



Health Information Exchange

***Platform White Paper***

---



## **Our Team**

- **Joyce Lignell** - Healthcare Strategic Advisor
- **Teri Thomas** - Senior Strategic Advisor
- **Jim Bonnette, MD** - Medical Advisor
- **Dick Escue** - Strategic Advisor
- **Kai Tsai** - Strategic Advisor
- **Robert Martin** - Strategic Advisor
- **Yirsa Abreu** - PA-C Medical Advisor
- **Miguel Esparza** - Project Manager
- **Will Lowe** - Managing Partner
- **Ramiro Pequeno** - Managing Partner
- **Oscar Zarate - Jr.** Business Development Director
- **Teo Tijerina** - Director Business Development, Latin America
- **Hardik Patel** - M.Eng. Software Engineer
- **Rushirajsinh Jadeja** - M.Eng. Software Engineer
- **Balachandren Sutharshan** - Software Engineer
- **Mukunthan Tharmakulasingam** - Software Engineer
- **Jay Pandya** - Software Engineer
- **Dmitry Nikitin** - Software Engineer



## Introduction

Personal health data is currently not used efficiently nor effectively due to fragmented information created and isolated throughout hospitals, physician practices, pharmacies, and laboratories<sup>1</sup>. Sharing healthcare data from one institution to another has been a complex task due to privacy concerns and fear that sharing information will give others a competitive advantage<sup>2,3</sup>. Today's electronic medical records (EMRs) have varying data standards that inhibit interoperability since records are not compatible between systems. Inconsistent rules and permissions prohibit health organizations from accessing real-time patient data<sup>3</sup>.

A health information exchange (HIE) is defined as a reliable and interoperable electronic sharing of clinical data obtained by the patients, physicians, nurses, pharmacists and other health care providers across unaffiliated institutions which in turn creates a network effect<sup>4,5,6</sup>. This enables data to follow patients wherever they receive care. A blockchain powered health information exchange (HIE) would establish the interoperability that is lacking in today's healthcare infrastructure<sup>7</sup>. Furthermore, this would allow for coordinated patient care and eliminate unnecessary services and duplicate tests. Improved data integrity, reduced transaction costs, decentralization and disintermediation of trust, establish the benefits that a health information exchange (HIE) delivers.

The purpose of Timicoin is to provide a blockchain solution that will secure healthcare information within a health information exchange (HIE). This will effectively deliver patient records in a consistent and real-time manner, only to be accessed via a smart contract after patient authorization. Timicoin's Health Information Exchange will provide an optimized environment where health data is structured and secured, leading to better data utility and improved patient care outcome.

---

<sup>1</sup> Vest and Gamm, "Health Information Exchange: Persistent Challenges and New Strategies."

<sup>2</sup> Clifton et al., "Privacy - Preserving Data Integration and Sharing."

<sup>3</sup> Peterson et al., "A Blockchain-Based Approach to Health Information Exchange Networks."

<sup>4</sup> "Health Information Exchange | HealthIT.gov."

<sup>5</sup> Vest and Gamm, "Health Information Exchange: Persistent Challenges and New Strategies."

<sup>6</sup> Hersh et al., "Outcomes From Health Information Exchange: Systematic Review and Future Research Needs."

<sup>7</sup> Linn and Koo, "Blockchain For Health Data and Its Potential Use in Health IT and Health Care Related Research."



## **HIPAA - Compliance Guidelines**

The Health Insurance Portability and Accountability Act of 1996 (HIPAA) sets the standards for entities that must protect electronic patient health information (ePHI) through physical, network, and security processes<sup>8</sup>. These entities can be categorized as those who provide treatment, payment, and operations directly linked to patients or business associates who support those who directly work with patients<sup>9</sup>. Business associates include subcontractors or any associated business that handles patient health information.

As the healthcare industry further integrates ePHI (electronic patient health information) entry systems to promote efficiency and mobility, entities must prioritize security risk and take the necessary measures to protect ePHI<sup>8</sup>. HIPAA protocols and policies provide entities the ability to adopt personalized risk management technologies according to size and organizational structure.

HIPAA's safeguards include:

- 1) Limited facility access and control with authorized access in place
- 2) Policies concerning user access and electronic media
- 3) Restrictions for transferring, removing, disposing, and re-using electronic media and ePHI

Access controls include:

- 1) Using unique user ID's, emergency access procedures, automatic log off, and encryption/decryption
- 2) Audit reports or tracking logs that record activity on hardware and software

Furthermore, integrity controls need to be established to reaffirm that ePHI data is not altered or destroyed<sup>8</sup>. IT disaster recovery and offsite backup must be put in place for insurance when electronic media errors and failures occur. The IT

---

<sup>8</sup> "Summary of the HIPAA Security Rule | HHS.gov."

<sup>9</sup> "HIPAA Compliance | Touch Support."



disaster recovery measures include data transmission security (including e-mail, internet, and private network security) to protect against unauthorized access to ePHI.

## ***De-identification***

Healthcare information is a lucrative target for hackers<sup>10</sup>. Due to the centralized nature of electronic health records, data can be easily hacked<sup>3</sup>. The rise in adoption rates of these technologies, as noted by the Department of Health and Human Services, increases the potential security risks<sup>11</sup>. Lack of security for patient records can lead to legal and financial consequences that jeopardize patient care, proprietary practices, and competitive advantages<sup>3</sup>.

