TECHONEY

Development of a **blockchain-based ecosystem** that allows an **improved positioning of small producers of honey** on local and international markets

DELIVERABLE

D4.2.1 Traceability system backend Inchain (smart-contract) and offchain

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	AUTHOR	Dr. **Hakim Badis** (LIGM, UGE), Dr. Hella Kaffel, Dr. Uwe Roth, Dr. Muluken Eressa		
	REVIEWER	Dr. Hella Kaffel, Dr. Uwe Roth and Dr. Muluken Eressa		
	APPROVER	Dra. Tiziana de Magistris (CITA)		
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VERSION TRACKER

VERSION	REVIEWER	PARTNER	ISSUE DATE	CHANGES
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2	Hakim Badis	LIGM	15.JULY.2023	Peer review input
4	Muluken Eressa	LIGM	15.AUGUST.2023	Peer review input
5	Hakim Badis	LIGM	20.SEPTEMBER.2023	Final version

STATEMENTS

ORIGINALITY

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

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REQUEST TO PARTNERS

This document fulfills **Project milestone #3** of **TECHONEY** PRIMA Proposal:[1]

- What: "Design and architecture of the consortium blockchain platform".
- When: M12 (month 12 – May 2023).
- How: Document uploaded in the private area of the project website

All partners are kindly asked to

- Read and understand this Deliverable.
- Use it for regular checking of actual performance vs project objectives.
- Report to project coordinator potential deviations of the project.

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[1] Depicted at "Project Milestones". Section 3.2 ("Management structure, milestones and procedures") of the PRIMA Full Proposal - Technical Annex (Part II)

TABLE OF CONTENTS

DOCUMENT CHARTER 2
STATEMENTS 3
GLOSSARY: ACRONYMS 5
PROJECT ABSTRACT 6
EXECUTIVE SUMMARY OF THE DELIVERABLE 8
DOCUMENT STRUCTURE 8
INTRODUCTIONH 9
HYPERLEDGER FRAMEWORK 10
UNDERSTANDING STAKEHOLDERS 12
SMART CONTRACT DEVELOPMENT 14

GLOSSARY: ACRONYMS

- **AI**: Artificial Intelligence
- **AR**: Augmented Reality
- **BDVA**: Big Data Value Association
- **C&D**: Communication and Dissemination.
- **CAP**: Common Agricultural Policy
- **CM**: Communication Manager
- **D**: Deliverable
- **DIAS**: Data and Information Access Services
- **EC**: European Commission
- **EU**: European Union
- **HILE**: Honey Innovation and Learning Living Lab
- **ICT**: Information and Communication Technologies
- **ICT**: Information and Communications Technology
- **KPI**: Key Performance Indicator
- **SC**: Steering Committee
- **SO**: Specific Objective
- **URL**: Uniform Resource Locator
- **WP**: Work Package

PROJECT ABSTRACT

TECHONEY project's main objective is to identify strategies and establish lines of resilience to the new challenges determined by the COVID-19 pandemic for beekeepers in the Mediterranean (Med) agricultural systems through the implementation, definition, enhancement and transfer of competitive, profitable, efficient and trustful honey supply-chain alternatives that address beekeepers' capacities and attractiveness to fulfil consumer needs on unexpected food market changes.

TECHONEY project proposes the development of a **traceability system to guarantee the quality and safety of honey within the supply chain** for more effective communication to consumers and to strengthen access to different markets (e-commerce, direct sales, etc.). This approach will be unfolded by the joint creation of two levels of interaction: **(1)** physical: characterization of honey; **(2)** "living laboratory": creation of a *Honey Community Living Lab* (**HCLL**) and a *Honey Innovation and Learning Ecosystem* (**HILE**) that will be the arena to collect information from beekeepers, stakeholders, and consumers to transfer and apply the new optimized models.

