Wireless Communication Requirements Selection according to PMUs Data Transmission Standard for Smart Grid

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Authors

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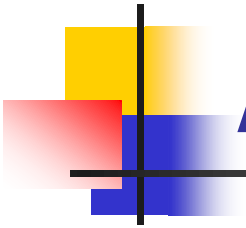


Agenda

- Introduction.
- PMU.
- PMU communication Requirements.
- Scope of paper.
- LTE communication performance.
- Conclusion.

Introduction

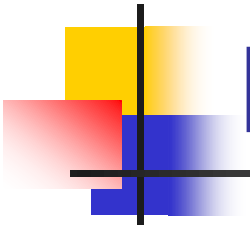
- Smart Grid refers to two-way communicational electricity grid.
- A smart grid is expected to be capable of remotely detecting statuses of electricity generations, transmission lines and substations; of monitoring consumption of user electricity usage; of adjusting the power consumption of household applications in order to conserve energy, reduce energy losses and increase electricity grid reliability.
- Future grid vision is using faster protection and control, more robust, more renewable, and more efficient.

Phasor measurement unit (PMU)

- A phasor measurement unit (PMU) or synchrophasor is a device which measures the electrical waves on an electricity grid, using a common time source for synchronization.
- The protection system for multi-terminal lines consists of PMUs located on the smart grid.

Scope of paper

- A new expected system protection is collecting data from different PMUs for final decision based on the shared information sent through a wireless communication network.
- The main challenge now what is the computability of the wireless protocol and its performance in relation to PMUs.
- The paper is going to answer these questions.



Long Term Evolution (LTE)

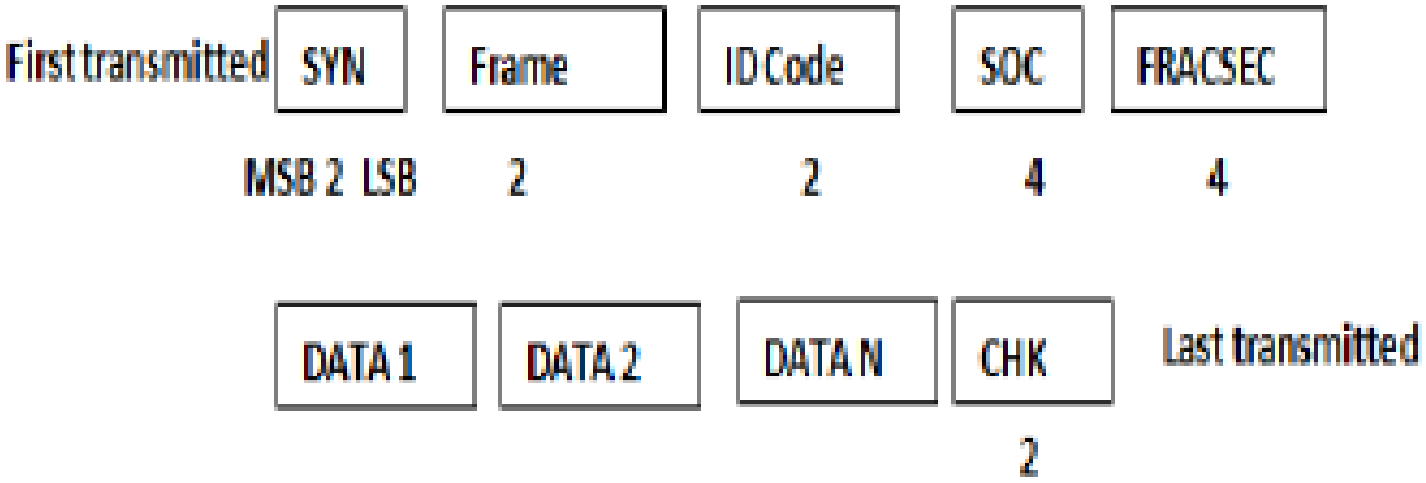
Long Term Evolution (LTE) is the next step forward in wireless communication. Expected in the 2008 time frame, LTE is a 3GPP standard that provides for an uplink speed of up to 50 megabits per second (Mbps) and a downlink speed of up to 100 Mbps. The proposed LTE protocol will be applied to studied system and its performance with PMU also will be evaluated in this paper.

PMU Communication Requirements

- There are three parameters must be put in consideration:

1. Amount of data collected.
2. Data rate of transmission.
3. Latency.

Amount of data calculation from all PMU



Frame format of data from N PMU

Amount of data calculation from all PMU

$$D = 16 + 36N \qquad (1)$$

where D is the total amount of data in bytes and N number of PMUs. 16 means the total number of the overhead bytes and given as

$$(2SYNC+2FRAMESIZE+2 \\ IDCODE+4Soc+4FACSE+2CHK)$$

& 36 means the measured set DATA for each device (current, voltage, etc.).

Bit rate calculation of data transmitted from PMU

- It is expected that a typical device will have access to measured line voltages and currents. Assuming such quantities to be sampled 16 times per ***f (50 Hz cycle), 800 samples will be produced per second for each*** measured quantity, so we need 800 messages per second from the PMUs. So, the transmission bit rate required for ***N PMUs is:***

$$R = 9.6\,(4+9N)\ \text{Kbits/Sec}$$

PMU Latency

- Standard IEC 61850-5 introduces the communication requirements for functions and device models in a substation. Based on IEC 61850-5, the required latency is 10msec about half cycle.

PERFORMANCE OF LTE IN TERMS OF LATENCY AND BANDWIDTH

- The studied configuration system given in the paper can cover area with a diameter equal to 40 km in case of line of site connection.
- We theoretically estimate the performance of LTE in terms of latency and Bandwidth based on the standards from 3GPP.

LTE Latency Analysis

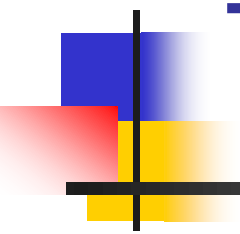
- In LTE there is control plane and user plane latency. Control plane deals with signaling and control functions, while user plane deals with actual user data transmission and it is calculated as one way transmit time. In this paper, we calculate the delay budget of user plane for both FDD (frequency division duplex) and TDD (time division duplex) modes of operation.
- the delay budget for FDD mode is ***4 msec.***
- the delay budget for TDD mode is ***5.1 to 9msec.***

LTE Bandwidth Analysis

- In order to evaluate the peak rates in both downlink and uplink, we consider the best case in both sides of UE and eNodeB.
- the downlink peak rate could be easily calculated by 100 × 6 × 84 bits/0.5 ms = 100 Mbps.
- the uplink peak rate is obtained by 100× 4 × 84 bits/0.5 ms = 67.2 Mbps.

CONCLUSION

- The performance of LTE from factors affecting on bandwidth and latency was investigated. The study summarized the following;
- The performance of the proposed communication protocol using PMU fulfills the IEEE standard requirements in term of latency and bandwidth.
- The proposed wireless communication protocol using LTE physical layer technology is reliable and can be implemented in the real smart grid applications.
- Frequency division duplex (FDD) operation mode has better lateness performance than time division duplex (TDD) mode of operation.



Thank You for your time

Q & A