



A Novel Cloud Based Data Management Framework for Team and Project Activities in Global Software Development (GSD)

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ABSTRACT

Today global software development is used to a great extent by software development teams because of its benefits like availability of expertise, twenty four hour development and cost etc. Along with its numerous benefits, GSD also has some challenges. Overcoming those challenges can significantly increase paybacks of GSD. Cloud computing is one of the latest patterns in computing that has various benefits and advantages. It provides many benefits to the customer. We argue that both GSD and cloud computing if combined can best serve to the users. Global teams can resolve most of the issues and achieve best from cloud practices. GSD challenges include most importantly data management as well as communication, coordination, security, project planning and management. Managing the data for such teams is one of the major issues. We surveyed the issues involved in detail from literature and answered two research questions regarding GSD challenges. We suggested to use Cloud Computing services and proposed a framework based on SAAS (Software-As-A-Service) cloud that will help to mitigate the problems.

KEYWORDS: Cloud Computing, Global Software Development (GSD), Data Management, Coordination; Communication; Project Planning; Project Scheduling, SAAS (Software-As-A-Service).

1 INTRODUCTION

From the literature it is shown that GSD is becoming more and more popular among software development teams and organizations due to its extreme benefits. Resources from different locations can be utilized. These may include human resources, infrastructure and other resources. Speed of project development can be increased as work continuous twenty four hours and cost can be decreased by hiring labour from where it costs less. There is a high possibility of projects developed globally to have more success rate as experienced and trained personnel are hired from different locations. Software development is a process where a lot of collaboration is required among the development teams or members of the teams. Team members need to communicate at each level of software development lifecycle like requirements engineering, system designing, development and testing for quality work. When we talk about Global Software Development, the necessity for this collaboration is very much intensified.

1. RESEARCH QUESTIONS

Besides many advantages GSD has some disadvantages as well [1][6]. Now the question is how can these shortcomings be minimized to achieve best performance through GSD benefits?

RQ1: How can be the challenges of GSD minimized?

When we talk about global development of software, there is a massive amount of project data that needs to be maintained in order to coordinate effectively throughout the project development lifecycle. The question here is that what are the best data management practices for managing GSD project data?

RQ2: What could be the best data management practices for GSD data on cloud?

2. OBJECTIVE OF RESEARCH

Objective of this research is to answer two important questions that could help GSD teams in better development of the projects and to best utilize the GSD benefits and paybacks. In a research on setting a research agenda for GSD [3], researchers concentrated on key research areas in the field of GSD and

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knowledge acquisition and management is one of them. In [3], authors have shown that there is a great potential in distributed software development as far as research is concerned. They extracted that tool support for GSD teams is a vibrant area for research.

So we worked on the areas of difficulties for GSD and available tools for those problem areas. Instead of using different tools for each type of problem we propose that using a cloud will help in better way. Tool support for GSD teams can be provided as SAAS cloud to mitigate the major challenges faced by the teams. Large scale data sharing and reuse definitely needs some good practices for management.

3. RESEARCH METHODOLOGY

We followed a survey based research methodology. From the literature, challenges that GSD teams face are identified and then the solutions are studied. We then suggested a cloud data framework to answer RQ1.

For RQ2 different data management strategies have been studied and a survey table has been extracted.

4. GSD AND ITS CHALLENGES

GSD is best practice for software development companies to develop quality software at small budget. Development teams containing skilled persons from all over the world to increase the market value and reduced costs are main goals of GSD [2].

4.1. Problems that GSD teams face: The problems are mostly because of the following reasons:

- Language
- Cultural
- Time-zone differences
- Geographically dispersed locations.

Due to the geographical distance among GSD teams, team members cannot see each other and as a result while communication they cannot understand each other's body language as well as mood. They cannot easily clarify their points. So due to lack of face-to-face communication decisions are not taken in a short time and misunderstandings can be developed which can lead to high rework later. Another very significant problem that GSD teams face is the difference in their languages. Due to language difference workers are not able to communicate effectively. From our day to day experience we observe that the meaning of the same word varies from language to language. The words that are used in a good way in one language may be used in the opposite way in another language. Workers also face problems in conveying their messages and feel difficult to remove misunderstandings. Due to language differences, conflicts are more likely to occur among the members and it is hard to remove those conflicts. Medium language also affects the way of thinking.

