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State of Art for Distributed Databases: Faster Data Access, processing, Growth Facilitation and Improved Communications

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Abstract:
The technological development has been experiencing rapid growth in the recent years. Individuals need access to required data and information more readily than ever before. To consider this need, the resource development and management are prioritized by the digital world entrepreneurs. In order to provide quick access to the individuals and provide necessary support are fundamentally important for the users. In the present aspects of the digital world, the concept of distributed database, grid system, and cloud systems have completely replaced the need for independent databases. Because of the increasing need and requirements of the computer power and capacity, digital world has been adopting different strategic concerns in order to promote and interconnect dispersedly reserved databases. The concept of distributed database provides the solution for the growing need for addressing the vital aspects of the data management and provision of the access to the required data. This article analyses the concept of database management system, considering relevant review of literature, systematic analysis, investigating the rules for distributed database management system DDBMS, finding appropriate architecture for the DDBMS solutions and providing justified recommendations based on the users' need and perception.

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1. Introduction

Data driven organisations have become reality at present day business world (Botan et al., 2010; Zebari et al., 2018; Zeebaree et al., 2020). Considering the vital challenges and requirements for different organisations and performance-based processes, the concept of distributed database was addressed (Akidau et al., 2015; Alzakholi et al., 2020; Zebari et al., 2020). Data streams are the outcomes for different unbound tuples and information generated over the time including the contexts of web logs, different forms of mobile applications, sensor networks, statistics for mobile usage etc. (Pääkkönen, 2016; Zebari et al., 2019; Zeebaree et al., 2019). Streaming and validating data and information are becoming increasingly popular in different social media platforms as well, such as LinkedIn, Facebook and Twitter (Jader et al., 2019; Kamburugamuve et al., 2014; Zeebaree et al., 2020). The concepts and challenges of the distributed database management is relevant to understand the present-day influences and management capabilities for the organisations. nowadays, the world needs continuous and integrated management of the information system, so that interconnected software, hardware management, database management systems etc. can perform effectively (Haji et al., 2020; Zeebaree et al., 2020; Zeebaree et al., 2020). Providing effective and justified solutions for the database management system, multiple organisational scenarios and processes can be resolved. Continuing the organisational challenges and database management system processes, organisational development of the systematic approach can be ensured (Pupezescu, n.d.; Shukur et al., 2020; Shukur et al., 2020). In this digital world, increasing need for access to data, storage of data and user perception play important role in the determination of the user preferences. Database management system for the distributed data set provide effective solution so that users can easily communicate with required data (Dino et al., 2020; Haji et al., Haroon, n.d.). Increasing need for database management has influenced the development of DDBMS architecture in the digital world. For this research paper, strategic development and management of the requirements relating to the development and design of the strategic model will be assessed.

2. Background Theory

2.1 Distributed Database

Compounding client machine to have rational database facility to be extended materially which are linked through forms of computer networks, can be regarded as distributed database (Abbas et al., 2016; Haji et al., 2020; Zeebaree et al., 2020). In distributed database system, all the storage devices are connected to any common central processing units. In this way, the distributed database systems can provide better solutions to different complexities (K. D. Ahmed & Zeebaree, 2021; HamaAli & Zeebaree, 2021; Hamad & Zeebaree, 2021; Husain & Zeebaree, 2021; Qadir & Zebaree, 2021). In the system of disperse network of interconnected computers and systematic approaches, the potential of the management system can be effective. In distributed database management system, the controlling software and management system need to be integrated to provide necessary support to the development of query (Abdullah et al., 2020; Dino et al., 2020; Yadav & Agarwal, 2010). In distributed database, developed Database Management System or DBMS can be used to determine and allocate the resources adopted for the control of data entry and data management for different websites (Larson et al., 2011; Sharif et al., 2020; Shukur et al., 2020). Software development and management for the integrated database management system needs to be aligned with the requirements of the overall system. The DBMS allows the users to control the data entry input and maintain the development processes (Ahmed & Sallow, 2017; Gupta et al., 2011; Sallow et al., 2020.).

In the distributed database system, processors communicate with each another in order to exchange the information and required entries for the overall processing of the system.

