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MedRec

Using Blockchain for Medical Data Access and Permission Management

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MIT Media Lab

MedRec:

Research Motivation

Technical Implementation

Prototype Evaluation & Deployment

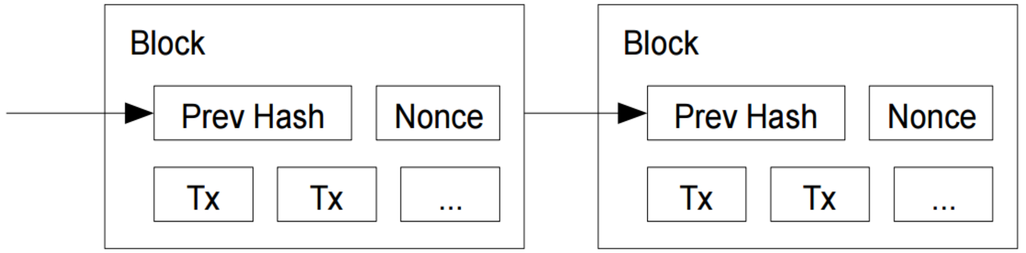
Interoperability

Future for Big Data applications

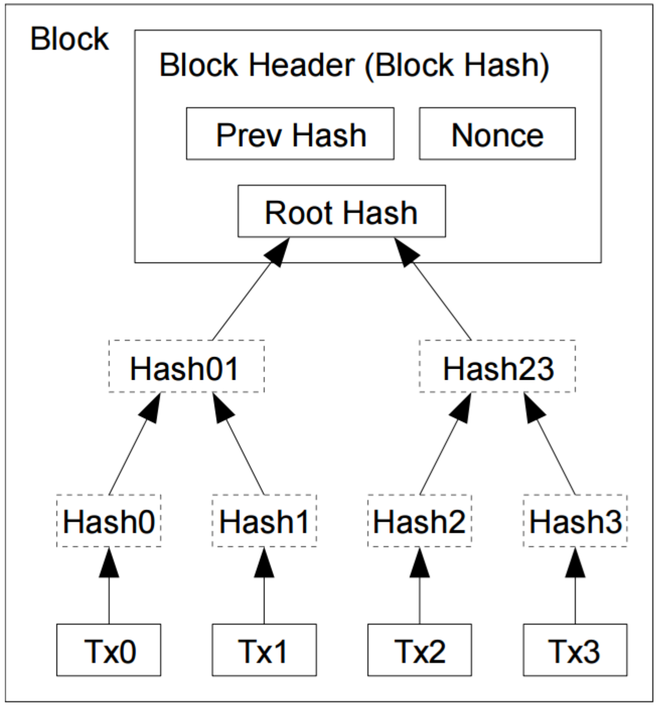
National Healthcare Priorities

Challenges & Next Steps

Blockchain Refresher



- Immutability, provenance and time-stamping
- A “trustless” P2P architecture, maintained by “mining” via Proof of Work hashing algorithm → Consensus



Source: Nakamoto. Bitcoin White Paper. 2008

MedRec Research Prototype | Motivation

1. Unify patient access to their medical data across providers, physicians, and treatment sites

2. Enable patient-initiated data sharing and “smart” permissioning

3. Empower researchers with Big Data from electronic health records (aggregate & anonymized)

MedRec Prototype | Key Implementation Choices

- “Smart contracts” on an Ethereum blockchain
- Updates managed through a notification system
- All medical data stays distributed in physician’s existing data storage infrastructure
- All nodes retain a copy of the blockchain permission log

MedRec Prototype | Smart Contracts

Patient-Provider Relationship (PPR)

- public key Ethereum addresses
- pointers to medical data (SHA-256 hashes)
- network location for data retrieval
- permission strings

