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Improving Reliability of ERP System in Cloud Architecture with Dynamic Cluster and Multi Handling Thread Approach

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Abstract.
Cloud Computing is a resource that provides network access to a shared group of customizable computing resources whenever it requires, promptly without any huge efforts or interaction with the service provider. Different organizations and services (ERP) can easily distribute their sources and services with the help of Cloud Computing which made the companies not to stress over the computing resources provision planning. Companies' ERP of companies' business and transactions are the shared responsibility of the Cloud system and the organization. Enhancing the secured data transaction on ERP at every level is the motive of this paper. In this research paper, Novel architecture is introduced for implementing optimized methodology which enables reliable ERP solutions with high speed.
Keywords: ERP, Cloud architecture, Threads, Time & Space and Network (N/W).

INTRODUCTION:

The organization might require much different software for processing their data if they don't use ERP systems which is a hard process for integrating and customizing (Netsuite, 2011). On the other hand, ERP system should be established properly for providing adequate data with on-time service. The misconfiguration while deploying ERP system may require few more additional implementations changes which might be expensive and time consuming. Which in turn forces the organization to provide their services at minimal cost with better service to manage the competition in the market? Novel data pre-processing mainly focus on Pattern Recognition, Data Clustering and Signal Processing. In which dynamic cluster forming and pattern recognition are given special attention. For data transaction with high speed along with shrinkage of data, Hybrid dynamic clustering algorithm is described. Dynamic Clustering with Data shrinking (DCDS) algorithm introduced in this paper.

ERP Cloud architecture responsible for following questions:

What is the limitation in their conventional ERP solution?
What makes people to get interested in using new technology and what they expect from new technology?
What are the services provided by the Cloud ERP in practice after they start using it?
How the users feel after using Cloud environment and are there any concerns regarding it?
What are the risks associated with Cloud ERP based on their experience and do they come across any security issues?
Is there any other area that has security issues which might require the utilization of convention ERP system, Cloud Computing and cloud ERP?

Enterprise Resource Planning Issues

Enterprise Resource Planning is a tool which is used for connecting functional departments on different modules by integrating business activities for enhancing the resource planning, management, and operational control functions of the organizations (Zhang 2005). A wide variety of major business activities (fig. 1) like finance, accounting, human resources, supply chain and customer information etc are focussed by a single ERP module. ERP system in the combination of hardware, software systems and services that communicate on a local area network (Motiwalla & Thompson 2011). An organization with the utilization of this design can safeguard the data integrity in a single shared database while adding or reconfigure modules (from different providers) and the database can be centralized or distributed (Holsbeck & Johnson 2004).

Cloud ERP Issues

Governance: It permits the customers to apply their configuration on the modules or services. The level of governance given to the customers should be kept in concern since the more privileges might create greater risks.

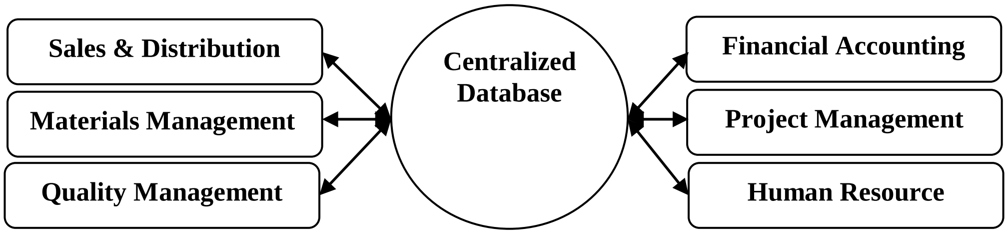

Fig No: 1 Modules of Enterprise Resource

Integration: The risk might increase while integrating based on the complexity and the size of the previous ERP solution. The capability and service of the provider can also affect the process of integrating old system to cloud ERP. The customer's expectations or requirements might not be satisfied by the system provider on the area of customization of the services given.

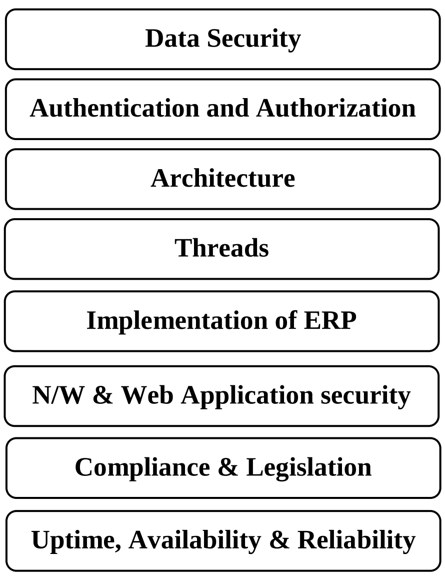

Fig No: 2 Cloud Data 's semi structural sessions

Provider Lock-in: Even if a customer needs to migrate to another cloud, the customer may not be able to do it as simple thinking of the risk that might arise because of the current cloud provider. Hence the risk and benefits of using the services should be kept in consideration before taking any migrating related decision.

