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Comparative Analysis of Various Routing Strategies in the Framework of the Proposed Models

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ABSTRACT: Quality of Service (QoS) is regarded as one of the most important factors to improve the performance of the network. The QoS can be improved in the Telecommunication Network (TN)by improving the ability to handle the traffic heterogeneous type and its requirements, which is what this paper tackles. In modern TN, optimizing the routing mechanism improves the QoS significantly because the routing methods orientation is used in the hybrid network, ensures an adaptability of routing process according to the change in system operation conditions, and in the implementation of the hierarchical management strategy. Applying the routing protocols that are used in practical TN and the required mathematic formulas are deduced and compared with the relative results, taking into consideration that the optimized routing processes by developing the appropriate hierarchical-coordination methods. The results show that the implementation of the adaptive strategy in accordance with the proposed models allows to increase the network productivity by 10-30% and to significantly reduce the possibility of overload which positively is reflected over the guaranteed QoS desired. Moreover, the experimental study of hybrid routing with QoS-support demonstrated that during a joint use of various packet switching modes, increases the network performance from 30% (with only the virtual connect mode) to 80% (with the introduction of the datagram exchange) on average is achieved.

KEYWORDS: Pouting Protocols, QoS, TN,Hybrid Network

I. INTRODUCTION

The routing protocol is such widely applied technique, for its important role in improving the Telecommunication Network (TN) parameters, such as Packet Error Probability (PEP) [1], network capacity [2] andthe consumption transmitted power as in [3, 4].

In [5], the referencing tools were investigated for routing protocols proposed for Wireless Sensor Network (WSN), the paper discussed the routing reputation and routing trust for the proposed applications.

For the same application, i. e., WSN, [6] discussed the energy consumption improvement for the traditional clustering method, and it shows how optimizing the routing protocol results to such better energy consumption for the proposed applications.

Both [7] and [8], give specific evaluation for such well-known routing methods, such as OSPF and RPI on IPV4 and IPV6 in [7], and Open shop scheduling algorithm for routing interconnection network in [8].

The proposed work in this paper is unlike [9] where QoS was investigated for Dynamic routing of IP traffic based on QoS parameters, as the proposed work in this paper is directed to analytically compare the quality of TN with implementation of both static and adaptive strategies, with the routing models discussed in [10], [11] and [12], where in [10] the Hamiltonian-based odd–even turn model for maximally adaptive routing in 2D mesh networks-on-chip were discussed, In [11] the fusion model was used to adapt information to predict the short time link travel time, and in [12] the modeling approach was analytically investigated for network routing algorithms that use “ant-like” mobile agents.

In this paper, the static routing is understood as the methods that are used as the basis for the protocols used in practice. Although in general these methods are dynamic, in practice, as shown in Section 1, their adaptation is limited only by response to changes in network configuration and, under the constancy of the latter, can be considered static. These methods

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are based on shortest path algorithms and implement a one-way delivery method.Adaptive strategy is routing based on the models proposed in [13], [14] and [15], which dynamically changes the information distribution plan even under conditions of a permanent network configuration.

The rest of the paper will be organized as following: Section 2 compares the proposed work with the single path routing based on the shortest path algorithm. Section 3 deals with Researching the influence of the error in forecasting the load on network performance. In Section 4, Analysis of hybrid routing processes in TN is emplaned. and finally Section 5 concludes the paper.

II. SHORTEST SINGLE-PATH ROUTING MODEL

The simulation results (Fig.2) for the networks shown in Fig.1 show that a gain in network performance due to the introduction of routing in accordance with the proposed models (adaptive routing) compared with single-path routing based on the shortest path [16](static routing) is 13% for a network of 5 nodes (curves 2,3) and 28% for a network of 7 nodes (curves 1,4). At the same time, an increase in capacity is observed at the value of the incoming network load exceeding 40 and 50 % of the network bandwidth for the investigated structures of seven and five nodes respectively.At a load below these values, a performance gain due to the introduction of adaptive routing for the considered networks does not exceed 5% (the performance curves for different strategies practically coincide), which allows us to conclude that it's advisable to make a transition to a static distribution plan under such a load.

