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Major: TEM010017 **-** Computer Science

MASTER THESIS

Title: Comparison of PostgreSQL & Oracle Database

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ABSTRACT

Goal thesis is to compare the practical side of Database Management Systems of famous databases: PostgreSQL and ORACLE in the consideration of commercial opinions and technical features.

As the goal that they have conjunctly engaged an essential part in the field of Database Management Systems, so, the complete comparison of the collection standards of these two databases is under a lot of attention of mixed users. Along with the profitable market analyze and anatomize the detailed technical functionalities of the two databases, readers could get a rich view of the usability of the databases while standing on a great vantage opinion and have a prophetic view of their future. The similar theme has not been in the Electronic library Theseus already which means it is a great chance to make up the vacant field. The Database Management Systems ideas and issues care the thesis content over the whole description construction that is regard as analysis tips for readers. The experiential study is more based on study and match of regular data that gather from Internet establishments and guide references the outcome of specific tests that done on dissimilar platforms. These rewards are to classify variations among ORACLE and PostgreSQL. Communications with administrators also plays a key role as a dynamic source of stimulus.

Conversely limits are still being as the inaccessible to those private statistics and the databases core skill confidentialities. Limitation also emerged for the analysis equipment were more persuasive enough to make deductions which are pleased the scientific standards. Additional observes and checks are advised if the thesis outcome is wanted to be used in academic.

Xülasə

Bu elmi işin məqsədi dünya səviyyəsində məhşur iki verilənlər bazaları olan PostgreSQL və ORACLE-ı Məlumatların İdarə Olunması alətlərinin işləkliyini həm biznes həmdə texniki cəhətdən qarşılaşdırmaqdır.

Bu səbəbdən Məlumatların İdarə Olunması sahəsində açar rol oynaması bu iki bazanı seçim kriteriyalarını ətraflı bir şəkildə qarşılaşdırılması fərqi istifadəçilər tərəfindən böyük diqqət kəsb edir. Biznes sektoruna görə bu bazaları spesifik texniki iş qabiliyyətlərini analiz edib xasiyyətlərini müəyyən etmək oxuçuların yüksək bir baxış bucağı ilə bazaların istifadəyə yararlılıq dərəcəsi aydın şəkildə görünür. Bu barədə elmi işlər kitabxanasında boşluq olduğu yaxşı fürsət yaradır. Məlumatların İdarə Olunması anlayışı və faktorları elmi işin məğzini oxuyuçular üçün daha oxunaqlı olması dəstəklənmişdir.

Ətraflı araşdırma daha çox fərqli platformalarda həyata keçirilən fərdi təcrübələrin nəticəsi olan internet mühitdən və yazılan elmi işlərdən toplanan statistik məlumatların analiz edilməsinə və qarşılaşdırılmasına əsaslanmaqdadır. Bu PostgreSQL və ORACLE arasında fərqləri müəyyən etməyə kömək edir. Bununla birlikdə bu gizli statistikaya və bazaların əsas biznes incəliklərinə əlçatanlıq hələdə məhtuddur. Elmi işin akademik sahədə istifadəsi daha çox araşdırma və test tələb edir.

INTRODUCTION

Information is data that is accurate and timely, specific and organized for a purpose, presented within a context that gives it meaning and relevance, and can lead to an increase in understanding and decrease in uncertainty. Information is valuable because it can affect behavior, a decision, or an outcome[1]

Data is generally information in raw or unorganized forms (such as alphabets, numbers, or symbols) that refers to, or represents, conditions, ideas, or objects. Data is limitless and present everywhere in the universe. Data is symbols or signals that are input, stored, and processed by a computer, for output as usable information on computers.

RAM is physical memory installed in a computer or storage device as silicon chips, hard disk, floppy disk, CD, etc., that is addressable by, and is directly accessible to, a computer (CPU – central processing unit) in a non-sequential (random) manner.

Data storage is a device for recording (storing) information (data). Recording can be done using virtually any form of energy, spanning from manual muscle power in handwriting, to acoustic vibrations in phonographic recording, to electromagnetic energy modulating magnetic tape and optical discs. A storage device may hold information, process information, or both. A device that only holds information is a recording medium. Devices that process information (data storage equipment) may both access a separate portable (removable) recording medium or a permanent component to store and retrieve data. In the storage device information to treat or that contain both. A device that contains only the information is a record carrier. The devices that treat the information (hardware of data storage) can access another laptop (removable) support to sound recording or a permanent body to store and retrieve data.

Information collects on data. Data collects on data storage on computers. Collecting information increase data storage. Data manage in RAM on computers as administrative process by which the required data is acquired, validated, stored, protected and processed

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[1] https://en.wikipedia.org/wiki/Database - Database, Terminology and overview

by which its accessibility, reliability and timeliness is ensured to satisfy the needs of the data users. Management of useful work between RAM and data storage make OS by background processes and other tools and demons.

Systematically organized or structured repository of indexed information usually as a group of linked data files that allows easy retrieval, updating, analysis and output of data. Stored usually in a computer, this data could be in the form of graphics, reports, scripts, tables, text, etc., representing almost every kind of information. Most computer applications including antivirus software, spreadsheets and word-processors are databases at their core.

Data management objects (RAM, CPU) on each computer have its own limits HWM (high water mark). For analyze some situation you must have information. For useful information set you must search needed information on data that places on databases. On database data situate on data blocks. For needed information database call data blocks to global area in RAM for defining and analyzing data for need. Always data storage is grate than RAM in computers. Because of searching needed information get more resource for analyzing. Dependently it gets more time and more resource for process.

In a world of exponentially increasing information dependently increasing data, people need ways to manage the data. The people use data to get information. Also, they save information on data. For fast getting information uses different methods object and tools. For saving and then finding needed information people use not raw data. They use logical structure for data keeping and for ease search. Logically to manage data uses databases.[2]

Different kinds of data structures are suited to different kinds of applications, and some are highly specialized to specific tasks. For example, relational databases commonly use B-tree indexes for data retrieval, while compiler implementations usually use hash tables to look up identifiers.[3]

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[2] http://www.myreadingroom.co.in/notes-and-studymaterial - Security of DBMS, Security Policies.
[3] https://en.wikipedia.org/wiki/Data_structure - Data structure, Implementation.

Data structures provide means to manage large amounts of data efficiently for uses such as large databases and internet indexing services. Usually, efficient data structures are key to designing efficient algorithms. Some formal design methods and programming languages emphasize data structures, rather than algorithms, as the key organizing factor in software design. Data structures can be used to organize the storage and retrieval of information stored in both main memory and in secondary memory.[4]

Chapter 1. GENERAL INFORMATION ABOUT DATABASE

A collection of data that is organized in a database. It is a schema, tables, queries, reports, view of the collection, and other objects will be included. The rooms in the hotel are a data availability for modeling the recruitment of hotel was favorable, to search for requests for information, such as the side of the reality to support the process to model, typically are organized.[5]

1.1   Database management system

Database management system (DBMS) is the software that interacts with the user in the other applications and to analyze the data to the database itself. To define a DBMS is designed for that allow you to create and manage the database query, update, or. In addition, the DBMS: MYSQL, PostgreSQL, Microsoft SQL server, Oracle, Sybase and IBM DB2, SAP and Hana known.

Database is the other laptops in the DBMS is not in general, SQL and ODBC or JDBC using standards such as the single use the applications to more so that you can work on the DBMS and can interoperate with another DBMS. A supported database management system is classified by the basic model of data.

The database system in the 1980s, expressed in all the SQL language supported in a relational model because it was more popular. Sometimes, the DBMS is usually called the "database".[6]

Formally the "database", it is the data to configure how it is organized to see. Of these, access to the data in the database management system is one or more of the user interactions with the database and to restrict access to specific data, but there may be a limit on all the data contained in the database allows you to access your computer software consists of a set of integrated (DBMS) is a commonly available (Definition, 2017). The

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[5] https://en.wikipedia.org/wiki/Database - Database, Applications.
[6] http://www.businessdictionary.com - Structure, Data.

entries in the large amount of information of the DBMS storage and that enables you to search a variety of features that offer this information is organized in a way that provides a way to manage. There is close relationship between them for the long-term "database", it is often used to manipulate the database, refer to the DBMS. Slightly used.

Information and technology expert of the outside world, the term database, in many cases, a spreadsheet, or any of the data, such as the index used to refer to the collection. This article is the size of the data to the bank of the issue and the use of the database by using the management system and applies only if you meet the requirements.

To use the existing DBMS and the database is one of the key features of Group 4. Data to allow you to manage the various features. To define the organization of the data to create the data defined in the Modify and Delete Definitions. Insert the update - the actual data of the change, and remove.

Use directly or by other applications in the subsequent processing, to provide the information that is entered in the form. Acquired data to the form that is essentially the same as in the database or in the change or to combine data from the database is stored in a new form in so that it can be used. The registered user monitoring, management, and monitoring the performance of the security of the data, applications, and data to maintain the integrity of the control of the competition in the information and the unexpected system failure has occurred at events such as the destroyed recovery.

The database and its database with the principles of the model which is consistent with the DBMS. Database in the "system" of the database is a database management system model are collectively referred to as the database.

To secure the base of the actual DBMS and associated software. To run the database server is a physical computer dedicated database server is typically a multiprocessor computer, the storage for the stability of the used RAID disk and memory of the generosity of the bay. Raid is one of the failed disk in the case of data to use for recovery. One or more of the connected to the server and the Database Accelerators through the channel high-speed of equipment is the large amount of transaction processing environment to use

as well. Most of the database application is the heart of the DBMS have been discovered. DBMS, multitasking support for custom network using a nucleus can be built, modern DBMS is the standard operating system, in general, these functions in the SQL before starting the Structured Query Language to verify that from the database. The variety of the recovery of data redundancy and the concrete structure to organize that there are no appropriate methods for the chaos.[7]

DBMS is economic market and information science and storage solutions for the configuration part of the supplier and the development of their own often plan, consider the requirements of the DBMS.

DBMS SQL to the database and is the XQuery, engineering and performance, availability, and reliability and security impact. Internal organization such as a database that is used to access the XML or relational on a server cluster to run a mobile phone, the query language such as the type of computer to support the model can be classified by the database.

The database is internal to the organization and to support the operation and the customer and supplier and online operations are used to support the. Database is the administrator of the technical data and economic models, and more specialized information and to hold the data used. The following example shows the application of a database. Library of computer system is the flight reservation system, computerized parts inventory management system, and the database of the web page that stores a collection of many of the web site content management system.

1.2   Database History

The progress in the areas of the processor technology to achieve the computers, computer, storage, computer network for the following memory size, capacity, and

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[7] Codd, Edgar F. (1970). "A Relational Model of Data for Large Shared Data Banks" (PDF). Communications of the ACM. 13 (6): 377–387.

performance of each of the DBMS database and the size of the order. Development of technology for basic data and data navigation in the era of the structure of the model SQL can be used to split a relational, post-relational.[8]

The Main navigation data in the first two models of the IMS to IBM and Network Model codicil (model), some of the products, such as IDM is implemented in the hierarchical model and the embodiment.

This is the first time in 1970 Edgar F-Codd is advocating the relational model, the application in the following link and not the content of the data you will need to search for the departure from this tradition by that claim. The Relational Model style of the great book, the set of tables for each employee to another entity of type. In the middle of the 1980s hardware in a relational DBMS powerful enough only in a broad range of system deployment (more and more applications to allow. At the beginning of the 1990, however, large-scale data processing of all the main application was dominated by the relational system and 2015 will remain the dominant from the IBM DB2, oracle, MYSQL, Microsoft SQL server is the main DBMS. The main language of the SQL database is a relational model for the standard and the data with other models of the language of the database of the affected.

80 years of the object to the object in the database has the following disadvantages - the invention of "Post" and the relational database that led to the development of relational impedance, object-relational hybrid developed to overcome.

At the end of 2000, the next generation of post relational database NOSQL database is known under the name of the value of the key store and a database for the rapid deployment of document-oriented. The "New Generation" database to a new relational model / NOSQL of commercially available in the report by DBMS to high-performance aims to match the retained as the implementation of the new SQL under the name of the known.

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[8] http://whatis.techtarget.com/definition/historical-data - Historical data, History.

1.3 Design and modeling

DBMS is the complexity of the system software and its development of the development of the efforts of tens of thousands of years of typically required between the direction of evolution. Oracle and DB 2, arabas, is the general purpose of the DBMS for some progress has been made in the 1970s or later. To use the common DBMS is application as far as possible to add to the complexity of the maximum number of) aims to meet the needs. However, their development costs are often the most cost-effective approach. A significant number of users assigned to the meaning of the fact that a DBMS for general use, however, is not the best solution, always: In some cases, the DBMS of unnecessary overload can occur. Therefore, the database of the system using the many of the examples.

A common example is the data to a variety of factors such as the insertion or deletion of messages that can be configured from the general purpose of the many of the features of the DBMS, or to associate the email address in the message. This is the e-mail system, these features, e-mail, and the user has to use the DBMS that provides all of the functionality available to treat the is not limited to what is required.

Many other databases to the end-user account to access the database for the software application, the DBMS, publish it directly to the interface. Application of the program to the protocol or application programming interface to directly through the more you can use the wire. The more knowledge to the database application to build and maintain a DBMS via a dedicated interface need to interact with the database and the database administrator and the designer of the DBMS is the adjustment of the DBMS and understand how to interact with the external interface of the parameter.[9]

The first task of the designer of the database is a database that reflects the structure of the information maintained by the conceptual data model. A common approach of this project is to use the relationship between the entities in the model, use the drawing tools

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[9] https://en.wikipedia.org/wiki/Data_structure - Data_structure,Model.

to frequent development. Another popular method is the Unified Modeling Language. (Database, 2017) The world outside of the success of the data model in the model to indicate a situation that can be accurate. For example, people are at least one phone number if it is that you have to enter this information. It is interested in things like organization, customers also ask questions to the supplier or the product packages are two different types of sales in the case of "", or "usually those products and products with the same or a different product? ", or "Frankfurt via the New York fly aircraft, flight, Dubai, or two (or possibly three) " If the answers to these questions, the flight segment of the entity (client, products, and services), and the relationships between them and attribute definitions of terms used in the established.[10]

Production of conceptual data model, business process in your organization, or the contribution of the work flow analysis. This database contains the information as needed and what is what is on one side and you can leave. It may help to establish a. For example, database and the historical data of the current must not contain the data can help you to decide if you want to.

Made user is satisfied and conceptual data model consists of the following steps to implement the data structures of the database diagram. This process is a logical data of the basic design is often referred to as the output and is represented in the form of a Diagram of logical data model. On the other hand, the data of the conceptual model is the data of the basic technology of choice (at least in theory), Independent, and logical data model is supported by the selected DBMS database models are represented by the terminology.

The most popular for the database to the database you have the generic model is the relational model, or, more precisely when the SQL language that expressed in the relational model. This model is used to create a logical data of the basic design of the process standardization and called the systematic approach is used. The purpose of the

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[10] http://www.myreadingroom.co.in/notes-and-studymaterial - DBMS, Security.

standards of the "facts" each of the elementary school is the only in one place and the observation of the insert, delete, and update automatically to ensure consistency and verify that you are in.

The final step in the database design, performance and availability and recovery that will affect the security of the. This is the design of the physical database and can also be called. During this procedure, the main purpose is to retrieve the data, the reasons for the decision from the optimize performance by the user and the application to hide the means that it must of independence. Physical Design is the heart of the performance requirements for the expected workload and the access mode of the DBMS sufficient knowledge is required, the functionality provided by the selected deep understanding.

The design of the physical database, one of the other aspects of security. In the Database object to control access to both the definition of the security level of the definition and the data to its own method is included.

1.4   Database features

To set the data structure of the implementation of the procedure to create an instance of this structure is common for people to write for and operation of the. You will not be able to specify a data structure, these operations and are separate from the effects were analyzed.

This is an abstract data type for the operations that you can perform on the indirect method that is defined in the data structure of the theoretical concepts that motivates observations, including cost of space and time, and then click the mathematical properties of these operations.

The database for the proper operation of the business of the importance of technology because it is the database that is required by the system to provide the performance,

security and availability. Complex includes a mechanism; the database administrator can use these features to be controlled.[11]

Availability

Database storage is bottle for the carnal unit of the database. It is at the physical level of the database architecture (inside). It is also the all the necessary information (for example, metadata is the "data about data", the concept of using the internal data structure), and the external level to level when it is necessary to rebuild the internal level is included. The database engine is the responsibility of the storage engine, or the insert data in persistent memory.

The underlying operating system and many of the operating system the file system is the storage layout as the broker for the use) to use the DBMS can access in general, storage and set the property in the DBMS to ensure the efficient operation of a very important to the database administrator is closely linked to retained. (Data Structure, 2017)

In the service of the DBMS, be sure and several types of storage (for example, memory and external storage that is stored on a company's database. Additional information about the database and if there is a need for very large amount, perhaps is in bits, color-coded.

