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Information Management of Bioenergy Supply Chains

Guidelines for users for implementation practices

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CONTENTS

1 ACKNOWLEDGEMENT AND AIMS OF THE WORK

In this report we publish the results of WP 2.2.2 task of **Sustainable Bioenergy Solutions for Tomorrow (BEST)**, a research program coordinated by FIBIC Ltd. and CLEEN Ltd. with funding from the Finnish Funding Agency for Technology and Innovation, Tekes. The task **Development of information management in bioenergy supply chains** was a work carried out by Metsäteho Oy in WP 2 **Radical improvement of bioenergy supply chains** of the program.

In the work the final objectives for the development of information management of bioenergy supply chains have been set as follows:

- Cost-efficient planning and control of material flows and improvement of the material quality control by means of automated measuring and IT systems

- Decision support systems and tools for planning and control of supply chains

- Development of an open information management platform and a web-based data interchange service to an operational environment of bioenergy supply chains

- A common data and information management model with specified data interfaces and standards for various biomass terminal concepts.

The work plan of the task consisted of next sub-tasks:

1. Pre-study of developing a common information management platform and data interchange service for biofuel logistics
2. Information needs of new biomass terminals
3. Specification of the data standard for biofuel logistics.

At this point of the development work we can state that the development process is in the beginning and the targets are still far, but the vision is clear. The work is to be continued in the next phase of BEST program. Based on the ideas and discussions so far we see a great potential to increase the cost-efficiency of the supply chains by improving the information management systems with modern IT solutions and standardized information. However, it requires close cooperation of the different parties involved in the bioenergy logistics.

2 DEVELOPMENT GOALS FOR INFORMATION MANAGEMENT OF BIOENERGY SUPPLY CHAINS

Information management is seen to be an essential part in the development of advanced bioenergy supply chains and cost-effective logistics. Procurement of biomass and logistic processes are planned, controlled and monitored on the basis of information and data related to material and operations throughout the supply chain. Information flow should therefore be closely linked to the material flow with the help of information systems. In the raw material supply of forest industries this has been carried out until these days mainly with company-specific information systems, but recently new information services for multi-party environment have been developed and launched. They rely basically on common data and e-document standards as well as agreements between the forest companies and IT system suppliers. This type of information management model would be possible to introduce on a wider scale in bioenergy procurement too. The big number of companies and contractors and their different business objectives make it however a more challenging than in conventional roundwood logistics.

Business concepts and operational environment of biomass-based industry define the information needs and set overall frames for how information is utilized in the business. Approaches and routes to information management are dependent on what is the value of information for the company. Different parties involved in the supply chains have their own interests concerning the information management as well as they have different roles in information chain. Value of information varies depending on the company's business role and tasks in the bioenergy supply chain. Ownership of information and responsibilities to provide and maintain data is also an issue that depends on the business concepts and agreements between the parties. Cooperation with energy companies in information management issues has been to some extent problematic from the point of view of forest companies. Various data communication methods and systems starting from e-mail based data transfer have slowed down also other development actions of the supply chains and fuel deliveries.

Operational models and arrangements in information management are also related to the market area and the business environment. Biomass flows are expected to be more and more global and to cross state and market area borders unlike the flows are today mainly domestic. For time being we do not have any fine examples from other market areas about how data communication and information management between trading and logistics partners is put into practice with sophisticated information systems on wide scale. When it comes to forest-based biomasses, Finland and Sweden are the leading countries in utilizing these resources and developing their logistics. There are several company-specific information management models with supporting IT systems in both of these countries, but widespread commercial information services are still lacking.

In BEST a goal has been set to describe and specify the frames and prerequisites for future information management model and system environment of bioenergy supply chains. The work has been started by specifying the information management needs of biomass terminals and their supply chains. Present practices of roundwood information management in forest companies offer an established ground for the specifications, since forest fuels are handled in the existing information systems just like other products. Data related to bioenergy harvesting and transportation operations is specified well detailed in StanForD and papiNet data standards. New planning services for contractors – LogForce and WoodForce (not running yet) – are based on these global standards, which lowers the step to apply the standards also in bioenergy supply chains. There are some additional requirements especially concerning the data produced by different biomass measuring systems, which has to be specified further in the standards by looking at the data structures of measurement data especially.

One of the goals in the program is to develop and pilot a web-based data interchange service to an operational environment of new biomass terminals. Depending on the terminal business and operation concepts the system should be adjustable to different material handling and measuring needs. In the long run the service should be scaled up to all bioenergy logistics, so that all parties could have a data communication channel via it. Discussions in the workshops of the program have shown that there is a great need for this type of service that operates on a common information management platform. The aim at the next phase of BEST is to define the platform that would be based on open technology and standardized data. The platform and data interchange service are described more in chapter 6.

3 INFORMATION NEEDS AND REQUIREMENTS

3.1 Information needs of supply chain parties

3.1.1 Information management use cases

Mapping of information needs and requirements of users is usually the first phase of constructing a new or a modified information system. In order to find out the information management targets of different parties it is a good way to carry it out by describing the logistic processes and decision making situations in a form of a use case. A single use case description can include several phases of the logistic chain or only one depending on the view and the role of a system user. The use case description can be a specification of requirements for an information system or an application which is in draft planning phase. Focus should be in describing how information is going to be used in business: how data and communication between logistic parties or inside the organization should be managed and applied in planning, decision making and follow-up of the processes.

Supposed that the use case description is to give guidelines for a new information system, it should include descriptions about next issues:

- who are the users of the system
- what is the use intensity in different cases
- what type and how much data is to be managed or to be passed through the system
- what kind of functionalities the system should have
- what are the requirements for data processing (e.g. conversions, calculations, data warehousing)
- what are the links and data interfaces to company's other systems
- what kind of data standards should be applied in the system
- what are the expected benefits for using the system
- what are the expected risks for the business and operations and
- open questions regarding to system design and future development goals.

In the use case descriptions it is also good to have a vision of the schedule: when should the described case be launched and what is the time frame for the users to adopt the new system in their business.

In BEST the preliminary idea was to start gathering use case descriptions from different parties in order to prepare the specification of bioenergy information management platform and especially the data interchange service that is to be used in biomass terminal logistics. However, it was noticed in workshops that BEST partners are not prepared yet to give detailed requirements and to assess the possible solutions. It was decided in the discussions that specifications for the information management platform is better to be finished in the latter phase of the program when there will be further understanding about the future terminal concepts and measurement systems as well as about technological options. Examples from other business and industry sectors should be found out too. Aim is also to get experiences from piloting one or two most promising information systems in some practical and restricted case.

3.1.2 Bioenergy suppliers

For forest companies as bioenergy suppliers it is essential to gain and manage quantity and quality information of single lots all the way from the forest to the power plant. The forest company is normally the owner of the material until it is delivered to the customer and arrived quantities have been measured. It is therefore in company's interests to follow the biofuel lots along the logistic chain. Stock accounting of the forest company requires up-to-date and reliable information of the material quantities and changes of the value.

