



# BlockChain Basics



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# Blockchain Ecosystem



# **“Bitcoin” with Blockchain**

# Agenda

- What is Blockchain Technology?
- How Blockchain Works?
  - Independent Verification of Transactions
  - Aggregation of Verified Transactions
  - Mining of a Block
- What if Someone Tries to Hack the System?

# What is Blockchain Technology?

*Blockchain is a **decentralized distributed database** of immutable records, where transactions are protected by strong **cryptographic algorithms** and the network status is maintained by the **Consensus algorithm**.*

区块链是一个不可变记录的分散分布式数据库，其中事务由强大的加密算法保护，网络状态由一致算法维护



# What is Blockchain Technology?

- In simple words, Blockchain is a chain of blocks that contain information.

简单地说，区块链是一个包含信息的块链

- The technology was originally described in **1991** and was intended to ***timestamp*** digital documents to avoid backdate or tempering of any records.

这项技术最初是在1991年提出的，旨在为数字文档加盖时间戳，以避免任何记录被回溯或篡改

- However great the technology was, its true potential was not realized until Satoshi Nakamoto used it to create a digital cryptocurrency ***“the Bitcoins”***.

无论这项技术多么伟大，直到中本聪(Satoshi Nakamoto)用它创造了一种数字加密货币比特币，它的真正潜力才被意识到

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Digital Timestamps

# Agenda

- What is Blockchain Technology?
- How Blockchain Works?
  - Independent Verification of Transactions
    - 独立核实交易
    - 汇总已核实的交易
    - 块的开采
  - Aggregation of Verified Transactions
  - Mining of a Block
- What if Someone Tries to Hack the System?

# How Blockchain Works?

Let's try to understand how blockchain works with a simple transaction over a Blockchain network.

让我们尝试理解区块链如何处理区块链网络上的一个简单事务

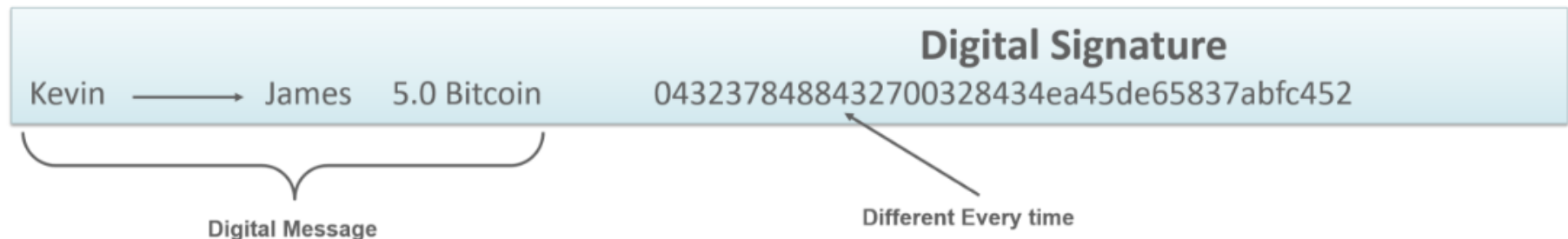




# How Blockchain Works?

Suppose James wants to send **5 BTC** to his friend Kevin. Now, this transaction is broadcasted in the form of a ***digital message***.

假设詹姆斯想要给他的朋友凯文发送5btc。现在，这一交易以数字信息的形式广播



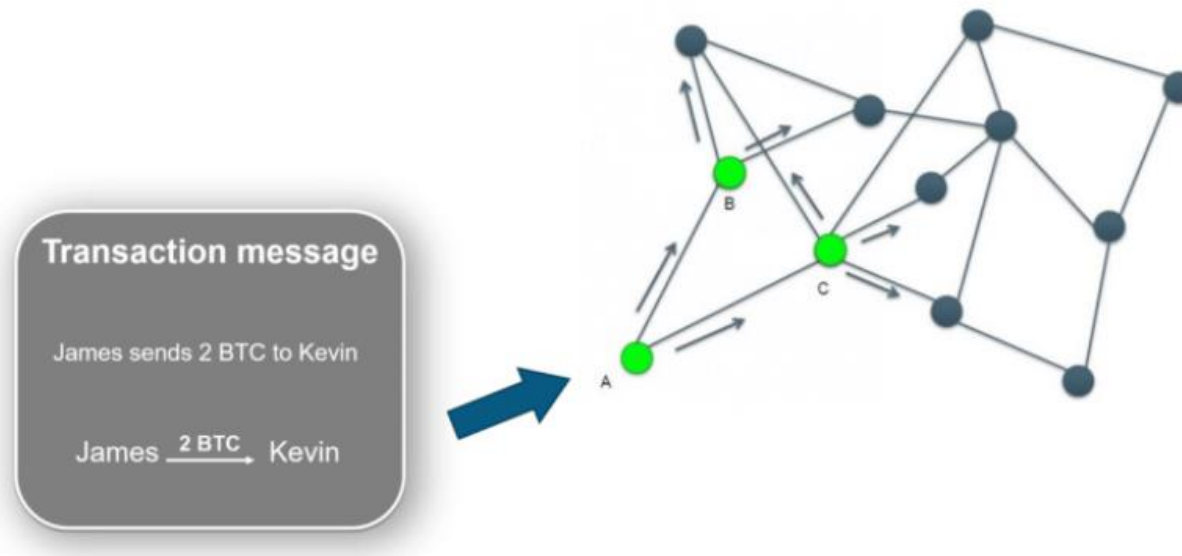
The digital message has a unique signature. Just like your signature provides the proof of ownership of the document, similarly, **digital signature** provides the proof that the **transaction is genuine**.

数字消息有唯一的签名。就像您的签名提供了文件所有权的证明一样，数字签名也提供了交易真实性的证明

# How Blockchain Works?

Now this generated transaction is broadcasted to the network where it propagates **peer to peer**.

现在这个生成的事务被广播到网络，在那里它被对等地传播



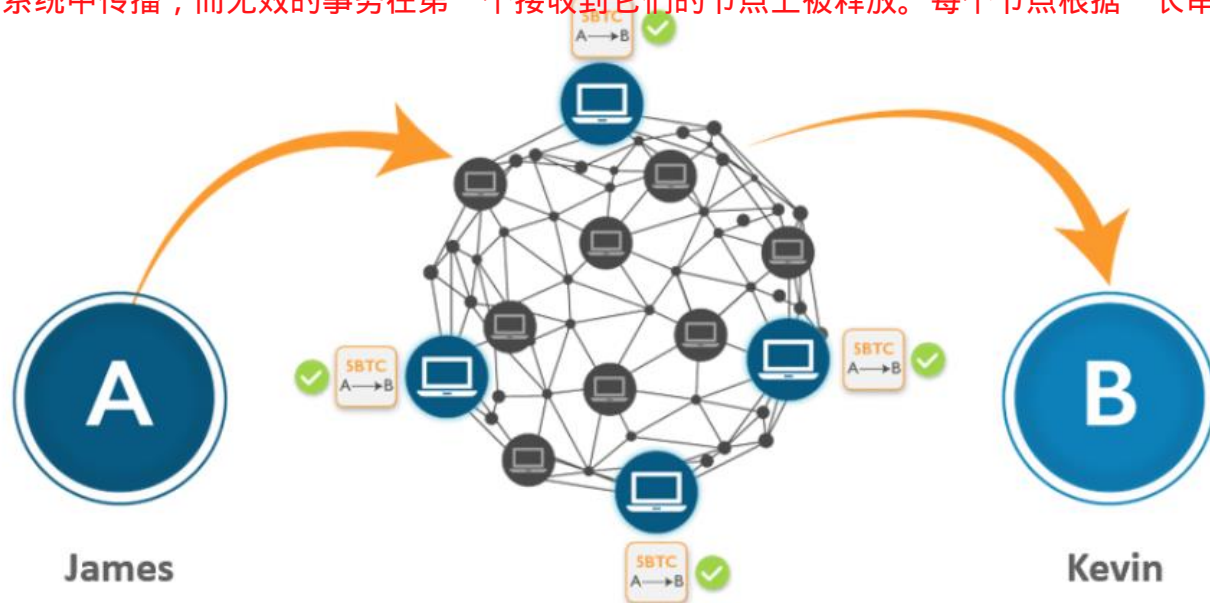
Suppose the above transaction is first received by **node A** in the network.

