Standardized Middleware for Energy System Information Transmission/Reception

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Abstract

We have promoted the introduction of various communication-related standards, including IEC61850, in order to promote the introduction of the international standards into the Japanese power network.

Recently, applications of eXtensive Messaging and Presence Protocol (XMPP) into the international standards have been widely adopted. The XMPP is an XML-based protocol and originally used for instant messenging.

Ahead of this trend, we developed communication middleware for IEC 61850. We used the XMPP protocol as a transport mechanism. By this development, it realized communication based on IEC 61850 very simply for widely distributed microgrids and smart grids.

1 Preface

Recently, with the increase of renewable energy resources such as solar and wind power, it has prompted the need to address the improvement of power supply reliability. Against this view, there is growth of microgrids, smart grids, and next-generation energy systems. In next-generation energy systems, it is required to interconnect the various power network systems by many venders and manage such power network systems. Presently, however, for the interconnection of various power network systems, multiple protocols unique to each vendor are used and interconnections with multiple power network facilities of various venders are becoming the issue.

In order to improve this interconnectivity, the operation of a monitoring control system is getting a lot of attention. This monitoring control system applied international standards based on International Standard IEC 61850[(1)-(5)]. This standard was enacted to standardize information exchange protocol among electronic units supplied by multiple vendors inside a substation. In so doing, it aimed to realize the interoperability among these units.[(6)(7)].

The concept of this standard IEC 61850 is, however, comprehensive and it could be fully applicable to other fields of power network systems. For this reason, this standard is becoming a core standard for next-generation energy system including microgrids, smart grids, etc.[(8)].

We developed and supplied[(9)(10)] remote monitoring control systems applying IEC 61850. In addition, communication middleware compliant with IEC 61850 was developed in 2011. This time, we added a communication function by applying XMPP protocol as a transport mechanism. This allowed communication over the Internet so that the above communication middleware can be applied to the widely distributed microgrids and smart grids.

This paper introduces the IEC 61850 communication middleware applying the newly developed XMPP protocol.

2 Configuration of IEC 61850 Communication Middleware

Fig. 1 shows a schematic diagram of the IEC61850 communication middleware developed this time. The Abstract Communication Service Interface (ACSI) is stipulated in IEC 61850-7-2 as a communication service relating to information exchange with an Intelligent Electronic Device (IED). The communication services are defined as an abstract style independent from the communication protocol. The Specific Communication Service Mapping (SCSM) is used to clarify how an actual communication protocol is used. Mapping to the Manufacturing Message Specification (MMS) protocol is stipulated in IEC 61850-8-1. Regarding the

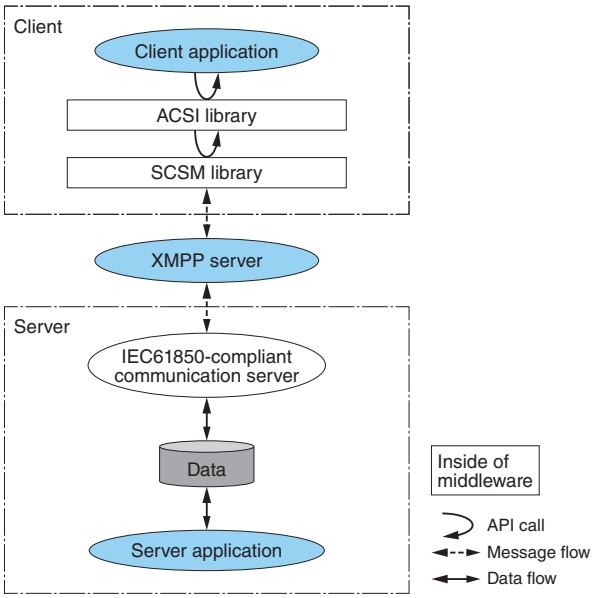

Fig. 1 Schematic Diagram of IEC61850-Compliant Communication Middleware

The IEC61850-compliant communication middleware is composed of the ACSI library, SCSM library, and communication server.

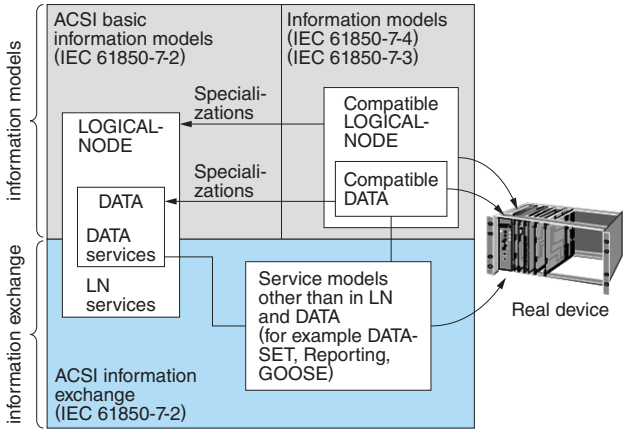

Fig. 2 Conceptual Diagram of the ACSI

Under the ACSI, information models and information exchange services are defined.

mapping to the XMPP protocol, we understand it is under review as a new standard of IEC 61850-8-2. Our development of middleware was made in advance based on the draft edition of IEC 61850-8-2.

