RealtimeInterface

Realtime Interface System Operator - DER

Dutch implementation of RfG interface requirements
Appendix A - IEC 61850 Protocol Implementation Document (PID)

Netbeheer Nederland

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Contents

Document management and distribution

Document management

Version	Date	Changes	Author
0.9	March 28th 2022	Initial document, for review	Technical specification WG
1.0 beta	April 11th 2022	No changes	Technical specification WG
1.0 beta 2	June 2022	Minor changes	Technical specification WG
beta 3	December 2022	Minor changes (M11, M17, S51 – S60)	Technical specification WG
1.0 beta 4	April 2023	See changelog	Technical specification WG
1.0 final	February 2024	See changelog	Technical specification WG

1. Introduction

This document specifies the implementation profile of the IEC 61850 Real Time Interface (RTI), as defined by the Dutch System Operators.

The purpose of this implementation profile is to unambiguously define and specify the minimum requirements for RTI equipment implementing IEC 61850. This implementation profile is based upon IEC 61850 edition 2 amendment 1: communication services, Logical Nodes (LN), together with the applicable Common Data Classes (CDC). This implementation profile is further referred to as PID (Protocol Implementation Document). This PID does not specify any special or supplier specific functions or requirements outside the standardized functions and models mentioned in the IEC 61850 standard.

This PID is based upon the IEC 61850 standard. The different parts of the PID provide an overview and details about the implemented IEC 61850 interfaces and engineering capabilities of Intelligent Electronic Devices (IEDs):

- ACSI basic conformance statement: to describe the basic communication features for use on the RTI
- ACSI models conformance statement: to describe the mandatory and optional data objects and attributes for data exchange on the RTI
- ACSI service conformance statement: the detailed mandatory communication services and implementation, features for use on the RTI

2. Scope and normative references

This profile is based upon IEC 61850, Communication networks and systems for power utility automation, edition 2 amendment 1.

Standard	Version	Definition
IEC 61850-6	2018	Part 6: Configuration description language for communication in electrical substations related to IEDs
IEC 61850-7-1	2020	Part 7-1: Basic communication structure - Principles and models
IEC 61850-7-2	2020	Part 7-2: Basic communication structure - Abstract communication service interface (ACSI)
IEC 61850-7-3	2020	Part 7-3: Basic communication structure - Common data classes
IEC 61850-7-4	2010	Part 7-4: Basic communication structure - Compatible logical node classes and data object classes
IEC 61850-7-420	2021	Part 7-420: Basic communication structure - Distributed energy resources and distribution automation logical nodes
IEC 61850-8-1	2020	Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3
IEC 61850-10	2012	Communication networks and systems for power utility automation – Part 10; Conformance testing; Edition 2.0

This PID utilizes existing communication services based upon IEC 61850-7-2 and IEC 61850-8-1. The used logical nodes and common data classes are defined in IEC 61850-7-4, IEC 61850-7-420 and IEC 61850-7-3.

3. Definitions

Contractor	See supplier
Shall	When used, the requirement is a need to have
Should	When used, the requirement is not mandatory but preferred
Optional	Optional, nice to have requirements.
Supplier	The supplier of equipment implementing this specification
Client	An IEC 61850 device or software on station level which receives information from servers IEDs.
Server	An IEC 61850 device providing protection and control functions inside the substation.

4. Acronyms

FAT	Factory Acceptance Testing
UCAIug	Utility Communication Architecture (UCA) International Users Group (Iug)
IED	Intelligent Electronic Device
IP	Internet Protocol
PDU	Protocol Data Unit
PID	Protocol Implementation Document
PICS	Protocol Implementation Conformance Statement
RTU	Remote Terminal Unit
SAT	System Acceptance Testing
TCP	Transmission Procedure Protocol
DO	Data Object
CDC	Common Data Class
ACSI	Abstract Communication Service Interface
LN	Logical Node

5. Testing

All test and inspections must be carried out per applicable IEC/IEEE standards. The supplier shall provide sufficient test and inspection specifications. Successful completion of inspections and testing shall be a prerequisite for delivery of products.

