# Chapter 1
# Blockchain: A New Era of Technology


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## 1.1 Introduction

The role of technology has presented a significant part in everyone's life. With the rapid growth of Internet and communication technologies, people around the world are doing transactions digitally across various domains like banking, healthcare, and business. The revolution of technologies happens very often; one such technology is called "blockchain" which will be a game-changer in many functional sectors of the society. Today, people are more conscious when they hear about the word "money." It has become an integral part of people's life. It can take the form of a banknote, plastic card, or coins. Quite often, you might have visualized the image of the banknote, some coins, or credit cards. It is just an object which has an intrinsic value to do transactions.

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Imagine you are going to a restaurant along with your family and ordering food items. The waiter serves the order and provides a bill that needs to be paid. The payment is digitally done with the interventions of the third-party agents. There is no direct communication between the payer and the receiver. This eventually led to the invention of new technology, where there is direct communication between the sender and the receiver. Before the invention of money into financial and economic system to do transactions, the concept of barter system was introduced in the era of 1920 by the Mesopotamian tribes for the exchange of materials, for instance, if two people want to exchange goods, i.e., a bag of wheat with a set of leather boots. There will be a direct communication for exchanges of goods. However, conflicts might arrive, if there is an opinion difference among a person who complies with other persons concerning the transactions. Therefore, money acted as a desire for the economy which enabled all types of transactions to be carried out in detail. The concept of Blockchain technology is analogous to a barter system, except that the transactions are digitally done without face-to-face involvement of individuals and interventions of third-party agents.

### *1.1.1 What Is Blockchain and How It Works?*

One of the important valuable assets in the digital world is data which needs to be protected and managed. With skillful criminal people, there is always a threat to steal data. In the past, several methods are proposed to protect the valuable data. One such approach is the use of Blockchain technology. In simple terms, a Blockchain refers to a chain of blocks that store data. Every data cached inside the block depends on Blockchain types. The main intent is to encode the sequence of characters in digital documents using cryptographic algorithms so that it's not possible to antecede them or to mess with them [1]. A Blockchain is a digital ledger that is spread completely to anyone who is intended to learn and use it. It becomes very difficult to change it once data is archived inside a Blockchain. Every block contains data, the hash of the current block with hash of previous block. The transaction details of the sender and receiver and number of coins are stored in a Bitcoin Blockchain. Each block has a long sequence hash key which is unique that makes it difficult to break by felony hackers. Once the block is created, its hash is counted. Any changes made inside a block cause the hash to change. Often, hashes are very useful when we want to detect changes to blocks. The next element inside each block is the hash of the previous block [2, 3].

As shown in the Fig. 1.1a [4], let's assume that we have a chain of three blocks in a Blockchain network. Each block has a hash and hash of the previous block. So block number three points to hash of block number two, and block number two points to hash of block number one. The first block is a special block which is called "genesis block" which can't point to the previous block. Now, let's say that we tamper the second block as shown in Fig. 1.1b [4]. These changes the hash block. Consecutively, it makes adjacent blocks unacceptable as it points to tampered block.

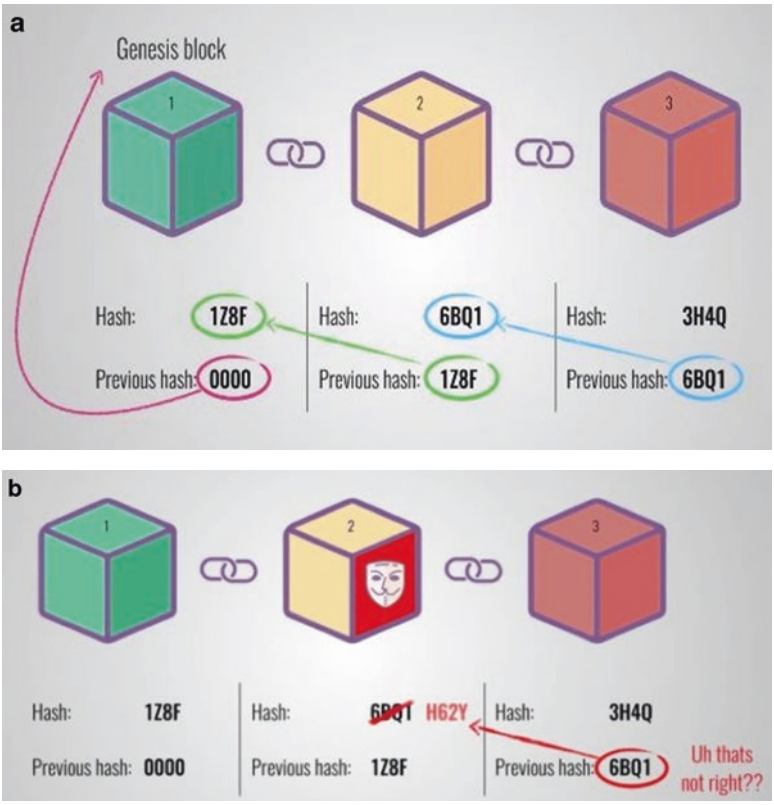


**Fig. 1.1** (**a**) Genesis block. (**b**) Tampered block

Nowadays, supercomputers are fast enough to compute millions of hash codes per second, so we cannot rely solely on hash concept to avoid tampering. To alleviate this problem, Blockchain has a concept called "proof of work." This method delays the process of new block creation. It takes nearly ten minutes to compute the essential proof of work in the case of Bitcoins to insert into the Blockchain [3]. Any alteration in a single block results in recomputation of proof of work. So the proof of work and use of hash concept make the Blockchain more secured. The peer-to-peer network concept is also used by Blockchain where anybody can get the full copy of Blockchain when they join to that network. The existing nodes of the Blockchain examine the new block which is created by somebody. Each node verifies that block to make sure that it hasn't been tampered with. All nodes mutually ensure a "consensus" to add new block to its chain. They comply which are valid and invalid blocks. Blocks that are meddled will be rejected by other nodes in the network. So to effectively tamper a Blockchain, all blocks on that chain need to be meddled, recalculate the proof of work for each block, and take control of peer-to-peer network. Then, only the tampered block become accepted by everyone.

