CA2 6001I – Developing Blockchain Systems

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Introduction

In the realm of global mobility and immigration, the VisaChain application stands as a beacon of innovation, leveraging Hyperledger Fabric to streamline and secure the visa processing journey. Much like supply chain management, visa processing involves a complex web of interconnected processes, spanning multiple entities and stakeholders. However, traditional visa systems often grapple with inefficiencies, lack of transparency, and vulnerabilities to fraud and errors.

Enter VisaChain – a revolutionary solution poised to transform the landscape of visa processing. Built on Hyperledger Fabric, a trusted blockchain framework, VisaChain orchestrates the collaboration of various entities, including embassies, consulates, immigration authorities, and supporting agencies, in a secure and transparent ecosystem.

With VisaChain, each step of the visa application process is securely recorded and validated on the blockchain network, ensuring immutable records and real-time access to information for all authorized participants. By embracing the principles of decentralization and transparency, VisaChain fosters trust and accountability across the visa processing workflow.

Furthermore, VisaChain enhances security measures by incorporating self-sovereign identity features, empowering applicants with greater control over their personal data while ensuring compliance with data protection regulations. Through the implementation of smart contracts, VisaChain automates and enforces key aspects of the visa application process, reducing manual intervention and administrative overhead.

In essence, VisaChain represents a paradigm shift in visa processing, offering unparalleled efficiency, transparency, and security. With its potential to revolutionize the way we navigate international travel and immigration, VisaChain stands at the forefront of innovation in the realm of global mobility.

Use case description and discussion of its suitability

A visa processing system is a vital component of immigration and travel management, facilitating the issuance of visas to individuals seeking entry into a country for various purposes, such as tourism, business, education, or employment. This system streamlines the application submission, evaluation, and approval or rejection processes, ensuring compliance with immigration laws and regulations while efficiently managing the influx of travellers.

The primary purpose of a visa processing system is to assess the eligibility of applicants based on criteria set by the host country, which may include factors such as the purpose of travel, financial stability, criminal history, and health status. By scrutinising these aspects, the system aims to mitigate security risks, prevent illegal immigration, and uphold the sovereignty of the nation's borders.

VisaChain serves as a comprehensive platform for managing visa applications, facilitating seamless interactions among stakeholders while ensuring data security and privacy. Applicants can submit visa applications, providing essential details such as personal information, purpose of travel, and supporting documents. These details are securely recorded on the Hyperledger Fabric blockchain, ensuring immutability and transparency.

Embassies and consulates utilize smart contracts to streamline the validation and verification of visa applications, incorporating automated procedures and conducting independent background checks through professional agencies such as the police. Upon approval, immigration authorities trigger the visa issuance process, updating the blockchain to accurately reflect the status of each application. This approach provides stakeholders with immediate access to the current status of visa applications, promoting transparency and fostering trust throughout the entire process.

Key entities involved in a typical visa application system

Applicant

The individual seeking a visa to enter a foreign country. Applicants are required to make an application giving accurate information, supporting documents, and may need to attend interviews or biometric appointments as part of the application process.

Embassy/Consulate

The diplomatic mission representing the host country in the applicant's home country or region. Embassies and consulates receive visa applications, conduct interviews or screenings, and make decisions on visa issuance.

Other Supporting Agencies

Entities that may assist in the visa processing system, such as governance bodies like Police, or legal bodies specializing immigration law etc.

Suitability

The VisaChain application aligns perfectly with the objectives and requirements of visa processing, requiring transparency, security, and automation. Hyperledger Fabric offers the necessary features and capabilities to address the challenges inherent in visa processing, such as data privacy, trust among stakeholders, and transparency.

Smart contracts automate key aspects of the visa application process, reducing manual intervention and enhancing efficiency. The immutable nature of blockchain ensures that visa application records are secure and cannot be tampered with, providing a reliable audit trail for compliance purposes.

Why distributed technologies like blockchain are good fit for this use case?

The use of blockchain technology in visa processing systems can result in a more secure, transparent, and efficient process for both applicants and authorities, while also reducing the risk of fraud and corruption. Distributed technologies like blockchain offer several advantages for a visa processing system, A few of major ones are outlined below -

Immutable Record Keeping: Blockchain provides a tamper-proof ledger where all transactions and interactions within the visa processing system can be recorded. This ensures transparency and trust in the application process, as all parties involved can verify the integrity of the data without relying on a centralised authority.

