Backup Management and Orchestration System
Final Year Project

Rob Shelly
Applied Computing
20068406

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1 Introduction

1.1 Problem Statement

In January 2017 GitLab suffered a data loss incident which was widely reported in media. It began with spammers targeting GitLab.com and culminated in an engineer erroneously deleting 300GB of PostgreSQL data in a production. The lost data included merger requests, users and comments (GitLab, 2017a). The bigger story was to come later however when it was realised that GitLabs backup process had failed silently. The backups did not exist, resulting in a total loss of the data. As it transpired, conflicting major versions of *pg_dump* (a utility for backing up PostgreSQL databases) in use for the backup procedure and the PostgreSQL database resulted in an error, and the procedure failing (GitLab, 2017b).

The incident was widely reported in the tech industry with the story being picked up by a number of outlets including TechCrunch (2017) and The Register (2017). For many, the focal point of the story was the failed backups. The incident highlighted the need for regular verification of backups. A simple way of performing this verification is to regularly restore data. The method of verification is to perform a restore of the data, which can be a mundane and time consuming task. The aim of this project is to create a solution to the issue. A system which can notify administrators when backups have failed may have prevented the data loss in the GitLab ordeal.

1.2 Aims & Objectives

The overall objective is to create a system to test that uncorrupted backups exist and contain valid, readable data. A system will be created that allows sysadmins to test backups and to schedule the regular testing of backups. Thus, the system will have two main objectives:

- Eliminate the mundane and time consuming task of backup testing by automating regular tests;
- Catch silent failures of the backup procedure by notifying sysadmins of failed backups.

The system will focus on backups of databases. For scope, design will focus on testing MongoDB data and MySQL data, thereby providing a sample of both relational and non-relational database management systems (DBMS). However, the system should be designed such that it can easily modified to test data from others forms of database management systems. As part of the system, the following should be implemented:

- **Web app:** This will act as a front end for the sysadmins run and schedule tests and view results.
- **Automation Server:** This will be the backend of the system. It will take care of retrieving the backup data before performing some sorts of tests.
- **Container Platform:** This will be utilised by the backend to test the server. For example, when testing the data from a MongoDB database, the backend will spin up a container with MongoDB installed in order to verify the data.

2 Technologies

2.1 Docker

Docker is a container platform for building and managing applications. This project is interested not in Dockers platform but rather in the Docker images that run on the platform. A container image is a modular piece of software. It encapsulates all the code and tools needed to run the software packaged in the image. The image can then be run in a container on any environment using a container platform or service. Thus, it runs independent of the hardware or operating system. The container also isolates the software from other images and software running within the environment (Docker, 2017).

The modularity of software makes Docker images appealing for this project. It will allow testing various data base types (e.g. MongoDB, MySQL) through it's software agnostic feature, by deploying an image with the corresponding DBMS software.

2.2 Amazon Web Services

The project will make extensive use of Amazon Web Services (AWS) with most or possibly all of the systems infrastructure deployed on AWS. More specifically the project will make use of two specific Elastic Compute Cloud (EC2) and EC2 Containers Service (ECS).

EC2 is Amazons compute services. It allows easy deployment and management of virtual compute resource within the cloud. The flexibility of operating systems, virtual machine (or instances and they are known in AWS) size of volume of storage make it ideal for this project (Amazon, 2017a).

ECS is Amazons service for running Docker images. It allows Docker images to be easily deployed to EC2 instances without the need to install Docker on the instances. There is no added cost for using ECS. i.e. the customer only pays for the EC2 instances (Amazon, 2017b).

ECS is an appealing platform for running Docker images for the following reasons.

- Images can be deployed on EC2 instances, meaning there is no need to install Docker on the instance, without any extra charge.
- Containers are created within the customers own EC2 instances, meaning they are not exposed to other AWS customers. The are secured by the same infrastructure created by the customer for their instances, for example Virtual Private Clouds (VPCs) and Security Groups.

