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Best candidate routing algorithms integrated with minimum processing time and low blocking probability for modern parallel computing systems

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ABSTRACT

This study has clarified the best candidate routing algorithms integrated with minimum processing times and low blocking probabilities for modern parallel computing systems. Different methods were employed, such as the fast window method (FWM), fast bitwise window method (FBWM), and fast improved window method (FIWM), to upgrade the processing time and reduce the network delay time. In addition, different algorithms were studied such as the fast window ascending, the fast window descending, the fast window sequential algorithm, and the fast window sequential down algorithms; these were studied to show the numerical results of the networks' blocking probabilities, processing times, and delay times.

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1. RELATED WORKS

Optical communication networks for optical computing systems have had an important role in researching optics, once the fiber optic bandwidth capacity advantages of the optical domain became evident [1-5]. Supported by the previous research in the fiber optic field of high-speed optical communication and computing networks, high-performance parallel computing systems could achieve low network latencies [6-10], low processing times, and high throughput or transmission data rates of interconnectivity between processing elements [11-15]. The basic requirements of the new high fiber optic bandwidth applications, such as medical imaging, video services [16-18], and distributed central processing unit interconnections, require basic recent or modern solutions with high transmission bit rates or throughputs. These solutions emulate the needs of the recent fiber optic communication systems which reach the limits of terabits per second for achieving high-speed performance for optical computing networks with minimum blocking probabilities [19-25].

2. MODEL DESCRIPTION AND RESEARCH METHOD

There are many types of routing: fixed routing, adaptive routing, and alternate routing. The basic advantage of fixed routing is the lack of a central processing unit for route selection [20]. The main drawback of fixed routing is the increased blocking probability because of its convergence. The main advantage of the adaptive algorithm is to avoid a highly-loaded route, but its main drawback is the necessity for the link-state information exchange [21-24]. The basic advantage of alternate algorithms is to carry retry other routes if the establishment fails, but its main drawback are results in the wrong route selection [26-31].

We have studied the fast window method (FWM), fast bitwise window method (FBWM), and fast improved window method (FIWM). In addition to the fast window ascending algorithm, the fast window descending, fast window sequential, and fast window sequential down algorithms were are also studied. All of the proposed fast window methods and routing algorithms are clarified in the numerical results to show the network processing time, network delay time, and final network blocking probability. All of the numerical results are compared with the previous conventional window methods and traditional routing algorithms.

3. PERFORMANCE ANALYSIS WITH DISCUSSIONS

Figure 1 presents the processing time and network delay time variations against the network size variations for the previous window method, and it proposes a fast window method. The processing time for the traditional window method is 0.35 ms, and the processing time for the proposed fast WM is 0.09 ms for the small network size value of 8. The processing time for the traditional window method is 18.13 ms, and the processing time for the proposed fast WM is 1.2 ms for the medium network size value of 128. The processing time for the traditional window method is 1392 ms, and the processing time for the proposed fast WM is 148.5 ms for the large network size value of 1024. In the same way, the network delay time for the traditional window method is 2.5 ms, and the network delay time for the proposed fast WM is 1.5 ms for the small network size value of 8. However, the network delay time for the traditional window method is 40 ms, and the network delay time for the proposed fast WM is 24 ms for the medium network size value of 128. The network delay time for the traditional window method is 320 ms, and the processing time for the proposed fast WM is 188 ms for the large network size value of 1024.

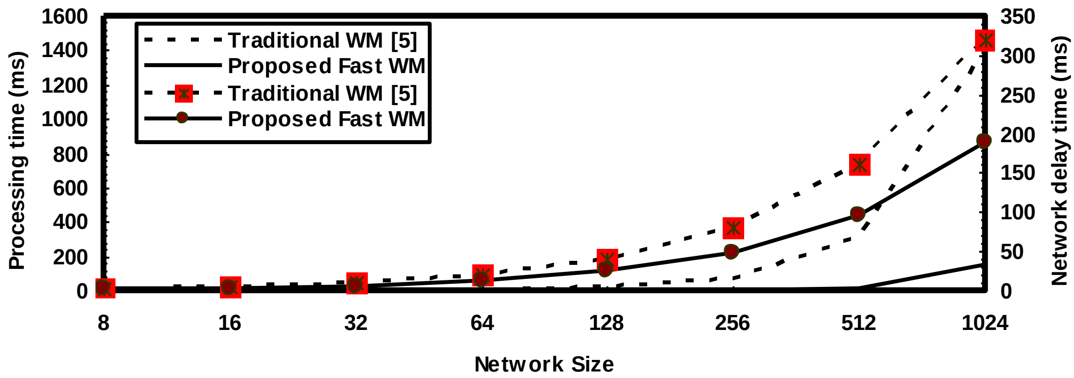

Figure 1. Processing time and network delay time variations against network size variations for the previous window method and the proposed fast window method