假设上述事务首先被网络中的节点A接收

# Independent Verification of Transactions

Before sending transactions to its neighbors, each bitcoin node that gets the transaction will initially verify the transaction.

在向其邻居发送交易之前，每个获得交易的比特币节点将首先对交易进行验证。这保证了只有有效的事务在系统中传播，而无效的事务在第一个接收到它们的节点上被释放。每个节点根据一长串标准议程确认每个事务



This guarantees only valid transactions are propagated across the system while invalid transactions are disposed of at the first node which receives them. Every node confirms each transaction against a long agenda of criteria.

# Aggregation of Verified Transactions

*Independent aggregation of those transactions into new blocks by mining nodes combined with exhibited calculation through a proof-of-work algorithm.*

- By autonomously confirming every transaction as it is received and before propagating it, each node fabricates a pool of valid (however unconfirmed) transactions known as the **transaction pool, memory pool or mempool**
- Transaction reaches **Mining nodes** it collects, validates, and relays new transactions just like other nodes
- Unlike other nodes, miner node will then aggregate these transactions into a **candidate block**

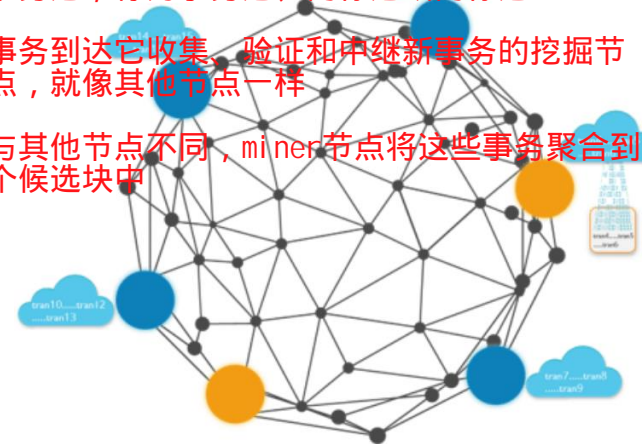
已验证事务的聚合

通过一种验证算法，挖掘节点与展示计算相结合，将这些事务独立地聚合到新的块中。

通过在接收到每个事务时以及在传播它之前自动地确认它，每个节点创建了一个有效(但未确认)事务池，称为事务池、内存池或内存池

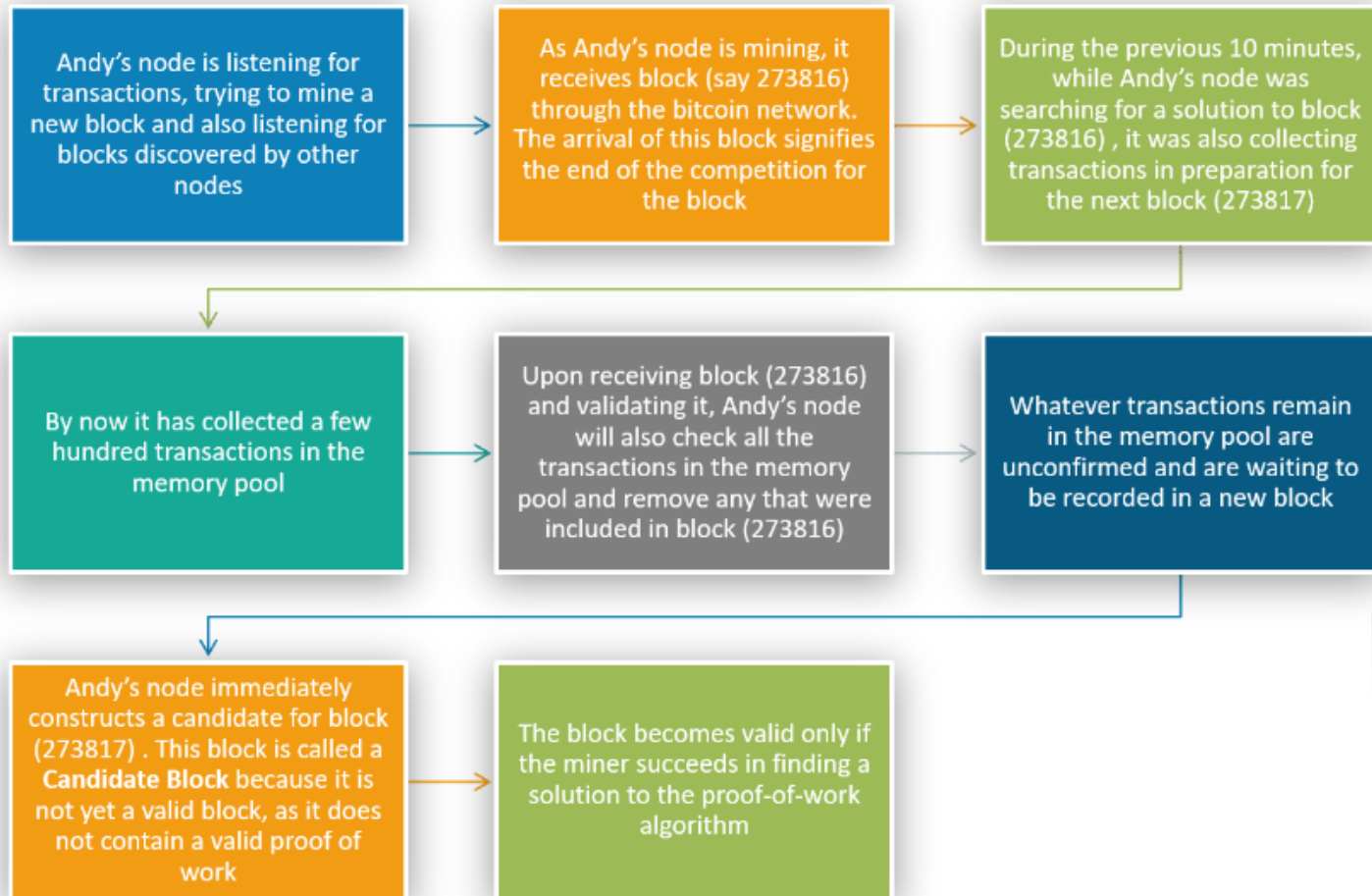
事务到达它收集、验证和中继新事务的挖掘节点，就像其他节点一样

与其他节点不同，miner节点将这些事务聚合到一个候选块中



# Aggregation of Verified Transactions

*Let's say Andy is a miner. (A mining node maintains a local copy of the blockchain, the list of all blocks created since the beginning of the bitcoin system in 2009)*



Now, after collecting all the transactions in a block, Andy needs to construct the block header.



