* at dispatch, should include at least an identification of producer, logistic units, and connected trade units. Links between each logistic unit and the connected trade units are required.

Table 9 Electronic data transfer from Raw material producer to feed producer.

Description	EAN identifications	EAN AI	Example
Creator of unit ID	GLN	AI (412)	(412)703064001532
Logistic unit ID	List of SSCC	AI (00)	(00)370306400000000003
Trade unit ID	List of GTIN+ GTIN Batch number Serial number	 AI (01) AI (10) AI (21)	 (01)17030640000016 (10)1234567cc01dd4kk7890 (21)01234567891011121314

5.3.2 Feed/nutrients producer

These recommendations apply to all production of fish feed in Feed producer.

5.3.2.1 Ordering

The identification of place of delivery should be sent as electronic data transfer from *Feed producer* to *Raw material producer*.

Table 10 Electronic data transfer from Feed producer to Raw material producer

Description	EAN identifications	EAN AI	Example
Feed producer establishment ID	GLN	AI (414)	(414)703064001532
Other order information			

At dispatch of the raw material order from *Raw material producer/distribution terminal*, *Feed producer* should receive electronically information that includes SSCC and the connected GTIN+, ref Table 9.

5.3.2.2 Raw material reception

At reception of raw material Feed producer should scan all logistic units received.

Table 11 Scan received logistic unit barcodes

Description	EAN identifications	EAN AI	Example
Logistic unit	SSCC	AI (00)	(00)370306400000000003

5.3.2.3 Production

At point of use in feed production, the ID of each trade unit of raw materials should be recorded and linked to the feed production batch.

Table 12 Scanning of trade unit barcodes of raw material at point of use.

Description	EAN identifications	EAN AI	Example
Trade unit	GTIN Batch number Serial number	AI (01) AI (10) AI (21)	(01)17030640000016 (10)1234567cc01dd4kk7890 (21)01234567891011121314

The information that is received electronically, scanned at reception and at point of use in the production should be stored in a way that ensures traceable links from a feed production batch back to received raw material ID's.
If an internal raw material batch number is used, a link should be established between all GTIN+ and the corresponding raw material batch number, see Figure 12.
.

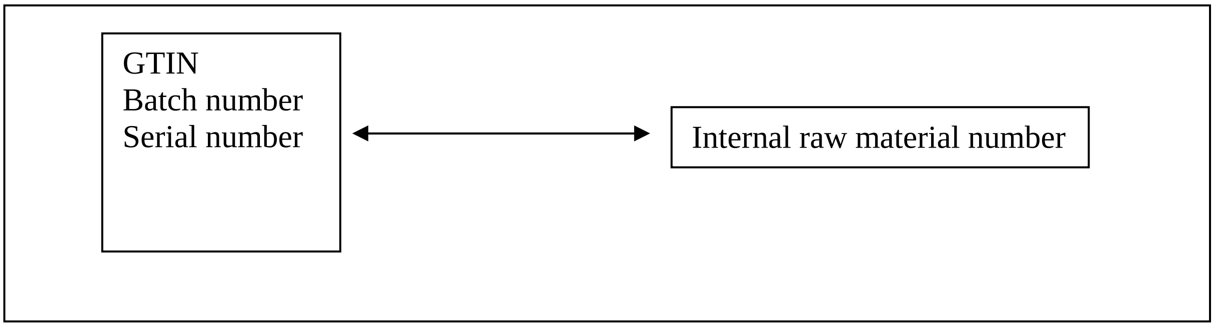

Figure 12 Link between GTIN+ and an internal raw material batch number

5.3.2.4 Identification and Labelling

At the end of the feed production the *Feed producer* should attach labels with barcodes on the logistic and trade units.

Table 13 Barcode labelling and identification of Feed producers trade units

Description	**EAN identifications**	**EAN AI**	**Example**
Logistic unit	SSCC	AI (00)	(00)370306400000000003
Trade unit	GTIN Batch number Serial number	AI (01) AI (10) AI (21)	(01)17030640000016 (10)1234567cc01dd4kk7890 (21)01234567891011121314

Big bags are both trade units and logistic units and should therefore be labelled with both a GTIN+ and a SSCC. Small bags are trade units on a pallet. In situations where small bags are sold individually, they are logistic units and should be additionally labelled with SSCC.

To ensure the link between trade unit/logistic unit and customer (farmer), a logistic unit ID data capture system should be in place at the feed transporters and at the farms.

5.3.2.5 Receiving orders

The ID of the place of delivery should be received as electronic transferred information from Farmer.

Table 14 Electronic transferred information received from Farmer.

Description	**EAN identifications**	**EAN AI**	**Example**
Farm establishment ID	GLN	AI (414)	(414)703064001532
Other order information			

5.3.2.6 Dispatch

The electronic data sent to Farmer at dispatch should include at least an identification of producer, logistic unit and accompanying trade units.