Security and privacy: It will not be an easy task to transfer an important system into a shared environment for the customers without having trust of the providers. The providers should focus on security services (fig. 2) which enhance the relationship and trust of their customers. An intensive set up and management is required while using complex application like ERP. Cloud Computing is just a delivery mechanism and hence it does not changes any services of the ERP but the solution alone gets altered.

Security Issues: Cloud computing and ERP has their own functionality based on their characteristics. The issues of Cloud ERP can be clarified based on the security issues and available resources. For creating a set of guidelines for the cloud users, the security of conventional ERP and Cloud Computing is taken in consideration. Before migrating to cloud, the ERP users should evaluate each aspect of their ERP system because these systems have their own security and privacy issues. This might arise a question whether cloud ERP solves the prevailing issues or it creates some new issues?

Cloud Computing Issues & Authentication: Cloud Computing consist of four different deployment models like private, community, public and hybrid cloud which is briefed in the Table 1 Cloud Computing deployment models (ISACA, 2009). Based on the delivery mechanism of each model, they possess different characteristics. The company has four different options and they can select the model which goes along with their risk profiles and optimum security requirements. The four different deployment models, their characteristics and the possible issues are summarized and listed below.

Table No: 1 Cloud Computing Deployment Models

Deployment Model	Description of Cloud Infrastructure	To be Considered
Private Cloud	Operated solely for an organization. May be managed by the organization or a third party. May exist on premise of off-premise.	Cloud Services with minimum risk. May not provide the scalability and agility of public cloud services.
Community cloud	Shared by several organizations. Supports a specific community that has shared mission or interest. May be managed by the organizations or a third party. May reside on-premise or off premise.	Same as private cloud, plus. Data may be stored with the data of competitors.
Public cloud	Made available to the general public or a large industry group. Owned by an organization setting cloud services.	Same as community cloud, plus. Data may be stored in unknown locations and may not be easily retrievable.
Hybrid cloud	Compositions of two or more clouds (private, community or public) that remain unique entitles but are bound together by standardized or proprietary technology that enables data and application portability.	Aggregate risk of merging different deployment models. Classification and labelling of data will be beneficial to the security manager to ensure that data are assigned to the correct cloud type.

Architectural Issues

Each system consists of an architecture which gets reflected in their functions and components. System architecture defines the behavioural properties of a system which helps in finding the behaviour of the system and managing the construction of the system and maintaining it (Leavens & Sitaraman, 2000). Several security benefits like centralization of security, data and process segmentation, redundancy and high availability are provided by the cloud environment architectural design and its characteristics (Zissis & Lekkas, 2012).

Cloud ERP evolved to replace the complex conventional ERP systems. Cloud ERP consists of same service as of conventional ERP, yet it comes with a flexible architecture. The requested ERP module can be modified in a short period of time yet customizing the ERP might differ based the cloud ERP provider. The Cloud ERP services are maintained by the provider and the customer can worry less about it and the cloud data canters are placed in the premises of the cloud provider for offering security and high availability for the Information Technology infrastructures. Physical data security is also enhanced as the cloud providers are specialized on the physical security. These data centres are designed in such a way that they can withstand and establish high-level security during natural disasters. DCDS algorithm (fig. 3) monitoring Security issues, Threads handling, Network busy, Dynamic Cluster generation, Dynamic Network path and Data shrinking for fast data transaction.

