# Employing *Takaful* Islamic Banking through State of the Art Blockchain: A Case Study

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***Abstract*—*Takaful* – an Islamic alternative to conventional insurance – is fast becoming one of the most important constituents of modern Islamic financial market. The fundamental difference between the two forms of risk mitigation is entrenched from the *type of contract* selected. The conventional insurance work on the principle of bilateral contracts between the customer (insured) and insurance provider where the insured pay regular premium in return for payment of compensation, in case of a predefined event occurs. On the other hand, *Takaful* works on the principle of mutual guarantee, cooperation and indemnity where the participants in the scheme mutually insure each other. The *Takaful* providers are mainly responsible for managing, administering and investigating the *Takaful* funds according to *Islamic laws*. This studies provides a decentralized architecture that securely implements *Takaful* risk mitigation system according to its principles. Since all major banking sectors are shifting towards Blockchain technology, as it is currently the only viable solution to offers security, transparency, integrity of resources and ensure trustworthiness among customers. The proposed studies offer state-of-the-art Blockchain technology and focus provide a *Takaful* system that strictly follows the underlying *Islamic laws* for this risk mitigation system. Moreover, the proposed platform provides all *Takaful* transactions over Blockchain that brings confidence and transparency to the community involved in the process.**

***Keywords*—*Takaful; hyperledger; blockchain; consensus; decentralized network; muzariba and wakalah***

## I. Introduction

Digital economy in its current shape is dependent on some form of *trusted entity* that is responsible for building the necessary trust among different participants. Almost all online transactions require a trusted third-party to vouch for authenticity of the participants as well as the transaction itself [1]. For instance, we rely on email service providers to assure that our email has been delivered to the target recipient; similarly, we rely on certification authorities to make sure that a certain digital signature is trustworthy; we rely on banks to assure that our money has been safely delivered to our loved ones remotely. In case of using social media, we rely on social networks like Facebook or Twitter to ensure that our posts or tweets are only shared with our contacts based on our privacy settings and not with the outer world. In fact, in order to keep our digital assets secure and private, we precariously rely on these third party entities, which are much prone to hacking, manipulation and hence can be compromised with ease [1].

*Takaful* is an elective type of monetary instrument to safeguard resources, liabilities and other individual interests of people and associations. Since its introduction – a few decades ago – the concept of *Takaful* has developed at such a fast rate that its market has extended from Western Asia, South Asia, South East Asia, to Africa, which are prevalently Muslim majority populated nations, to that of some parts of Europe and North America. The great development worldwide and potential venture into new Western markets has a solid ramifications to would-be *Takaful* providers to adapt themselves with creative frameworks for *Takaful* risk mitigation mechanism.

The conception of *Takaful* started back in 1979 in Sudan and currently the business model is implemented in different parts of the world [2]. *Takaful* has achieved significance adoption in the Muslim world as a result of various Islamic finance conferences. It is adopted even by non Muslim countries with Muslims living in majority. *Takaful* business industry has immense potential in the global market. Currently, the market is focused in Gulf Arab nations and some south Asian nations but *Takaful* activities are extending to European Union and as far as Australia. It is projected that this business model will extend to other parts of the world and public will in general receive *Takaful* protection over regular insurance sooner rather than later [3]. Both the conventional insurance and *Takaful* system are tools used for managing and mitigating risk to achieve justice in the society. The primarily and fundamental difference between the two systems is that the former works on the principle of bilateral contracts between the participant and insurance provider where the participant pay regular premium in return for payment of compensation, in case of a predefined event occurs. While later one works on the principle of mutual guarantee, cooperation and indemnity where the participants in the scheme mutually insure each other. The organization providing *Takaful* services are mainly responsible for managing, administering and investigating the *Takaful* funds according to *Islamic laws*. Adherence to these laws are *mandatory* for an insurance scheme to be considered as *shari'h* complaint, which is the essence of *Takaful* scheme and desirable by the wast majority of consumers of such schemes. Therefore, a technological based framework is required for assurance that *Takaful* providers adhere to Islamic laws for providing their services. Furthermore, such a framework should allow consumers to verify these services and ensure trustworthiness of *Takaful* system in its entirety.

