

Configuration Manual

MSc Research Project Cloud Computing

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MSc Project Submission Sheet

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Programme: Cloud Computing

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Project Title: A Comprehensive Framework for Ensuring Secure Sharing of Electronic Health Records in AWS Environment

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Configuration Manual

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1 Introduction

This document serves as a detailed configuration manual for the replication of the work "A Comprehensive Framework for Ensuring Secure Sharing of Electronic Health Records in AWS Environment." This work involves a multiple components and configurations, and the following sections provide a step-by-step guide for successfully reproducing this work.

Research Work: A comprehensive framework for ensuring the secure sharing of electronic health records (EHR) in an AWS environment. The primary objective is to enhance the security of EHR sharing through the utilization of the Ciphertext-Policy Attribute Based Encryption (CPABE) mechanism. Additionally, a deduplication technique has been designed to efficiently optimize storage costs on Amazon S3.

2 System Configuration

2.1 Hardware Configuration

Below Fig1 specifies the hardware configuration that are required to develop and run the application.

```
      Device specifications
      Copy
      ^

      Device name
      LAPTOP-RT80PLLD

      Processor
      11th Gen Intel(R) Core(TM) i7-1165G7 @ 2.80 GHz 2.80 GHz

      Installed RAM
      16.0 GB (15.7 GB usable)

      Device ID
      4D17B59A-74C4-493D-9D58-ECE9C02D7121

      Product ID
      00342-42626-34654-AAOEM

      System type
      64-bit operating system, x64-based processor

      Pen and touch
      No pen or touch input is available for this display
```

Fig1. Hardware Requirements

2.2 Software Configuration

Below are the list of software's and the AWS services that are used.

IDE: Eclipse IDE. Server: Apache Tomcat. Database: MySQL Amazon IAM: To regulate access permissions to the S3 buckets within the development. Amazon S3: For storing EHR reports securely.

3 Environment Setup

3.1 Installing and Configuring Eclipse with Tomcat

- Download and install Eclipse IDE.
- Set up Apache Tomcat as the server for deploying the web-based application.
- Configure Eclipse to work with Tomcat.
- The following figures from Fig2. To Fig7. shows the process of installing the Eclipse and configuring the Eclipse with Tomcat Server.



Fig4. Run Eclipse

New		\times
elect a wizard		 ~
Define a new server		2
<u>N</u> izards:		
type filter text		
 > Oomph > Plug-in Development > Remote System Explorer > Server > SQL Development > Tasks > User Assistance > Web Services > Web Services > XML 		Ŷ

Fig5. Integrating Tomcat Server

New Server			\times
Define a New Server			1.11
Choose the type of serv	er to create		
Select the server type:			
type filter text			
Tomcat v6.0 Tomcat v8.0 Tomcat v8.0 Tomcat v8.0 Cloud Foundry Publishes and runs J2EE Tomcat server. Server's host name:	Server Server Server Server and Java EE Web projects and se	erver configurations to a local	(
A CONTRACTOR OF A CONTRACTOR OFTA CONT			
Server na <u>m</u> e:	Tomcat v9.0 Server at loca	alhost	

Fig6. Tomcat Version

omcat Server	
Specify the installation directory	
Na <u>m</u> e:	
Apache Tomcat v9.0	
Tomcat installation <u>d</u> irectory:	
C:\Software\apache-tomcat-9.0.10	Browse
	Download and Install.
IRE:	
< Back Next >	Einish Cancel

