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Indexes for Determine the Number and Location of Area Operation Centers (AOC) In Power Network

Second Level of Dispatching System

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***Abstract*—Dispatching centers are regarded as the heart of the integrated network both in generation and transmission network and play an important role in safe and stable operation and also have a great importance observing economical usages. Basically stepwise dispatching system is corresponding to electrical network structures and the ministry of power management methods, and also has to be more flexible with future operation methods and able to coordinate with future ministry of power structures.**

In this paper, important hints and tips to improve dispatching situation, is presented besides clarifying indexes to find the optimum number and location of area operation dispatching centers (AOC).

Keywords-Area Operation Center (AOC); dispatching; index; location of AOC; power system control

I. INTRODUCTION

The electric power passes various processes from generation area to consumption area when running through meshed integrated network. Regarding the recent shapes and structures of electrical network in Iran, this process is followed as [1-4]:

- Generation network (vapor, water, gas power plant and combine cycle)
- Transmission network (400,230kV)
- Super distribution network (63, some 132kV)
- Distribution network (33, 20, 11kV)
- Low voltage distribution network (400,230V)

Due to different voltage level, each mentioned network is controlled and performance by different managed centers, although two or more of these centers might be observed by a unit company [5].

The basic and natural structure of integrated power electric network is such that the power generation sources and load centers are normally kilometers apart from each other, and the power system has expanded in a big and vast geographical area, which could be a country or sometimes many adjacent countries. Economical and stable operation of this vast network requires gathering and processing data in a control center and making appropriate commands to the system equipments. This kind of control center is called dispatching center. Since dispatching centers should control a network with hierarchical structure, so it must be compatible with the network. Therefore the dispatching center also should have hierarchical structure [6].

One of the major factors in dispatching and communication power industry is the updating speed and the accuracy of received data in dispatching centers, which is seriously influenced by related communication protocol among dispatching centers and terminals [7-8].

Remote transmission of information has always had the problem of limitation in transmission channel and sometimes lack of speed, and therefore is one of the major obsessions for protocol designers is the algorithm and the way of sending information and the type of communication system for data transmission [9].

Due to lack of information in this field, this paper is based on the earlier experiences in Iran and reviewing the main relevant references. Regarding what was mentioned above the aim in this paper is to produce a dispatching system in order to reduce the amount of work in a single unit, and thus being able to control one area without the existence of a main headquarter.

Since there is no reference for determining the number and location for Area Operation Centers (AOC's).

In this paper presents the major indexes for site placement of AOC's in power network. The indexes are introduces according to experience of authors in III.

II. DIFFERENT LEVELS OF DISPATCHING SYSTEM

In the Iran power network and the search dispatching center from other countries around the world. Results of the paper can be used for the optimal and effective placement of AOC's.

There are five levels in power system dispatching which are explaining follow:

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A. First Level: Central Dispatching (National Dispatching)

In all countries there is a main dispatching center called as "national dispatching" or System Control Center (SCC). This center connects to power system equipments with SCADA (System Control And Data Acquisition) system.

The SCADA equipments, installed in power plants, transfer the information such as the amount of active power, reactive power, unit voltage and energy, switch situation, and run/stop situation of units, directly from power system to SCC [6].

B. Second Level: Area Operation Centers

Regarding this fact that voltage is a non-centered conception and that country's transmission network is really vast, thus transmission network has been divided into smaller regions to control each regions load and voltage locally.

For example in Iran network, there are 9 regional dispatching centers as shown in Fig. 1, which are connected to the national center (SCC) in a master-slave way.

Figure 1. Present AOC in Iran

C. Third Level: Regional Dispatching Center (RDC)

These centers are known as super dispatching distribution centers, and control power network in a province.

Their main duty is to control and observe Super distribution networks which are mainly 63kV and 132 kV in Iran.

D. Fourth level: Distribution Dispatching Center (DDC)

These centers control and manage distribution systems which are located in urban area in Iran. These centers of dispatching are used in 11, 20, and 33 kV networks in Iran. These centers are sometimes called events or incidents offices.

E. Fifth Level: Low Voltage Distribution Dispatching

In vast cities, low voltage networks from medium voltage substation to costumer are controlled by 400 volt centers and the numbers of these regions are determined regarding expansion and bigness of cities [2].

Distributed Generation(DG) and also private power industry, which is followed by dispersion in power industry has made new incidents and problems in power and electrical management, which proves the need of smart grids and equipped with controlling and communicative tools. Therefore nowadays smart grid (or Microgrids) which are capable of suitable connection and independent action, have an important role in distribution network as shown in Fig. 2 [10-11].

