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Practical and Technological challenges for introduction of electronic traceability systems related to IUU

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ABSTRACT

This report investigates practical and technological challenges related to an introduction of electronic traceability systems in the Norwegian fish industry that can be used to document and control the legality of fish. The report outlines the requirements for such a system to reduce, prevent, and defer Illegal, Unregulated, and Unreported (IUU) fishing. The report also contains analysis and recommendations for electronic management of information related to fishing in national waters and how this information can help to provide means to issue IUU certificates. The report is concluded with recommendations for an electronic traceability system for IUU management.

KEYWORDS	ENGLISH	NORWEGIAN
GROUP 1	IUU fishing management	UUU fiske forvaltning
GROUP 2	Certification system	Sertifikat system
SELECTED BY AUTHOR	Practical challenges	Praktiske utfordringer
	Technological challenges	Tekniske utfordringer

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1 Introduction

The Norwegian government has an ambitious goal to become the world leader in food traceability. The government has through the eSporing (www.esporing.no) project, the objective to establish a national electronic infrastructure to enable an effective exchange of traceability information within the food chains by the end of 2010.

At the same time, the Norwegian fish industry is exposed to new regulations that include enhanced traceability. These regulations require information to certificate that fish and fish products are based on reported catches and legally fished from a regulated fish stock.

This report is focusing on investigating practical and technological challenges concerning the introduction of electronic traceability systems that can be used to document and control the legality of fish and thus contribute to reduce, deter and eliminate Illegal, Unregulated, and Unreported (IUU) fishing. The report also contains analysis and recommendations for electronic management of information related to fishing in national waters and how this information can help to provide means to issue IUU certificates.

The report starts with background information on IUU and electronic traceability. It then describes which actors that are the main stakeholders within such a system. The report then moves on to laws and regulations and the principles a good traceability system should be built on. Then several scenarios for IUU fishing are described as well as a suggestion for an overall solution to these. With this solution in mind, the report then describes which practical and technological challenges that may apply to the different actors based on prime interests and technological capabilities. Further, the report outline some requirements and analyse how these will impact an infrastructure for IUU control and how these requirements compare to the vision of eSporing, thus making recommendations for how to build a system for this special kind of functionality and considerations. The report concludes with recommendations for a future electronic system for IUU management.

1.1 Assumptions and limitations

This report will not cover any measures or methods of governmental practices, regulations, or laws related to:

- Conservation, calculation and regulation of fish stocks
- Establishment, distribution, or communication of fish quota
- Physical monitoring and control of vessels or any processors related to IUU
- International trading or other international conditions or activities that is not directly covered by Norwegian law

The report is not discussing any national or international political issues that may result based on the conclusions of this report, even though IUU issues in themselves are on the political agenda. Economical issues related to the actors that are directly or indirectly affected by the proposed solution(s) are not analysed or discussed even though any kind of implementation of electronic traceability systems will cause investments both for the governing authorities and affected actors in the fish value chain.

This report is limited to analysis and recommendations of electronic management of information related to fishing in national waters and how this information can help to provide means to issue IUU certificates required by EU, and/or eventually increase the national IUU control. It is assumed that the trade is continued to be regulated by the current national laws and practices like

the raw fish act[1] and the salt water fish act[2]. The current practices and requirements of documentation of catch and delivery of fish from fish vessels are thus assumed to be continued even though the report might suggest some extensions to these practices. Although it can be expected in the near future that fish vessels will be required to report their catches electronically thus making it easier to keep account of quota coverage and the assumed amount of fish in the market, the report will concentrate on the chain starting from the trading and landing of the caught fish.

[1] Råfiskloven in Norwegian
[2] Saltvannfiskeloven in Norwegian

2 Background

This chapter provides background information on IUU fishing regulations, and on electronic traceability.

2.1 Background on IUU

Documented quality and sustainability within the fishery and aquaculture sectors have received an increased focus from both the consumers and the governments nationally and internationally[3], including the UN and EU. IUU fishing poses a major threat to sustainable exploitation of living aquatic resources and the marine biodiversity because of reduced fish stocks. The general focus on the environment has also actualised that capture, processing, and transport of fish to a larger degree are to be performed in an environmental green and sustainable way (this also includes aquaculture).

EU has through the proposal of a council regulation, "Establishing a Community system to prevent, deter and eliminate illegal, unreported and unregulated fishing" – 2007/0223 (CNS) [1], lifted/enhanced the management of IUU from a national/regional perspective (like NEAFC [2]) to an international issue by suggesting establishment of specific international certificates that should follow the fish whenever entering or leaving the EU economic area. The certificates are to be issued by validating authorities and were originally proposed to be presented through customs stations by transporters/importers. Vessels/loads without such certificates are to be stopped before entering the EU area. The ratified law presented September 22nd 2008, [3], has changed how such certificates are to be presented, but the main information as proposed in [1] is kept. Certificates are to be presented three days before entering the EU area by importers to designated competent authorities. The importers can however be granted a status of approved economic operators and can then advise the authorities of the arrival of the products and keep the certificates available for the authorities for the purposes of checks. This means in practice that the certificates need to be present at any time by the importers.

In Norway, all first-hand fish trade with wild caught fish are by law (the raw fish act) managed by fishermen's sales associations[4]. In practice, the fishermen are reporting their catches to the sales associations, which then carry out the economic transactions on their behalf. During this process, a catch certificate/contract note is issued. The contract notes include detailed information about the fishermen, vessel, catch area, catch equipment, species, and weights of fish in addition to trade information (seller, buyer, and price). The catch is in this process checked against legality related to permission to fish and sell fish and that the catch is taken within the current quota regulations. The contract notes are regularly reported to the Norwegian fishing authorities, Directorate of Fisheries. In the case of landing of fish that has not been traded at the time of landing, a system of landing notes has been established that also report and check catches that temporarily are falling outside the contract note system.

In a perfect legal and regulated system, all fish caught and landed are reported and can through the contract note/landing note systems, be certified to be legal, reported, and regulated. It is however possible in the fish chain to introduce IUU or "black" fish through the processing or distribution, so the fish appears legal or "white". These issues will be discussed further in Section 4.

The requirement for certification of all imported fish into the EU area will have a great impact on the fish industry. Basically, this means that the whole fishing management and information regime from quota control to the end-sale point will be affected. Information that earlier have been an issue between the fisherman, the fish buyers and the authorities, will need to be

[3] http://www.illegal-fishing.info/
[4] Fiskesalgslag in Norwegian

aggregated and directly related to the actual physical movement of fish. This report will propose a solution that takes into account the new requirements and show how the strengthening of traceability within and between the actors in the fish chain probably is necessary to enforce and implement IUU management and certification. The introduction of such a traceability system can in addition to providing IUU certification for export, also offer the same information to national actors in the fish chain, including the consumers.

2.2 Electronic traceability

Electronic chain traceability means a very complex network of (food) value chains and actors who all are to offer a transparent, electronic interface for relevant information (either by choice or by demand) to other parties. Some of the main challenges are to identify how and if such a system can give value to defend the necessary investments, and how and if concerns like privacy, security, safety, scalability, and reliability can be built into a system where the information mostly is distributed and decentralised, if existing at all. It is further of interest how such a system can be organised to give the promised functionality and value related to the different stakeholders' needs and stakes.

Documentation of origin, quality properties, legality, and sustainability requires an electronic traceability infrastructure and different means to provide correct and validated information. The infrastructure should connect industrial actors together into an information chain where the information about the food can be followed and extended as the food flows between the different actors and processing steps. The actors span from producers (resources/vessels), processing industry, transportation, wholesalers to retail stores and end consumers.

A common infrastructure needs to give value to all involved actors in fish management, including the authorities. The government must, e.g., be given the opportunity to control that the information provided is correct and according to the given laws and regulations, and thus enable the government to take measures to prevent, deter and eliminate management and sale of IUU fish through the value chain(s). It may, however, be conflicting interests and driving forces of how such an infrastructure can be constructed to provide value for the different actors.

A precondition for any traceability system, whether internal or external, is the need for keeping information about what kind of additives and raw materials that are used before dispatching of the goods. The physical goods are by law required to be applied with the last date of sale/shelf life.

A pilot project in a pelagic fishery chain [4] shows that it is possible to establish a solution for electronic exchange of traceability messages in a net-centric chain traceability system. The information exchange format used in this project was based on TraceCore XML (see www.tracefood.org [5] for more information about TraceCoreXML). The messages were sent through traceability hubs to receiving partners. Information about the legality of the products was however not considered in this project. Other possible solutions like point-to-point direct communication, a centralised information service or combinations of these were not tested in the project.

The SINTEF report, "Alternative directions for standardised traceability information exchange" [6], was written based on discussions in an international workshop and shows that there are several possible solutions for information exchange standards in addition to TraceCore XML. Unpublished information in relationship to this workshop shows in addition that there are several alternatives with respect to electronic traceability based partly on different architectural solutions.

In projects focusing on electronic traceability performed in Norway, it has not yet been performed any thorough analysis and evaluation of technical and practical challenges with respect to the different solutions that are possible candidates for an IUU control solution. An introduction of a

national electronic traceability solution/infrastructure will have great impact in the practical and technical everyday life of every actor in the fish value chain, large or small. It is therefore relevant to make investigations with respect to what the possible solutions are and how such solutions can influence the Norwegian seafood industry both practically and technologically. It is further of interest to evaluate whether the assumption that a general introduction of electronic chain traceability in the fish value chains can actually help in IUU control, and if not, which other means that can be used to electronically provide systems to help in this control.

The introduction of/requirement to electronic chain traceability means that all companies/actors involved in Norwegian food production, including transport and sale, need to establish electronic traceability systems internally or eventually let them be managed by other parts of the value chain.

There exist many different providers for supporting electronic internal/chain traceability in one or another form. For an insight into the state-of-the-art, we have provided an overview of suppliers of software for traceability and supporting systems in Appendix B.

3 Stakeholders

A stakeholder description is of high importance in the work of identifying the challenges of introducing electronic traceability architecture for the Norwegian fish industry. This chapter describes the generic stakeholders in the actual chain. An overview of traceability software systems and suppliers are presented in Appendix B. This report does however not cover a detailed stakeholder analysis related to chain traceability but cover issues related to IUU management and control.

3.1 The fish value chain

The following description is meant as a depiction of the actors/stakeholders in the material and information flow as shown in Figure 1.

