



# **Database Management Systems**

**A Technical Review**

**Alan Mayne**

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# Preface

This book is a technical review of some of the major Database Management Systems (DBMS). It assumes that the reader has a good general knowledge of data processing and has read some introductory material about database.

The objective of the book is to describe the major facilities provided by a number of DBMSs and explain how these work. This is done by comparing, on a facility-by-facility basis, the following DBMSs:

- ADABAS;
- DMS 1100;
- IDMS (Cullinane and ICL products);
- IMS-DL/1;
- TOTAL.

Since these systems are continually being enhanced, the book concentrates on the major features and principles which are unlikely to change dramatically.

The book will be useful to:

- organisations which are in the process of selecting a DBMS;
- training organisations running database courses;
- existing users of one of the systems described as a training aid;
- computing science students interested in database and DBMS implementation techniques.

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# 1 Introduction

## SCOPE AND BACKGROUND

It is first necessary to explain what is meant by a DBMS. Before this can be done it is necessary to define *database*:

'A database is a collection of stored data organised in such a way that all user data requirements are satisfied by the database. In general there is only one copy of each item of data although there may be controlled repetition of some data.' (See item 6 in bibliography.)

Given this definition it is now possible to state the formal definition of a DBMS:

'A database management system is a general-purpose set of programs that aid and control each user's access to and use of the database for adding, modifying and retrieving data, and this includes facilities giving data independence, integrity and security.' (See item 6 in bibliography.)

It is assumed that the reader is already familiar with the general concepts of 'database'. Consequently this book does not include a description of what a database is, nor does it discuss the claimed benefits and disadvantages of database. The objective is to describe the major facilities provided by a number of DBMSs and to explain, in general terms, how these facilities work.

In order to achieve this objective, five widely used DBMSs, which are representative of the types of DBMS software available, are compared on a facility-by-facility basis. This approach highlights the differences between the various DBMSs and illustrates the different ways in which a

given facility may be implemented. The five DBMSs described and the organisations responsible for them are:

ADABAS	Adabas Software Limited
DMS 1100	Sperry Univac
IDMS	The Cullinane Corporation and International Computers Limited (ICL)
IMS-DL/1	International Business Machines Limited (IBM)
TOTAL	Cincom Systems Limited

Both DMS 1100 and IDMS are known as 'CODASYL' systems, ie their basic philosophy and the facilities which they provide are based on the recommendations endorsed by CODASYL, the Conference of Data Systems Languages. CODASYL is generally responsible for the development of the COBOL programming language. However, the database facilities are also applicable to other programming languages. Although both of these DBMSs are based on the same recommendations, there are differences in the facilities actually supported and in the way they are implemented. The inclusion of descriptions of two similar systems has resulted in limited duplication of some information. In many cases the differences between the two systems are subtle.

The descriptions of the DBMSs were compiled by studying the vendors' literature. This included basic sales brochures, programmer reference manuals and documentation containing information about the internal organisation of the systems. With the exception of IBM, all the vendors were visited in order to clarify various points and obtain further information. A draft description of each system was then produced and its vendor was invited to comment. All the vendors provided constructive comments which allowed a number of errors to be corrected and various other improvements to be made to the text. However, if any errors remain they are the author's responsibility.

The vendors of DBMSs are continually improving their products. Consequently, a book providing very detailed descriptions would rapidly become out-of-date. This book does not attempt to provide definitive descriptions. Instead, it aims to describe, in general terms, how the systems operate. Some DBMS facilities are not covered; for example, special recovery facilities which are not widely used. For this reason, organisations using this book to help them select a DBMS are urged to

contact the vendors in order to ensure that they base their decision on up-to-date information. That the book does not say that a given feature is supported by a DBMS does not necessarily imply that the feature does not exist or that there are no other ways of fulfilling the requirement. As the book concentrates on the major features, which are unlikely to change dramatically, it should be a useful reference for a considerable period of time.

## THE STRUCTURE OF THE BOOK

This book is divided into the following chapters:

- 1 Introduction
- 2 Logical Structuring and Data Independence
- 3 Security and Integrity
- 4 Language Interfaces
- 5 Internals
- 6 Installation and Operation

Chapters 2, 3 and 4 each cover one of what the author considers to be the three most important aspects of a DBMS. The detailed structure of this book, as presented in the contents list, may be used as a frame of reference for comparing any DBMS. Alternatively, a detailed list and discussion of selection criteria may be found in items 2 and 3 (see bibliography).

The logical structuring facilities are important because these influence the way in which application systems are designed and implemented. They determine how the natural relationships between an organisation's data may be modelled for implementation on the computer. Chapter 2 also includes a discussion of Data Independence.

The security and integrity facilities described in Chapter 3 are clearly vital. In the event of the database being damaged in any way it is essential that it can be repaired. As the data in the database is shared between a number of users, it may be desirable or even necessary to specify access control constraints in order to prevent unauthorised access. Sharing of data may also cause problems if the database may be updated. The DBMS must be able to protect the integrity of the data in the event, for example, of two different programs attempting to update the same data concurrently.

The interface between the users of a DBMS and the system itself is

clearly important. Here, a user means anybody who interfaces directly with the DBMS itself. This includes application programmers and the people responsible for describing the required database to the system. The language interfaces with the DBMS determine the power of the system for manipulating data. Their ease of use, or otherwise, will strongly influence the training overheads and will be reflected in the error rate or debugging time during programming.

Chapter 5 reviews the more technical aspects of the DBMSs. It describes how the various DBMSs interface with the computer's operating system. There is also a detailed description of how the data is stored in physical storage and how the logical data structures are implemented. This information will be of particular interest to database systems (software) programmers. A knowledge of the internals of a DBMS is also invaluable to the people who design the (physical) database in order to produce an efficient system.

The final chapter considers the installation of the DBMS and its maintenance when in use. It describes the facilities provided for restructuring and reorganising the database as it grows and changes. The performance of an operational system can also cause major headaches so facilities for monitoring and tuning are discussed. The specific problems of optimising storage requirements and access times are also important so the facilities provided (with the DBMS) to assist in this area are presented.

## HOW TO USE THIS BOOK

This book is organised so that it may be used in a variety of ways:

- *Serially*: The book may be read in its entirety from start to finish. When used in this way the reader will notice some repetition of information, especially in Chapter 2 and generally in the entries for DMS 1100 and IDMS. Chapter 4 may prove to be 'heavy' reading but it may safely be 'browsed' through as subsequent chapters are not dependent upon it. Readers who are not interested in the technical detail may bypass Chapter 5 although small parts of Chapter 6 are dependent upon it.
- *Sequentially for a Management Overview*: A busy manager who is not concerned with the technical discussion may bypass the entries about the five DBMSs.

- *Sequentially by DBMS*: A reader who is primarily interested in one particular DBMS can bypass the entries for the others. Within any given section, each entry is independent of the others; information has been repeated where necessary to allow the book to be used in this way.
- *Indexed*: The contents list at the front of the book, or the index at the back enables the book to be used as a general reference book.
- *Direct*: Information may be accessed directly if the page number is known.

## TERMINOLOGY

In a book of this kind, terminology poses special problems. Each DBMS has its own set of jargon. A standard set of terms for use throughout the book was considered but it was thought that this would make it more difficult for the reader to transfer to the vendors' documentation, especially if the book is used as part of a training course. Therefore, the vendors' terminology has been used. It is hoped that the reader can slip from one to another without confusion. The only exception to this is that the term 'field' has been used throughout since it is easier to write, type and speak than 'data-item' or 'data-element'.