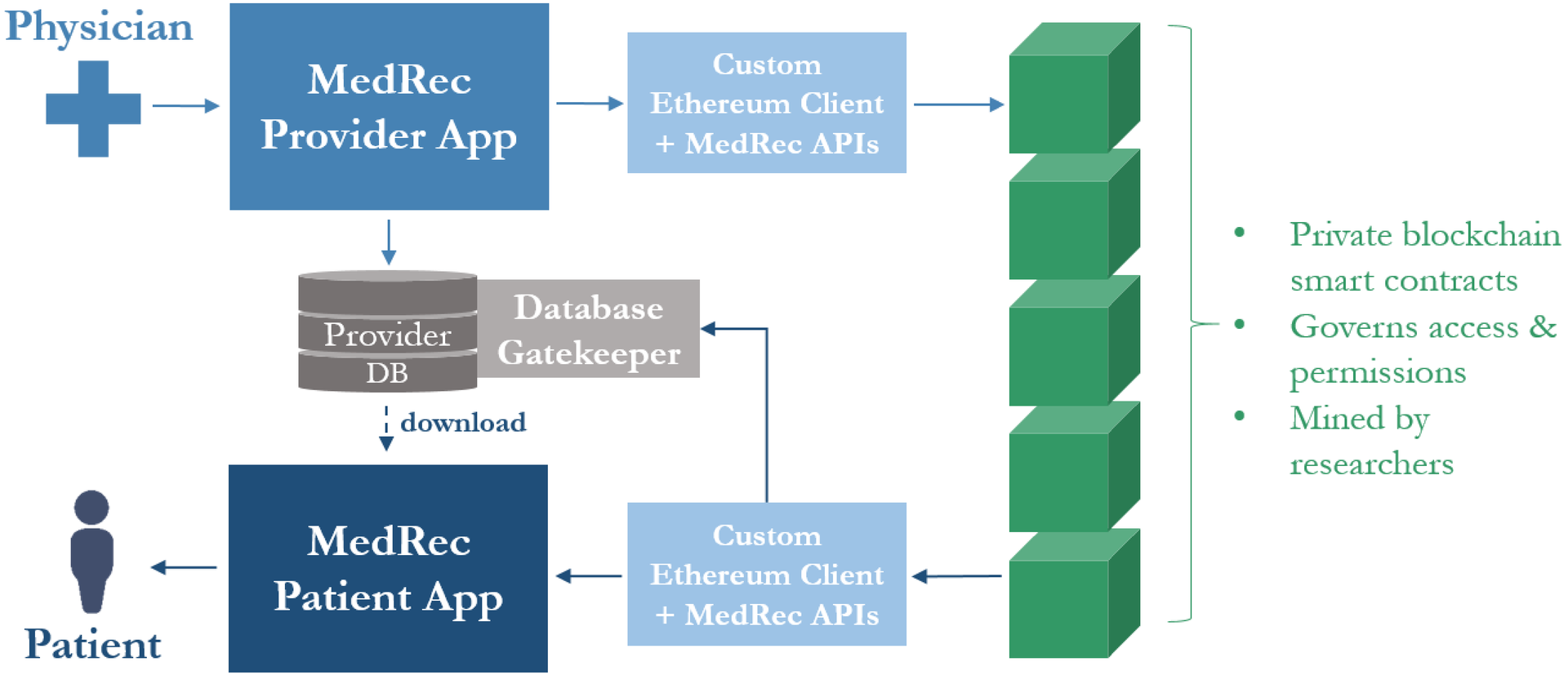
Summary Contract

- Per user, a list of all PPR addresses for lookup
- A status variable for each PPR, indicating new content