Table 15 Electronic data transfer from Feed producer to Farmer

Description	EAN identifications	EAN AI	Example
Feed producer establishment ID	GLN	AI (412)	(412)703064001532
Logistic unit ID	List of SSCC	AI (00)	(00)370306400000000003
Trade unit ID	List of GTIN+ GTIN Batch number Serial number	 AI (01) AI (10) AI (21)	 (01)17030640000016 (10)1234567cc01dd4kk7890 (21)01234567891011121314

5.3.3 Farmer

These recommendations apply to all kind of primary production of animal or vegetable products. The generic term for all these links will be Farmer.

5.3.3.1 Input factors

Labels on all input factors like feed, nutrients medicine etc. should be recorded to provide traceability. These examples are made for traceability of feed in particular.

5.3.3.2 Orders

The identification of place of delivery should be sent as electronic data transfer from Farmer to Feed producer. GLN should be used as a unique identifier for each location in Fjord Seafood. This includes all production sites for hatching, smolt production, and farms.

Table 16 Electronic data transfer from Fjord to Feed producer

Description	EAN identifications	EAN AI	Example
Hatchery, smolt or farms establishment ID	GLN	AI (414)	(414)703064001532
Other order information			

At dispatch of feed from Feed producer, each farm receives electronically information from *Feed producer* that includes SSCC and list of connected GTIN+, see Table 17.

5.3.3.3 Feed reception

At reception of fish feed, Farmer should scan the barcodes on all logistic units received.

Table 17 Received logistic unit ID (text and barcode)

Description	EAN identifications	EAN AI	Example
Logistic unit	SSCC	AI (00)	(00)370306400000000003

5.3.3.4 Use of feed

At point of use the GTIN+ of each fish feed trade unit should be scanned, recorded and linked to the relevant animal/animal group ref Table 18.

Table 18 Trade unit GTIN+ of feed (text and barcodes)

Description	EAN identifications	EAN AI	Example
Trade unit	GTIN Batch number Serial number	AI (01) AI (10) AI (21)	(01)17030640000016 (10)1234567cc01dd4kk7890 (21)01234567891011121314

The information that is received electronically, scanned at reception or point of use should be stored in a way that ensures traceable links from animal/animal group ID's to the attributes of the connected input factors.

5.3.4 Hatching, smolt and salmon production

These recommendations apply to all types of fish production in Farmer.

5.3.4.1 Animal/animal group identification

Animal/animal group is a trade unit. The records of identifications should be made in the production management applications.

Table 19 Identification of Fjord Seafood's trade units

Description	EAN identifications	EAN AI	Example
Trade unit	GTIN Batch number Serial number	AI (01) AI (10) AI (21)	(01)17030640000016 (10)1234567000205 (21)0123

5.3.4.2 Live fish order

The ID's of the place of delivery should be sent as electronic data transfer from receiving farm to supplying farm.

Table 20 Electronic transferred ID's of place of delivery

Description	EAN identifications	EAN AI	Example
Receiving farm establishment ID	GLN	AI (414)	(414)703064001532
Other order information			

5.3.4.3 Live animal dispatch

At dispatch of animal, the information in Table 21 should be electronically transferred to the receiving farm.

Table 21 Electronic data transfer form Farmer to other Farms, processing plant.

Description	EAN identifications	EAN AI	Example
Dispatching farm establishment ID	GLN	AI (412)	(412)703064001532
Transport vehicle/vessel ID	Registration number		ST-F 123
Trade unit ID	List of GTIN+ GTIN Batch number Serial number	 AI (01) AI (10) AI (21)	 (01)17030640000016 (10)1234567000205 (21)0123

5.3.4.4 Live animal reception

At reception of fish, the electronic information in Table 21 should be verified as received. In addition, the registration number of vessel/vehicle should be recorded.

5.3.5 Live animal transport

These recommendations apply to transport of animals to processing. It is assumed that the live fish Transport Company never mix trade units or make new trade units during transport.

5.3.5.1 Loading

After loading is completed, the Transport Company should record the GLN of the loading, unloading locations and the dispatched trade unit's ref Table 22.

Table 22 Links between locations ID's and trade units recorded by Transport Company

Description	**EAN identifications**	**EAN AI**	**Example**
Transport vehicle/vessel ID	Registration number		ST-F 123
Dispatching Farm establishment ID	GLN	AI (414)	(414)703064001532
Receiving Farm establishment ID	GLN	AI (414)	(414)703064001532
Trade unit	GTIN Batch number Serial number	AI (01) AI (10) AI (21)	(01)17030640000016 (10)1234567cc01dd4kk7890 (21)01234567891011121314

5.3.5.2 Unloading

At unloading of animals the information in Table 23 should be electronically transferred to the receiver.

