

IEC 61850 Interoperability Testing

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# Executive Summary

The UCAIug Testing Committee charter provides to the creation of a wide range of testing procedures to assure device and system interoperability. The first step, conformance test procedures, is already well established by the industry. This document extends testing into the area of multi-vendor interoperability.

Interoperability tests are inherently difficult to create because each user has a different concept of the goal. Quite simply, the goal is “ensure that my system will function with my selected devices, functions, and services with minimal effort”.

These interoperability take the middle ground of choosing a synthetic user system with pre-specified functional and services as the “system under test” and performs interoperability tests under those conditions. Note that devices which meet all tests in this suite are NOT guaranteed to interoperate in any specific real system, but only in the synthetic environment.

Two major outcomes of the interoperability testing are 1) Successful demonstrations of interoperability and 2) corrections to standards and conformance testing procedures. Other artifacts include the creation of interoperability guidelines and application advice to both vendors and users.

The interoperability tests will be limited to IEC 61850 Edition 1 documents (with TISSUE corrections) and will specifically exclude performance testing.

(Perhaps we should say more or less here …)

# Interoperability Overview

Interoperability tests will attempt to test as many of the 61850 services data object as is reasonably possible. It is driven by use cases agreed upon by industry representatives.

These use cases are partitioned into major groups such as design-phase activities and maintenance stage.

Formal test cases are developed at both the abstract and concrete level. An example of an abstract test case would be “Transfer information using GOOSE service” whereas the corresponding concrete test case would include the selection/configuration of publishers/subscribers, conditions for data transfer, and observation of data flow.

The actual interoperability “plug-fest” will be preceded by detailed discussion among participants to identify exactly which tests will be performed and how the test execution can be performed. Post-test results included private reports to participating vendors, public reports of interoperability failures (with vendor names removed), recommendations for further interoperability tests, and a summary of interoperability difficulties encountered.

(perhaps more can be added here)

# IEC 61850 Services

The following list of services is derived from 61850-7-2 and is organized according to logical “service groups” chosen to match actual expectations of users. These services map closely with the conformance blocks defined in both 61850-10 and the Server conformance test procedures.

The service groups are defined in the following table (taken from 7-2 Table 1):

|  |  |  |  |
| --- | --- | --- | --- |
| Service Group | ACSI  Service | MMS Service | Notes |
| Model Discovery | GetServerDirectory(LD) | GetNamedList(Domain) |  |
| GetLogicalDeviceDirectory | GetNamedList(NV) |  |
| GetLogicalNodeDirectory | GetNamedList(NV) |  |
| GetDataDirectory | GetVariableAccessAttributes |  |
| Data Discovery | GetDataSetDirectory | GetNamedList(NVL) |  |
| GetServerDirectory(FILE) | FileDirectory |  |
| Attribute Discovery | GetDataDefinition | GetVariableAccessAttributes |  |
| GetFileAttributeValues | FileDirectory |  |
| Data Operations | GetAllDataValues | Read |  |
| GetDataValues | Read |  |
| SetDataValues | Write |  |
| Dataset Operations | GetDataSetValues | Read |  |
| SetDataSetValues | Write |  |
| CreateDataSet | DefineNamedVariableList |  |
| DeleteDataSet | DeleteNamedVariableList |  |
| Basic Substitution | SetDataValues | Write |  |
| GetDataValues | Read |  |
| Extended Substitution | SelectActiveSG | Write |  |
| SelectEditSG | Write |  |
| SetSGValues | Write |  |
| ConfirmEditSGValues | Write |  |
| GetSGValues | Read |  |
| GetSGCBValues | Read |  |
| Reports Buffered And Unbuffered | GetBRCBValues | Read |  |
| SetBRCBValues | Write |  |
| GetURCBValues | Read |  |
| SetURCBValues | Write |  |
| (send) Report | InformationReport |  |
| Logs | GetLCBValues | Read |  |
| SetLCBValues | Write |  |
| QueryLogByTime | ReadJournal |  |
| QueryLogAfter | ReadJournal |  |
| GetLogStatusValues | Read |  |
| GOOSE | GetGoCBValues | Read |  |
| SetGoCBValues | Write |  |
| SendGOOSEMessage | (layer 2 EtherType) |  |
| GOOSE Management | GetGoReference | (layer 2 EtherType) |  |
| GetGOOSEElementNumber | (layer 2 EtherType) |  |
| SMV (SV) | GetMSVCBValues | (undefined, READ?) |  |
| SetMSVCBValues | Undefined, WRITE?) |  |
| SendMSVMessage | (layer 2 EtherType) |  |
| GetUSVCBValues | (undefined, READ?) |  |
| SetUSVCBValues | Undefined, WRITE?) |  |
| SendUSVMessage | (layer 2 EtherType) |  |
| Controls | Select | Read |  |
| SelectWithValue | Write |  |
| Cancel | Write |  |
| Operate | Write |  |
| CommandTermination | InformationReport |  |
| TimeActivatedOperate | Write |  |
| Time Sync | TimeSynchronization | (layer 4 SNTP) |  |
| Files | GetFile | FileOpen FileRead FileClose |  |
| SetFile | ObtainFile |  |
| DeleteFile | FileDelete |  |
| GetFileAttributeValues | FileDirectory |  |
| SCL | Export ICD | (offline) |  |
| Import SCD (CID?) | (ObtainFile? or offline) |  |
| Others? |  |  |  |