Considering the growth and management of the overall system, the users and clients need to exchange the information and ideas so that the connection can be maintained stable (Ahmed & Abduallah, 2017; Obaid et al., 2020; Yu & Meng, 1998). In the DDMS , effective sending and receiving the data can be organised to ensure necessary controlling and processing of the information. In designing a typical database system, the interaction between client and server needs to be maintained effectively. Considering the requirements and processes required for effective database management system, justified approach to select the appropriate strategic aspects for the evaluation and management of the database management needs to be ensured. Support management and reviewing the architecture for the database management needs to be ensured for management of the requirements of the client and server interaction (Khalifa et al., 2019; Zeebaree et al., 2020; Zeebaree, 2020) . The concept of database management system to align the organisational processes and facilitate performance management model, organisational development of the distributed database criteria can be resolved (Abduallah & Zeebaree, 2017; Pupezescu, 2012; Zebari et al., 2017).

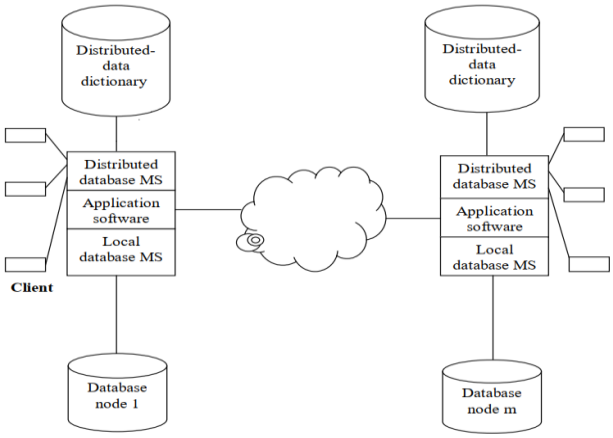

Fig 1. Distributed database management system

A distributed database is the collection of decentralized databases which are connected in order to accelerate the database management system and arrangement of the usable computer systems to operate (ADEL AL-ZEBARI, 2017; Pupezescu & Radescu, 2016; Qaqos et al., 2018). Systematic design and development of a distributed database is as follows : Conceptual schema design for the Database Management Model, Local schema processing and design for the local systems, Global design and development of the architecture and schema design, Fragmentation allocation modelling and design to address the needs for the database management model and Fragmentation design for the logical determination of the software development and design. For the integrated database management system, primary targets are to ensure transparency within the development and design of the software components (Pupezescu, 2015; Zeebaree & Zebari, 2014; Zeebaree & Rajab, 2019). Allocating applicable resources and capabilities to ensure necessary performance of the system module and software development, strategic processing of the performance assessment can be ensured (Dino & Abdulrazzaq, 2019; Pupezescu, 2016; Sallow et al., 2020).

2.2. DDBMS Types

A database can be of several types based on the actions, requirements, performance, and user engagement traits (Siegenthaler & Birman, 2009).

2.2.1 Homogeneous Database

In this system, data is randomly distributed across the server where different nodes and centers use multiple software. Multiple DDBMS software controls the multiple software and

nodes (Black & Luk, 1982; Dino & Abdulrazzaq, 2020; Saeed et al., n.d.). The actions and performance can be addressed to justify the performance. Considering the development and utilization of the resource capabilities in this system, sufficient management and software development opportunities are required (Ageed et al., 2020; Apers et al., 1983).

2.2.2 Distributed Database System Rules

In order to determine different outcomes and system preferences for the development of database management system, theoretical development of the perspectives continues to this date (Rumelhart et al., 1985). Chris Date came up with 12 golden rules for modern day distributed database management system which needs to be addressed in order to understand modern day approaches to DDBMS.

