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Contents

Scope and Content.....	4
Use Cases	5
1.1 Participant Authentication.....	5
2.1 Open Capacity Reservation Market	5
2.2 Placing Capacity Reservation Market Offer	6
2.3 Close Capacity Reservation Market	6
3.1 Open Reserve Activation Market.....	7
3.2 Placing Reserve Activation Market Offer	7
3.3 Close Reserve Activation Market	8
4.1 Activation	8
5.1 Settlement of Capacity Reservation Market.....	9
5.2 Settlement of Reserve Activation Market	9
6.1 Observe Markets.....	9
6.2 Observe Offers/Contracts	10
6.3 Observe Payments/Invoices.....	10
Implementation	11
Component Diagram.....	11
Sequence Diagrams.....	12
2.1 Open Capacity Reservation Market	12
2.2 Placing Capacity Reservation Market Offer	12
2.3 Close Capacity Reservation Market	12
3.1 Open Reserve Activation Market.....	13
3.2 Placing Reserve Activation Market Offer	13
3.3 Close Reserve Activation Market	13

4.1 Activation	14
5.1 Settlement of Capacity Reservation Market.....	14
5.2 Settlement of Reserve Activation Market	14
6.1 Observe Markets.....	15
6.2 Observe Offers	15
6.3 Observe Contracts.....	15
FLECH Message Definition	16

Scope and Content

The purpose of this document is to describe the interactions of DSOs and Aggregators with the Flexibility Clearing House (FLECH) from the perspective of an actual implementation. Communication between the three parties is based on a central message broker service.

The whole auction process is assumed to consist of two separate phases. In the first phase, a DSO sends a capacity request to the market asking for flexibility in some fixed future delivery period. This might happen several months or even years in advance. Once aggregators have placed their offers and the market has closed, FLECH clears the offers according to the merit order. All Aggregators are notified by the market of the status of their offers (either accepted or rejected).

The second phase starts ahead but close to the delivery period. Whenever a DSO is actually interested in an activation that falls into an upcoming delivery period, he explicitly asks the FLECH to open the corresponding activation market. The market then immediately notifies all Aggregators that got reserved in the first place as well as Aggregators that did not get reserved but could potentially deliver flexibility. Similar to the capacity market, the Aggregators' activation offers are collected by FLECH and the activation market is cleared. The DSO is informed about the accepted offers and Aggregators are informed about the status of their offers.

The DSO now has one or more contracted resources that can be activated during the delivery period. The activation is done solely between the DSO and the Aggregator and FLECH is not involved.

After the delivery period, FLECH communicates invoice and payment records to the participants involved in the markets.

The document is structured in three main sections, first the description of the use cases, secondly, the description of the implementation with sequence diagrams for each use case. Finally, the specification of the message contents is shown using XML Schema Definition.

Use Cases

This section lists use-cases that describe the communication process depicted in figure 2 between buyers of flexibility, sellers of flexibility and the clearing house (FLECH) in more detail. Whenever the actor field of a use-case lists 'participant', it refers to either a buyer or a seller.

1.1 Participant Authentication

Name	Use-Case Participant Authentication
Description	Authenticates a participant at the FLECH. The participant's credentials are verified against the information stored at the FLECH's user database. Furthermore, the location the participant is sending from is checked against the list of valid locations for that participant. Finally, FLECH checks whether the participant is allowed to send a message of this type depending on his role (buyer or seller).
Actors	FLECH, Participant
Pre-Condition	
Post-Condition	<ul style="list-style-type: none"> If the authentication succeeds, the message is approved to be processed by the FLECH.
Trigger	A new message is being processed at the FLECH
Basic Flow	<ol style="list-style-type: none"> A participant sends a message together with his credentials. In case of a failed authentication, the reply sent by FLECH informs the participant about the failure.
Alternate Flow	
Comments	This process is invoked whenever a new message arrives at the FLECH and the information necessary for authentication is part of every message.

2.1 Open Capacity Reservation Market

Name	Use-Case Open Capacity Reservation Market
Description	To reserve capacity in the future, a DSO opens a new capacity reservation market in FLECH. All sellers that could potentially deliver flexibility are informed by FLECH.
Actors	Buyer, FLECH, Seller
Pre-Condition	<ul style="list-style-type: none"> Successful Participant Authentication
Post-Condition	<ul style="list-style-type: none"> The FLECH has stored the information for the CRM and notified all the relevant sellers. The buyer that opened the CRM has been notified about the success/failure of opening the CRM.
Trigger	Buyer demand

Basic Flow	<ol style="list-style-type: none"> 1. The Buyer sends a request to FLECH specifying the new market and conditions. 2. All sellers receive a notification with all information necessary to place offers. 3. The Buyer receives an acknowledgement with the status and market ID of his new market.
Alternate Flow	<ul style="list-style-type: none"> • If opening the capacity market is not possible, the Buyer receives a negative acknowledgement and no sellers are notified.
Comments	

2.2 Placing Capacity Reservation Market Offer

Name	Use-Case Placing Capacity Reservation Market Offer
Description	For an open capacity reservation market sellers can submit any number of offers.
Actors	Seller, FLECH
Pre-Condition	<ul style="list-style-type: none"> • Successful Participant Authentication • An existing CRM has been opened by a buyer
Post-Condition	<ul style="list-style-type: none"> • The FLECH has stored the information for the CRM offers. • The seller that placed the CRM offer has been notified about the success/failure of the placement.
Trigger	Available flexibility of an aggregator after a new market has been opened.
Basic Flow	<ol style="list-style-type: none"> 1. The Seller sends an offer to FLECH. 2. FLECH acknowledges the offer with the status.
Alternate Flow	
Comments	

2.3 Close Capacity Reservation Market

Name	Use-Case Close Capacity Reservation Market
Description	The CRM closes and clears the market by selecting the minimum cost combination of offers based on the desired volume and other pre-conditions.
Actors	FLECH, Seller, Buyer
Pre-Condition	<ul style="list-style-type: none"> • An existing open CRM
Post-Condition	<ul style="list-style-type: none"> • The CRM is closed and not accepting any more offers. • The buyer knows about the offers that got accepted and therefore bought by the buyer. • The sellers know if their offers got accepted or rejected. • Information on acceptance/rejection is stored in FLECH for future use.
Trigger	Trigger at the time when the CRM is scheduled to close.
Basic Flow	<ol style="list-style-type: none"> 1. After the closing time FLECH acknowledge incoming offers with the