Blockchain is constantly evolving. One of the most recent developments is the creation of "smart contracts" which makes a Blockchain more secure [4].

### *1.1.2 Basic Framework of Blockchain*

In the previous sections, we gave a brief outline of Blockchain and introduced how a Blockchain works. We take a deep dive into the Blockchain framework by explaining the different Blockchain types along with its structure. This section also describes the role of smarts contracts, centralized and decentralized networks, and challenges faced by Blockchain. So let's get started.

## 1.2 Types of Blockchain with Its Structure

Let's take a look at three major types of Blockchain in detail:

- Public Blockchain.
- Private Blockchain.
- Hybrid Blockchain.

**Public Blockchain.** As the name itself signifies, it is one type of Blockchain which is open to everyone who is interested to participate as users, miners, developers, and any other stakeholders. The Blockchain transaction which happens is fully transparent and can be examined by anyone regardless of details of the transactions. These are designed to be completely decentralized with "no individual or entity control" where the transactions are recorded in the Blockchain or the order in which they are processed. A public Blockchain is highly resistant since it is open to join networks regardless of location, nationality, etc. This makes it hard for the authorities to shut the network down. Lastly, these have a token with them designed to motivate and reward the stakeholders in the network. Some examples of public Blockchain are Bitcoin and Ethereum [5]

**Private Blockchain.** Unlike a public Blockchain, private Blockchain are focused on specific stakeholders or organizations who want to collaborate and share data but don't want their sensitive business information visible on the public domain. By nature, they are more centralized. In a private Blockchain, each stakeholder needs the consent to join the peer network or group. All the transactions are available to the stakeholders of the private local ecosystem which has been permitted to join that network. Private Blockchain may or may not have token associated with the chain. The entity running the chain has complete control over the participants or the governance structures. Some examples of private Blockchain are Hyperledger and R3 Corda [5, 6].

**Hybrid Blockchain.** As the name itself signifies, it is another type of Blockchain that combines the features of the above two Blockchain, i.e., private and public. It

combines the privacy and transparency benefits of public and private Blockchain which offers the flexibility to the businesses to select what type of data makes it public and private. In this type, the user will have the complete control of data that needs to be stored and provides some restrictions to gain access to other data. The only selected portion of data will be sent to the public while keeping other data in a private network. In a hybrid Blockchain, any users can easily join the public network, while all the transactions in the private network are completely verified within that network. Some example of hybrid Blockchain is the Dragonchain [5, 6]. Now, let's take a closer look at the basic structure of the Blockchain along with its components.

A Blockchain is a network of computers connected with every node in the network. There is a specific protocol imposed on the data in which every node has to agree and follow the constraints imposed on the shared data in the network. This makes the Blockchain structure very unique from other networks. As seen in Fig. 1.2 [7], every block in a Blockchain has two pieces of information, namely, the header block and transaction counter block. Every block in the header has one parent block which has a previous block hash value. Each block header has the following piece of information:

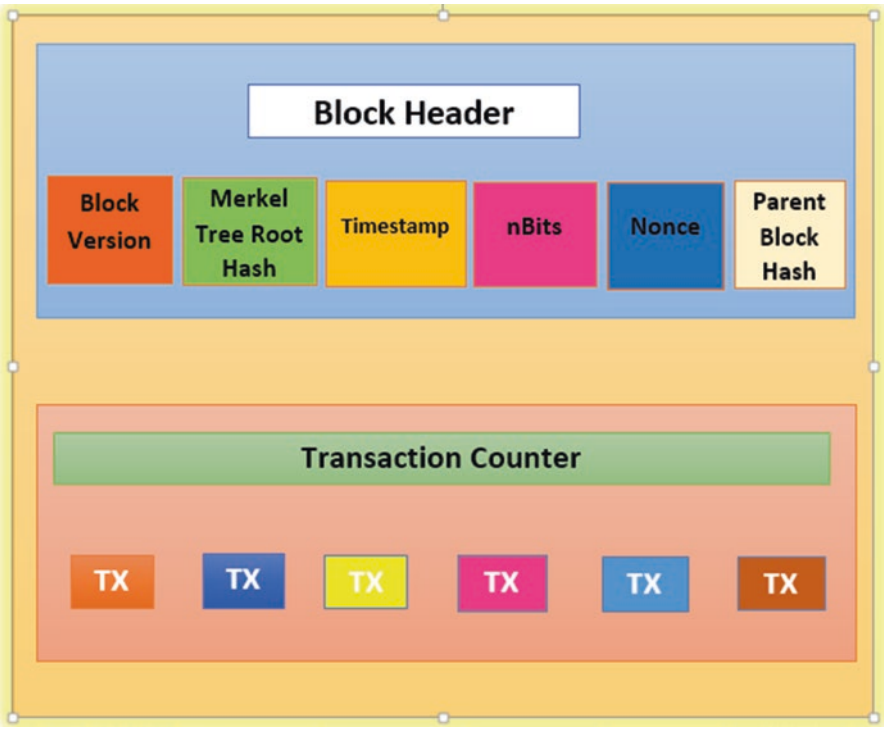


**Fig. 1.2** Structure of Blockchain

**Block version:** It specifies the version of the block used for validating the block.
**Merkel tree root hash:** It basically has all the hash values for all types of transactions in a block within a Blockchain.
**Timestamp:** It represents the present time in unit seconds.
**nBits:** It represents the original value of the available block of the hash.
**Nonce:** It is a random nonrepeated four-byte field which starts with zero and increases with every calculation.
**Parent block hash:** This block points to the previous block which has a previous hash value of 256 bits depending on the type of cryptographic algorithms used [7].