TECHONEY is structured in 4 main technological pillars: **(1)** creation of a consortium IoT (*Internet of Things*) Blockchain platform that involves various actors in the honey supply chain to ensure transparency and traceability, in addition to reducing costs and ensure the traceability in the honey supply chain; **(2)** creation of a transformative learning community to ensure a smart-short-resilient shared supply chain; **(3)** characterization of the quality of honey to guarantee its traceability within the Blockchain directly by consumers; **(4)** ICT tools for honey supply chain participants and consumers.

TECHONEY will be committed not only to promote the continuation of the direct sales of honey from producers to consumers even after the COVID crisis but also **develop a common methodology and clear new optimized resilience protocol** to be used by small-scale farmers, beekeepers, smallholders as a new business model with a more efficient added-value chain, sustainable with fair profit, accepted by final consumers, which will be replicable to other food products and supply chains.

TECHONEY will **help beekeepers to**: **(1)** generate a traceability mechanism for honey produced in the Med. Area; **(2)** diversify markets and distribution channels offers business flexibility and freedom from dependence on a single market, which will reduce risk in the event of a crisis; **(3)** cooperate and pool resources among themselves (pooling of the workforce, etc.) for logistical flexibility and solidarity in the supply chain, which will also reduce the risks in the event of a crisis.

TECHONEY proposes to design and develop a **multidimensional framework** to analyse 6 full honey supply chains (farm to table) that will integrate economic, social and environmental indicators and a traceability system, with a *bottom-up* approach considering the stakeholders´ perspectives. A consortium blockchain, coupled with IoT (*Internet of Things*), system will be created to offer real-time tracking and complete traceability of honey along the supply chain from the characterization of honey in a certified laboratory, the retailer, until the end consumer.

The characterization of the quality and safety aspects of local honey through **local certified laboratories jointly with the use of e-commerce and quality labeling schemes** will increase the opportunity for beekeepers to be identified locally, and allow them to gain access to new markets (foreign markets). The implementation of e-commerce with the mobile application will enable local honey to be **better traced by consumers who attach more value to local food and local beekeepers**.

TECHONEY contributes to increasing farm profitability and increasing flexibility and risk mitigation capabilities. A shared, short and circular supply chain will allow actors in the honey supply chain to **access markets** and have **higher incomes**, **share resources and skills** and **save money** by reducing costs (economies of scale) and increase the efficiency, sustainability and flexibility of processes to strengthen resilience and flexibility to face crises and lower risks. The learning community lab and the use of the Blockchain network will secure the storing of records, will **strengthen intellectual property rights**, as well as **bring transparency throughout the supply chain**; it will **reduce frauds**, **enhance food safety** and **improve the communication** between retailers and beekeepers. The traceability system offered will also allow consumers to give direct feedback to beekeepers.

To reach the overall objective, several **specific objectives** (SO) are set out as intermediate goals:

- **SO1:** Map the current added-value chains and complexity level for honey products in six case studies (Spain, Algeria, Tunisia, Turkey, Luxembourg and Morocco).

- **SO2:** Increase the competitiveness and power of the beekeeping supply chain by understanding consumers' and retailers' opinions and acceptance through non-hypothetical methods.
- **SO3:** To promote the traceability to differentiate local honey and guarantee food safety of honey produced in the Med. area by characterizing it in a reliable, certifiable, and documentable manner.
- **SO4:** Design and explore the feasibility of a new traceability ecosystems and effective business models across different stakeholders.
- **SO5:** Development of a new "Multichannel distribution" e-commerce platform implementing new business model as well as integrating and scaling up the outcomes from WPs 1, 2, 3 and 4.
- **SO6:** Maximize outreach and beneficial influence of the project results and reach the target users (beekeepers, small-scale food manufacturers and local distributors, canteens and retailers, local public authorities) through an effectively established communication and dissemination plan, including innovative training capsules.

Moreover, a **TECHONEY** web ICT tool consumer/farmer-centred will be developed, by testing and evaluating several machine and deep learning algorithms, providing small-scale beekeepers with key information on new markets and opportunities, contributing to a better decision making and to ensure the traceability of their product. Consumers will have exhaustive knowledge of the different honeys of the Med. area, knowing their traceability from the initial producer, guaranteeing the quality and safety of each product.