Data anonymity secures patient records, by removing certain identifiable information and only providing partial data<sup>3</sup>. This process de-identifies the patient, maintaining a HIPAA compliant environment and providing valuable resources to institutions for better patient therapies, medication research, and overall patient outcome.

Timicoin's blockchain network never reveals the patient's identity. Instead, it uses a unique identifier to distinguish between patients. When anyone requests data from the network, the patient is notified via the TimiPatient App. The patient grants the permission to use their data, without revealing their identity. Without confirmation, the data on the network is encrypted and cannot be accessed.

Health data demands heavy storage and bandwidth requirements for numerous documents and large images. Requiring a blockchain to distribute data for every patient among all members on the blockchain would deem impossible from a data storage perspective. The healthcare industry needs a blockchain solution that serves as an access-control manager for health data<sup>7</sup>.

---

<sup>10</sup>"The Biggest Healthcare Breaches of 2017 | Healthcare IT News."

<sup>11</sup>O'Hara, "Thousands of Patient Records Leaked in New York Hospital Data Breach."



Timicoin's Health Information Exchange will index all health data for patient's and tie the associated health data to a unique identifier for the patient. The transaction blocks will provide the user unique identifier, an encrypted path to the health record and a timestamp for date of creation. Timicoin's blockchain will contain a complete indexed history of all health data and its associated patient via the unique identifier. Health data from wearable devices and mobile applications will also be stored and indexed accordingly<sup>7</sup>.

The TimiHealth ecosystem works by containing the medical data in a data repository called a data bucket. Data buckets will store health data from images to documents. The data buckets will provide health research institutions the tools for data mining. Advanced query tools for clinical research studies, text mining, and data analytic tools will provide institutions a powerful HIE experience<sup>7</sup>.

Medical records created by providers produce a digital signature that is used for authenticity verification. The health data is encrypted and sent to the data bucket for storage. The blockchain is notified when an object is added to the data bucket and creates a pointer to the health record that is recorded on the blockchain as a transaction assigned to a unique identifier. The patient is then notified via the TimiPatient App where the patient can verify the transaction and add health data from wearables and apps<sup>7</sup>.

## **Consistent Structures**

The current environment for patient health data is hindered by a monopolized information environment controlled by a few single authorities<sup>12</sup>. Each of these centralized EMR's have their own data structures and technical architectures, and thus create obstacles for interoperability. A decentralized health information exchange would aggregate data from all EMR providers and create a consistent view of patient records across a cohesive data sharing network.

---

<sup>12</sup> Krawiec et al., "Blockchain: Opportunities for Health Care."



## Interoperability

The ability of a system to be able to exchange and use the electronic health information from another system without special effort to be done by the user is known as interoperability<sup>13</sup>. Currently EMR systems are not compatible with each other which inhibit real-time data to be obtained seamlessly<sup>12</sup>. The lack of communication among the EMRs create data discrepancies which produce data errors that can lead to consequences such as medical miscommunication and result in reduced patient health outcomes. In the present environment, the patient has limited interaction in the exchange of information. The patient needs to be integrated into the healthcare ecosystem because the patient is the principal component of a health information exchange<sup>7,14</sup>. (Figure 1.1)

By eliminating intentional data blocking, improving consumer access to health data and implementing standards for health data interoperability the appropriate and effective use of health data will be facilitated<sup>13</sup>. Consumers should be able to easily and securely access their electronic health information which will in turn benefit their health by ensuring transparency of all records between healthcare providers leading to better health practices<sup>15</sup>.

## A Healthcare Blockchain

A blockchain is a distributed transaction ledger which is composed of blocks that represent transactions<sup>12</sup>. Each peer to peer transaction is linked creating a shared, immutable record. The blockchain is established using cryptographic techniques for full transparency and decentralization forgoing the requirement of a central authority and thus creating a trust-less consensus. Mining is a process of validating a transaction or block in a network by the process of complex algorithms to prove and validate the correctness of a transaction and thereby adding the new block to the respective blockchain. Miners are nodes that assemble the blocks and link them to the blockchain<sup>3</sup>. Miners only build on top of valid blocks due to implemented incentives which drive the consensus strategy within the network.