2.3 Jenkins

Jenkins is an automated build server. It can be used to implement continuous integration (CI) and continuous delivery (CD). Configuration and management of the server can be achieved using both a web interface and an API. Jenkins service is also extensible through a library of plugins (Jenkins, 2017). One plugin which will be of particular interest to this project is the Pipeline plugin. It allows the creation of pipeline as code.This means that for this project, pipelines can be used to create EC2 instances and deploy the necessary Docker images using ECS in order to test backup. Utilising the API, this can be achieved through a user-friendly web based frontend for user who are not familiar with Jenkins.

3 Design

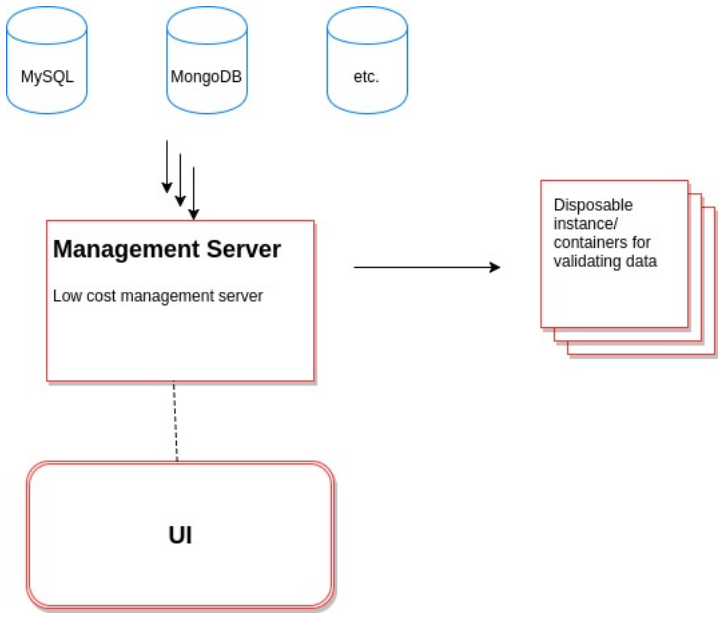
3.1 System Architecture Overview

The system will comprise of three main components:

- Management Server
- User Interface
- Disposable instances/containers

The system will also use existing infrastructure. This is where the backups are stored. Depending on the user of the system there may be multiple backup server in different location (such as AWS regions) or for different data types (relational and non-relational databases). Backup data may be stored in a variety of ways such as on EC2 instance or S3 buckets.

Figure 1: Diagram of System Architecture



Management Server: This will be a small low cost AWS instance on which the Jenkins automation server will be installed. The majority of the systems functionality will be carried out and/or orchestrated by this server. Jenkins jobs will copy the backups from their location to a disposable instance and implement the necessary steps to validate them such as importing and and reading.
User Interface: This will provide a simple user interface (UI) for the system, implemented as a simple web app, hosted on AWS.It will allow users with little knowledge of Jenkins and AWS to perform backup restoration checks by adding a layer of abstraction. Users will be able to run restorations by providing the parameters such as the backup file and it's location. The UI will utilise the Jenkins API to run execute the restoration with the parameters provided.

Disposable Instances or Containers: Disposable infrastructure will be used to perform the restoration. EC2 instances or containers can be used to quickly and easily deploy the necessary software to perform the restoration (i.e. the correct DB management system). They can also be destroyed afterwards, destroying the data and therefore maintaining confidentiality.

3.2 Formal Modelling

3.2.1 Sequence Diagrams

3.2.2 User Stories

As a	I want to	so that
user	perform a restoration of a database backup	I can verify the backup restore process works
user	view the results of a backup restore	I can verify the backup contains valid, readable data
user	schedule a regular automated restoration of a particular backup	I don't have to manually do it myself
user	view the results of an automated restoration check	I can verify the backup contains valid, readable data
user	view past results of all automated checks	I can keep track of successful and unsuccessful restorations
user	be easily notified when a restoration fail	promtly address the issue a possible backup failures

3.3 Front End Design

3.3.1 Wireframes

4 Methodology

4.1 Agile

4.2 Tool 1

4.3 Tool 2

4.4 Tool n

4.5 Testing Approach

5 Implementation of Prototype

5.1 Sprint 1

5.2 Sprint 2

5.3 Sprint 3

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