IEC TR 61850-90-10

Edition 1.0 2017-10

TECHNICAL REPORT

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Communication networks and systems for power utility automation – Part 90-10: Models for scheduling

IEC TR 61850-90-10:2017-10(en)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.200

ISBN 978-2-8322-4917-8

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CONTENTS

FOREWORD 5
1 Scope 7
2 Normative references 7
3 Terms, definitions and abbreviated terms 8
3.1 Terms and definitions 8
3.2 Abbreviated terms 8
4 Requirements for schedules 8
4.1 Schedules for establishing time-based behaviour 8
4.2 Relation between schedules and directly set values and parameters of the DER system 9
5 Principles for modelling schedules 9
5.1 Schedule controllers and their schedules 9
5.2 Scheduling and direct control / setting 10
5.2.1 General 10
5.2.2 Case when the scheduled entity is of type "controllable data object" 10
5.2.3 Case when the scheduled entity is of type "setting" 10
5.3 Schedule behaviour 11
5.4 Schedule structure 13
5.5 Managing schedules 14
5.5.1 Overview 14
5.5.2 The state machine of the schedule 14
5.5.3 The role of the schedule controller 17
5.5.4 Relations between schedule controller, schedule and scheduled entity 18
5.6 Configuration of schedules 19
6 IEC 61850 LNs and CDCs 19
6.1 CDCs of supported scheduled entities 19
6.2 Package CommonDataClasses_90_10 20
6.2.1 General 20
6.2.2 Package CDCStatusInfo 21
6.3 Logical node classes 23
6.3.1 General 23
6.3.2 Package LNGroupF 24
6.4 Enumerated data attribute types 28
6.4.1 General 28
6.4.2 Schedule states (ScheduleStateKind enumeration) 28
6.4.3 Schedule states (ScheduleEnablingErrorKind enumeration) 28
6.5 SCL enumerations (from DOEnums_90_10) 29
6.6 Schedule implementation examples 29
Annex A (informative) Impact of Mode (Mod) on the schedule status and on the controllable entity 30
Annex B (informative) Conditions for element presence 31
Annex C (informative) Abstract classes used as a basis for new LNs/CDCs 33
C.1 General 33
C.2 <<abstract>> Common attributes for primitive CDC (BasePrimitiveCDC) 33
C.3 <<abstract,admin>> LN: Domain Name: DomainLN 33
Annex D (informative) Time setting related CDC and attributes 35

Documents
Document Sharing Hub
Full document details: IEC TR 61850-90-10 2017

D.1 General ... 35
D.2 Calendar time definition (CalendarTime) ... 35
D.3 Time setting CDC (TSG) ... 36
D.3.1 General ... 36
D.3.2 <<abstract>> Time setting (TSG) ... 37
D.3.3 Time setting (FC=SP) (TSG_SP) ... 37
D.3.4 Time setting (FC=SG) (TSG_SG) ... 37
D.3.5 Time setting (FC=SE) (TSG_SE) ... 38
D.3.6 Month (MonthKind enumeration) ... 38
D.4 Occurrence (OccurrenceKind enumeration) ... 39
D.5 Period (PeriodKind enumeration) ... 39
D.6 Week day (WeekdayKind enumeration) ... 40
Annex E (informative) Scheduling example ... 41

Figure 1 – Scheduling principle ... 10
Figure 2 – State diagram for schedule ... 15
Figure 3 – Flow chart for transition out of running state ... 16
Figure 4 – Handling priorities of schedules to determine the *Active* one ... 18
Figure 5 – Relation between schedule controller, schedules and entity controlled ... 19
Figure 6 – Class diagram CDCStatusInfo::CDCStatusInfo90_10 ... 21
Figure 7 – Class diagram LogicalNodes_90_10::LogicalNodes_90_10 ... 23
Figure 8 – Class diagram LNGroupF::LNGroupF ... 24
Figure 9 – Class diagram DOEnums_90_10::DOEnums_90_10 ... 28
Figure D.1 – Interpretation of calendar time settings ... 35
Figure D.2 – Class diagram TSG::TSG ... 36
Figure E.1 – LN instances and relationships involved in the implementation of the schedule example ... 41
Figure E.2 – Timelines associated to the example ... 42