In this regard, the Kingdom of Saudi Arabia like other nations is also adopting Blockchain technology in its various sectors for more efficient, reliable and integrated flow of information [4]. Banking sector is shifting towards blockchain

as it offer a number of features which are not offered by traditional banking systems [5], [6]. These features among others include transparency, trustworthiness, availability of resources, efficacy, availability and integrity of assets through ledger [7]. To implement transparency in the ledger, Blockchain provides un-tampered public ledger as depicted in Fig. 1.

A number of insurance based systems have been reviewed [8]–[11] and based on the recent trends, the takaful insurance system is proposed to be implemented through Blockchain that will have a bright future. The proposed studies will improve the critical performances and efficiency of the Takaful system and will further ensure transparency in the system. To the best knowledge of the authors after reviewing the literature, such a blockchain based takaful based system is not provided earlier.

Blockchain technology has a number of variants that are used for specific purposes. Based on the nature of the problem in hand, this study propose to use a *permissioned* blockchain as a case study for Saudi Arabia *Takaful* insurance mechanism. The following subsection outlines objectives of the study.

### A. Objectives of the Study

The objectives of the proposed study are provided hereunder:

1) To make sure *Sharia* laws are followed in the implementation of *Takaful* insurance mechanism.
2) To implement elements of *Takaful* through state-of-the-art Blockchain technology.
3) To automate Islamic banking laws for implementation on Blockchain multi-node architecture.

To achieve the aforementioned objectives, the study opts for Blockchain technology that offers a number of features explained in the subsequent sections.

The remainder of the paper is organized as follows. Section II presents background of *Takaful* system and also provides details related to Blockchain technology. Section III presents detailed methodology of the proposed solution followed by implementation of the proposed solution, which is detailed in Section IV. At the end, Section V concludes the paper.

## II. Background Literature

This section provides details regarding *Takaful* insurance mechanism and elaborates Blockchain core concepts that are essential to comprehend the proposed solution.

### A. Evolution of Takaful

*Takaful* framework is developed with the standard conception of *Ta'awun* meaning, common collaboration and *Tabarru* that is willful and joint contribution. The individuals in *Takaful* plan are capitalists. They pool their contributions with *Takaful* vendor serving as *Mudarib*. This is a single direction exchange which does not guarantee an unmistakable profit for various contribution.*Takaful* insurance mechanism is an unadulterated common build [12]. The idea of *Takaful* depends on common collaboration and deliberate contribution through which the hazard factor is owned among individuals that contribute in *Takaful* and the people that runs the scheme. In the traditional insurance mechanism, risk factor is totally transferred from policy member to the administrators that run the insurance scheme. In *Takaful* scheme, individuals consented to partake in a pool which is further reinvested and the benefits are held in the pool [13], [14]. Later on, if any misfortune happens to any stakeholder; she would be compensated from the pool.

As per Takful schemes, on the off chance that any part or member endures a fiasco or catastrophe, the individual in question would get money related profit by a reserve to help meet that misfortune or harm. The sum is drawn out of a typical pool made with the individual contribution of all members. In this manner, *Takaful*, coming from the Arabic term *kafal*, which means to deal with one's needs. This is rather than traditional protection, which represents various challenges to Muslims.

### B. Basic Principles of Takaful

Under Malaysian *Takaful* Act 1984, *Takaful* is defined as, "A scheme based on brotherhood, solidarity and mutual assistance which provides for mutual financial aid and assistance to the participants in case of need whereby the participants mutually agree to contribute for that purpose". While the *Takaful* business model is defined as "business of *Takaful* whose aims and operations do not involve any element which is not approved by the Islamic law". From the perspective of Islamic laws, the essential complaint against insurance offered by conventional system is that it is successfully a bet upon the frequency of the possibility guaranteed against [15], in light of the fact that the interests of the two gatherings are oppositely restricted, and the both parties don't have the foggiest idea about their separate rights and liabilities until the event of the safeguarded occasions.

