

Control System of Mobile Ad-hoc Networks

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Abstract - In this paper we consider the problem of control in mobile ad-hoc networks (MANETs). The architecture of a control system of node, its function and process of decision-making on maintenance of the quality and service of transfer of packages in networks MANET are considered.

Keywords - Control system, cross-layer design, mobile ad-hoc networks.

I. INTRODUCTION

Mobile Ad hoc Networks are formed by autonomous system of mobile nodes (hosts) connected by wireless links with no supporting fixed infrastructure or central administration. Communication is directly between nodes or through intermediate nodes acting as routers. The advantages of such a network are rapid deployment, robustness, flexibility and inherent support for mobility [1]. In some application environments, such as battlefield communications, national crises, disaster recovery etc., the wired network is not available and ad hoc networks provide the only feasible means for communications and information access.

Features of MANET are: dynamical topology; unreliability of a radioresource and collective character of its use; limitation and heterogeneity of node resources; the limited safety etc. It is impossible to provide efficient control MANET without a corresponding control system [2].

II. MAIN PART

Features of MANET determine peculiarities of a control system of the given network:

- The multidimensionality caused by a large amount of subsystems, elements and connections between them;
- Multi parameters, determined by a variety of the purposes of separate subsystems, a variety of their characteristics, requirements and parameters of efficiency;
- Multifunctionality and hierarchically, following from necessity to decide various tasks of management at various levels and stages of system functioning;
- Strong dependence of functioning character on MANET parameters and external influences.

At the same time should meet the control system MANET following basic requirements [2]: transfer provision of various types of traffic with a set quality; ensuring the adaptive and distributed network functioning and an opportunity of its self-organizing; decision-making in real or close to a real time scale; the minimal loading of a network by the service information; a network characteristics optimization; the maximal automation of control processes.

In [2] main principles of management MANET are determined: adaptability, functionality, distribution, coordination of interaction, hierarchy, an optimality and

automation. The functional model of system operative management by a network has been offered with allocation of the following basic subsystems: the control, gathering and storage of the information on a network status, decisions making (on topology, routing, loading, power resources, quality of service (QoS), security, a radioresource), learning and realizations of decisions (fig. 1).

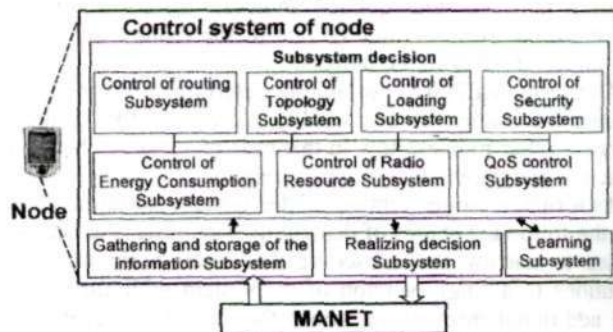


Fig. 1. Functional model of control systems MANETs

Each of management functional subsystems is realized at one or several ISO levels. The common decisions are: adaptation of level ISO (a subsystem of control) to conditions of MANET functioning and requirements of the traffic, maintenance of the differentiated service and a resource reservation.

1. Methods of management at a physical level. Adaptation of a radio channel is based on measurement of the parameters characterizing quality of the channel and carried out by a choice of parameters of modulation, coding, power level, a frequency choice, cadres structure change etc.

2. Methods of management at a MAC level. The decision of the given task depends on a class used in MANET protocols of a channel level (casual or determined) [3].

Management of errors correction includes methods of automatic inquiry of repeated transfer and methods of coding with direct correction errors.

3. Methods of management at a network level. Process of QoS-routing includes the following stages: construction of set quality route (taking into account of the accepted MAC protocols), realization of its reservation and maintenance with the set parameters. It is offered to realize so-called "active" routing which provides: functioning set of methods of routing in a network; dynamic formation of metrics a choice a route; management of a network topology as a component of routing in MANET; intellectualization of processes decision-making on routing [4].

4. Methods of management at a transport level. It is supposed that in the Internet within the functioning of TCP protocol the majority of losses of packages is caused by overloads in a network which is not true in conditions MANET. Therefore for the improvement TCP protocol, three groups of methods can be used: TCP with an obvious feedback (TCP-F, TCP-ELFN, ATCP), TCP without an

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obvious feedback (TCP-DOOR) and TCP, taking into account other ISO levels.

