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a quarterly bulletin of the IEEE computer society technical committee on

Database Engineering

Contents:

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Database Engineering Bulletin is a quarterly publication of the IEEE Computer Society Technical Committee on Database Engineering. Its scope of interest includes: data structures and models, access strategies, access control techniques, database architecture, database machines, intelligent front ends, mass storage for very large databases, distributed database systems and techniques, database software design and implementation, database utilities, database security and related areas.

Contribution to the Bulletin is hereby solicited. News items, letters, technical papers, book reviews, meeting previews, summaries, case studies, etc., should be sent to the Editor. All letters to the Editor will be considered for publication unless accompanied by a request to the contrary. Technical papers are unrefereed.

Opinions expressed in contributions are those of the individual author rather than the official position of the TC on Database Engineering, the IEEE Computer Society, or organizations with which the author may be affiliated.

Membership in Database Engineering Technical Committee is open to IEEE Computer Society members, student members, and associate members. (Application form in this issue.)

FROM THE CHAIRMAN

I am pleased to report that our TC is healthy and growing. There are many new things being planned for this year. We are always eager to hear of additional suggestions from our membership -- so don't be shy.

On behalf of the members of the TC, I would like to express our thanks to Jane Liu. Jane has served as our diligent and energetic editor for almost two years. She has recommended that a new editor be appointed (two years as editor seemed a long enough sentence, so she was let off for good behavior). I am pleased to note that she will continue to be active in the TC as our Secretary/Treasurer.

As you will quickly notice, our new editor, Richard Winter, has put together a fine first issue. He has also assembled a formidable editorial staff that should help to keep the DBE Bulletin an important publication. Additional material and assistance from our membership will also be greatly appreciated.

Once again our TC will be active in many professional activities. We are co-sponsoring the Fifth VLDB Conference in Brazil and organized sessions at the 78 COMPCON. We plan to organize sessions for several upcoming conferences. If any of you are interested in helping to set up a session, present a paper, or participate in a panel, please contact me.

Our membership has been growing steadily and now numbers well over 250. Although size, per se, is not the important issue, I continually find colleagues in the database field who are very interested in the topics and activities pursued by our TC but were just not aware of its existence. I would like to solicit your assistance in making your associates aware of us. If there is anyone that you feel would be interested in joining our TC, please send me his or her name and we will arrange to send background information and recent copies of our Bulletin.

As you can see, there are ample opportunities for you to be active in our TC. The extent that you would like to participate is your own choice. I can be contacted at MIT, Room E53-317, 50 Memorial Drive, Cambridge, MA 02139 or called at (617) 253-6671. With your help I am looking forward to another successful year for our TC.

Stuart

April, 1979

FROM THE EDITOR

As the new editor of Database Engineering, I have been encouraged by the interest expressed by colleagues in an informal publication on engineering aspects of database technology. People have said that they would like to see a forum for the discussion of ongoing research and unsolved problems; for the vigorous debate of pragmatic technical issues; for informal case studies (how many database system designers and researchers would like to have access to more hard data on system performance and application requirements?); for the analysis of unusual applications and their implications for generalized system design; for the deeper technical issues in the continuing standards debate; and for tutorial articles on emerging engineering issues.

Our editorial policy calls for an informed review of substantive articles, but does not include formal refereeing and its attendant delays. Coupled with an emphasis on brief articles and rapid publication, this policy is expected to result in a bulletin which carries timely material of high interest which might not otherwise reach the membership.

For the coming year, we are placing special emphasis on four subject areas and will have an expert associate editor for each. Three of these areas have been selected: distributed database management, database machines and database security. They appear to have especially high potential for significant engineering progress in the near term.

The new editorial staff of the bulletin, including Ann Bandurski, Gene Lowenthal, Gerald Popek, Chris Reeve, Nancy Wolfe and me, are looking forward to stimulating interaction with you, the database engineering community. If you actively contribute to the bulletin, it can become a unique and outstanding publication. Please do.

Sincerely,

Richard Winter

Richard Winter
Editor

Handling Network Partitions in Distributed Databases

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Abstract

Communication failures may partition a network into a number of disjoint, non-communicating sub-networks. When redundant copies of data items are stored on more than one such sub-network, access to such data items must be restricted in order to preserve the mutual consistency of the data across the partition boundary. Several general approaches to access restriction are discussed. It is pointed out that none of these approaches are satisfactory in all cases. However, the need to restrict access can be lessened through the use of application specific knowledge. How should systems be designed to allow specification of such application specific knowledge? What facilities can reasonably be offered in this regard? These remain as open questions.