Dahi et al. [16] provides a mechanism for direct *Takaful* as follows:

1) To partake in *Takaful*, one must have genuine budgetary intrigue.
2) *Takaful* individuals accumulate for their basic great with great confidence and trust, in this way, uncover material data.
3) Every *Takaful*-member adds mutually agreed donation to the pool.
4) If there should be an occurrence of misfortune, the one will be repaid to the degree of the evaluated loss.
5) *Takaful* administrator will be qualified for any addition or recuperation from another party after misfortune remuneration.
6) Hazard will be expelled as for memberships and misfortune remuneration.

The Islamic protection division or *Takaful* has extended in many real markets and in Muslim majority nations around the globe [17]. The insurance business is a feasible solution for risk mitigation, yet does not abide by the Islamic conventions [18]. The insurance systems is being talked about at numerous dimensions by Muslim legal advisers since the eighteenth century. They gave different feelings over the reasonability of protection contracts. Some trusted it is completely prohibited under Islamic laws and some announced admissibility on different grounds. The reasonable decision as per different sentiments proclaimed the current protection contracts illegal.

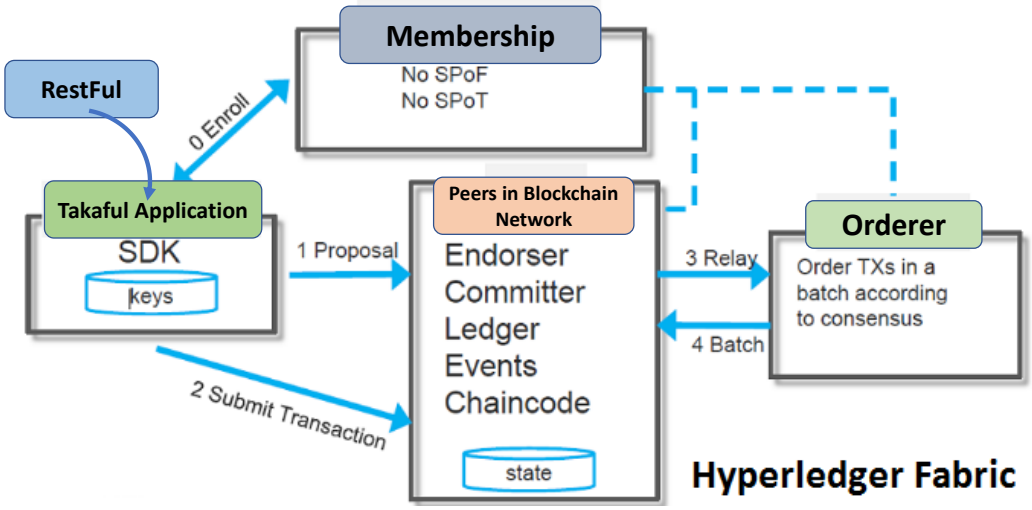


Fig. 1. Generic Blockchain Takaful-HyperLedger Fabric Network

Later on, they contended that common or helpful protection could be substantial. This goals talked about at numerous dimensions and numerous researchers put their endeavors on it [19]. A short time later, Noordin et al. [20] ascertained the goals lead to the foundation of "Islamic protection establishment" in 1979 which accomplished positive reaction from the Muslim world.

### C. Blockchain

Digital infrastructure and services are rapidly evolving to embrace the ongoing openness and decentralization approach in technological innovation. One of the most discussed and undeniably ingenious inventions of current era is the blockchain, which allows digital information to be distributed openly but not allowing the same to be copied and/or modified [21]. The blockchain technology facilitate in creating the backbone for a new type of Internet, which was initially perceived to be used only for digital currencies but this perception is briskly changing due to the myriad opportunities offered by this new technology [22]. Although this technology is still in its infancy, the customization, experimental adoption and heavy investment by technological and financial institutes seem to be on the rise since its adaptation by the popular cryptocurrency platform known as Bitcoin [23].

