

Capsule Reviews

The Capsule Reviews are intended to provide a short succinct review of each paper in the issue, in order to bring the content to a wider readership. This issue's Capsule Reviews were compiled by Fairouz Kamareddine. Professor Kamareddine is an Associate Editor of *The Computer Journal* and is based in the School of Mathematical and Computer Sciences at Heriot-Watt University, Edinburgh, UK.

Synchronization Schemes for Controlling VCR-Like User Interactions in Interactive Multimedia-on-Demand (MOD) Systems. C. WANG AND C.-M. HUANG

Different approaches that transmit multimedia information via the internet have already been proposed in the literature. In multimedia Systems, however, it is vital to integrate several media streams (e.g. video, audio, text and image). Moreover, in Multimedia-on-Demand (MOD) systems, it is necessary to have VCR-like user interactions (e.g. reversing the presentation sequence, skipping forward or backwards several media units, freezing the presentation for a while and then restarting it, and scaling down or up the presentation speed). Such requirements when transmitting multimedia information and allowing users' interactions cause MOD systems to face major problems. For example, how to synchronize multimedia information so that associated information units, which are sent simultaneously, do indeed arrive simultaneously at the client site. Since transmission delays remain largely unpredictable and uncontrollable, synchronization control of an interactive MOD system is complicated and difficult. This paper proposes several control schemes to handle transmission and user interactions in an MOD system. This is done by using several buffers to control the information (especially the feedback information provided by the clients to the peered server according to its buffered status; the server then uses such information to control the transmission). These buffers are managed by control schemes so that they don't overflow or underflow. The authors demonstrate the feasibility of their control schemes by providing some performance measurements.

Efficient Region Layouts for Region-based Video Servers Employing Multi-zone Disks. S.-R. TONG, Y.-T. YU AND C.-M. HUANG

Videos are widely used in many applications related to multimedia Technologies, such as distance learning and digital libraries. Videos, however, even after compression, need considerable storage space and playback bandwidth. Hard disks are usually seen as video servers which can best deal with the archiving and delivery on demand of videos to a wide range of remote users. This paper investigates video servers that employ multi-zone disks as regions for implementing region-based data placement for video retrieval. In a multi-zone disk, tracks on the disk platter are divided into circular zones where the tracks of the outer disk zones are divided into more sectors to store more data blocks and hence the disk head goes through a

larger increase of data transfer rate as it moves from the inner to the outer zones. In order to take full advantage of the multi-zones and their properties so that performance can be improved, this paper formulates the region-layout problem for implementing the region-based data placement in multi-zone disks. Based on this formulation, two theories for region layout optimality are derived and then two efficient algorithms for constructing region layouts are proposed. The performance of the proposed schemes is also studied and the authors show that they can effectively customize region layouts to achieve 85–99% resource utilization.

An Efficient Link Polling Policy by Pattern Matching for Bluetooth Piconets. T.-Y. LIN, Y.-C. TSENG AND Y.-T. LU

Bluetooth is a promising wireless technology for personal-area networks (PANs). The smallest network unit in Bluetooth is a piconet consisting of one master and one or more slaves. Two physical links are supported in Bluetooth of which this paper considers the asynchronous connectionless link (ACL) for data traffic. This paper focuses on the management of the Bluetooth ACL link involving one master and multiple slaves. The link polling policy adapted by a master influences the bandwidth utilization of a piconet. Although a number of studies of the polling policy of a piconet have been carried out, this paper observes two deficiencies in existing methods: they fail to address the asymmetry of traffic between masters and slaves and they do not exploit the different packet types provided by Bluetooth to match the traffic needs. Supposing that the traffic ratio between each master–slave pair can be approximated, this paper proposes a pattern matching polling policy for ACL link scheduling that selects the polling pattern and the polling time that best matches the master–slave pair's traffic characteristics. This paper discusses how this policy can be applied to single- and multi-slave environments and gives an overflow mechanism to handle unpredictable traffic.

A Framework for the Analysis of Denial of Service Attacks. A. R. SHARAFAT AND M. S. FALLAH

Service availability is the provision of a service during an expected time interval to a user who is authorized to request the same. Attacks on service availability are called Denial of Service (DoS) attacks and there are still no satisfactory solutions to making systems resilient to such attacks. This paper argues that effective solutions to DoS attacks can be devised through methodical analysis of system vulnerabilities to these attacks. The approach of the paper is to analyse the DoS problem by extending a static model (for the

analysis of survivability) into a dynamic model suitable for the analysis of DoS attacks. The paper proposes a framework where the availability of a service can be evaluated based on the availability of its resources. The authors show that the framework can be used to devise appropriate modifications to a service for improving its resilience against some DoS attacks. This framework also includes a method for comparing the resilience of services against DoS attacks by resilience pre-ordering. The proposed framework is applied to some examples and it is shown that in some cases, it is possible to reduce the vulnerabilities of the system against some DoSs.