Fig7. Tomcat Server

Eile Edit Source Refactor Navigate Sear	h Project Bun Window Help		
	(の)(1) 弓(1) ちょう・ ひ・ ひ・ (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)		Q 1819
🖕 Project Explorer × 🛛 🖻 😫 🗑 🖢 👔	👎 🛛 ABE java 🗴 🖄 ViewPersona 🗟 ViewPersona 🗟 ViewPersonal 🗟 ViewPersona 🗋 ViewPersona 🗟 ViewPersona	»26	- 6
B > EHealth (Desktop master)	a Printing Key Generated 1.		
> % Deployment Descriptor: EHealth	36 prv delegate ok = Bswahe delegate(pub. prv. ok):		
JAX-WS Web Services	<pre>87 println("request delegated");</pre>		
> 🛅 Java Resources	38		
> @+ > build	39 BswabeCphKey crypted = Bswabe.enc(pub, policy);		
> 2+ > lib	<pre>40 long startTime = System.currentTimeMillis();</pre>		
V BY > SIC	<pre>41 cph = crypted.cph;</pre>		
× At ≥ main	<pre>42 //long endTime = System.currentTimeMillis();</pre>		
x Re 2 java	<pre>43 //println("Encryption completed in " + (endTime - startTime) + " milliseconds"); 141/10/10/10/10/10/10/10/10/10/10/10/10/10</pre>		
Y Pt > com	as principle end completer),		
ABE java	<pre>46 result = Bswabe.dec(pub, prv, cph);</pre>		
AccessPolicy java	<pre>47 if ((result.b == true) && (result.e.equals(crypted.key) == true))</pre>		
Amazoni inicadiava	48 System.out.println("succeed in decrypt");		
CreateProfile java	49 else		
B DBConnection java	50 System.err.println("failed to decrypting");		- 1
P Login java			
P PatientCondition java	52 result = Bswade.dec(pub, prv delegate ok, cpn);		
Difference international ava	54 System out minth ("succeed in dervot with ok delegated key");		- 1
P Register invo	55 flag = true;		
P Steracchart inva	56)		- 1
B TestResult inva	57 else		- 1
R Undets Deefile inter	58 System.err.println("failed to decrypting with ok delegated key");		- 1
Be OpdateProfile.Java	59 return flag;		

3.2 MySQL Database:

- Visit the MySQL Community Downloads page.
- Download the MySQL Installer for Windows.
- Run the downloaded installer, and it will guide you through the installation process.
- Choose the setup type (Typical, Complete, Custom).
- During installation, you'll be prompted to configure MySQL Server.
- Set a root password and choose other configuration options as needed.
- Once installed, MySQL Server should start automatically.
- You can also start it manually using the MySQL Notifier or by going to the Services application and starting the MySQL service.
- Open a command prompt and type mysql -u root -p. Enter the root password when prompted.
- You should now be in the MySQL shell.
- The following figures from Fig9. to Fig15. shows the installation and configuration of MYSQL.



Fig9. MySQL Page

OMYSQL Community Downloads

Seneral Availability (GA) Releases	Archives	9		
MySQL Installer 8.0.33				
elect Operating System:			Looking for preversions?	evious GA
Microsoft Windows			~	
Windows (x86, 32-bit), MSI Installer	8	.0.33	2.4M	Download
(mysql-installer-web-community-8.0.33.0.msi)	MDS	: 2a330cf2	24915964cca87e04db	b34e5d3 Signature
Windows (x86, 32-bit), MSI Installer	8	.0.33	428.3M	Download
(mysql-installer-community-8.0.33.0.msi)	MDS	: 9b4ce33a	ab05ae7e0aa30a6c4f	1a4d1c2 Signature

Fig10. MySQL Windows Installer

MySQL. Installer	Choosing a Setup Type	
Adding Community	Please select the Setup Type that suits you	ur use case.
Choosing a Setup Type	O Developer Default	Setup Type Description
Select Products	Installs all products needed for MySQL development purposes.	Allows you to select exactly which products you would like to install. This also allows to pick other server versions and architectures (depending on
Download	Server only	your OS).
Installation	Installs only the MySQL Server product.	
Installation Complete	O Client only	
	Installs only the MySQL Client products, without a server.	
	O Full	
	Installs all included MySQL products and features.	
	O Custom	
	Manually select the products that should be installed on the system.	

