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Study of Perfect Difference Network: Review

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Abstract -In this paper, we focus on D=2, the next best value to that of the complete network, and proceeding to somewhat larger (constant) values leading to more economical networks. We show that perfect difference networks (PDNs), which are based on the mathematical notion of perfect difference sets, offer a diameter of 2 in an asymptotically optimal manner. In other words, PDNs allow O (d2) nodes when nodes are of degree d, or, equivalently, have a node degree that grows as the square-root of the network size. The symmetry and rich connectivity of PDNs lead to balanced communication traffic and good fault tolerance for wired network.

Keywords-economical, network, PDNs, fault tolerance

I. INTRODUCTION

Interconnection networks have been studied by mathematicians, computer designers and computer scientists intensively because of their applicability in large number of areas. Study of the interconnections is of particular interest when a computer network is implemented as low latency, high bandwidth, energy efficiency, and robustness are some of the properties that are sought in networks for parallel and distributed computing. Given that network performance parameters depend not only on the network architecture but also on a number of factors relating to applications and their data exchange characteristics, the challenge in interconnection network design is

Finding the right match between communication needs of applications on one side and capabilities and limitations inherent in each architecture on the other. Moreover, cost of implementation of particular network architecture for a given number of terminals and its ease of implementation also plays a major role in choosing which type of network interconnection should be implemented. It is easy to consider complete graph connectivity but it suffers some major limitations when it is considered for large systems that are of practical interest, due to both the high cost of nodes with many communication channels and lack of scalability for system growth. Hence, it is obvious that under the circumstances when we cannot implement a complete graph connectivity network with diameter

1, we will definitely like to implement a network interconnection having diameter 2 and thus perfect difference network comes into the scene. The following paragraphs are aimed at throwing some light on what perfect difference network is, its history and some other aspects concerning research work done on this subject.

II. LITERATURE REVIEW

Perfect difference sets were first discussed in 1938 by J. Singer. The formulation was in terms of points and lines in a finite projective plane, therefore it was not at all considered so much important until it was incorporated into perfect difference network [2]. The perfect difference sets were considered a really good prospect for being developed into a network mainly through the works of Dr. Behrooz Parhami and Dr. Mikhail A. Rakov.

In their paper[1] they have discussed low-diameter networks, beginning with D=2, the next best value to that of the complete network, and then proceeding to somewhat larger (constant) values leading to more economical networks. They have showed that perfect difference networks (PDNs), which are based on the mathematical notion of perfect difference sets, offer a diameter of 2 in an asymptotically optimal manner. In other words, PDNs allow O(d2) nodes when nodes are of degree d, or, equivalently, have a node degree that grows as the square-root of the network size. They also showed that symmetry and rich connectivity of PDNs lead to balanced communication traffic and good fault tolerance. And finally they proved that multidimensional PDNs offer a tradeoff between cost and performance in the sense that for any constant number q of dimensions, a q-dimensional PDN has diameter D = 2q and node degree that grows as the (2q)th root of n [2].

In their yet another paper [2], they have proposed an asymptotically optimal method for connecting a set of nodes into a perfect difference network (PDN) with diameter 2, so that any node is reachable from any other node in one or two hops. They have shown that PDN interconnection scheme is optimal in the sense that it can accommodate an asymptotically maximal number of nodes with smallest possible node degree under the constraint of the network diameter being 2. They have bisection width of a PDN. They concluded that PDNs and their derivatives constitute worthy additions to the repertoire of network designers and may offer additional design points that can be exploited by current and emerging technologies, including wireless and optical interconnects [3].In the companion paper to the above paper [3], they have compared PDNs and some of their derivatives to interconnection networks with similar cost/performance, including certain generalized hypercubes and their hierarchical variants. Additionally, they have also discussed point-to-point and collective communication algorithms and have derived a general emulation result that relates the performance of PDNs to that of complete networks as ideal benchmarks. They have shown that PDNs are quite robust, both with regard to node and link failures that can be tolerated and in terms of blandness (not having weak spots). In particular, they have proved that the fault diameter of PDNs is no greater than 4. Finally, they have studied the complexity and scalability aspects of these networks, concluding that PDNs and their derivatives allow the construction of very low diameter networks close to any arbitrary desired size and that, in many respects, PDNs offer optimal performance and fault tolerance relative to their complexity or implementation cost [3].

In the paper[4] some light has been thrown on the various properties of periodically regular rings and on those of swapped interconnection networks respectively, which is equally helpful in understanding the various properties of perfect difference networks and their applicability.

