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TESTING THE PERFORMANCE OF THE LOCAL AREA NETWORK OF THE EASTERN LIBYAN CONTROL CENTER UNDER THE HIGH VOLTAGE NETWORK EXPANSION

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ABSTRACT
In this paper, the existed local area network of the eastern Libyan 220 kV network control center is studied in an order upgrade it according to the epansion of the high voltage network. A new plan of the 220kV Eastern high voltage network is proposed and, accordingly, the highest loading permitted capacity of the local area network is investigated after making the factory acceptance tests.

KEY WORDS
High Voltage Network, Local Area Network, Network Upgrading

1. Introduction

The high voltage Libyan system is divided into two main interconnected networks (western and eastern). The eastern high voltage network consists of a number of power stations and substations distributed over a wide geographical area. To control this high voltage network, a modern control center has been established according to the international specifications and has been released for operation starting from September 1999. The operation of this control center is based on collecting the data , measurements, and statues indications in each substation by special remote terminal units and then sending them via a communication network to the control center. The central control center building contains a local area network, which is responsible for managing the collected data and transferring them between a number of different servers and clients each with its own monitoring and control mission. The capability of the installed local area network is so sufficient for managing and operating the high voltage network in its current situation. A limited number of commands, statues indication, and measurements are available for the high voltage network components and substations which causes a lake in the ability of managing the network in a sufficient way. To enhance the network management, an additional operations and data has to be added , for each substation and component, which means an additional load on the local area network during the data transferring process.

Due to the rapidly architectural, agricultural, and industrial growing in the Libyan eastern region, an increase in the electrical load demand is expected during the next five to ten years, and ,consequently, additional number of substations and power stations have to added to the high voltage network in addition to the under construction stations. The addition of power stations and substations means an addition of data transfer to the control center and consequently, an additional data and commands to be managed by the local area network.

It is probable that problems like data collision, stock, and slow down and shut down are to appear in the local area network after adding the new commands and operations to the currently available stations and adding the new stations with the full number of commands and facilities to the high voltage network.

The aim of this paper is to upgrade the local area network of the 220 kV Libyan eastern control center according to the expected increase in the data transfer to and from the control center due to the extension during the next five to ten years. The extension of the 220kV high voltage network is to be studied and the limit of extension that meets the ability of the current local area network capabilities is to be determined.

Finally, a new figure of the local area network of the control center of the 220kV Libyan eastern network is to be established and all investigations and recommendations are recorded.

2. System Description

Currently, the 220kV Libyan eastern network consists of 20 substations with a modern control center. All the data are collected from the power stations and substations by remote terminal units and sent to the control center via communication links. The number of the data available in any substation or power station is more than the data those are actually gathered and sent to the control center.

In the near future, this network is going to be extended due to the additions of new substations and power stations according to a pre prepared plan in a certain time scheduling.
Figure 1 represents the current 220 kV Libyan eastern network[1].

The control center of this network is designed to manage more than the present available data sent by the remote terminal units in the substations.

The local area network consists of servers, clients, and interfacing tools. The operation and managing the network depends on interchanging the data between these clients and servers.

To operate the network easily and to manage the data comfortably, the data have to be transferred and exchanged between clients in a suitable time.

Some usual problems are facing any local area network are mentioned here:

- data collision
- stock
- slow down
- shut down

Since September 1999, where this control center has been released to operate, these problems have been experienced it is expected that the effect of these problems on the LAN is to be increased when the number of data are more than those of today.

The addition of any new substation or power station means the addition of about 5.4 % of the data currently managed by the LAN. An other important part in the control center is the Energy Management Systems (E.M.S), which gives indication of the operators about the electrical system, and helps in decisions taking. E.M.S. represents an other important part of the data managed and transferred between the clients and servers. Figure 2, represents the local area network of the 220kV Libyan eastern network control center.

