DECISION OF PROBLEM OF CHOICE ON SET OF TELECOMMUNICATION NETWORKS' STREAMS' MATHEMATICAL MODELS

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Abstract: *Decision of problem of choice on set of mathematical models of telecommunication networks' streams is presented. By means of comparison of alternatives – calls' streams' models used in teletraffic theory by Slater's vector criterion plural optimum decision is received.*

Keywords: *convergent telecommunication network, calls' stream, teletraffic theory, vector criterion of preference.*

ACM classification keywords: *H. Information Systems - H.1 MODELS AND PRINCIPLES.*

"I've said to you many times," he said, "that in order to follow the path of knowledge one has to be very imaginative. You see, in the path of knowledge nothing is as clear as we'd like it to be."

C. Castaneda

Introduction

Present article is development of theme which beginning is presented ITHEA in enacting article [1]. In [1] research object - convergent telecommunication network (CTN) [1,2] is considered from system positions, formal representations and approach for decision of problems of CTN's analysis and synthesis are formulated. Also formal description of CTN's mediums and entrance streams is offered, research of interaction models between CTN and environment was carried out and it is established impossibility of existing mathematical apparatus's use in an initial kind for definition of probabilistic-temporal characteristics of CTN which network-forming process is convergence and delivery of difficult by the nature and structure integrated information formed by the incorporated traffic of label's and position's multiplexing is provided inside it. In the same work urgency and necessity of working out of interaction model between CTN and environment considering self-similar character of traffic in this network is proved. In [2] analysis of arriving into telecommunication networks (particularly into CTN) streams' basic properties is made on the grounds of basic works [3-5], possibility of use of analyzed streams for CTN is considered and it is defined that for the description of arriving and circulating in CTN streams it is expedient to use superposition of streams' models (as it is shown in [6]) which are the most adequate to the formulated CTN's representations taking into account that traffic formed by these streams is self-similar.

Present article is devoted to the definition of what calls streams' mathematical models can be used as model of streams in CTN. Problem of choice with specified set of alternatives (in this case calls streams' models) and varied principle of optimality is solved for this purpose. Stated in [7] principles are taken for a basis at statement and decision of problem of choice.

Statement and decision of problem of choice

Problem of choice makes sense only for homogeneous objects or objects from homogeneous sets of alternatives as which we understand variants' sets of one functional purpose's objects described by the same set of external characteristics. Considered calls' (events') streams represent sequences of arriving into telecommunication networks (TN) calls (events) classified from the point of view of stationarity, regularity and independence. These calls streams' models are accepted as objects of homogeneous set of alternatives satisfying statement of problem of choice. Thus the problem of choice is shown hereto to choose the variant (stream) possessing the best values from the point of view of accepted criterial statement among the specified set of admissible decisions (streams).

Criterial statement specifying formal rules of alternative variants' choice is optimality principle. Consequently the optimum variant is defined by check of all possible alternatives about conformity to the optimality principle. At the same time reception of effective decision is meant but let's notice that efficiency is subjective concept.

Let's formalize initial set of variants by quality indicators of each of them. For this purpose let's express quality indicators in the form of alternative's (stream's) conformity (+) or discrepancy (–) to representations about the stream according to the accepted [3-5] streams' classification. In some cases for obviousness let's evidently specify character of streams' properties adding to the quality indicator's formalized representation description of its character. Formal representation of alternatives' (streams') set for which the problem of choice is solving is given in tab. 1.

Table 1 – Formal representation of calls' streams - alternatives' set of problem of choice

Calls' stream's model	Calls' stream's properties		
	Stationarity	Regularity	Dependence
Simplest (Poisson)	+	+	–
Nonstationary Poisson	– call's arriving's probability depends on both interval and initial time	+	–
Nonregulary Poisson	+	–	–
Symmetrical	– stream's parameter depends on time moment	+	simple stream's parameter depends only on number of calls carrying at this moment
Primitive	– stream's parameter depends on time moment	+	simple simple stream's parameter is directly proportional to number of sources free at the moment

Continuation of table 1.

Calls’ stream’s model	Calls’ stream’s properties		
	Stationarity	Regularity	Dependence
With call-backs	– stream’s parameter depends on time moment	+	simple call-back’s stream’s parameter depends on switching system’s state
Palm’s	+	+	restricted intervals between calls are independent, their distribution is setting
Erlang’s	+	+	restricted intervals between calls are independent and distributed by one law

Statement of problem of best decision's choice assumes presence of rule allowing to compare quality of possible alternatives. At the decision of the formulated problem of variants' choice in the formalized statement let's characterise alternatives by means of optimality principle which let's formally express through choice function. Let's set choice function by preference's (optimality) criterion. Such optimality principle setting by choice function consists from criterial requirements. Thus choice of variants will be done on set of requirements. For this purpose let's formally express solving rule in a kind of some ideal stream which criterial requirements represent set of quality's indicators. Quality's indicators as well as at the executed formalized alternatives' representation will be expressed by means of ideal stream's (solving rule's) conformity to one stream's properties according to the accepted streams' classification and nonconformity to another.