## 1.3 Smart Contracts and Its Benefits

The idea of a smart contract was the brainchild of Nick Szabo in the year 1993 who is a computer scientist and a cryptographer. It can be simply defined as a small computer program which runs on top of Blockchain network. A smart contract provides a very powerful capability of code execution for embedding business logic on the Blockchain. These are the set of instructional codes that are stored on a Blockchain network which will be executed automatically based on some conditions. Smart contracts work on the basic principles of "simple if then else." At the simplest level, it is just a piece of code or program which is executed automatically based on some predetermined conditions. It is some type of agreement or a contract that gets automatically executed without any human involvement.

One of the better ways to understand the smart contract is through an example. Let's assume that you are buying a car from a dealer through a financial scheme. This involves a series of steps, wherein you need to interact with several people like financer, broker, lender, sales representative, and banker. This could be a tedious and frustrating process as it requires a lot of involvement from several people. One smart idea to streamline this process is to use a smart contract which eases the workflow of this system. With smart contracts, it's possible to create trust among the several stakeholders with ease of transactions. Since complete data is stored on the Blockchain network, the identity of the buyer with all his credentials is within the block which enables the lenders to quickly decide the credit. Smart contracts could be created between the bank, dealer, and lender so that the funds can be automatically released to the various stakeholders based on agreed terms and conditions. With this, the transfer of ownership will be automatic, and the complete transactions are recorded in the Blockchain network which can be verified anytime [8, 9]. Now, let's look at some of the benefits of smart contracts [8]

**Transparency.** One of the key aspects of any system to operate is completely dependent on the information. Automation played a crucial role in processing and managing digital data. It is possible to have full access and visibility of terms and conditions to concerned individuals without any disputes.

**Accuracy.** One of the primary goals of smart contracts is to maintain the records of all terms and agreements in a precise manner. It is an important aspect, as omissions will result in transaction errors. So smart contracts try to avoid the pitfalls and improve the accuracy of the transactions.

**Speed.** With the rapid growth of communication technologies and wide usage of the Internet, smart contracts run as a freeware code that can execute the transactions quickly. This saves the time required to do the transactions when compared to traditional business processes.

**Storage and Backups.** One of the key aspects of smart contracts is the ability to store complete transaction details in a single Blockchain which can be used for future reference. So whenever there is a loss of data, all the data attributes can be completely covered from storage. thereby providing full support for complete backup.

## 1.4 Centralized and Decentralized Networks

So far, we have seen the different types of Blockchain and understood the role of smart contracts along with its benefits. Now, it's time to understand the importance of different types of networks supported by Blockchain technology. Let us understand the concept in simple terms.

As seen in Fig. 1.3 [10], the Blockchain networks can be broadly classified into two types, namely, centralized and decentralized.

**Centralized Networks.** In this type of network, all nodes are connected to the centralized hub. This hub acts as an information server. All data are routed through a centralized server. When a message is transferred from one node to another node, it passes through the central hub. This is also called as "private network" as only authorized users are allowed to use this network due to entry restriction [11].

**Decentralized Networks.** This network is similar to that of a centralized network except that there is a single network connected to a centralized hub, whereas in decentralized networks, there is a chain of networks, i.e., multiple networks are

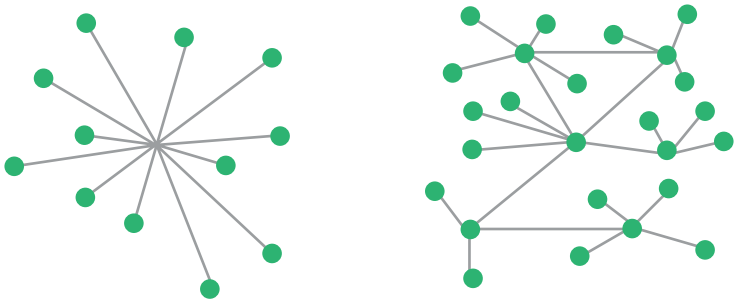

**Fig. 1.3** Types of networks in Blockchain

connected to a centralized hub which enables the proper exchange of messages between them.

## 1.5 Blockchain Challenges

Even though Blockchain has a wide variant of applications, still, there are few challenges faced in terms of deployment and adaptability in industrial applications and other sectors. Some of them are given below [12].

**Scalability.** The biggest challenges of implementation of Blockchain are the inability of the technology to scale as large number of users is managed at a single time. Multiple users get connected through a chain of Blockchain structure. Different algorithms are used to process the transactions which seems to be a tedious task. The Bitcoin Blockchain can handle 3–7 transactions per second, On the other hand, Ethereum Blockchain can handle 15–20 transactions. This makes it not feasible to work for large industrial applications.

**No Common Standard.** With numerous platforms available in Blockchain environment, there is no common standard defined that can be used for project implementation. Many active projects use different platforms which have its own protocols, coding language, and consensus mechanism that make it difficult to use in industrial applications. Many organizations are working toward building a standard version in Blockchain to reform cross-platform collaborations.