Figure 2 indicates the relation between the processing time and network delay time variations against network size variations for the previous improved window method and the proposed fast, improved window method. The processing time for the traditional improved window method is 0.18 ms, and the processing time for the proposed fast improved WM is 0.03 ms for the small network size value of 8. The processing time for the traditional improved window method is 30.35 ms, and the processing time for the proposed fast improved WM is 1.87 ms for the medium network size value of 128. The processing time for the traditional improved window method is 1228 ms, and the processing time for the proposed fast improved WM is 150 ms for the large network size value of 1024. In the same way, the network delay time for the traditional improved window method is 5 ms, and the network delay time for the proposed fast improved WM is 3 ms for the small network size value of 8. However, the network delay time for the traditional improved window method is 80 ms, and the network delay time for the proposed fast improved WM is 48 ms for the medium network size value of 128. The network delay time for the traditional improved window method is 500 ms, and the processing time for the proposed fast improved WM is 327 ms for the large network size value of 1024.

Figure 3 shows the relation between the processing time and network delay time variations against network size variations for the previous bitwise window method and the proposed fast bitwise window method. The processing time for the traditional bitwise window method is 0.28 ms, and the processing time for the proposed fast bitwise WM is 0.15 ms for the small network size value of 8. The processing time for the traditional bitwise window method is 50.35 ms, and the processing time for the proposed fast bitwise WM is 30 ms for the medium network size value of 128.

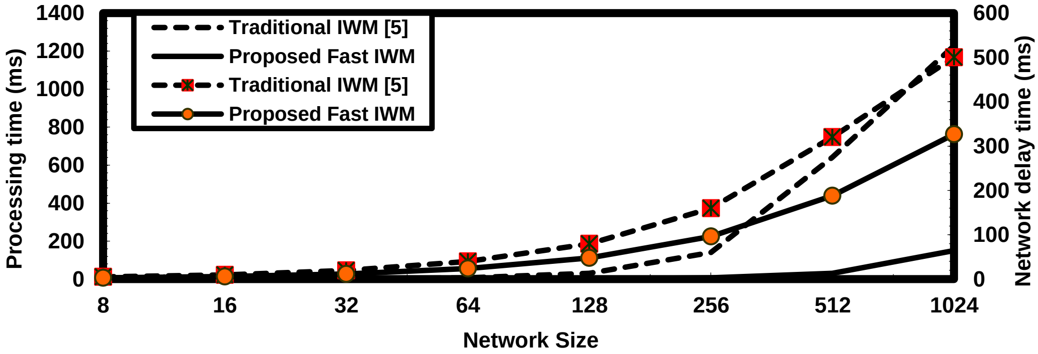

Figure 2. Processing time and network delay time variations against network size variations for the previous improved window method and the proposed fast, improved window method

The processing time for the traditional bitwise window method is 1564 ms, and the processing time for the proposed fast bitwise WM is 657 ms for the large network size value of 1024. In the same way, the network delay time for traditional bitwise window method is 0.36 ms, and the network delay time for the proposed fast bitwise WM is 0.1 ms for the small network size value of 8. The network delay time for the traditional bitwise window method is 5.65 ms, and the network delay time for the proposed fast bitwise WM is 1.6 ms for the medium network size value of 128. The network delay time for the traditional bitwise window method is 40.65 ms, and the processing time for the proposed fast bitwise WM is 13 ms for the large network size value of 1024.

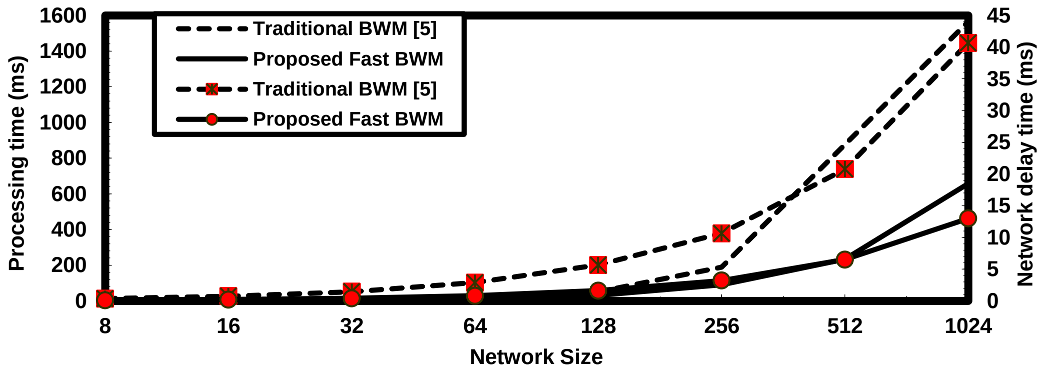

Figure 3. Processing time and network delay time variations against network size variations for the previous bitwise window method and the proposed fast bitwise window method

