Hyperledger Fabric Based Access Control

<table>
<thead>
<tr>
<th>Title</th>
<th>Hyperledger Fabric Based Access Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status</td>
<td>PROJECT COMPLETED</td>
</tr>
<tr>
<td>Difficulty</td>
<td>HIGH</td>
</tr>
</tbody>
</table>

Description

Access control systems exist to protect resources from unauthorized accesses. Auditability plays an important role and has its importance increased when it comes to public and private administration, and can be leveraged within a blockchain-based access control system. Hyperledger Fabric will leverage a solution that aims to discourage unauthorized accesses to confidential information while decentralizing trust when it comes to access control. This work will not only be focused on the implementation of such Proof-Of-Concept but also leveraging effective techniques to its provisioning and deployment.

Building such a system based on the blockchain technology is challenging. Distributed ledger technologies are indeed a complex distributed system. Concerning blockchain access control, there are two main challenges:

1) Provisioning, especially for scenarios with requirements on permissions, data privacy, and security.
2) Lack of standardized processes for development and operations, i.e., continuous integration, continuous deployment and continuous improvement.

The internship aims to:

1. Contribute to the open-source community, by advancing the state-of-the-art on the access control using the blockchain
2. Create a blockchain-based access control system using Hyperledger Fabric
3. Develop an efficient, practical DevOps framework to provision and deploy the created system
4. If time suffices, propose alterations to Fabric in order to facilitate the creation of such system (i.e., creating a tutorial, scripts)
5. If time suffices, develop a small web application to help visualize the solution

Although this project solves real-world problem, it will also be research-focused. The goal is to give a contribution in the state of the art of blockchain-based access control with Hyperledger Fabric.

Additional Information


Some relevant papers:
https://pdfs.semanticscholar.org/6192/0f308bd8cd7782b55a05557db66f323638853.pdf
https://www.researchgate.net/publication/330468939_Blockchain_Based_Access_Control_Services

Relevant technologies:
1. Hyperledger Fabric
2. MEAN stack (MongoDB, Express, Angular, NodeJS)
3. Docker and Kubernetes

Learning Objectives

- You will learn about Hyperledger Fabric and general concepts about blockchain.
- You will learn how to program chaincode using Javascript.
- You will learn how to research a topic like a researcher.
- You will learn how to contribute (and lead) an open source project, document your work and create tests.
- You will learn about access control paradigms - and its application with regard to the distributed ledger technologies.
- You will learn how to implement security, privacy and access control features in distributed systems.
- You will have the opportunity to experience first hand of what is to research a topic and apply knowledge gathered from the research
- You will learn DevOps practices and DevOps practices applied to distributed ledger technologies.
- You will learn how all the pieces work as a whole, by developing a small web app, that serves as the client of the system developed (along with a frontend)

Expected Outcome

1. Contribute to the open-source community, by advancing the state-of-the-art on the access control using blockchain
Create a blockchain-based access control system using Hyperledger Fabric
Develop an efficient, practical DevOps framework to provision and deploy the created system
If time suffices, write an academic paper with the work developed
If time suffices, develop a simple web application to help visualize the solution

Relation to Hyperledger
Hyperledger Fabric

Education Level
Any level is applicable, undergraduate or masters student. Experience in research is preferred, but not mandatory.

Skills
Desirable Skills:

- Experience in programming with Javascript (NodeJs)
- Knowledge about Hyperledger Fabric's architecture
- Basic knowledge of chaincode programming
- Basic understanding of general blockchain concepts
- Basic understanding of access control concepts
- Ability to model a system/architecture, under the mentors' supervision

Bonus:

- You have some experience in scientific research (if you don't, no worries - we can help)
- You are familiarized with the MEAN stack or other web stacks.
- You are familiarized with Docker, Kubernetes or other deployment tools
- You understand in depth Fabric's architecture

Future plans
The end of the internship does not need to mean an end to collaboration. The ideal goal is to build a blockchain based access control system capable of others to use. On top of that, an academic paper might be written as the sum of the knowledge learned.

Preferred Hours and Length of Internship
Both Full-time or Part-time are possible options. Full-time is preferred.

Mentor(s) Names and Contact Info
Rafael Belchior, Teaching Assistant at Instituto Superior Técnico, Universidade de Lisboa: rafael.belchior@tecnico.ulisboa.pt
Rui Cruz, Ph.D., Senior Member IEEE, Assistant Professor at Instituto Superior Técnico, Universidade de Lisboa: rui.cruz@ieee.org, rui.s.cruz@tecnico.ulisboa.pt

Mentee
sara.rouhani@usask.ca
Sara Rouhani

Project Deliveries:

- Designing the system architecture and application components
  - Choose the tools for implementing the attribute-based access control model
  - Design system architecture and initial model
Deliverable: System Architecture Design Document

- Configuring Hyperledger Fabric 1.4 based on the project application

Deliverable: configuration code for HF 1.4

- Implementing Chaincodes/ smart contracts based on attribute-based access control components
  - Implementing the chaincodes, which are responsible for storing subject and objects attributes
  - Implement chainCode that record policies on blockchain
  - Implement PDP chainCode, which is a chainCode that evaluates requests and checks requests access permissions (Policy Decision Point)
  - Implement tests for chainCode

Deliverable: Application ChainCodes and smart contracts

- Testing and analyzing system based on a designed case study
  - Defining a case study and defining attributes and policies based on the case study
  - Evaluating the implemented system based on designed case study

Deliverable: Test results and Documentation

- Writing an academic paper based on system design, implementation, and analysis
  - Outline the paper
  - Writing the paper based on system features and capabilities

Deliverable: Academic paper

- Throughout the documentation, including:
  - Project Wiki
  - Presentation slides
  - Demo video

Project milestones:

First Quarter:
- Project kick-off, discuss project steps, investigate the required tools and components of the project, design project objectives, milestones, and planning the project (June 14)
- Hyperledger Fabric 1.4 network configuration and running, design system architecture and components using ArchiMate (July 5th)
- ChainCodes/ Smart contracts implementation for attribute and policy recording (July 18th)
- 1st Evaluation and report (July 18th)

Second Quarter:
- ChainCodes/ Smart contracts implementation for access control evaluation (PDP) (August 2nd)
- Define a case study to implement for evaluating the system (August 4th)
- Implementing the case study and application API for sending requests to the blockchain applications and receiving responses from it. (August 30th)
- 2nd Evaluation and report (August 29th)

Third Quarter:
• Testing the system (September 12th)
• Analyzing the result (September 22th)
• Investigating the possibility to present a project as a module for Hyperledger Fabric (October 17th)
• 3rd Evaluation and report. (October 17th)

Final Quarter:

• Drafting the paper outline (October 20th)
• and writing the academic paper (November 5th)
• Completing documentation and project wiki and creating project presentation slides and video tutorial for running the project (November 15th)
• Final Evaluation and report (November 15th)

Summary reports

Hyperledger Me...n- 2019-V2.pdf