Hippocrades White Paper

Decentralized Healthcare Infrastructure and Protocol for Web 3.0
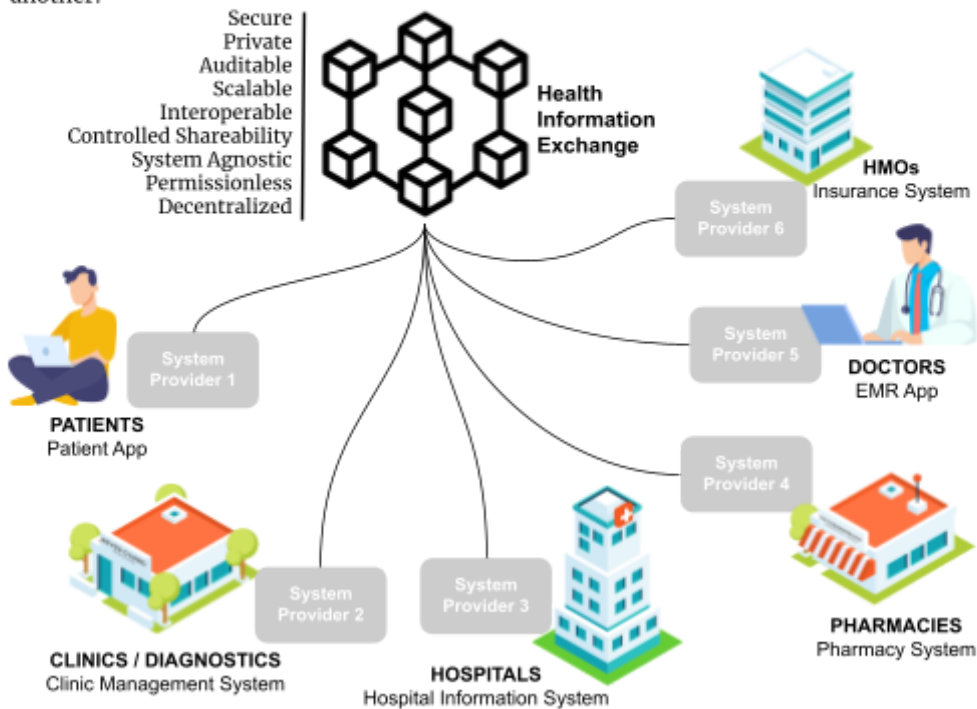
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www.hippocrades.com

WHAT HIPPOCRADES IS SOLVING?

Holy Grail of Healthcare Data

How to make sensitive personal health data shareable and interoperable while keeping health data private and secure? How to make a system that is scalable, compliant and auditable in a decentralized structure? Simply, it's the quest of achieving all of the following attributes in a platform without compromising an attribute's standards over another:

Secure
Private
Auditable
Scalable
Interoperable
Controlled Shareability
System Agnostic
Permissionless
Decentralized

Health Information Exchange

HMOs
Insurance System

System Provider 6

System Provider 5

DOCTORS
EMR App

System Provider 1

PATIENTS
Patient App

System Provider 2

System Provider 3

System Provider 4

PHARMACIES
Pharmacy System

CLINICS / DIAGNOSTICS
Clinic Management System

HOSPITALS
Hospital Information System

Abstract. With different providers and diverse markets, healthcare solutions have become increasingly fragmented. Thus, a truly *decentralized, secure, and permissionless* Healthcare Infrastructure continues to be a holy grail in the healthcare ecosystem. The pursuit of data privacy and security, which are of utmost importance, is also what makes it very difficult and challenging to make data more interoperable and shareable across different providers.

Over the last few years, there were experimental attempts to address this concern using blockchain technology. However, blockchain, despite showing potential, still falls short given its limitation on scalability, privacy, and auditability. If every healthcare transaction is placed in the chain, for example, this will be resource-intensive. Furthermore, blockchain's '*transparent, anyone can see*' setup becomes a liability to some degree as data privacy can never be compromised at any rate. Simply put, blockchain needs an additional element to optimize its power.

We propose Hippocrades — a solution that intends to finally resolve this dilemma. First, by adding a zero-knowledge proof cryptographic protocol on top of blockchain: addressing security, privacy, and scalability. Second, by providing healthcare applications and tech infrastructure designed for Web 3.0: any health system providers can easily utilize to create or augment their existing solutions making them secure, compliant, interoperable, and integrable in the blockchain. Third, by setting it up as a Decentralized Autonomous Organization (DAO): governed by set rules in a smart contract that is transparent and controlled by the organization members.

Hippocrades is beyond just a concept. Its three (3) technologies are already existing and will be presented in this paper.

There are three things in life that are certain:
Death, Taxes, and
Data Breaches

"In 2009 – 2020, there were 200 million records that were breached."

– US Department of Health and Human Services

1. By end of 2020, security breaches cost $6 trillion dollars for healthcare companies.

2. Healthcare data breach costs highest of any industry at $408 per record.

3. In 2020, data breaches affected 26.4 million records in the US alone.

4. It has been estimated that lost or stolen PHI may cost the US healthcare industry up to US$7 billion annually.

5. The most popular targets among hackers are the healthcare and finance industry, at 15% and 10%.

source: https://techjury.net/blog/healthcare-data-breaches-statistics/

1. Introduction

Many studies have shown the enormous benefits of having a Health Information Exchange (HIE) - from the improvement in the quality of care, better healthcare delivery, increased safety, elimination of duplicate testing, to the reduction of healthcare costs.

An HIE allows the exchange of healthcare information electronically from one organization to another among different information systems. The demand for this is growing along with nationwide efforts to improve the quality, safety, and efficiency of health care delivery. The supposedly efficient, timely, and safe access and retrieval of health data bring about the many advantages of having such a platform[1].

In the US, meaningful use requirements, new payment approaches that stress care coordination, and federal financial incentives drive the interest and demand for health information exchange[2].

For many countries, especially the emerging ones, implementing an HIE is still a far cry from reality. This is because of the many significant challenges in building one, such as standardizations, at-scale interoperability, data security, data privacy, data integrity, identity assurance, risk management, and auditability. Even for developed countries that have taken big steps toward this direction, there are still ongoing obstacles in achieving the intended setup.

Simply put, having a *decentralized, secure and permissionless* Health Information Exchange (HIE) platform has always been quite an impossible goal. Most, if not all, of the existing HIEs now, while functional, still have not fully addressed the security and trust concerns. On top of this, there are apprehensions of private data being managed on a centralized platform by a single organization.

HIE in Blockchain

The advent of *Blockchain* technology has brought much potential to stamping out these challenges. In 2016, different whitepapers were submitted in the Healthcare Blockchain Challenge[3] by the US Department of Health and Human Services' Office of the National Coordinator for Health Information Technology (ONC). The papers were from reputable organizations that provided sound concepts and ideas on the uses and benefits of blockchain and how it can be integrated in achieving a decentralized healthcare infrastructure.

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[1] Health Information Exchange https://bit.ly/3kxHUWm
[2] Health Information Exchange https://bit.ly/3kxHUWm
[3] HIPAA Journal https://bit.ly/3D9EgJt

It was emphasized that blockchain technology would change the model for engaging with and governing a Health Information Exchange giving patients more control over their healthcare information.[4] And since records are guaranteed to be cryptographically secure, there is no possibility of bad actors threatening data integrity. Fraud and abuse are reduced with blockchain-timestamped protocols and blockchain-enabled traceability and accountability allowing health providers to share networks without compromising data privacy, security, and integrity.[5]

In addition, a blockchain-powered health information exchange could unlock the true value of interoperability. In this interoperable blockchain, smart contracts can be created to a Hub as the gateway to store standardized information, which can be immediately accessible to all organizations allowed by the blockchain. This can be accomplished by creating an application program interface (API) oriented architecture to feed the smart contract. The APIs will be published and made available to all participating organizations connected to the blockchain – enabling frictionless integration with each organization's existing systems.[6]

Capitalizing on this technology has the potential to connect fragmented systems to generate insights and to better assess the value of care. In the long term, a nationwide blockchain network may improve efficiencies and support better health outcomes for patients.[7]

Indeed, there is no lack of literature pointing out the numerous opportunities of blockchain in healthcare. Concepts including frameworks have been provided on how it can be set up.
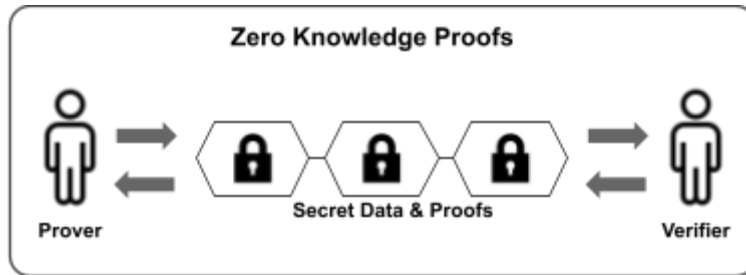
Today, while there have been attempts to implement these ideas, an effective, decentralized, secure, trustless HIE platform and healthcare infrastructure have yet to emerge. This is primarily because of the limitations that decentralized ledgers supporting rich applications create: scalability, privacy, and auditability.

