Journal of Informatics and Mathematical Sciences
Vol. 9, No. 4, pp. 1061–1066, 2017
ISSN 0975-5748 (online); 0974-875X (print)
Published by RGN Publications
DOI: 10.26713/jims.v9i4.1005

http://www.rgnpublications.com

Research Article

A Study of Relations between Optimal Network Card Mode and Data Transmission Size

Okta Nurika, Mohd Fadzil Hassan and Nordin Zakaria

Department of Computer & Information Sciences, Universiti Teknologi PETRONAS, Tronoh, Malaysia
***Corresponding author:** nordinzakaria@petronas.com.my

Abstract. There is a necessity to study the relations between optimal network card mode and its data transmission size, in order to investigate if a specific network card mode is more suitable for a certain size of transmission. Three network card modes are examined, which are active wait, passive wait, and watermark. The existing data of 47 different transmission sizes and their respective optimal network card modes are observed. The analyses conclude that all network card modes are suitable for all levels of transmission size (small, medium, and big), as long as their optimal value takes place. However, it is better to implement the network card mode with the least generated kernel interrupts. Hence, the CPU cycles can be preserved.

Keywords. Network card mode; Active wait; Passive wait; Watermark; Transmission size; Nurika equation

MSC. 05; 68; 94

Received: May 9, 2016 **Accepted:** August 15, 2016

1. Introduction

This paper analyses the relation between network card mode (active wait, passive wait, and watermark) and transmission size. The analyses are based on the experiments conducted in our previous paper [1]. The objective of this study is to investigate if specific network card mode is suitable for particular level of transmission level.

Per our knowledge, the relation between network card mode and transmission size has not been observed before. The closest related studies are about the finding of transmission patterns in a data centre, which are done by [2], [3], [4] and [5]. Additional related works are regarding network throughput measurement by [6], [7], [8] and [9]. Therefore, this paper will fill up a research gap in the area of network hardware.

2. Network Card Modes and Tested Transmission Sizes

The utilized network card modes are active wait where every packet activates kernel interrupt to process the packet, passive wait where timer based polling is used to indicate when to process the received packets, and watermark mode where packet polling uses the amount of received packets instead of timer.

Furthermore, for passive wait mode, the range of timer starts from 10ms up to 200ms, with escalation every 10ms unit. In case of watermark mode, the range of amount of packets to poll starts from 1 Byte until the half of maximum ring buffer size, which in our case is 4096 Bytes, hence its range is from 1 Byte to 2048 Bytes with escalation every 1 Byte unit.

Every network card mode has their own throughput equation as described in [10] and implemented in [1]; Nurika equation I for passive wait mode, Nurika equation II for active wait mode, and Nurika equation III for watermark mode.

The above mentioned network card modes generate throughput in Mbps unit after receiving data transmission. This simulation of comprehensive data transmissions was done in [1] and since this paper specially discusses about data transmission handling, thus it is important to present the list of grouping of tested transmissions from [1] in the next table. The table contains data transmissions, along with their minimum number of interrupts generated by optimal network card mode settings; 'A' stands for active wait mode, 'P' followed by a number represents passive wait mode and its optimal value e.g. 'P30' means passive wait mode with 30ms of duration, and finally 'W' tailed by a number represents watermark mode and its optimal value e.g. 'W23' means watermark mode with 23 Byte of poll limit size. The presented minimum numbers of interrupts in the Table1 are taken from one of the 36 experiments conducted in [1], specifically from experiment No. 6, whose genetic algorithm properties consist of 50 population size and 100 generation size. Additionally, the packet size for every data transmission can be found in [1].

In active wait mode where every packet triggers an interrupt, the number of interrupt generations is calculated by $\frac{S}{p}$, where S is the transmission size (Byte) and p is packet size (Byte). Subsequently, in passive wait mode, the number of required interrupts can be calculated in the 1st step of Nurika equation for passive wait mode ([10]), where the longer poll duration is preferred over the shorter ones as long as the fitness value is equally high enough. While in watermark mode, it can be calculated in the 4th step of Nurika equation for watermark mode ([10]), where the total required watermark polls is calculated; the lesser the less interrupts generated.

