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Technical paper



Project Workflow Management: A Cloud based Solution-Scrum Console

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Abstract

Today, there is a data workload that needs to be managed efficiently. There are many ways for the management and scheduling of processes, which can impact the performance and quality of the product and highly available, scalable web hosting can be a complex and expensive proposition. Traditional web architectures don't offer reliability. So in this work a Scrum Console is being designed for managing a process which will be hosted on Amazon Web Services (AWS) [2] which provides a reliable, scalable, highly available and high performance infrastructure web application. The Scrum Console Platform facilitates the collaboration of various members of a team to manage projects together.The Scrum Console Platform has been developed using JSP, Hibernate & Oracle 12c Enterprise Edition Database. The Platform is deployed as a web application on AWS Elastic Beanstalk which automates the deployment, management and monitoring of the application while relying on the underlying AWS resources such EC2, S3, RDS, CloudWatch, autoscaling, etc.

Keywords: *Agile; Scrum; Performance; Manage; AWS; reliable; scalable; high availability; Hibernate; AWS Elastic Beanstalk.*

1. Introduction

In an organization, there are multiple projects being developed at once. These projects involve various developers, managers and executives within the organization, all of whom should be well informed of the status of the project and the underlying tasks. Thus, every firm requires a consolidated platform accessible by all employees concerned. This gives rise to Project Workflow Management. The aforementioned platform has to be reliable, highly available, scalable and easily updatable, so the projects and tasks can be continuously updated and the information is visible to the members. This can be achieved by using Agile Methodology. Agile software development relates to many software development techniques based on iterative development, where solutions as well as requirements vary over cooperation between cross-functional self-organizing teams. Scrum is a part of agile development [1]. It is a light-weight process framework for an agile development, and the most widely used one.

1.1. Motivation

In this work, we have tried to solve the problem of Project Workflow Management in an organization by providing a consolidated platform for all employees to update and view the projects and tasks. This platform needs to be scalable, reliable and highly available.

1.2. Scrum

Scrum is a framework which is used for managing any process and is an agile way for managing a project. Scrum is used to manage product development and complex software, using incremental and iterative practices. Scrum reduces time as compare to classic "waterfall" processes and increases the productivity. Scrum process enable organization to adjust smoothly with rapidly changing requirements, and also produce a product that fulfils evolving business goals. Scrum development team (software development team) knows the best way to solve the problem which is presented to them. There is no requirement to give detailed, complete descriptions of how everything is to be done in a project [2].

1.3. Why Scrum is Used?

Scrum has power to change project management in every business, every industry, and across life in general. With the help of Scrum, we will become more Agile, and discover how to respond more quickly, and respond more precisely to an inevitable change that comes our way and by remaining collaborating, communicating, and focused, we can achieve what really requests to be done effectively. An agile Scrum method aids the organization by assisting it to

- Increase the excellence of the deliverables
- Manage better with change
- Have more control on project schedule and state
- Provides better approximations while spending less time in

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Figure 1: Gartner's Magic Quadrant categorizes Amazon Web Services and Microsoft as leading cloud service providers [3]

creating them
- Reduced time-to-market and Higher Productivity
- More engaged Employees

1.4. Amazon Web Services

Amazon Web Services (AWS) deals with wide ranging of cloud computing facilities developing a highly scalable and an on-demand computing platform [3]. It provides the full computing stack in the form of virtual resources such as:

- Compute servers (AWS EC2),
- Storage (Glacier, AWS S3, EFS and EBS)
- Database (DynamoDB and AWS RDS), etc.

These services are operated from 13 geographical areas across the world, with number of different available zones in each region. AWS has more than 70 services that extent a wide range including storage, compute, database, networking, application services, analytics, deployment, mobile, management, developer tools and services for the Internet of things. According to Gartner's Magic Quadrant (as shown in Figure 1), Amazon Web Services has been categorized as a leading cloud service provider [4].