In general, data to the storage of the air in the conceptual framework and the appearance of the data in the external level, in order to optimize the users and programs, and, if necessary, depending on the levels for the reconstruction of the try (as far as possible in the best way, as well as other data (such as the question in the database from the type of information you need in order to calculate the method and is completely different structure is present.[12]

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[11] Halder, Raju; Cortesi, Agostino (2011). "Abstract Interpretation of Database Query Languages" (PDF). COMPUTER LANGUAGES, SYSTEMS & STRUCTURES. Elsevier. 38 (2): 123–157.

[12] https://en.wikipedia.org/wiki/Data_structure – Data structure, Availability.

To save the data in some of the DBMS. Because of this, some of the same database, you can use the encoding used by the character encoding of the specification.

Low-level data in several different storage structures to the storage engine in the data model to your favorite can be written to the media. Used as a base to serialize. Create Index and other technology to increase performance by can be used. Traditional storage in a line to focus on the interactions between the columns and the database, which can also be found in the other.

Storage redundancy is used for improving the performance of many. A typical example is the materialization of the is often required external view or the results of the query to display the view consists of the storage. This view of the storage is required at each point in time to save the expensive computer. The disadvantages of a materialized view to update data in a database to ensure the synchronization occurred during the update overhead costs, and can help reduce the cost of the storage redundancy.

If you want to save the database on the spot, and replication of data copy of one or more of the basic object has a redundancy and to improve the availability of data (both the end-user is the same for multiple concurrent access to the database object to improve the performance of a distributed database of a partial failure occurs, the fault tolerance. A copy of the update of the replication object will need to be synchronized. In many cases, the entire database is duplicated.

Performance

After the end of the database transaction is an accident, fault tolerance and data integrity level can be used to deploy a. The number of operations on a database transaction in the database are usually unit of work (for example, database objects, such as read, write and lock acquisition) is supported on the other system is also a database abstraction. Each transaction is the execution of the program code and/or included in this transaction in those conditions well-defined boundaries (operation of timer command is used is determined by the special operation).

For information about the ACID (atomic, the coherence and insulation on the following connection Japan for sustainability), set the property to a database transaction. One of the data in the context of the database of the logical operation is called a transaction. For example, one bank account to another account to transfer the supply of funds to the account of the flow and another credit is one of the operation of the changes.[13]

Jim Gray, these reliable transactions at the end of the system properties of the 1970s was developed and that is defined in the report to automatically offer a technology. The acronym of the acronym acid database transactions ideal describes the properties of some atomic, consistent, isolated, and sustainability.
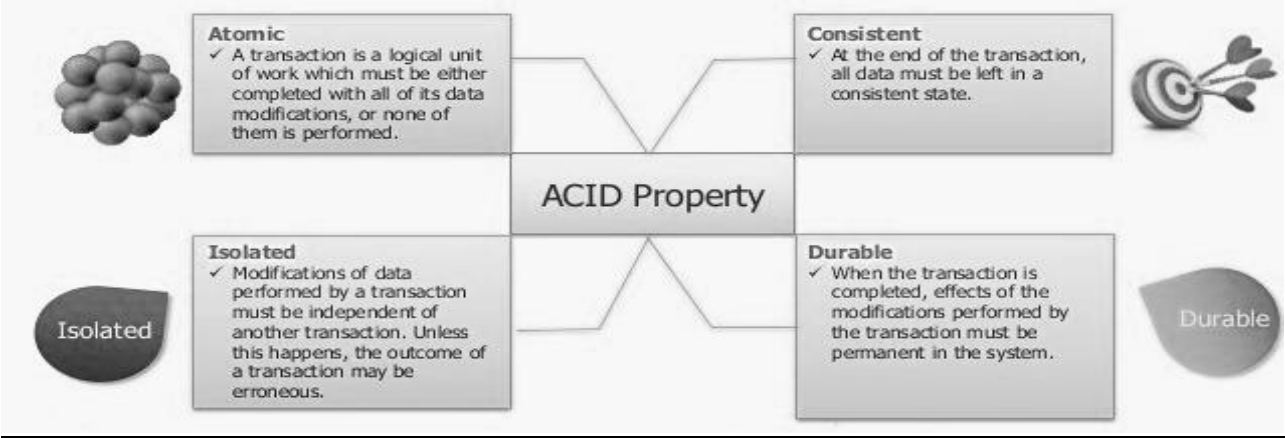
Figure 1 ACID Property

Each atom in the all or nothing of the transaction,"" is the operation failed for some of the tasks in the event of the failure of the entire database does not change the state of the you need to leave. The atoms in the system, verify that the status is required. Fault, errors, and accident. The world outside of the uncommitted transaction based on the data of the effect is shown.) You can split (not "atomic"), if the operation fails.

Consistent property of any transaction is in a valid state, the database to another that is guaranteed. All the data that is written to the database, (Diagnosing and Tuning Database Performance, 2016) Cascade, including constraints all the defined rules,

[13] Gray, Jim (September 1981). "The Transaction Concept: Virtues and Limitations" (PDF). Proceedings of the 7th International Conference on Very Large Databases. Cupertino, CA: Tandem Computers. pp. 144–154. Retrieved March 27, 2015.

triggers, and all of that is valid for any combination of these factors. This is the all of the application programs to the desired accuracy of the operation that is the way (this is the responsibility of the application-level code is not guaranteed to have a simple programming error is one of the rules defined in the ' the violation of.

To specify the properties for the sheath of the transaction if you are running in a series of acquisition in the results to the state of the system is the execution of concurrent transactions. This means that the other one later. The insulation is provided by the main objective of the concurrency control. Concurrency Control Method (in other words, if you are using strict and expressed opposition to the atmosphere of the maintenance, depending on the transaction effects is also displayed in the incomplete another transaction could not be with.

Properties of Japan for sustainability is a transaction is committed, he is a loss of power occurs, even if you have that you have not left is a block or an error occurs. In a relational database, for example, the SQL statement to run one time a group of the results must be stored in the permanent. (If the database crashes if) immediately after. To protect themselves against loss of power, the operation (or its effect), you must register the other non-volatile memory.

Built using the DBMS databases, another portable computer (that is, the other to the DBMS is not activated). In certain situations, however, the migration of the DBMS, another, it is desirable to the database. The reason is essentially the economic (For other DBMS ownership or TCO costs to the total), functional and operational (different DBMS have different capacities. Migration of the DBMS type of conversion to another. Convert the database-related applications (for example, all the applications you need to keep the program-related) (if available). As a database and external conceptual architecture of the level of conversion should be maintained. The architecture of the internal level, several aspects of it is desirable that is maintained. Fundamentals of complex data, or migration is a complex itself, the cost that must be considered in the decision to migrate (1 times) project, you can do so. Use the tool to help you transition between the DBMS specific to

be present. In general, use the tool to other popular DBMS database from some DBMS vendors to provide the import.

The design of the database for the application in the next step after the construction of the database. In general, for general use in the DBMS is used for this purpose and can be selected. DBMS data for each of the models, the application data structures required to define the database administrator is required to use to provide a user interface. The user interface of the other settings as required, such as parameters of the DBMS (storage space as related to security, etc.) and to select the use.

Are you ready for the database (all data structures and other necessary components are defined in the case of the first data from the application (base is typically a separate project, initialize it. Also, in many cases, normal, in a bulk insert into the interface to support it by using the dedicated DBMS), please make sure to pre-production. In the case of some of the application data while it is empty, the database operation, data is accumulated during its operation.

After the database is created and initialized, the data is inserted in the need to maintain it. Database, you may need to change the various parameters of the database (for best performance tuning), the application of the data structure for the new application programs can be modified or added. To add a specific feature, etc.

You can also write the time for many reasons to return to the previous condition you will need to create a database (for example, database, and software error has occurred and the damaged is detected or when the wrong data if it was updated in the must monitor the). To perform this operation, the backup operation is the opportunity or a continuous desired database of each state (that is, the database of the data structure of the data and its integration of value) is a dedicated (must be effective, there are several ways), the backup files are maintained in the run. This state is the database administrator to restore the database to the state (for example, the point is in this state, the time the database is in this state if it is to indicate that the file will be used. This condition when you are determining the that you want to restore, if necessary.

Software for verification of static analysis technique is also applied to the query language of the scenario. The framework is an abstract interpret approximation methods to query language of the relational database to support has been extended to the field. Semantic query language specific data fields can be adjusted by an abstraction. Relational database of abstractions such as access control, the watermark strategy, for security reasons, many interesting applications, etc.

You can include the functionality of another DBMS. This database is a data warehouse, a component in the system is to create a table of the graphics or the log. Query Optimizer to optimize the query of each request in the query plan to make the most efficient it in (part of) query command (Operation of the shaft to run to calculate a result of the selection. The storage engine to a particular application program to design a database for tools and hooks, programming and maintenance, analysis, the control performance of the database is a database that controls the configuration of the DBMS and related data of the hardware configuration (unit in the computer to scale the network storage unit) and the database mapping (DBMS is being distributed to the center) is a basic model for storage of the monitoring data distribution, storage migration. Some of the more and more in a single methodology is the same as the construction of these features is the source database and control framework testing, deployment, and management of the basic is built into the system of supporters in the software industry trends of lending to the some of the database to provide such as the "DEVOPS labeling. Also, Packaged, these database management solution is a stable, secure, backup, and test for compliance with the consistent between the environment and the possible.

Security

Security activities to measure the confidentiality, integrity and availability of information system and its major assets to ensure the data is related to the 3. To ensure the security of data and comprehensive approach is the scale of the companies that you need to approach it is important for you to understand.

To understand the scope of the security of your data, we are more information about each of the three security purposes: confidentiality of data is protected from unauthorized access and debate and make sure that the data is accessible to authorized users if the data is only used for that purpose. In other word, sensitive to compromise the privacy rights of the people and organizations without any means of backing up data for the disclosure of information. To evaluate the data is classified by the level of confidentiality. A very limited number of people), confidentiality (access only certain groups have access, and all users can access the without restrictions. The integrity of the framework of the security of your data, consistent data, error, or failure to take an interest in the preservation of the free. (Administering Global Data Services Configurations, 2017) Emphasis on maintaining consistency and integrity and anomaly of free data is displayed. A DBMS is to ensure the integrity of the data in a database on which played a central role in. However, from the perspective of the security and integrity of the data in a database and the user of the processes your organization not only in the use pattern, to maintain the integrity of this and also so that authorized users and allowed for the purpose for which they were required, availability, and data for each time accessibility. To ensure the availability of data on the entire system is not the only data components for the service or any of the source (internal or external), must be protected from the deterioration. [14]

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[14] http://www.myreadingroom.co.in/notes-and-studymaterial -DBMS, Security.

Chapter 2. ORACLE DATABASE & IT'S MAIN FEATURES

Oracle Database is a collection of data that has been treated as one unit. The purpose of the database to obtain the information related to the store. The database server will be the key to solving the problem of information management.

In general, server reliability, many users are in the same data at the same time, multiple users can access the environment to manage the large amount of data. All of this while delivering the high performance. Preventing unauthorized access to a database server to recover from the failure that occurred for the efficient solution.[15]

This part of the oracle database to provide a general overview of the integrity of the data in the database, including the rules described in the basic data structure, and metadata are stored in a structure.

Not all the organizations, to meet its requirements must save the management and information. For example, the company will collect the employee personnel records must be managed. This information to the people who need to use must be available. In the current version of the oracle database, and innovative development of 35 years or more of the results.

2.1   Oracle database architecture

The database server is the key that is used to manage information. In general, reliable server-user environment so that users can access the same data at the same time, multi-a large amount of data to manage. Preventing unauthorized access to a database server to recover from the failure that occurred for the efficient solution. To use the oracle database memory structure and process to manage and access the database. All the memory structure to configure the RDBMS that exists in the main memory of a computer.

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[15] http://docs.oracle.com/database/121/CNCPT/toc.htm - Introduction to Oracle Database, Relational Model.

Database Instance: The database instance, the database file to manage memory structure. An instance of the shared memory space. SGA, called the System global area is set to background processes. (Garcia-Molina, 2008) The instance of the database files can exist independently. The figure below shows the database and its instances. Each user of the instance you want to connect to the client in the process, the application will run. Each of the client process is associated with its own server process. The process of the server is known as the global area that program your own private session of memory, (PGA).[16]
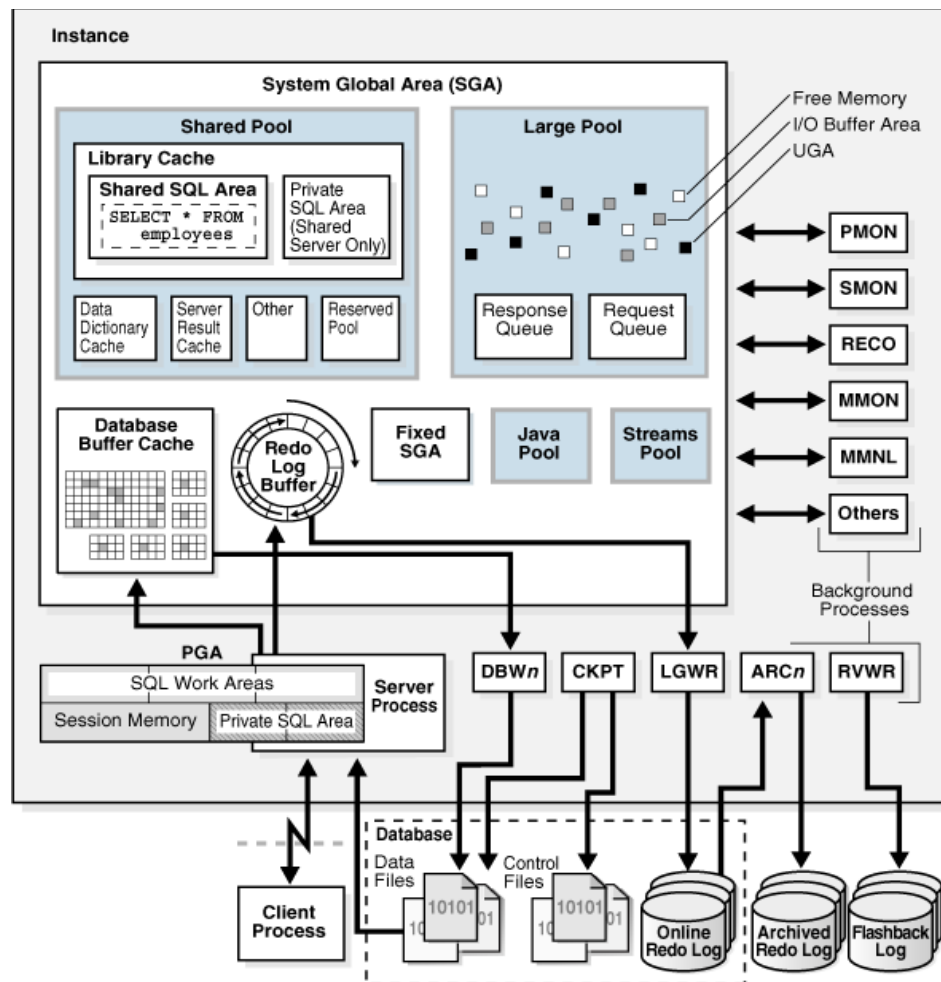
Figure 2 Oracle Instance and Database

Application to connect to the oracle database and to the database instance. In addition to instances of SGA and assigning it to the other areas of memory, application services, and background processes to initiate the process in addition to the other.

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[16] https://docs.oracle.com/cd/E11882_01/server.112/e40540/startup.htm - Database, Instance Configurations.

The process is a series of procedures can be performed within the operating system mechanism. For some operating systems, the terms and conditions to use the job, a task, or thread.

The purpose of this topic thread is equivalent to the process. The process in the next instance of the oracle database can be of different types.

• Client Processes **-** these processes are created, an application program, or oracle to run code of the software tools and management. In most environments, a separate computer for the client process.

• Background Processes **-** for each client in the process of running the oracle database program that the ability to process integration. Background processes to an asynchronous I/O, and other to monitor an Oracle database for better performance and reliability to provide increased parallelism of process to run.

• Server Process **-** Oracle client processes of these processes and interactions with the database in order to meet a request to communicate.

Oracle process server process and background process is included. In most environments, oracle, a client is running on a different computer process.

To create an Oracle database, program code memory structure shared between the user uses the data for each connected user's private data area.

The following memory structure in the database instances associated with it.

• System global area (SGA) **-** A single instance of the database and the SGA data and control information is included in the shared memory structure of the group. An example of the component to the SGA database buffer cache, shared SQL area is included. Release 1 of Oracle Database 12 c (12.1. 0.2) is the store options column of SGA in-memory (IM), the data in the Column stores in memory in the form of, it can be included to enable.

• Program Global Areas (PGA) **-** The PGA on the server or on a background process in which data and control information is included in the memory area. To access the PGA is limited to the process.

Database Storage Structures: The elementary responsibilities of a relational database are data storage. In this section, use the oracle database provides information about physical and logical storage structure.

The physical database construction is to apart from the data files.

After executing the statement, the database is created.

• Data **-** The entire oracle database to one or more of the physical data files of the database is a file that contains all the data. Table and index to a logical structure of the database and the data is physically stored on the data files.

• Control **-** The entire oracle database to the control file. In the control file is a database file containing the name and location of the database name and to specify the physical structure of the database metadata is included.