TECHONEY *is a project coordinated by CITA (Spain) and funded through the PRIMA Section 2 Multitopic 2021 – Thematic Area 3-Agrofood chain – Topic 2.3.1 Increasing the resilience of small-scale farms to global challenges and COVID-like crisis by using adapted technologies, smart agri-food supply chain and crisis management tools. (RIA*[5])" under the funding scheme of "Collaborative Project" and type of Action "Research and Innovation Actions (RIA)."*

EXECUTIVE SUMMARY OF THE DELIVERABLE

This Deliverable D4.2.1 is about the **traceability system backend Inchain (smart-contract) and offchain** questionnaire design that is paramount for the development of a flexible, scalable and robust blockchain based honey supply chain. The realization of a honey supply chain based on the hyperledger fabric blockchain demands a careful consideration of the legal, regulatory, governance, configuration and practical requirements pertaining to the framework; acknowledge the needs, concern and preference of the direct participants within the supply chain and design smart contracts that encapsulate the underlying business logic and binding agreements. Consequently, this deliverable highlights the importance of preparing a comprehensive questionnaire with a general and specific scope based on the roles each participating stakeholders play within the supply chain. The preparation of this questionnaire signify an important stage in the implementation of the blockchain based e-commerce for honey supply chain and serves as a crucial mechanism for gathering user specific data, preference, addressing concerns, defining the business logic and adherence to the rules & regulation pertaining to the specific country & participating organizations. Furthermore, such questionnaire can help in addressing the security issue, conflict resolution and data privacy concerns that may arise in blockchain based platforms. Hence, in addition to simplifying the design process, improving the functionality of the smart contracts and accommodating user specific preferences, the questionnaire can greatly help in testing the network & preparing the needed documentation which can later help in understanding & teaching the functionality and overall operation of the network.

DOCUMENT STRUCTURE

This D4.2.1 document is organized according to the following structure:

- **INTRODUCTION:** Depicts the context, purpose and scope of the document and relevance of the questionnaire.
- **HYPERLEDGER FABRIC FRAMEWORK :** Short introduction to the core components of the fabric network
- **UNDERSTANDING STAKEHOLDERS:** Depicts the importance of identifying and engaging the stakeholders
- **SMART CONTRACT DEVELOPMENT:** Reviews some considerations that needs to be considered when designing the business logic in fabric framework.

INTRODUCTION

The survey we conducted on **traceability in IoT and Blockchain based agri-food supply chain** in deliverable D4.1.1 has given us the needed insight about the different blockchain frameworks & IoT devices that are employed practically, proposed or researched as a proof of concept in agri-food supply chain. As a result, we have identified the gaps in terms of the implementation & governance of the underlying framework. Furthermore, the resources required for the realization of end-to-end honey supply chain that guarantees its safety, traceability and minimization of waste and fraud. Now, we are diving toward specific implementation both in regards to the Hyperledger Fabric blockchain framework, smart contract design, front and back-end web interface developments. However, due to the diverse nature of the expectations, scale, size and reach of the participating stakeholders in the honey supply chain, ratifying policies to configure & govern the blockchain network and design client interface's that encapsulate the needs of the majority requires a comprehensive questionnaire. For instance, in regards to the framework, the questionnaire can help in determining the minimum number of nodes required for the safe and optimal operation of the network, the direct and indirect governing bodies, the legal and regulatory rules, agreements, authorization and consensus etc.

