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Project Proposal

(SCOPE DOCUMENT)

for

Health Monitoring with Theta Middleware

Version 1.1

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Bachelor of Science in Software Engineering (2017-2021)

SCOPE DOCUMENT REVSION HISTORY

No.	Comment	Action
1.	• Supervisor Changed • Explain more clearly how the said middleware will function.	• Document revised and updated to present more precise and clear description of the middleware and system.

Supervisor Signature

Date:

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Project Category: (Select all the major domains of proposed project**)**

○ **A-**Desktop Application/Information System ○**B-Web Application**/Web Application based Information System ○**C-** Problem Solving and Artificial Intelligence ○ **D-**Simulation and Modeling ○ **E- Smartphone Application** ○ **F-** Smartphone Game ○ **G-** Networks ○ **H-** Image Processing ○Other: **Middleware**

Abstract

Internet of Things (IoT) has become the most important invention after Internet. It has the ability to revolutionize the human daily lifestyle as it provides intelligent and remote interaction with our daily commodities. IoT devices exchange a lot of data between them which needs to be stored in a secure storage. Many IoT devices use middlewares for this purpose. Middleware is a software which let them to store their data by acting as a bridge between backend database and the device. Mostly, existing middlewares like Hydra, Google Fit use a centralized database which, in the modern security challenges, does not provides us secure storage. Hence, in this document we propose a middleware based on IoTA distributed ledger which would store our data in a distributed ledger which uses Tangle protocol to ensure data security and privacy. Our middleware would include different modules which would provide easy integration of new devices, encrypted communication of devices with IoTA Ledger and easy and manageable interface for users.

1. Introduction

Internet of Things and Distributed Ledgers are the latest advances in IT industry. IoT will bring endless opportunities and impact in every corner of our planet. IoT provides a remote and wireless interaction between human and commodities in its surroundings. IoT devices mostly use middlewares for communication with backend database and acts as a bridge between both. But existing middlewares store IoT data in a centralized database which poses single point of failure risk. Invention of distributed database like Blockchain has greatly solved this issue. Distributed ledgers provide us immutable and secure data storage. With the advent of distributed ledger technologies, we are now able to distribute and synchronize ledgers of data money in secure, distributed, decentralized and permission less environments. But Blockchain is mostly resources demanding for transaction validation. So, our proposed system intends to develop a middleware which allows different types of devices to store their data while using a distributed ledger named IoTA, which is designed for resource constrained devices like sensors used in IoT.

2. Problem Statement

Increased use of IoT devices has increased the amount of data. Existing IoT systems mostly use centralized storage for this data which is a single point of failure. While distributed ledgers like Blockchain provide a trustable data privacy and integrity solution, these ledgers need a lot of resources for validation of transaction. Hence, we intend to solve this problem by taking a combined approach to solve both issues by using a middleware which stores IoT data in a distributed ledger called IoTA which is designed for resource constrained device. Although, there are existing middlewares for IoT devices including Hydra (now known as LinkSmart), Global Sensor Networks, Calvin and Node-Red. But security is a major issue in these systems. Our proposed middleware will solve security issue faced in these middlewares by using Tangle protocol to ensure data privacy, security and integrity. We intend to learn not only new programming languages but also implementation of an enterprise solution by using multiple new tools, protocols and technologies.