Enhanced Security: Blockchain technology employs cryptographic techniques to secure data, making it extremely difficult for unauthorised parties to alter or manipulate information. This level of security is critical in visa processing systems, where sensitive personal and immigration-related data is exchanged.

Decentralisation: By utilising a decentralised network, blockchain removes the need for a single point of control or authority in the visa application process. This can mitigate the risk of fraud, corruption, or biased decision-making that may arise from centralised systems.

Efficiency and Transparency: Smart contracts, which are self-executing contracts with the terms of the agreement directly written into code, can automate various stages of the visa application process. This includes validation of applicant information, background checks, and even decision-making based on predefined criteria. Automation through smart contracts can significantly reduce processing times and improve the overall efficiency of the system. Additionally, all parties involved can track the progress of an application in real-time, enhancing transparency.

Interoperability and Interconnectivity: Blockchain technology can facilitate seamless integration and communication between different entities involved in the visa processing system, such as embassies/consulates, immigration authorities, and supporting agencies. This interoperability streamlines data exchange and collaboration, leading to a more cohesive and efficient process.

Data Privacy and Consent Management: Blockchain allows individuals to have greater control over their personal data through mechanisms such as self-sovereign identity. Users can securely manage and share their information with relevant parties, ensuring privacy and compliance with data protection regulations.

In general, any permissioned or consortium based blockchain can be seen as an ideal choice while building use cases like visa processing systems. Such blockchains provides four fundamental benefits for alike application, as displayed in figure 1 below.
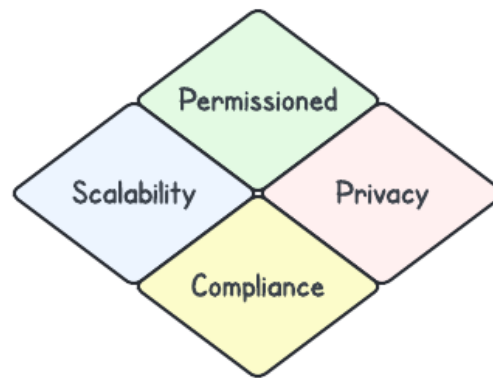
Figure 1 blockchain benefits

Permissioned Network: Such blockchains allow only authorised participants (organisations) to join the network, ensuring that only trusted entities, such as government agencies, embassies, and consulates, are involved in the visa processing system. This enhances security and confidentiality, as sensitive information is only accessible to authorised parties.

Privacy and Confidentiality: Provides private transactions features, enabling selective disclosure of data to specific participants. This is crucial in visa processing systems where certain information, such as biometric data or financial details, must be kept confidential and only shared among relevant parties involved in the application process.

Scalability and Performance: Provides enhanced modularity through architecture which allows better scalability by enabling the network to be divided into multiple sub-networks/channels, each handling a specific set of transactions. This ensures that the visa processing system can accommodate a large number of applications and participants without compromising performance.

Regulatory Compliance: Permissioned nature and support for privacy features make it easier for systems to comply with regulatory requirements, such as data protection regulations and privacy laws. Consortium members can enforce data governance policies and ensure compliance with local regulations governing immigration and visa processing.

Why Hyperledger Fabric?

Hyperledger Fabric also has multiple important key features and concepts that are crucial for the VisaChain application.

Channel: enables the creation of data isolation and confidentiality scopes within Hyperledger Fabric. Peers can participate and interact with one or multiple channels providing a valid authentication. Channels are a private layer of communication between specific network members. Channels can be used only by organisations that are invited to the channel, and are invisible to other members of the network. Each channel has a separate blockchain ledger. Organisations that have been invited "join" their peers to the channel to store the channel ledger and validate the transactions on the channel.

Fabric Ledger: An encrypted ledger that is distributed and managed by the different peers in the network. Fabric Ledger is composed of two distinct parts:
- blockchain which is an immutable chain and
- the state database (a.k.a., the world state, or the current state) which is a database for storing the latest values of key-value pairs in the blockchain. It can be either LevelDB or CouchDB, where LevelDB is a simple key-value store and CouchDB is a database that allows complex queries.

