Private Blockchain-driven Health Insurance

Major Project under the Supervision of

Dr. Sweta Mishra

Assistant Professor

Department of Computer Science and Engineering

SHIV NADAR
INSTITUTION OF EMINENCE DEEMED TO BE
UNIVERSITY
DELHI NCR

Presented by: Aayush, Naman, and Rahul

Health Industry in India

Market Dynamics and Potential

- **Market Size:** Projected USD 372 billion by 2024
- **Growth Rate:** Impressive 16-17% CAGR
- **Key Sectors:**
  - Healthcare Services
  - Pharmaceuticals
  - Medical Devices
  - Health Insurance
- **Government Initiatives:** Ayushman Bharat

Figure 1: Healthcare Industry in India

Image Source: Web

Motivation

Addressing Key Challenges in Healthcare

Recent Security Incidents

- **Star Health Insurance:**
  Major data breach, October 2024
- **HDFC Life Insurance:**
  Cyber attack, November 2024

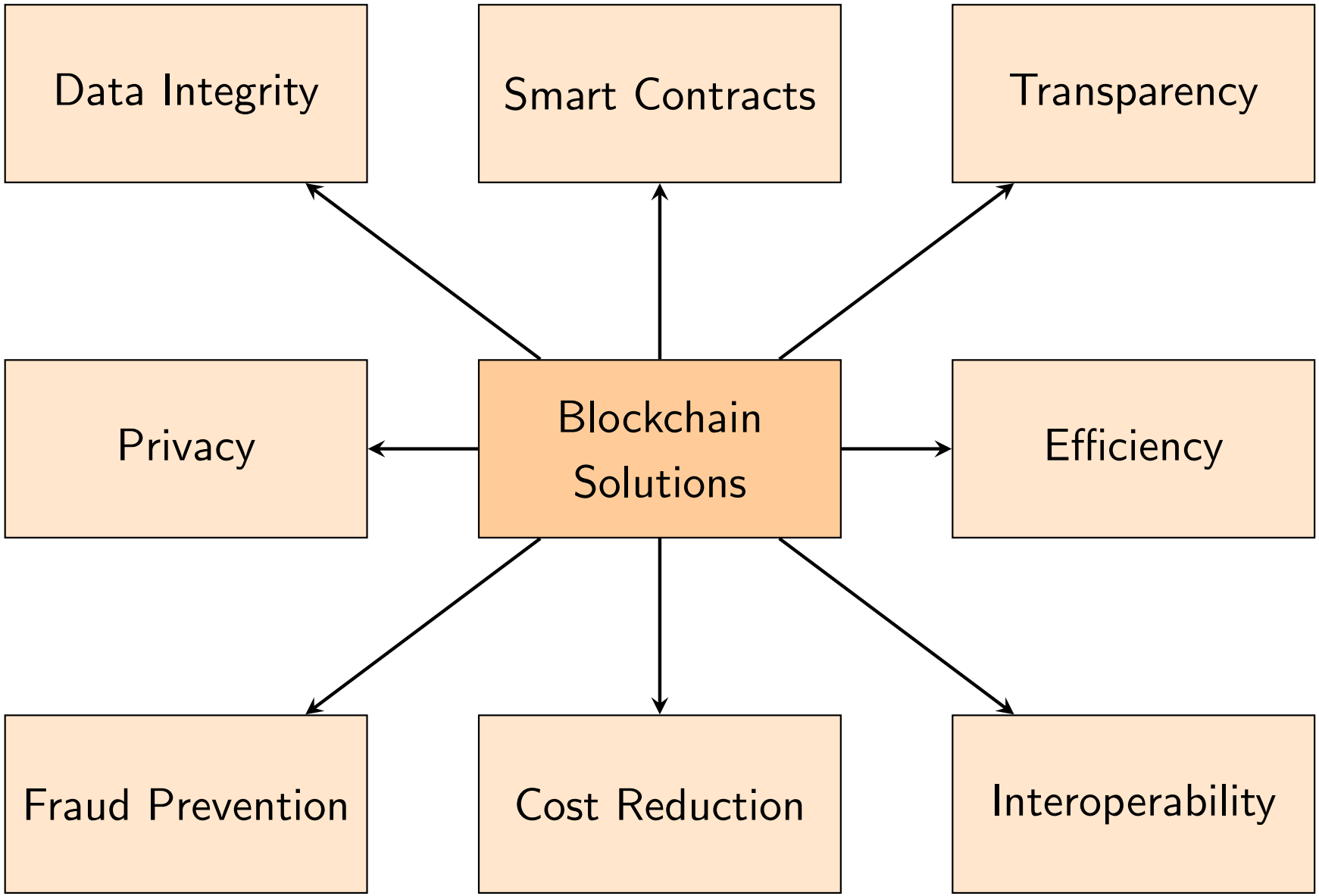
Critical Observations

- Lack of solutions tailored to the Indian landscape.

Current System Challenges

- Centralized, excessive paperwork
- Multiple complex intermediaries
- High administrative overhead
- Inefficient claim processing

Blockchain Solutions: Overview



Types of Blockchains

Figure 2: Blockchain Spectrum

Image Source: Web

Public Blockchain

- Open participation
- Fully decentralized
- Maximum transparency

Private Blockchain

- Restricted access
- Controlled environment
- Enhanced privacy

Consortium Blockchain

- Shared control
- Multiple organizations
- Balanced governance

Blockchain in Healthcare: Literature Review

- *Azaria et al.* (2016): MedRec - Ethereum-based system for EHR authentication and decentralized access management
- *Xia et al.* (2017): Attribute-based encryption (ABE) approach for secure and granular EHR access control
- *Raikwar et al.* (2018): First prototype demonstrating blockchain's potential in private health insurance management platforms
- *Aleksieva et al.* (2019): Ethereum smart contracts exploring automated health insurance claim processing
- *Zheng et al.* (2020): Advanced multi-layered blockchain architecture for comprehensive health insurance security
- *Anuj* (2021): Hyperledger Fabric framework enabling secure, API-driven electronic health record storage and retrieval

Hyperledger Fabric: Key Highlights

- **Enterprise-Grade:** Permissioned blockchain platform.
- **Modular Components:** Clients, peers, and ordering nodes.
- **Chaincodes**
- **Efficient Transactions:** Endorse, order, and validate process.
- **Membership Service Provider**
- **Data Privacy:** Strong isolation and customizable policies.