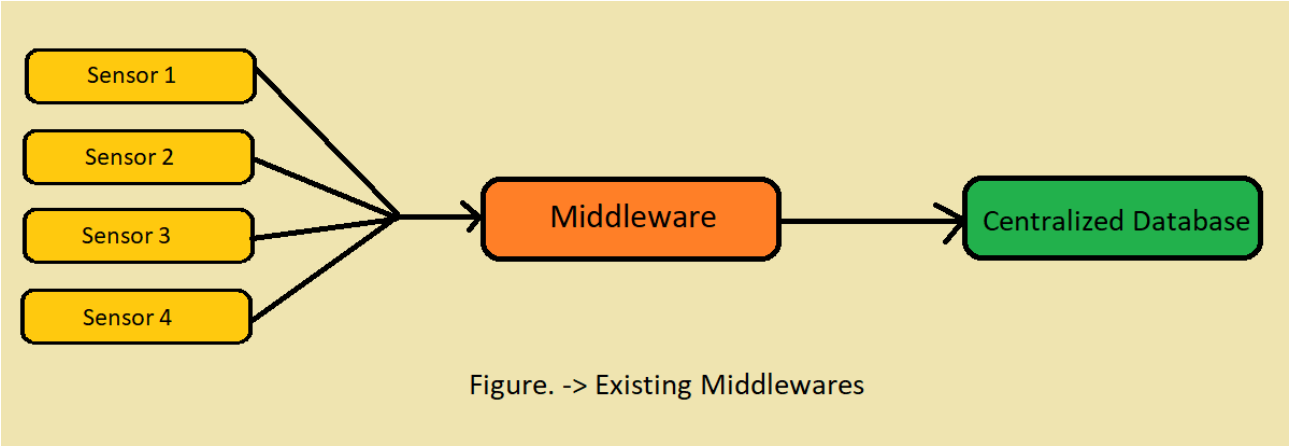


Figure. -> Existing Middlewares

3. Problem Solution for Proposed System

We propose a Health Monitoring system by developing a new Middleware based on IOTA ledger which would provide distributed data ledger which is suitable for resource constrained devices used in IoT networks. All the computations and communication will be carried out by the Middleware. This will reduce resource demand of IoT devices. Our Middleware will take 3-Layered Approach to solve the issues faced. In first layer of our system, there would be a Health Monitoring Device to measure patient's readings. There would be Mobile and Web Application which would act as interface sensors. Second layer is the main component of our solution, which is our Middleware. In second layer, we will provide easy integration of devices by using our Integration Module. There will be an Asset Manager which keep track of all of our IoTA Seeds, Addresses and Transaction Hashes. Device communication with IoTA will be carried out by Data Transmitter and Data Receiver Modules. We have IRI Node Module and Reverse Proxy Module Here. These modules will take over task of validating transactions and adding into ledger in the form of trytes as well as receiving trytes from IOTA ledger. Reverse Proxy Module will ensure protection against DDoS attacks by defining number of requests allowed to device for a specific time.