6. IEC 61850 concept

6.1. Two-Party Application Association

The communication between an IEC 61850 client and one server is established using the association service. The communication is terminated by the client via the release or abort service. The client shall restore the connection automatically when an interruption occurs.

[R.1] An IED acting as a server shall support a maximum of 1 association.

[R.2] Each connection from a client is registered as 1 association.

[R.3] Authentication in MMS is not used within this profile.

[R.4] The following Association parameters shall be used for all IEC 61850 IEDs:

Parameter	Checked during association?	Value
Transport selector	Y	0001
Session selector	Y	0001
Presentation selector	Y	00000001
AP Title	N	ANY
AE Qualifier	N	ANY

Only the “called” selectors should be checked during association.

[R.5] After a successful association, the client shall check the data sets and control blocks from the server.

[R.6] When a server IED is not fully started incoming association requests are not accepted.

[R.8] Client IEDs shall terminate (when needed) the association to a server IED by using the release or abort service.

[R.9] After Release the IED shall free up all used network resources and be ready for a new IEC 61850 association request until the maximum is reached.

[R.10] When the association to a server IED is interrupted the client shall perform an automatic reconnection. The client system shall issue an alert when a connection cannot be established.

[R.11] A TCP keep-alive value of 20 seconds should be implemented. The aim of this requirement is for the supervision of a dead connection.

6.2. Data sets

Data sets are sets of information that have a user-defined relation and can be transmitted in a group via the communication interface. IEC 61850 offers support for dynamic and static data-sets.

Static data sets are described in the SCL-file and are configured during engineering. Static data sets are saved in the IED and remains even without power.

[R.12] The exchange of status information and measurements shall be done via the reporting model.

[R.13] Only static data sets shall be used.

[R.14] The IED shall be capable to have at least 50 data attributes per configured data-set.

[R.15] The number of available data sets shall be at least 3.

[R.16] The minimal amount of data sets shall be equal or larger than the sum of all Report Control Blocks.

6.3. Reporting of data

Reporting is used for transmitting non-real-time process data from the servers towards the client systems. Within the Reporting model two sub-models are defined, unbuffered- and buffered reporting. The configuration of both models is done via the applicable Report Control Blocks (RCB).

[R.17] The configuration of RCBs is done offline via SCL.

[R.18] Each IED shall support at least 3 RCBs.

[R.19] The field rptID is used to identify different RCBs and shall be configured by the client or by the engineering tool.

[R.20] The following optional fields (optFlds) shall be supported by the server:

- Sequence-number
- Report-time-stamp
- Reason-for-inclusion
- Data-set-name
- Data-reference
- entryID
- configRef
- bufOvfl

[R.21] All IEDs shall allow the configuration of the following trigger options (TrgOps):

- integrity
- data change
- quality change
- general interrogation

[R.22] When a report does not fit in one single message, the sending IED shall segment the reports. The receiving client shall support segmented reports and process these as normal when segments are received.

[R.23] To optimize the transmission of reports the IED shall support BufTm > 0 to combine multiple events in one report.

[R.24] The use of unbuffered or buffered reporting as specified in the SCL.

6.4. Unbuffered Reporting Model

Reports generated by the Unbuffered RCB (URCB) in this model are not saved in the IED and therefore not protected against communication failures. When the communication is interrupted (for example due to a cable or network switch failure) reported information is lost. The URCB model shall only be used for information where archiving of data is not necessary.

[R.25] To publish changes in the connected URCB data-set when changes occur, the TrgOps = data-change shall be used.

[R.26] To cyclic report the contents of the connected URCB data-set TrgOps = integrity and IntgPd > 0 shall be used. The value of IntgPd is dynamic and can be changed by the client.

6.5. Buffered Reporting Model

Reports generated by the Buffered RCB (BRCB) in this model are saved inside the IED and protected against communication failures. The exact number of events that can be buffered depends on the available memory inside the IED. Reports are placed inside a buffer and remain available until the free memory of the buffer is insufficient to hold new reports or when the client purges the buffer.

