Secure Data Management - Public Health Record system

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Project Requirements

Functional Requirements

Active Users

Users with write access who constantly interact with the PHR

Passive Users

Users with read-only access who only observe the PHR

Authorities

Entities responsible for issuing keys

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Active Users

Patients

Have complete control over their own health record

Doctors

Read patient data and write health data in the PHR

Trainers

Read patient data and write training data in the PHR

Passive Users

Insurance representatives

Employer representatives

Can be granted read access, but not write.

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Authorities

Hospitals

Health Clubs

Insurance companies

Employers

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Security Requirements

Data encryption

Health-related data is highly confidential → has to be stored encrypted

Access Control

Make sure parties can only perform actions that they are entitled to

Authorization

Authorize users before performing actions

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02

Solution Overview

Solution Overview

PHR System

- **Access Control** — Cryptographically enforced via MA-CP-ABE
- **Encryption Scheme** — AES Encryption with key encrypted with MA-CP-ABE
- **Authorization** — Cryptographic Challenge-based authorization
- **Client - Server Model** — Central server with aggregated data, and client with cache database

03

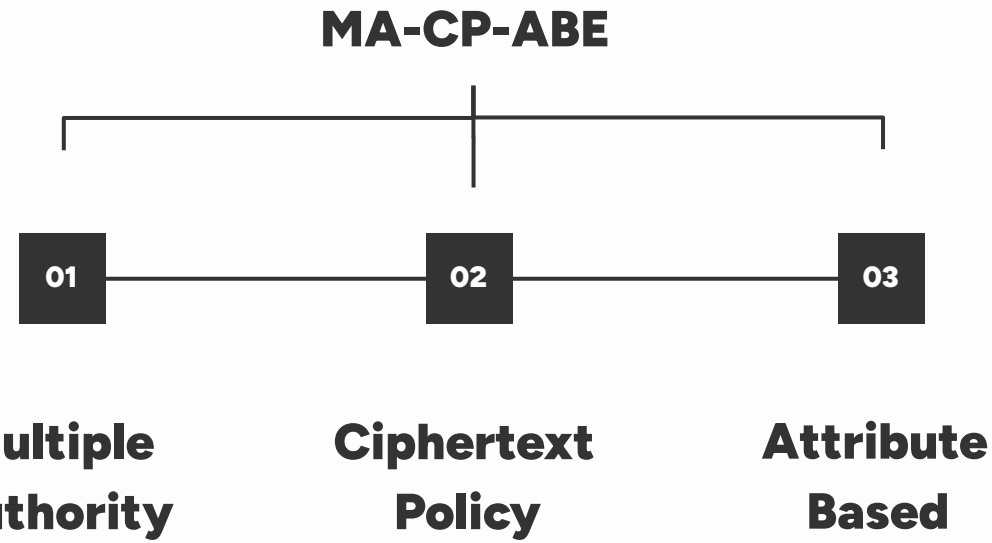
Software Architecture

System Architecture -
Client - Server Model

Client

Server

System Architecture -
Access Control



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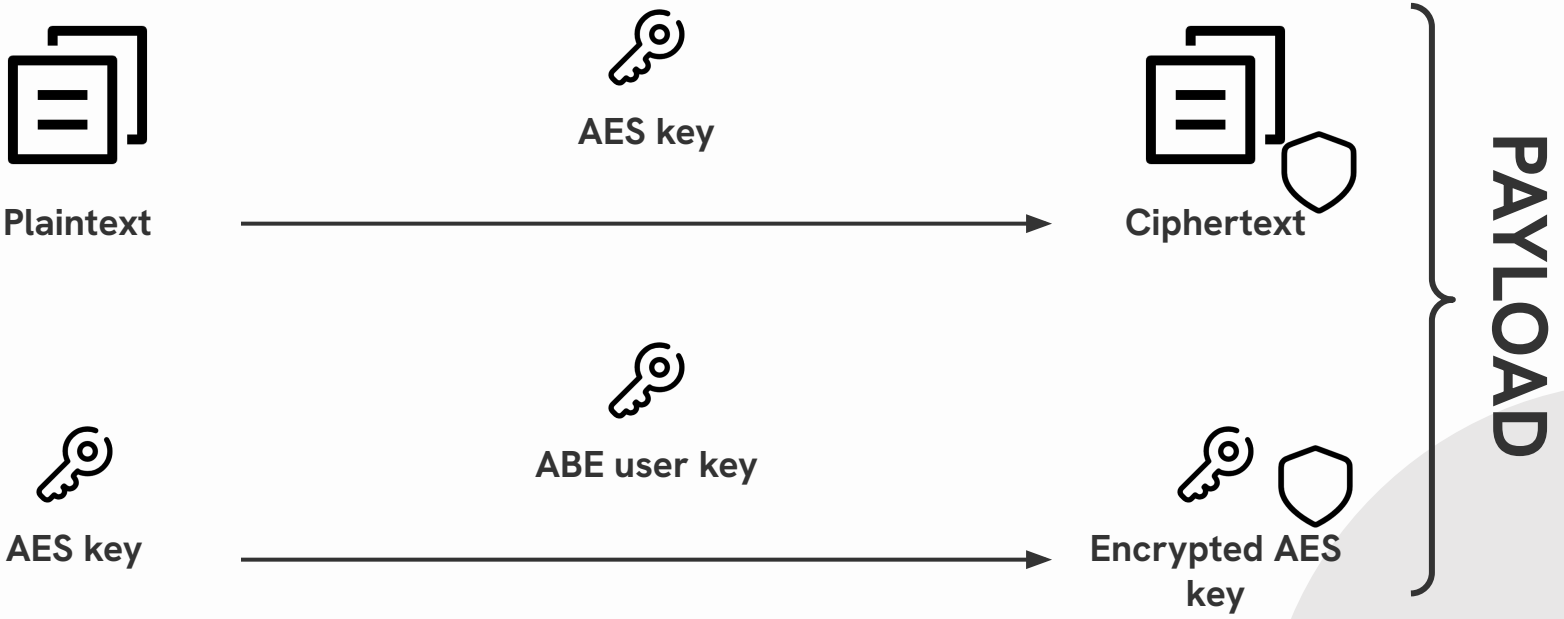
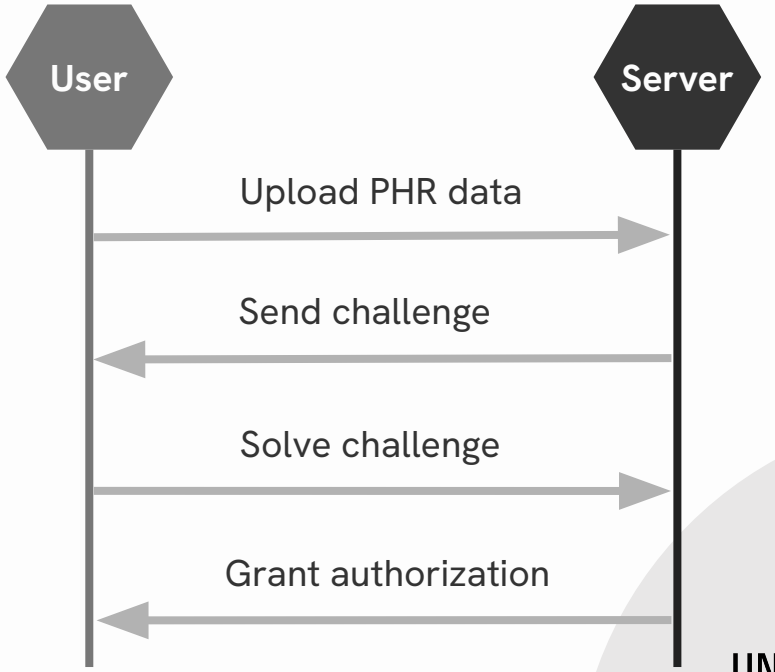
System Architecture -
A Hybrid Approach



System architecture -
Authorization

- MA-CP-ABE does not distinguish R/W type of access
- Challenge-Response protocol



