Integration Profile
60870 Send Planned Schedule

Version 00.10

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Table of Content

1 About the Document

A **Functional Integration Profile** represents a particular technical specification that is integrated into a predefined document structure, a Technical Framework, as specified by IES (Integration the Energy System). The Technical Framework consists of introductory information on the application scenario it is intended for (Volume 1) and all the Integration Profiles and Functional Integration Profiles that specify the application scenario covered (Volume 2), as shown in Figure 1. A Functional Integration Profile, i.e., the specification of the application scenario, comprises a complete section in the second Volume of the Technical Framework, but shall be bundled into common operational Integration Profiles only, as sketched in **Fehler! Verweisquelle konnte nicht gefunden werden.**.

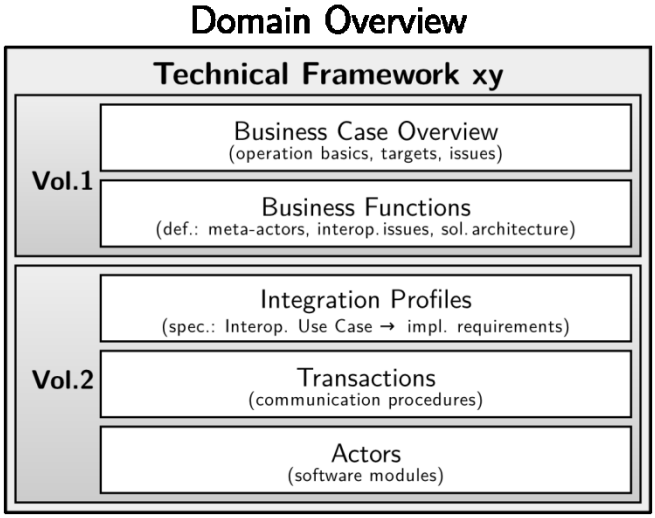


Figure 1: Structure of the IES Technical Framework – with focus on Integration Profiles

Please note that neither a Technical Framework nor an Integration Profile or a Common Feature equal a new standard. This hierarchy of documents rather describes the normalised use and combined application of existing standards and good practices. It is intended to prevent interoperability issues when functionalities and features are implemented as specified by the individual parts constituting a Technical Framework. The individual parts may be reused in other Technical Frameworks to maximise synergies (multiple utilisation of same implementations).

2 Definitions

Actor
is a functional software component of a system that executes transactions with other actors as defined in an Integration Profile.

Business Case
is the economic viable application of an idea or technology.

Business Function
is a feature required to be realised for a Business Case to work.

Conformance Testing
is a standalone process to ensure that the implementation conforms to specified standards and profiles, i.e. the implementations outputs and response are checked against rules and patterns.

Integration Profile
is the specification required to realise a part of a Business Function (or combination thereof) in an interoperable fashion (normalised).

Interoperability Testing
is a process to check whether the system interacts effectively with foreign systems, i.e. when different vendors meet to test their interfaces against each other (e.g. Connectathon).

Interoperability Use Case
is a (part of a) Business Function that relies on data exchange between different actors according to an Integration Profile (i.e. where interoperability is required).

Meta-Actor
is the composition (grouping) of all the functional components (actors) that the Meta-Actor is required to integrate in order to perform all the Business Functions related to it (according to the Use Case Diagram). It could be a human operator, but typically it is a software component embedded in some device that provides an interface to some communication infrastructure.

Transaction
is the specification of a set of messages (1..n) exchanged between at least two actors that realise the Use Case specific information exchange (in one or both directions, in a strict or loose order) as specified by an Integration Profile.

Operational Use Case
is a (part of a) Business Function that describes an activity not involving any data exchange between actors. Operational Use Cases are mentioned in the Technical Framework, but not considered by Integration Profiles because per se they do not raise interoperability problems.

3 Integration Profile: 60870 Send Planned Schedule

The profile “60870 Send Planned Schedule” describes the interoperability issue for the data exchange of a VPP schedule, where power values are transmitted from the VPPOP/DEUOP to the DEUOP/DEUC. The content of the exchanged information depends on the Business Function, have a look at the description provided in Volume 1 of the IES Technical Framework. The format of the exchanged information and the exchange per se are specified by the used standards IEC 60870-5-101 and 60870-5-104. The different communication relations and the used communication standard lead to the following actors-transactions relations in Figure 2. The concrete implementation strategy of the transaction is described in Section 4.