1.5. AWS Elastic Beanstalk?

AWS Elastic Beanstalk, the orchestration service (under Compute services) offered by Amazon Web Services is used to deploy infrastructure. Elastic beanstalk relies on various other AWS offerings, such as EC2, S3, RDS, CloudWatch, SNS, autoscaling and Elastic Load Balancers which work in the background to provide a complete platform to the user through which he can deploy, manage and monitor his application. Elastic Beanstalk provides an added layer of abstraction on top of the OS and the bare server. Therefore, users see a pre-built configuration of OS and platform[5].
Deployment requires various components to be defined, namely:

- A logical container for the project ('application')
- A deployable build of the application ('version')
- Configuration information for the Beanstalk environment and the product ('configuration template')
- Combination of a 'version' with a 'configuration' to deploy them ('environment')

To use Elastic Beanstalk, the application version is uploaded as an application source bundle (Java .war file) to Elastic Beanstalk, along with some user-provided information. Elastic Beanstalk launches the

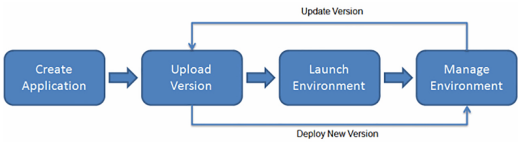


Figure 2: Complete lifecycle of the web application deployed on AWS Elastic Beanstalk

environment as well as creates and configures the AWS resources required to run the application. Figure 2 illustrates the workflow of Elastic Beanstalk.
There is no extra charge for Elastic Beanstalk. The user pays only for the AWS resources being used by the environment.

2. Background

Scrum is an agile and lightweight process framework which is used for the management of software development (Scrum Guide,2016). Scrum is:

- Lightweight since it has few prescribed elements.
- Agile since it maximizes responsiveness to varying customer needs.
- A process framework because it is a collection of concepts and practices around which a process is built.

2.1. The Agile Scrum Project: Main Roles

- **Scrum Master:** The Scrum Master helps the practitioners to attain the highest level of performance. Scrum Master varies from a traditional project manager such that a Scrum master does not allocate tasks to the employees and is not responsible for providing day-to-day direction to the team.
- **Scrum Owner:** While the Scrum Master emphasizes on helping the team improve, the product owner works to direct them towards the goal. The product owner visualizes the product, and then conveys the vision to the team. The product owner also prioritizes the backlog during the development.
- **Scrum Team:** Individuals may join the Scrum Team with various job titles. According to the Scrum methodology, each person contributes in any way they can to finish the work of each sprint.

2.2. Cloud Computing

According to NIST (National Institute of Standards and Technology) [6], "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.." Characteristics of Cloud Computing include on-demand self-service, broad network access, resource pooling, rapid elasticity and measured service. Implementation of a cloud computing model instead of the traditional datacenter infrastructure offers various benefits. Some of them are:

- No need to own a datacenter: In a cloud computing model, the user runs his applications or tasks on the virtualized infrastructure provided by the Cloud Service Provider (CSP). Therefore, the end user does not need to worry about the ownership, and maintenance of the datacenter.
- Reduced cost: The Cloud computing model relieves the user of the capital expenditure spent in purchasing the IT infrastructure. Also, the Operational expenditure is reduced as the user only pays for the subscription charges and for the services he uses.

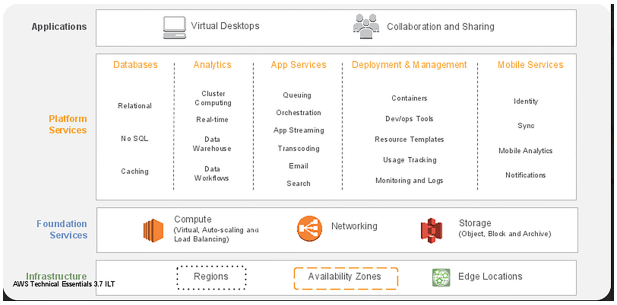


Figure 3: AWS provides various cloud computing services such as Compute, Storage, Networking, Database, Deployment, etc.

- High scalability and rapid provisioning: The user can scale his infrastructure as hios business grows. The computing infrastructure requested by the user can be provisioned by the Cloud Administrator in a few seconds or hours.
- Access from anywhere: The cloud services are provided to the user over the internet and are accessible through the web browser on the client machine. Therefore, the services can be accessed and managed from anywhere.
- High availability: Nowadays, the CSPs guarantee minimum downtime of the cloud services thus, providing the user with highly available (upto 99.999%) infrastructure for his business. There are also various disadvantages associated with the cloud model, such as decreased security, Lack of control on data and infrastructure, Vendor Lock-in, etc.

