



CimWay - IEC 61850 PIXIT

Description: This document contains Protocol eXtra Information for Testing of the CimWay built-in driver for IEC 61850.

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1 Introduction

This document specifies the Protocol Implementation eXtra Information for Testing (PIXIT) of the CimWay built-in driver for IEC 61850, further referred to as "the Client".

Together with the PICS, MICS and TICS, the PIXIT forms the basis for conformance testing according to IEC 61850-10.

The following chapters specify the PIXIT for each applicable ACSI service model as structured in IEC 61850-10 and the "Conformance Test Procedures for Client System with IEC 61850-8-1 interface".

The following documents are available separately:

- The Protocol Implementation Conformance Statement (PICS),
- The Protocol Implementation eXtra Information for Testing (PIXIT),
- The Model Implementation Conformance Statement (MICS),
- The Tissues Implementation Conformance Statement (TICS).

1.1 Glossary

Apart from the IEC 61850 terminology for which basic knowledge is assumed, this document makes use of the following terms related to CimWay or PcVue. While they will sound familiar to users of ARC Informatique's products, a definition is given here to avoid confusion.

Network item

Also referred to as Network configuration item.

Represents and provides access to the physical connection to a network of IEC 61850 devices.

Device item

Also referred to as Device configuration item.

Represents and provides access to an IEC 61850 physical device.

Group

Represents and provides access to a subset of data – Data Objects and/or Data Attributes – available in an IEC 61850 server.

3 types of data group exist: Report groups, Dataset groups and Data groups, each making use of a particular data exchange mechanism.

Variable

Represents and provide access to a particular data in general, and an IEC 61850 data in particular.

A variable has configuration properties, including mapping information to an IEC 61850 DO or DA (Network, Device, LD, LN, CDC/DO or DA).

At runtime, it holds a value, a timestamp and a quality (among other properties).

Variables are also used to support commands and controls.

Data acquisition server and server association

A data acquisition server is a computer – an IEC 61850 client - in charge of exchanging data with IEC 61850 servers over one or more networks.

Data acquisition server redundancy is based on "associations of servers", often referred to as "clusters of servers".

Such an association of servers for data acquisition redundancy is not to be confused with an association to an IEC 61850 server that is, 61850 speaking, the process of connecting a client to an IED.

Client diagnostic traces

Apart from data logging and archiving (not discussed here), the Client is able to log diagnostic messages.

By activating specific levels of traces, more detailed messages (information, warnings and errors) may be logged, which is particularly useful for diagnostics during development, testing, commissioning and maintenance phases.

Such traces are easily accessible via the well-known "Event viewer". They are also stored in files for preventive and post-mortem analysis.

1.2 Reference documentation

The online help is worth reading for more advanced explanation, in particular for more information on:

- Licensing,
- Configuration,
- Runtime data handling,
- Diagnostics.

2 PIXIT for Configuration

Table 1 – PIXIT for Configuration

Description	Value / Clarification
Describe how the client handles nameplate configuration revision mismatches	<p>Cyclically, the nameplate configuration revision is read. If there is a difference between the last read value and the previous one, the association with the device is released, a new association is done and the configuration of the device is reread.</p> <p>In this case, a warning is logged in the client diagnostic traces and the new configuration revision value is taken into account as the new reference.</p> <p>Note that the period of the nameplate configuration revision is configurable and the default period is 5 seconds.</p>
Describe how the client handles report control block configuration revision mismatches	<p>When a report control block configuration revision mismatch is detected, the association with the device is released, a new association is done and the configuration of the device is reread.</p> <p>A warning is logged in the client diagnostic traces and the received revision value is taken into account as the new reference confRev for later data exchanges.</p> <p><u>Note:</u> This does not affect data exchange consistency because RCB handling supports the transmission of data names in reports. Measures are taken at the time of receiving reports if inconsistencies in data names are detected.</p>