2.1 Mounting the ACSI

Fig. 2 shows a conceptual diagram of the ACSI. For the ACSI, information models and information exchange services are defined.

Fig. 3 shows an interconnection inter connection diagram overall information model of the ACSI. In the ACSI, a character string is used as an object reference in order to designate the data. Each attributable object names such as LOGICAL-DEVICES, LOGICAL-NODES, DATA, and Data Attributes are combined.

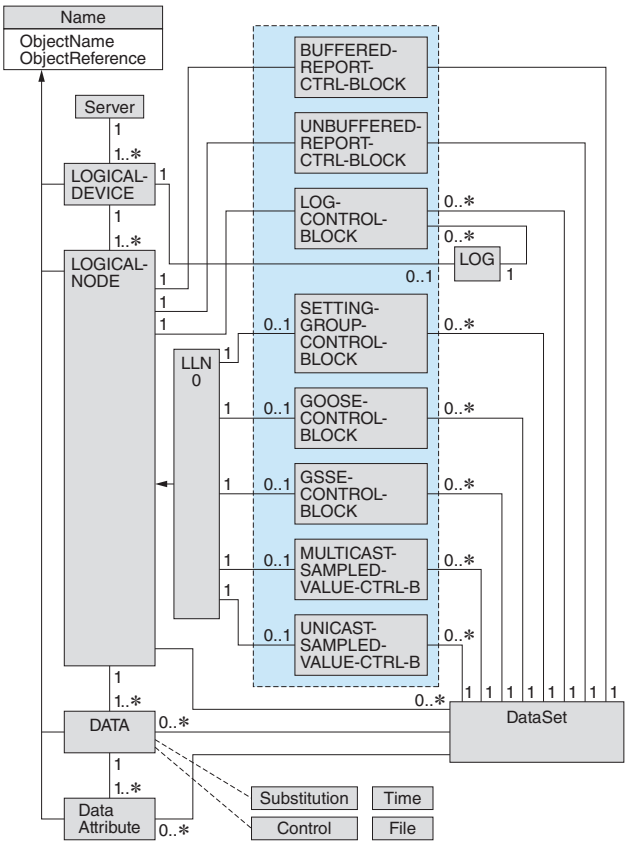

Fig. 3 Inter-Connection Diagram on Overall Information Model of ACSI

ACSI data are arranged in a hierarchical structure.

Table 1 List of Implemented Services

A list of ACSI services implemented by this middleware is shown.

Service	Description
Associate	Establish an association
Release	Release an association
GetDataValues	Retrieve values of DATA contained in the LOGICAL-NODE
SetDataValues	Write values of DATA contained in the LOGICAL-NODE
GetDataSetValues	Retrieve all values of DATA referenced by the members of the DATA-SET
SetDataSetValues	Write all values of DATA referenced by the members of the DATA-SET
Report	Send a report
GetURCBValues	Read an attribute of an instance of URCB
SetURCBValues	Write an attribute of an instance of URCB
GetFile	Transfer of the contents of a file from the server to the client
SetFile	Transfer of the contents of a file from the client to the server

Among information exchange services, Table 1

shows a list of services implemented by this middleware. Functions in response to these services are implemented as a C-language function where object references are regarded as arguments.

2.2 Mounting SCSM

Fig. 4 shows an overall mapping diagram of SCSM. In IEC 61850-8-1 where mapping to MMS is stipulated, protocols are mapped to the following messages against Type1 through 6:

(1) Type1 (Fast messages)
(2) Type1A (Trip)
(3) Type2 (Medium speed messages)
(4) Type3 (Low speed messages)
(5) Type4 (Raw data messages)
(6) Type5 (File transfer functions)
(7) Type6 (Time synchronization messages)

Fig. 5 shows the XMPP mapping. The SCSM of this middleware is implemented as C standard library and the XMPP is used as the T-Profile protocol for Type2, 3, and 5.