	<p>information that the market is closed.</p> <ol style="list-style-type: none"> 2. FLECH receives historical data from the Buyer 3. FLECH clears the market and labels all offers with accept or reject. 4. Sellers are notified with the status of their offer 5. Buyer is notified with the details of the accepted offers.
Alternate Flow	
Comments	

3.1 Open Reserve Activation Market

Name	Use-Case Open Reserve Activation Market
Description	To buy activation reserves in the near future, a DSO opens a new reserve activation market (RAM) in FLECH. All sellers that could potentially deliver flexibility in the near future are informed by FLECH.
Actors	Buyer, FLECH, Seller
Pre-Condition	<ul style="list-style-type: none"> • Successful Participant Authentication
Post-Condition	<ul style="list-style-type: none"> • The FLECH has stored the information for the RAM and notified all the relevant sellers. • The buyer that opened the RAM has been notified about the success/failure of the opening of the RAM.
Trigger	Buyer demand
Basic Flow	<ol style="list-style-type: none"> 1. The Buyer sends an open activation market request to FLECH specifying the new market and conditions. 2. All sellers receive a notification with all information necessary to place offers. 3. The Buyer receives a message with the status and market ID of his new market.
Alternate Flow	<ul style="list-style-type: none"> • If opening the activation market is not possible, the Buyer receives a negative acknowledgement and no sellers are notified.
Comments	All sellers that had an accepted CRM offer also have a forced offer in the RAM.

3.2 Placing Reserve Activation Market Offer

Name	Use-Case Placing Reserve Activation Market Offer
Description	For an open capacity reservation market sellers can submit any number of offers.
Actors	Seller, FLECH
Pre-Condition	<ul style="list-style-type: none"> • Successful Participant Authentication • An existing RAM has been opened by a buyer
Post-Condition	<ul style="list-style-type: none"> • The FLECH has stored the information for the RAM offers. • The seller that placed the RAM offer has been notified about the success/failure of the placement.

Trigger	Available flexibility of an aggregator after an notification of a new open activation market has arrived.
Basic Flow	<ol style="list-style-type: none"> 1. The Seller sends an offer to FLECH. 2. FLECH acknowledges the offer
Alternate Flow	
Comments	All sellers that had an accepted CRM offer also have a forced offer in the RAM.

3.3 Close Reserve Activation Market

Name	Use-Case Close Reserve Activation Market
Description	The RAM closes and clears the market by selecting the minimum cost combination of offers based on the desired volume and other pre-conditions.
Actors	FLECH, Seller, Buyer
Pre-Condition	<ul style="list-style-type: none"> • An existing open RAM
Post-Condition	<ul style="list-style-type: none"> • The RAM is closed and not accepting any more offers. • The buyer knows about the offers that got accepted and therefore bought by the buyer. • The sellers know if their offers got accepted or rejected. • Information on acceptance/rejection is stored in FLECH for future use.
Trigger	Trigger at the time when the RAM is scheduled to close.
Basic Flow	<ol style="list-style-type: none"> 1. After the closing time FLECH acknowledge incoming offers with the information that the market is closed. 2. FLECH receives historical data from the Buyer 3. FLECH clears the market and labels all offers with accept or reject. 4. Sellers are notified with the status of their offer 5. Buyer is notified with the details of the accepted offers.
Alternate Flow	
Comments	All sellers that had an accepted CRM offer also have a forced offer in the RAM.

4.1 Activation

Name	Use-Case Activation
Description	This use-case is not part of FLECH but is essential for reaching the goal with FLECH.
Actors	Buyer, Seller
Pre-Condition	<ul style="list-style-type: none"> • An accepted Activation offer for an existing RAM
Post-Condition	<ul style="list-style-type: none"> • Seller has delivered flexibility
Trigger	Buyer demand according to the conditions set in the market opening phase
Basic Flow	<ol style="list-style-type: none"> 1. Buyer informs Seller about activation

Alternate Flow	
Comments	It is unclear how the Buyer informs the Seller.

5.1 Settlement of Capacity Reservation Market

Name	Use-Case Settlement of Capacity Reservation Market
Description	The information of invoices and payments are communicated to the participants
Actors	Buyer, FLECH, Sellers (with accepted CRM offers)
Pre-Condition	<ul style="list-style-type: none"> • An existing CRM period has passed
Post-Condition	<ul style="list-style-type: none"> • Buyer and Seller have the information about payments and invoices
Trigger	Triggered after market period has passed, or with a fixed delay afterward.
Basic Flow	<ol style="list-style-type: none"> 1. Payment information is sent to Seller 2. Invoice information is sent to Buyer
Alternate Flow	<ul style="list-style-type: none"> •
Comments	

5.2 Settlement of Reserve Activation Market

Name	Use-Case Settlement of Reserve Activation Market
Description	The information of invoices and payments are communicated to the participants
Actors	Buyer, FLECH, Seller (with accepted RAM offers)
Pre-Condition	<ul style="list-style-type: none"> • An existing RAM (with existing CRM) period has passed
Post-Condition	<ul style="list-style-type: none"> • Buyer and Seller have the information about payments and invoices
Trigger	Triggered after market period has passed, or with a fixed delay afterward.
Basic Flow	<ol style="list-style-type: none"> 1. Payment information is sent to Seller 2. Invoice information is sent to Buyer
Alternate Flow	<ul style="list-style-type: none"> •
Comments	

6.1 Observe Markets

Name	Use-Case Observe Markets
Description	Observe existing and historical markets
Actors	Buyer, Seller, FLECH Operator
Pre-Condition	<ul style="list-style-type: none"> • There are existing markets
Post-Condition	<ul style="list-style-type: none"> • Information about historic and current market is known by actor

Trigger	Triggered by the actor
Basic Flow	1.
Alternate Flow	•
Comments	Not yet defined if this will be a HTTP REST interface or a JMS interface

6.2 Observe Offers/Contracts

Name	Use-Case Observe Offers/Contracts
Description	Observe existing and historical offers and contracts
Actors	Buyer, Seller, FLECH Operator
Pre-Condition	<ul style="list-style-type: none"> • There are existing offers/contracts
Post-Condition	<ul style="list-style-type: none"> • Information about historic and current offers/contracts is known by actor
Trigger	Triggered by the actor
Basic Flow	1.
Alternate Flow	•
Comments	Not yet defined if this will be a HTTP REST interface or a JMS interface

