Wide Area Synchronized Frequency Measurement System Architecture with Secure Communication for 500kV/220kV Egyptian Grid

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ABSTRACT

- This paper introduced a secure communication infrastructure for synchronized frequency monitoring network (FNET) using a number of GPS-time synchronized Frequency Disturbance Recorders (FDRs) deployed a cross part of the 500kV/220kV Egyptian power grid

- VPN tunnels are used to provide secure communication channels between FDRs and the remote control center over public telecommunication infrastructure (Internet)

INTRODUCTION

- Wide-area monitoring systems (WAMSs) utilizing synchrophasor measurements can help with understanding, forecasting, or even controlling the status of power grid stability in real-time

- Frequency Disturbance Recorders (FDRs) are power system devices that provide synchronized measurements of real-time frequency, phase angle, and amplitude of a single phase voltage source

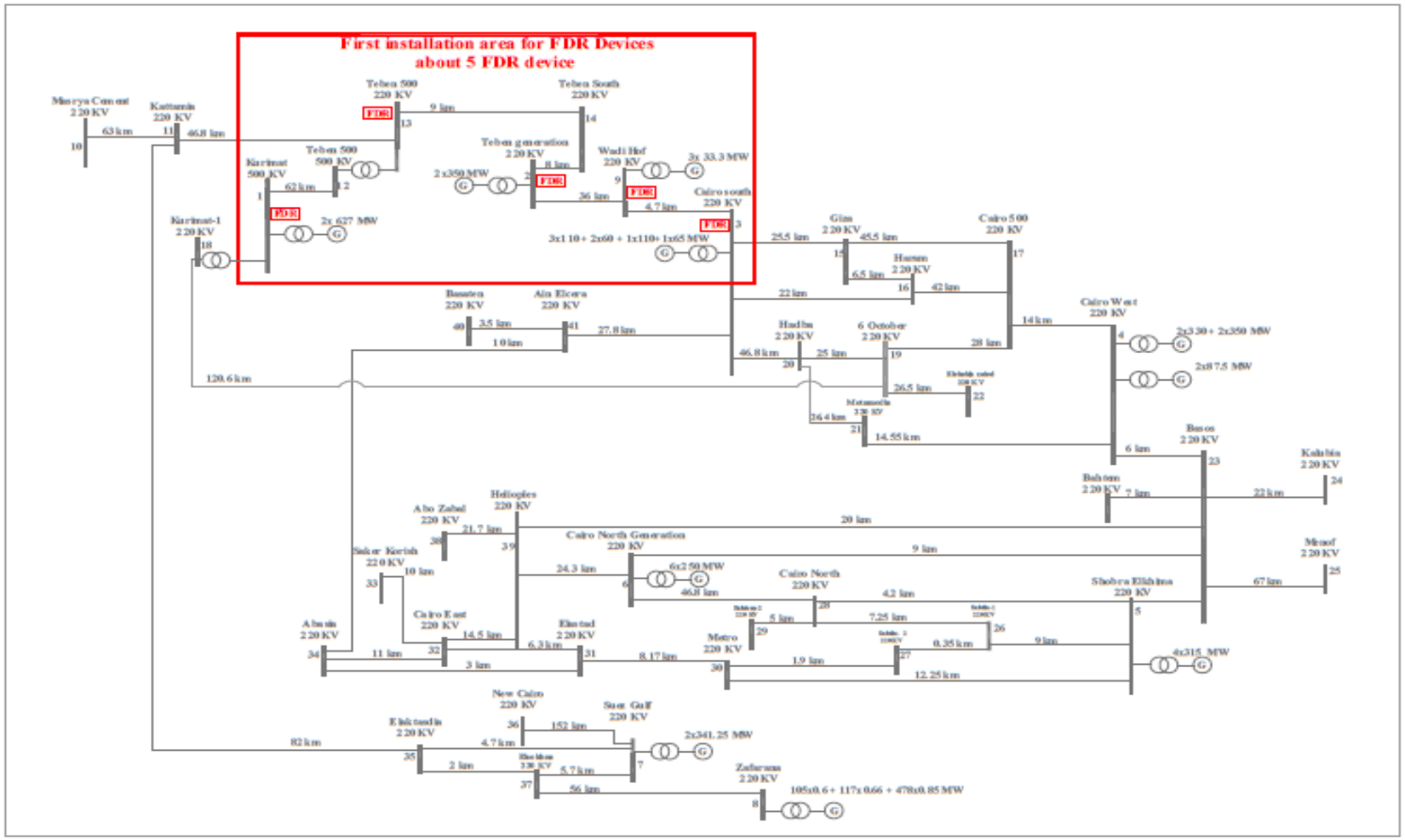
- FDRs are becoming an important element of wide area measurement systems used in advanced power system monitoring, protection, and control applications

