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First edition
2005-02

Framework for energy market communications –

Part 102:
Energy market model example

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FRAMEWORK FOR ENERGY MARKET COMMUNICATIONS –

Part 102: Energy market model example

FOREWORD

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IEC 62325-102, which is a technical report, has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

The IEC 62325 series cancels and replaces IEC 62195 (2000) and its amendment (2002). It constitutes a technical revision.

IEC 62195 (2000) dealt with deregulated energy market communications at an early stage. Its amendment 1 (2002) points out important technological advancements which make it possible to use modern internet technologies based on XML for e-business in energy markets as an alternative to traditional EDI with EDIFACT and X12. The new IEC 62325 framework series for energy market communications currently consisting of IEC 62325-101, IEC 62325-102, IEC 62325-501, and IEC 62325-502 follows this direction and replaces IEC 62195 together with its amendment.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
57/705/DTR	57/722/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 62325 consists of the following parts, under the general title *Framework for energy market communications*:

Part 101: General guidelines

Part 102: Energy market model example

Part 201: Glossary [1]

Part 3XX: (Titles are still to be determined) [2]

Part 401: Abstract service model [3]

Part 501: General guidelines for use of ebXML

Part 502: Profile of ebXML

Part 503: Abstract service mapping to ebXML [3]

Part 601: General guidelines for use of web services [3]

Part 602: Profile of Web Services [3]

Part 603: Abstract service mapping to web services [3]

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual edition of this document may be issued at a later date.

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1 Under consideration. Because the technologies have an inherent own glossary within their standard definitions, this glossary is a placeholder for a glossary for future parts indicated with [2)] including energy market specific terms and definitions.

2 Under consideration. These parts for business content are mentioned for completeness only with a number space as placeholder. They extend the original scope and require an agreed new work item proposal for further work based on an overall strategy how to proceed.

3 Under consideration. These technical parts are mentioned for completeness with provisional title. They extend the original scope and require an agreed new work item proposal for further work.

INTRODUCTION

The market model depends on the market rules of the country or region. An incomplete list may include the legal and regulatory framework, business rules, technical market rules (network access, balance management, schedule management, congestion management), identification schemas of market participants and e-business objects, metering code (service and access to metering values), grid code (operation), distribution code (operation), and load profiles (synthetic and analytical). The model has to comply with these rules and should include all market participants and transactions to allow seamless communication.

This part of IEC 62325 deals with the UMM (UN/CEFACT modelling methodology) modelling of the energy market and its result, the business and information model. The model has been derived but is not identical with those from some existing markets. It serves as an informative *example* for business processes and associated information. For the purpose of the IEC 62325 series, and for reasons of space, the model has been simplified and shortened and is by no means complete. Some descriptions and modelling parts are derived from existing technology independent market models as EDIEL (http://www.ediel.org/), ETSO (www.edi.etso-net.org/, see ETSO Scheduling System (ESS)), ERCOT (http://www.ercot.com/, see Market Guide), VDEW (http://www.strom.de/, see Choice of Supplier). An other approach would be to derive variations and extensions of an existing model from artefacts in a registry/repository and business library.

Where the UML business model workflow is almost completely described, the other workflows are complete only with focus on specific business processes within process areas such as the process planning of scheduling and to some extent the process change of supplier. For simplicity in the collaborations and transactions, only business failures are shown and technical failures and business signals (as acknowledgements on the messaging level) are omitted.

The message content is based on a energy market specific vocabulary which can be shared over messages, business areas and business domains. Note that with the planned market extension of the CIM (Common Information Model, IEC 61970-301) model of the power system, the vocabulary for system operators may be derived in future from the extended CIM acting as a knowledge based market information model. This will be treated in future parts of the IEC 62325 series.

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FRAMEWORK FOR ENERGY MARKET COMMUNICATIONS –

Part 102: Energy market model example

1 Scope

This part of IEC 62325 defines a restricted (see introduction) *example* business model of the electricity market following the Open-edi reference model ISO/IEC 14662. Fundamental to the model is the division of the business transactions into the Business Operational View (BOV) and the Functional Service (FSV) with mapping of services between to ensure independence of the communication technology used.

Because energy markets vary, this model example is only informative. The main purpose of the model is to show how the modelling methodology can be applied to the energy market, and to serve as the base of technology-dependent configuration examples in other parts of the IEC 62325 series.

The model uses the UN/CEFACT modelling methodology UMM based on UML (Universal Modelling Language) for the Business Operational View, but other modeling methodologies may also be used. The modelling is done from the beginning for the whole market and its result is the “business process and information model” which can be taken as the input for the technology-dependent modelling in the design phase of systems and further for the Functional Service View. See IEC 62325-501 and future parts of the IEC 62325 series for this.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 Generic Open-edi standards

ISO/IEC 14662, *Information technology – Open-edi reference model*

UN/CEFACT *Modelling Methodology (UMM)*, NO90 R10 or higher

UN/CEFACT *Modelling Methodology Meta Model*, NO90 R10 or higher

NOTE Work is in progress at UN/CEFACT regarding the “content” of business information exchange for example as Core Components (UN/CEFACT - Core Components Technical Specification), Core Component Library (CCL, accessible through an registry/repository), Catalogue of Core Components (including industry groups), Common Business Processes, UMM Business Library, XML message design rules (UN/CEFACT – XML Naming and Design Rules (Draft 2004)).

The energy market specific vocabulary can be derived from Core Components or/and an energy market information model.

2.2 Sectorial Open-edi standards

Market modelling based on this implies to some extent sectorial standards. At the moment, no references are given.

3 Terms, definitions and abbreviations

3.1 Terms and definitions

None.

3.2 Abbreviations

BIE	Business Information Entity
BOV	Business Operational View
CC	Core Component (based on BIE)
CIM	Common Information Model
DSO	Distribution System Operator
DUNS	Data Universal Numbering System (North America)
EAN	European Article Number (Europe)
EDI	Electronic Data Exchange
FOV	Functional Service View
ICT	Information and Communication Technology
ISO	Independent System Operator
IT	Information Technology
MIS	Market Identification Schema
UML	Unified Modelling Language
UMM	UN/CEFACT Modelling Methodology
SO	System Operator (Transmission, Distribution)
TSO	Transmission System Operator

4 Market guide

4.1 General

In the following, an informal and conceptual textual description of the electricity market called Market Guide is provided for basic understanding. The description is a not complete example. Real markets may differ. Note that different time intervals are used in energy markets for scheduling and metering.

Figure 1 shows a high-level presentation of the supply chain of energy with basically three main phases: in the *trading planning phase,* energy consumption is forecast and trading is planned. In the *trading operational phase,* energy is traded to meet the forecast, and respective generation resources are allocated. The implementation of the physical energy path from generation over the transmission and distribution network to consumption affords co-ordinated planning of balanced schedules in the *system operation planning phase* for generation, import/export and consumption. In the *system operation operational phase,* energy flows directly from the producer to the customer over the transmission and distribution network. System operation guarantees in this phase that generation meets consumption in real-time (balancing) and that the system is reliable. Many services are needed to support the core processes. In the *settlement phase,* for example, the settlement service provides the means to bill consumption and imbalances. Any imbalance of operation (difference between schedules and metered generation and consumption) is in the financial responsibility of the Balance-Responsible Parties (traders and others).

Additionally, supporting system operation services and energy services are necessary. Each business area has one or more market participants who initiate the business process and/or act as stakeholder responsible for the outcome of it. Exceptions to this are energy services, which may be outsourced and driven by various market participants following the value chain.

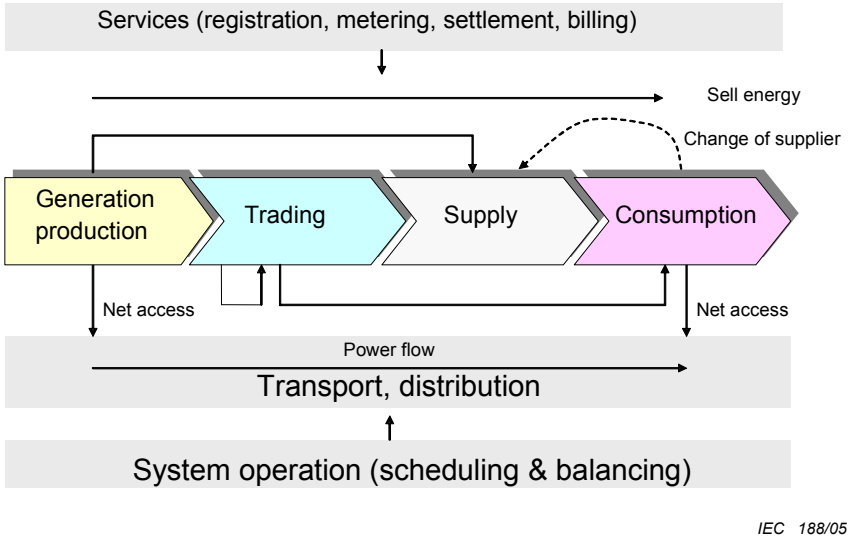


Figure 1 – Value chains and services in the energy market

4.2 Trading

There are two types of trading, bilateral contracts and trading on the spot market (power exchange). Bilateral trading may take place over an intermediate broker. Trading may also include seasonal products. Trading may afford a financial clearing of risks if one party is not able to fulfil the contract.

4.3 Supply

Suppliers represent competitive retailers that sell electricity directly to eligible customers who have the choice of supplier. Suppliers may be retail providers (without own distribution network) or distribution utilities in the role of suppliers. Suppliers will forecast their customer load and negotiate privately with traders to buy energy. Suppliers will communicate the resulting schedules to the transmission system operators (see 4.5).

With supply, many services are associated (see for example 4.6 and 4.7).

4.4 Customer management

The management of customers requires the business processes change of supplier, relocation of customer, metering and access to the metering values, change of meter, contract for new access to the network. Because some business processes are complicated, multi-party collaborations with shared market meta data, some markets have implemented a centralised clearing service for all these business processes within a region.

Suppliers interact with each other and the distribution service provider (providing network access) when they need to submit switching requests, where customers choose a new supplier. The switching requests are processed by working with metering service providers to obtain the initial and final meter reads, confirming switches with customers, and confirming the switch with the relevant suppliers once the switch is approved. Switch confirmations are also sent as notices to customers.

4.5 Scheduling and balancing

Scheduling and balancing of transmission system operators (TSO) follows two business processes: (1) planning of balanced scheduling, (2) operation. The first process involves the following three phases: schedule message validation, balance validation, and system validation.

The TSO is responsible for maintaining the real-time balance of consumption and generation and for the reliability of the electricity system within in its region. The TSO relies on the availability of generation capacity to provide balancing energy to maintain the electric system within allowable reliability limits. The provision of capacity and energy are competitive services that will be provided in the market. Generation units that can be on standby and available to be called upon to provide energy or loads that are available to be interrupted to relieve the need for additional energy may provide these services. These services needed for generation or load resources to ensure reliability are called ancillary services. There are two types of ancillary services: (1) generation reserve available to be used if needed to provide balancing energy or loads available to be interrupted reducing the need for additional capacity and (2) balancing energy to ensure that supply and demand are in balance or loads interrupted to avoid the need for additional energy.

The TSO will continuously monitor the amounts of reserve capacity available across the system to insure against unforeseen events, ranging from differences between scheduled and actual demand to the sudden loss of a generating unit or transmission facility. If the analysis identifies a difference, the TSO will procure a replacement reserve to ensure sufficient capacity to deal with the projected capacity inadequacy or congestion.

As the TSO moves closer to the real-time interval in which the energy will actually be delivered, it will continuously get additional information that improves its ability to forecast system conditions. For instance, as the day-ahead energy schedules are finalised for a given 24-hour period, scheduling entities will submit resource plans for generators that indicate the amounts of:

- Capacity, which is generation capacity that will be readily available if needed, but is not actually delivered to the grid as energy.
- Energy, which is the energy that will be generated and sent to the grid to meet the generators' contracted amounts of load.