Figure 4 illustrates the relation between the processing time and network delay time variations against the network size variations for the previous Ascending algorithm and the proposed fast ascending window method. The processing time for the Ascending algorithm is 0.013 ms, and the processing time for the proposed fast Ascending WM is 0.0052 ms for the small network size value of 8. The processing time for the Ascending algorithm is 1.742 ms, and the processing time for the proposed fast Ascending WM is 0.217 ms for the medium network size value of 128. The processing time for the Ascending algorithm is 4.753 ms, and the processing time for the proposed fast Ascending WM is 0.319 ms for the large network size value of

1024. In the same way, the network delay time for the Ascending algorithm is 0.2 ms, and the network delay time for the proposed fast Ascending WM is 0.05 ms for the small network size value of 8. However, the network delay time for the Ascending algorithm is 3.2 ms, and the network delay time for the proposed fast Ascending WM is 0.8 ms for the medium network size value of 128. The network delay time for the Ascending algorithm is 25 ms, and the processing time for the proposed fast Ascending WM is 6.65 ms for the large network size value of 1024.

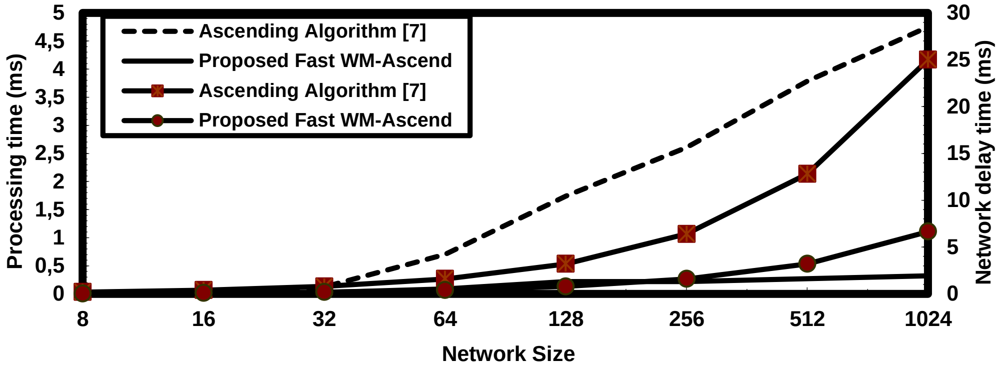

Figure 4. Processing time and network delay time variations against network size variations for the previous Ascending algorithm and the proposed fast ascending window method

Figure 5 clarifies the relation between the processing time and network delay time variations against the network size variations for the previous descending algorithm and the proposed fast descending window method. The processing time for the descending algorithm is 0.016 ms, and the processing time for the proposed fast descending WM is 0.0049 ms for the small network size value of 8. The processing time for the descending algorithm is 0.6715 ms, and the processing time for the proposed fast descending WM is 0.145 ms for the medium network size value of 128. The processing time for the descending algorithm is 1.243 ms, and the processing time for the proposed fast descending WM is 0.342 ms for the large network size value of 1024. In the same way, the network delay time for the descending algorithm is 0.031 ms, and the network delay time for the proposed fast descending WM is 0.027 ms for the small network size value of 8. The network delay time for the descending algorithm is 0.862 ms, and the network delay time for the proposed fast descending WM is 0.431 ms for the medium network size value of 128. The network delay time for the descending algorithm is 1.51 ms, and the processing time for the proposed fast descending WM is 0.746 ms for the large network size value of 1024.

