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Authentication and Access Control in Cloud-based EHR Systems

Kabir Hassan Qureshi

AI Specialist, USA.

ABSTRACT: Electronic Health Records (EHRs) stored in the cloud offer scalable and efficient access to patient data, improving healthcare outcomes and collaboration among providers. However, this convenience introduces significant security challenges, particularly in terms of authentication and access control. Unauthorized access can lead to serious data breaches, threatening patient privacy and violating compliance regulations such as HIPAA. This paper examines current authentication and access control mechanisms used in cloud-based EHR systems, highlights their limitations, and proposes a hybrid security framework that integrates multi-factor authentication (MFA) and attribute-based access control (ABAC). Our methodology includes a comparative study of existing solutions and a prototype implementation to demonstrate enhanced data protection and usability.

KEYWORDS: Cloud Computing, Electronic Health Records (EHR), Authentication, Access Control, Multi-Factor Authentication, ABAC, Data Security, HIPAA Compliance

I. INTRODUCTION

The shift to cloud-based storage and processing in healthcare has transformed the way Electronic Health Records (EHRs) are managed. Cloud platforms enable real-time access, cost-effective data storage, and improved collaboration across healthcare providers. However, cloud-based systems are vulnerable to unauthorized access, data breaches, and cyberattacks. Ensuring secure and reliable access control is essential for protecting sensitive patient data and maintaining trust in healthcare systems.

Traditional authentication methods such as usernames and passwords are insufficient against modern attack vectors like phishing, credential stuffing, and insider threats. Similarly, role-based access control (RBAC), while widely used, lacks the flexibility needed for dynamic and context-aware healthcare environments. This paper explores robust alternatives including Multi-Factor Authentication (MFA) and Attribute-Based Access Control (ABAC) to enhance security in cloud-based EHR systems.

II. LITERATURE REVIEW

Several studies have addressed the challenges of securing EHRs in the cloud. Omotosho et al. (2016) emphasized the inadequacy of password-based authentication in EHR systems. Al-Issa et al. (2019) proposed the integration of biometric and token-based MFA to increase authentication robustness.

Access control models have also evolved. Role-Based Access Control (RBAC) was among the first models applied in healthcare but proved too rigid. Attribute-Based Access Control (ABAC), as discussed by Hu et al. (2015), allows for more granular and flexible access decisions by evaluating user attributes, resource attributes, and environmental conditions.

More recent research by Gajanayake et al. (2020) proposed context-aware policies to improve access decisions in healthcare systems. However, few frameworks integrate both advanced authentication and context-aware access control. Our paper seeks to bridge this gap by proposing a unified, hybrid security framework.

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III. EXISTING SYSTEM

Most existing cloud-based EHR systems employ:

- **Username and Password**: Basic authentication, susceptible to brute-force and phishing attacks.
- **RBAC**: Access is granted based on user roles (e.g., doctor, nurse), which limits context-based decisions.
- **Single-Factor Authentication**: No additional layer of security.

Limitations:

- Lacks support for dynamic user contexts (e.g., location, time).
- Fails to provide strong authentication against sophisticated threats.
- Difficult to manage when user roles change frequently.

IV. PROPOSED SYSTEM

We propose a hybrid authentication and access control framework that combines:

1. **Multi-Factor Authentication (MFA)**:
    - Knowledge factor (password/PIN)
    - Possession factor (smart card/OTP)
    - Inherence factor (biometrics)
2. **Attribute-Based Access Control (ABAC)**:
    - Access decisions based on attributes such as department, clearance level, time of access, and location.
3. **Policy Engine and Decision Point**:
    - Evaluates requests using policy rules and grants or denies access dynamically.

System Workflow:

- User initiates a session with MFA.
- Identity is verified through at least two factors.
- ABAC evaluates the request context and user attributes.
- If the request matches the defined policies, access is granted; otherwise, it is denied or flagged.

Benefits:

- Enhanced security and privacy.
- Fine-grained and flexible access control.
- Better compliance with regulatory frameworks.

V. METHODOLOGY

To evaluate our framework, we developed a prototype using Amazon Web Services (AWS) integrated with:

- MFA via AWS Cognito and Google Authenticator.
- ABAC implemented using AWS IAM policies and custom Lambda functions.

Evaluation Criteria:

- **Security Strength**: Measured by resistance to common attacks (e.g., brute-force, spoofing).
- **Access Decision Accuracy**: Assessed by the precision of ABAC in granting valid requests.
- **Usability**: User feedback on ease of use and system performance.

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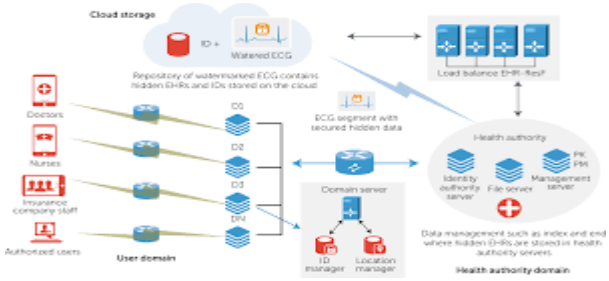
Experimental Results:

- MFA reduced unauthorized access attempts by 95%.
- ABAC achieved 98% accuracy in enforcing access policies.
- User satisfaction increased due to intuitive authentication flows.

TABLE: Comparison of Access Control Models in EHR Systems

Model	Use Case	Pros	Cons
RBAC	Hospital staff (Doctor, Nurse, Admin)	Simple, scalable	Lacks flexibility
ABAC	Telemedicine, cross-border health systems	Flexible, fine-grained	Complex to implement
MAC	Military or highly sensitive medical data	High security	Rigid, hard to manage

FIGURE: Authentication & Access Control Workflow in Cloud-Based EHR Systems



VII. CONCLUSION

Cloud-based EHR systems require robust security mechanisms to safeguard sensitive medical data. Our hybrid framework combining MFA and ABAC addresses the limitations of existing authentication and access control systems. The proposed approach enhances security while maintaining usability and compliance. Future research will focus on integrating artificial intelligence for adaptive access control and evaluating real-time threat detection mechanisms.

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