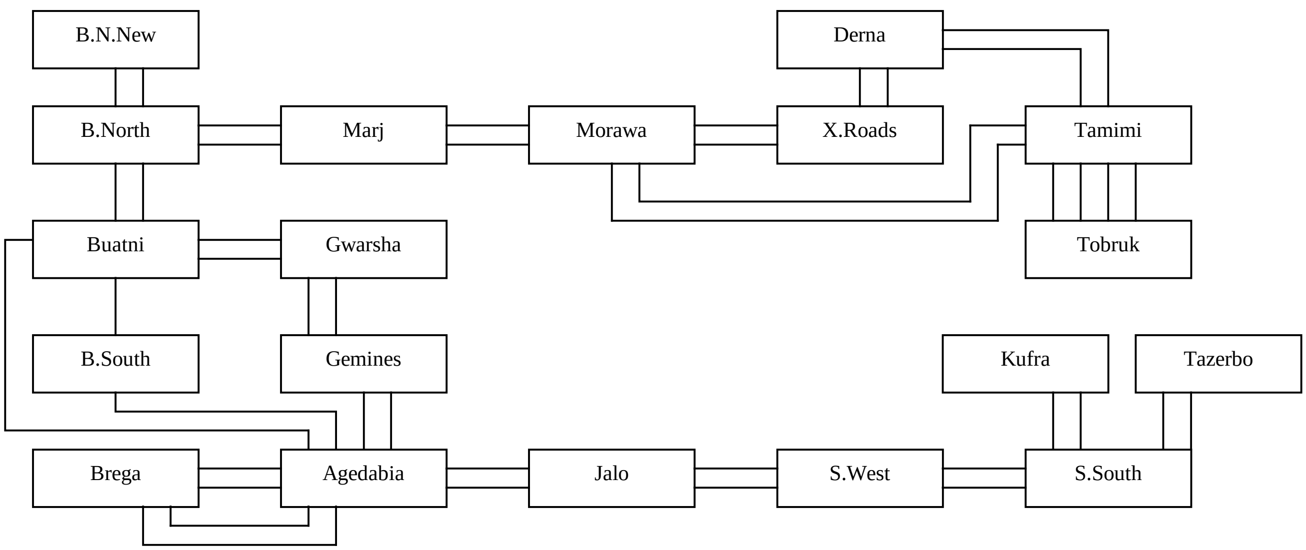

Figure 1 220 kV Libyan Eastern Network

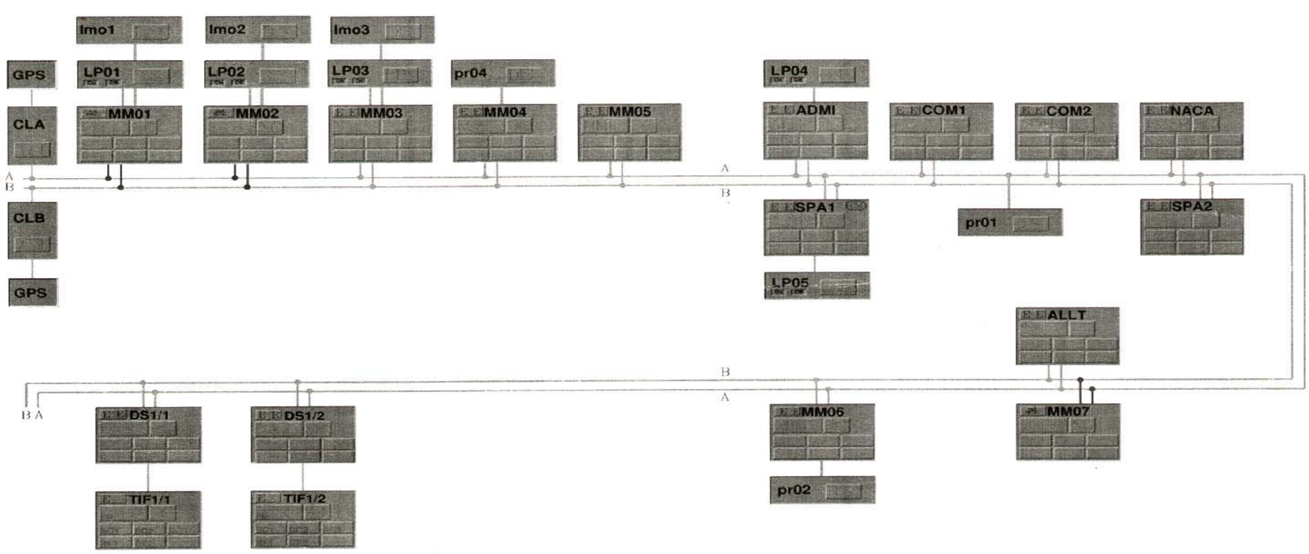

Figure 2 Local Area Network of the BRCC

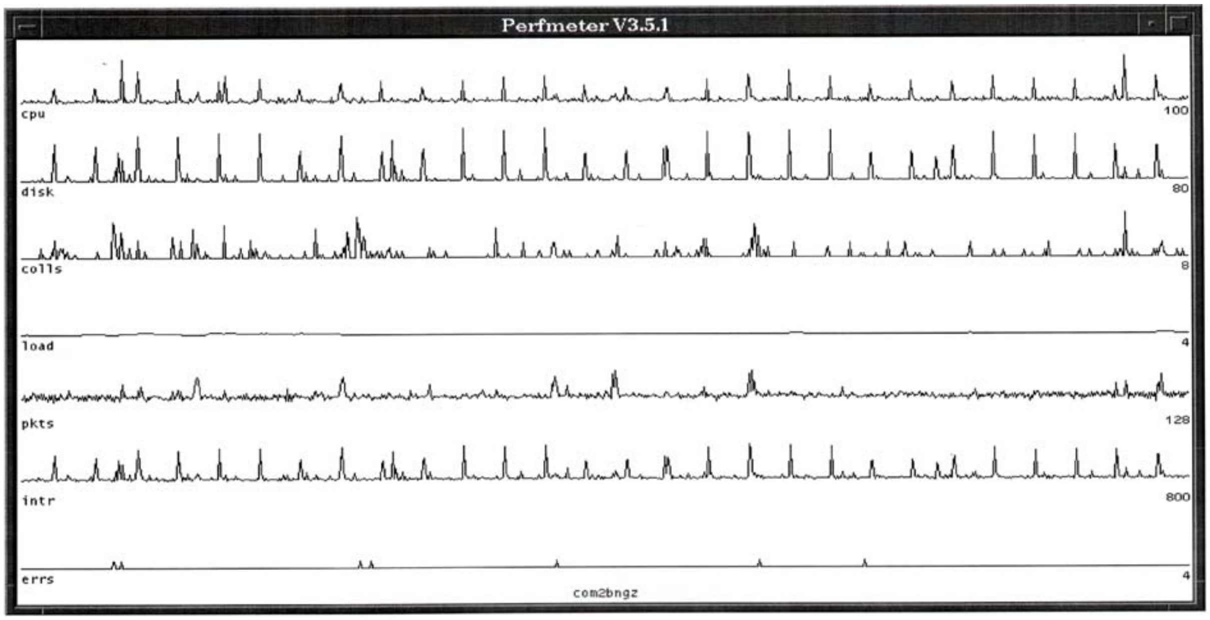

Figure 3 Performance of the Local Area Network of the BRCC under normal conditions

3. System Pereformance

The definition of system performance is divided into sections. Each of these sections defines a scenario and then specifies the expected performance of the system when these scenarios are performed. The system performance is designed along to the following principles:

- no information from the process will be lost,
- response time to operator actions will meet the requirements for each activity state.
- All data coming from the process are handled within the response times required for each activity state.

Each scenario is a simulation of a particular state in the system. The scenarios are:

- Normal condition
- Peak condition
- High burst activity

The following definitions are valid for the performance of the system:

3.1 Display response time

The display response time is defined as the elapsed time between display request made by the operator and the moment , the requested display with all variables updated is completely shown on the CRT screen.

The response time distribution is defined based on the response time (D) , which defined for each scenario:

- Response time<= D for 50% of the requests
- Response time <= 1.5 * D for 68% of the requests
- Response time <= 2.5 * D for 99% of the requests.

The maximum response time will never exceed 3* D.

3.2 Alarm response time

The alarm response time is defined as the elapsed time between receiving the event at the process interface and reporting the event.

The distribution is defined based on the response time (A), which is defined for each scenario:

- Response time for indications <= A for 50% of the requests
- Response time for indications <= 1.5 * A for 68% of the requests
- Response time for measurements <= 2.5 * A for 99% of the requests.

The maximum response time will never exceed 2* A for indications and 3 * A for measurements.

3.3 Request Completion Time

The request completion time is defined as the time between a user and the corresponding system reaction. The following user requests and the corresponding system reactions are defined:

- monitoring request
- command request
- application request

3.4 Function Execution Frequency

The following function execution intervals are defined for the system.

- data acquisition for the RTUs
- data acquisition for other systems
- supervisory control
- CRT updating
- Archiving

3.5 Scenarios

3.5.1 Normal Condition Scenario

Normal condition scenario describes a normal load on the system. The observation period for the considerations belonging to normal conditions scenario is sixty minutes.