Fig11. MySQL Setup

MySQL. Installer Adding Community	Select Products Please select the products you would Filter	d like to install on this computer.	
Choosing a Setup Type	All Software, Current Bundle	,Any	Edit
Select Products	Available Products:	Products To Be Insta	lled:
Download Installation Installation Complete	MySQL Server 8.0 MySQL Server 8.0 MySQL Server 8.0.33 MySQL Workbench MySQL Workbench 8.0 MySQL Workbench 8.0 MySQL Shell 8.0 MySQL S		
	Published: Tuesday, April 18, 2023 Release Notes: <u>http://dev.mysol.com/doc/rel</u>	Enable the Select customize produ	Features page to ct features

Fig12. MySQL Products



Fig14. mySQL Account



• Below Fig16. shows the commands that needed to be executed in the MySQL database in order to create the database and the tables.

create database ehealth; use ehealth; create table newuser(username varchar(50),password varchar(50),usertype varchar(50),contactno varchar(12),address varchar(50));
create table Createprofile(name varchar(50),dob date,age varchar(50),gender varchar(10),S5no varchar(50),profile_id int,username varchar(50),problem varchar(50));
create table accesspolicy(friend varchar(50),faccess varchar(50),physician varchar(50),paccess varchar(50),nurse varchar(50),naccess varchar(50),lab varchar(50),laccess varchar(50),insurance
create table prescription(pname varchar(50),physician varchar(50),prescription varchar(250),pre_date date);
create table patientcondition(pname varchar(50),nurse varchar(50),pcondition varchar(250),pre_date date,bp double,rr double,hr double,pr double);
create table testResult(pname varchar(50),labtechnician varchar(50),testname varchar(100),results varchar(250),report_name varchar(100),report longblob,pre_date date);

Fig16. Commands

The below Fig17. shows the DB endpoint configured in the code.

```
public static Connection getCon()throws Exception {
    try{
        Class.forName("com.mysql.jdbc.Driver");
        con = DriverManager.getConnection("jdbc:mysql://localhost:3306/ehealth","root","root");
    }catch(Exception e) {
        e.printStackTrace();
    }
    return con;
}
```

Fig17. DB EndPoint

4 AWS IAM Creation:

- Log in to the AWS Management Console using https://aws.amazon.com/.
- Navigate to the IAM service.
- In the IAM dashboard, select "Users" from the left-hand menu.
- Click on the "Create user" button.
- Enter a username for the new IAM user.
- On the "Set permissions" page, choose "Attach policies directly."
- Search for and attach the policy named "AmazonS3FullAccess" to grant full access to S3.
- Review the configuration and click "Next".
- Review the user details and permissions one last time.
- Click "Create user."
- Once the user is created, go to security credentials and click on create Access key.
- Next, click "Download .csv" to download the user's access key ID and secret access key.
- Configure the access keys for the IAM user in the code.
- Below Figures from Fig18. to Fig 24. shows the step by step process of creating IAM user.

Identify and Access X Management (IAM) Add MAD Security recommendations Commendations Commendations Security recommendations Commendations	<u>60</u> EC2							
Management (IAN) IAM Dashboard Image: Comparison of the com	Identity and Access 🛛 🕺	IAM > Dashboard						٢
Cashbaard	Management (IAM)	IAM Dashb	oard				G	Θ
Dashbard A dd MA for root curf * Access management The site is not is not interior to the machine the transmission of H03 drives in the interior section for H03 drives in the interion for H03 drives in the interion for H03 drives in th	Q. Search IAM	Security reco	mmendations	3		C	AWS Account	
Access Fundances Marriers Access Analyzer External access Unser and settings Credential report O 3 7 1 O	Dashbaard V Access management User groups Users Roles Policies Identify providers Accent settings	Add MFA for Sign in as the r root user to im Add MFA for Add multi-facts Your user, Ha Deactivating or	root user oot user (or contact you prove security for this a yourself or authentication (MFA) rsha, does not have deleting unused access	r administrator) and registe cocount. for yourself to improve sect any active access keys t keys improves security.	r a multi-factor authenticati wity for this account. hat have been unused fo	on (MFA) device for the Add MFA r more than a year.	Account ID 7 782462774344 Account Allus neeraj 1234 Edit Delete Sign-in UBL for LM users in this account Mttps://neeraj1234.signin.aws.amazon.com/c onsole	
Unicida access Users Roles Policies Identity Manage your access keys, multi-Actor Analyzers and settings. Credential report - 0 3 7 1 0	▼ Access reports Access Analyzer External access	IAM resources	s 5 Account			C	Quick Links My security credentials	
Credential report 0 3 7 1 0	Unused access Analyzers and settings	User groups	Users	Roles	Policies	Identity providers	Manage your access keys, multi-factor authentication (MFA) and other credentials.	
	Credential report	0	3	7	1	0		