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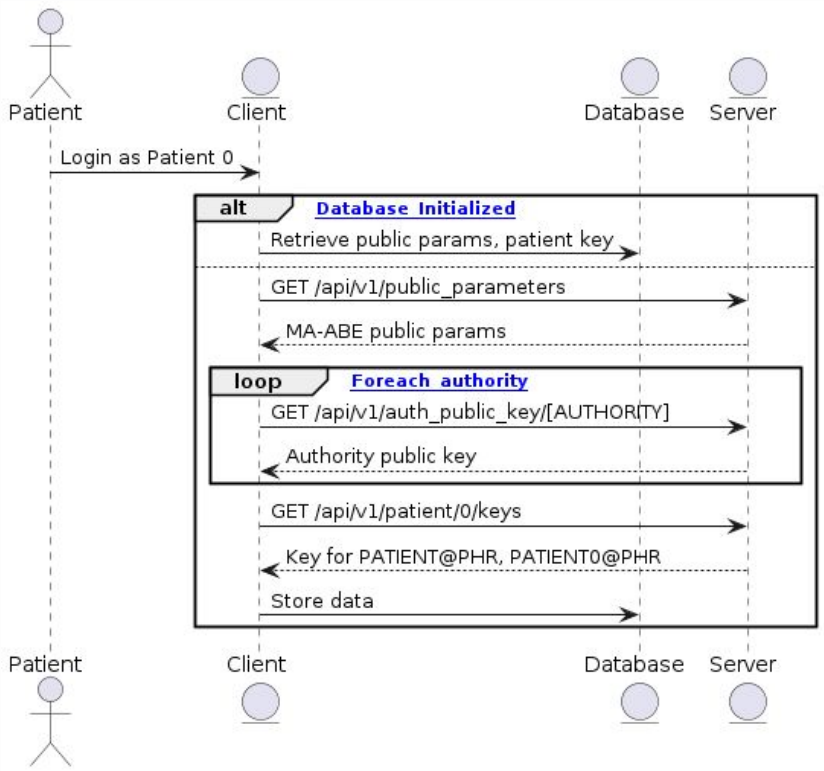
Implementation

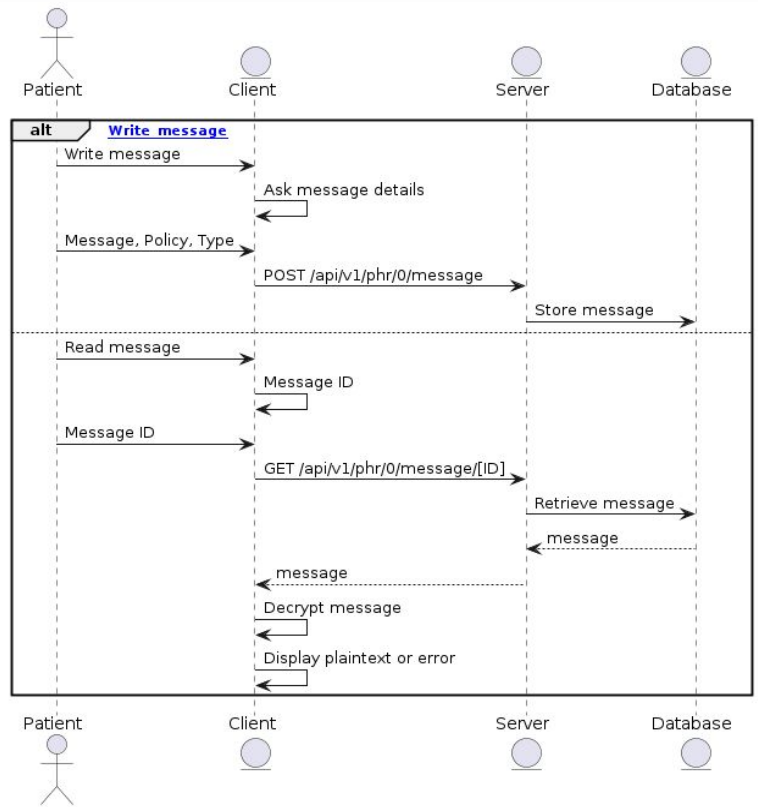
Implementation -
Client and Server model

- Server implemented using Django
- Server provides REST API endpoints
- SQLite DB on both sides

Implementation - Initial Setup



Implementation - Patient Communication



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Implementation -
Access Control

- Charm framework
- [abenc_maabe_rw15] module

Attribute structure
ATTRIBUTE@AUTHORITY

Policy structure
PATIENT@PHR OR
DOCTOR@HOSTPITAL

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Implementation -
Encryption scheme