TABLE 1: CHRIS DATE TWELVE RULES FOR DDBMS

Particulars	Description
Rule 0: The fundamental principle	The user needs to perceive a distributed database system as a non-distributed one. This notion serves as the basic principle of the rule. In the distributed database management system, the user needs to be liberated despite there are complications in the inner system (Borsook, 1988).
Rule 1: Local Autonomy	In the DDBMS, different local sites need to be facilitated to work as individual unit. Each local nodes and point can perform with the support with the central units. Different vital functions such as concurrency management and control, recovery, backup, security and management processes are controlled by the central unit (Borsook, 1988).
Rule 2: Autonomy of Centre	In this rule, Chris Date argued that in the distributed database, there should be provision so that no site is dependent on the other site. In this way, different nodes and functions can be effectively maintained. Though there are deviation from this rule in modern day practice . Ensuring autonomy of the local and central nodes can be effectively processed so that the relative perspectives of the performance can be effectively maintained. If the central nodes are autonomous in performance, the management system can be accelerated (Kanungo & Rustom, 2015).
Rule 3: Autonomy of Failure	If any of the nodes fail, overall system is not affected by its performance. Effective management of the performance and management of the allocation of resources can be effectively maintained. The distributed database management serves as the no stop module even if one or more nodes fail . Considering the management and growth of the system, different architectural solutions can be adopted (Gupta et al., 2011) [20].
Rule 4: Transparency Autonomy	The user never knows about the location of the selected data in the database management systems. In the distributed management of the database, effective monitoring and evaluation of the system requirements are considered. Physical location and access to data are secured in this process (Souza & Dantas, 2015).
Rule 5: Autonomy of Fragmentation	The users of DDBMS always know about the concept of data fragmentation. In this way, the users have real time information on the data fragmentation. In this process, logical database is secured so that users can know about the autonomy of data fragmentation (C. J. Date, 1987).
Rule 6: Autonomy of Replication	Fragments and relative constants are considered as distinct, multiple and properly secured copies which are accessible to the users. In this case, the users can regulate and maintain the database and effective management of the considered data (C. J. Date, 1987).
Rule 7: Rule of Query Processing	DDBMS supports the execution of any query which is run on different nodes. Reflected on the processes and management capability for the query processing, distributed query processing can be adopted in this case (Christopher John Date, 1975).
Rule 8: Rule of Transaction Management	Transparent execution of the user data enables the user to update data wherein application in the management system. Management of the systematic approach for the database can be handled (Brunnström et al., 2013).
Rule 9: Hardware Independence	Appropriating the requirements of the basic functionality, the database system can operate on any hardware platforms. Considering the growth challenges for thes hardware independence, users can select independent modules in applicable scopes (Gupta et al., 2011).
Rule 10: OS Independence	Irrespective of any operating systems such as Linux, Windows, Android or MacOS, the system can operate on any platforms. This operating system independence has accelerated the growth of the management system (Erl et al., 2013).
Rule 11: Network Independence	In any suitable network platforms, the database management system can be installed and operated. Users can retrieve required data and information from these system (de Carvalho Costa & Furtado, 2011).
Rule 12: Database Independence	Different vendors provide different forms of database products. This system will allow all the formats irrespective of the vendors and associated database management processes (de Carvalho Costa & Furtado, 2011).

2.2.3 Query Processing

Based on previously mentioned rules and models, modern development of the database management systems are addressed. Query processing and executing target query is a challenge for effective database management system (Apers et al., 1983). In geographically dispersed locations, the query requires to be divided into sub queries, handling of the user request can be challenging. In such cases, the query management needs to be adapted with the sequence of the sub queries along with the required user requests (Thuraisingham & Ford, 1995). Concerning with the required user requests and performance management for the database management systems, different query processing modules can be formulated (Thuraisingham & Ford, 1995).

3. Comparison and Discussion

3.1 Related Works

TABLE 2: AUTHOR BASED COMPARATIVE ASSESSMENT

Authors	Contribution
Abbas *et.al* 2016 (Abbas et al., 2016)	The researchers worked on the ACID properties and controlling of the concurrency model facilitation of the database management systems. In this way, they propsed effective criteria for the development of the security and enhancement of the user interaction with the DBBMS system.
Gupta and Gore, 2016 (A. M. Gupta & Gore, 2016)	Akshay and other researchers shed light on the security management and imporvement of the database management facilities in different aspects. They adopted specific methods and clilent- server interaction to propose and maintain development of the effective database management system.
Mhatre & Shedge (Mhatre & Shedge, 2014)	In this research, target approach was to determine the aspects for assessing any anomalies and issues arising within the determination of the user specified database management system. Providing necessary support processes for the database management system. Considering the development and management challenges for the database manageemnt process, effective delivery of the database selection can be assessed.
Abdul Moiz et al, 2011 (Abdul Moiz et al., 2011)	The researchers proposed subsequent models for concurrency control mechanisms to determine the adequacy and management capability of the database management systems. This client-server model works as the basis for effective determination of the performance and management output.

