Cloud Collaborative Framework for Adversity Management

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***Abstract*— ICT and the advancement of technology like cloud computing has remarkably changed the computing approach. The infrastructure and support systems required for planning and execution of Disaster Management tools are becoming more complex with higher costs of implementation. 3G and now 4G has also made revolutionary changes to enhance the internet speed contributing in efficacy of Cloud. Cloud could contribute to the Adversity Management in a new way keeping the continuity of operation. As the comprehensive Disaster Management plan involves heterogeneous group of agencies so cloud could be best utilized for sharing infrastructure and information among various agencies. This paper demonstrates the frame work for Disaster Management using Cloud.**

***Index Terms*— Cloud, Disaster Management, Resource, Recovery, Collaboration, Scheduling, GIS.**

I. Introduction

Cloud computing provide [3] Internet-based access to a shared pool of computing Resources, including networks, storage and applications describing both a platform and type of application. A cloud computing platform dynamically provisions, configures, reconfigures, and de-provisions servers as needed. Servers in the cloud can be physical machines or virtual machines. Advanced clouds typically include other computing Resources such as storage area networks (SANs), network equipment, firewall and other security devices. Cloud computing also describes applications that are extended to be accessible through the Internet. These cloud applications use large data centers and powerful servers that host Web applications and Web services.

The infrastructure of computing, network and storage form the foundation of cloud. It is a service, and its components must be readily accessible and available to the immediate needs of the application stacks it supports. Cloud computing removes the traditional application silos within the data center and introduces a new level of flexibility and scalability to the IT organization.

II. Cloud Services

Briefly the Cloud computing environment consists of servers, applications, online data and backup. In the development of Cloud computing following categories have been identified [9] and defined as shown in Fig. 1.

(a) Infrastructure as Service (IaaS):

This service provides virtual machines and other abstracted hardware and operating systems which may be controlled through a service Application Programming Interface (API).

(b) Platform as a Service (PaaS):

This service allows developing new applications using APIs, which is implemented and operated remotely.

(c) Software as a Service (SaaS):

This is software services offered by a third party provider, available on demand, usually through a Web browser, operating in a remote manner.

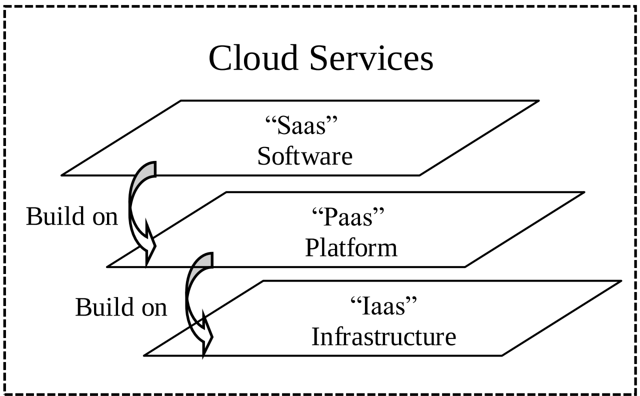

Fig. 1: Cloud Services

III. Disaster Management Scenario

The design of the present work considered the aspect of Disasters at multiple locations and there mitigation by deploying appropriate teams from multiple Resource locations. This aspect of the design is also helpful in handling large Disaster scenario (Disasters at multiple locations) by modularizing (creation small silos) the Disaster scenario. This functionality can also be appropriately introduced in the system.

It is seen that there are various agencies involved for the management of a Disaster, which may include hospitals, police, social system, fire system, administration and need to use technologies like GIS, GPS and mobile devices. Therefore, in the present era when cloud computing is making its impact, a proper mapping of such system can be done on the cloud architecture. Some of the directions of this mapping are discussed in the following section.

IV. ICT & Disaster Management Phases

As Disaster Management systems are information intensive, ICT based Disaster Management systems are vital for Disaster detection, response planning, and management [6]. These systems aid in early warning, and provide decision support for Disaster response and recovery management. Managing past knowledge for reuse can expedite the process of Disaster response and recovery management. There have been also some efforts to utilize geographic information systems (GIS) for Disaster Management [11].