Table 1 – Normative abbreviations for data object names ... 8
Table 2 – Expected behaviour of a schedule ... 13
Table 3 – Structure of a schedule ... 14
Table 4 – Attributes of TCS ... 22
Table 5 – Attributes of ORS ... 22
Table 6 – Data objects of FSCC ... 25
Table 7 – Data objects of FSCH ... 26
Table 8 – Literals of ScheduleStateKind ... 28
Table 9 – Literals of ScheduleEnablingErrorKind ... 28
Table B.1 – Conditions for presence of elements within a context ... 31
Table C.1 – Attributes of BasePrimitiveCDC ... 33
Table C.2 – Data objects of DomainLN ... 34
Table D.1 – Attributes of CalendarTime ... 36
Table D.2 – Attributes of TSG ... 37
Table D.3 – Attributes of TSG_SP ... 37
Table D.4 – Attributes of TSG_SG ... 38

Documents
Document Sharing Hub
Full document details: IEC TR 61850-90-10 2017

Table D.5 – Attributes of TSG_SE 38
Table D.6 – Literals of MonthKind 39
Table D.7 – Literals of OccurrenceKind 39
Table D.8 – Literals of PeriodKind 40
Table D.9 – Literals of WeekdayKind 40

Documents
Document Sharing Hub

Full document details: IEC TR 61850-90-10 2017

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COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 90-10: Models for scheduling

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IEC TR 61850-90-10, which is a technical report, has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

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

Enquiry draft	Report on voting
57/1762/DTR	57/1902/RVDTR

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

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

A list of all parts in the IEC 61850 series, published under the general title *Communication networks and systems for power utility automation*, can be found on the IEC website.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 90-10: Models for scheduling

1 Scope

This part of IEC 61850, which is a Technical Report, describes scheduling for devices using IEC 61850.

The parameters, which identify this new namespace, are:

- Namespace Version: 2017
- Namespace Revision: A
- UML model file which reflects this namespace edition: wg10uml02v17-wg18uml02v11b-wg17uml02v18-jwg25uml02v04c.eap, UML model version WG17UML02v18
- Namespace release date: 2017-06-12
- Namespace name: "(Tr)IEC61850-90-10:2017A"

The namespace "(Tr)IEC61850-90-10:2017A" is considered as "transitional" since the models are expected to be included in the next editions of IEC 61850-7-4xx and IEC 61850-7-3. Potential extensions/modifications may happen if/when the models are moved to International Standard status. Only the new data objects and CDCs that are not said inherited from existing LNs will be tagged with this namespace name. The others should still refer to the namespace where they are primarily defined.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC TS 61850-2, *Communication networks and systems in substations – Part 2: Glossary*

IEC 61850-7-1:2011, *Communication networks and systems for power utility automation – Part 7-1: Basic communication structure – Principles and models*

IEC 61850-7-2:2010, *Communication networks and systems for power utility automation – Part 7-2: Basic information and communication structure – Abstract communication service interface (ACSI)*

IEC 61850-7-3:2010, *Communication networks and systems for power utility automation – Part 7-3: Basic communication structure – Common data classes*

IEC 61850-7-4:2010, *Communication networks and systems for power utility automation – Part 7-4: Basic communication structure – Compatible logical node classes and data object classes*

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3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 61850-2 IEC 61850-7-2 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1 scheduled entity

data object of one of the following common data classes APC, ASG, INS, ING SPC, SPG, ENC or ENG where the control output or the value of the setting may be determined by the scheduling system

3.1.2 scheduling system

collection containing a schedule controller and the schedules to which the schedule controller refers

Note 1 to entry: The scheduling system is associated to a scheduled entity (by reference in the schedule controller) and determines the behaviour of the scheduled entity.

3.2 Abbreviated terms

Clause 4 of IEC 61850-7-4:2010 defines abbreviated terms for building concatenated data names.

For the purposes of this document, some new abbreviations have been introduced as presented in this table.

Table 1 shows normative terms that are combined to create data object names.

Table 1 – Normative abbreviations for data object names

Term	Description
Dsa	Disable, disabled
Entr	Entry, entries
Prio	Priority
Req	Requested
Reuse	Reuse
Schd	Schedule

NOTE Abbreviated terms used for the identification of the common data classes and as names of the attributes are specified in the relevant clauses of this document and are not repeated here.

4 Requirements for schedules

4.1 Schedules for establishing time-based behaviour

Schedules establish which behaviour (for example, tariff 1 or 2, mode 1 or 3) is applied during specified time periods. A schedule consists of a series of entries. Entries of a schedule represent the value of a setpoint, the activation value of a particular mode or the value of a parameter for a mode. All the entries of a single schedule refer to a same data object which is

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a controllable object, a setpoint or a setting and which is called "scheduled entity" in this document.

One of the most common uses of schedules is for scheduling real power output. In that case, DER systems that directly manage their power output, such as reciprocating engines and energy storage systems, may use schedules to determine the time and level of power output.

