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Shuffle Exchange Diagonal Mesh Interconnection Network

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Abstract*: The Shuffle Exchange Diagonal Mesh (SEDM) interconnection network uses the properties of the mesh, diagonal links and the shuffle-exchange to form a hybrid interconnection network in place to enhance the efficiency of communication in parallel computing systems. SEDM enhances performance by reducing network diameter and average path length and as a result decreases communication latency and increases fault tolerance. Its architecture is consistent and exhibits a regular structure that is suitable to VLSI implementation and it scales. Fault resilience and flexibility of data routing is enhanced by the inclusion of diagonal links and shuffle links thus liberating the topology when compared with conventional mesh and shuffle-exchange networks. Applications that depend on reliable and quick inter-processor communications gain a lot using this design. A de facto prospective design to next-generation multiprocessor systems is SEDM as it poses a reasonable compromise between complexity, performance and cost.*

Keywords*: Traffic patterns, Meshes, OMNET, Interconnection networks*

I. Introduction

Distributed and parallel computing systems Pentium/Dual-Pentium workstations require efficient interconnection networks that will support high-speed processor communications. The performance of such systems is greatly affected by the underlying network topology that defines the efficiency of data routing, the latency, fault tolerance, and scalability of such systems. The traditional connectivity networks, example: mesh and shuffle-exchange, are also quite advantageous yet have their disadvantages when used independently. To allow transgressing these constraints, Shuffle Exchange Diagonal Mesh (SEDM) interconnection network is an innovative hybrid architecture using the benefits of diagonal, mesh, and shuffle-exchange interconnections.

The SEDM architecture enhances communication because the average path length and the network diameter are reduced, resulting in reduced latency and increase throughput. It incorporates local-communicating mesh links, fault tolerant and additional routing capabilities with diagonal linkages and global connectivity with shuffle-exchange links. Due to hybrid nature SEDM has potential to support efficient transfer of data across the network with maintaining reasonable scalable and regular structure suitable to VLSI design. The SEDM network avoids complexity, performance, and cost trade-offs by meeting the ever-increasing demand of high-performance interconnect to achieve the multiprocessor systems. Due to its robust design, it can be applied to many environments, including data centers, real-time processing workloads as well as scientific computing [1].

II. Preliminaries and Background

Basic network topologies applied in parallel computing, which are extended in the Shuffle Exchange Diagonal Mesh (SEDM) interconnection network, are the mesh, shuffle-exchange and diagonal interconnect. The mesh topology is also familiar with simple and grid-like structure that can be easily built and locally connected. It however has wider communication latency across longer distances. The shuffle-exchange network enables better global connectivity, and has shorter paths, although it is neither resilient nor scalable [2-4]. Fault resilience and a reduction in network diameter are achieved by the addition of diagonal relationships to a mesh. Apposition of these three allows SEDM to provide a hybrid topology that exploits the strength of diagonal connections, the local of mesh, and global of shuffle-exchange. This combine assures additional scope in latency, throughput, and scalability of the system in parallel structures.

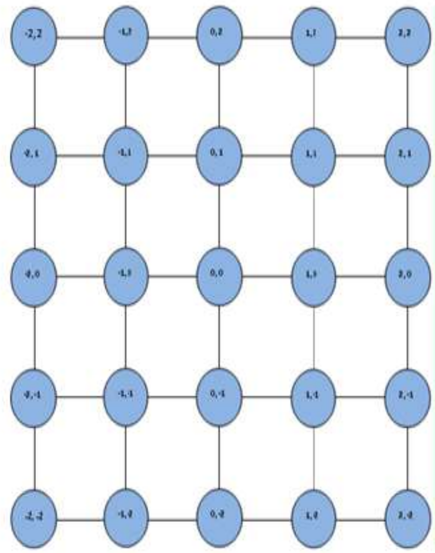

Fig 2: Mesh analysis 2D

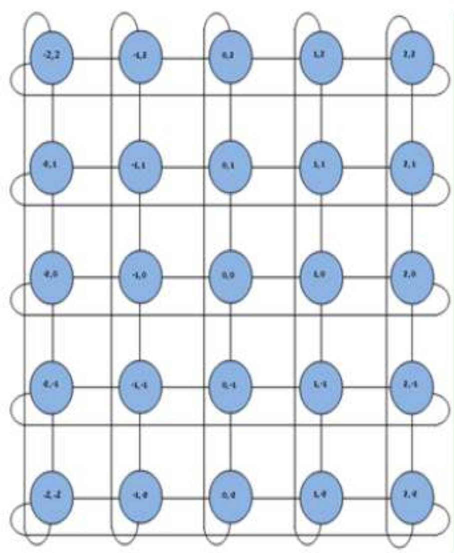

Fig 2: 3D Mesh analysis

III. Diagonal Mesh Interconnection Network (DMIN)

Diagonal Mesh (DMESH) Interconnection Network is an enhanced version of the usual 2D meshed topology which is commonly applied in massively parallel computing systems. Each node on a common mesh network would be connected to their respective neighbors in the north, south, east and west making a grid like arrangement. The mesh networks are easy to configure and expand, but larger average delays between communication and networks diameter tend to occur with added nodes. To avoid these limitations Diagonal Mesh (DMESH) topology is formed by adding diagonal links to the mesh. DMESH minimizes the diameter of the network and provides other routing possibilities by adding each node one additional connection each to its neighbors on the diagonal (northeast, northwest, southeast, and southwest).