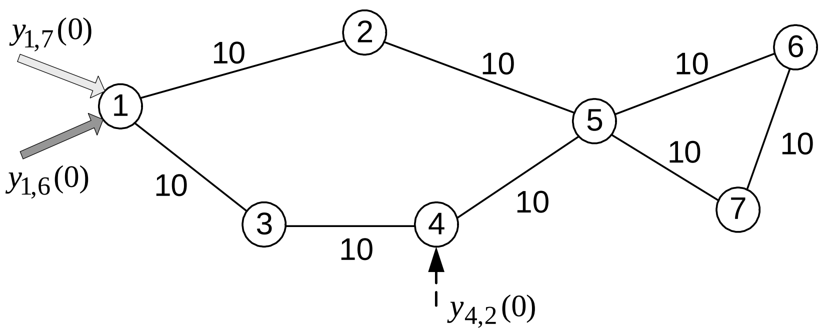

Fig. 1Example for a suboptimal network protocol [23]

As the simulation results show, a load amount, at which the increase in performance becomes significant and the increase in overhead amount that accompanies adaptive routing becomes justified [17] and [18], depends on the network configuration and is about 30-50% of its bandwidth.

Thus, a region of workloads, at which the efficiency of adaptive routing is greatest, can be considered to be a region of high loads amounting to 75-100% of the network bandwidth. This allows to talk about increasing network performance by switching to adaptive routing without commissioning new channel resources.

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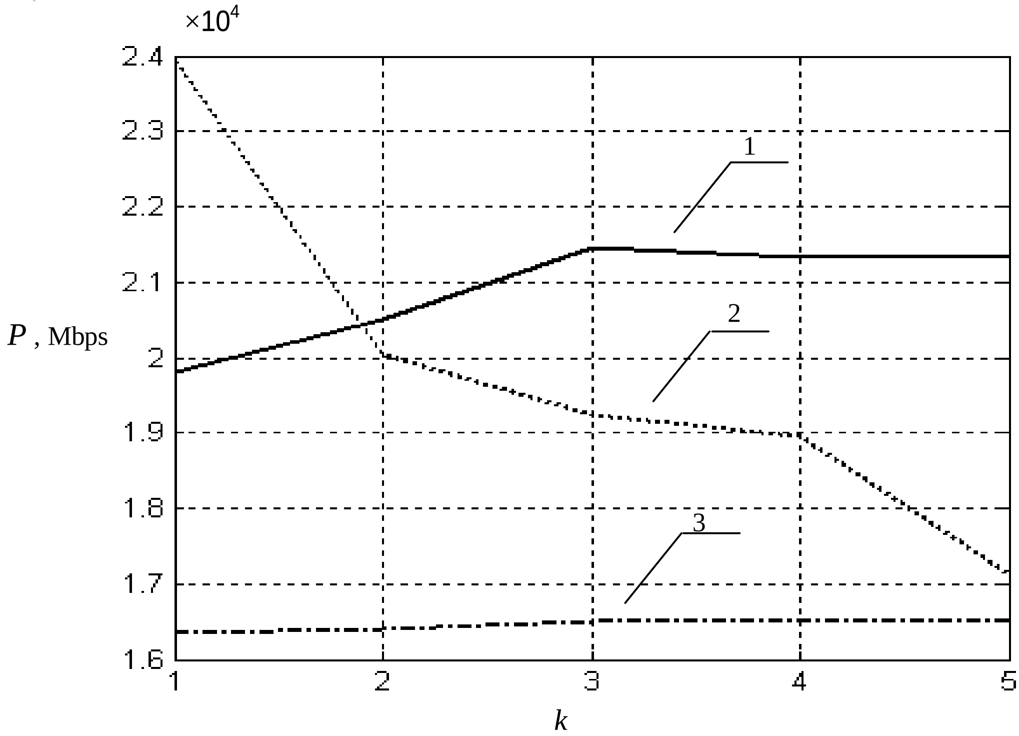
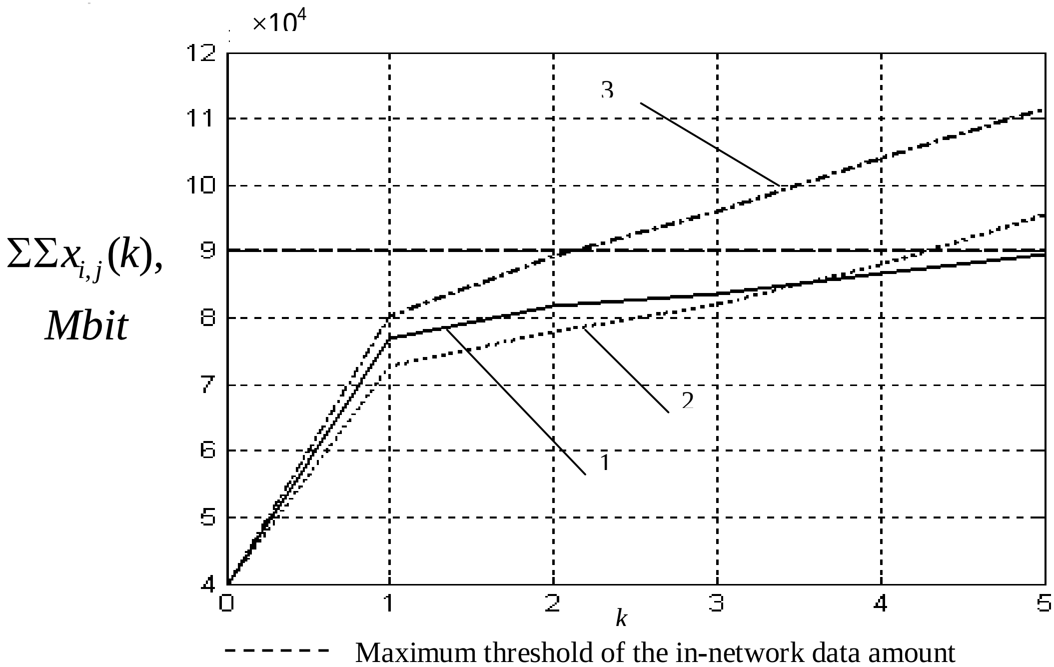