3.2. The Ideal DDBMS

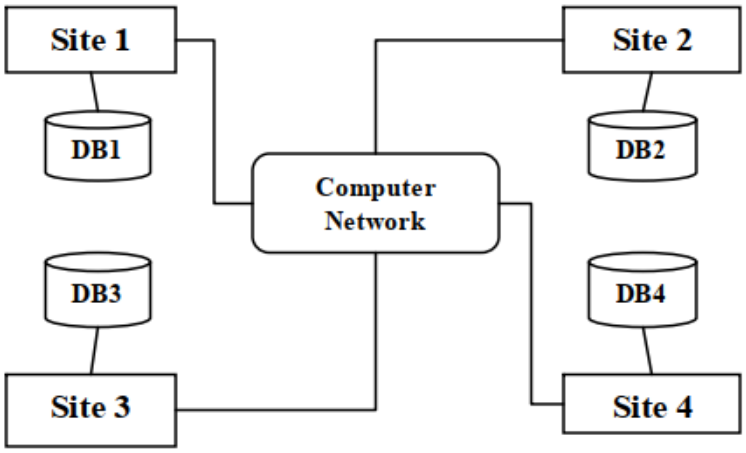

Fig 2. An Ideal DBBMS

Database management system has several characteristics of an ideal (Mishra & Singh, 2015). Distribution of database management system need to be geographically dispersed and should be able to work in transparent mode, The spread and management of the DDBMS

needs to be involving variety of systems, This needs to be adapted with different operating systems and Need to be able to perform across varying platforms.

3.3. DDBMS Problem Areas

Several problem areas for the distributed systems for database management have been cited in the literature. These components need to be assessed. Integrity and management capability of the different forms of database management needs to be assessed with relevant architecture. Assessing the outcomes for different DDBMS can be assessed to identify the required criteria for selection (A. M. Gupta & Gore, 2016). Replication control for the database management system needs to be aligned. Processing the outcomes for effective modelling and management of the database management system needs to be aligned with the varying process (Mhatre & Shedge, 2014). Replication criteria and processing the architectural development for the database can be adopted. Deadlock handling and management of the user control need to be assessed for the development of effective criteria (Mishra & Singh, 2015). If numerous users request for similar information from the database, effective selection for the deadlock handling need to be implemented. Transparent controlling and management for the user centered database need to be assured (Ceri, 1984). Transparent Management can be effectively implemented in DDBMS processes.

3.4. System Architecture

3.4.1 Top Down Approach

Top down approach for DDBMS can be adapted to different user requirements. While implementing a database and designing process, the top-down approach is used mostly (Mishra & Singh, 2015). Considering the developmental needs, the users can select the top-down approach.

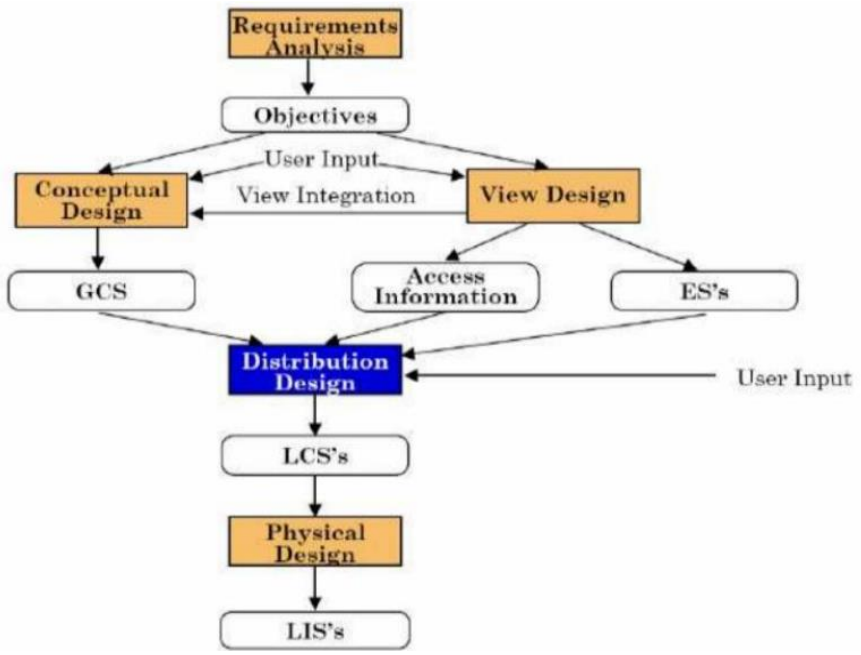

Fig 3. Top down approach for DDBMS

3.4.2 Bottom UP Approach

Bottom up DDBMS system is adopted while the modification of an existing system is conducted. In this approach, the control panel works to add new database to the existing database in the system. Managing and controlling different forms of databases, any models