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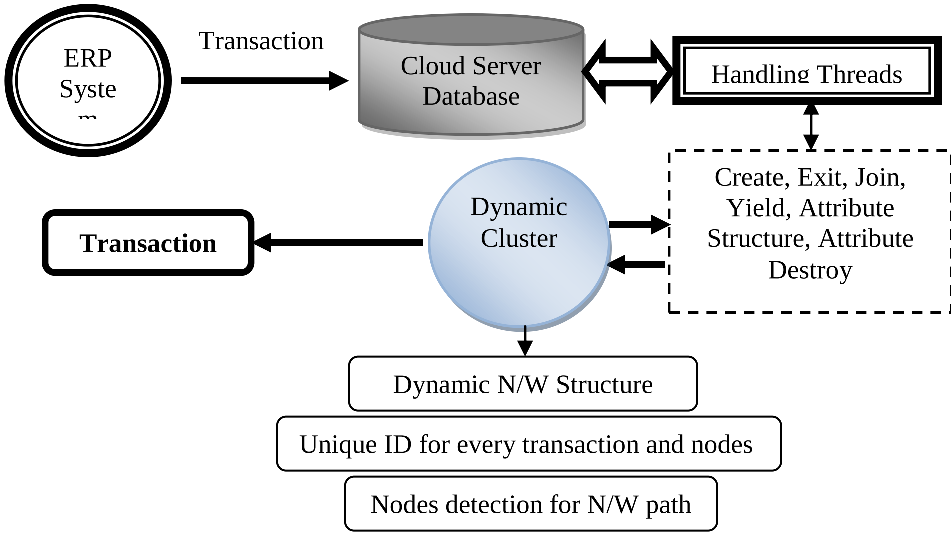

Fig No: 3 Proposed DCDS algorithm architecture

Threats

A threat appears to be a possible violation of the security and violation is not always considered as threat (Bishop, 2004). Author says if there is unavailability in the system it must be considered as no system at all. Threats are very common problems for the conventional ERP and cloud computing. The cloud service is provided by the service provider which can be accessible by the customer who uses ERP service. Only authorized tenants can access the service of user application interface though it is available on the internet. (Prasanth, 2020) The responsibility of protecting the application, network, operating systems and the physical-level security are in the hands of the cloud provider, yet Cloud ERP user also possess some minimum level of responsibilities for the network level security. Which in turn helps them to get connected to the cloud ERP service and for processing data through the internet? By the utilization of SSL, Virtual Local Area Networks, firewalls, packet filters etc, internet browser security can be taken care which is important in this case. For the user to access the services, control over the user access is important which is done through password check by the cloud vendor's identity control and management service. This process can be improved by the usage of biometrics, one-time password, smart cards etc. which are multi-factor authentication methods.

Data Shrinking Preparation

The data shrinking and cluster detection process are performed simultaneously with different sizes of cell. The generation of multi-dimensional data has taken place in high speed in this advance modern technology in many disciplines. In utilizing and exploration of real data, Data pre-processing procedure plays the very efficient role.

1. Data shrinking preparation
2. Multi-dimensional data analysis (Data shrinking, Cluster detection, Cluster evaluation, Selection)

Existing clustering algorithms can be broadly classified into four types,

Partitioning algorithms (PA) – K-means	PA starts with an initial partition and then use an iterative control strategy to optimize the quality of the clustering results by moving objects from one group to another.
Hierarchical algorithms (HA)	HA create a hierarchical decomposition of the given data set of data objects.
Grid based algorithms (GA)	GA quantizes the space into a finite number of grids and performs all operations on this quantized space.
Density-based (DA)	DA approaches are designed to discover clusters of arbitrary shapes

These approaches hold that, for each point within a cluster, the neighbourhood of a given radius must exceed a defined

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threshold.

Termination of shrinking: Normally a boundary covers the manifold of a data set and it is further pushed inward during the process of shrinking until the reduction of the manifold reaches the skeleton stage. And it is further skeletonised if the skeleton is also a manifold. This process is continued until the manifold reaches a point where there is no boundary as shown in figure 4. Although well-defined shapes in high-dimensional spaces may not be seen in the data sets of real-world application. Individual clusters are produced in general during the shrinking process which are condensed and separated widely enabling the clusters to get separated.

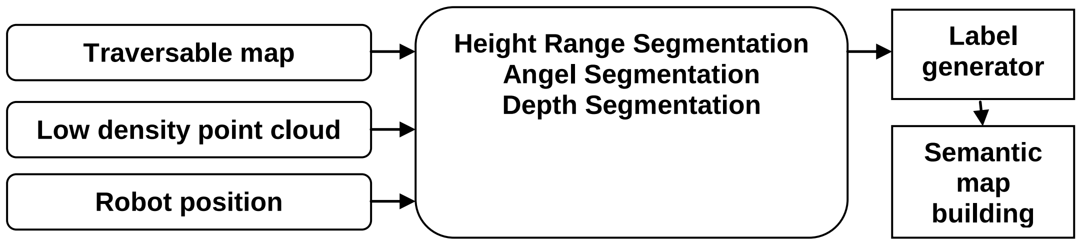

Fig No: 4 Repeated skeletonization

For determining the stability of the data set, the average movement of all points in every iteration is checked. Suppose that in the i^{th} iteration, the movements for the n points are $\vec{v}_1, \vec{v}_2, \ldots \vec{v}_n$, respectively. Then the average movement is $\frac{\sum_j^n \|\vec{v}_j\|}{n}$. If the average movements for two consecutive iterations are both less than$T_{amv} * \frac{1}{k}$, where T_{amv} is a threshold, then the data set is considered stabilized and the shrinking process is terminated.