Fig.2Network performance dynamics of various routing strategies



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In the region close to overload, that is when $Y_{\text{BX H}} \cong 100\%$, usage of adaptive routing (curves 1,2 in Figs.2, 3) allows not only to significantly increase the performance in comparison with static (curve 3 in Figs.1, 3) but also to delay entering the overload mode or prevent it at all (if it's a short-term surge of load).

As mentioned before, the quality of routing expressed by network performance is determined by the degree of the input stream unevenness and deteriorates with increasing σ_y (Fig.5), but this value practically does not affect a performance gain from a transition from static to adaptive routing strategy.

(Fig.6) shows the dependences between the data amountsentering the network $Y_{\text{BX}\Sigma}$ and those sent via bypass routes $P_{(\text{li})} T_{\text{M}}$ for full-mesh networks, $T_{\text{M}} = \Delta t$. Here $P(li)$ is a load amount brought per unit time by bypass (indirect) routes. Hence it's clear that the share $P(li)$ of the total traffic P depends on the network structure and grows in direct proportion to the number of bypass routes. This allows to draw a conclusion about the balanced use of resources in implementation of the considered routing models, which is manifested in an absence of overload in some directions with under loaded others.Thanks to this, the increase in performance is achieved compared with single-path routing which is based on shortest path models.

III. RESEARCHING THE INFLUENCE OF THE ERROR IN FORECASTING THE LOAD ON NETWORK PERFORMANCE

The peculiarity of the considered routing models is that they have the property of forecasting the network state and within their framework the resource allocation is formed taking into account future network conditions.A prerequisite for this is awareness of the expected load amount which is supposed to reach the network in nearest a time intervals.

The initial data for solving the routing problem in the framework of the proposed models is an average intensity of the external load input into the network nodes $\zeta_{i,j}(k)$ during the k time interval.In general case, in order to improve the quality of routing, in addition to the average value, it is necessary to have information about possible traffic ripples.

Forecasting the amount of incoming network load is an independent task which can be solved, for example, with the help of fractal analysis [19] and [20] using a self-similar random process as a traffic model.Regardless of the method being implemented, the load forecasting occurs with some error (inaccuracy), i.e. the predicted value of the input load which appears in an equation of states can be written as in Eq. (1)

$$y_{i,j}(k) = y_{\text{BX}\, i,j}(k) + \Delta y_{i,j}(k) \qquad (1)$$

or in a vector form:

$$Y(k) = Y_{\text{BX}}(k) + \Delta Y(k), \qquad (2)$$

where $y_{i,j}(k)$ is the predicted value of the load arriving at the node V_i and intended for the node V_j;

$y_{\text{BX}\, i,j}(k)$ is an actual amount of the incoming load; $\Delta y_{i,j}(k)$ is an error in forecasting the incoming load value.