Bioenergy includes various products with their specific properties and requirements for material handling and storing. Planning of cost-effective logistic chains and optimal deliveries call for accurate and updated information about the single lots. Time span of forest fuel supply chain is normally much longer compared to the one of roundwood. Also the operations differ, for example measuring systems are targeted to estimate the energy content mainly. They are also not as fixed as the systems for roundwood. These are challenges for the information management in general, since same back-end systems in wood procurement organizations should be used in both types of supply chains.

Until now information systems for data and message interchange between forest and energy companies have not been developed organized on large scale. Therefore there are various practices, operational models and technologies in the interchange of transportation and measurement information. A big number of customers and incompatible systems cause a lot of practical problems from the viewpoint of forest companies. Data handling must be done partly manually, error solving requires a lot of work time and lacking or delayed information causes extra planning of logistic operations. It can be stated that information management today is far from rational and effective.

3.1.3 Energy companies

In the energy companies' interests it is important to organize first the management of different fuel supply chains internally. Many types of fuel (biofuel and others) and a big number of sources and fuel suppliers makes it challenging for organizing the information management. Follow-up of fuel origins and managing sustainability demands will probably be increasingly important incentives for the energy companies to start developing information management in close cooperation with the suppliers.

As already said, in our domestic forest-based bioenergy logistics there are no data interchange systems or services that would be commonly and widely used between suppliers and energy companies. This is especially true if we look at how energy companies and suppliers communicate and transfer data between each other today and what is the information content there. In the market there are a couple of very advanced mill gate, storage management and process control information systems for power plants (ONCE and Metso DNA). With those the power plants can manage measurement data of the delivered fuel. Neither these commercial applications nor tailored own systems of energy companies do not employ today commonly agreed standardized data or e-document interface between them and IT systems of the logistic parties. However, there have been some one-to-one projects to implement papiNet standard (XML) or the older text based data protocol for roundwood (KUVA, based on agreement within forest companies) as a data interface between the information systems.

3.1.4 Logistic operators

Harvesting, material processing and transport operations are practically totally outsourced to bioenergy contractors. Those are the stages in the supply chain where main part of the data is born in measuring systems. Therefore there must be well-established and fixed methods and techniques to handle and transfer data to the company's back-end system from the contractor's machines. They are thus an important link in the bioenergy information chain. Usually the forest company gives the demands for the measuring equipment and data transfer devices, but it is on contractor's duty to acquire them and keep them working.

Reliable and updated information must also be at hand for the contractors themselves for planning and monitoring of the operations. Outsourcing of operations is not a problem for the forest company from the point of view of information management supposed that the contractors, machines and measuring equipment all are connected to the company information system with standardized data interfaces. However, this is not always the case.

Bioenergy contractors have in recent years expanded their business so that many of them can offer all types of logistic services from logging operations to material processing and transportations. New LogForce and WoodForce information services give them improved tools for planning and monitoring the operations. However, there will still be a gap in information chain what comes to the information related to biofuel deliveries and measurements at the gate of the energy plant. Today that information is mainly received via forest company systems which makes it often too slow for a contractor to react to the situation if necessary. Independence from forest company systems and an open commercial data interchange service would be therefore an essential improvement in the contractors' business management. The service should provide data transfer channels based on standardized data and documents, data storing and reporting facilities as well as tools to support contractor's invoicing and accounting.

3.2 Biomass supply chains and terminal concepts

3.2.1 Logistic processes of supply chains

Present supply chains for principal forest fuels - small sized stem wood, logging residues and stumps - have been taken as a starting point for looking at the information management needs in this work. Existing measurement methods and measuring needs are supposed to set frames for the information management also in the near future. The supply chains normally include next processes:

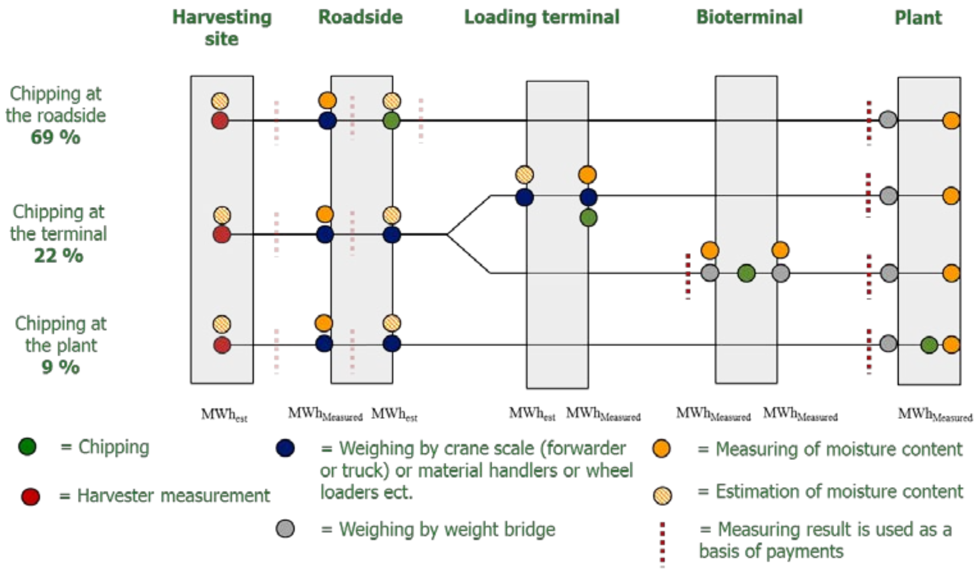
- logging and storing on harvesting site (logging residues)
- forwarding
- storing at roadside
- chipping or crushing
    - chipping at roadside
    - chipping or crushing at terminal
    - chipping at plant
- transportation to terminal or to plant.

New bioterminal concepts may modify these basic supply chains by adding some material handling processes like artificial drying, sorting and combining / mixing of the fuels at the terminal. Quality parameter (moisture, temperature) measurement at the terminal or at the roadside during the storing phase is also an issue that may change the present supply chains regarding the operation planning. Each of the physical processes ends normally in some type of measurement event and results in data of quantity and quality attributes.

3.2.2 Measuring systems

A big goal for advanced bioenergy supply chains is to keep the use value of the raw material as high as possible and to optimize and control the processes according to the use value potential. This is realized in the management of moisture and energy contents of the material and in estimation tools that help the decision maker to avoid dry matter losses by selecting a suitable drying method and controlling the storage time before the transportation to energy plant. Measurement data provided by the operations along the supply chain is therefore in key role in managing the material properties. Aim is that diverse data from the forest fuel lots would be derived linked to the operations by advanced methods without any critical gaps in the chain.

Existing measuring systems can provide quantity data to sufficient degree for most of the logistic decision making occasions. Yet in MWh –RoadMap prepared in BEST the target has been set higher. New measuring and estimation methods are developed for monitoring quality of the raw material during the supply chain aiming at systems that calculate the energy content during the time and control the heat value of the material in real time. As an example, in picture 1 are shown the supply chains of small-sized stem wood and the potential measuring points and methods described in MWh – RoadMap.



Picture 1. Supply chains of small-sized stem wood (MWh –RoadMap).

