Open Smart Charging Protocol 1.0

Interface description between DSO and Central System

Document Version	1.0
Document Status	Final
Document Release Date	09-04-2015

Contents

1. Introduction

1.1 Goal

The goal of this document is to describe a protocol for smart charging electrical vehicles based on available capacity that divided by the DSO.

1.2 Scope

This document describes the message flow defined for smart charging. The scope of this documents is primarily focused on the communication between DSO and CSP.

With respect to the communication between the CSP and the local controller, which is also described, the messages used in this document are taken from OCPP. Although this is protocol has been used in a practical setup, it is of course possible that a different protocol is used between CSP and Local Controller. This does mean that similar functionality has to be present in the used alternative. In this document we will use OCPP as an example protocol to implement a complete solution.

1.3 Terms and acronyms

Term / acronym*	Meaning
Cable capacity	This is the maximum capacity (in Amps) that can go to a cable before something goes wrong (burning fuse or damaging cable itself)
CP Module	**C**ommunication **P**rotocol **Module**. This is a module in the charge spot which enables the charge spot to receive messages from the outside world
CSP	**C**harge **S**ervice **P**rovider. The CSP is defined as the party that pays for the electricity with which the EV is charged
CSO	**C**harge **S**ervice **O**perator or charge point operator. It is the party that operates a network of charge points and has contracts with CSPs to allow their customers to use the charging facilities.
DSO	**D**istribution **S**ystem **O**perator. The DSO manages the distribution network and has the interest of not overloading the (local) grid. In order to do this the DSO sends out a (time varying) capacity forecast , informing about the available capacity for charging EVs.
EV	**E**lectric **V**ehicle
Offline mode	This is a working mode for a charge point in which it has no communication with the backoffice of the operator (usually due to communication failure).
Local Controller (LC)	Component that communicates with the CP modules in the charge spot and is able to change the maximum charge current in the charge spot. The LC is controlled by the CSP (but can also operate in offline mode)
SCiP	**S**mart **C**harging **i**n **P**ractice

1.4 Version history

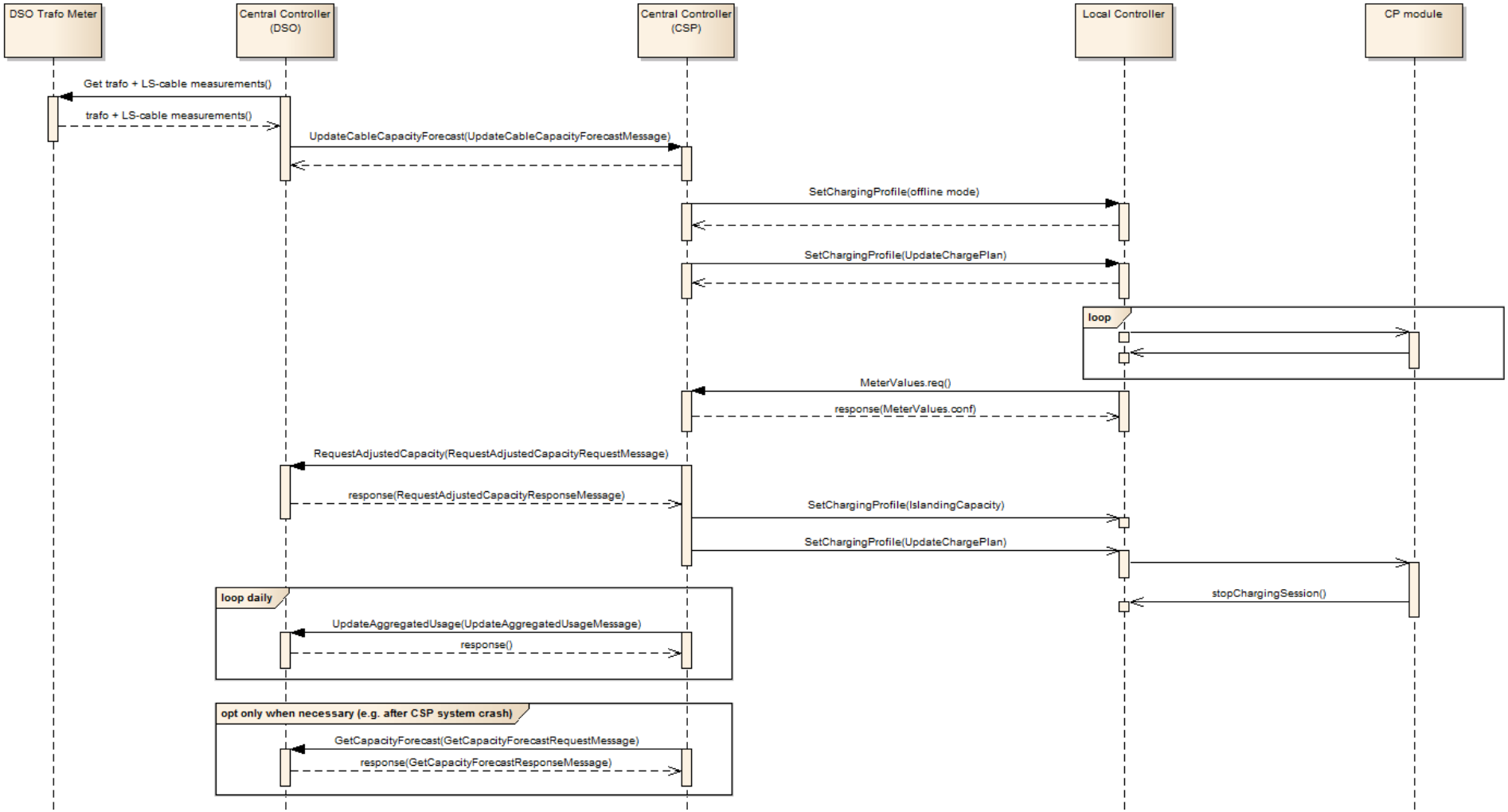
Version	Date changed	Change
C0.1 -C0.84	27-05-2013 26-7-2013	First draft incl. changes based on GAP analysis E-Laad (Klaas van Zuuren)
C0.9	29-7-2013	Translated the document to English Also changed the priority description (again)
C0.91	9-8-2013	Made block-size and unit variable within the messages. Adjusted picture in chapter 2.
C0.92	16-8-2013	Changed UnitOfMeasure into attribute for OSCP messages (similar to OCPP)
C0.93	20-9-2013	Changed field Primary to primary in message SetChargingProfile. Removed all information irrelevant for the protocol.
C0.94		Changes for project SCndP.
C0.95	16-4-2014	Future improvements. - Remaining capacity in Request-AdjustedCapacity response - Added EMSP field to UpdateAggregatedUsage - GetCapacityForecast: per cable
C0.96	1-7-2014	Processed review comments call 2014/06/26
C0.97	9-7-2014	Processed review comments call 2014/07/09
C0.98	28-7-2014	Processed review comments call 2014/07/23
C0.98b	6-8-2014	Initial draft security chapter added, based on security design LaQuSo and field experiences at e-Laad and Enexis
C0.98c + d	23-09-2014	Some minor changes
C0.98e	27-10-2014	Review Patrick Rademakers, Robert de Leeuw & Franc Buve.
1.0 RC1	12-11-2014	Some minor changes based on review Ronald Steeghs
1.0	09-04-2015	Added example messages.

1.5 References / sources

No.	Title	Version	Author	Date
1	System description SCiP Reference Architecture	7	GreenFlux / Enexis	4-6-2013
2	Open Charge Point Protocol	1.5	OCA	8-6-2012
3	Open Charge Point Protocol	2.0 (draft)	OCA	4-8-2014
4	An end-to-end security design for smart EV-charging for Enexis and Stichting e-laad by LaQuSo		van Eekelen, Marko, Poll, Erik, Hubbers, Engelbert, Vieira, Bárbara & van den Broek, Fabian	06-08-2014
5	A flexible and privacy friendly ICT architecture for Smart Charging of EV's, Procedings Cired Conference, paper 0199		Montes Portela, Carlos, Geldtmeijer, Danny, van Eekelen, Marko & Slootweg, Han	2013
6	Guide for Conducting Risk Assessments		NIST – National Institute of Standards and Technology	2012

2. High level overview process / message flow

Before discussing the protocol messages itself, in this paragraph a brief overview is given of how the protocol should / can be used. The following figure shows the message flow from the measurements by the DSO to charging the EV's based on the available capacity. A more detailed explanation can be found on the next page.



Explanation:

In the previous flow diagram the message flow between the different parties is depicted. The initial design has been compared with the draft version of OCPP 2.0. Based on this comparison several messages from the original design have been replaced by messages from OCPP 2.0.

The process as described in the diagram above exists roughly of the following steps/parts:

1. The DSO receives measurements from the transformer station. This is displayed in the diagram as "Trafo + LS-cable measurements" (outside of OSCP protocol).
2. Based on these measurements a forecast of the available cable capacity is made, which is forwarded to the CSP using the UpdateCableCapacityForecast message from the OSCP procotol. This forecast informs about available capacity, so the basis for the protocol is that the DSO does not have to know about EV charging needs.
3. Based on this forecast the CSP can tell the Local Controller what its capacity for the next period of time will be in case the LC needs to go to offline mode[1]. This offline mode occurs only in case the LC does not receive forecasts from the CSP / DSO (eg. in case of technical problems). For forwarding the forecast with regard to offline mode the message SetChargingProfile can be us as specified in OCPP2.0.
4. Subsequently the CSP (based on customers wishes) can tell de Local Controller what the maximum power is that may be used to charge the EVs connected to the LC (the EV might draw less energy). Again the message SetChargingProfile can be used for this. With respect to priority: in general the LC will execute the charge plan it receives from the CSP. This charge plan has priority over the forecast for Offline mode.
5. Subsequently the EVs at the charge spot(s) connected to the LC can be charged. To enable this, communication is necessary between de LC and the CP Module. The LC can set a maximum charge current for the charger in the EV, which results in the EV not charging at full capacity.
6. Using the message MeterValues from OCPP 2.0, the LC can indicate that he is using less capacity than he was allowed to according to the CSP.
7. If the CSP notices there is not enough capacity available for a LC, there is the possibility to request extra capacity from the DSO. This can be done using the message "RequestAdjustedCapacity" from the OSCP protocol.
8. On the DSO side, two algorithms are active, one for calculating the capacity forecast and one or the division of capacity over the different CSP's. Both these algorithms need historical data, so in order to improve the algorithm output, the DSO needs information from the CSP what its actual consumption has been. The OSCP message "UpdateAggregatedUsage" can be used for this.
9. In case there has been an issue on the side of the CSP or DSO, the CSP has the possibility to request the most recent forecast using the GetCapacityForecast message from the OSCP protocol. This is to prevent the CSP having to wait for the next forecast.

[1] Even though out of scope of this protocol, coping with offline behavior or offline mode, is an interesting topic that deserves attention in every implementation. One example implementation is to give a limited detailed forecast (e.g. 2 hours in 15 minute blocks) and a much lower, less detailed forecast for the 22 hours after that. If that less detailed forecast is chosen in a smart way, this value can be used in case communication fails and the grid can still be safe from overloading. Another option is to add intelligence in the chargepoint, which should decide itself what to do when no forecast are received for a longer period of time. This choice between intelligence in the CP or not is however a issue for implementation, this does not effect OSCP.

3. OSCP protocol messages

3.1 General

In this chapter the messages are discussed in more detail. Paragraph 3.2 describes the messages which are necessary to implement the process described in Chapter 2. To separate the logical protocol from the technical implementation, the protocol binding is discussed in a separate chapter, chapter 4.