Table 1: Dependencies among Integration Profiles (bundling with external IPs)

Integration Profile	Depends on	Dependency Type	Purpose
60870-5-104 Send Planned Schedule	IHE – Audit Trail and Node Authentication	Each SPS Actor shall be grouped with IHE Secure Node or IHE Secure Application Actor	Required to manage audit trail of exchanged messages, node authentication and transport encryption
60870-5-104 Send Planned Schedule	Establish a secure connection	Each transaction shall be done via a secure TLS 1.2 connection.	Before data exchange can be executed, a secure connection between client and server has to be created.

3.1 Actors/Transactions

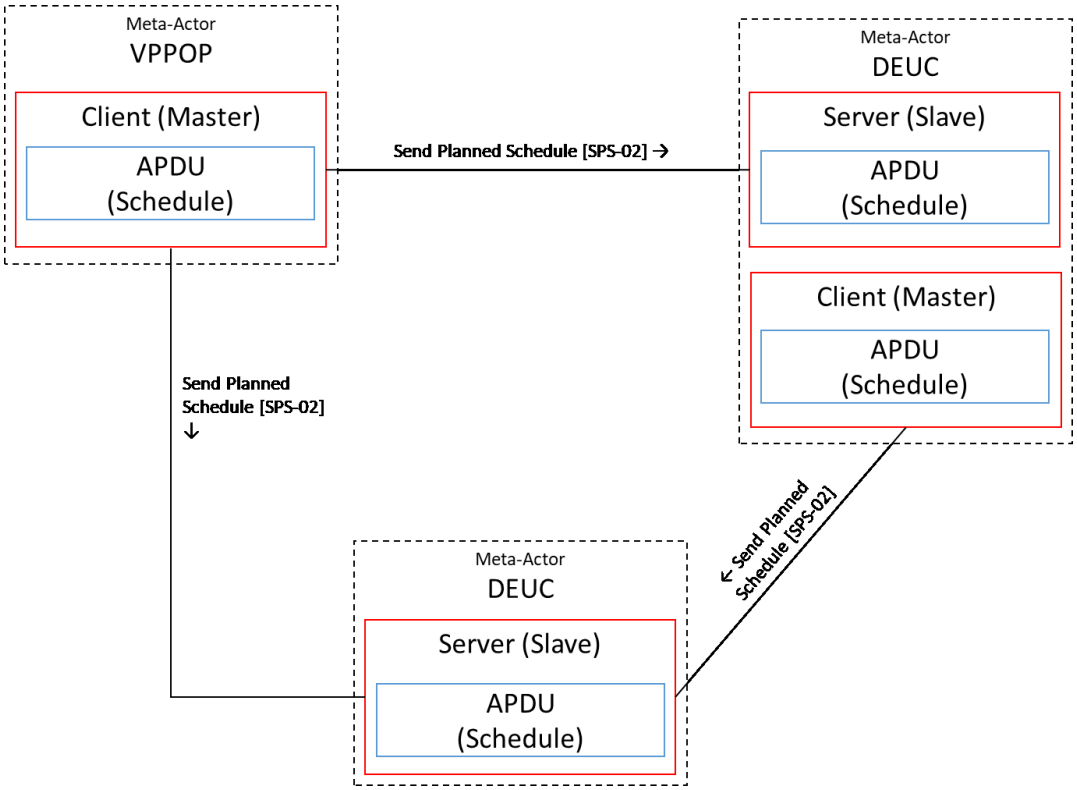


Figure 2: Actors/Transaction Diagram for sending a planned schedule: The dashed lines represent the grouping of actors into Meta-actors.

Table 2: Transactions for Get Measured Values

Actors	Transaction	Optionality	Section
Client (Master)	Send Planned Schedule [SPS-02]	R	**Fehler! Verweisquelle onnte nicht gefunden werden.**
Server (Slave)	Send Planned Schedule [SPS-02]	R	**Fehler! Verweisquelle onnte nicht gefunden werden.**

3.1.1 Actor Descriptions and Actor Profile Requirements

Some of the meta-actors/actors definitions are available in Section 3 of Volume 1.

3.1.1.1 Client

The Client (Master) is the actor that initiates a communication over a TCP channel to the Server (Slave). Either it wants to send some information, or it receives some information. If a TCP channel to the Server (Slave) is not already established, it initiates the connection setup with the Integration Profile “Establish a secure connection” and applies the bundled IHE ATNA Integration Profile to assure secure authorisation, encrypted data transport and adequate logging options. Also, the Client (Master) is now ready to receive data.

