

NUMERICAL TECHNIQUE FOR VERIFICATION OF SUCCESS STATES IN THE NETWORK

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Abstract: This paper analyzes efficiency of two techniques for verification of success states in the network. The first method verifies existence some links in the network using o successive drop out method of nodes until it is generated o link between these nodes. The second method is based on the successive connection of nodes to the trees which have as root source nodes or system nodes. There are compared these methods and are applied for a test network.

Keywords: success states, sparse matrix, calculation time, numerical techniques

1. INTRODUCTION

For reliability calculus of complex energetic installations, like as electrical and thermal network, it is necessary generation of states and verification of success states. Also, for calculus of network regimes, it is necessary verification of essential nodes connection to the network. Verification of success states is based on the verification of existence some links between system nodes and consumption nodes or generation nodes. Verification of success states necessities many calculus for the big network, [1], because there are many states theoretical possible. Thus, if there are generated all states possible, the total number of them is:

$$N_{s,tot} = 2^n \dots\dots\dots (1)$$

where n is number of network elements, nodes and lines. If it is generated only states with $n-3$, $n-2$ or $n-1$ elements which working, then states number is given by the relation (2), (3) or (4):

$$N_{s,n-3} = C_n^3 + C_n^2 + n + 1 \quad (2)$$

$$N_{s,n-2} = C_n^2 + n + 1 \quad (3)$$

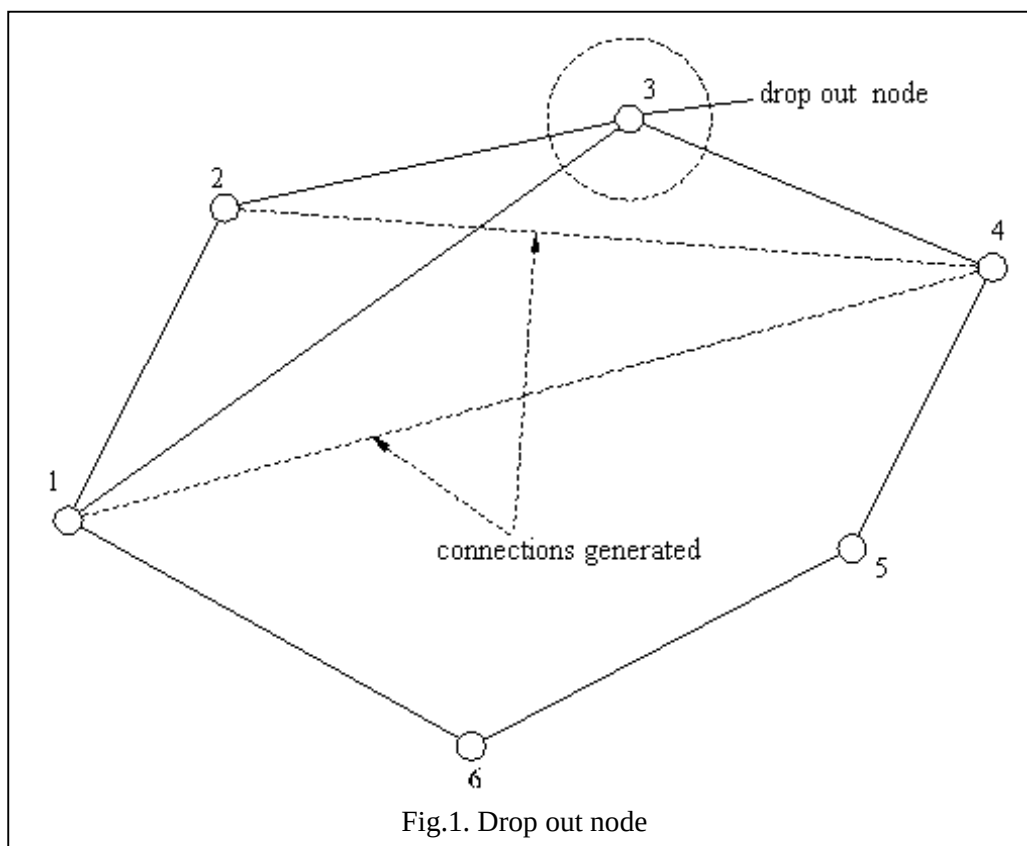
$$N_{s,n-1} = n + 1 \quad (4)$$

From this reason, it is very important to use some methods which necessity a short calculation time. There are presented below two methods: drop out method and tree method.