HYPERLEDGER FABRIC FRAMEWORK

In Hyperledger Fabric, peer nodes constituent the core elements of the blockchain network. Their responsibility lies on the management of smart contract, the immutable ledger, the execution and endorsement of transaction proposals. The number of peer nodes is not only dependent on the number of the participating organizations, but also on the anticipated volume of transactions, the required level fault tolerance, load balancing, availability etc. The scalability of the fabric framework allows for the addition/deletion and easier reconfiguration of these elements. However, determining the minimum number of participating peer nodes & the required redundancy to rectify faults based on historical transactional data would greatly help the network development process and the continuous operation of the network. Such considerations are also applicable to the other core components of the network, the orderer node and the specific consensus mechanism selected. The Hyperledger fabric framework relies on the collaboration of peer nodes for the execution & endorsement of the transactional chain codes and the orderer nodes or ordering services for the commitment, block creation and final addition to the immutable ledgers. The importance of the ordering services, however, transcends the mere creation & addition of the transaction block to the ledger. The creation of the system channel for the configuration of the fabric network is under the purview of the ordering services. Meaning that the authorization for who has the access to configure the network/channel and send or write data to the ordering services is enforced by the orderer nodes itself. Although such configurations are made by the administrators who have the right credentials, they do it through a set of policies.

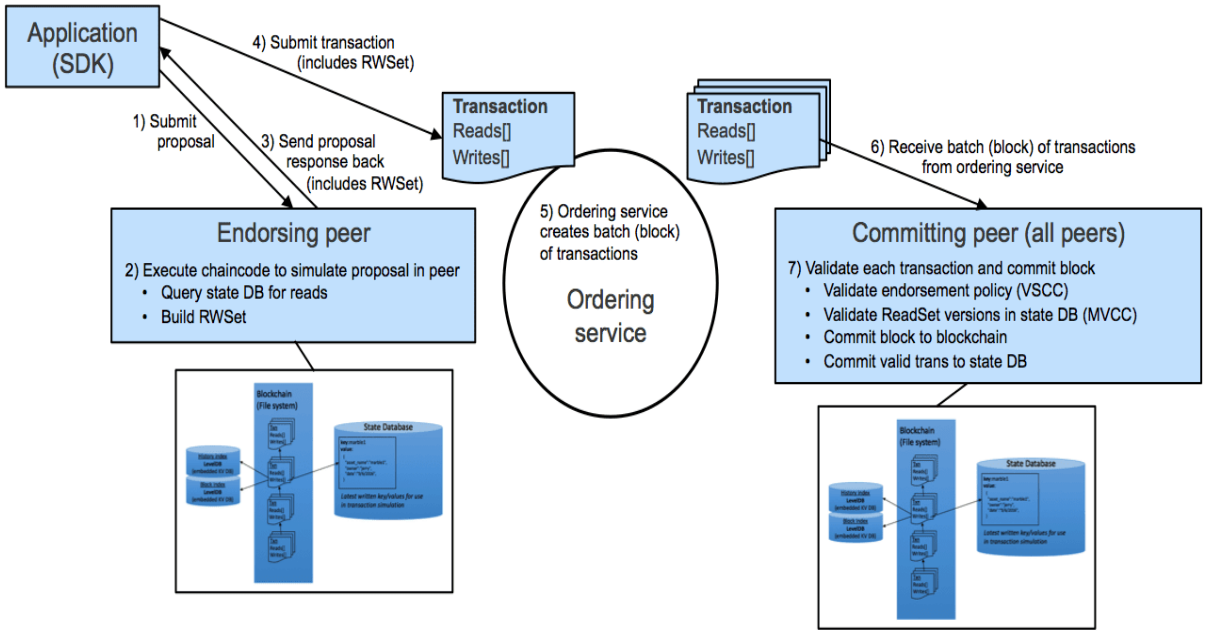

Figure 1. Sample transaction flow in Hyperledger fabric.

The ordering services references those rules to enforce access control and filter the allowed peers for transactional participation on a given channel. Moreover, for any request or event feedback from ordering nodes to the participating peer nodes, the ordering nodes requires administrative permission as dictated by those rules. The ratification of these polices demands transparency, consent and should be acknowledged by all stakeholders. This doesn't mean that organizations don't have their own preferences when it comes to setting their own policies to manage their respective domain. But, for the network configuration that is common, they all have to agree on the specific rules. The determination of what should be common and what should be private demands identifying the stakeholders, understanding their needs, concerns, preferences etc. As such framework specific questionnaire such as,