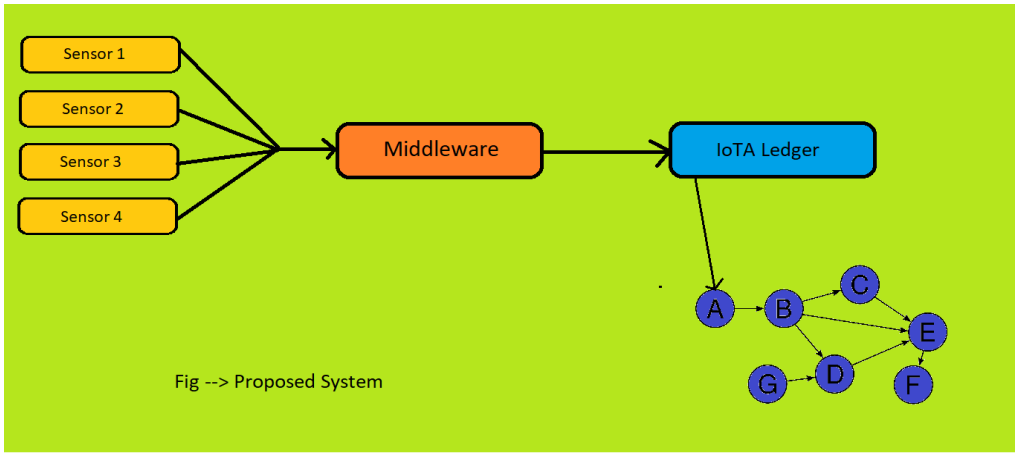


Fig --> Proposed System

4. Related System Analysis/Literature Review

Table 1Related System Analysis with proposed project solution

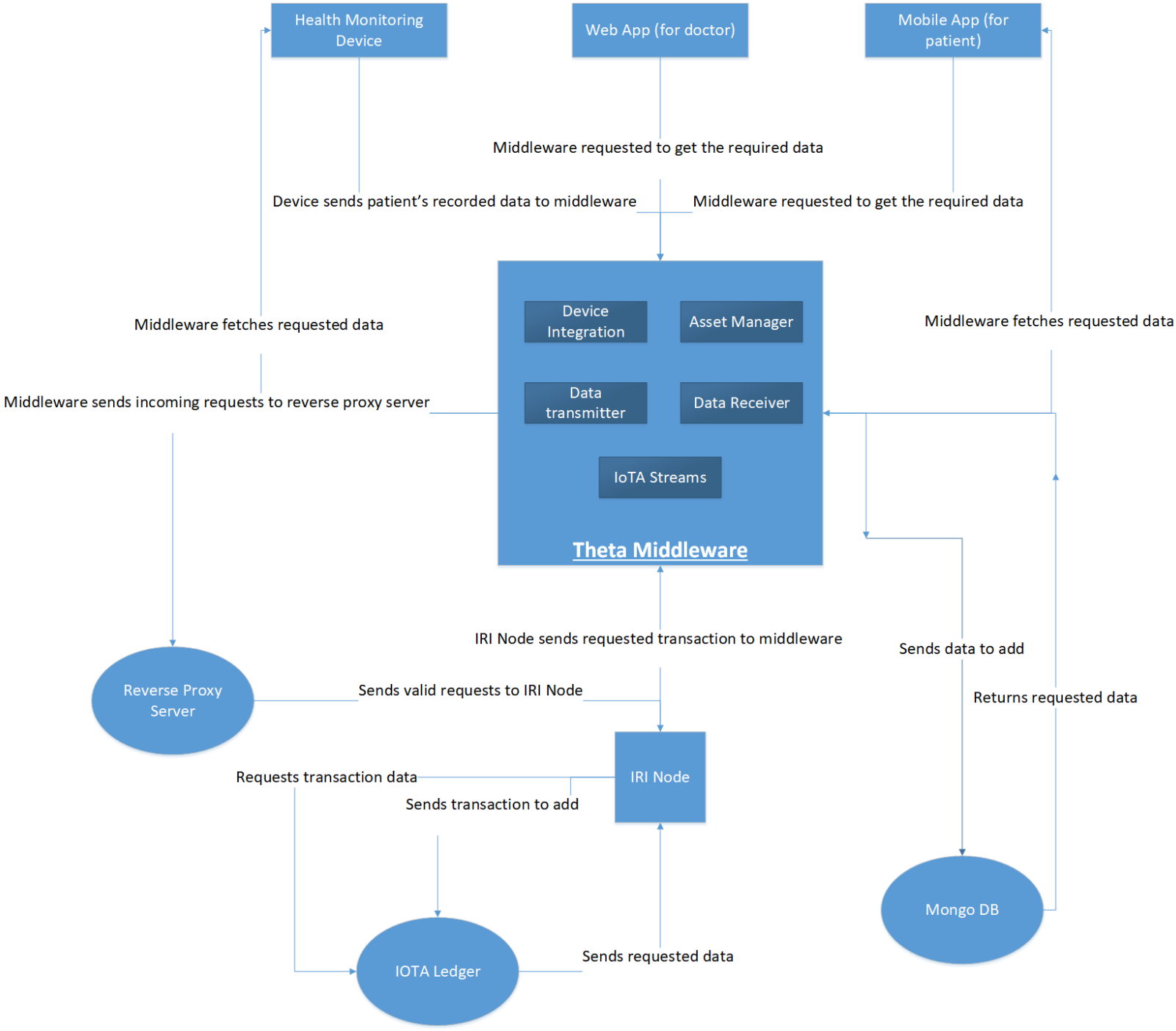
Application Name	Weakness	Proposed Project Solution
Hydra (now Known as LinkSmart)	Centralized Storage, Designed for heavy gateways like laptops, PCs, Mobiles.	We Use IOTA Ledger which require very little resources and network availability
Global Sensor Networks	Centralized Storage, Data Integrity Not ensured	We use IOTA Ledger which uses distributed ledger for data integrity.
Google Fit	Centralized storage, Has privacy issue and security issue	We will use MAM protocol to encrypt data and store it in IoTA distributed Ledger.