• Online File **-** All the oracle database is online, two or more of the online redo log file settings to re-run the redo logs, log. Online redo logs are also called the redo entries (redo logs) record is the all of the changes you made to the data in a record.

Many of the other files in the oracle database server for the function of important. These files are included in the parameter file and the network. Backup files and the archived redo log files for backup and recovery logs vital separated records.

To enable the logical storage structures in Oracle Database is to use the disk space and detailed control.

This topic is a logical storage structure.

• Data Block - The granularity of the highest level of data blocks to the oracle database data is stored in the data block. One data disk on a certain number of bytes of the block.

• Extents - of a certain type of information that will be used to store the one obtained in the assignment of logical contiguous data block, a specific number.

• Segment **-** The user object (for example, tables and indexes), to return to the original data to temporary or temporary data that is allocated for the extents of a set.

• Tablespace **-** of the database is separated into logical storage part named the tablespace. Tablespace is a logical container for the segment. Each table space, at least one of the data files.

Application & Networking Architecture

The specified computer system or network to take full advantage of the oracle database to the database server and the client program is split between the processing is enabled. The RDBMS on the computer that is running applications that are running on the computer that you want to display content and processes the data to the database server process.[17]

The architecture of the application computing, database application is connected to a database in the oracle environment. The two most common database architecture is a client/server and multi-tier.

• Client/server architecture, the client application is running on the database server to start the operation that you want to request.

Run the oracle database software to the server at the same time to process the required features and shared data to be accessed. In the request from the client to the server is receiving and processing.

• traditional multi-tier architecture, one or more of the applications to perform some of the behavior of the server.

The Application Server is the application logic for the most part, and it contains the client to provide access to the data and the number of query processing. In this way reduces the load on the database. The client and the multiple database and application server acts as the interface between the additional level of security that you can provide.

The service-oriented architecture (SOA) is the application of features to the service that is encapsulated in the multi-tier architecture. SOA service acts as a web service implemented. You can access a web service through HTTP, Web Services Description

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[17] https://en.wikipedia.org/wiki/Network_architecture - Network, Architecture.

Language (WSDL) and XML-based standards such as SOAP based on it. Oracle Database is a SOA environment with multiple tiers of traditional or can function as a web service provider.[18]

Oracle net service is a database and distributed processing network communications for the interface between the protocol and the distributed database. Communication protocol data is received on the network to define how, sent by the. Oracle net service is TCP / IP, HTTP, FTP, and WEBDAV to include all major network protocol is a communication support.

Oracle Net services to establish the components of the net, oracle database server from the client application to maintain a network session. Network after the session has been established for the oracle net data on both the client application and the database server functions as a courier service, messages are exchanged between them. Oracle net, because these are each of the computers in the network that you want to run the job.

A key component of the Oracle Net service called the net listener), or in a different location of the database in a network running in the process. The client application is the joining invitation to the listener is a database of these wishes to manage the traffic and send it. If the connection is established and communicates directly with the client and in the database.

The client requests the service is the most common method to configure the oracle database.

• Dedicated Server

Construction of the process, separately client to join to a dedicated server procedure. The server processes the client during the period of the session by other clients is not shared. Each new session on a dedicated server process is assigned.

• Shared server

The sharing of multiple sessions of the database on the server to use the swimming pool of the process. A client process, the dispatcher, which is often the client is a dedicated server for each client process, without the need to connect to the same database instance processes and communication.

Multitenant Architecture

The Oracle Database 12 C, multi-tenant architecture to start the oracle database (CDB) multi-tenant database to enable container.

CDB is 0, 1, or many users create a plug-in available database that contains a single physical database. Plug-in available database (PDB), the schema in the schema object oracle net client of the CDB portable collection to appear and nonschema object. Non-CDB is PDB cannot be included. The traditional oracle database.[19]

To start the Oracle Database 12 C CDB, either or non-you need to create the database. CDB to non-you can plug in to the PDB. To move to the PDB is the non-CDB, oracle data pump must be used. (Pavlovic, Z., & Veselica, M., 2016)

A single database on a single computer on different computers on multiple physical database will be integrated with the multi-tenant architecture has the following advantages:

• Hardware

• Easy data and code

• Make it easy to manage the physical database, the administrator of the PDB to the duties

• The PDB is she or he will be allowed to manage the only with permissions to administrators of the CDB

Figure 1-1 the whole is managed by the same data between the name of the integrated in the CDB MYCDB after. Separation of the data and code

• Isolation of the monitoring of the Reduce cost of move more quickly.

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[19] https://docs.oracle.com/cd/E11882_01/server.112/e40540/startup.htm - Oracle System, Identifier.

This is the physical MYCDB is the oracle database (one of the database instances and multiple instances of the oracle real application clusters, CDB) and non-it is possible to one of the files for the database as well as the configured.

Two includes the PDB: hrpdb MYCDB salespdb and. As shown in Figure 1-3, these database PDB is integrated as before and is displayed in the respective application. The CDB itself, or any of the contained in the PDB to manage the IT administrator, this is the root of the CDB schema is a collection of schema object with the connection and all non-schema objects belonging to the PDB. The Architectural Differences Between CDBS and non-cdb is Unless specified otherwise in this manual and the non-architecture - it is assumed that the CDB.
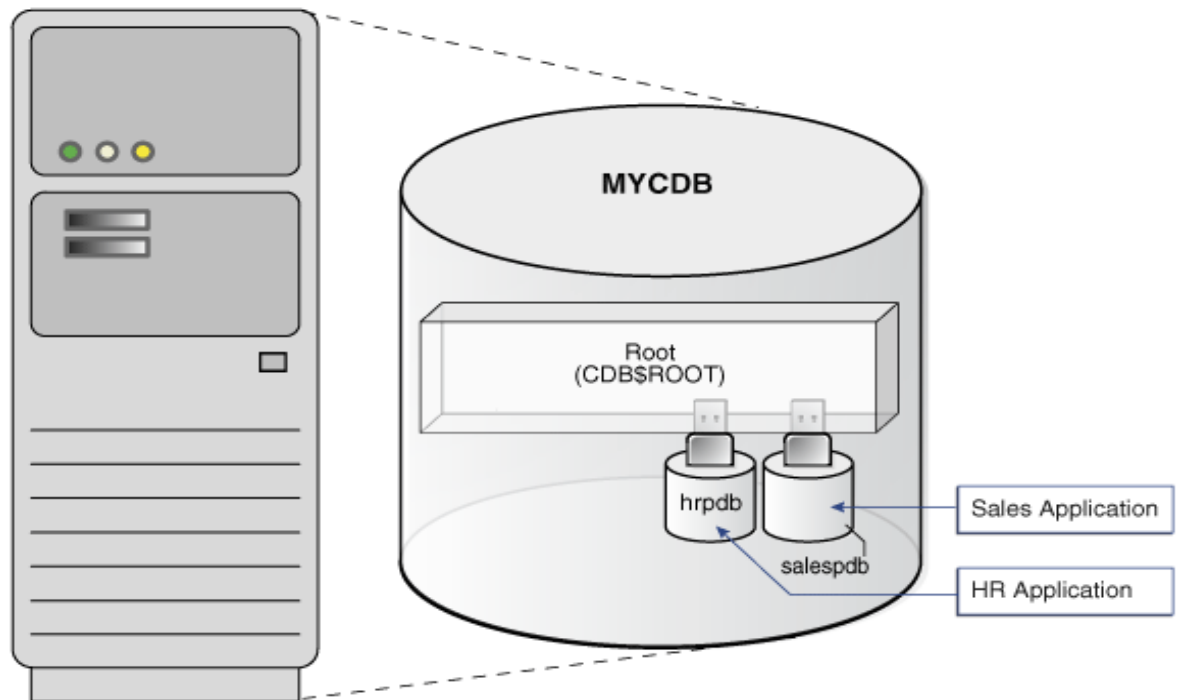
Figure 3 CDB

2.2   Oracle schema objects

The schema of the database is a schema object a data structure called a logical container. Examples of schema objects from the table and index is created. To use SQL to create the schema objects in the operation.

The database user account with a password is set to the specific database permissions. Each user account in a single schema to the user that has the same name as the owner. This schema is the user schema to own the data is included. (Oracle Database Concepts, 12c Release 1, 2017) For example, if the schema of the user account HR Employee table contains the schema objects, such as the owner. The owner of the schema in the production database is a database application that is usually not the people.

Within the schema of a specific type of each schema object has a unique name. For example, time employees time tables in a schema refers to the employee. The owner of the schema in the schema of the HR below named hr and schema objects.
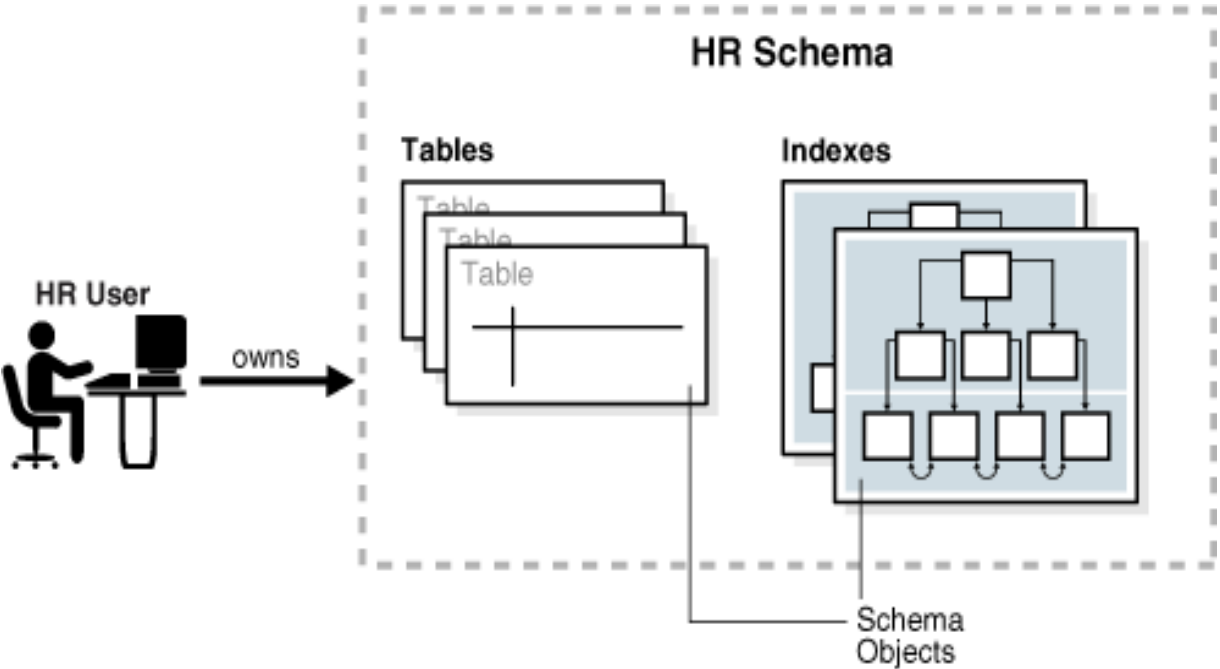

Figure 4 HR DB Schema

Schema Object Types

To enable SQL oracle schema object is to create many other types of operations. The main types of schema objects.

• Table **-** Rows in the table to store data. Table is the most important in a relational database schema object.

• Index **-** index is the index of the table or tables, and the rows in the cluster contains entries directly into the line to provide high-speed access schema object. There are several types of the index of the oracle database support. Index is the index of the data in the table that was organized in a structure that is stored in a table.

• Partition **-** table and index partitions are large part. Each partition has its own name and if necessary, of their own storage characteristics.

• View **-** views of one or more tables or other views of data in a presentation to the customized. To run a saved query, you can think of. The view of the actual data is not included.

• Sequence **-** to generate a sequence is a user is an integer multiple users, you can also share a. To create objects. Typically, use the sequence to generate the primary key value.

• Dimensions **-** to set the parent column set of columns, all the columns in the same table from where you will need to come to define the parent-child relationship between the pair of. The dimension is generally classifying the data such as the customer, product, when used.

• Synonyms - in another schema object's alias. Thesaurus, simply because it is an alias to the definition of the data dictionary other than the storage is not required.

• PLSQL and PLSQL sub-program - The SQL oracle package for the procedure of the extension. PLSQL the subprogram is to use the set of parameters that can be invoked with the name of the PLSQL to block. PLSQL package group PL / types, variables, logically related to the subprograms.

Other types of objects are also stored in the database, a SQL statement to the operation, you can create a schema is not included in the. These objects are database user accounts, roles, context, and the dictionary object.

Schema Object Storage: Some types of logical storage structure of the schema object data segment and the called save. For example, the non-partitioned tables or indexes that are organized in heap segments to create.

Views, sequences, and others such as the schema objects in the metadata only. This topic describes only the segment is a schema object.[20]

The following figure shows the table space in the segments of the table and index of the possible settings, and data files. One of the tables of the two files are in the same table area, both part of the data segment of the span. Cannot be more than one table segment to area.[21]
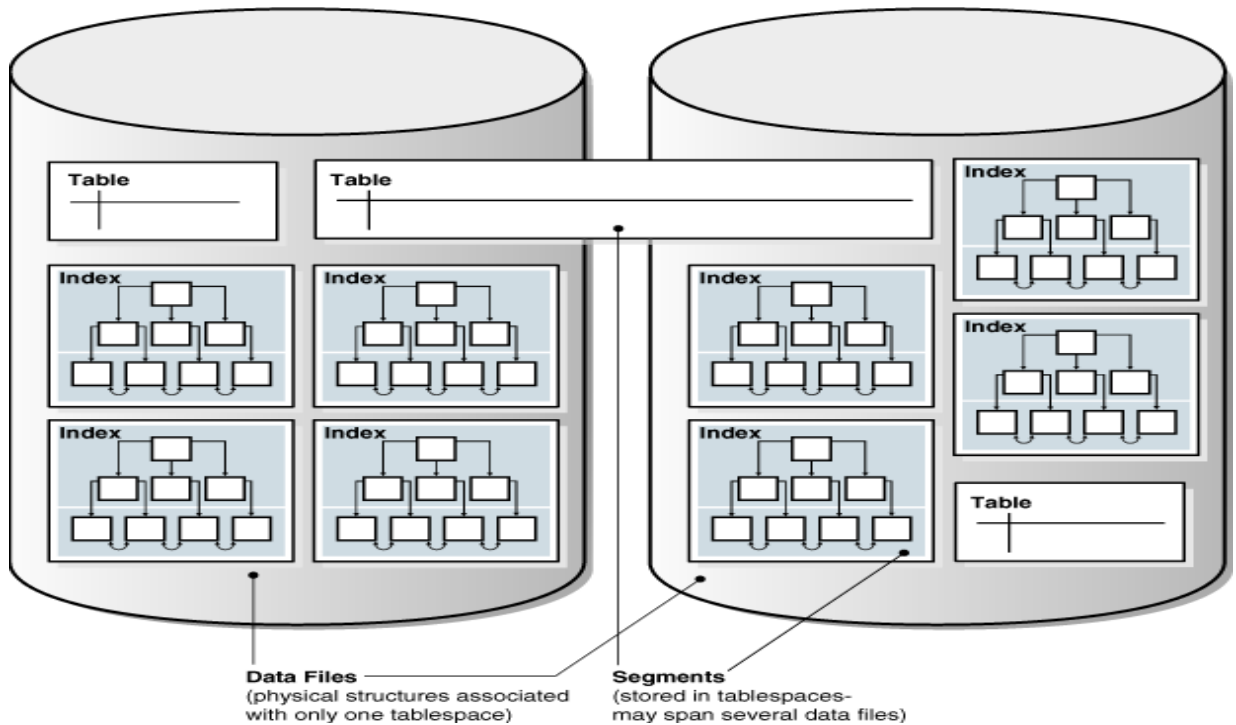
Figure 5 Data Files and Segments

Data Integrity

The integrity of the data in the data in the database is determined by the administrator or application developers to maintain compliance with business rules is important. Business rules are always true or false if you must always specify the conditions and relationships. For example, each company's payroll, employee number, tracking inventory information, to define its own policy.

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[20] https://docs.oracle.com/cd/E11882_01/server.112/e40540/tablecls.htm - Tables, Table Clusters.
[21] http://docs.oracle.com/database/121/CNCPT/toc.htm - Advantages, Integrity Constraints.

Oracle database tables and columns both at the level of the constraints can be applied. As part of the definition of the column or attribute to the constraints specified in the inline specification. As part of the definition of the table the constraints specified in the out-of-line specifications.

Key is a string or integrity constraints of a certain type to be included in the definition is set to the column. (Enterprise anager, 2017) Use the key to the relational database provides information about the relationships between the tables and columns. Individual values in the key are called the key value.

The following table describes the type of the constraint. Each line of the inline, or in the case of NULL must not inline, except that can be specified.

Integrity constraints.

• Not Null – there is no restriction on NULL values in the columns of the table must be included. To check whether a value is not null. By default, NULL values in all the columns in the table.

• Unique Key **-** a key constraint on a column or set of columns in all the values in a must be unique. There is no row of the table is a duplicate of a single column or the value of a unique key use the unique key constraint column (composite unique key).