Table 23 Electronic data transfer from Transport Company to receiving site

Description	**EAN identifications**	**EAN AI**	**Example**
Transport vehicle/vessel ID	Registration number		ST-F 123
Trade unit ID	List of GTIN+ GTIN Batch number Serial number	 AI (01) AI (10) AI (21)	 (01)17030640000016 (10)1234567000205 (21)0123

5.3.6 Processing

5.3.6.1 Processing/transfer notice

The identification of place of delivery should be sent as electronic data transfer from Processing plant to Farmer.

Table 24 Electronic data transfer sent from Processing plant to Farmer

Description	EAN identifications	EAN AI	Example
Processor establishment ID	GLN	AI (414)	(414)703064001532
Other order information			

5.3.6.2 Receiving fish

Processing plant receives electronically information from Farmer and Transport Company that includes a list of GTIN+, see Table 21 and Table 23.

5.3.6.3 Identification and Labelling

At the end of production the Processing plant should barcode the logistic and trade units as in Table 25.

Table 25 Identification of logistic or trade unit at end of production

Description	EAN identifications	EAN AI	Example
Logistic unit	SSCC	AI (00)	(00)370306400000000003
Trade unit ID	List of GTIN+ GTIN Batch number Serial number	 AI (01) AI (10) AI (21)	 (01)17030640000016 (10)1234567000205 (21)0123

The information that is received electronically, scanned at reception or point of use should be stored in a way that ensures traceable links from production batch ID's to the GTIN+ of the received animal/animal groups.

5.3.6.4 Receiving orders

The ID of place of delivery should be received as electronic transferred information.

Table 26 Electronic transferred information received from secondary processing.

Description	EAN identifications	EAN AI	Example
Processing establishment ID	GLN	AI (414)	(414)703064001532
Other order information			

5.3.6.5 Dispatch

The electronic data sent to *secondary processing* at dispatch should include at least an identification of producer, transport vehicle, logistic units and accompanying trade units.

Table 27 Electronic data transfer form Fjord Farming to 2. PROCESSING

Description	EAN identifications	EAN AI	Example
Processor establishment ID	GLN	AI (414)	(414)703064001532
Transport vehicle/vessel ID	Registration number		VF 12345
Logistic unit	SSCC	AI (00)	(00)370306400000000003
Trade unit ID	List of GTIN+ GTIN Batch number Serial number	 AI (01) AI (10) AI (21)	 (01)17030640000016 (10)1234567000205 (21)0123

5.3.7 Transporters

These recommendations apply to transport of salmon from first processing to secondary processing.

5.3.7.1 Loading

The Transport Company receives electronically information from Farmer that includes the GLN of dispatching and receiving locations in addition to a list of SSCC's and the respective GTIN+, see Table 27.

After loading is completed the Transport Company should record the registration number of the vehicle and the GLN of the dispatching and receiving location to the dispatched logistic unit SSCC, see Table 28.
If the Transport Company rebuilds pallets there is also a need for documentation of GLN of repacking site and all trade items (GTIN+) on each new logistic unit.

Table 28 Links between location ID's recorded by transport company

Description	EAN identifications	EAN AI	Example
Transport vehicle ID	Registration number		VF 12345
Dispatching processor establishment ID	GLN	AI (414)	(414)703064001532
Receiving processor establishment ID	GLN	AI (414)	(414)703064001532
Logistic units	SSCC	AI (00)	(00)370306400000000003

5.3.7.2 Unloading

At unloading of pallets verification of Table 27 should be made.

5.3.8 Secondary processing

This recommendation applies to the salmon processing plants secondary processing.

5.3.8.1 Ordering

The identification of place of delivery should be sent as electronic data transfer from Secondary processing to Farmer and Transport Company.

Table 29 Electronic data transfer from Secondary processing to Farmer,

Description	EAN identifications	EAN AI	Example
Processing establishment ID	GLN	AI (414)	(414)703064001532
Other order information			

At dispatch from first processing/distribution terminal, secondary processing should receive electronic information that includes all SSCC's and a list of related GTIN+, see Table 27.

5.3.8.2 Reception

Secondary processing should scan the logistic units (SSCC) at raw material reception. In addition, the registration number of vehicle should be recorded.

Table 30 Scan received logistic units

Description	EAN identifications	EAN AI	Example
Transport vehicle ID	Registration number		VF 12345
Logistic unit	SSCC	AI (00)	(00)370306400000000003

5.3.8.3 Production

At point of use the ID of each trade unit should be recorded and linked to the relevant production batches.

Table 31 Scanning of trade units of salmon used in a production batch.