5. Advantages/Benefits of Proposed System

- Our system provides data integrity through IOTA Distributed Ledger.
- Data Privacy is ensured by using MAM protocol of IOTA.
- Reverse Proxy Server will ensure protection against DDoS attacks.
- Different devices can be added in Network easily by using Integration Module.
- IoT resource fit for distributed storage.

6. Scope

Our proposed system takes a layered architecture approach. In first layer of our middleware, there will be our Health Monitoring IoT devices/ sensors. This layer is used to record the readings of different sensors and send it to respective place in the layer two. There will be Web and Mobile Apps to act as interface for sensors. In second layer, there will be modules mainly focused on secure communication to and from IoTA ledger. Data Transmitter Module collects and sends data to IOTA Ledger. Data Receiver Module will be responsible for getting requested data from Ledger and converting it from Trytes format to more general data formats. We will provide easy integration of devices by using our Integration Module. There will be an Asset Manager Module which will keep track of our IoTA Seeds, Addresses and Transactions. We assume that Asset Manager module will have the functionality of allowing and denying requests coming from remote devices i.e: that are not a part of our network. Data Visualization module will provide graphical insights to user. Third Layer is mainly concerned with making the system distributed using IRI node. IRI node will communicate with IOTA ledger and store the data in it. IOTA Ledger will be used as main Data Storage Ledger. Reverse proxy server will be used to avoid DoS attacks. Main functionalities would be provided by using libraries of the IOTA ledger as it is the backbone of our middleware.


Health Monitoring Device
Web App (for doctor)
Mobile App (for patient)
Middleware requested to get the required data
Device sends patient's recorded data to middleware
Middleware requested to get the required data
Device Integration
Asset Manager
Data transmitter
Data Receiver
IoTA Streams
Theta Middleware
Middleware fetches requested data
Middleware sends incoming requests to reverse proxy server
Middleware fetches requested data
IRI Node sends requested transaction to middleware
Sends data to add
Reverse Proxy Server
Sends valid requests to IRI Node
Returns requested data
IRI Node
Requests transaction data
Sends transaction to add
Mongo DB
IOTA Ledger
Sends requested data

7. Modules

7.1 Module 1: Health Monitoring Device

Health monitoring device will be used to collect data of patient and pass it to IOTA Network.

7.2 Module 2: Doctor's Web App

This module will be used by Doctor as the web interface to access Patients and get Health Monitoring Device readings. Doctor will be able to create new account, add new Patients and viewing respective Patient reading after logging in.

7.3 Module 3: Patient's Mobile App

The Mobile interface will be used by Patients to get readings of their respective device after scanning barcode of device. The app will contain and show the data of the device connected. The user can only access and visualize the data of his/ her own device.

7.4 Module 4: Device Integration

Device Integration module deals with addition of new devices in the network. This module will deal with defining new permissioned devices and their credentials. This module will define an easy-to-implement procedure for new devices in order to use our system.

7.5 Module 5: Asset Manager

Asset Manager will keep track of our IoTA Seeds, Addresses and Transactions. Credentials of the devices will be defined when it is added by Doctor. Asset Manager module will then keep track of the devices to ensure that every request sent is by an authenticated device.

7.6 Module 6: Data Transmitter

This module deals with transmits the data from the IOT device(s) to the IOTA Ledger. Data Transmitter takes data to be transmitted and handles all the backend pre-requisites to transfer given data to IoTA ledger.

7.7 Module 7: IoTA Streams

This module deals with IoTA Streams which use MAM Protocol to send and receive near-real time data over IoTA Ledger. This module will enable users to publish and receive data in near real time.

7.8 Module 8: Data Visualization

The proposed system provides the visualization tool for the data. All the data from Web App will be sent to visualization tool to be visualized. In this way the user can better understand the data without any effort.

7.9 Module 9: Data Receiver

Where the Data Transmitter deals with transmitting the data from IoT Device(s) to IOTA Ledger, the Data Receiver transmits data from IOTA to the IoT Device(s). This Module will get requested data from IOTA Ledger in Trytes form and convert it into general data formats.