• Primary Key **-** constraint, the constraint for the primary key of one or more of the columns of the values for a group of uniquely identify the row. Each of the primary key for the table is one of the effect is to ensure that in the name of the row and the duplicate row does not exist, you can have it.

The primary key is a natural or a surrogate. Natural keys in the table has made using the existing attributes of meaningful identifiers. For example, natural keys in the lookup table for the postal code. In contrast to this, a surrogate key are generated in the system within the table that is guaranteed to be unique and an identifier that is incremented. Typically, a sequence of surrogate generates the key.

The following statements are true:

➤   There is no of rows in the specified column or set of columns with a duplicate value in a primary key constraint is guaranteed to be in the oracle database deployment.

➤   Columns in the primary key. Do not allow NULL values.

• Foreign Key **-** External key for every two tables, one or more of the common column that contains the oracle database of foreign key constraint to use two of the relationships between the tables, you can apply a referential integrity constraint, sometimes referred to as the. Each value of the constraints of the constraints are defined, the other columns in the table to the value specified in the other must match the column. An example of a referential integrity rules, employees of the existing only department of activities can be performed.

• CHECK **-** to check a column or set of CHECK constraints on the specified condition is true for all rows in the or unknown, it is required. To false to evaluate the result of the constraints and the conditions of the DML, SQL statement is rolled back.

2.3   Oracle database security

In general, database security user authentication, encryption, access control, and need to be monitored. This section contains the following topics:[22]

❖   User Accounts

❖   Authentication

❖   Encryption

❖   Data Redaction

❖   Access Control

❖   Monitoring

User Accounts

Each of the oracle database is a valid user of the Database list is displayed. The database has a default administrator account is the default account that contains several

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[22] http://docs.oracle.com/database/121/CNCPT/toc.htm - Logical Storage, Structures.

systems and included. If required, you can create a user account. To contact the oracle database application user is as well permits you to construct.

To access the database user is a valid user name and authentication credentials must be provided. Credentials, Password, Curberos tickets, or public key infrastructure (PKI) certificate. Failed login attempts on the security of the database based on the account can be configured to lock.

In general, access to the database for data access control, and there is a need to limit the database activity. For example, Query to run the specified table or the specified database statement allows you to limit the user from running.

Privileges - The permissions of the user who has the right to perform a SQL statement. Permissions are grouped in the following categories:

• System Privileges - within the database to perform a specific action, right-click, or for all objects of a specific type to execute the action. For example, to create the user to create a session, the system privileges.

• Objects Privileges - the object of this method is to perform a particular operation, for example, employees to run the query against the table. The type of permissions that are defined in the database.

At the option of the other user authorizations approved to the user. The administrator must grant the user permissions to perform the tasks you need to complete to your own work so that they can. Good security practices, the privileges for the privilege for the users who need to perform the required tasks you must only be granted.

Roles

The role of the user is another user or role to grant the privileges associated with the named group. Role is to manage the permissions for the group or user in the database application to help you.

The following roles for general use. Role of the payment of the clerk, manager of the REC, clerk is already assigned to another user. The role of the application to run the application for payment of the privilege to the account are included in the payment office

employees and managers are assigned the role assigned to the user. The role of the application, in the permission to the REC account to run the application in the REC, clerk and manager are assigned the role assigned to the user.
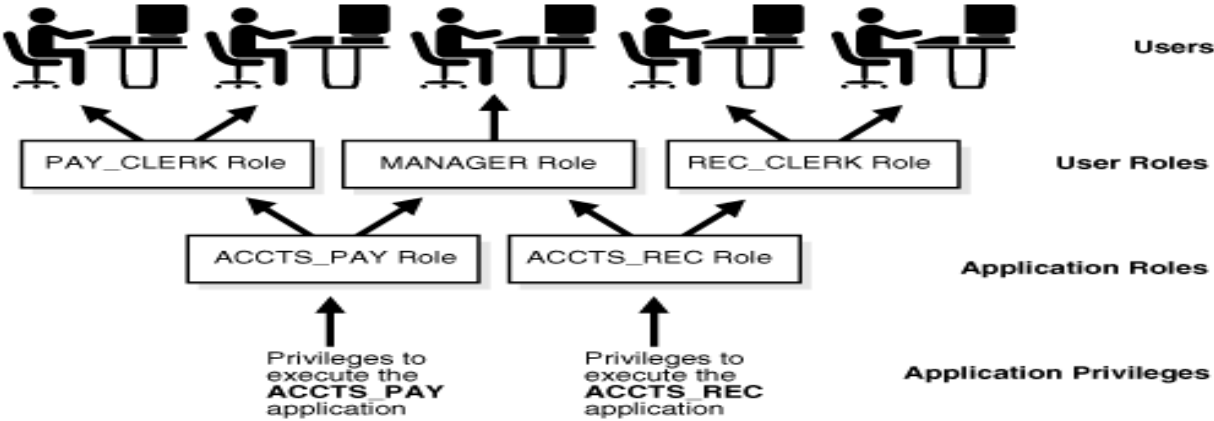
Figure 6 Common Uses for Roles

Privilege Analysis

To use the privileged to analyze mechanisms and the requirements specified in the database depending on the use of privileges. In this way, the application of the module specific to execute a SQL statement, or to run to get the necessary permissions. For example, certain database during the session if the user is a member of the exercise of rights can be found on.

Production database, permissions, and roles to the relationship between the roles, role, and the role and the user is a complex. In the analysis of complex system privileges must be granted privileges can be identified. Based on the analysis of collected results and unnecessary permit or grant privileges to re-configure the database to a more secure, you can delete it.

User Profiles

In the context of the system resources on the user profile in the user's database usage is to limit the resources of the database instance and resource limits, and is set to the name of the password parameter.

To use a profile that the user is available on a per session of CPU processing time, and the number of concurrent sessions the amount of logical I/O can be restricted. For example, the clerk's profile office work required system resources and may be limited by the user.

Profile attributes of users that share a single point of reference for the. One of the user settings to assign a profile to all the other default profile. Each user is assigned to the most at any point in one of the profiles.

Database Authentication

In the database to an Oracle database using the authentication is the user database is to use the credentials and verify access to the database and to present credentials so that you can process. Confirm the individuality and to found a trust connection for the interface. To access the authentication for a specific ID so that you can link to an action, accountability is also enabled.

The oracle database has the following a variety of authentication methods include the following:[23]

• Authentication by the Password **-** database is used to authenticate a user to the Cerberus ticket, or PKI certificate. Oracle and other forms of authentication, including biometric - RADIUS-compliant devices are also supported. Oracle user is created in the database when you need to specify the type of authentication.

• Operating System Authentication **-** some operating systems, the information in the oracle database to authenticate a user to maintain the permitted to use. Is authenticated by the operating system after the user to specify a user name or password to connect to a database without. In a database, other than the administrator user account when you shut down or start a database you need to perform such database operations. SYSDBA and SYSOPER privileges, these operations are SYSDG SYSBACKUP or permissions.

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[23] http://docs.oracle.com/database/121/CNCPT/toc.htm - Oracle Database, Instance.

Encryption: The private key and encrypt the oracle database encryption algorithm is used to decrypt the data becomes unavailable to the process of converting the data into a format. If encryption is often the Payment Card Industry Data Security Standard (PCI DSS) or violation notification laws and regulations such as that are associated with to meet the requirements of compliance to use. For sample, credit card numbers and social security numbers, or patient health information must be encoded. (Securing Data on the Network, 2017)

Transparent Data Encryption - Oracle advanced security for transparent data encryption, the individual table column or table space allows you to encrypt. The Encrypted columns in the user data to the database data to automatically insert the when the encryption. If you select a column to the user, the data is encrypted. This encryption format is a transparent, high-performance and is easy to implement.

The industry is transparent data encryption standards, such as the advanced encryption standard (AES) encryption algorithms and key management.

Oracle Data Redaction

Oracle advanced security of Oracle data redaction, some in the for low privilege users or applications can be queried by the mask (redact) data is enabled. The redaction of users to perform queries against the data in real time when the occur. Type the following data redaction feature:

Full data redaction **-** In this case, the database of the complete data redaction redacts table or view the entire contents of the columns specified in the support. For example, last name VARCHAR column 2 to one space and is displayed.[24]

Some of the data redaction **-** in this case, the database is a part of the output displayed redacts for example, Application - credit card number xxxx xxxx xxxx in 1234 as the end of the current, you can. Both entire or a slice of it to practice a even appearance for

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[24] http://www.oracle.com/technetwork/database/options - Advanced, Security.

redaction. A regular expression is a pattern that is based on the data to redact. For example, uses a regular expression to a specific phone number or e-mail address to redact.

The random data redaction - in this case, the database depending on the data type of the column that contains a randomly generated value in the data is displayed. For example, Number 1234567 appears as an 83933895 Data Redaction is a comprehensive security solution. For example, is attached directly to the you will not be able to block your edited data in guessing attack, perform the privileged user. To this type of attack is to identify the column that was revised in the process of eliminating the stored value, you guessed it, by repeating the SQL query to the actual data to the backup. Privileged users can be inferred from the other attacks to detect and prevent the, oracle, oracle audit vault and the oracle database vault, such as firewall and database related database security products to the oracle data redaction to pair is recommended.

Access Control

Oracle database control access to data in a lot of technology. In this section summarizes some of these technologies.

Oracle Database Vault

Oracle database vault privileges restrict user access to the application's data. Oracle database vault 12 c of the oracle database, and extend the standard database audit data structure. In addition, if you migrate a unified audit database Oracle files to the security to protect the oracle database audit records to the centralized audit records in the audit trail for integration to write to.

Oracle database vault, the database by using the data and applications when you access the where and how you can control. Therefore, Insider Threat Protection and other common security issues, regulatory requirements, and to comply with the address you want to apply the separation of duty. Oracle database vault is the responsibility of management of oracle database vault, in addition to the metadata database to verify the change audit settings required. Oracle database vault, these changes are relevant to the investigation authorities, and grants and protection in the role of the revocation of the

create, modify, and oracle data pump and other components, such as the Job Scheduler, delete, and approvals are included.

Virtual Private Database (VPD)

Oracle Virtual Private Database (VPD) in the rows and columns of the level of security to apply a is enabled. The security policy of the data and the database infrastructure to damage from accidental or malicious destruction to establish a method to protect the database.

Permissions and roles for security measures such as VPD is sufficiently detailed setting is useful when you do not. For example, all the user must be able to access the employee table that is the same as the user security, you can restrict access to the employees of a department, you can create a policy.

Basically, the database is Oracle's VPD security policies are applied to the table, view, or a synonym for dynamic SQL statement that was issued for the WHERE clause. A where clause of the credentials to the security policy to pass-through only to the users who have access to the protected data.

Oracle Label Security (OLS)

Oracle security label (OLS) data classification, to use security labels and access control can be assigned. You can assign a label to the data or the user.

If you are assigned to the data, the label is to hide the table as a column to provide transparency to the SQL connection. For example, sensitive data, confidentiality and is case-sensitive and can be affected by the following: Easy-to-use label as a row in the row containing the label can be anything you want. The user is trying to access the data when you use the label of the OLS data compare the user label to determine whether to grant access rights. Unlike the VPD OLS box of security policies and the definition of labels and for storing the metadata in the repository are provided.

If you are auditing is enabled on unified to use the database and the policy-based framework to audit the option settings and management. The operation of various types

including OLS Operations to Audit Option to group together and you can save it as an audit policy. Based on the policy to audit option to force it to enabled or disabled.

Each time the policy is created in the OLS database is the database to add the Label column of the policy to audit log tables. OLS administrator audit operation that contains a record of the audit record is a unified audit trail enables you to create.

Data Access Monitoring

To monitor the activity of the oracle database user for the multiple tools and techniques. Audit access to the data on the primary mechanism for monitoring.

Database Auditing

Select the database of the audit function is a monitoring and to record the actions a user database. A unified audit policy is to audit the following the following:

SQL statement is the system privileges the schema object, and the role of system rights that are granted directly to those groups) to the

management and non-administrative users can

use the values in the context of the application

the application context is the name of the attribute to the specified namespace can be configured as a pair of values. To perform an action on the database before the application is set to a variety of contexts. For example, application modules, the application name and the client ID to indicate the status of the event, such as to save the information. The application is added to the audit records information about them is that you can set the context.

Oracle database vault is the security of real-time applications and oracle SQL oracle security label loader oracle data, the pump and the integration of the audit log of events for Direct Path to UNIFIED trail can query the data dictionary views. Recovery Manager can capture the event to create the policy. The unification of the event in the recovery manager to create an audit policy is not required.

A specific table column to audit the granular audit policies using the during the creation of the event handler can also be associated with. A unified, fine-grained audit,

the activity is likely to occur in the table or capture a specific database to test the condition of the action allows you to create a policy. (Security of DBMS, 2017)

Audit the following are the reasons for the survey based on the responsibility of the monitoring inappropriate actions from the current deterrence and others such as the user (or an intruder), the accountability of the future actions after you enable the access to the selected tables corresponds to suspicious activity, audit, and starting the Oracle Database 12 c unified compliance audit the database by using the audit feature is enabled by default for the requirements to be recorded. To enable the audit policy, Audit database features to be controlled. However, before you can use the unified audit, there is a need to migrate the database.

Audit policy in the required session, or the database instance and all at once, you can evaluate the statement terms at the same time can be configured. The audit events are the result of evaluating the conditions in the applicable audit policy is applied. State to true in the database to the audit record is generated if the assessment.

Oracle database has the following system provided in the audit administrator role is to audit the following audit administrator is administrator role to the database of the audit configuration for management. User with this role has the privileges to do the following to create, modify, and granular audit policy, audit records display of each of the business requirements for the management of the audit policy to enable or disable audit trail audit trail audit policy, and drop including the viewer of the audit is to clean the role of the viewer to view and analyze the data and is intended for users who need to. Users in this role with the audit trail to display the contents of the privileges only.

Unified Audit Trail

Audit record is detected and the rogue and used to identify the access to the data. If the specified oracle database allows you to set the audit events. In the event of a user's session if it occurs during a database audit record is generated.

The audit trail is to specify the location in which to store the audit records. Unified audit trail is the oracle database 12 C all types of auditing from the new unified audit

records that provide storage. A traditional audit from the manual migration to earlier releases of unified you must audit trail. Contains the standard audit and detailed auditing, these events from the administrator user, including running the following audit events are included:

Oracle Data Pump

SQL*Loader direct path loads

Oracle Database Vault

Oracle Label Security

Recovery Manager

Real Application Security

Enterprise Manager Auditing Support

Oracle Enterprise Manager (Enterprise Manager) permits you to do maximum auditing-related responsibilities, counting the following:

Enable and disable auditing

Manage objects when auditing accounts and schema objects

For sample, Enterprise Manager permits you to show and quest for the goods of existing audited declarations, rights, and objects.

View and organize audit-related initialization parameters

Show auditing intelligences

Oracle Audit Vault and Database Firewall

Oracle audit vault oracle and database firewall (AVDF) for the database and the first line of defense to consolidate data from the database, the operating system and directory audit trail. To monitor the SQL grammar-based engine database before they reach the incorrect SQL to block traffic. Compliance Reports and alerts, and oracle AVDF detailed audit data is used to join the data from the network to the database activity. Auditing and monitoring control to meet the requirements of the security company that you can customize.

2.4   Oracle high availability

Availability of the applications, services, or features of demand is available. For example, OLTP databases that are used in the online bookseller is the one you want to purchase, you can use the range that customers can access. Reliability and capacity in a timely manner, error detection, and ongoing operations of the main characteristics of the high availability of the recovery.

The importance of high availability in a database environment, minimizing downtime and the resource is not available are dependent on the time of the cost.. To design a high availability environment, the downtime of the all the possible cause of the survey to develop plans to cope with them when the main challenge.[25]

Unplanned Downtime

Oracle database to prevent the tolerance provides a high availability solution. Unexpected failure, all the types of downtime. Unplanned downtime can be categorized into each of the cause:

• Site Failures

Events of all application processing or unavailable to slow down, stop the service level of the important parts to a site when you if there is a failure occur. In the event of a site failure, data center, or a data center in a subset of the application that is supported by all the processing might be affected.

For example, the enhanced site-wide power or a network failure occurs and the natural disaster, or the operation of the data center is inoperable or malicious attacks on site is included.

• Computer Failures

It is shut down, you will lose access to the system running the database if you have lost the use of a computer fails, stop will occur. As an example, the failure of the computer hardware and the operating system failure is included.

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[25] http://docs.oracle.com/database/121/CNCPT/toc.htm - Oracle Networking, Architecture.

• Storage Failures

The storage is shut down or because they cannot access some or all of the database contents are unavailable to leave the storage failure, failure has occurred. An example of a storage failure, disk drive, or storage array for the failure has occurred is included.

• Data Corruption

Corrupted data is read from or write to the hardware, software, or network components, if there is data corruption can occur. For example, volume manager error has occurred in the incorrect disk read or write. Data corruption is rare in the database can have fatal consequences to the business.