- Unlike traditional PMUs, the FDR based Frequency Monitoring Network (FNET) is an Internet–based, GPS–Synchronized wide area Network deployed at the distribution level, providing a low-cost and easily deployable WAMSs solution.

APPLICATIONS OF FNET

- Dynamic simulation based power system event location estimation is considered one of main applications of FNET Network
- Event location estimation helps in increasing stability and reliability of Egyptian power grid
- There are other various applications of FNET such as post-mortem analysis, adaptive protection, system protection schemes, and state estimation

TOPOLOGY OF THE EGYPTIAN POWER GRID



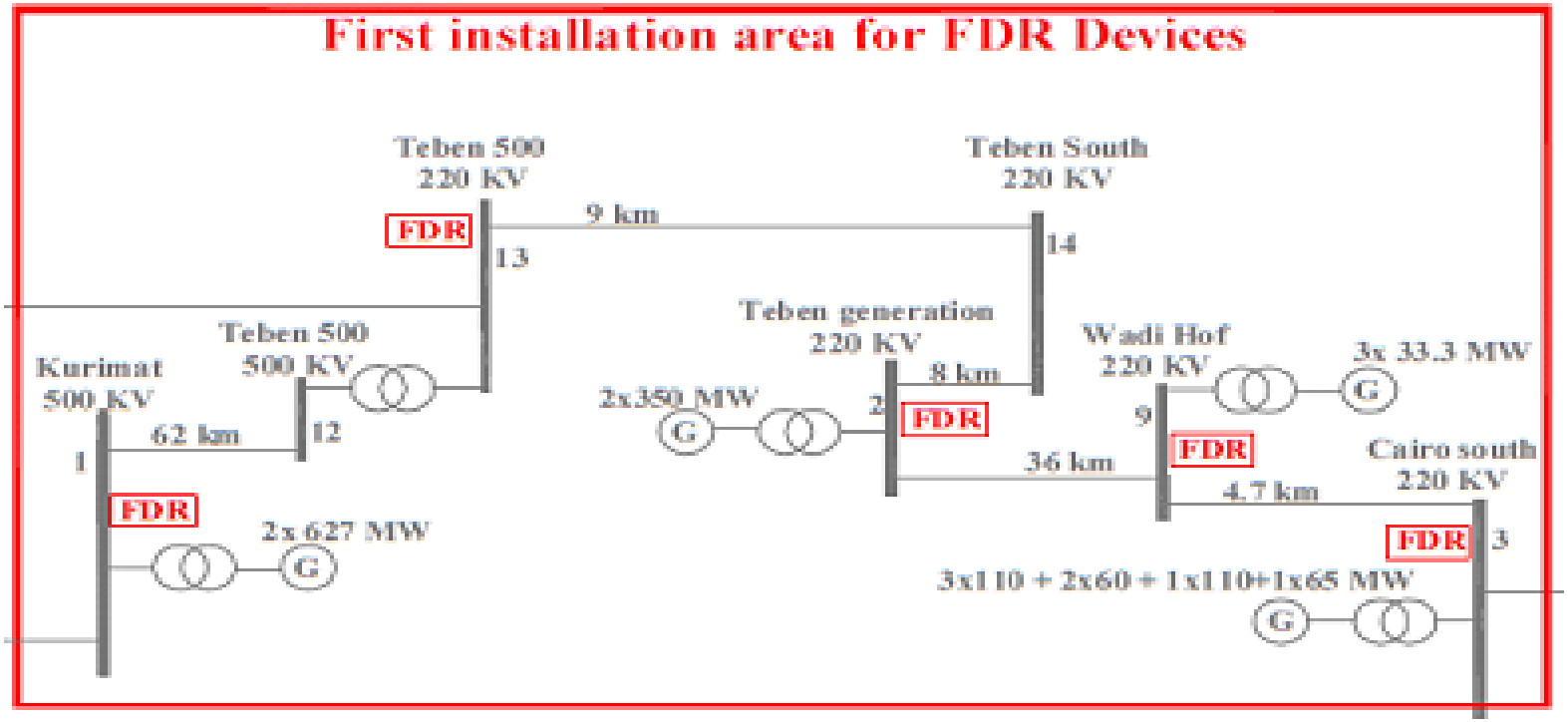
Part of the 500/220 kV Egyptian Power Grid

