DATABASE ADMINISTRATION AND SECURITY NOTES

What Is a Database?

A database can be summarily described as a repository for data. This makes clear that building databases is really a continuation of a human activity that has existed since writing began; it can be applied to the result of any book keepingor recording activity that occurred long before the advent of the computer era.

However, this description is too vague for some of our purposes, and we refine it as we go along.

The creation of a database is required by the operation of an enterprise. We use the term enterprise to designate a variety of endeavors that range from an airline, a bank, or a manufacturing company to a stamp collection or keeping track of people to whom you want to write New Year cards.

DBMS contains information about a particular enterprise. Collection of interrelated data. Set of programs to access the data. An environment that is both convenient and efficient to use

Database Applications: Banking; all transactions,Airlines: reservations, schedules; Universities: registration, grades;Sales: customers, products, purchases;Online retailers: order tracking, customized recommendations; Manufacturing: production, inventory, orders, supply chain; Human resources: employee records, salaries, tax deductions ;Databases touch all aspects of our lives

How does the introduction of a database affect an organisation?

Introduction of a DBMS is likely to have a profound impact Might be positive or negative, depending on how it is administered Three aspects to DBMS introduction: Technological Managerial Cultural One role of DBA department is to educate end users about system uses and benefits

How has the database administration function evolved?

Data administration has its roots in the old, decentralized world of the file system Advent of DBMS produced new level of data management sophistication DP department evolved into information systems (IS) department. Data management became increasingly complex: development of database administration function

What is the DBA's managerial role?

DBA responsible for: Coordinating, monitoring, allocating resources Resources include people and data Defining goals and formulating strategic plans Interacts with end user by providing data and information Enforces policies, standards, procedures Manages security, privacy, integrity Ensures data can be fully recovered Ensures data distributed appropriately

What is the DBA's technical role?
Evaluates, selects, and installs DBMS and related utilities Designs and implements databases and applications Tests and evaluates databases and applications Operates DBMS, utilities, and applications Trains and supports users Maintains DBMS, utilities, and applications

DATABASE ADMINISTRATION

Imagine it's the first day of class in college, and you sit down for the first lecture. Your Head of Department walks in and makes an announcement:
'Welcome back after the holiday break everyone. I have to start off with some bad news. Due to a glitch in the university's database, all grades and credits from last semester have been lost. I'm sorry, but we are going to have to do last semester all over again. Now open your book on page?'
That would be disastrous, right? Could you imagine? How could the university lose all that information? Luckily, these things almost never happen. The important question really is how can we prevent this from happening? Who is responsible for keeping all the data secure in an organization? That would be the database administrator, or DBA.

Database administration refers to the whole set of activities performed by a database administrator to ensure that a database is always available as needed. These activities are closely related to database security, database monitoring and troubleshooting, and planning for future growth.

Who is a Database Administrator?

A database administrator (DBA) is a specialized computer systems administrator who maintains a successful database environment by directing or performing all related activities to keep the data secure. The top responsibility of a DBA professional is to maintain data integrity. This means the DBA will ensure that data is secure from unauthorized access but is available to users.

The DBA is usually a dedicated role in the IT department for large organizations. However, many smaller companies that cannot afford a full-time DBA usually outsource or contract the role to a specialized vendor, or merge the role with another in the ICT department so that both are performed by one person.

Tasks/Functions of a Database Administrator

A DBA must be capable of performing many tasks to ensure that the organization's data and databases are useful, usable, available, and correct.

1. **Selection of hardware and software**

- Keep up with current technological trends
- Predict future changes
- Emphasis on established off the shelf products
- Evaluate Database features and Database related products.

2. **Database Design**

The DBA must be able to transform a logical data model into a physical database. To properly design and create relational databases DBAs must understand and adhere to sound relational design practices. They must understand both relational theory and the specific implementation of the RDBMS being used to create the database. Database design requires a sound understanding of conceptual and logical data modeling techniques. The ability to create and interpret entity-relationship diagrams is essential to designing a relational database.

2. **Performance Monitoring and Tuning**

Database performance can be defined as the optimization of resource usage to increase throughput and minimize contention, enabling the largest possible workload to be processed. The DBA must be vigilant in monitoring system, database, and application performance. As much as possible this should be accomplished using automated software and scripts. Polling system tables and building alerts based on thresholds can be used to proactively identify problems. Alerts can be set up to e-mail the DBA when performance metrics are not within accepted boundaries.

3. Ensuring Availability

The DBA must understand all of these aspects of availability and ensure that each application is receiving the correct level of availability for its needs. Availability of data and databases is often closely aligned with performance. If the DBMS is offline, performance will be horrible because no data can be accessed. Ensuring database

availability involves keeping the DBMS up and running and minimizing the amount of downtime required to perform administrative tasks.

4. Database Security and Authorization

Once the database is designed and implemented, only authorized programmers and users should have access to prevent security breaches and improper data modification. It is the responsibility of the DBA to ensure that data is available only to authorized users. Security must be administered for many actions required by the database environment including: creating database objects, altering the structure of database objects, reading and modifying data in tables, creating and accessing user-defined functions and data types, running stored procedures and starting and stopping databases and associated database objects.