---

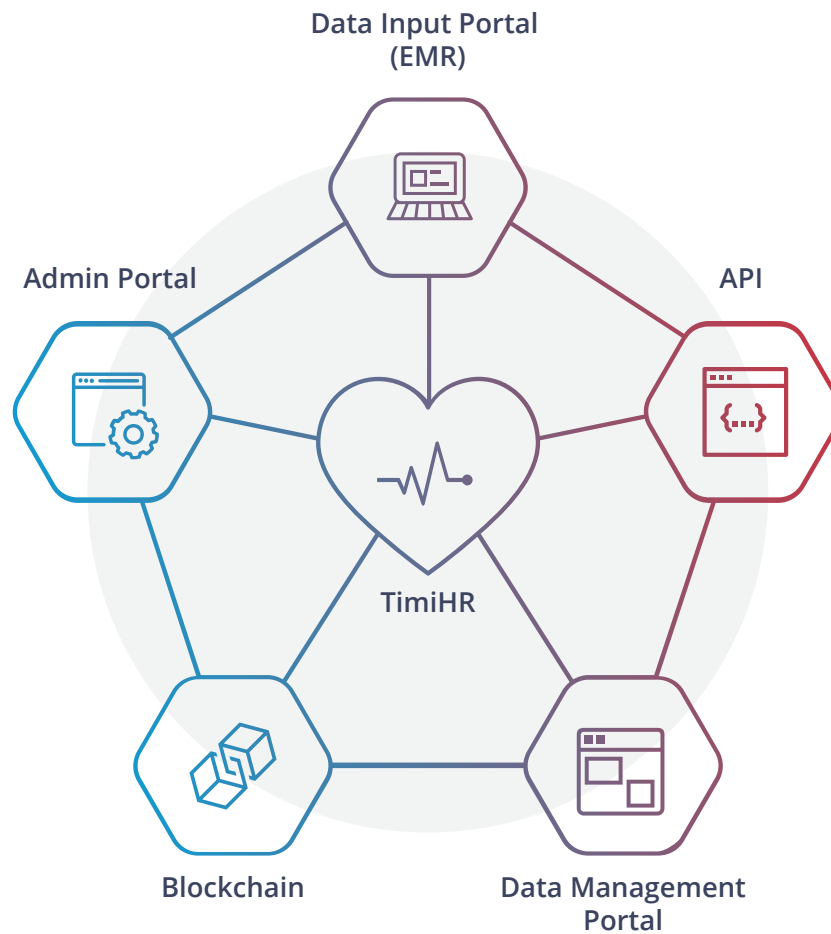
<sup>13</sup> The Office of the National Coordinator for Health Information Technology (ONC), "Update on the Adoption of Health Information Technology and Related Efforts to Facilitate the Electronic Use and Exchange of Health Information."

<sup>14</sup> Heath, "HHS Interoperability Pledge Gains Major Support at HIMSS 2016."

<sup>15</sup> "Interoperability Pledge | HealthIT.gov."



## Timicoin Ecosystem



## Timicoin Ecosystem

(Figure 1.1)

## Proof of Work

There are multiple mining techniques in use; Timicoin uses a technique referred to as Proof of Work. This technique requires a feasible amount of effort in order to prevent malicious uses of computing power such as launching denial of service attacks. In proof of work, miners receive new transaction blocks from the network, and generate hash codes. Once a solution to a mathematical problem of a transaction is resolved, the derived hash is attached to the particular





transaction and that transaction is broadcasted back as a mined transaction. The hash of any transaction block is matched based on the previous block's hash. So once a transaction is mined, no one can tamper with the data and republish it on the network. The hash is a one-way function may only be used to verify the data that generated the hash matches the original data.

Mining in the TimiHR network is used to enforce no patient record key is removed or tampered with by a Man in the Middle Attack (MITM). All the data remains within the boundaries of allotted access and no external node can gain access. This will also avoid the double spending of token balances as the financial chains are utilized.

Miners are rewarded in the form of transaction fees via newly generated Timicoins. In some specific cases, patients will also be rewarded from the transaction fees for providing their anonymous data for research or commercial purposes. When organizations query large amounts of data, they have to pay for the associated data fees. Patients and management receive their share, allotted from the total payment.

## ***Utility Token Fundamentals***

The development of a decentralized health data ecosystem requires a series of services and systems. Utility tokens are units of services that are used to access data and have a well-defined utility within their blockchain or ecosystem. The TimiHR Ecosystem will require the Timicoin Utility Token to process all services and data requests for patients, providers, and consumer organizations. TimiHR users will be able to transact their Timicoin's to validate smart contracts, request or provide data permissions, access invaluable data via the TimiPatient App and connect company proprietary software via API's.



## **Health Utility Token**

To understand the value of a utility token, one must understand the flow of health data through multiple services and players. Initially, health data is stored with Health Organizations and Provider offices. When Health Organizations provide services to patients, clinical data is captured. This clinical data is stored in electronic medical record systems. At this point, patient data will be submitted to the TimiHR ecosystem via a Smart Contract process and each transaction is stored on the blockchain along with the patient's public ID. This means that the submission and acceptance process has been completed and uniquely identified. Timicoins are distributed accordingly to the users.

The value of the TimiHR Ecosystem derives from the rich patient health data that will be analyzed to reveal new insights. Health Organizations and Institutions will access the Timi Health Information Exchange to query the blockchain. Their queries include non-identifiable patient information (age, gender, illness) that is viewable. The organizations will submit a request to access the data and patients will grant or deny permission and receive Timicoins for access to their data.