Figure 3: Fabric Logo

Image Source: Hyperledger Fabric Documentation

Transaction Flow in Hyperledger Fabric for Insurance

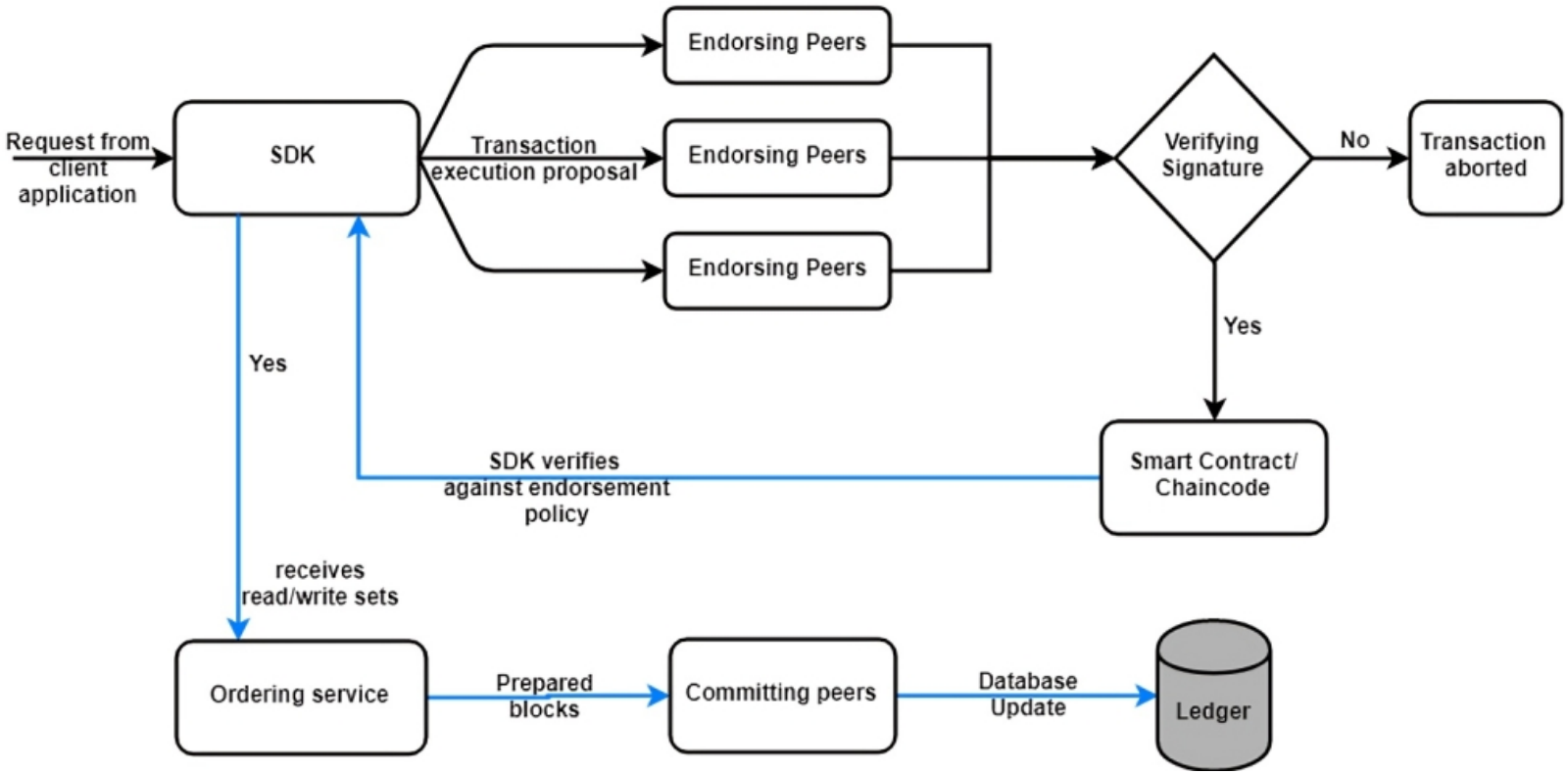


Figure 4: Transaction flow in Hyperledger Fabric.

Image Source: Hyperledger Fabric Documentation

Healthcare Blockchain Network Setup

Initial Configuration by MSP

- **MSP (Membership Service Provider):**
  - Issues digital identities
  - Manages certificates
  - Establishes trust
- **Channel Formation:**
  - Private communication pathway
  - Connects Patient, Trusted Hospital, Insurer
  - Ensures data privacy