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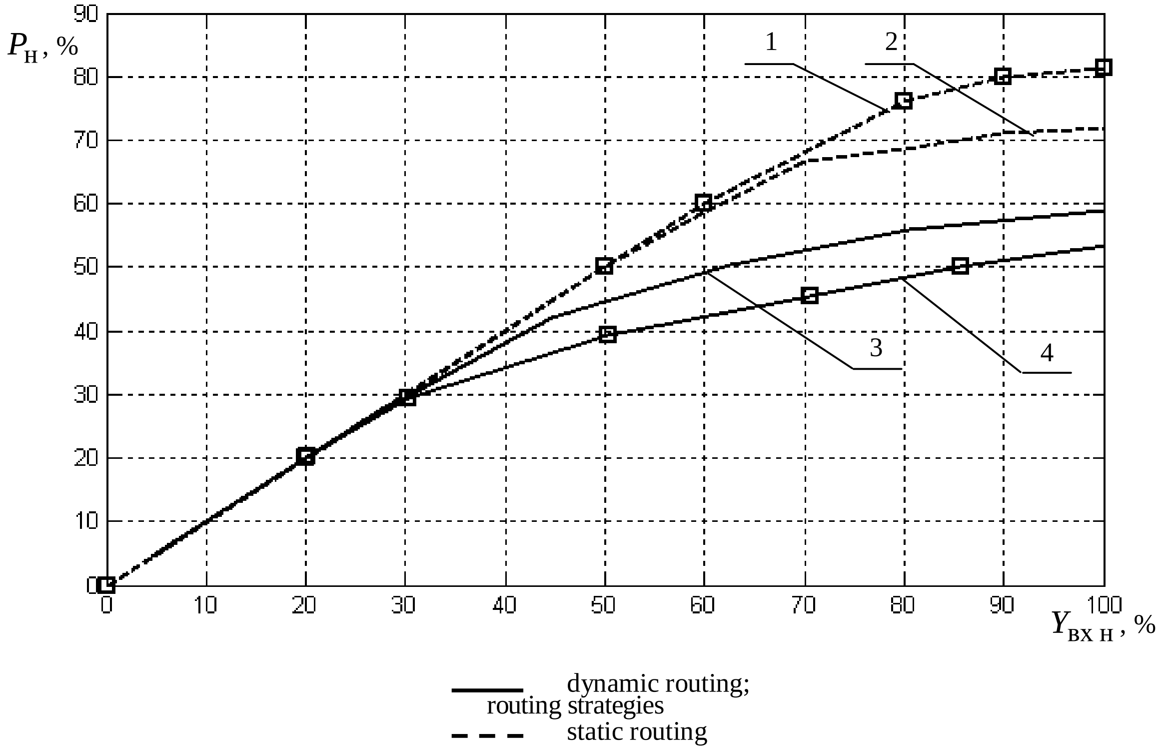
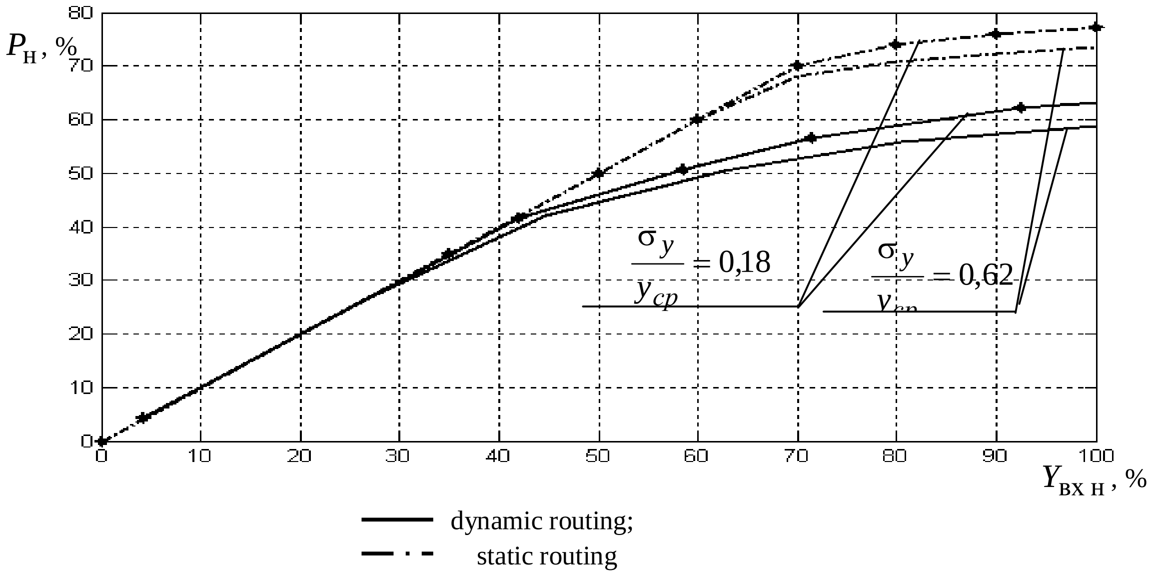


Fig.5Dependence of the normalized performance of partially connected network of 5 nodes on the incoming load amounts under different routing strategies