## **Utility Token Fundamentals**

The TimiHR Ecosystem will require the Timicoin Utility Token to process all services and data requests for patients, providers, and consumer organizations. (Figure 1.2 & 1.3)

TimiHR is the data request and management portal for the ecosystem. Timicoin the utility fuel token running the TimiHR Ecosystem. From here, consumer organizations can:

- Discover new Providers
- Request new data from available sources
- Pay with Timicoin for requesting access to data
- Manage accessible data
- Contact Providers



# TimiHR Visuals

**TimiHR** Logout

**DRA ADRIANA REYES**  
Administrator

**Dashboard**

Filter by: Type of share, Type of data, Period: Type of data

Search Data: heart | Page 1 of 5

**RECORDS** Record Shared 1,540 | 06 . 12 . 2017

ID	Patient Name / Title	Status	Actions
1	Diego Luna (2 records)	Identity	
2	Pedro Reyes (2 records)	Identity	

Purchase Data

**TimiHR** Logout

**DRA ADRIANA REYES**  
Administrator

**Dashboard / Records / Patient Health Records /**

Patient ID 1

Name: Diego Luna | Date of Birth: 23-1-1984 | Data share: Identity

[HISTORIES](#)
[CHIEF COMPLAINT](#)
[DEMOGRAPHICS](#)
[HEALTH MAINTENANCE](#)
[HISTORIES](#)
[HISTORY OF PRESEN](#)

**HISTORIES**

DATA	
Family History Disease	- Heart disease Father Brother - Heart attack Father Brother
Past Medical History	HTN, HLD, CAD with PCI past, Denies DM
Procedure History	Negative
Social Alcohol Assessment	Past
Social Other Assessment	Confidential
Social Sexual Assessment	Confidential
Social Substance Abuse Assessment	Denies Substance Abuse, Never
Social Tobacco Assessment	Past, Former Smoker

Figure 1.2 | Figure 1.3



TimiHR consists of nicely refined interface and backend algorithms to find the exact recordset of the data that consumer asks for. It has its own Health Data Search Engine and it works efficiently based on the keywords in the search query, as well as the external filters applied.

The process of searching and obtaining the health data is now simple and efficient. Consumer Organizations only need to type in their search query keywords, like any other search engine, and apply extra filters if the results need to be more specific and constrained. Then the Health Data Search Engine performs its work and fetches the most relevant recordset from multiple available providers based on constraints. A smart contract is established on the TimiHR network ledger, and every patient who has granted permission to access their data is then rewarded Timicoins. The data is then released to the Consumer Organization.

## ***TimiPatient App***

The TimiPatient App provides multiple utility functions to the patients connected to the TimiHR network. The functions performed require Timicoins to be invoked. (Figure 1.4 and 1.5) Patients use the TimiPatient App to:

- View data, share statistics
- Manage data access and connect providers who are multicasting the data
- View their updated health data in real-time including; sugar levels, disease information, blood group, etc. (Figure 1.6 and Figure 1.7)
- Real-time data for patients to monitor their health
- Diagnoses and Treatment efficiency by allowing patients to maintain a synchronized medical history from multiple healthcare facilities. When a patient visits a new facility, providers can review the past medical activities and decide on medication or treatments effectively and instantly. This is a huge time saver for the healthcare system!