from these two bottom-up and top down approach can be adopted to address the need of the system (Ling & Bell, 1992).

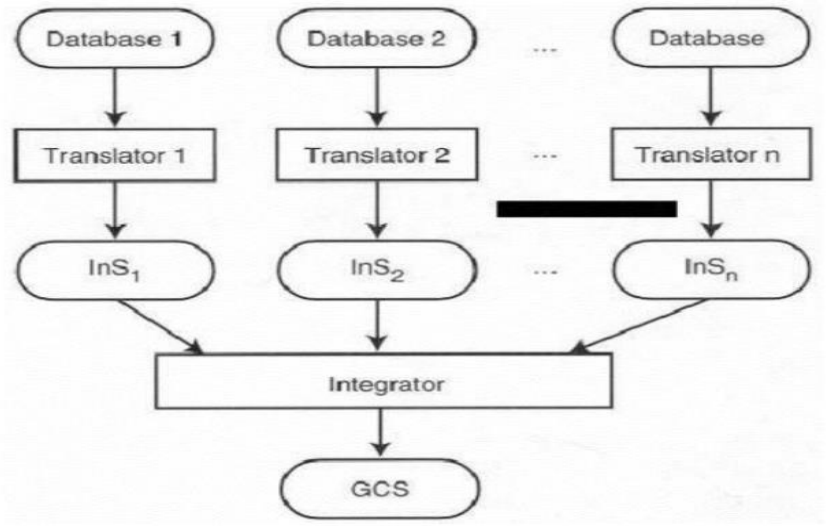

Fig 4. Bottom up approach

3.5. Security Management

Security management for the DDBMS is fundamentally important as in the system, data and information are stored (Akintola et al., 2005). Security management for the system can be described as the process involving the prevention of unauthorized access, misuse of information and user data, security authorization, authentication of user data, controlling of the user information, management of the software development process, encryption, and controlling multi-level user access for the providers (Mathew, 2018). Different components of the security management for DDBMS are assessed below:

TABLE 3: SECURITY MANAGEMENT FOR DDBMS

Security Particulars	**Traits**
Authentication	While accessing to a database, users need to provide passwords to enter specified sites. In this way, the users can ensure security and management of the user defined controls (Chen et al., 2019). Ensuring necessary security management and user access control, the authentication process can be maintained effectively.
Authorization	The context of authorization in the distributed database management systems, provides one secure control and access point to enter specified locations. In this way, the users can control the access and management of the data entry (Magdalena, 2011).
Encryption	Data encryption provides extra layer of protection for the user data. In this way, the data and information Can't be misused by any other users (Özsu & Valduriez, 1999). Considering the development and security management for the user data, effective processing of the data entry can be ensured for the user specified data management processes (Rahimi & Haug, 2010). Providing user access to the different problems and management processes, the security management is important to ensure user integrity (Mishra & Singh, 2015).
Multi-level Access management and Control	In this system, the user is restricted to get the complete access to the data and information (Mishra & Singh, 2015). The users can only get specified and permitted set of data in this case. Security management provides essential support in protecting access to the data(Tosun, 2014).

4. Conclusion

Development of the system architecture and modules for database management system can be challenging to meet the real life challenges for the digital world. In this article different aspects of the prospects and management prospects for the database management systems have been evaluated. To meet the requirements and digital needs of the world, the concept of

distributed database is getting more and more popular. With increasing value and need assessment, the architecture development and management of the considerations are important for projecting the overall prospects of the database management systems. In order to retain and facilitate the prospects of the database management system, development of the required system values and considerations are important. Future research opportunity for the topic can be proposed as the enhancement of the security and development of the architecture to meet the digital needs of the time.

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