

A Framework for Cloud-Based EHR Security Using Hybrid Cryptographic Methods of AES and ECC

MSc Research Project

MSc Cybersecurity

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National College of Ireland

MSc Project Submission Sheet

School of Computing

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Programme: MSc Cyber security

Module: MSc Research Project

Supervisor: Dr. Rohit Verma

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Configuration Manual

Vansh Arora Student ID: 21144222

1 Introduction

The purpose of the configuration guideline is to furnish a concise summary of the necessary prerequisites for constructing the application, while also serving as a guide for the systematic steps involved in its proper development, operation, testing, or replication. The remainder of the document is divided into five modules, with Module 2 focusing on system configuration, Module 3 outlining the required libraries, Module 4 discussing database tables, Module 5 addressing Electronic Health Record implementation, and Module 6 covering Cloud Deployment.

2 Configuration of System

2.1 ASP .Net Environment Setup

The entire application was coded using the C# language and developed on the Visual Studio platform. The Visual Studio platform can be downloaded and set up for free from the Microsoft website, making it a desirable choice due to its compatibility with various platforms and ability to support several programming languages. For this project, Visual Studio Community 2019 (version 16.11) was the preferred text editor.



Figure 1: Download page of Visual Studio

2.2 Database Server Setup

The project employs Microsoft SQL database to store application data, which enables us to connect to both local and cloud data storage. The version of Microsoft SQL Management Studio utilized in the project is 19.0.2. To access the database, the user must provide authentication credentials. Open-source versions of the SQL Management tool can be obtained online at no cost.

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	SQL Server			
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	Login: http://www.automatication			
	Password			
	Remember password			
	Connect Cancel Help Options >>			

Figure 2: Microsoft SQL Management

2.3 Hardware specifications

- RAM: 8 GB
- Processor: Intel Core i5
- Hard Disk Drive: 20 GB HDD

2.4 Software specifications

- OS Used: Microsoft Windows 10
- Language: C# .Net
- IDE used: Visual Studio Code

3 Libraries Used

The web application was developed using various libraries and import statements, which are highlighted in the list below as the primary ones.

1	⊡using System;
2	<pre>using System.Collections.Generic;</pre>
3	using System.Configuration;
4	using System.Data;
5	<pre>using System.Data.SqlClient;</pre>
6	using System.IO;
7	using System.Linq;
8	<pre>using System.Net.Mail;</pre>
9	<pre>using System.Security.Cryptography;</pre>
10	using System.Text;
11	using System.Web;
12	using System.Web.UI;
13	<pre>using System.Web.UI.WebControls;</pre>
14	

Figure 3: Imported Libraries

1	⊡using	System;
2	using	System.Collections.Generic;
3	using	System.Configuration;
4	using	System.Data;
5	using	System.Data.SqlClient;
6	using	System.Diagnostics;
7	using	System.IO;
8	using	System.Linq;
9	using	System.Net.Mail;
10	using	System.Security.Cryptography;
11	using	System.Text;
12	using	System.Web;
13	using	System.Web.UI;
14	using	System.Web.UI.WebControls;
15	-	

Figure 4: Imported Libraries

4 Database Tables Used

	Resu	ts 📑 Message	S					
	ld	Full_Name	Degree	Specialist	Email	Phone	Password	Address
1	3	Pravin Patel	M.B.B.S	Heart, Diabities	pp62@gmail.com	8657482459	9Qm1kEVx	North Delhi
2	2	Sunil Dixit	M.B.B.S	Heart	sunil1971@gmail.com	9878856932	DOIY1Vsc	East Delhi
3	4	Gautam Kapoor	ME	HEart	spsahab97@gmail.com	8028989796	AOxljvBm	South Delhi
4	5	Rajat Dua	MBBS	Spec	dua100rajat@gmail.com	9293322122	123456	West Delhi

