STUDIES IN CONCURRENCY CONTROL FOR CENTRALIZED, DISTRIBUTED AND NESTED TRANSACTION SYSTEMS

by

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Certificate

This is to certify that the thesis titled "Studies in Concurrency Control for Centralized, Distributed and Nested Transaction Systems" being submitted by Ram Prakash Rustagi to the Indian Institute of Technology, Delhi, for the award of the Degree of Doctor of Philosophy, is a record of bonafide research carried out by him under my guidance and supervision. The results obtained in this thesis have not been submitted to any other University or Institute for the award of any other degree or diploma.

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Abstract

We present a new framework for concurrency control algorithms based on a subset of conflict graph which we call position graph. Using the position graph framework we propose a new concurrency control mechanism, called DFNM protocol, which is deadlock free, performs no cycle checking, is simple and efficient to implement, achieves more than two phase locking and timestamp ordering, and with implementation complexity no more than that required for two phase locking.

We show that existing concurrency control algorithms can be interpreted in the position graph framework by imposing specific restrictions on the way the edges are added to the position graph. The general position graph scheduling defines a hierarchy of schedulers based upon the limitation imposed on work done required to maintain the position graph. The timestamp ordering occurs at the lowest level in the hierarchy, the two phase locking is contained in the next level, and full conflict serializability occurs at the highest level in the hierarchy. General position graph scheduling is a problem of dynamic maintenance of directed graphs under a sequence of edge insertions. We propose a new mechanism for dynamic maintenance of directed acyclic graph which is expected to take sub-linear time (in n) for an edge insertion in a dense graph.

We extend the position graph based concurrency control mechanism from centralized databases to distributed databases. Distributed position graph based concurrency control works mainly with local views (local position graphs), and accepts all schedules which are acceptable by distributed two phase locking and timestamp ordering scheduler. Global communication, if carried out by the distributed position graph based scheduler, is of the similar nature as in two phase commit.

The position graph framework has been extended to nested transaction environment. As for flat transactions, nested two phase locking and timestamping algorithms are shown to be special cases of nested DFNM protocol, the extension

of DFNM protocol to nested transaction environment.

We also analyze the nested position graph scheduling in the rigorous framework of I/O automaton model. We introduce the notion of "position atomicity" and correspondingly "local position atomicity" for the objects and show that this position atomicity is a natural way to show serialization graph based algorithms correct. This eliminates the need for an indirect proof method for showing correctness of serialization graph schedulers using I/O automata model. We use position atomicity to show correctness of nested DFNM protocol.

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