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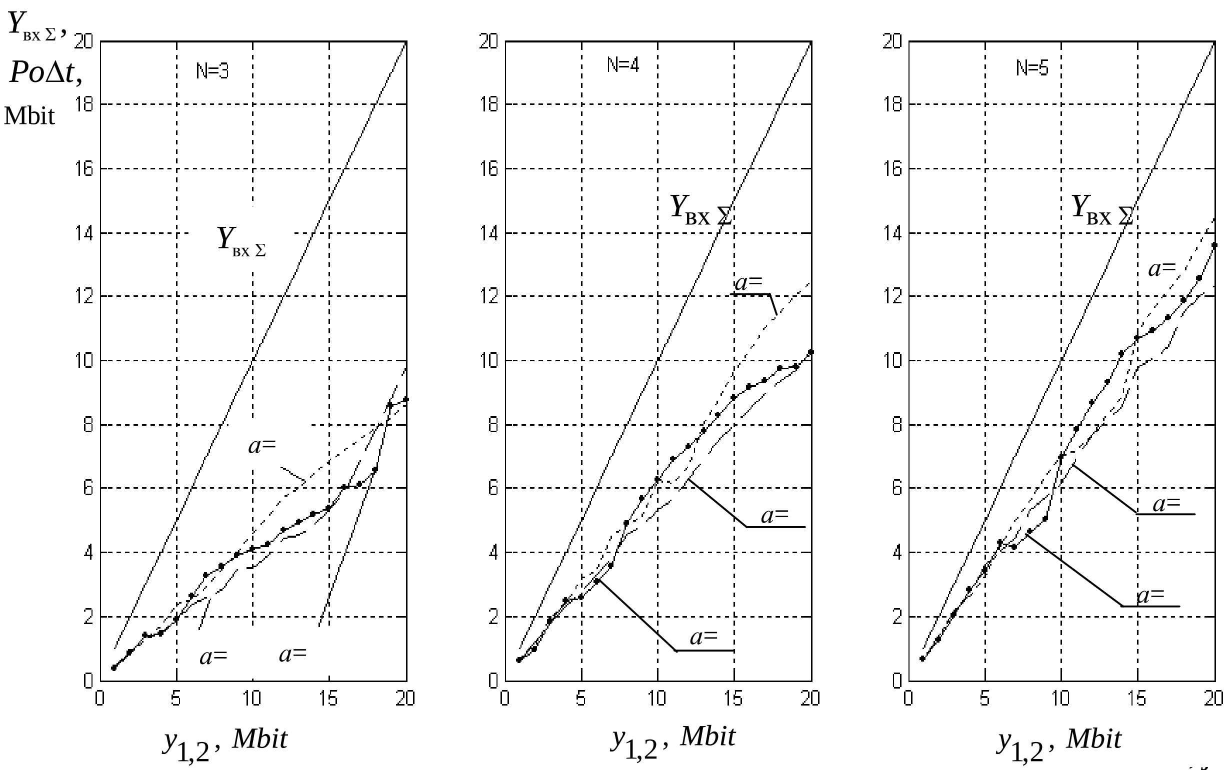

can take either positive or negative values. In the first case the network receives a load $y_{BX\,i,j}(k) < y_{i,j}(k)$, and, given that the problem solution was performed for larger values, the allocated resources should be sufficient for $y_{BX\,i,j}(k)$. As a result, there are no performance losses.In case of $\Delta y_{i,j}(k) < 0$ the expected load is less than the actual incoming, and the reserved resources become insufficient to process incoming traffic which is the cause of the performance loss.

The performance loss due to the external load forecasting error was estimated using the following formula Eq. (3):

$$\Delta P_{\text{per}} = \frac{\sum_{k=1}^{v} P(k) - \sum_{k=1}^{v} P_{\text{ош}}(k)}{\sum_{k=1}^{v} P(k)}, \qquad (3)$$

where $P(k)$ is the network performance in the absence of forecasting errors;

$Per(k)$ is the network performance with non-zero forecasting errors and other things being equal.

As the simulation results show, the performance loss value $\Delta Pper$ is greatest when all $y_{BX\,i,j}(k) > y_{i,j}(k)$, that is $\Delta y_{i,j}(k) < 0$, $i, j = \overline{1,N}$, $i \neq j$. Let's assume that all $\Delta y_{i,j}(k)$ take the same values $\Delta y_{i,j}(k) = \Delta y$, $\Delta y < 0$, then, depending on the unevenness of incoming load σ_y, the losses $\Delta P_{\Pi p}$ take a different value. Fig. 4.17 shows the dependence of performance losses $\Delta P_{\Pi p}$ on Δy for the network shown in Fig.