Figure 5: Doctor Table

Detient Id	Decid	E.U. Marrie	Deserved	Castantina	Energi ist	Antonio	Description	Dements	Dete
Patient_Id	Doc_la	Full_IName	Password	Contact_no	Email_id	Address	Description	кетак	Date
1	3	Vansh Arora	Wd8mUUI5	9227986929	vanshsir202	Delhi	Diabetes Su	Blood Repo	2023-04-12
2	4	Poonam Ar	II3qURoa	9989823997	poonam877	Delhi	Flu	Bed Rest	2023-03-24
3	2	Praveen Aro	PpaaVgYf	9479224154	p.arora@g	Delhi	Fever and c	Blood Repo	2023-03-26
4	3	Kunal Arora	qaeMqcNe	8560021057	kunalmiki@	Delhi	Covid	Test	2023-03-20
5	5	Kanika Arora	tKubluDj	9097765213	kanikashinu	Delhi	Blood Press	Balanced Di	2023-03-22
6	4	Palak Pahwa	zvPITh8H	9988776600	palakkanu@	Delhi	Full body ch	Heart Patient	2023-03-29
NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL

Figure 6: Patient Table

100 12	results	g# Message	15						
	ld	Date	File_Name	File_Path	Patient_ld	Description	doc_id	File_enc	Key_Value
1	3008	2023-03-29	jwalamma-85years.pdf	C:MedicalMedicalWeb/MedicalWeb/Doctor/Files/jwalam	2	sample test	4	C:Medical/MedicalWebiMedicalWebiDoctor/Files/jwalam	InO3qIOH7OwDY6+2P9keDCaLOjvw8+jHcr6C7pk6X9U=
	3009	2023-03-29	TMCC_bank_details.pdf	C:MedicalMedicalWebiMedicalWebiDoctor/Files/TMCC_b	6	Blood report	4	C:MedicalMedicalWebiMedicalWebiDoctorFilesITMCC_b	USdVHc6x1s26KMn6xaeCo4rObj7+uQMSXLhVs6Xev/A=
8	3010	2023-04-17	Free_Test_Data_1M8_DOCX-1.docx.doc	Finew_version/new_version/Medica/Web_AES_ECC/Medi_	1	word file docx	3	Finew_version/new_version/Medica/Web_AES_ECO/Medi_	i+N1dReK7yRIRAXFwKJDcAi90EUoja4ozMzoy0Zgjul=
1	3011	2023-04-17	word 1.doc	Finew_version/new_version/Medica/Web_AES_ECCIMedi_	1	word file 1	3	Finew_versioninew_versioniMedicalWeb_AES_ECCIMedi_	cJrloKiAZ8VoNeI07/YJ92/WcnhwC00KZm0UQhtHik=
5	3013	2023-04-17	Free_Test_Data_1M8_PDF-2.pdf	Finew_versioninew_versioniMedicalWeb_AE8_ECCVMedi_	1	pdf 1mb	3	Finew_version/new_version/MedicalWeb_AES_ECC/Medi_	XpupsPAuXJjTFUXtaPkNYG9MGVNkNdyiLqdzus5hcEU+
5	3014	2023-04-17	Free_Test_Data_1M8_PPTX.pptx.ppt	Finew_version/new_version/MedicalWeb_AES_ECC/Medi_	1	ppt	3	Finew_versionInew_versionIMedicalWeb_AES_ECOMedi_	vgG+d0JDqo+r6JQ0vHMpM8IVRQp0Q4YYr6qRVWq8WQ
	3016	2023-04-17	Free_Test_Data_1M8_XLS.xls	Finew_version/new_version/Medica/Web_AE8_ECC/Medi_	1	xis file	3	Finew_versioninew_versioniMedicalWeb_AES_ECCIMedi_	kUmB3nD2m0fioYD7NJCyPoTkIDDoMo1wPeS1oJfzvQ+
5	3017	2023-04-17	png-1mb.png	Finew_version/new_version/MedicalWeb_AEB_ECC/Medi_	1	png	3	Finew_version/new_version/Medica/Web_AES_ECC/Medi_	nG7Ugilo7/5/kMkdwzvgoC4Ga1w3nZHMMsB0tWyO42Q
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14	3025	2023-04-18	10.7.pdf	F:Medical web/EHR/MedicalWeb_AES_ECC/Medica/Web/	4	10.7mb	3	F:Medical web/EHR!MedicalWeb_AES_ECC/MedicalWeb/	sfoLIGCsrrpYYLoSqX6Mrzp1JUdXXwsCVOIrxRvUI7I=
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33	3036	2023-04-18	21.pdf	F:Medical web/EHR/MedicalWeb_AES_ECC/MedicalWeb\	1	20.3mb	3	FiMedical web/EHR/MedicalWeb_AES_ECC/MedicalWeb/	c7DBv6Rq1DiuwkfLHhbCSXrfOsSk1sR/Km+waNKGqvE+