Many channels can be created in Fabric, and we can have one different Fabric ledger per each channel. Peers that are part of the same channel maintaining copies of its ledger.

Endorsement: refers to a peer executing a chaincode transaction and returning its response to the client. The endorsement response includes the response message from the chaincode execution, and the potential read and write results and events. In addition, the response also includes the peer's signature, which can be used to prove the chaincode execution by the peer. Chain Codes are defined with endorsement policies which specify the conditions that should be met when endorsing transactions to be considered valid. For instance, an endorsement policy may set a minimum or percentage endorsing peers for every transaction.

Membership services provider (MSP): is responsible for issuing, validating and managing credentials to clients and peers to enable them to participate in a Hyperledger Fabric network. Credentials enable clients to sign their transactions and allow peers to endorse the result of a transaction. The MSP specifies access control rights to resources in the form of policies (e.g., indicate the identities that can read or write to a channel, or identities that can use a specific chaincode command). A network may include multiple MSP, especially when there are multiple organisations.

Organisation: a.k.a., member, enables the definition of a boundary within a Fabric blockchain network (e.g., within a company or an organisation). To join the blockchain network, every organisation needs to be invited by the blockchain service provider. Every organisation has a unique ID and can set an MSP to identify its clients and peers and specify how their signatures can be verified by other organisations. A network can include many organisations, representing a consortium. A collection of organisations may gather to form a Consortium.

Chaincode: Smart contracts that runs on the peers and creates transactions. Chaincode enables users to create transactions in the Hyperledger Fabric network's shared ledger and update the world state of the assets. The chaincode manages the ledger state through transactions invoked by applications. Applications interact with the blockchain ledger through the chaincode. Therefore, the chaincode needs to be installed on every peer that will endorse a transaction and is instantiated on the channel.

Flexible Consensus Mechanism: Hyperledger Fabric offers pluggable consensus mechanisms, allowing consortium members to choose the most suitable consensus algorithm for their specific requirements. This flexibility enables the network to achieve consensus efficiently while accommodating the diverse needs of different organisations participating in the visa processing system.

Identity Management: Provides robust identity management features, allowing organisations to maintain control over their identities and permissions within the network. This ensures that only authenticated and authorised users can interact with the blockchain, reducing the risk of unauthorised access or fraudulent activities.

Benefits Exclusive to Hyperledger Fabric -

- Plug-and-play ability to integrate components such as consensus algorithm and membership services.
- Chaincode(s) are hosted using the container technology make them handy and lightweight.
- Channel tech enables confidential transactions, letting participants create a separate ledger.
- Identity management through a trusted Membership Service Provider (MSP).
- Permissioned and modular infrastructure.
- Database services like LevelDB and CouchDB.

Roadmap for Visa Chain Application

Vision Statement

"To revolutionise the global visa processing landscape by leveraging Hyperledger Fabric technology, enabling secure, transparent, and efficient visa application processes that foster international travel, cultural exchange, and economic growth."

Mission Statement

"Our mission is to develop VisaChain, a cutting-edge blockchain-based visa processing system, to streamline the visa application process, enhance security and privacy, and ensure compliance with regulatory requirements. By providing a trusted platform for collaboration among stakeholders, VisaChain aims to simplify visa processing, promote tourism and business travel, and facilitate cross-border mobility in a rapidly evolving global landscape."
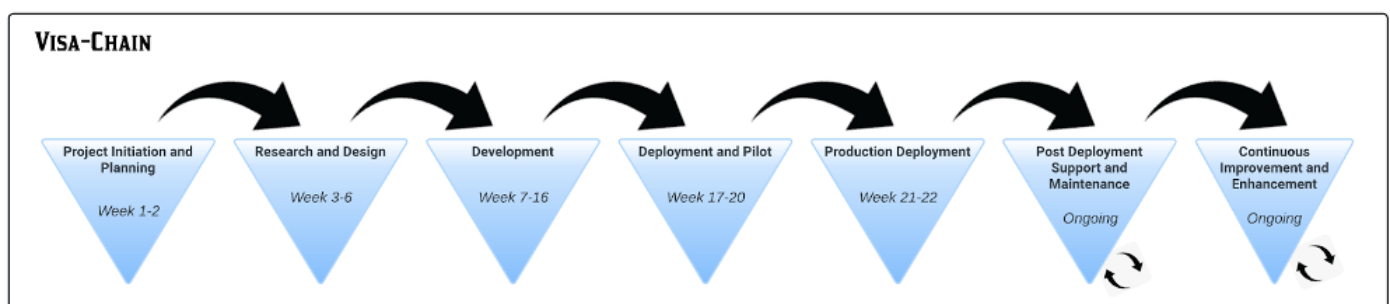