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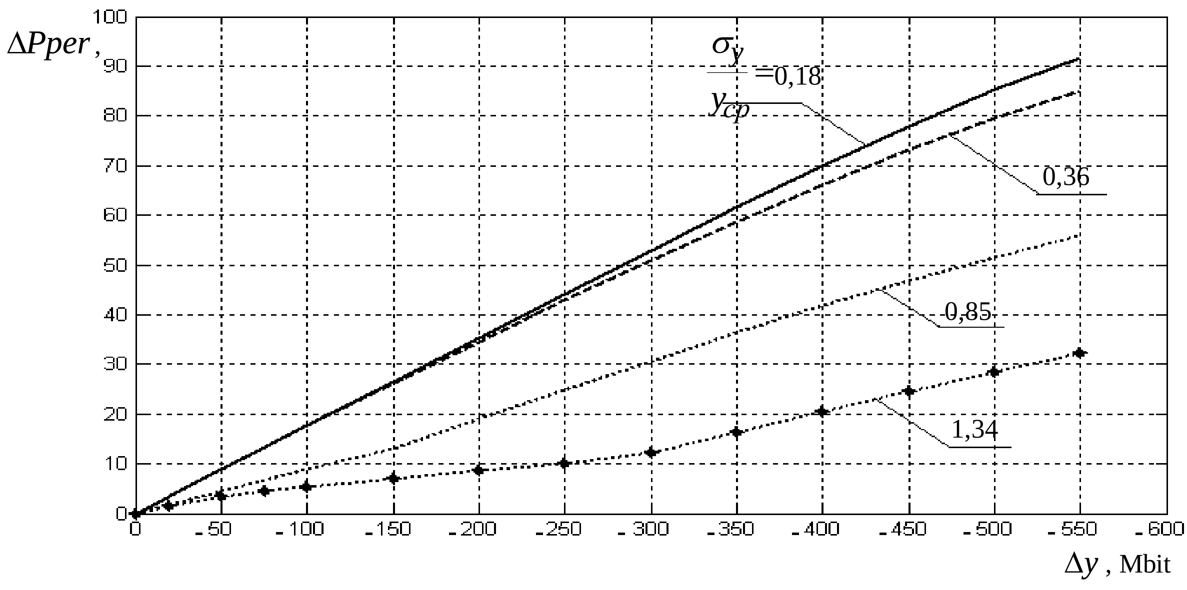
4.2a (the bandwidth of the transmission paths is 200 Mbps, recalculation interval $\Delta t = 10$ s, the network is loaded by 50% on average).The upper limit is the dependence of the load $\sigma_y = 0$.

However, forecasting errors take both negative and positive values. Assume that the quantity $\Delta y_{i,j}(k)$ is a random variable with a normal distribution law and the following parameters: zero mathematical expectation and standard deviation $\sigma_{\Delta y}$. In this case, the dependences $\Delta Pper$ (Fig.8) are similar to those shown in (Fig.7)with the difference that the losses now take a smaller value. This is due to the fact that forecasting for a number of $y_{i,j}(k)$ is carried out with an error $\Delta y_{i,j}(k) > 0$, which does not affect the total productivity loss.

IV. ANALYSIS OF HYBRID ROUTING PROCESSES IN TN

As you know, the virtual connect mode allows to achieve high quality of service to network users but does not contribute to the balanced use of network resources. As indicated in [15], in practice the degree of use of network resources during network operation in the virtual connect mode does not exceed 30% on average. The degree of use of network resources depends on the load uniformity and reaches its maximum at the same values of $\zeta_{i,j}^{(B)}(k)$, that is $\zeta_{i,j}^{(B)}(k) = \zeta,\ i,j = \overline{1,N}$. In this case, the maximum normalized performance of the investigated networks (Fig. 4.2) is 55% and 56% and is observed at ζ = 66 Mbps and ζ = 99 Mbps respectively.