Cloud computing also offers three service models, namely:

- **Infrastructure as a Service:** The computing capability provisioned to the user is in the form of processing, storage, networks, and other fundamental computing resources.
- **Platform as a Service:** The computing capability is provisioned to the user is to deploy consumer-created applications onto the cloud infrastructure.
- **Software as a Service:** The computing capability is provisioned to the user to use the provider's applications running on the cloud infrastructure.

Also, depending on the degree of data and infrastructure control, cloud is implemented in four deployment models. NIST defines them as:

- **Public Cloud:** The cloud computing infrastructure is provisioned to the general public for open use.
- **Private Cloud:** The cloud computing infrastructure is provisioned to a single organization comprising multiple consumers.
- **Hybrid Cloud:** The cloud computing model is a combination of multiple (generally two) distinct cloud infrastructures (private, community, or public). These infrastructures remain unique entities, however are bound together by proprietary technology.
- **Community Cloud:** The cloud computing infrastructure is provided to a specific community of consumers from multiple organizations.

2.3. Amazon Web Services

Amazon Web Services (AWS) is a primary provider of cloud services. With 13 geographical regions and 35 Availability Zones all over the world, AWS provides highly available, robust, low cost and compliant cloud infrastructure to deploy web applications.AWS provides a full computing stack (as shown in Figure 3) in the form of services which can be accessed through a GUI (over a browser) or the command line interface (known as the AWS CLI).
Comprehensive documentation of all the services is also available.

1. Amazon Elastic Compute Cloud is a cloud service that provisions scalable compute capacity. It provides the users with full control of their resources and runs them on Amazon's Environment. It decreases the time required to provision and boot server instances, allowing the users to rapidly scale capacity, up and down, as their computing requirements fluctuate.
2. Amazon Simple Storage Service is a service which allows to store files on the AWS cloud. Interface of S3 is very simple. User can use it to store any amount of information, from anywhere on the web, at any time and also retrieve the data. It gives any user access to the same highly reliable, fast, scalable, inexpensive data storage platform on which Amazon runs its own worldwide network of websites. S3 aims to maximize benefits of scaling and to provide it to the developer. AWS S3 is very cheap.
3. Amazon Relational Database Service allows users to obtain, scale and operate a relational database in the cloud. It provides resizable capacity and cost-efficient while managing database administration tasks. Amazon RDS provides six database engines, including Amazon Aurora, Microsoft SQL Server, MySQL, Oracle, PostgreSQL and MariaDB.
4. Amazon Simple Notification Service is a flexible, fast push notification service which lets us send individual messages or group messages to numbers of recipients. Amazon SNS makes it cost effective and simple to send notifications to email recipients, mobile device users or even send messages/notifications to other distributed services
5. Amazon Elastic Beanstalk is the orchestration service (under Compute services) offered byAmazon Web Services to deploy infrastructure. Elastic beanstalk relies on various other AWS offerings, such as EC2, S3, RDS, CloudWatch, SNS, autoscaling and Elastic Load Balancers which work in the background to provide a complete platform to the user through which he can deploy, manage and monitor his application.

3. Problem Statement

In today's world, the workload has to be managed efficiently. Various methods can be used for the scheduling and management methods that can also affect the quality and performance of the product. Scrum Console is a platform that is created for teams that plan their work collaboratively. It allows Scrum Owners to optimize its resources (the scrum team) and leads to performance tuning of environment. Deployment of the Scrum Console on the AWS Elastic Beanstalk helps to automatically manage and monitor the application while reducing the costs. "Scrum" is a web application deployed on the AWS cloud which aims at managing any application more efficiently using an Agile and iterative framework, while employing an integration of AWS services such as EC2, S3, CloudWatch, autoscaling, etc. to manage and monitor the application.

4. Tools Used

4.1. Hibernate

Hibernate ORM is an Object/Relational persistence and query service which provides high performance. It is licensed under the open source GNU Lesser General Public License. Hibernate [7] not only creates mapping between the Java classes and the database tables (and from Java data types to SQL data types), but also offers data query and retrieval facilities [8].Figure 4 shows the architecture of the Hibernate ORM.

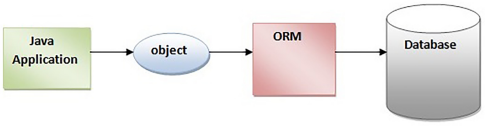


Figure 4: Java web applications connect to the databases using Java POJO classes and the Hibernate ORM

4.2. AWS Elastic Beanstalk

AWS Elastic Beanstalk is the orchestration service (under Compute services) offered by Amazon Web Services to deploy infrastructure. Elastic beanstalk relies on various other AWS offerings, such as EC2, S3, RDS, CloudWatch, SNS, autoscaling and Elastic Load Balancers which work in the background to provide a complete platform to the user through which he can deploy, manage and monitor his application.