6.3 Observe Payments/Invoices

Name	Use-Case Observe Payments/Invoices
Description	Observe existing and historical payments and invoices
Actors	Buyer, Seller, FLECH Operator
Pre-Condition	<ul style="list-style-type: none"> • There are existing payment/invoices
Post-Condition	<ul style="list-style-type: none"> • Information about historic payment/invoices is known by actor
Trigger	Triggered by the actor
Basic Flow	1.
Alternate Flow	•
Comments	Not yet defined if this will be a HTTP REST interface or a JMS interface

Implementation

Component Diagram

The implementation of the use cases is done using a message based service, in particular, using Java Message Service (JMS). The JMS consists of a message broker and several clients. The communication schema can be sketched as follows:

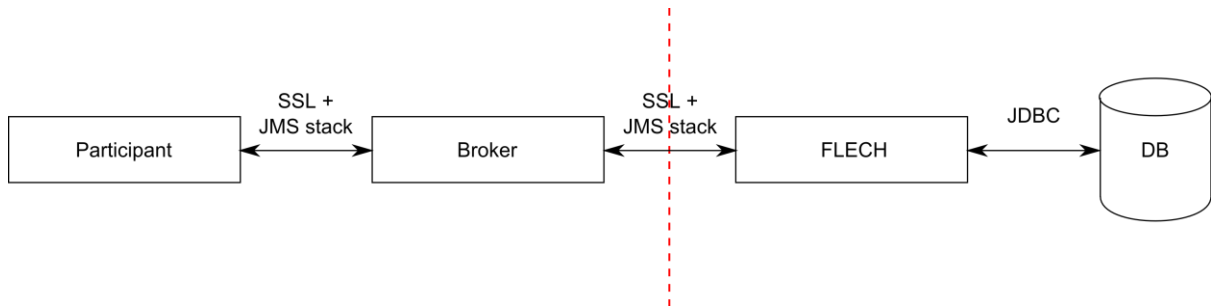


Figure 1: Components and communication infrastructure

Secure communication is crucial for the security of the whole system. Currently four different entities communicating are involved:

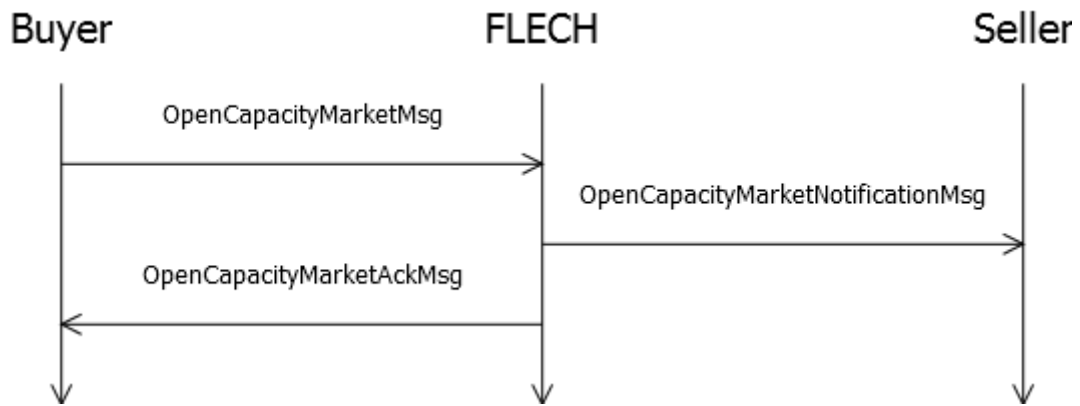
1. The message Broker
2. The FLECH
3. Participants being either buyers or sellers
4. The database backend

SSL secures the JMS communication from the participants and the FLECH to the broker. While the broker has to be available from the internet, the FLECH server and the database can operate from a subnet that is not accessible directly from the net.

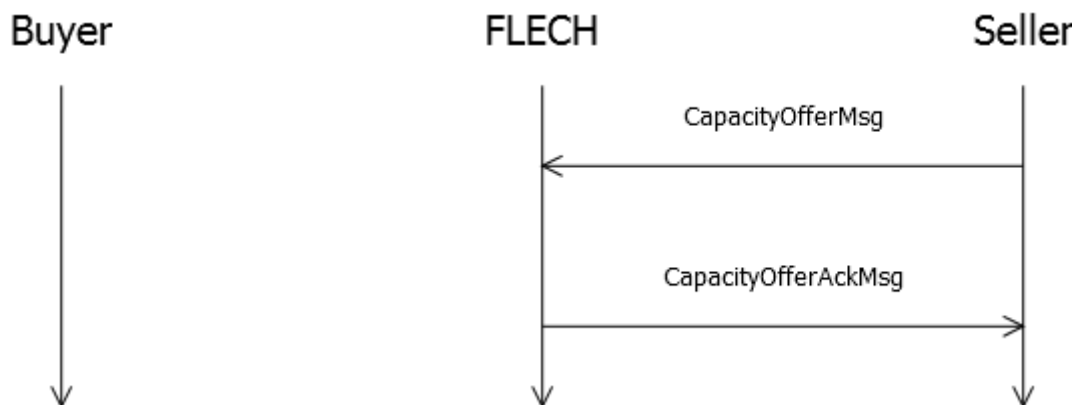
Sequence Diagrams

The following figures show the sequence diagrams for each of the use cases. The diagrams also show the names of the message types involved in the communication. The detail description of the messages is shown in the section XSD.