The objective is that in the future information management of bioenergy supply chains employs data from different sources and merges it into form that can be applied in calculation and estimation applications. For example, material from different origins can be combined into larger batches and flows. In those cases the gained information should be available without deficiencies and possible to be used reliably yet. Information that is applied in decision making or in planning tools can be simple measurement data without any modifications. Alternatively it can be formed by combining different measuring events or data sources. Here new technology – like Internet of Things - creates interesting perspectives for how measuring devices and sensors can be connected to logistics information systems in the future. One of the key questions is how the different measuring systems and devices can be a part of the overall system in a fixed but flexible manner. Standardized data interfaces may be needed then.

3.2.3 Planning and management of operations at biomass terminals

Developing of new type of large-scale biomass terminals has been in the focus of BEST. Depending on the cost-efficiency of the operations it will be assessed what will be their role in entire biofuel logistics and related to conventional types of terminals. Biomass terminals can provide an opportunity to invest in measurement systems that are not cost-effective on small-scale or temporary terminals. If such a development takes place, data management must be designed carefully with taking into account the scalability of the systems. This is critical especially when material flows of different companies run through the terminal and operator serves more than one company.

Business model of a terminal obviously has an impact on how the operational planning and management should be done. A few questions to be answered when planning the terminal information management environment are:

- Does the terminal need its own tailored managing system or will it be operated by using the forest company system?

- Who is the owner of the management system and responsible for it? Depending on the business concept it can be either
    1) forest company
    2) forest companies together or
    3) terminal operator.

- What type of data communication is needed between the terminal and other logistic parties related to inbound and outbound material flows?
    - E.g. what type of technology is applied in identifying the vehicles and loads (RFID, NFC, other)?
    - Are the deliveries from the terminal to the use places or to secondary transportation on the terminal operator's responsibility?
    - Who is responsible for managing the secondary transportation, especially railroad transportation? Which systems are used for that?

- How the stock management inside the terminal is arranged? How to control the changes in material amounts due to dry matter loss for example?

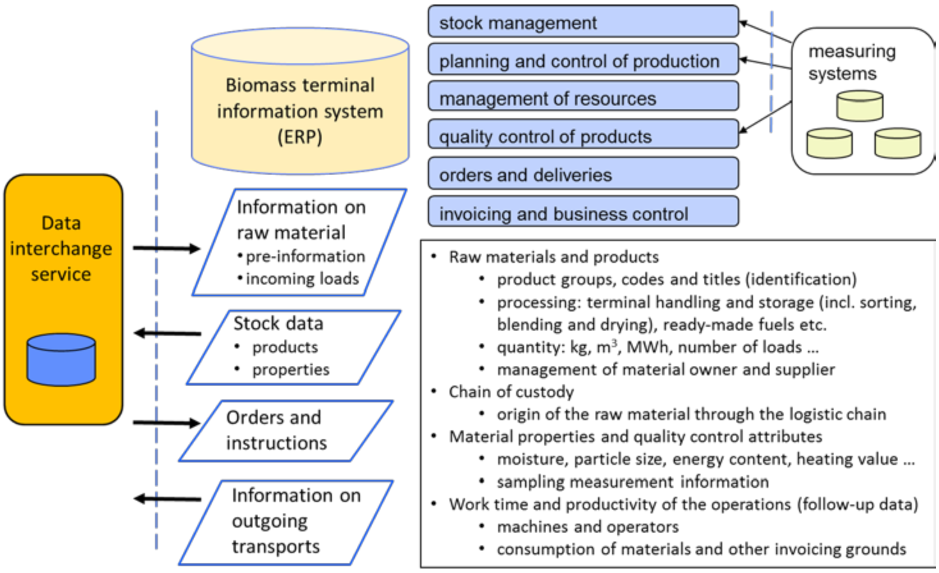
- What are the measuring systems to be used and how they are connected to the terminal system?

- Is there a calculation system to estimate the quality properties of the material?

- How is the resource management arranged (machines, operators)?

Data interfaces between the terminal management system and the measurement systems must be defined and specified to each system, e.g.:

- weight scales of material handling machines
- measurement systems for load volumes
- moisture and temperature sensors and analyzers (online and offline systems) and
- measurement systems for particle size analysis.



Picture 2. Information management aspects of a biomass terminal applying a data interchange service.

4 DATA STANDARDS AND INTERFACES

4.1 Role of data standards

Open and standardized data communication is considered to be a prerequisite for an effective information management of bioenergy logistics. Objective of the task in BEST has been to develop information standards for the electronic data transfer in logistic processes and to specify them for designing the future information systems. This involves both business e-documents for the use of suppliers, logistic operators and users of bioenergy and data interfaces between the systems. Commonly agreed and standardized data interfaces between information systems of the different parties is the target which enables a stable but adaptable basis for the information interchange.

In Finland we have three data standards that are used in different sectors of forestry and wood supply. All of them are open and free to use for everyone. In addition to these there is a recommendation for a standardized data interface for weight scales. A short overview of the standards:

1. National Finnish forest data standard
    - a group of data standards specified for managing basic information about forests organized by The Finnish Forest Centre
    - WoodForce project has specified set of messages for wood supply and silviculture including harvesting operations
    - in bioenergy logistics the standard can be used e.g. in describing the characteristics of roadside storages and bioenergy lots

2. StanForD
    - a global data standard for forest machines
    - national cooperation in Finland is organized by Metsäteho
    - StanForD 2010 is a new XML version of the standard and is currently in implementation phase
    - includes messages and data structures for production and measurement data (harvesting and forest forwarding)

3. papiNet
    - a global XML –based data and e-document standard for forest industry logistics and supply chains of raw materials
    - Forest Wood Supply user group of papiNet organization has specified and maintains the standard for wood supply logistics
    - national cooperation in Finland is organized by Metsäteho

- a Finnish specification of papiNet FWS standard has been carried out in cooperation within forest companies
- all the specification documents are available from Metsäteho
- LogForce service has implemented the Finnish specification of papiNet
- includes the entire set of business messages that can be applied in bioenergy logistics
- for further information and upload of papiNet standard and supporting documents: www.papinet.org

4. Weight scale data interface standard
- national recommendation in Finland specified by Metsäteho
- specifications for data communication between weight scale and vehicle computer in timber trucks and loading machines.

4.2 Specification of the papiNet standard for biofuel logistics

In the BEST project plan it was defined that specification of papiNet standard for data interchange service and biomass terminal logistics will be done. The work is supposed to cover
- e-documents, data structures, coding and data enumerations
- descriptions of implementation
- proposals for changes of the standard and international cooperation.