# Use Cases

The interoperability use cases are grouped into broad categories.

|  |  |  |
| --- | --- | --- |
| Group | Abstract Use Case | Notes |
| Design using tools | To Be Determined Later |  |
| Installation | Create SCD from ICD files |  |
| Configure Dataset/GOOSE publish (FCD and FCDA selections) |  |
| Configure Dataset/Report publish (unbuffered and buffered) |  |
| Configure GOOSE reception |  |
| Configure Report reception (dynamic data set issues?) |  |
| Configure IEDs from SCD file |  |
| Create ICD file from IEDs (in case of alterable ICD files) |  |
| Operation | Configure network devices for operation (VLAN, multicast,etc) |  |
| Check device presence/health |  |
| Transfer data via polling (LN/DO/DA/dataset/dataset element) |  |
| Transfer data via GOOSE |  |
| Transfer data via reports (buffered and unbuffered) |  |
| Reconnect buffered report after connection loss |  |
| Perform controls (all 4 types: DOns, DOes, SBOns, SBOes) |  |
| Generate/read/observe COMTRADE files (including re-reads) |  |
| Read logs |  |
| Abnormal Conditions | Mesh network cable disconnected causing RSTP operation |  |
| Network cable to IED disconnect/reconnect |  |
| Disconnect IED cable long enough to overflow buffered report |  |
| Substation power loss (black start all servers) |  |
| Client power loss |  |
| IED reconfiguration (no operational change, only ConfRev update) |  |
| Diagnostics | Verify health of all GOOSE subscriptions |  |
| Perform substitution |  |
| Aim diagnostic messages at another device (transmit GOOSE and controls with test bits) |  |
| Aim diagnostic messages at device in test mode |  |
| Change device status from Normal to test modes and return to normal |  |
| Maintenance | Engineer views device directory via SCD and online discovery |  |
| Engineer views present information from desktop via SCD discovery |  |
| Engineer view present information from desktop via online discovery |  |
| Engineer operates control from desktop |  |
| Engineer perform unsafe operation |  |
| Others? |  |  |

# Use Case Template

(This is very rough at this time)

Use case name

Description of use case

Steps involved (from a user point of view)

Expected outcome of use case

Preconditions

Execution steps

Observation of outcome and verdict algorithm

Postconditons

# Interoperability Planning

(This is very rough at this time)

Procure funding of interopereablity

Training (as-needed)

Identify participants

Identify witness roles

Identify witnesses (these should be vendor independent if possible)

Identify use cases

Identify tests

Create SCD file template

Distribute files to participants

Resolve problems from participants (pre-interop)

Create test record form

Perform interop

Distribute test results to participants

Resolve test observations with participants

Create draft public interop report (circulate to participants for their input)

Final report to interop sponsor