CHALLANGES OF FIBER OPTIC INFRASTRUCTURE USED IN WIDE AREA PROTECTION OF THE ROMANIAN POWER GRID

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Abstract: The field of protection systems used in power systems is more and more dominated by computer based relays. In the power systems of Europe, but not only, the deregulation is appeared and works. Due to the operational demands imposed on transmission networks by this, it is clearly that wide-area measurements and their integration in protection and control systems becomes more then a necessity.Wide Area Protection (WAP) using fiber optic is one exemple of integration of communication in protection systems. Transelectrica SA (Romanian Transmission Power Grid and System Operator), trough the Teletrans Sa (which ensure the operation and maintenance for telecomunication networks and systems owned by Transelectrica SA), has a strongly and robust communication architecture witch can be used for WAPaC (Wide Area Protection and Control) of Transmission Power Grig, in order to extend the system operational limits

Keywords: Wide Area Protection, Wide Area Protection and Control

1. INTRODUCTION

The paper speak about:

- How is used the FO backbone for teleprotections in the east of Romanian Power System.
- The possibility existing with the FO backbone of Romania Power Grid, concerning Wide Area Protection.
- Challenges alternative forms of generation on telecommunication infrastructure used in WAPaC of The Romanian Power Grid.

2. THE INFRASTRUCTURE

Traditionally protection systems do not depend upon wide area measurement systems.
Modern power systems are making greater use of new types of sensors, communication systems, and distributed computer networks.Measurement provided by the sensors is usually collected by a hoast computer in substations over a local-area communication network.

The sensors are able to obtain time-stamps from synchronizing clocks provided by GPS. The computer based protection relays may be considered to be elements of this larger computer network, which perform parallel computations providing local decision and control outputs.

Consequently their response times are slower than those of the substation level computers. Their actions tend to affect larger areas of the power system and often lead to actions which impact the power system as a whole.
The close interactions and interdependencies between power computer and communication infrastructures lead one to the concept of super-infrastructure.

The electric field is measured in relation to a reference to provide an indication of voltage (V) on a conductor . The magnetic field indicates the current(I) flowing in a conductor. Power, and energy derived from voltage and current Transducers are also commonly used for high voltage sensing

Voltage and current measurements based on optical systems are now being deployed. This includes both hybrid designs with an electronic detector with fiber optic (FO) coupling, and direct field measurement with electro-optic techniques. The typical hybrid unit is a current sensor that use a Rogowski coil to sense the magnetic field and then transmits the measurement to secondary equipment via FO communication.

Most common analog transducers in use today utilize electronic signal conversion including Hall Effect or pulse width multipliers to measure power and energy. These are much more accurate than the purely transformer based transducers and can be adapted for much higher bandwidth operation

A Wide Area Protection System can use any of these transducer types depending on the type of protection system. Wide area protection and control can either be a system response to a power system disturbance or a system respons to a locally detected disturbance.

Traditional short circuit protection systems measure local signals and respond in 4 to 40 ms to disturbances in the local area.

Some system disturbances are:

- Transient instability(<1s)
- Dynamic instability (<a few seconds)
- Frequency instability (<a few seconds);
- Poorly damped or undamped oscillations(<some seconds)
- Voltage instability (<a few minutes)
- Severe thermal overload (<some minutes)

A complete Wide area protection and control (WAPaC) system would have the capability to not only detect the incipient disturbance, but also to respond in real time with effective control action.

A system to meet the above detection, decision, and reaction times is strongly dependent on a robust communication architecture. Basic criteria include high bandwidth, low Bit Error Rate, multi-point access, and some degree of redundancy.

Today's wide area communication based on SONET and SDH are capable of delivering messages from one area of a power system to multiple nodes on the system in as little as 6 ms. Assuming a decision calculation time of 50 ms , a disturbance on a system could be detected and a corrective response delivered in less than 200ms
Communication systems are a key component of a wide area protection system.

Many utilities use the Synchronous Optical Network (SONET and SDH) standard architecture for corporate and wide area relaying. The megabit and gigabit per second transmission speed of SONET and SDH networks, ensure any wide area protection speed requirements. By using dedicated synchronous communications, relay channel latency or data delay can be minimized. SDH and SONET provides redundant communication via its bi-directional data ring topology.
The switching can occur in as little as 4 miliseconds to restore protection communications.

3. THE POSSIBILITY TO MAXIMIZE POWER SYSTEM STABILITY

To increase the power system transmission capability and to increase the power system reliability Wide area protection and emergency control systems can be introduced in the power system.
In this way the grid company can extend the system operational limits without any investments in high voltage equipment, and to make operate the system closer to the natural constraints.

Protection is very closely related to circuit-breaker trip signals to disconnect faulty or overloaded equipment from the network, to save the component and pupils, and to reestablish normal operation of the healthy part of the power system.

System wide area protection is used to save the system from partial or total blackout.
SCADA/EMS functions are tools that assist the power system/grid operator in his effort to optimize the power system operation, with respect to economy, operational security and robustness, as well as human and material safety. All his actions are preventive.