**Privacy.** Another challenge that needs to be addressed is privacy concern in public Blockchain. All transactions of electronic ledgers in public Blockchain are visible to all servers which are more vulnerable to attacks. Some degree of modification is required in public Blockchain to restrict access to authorized persons only. For example, under any circumstances, the patient medical records can't be disclosed to the public.

**Security.** One of the major concern in the public Blockchain is that these are more vulnerable to attacks. As per [12], all the transactions in a Blockchain network are verified by miners which are present in the same network. Any miner which gains control of 51% of nodes on that network will restrict other miners to create a block and delay validating new transactions. These types of attacks decreases the number of miners that want to join the Blockchain network.

## 1.6 History of Blockchain

Initially, the origin of Blockchain started with the concept of adding timestamp to digital documents in the year 1991, by two data scientists Stuart Haber and W. Scott Stornetta, for avoiding the backdated and tampering of documents. This system got an upgradation in the year 1992 by the addition of cryptographic algorithm, providing security for the chain of digitally stored documents according to the timestamp.

Later in the year 2008, a paper related to peer-to-peer, decentralized network-based digital cash was proposed by Satoshi Nakamoto called Bitcoin. This was the first cryptocurrency that came to the market with the functionalities of Blockchain as the backbone.

Later in the year 2013, the upgradation with respect to Bitcoin happened with a scripting language as addition for building decentralized applications. This cryptocurrency got its name as "Ethereum." Presently, there are more than 20000+ cryptocurrencies available in market, which works on Blockchain technology.

## 1.7 Comparison of Blockchain with Notebook

In simpler terms, a Blockchain is compared to notebook as shown in Fig. 1.4 [13]. A blockchain is a distributed immutable ledger. Every entry in a notebook will take one line when anything is written into it. Similarly, Blockchain can be viewed as a notebook where entries will be written but can't be erased. Each page in a notebook is compared to a block on a Blockchain, and entries in a page are blockchain transactions. When Blockchain is compared to a notebook, it is precise to adopt that not all Blockchains are created equal just as all notebooks are equal. For example, the handling of transactions in Ethereum is somewhat different from Hyperledger Fabric with respect to ordering and validation. Blockchain is a revolutionary way of

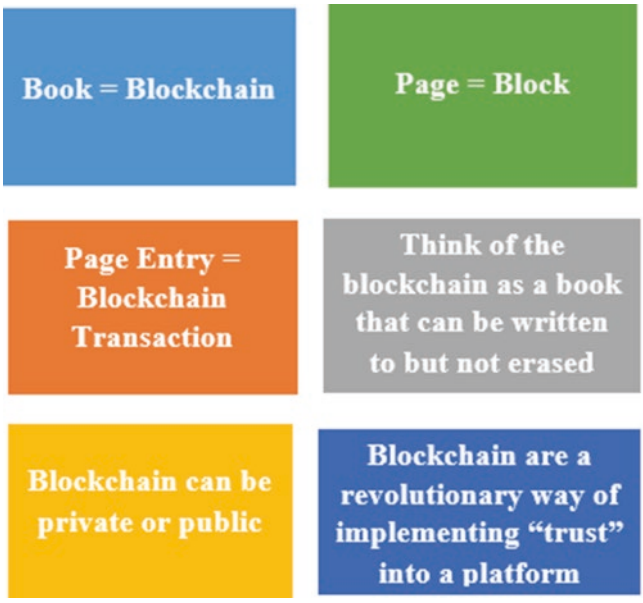


**Fig. 1.4** Blockchain comparison to a notebook

implementing trust which removes third-party agents. It is transaction backend database which is secure which is read by everyone in the database. If anything needs to be changed in the database, transactions are created which should be accepted by all in the network; Blockchain is a fully robust technology, while database is not a robust technology [13].

## 1.8 Future of Blockchain in Industrial Applications

The usage of cryptocurrency has made Blockchain one of the promising technologies in the digital world. The revenue of industrial application can be improved through operational implementation by sharing data across multiple sectors. In this section, two applications are discussed that provide benefits to society [14, 15].

### *1.8.1 Telecommunication*

Extreme competition and pressure to innovate are often faced by few industries in telecom domain. With billions of subscribers worldwide, telecom sectors employ different strategies to attract the brand-new customers, satisfying the current one and replacing the old. Demand for 5G network created impact for high-speed data. Technologies like AI and Internet of Things (IoT) are creating pressure to industries. Blockchain employs strategic levels to handle data privacy and operational challenges in 5G telecommunication networks which are as follows.

**Data Privacy.** Blockchain secures the privacy of data by protecting data and reducing annoyance through user preferences and immutable records. For example, Bharti Airtel in collaboration with IBM are working together to protect 250 million users' data from spam callers. Airtel uses Blockchain scrubbing process to protect users' mobile numbers from telemarketers. Immutable record of user preference is the next step to handle personal data and secure privacy.

**Customer Experience.** The customer experiences can be improved by creating new avenues and expanding business opportunities in industries. Smartphones and digital wallets are now merged rapidly that created pathways to offer financial services. Many banking applications use smartphones to make digital payments. There are three key ingredients to perform operations—a mobile platform to host application, customer relationship for postpaid billing, and meet Know Your Client (KYC) standard. All that is missing is a secure transaction with acceptance of payments; Blockchain overcomes this problems. TBCASoft and SoftBank in collaboration with IBM Blockchain are working together to build Cross-Carrier Payment System (CCPS) where payments can be made to local trader by single unified global payment platform. Immutable record and distributed ledger technology is adapted by TBCASoft to optimize transactions. CCPS uses smartphone access to provide over-the-top (OTT) payments [16].