3.2 Messages

3.2.1 General information in header

For all messages sent between the different parties, the sending party will include in the header both the receiving party and the priority of the message. Furthermore, the WS-addressing standard will be used. Messages have a unique ID to identify messages (in the wsa:MessageID).

For the identification of the sender / receiver it is customary in the Dutch energy market to use an EAN code (European Article Number) containing 13 digits. Since this is not necessarily the case in other countries, the fields will be of type string. However in the examples Dutch EAN codes are used.

An example of the information in the header is:

```
<soap:Header>
   <wsa:MessageID>uuid</wsa:MessageID>
   <wsa:To>http://localhost:9090/To</wsa:To>
   <wsa:Action>http://localhost:9090/Action</wsa:Action>
   <ns:Priority>1</ns:Priority>
   <ns:DateTime>2013-06-28T00:00:00.000Z</ns:DateTime>
   <ns:Parties>
      <ns:senderID>8712423014022</ns:senderID >
      <ns:receiverID>8712423222120</ns:receiverID>
   </ns:Parties>
</soap:Header>
```

With respect to priorities, the following priorities can be used:

Prority	Meaning
0	Normal. Used for example for forecast messages. These messages have to be processed by the receiving party.
> 0	A positive priority value means that the message is more critical than normal. This could be used for messages that need fast attention due to, for example, capacity problems. These messages have to be processed by the receiving party within SLA times.
< 0	A negative priority value means that the message is less critical than normal.

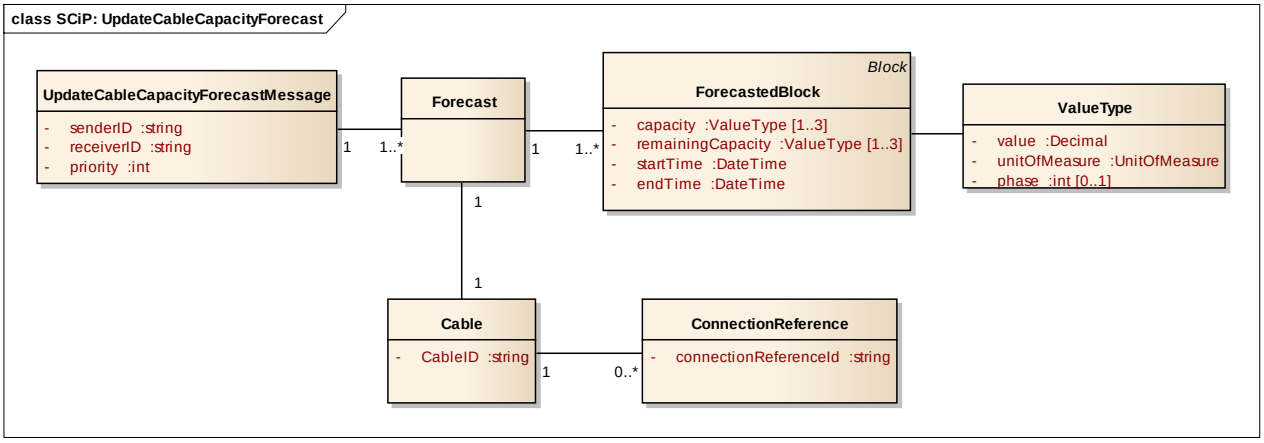
3.2.2 Timezones

As with OCPP, to improve interoperability between Central Systems and DSO all time values should be exchanged as UTC, with the time zone designator 'Z', as specified by ISO 8601.

3.2.3 UpdateCableCapacityForecast

The UpdateCableCapacityForecast message contains a forecast of the cable capacity which can for example be created based on measurements from a trafo, weather forecasts (for PV), type of energy etc. This message is sent from the DSO to the CSP which should follow this capacity as a maximum value for the capacity that can be used on a cable. The message is based on the principle of time division, so the message contains blocks.

The DSO can keep some remaining capacity for the case where the division over different CSP parties is not optimal. Parties can request this capacity in case they need it (see 3.2.5).



Field Name	Field Type	Card.	Description
ForecastedBlock	ForecastedBlock	1..*	A ForecastedBlock contains a timeslot with a specific maximum capacity for a cable that is forecasted by the DSO.
CableID	String	1..1	Cable where the CSP has connections for EV, connections for households, lampposts etc. excluded
ConnectionReferenceId	String	0..*	Reference (known to CSP) to a connection of the CSP. Connections for households excluded.

ForecastedBlock

A ForecastedBlock represents a timeslot with a specific maximum capacity for a cable that is forecasted by the DSO. The capacity per cable is divided over the parties that have connections to that specific cable.

The remaining capacity is a part of the available capacity that is not given away to parties, but which can be requested (see 3.2.5).

Field Name	Field Type	Card.	Description
capacity	ValueType	1..3	The value is the maximum *forecast value*
remainingCapacity	ValueType	1..3	The remainingCapacity is the capacity which the DSO has available as backup capacity, to be able to serve parties that request extra capacity. For dividing the capacity over the different CSPs the DSO uses an algorithm based on total connected power and historical consumption. The backup capacity is to cope with unexpected events. If it turns out that this backup capacity is frequently insufficient the DSO might have to expand its network capacity.
startTime	DateTime	1..1	Start time of this block
endTime	DateTime	1..1	End time of this block

ValueType:

Field Name	Field Type	Card.	Description
value	Decimal	1..1	The value is the maximum *forecast value*
attribute:unit	UnitOfMeasure	0..1	UnitOfMeasure, unit of the value. Default = “Amp” (= Ampère per phase)
attribute:phase	Integer	0..1	The specific phase this ValueType refers to. Valid values are 1, 2 and 3.

UnitOfMeasure

Enumeration

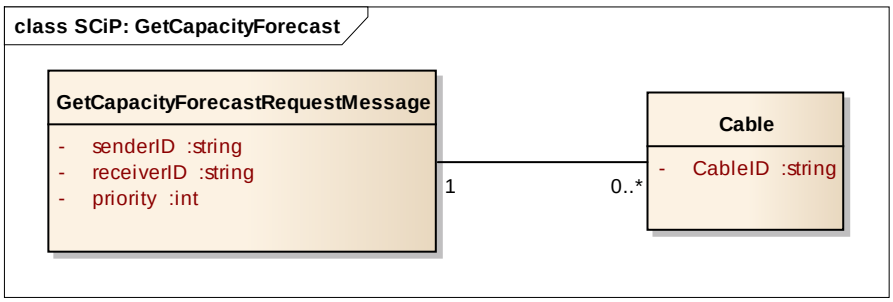
Value	Description
A	Amperes (current).
ASU	Arbitrary Strength Unit (Signal Strength)
C	Celsius (Temperature).
dB	Decibel (Signal Strength)
Deg	Degrees (Angular Position)
F	Fahrenheit (Temperature)
g	g-force (Acceleration)
Hz	Hertz (Frequency)
kPa	kiloPascal (Pressure)

kvar	kilovars (reactive power).
kvarh	kilovar-hours (reactive energy).
kW	kilowatts (power).
kWh	kiloWatt-hours (energy).
lx	Lux (Light Intensity)
ms2	Meter per second square (Acceleration)
N	Newtons (Force)
ohm	Ohms (Resistance)
pct	Percentage (dimensionless)
RH	Relative Humidity% (Humidity)
RPM	Rotation per Minute (Angular Velocity)
s	Second (Time)
var	Vars (reactive power).
varh	Var-hours (reactive energy).
V	Voltage (r.m.s. AC).
W	Watts (power).
Wh	Watt-hours (energy). Default.

3.2.4 GetCapacityForecast

This message is intended to enable a CSP to ask for a new forecast . This service only contains a request to which the answer will be OK. Subsequently the DSO calls the UpdateCableCapacityForecast service for the specific CSP. This is an optional message, so a DSO can decide not to implement this message.

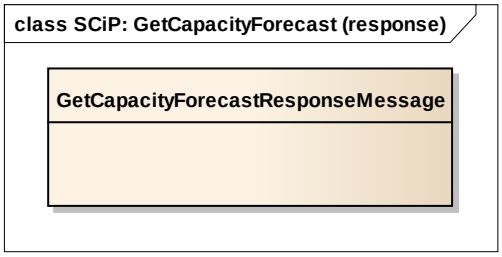
3.2.4.1 GetCapacityForecastRequestMessage



Field Name	Field Type	Card.	Description
CableID	String	0..1	An optional list of cables for which a new forecast is required.

See paragraph 3.2.1 for the exact fields in the header.

3.2.4.2 GetCapacityForecastResponseMessage



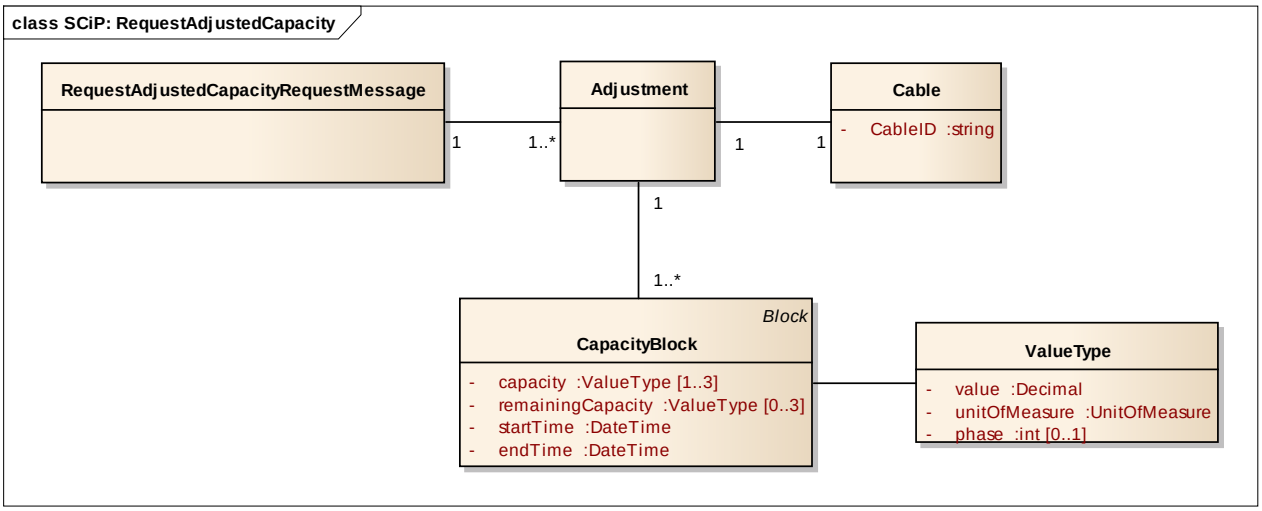
In this case the reply only contains OK, see 3.2.8 for the standard response fields. In case the message is not implemented by the DSO, the ResultType will be “NOT IMPLEMENTED”.

3.2.5 RequestAdjustedCapacity

3.2.5.1 RequestAdjustedCapacityRequestMessage

This message is intended to enable a CSP to request extra capacity in the case there is not enough capacity available as forecasted by the DSO. The DSO can send an UpdateCableCapacityForecast message containing a remaining capacity that can be requested by parties. The RequestAdjustedCapacity message can be used to request this remaining capacity. If more capacity is requested than is remaining, the DSO is likely to deny the request.

This message can also be used to “give back” energy to the DSO in case it is not needed by the CSP.