7.10 Module 10: IRI Node

This module will have an IoTA Software hosted on an Ubuntu Server which will act as bridge between our User applications and IoTA Ledger. IRI Node has following responsibilities:

- Validate transactions
- Store valid transactions in a ledger
- Allow clients to interact with the IRI and have their transactions appended to the ledger

7.11 Module 11: Reverse Proxy Server

Reverse Proxy server will be setup to prevent spam request to our IRI node. Clients can abuse the open API port of an IRI Node by spamming requests to it. We will use this module to restrict API requests by IP address or limit the number of requests an IP can send in a specific time.

8. System Limitations/Constraints

- The system shall be designed only to demonstrate Middleware functionalities. Hence it would have constrained functionalities.
- The system shall use the Client Libraries provided by IOTA.
- The system shall use Javascript and Rust language for middleware implementation.
- If support for a specific function by IoTA framework is no more supported then, it would not considered in our system.
- As IoTA is being constantly updated, Middleware modules will be updated as per updates of IoTA.
- IoTA Client libraries are in beta mode at this time and hence we may face some implementation constraints.

9. Software Process Methodology

We intend to use the Object-Oriented Approach for development of our proposed system. The motivation behind using this methodology is that our middleware will mainly use IoTA Client Libraries. Middleware will interact with these libraries by using Objects. Moreover, data passing between User applications and Middleware will also be carried out by Objects.

10. Tools and Technologies

Table 2Tools and Technologies for Proposed Project

	Tools	**Version**	**Rationale**
Tools And Technologies	Netbeans	10.0	IDE
	IOTA Ledger	2019	Ledger
	IRI	2019	IoTA Node Software
	Adobe Illustrator	CC 2018	Design Work
	Adobe Xd	CC 2018	Mockups Creation
	Sublime Text	3	Web Editor
	Technology	**Version**	**Rationale**
	Rust	1.45.2	Programming language
	Javascript	1.8.5	Web language
	HTML+CSS	5	Web language

11. Project Stakeholders and Roles

Write down the project stakeholders and their roles.

Table 3Project Stakeholders for Proposed Project

Project Sponsor	COMSATS University, Islamabad
Stakeholder	• Developer: Noman Nasir Minhas • Developer: M. Wahaj Mubeen • Developer: Hasnain Khawaja • Project Supervisor Name: Dr. Adeel Anjum • Final Year Project Committee: Evaluation of project

12. Team Members Individual Tasks/Work Division

Table 4Team Member Work Division for Proposed Project

Student Name	Student Registration Number	Responsibility/ Modules
Hasnain Khawaja	SP17-BSE-004	Module 2,8,5 Web App, Data Visualization
Noman Nasir Minhas	SP17-BSE-010	Module 1,6,7,9 Health Sensors, Data transmitter, IoTA Streams, Data Receiver, Device Integration, Asset Manager
Muhammad Wahaj Mubeen	SP17-BSE-029	Module 3,4,10,11 Mobile App, , IRI Node, Reverse Proxy Server

13. Data Gathering Approach

Our main data gathering technique will be literature review. We will study existing middlewares like LinkSmart, Global Sensor Networks, Calvin. Another source of data will be open source IoT data repositories which will be used for testing purpose. Evaluation will be done by using prototypes.

14. Concepts

14.1 Concept 1: Internet Of Things

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

14.2 Concept 2: IOTA Ledger

IOTA is an Open-Source Distributed Ledger. It is the first open-source distributed ledger that is being built to power the future of the Internet of Things with feeless microtransactions and data integrity for machines. By solving the inefficiencies of the Blockchain, IOTA, based on the revolutionary distributed ledger technology, the Tangle, is the missing link for the Internet of Everything and Web 3.0. Powering a secure, scalable and feeless transaction settlement layer, IOTA will empower machines and humans to participate in flourishing new permission less economies - the most important one being the Machine Economy which we are building.

14.3 Concept 3: Nodes

Nodes are the only devices that have read and write access to the immutable record of transactions called the Tangle. Interconnected nodes form an IOTA network by running the same node software, allowing them to validate transactions and attach them to the Tangle.