[R.27] The size of the BRCB buffer for server IEDs shall be large enough to fulfil the functional requirements of the Realtime Interface (15 minutes minimum, maximum and average active power measurements for 8 hours).

[R.28] When BRCB memory is insufficient, the oldest report shall be replaced first. This shall be indicated by the presence of the BufOvl flag in the first report after the actual buffer overflow.

[R.29] The use of Buffered Reporting is mandatory to ensure no process data will be lost when there is a communication failure between servers and connected clients.

[R.30] To publish changes in the connected BRCB data set when changes occur, the TrgOps = data-change shall be used.

[R.31] The OptFlds = entryID shall always be set by the client system to ensure proper synchronization in the event of a communication failure.

[R.32] The client system shall explicitly reserve any RCB by writing for each BRCB the ResvTms > 0 and for each URCB Resv=T.

[R.33] To cyclic report the contents of the connected BRCB data set TrgOps = integrity and IntgPd > 0 shall be used. The value of IntgPd is a local issue.

6.6. Time-synchronization

[R.34] Time shall be expressed in UTC.

[R.35] When time-stamps differ more than 10 seconds commands shall be rejected.

[R.36] All IEDs shall support the time-quality bits:
- LeapSecondsKnown
- ClockNotSynchronized
- TimeAccuracy

[R.37] LeapSecondsKnown shall always be 1 when synchronized.

[R.38] The ClockNotSynchronized bit shall be 0 when synchronized.

[R.39] TimeAccuracy of the IEDs on the station bus shall be equal or less than 10 ms.

7. Data modelling and naming

7.1. Naming requirements

The use of IEC 61850 without vendor or product specific dependencies is mandatory. It is possible to use the Logicial Device Name (LD.ldName) or the Logical Device Instance Name name (LDevice.inst). The provided data model has a configured ldName, which contains a reference to the applicable RTI version. The following format is used: RTIserver1_0_0. The numbers 1_0_0 will change with every RTI version and correspond with major, minor and patch, i.e [major_minor_patch] changes that are applied in each version. The Netbeheer Nederland SCL files can be found on the website of Netbeheer Nederland.

The following aspects of the data model needs to be configured and leads to a flexible configuration of data sets and control blocks.

[R.40] The data model is provided by Netbeheer Nederland as a SCL file and shall be completely implemented in each product.

[R.41] IED name

[R.42] Practicable amount (1, see SCL file) of logical devices

[R.43] Logical device instance name (LDevice.inst)

[R.44] Logical device name (LD.ldName)

[R.45] Logical node prefix (LN.prefix) (max 16 chars)

[R.46] Logical node instance number (LN.inst)

[R.47] Using logical node classes (LN.lnClass), data objects and data attributes to fulfil the functional requirements

[R.48] Assignment of logical nodes (LN) to logical devices (LDevices)

7.2. IEC 61850 naming convention

The naming convention follows the rules of IEC 61850 references defined in parts 7-4 and 7-420. In the SCL file all naming parts of IEC 61850 reference are specified and shall be consumed by the IED:

- IED.name
- LD.inst
- LD.ldName
- LN.prefix
- LN.lnClass
- LN.inst

- DO.name[s]
- DA.name[s]

[R.49] It is not allowed to include vendor specific changes to LNs and/or the naming of them.

[R.50] The maximum length of object references shall not exceed 128 characters.

7.3. Data modelling

[R.51] The reference data model contains the mandatory LNs.

[R.52] The reference data model contains the mandatory DOs and DAs.

[R.53] The reference data model shall be used for all implementations of the RTI.

8. Engineering

It is preferred to apply the top-down configuration method to configure the RTI in the IED based upon the supplied SCL-file.

The use of the SCL-file enables easy reconfiguration and adjustments for future versions of the RTI.

9. ACSI Basic Conformance Statement

The basic conformance statement describes the mandatory set of IEC 61850 communication services. The basic conformance statement is defined in Table 1.

