Data Centric Systems: Technology and Applications

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Abstract— **Data centric systems have several meanings, in general it means how the computing performance can be improved by data. This paper discusses how data centric systems help in changing the computing procedure in various fields such as distributed databases, data centric security and distributed computing. Data is growing rapidly and the data available makes effectiveness of computing inherently dependent on it. In the current scenario the requirement of a high-speed database is necessary. In today's technology data centric systems has influenced the field of distributed computing to a great extent, these include features such as memory sharing and be implemented in a computer network. Application behavior and data semantics as a combination is the data centric architecture. In memory hierarchy, the aim is to control data at various points also in distributed computing. Accessing data tends to be very high and this can be reduced through data centricity. A key topic that will be discussed is how data centric architecture is used in distributed computing and improves processing in big data analytics. An important topic would be data centric security during the procedure of processing data applications are being used, it is necessary to ensure that these applications do not endanger the data, and this maintains confidentiality. Approaches on how data centric system can enable security will be discussed. A combination of data and decision theory could improvise on the enterprises.**

I. INTRODUCTION

A data centric system/Architecture would have several meanings but in general it means of data is the most permanent and valuable and asset and everything including computers to applications depend on it for performance. This generally means how databases play a very important role in order to enhance computation. It can be considered to be a regular relational DBMS not like the typical file-based data storage developer have now become completely involved in relying on data for quicker development. Mainly in this paper we will focus on a shared database for the basis of parallel process in the field of distributed computing unlike the direct inter process communications and message-oriented middleware. A major benefit of this data centric system in distributed computing would be utilizing the DBMS enabled processing, transactions and also indexing in order to endure a very higher reliability, also includes performance and capability, some of the companies have opted to a data centric architecture. This kind of architecture improves the following such as security, fault tolerance and most importantly scalability. Data-centric computing concerns the acquisition, processing, analysis, storage, and query of data sets and streams. Data centric computing can be a field that involves the acquisition, processing, analysis, storage of data and how that data can be used to improvise on computing. A data centric system can also be defined as a system where the data is the permanent primary asset. Note that currently a data explosion is taking place data is significantly growing and the amount of redundant data available is in plenty it's increasing exponentially for the number of devices available and what an architecture like this could do is make use of the available data and enhance all kinds of computing not only distributed computing. This amount of data available can enhance the technology in a very different way.

In the current scenario and soon devices will display much advanced behavior and interactions with many other types of advanced devices. All of these are possible with a data centric approach. In general computing with various devices always has caused a problem for data management. The old standard of storing data has become difficult and inefficient in the current scenario. In a database they exhibit a very small amount of distribution and always their location remain fixed. In this paper several applications of data centric systems will be discussed. Some examples and case studies of data centric systems will be represented. A representation for data and metadata is Known to make exchange of information much easier and enables sharing. Note that computation is performed by including various databases which includes networked devices and devices on the cloud, these kinds of databases can communicate with each other and further improve computing, on having a shared database parallel and distributed computing can be made much easier and the major factor power and cost are reduced as well. In the field of distributed computing, super computers and its architectures can be used in a very higher level of parallelism this naturally improves the computer performance and this also makes it tedious for scientists to develop a code that works in high performance and also in a very short span of time, in order to successfully bring about parallel processing. A system with very fewer devices connected and at the same time brings about the same features of a perfect parallel system is something that will be focused in this paper. This method can be considered to increase the overall performance.

On comparing with a regular enterprise normal workload for example online transactions and web services, data centric architecture can change workloads and also the assumptions about this design clearly, these kinds of workloads are capable of operating at higher proportion and different kinds of structured data.

In general, distributed computing can be considered to be a group of computers in a network sharing common databases and computing capabilities in a data centric approach to distributed computing all kinds of data are shared through a common data base to enable computing. It can be considered as the way of increasing and aggregating various computing entities that are distributed geologically, the main ultimate purpose is to run a particular task in a very coherent way, so they appear to be a unique, centralized and data centric system. On the other hand, parallel computing and distributed computing do not differ much parallel computing

can be noted as the simultaneous execution of a particular task in a number of processors, this obtains very quick results .This method of distributed computing can consist of a number of databases and would require to access memory from different points .This multiple processing types can be considered to be a multiprocessor system and it consists of a number of independent computers that are connected by various networks.