Blockchain is a *distributed, transactional database*, which comprises of a number of *nodes* that are globally distributed, and are linked together by a peer-to-peer *communication network* [21]. These peers use their own layer of protocol messages for peer discovery and node communication. The blockchain nodes use IP addresses to identify each other while users are referenced through their public keys. Each user uses their corresponding private key to perform cryptographic signature over transactions or communications with peers.

The blockchain technology is implemented in the form of public decentralized ledgers and private decentralized ledgers [24]. The former is openly accessible to every user over the Internet. In the public ledgers everyone is free to participate unconditionally in the process of determining the current state of the chain and which blocks are added to it [25]. For validation purposes, these fully decentralized blockchains uses distributed consensus mechanism as proof-of-stake. For instance, Bitcoin considers the "longest chain – the chain with the most proof-of-work – to be the valid ledger" [26]. On the other hand, permissioned or fully private ledger are accessed by assigning write and read permissions. The write permissions are assigned and monitored by a central (private to the organization) decision making entity while the read permissions are either public or restricted [25]. In the permissioned ledger, each organization is responsible to commission the white listing or blacklisting of user identity is based on their organizational procedural structure. The difference between public and private blockchains is the extent to which they are decentralized, or ensure anonymity.

One of the most prevalent examples that is almost inherently tied to blockchain technology is bitcoin [23]. Bitcoin is also the most controversial use case of blockchain technology due to its regularity issues with financial and governments institutes. However, the underlying blockchain technology is not controversial at all and has been adopted flawlessly in both financial and non-financial sectors around the globe [21]. Internet of Things use Blockchain in a number studies [24]. Similarly, blockchain is used health sectors [27] and in collection of Value Added Tax systems [28]. The pundits of

global economy and finance consider blockchain invention the same as the invention like steam or combustion engine that most rightly has all potential ingredients to transform the current world of finance and beyond [29]. Similarly, the Silicon Valley's capitalists termed it as one of the most important inventions since the birth of Internet itself [30].

Blockchain-based transactions are not only confined to digital currencies rather blockchain can be adopted in a wider range of use cases both in financial and non-financial sectors [21], [31]. In fact, Blockchain applicability is mostly discussed in the financial sector related to trading and settlement, insurance and private securities insurance [32]–[34]. Other potential application areas include digital marketplace, digital assets, digital notary services [35], [36], health sector [37], energy sector [38] and supply chain information [35]. One of the main reason behind its widespread adoption is that Blockchain-based transactions are verifiable through consensus build from the majority of the participants in the system. This way, Blockchain can be adopted to overcome *trust* issues in the current digital ecosystem. It introduces the concept of *distributed consensus* to revolutionize the digital world. In essence, any transaction that involves digital assets, whether it occurred in past or occurs in present, can easily be verified at any given time in the future [1]. This verification is performed without compromising the privacy of the parties involved and the privacy of the digital assets used. Therefore, *anonymity* and *distributed consensus* are the two paramount features provided by blockchain technology.

## III. Blockchain-based Takaful Insurance Mechanism

Before providing details of how the proposed solution works, we provide brief details regarding the elements of the *Takaful* insurance.

### A. Elements of Takaful Insurance Mechanism

The *Takaful* administrator considers five key elements for running the insurance scheme. First, is the cooperative spirit among the stakeholders that is mutual help among participants of the scheme or conformity to the brotherhood. The second element is the ownership of *Takaful* funds that are gathered from various members. The third element is related to investment of the collected funds in an ethical manner. The fourth element accumulates the profits received by investment of the funds. Lastly, the fifth element of the scheme deals with the surplus funds that remains when the use or needs of the individuals are fulfilled. The surplus is shared between policy holders and the *Takaful* operator. A basic flow of this insurance mechanism is provided in Fig. 2.

