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Influence Mass Distribution Function for Dependability of Processing Transactions with Temporal-Probabilistic Description

AFIF MGHAWISH
AL-ZAYTOONAH UNIVERSITY
JORDAN

ZYGMUNT MAZUR, PIOTR MICHALEC, MAREK WODA*
Institute of Applied Informatics
Institute of Computers Engineering, Control and Robotics*
Wroclaw University of Technology
Wybrzeze Wyspianskiego 27
POLAND

Abstract: Real time systems are used wider and wider in the practical solutions. It results from the fact, that there is need of creating distributed applications, which have to deal with specific requirements applied to task's execution time. In this paper, there are presented methods of transaction scheduling. There are also presented results of dependability tests for transaction processing with temporal-probabilistic description for different mass distribution functions in comparison to other priority assigning criteria used in the real time database systems

Key-Words: real-time databases, distributed transactions processing

1 Introduction

Distributed real-time systems are used wider, and wider nowadays. They combine IT areas treated as separated so far. The real-time database system is an integration of database management system and real-time system, it inherits many features either form real-time systems and database systems. The increasing interest in these systems results form fact, that there is a need to build systems, which are oriented for processing huge amounts of data, which must fulfill specific requirements put on time of tasks' executing, where values of data depend on time, and have limited valid time. Applying of real-time systems includes among other things, air traffic control systems, integrated production systems, military systems, computer and telecommunication network management systems, as well as banking, stock or multimedia applications.

In respect of distributed nature of enumerated systems, their primary task is processing distributed transactions. Moreover, in real-time systems, transaction processing is connected with time limits. The time limits can concern either transaction processing and data valid time. System has to process transactions, and return results before deadline. Thus the main aim of real time systems is to increase number of transactions, which are finished before their deadlines (improve dependability of system).

The aim of this paper is to present temporal-probabilistic description of transaction, using it in priority assigning algorithms. Furthermore, there are presented results of dependability tests for different mass distribution functions in comparison to other priority assigning criteria used in real time database systems.

2 Transaction Scheduling

2.1 Attributes of transaction

Transactions in real time systems are connected with occurrence of following attributes [4]:

· arrival time of transaction to system A
· deadline D
· execution time E
· max slack time S
· value function V
· criticalness C
· priority P

Arrival time A and deadline D define time limits connected with transaction processing. Execution time E is an approximate value and usually it is not known before execution of transaction is finished. Attribute S informs about maximum allowed slack of starting of transaction execution. The value function V define validity of finishing transaction in particular moment, and value of this function for deadline time is named criticalness value C. Priority P is assigned to transaction to optimize efficiency of transaction processing and to increase dependability of the system.

The time limits of transaction come from two sources. First source is defined as requirement of temporal consistency of data. Data stored in real time systems are defined as temporal data, which value is valid only in defined time period. Actual state of environment can be queried only in time defined by this period. The second source of time limits is requirement of system concerning reaction time for event occurrence. The result of system activity must be returned in defined time period (before deadline) [10].

2.2 Real-time algorithms of priority assigning

Transaction scheduling algorithms are working in principle assigning to transaction priorities and using methods, which solve conflicts in access to system's resources. System can use different strategies of priority assigning for different types of resources. If there occurs conflict, assigned priority is used for solving this conflict. However standard algorithms of transaction scheduling are inadequate for real time systems. It results from fact, that in real time systems transaction must be scheduled with taking into consideration their criticalness and other constraints put on by deadline.

Fundamental aim of scheduling in real-time database environment is finishing all transaction before their deadlines. Because access to resources is exclusively, in one time only one transaction can use it. Execution of one transaction keeps correct state of database, but execution of many transactions in one time needs coordination. For that purpose, scheduling procedures are introduced, which are using priority assigning mechanism. The value of priority should have influence for concurrent execution of transaction to optimize effectiveness parameters of system. Transaction attributes presented in point 2.1 are influencing the value of priority as follows:

· criticalness – the higher value of transaction criticalness, the higher transaction priority

· deadline – the earliest deadline of transaction, the higher transaction priority

· arrival time – transaction, which was notified earlier in system, have higher priority, than transaction notified later

· slack time – the shortest time of transaction's slack time, the higher transaction priority

· amount of calculations already done by system – transaction, which is already processed, and processing was lasting long period of time, should have higher priority, because database systems require, not only releasing of resources, but also rollback of transaction. It is easier (and with less time waste) to process transaction to its end if it was already almost finished.