After evaluating the effect on the power grid of forecasted loads, schedules, transmission system conditions and resource plans, the TSO will determine how much additional capacity needs to be reserved to assure the TSO will have resources that can provide balancing energy in real-time to maintain reliability. The TSO will procure the needed capacity services to ensure that it is able to serve the scheduled loads as well as relieve loading on transmission lines that appear to be constrained upon a study of the submitted schedules. The TSO will procure balancing energy typically about 10 min before the time of actual power flow, by which time the right amount can be predicted very accurately using short-term forecasting tools.

Replacement reserve ancillary service providers will submit balancing energy bids when they submit their Replacement Reserve capacity bids. Their balancing energy bids will go in the balancing energy bid stacks for the hours for which they were awarded to provide Replacement Reserve capacity service. Ancillary service providers will not, however, bid the capacity that they have sold to the TSO into the market for other capacity services.

The TSO will select and deploy balancing energy in the amount necessary to keep the system in balance and minimise the net energy needed in real time from regulation service providers.

A key feature of the competitive retail electricity market is that it will be based on bilateral transactions between buyers and sellers of energy. Balance Responsible Parties (traders, producers and suppliers) are required to turn into the TSO balanced energy schedules of load and energy required to generate and serve the load. The balance schedules are a result of bilateral trade between load and resource entities. The TSO only operates the electricity market as far as the TSO is needed to mitigate the energy imbalances. This is unlike some other markets, where power generating companies sell electricity into a “pool” and load serving entities (trades, suppliers) purchase from the same “pool” in an exchange where the amount of demand and supply sets market prices for buyers and sellers.

Traders and supplier acting also in the role of traders buying energy and producers selling energy will communicate operational information such as their bilaterally arranged balanced schedules of loads and resources to the TSO through their scheduling entities. The TSO will ensure that the power network can accommodate the schedules that were generated by the bilateral market.

The TSO makes an assessment of the ancillary services needed to accommodate the bilateral schedules and the scheduling entities are asked to either provide their share of these services from their own resources or let the TSO purchase these services from the market on their behalf. Market participants may self-provide all or part of their share of ancillary services. The TSO is uniquely positioned to identify the ancillary services needed to resolve system conditions such as capacity inadequacy and congestion, to maintain reliability, as shown in the previous section.

The TSO, in addition to the activities described above, will help market participants plan and manage their competitive market operations effectively by giving them timely information like forecasts of weather, load, losses, and ancillary services requirements.

For every settlement interval, the TSO will accept balanced schedules from Balance Responsible Parties (traders, producers and suppliers) that identify the source and destination of contracted power flows, as well as their amount and timing. TSO will compare the sum of these schedules to its own load forecasts, to determine balancing energy and ancillary services requirements.

The TSO will work with traders and suppliers to procure ancillary services through a series of markets, which the TSO will operate, and will deploy them as needed to ensure system reliability. If the submitted schedules ultimately result in congestion of the transmission system and the TSO needs to re-dispatch system resources to resolve the congestion, market participants will pay for the re-dispatching or congestion costs.

In order to settle with the balance-responsible parties, the Imbalance Settlement Responsible party will aggregate load and resource data for every settlement interval. He will then calculate the load imbalance as the difference between scheduled and the aggregated load data, to issue the appropriate credits and/or debits to balance-responsible parties. The same comparison is made between aggregated energy supplied from the resources provided by the Balance-Responsible parties and the scheduled energy to allocate the appropriate debits and/or credits due to the resource imbalance.

The TSO will also work with distribution network providers to manage the transmission system. Distribution network providers are also responsible for load and resource meters installation as well as submitting meter data for all loads and resource meters that are not directly polled by the TSO.

The TSO which acts as an ISO (Independent System Operator) may have a central premise clearing system that will facilitate for example the customer switching process (choice of supplier) by transmitting switch requests and meter consumption data between suppliers and distribution network providers and keeping track of the association between premises and suppliers. In the case where there is no central clearing system, the customer switching process is decentralised between the suppliers and the Distribution Network Providers.

Producers are the only entities that can own generation or loads that can act as resources. They negotiate bilaterally in their role as traders with traders/power exchanges to sell their energy, and communicate the resulting schedules to the TSO.

Balance-responsible parties can also bid into the balancing energy market and other ancillary service markets from the resources in their portfolio. The TSO reimburses the balance-responsible parties at the market-clearing price if the TSO selects the bid.

4.6 Metering

Metering service provider or distribution network providers in the role of Metering Service Provider, provide meter reading and consumption information, in order to settle correctly the balancing energy and ancillary service markets. For example, consumption information for each supplier in the Balance-Responsible role will be needed to determine whether the actual load matches the schedules submitted. If it did not match, the difference will be settled at the balancing energy market-clearing price.

Most customer meters measure accumulated consumption between meter read-dates and are typically read once per month or year. An estimate of the energy consumption for each period (15 min for example) is needed to properly perform settlement. The estimation is done by standard load profiles that break down monthly consumption into the above mentioned periods for the different customer segments in the region. Some customers with load-profile meters can meter the consumed energy within periods.

Suppliers have authorised access to the meter readings for the purpose of forecast and billing. The optimisation of load schedules may afford the reading of load profile meters and the access to the meter readings each day.

4.7 Settlement of accounts and billing

The financial settlement for balancing energy and ancillary services that were used by the TSO will take place between traders and the TSO and is performed by the Settlement Responsible Party. Settlement of the balancing energy will be based on the load imbalance and resource imbalances from each Balance Responsible Party. The load imbalance is the difference between the scheduled load and actual load from each trader. Resource imbalance is the difference between the scheduled energy and actual energy for each trader. The actual load and energy amounts are derived from the load and resource meter readings. For example, if a trader's actual energy supplied from the resources it represents is insufficient to match the scheduled energy in the balanced schedule it provided to the TSO, that trader would be required to reimburse the TSO for the balancing energy the TSO procured, at the market clearing price or other price. On the other hand, if the TSO accepts a balancing energy bid from the ancillary services market, the TSO will pay for it as appropriate at the market-clearing price.

Suppliers bill their customers based on the metered consumption and tariffs. Transmission and distribution providers bill the producers and customers that have access to the network with a network usage fee.

5 UMM market model

NOTE The model uses the Unified Modelling Language (UML) notation.

5.1 Business modelling workflow

5.1.1 General

The purpose of business modelling according to UMM is:

- to understand the structure and dynamics of the business domain,

- to ensure that all users, standards developers and software providers have a common understanding of the business domain,
- to understand the daily business in the business domain independent of any technical solution,
- to create categories to help partition the business domain that enables an iteration plan to complete the model,
- to structure the model in the form of a Business Operations Map (BOM)
- to capture the justification for the project,
- to identify the stakeholders concerned with the modelled domain, some of whom will be independent of the processes within the domain.

Business areas can contain groups of process called process areas which in turn include individual business processes. Business processes identified in the business modelling workflow consist of business collaborations and transactions described in the requirement workflow and in more detail in the analysis workflow.

After this general structuring, UML use case diagrams are organised as groups within UML packages that use the names of business areas.

The main focus of business modelling workflow is on business domain, business area and business process areas understanding, not on processes, which are only identified.

Table 1 shows the workflow for methodology and model artefacts.

Table 1 – Methodology and model artefacts

Workflow	Methodology	Model artefacts (BOM with UML)
Business modelling	Domain analysis	Business area, process area (UML packages)
	Use case analysis	Use cases
	Process discovery	Identification of processes
	Activity modelling	Activity diagrams

5.1.2 Business process discovery and identification

For the high-level business domain, analysis worksheets are used.

5.1.2.1 Business reference model

Table 2 shows the worksheet business reference model for the business domain energy market. All worksheets, this and the following ones, are examples only.

Table 2 – Business reference model

Form: Describe business reference model	
Business reference model name	**Energy market**
Industry segment	Electricity
Domain scope	The domain scope covers all stages from the planning phase to the settlement phase of generation, transmission and distribution of electricity, and energy services with focus on the exchange of market information and documents. In the electricity market, energy is generated, traded (wholesale on power exchange or bilateral) and supplied (retail) to the customer (consumption). At every moment, generation and supply should be in balance and the security of the network should be granted. Producer and customer have non-discriminated access to the energy network and customers can chose their supplier. The commercial use of networks for transmission and distribution is transparent to the market participants regardless of the physical structure (voltage level, hierarchy, control areas involved). The market also needs services to support the core functions such as registration of market participants with access to the network, exchange of market metadata, ancillary services, change of supplier, metering, settlement of imbalances, settlement of accounts, and billing.
Business areas	Generation, trading, supply, system operation, transmission and distribution, energy services.
Business justification	The business model is intended to enable e-business communication between electricity market participants in an efficient way with low transaction cost based on a common understanding of processes and transactions.
Constraints	The legislation and rules are different in different countries. The deregulation process is not co-ordinated in different countries or regions. The deregulation process accelerates splitting and merging of companies. The companies and markets are more and more international. Due to the increased competition, the prices to end-users may be reduced. Environmental problems may prevent necessary system resources.

5.1.2.2 Description of business areas

Table 3 shows the worksheet for the business area generation.

Table 3 – Business area generation

Form: Describe business area	
Business area name	**Generation**
Description	Generation of electricity according to the schedules given by traders. Providing auxiliary services for system operators.
Scope	Generation of electricity and providing auxiliary services.
Boundary of the business area	Generation
References	…
Constraints	Environmental problems may prevent necessary system resources. There is a resistance to nuclear power plants. There is a resistance to pollution from power plants using coal, oil, gas etc. Resistance to noise, blinking shadows, from windmills.
Stakeholder	Power generator, trader, and system operators.
Process areas	Generation
Objective	Produce energy and provide auxiliary services with low cost.
Business opportunity	Become an Independent Power Producer (IPP).

This business area is not further detailed in the workflows because relevant processes for e-business are included in the business area trading. Table 4 shows the worksheet for the business area trading.

Table 4 – Business area trading

Form: Describe business area	
Business area name	**Trading (wholesale)**
Description	Energy is traded bilaterally or on the spot market (power exchange). Bilateral trading is done directly between traders or with support of brokers who do not trade themselves but provide traders with necessary trading information. Bilateral trading is based on long-term to short-term contracts, whereas the power exchange serves as a day-ahead spot market with intra day trading with base load and peak load including auctions of hour or MW blocks. The power exchange provides the central financial settlement of trade between traders. Combined (physical and financial) power exchanges minimise the financial risk of non-fulfilment of contracts by clearing of OTC trades and trade financial products as for example futures. Traded energy is sold to suppliers or directly to customers (for example big industrial consumers). The result of trading (bought and sold) is sent as aggregated schedules to the system operator to balance the system.
Scope	Trading on the wholesale and auxiliary market.
Boundary of the business area	Trading
References	…
Constraints	Limited transmission network capacity, limited available generation capacity, system outages (for example cables, overhead lines, generators), financial risk of non-fulfilled contracts.
Stakeholder	Trader, supplier, producer, power exchange, brokers.
Process areas	Planning of consumption and generation (schedules), bilateral trade, trade on spot market, trade on auxiliary market (adjustment market (after completion of the sport market prior to delivery), trade on balance regulation market (within delivery)), and trade on financial market (clearing, futures).
Objective	Buy energy and auxiliary services with low cost and minimum financial risk.
Business opportunity	Bid in the market.

Table 5 shows the worksheet for business area supply.

Table 5 – Business area supply

Form: Describe business area	
Business area name	**Supply (retail)**
Description	Supplier buys energy from wholesale traders and supply eligible end-customers based on a contract. For small enterprises and households the supplier plans and initiates aggregated load schedules and initiates as a new supplier the process “change of supplier” on behalf of the customer. The result of bought and sold energy is send as aggregated schedules to the system operator to be able to prepare for operation (see system operation).
Scope	Supply of eligible customers with electricity.
Boundary of the business area	Supply.
References	…
Constraints	
Stakeholder	Supplier, customer.
Process areas	Supply.
Objective	Supply customers with energy to low cost.
Business opportunity	Suppliers without an own distribution network can compete in the energy market.