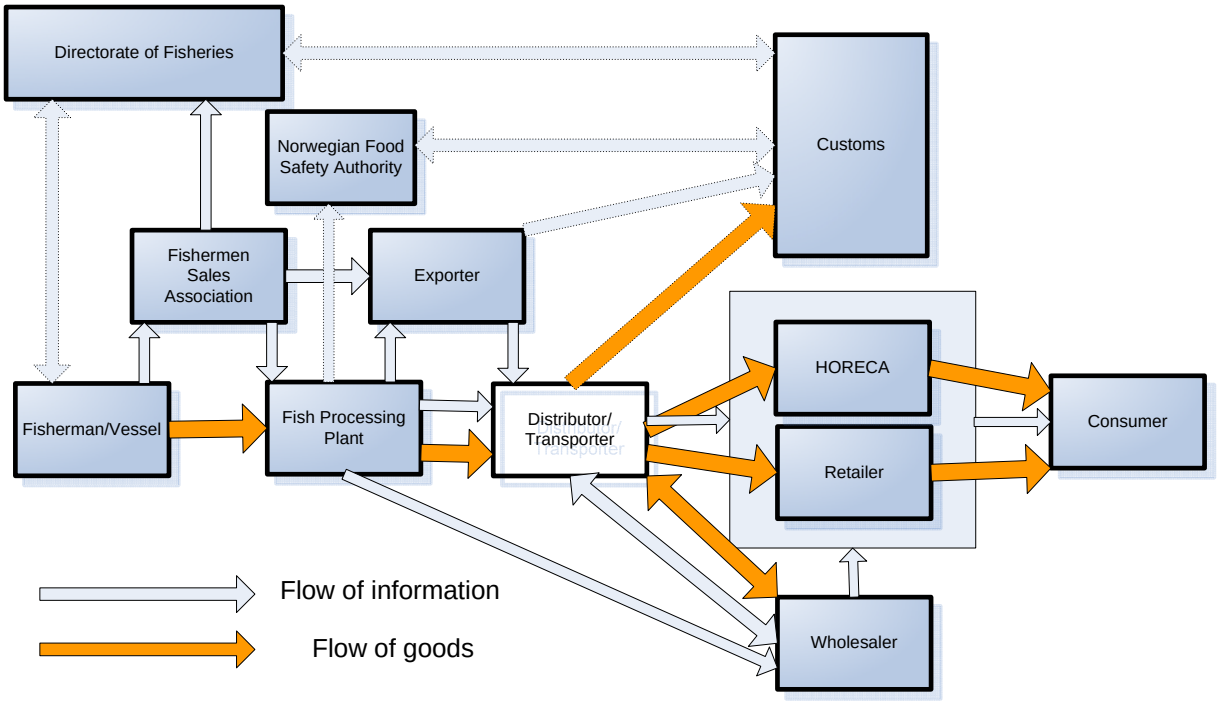

Figure 1 The fish value chain

The fish value chain as shown in Figure 1, consists of many actors that either are managing the fish, information about the fish and fishing, or both. The different actors/stakeholders are briefly described below. Actors providing additives, processing equipment, and packaging materials are not shown in the figure since these are not affected by IUU fishing.

Directorate of Fisheries – The Directorate of Fisheries have the main responsibility for management of the fish stocks in Norwegian waters. They have the responsibility to set and monitor fish quota. The Fishermen sales associations are responsible for collecting information about fish sale that is used by the directorate for quota control and fisheries statistics. These data are thus the foundation for a system that can be used to monitor that fish are legally caught, landed and sold.

Fishermen's Sales Associations – The sales associations are responsible for and have exclusive right to all first-hand sales of wild caught fish in Norway. It is their responsibility to implement the quota regulations from the directorate of fisheries, and distribute the quota among the fishing vessels. They have thus the responsibility for recording all fish sold in Norway. This information is passed to the Directorate of Fisheries for quota control, regulations and fisheries statistics.

Fishermen – The fishermen are the first part of the value chain where fish are traded. To be able to catch and sell fish, the fishermen need to be registered in a fishermen register that shows that they are eligible to catch and sell fish. The Directorate of Fisheries regulate the fish quotas and each vessel is assigned a quota of fish (by type, class and weight). The fish can either be landed at a processing plant, another vessel, a "mutual" freezing storage (on plant), or be landed at a foreign harbour.

Hobby or leisure fishing, or fishing for private use are at the moment not reported to any authority, nor are the fishermen registered in any register when fishing in salt water. In fresh water, it is however required to pay for the right to fish by acquiring a fishing license either from the government or from private actors (owners of the area where the fisherman wants a right to fish).

Fish processing plants – The fish processing plants are normally buyers of the fish sold through the Fishermen sales associations. The fish is either landed directly from the vessel at the processing plant or transported by other vessels or transporters to the plants.

Exporters – The exporters are actors that export the fish outside Norway. The fish sold can either be sold without any processing, or after processing.

Wholesaler – The wholesaler normally buy fish directly from the fish processing plants for further processing or resale. The wholesaler can break the original shipments and repack them in either smaller or bigger dispatches for resale.

HORECA – Hotels, restaurants and catering companies.

Retailer – The retailer of the chain constitutes the last link in the chain before the fish is consumed.

Consumer – The fish chain ends when the fish has been consumed. The consumer is normally buying their fish from the retailer or from HORECA.

Distributors /transporters – The distribution/transport part of the fish chain is all actors transporting fish from one geographical location to another. The fish transported is normally declared through a consignment bill. The transporters will rarely be the legal owner of the transport.

Customs – The customs is responsible for custom declaring transports in and out of Norway. The customs are authorized to stop any transporters that are not able to show proper certificates of the cargo.

Tax authorities – The tax authorities is an additional actor (not shown in Figure 1) which also have stakes related to IUU management. Income related to IUU fish will most often not be reported into the tax authorities, thus VAT, income tax etc., are not paid.

4 Requirements and liability challenges related to IUU and electronic traceability

This chapter will present the traceability requirements based on national and international laws and regulations, from traceability standards and from national initiatives in Norway.

4.1 Laws and regulations

The fishing and trading of fish in Norway is regulated through several laws where the Raw fish act (råfiskloven) and the Salt water fishing act (saltvannsfiskeloven) are the most important. In addition is the Participation act (deltakerloven) important for regulating who are allowed to participate in commercial fishing.
The Norwegian authorities have proposed a new law for management and administration of wild marine resources (NOU 2005: 10 "Lov om forvaltning av viltlevende marine ressurser – Havressursloven") [7]. It is of special interest the parts that are related to reporting from the actors in the fish chain and the responsibility of the fishing authorities (§8-2, §8-4, §8-5, §8-6, §12-1, §12-2, §12-4, §12-5, and §12-6). §12-4 opens for establishing a register for collection, storage and use of information gathered through electronic traceability of vessels or through other reporting established by or pursuant to the law. The sales associations shall perform control of raw fish trading especially related to catches and landings within their natural role defined by the raw fish act. In addition to the law paragraphs mentioned above, §14-2 is of interest related to reporting of fishing and fishing quanta that is harvested by people or vessels not covered by the law related to the right to participate in fishing (this part is probably covering leisure/hobby fishing, fishing for private use).

A changed version of [7] was approved by the government and published in [8] June 6th 2008. The law paragraphs in chapter 6 (§36, 37, 38, 39, 40, 41, 42 and 43), chapter 7 (§44, §48, §49), chapter 8 (§50, §51, §52) as well as chapter 10 (§56, §57), cover issues and relevant rules related to IUU management, including traceability and the possibility to establish specific registers for controlling purposes. Sport/hobby fishing is covered in chapter 4 (§22, 23). The law opens for rules that require all the fish chain actors to keep and use documentation that ensure control of the quanta received, transported, stored, produced, taken out of stock, or is traded (§40). Similarly, §41 gives the possibility for the department (FKD) to give rules that require all actors in the fish chain to keep information to at all time document the relationship of fish back to the original catch registered on a contract/landing note. §42 deals with the possibility for the department to give yield/conversion factors from processed or landed fish back to round weight and between different grades of processing. Specific electronic equipment and software can through department given regulations, be required to be used by the actors to collect information mention in chapter 6 in the law text (§43).

The North-East Atlantic Fisheries Commission, NEAFC, provides a scheme of control and enforcement [2] that applies for all contracting parties in NEAFC. NEAFC is an international body that recommends fishing quotas for the member states. Norway is a member of NEAFC.

The EU proposal for council regulation gives clear indications of what kind of information requirements that all fish imported into the EU area need to conform to. The European Community Catch Certificate is proposed as a means to document the legality of fish by relating all the fish back to the fishing vessel. This requirement means that it is necessary to establish a system for tracing the fish back to the fishing vessel. At the present, this information is recorded using the contract/landing note system which is not further used after the first-hand sale has taken place.

In summary, the laws and proposals of laws and regulations give quite clear requirements of how to manage and document fish products related to IUU. The fishing authorities in Norway have the right to require insight into all fish management nationally and is further responsible for issuing catch certificates according to the new council regulation. The authorities can establish new electronic systems to enable better resource management and control, and thus provide better means and methods for providing certification when needed.

4.2 Traceability principles

Product traceability is based on the ability to identify products uniquely based on physical markers or by records [9]. Traceability trough a supply chain also requires identification of the companies involved [10].

The principle operations of both chain traceability and internal traceability are described in [11]:
"As a basis for chain traceability, the identities for traceable units must be recorded at reception and shipping"

"Three types of operations are necessary for obtaining internal traceability:

- Record the unique identities of traceable units (typically input to processes)
- Assign unique identities to new traceable units (typically output from processes)
- Link a set of input (sourced) unit identities to one or more sets of output (delivered) identities

Several projects [11] [12] [13] indicates that a chain traceability system based on minimum requirements will not result in any additional value in providing increased traceability. The minimum requirements are to keep track of business partners that send to or receive products from your company. In order to increase value from traceability it is necessary to provide relations between both input and finished products through internal production as described in the bullet points above.

5 Issues related to IUU management

In Norway, fishing quotas are decided based on envisioned/forecasted/measured fish stocks and sustainability strategies related to how to preserve and protect the fish stocks. The quotas are set for fish species, fishing zones and time of year. This is done in accordance with both national and international authorities. Each vessel or group of vessels are then assigned a quota with the same differentiations. The vessels need permits to fish and to sell the fish. All fish caught shall then be compared to and subtracted from the quota to prevent IUU fishing. When the individual and/or total quota has been reached, the fishing is to be stopped for that particular fish specie. The quotas are all calculated in round weight.

5.1 IUU Scenarios

A problem for the fishermen is that it is not possible to actually control which kind of fish that will be caught, and will thus most often catch other types and classes of fish than what is the preferred catch. Seasonal variations and migration patterns decide where to fish and what to fish. Thus, secondary- or by-catches may cause a problem if the quotas already have been filled. A result of this may be that the secondary catches may be treated as a primary catch to avoid penalties. Typically, the fish may be recorded as a different specie.

The catches can vary in volume and type of fish. When landing the fish at a fish processing plant, the fish will typically be loaded into boxes or containers of a given size and eventually sorted based on species and sizes. To save storage space, fish from several catches are normally mixed. Without any proper control of who deliver which fish, the contract/landing notes are stacked together to form a “super note” including catches from many sources. The containers are filled up and catches from a vessel may also be split into several containers and mixed with other catches. In this way, it is hard to trace the actual fish to a single vessel or catch. Thus, fish caught according to a contract note is both split in different ways as well as mixed with fish from other contract notes making a many-to-many relationship between the actual fish and the contract notes.

Another problem encountered at the landing is that only the catches within the quota is actually registered through contract and landing notes while the remaining either is bought black from the fisherman or is plainly given as an addition to the processing plant. Missing weight control and traceability in the landing can thus mask the extra fish since the processing itself can reduce the amount within limits of the official accepted yield factor.