3.1.1.2 Server

The Server (Slave) honours the connection request from the Client (Master) by answering the request. The Server (Slave) is now ready to receive and send data. Latter can be the execution of a periodic or trigger-based data exchange to the Client (Master).

3.1.2 Transactions

3.1.2.1 Send Planned Schedule

The VPPOP/DEUOP Client (Master) creates the connection to the Server (Slave) and sends the planned schedule to the DEUC Server (Slave) via a secure TLS 1.2 connection. The VPPOP/DEUOP sends the planned schedule trigger-based if changes occur by single information objects described in IEC 60870-5-104 via bit sequences in the ASDU format I (informative) with control direction mode. The values for start and duration of the schedule as well as the power readings are transmitted.

3.2 Actor Options

Options that may be selected for each actor in this profile are listed in Table 3. Afterwards, the options are described and dependencies between options are specified. The actor options for the VPPOP, DEUOP and DEUC are already described in the Integration Profile “61850 Send Planned Schedule”.

Table 3: Actor Options for Get Measured Values

Actor	Role	Option	Vol. & Section
VPPOP	Aggregator	Market participant	IP “61850 Send Planned Schedule” Vol. 2, 3.2.1
	Operator (Client (Master))	Plant Operator	IP “61850 Send Planned Schedule” Vol. 2, 3.2.2
DEUOP	Controller (Server (Slave))	DEU Controller	IP “61850 Send Planned Schedule” Vol. 2, 3.2.3
	Operator (Client (Master))	Station Operator	IP “61850 Send Planned Schedule” Vol. 2, 3.2.4
DEUC	Controller (Server	DEU Controller	IP “61850 Send Planned

	(Slave))		Schedule" Vol. 2, 3.2.5
DEU	Technical Unit	Producer	IP "61850 Send Planned Schedule" Vol. 2, 3.2.6
		Consumer	IP "61850 Send Planned Schedule" Vol. 2, 3.2.7
		Storage	IP "61850 Send Planned Schedule" Vol. 2, 3.2.8
DSO	Operator (Client (Master))	Grid Operator	Vol. 2, 3.2.1.1
	Controller (Server (Slave))	Balance Power Controller	Vol. 2, 3.2.1.2

3.2.1.1 Grid Operator

The DSO is responsible for the operation and expansion of the electric power grid that can be used by the energy producer and consumer to transport electricity from the generator to the customer.

3.2.1.2 Balance Power Controller

The DSO has to check the current status of the electric power grid at each time. Therefore, measured values from DEUC are used as well as own measurements and key performance indicators.

3.3 Information Flow Process

The transmission of measured values can be separated in the following two steps "establishSecureConnection" and "setPlannedSchedule". The detailed message transmission is summarized in the transaction "Send Planned Schedule". Both steps are executed between the DEUC and the DEUOP/VPPOP/DSO or the DEUOP and VPPOP/DSO. Messages of the transaction are always the same independent of the involved actors. The detailed description of the transaction, their information objects with exemplary values can be found in Section 4.1.4.2.