OPTIMAL PLACEMENT OF FDR DEVICES

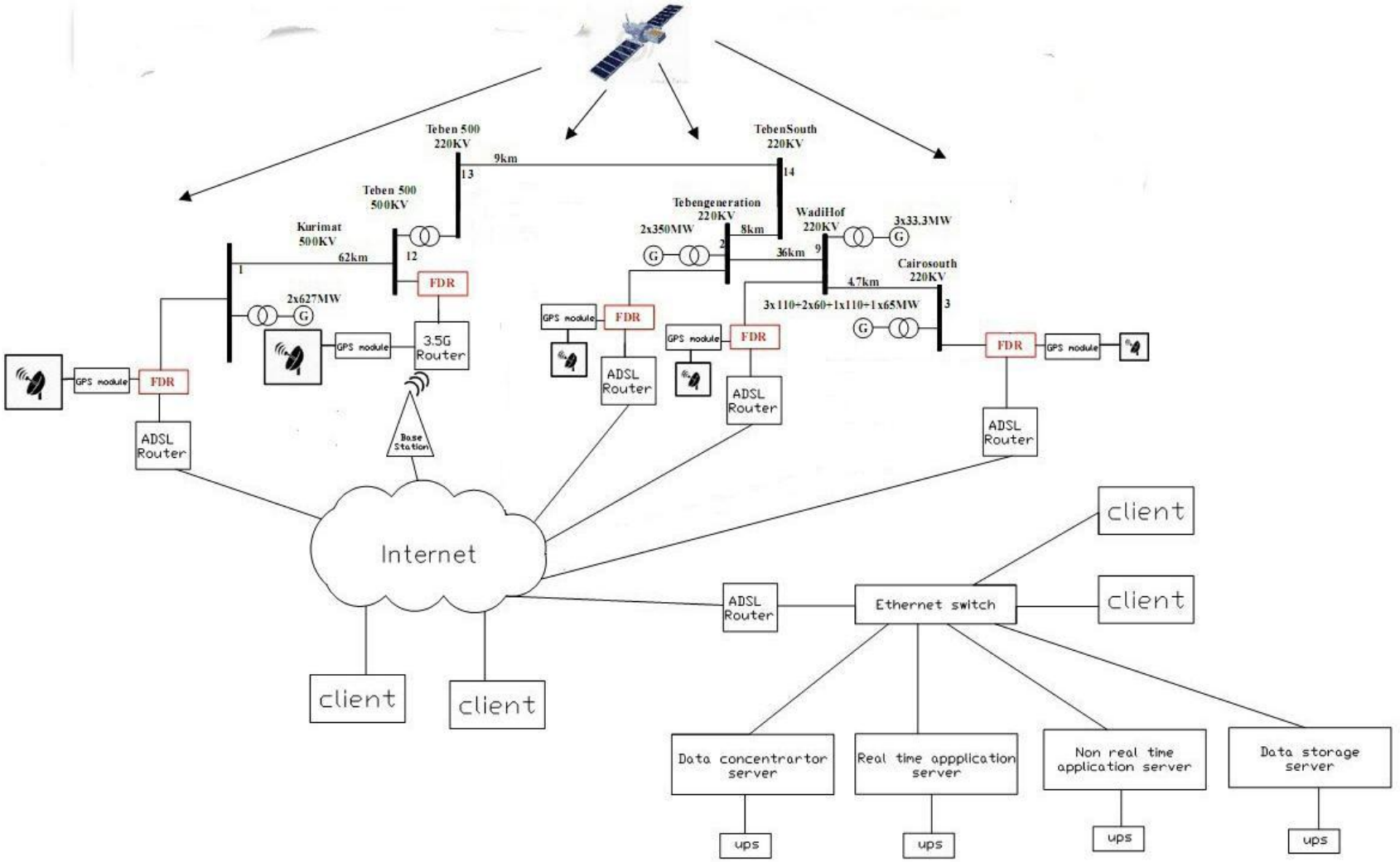
- The best possible locations of FDRs in the power grid must be decided before the installation process
- Harmony Search (HS) algorithm is one of the recent techniques used for optimum selection of FDRs locations
- HS algorithm formulates the optimal FDRs placement problem to minimize the number of FDRs installation subject to full network observability and to maximize the measurement redundancy at the power system buses
- Several factors are considered to ensure full network observability; such as the available data from existing conventional measurements, the number and locations of zero injection buses, the number and locations of installed FDRs