Parallel computing can be considered as the technology to reduce computation time for several processes. A number of research activities require large scale computer and clusters and parallel computers make this process easier if not for such computer's computation would take a number of years to perform. For example, in the field of weather forecasting a large dataset is required and it usually involves an uncommon and a very complex computation technique moreover it has timing constraints in such kind of a scenario the solution to that would be a distributed computing with a data centric approach. A kind of data centric architecture is one which involves parallel computing and distributed database

In the current scenario the world is dependent heavily on information everybody needs to access information from their databases and to make a distributed computing system work the most important feature would be enabling shared database. A shared database architecture predominantly increase the computing process and power, able to access the memory at any time and point by a particular system would constitute for its data centricity .In a company it can happen that all the kind of database are stored in a particular location a single problem could ruin the access to the database a possible solution to this would be a distributed database, in general it means a database that could be a collection of databases stored at different locations this increases high reliability, a purpose of distributed database management system would be to control and use a database that appears to other users as a central database.

In addition to a data centric system for large computers in distributed computing and shared databases a key topic in data centric systems would be data centric security in computing, this paper will be introducing key data centric topics and also providing certain case studies on them.

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II. BACKGROUND

Data centric system is one which data is the primary model, in large computers a data centric model may be implemented to improve business, finance and growth in various sectors. This paper will also discuss how a data centric system improves overall business. Through a data centric system data is accessed and reused periodically. Every application system has its own business model and it is inherently dependent on the data model, A data centric approach changes this all, it can be considered as a semantic data model and everything access through a shared model. Data centricity can be ultimately implemented through advanced machine learning techniques this enhances the process. In this kind of a model data is reused again to improvise on various factors and through advanced analytics this is possible too.

A.RDBMS

A topic that will be further discussed is a relational database management system which uses a data centric architecture it is a DBMS that stores various data in the form of tables they are very important and play a vital role in data storage and access. A feature of this is that it can be accessed in many ways. This kind a of a database is data centric and has played a vital role in the fields of computing and storage.

B. Distributed and shared database management systems

A shared database management system is needed for many reasons, a distributed DBMS does not require to access data from a single database it relatively shares the data and it can be accessed from anywhere thereby providing a data centric architecture which enables data flow much easily.

C. Data centric architecture for distributed computing

In distributed computing computers and devices connected in different zones must be able to communicate with each other in order to speed up the computation process a data centric approach to computation has been provided in this paper and how this form of computing using a data centered architecture with DRAM technology aids in bog data analytics.

D. Data centric security

Data centric security is a growing area of research and it targets to provide all the owners of data high level security from using the data itself literally by making use of the data. Note that the data available are self-defending and can protect themselves through this approach. The various processes in data centric security will be discussed, key concepts such as Discover, Manage, protect and monitor through a data centric model.

Data centric security can be a particular approach in providing security mainly to the data, this is a key field of growth since technology is moving towards big data and the purpose of preserving it is a must. Some of the data centric techniques in security would be data access controls and policies, encryption, data masking and auditing also cloud computing is an important field for data protection. In encryption which is considered to a very data centric technique that can give ways to prevent data theft through networks, mobile phones[4]. However, encryption does not turn out to be a reliable technique. In data Masking it can be considered as the way of hiding data within a database and this ensures security is provided, the approach to this would be masking data from users and other sources. It can be done by several ways for example duplicating data. Another data centric approach for security would be auditing. Auditing is nothing but monitoring all kinds of activity, this gives several ways to know a data breach and it also reduces the damage caused by a breach. Note that security in a cloud computing is more data centric, cloud computing is a growing field and brings about several privacy challenges.

III. ANALYSIS

A.Data Centered Architecture

A data centered architecture can be considered as one in which all the data is centralized and can be also accessed by various other components that are able to modify this data. One of the key reasons for this kind of an architecture would be to get maximum integrality of the data. As a whole a data centered architecture can be considered to be an architecture of a number of components that are able to communicate via a number of shared data repositories. These components are able to retrieve and access the shared data structure this makes it much more independent clearly in a way they are interact with storage only.