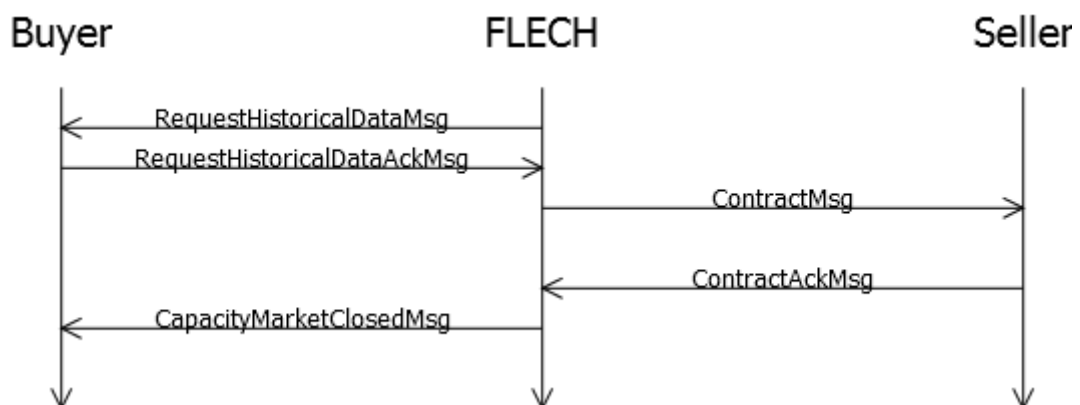
2.1 Open Capacity Reservation Market



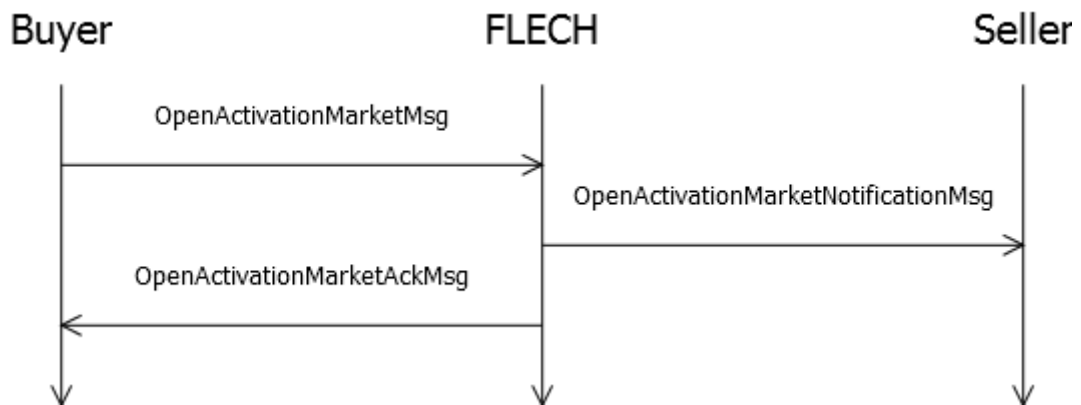
2.2 Placing Capacity Reservation Market Offer



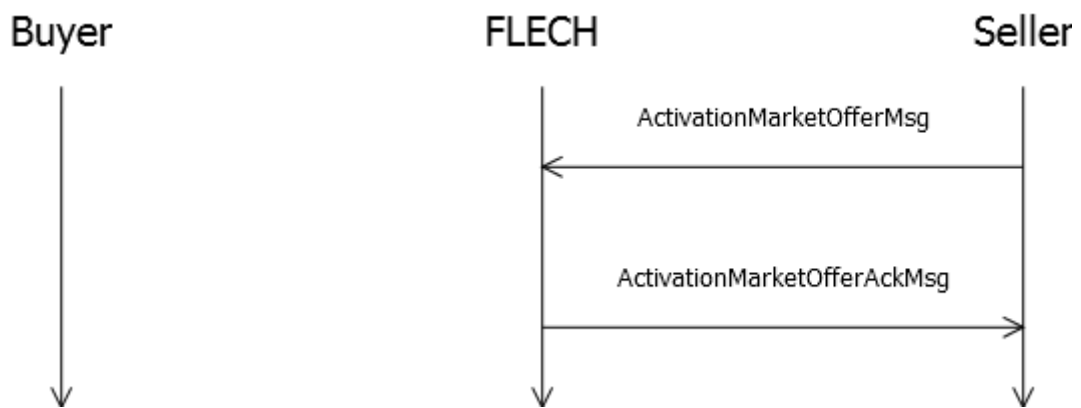
2.3 Close Capacity Reservation Market



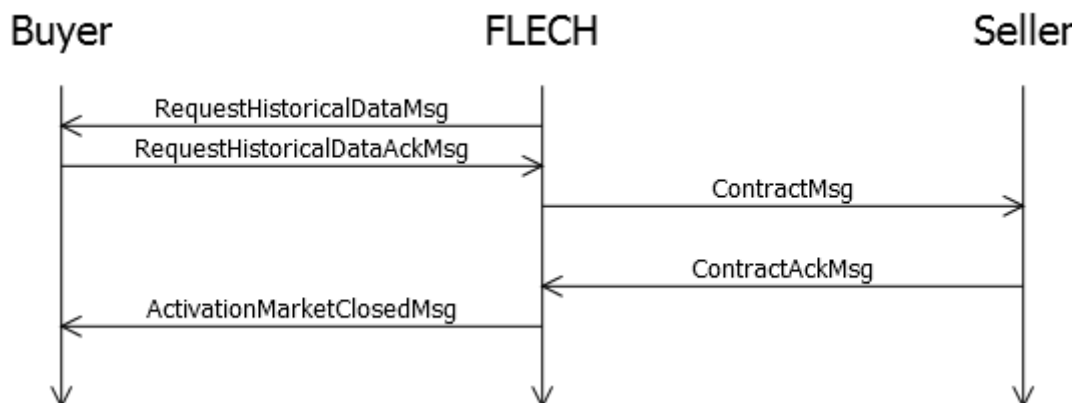
3.1 Open Reserve Activation Market



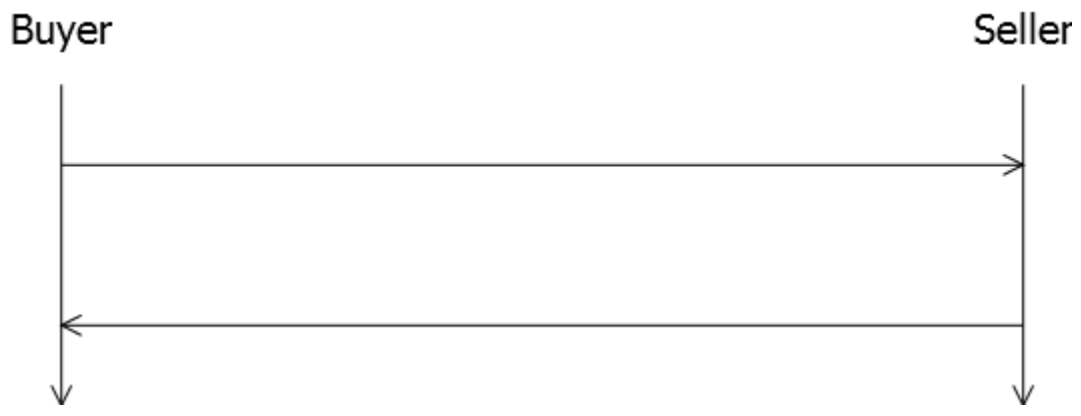
3.2 Placing Reserve Activation Market Offer