A distributed data base system is one in which the data base is stored at several nodes in a computer network [1]. In some designs, data may be stored redundantly at several sites. The system presents an interface to the user which does not reflect the distributed nature of the data base. Except for timing differences, the system behaves as if it were a traditional centralized system with a non-distributed database. In order for this effect to be achieved efficiently, the system must present a high-level language interface (on the order of QUEL, for example) and be responsible for such details as formulating distributed query execution strategies, preventing reader/writer interference, and ensuring reliable operation of the system in the face of site and communication outages.

The problem we are concerned with in this paper is how to cope with network partitions; i.e. situations in which communication failures have split the network into two or more independent sub-networks. The difficulty is illustrated in Figure 1. Figure 1a illustrates the network before the partition has occurred. The system is able to ensure the mutual consistency of all the data items in the data base, by means of appropriate reader/write control (e.g. via locking or a number of alternative techniques which have been proposed for distributed systems). After a partition has split the network in two (see Figure 1b), each sub-network can be kept internally consistent by using the same techniques. However, because communication between the two sub-networks has been cut off, it is impossible for the data in the two sub-networks to be kept mutually consistent. What is to be done when the partition is lifted? Because of their mutual inconsistency, the two sub-data bases cannot simply be merged.

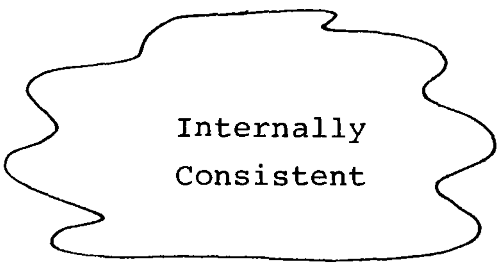

Fig. 1A: Network
Before Partition

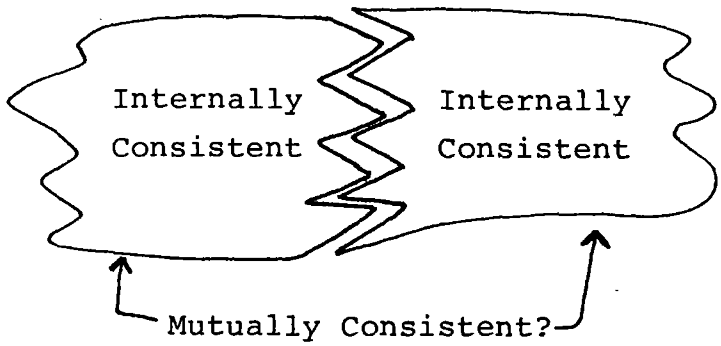

Fig. 1B: Sub-networks After
Partition

FIGURE 1

A number of solutions to this problem have been proposed and are reviewed here. Each of these approaches requires that certain transactions be prevented from running while the partition is in effect. We point out that this is not a practical solution for many applications and show cases in which less severe processing constraints are possible. Characterizing these constraints is not a simple task however. The purpose of this paper is to propose the network partition problem as a research issue and suggest approaches for its attack.

A few basic points should be made at the start. First, it is impossible to run transactions which require any data which is not available on the local sub-network. There is simply no way to retrieve that data. Consequently, our only concern is what to do with transactions which request only data which is available on the local sub-network. Second, read-only transactions do not pose a problem and can always be run. Because the data base is consistent within a sub-network, read-only transactions can easily be guaranteed to read consistent data. The difficulties arise only with updating transactions. Third, there is no problem unless data is being updated for which copies exist on more than one sub-network. Thus, non-redundant databases do not pose a problem. So long as the effect of an update is confined to a single sub-network, transactions in separate sub-networks cannot interfere with each other's operation. Redundancy causes a problem because an update to one copy of a data item requires that some control (e.g. a lock) be placed over all other copies of the data item. The partition, however, prevents the communication of necessary control information to sites holding other copies.