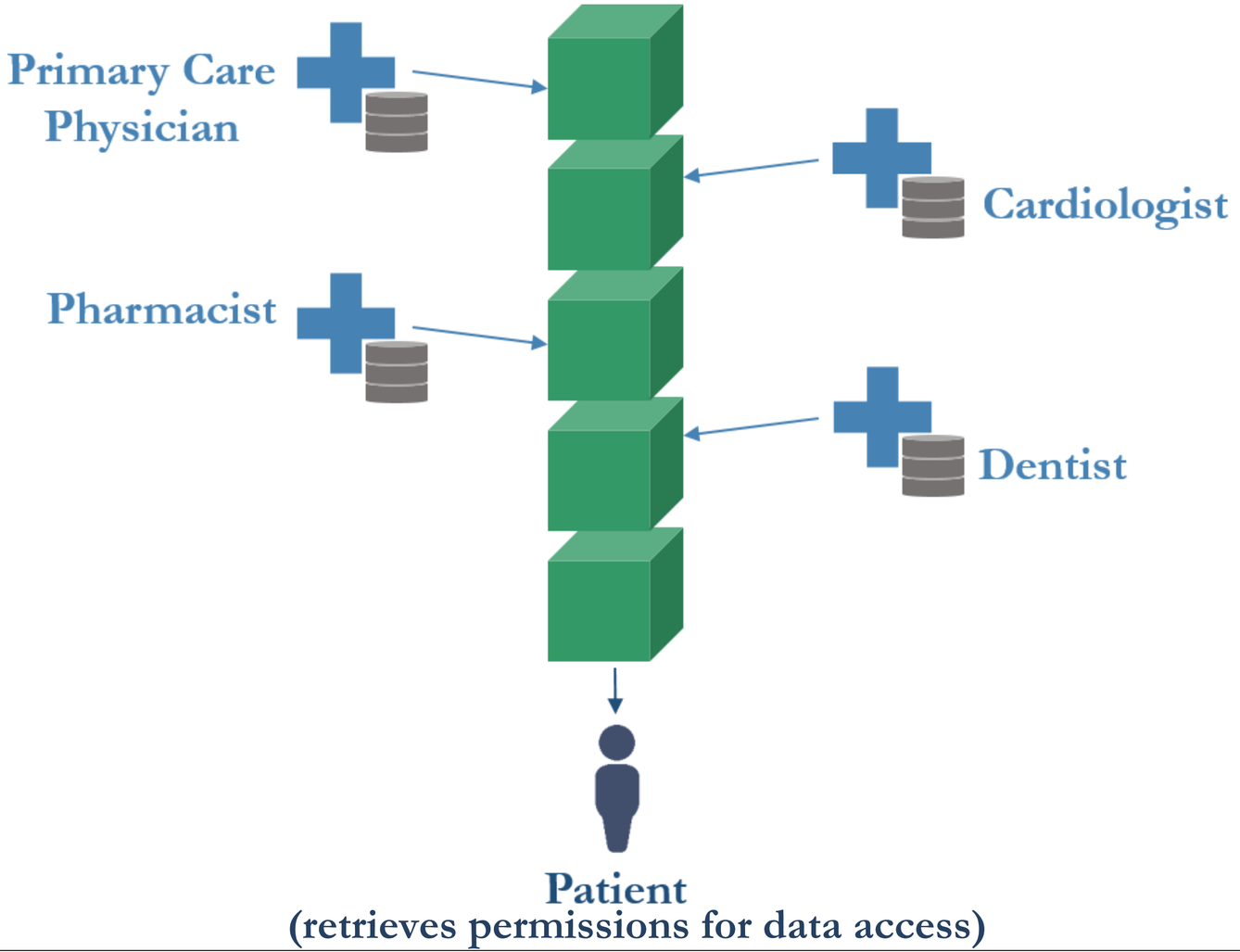
Registrar Contract

- public key Ethereum addresses → Identity string
- public key Ethereum address → Summary Contract address
- Custom registrar logic