## TimiPatient App Visual

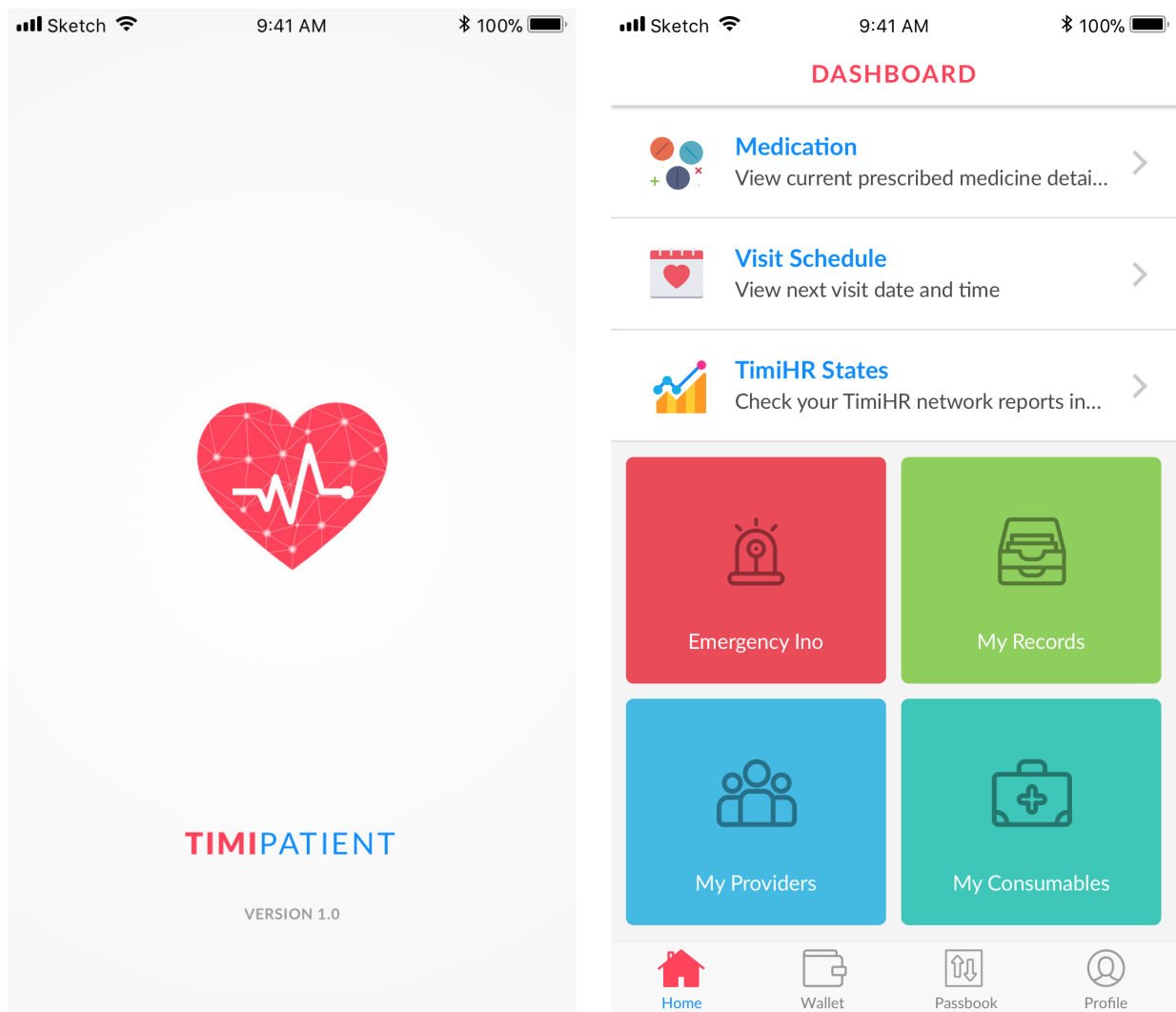


Figure 1.4 & Figure 1.5



## TimiPatient App Visual

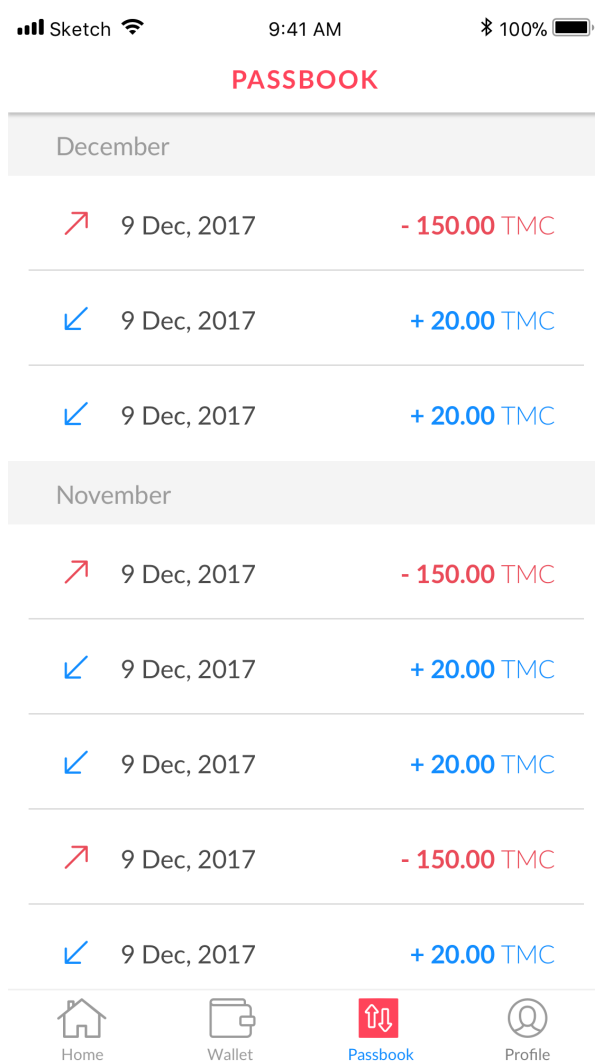
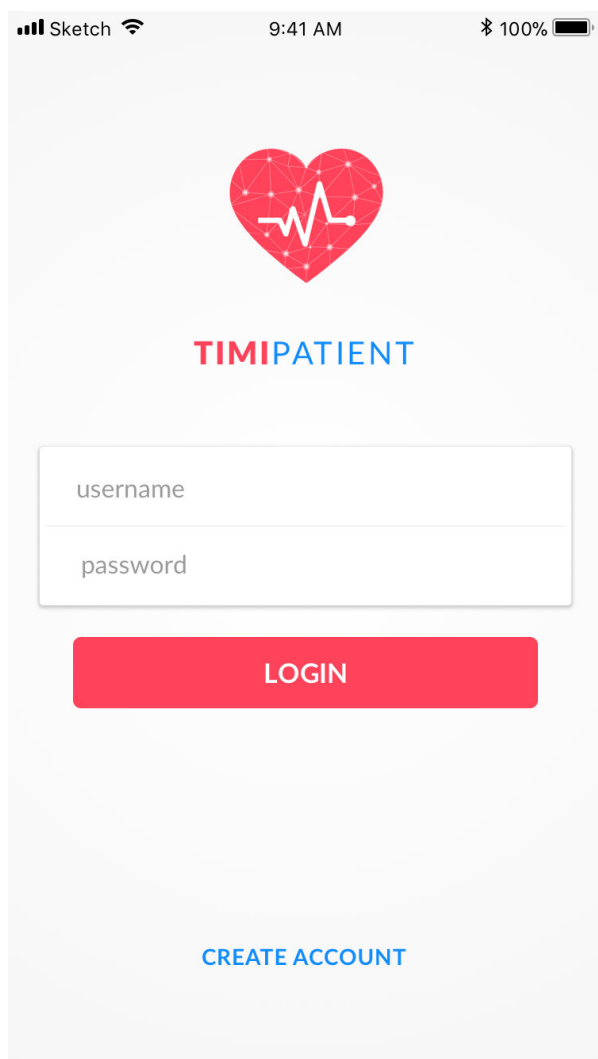