What can a system do about this? There are various possible solutions. The most drastic approach would simply be to not allow any updating transactions to run while a partition is in effect. This certainly solves the problem but is a little heavy handed. A less restrictive solution is to allow only one of the sub-networks to execute updating transactions and then have it report its updates to the other sub-network when the partition is lifted.

The difficulty here is to ensure that one and only one sub-network remains "update-active". Unfortunately, it is no longer possible for the sub-networks to communicate with one another in order to choose which one will continue updating. The solution is to define the concept of a "majority sub-network". The concept of majority is defined in such a way that a sub-network can decide on its own whether or not it is a majority sub-network, and furthermore that at most one sub-network can be the majority. A simple majority definition would be that a sub-network was a majority sub-network if and only if it contained over half the sites. More complex definitions may be more desirable, for example one in which each site was given a weight. Under this definition, so long as the total of the weights of the sites in a sub-network was greater than half the total of the weights of all sites, then that sub-network would be a majority. A special case of such a majority definition would be, for example, "A sub-network is a majority sub-network iff it contains site #13" (in this case, site #13 would be assigned a weight of 1 and all others a weight of 0). The notion of majority sub-network is utilized in the Thomas' algorithm for distributed concurrency control [2].

The majority sub-network solution is undesirable in general because any given piece of data in a distributed network is typically associated with a single site which uses the data heavily even though other sites may access the data via local copies. For example, a warehouse may keep its inventory data at a local site although a copy of this data is kept at the corporate headquarters' site. When a partition splits the warehouse from the corporate headquarters, it would be desirable for the warehouse to be able to continue updating its inventory data even though it may not be in the majority sub-network. One could formulate an alternative policy as follows. Each piece of redundant data has a "primary copy". A piece of data can be updated so long as its primary copy resides in the same sub-network. Non-primary copies residing in other sub-networks will be updated as soon as the partition is lifted. In our example, the primary copy of the inventory data would reside at the warehouse site. In event of a partition separating the warehouse from corporate headquarters, the warehouse would be able to update the inventory but the corporate headquarters would be prevented from updating it. This is an improvement over the majority sub-network approach because in that approach the warehouse would be able to update its inventory only when it happened to be in the majority sub-network.

The only problem with the primary copy policy as stated above is that it doesn't work. Consider the following scenario. The network has been partitioned into two sub-networks, P1 and P2. There are two data items, X and

Y. X1 and X2 are two copies of X. Y1 and Y2 are two copies of Y. X1 and Y1 reside in partition P1, while X2 and Y2 reside in P2. The primary copy of X is X1, the primary copy of Y is Y2. There are two transactions, T1 and T2. T1 runs in partition P1 and performs the operation X := Y+1. T2 runs in partition P2 and performs the operation Y := X+1. Now, under the primary copy policy as stated above, both T1 and T2 are allowed to run since the primary copy of the data item which they update resides in the same sub-network. Such a concurrent execution would be faulty. Assume that before the partition occurred, both X and Y were 0 (and hence, X1, X2, Y1 and Y2 were 0). After the two transactions T1 and T2 had run, X would have value 1 and Y would have value 1. This result is not correct because it fails to satisfy the serializability criterion for concurrent correctness [3]. Under this criterion, the result of any concurrent execution of transactions must be equivalent to some serial execution of the transactions. In the case of two transactions, there are only two possible serial execution orders. In the first, T1 precedes T2 in which case the result is X = 1 and Y = 2. In the second, T2 precedes T1 in which case the result is Y = 1 and X = 2. Neither of these corresponds to the result obtained in the scenario, X = 1 and Y = 1. Therefore, the primary copy policy used there is incorrect.

This admittedly involved and subtle example illustrates the necessity of developing a formal understanding, accompanied by proofs, of the correctness of any concurrency or reliability algorithms. The correct statement of the primary copy policy (without proof) is as follows. Every data item has a primary copy. An update transaction is allowed to run only if the primary copies of all the data items it reads or writes reside in the same sub-network.

Still, the corrected primary copy policy falls short of the ideal. For any piece of data, only one sub-network is allowed to update it. When we consider the constraints of particular applications it is possible to devise special algorithms which allow several sub-networks to update copies of the same piece of data. Consider the case of an airline reservations system. Copies of seat assignment information is kept at several sites within the network. Assume a 10 site network partitioned into a 7 site sub-network and a 3 site sub-network. The policy could state that the 7 site network is allowed to allocate up to 70% of the remaining seats on any flight, while the 3 site network was allowed to allocate up to 30% of the remainig seats. No conflicts would occur. After the partition had lifted, each sub-network would inform the other sub-network of how many seats it had allocated during the partitioned operation. This is much more desirable than allowing only one sub-network to allocate seats during the partition.