Note that the business area consumption is not shown here because in some cases, suppliers act on behalf of customers and customers are included in the business area's supply and energy services.

Table 6 shows the worksheet for the business area system operation.

Table 6 – Business area system operation

Form: Describe business area	
Business area name	**System operation**
Description	The fundamental requirement of the electricity market is that each electricity trader and supplier in the market should be in balance. This means that the amount of electricity produced and consumed through bilateral agreements is balanced. The balance is planned and with the imbalance settlement, any imbalance is invoiced. The balancing process has three phases: 1) A planning phase, where balance responsible parties (for example trade responsible, generation responsible, consumption responsible parties, etc.) calculate in advance the consumption of all involved parties for the day ahead. At the conclusion of this phase, the transmission system operator informs each balance responsible party of what has been accepted of their schedules and informs the entity responsible for imbalance settlement, called the "imbalance settlement responsible" of all the schedules in question. 2) An operation phase, where the schedule that has been determined during the planning phase is executed. The system operator, to ensure system balance at any moment, handles any deviations between generation, consumption and unforeseen congestion. For this, he orders ancillary services. 3) A settlement phase, where following the date of operation, the metered data aggregator sends the data to the imbalance settlement responsible. The imbalance settlement responsible, along with complementary data received from other sources, then carries out the imbalance settlement itself.
Scope	The scope is the secure and reliable system operation while facilitating electricity market transactions.
Boundary of the business area	Transmission system operators, balance responsible parties such as traders, imbalance settlement responsible parties, suppliers, producers.
References	Market model for …
Constraints	Congestion and outages. Limited transmission capacity. International trade. Import/Export of energy cross control areas or market regions. Non-discrimination of market participants.
Stakeholder	Transmission system operators. Balance responsible parties such as traders, suppliers, and producers. Imbalance settlement responsible.
Process areas	Scheduling (intra area scheduling, inter area scheduling (import/export)), Operation (congestion management, capacity allocation, auxiliary services), imbalance settlement and invoice.
Objective	See scope.
Business opportunity	ISO (Independent System Operator).

Table 7 shows the worksheet for the business area transmission and distribution.

Table 7 – Business area distribution

Form: Describe business area	
Business area name	**Transmission and distribution**
Description	The transmission and distribution service provider operates the network (planning, engineering, and maintenance) and provides access to it.
Scope	Access of generators and customers (load) to the network for transmission and distribution of energy.
Boundary of the business area	Transmission service provider, distribution service provider, producer, customer
References	…
Constraints	Environmental problems may prevent necessary system resources (for example cables or overhead lines). Capacity of the network and its components.
Stakeholder	Transmission service provider, distribution service provider, producer, customer
Process areas	Contract and registration of network access.
Objective	Providing economic and reliable network access and network usage to support supply of customers with energy.
Business opportunity	Collect fees for network access and use of the network.

Table 8 shows the worksheet for the business area energy services.

Table 8 – Business area energy services

Form: Describe business area	
Business area name	**Services**
Description	Services for the market core processes, sometimes provided by independent service providers.
Scope	Energy services.
Boundary of the business area	Settlement of accounts, metering, invoicing, change of customer.
References	…
Constraints	…
Stakeholder	All market participants. This will be more defined within the processes.
Process areas	Settlement of accounts (processes: imbalance, generation, consumption, auxiliary services), Metering, change of metering equipment, collection of metering data, access to metering data, network registration of customers, Change of supplier, relocation of customer, central clearing of customer management (including change of supplier), etc. Exchange of market metadata. Central trade confirmation matching, etc.
Objective	Providing services to support the core business.
Business opportunity	Outsourcing

5.1.2.3 Description of process areas

In Tables 9 and 10, only a few examples are shown.

Table 9 shows the worksheet for the identification of the business process area planning (scheduling).

Table 9 – Identification of the process area planning

Form: Describe process area	
Process area name	**Planning (scheduling)**
Objective	Plan balanced schedules of generation and consumption. Plan import/export energy transactions.
Scope	System operation planning according to the schedules of balanced responsible parties.
Boundary of the process area	Energy transactions and balancing.
References	…
Constraints	Congestion and outages of network.
Stakeholder	Transmission system operators. Balance responsible parties as traders, suppliers, and producers.
Business processes	Intra area scheduling, import/export scheduling.
Objective	Providing system services to support trading and supply.
Business opportunity	-

Table 10 shows the worksheet for the identification of the business process area operation.

Table 10 – Identification of the process area operation

Form: Describe process area	
Process area name	**Operation**
Objective	Keeping the balance of generation and consumption. Carry out import/export energy transactions. Reliable and secure system operation.
Scope	Carry out system operation.
Boundary of the process area	Energy transactions and balancing.
References	…
Constraints	Congestion and outages of network.
Stakeholder	Transmission system operators, balance responsible parties as traders, suppliers, and producers.
Business processes	-
Objective	Providing system services to support trading and supply.
Business opportunity	-

5.1.2.4 Description of business processes

An appropriate granularity for a business process allows the smallest exchange of signals between stakeholders that has an identifiable economic value. Note that this is not always appropriate since “negotiation” could be a valid business process but it doesn’t really result in an economic consequence.

In Table 11 and 12, only a few examples are shown.

Table 11 shows the worksheet for the identification of the business process scheduling.

Table 11 – Identification of business process scheduling

Form: Identification of business processes	
Business process name	**Scheduling**
Process area	Scheduling
Business area	System operation

Table 12 shows the worksheet for the identification of the business process change of supplier.

Table 12 – Identification of the business process choice of supplier

Form: Identification of business process change of supplier	
Business process name	**Change of supplier**
Process area	Customer management
Business area	Energy services

5.1.3 Business model artefacts

5.1.3.1 General

The results of the domain analysis with discovery and identification of business areas, process areas and business processes are mapped to the UMM business meta model. The business model is in UML and structured in the form of the Business Operations Map (BOM), see Figure 2. With greater detail, business processes can include business processes till the business process is the parent business process of atomic transactions called business collaborations. Collaboration use cases are treated in the requirement workflow given in 5.2.

The UML artefacts of the UMM business modelling are described in Figure 2.

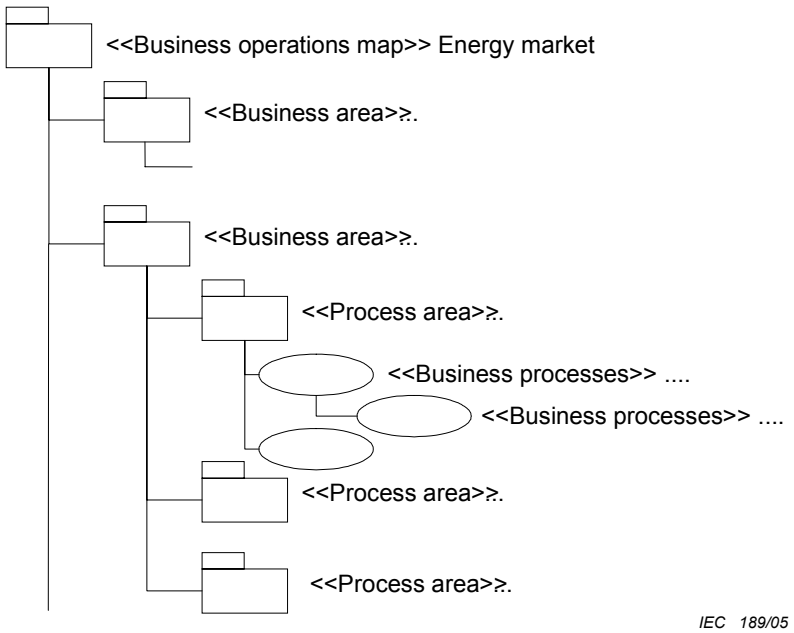


Figure 2 – Structure of the Business Operations Map (BOM)

5.1.3.2 Business operations map

The Table 13 shows the BOM of the energy market in a tabular presentation. For reasons of space, the table is not complete (missing details are marked with …).

Table 13 – Business operations map

BOM 🗀	Business area 🗀	Process area 🗀	Business process
Energy market			
	Generation	…	
	Trading		
		Bilateral market	…
		Spot market	…
		Auxiliary market	…
			Adjustment
			Balance regulation
		Financial market	
			Clearing
			Futures
		Planning	
			Generation
	Supply		
		Planning	
			Consumption
	System operation		
		Planning	
			Scheduling (intra area)
			Import/export
		Operation	…
	Transmission and distribution	…	
	Services		
		New network access	Contract
		Exchange of metadata	Registration
		Relocation of customer	
			New contract
			Old contract
		Change of supplier	
		Metering	
			Meter reading
			Change of meter
		Settlement	
			Imbalance
			Generation
			Consumption
			Auxiliary services
		Billing	…
		Information	…
		Clearing (optional)	…
The names and symbols at the head of each column correspond to Figure 2.			

5.1.3.3 Packages

The main functionality of the market is represented with UML packages, which group artefacts (class diagrams, activity diagrams, use case diagrams, collaboration diagrams, sequence diagrams) as shown in Figure 3. Within the business modelling workflow, conceptional activity diagrams and use case diagrams are used.

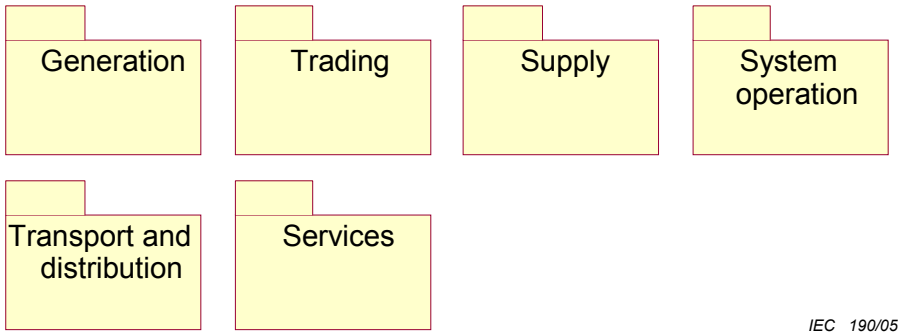


Figure 3 – Business areas

Figures 4 to 6 show example packages of process areas within the packages of business areas above.

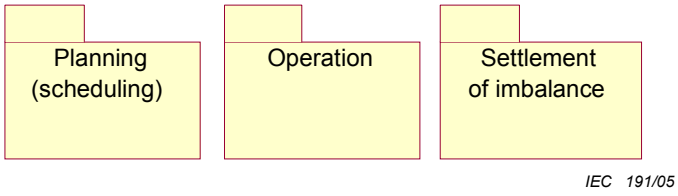


Figure 4 – Process areas of system operation

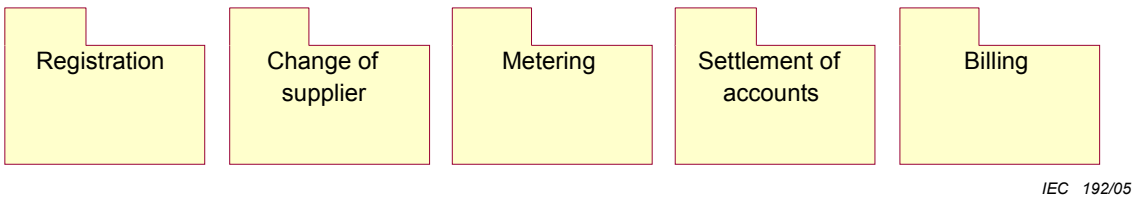


Figure 5 – Process areas of services

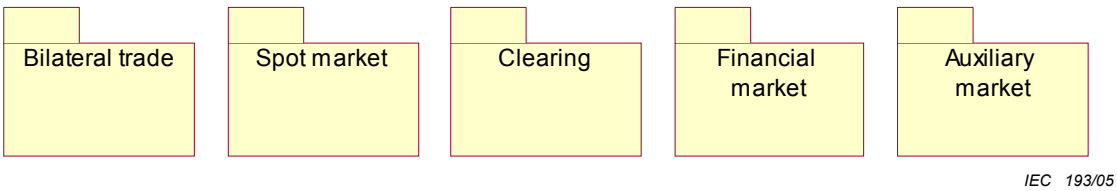


Figure 6 – Process areas of trade

5.1.3.4 Use case diagrams

The use cases are organised in packages following the definition of business areas and the value chain.