Key Components

- Digital Certificates
- Access Policies
- Channel Policies

Credential Provided by MSP

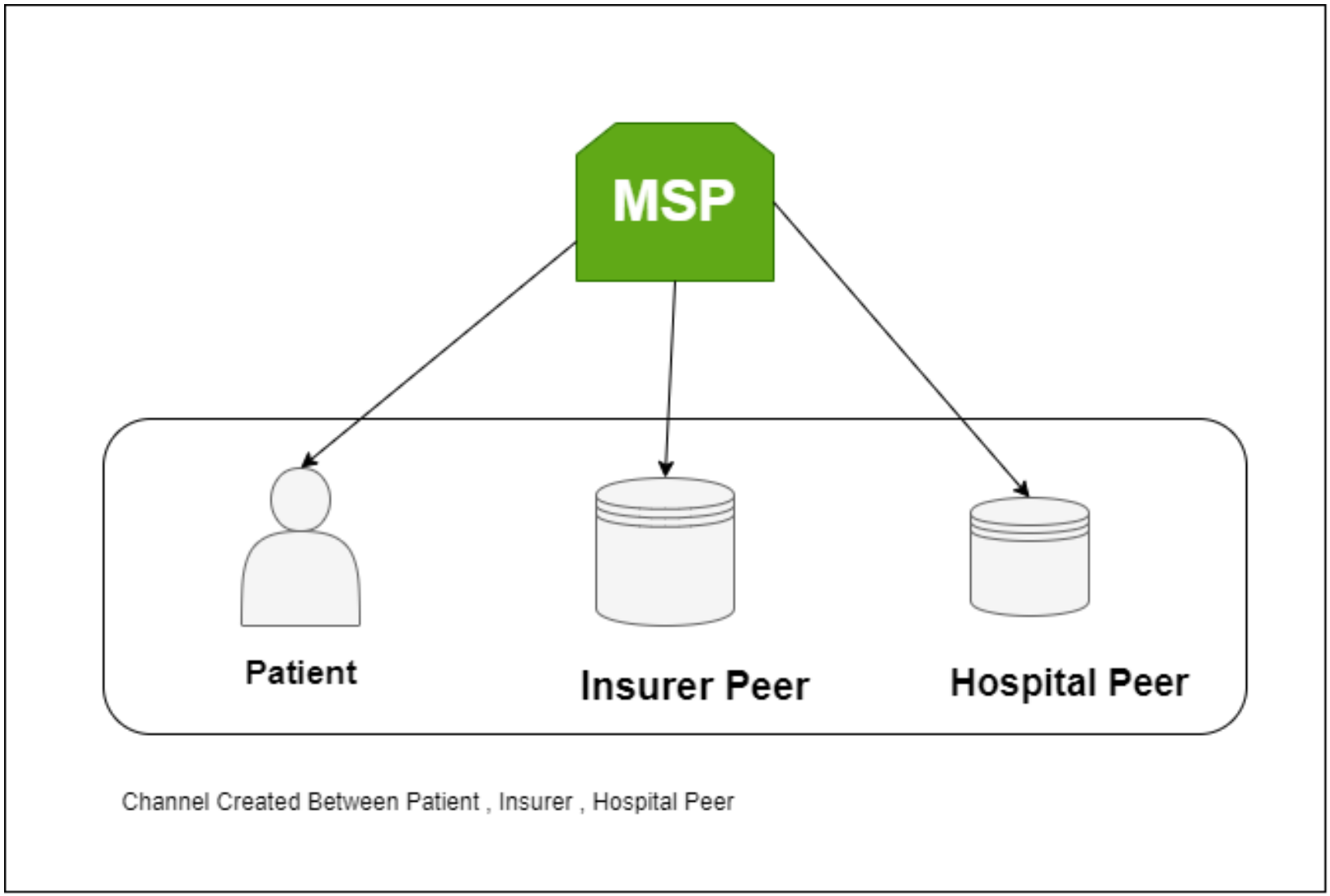


Figure 5: Channel for Trusted Hospitals, Patient Peer, Insurer Peer

Traditional Registration Flow of Insurance

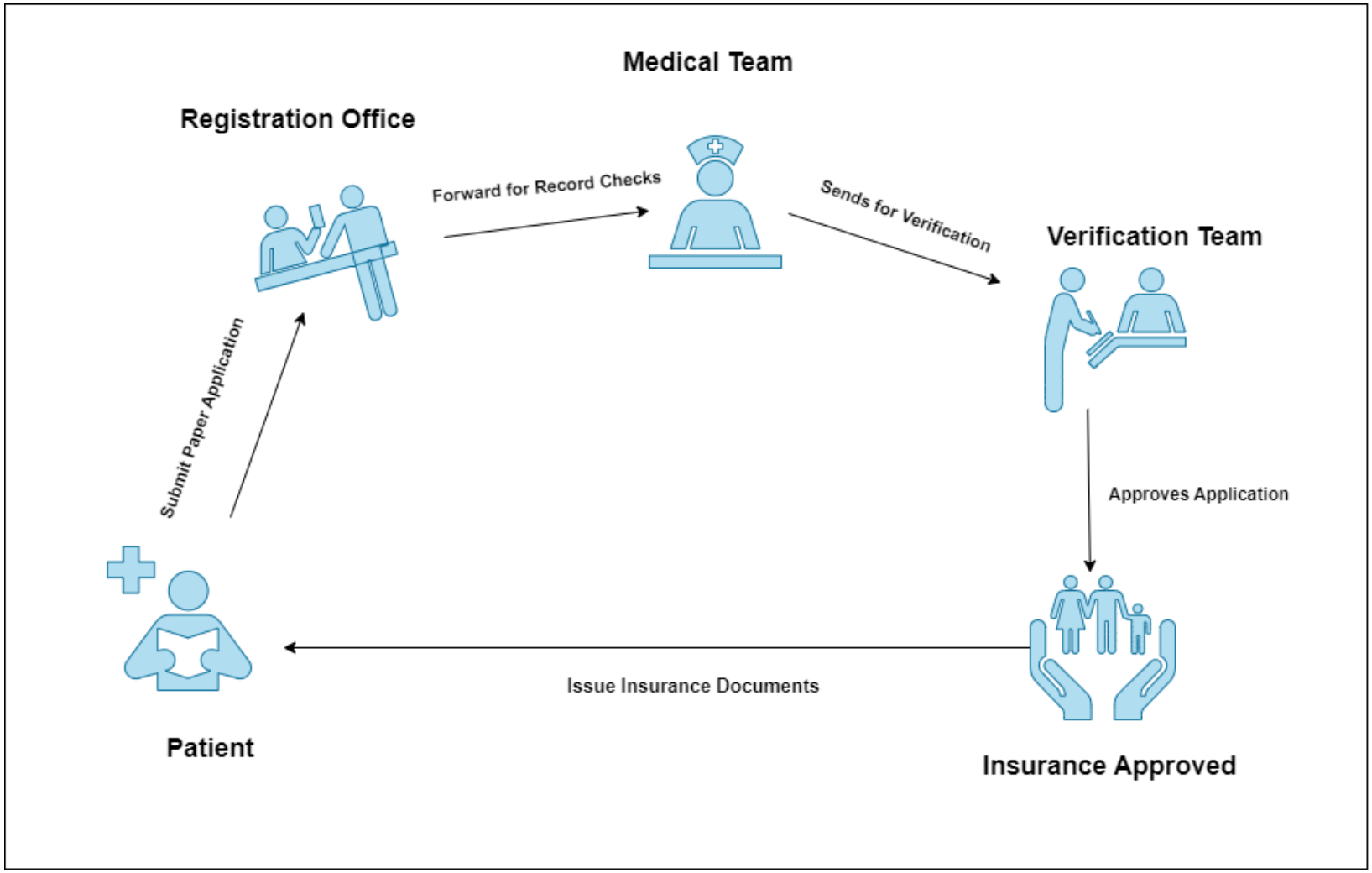


Figure 6: Traditional Flow of Registration