Field Name	Field Type	Card.	Description
CableID	String	1..*	CableID belonging to the

			connection(s) for which the CSP requests extra capacity.
capacityBlock	**CapacityBlock**	1..*	

CapacityBlock

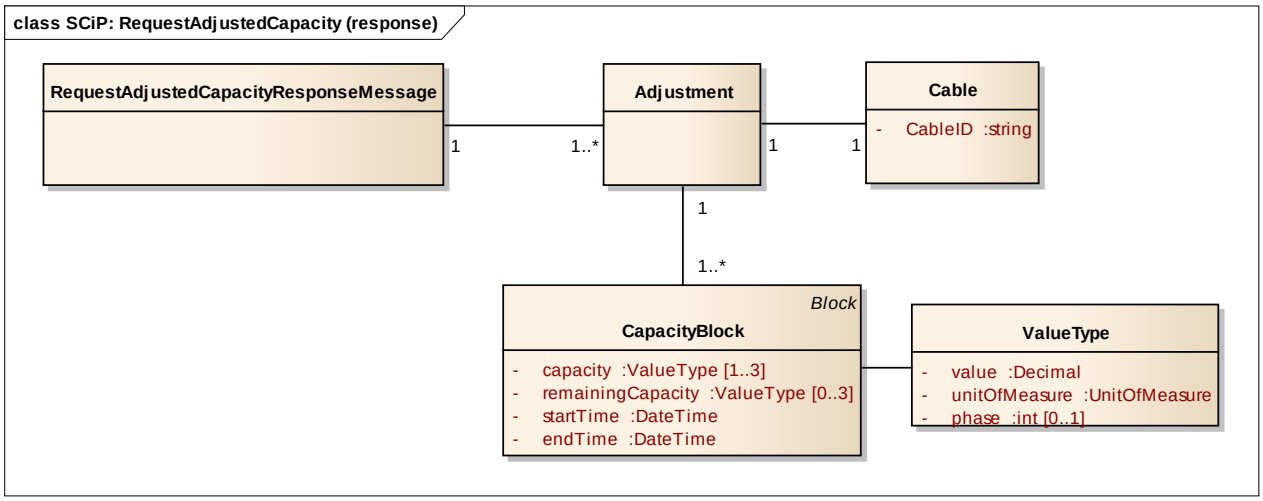
Field Name	Field Type	Card.	Description
capacity	ValueType	1..1	Requested extra or lesser capacity.
startTime	DateTime	1..1	Start time of this block
endTime	DateTime	1..1	End time of this block

ValueType:

See paragraph 3.2.2.

3.2.5.2 RequestAdjustedCapacityResponseMessage

The answer to a request for extra capacity. See 3.2.7 for the standard response fields (not in the picture below). . In case the message is not implemented by the DSO, the ResultType will be “NOT ALLOWED”.



Field Name	Field Type	Card.	Description
CableID	String	1..*	CableID belonging to the connection(s) for which the CSP requests extra capacity.
capacityBlock	**CapacityBlock**	1..*	

CapacityBlock

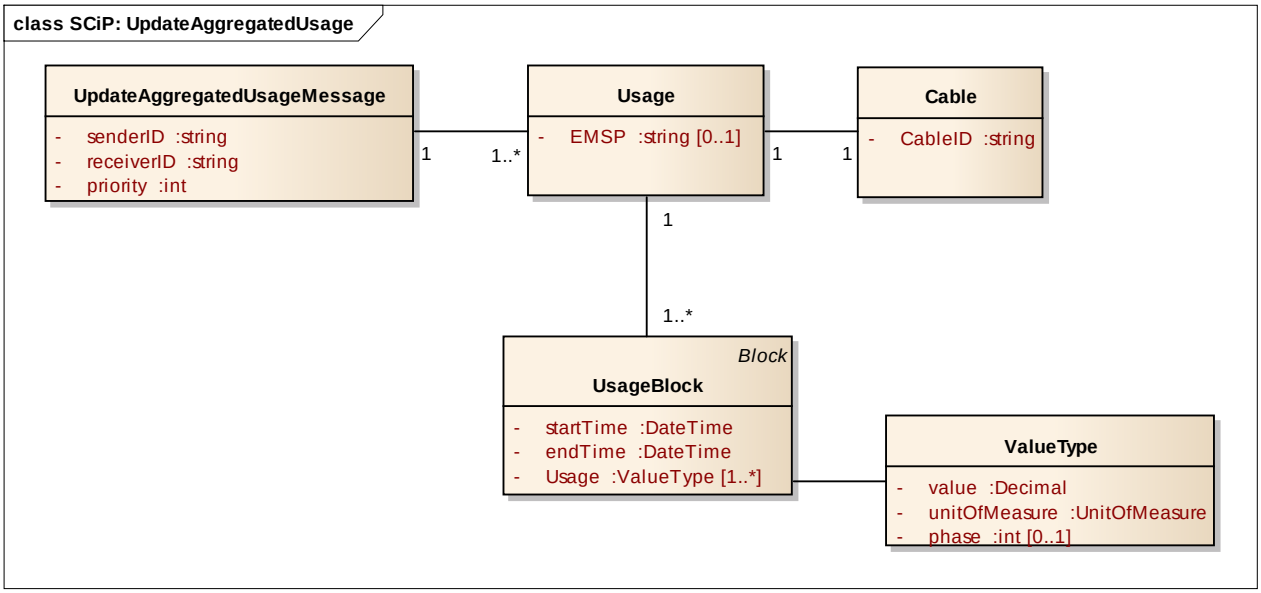
Field Name	Field Type	Card.	Description
capacity	ValueType	1..3	Assigned capacity delta.
remainingCapacity	ValueType	0..3	The remainingCapacity is the capacity which the DSO has available as backup capacity, to be able to serve parties which indicate to need extra capacity.
startTime	DateTime	1..1	Start time of this block
endTime	DateTime	1..1	End time of this block

ValueType:

See paragraph 3.2.2.

3.2.6 UpdateAggregatedUsage

This message is for communicating the total usage per CSP back to the DSO. This information is necessary for the DSO to know how much each CSP has used as input for checking whether parties have not used too much / little. Furthermore it can be used to determine a division of the forecast over the different parties[2].



Field Name	Field Type	Card.	Description
CableID	String	1..1	CableID beloning to the connection(s) for which the CSP gives the consumed capacity
EMSP	String	0..1	Support for future market model

[2] This division can also be done based on SLA's.

			where EMSP and CSO can be separate roles / parties.
usageBlock	**UsageBlock**	1..*	

CapacityBlock

Field Name	Field Type	Card.	Description
Usage	ValueType	1..*	Consumed capacity / usage.
startTime	DateTime	1..1	Start time of this block
endTime	DateTime	1..1	End time of this block

ValueType:

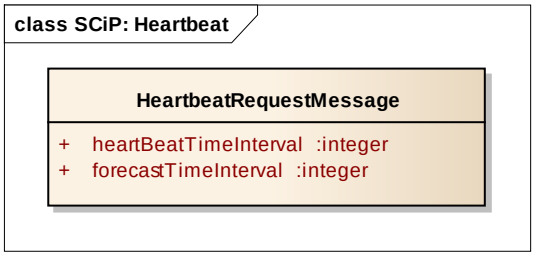
See paragraph 3.2.2.

3.2.7 Heartbeat

The OSCP heartbeat is a signal from DSO to CSP to let the CSP know that the forecasting algorithm is still running and forecasts are being sent out periodically. Since the DSO periodically sends out UpdateCableCapacityForecast messages to all parties, it could keep track of which parties are available and which are not. The reason that the DSO sends out the heartbeats, is that the heartbeat includes the intervals, which have to be announced to the different parties.

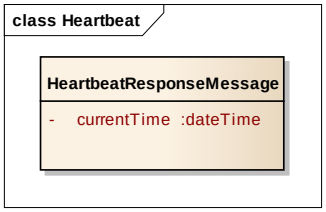
Settings fundamental to the protocol, such as block size, will be agreed on by markets and will not be dynamically negotiated within the protocol.

3.2.7.1 HeartbeatRequestMessage



Field Name	Field Type	Card.	Description
heartBeatTimeInterval	Integer	1..1	The time interval between the heartbeats that are sent by the DSO in seconds.
forecastTimeInterval	Integer	1..1	The time interval between the forecasts that are sent by the DSO in seconds.

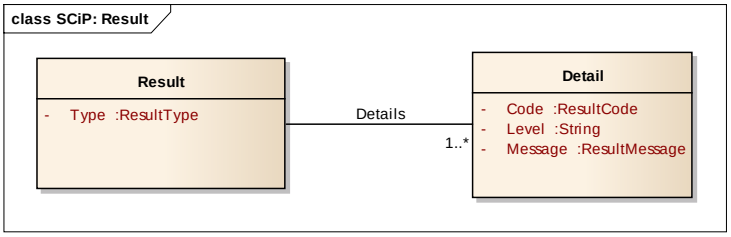
3.2.7.2 HeartbeatResponseMessage



Field Name	Field Type	Card.	Description
currentTime	**dateTime**	1..1	Mandatory. This contains the current time of the CSP system. Time values are in UTC.

3.2.8 Response messages

In response messages the following fixed part is used:



Field Name	Field Type	Card.	Description
Type	**ResultType**	1..1	Indicates success or error response
Details	**Detail**	1..n	Identifier of the response result

ResultType

Enumeration of the following values

Value	Description
SUCCES	Action succeeded.
FAILED	The action that was executed failed.
NOT ALLOWED	The action that was executed is not allowed (in the current state).
NOT IMPLEMENTED	The action that was executed is not implemented by the receiver.
ERROR	An (unexpected) error has occurred.

Detail

Field Name	Field Type	Card.	Description
Code	**ResultCode**	1..1	Code of the response result
Level	**LogLevelType**	1..1	Loglevel
Message	**ResultMessage**	1..1	Response message corresponding with response Code

ResultCode

A String error code with maximum length of 15.

ResultMessage

A String message with maximum length of 254.

LogLevelType

Enumeration of the following values

Value
INFO
WARN
ERROR
DEBUG

4. Additional protocol messages

4.1 General

With respect to the communication between the CSP and the local controller, which is also described, the messages used in this document are taken from OCPP. Although this protocol has been used in a practical setup, it is of course possible that a different protocol is used between CSP and Local Controller. This does mean that similar functionality has to be present in the used alternative. In this document we will use OCPP as an example protocol to implement a complete solution.

4.2 Messages

4.2.1 SetChargingProfile

This message concerns information sent to the Local Controller for the case of Offline mode or for updating a chargeplan. This is an *example* message, any protocol between a central system and charge point that can communicate similar information can be used here. However, to make the OSCP protocol complete, as an example the OCPP 2.0 version of the SetChargingProfile is included. This also includes pricing information which is not used for OSCP.

4.2.1.1 Header

The OCPP 1.5 specification, paragraph 8.1, states the following with respect to the identification of a charge point:

To be able for the Central System to identify uniquely a Charge Point, a Charge Point MUST send its identifier in the SOAP header of each request PDU. The header name "chargePointIdentity" SHALL be treated as case insensitive. For example:

```
<!-- Header with the identifier of the sending Charge Point -->
<ns:chargePointIdentity>CB1234</ns:chargePointIdentity>
```

When a Central System needs to send requests to a Charge Point, the Central System MUST send in each request the "chargePointIdentity" for which Charge Point the request is intended. If the receiving Charge Point is not the intended one, then the Charge Point MUST send a SOAP Fault Response message, indicating that the identity is wrong (e.g. sub-code is "IdentityMismatch").