Fig18. IAM Dashboard

Step 1 Specify user details	Specify user details
Step 2 Set permissions	User details
Step 3 Review and create	User name EHRS3Access The user name can have up to 64 characters: A-Z, a-Z, 0-3, and + = , , @ (hyphen) Provide user access to the AWS Management. Console - optional If you're providing console access to a person, it's a best practice if to manage their access in IAM identity Center.
	() If you are creating programmatic access through access keys or service-specific credentials for AWS CodeCommit or Amazon Keyspaces, you can generate them after you create this IAM user. Learn more ∠

Fig19. User Details

Step 1 Specify user details	Set permissions			0
	Add user to an existing group or create a new one. Usin	g groups is a best-practice way to manage user's permiss	ions by job functions. Learn more 🖸	0
Step 2				
Set permissions	Permissions options			
Step 3				
Review and create	 Add user to group Add user to an existing group, or create a new group. We recommend using groups to manage user permissions by job function. 	Copy permissions Copy all group memberships, attached managed policies, and inline policies from an existing user.	 Attach policies directly Attach a managed policy directly to a user. As a best practice, we recommend attaching policies to a group instead. Then, add the user to the appropriate group. 	

Fig20. Permissions

and a second			create policy E
loose one or more policies to attach to your new u	er.		
	Filter by Type		
ે, s3full	X All types	▼ 1 match	< 1 > @
		Attached entities	
Policy name 🔀	▲ Type	Attached entities	
Policy name [2] AmazonS3FullAccess	AWS managed	<u>1</u>	
	Type AWS managed	1 1 ced feature used to delegate permission mana	gement to others. Lear

Fig21. Policies

Step 20 User details Step 30 Life rame this State console password type hone Require password reset hone Review and oreate Life State console password type hone Require password reset hone Permissions summary < 1 > Name [2] Image: Type with the state of the state	Step 1 Specify user details	Review and create Review your choices. After you create the user,	you can view and download the autogenerated password, i	if enabled.	
Sime Console password type None Require password reset No Permissions summary < 1 Name (2) Improve (1) Used as < 1 Name (2) Improve (1) Vortige (1) < 1 Tage - optionel Tage are ley-value pairs you can add to AWS resources to help identify, organize, or search for resources. Improve Tage No No No Made one varge Was can add up to 50 more tage. So the metage.	Step 2 Set permissions	User details			
Permissions summary Image: Comparison of the summary of the summa	Step 3 Review and create	User name EHR53Access	Console password type None	Require password reset No	
Name (2) Type Used as AmiscondSTrultAccess AWS managed Permissions policy Tags - optionof Tags are toy-value pairs you can add to AWS resources to help identify, organice, or search for resources. Gloose any tags you want to associate with this user. No tags associated with the resource. Add new tags. Yas can add up to 50 more tags.		Permissions summary			< 1 >
AmisandsTrubLecess AMiS managed Permissions policy Image: a performed Tags - optionel Tags are key-value pairs you can add to MVS resources to help identify, organize, or search for resources. Choose any tags you want to associate with this user. No tags associated with the resource. Add new tags You can add up to 50 more tags. You can add up to 50 more tags.		Name 🔀	▲ Туре	▼ Used as	∇
Tags - optional Tags relevable plan you can add to AWS resources to help identify, organize, or search for resources. Choose any tags you want to associate with this user. No tags associated with the resource. Add new tag You can add up to 50 mont tags.		AmazonS3FullAccess	AWS managed	Permissions policy	
		Tags are key-value pairs you can add to AWS resour No tags associated with the resource. Add new tag You can add up to 50 more tags.	res to help identify, organize, or search for resources. Choose any tag	gs you want to associate with this user.	