Figure 7: File Upload Table

5 Implementation of Electronic Health Record

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	spsahab97@gmail.com						
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Figure 8: Signup Page

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🔗 Sign in								
Login as								
Doctor								
Email ID								
pp62@gmail.com								
Password								
Login New User ? Register Here								
								63

Figure 9: Doctors/Patient Login Page



Figure 10: Doctor Dashboard

	localhost:57713/Doctor/Managei	× +							-	٥	×
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	ADMIN PANEL				Manage Patient						Q Q Q
र्द्ध	DASHBOARD										0
	MANAGE PATIENT	ADD PATIENT									+
		SrNo	Name	Contact	Email ID	Address	Creation Date				
Ш	PATIENT RECORDS	1	Vansh Arora	9227986929	vanshsir2020@gmail.com	Delhi	12-Apr-2023				
		2	Palak Pahwa	9988776600	palakkanu@yahoo.com	Delhi	29-Mar-2023				
Ш	VIEW SHARED FILE	3	Praveen Arora	9479224154	p.arora@gmail.com	Delhi	26-Mar-2023				
ши		4	Poonam Arora	9989823997	poonam8776@yahoo.com	Delhi	24-Mar-2023				
		5	Kanika Arora	9097765213	kanikashinu@gmail.com	Delhi	22-Mar-2023				
Ċ	LOGOUT	6	Kunal Arora	8560021057	kunalmiki@gmail.com	Delhi	20-Mar-2023				
											263



	localhost:57713/Doctor/AddPatie ×	+						-	0	×
\leftarrow	C i localhost:57713/Doc	tor/AddPatient.aspx?action=add		A»	ŵ	5⁄≡	Ē			b
	ADMIN PANEL									Q
କ୍ଷିଣ	DASHBOARD	Patient Details								<u>o</u>
血	MANAGE PATIENT	Name								+
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Figure 12: Add patient details

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面	PATIENT RECORDS	1	Vansh Arora	word2.doc		19-Apr-2023					
		2	Vansh Arora	sample-2mb-text-file.txt	1mb txt	19-Apr-2023					
ന്ന		3	Vansh Arora	26.pdf	24.6mb	18-Apr-2023					
ш	VIEW SHARED FILE	4	Vansh Arora	28.pdf	27.1mb	18-Apr-2023					
		5	Vansh Arora	21.pdf	20.3mb	18-Apr-2023					
Ċ	LOGOUT	6	Vansh Arora	17.pdf	17.9mb	18-Apr-2023					
		7	Vansh Arora	10.pdf	10.7mb	18-Apr-2023					
		8	Vansh Arora	7.pdf	7.13mb	18-Apr-2023					
		9	Vansh Arora	3.pdf	3.57mb	18-Apr-2023					
		10	Vansh Arora	1mb.pdf		18-Apr-2023					
		11	Kunal Arora	1.18.pdf		18-Apr-2023					
		12	Kunal Arora	24.pdf	24mb	18-Apr-2023					
		13	Kunal Arora	24.6.pdf	24.6mb	18-Apr-2023					
		14	Kunal Arora	7.13.pdf	7.13mb	18-Apr-2023					
		15	Kunal Arora	7.14.pdf		18-Apr-2023					
		16	Kunal Arora	10.7.pdf	10.7mb	18-Apr-2023					
		17	Kunal Arora	17.8.pdf	17.8mb	18-Apr-2023					
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रहे 3	DASHBOARD	Patient Details							a
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血	VIEW SHARED FILE	Choose File No file chosen							
Ċ	LOGOUT	Submit							
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Figure 14: Doctor uploads patient file