14.4 Concept 4: IRI

The IOTA Reference Implementation (IRI) is written in Java and is currently the only core client available. It has all the core functionality implemented necessary for participating as a full node in the network. It exposes an API (with certain restrictions) that makes it possible to access all required functionality to get an overview of the network, and utilizes IRI for making transactions.

The API exposed by IRI is rather limited, this is largely for security reasons, making it possible to connect to a remote node with doing all of the necessary key signing and handling locally. As such, in order to fully use IOTA, you need to also use one of the provided libraries.

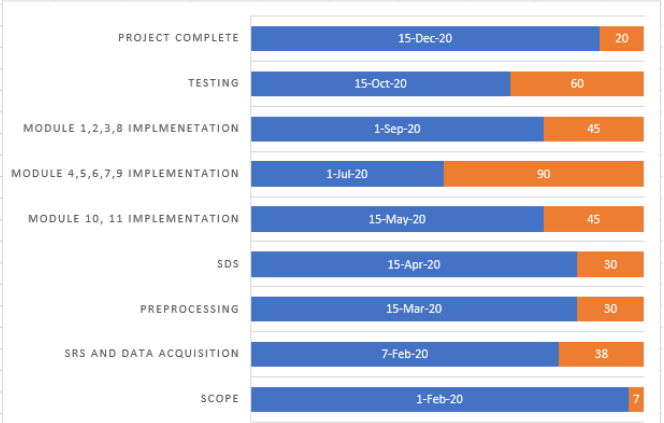
14.5 Concept 5: Tangle

The Tangle is a DAG, where vertices represent transactions, and edges represent approvals. When a new transaction is introduced, it is added as a new vertex in the DAG.

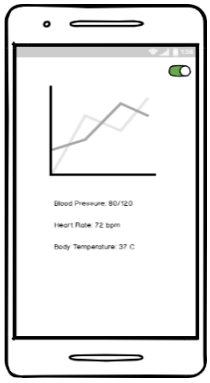
It is also attached to two previous transactions, which it is said to approve. The process for selecting these two transactions is described below. Approving a transaction implies that its history was verified and found to be valid. In particular, it means all accounts have positive balances. This makes sure there are no double-spends or new illegitimate tokens created.

15. Gantt chart

ID	Task Name	Duration	Start
1	Scope	7	1-Feb-20
2	SRS and Data Acquisition	38	7-Feb-20
3	Preprocessing	30	15-Mar-20
4	SDS	30	15-Apr-20
5	Module 10, 11 Implementation	45	15-May-20
6	Module 4,5,6,7,9 Implementation	90	1-Jul-20
7	Module 1,2,3,8 Implmenetation	45	1-Sep-20
8	Testing	60	15-Oct-20
9	Project Complete	20	15-Dec-20



16. Mockups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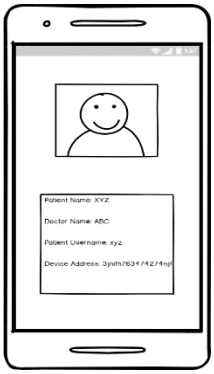
Heart Rate: 72 bpm
Body Temperature: 37 C