5. Our Work

In this work, we have developed a Scrum Console Platform which facilitates the collaboration of various members of a team to manage projects together, The Scrum Master can control all the projects and the employees in his organization. The Scrum Owner has control only over his own project and can allocate various task to his team members. The members of the Development Team can only view and edit the status of the task allocated to them. The Scrum Console Platform has been developed using JSP, Java, Hibernate and Oracle 12c Enterprise Edition Database. The Platform is deployed as a web application on AWS Elastic Beanstalk which automates the deployment, management and monitoring of the application using the underlying AWS resources such EC2, S3, RDS, CloudWatch, autoscaling, etc.

5.1. Overview

The work aims to manage a project efficiently using Agile Framework, Scrum. Further tune the performance of the whole Scrum Team by creating a single platform for management of tasks and employees.
The work uses the following technologies:

- AWS Elastic Beanstalk is used to automate the deployment, management and monitoring of the web application. It orchestrates the following underlying AWS Services:
  - AWS Elastic Compute Cloud (EC2): EC2 provides the compute servers on which the application runs [10].
  - AWS Simple Storage Service (S3): S3 is an object-storage service that stores the source bundle of the web application in the form of a ZIP archive or a WAR file [11].
  - AWS Relational Database Service (RDS): RDS creates and manages a relational database instance using an Oracle database [12].
  - AWS Auto-scaling: Auto-scaling helps to maintain application availability and scale the application up or down (by increasing or decreasing the number of running EC2 instances) according to predefined conditions [13].
  - Amazon Cloud Watch: Amazon Cloud Watch is the performance monitoring service for AWS cloud resources and the web applications running on AWS [14].
- JSP is used for Server side Scripting and to dynamically create web pages using HTML. It imports the java files which are used to communicate with the database.
- This work contains Java Classes based on POJO (Plain Old Java Object) i.e., they only contain getter and setter function. These classes are used to describe the database tables and their contents.
- The Java classes use Hibernate to interact with the database deployed on AWS Relational Database Service (RDS) which use Oracle 12c Enterprise Edition as the DB Engine (Oracle EE 12.1.0.2.v5). Hibernate maps Java classes to the database table. Hibernate helps us to make changes easily as it does not use SQL queries, therefore only the XML properties file has to be modified.



Figure 5: Scrum portal login interface

5.2. Detailed Work

The Scrum Console Platform allows a team of Scrum Owners, Owners and Developers to collaborate and manage their projects and tasks conveniently. It creates a single platform through which all the employees can view, edit and update their tasks.
The platform runs on AWS Elastic Beanstalk which orchestrates all the underlying AWS services to automate the deployment, management and the monitoring of the application. The following points describe the detailed working of the web application:

1. The web application is accessed through the URL provided by AWS Elastic Beanstalk on the Environment management console.
2. The URL opens the Login page (as shown in Figure 5) where the user can input his credentials to login into the application.
3. There are three types of users specified, each of which have different permissions:
   - Scrum Master: The Scrum Master has full control of the web application. He can create/delete/modify the users, projects or tasks in the organization. A master can create a new user in the application, can assign a project/task to any user and can also change the category of any user
   - Scrum Owner: He cannot edit/delete the user and has no rights to create new Users. An owner can only deal with tasks and projects. The owner can create projects/tasks and assign to any of the user, and can also update the status of project and task.
   - Scrum Development Team: A member of the development team can create/update/delete tasks but has no right to create a project or register a new user. He cannot edit the details of any user and project.
4. After logging into the application, the user can view his dashboard (as shown in Figure 6) which shows the following details: o Number of users registered o Number of projects o Number of tasks running in the organization. Based on the category of the user, he/she has the rights to edit the details of user/projects/tasks.
5. The web application uses dynamic JSP Pages along with Java POJO classes, Hibernate and the Oracle 12c Enterprise Edition database (running on AWS RDS instance) to serve the requests created by the user. At every request made by the user on JSP web page: o The JSP Page (which import the Java classes) make a call to a particular Java class. o The Java class (which contains only getter and setter functions), in turn uses Hiber-