One of the most commonly used data centered architecture would be the database architecture.
Here the general database method is created with its definition protocol, a typical illustration is a set of related tables with its data types in a Relational Database management system (RDBMS), RDBMS and its working will be discussed in detail.

On the other hand, another example of a data centered architecture is a typical web architecture
this architecture has a very common data schema known as the meta structure of the web and it utilizes a hypermedia data model, this is a model where the processes are able to communicate with the help of web-based data services it produces a very clear shared model[3]. The components of the architecture are the
1) Central data and the
2)data accessor.

Central Data:

A centralized data centric module which is capable of being a data store or it can be a repository
This is responsible in giving a data storage module that is permanent, in general it explains the present state.

Data accessor:

This is the part that deals with the collection of various independent components that are capable of operating on the storage, they can perform several requirements and return back the result.
Data is the only way of communication in this module.

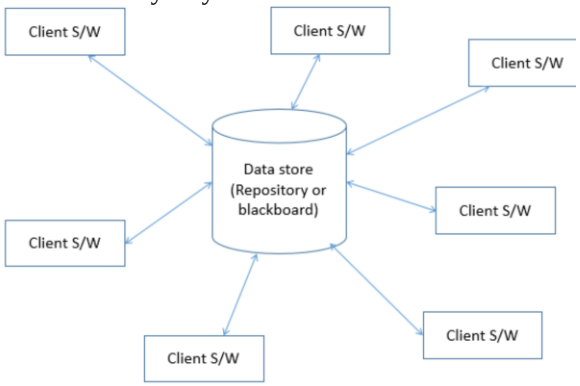

Figure 1. Data Centric Architecture

Apart from all the data centric system RDBMS and Web architecture are the common most types.

B. RDBMS

A relational type database is a type of data centric architecture and basically it provides a simple relational model and facilitates the creation of relational databases. An RDBMS is the most frequently used type of DBMS, a relational database is one which can efficiently store data once entered and reference it from any other part in the database.

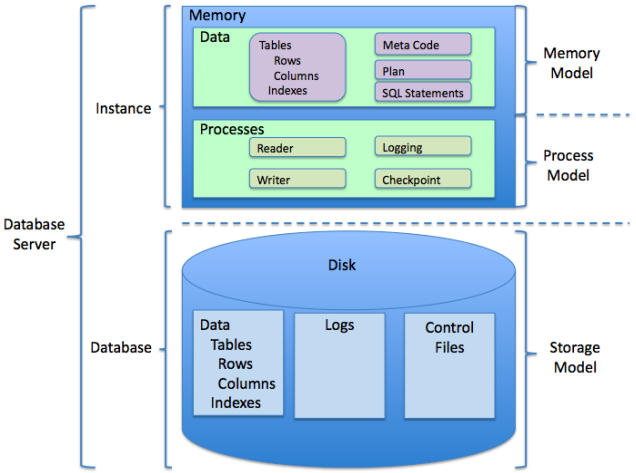

Figure 2. RDBMS MODEL

C. Distributed DBMS for Database sharing

A distributed DBMS is a typical application of a data centric system, Information storage has been one of the most tedious parts of computer systems a distributed DBMS provides a data centric approach for the collection and reutilization of data. Large amounts of data are required to be managed every day and data should be centralized and communicating with it must be as simple as storing data. IN the current scenario the centralized data are required just to store and manage the data available. A clear disadvantage of this is communication however it reduces the cost of localization. In a distributed database management system, all the database applications that are running at any particular location must have the capability of operating on any of the database fragments without any aid. The software that manages a distributed database is know as a DDBMS, it generally implies to a growing collection of sites that are linked with each other but however these sites are made to work as though data is accesses directly from one site.