When members of the team belong to different geographical areas they have different norms, values, beliefs and languages. Their communication styles and ways of thinking are also different. This may create problems in knowledge sharing and cause lack of trust among the team members. Team members can get frustrated if they feel trouble in communicating. Teams at geographically distinct locations also have different time zones and working hours of such teams are different which creates great trouble in informal and direct communication through telephone, IM (Instant Messaging) and video conferencing. Arranging collective meetings for such teams is a difficult task. Lack of spontaneous informal communication can increase the manager's workload because misunderstandings can go longer and result into increased rework. Members hesitate to describe their problems if they do not know each other informally.

Team members of working at same place can easily have informal communication among them during breaks and other events but globally distributed teams have no such opportunities to communicate informally. So it is more difficult to build trust and good relationships among global teams. Experienced employees can't share their knowledge due to the distance among teams. When we talk about teams in the same location they can easily communicate and discuss any issues related to their work, but distributed teams hardly communicate.

In distributed teams, due to the distance among teams it may take longer in getting response of a question. If the response delays occur, the project will not be completed on time. Delays in response can also become a reason of frustration among the team members.

Unavailability of project management tools can lead a project to a failure state. If team members are unaware of project updates, task assignments, status, latest information, documentation and information of people online, the project can never be successful. Project management tools are more necessary when the

developing teams are globally dispersed. Selection of experts from a wide domain of global village is also a challenging job for the project managers of GSD teams. Teams are difficult to initiate due to organization invisibility.

4.2. Available Solutions to the problems: There are different tools available for each problem faced by the teams such as communication problems are solved by providing the teams with appropriate communication tools like e-mail, telephone, discussion forums. Summary of these tools that are being used now a day is given in figure 1 below:

Problems with GSD Teams	Solutions available for those problems
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Lack of face to face communication	<input type="checkbox"/> Video conferencing
<input type="checkbox"/> Response delays	<input type="checkbox"/> Email notifications
<input type="checkbox"/> Spontaneous informal communication	<input type="checkbox"/> Instant Messaging
<input type="checkbox"/> Knowledge sharing	<input type="checkbox"/> Discussion Board
<input type="checkbox"/> Cultural difference	<input type="checkbox"/> Theme based Interfaces
<input type="checkbox"/> Language difference	<input type="checkbox"/> Language choices or language translator
<input type="checkbox"/> Unavailability of project management tool	<input type="checkbox"/> Web Based Project Management Systems
<input type="checkbox"/> Data management	<input type="checkbox"/> Databases
<input type="checkbox"/> Managing documentation	<input type="checkbox"/> Wikis and Google doc etc
<input type="checkbox"/> Replicating code	<input type="checkbox"/> Content Versioning Systems
<input type="checkbox"/> Security of network	<input type="checkbox"/> Encryption Techniques
<input type="checkbox"/> Avoiding unauthorized access	<input type="checkbox"/> Giving Privileges

Fig. 1.Problems for GSD teams with tools used for those problems

File sharing is a necessary activity for software development teams and a problem for global teams because of the distance. Emails can solve this problem through attachments. Problems due to language difference can be solved and collaboration among team members can be increased. Specific user interfaces for members can solve the cultural problem in using the system.

Project management also includes managing the projects in a way that keep them in a consistent state. The problem of expertise identification and selection can be minimized by giving willing people a facility so that they can upload their CV. Experts can be selected through their CVs. The point of suggestion here is that many tools are available now a day that discourse one or more than one problematic issue identified above but there is no centralized solution for every issue.

5. CLOUD COMPUTING AND ITS BENEFITS

Cloud computing is one of the hot topics in research now a day in the field of computing. A lot of researchers are working on it due to its benefits and demands in the industry. Cloud computing is basically putting all services on an internet resource and access those services on demand. The services may be provided by different cloud vendors. These services may include software applications, hardware equipment and different platforms to run businesses and also for software development. The major aim of the cloud computing paradigm is to develop low cost system with high proficiency.

If anyone needs a high cost infrastructure or any other service that is not affordable then one can take those services from any cloud vendor on Pay-as-u-go basis. Customers only have to pay for the services they use and do not need to buy on their own. This can be cost effective policy for the organizations and also they don't need to have installation overhead. Computing professionals are not required by the company as they have set up the services in their own organization. Cloud can be implemented in different ways such as SaaS (Software-as-a-Service), IaaS (Infrastructure-as-a-Service) and PaaS (Platform-as-a-Service). Platform-as-a-Service means to give development tools and platforms to the customers on demand basis. In this way developers don't have to buy expensive programming tools on their own. They just hire the platform from any cloud provider and use it for their business. They also don't need to bother about the installations and maintenance details of those platforms. Infrastructure-as-a-Service clouds provide hardware and storage services, again making it very cost effective. Another major advantage of hiring storage services is increased availability and decreased probability of data loss. Software-as-a-Service clouds means to provide different services in the form of software applications. SaaS is becoming more famous as the organizations or teams availing SaaS do not have to look into the limitations of software installation and configuration. There are some exceptional characteristics of cloud computing that are a motivation for us in an attempt to use cloud computing concepts for GSD. These characteristics are also motivating researchers to work in cloud computing and cloud computing is becoming very fertile for research.