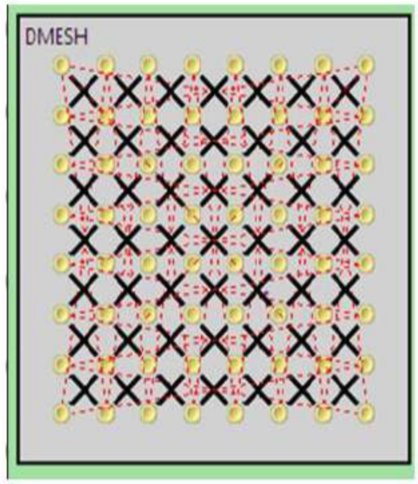

Fig 3: Omnet D mesh

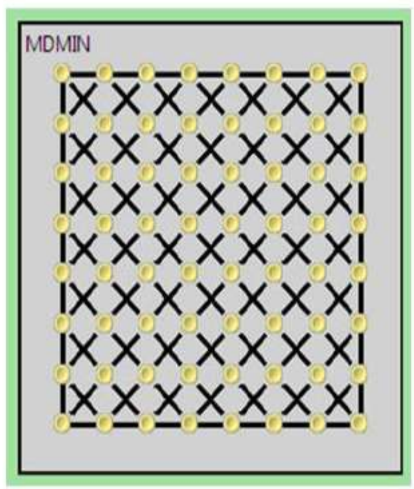

Fig 4: Designed on Omnet MDMIN

This extra links enhances fault tolerance, reduce latency and accelerate communication by bypassing failures of nodes or links, as redundant links are typically inserted in the path. Diagonal networks also enhance throughput to a given node and mitigate congestion, as the mean number of hops, on average, per node required to transfer data decreases. DMESH maintains uniformity of structure that is suitable to VLSI implementation and hardware design. The DMESH is an absolutely necessary substructure of the Shuffle Exchange Diagonal Mesh (SEDM) which enhances general robustness and functioning of the network in the end [1-3].

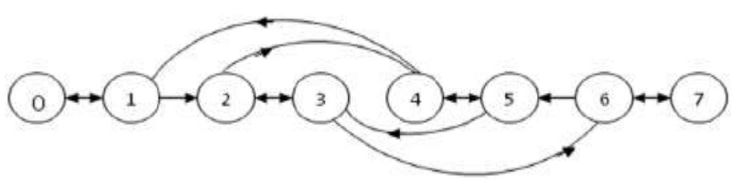

Fig 5: Shuffle exchange architecture

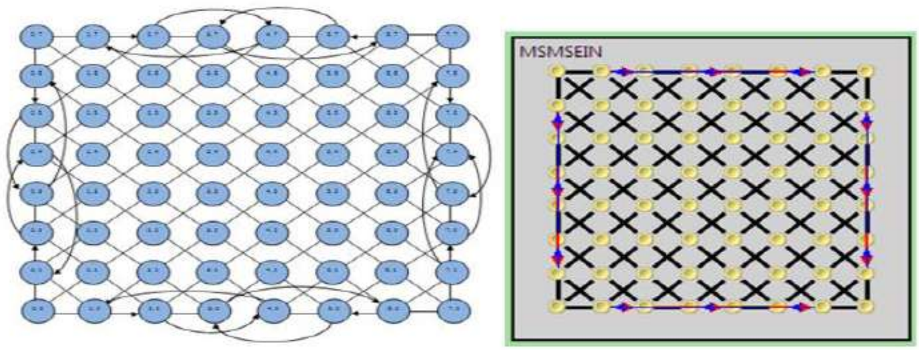

Fig 6: OMNeT version architecture

IV. Comparative Discussion and Analysis

The most common among them, mesh, shuffle-exchange and diagonal mesh can be interconnected in a new manner: with the help of the Shuffle Exchange Diagonal Mesh (SEDM) interconnection network. This hybrid architecture significantly improves performance, fault tolerance and communicational efficiency over the traditional networks [5]. When compared to the standard mesh networks, SEDM offers greater advantages due to a smaller network diameter and an average number of hops, which results in reduced latency and the improved speed of data transfer. Since SEDM uses mesh and diagonal links, it is more scalable and reliable than all shuffle-exchange networks. The shuffle-exchange linkages ensure a better global connectivity offered by SEDM as compared to Diagonal Mesh (DMESH) which is a crucial advantage when it comes to long distance communications within large networks.