The Finnish papiNet FWS specification for wood supply logistics including also bioenergy logistics was published 2012 for all users to implement. The specification contains next message categories which again include several sub-types:

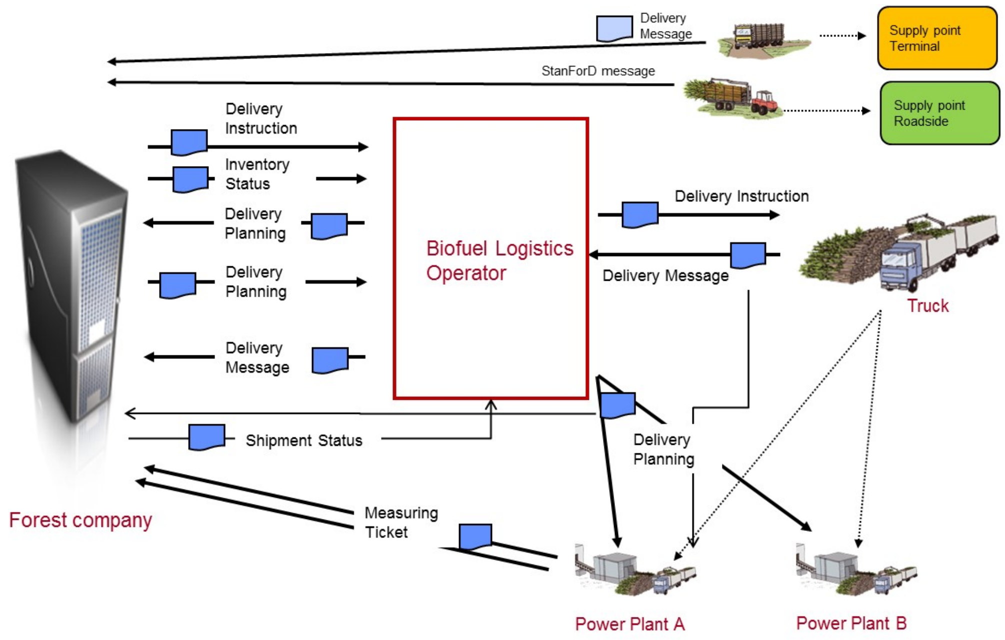
Table 1. Message categories in Finnish papiNet FWS specification

Information content	Corresponding papiNet e-document
Logistics resources and capacities	Delivery Planning
Delivery / transport plan	Delivery Planning
Transport orders and instructions including batch information	Delivery Instruction
Inventories (biofuel storages)	Inventory Status
Transport message (from vehicle or operator)	Delivery Message

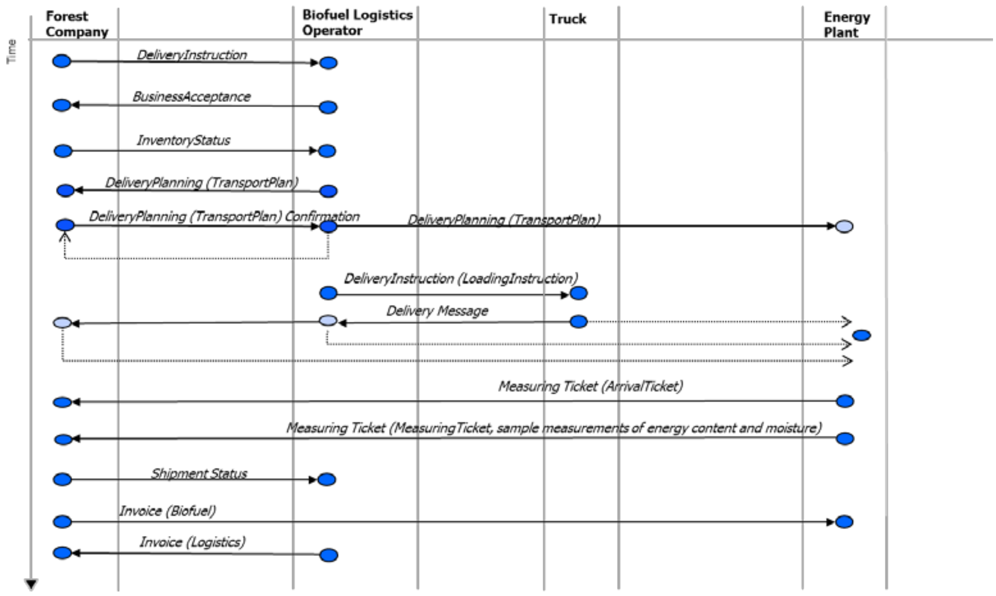
Status report (short message)	Shipment Status
Measurement data	Measuring Ticket, Shipment Status
Delivery destinations with gate open hours (mills, energy plants, terminals etc.)	Calendar
Queries (specified queries, e.g. for weight scale measurement control)	Info Request

The raised proposals for new data structures, data elements and value enumerations in the standard have been handled by papiNet FWS user group as a continuous work process. By now most of the new issues and initiatives have been raised from Finland which is also the only country where papiNet has already been adopted as a data standard in bioenergy logistics. A special emphasis has been put on measurement data so that the measurement documents and their data structures would be applicable to all types of measurement systems and methods.

papiNet FWS user group has prepared a use case description for a biofuel logistics case in order to give guidelines for starting users how to implement the standard and its e-documents. The use case is titled “Biofuel to multiple destinations”. It has been outlined in most parts based on the Finnish forest companies’ information needs of terminal logistics. The use case contains a case description document with message diagrams and examples of XML files that are used in the case. The use case will be published in 2015 on the papiNet web pages (www.papinet.org).



Picture 3. Overview of messages related to logistics operations in papiNet FWS biofuel use case.



Picture 4. Diagram of papiNet documents in biofuel use case.

5 OPERATIONAL REQUIREMENTS FOR A COMMON INFORMATION MANAGEMENT PLATFORM

In workshops with BEST participants it has been summarized that the most probable solution for information management in general is that parties of the biofuel supply chain keep using their own company-specific information systems and the systems are networked and communicate with other systems via data interfaces based on standards. Smaller companies and bioenergy contractors may not today have their own ERP's or systems for operation planning and management. Harvesting contractors are often extranet users of forest company systems. Contractors also might have some applications for business and resource management and invoicing. Introduction of WoodForce service will bring a change to this operational model.

Especially bioenergy contractors and minor biofuel suppliers have a constant need to communicate and interchange information with their customers. An open market-based data interchange service would be a good tool for them to manage the operations for different customers. The service should be easy to adopt and have full support to operate in most common technological environments (mobile phones and devices, vehicle computers).

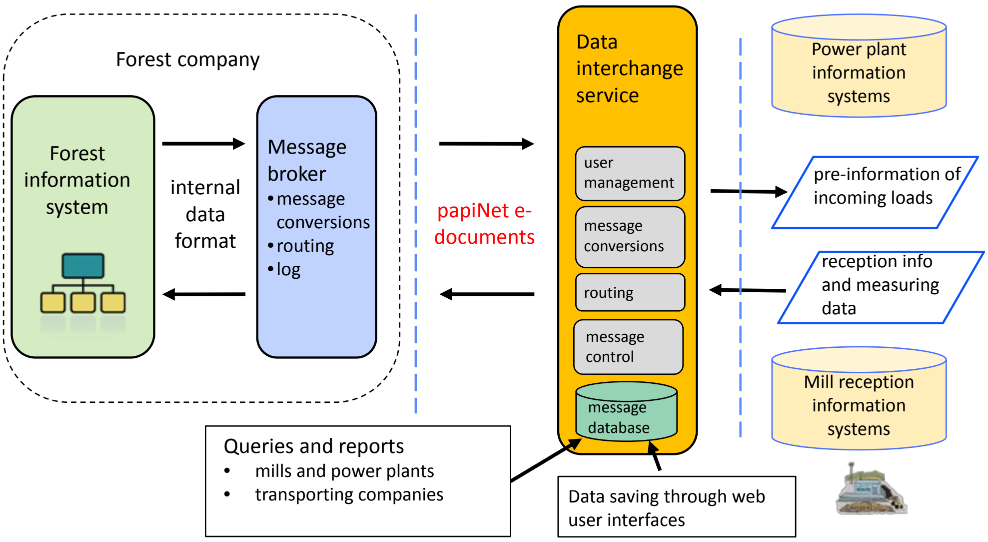
In order to realize this kind of information management environment we need a common information management platform and a commercial data interchange service which operates on the platform. At the minimum the platform offers only a standardized channel to send and receive data and documents. Services and applications based on the platform may be needed to supplement the functionalities of the platform.