The major characteristics include:

- **Easy scalability:** infrastructure can be enhanced easily on demand.
- **Reduced cost:** server side infrastructure and equipment cost is not included.
- **Better performance:** response time is reduced and availability of data or services is increased.
- **Easy to use:** cloud does not need any software downloads and installations.

6. CLOUD DATA MANAGEMENT

Cloud is basically a central hub containing all the data so there should be some mechanism to manage this huge amount of data, reduce the access time and also to consider security and privacy of that data. In a research [21], authors presented features that a DBMS should contain which is designed for huge data. They discussed some of the available database options and concluded that none of the available database systems are as much effective for cloud environments. So they proposed a newly architected database for cloud deployments. The issues they identified in deploying database for cloud based environments include:

- Data stored at untrusted host i.e. cloud computing vendors
- Data duplication frequently across physical locations for accessibility and robustness

Data stored at untrusted host can make the customer nervous in concern with privacy and security of their data. This is one of the shortcomings of cloud computing. For increasing availability and durability of data it has to be replicated at different sites which increase data access overhead on network.

7. GSD DATA MANAGEMENT

Global means the data related to the development of projects is dispersed at different locations. Development teams need to communicate this data with each other at different stages of software project development. Sometimes more than one person is working on a single module or deliverable. So the data must be maintained in a way that each team member of all the teams can access the data efficiently and with consistency. Data needs to be updated regularly and managed in a useful way. All the actions that are performed on data must be recorded and stored at a safe place. Data and the database must be protected from unauthorized access. Skilled, trained and qualified workers are required for data management. When we talk about global software development more resources are required for data management, either human resources or hardware resources. Improperly stored data can create problems. Managing data obtained through email and other communication medium in GSD teams is very difficult. Data management also includes keeping the projects in consistent state when teams are working on a same piece of code or data. Team members may face the problem when they complete their assigned task and want to send it to the Manager and other members for further processing. Sometimes the same code is needed for development of another component of the same system. In that case replicating large amounts of code globally is surely a difficult task. And data and information consistency is difficult to manage.

RESEARCH IDEA

The research idea is based on seeking answers to the two basic research questions.

1. Answer to RQ1

Our assumption is that cloud computing concepts and services can help GSD teams overcome the challenges and develop better products. All the software tools used now a day to meet GSD challenges should make a SaaS cloud together. This type of cloud can increase the usefulness for Global Software Development to a great extent. Other types of clouds like IaaS and PaaS can also help mitigate challenges posed by global development of software. It can help in data management of the teams and projects.

Global software development teams should develop a cloud of their own so that all the members of team can access the services through cloud. Each team member in all the teams does not have to install many tools like communication tools and project management tools that support them in software development. Rather they can use any service required on demand basis when and where required. Each member of the teams whether he is on one location or other can avail the services provided by the company cloud on as needed base. The services include:

- Coordination services
- Communication services
- Project management services
- Project planning services
- Data management services

There are a lot more services that come under these broad categories, which any member of Global Software Development teams can avail. The whole cloud is considered as a platform for software development, hence providing Platform-as-a-Service cloud. Software tools providing IM, SMS, Telephone, Video Conferencing, emailing, Discussion Board, language translation, Content Versioning, progress, document and resource management, report generation, querying, task scheduling and updating, bug and activity monitoring, and effort, time and cost estimation all of these services act as Software-as-a-Service cloud. Heavy computation servers and data storage hardware acts as Infrastructure-as-a-service.

Every phase of software development lifecycle can put forth to the new level of understanding, management and quality by using these cloud services.

