IEC 61850 Communication Model

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Before discussing operational applications over utility telecom networks, a brief introduction is necessary on IEC 61850 standards. The initial objective of this standardization effort was to define vendor-independent data exchange architecture for the electrical substation automation system allowing interoperability of devices from different vendors. It defined substation automation data and application models and adopted standard existing communication protocol stacks and services. Over the years, IEC 61850 has grown out of the substation boundaries to cover substation-to-substation, substation-to-control center, asset condition monitoring, and synchrophasor applications, as well as communications in other power system domains. At present IEC 61850 standards are an architectural reference for data modeling of new communicating applications.

The IEC 61850 standards cover the networking of substation automation devices enabling Intelligent Electronic Devices (IEDs) to exchange information (i.e., interoperability). It comprises the following:

- a data model defining Logical Nodes (LN),
- data exchange services (Abstract Communications Service Interface or ACSI) mapped to a communication stack (MMS, TCP/IP, and Ethernet with priority tagging).

IEC 61850 is initially introduced at substation level (i.e., intra-device exchanges over a LAN). However, extensions beyond substation boundaries over a WAN have been specified and published and still ongoing. This allows, in particular, the interconnection between IEC 61850 islands.

Some of these standards and guidelines are listed below:

- IEC 61850-90-1 Use of IEC 61850 for the communication between substations
- IEC 61850-90-2 Use of IEC 61850 for the communication between control centers and substations
- IEC 61850-90-3 Using IEC 61850 for Condition Monitoring

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- IEC 61850-90-4 IEC 61850—Network Engineering Guidelines
- IEC 61850-90-5 Use of IEC 61850 to transmit synchrophasor information according to IEEE C37.118
- IEC 61850-90-6 Use of IEC 61850 for Distribution Feeder Automation System
- IEC 61850-7-410 Hydroelectric Power Plants—Communication for monitoring and control
- IEC 61850-7-420 Communications systems for Distributed Energy Resources (DER).

Figure 2.1 presents the interaction between the data model and the communications inside the IEC 61850 model. It should be noted that the standard largely leaves the implementation and architectural aspects of the communication network to the designer's initiative. A companion guideline document titled "Network Engineering Guidelines" is to provide architectural and performance analyses for both local and wide area communication networks.

The IEC 61850 standard enables information exchange through different communication services (Fig 2.2):

- Sampled Values (SV) are encapsulated and transmitted as a multicast service over Ethernet providing fast and cyclic exchange of voltage and current measurement values for protection and control replacing traditional analog wiring. Any sample loss or a delay longer than 4 ms between two consecutive samples prevents IEDs from functioning correctly. For example the Busbar voltage used to trigger protection relays is measured at 4000 samples/s and transmitted cyclically at 1 kHz. MAC-layer multicast addressing is used to make the sample values available to multiple users.

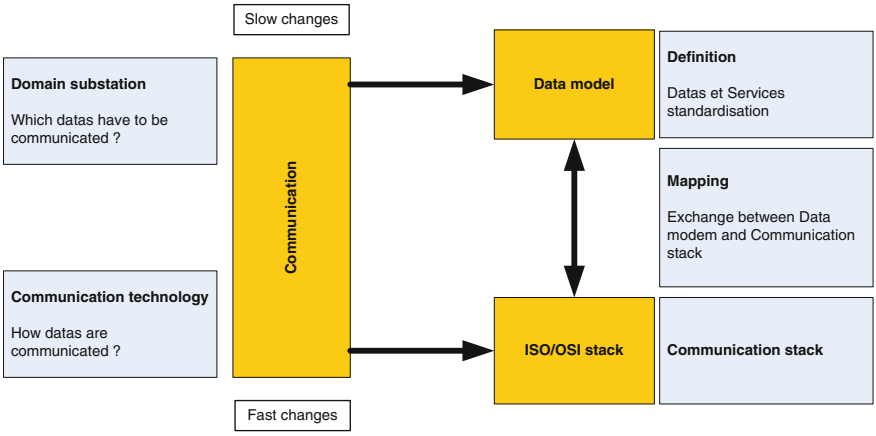

Fig. 2.1 IEC 61850 model presenting data model and communication stack

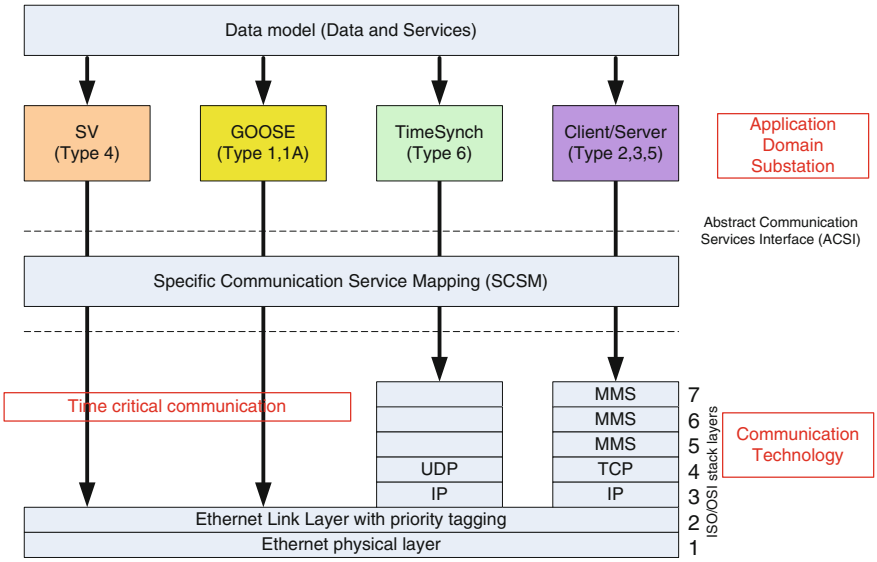

Fig. 2.2 IEC 61850 message services

- GOOSE (Generic Object Oriented Substation Event) is used for transmission of critical events in real time (e.g., tripping commands) between two or more IEDs using Ethernet multicast. The GSE service model of 61850-7-2 details fast and reliable system-wide distribution of input and output data values using a specific scheme of retransmission to achieve the appropriate level of reliability.
- TCP/IP-based messages using MMS (Manufacturing Messaging Service) data presentation layer are employed for download and upload of configuration, parameter setting, monitoring, etc.

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