In order to develop a comprehensive system and framework the phases of disaster management can be categorized as follows:

Phase 1: Location & Affected Area Mapping

Location identification and geo-ICT (Zlatanova, 2009) plays a major role in all the phases of disaster management. The first questions after reporting a disaster is about the location of the incident and its possible extensions. A variety of systems use maps, models, tracking of rescue personnel, images obtained from various scanners and imagery from various sensors to monitor a disaster, to make forecast, to estimate damages, to predict risks and vulnerability, etc. (Zlatanova, 2008).

Also, it is difficult to consider only one type of hazard. Very often one hazard is triggered by another. Therefore, often it is the chaining of disasters triggered by a primary hazard and developing to secondary hazards that must be considered as likely (Zhao, 2008).

Phase 2: Risk & Damage Assessment

Risk visualization for risk management combines risk analysis and risk evaluation (Higashida, 2010). Generally a risk map shows the distribution of risk levels, or of objects representing risk levels, across an area of concern. Such levels are to assist a decision maker in taking action towards risk avoidance or mitigation, and eventually also in disaster response. For instance, a map of flood risk should show the inundation levels expected as a result of likely events such as exceptionally heavy rainfalls or hurricanes. Now to develop this methodology, the disasters have to be parameterized by their causal effects. The contexts and the aspects are identified as parameters to assess the disaster. Depending on these factors the various types of disasters can be defined.

Phase 3: Resource Requirement Generation

The purpose of the resource understanding phase is to become well acquainted with all the resources require to recover from a particular emergency to map these resources on a particular time frame of recovery. This is a very critical allocation taking into consideration and defining the interdependency of various resources, their concurrency as well as correlation for a particular task (Sodhani, 2013). These may even be required to change at the fly.

It is obvious that every disaster is having a unique set of equations for resources allocation. Now to address disasters in a fast and highly efficient manner, the optimal provision of information concerning the situation forms an essential pre-requisite. This highlights the need for Inter-Resource Orchestrization (Annoni, 2005) using collaboration, coordination and cooperation.

Phase 4: Resource Mobilization and Scheduling

The optimal resource allocation and scheduling during recovery is associated with the mobilization/execution of required resources of personnel/material within the affected area of relief operation (Sodhani, 2013). This is comprised of various facilities, equipment, methods, utilities to deploy, distribute, install and control between heterogeneous inflows and distribution to the victim and damaged location in the disaster area. An ICT driven system (Vogt, 2010) that can coordinate and collaborate multi-resource mobilization to immediately improve the drastic conditions at all the levels has been identified as an utmost priority and need for the Society.

Phase 5: Recovery Assessment & Restoration

Again the GIS maps are utilized to estimate and assess the recovery done so far comparing the previous risk maps generated. Various image processing and pattern recognition techniques are available to analyze the given image. This will further generate the needful data and instruction for the risk and damage assessment and to understand the current resource requirements. As the disaster is not necessarily a short duration phenomenon and it may last for long duration, that is why a continuous online feedback support system is required to fine tune the adversity management without this a system may tend toward a deadlock and may fail.

V. Mapping Of DM Phases On PAI Model

The objective of this paper is to map all these phases on the cloud framework. The framework proposed for the DM in our earlier work incorporates all these phases in a PAI model in terms of Planning, Adaptation and Implementation. The scope of DM starts with the 'Planning' of various infrastructure requirements, services, information base and Resources, required for preventing, mitigating and managing the Disaster. This would involve various Actors and activities with multiple assignments and team building. It is obvious that Disasters are of diverse nature, and it is very difficult to know its details in totality (in advance); its size, type, area, Vulnerability, constraints and effects.

Therefore, a preliminary DM plan needs to be initiated to avoid delays and the team so involved could assess the situation and help deploy a comprehensive plan. Then there would be a need to further refining the DM plan and this work refers it as an 'Adaptation' stage. At this stage, there is a need to customize the initial plan according to the Disaster information perceived from the deployed team.