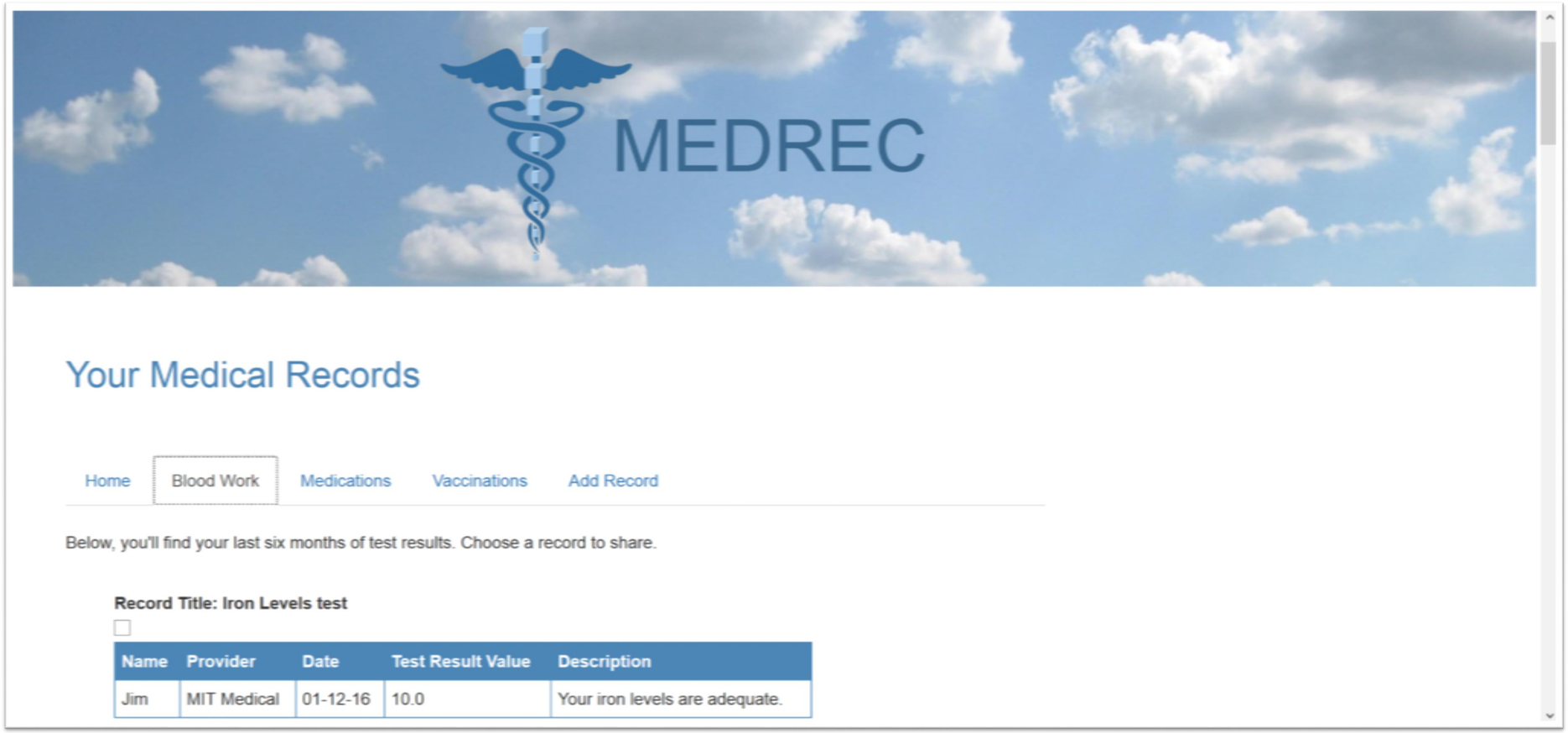
MedRec System Diagram | single node



MedRec System Diagram | multi-node network



MedRec User Interface



MedRec Virtual Machines

Miner

- Listens for new “transactions”
- Mining difficulty can be customized
- Always up-to-date on the latest block
- Supports many mining nodes