When the datagram mode is introduced in addition to the virtual mode, i.e. when TN hybridises, the network productivity increases, and the degree of use of channel resources increases by an amount that depends on the size of the streams $\zeta_{i,j}^{(B)}(k)$ .As shown by the modeling results, the increase in productivity is 30-50% on average.For example, for a network of 5 nodes (Fig. 4.2a) with $\zeta_{1,2}^{(B)} = 150$ Mbps, $\zeta_{1,4}^{(B)} = 100$ Mbps, $\zeta_{1,5}^{(B)} = 100$ Mbps, all other input streams at 50 Mbps the normalized network performance P_H is 43.75%, at the same time there are failures: the required quality of service is not provided to the streams $\zeta_{1.5}^{(B)}$



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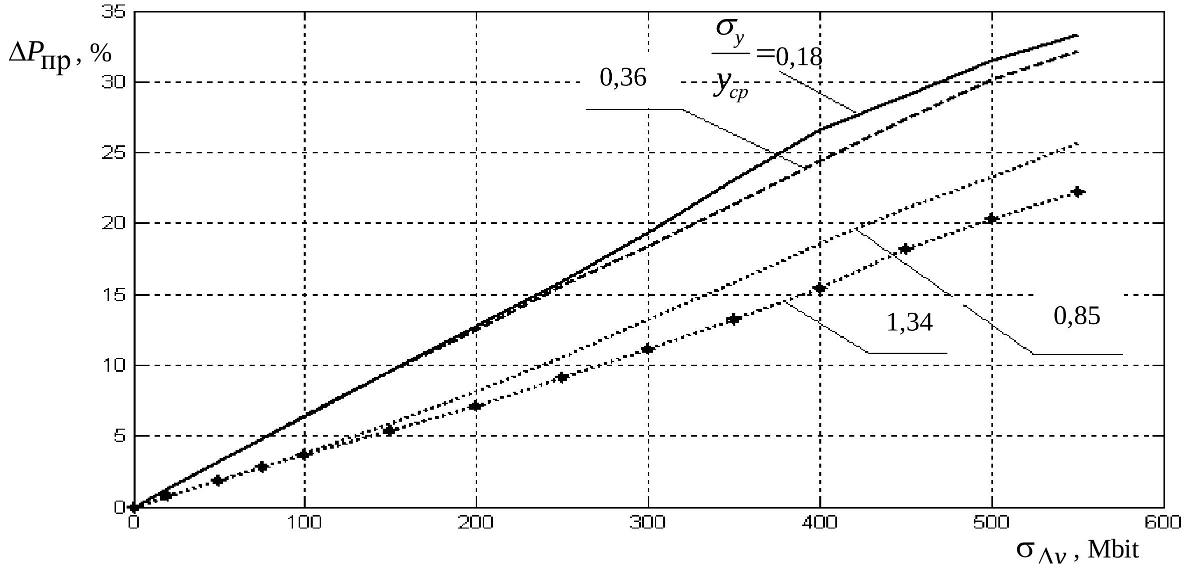

Fig.8 Dependence of the performance loss $\Delta Pner$ on the standard deviation of the forecasting error

V. CONCLUSIONS

In the framework of the proposed models a comparative analysis of various routing strategies was made: based on the proposed models (adaptive strategy) and the shortest path model (static allocation plan), it was shown that implementation of the adaptive strategy in accordance with the proposed models allows to increase the network productivity by 10-30% and to significantly reduce the possibility of overload, which is one of the conditions for providing the network with guaranteed QoS (Fig.2).With the increase in network dimension, there was a tendency of increasing in productivity gains up to 40-45%. The results of an experimental study of hybrid routing with QoS-support demonstrated that during a joint use of various packet switching modes (with and without connection establishment) an increase in the network performance from 30% (with only the virtual connect mode) to 80% (with the introduction of the datagram exchange) on average is achieved. The research of HC routing methods is conducted, the results of which showed the high convergence of the proposed routing methods. The number of minimization cycles necessary to obtain the optimal value of the target functional (with a deviation of not more than 2%) is 2-4 when using the IF-TC method and 5-8 for the EI-TC method, depending on the forecasting interval. Significant reduction of the number of cycles (up to 1-3 using the IF-TC method and 4-6 using the EI-TC method), and hence the reduction of the decision time, can be achieved by choosing as the initial values of the vector of route variables the results of the optimization problem solution for the previous time interval. The simulation results showed that the IF-TC and EI-TC methods, under conditions of the incoming load stability (when $\sigma_y / y_{\text{cp}} < 1$), tend to converge.

The future work will be directed toward applying Network Coding (NC) proposed in [21] and [22] over the proposed technique in this paper, and then find out the analytical formulas and the optimizing routing model.