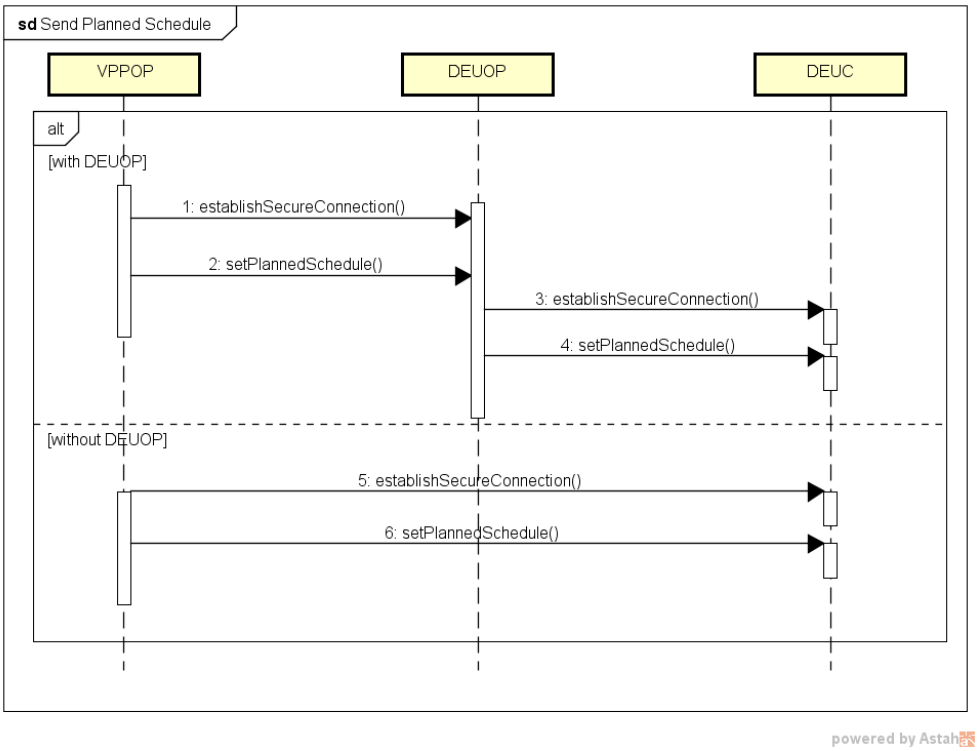


Figure 3: Sequence Diagram for "Transfer Measured Values"

3.4 Communication Requirements

The duration of the data transfer shall be no longer than 5 sec between Client (Master) and Server (Slave). The planned schedule shall be transmitted once per day and if changes occur. The communication between the actors shall be carried out in a closed user group with an encoded data transfer [7].

4 Transactions

4.1 Transaction: Send Planned Schedule

4.1.1 Scope

The VPPOP/DEUOP creates the schedule and transmits it to the DEUOP/DEUC with the transmission protocols of the standard IEC 60870-5-101 and -104. The DEUOP manages different DEUCs and maybe divides the received schedule from the VPPOP into schedules for each DEUC. The interoperability issue is the data exchange between Client (Master) and Server (Slave), i.e. between VPPOP and DEUOP, VPPOP and DEUC, and DEUOP and DEUC, whereat the protocol and data structure is also the same. Therefore, the Client (Master) has to prepare the ASDUs with the information objects which shall be transferred as single bit sequences to the Server (Slave) via a secure connection.

4.1.2 Actor Roles

Role	Description	Actor
Client (Master)	The Client (Master) is the transaction initiator that starts and sends or requests the values of the APDU to a receiving server actor via TCP/IP. If specified, the Client (Master) uses the IHE ATNA profile to establish a secured connection before the data transmission actually starts, if it is not already in place.	The following actors may play the role of the Client (Master): VPPOP, DEUOP
Server (Slave)	The Server (Slave) is the transaction responder that receives the values of the APDU or the request. In case a secure connection is required, it cooperates with the Client (Master) in establishing security.	The following actors may play the role of the Server (Slave): DEUOP, DEUC

4.1.3 Referenced Standards

- IEC 60870-5-101 (coded bit serial data transmission – communication profiles)
- IEC 60870-5-104 (definition of application message types)

4.1.4 Interaction Diagrams

The transaction “Send Planned Schedule” includes the following steps to transmit the planned schedule from the VPPOP/DEUOP Client (Master) to the DEUOP/DEUC Server (Slave). First, the Client (Master) shall establish a secure connection. Than the schedule mode of the Server (Slave) shall be activated and finally, the planned schedule shall be transmitted by the Client (Master) periodically or as soon as a value of the schedule changes (trigger-based).