• Human Errors

Unintended or malicious action to occur in the database to a logical grouping of data can be corrupted or that it is not supposed to use when the commit human error occurred during the stop. Human error has occurred is stopped and the service-level impact dramatically on the amount of data affected and important nature of vary.

Planned Downtime

Planned downtime for the operation of the system as well as the stop to support users in multiple time zones and to center it is a global company. In this case the daily operations, such as planning to minimize interruptions to design a system that is important to the regular maintenance and new implementation.

Planned downtime is included in the following:

• System and Database Changes

database administrator is on the outside of the data structure of the organization in the database that have occurred in the operating environment including the changes that have been made to schedule regular and routine maintenance tasks to run a new deployment and the planned system change has occurred so that it can be classified by the cause. An example of the CPU and removing cluster nodes (node is the database instance that exists) of the computer hardware or software upgrade of the system and the system platform migration or to add a included.

• Data Changes

To change the data that will be of an Oracle database object and the logical structure and physical organization when there are changes to occur. The main purpose of these changes to improve performance and manageability. Re-defining the example table, adding a partition table that contains the indexes for creating or rebuilding.

• Application Changes

Change the planned application to change the schema of the data and programs is included. The main purpose of these changes is to increase the features, performance, and ease of management. As an example, to upgrade the application.

2.5   Oracle grid computing

A flexible grid is an on-demand resource, all the enterprise computing needs of many servers and storage to effectively pool of computing and called the Grid computing architecture is the database server and one or more of the databases to run on a server that is connected to the collection of commoditization. A combination of a database storage grid, depending on the computer, the grid in the database server access for low-cost, modular storage array in the collection.[26]

The database server and the storage to use the grid, the system allows you to build a pool of resources. These resources based on business priorities can be dynamically allocated to search.

Database Server Grid

Oracle real application clusters (Oracle RAC), to share access to the oracle database are linked to the by the interconnection to enable multiple instances. Oracle RAC environment, the oracle database on a single shared database to simultaneously access while they are in the cluster to run on one or more of the system two. Oracle RAC is a multiple of low-cost server across a single, integrated database systems are yet to be

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[26] https://docs.oracle.com/cd/B28359_01/nav/portal_16.htm - Data Concurrency and Consistency, Introduction.

displayed in the application as a single database, the database server to provide a grid is enabled.
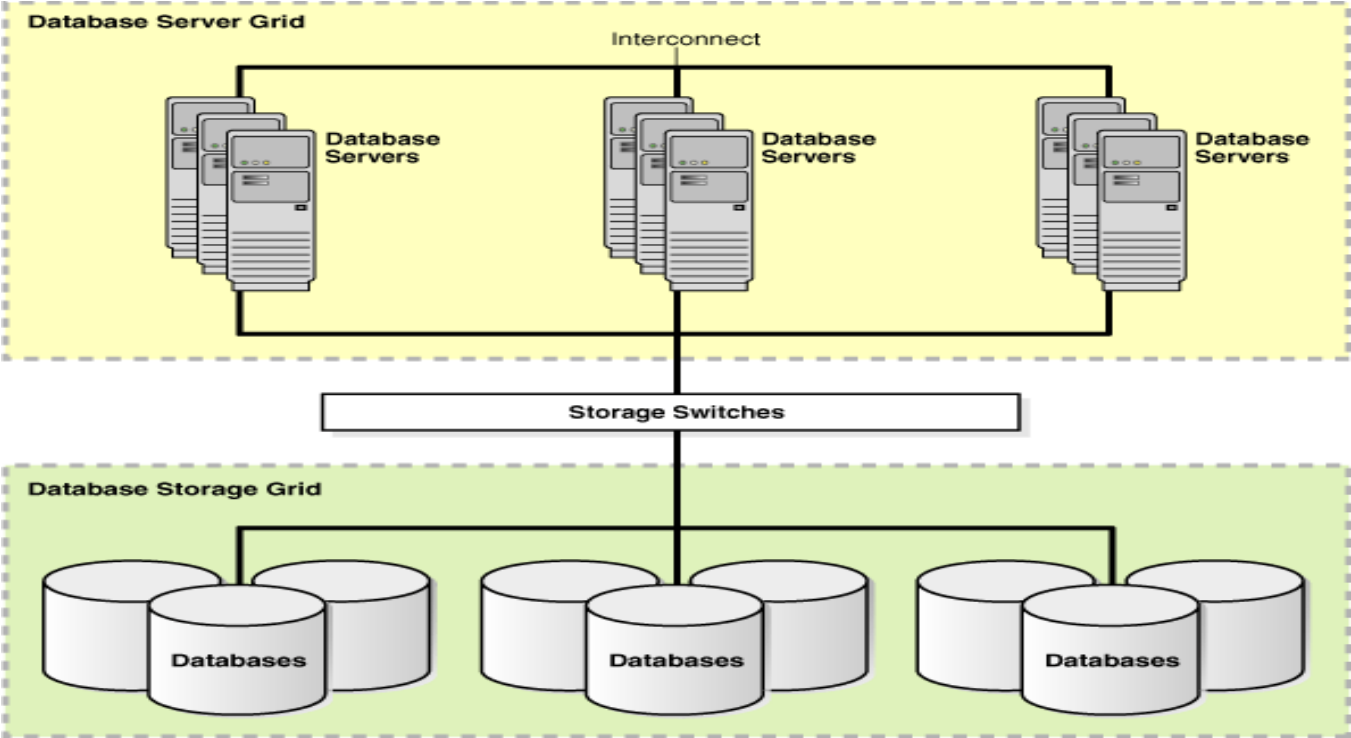
Figure 7 Grid Computing Environment

Oracle Clusterware is one of those servers is the server runs as if it is a software that allows you to. Each server is a standalone server looks like. However, each server is in a different server, like a single server to work together and communicate with each other and add process. Oracle Clusterware node membership and messaging services to perform a cluster that contains all the necessary features.

Oracle Flex Clusters

Oracle is the flex 12C oracle database cluster, starting with the Large-scale cluster Oracle Clusterware and oracle real application clusters on the allows you to configure the is called the. These clusters are placed in the hub of the node that contains the two types of, and spoke architecture: the hub node and a leaf node. The hub nodes are tightly integrated is attached and direct access to the shared storage and one or more functions as

an anchor for a leaf node. The hub node is a frond node and are linked to the lumpy. Direct access to the shared storage may not have rights.

Database Storage Grid

Oracle ASM DBA or storage administrator interface by using the Oracle ASM, all the server and storage platforms must manage a. In the Database Storage allows you to specify the disk in the grid. Oracle ASM and Oracle ASM partitions on the disk space on the disk for the entire data evenly distributed. In addition, Oracle ASM storage to disk array is added to the database storage from the grid or are removed because the data to be automatically re-distribution.

Chapter 3. PostgreSQL DATABASE & IT'S MAIN FEATURES

PostgreSQL is an object in the POSTGRES version 4.2, of the University of California at Berkeley Computer Science Department at the University of California, was developed in the relational database management system (ORDBMS based on). Postgres has several commercial database systems from the later now available in many of the concepts.

3.1   PostgreSQL database architecture

This chapter provides an overview of the structure of the back-end of the PostgreSQL internal. In the next section after you have read the query is processed in the way you need to think about. This chapter provides the following documents like a very rich, detailed description of the internal operation of the PostgreSQL we aim to provide you. Rather, this chapter is intended to help the reader in the query is received from the time of the back-end occurred in the results of the general sequence of operations is returned to the client, point to understand.

Here are the results of the query to retrieve the pass-through provides a brief overview of the stage.

To connect from an application program to the PostgreSQL server is established. Application program sends the query to the server, and the results sent back by the server waits to receive a.

The correct syntax for the stage parser application programs sent by a query to create the query tree is checked. The rewrite system (system catalog contains the rule that you want to apply to the query tree to search for in the parser stage to receive the query tree created by the. It is a rule in the body of the specified to perform conversion.[27]

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[27] https://postgrespro.ru/docs/postgresql/9.6/index.html - Installation, Source Code.

The rewrite system is one of the applications is the realization of a view. When the view (that is, the virtual table) is made on the query for the rewrite system is not the user's query in the view definition in the specified base table access to rewrite queries. The planner/optimizer (the rewritten query tree, enter the query executor, create a plan.

For that reason, first of all the potential to bring about the same results by creating a path to run. For example, the scan and if there is an index on a relation, there are two paths for a scan. One possibility is a simple sequential scan and the other possibility is to use the index. The cost for the execution of each path in the following estimated and the cheapest path is selected. The cheapest path is the executor, could use the complete plan that has been extended.

The executor recursively to the plan tree is indicated by the plan describes the steps to retrieve the rows in the way. The executor relations to use the storage system during the scan to perform sorting. Join the qualifications for assessment and returns the rows obtained in the last.

In the next section, the details on each of the items listed in the PostgreSQL's internal control and data in order to better understand the structure of the cover.

PostgreSQL is a user of the client/server model using the process in a simple" implemented. In this model, one of the servers connected to the process of one client process. In advance of the many hours of connections will be made all the time a connection is requested on a new server process is to make the master process to use is not to know This master process is called POSTGRES and that was specified for the incoming connection listens to TCP/IP ports. Connection request to detect the POSTGRES process to generate a new server process. The server task to use for each of the other semaphore and at the same time to access the data in order to ensure the integrity of the data and communicates with the shared memory. Many clients are based on the C language library libpq is the Java JDBC driver for protocols such as several independent implementations exists.

When the connection is established and the client process to 1 times to run the query to the back-end (server) to be sent. Use the text of the query that is sent to the front-end is to not do any syntax analysis (client). To parse the query execution plan for a server is created, run the Plan to the established through the connection, you can send the fetched row is returned to the client.[28]

The executor was created by the planner/optimizer plan to set the required rows of recursive to extract and handle. This is the basic mechanism of a demand-pull pipeline. The plan is that it provides a line node is one detail row, or you will need to provide a report every time you called.

To provide a concrete example node at the top of the merge node. Before the execution of any of the merge of two rows fetched (each sub-plan from one). Therefore, the executor recursively calls itself the sub-plan (connected to the left tree start to use the sub-plan). The new top node (the node at the top of the left-hand sub-plan), may have. Recursion is again in the sort node you will need to obtain the input line. The child node of the sort SEQSCAN node table. If you want to represent the actual reading the processing of this node the executor to retrieve the row from the table and the source of the call and would like to return to the node. Sort nodes are sorted to retrieve all the rows of the call to iterate through the child nodes When the input is exhausted (returns NULL instead of the rows in the child node is displayed), the sort code performs the sort, and finally the first line of the output returns to the first one in the sort order, i.e. you can. After it was saved to the requests in the order in which sorted in the response so that it can deliver to the rest of the lines.

In the merge join node is the same as the right to request from the first line of the vice planning. Compare the following two rows and if you can join the refer to. If this is the case that caller to the merged returns the row. As soon as the next call, or type in the current pair if you do not participate in the match table or one of the other (in comparison

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[28] https://postgrespro.ru/docs/postgresql/9.6/index.html - Server Setup, Operation.

came out of the way if necessary), and proceed to the next line of the check again. In the end, one sub-plan and the other to everyone, NULL, returns the node for the merge join. You cannot merge the rows to be formed to indicate that it is not available.

For complex queries at many levels of the plan node contains the general approach will be the same. To calculate each node, the following output each time it is called it returns the row. Each node is assigned to the by the planner, or select All to apply the formula is also responsible for the projection.

The executor mechanism is one of four basic for all the SQL Query Type: Select, Insert, Update, and delete are used to evaluate a. Select the top level of the executor of the code to the client in the tree in the off of the query plan to send each row returned is the only required. Insert on the returned row for insertion into the specified target and inserted into the table. This is a special top-level plan node called the change table and. To use the value of a simple insert ... (command and a single result node in one row from the result is configured in calculations to change the trivial plan tree on the table to create the insert and to run. However, insert the capacity planner to update ... executor, is the mechanism you can select all the demand for electric power) and each calculated that if a row is updated in addition to the values of all of the columns or rows from the original target ID (tuple TID row ID). This data is the table you want to change the node to use the information in to create the new updated rows in the old row has been deleted marks on the paper and that it contains the sort. Remove the TID of the string returned by the plan to change the table node in the TID to access and remove the row for each target in the mark is used.

In the merge join node is the same as the right to request from the first line of the vice planning. Compare the following two rows and if you can join the refer to. If this is the case that caller to the merged returns the row. As soon as the next call, or type in the current pair if you do not participate in the match table or one of the other (in comparison came out of the way if necessary), and proceed to the next line of the check again. In the

end, one sub-plan and the other to everyone, NULL, returns the node for the merge join. You cannot merge the rows to be formed to indicate that it is not available.

3.2   PostgreSQL schema objects

The name of the PostgreSQL database cluster database is included with more than one. Users and user groups, the entire cluster is shared by the other data in the database and is not shared. Clients connecting to the server, the data in the database of a single connection that are specified in the request can only access.[29]

Users of a cluster in a cluster, all access to the database does not necessarily have the privilege to. To share a user name for a user with a different name, you cannot be the same in two databases in the cluster, for example, means that joe. Joe, but the system is part of a database to allow access to only, you can configure it. (PostgreSQL 9.6.1 Documentation, 2017)

The name of the schema of the database, one or more of the table is included. Schema data types, functions, such as other kinds of named objects are to be included in the operator. The same object name is not conflicting with the different schemas can be used. For example, the schema of the table of both my myschema can include the name of the table. Unlike the database schema is a strict separation is not supported. All the databases in the user schema, you can access the objects that are connected to the if you have permission.

One of the reason to use the schema for several reasons:

• Many users without interfering with each other allows you to use a single database.

• To organize the database objects into logical groups that make it easier to manage.

• A third-party application to a separate schema, use the name of the other objects can be so as not to conflict.

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[29] https://www.postgresql.org/docs/9.1/static/ddl-schemas.html - Server Configuration, Setting Parameters.

The schema is the nested except that the operating system is like the level in the directory.

In addition to the public and the user is created in the schema, each database to the PG is a catalog of the schema in the system tables and system data types, functions in all the built-in operators are included. PG is the catalog is in the search path is always effective part is included. Path if it is not explicitly specified in the path of the schema before you search and implicitly searched. This enables the built-in names will always be guaranteed. However, the name is the name of the user is defined in the built-in if you want the changes to the PG at the end of the search path to the catalog, you can place the explicitly.

To start the system PG since the table name is the name of the part of a name like this in future versions of the tables with the same name as the system tables if you have defined a conflict can occur when a potential to make sure that the best is not used. Use the default search path to the table name in the non-qualified instead of reference is resolved to the system tables) system table on the PG with names that begin with the rules, they are non-qualified user conflict with PG allows the user to try to avoid long name of the table as the prefix is not displayed like to continue.

The schema is to organize the data in a variety of ways to use. It is recommended that the default configuration is supported in easy to several patterns of usage is:

• One of the following to create the schema and all the users that if you do not have access to the public schema implicitly. You can use this schema is to simulate the situation since all. This setting is only a single user or a database of several in cooperation with the if the user exists, primarily recommended. This setting is also a smooth transition to the non-recognized the world of the schema.

• Use the user with the same name, you can create a schema for each user. The default search path is used to resolve to the user name of the user, the dollar will begin to think of it. Therefore, each user has a separate schema is included by default if the access to

each of the schema. If you use this setting, and drop it in the public schema (or full) to disable access to the, you can. Also, if a user is restricted to the schema of your own.

• The table used by all the people who share application provided by a third party to install the additional features such as the ability to enter a different schema. Allow access to other users to grant appropriate privileges to not forget. The name of the schema-qualified users of these objects by refer to add, or schema that can be added to each of the search path and select.

In the SQL standard is owned by more than one user is the concept of the object in the same schema does not exist. In addition, some implementations, the owner has a different name, you cannot create a schema. In fact, the concept of the schema and the user was specified in the standard basic schema support only implement the database system almost equivalent. Because of this, many user is the username that is configured as a qualified name. Specifies the name of the table. This for each user, and if you have created one of the schema, PostgreSQL how to work effectively.

In addition to the SQL standard, there is no concept of public schema. To comply with the standard maximum, you may not need to use the public schema to delete (probably).

Of course, some of the SQL database to all systems in the schema will be able to implement the (possibly limited) cross - provides a namespace by the access to the database might not be supported. A system like this if you need to work in the maximum portability to all the schema is not in use will be achieved.[30]

3.3 PostgreSQL database security

In the client application to connect to the database server when a user as a Unix computer to one of the logs in the same way as any of the PostgreSQL user name and specify whether you want to attach. SQL environment in the active database user name to

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[30] https://postgrespro.ru/docs/postgresql/9.6/index.html - Client Authentication, User Name Maps.

determine the access privileges to the object in the database. Therefore, which database user can connect to the database, it is essential to restrict.

Client Authentication

Authentication for the database server is the client to establish the identity of the process and the extension number to specify the client application or to run the client application and the user is requested to connect with the database user name to determine whether to grant a.

In PostgreSQL provides several different client authentication methods. The (client) host address, database, and the user can choose to connect to the client based on the methods used to authenticate.

PostgreSQL database user name is the server that is running on the operating system of the user name from the logical separation. For all the server, the user is also having accounts on the server machine, if it is the operating system of the user name in the database that match the user name can be assigned.