Description	EAN identifications	EAN AI	Example
Trade unit ID	List of GTIN+ GTIN Batch number Serial number	 AI (01) AI (10) AI (21)	 (01)17030640000016 (10)1234567000205 (21)0123

The information that is received electronically, scanned at reception or point of use should be stored in a way that ensures traceable links from animal/animal group ID's to the attributes of the connected input factors.
If internal raw material batch number is used then there should be established a link between all GTIN+ and the corresponding raw material number, see Figure 12.

5.3.8.4 Identification and Labelling

At the end of production secondary processing should barcode the logistic and trade units.

Table 32 Barcode labelling and identification of secondary processing trade units

Description	EAN identifications	EAN AI	Example
Logistic unit	SSCC	AI (00)	(00)370306400000000003
Trade unit ID	List of GTIN+ GTIN Batch number Serial number	 AI (01) AI (10) AI (21)	 (01)17030640000016 (10)1234567000205 (21)0123

Pallets are logistic units. Boxes are trade units
If boxes are sold individually, they should be identified and labelled with a SSCC.
To ensure the link between trade unit/logistic unit and customer, an ID data capture system should be in place at transporters and at secondary processing.

5.3.8.5 Dispatch

The electronic data sent to customer at dispatch should include at least an identification of producer, logistic unit, and accompanying trade units.

Table 33 Electronic data transfer form secondary processing to customer.

Description	EAN identifications	EAN AI	Example
Processor establishment ID	GLN	AI (412)	(412)703064001532
Logistic unit ID	List of SSCC	AI (00)	(00)370306400000000003
Trade unit ID	List of GTIN+ GTIN Batch number Serial number	 AI (01) AI (10) AI (21)	 (01)17030640000016 (10)1234567cc01dd4kk7890 (21)01234567891011121314

5.3.9 Wholessaler

This recommendation applies to the special wholesaler.

5.3.9.1 Ordering

The identification of place of delivery should be sent as electronic data transfer from wholesaler to the Supplier.

Table 34 Electronic data transfer from wholesaler to supplier,

Description	EAN identifications	EAN AI	Example
Supplier establishment ID	GLN	AI (414)	(414)703064001532
Other order information			

At dispatch from supplier/distribution terminal, wholesaler should receive electronic information that includes all SSCC's and a list of related GTIN+, see Table 41.

Table 35 Electronic data transfer form supplier to wholesaler

Description	EAN identifications	EAN AI	Example
Supplier establishment ID	GLN	AI (414)	(414)703064001532
Transport vehicle ID	Registration number		VF 12345
Logistic unit	SSCC	AI (00)	(00)370306400000000003
Trade unit ID	List of GTIN+ GTIN Batch number Serial number	 AI (01) AI (10) AI (21)	 (01)17030640000016 (10)1234567000205 (21)0123

5.3.9.2 Reception

Wholesaler should scan the logistic units (SSCC) at raw material reception. In addition, the registration number of transport vehicle should be recorded.

Table 36 Scan received logistic units

Description	EAN identifications	EAN AI	Example
Logistic unit	SSCC	AI (00)	(00)370306400000000003
Transport vehicle ID	Registration number		VF 12345

5.3.9.3 Production

At point of use the ID of each raw material trade unit should be recorded and linked to the relevant production batches.

Table 37 Scanning of trade units of salmon used in a production batch.

Description	EAN identifications	EAN AI	Example
Trade unit ID	List of GTIN+ GTIN Batch number Serial number	 AI (01) AI (10) AI (21)	 (01)17030640000016 (10)1234567000205 (21)0123

The information that is received electronically, scanned at reception or point of use should be stored in a way that ensures traceable links from animal/animal group ID's to the attributes of the connected input factors.

If internal raw material batch number is used then there should be established a link between all GTIN+ and the corresponding raw material number in Figure 12.

5.3.9.4 Identification and Labelling

At the end of production wholesaler should barcode the logistic and trade units.

Table 38 Barcode labelling and identification of wholesaler trade units

Description	EAN identifications	EAN AI	Example
Logistic unit	SSCC	AI (00)	(00)370306400000000003
Trade unit ID	List of GTIN+ GTIN Batch number Serial number	 AI (01) AI (10) AI (21)	 (01)17030640000016 (10)1234567000205 (21)0123

Pallets are logistic units. Boxes are trade units
If boxes are sold individually, they should be identified and labelled with a SSCC.
To ensure the link between trade unit/logistic unit and customer, an ID data capture system should be in place at transporters and at wholesaler.

5.3.9.5 Dispatch

The electronic data sent to customer at dispatch should include at least an identification of producer, logistic unit and accompanying trade units.

Table 39 Electronic data transfer form wholesaler to customer.