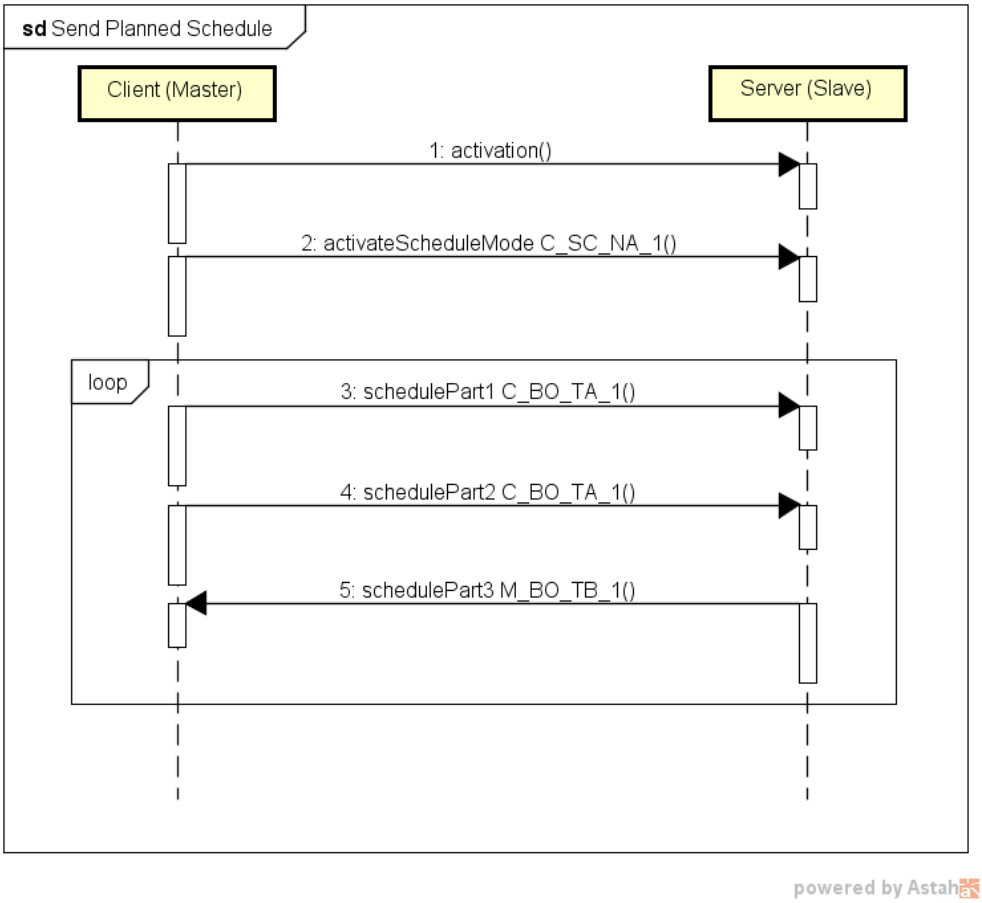


Figure 4: Data flow for planned schedule

4.1.4.1 Establish secure connection

A secure connection between Client (Master) and Server (Slave) is established by the functional Integration Profile “Establish a secure connection”.

Triggering Event
The VPPOP/DEUOP wants to establish a secure connection to a DEUOP/DEUC.

4.1.4.1.1 Message Semantics
Have a look at the specification in “Establish a secure connection”.

4.1.4.1.2 Expected Action
TCP connection has established between VPPOP/DEUOP and DEUOP/DEUC. Data transfer via IEC 60870-5-104 is possible.

4.1.4.2 Create message

4.1.4.2.1 Triggering Event
A secure connection between the Client (Master) and Server (Slave) addressed in the APDU has been created or is already established. The Client (Master) sends the planned schedule periodically or as soon as a value of the schedule changes to the Server (Slave).