5. Methods of QoS-control at an applied level. The conducted research shows absence of a uniform management method providing optimization on any ISO levels. Therefore for the decision of a task of information transfer with the set quality at an applied level it is supposed to introduce a subsystem of QoS-control (fig. 2), coordinating functioning of sets of management methods on ISO levels with the purpose of network optimization of parameters functioning.

The input traffic (user and control) can be classified as follows: the service traffic is transferred for processing by corresponding methods of control (on ISO levels), the user traffic according to its class is located in queue. Methods provide of management queues receipt, storage and transfer of packages, coming in node on service. The block of measurements carries out estimation of QoS parameters and their record in a management information base (MIB).

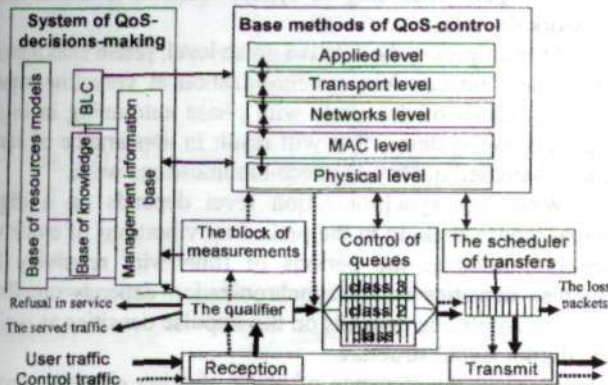


Fig. 2. Architecture (cross-level) of QoS-systems control of node

The existing approach confirms independence management of functions on OSI levels and does not allow providing optimization of MANET parameters in various conditions of its functioning at requirements of the certain type of the traffic. Moreover the conduct research shows absence of a uniform management method providing optimization on any OSI levels. Therefore the new paradigm of networks control system construction is proposed – to introduce the base of management methods and an intellectual superstructure above it (system of decision-making on management), coordinating functioning of sets of management methods on levels with the purpose optimization of a network functioning parameters (fig. 2). The base of management methods contains set of methods of management for each OSI level. The system of making of the QoS-decision will consist of base of knowledge (contains knowledge of object of management, knowledge of the purposes of functioning and management, knowledge of ways of achievement of the purposes), Management Information Base, the block of logic conclusion (BLC) and base of models of network resources [5].

In distributed managements conditions each node will realize two interconnected groups of purposes: the user purposes (achievement of the set quality service of node) and the network purposes (optimization of network efficiency parameters). The task of decision-making in QoS-management of MANET is shown to a task of multi criteria's optimization

for indistinctly set purposes and alternatives [5]. There has been conducted decomposition of the global MANET management purpose according to functions (subsystems), each being divided into task and realized on ISO levels.

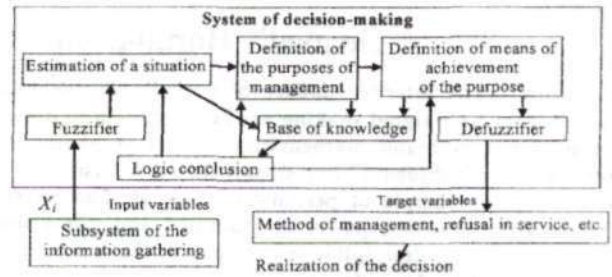


Fig. 3. The circuit of decision-making

Because of dynamic character of control tasks, complexity of forming the complete system of efficiency parameters of the control system itself, their high dimension, incompleteness and unauthenticity of the control information, use of fuzzy control system is expedient. It uses the indistinct description of controlled process and system of its management as indistinct base of knowledge, and also will transform the indistinct description to sequence of commands, for achievement of the purposes of management [5]. Features of the suggested circuit of an indistinct control system is the getting the sequence of a management cycle registered: an estimation of a situation, definition of the purpose of management, revealing the necessity of management, search of admissible decisions and a way of achieving an objective in view and realization of the chosen way of its achievement (fig. 3).

III. CONCLUSION

Maintenance of the set quality of service in MANET should be carried out by a networks control system, called to coordinate and intelligence the network management functions, realized on different levels ISO. The structure of system of the indistinct management realized on each node is offered. Decision-making process of a control system by methods having the purpose to estimate alternatives in conditions of the indistinct initial information on its status is considered. The suggested control system of a network will allow to considerably increasing the efficiency use of resources in MANET.

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