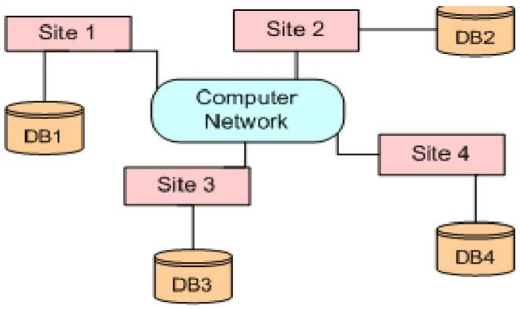

Figure 3. Distributed DBMS Model

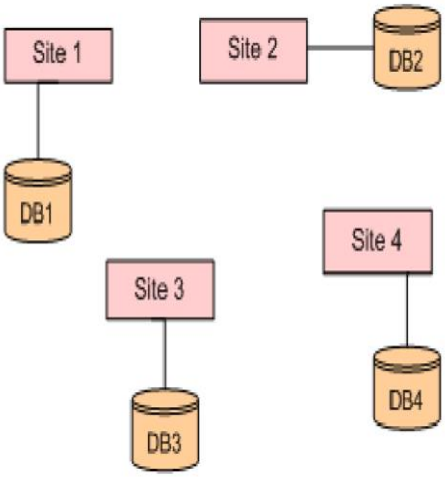

Figure 4. Regular DBMS Model

Distributed database architecture

The distributed database can be defined as a number of collections of interrelated databases which can be distributed over the computer network. This however can be a single database which are further subdivided into smaller parts and the scattered, the database is typically scattered over a number of locations[3]. This provides access to data frequently and reduces communication costs Online processing has created the demand for this kind of an architecture, the reason data is being distributed is mainly for economic and competitive reasons, a number of features have given rise to the demand to step into a distributed database.

Distributed data base Design

The methods of a designing a centralized database is very similar to the distributed one, a distributed data base is data centric in the terms that its able to communicate with other components and data being the primary, designing a distributed database involve the following factors to be taken into account:

Data Fragmentation:

This factor decides how much data is to be stored before distributing it and also must determine the number of for distribution, the database can be broken into smaller units called fragments and these would be stored in different sites, the very simple units in a database can be considered to be the tables.

1.Horizontal fragmentation:

In a table the horizontal fragment is the subset of rows available in it, hence horizontal fragmentation can divide the table in to horizontal points by choosing the rows and the fragments are assigned to different sides on a distributed system.

2.Vertical Fragmentation:

The vertical fragmentation of the table can only keep certain attributed that are related to it, this divides the table vertically into columns. This is necessary to include the primary keys in the table in order to reconstruct the table whenever needed.

3.Mixed fragmentation:

In this kind of a fragmentation a particular fragment specified by the combination of operations, From here the original table can be reconstructed in the appropriate order.

4.Data Replication:

In this part a copy of each of the fragment is stored at different sites, this is the process of deciding which will be replicated and which won't.

5.Data Allocation:

The fragment Is allocated to one more site where this will be stored.

Strategies for Data allocation:

1.Fragmented: Disjoint fragments of the database are created with each fragment being assigned to no replication. This known to be non-Redundant allocation.

2.Complete replication:

A copy of the complete database is maintained at every site, in this feature storage and communication cost increase.

3.Selective replication:

In selective replication this involves a combination of replication and fragmentation parts.

Types of distributed database systems:

Distributed database systems are classified into:

1.Homogenous distributed system:

In a Homogenous distributed database system, the data is distributed, and all the servers are capable of running the same DBMS software.

2.Heterogenous distributed system:

In a heterogenous distributed system, note that different sites run the control of different distributed database. These databases are connected but they run different software on each other.

Advantages of Distributed database systems:

1)Robust, failure in one part of the program will not affect other parts.

2)Security: Access can be provided only to a portion of the data, and not all data can be made accessible.

3) Easier error detection and keep the errors local rather than affecting the entire database.

Disadvantages of distributed database systems

Complexity-. A distributed database is comparatively more difficult to setup and use.

Security–many access points to the data.

Distributed systems are not efficient if there are heavy interaction between sites.