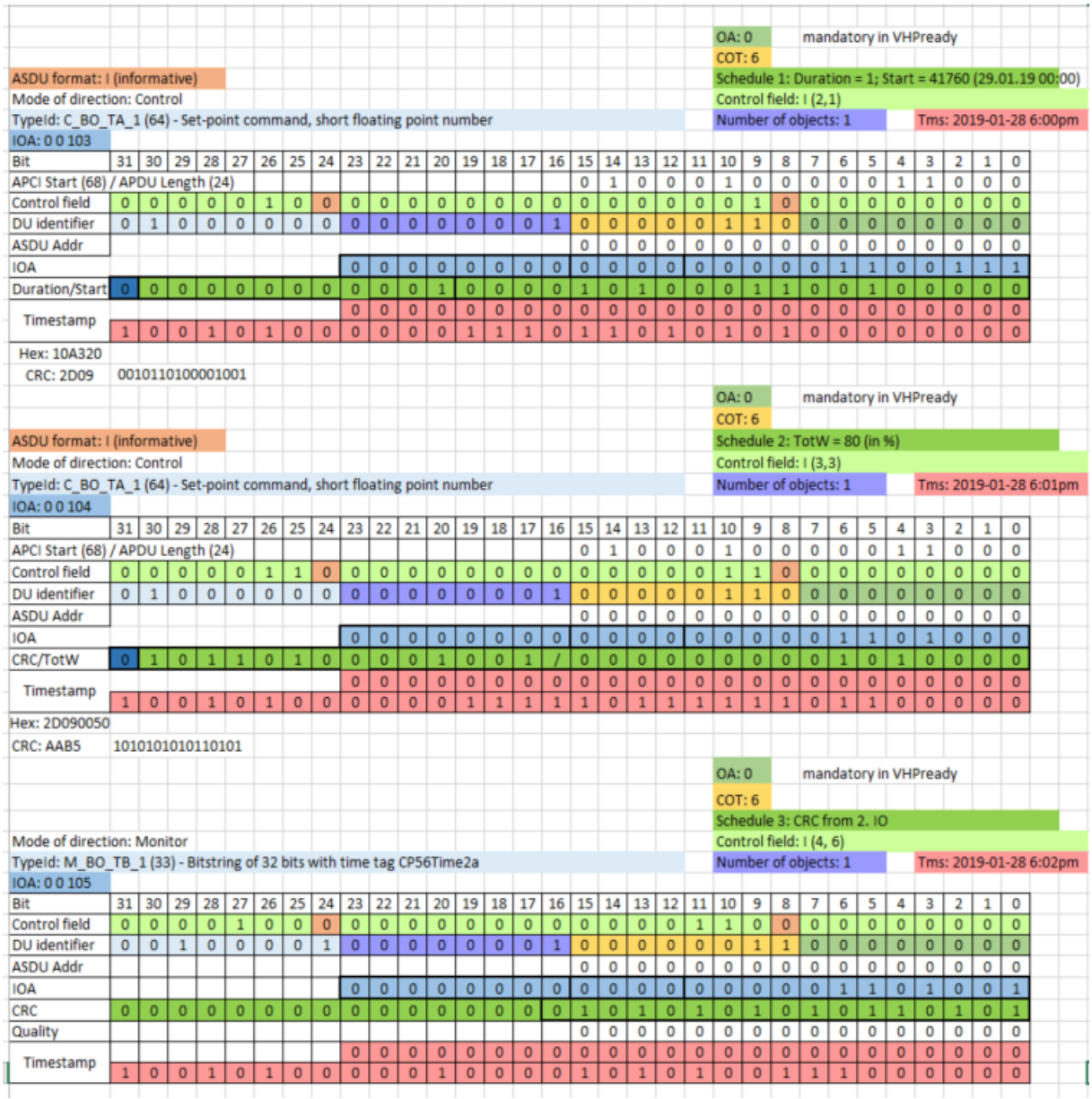
4.1.4.2.2 Message Semantics
For the data exchange, the Client (Master) has to create APDU for the planned schedule to transmit the following data objects: start time, duration, input/output power (TotW), and the values of the CRC (cycle redundancy check); that shall be transferred to the Server (Slave), see Figure 5.

APDI start	1 Byte	
APDU Length	1 Byte	
Control Field	4 Byte	ASDU format, control field
DU identifier	4 Byte	type (8 Bits)
		number of objects (8 Bits)
		COT (8 Bits)
		OA (8 Bits)
ASDU Addr	2 Byte	
IOA	3 Byte	plant type (8 Bits)
		plant number (4 Bits)
		data type (12 Bits)
Content	4 Byte	content (31 Bits), test criteria (1 Bit)
Timestamp	7 Byte	

Figure 5: APDU structure

An APDU consists of a header with the APDI start, the APDU length, and a control field. Furthermore, a DUI identifier, ASDU address and information object address (IOA) is given to identify the APDU. The IOA contains the plant type, plant number and the transferred data type, which is followed by the content. For the schedule, the first part contains the start time and duration (31 Bits), the second part includes the CRC of the first part (16 Bits) and the TotW (15 Bits), and the third part contains only the CRC of the second part (16 Bits) to confirm the correct transmission of the schedule. Exemplary, the structure of the APDU with the information object for one schedule is shown below in Figure 6. The planned schedule starts at 29th January 2019 00:00 h. The duration amounts 1 min with an output power of 80 % of the plant performance.

Hint: The time is indicated with the UTC standard (i.e. no summer time is considered) in minutes of the year. For checking the plant performance, the Server (Slave) can transmit the current TotW in monitor direction to the Client (Master) by M_ME_TF_1. The TotW is given as signed integer; therefore, the percentage of the performance is multiplied with 100. For the CRC check, the polynomial is 16#8005 and the initial value of the shift register is 16#FFFF (cf. https://www.lammertbies.nl/comm/info/crc-calculation.html). Also, consider that one IP package can contain more than one message so that the confirmation of a message can be later than a new message.