Figure 2 Visachain roadmap

Project Initiation and Planning (Week 1-2)
- Define project objectives, scope, and requirements.
- Identify stakeholders and establish communication channels.
- Formulate a project team including developers, blockchain experts, and domain specialists.
- Develop a high-level project plan outlining key milestones, deliverables, and timelines.

Research and Design (Week 3-6)
- Conduct a detailed analysis of existing visa processing systems and regulatory requirements.
- Design the architecture of VisaChain, including network topology, consensus mechanism, and data privacy features.
- Define smart contracts for various stages of the visa application process, such as application submission, verification, and approval/rejection.
- Identify integration points with external systems such as identity verification services and government databases.

Development (Week 7-16)
- Set up the Hyperledger Fabric network environment, including the creation of channels, peers, and ordering service.
- Develop and deploy smart contracts using Chaincode in Hyperledger Fabric.
- Implement user interfaces for visa applicants, embassies/consulates, immigration authorities, and supporting agencies.
- Integrate identity management and authentication mechanisms to ensure secure access to the blockchain network.
- Conduct rigorous testing to ensure the reliability, security, and performance of the VisaChain platform.

Deployment and Pilot (Week 17-20)
- Deploy VisaChain in a test environment and conduct pilot testing with a limited number of users and visa applications.
- Gather feedback from stakeholders and make necessary refinements to the system based on user experience and performance.
- Develop training materials and provide training sessions for end-users and administrators.
- Prepare for the production deployment by finalising infrastructure requirements and deployment procedures.

Production Deployment (Week 21-22)
- Deploy VisaChain into the production environment with appropriate monitoring and backup mechanisms in place.
- Conduct data migration from legacy systems if applicable, ensuring the integrity and accuracy of migrated data.
- Implement disaster recovery and failover procedures to ensure business continuity in case of unforeseen events.

Post-Deployment Support and Maintenance (Ongoing)
- Provide ongoing support and maintenance for VisaChain, addressing any issues or bugs that may arise.
- Monitor system performance and scalability, making optimizations as needed to ensure smooth operation.
- Stay updated with Hyperledger Fabric releases and security patches, applying updates as necessary to keep the system secure and up-to-date.

Continuous Improvement and Enhancement (Ongoing)
- Collect feedback from users and stakeholders to identify areas for improvement and new features.
- Plan and prioritise enhancements based on business value and strategic objectives.
- Iteratively enhance VisaChain to meet evolving business requirements and regulatory changes in the visa processing domain.