FDRs DEPLOYMENT ON THE EGYPTIAN POWER GRID

- Five locations are selected and five FDRs will be installed to provide a pilot architecture for FNET network in the Egyptian power grid
- FDRs are powered by the output voltage from the voltage transformer in each substation (100 volt phase-to-phase)



PROPOSED FNET ARCHITECTURE FOR EGYPTIAN POWER GRID



PROPOSED FNET ARCHITECTURE FOR EGYPTIAN POWER GRID

- Electrical parameters measured by the five FDRs are transferred through Internet VPN tunnels and collected remotely in the control center that consists of:

- **Data Concentrator Server (DCS):**
  - Collecting the measured data and performing time alignment using time stamp
  - Performs quality checks on the measured data and inserts appropriate flags
  - Checks disturbance flags and records files of data for analysis
  - Monitors the overall measurement system and provides a display and record of Performance

PROPOSED FNET ARCHITECTURE FOR EGYPTIAN POWER GRID

- **Real time application server:** Equipped with real time modules like frequency interface, frequency event trigger, event location module, oscillation detection module, and oscillation alert module

- **Non-real time application server:** Runs some applications like event visualization and web service

- **Data storage server:** Stores all processed data by other servers and also the transmitted data from FDRs sensors as a backup

CONCLUSION

- **The expected general deliverables from the proposed FNET system are:**
  - Improvement in the performance of the Egyptian power grid from the reliability, security and stability viewpoint
  - Reduction in the risk of the grid from the blackout and system failure
  - On-line power and protection application techniques
  - Reduction the risk of catastrophic large area disturbances in systems
  - Reliable power system with increase in the system generation
  - Design early dynamics detection and corrective actions monitoring system
  - Provide economical solution for the large scale grid
  - Increasing the system selectivity and sensitivity

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- More details about the project (Smart Grid Frequency Monitoring Network Architecture and Applications) are given in www.helwan-ntra.com.

Q & A

Thank You