Investigation of Communication Parameters in Multicomputer Architecture with Ring Topology

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Contents

Abstract

The implementation of high-volume calculation requires using high-performance computer systems based on MIMD computer architectures – multi-processors & multi-computers.

The article proposes an approach for functional investigation and evaluation of communication parameters in the organization of multiple processing of tasks in multicomputer architecture with ring topology and additional chord connections between certain nodes (chord ring).

Analytical estimates for basic parameters used in the organization of simulation experiments are presented, and the analysis of the experimental results is done by statistical processing.

I. Introduction

The role of topology is especially important in DM MIMD architectures in connection with the optimization of communication time (CT) whit suitable hardware approaches such as additional connection lines.

The aim of the article is to present an approach for evaluation of the communication parameters of DM MIMD architecture with ring topology in the presence of chord connections between certain nodes (Chord ring – HRING), making a comparative analysis of experimental data with varying the number of nodes and the degree of connection. The study was conducted by simulation experiments with initial formalization of primary factors and by varying the controllable factors.

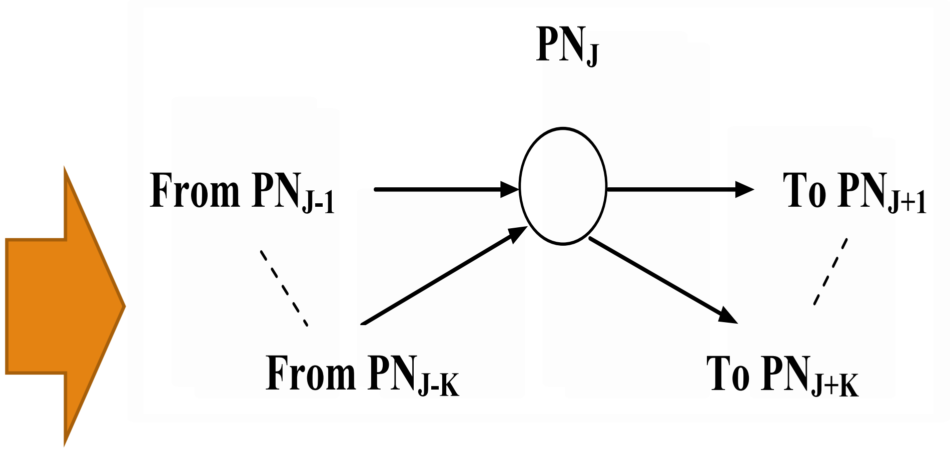
II. Related Works

Review of some publications in the field of the discussed problem is made in this section, including approaches of modelling used for investigation different problems.

III. Preliminary Organization of the Investigation

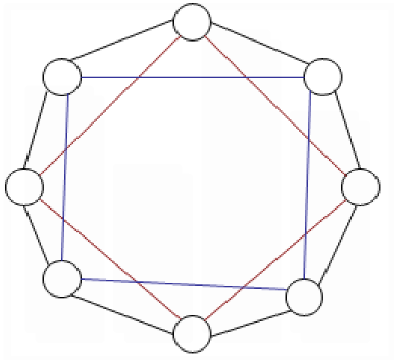
A. Problem Definition

In a ring topology, the connection is serial, with each processor node (PN) having a direct connection to its two neighbors. To reduce communication losses, chord connections at distances *K* positions are added, usually of a regular nature.

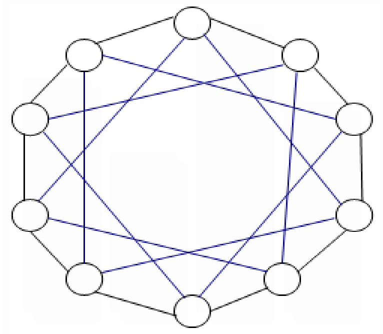


The object of the present study are three multicomputer architectures with topology connection “chord ring” type – with 8, 10 and 12 processor nodes, respectively:

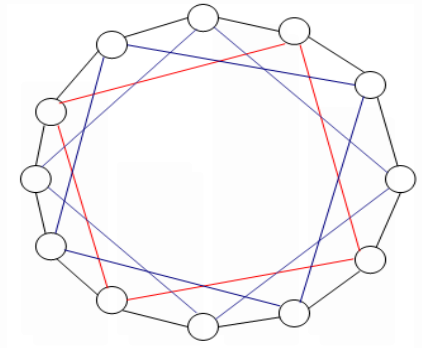
HRING-8



HRING-10



HRING-12

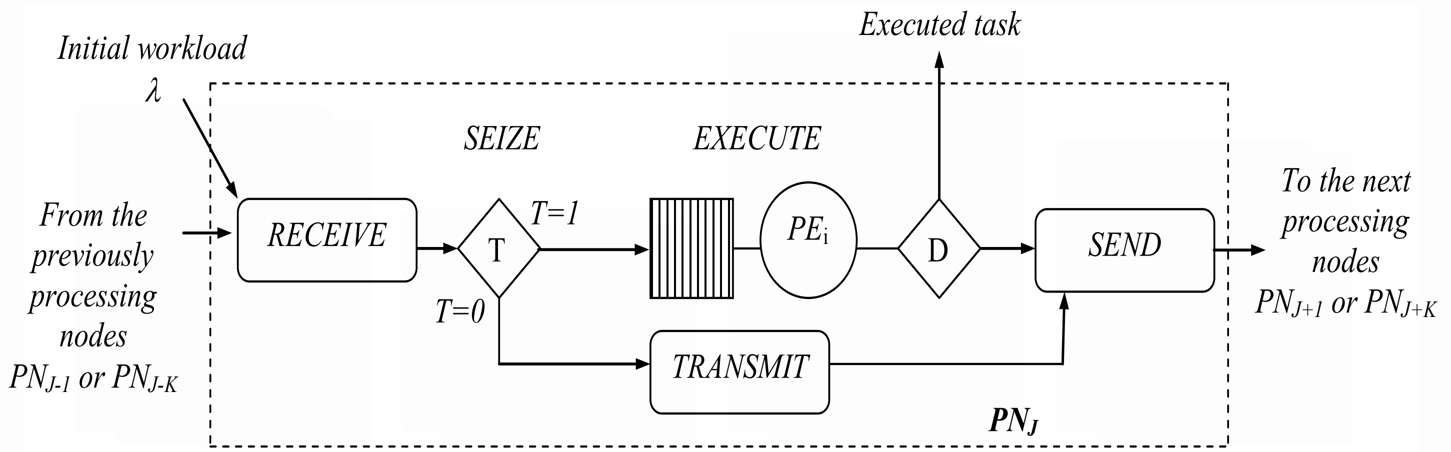


B. Formalization and Conceptual Model

Table 1. Basic Components of the Formal Description

RECEIVE	Input and initial processing of an information object
SEIZE	Internal management of information object targeting.
EXECUTE	Processing of an information object in the current PN with analysis (parameter D) of additional processing.
TRANSMIT	Transfer of an information object to the next PN.
SEND	Transmission of an information object to a neighboring PN based on the address of the receiver.

Fig. 3. Abstract model of information services for processor node PN_J $(J=1, 2,\dots,N)$



C. Mathematical Model Development

The model of each PN is a single-channel service systems of type M/M/1, the general model is a network of these PN-models. The topological connections are represented by probabilistic directing of the information flows from a given output to the entry points of the respective neighbors, reflecting the parameters K and α. The targeting to the next PN is probable on the base of parameter D. The input flow of information objects for service is defined as a random process, subject to exponential law and with intensity λ.

IV. Program Experiments and Results

A. Program Model Realization

The program model is developed by using GPSS World (Windows-based simulation environment). The primary factors are specified, and the main observable factors are defined – processor load (PW), system performance (SP), processor time (PT), waiting time (WT).