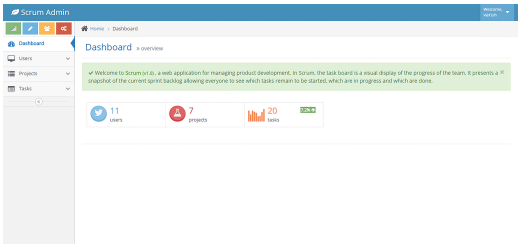


Figure 6: Dashboard of Scrum

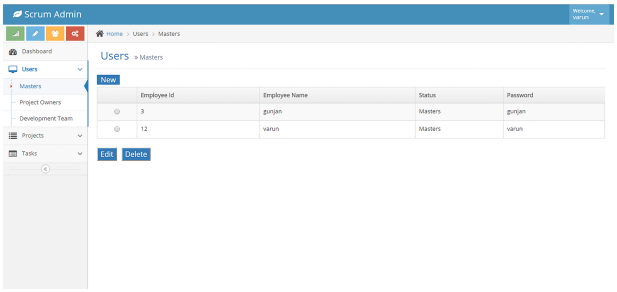


Figure 7: Scrum Master dashboard for actions

nate to query into the database. Hibernate allows us to use Java itself to view/update/alter the database without the need of SQL queries. o Hibernate forms a connection to the Oracle database by using various parameters such as Connection String, Dialect, Database name, Host name, Username and Password. This connection is formed through the AWS Relational Database Service (RDS) on which our Oracle Database runs. o As soon as the request is received by AWS RDS, the appropriate response is generated, which is then sent to Hibernate. o Further, Hibernate sends the database response to the JSP Page which displays the information on the web page.

6. The user can view all the users, projects and tasks in the organization and depending upon his rights, he can edit the details. Figure 7 and Figure 8 show that the user 'varun' (Scrum Master) has the right to perform actions (such as edit or delete) on the users and tasks respectively.

6. Results and Discussions

In this work, we have developed a Scrum Console Platform and deployed the web application on the AWS cloud using the AWS Elastic Beanstalk service. The AWS Elastic relies upon the underlying AWS services (such as EC2, S3, Auto scaling etc.) to deploy and manage a web application. This infrastructure is reliable, scalable and has a high performance. These features are provided by AWS through its monitoring and health check systems. The AWS Elastic Beanstalk service provides an easy-to-use web GUI dashboard, shown in Figure 9. The dashboard lists the user-created applications and environments.

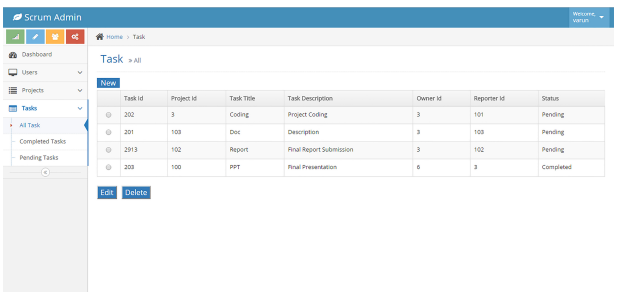


Figure 8: Scrum Master Dashboard for Edit

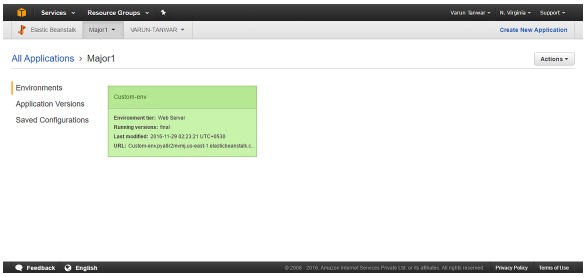


Figure 9: Dashboard Shows User-Created Applications and Environments.

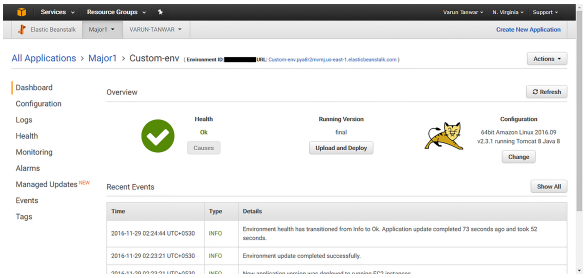


Figure 10: User Environment Dashboard

A user-created environment dashboard (as shown in Figure 10) provides all the details such as the Environment ID, URL of the web application, the health status, current version of the application, configuration of the EC2 instance, etc. The health status (Ok, Grey, Degraded or Severe) can be quickly used to determine whether the application is available or not.