The quotas can illegally be transferred from one year to another if the actual catches either are above of below the quota. This is referred to as “paper/wall-fish” when below; contract notes are created the year before and the actual fish is delivered the year after. When the opposite happens, i.e., fishing above the quota, the fish is delivered the previous year while the contract notes are dated the year after. This is a similar situation as in fiscal budgeting where expenses are taken the year before while the actual delivery is the year after. It is, thus, not always clear to which quota a catch actually belongs to since it is possible to move some or all of the catch either to the year before or to the year after even though this practice is illegal.

Big hundred[5] is another way to let black fish into the market without reporting the quota excess. In this case, the fisherman is delivering more than the registered catch, but officially only gets paid for the registered catch. Issues here are that a) some processing plants may pay better for the registered catches to the fishermen in exchange getting more fish; b) they may also pay the excess catch black to a reduced price and thereby the processing plant is avoiding VAT/tax in addition to that the fisherman is avoiding paying tax.

[5] Storhundre in Norwegian

All fish exported need to be certified as legally caught and traded in the new EU system. A way to whitewash IUU fish is to falsely refer to real or fake contract notes, thus the black fish is apparently shown as white.

A problem that may be encountered with the new EU reporting/certification routines/requirements is that the trade of fish domestically is managed differently from when exported. If only fish exported are set under a certification regime, the actors may always rigorously report this fish and thus make the system certify that it is within the IUU requirements, while the domestic fish trade then is "open" for IUU fish. To avoid such a situation, it may thus be necessary to also include a certification system for domestic trade. It is therefore important to consider to implement the same system for certification independently of where the fish will be traded, and also how far in the fish chain such a certification needs to be managed.

The official yield factor is an important measure in the fishing industry to provide a mean to go back from the processed fish weight to the original quotas where the fish always are measured in round weight. Several attributes or properties may decide what reasonable yield factors are. Since many attributes provides differentiating factors for mass calculation, it may be difficult to actually "prove" that the yield is reasonable or not. Examples of properties that can change the yield factor of fish are, e.g., specie, size, water content, fat content, filleting skills (manual or fillet machine adjustment), season, additives used, fishing area, feed, processing methods, end product etc. IUU fish can thus be mixed with non IUU fish camouflaged using yield factors.

Control may also be hampered by long time storage of fish, thus trade can include fish theoretically caught several years ago (e.g., dried/stock fish). Storage control and batch sizes are therefore practical problems that need to be taken into account when establishing a certification system. It is especially issues related to keeping track of which fish belonged to which catch or batch (long time after the contract notes were issued), and that the sorting and sales procedures may cause a new batch of fish that is exported.

5.2 Future IUU system

This chapter has presented several issues that have are of importance related to how to build systems and procedures for both discovering and prevent fraud (whether intentionally or not) related to IUU management and control.

The only way to have a precise enough system to prevent IUU fishing is to make a control system based on mass balance through the fish chain. In practice this means that all incoming and all outgoing mass should be measured and reported to the authorities at timely intervals. The mass needs to be reported against the origin, i.e., the contract notes. In practice this means that the actors needs to keep track of incoming mass of fish (already documented through the catch/contract/landing notes) as well as mass of the outgoing fish including processed fish and waste. Mass account balancing needs empirical data and/or actual data on the use of additives including water, production process and eventually expected yield factors. The authorities can use the reported data to both issue certificates on legality as well as identify possible breaks on expected production and documentation among the fish chain actors.

All domestic trade of fish shall be reported to the authorities by informing about seller, buyer, species, weight and to which contract notes the fish belongs to. Such reporting can then be used to balance the traded fish against the contract note system to ensure that the traded fish is within the expected limits of the original catch(s) and that IUU fish is not traded masked as legal fish. Both dispatch and receipt advices should be included in the reporting. The reporting should be performed electronically, either by automatic message passing to a web service hosted by the authorities or by reporting through, e.g., AltINN using web forms designed for this purpose.

Establish a fish yield research project together with the industry to investigate which yield factors that are most common/probable based on fish type, refinement process, seasonal variations, location variations, and eventual other factors that might influence yield factors. The results of such a project can be used to algorithmically narrow down what are probable yield factors for the different products and thereby identify possible frauds.

The fish industry needs to establish an internal traceability/logistic system that ensure that all fish dispatched can be traced to the original contract notes. In practice, this means that all mix and split activities within the companies needs to be documented and thereby provide traceability information. It should also be considered whether weight systems should be used for measuring additives and waste in the production process where applicable.

The practice of mixing and splitting contract notes at the landing makes documentation and traceability back to contract/catch/landing notes difficult. We therefore recommend implementing systems that are able to keep track of these transformations. To prevent possible fraud, either the sales associations or the Fishing authorities should implement this system to enable new landing notes to be issued based on the actual transformations. In this way, mixing of catches will keep a relation to the original catch/contract notes and at the same time define a new identification to be used in the later refinement/processing activities.

Chapter 6 will analyse how some of the above scenarios also are challenging from a practical point of view for the actors in the fish chain.

6 Practical challenges for actors in the fish value chain

This chapter will present and discuss some of the practical challenges related to implementation of a more elaborate internal traceability system as well as providing a reporting interface for enabling certification and documentation of the fish goods related to IUU. A key issue to achieve better control of the actual amount (mass) of fish managed in the fish value chain is to establish better internal traceability systems to make account of how the input of fish is managed through transformations in the form of processing, splitting, joining and storage. An internal traceability system can document the actual transformations in the production process and thus enable traceability from the time the fish is received by an actor until it is delivered.

The physical processes and activities within each actor in the fish value chain as well as a physical environment itself impose challenges related to collection and management of electronic information. A major problem is that the information capture and flow very often is separated from the physical flow of goods between different stages in the value chain.

Within the fish chain, the fishing vessels can play many different roles like fisherman, processing plant, transporter, and exporter. In practice this means that their own catches are “sold” to themselves (self acquisition) and the physical flow of the fish will be within the vessel while the information flow may involve several other actors. It may thus be hard to relate the catches to specific contract notes since several catches can be stored or processed (mixed) together.

The vessel can also buy catches from other vessels and include those through reloading at sea (even though there are restrictions to this practice according to [7]). The authorities have thus just the contract notes as information and need to perform physical inspections to ensure that the information and the catches actually are in accordance with each other, especially when the load is exported.

Another practical challenge is that some of the fish is in the refinement process quite a long time, e.g. dried fish (stockfish) or clip fish. It is thus very difficult without any proper identification or stock system to keep track to which contract note the fish originally belonged. This area is probably the most troublesome for the processing industry since this kind of fish products often is stacked together and treated as several new batches when sold. In the sale process, the buyer or a representative of buyer will sort the products according to different criteria where the criteria decide the price of the fish. The amount and different representations of fish that thus needs to managed and registered electronically can become quite big. Such challenges can be met by individually identifying the fish and thus be able to trace the actual fish in the storage and processing system. This may, however, be problematic since in practice tagging individual items will take to much resources and the tag itself may distort the quality of the product (this may not be the case, but is an issue to be studied further). Other solutions used is to stack related fish together and thus keep records of the relationships between certain areas/parts of the stock and when the product was received (and in this way relate the fish to contract/landing notes). The areas must then be tagged instead of the individual fish and can then provide a more coarse-granular relationship. The sorting process may then be better monitored and more reliable documentation can be made and presented with respect to traceable catch information.

The time the fish is physically within an actor’s domain can differ from actor to actor, and from time to time. It is therefore expected that in addition to the fish received and delivered, it will always be some fish in processing or in stock (either frozen, dried, chilled or in another form). An internal traceability system needs to consider all states the fish can be in, and thus register whenever the state changes. This means in practice that to manage a mass control in the different states, it is necessary to weigh everything that is going in or out of a state. This also includes

eventual wastes. A stronger mass regime may however, for many actors be problematic since the increased number of weighting stations will both take more space and introduce more work. It will in addition mean more administrative procedures to record and keep track of the different stages of the production.

A requirement of a complete and waterproofed mass balance system is problematic since many factors can change the weight of the products during processing. Yield factors are often used to calculate back to the original round weight, but will of several reasons be very imprecise and difficult to keep correct or trustful. Factors like specie, sex, size, catch area, season, year, feed, water temperature, spawning period etc., are all attributes or properties that may change what can be perceived as a normal product yield of a fish. The removed waste of the fish may be different based on all the above factors as well as the actual usable parts of the fish. Since so many factors can influence “normality”, it is a need to provide studies and analyses of empirical data in the fish industry to better make predication models of yield factors. A better weight control in the different parts of the fish industry could provide these data and thus during a period of a few years, it would be possible to build statistical distributions to be used both for round weight calculations and for eventual control of actors who are not within the normal distributions.
Other factors that clearly are of importance related to the yield factor issue, is processing or production methods to make final end product. Calibration of machinery or good skills in managing the fish can provide better yield and is thus regarded as a competition advantage. The same applies to the application of additives and storage methods that will influence the product weight. It is thus also important to document and collect data from the fish industry, both in general and for exceptional good producers to make calibrations to the statistical models.
In summary, the collection and eventual application of these data can be a common responsibility of the fish industry to enable statistical yield factors to be used in quota calculations.

6.1 Implementation readiness

R&D projects and activities focusing on developing and implementing prototypes of electronic chain traceability systems have shown that this is a complex task. So far there are no reports on successful implementations in any complete Norwegian food chain/network. The reasons of this are reported to be based on both organisational and technical challenges.

A project focusing on implementing a chain traceability system in the Norwegian pelagic fish industry, developed sector specific guidelines for how to implement traceability in addition to a XML schema to be used by the software suppliers. Implementation at the industrial companies was not complete due to considerable challenges related to economical investments and confusion on the organisational procedure. Regarding the work on software adaptation/development, one of the suppliers experienced that their software did not comply with the internal traceability requirements. The project also concluded that know-how of traceability among some of the participants was limiting [4]. This indicates that implementation readiness of industry actors are of importance when introducing an electronic traceability system.

An evaluation of challenges regarding implementation of electronic chain traceability made in the farmed salmon industry [11], reported that only two of eight companies demonstrated a complete implementation. Eight important criteria for determining the implementation readiness were defined.

Implementation readiness should therefore be regarded as one important practical challenge for introducing electronic chain traceability.

7 Technological challenges for actors in the fish value chain

One of the most important technological challenges related to IUU is the lack of systems to follow up activities and information related to the physical movement of fish within a plant and between actors (either within a company or between companies). This gives possibilities to mask IUU fish as part of fish legally traded. The authorities do not at the present see other information than the contract and landing notes, and must thus physically inspect the fishermen and fish processing plants.

Another central aspect related to fish chains is food safety. The ability to react fast to withdraw possible danger food requires a system that can follow food through a complex network of chains and actors that can have had dealings with the food in question. A goal is the possibility in a chain perspective to track single products back to possible contamination sources and thus identify which other products that can have been contaminated. A surgical withdrawal can save costs and a fast reaction is vital to both save lives and eventually to prevent lasting harm on reputation.