Therefore, in the messages from CSP to LC, this needs to be part of the SOAP header!!

4.2.1.2 SetChargingProfile.req

The message below has been copied directly from the OCPP 2.0 specification, paragraph 1.7.4.2 ([3]).

Field Name	Field Type	Card.	Description
evse	Evse	1..1	Mandatory. The EVSE and connector to which the charging profile applies. If evse.id = 0, the message contains an overall limit for the charge point.
csChargingProfiles	ChargingProfile	1..*	Mandatory. The charging profiles to be set at the Charge Point.

Evse

Field Name	Field Type	Card.	Description
Id	integer id >= 0	1..1	Mandatory. The id of the Evse. Id '0' (zero) is used to target the entire charge point as a whole
connectorType	ConnectorType	0..1	Optional. Specific connector type on a EVSE.

ConnectorType

Value	Description
cCCS1	Combined Charging System 1 (captive cabled) a.k.a. Combo 1
cCCS2	Combined Charging System 2 (captive cabled) a.k.a. Combo 2
cG105	JARI G105-1993 (captive cabled) a.k.a. CHAdeMO

cTesla	Tesla Connector (captive cabled)
cType1	IEC62196-2 Type 1 connector (captive cabled) a.k.a. J1772
cType2	IEC62196-2 Type 2 connector (captive cabled) a.k.a. Mennekes socket
Other1PhMax16A	Other single phase (domestic) sockets (16A max) CEE7/17, AS3112, NEMA 5-15, NEMA 5-20, JISC8303, TIS166, SI 32, CPCS-CCC, SEV1011, etc.
Other3Ph	Other 3 phase sockets NEMA14-30, NEMA14-50
s309-1P-16A	16A 1 phase IEC60309 socket
s309-1P-32A	32A 1 phase IEC60309 socket
s309-3P-16A	16A 3 phase IEC60309 socket
s309-3P-32A	32A 3 phase IEC60309 socket
sBS1361	UK domestic socket a.k.a. 13Amp
sCEE-7-7	CEE 7/7 16A socket. May represent 7/4 & 7/5 a.k.a Schuko
sType2	IEC62196-2 Type 2 socket a.k.a. Mennekes connector
sType3	IEC62196-2 Type 2 socket a.k.a. Scame
Undetermined	Yet to be determined (e.g. before plugged in)
Unknown	Unknown; not determinable
wInductive	Wireless inductively coupled connection (generic)
wResonant	Wireless resonant coupled connection (generic)

ChargingProfile

Field Name	Field Type	Card.	Description
chargingProfileId	integer	1..1	Mandatory. Unique identifier for this

			profile.
primary	boolean	0..1	Optional. Indicates whether the limit schedule is the primary limit schedule or an alternative limit schedule that can be used during negotiation according to ISO15118. A SetChargingProfile.req message contains exactly one primary limit schedule. If the charge point is working with local smart charging, the algorithm to merge limit schedules for the overall energy consumption has to ensure that there is only one primary schedule applicable to a schedule negotiation according to ISO15118. If an EV charges controlled by PWM (mode 3) or doesn't support multiple sales tariff tables when charging with ISO15118, the primary limit schedule shall be used. *Note:* The term "alternative limit schedule" is used for limit schedules with primary = false. MAY be empty if the Charge Point doesn't support ISO/IEC 15118 or doesn't support alternative schedules.
stackLevel	integer >=0	1..1	Mandatory. Value determining level in hierarchy stack of profiles. Higher values have precedence over lower values. Lowest level is 0.
chargingProfilePurpose	ChargingProfilePurposeType	1..1	Mandatory. Defines the purpose of the schedule transferred by this message.
chargingProfileKind	ChargingProfileKindType	1..1	Mandatory. Indicates the kind of schedule.
recurrencyKind	RecurrencyKindType	0..1	Optional. Indicates the start point of a

			recurrence.
validFrom	DateTime	0..1	Optional. Point in time at which the profile starts to be valid. If absent, the profile is valid as soon as it is received by the charge point. Not to be used when ChargingProfilePurpose is *TxProfile*.
validTo	DateTime	0..1	Optional. Point in time at which the profile stops to be valid. If absent, the profile is valid until it is replaced by another profile. Not to be used when ChargingProfilePurpose is *TxProfile*.
chargingSchedule	ChargingSchedule	1..1	Mandatory. Contains limits for the available power over time.
salesTariff	SalesTariffTable	0..1	Optional. Contains indications of the relative value of energy over time (for example price or percentage of green energy). Mandatory for an alternative limit schedule.

ChargingProfileKindType

Enumeration

Value	Description
Absolute	Schedule periods are relative to a fixed point in time defined in the schedule.
Recurring	The schedule restarts periodically at the first schedule period.
Relative	Schedule periods are relative to a situation-specific start point (such as the start of a session) that is determined by the charge point.

ChargingProfilePurposeType

Enumeration

Value	Description
ChargePointExternalConstra	Additional constraints that will be incorporated into a local power schedule. Only valid for a Charge Point. Therefore evse.Id MUST be 0

ints	in the SetChargingProfile.req message.
ChargePointMaxProfile	Configuration for the maximum power available at a Charge Point. Only valid for a Charge Point. Therefore evse.Id MUST be 0 in the SetChargingProfile.req message.
TxDefaultProfile	Default profile to be used for new transactions. In the SetChargingProfile.req message evse.Id MAY be 0, in which case the profile applies to all EVSEs of the Charge Point.
TxProfile	Profile with constraints to be imposed by the Charge Point on the current transaction. A profile with this purpose SHALL cease to be valid when the transaction terminates. In the SetChargingProfile.req message evse.Id MUST NOT be 0.

ChargingSchedule

Class

Field Name	Field Type	Card.	Description
chargingScheduleId	integer	1..1	Mandatory. Unique identifier for a charging schedule.
duration	integer	0..1	Optional. Duration of the charging schedule in seconds. If the duration is left empty, the last period will continue indefinitely or until end of the transaction in case startSchedule is absent.
startSchedule	DateTime	0..1	Optional. Starting point of an absolute schedule. If absent the schedule will be relative to start of charging.
chargingSchedulePeriod	ChargingSchedulePeriod	1..*	Mandatory. List of ChargingSchedulePeriod elements defining maximum power usage over time.

ChargingSchedulePeriod

Class

Field Name	Field Type	Card.	Description

startPeriod	integer	1..1	Mandatory. Start of the period, in seconds from the start of schedule. The value of StartPeriod simultaneously defines the stop time of the previous period.
maxPower	integer	0..1	Mandatory if no maxCurrent provided. Maximum power in kiloWatt that may be delivered during the schedule period.
maxCurrent	decimal	0..1	Mandatory if no maxPower provided. Maximum allowed current in Ampères per phase during the schedule period.
numberPhases	integer	0..1	Optional. The number of phases that can be used for charging. If a number of phases is needed, NumberPhase=3 will be assumed unless another number is given.

RecurrencyKindType

Enumeration

Value	Description
Daily	Daily: The schedule restarts at the beginning of the next day.
Weekly	The schedule restarts at the beginning of the next week (defined as Monday morning)

RequestedEnergyTransferType

Enumeration

Value	Description
Ac	AC charging
DcChademo	DC charging Chademo
DcIso	DC charging ISO

SalesTariffTable

Class

Used for smart charging operations.

Field Name	Field Type	Card.	Description
salesTariffId	integer	1..1	Mandatory. Identifier used to identify one sales tariff.
tariffDescription	LocalizedText	0..1	Optional. A human readable short description (for visualization and reporting).
maxEPriceLevel	integer	1..1	Mandatory. Defines the maximum number of distinct price levels across all provided sales tariff tables (e.g. on-peak, mid-peak, off-peak).
tariffPeriods	TariffPeriod	1..*	Mandatory. List of TariffPeriod elements.

TariffPeriod

Field Name	Field Type	Card.	Description
startPeriod	integer	1..1	Mandatory. Start of the period, in seconds from the start of schedule. The value of StartPeriod simultaneously defines the stop time of the previous period.
periodDescription	string[32]	0..1	Optional. A human readable short description (for visualization and reporting).
ePriceLevel	integer	1..1	Mandatory. Defines the price level of this period. 0 if comparison of price levels shall not be used (e.g. because payment is handled by external means).

4.2.1.3 SetChargingProfile.conf

Field Name	Field Type	Card.	Description
status	GenericStatus	1..1	Mandatory. Returns whether the Charge Point has been able to process the message successfully. It does not imply acceptance or

			adherence to the charging profile by the EV.

4.2.2 MeterValues

This concerns a message from the LC to the CSP to inform the CSP of the charging status. Again, similar to the SetChargingProfile message, this is an example message from OCPP. Any protocol that can communicate similar information can be used here. The reason this message is used during smart charging are:

- Metervalues make it possible to report the aggregated usage in predefined time blocks. This makes the usage reports more accurate.
- Visualization purposes. To visualize a charging session, metervalues can be used.
- Determine whether an EV is in its charging 'tail' (last part of charging) where it uses less power. This information can be used in the CSP algorithm for prioritizing.

4.2.2.1 MeterValues.req

This contains the field definition of the MeterValues.req PDU sent by the Charge Point to the Central System.

Field Name	Field Type	Card.	Description
evse	Evse	1..1	Mandatory. This contains an evse.id number (>=0) identifying an EVSE. evse.id = 0 (zero) is used to designate the main power meter. evse.connectorType is irrelevant in this message and can be ignored.
transactionId	TransactionId	0..1	Optional. The transaction to which these meter samples are related.
values	MeterValue	0..*	Optional. The sampled meter values with timestamps.

MeterValue

Class
Collection of meter values in MeterValues.req. Each value can optionally be accompanied by one or more attributes.

Field Name	Field Type	Card.	Description
timestamp	dateTime	1..1	Mandatory. Timestamp for measured value(s).
value	string[250]	1..*	Mandatory. Values for one or more measurands. Value as a “Raw” (decimal) number or “SignedData”. Field Type is “string” to allow for digitally signed data readings. Decimal numeric values are also acceptable to allow fractional values for measurands such as Temperature and Current.
attribute: **context**	ReadingContext	0..1	Optional. Type of detail value: start, end or sample. Default = “Sample.Periodic”
attribute: **format**	ValueFormat	0..1	Optional. Raw or signed data. Default = “Raw”
attribute: **measurand**	Measurand	0..1	Optional. Type of measurement. Default = “Energy.Active.Import.Register”
attribute: **location**	Location	0..1	Optional. Location of measurement. Default=”Outlet”
attribute: **unit**	UnitOfMeasure	0..1	Optional. Unit of the value. Default = “Wh” if the (default) measurand is an “Energy” type.

ReadingContext

Enumeration
Values of the context attribute in of a value in MeterValue. Some of the values are not used in the DSO interface.

Value	Description
Interruption.Begin	Value taken at start of interruption.
Interruption.End	Value taken when resuming after interruption.
Sample.Clock	Value taken at clock aligned interval.

Sample.Periodic	Value taken as periodic sample relative to start time of transaction.
Transaction.Begin	Value taken at end of transaction.
Transaction.End	Value taken at start of transaction.

ValueFormat

Enumeration
Format that specifies how the value element in MeterValue is to be interpreted.

Value	Description
Raw	Data is to be interpreted as integer/decimal numeric data.
SignedData	Data is represented as a signed binary data block, encoded as hex data.