5. Governance and Regulatory Compliance

Assuring compliance with industry and governmental regulations is an additional task required of database administration, at least in terms of implementing proper controls. The DBA must work with management, auditors, and business experts to understand the regulations that apply to their industry and the manner in which data is treated. Certain aspects of regulatory compliance address standard DBA operating procedures. For example, regulations may contain language enforcing specific security and authorization procedures, auditing requirements, data backup specifications, and change management procedures.

6. Backup and Recovery

The DBA must be prepared to recover data in the event of a problem. "Problem" can mean anything from a system glitch or program error to a natural disaster that shuts down an organization. The majority of recoveries today occur as a result of application software error and human error. The DBA must be prepared to deal with all types of recovery. This involves developing a backup strategy to ensure that data is not lost in the event of an error in software, hardware, or a manual process. The strategy must be applicable to database processing, so it must include image copies of database files as well as a backup/recovery plan for database logs. It needs to account for any non-database file activity that can impact database applications as well.

Types of Database Administrators

Some organizations choose to split DBA responsibilities into separate jobs. Of course, this occurs most frequently in larger organizations, because smaller organizations

often cannot afford the luxury of having multiple, specialty DBAs. Some of the most common types of DBAs include:

1. System DBA

A system DBA focuses on technical rather than business issues, primarily in the system administration area. Typical tasks center on the physical installation and performance of the DBMS software. System DBAs rarely get involved with actual implementation of databases and applications. They may get involved in application tuning efforts when operating system parameters or complex DBMS parameters need to be altered.

2. Database Architect

A database architect focuses on designing and implementing new databases. Database architects are involved in new design and development work only; they do not get involved in maintenance, administration, and tuning efforts for established databases and applications. The database architect designs new databases for new applications or perhaps a new database for an existing application. Typical tasks performed by the database architect include: creation of a logical data model, translation of logical data models into physical database designs, analysis of data access and modification requirements to ensure efficient SQL and to ensure that the database design is optimal and creation of backup and recovery strategies for new databases.

3. Database Analyst

Another common staff position is the database analyst. There is really no common definition for database analyst. Sometimes junior DBAs are referred to as database analysts. Sometimes a database analyst performs a role similar to the database architect. And sometimes database analyst is just another term used by some organizations instead of database administrator.

4. Data Modeler

A data modeler is usually responsible for data modeling tasks including: collection of data requirements for development projects, analysis of the data requirements, design of project-based conceptual and logical data models, creation of a corporate data model and keeping the corporate data model up-to-date and working with the DBAs to ensure they have a sound understanding of the data models.

5. Application DBA

Application DBAs focus on database design and the ongoing support and administration of databases for a specific application or applications. The application DBA is likely to be an expert at writing and debugging complex SQL and understands the best ways to incorporate database requests into application programs. The application DBA also must be capable of performing database change management, performance tuning, and most of the other roles of the DBA. The difference is the focus of the application DBA—

not on the overall DBMS implementation and database environment, but on a specific subset of applications.

6. Task-Oriented DBA

Larger organizations sometimes create very specialized DBAs who focus on a single specific DBA task. But task-oriented DBAs are quite rare outside of very large IT shops. One example of a task-oriented DBA is a backup and recovery DBA who devotes his entire day to ensuring the recoverability of the organization's databases. Most organizations cannot afford this level of specialization, but when possible, task-oriented DBAs can ensure that very important DBA tasks are tackled by very knowledgeable specialists.

7. Performance Analyst

The performance analyst, more common than other task-oriented DBAs, focuses solely on the performance of database applications. A performance analyst must understand the details and nuances of SQL coding for performance, as well as have the ability to design databases for performance. Performance analysts have knowledge of the DBMS being used at a very detailed technical level so that they can make appropriate changes to DBMS and system parameters when required. The performance analyst is usually the most skilled, senior member of the
DBA staff. It is very likely that a senior DBA grows into this role due to his
experience and the respect he has gained in past tuning endeavors.

8. Data Warehouse Administrator

Organizations that implement data warehouses (a large store of data accumulated from a wide range of sources within a company and used to guide management decisions) for performing in-depth data analysis often staff DBAs specifically to monitor and support the data warehouse environment. Data warehouse administrators must be capable DBAs, but with a thorough understanding of the differences between a database that supports online transaction processing (OLTP) and a data warehouse.

9. Installation, configuration and upgrading of Database server software and related products.

- Plan growth and changes (capacity planning).
- Work as part of a team and provide 24x7 support when required.

How Many DBAs?

One the most difficult things to determine is the optimal number of DBAs required to keep an organization's databases online and operating efficiently. Many organizations try to operate with the minimal number of DBAs on staff, the idea being that having fewer staff members lowers cost. But that assumption may not be true. An overworked DBA staff may make mistakes that cause downtime and operational problems far in excess of the cost of the salary of an additional DBA.