The frame, business and operational model and features of the platform still need to be investigated and specified in the next phase of BEST. In addition, technological solutions must be benchmarked and studied. The primary idea has been that the platform will be constructed on open-source code, which would give several IT companies possibility to develop services and applications. If there are information platforms or systems designed for other business areas and they are already in operation, it is wise to look at those and assess how they could be adjustable in biofuel logistics. Interesting solutions for message interchange between organizations can be found e.g. from health care, traffic and security sectors.

Introduction of information management platform also requires modifications to existing information systems of the companies when new data interfaces have to be specified and built. In addition, there is a need for a conversion application (message broker) which is used for converting the data between the internal data format of the systems to the data interchange format, like XML of papiNet.

The data interchange service should fulfil the main data transfer and business communication demands of biofuel suppliers and energy companies in a flexible way. At the same time it could be a low cost solution for small-sized suppliers and energy companies as well as for bioenergy contractors, as already mentioned. The goal for the next phase is to finalize the specifications of the operational requirements and data interfaces (messages, data content). Target is to find the best available application from the market, to develop and modify it to an operational environment of biomass terminal logistics and finally to test it in a real use case. This should be done in close cooperation with the chosen IT provider.

Planning and managing the operations of the biomass terminals by using sophisticated information and measurement systems is one of the development objectives set for improved bioenergy supply chains. Using automation and sensor technology in the measurement systems at the terminals sets extra requirements for the data management and for the functions and ways of using of information systems.



Picture 5. Overview of the data interchange service.

A preliminary list of the operational requirements for the data interchange service was prepared in the project:

1. Web-based service operating on cloud services or on server technology
    - based on advanced browser technology
    - flexible and user-friendly user interfaces
    - fast connections also from mobile devices.

2. Open possibility for all supply chain parties to join the service and transfer data
    - registered customers and users of the service
        - forest companies and other bioenergy suppliers, bioenergy contractors, logistic operators (e.g. terminal operators and transporting companies), energy companies
    - control of user rights by system supplier
    - restricted view to data to the operations of user's own organization only
    - guaranteed data security based on strict security policy.

3. Automatic routing and control of data/document sending
    - event log (tracing of sending and receiving events and errors)
    - notifications of users about sending errors.

4. Data interfaces based on papiNet standard
    - conversion of the data from user's back end system to papiNet format is done by the sender's system, not in the service
    - again, conversions of data from papiNet format to receiver's system format is done by the receiving system
    - specifications of the supported e-documents and the data content is to be done according to users' needs in the planning phase of the service; data interfaces to be designed based on those
    - the service must always support the latest version and build of the standard
    - validation of the documents should be done in the sending system, but there must be a support for the validation in the service too
    - other data formats than chosen standards are also possible, if there is a common and rational need for them
    - however, the service is not meant to support one-to-one data formats.

5. Data conversions
    - code conversions can be done by the data interchange service
        - conversions from sender's codes and data enumerations to receiver's ones
        - mapping tables of company-to-company conversions must be supported by the service and managed by main users for instance
        - company-specific timber assortment codes (bioenergy assortments) can be converted to common standardized codes provided by Finnish forest data standard
        - a specific user interface for managing the conversions
    - calculation application also for unit conversions can be included in the service (e.g. kg → m^3 → MWh).

6. Saving data into the database of the service
    - possibility for the users without own information systems
    - databases to save
        - papiNet documents
        - table-format data for most common use cases
            - manual data saving in tables via a user interface
            - specification of the database according to information needs
            - possibility for the users to specify their own data tables
    - creation and sending of reports from the database.

Specification of the messages (e-documents) that are communicated between logistic parties in various types of biofuel supply chains has been done preliminary in the project. The messages and their content is estimated to be very similar to roundwood logistics, except that structure and data elements of new types of measurement data are still more or less question marks.

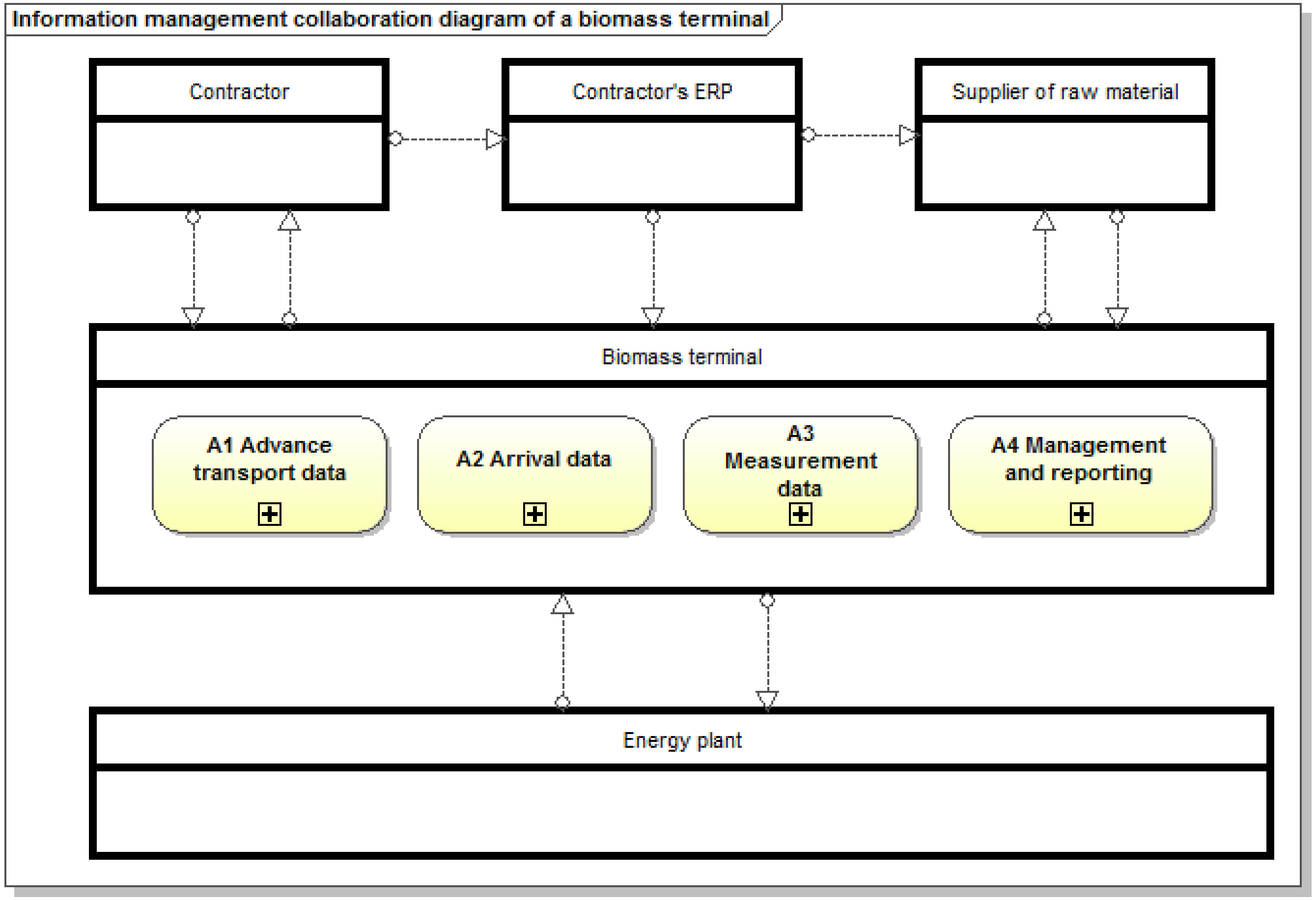
Processing of the messages and the data content in them can be described and illustrated in a form of a process diagram. This has also been done preliminary for the basic messages which would be transferred via a data interchange service. The participants of the information management chain, their roles and back-end information systems should be described in the diagrams as well as the functionalities of the service itself. The main purpose of the diagrams is to show clearly how the messages and the data are running, what the process events are and how the data is modified. Process diagrams prepared are presented in Appendix 1.