Approximations for λ -Colourings of Graphs. H. L. BODLAENDER, T. KLOKS, R. B. TAN AND J. VAN LEEUWEN

The $L(2,1)$ -labelling problem is the problem of assigning radio frequencies to transmitters in such a way that close transmitters (distance 2 apart) receive different frequencies and very close transmitters (distance 1 apart) receive frequencies that are at least 2 apart. Call λ the minimum span of (difference between the highest and lowest) frequencies. A λ -colouring of a graph G is an assignment of colours from the integer set $0, \dots, \lambda$ to the vertices of G such that vertices at distance of at most 2 get different colours and adjacent vertices get colours which are at least 2 apart. The smallest λ for which there is a λ -colouring of the graph G is denoted by $\lambda(G)$. Different bounds (upper and lower) of $\lambda(G)$ have been obtained in the literature for various types of graphs. Moreover, for special classes of graphs, tight bounds for $\lambda(G)$ are known and can be computed efficiently while, for others, only approximate bounds are known. This paper extends the results of upper bounds to other types of graphs and improves existing bounds for some classes of graphs. Efficient algorithms for λ -colouring the graphs achieving some bounds are given. The paper also shows that the problem of finding the minimum λ for some types of graphs is NP-complete.

Experiences from Implementation and Evaluation of Event Processing and Distribution of Notifications in an Object Monitoring Service. A. LAURENTOWSKI AND K. ZIELINSKI

This paper aims to provide practical guidelines on how to implement and use the monitoring of information and the dissemination frameworks in an efficient way during the processing, organization and distribution of events. These guidelines provided by the authors are based on the experiences of the authors from the implementation, configuration and evaluation of the Melita Online Object Monitoring Service (MOOMS), which was conducted independently of and concurrently with the recent proposal by Sun Microsystems of the Java Management Extensions (JMX) specification. JMX is seen by the authors to be a high level of abstraction and generality which leaves much space for implementation details that may influence the performance of applications. The paper describes the architecture of MOOMS and compares it to that of JMX.

Since there seem to be no significant structural differences between MOOMS and JMX apart from the more restricted functionality of MOOMS, the authors believe that similar implementational solutions could be used in JMX to provide good performance. In particular, since MOOMS's design and implementation were strongly performance-driven, where execution-time overheads were reduced, the authors believe that its performance evaluation may shed light on how JMX implementations may be designed.

Piggyback Statistics Collection for Query Optimization: Towards a Self-Maintaining Database Management System. Q. ZHU, B. DUNKEL, W. LAU, S. CHEN AND B. SCHIEFER

Query optimization is crucial in achieving efficient query processing for a database management system (DBMS). A DBMS performs query optimization based on statistical information about data in the underlying database. A typical statistics-collection method, the utility method, is to invoke a utility which periodically collects and updates statistics about the underlying database. However, the utility method suffers from various disadvantages and this has led to various approaches at improving it. This paper deals with the issue of collecting and estimating database statistics arguing that a DBMS should employ a statistics-collection method which meets the following performance requirements: (i) collecting up to date statistics for all pertinent data; (ii) incurring as low an overhead as possible; (iii) reducing the database administrator's burden of invoking a utility manually. This paper proposes the so-called 'piggyback' framework to gather statistics during query processing. The proposed framework meets the above performance requirements, generalizes various statistics collection techniques and integrates automatic invocation of the utility method to gather and update statistics. The architecture of a piggybacking prototype is outlined and some experimental results are presented.

On Generating Set Index Functions for Randomized Caches. H. VANDIERENDONCK AND K. BOSSCHERE

A cache is a small fast memory that stores the most recently used blocks of data. Because the speed difference between processors and memory grows exponentially, today's processors contain multiple levels of cache memories. In this way, requested data is quickly available when found in the cache (a cache hit). Otherwise, a cache miss occurs and the next level of memory is accessed. Cache misses are either capacity misses, which can be avoided by increasing the cache size, or conflict misses, which are due to the organization of the cache. To limit the search time through the cache, caches are organized in a direct mapped or set-associative way. This organization introduces many conflict misses that can be avoided by one of many techniques. This paper concentrates on the so-called randomizing set index functions technique, used to place the data in the cache in a way that avoids conflict misses. There are numerous possibilities for randomizing set index functions, each of

which strongly influences the performance of the cache. Yet it is hard to know which particular randomizing set index function gives the best performance. This paper develops a methodology aimed at guiding the selection of randomizing set index functions through a two step process: the profiling of program behaviour (studied in earlier papers) and the search of the design space of the randomizing set index functions. This paper studies in detail the search of the design space of the randomizing set index functions giving various search algorithms which are all evaluated.

Untangling Binary Trees via Rotations. J. M. LUCAS

A common way to restructure a binary tree is the rotation operation, a simple constant time operation that preserves the symmetric order of the tree. The rotation (undirected) graph $RG(n)$ of binary trees of n nodes is defined as follows: the

nodes are binary trees of n nodes and the edges connect two trees, one of which is obtained from the other by a single rotation. $RG(n)$ is exponentially large with respect to n . Various properties of $RG(n)$ have been studied in the literature and various interesting questions remain to be solved. This paper looks at the problem of finding the shortest sequence of rotations that converts one binary tree into another. The rotation distance between a tree and its rotation can be computed in exponential time, but it remains an open problem whether it can be computed in polynomial time. Several studies have offered approximation algorithms for computing rotation distances. This paper presents a polynomial time algorithm for finding the exact rotation distance between any two binary trees that belong to a limited class. The limitation is that in both trees, every node has at most one child and in the final tree, there is at most one zig-zag pair of edges. Such a rotation is hence called untangling.