Table 1. The grouping of nodes based on data transmission size

Small Transmissions		Minimum Interrupts	Medium Transmissions		Minimum Interrupts	Big Transmissions		Minimum Interrupts
Node ID	Size (GB)		Node ID	Size (GB)		Node ID	Size (GB)	
1	7.5	21,475 (P30)	4	21	16,399 (P110)	25	400	229,065 (P150)
2	6.9	13,822,423 (A)	5	86	49,249 (P150)	26	368.64	263,882,791 (A)
3	9.9	4,798,284 (W23)	7	33	2,960,879,852 (W12)			
6	19	1,144,115,443 (W18)	8	61	40,936,408 (A)			
10	14	50,107,952 (W300)	9	61	10,916,375,210 (W6)			
18	16	45,813 (P30)	11	62	33,286 (P160)			
19	19	276,871,999 (W75)	12	80	76,355 (P90)			
20	7.9	5,655,041 (A)	13	61	233,922,326 (A)			
21	18	13,805,253 (A)	14	62	48,416 (P110)			
23	7.4	19,864,224 (A)	15	26	5,583,457,484 (W5)			
24	17	208,612,698 (W91)	16	21	273,804,166 (W83)			
27	1	1,718 (P50)	17	65	49,852,299 (A)			
28	2	3,436 (P50)	22	21	66,319,348 (A)			
29	3	1,718 (P150)						
30	4	3,436 (P100)						
31	5	167,772,160 (W32)						
32	6	343,597,384 (W19)						
33	7	6,013 (P100)						
34	9	5,154 (P150)						
35	1.5	859 (P150)						
36	2.5	3,441,481 (A)						
37	3.5	44,739,243 (W86)						
38	4.5	2,577 (P150)						
39	5.5	4,295 (P110)						
40	6.5	7,121,757 (A)						
41	7.6	39,232,875 (W209)						
42	9.5	9,444,952 (A)						
43	10	518,033,337 (W21)						
44	10.5	1,261,191,668 (W9)						
45	11	514,356,971 (W23)						
46	11.5	19,757 (P50)						
47	12	759,632,275 (W17)						

According to Table 1 above, the levels of transmission size are categorized as small (less than 20GB), medium (between 20GB and 100GB inclusive), and big (beyond 100GB). There are total 47 different transmissions from 47 nodes as mentioned in [1], which have gone through 36 runs of network optimization experiment. Each one of these transmissions has their multiple optimal settings that may include one or more or even all of the network card modes. The utilizations of these network card modes in every experiment will be examined in the next section to discover their suitabilities.

Our initial hypotheses about the relation between network card mode and data transmission size are as follows:

(1) Active wait mode is suitable for small data transmissions, because the generation of kernel interrupt for every packet received is expected to be efficient only with small transmission.

(2) Passive wait mode is effective for medium data transmissions, because the timer based polling it uses can be adjusted according to estimated transmission size. Hence, it offers flexibility for moderate transmissions.

(3) Watermark mode is appropriate for big data transmissions, since the adjustment of watermark value according to amount of polled packets is assumed to have further packet handling range than using timer based polling.

3. Analysis of Conducted Experiments

This section presents the statistics for every network card mode in all 36 experiments conducted in [1]. The frequencies of utilized network card modes in the optimal solutions for each level of transmission size are calculated and tabulated in the below table.