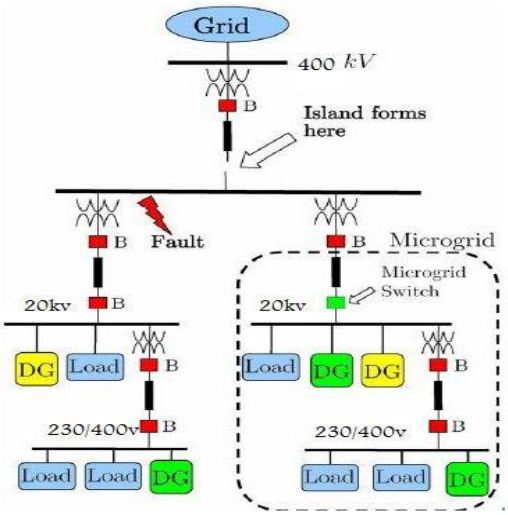

Figure 2. Structure of a Microgrid

A better way to realize the emerging potential of distributed generation is to take a system approach which monitors generation and associated loads as a subsystem or a “micro grid”. This approach allows for local control of distributed generation thereby reducing or eliminating the need for central dispatch.

III. INDEXES FOR OPTIMAL PLACEMENT OF AOC's

This paper is concerned with regional dispatching areas as second level of dispatching centers and investigates the needed criteria in a region power network which make these areas as an AOC. On the other hand, the possibility of AOC improvement and building a new one, in order to decrease data traffic in System Control Center (SCC), is investigated.

Main indexes for specifying the number and location of AOC as follow:

A. Possession or heritage

Some parts of a dispatching network had previously been an independent network, and were controlled separately. Therefore they had not been connected to the main network, thus controlling operations were separately done on them. So, when these parts were connecting to the main network, they were automatically turned into a regional dispatching.

B. Generation and consumption balance

This index is very important to specify an AOC to a certain region or area. It is important to have an independent AOC, so that the balance between generation and consumption has to be controlled. So, in case of disconnection between SCC and AOC, islanding situation, AOC will be capable to produce its inner consumption and this capability improves the reliability of whole network. Also when it is connected to SCC and other regional dispatching centers, if such balance doesn't exist,

causes the transferring AOC networks to be busy, which may even exceeds from their line thermal limitation and CT limitations. Consequently this allow doesn't more current flowing through the lines and causes voltage and frequency interferences.

C. The least transferring connection (minimum connection)

Any previously independent AOC needs a number of lines in order to connect to the network. After determination of these points, it is possible to connect them with minimum number of lines. This connection can be done only by a single line, but in order to increase the reliability, usage of two parallel lines is preferable [3-4],[7-9]. So in case of a fault, AOC won't be disconnected from the main network as much as possible .but of course even in this situation the network has to be capable to estimate the load amount and making the balance between generation and consumption in an islanding situation. Using two parallel lines reduces the impedance and increase the thermal limit which causes more current or in fact more power flowing capability and hence, more stability in an integrated network dispatching. It is predictable that in near future three parallel lines are used to connect AOCs.

Regarding to advantages of independent AOC networks, it is more useful to have minimum connection among area operation centers.

D. Major power plant

Because of high importance of power plants as generation sources and specially power plants with larger units, it has been tried to place the lines which are connected to the buses of these power plants, on boundary of two AOC's. So, they will have a special control since they are controlled by two AOC's, and furthermore they are controlled through a central dispatching and considered as sensitive points of the network as shown in Fig. 3.

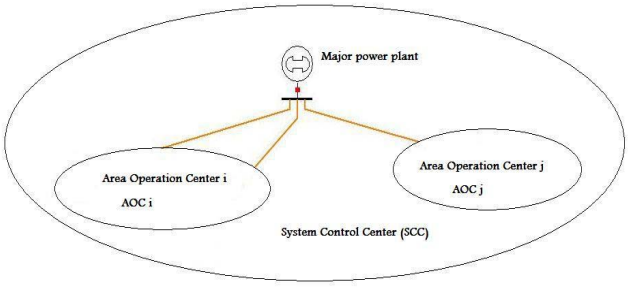

Figure 3. Major power plant connection to AOC

E. Sensitive points for extra controlling

Sensitive points are denoted to the points in which all the network will be controlled if they are controlled. This is due to power network continuity. Control here refers to frequency control and voltage control.

In order to fix the frequency in the network one has to minimize number of sensitive points, so that the frequency of sensitive points through national dispatching center (SCC) will be more accurate and faster.