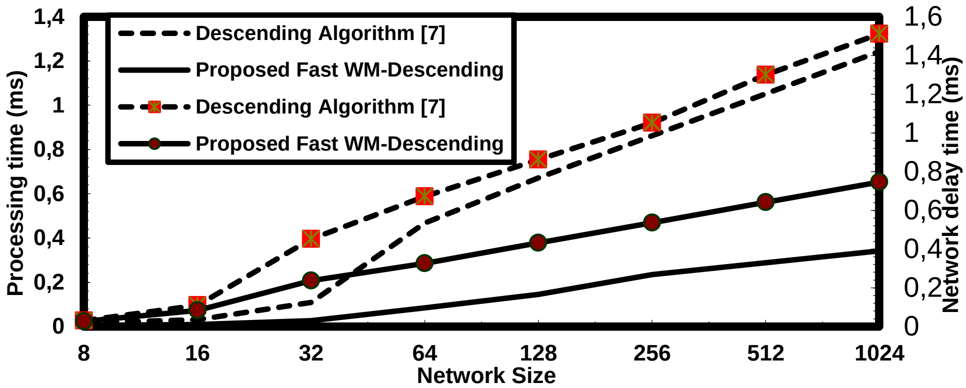

Figure 5. Processing time and network delay time variations against network size variations for the previous descending algorithm and the proposed fast descending window method

Figure 6 shows the relation between processing time and network delay time variations against the network size variations for the previous sequential algorithm and the proposed fast sequential window method. The processing time for the sequential algorithm is 0.01 ms, and the processing time for the proposed fast sequential WM is 0.005 ms for the small network size value of 8. The processing time for the sequential algorithm is 1.425 ms, and the processing time for the proposed fast sequential WM is 0.225 ms for the medium network size value of 128. The processing time for the sequential algorithm is 3.625 ms, and the processing time for the proposed fast sequential WM is 0.328 ms for the large network size value of 1024. In the same way, the network delay time for the sequential algorithm is 0.125 ms, and the network delay time for the proposed fast sequential WM is 0.085 ms for the small network size value of 8. The network delay time for sequential algorithm is 3.71 ms, and the network delay time for the proposed fast sequential WM is 0.387 ms for the medium network size value of 128. The network delay time for sequential algorithm is 6.413 ms, and the processing time for the proposed fast sequential WM is 0.595 ms for the large network size value of 1024.

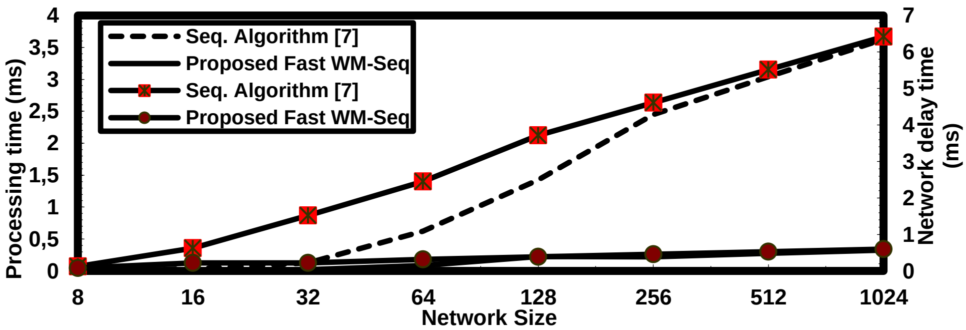

Figure 6. Processing time and network delay time variations against network size variations for the previous sequential algorithm and the proposed fast sequential window method

Figure 7 illustrates the relation between processing time and network delay time variations against the network size variations for the previous sequential down algorithm and the proposed fast sequential down window method. The processing time for the sequential down algorithm is 0.014 ms, and the processing time for the proposed fast sequential down WM is 0.004 ms for the small network size value of 8. The processing time for the sequential down algorithm is 0.68 ms, and the processing time for the proposed fast sequential down WM is 0.154 ms for the medium network size value of 128. The processing time for the sequential down algorithm is 1.256 ms, and the processing time for the proposed fast sequential down WM is 0.3089 ms for the large network size value of 1024. In the same way, the network delay time for the sequential down algorithm is 0.031 ms, and the network delay time for the proposed fast sequential down WM is 0.025 ms for the small network size value of 8. The network delay time for the sequential down algorithm is 0.873 ms, and the network delay time for the proposed fast sequential down WM is 0.303 ms for the medium network size value of 128. The network delay time for the sequential down algorithm is 1.58 ms, and the processing time for the proposed fast sequential down WM is 0.507 ms for the large network size value of 1024.