																					OA: 0	mandatory in VHPready								
																					COT: 6									
ASDU format: I (informative)																					Schedule 1: Duration = 1; Start = 41760 (29.01.19 00:00)									
Mode of direction: Control																					Control field: I (2,1)									
Typeld: C_BO_TA_1 (64) - Set-point command, short floating point number																					Number of objects: 1							Tms: 2019-01-28 6:00pm		
IOA: 0 0 103																														
Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
APCI Start (68) / APDU Length (24)																	0	1	0	0	0	1	0	0	0	0	0	1	1	0	0	0
Control field	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
DU identifier	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
ASDU Addr																	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IOA									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1
Duration/Start	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0
Timestamp									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	1	0	1	0	0	0	0	0	0	1	1	1	0	1	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0
Hex: 10A320																																
CRC: 2D09	0010110100001001																															
																					OA: 0	mandatory in VHPready								
																					COT: 6									
ASDU format: I (informative)																					Schedule 2: TotW = 80 (in %)									
Mode of direction: Control																					Control field: I (3,3)									
Typeld: C_BO_TA_1 (64) - Set-point command, short floating point number																					Number of objects: 1							Tms: 2019-01-28 6:01pm		
IOA: 0 0 104																														
Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
APCI Start (68) / APDU Length (24)																	0	1	0	0	0	1	0	0	0	0	0	1	1	0	0	0
Control field	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
DU identifier	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
ASDU Addr																	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IOA									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0
CRC/TotW	0	1	0	1	1	0	1	0	0	0	0	1	0	0	1	/	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
Timestamp									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	1	0	1	0	0	0	0	0	0	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	0	0
Hex: 2D090050																																
CRC: AAB5	1010101010110101																															
																					OA: 0	mandatory in VHPready								
																					COT: 6									
																					Schedule 3: CRC from 2. IO									
Mode of direction: Monitor																					Control field: I (4, 6)									
Typeld: M_BO_TB_1 (33) - Bitstring of 32 bits with time tag CP56Time2a																					Number of objects: 1							Tms: 2019-01-28 6:02pm		
IOA: 0 0 105																														
Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control field	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
DU identifier	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
ASDU Addr																	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IOA									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0
CRC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	1	0	1	1	0	1	0	1
Quality																	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Timestamp									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	1	0	1	0	1	0	0	1	1	1	0	0	0	0	0	0

Figure 6: ASDU structure for the schedule (part 1, 2, and 3)

4.1.4.2.3 Expected Actions

The DEUC/DEUOP has prepared the information objects to provide the measured values for the VPPOP/DSO/DEUOP.

4.1.4.3 Transmit message

The Client (Master) transfers the values of the information objects to the Server (Slave) via the secure TCP/IP connection that was established in the step 4.1.4.1.

4.1.4.3.1 Triggering Event

The VPPOP/DEUOP has prepared the ASDUs for the planned schedule to transfer these data as bit streams to the DEUOP/DEUC.

4.1.4.3.2 Message Semantics

The data exchanges between the Client (Master) and Server (Slave) with their control fields is shown in Figure 7.

