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BlockIoT: Blockchain-based Health Data Integration using IoT Devices

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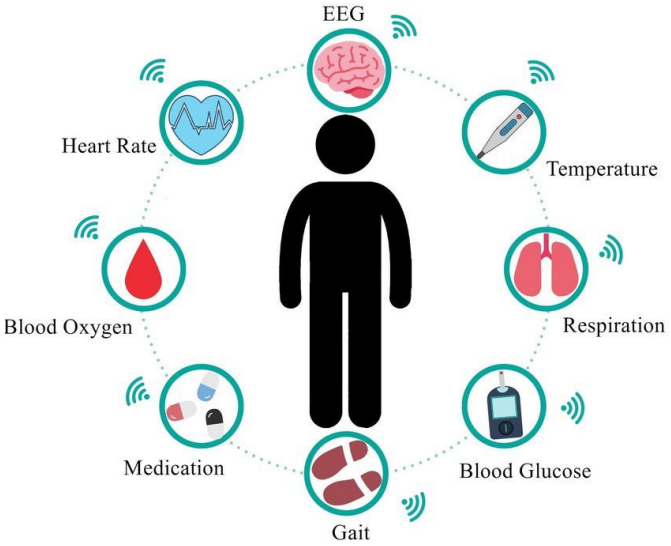
Project Relevance

- Health Information has become widely accessible from past 10-20 years

- EHR Systems provide patient symptomatic history, lab reports, etc

- **Medical Devices** provide **physiological** and **granular** data
  - Day-to-day quantitative view of a patient's health
  - Algorithms can predict, recognize or confirm health events



Research Statement

- Lack of **trust** and **accountability** with the data shared between healthcare providers

- Significant **lack of integration** between medical devices and electronic medical record systems

- **Smart Contracts** and **Solidity** are unable to execute complex data analysis necessary for certain fields such as healthcare data

Ex: How can you treat hypertension without knowing the patient's BP value over time?

Hypothesis

- Providing **granular** and **physiological** data to physicians using a **trustless** mechanism can allow for better patient outcomes

- Using **off-chain environments** to analyze health data can circumvent issues with smart contracts and blockchain

Work Plan/Milestones

- Started Spring 2020
- **Spring 2020-Fall 2020:** Idea conception/initial prototype development
- **January 2021:** Physician participatory survey
- **Spring 2021:** Prototype 2.0, AMIA conference submission acceptance
- **Summer 2021:** Development of RETEL, IEEE conference acceptance
- **Fall 2021:** Further development of RETEL, EMSights- Hackathon “out-of-the-box” winner
- **Spring 2022:** Initial BlockAI Prototype, second BlockIoT physician evaluation

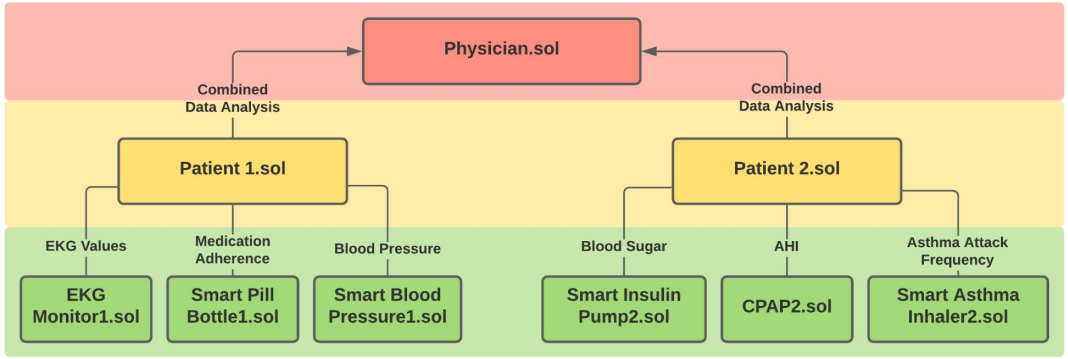
Methodology- BlockIoT

- Designed to enable connectivity between IoT devices and interested parties through a blockchain system.

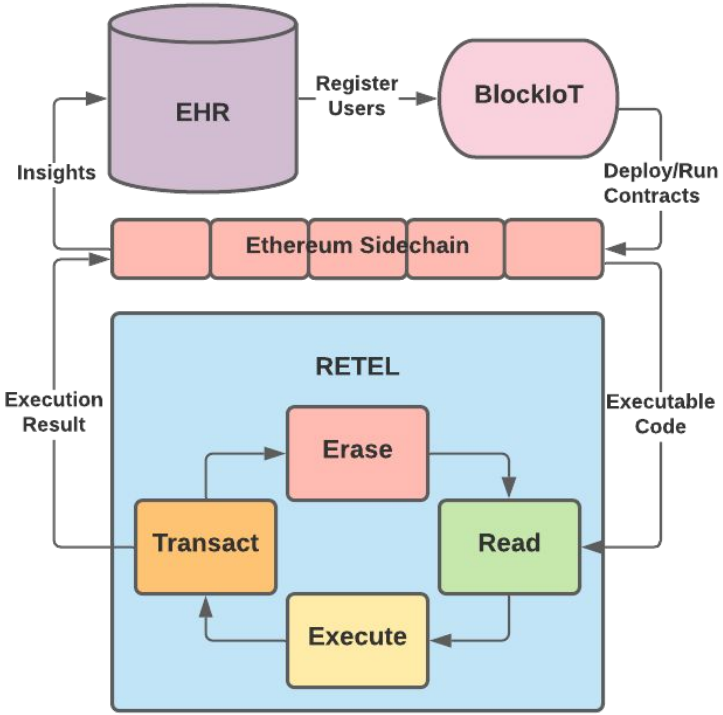
- Provides **better patient health metrics**, and helps facilitate better patient interventions

- RETEL- serves as an environment used by smart contracts to execute computation-heavy analysis
  - **R**eads commands from smart contracts,
  - **E**xecutes these commands through Python,
  - **T**ransacts results back into the contract,
  - **E**rases the environment, and
  - **L**oops to the next smart contract

Methodology- System Design



BlockIoT Smart Contract Layers



High-Level Execution

Methodology- Participatory Evaluation

- **13 physicians** (recruited through personal/professional connections)

- **Different specialties** (cardiologist, GI, dermatologist, geriatrician, emergency physician, surgeon, anesthesiologist, pulmonologist/allergy/sleep medicine, internal medicine, and primary care)

- 1-1.5 hr interviews, with Google Form

Patient Basics	Diagnoses	Devices	Current Medication
Wendy Barnes (Age: 52; 80 bpm/98)	Diabetes	Smart Blood Sugar Monitor	Metformin
	Obstructive Sleep Apnea	CPAP Machine	N/A
	Hypertension	Smart Blood Pressure Cuff	Lisinopril
	Asthma	Smart compliance tracker (for each medication)	Symbicort, Albuterol
	Obesity	Smart weight tracker	

Table 1: Patient HPI Summary

Synthetic Patient Chart of Blood Pressure Shown to Physician Evaluators

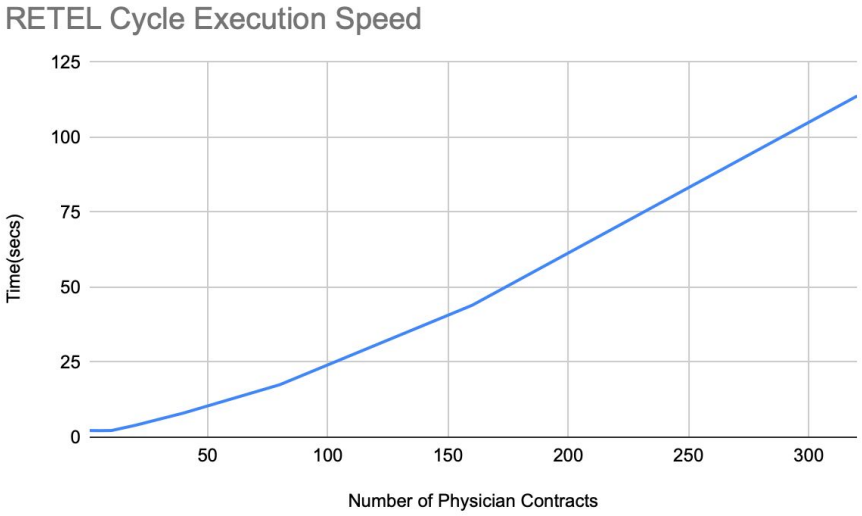
Results- Participatory Survey

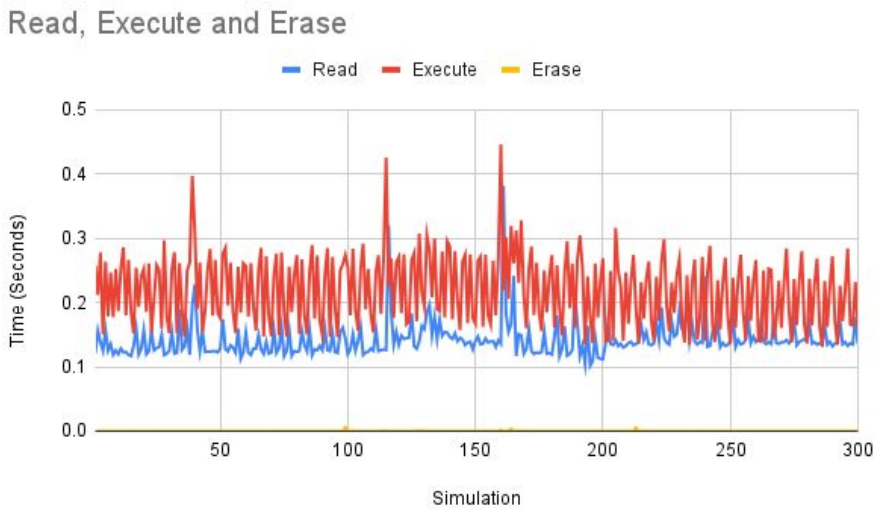
- Access to means for obtaining physiological data from patients is **minimal** or **non-existent.**

- **87%** of physicians reported that they would be willing to use the **summary views** as well as the patient/physician interventions throughout the patient care

- All of the physicians stated that the given data would make them more efficient in the diagnosis process

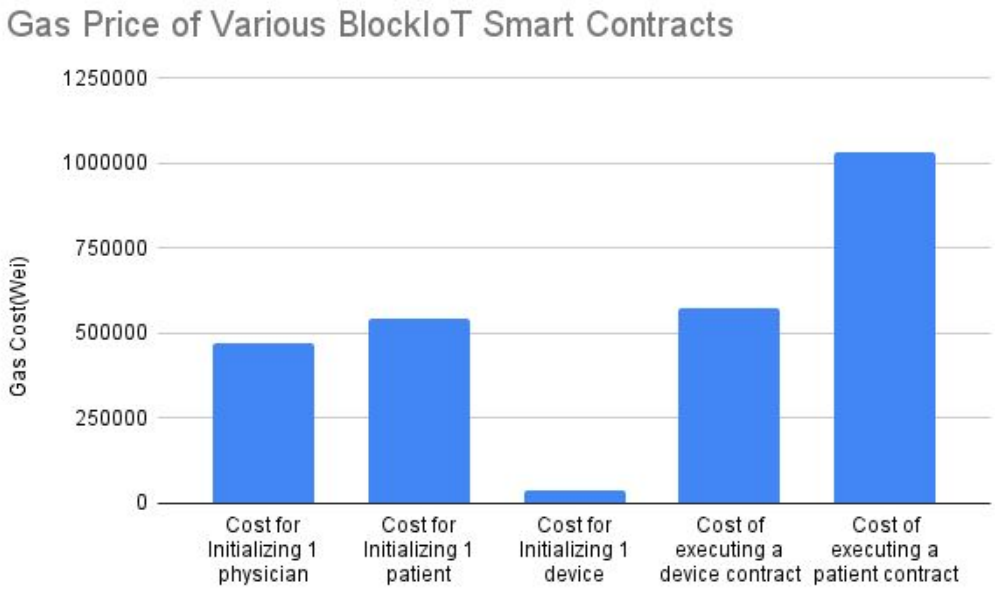
Results- Performance Evaluation





Results: Overall Gas Costs per Transaction

- Gas costs are examined to show the overall economic costs of running such a system
- 1000 Giga-Wei = 0.00000335 USD
- **Insight:** Cost per transaction remains low



Conclusion

- **BlockIoT** enables connectivity between **IoT devices** and **data-intensive systems** through a novel smart contract execution framework.

- **RETEL** provides the **balance** between the flexibility and computation necessary to **gather, parse and analyze data.**

- RETEL was shown to be **able to scale**, and maintain a **relatively constant speed** under a large load of smart contracts, while requiring **low gas costs.**

- Physicians expressed a need for **standard access** for medical data, and found BlockIoT to be **useful in their practice.**