Figure 7 shows as an example, the high-level business process area “system operation” with its associated use cases. In the planning phase, the balance-responsible parties send their planned schedules about trade, supply (load) and generation to the system operator to check any imbalance. In the operation phase, the plans are executed and the system is balanced with auxiliary services taking care of network congestion and reliability.

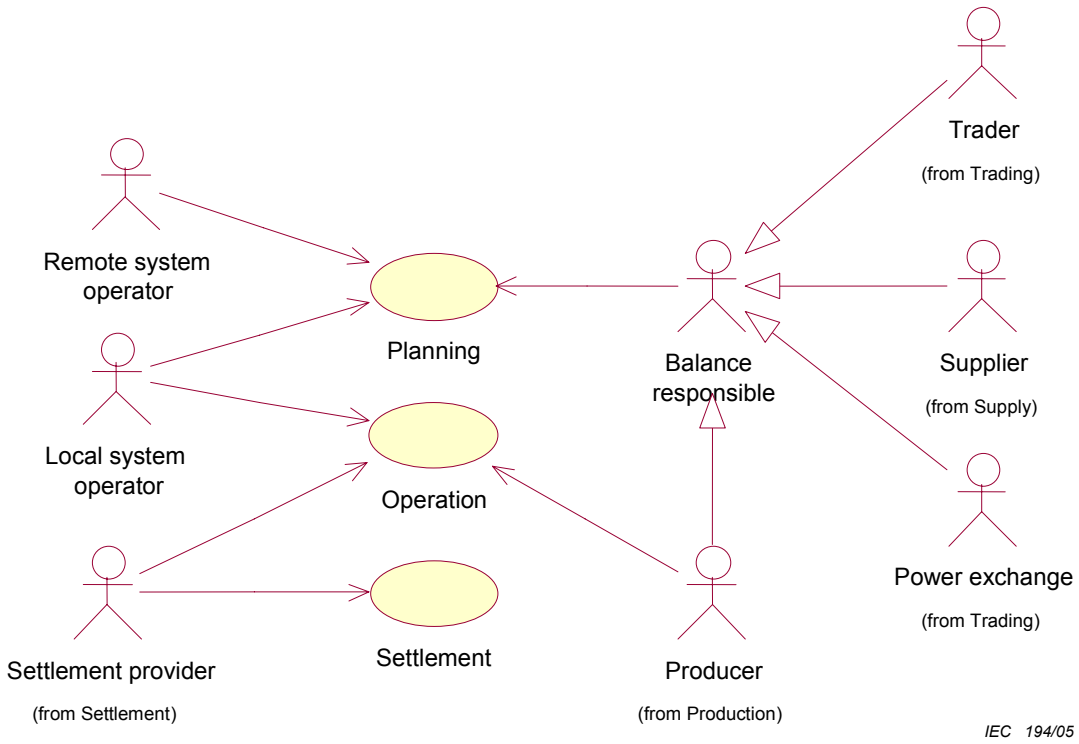
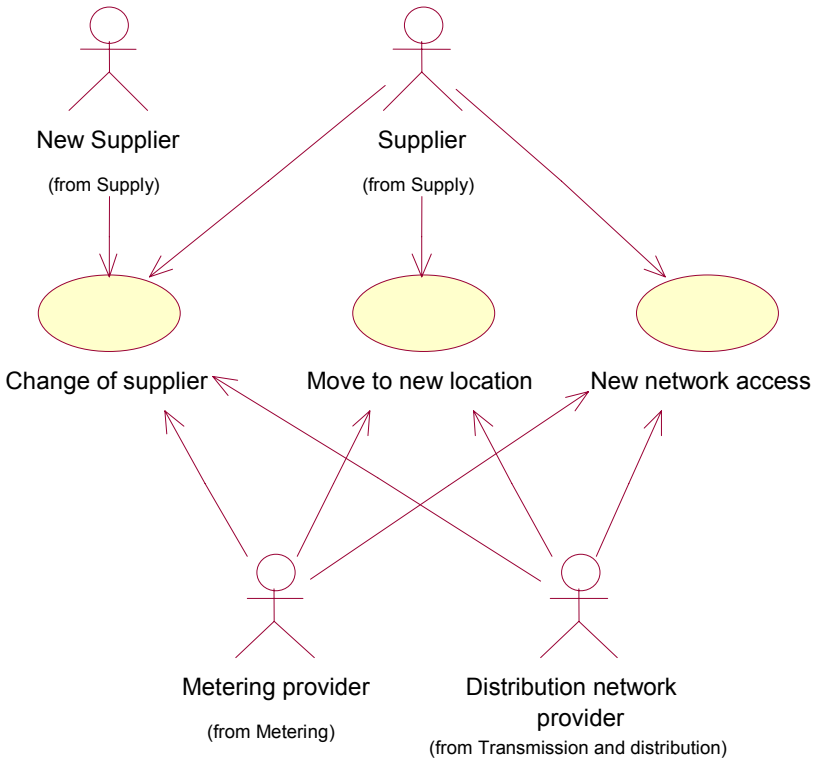
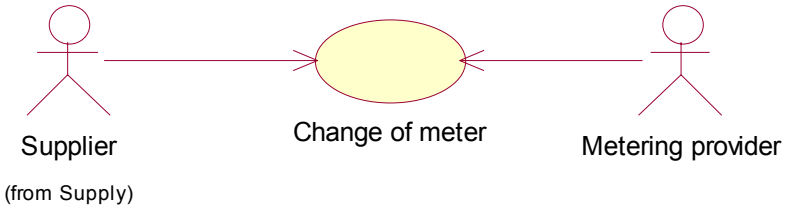
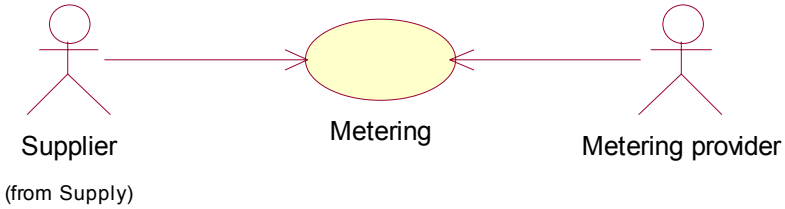


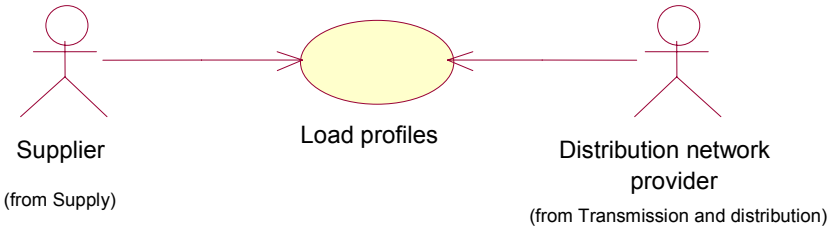
Figure 7 – Use case system operation

Figure 8 shows examples of Use cases services.









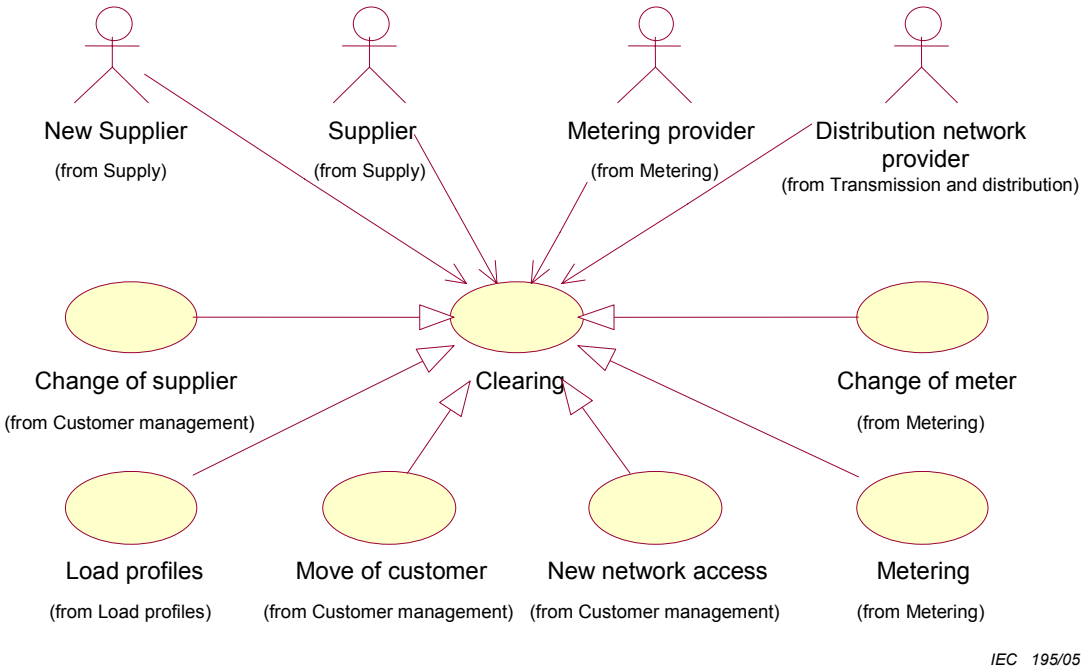


Figure 8 – Use cases service

5.1.3.5 Activity diagrams

Figure 9 shows as an example the high-level activity diagram of the system operation planning (scheduling) collaboration. This diagram shows no details and will be detailed further in the following workflows of 5.2, which deal with collaborations and transactions.

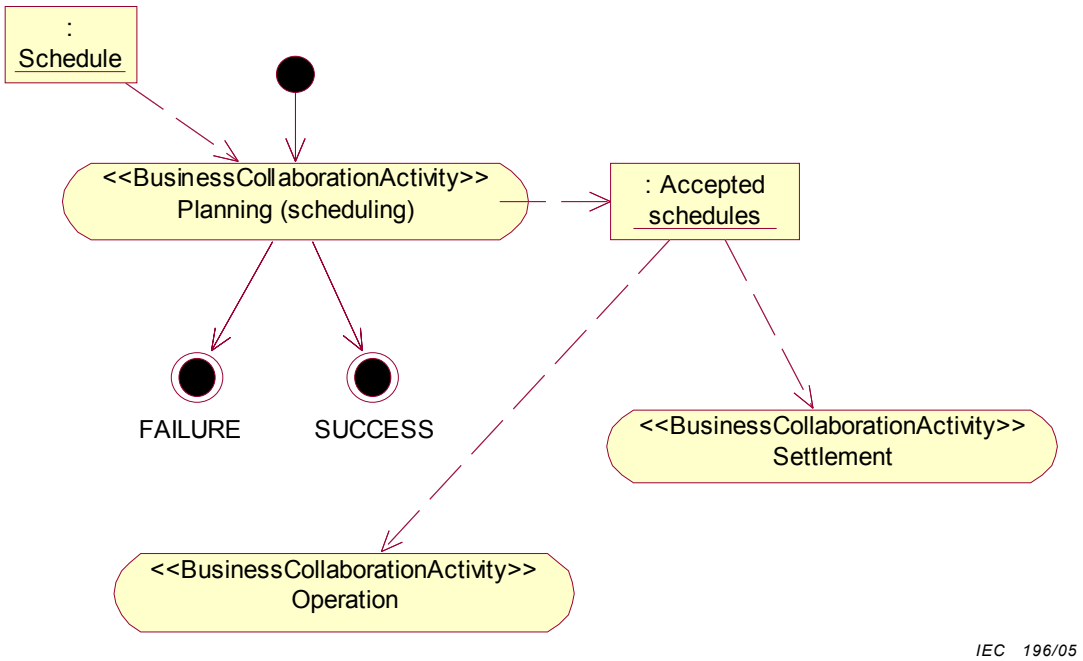


Figure 9 – Activity diagram planning process of scheduling

5.2 Business requirement workflow

5.2.1 General

The purpose of the Business Requirements workflow is to capture the detailed user requirements, specified by the stakeholders, for the business-to-business project. The business models derived from the Business Modelling workflow are used as important inputs to identify use cases and to provide the framework for understanding of the requirements. This workflow develops the Business Requirements View (BRV) of a process model that specifies the use case scenarios, input and output triggers, constraints and system boundaries for business transactions, business collaborations and their interrelationships.