Description	EAN identifications	EAN AI	Example
Processor establishment ID	GLN	AI (412)	(412)703064001532
Logistic unit ID	List of SSCC	AI (00)	(00)370306400000000003
Trade unit ID	List of GTIN+ GTIN Batch number Serial number	 AI (01) AI (10) AI (21)	 (01)17030640000016 (10)1234567cc01dd4kk7890 (21)01234567891011121314

5.3.10 HORECA

This recommendation applies to the HORECA links

5.3.10.1 Ordering

The identification of place of delivery should be sent as electronic data transfer from HORECA to the Supplier.

Table 40 Electronic data transfer from HORECA to supplier,

Description	**EAN identifications**	**EAN AI**	**Example**
Supplier establishment ID	GLN	AI (414)	(414)703064001532
Other order information			

At dispatch from supplier/distribution terminal, HORECA should receive electronic information that includes all SSCC's and a list of related GTIN+, see Table 41.

Table 41 Electronic data transfer form supplier to HORECA

Description	**EAN identifications**	**EAN AI**	**Example**
Supplier establishment ID	GLN	AI (414)	(414)703064001532
Transport vehicle ID	Registration number		VF 12345
Logistic unit	SSCC	AI (00)	(00)370306400000000003
Trade unit ID	List of GTIN+ GTIN Batch number Serial number	 AI (01) AI (10) AI (21)	 (01)17030640000016 (10)1234567000205 (21)0123

5.3.10.2 Reception

HORECA should scan the logistic units (SSCC) at raw material reception. In addition, the registration number of transport vehicle should be recorded.

Table 42 Scan received logistic units

Description	**EAN identifications**	**EAN AI**	**Example**
Logistic unit	SSCC	AI (00)	(00)370306400000000003
Transport vehicle ID	Registration number		VF 12345

5.3.10.3 Production

At the point of use, the ID of each raw material trade unit should be recorded and linked to the relevant production batches.

Table 43 Scanning of trade units of salmon used in a production batch.

Description	EAN identifications	EAN AI	Example
Trade unit ID	List of GTIN+		
	GTIN	AI (01)	(01)17030640000016
	Batch number	AI (10)	(10)1234567000205
	Serial number	AI (21)	(21)0123

The information that is received electronically, or scanned at reception or point of use, should be stored in a way that ensures traceable links from animal/animal group ID's to the attributes of the connected input factors.

If internal raw material batch number is used, then there should be established a link between all GTIN+ and the corresponding raw material number, see Figure 12.

5.4 Proof-of-concept implementation for electronic chain traceability

In addition to the guidelines for use of EAN number systems and standardised TraceFish information elements, the Telop Trace project also made a proof-of-concept implementation regarding electronic chain traceability.

The project aimed to develop an online, decentralized exchange of traceability information between independent players along the entire value chain.

The formal project objective was set as:

> *Through automated and cost-effective processes, develop TraceTracker's system for chain traceability so that the integration to both data capturing peripheral devices and external proprietary systems for internal traceability is effective and user-friendly.*

Companies from each link in the farmed salmon chain were invited to take part in the TELOP Trace project. A cluster of companies was assembled over the project period 2003-2005. Some companies/links in the chain were replaced during the project period. The links that finally were included in TELOP Trace cover a complete supply chain as shown in Figure 10 and Figure 11.

The technical platform for the TELOP project allows fast, precise, secure, and easy access to relevant traceability information in the value chain for a specific product. The platform allows for connection to data from different systems as shown in Figure 13.

Only one of the participating actors in the value chain already had systems for electronically handling the complete internal traceability. For the ones without such a system, a TraceTracer TTES (Enterprise System) was installed including those participating actors that had only manual paper-based systems.

Data to TTES was imported from different existing platforms, exemplified for the different companies: SAP, Superior, Maritech, and Excel. Importing data from different platforms has been an important element, proving that TT systems are independent from the way data are captured.

TTES models the internal traceability of each of the companies in question, by configuring with the traceability model suggested by the traceability survey in each one of the cases (see Chapter 4).

The TTES allows each company to visualize the internal traceability for each trade unit or batch and to view relevant properties for each trade unit or batch. As mentioned above, this information is captured by other systems (SAP, Superior, Maritech, and Excel) and delivered through XML files. An example of such a file is shown in Figure 14.

