On Some Aspects of Design of Cheapest Survivable Networks

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Abstract
The goal of topological design of a computer communication network is to achieve a specified performance at a minimal cost. Unfortunately, the problem is completely intractable. A reasonable approach is to generate a potential network topology. One such heuristic for generating a potential network topology is due to Steiglitz, Weiner and Kleitman and is called the link deficit algorithm. This paper presents an unusually cute method for designing a K-connected computer communication network when all the nodes of the network are equispaced and lie on a circle.

Keywords:
Topological design, Computer Networks, link deficit algorithm, K-connected network, starting network, survivable network.

1. ntroduction

The terms K-connected network, survivable network, starting network, link deficit algorithm and topological design have the usual meanings [1, 2, 3, 4, 5, 6, 7, and 8].

The goal of the topological design of a computer communication network is to achieve a specified performance at a minimal cost. Unfortunately, the problem can be solved only by using exponential algorithms and as such, the problem of topological design is completely intractable [2]. The fastest available super computers cannot optimize a 25-node network, let alone a 100-node network. Thus, a reasonable approach is to generate a potential network topology (called a starting network) and see if it satisfies connectivity and delay constraints. If not, the starting network is subjected to small modification (called perturbation) to yield a slightly different network which is now checked to see if it

is better. If a better network is formed, 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. This process is repeated until the computer budget is used up [4, 5].

One of the many heuristics for generating a starting network is the link deficit algorithm [6]. Gerla and Kleinrock have presented a link elimination algorithm [1]. We present a cute and novel algorithm for carrying out the topological design when the nodes of a network form a regular polygon (i.e. they are equispaced and lie on a circle).

2.Algorithm

We use the notation $G_{K,\ n}$ to stand for a K-connected graph having n-vertices. It is well known that $K \leq$ n-1 [1].

Case I: K is even and n is either even or odd

Here every node (vertex) is directly connected to the nearest K/2 vertices in each direction around the circle-giving rise to a K-connected network.

Case II: K is odd and n is even

Here every vertex is directly connected to the nearest (K-1)/2 vertices in each direction and in addition, vertices which are diametrically opposite to one another are connected resulting in a K-connected network.

Case III: K and n are both odd

First the graph $G_{K-1,n}$ is constructed; as indicated above. Every vertex 'i' is directly connected to every vertex i + (n-1)/2 for all $0 \leq$ i $\leq$ (n-1)/2. The graph $G_{K,\ n}$ results.

3. Illustrative Examples

Example 1: Eight vertices are equispaced and lie on a circle. Design a 4-connected network.

Solution: Here K is even. Every vertex is connected to nearest 4/2 or 2 vertices in either direction giving the graph $G_{4,\ 8}$ as shown in Fig.1.

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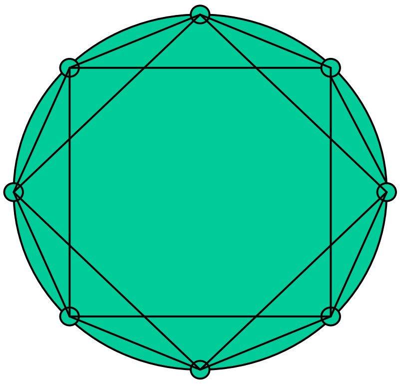
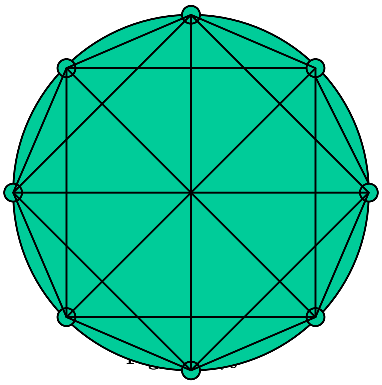


Fig 1:$G_{4,8}$

Example 2: Eight vertices are equispaced and lie on a circle. Design a 5-connected network.
Solution: Here K is odd and n is even.
Every vertex directly connected to the nearest (K-1)/2=2 vertices in either direction and geometrically opposite vertices are directly connected yielding $G_{5,8}$ as shown in Fig. 2.



Example 3: Nine vertices are equispaced and lie on a circle. Design a 5-connected network.
Solution: The vertices are labeled 0 through 8.
Here, both K and n are odd. The graph $G_{4,9}$ is drawn first. Every vertex i is connected to i+ (9-1)/2 = i+4 for all $0 \le i \le 4$. This results in graph $G_{5,9}$ as shown in Fig 3.

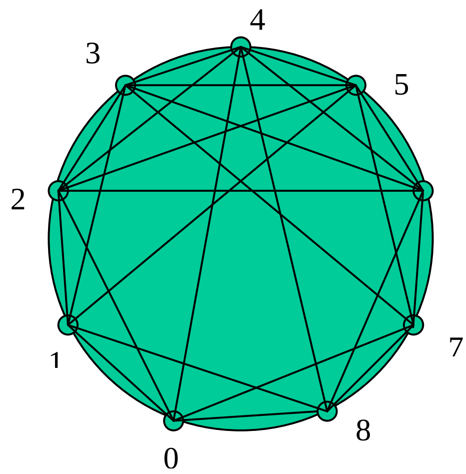


Fig 3: $G_{5,9}$

4. Conclusion

This paper presents a novel and cute algorithm for the topological design of a K-connected computer network when the nodes of the network form a regular polygon (i.e. they are equispaced and lie on a circle). The algorithm has been illustrated by examples.

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