	Image: Strate State S												
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883	DASHBOARD			ОК				a					
血	MANAGE PATIENT	UPLOAD FILE						+					
		SrNo	Patient	File Name	Description	Creation Date							
血	PATIENT RECORDS	1	Poonam Arora	hospital_dec.png	full checkup	24-Apr-2023							
		2	Palak Pahwa	TMCC_bank_details.pdf	Blood report	29-Mar-2023							
m	VIEW SHARED FILE	3	Poonam Arora	jwalamma-85years.pdf	sample test	29-Mar-2023							
Ċ	LOCOUT							C. Ø3					

Figure 15: Time taken in file uploading





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रहीर	DASHBOARD	SrNo	Doctor	Contact	File Name	Description	Date						0
	VIEW REPORTS	1	Pravin Patel	8657482459	word2.doc		19-Apr-2023	Down	nload				+
血	SHARE REPORTS	2	Pravin Patel	8657482459	sample-2mb-text-file.txt	1mb txt	19-Apr-2023	Down	nload				
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		4	Pravin Patel	8657482459	28.pdf	27.1mb	18-Apr-2023	Down	nload				
		5	Pravin Patel	8657482459	21.pdf	20.3mb	18-Apr-2023	Down	nload				
		6	Pravin Patel	8657482459	17.pdf	17.9mb	18-Apr-2023	Down	nload				
		7	Pravin Patel	8657482459	10.pdf	10.7mb	18-Apr-2023	Down	nload				
		8	Pravin Patel	8657482459	7.pdf	7.13mb	18-Apr-2023	Down	nload				
		9	Pravin Patel	8657482459	3.pdf	3.57mb	18-Apr-2023	Down	nload				
		10	Pravin Patel	8657482459	1mb.pdf		18-Apr-2023	Down	nload				
													263

Figure 17: View reports of patient uploaded by doctor

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8 83	DASHBOARD	Enter Key to download file A the key that has been sent to your registered Email ID							۵ ۵
血	VIEW REPORTS	Enter Key							+
血	SHARE REPORTS	Decryption Time:							
Ċ	LOGOUT	Submit							
		Download							
									1

Figure 18: Enter Key for file downloading



Figure 19: Key received in email immediately after uploading the patient file by doctor

	localhost:57713/Patient/Downloa ×	🔍 google signin - Search 🛛 x G Google Account x M Authentication Details - vanshsin x +					0	×
\leftarrow	C i localhost:57713/Pati	ent/DownloadFile.aspx?ld=3040	A	ŵ	£≞	Ē		b
	ADMIN PANEL							Q
रहीर	DASHBOARD	Enter Key to download file A the key that has been sent to your registered Email ID						• •
ш	VIEW REPORTS	Enter Key						+
血	SHARE REPORTS	USfVBAva7M8kbWsTr2MiZzvBSaZrMemfXgt2im4+hhV=						
Ċ	LOCOUT	Submit						
								(j)

Figure 20: File downloading and Calculating the time for decryption

	🕐 localhosts7713/Patient/Manage x +												
\leftarrow	C 🕕 localhost:57713/Pa	atient/ManageFiles	aspx			A	as 6	£≡	Ð				
-	ADMIN PANEL			Vi	ew Repo	orts) a o	
28	DASHBOARD											0	
m	VIEW REPORTS	SHARE FILE										+	
-		SrNo	File Name	Doctor	Mobile	Description	C	ate					
m	SHARE REPORTS	1	word2.doc	Gautam Kapoor	8028989796	share	Apr 19 2	023 1:21	PM				
-		2	1mb.pdf	Gautam Kapoor	8028989796		Apr 19 20	23 11:01	MAI				
7755	LOCOUT	3	Free_Test_Data_1MB_DOCX-1.docx.doc	Sunil Dixit	9878856932		Apr 19 20	23 10:59	MAG				
		4	5.jpg	Pravin Patel	8657482459	Dengue Report Please View this report	Mar 26 2	022 12:3	IPM				
		5	80.jpg	Gautam Kapoor	8028989796	dddd	Mar 24 20	022 6:44	BPM				
		6	80.jpg	Gautam Kapoor	8028989796	asdadasd	Mar 24 2	022 6:4	3PM				
		7	drawio.png	Sunil Dixit	9878856932	Check for Diabetes	Mar 13 20	22 11:50	MAC				
												567	
												- 25	