Table 2. Messages to be communicated in biofuel supply chain (message categories based on preliminary definition).

Message	**Main data content**	**papiNet e-document**
1. Delivery plan - delivery plan from a forest company to energy company or to logistics operator	Quantities of biofuel planned to be delivered to an energy plant within a time period - by product (assortment) and quality class - by delivery origin area - by transport mode	Delivery Planning type DeliveryPlan
2. Transport plan - transport plan from a logistics operator/forest company to energy company (or to forest company)	Quantities of biofuel to be transported to an energy plant within a time period - by product (assortment) and quality class - by delivery origin area - by transport mode	Delivery Planning type TransportPlan
3. Transport order - transport order may also include detailed transport instructions	Information to specify - transport batches (quantities, origins / storages, map symbols etc.) - transport destinations - transporting time - vehicles and transport units required - other instructions	Delivery Instruction
4. Storage (inventory) data - update of data	Information to specify and update the storage and batch information - quantities by products	Inventory Status
5. Transport message - from a vehicle to the transport destination - in order to identify the vehicle and the load at the mill or the terminal	Specific data of a loaded transport - preliminary information about incoming transport - truck load, railcars or other type of transport vehicle and unit - load specification and quantities by products - identification information needed to measuring	Delivery Message

6. Arrival message - from a vehicle or transport destination gate system - to report of an arrived transportation	Information about an arrived load - vehicle, transport unit and load identities - quantities, if measured - arrival date and time - possible transport data (distances, work hours)	Measuring Ticket type ArrivalTicket or Shipment Status
7. Arrival measurement data - from a transport destination measurement system	Detailed measurement data of an arrived load - quantities by products and quality classes - units according to the measuring system, e.g. weight bridge	Measuring Ticket type Measuring-Ticket
8. Quality analysis data - from the user to the supplier	Detailed analysis data of delivered batches - moisture content, energy content, heating value (laboratory values)	Measuring Ticket type Sample-MeasuringTicket
9. Biomass terminal measurement data - from the terminal operator / measurement system to the user of data	Measurement data of quantity and quality properties provided by automatic or manual measurement systems at the terminal - e.g. continuous sensor data of biofuel piles or material running through the terminal	Measuring Ticket type Measuring-Ticket
10. Control measurement data	Sample measurement data or control reports from the measurement system	Measuring Ticket type Sample-MeasuringTicket
11. Material processing order - an order and instructions from supplier / material owner to bioenergy contractor / logistic operator	Information to specify - batches to be processed or handled (quantities, origins / storages etc.) - working instructions - delivery information	Delivery Instruction
12. Material production data - a message from bioenergy contractor / logistic operator to supplier / material owner	Data of produced material (chipping, crushing, other type of processing) - batches handled - quantities by products and quality classes - quality sample data	Measuring Ticket type Production-Ticket or Delivery Message