Resource access conflicts are solved to transaction with higher priority advantage. It means that transaction with lower priority is restarted if transaction with higher priority occurs in the system with demand to the same system resources. This mechanism is accompanied by unfavourably situations. It is possible that transaction with higher transaction restarts transaction with lower priority, and than it is restarted by another transaction with highest priority. Another, unfavourably situation is when transaction with higher priority restarts transaction with lower priority, and than it exceeds its deadline, and restarted transaction also exceeds its deadline by reason of restarting.

2.3 Priority assigning using of temporal-probabilistic description of transaction

The time losses caused by situations described above can be reduced by temporal-probabilistic description of transaction [7]. The temporal-probabilistic description of transaction is defined as probability of transaction execution according to mass distribution function in defined time period. Transaction's managing system can forbid execution of transaction with low probability of finishing transaction before deadline.

Reducing of time losses, increasing of number of transaction finished with success, is achieved by elimination of transactions which have low (or no) chances to finish with success. Transactions with lower priority are not restarted by transactions, which do not have chances to finish before their deadlines, so time allocated to them is longer. In real systems it is also possible to assign different mass distribution functions to different sources of transactions Applying of temporal-probabilistic description of transaction, and scheduling according to this description can be also used as additional information for known, advanced algorithms of transaction scheduling.

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3 Testing dependability of transaction processing, using temporal - probabilistic description of transaction for different mass distribution functions

The main aim of experiments is to measure effectiveness of processing transactions with temporal-probabilistic description for different mass distribution functions. When effectiveness is higher it means that dependability is also higher. Testing was conducted for different transactions workload of testing system. Experiments were done also for standard strategy of priority assigning, to get comparison of effectiveness.

3.1 Description of testing system

All experiments were conducted on the same system environment i.e. AMD Athlon 1700 MHz, 512 MB RAM, Windows XP and SQL Server 2000. The clients applications and server application are programmed in Visual C# with .NET framework. Because the structure of database is not connected with aim of experiment the standard Northwind database was used. Configuration of testing system is presented on Figure 1.

The client applications send request for transaction execution to server application, and server application assigns priorities and executes transactions according to these priorities.

3.2 Experiments' results

Experiments were conducted mainly for priority assigning using of temporal-probabilistic description of transaction, for different mass distribution functions and also to get comparison with standard priority assigning algorithm based on criterion of deadline.

For each strategy of priority assigning measure of transactions processing effectiveness were done. Results are presented in Table 1, and graphic interpretation is shown on Figure 2.