### *1.8.2 Healthcare*

Pharmaceutical sector is one of the prime departments in healthcare domain which focuses on patient safety through quality medicines. Blockchain revolutionizes healthcare enterprises by enabling new ecosystem with increased quality care. Several governments and other organizations collaborate to ensure safety of medicines with quality ingredients. Innovation requires continues evaluation, manufacturing with proper distribution, and technical approach to provide solution.

Different organizations like IBM, Walmart, Merck, and KPMG propose a Blockchain solution in response to FDA pilot program to accept this technology for verifying and tracking pharmaceutical product. Several challenges of the pharmaceutical supply chain are addressed through Blockchain technology with its immutable data, sharable ledger, and ability to track drug origin. Pilot program was devised to allow quick alert to supply chain partners. The process of notification is manual and fragmented using diverse systems which increased the response time and number of patients [17].

The pilot program proposed two objectives to check if Blockchain technology would be suitable to address pharmaceutical supply chain needs which are as follows:

- To achieve interoperability requirements in a secure way, Blockchain provides a common record of product movement connecting different systems and organizations.
- Improve safety of patient by bringing about product alerts and increasing visibility to suitable supply chain partners in the product investigation.
- The Blockchain successfully exhibited the above objectives.

## 1.9 Case Studies of Blockchain

Even though Blockchain has evolved as a disruptive technology, it has provided opportunities to scholars and industry personnel to explore this technology in detail, which contributes solutions to the society. This section will throw light about some case studies [18] and how it can be solved using the Blockchain technology in interdisciplinary fields like the judicial system and land and revenue sectors.

### *1.9.1 Judicial System of India with Its Issue and Blockchain Solutions*

The judicial system is one of the main pillar of Indian democracy which indicates the rules in how democracy works. The judiciary is the institution which provides justice and executes the new laws and amendments passed by the government. The

**Table 1.1** Pendency of cases in Indian judicial system

| Court (as on) | Pending cases | | Cases pending for more than 10 years | |
|---|---|---|---|---|
| | Civil | Criminal | Civil | Criminal |
| Supreme court (19 February 2016) | 48,418 | 11,050 | 1132 | 84 |
| High court (31 December 2014) | 3,116,492 | 1,037,465 | 589,631 | 187,999 |
| Subordinate courts (31 December 2014) | 8,234,281 | 18,254,124 | 611,658 | 1,432,079 |

purpose of justice is defeated over years due to the pendency of cases. Still, millions of cases are still pending in Indian courts for the past 10 years. Many persons have struggled to seek justice and lost their lives in legal trials. Even though the judicial systems are considered to be the powerhouse of the system, still, there are a lot of loopholes in the current system. Key stakeholders like police, advocates, judicial officials, and individuals are utilizing these existing loopholes for their own benefits. In fact, over a period of time, stakeholders will lose faith and trust in the judicial systems. According to [19], regarding the ease of doing business operations, World Bank ranks India at 77th out of 190 countries concerning the trait of judicial standards. What are the prime reasons for many cases pending in the courts? A report from the supreme court and other chief judicial officials stated that the delay was due to the acute scarcity of judges which lead to the pendency of cases. The details of the pending cases in various courts are shown in Table 1.1 [20].

A report submitted by the Law Commission in 2009 states that in Delhi high court, to clear the pendency cases, it would require around 464 years with the available strengths of judges. However, we can't say that shortage of judges is the only reason for justice being delayed [20]. A study conducted by Vidhi Centre for legal policy states that 8086 orders are cleared by Delhi high court between 2011 and 2015. They categorized it as delayed cases if it is pending for more than 2 years. There are two prospects of delay, i.e., court side and counsel side delays. Finally, the survey summarizes that 82% of the delays caused could be credited to counsellor [21].

If gouged deeper with a reality check, the current records include statements of stakeholder getting pieces of evidence updated, modified, misplaced, or sometimes deleted to defeat opponent, thus destroying the justice. Is it possible to provide justice to all using current technology and solve the core judicial issues to speed up the judicial process? The answer is yes and it is possible through Blockchain technology. Even if there is a 1% improvement in the current judiciary, it hits the minds of crores of people to gain faith in the judicial system.Some of the challenges of the current Indian judicial systems is as follows:

**Provenance:** The origin of data has lacked currently in Indian judicial systems. The original data can be easily forged by any external agency which needs to be questioned.

**Transparency:** Besides having the copies of certified legal documents, the judicial systems lack transparency as a result of dereliction conducted by lawyers and other court officials which doesn't prevail justice.

**Data integration:** Many judicial representatives will have the information of particular zones. It's a better opportunity to integrate criminal records across the country so that it can track offender with their data to impede undue events in the future.

**Scalability:** Existing legal system is not scaled to maintain case records uniformly across different parts of states.

The abovementioned challenges can be tackled completely using Blockchain technology. As a part of the solution, different stakeholders like police, court officials, individuals, lawyers, and judges need to register their credentials on a Blockchain as shown in Fig. 1.5 [20].

After successful registration, each stakeholder will be granted an authenticated and unique wallet identifier with an address. To log into the wallet, a two-factor authentication like wallet ID, a password is required. This wallet ID is a combination of alphanumeric characters which will be used as a username through which all transactions are recorded. A unique hash key is generated to a block for validating the transactions. To send funds from wallets, the recipient address or QR code is required. All these details will be stored on the Blockchain, and the stakeholder can access credentials like a case number, court number, date of proceedings, advocate, judge and investigation officer details, and next hearing dates. The events will be automatically executed by smart contracts which are notified to the convict regarding the petition filed through email. Figure 1.6 [20] shows Blockchain solution for Indian judicial system.

