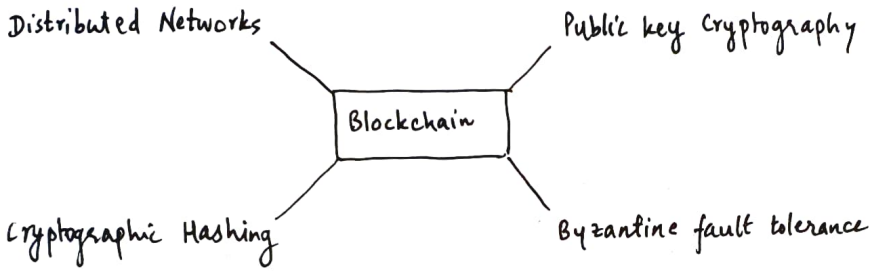
JP MORGAN CHASE & CO.

CAMPUS TO CORPORATE PROGRAM - SESSION 1 - BLOCKCHAIN

- Blockchain is a digital ledger where transactions are recorded
  - Transactions are recorded chronologically
  - Many blockchains are public
  - Transactions are verified by many nodes in the P2P network to enhance security

- Blockchain provides a trust framework which allows systems to be developed for actors to interact reliably and securely. At the core of the technology are four well proven tech:



- Benefits of blockchain

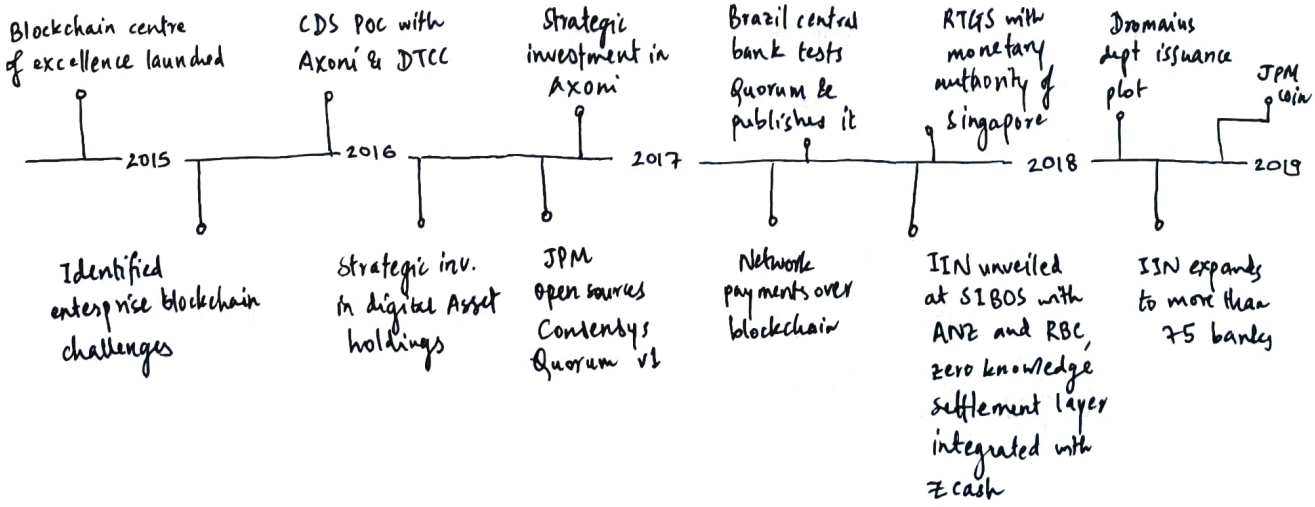
Short-to-medium term Blockchain benefits

Business Opportunities
- Reduced settlement time
- Improved liquidity
- Open brand new markets