Fig22. Create User

Permissions Groups Tags Security crede	tials Access Advisor		
Console sign-in			Enable console access
Console sign-in link D https://neeraj1234.signin.aws.amazon.com/console		Console password Not enabled	
Multi-factor authentication (MFA) (0) Use MFA to increase the security of your AWS environment. Signing in	with MFA requires an authentication code f	rom an MFA device. Each user can have a maximum	Remove Resync Assign MFA device n of 8 MFA devices assigned. Learn more [2]
Device type Id	entifier	Certifications	Created on
No M	FA devices. Assign an MFA device to ir Assign 1 Assign 1	nprove the security of your AWS environme	nt
Access keys (0) Use access keys to send programmatic calls to AWS from the AWS CLU	AWS Tools for PowerShell, AWS SDKs, or di	rect AWS API calls. You can have a maximum of tw	Create access key vo access keys (active or inactive) at a time. Learn more 🛃
No access keys. As a best practice, avoi	d using long-term credentials like acco	ess keys. Instead, use tools which provide sh	nort term credentials. Learn more 🔀
Patriava access kavs v	Fig23. A	ccess key	
terreve access keys into			
Access key If you lose or forget your secret access key, you cannot	retrieve it. Instead, create a new a	access key and make the old key inactiv	e.
Access key	Secret access key		
AKIA3MLTKNREBVYZM6X3	D ************	Show	
Access key best practices			
 Never store your access key in plain text, in Disable or delete access key when no longe Enable least-privilege permissions. Rotate access keys regularly. 	a code repository, or in code. r needed.		

Fig24. Create Access key

Download .csv file

• Below Fig25. shows replacing the keys with the IAM keys in the code.

public vo	id upload() throws Exception {
Syste	<pre>m.out.println(user.toUpperCase());</pre>
Basic	AWSCredentials credentials = new BasicAWSCredentials("AKIA3MLTKNREAJG4KBQD","I0U8eIgVrKRqIFk02TxP
Amazo	nS3 s3Client = new AmazonS3Client(credentials);
if(!s	<pre>3Client.doesBucketExist("ehr-"+user)){</pre>
B	ucket bucket = s3Client.createBucket("ehr-"+user,"us-east-2");
s3Cli	ent.putObject("ehr-"+user,file.getName(),file);
msg =	"success";

Fig25. Access Key usage in the code

5 Execution:

- Right click on the code artifact in the eclipse and click on Run server.
- Select Tomcat server and click on Finish.
- The following figures from Fig 26. to Fig28. shows the deployment of the application.

Run On Server Select which server to use How do you want to select the server? Choose an existing server O Manually define a new server Select the server that you want to use: Select the server that you want to use: Server * Image: Docalhost State * Tomcat v8.5 Server at localhost Stopped	💮 Run On Server						\times
Select which server to use How do you want to select the server? Choose an existing server O Manually define a new server Select the server that you want to use: type filter text Server State * Elocalhost Tomcat v8.5 Server at localhost * Tomcat v8.5 Server at localhost * Apache Tomcat v8.5 supports J2EE 1.2, 1.3, 1.4, and Java EE 5, 6, and 7 Web modules. Columns Always use this server when running this project	Run On Server						
How do you want to select the server? Choose an existing server Manually define a new server Select the server that you want to use: type filter text Server State * Elocalhost Image: Tomcat v8.5 Server at localhost Apache Tomcat v8.5 supports J2EE 1.2, 1.3, 1.4, and Java EE 5, 6, and 7 Web modules. Columns Always use this server when running this project	Select which server to	use					
Choose an existing server Manually define a new server Select the server that you want to use: type filter text Server	How do you want to set	lect the server?					
O Manually define a new server Select the server that you want to use: Type filter text Server ✓	Choose an existing	server					
Select the server that you want to use: type filter text Server State Server State <td>Manually define a r</td> <td>new server</td> <td></td> <td></td> <td></td> <td></td> <td></td>	Manually define a r	new server					
Server State Server State Tomcat v8.5 Server at localhost Stopped Apache Tomcat v8.5 supports J2EE 1.2, 1.3, 1.4, and Java EE 5, 6, and 7 Web modules. Columns Always use this server when running this project Columns	Select the server that yo	ou want to use:					
Server State ~ Pocalhost Tomcat v8.5 Server at localhost Apache Tomcat v8.5 supports J2EE 1.2, 1.3, 1.4, and Java EE 5, 6, and 7 Web modules. Columns Always use this server when running this project Columns	type filter text						
Column Always use this server when running this project	Server			State			
Apache Tomcat v8.5 Server at localhost Stopped	V Docalhost						
Apache Tomcat v8.5 supports J2EE 1.2, 1.3, 1.4, and Java EE 5, 6, and 7 Web modules.							
	Apache Tomcat v8.5 sup	pports J2EE 1.2, 1.3	, 1.4, and Java EE 5, s project	6, and 7 Web	modules.	Co	lumns
(?) < Back Next > Finish Cancel		< Back	Next >	Finish		Cance	el

