DESIGN OF EXPERIMENTAL PLATFORM FOR TESTING REAL-TIME DATABASE TRANSACTION PROCESSING

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Abstract: It is very difficult to achieve guaranteed real time database services when putting a database into a real-time environment because various components can compete for system resources. Previous research in real-time databases has focused primarily on evolution of transaction processing algorithms, priority assignment strategies and concurrency control techniques. But for the most part the research efforts are based only on simulation studies with many parameters defined. Our objective is to design and implement an experimental real-time database system suitable for study of real time transaction processing. The experimental system is implemented as an integrated set of the most important functional parts upon the real-time operating system VxWorks. It serves as a support platform for performance evaluation of known and new algorithms of the particular processing components to understand their effect on system performance and to identify the most influencing factors.

Keywords: Real-time database, transaction processing, CPU scheduling, concurrency control, real-time operating system

1. MOTIVATION

There are essentially three problems with which real-time database (RTDB) systems must deal: resolving resource contention, resolving data contention, and enforcing timing constraints (Lehr, 1995). So one of the basic concepts of RTDBS consists in integration of all these inevitable aspects. While tasks are considered as the basic schedulable unit in real-time systems, transactions are the schedulable units in database management systems (Aldarmi, 1998). Up to now the major part of RTDB research was focused on evolution and evaluation of transaction processing algorithms, priority assignment strategies and concurrency control techniques. Evaluation was usually based on simulation studies (Sivasankaran, 1994) or the results were obtained by modifying an existing database management systems (Kim, 2002). Simulations often consist of a number of parameters. The parameters specify maximal count of data items, processor time needed to manipulate data items, average disk access time, probability of read vs. write transaction, etc. There is even a study where all the functional blocks are designed as object-oriented and described by means of classes with a number of attributes (Taina, 1999). Much less attention was paid to architecture aspects of the operating systems, developed especially for real-time systems and for better support of time critical operations. So we can define two basic drawbacks of the presented research:

1. For the most part there is only one functional part considered for investigation without any interaction with other system parts. Because of the strong interactions among the various processing components in RTDBS, an integrated approach is necessary.
2. Research work at real-time transaction processing is based on simulation studies only. It is necessary to investigate the real-time transaction processing algorithms in their natural environment to achieve really relevant results. It means that the operating platform is a real-time operating system and the particular RTDB functional blocks communicate with each other by means of this operating system.

1.1. The fundamental idea

The main goal of the project is to design and implement an experimental RTDB system suitable for study of real-time transaction processing. The experimental system must be implemented as an integrated set of the most important parts of a veritable RTDB system. It would enable testing and performance evaluation of known and new algorithms of the particular functional components to understand their effect on system performance and to identify the most influencing factors. The idea is outlined on fig. 1.

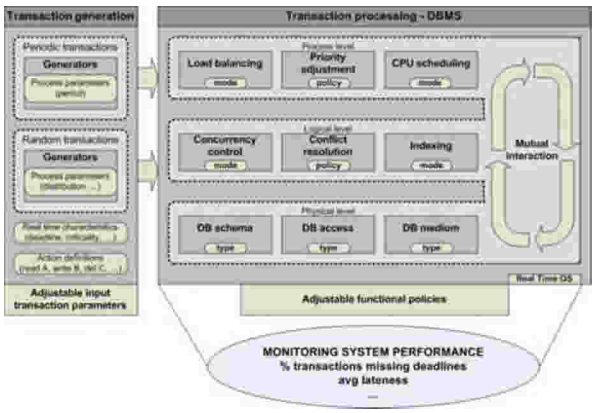

Fig. 1. The fundamental idea

1.2. Integrated approach to system construction

One of the most important aspects of our research is to consider the intended experimental system as one whole composed of integrated particular components. An integrated approach is necessary because even a single component in the system which ignores timing issues can undermine the best efforts of algorithms which do account for timing constraints.

1.3. Implementation in RTOS environment

Without adequate support from the underlying subsystems, none of the scheduling algorithms can guarantee predictable transaction performance. RTDB building blocks must be integrated with the real-time operating system kernel in order to avoid wasteful duplication and provide predictable services.

2. SYSTEM DESIGN

The system named V4DB is currently implemented upon the real time operating system platform VxWorks as a centralized system with memory resident database. Overall design is presented on fig. 2. Some of the tasks are grayed. Such tasks have a uniform interface and can be replaced by tasks with the same interface but different internal functionality, for example with a different priority assignment algorithm. Their runtime behaviour can be changed according to predefined setting before the system start. Particular components are described in more detail in the next chapters.

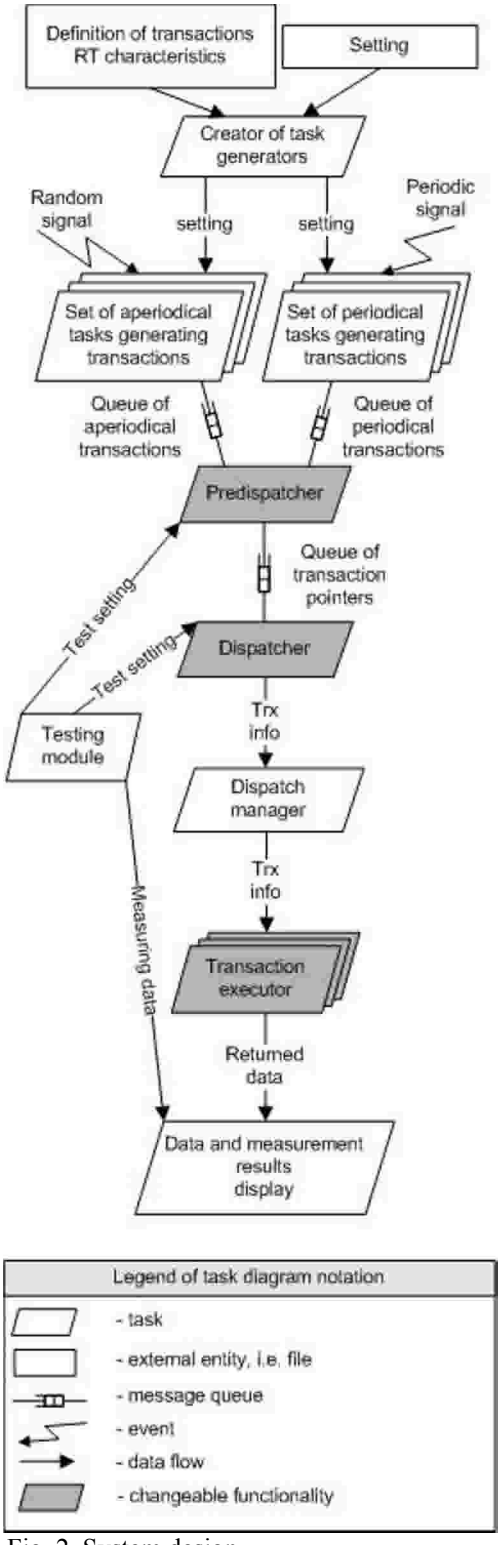

Fig. 2. System design