3 PIXIT for Association model

Table 2 – PIXIT for Association model

Description	Value / Clarification
Guaranteed number of servers that can set-up an association simultaneously (one association per server)	Tested with up to 250 associations. Performance in general and maximum number of associations in particular are mainly limited by system resources availability.
Lost connection detection time range (default range of TCP_KEEPALIVE is 1 – 20 seconds)	TCP_KEEPALIVE: 5 seconds Not configurable
Lost (abort) connection retry time	Configurable from 1 second to 10 minutes Defaults to 5 seconds
Is authentication supported	Yes
What is the maximum and minimum MMS PDU size	Max MMS PDU size: 65 000 bytes Min MMS PDU size: The Client does not impose a minimum MMS PDU size. One or more services may not be usable if a server device constrains PDU size.
What is the typical startup time after a power supply interrupt	Depends on the project configuration, computer and network set-up. May range from a few seconds to several minutes.
How does the client behave in case of a lost connection with (one of) the associated servers?	An error is logged in the Client diagnostic traces. System variables allow application-specific processing to react in a way defined by the application designer (such as trigger an alarm for the operators, hot-standby data acquisition server switch...) All variables mapped on this server are set invalid (NS COM). The Client tries to reconnect to the server device automatically. Losing an association to a server device does not affect associations with other servers.
How does the client behave when a server denies an Association request by the client?	An error is logged in the Client diagnostic traces. System variables allow application-specific processing to react in a way defined by the application designer (such as trigger an alarm for the operators, hot-standby data acquisition server switch...) All variables mapped on this server are set invalid (NS COM). The Client tries to reconnect to the server device automatically. Losing an association to a server device does not affect associations with other servers.

Description	Value / Clarification
Does the client automatically reconnect to the configured servers after startup (Automatic statup)?	Yes The startup of the operating system can be configured to launch the SCADA on a specific project automatically.

Additional items

Table 3 – PIXIT for Association model – Additionnal items

Description	Value / Clarification
Do standby data acquisition servers associate to server devices ?	Yes The exact behavior in exchanging data depends on the type of data acquisition server association (single active server or multiple active servers).

4 PIXIT for Server model

Table 4 – PIXIT for Server model

Description	Value / Clarification
Maximum object identification length	129 octets: <64>/<64>
Does client support autodescription	Yes , the driver includes online browsing mechanisms that can be used at configuration time: <ul style="list-style-type: none"> - List of Datasets and RCBs to set up data groups, - Full hierarchical browsing - LDs, LNs, DOs, DAs – to easily map variables to IEC 61850 object/data.
What analogue value (MX) quality bits are used in the client	Yes Good Yes Invalid Yes Reserved Yes Questionable Yes Overflow Yes OutofRange Yes BadReference Yes Oscillatory Yes Failure Yes OldData Yes Inconsistent Yes Inaccurate Yes Process Yes Substituted Yes Test Yes OperatorBlocked
Which status value (ST) quality bits are used in the client	Yes Good, Yes Invalid Yes Reserved Yes Questionable Yes BadReference Yes Oscillatory Yes Failure Yes OldData Yes Inconsistent Yes Inaccurate Yes Process Yes Substituted Yes Test Yes OperatorBlocked
Describe how to view/display quality values	<p>An information is logged in the Client diagnostic traces if the quality is configured to be processed as <i>Invalid</i>.</p> <p>The IEC 61850 quality can be stored in variable extended attributes for further application-specific processing.</p>

Description	Value / Clarification
Describe how to force a SetDataValues request	Map a variable on a writable DA. Set the variable value via a command animation.
Describe how to force a GetAllDataValues request	The service is not supported
Describe how the client behaves in case of: <ul style="list-style-type: none"> - GetDataDefinition response- - GetDataValues response- - SetDataValues response- 	<p>A warning is logged in the Client diagnostic traces.</p> <p>The quality of variables mapped on the IEC 61850 object is set invalid (NS COM).</p> <p>When a GetDataDefinition response- is received, up to 4 attempts are done. New data attributes found in a GetDataDefinition do not affect i.e. SUT behaves as normally.</p> <p>When a GetDataValues response- is received, the polling continues with the same polling period as defined.</p> <p>Note about SetDataValues: In addition to the warning related to the negative service response, an additionnal error related to the unsuccessful command is logged in the client diagnostic traces.</p>