APPENDIX: DATA INTERCHANGE SERVICE PROCESS DIAGRAMS



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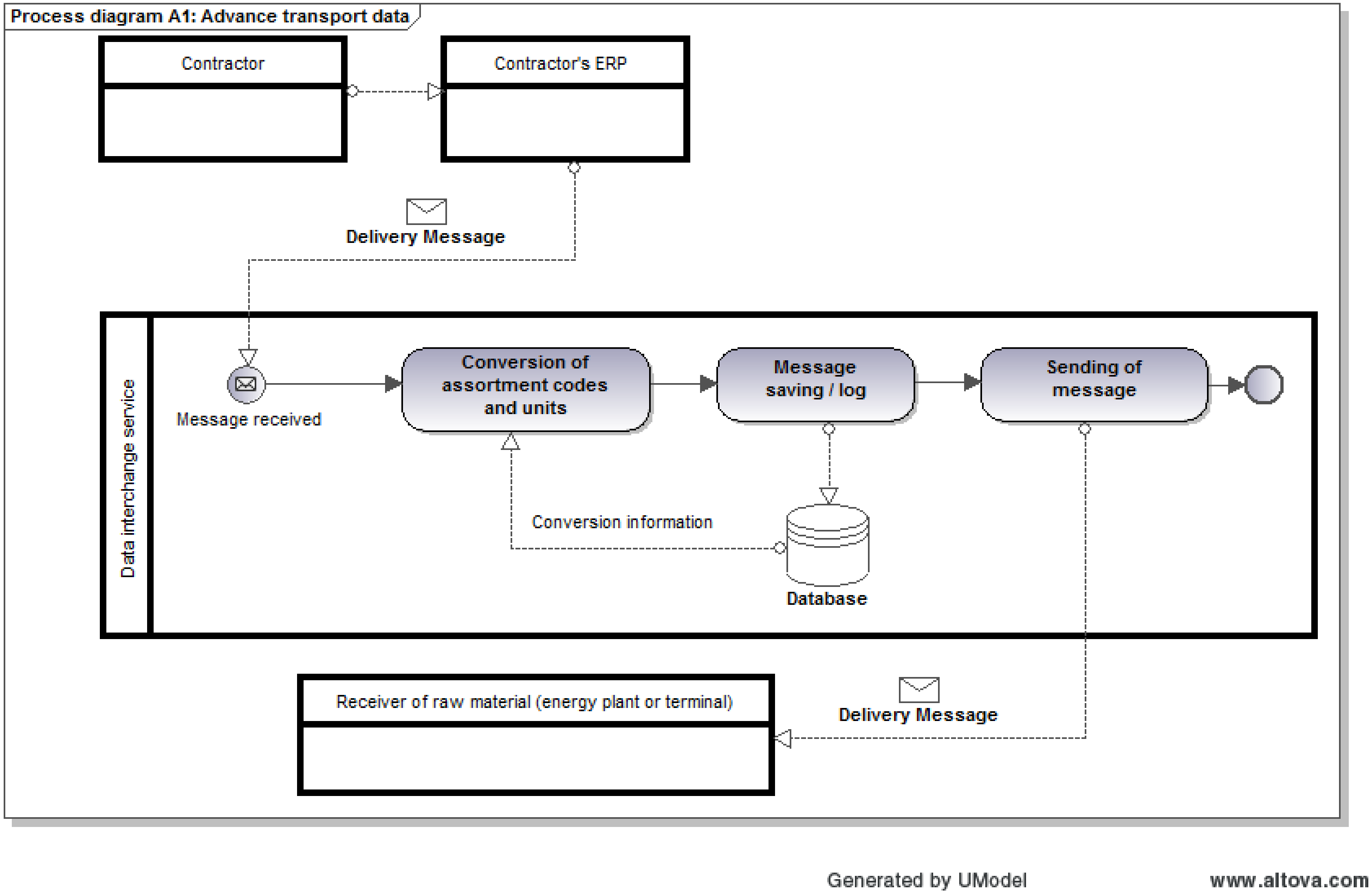
Process diagram A1: Advance transport data
Contractor
Contractor's ERP
Delivery Message
Data interchange service
Message received
Conversion of assortment codes and units
Message saving / log
Sending of message
Conversion information
Database
Receiver of raw material (energy plant or terminal)
Delivery Message
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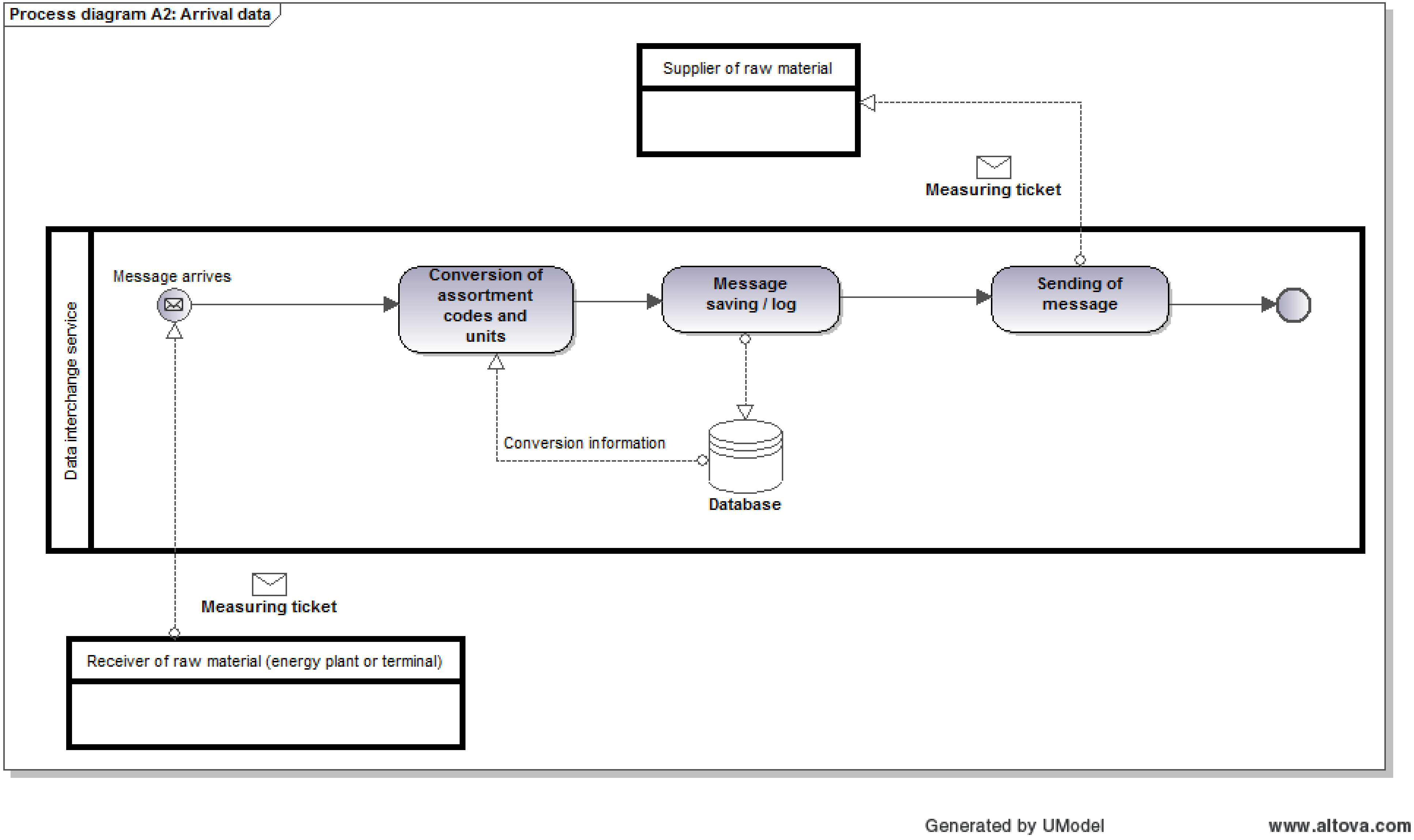
Process diagram A2: Arrival data
Supplier of raw material
Measuring ticket
Data interchange service
Message arrives
Conversion of assortment codes and units
Message saving / log
Sending of message
Conversion information
Database
Measuring ticket
Receiver of raw material (energy plant or terminal)