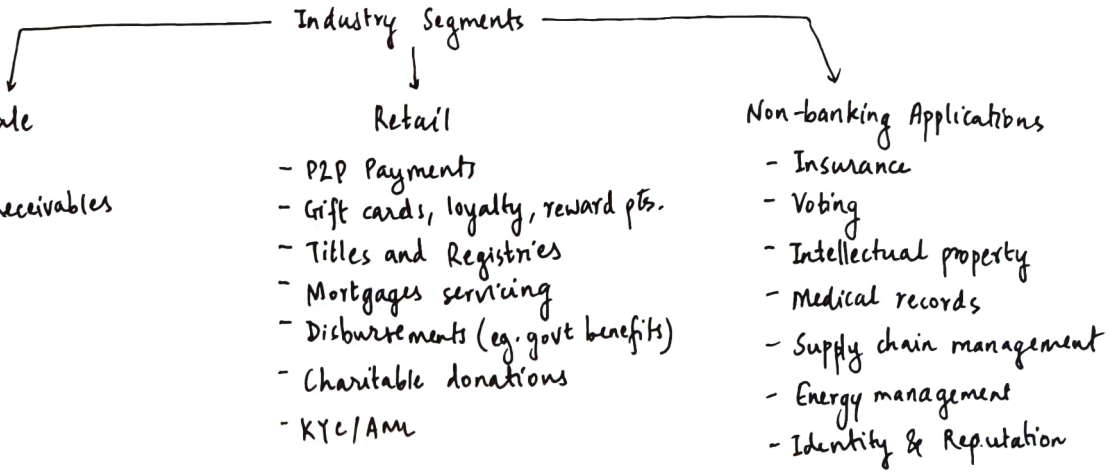
Operational Efficiencies
- Lower intermediary costs
- Increased automation
- Reduced need for reconciliation

Risk Reduction
- Simpler regulatory reporting
- immutable audit trail
- transparency in management
- Enhanced cybersecurity, resilience

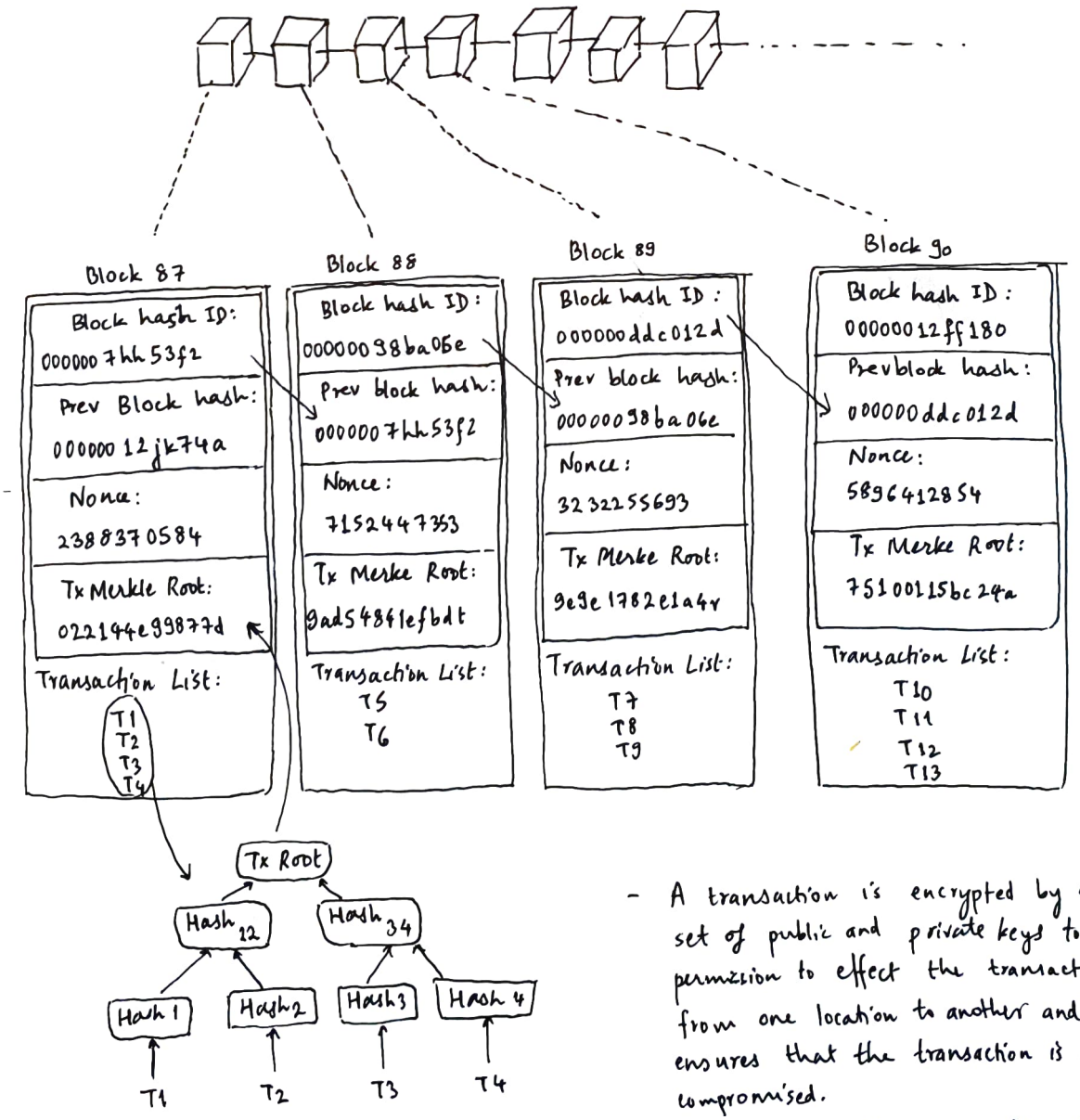
- JP Morgan is an industry leader in Blockchain