5 PIXIT for Data set model

Table 5 – PIXIT for Data set model

Description	Value / Clarification
Describe how to force a GetDataSetValues request	A periodic call to the GetDataSetValues service is performed for each group of data of type <i>Dataset group</i> . At least one variable must be mapped on the data group for the service to be called.
Describe how to force a SetDataSetValues request	The service is not supported
Describe how to force a DeleteDataSet request	The service is not supported
Describe how the client handles following dataset mismatches between the SCL and the data sets exposed via MMS: (1) new dataset element (2) missing dataset element (3) Reordered dataset members in a dataset of a different data type (4) Reordered dataset members in a dataset of the same data type	When a mismatch between SCL and dataset exposed by MMS is detected, the association with the device is released, a new association is done and the configuration of the device is reread. In this case, a warning is logged in the client diagnostic traces.
Describe how the client behaves in case of: - GetLogicalNodeDirectory(DAT A-SET) response- - GetDataSetDirectory response-	A warning is logged in the Client diagnostic traces. Note about GetLogicalNodeDirectory: GetLogicalNodeDirectory(DATA-SET) is requested by SUT only after association. 1/ It isn't possible to request GetLogicalNodeDirectory(DATA-SET) on inexistent logical device of the server since the list of Logical devices are read by SUT after each association 2/ Newly declared Dataset in the server are detected after association by SUT and are available immediately in the configuration of the SUT. Note about GetDataSetDirectory: This service is used at runtime. Upon reception of a GetDataSetDirectory response-, the data acquisition server aborts the association to the server device.
Does the client support the creation of: - persistent datasets - non-persistent datasets	Not supported

Description	Value / Clarification
<p>Describe how the client behaves in case of:</p> <ul style="list-style-type: none"> - CreateDataSetDirectory response- - DeleteDataSet response- 	Not applicable
<p>Describe how the client behaves when it receives a SetDataSetValues.Response-</p>	Not applicable
<p>Describe how the client behaves when it receives a GetDataSetValues.Response-</p>	<p>When a GetDataSetValues response- is received, the quality of variables mapped on the IEC 61850 object is set invalid (NS COM) and the polling continues with the same polling period as defined.</p> <p>In normal case, GetDataSetValues response contains dataset members as defined and ordered by GetDataSetDirectory response+. As the GetDataSetDirectory is called at each association with the device, no deviation should occur.</p> <p>In case deviations such as 'new dataset element', 'missing dataset element' or 'reordered dataset members of a different data type' are detected, the connection is released, a new association is done and the configuration is reread.</p> <p>In case a deviation such as 'reordered dataset members of the same data type', SUT does not detect anything and the data acquisition continues.</p>