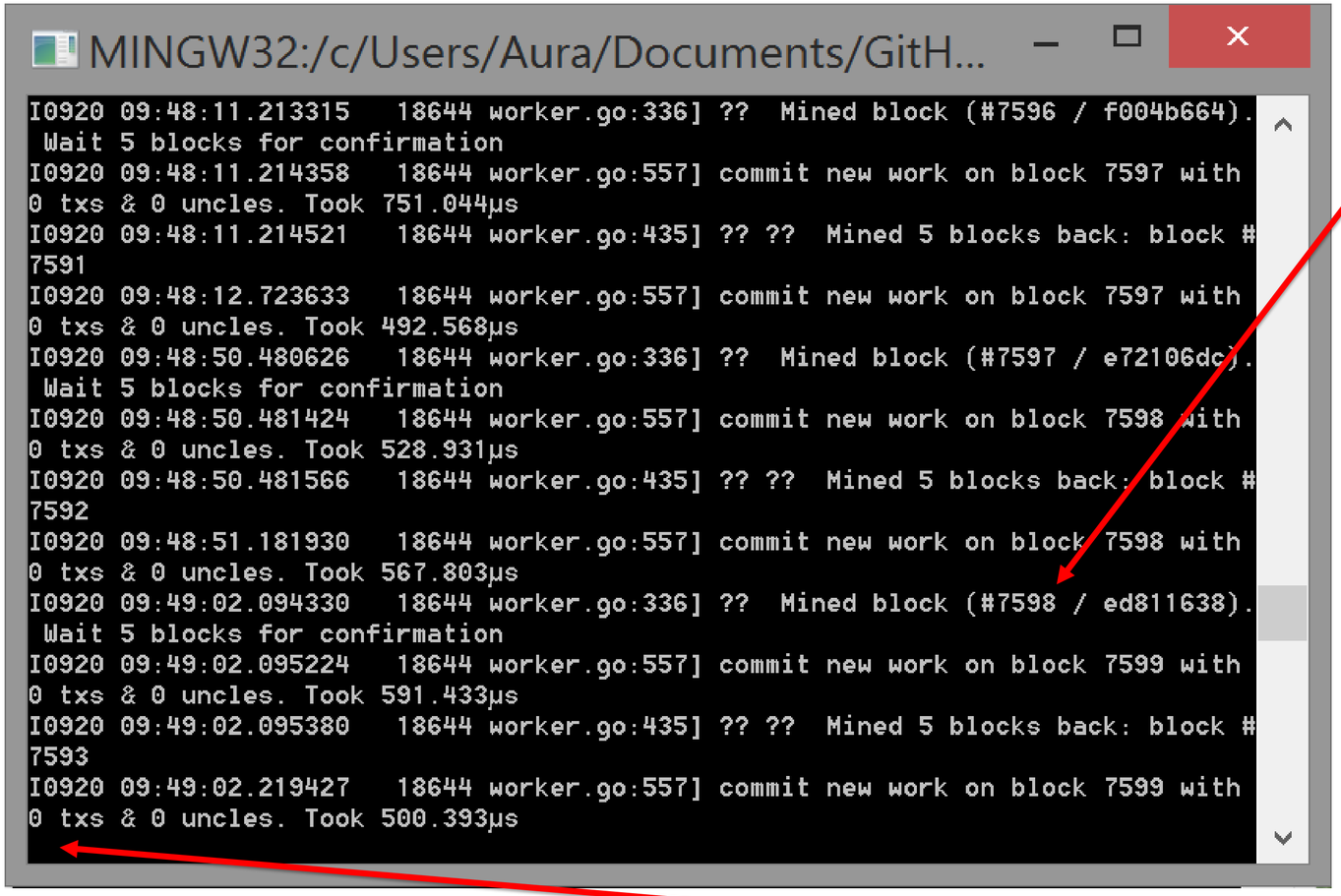
Physician/Care Provider

- Runs a webapp UI view
- Runs a custom Ethereum client, crawling the chain listening for updates pertinent to that identity

Patient

- Runs a webapp UI view
- Runs a custom Ethereum client, crawling the chain listening for updates pertinent to that identity

