A Multi-Tenancy Database Approach to Effective Emergency Preparedness and Mitigation

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ABSTRACT

Emergency managements' sole idea is to reduce occurrences, reduce the intensity of occurrences or to safeguard lives and properties during emergency situations. **Preparedness, Mitigation, Response and Recovery phases** are four phases of emergency management. While **Mitigation** phase is concerned with actions taken to reduce the chances of an accident occurring through risk assessment or early attempts to make the consequences of an accident as small as possible, preparedness phase deals with every method applied to get ready for future imaginable incidents. They include developing systems, managing resources, developing scenarios and plans and engaging in realistic training. Emergency management agencies are in constant search of ways to enhance preparedness and mitigation phases to reduce the chances of accidents occurring. In this research, we present an architecture based on multi-tenancy which consolidates multiple databases from multiple emergency management agencies to improve access to emergency information, strategic planning and risk assessment thereby enabling easy development of emergency management systems (EMS), reducing cost of such development and also its operations.

KEYWORDS: Emergency, Preparedness, Mitigation, ICT, Emergency Management System, Multi-tenancy Database, Container Databases and Pluggable Databases

1. INTRODUCTION

Emergency situations can arise from natural disaster or unconsidered risks. Even when all risk prone situations have been considered and appropriate management programs put in place, accidents and emergency situations can happen arising from a natural or man-made source. Emergency preparedness are activities performed before emergency situations occur. These activities *establishes a state of readiness to which emergency managers can respond to extreme events that could affect a community.* It encompasses all efforts made by an organization to minimize the adverse impact of disaster by providing active responses to protect the health and safety of individuals and the integrity and functioning of physical structures. Adequate preparedness is achieved by establishing the basic plan, annexes, and appendixes of the jurisdiction, training of members of the emergency response teams to perform their duties, purchasing of equipments, and testing the plan's effectiveness with psudo emergency exercises. It also entails development of comparable organizational structures, plans, and preparedness for disaster recovery phase.

Emergency planning is more likely to be successful when it is viewed (explicitly or implicitly) as a collection of components that work together (Lindell & Perry, 1992). It involves understanding of the resources available to tackle emergency situations, the goals of the emergency response, and the need for effective interaction between different units in the system. Primarily the goal of an emergency response is to provide protection to health, public and private properties, environment, ensure the safety of the public and the responders and minimize the disruption of activities in the community. The *resources* available to tackle emergency are trained personnel, equipment and materials and other emergency facilities. Households, most governmental agencies and private organizations are units that can take actions in an emergency situation. It is a common

expression that “every emergency is unique” but improvising during an emergency does not sound reasonable. It is important to note that more time will be gained implementing preplanned actions than improvising and implementing response actions. Time in an emergency situation is of great importance. Moreso, improvision and poor planning can impede or duplicate the plans of other organizations (Perry, et al., 1981) Consequently, there is a need to develop a community emergency preparedness to limit *unnecessary* improvisation and collision, though improvisation cannot be eliminated altogether.

Emergency managers need to practice some functions everyday. They do not depend on depend on events to prove their value. For mitigation to be effective, it requires bringing several stakeholders together and developing partnerships disparate parties to solve common problems. It involves bringing private sector into emergency management system to ensure economic sustainability of their businesses and reduction in risk. Mitigation therefore promotes the support and leadership of private organisations providing the entry point to involve them in other phases of emergency management and to understand their unique needs in response and recovery.

To ensure coordination and timely intervention of emergency managers, there is a need to build applications that will enable stakeholders access and manipulate upto date information to enhance planning for future occurace and to predict trends in disaster. The multi-tenancy approach ensures that multiple databases share data while maintaining indepence and provide applications with richer data source.

Motivation

Improvising and poor planning can impede or duplicate the plans of other organizations (Perry, et al., 1981) Consequently, there is a need to develop a community emergency preparedness to limit *unnecessary* improvisation and collision, though improvisation cannot be eliminated altogether.