As the making decisions person (MDP) let's consider that calls' arriving's (events' approaching's) probability in CTN depends not only on considered time interval's length but also on its arrangement on time axis. It means that number's of calls in CTN's stream distribution law doesn't satisfy to the assumption about stream's stationarity. Stream's regularity is not obviously important criterion because practical impossibility of two and more calls' arriving (two and more events' approaching) during the considered time moment from our point of view is easily reaching by time base's discretization on small and infinitesimal time intervals. So CTN's stream can both to satisfy and not to satisfy to the assumption of its regularity.

Stream's dependence is represented as the most important criterion since being based on the executed analysis of problem’s status in sphere of modern TN and streams in them it is possible to assume that the probability of calls' arriving (events' approaching) for the considered time interval depends on calls' (events') arrival process before the beginning of the considered interval and this dependence is long-ranged. So CTN's stream is not independent stream. Thus formal representation of ideal stream which is the solving rule of the formulated problem of choice has the following appearance (**–**, **+/–**, **+**).

All necessary conditions from the point of view of solving problem of choice are formulated in classification's representations about the stream which have formed basis of alternatives' quality's indicators' definition and on which basis then criterion of preference by quality's indicators has been formulated. Therefore there is no necessity to additionally include in the formulated solving rule requirements by admissibility and restrictions.

For convenience of choice of optimum alternative by means of definition of variants' (calls streams') conformity to the formal rule of choice (ideal stream) let's exclude the variants' quality indicators' character's description from formal representation of alternatives' (see tab. 2).

Table 2 – Formal representation of streams – source alternatives' set of problem of choice

Calls' stream's model	Calls' stream's properties		
	Stationarity	Regularity	Dependence
Simplest (Poisson)	+	+	–
Nonstationary Poisson	–	+	–
Nonregulary Poisson	+	–	–
Symmetrical	–	+	+
Primitive	–	+	+
With call-backs	–	+	+
Palm's	+	+	+
Erlang's	+	+	+

It is defined that the decision of problem of choice on set of the formulated quality's indicators is necessary. Such decision leads to formation of vector or scalar criteria.

Scalar criteria (conditional L-criterion, D-criterion with concessions, integrated (generalized) criterion) are attractive because they can essentially lead to the unique decision however their use in the context of solving problem of choice is not obviously possible. Firstly scalar criterial statements demand attraction of the additional information and accordingly input of certain additional conditions that is neither possible nor expedient as it has been noted above. Secondly scalar criterial statements demand rather considerable quantity of quality's indicators that is not present in the formulated problem of choice. Thirdly scalar criterial statements demand essential scalarization of solved problem that is impossible since further manipulations in comparison with the spent formalization will lead to loss of data on the variants' indicators' qualitative side that will make the decision of problem of choice by DMP impossible.

Vector criteria (Slater's and Pareto's criterion) allow to reject only obviously the worst variants and thus to reveal not the worst being effective according to specified vector criterial statement. In view of the fact that quality's indicators of variants are not applied by conditions in vector criteria and thus quality's indicators are orthogonal vector criteria are objective. Let's apply such objective unconditional vector criterion in the context of formulated problem of choice.

According to optimality principle by Pareto (P-criterion) for minimization of initial alternatives' set it is accepted that one variant dominates by Pareto if its quality's indicators are higher or equal to indicators of another and at least for one of indicators such inequality is strict. There is fear that the initial set is so homogeneous that at binary comparison of alternatives by Pareto criterion it will not be possible to reveal effective variants for which value at least of one quality's indicator is strictly higher than others (at other components' equal values).

Therefore let's use another unconditional criterial statement – Slater criterion (S-criterion) at use of which unlike P-statement during binary comparison of alternatives optimum variants should not necessarily strictly dominate at least by one quality's indicator. In spite of the fact that thus S-statement is weaker than P-statement since it leads to inclusion in number of optimum decisions also actually boundary areas the decision of problem of choice according to optimization principle by Slater is represented expedient.

Let's normalize initial set of alternatives (streams) resulted in tab. 2 by S-criterion.

Stationary, regulary Erlang's and Palm's streams without independence according to the formulated solving rule are equal by Slater. They form group of streams with limited dependence. Also non-stationary, regulary symmetric, primitive and with calls-back streams without independence are equal by Slater. They form group of streams with simple dependence. According to regulary (or non-regulary that is no matter) ideal stream without independence groups of streams with simple and limited dependence are equal by such quality's indicators as regularity and independence. However ideal stream is non-stationary therefore the group of streams with simple dependence is optimum by Slater in comparison with group of streams with limited dependence.

According to solving rule stationary, regulary elementary stream with independence is equal to stationary, non-regulary stream with independence. Both of these streams are included into group of Poisson's streams and according to the fact that ideal stream is non-stationary are not optimum by Slater in comparison with one more stream from this group – non-stationary, regulary stream with independence.

As non-stationary Poisson's stream mismatches statement about stream's dependence and group of streams (Erlang's and Palm's) with limited dependence is rejected earlier on initial alternatives' set group of streams (symmetric, primitive and stream with calls-back) with simple dependence is optimum by Slater.

Conclusion

Thus having objectively normalized initial set of alternatives – mathematical models of calls' streams the plural effective decision – group of streams with simple dependence is received. Solution of plurality by attraction of additional information for the purpose of stronger criterial statements' use is not obviously possible no less than any ranging or involving and arrangement of weighting coefficient is represented no more than speculative.

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