Given any particular application it is usually possible to conceive of some policy that would allow updates to occur from several sub-networks at once. It is not, in general, necessary to restrict updates on a data item to only one sub-network. It seems clear however, because of the application specific nature of these solutions, that the policies must be specified by the DBA.

What can the system do to make this task easier? Are there any general solutions which are suitable to a large domain of applications? What are the formal specifications for such policies and what techniques can be used to prove their correctness? These remain as unsolved problems in an as yet unexplored research area.

[1] Rothnie,J.B.; and Goodman,N. "A Survey of Research and Development in Distributed Databases Systems", Proceedings of the Third International Conference on Very Large Data Bases, Tokyo, Japan, October, 1977.

[2] Thomas, R.H., "A Solution to the Concurrency Control Problem for Multiple Copy Data Base", Proc. 1978 IEEE COMPCON Conference., IEEE, N.Y.

[3] Gray, J.N., "Notes on Data Base Operating Systems," Operating Systems: An Advanced Course, Volume 60 of Lecture Notes in Computer Science, Springer-Verlag, 1978, pp. 393-481.

Database Activities at Compcon

Terry Welch

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Compcon 79 was notable for its technical atmosphere, pleasant facilities, good organization and fortunate location. The sessions tended to be created by the session chairman rather than being selected from contributed papers. Relative to most conferences, this produces a higher fraction of papers coming from industry, and more overviews of existing systems and problems.

Data management topics were very much in evidence at Spring Compcon 79, being featured in three of the 24 sessions. This reviewer's sampling of four topic areas are given here.

Storage Technology. Attention continued to focus on memory hierarchies and on devices to fit the gap between MOS RAMs and magnetic disks. The proponents of CCDs were outspoken, but critics are starting to be heard. Proponents of E-beam and bubble devices were not in evidence. People who are designing new database systems are finding that the declining costs of disks and MOS RAMs are making the "gap" hard to fill (papers by A. Hoagland, G. Champine).

Database Systems. The only two papers on database systems served to draw the headlines for the conference (in Computerworld). G. Champine's discussion of common database concepts served to illustrate the narrowing perceived differences between relational and network system models. A paper by J. Gray on System R gave a very good discussion of ease-of-use aspects of a database system. System R is an experimental IBM relational system which is designed for simple installation and system definition, without loss of system functionality. It was reported that field trials have shown System R to be as fast as IMS in simple transaction processing, thus indicating that performance has not been sacrificed. A more complete paper will appear in the May 1979 issue of Computer.

Distributed Database Systems. The several sessions on networks and distributed database management showed that expectations and activity are still high in this field.

Database Machines. An experimental machine being tested at ICL in England was described by V. Maller. It is the Content Addressable File Store, which carries out search and relational operations on a standard moving head disk. Its test installation at the British Post Office has demonstrated big performance gains on certain file operations and high transaction rates on telephone directory queries. This effort reflects the general status of the database machine field: it is an interesting experiment but still no commercial product has been announced.

The Evaluation of Abstract Data Types as an Implementation Tool for Database Management Systems

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This dissertation examines the application of current research on abstract data types and on generic procedures to the implementation of a network model database management system. The data manipulation routines which access the database are examples of generic procedures since they utilize the descriptors of the record and set types in the schema and subschema to determine the functions which are to be performed for a given actual parameter. A generic procedure model of database management systems is presented and is extended to represent the schema and subschema as a collection of shared abstract data types. Generalization, developed by Smith and Smith, is used to define generic objects which represent the network data model and which are used as templates to translate the schema and subschema into the equivalent declarations of abstract data types. The data manipulation routines are implemented in terms of the data attributes and procedures associated with the abstract data types.

A simulation model is developed to compare the abstract data type model with the commonly used interpretive approach. This model is used in combination with analytic modeling to study the locality of references to schema descriptors, the effect of multiprogramming on system overhead, and the effect of mass storage I/O time on system performance.