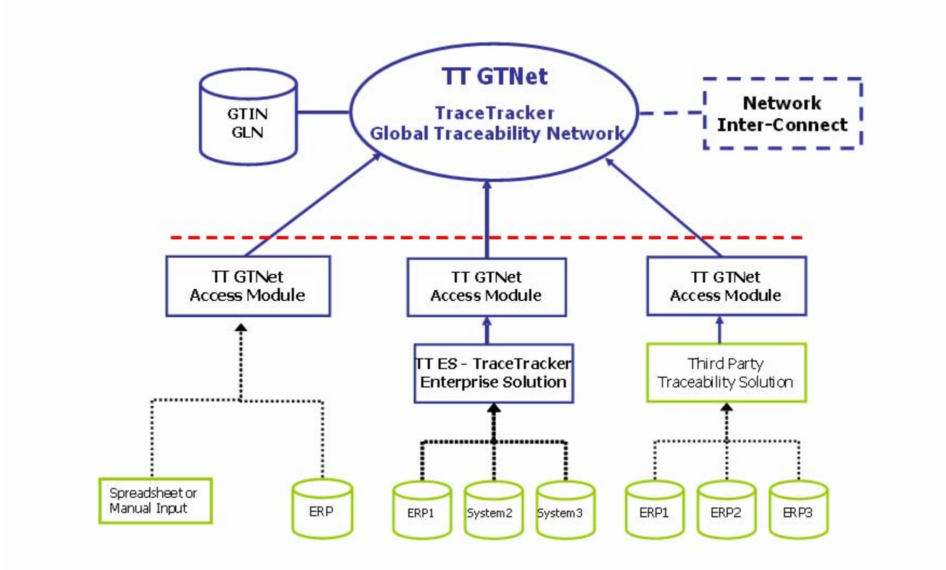

Figure 13 Solution Architecture


```xml
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE Data PUBLIC "-//TraceTracker//DTD Data V2.4//EN"
"http://www.tracetracker.com/tt/dtd/ttData_2_4.dtd">
<Data trd-ref="lmb" upload-mode="incremental">
	<Message>
		<TransMsg>
			<Split from="(01)070100000001(10)226987(21)0001">
				<Into id="308/07" timestamp="2004-11-03T00:00:00.0+01"/>
				<Into id="309/04" timestamp="2004-11-04T00:00:00.0+01"/>
				<Into id="310/05" timestamp="2004-11-05T00:00:00.0+01"/>
			</Split>
			<Split from="(01)070100000001(10)226987(21)0002">
				<Into id="314/14" timestamp="2004-11-09T00:00:00.0+01"/>
			</Split>
			<Split from="(01)070100000001(10)226987(21)0003">
				<Into id="308/01" timestamp="2004-11-03T00:00:00.0+01"/>
				<Into id="310/03" timestamp="2004-11-05T00:00:00.0+01"/>
				<Into id="308/15" timestamp="2004-11-03T00:00:00.0+01"/>
			</Split>
			<Split from="(01)070100000001(10)226987(21)0004">
				<Into id="308/01" timestamp="2004-11-03T00:00:00.0+01"/>
				<Into id="308/01" timestamp="2004-11-03T00:00:00.0+01"/>
			</Split>
			<Split from="(01)070100000001(10)226987(21)0005">
				<Into id="308/04" timestamp="2004-11-03T00:00:00.0+01"/>
				<Into id="308/05" timestamp="2004-11-03T00:00:00.0+01"/>

			<Split from="48/074">
				<Into id="330/03" timestamp="2004-11-25T00:00:00.0+01"/>
				<Into id="330/02" timestamp="2004-11-25T00:00:00.0+01"/>
			</Split>
		</TransMsg>
	</Message>
</Data>
```