Table 14 shows the workflow for methodology and model artefacts.

Table 14 – Methodology and model artefacts

Workflow	Methodology	Model artefacts (BRV with UML)
Business Modelling	Requirements gathering	Detailing of the BOM
	Use Case Analysis	Use cases of business collaborations, transactions
	Process Analysis	Use case identification of business processes
	Activity Modelling	Activity diagrams of business collaborations

Deliverables for the Business Requirement workflow are expansions to any or all of the Business Operations Map (BOM) deliverables including the scope for the business-to-business project, requirements list, glossary, use case diagrams and descriptions and activity diagrams. The requirements list and glossary are omitted here for reasons of space.

The main focus of the Business Requirements workflow is on business collaborations and business collaboration protocols.

5.2.2 Market activity diagram

The market activity diagram shown in Figure 10 gives a conceptual overview of the functional decomposition of the energy market in business areas, business processes, and business collaborations without going too much into detail. The swim lanes represent core business areas. Business processes, which represent market services, do not have their own swim lanes and are mapped to the core business areas, which they serve.

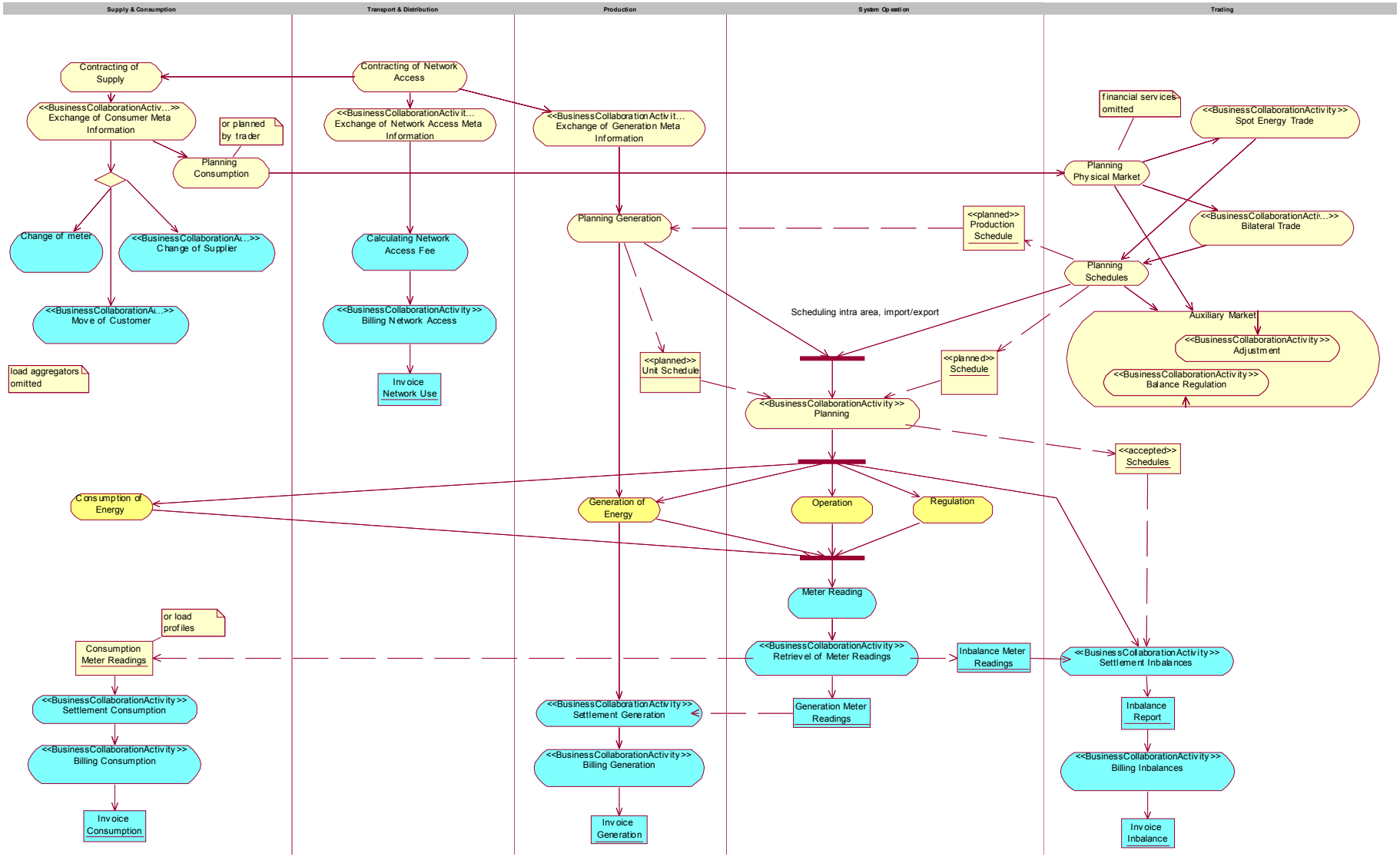


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Figure 10 – Overall conceptual market activity diagram

5.2.3 Business process use cases

5.2.3.1 General

The process area planning within the business area system operation is now expanded to describe the business process use cases. In UMM, process areas are normally viewed as subcategories within business areas. Alternatively, process areas can be modelled as separate dimensions used to classify processes.

5.2.3.2 Use case worksheet

As an example, Table 15 shows the description of the business process use case “scheduling (intra area)” within the process area planning. For the business process scheduling, a chronological order of phases within more encompassing use cases is applied. This sub use cases are described later as collaborations.

Table 15 – Business process use case scheduling (intra area)

Form: Describe business process use case	
Business process name	**Scheduling (intra area)**
Identifier	To be supplied.
Actors	System operators, balance responsible parties.
Performance goals	Balance the schedules.
Preconditions	Reliable power system.
Begins when	The planned schedules are send by the balance responsible parties to the system operator.
Definition	Schedules are balanced and accepted if the planned generation meets the planned load, taking into account the overall power system condition.
Ends when	The accepted schedules are send by the system operator to the balance responsible parties.

5.2.3.3 Use case diagram

Figure 11 shows as an example the refined use case diagram “system operation” from the business modelling workflow. The business area “system operation” is further subdivided into the process area use cases “planning”, “operation”, and “settlement”. The process area use case settlement from the package service is included here to give a complete overview beyond package boundaries. The process area planning includes the processes scheduling (intra area) and import/export.

In the process scheduling (intra area), the balance responsible parties send their planned schedules about trade, supply (load) and generation to the system operator to check any imbalance. The process is further detailed in the chronological phases: message validation, balance validation, and system analysis. These three phases are transactions within a collaboration and cannot be further divided. Note that in this case the process scheduling (intra area) has only one collaboration with the same name.

In the operation phase, the plans are executed and the system is balanced with auxiliary services taking care of network congestion and reliability. In the settlement phase, any imbalance (difference between actual meter readings or load profiles and schedules) is billed to the balance responsible.

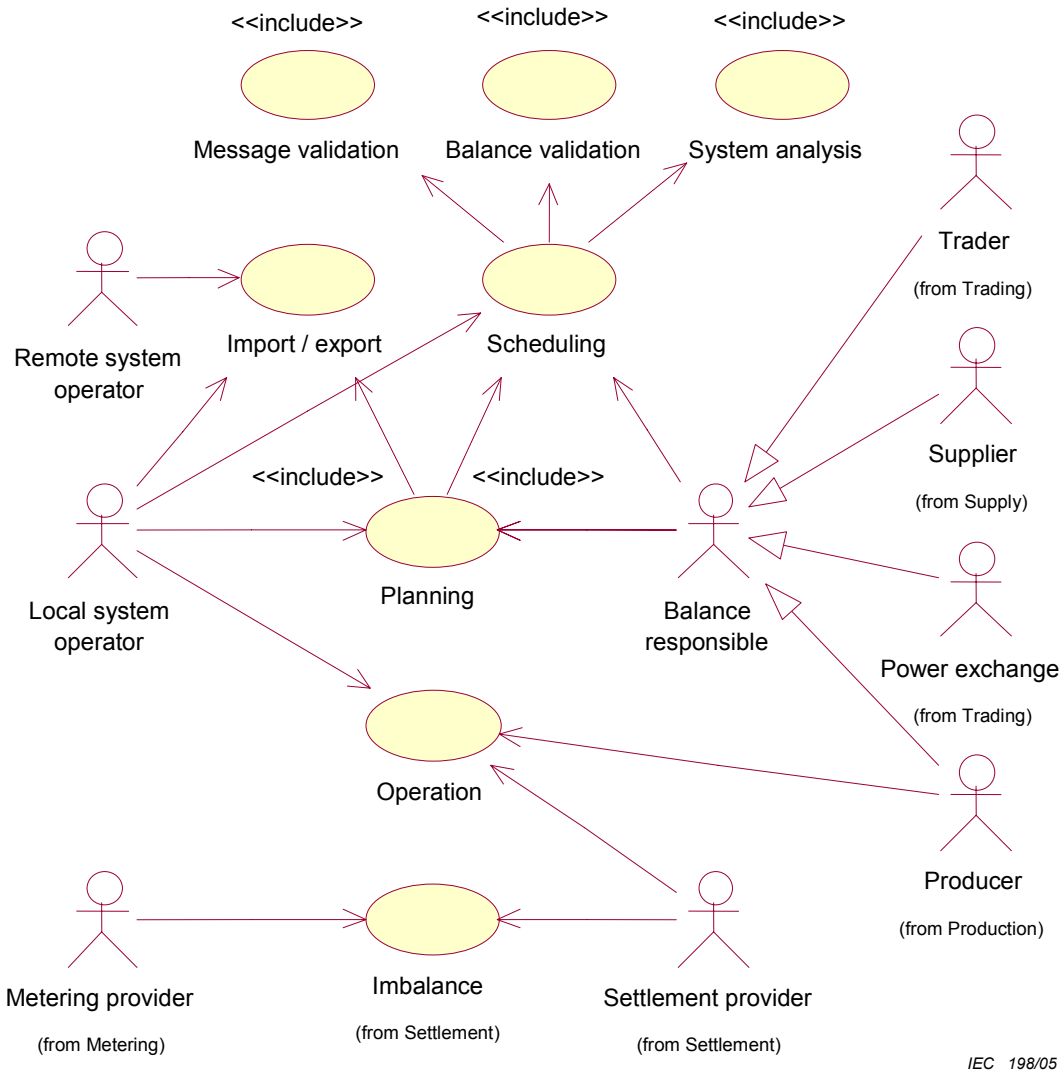


Figure 11 – Use case system operation

5.2.4 Business collaborations

5.2.4.1 Collaboration worksheets

See Tables 16 and 17.