The instances deployed and tested on 10 developers team for coding environment and is being monitored through the EC2 dashboard (as shown in Figure 11) which provides details such as instance ID, instance type, availability zone, status, security group, Public or Elastic IP, Private IP, DNS details, etc. The EC2 dashboard also provides the monitoring details of various parameters graphically (as shown in Figure 12). These parameters include CPU utilization, Disk reads, Disk Writes, Network In, Network Out, etc. These statistics help us to continuously monitor the utilization of the instance and thus, the efficiency of the environment. In our work, we have used an AWS RDS instance with the Oracle database engine. The AWS RDS dashboard (as shown in Figure 13) provides the details and the monitoring statistics of the RDS instances.

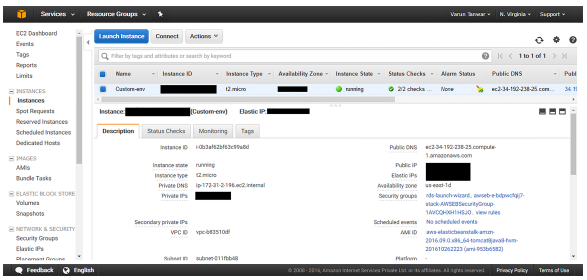


Figure 11: EC2 Environment Dashboard

AWS Elastic Beanstalk uses AWS S3 service to store the content of the web application. The S3 dashboard (as shown in Figure 14) provides a list of all the user-created S3 buckets, their contents and also their details. A single bucket is created for every Elastic Beanstalk environment.

7. Conclusion

In this work, a Scrum Console Platform has been developed on the AWS Cloud using AWS Elastic Beanstalk. The salient features of

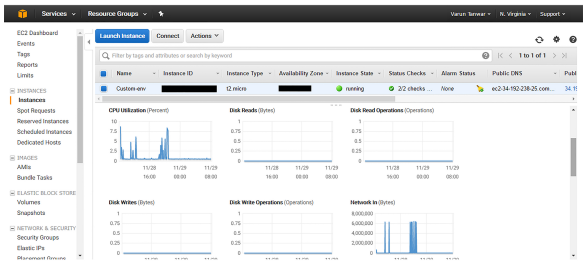


Figure 12: EC2 Dashboard Monitoring Details

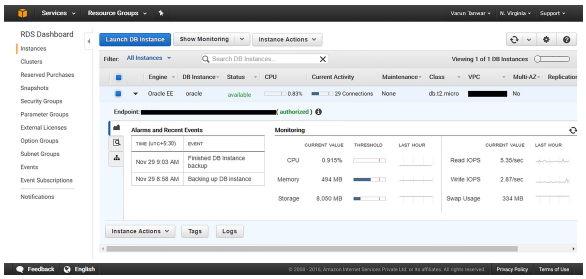


Figure 13: RDS Dashboard

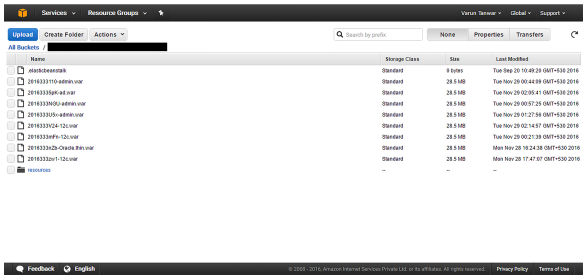


Figure 14: S3 Dashboard

this web application are:

1. Consolidated Platform: The Scrum Console provides a single platform for all the employees of an organization to collaborate and manage all the projects and tasks.
2. Iterative: The Platform is iterative i.e., after the completion of each task (or project), a new task (or project) has to be created.
3. Scalability: Since the web application has been deployed on the Cloud, any number of instances (web servers) can be created. The application can also be scaled up or down anytime according to the requirements of the user.
4. Cost-efficient: Deployment of the web application on AWS Elastic Beanstalk requires no capital expenditure since there is negligible investment on physical infrastructure. Moreover, scaling the storage and the processing capability of the application incurs minimal operational expenses and subscription charges.
5. Security: AWS provides various security features such as Security Groups, Instance Profiles, Authentication etc. to ensure that the application and the data is secure and private.

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