3.5.2 Peak Condition Scenario

The peak condition scenario simulates a major disturbance at the network. The observation period for the considerations belonging to peak condition scenario is thirty (30) minutes.

3.5.3 High Burst Activity State Scenario

The burst activity scenario describes a state that simulates a major breakdown of the network. The observation period for the considerations belonging to burst activity is ten minuets.

In all the mentioned above three types of tests, a safety margin of 30% of the local area network (LAN) must be available.

4. Scope of Function

A SCADA
B Network Analysis
- State Estimation
- Online load flow calculations
- Contingency evaluation
- Online short circuit calculations
- Switching operations check

5. Test Configuration

The performance measurements were carried out on the complete LAN system described in figure 2.

Figure 4 shows the test configuration. The required total load on the system is defined by three different components, namely, the process load, the load due to operator activities, and the server could start load. A tool were available for simulation of process load by means of which any desired variables could be selected from the planned system data and combined into sequences which could be repeated as well. The tool was installed on the dedicated auxiliary server connected tom the LAN. Messages were then transmitted from this server simulating a real connection to the process via the LAN to the COM server.

The operator activity load was partly generated automatically. A tool was run on three operator control stations for automatic selection of various displays. At the other operator desks, operator actions were simultaneously implemented such as acknowledgement, network control activities and selection of new displays.

The cold start o an MMI server was selected as the third type of load. In this case, the necessary data were transferred from the ADM server over the LAN to the MMI server (total 40 Mbytes).

For measuring the time for output of commands, a switching element was operated via a Tele-control Interface unit and an RTU.

Tools for measuring the LAN and server loading were available for the performance measurements. The LAN measurements were carried out by means of hardware analyzer directly connected to the LAN cable. Software tools from the UNIX environment were available for measuring the server loading. Some of the tools were specially supplemented for detailed measurements.

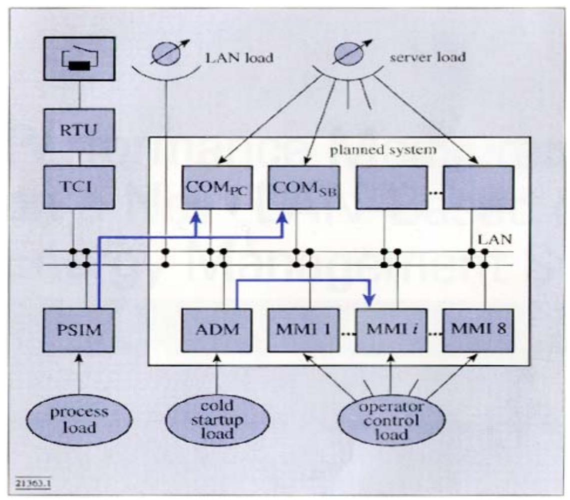

Figure 4 Test configuration

Also, the tests included the measurements of the CPU and disk loading of the servers at specified intervals. The server loading was broken down to the individual programs and for each program the loading for the system part and application part.

A factory acceptance test has been carried out for the local area network of Benghazi Regional Control Center and all the results were accepted for the three scenarios mentioned in the previous section [3].

The LAN did not constitute a bottleneck in all three scenarios. The maximum LAN load was below 30% [2].

6. Conclusion

The tests show that the configuration of the LAN of the Benghazi Regional Control Center (BRCC) is so suitable for the 220kV Libyan Eastern network under it is current configuration.

In case of the highest loading and burst cases scenarios, in the current situation of the 220kV network, and even after the full utilization of the whole Energy Management Systems (EMS) capabilities, the LAN should not be loaded more than 30% of it is full load capacity. Taking into account the 30% safety margin of the LAN full capacity [2], it should not be upgraded before the 220kV Libyan Eastern Network reaches twice of it is current size. It means that the duplication of the number of measurements, alarms, statues indications, which are manipulated nowadays, will not cause a traffic problems for the data transmitted through the LAN. This duplication is expected to be reached in the 220kV Libyan Eastern network in 10-20 years from now.

References

[1] General Electricity Company of Libya documents

[2] Minuets of meeting of GECOL and SIEMENS in BRCC project

[3] Gerhard Aumayr, Josef Bader and Ernst Wolters," Performance Measurements on a new LAN-Based Distributed Energy Management System," SEIMENS, 1993 Volume 4