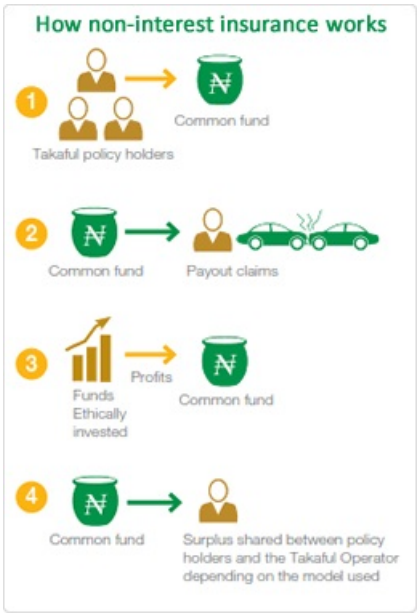


Fig. 2. Takaful Insurance Mechanism

### B. Proposed Solution

Generally, all participants in *Takaful* scheme would like to have a transparent system for the scheme where all transactions such as business investment, profit and loss should be open and trusted upon by the participants. For a risk mitigation scheme like *Takaful* where many participants are interacting with each other and perform various business transactions, Blockchain seems to be a viable solution for trust management, openness and securely managing all transactions. Keeping these requirements in mind, we have proposed a decentralized, transparent and trusted architecture for the *Takaful* system. Since there are various models available for realization of *Takaful* services in the market (see Section II-A), we have incorporated all these models as a smart contract in our proposed architecture. For instance, in *Mudareba* model, the operator and contributors agree on certain percentage of the surplus amount, which is defined through mutual agreement among the participants. The deposited money by the contributors and the surplus received are considered as assets in the Blockchain chain code. Similarly, all participants and their associated assets are added in the system. To perform certain transactions over the assets, participant transactions are defined. Fig. 3 shows various transactions, such as deposit money, define shares, invest money and compensation defaulter in case of any loss to the contributor (in a stipulated event agreed in contract). The basic aim of *Takaful* system is to mutually contribute for the defaulter in case of any loses. Therefore, to provide such services transparency and trust are very important aspects of the system. The transactions mentioned above are endorsed and approved by endorsers. The transactions are further sent to a consensus algorithm called `Orderer node` to agree upon the transaction and commit to the ledger. At the same time, the committed transaction to the ledger is also stored in the world state database. In fact, the correct status of assets are stored along with its current owner. This process is defined in a *Smart Contract* which is called the `Lifecycle of and Asset` in Blockchain. Similarly, our proposed system integrate the *Wakalah* model of the *Takaful* system. The difference between *Wakalah* and *Mudareba* is that in the former model instead of giving percentage to the operator, a predefined fee, based on their expenses are given from the premium. This change of concept is defined as `Second Smart Contract` in the Blockchain network. The complete framework for *Takaful* system over Blockchain is depicted in Fig. 3.

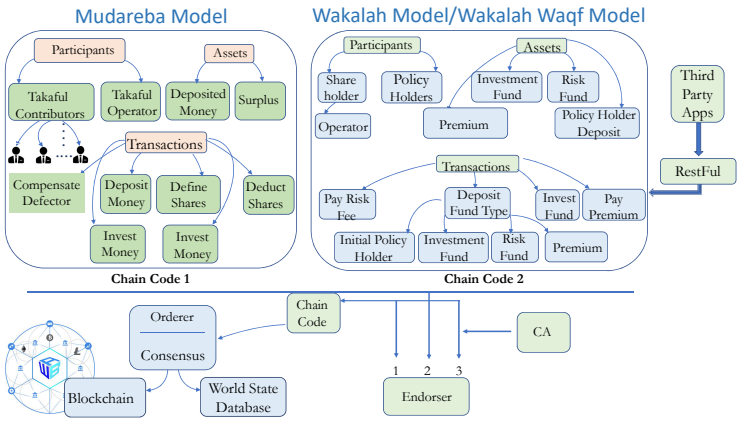


Fig. 3. Proposed Blockchain Based Takaful Insurance Architecture

## IV. Selected Implementation Details

In order to provide a more viable solution for *Takful* system over blockchain, a prototype implementation of the proposed system is provided. The architectural framework of *Takaful* is built upon Hyperledger Fabric (HLF) network [39], which connect all members of the system including the operators.