Figure 14 XML file used for delivering information from subsystems to TT GTNet

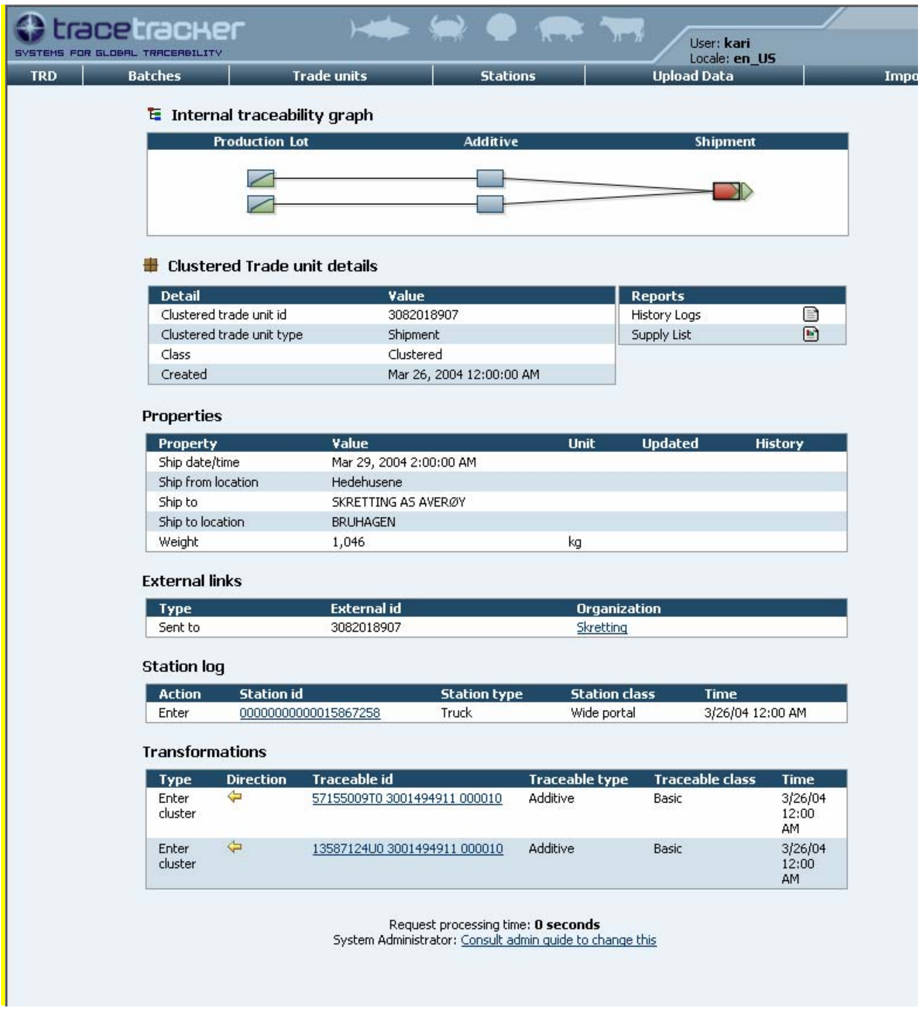

Figure 15 Examples of screenshot from TTES

Architecture:

To manage the challenge of exchanging traceability data between different organizations, TraceTracker provided access to GTNet for all the participating organizations. GTNet is a net-centric service where companies access the data relevant for global traceability, ensuring the ownership of data to the company that has generated the data. An example of traceability view is shown in Figure 15 and Figure 16.