D. Data centric architecture for large scale parallel and distributed Systems

Volumes of data have been increasing rapidly and the complexity of processing data handled by in general both the private and public sectors becomes tedious, an approach to solve this is large scale parallel and distributed systems with a data centric architecture which can perform many number of computations parallelly are needed to solve this, this process is generally difficult because of not able attain the required speed for data processing[5]. A solution to this would be ultra-high-speed data processing and by making use of a data centric architecture and a combination of controllers with network port the module provides high speed performance, such a module can used easily for big data analysis which requires high speed processing of very large quantities of data. Data processing is generally becoming very complex, the purpose is to process high volume, high variety and also at a high velocity. In order to do this a large scale parallel distributed system are required and further these data must be distributed to get centralized management. A data centric architecture to solve all the problems

is a computer system that has NAND flash memory, this architecture minimizes the data management process and furthermore it's needed for parallel distributed processing.

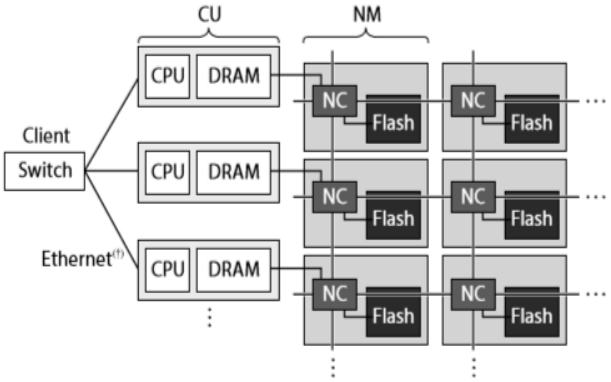

Figure 5. Parallel and distributed systems architecture

Architecture

The architecture has several benefits, its capable of storing active data in the memory. Through a data centric architecture it can be seen that parallel processing is much faster compared to regular architecture and along with NAND flash memory this provides suitable processing for big data, the main characteristic concern of the architecture for parallel processing is data centricity, comparing with a standard architecture the standard one tries to increase the computational performance by sending in a large amount of data at very high speed possible, the data centric architecture on the contrary improves the system performance as a whole, this is done by increasing the number of CPUS that will be operating on the data sets in parallel[9]. This highlights that the data centric architecture is useful and convenient for a system that would require to perform big data analytics which has to process huge variety of data at a high speed. The architecture would typically consist of a number of node controllers and these are associated with NAND flash memory, these gates are now capable of forming a 2-dimensional matrix which can send and receive data from one another. The network provides as very high-speed storage system which is typically addressable in a single space. The parallel computation is now capable of providing very high computing power. The architecture is capable of providing of device to medium scale industries and also cloud service providers and mainly to high performance appliance distributors. It is now capable of providing a full component level redundancy and this eliminates single point of failure and provides redundant array of inexpensive disks RAID5 that can protect the data without reducing performance.