- ✓ Information sharing, transparency and degree of visibility that is amicable to all participants;
- ✓ The consensus mechanisms selected and its management within the network;
- ✓ Relevant business logic and chain code design;
- ✓ On-chain and off-chain data storage and management;

- ✓ Industry standards, regulatory requirements & compliance and country specific rules & regulations pertaining to honey supply chain;
- ✓ Rules in certification and its revocation;
- ✓ Concerns related to the security and privacy of the participating stakeholders within the honey supply chain;
- ✓ Average anticipated volume of transactions and size of supply chain;
- ✓ Relevance of machine learning models in fraud detection, quality determination, as an early warning indicator for bee colony losses and honey quality deterioration due to contamination, parasites, pathogens, etc.

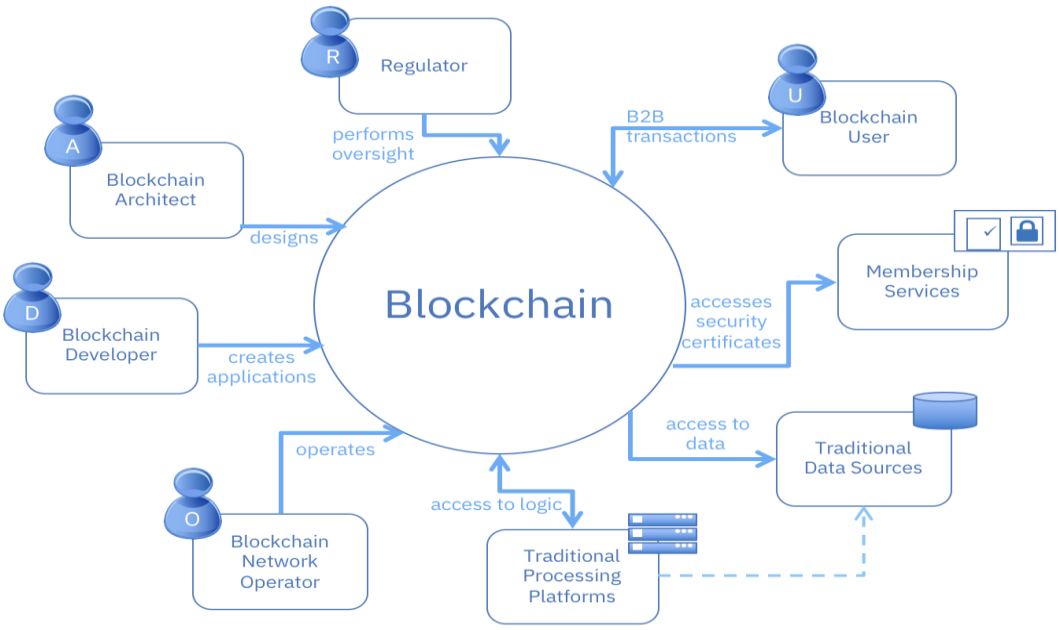

Figure 2: Roles, governance and interaction in Hyperledger fabric blockchain.

can help in designing a robust framework. Beyond the specific requirements of the framework, the usability of the network is also dependent of the relevance of the smart contract designed and the suitability & conformance of the application (user interfaces) to the needs of the respective stakeholders. Although they operate on a similar recorded data shared across the blockchain network, the functionality that the honey producers expect from the interface can greatly vary from those of distributors or retailers. Consequently, questionnaire that help in identifying and aligning the interest's of the different stakeholders in honey supply chain would help in designing user interfaces and data presentations that are more tailored to the demands of the participating stakeholders.

UNDERSTANDING STAKEHOLDERS

The involvement of all stakeholders in the realization of a traceable blockchain-based honey supply chain is paramount. The ultimate goal of this blockchain based e-commerce is to give farmers the needed exposure so that they can trade their products. It should also guarantee the safety and traceability of the product. And yet, not all beekeepers or any of the stakeholders involved in production, processing, transportation and trading of honey have similar concerns when it comes their business representation on the blockchain. For instance, the size & reach of their trade horizon makes a difference in terms of the services and product type they provide. The type of stories they would like to tell to their potential clientele, how their information should be structured, how they describe the type and quality of honey they produce: raw, bottled or processed etc., all goes toward designing not only a client interface but also dictate the very transactional data that will be used for recording into the ledger and product tracking during traceability. As such, understanding and identifying stakeholders in the honey supply chain, what their needs are and their preferences through questionnaires, in addition to aligning their interest, it can also simplify designing the interface.