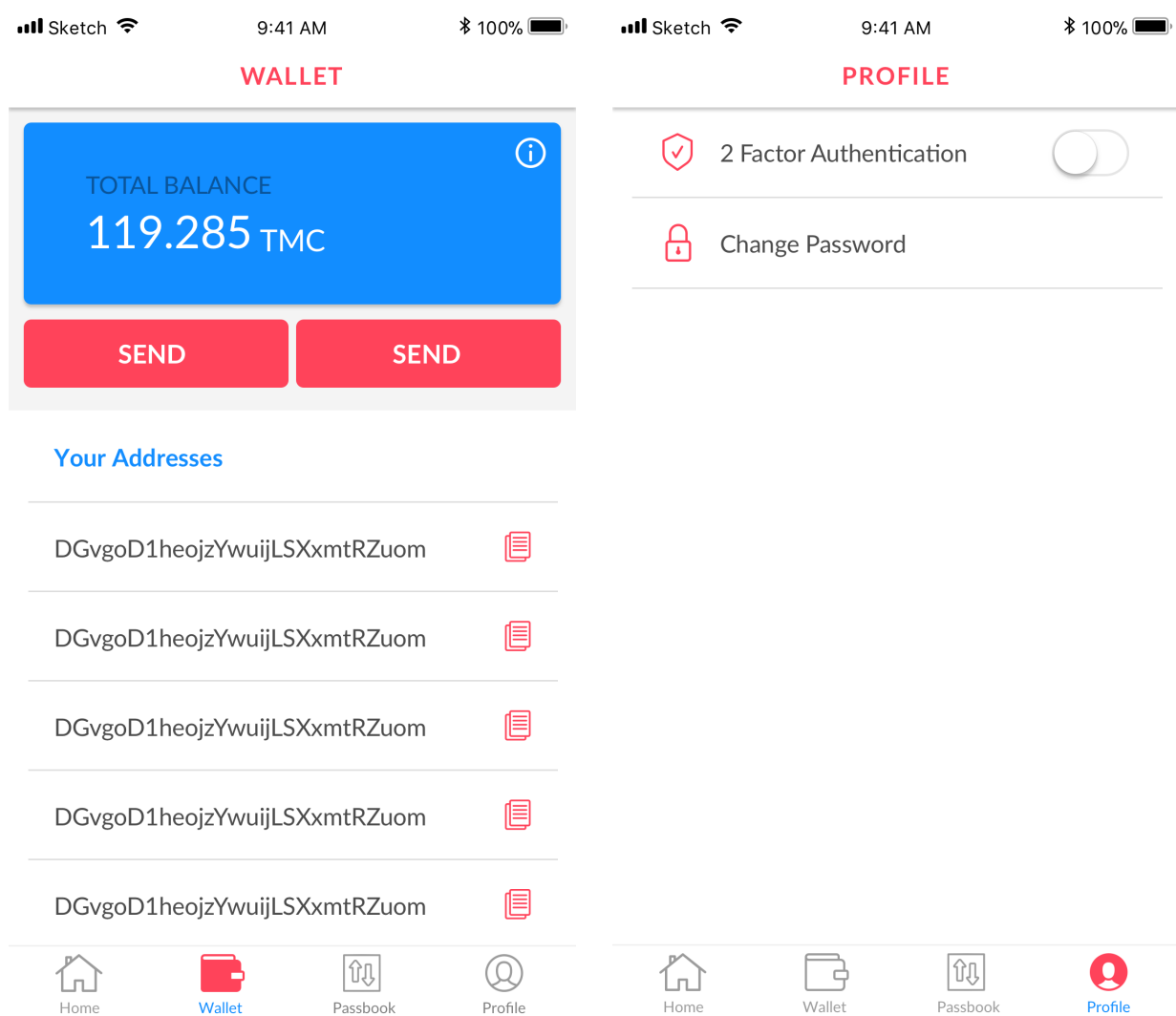
Figure 1.6 & Figure 1.7



## TimiWallet

The TimiWallet is the essential wallet app for any user connected to the TimiHR Ecosystem or who wants to trade Timicoin tokens. Neatly designed, secure and efficient lite wallet client for Timicoin's token ledger. (Figure 1.8)

TimiWallet is also connected to the TimiHR smart contract system so for the consumers, it automatically generates an order invoice for the data they are purchasing. Consumer Organizations will be able to easily tap a button on the app to pay for the data. (Figure 1.9)



**Figure 1.8 & Figure 1.9**

## **User Roles**

- **Providers** - Providers are the hospitals and other medical facilities that serve patients. They serve as the input source for the medical data in TimiHR systems.
- **Patients** - Patients are the primary source of data, however, they are an indirect source as they are not allowed to handle the operations of the input system. Their only responsibility is to grant the data access when new requests are created. They can view their data from various providers as the reward for being a TimiHR participant.
- **Consumers** - Consumers are the health related business organizations which take benefit from the patient data that is on TimiHR.