3.1. The phenomena

The phenomena which must be counteract are:

- Transient angle instability(first swing)
- Frequency instability
- Small single angle instability(damping)
- Short-term voltage instability
- Long-term voltage instability
- Cascading outage

The most utilized device in these cases is Phasor Measurement Units (PMU).

This is a device for synchronized measurement of voltages and currents (alternative current-AC), with a common time (angle) reference GPS-signal which has a precision down to 1μs. In this way those can be measured as complex values and represented by their magnitude and phase angle to deal with complex system events.
A reliable (based on redundancy and robustness) protection system has to be designed. Parallel systems counteracting different phenomena and different loyers of safety nets can be designed and coordinated.

3.2. The architecture

Protection devices or terminals are traditionally used in protecting equipment (lines, transformers, etc.) Modern protection devices havesufficient computing and communications capabilities that they are capable of performing beyond the traditional functions. When connected together via communications links, these devices can process intelligent algorithms based on data collected locally or shared with other devices

Wide area protection systems can be designed based on de-centralized, especially developed interconnected system protection terminals installed in substations. Fig. 2 present a possible example of FO backbone in east area of Romania concerning Wide Area Protection with PMUs, the for protection against voltage instability (similar illustration can be done for angular instability). Actions are preferable local.

Different schemes, e.g. against voltage instability and against frequency instability, can be implemented in the same hardware. If the communication is partially or totally lost, actions can still be taken based on local criteria.

4. POWER SYSTEM ROMANIAN SITUATION

Teletrans SA ensure operation and maintenance for TC networks and systems owned by NC Transelectrica SA for around of 4000 km (Fiber Optic network using OPGW and OPUG, Transmission systems over fiber optic DWDM, SDH, PDH), Syncronizing system for fiber optic transmission networks, Management platforms for transmission systems, Management platforms for fiber optic network (ACOL) etc

The existing fiber optic infrastructures SDH, PDH (fig.1 SDH TEL Network) and DWDM can be used for a complete Wide Area Protection and Control (WAPaC) realized with PMU. In East of Romania the FO infrastructure is used now in teleportation systems