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[4] Blockchain: Securing a New Health Interoperability Experience, Accenture, https://bit.ly/3F9oHC1
[5] Blockchain: The Chain of Trust and its Potential to Transform Healthcare - Our Point of View, IBM, https://bit.ly/30jgvQr
[6] Blockchain: Opportunities for Healthcare, Deloitte, https://bit.ly/3HdpCmR
[7] Blockchain: Opportunities for Healthcare, Deloitte, https://bit.ly/3oq0XTo

Zero Knowledge Proofs

Prover — Secret Data & Proofs — Verifier

Fortunately, a cryptography method that has found its way to blockchain, called *Zero-Knowledge (ZK) Proof,* a protocol, where prover (A) can prove that A knows information X to a verifier (B) without sharing any other knowledge to B other than that A knows X.

Popularized and deployed by the likes of Zcash, this indeed may be the missing piece to address these concerns and finally fully optimize blockchain's potential.

Health Infrastructure

As an important aside, designing and building this decentralized HIE is only a part of the pie, albeit a big one at that. It necessitates looking at the macro view of the ecosystem's healthcare infrastructure in general. This is to discover if there are other gaps in the processes that need to be addressed. The sector is a deluge of different markets with varying needs resulting in numerous providers creating independent solutions to these differing requirements.

First, the availability and effectiveness of Health Information Systems and solutions (such as Electronic Health Records or EHR) used by the health facilities are in various stages. Many are still using old technologies that are neither interoperable nor compliant with today's standards. Some health facilities do not even have their own EHR applications while some use systems that lack important modules and functionalities. Second, all these health information systems, as they integrate with the HIE, should comply with standards so as not to compromise security, privacy, and auditability. Currently, not all industry-set standards are met.

Furthermore, the main point of having an HIE is to centralize the exchange of transactions, but aggregating all these under one platform and organization does not lead to a decentralized approach. Why? Because of the hesitation and resistance of giving this responsibility to one single entity. There are trust issues with providers, transparency and integrity of the application, and the potential vulnerability to attacks.

Hippocrades in a Nutshell

To resolve the above-mentioned concerns, Hippocrades will be utilizing these two amazing technologies – the blockchain and zero-knowledge. The combination of this powerful duo and integrating them into Hippocrades' existing health-tech platform could ultimately address the dilemma the healthcare industry has long been wanting to solve.

Hippocrades' tech which has been in constant development and improvements since 2016, includes comprehensive front-end solutions like Electronic Health Records or EHR systems (*CURIE*, status: done), Healthcare API endpoints (*FLEMING*, status: done), and its HIE Blockchain (*NIGHTINGALE*, status: POC done) which acts as a 'smart contract' for health data exchanges.

As a logical extension, Hippocrades will implement the DAO (Decentralized Autonomous Organization) model so that the dream of having a truly decentralized, secure, and trusted healthcare infrastructure will finally come to fruition.
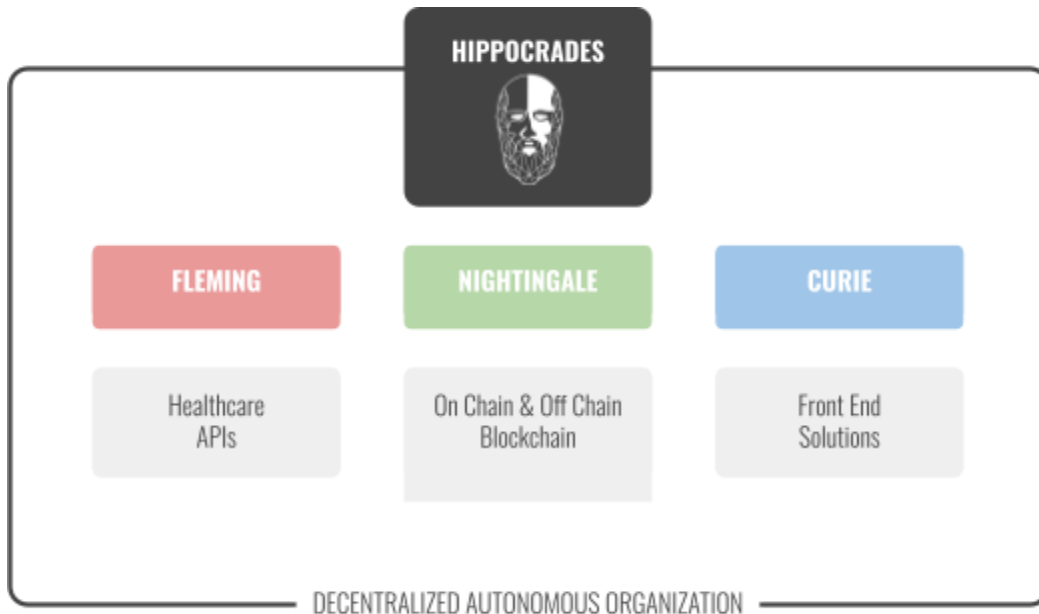
2. Challenges in Building a Decentralized Healthcare Infrastructure

There are many players across the healthcare sector with increasing and differing pain points. Each uses their own solutions provided by different system providers using varying tech stacks. Naturally, interoperability becomes a concern on top of data security and privacy, especially if data needs to flow from one silo to another.
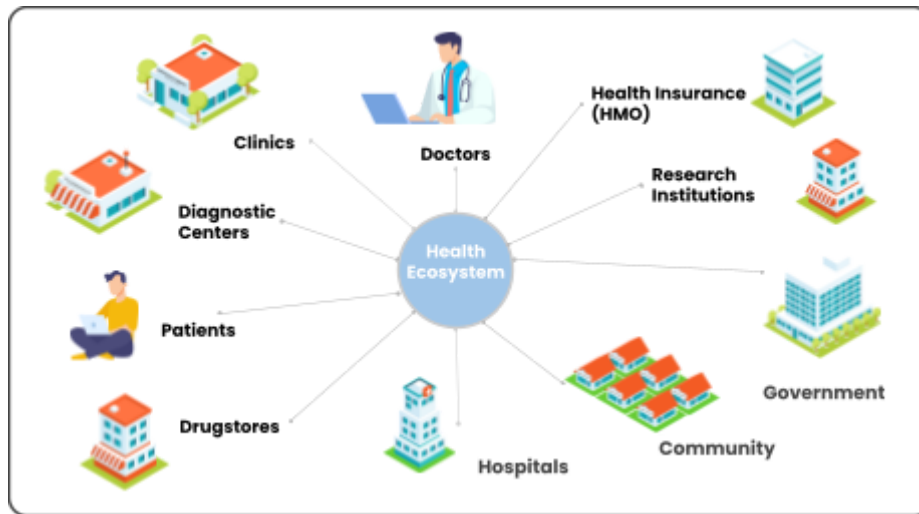
The previous and ongoing attempts of blockchain tech startups generally focus on addressing certain issues separately. Using blockchain definitely addresses those concerns, however this further adds up to creating more silos.