Some of the issues to be managed on a national electronic traceability infrastructure are, e.g., scalability, maintainability, security, privacy, and how the traceability information is collected and/or distributed. Information quality is of vital importance to build trust into the system, but is at the same time hard to ensure in a timely manner.

Important considerations that should be analysed are which users are responsible for providing the information, which users are entitled to access the information, and what are the objectives for the provision and access to this information. Further, it is important to have user interfaces and system functionality that are built for satisfying the different needs the different actors may have related to the collected information.

In an IUU context, it is of vital importance that information that documents legal catches not in any way can be tampered or misused by any actor to whitewash IUU fish. This means in practice that the authorities and the next part of the fish chain always should be able to compare the information about the received products against the original reported and documented legal catches and landings.

7.1 Software Architectures and Solutions

The number of actors and the different needs of information for the different actors give important input into which kinds of software solutions that are most practical and/or meaningful related to stakeholder requirements. Different types of software architectures for electronic traceability are relevant in an electronic networked fish industry to fulfil many of the stakeholder needs related to IUU. The software architectures will however influence different non-functional properties of the solutions. The stakeholders may have different needs dependent on, e.g., timeliness, information need and quality, functional properties as well as the need to keep some of the information private from competitors. eSporing has in [14] presented and evaluated different architectural infrastructures that can fulfil the needs related to the introduction of a national solution for electronic traceability. The extent of eSporing is much bigger than the fish chain and IUU issues since it shall cover all food chains. Some of the issues and considerations presented are similar as for an IUU control system. The main issues are however different in these systems since traceability can be regarded as a necessary tool to establish IUU control while for eSporing chain traceability is the key issue. I.e., the driving forces for these solutions are different.

7.1.1 Distributed architecture

A distributed architecture is an infrastructure where each actor owns/controls its own data, i.e., the information is spread or distributed in separate databases or information systems. The owner of the systems and information needs to provide means for enabling access to the data. A data access

layer needs to be defined to provide interfaces to what kind of data to be shared, standardised methods to access and represent data, mechanisms for providing information security and privacy (who can access what information or services). Service-Oriented Architecture (SOA) is a common term used to describe this kind of architecture where data are provided by the current legacy systems and made available through pre-defined services in a standardised way.

This type of architecture is valuable for enabling business-to-business communication since it uses the Internet and open standards and protocols. The main problem with such an infrastructure is that it is difficult to define methods for collecting statistics of, e.g., fish trading. In an IUU perspective, it will be important to ensure the legality of the fish wherever in the value chain it is. It must thus be possible to track both origin and trade of fish between actors. In a control perspective, the authorities must have means for making statistics of how much fish that is in the market compared to the current control regime, including quotas and contract/landing notes. A distributed architecture makes it very hard to collect all the data necessary to generate such statistics.

7.1.2 Point-to-point architecture

A point-to-point solution requires that every partner in the value chain makes an interface to the other partners. Exchange protocols and data formats need to be defined and agreed upon. It can be argued in this kind of solution that the interfaces are “hardcoded”, i.e., that it is a fixed interface with some proprietary solution between each partner and that new partners require new interfaces. A standard interface and data exchange standard can however be established and thus the point-to-point architecture will migrate towards a distributed architecture.
A point-to-point architecture might already be in place between many actors using, e.g., EDI, ebXML/UBL or other B2B exchange standards to move business relevant data. In such a setting, traceability data can easily be included in the normal B2B communication if some of the prerequisites for traceability are fulfilled. The traceability information is however local between two partners and it may thus be hard to both track and trace the information since this will require such interfaces for all actors in the value chain.

7.1.3 Centralised database architecture

In centralised database architectures, each actor registers their data into a central database through some defined interfaces. The registering actors need to create interfaces from their own systems (like in the distributed architecture case) to extract the relevant traceability and/or trade information. This type of architecture needs to provide different means of registering data. The data can be sent using standard exchange formats or be manually registered through a web portal. A SOA interface can be built on top of such an architecture providing services as described above. The database can be distributed at different locations and different services can be provided for authorised users.

The main advantage of this architecture is the possibility to perform direct queries and statistics since all data are collected at the same place. For stakeholders like the fishing authorities, such a solution may be preferable since it is possible to create algorithms that automatically analyse the received information with respect to possible IUU issues. By connecting this kind of database to other sources of information already present for the fishing authorities like the contract notes database, it is possible to directly issue IUU certificates and send these to the interested actors.
The ability to provide information using different means of data input is clearly an advantage in value chains where many actors have few or no information systems available. Small companies and producers will not need to invest in systems that provide electronic interfaces, while larger companies with existing information systems can make the information exchange totally electronic.

It can be argued that standardisation of data exchange protocols and formats can be problematic, but it is important to understand the stakeholders' requirements for information. In an IUU context, the most important issue is to provide means for controlling the catch and trade of legal and illegal fish, and identify possible actors that are involved in illegal activities as well as certify actors with legal catches. The information necessary will be connected to contract notes and fish volumes related to these.

7.1.4 Combined architectures

Different architectures have been presented above and briefly discussed related to how to solve IUU issues in the fish chain. There exist many different software solutions related to food trade and traceability. Some of these are internal systems to support the production processes and systems for managing the enterprise (ERP). It is clearly a need for every enterprise to have internal traceability systems to get control of the internal flow of goods and to enforce traceability back to the contract notes. Normal business-to-business communication will continue between the different actors even though traceability systems are introduced (point-to-point communication). Thus, the enterprises need to be able to support different means of communicating with each other and with the authorities. In a pure traceability context, distributed infrastructures can be fitting as long as the systems in the enterprises are up and running 24/7 and the participating enterprises are stable. It is an issue that companies go out of business and thus missing links can be introduced. In that respect central database architectures are more stable and safe to keep data persistent and available even though companies cease to exist.

It can be argued that there will always be different information requirements based on which type of information that are necessary to share, what are required by customers and the authorities, and what information that is clearly regarded as private and thus will require special requirements related to security and privacy to open up for access. The vulnerability of computer and communication systems is a main concern for how the information is to be organised, stored, and communicated. It can be expected that enterprises will use different means of communication based on type of business, business transactions, and government requirements. Some of the traceability information will be of interest for more than one actor in the chain and can be communicated either together with other business information in B2B communication, or be offered through Web interfaces that are either open or have some authorisation and authentication control. It is further possible to upload information to other parties either through electronic messages or through registration of information at Web portals. Thus, all the different architectures/infrastructures as described above are already used in one or another form in and between different actors in the industry.

7.1.5 Non-functional requirements

The selection of proper software architectures is almost always a careful choice based on a lot of different functional and non-functional requirements. Especially non-functional requirements tend to be important with respect to which kind of architecture that should be selected. Below, different non-functional issues/requirements will be presented and discussed with respect to a system for supporting IUU control.

One of the main issues is to provide means for communicating information between different actors in a standardised way to ensure that the right information reaches the right address and that this information can be interpreted and managed in the internal systems on the receiving side. Driving forces the last recent years have been to use Internet protocols as the carrier (http, ftp), and open information exchange standards/languages like XML to give the messages a semantic meaning and an interpretation method, and to send this information in pure ASCII text. Open protocols like http and the use of text-based messages are however not secure since they can be

both listened to and tampered with. In addition, privacy issues are important to consider since the messages can contain private or business sensitive information.

Scalability is an issue that needs to be considered when the number of users increases. Distribution and load-balancing are most often used to increase the scalability. The assumed number of yearly transactions related to the management of an IUU certification system is compared to other transactional systems, quite low (10 millions à year). The transactions are in addition not of a very complicated nature since they mostly can be managed one by one and all information is assumed to be in a central database. It is thus not necessary to take extra precautions related to scalability with the present state-of-the-are hardware, communication and software systems.

Performance is another issue that are related to response time and operation time. A message-based system needs to be scaled to a proportion than ensure a timely management to avoid that messages are queued and thus ensure timely responses to the sender. Performance can be related to network, processor, database and general information system performance. A traceability system with many actors will lead to a large number of traceability messages to be managed, both at the different companies and in an eventual collection of such messages.

Another aspect is the use of the data already processed and stored in the systems. Different stakeholders will have different needs where the reaction time is decided by these needs.

8 A System to Support IUU control

This section will explore the most important requirements with respect to a system with the emphasis to monitor fish trade to control and certify trade to avoid the introduction of IUU fish in any part of the chain. Both functional and non-functional requirements and/or issues will be presented and briefly discussed. The section will also briefly compare such a system with the work done in/vision of eSporing to establish a national chain traceability infrastructure.
If we take an information-driven approach, then we see the need to collect all information generated through the fish value chain related to catch, sale, delivery, receipt, refinement and production, waste management, additives used etc. A fish mass account is possible only if all processes that reduce or add mass to the products are taken into account.

The system shall fill the following *vision*:
*An IUU control system shall provide the fishing authorities a way to **electronically** control and validate that all fish traded in the fish value chain are caught and traded according to the **established control and regulation regime**. This is to be done by collecting fish trade and transformation information through the fish value chain, from the regulation of quotas and fishing, through catch reports at the vessels, to report of all trade (and landing) of fish within the Norwegian waters and trade markets.*

8.1 External Prerequisites and Constraints

One of the conditions for preventing and deterring IUU fishing is a control system that is able follow the fish caught through the fish value chain. This means that every actor managing or trading fish needs to establish systems for **internal traceability** and to provide sufficient **chain traceability** information together with the flow of physical goods within the company and between companies. The information provided by these systems can then be reported to the authorities for issuing of continued catch certificates wherever in the value chain the fish is situated. A system where both shipment notes and receipt notes are collected and reported will ensure that there is balance at every step in the chain.

An internal traceability system is required to be able to track the movements of goods within production plants to ensure a mass balance from each step of the production process to the next. At the same time it is necessary to implement an identification system for goods that can be used to create electronic relationships between the contract/catch notes and the shipped goods (including eventual waste). The identification system needs to be unique in the context of the fish chain to identify the actor, the production plant and which production batch the products belong to. In the case of splitting, tampering, or joining of goods, it is necessary to give new identities for the resulting products. These identities will always need to relate back to the input factors which eventually will form a relation to the first step, i.e., the original contract/catch notes.

ER1: Actors joining, splitting or processing fish products needs to establish an internal traceability system to keep track of such activities.

ER2: Information about joining of products from several contract/catch/landing notes needs to be reported to the authorities.

ER3: The shipped products at the first part of the chain need to be reported to the authorities with a relationship to the actual contract/catch/landing notes, the shipped quantities, and the receiving party.

ER4: Receivers of fish products needs to report received quantities to the authorities with all relevant identities and quantities (relationships to contract notes are established by ER3).

ER5: Actors that process, mix or otherwise refine received products needs to report origin and the produced quantities to the authorities.

ER6: All actors need to implement an identification system of goods that are unique in the context of the fish chain.

8.2 Functional requirements

FR1: It should be possible to follow all physical movement of fish from the catch/contract note to the end-sale point.