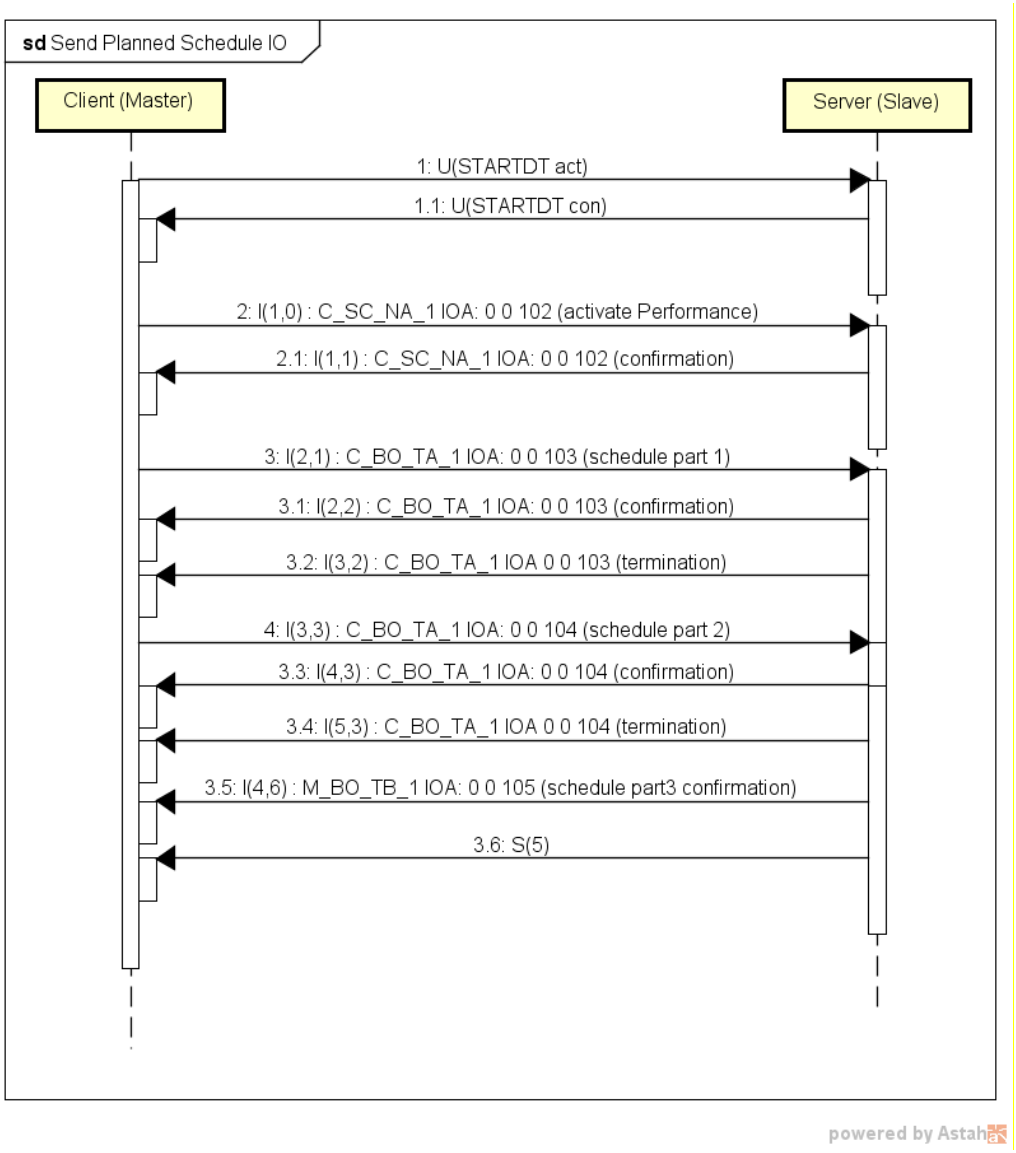


Figure 7: Transmit Message

4.1.4.3.3 Expected Actions

The DEUOP/DEUC got the planned schedule.

4.1.5 Security considerations

For a secure transmission, a connection via TLS 2 (Transport Layer Security 2) is mandatory (cf. F_IP_Establish-a-secure-connection). Aspects for authentication/authorization and logging as described in the IHE ATNA Profile shall also be considered for this transaction: http://wiki.ihe.net/index.php/Audit_Trail_and_Node_Authentication. The logging should contain parameters of the transmitter, receiver, time-stamp, and status of the transmission (successful or failing). Additional, reasons for the incorrect message transmission can be defined. A concrete schema for the logging still has to be defined. The logging and the schema are specified in the Functional Integration Profile "Audit Trail Event".

5 Abbreviations

ATNA	Audit Trail and Node Authentication
CDC	Common Data Classes
CIM	Common Information Model
DER	Distributed Energy Resource
DEU	Distributed Energy Unit
DEUC	Distributed Energy Unit Controller
DEUOP	Distributed Energy Unit Operator
DO	Data Objects
DSO	Distributed system operator
FFG	Austria Research Promotion Agency
GMV	Get Measured Values
GOOSE	Generic Object Oriented Substation Events
IEC	International Electrotechnical Commission
IES	Integrating the Energy System
IETF	Internet Engineering Task Force
IHE	Integrating the Healthcare
IP	Integration Profile
ISO	International Organization for Standardization
IT	Information Technology
LAN	Local Area Network
LD	Logical Device
LN	Logical Node
SCSM	Specific Communication Service Mapping
SGAM	Smart Grid Architecture Model
SO	System Operator
TCP/IP	Transmission Control Protocol/Internet Protocol
TLS	Transport Layer Security
UCMR	Use Case Management Repository
VPP	Virtual Power Plant
VPPOP	VPP Operator

6 References

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[2] IEC 60870-5-104: Transmission Protocols - Network access for IEC 60870-5-101 using standard transport profiles

[3] ISO/IEC 88241: 1999, Information technology – Abstract Syntax Notation One (ASN. 1) ITU X.690 (07/2002), Information technology

[4] RFC 5246: The Transport Layer Security (TLS) Protocol Version 1.2 – Communication security over the Internet

[5] IEC 62351: Power systems management and associated information exchange - Data and communications security

[6] IEC 61850-5: Communication requirements for functions and device models.

[7] Mindestanforderungen an die Informationstechnik des Anbieters für die Erbringung von Sekundärregelleistung, VHPready, 2014.