Application Design and Implementation

In this demo, We have three orgs representing three different parties interested in performing this use-case. In real scenario there could be many different parties involved in this use case for example immigration departments, courier services, medical practitioners to verify the health reports, insurance companies, banks or other financial companies, travel agencies etc. However, for the simplicity of this demo, we have considered three main parties of this ecosystem.
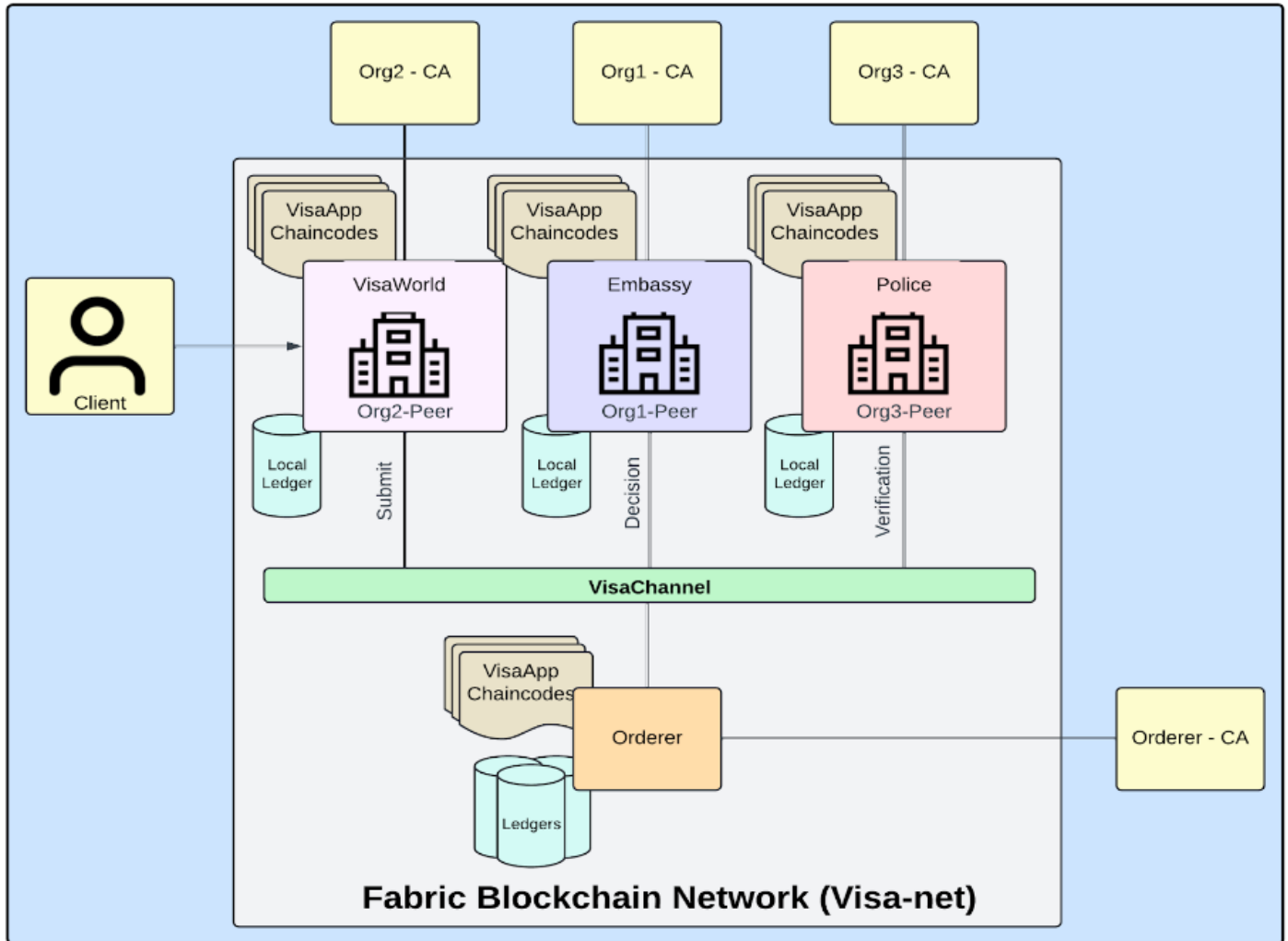
Figure 3 Application block diagram

Embassy (Immigration department)
Allowing a legal process for a foreign national to visit the country. (Visa - law), Verifying the documentations with the embassy to make the visa decision.

Police
Background checks, Criminal history check, Verification etc.

Visa application agencies
Submitting the applications on behalf of travellers seeking permission to visit.

Network Configuration
In this demo, visa-net (our test network) will be launched with [3(a) + 2] docker containers, where a = no of orgs participating in the ecosystem. Details of the different entities are as follows -
- 1 orderer node
- 1 CA node for orderer
- 3 orgs nodes with one peer in each organisation.
- 3 CA nodes, one for each org
- 3 CouchDB nodes, one for each peer

Channel
There will be a secure channel named "*visachannel*" on which all orgs will be able to transfer data securely.