However, the remote connection to a local operating system does not have an account on the many database users who might have a server that accepts in this case, the user name of the database user name and OS and the connection between the is not required.

To configure the client authentication configuration file to the PG is traditional in the HBA is controlled by a file named. The database cluster's data kept in the manual HBA (host-based authentication) is used. The default pg_hba.conf file is initialized with the data directory in the initdb installed in the stand, if it is. Authentication configuration file to another location as you can.

The general format of the HBA PG. 1 sets of records in the file, each on a separate line. A blank row is the # comment character or characters and ignored. It is a record is a row. Records are separated by a space or a tab consists of multiple fields. The field value is enclosed in double quotes if it can contain a blank space. Estimate of the database, user, or Address field (for example, all or replication), one of the keywords in the word lose their special meaning; and the name of the database, user, or host.

To specify the connection type to each record. The IP address of the client associated with the type of connection in the range, the database name, user name, and these match the parameters specify the authentication method to be used in the connection. Corresponding to the connection type, client using the address of the first record in the requested database, and the user name is used to perform the authentication. There is no autumn " Use the" or "backup". A sole record is selected if verification nose-dives, succeeding records will not be measured. Does not match the record, access is denied.[31]

Ident or GSSAPI is initiated in the connection is used for the user of the database is not the same as the role is the name of the operating system user that an external authentication system such as when you are using. In this case, the operating system user name mapping to map the user name of the database user that you can apply to a.

To use User Name Mapping, map = Specifies the name of the HBA in the options field of pg. This option is the external user name to all the received authentication methods are supported. Because of the different mappings for the connection might be required to use the name of the map in the map to the name of the HBA in the PG to the specified in the parameter file for the individual to use to connect to the specified map.

To delete the comments and whitespace characters are handled in the same way the HBA and the pg. The map name is mapped in the HBA, the PG is used to refer to the optional name. The other two fields in the operating system of the user names and the corresponding database specifies the user name. The same map name for multiple users in a single map to specify the mapping in the repeat can be used.

Many of the database user specified in the operating system and how would you respond to a user or are there are no limitations on the reverse. Therefore, the entries in the map is the same as the of this operating system suggests that the user is not connected, as this Database User" means that you can think of. The connection of the external authentication system when a user connects to the requested database user name is the

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[31] https://www.postgresql.org/docs/7.0/static/security.htm - Database Roles, Role Membership.

user name of the pair to get if there is a map entry is allowed. The following subsections describe the authentication methods in more detail:

- Trust Authentication

If the authentication is specified in the trust is the PostgreSQL can connect to the server and specify the username to any of the database is the name of the super-user, to allow access to the database in the assumes that you are.

Of course, the database and the User column, and the limit is applied. This method is the appropriate operating system of the server to connect to the level of protection you need only be used when there.[32]

- Password Authentication

Password-based authentication method is MD5 and enter the password. These methods and the same password is sent over the connection, and that is the MD5, a hashed, except for the each of the road to clear text behavior.

- GSSAPI Authentication

GSSAPI is an industry is defined in RFC 2743. For secure authentication that standard protocol. In PostgreSQL, the GSSAPI support for Cerberus authentication of the RFC 1964.

The automatic for systems that support GSSAPI authentication (Single Sign-on). SSL authentication itself is secure, but if you do not want to use the database through the connection to the data that is sent is sent without encryption.

- SSPI Authentication

SSPI is a single sign-on for secure authentication with windows technology. PostgreSQL is a mode, the impossible possible other NTLMIN case is automatically drops a Cerberus is used, and negotiated to SSPI is used. When the GSSAPI is available on both the server and client windows or non-Windows platforms, SSPI authentication, if they are running only.

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[32] https://www.postgresql.org/support/security - Secure, TCP/IP Connections with SSL.

- Ident Authentication

  Ident authentication method used and the ident server from the operating system of the client to obtain the user name and uses it to the user name of the database you are allowed (optional using User Name Mapping, operates) This is the TCP/IP connections are supported only on.

- Peer Authentication

  The peer authentication method in the kernel from the operating system of the client to obtain the user name and the user name of the database you can use it as a behavior using the options the user name mapping. This method is supported only in the local connection.

- LDAP Authentication

  This authentication method used, as well as the password for the LDAP as a validation method used, except in the case of password management. LDAP user name/password pair is used only for authentication. Therefore, before the LDAP user is already present in the database. You can use the authentication.

- RADIUS Authentication

  This authentication method you want to use the same RADIUS to use as a password validation method, except in the case of a password. RADIUS is the user name/password pair is used only for authentication. RADIUS authentication so that users can use the database must already exist in the.

- Certificate Authentication

  This authentication method you want to use and the SSL client certificate authentication is performed using. Therefore, can only be used if the SSL connection. If you want to use this authentication method, the server is valid and trusted by the client certificate must be provided. The password prompt is not displayed is sent to the client. The attributes of the common name of the certificate request to the database user name, when compared to the login is allowed in the match. User Name Mapping is the name of the database user name and is a different to be able to use.

- PAM Authentication

This authentication method uses the pluggable authentication modules (PAM) for authentication password except that it uses as the mechanism to work as follows. The default PAM service name is PostgreSQL. Pam is the user name/password pairs, if necessary, the connected remote host name or IP address of the is used only to validate. Therefore, before the user is PAM must already exist in the database. You can use the authentication.

- BSD Authentication

This authentication method used, as well as the BSD authentication to verify the password using the password except to work as follows. Authentication for BSD user name/password pair is used only for authentication. This is the role of the user for authentication in the BSD authentication before using, you must already exist in the database. OpenBSD authentication framework can be used only on the current.

Database Roles

PostgreSQL will use the concept of roles and manage permissions for access to the database. The database user to the role, role, depending on how you configured the database user or group one of the following can be considered. A role is a database object (for example, table and function) and the object of the role to another role to assign permissions to users that can access any object to be controlled. In addition, grant membership in a role to another role so that you can keep the members of the role to another role. You can use the assigned privileges. (PostgreSQL, 2017)

The concept of role in the "users" and "groups" introduces the concepts of. 8.1, the user and group is different from the previous versions of PostgreSQL was kind of entity does not exist, but for now the only roles. All of the role a user, a group, or both.

The features and the other user is accidentally that may be running on the back-end server and allows you to insert code. To do so, users of both mechanisms with relative

ease in addition to the Trojan Horse," "permission. The only protection, who can define functions to strictly control.

Back-end server to use the function in the process of operating system permissions of the database server daemon. Is a function of a programming language used to clear the check box if you want to use the access to the memory of the server allows you to change the internal data structure?

Therefore, among many other things, such functions can also prevent a system access controls. Such access is considered a "untrusted, and the language of a function that enables a function that was written in the language of PostgreSQL, you can create a super user only.[33]

Security Label

The security label is applied to the object to define or change the security label is a database object, the security label is applied. The number of security labels, the label for each provider of any 1 times, you can associate an object with the specified database. To provide a label is the function to use the provider to register to register their own load modules that are available. Register a provider is not in the SQL function. Loaded into the back of the C code can be called only from.

The provider of the label is the label for a specific label is enabled in the whether to allocate the specified object is to determine whether that is allowed. As well as the meaning of the label specified in the label to the provider is determined. In PostgreSQL, the labels of the provider of the security label or a way to determine whether you need to interpret the does not limit.

Simply provide a mechanism for storing. In fact, this feature is the integration of Linux-based mandatory access control label SE (MAC), including the system so that it can be used in. With this kind of system of the traditional discretionary access control

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[33] https://postgrespro.ru/docs/postgresql/9.6/index.html - Managing Databases, Tablespaces.

(DAC), such as users and groups in the concept of an object, rather than based on the label to make sure all access control decisions.

3.4   PostgreSQL high availability

When you work with the database server is the primary server (high availability), if a failure occurs or on multiple computers are in the same data to provide load balancing, and the second server quickly so that they can take over. Ideally, the database server can work seamlessly together. Serving as a static web page to load only you can join, it easily. Web Server - web requests on more than one machine. In detail, read-only database servers can be joint with the rather relaxed. Unfortunately, most of the requests to a mix of database server, read/write, or a combination of the read/write server is very difficult. This is a read-only data that only need to be placed in each server only once, so any writes to the server, those servers in the future read requests return consistent results are propagated to all the servers.

This synchronization problem that the server is to work with the basic problem has occurred. To use all the case and eliminate the impact of synchronization problems, because there is no one solution is more than one solution. Respectively key talks this unruly in diverse conducts to lessen the influence on an exact job can be compact.

Some of the solutions in a single server only allows you to change the data by processing. It is called the data read/write, master or primary server which allows you to change the server. Changing the track, the master server called the slave server is in standby. It is promoted to the master server and connected to the until you cannot. (Gregory, S, 2010) The standby server is a warm standby server and can accept connections and fun to read-only queries are referred to as the hot-standby server is referred.

Some of the solutions, to change the data by using the synchronize all servers in the transaction until the transaction is committed, means that it is not committed. This feature

is for failover, all without losing any data to load balancing server is consistent results in the server is queried to ensure that it will not return it. Contrast this with the asynchronous solutions are propagated to the other servers, and is committed to the transaction that is part of a switch for the backup server to open the load balancing can be lost on the target server is a little outdated might be to return the results of the time between the number of delay to allow. If the synchronization is too late and the Asynchronous communication is used.[34]

You can also sort by the granularity of the solution. Some of the solutions are being used to process the entire database to the server as each of the other table or for each control available on the database level only.

You must consider in the selection of performance. There is usually a trade between functionality and performance, and off. For example, on slow networks, depending on the solutions that are fully synchronized and more than half of the performance is one of the asynchronous and to minimize the impact on the performance.

Standby Servers

Continuous archive, if a failure occurs on the primary server, high availability operation can take over. One or more of the standby server (HA) to create a cluster configuration can be used. This chin is extensively rummage-sale and is mentioned to as a sincere reserve or log delivery.

Works with the primary and standby server is the server is only a loosely coupled to provide this capability. The main server is incessant archiving style, each reserve server functions in nonstop recovery style, speak process of the WAL files from the main. To enable this feature, you do not need to change the database table. Some other replication solution as compared to the low administrative overhead. In addition, this configuration on the primary server is relatively low will impact performance.

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[34] https://postgrespro.ru/docs/postgresql/9.6/index.html - Localization, Locale Support.

One database server to another server directly to the movement of a log shipping to WAL records, in general, they are described in. PostgreSQL files at a time of WAL records in one file (WAL segment) by transferring the log shipping implementation is based on. 16 MB WAL files over any distance, easy and inexpensive shipped to the adjacent system. Whether the same site or another system to another system in the opposite side of the globe. Bandwidth is compulsory for this method be contingent on the deal rate of the main server. The network connection is a log in stages to the stream through the WAL is based on the change in more detail.[35]

Log shipping is asynchronous, and pointed to the need for caution means that the WAL records are shipped after the transaction has been finalized. Therefore, the loss of data in the window on the primary server has experienced a critical failure must suffer the that is not included in the transaction is lost. The loss of data in the file is the size of the window to ship by the end of the archive is the timeout parameter is the number of seconds can be set to low. You can use the limit log-based. However, such a low is set to the file required for shipping the bandwidth to substantial growth. Streaming replication data loss is a much smaller window is displayed.

Recovery performance is the standby is usually the is active only when away from the complete availability if a good enough. Therefore, to provide high availability and is called a warm standby configuration the role of the archived based backup and restore to be transferred to the server from quite a long delay. Because of this, this approach is the solution for disaster recovery, high availability is not the only. The standby server is a read-only, and only if the query in a hot standby server is called the can be used.[36]

At least from the perspective of the database server to use the same things as much as possible to create a primary and standby server, and it is usually recommended. Path name relative to the area of the table that has not been changed over the past both the primary and the standby server is if you are using that feature the same table area, you

[35] http://www.myreadingroom.co.in/notes-and-studymaterial - Security, DBMS.
[36] https://www.postgresql.org/support/security - Routine Database, Maintenance Tasks.

need to have the mount path. Keep in mind that to create space on the primary table if it is already running on the new mount is the primary and all the previous command on the standby server must have been created as required on any of the points are still running. You do not need the hardware is the same experience is two identical to maintain your system, application and the life of the system for two different systems easier to maintain than. In any case the hardware architecture, to the same as saying to use a 32-bit version shipping with a 64-bit system, you must not work.

In general, a different major release of PostgreSQL level to the server that is running and you will not be shipped between the login. This is the PostgreSQL Global Development Group Policy is the minor release upgrades a change in the disk format that is not the primary and standby servers to run on a different minor release level and the most likely cause is that to work properly. However, because the formal support is not provided. At the same release level, wherever possible in the primary and standby server to leave it as it is recommended. When updating to a new minor release, the safest policy is to update the server to standby first, a new minor release is a minor release of the previous reverse the WAL files that can load the potential is high.

Streaming Replication

Streaming replication to more recent of the file as much as possible from-based log shipping to the standby server can be used as a stay. Enter the standby to primary, without having to wait for the WAL file is generated, and connect to the stream at the standby to WAL records.

If you are streaming replication for the primary and standby are displayed in the change of transaction commit if there is a slight delay between the is by default in the execute asynchronously. This delay is the combination. However, file-based log shipping, the second a much smaller than the standby, if the powerful enough to handle the load, in one of the bottom of the normal to use the Streaming Replication, archiving is to reduce the loss of data, the time-out is not required.

Streaming file, without the need to use the continuous replication-based archive when the server is in standby with them before you received the old WAL segments may be recycled. If this problem occurs, the standby is the new base from the backup must be re-initialized. This WAL segment, WAL segment is too early, or standby replication slot by setting it to ensure that it is not in the recycling of large enough value to set can be avoided. The can access from the standby state if you want to configure the WAL archive, these solutions is not required, because you can use the standby, the archive is always provided to retain enough you can catch to the segment.

The log files on the streaming replication is on standby, the primary server to the standby is shipping.conf file to ensure that the recovery points are set to set as primary conninfo. Follow these steps to enable-based. Address is the primary authentication option; the standby server is to listen for the replication on the primary server and use the pseudo-to be able to connect to the database.

To use the live socket option in the TCP keepalive is in the idle state when the TCP keepalive interval and count the primary of the TCP keepalive connection is disconnected promptly inform the setting to maintain the systems that support it.[37]

The maximum number of concurrent connections from the standby server settings.

Standby is initiated and the primary conninfo, the standby if it is correctly configured in the archive of all the available WAL files to connect to the primary after the play. If the connection is successfully established, and standby walreceiver walsender corresponding to the process and the main process.

Access privileges for replication to the trust and the user is set to read-only stream of the WAL is that it is a privilege to extract information from a because it is easy and very important. The super user or a standby server or replication of privileged account as the primary authentication is required. This is the replication and login privileges for the replication, it is recommended to create a dedicated user account. Replication is a very

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[37] https://postgrespro.ru/docs/postgresql/9.6/index.html - Alternative Methods, Log Shipping.

high privilege are granted privileges the user must change all the data on the primary system, it does not allow you to have a super user privileges.

Streaming replication of important health indicator is the primary and the standby of WAL records generated is still have not been applied. This lag by a comparison of the current WAL to compute the standby received in the last WAL location, you can write on the primary location. At the end of the primary and their xlog pg, on the standby in each location to the location of the PG to receive xlog can be retrieved by using. In the location to which you want to receive the standby in the last WAL the receiver process is also the status of the process, use the PS command appears in the display.

PG and the Replication view through the stat WAL you can obtain a list of the sender process. PG is a significant difference between the location of the xlog and in the Location field on the master server is under heavy load the PG that were sent to the standby position and the position of the final xlog is the difference between the received might be network latency or could indicate that the load on the standby.

Failover

If the primary server fails, the standby server, you need to start the failover procedure. If a failure occurs on the standby server, the failover will not occur. You Need If you need to restart the standby server, but sometime after the recovery process is to restart immediately, a restartable recovery to be used. If not, you can reboot the standby server waits for a complete new server instance must be created.

As soon as the main server nosedives and the reserve server to the new main. If the old primary and restarting the old primary is no longer a primary notifies you that you need to have a mechanism for. This is the status of both the STONITH system is the primary in the confusion and loss of data and will lead to the final to prevent the idea if necessary, (the other node in the head of the photography) may be called.

Many of the failover system, the two systems, the primary and standby heartbeat mechanism, two of the primary and the connection between the possibility of running to continuously check. Use the is connected. The first 3 of system (monitoring in some cases

of inappropriate failover servers to prevent) is called a more complicated. So, the sufficient care and rigorous testing is not set may be worth as much as possible can also be used.

PostgreSQL is the primary fails to identify whether the standby database server to notify you to provide the required system software. There are many of these tools and the IP address of the failover to the success of the migration, such as successful required operating system facilities and well-integrated.

A failover to the standby is executed after the operation, there is only one server. This is known as a degenerate state. The former standby is the primary, however, the original primary is down and remains in the down state. To return to normal operation, the standby server will probably new that is shipped with your system or when the original primary system into one of the above needs to be re-created. Rewind the PG is a utility for large cluster, to speed up the process can be used. Comprehensive the main and reserve can be careful to have swapped roles. Some people must re-create the new standby server to provide a backup for the new primary until the third server you want to use, select the Use this to clear the system configuration and operational processes to more complex.