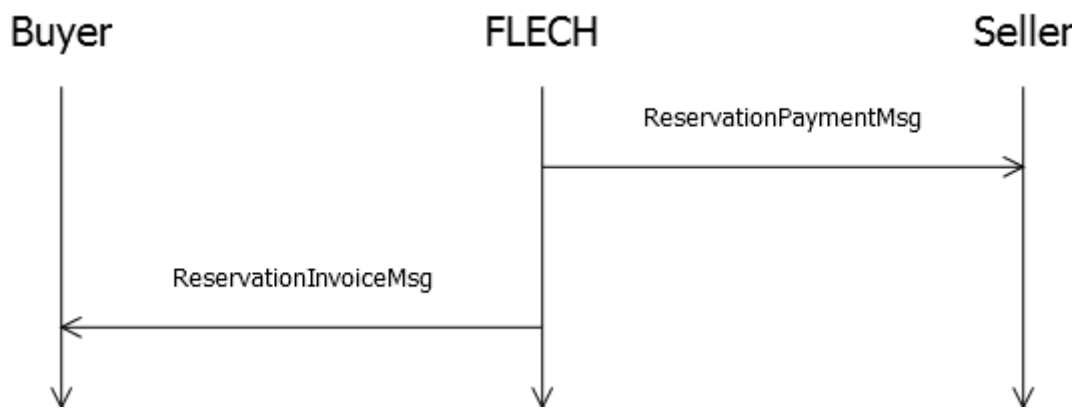
3.3 Close Reserve Activation Market



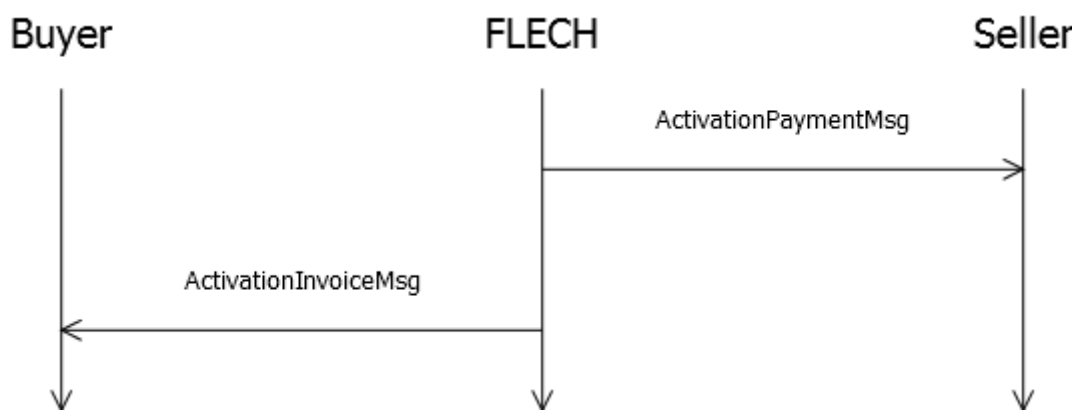
4.1 Activation



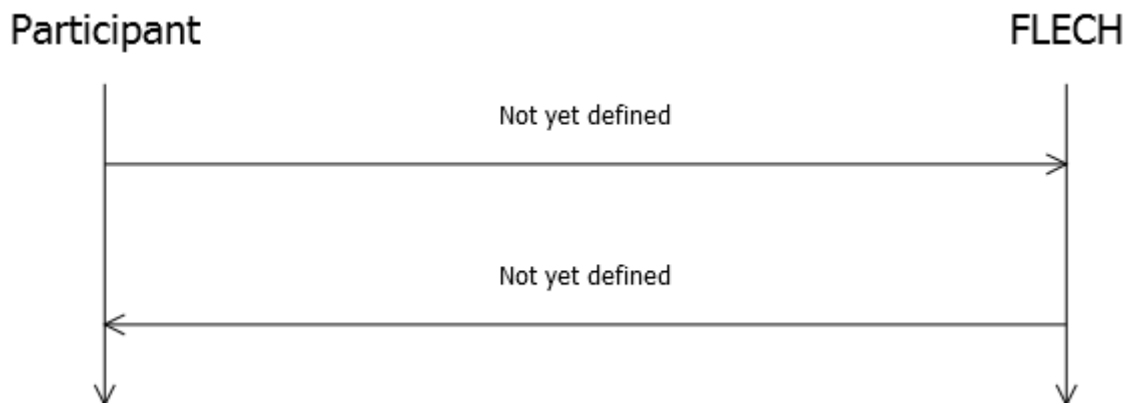
5.1 Settlement of Capacity Reservation Market



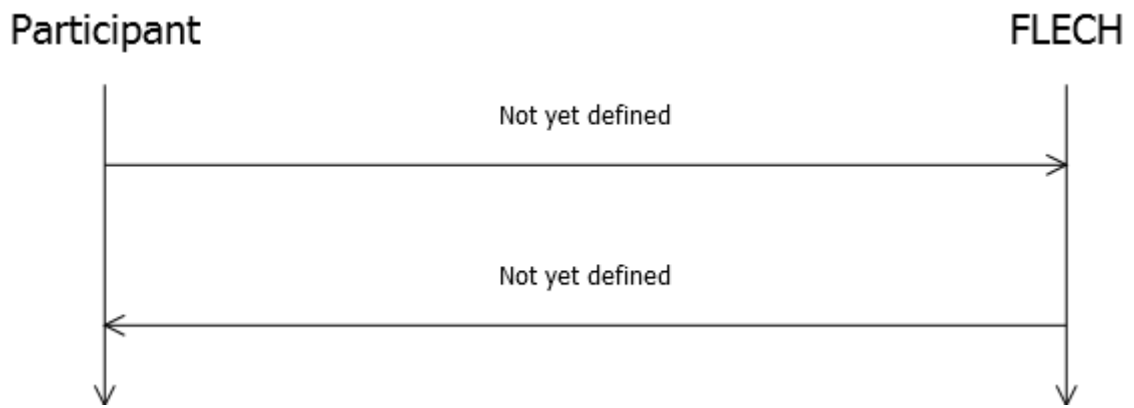
5.2 Settlement of Reserve Activation Market