In current scenarios, intermediaries in the judicial system have a fair chance to intervene and affect the processes of judicial systems. Let's take a close look at it one by one.

**Next Date.** As per the present court proceedings, the hon'ble judges in the current judicial system allocate the next hearing date for the proceedings of case. However, the officials of court who sit adjacent to the judge will record the next date on the document ledger. The proponent of the court who has a good harmony with these officials enables court officials to bribe them and ask them to pen down the next date as per their wish, e.g., hon'ble magistrate might have given the next date as 15 September, but the court official might note down the next date as 15 October. This is a major loophole in the judicial system as there is a prohibition of audio and video recordings in court which is a major loss to a victim in terms of delay with court proceedings. One solution using Blockchain technology is to design an efficient algorithm for the next date generation based on court type, type of case, different Indian Penal Code (IPC) and Criminal Procedure Code (CrPC) sections, case age, FIR number, advocate name, etc. This information should be intimated to all the individuals through email for the next date.

**Warrant Issuance.** In the present court proceedings, the hon'ble judge in the judicial systems issues an order to recover the fine. As a part of this process, the judge passes an order with the issuance of a warrant against the complainant or respondent for the recovery of the fine. The court officials direct the concerned police station to issue the warrant to take necessary action and report back within a

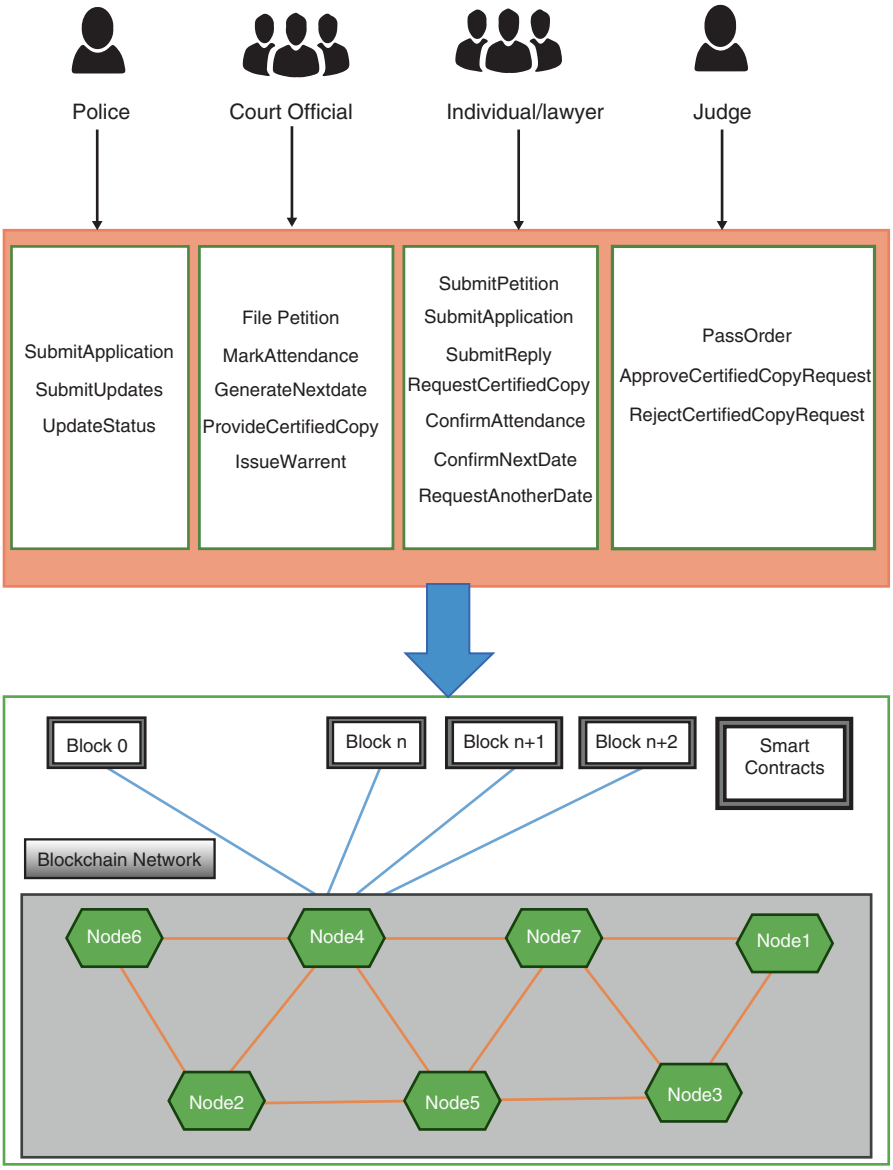


**Fig. 1.5** Proposed Indian judicial system

| scenario | New Individual |
|---|---|
| Invoked By | Court Official |
| Input | Name,Age,Gender, Address, ContactNumber, emailaddress, PANcardNumber |
| Output | wallet address |
| Trigger Event | Email wallet address to individual |
| Event Details | wallet address |

| scenario | File Protection |
|---|---|
| Invoked By | Court Official |
| Input | Case type,Current year, PetitionIPFSHash, sections, lawyer |
| Output | Casenumber, courtNumber, nextDate |
| Trigger Event | Intimate accused |
| Event Details | Complainant,CaseType, CaseNumber,CaseYear, sections,courtNumber, nextDate,petitioncopy |