Measurand

Enumeration
Allowable values of the optional "measurand" attribute of a Value element, as used in MeterValues.req and StopTransaction.req messages. Default value of "measurand" attribute of Value is always "Energy.Active.Import.Register"

Value	Description
Current.Export	Instantaneous current flow from EV
Current.Import	Instantaneous current flow to EV
Energy.Active.Export.Interval	Energy exported by EV (Wh or kWh)
Energy.Active.Export.Register	Energy exported by EV (Wh or kWh)
Energy.Active.Import.Interval	Energy imported by EV (Wh or kWh)
Energy.Active.Import.Register	Energy imported by EV (Wh or kWh)
Energy.Reactive.Export.Interval	Reactive energy exported by EV. (varh or kvarh)
Energy.Reactive.Export.Register	Reactive energy exported by EV (varh or kvarh)
Energy.Reactive.Import.Interval	Reactive energy imported by EV. (varh or kvarh)
Energy.Reactive.Import.Register	Reactive energy imported by EV (varh or kvarh)
Power.Active.Export	Instantaneous active power exported by EV. (W or kW)
Power.Active.Import	Instantaneous active power imported by EV. (W or kW)

Power.Reactive.Export	Instantaneous reactive power exported by EV. (var or kvar)
Power.Reactive.Import	Instantaneous reactive power imported by EV. (var or kvar)
Temperature	Temperature reading inside charge point.
Voltage	AC RMS supply voltage

Location

Enumeration
Allowable values of the optional "location" attribute of a value element in MeterValue.

Value	Description
Body	Measurement inside body of charge point (e.g. Temperature)
Inlet	Measurement at network (“grid”) inlet connection
Outlet	Measurement at an EVSE connection outlet (Connector). Default value

UnitOfMeasure

See paragraph 3.2.2.

4.2.2.2 MeterValues.conf

This contains the field definition of the MeterValues.conf PDU sent by the Central System to the Charge Point as response to a MeterValues.req PDU.

No fields are defined.

5. Binding protocol to transport

This chapter gives more information on how to use OSCP on transport level. This is done in a separate chapter to clearly separate the logical protocol from the technical implementation. This chapter covers the communication protocols to use and the security that must be implemented to use the protocol in a responsible way.

5.1 Communication protocols

The following table shows the manner of communication between the different parties in the smart charging chain:

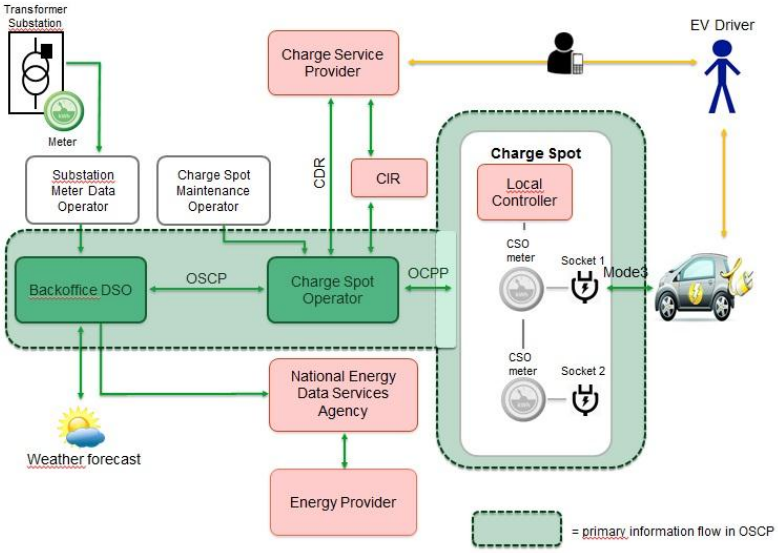
From	To	Communicationprotocol	Description
DSO TRAFO meter	DSO Backend System	DSO choice[3]	.
DSO Backend System	CSP Backend System	SOAP / http (incl. WS-addressing)	This holds both for traffic initiated by the DSO as by the CSP.
CSP Backend System	Local Controller	See OCPP 2.0 specification	

Please note: this section will be moved to the implementation guide as soon as the protocol specification is final.

5.2 Security

Appendix 1: Security gives an overview of the main risks and how they could be dealt with. It is based on an ongoing study by Dutch security research institute LaQuSo that will lead to an end-to-end security design for smart charging. The final version is expected to be available at the end of 2014 and will be made available to the OCA members. One of the conclusions of a preliminary study was that the OSCP protocol cannot be considered by itself, but that the complete chain of all involved parties / components must be considered. The current content of this chapter is a summary based on the latest draft version [4] and field experiences with smart charging [5]. The scope of the study is visualized in the following picture:

[3] Since this is a connection between the DSO and one of its own components (transformer), the DSO can decide on the communication itself. Since the damage that can be done by manipulating data, security measures should be in place.



Actors involved in smart charging and primary information flow in OSCP

The highest risks found in smart charging are:

- Authentication of EV drivers
- Integrity and confidentiality of communication between DSO and CSO, and between CSO and CS
- Integrity of the Charge Spot

Based on the mentioned risks and interviews with field experts (qualitative analysis) 3 main security goals were derived that are the basis for the end-to-end security design for smart charging of EVs:

1. Security mechanisms to enforce the normal operation of the grid **availability** of the grid is the most important requirement
2. **Integrity** of the data exchanged between all system entities must be enforced
3. **Confidentiality** of customer data as customer personal information must not be disclosed to unauthorized parties.

The two main measures that should be taken are

1. Integrity protection of meter readings and
2. Implementing secure channels for all information exchanges between actors.

Integrity protection of the meter readings is of crucial interest as they form the basis for billing purposes, capacity forecasts and verifying if smart charging was executed as agreed upon. Implementing secure channels is necessary to enforce authenticity, integrity and confidentiality where necessary.

The following list measures must be taken, please refer to *Appendix 1: Security* for other security requirements (among which the “should haves”):

Involved roles	From	To	MOSCOW	Security measure
DSO	DSO substation cable meter	DSO backoffice	MUST have	TLS – secured channel
DSO CSO	DSO backoffice	CSO backoffice	MUST have	TLS – secured channel
CSP CSO	CSP backoffice	CSO backoffice	MUST have	TLS – secured channel
CSO	CSO backoffice	Local Controller / Charge Station	MUST have	TLS – secured channel
CSMO CSO	Charge Station Maintenance Operator backoffice	CSO backoffice	MUST have	TLS – secured channel
CSO	CSO backoffice	Local Controller / Charge Station	MUST have	Implement integrity proving mechanisms in the charge station / local controller for energy measurements and data related to a charging transaction

5.3 Fault Response

In cases where the receiving party (e.g. DSO system or Central System) cannot process the request and the corresponding confirmation doesn't have to ability the report the error, then the SOAP Fault Response Message should be used. This can be used, for instance, when an internal error has occurred. In this case a difference between client and server error s (indicated in faultCode):

- A server error can be retried since the server might be recovered since the last attempt. If an error is reported back when resending, a sensible maximum retries is to be used (not unlimited).
- A client error should normally not be tried again, since this indicates that the error is caused by the client. Resending the same message will lead to similar behavior.

6. Example messages

6.1 UpdateCableCapacityForecast

6.1.1 Request

```
<soap:Envelope xmlns:soap="http://www.w3.org/2003/05/soap-envelope">
	<soap:Header>
		<Action
xmlns="http://www.w3.org/2005/08/addressing">/UpdateCableCapacityForecast</Action>
		<MessageID xmlns="http://www.w3.org/2005/08/addressing">f474139b-357a-
4a8a-9d7f-c1e9940914b7:1</MessageID>
		<To
xmlns="http://www.w3.org/2005/08/addressing">https://dsoserviceacc.greenflux.nl/Service
s/OSCP/ChargeServiceProviderServiceV10.svc</To>
		<ReplyTo xmlns="http://www.w3.org/2005/08/addressing">
			<Address>http://www.w3.org/2005/08/addressing/anonymous</Address>
		</ReplyTo>
		<Parties xmlns="http://OSCP/CSP/2013/06/">
			<senderID>8712423014022</senderID>
			<receiverID>8712423222120</receiverID>
		</Parties>
		<Priority xmlns="http://OSCP/CSP/2013/06/">2</Priority>
		<DateTime xmlns="http://OSCP/CSP/2013/06/">2015-04-
09T00:00:04.609Z</DateTime>
	</soap:Header>
	<soap:Body>
		<UpdateCableCapacityForecastRequest xmlns="http://OSCP/CSP/2013/06/">
			<Forecast>
				<Cable>
					<CableId>Amsterdam</CableId>
					<Connection>

	<ConnectionReferenceId>991188227733664455</ConnectionReferenceId>
					</Connection>
				</Cable>
				<ForecastedBlock>
					<Capacity Unit="A">24.00</Capacity>
					<StartTime>2015-04-09T00:00:00Z</StartTime>
					<EndTime>2015-04-09T00:14:59Z</EndTime>
					<RemainingCapacity Unit="A">0.00</RemainingCapacity>
				</ForecastedBlock>
				<ForecastedBlock>
					<Capacity Unit="A">16.00</Capacity>
					<StartTime>2015-04-09T00:15:00Z</StartTime>
					<EndTime>2015-04-09T00:29:59Z</EndTime>
					<RemainingCapacity Unit="A">0.00</RemainingCapacity>
				</ForecastedBlock>
				<ForecastedBlock>
					<Capacity Unit="A">24.00</Capacity>
					<StartTime>2015-04-09T00:30:00Z</StartTime>
					<EndTime>2015-04-09T00:44:59Z</EndTime>
					<RemainingCapacity Unit="A">0.00</RemainingCapacity>
				</ForecastedBlock>
				<ForecastedBlock>
					<Capacity Unit="A">16.00</Capacity>
					<StartTime>2015-04-09T00:45:00Z</StartTime>
```

```
                        <EndTime>2015-04-09T00:59:59Z</EndTime>
                        <RemainingCapacity Unit="A">0.00</RemainingCapacity>
                    </ForecastedBlock>
                    <ForecastedBlock>
                        <Capacity Unit="A">24.00</Capacity>
                        <StartTime>2015-04-09T01:00:00Z</StartTime>
                        <EndTime>2015-04-09T01:14:59Z</EndTime>
                        <RemainingCapacity Unit="A">0.00</RemainingCapacity>
                    </ForecastedBlock>
                    <ForecastedBlock>
                        <Capacity Unit="A">16.00</Capacity>
                        <StartTime>2015-04-09T01:15:00Z</StartTime>
                        <EndTime>2015-04-09T01:29:59Z</EndTime>
                        <RemainingCapacity Unit="A">0.00</RemainingCapacity>
                    </ForecastedBlock>
                    <ForecastedBlock>
                        <Capacity Unit="A">24.00</Capacity>
                        <StartTime>2015-04-09T01:30:00Z</StartTime>
                        <EndTime>2015-04-09T01:44:59Z</EndTime>
                        <RemainingCapacity Unit="A">0.00</RemainingCapacity>
                    </ForecastedBlock>
                    <ForecastedBlock>
                        <Capacity Unit="A">16.00</Capacity>
                        <StartTime>2015-04-09T01:45:00Z</StartTime>
                        <EndTime>2015-04-09T01:59:59Z</EndTime>
                        <RemainingCapacity Unit="A">0.00</RemainingCapacity>
                    </ForecastedBlock>
                    <ForecastedBlock>
                        <Capacity Unit="A">16.00</Capacity>
                        <StartTime>2015-04-09T02:00:00Z</StartTime>
                        <EndTime>2015-04-09T23:44:59Z</EndTime>
                        <RemainingCapacity Unit="A">0.00</RemainingCapacity>
                    </ForecastedBlock>
                </Forecast>
            </UpdateCableCapacityForecastRequest>
        </soap:Body>
</soap:Envelope>
```