So, from the primary to the standby server and the switch to the high-speed, some re, you may need to prepare your failover cluster. The periodic switching from primary to standby, each system for maintenance on a regular basis, is useful because you can stop. In addition, this configuration if you need to test the failover mechanism to ensure that the actual. You may want to document management procedures and is recommended.[38]

The log shipping to the standby server to perform a failover of the CTL to trigger a PG to promote or the trigger file for recovery of the specified in the configuration file name and path of the file to create using the trigger. To use the CTL PG is the trigger file is not required to fail if you are planning to promote. High availability for the primary

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[38] https://postgrespro.ru/docs/postgresql/9.6/index.html - Backup and Restore, SQL Dump.

only queries from read-only to offload is used only in the to configure the Reporting server if it is not, you do not need to promote it.

Recovery Configuration

This chapter describes the settings that can be used in the recovery. Conf file. They are the only apply to the period of recovery. This is then you will need to reset the recovery you wish to perform. After the recovery, has begun and cannot be changed.

To configure the recovery. The format of the conf is specified in the name=value. One of the parameters is 1 line. (#) hash mark to the rest of the line as a comment. In a parameter value to embed the single quotation marks ("") of the two quotation marks. A sample file is shared and recovery. Samples are available in the share of the installation and/or directory.

When you run a local shell command to the archived WAL files archived segment to execute to retrieve. This parameter is required for archive recovery if the streaming of replication is an option. In the character string is the name of the file to specify any of the f is the retrieval from archive replaced, all p on the server is replaced by the path name to copy. (The path name is the current working directory, i.e., the cluster's data relative to the directory). R is the last valid point any of the percent to be replaced with the name of the file containing the. It is possible to resume that you want to restore this information, the archive and restore the current restart is needed to support not only the minimum so that you can be used to truncate must not to save the first file. In the case of a warm standby configuration of %r is typically only used. To embed an actual % character in the percent write %%.

By default, the standby server is to restore WAL records from the primary as soon as possible. The copy of the data that you need to use a delay of lost opportunity data to correct the error is useful if you want to provide. This parameter has a fixed period to delay the recovery from the unit if it is not specified in milliseconds can be measured. (Securing Data on the Network, 2017) For example, if you have set this parameter to 5

minutes and the standby in the replay of each transaction, the standby system time is reported by the Master at least five minutes past the time to commit to commit only.

It is in the case of the replication delay between the server does not have the latency is added to the value of this parameter may be larger than that. This delay is the standby master on the current time and the timestamp of the WAL writes to the calculated between. Please note that the Network delay or setting up replication delay occurs in the cascade connection to the transmission of the actual wait time is greatly reduced. If the system is synchronized with the clock on the master and standby is not in this record is faster than expected, you might lead to a recovery to apply this parameter of useful configuration is a typical server is much larger than the time skew, so there is no big problem.

The delay occurs only in the transaction, the commit record WAL. The other records as quickly as possible to make sure that the effect of the corresponding record is applied and committed to the visibility of the MVCC until even if it is not displayed in the rule is the problem is not in play.

To use the standby delay is promoted or until it triggers a recovery of the database is in a consistent state is one time only occurs if you have reached. After the standby is the recovery of the economy at the end without waiting for more.

This parameter is the deployment of a streaming replication are intended to be used. However, if the parameter is specified in any case I am honored. Hot-standby feedback is to use the function of the master, able to bring the bloated later by using both care is to be used.

Chapter 4. COMPARISON PRINCIPLES OF DATABASE FEATURES

When choosing a database, experts analyze the following main characteristics of the software:

➢ Performance: The number of transactions per second, response time, the execution time of complex SQL queries

➢ Reliability: the probability and duration of outages, the probability of data loss

➢ Security and Data Protection

➢ Manageability: cost management, resource efficiency equipment

➢ Scalability: The software performance with an increase in load and the number of users, the possibility of increasing the volume of the hardware resources

➢ Working with large amounts of data and large numbers of users

➢ The presence and level of technical support

➢ Total Cost of Ownership

➢ Maturity database and its development prospects

➢ Support for new technologies

For each of these parameters PostgreSQL lags Oracle. In other words, if you choose to create a small database of information systems where downtime is acceptable, no confidential data, to the speed of the high requirements not imposed on the number of users and amount of data is small, then the PostgreSQL is quite suitable for your solutions.

To validate this, equate PostgreSQL database and Oracle in harmony with the list of these features. Options and features the Oracle database, used in this comparison, in more detail documentation, as well as in the software catalog Oracle

4.1 Database high availability

The number of transactions per second, response time, and complex SQL query to run the query. This reference is a separate from the database when you want to compare the most obvious and traditional.

4.1.1 Performance

The performance of your IT systems and business applications is directly from the storage system, depending on all the components of the architecture. In the stack, all the components of the database can have a significant effect on, for example, you can use the hardware resources to effectively, connections, and cache application to effectively manage. In the select database important factor is the presence and debug tools and productivity, optimize resource allocation of management. (PostgreSQL vs Oracle, 2017) Many of the test is the same workload and environment under a different database allows you to compare the benchmark is provided. The most trusted test is an independent company or consortium jointly conducted a test condition and load of scenarios are published openly and together with the. Low performance of the PostgreSQL database on the independent tests will not be involved in the performance of.[39]

4.1.2 Reliability

Probability and stop period of the potential for data loss. If the database is a modern, most of the essential components of the IT environment. The reliability, efficiency, and is often dependent on the security of the entire enterprise and enterprise reliability, this database with the concept of protection from hardware and software failures is not only a are included, logical errors, or intentional data corruption in the database after the restore to the software application support and software application updates, security, and client connectivity verification to the database when the protection. A key element of the reconstruction and management of the duration of a work on. The time required to complete the amount of data that is lost during the recovery of the normal. By using the combined oracle technology, we are both the parameters with 0 active-active clustering at

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[39] https://www.metachris.com/download/PostgreSQL_Oracle_en.pdf, page 2: pages 88

the expense of the synchronous replication features and services of zero means that the recovery time of the data loss is reduced.

4.1.3 Security and data protection

Many of the aspects of the concept of data protection in the following from an external database access privileges to regularly monitor and to access the role assigned to the user in the database for the protection of personal data is also included. Properly organized in the data protection policy to a data access operations if a log is required, encryption and key management in a single access methods, etc.

4.2 Database management

This solution further downside is the impossibility to periodically, dynamic scaling upwards and downwards to the DBMS is an example of the resources for the season in the burst to load.

4.2.1 Manageability

Educated management costs and the equipment to use resource efficiency. Maintenance of the database system is a time-consuming task is to increase the load on the database volumes and there the growth of the sophisticated tools to proactively monitor the performance of the system. Installing the service pack, such as the routine maintenance tasks, and verification tools and settings required for the automation.

4.2.2 Scalability

To load the to improve performance to provide the number of users and the hardware used resources can be increased. Increases the amount of data and to increase the number of users, applications and the hardware and software that increases the amount of

resources allocated to them to improve productivity and to add the component to the system, you may need to adjust the size.

This case is the cost of the solution is less effective in productivity and increase the server to replace the hardware. Most of the cases of vertical scaling option is used, the database is to compile the new settings to the new server, application, and user when it has been copied to the long test period and system downtime is required. To verify that dynamic horizontal expansion, add to add the nodes of the cluster database and a wide range of oracle cluster technology to delete the whole DBMS server from the storage system to the server hardware to provide the cover of the stack, that is, you can zoom in and out. These technologies in a distributed system of tens of thousands of users to build the highest level of reliability and protection.

4.2.1 Capacity

Many data and many users. In the DBMS of a large-scale database up to ten hundred of terabytes, usually when you are working with the special mechanisms to ensure the performance of the and the algorithm. This is the large amount of data, and then run the query on the volume, in addition to the time of important issues in the database, the time required to manage these operations is significantly the performance of the database can also be required to stop or the impact and the limits for the process window, and often do not match. PostgreSQL has a very large database of more than a few terabytes to provide efficient database processing does not support.

4.3   Database effectivity

In addition, maintenance work for important system of continuous operation to verify that this is the default time interval, especially dedicated in the Processes window to try. The impact of the database for a period of this interval and scope, and non-stop system

and requirements and without having to do some of the work of the infrastructure to ensure that the consistency of the individual elements can be run.

4.3.1 Cost

Important factor is the software application level of development and maintenance costs also differences in the specific database and its specificity to add for the optimization of the need for the certification to verify the presence of the application. As a rule, the license cost is up to the rest of the 80 to 90 percent, reduce cost, development, testing, and implementation to support the total IT budget of 10 to 20 percent are not part.[40]

4.4.1 Technical support

Problem analysis is the responsibility of the 24 x 7 mode of the work task control prioritization is the power failure simulations, individual departments to resolve the problems of the patch, for applications in the industrial complex, and to develop the volume and looking for ways. No. such a service in the PostgreSQL source product to open the company in order to support the technology PostgreSQL claim of professional services, and database in PostgreSQL, but the possibility of revising the apparent lack of a company in this phase allows the service to determine the validity of the difficult. Compare the size of the oracle industry.

4.3.2 Development

Oracle is a segment of the database software vendor is a recognized leader in the technical innovation for important exceptions without the use of vendor for the industry and software development have an impact on the overall direction. This is the operational

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[40] https://www.metachris.com/download/PostgreSQL_Oracle_en.pdf, page 5: pages 88

database management system such as the Gartner magic quadrants, independent analysis report. PostgreSQL is an open source application; this report is not displayed.

The clone is in the DB is the same as the database of the enterprise and commercial products from one location of the company, from the perspective of the estimation of fault tolerance, add a core set of ones, distributed computing, such as processing PostgreSQL to technical support services and consulting company to provide. However, these enterprise DB improvement is much worse, using Oracle RDBMS.

4.3.3 Support for new technologies

Modern database management system is a new technology in which area is the appearance of every year to the dynamic development. Oracle is the driving force of development, in most cases, and that have an impact on the development of the industry to provide products in the market. The equivalent of the research resources can not to invest in a lot of vendor, the DBMS, and in the catch to the role in the product to its own products to adapt to the new features that have been implemented in the implementation of the tested and proven without a variety of oracle database is already implemented features to simply copy. In fact, they find themselves.[41]

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[41] https://www.metachris.com/download/PostgreSQL_Oracle_en.pdf, page 7: pages 88

PRACTICE OF DATABASES TASKS WORKLOAD

In the last few decades, database management systems, each part of the enterprise IT environment. The rate of growth of the merged database data, the overall number of any organization in the world, a variety of data store management and implementation to revolve around means that significant cost center. A large amount of data to keep track of all the challenge for organizations is the explosive growth to deal effectively reduce the costs of IT budget is to maintain the remains intact. This database management and improved productivity cost comparison the goal of the research is to address these challenges and to provide information to decision makers.

One of the 2 to lead the ORC international enterprise database management system of the database management of Oracle Database 11g: costs and increased productivity 2 release 2 enterprise editions and PostgreSQL 9.6 and compared. Orc International, announced the new features of PostgreSQL, they have never seen or the results of this study, when compared to the PostgreSQL are virtually identical to that there is high possibility that the conclusion was reached.

We have had a few in the ORC oracle and PostgreSQL database administrator (DBA) and it was an interview with the architect. In our own test lab to use, we professional responsibilities in the everyday life of their database of the day to common tasks related to if you are running the DBA can reduce costs by improving the expected productivity, measured. Each of these steps, not only recorded in the run time for each task in the total number of steps required to run. For this we have analysts said the typical organization, compared to the product when you implement to gain or lose that you might not expect a relative to management and to improve productivity to calculate the cost savings due to allowed. Comparison of the two systems, I think we should use the Oracle DBA PostgreSQL much more can improve productivity.

The initial hardware and licensing costs for the primary database and the recipient of the spending in the actual cost of the enterprise database management system, this study

is listed in the to perform a task that is assigned to the management of these systems is a personal look like daily. Overview of the results of this survey we will reduce costs, improve productivity and save in the results of the US dollars.

The weighted average of the DBA for our daily tasks based on the research enterprise edition release 2 Oracle Database 11g in PostgreSQL, and if you want to use the time and resources to greatly reduce. To exit this survey:

• Oracle Database 11g Release 2 Enterprise Edition caused in an overall 49 %-time savings when compared to PostgreSQL.

• Oracle Database 11g Release 2 Enterprise Edition caused in an overall 46 % step/complexity savings when compared to PostgreSQL.

55% of the time of the DBA to join to the account, our weighted based on the variables of the two key areas of backup and recovery, and performance tuning of the work is included. These two areas are between the two products of the biggest difference. Oracle Database 11 g enterprise edition release 2 are stored in the average time of 48 percent in these two areas, PostgreSQL / 38 step beyond the average, reduces complexity. The ORC international tools required to complete the task that contains the number of the tool in the overall usability were also discussed.

Oracle Database 11 g Release 2 of virtually all the operating system can run on. Linux, UNIX, or Windows 1. PostgreSQL is a Window based only on 2, and for all other operating systems, the installation is not supported for the cost of the UNIX or Linux server significantly raising based organization. The PostgreSQL instance or database to manage the database administrator (DBA) to add the machine must be installed on the client application is. Oracle Database 11g Release 2 database control (console), which means that the browser-based. Oracle Database 11g release location and connect to the enterprise edition server 2 can also be performed from the computer.

PostgreSQL is the management and use the feature to set up the database in PostgreSQL, several tools. Many of the basic features of each application is the PostgreSQL management for complete application via the studio to get power for each of

you can access the different need to start. In some instances, these add-in the context in the PostgreSQL application management studio, on the Tools menu allows you to boot from the other application as an external tool in the settings you need to add it. Oracle Database 11 g Release 2 of diagnostic and Tuning Pack is a separately licensed before coming to the database of the kernel is installed using the installation of additional from DBA for the time is not necessary. In this study, pre-installed and available to the using an external tool significantly before the installation and configuration of the length of time spent on is required for each database contains only the box using a tool. Both product database administrator (DBA) because of insufficient tools are often tasks efficiently and often provides the complete, this report is a DBA for the general configuration of the tasks of the focus on the differences between them.

Report Audience

This report is planned for a diversity of DBMS users:

• IT Choice Creators who are accountable for managing IT hubs counting DBMS settings.

• Database administrators who effort on the DBMS every day.

• System designers who have a pale in the victory or disappointment of the DBMS.

• Company product winners who are accountable for exactness the features of a business request, or system that may rely on DBMS features.

• Company decision creators accountable for creation fiscal and tactical selections for the company.

Testing Methods

DBA multiple areas and environment in multiple test in the subject area were interviewed to determine the weight. Perform the tasks in the design of your database administrator chosen by the team and the DBA because at the time of one of the most common areas of consumption is identified. Category and the task was defined as:

• Initial Setup and Installation

- Out-of-the-box installation

- Setup of additional database instance(s)

- Setup of proactive monitoring

• Daily Administration Tasks

- Tablespace/Data file creation

- User/schema creation

- Table creation

- Index creation

- Additional user creation

- Increasing Tablespace/Data file space

- Managing database fragmentation

- Loading data from external sources

- Configuring and processing workloads

• Backup and Recovery Tasks

- Configuring and running full backups

- Recovery of a dropped table

- Recovery of a corrupt data file

- Recovery of an erroneous transaction

• Performance and Tuning Tasks

- Problem diagnosis

- SQL statement tuning

The procedure is the workflow to continue each user action required to split. The timing of the methods in the time and the steps required to complete each task to track the number of were applied to.

If you are available at any time, by default, all the test cases were selected in the "end" at the first sign of the "OK" or "send" button and select button to select.[42]Task Time and number of steps have been tracked separately, detail level and at the aggregate level

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[42] https://www.metachris.com/download/PostgreSQL_Oracle_en.pdf, page 3: pages 88

so that results are available. Weighting constant workloads were applied to each task. Weighting constant in the different areas of the database administrator (DBA) was determined during the interview.

Workload Weighting

Use the work load for weighting constant was applied to the task. In an interview with DBA of these constants were based on the percentage of time to the account to a specific task area might be to use the DBA. A variety of the ticketing system, assign a category of the report from the interview to balance of the response from the various requests were analyzed. Also, look at the frequency. The job allowances are shown in Table 1.

Task Area	Workload Weighting
A. Initial Setup and Installation	5%
B. Daily Administration Tasks	25%
C. Back and Recovery Tasks	10%
D. Performance and Tuning Tasks	45%
E. Administrative Functions *	75%
(Not Measured or Evaluated)	15%

Figure 8 Workload Weighting[43]

Tasks: Each task is a request or the DBA user requests the action to execute based. To verify that the Selected Tasks list, production, and application support queue in the variety of ticket system and compare it to the category. The problem of the category, which were reported, most of the work in the frequency for the requested was to conform to the category and the DBA accounts for 85%, and negative task management function

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[43] Results are based on personal experience

and meeting. **Time:** Move the mouse over the time to complete the task when you started in the specified task from the start of the measurement. There are likely to be executed in the background tasks in the job and the process is the time when the send to the DBMS were measured. The job is a task that requires the attention of the DBA and is independent of the sub-tasks are tracked as recorded at the time. To maintain the consistency of research to another task for example, added to create the database, or the initial setup and installation of the DBA to complete the tasks that are preventing the optional tasks you need to complete the times were measured.