Below are the major challenges blocking the creation of a truly decentralized and secure healthcare infrastructure:

Blockchain's Limitations[8]

1. *Scalability.* Applications are provisioned for tiny execution environments with limited running time, minimal stack size, and restrictive instruction sets.

    a. *Wasteful.* Each miner must re-execute transaction
    b. *Constrained.* Limited running time, minimal stack size, & restrictive instruction sets

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[8] Aleo.org, www.aleo.org

2. *Privacy.* Applications must reveal their state transition, enabling miner frontrunning attacks and consensus instability. The core strength is also its weakness. The history of all state transactions must be executed by all parties.

3. *Auditability.* Applications offer weak guarantees of correctness & safety.

Health Applications and Solutions

1. *Data Standardization and Scope.* Some of the existing health solutions use old technologies, are not interoperable, and not compliant to industry standards. These add up to the difficulty in integrating with an HIE.

2. *Availability of Front End Solutions.* Some still do not have their own health solutions (EMR, LIS, RIS, Pharmacy, etc.) especially in emerging countries due to limitations on costs and technical challenges.

3. *Availability of APIs for Easy Integration.* Application Programming Interface (API) is an industry-standard that allows for an easy integration. The HIE should have a complete documentation of its APIs that integrators can use and reference with. This has not been reached.

External Factors

1. *Adoption and Incentives for Participation*[9]. While the benefits can be great, there are a handful of challenges as mentioned above that disincentivize participation even when a government formulates a bill that requires health facilities to do so.

2. *Regulatory Considerations.* Blockchain has made good progress but may still be challenged by enactment of new laws that may limit its use.

Truly Decentralized Setup

1. *Governance.* If it is run solely by a particular organization or government entity, then it is run in a centralized manner. Issues may arise on accountability, transparency of operations, management decisions among other things.

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[9] Blockchain: Opportunities for Healthcare, Deloitte, Challenges 1 to 5, https://bit.ly/3HjiJ3l

3. Hippocrades

HIPPOCRADES is short for Health Infrastructure and Private Protocol On Chain with Ready-to-use Applications in a Decentralized Environment and Setup.

Hippocrades is the Web 3.0 infrastructure and protocol for health information. Its primary purpose is to be a platform for interoperability and health data exchange among different information systems. To reach this desired but elusive goal however, it requires an infrastructure of (1) health applications and (2) a comprehensive set of secured APIs even before attempting to put together a blockchain protocol for it.

These are necessary solutions, without them, onboarding in the blockchain will have extreme challenges. Thus, a lot of blockchain tech startups are not able to reach their full potential as they primarily focus on building their blockchain apps with little consideration to addressing the other gaps.


Two Facets

Hippocrades seeks to address two important facets of being a platform for health information:

1. *Privacy.* Because Hippocrades deals in health information, a top concern is privacy – to what extent must we allow a patient's information to be revealed and shared among parties, in order to succeed in providing that patient with the healthcare they need?

2. *Interoperability.* The most significant barrier today to efficient health information is that health information is highly fragmented. Health information is either kept manually on paper or digitized in disparate information systems (in practice, even two health facilities beside each other are likely to have separate, wildly incompatible databases!).

Additionally, what connects Hippocrades to the real world is its goal of accessibility. Hippocrades seeks to provide a solution for the above problems of interoperability and privacy, while at the same time making it concretely applicable to clinics, hospitals, and health facilities in their day-to-day operations.

Hippocrades Approach

Hippocrades provides three (3) major components to fill the gaps in building the decentralized healthcare infrastructure.
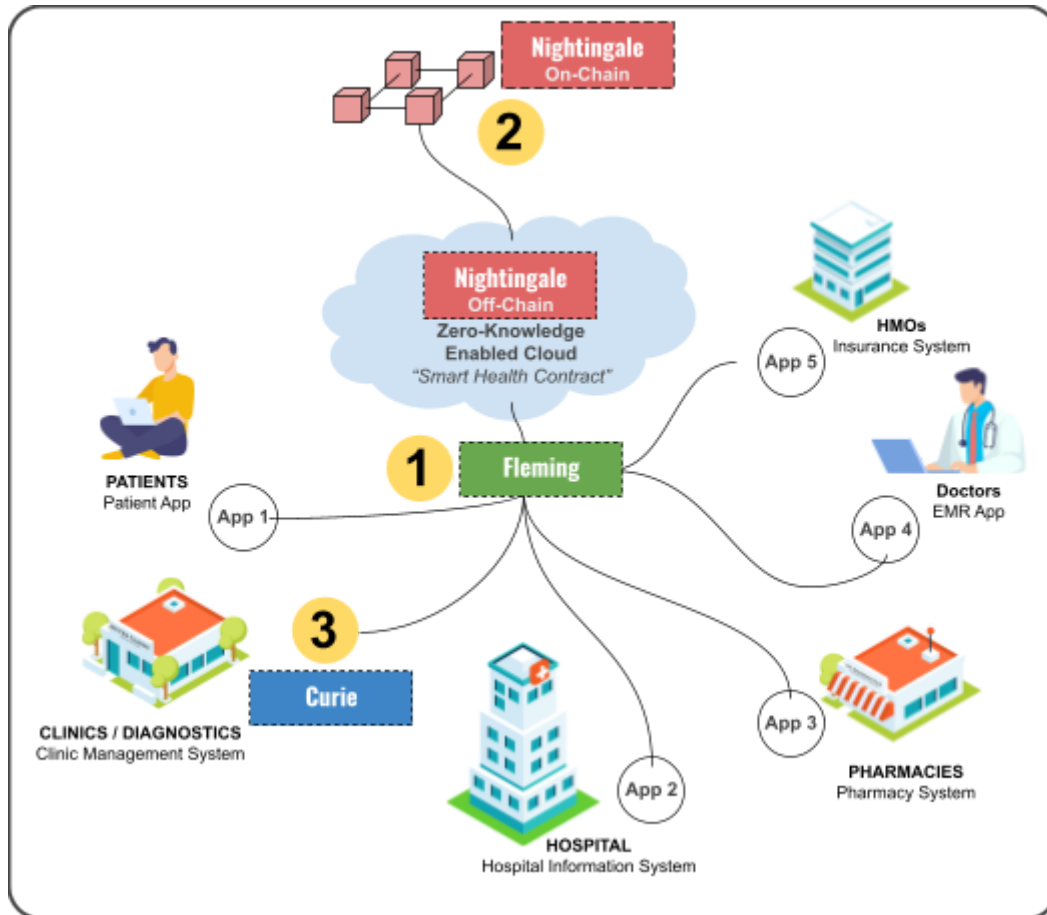
Fleming, NightIngale, and Curie comprise Hippocrades' advanced solutions and comprehensive API services to address different healthcare needs making systems compliant and interoperable while protecting and securing sensitive personal health records.

While this may sound grandiose and far-fetched considering the amount of time needed for development work, the next section would show that a significant part of the Hippocrades setup is already existing and in place.
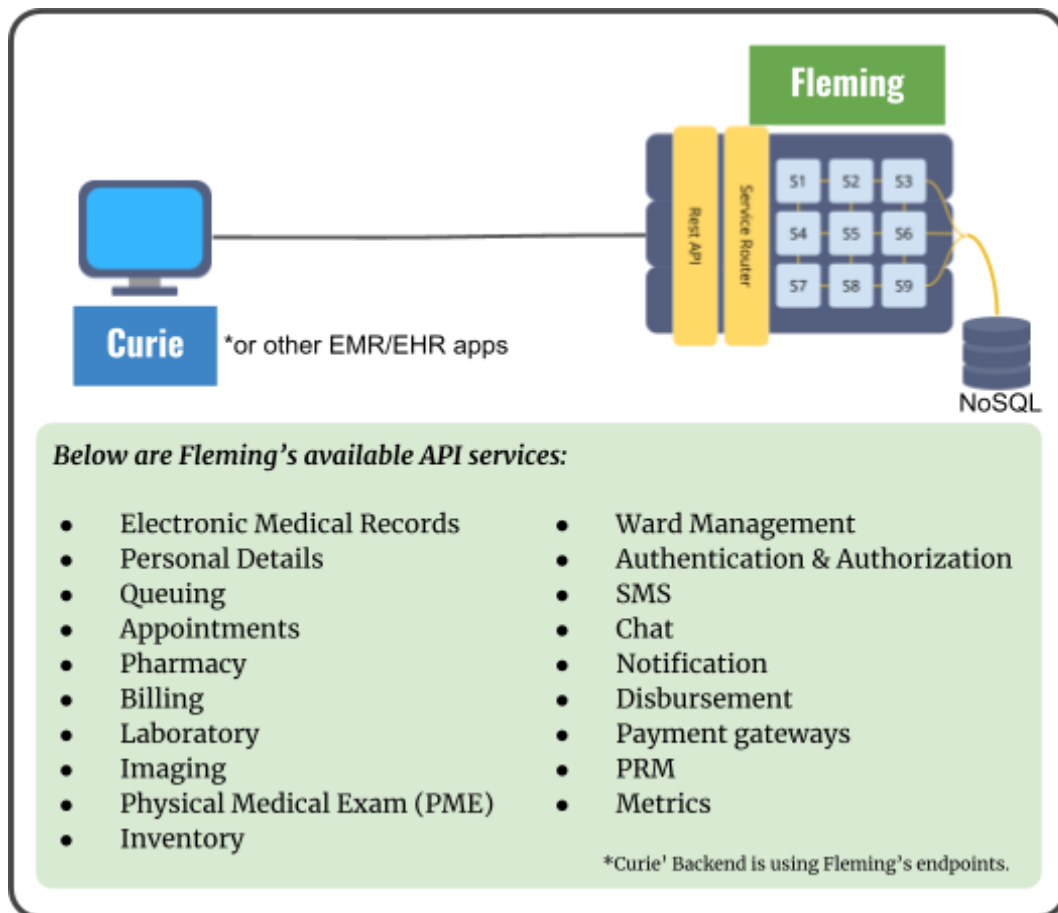
4. Hippocrades Solutions

FLEMING

Hippocrades is exposed as a set of comprehensive healthcare APIs covering crucial medical information such as patients, medical records, diagnostic test results, and so on. These APIs collectively form Fleming.

Fleming APIs have been developed to form the backbone of health-tech products for doctors, clinics, hospitals, pharmacies, and other health facilities, capturing important business logic cross-connecting all these different sources of medical information with each other.

These APIs are exposed as well-documented REST endpoints, promoting interoperability with any modern information system. Even legacy information systems may connect to Fleming and begin storing on the Health Information Exchange by developing a thin REST client layer on top of their existing architecture, driving the potential for market acceptance even higher.

Below are Fleming's available API services:

- Electronic Medical Records
- Personal Details
- Queuing
- Appointments
- Pharmacy
- Billing
- Laboratory
- Imaging
- Physical Medical Exam (PME)
- Inventory

- Ward Management
- Authentication & Authorization
- SMS
- Chat
- Notification
- Disbursement
- Payment gateways
- PRM
- Metrics

*Curie' Backend is using Fleming's endpoints.

Below are the security/privacy/compliance features:

- 2FA Authentication
- Encryption by default, at rest and in-transit
- Industry-standard encryption algorithms (AES256)
- Data hashing for integrity checks
- Disassociated records
- Audit logs
- Privileged access management
- Adheres to HIPAA guidelines

Fleming is system agnostic, allowing any system to easily integrate with it. In doing so, an existing EHR system can utilize Fleming's API endpoints to avail of its different services, as mentioned above. As such, EHR System or Health Platform Providers can also add modules and functionalities using Curie's front-end solutions or create their Custom App from scratch using the services provided by the APIs.
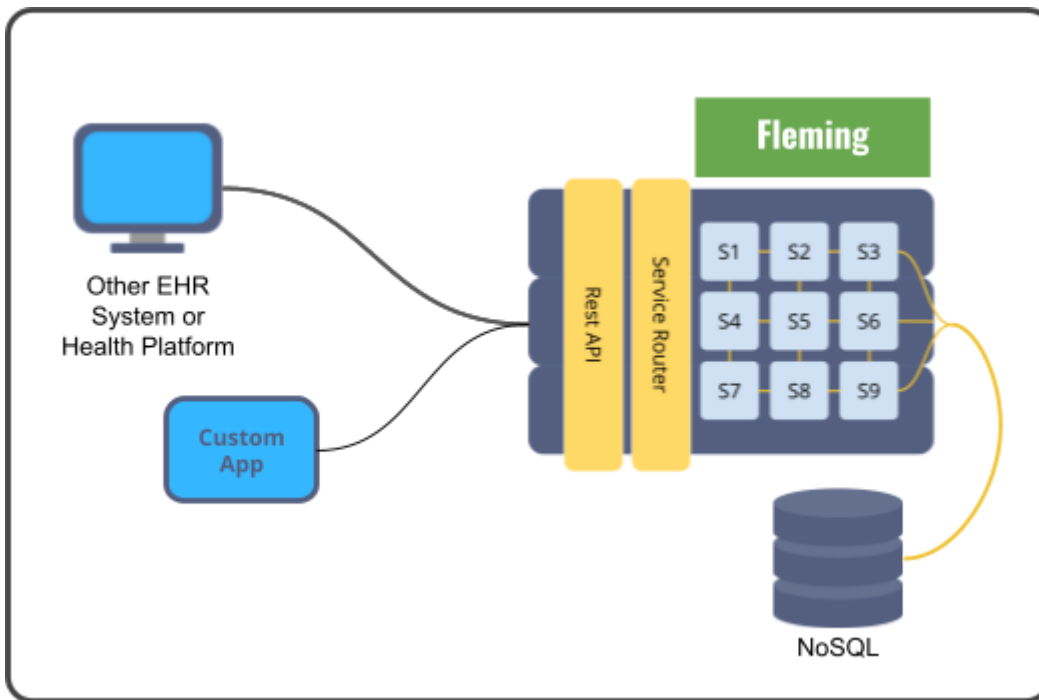
Ownership and privilege-based access are first-class concerns in Fleming's architecture in its effort to maintain privacy even while promoting interoperability. In fact, the system is even architected to dissociate personally identifiable information (PII) from protected health information (PHI) via encryption.

Even with these safeguards, however, there are still cases where different parties must verify health information, and traditionally there would be no other way to accomplish this than to share the health information in question. Privacy concerns in these cases are mitigated by strict privacy compliance legislation, but it doesn't change the fact that there are different eyes on the health information in question. Not to mention that privacy compliance in this way is based on trust – that the third parties are not secretly taking advantage of access to patients' health information.

This is where Nightingale blockchain comes in, using the novel concept of zero-knowledge proofs to accomplish completely private information exchange.

Status: DONE
Fleming is already existing and functional. Curie's backend is primarily using Fleming. One can check the available APIs at www.hapihub.com/api.

NIGHTINGALE

Nightingale architecture is designed to be the decentralized, secured, and trusted Health Information Exchange (HIE) platform. It acts as the 'smart health contract' where pre-specified rules are set.

It utilizes the zk-SNARKs in a Zero-Knowledge Proof enabled cloud. This is one part of the Nightingale that runs outside of the blockchain. Typically, smart contracts are also stored 'on chain' thus concerns on privacy, storage, and run-time constraints arise. Having this setup eliminates mentioned issues while maintaining the integrity and validation the blockchain provides.

Since this is outside the blockchain, the setup allows the chain to be scalable without compromising security and privacy. It remains auditable as transactions, recorded as 'zk proofs', are submitted and timestamped in the blockchain.

Zero-Knowledge Proof

> *"I can't tell you the secret, but I can prove to you that I know the secret."*

Zero-knowledge (zk) techniques are mathematical methods used to verify things without sharing or revealing underlying data. Zero-knowledge protocols are probabilistic assessments, which means they don't prove something with complete certainty. Instead, they provide small pieces of unlinkable information that can accumulate to show that the validity of an assertion is overwhelmingly probable.[10]

zk-SNARKs

zk-SNARK stands for "Zero-Knowledge Succinct Non-Interactive Argument of Knowledge," and refers to a proof construction where one can prove possession of certain information, e.g. a secret key, without revealing that information, and without any interaction between the prover and verifier.[11]

ZEXE Protocol

Zexe is a new blockchain design that enables both data privacy and function privacy in addition to succinctness. In other words, not only can transactions be generated offline and efficiently verified on-chain, the time needed to verify the transaction is independent of the time required to do the offline computation to which the prover attests to. It achieves this by introducing a new cryptographic primitive called a Decentralized Private Computation (DPC).[12]

	Decentralized	Private	Programmable
Bitcoin	✔	✘	✘
Ethereum	✔	✘	✔
Zcash	✔	✔	✘

* ZEXE is a protocol for decentralized private computation[13]

	Decentralized	Private	Programmable
Hippocrades ***via zk-enabled cloud**	✔	✔	✔

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[10] Hacker Lexicon: What Are Zero-Knowledge Proofs?, Wired Magazine, https://bit.ly/3HfM0Mr
[11] What are zk-SNARKs? https://z.cash/technology/zksnarks/
[12] Blockchain Research Newsletter, https://bit.ly/30gReHi
[13] Howard Wu, Aleo.org presentation in ZKSummit6, https://bit.ly/30nUbFU

Hippocrades will have two (2) parts, the off-chain, and the on-chain. In doing so, the three components - Decentralization, Privacy, and Programmability are attainable in the setup.
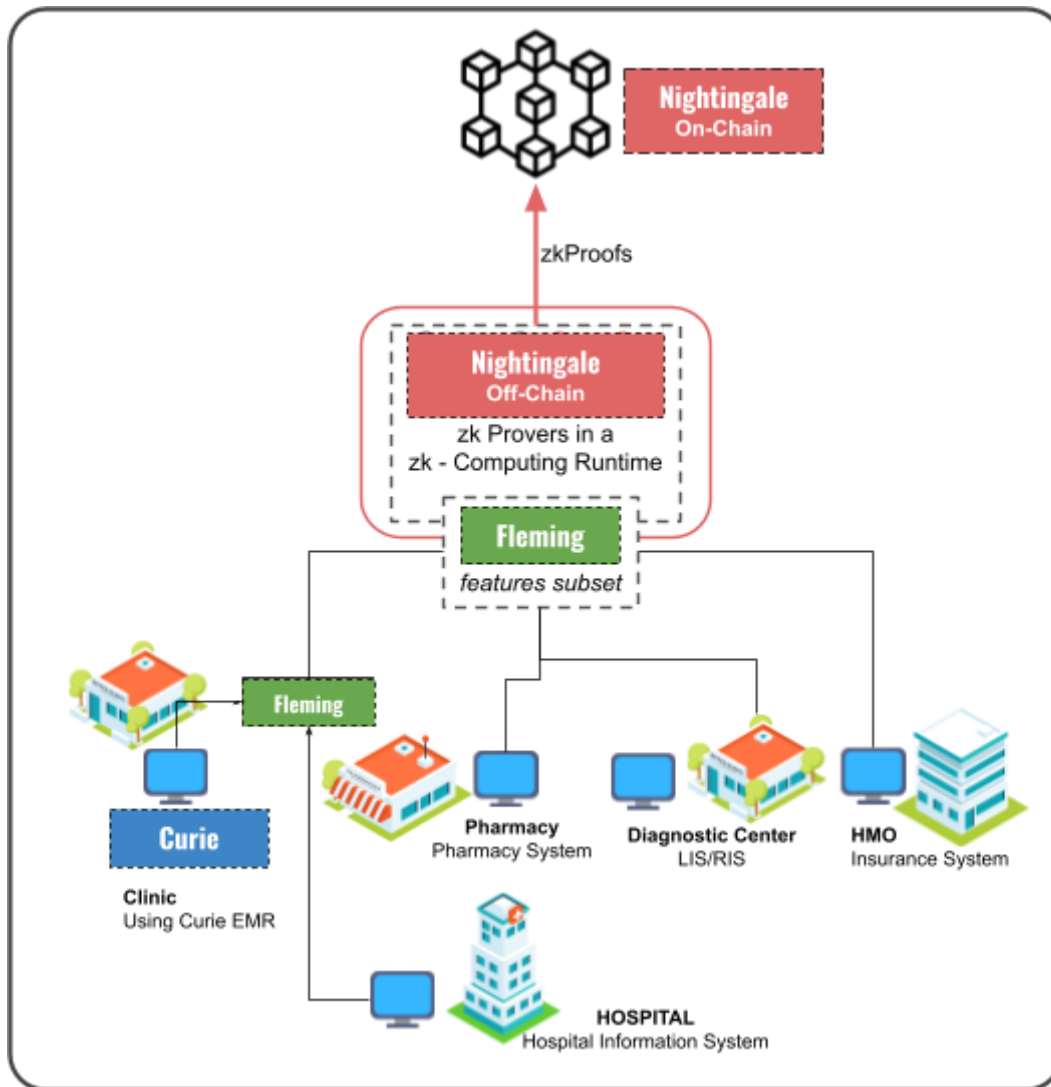
Off-Chain

Fleming information intended for verifying (which was previously accomplished by sharing said information!) will be processed into a zero-knowledge proof (specifically, a zk-SNARK). This is done in a separate RPC-controlled server with access to cryptographic primitives and libraries required to produce the zero-knowledge proof.

Verifiers can use this zero-knowledge proof publicly to affirm truths about the information without requiring the data itself to be shared with them.

For example, a pharmacist may verify that a patient indeed has a prescription for a certain medicine without ever receiving a copy of the prescription. An insurance company may verify that a patient indeed received treatment for a certain diagnosis without ever receiving a copy of either the diagnosis or the invoice for the treatment procedures.

The ZK server then sends this zero-knowledge proof via RPC to the on-chain component of Nightingale.

On Chain

Zero-knowledge proofs from the off-chain component of Nightingale are received via RPC and encoded into a transaction on the blockchain. This step confers blockchain's advantages of integrity, immutability, decentralization, and resilience to forgery to all zero-knowledge proofs generated for Fleming information.

Nightingale's blockchain is flexible in its requirements, only requiring Turing-complete smart contracts to be supported (of which there are numerous available on the market today, such as Ethereum or Cardano). To prepare any blockchain for connection to Nightingale, there are two components:

1. A thin RPC-ready layer to expose blockchain operations via RPC (such as creating transactions and finding their blocks on the chain)
2. A set of general smart contracts to cover Nightingale's use cases and domain

Because of the clear separation of concerns between the off-chain and on-chain components (communicating only via RPC), Nightingale may be deployed onto any chain (and even several chains!) by developing only the above two (2) components, instead of re-outfitting the entire architecture from scratch.
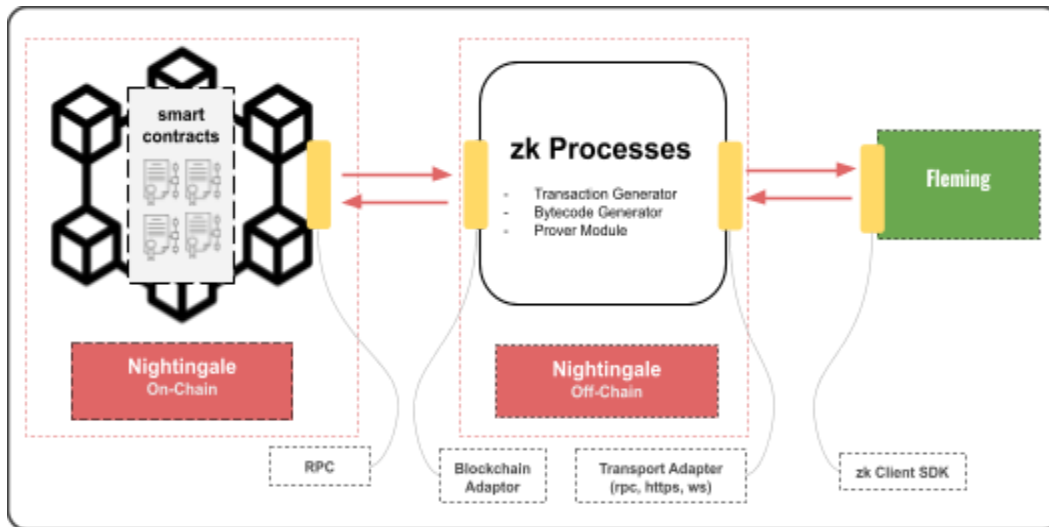
Status: Proof of Concept (POC), DONE
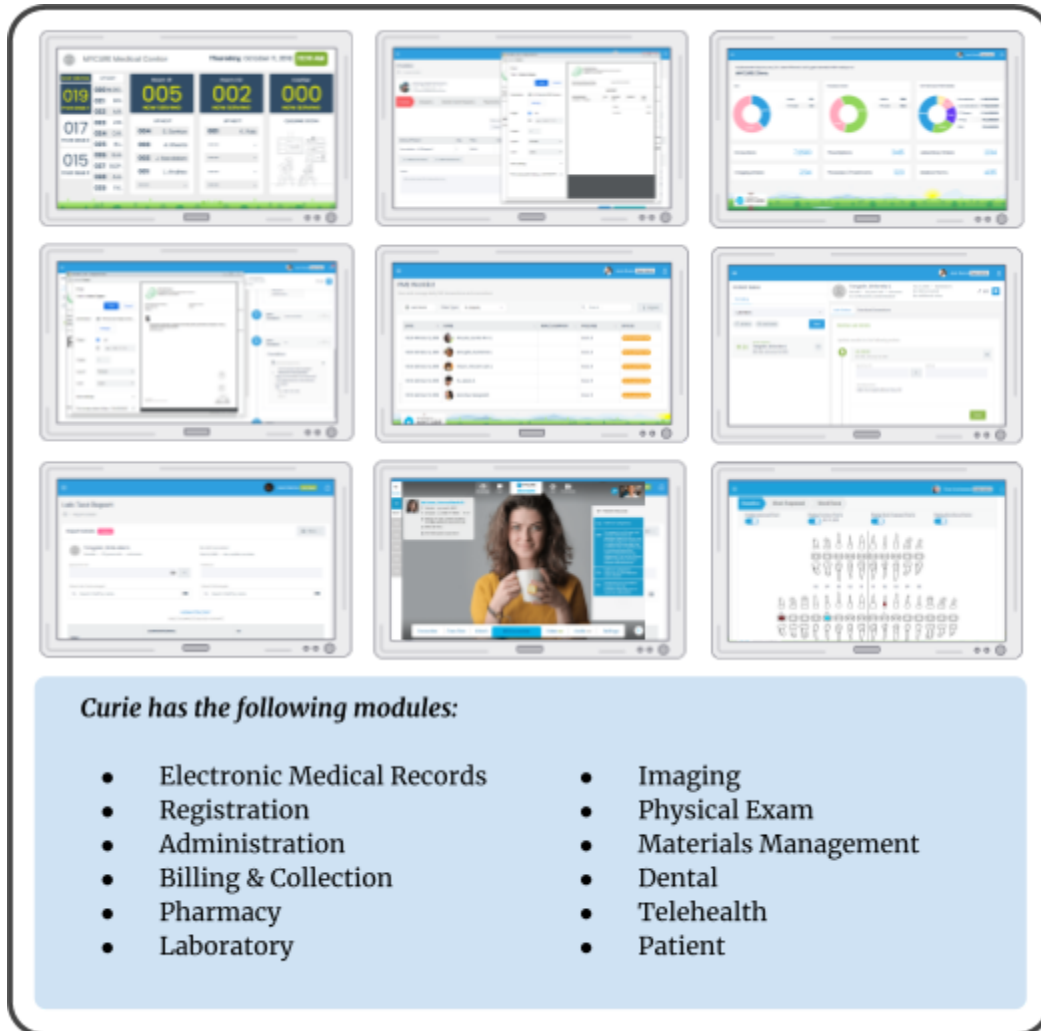Request Access at [Hippocrades Community](#).

CURIE

While Fleming and Nightingale together already comprise a health information platform model on their own, Hippocrades also seeks to make this solution accessible not just to the information technology industry at large, but all the way down to the grassroots level: actual players in the healthcare industry (doctors, patients, clinics, health facilities).

As such, the entry point to Hippocrades does not stop at RPC endpoints and APIs. A complete health facility information system has also been built using Fleming as a backend. This information system, implemented as a set of web applications, is collectively known as Curie.

Curie uses modular design in order to expose its complete set of modules and features (e.g. Registration and Queueing, Electronic Medical Records, Billing, Inventory, Laboratory and Radiology, Ward Management) into products fit for different health facilities:

- An electronic medical records system for individual doctors
- A clinic management system for outpatient clinics
- A laboratory information system and/or a radiology information system for diagnostic centers
- A hospital management system for hospitals
- A pharmacy management system for drugstores and pharmacies

Curie makes it possible for health facilities to digitize their operations, all while automatically connecting to Hippocrades and enjoying the benefits of interoperability and privacy.

Curie has the following modules:

- Electronic Medical Records
- Registration
- Administration
- Billing & Collection
- Pharmacy
- Laboratory

- Imaging
- Physical Exam
- Materials Management
- Dental
- Telehealth
- Patient

Any health facility or care provider can easily sign up for an account and even create its own self-managed MongoDB database in Google Cloud, AWS, or Azure. With Curie, a user can easily enable the system to participate and be integrated with the Nightingale blockchain network via the Fleming interface (see diagram). In doing so, the health facility ensures compliance with regulatory requirements.
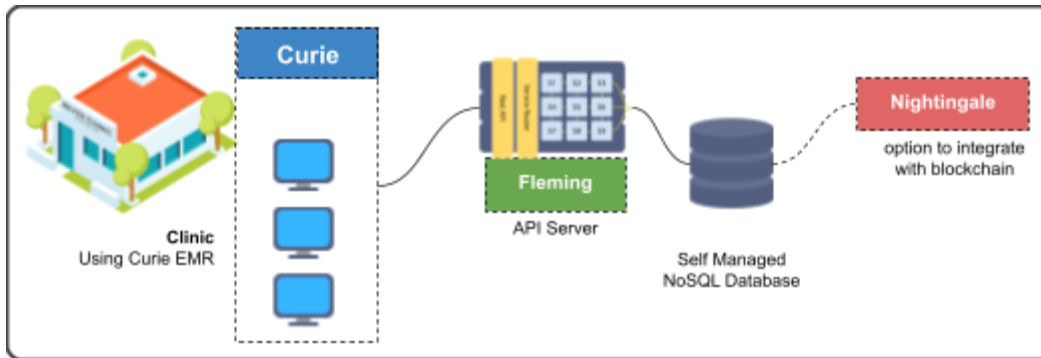
Curie is ideal for those health care providers who are still not using any EMR/EHR systems. Likewise, it is also good for those who want to upgrade their existing systems and be compliant with regulations.


Status: DONE

Curie is already existing and functional. It is already deployed and being used by health facilities and care professionals via a partnership with a provider called MYCURE, please check www.mycure.md.
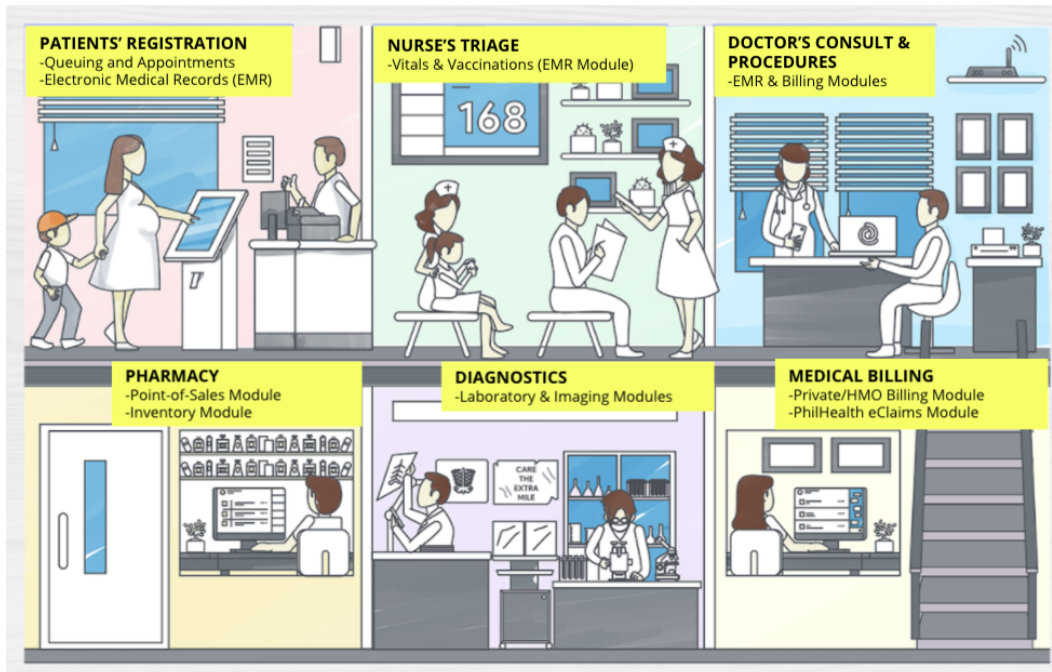
5. Hippocrades Application and Use Cases

Health Information Exchange

A truly decentralized and secure HIE remains elusive, even for advanced countries. But putting blockchain technology + zk proof with Hippocrades could ultimately be the holy grail the healthcare industry has long been wanting to achieve. See section on HIE.
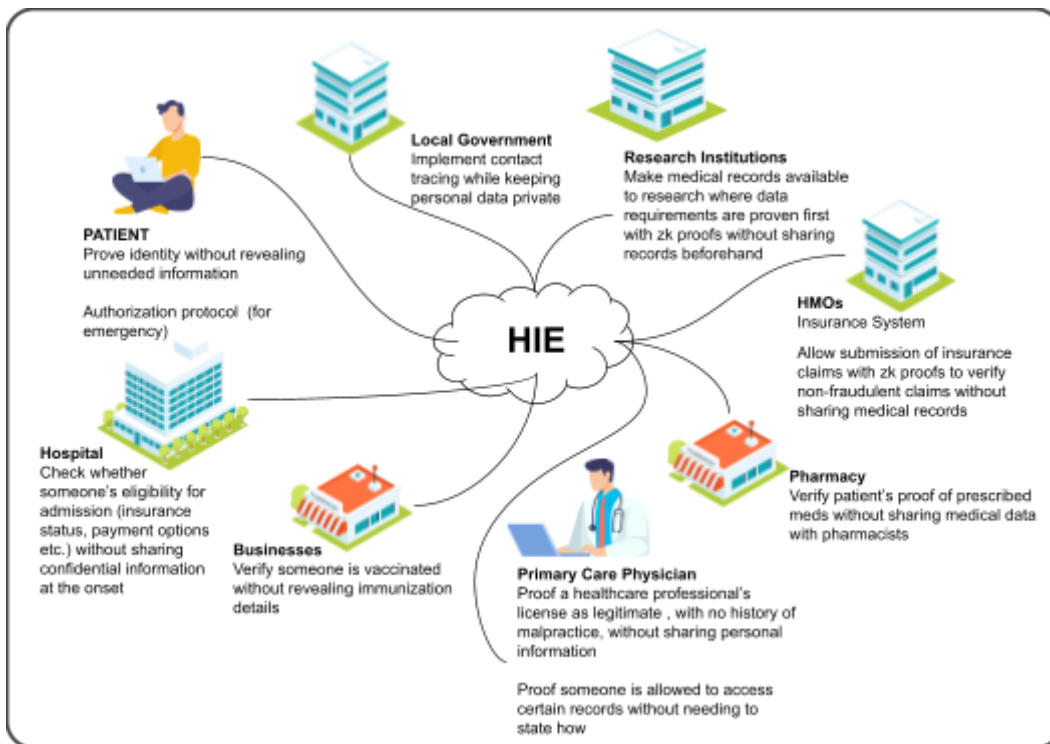

Note: One good use case for this is that there are several 'vaccine passport' system providers or health government units but use one central exchange for validation. It would be a mess if each one would create its own validation. Even riskier if one big tech company would monopolize handling of such data.

Health Apps Development

If one is building a health app, there is a high chance it would need a module for storing user health records. Instead of doing this component from scratch, it can utilize Hippocrades' comprehensive API services. This way the focus is on building the intended app itself without worrying about compliance as this is already built-in in the infrastructure.

There are many possible ways on custom building apps with the extensive APIs available. The API docs can be seen at www.hapihub.com/api.

Note: API is short for Application Programming Interface, which acts as a 'bridge' to easily integrate another system.
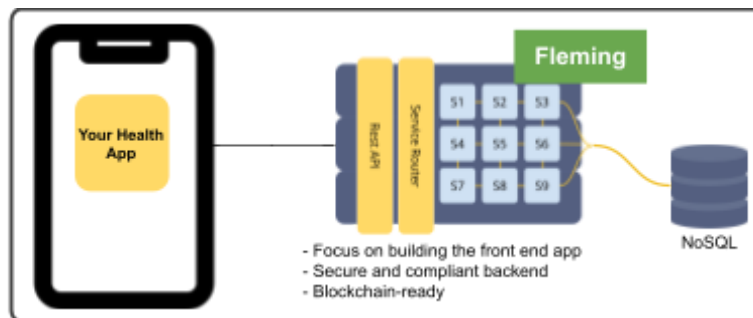

Ready-to-Use Solutions

Up to now, many health facilities still have zero medical records systems. Some use basic spreadsheets to record data. A few still use old legacy systems. It is not only capital intensive to implement a new system but the upkeep on compliance and upgrades can also be cost-prohibitive and expensive.

Curie already has available solutions like EHR, LIS, RIS, and other health modules (see list in Curie section). They can also be integrated with Web 3.0.

**Privacy & Security Compliance**

Around the globe, there are thousands of health facilities (clinics, health centers, hospitals) using Electronic Health Records (EHR) systems that are still NOT compliant with data privacy laws. Therefore, there are higher risks for potential exposure of health records.

Without changing their existing solutions, they can utilize Fleming's services to upgrade their platform.[14]
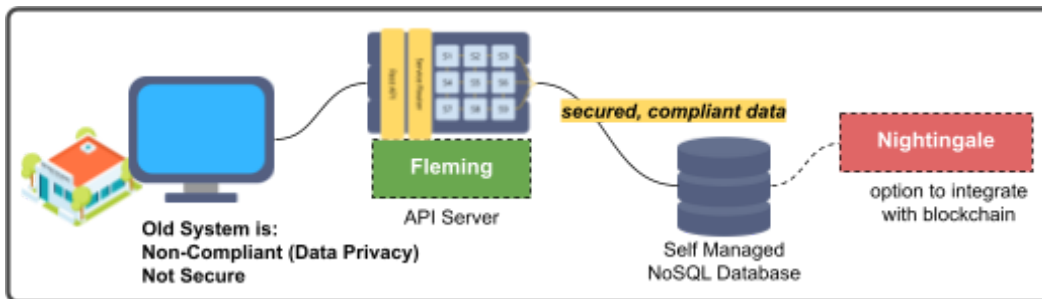
Web 3.0

Integrating with Hippocrades' blockchain is easy. It has documented APIs that devs can utilize to make their apps Web 3.0 ready.


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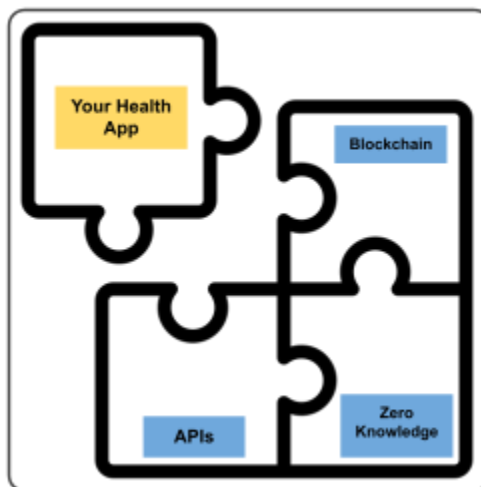
[14] Provided that their solutions are able to communicate with APIs

Standards & Interoperability

Existing systems of health facilities have different providers, meaning their tech stacks are built differently following various standards. As such, most of the systems are not compatible to communicate with one another.

Integrating Hippocrades will make it interoperable with other systems as it follows industry-standard protocols.

Imagine a whole town, city, or even a nation's health systems interconnected. *Note: Hippocrades is system agnostic.*
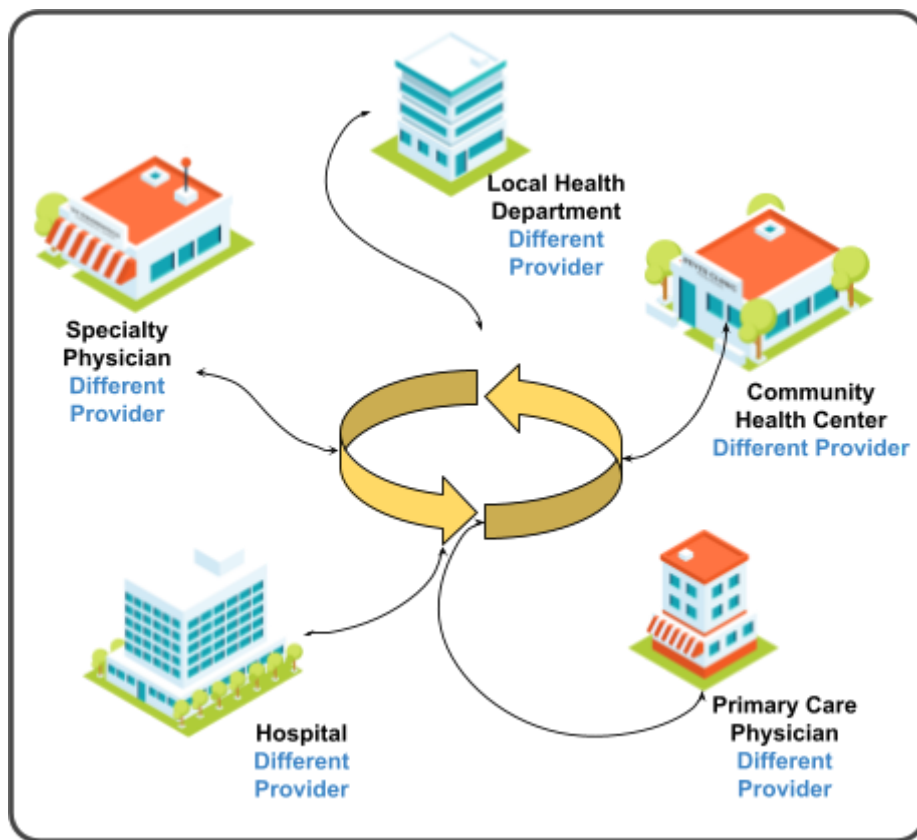
6. Decentralized Autonomous Organization

Complete Decentralized Setup

To have a truly decentralized setup, Hippocrades will apply the Decentralized Autonomous Organization (DAO) model.

What is a DAO?

> *"A DAO is like a subreddit with a bank account and some governance rules applied to it."*

A Decentralized Autonomous Organization (DAO) is an organization governed by rules encoded as a computer program that is transparent and controlled by the organization members and not influenced by a central government.[15]

Through smart contracts, a DAO can work with external information and execute commands based on them – all this without any human intervention. A DAO makes the decentralized ownership of an organization possible.

Members of a DAO are not tied by any formal contract. They are instead bound together by a common goal and network incentives tied to the consensus rules. Once a DAO is deployed, it cannot be controlled by a single party but is governed by a community of participants. The DAO framework can be considered the last piece of a puzzle that pushes the entire blockchain ecosystem to become fully autonomous and decentralized.[16]

Integrating the DAO model plus the Zero Knowledge Proof protocol in Hippocrades will ultimately bring the platform to the ideal setup that was originally intended for a truly decentralized, secured and trustless Health Information Exchange (HIE).

Health Infrastructure Protocol

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[15] DAO, Wikipedia, https://en.wikipedia.org/wiki/Decentralized_autonomous_organization
[16] What is a DAO?, Liquid, https://blog.liquid.com/decentralized-autonomous-organization-dao
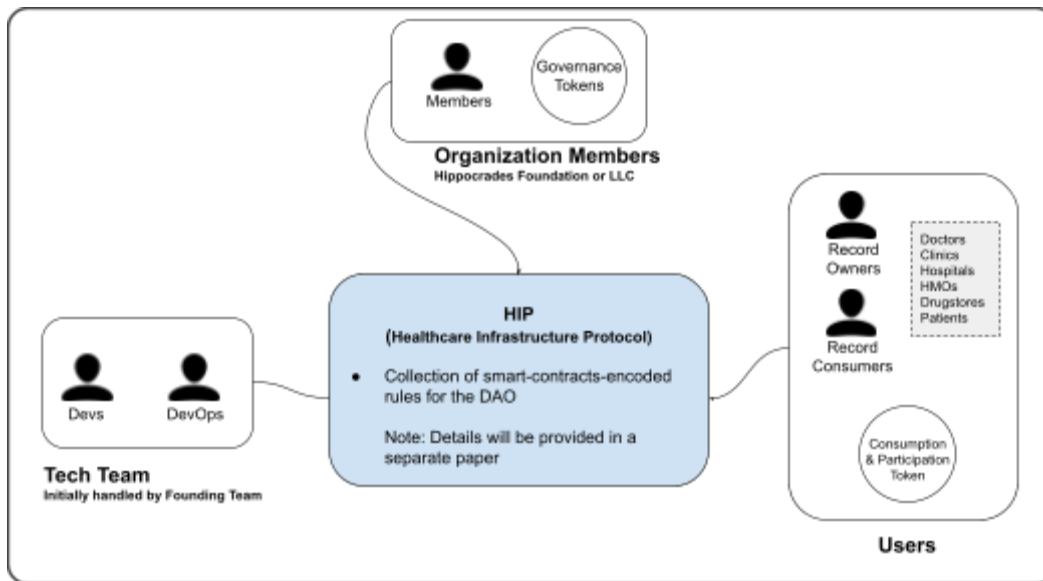
Protocol: Where the smart contracts will be set. Details of this will be written on a separate paper, including the defined roles, benefits, incentives, etc. of the different players.

Organization Members: The members will control Hippocrades' direction. The majority would ideally be coming from the healthcare ecosystem.

Users: There would be exchanges between record owners and record consumers. Generally, they would be doctors, clinics, hospitals, HMOs, drugstores, and patients.

Tech Team: The tech platform will be maintained by this group as directed from policies set by the members. Initially, this will be handled by the founding team until proper turnover.

*Initially, Hippocrades core team will set up and set the direction until proper turnover to the DAO. Activities and timeline will be provided accordingly.

7. Conclusion

We have proposed Hippocrades' infrastructure, with healthcare applications and comprehensive APIs, that developers and health providers can use to enhance their systems — making them interoperable while being compliant and secure. In addition, it could also make their systems Web3.0 integratable taking advantage of what blockchain and zero-knowledge can do. Furthermore, this platform can also be used as a permissionless health information exchange that would accelerate important transfer of health information without having to risk data privacy.

In the finance world, blockchain has already driven a significant number of tech startups creating innovative decentralized finance (DeFi) apps. In healthcare, however, there is little progress for blockchain-based apps, relative to that of finance'. This is quite ironic considering healthcare is dealing with tons of sensitive, private, and personal data, which is actually the ideal use case for the application of the said technologies.

Hippocrades architecture is designed so that more DeHealth (Decentralized Health) apps would come into fruition. Instead of worrying about security, compliance, interoperability, and decentralization, developers can just build on top of Hippocrades' platform and focus on the core feature of the product they are building.

The core tech of Hippocrades - Curie, Fleming, and Nightingale, are not just concepts, they are already existing. Specifically, the first two (Curie and Fleming) are already built and in production. The team has started building them since 2016 and has made significant improvements in the last 5 years. On the other hand, Nightingale's POC (proof of concept) is also already built and in the initial testing phase.

Together, Hippocrades' three products can unlock major use cases in the healthcare sector that previously were not possible or would have limitations. This would bring widespread convenience and efficiency in the ecosystem from healthcare providers to doctors, to patients, to pharmacies, to insurance companies, to research institutions, and to government units.

With a DAO setup, we can have a truly decentralized health infrastructure paving the way to finally reach the holy grail of health data exchange that has long eluded the industry.