B. Experimental Results

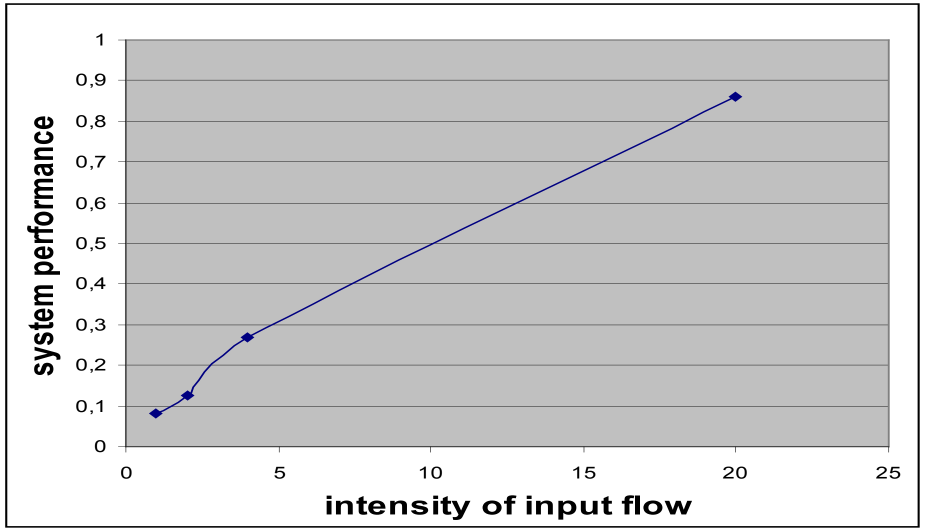
Table 2. Assessments for Basic Parameters of HRING-8

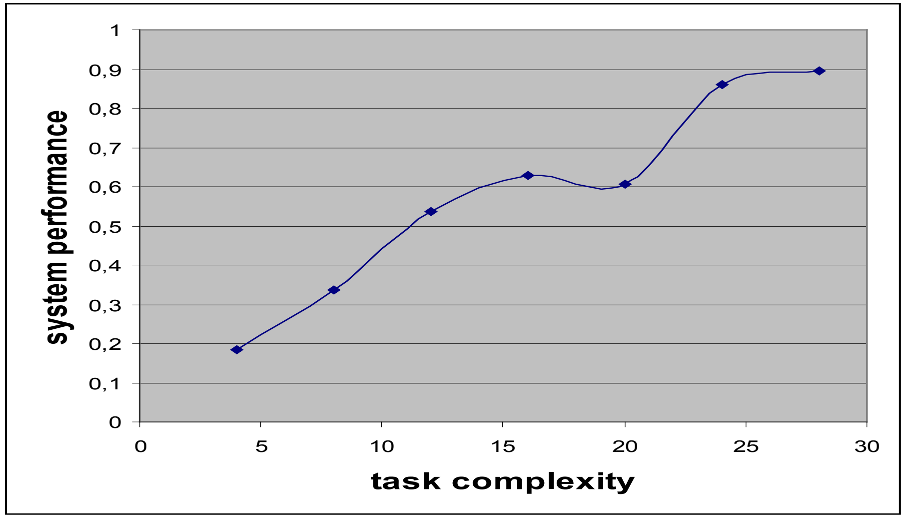
	PN1	**PN2**	**PN3**	**PN4**	**PN5**	**PN6**	**PN7**	**PN8**	**average**
PW	0,787	0,932	0,974	0,934	0,974	0,794	0,66	0,814	**0,85863**
PT	29,53	29,75	29,82	28,81	29,82	29,77	30,00	29,78	**29,66**
WT	**26,16**	**73,74**	**161,11**	**86,28**	**111,47**	**63,24**	**18,31**	**16,13**	**69,555**

Table 3. Assessments for Basic Parameters of HRING-8 Depending on Intensity of the Input Flow (SP – System Performance)