- Use cases across industry segments

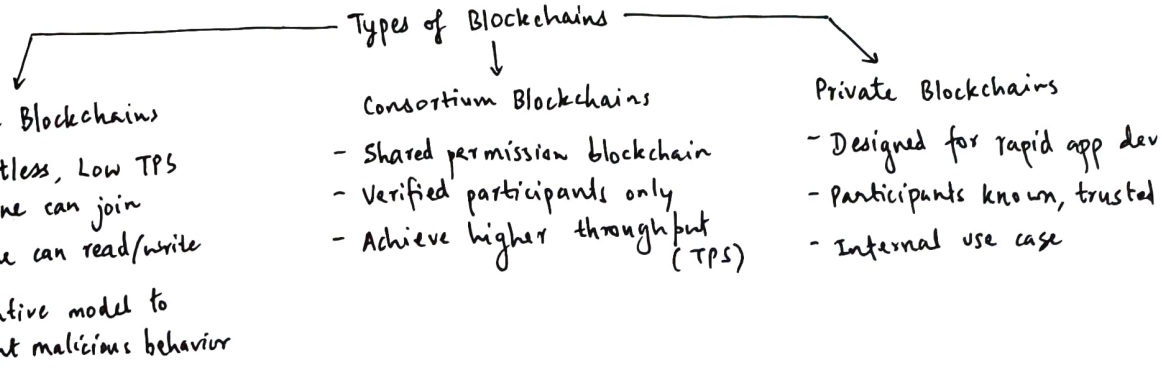


- Construct of a Block in Blockchain



- A transaction is encrypted by a set of public and private keys to grant permission to effect the transaction from one location to another and this ensures that the transaction is not compromised.
- New transaction blocks are added at defined intervals which link back to the earlier blocks added to the ledger.