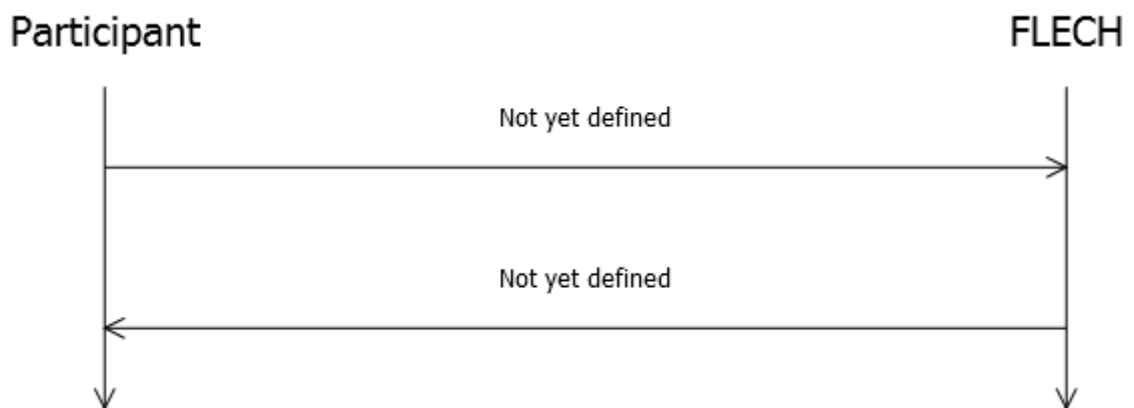
6.1 Observe Markets



6.2 Observe Offers



6.3 Observe Contracts



FLECH Message Definition

FLECH messages have been specified in an XSD schema file. The messages sent to the JMS broker should be XML strings. This section shows the XSD describing the message structure.

```
<?xml version="1.0" encoding="UTF-8"?>
<schema jxb:version="2.1"
  targetNamespace="http://www.zurich.ibm.com/ipower/flech/messages"
  elementFormDefault="qualified" xmlns="http://www.w3.org/2001/XMLSchema"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  xmlns:jxb="http://java.sun.com/xml/ns/jaxb"
  xmlns:fern="http://www.zurich.ibm.com/fern"
  xmlns:fm="http://www.zurich.ibm.com/ipower/flech/messages"
  xmlns:fc="http://www.zurich.ibm.com/ipower/flech/content">

  <!-- Root of the hierarchy. Every Message is a FLECHMsg and hence every
  message
        has a meta information attached -->
  <complexType abstract="true" name="FLECHMsg">
    <sequence>
      <element name="MetaInfo" type="fc:FLECHMsgMetaInfo" />
    </sequence>
  </complexType>

  <!-- A command message is an initial request sent by a market participant
  or the
        FLECH and is in particular not a reply to any message before. -->
  <complexType abstract="true" name="FLECHCommandMsg">
    <complexContent>
      <extension base="fm:FLECHMsg">
      </extension>
    </complexContent>
  </complexType>

  <!-- An acknowledgement message always belongs to a previous Command
  Message
        and always contains both, a generic (numeric) status code and a
  textual
        statement describing the outcome of the Command Message. -->
  <complexType abstract="true" name="FLECHAckMsg">
    <complexContent>
      <extension base="fm:FLECHMsg">
        <sequence>
          <element name="Status" type="fc:StatusCode" />
          <element name="Reason" type="string" />
        </sequence>
      </extension>
    </complexContent>
  </complexType>

  <!-- A notification message is sent from the FLECH to a participant and is
  usually triggered by a previous Command Message -->
  <complexType abstract="true" name="FLECHNotificationMsg">
    <complexContent>
      <extension base="fm:FLECHMsg">
      </extension>
    </complexContent>
  </complexType>
```



```

        </complexContent>
    </complexType>

    <!-- Opening a market -->

    <!-- The command -->
    <element name="OpenCapacityMarketMsg">
        <complexType>
            <complexContent>
                <extension base="fm:FLECHCommandMsg">
                    <sequence>
                        <element name="CapacityMarketRecord"
type="fc:CapacityMarketRecord" />
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
    </element>

    <!-- The acknowledgment -->
    <element name="OpenCapacityMarketAckMsg">
        <complexType>
            <complexContent>
                <extension base="fm:FLECHAckMsg">
                    <sequence>
                        <element name="CapacityMarketID"
type="fc:FlechID" />
                    </sequence>
                    <attribute name="ParentMessage"
fixed="OpenCapacityMarketMsg" />
                </extension>
            </complexContent>
        </complexType>
    </element>

    <!-- The notification -->
    <element name="OpenCapacityMarketNotificationMsg">
        <complexType>
            <complexContent>
                <extension base="fm:FLECHNotificationMsg">
                    <sequence>
                        <element name="CapacityMarketRecord"
type="fc:CapacityMarketRecord" />
                        <element name="CapacityMarketID"
type="fc:FlechID" />
                    </sequence>
                    <attribute name="ParentMessage"
fixed="OpenCapacityMarketMsg" />
                </extension>
            </complexContent>
        </complexType>
    </element>

    <!-- Placing a capacity market offer -->

    <element name="CapacityOfferMsg">
        <complexType>