*Takaful* mechanism is hosted on distributed network of peer nodes that manages and control the entire logical components of Blockchain network including endorsers, orderer node, certification authority, and a peer node of membership service provider (MSP). For a proof of concept, the proposed architecture is deployed using single node implementation where both the `Endorser` and `Orderer` are configured within a single node. The primarily task of the `Endorser` is to validate that the `Chaincode` for the proposed system is deployed and running on different nodes. All payments received as donations in the system from the members are posted to the public ledger through the MSP node, which is also configured to provide opportunity for new members to join the distributed network. For this purpose, a *service subscription* interface is provided that helps new users to subscribe for membership as well as allows existing users to modify their membership information.

The *smart contract* interface incorporates different aspect of *Takaful* business transactions. For instance, we have defined smart contracts for new user subscription, premium selection, contribution and subrogation, indemnity, claims and distribution to name a few. These contracts are combined together to establish *Takaful* business model that govern all of the interactions between participating members. A number of processes and stakeholders are defined regarding how various users shall subscribe to the framework including contributors, operators, takaful providers etc. Using the Hyperledger Fabric network, the rules (defined in the contracts) are automatically enforced when the smart contract is executed during transactions. For instance, one of the transactions ensure collection of the funds from stakeholders and submit to takaful operator. Another example of smart contract ensures that in case of claims, funds are distributed according to prearranged terms. The system authorize and control all members regarding updating the ledger and allow them to connect to the distributor network through peer nodes.

The sequence of events in the proposed *Takaful* system is depicted in Fig. 4. Various transactions can be observed in the same figure. However, one of transactions can be elaborated that a defector make a request for the compensation for his loss. Using the `Takaful Interface`, the defender participant is allowed to invoke claim for compensation when a stipulated event occurs and once all formalities of verification and estimation of cost is conducted and finally the defender is provided with deemed appropriate fund transfer from the Bank. The `Hyperledger` node issue a transaction for the compensation received. The `Chaincode` node requires to validate the participant for the specified claim. The loss claimed by the participant is evaluated and the `Endorser` is asked to execute the particular transaction. The `Endorser` based on the policy mentioned in the endorsement policy performs validation of the claim in terms of its feasibility, i.e. it checks and verifies the blockchain environment wherein a participant is entitled to claim in the framework or not. Any transaction for which approval is granted from the `Endorser`, that transaction is send to the `Orderer` to perform the required consensus before committing it to the public `Ledger`. Order node upon receiving the transactions order these transactions, make a standard block of transactions, as specified in its configuration (e.g. 10, 15, 20 etc), and generate a hash of the block to further communicate it to the network. The nodes that are hosting the Blockchain ledger use consensus mechanism in order to rest assure that the addition to the ledger is updated and synchronized on all the nodes. The ledger becomes updated on the nodes while in response to the execution of transaction, the updated records and data is saved in the couchDB. In this manner, transparency is controlled in the proposed system wherein all the participants can view how various transactions are carried out, and they are informed about the flow of data as well.