Table 16 – Business collaboration planning (scheduling)

Form: Describe business collaboration	
Identifier	To be supplied.
Description	**Planning (scheduling)**
Partner Types	System operator, Balance responsibles.
Authorized roles	Schedule requester, balance provider.
Legal steps/requirements	The system operator should balance the system.
Economic consequences	The balance responsible is required to cover the cost of imbalance.
Initial/terminal events	Initial: the balance responsible sends his schedules to the system operator. Terminal: the schedule is valid if confirmed by the system operator.
Scope	A pre-existing framework contract between the balance responsibles and the system operator defines rules and cost of balancing.
Boundary	Balance responsibles and system operators have IT-systems for scheduling management.
Constraints	All schedules send to the system operator should be balanced. System congestion and outages may afford re-scheduling of generation.

Table 17 – Business collaboration protocol table

Form: Business collaboration protocol table				
Identifier	**To be supplied.**			
From business transaction activity	**Initiating partner type**	**To business transaction activity**	**Responding/receiving partner type**	**Transition condition**
START	Balance responsible	Schedule exchange	System operator	NONE
Schedule exchange	System operator	Balance validation	N/A	… = SUCCESS
Schedule exchange	System operator	Schedule exchange	Balance responsible	… = FAILURE
Schedule exchange	Balance responsible	FAILURE	N/A	… = FAILURE
Balance validation	System operator	System analysis	N/A	… = SUCCESS
Balance validation	System operator	Schedule exchange	Balance responsible	… = FAILURE
System analysis	System operator	SUCCESS	N/A	… = SUCCESS
System analysis	System operator	System analysis	Balance responsible	… = FAILURE

5.2.4.2 Collaboration use case diagrams

Figure 12 shows the business collaboration use case planning.

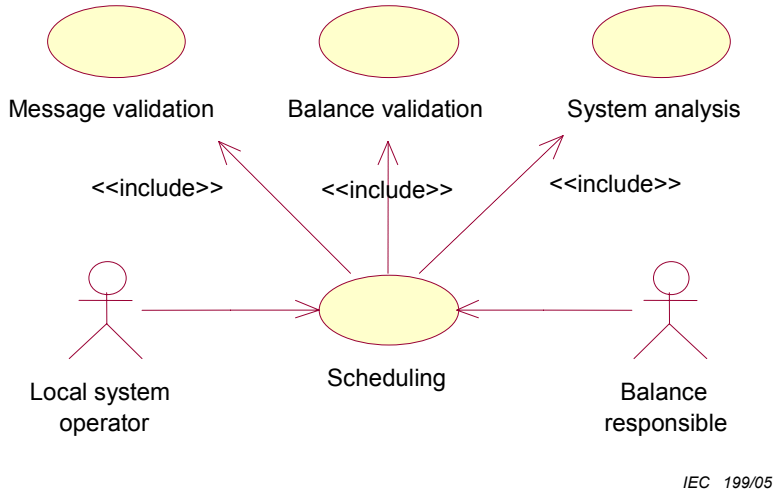


Figure 12 – Business collaboration planning (scheduling)

5.2.4.3 Collaboration activity diagrams

Figure 13 shows as an example, the collaboration activity diagram of the collaboration scheduling, which is a more detailed version of the corresponding diagram in the business modelling workflow. The diagram covers the above-mentioned three phases of scheduling with the transaction activities schedule exchange with message validation (phase 1), balance validation (phase 2), and system analysis (phase 3). The classes planned schedules, message evaluated schedules and accepted schedules are stereotypes of the class schedule and represent the state before or after an activity. The accepted schedules are the input state for the imbalance settlement activity (which is not shown).

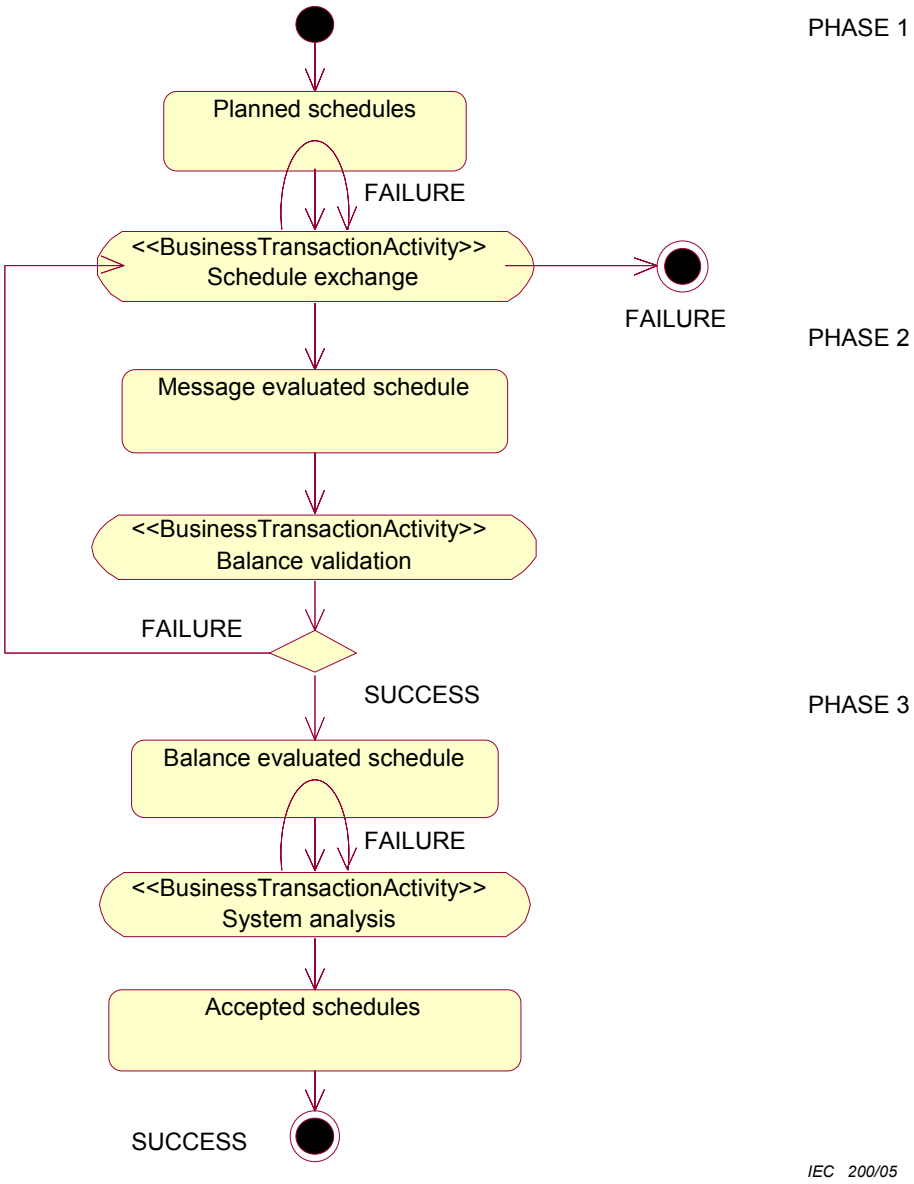


Figure 13 – Activity diagram of the planning process (scheduling)

5.3 Analysis workflow

5.3.1 General

The purpose of the analysis workflow is to translate the requirements identified in the business requirements workflow into a specification that enables software developers and message designers to design and implement electronic business solutions. Analysis goals are:

- to build a set of business objects from the requirements workflow,
- to transform the requirements into a precise, object oriented specification,
- to provide a foundation for the design of electronic information exchange,
- to provide system integrators interfaces to hook into their existing information systems,
- to explicitly specify the dynamics of the business system.

Table 18 shows the workflow for methodology and model artefacts.

Table 18 – Methodology and model artefacts

Workflow	Methodology	Model artefacts (BTV with UML)
Analysis	Process analysis	
	Activity modelling	Business collaboration protocol [activity diagram] Business transactions [activity diagram]
	Conceptual class modelling	Business documents (conceptual)

The main focus of the Business Analysis workflow is on business transactions.

5.3.2 Business transaction worksheets and activity diagrams

With the following worksheets (Tables 19 to 27) and activity diagrams (Figures 14 to 16), the three chronological transactions of the business collaboration scheduling are described where the result of one is the input for the other.

Scheduling phase 1

Table 19 shows the business transaction-scheduling phase 1.

Table 19 – Business transaction scheduling phase 1

Form: Describe business transaction	
Identifier	To be supplied.
Description	Scheduling phase 1 (schedule validation).
Pattern	Business transaction.
Business activities and associated authorised roles	Schedule validation request.
Constraints	Schedule is balanced.
Initiating/requesting partner type	Balance responsible.
Initiating/requesting activity role	Schedule requestor.
Initiating/requesting activity document	Schedule.
Responding partner type	System operator.
Responding activity role	Schedule provider.
Responding activity document	Acknowledgement report.

Table 20 shows the business transaction property values of scheduling phase 1 (schedule validation). The time to acknowledge receipt is for the XML schema validation (structure), the time to acknowledge acceptance is for the XML content validation and the time to perform is for the response message with the acknowledgement report. The time to acknowledge acceptance is not used because content validation is performed by the application (see time to perform) itself.

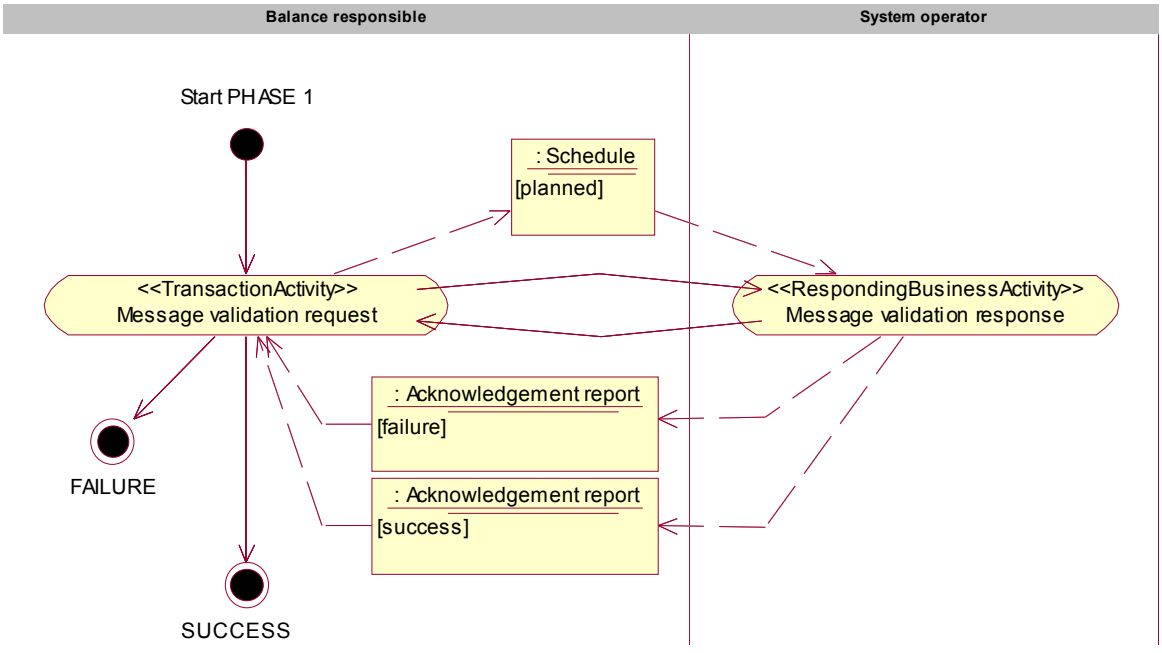
Table 20 – Business transaction property values

Form: Business transaction property values							
Form ID	**Scheduling phase 1 (schedule validation).**						
	Time to acknowledge receipt	Time to acknowledge acceptance	Time to perform	Authorization required	Non-repudiation of origin and content	Non-repudiation of receipt	Recurrence
Requesting business activity	1 min	1 min	1 h	true	true	true	3
Responding business activity	1 min	1 min	1 h	true	true	true	

Table 21 – Business transaction transition table

Form: Business transaction transition table					
Form ID	**Scheduling phase 1 (schedule validation)**				
From activity	**From rule**	**Document**	**To activity**	**To role**	**Guard condition**
START	N/A	N/A	Message validation request	Schedule requestor	NONE
Message validation request	Schedule requestor	Planned schedule	Message validation response	Schedule provider	NONE
Message validation response	Schedule provider	Acknowledgement report	SUCCESS	N/A	
Message validation response	Schedule provider	Acknowledgement report	FAILURE	N/A	

Figure 14 shows the corresponding business transaction activity diagram. The e-business situation is modelled with two swim lanes grouping the actors and activities of transactions.