This work was done in partial fulfillment of the degree of Doctor of Philosophy at the University of Wisconsin-Madison. It was published as Computer Sciences Technical Report 330, Computer Sciences Department, University of Wisconsin-Madison.

April, 1979

An Overview of Recent Data Base Research

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Technical Report SDBEG-5
April 1978

This report is an overview of key theoretical and experimental developments in the database field over a four-year period. It is intended for researchers familiar with database management concepts. Its 16 topic discussions enumerate major research issues and refer the reader to articles and books on each issue. The bibliography lists about 400 references. Contents of the report are:

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* Part of this work was done while the author was an undergraduate student at the Indian Institute of Technology, Madras, India.

Part of this work was supported by the Air Force Office of Scientific Research under Grant AFOSR-77-3409.

Distributed Data Base Task in the Distributed Data Processing (DDP) Program

Organization(s): Computer Network Systems Department, TRW, DSSG, One Space Park, Redondo Beach, California 90278.

Personnel: Task Manager: Dr. Edward Y.S. Lee. Program Manger: Mr. Michael P. Mariani.

Keyword(s): Distributed Data Base, Replicated File Maintenance, Synchronization, Data Base Design, File Allocation, Real-Time Data Control.

Description: The distributed Data Base Task is one of the major tasks in the Distributed Data Processing (DDP) Program supported by the Army Ballistic Missile Defense Advanced Technology Center (BMDATC), Huntsville, Alabama.

For reasons of performance and reliability/survivability the BDM data base design and real time management function will require advances to the current technology. Most of the current research in distributed data bases has been oriented toward information systems with relaxed real time response requirements. Although some of the issues are similar (e.g., remote file access and deadlock prevention) for the BMD problem, the fact that the BMD data base will itself involve distributed, and in many cases redundant, data files creates unique issues such as real time replicated file maintenance. All these issues further complicate the solutions for file access, deadlock prevention and coherency.

Implications: Distributed data base research is a very complex and difficult problem. We plan to emphasize one or two of the critical issues by concentrating on the redundant files update synchronization issue. Instead of using one protocol, we hope to use an approach with multiple protocols based on the real time requirement of the application.

References:

M.P. Mariani and Edward Y.S. Lee, "Distributed Data Bases - Concepts and Critical Issues", Distributed Data Processing Conference, Boston, Massachusetts, 24-25 August, 1978 and Washington, D.C., 25-26 September 1978.

Edward Y.S. Lee, "Distributed Data Base Design Methodology", July 1978, TRW Working paper.

M.P. Mariani, 3rd Quarterly Technical Report, DDP Technology Program, 5 October 1978.

M.P. Mariani, 2nd Quarterly Report, DDP Technology Program, 5 July 1978.

M.P. Mariani, 1st Quarterly Report, DDP Technology Program, 5 April 1978.

M.P. Mariani, Final Report, DDP Technology Program, Volumes I and II, 31 December 1978.

A CODASYL DDLC Pseudo-Working Paper on Schema Terminology

F.A. Manola

My recent activities in connection with the Working Group on Environment, which have included the re-reading of several recent DDLC working papers, have led me to the conclusion that there is considerable talent on the DDLC for the concoction of terminology which tends to obscure the meaning of whatever the terminology is supposed to describe. Examples of the use of this talent abound in the DDLC "literature", but none seems to me so striking as the creation of the various prefixes for the word "schema" which appear in our work. Originally, the sole member of this set was "sub", but membership has increased dramatically as members of the DDLC have rushed to fill this vacuum. We now have (at last count) "sub", "super", "mini", and "maxi".

The problem with this terminology is that it is too technically-oriented, too ivory-tower. We must instead aim our terminology toward non-technical people, who will be the major data base users of the future. You may scoff and say that non-technical people will never to use our DDL successfully; I believe this is nonsense. Look at how well ordinary people have handled problems which were formerly thought to require technical training -- problems such as energy production, pollution control, Middle-East diplomacy, the economy, bugging offices, making tape recordings, etc. As a consequence, I discuss below some revised terminology, the meaning of which is more readily appreciated by lay persons, who need have no computer background, but only average acquaintance with comic books. I must acknowledge those pioneering members of the DDLC whose original work in this direction has provided the foundation for this idea.