Table 2. The utilizations of network card modes in optimal solutions of 36 experiments

Network card mode	Small transmissions	Medium transmissions	Big transmissions
Active Wait	36	36	36
Passive Wait	36	36	33
Watermark	36	36	17

In the previous compilations from Table 2, it is seen that active wait mode 100% consistently exists in all transmission levels in all 36 experiments. Subsequently, passive wait mode is found in the small and medium transmissions with both transmission levels achieving 100% utilization (36 out of 36 experiments). Additionally, in big transmission portions, passive wait mode is discovered in 33 experiments or 91.67% out of the overall 36 experiments. For watermark mode, it is observed to be utilized in 100% of total 36 experiments for both small and medium transmission level. While in big transmissions, watermark mode is implemented in only 17 experiments or 47.22% of the total 36 experiments.

In cases, where optimal solutions for a network card towards particular transmission size, consist of all the network card modes, it is recommended to choose or implement the optimal solution that has the least kernel interrupt generation, in order to save CPU cycles (as displayed in Table 1), so they can be used for other processes or computation purposes.

4. Conclusions

The most frequent pattern of network card mode utilization is the diverse spread of active wait and passive wait mode across all levels of transmission size, while watermark mode mostly covers small and medium transmissions. However, in some experiments, it is also found that watermark mode is utilized in all types of transmission size. Thus, it is concluded that all network card mode is suitable for all tested levels of transmission size, whether it is small, medium, or big. This conclusion is valid with the condition that the value setting of each network card mode is optimal. These findings also negate our initial hypotheses in Section 2, where the 3 network card modes were predicted to be suitable for different level of transmission size. Nevertheless, these initial hypotheses could be affected by the relative grouping of transmission sizes, where in different cases, the ranges of big, medium, and big data transmissions might be determined differently.

Finally, there is no specific consistent pattern if certain network card mode is more appropriate for particular transmission size, therefore all the 3 network card modes have the potential to optimally handle small, medium, and big data transmissions, as long as the value of the utilized mode is correct or optimal. This fact delivers numerous possible combinations to handle specific transmission using one of the optimal settings of network card modes, with the recommended ones are the ones with less interrupts generated, in order to preserve CPU cycles.

Competing Interests

The authors declare that they have no competing interests.

Authors' Contributions

All the authors contributed significantly in writing this article. The authors read and approved the final manuscript.

References

[1] O. Nurika, M.F. Hassan, N. Zakaria and L.T. Jung, Genetic algorithm optimized network in cloud data centre, *Advanced Science Letters*, in press, December (2015).

[2] T. Benson, A. Akella and D.A. Maltz, Network traffic characteristics of data centers in the wild, *The 10th ACM SIGCOMM Internet Measurement Conference 2010* (IMC'10) (2010), 267 – 280.

[3] Y. Qiao, Z. Hu and J. Lu, Efficient traffic matrix estimation for data center networks, *2013 IFIP Networking Conference* (2013), 1 – 9.

[4] M. Alizadeh, A. Greenberg, D.A. Maltz, J. Padhye, P. Patel, B. Prabhakar, S. Sengupta and M. Sridharan, *Data Center TCP (DCTCP), ACM SIGCOMM* 2010 (2010), 63 – 74.

[5] T. Benson, A. Anand, A. Akella and M. Zhang, Understanding data center traffic characteristics, *ACM SIGCOMM Computer Communication Review* **40**(1) (2010), 92 – 99.

[6] S. Kandula, S. Sengupta, A. Greenberg, P. Patel and R. Chaiken, The nature of datacenter traffic: measurements & analysis, *9th ACM SIGCOMM Conference on Internet Measurement Conference* (IMC'09) (2009), 202 – 208.

[7] Spirent Communications, *Test Methodology Journal*, IMIX (Internet Mix) Journal (2006).

[8] Agilent Technologies, *The Journal of Internet Test Methodologies* (2007).

[9] S. Leinen and V. Reijs, *Testing of Traffic Measurement Tools*, RE – Report (2002).

[10] O. Nurika, M.F. Hassan, N. Zakaria and L.T. Jung, Mathematical models for network card simulation and their empirical validations, *International Symposium on Mathematical Sciences & Computing Research* (iSMSC) 2015 (iSMSC'15) (2015).