Conceptual Framework

This paper provides a framework based on multi-tenancy system for emergency management to enhance preparednes and mitigation. It provides a consolidated data store for efficient access of emergency situations, equipment, staffs and training, responses and their effect. This will enhance effecetive planning of the emergency managers

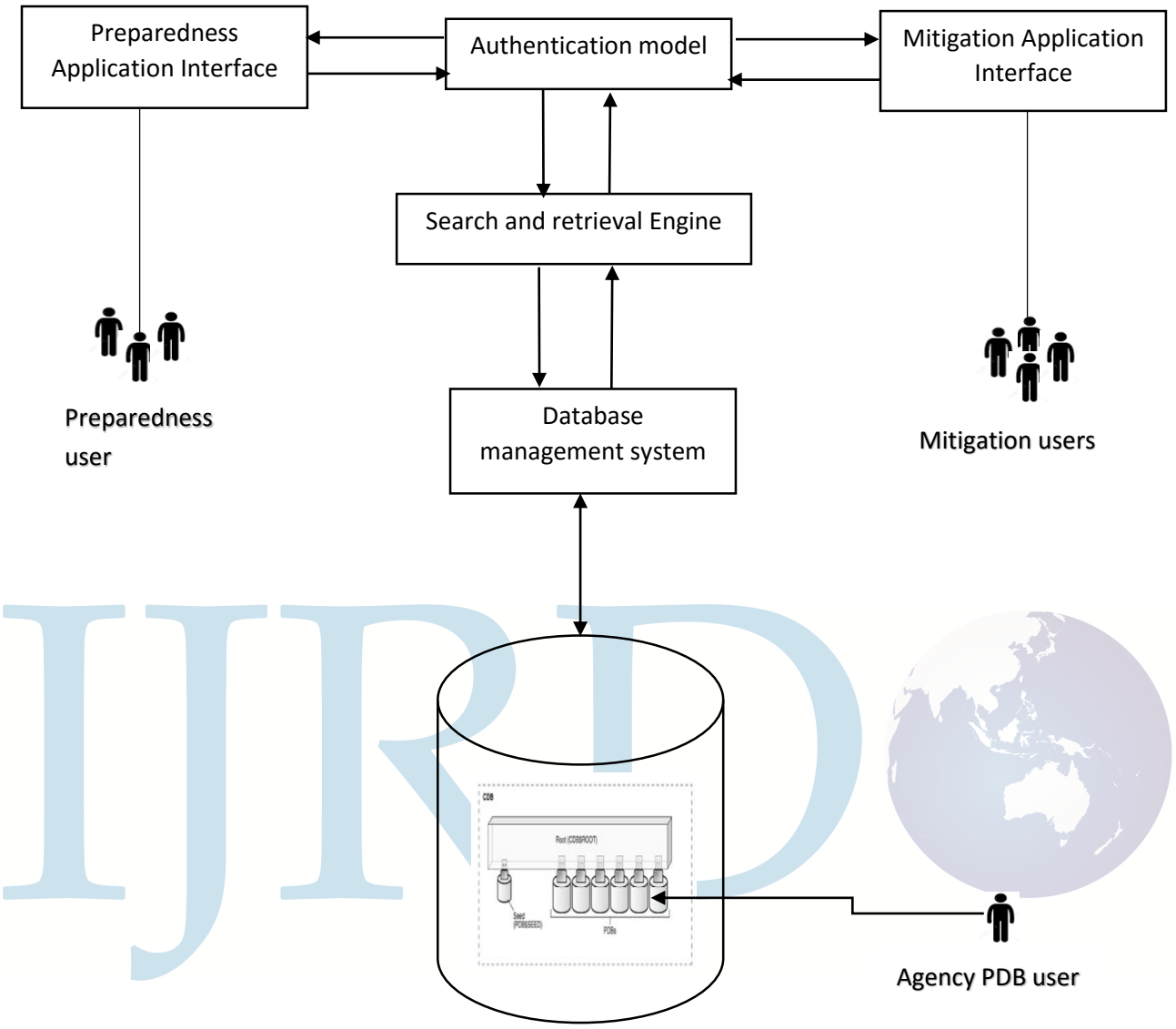

Figure 1: Multi-Tenant framework to enhance emergency preparedness and mitigation

Figure 1 shows the proposed multi-tenant framework. The framework have the following components: two user interfaces to serve the purposes of mitigation and preparedness, a distributed search engine and retrieval engine, the system data repositories and an authentication component. The authentication component identifies users and verifies them. Each request is done by providing set of parameters to show that the user is who they claim to be.