As a start in the proper direction, I suggest that, instead of our present schema, subschema pair (which might be referred to as "dynamic duo"), we introduce a trio suggested by Ian's terms "superschema", namely, "superschema", "batschema", and "plasticschema", with possibly a "wonderschema" thrown in for the female chauvinists. Definitions are:

superschema (appropriate for the relational model of data) -- has super powers, x-ray vision (can see into minds of application programmers, data administrators, and operating system designers), super speed (gets around all those nasty implementation problems). Weakness is that it is very sensitive to the absence of a mysterious green substance, lack of which can have drastic adverse effects on its performance (this substance is denoted by the symbol $$$$).

plasticschema (similar to our present subschema) -- stretches to fit everybody's data requirements. Its exact specifications are hard to define rigidly.

batschema (similar to our schema) -- has super powers, but someone must learn the ropes to define it. Requires assistance of strange partner (called "data administrator"), plus a number of clever inventions ("BatOSystem", "BatDMCL", etc.).

wonderschema -- has good intuition about user needs; rest is Greek to me.

In addition to the above terms, the use of the term "mini-schema" naturally suggests:

Mickeyschema -- used by bartenders and application programmers.

while use of the term "maxi-schema" suggests:

pantyschema -- most transparent to user, but still covers critical areas; and

midischema -- largely out of fashion now.

Further work in this same direction would lead to such terms as "eco-schema" (describes the DBMS environment), "nano-schema" (describes that portion of the database seen by a mail-room clerk), "Neanderthal-schema" (describes some of our recent DDLC meetings), etc.

These terms are only some of the wonderful ones we can think up if we spend enough time on the subject (and I detect a trend to do exactly that). While I believe that the appropriate direction for further work in this area is a sharp right turn in the middle of the Golden Gate Bridge, nevertheless I do not wish to forestall anyone's future efforts at defining new terminology like this. After all, it may turn out that Dr. Seuss is a more appropriate source for the derivation of our new terminology than are comics.

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Meetings of Interest

May 30-June 1 - Boston. Ninth SIGMOD International Conference on Management of Data. General Chairman: James B. Rothnie, Jr., Computer Corporation of America, Cambridge, Massachusetts.

August 28-30 - San Francisco. Fourth Berkeley Conference on Distributed Data Management and Computer Networks. General Chairman: Dennis Hall, Lawrence Berkeley Laboratory of the University of California.

October 3-5 - Rio de Janiero, Brazil. Fifth International Conference on Very Large Data Bases. U.S. Conference Chairman: Prof. Stanley Y.W. Su, Dept. of Computer and Information Sciences, University of Florida, 512 Weil Hall, Gainesville, FL 32611.

November 6-8 - Chicago. IEEE Computer Society Third International Computer Software and Applications Conference. General Chairman: Dr. William Smith, Executive Director, Toll Electronic Switching and Operator Services Division, Bell Laboratories, Naperville, IL 60540, 312-690-2389. Papers due June 1, 1979 to Prof. K.S. Fu, School of Electrical Engineering, Purdue University, West Lafayette, Indiana, 47907.

ACM-SIGMOD 1979
International Conference on Management of Data

May 30–June 1

The 57 Park Plaza Hotel
Boston, Massachusetts

Preliminary SIGMOD Program

Tuesday, May 29

8:30 pm–10:30 pm Evening Registration and Reception

Wednesday, May 30

8 am–9 am Morning Registration

9 am–9:30 am Opening Remarks

9:30 am–11:45 am*

A. Session: Database System Implementation
Murray Edelberg, Sperry Research Center

"The Use of Technological Advances to Enhance Data Management System Performance"
P. Hawthorn and M. Stonebraker, University of California at Berkeley

"Query Execution in Direct"
D.J. DeWitt, University of Wisconsin

"Access Path Selection in a Relational Database Management System"
P. Griffiths Selinger, M.M. Astrahan, D.D. Chamberlin, R.A. Lorie, and T.G. Price, IBM Research, San Jose, California

B. Panel: Future Trends of Database Research
J.B. Rothnie, Computer Corp. of America

12 noon–1:30 pm SIGMOD Luncheon
Speaker: L.G. Roberts, Chairman, Telenet Communications Corporation

1:40 pm–3 pm*

A. Session: B-Trees
Ronald Fagin, IBM

"Multi-Table Search for B-Tree Files"
D. Lomet, IBM T.J. Watson Research Center

"Compact B-Trees"
A.L. Rosenberg, IBM T.J. Watson Research Center, and L. Snyder, Yale University