FR2: In any point of the value chain, it should be possible to find which catch/contract notes the actual fish product belongs to (or set of contract notes).

FR3: The system should use established yield factors[6] for all major fish types and fish products, to possibly identify unnatural or wrong values that may appear in the fish value chain[7].

FR4: The system should be able to establish statistics related to quotas, contract/catch notes, export, production, consumption, waste, yield factors etc. as a way to identify possible IUU fishing.

FR5: The system should be able to issue catch certificates at any point of the fish chain to document the legality of the fish received at the issuing actor.

FR6: The system should be able to receive electronic messages from all fish actors on an agreed exchange format.

FR7: The system should be able to receive manual reporting through designated web interfaces/web portal as an alternative to electronic exchange messages.

FR8: Actors sending messages should be able to send updates of the message/transaction which should be taken care of the system.

8.3 Use case specification of an IUU Certificate System

[6] We believe that it is necessary to do research on which yield factors that are within acceptable limits based on e.g. fish type, fish size, time of season, regional stocks etc.

[7] Actual physical tests of possible suspect products can be performed to establish a more accurate yield factor range when actors or products are outside the normal range established through research.

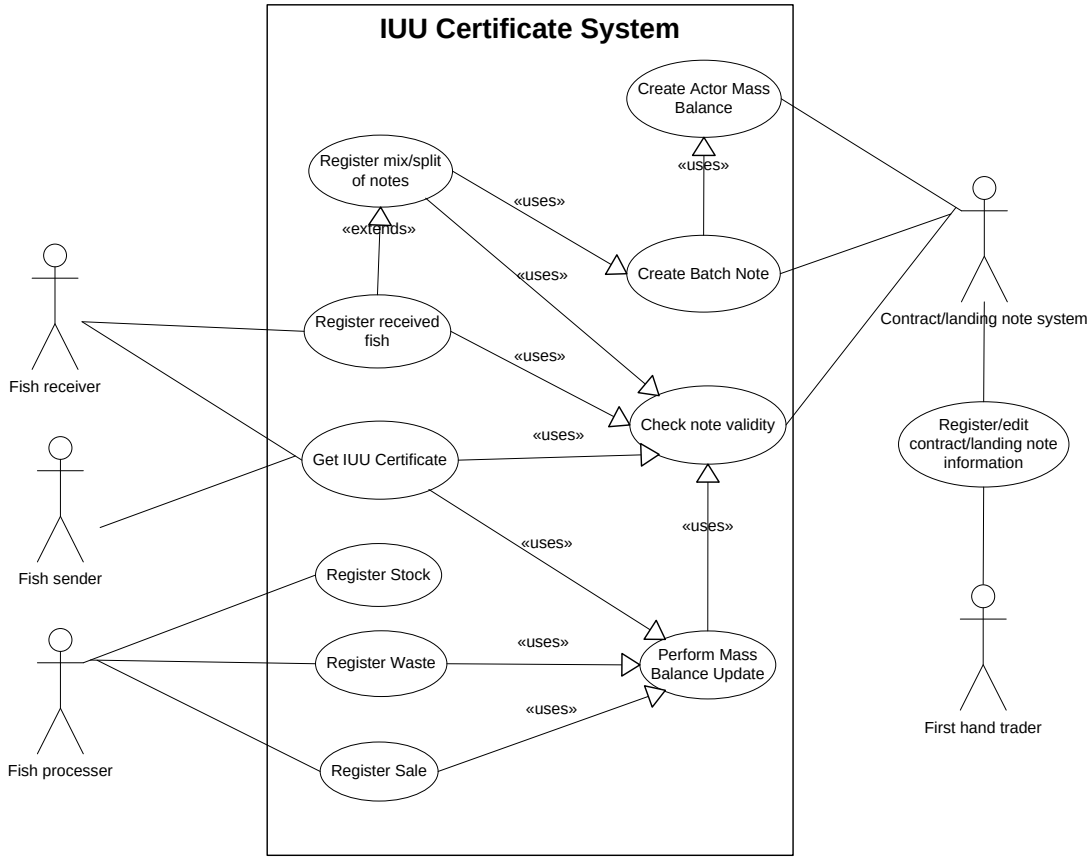

Figure 2 Use cases in an IUU Certificate System

This section will present a conceptual view of a system to meet the requirements for a trustworthy and effective IUU certification of fish managed by Norwegian fish actors. The mission of the system can thus be described as:
To provide a trustworthy electronic source for issuing IUU certificates according to [1] for all fish managed by commercial actors in the whole fish value chain, both nationally and internationally.

The ownership of this system needs to be a single certification authority according to the IUU management proposal. The use cases described in this chapter are sketches of how a system can be seen from the users' point of view. The use cases need to be further elaborated and a more detailed description of how the system is to be interfaced to the existing contract/landing note systems need to be specified.

8.3.1 System prerequisites

The system will need some basic prerequisites to become trustworthy:

- Every buyer and seller of fish in any market should be able produce or reproduce an IUU certificate showing the legality of the fish received. Thus, an IUU certification system needs to be implemented both nationally as well as internationally.
- The physical flow of fish between actors in the fish chain needs to be connected to specific IUU certificates, thus all actors needs to keep account of which fish belongs to which IUU certificate.
- The only way for any system to become trustworthy related to IUU management, is to keep account of the mass managed by the every actor in the fish chain. The origin of quotas needs to be reflected through the whole system and products redrawn from the quotas need to be documented through the whole chain. Thus, a mass balance system

related to the actual catches needs to be implemented to avoid duplicate reporting towards the same origin and masses without any relationship to the established quotas. The transmission between and internal management within the fish chain actors of the actual fish masses is thus a key for the providing a working mass balance system.
- The principal documentation of incoming mass into the system is the already established contract/landing electronic note system.
- Some deviations from the reported masses to the actual quota masses can be expected, but it is more likely that mass will be missing in the note accounts rather than increasing.

8.3.2 System users/actors

The main actors in the system can thus be differentiated according to the role of the actor related to fish management. These roles are:

- Fish sender: The “Fish sender” is any actor that somehow transmits a mass of fish to another actor.
- Fish receiver: The “Fish receiver” is any actor that receives a mass of fish from another actor.
- Fish processor: The “Fish processor” is any actor that somehow process or make any changes to the actual mass of fish.

Any actor can thus play one or more role in the system. The roles “Fish receiver” and “Fish processor” intercede when doing actual splits or joining of fish masses received from several fish senders. Any mixing or splitting should be documented and reported to be able to reissue an IUU certificate for the new mix.

Outside the system, two basic roles are described to reflect the current management situation related to quota and trade management. The current contract/landing note system is thus a closely related and important system to provide the basic mass balance that will be managed by the IUU certificate system.

Other actors that also will be natural with respect to the system are:

- IUU controller: This role is an authority actor responsible for management of the fisheries and fish quotas with respect to investigation of possible IUU fishing and general quota management.
- Tax controller: This role is an authority actor responsible for tax collection and investigation possible mismatches between reported and actual flow of goods and money.
- Customs: This role is an authority actor responsible for toll declarations of goods imported/exported from a national border. Customs can check the validity of the issued IUU certificates and stop and confiscate transports without any proper documentation and/or illegal goods.

8.3.3 Basic use cases and use case analysis

Five main use cases for an IUU certificate system have been identified where four of these are closely related with respect to information management. A use case can be described as how the system looks from the user point of view, and should not be compared to how to actually implement the system

1. Register Received Fish
2. Register Stock
3. Register Waste
4. Register Sale

5. Get IUU certificate

The perceived use of these use cases are illustrated for the chain perspective in Figure 3 and for the internal perspective in Figure 4.

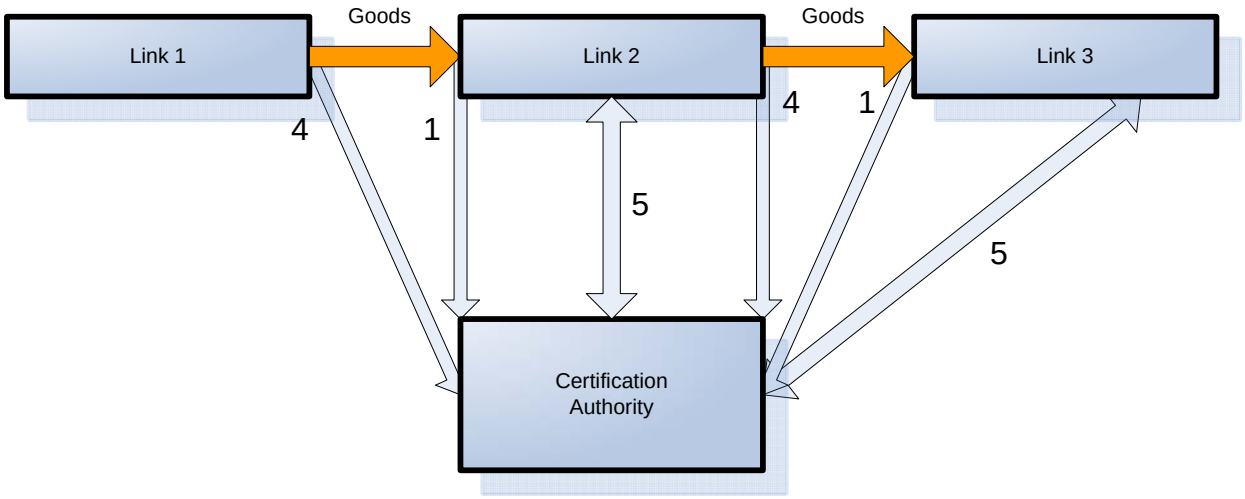

Figure 3 Certification authority in a chain perspective

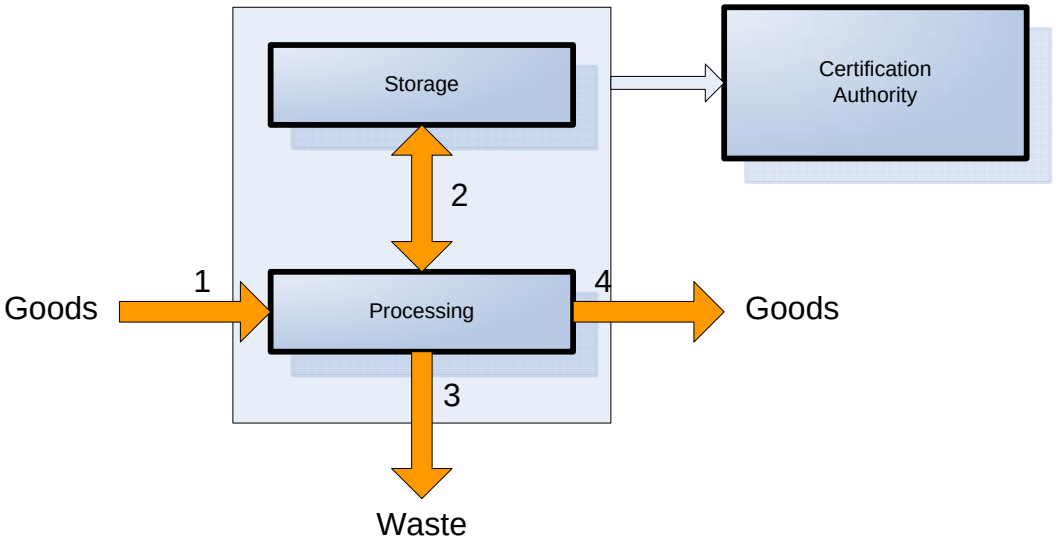

Figure 4 Certification authority in internal perspective

In addition to these main use cases, the system has defined five supporting use cases that show how the system is intended to be used. These are:

- Register mix/split of notes
- Create batch note
- Create actor mass balance
- Check note validity
- Perform mass balance update

All the use cases specified are directly connected to the actual population of data and direct use with respect to the fish chain actors.