6 PIXIT for Reporting model

Table 6 – PIXIT for Reporting model

Description	Value / Clarification
Does the client search for RCB in all logical nodes? when not specify the logical nodes	<p>No</p> <p>RCBs are searched for in the following logical nodes:</p> <ul style="list-style-type: none"> - LLN0, - Any other logical node having at least a dataset configured. <p>The RCBs are searched using the GetDataDefinition service.</p>
Which dynamic RCB attributes are/can be configured by the client	<p>Dynamic RCB attributes configuration can be optionnally enabled separately for each of them on the Report group</p> <p>RptID Yes (set by default to the alias of the report in the SUT)</p> <p>DataSet No</p> <p>Optional fields Yes (set by default to sequence-number, reason-for-inclusion, data-set-name, data-reference, conf-revision)</p> <p>Trigger conditions Yes (set by default to data-change, quality-change, integrity-period, general-integration)</p> <p>Buffer time Yes (set by default to 100 ms)</p> <p>Integrity period Yes (set by default to 0)</p>
Does the client supports IEDs with indexed and non-indexed report control blocks (RCB)	<p>Buffered RCB indexed Yes</p> <p>Buffered RCB not indexed Yes</p> <p>Unbuffered RCB indexed Yes</p> <p>Unbuffered RCB not indexed Yes</p>
The supported trigger conditions are	<p>integrity Yes</p> <p>data change Yes</p> <p>quality change Yes</p> <p>data update Yes</p> <p>general interrogation Yes</p>
The supported optional fields are	<p>sequence-number Yes</p> <p>report-time-stamp Yes</p> <p>reason-for-inclusion Yes</p> <p>data-set-name Yes</p> <p>data-reference Yes</p> <p>buffer-overflow Yes</p> <p>entryID Yes</p> <p>conf-rev Yes</p>
The minimum required optional fields are	<p>sequence-number Not required</p> <p>report-time-stamp Not required</p> <p>reason-for-inclusion Not required</p> <p>data-set-name Not required</p> <p>data-reference Not required</p> <p>buffer-overflow Not required</p> <p>entryID Not required</p> <p>conf-rev Not required</p>

Description	Value / Clarification
Does the client support segmented reports	Yes
Does the client support pre-assigned RCB	Yes There is no difference in the SUT with pre-assigned or not RCBs.
Does the client support reported data set containing structured data objects or data attributes?	reporting of data objects Yes reporting of data attributes Yes
Describe how the client does respond when an URCB is already reserved	Upon connection, the URCB initialization phase includes an attempt to write the RptEna attribute to False and then to True. If the URCB is already reserved, the attempt fails, and the Client tries to set the RptEna attribute to False on timer, by default every 5 seconds (configurable). Upon first error during this phase, variables are set invalid (NSCOM) immediately.
Describe how the client does respond when a BRCB is already reserved	Same as URCB. The handling of BRCB and URCB differs only after succesful write of the RptEna attribute to False during the initialization phase.
Describe how the client does respond on a SetBRCBValues(EntryID) respond-	The client responds by a sequence attempting to: <ol style="list-style-type: none"> 1. Purge the buffer 2. Configure the report 3. Set RptEna to True 4. Request for a GI If an error is returned during this sequence, the report initialization phase is aborted and retried on timer.

Description	Value / Clarification
Describe how the client does respond when a report has an unknown: dataset, RptID, unexpected number of dataset entries, and/or unexpected data type format entries	<ul style="list-style-type: none"> - Unknown Dataset - During the initialization phase: If the Dataset referenced by the RCB does not exist, variables associated to the data group are set invalid (NSCOM), and a warning is logged in the Client diagnostic traces. - Unknown Dataset - During the reporting phase: If the Dataset associated to a report is changed, the client behaves as if the ConfRev had been changed. - Unknown RptID: A warning is logged in the Client diagnostic traces, indicating the unknow RptID, and the connection to the IED is aborted (communication is stopped for the CimWay device item). The communication with the IED can only be resume by a user action or script. - Unexpected number of dataset entries: The client behaves as if the ConfRev had been changed. - Unexpected data type format entries: The client behaves as if the ConfRev had been changed. <p>Note that in the case of dataset mismatch, if variables are mapped on missing dataset members, they are flagged as NS COM but the other variables of this dataset continue to be monitored normally.</p>
Describe how the client detects reporting configuration changes (mismatches). Does it check the "configuration revision" attributes and/or does it check the dataset members?	The conf revision value is checked if included in reports. In the case of configuration revision change, the connection is released, a new association is done and the configuration is reread.
Describe how to force the client to change the RCB BufTm	The bufTm attribute value is configurable separately for each data report group.
Describe how the client behaves when it receives a report that has the buffer overflow flag set?	The client sets the RptEna attribute to false and issue a report initialization phase (including a purge buffer and a general interrogation). An error is logged in the Client diagnostic traces.
Describe how to force the client to write a (valid) EntryID value.	<p>EntryIDs are tracked by the client, persisted and restored upon re-start.</p> <p>In order to allow IEDs to free-up buffers, the EntryID is written:</p> <ul style="list-style-type: none"> - Upon report initialization, - On timer (configurable – defaults to 10 sec) - Every n reports (configurable – defaults to 100) <p>It is also possible to map a commandable variable on the EntryID attribute of the RCB and set it to an arbitrary value.</p>