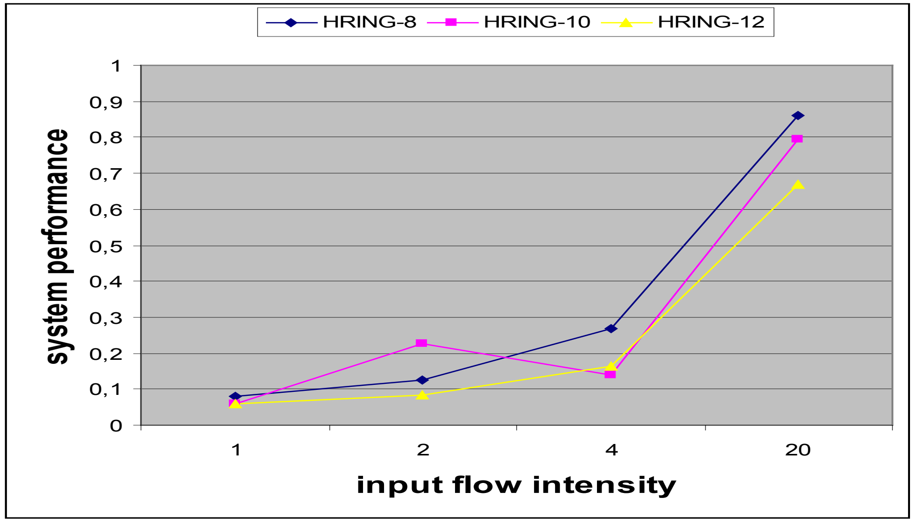
	PW1	**PW2**	**PW3**	**PW4**	**PW5**	**PW6**	**PW7**	**PW8**	**SP**
λ	0,1	0,08	0,08	0,12	0,08	0,02	0,12	0,04	**0,08**
2λ	0,1	0,18	0,16	0,08	0,18	0,12	0,113	0,08	**0,12663**
4λ	0,28	0,3	0,26	0,28	0,22	0,3	0,308	0,2	**0,2685**
20λ	**0,787**	**0,932**	**0,974**	**0,934**	**0,974**	**0,794**	**0,66**	**0,814**	**0,85863**

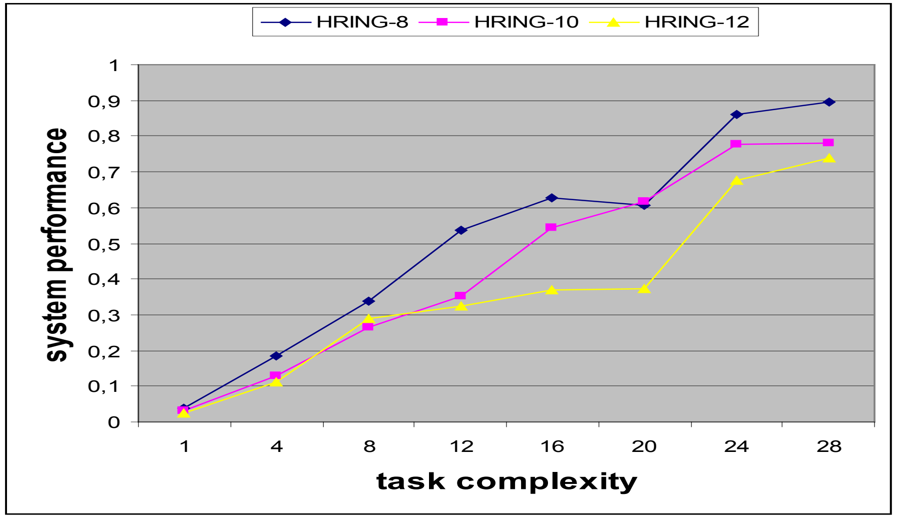
Dependency of system performance SP on the intensity of the input flow and on the complexity of the tasks





