Selective Data Transmission Scheme for Wide Area Smart Grid Communication Network

Sharda Tripathi, Swades De
Department of Electrical Engineering
Indian Institute of Technology Delhi, New Delhi, India

***Abstract*—In this work, we propose a novel selective data transmission scheme for intelligent reduction of PMU data and study how the power grid health monitoring with pruned PMU data is impacted by fading channel characteristics.**

***Index Terms*—Smart grid, PMU, sampling rate, bandwidth saving, Rayleigh fading**

I. Introduction

Wide area monitoring facilitates identification of disturbances in smart grid to avert large scale blackouts. In a wide area network, phasor measurement units (PMUs) continuously transmit the system state to phasor data concentrator (PDC) [1]. Due to frequent sampling and near real time data reporting, enormous volume of generated data will likely exceed the network transmission capacity in near future. Thus, intelligently pruning PMU data to optimally utilize the channel bandwidth and investigating the effect of channel characteristics on pruned data transmission to ensure reliability of the communication network without hampering detection in the power grid is of our key interest.

II. Conventional Scheme

According to [2], reporting rate of PMU data is presently fixed at 25 and 30 samples/sec, respectively for 50 Hz and 60 Hz system. Thus continuous data transmission takes place over the communication channel.

However, due to large redundancy in PMU data, continuous transmission is needless for bandwidth saving. Also, owing to fading nature of communication channel, critical system information in continuous transmission remains vulnerable to loss, especially during deep fades. To this end, we propose a novel selective data transmission scheme and study how the power grid health monitoring with pruned PMU data is impacted by fading channel characteristics.

III. Proposed Scheme

At the PMU, data redundancy is identified using ϵ-support vector regression model and excess samples are prevented from being transmitted. Meanwhile, missing samples are predicted at PDC using the same model. In case of degrading prediction accuracy, the model is retrained with latest PMU data. Thus, as against continuous transmission, our proposed scheme selectively transmits PMU data batches only when necessary to sustain quality of predictions. This is shown in Fig.1

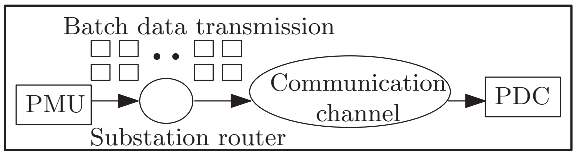

Fig. 1: Proposed selective data transmission scheme.

IV. Performance Evaluation

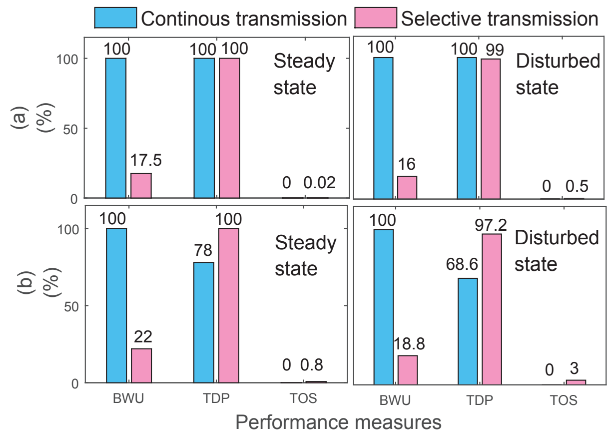

Fig. 2: Performance comparison of selective transmission and continuous transmission for (a) ideal channel; (b) Rayleigh fading channel.

Performance indices considered here are bandwidth utilization (BWU), transient detection probability (TDP) and training overhead/sample (TOS). In Fig.2, selective versus continuous transmission is compared during steady and disturbed power system states for ideal and Rayleigh fading channel. It is observed that in ideal channel, selective transmission utilizes 83% less bandwidth and has comparable TDP with respect to continuous transmission. Further, in Rayleigh fading scenario, it outperforms in terms of BU as well as TDP by 80% and 14%, respectively. However in selective transmission, small training overhead per sample is incurred unlike the continuous case.

References

[1] S. Das and T. Singh Sidhu. Application of compressive sampling in synchrophasor data communication in WAMS. *IEEE Trans. Ind. Informat.*, 10(1):450–460, Feb. 2014.

[2] IEEE standard for synchrophasor data transfer for power systems. *IEEE Std C37.118.2-2011 (Revision of IEEE Std C37.118-2005)*, pages 1–53, Dec. 2011.