Description	Value / Clarification
Describe how to force the client to purge the report buffer.	<p>Buffer is purged when an overflow is detected.</p> <p>Upon reception of a response- while writing an EntryId, SUT assumes that an overflow occurred and the buffer is purged.</p> <p>It is also possible to map a variable on the PurgeBuf attribute of the RCB and set it to True.</p>
Describe how the client responds when it receives a GetXRCBValues.response-	An error is logged in the Client diagnostic traces and the report initialization phase is aborted.
Describe how the client responds when it receives a SetXRCBValues.response-	<p>An error or a warning is logged in the Client diagnostic traces. Depending on the considered RCB attribute, a negative response is processed as:</p> <ul style="list-style-type: none"> - A warning (but data acquisition can be done) or, - An error (too much risks to proceed, the report initialization phase is aborted). <p>Failing to write one of the following attribute is processed as a warning:</p> <ul style="list-style-type: none"> - BufTm, - TrgOp, - IntgPd, - OptFlds, - EntryId. <p>Failing to write one of the following attribute is processed as an error:</p> <ul style="list-style-type: none"> - RptID (only if the configuration requires setting the RptID), - RptEna, - PurgeBuf, - GI.
Describe how the client responds when it tries to use a RCB that is reserved by another client	If RCB is already reserved by another client, the Client tries to enable it cyclically (configurable – defaults to 5 sec).
Describe how the client behaves when it receives a report that contains optional fields that are not supported by the client	All optional fields are supported but not all optional are used.
Describe how the client behaves when it receives a report that was caused by one or more trigger conditions that are not supported by the client	All standard trigger conditions are supported.
Describe how the client behaves when it encounters an RCB with a different dataset configuration than expected.	The Client behaves as if the ConfRev had been changed: connection is released, a new association is done and the configuration is reread but the dataset is not set to its original value by the SUT.

Description	Value / Clarification
Describe how the client behaves when it encounters an RCB with a different confRev value than expected	An error is logged in the Client diagnostic traces, the communication with the IED is stopped and restarted in order to achieve the initialization sequence including a full synchronization of Datasets and RCB attributes.
Describe how the client responds when it sets an EntryID value that is not recognized by the server.	A warning is logged in the Client diagnostic traces and the buffer is purged before enabling reports.
Is there a maximum number of report control blocks that the client can enable?	No maximum number of report control blocks is enforced. The ability to support a large number of enabled RCBs depends on the available computer resources and network infrastructure. They shall be sized according to project requirements in planning phases.

Additional items

Table 7 – PIXIT for Reporting model – Additionnal items

Description	Value / Clarification
Recommended optional fields are	sequence-number Yes report-time-stamp No reason-for-inclusion No data-set-name Yes data-reference Yes buffer-overflow Yes entryID Yes conf-rev Yes For most of these optional fields, not having them in reports lead the Client to a downgraded mode close to URCBs handling.

7 PIXIT for Control model

Table 8 – PIXIT for Control model

Description	Value / Clarification
What control modes are supported	Yes status-only Yes direct-with-normal-security Yes sbo-with-normal-security Yes direct-with-enhanced-security Yes sbo-with-enhanced-security
Is Time activated operate (operTm) supported	No
Is "operate-many" supported	No
Can the client set the test flag?	Yes
What check conditions can be set	Yes synchro-check Yes interlock-check
Which originator categories are supported and what is the originator identification?	Originator category and originator identification are configurable (global settings)
Describe if and how the client sets/increments the ctlNum	The ctlNum is handled internally in the client driver. It is auto incremented with each new control sequence and can not be set to an arbitrary value (even for test purpose).
What does the client do when it receives a LastApplicationError and describes how to view the additional cause?	An information is logged in the Client diagnostic traces along with the description.
What does the client do when it receives a Select, SelectWithValue or Operate respond negative ?	An error is logged in the Client diagnostic traces.
Can the client change the control model via online services?	Yes, by mapping a variable on the CtlModel data attribute and setting it to the desired value (if supported by the IED).
What does the client do when the ctlModel is not initialized in the SCL?	<p>The use of a particular ctlModel for a given command is defined by a property of the corresponding variable. A possible value of this property - Automatic detection - enforces the use of the ctlModel as defined in the device at the time of sending the command.</p> <p>This behavior allows adaptation to the current device configuration, whatever SCL definition was used.</p>

