Performance Evaluation of IEC 61850 safety-related communication architecture

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Abstract

Recent improvements, in electrical power transmission and distribution, require considerations of existing regulations that enforce increasing of reliability and reducing of environment impact.

Smart grids become industrial solutions that follow standardized development. It is used to satisfy both the electrical energy supply from producers to consumers and the need for consumers' data transmission to electrical utility and providers.
This technology is affected by international standardization in the field of power transmission and distribution.

Modern electrical substations, i.e. electrical transmission and distribution stations, are part of smart grids. These substations follow new technological trends [1].

The IEC 61850 standard consists of 10 parts to enforce interoperability between different manufactured devices, e.g. intelligent electronic device (IED), in the substation communication systems [2].
The standard uses high speed time-critical communication to exchange events and states between substation devices. This standard sets a latency constraint to achieve a response time of less than four milliseconds for critical event communications, especially in the protection and automation fields [3].

One of the objectives of the current research is to evaluate latency of Ethernet based GOOSE (General Object Oriented Substation Events), i.e. time-critical messages , transmission for both message priority and time delay.
In particular, to evaluate theses parameters, especially when network redundancy is existed, a simulation model scenario is developed.

In this study modeling is done by employing Matlab Simulink and Stateflow libraries. A model uses state machine charts is therefore used to build and evaluate GOOSE real time communications. The main components of the model are Ethernet network, publisher and subscriber IEDs. This model and its components are simulated to provide frame delivery delays to measure the network latency.

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The first model is a simple station bus architecture that gave interesting results. Its output will be verified to validate GOOSE communication paradigm in respect of the standard time constraint.

The main aim of this research is to evaluate safety-related functions and their reaction, i.e. protective relay response, hence that current work will require further expansion to simulate safety-related functions and network redundancy within an IEC 61850 substation network.

Keywords: Smart Grid, Time-Critical, Ethernet, Safety.

[1] ALSTOM, Network Protection and Automation Guide, edition may 2011

[2] IEC 61850 standard and its parts

[3] S. Choi, C. Kim, S. Choi, I. Kim and T. Jeong, *Communication Interconnection Network Architecture and Logical Devices Application, international journal of software engineering and its applications, Vol. 6, No. 3, July, 2012*