2. DROP OUT METHOD

This method verifies success states using a drop out method type Gauss. When a node is drop out, there are generated direct links between all nodes which have a link with this node (fig. 1).

In the fig.1, for verification of link between nodes 1 and 4, it is dropping out node 3 and there are generated links between nodes 1-4 and 2-4. Another variant is dropping out nodes 5 and 6, successively. In general, for to verify existence a link in one situation, it is dropping out all nodes,



successively, (without nodes between which it is verified link) until it is generated a link between nodes analyzed. If after drop out all nodes did not generated a link between nodes analyzed, then there isn't any link between them. For memorizing network structure it is used a matrix where diagonal elements represent network nodes and the other elements represent network line. This matrix has the same structure like nodal admittance matrix. It is necessary to memorize only main diagonal and elements above its because matrix is symmetrical (fig. 2). It is necessary to use a sparse matrix technique for reducing of calculation time and memory engaged. In fig.2, registering N refer to nodes and registering L refer to line.

$$\begin{bmatrix}
 N & L & L & & L \\
 & N & L & & \\
 & & N & L & \\
 & & & N & L \\
 & & & & N & L \\
 & & & & & N
 \end{bmatrix}
 \begin{bmatrix}
 N & L & L & L \\
 & N & L & \\
 & & N & L \\
 & & & N & L \\
 & & & & N
 \end{bmatrix}$$

Fig. 2
Structure matrix of
network from fig.1

a – before drop out node 3

b – after drop out node 3

Registering from structure matrix must contain element state (working or fault), supply state (supplied or no), node type (source, consumer, connection). For every link verified it must generate (copied) the other manoeuvre matrix because initial structure matrix deteriorate after drop out node.

Steps of this method are following:

- a. It is loaded data referring to network.
- b. It is generated the structure matrix.
- c. It is generated a state from state set established. If there are no more state generated then it goes to step *a*.
- d. It is processed set of consumption nodes or generation nodes (which must to have a link with system). If there are no more nodes then it go to step *k*.
- e. It is processed source nodes set which working for to see if it is a link to consumption node. If there are no more nodes then it goes to step *j*.
- f. It is generated the manoeuvre matrix from structure matrix by drop out elements which there is not working in the respective state.
- g. It is verified existence a direct link between current source node and current consumer node or current generation node. If there is a link then it goes to step *d*.
- h. In the manoeuvre matrix it is dropping out nodes (without node couple source-consumer) until it is generated a link between those two nodes or until it is finished nodes.
- i. If it is generated a link source-consumer then go to step *d*, otherwise go to step *e*.
- j. It draws the conclusion that state is an unsuccess state. Then it goes to step *c*.
- k. It draws the conclusion that state is a success state. Then it goes to step *c*.
- l. STOP.