Description	Value / Clarification
Describe how the client responds when it receives a positive Command Termination	<p>The internal write request corresponding to the command is positively acknowledged. An information can be logged in the Client diagnostic traces along with the description.</p> <p>If the command was started by script, the command status (step and response value - positive or negative) is asynchronously brought back to the script for further application-specific processing.</p>
Describe how the client responds when it receives a negative Command Termination	<p>The internal write request corresponding to the command is negatively acknowledged. A warning is logged in the Client diagnostic traces along with the description.</p> <p>If the command was started by script, the command status (step and response value - positive or negative) is asynchronously brought back to the script for further application-specific processing.</p>
Describe how the client responds when it receives a negative Operate response	Same as for a negative Command Termination reception.
Describe how the client send a cancel command	When executing a command via a script, a dedicated instruction can be used to send a cancel command.
Describe how the client responds when it receives a cancel negative response	<p>The pending internal write request corresponding to the command is negatively acknowledged. A warning is logged in the Client diagnostic traces along with the description.</p> <p>If the command was started by script, the command status (step and response value - positive or negative) is asynchronously brought back to the script for further application-specific processing.</p>

8 PIXIT for Time and time synchronisation model

Table 9 – PIXIT for Time and time synchronisation model

Description	Value / Clarification
Described how to view the internal time & quality or how to expose the timestamp and timestamp quality via the IEC 61850 interface	<p>The internal time can be viewed via system variables @DATE & @TIME (low precision). The Client relies on the computer clock system. Therefore any tool supported by the operating system can be used to view, monitor, diagnose and synchronize the reference time.</p> <p>Timestamp and timestamp quality of data are properties attached to variables (as the value...VTQ):</p> <ul style="list-style-type: none"> - The timestamp can be viewed directly in the Application Explorer or any other tool showing VTQs. - Timestamp quality is used to determine the variable status. Its 61850 raw value can only be viewed in diagnostic traces and the interpreted value (Timestamp type) can be monitored in the Application Explorer.
What time quality bits are supported	<p>Quality bits in response supported by the client :</p> <p>No LeapSecondsKnown Yes ClockFailure Yes ClockNotSynchronized</p> <p>Quality bits in request supported by the client :</p> <p>No LeapSecondsKnown No ClockFailure Yes ClockNotSynchronized</p>
What is the behavior when the time synchronization signal/messages are lost	<p>It is up to the system designer to define the strategy and implement the required behavior according to the master clock and time sync issues. Typical behavior consists in raising alarms. It is also up to the system designer to signal to the SUT (using scripts) that the clock is synchronized or not in order to set the ClockNotSynchronized quality bit to the adequate value in requests.</p>
When is the quality bit "ClockFailure" set?	The quality bit "ClockFailure" is never set.
When is the quality bit "ClockNotSynchronised" set?	It is up to the system designer to signal to the SUT (using scripts) that the clock is synchronized or not in order to set the ClockNotSynchronized quality bit to the adequate value in requests.

Additional items

Table 10 – PIXIT for Time and time synchronisation model – Additional items

Description	Value / Clarification
What happens upon reception of a data with quality bit "ClockFailure" or "ClockNotSynchronised" set?	The TS Type property of the corresponding variable is set to <i>PLC ?</i> indicating the fact that the variable timestamp comes from a device, but is considered as "suspect".