Determining the Permeable Efficiency of Elements in Transport Networks

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The transport network is simulated by a directed graph. Its edges are evaluated by length (in linear units or time units), by permeability and by the cost of driving through in a transport unit. Its peaks (nodes) are evaluated in terms of permeability, the time of driving through the node in time units and the cost of driving a transport unit (set) through this node.

For such a conception of the transport network a role of optimisation and disintegration of transport flow was formulated, defined by a number of transport units (transport sets). These units enter the network at the initial node and exit the network (or vanish at the defined node). The aim of optimization was to disintegrate the transport flow so that the permeability was not exceeded in any element of the network (edge, nod), so that the relocation of the defined transport flow was completed in a prearranged time and so that the cost of driving through the transport net between the entry and exit knots was minimal.

Keywords: *the transport networks, elements in transport network, disintegration of transport flow in transport networks, permeability of elements in transport network, permeability of networks, determining of the permeability of edges, deterministic and stochastic work regimes, systems of queuing theory, a transcendental equation.*

1 Problem formulation

The optimization problem of the net was studied. In the solution it was necessary to define an evaluation of the net elements, i.e., an evaluation of the edges and nodes.

The values of the net elements are defined:

- by the permeability of the edge or the node,
- by the cost of the transport unit or of the transport set driving though the element of the transport network,
- by a time value representing the transport unit or the transport set driving through an element of the transport network. For the edges of the transport network it is the duration of the journey between two nodes. For the nodes it is the time value of the entry to the node, the service of the transport unit or the transport set at the nod and the exit from the node.

The transport nets defined by the plane network chart (i.e., mainly nets for road transport, nets for railway transport and nets for systems of multimodal and combined transport as heterogeneous nets) have to be solved in dual work mode:

- in a deterministic work mode,
- in a stochastic work mode.

In some cases it is also necessary to solve hybrid systems, for example if fixed lines are kept for transport services in personal transport and random lines for cargo transport. This refers to all the above-mentioned types of transport.

Taking into account the importance as well as the complexity of determining the first index of transport net element evaluation, this stage was dedicated to ***an investigation to determine the permeability of edges and nodes in both service regimes***.

A major transport network with a substantial number of nodes and edges is assumed in a basic optimalization role. Therefore no simulation methods were applied, only analytic methods. Simulative methods are much more time-consuming, and could hardly be accomplished for such a large complex.

The use of graphical-analytical methods for deterministic work regimes seems to be sufficient for methods that use some form of elaboration of graphs or graphic work models for each element. For the graph edges we can use the forms of layout transport order. For the knots we can use a graphical model of individual activities, the deterministically given duration of which is known.

In order to determine the permeability of the transport net element with a stochastic work regime, operations research methods were mainly used, in particular queuing theory for typical service systems and stock theory for systems where the transport sets are made up of transport elements. Stock theory procedures were applied to create the sets and optimize the time for assembly.

It should be pointed out that classical systems of queuing theory mainly solve the economic evaluation of a work system, i.e., the mean of the system, the mean of the requirements refused by the system, the mean length of the queue and, finally, the mean time of the customer s downtime in the queue. It is however necessary to determine the permeability of the system for a given optimization function. The speculation that the gaps between entries of subsequent requirements can take on values that are multiples of the time of service in the system forms the basis for solution. For this reason, we can if necessary insert another service requirement into these gaps without it being rejected. It may be assumed that if we determine the number of gaps thus arising, added to the mean load of the system, it will also be possible to define the permeability of the whole system. However this assumption cannot be accomplished, because on the one hand the entry requirement does not need to be available at the stochastic entry while, on the other hand, at the moment of system occupation there can be several entry requirements that are rejected. It can be proved that if the average value of entry flow of the requirements to the system increases, the number of gaps into which it is possible to insert other services decreases. Conversely the probability of the amount of refused entries increases. The point at which the number of gaps into which another service can be inserted is equal to the number of refused requirements can be considered as the permeability of the system, because during every increase in average entry flow the number of refused requirements is greater than the number of those additionally inserted, and the system works with losses.

2 Conclusion

The solution was accomplished for single-line systems with a limited queue and for a-line systems with rejection. Since the solution is a transcendental equation soluble only by interaction steps, graphs were developed from which values of permeability can with sufficient accuracy be directly subtracted.

References

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