
# Seminar on
# Wide Area Measurement Security

# I. Introduction

Power grid is centralized power generation where power is generated in generation sub-stations and then transmitted to transmutation points to distribution substation. It also provides the power flow from the generation to the consumers

The smart grid defined by NITS national institute of standard and technology is the angle of bidirectional flow of energy and uses two ways communications and control capability that would be an array of new functionalities and publications. In 2007 NITS divided the domain into 7 main domains. However to be able to run those applications(domains) we needs measurement that comes from different parts of the array in information technology and which is the introduction of Wide Area Measurement System(WAM's). This report introduces new vulnerabilities to cyber attacks on WAMPS and Proposed System for its Prevention.

# II. Wide Area Measurement System (WAMS):

WAMPS components are explained as follows.

## a. Phase measurement Unit (PMU)

This work provides a time-stamped voltage and current phasors. High resolution scans can track grid dynamics in real time. So the ability to calculate synchronized phasors makes the PMU one of the important measuring devices in the future of power system monitoring and control.

## b. Phasor Data Concentrator(PDC)

This work has much functionality. It groups measurements from different PMUs and aggregate the synchronized data set as single data stream. It archive data and process the information and exchange record with PDCs at other locations. Components of PDC consists of four main modules. i.e. pre processing module, data processing , output interface,and the exception handling and diagnostics module

### c. Communication Network

Communication network links multiple PMUs to a PDC or one PDCs to other PDCs for real time data transfer based on wireless or wired IP-based network. Currently PMUS transfer their measurements using IP unicast network transmission that causes the message delays, limilited scalability and throughput.

## III. Address problems related to WAMS are

- Cyber attack propagation
- Delay attacks and system observability
- The impact of attacks on WAMS applications.

The Phasor measurement are being received by the PDC from different PMUs that are spread and installed on different geographical location. A shared ip is used to provide services to the sensors through measurement to PDC. By cyber attack on the communication can cause failure in the underling communication which can have impact on the system observability.

## IV. Accomplished Research Activities: Cyber-Attack Propagation

In the presence of a cyber-attack, the attacker can use the compromised PMU to propagate the attack to other connected PMUs. The main components of this system are PMUs, routers, and PDCs. Each PMU is directly connected to a router, through which its measurements are sent to a set of destinations using the IP multicaset routing protocol. The problem, gather PMUs measurements at end paths PDCs using IP-multicast while minimizing cyber attack propagation

## V. Recent Research Activities

The PDC groups measurements from different PMUs with similar time stamp into a time stamped buffer. When the buffer is full, the PDC forwards the set of measurements to others PDCs or Synchrophasor applications. In case of delays, the PDC have to wait for the delayed measurements. The PDC timer is the amount of time the PDC is actively waiting for the rest of synchrophasor measurements to arrive. When the timer goes off the PDC forwards the receive measurements

without waiting for the delayed measurements. The timer introduces the problem of data incompleteness when measurements arriving after the expiration of the timer are dropped resulting in incomplete information which can even impact WAMS observability.

A straightforward solution is to increase the value of the timer at PDC to recover all required measurements

## VI. Proposed model:

we develop a mathematical tree model to connect PMUs with PDCs and transfer phasor measurements within different applications delay requirements. The objectives is to construct trees and collect phasor measurements for PMUs to maximize the network observability against delay attacks. This can be done through the minimizing the number of invalid measurements per PDC timer. This can be subjected to

Flow conservation constraints: To construct the forwarding tree between PMUs and PDCs and avoid loops in the constructed trees
Edge capacity constraint: To ensure that the constructed trees satisfies edge capacity constraints
Delay constraint: To ensure that the constructed tree satisfies the end to end delay

## VII. conclusion:

The ongoing work focuses on maximizing the network observability against delay attacks on WAMPS communication network.
A mathematical model for PMU communication routing in WAMS with the objective of minimizing the number of invalid measurements.
Delay attack and not properly configured routing paths for the measurements can severely affect applications. The impact of attacks and delays is not always clear and needs to be analyzed.