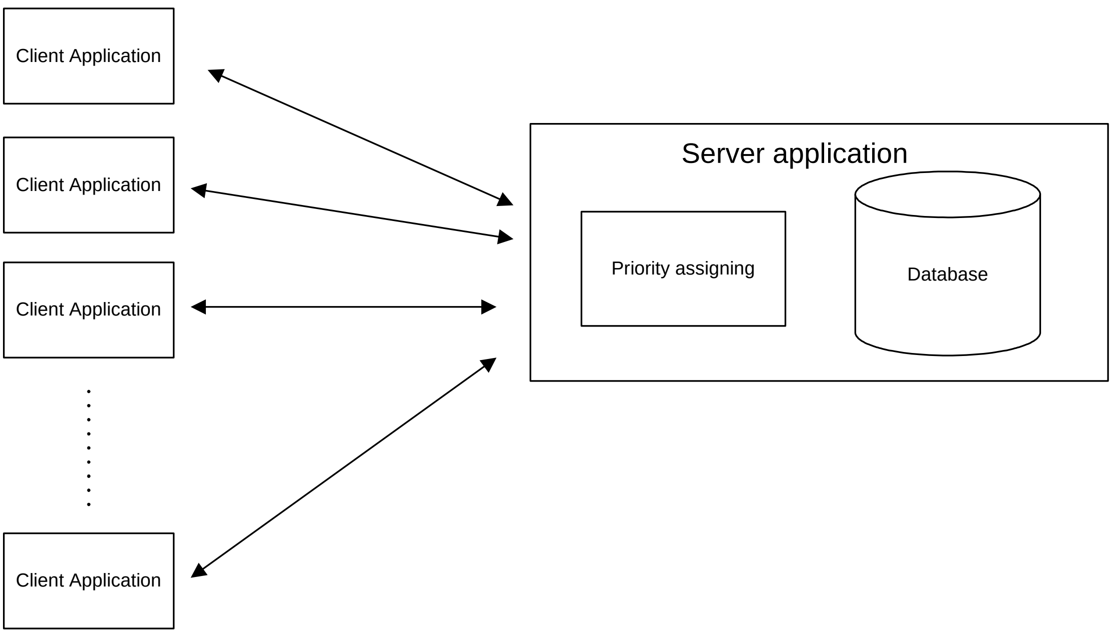

Figure 1. Configuration of testing system

Table 1. Achieved results

Number of requested transactions	100	500	1000	1500	2000	2500	3000
Priority by Deadline	100	274	645	840	1268	1832	2152
Priority by temporal-probabilistic: linear	99	328	695	877	892	1174	1553
Priority by temporal-probabilistic: exponential	100	439	462	1003	1344	1552	2238
Priority by temporal-probabilistic: gauss	99	224	474	702	934	558	1670
Priority by temporal-probabilistic: inversion gauss	96	350	507	1058	1061	1119	1463

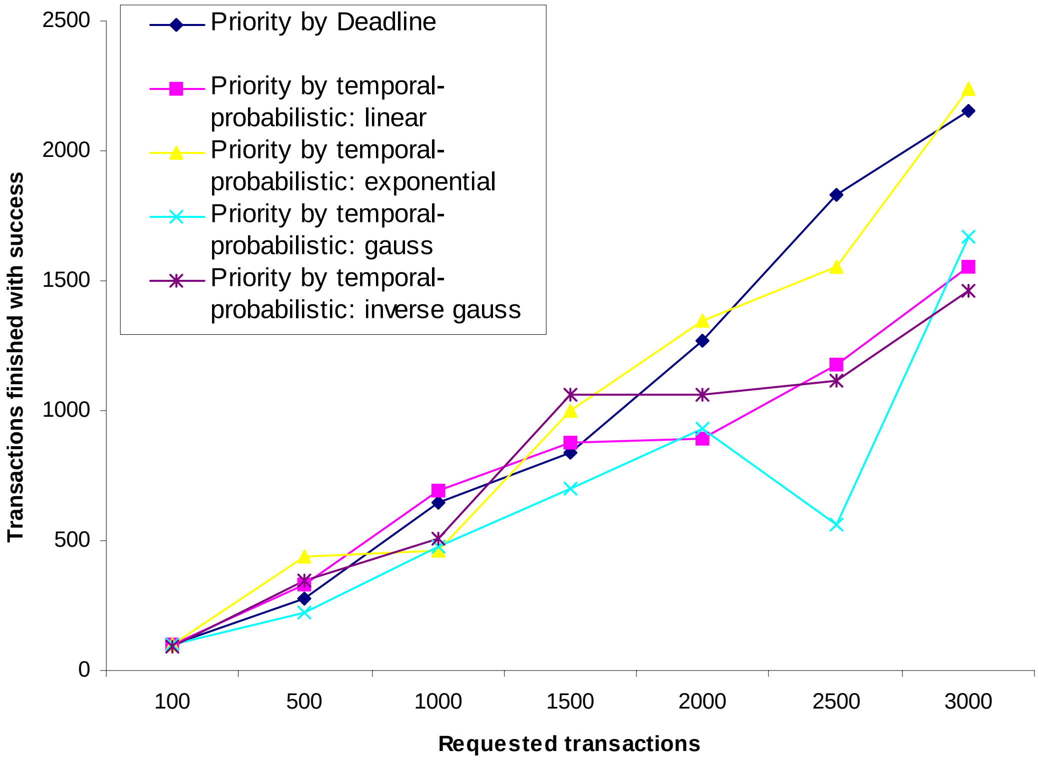

Figure 2. Graphic interpretation of achieved results

4 Conclusions

Analyzing achieved results it should be noticed, that in assigning priority according to the temporal-probabilistic algorithm results depends on the mass distribution function. For linear, gauss and inverse gauss mass distribution functions results are not satisfactory, but for exponential mass distribution function temporal-probabilistic algorithm can be competitive to standard priority assigning algorithms. Furthermore, achieved results of tests show that introducing temporal-probabilistic dependencies into transaction processing can have influence for dependability of transaction processing, but effectiveness depends on chosen mass distribution function.

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