| scenario | Mark Attendance |
|---|---|
| Invoked By | Court Official |
| Input | CaseType,CaseNumber, CaseYear, Individual/lawyer present |
| Output | attendanceUpdated |
| Trigger Event | Intimate concerned individuals to confirm Attendance |
| Event Details | CaseType, CaseNumber, CaseYear, Individual/lawyer present |

| scenario | Issue Warrant |
|---|---|
| Invoked By | Court Official |
| Input | CaseType,CaseNumber, CaseYear, applicationIPFSHash, orderIPFSHash |
| Output | exhibitNumber |
| Trigger Event | Issue Warrant as applicable and intimate concerned police officials |
| Event Details | warrant |

| scenario | Assign Next Date |
|---|---|
| Invoked By | Court Official |
| Input | CaseType,CaseNumber, CaseYear |
| Output | nextDate |
| Party present | confirmDate or requestAnotherDate |
| Party absent | automaticConfirmDate |
| Trigger Event | Intimate concerned individuals by email |
| Event Details | CaseType,CaseNumber, CaseYear, nextDate |

| scenario | Request Certified Copy |
|---|---|
| Invoked By | Individual/Lawyer |
| Input | CaseType,CaseNumber, CaseYear,exhibitNumber |
| Output | certifiedCopyNumber |
| Trigger Event | Judge Approval |
| Event Details | CaseType,CaseNumber, CaseYear,exhibitNumber |
| Approved | Trigger Event for Applicant to pay charges |
| Charges paid | Trigger event to email Certified Copy |
| Rejected | Intimate reason for rejection |

| scenario | Inward Entry |
|---|---|
| Invoked By | Court Official |
| Input | CaseType,CaseNumber, CaseYear,sender,sentDate,subject, documentIPFSHash, receiver,receivedDate |
| Output | InwardEntryNumber |
| Trigger Event | Intimate concerned individuals by email |
| Event Details | InwardEntryNumber,sender, sentDate,subject, receiver,receivedDate |

| scenario | Outward Entry |
|---|---|
| Invoked By | Court Official |
| Input | CaseType,CaseNumber, CaseYear,sender,sentDate, subject, documentIPFSHash,receiver |
| Output | outwardEntryNumber |
| Trigger Event | Intimate concerned individuals by email |
| Event Details | outwardEntryNumber,sender, subject, receiver,sentDate |

**Fig. 1.6** Blockchain solution for Indian judicial system

certain time period along with recovery details for further actions. However, sometimes, the court officials do not issue the recovery warrants to concerned individuals or police stations for several months or years unless it is followed up by the individuals or the advocate if not traced. Even if it is dispatched to the police, it will be difficult enough to keep track of when it was dispatched to the police to take further actions. In turn, the police may delay these actions for several reasons defeating the purpose of justice. The solution to this problem is achieved through Blockchain technology. The state government issues the predefined warrant format for different Indian Penal Code (IPC) and Criminal Procedure Code (CrPC) sections. Here, smart contracts can be used effectively to automatically generate the warrant upon the issuance of the order and add an action for police Blockchain. A report can be submitted to the court by the police through Blockchain which cannot be altered or deleted.

## 1.10 Maintenance of Land Records Using Blockchain

Keeping a secure data and storing it in real time are considered as some of the biggest challenges of the revenue department. Several issues related to land records arise due to inadequate information in different sections of the department and having no proper record management. Currently, registration of lands is done through

paper format which is more vulnerable and can be tampered easily. Due to unavailability or limited support of database, tracking changes of records in real time complicates the land issue registry. This problem can be solved using the Blockchain technology which is immutable, scalable, and more secure. With Blockchain, it's possible to store any information in real time. Any person can now sell, buy, or transfer the assets which are owned with less or no interventions from third-party agents like brokers making the system more transparent, secure, and cheaper.

### *1.10.1 Current Scenarios*

In India, across all states, there are around two to three departments which take care of property-related registration and land-related documents. They are as follows.

**Department of Stamps and Registry (DoSR).** This department has the responsibility to maintain land registration along with verification during transfer of documents. This handles different types of deeds such as transfer of immovable property, marriage registration, bond paper, and other land-related documents. There are several different ways of acquiring immutable property like inheritance, through will, property purchase, property granted by court, or court. All the work of registration process and public interaction takes place at the Office of Sub-Registrar (OSR) which has the responsibilities like estimating value of the property, registering and preserving copies of sale deeds, collection of stamp duties, and issuing registration certificate

**Department of Revenue (DoR).** This department has the responsibility of preparing and maintaining records or transaction. Apart from these, it has complete authority of verifying transaction to handle disputes from revenue courts and any other governing agencies.

**Survey and Settlement Department.** This department has the responsibility of maintenance of cadastral and other survey maps [22]. Globally, many organizations have developed numerous platforms for maintenance of land records through Blockchain. Propy [23] is one platform which uses website and distributed application (dApps) for providing solution using Blockchain. Testbed [24] is another Swedish project which provides solution through Blockchain.

### *1.10.2 Blockchain Solutions*

Even though digitization has improved the maintenance of property documents of land records, still, security, privacy, and transparency are major concerns for the revenue department. This problem can be solved using Blockchain technology which uses smart contracts for land record maintenance. Different stakeholders like the buyer, seller, bank, and government are involved in carrying out a Blockchain transaction. User details (buyers, sellers) are registered on a web portal to buy or sell

the property, and all the transactions are recorded on each different block in a Blockchain. The various roles of stakeholders are as follows:

**Government:** Any unowned land or property is registered by the government with details of land with its location (area per square feet).
**Buyer:** Using the website, the buyer registers details on a portal. The buyer is one who plans to buy assets.
**Seller:** The seller registers details on a portal using a website. The seller is one who wants to sell the property and notifies if there is any appeal from the buyer.
**Bank:** The bank acts as middle agent to authenticate the status of the buyer and seller.