# Constructing a Block Header

To construct the block header, the mining node needs to fill in six fields, as listed in the table:

Size	Field	Description
4 bytes	Version	To construct the block header, the mining node needs to fill in six fields, as listed
32 bytes	Previous Block Hash	A reference to the hash of the previous (parent) block in the chain
32 bytes	Merkle Root	A hash of the root of the Merkle tree of this block's transactions
4 bytes	Timestamp	The approximate creation time of this block (seconds from Unix Epoch)
4 bytes	Difficulty Target	The proof-of-work algorithm difficulty target for this block
4 bytes	Nonce	A counter used for the proof-of-work algorithm

Once Andy's node has all the fields filled in the block header, Andy started *Mining* the block.

# Mining of a Block

- With all the other fields filled, the block header is now complete and the process of mining can begin
- The goal is now to find a value for the **nonce** that results in a block header hash that is less than the difficulty target
- The mining node will need to test billions or trillions of nonce values before a nonce is found that satisfies the requirement

*Now that a candidate block has been constructed by Andy's node, it is time for Andy's hardware mining rig to “mine” the block, to find a solution to the proof-of-work algorithm that makes the block valid.*

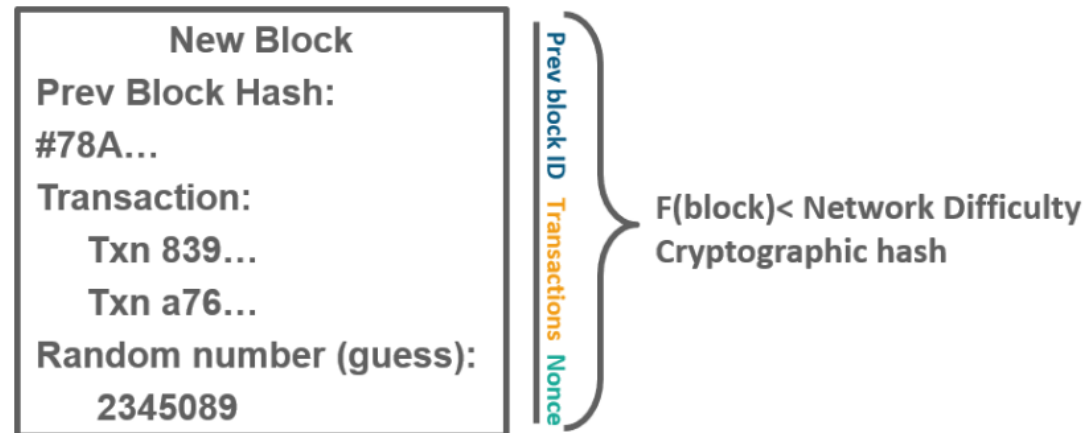
**Proof of work** is a piece of data which is difficult (costly, time-consuming) to produce but easy for others to verify and which satisfies certain requirements.

# Finding the Puzzle- Why is it hard?

- The SHA-256 is a one-way function hence, **brute force** is the only way to a particular output value
- On an average, it takes many random guesses to find a solution and thus the challenge is tough
- It takes around 10 minutes on an average for someone to find the special key to the solution

*To keep the coin distribution predictable, puzzles becoming increasingly difficult to solve when more people work on them.*

To validate the block according to the *proof-of-work* algorithm, Andy's mining node has to reach the difficulty target.



# Difficulty Representation

- The block contains the difficulty target, in a notation called “difficulty bits” or just “bits”
- Let’s say a block has 0x1903a30c as the difficulty bits. This notation expresses the difficulty target as a coefficient/exponent format, with the first two hexadecimal digits for the exponent and the next six hex digits as the coefficient

**The formula to calculate the difficulty target from this representation is:**

$$\text{target} = \text{coefficient} * 2^{(8 * (\text{exponent} - 3))}$$

So, such is the difficulty coefficient that Andy’s mining node has worked really hard to reach the difficulty target.

# Successfully Mining the Block

- Andy has several hardware mining rigs, each running the **SHA256** algorithm in parallel at incredible speeds
- The mining node running on Andy's desktop transmits the block header to his mining hardware, which starts testing trillions of nonces per second
- Almost 11 minutes after starting to mine block, one of the hardware mining machines finds a solution and sends it back to the mining node
- Immediately, Andy's mining node transmits the block to all its peers
- They receive, validate, and then propagate the new block. As the block ripples out across the network

*Now that that block is propagated in the network, each full nodes independently verifies the block*



# Independent Confirmation of Each Block

- In **bitcoin's consensus** mechanism, each new block is validated independently by every node on the network
- This ensures that only valid blocks are propagated on the network
- Nodes validate the block by checking it against a long list of criteria that must all be met

# Assembling and Selecting Chains of Blocks

- Once a node has validated a new block, it will then attempt to assemble a chain by connecting the block to the existing blockchain

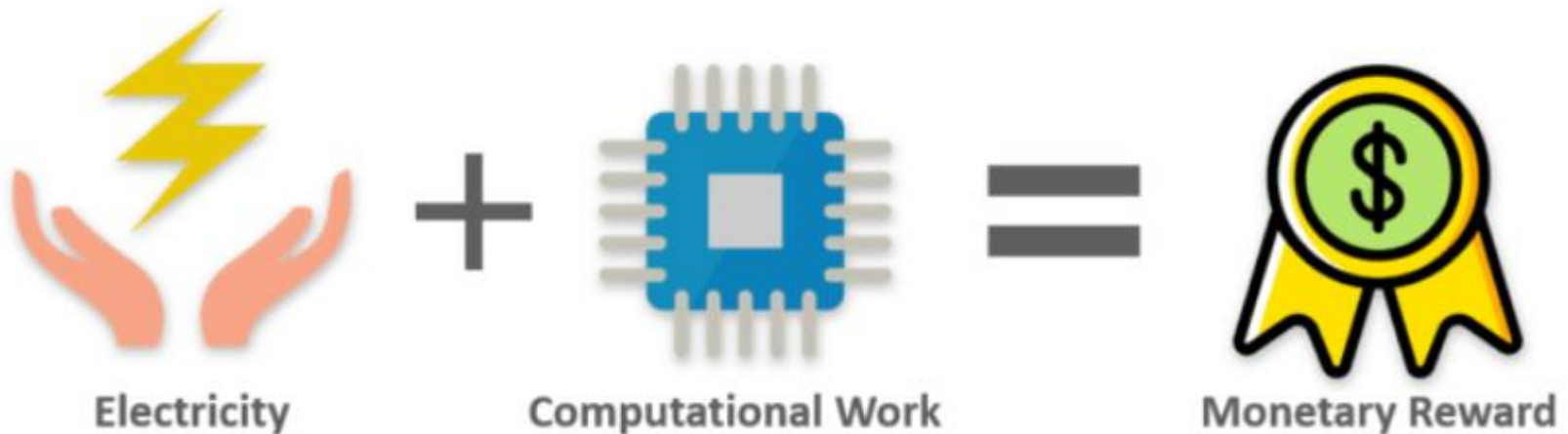
Once the block is verified by the network, it becomes the part of the blockchain and for successfully solving the block puzzle the miner is rewarded.



*In the network shown above, once the node (in orange) validates the block, it assembles the chain by connecting the block to the existing blockchain*

# Miners Reward

- Since Miners use their valuable resources to validate the block, they are given a **monetary award**
- In case of Bitcoin, they get some newly created Bitcoins as a reward

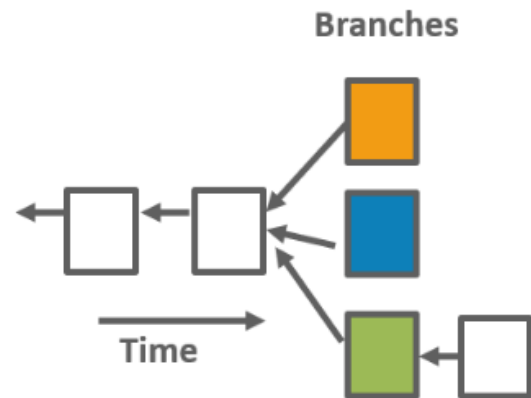


*Now, the question arises, what happens in the case when more than one block gets solved at the same time?*

Yes, this is possible indeed! In such case, several branches exist.