Endorsement Policy

Default network endorsement policy has been modified from `MAJORITY` to `ALL` to make sure all org provide the consent before the transaction is finalised on chain. Here is a snapshot from our customized policy.

```
Policies:
    Readers:
        Type: ImplicitMeta
        Rule: "ANY Readers"
    Writers:
        Type: ImplicitMeta
        Rule: "ANY Writers"
    Admins:
        Type: ImplicitMeta
        Rule: "ALL Admins"
    LifecycleEndorsement:
        Type: ImplicitMeta
        Rule: "ALL Endorsement"
    Endorsement:
        Type: ImplicitMeta
        Rule: "ALL Endorsement"
```

- All 3 orgs will be responsible for doing the following steps on their peers.
    a) Packaging chaincode
    b) Installing chaincode
    c) approving chaincode

- Any org can commit the chaincode to the channel. However, in our case Embassy org is responsible for committing the chaincode onto the channel.

- All 3 orgs will be having their cryptographic materials set in their corresponding directories.

- All 3 orgs will be having their identities set in their corresponding wallets. Details are as below, roles are appended with the name for clarity -
    ▪ *RobertOfficer* is the identity of the officer who is responsible for taking action and executing the chaincode on behalf of the Embassy.
    ▪ *JackCop* is responsible for taking actions on the basis of Police org.
    ▪ *MarkAgent* is responsible for taking actions on the basis of Visa Agency org.

Use of Fabric can be demonstrated with the help of a very simple set of transactions in the context of a Visa application process where different orgs/entities involved in a typical visa process take collective decision of Visa approval or denial based on various intermediate stages. This use case demonstrates a decentralised decision making process where all parties are known to each other.

Visa application stages
- New
- Documents_Check_Pass
- Documents_Check_Fail
- History_Check_Pass
- History_Check_Fail
- Approved
- Declined

Application Flow
- Visa application agency org will submit a new Visa application order to the chaincode. State will be set to "*New*" initially.
- Embassy org will verify the documents and biometrics as per standard procedures and if found satisfactory will update the application state as either "*Documents_Check_Pass*" or "*Documents_Check_Fail*".
- Police org will then do the criminal and background checks for the applications having "*Documents_Check_Pass*" state and if found satisfactory will again update the application state to either "*History_Check_Pass*" or "*History_Check_Fail*" if not satisfied.
- Embassy org again will verify the final state of the application and based on that will give the final decision as "*Approved*" or "*Declined*", eventually again updating the world state on blockchain.

Implementation Overview
Below is an overview of the main artifacts of the Visachain application.

Chaincode(s) (smart-contracts)

Visaappcontract.js

Main smart contract responsible for executing the state functions of the application. It mainly contains the following function to interact with the fabric blockchain. Major functions are –

- appsubmit()   :Creation of a new application

- documentsCheckPass() :Documents check successful, process world-state as Passed
- documentsCheckFail() :Documents check unsuccessful, process world-state as Failed

- historyCheckPass()   :Background/History check successful, process world-state as Passed
- historyCheckFail()   :Background/History check successful, process world-state as Failed

- applicationApproved() :Visa approved, process world-state as Approved
- applicationDeclined() :Visa declined, process world-state as Declined

Visaapp.js

Class to represent visa application entity, holds application data and states.

Visaapplist.js

Utility class for collections of ledger states. Collection of visaapp instances.

Queries.js

Contains various queries to interact with the fabric to fetch the data, typically information stored on fabric. This class doesn't modify any state, just for read-only operations.

Client classes

VisaApplication.js

Client program to submit the visa application. This program belongs to the VisaWorld organisation which acts as an agency to submit the visa application on behalf of their customers.

VisaClearencePass.js

VisaClearenceFail.js

Client programs to update the state of application based on the background checks performed by the authorities. These programs belongs to the Police organisation.

VisaApprove.js

VisaDecline.js

Client programs to update the state of application based on the final decision taken by the authorities. These programs belongs to the Embassy organisation.

AddToWallet.js

Represents a wallet for the client which activates the user-identity to be used to interact with the fabric. Every org application has their own client-wallet which can be used to load the user-identity before performing any operation.

BlockListener.js

Utility class to log the blocks on terminal in real time. Requires user-identity.