		Client/ Subscriber	Server/ Publisher	Value/ Comments
Client-Server roles				
B11	**Server** side (of TWO-PARTY-APPLICATION-ASSOCIATION)	—	Y	
B12	**Client** side of (TWO-PARTY-APPLICATION-ASSOCIATION)	Y	—	
SCSMs supported				
B21	**SCSM**: IEC 61850-8-1 used	Y	Y	
B22	**SCSM**: IEC 61850-9-1 used	N	N	
B23	**SCSM**: IEC 61850-9-2 used	N	N	
B24	**SCSM**: other			
Generic substation event model (GSE)				
B31	**Publisher** side	—	N	
B32	**Subscriber** side	N	—	
Transmission of sampled value model (SVC)				
B41	**Publisher** side	N	N	
B42	**Subscriber** side	N	N	
Y = supported N or empty = not supported				

Table 1 Basic conformance statement

All IEDs at customer side are server devices (B11) and devices at the system operator side are clients (B12).

10. ACSI Model Conformance Statement

The modelling of functions, storage and exchange of data between IEDs inside a substation is organized per the model conformance statement as defined in Table 2.

		Client/ Subscriber	Server/ Publisher	Value/Comments
If **Server or Client** side (B11/12) supported				
M1	**Logical device**	Y	Y	
M2	**Logical node**	Y	Y	
M3	**Data**	Y	Y	
M4	**Data set**	Y	Y	
M5	**Substitution**	N	N	
M6	**Setting group control**	N	N	
	Reporting			
M7	**Buffered report control**	Y	Y	
M7-1	sequence-number	Y	Y	
M7-2	report-time-stamp	Y	Y	
M7-3	reason-for-inclusion	Y	Y	
M7-4	data-set-name	Y	Y	
M7-5	data-reference	Y	Y	
M7-6	buffer-overflow	Y	Y	
M7-7	entryID	Y	Y	
M7-8	BufTm	Y	Y	
M7-9	IntgPd	Y	Y	
M7-10	GI	Y	Y	
M8	**Unbuffered report control**	Y	Y	
M8-1	sequence-number	Y	Y	
M8-2	report-time-stamp	Y	Y	
M8-3	reason-for-inclusion	Y	Y	
M8-4	data-set-name	Y	Y	
M8-5	data-reference	Y	Y	
M8-6	BufTm	Y	Y	
M8-7	IntgPd	Y	Y	
M8-8	GI	Y	Y	
	Logging	N	N	
M9	**Log control**	N	N	
M9-1	IntgPd	N	N	
M10	**Log**	N	N	
M11	**Control**	Y	Y	
If **GSE** (B31/32) is supported				
M12	**GOOSE**	N	N	
M13	**GSSE**	N	N	
If **SVC** (41/42) is supported				

		Client/ Subscriber	Server/ Publisher	Value/Comments
M14	Multicast SVC	N	N	
M15	Unicast SVC	N	N	
If **Server or Client** side (B11/12) supported				
M16	**Time**	Y	Y	
M17	**File Transfer**	N	N	
Y = service is supported N or empty = service is not supported				

Table 2 Model conformance statement

11. ACSI Service Conformance Statement

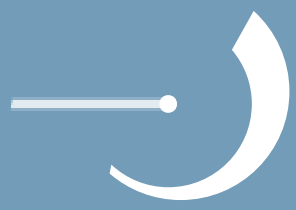
The detailed ACSI service conformance statement in Table 3 defines in detail the mandatory IEC 61850-7-2 communication services for the IEC 61850 station bus c.q. interface.