However, many other controllable entities may also be scheduled. Larger inverter-based DER systems and large aggregations of small inverter-based DER systems have significant influence on the distribution system and have local Volt-VAr characteristics that may vary throughout the day. As a result, a single function or operational mode such as a specific Volt-VAr curve may not be suitable at all times. Yet sending many control commands every few hours to many different DER systems may impact bandwidth-limited communications systems or may not be received in a timely manner, leading to inadequate DER system responses. However, if schedules are established that the DER systems will follow autonomously, then these communication impacts will be minimized.

Schedules may be used to allow even more autonomous control of the behaviour of DER equipment. They are usually sent ahead of time, and then activated at the appropriate time or by an external trigger event. There are different applications for schedules:

- schedules for direct values (e.g. setpoints for P/Q/cosphi);
- schedules for constraints (e.g. do not exceed the maximum value of P/Q/cosphi at a certain time);
- schedules for pricing information (act on constraints);
- schedules for activation of modes (e.g. Volt-VAr curves);
- schedules for parameters of modes.

4.2 Relation between schedules and directly set values and parameters of the DER system

As has been mentioned before, schedules are an alternate way to determine the behaviour compared to direct control possibilities (i.e. using setpoints or activate and configure a selected mode of operation). Therefore, it is important to describe how schedules and direct control possibilities interact.

5 Principles for modelling schedules

5.1 Schedule controllers and their schedules

Within an electrical system, multiple entities may be scheduled in parallel. For example, it is possible to schedule active power and reactive power. For each of the scheduled entities (see 4.1 and 6.1), there will be, as depicted in Figure 1, at most one schedule controller and potentially several schedules referenced (used) by the schedule controller. One given schedule may be referenced by multiple schedule controllers.

An entity is a data object that exists in the IEC 61850 data model which is either a data object supporting control services (e.g. binary control or setpoint) or it is a setting (data object that includes attributes of FC=SP). The schedule controller has a data object which is a reference to the scheduled data object (see 6.3). For instance, a schedule controller could be associated with WMax (setting of the maximum real power output of a DER – namespace "(TR) IEC 61850-90-7:2012"). Another schedule controller could be associated with OpModVVAr which enables/disables the volt/var mode (namespace "(TR) IEC 61850-90-7:2012").

The description in this subclause applies to one scheduled entity (i.e. one schedule controller and multiple schedules).

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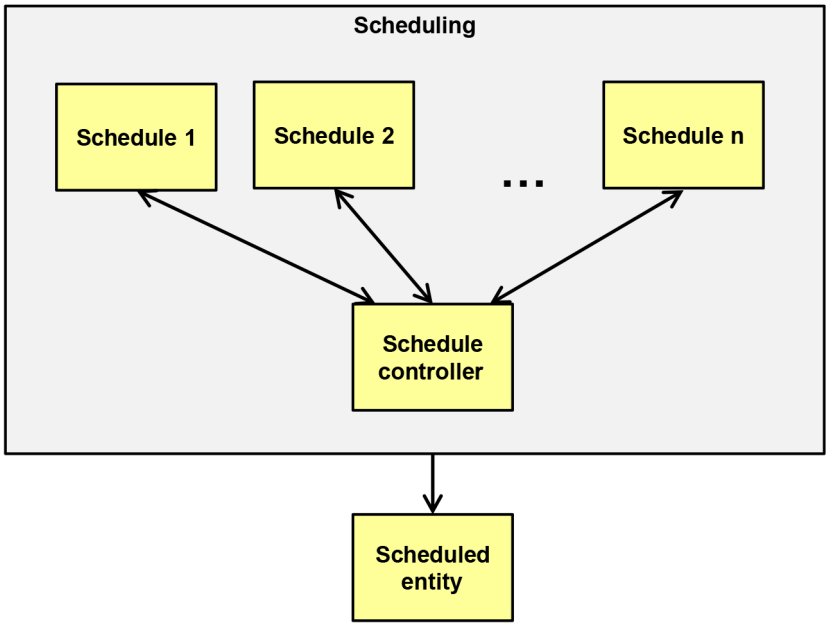

Figure 1 – Scheduling principle

5.2 Scheduling and direct control / setting

5.2.1 General

As mentioned in 5.1, scheduling applies to scheduled entities which are data objects in the IEC 61850 data model which may be controlled through control services (controllable data object) or which are settings where the value may be written.

5.2.2 Case when the scheduled entity is of type "controllable data object"

For controllable data objects a new data object will be added in IEC 61850-7-4[1] for each logical node which will indicate if direct settings control shall be used or if scheduling shall be used.