```

```

        <complexContent>
            <extension base="fm:FLECHCommandMsg">
                <sequence>
                    <element name="LocalRef" type="fc:FlechID"
/>
                    <element name="CapacityOfferRecord"
type="fc:CapacityOfferRecord" />
                </sequence>
            </extension>
        </complexContent>
    </complexType>
</element>

    <element name="CapacityOfferAckMsg">
        <complexType>
            <complexContent>
                <extension base="fm:FLECHAckMsg">
                    <sequence>
                        <element name="CapacityMarketID"
type="fc:FlechID" />
                        <element name="CapacityOfferID"
type="fc:FlechID" />
                        <element name="LocalRef" type="fc:FlechID"
/>
                    </sequence>
                    <attribute name="ParentMessage"
fixed="CapacityOfferMsg" />
                </extension>
            </complexContent>
        </complexType>
    </element>

    <!-- Request historical data -->

    <element name="RequestHistoricalDataMsg">
        <complexType>
            <complexContent>
                <extension base="fm:FLECHCommandMsg">
                    <sequence>
                        <element name="CapacityMarketID"
type="fc:FlechID"/>
                        <element name="ActivationMarketID"
type="fc:FlechID"/>
                        <element name="MetricName" type="string"
/>
                        <element name="ReportingPeriod"
type="fc:TimePeriod" />
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
    </element>

    <element name="RequestHistoricalDataAckMsg">
        <complexType>
            <complexContent>
                <extension base="fm:FLECHAckMsg">

```

```

                <sequence>
                    <element name="CapacityMarketID"
type="fc:FleChID"/>
                    <element name="ActivationMarketID"
type="fc:FleChID"/>
                    <element name="Value"
type="fc:HistoricalData" minOccurs="0" maxOccurs="unbounded"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
</element>

<!-- Contract closing -->

    <element name="ContractMsg">
        <complexType>
            <complexContent>
                <extension base="fm:FLECHCommandMsg">
                    <sequence>
                        <element name="MarketType" type="int"/>
                        <element name="MarketID"
type="fc:FleChID"/>
                        <element name="OfferID" type="fc:FleChID" />
                        <element name="Accepted" type="boolean"/>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
    </element>

    <element name="ContractAckMsg">
        <complexType>
            <complexContent>
                <extension base="fm:FLECHAckMsg">
                    <sequence>
                        <element name="MarketType" type="int"/>
                        <element name="MarketID"
type="fc:FleChID"/>
                        <element name="OfferID" type="fc:FleChID" />
                        <element name="Confirmed" type="boolean"/>
                    </sequence>
                <attribute name="ParentMessage"
fixed="ContractMsg" />
            </extension>
        </complexContent>
    </complexType>
</element>

<!-- Closing a capacity market -->

    <element name="CapacityMarketClosedMsg">
        <complexType>
            <complexContent>
                <extension base="fm:FLECHNotificationMsg">

```

```

                <sequence>
                    <element name="CapacityMarketID"
type="fc:FLechID"/>
                    <element name="CapacityOffer"
type="fc:CapacityOfferRecord" minOccurs="0" maxOccurs="unbounded"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
</element>

<!-- Opening an activation market -->

<element name="OpenActivationMarketMsg">
    <complexType>
        <complexContent>
            <extension base="fm:FLECHCommandMsg">
                <sequence>
                    <element name="ActivationMarketRecord"
type="fc:ActivationMarketRecord" />
                    <element name="CapacityMarketID"
type="fc:FLechID"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
</element>

<element name="OpenActivationMarketAckMsg">
    <complexType>
        <complexContent>
            <extension base="fm:FLECHAckMsg">
                <sequence>
                    <element name="ActivationMarketID"
type="fc:FLechID"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
</element>

<element name="OpenActivationMarketNotificationMsg">
    <complexType>
        <complexContent>
            <extension base="fm:FLECHNotificationMsg">
                <sequence>
                    <element
name="ActivationMarketRecord" type="fc:ActivationMarketRecord" />
                    <element name="CapacityMarketID"
type="fc:FLechID"/>
                    <element name="ActivationMarketID"
type="fc:FLechID"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
</element>
fixed="OpenActivationMarketMsg" />

```

```
        </extension>
      </complexContent>
    </complexType>
  </element>
```

```

<!-- Placing an activation market offer -->

  <element name="ActivationMarketOfferMsg">
    <complexType>
      <complexContent>
        <extension base="fm:FLECHCommandMsg">
          <sequence>
            <element name="LocalRef" type="fc:FlechID"
/>
            <element name="ActivationOfferRecord"
type="fc:ActivationOfferRecord" />
          </sequence>
        </extension>
      </complexContent>
    </complexType>
  </element>

  <element name="ActivationMarketOfferAckMsg">
    <complexType>
      <complexContent>
        <extension base="fm:FLECHAckMsg">
          <sequence>
            <element name="ActivationOfferID"
type="fc:FlechID" />
            <element name="ActivationMarketID"
type="fc:FlechID"/>
            <element name="LocalRef" type="fc:FlechID"
/>
          </sequence>
          <attribute name="ParentMessage"
fixed="ActivationMarketOfferMsg" />
        </extension>
      </complexContent>
    </complexType>
  </element>

<!-- Closing an activation market -->

  <element name="ActivationMarketClosedMsg">
    <complexType>
      <complexContent>
        <extension base="fm:FLECHNotificationMsg">
          <sequence>
            <element name="ActivationMarketID"
type="fc:FlechID"/>
            <element name="ActivationMarketOffer"
type="fc:ActivationOfferRecord" minOccurs="0" maxOccurs="unbounded"/>
          </sequence>
        </extension>
      </complexContent>
    </complexType>
  </element>

<!-- Settlement -->

  <element name="ActivationPaymentMsg">

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        <complexType>
            <complexContent>
                <extension base="fm:FLECHNotificationMsg">
                    <sequence>
                        <element name="PaymentRecord"
type="fc:PaymentData" />
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
    </element>

    <element name="ReservationPaymentMsg">
        <complexType>
            <complexContent>
                <extension base="fm:FLECHNotificationMsg">
                    <sequence>
                        <element name="PaymentRecord"
type="fc:PaymentData" />
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
    </element>

    <element name="ActivationInvoiceMsg">
        <complexType>
            <complexContent>
                <extension base="fm:FLECHNotificationMsg">
                    <sequence>
                        <element name="InvoiceRecord"
type="fc:InvoiceData" />
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
    </element>

    <element name="ReservationInvoiceMsg">
        <complexType>
            <complexContent>
                <extension base="fm:FLECHNotificationMsg">
                    <sequence>
                        <element name="InvoiceRecord"
type="fc:InvoiceData" />
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
    </element>

    <!-- Possible roles in the market -->
    <simpleType name="FLECHRole">
        <restriction base="string">
            <enumeration value="ClearingHouse" />
        </restriction>
    </simpleType>