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REFERENCES

[1] H. Attar, D. Vukobratovic, L. Stankovic and V. Stankovic, "Performance Analysis of Node Cooperation with Network Coding in Wireless Sensor Networks," 2011 4th IFIP International Conference on New Technologies, Mobility and Security, Paris, 2011, pp. 1-4. doi: 10.1109/NTMS.2011.5721048

[2] H. Attar, L. Stankovic and V. Stankovic, "Cooperative network-coding system for wireless sensor networks," in IET Communications, vol. 6, no. 3, pp. 344-352, February 14 2012.doi: 10.1049/iet-com.2011.0143

[3] Attar, H. (2016) Physical Layer Deterministic Network Coding Using PUM Turbo Codes over AWGN Channel, N Nodes through a Base Station Scenario. Communications and Network, 8, 241-256. http://dx.doi.org/10.4236/cn.2016.84022

[4] Bouallegue, Mehdi, et al. "Design and implementation of new routing strategy for enhanced energy efficient in wsn." International Journal of Computer Networks and Communications (IJCNC) 7.4 (2015).

[5] Salam, Mohammad Abdus, and Alfred Sarkodee-Adoo. "Referencing Tool for Reputation and Trust in Wireless Sensor Networks." arXiv preprint arXiv:1508.01430 (2015).

[6] Hung, Tran Cong, and Ly Quoc Hung. "ENERGY CONSUMPTION IMPROVEMENT OF TRADITIONAL CLUSTERING METHOD IN WIRELESS SENSOR NETWORK." network 6: 7.(2016)

[7] Syed, M. and Ambore, I.Y., PERFORMANCE EVALUATION OF OSPF AND RIP ON IPV4 & IPV6 TECHNOLOGY USING G. 711 CODEC (2016).

[8] Birmpilis, Stavros, and Timotheos Aslanidis. "A Critical Improvement On Open Shop Scheduling Algorithm For Routing In Interconnection Networks." arXiv preprint arXiv:1702.08236 (2017).

[9] Kriska, Martin, Jozef Janitor, and Peter Fecilak. "Dynamic routing of IP traffic based on QoS parameters." International Journal of Computer Networks & Communications 6.4 (2014): 11

[10] Bahrebar, Poona, and Dirk Stroobandt. "The Hamiltonian-based odd–even turn model for maximally adaptive routing in 2D mesh networks-on-chip." Computers & Electrical Engineering 45 (2015): 386-401.

[11] Du, Lili, Srinivas Peeta, and Yong Hoon Kim. "An adaptive information fusion model to predict the short-term link travel time distribution in dynamic traffic networks." Transportation Research Part B: Methodological 46.1 (2012): 235-252.

[12] Bean, Nigel, and Andre Costa. "An analytic modelling approach for network routing algorithms that use “ant-like” mobile agents." Computer Networks 49.2 (2005): 243-268.

[13] Han, Ming-Feng, et al. "Dynamic group-based differential evolution using a self-adaptive strategy for global optimization problems." Applied Intelligence 39.1 (2013): 41-56.

[14] Tian, Daxin, et al. "An adaptive vehicular epidemic routing method based on attractor selection model." Ad Hoc Networks 36 (2016): 465-481.

[15] Liu, Jianqi, et al. "A survey on position-based routing for vehicular ad hoc networks." Telecommunication Systems 62.1 (2016): 15-30.

[16] El-Hihi, M., Attar, H., Solyman, A.A.A. and Stankovic, L. (2016) Network Coding Cooperation Performance Analysis in Wireless Network over a Lossy Channel, M Users and a Destination Scenario. Communications and Network, 8, 257-280.

[17] Alhihi, Mohammad. "Network Coding for Wireless Sensor Network Cluster over Rayleigh Fading Channel: Finite State Markov Chain." International Journal of Communications, Network and System Sciences 10.01 (2017): 1.

[18] Attar, Hani, et al. "Deterministic network coding over Long Term Evaluation Advance communication system." Digital Information and Communication Technology and it's Applications (DICTAP), 2014 Fourth International Conference on. IEEE, 2014.

[19] Gorodetsky A.Ya., Zaborovsky VS. Computer science. Fractal processes in computer networks. - St. Petersburg: SPbSTU, 2000. - 102 p.

[20] Norros I. The Managnent of Large Flows of Connectionless Traffic on the Basis of Self-Similar Modeling // Proc. of IEEE International Conference on Communications (ICC'95). – Seattle (USA), 1995. – P. 451–455.

[21] Attar, H. (2017) Data Combination over Physical Layer Using Network Coding with PUM Turbo Codes. Journal of Computer and Communications, 5, 32-44. https://doi.org/10.4236/jcc.2017.56002

[22] Attar, H. H., et al. "Physical layer multi-source network coding using PUM turbo codes." 10th International Symposium on Communication Theory and Applications, July 2009. 2009.

[23] Alhihi, M. (2017) Practical Routing Protocol Models to Improve Network Performance and Adequacy. Journal of Computer and Communications, 5, 114-124. https://doi.org/10.4236/jcc.2017.56007