The system can easily be extended to also provide information and statistics to the fishing authorities for use in the IUU management. It will in this respect be natural to populate the system with empirical data to perform yield factor calculations and thus fish actor control in the different parts of the fish value chain. This information is, however, not strictly required for the basic system related to basic mass balance control. The trustworthiness of the system without adaptive yield factor calculations is weakened and it is thus recommended to include functionality and information models to extend the usefulness of the system. Proposed use cases for this extension are:

- Register waste and residual per Individual fish/fish batch (specie, size/weight round, sex, season, area etc.)
- Register change of weight by processing method (start weight, end weight, additives, processing method, end quality, etc.)
- Calculate yield factor distribution for different factors and interpolate into a normal distribution
- Check reported yield factor against normal distribution
- Create yield factor reports for possible IUU

8.3.3.1 Register Received Fish

Brief description:
This use case has the responsibility to provide an interface into the system for registering any fish received from other actors in the chain. The fish received is to be validated for legality against the IUU register.
Actors: Fish receiver (primary), existing note system (secondary)
Pre-condition*:* The fish mass is already registered in the contract/landing/batch note system and has thus a unique identification with respect to a note and specific note line. Each actor in the fish chain has been registered into the system for identification and authorisation. The contract/landing notes registered into the contract/landing note system should be automatically available for the IUU certificate system as soon these are accepted. The Fish receiver can then use already registered information to create the batch notes. It is also possible to automatically create batch notes based on normal split/mix at the actor, e.g., daily batches.
Post-condition*:* The received fish mass has been assigned a new batch note identifier and the receiving actor has been assigned the incoming fish mass in the system. The mass used from the original note are subtracted from the note to ensure mass balance.
Extension points:
Register mix/split of notes
Check note validity

8.3.3.2 Register Stock

Brief description:
This use case has the responsibility to provide an interface into the system for registering any fish in stock at the local actor. The system does not need to relate the stock to any specific note system since stock management is the responsibility of the fish actor and should be managed locally. It is however important for the mass balance system to keep an account of how much fish that is at different stages in the fish chain until it is consumed or otherwise outside the responsibility of the IUU management system. It could, however, be natural to relate the current stock to batch notes since all fish will belong to a batch note and thus mass balance is ensured also for the fish in stock
Actors: Fish processor (primary)
Pre-condition: The stock has already been assigned to batch notes.
Post-condition: The system will now how much fish that is at different stages in the fish value chain.

***Extension points*:**
None or *Perform mass balance update* (this must eventually be based on a practical or political decision)

8.3.3.3 Register Waste

Brief description:
This use case has the responsibility to provide an interface into the system for registering any waste of the received fish mass. The waste reported needs to be related to the batch note thus reducing the remaining mass of that note.
Actors: Fish processor (primary)
Pre-condition*:* The outgoing mass has previously been assigned to/registered in batch note(s).
Post-condition*:* The mass balance of the affected batch notes are updated, i.e., the remaining mass in the batch notes is decreased accordingly.
Extension points:
Perform mass balance update

8.3.3.4 Register Sale

Brief description:
This use case has the responsibility to provide an interface into the system for registering sale of fish. The sale must be reported against the belonging batch note thus reducing the remaining mass of that note for the particular actor. The buyer(s) of the outgoing logistic units needs also to be registered to prepare for incoming mass in a new part of the chain.
Actors: Fish sender
Pre-condition: The outgoing mass has previously been assigned to/registered in batch note(s).
Post-condition: The mass balance of the affected batch notes are updated, i.e., the remaining mass in the batch notes is decreased accordingly.
Extension points:
Perform mass balance update

8.3.3.5 Get IUU certificate

Brief description:
This use case has the responsibility to provide an interface into the system for issuing an IUU certificate of either received or sent fish. The input into the system is an identifier to either the whole shipment or to parts of the shipment if the shipment has several batch/contract/landing note identifiers. Every shipment needs to be identified by a batch note identifier, eventually a contract/landing note identifier. This process may formally change the ownership or state of the fish from stock to outgoing/incoming/transport. If the shipment belonging to one certificate is split, new batch notes have to be registered (dispatch notes) and issued as part of the certification process to ensure traceability.
The remaining mass of the involved batch notes before dispatching needs to be within certain thresholds to allow certification. If the mass in the involved in the current batch notes are already used, the system will not create a certificate.
An IUU certificate can also be issued to receiving parties to ensure legality of the received fish. The content of this certificate should match the certificate issued to the sender and is thus an acknowledgement of the change of ownership/managing party as well as a receipt into the IUU certification system. The receiving party will then eventually change role in the system with respect to batch management if applicable.
Actors: Fish receiver (primary,) Fish sender (primary)
***Pre-condition*:** The fish is physically received by/sent to an actor registered in the system, and all the mass do originally belong to a contract/landing/batch note.
Post-condition: The mass belonging to the shipment are subtracted from the mass balance account of the shipping actor and the mass are assigned to a new handler (either temporary like a

transporter, or to a receiving party). An IUU certificate is created for the shipment containing information fulfilling the requirements for the certificate. The system updates the state of the batch note(s) with respect to remaining mass and eventually creates a new batch note for the receiving party (if applicable).
Extension points:
Check note validity, Perform mass balance update

8.3.3.6 Register mix/split of notes

Brief description:
This use case has the responsibility to provide an interface into the system for registering mix or split of existing contract/landing/batch notes by the *Fish receiver*. The Fish receiver will thus be issued one or many batch notes related to how the mix or split is performed within the business. The role of Fish receiver will be all actors that somehow receive fish from other actors. Any point in the fish chain where a shipment of fish is split or mixed will have a Fish receiver role.
This is use case is an extension to the *Register received fish* use case and will be invoked whenever a new batch note needs to be issued, most often as part of a mix or split of the received fish shipments.
Actors: Fish receiver (primary)
Pre-condition*:* The input notes are valid notes
Post-condition*:* A new batch note has been registered for each mix or split of the received fish mass and a mass has been assigned to each batch note.
Extension points: Create batch note, Check note validity

8.3.3.7 Create batch note

Brief description:
This is a system internal use case with the responsibility to provide an interface to create batch notes that can be used by the "Register mix/split of notes" use case. The system performs an account update on the original/present note with respect to mass assigned to the new batch note. The batch note is then related to original notes either directly to contract/landing notes or indirectly through other batch notes. All notes in the system needs an incoming mass that is validated as legal through the landing/contract note system.
Actors: Fish receiver.
Pre-condition*:* The incoming notes and masses assigned to the new note is validated as legal through mass balance calculations against the original masses
Post-condition*:* A new batch note is issued with relationships to the original contract/landing notes and an incoming mass has been assigned to the particulate note. The outgoing mass balance of the incoming notes is likewise reduced with the total amount taken from each incoming note. The note has been assigned an owner.
Extension points: Create actor mass balance

8.3.3.8 Create actor mass balance

Brief description:
This is a system internal use case with the responsibility to provide an interface to create a mass balance account for the different notes and note types in the system.

Actors: Internal
Pre-condition*:* All contract/landing notes are already registered or accessible for the system to create an incoming mass balance. The current actor owning or managing the fish mass is assigned as owning actor of the mass.
Post-condition*:* The new batch note has been assigned a mass with an owning actor. The original or incoming notes are likewise reduced with the same amount of mass to keep the mass balance in the different parts of the fish value chain.

Extension points: None

8.3.3.9 Check note validity

Brief description:
This is a system internal use case responsible for checking the validity of the input mass and notes into the system. The check is either performed against the existing contract/landing note system (for contract/landing notes) or internally against the batch notes. It should not be possible to validate incoming masses that extend the original mass for the note. Yield factor calculations and/or statistically distributions can however affect the probability of such changes.

Actors: Internal
Pre-condition*:* The note systems are updated with the current mass balance. Any outgoing/incoming mass to be checked for validity are thus to be checked for existence and probability related to the previously reported mass in the related notes.
Post-condition*:* The system either accepts the note as valid (e.g. change of ownership of an already issued shipment) or as a probable withdrawal from stock/production, or reject the note.
The system can send a message to the fishing authorities related to the acception/rejection, and should make the active actor attentive of the issue and how to eventually solve it.
Extension points: None

8.3.3.10 Perform mass balance update

Brief description:
This is a system internal use case with the responsibility for updating the mass balance account related to specific note identifiers. Any incoming mass is increasing the mass while any outgoing mass is reducing the mass. When all mass has been accounted for, the note can change state to *closed* and no more reporting can be performed against the particular note.

Actors: Internal
Pre-condition: All notes in the system have assigned an incoming mass
Post-condition: The registering of outgoing masses updates the remaining mass of the current note to account for a mass balance pr. Note.
***Extension points*:** Check note validity

8.3.4 System extension for controlling purposes

The use cases briefly described below are extensions to the basic catch note system for providing functionality for controlling purposes by the fishing authorities. An important part here is the population of statistical data for yield factor calculations as well as checks of how reported masses in the fish chain relate to the recorded normal distributions for the type of product.

Use cases:
Register waste and residual per individual fish/fish batch
This is a use case responsible for providing an interface for registering data for statistical purposes related to yield factor distributions and calculations based on specific attributes related to the fish.

Register change of weight by processing method
This is a use case responsible for providing an interface for registering data for statistical purposes related to yield factor distributions and calculations based on production/processing methods.

Calculate yield factor distribution for different factors and interpolate into a normal distribution
This is a system internal use case responsible for calculating a yield factor distribution based on the data populated through registered data.

Check reported yield factor against normal distribution
This is a use case responsible for checking the likeliness of reported yield factors against the statistical data in the system and thus can be used for controlling purposes.

Create yield factor reports for possible IUU fish
This use case is responsible for creating reports of possible frauds or likely IUU fish based on the incoming data and yield factor calculations based on likelihood distributions related to the actual products. This is a tool that should only be available for the fishing authorities and/or other authority bodies that have public interest in preventing criminal activity.

8.4 System architecture and design considerations

An IUU certification system will require a designated portal to offer specific interfaces for management updates of notes and issuing of certificates. It is possible to automate some of the use cases described above by providing specific interfaces to support communication between internal traceability systems among the different actors and the certification system. Thus, a practical electronic solution can be built between the sales associations, the different fish industry actors and the fishing authorities.

