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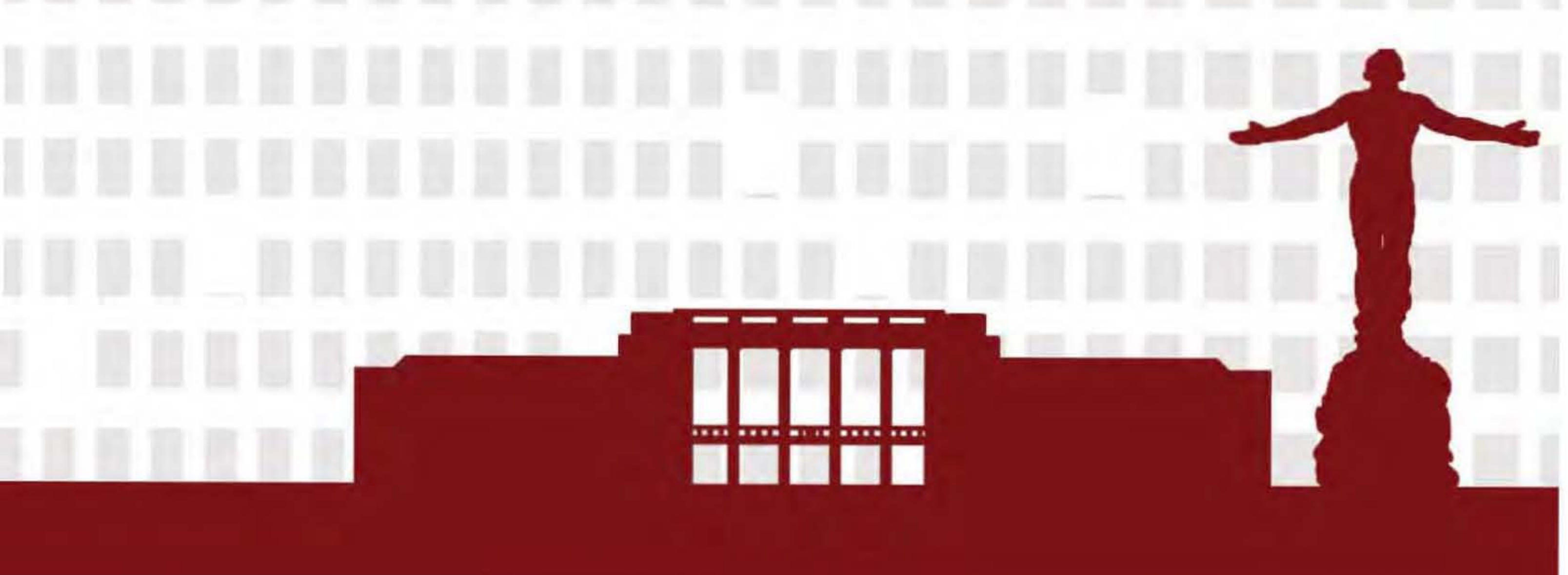

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PE04

OPTIMAL PLACEMENT OF PHASOR MEASUREMENT UNITS (PMU) FOR THE POWER TRANSMISSION SYSTEM

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ABSTRACT

The observability of power system topology, as well as real time information of power flows in the power network plays a crucial role in determining correct and appropriate dispatching actions. The advent of Phasor Measurement Units (PMU) can potentially improve the accuracy of state estimation, and the overall observability of the network. The fundamental difference between PMU and legacy SCADA technology is that not only bus voltage magnitude can be measured, the relative angle difference between system buses can also be measured by the PMU, thanks to the very high accuracy of the Coordinated Universal Time provided by its GPS signal [1]. Not only PMU provides better real-time power system information, PMU data can help improve the accuracy of post-disturbance analysis, especially during large-scale system events.

The installation of large number of PMU at power system buses, however, requires thorough consideration. An effective PMU placement strategy can minimize the number of PMU, while still ensuring full system observability even if some of the PMU devices become defective during operation. This paper studies the optimization problem of PMU placement on the transmission system.

The main objective function of PMU placement is as follows [3, 4]:

$$\min \quad F = \sum_{i \in I} x_i - \lambda . \sum_{i \in I} f_i$$

Where: $\lambda = \frac{1}{\sum_{i \in I} u_i}$; I is the set of system buses that need to be observed; x_i is a binary variable indicating whether a PMU unit is placed at bus i; f_i is the number of time bus i is observed with current PMU placement (for important buses, f_i can be greater than 1).

In this work, we also take into account some other considerations for PMU placement:
The bus with no load (so called Zero Injection Bus) is considered. With only one PMU, this bus and its two adjacent buses can be observed. This consideration helps reduce the number of PMU.
The loss of certain branches in the network is considered; The full system observability will be ensured even with an outage of one of these branches.

The optimization problem is formulated as an Integer Programming problem, and is solved using the CPLEX software [6]. The result obtained for several standard power system models is shown in the Table 1 below: