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Le forum pour les TIC dans le système de santé

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**SwissTech Convention**  
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21.-22. September 2017

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# SHARING MEDICAL DATA

- Primary care
- Medical research
- Connected health



“Somehow your medical records got faxed to a complete stranger. He has no idea what’s wrong with you either.”

# ELECTRONIC MEDICAL RECORDS (EMR)

- HITECH Act (US, 2009) provided a series of incentives to encourage widespread EHR adoption
  - As of 2015, nearly 9 in 10 (87%) of office-based physicians
- Countries of the European Region: According to WHO 59% have a national electronic health record system; 69% of those have legislation governing its use

# MANAGEMENT OF PROTECTED HEALTH INFORMATION (PHI)

- **HIPAA** (Health Insurance Portability & Accountability Act of 1996)
- **The Data Protection Directive 95/46/EC** (1995)
- Health information exchange (**HIE**) is a sharing infrastructure for electronic healthcare information across organizations within a region, community or hospital system

# EMR DATA SHARING BETWEEN PROVIDERS: CURRENT STATUS

- Patient (or legal representative) signs a disclosure form
  - Patient contact
  - Visit dates
  - Types of records
  - Who will receive it
- **Printed** records sent by **fax** or **mail** (CDs for images), or **carried** by patients: taking **days**

# PROBLEMS

- Complicated processes on consent management
  - Patient transfer between hospitals may not be predicted
  - Time consuming and delay treatment
  - Wasted resources and increased costs
- Hard copied data difficult to manage
- Control over the data is lost once records shared

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How to **speed-up & facilitate** medical data sharing while ensuring **privacy, security and auditability**?

# BLOCKCHAIN FOR EHEALTH: FROM PERSPECTIVES TO AN APPLICATION FOR RADIATION ONCOLOGY

- Alevtina Dubovitskaya, Zhigang Xu, Samuel Ryu, Michael Ignaz Schumacher and Fusheng Wang



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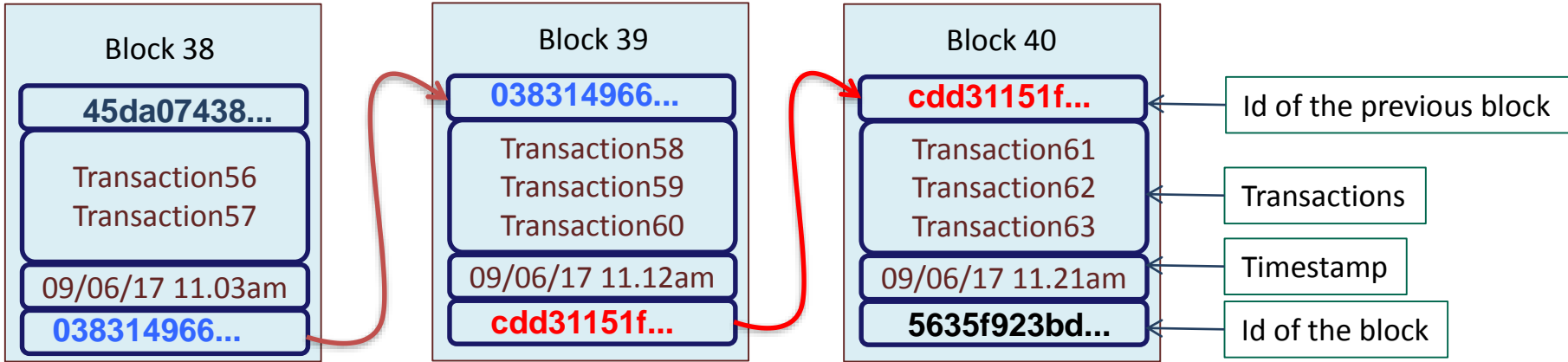


# BLOCKCHAIN

- Ledger
- Distributed (non-centralised)
- Secured (using crypto)
- Immutable



# BLOCKCHAIN



# DIFFERENT TYPES OF BLOCKCHAIN

- **Permissionless (public) blockchain**

anyone in the world can read, send transactions to and expect to see them included if they are valid, can participate in the consensus process

- Bitcoin
- Ethereum



- Consensus: Proof of Work\* (PoW) (PoStake, PoBurn)
- Crypto-currency
- Anonymous nodes
- «*Smart contracts*» (*Solidity*)

# DIFFERENT TYPES OF BLOCKCHAIN

- **Permissionless (public) blockchain**  
anyone in the world can read, send transactions to and expect to see them included if they are valid, can participate in the consensus process
- **Permissioned (consortium / fully private ) blockchain**  
consensus process is controlled by a pre-selected set of nodes /one organization
  - Hyperledger
    - No crypto-currency
    - Registered nodes
    - «Chaincode» (GO, java)



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- Hyperledger



Trade-off: the ability to create trust and the ability to scale

# BLOCKCHAIN FOR EMR



EMR	Blockchain (permissioned)
Private and sensitive	Secure and trusted
Can not be altered	Immutable
Audit trails needed: who accessed and reviewed	History kept on blockchain
Sharing needed among multiple actors	Distributed data sharing architecture
Fast turnaround for sharing	Quick (second to minute)

# MANAGING ONCOLOGY DATA USING BLOCKCHAIN

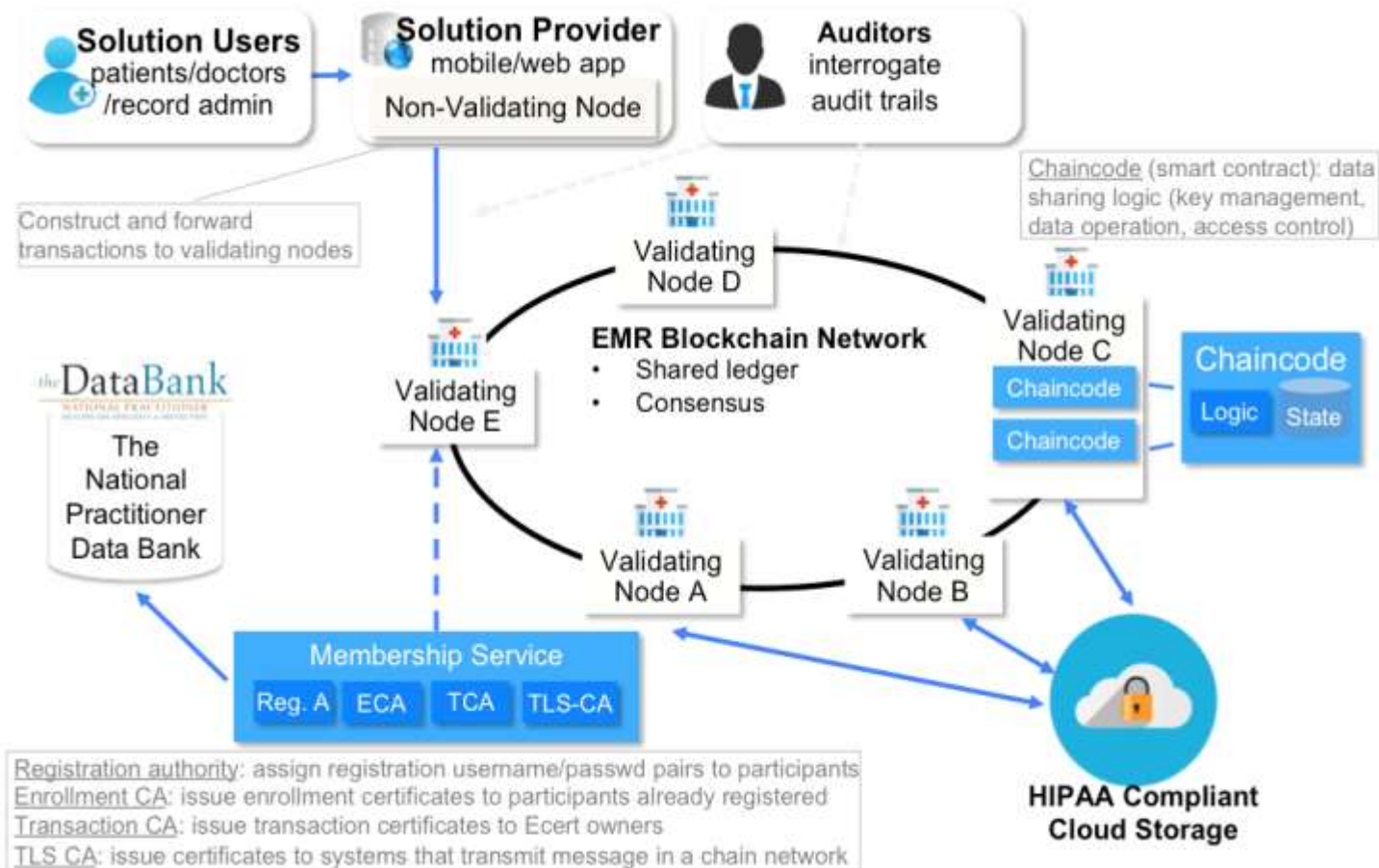
- Oncology patients may require long term treatment and life-long monitoring.
- Diagnosis and treatment at multiple hospitals are common.
- Legislation requires signed patient consents for sharing data. Consent management may become complicated.

# CHOICE OF TECHNOLOGY

- Permissionless (public) blockchain
  - Unnecessary expense of computer power
  - Transaction fee is a major hurdle for patients
  - Anonymity of nodes
- **Permissioned (consortium) blockchain**
  - Consensus process is controlled by a pre-selected set of nodes
  - Efficient
  - No transaction fee



# EMR BLOCKCHAIN ARCHITECTURE

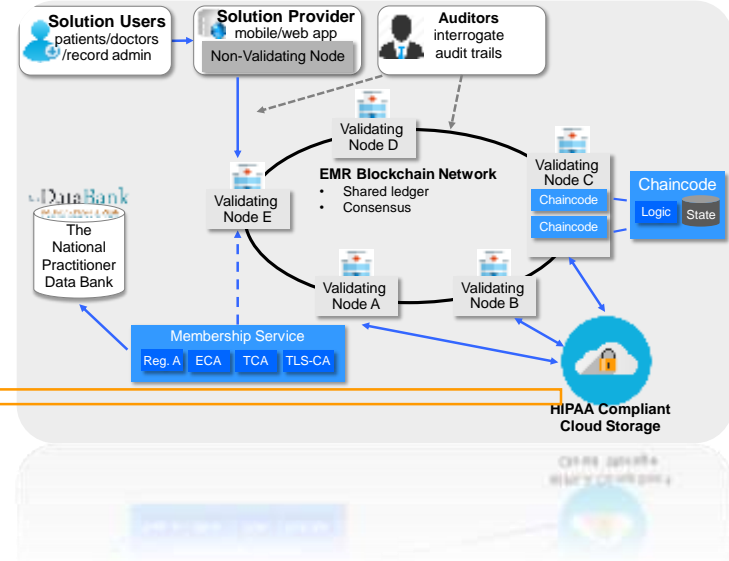
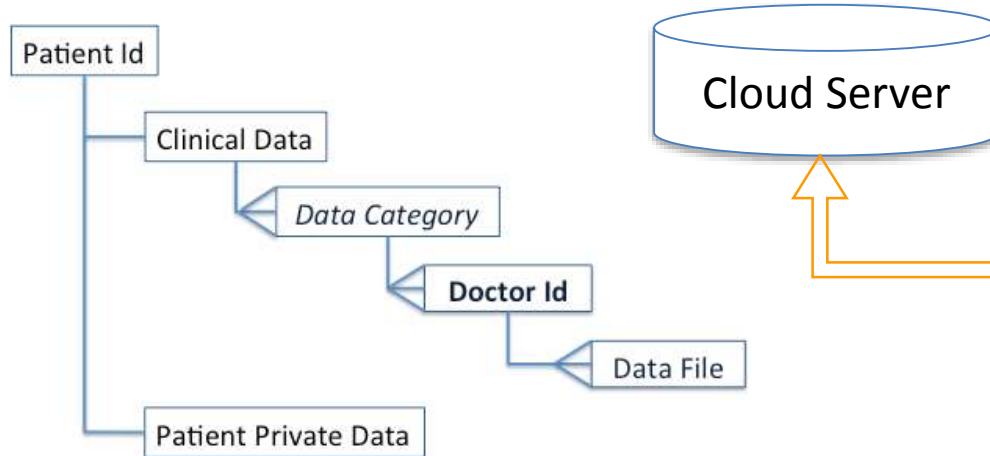


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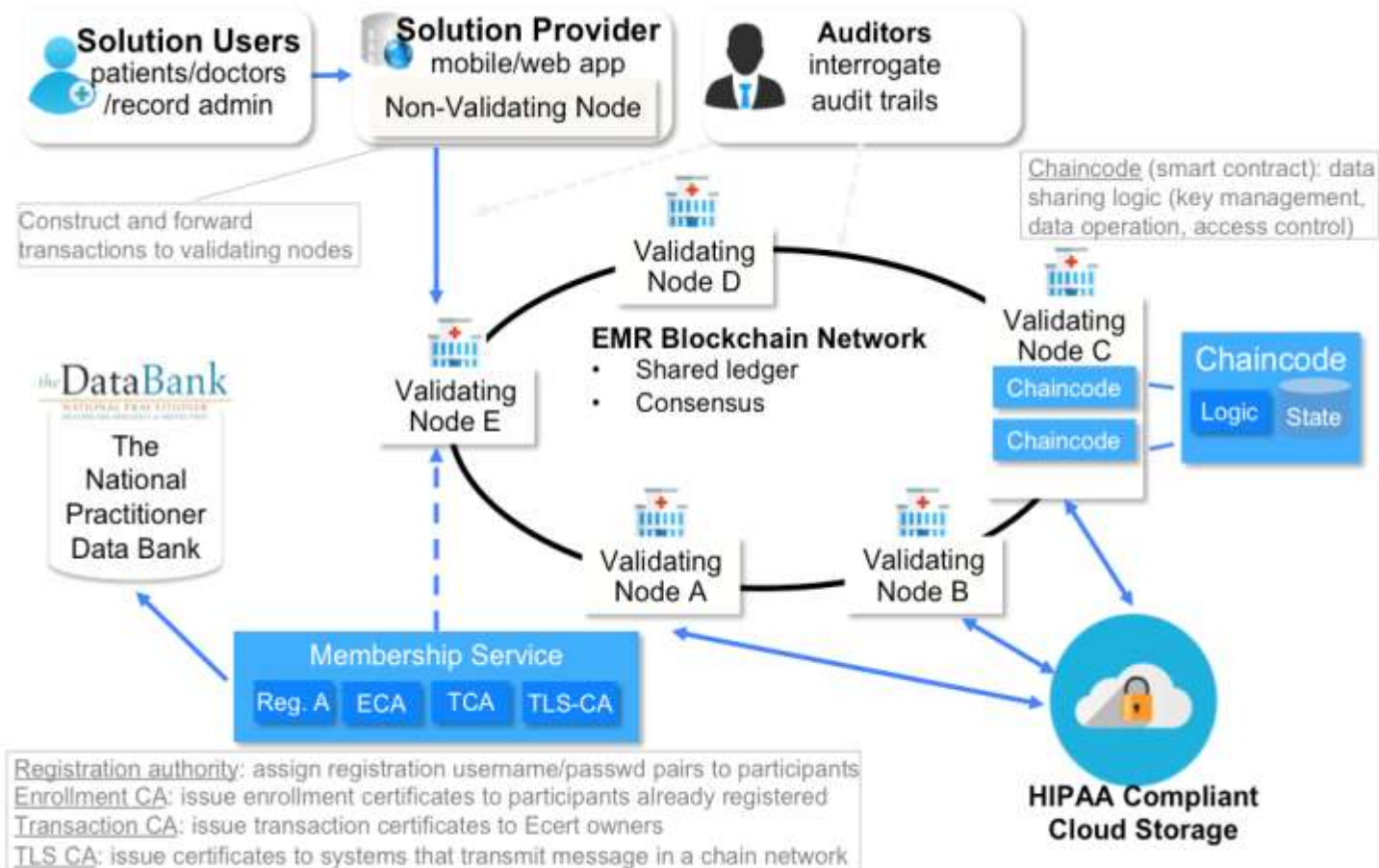
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# STRUCTURE OF THE DATA STORED IN THE CLOUD:



# EMR BLOCKCHAIN ARCHITECTURE

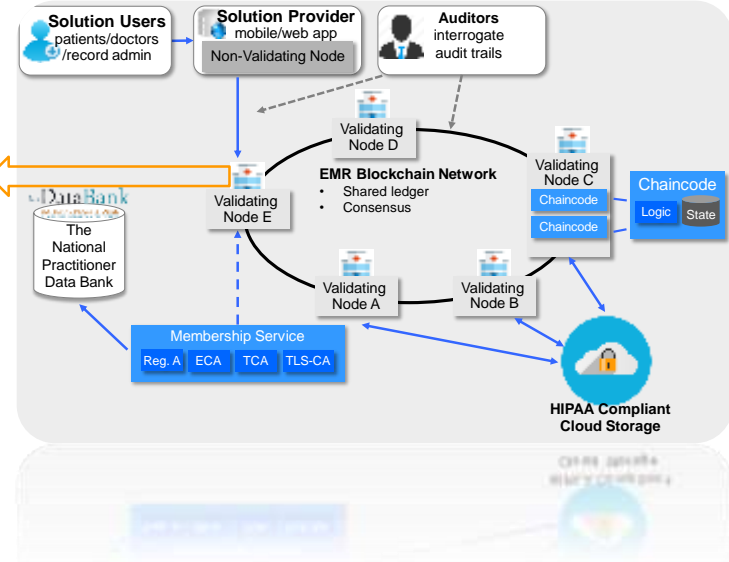
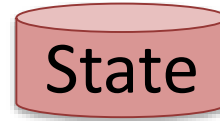
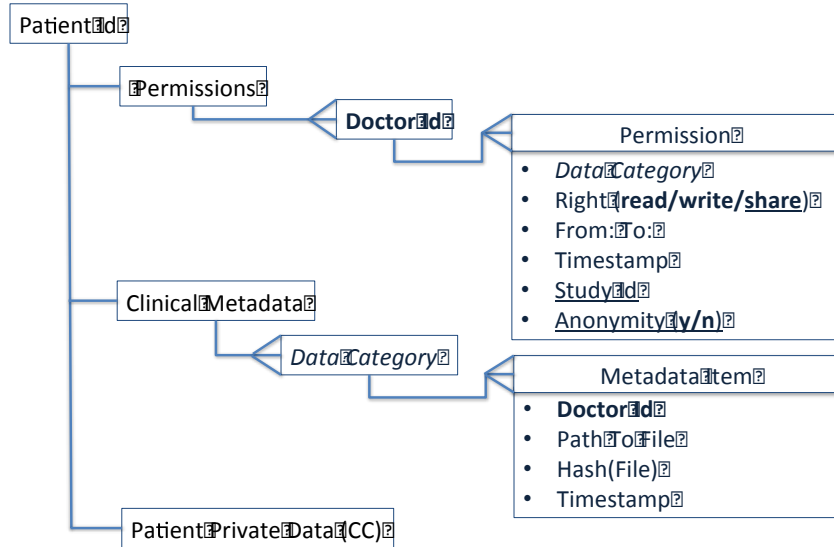


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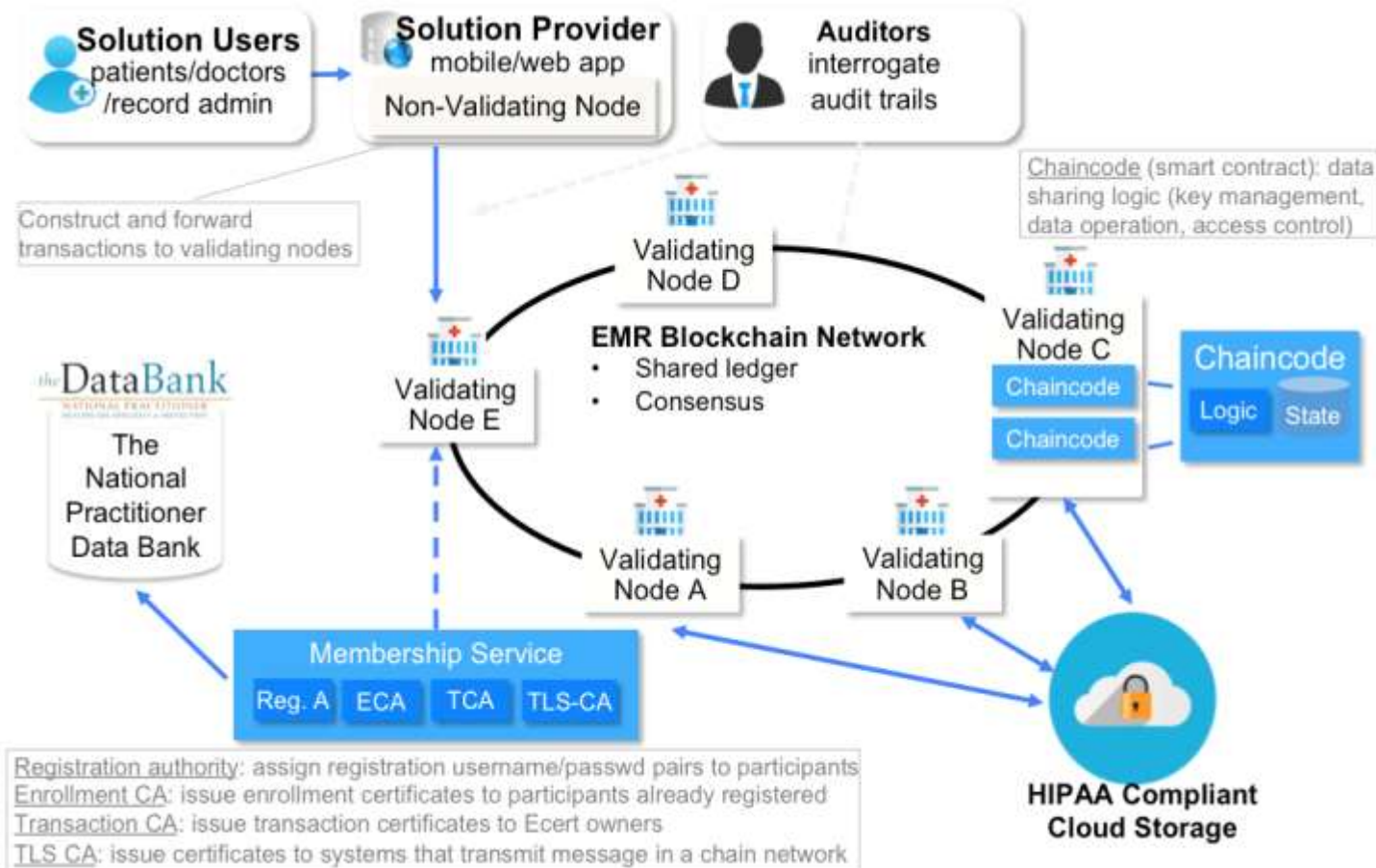
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# STRUCTURE OF THE DATA STORED ON THE CHAINCODE:



# EMR BLOCKCHAIN ARCHITECTURE



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# ADVANTAGES

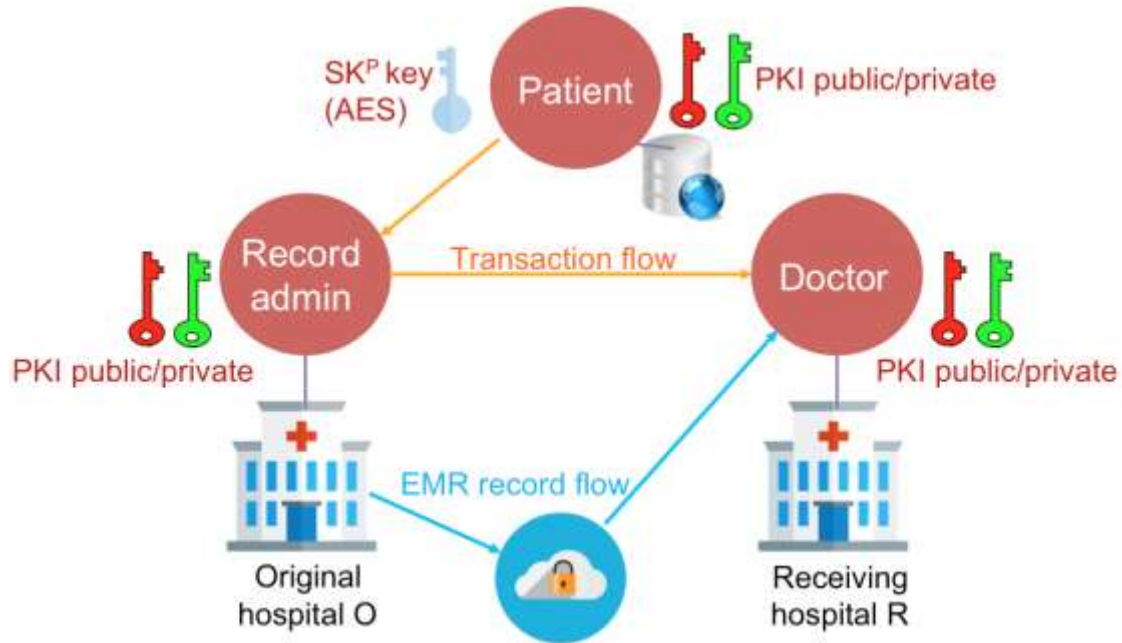
- No single point of failure
  - Distributed and replicated
- No need to trust the network nodes
  - Only registered hospitals will participate
- Transparency and immutability
  - All transaction history preserved, forming audit trails
- Security and privacy
  - Enrollment, encryption, access control

## WORKFLOW: SETUP

- Multiple hospitals setup an agreement to use the system and install the software
- A Web app is available for users
- Each hospital will have an admin role (virtual or real user) for retrieving EMR records
- Doctors in the hospital are registered through member service
  - A service based on the National Practitioner Bank to verify the identity



# ROLES IN A TRANSACTION





## STATE OF THE ART

- **GemOS:** generic platform to create applications based on blockchain
- **Guardtime:** technology based on *KSI (Keyless signature infrastructure)*
- **MedREC:** *decentralized* system based on *public blockchain*

# OPEN QUESTIONS

- No legal base
- Verification of the chaincode?
- Risks of the new technology (adoption?)
- Who controls Membership service?
- Key management

## CONCLUSIONS AND FUTURE WORK

- Lack of secure and trustable sharing architecture harms the quality of patient care and increases cost
- Our solution using permissioned blockchain is the first work in this field
- Prototype ensures privacy, security, availability, and fine-grained access control over patients' data
- HyperLedger Fabric continues improving and we will improve the system based on latest release
- Next step will be testing across multiple hospitals with patients' data