6.1.2 Response

```
<s:Envelope xmlns:s="http://www.w3.org/2003/05/soap-envelope">
        <s:Header>
            <h:DateTime xmlns:h="http://OSCP/CSP/2013/06/"
xmlns="http://OSCP/CSP/2013/06/">2015-04-08T23:59:59.7203093Z</h:DateTime>
            <h:Parties xmlns:h="http://OSCP/CSP/2013/06/"
xmlns="http://OSCP/CSP/2013/06/" xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
                <senderID>8712423222120</senderID>
                <receiverID>8712423014022</receiverID>
            </h:Parties>
            <h:Priority xmlns:h="http://OSCP/CSP/2013/06/"
xmlns="http://OSCP/CSP/2013/06/">2</h:Priority>
            <h:Action xmlns:h="http://www.w3.org/2005/08/addressing"
xmlns="http://www.w3.org/2005/08/addressing">/UpdateCableCapacityForecastResponse</h:Ac
tion>
            <h:MessageID xmlns:h="http://www.w3.org/2005/08/addressing"
xmlns="http://www.w3.org/2005/08/addressing">d50df982-2b84-4ce3-83aa-
45ec77072b80</h:MessageID>
```

```
            <h:To xmlns:h="http://www.w3.org/2005/08/addressing"
xmlns="http://www.w3.org/2005/08/addressing"/>
      </s:Header>
      <s:Body xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xsd="http://www.w3.org/2001/XMLSchema">
            <UpdateCableCapacityForecastResponse xmlns="http://OSCP/CSP/2013/06/">
                  <Result>
                        <Type>SUCCESS</Type>
                        <Details>
                              <Detail>
                                    <Code>MESSAGE_PROCESSED</Code>
                                    <Level>INFO</Level>
                                    <Message/>
                                    <Description>MESSAGE_PROCESSED</Description>
                              </Detail>
                        </Details>
                  </Result>
            </UpdateCableCapacityForecastResponse>
      </s:Body>
</s:Envelope>
```

6.2 RequestAdjustedCapacity

```
<s:Envelope xmlns:s="http://www.w3.org/2003/05/soap-envelope">
      <s:Header>
            <h:DateTime xmlns:h="http://OSCP/DSO/2013/06/"
xmlns="http://OSCP/DSO/2013/06/">2015-04-09T08:02:49.1339663Z</h:DateTime>
            <h:Parties xmlns:h="http://OSCP/DSO/2013/06/"
xmlns="http://OSCP/DSO/2013/06/" xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
                  <senderID>8716892000005</senderID>
                  <receiverID>8712423014022</receiverID>
            </h:Parties>
            <h:Priority xmlns:h="http://OSCP/DSO/2013/06/"
xmlns="http://OSCP/DSO/2013/06/">1</h:Priority>
            <h:Action xmlns:h="http://www.w3.org/2005/08/addressing"
xmlns="http://www.w3.org/2005/08/addressing">/RequestAdjustedCapacity</h:Action>
            <h:MessageID xmlns:h="http://www.w3.org/2005/08/addressing"
xmlns="http://www.w3.org/2005/08/addressing">4fdd4acc-0339-4da9-8395-
df95682c23af</h:MessageID>
            <h:To xmlns:h="http://www.w3.org/2005/08/addressing"
xmlns="http://www.w3.org/2005/08/addressing">https://elmo-
acc.smartcharging.nl/OSCP/DistributionSystemOperatorServiceV10</h:To>
      </s:Header>
      <s:Body xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xsd="http://www.w3.org/2001/XMLSchema">
            <RequestAdjustedCapacityRequest xmlns="http://OSCP/DSO/2013/06/">
                  <Adjustment>
                        <Cable>
                              <CableId>SP2</CableId>
                        </Cable>
                        <CapacityBlock>
                              <Capacity Unit="A">12.00</Capacity>
                              <StartTime>2015-04-09T08:15:00</StartTime>
                              <EndTime>2015-04-09T08:29:59</EndTime>
                        </CapacityBlock>
```

```
<CapacityBlock>
       <Capacity Unit="A">12.00</Capacity>
       <StartTime>2015-04-09T08:15:00</StartTime>
       <EndTime>2015-04-09T08:29:59</EndTime>
</CapacityBlock>
<CapacityBlock>
       <Capacity Unit="A">12.00</Capacity>
       <StartTime>2015-04-09T08:30:00</StartTime>
       <EndTime>2015-04-09T08:44:59</EndTime>
</CapacityBlock>
<CapacityBlock>
       <Capacity Unit="A">12.00</Capacity>
       <StartTime>2015-04-09T08:15:00</StartTime>
       <EndTime>2015-04-09T08:29:59</EndTime>
</CapacityBlock>
<CapacityBlock>
       <Capacity Unit="A">12.00</Capacity>
       <StartTime>2015-04-09T08:30:00</StartTime>
       <EndTime>2015-04-09T08:44:59</EndTime>
</CapacityBlock>
<CapacityBlock>
       <Capacity Unit="A">12.00</Capacity>
       <StartTime>2015-04-09T08:30:00</StartTime>
       <EndTime>2015-04-09T08:44:59</EndTime>
</CapacityBlock>
<CapacityBlock>
       <Capacity Unit="A">12.00</Capacity>
       <StartTime>2015-04-09T08:30:00</StartTime>
       <EndTime>2015-04-09T08:44:59</EndTime>
</CapacityBlock>
<CapacityBlock>
       <Capacity Unit="A">12.00</Capacity>
       <StartTime>2015-04-09T08:45:00</StartTime>
       <EndTime>2015-04-09T08:59:59</EndTime>
</CapacityBlock>
<CapacityBlock>
       <Capacity Unit="A">12.00</Capacity>
       <StartTime>2015-04-09T08:45:00</StartTime>
       <EndTime>2015-04-09T08:59:59</EndTime>
</CapacityBlock>
<CapacityBlock>
       <Capacity Unit="A">12.00</Capacity>
       <StartTime>2015-04-09T09:00:00</StartTime>
       <EndTime>2015-04-09T09:14:59</EndTime>
</CapacityBlock>
<CapacityBlock>
       <Capacity Unit="A">12.00</Capacity>
       <StartTime>2015-04-09T08:45:00</StartTime>
       <EndTime>2015-04-09T08:59:59</EndTime>
</CapacityBlock>
<CapacityBlock>
       <Capacity Unit="A">12.00</Capacity>
       <StartTime>2015-04-09T09:00:00</StartTime>
       <EndTime>2015-04-09T09:14:59</EndTime>
</CapacityBlock>
<CapacityBlock>
       <Capacity Unit="A">12.00</Capacity>
       <StartTime>2015-04-09T09:00:00</StartTime>
       <EndTime>2015-04-09T09:14:59</EndTime>
```

```
                        </CapacityBlock>
                        <CapacityBlock>
                              <Capacity Unit="A">12.00</Capacity>
                              <StartTime>2015-04-09T09:00:00</StartTime>
                              <EndTime>2015-04-09T09:14:59</EndTime>
                        </CapacityBlock>
                        <CapacityBlock>
                              <Capacity Unit="A">12.00</Capacity>
                              <StartTime>2015-04-09T09:15:00</StartTime>
                              <EndTime>2015-04-09T09:29:59</EndTime>
                        </CapacityBlock>
                  </Adjustment>
            </RequestAdjustedCapacityRequest>
      </s:Body>
</s:Envelope>
```

6.3 UpdateAggregatedUsage

```
<s:Envelope xmlns:s="http://www.w3.org/2003/05/soap-envelope">
      <s:Header>
            <h:DateTime xmlns:h="http://OSCP/DSO/2013/06/"
xmlns="http://OSCP/DSO/2013/06/">2015-04-09T08:06:40.0930626Z</h:DateTime>
            <h:Parties xmlns:h="http://OSCP/DSO/2013/06/"
xmlns="http://OSCP/DSO/2013/06/" xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
                  <senderID>8716892000005</senderID>
                  <receiverID>8712423014022</receiverID>
            </h:Parties>
            <h:Priority xmlns:h="http://OSCP/DSO/2013/06/"
xmlns="http://OSCP/DSO/2013/06/">1</h:Priority>
            <h:Action xmlns:h="http://www.w3.org/2005/08/addressing"
xmlns="http://www.w3.org/2005/08/addressing">/UpdateAggregatedUsage</h:Action>
            <h:MessageID xmlns:h="http://www.w3.org/2005/08/addressing"
xmlns="http://www.w3.org/2005/08/addressing">fdd6e27a-1a5e-4975-b495-
c634322e2c5a</h:MessageID>
            <h:To xmlns:h="http://www.w3.org/2005/08/addressing"
xmlns="http://www.w3.org/2005/08/addressing">https://elmo-
acc.smartcharging.nl/OSCP/DistributionSystemOperatorServiceV10</h:To>
      </s:Header>
      <s:Body xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xsd="http://www.w3.org/2001/XMLSchema">
            <UpdateAggregatedUsageRequest xmlns="http://OSCP/DSO/2013/06/">
                  <Usage>
                        <Cable>
                              <CableId>SP1</CableId>
                        </Cable>
                        <UsageBlock>
                              <Usage Unit="Wh">0</Usage>
                              <Usage Unit="A">0</Usage>
                              <StartTime>2015-04-09T07:45:00</StartTime>
                              <EndTime>2015-04-09T07:59:59</EndTime>
                        </UsageBlock>
                  </Usage>
                  <Usage>
                        <Cable>
                              <CableId>SP2</CableId>
```

```
        </Cable>
        <UsageBlock>
                <Usage Unit="Wh">0</Usage>
                <Usage Unit="A">16.00</Usage>
                <StartTime>2015-04-09T07:45:00</StartTime>
                <EndTime>2015-04-09T07:59:59</EndTime>
        </UsageBlock>
</Usage>
<Usage>
        <Cable>
                <CableId>SP3</CableId>
        </Cable>
        <UsageBlock>
                <Usage Unit="Wh">0</Usage>
                <Usage Unit="A">0</Usage>
                <StartTime>2015-04-09T07:45:00</StartTime>
                <EndTime>2015-04-09T07:59:59</EndTime>
        </UsageBlock>
</Usage>
<Usage>
        <Cable>
                <CableId>SP4</CableId>
        </Cable>
        <UsageBlock>
                <Usage Unit="Wh">0</Usage>
                <Usage Unit="A">0</Usage>
                <StartTime>2015-04-09T07:45:00</StartTime>
                <EndTime>2015-04-09T07:59:59</EndTime>
        </UsageBlock>
</Usage>
<Usage>
        <Cable>
                <CableId>SP5</CableId>
        </Cable>
        <UsageBlock>
                <Usage Unit="Wh">0</Usage>
                <Usage Unit="A">0</Usage>
                <StartTime>2015-04-09T07:45:00</StartTime>
                <EndTime>2015-04-09T07:59:59</EndTime>
        </UsageBlock>
</Usage>
<Usage>
        <Cable>
                <CableId>SP6</CableId>
        </Cable>
        <UsageBlock>
                <Usage Unit="Wh">0</Usage>
                <Usage Unit="A">0</Usage>
                <StartTime>2015-04-09T07:45:00</StartTime>
                <EndTime>2015-04-09T07:59:59</EndTime>
        </UsageBlock>
</Usage>
<Usage>
        <Cable>
                <CableId>SP7</CableId>
        </Cable>
        <UsageBlock>
                <Usage Unit="Wh">0</Usage>
                <Usage Unit="A">0</Usage>
```

```
                <StartTime>2015-04-09T07:45:00</StartTime>
                <EndTime>2015-04-09T07:59:59</EndTime>
        </UsageBlock>
</Usage>
<Usage>
        <Cable>
                <CableId>SP8</CableId>
        </Cable>
        <UsageBlock>
                <Usage Unit="Wh">0</Usage>
                <Usage Unit="A">0</Usage>
                <StartTime>2015-04-09T07:45:00</StartTime>
                <EndTime>2015-04-09T07:59:59</EndTime>
        </UsageBlock>
</Usage>
<Usage>
        <Cable>
                <CableId>SP9</CableId>
        </Cable>
        <UsageBlock>
                <Usage Unit="Wh">0</Usage>
                <Usage Unit="A">0</Usage>
                <StartTime>2015-04-09T07:45:00</StartTime>
                <EndTime>2015-04-09T07:59:59</EndTime>
        </UsageBlock>
</Usage>
<Usage>
        <Cable>
                <CableId>SP10</CableId>
        </Cable>
        <UsageBlock>
                <Usage Unit="Wh">0</Usage>
                <Usage Unit="A">0</Usage>
                <StartTime>2015-04-09T07:45:00</StartTime>
                <EndTime>2015-04-09T07:59:59</EndTime>
        </UsageBlock>
</Usage>
<Usage>
        <Cable>
                <CableId>SP11</CableId>
        </Cable>
        <UsageBlock>
                <Usage Unit="Wh">0</Usage>
                <Usage Unit="A">0</Usage>
                <StartTime>2015-04-09T07:45:00</StartTime>
                <EndTime>2015-04-09T07:59:59</EndTime>
        </UsageBlock>
</Usage>
<Usage>
        <Cable>
                <CableId>SP12</CableId>
        </Cable>
        <UsageBlock>
                <Usage Unit="Wh">0</Usage>
                <Usage Unit="A">0</Usage>
                <StartTime>2015-04-09T07:45:00</StartTime>
                <EndTime>2015-04-09T07:59:59</EndTime>
        </UsageBlock>
</Usage>
```

```
                    <Usage>
                          <Cable>
                                <CableId>SP13</CableId>
                          </Cable>
                          <UsageBlock>
                                <Usage Unit="Wh">0</Usage>
                                <Usage Unit="A">0</Usage>
                                <StartTime>2015-04-09T07:45:00</StartTime>
                                <EndTime>2015-04-09T07:59:59</EndTime>
                          </UsageBlock>
                    </Usage>
                    <Usage>
                          <Cable>
                                <CableId>SP14</CableId>
                          </Cable>
                          <UsageBlock>
                                <Usage Unit="Wh">0</Usage>
                                <Usage Unit="A">0</Usage>
                                <StartTime>2015-04-09T07:45:00</StartTime>
                                <EndTime>2015-04-09T07:59:59</EndTime>
                          </UsageBlock>
                    </Usage>
                    <Usage>
                          <Cable>
                                <CableId>SP15</CableId>
                          </Cable>
                          <UsageBlock>
                                <Usage Unit="Wh">0</Usage>
                                <Usage Unit="A">0</Usage>
                                <StartTime>2015-04-09T07:45:00</StartTime>
                                <EndTime>2015-04-09T07:59:59</EndTime>
                          </UsageBlock>
                    </Usage>
              </UpdateAggregatedUsageRequest>
      </s:Body>
</s:Envelope>
```

