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NETWORK FLOW DEPENDING ON AVAILABILITY OF NETWORK ELEMENTS

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Efficiency as the most important system feature also depends on reliability and maintainability, resp., and unfortunately one must say, to a rather high degree. Therefore up to now efficiency and availability of system are calculated separately. But as a result of this classical way we obtain two different statements without a connection between them. That means that this manner is not sufficient because the influence of availability of system elements cannot be computed and so it is also impossible to estimate the economical importance of availability of system elements with regard to system efficiency. But only if we succeed in integrating of availability features into the system efficiency we are able to derive concrete requirements relative to reliability and maintainability of system elements. Therefore our research work aimed at such solutions where the availability of system elements can be integrated into the calculation of system efficiency. For solving this problem a new reliability concept for performance systems was developed and applied to communication systems. In our opinion this general way outlined here must also be used for network considerations. In this case the network flow between a source and a terminal can be used as the most important network feature. But it also depends on reliability and maintainability parameters of network elements (e.g. branches and nodes). The maximal network flow between two points is only given if all network elements are working free of failure. But in reality often some of the network elements are out of order. Therefore it is necessary to compute the instantaneous (deterministical consideration) and the expectation value (stochastical consideration) of the different network states.
To solve the given task for networks the following steps have to be realized:

- to compute the reliability that the maximal flow x is possible between source and terminal
- to compute the maximal flow x of each elementary state of the network which occurs as the result of disturbed network elements
- to compute the expectation value of network flow between two points by using the results from the calculations mentioned above. This can be realized by combining these two results based on the equation of the total probability.

The practical importance of this result achieved is very high because the calculation of the reliability that two points of the network are connected contains no information if it is possible to translate a determined quantity of data in a fixed period. Based on the new consideration and methods developed the dimension of networks can be realized on a more realistic foundation. The main problem consists in computing the probabilities of all elementary states with the network flow x. For solving this task a new reliability branching algorithm was developed (Based on pathsets or cutsets).
The main ideas of this algorithm are the following:

- all sets of network states are arranged by using two special rules
- the sets are generated one after the other by taking into account the rules of arrangement
- the sets are tested whether the network flow demanded is possible or not. The last one is marked as system failure
- if the set tested is not equal to a system failure the next set is generated
- if the set tested represents a system failure then a tree-node of the branching tree is fixed
- after finding out a set representing a system failure all uppersets of this set do not need to be generated, which can be shown by using the monotony of networks
- there exist some stopping rules for finishing the algorithm.

The developed algorithm is very fast and needs only a small capacity of memory which can be seen by the written program.

Summarizing a method was developed which permits the calculation of a network flow also depending on availability features. It is possible to go on developing these results to a general Performance-Reliability-Model applicable to further system structures.