

IEC 61850 기반의 OCR IED에 대한 적합성 시험방안

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Conformance Testing for IEC 61850 based OCR IED

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Abstract - IEC 61850 is a new approach international standard which is applicable to Substation Automation System (SAS) and defines the communication between intelligent electric devices (IEDs) in the substation and the related system requirements. It already has a significant impact on the development of different devices or systems used in substation. Conformance claims and the establishment of their validity are important parts of the acceptance of systems and equipment. This paper introduces the conformance testing, mapping of IEC 61850 services and MMS services, and in case study part it gives the example of testing OCR IED.

1. Introduction

IEC 61850 is a new international standard for communication networks and systems in substations that has a significant impact on the developments in power system protection. It has many benefits such as it supports the implementation of high-speed peer-to-peer communications based applications and distributed protection solutions using sampled analog values. All major substation protection and control equipment manufacturers have products that implement different forms of IEC 61850 communications to simplify integration in substation automation systems and improve the functionality of the system, while at the same time reduce the overall system cost.

As the IEC 61850 standards are very complex, so after the products which made by manufactures or the devices made by some research department are finished, the strictly testing should be done. Testing of high-speed peer-to-peer based protection and control systems presents new challenges to protection engineers.

As we know, there are a few company can provide the conformance testing services and the testing will cost a lot of money, in order to minimize the test cost, we can do our best to do the testing by ourselves.

This paper describes the conformance testing for IEC 61850 based OCR IED made by SIEMENS company. The performance testing is still under way, so this paper only focus on the device related conformance test.

2. Conformance Testing

2.1 Introduction of conformance testing

A conformance testing is the type test for communication and the system related test of the incorporated IEDs. In general, conformance testing of the communication behavior of an IED should address the functional requirements and performance requirements of typical applications supported by these devices in a Substation Automation System (SAS). The test demonstrates the capability of the DUT to operate with other IEDs in a specified way according to the IEC 61850 series.

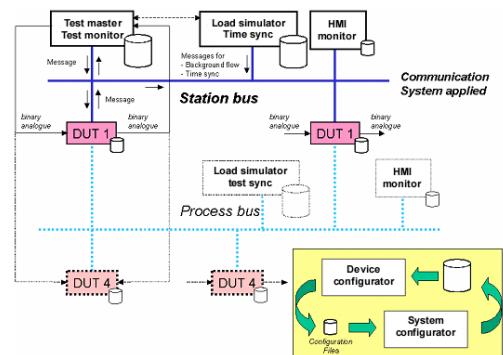
Conformance testing requires consideration of the following issues: The problem of all testing is the completeness of the test. It is impossible to test all system configurations using IEDs from different world-wide suppliers, which means the needing of a standardizing test architecture.

A communication standard does not standardize the functions of the communicating equipment.

Some properties of the device, which are out of the scope of standard, may be proven by information and documents provided with the Device Under Test (DUT).

2.2 Device related conformance testing

The test system architecture is given by IEC 61850-10 shown as in Fig.1. This architecture contains the minimum test set-up for station bus, the process bus, and an optional DUT4.



<Fig.1> Test system architecture

As it mentioned in IEC 61850-10, it is said that verification of functional applications (use of GOOSE messages) is not part of a conformance test, so this paper also ignores the GOOSE communication part.

The comprehensive interoperability testing of communication among devices for all possible products is not feasible. Therefore, the test concept shall include test devices, test configurations and test scenarios. The dynamic behavior should be tested properly by using well-defined test cases.

Conformance testing contains the positive test, which means while verification of normal conditions, typically resulting in response +, and negative test, which means while verification of abnormal conditions, typically resulting in response -. Some probable test cases are summarized in IEC 61850-10. According to the summarized information, the test procedure can be made as the format given by the standards. Take test case Srv2 as an example, which is described as Issue a GetLogicalDeviceDirectory request and check response. The test procedure is shown in Table 1:

<Table 1> Test case procedure of Srv2

Test reference	Test purpose	<input type="checkbox"/> Passed
Srv2	Issue a GetLogicalDeviceDirectory request and check response	<input type="checkbox"/> Failed <input type="checkbox"/> Inconclusive
<u>Ref. Part, Clause and Subclause of IEC 61850</u>		
IEC 61850-7-2 Subclause 8.2.1		
IEC 61850-8 Subclause 11		
MMS-EASE Reference Manual, GetNameList Service		
<u>Expected result</u>		
Server response + "LNReference"(The GetNameList object class has a value of NamedVariable within the scope of a particular domain)		
<u>Test description</u>		
Client request a GetLogicalDeviceDirectory service (GetNameList)		
<u>Comment</u>		

The right-top part of Table 1 is the test result, when the observed test outcome gives evidence of conformance to the conformance requirement on which the test purpose of the test case is focused

and when no invalid test event has been detected, the Passed verdict should be given; when the observed test outcome either demonstrates non-conformance with respect to at least one of the conformance requirement on which the test purpose of the test case is focused, or contains at least one invalid test event, with respect to the relevant specifications, the Failed verdict should be given; when the observed test outcome is such that neither passed nor failed verdict can be given, then the Inconclusive verdict should be given

2.3 Mapping between IEC 61850 services and MMS services

Until now, almost all the application should be realized in base of Manufacturing Messaging Specification (MMS) made by SISCO company, however, the services defined by MMS is not exactly the same with IEC 61850 services, the standard IEC 61850-8-1 give the mapping of these two. According to the standard a mapping table of the services can be made, which is shown in Table 2:

<Table 2> Mapping between IEC 61850 services and MMS services

IEC 61850 Services	MMS Services	IEC 61850 Services	MMS Services
GetLogicalDeviceDirectory	GetNameList	SetLCBValues	Write
GetAllDataValues	Read	QueryLogByTime	ReadJournal
GetDataValues	Read	QueryLogAfter	ReadJournal
SetDataValues	Write	GetLogStatusValue	GetJournalStatus
GetDataDirectory	GetNameList	Select	ReadWrite
GetDataDefinition	GetVariableAccessAttributes	SelectWithValue	ReadWrite
GetDataSetValues	Read	Cancel	Write
SetDataSetValues	Write	Operate	Write
CreateDataSet	CreateNamedVariableList	Command-Termination	Write
DeleteDataSet	DeleteNamedVariableList	TimeActivated-Operate	Write
GetDataSetDirectory	GetNameList	GetFile	FileOpen/FileRead/FileClose
Report(Buffered and Unbuffered)	InformationReport	SetFile	ObtainFile
GetBRCBValues/GetURCBValues	Read	DeleteFile	FileDelete
SetBRCBValues/SetURCBValues	Write	GetFileAttributeValue	FileDirectory
GetLCBValues	Read		

After finding the mapping of the services, the next step is to find the related parameters, because not all the parameters are directory mapped between IEC 61850 and MMS. Take test case Srv2 as the example again. The mapping relationship of parameters between IEC 61850 GetLogicalDeviceDirectory service and the MMS service is shown in Table 3:

<Table 3> Parameters mapping of GetLogicalDeviceDirectory service

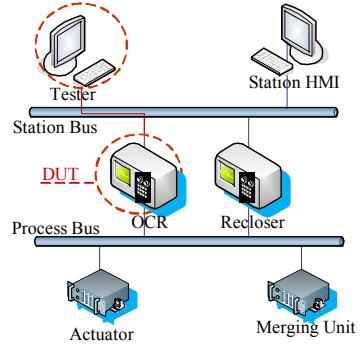
	GetLogicalDeviceDirectory	GetNameList
Request	LDReference	Domain Name
Response +	LNReference[3..n]	Named Variable List
Response -	ServiceError	Error information

3. Case Study

In order to test the implemented OCR IED, a MMS based test program is written, the five typical functions of which is:

- associate(ST_CHAR *ServerAccessPointReference,
 ST_CHAR *AuthenticationParameter)
- getLogicalDeviceDirectory (ST_CHAR *LDReference)
- getLogicalNodeDirectory (MVL_NET_INFO *clientNetInfo,
 ST_CHAR *LDReference)
- getDataValue (MVL_NET_INFO *clientNetInfo, ST_CHAR * LDReference,
 ST_VOID *dataDest, ST_CHAR * LNReference, ST_INT scope)
- getAllDataValues (MVL_NET_INFO *clientNetInfo,
 ST_CHAR * LDReference, ST_CHAR *FC, ST_INT scope)

The structure of the test system is shown in Fig. 2:



<Fig.2> Structure of test system

The result of request getLogicalNodeDirectory(clientNetInfo, "mjuCTRL", "CALH1") will be shown in Fig. 3:

```

C:\Wmmssite_test\Wmv1\W...
MMS-LITE-80X-001 Version 5.02, B
Copyright (c) 1986-2005 SISCO, Inc.

Connecting ...Connected
mvl_getname request send ok!
mvl_getnam OK
  More Follows : TRUE
    CALH1
    CALH1$CF
    CALH1$CF$Mod
    CALH1$CF$Mod$ctlModel
    CALH1$DC
    CALH1$DC$NamPlt
    CALH1$DC$NamPlt$configRev
    CALH1$DC$NamPlt$d
    CALH1$DC$NamPlt$swRev
    CALH1$DC$NamPlt$vendor
    CALH1$EX
    CALH1$EX$urcbA01
    CALH1$EX$urcbA01$owner
    CALH1$EX$urcbB01
    CALH1$EX$urcbB01$owner
    CALH1$RP
    CALH1$RP$urcbA01
    CALH1$RP$urcbA01$BufTm
    CALH1$RP$urcbA01$ConfRev
    CALH1$RP$urcbA01$datSet
    CALH1$RP$urcbA01$GI
    CALH1$RP$urcbA01$IntgPd
    CALH1$RP$urcbA01$OptFlds
    CALH1$RP$urcbA01$Resv
    CALH1$RP$urcbA01$RptID
    CALH1$RP$urcbA01$SqNm
    CALH1$RP$urcbA01$TrgOps
  CALH1$ST
  CALH1$ST$Beh
  CALH1$ST$Beh$Eq
  CALH1$ST$Beh$stUal
  CALH1$ST$GrAlm
  CALH1$ST$GrAlm$Eq
  CALH1$ST$GrAlm$stUal
  CALH1$ST$GrAlm$stUal
  CALH1$ST$GrWrn
  CALH1$ST$GrWrn$Eq
  CALH1$ST$GrWrn$stUal
  CALH1$ST$Health
  CALH1$ST$Health$Eq
  CALH1$ST$Health$stUal
  CALH1$ST$Mod
  CALH1$ST$Mod$Eq
  CALH1$ST$Mod$stUal
  CALH1$ST$Mod$stUal
  ring 'server' mode, hit ^c
  
```

<Fig.3> Test result of Srv2

4. Conclusion

The test result verified SIEMENS OCR IED performs a good communication possibility and during making the testing program, we can get a deeper understanding of the whole standard. We can utilize the test program instead of commercial ones such as product of KEMA company. Otherwise, even though the conformance testing made by ourselves is not valid for industry acceptance testing, the test itself has good meaning which can minimize the cost of industry acceptance testing.

Acknowledgment

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Reference

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