6.4 GetCapacityForecast

```
<s:Envelope xmlns:s="http://www.w3.org/2003/05/soap-envelope">
      <s:Header>
            <h:DateTime xmlns:h="http://OSCP/DSO/2013/06/"
xmlns="http://OSCP/DSO/2013/06/">2015-04-09T00:02:05.433853Z</h:DateTime>
            <h:Parties xmlns:h="http://OSCP/DSO/2013/06/"
xmlns="http://OSCP/DSO/2013/06/" xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
                  <senderID>8716892000005</senderID>
                  <receiverID>8716874000009</receiverID>
            </h:Parties>
            <h:Priority xmlns:h="http://OSCP/DSO/2013/06/"
xmlns="http://OSCP/DSO/2013/06/">1</h:Priority>
            <h:Action xmlns:h="http://www.w3.org/2005/08/addressing"
xmlns="http://www.w3.org/2005/08/addressing">/GetCapacityForecast</h:Action>
            <h:MessageID xmlns:h="http://www.w3.org/2005/08/addressing"
xmlns="http://www.w3.org/2005/08/addressing">f5419d2d-5039-40ee-a468-
328c38b372be</h:MessageID>
```

```
            <h:To xmlns:h="http://www.w3.org/2005/08/addressing"
xmlns="http://www.w3.org/2005/08/addressing">https://elmo-
acc.smartcharging.nl/OSCP/DistributionSystemOperatorServiceV10</h:To>
      </s:Header>
      <s:Body xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xsd="http://www.w3.org/2001/XMLSchema">
            <GetCapacityForecastRequest xmlns="http://OSCP/DSO/2013/06/"/>
      </s:Body>
</s:Envelope>
```

6.5 Heartbeat

6.5.1 Request

```
<soap:Envelope xmlns:soap="http://www.w3.org/2003/05/soap-envelope">
      <soap:Header>
            <Action xmlns="http://www.w3.org/2005/08/addressing">/Heartbeat</Action>
            <MessageID xmlns="http://www.w3.org/2005/08/addressing">52228013-1762-
4007-8648-f2b76ed7df9f</MessageID>
            <To
xmlns="http://www.w3.org/2005/08/addressing">https://dsoserviceacc.greenflux.nl/Service
s/OSCP/ChargeServiceProviderServiceV10.svc</To>
            <ReplyTo xmlns="http://www.w3.org/2005/08/addressing">
                  <Address>http://www.w3.org/2005/08/addressing/anonymous</Address>
            </ReplyTo>
            <Parties xmlns="http://OSCP/CSP/2013/06/">
                  <senderID>8712423014022</senderID>
                  <receiverID>8712423222120</receiverID>
            </Parties>
            <Priority xmlns="http://OSCP/CSP/2013/06/">2</Priority>
            <DateTime xmlns="http://OSCP/CSP/2013/06/">2015-04-
09T00:05:00.423Z</DateTime>
      </soap:Header>
      <soap:Body>
            <HeartbeatRequest xmlns="http://OSCP/CSP/2013/06/">
                  <HeartBeatTimeInterval>300</HeartBeatTimeInterval>
                  <ForecastTimeInterval>900</ForecastTimeInterval>
            </HeartbeatRequest>
      </soap:Body>
</soap:Envelope>
```

6.5.2 Response

```
<s:Envelope xmlns:s="http://www.w3.org/2003/05/soap-envelope">
      <s:Header>
            <h:DateTime xmlns:h="http://OSCP/CSP/2013/06/"
xmlns="http://OSCP/CSP/2013/06/">2015-04-09T00:04:51.9062712Z</h:DateTime>
            <h:Parties xmlns:h="http://OSCP/CSP/2013/06/"
xmlns="http://OSCP/CSP/2013/06/" xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
                  <senderID>8712423222120</senderID>
                  <receiverID>8712423014022</receiverID>
```

```
            </h:Parties>
            <h:Priority xmlns:h="http://OSCP/CSP/2013/06/"
xmlns="http://OSCP/CSP/2013/06/">2</h:Priority>
            <h:Action xmlns:h="http://www.w3.org/2005/08/addressing"
xmlns="http://www.w3.org/2005/08/addressing">/HeartbeatResponse</h:Action>
            <h:MessageID xmlns:h="http://www.w3.org/2005/08/addressing"
xmlns="http://www.w3.org/2005/08/addressing">710deef5-0c3e-4f35-a36f-
e733bb690821</h:MessageID>
            <h:To xmlns:h="http://www.w3.org/2005/08/addressing"
xmlns="http://www.w3.org/2005/08/addressing"/>
      </s:Header>
      <s:Body xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xsd="http://www.w3.org/2001/XMLSchema">
            <HeartbeatResponse xmlns="http://OSCP/CSP/2013/06/">
                  <CurrentTime>2015-04-09T00:04:51.9062712Z</CurrentTime>
                  <Result>
                        <Type>SUCCESS</Type>
                        <Details>
                              <Detail>
                                    <Code>MESSAGE_PROCESSED</Code>
                                    <Level>INFO</Level>
                                    <Message/>
                                    <Description>MESSAGE_PROCESSED</Description>
                              </Detail>
                        </Details>
                  </Result>
            </HeartbeatResponse>
      </s:Body>
</s:Envelope>
```

7. Appendix 1: Security

7.1 Introduction

As smart charging of EVs is an activity that is executed by multiple parties and end-to-end security design instead of one per actor is a suitable approach. In this appendix the generic security measures are presented. One could see this as the minimum set of measures that have to be implemented. Depending on the characteristics of the organization implementing these measures and for example country specific role models, legislation and regulatory frameworks, specific security measures might be needed. For that purpose individual organizations implementing smart charging functionality (including the support of the OSCP protocol) are encouraged to execute a risk analysis. An example of a risk analysis approach is the NIST 800-30 [6]. It gives an organization a step-by-step approach to discover relevant risks and a process to determine what actions need to be taken per risk. Basically an organization can choose to mitigate, transfer, avoid or accept a certain risk. The picture below shows how the full risk assessment process looks like.

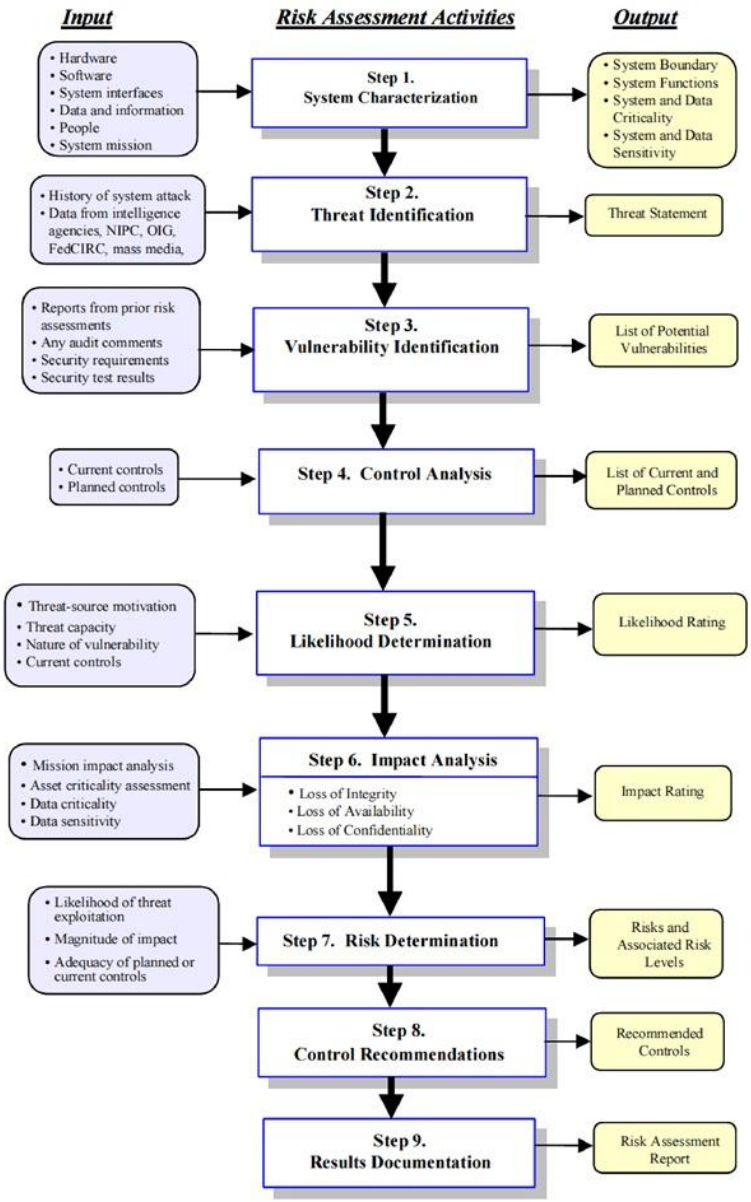


Figure 1 - NIST 800-30 risk assessment process [6]

Note that not all control recommendations will result in ICT related security measures like applying TLS to secure the transport layer. Control recommendations can also consist of measures on organizational level by implementing separation of duties or organizing privacy awareness sessions to involve employees in this topic. In the end it is up to the individual organization to define and prioritize the controls that need to be implemented.