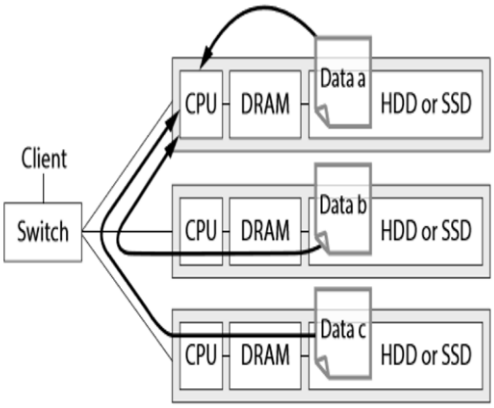

Figure 6. Conventional architecture

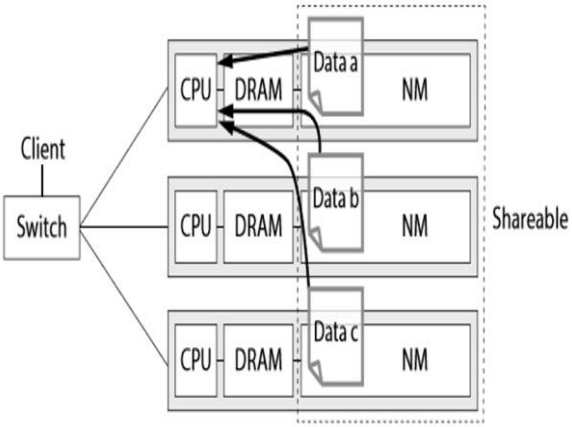

Figure 7. Data Centric architecture

Parallel Distributed Processing in a Data Centric Architecture

The other major advantage of such an architecture would be its ease of data management and this eventually leads to much faster computation[9]. A general parallel distributed system is capable of splitting and storing given sets of data mainly across the computer nodes. When the computer node works in a collection of data sets each node must be capable of communicating with the other whenever its required to store data, for these nodes to access the data items the computer must be able to trace the

Sets of data this data is known as meta data and it describes and gives information about the required target data items. Thus, moving data in a distributed system typically causes degradation.

In the data centric architecture all the CPUS share the entire NAND flash memory space this eliminates the need to move data using the ethernet, this kind of a model is called shared everything architecture. In the standard parallel distributed system, the computer nodes transfer data with each other, this indirectly leads to the networking traffic in it, the data centered architecture is free from this kind of bottleneck. Even a standard architecture along with the shared everything architecture requires a large and exclusive control over its data, in the data centered architecture the NC'S provide most control[9].

In general, a complex data management outsourced to various computer nodes is the cause for the performance degradation and results in a bottle neck along the parallel distributed system[9]. A number of methodologies have been put in place to avoid these bottlenecks which includes data storage and processing. While dealing with big data its difficult to predict the nature of its processing and the type of incoming data, which brings about the bottleneck again. The data centric architecture reduces the overall performance degradation which minimizes data management process and focusses primarily on high speed computation.

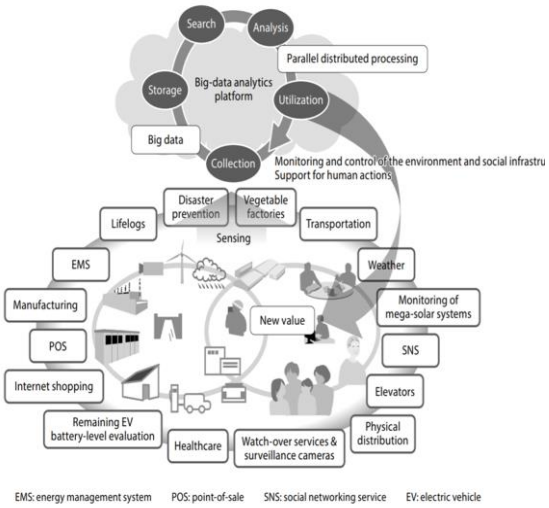

Figure 8. Data centric Model

Using a data centered architecture for parallel processing

In standard architecture parallel computing would typically have a trade off in certain cases such as data volume and computing latency. In a scenario where the data volume is large up to petabytes a regular system is used for the batching process. In real time processing latency is required to be as low as one millisecond[9]. In such a scenario the data centered architecture plays a major role, it can now serve as big data analytics platform. This architecture delivers horizontal scalability and at the same time high speed computing. The area of usage is very large, and the such an architecture will suit all the purposes of big data analytics.

E. Data centric Security

In the general techniques of protecting data, security is always provided by the server which is capable of storing the data. The techniques of protecting the data and considering the server administrators take steps to manage the protected data. This is a typical system centric way and is not very much suitable for the shielding all the client's data in a cloud system[7]. A data centric approach is one which is expected to be more effective and at most adaptive to all its services available in cloud. Data centric security typically means security to data from its inside so that the data will be capable of having its own requirements for security, which is built into the actual data and also provides optimal data security at any given time irrespective of the environment where the data is stored.

The usual security features mainly the technologies and the components that are used to store and manipulate data, this at times becomes tedious and must be adapted in order to bring about the necessary security procedures to store and handle sensitive and confidential data[7]. The solutions that are proposed focus on securing and underlying the operating systems and virtual machines.