An IUU system will need a quite tight coupling to the contract/landing note system already present and provide interfaces for both validation and for population of mass data from these systems. Thus, an IUU certification system can be looked upon as an extension of the existing systems with mass balance accounting, calculations and monitoring. The batch note addition can be seen as a specialisation of the contract/landing note where the selling and buying actors provide information about which physical transformations a catch/landing has been through during the management at the specific actors. Price and monetary information is not of interest with respect to IUU monitoring and control, but will be of interest for the tax authorities.

The practice of mixing/splitting several contract notes will give some issues of what the certificates actually should contain since it is not very practical to issue many certificates for a specific shipment of fish originating from many catches. It could therefore be a proposal to instead of issuing an IUU certificate for each catch, issuing an IUU certificate for the shipment or parts of a shipment with references to the actual contract notes. Thus, it is the batches that are certified with respect to the original quotas and contract notes.

Security and privacy issues will be of great concern for many of the actors to avoid giving out business-sensitive information to competitors. The system should thus not make public actor specific information, and all operations to be performed in the system should be protected by sufficient authorisation and identification privileges for the different actors.

The system description above has been split into two different parts, where the most important part is the establishment of an electronic IUU certification system. The second part is concerned with yield factors and will be a necessary extension to increase the credibility of the system. The two parts can thus be developed separately and integrated at a later stage.

The data model used by the contract note system should be easily extended to also provide transactions related to mass balance calculations and accounting. The contract notes will thus be assigned processing states in the first part(s) of the fish chain, and then be replaced by batch notes when physical transformations have taken place related to the contract notes.

The IUU certificates should be issued at any stage in the fish chain. This will require that all buyers of the fish until end sale/consumption should report and ask for certificates related to the acquired fish. In practice, this means that the fish should be identified uniquely to a quite fine

granularity (possibly to the lowest trade unit) and this identification should be enough to ask for an IUU certificate.

8.5 Relationship to eSporing

The establishment of a national traceability infrastructure will influence how the fishing industry needs to create systems and routines to enable more transparent and better traceability related to the requirements and stakes of eSporing. The need for a more stringent IUU management and documentation is a specific requirement that is closely related to the chain traceability requirements assumed to be supported by eSporing. It is however a difference in that a third party need to control and issue the necessary certificates based on reliable and trustworthy information supplied by the chain actors.

One of the common issues for both eSporing and IUU management is the need to have high-quality information ready when required. In the IUU management case, the information will be generated and used all the time. In the food safety case, the information generated for traceability purposes will be similar to the fish case, but this information will probably only be used when there is a suspicion or an actual food contamination/fraud case.

Special functionality like mass balance accounting and yield factor distributions and checks require centralised systems to ensure a common view and account of available information. The information reliability will however be a responsibility for all actors. The same information can flow between the different actors, but such information can be tampered with intentionally or unintentionally. Thus, it will be necessary to provide a third-party solution for quality checks and access to additional information when appropriate.

eSporing envisages a traceability infrastructure for many purposes, including value-added services for the actors in the food chain. In the IUU case, the necessity to provide IUU certificates will be a requirement to be able to export fish to the EU market. Thus, solutions to this requirement can be seen as necessary tools for market access and thereby an increased value in the products.

Improvement of internal traceability is seen as a necessary requirement for both eSporing and IUU certification. The necessary changes in the production and logistics practices at every stage of the fish chain related to IUU will thus probably also increase the ability to also provide information for other use since information about the fish always will need documented catch and process information.

9 Conclusion

One of the main challenges in IUU management is the possibility to incorporate IUU fish together with legal fish in the fish value chain without later being able to differentiate between what has been legally and illegally traded. By hiding behind differentiating yield factors based on production processes, illegal fish can easily be whitewashed without any apparent traces, especially since acceptable yield factors are very imprecise and general. The authorities are at the present only directly informed about the first-hand trade. Later trade and refinement processes are less regulated and can thus open up for IUU fish.

Our recommendations are as follow:

- The only way to have a precise enough system to prevent IUU fish entering the legal value chain is to make a control system based on mass balance through the fish chain.
- Catch notes should be reported electronically, either by message passing from onboard catch note systems or by providing an interface through, e.g., AltINN that makes it possible for fishermen without any onboard catch note system to report their catches. The contract note system must be able to trace back to the catch notes.
- All domestic trade of fish shall be reported to the authorities by informing about seller, buyer, species, weight and to which contract notes the fish belongs to (either directly or indirectly through issued batch notes).
- All trade units shall be uniquely identified to enable traceability from the trade unit to the contract note(s). The uniqueness of the identifier needs to be within a national context.
- Establish a fish yield research project to investigate which yield factors that are most common/probable based on fish type, refinement process, seasonal variations, location variations, and eventual other factors that might influence yield factors. The results of such a project can be used to algorithmically narrow down what are probable yield factors for the different products and thereby identify possible frauds.
- The fish industry needs to establish an internal traceability/logistic system to ensure that all fish dispatched can be traced to the original contract notes.
- The practice of mixing and splitting contract notes at the landing makes documentation and traceability back to contract/catch/landing notes difficult. We therefore recommend implementing systems that are able to keep track of these transformations. To prevent possible fraud, either the sales associations or the Fishing authorities should implement this system to enable new batch notes to be issued based on the actual transformations.

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Appendix A: Original project description (open version)

SINTEF Fiskeri og havbruk AS
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PROSJEKTFORSLAG

TITTEL

Praktiske og teknologiske utfordringer for innføring av elektroniske sporbarhetssystem relatert til UUU

MOTTAKER

Innovasjon Norge

MOTTAKERS REF./KONTAKTPERSON

Emil Jessen

ARKIVKODE	GRADERING	UTFØRENDE ENHET(ER) I SINTEF	
	Åpen	SINTEF Fiskeri og havbruk AS	
ELEKTRONISK ARKIVKODE		KONTAKTPERSON I SINTEF	ANTALL SIDER OG BILAG
Rapport_v15.doc		Eskil Forås	6
FORSLAG NR.	SVARFRIST/GYLDIG TIL	KONTROLLERT AV (NAVN, SIGN.)	
	2008.03.14	Gunnar Senneset	
DATO		GODKJENT AV (NAVN, STILLING, SIGN.)	
2008-03-07		Jostein Storøy, Forskningssjef	

MÅL

Målet med dette prosjektet er å utrede praktiske og teknologiske utfordringer relatert til en **massiv** innføring av elektronisk sporbarhetssystemer innenfor norsk sjømatindustri.

STARTÅR	2008	SLUTTÅR	2008
ØKONOMISK RAMME STARTÅRET		ØKONOMISK RAMME TOTALT	

Følgende graderinger benyttes:

Åpen:	Materialet er tilgjengelig for alle interesserte
Intern:	Materialet skal ikke distribueres eksternt
Fortrolig:	Materialet skal ikke komme uvedkommende til kunnskap
Strengt fortrolig:	Materialet gis spesiell beskyttelse ved oppbevaring, forsendelse, omtale m.v.
Personlig	Materialet gjøres bare kjent for en eller et fåtall personer

Bakgrunn

Den norske regjering har som mål at Norge skal blir best i verden på matsporing. eSporing (tidligere kalt regjeringens e-sporings prosjekt) har fått oppdraget med å utarbeide et grunnlag for dette, både strategisk, økonomisk og teknologisk. Målsettingen for e-sporingsprosjektet er å etablere en nasjonal elektronisk infrastruktur for effektiv utveksling av informasjon og sporbarhet i matkjeden innen utgangen av 2010.

Dokumentert kvalitet og bærekraftighet innenfor fiskeri og havbruk har etter hvert fått stor fokus fra konsumenter og myndigheter. Dette henger sammen med reduserte fiskebestander og en økende trussel om overbeskatning/overfiske gjennom ulovlig fangst og omsetning av fisk – UUU[8]. Det generelle miljøfokuset i den senere tid har også aktualisert at fangst, foredling, oppdrett og transport av fisk i større grad skal kunne skje på en miljøvennlig og bærekraftig måte.

Dokumentasjon om opprinnelse, egenskaper knyttet til kvalitet, lovlighet og bærekraftighet krever en elektronisk sporbarhetsinfrastruktur som evner til å knytte aktører sammen i en kjede der informasjon om maten kan følges fra opprinnelse gjennom foredling og transport, helt frem til sluttbrukeren. En slik løsning må samtidig gi kontrollmyndigheter mulighet til å kontrollere at informasjonen er riktig og i henhold til gjeldende lovverk og reguleringer, og for å hindre at og eventuelt dokumentere om aktører håndterer eller omsetter UUU fisk gjennom kjeden(e).

Innføring av/krav om elektronisk kjedesporbarhet medfører at alle bedrifter/aktører som er involvert i norsk matproduksjon, inkludert transport og omsetningsledd, må etablere elektroniske sporbarhetssystemer internt (eventuelt håndtert gjennom andre ledd i kjeden). Elektronisk sporbarhet i alle matkjeder medfører et meget komplekst nettverk av kjeder og aktører som alle må tilby ett transparent, elektronisk grensesnitt for relevant informasjon.

Sentrale tema er reaksjonshastighet i kjedeperspektiv i forhold til sporing (tracking) av enkeltprodukter, og evne til å styre tilbakekalling/tilbaketrekking (tracing) av produkter gjennom det komplekse nettverket av kjeder og aktører som kan ha hatt befatning med tilsvarende produkter. Problemstillinger som må håndteres i en nasjonal elektronisk sporbarhetsinfrastruktur er f.eks. skalerbarhet, vedlikeholdbarhet og hvordan informasjon skal samles/distribueres.

Hvilke brukere som skal ha tilgang til sporbarhetsinformasjon og til hvilke formål, er også en utfordrende problemstilling relatert til blant annet sikkerhet, personvern (vern av bedriftshemmeligheter, privacy), utforming av brukergrensesnitt og effektivitet. I en UUU-sammenheng er det spesielt viktig å hindre at informasjon som dokumenterer lovlig fangst, ikke på noen måte blir endret eller misbrukt av aktører for å hvitvaske UUU-fisk. Dette medfører at neste ledd i en omsetningskjede av fisk samt myndigheter, alltid skal kunne sammenstille informasjon om mottatte produkter, i forhold til opprinnelig rapporterte og dokumenterte lovlige fangster og landinger.

Et pilotprosjekt i pelagisk fiskerikjede [1] viser at det er mulig å etablere en løsning for elektronisk utveksling i et nett-sentrisk kjedesporbarhetssystem. Løsningen som ble valgt for elektronisk informasjonsutveksling i dette prosjektet var TraceCore XML.

Det samme prosjektet manglet imidlertid resultater for en planlagt alternativ løsning for direktekommunikasjon (punkt-til-punkt) mellom virksomhetene.

[8] UUU står for Ulovlig, Urapportert og Uregulert fiske, og er et samlebegrep for fiskeaktiviteter som foregår uten tillatelse eller i strid med nasjonale lover og internasjonale forpliktelser. Det engelske begrepet er ”Illegal, Unregulated and Unreported” eller IUU. Vi vil bruker betegnelsen UUU gjennomgående for dette dokumentet.