7.2 Risk analysis of the smart charging use case (end-to-end)

In the security design of LaQuSo [4] an overview is given of the main risks that come with smart charging in the Netherlands. As the Dutch energy market is liberalized and it counts with an implemented interoperable EV charging infrastructure, the risks that have been identified will most likely also be applicable to other countries where smart charging is being implemented.

The following table shows the risks that were identified:

	Issue	Impact	Feasibility	Detectability
1	I/U measurements by the DSO	Medium	Low	Low
2	Weather forecasts influencing capacity forecasts	Medium	Low	High
3	Capacity forecasts performed by the DSO back office	High	Low	High
4	Communication of local capacity forecasts to the CSO	High	Medium	Low
5	Misusage of local capacity forecasts by the CSO	Medium	Medium	Medium
6	Weak authentication of EV driver at CS	Medium-High	High	Low
7	Communication between CSO and LC can be manipulated	High	Medium	Low
8	Communication between CSO and LC can be eavesdropped	Medium	Medium	Low
9	Communication between LC and CS can be manipulated	High	Medium	Low
10	Communication between LC and CS can be eavesdropped	Low	High	Low
11	Integrity of the charge spot	High	High	Low
12	No privacy guarantees on data collected by CSO/EMSP	Medium	Medium	Low
13	Manipulation of data by an insider	High	Medium	Low
14	Availability of EV charging	High	Medium	Medium-High

Figure 2 – List of security risks found in smart charging of EVs [4]

As risk is the product of impact and feasibility from this list the highest risks found in smart charging are:

- Authentication of EV drivers
- Integrity and confidentiality of communication between DSO and CSO, and between CSO and CS
- Integrity of the Charge Spot

Authentication has a high ranking as in the Netherlands the Mifare Classic RFID card has been used for both identification and authentication of EV drivers. The ranking of this risk can be different in other countries depending on the selected identification and authentication schemes. The integrity related risks are less likely to be country specific. Based on the mentioned risks and interviews with field experts (qualitative analysis) 3 main security goals were derived that are the basis for the end-to-end security design for smart charging of EVs:

4. Security mechanisms to enforce the normal operation of the grid **availability** of the grid is the most important requirement
5. **Integrity** of the data exchanged between all system entities must be enforced

6. **Confidentiality** of customer data as customer personal information must not be disclosed to unauthorised parties.

7.3 End-to-end security design for Smart Charging

As stated the full security design can be found in [4]. In this paragraph a brief overview is given and a table with a set of measures that need to be implemented. In the *figure 3* one can see all the actors involved in smart charging. The actors within the green area are responsible for the primary OSCP related information flows. However, for an end-to-end security the full set of actors and their information flows have to be taken into account. In *figure 4* the full list of measures is presented.

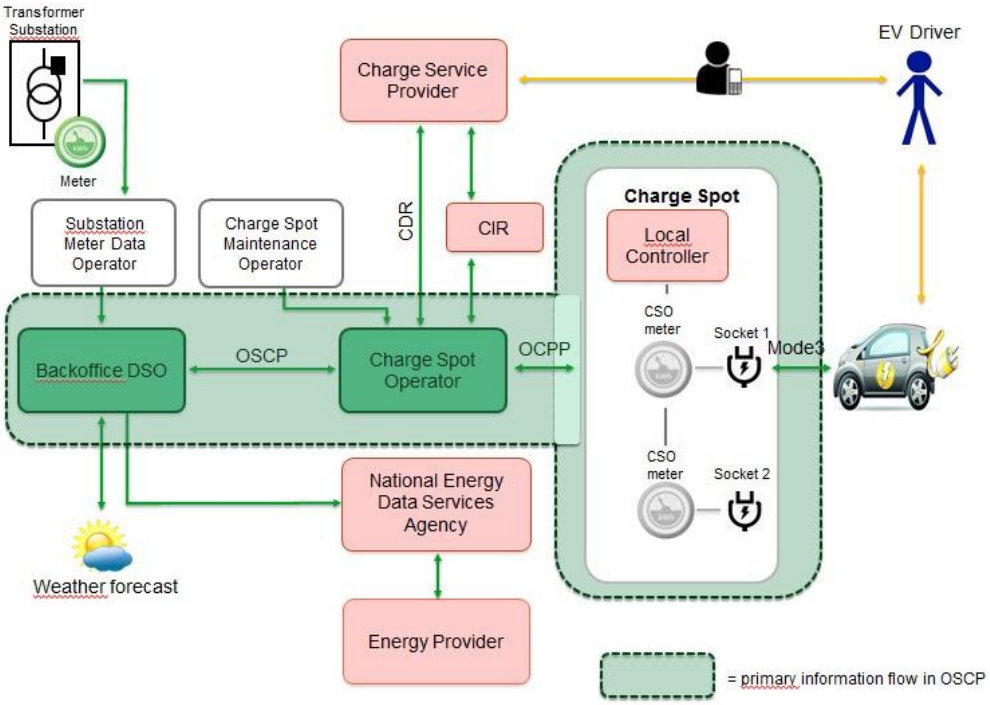


Figure 3 – Actors involved in smart charging and primary information flow in OSCP

Although the CSO, charge station and DSO are the main actors involved in exchanging OSCP related messages other actors like CSP, Substation Meter Data Operator and Charge Spot Maintenance Operator also need to be taken into account.

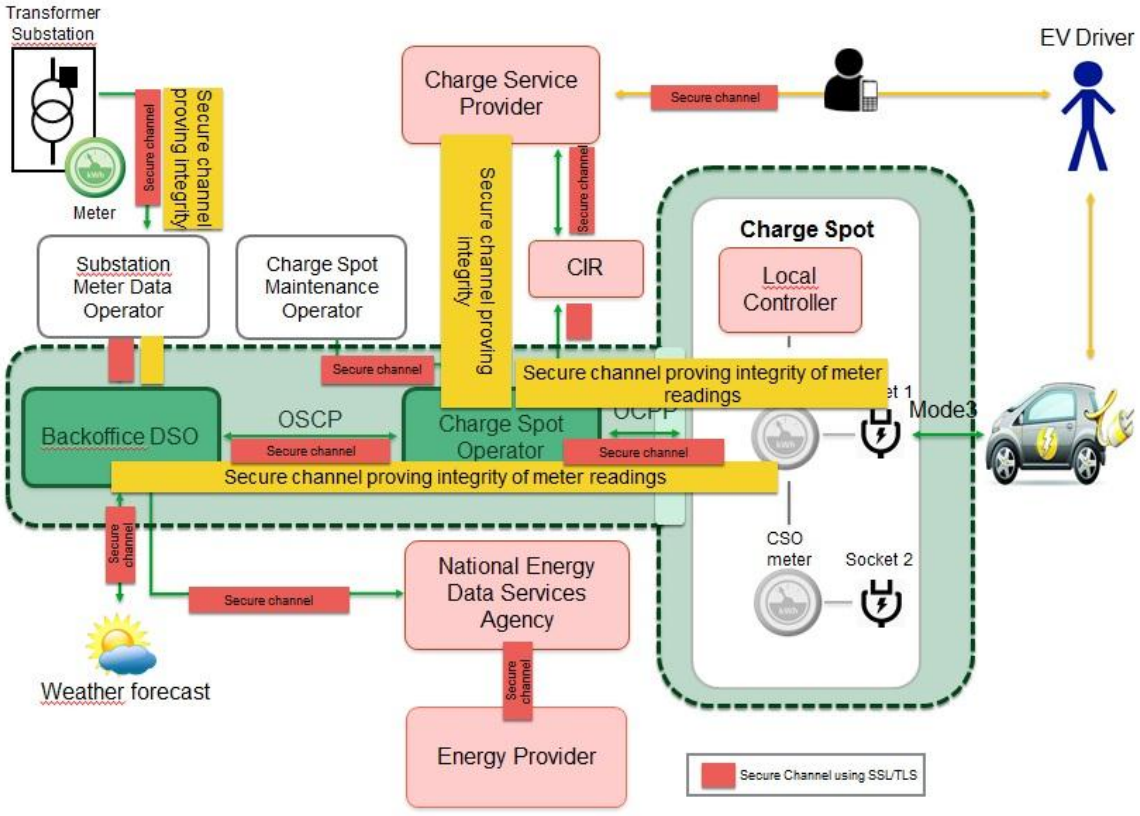


Figure 4 – End-to-end security design

The two main measures in *figure 4* are integrity protection of meter readings (marked with yellow rectangles) and implementing secure channels for all information exchanges between actors (marked with red rectangles). Integrity protection of the meter readings is of crucial interest as they form the basis for billing purposes, capacity forecasts and verifying if smart charging was executed as agreed upon. Implementing secure channels using TLS / SSL is necessary to enforce authenticity, integrity and confidentiality where necessary.

7.4 Security measures per actor / component

To achieve end-to-end security each and one of the actors / components will have to implement individual measures. These measures are listed below:

Involved roles	From	To	MOSCOW	Security measure
DSO	DSO substation cable meter	DSO backoffice	MUST have	TLS – secured channel
DSO CSO	DSO backoffice	CSO backoffice	MUST have	TLS – secured channel
CSP CSO	CSP backoffice	CSO backoffice	MUST have	TLS – secured channel
CSO	CSO backoffice	Local Controller / Charge Station	MUST have	TLS – secured channel
CSMO CSO	Charge Station Maintenance Operator backoffice	CSO backoffice	MUST have	TLS – secured channel

All	n/a	n/a	SHOULD have	Implement information security management system based on ISO2700x to ensure a structured and companywide embedded security culture.
All	n/a	n/a	SHOULD have	For the development, test and acceptance-environment self-signed certificates can be used to setup the TLS channel(s).
All	n/a	n/a	MUST have	For the production-environment official and valid CA certificate(s) must be used.
All	n/a	n/a	COULD have	For those parties developing software a mature software development lifecycle should be implemented including security and privacy by design principles on all levels
All	n/a	n/a	SHOULD have	Have security audits executed periodically (at least once per year) to ensure measures have been implemented properly
CSO	CSO backoffice	Local Controller / Charge Station	MUST have	Implement integrity proving mechanisms in the charge station / local controller for energy measurements and data related to a charging transaction
All	n/a	n/a	SHOULD have	Actors that would like to access the 'smart charging arena' should have their OSCP functionality tested / verified against the OCA supplied test tool.