## **Subsystems**

- **TimiHR** - the decentralized blockchain based Health Information Exchange Network that enables a profitable ecosystem between patients, hospitals and healthcare organizations.
- **TimiEMR** - The Electronic Data Management system that will be used in provider facilities as their lead EMR system or the connecting point between their existing EMR system and TimiHR network.
- **TimiReports** - TimiReports is the online portal to view the allowed healthcare data for Organizations and Patients.
- **TimiCloud** - The online data management and data search portal for all the users to request new data, grant access or manage the available data on TimiHR respective of what access is provided to the particular user. TimiCloud serves as the face of TimiHR network.





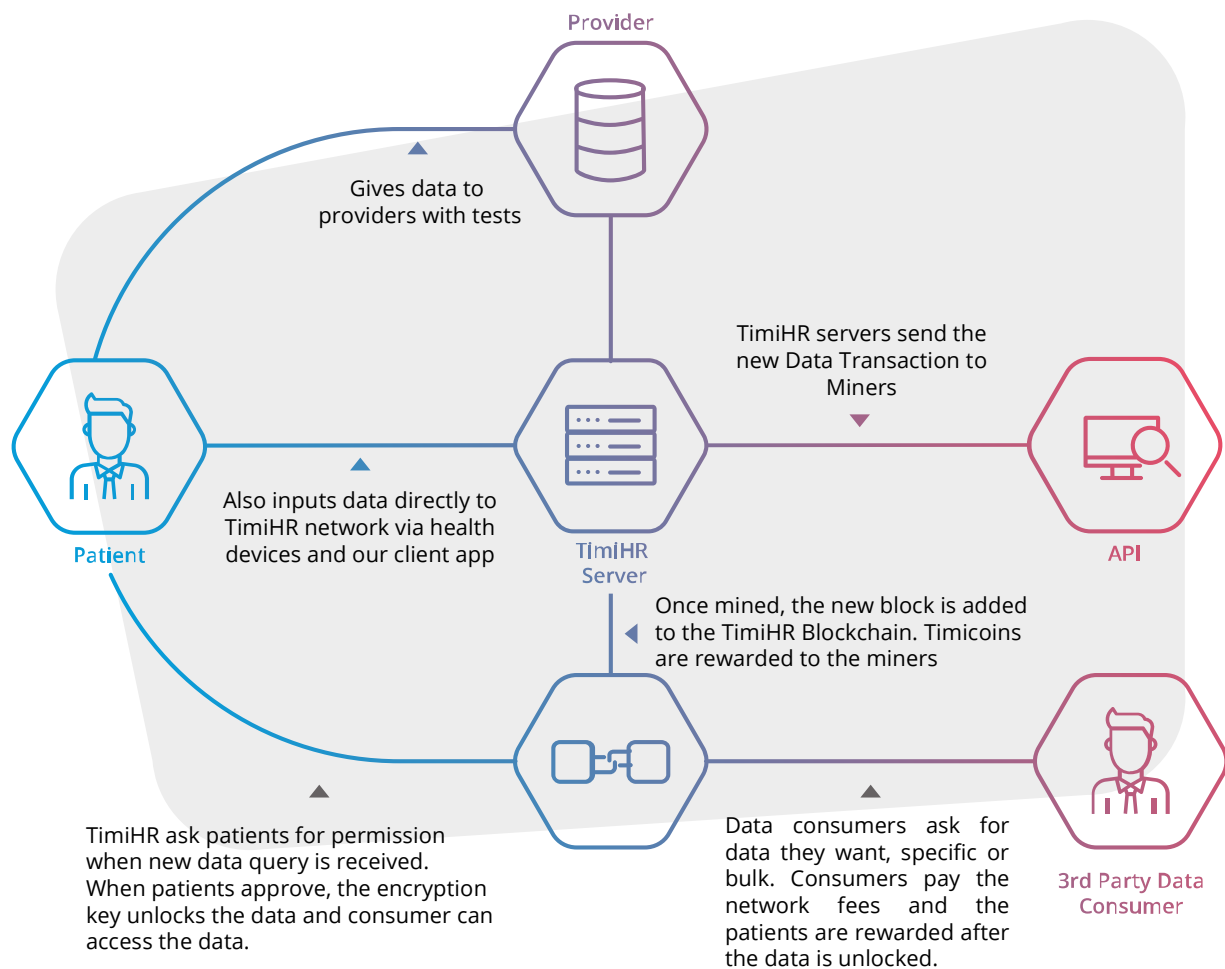
## ***TimiHR Data Flow***

The data flow and transaction process in Timicoin is designed to provide the maximum data security along with ease of access and efficiency on the cloud. The TimiHR network process is divided into 3 sub-procedures. (Figure 1.10)

- **Data Input** - When a new hospital joins the network, they connect the data from their existing EMR systems or TimiEMR to the TimiHR cloud. The data is indexed on the cloud and keywords are matched. So while the actual data stays on the facility computers, TimiHR has the indices and decryption keys to the data.
- **Data Access** - When a consumer organization searches for specific categories of data, TimiHR's search engine algorithms search the indices and fetches the source locations for the type of data the organization queried. The organization will be provided with the cost for the data based on the source locations and data categories. The organization can then submit a request to the patients to grant the access.
- **Granting Permissions** - When a new access request is submitted, the cloud engine reaches out to facilities and the involved patients for the digital NOC in form of a smart contract. When the access request is approved by both the parties, the request is granted and all the asked data is made available to the consumers in the TimiReports Portal. The data will also be available via the Developers APIs and can be fetched into their own systems.
- **TimiHR engine uses a more efficient functionality called the Pre-Granted Access.** When a new facility joins the TimiHR network or a new patient joins the facility, they are asked if they want to join the TimiHR Data Exchange Program. If they agree, their information is flagged as "Always Accessible" data and that makes the process seamless and efficient for the organizations to consume health data.