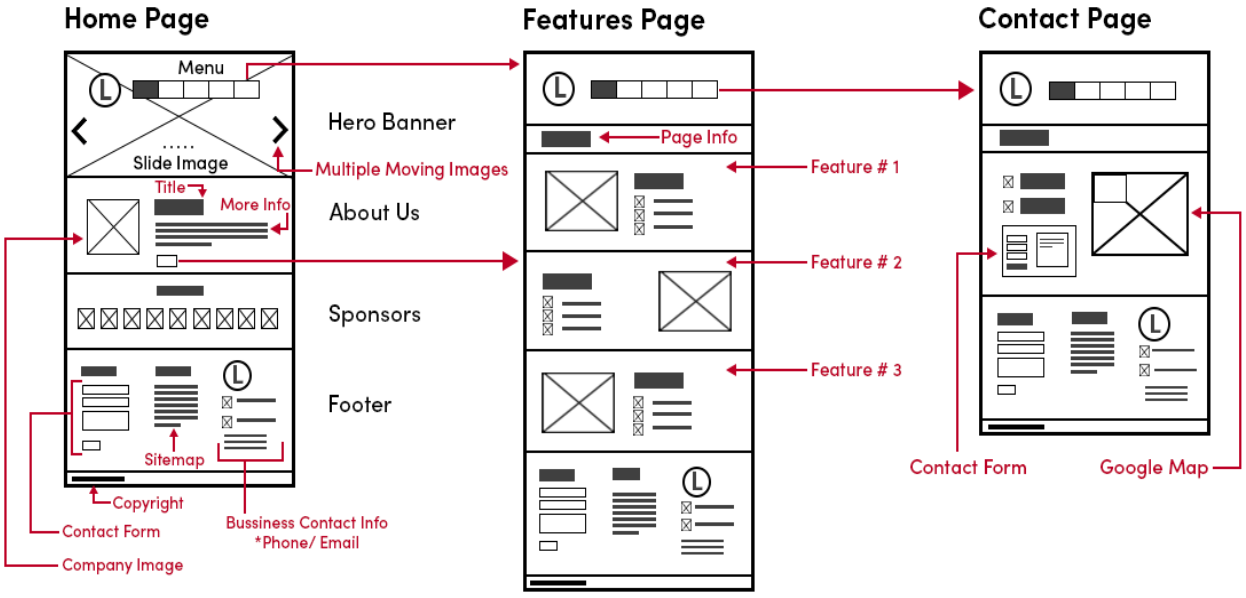

Figure 3: Sample wire frame.

Such collaboration with the relevant stakeholders could also help in strength the trust the stakeholders put on the framework. Furthermore, the analysis of the gathered data through the questionnaire, can help in understanding the challenges small scale honey farmers faces in trade penetration, financial losses and give a valuable insight into how best to minimize the gaps, risks and provide better exposure through the blockchain network. Hence, we are preparing questionnaires encompassing relevant details, such as

- ✓ Preferred general information details for profile description within in the e-commerce for all stakeholders;
- ✓ Honey product quality and description containing type of honey, its origin, quality, packaging, certification, etc.;
- ✓ Prominent features when searching and filtering honey products, delivery mechanisms, etc.;
- ✓ Preferred product listing, description and tracking on the e-commerce;
- ✓ Features for inventory management and waste minimization/ expiry date tracking;
- ✓ Preferred customers details for placing, reception and confirmation of order;
- ✓ Willingness for regulatory body oversight, certification and quality assurance;
- ✓ Information sharing, adherence to expected rules and regulation;

- ✓ Willingness for the deployment of IoT devices;
- ✓ Preferred means of communication with customers;
- ✓ Dispute resolution.