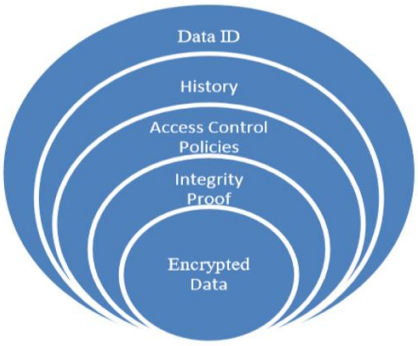

Figure 9. Data Centric security

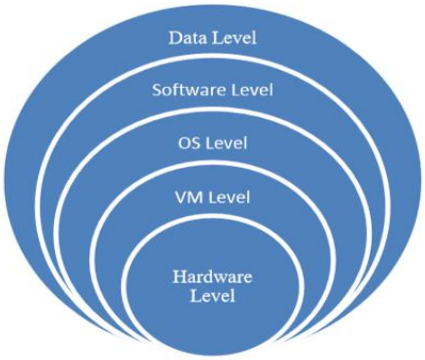

Figure 10. Regular Security model

Data centric security Model

The foremost consideration in any enterprise when they take up a data security program is that it determines the guidelines for a number of enterprise data handling based on its policies, certain questions that arise are who would be the owner of the data and what kind of a data it is to get through all these a data centric security model is used. Moreover, the technology of a data centric security model relies mainly on its access control and policies.

The pillars of a data centric security model

There are many aspects to information security solutions; common to all solutions are three major functional pillars: data classification, identity management, and access-control

policy definition and enforcement. The data-centric security model architecture also relies on three distinct but interdependent pillars of operation: 1. The data pillar focuses on providing classification and serving of permissible data requests through the elevation of data classification in line with business processes. 2. The role pillar focuses on authentication of data users via RBAC mechanisms. 3. The policy pillar focuses on the translation of policy requirements into actionable low-level security pol
In order to achieve information security solutions there are 3 major pillars to be followed:
1)Data classification
2)Identity management
3)Access control policy definition
In a data centric security model it ensures that it is also dependent on each other 1) The data pillar targets on bringing about classification and providing data requests with an increase in processes,2) the role pillar targets primarily on authentication this done through a mechanism known as the RBAC and the policy pillar finally targets the translation of all requirements into what is known as a low security policy.
The various pillars of a data centric security architecture will be discussed in detail:

1.Data pillar

This what protection at a resource level and also the data element level, the data must be sorted as per requirements, which means the metadata coexist along with a number of attributes that provide access control policies, these include labels and the labels can be information such as the data owner, data type and also the sensitivity of the data. A common problem now that is being faced the type and the sensitivity of the data will define information that are intellectual property and privacy property[6]. In this pillar it is shown that both the structured and unstructured data can be classified.
The other concept is data proliferation, and this leads to serious problems within the organizations and they are unable to show if copies of the sensitive information exist and where they are exactly located, this enable the user to get much more control over the information that is available.

2.Role pillar

This kind of a pillar is involved in the process of identifying and also validating any authorized user and this is done by the identity management system, the main purpose of the role pillar is not identification process rather it is the requirement of the architecture is to provide data access through the available control policies for the and not for the systems and devices[6]. The main aim of the role pillar is to find subsequent requests of information or data access and then these undergo an authorization check. The benefits of this include simplification of the policy definition process and also that reduces management.

3.Policy pillar

The roles to be performed on the role pillar and the data which is kept in the inventory and also classified in the data pillar, here access control policies are written for the purpose of identifying the roles to access specified data and its classification[7]. A higher level of abstraction is used in defining the access control policies and access privileges. These high-level statements must include the role, data class and the purpose.

Policy enforcement:

The high-level access control policies are ones which are changed into machine executable statements this enables the point of policy enforcement, it takes data access request and decision to be made, a clear decision is made which either permits or denies it.
The policy decision take input as the user credential and other attributes and then read the policy form the storage which further identifies the classification of data information of the data request and thereby produces an enforcement point[7]. These policies are then transformed into (XACML) the extensible access control markup language thereby allowing the authorization body such as the resource control to take over.