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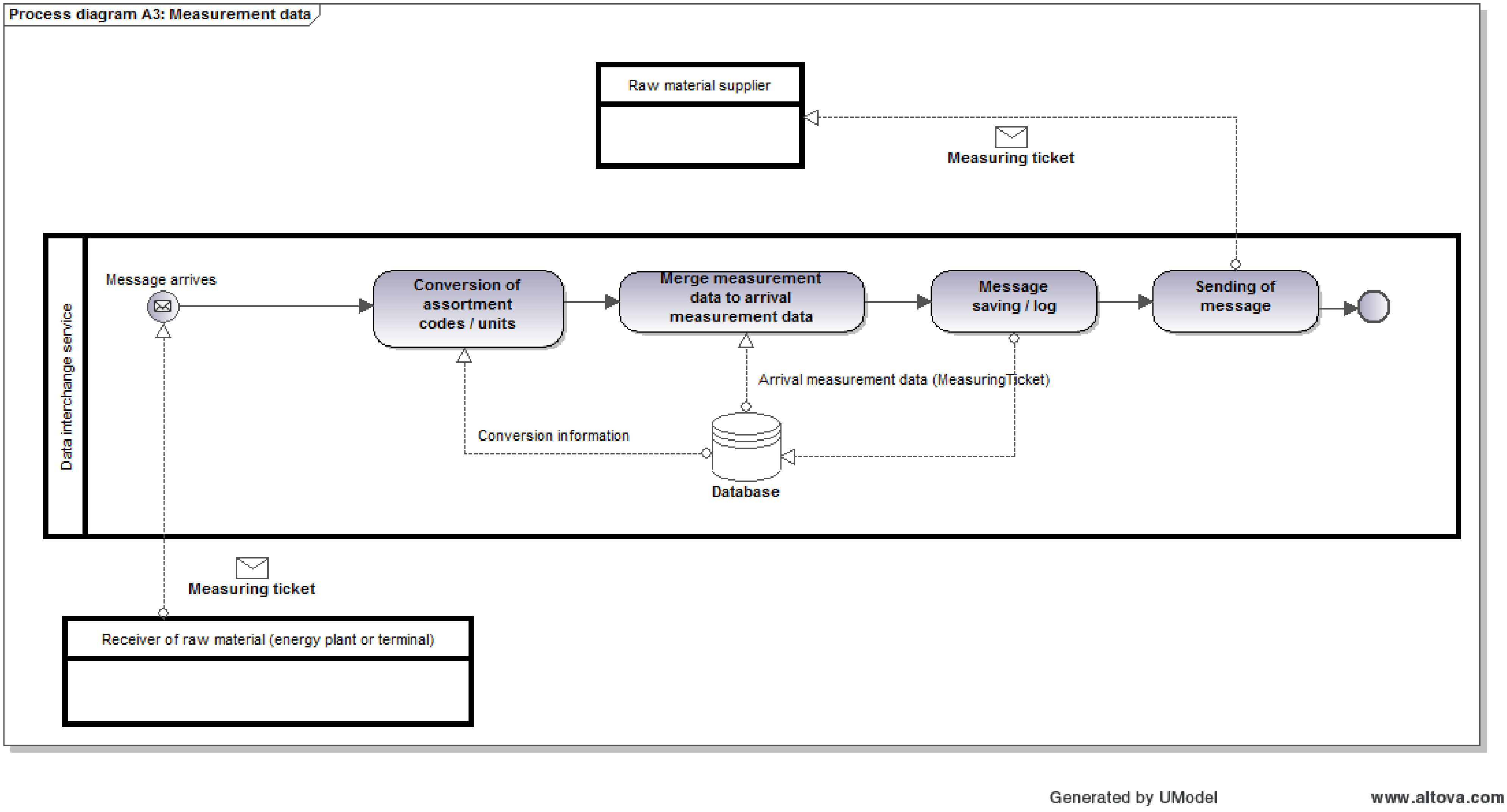
Process diagram A3: Measurement data
Raw material supplier
Measuring ticket
Data interchange service
Message arrives
Conversion of assortment codes / units
Merge measurement data to arrival measurement data
Message saving / log
Sending of message
Arrival measurement data (MeasuringTicket)
Conversion information
Database
Measuring ticket
Receiver of raw material (energy plant or terminal)
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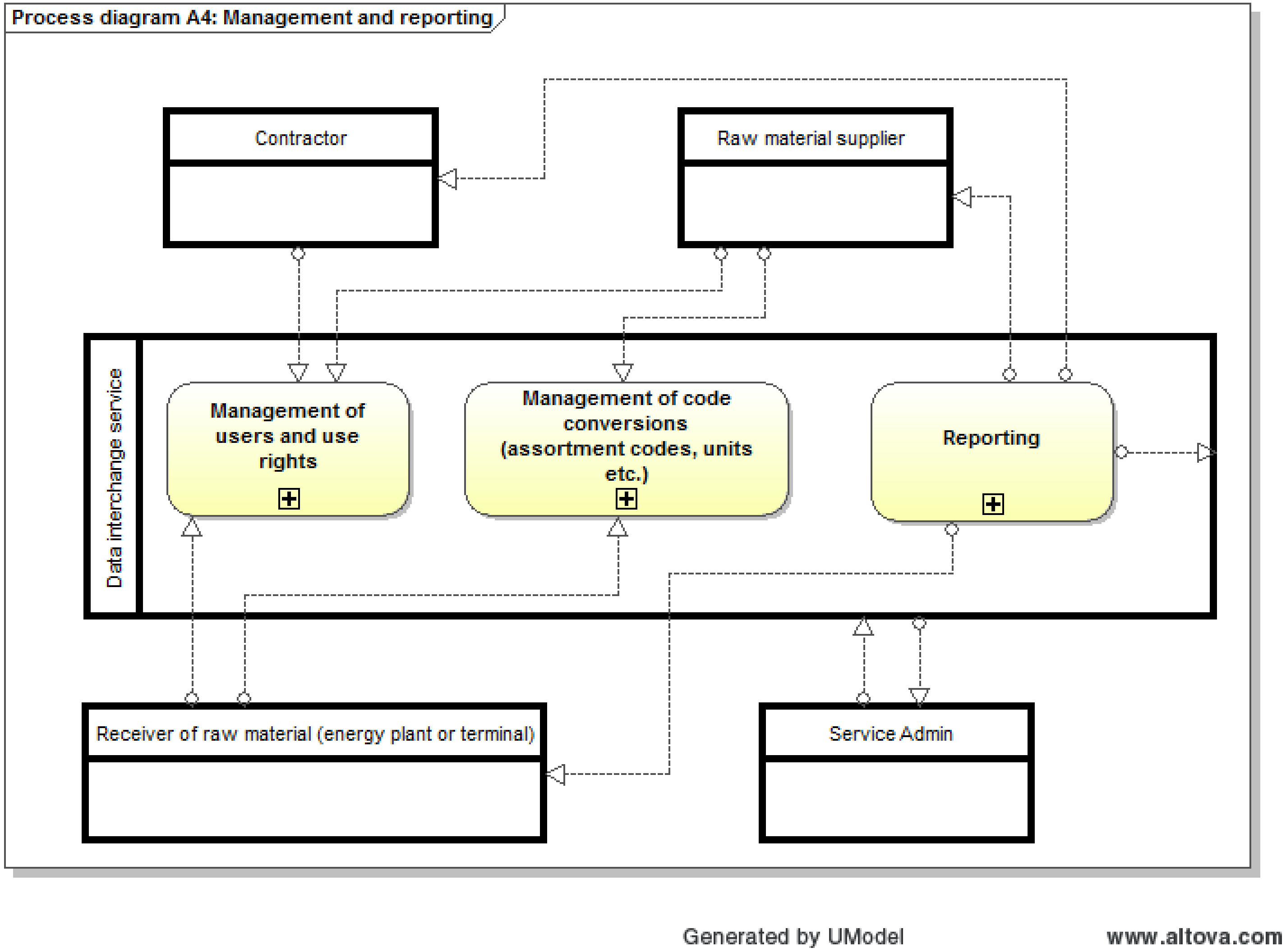
Process diagram A4: Management and reporting
Contractor
Raw material supplier
Data interchange service
Management of users and use rights
Management of code conversions (assortment codes, units etc.)
Reporting
Receiver of raw material (energy plant or terminal)
Service Admin
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