Fig26. Tomcat Server



Fig27. Application Deployment



Fig28. Application

← → で O localhost:2020/E-Health/TestResult.jsp7t1=lab&t2=Patient1		🕁 🖬 🌚 Incognito 🕴
Vew Personal Profile Vew Mod	Electronic Health Records	
	Test Results Screen	
	Lab Technisian Kolo Test Report V Upload Report Choose File X-roy Jpg: Normal	
	Test Results Create	3

Fig29. Report Upload

From the above Fig29. shows that when the user uploads the report it automatically creates the S3 bucket in the AWS and uploads the report to the S3 bucket as shown in the below Fig30. and Fig31.

Account snapshot	se Lans. Matrics are nenerated avery 74 bours. Matrics don't in	vlude directory burkets. Learn more 🔽	View Storage Lens dashboard
	p cens, meana ano generacea every 24 meana meana aon e a	Relate diffectory discrets.	
al storage	Object count	Average object size	You can enable advanced metrics in the "default-account-dashboard" configuration.
eneral purpose buckets Di	irectory buckets		
eneral purpose buckets Di eneral purpose buckets (ckets are containers for data stored in	(1) Info	D	Copy ARN Empty Delete Create bucket
eneral purpose buckets Di eneral purpose buckets (ckets are containers for data stored in 2, Find buckets by name	(1) Info SSI Learn more [2]	C C	Copy ARN Empty Delete Create bucket Create bucket
eneral purpose buckets Di eneral purpose buckets (ckets are containers for data stored in 2, Find buckets by nome Name	(1) Info 153 Learn more 2 A AWS Region	C C	

Fig30. S3 Bucket

aws Services Q Search	[Alt+S]	도 🕹 🖗 🎯 Global 🕶 Harsha	i @ neeraj1234 🔻
60 EC2			
Amazon S3 ×	Amazon 53 > Buckets > ehr-patient1		0
Buckets	ehr-patient1 Info		9
Access Grants New Access Points Object Lambda Access Points	Objects Properties Permissions Metrics Management Access Points		
Multi-Region Access Points Batch Operations IAM Access Analyzer for S3	Objects (1) Info Objects are the fundamental entities stored in Amazon S3. You can use <u>Amazon S3 investory</u> (2) to get a list of all objects in you them permissions. <u>Learn more</u> (2)	r bucket. For others to access your objects, you'll need to explicitly gran	et
Block Public Access settings for this account	C O Copy S3 URI O Copy URL Download Open Delete	Actions ▼ Create folder Image: Create folder	9
▼ Storage Lens	Name ▲ Type ▼ Last modified ▼ 5	Size V Storage class	~
Dashboards Storage Lens groups New AWS Organizations settings	Link December 8, 2023, 11:30:11 (UTC+00:00)	5.9 KB Standard	
Feature spotlight 🥑			6

Fig31. S3 Bucket Objects.

6 Evaluation

Below Fig32 shows the importing libraries for the Fernet (Symmetric) Encryption in order to compare the performance with the CPABE.

```
import boto3
from cryptography.fernet import Fernet
import zlib
import time
```

Fig32. Importing libraries for Fernet

Below Fig33. shows the logic for the time taken for the fernet to encrypt/decrypt and upload the compressed data into S3 bucket.



Fig33. Data Encryption/Decryption for Fernet

Below Fig34. shows the logic for the time taken for the fernet to encrypt/decrypt and upload the compressed data.



Fig34. Data Encryption/Decryption for CPABE



References

Alabdulatif, A., Khalil, I. and Mai, V., 2013, July. Protection of electronic health records (EHRs) in cloud. In 2013 35th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC) (pp. 4191-4194). IEEE.

Pandit, P., 2021. Case Study on AWS Identity and User Management.