SINTEF – rapporten ”Alternative directions for standardised traceability information exchange” [2], ble laget på grunnlag av en internasjonal workshop og viser at det finnes flere mulige løsninger for utvekslingsstandarder i tillegg til TraceCore XML. Upubliserte opplysninger i forbindelse med denne workshopen viser at det også finnes flere initiativ med hensyn på elektronisk sporbarhet basert på til dels ulik arkitektur.

I prosjekter med fokus på elektronisk kjedesporbarhet utført i Norge, har man hittil ikke utført noen større evaluering av tekniske og praktiske utfordringer med hensyn på de ulike løsningene som finnes. En massiv nasjonal innføring av løsning for elektronisk sporbarhet vil ha stor innvirkning på enkeltbedrifters praktiske og tekniske hverdag. Man ser det derfor som relevant å gjøre en utredning i forhold til hva som finnes av mulige løsninger og hva de ulike løsningnen medfører for norsk sjømatnæring.

Målsetting

Målet med dette prosjektet er å utrede praktiske og teknologiske utfordringer relatert til en **massiv** innføring av elektronisk sporbarhetssystemer innenfor norske matkjeder relatert til sjømat som hovedfokus.

Organisatoriske utfordringer for innføring og drift av sporbarhetsløsning er et sentralt tema, men vil ikke inngå som del i dette arbeidet

Leveranser

Utredningen skal resultere i en teknisk rapport som:

1. Sammenstiller/utreder *teknologibruk* nasjonalt og internasjonalt innenfor *elektronisk sporbarhet* (av mat og eventuelt andre produkter) relatert til IKT løsninger/arkitekturer/infrastruktur, med eventuelle erfaringer fra innføring (state-of-the-art) og drift av slike systemer.
2. Utrede *praktiske utfordringer* for enkeltaktører/kjeder/nettverk av kjeder/myndigheter relatert til massiv innføring av elektronisk sporbarhet både nasjonalt og internasjonalt.
3. Utrede *teknologisk utfordringer* for enkeltaktører/kjeder/nettverk av kjeder/myndigheter relatert til massiv innføring av elektronisk sporbarhet både nasjonalt og internasjonalt.
4. Utarbeide, dokumentere anbefalinger og synliggjøre de praktiske og teknologiske problemstillingene som enkeltaktører/kjeder/nettverk av kjeder/myndigheter har relatert til en massiv innføring av elektronisk sporbarhet i forhold til forvaltning og dokumentasjon av UUU.

Arbeidsbeskrivelse

Arbeidet vil bestå av dokumentasjon og sammenstilling av relevant informasjon og kunnskap presentert gjennom eksisterende litteratur rundt temaene og evaluering av eksisterende teknologi mot de krav og problemstillinger som en massiv innføring av elektronisk sporbarhet i forhold til UUU medfører.

Dette vil danne basis for utarbeidelse av konkrete anbefalinger og hvordan SINTEF oppfatter veien videre for å oppnå de målene som er satt av regjeringen i forhold til forvaltning av UUU.

For å sikre internasjonale innspill anbefaler SINTEF Fiskeri og havbruk at det arrangeres en workshop i løpet av første halvdel av prosjektet som har som mål å presentere og diskutere "state-of-the-art" innefor elekronisk matsporing. Andre relevante teknologiløsninger bør eventuelt også presenteres/diskuteres.

For å sikre informasjonsspredning og mulighet for tilbakemelding fra industri anbefales det også å arrangere et seminar mot slutten av prosjektet der resultater presenteres og diskuteres med interessenter.

Organisering

Arbeidet ledes av SINTEF Fiskeri og Havbruk som rapporterer til Innovasjon Norge

Tidsplan

Arbeidet med dette prosjektet kan deles inn i fire faser der hver fase kan relateres til leveranse beskrivelsen i kapittel 3. Resultatet av hver fase kan inngå som delleveranse i forhold til dette prosjektet.

Fase 1: Sammenstilling/utredning av *teknologibruk* nasjonalt og internasjonalt innenfor *elektronisk sporbarhet*.

Fase 2: Utredning av *praktiske utfordringer* for enkeltaktører/kjeder/nettverk av kjeder/myndigheter relatert til massiv innføring av elektronisk sporbarhet både nasjonalt og internasjonalt.

Fase 3: Utredning av *teknologisk utfordringer* for enkeltaktører/kjeder/nettverk av kjeder/myndigheter relatert til massiv innføring av elektronisk sporbarhet både nasjonalt og internasjonalt.

Fase 4: Utarbeide og sammenstille anbefalinger og synliggjøre de praktiske og teknologiske problemstillingene som enkeltaktører/kjeder/nettverk av kjeder/myndigheter har relatert til en massiv innføring av elektronisk sporbarhet i forhold til forvaltning og dokumentasjon av UUU.

Oppstart for prosjektet 1. mai 2008, avslutning til 31. oktober 2008.

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Appendix B: Traceability software suppliers

There exist many different providers for supporting electronic internal/chain traceability in one or another form. Normally the information exchanged between different actors in the chain is in the form of, e.g., orders, dispatch advices, consignment notes, invoices and payments. All these are normal business-to-business information. Traceability information is normally not attached to the different forms of business communication but amount and type of goods are however part of the information. One of the main challenges in connecting physical goods with traceability information is the lack of unique identification of the goods and providing relationships between trade/logistic units and origin information.

To provide an overview of the state of the art on chain traceability we have identified some companies that specialises in either chain traceability or any of the supporting systems that needs to be in place to support this.

Identification systems

Several traceability solutions use their own proprietary identification system to keep track of goods, however some standard identification systems exists. One of the more known organizations is the GS1 (www.gs1.no), a global organisation dedicated to the design and implementation of global standards and solutions to improve the efficiency and visibility in supply and demand chains. It is a neutral, not-for-profit standards organisation. Their portfolio ranges from GS1 BarCodes to GS1 eCom (electronic commerce tools) to next generation technologies, such as GS1 EPCglobal (using RFID), and solutions such as GS1 GDSN (Data Synchronisation) and GS1 Traceability. The GS1 Traceability Standard is a business process standard describing the traceability process independently from the choice of enabling technologies.

Marking systems

Several commercial vendors exist that specialises in marking technology. The main focus of this industry seems to be on barcodes and rfid solutions, including both hardware and software.

Markem	www.markem.com	Their proclaimed mission is to help industry mark, code, or identify products through innovative marking equipment, software, supplies, and service.
Lasea	www.laser-ea.com	Specialising in laser marking technology. Laser marking has gained an increasingly important position on grounds of flexibility and process friendliness.
Mecco	www.mecco.com	Deals with direct part marking, laser marking and dot peen solutions for traceability and part verification. The solution enables marking and traceing, especially products that must withstand the harshest environments and processes.
ScanPlanet	www.scanplanet.com	Marking technology like barcodes and rfid. For use in warehouse and inventory management systems.
Sato Europe	www.satoeurope.com	Provides data collection systems and labelling

		solutions, especially barcodes and rfid.
BRADY Europe	www.en.bradyeurope.com	Provides data collection systems and labelling solutions, especially barcodes and rfid.
Imaje	http://www.imaje.com/	Marking technology like printers etc.
Segepar	http://www.segepar.com/	They design, develop and deliver products which companies use for supply chain management. Especially marking printers etc.

Automatic Data Capture

One step up from marking technology is automated data capture. These solutions provide more data on a product than just the identifier. We identified some companies that specialises in this. Some of the internal traceability systems described below also offers this functionality.

Baracoda	www.baracoda.com	Specializes in wireless data capture solutions for mobile applications in markets like: Logistics & Transport, Retail / Distribution, Healthcare, and Manufacturing.
Avery Weigh-Tronix	http://www.averyweigh-tronix.com/	Works with industries to develop weighing-based solutions that focus on specific needs for information and control from the shop floor to the boardroom.

Internal Traceability

In order to meet requirements of chain traceability, internal traceability has to be established within a company. There are several commercial actors that specialises in delivering these solutions.

foodReg	www.foodreg.com	Delivers proprietary systems for internal traceability.
Marel	www.marel.com	Developes sophisticated equipment and machinery for the world's food processing sectors. Their systems deal with fish flowlines, grading / batching, packing, portioning, quality control, and weighing.
Agility Systems	http://www.agilitysystems.co.uk/	Develops warehouse management systems to automate and gain business intelligence from the supply chain processes.
PControl	http://en.imsinc.ca/automated-identification/labelling-and-traceability/inplant-traceability.htm	PControl provides information needed for good resource management by tracking products down to the smallest measurement; it also captures data on performance and packaging volume during different shifts.
Prevas AB	www.prevas.se	Internal traceability system from arrival to delivery of products.
Enostoria	http://www.mosaico-mi.it/html_eng/home.php	A software application to control wine-making processes.

Chain Traceability

We identified several proprietary traceability solutions, all claiming to provide chain traceability:

TraceTracker	www.tracetracker.com	This company provides a specialized subscription based service (GTNet®) enabling companies to establish electronic traceability, both in their internal chain as well as with trading partners upstream and downstream.
FQCode	www.fqcode.com	They use GS1 data standards, in addition to running proprietary systems in parallel. They claim their traceability solutions for the produce industry provide and maintain complete capture of all supply chain steps
TraceAll	www.traceall.co.uk	Fishtrace online from Traceall is an end to end traceability system solution for the aquaculture industry.
Soft Trace	www.soft-trace.com	They develop traceability and quality management solutions for a wide range of industries, including dairy, beverage, pharmaceutical, health care and independent laboratories.
TEKLynx	www.teklynx.com	Their software provides a solution with a range of identification, tracking and mobility products that offer traceability throughout the entire supply chain.
CoolPak	http://www.cool-pak.com/traceability.asp	Proprietary traceability system in the field of fresh produce. Including strawberries and claimshell.
Valor	http://www.valor.com	Traceability system for manufacturing. The system is built to simplify the component identification processes, product recall planning, and component supplier quality monitoring.
TraceAssured	http://www.traceassured.com	They provide a food chain traceability service to the agri-food industry. Using standard barcode technology, traceability data can be securly captured and graphically displayed.
Lyngsoe Systems	www.lyngsoesystems.com	Their system, Catellae, is an end-to-end food and product traceability system, providing a supply chain overview of products from producer inputs and products through manufacturing and distribution centres and into retail stores or restaurants.
Maritech (AKVAgroup)	www.maritech.no	Their system WiseFish is a module based software solution designed to meet the requirements of the seafood industry. The solution covers the entire valuechain.
Kezzler	www.kezzler.com	Delivers secure track and trace solutions to the pharmaceutical and fast moving consumer goods industry. Their traceability solutions delivers a Product ID Management infrastructure.

Information sources/providers

There are several systems established, that are used in the quota management and regulation of fishing in Norwegian waters. The directorate of fisheries and the sales associations have

established systems for managing the first part of the system, i.e., regulation of the fisheries through fish quotas and participation registers, and the trading systems through the use of contract notes and landing notes. This means in practice that information about the catches and the first-hand trade of fish either is or is planned registered electronically.