Entire Registration Process Flow

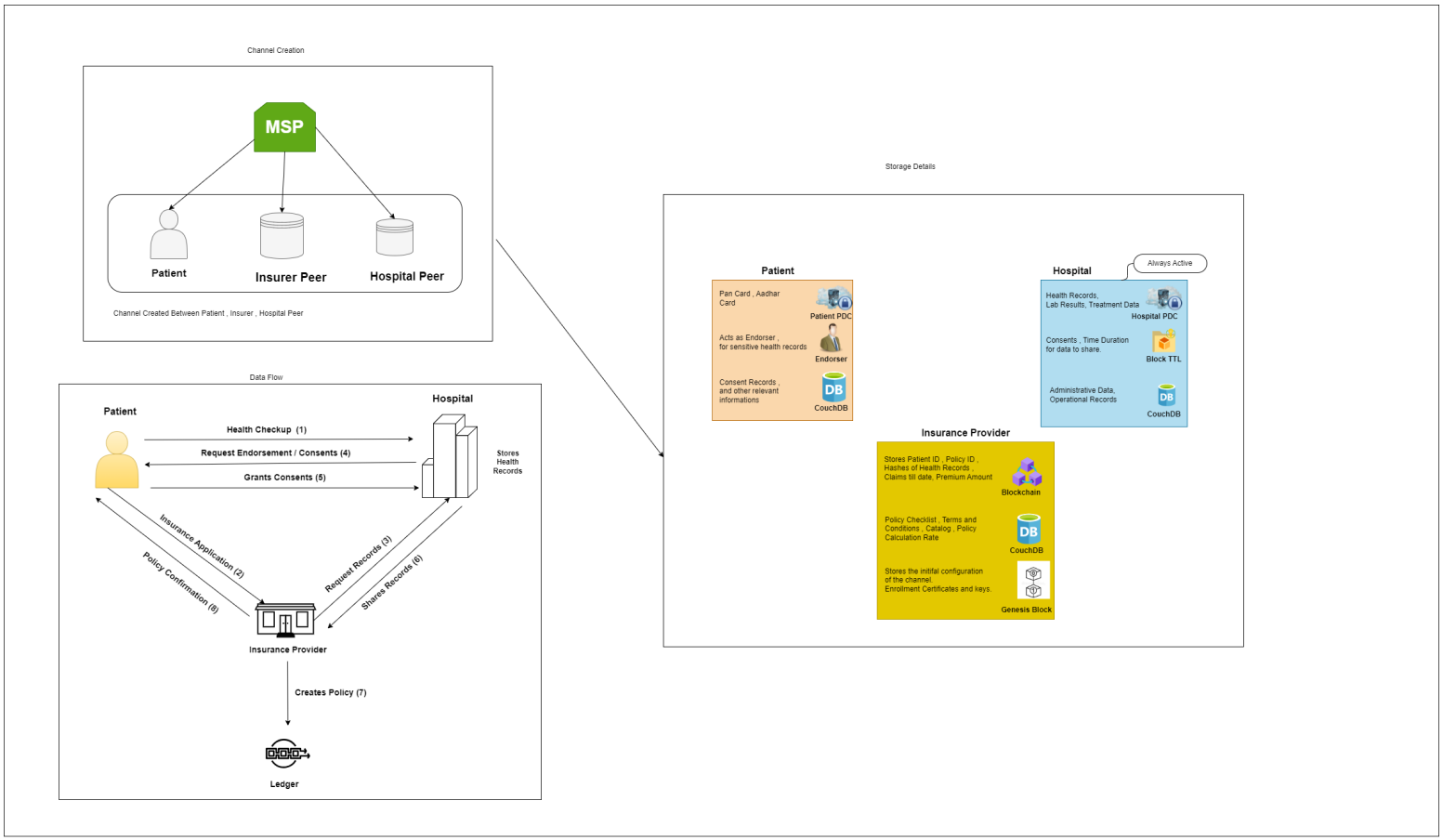


Figure 7: Registration Process Flow

Registration Process in Our System

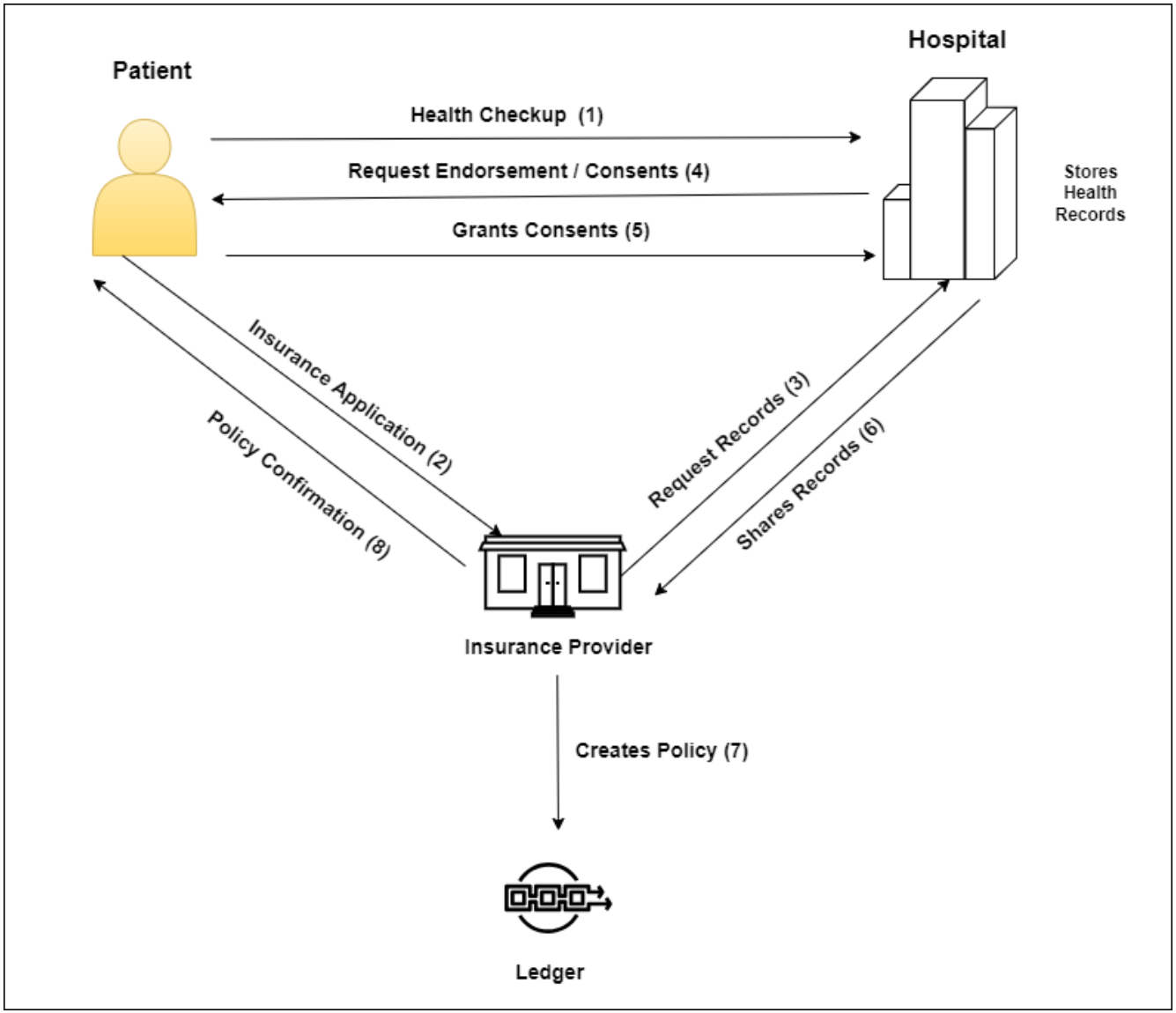


Figure 8: Registration Flow in Our System

Storage Architecture

Distributed Data Management

- **Patient Storage:**
  - Personal documents in PDC
  - Consent records
  - Access logs
- **Hospital Storage:**
  - Health records in PDC
  - Treatment data
  - Administrative records
- **Insurance Storage:**
  - Policy details
  - Claim information
  - Risk assessments
- **Blockchain:**
  - Transaction hashes
  - Policy references
  - Consent status

Storage details for each peer

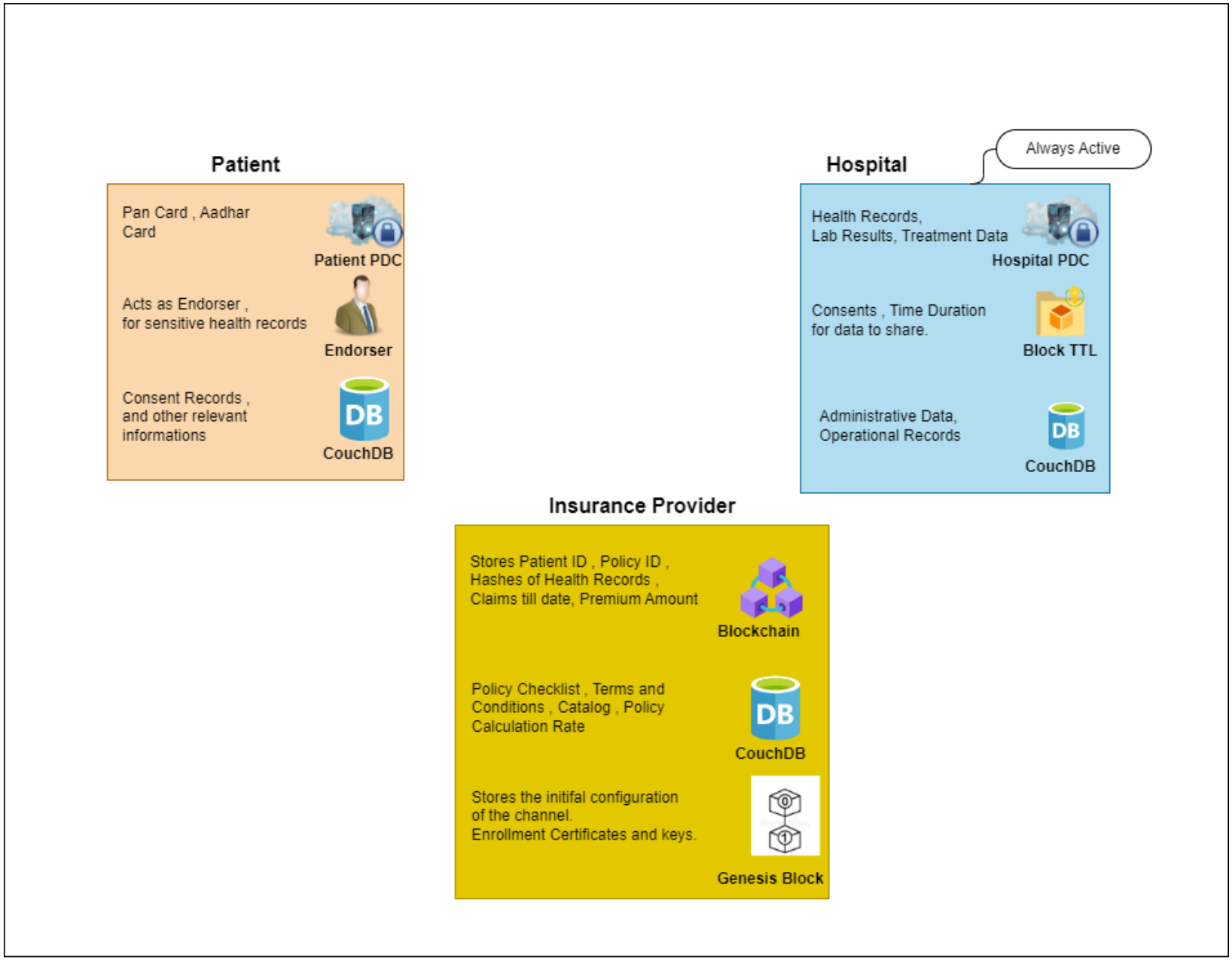


Figure 9: Storage Architecture

Sequence Diagram of Registration Process Flow

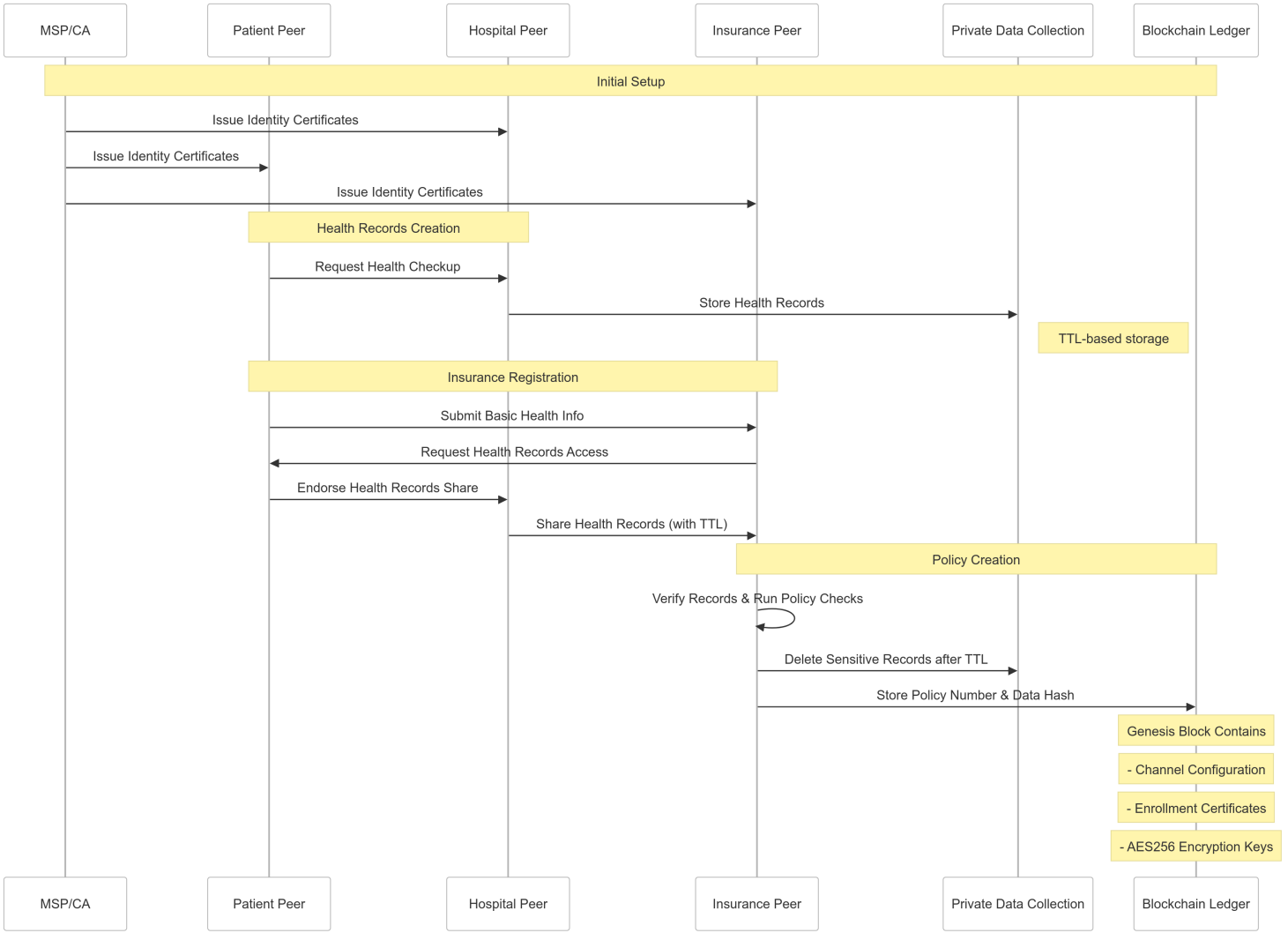


Figure 10: Sequence Diagram of Registration Process Flow

Security Benefits Breakdown in Registration Process

Security Feature	Healthcare Insurance Benefits
Private Data Collections	Confidential storage Selective data sharing Granular access control
AES-256 Encryption	Military-grade protection End-to-end confidentiality Prevents data interception
Endorsement Policies	Validates transaction authenticity Multi-party consensus Prevents unauthorized modifications
Channel Creation	Isolated communication networks Restricts data visibility Prevents cross-entity leakage
Membership Service Provider	Identity management Digital certificate issuance Access control enforcement

Traditional Cashless Claim Flow of Insurance

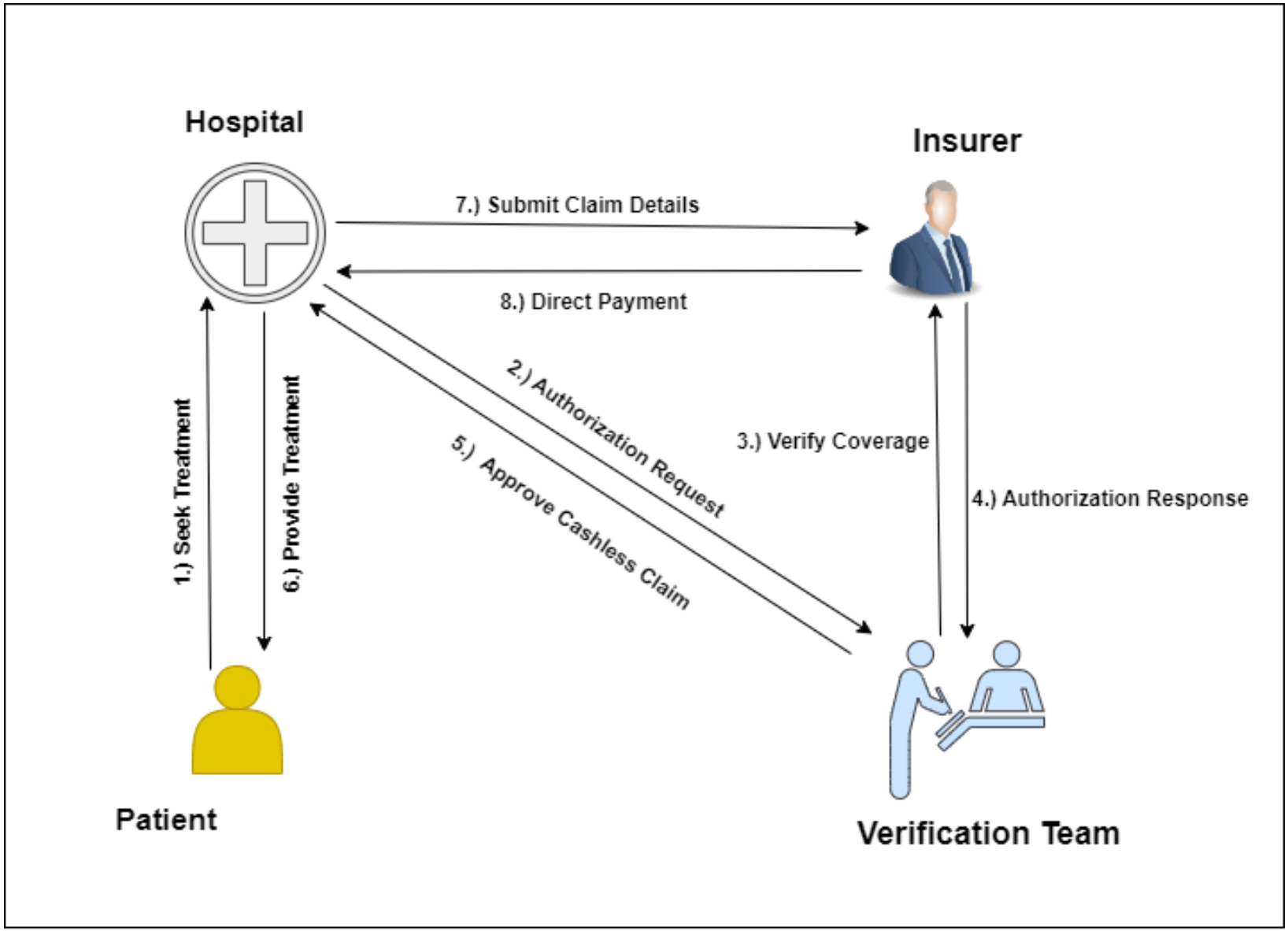


Figure 11: Traditional Flow of Cashless Claim

Cashless Flow in our System

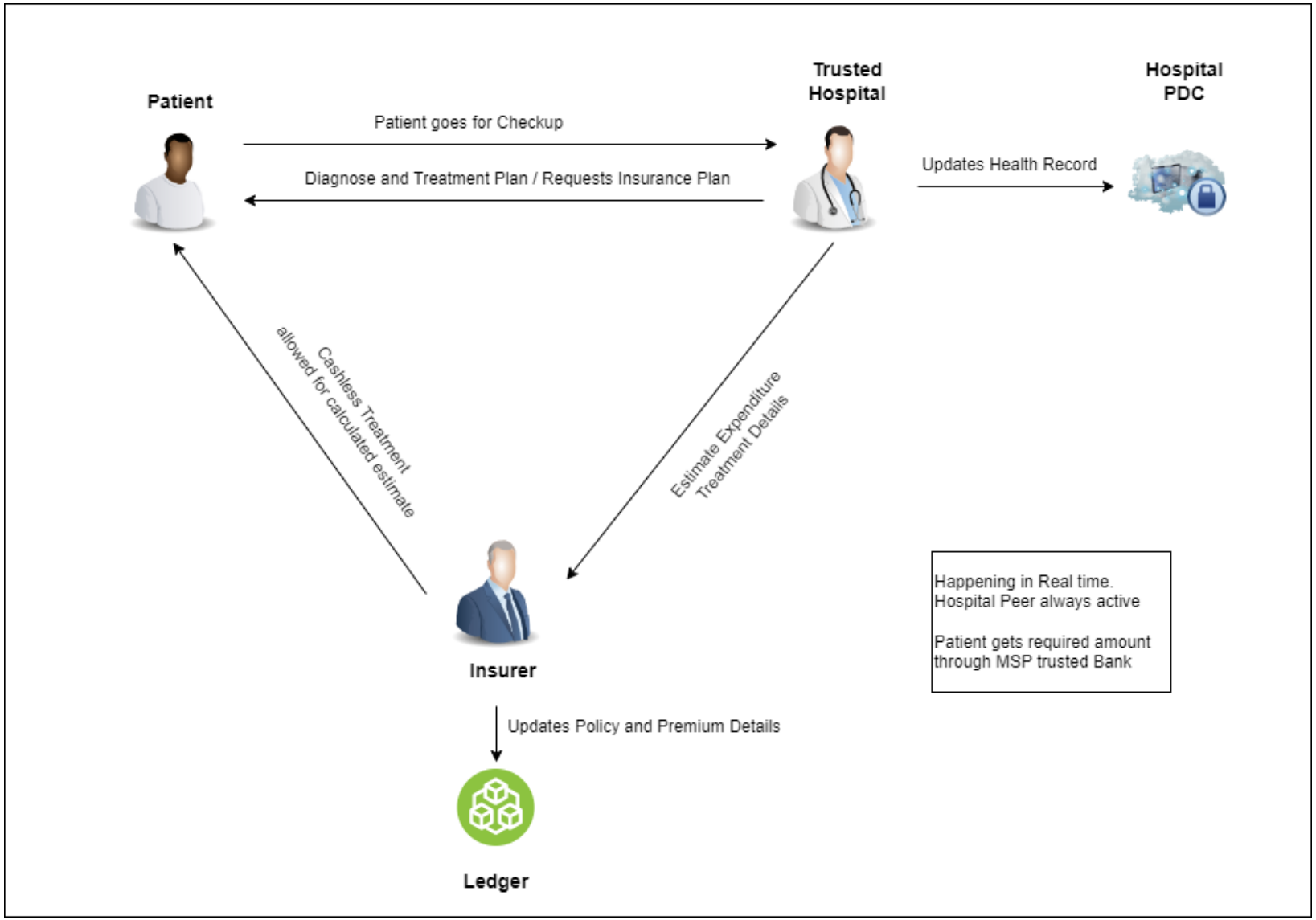


Figure 12: Claims Processing Architecture

Claims Processing Benefits Breakdown

Blockchain Feature	Claims Processing Advantages
Smart Contracts	Automated claim rules Instant policy compliance check Eliminates manual interpretation
Decentralized Verification	Multiple stakeholder consensus Reduced manipulation risk Transparent decision-making
Immutable Record Keeping	Complete audit trail Tamper-proof documentation Permanent claim history
Cryptographic Security	End-to-end data protection Secure inter-organizational communication Prevents unauthorized access
Real-time Tracking	Instant claim status updates Transparent processing stages Reduced customer anxiety

Claims Processing and Registration: Comparative Analysis

Parameter	**Traditional System**	**Blockchain Solution**
Documentation	Paper-based, Manual	Digital, Automated
Verification Process	Lengthy, Multi-departmental	Instant, Smart Contract Enabled
Fraud Detection	Retrospective	Real-time Prevention
Consent Management	Minimal	Explicit, Granular
Cost of Processing	High Administrative Overhead	Significantly Reduced
Transparency	Limited Visibility	Complete Audit Trail
Data Privacy	Limited	Cryptographically Secured

Security Measures in Registration and Claims Processing

Security Aspect	Centralized System	Blockchain System
Data Storage	Centralized databases Single-point breach risk Physical storage	Distributed ledger Hash-based tracking **Confidentiality, Integrity, Availability**
Data Encryption	Inconsistent encryption Basic protection Limited security	AES-256 encryption End-to-end protection Advanced management **Confidentiality, Non Repudiation**
Access Control	Basic username/password Limited logs Easily compromised	MSP-driven Digital certificates Granular controls **Confidentiality, Integrity**
Data Integrity	Manual reconciliation Error-prone Limited tracking	Immutable records Automatic verification Comprehensive history **Integrity, Non-Repudiation**

Conclusions

- **Landscape Mapping:** Insurance to Blockchain transition
- **Challenges:** Limited resources, support systems
- **Security:** Focused on Secure Implementation
- **Chaincode Development:** Smart contracts for Registration and Claims Processing
- **Prototype:** Proof-of-concept developed

Future Directions

- **Scalability:** Enhance current architecture
- **Security:** Implement proxy re-encryption
- **Claims Processing:** Robust reimbursement mechanism
- **Fraud Detection:** Integrate AI technologies
- **Compliance:** Develop Indian regulatory framework

References (1/3)

[1] Forbes Advisor, "Indian Health Insurance Market Report," 2024, Accessed on October 5, 2024, https://www.forbes.com/advisor/in/health-insurance/health-insurance-statistics/