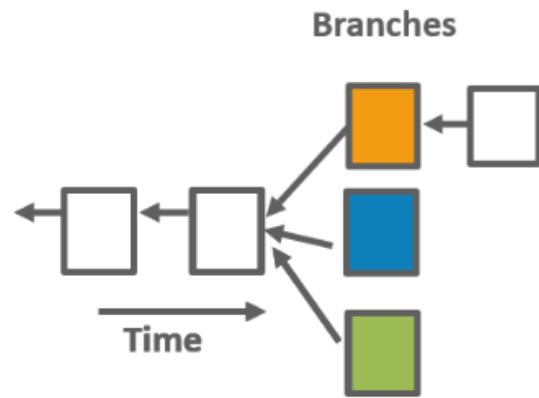
# Several Branches

- Although the problem is tough, however, there are chances that more than one block will be solved at the same time
- **Several branches** in the blockchain are possible in such cases
- Everyone should simply build the blocks on top of the first block that they receive
- Other Nodes may have received the blocks in a different order
- They will be building on the block they first receive



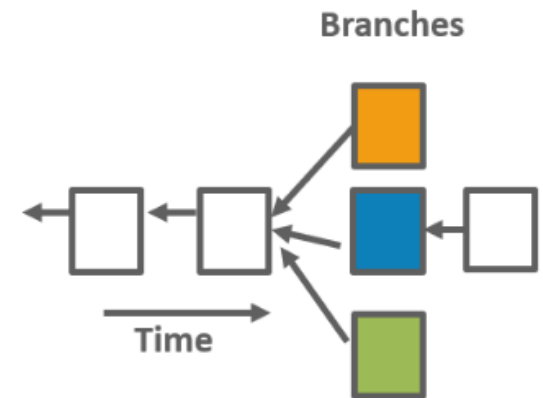
**Paul's Blockchain**

Paul received green block first.  
Hence, he builds the next block on top of green



**Robert's Blockchain**

Similarly, Robert received orange first.  
Hence, he builds the next block on top of orange

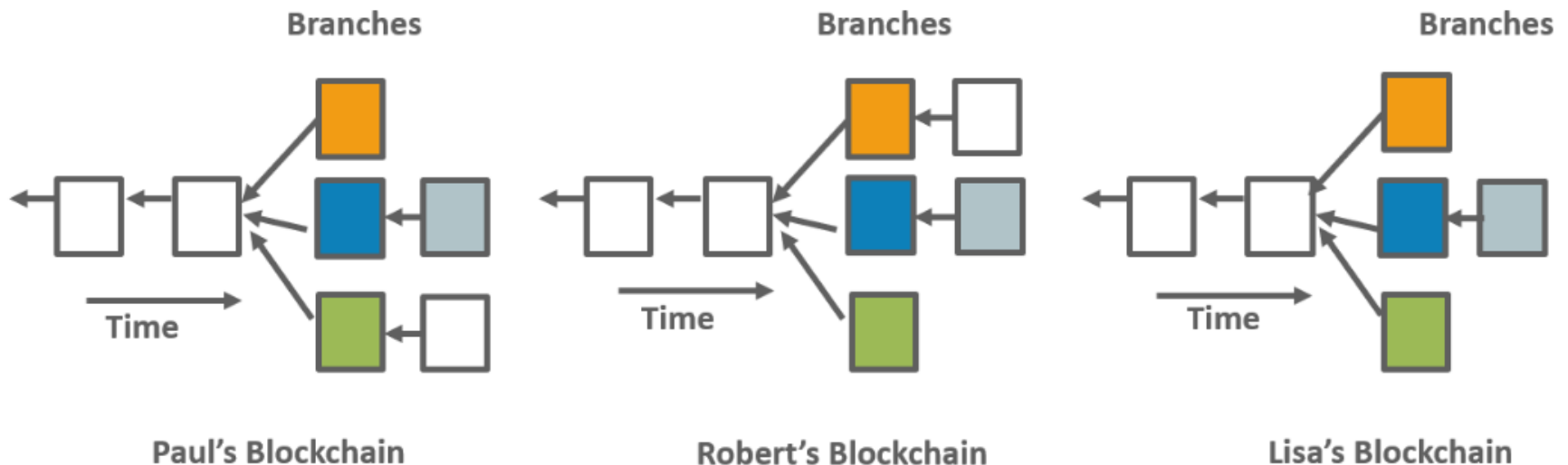


**Lisa's Blockchain**

Also, Lisa received blue first.  
Hence, she builds the next block on top of blue

# Several Branches

- The tie gets broken when someone solves the next block because it is very rare for this situation to happen multiple times in a row

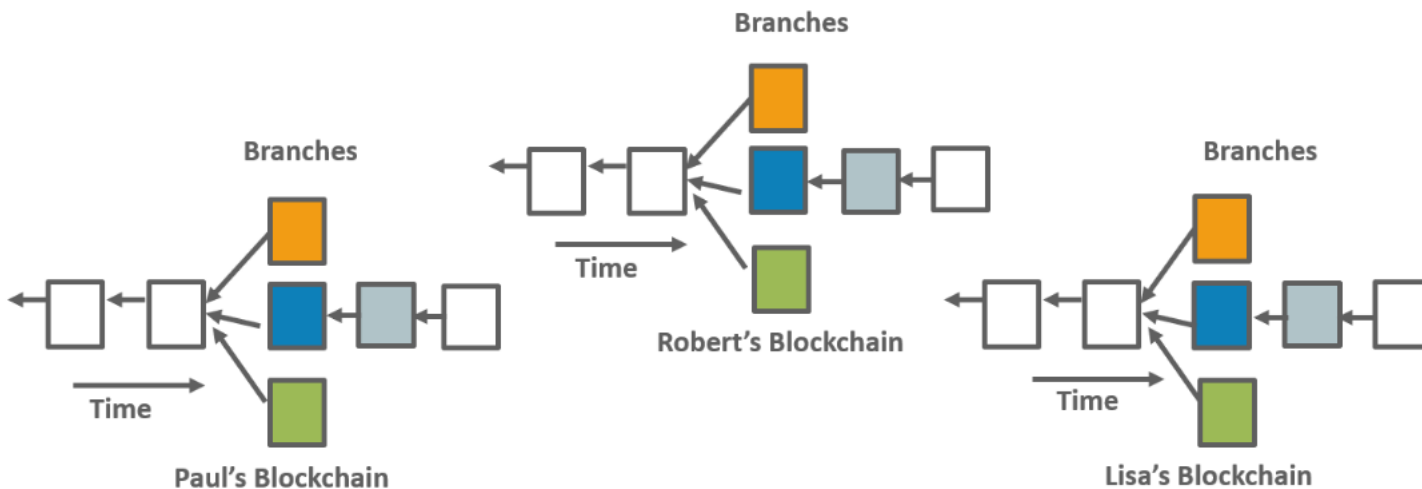


- Blockchain quickly stabilizes in this situation
- The general rule is to switch to the longest chain available



# Several Branches

- Blockchain quickly stabilizes in this situation
- The general rule is to switch to the longest chain available



The Blockchain quickly Stabilizes.