Incremental addition to these questionnaire will help in designing a user-interface that is flexible enough to accommodate and meet the demands of all stakeholder in the honey supply chain.

SMART CONTRACT DEVELOPMENT

In blockchain context, smart contracts are what gives meaning to the objectives of participating in the given network. It represents the terms of agreement and rules of engagement between the participating organizations who agreed to transact within the blockchain. These agreements are later changed into self-executing codes on the blockchain where under the right endorsement criteria, can facilitate business transactions without intermediary oversight. As they represent the underlying business logic and binding agreements, they are mostly bundled together into a chain code and deployed across the blockchain network so that it can be accessible to all participating stakeholders. Hence, smart contract design goes hand in hand with understanding the business process and legal frameworks. A discussion with all stakeholders in honey supply chain through appropriate questionnaires can help in designing smart contracts that carries the needs and specific requirements of the participating stakeholders. For instance, questionnaire containing:

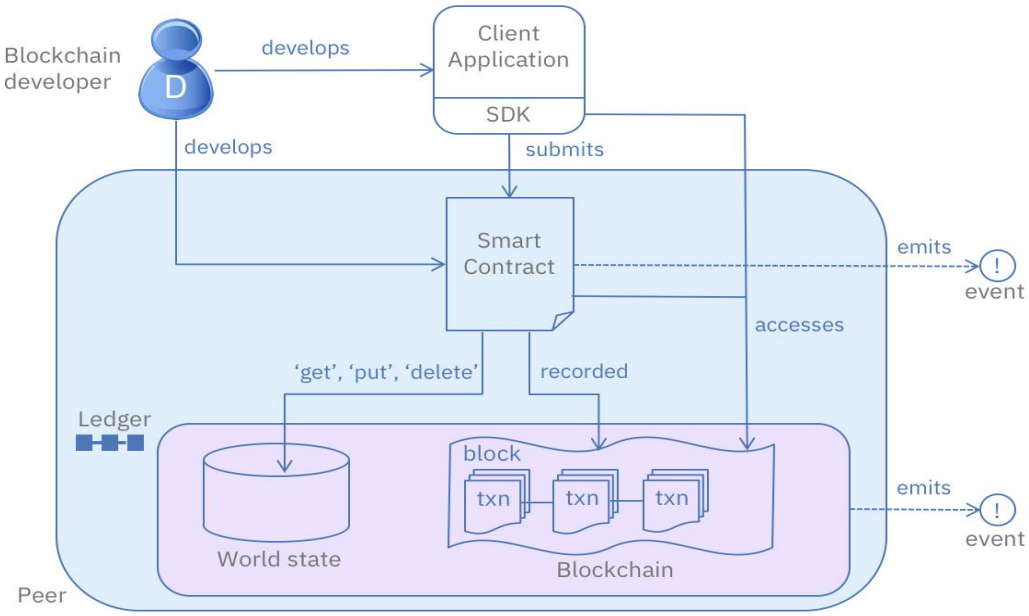

Figure 4: Smart contract invocation and execution in Hyperledger fabric.

- ✓ The underlying business process that the smart contracts need to articulate and enforce;
- ✓ The conditions that should be meet for its invocation and execution;
- ✓ Specificity of the binding agreement;
- ✓ Legal and country specific rules and regulation for honey trading;
- ✓ Certification requirements for quality assurance and honey trading;
- ✓ Endorsement policy and the participating governmental or regulatory bodies besides the stakeholders in honey supply chain;
- ✓ Potential security risks, data protection and access control;
- ✓ The absence and presence of user interactions within the honey supply chain business logic/smart contract, the specific requirements and communication preferences, etc.

can help in capturing the core elements needed for the implementation of honey supply chain's smart contract. As a result, the consideration of the requirements of the fabric frameworks, the stakeholders and the smart contract can facilitate the design, test, documentation and successful deployment of the honey supply chain. The questionnaire preparation is still a work in progress. When finished, the questionnaire will be reviewed and then later distributed among the participating organization.