Figure 21: Patient share reports by other doctors

	localhost:57713/Patient/ShareFile >	+					-	0	×
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	ADMIN PANEL								Q
88	DASHBOARD	Share File Select doctor to share file with							a
m	VIEW REPORTS	FileSelect	Doctor	<u> </u>					+
መ	SHARE REPORTS	Description							
Ċ	LOGOUT								
		Submit							
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Figure 22: Choose file and doctor for sharing reports

	Calibost57713/Doctor/MewUs: x +											×
÷	C 🕕 localhost:57713/Doctor/Vie	wUserFile.	азрх				A	136 € ≊	Ð			
	ADMIN PANEL					View Shared Reports						Q 0
5833	DASHBOARD	SrNo	Patient	Contact	File Name	Descripion	Creation Date					0
m	MANAGE PATIENT	1	Vansh Arora	9227986929	5.jpg	Dengue Report Please View this report	Mar 26 2022 12:31PM	Download				+
m	PATIENT RECORDS											
	VIEW SHARED FILE											
Ó	LOGOUT											
												۵
												1 (3)

Figure 23: File shared by patient to other doctor

	localhost:57713/Doctor/Downloa ×	+					-	٥	\times
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									0
	ADMIN PANEL								
		Fater OTD to develop of file							0
रहेर	DASHBOARD	A One-Time Password has been sent to your registered Email ID							0
									+
面	MANAGE PATIENT	Enter OTP							
ШU Ш	PATIENT RECORDS								
ф		Submit							
шш	VIEW SHARED FILE								
cb	LOGOUT								
									(j)

Figure 24: Authentication for downloading the share report



File Access details

To: spsahab97@gmail.com

File name: word 1.doc Otp:QyZzLt

Figure 25: OTP received on shared doctor registered email ID

	localhost:57713/Doctor/Downloa	🗙 🔍 google signin - Search 🛛 x G Google Account x M Inbox (189) - vanshsir2020@gmi x [New tab	$\times +$	- (o ×
\leftarrow	C i localhost:57713/Do	cctor/DownloadFile.aspx?Id=1012		A & & € @ ¥		· 🜔
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			word 1.doc			6
පතින		Enter OTP to download file	See more			
ogo	DASHBOARD	A One-Time Password has been sent to your registered Email ID	Jeemore			
血	MANAGE PATIENT	Enter OTP				+
		QyZzLt				
血	PATIENT RECORDS					
m	VIEW SHAPED FILE	Submit				
Щ	TEW SHARED FILE					
Ċ	LOGOUT					
						~
						263

Figure 26: File downloaded after submit the correct OTP

6 Cloud Deployment

6.1 New Application Creation

The complete application is deployed on the cloud, utilizing the Windows Azure cloud service, which supports public cloud-based services and can be developed in multiple programming languages. To develop a new application in the Azure cloud, the user must first log in to the cloud environment and then select the App service. After the application is created, a cloud access URL is issued for the program.

6.2 Create Cloud Database

The Azure Cloud provides an option to create a database, as shown in the screenshot below. However, the database connection details may differ when using the cloud platform.



Figure 27: Create Cloud Database



Figure 28: Database created for Application in Cloud

6.3 Publish Updated details in Cloud Environment

If there are any modifications to the current code base, it is recommended to publish them on the cloud. Local changes can also be updated in a cloud environment. The below Fig:29 illustrates an option for publishing changes from the local machine to the cloud environment.

Proje	ct	Buil	d	Debug	Test	Analyze	Tools	Extensions	Windov	v Help
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			Re	build Solu	tion					
aspx.cs			Cl	ean Solutic	on					Shi
			Ru	ın Code An	alysis o	n Solution		Alt+F1	1	
m; m.Colle	cti	*	Bu	ild Medica	lWeb			Ctrl+B		
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em.Data; em.Data.	Sq]		Cl	ean Medica	alWeb					
em.IO;		Ð	Pu	ıblish Medi	calWeb					
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<pre>em.Web;</pre>			Сс	onfiguration	n Manag	ger				
m.Web.U m.Web.U	I; I.V		Сс	onfigure Co	ontinuou	ıs Delivery t	o Azure			
HR.Pati	ent	_								

Figure 29: Publish Code Changes in Cloud

6.3 Electronic Health Record Web Application URL

https://hctehr.azurewebsites.net/Login.aspx