Every node is in agreement with the current state of the ledger.

# Several Branches

- The Blockchain quickly Stabilizes.
- Every node is in agreement with the current state of the ledger.

**Paul's Blockchain**



**Robert's Blockchain**



**Lisa's Blockchain**



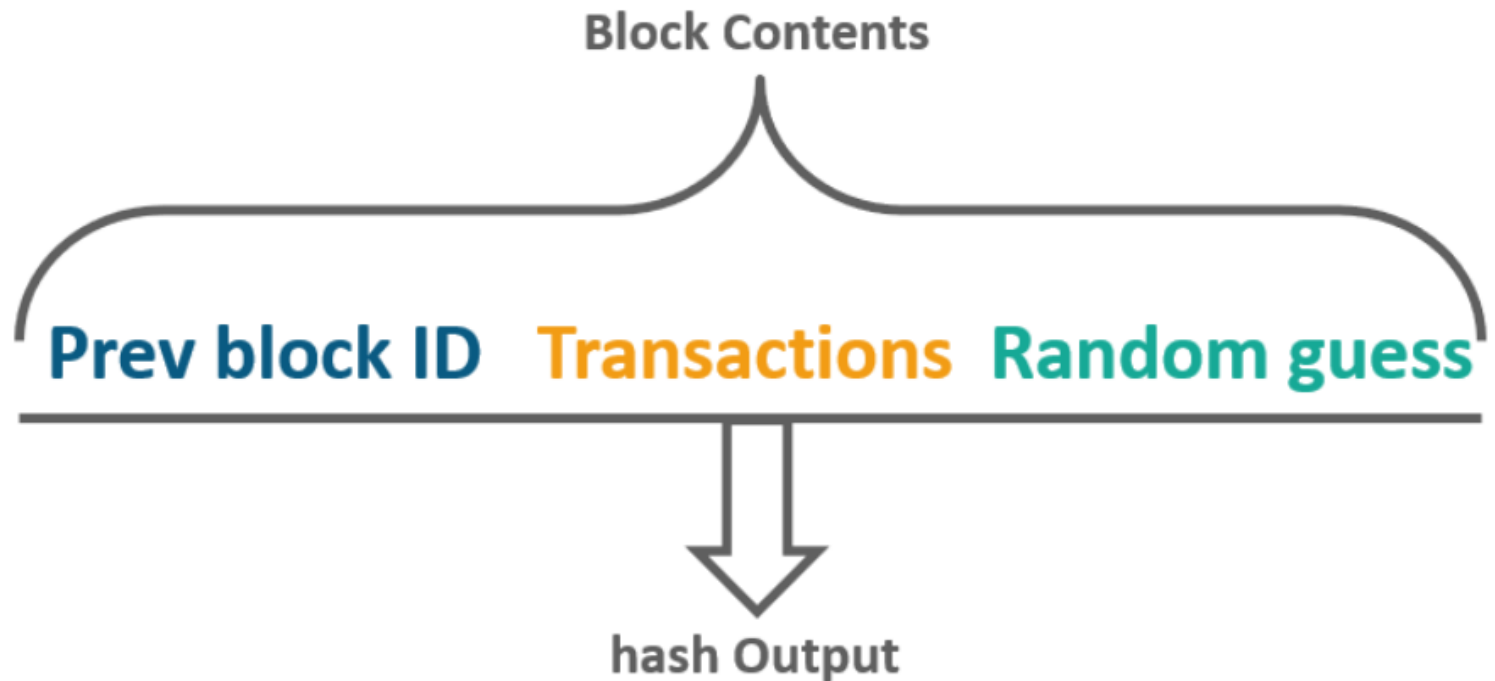
So, consensus rules save the blockchain network from such ambiguity.  
Now, another question arises here, what if someone tries to alter any transaction or records in the system?

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# Someone tries to Hack the System

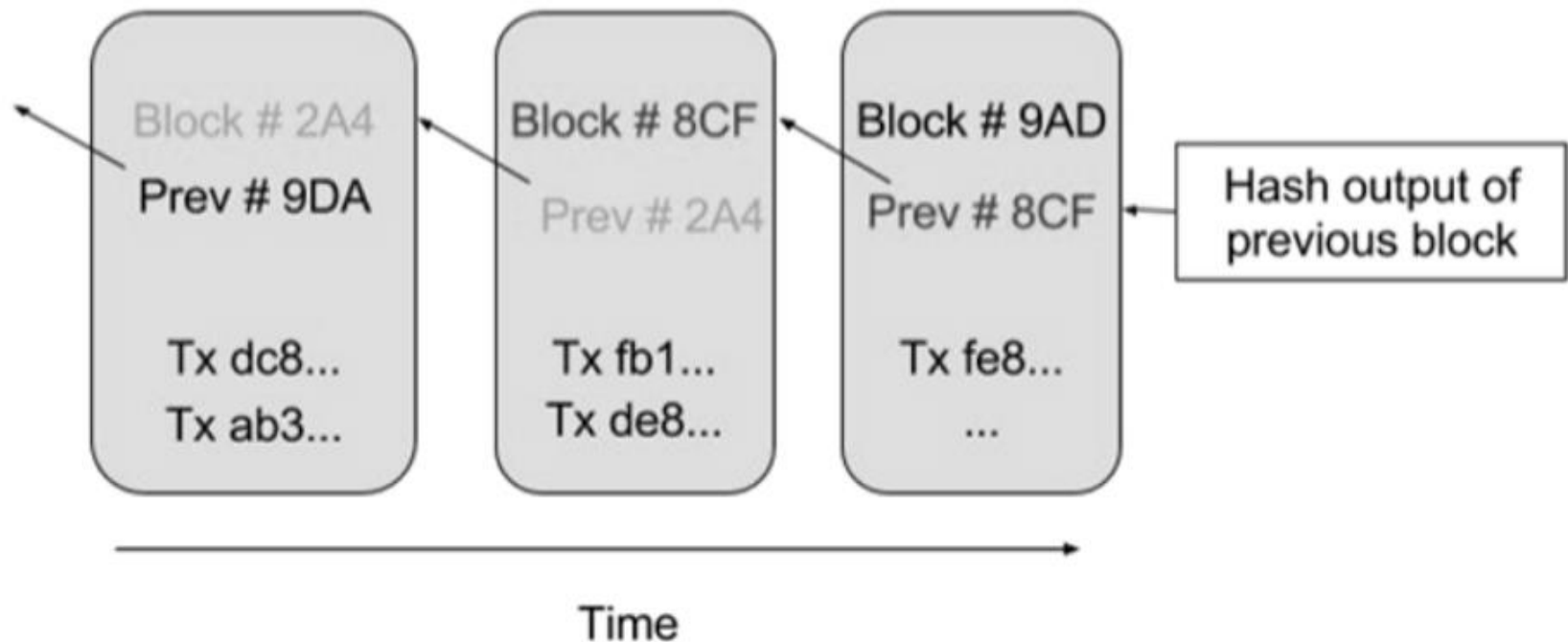
- Once a block is solved the cryptographic hash output becomes the identifier of that block.



So, consensus rules save the blockchain network from such ambiguity. Now, another question arises here, what if someone tries to alter any transaction or records in the system?

# Someone tries to Hack the System

- Since Blockchain is a back-linked distributed database of records. When a block is formed, the cryptographic hash output becomes the identifier of that block, which ties into the next block, creating a chain of blocks.