- Messages, keys stored in DB
- MA-CP-ABE extended with AES

Implementation -
Authorization

Generation
- Server

1. Generate challenge
2. Encrypt with policy
3. Store correct result
4. Send to User

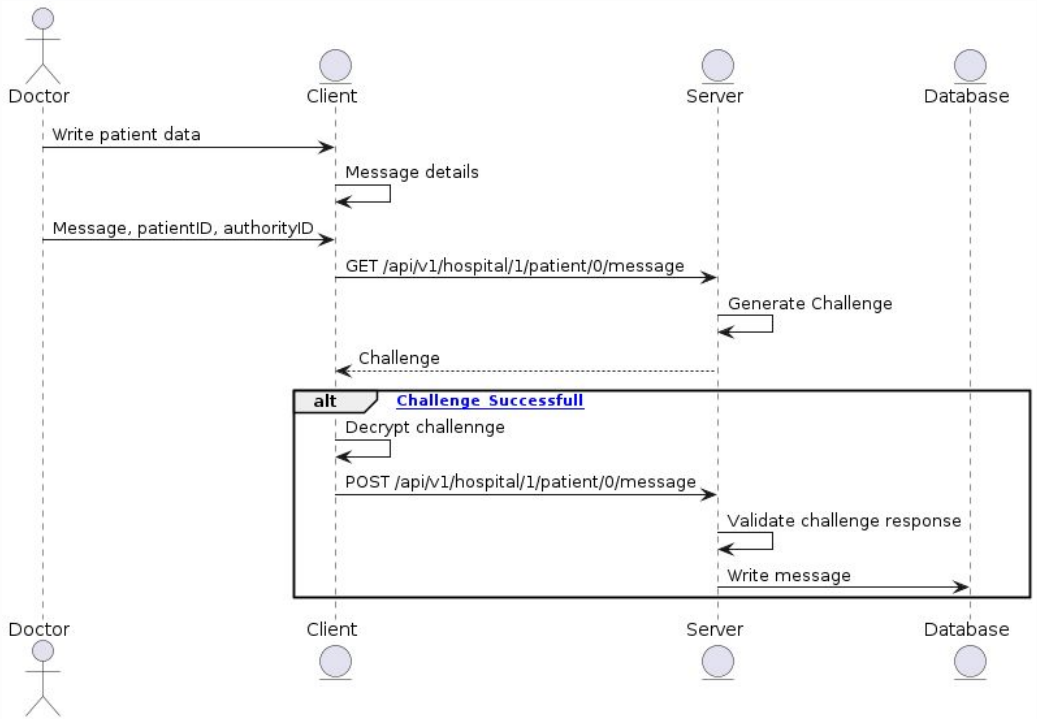
Solving
- User

1. Receive challenge
2. Encrypt with policy
3. Return to Server

Verification
- Server

1. Receive response
2. Check response with saved solution
3. Grant or deny access

Implementation - Authorization



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Implementation -
Data models

- **Authority** models
- **Key** models: for Authority public & secret keys
- **Authority representative** models: reps. on behalf of Authorities
- **Patient** models
- **Encryption** models: MA-ABE public params. & encrypted AES keys
- **Message** models: health or training related data

- **PatientRep**: relationship between patients and reps.

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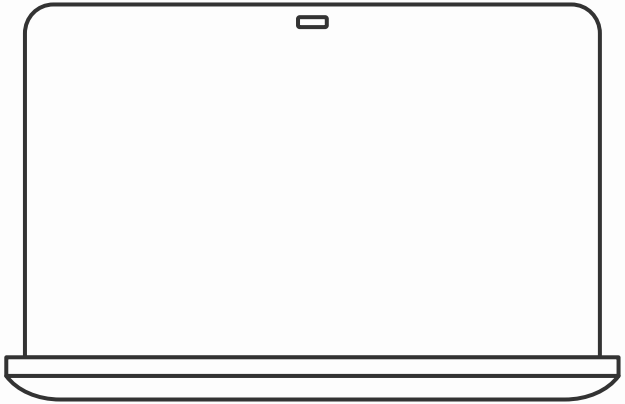
Project demo

Demonstration



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Limitations

Current Limitations -
Overview

- Possible MitM attack against challenges
- Unique AES keys per message
- Client-side ABE key stored in plaintext
- No key revocation
- Rudimentary UI

Q&A