[2] Forbes, "Health Insurance Statistics in India," 2024, Accessed on October 10, 2024, https://www.forbes.com/advisor/in/health-insurance/health-insurance-statistics/

[3] A. Azaria, A. Ekblaw, T. Vieira, and A. Lippman, "MedRec: Using Blockchain for Medical Data Access and Permission Management," 2016, Accessed on October 5, 2024, https://people.cs.pitt.edu/~babay/courses/cs3551/papers/MedRec.pdf

[4] X. Emmanuel Sipha, "MeDShare: Trust-less Medical Data Sharing Among Cloud Service Providers Via Blockchain," 2017, Accessed on October 5, 2024, https://www.researchgate.net/publication/318666875_MeDShare_Trust-less_Medical_Data_Sharing_Among_Cloud_Service_Providers_Via_Blockchain

[5] V. Aleksieva and H. Valchanov, "Application of Smart Contracts based on Ethereum Blockchain for the Purpose of Insurance Services," 2019, Accessed on October 7, 2024, https://ieeexplore.ieee.org/document/8967468

References (2/3)

[1] H. Zheng, L. You, and G. Hu, "A novel insurance claim blockchain scheme based on zero-knowledge proof technology," 2020, Accessed on October 7, 2024, https://www.sciencedirect.com/science/article/pii/S0140366422003152

[2] M. Raikwar et al., "A Blockchain Framework for Insurance Processes," 2018, Accessed on October 8, 2024, https://ieeexplore.ieee.org/document/8328731

[3] A. Mishra, "Study on Blockchain-Based Healthcare Insurance Claim System," 2021, Accessed on October 8, 2024, https://ieeexplore.ieee.org/document/9544892

[4] LFX Team, "Hyperledger fabric: a distributed operating system for permissioned blockchains," 2018, Accessed on October 9, 2024, https://dl.acm.org/doi/10.1145/3190508.3190538

[5] Hyperledger, "A Blockchain Platform for the Enterprise," Accessed on October 9, 2024, https://hyperledger-fabric.readthedocs.io/en/release-2.5/

References (3/3)

[1] IEEE, "On the Security and Privacy of Hyperledger Fabric: Challenges and Open Issues," Accessed on October 9, 2024, https://ieeexplore.ieee.org/abstract/document/9284197

[2] IJCRT, "Review of transfer of Secret Data Using ReEncryption Technique with Hyperledger Fabric Based on Blockchain," Accessed on October 9, 2024, https://ijcrt.org/papers/IJCRT2104515.pdf

[3] Indian Express, "43% consumers faced problems in health insurance claims: LocalCircles survey," Accessed on October 10, 2024, https://indianexpress.com/article/business/43-consumers-faced-problems-in-health-insurance-claims-localcircles-survey-9304406/

[4] Forbes, "Indian Health Insurance Market Report," Accessed on October 5, 2024, https://bit.ly/3eLnlS8

[5] India Today Technology, "Star Health Insurance Hack Led to Personal Data of 31 Million Customers Being Compromised - Story in 5 Points," Accessed on December 2, 2024, indiatoday.com

[6] India Today Business, "HDFC Life Insurance Faces Cyberattack: Fraudsters Steal Customer Data, Demand Extortion," Accessed on December 2, 2024, indiatoday.com

Thank you !
Any questions?