The XMPP is an XML-based protocol and it has been originally used as the instant messenger. Recently, there have been growing applications on the international standards. Functionally, it offers a variety of advantages such as asynchronous communication function, delivery confirmation function, confirm-the-condition function, high security function, and the easy of building application. Fig. 6 shows an outline configuration of the SCSM library.

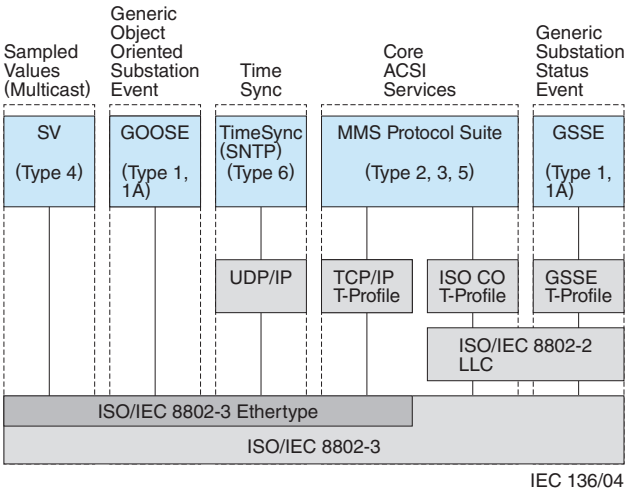

Fig. 4 Overall Mapping Diagram of SCSM

Under the SCSM, a protocol is mapped for each message type.

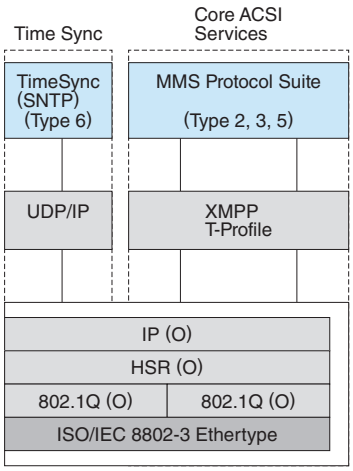

Fig. 5 XMPP Mapping

Under the XMPP, mapping is arranged for the T-Profile.

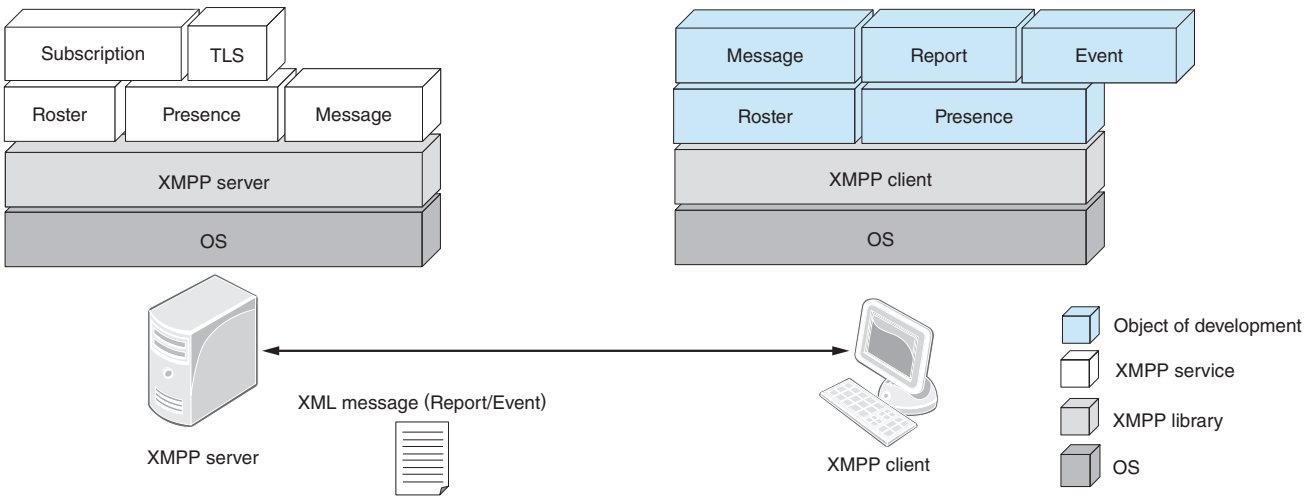

Fig. 6 Outline Configuration of SCSM

Under the SCSM, "libstrophe" is used as an XMPP client library.

3 Postscript

This time, we developed an IEC 61850-compliant communication middleware where the XMPP protocol is used as a transport mechanism. By this development, it became easier to use, IEC 61850-based communication for widely-distributed microgrids and smart grids.

Going forward, we will work on to the development of communication middleware so that international communication standards other than IEC 61850 can also easily be used.

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