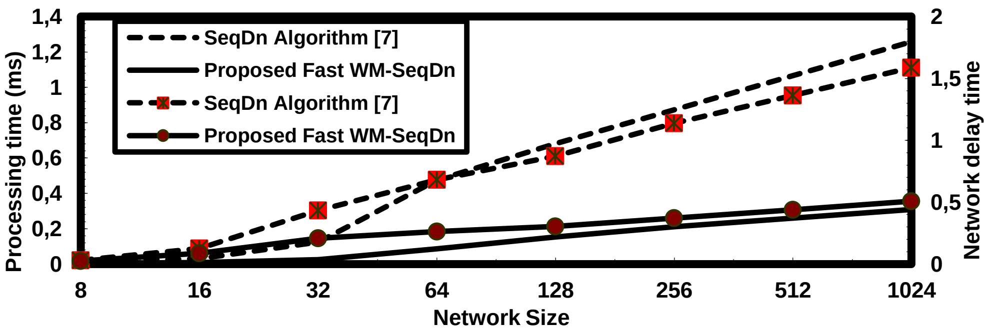

Figure 7. Processing time and network delay time variations against network size variations for the previous sequential down algorithm and the proposed fast sequential down window method

The network blocking probability variations versus network size variations for various fast window methods and proposed routing algorithms is shown in Figure 8. The blocking probability for the WM is 0.0009 for the small network size value of 8. The blocking probability for the WM is 0.0054 for the medium network size value of 128. The blocking probability for the WM is 0.0098 for the large network size value of 1024. The blocking probability for improved WM is 0.0003 for the small network size value of 8. The blocking probability for the improved WM is 0.0058 for the medium network size value of 128. The blocking probability for the improved WM is 0.0987 for the large network size value of 1024. The blocking probability for BWM is 0.0015 for the small network size value of 8. The blocking probability for BWM is 0.254 for the medium network size value of 128. The blocking probability for BWM is 0.3321 for the high network size value of 1024. The blocking probability for fast ascending WM is 0.0052 for the small network size value of 8. The blocking probability for fast ascending WM is 0.217 for the medium network size value of 128, while the blocking probability for fast ascending WM is 0.319 for the large network size value of 1024. The blocking probability for fast descending WM is 0.004 for the small network size value of 8, but the blocking probability for the fast descending WM is 0.145 for the medium network size value of 128. Meanwhile, the blocking probability for fast descending WM is 0.342 for thelarge network size value of 1024. The blocking probability for the fast sequential WM is 0.005 for the small network size value of 8, but the blocking probability for fast sequential WM is 0.225 for the medium network size value of 128. Meanwhile, the blocking probability for fast sequential WM is 0.328 for the large network size value of 1024. The blocking probability for the fast sequential down WM is 0.0046 for the small network size value of 8, but the blocking probability for fast sequential down WM is 0.1542 for the medium network size value of 128. The blocking probability for the fast sequential down WM is 0.3089 for the large network size value of 1024.

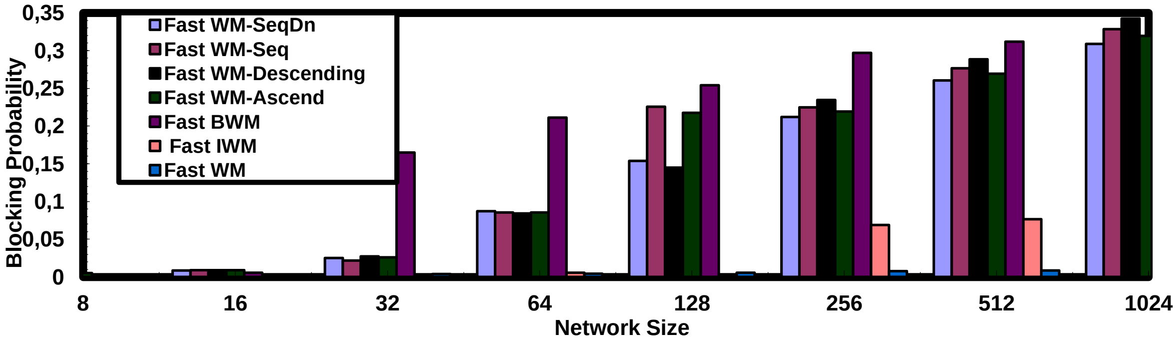

Figure 8. Blocking Probability variations versus network size variations for various fast window methods and the proposed routing algorithms

4. CONCLUSION

We have studied various routing algorithms and different fast window methods for upgrading the performance of optical computing networks. The processing time and network delay time variations against the network size variations for the previous routing algorithms and the proposed routing algorithms have been measured. In the same way, the Processing time and network delay time variations against the network size variations for the traditional window methods and the proposed fast window methods have been verified. The proposed fast window methods and routing algorithms presented a better network performance efficiency than the traditional window methods and the conventional routing algorithms. The fast window method presented the lowest network blocking probability compared to the other proposed window methods.

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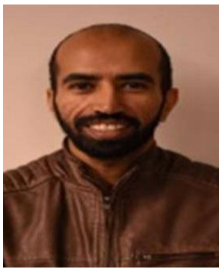
BIOGRAPHIES OF AUTHORS



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