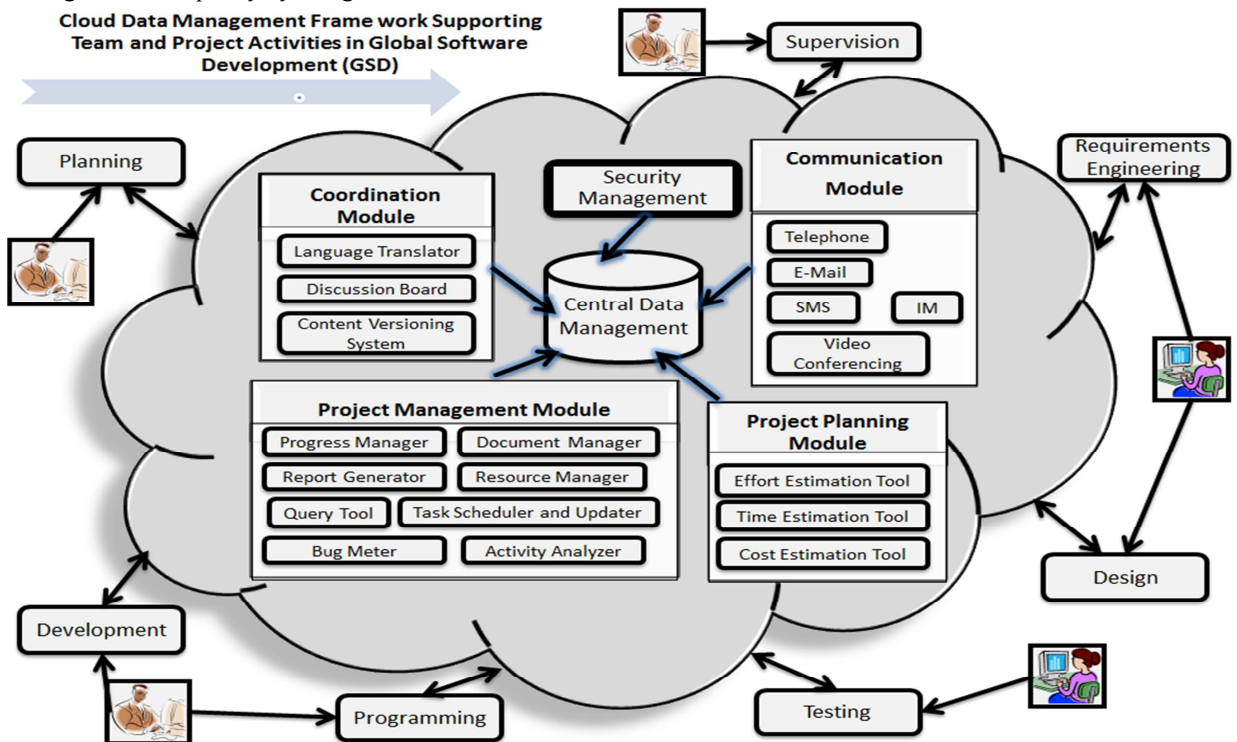


Fig. 2.A Novel Cloud based Data Management Framework for Team and Project Activities in Global Software Development (GSD)

2. Answer to RQ2

All these services that the proposed framework performs in turn help in managing project and team data. For efficient data management there should be proper methodologies and techniques. A survey performed by authors [25] concluded best nominee of type of applications that can be deployed in cloud. This survey was performed on big scale data managing methodologies in cloud settings [25]. We identified three areas where a lot of work is needed for efficient data management. These regions include:

- Reduce access time
- Data security
- Maintain data consistency

2.1. Reduce access time: Performance could be enhanced by reducing the access time. Following points could be taken into account for having better access time.

- Query optimization techniques
- Smart object placement [22]
- Reduce query processing time [26]

Logically related data should be placed at one place to reduce access time and manage the data efficiently. As cloud is all time available resource available globally on the internet so there could be numerous of requests asking for some sort of services. To handle these requests there must be an efficient data management algorithm in place. Authors [22] presented a technique of using “Smart Object Placement” in their work. They concluded that related objects if placed together smartly cloud data access performance can be enhanced even with of frequent data access demands. Based on the two parameters, storage architecture and storage model, authors [24] has proposed a benchmark for cloud based data management systems. Efficient data mining technique can also help reduce access time. In [27] authors presented a data mining model based on genetic algorithm. Their work shows that this model is very scalable and it do not increase access time proportional to the increase in amount of data.

2.2. Data security: Security is definitely an important issue which should be addressed. Following issues should be catered for secure data management:

- Conformance to data availability
- Guarantee to data privacy

Data availability and security from data loss can be achieved through backup. Unauthorized access should be avoided and important information is on internet, so there are more chances of unauthorized access to the data. For this appropriate encryption mechanism for data should be used.

2.3. Maintain data consistency: Data consistency is also an important issue. If one user is updating some data and at the same time other user is accessing it the data may be in an inconsistent state. Inconsistent data can result in great problems. So there must be a mechanism like locking for the cloud data.