But determining the optimal number of DBAs is not a precise science. It depends on many factors, including:

1. Number of Databases

The more databases that need to be supported, the more complex the job of database administration becomes. Each database needs to be designed, implemented, monitored for availability and performance, backed up, and administered. There is a limit to the number of databases that an individual DBA can control.

2. Number of users

As additional users are brought online as clients of the applications that access databases, it becomes more difficult to ensure optimal database performance. Additionally, as the number of users increases, the potential for increase in the volume of problems and calls increases, further complicating the DBA's job.

3. Number of applications

A single database can be used by numerous applications. Indeed, one of the primary benefits of the DBMS is to enable data to be shared across an organization. As more applications are brought online, additional pressure is exerted on the database in terms of performance, availability, and resources required, and more DBAs may be required to support the same number of databases.

4. Service-level agreements (SLAs)

The more restrictive the SLA, the more difficult it becomes for the DBA to deliver the service. For example, an SLA requiring subsecond response time for transactions is more difficult to support than an SLA requiring 3-second response time.

5. Availability requirements

When databases have an allowable period of scheduled downtime, database administration becomes easier because some DBA tasks either require an outage or are easier when an outage can be taken. Considerations such as supporting e-business transactions and the Web drive the need for 24/7 database availability.

6. Impact of downtime

The greater the financial impact of a database being unavailable, the more difficult DBA becomes because pressure will be applied to assure greater database availability.

7. Performance requirements

As the requirements for database access become more performance oriented and faster and more frequent access is dictated, DBA becomes more complicated.

8. Type of applications

Organizations implement all kinds of applications. The types of applications that must be supported have an impact on the need for DBA services. The DBMS and database needs of a mission-critical application differ from those of a non-mission critical application. Mission-critical applications are more likely to require constant monitoring and more vigilance to ensure availability.

9. Volatility

The frequency of database change requests is an important factor in the need for additional DBAs. A static database environment requiring few changes will not require the same level of DBA effort as a volatile, frequently changing database environment. Unfortunately, the level of volatility for most databases and applications tends to change dramatically over time. It is difficult to ascertain how volatile an overall database environment will be over its lifetime.

10. DBA staff experience

The skill of the existing DBA staff will impact whether or not additional DBAs are required. A highly skilled DBA staff will be able to accomplish more than a novice team. Skills more than experience dictate DBA staffing level requirements. A highly motivated DBA with two years of experience might easily outperform a ten-year veteran who is burned out and unmotivated.

11. Programming staff experience

The less skilled application developers are in database and SQL programming, the more involved DBAs will need to be in the development process, performing tasks such as complex SQL composition, analysis, debugging, tuning, and ensuring connectivity. As the experience of the programming staff increases, the complexity of DBA decreases.

DBA Certification

Professional certification is an ongoing trend in IT and is available for many different IT jobs. The availability and levels of certification have been growing at an alarming rate for database administration. Certification programs are available for most of the popular DBMS platforms, including IBM DB2, Microsoft SQL Server, and Oracle. The concept behind certification of DBAs is to certify that an individual is capable of performing database administration tasks and duties.

The problem is that passing a test is not a viable indicator of being able to perform a complex job like DBA. Organizations should hire DBAs based on past experience that indicates a level of capability. Certification can make you more employable, but, someone with both experience and certification is better than someone with only one of the two.

DBMS Vendors

There are many DBMS vendors from which to choose. However, there are definite tiers in terms of popularity, support, and leadership in the DBMS market.

In general, the marketplace can be broken down into the following groups:

1. **The Big Three**
   The three market leaders that constitute the greater part of the DBMS installed base as well as the bulk of any new sales.

   They are:
   1. Oracle Corporation - Oracle
   2. IBM Corporation - DB2
   3. Microsoft - Microsoft SQL Server

2. **The second tier**
   Large DBMS vendors with stable products, but lagging behind the Big Three in terms of functionality and number of users.

   They are:
   1. Sybase
   2. Teradata
   3. Informix

3. **Other significant players**

Other DBMS vendors with viable, enterprise-capable products. They are:

1. Actian Corporation - Ingres
2. Software AG - Adabas and Tamino

4. Open source
DBMS products supported as open-source software (as opposed to by a single vendor).

They are:
1. PostgreSQL
2. MySQL

5. Non-relational
Vendors that supply pre-relational DBMS products to support legacy applications.

They are:
1. IBM - IMS
2. Cullinet - IDMS

6. NoSQL
Non-relational DBMS products for Big Data that are highly scalable to support modern Web applications.

They include:
1. CouchDB
2. MongoDB
3. Hadoop and HBase

7. Object oriented
Vendors of ODBMS products that are used in conjunction with OO languages and development projects.

They are:
1. Object Store from Progress Software
2. Ontos
3. Poet

8. PC based
Although many of the other vendors create PC versions of their DBMS products, these companies or products focus exclusively on the PC platform.

They are:
1. dBase
2. FileMaker
3. Lotus Approach (included in Lotus SmartSuite)
4. Microsoft Access
5. Paradox (included in the Professional edition of WordPerfect Office)