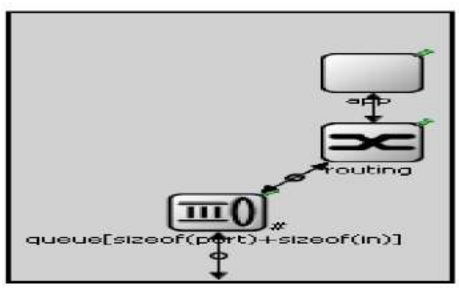

Fig 7: Omnet module nodes

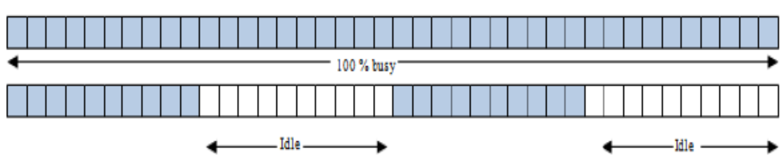

Fig 8: Channels with different percentages

This will enhance data speed and minimizing communication sluggishness. Additionally, the presence of multiple possible routes used in the data routing process enhances the capability of fault tolerance found with the diagonal and the shuffle-exchange connection. SEDM has additional links per node that increases the cost and difficulty of design in hardware regard. But the performance benefits caused by the difference in cost are quite sufficient especially in multiprocessor systems where performance gain becomes measurable. Overall, SEDM trades off between fault tolerance, scalability, high throughput, and low latency and can outperform other systems under high-performance computing conditions; thus, is a nice choice to be used in high-performance computing and the new parallel processing systems.

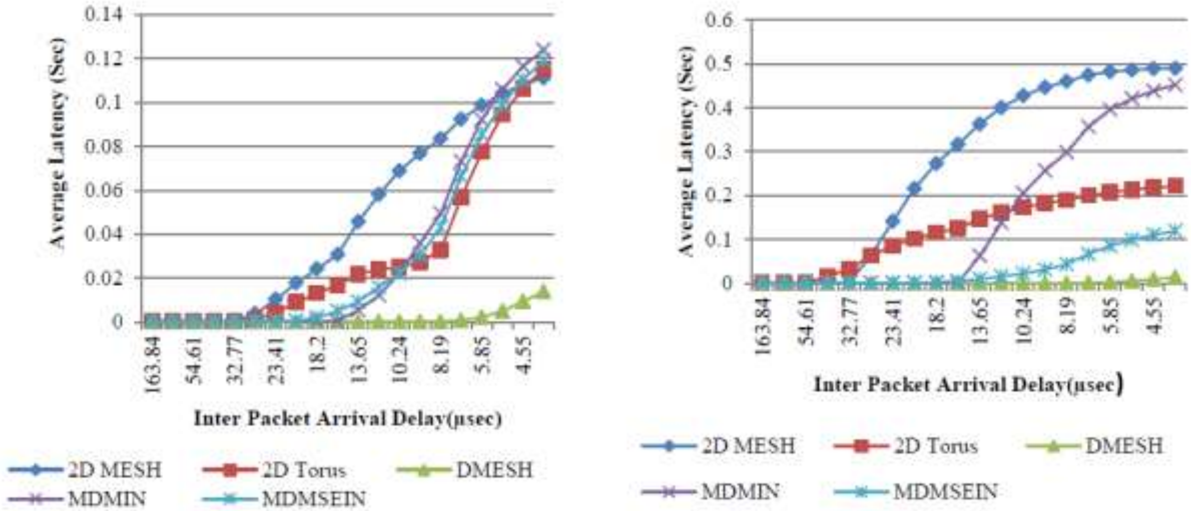

Fig 9: Average Latency on different traffic

References

[1] Chie Lee and Yadav Kumar. "An Matrix Converter using Array System in Power Electronics in Communication Systems". Springer Conference in Hindustan University, Chennai, VOL. 2, NO. 3, March 2009

[2] Saritha, Srikanth, Subhakar and Sunitha, "A Process control system in Industrial Applications using Thyristors in power electronics for PMSG",". Elsevier 2011. China, 7 – 9, January 2012.

[3] Niharika, Lakshman Reddy and Shanchie, "A Novel of MIMO concepts in wireless relay networks in Space Time and Space Frequency in achieve diversity", " IEEE Conference Proceedings on Innovative Research in Communication Systems (IRCS), International Conference. vol. 2, pp. 67 – 75, January. 2010

[4] John Diesel, Shang Chee and Cooper Lee, "Standalone Grid system for On and OFF modes Using Renewable energy sources using PMMC Technology', "Springer Proceedings on Green Energy on World environmental Day", IEEE conference proceedings held at Madras University, on the 20tt Century. pp.10-19, 2020

[5] F Max Savio, M Sasi Kumar. "An Effective Control Technique for an Impedance Source Inverter Based Wind Energy System". 2012 IEEE International Conference on Emerging Trends in Electrical Engineering and Energy Management (ICETEEEM-2012)

[6] Sasikumar M and Chenthur Pandian S. "Characteristics Study of ZSI For PMSG Based Wind Energy Conversion Systems". Journal of Electrical Engineering (JEE). ISSN: 1582-4594.