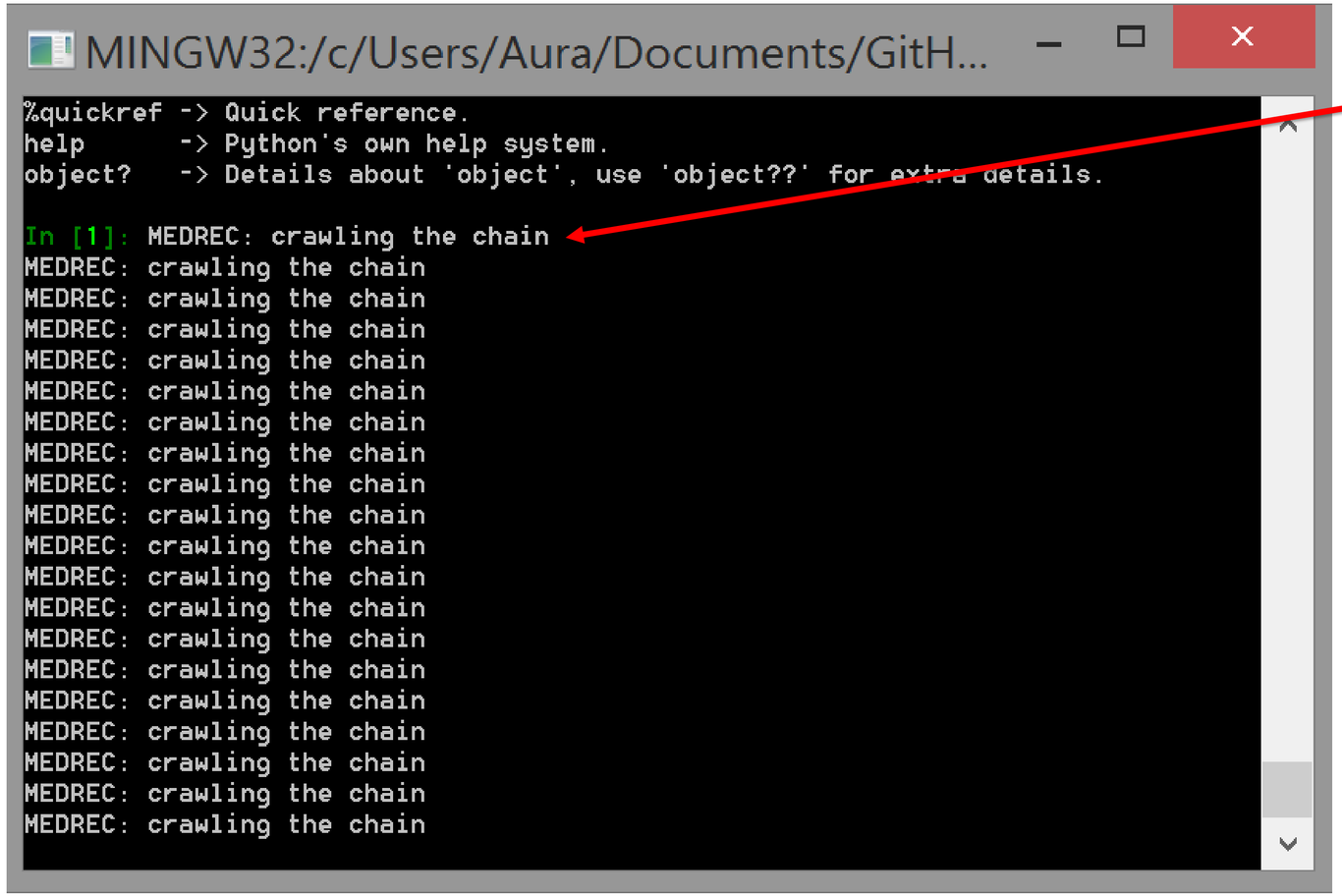
MedRec Virtual Machines | Miner



Block number

Turns to “1 txs” when a transaction is found

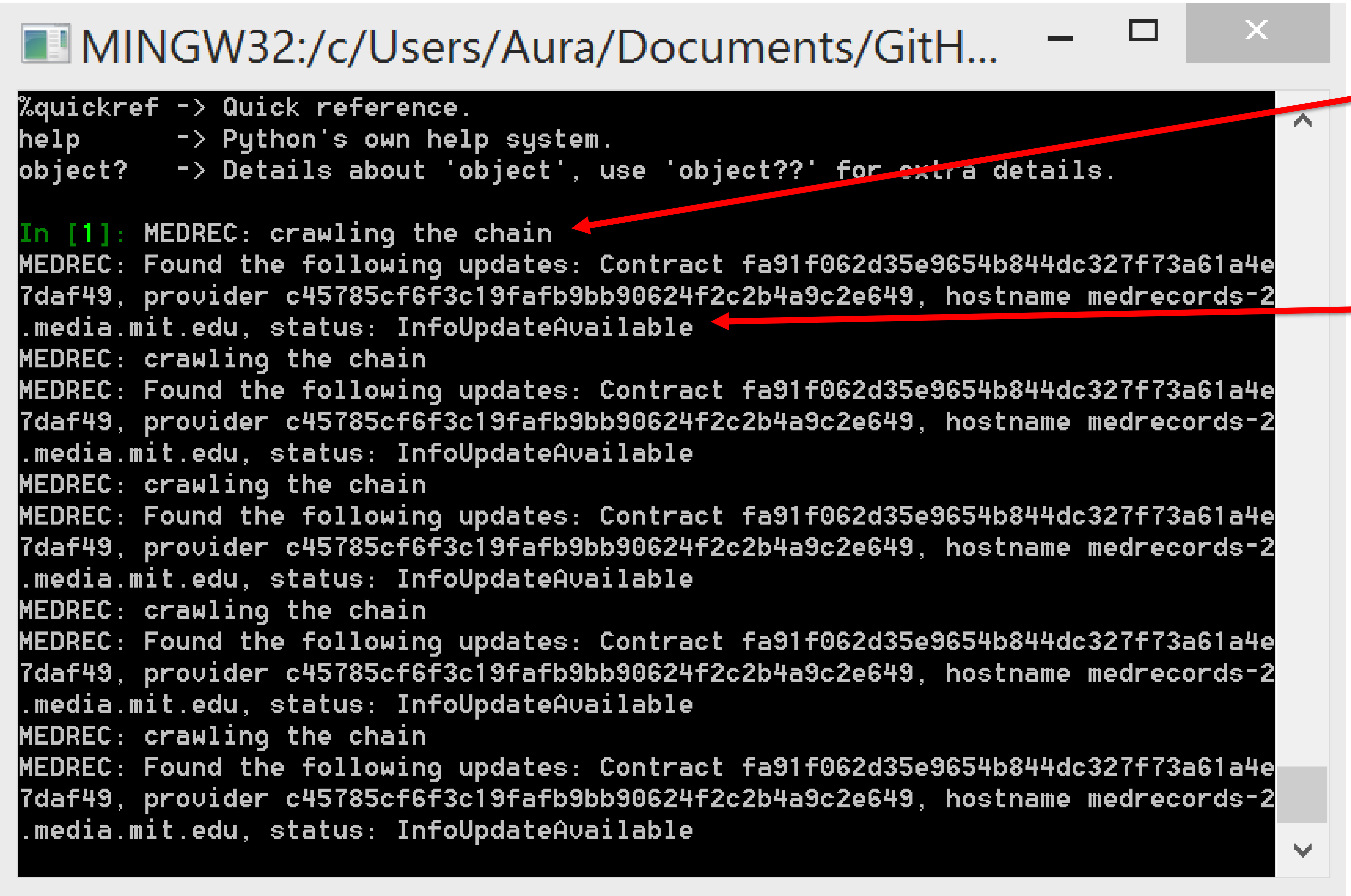
MedRec Virtual Machines | Physician/Care Provider