In other words, all the transfer buses of power network could be considered as important points but some of these buses could be controlled trough controlling one of them which is considered as one of the sensitive points.

F. Number of available regional electric company in country

Regional electric companies (REC) are defined as geographic areas which consist of one or some provinces. The responsibility of regional electricity company is operation and maintenance and development of power system in related areas. In the present structure of country, Iran grid management company (IGMC) in Iran is in the head of management and industry and regional electricity companies are under its observation. On the other hand each regional electricity company manages the power plant and transmission lines in its regional geographic section.

In the past, regional electric companies were controlled separately and were less connected to the central dispatching and had a complicated connection like the spider's web. So, when specifying an AOC, the center has to be made of several regional power networks, not some part of them. If a part of above mentioned spider web is controlled by an AOC and another part is controlled by other AOC, then there will be several lines between these two AOCs which is not a suitable situation. For example Iran's power network has 16 regional electricity companies, so 16 AOC centers can be specified to Iran's power network. Thus the number of boundary lines between two AOCs which were mentioned in indexes number 2 and 3 shouldn't be increased.

G. "n-1" Contingency

Safety in a power system means the probability of system to pass disturbances without any disconnection of service for users. This depends on the system's stability against interferences and thus is reliant on the type of faults and operation conditions.

In an integrated network one has to observed (n-1) contingencies, which means that by lose of an equipment of the network, the power system continues its operation without any problem. Here total number of equipments has been considered as *n* which they include power plants, substations, transmission lines, transformers, etc.

There are some reserves to avoid from incidents and problems. For example there are reserves as much as the largest power plant unit of country as spare. Also parallel lines are located to gain more reliability, as well as considering taps for transformers to tolerate more overloads. Therefore all the above mentioned precautions have to be observed in each AOC networks, so that the network can continue its operation in islanding situation.

H. Islanding operation

As it was mentioned before each of the AOC regions should be capable to operate in islanding condition. Such situation is reached when the connection between AOC and headquarter is disconnected. In this condition AOC should be able to control the inner frequency and balance the generation and consumption. To meet this aim, it must have inner self-

restarting power plants, which could be water powered or gas, in order to control the frequency. This issue can also be used in high voltage networks such as AOC's. The possibility of intentional islanding requires a complete review of the safety procedures and a larger adaptation of automation and communication systems [12].

I. Communication capacity limitation

Generally this index is one of the important indexes to prove the necessity of dispatching centers and is one of the main reasons to lay off the system from the main center and change it to a system with more dispatching centers. Because transferring information from substations, power plants and other power network equipments, to a single main center besides having a high volume of data and the problem of processing these data, faces with the lack or shortage of communication capacity. Furthermore, processing all these data needs a high capacity memory. So the unity of receiving point has these problems and can be solved by changing it to a system with many dispatching centers. In fact, the information of substations and power plants and other equipments of an AOC region will be send to its corresponding AOC center and processing will be done in the same place. Finally after decreasing the amount of information it will be sent to the system controlling center or SCC, and the final processing will be done there.

It has to be mentioned that there has been a major breakthroughs in the communication and nowadays optic fibers are used to transfer information to the main center or AOC centers, and having an AOC in each province has made the information transferring easier. Because in the present network there is a limitation of communication capacity and one has to use optimally from this capacity.

J. Information processing speed

Sending a huge amount of information in a dispatching center certainly decreases the data processing speed, which result in delay in the integrated network controlling. By constituting more AOC centers one can increase information receiving points, which can cause a faster transmission and a division of information amount. But of course, the most important point is to have an AOC which has enough ability of data processing.

Regarding its facilities each AOC network should have an acceptable data processing capacity and if the volumes of data processing exceed from a certain amount (especially load amount) that AOC center has to be divided into two separated AOC regions in order to have a better controlling on them.

K. The specified budget

If there are separated AOC networks, the specified budget can be used optimally considering their inner network requirements.

L. Vulnerability of war issues

In this case if one of the AOC is damaged, it doesn't result in overall blackout. And it's only cause electrical outage in that special region. If there is only a unit dispatching center it cause critical and major damages to the country which can even cause accruing a complete electricity blackout in whole country.

IV. CONCLUSION

In this paper the index of number and site determination of area operation centers (AOC) in power network dispatching was introduced. This index can be used to determine the location and number of AOCs in any country.

Because of day by day load growth, especially in developed countries like Iran, congestion, integration and complexity of power network is gradually increased. On the other hand, increasing the private section management in power networks and also creating the electricity market results in increasing the loading level and consequently reducing the network safety. Therefore, finding some certain precautions for optimally using of this complicated network is inevitable.

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