File Edit View Help
Scan Barcode to add new Text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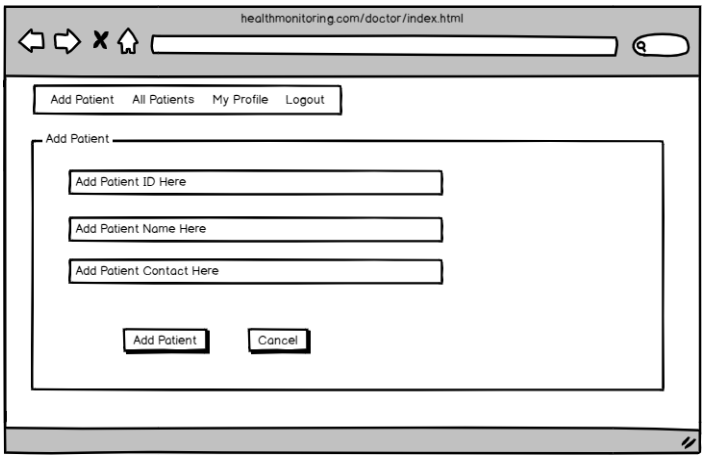
Doctor Name: ABC
Patient Username: xyz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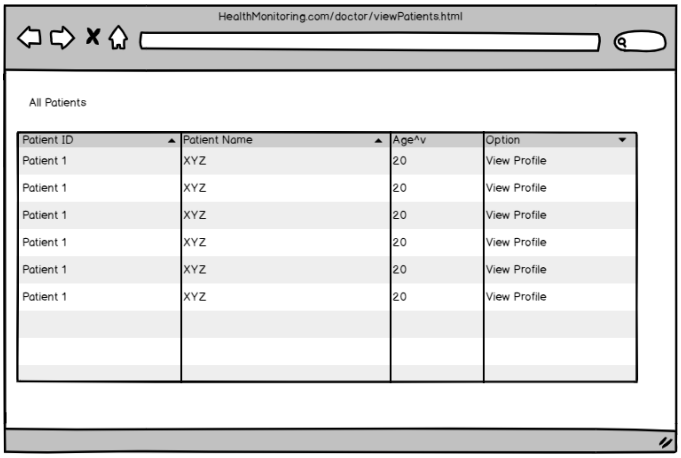
Add Patient All Patients My Profile Logout
Add Patient
Add Patient ID Here
Add Patient Name Here
Add Patient Contact Here
Add Patient
Cancel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All Patients
Patient ID
Patient Name
Age^v
Option
Patient 1 XYZ 20 View Profile
Patient 1 XYZ 20 View Profile
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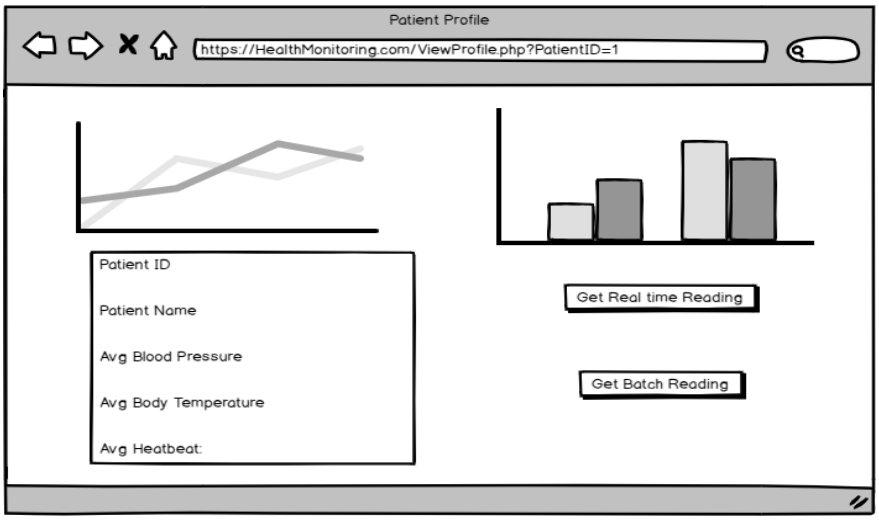
Patient 1 XYZ 20 View Profile
Patient 1 XYZ 20 View Profile
Patient 1 XYZ 20 View Profile


Patient Profile
https://HealthMonitoring.com/ViewProfile.php?PatientID=1
Patient ID
Patient Name
Avg Blood Pressure
Avg Body Temperature
Avg Heatbeat:
Get Real time Reading
Get Batch Reading

17. Conclusion

Our proposed system will be used to allow IoT devices to communicate with IoTA ledger easily while ensuring data integrity and privacy at the same time. Our proposed system will be designed to suit ecosystem of IoT devices. We will use IOTA Ledger to fulfil data security and privacy challenge. This system can be used by any network using IoT devices to provide scalable and secure solutions.

18. References

1- https://www.iota.org/get-started/what-is-iota
2- https://linksmart.eu/
3- http://ceur-ws.org/Vol-1401/paper-04.pdf
4- https://ieeexplore.ieee.org/document/8752917
5- http://nodered.org
6- https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7582463
7- https://en.wikipedia.org/wiki/Internet_of_things

19. Plagiarism Report