Time and space analysis: The locations of all points must be tracked throughout the process of shrinking which together occupies $O(n)$space. Data points are assigned to grid cells and every grid cell provides the space to its points as a container along with centroid and movement. The data structure represented by the dense cells occupies $O(n)$ space; therefore, the total space needed is $O(n)$. the time required for each iteration is $O(m^2 + n \log n)$, where m is the number of dense cells. Since the maximum number of iterations is T_{it}, the total running time is $O(T_{it}(M^2 + n \log n))$, where M is the maximum number of dense cells in all iterations.The value M, representing the maximum number of dense cells, has a significant impact on running time. M can be controlled through the selection of a density thresholdT_{dn-1}. The number of data points in a dense cell must be no less than the product of $T_{dn\,1}$ and the volume of the cell or $T_{dn\,1} * \left(\frac{1}{k}\right)^d$. Thus the number of dense cells must not exceed$\frac{n}{T_{dn\,1} * \left(\frac{1}{k}\right)^d}$. Given a desired value -$\widetilde{M}$, we can choose a value $T_{dn\,1}$such that$\frac{n}{T_{dn\,1} * \left(\frac{1}{k}\right)^d} \le M$, thus ensuring that the number of dense cells will not exceed$\widetilde{M}$. If the densities of most cells happen to fall below a threshold $T_{dn\,1}$chosen via method, the data shrinking process will be unproductive. Alternatively all non-empty cells can be sorted by the number of data points they contain. The density threshold $T_{dn\,1}$is then chosen so that the first M cells are dense cells. Cases may occur where, for a given grid-cell side length $1/k$ most non-empty cells will be very sparse, containing only one or two points each. In such instances, the side length $1/k$ is too small and a larger scale grid should be used.

Space subdivision: Given the side length $1/k$ of grid cells, the hypercube $[0,1]^d$ is subdivided into k^d cells:

$$\{C(i_1, i_2, \ldots, i_d) = \left[\frac{i_1}{k}, \frac{i_1+1}{k}\right) * \left[\frac{i_2}{k}, \frac{i_2+1}{k}\right) * \ldots * [\frac{i_d}{k}, \frac{i_d+1}{k}) | i_1, i_2, \ldots, i_d \in \{0,1,\ldots,k-1\}\}$$

Each cell $C(i_1, i_2, \ldots, i_d)$ has a unique ID: $(i_1, i_2, \ldots, i_d)$.Two distinct cells $(C\, i_1, i_2, \ldots, i_d)$ and $(j_1, j_2, \ldots, j_d)$ are neighboring cells if $|i_k - j_k| \le 1$ for all $k = 1,2, \ldots,$ or d. the neighboring cells of a cell C are also called the surrounding cells of C.

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Denote the set of dense cells as,

$$\mathrm{DenseCellSet} = \{C_1, C_2, \ldots, C_M\}$$

$$\mathrm{DataCentroid}\ (C) = \frac{\sum_j^k \vec{X}_{i_j}}{k}$$

$$\{\vec{X}_1^i, \vec{X}_2^i, \ldots, \vec{X}_n^i\}$$

$$\mathrm{DenseCellSet}^i = \{C_1^i, C_2^i, \ldots, C_m^i\}$$

$$\phi_1, \phi_2, \ldots \phi_m$$

$$\frac{\sum_{k=1}^{\omega} n_{jk} * \vec{\phi}_{j_k}}{\sum_{k=1}^{\omega} n_{jk}}$$

which is denoted as $\vec{\phi}_j^s$

$$\mathrm{Movement}\left(C_j^i\right) = \begin{cases} \vec{\phi}_j^s - \vec{\phi}_j \text{ if } \left\|\vec{\phi}_j^s - \vec{\phi}_j\right\| \geq T_{mv} * \frac{1}{k} \text{ and } \sum_{k=1}^{\omega} n_{j_k} > n_j; \\ 0 \text{ otherwise,} \end{cases}$$

$\vec{\phi}_j^s - \vec{\phi}_j$	The distance between the two centroids
T_{mv}	A threshold to ensure that the movement is not too small
$\frac{1}{k}$	The side length of grid cells
C_j^i	It is data centroid is moved to the data centroid of the surrounding dense cells

Data Shrinking, Cluster Detection, Cluster Evaluation and Selection algorithms are the basics in our clustering version. For achieving much easier and more efficient cluster detection, the testing data sets are shrunken initially thus natural clusters become more condensed. The detection of clusters is done in different scales. For comparing clusters at those scales, cluster wise evaluation measurement is done, and the final result is achieved[11].