Bash scripts

start-visanet-network.sh

Custom script to bring up the visanet network in one-click. It launches 2 org network (Visaworld, Embassy) with 2 peers, 2 CAs, 2 CouchDBs, 1 orderer, and a channel with all required configurations.

add-org3.sh

One-click script to add another org (Police) in the existing network and set up required configs.

deploy-chaincode.sh

Another single click script to facilitate the lifecycle steps required for the chaincode to Package, Install, Approve, and Commit to Fabric. This was required to manage all the intermediate steps and was really handy during coding and debugging to quickly launch network and chaincode repetitively.

Monitor-logs.sh

Utility script to launch logspout container to process and display logs from various docker containers into single screen. This was also quite handy to analyse the log streams from multiple containers.

stop-visanet-network.sh

Script to take down the complete network with all deployed chaincode and databases in single click.

README.md

Outlines all the steps to install the network, deploy the code and run the use-case. It's a step by step guide to run this application.

Technology and Tools

The implementation relies on Docker for infrastructure provisioning, Hyperledger Fabric API for blockchain network interactions, Node.js for writing chaincode and applications, and Visual Studio Code as the integrated development environment (IDE). These tools provide a robust foundation for developing and deploying the VisaChain application.
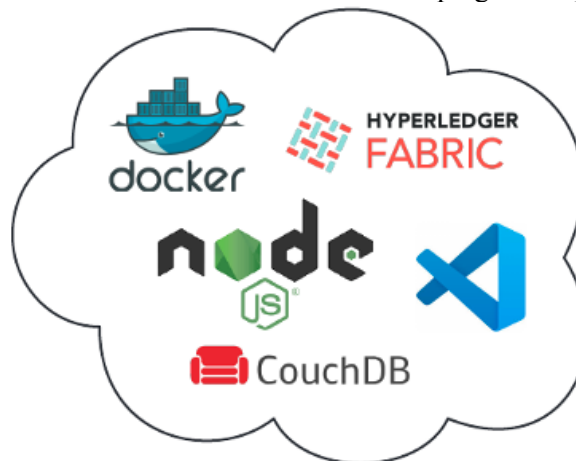
Figure 4 Tech stack & Tools

Discussion and Analysis

The VisaChain application presents a compelling use case for leveraging Hyperledger Fabric technology to streamline and secure the visa application process. The above design and implementation notes outlines the architecture, entities involved, policies, and major functions of the VisaChain application, providing insights into its design and functionality.

Key Components and Entities

The application involves three main entities representing different parties within the visa processing ecosystem: Embassy (Immigration department), Police, and Visa Application Agencies. Each entity has specific responsibilities, such as document verification, background checks, and application submission, contributing to the overall visa processing workflow.

Infrastructure and Policies

The infrastructure of the VisaChain network consists of Docker containers hosting nodes for orderer, peers, Certificate Authorities (CA), and CouchDB instances. A secure channel named "*visachannel*" is established to facilitate secure data transfer among participating organizations.

Chaincode Functions

The VisaChain smart contract, or chaincode, defines key functions to manage the visa application process, including creating new applications, marking document and history checks, and approving or declining applications. These functions automate and enforce the various stages of the visa processing workflow, ensuring consistency and transparency.

Suitability and Potential Impact

The VisaChain application demonstrates the potential of blockchain technology, particularly Hyperledger Fabric, to transform the visa processing landscape. By leveraging blockchain's transparency, security, and automation capabilities, VisaChain streamlines the visa application process, enhances trust among stakeholders, and improves the overall efficiency of visa processing operations.

Application Improvements

This application serves as a small-scale prototype showcasing a visa application scenario operating on Hyperledger Fabric, a consortium network characterised by distributed yet closely-knit participants with mutual trust. This initial model lays the foundation for future enhancements, such as incorporating additional use cases related to visa processing. By integrating other organisations commonly involved in the process and implementing robust validation and verification procedures, the application can offer a more comprehensive solution. Following are a few areas for future work -

Improve User Experience and UI
To build a user interface to improve the experience of the application which makes it more intuitive and user-friendly.

Expand Use Cases
Introduce additional use cases related to visa processing, such as visa renewals, visa extensions, or visa cancellations. This will provide a more comprehensive demonstration of the capabilities of the system.

