Study on the Interaction between Power System and Communication Network

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Abstract. In the past, the research about electric power system primacy network and the research about the electric power communication network are separated. The interactions between 2 complex networks were not considered, but in fact this 2 complex network are interdependent, mutual influenced.

Keywords: Power system, electric power communication network.

1. Introduction

With the rapid development of economy, the demand for electricity grows great. At present, many scholars have applied the theory of complex network to research the power grid security. At the same time, with the rapid development of communication and information technologies in recent years, the electric power communication system is undergoing profound change. The node of the electric power communication system is continuously increasing, and the coverage gradually increased. Electric power communication network has become a complex network, the statistical characteristics of its network topology exhibit general features of complex networks.

2. Simulation of electric power communication system

Power system information system generally consists of three parts: computing, communication and sensing. They are used for information transmission, acquisition and processing. Power system state information and control information involved may come from the generator, load, energy storage equipment, transmission equipment etc. the transmitted information mainly include excision of information of power line, and the information produced by adjustment of generator and load shedding, when the dispatch center optimal scheduling. The process of information transmission roughly is: the information of line resection is produced when errors occur in electric power primacy network, the dispatch center optimal scheduling the electric power network after it received the information of line section. At the same time, send the information of generator adjustment and load shedding to each node. Suppose the electric power communication network is a size N scale-free network. The N-1 nodes corresponding to the electric power primacy network node. Another information node is scheduling center node. Connect two randomly selected nodes and scheduling center node, each node added has 2 sides. Each sides connect to node i as $p(k_i) = k_i / \sum_j k_j$. k_i is the degrees of the node. $\sum_j k_j$ is the sum of the degrees of the nodes.

Suppose the set of neighbor nodes of the source node i is L_i, node $j \in L_i$. The effective distance from node j to target node is

$$H_j = h_d d_j + (1 - h_d) c_j \tag{1}$$

d_j is the shortest distance from node j to target node. c_j is the queue length of node j. h_d is the routing strategy control coefficient. The probability that node j chosen to be the new source node is

$$P_j = \frac{e^{-\beta Hj}}{\sum_{m \in Li} e^{-\beta Hm}} \quad (2)$$

β is the routing probability control coefficient. When $\beta = 0$, neighbor node is randomly selected; when $\beta > 0$, the probability is larger that the node with shortest effective distance is chosen; when $\beta < 0$, the probability is larger that the node with longest effective distance is chosen. Obviously, when $\beta > 0$, it is conducive to the transmission of information in a communication network. So, this paper only consider the situation when $\beta > 0$.

3. Interaction model of power network and communication network

The main reason of cascading failure of power system is transfer of power flow and protection of inappropriate action. A random line is disconnected, the power flow transfer in a large scale, part of lines overload, the scheduling center optimizes the control of electric power system primary network after it received the line resection information, to ensure that each line running under its thermal limit. But when the line flow is larger than the thermal limit, the over current protection device works. The larger the line flow is, the shorter the time slot is. So, when the optimization control is not completed, the new overload may appear. In this process, the packet number in communications network will be gradually increased. If congestion forms in communication network, optimization of commands will not be promptly sent to the corresponding node, this will further aggravate the cascading failure.

4. Analysis of model parameters and results

Current tripping characteristic is:

$$t_i = \frac{K}{|I_i / I_{\max}|^{\alpha} - 1} \quad (3)$$

K is proportional coefficient, the larger K is, the longer the actuation time t_i is. In this paper, $K = 7$. I_i is the value of line flow, $I_{\max}$ is the maximum value of I_i. α is a constant , usually value 0~2. in this paper, $\alpha = 0.3$. The basic parameters of the power system operation $g = 0.2$, $u = 1.25$.

4.1 The influence of the routing strategy control coefficient

The routing strategy control coefficient h_d determines the routing strategy of communication network of electric power system. When Communication network select next hop in the routing process, if h_d increases, the dependant of shortest distance from next node to target node gradually increase, the dependant of packet queue length of next node gradually decrease.

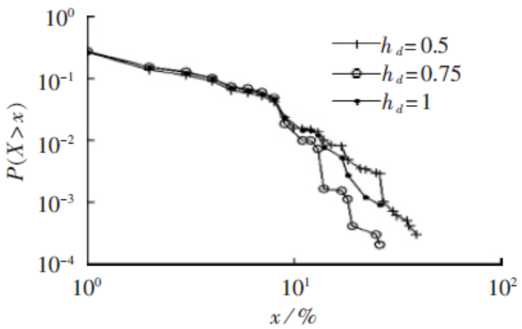

Fig.1 Log-log plots of probability vs. load loss at different h_d

It shows that, in the process of information routing, the shortest distance from information node to the target node plays a dominant role, the packet queue length plays a supplementary role. It is not desirable to only consider single factor or equal treat 2 factors.

4.2 The influence of the routing probability control coefficient

The process that routing probability control coefficient β increase from 0 to infinity, the routing strategy complete a conversion from random to certain. The larger β is, the stronger the dependant of effective distance is.

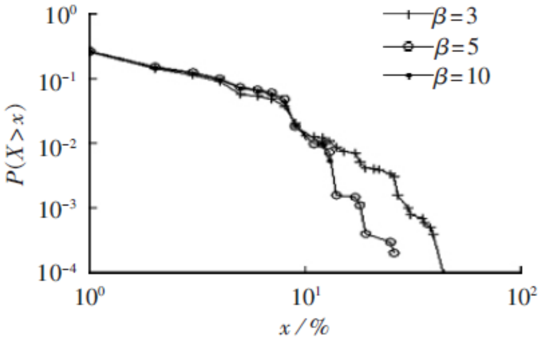

Fig.2 Log-log plots of probability vs. load loss at different β

It shows that, the larger the routing probability control coefficient β is, the larger the probability of the node with shortest effective distance being chosen is. Then the efficiency of communication network is higher, the possibility of congestion is lower, and the probability of occurrence of large-scale cascading failures is smaller.

5. Conclusion

The simulation results show that, by setting the appropriate routing strategy, adjusting the related parameters of communication network, the information transmission efficiency can be improved. And the probability of large-scale cascading failures can also be reduced. The conclusion reveals the interaction of power network and communication network. It has certain guiding significance to the power system and communication network planning and design.

References

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