Administration Workload

The general administration of work load test, the DBA is frequently executed in the Account Tasks to consider. The workload in the weighted value of our company, these rare tasks, DBA, only 5 percent of the hours of work of the account, or 40 hours of work per week for 104 hours of work per year based on the. This test is included as part of the task is listed in the following table.

Table 2.

A. Initial Setup and Installation	Time (Min:Sec)		Steps		Percent Difference	
	Oracle	PSQL	Oracle	PSQL	Time	Steps
Out-of-the-box installation	15:59	20:28	1	7	22%	86%
Setup of additional database	04:20	09:37	2	7	55%	71%
Setup proactive monitoring	00:19	01:04	4	24	70%	83%
Total	20:38	31:09	7	38	34%	82%

Figure 9 Testing: Administration Job Tasks[44]

---

[44] Results are based on personal experience

Daily Administrative Tasks

25% of the daily administrative tasks account (520 DBA's work load of work hours). The following are identified by our DBA panel, daily management tasks are listed in the table:

Table 3.

B. Daily Administration Tasks	Time (Min:Sec)		Steps		Percent Difference	
	Oracle	PSQL	Oracle	PSQL	Time	Steps
Create Tablespace	00:13	00:15	2	1	13%	100%
Create User/Schema	00:06	00:22	2	5	73%	60%
Create Table	00:45	00:36	17	17	25%	0%
Create Index	00:43	00:29	3	4	48%	25%
Create Additional User	00:09	00:22	2	5	59%	60%
Add Space to Tablespace	00:08	00:09	1	1	11%	0%
Reclaim Fragmented Space	00:33	00:25	4	5	32%	20%
Load Data from Text File (csv)	01:20	00:40	13	4	100%	225%
Configure Adaptive Thresholds and Perform Workloads	00:46	01:09	0	9	33%	100%
Total	4:43	4:27	44	51	6%	14%

Figure 10 Testing: Daily Administration Tasks[45]

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[45] Results are based on personal experience

Backup & Recovery Tasks

Backup and Recovery are a DBMS platforms is a very important, not surprisingly, in both systems to perform these tasks. Oracle Database 11g R2 of PostgreSQL, dramatically improving productivity. The following table provides an overview of the tasks that are performed.

Table 4.

C. Backup and Recovery Tasks	Time (Min:Sec)		Steps		Percent Difference	
	Oracle	PSQL	Oracle	PSQL	Time	Steps
Configure and Run Full Backup	00:08	00:10	0	0	20%	N/A
Recover Dropped Table	00:28	02:23	3	8	80%	63%
Recover Corrupt Datafile	01:32	01:13	5	2	26%	150%
Recover from erroneous transaction using Flashback	01:18	01:46	8	11	26%	27%
Total	3:26	5:32	16	21	38%	24%

Figure 11 Testing: Backup & Recovery Tasks[46]

Performance & Tuning Tasks

Performance and tuning of the work, scalability and application of survivability and indispensable for in this area, it is important to improve productivity. In order to quickly resolve the DBA performance tuning to diagnose the problem and need to be available. The ORC international database of expert panel 7 of the real 24 x in the environment, this task in the database administrator (DBA) take up almost half of the time it was found. Oracle Database 11gR2 - The timing point of 143 times the improvement in PostgreSQL

---

[46] Results are based on personal experience

is performed by a substantial margin of more. PostgreSQL is one of the tasks in the height difference between the SQL statement tuning of the more complex process of oracle database 11 g, and many were R 2 than the time it took to process occurs because of a difference in.[47]

Table 5.

D. Performance and Tuning Tasks	Time (Min:Sec)		Steps		Percent Difference	
	Oracle	PSQL	Oracle	PSQL	Time	Steps
Problem Diagnosis	00:08	00:14	2	2	43%	0%
Tune Instance Memory	00:00	00:00	0	0	0%	0%
Tune SQL Statements	00:00	18:50	0	8	100%	100%
Total	00:08	19:04	2	10	99%	80%

Figure 12 Testing: Performance & Tuning Tasks[48]

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[47] https://www.metachris.com/download/PostgreSQL_Oracle_en.pdf, page 4: pages 88
[48] Results are based on personal experience

Final Results

Task	Time (Min:Sec)		Steps	
	Oracle	**PSQL**	**Oracle**	**PSQL**
A. Initial Setup & Installation	**20:42**	**31:09**	**7**	**38**
Out-of-the-box installation	15:59	20:28	1	7
Setup of additional database	4:20	9:37	2	7
Setup proactive monitoring	0:19	1:04	4	24
B. Daily Administration Tasks	**4:43**	**4:27**	**44**	**51**
Create Tablespace	0:13	0:15	2	1
Create User/Schema	0:06	0:22	2	5
Create Table	0:45	0:36	17	17
Create Index	0:43	0:29	3	4
Create Additional User	0:09	0:22	2	5
Add Space to Tablespace	0:08	0:09	1	1
Reclaim Fragmented Space	0:33	0:25	4	5
Load Data from Text File (csv)	1:20	0:40	13	4
Configure Adaptive Thresholds and Perform Workloads	0:46	1:09	0	9
C. Backup and Recovery Tasks	**3:26**	**5:32**	**16**	**21**
Configure and Run Full Backup	0:08	0:10	0	0
Recover Dropped Table	0:28	2:23	3	8
Recover Corrupt Datafile	1:32	1:13	5	2
Recover from erroneous transaction using Flashback	1:18	1:46	8	11

D. Performance and Tuning Tasks	0:08	19:04	2	10
Problem Diagnosis	0:08	0:14	2	2
Tune Instance Memory	0:00	0:00	0	0
Tune SQL Statements	0:00	18:50	0	8

Figure 13 Summary of Testing Results[49]

Tasks Area	Workload	% Difference		Workday Savings	
	Weighting	Time	Steps	Time	Steps
A. Initial Setup & Installation	5%	34%	82%	*2%*	*4%*
B. Daily Administration Tasks	25%	6%	14%	*1%*	*3%*
C. Backup and Recovery Tasks	10%	38%	24%	*4%*	*2%*
D. Performance and Tuning Tasks	45%	99%	80%	*45%*	*36%*
Total	85%	49%	46%	*50%*	*45%*

Figure 14 Summary of Weighted DBA Time and Step Savings[50]

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[49] Results are based on personal experience
[50] Results are based on personal experience

Conclusion

According to the research, PostgreSQL definitely has the all-round functions as a DBMS. ORACLE is easier to operate and has a higher reputation and influence than PostgreSQL among public, which can somehow make up for the shortages in functions. The higher reputation also makes people believe that ORACLE does have the potential ability to improve to a higher level.

With the experiences of deeply researching ORACLE and PostgreSQL, I have obtained a lot. First of all, database management system is no longer a mystery to me in the reason that I understand the developing history and concept of it. Secondly, I not only acquired information thorough understanding every aspects of ORACLE and PostgreSQL, but also knowledge of Linux-like and Unix-like operating systems as well; this will crucially helpful for my further learning definitely. The last but not the least, this is the first time I do a project totally on my own, which turns out to be the unique experience to inspire me a lot to be more brave and independent.

The research is attractive to me because I have a strong interest in information system, which is linked tightly with DBMS. According to the research experience, I have the opportunities enable myself to explore my desirable field as well. Within the help of this research, I have established the fundamental basic knowledge of DBMS and obtained more confident about my future study plan. Additionally, the self-learning process formed me a more clear self-awareness because I proved my professional knowledge and study ability.

Transaction, advanced queries, query optimization as well as concurrency, they are the key points in my research. The aim - covered audiences are not only those new beginners in DBMS but also professional individuals. After experienced continuous acquisition, ORACLE has drawn a great attention and PostgreSQL is increasing shining as open source DBMS, the thesis will follow the main stream of public interests to show the sparkle from the impact of ORACLE's and PostgreSQL's culture and techniques.

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Appendix A

Test Platform Details

Hardware

• Processors: Dual Xeon 5520

• Memory: 12 GB DDR, 6x2 GB

• Storage

o   Primary system drives

2 146 GB SAS 15k RPM RAID 1

o Data drives

3 146 GB SAS 15k RPM RAID 5

Operating System

• CentOS Linux 7

Oracle

• Oracle Database 11g Release 2 Enterprise Edition (64 bit)

• Oracle Enterprise Manager Diagnostics and Tuning Packs

• Oracle Database Configuration Assistant

PostgreSQL

• PostgreSQL 9.6.2

• Citrus Replay Professional

• Database Designer for PostgreSQL

• DB Schema Defective

Appendix B

Used scripts & Procedures

Initial Setup & Installation

CREATE DATABASE mydb OWNER myname;

CREATE DATABASE mydb

  USER SYS IDENTIFIED BY pswd

  USER SYSTEM IDENTIFIED BY pswd

  LOGFILE GROUP 1 ('/u01/redo01.log') SIZE 100M,

     GROUP 2 ('/u01 /redo02.log') SIZE 100M,

     GROUP 3 ('/u01 /redo03.log') SIZE 100M

  MAXLOGFILES 5

  MAXLOGMEMBERS 5

  MAXLOGHISTORY 1

  MAXDATAFILES 100

  CHARACTER SET US7ASCII

  NATIONAL CHARACTER SET AL16UTF16

  EXTENT MANAGEMENT LOCAL

  DATAFILE '/u01/system01.dbf' SIZE 325M REUSE

  SYSAUX DATAFILE '/u01/sysaux01.dbf' SIZE 325M REUSE

  DEFAULT TABLESPACE users

    DATAFILE '/u01/users01.dbf'

    SIZE 600M REUSE AUTOEXTEND ON MAXSIZE UNLIMITED

  DEFAULT TEMPORARY TABLESPACE tempts1

    TEMPFILE '/u01/temp01.dbf'

    SIZE 20M REUSE

  UNDO TABLESPACE UNDOTBS

    DATAFILE '/u01/undotbs01.dbf'

SIZE 200M REUSE AUTOEXTEND ON MAXSIZE UNLIMITED;

Daily Administration Tasks

psql -lqt | cut -d \| -f 1 | grep -qw mydb

select (select sum(bytes)/1024/1024/1024 data_size from dba_data_files) +

(select nvl(sum(bytes),0)/1024/1024/1024 temp_size from dba_temp_files) +

(select sum(bytes)/1024/1024/1024 redo_size from sys.v_$log) +

(select sum(BLOCK_SIZE*FILE_SIZE_BLKS)/1024/1024/1024 controlfile_size from

v$controlfile) "Size in GB" from dual;

SELECT tablespace_name, sum (blocks) as free_blk , trunc (sum (bytes) / (1024*1024)

) as free_m

, max (bytes) / (1024) as big_chunk_k, count (*) as num_chunks

FROM dba_free_space

GROUP BY tablespace_name;

SELECT tablespace_name, largest_free_chunk

    , nr_free_chunks, sum_alloc_blocks, sum_free_blocks

    , to_char(100*sum_free_blocks/sum_alloc_blocks, '09.99') || '%'

      AS pct_free

FROM (SELECT tablespace_name

        , sum(blocks) AS sum_alloc_blocks

    FROM dba_data_files

    GROUP BY tablespace_name

)

 , (SELECT tablespace_name AS fs_ts_name

        , max(blocks) AS largest_free_chunk

        , count(blocks) AS nr_free_chunks

        , sum(blocks) AS sum_free_blocks

```
        FROM dba_free_space

        GROUP BY tablespace_name )

WHERE tablespace_name = fs_ts_name;


BEGIN

  dbms_utility.analyze_schema ( '&OWNER', 'ESTIMATE', NULL, 5 ) ;

END ;

/


SELECT  e.owner,  e.segment_type ,  e.segment_name ,  count(*)  as  nr_extents ,
s.max_extents

, to_char ( sum ( e.bytes ) / ( 1024 * 1024 ) , '999,999.90') as MB

FROM dba_extents e , dba_segments s

WHERE e.segment_name = s.segment_name

GROUP BY e.owner, e.segment_type , e.segment_name , s.max_extents

HAVING count(*) > &THRESHOLD

    OR ( ( s.max_extents - count(*) ) < &&THRESHOLD )

ORDER BY count(*) desc;


SELECT a.table_name, a.next_extent, a.tablespace_name

FROM all_tables a,

    ( SELECT tablespace_name, max(bytes) as big_chunk

      FROM dba_free_space

      GROUP BY tablespace_name ) f

WHERE f.tablespace_name = a.tablespace_name

          AND a.next_extent > f.big_chunk;


CREATE TABLE utl_vol_facts
```

```
(
 table_name              VARCHAR2(30),
 num_rows                NUMBER,
 meas_dt                 DATE
)
TABLESPACE platab
STORAGE  (
    INITIAL    128k
    NEXT       128k
    PCTINCREASE 0
    MINEXTENTS  1
    MAXEXTENTS  unlimited
  )
/


SELECT segment_name, segment_type, ds.next_extent as Actual_Next
, dt.tablespace_name,  dt.next_extent as Default_Next
FROM dba_tablespaces dt, dba_segments ds
WHERE dt.tablespace_name = ds.tablespace_name
  AND dt.next_extent !=ds.next_extent
AND ds.owner = UPPER ( '&OWNER' )
ORDER BY tablespace_name, segment_type, segment_name;


SELECT object_name, object_type
FROM user_objects MINUS
SELECT object_name, object_type
FROM user_objects@&my_db_link;
```

SELECT owner, constraint_name, table_name, status

FROM all_constraints

WHERE owner = '&OWNER' AND status = 'DISABLED' AND constraint_type = 'P';

SELECT index_name, table_name, uniqueness

FROM all_indexes

WHERE index_name like '&PKNAME%'

 AND owner = '&OWNER' AND uniqueness = 'NONUNIQUE';

Backup and Recovery Tasks

touch /var/lib/pgsql/backup_in_progress

psql -c "select pg_start_backup('hot_backup');"

tar -cf /var/lib/pgsql/backup.tar /var/lib/pgsql/data/

psql -c "select pg_stop_backup();"

rm /var/lib/pgsql/backup_in_progress

tar -rf /var/lib/pgsql/backup.tar /var/lib/pgsql/archive/

restore_command = 'gunzip < /mnt/server/archivedir/%f > %p'

TO OPEN THE DATABASE IN ARCHIVE LOG MODE. FOLLOW THESE STEPS:

STEP 1: SQL> SHUTDOWN

STEP 2: Take a full offline backup.

STEP 3: Set the following parameters in parameter file.

LOG_ARCHIVE_FORMAT=ica%s.%t.%r.arc

LOG_ARCHIVE_DEST_1="location=/u02/arc1"

STEP 3: SQL> STARTUP MOUNT

STEP 4: SQL> ALTER DATABASE ARCHIVELOG;

STEP 5: SQL> ARCHIVE LOG LIST;

STEP 6: SQL>ALTER DATABASE OPEN;

TAKING ONLINE (HOT) BACKUPS

SQL> alter tablespace users begin backup;

SQL> host cp /u01/usr1.dbf   /u02/backup

SQL> alter tablespace users end backup;

RECOVERING FROM LOST OF CONTROL FILE

STEP 1: Start sqlplus

STEP 2: connect / as sysdba

STEP 3: SQL> STARTUP NOMOUNT

STEP 4: Run the "CR.SQL" script file.

STEP 5: SQL> ALTER DATABASE MOUNT; SQL> ALTER DATABASE OPEN;

Performance and Tuning Tasks

EXPLAIN [(option [, ...])] statement

EXPLAIN [ANALYZE] [VERBOSE] statement

where option can be one of:

    ANALYZE [boolean]

    VERBOSE [boolean]

    COSTS [boolean]

    BUFFERS [boolean]

    TIMING [boolean]

    FORMAT { TEXT | XML | JSON | YAML }

SELECT pg_stat_get_backend_pid(s.backendid) AS pid,

    pg_stat_get_backend_activity(s.backendid) AS query

   FROM (SELECT pg_stat_get_backend_idset() AS backendid) AS s;

```
select event, count(1)

from v$active_session_history

where machine = 'prolaps01'

and sample_time between

    to_date('29-SEP-12 04.55.00 PM','dd-MON-yy hh:mi:ss PM')

    and

    to_date('29-SEP-12 05.05.00 PM','dd-MON-yy hh:mi:ss PM')

group by event

order by event;


select sample_time, session_state, blocking_session,

owner||'.'||object_name||':'||nvl(subobject_name,'-') obj_name,

    dbms_ROWID.ROWID_create (

        1,

        o.data_object_id,

        current_file#,

        current_block#,

        current_row#

    ) row_id

from dba_hist_active_sess_history s, dba_objects o

where user_id = 92

and sample_time between

    to_date('29-SEP-12 04.55.02 PM','dd-MON-yy hh:mi:ss PM')

    and

    to_date('29-SEP-12 05.05.02 PM','dd-MON-yy hh:mi:ss PM')

and event = 'enq: TX - row lock contention'

and o.data_object_id = s.current_obj#

order by 1,2;
```