IEC 201/05

Figure 14 – Business transaction activity diagram planning phase 1

Scheduling phase 2

Table 22 shows the business transaction scheduling phase 2.

Table 22 – Business transaction scheduling phase 2

Form: Describe business transaction	
Identifier	To be supplied.
Description	Scheduling phase 2 (balance validation).
Pattern	Business notification.
Business activities and associated authorised roles	Balance validation notification.
Constraints	Schedule is balanced. No network outages and congestions within the control areas.
Initiating/requesting partner type	Balance responsible.
Initiating/requesting activity role	Schedule provider.
Initiating/requesting activity document	Acknowledgement report.
Responding partner type	Balance responsible.
Responding activity role	Schedule requestor.
Responding activity document	N/A

Table 23 shows the business transaction property values of scheduling phase 2 (balance validation). The time to acknowledge receipt is for the XML schema validation (structure), the time to acknowledge acceptance is for the XML content validation and the time to perform is for the response message with the acknowledgement report. The time to acknowledge acceptance is not used because content validation is performed by the application (see time to perform) itself.

Table 23 – Business transaction property values

Form: Business transaction property values							
Form ID	**Scheduling phase 2 (balance validation)**						
	Time to acknowledge receipt	Time to acknowledge acceptance	Time to perform	Authorisation required	Non-repudiation of origin and content	Non-repudiation of receipt	Recurrence
Notification business activity	1 min	null	1 h	false	true	true	3
Responding business activity	null	null	null	false	false		

Table 24 – Business transaction transition table

Form: Business transaction transition table					
Form ID	**Scheduling phase 2 (balance validation)**				
From activity	**From rule**	**Document**	**To activity**	**To role**	**Guard condition**
START	N/A	N/A	Balance validation notification	Schedule provider	NONE
Balance validation notification	Schedule provider	Planned schedule	SUCCESS	N/A	
Balance validation notification	Schedule provider	Anomaly report	FAILURE	Schedule requestor	

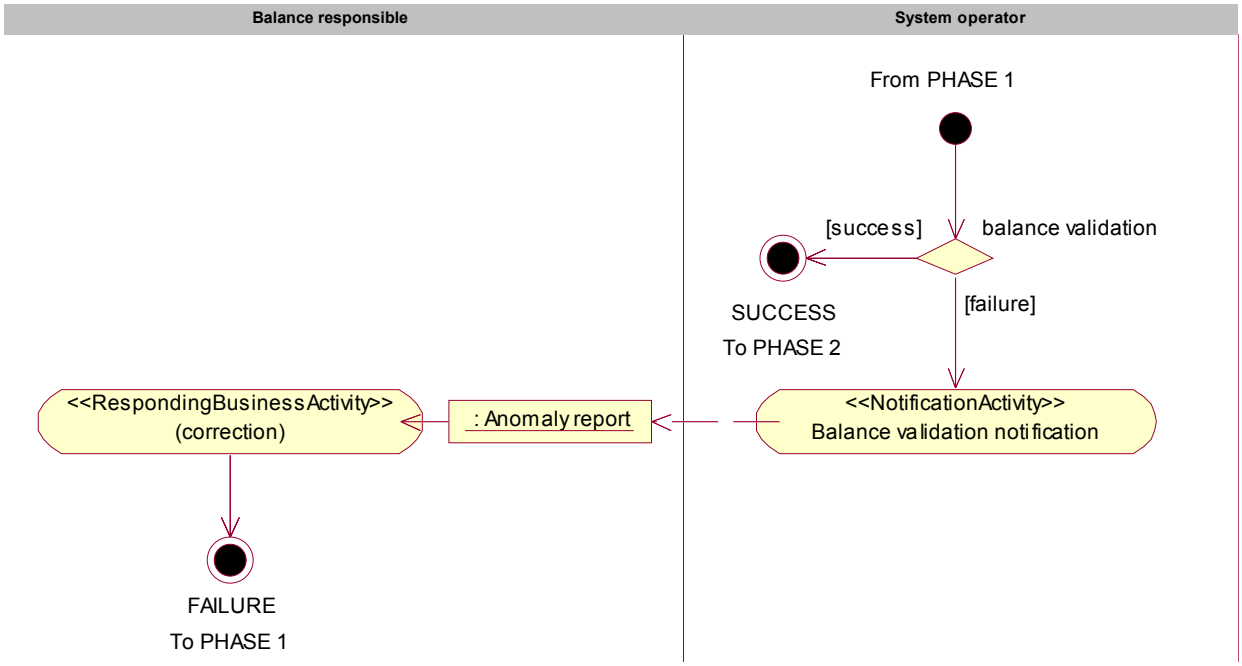


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Figure 15 – Business transaction activity diagram planning phase 2

Scheduling phase 3

Table 25 shows the business transaction scheduling phase 3.

Table 25 – Business transaction scheduling phase 3

Form: Describe business transaction	
Identifier	To be supplied.
Description	Scheduling phase 3 (system validation).
Pattern	Business notification.
Business activities and associated authorised roles	System validation notification.
Constraints	Schedule is balanced. No network outages and congestions cross control areas.
Initiating/requesting partner type	System operator.
Initiating/requesting activity role	Schedule provider.
Initiating/requesting activity document	Schedule.
Responding partner type	Balance responsible.
Responding activity role	Schedule requestor.
Responding activity document	Confirmation report.

Table 26 shows the business transaction property values of scheduling phase 3 (schedule validation). The time to acknowledge receipt is for the XML schema validation (structure), the time to acknowledge acceptance is for the XML content validation and the time to perform is for the response message with the acknowledgement report. The time to acknowledge acceptance is not used because content validation is performed by the application (see time to perform) itself.

Table 26 – Business transaction property values

Form: Business transaction property values							
Form ID	**Scheduling phase 3 (system analysis)**						
	Time to acknowledge receipt	Time to acknowledge acceptance	Time to perform	Authorisation required	Non-repudiation of origin and content	Non-repudiation of receipt	Recurrence
Requesting business activity	5 min	N/A	1 h	true	true	true	3
Responding business activity	5 min	N/A	1 h	true	true	true	

Table 27 – Business transaction transition table

Form: Business transaction transition table					
Form ID	**Scheduling phase 3 (system analysis)**				
From activity	**From rule**	**Document**	**To activity**	**To role**	**Guard condition**
START	N/A	N/A	System validation notification	Schedule provider	NONE
System validation notification	Schedule provider	Confirmation report	SUCCESS	Schedule requestor	

Figure 16 shows the corresponding business transaction activity diagram. The result is forwarded to the imbalance settlement business activity which is not further detailed here.

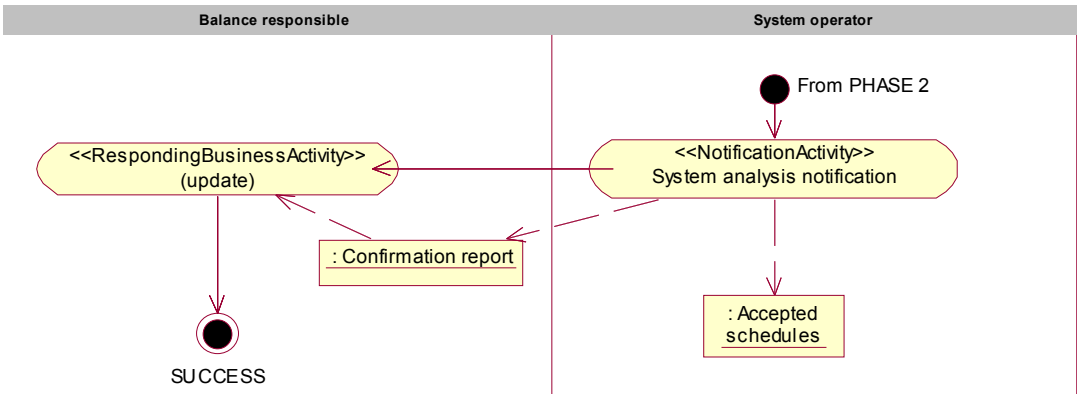


Figure 16 – Business transaction activity diagram planning phase 3

5.3.3 Conceptual class diagrams of messages

Figure 17 shows the conceptual class diagrams of the messages and their interrelation. The schedule message consists of the message header and multiple time series with each of the latter including time interval quantities (for example power in megawatt for each quarter of a hour).

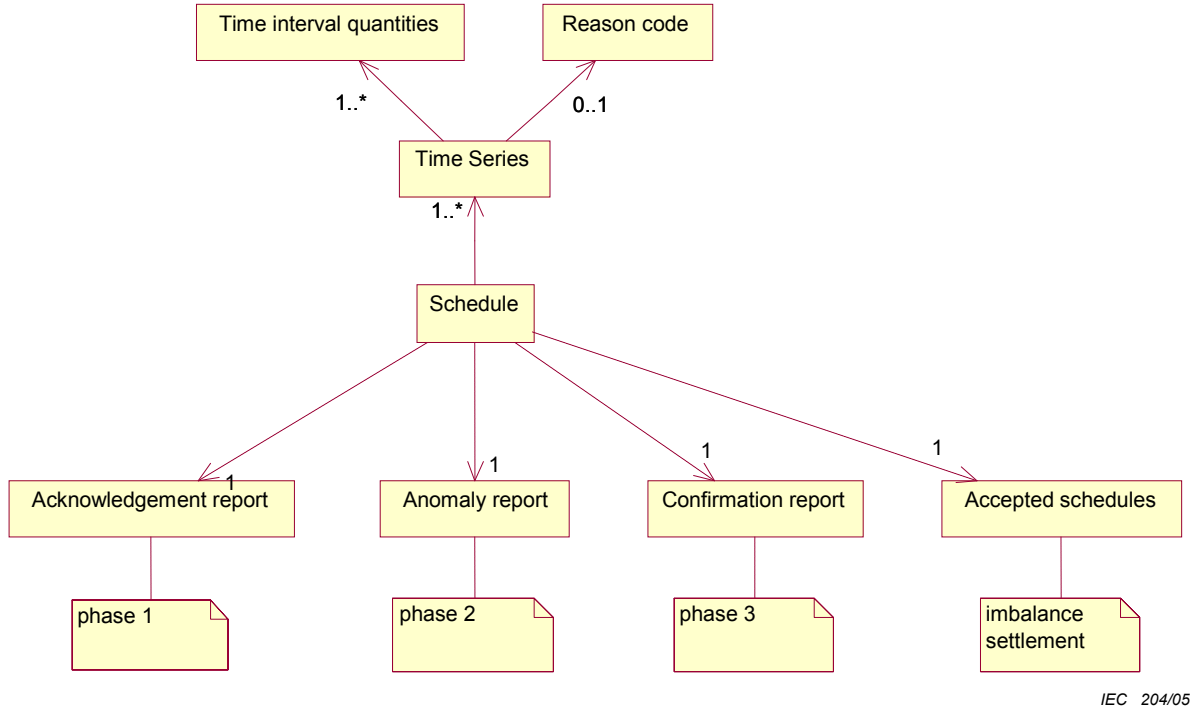


Figure 17 – Conceptual class diagram of the schedule messages

5.4 Design workflow

5.4.1 General

The purpose of the design workflow is:

- To develop an information model from the conceptual class diagram in the analysis workflow.
- To develop a business service view that describes the business collaborations amongst networked components.
- To develop class diagrams that describe the business messages exchanged (business actions and signals) in a business collaboration.
- Integrate the information model into an inter-industry model.
- Integrate business objects into the information model.
- Select business service interaction patterns to describe each exchange.