Incorporate External Organisations
Extend the application to involve other organisations that are typically involved in the visa processing workflow, such as immigration departments, border control agencies, third-party information collectors and verifiers, partners organisations like tourism sectors, tour and travelling companies etc. This would require integration with external systems and APIs to facilitate data exchange and collaboration.

Integrate Self-Sovereign Identity (SSI)
Incorporate self-sovereign identity (SSI) principles to provide individuals with greater control over their personal data during the visa application process. This would enable applicants to securely manage and share their identity information, enhancing privacy and compliance with data protection regulations.

Implement Real-Time Updates
Enable real-time updates and notifications for stakeholders on the status of visa applications. This would improve transparency and communication throughout the process, reducing uncertainty and delays.

Optimise Performance
Optimise the performance of the application by fine-tuning the smart contracts, improving data processing efficiency, and optimising network resources. This will ensure smooth and responsive operation, even during peak usage periods.

Enhance Security Measures
Strengthen security measures to protect sensitive data and prevent unauthorised access or tampering. Implement encryption, access controls, and audit trails to enhance data security and compliance with regulatory requirements.

Conclusion

In conclusion, the VisaChain application represents a ground-breaking solution for revolutionizing the visa processing landscape through the innovative utilization of Hyperledger Fabric blockchain technology. By streamlining and securing the visa application process, VisaChain addresses key challenges faced by stakeholders involved in cross-border travel and immigration.

Through the collaborative efforts of participating entities such as embassies, police departments, and visa application agencies, VisaChain facilitates a transparent, efficient, and trust-based ecosystem for managing visa applications. The application's architecture, policies, and functions are meticulously designed to ensure data integrity, privacy, and compliance with regulatory requirements.

The VisaChain application's impact extends beyond mere process optimization; it fundamentally transforms the way visa applications are managed and processed. By leveraging blockchain's immutable ledger and smart contract capabilities, VisaChain eliminates the need for centralized intermediaries, reducing bureaucracy, minimizing errors, and enhancing the overall efficiency of visa processing operations.

Furthermore, VisaChain empowers applicants with greater control over their personal data through the integration of self-sovereign identity features, ensuring privacy and compliance with data protection regulations. This not only enhances the security of sensitive information but also fosters a sense of empowerment and trust among visa applicants.

Looking ahead, the VisaChain application holds immense potential for further enhancement and expansion. Future iterations of the application could incorporate additional features such as real-time tracking of application status, integration with external systems like medical practitioners' health reports and insurance companies, and leveraging emerging technologies like Internet of Things (IoT) and artificial intelligence (AI) for predictive analytics and decision-making.

Overall, VisaChain stands as a testament to the transformative power of blockchain technology in reimagining traditional processes and driving innovation in the realm of global mobility and immigration. By providing a secure, transparent, and efficient platform for managing visa applications, VisaChain paves the way for smoother cross-border travel, fostering economic growth, cultural exchange, and global connectivity in an increasingly interconnected world.

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Appendix

Notes to setup and run the application with all configurations.

Disclaimer – following steps have been tested on (MAC M1 chip) only.
Recommended shell - bash

Prerequisite

You would need following components before running the application.
1. Docker desktop or any similar software which provides dockerized container infrastructure. I used Rancher desktop on MAC (https://github.com/rancher-sandbox/rancher-desktop/issues)
2. Node (v20.11.1)
3. NPM (10.5.0)
4. Git (git version 2.39.3 (Apple Git-146))
5. Go (go version go1.22.0 darwin/arm64)
6. Curl (curl 8.4.0 (x86_64-apple-darwin23.0))
7. JQ (jq-1.7.1)
8. Bash shell

Once all the above dependencies are met, we are good to work with the Hyperledger APIs.

High level steps

Fine details on running each step are given in README.md file

1. Launch the visanet network
2. Add 3rd org to existing two org network
3. Deploy the chaincode to fabric
4. Login as VisaWorld agent
5. Create a new visa application using identity of agent. i.e. markAgent
6. Login as Police personnel
7. Approve or Disapprove the background checks for the application using identity of a cop. i.e. jackCop
8. Login again as Embassy personnel
9. Give the final decision as Approve or Decline for the visa application using identity of a visa officer. i.e robertOfficer
10. Check the application history by querying the fabric using any of the above identity