Benefits of Data centric security

The benefits of a data centric security model and also its pillars are that it can be further integrated into other types of architectures for example the information on demand architecture and service-oriented architecture, these architectures can utilize the data centric security concepts and aid in further requirements. Through an Extensible markup language (XML) structure data labelling points can be implemented to provide information[6]. In the case of simple object access protocol message, the labelling construct (SOAP) it is placed in the header of the construct. In addition, a data centric approach provides higher security in the field of cloud computing. Also focuses on what sensitive data actually has to be protected

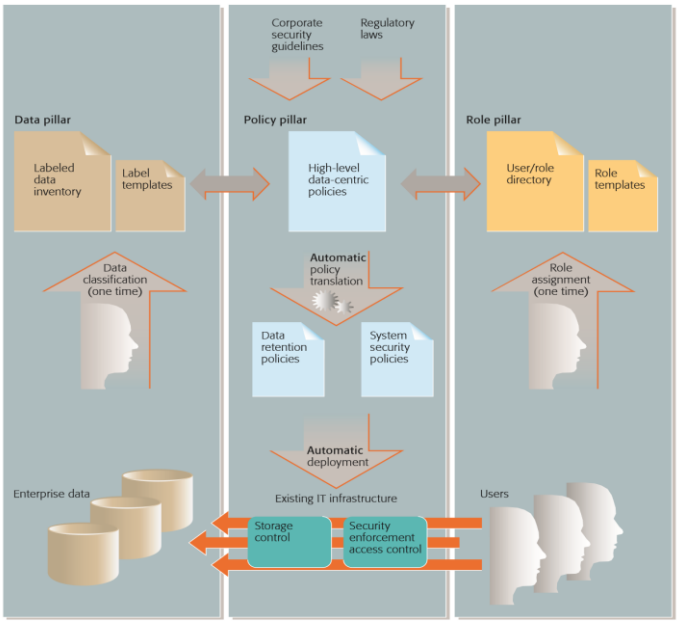

Figure 11. Data centric security Model

IV. FUTURE WORK

The data centric systems have several applications that has been presented in this paper, how a data centric system and data centric technology can be used was discussed. However, in the future there will be a rapid growth in data centric applications, distributed database can take over the conventional database and this probably because when databases are able to communicate with each other it makes the work flow process easier data will be easily retrieved and accessed, in the coming years relational database management systems will grow rapidly and this kind of approach brings about improvement in all most of the fields that require high performance computing. The DRAM based data centric approach for high speed distributed computing will see a growth in the coming years mainly due to the demand for big data analytics. Much better advanced systems could even replace the DRAM technology with a enhanced data centric architecture for distributed computing. Most of the security systems are now data centric, in the future there will be a rapid growth towards this approach. In data centric security once the confidentiality and protections are obtained the next part is to bring about an extension of that confidentiality across machines, this very different from current scenario of protection where just the data travelling between machines are secure, in the future through the data centric approach a system must be created where data can travel protected even without encryption.

It can be observed the emergence of a new generation of connected systems, the data centric architecture will ensure a change by making information pervasive. Information which are always available in real time returns capable distributed and data critical applications. A technological key leading to this transformation is the real time middleware which drives towards the data centric transformation. The evolution of technologies is very rapid, and they can satisfy most of the real time requirements of various systems in place to bring about high-performance data access. Though there are some hurdles in obtaining high performance, data integrity and scalability. Data centric systems for the future is very near.

V. CONCLUSION

In this paper data centric systems with its technology and applications was discussed. This paper highlights some of the key aspects of data centric systems topics on distributed database, data centric systems for distributed computing and data centric security were the key topics that were discussed. The paper brings about comparison between a conventional system and data centric system for a number of applications. In the distributed database management systems, it presents several aspects related to it and the purpose of accessing data from multiple remote locations bringing about speed, another important data centric systems application was the development of a high-speed system for distributed computing a data centric approach along with NAND ROM for big data analytics. Finally, the data centric security model and its approaches are discussed, and it compares with a standard security model. Some of the topics related to data centric systems such as message-oriented middleware could not be discussed but most key topics have been explained in depth in this paper.

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