Mathematical Modelling of the Spreading of Software Threats in Computer Network

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Abstract - **In this paper the results of mathematical modeling of software threats' spread in computer networks are listed. A comparative analysis of different approaches of mathematical modeling (using hierarchical graph model, random graph model, spatial model) is given. The adequacy of simulation results with hierarchical and spatial approaches has been proved.**

Keywords – **Software threat, Random graph model, Hierarchical model, spatial model.**

I. INTRODUCTION

Despite of the information security problems due to computer viruses spreading into Computer Systems [1] and infection the computers, developers pay little attention for research, theoretical studies and mathematical modelling of the spreading of the software threats in computer networks.

II. DETAILS

The article represents the results of mathematical modelling of the spreading of software threats [2] into computer network based on following models: random-graph model, hierarchical model, spatial model.

During modelling the directed model of random graphs, its behaviour was studied using following methods: the deterministic approach [3] and stochastic approximation [4]. Got theoretical results which are equal to a classic theory of homogeneous viruses interaction.

In particular, it was found that the epidemic can't be occurred if the speed of infecting neighbour nodes less than nodes curing. If infecting level is above this threshold, it's quite possible that the epidemic still won't occur, but its probability increase due to continuous increasing infecting level and it above the threshold. Average number of infected nodes in equilibrium increases due to increasing infection level. It can take any value: from close to zero (when infection level slightly above the threshold) to the total number of nodes (when the cure rate is zero).

During modeling the hierarchical model distribution of rate speed of software sharing in real conditions has been considered. Considering this fact allowed to increase reliability of received modelling result in 1.5 times.

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During modelling the spreading of the spreading of the software threats into computer systems via spatial approach, relative position of computers in the computer system network, as well as the number of active operators' actions during its functioning are considered.

In the result of modelling analytic equations, which allow to calculate main probability-temporal characteristics of process spreading the software threats were obtained. Researching the modelling results shows that mathematical simulation results based on spatial approach are comparable with the simulation results based on spread of conventional biologic viruses.

The results of researching the behaviour of computer viruses obtained using hierarchical and spatial models show that infected computer nodes amount increases in network only if "epidemiologic situation" has polynomial dependence. At the same time simulation of random graph model (using same initial parameters) shows exponential dependence modelling of the spreading of the software threats in computer networks.

III. CONCLUSION

In this paper the researches show the adequacy of the results of mathematical modelling using the hierarchical and spatial approaches. However, the simplicity and accessibility of random-graph model approach makes it to be used during analysis and evaluation the process of spreading the computer viruses in networks with little amount of nodes and connectivity.

REFERENCES

[1] Кузнецов О.О., Семенов С.Г. Протоколи захисту інформації у комп'ютерних системах та мережах: Навч. посібник. – Харків: ХНУРЕ, 2009 186 с.
[2] F. Cohen, "Computer viruses, theory and experiments," Computers & Security, vol. 6, 1987, pp. 22-35.
[3] P. Waltman, "Deterministic Threshold Models in the Theory of Epidemics," Springer-Verlag, New York, 1974.
[4] D. Ludwig, "Stochastic Population Theories," Springer-Verlag, New York, 1978.