Comparative assessments of SP in different architectures

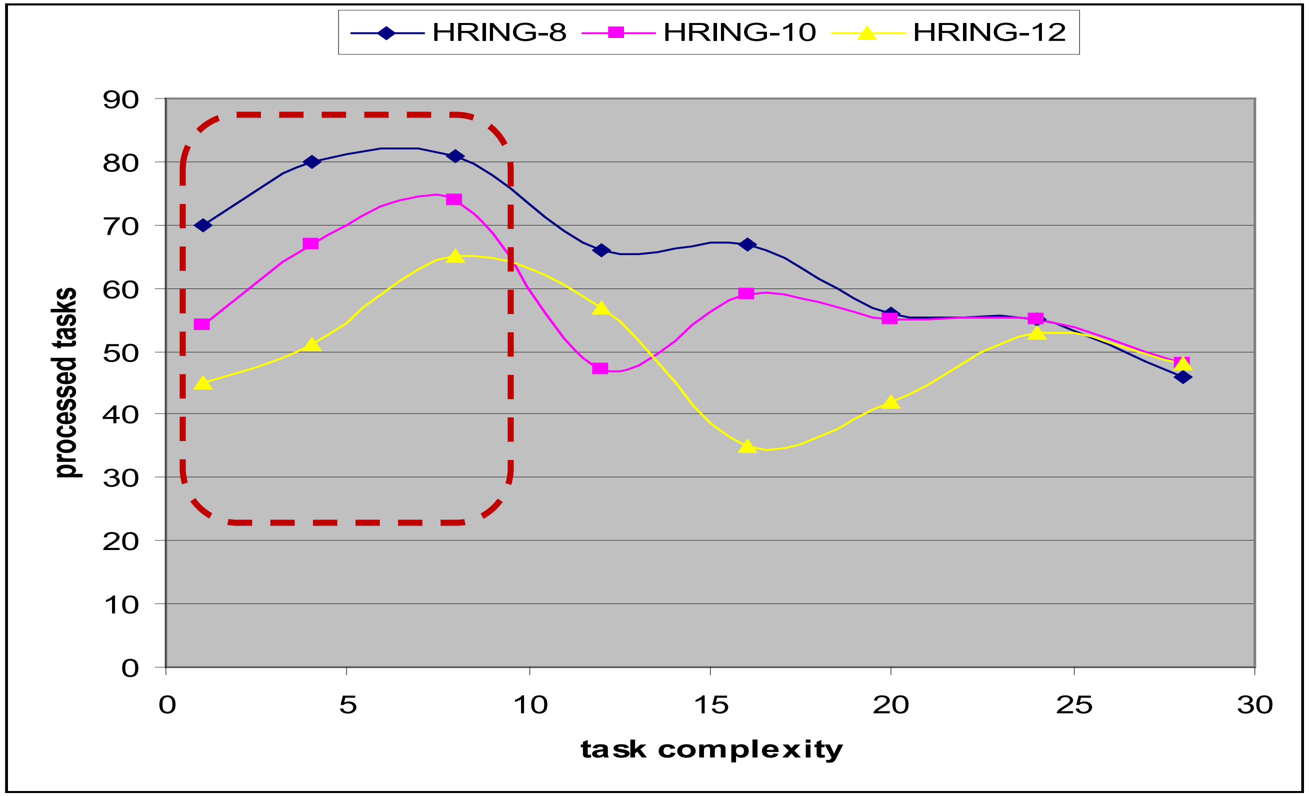




V. Conclusion

The conducted research and the dependences obtained on the basis of the experimental results allow to analyze the impact of the number of PN and communication lines on the system performance **SP**, as well as the reaction of the system when increasing the input load and its complexity. The conclusion from the results summarized in the latest graphical diagrams is that SP reacts more significantly with increasing complexity of tasks in the initial sector, as well as the serious impact of increasing intensity of the input flow of incoming tasks on it.

Another conclusion that can be drawn from the last scheme is that in the range of **tasks with less complexity**, the structure with 12 PN is less efficient than the others, because **most PN are not loaded** at total runtime



Thank you for your attention

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