Table 28 shows the workflow for methodology and model artefacts.

Table 28 – Methodology and model artefacts

Workflow	Methodology	Model artefacts (BSV with UML)
Design	Process analysis	Detailing of the BDV
	Collaboration modelling	Service collaborations [object collaboration] Network component [class diagram] Business service [class diagram]
	Message sequencing	Service transactions [sequence diagrams]
	Information modelling	Activity diagrams of business collaborations
	Business message modelling	Business documents [class diagrams]

The main focus of the Business Requirements workflow is on class diagrams of messages and on business service. The business service view (BSV) models the dynamic aspects of business collaborations.

5.4.2 Class diagrams

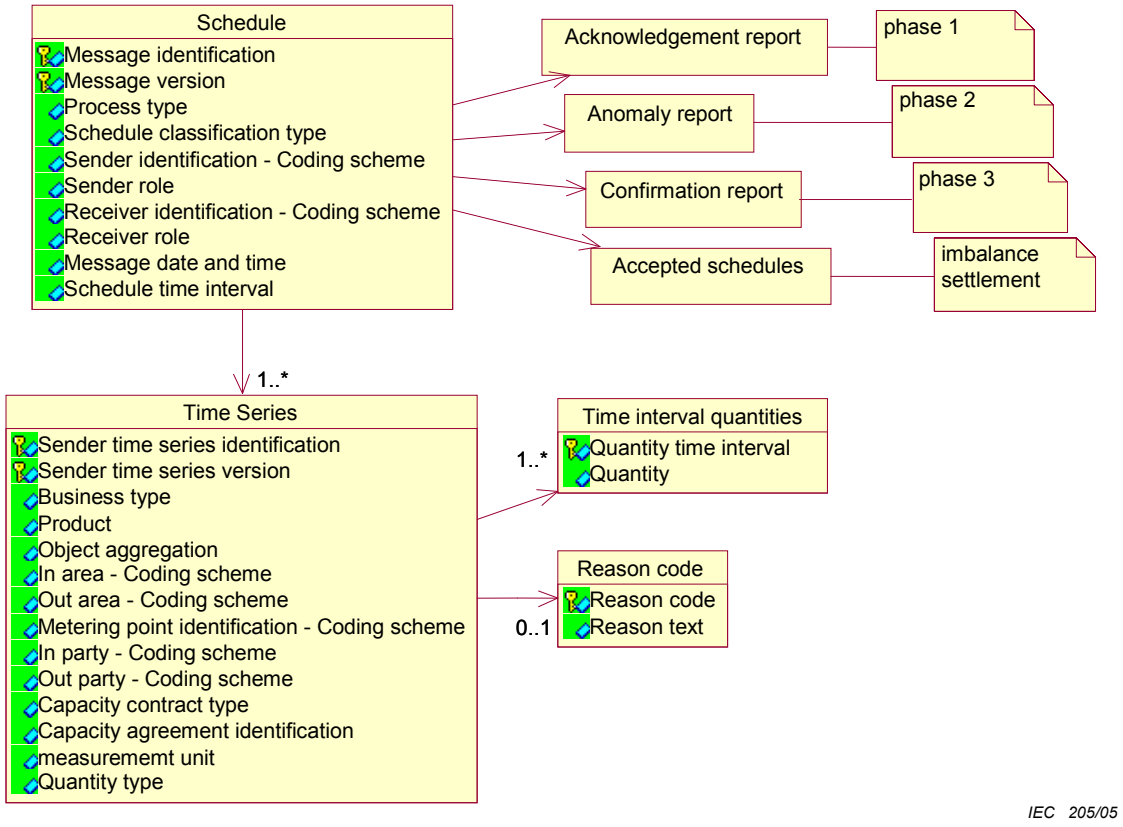


Figure 18 – Class diagram of the schedule document

5.4.3 Sequence diagrams

5.4.3.1 General

Sequence diagrams model the message flow in time. The sequence diagram of the scheduling business process in Figure 19 is derived from the business modelling workflow use case and activity diagram and shows the scheduling business process with the three phases mentioned above.

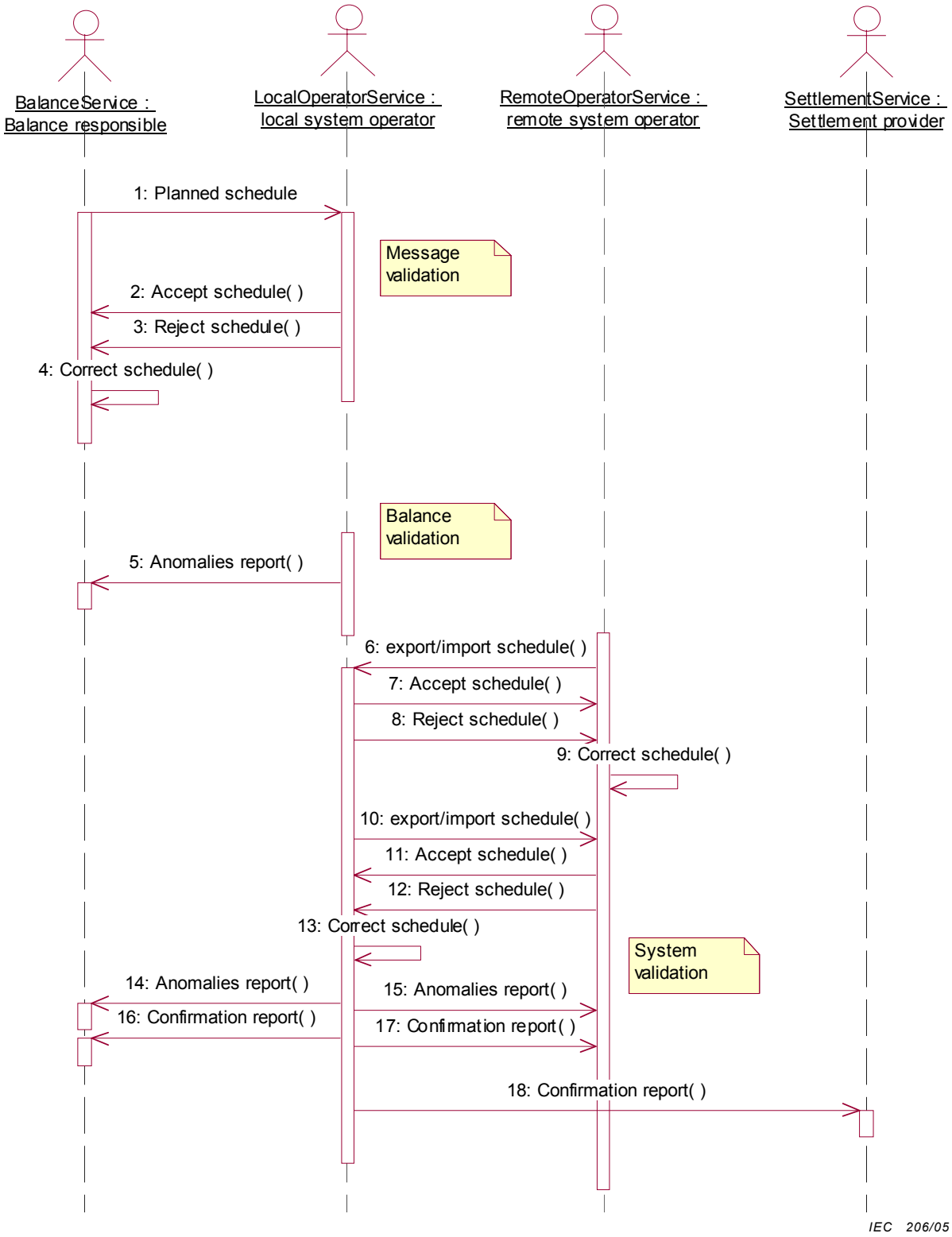
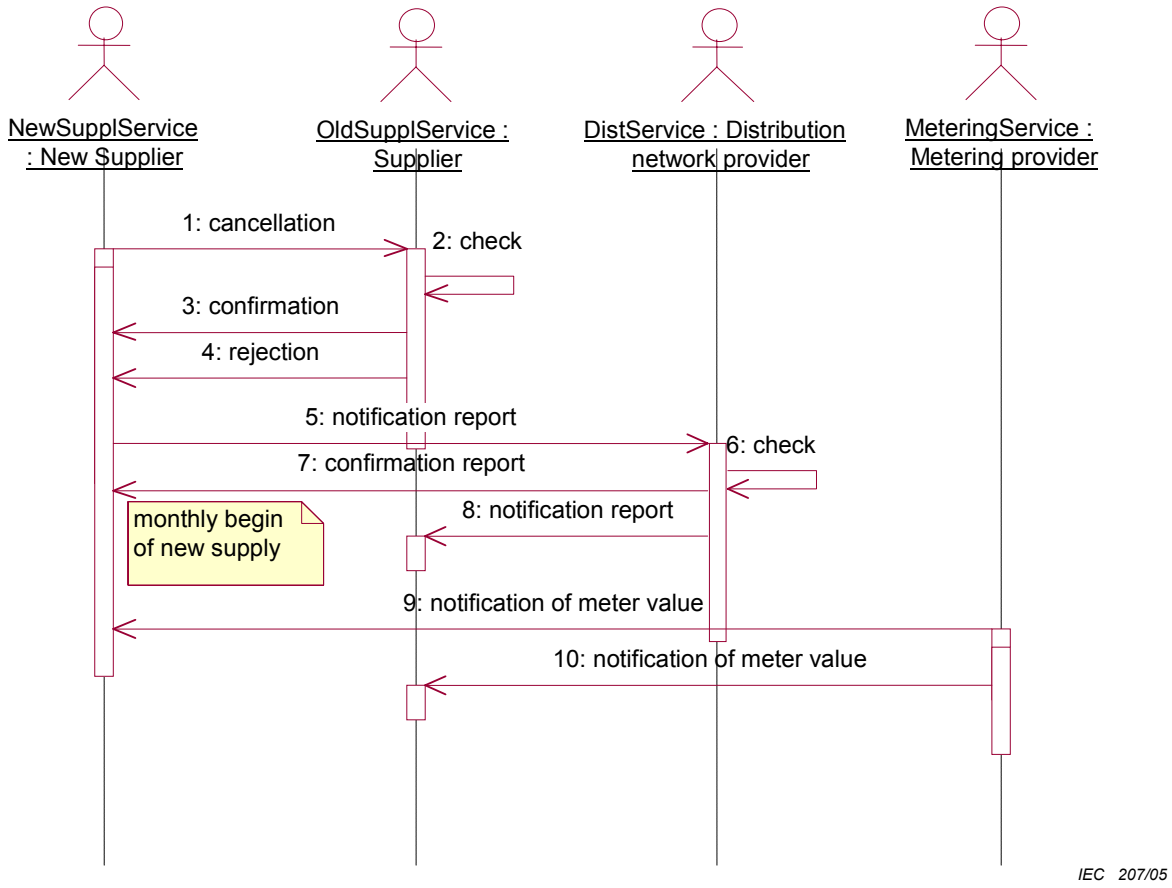


Figure 19 – Sequence diagram of the planning (scheduling) business process

For reasons of space, the change of supplier model is not represented here. But to give an idea of the model, Figure 20 shows as an example the sequence diagram.



[1)] The new supply with changed supplier does not begin in the middle of the month but at the beginning of the month (first day of the month).

Figure 20 – Sequence diagram of change of supplier

5.4.3.2 Class diagram

In the design workflow the detailed class diagrams of the messages (business documents) are worked out. For reasons of space the class diagrams are omitted here.

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