Transition state of clusters (C) in dynamic cluster selection

We assume that nodes are initially in the state of sleep which guarantees minimal energy consumption. It is also assumed that the nodes have knowledge of their geographical positions and the first target detection is done. Estimate the distance $d(N_i, N_j)$ from the received signal.

$$r_i = \begin{cases} \frac{\beta}{d^{\alpha}(N_i, N_j)} if\ d(N_i, N_j) \leq r_s else \\ 0 \end{cases}$$

R_t	Nodecommunicationrange
r_s	Node detection radius
$R(n_i, r_s)$	Detection region of node N_i with the detection range r_s
G	Wireless sensor network
E	Set of linkeds between nodes
V	Set of all nodes
C_i	Cluster head node

All the cluster heads (CH) should be alive and with interconnected. This structure forming based on dynamic structure (fig. 5) but with K-means algorithm and PSO (Prasanth, 2019) approach to reach nearest clusters from public/private networks. If any clusters in sleeping stage or deadline, the nearest cluster have to take in charge as a alternative one (CH-ready, CH, CH-for, and member). Initially or when there is no target activity in the network, all nodes are in the state of “sleep.” When node is in “sleep” state, it receives Msg-data packet from another node j belonging to the active cluster; node i goes to the CH-For state if dij < r_s or CH-ready state otherwise. Dij is the distance between the two nodes and r_s is the detection range. Only the nodes with the CH-ready state can become CH after their detections of the target; contrariwise, the nodes j with the CH-For state can only become members.

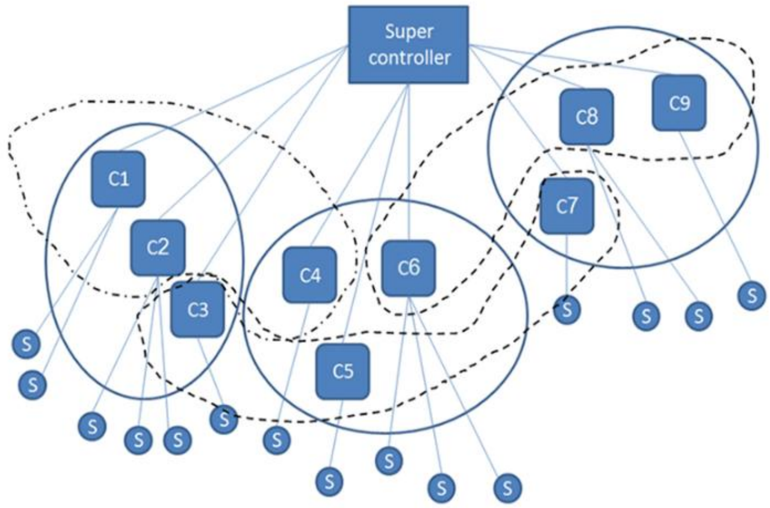

Fig No: 5 Network (super controller) Structure of Dynamic Cloud

A node i in CH-ready state and receiving MSG-data to another node j , which is belonging to the active cluster with dij < r_s , must pass to the CH-for state and remains there until becoming a member of a cluster or return to the sleep state, if the sleep counter timer expires. A node i in CH-ready state and detecting the target triggers T timer. If node receives a MSG-inv, another CH before the expiry of the T timer, node i switch to the member state. A node i in CH-ready state or CH-for, receiving MSG-inv invitation message, switch automatically to the state member. A member which is not receiving MSG-data messages after a system time sends a cluster destruction message to his CH and returns to the sleep state. A CH, receiving cluster destruction messages, removes those members of the member vector until having no members; it returns itself ultimately to the sleep state. K-means algorithm is too flexible compare with PSO algorithm because of dynamic consistency structure.

CONCLUSION

DCDS algorithm has built dynamic clusters on demand and included a phase to activate the sensors based on overhearing messages of the nodes in the active cluster. Load balancing is not depending only on network path that should balance at all the streams. Dynamic clustering is similar to hieratical (not require to prespecify the number of clusters) clustering based approach, that schedule the transaction path based on busy and failures states and then alert system will derive by network control system. Data shrinkage, threads finding, architecture flows are played a major role in overall performance.

CONFLICTS OF INTEREST:

The author have declared no conflicts of interest

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