## Data Flow Visual



## Benefits of a Health Care Blockchain

Patients, providers and healthcare organizations all benefit from the Health Information Exchange platform provided by Timicoin's blockchain technology. Patients will no longer have to gather data from various providers to share with their specialists. Instead, Timicoin creates a single storage location for all real-time health data, which is easily accessible through granted access. This ultimately frees the patient from needing to manually manage the information from each visit to his/her different providers. Better, more readily available data leads to improved patient outcome. The patient now has access to his/her own health data leading to a more engaged patient and thus improving compliance.



Blockchain will ensure continuous availability and access to real-time data, improving clinical care coordination and providing industry wide incentives via Timicoin's Health Information Exchange. Providers and organizations will now have access to the same existing data, leading to optimized patient care. Aggregating data from a larger and more diverse patient population enables improved research activities including clinical trials that can result in a more accurate representation of the general public.

Blockchain technology creates a global solution for seamless collaboration. This revolutionary technology will evolve healthcare into what it was supposed to be: a progressive environment where a patient has full control of their health data and providers work together to ensure the full potential of a patient's health outcome while reaping the economic benefits of an efficient healthcare system.



## Works Cited

Clifton, Chris, Murat Kantarcı, Anhai Doan, Gunther Schadow, Jaideep Vaidya, Ahmed Elmagarmid, and Dan Suciu. "Privacy - Preserving Data Integration and Sharing." Accessed November 5, 2017. <https://oi.org/10.1145/1008694.1008698>.

"Health Information Exchange | HealthIT.gov." Accessed December 10, 2017. <https://www.healthit.gov/topic/health-it-basics/health-information-exchange>.

Heath, Sara. "HHS Interoperability Pledge Gains Major Support at HIMSS 2016." EHR Intelligence, 2016. <https://ehrintelligence.com/news/hhs-interoperability-pledge-gains-major-support-at-himss-2016>.

Hersh, William R, Annette M Totten, Karen B Eden, Beth Devine, Paul Gorman, Steven Z Kassakian, Susan S Woods, Monica Daeges, Miranda Pappas, and Marian S McDonagh. "Outcomes From Health Information Exchange: Systematic Review and Future Research Needs." JMIR Medical Informatics 3, no. 4 (December 15, 2015): e39. <https://doi.org/10.2196/medinform.5215>.

"HIPAA Compliance | Touch Support." Accessed October 12, 2017. <https://www.touchsupport.com/hipaa-compliance/>.

"Interoperability Pledge | HealthIT.gov." Accessed September 12, 2017. <https://www.healthit.gov/commitment>.

Krawiec, Rj, Dan Housman, Mark White, Mariya Filipova, Florian Quarre, Dan Barr, Allen Nesbitt, et al. "Blockchain: Opportunities for Health Care." NIST Workshop on Blockchain & Healthcare, 2016. <https://oncprojecttracking.healthit.gov/wiki/display/TechLabI/Blockchain+Challenge+on+ONC+Tech+Lab#BlockchainChallengeonONCTechLab-Winning>.

Linn, Laure, and Martha Koo. "Blockchain For Health Data and Its Potential Use in Health IT and Health Care Related Research." Accessed October 5, 2017. <https://www.healthit.gov/sites/default/files/11-74-ablockchainforhealthcare.pdf>.



O'Hara, Mary. "Thousands of Patient Records Leaked in New York Hospital Data Breach," 2017. <https://www.nbcnews.com/news/us-news/thousands-patient-records-leaked-hospital-data-breach-n756981>.

Peterson, Kevin, Rammohan Deeduvanu, Pradip Kanjamala, Kelly Boles, and Mayo Clinic. "A Blockchain-Based Approach to Health Information Exchange Networks." Accessed October 4, 2017. <https://www.healthit.gov/sites/default/files/12-55-blockchain-based-approach-final.pdf>.

"Summary of the HIPAA Security Rule | HHS.gov." Accessed October 8, 2017. <https://www.hhs.gov/hipaa/for-professionals/security/laws-regulations/index.html>.

"The Biggest Healthcare Breaches of 2017 | Healthcare IT News," 2017. <http://www.healthcareitnews.com/slideshow/biggest-health-care-breaches-2017-so-far?page=25>.

The Office of the National Coordinator for Health Information Technology (ONC). "Update on the Adoption of Health Information Technology and Related Efforts to Facilitate the Electronic Use and Exchange of Health Information," 2016, 20–38. <http://healthit.gov/>.

Vest, Joshua R, and Larry D Gamm. "Health Information Exchange: Persistent Challenges and New Strategies." *Journal of the American Medical Informatics Association: JAMIA* 17, no. 3 (2010): 288–94. <https://doi.org/10.1136/jamia.2010.003673>.