Dr. Mahendra Gaikwad under the guidance of Dr. Rajendra Patrikar has implemented PDN in Network-on-Chip (NoC) and also purposed energy model in paper [5]. The proposed energy model is then validated against the simulation results obtained with Inter-tile link geometry and PDN circular geometry for NoC architecture. In paper [6] Dr. Sudhir G. Akojwar under the guidance of Dr. Rajendra Patrikar has implemented PDN in Wireless Sensor Networks (WSN), where nodes are randomly deployed. Most of all protocols in WSN are designed for its random deployment. Projective Geometry can be used for the fixed-geometrical deployment of wireless sensor nodes. Which leads to reduces the cost and optimization of network can be achieved using Perfect Difference Set (PDS).

The paper [7] gives the brief introduction of Perfect difference Network(PDN). PDN is an asymptotically optimal method for connecting a set of nodes into a Perfect Difference Network (PDN) with diameter 2, so that any node is reachable from any other node in one or two hops utmost. It is mainly based on the mathematical notion "the Perfect Difference Sets". This paper proposed simulated result of the data transmission in PDN and the bandwidth and latency explained by a graph using NS2. This paper give introduction of NS2 and how to run tcl file in NS2. Perfect Difference Network deigns for =2 and node is 7. PDNs have a diameter of 2 and a node degree of approximately 2, which place them close to complete networks in terms of routing performance and much lower with respect to implementation cost. The rich connectivity and small diameters of PDNs and related networks make them good candidates for wireless/optical network technologies. The paper in [8] Give brief introduction of Perfect Difference Network (PDN) and done simulation of PDN by using NS2. A simulated result of the data transmission in PDN for δ value 2 & 3 for wired network and later analysis of trace file to find the Throughput. This paper based on simulation part of PDN for δ value 2 & 3. .It primarily shows the communication from one node to the other node. Some conditions are so arising in which the links are made down. So in this case it finds the other way which is again optimums and reaching the destination in which we find it tries to find simple 2 hop path but if more number of links are failed then at most it find 4-hop path. At end of the this paper , the results are very different than what expected and though there are link failures during the transition of data but the throughput graph shows the steady output for both the values of 'δ' in wired network.

The paper [9] have shown some properties of hypercube and compared them with corresponding properties of PDN. This paper gives some brief introduction of Perfect difference network and hypercube network. Some topological properties of hypercube make them attractive. Hypercube degree and diameter are equal so it achieves good balance between the communication speed and complexity. This paper show broadcasting of packet in perfect difference Network for PDS {0,1,3} , n=7 and hypercube network. Discuss some topology properties of hypercube and Perfect difference Network that are given follow:-

(1) PDN provides a large advantage over the hypercube architecture. PDN exist every prime power but hypercube exist only for the power by 2.

(2) Hypercube have large gaps in size of system then PDN.

(3) Diameter of hypercube is n and the diameter of PDN is 2.

(4) Degree of hypercube is n and degree of PDN is 2 □.

(5) Hypercube contain 2n node and n links, but PDN has (□2 + □ + 1) node and □ (□2 + □ + 1) link.

(6) All connection of a hypercube node meets at right angles with respect to each other, where PDN connection makes a chordal ring.

(7) Hypercube achieves good balance between communication speed and the complexity of the topology network then PDN.

III. APPLICATIONS OF PERFECT DIFFERENCE NETWORK

PDN can be used for Network-on-Chip (NoC). NoC is a technique based on System-on-Chip (SoC) which attempts to provide high performance nanoscale architectures. Network can be made reusable by separating the communication infrastructure from computing resources. Using PDN based on PDS, an energy aware model for NoC can be obtained which saves significant energy as compared to inter-tile geometry of NoC architecture .

PDN can be used in designing the Wireless Sensor Networks (WSN). Wireless Sensor Nodes are battery powered and thus optimizing their energy consumption is a major issue. Wireless Sensor Nodes have 3 units: sensing, computation and communication, communication unit consumes the largest energy. If the Wireless sensor nodes are deployed using PDS-Networks then all the nodes in the network knows their relative as well absolute position this removes the need of Location finding system in the Wireless Sensor Node and hence simplifies the routing technique.

The PDN topology and its various derivatives are well suited to meet the" graph search" challenge. "Graph search" initiative underway at Facebook, which seeks to find and harvest the hidden information originating in its own network in the billions of interconnections among more than a billion nodes.

IV. CONCLUSION

This paper describes perfect difference Network is an asymptotically optimal method for connecting a set of nodes into a Perfect Difference Network (PDN) with diameter 2, so that any node is reachable from any other node in one or two hops utmost. It is mainly based on the mathematical notion "the Perfect Difference Sets" given by "Singer". Perfect difference network is a robust, high-performance interconnection network for parallel and distributed computation. PDNs have a diameter of 2 and a node degree of approximately 2, which place them close to complete networks in terms of routing performance and much lower with respect to implementation cost. Complete Network has good performance but it is costly and no scalability.

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