	Services	AA: TP/MC	Client (C)	Server (S)	Comments
Server					
S1	GetServerDirectory	TP	Y	Y	
Application association					
S2	Associate	TP	Y	Y	
S3	Abort	TP	Y	Y	
S4	Release	TP	Y	Y	
Logical device					
S5	GetLogicalDeviceDirectory	TP	Y	Y	
Logical node					
S6	GetLogicalNodeDirectory	TP	Y	Y	
S7	GetAllDataValues	TP	Y	Y	
Data					
S8	GetDataValues	TP	Y	Y	
S9	SetDataValues	TP	Y	Y	
S10	GetDataDirectory	TP	Y	Y	
S11	GetDataDefinition	TP	Y	Y	
Data set					
S12	GetDataSetValues	TP	Y	Y	
S13	SetDataSetValues	TP	N	N	
S14	CreateDataSet	TP	N	N	
S15	DeleteDataSet	TP	N	N	
S16	GetDataSetDirectory	TP	Y	Y	
Substitution					
S17	SetDataValues	TP	N	N	
Setting group control					
S18	SelectActiveSG	TP	N	N	
S19	SelectEditSG	TP	N	N	
S20	SetSGValues	TP	N	N	
S21	ConfirmEditSGValues	TP	N	N	
S22	GetSGValues	TP	N	N	
S23	GetSGCBValues	TP	N	N	
Reporting					
Buffered report control block (BRCB)					
S24	Report	TP	Y	Y	
S24-1	data-change (dchg)		Y	Y	
S24-2	quality-change (qchg)		Y	Y	
S24-3	data-update (dupd)		N	N	
S25	GetBRCBValues	TP	Y	Y	

	Services	AA: TP/MC	Client (C)	Server (S)	Comments
S26	SetBRCBValues	TP	Y	Y	
Unbuffered report control block (URCB)					
S27	Report	TP	Y	Y	
S27-1	data-change (dchg)		Y	Y	
S27-2	quality-change (qchg)		Y	Y	
S27-3	data-update (dupd)		N	N	
S28	GetURCBValues	TP	Y	Y	
S29	SetURCBValues	TP	Y	Y	
Logging					
Log control block					
S30	GetLCBValues	TP	N	N	
S31	SetLCBValues	TP	N	N	
Log					
S32	QueryLogByTime	TP	N	N	
S33	QueryLogAfter	TP	N	N	
S34	GetLogStatusValues	TP	N	N	
Generic substation event model (GSE)					
GOOSE-CONTROL-BLOCK					
S35	SendGOOSEMessage	MC	N	N	
S36	GetGoReference	TP	N	N	
S37	GetGOOSEElementNumber	TP	N	N	
S38	GetGoCBValues	TP	N	N	
S39	SetGoCBValues	TP	N	N	
GSSE-CONTROL-BLOCK					
S40	SendGSSEMessage	MC	N	N	
S41	GetGsReference	TP	N	N	
S42	GetGSSEDataOffset	TP	N	N	
S43	GetGsCBValues	TP	N	N	
S44	SetGsCBValues	TP	N	N	
Transmission of sampled value model (SVC)					
Multicast SVC					
S45	SendMSVMessage	MC	N	N	
S46	GetMSVCBValues	TP	N	N	
S47	SetMSVCBValues	TP	N	N	
Unicast SVC					
S48	SendUSVMessage	TP	N	N	
S49	GetUSVCBValues	TP	N	N	
S50	SetUSVCBValues	TP	N	N	
Control					
S51	Select	TP	N	N	
S52	SelectWithValue	TP	N	N	
S53	Cancel	TP	N	N	
S54	Operate	TP	Y	Y	
S55	CommandTermination	TP	N	N	
S56	TimeActivatedOperate	TP	N	N	

	Services	AA: TP/MC	Client (C)	Server (S)	Comments
File transfer					
S57	GetFile	TP	N	N	
S58	SetFile	TP	N	N	
S59	DeleteFile	TP	N	N	
S60	GetFileAttributeValues	TP	N	N	
Time					
T1	Time resolution of internal clock			10 (1ms)	nearest negative power of 2 in seconds
T2	Time accuracy of internal clock			T0	**T0 (10ms)** T1 (1ms) T2 (100µs) T3 (25µs) T4 (4µs) T5 (1µs)
T3	Supported TimeStamp resolution			10 (1ms)	nearest negative power of 2 in seconds
Y = service is supported N or empty = service is not supported					

Table 3 Service conformance statement



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