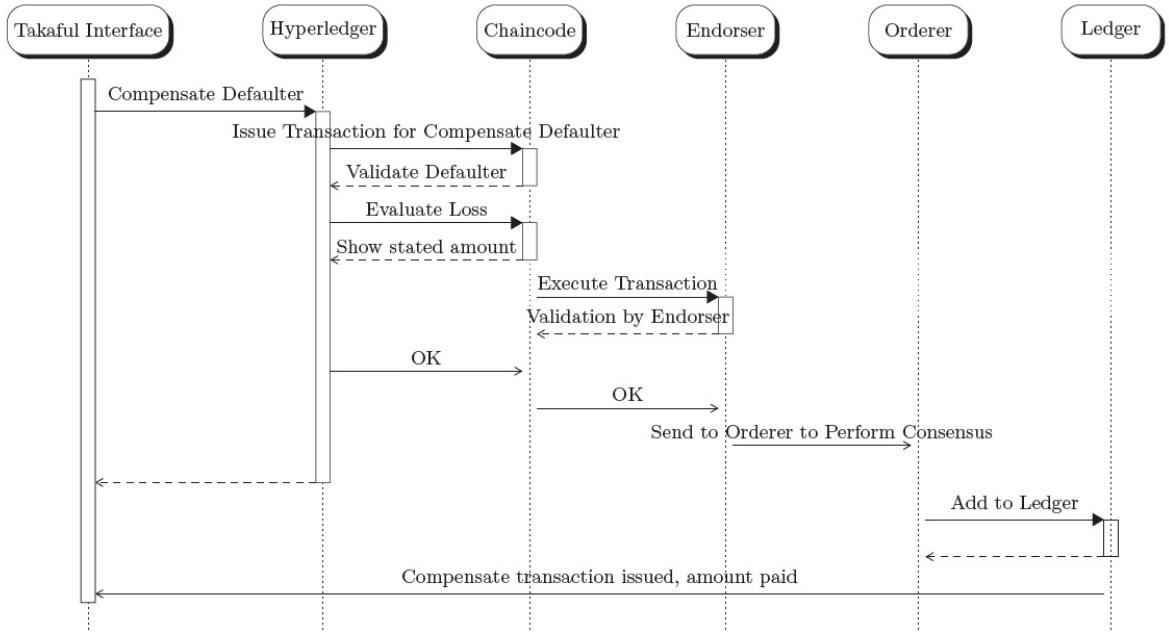


Fig. 4. Sequence Diagram for Takaful Transactions

### A. Deployment of the Hyperledger Fabric

In the Hyperledger Fabric, a network is built that consist of cluster of servers for hosting *Takaful* participants and operators or administrators that collect donations from participants. A new participant intending to join the permissioned *Takaful* blockchain network is issued certificates by the Certificate Authority (CA) of Saudi Arabia Takaful Operator. These certificates are issued to participants and operators for a particular role. These roles are used to control transactions in the Blockchain.

### B. Deployment of Hyperledger Composer

The Hyperledger composer business network is deployed over each node for issuance of profile for each member of the *Takaful* insurance scheme. These profiles are used by REST API provided by Hyperledger composer to create URLs for performing different operations such as creation and deletion of records. *Takaful* members are provided with an interface to easily initiate `smart contract` transactions for adding donation to the system and requesting to add transaction to the ledger. In return, the transactions are updated and the donation amount submitted by the members are easily verified.

## V. Conclusion

*Takaful* is a widely adopted insurance mechanism spreading across major parts of the world. The banking sector is closely associated with all transactions made under *Takaful* scheme. Monitoring and ensuring security of transactions along with providing transparency, integrity of resources and trustworthiness among all involved stakeholders have become a complex task then ever. This research provides a framework for *Takaful* scheme through implementation of state-of-the-art Blockchain technology, which ensures all rules and regulations required for the *Takaful* system are implemented as per Islamic laws – which is the essence of this scheme and a major difference to that of conventional insurance schemes. We aim to extend our proposed framework to other major Islamic market sectors such Islamic banking market, Islamic money market and Islamic capital market to name a few. For the proof-of-concept, the study opts to select the Kingdom of Saudi Arabia as a use case but it can easily be implemented in any other country that provide Islamic banking system.

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