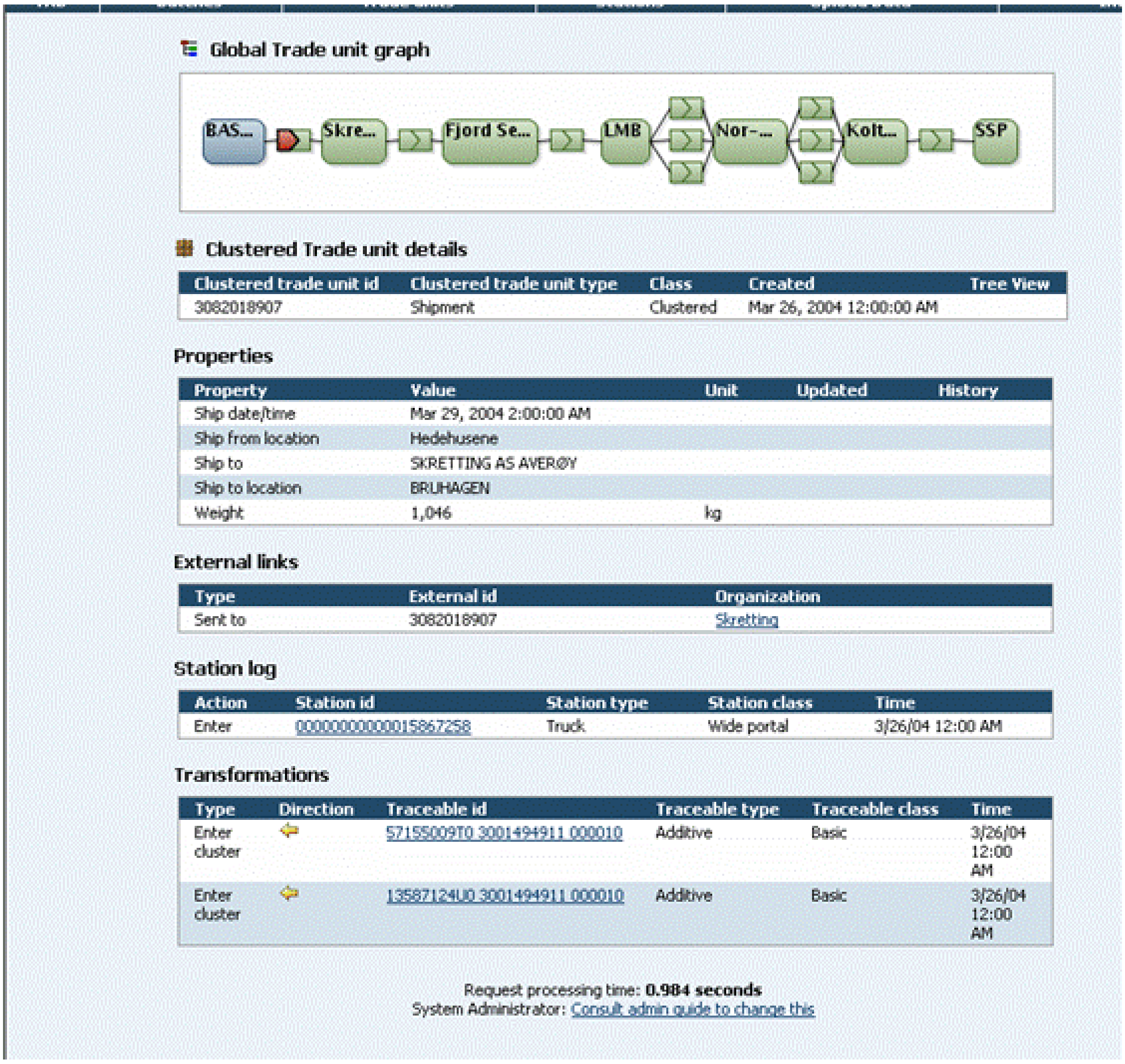

Figure 16 Example of global view for one particular trade unit

History of software development:
The project was initially set up with version 2.2 of the TraceTracker software. In August 2005, it was updated to version 2.4, which included many of the improvements suggested by the users. Chain participants were given full access to their systems.
TraceTracker software has continued to evolve after the Telop project and version 2.6 may now be previewed at http://demo.tracetracker.com

Test results from electronic exchange of information:
As shown in Figure 16, complete chain traceability was demonstrated trough TT GTNet. This indicates that the technology and architecture may be regarded as applicable to establish effective solutions for chain traceability. Regarding the level of implementation in the different links, the results show a distinct dissimilarity (Senneset, et.al 2007). One company did not exchange any traceability information. Three companies exchanged the information through paper files. Two companies exchanged information manually from internal database files, and two companies exchanged information digitally and online from their systems. These results indicate the problems that may occur during implementation of electronic chain traceability. A standard for digital exchange of traceability data between internal software and the chain traceability solutions may facilitate such implementation. Such a standard is now being developed; TraceCoreXML (www.TraceFood.org).

6 Overall conclusion

According to the plan, demonstration activities have covered the following tests:

- Electronic data capture technology (RFID tags).
- A new method for food chain process mapping.
- Exchange of structured electronic information.

In 2004, technology and software solutions for chain traceability were rather immature. Since then both international standardization and rapid technological development have led to a new and improved situation. Now the first version of TraceCore XML, a standard for structured exchange of electronic traceability information is launched. At the same time, it has been agreed upon global standards for RFID tags, and recent test results show that readability and applicability of such tags are becoming satisfactory.

As a whole, experiences made in this project found a good basis for further work on implementation of electronic chain traceability systems, as well as international standardization on the area.

References

CEN Tracefish Workshop Agreement (CWA): Traceability of fishery products – Specification of the information to be recorded in farmed fish distribution chains.

CEN Tracefish Workshop Agreement (CWA): Traceability of fishery products – Specification of the information to be recorded in captured fish distribution chains.

ECR D-A-CH, ECR France & ECR Spain, 2004. ECR - Using traceability in the supply chain to meet consumer safety expectations. ECR (Efficient Consumer Response) Europe.

EAN-UCC: Global Tag GTAG™ Technical Specification Draft V0.2, August 2002.

EAN-UCC: Traceability of fish guidelines, November 7, 2002.

EPCGlobal: Working documents available at the time of writing.

Klaus Finkenzeller: RFID Handbook Fundamentals and Applications in Contactless Smart Cards and Identification, Second Edition, 2003.

Forås, E.; Senneset, G.; Storøy J. (2004). Sporbarhet i forsyningskjeden for fisk. Status for bruk av RFID som informasjonsbærer i forsyningskjeder. SINTEF Fiskeri og havbruk (STF80 A044100).

Forås, E., K. Fremme, et al. (2006). Internal project report TELOP Trace, TraceTracker.

Forås, E., J. Storøy, et al. (2004). Kjedesporbarhet innen fiskeri og havbruksnæringen. (STF80 A044068): SINTEF Fisheries and Aquaculture.

ISO/IEC JTC 1/SC 31/WG4: Working documents available at the time of writing.

Olsen, P., 2007. Analysis of traceability in food supply chains - Standard method. Submitted to *Journal of Supply Chain Management*.

Senneset, G., Forås, E., & Fremme, K. (2006). Internal project report TELOP Trace (Project report March 2006): TraceTracker.

Senneset, G., Forås, E., & Fremme, K. (2007). Challenges regarding implementation of electronic chain traceabilty. British Food Journal. Accepted. In press.