

**Question 1.5: How can we define the optimal number of synchro-phasor measurement devices for a given area?**

The optimal number of synchrophasors primarily depends on the following conditions:

1. Grid topology (number of nodes, the number of no-load/gen buses, number of lines connected to a node).
2. The preferred level of observability (e.g. full vs partial) and redundancy (e.g. N-1 for each contingency, incl. a single synchrophasor failure).
3. The desired WAMS and WAMPAC applications in the grid (state-estimation, wide-area protection/control algorithms, backup protection, etc).

There are various methods for determining the optimal number and placement of PMUs. The widely known and efficient are methods based on Integer Linear Programming methods, and an incremental approach based on the graph approach. Both algorithms are capable of taking into account different depths of observability. When selecting optimal placement of PMUs it is also important to report the depth of observability, which can be fully observable, depth of -1, -2, or -3.

To benefit from various possible WAMPAC applications (today and in the future), full observability and sufficient redundancy are desired. In the work presented in C2-10550, this question was out of the scope and it has been considered that the network is fully observable. It will be challenging in the future to adapt our algorithms to a network which is not fully observable and investigate the methods' efficacy under such conditions.