Initially crawling the chain for updates

Waiting for requests or newly submitted patient records

MedRec Virtual Machines | Patient



Initially crawling the chain for updates

Finds an update, identifies the relevant Patient-Provider Contract address and Provider address

Patient web app will now display a notification related to this update

Prototype Evaluation | Hospital Deployment

HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL

Beth Israel Deaconess
Medical Center

- Local integration with BIDMC data servers (SQL Server)
- Testing ability to smoothly intake and parse a standard clinical document
- Linking our Database Gatekeeper utility to hospital test server endpoint
- Completing multiple end-to-end system flows

MedRec Prototype | Interoperability

- Designed as a system of Open APIs – FHIR rails, Argonaut Project, etc
- Designed with HIPAA regulations in mind
- Designed to accept standardized data formats, or work directly with on-premise DBs
- Goal: support end-to-end encryption for the off-chain data transfer

MedRec | A framework for Big Data applications

Identifying patterns & trends in your personal healthcare data

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Predictive analytics based on MedRec population data

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For researchers: precision medicine, specify demographic data, longitudinal studies

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For researchers: precision medicine, specify demographic data, longitudinal studies

Analytics layer for trend discovery: narcotics abuse, conflicting prescriptions, epidemiological trends

MedRec | National Healthcare Priorities

ONC Interoperability Roadmap:

“Individuals have access to longitudinal electronic health information, can contribute to the information, and can direct it to any electronic location”

“Learning Health System”

“Service Oriented Architecture”

“Healthcare Directory & Resource Location”

“Consistent Representation of Authorization to Access Electronic Health Information”

MedRec | National Healthcare Priorities

Precision Medicine Initiative & PCOR:

- *Establishing a national research cohort*
- *Evidence-based, personalized research*

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Data Sovereignty | Open Stack for Big Data in Healthcare

MedRec | Your Perspective

How can this project contribute to an interoperable, health IT stack?

MedRec | Challenges & Considerations

- Privacy: frequency analysis on open blockchain
- Natural, limiting size of a MedRec “network”
- Data aggregation across many endpoints
- Relying on digitization of medical records
- Relying on momentum behind FHIR & record standardization

Next Steps & Future Work

- Preparing to open-source the code in Fall 2016
- Additional real-world deployments
- Moving from POC to scalable code base
- Extensibility to other non-healthcare use cases
- Integrating with other Blockchain + Open Data projects

Thank you to our sponsors & collaborators!

MIT Media Lab Consortium

MIT Digital Currency Initiative

Beth Israel Deaconess Medical Center

For more information on the MedRec project, please email:

medrec@mit.edu

Read our blog post at:

pubpub.org/pub/medrec