B. Panel: Information Retrieval and Database Management
G. Salton, Cornell University

3 pm–3:20 pm Coffee Break

3:20 pm–6 pm*

A. Session: User Interfaces
C.J. Date, IBM

"FQL—A Functional Query Language"
P. Buneman and R. E. Frankel, University of Pennsylvania

"The Functional Data Model and the Data Language DAPLEX"
D.W. Shipman, Computer Corp. of America

"The Data Management Facilities of PLAIN"
A.I. Wasserman, University of California at San Francisco

"Data Abstraction, Views, and Updates in RIGEL"
L.A. Rowe and K.A. Shoens, University of California at Berkeley

B. Panel: Is Now the Time for Standards?
S. Madnick, Massachusetts Institute of Technology

Thursday, May 31

9 am–11:45 am*

A. Session: Performance Issues
S. Bing Yao, New York University

"Performance Analysis of Three Related Assignment Problems"
C.T. Yu, University of Illinois at Chicago Circle
M.K. Siu and K. Lam, Hong Kong University
M. Ozsoyoglu, University of Alberta

"A Heuristic Approach to Attribute Partitioning"
M. Hammer and B. Niamir, Massachusetts Institute of Technology

"Evaluation of Transmission Requirements in Distributed Database Access"
G. Pelagatti and F.A. Schreiber, Politecnico di Milano

"Cost and Performance Analysis of Semantic Integrity Validation Methods"
D.Z. Badal and J.G. Popek, University of California at Los Angeles

B. Panel: Database Administration
J. Lyon, Colonial Penn Group

11:45 am–1:15 pm Lunch (Open)

1:15 pm–3:15 pm*

A. Session: Database Concurrency Control
David W. Shipman, Computer Corp. of America

"An Optimality Theory of Concurrency Control for Databases"
H.T. Kung, Carnegie-Mellon University
C.H. Papadimitriou, Massachusetts Institute of Technology

"The Complexity of Testing Predicate Locks"
H.B. Hunt III, Columbia University
D.J. Rosenkrantz, SUNY at Albany

"Queueing Network Models for Concurrent Transaction Processing in a Database System"
K.B. Irani and H.L. Lin, University of Michigan

B. Panel: Data Dictionaries
R. Curtice and V.K. Whitney, Arthur D. Little Inc

3:15 pm–3:30 pm Coffee Break

3:30 pm–5:30 pm*

A. Session: Data Dependency Theory
A.V. Aho, Bell Laboratories

"Synthesizing Independent Database Schemas"
J. Biskup, Lehrstul fur Angewandte Mathematik, insbesondere Informatik, Aachen, Germany
U. Dayal and P.A. Bernstein, Harvard University

"Testing Implications of Data Dependencies"
D. Maier, SUNY at Stony Brook
A. Mendelzon, Princeton University
Y. Sagiv, University of Illinois at Urbana-Champaign

"Normal Forms and Relational Database Operators"
R. Fagin, IBM Research, San Jose, California

B. Panel: Office Automation
M.M. Hammer, Massachusetts Institute of Technology
H.L. Morgan, Harvard Business School

6 pm SIGMOD Banquet—at New England Aquarium

Friday, June 1

7:45 am–9 am SIGMOD Business Breakfast

9 am–11 am

Session: Database Semantics I
Beatrice Yormark, Interactive Systems Corporation

"Extending the Data Base Relational Model to Capture More Meaning"
E.F. Codd, IBM Research, San Jose, California

"Null Values in Data Base Management—A Denotational Semantics Approach"
Y. Vassiliou, University of Toronto

"Improving Semantic Specification in a Relational Database"
E. Sciore, Princeton University

11 am–11:15 am Coffee Break

11:15 am–12:35 pm

Session: Database Semantics II
John M. Smith, Computer Corporation of America

"Design of Relational Views Over Network Schemas"
C. Zaniolo, Sperry Research Center

"Data Model Integration Using the Structural Model"
R. El-Masri and G. Wiederhold, Stanford Univ

Contact Pennie Dhionis, Computer Corporation of America, 575 Technology Square, Cambridge, Massachusetts, 617-491-3670, for registration information.