ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 6, June 2015

On the Numbering of Nodes in a Computer Communication Network

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ABSTRACT: The goal of the topological design of a computer communication network is to achieve a specified performance at a minimal cost. Unfortunately, an exact algorithm to solve this problem is exponential in behavior. So a reasonable approach is to generate a potential network topology. In the heuristic given by Steiglitz, Weiner and Kleitman for generating a potential network topology, the nodes of the network are numbered at random. Srivatsa and Seshaiah have developed a heuristic for numbering the nodes in a systematic manner. In this paper, we show that if the number of nodes in a computer communication network does not exceed four, any arbitrary numbering of the nodes will give rise to the same starting network.

KEYWORDS: Topological design, computer networks, link deficit algorithm, starting network, K-connected network.

1. INTRODUCTION

The terms 'Topological Design of a Computer Communication Network', 'Link deficit algorithm' and K-connected network' have the usual meaning [1,2,3].

The fastest available computers cannot optimize a 25-node network let alone a 100-node network. So a potential network topology (starting network) is generated and tested to see if it satisfies connectivity and delay constraints. If not the starting network topology is subjected to a small modification ("perturbation") yielding a slightly different network, which is now checked to see if it is better [4]. If a better network is found, it is used as the base for more perturbations. If the network resulting from perturbation is not better, the original network is perturbed in some other way. The process is repeated till the computer budget is used up.

A popular heuristic for generating a starting network is due to Steiglitz, Weiner and Kleitman and is called the link deficit algorithm [1]. This heuristic begins by numbering the nodes of the network at random. Srivatsa and Seshaiah [2] have given a systematic method for numbering the nodes of a network. When the nodes are numbered in a systematic method for numbering the nodes of a network. When the nodes are numbered in a systematic fashion, the starting network thereafter obtained will need relatively lesser amount of perturbation before an acceptable network is found.

II. THEOREM

If the number N of nodes of a computer communication network does not exceed four, then any arbitrary numbering of nodes will give rise to the same starting network.

An exhaustive proof follows:

Case1: N =1. This corresponds to a stand-alone processor and we do not have a network.

Case2: N =2. The two nodes A and B are as shown in Fig 1.

Fig 1

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Vol. 4, Issue 6, June 2015

Any numbering gives rise to the same starting 1-connected network as shown in the Fig 2.

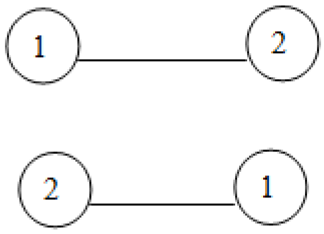

Fig 2

Case 3: N= 3. The geographical positions of the three nodes A, B and C are shown in Fig 3.

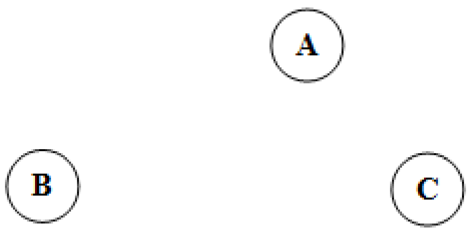

Fig 3

Case 4: N=4. The geographical positions of the four nodes of a network are shown in Fig 6.[6,7]

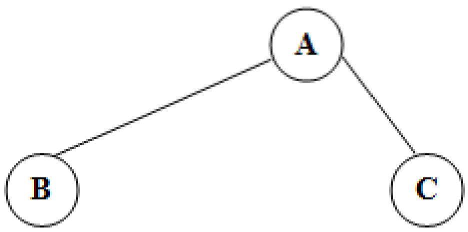

Fig 4

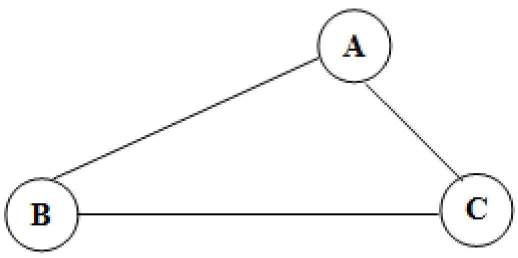

Fig 5

The nodes can be numbered in 4! or 24 different ways. Application of the link deficit algorithm yields the same starting 1-connected network as shown in Fig 7.
The nodes can be numbered in 3! or six different ways and application of the link deficit

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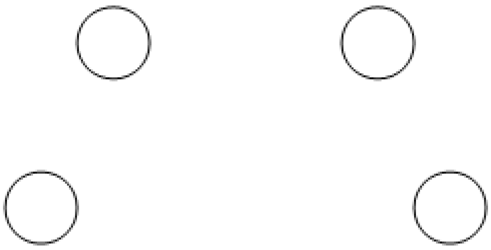

Fig 6

algorithm gives the same starting 1-connected network as shown Fig 4.

For all the six ways of numbering three nodes, application of the link deficit algorithm gives the same starting 2 – connected network as shown in

Fig 7

If however, a 2-connected starting network is sought, the application of the link deficit algorithm gives the same starting network as shown in Fig 8.[8,9]

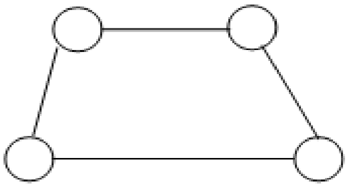

Fig 8

In addition, if a 3 connected starting network is sought, the application of the link deficit algorithm, in all the 24 cases, gives the same starting network as shown in Fig 9.[10]

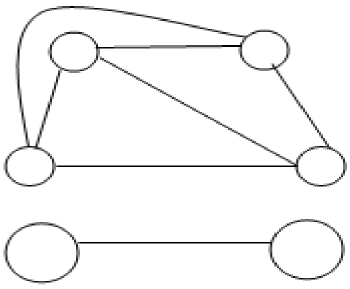

Fig 9

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ISSN (Online): 2278 – 8875

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Vol. 4, Issue 6, June 2015

This completes the proof of the theorem.

It is easy to see that if the number of nodes exceeds 4, different numberings of the nodes lead to different starting networks.

III. CONCLUSION

In general, different numberings of the nodes of a network lead to different starting networks and different starting networks need different amounts of perturbation. We have shown that if the number of nodes in a computer communication network does not exceed four, any labeling of the nodes leads to the same starting network.

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