The behaviour, if scheduling is used and the schedule controller has no valid output (e.g. no schedule is active), shall be the same behaviour as when a setpoint has never been initialized, or when a controllable object has not received any control yet. It depends on the scheduled entity and shall be defined by user requirements or declared in the MICS of the device.

NOTE As an example, a photovoltaic system may feed in as much power as possible into the grid if no schedule is active. A pump may not operate anymore if no schedule is active. A valve may stay at the position it has last reached.

If the scheduled entity is of type "controllable object" and is used as a setpoint (data objects of the CDC APC that are not controlling equipment), the value applied shall be reflected in the data attribute mxVal. If the schedule controller has no valid output, the quality of mxVal of the scheduled entity shall be set to invalid.

5.2.3 Case when the scheduled entity is of type "setting"

For settings, the DO Mod of the schedule controller shall be set to "off" to indicate that the direct settings shall be used.

1 Extension under consideration, within the edition 2.1 of IEC 61850-7-4.

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If scheduling is used, the setting value (data attribute with FC=SP) of the scheduled entity will be updated with the scheduled value. If the schedule controller has no valid output, the last value will remain active.

5.3 Schedule behaviour

Schedules may be started by one or multiple UTC times (e.g. 2016-06-10 06:00), one or multiple calendar times (e.g., every Monday at 08:00 h), or by an external trigger.

Implementation rules for the start time:

- A start time is *configured as "UTC time"* when setTime is defined and holds the specified UTC start time within the TSG CDC and not setCal.
- A start time is *configured as "periodic"* when setCal is defined and hosts the calendar-based period parameter within the TSG CDC and not setTime.
- A "periodic" start time may also be configured as *"periodic starting after a defined UTC time"* when both setTime (specifying the UTC time) and setCal (specifying the calendar-based period) are defined within the TSG CDC.

There are variants in the usage of a schedule:

- a schedule may run just once at a defined UTC time if only one start time is present and *configured as UTC time*;
- a schedule may run multiple times at multiple UTC time due to multiple start times that can be *configured as UTC time*;
- a schedule may be repeated periodically at a defined calendar-based period if start time is *configured as periodic*;
- a schedule may be repeated periodically at a multiple calendar-based periods if multiple start times are *configured as periodic*;
- a schedule may be repeated periodically after a defined UTC time if start time is *configured as periodic after a UTC time*. This can also apply with multiple start times defined;
- a schedule may start running based on an external trigger; in such a case, it is said to be "*event driven*";
- the configured values of a schedule may be reused with a new start time or a new external trigger.

Implementation rules for the schedule:

- "*reuse*" condition reflects the status of the "SchdReuse" setting, "not reuse" condition means the opposite of "reuse" condition;
- "*event driven*" condition reflects the status of the "EvTrg" setting, "not event driven" condition means the opposite of "event driven" condition;
- "*periodic*" condition means that at least one StrTm of the schedule is defined as periodic (refer to implementation rules defined in 5.3), "not periodic" condition means the opposite of "periodic" condition;
- "*all StrTm consumed*" condition means that, considering that all defined StrTm are not periodic, all of them are past, "*not all StrTm consumed*" condition means the opposite of "all StrTm consumed" condtion.

The following basic rules apply:

- A schedule can be configured to be *event driven* – in that case, start times are ignored. Once an event triggered schedule has started, it cannot be restarted by another event.

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- If a start time is *configured as periodic*, the schedule will be executed periodically based on the configuration of start time. If the start time is *configured as UTC time*, the schedule will run once based on that start time.
- If multiple start times are available, a mixture of start times *configured as UTC time* and others *as periodic* is not allowed. If at least one start time is *configured as periodic*, all start times that are *configured as UTC time* will be ignored.
- If a schedule which is configured with multiple start times as UTC time is running and another start time becomes ready, the running one will have to end by anticipation and the schedule will be restarted with the new start time.
- If a schedule is configured to run periodically (i.e a start time is *configured as periodic)* and the period is shorter than the length of the schedule, **or if another start time is configured as periodic and its period start time occurs,** the running schedule will have to end by anticipation and it will restart. Thus it will strictly respect the given period(s).
- In case, for whatever reason, the schedule cannot start at the time given by the occurrence of a start time setting, but afterwards, then the schedule will run sharply as if it has started at the time given by the start time setting. Said in other words, the schedule won't shift the scheduled values based on the real-time start.

Schedules that are not *configured as periodic* will be automatically released (back to *Not ready* state) once an external trigger has happened or *all StrTm consumed* is true, unless they are configured to be *reuse*.

The overall expected behaviour is described in Table 2.

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