```

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        <enumeration value="Buyer"/>
        <enumeration value="Seller"/>
        <enumeration value="BuyerAndSeller"/>
    </restriction>
</simpleType>

<!-- All properties needed to identify and authenticate a client -->
<complexType name="ClientIdentity">
    <sequence>
        <element name="ClientID" type="string"/>
        <element name="Credentials" type="dateTime"/>
        <element name="Nonce" type="string"/>
        <element name="Role" type="fc:FLECHRole"/>
    </sequence>
</complexType>

<!-- A FLECH Endpoint, namely a queue and the technology type to access the
queue -->
<complexType name="FLECHEndpoint">
    <sequence>
        <element name="Address" type="string"/></element>
        <element name="Type" type="fc:EndpointType"/></element>
    </sequence>
</complexType>

<!-- Technology to access the broker, e.g. a client's queue -->
<simpleType name="EndpointType">
<restriction base="string">
    <enumeration value="activemq"/></enumeration>
    <enumeration value="mqseries"/></enumeration>
</restriction>
</simpleType>

<!-- The meta information that is part of every FLECH message -->
<complexType name="FLECHMsgMetaInfo">
    <sequence>
        <element name="ClientIdentity" type="fc:ClientIdentity"/>
        <element name="TimeSent" type="dateTime"/></element>
        <element name="Receiver" type="fc:FLECHEndpoint"/></element>
        <element name="Sender" type="fc:FLECHEndpoint"/></element>
    </sequence>
</complexType>

<!-- An all-purpose return code used in all acknowledge messages -->
<simpleType name="StatusCode">
    <restriction base="string">
        <enumeration value="Success" />
        <enumeration value="Failure" />
        <enumeration value="NotAuthenticated" />
        <enumeration value="NotAuthorized" />
        <enumeration value="NotRegistered" />
        <enumeration value="MarketIsClosed" />
        <enumeration value="Invalid" />
    </restriction>
</simpleType>

```



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        </restriction>
</simpleType>

<simpleType name="FlechID">
  <restriction base="string">
    </restriction>
  </simpleType>

<!-- Service types -->
<simpleType name="ServiceType">
  <restriction base="string">
    <enumeration value="PowerCutPlanned" />
    <enumeration value="PowerCutUrgent" />
    <enumeration value="PowerReserve" />
    <enumeration value="PowerCap" />
    <enumeration value="PowerMax" />
    <enumeration value="VoltageSupport" />
    <enumeration value="VARSupport" />
  </restriction>
</simpleType>

<!-- Area defined as a (string) list of PODs -->
<complexType name="GridArea">
  <sequence>
    <element name="PODList" type="string"/>
  </sequence>
</complexType>

<!-- Preliminary Volume -->
<complexType name="Volume">
  <sequence>
    <element name="Power" type="double"/>
  </sequence>
</complexType>

<!-- Period to describe any time window -->
<complexType name="TimePeriod">
  <sequence>
    <element name="Begin" type="xsd:dateTime"/>
    <element name="End" type="xsd:dateTime"/>
  </sequence>
</complexType>

<!-- Start time and duration -->
<complexType name="StartAndDuration">
  <sequence>
    <element name="Start" type="time"/>
    <element name="Duration" type="int"/>
  </sequence>
</complexType>

<!-- Market opening records -->

<complexType name="CapacityMarketRecord">
  <sequence>
    <element name="ServiceType" type="fc:ServiceType" />

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        <element name="CapacityMarketPeriod" type="fc:TimePeriod" />
        <element name="ReservationPeriod" type="fc:TimePeriod" />
        <element name="DailyActivationPeriod"
type="fc:StartAndDuration" />
        <element name="Volume" type="fc:Volume" />
        <element name="Area" type="fc:GridArea" />
        <element name="MaxActivationPrice" type="double" minOccurs="0"
maxOccurs="1" />
        <element name="MaxReservationPrice" type="double"
minOccurs="0"
maxOccurs="1" />
        <element name="ExpectedNumOfActivations" type="int"
minOccurs="0" maxOccurs="1" />
    </sequence>
</complexType>

<complexType name="ActivationMarketRecord">
    <sequence>
        <element name="ServiceType" type="fc:ServiceType" />
        <element name="ActivationMarketPeriod" type="fc:TimePeriod" />
        <element name="ReservationPeriod" type="fc:TimePeriod" />
        <element name="DailyActivationPeriod"
type="fc:StartAndDuration" />
        <element name="Volume" type="fc:Volume" />
        <element name="Area" type="fc:GridArea" />
        <element name="MaxActivationPrice" type="double" />
        <element name="ExpectedNumOfActivations" type="int"
minOccurs="0" maxOccurs="1" />
    </sequence>
</complexType>

<!-- Offer records sent at the end of respective market close -->

<complexType name="CapacityOfferRecord">
    <sequence>
        <element name="CapacityOfferID" type="fc:FlechID"/>
        <element name="CapacityMarketID" type="fc:FlechID"/>
        <element name="Volume" type="fc:Volume"/>
        <element name="Area" type="fc:GridArea"/>

        <element name="ActivationPrice" type="double"/>

        <element name="ReservationPrice" type="double"/>
        <element name="MaxNumOfActivations" type="int" />
    </sequence>
</complexType>

<complexType name="ActivationOfferRecord">
    <sequence>
        <element name="ActivationOfferID" type="fc:FlechID"/>
        <element name="ActivationMarketID" type="fc:FlechID"/>
        <element name="Volume" type="fc:Volume"/>
        <element name="Area" type="fc:GridArea"/>

        <element name="ActivationPrice" type="double"/>
    </sequence>
</complexType>

```

```
<!-- Historical data -->
<complexType name="HistoricalData">
  <sequence>
    <element name="Timestamp" type="dateTime" />
    <element name="Value" type="double" />
  </sequence>
</complexType>

<!-- Payment -->
<complexType name="PaymentData">
  <sequence>
    <element name="MarketID" type="fc:FlechID"/>
    <element name="OfferId" type="fc:FlechID"/>
    <element name="Amount" type="double"/>
  </sequence>
</complexType>

<!-- Invoice -->
<complexType name="InvoiceData">
  <sequence>
    <element name="MarketID" type="fc:FlechID"/>
    <element name="Amount" type="double"/>
  </sequence>
</complexType>
</schema>
```