Parallel Processing Letters,

SPECIAL ISSUE ON GRAPH THEORY AND COMMUNICATION NETWORKS

ARTHUR M. FARLEY and ANDRZEJ PROSKUROWSKI
Departament of Computer and Informatino Science, University of Oregon
Eugene, Oregon USA
E-mail: {art,andrzej}@cs.uoregon.edu

Received November 1997
Revised February 1998
Communicated by Prof. M. Cosnard

This volume of PPL contains papers presented or announced at the "International Workshop on Graph Theory and Communication Networks" that took place 15–18 July 1996 on the University of Oregon campus in Eugene, Oregon. The workshop was the sixth in a series of workshops with locations alternating between North America (*International Workshop on Broadcasting and Gossiping*) and Europe (*International Workshop on Interconnection Netoworks*). These workshops attract an diverse, interdisciplinary community of researchers addressing network communication problems from a graph-theoretic perspective.

Of twenty-two papers submitted, we have selected twelve for presentation in this edition. The papers selected for this special edition fall into one of two general topic areas:
(i) networks and algorithms for complex information dissemination tasks,
(ii) locating particular, regular graph topologies in other given graphs.

The first topic is one that has been of interest to this research community for nearly 20 years. It involves the design of efficient network structures and algorithms for broadcasting and gossiping among network sites. *Broadcasting* is the information dissemination process whereby a message, initially known by one site (or a subset of sites) as source becomes known to all sites. *Gossiping* is the process whereby all sites, each acting as source of a message, become informed of all messages. Thus, broadcasting is a one-to-all communication process, while gossiping is an all-to-all process. By varying constraints on calling protocols and by adjusting definitions of cost functions, a number of intriguing problems have been considered. Issues of reliability in communication networks and algorithms also have been addressed.

Several papers in this special edition consider broadcasting. Assuming a site can only call one neighbor at any time (i.e., single-port assumption), the lower bound on the broadcasting time is clearly logarithmic; the number of sites that are informed of a message can at most double over a time unit. Much research has been done on defining classes of graphs that provide for minimum-time broadcast from every site, i.e., *minimal broadcast networks* (see Hedetniemi *et al.* [2] for a survey of results). One problem of interest has been finding minimal broadcast networks having the fewest possible edges for a given number of sites (see Farley *et al.* [1] for classical results.)

Minimal broadcast networks minimize the maximum time required to broadcast over all sites as message source. Liestman and Przulj, in "Minimum Average Time Broadcast Networks", present a definition of networks that minimize the average (or sum) of times that sites become informed of a message during a broadcast for certain numbers of sites. This is a stricter requirement than minimizing maximum broadcast time, so a greater than or equal number of edges are required in these optimal graphs. In "Messy Broadcasting", Harutyunyan and Liestman consider a broadcast process in which each site acts as a relatively independent agent, eliminating much of the coordination found in optimal broadcast algorithms. They consider three models of such broadcasting, differing in what a site knows about its past behavior and about the informed states of its neighbors.

In "Global Communication on Circuit-switched Toroidal Meshes", Peters and Spencer consider both broadcasting and gossiping in toroidal meshes, using a linear cost model to compare the performance of optimal, single-port and multi-port algorithms. Diks et. al. consider the message complexity of broadcasting in networks without local sense of direction in "Broadcasting in Unlabeled Toroids". Fujita, Perennes and Peters, in "Neighbourhood Gossiping in Hypercubes", consider a variant of gossiping wherein sites need only become informed of only their neighbors' messages rather than all other messages. They establish upper and lower bounds on time required, assuming a single-port algorithm and either one-way or two-way communication lines. Hromkovic et. el., in "Effective Systolic Algorithms for Gossiping in Cycles" establish tight lower and upper bounds on the complexity of one-way, systolic gossip in such networks.

In considering problems raised by particular netowrk technolgies, Eilam et. al, in "A Complete Characterization of the Path Layout Construction Problem for ATM Networks with Given Hop Count and Load", establish that most interesting path layout optimization problems are NP-complete, while providing polynomial-time algorithms for those that are not. Finally, fault tolerance is an important property of communication networks and protocols. Rescigno and Vaccaro, in "Highly Fault Tolerant Routing in the Star and Hypercube Interconnection Networks" present routing protocols establishing bounds on the diameter of the operative parts of such networks, given an arbitrary set of failures not disconnecting the networks.

The second group of papers selected for this special edition addresses problems of finding either subgraphs or embeddings of highly regular graph topologies in other such graphs. These problems are of practical interest in that the graph structures considered enable efficient communication algorithms. One measure of the goodness of an embedding is *edge congestion*, i.e., the number of edges of the embedded graph that share a common edge in the host graph. Röttger and Schroeder, in "Embedding 2-Dimensional Grids into Optimal Hypercubes with Edge Congestion 1 and 2" define methods for embedding 2-dimensional grid graphs into hypercubes such that edge congestion is at most 2. Another measure of an embedding is *edge dilation*, i.e., the maximum length of a path in the embedding that corresponds to an edge in the orginal graph. In the paper "Embedding Grids in Grids: Dilation Four Suffices", Ellis and Markov establish an upper bound on dilation when embedding one two-dimensional grid in another.

In the paper "An Optimal Pair of Disjoint, Constant-Delay Spanners of the Infinite 3-D Grid", Krumme considers spanning subgraphs of a three-dimensional grids. The measure of interest here is the multiplicative stretch factor of distances between vertices. The paper identifies two disjoint spanners of the infinite two-dimensional grid that have a constant stretch factor. Andreae and Hintz, in the paper "On Hypercubes in de Bruijn Graphs" address a graph-theoretical problem of finding de Bruijn graphs of least possible alphabet size that contain hypercubes of odd dimension as subgraphs.

The twelve papers presented in this special edition are a representative sample of the mathematical approach to communication network design and analysis taken by members of the research community associated with these workshops. We hope this introduction to their efforts will spark interest among others addressing problems in parallel and distributed computing and communication.

References

[1] A.M. Farley, S.T. Hedetniemi, S. Mitchell and A. Proskurowski, Minimum broadcast graphs, *Discrete Mathematics 25*, 2(1979), 189-193

[2] S. T. Hedetniemi, S. M. Hedetniemi, and A. L. Liestman, A survey of broadcasting and gossiping in communication networks. *Networks 18* (1988), 319-349.