Any user who needs to buy or sell the property needs to go through with the registration process. Figure 1.7 [10] describes the registration process where stakeholders like buyers, sellers, bank, and government create an account and get a private transaction key. Each user has unique key and address for website created by the Blockchain. Using this private key and address, user can log into the website for undergoing transactions [23].

After successful registration, the user can sell or buy single or multiple properties. Figure 1.8 [10] portrays the process of selling the land property where the buyer sends a request to the seller. The trade will be successful if the seller accepts

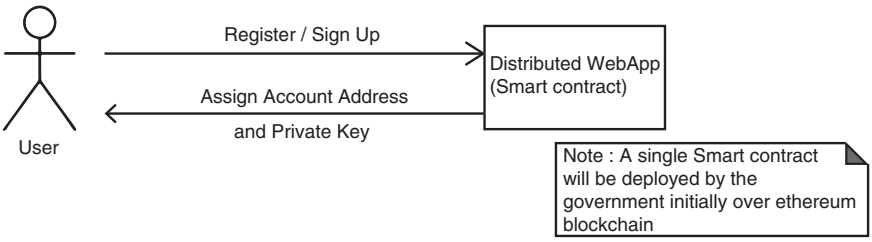


**Fig. 1.7** User registration process for web app

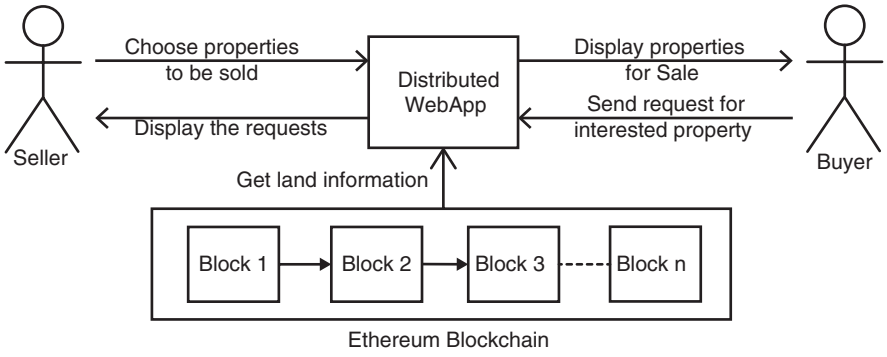


**Fig. 1.8** Process of selling land property using Blockchain

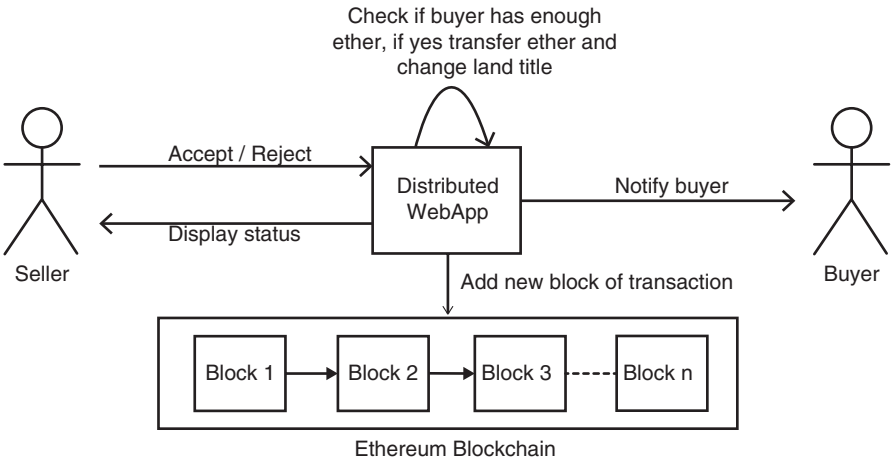


**Fig. 1.9** Process of buying land property using Blockchain

request from the buyer and the buyer has sufficient ethers. The seller puts the property information that needs be sold on the application display with the property cost as digital currency ethers. The trade would be successful if all rules are satisfied as per the contract terms.

The buyer can buy the saleable property according to the price and owner details along with location of the land. Figure 1.9 [10] describes the process involved in buying property. Using the digital signature of the web app, the buyer makes a request to the seller to buy a property. The seller can accept or reject the request depending upon his interest. If the seller accepts request of the buyer, the smart contract will be automatically executed to check if all conditions are agreed and the consent is sent with money transfer in form of ethers. The buyer affirms it using digital signature, and the transaction is completed with land transferred to the buyer [23].

## 1.11 Conclusion

Blockchain is considered as one piece of emerging technology which has created an impact on the digital world. Even though this technology is not known to many people, it revolutionized and created an impression in the industrial world. This Blockchain technology has made life simpler by storing the information on a block by which some traditional transactions are transformed to being smooth and protected.

This chapter shows a brief insight about the fundamentals of Blockchain technology and how it works and explains the role of genesis block and other blocks in Blockchain. The different Blockchain types are discussed and the role of smart contracts to create trust and ease the transactions without third-party interventions. This chapter addresses solutions to industrial applications using blockchain technology in telemedicine and healthcare sectors which benefits society. This chapter concludes that functioning of Blockchain is secure and how it is implemented in many areas by considering two important case studies in the field of judicial and revenue systems.

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