Search and Retrieval Engine

The search engine gets the Meta data from a repository regarding the users' data. It provides data about the searched data of the user. This is used to access data from the database. The retrieval engine gives access to data that is in the multitenant database.

The database management system

The database management system is made up of Query Optimizer/gateway which support a distributed access to data and converts a given query into a supported format, Resource Manager enforces contention strategy for system resources among the PDBs running on the same computer, Load Balancer distributes workloads across multiple computing resources, such as computers, a computer cluster, and central processing units.

Container Database

The container database has all the databases of agencies involved in emergency management and two extra databases. The extra databases are the root and the seed databases while the agencies databases are all pluggable. The root is a collection of schemas, schema objects and non-schema objects to which all pluggable databases belong. Every container database has only one root which is required to manage all pluggable databases. Pluggable database is a user created set of schemas and objects that appears as a non-CDB. Each pluggable database has its own dedicated applications. The Seed is a template for creating new PDBs. So when queried, the system searches the entire PDBs to locate the required information. This system saves time and eases procurement process.

Related works

Chen et al., (2011) divided the stages in emergency management into preparedness, mitigation, response and recovery stages. These stages are also called phases.

Preparation encompasses all actions taken to be ready for any supposable incidents that can happen in the future. It extends to plans on how new systems can be developed to enhance speedy management of emergencies, resource managements, scenario development, planning and training of emergency management staffs.

Mitigation stage takes care of all actions that reduces the level and the possibility that an accident can happen. It is don through a series of risk assessment.

The **Response stage** takes care of every activity of emergency personnel to save lives and properties and also reduce the damage done to structures. Detection, Preparation, Response Travel and Clearance are four phases of response (Salasznyk and Lee, 2006).

Recovery phase: At the end of the response stage, there is a need to reestablish normalcy among people, activities, infrastructure and properties (Borges et al., 2011).

Zulueta, et. al, (1999) observed that disaster preparedness is a component of a social system of management considers the organization as a social organism which is subject to pressures and conflicts coming from the social environment. They stated that cooperation, adaptation, segregation and differentiation are the basic tenets of adequate preparedness. Cooperation is the primary thrust in an organization were people work to achieve a common goal.

Martires, (2011), acknowledges the need to adopt an approach that is holistic, integrated, comprehensive and proactive in reducing the social, economic and environmental impacts of disasters. He also stated that there is a need to promote the involvement and participation of all stakeholders involved in disaster management, at all levels, especially the local community."

Disaster preparedness, aside from being a multilevel system (global, regional, national, community, individual), is also multi-relational (physical, social, economic, environmental) having many subsystems that are interdependent on each other.

The communication system of disaster preparedness is likened to the human circulatory system with regards to the role it plays in contingency planning. Within the communication structure, the researchers find such activities as coordinating and facilitating all the available resources to its priority users in a timely and appropriate manner. Also, the system unifies the chain of command necessary to the entire disaster management cycle of prevention, mitigation and adaptation; alertness and preparedness; response; and recovery.

To call those in the danger areas for action by explaining precautionary measures that should be taken by the families, and to be alert, prepared, and stand by for possible worse events.

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Roles of ICT in Emergency Preparedness and Mitigation

ICT has a great impact in our everyday life and can be applied disaster management. The most prevalent role of ICT is to enhance the effectiveness of raising public awareness through providing real-time data, and enhance coordination and communication, which often lead to quicker reactions and actions to on coming disasters (Dorasamy et.al.2011).

There has been information platforms developed for disaster management. Churilov et al., (2006), proposed a model for cyber infrastructure made up of the following components: Knowledge management systems, Communicational infrastructure, database systems and digital libraries, Organizational structure and agencies involved, Services and expertise, Software, collaborative tools, equipment, advanced applications, algorithms and models and Computational, physical, technological and human resources. The model explains information sources, organizations, resources, infrastructure and tools that become available due to its existence. The model sought to enhance cooperation among disaster managers.