Hence, the blockchain is secured by the strong cryptographic algorithm and there is no way to alter any record. *If someone tries to alter any transaction in any of the blocks, the hash of the block changes and consequently hash of all the previous blocks will change. The nodes will not arrive at the consensus and hence, the fraud can easily be detected*



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# **“Enterprise” with Blockchain**

# Agenda

- What is Blockchain for Business?
- How blockchain is related to Business?
  - Consensus use case
  - Provenance use case
  - Immutability use case
  - Finality use case
- Blockchain Business Network

# What is blockchain for Business?

Business networks today are often inefficient because each participant in the network keeps records, or a ledger, of all transactions between all the parties that the business interacts with. This process is expensive because of duplication of effort and intermediaries adding costs for their services.

One solution to this problem is blockchain, which provides a shared ledger technology that allows any participant in the network to see the *one* system of record, or ledger. By using blockchain technology, businesses can benefit from a more efficient transfer of goods and services.

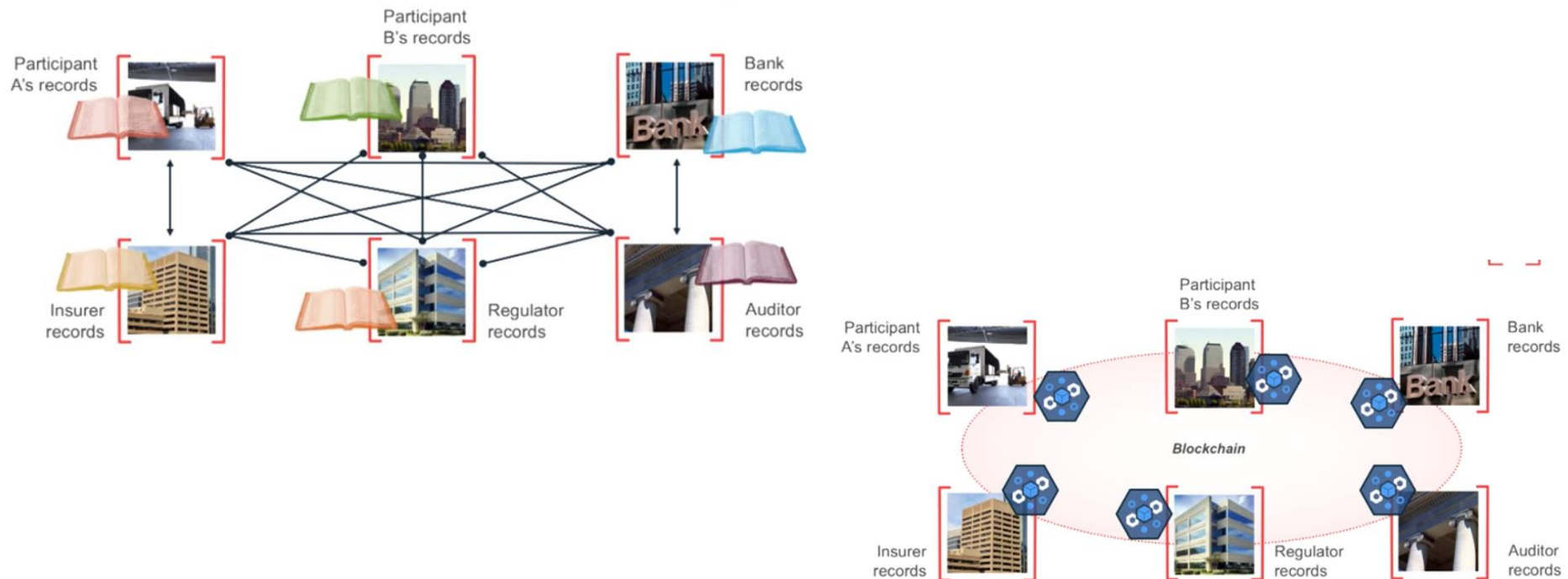
The next module describes business networks and transactions, the problems that blockchain can solve, what blockchain is and how it works, and key use cases.

# The business backdrop

- Most if not all business operate on public or private networks.
- Tangible and intangible assets must be transferred across networks to network participants.
- Ledgers are used to document all those transactions, and networks are governed by a contract.
- At the highest level, a blockchain is a trusted, distributed ledger with shared business processes.

# The problem area

- Talks about the challenges of current business networks: multiple manual ledgers.
- This means that all participants in a network must update or audit their own ledgers, which is inefficient, error-prone, and unsecure.



## Legacy business networks vs blockchain business networks



# Agenda

- What is Blockchain for Business?
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# How blockchain is related to Business

- Bitcoin is an unregulated shadow-currency and was the first popular blockchain application.
  - The Bitcoin application works in an anonymous network, so no one knows who the participants are.
- Blockchain for business, which is what is covered in this course, is not about Bitcoin and differs from Bitcoin in several ways.

**Blockchain for business** differs in key areas:

- *Identity* over anonymity
- *Selective endorsement* over proof of work
- *Assets* over cryptocurrency

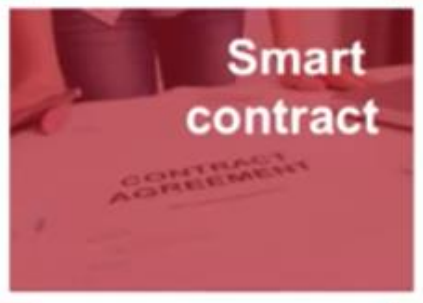
# Requirements for a blockchain in a business environment

a shared ledger, smart contract, privacy, and trust.

Append-only  
distributed system of  
record shared across  
business network




Shared  
ledger




Smart  
contract

Business terms  
embedded in  
transaction database  
& executed with  
transactions

Ensuring appropriate  
visibility; transactions are  
secure, authenticated  
& verifiable



Privacy



Trust

Transactions are  
endorsed by  
relevant  
participants

## 4 fundamental components of a blockchain for business

# Apply blockchain to business

Blockchain for business has several advantages:

- Saves time
- Removes cost
- Reduces risk
- Increases trust

For example, for financial services network, a business network that runs on a blockchain can speed up transaction processes and audits. That in turn reduces costs and can lead to greater customer satisfaction. A business that runs a supply chain network can benefit from blockchain by reducing errors in shipments, have better tracking of materials, and reduce the risk of illicit tampering of records.

# Blockchain benefits

Blockchain increases the speed of transactions, slash auditing costs, reduces risk of cyberattacks, and increases trust.



## **Saves time**

Transaction time  
from days to near  
instantaneous



## **Removes cost**

Overheads  
and cost  
intermediaries



## **Reduces risk**

Tampering,  
fraud  
& cyber crime



## **Increases trust**

Through shared  
processes and  
recordkeeping



# How blockchain participants can share data in a business network

For example, routing codes for your bank can be a shared reference data. Blockchain can be used to manage this kind of data, where there is a single set of data that can be more easily updated.



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# Consensus use case – Shared reference data

- What**
- Competitors/collaborators in a business network need to share reference data, e.g. bank routing codes
  - Each member maintains their own codes, and forwards changes to a central authority for collection and distribution
  - An information subset can be owned by organizations

- How**
- Each participant maintains their own codes within a Blockchain network
  - Blockchain creates single view of entire dataset

## Benefits

1. Consolidated, consistent dataset reduces errors
2. Near-real-time of reference data
3. Naturally supports code editing and routing code transfers between participants

# Tracking an item through a supply chain with blockchain

- This is another example of using blockchain to improve the business processes.
- You can track the parts of an aircraft by using a blockchain network.
- You can see the life cycle of an asset.
- As another example, a diamond retailer can see whether a diamond is from an illicit source.

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# Provenance use case – Vehicle maintenance

- What**
- Provenance of each component part in complex system hard to track
  - Manufacturer, production date, batch and even the manufacturing machine program

- How**
- Blockchain holds complete provenance details of each component part
  - Accessible by each manufacturer in the production process, the aircraft owners, maintainers and government regulators

## Benefits

1. Trust increased, no authority "owns" provenance
2. Improvement in system utilization
3. Recalls "specific" rather than cross fleet

# How blockchain can benefit auditing and compliance in FinTech

- This is another use case about compliance.
- A bank wants to use blockchain to keep an indelible record of all key transactions over a reporting period.
- Blockchain assures that this record is private, secure, and complete.



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# Immutability use case – Financial ledger

## What

- Financial data in a large organization dispersed throughout many divisions and geographies
- Audit and Compliance needs indelible record of all key transactions over reporting period

## How

- Blockchain collects transaction records from diverse set of financial systems
- Append-only and tamperproof qualities create high confidence financial audit trail
- Privacy features to ensure authorized user access

## Benefits

1. Lowers cost of audit and regulatory compliance
2. Provides “seek and find” access to auditors and regulators
3. Changes nature of compliance from passive to active

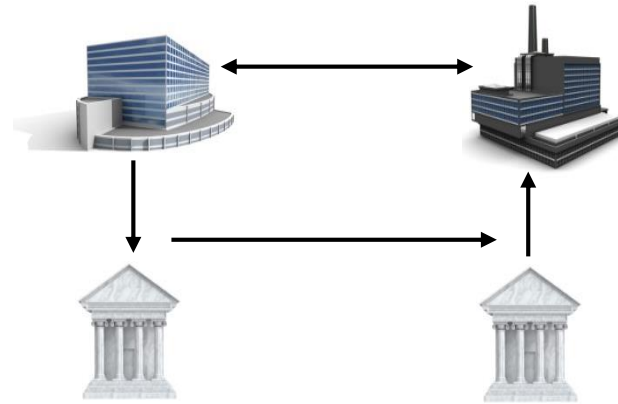
# How blockchain can streamline letters of credit in FinTech

- This is a use case about compliance.
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# Finality use case – Letter of credit



- What**
- Bank handling letters of credit (LOC) wants to offer them to a wider range of clients including startups
  - Currently constrained by costs & the time to execute

- How**
- Blockchain provides common ledger for letters of credit
  - Allows all counter-parties to have the same validated record of transaction and fulfillment

## Benefits

1. Increase speed of execution (less than 1 day)
2. Vastly reduced cost
3. Reduced risk, e.g. currency fluctuations
4. Value added services, e.g. incremental payment

# Blockchain examples by (selected) industry



Financial	Public Sector	Retail	Insurance	Manufacturing
Trade Finance Cross currency payments Mortgages	Asset Registration Citizen Identity Medical records Medicine supply chain	Supply chain Loyalty programs Information sharing (supplier – retailer)	Claims processing Risk provenance Asset usage history Claims file	Supply chain Product parts Maintenance tracking



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# Blockchain for Business



## Community + Code

Linux Hyperledger  
Project

Open Source Code: Blockchain for business;

**Consensus | Provenance | Immutability |  
Finality**

Open Governance – 100 member cross industry  
board



## Cloud

IBM Blockchain

Blockchain managed service on IBM Cloud and  
z Systems;

**Identity | Consensus | System Integration |  
Hardware-assist for Performance & Security**

IBM Blockchain on Bluemix



## Clients

Blockchain Solutions  
Blockchain Garage

Making Blockchain real for business

Blockchain Garage;

**New York | London | Singapore | Tokyo**

Blockchain Services Practice

# What is the easiest way to start with blockchain?

- Need to remember that blockchain is still an emerging technology.
- One suggestion for those looking to adopt blockchain is to start with a simple first use case.
- Business owners need to start small and then look for more ways to grow and expand the use of blockchain networks.
- Speaker briefly mentions some of the roles in a business such as regulators, market makers, and industry groups.

# Patterns for customer adoption [?] Why

## HIGH VALUE MARKET

- Transfer of high value financial assets
- Between many participants in a market
- Regulatory timeframes

## ASSET EXCHANGE

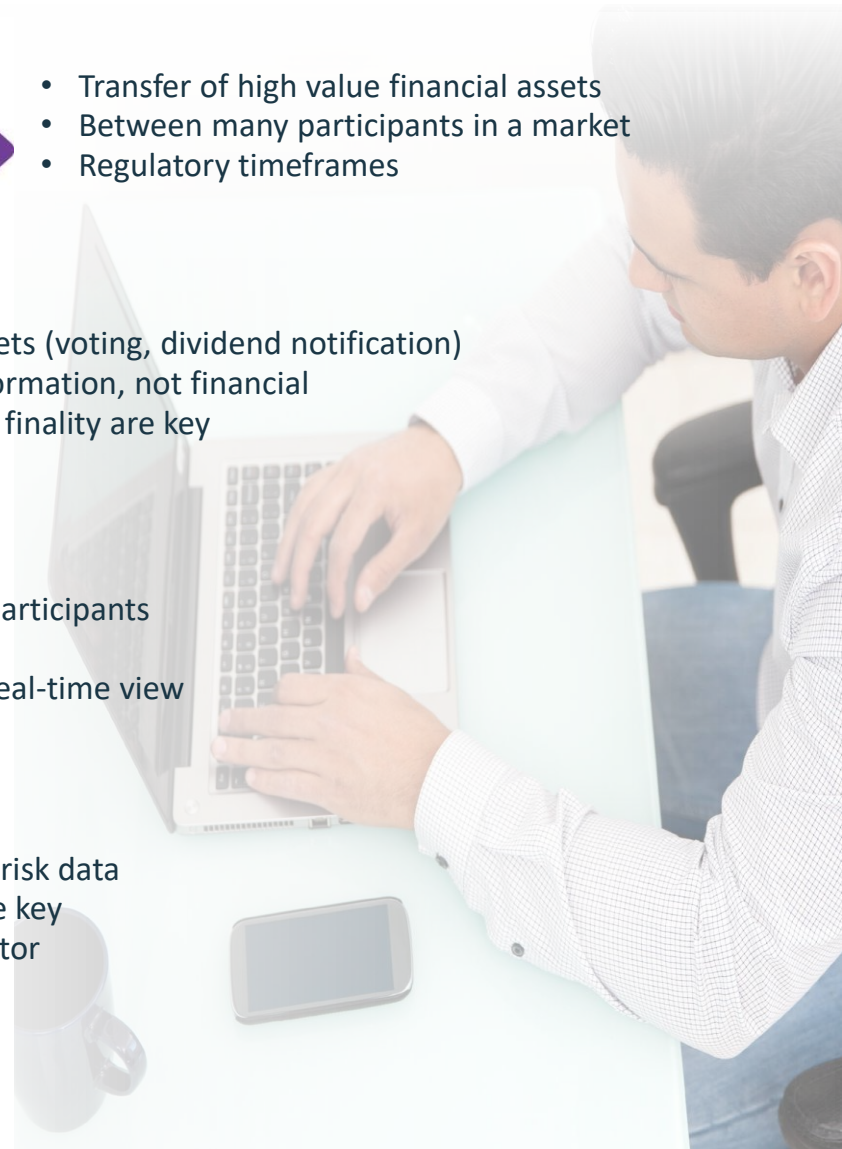
- Sharing of assets (voting, dividend notification)
- Assets are information, not financial
- Provenance & finality are key

## CONSORTIUM SHARED LEDGER

- Created by a small set of participants
- Share key reference data
- Consolidated, consistent real-time view

## COMPLIANCE LEDGER

- Real-time view of compliance, audit & risk data
- Provenance, immutability & finality are key
- Transparent access to auditor & regulator



# Key players for Blockchain adoption



## Regulator

- An organization who enforces the rules of play
- Regulators are keen to support Blockchain based innovations
- Concern is systemic risk – new technology, distributed data, security



## Industry Group

- Often funded by members of a business network
- Provide technical advice on industry trends
- Encourages best practice by making recommendations to members



## Market Maker

- In financial markets, takes buy-side and sell-side to provide liquidity
- More generally, the organization who innovates
  - Creates a new good or service, and business process (likely)
  - Creates a new business process for an existing good or service

# IBM and Hyperledger relationship:

## Blockchain for business

- IBM is a premier member of the Linux Foundation Hyperledger Project.
- IBM also has other services and technologies to help you build a blockchain network such as IBM Cloud (IBM Cloud) and Docker containers.
- IBM provides support and engagement to help you build with blockchain.





