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Network coding with the Reed-Solomon code

ABSTRACT

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INTRODUCTION

Network coding is a new technology that in recent years has attracted a lot of attention from both academic and industry fields. Many approaches have been proposed that have proven that network coding is very important for the success of network services.

This thesis analyzes the methods and algorithms that can be used for network coding of information in terms of interference.

Currently, mesh networks use various protocols and methods for encoding information. Under the conditions of interference, it is necessary to conduct a comparative analysis of protocols and coding methods and determine the most effective solutions.

Modeling of the AODV protocol showed its ability to counteract reactive interference quite effectively.

The algorithm of noise-resistant coding information of Reed-Solomon codes, which corrects independent errors and erasures, is developed.

It is proposed to use the data encoding algorithm in the process of transferring network packets of Reed-Solomon codes in combination with the AODV protocol.

It is shown that the gain from such a complex solution allows obtaining a gain in resources and in network bandwidth 1, 6 times as compared with traditional algorithms, which use XOR operation for encoding packets

The performance improvement of the proposed network coding scheme with the integration of AODV compared to the original network coding scheme increases with increasing network density distribution.

Therefore, a major change in the detection of a reduced sub-graph from the first source sub-graph using the AODV routing scheme can significantly improve the performance of network coding.

GENERAL DESCRIPTION OF WORK

Aims of research

The goal of the thesis is to develop and simulate efficient network coding algorithms based on the noise-resistant Reed-Solomon code for mesh-net

Objectives of research

To determine the possible threats from possible impacts on the functioning of the network, choose an effective data transfer protocol.

To analyze the options for network coding with XOR operations and error-correcting code.

To optimize the parameters of the selected code for the given conditions of external influences.

Develop algorithms for network encoding and decoding of packets

Conduct a simulation of the work of protocols and network coding algorithms.

Develop a model and simulate protocol and network code collaboration

Problem statement and motivation

Known methods and algorithms for network coding use technology based on the summation of packets modulo two. At the same time, problems associated with the correction of independent errors and erasures due to the effect of interference in the transmission channel of self-organizing networks are not solved. In the thesis, the possibilities of using the Reed-Solomon code with the AODV protocol to counteract the interference at the transport level are investigated.

Research scope

The model of the self-organizing network protocol is built in the Matlab environment with the interference models in the form of independent and related additive errors.

The solution of network coding problems is sought in the field of algebraic noise-resistant coding, modeling algorithms in the Maple and Matlab environment.

The main results of the thesis were obtained as a result of modeling the joint operation of the AODV protocol and network coding using the Reed-Solomon code.

Thesis outline

Chapter 1 is devoted to an overview of the development of self-organizing mesh networks. The properties of the networks are determined. The types of interaction protocols, possible attacks on the network at the channel and transport levels are considered. A classification of jammers and transport protocols is given. The most appropriate protocol for countering reactive interference is determined by the AODV protocol.

Chapter 2 describes network coding models. The definition of a linear model and a MIMO model is given. We consider the possibility of network coding based on error-correcting codes and the addition of packets from different users of the network modulo two. The algorithm for encoding network packets using the Reed-Solomon code is determined. The problem of local optimal choice of code size is solved.

Chapter 3 presents the methods and coding algorithms using the Reed-Solomon code. Encoding and decoding algorithms for detecting and correcting independent errors and erasing are given. Encoding algorithms are adapted to the task of encoding network packets. The possibility of building a cascade code to increase the speed of information transmission is shown. Coding and decoding schemes are synthesized.

The fourth chapter shows the simulation results of the AODV protocol in various jamming environments. The possibilities of the protocol are considered to choose safe packet transmission routes without affecting the transfer process of possible interference. Random structures of self-organizing networks are used. For simulation, the protocol simulation package in the Matlab environment is used.

Chapter 5 presents the results of the simulation of cooperative power and energy-efficient routing algorithms using the AODV protocol and network coding using the proposed Reed-Solomon network code and the well-known algorithm using the XOR operation of summing packets of different network nodes. Shows the gain of the proposed coding options. The model uses the parameters of a random wireless network IEEE 802.11. The definition of analog network coding summarizing the results is given.

CONCLUSION

1. The mesh-net structures are considered, the threats of interference impact on the network operation are determined. The AODV protocol was selected as the most effective for countering reactive interference.

2. Considered options for network coding using XOR operation and Reed-Solomon code. The parameters of the Reed-Solomon code were optimized for a given jamming environment.

3. Algorithms for noise-resistant coding of network node packets with the possibility of correcting independent errors and erasures have been developed. The simulation of the developed algorithms in the Matlab environment was carried out.

4. Simulated in the Matlab environment the operation of the AODV protocol in the presence of active interference. The protocol property on the spatial neutralization of active interference is shown.

5. A model was developed for the operation of the AODV protocol in conjunction with packet coding with the Reed-Solomon code. The increase in network bandwidth by 1.6 times compared with the option without the use of network coding is shown.

6. A comparative analysis of network coding algorithms using the XOR operation and Reed-Solomon code showed that the algorithms have approximately equal bandwidth, but the algorithm with the XOR operation spends more resources when choosing encoding packets.