3. TREE METHOD

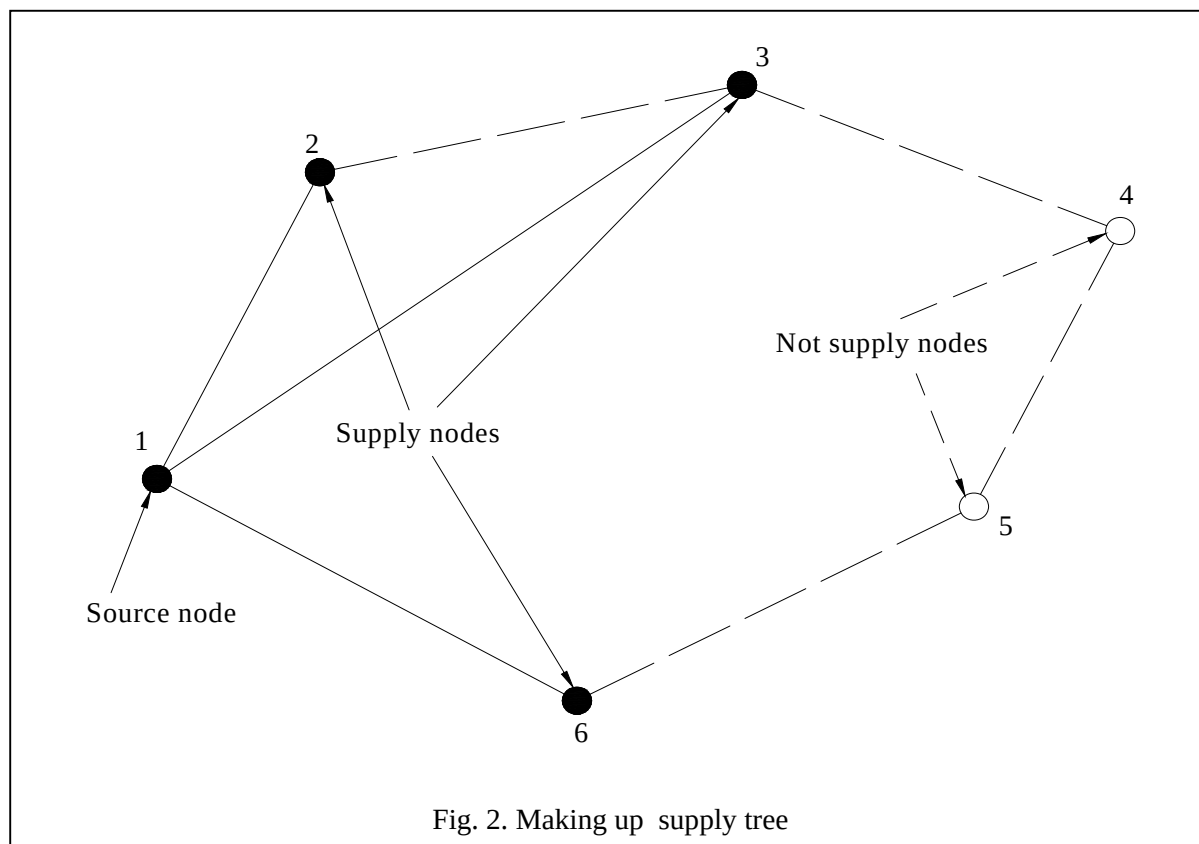
This method generates trees which contain consumption nodes or generation nodes, beginning with source nodes that working. The first, it is traced out working source nodes which “are reddened”. Then, it is passed repeatable through lines set and nodes set which are available in this state. For every passing, there “are reddened” elements that are next to working elements, fig.2. The process is stopping then for a passing did not working any elements.

Tree method has advantage that there are verified simultaneously the success state for all consumption and generation nodes.

Note, fig. 2, that there aren't supplied lines which unite two nodes, both available, generating only a tree that unites nodes supplied.

Steps of this method are following:

- a. It is loaded data referring to network
- b. It is generated a state from state set established. If there are no more state generated then it goes to step *h*.
- c. It is supplied source nodes available in this state.
- d. It is initialized passing process through nodes and lines set. If there are no more elements then it goes to step *f*.
- e. It is supplied nodes and lines that there are next to nodes supplied already.
- f. If after passing all nodes and lines it was made at least a supply then it goes to step *d*.
- g. If all consumption and generation nodes are supplied, then it draws the conclusion that current state is a success state; otherwise current state is an unsuccess state. Then it goes to step *b*.
- h. STOP.



4. CONCLUSIONS

- Tree method has results better than drop out method, from view calculation time point.
- Drop out method has advantage that it offers individual verification of link between two nodes, in a current state.
- Tree method has advantage that it verifies simultaneously the success state of all nodes.
- For the big network it is recommended only tree method.

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