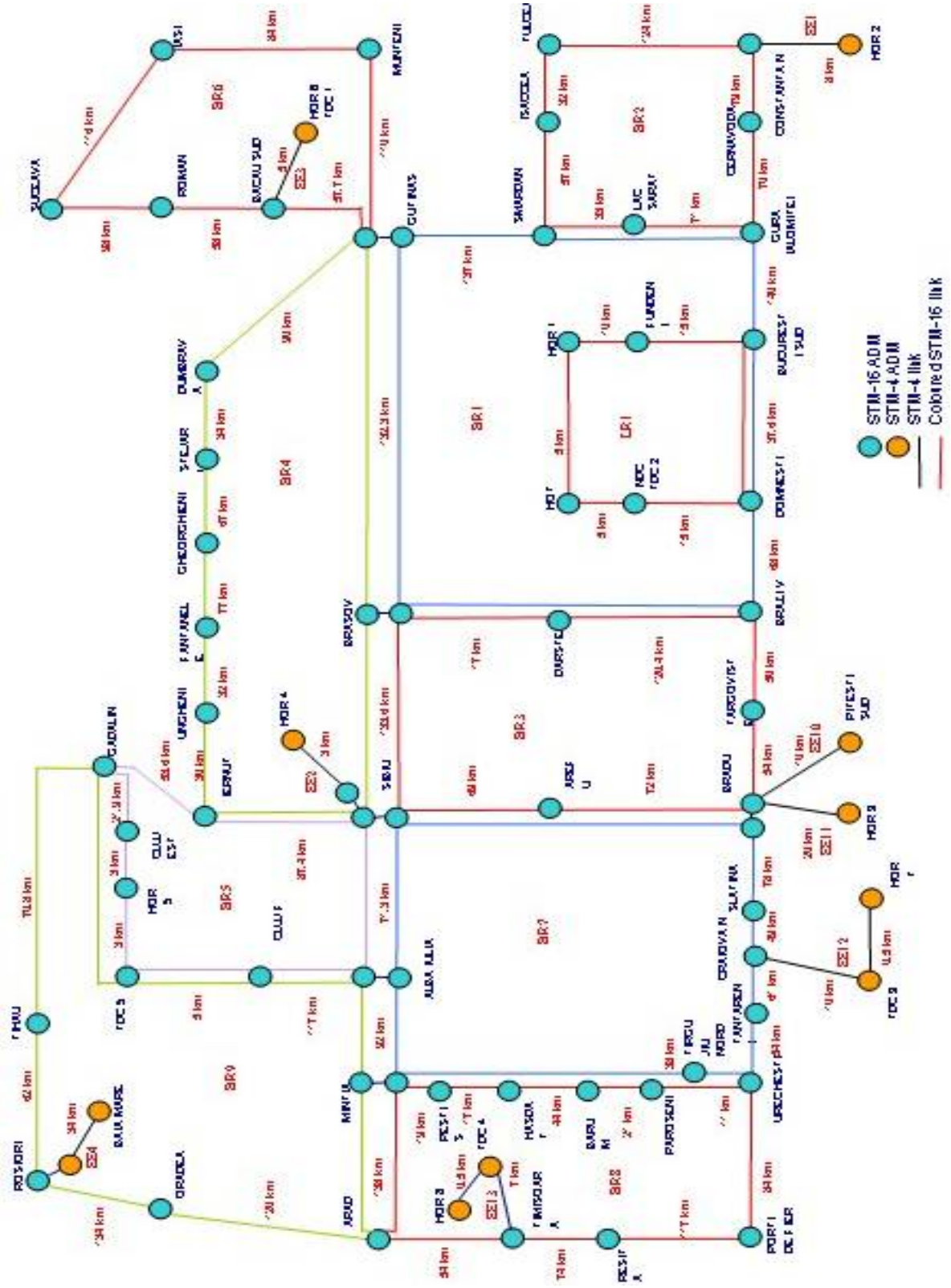

Fig.1 SDH Network

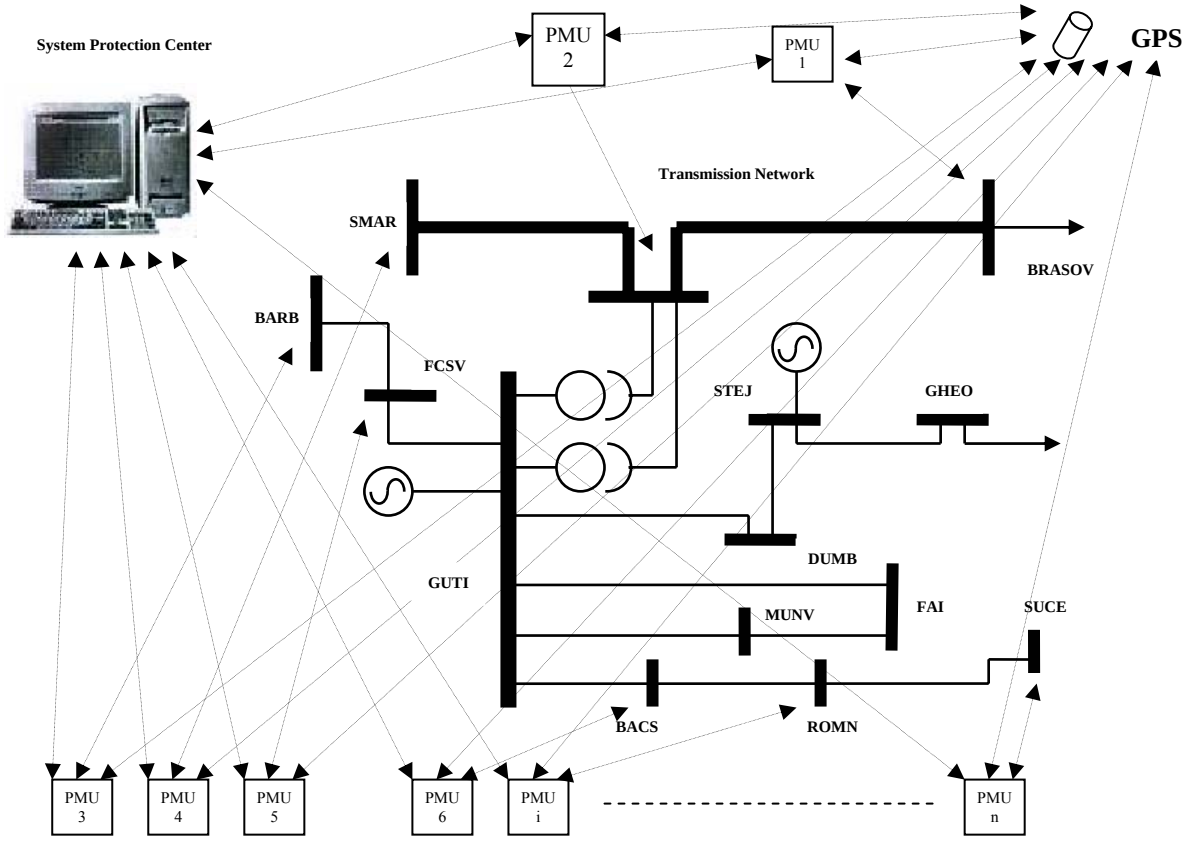

Fig. 2. Exemple of FO backbone for WAP in East Area of Romania

5.CONCLUSIONS

To increase the power system transmission capability and to increase the power system reliability, Wide Area Protection and emergency control systems can be introduced in the Romanian Power System.

Transelectrica has a strongly a robust communication architecture witch can be used for WAPaC in order to extend the system operational limits without any investments in high voltage equipment, and to make operate the system closer to the natural constraints, maximizing return on initial investments in high voltage equipment,
A strategy in this direction is necessary.

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