This customization has to take place 'on the fly' with minimum delays for success of Disaster Management activities. Having done this an improved implementation needs to be put in place. Table 1 summarizes various activities / components of this PAI model. It may be noted that this is only possible by making communication as an integral part of the total PAI activities. As such the communication technology is coming handy in realizing such systems of management, however, extensive and iterative use by a large number of Actors may lead to other complications - like communication congestion resulting into a chaos.

Table 1: Mapping Tasks in PAI Architecture

PLANNING	ADAPTATION	IMPLEMENTATION
Past Experience & Database	Immediate Disaster Information	Resource Deployment
Geographical Maps	GIS/GPS	Resource Final Allocation
Vulnerability Maps	Disaster Categorization	Coordination
Resource Organization Structure	Disaster Location Priority	Collaboration
Knowledge-Base	Annunciations	Cooperation
ICT Framework	Resource Requirements	Disaster Mitigation Progress
Communication Protocols	Resource Mobilization	Lesson Learnt & Feedback
Sensor Networks	Re-confirmation Disaster Information	Mitigation Measures

VI. Cloud Framework For Incorporating PAI Model

The mapping of this framework on cloud would require various servers, large memory systems, processing machines not only for Control Center but as well as for the Nodal Centers. All these system could be a part of the lowest layer i.e. "Infrastructure at a Service" of the cloud architecture. This would also include infrastructure like satellite for getting continuous geographical positioning of Resources as well as sensor networks which may issue alerts in advance to the control center.

Similarly this research work needs to involve various dedicated compatible platforms for the development of GIS-Based System, Expert Systems and Annunciation Systems. These can be mapped on the middle layer of the cloud architecture i.e. "Platform as a Service". This layer would also include various developer tools, Libraries for Spatial Indexing and Data services particularly for knowledge management based on historical data and experience.

And lastly we know that immediate Disaster information plays a critical role in implementing effective DM plan and requires various mobile application software and messaging services. The team involved in the DM activity needs to be equipped with handheld mobile units for getting directions and Resource Sequencing plan. Effective DM also involves tracking the physical location and movement of the agencies responsible for mitigation. As it is not possible all the time to get the precise disaster details through disaster indicators, this indicates the need to modify the plan on-the-fly and continuously monitoring the status of the job execution. All these software related need could be a part of the "Software as a Service" layer of the cloud architecture.

Fig. 2 shows the overall framework structure of cloud based Adversity Management system which will incorporate all the five mentioned modules.

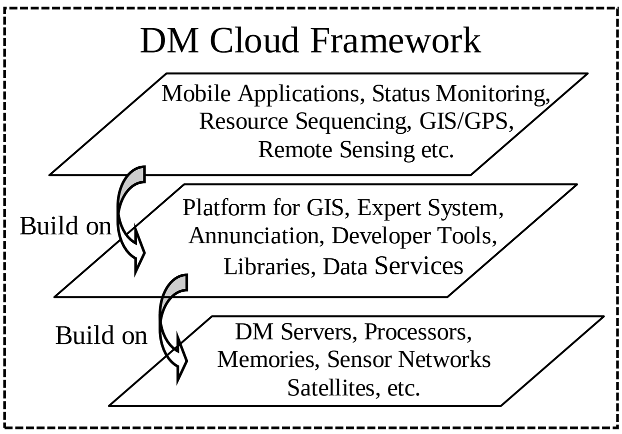

Fig. 1: DM Cloud Framework

VII. Conclusion

The heterogeneous, diversified, vast, large data handling, technological and social barrier requirements for the adversity management signify to develop management system using cloud. It is demonstrated that cloud have complete modularity and can collaborate all the phases of a typical disaster management with ease of accessibility and implementation irrespective of the physical boundaries. Its virtual infrastructure, services and storage will also avoid vulnerability of the disaster management system itself. This approach may change the vision for development of a comprehensive disaster management plan for most of the fatal emergencies and this social orchestrization will help the society at large. So the collaborative approach using cloud could be the best to handle the diversified and multi facet challenging task of preparedness, mitigation, management and restoration in the pre as well as post disaster scenario.

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