# Shared ledger



Records all transactions across business network

Shared between participants

Participants have own copy through replication

Permissioned, so participants see only appropriate transactions

THE shared system of record

# Smart contract



What

Business rules implied by the contract ... embedded in the  
Blockchain and executed with the transaction

Verifiable, signed

Encoded in programming language

Example:

Defines contractual conditions under which corporate Bond transfer occurs

# Privacy



What



Ledger is shared, but participants require privacy

Participants need:

- Transactions to be private

- Identity not linked to a transaction

Transactions need to be authenticated

Cryptography central to these processes

# Consensus



... the process by which transactions are verified

## Anonymous participants

Bitcoin *cryptographic mining* provides randomized selection among anonymous participants

Significant compute cost (proof of work)

## Known & trusted participants

Commitment possible at low cost

Byzantine fault tolerance (BFT)

## Multiple alternatives

Proof of stake, where influence is determined by risk of validators

Multi-signatures, validation needs consent from 3 out of 5 validators

Industrial Blockchain needs “pluggable” consensus





# Other potential use cases

## — Securities

- Post-trade settlement
- Derivative contracts

## — Trade Finance

- Bill of Lading
- Cross-currency payment

## — Syndicated Loans

## — Supply Chain

## — Retail Banking

- Cross border remittances
- Mortgage verification & contracts

## — Public Records

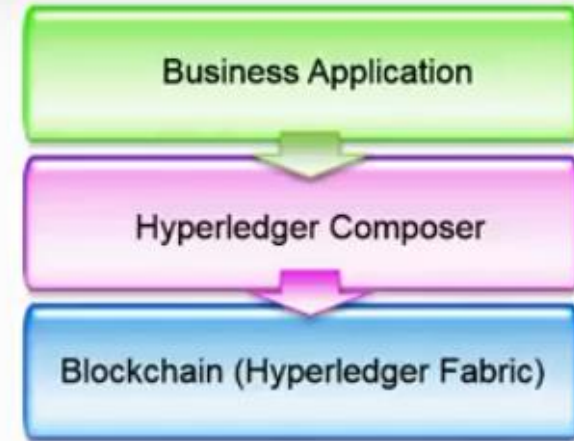
- Real estate records
- Vehicle registrations
- Citizen Identity

## — Digital Property Management

# Hyperledger Composer

Provides a high-level, brief overview of Hyperledger Composer and how it's a faster, easier way to build networks rather than build with chaincode in the Go programming language.

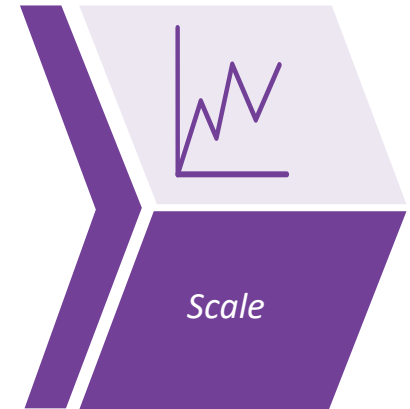
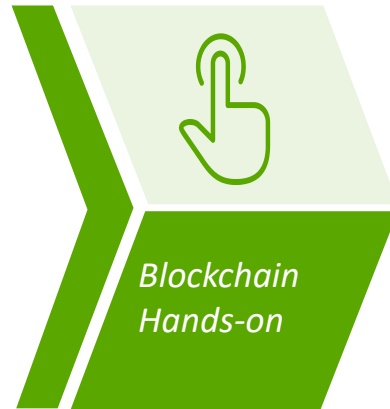
- A suite of high level application abstractions for business networks
- Emphasis on business-centric vocabulary for quick solution creation
- Reduce risk, and increase understanding and flexibility



- Features
  - Model your business networks, test and expose via APIs
  - Applications invoke APIs transactions to interact with business network
  - Integrate existing systems of record using loopback/REST
- **Fully open** and one of eight Hyperledger projects



# Engagement model overview



1. Discuss Blockchain technology
2. Explore customer business model
3. Show Blockchain Application demo

1. Understand Blockchain concepts & elements
2. Hands on with Blockchain on Bluemix
3. Standard demo customization

1. Design Thinking workshop to define business challenge
2. Agile iterations incrementally build project functionality
3. Enterprise integration

1. Scale up pilot or Scale out to new projects
2. Business Process Re-engineering
3. Systems Integration

**Remote or face to face**

**Remote or face to face**

**Face to face**

**Face to face**

**Free of charge**

**Free of charge**

**For fee**

**For fee**

# Participants in a blockchain business network

Except for the Regulator, all other users can see only part of the lifecycle of the transfer of assets.

They can see what happened to the asset before their ownership and while they owned it, but they cannot see what happened to the asset after they transferred it.

# Summary

## Blockchain ...

- is a shared, replicated, permissioned ledger technology
- can open up business networks by taking out cost, improving efficiencies and increase accessibility
- addresses an exciting and topical set of business challenges, which cross every industry

## IBM ...

- supports the Linux Foundation Hyperledger open standard, open source, open governance Blockchain
- has an easy to access, proven and incremental engagement model giving customers the confidence to get started NOW

# Summary

You should now have a better understanding of how blockchain can be used for business and how this technology adds value.

More specifically, you should understand:

- Blockchain and distributed ledger systems
- Key use cases of blockchain for business
- How asset transfers can occur in a blockchain network

Check out the follow up course [IBM blockchain foundation developer](#) where you can find tutorials, sample code, and other information about blockchain.

Jump to the next step in your blockchain training by taking the developerWorks' course [IBM blockchain foundation developer](#).

Start building your blockchain applications on [Hyperledger Composer!](#)

# Agenda

- ✓ What is Blockchain for Business?
- ✓ How blockchain is related to Business?
  - ✓ Consensus use case
  - ✓ Provenance use case
  - ✓ Immutability use case
  - ✓ Finality use case
- ✓ Blockchain Business Network

# The End !

धन्यवाद

Hindi

多謝

Traditional Chinese

ขอบพระคุณ

Thai

Спасибо

Russian

Gracias

Spanish

Thank You

English

شكراً

Arabic

Obrigado

Brazilian Portuguese

Grazie

Italian

多谢

Simplified Chinese

Danke

German

Merci

French

நன்றி

Tamil

ありがとうございました

Japanese

감사합니다

Korean



# Ledgers are key ...

Ledger is THE system of record for a business. Business will have multiple ledgers for multiple business networks in which they participate.

**Transaction** – an asset transfer onto or off the ledger

John gives a car to Anthony (simple)

**Contract** – conditions for transaction to occur

If Anthony pays John money, then car passes from John to Anthony (simple)

If car won't start, funds do not pass to John (as decided by third party arbitrator) (more complex)