There are some tools proposed [28] for GSD that manage the data consistency by using Content Versioning. These tools are called Content Versioning Systems (CVS). A CVS ensures that a user requesting for a piece of data must get the latest copy of that data. CVS acquires a lock on the data being used by a user so that other members may not access it when the data is in changeable state. Hence CVS on cloud can solve the issues related to consistency of code, documents and other data obtained from communication mediums.

SURVEY

From literature survey we extracted the issues faced by GSD teams and their negative impact on the projects developed through GSD. We then find out how cloud can help to reduce those negative impacts.

Table 1. Survey

Challenges	Issues	Negative impact	Cloud services for GSD
Coordination	Problem in knowledge sharing Cultural differences Language difference	Lack of trust Problems in conveying messages Difficult to remove misunderstandings Conflicts are more likely to occur Medium language also affects the way of thinking No sharing of ideas and transfer of expertise.	SaaS paradigm of cloud can overcome coordination issues by providing Language translator, Discussion board and CVS software as services to the dispersed teams.

Project planning	Problems in effort, cost and time estimation	Poor estimate of effort, cost and time required for completing the project.	For planning software estimation tools available on cloud can be used and the estimates are available whenever required throughout the project development.
Project management	Unavailability of project management tool	Can lead a project to a failure state Poor quality of projects	A proper project management tool containing modules that maintain tasks, human resources, documents, project status etc. must be useful for the teams in order to develop quality products.
Communication	Response delays Lack of informal communication Lack of face to face communication Difficulty in building trust and good relationship	Communication gap Difficult to complete a project on time Reason of frustration among the team members Less number of collective meetings Can increase rework due to misunderstandings as members cannot easily clarify their points Decisions take longer time to be made and executed	One communication tool is not enough for the teams. For quality project development team members must have informal, formal, audio, video and text based communication as required. All the communication tools are available to the teams on demand on cloud hence do not require individual installations of each tool.
Data management	Difficulty in managing data obtained through email and other communication medium Problem in updating data regularly Difficulty in maintaining the consistency of data. Problem in managing documentation Problem in code replication	Increase cost. Increasing data access time. Increase in ambiguities and errors in the project. Increase project completion time. Unavailability of history projects data can cause rework.	A type of software that is maintaining the versions of data must be centralized for the teams. Hence CVS on cloud will solve the issue consistency of code, documents and other data obtained from communication mediums.
Security	Lack of security of network Avoiding unauthorized access Data loss	Important data could be lost Data could be miss used	Security services can also be provided on cloud including the authentication services.

RELATED WORK

There is a lot of work done on the problem identification of GSD teams. Different areas identified include: [4][2][5][6][7]

- Cultural issues
- Knowledge managing
- Strategy development issues
- Poor communication
- Technical issues
- Project and process supervision
- Time difference
- Work distribution

Many people also worked on the solutions against these issues [12][13][14][15][16]. The solutions are either for one type of issue or not satisfactory for the GSD teams. One of the authors of this paper worked on the challenges faced by GSD teams and projects and proposed a framework that can help in mitigating the issues [28]. The study contains detailed survey of tools available for communication, coordination and project management. Data management issues are not discussed and not any proper discussion related to the data management was made. This paper proposed that there should be a centralized tool for GSD teams based on that framework.

In a research [23], authors proposed the idea of using GSD as SAAS cloud but there is no exact detail of problems that GSD face and how exactly these problems can be solved through cloud. Moreover they only worked on the collaboration challenges of GSD and not the communication, project planning and management and security issues. Their study amplified the motivation of using cloud to support GSD [29][30][31].

CONCLUSION AND FUTURE WORK

This work is extension to the author's previous study that clearly identified the importance of GSD, challenges posed by GSD and a complete survey of available tools for GSD. As cloud computing is a hot topic in research these days because of its various benefits to the industry. Hence we proposed to take advantage from those benefits and take GSD to the next level of performance so that quality products with low failure rate can be developed with low budget.

We proposed a data management framework that is based on cloud and argue that this cloud based framework of software application services can overcome all the issue of GSD by using every tool required for communication, coordination and project management as SaaS cloud. The framework resolves many issues that come in communication, collaboration, security of data and data management. It is based on the very preeminent characteristic of cloud computing that is SAAS (Software-As-A-Service). Also we have extracted and worked on data management policies for cloud setups and proposed three areas of research where a lot of work can be done. In future we will try to evaluate and validate our judgments. We will have more focus on technological aspects and we will keep digging in data management area.

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