Multi-Tenant Database Achitecture

A Multi-Tenant Database (MTD) is a way of having a single database shared by different users. It is accessing Data storage features as a Service (DaaS). A single instance of a Database Management System (DBMS) is to run on a server, providing storage for multiple clients (tenants) as shown in figure 2. The tenants are to subscribe for the use of the database and access it across the Internet through web technology (Schiller et. al., 2011) The tenants can out source this service for some reasons that are obvious to them.

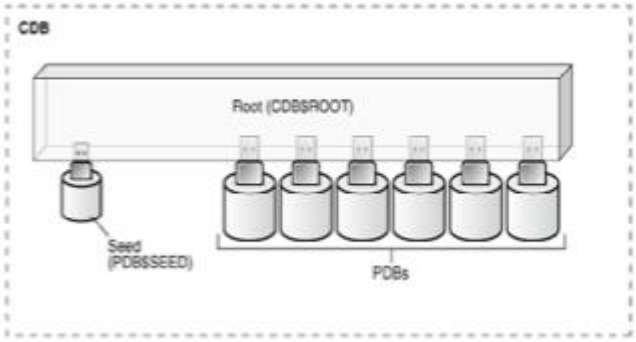

Figure 2: Multitenant Database Architecture (Oracle Corporation, 2013).

Container Databases (CDBs) and Pluggable Databases (PDBs) enables multiple databases to be united and is neccessary to provide a union among databases of organizations (Morle, 2013). A CDB can contain one or more PDB, and a PDB is the actual database from the viewpoint of an application. PDBs are plugged into and unplugged from CDBs by executing simple commands. They are cloneable and can be moved to other CDBs. All the PDBs that are plugged into a CDB share a single instance and can be resource-managed by a single set of controls within the CDB.

Approaches To Managing Multi-Tenant Databases

The typical character of Software as a Service applications is 'single-instance multi-tenancy', according to this feature, three main approaches have been proposed: Separate database, Shared Database with Separate Schemas and Shared Database with Shared Schemas (Jacob and Aulbach, 2007). Of the three approaches, the shared schema approach has the lowest hardware and backup costs because it allows you to serve the largest number of tenants per database server. However, because multiple tenants share the same database tables, this approach may incur additional development effort in the area of security, to ensure that tenants can never access other tenants' data, even in the event of unexpected bugs or attacks. The shared-schema approach is appropriate when it is important that the application be capable of serving a large number of tenants with a

small number of servers, and prospective customers are willing to surrender data isolation in exchange for the lower costs that this approach makes possible.

Factors Influencing The Choice Of Multi-Tenant Database Approaches

There are several factors to be considered while chosing a multi-tenant system. The use of the system should be one of the influencing factors towards the decision. Elmore et. al., (2011) emphasize that the tenant application and usage requirements should be the primary consideration in deciding the right model of multi-tenant database. Sometimes users (tenants) are not equipped with necessary information about this before taking decision on what approach to adopt. Their decision is sometimes influenced by what vendors tell them. There is need to examine all these basic factors before approaching a service provider in order to make the right decision on this. Some are Number of tenants, Size of tenant database, Number of users per tenant, Growth rate of tenant database, Growth rate of tenants, Security, Flexibility – ability to create multiple tables by tenants and Cost (Keemti, 2011). All these are major consideration that to are be made for effective decision about the adoption of a multi-tenant database model depending on the tenant individual system requirements.

Conclusion:

Mitigation and preparedness are two major concerted phases of emergency management. They are so vital to the extent that when value for their processes, emergency or incidence occurrences would be drastically reduced. This system advocates the establishment and use of well-designed database for easy accessibilities in handling emergency situations.

Recommendation:

It is recommendation that this system should be giving a face-off trail to see its workability, adoption and deployment. Thus, managers of emergency situations are implored to explore the opportunity inherent in this multi-tenancy database approach to effective emergency Preparedness and Mitigation in reducing the-would be emergency consequences.

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