- Types of Blockchains



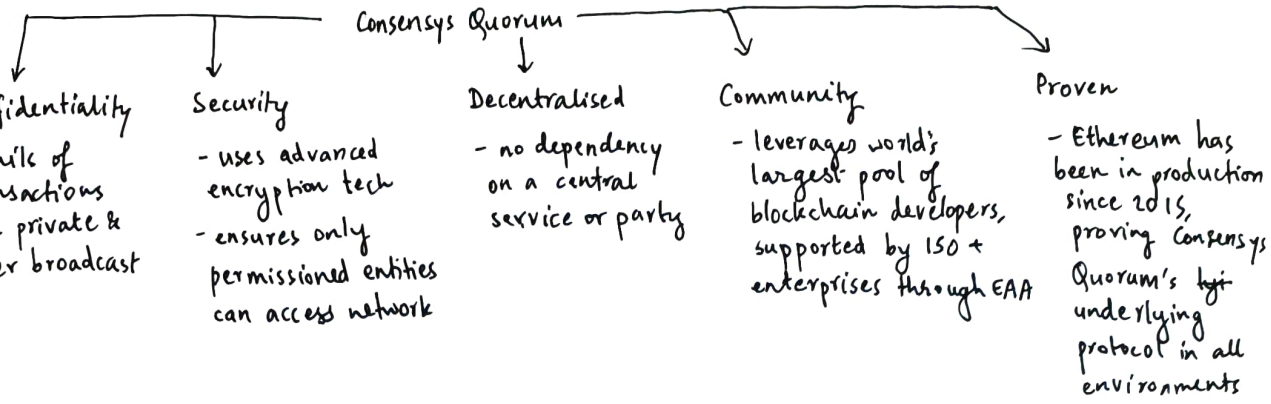
- Blockchain platforms comparison

	Bitcoin	Ethereum	Consensys Q	Hyperledger	Corda	Ripple
Consensys Algorithm	Proof of Work	Proof of Work (Configurable)	PBFT or RAFT (configurable & pluggable)	PBFT	BFT or RAFT	Ripple Protocol
Enterprise Use	Remitances & Money Transfer	Enterprise grade D-app dev	Enterprise Grade D-adp dev	Enterprise grade D-app dev	Finance-focused block-chain app-dev	Remittances & Money Transfer
Protocol Implementation	C++, Java	Go, C++, Python, Haskel, Java, Rust, Ruby, JS	Go, C++, Python, Haskel, Java, Rust, Ruby, JS	Go, Java	Kotlin, Java	N/A
Native Digital Currency	Yes	Yes	No	No	No	Yes
Built-in smart contracts	Yes	Yes	Yes	Yes	Yes	No
Mining	Yes	Yes	No	No	No	No
Public-pvt Interoperability	Public/ Permissionless	Public, Private/ permissioned, Permissionless	Public, Private/ Permissioned, Permissionless	Private/ Permissioned	Private/ Permissionless	No

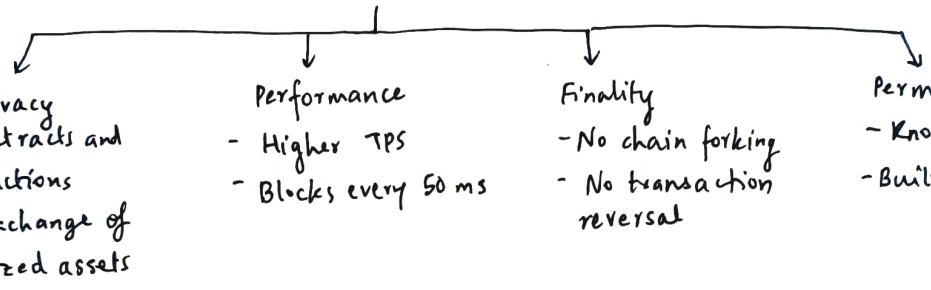
- Ethereum
  - It is an open-source, generalised block-chain for smart contract development.
  - It is not just a cryptocurrency - it is also a platform for developing decentralized apps. (d-app).
  - Consensys Quorum (platform used by JPM for various use cases) is built on top of Ethereum, the platform.

- Consensys Quorum
  - It is a fork of the Go-Ethereum (geth) client, which is the official language (Go-Lang) implementation of the Ethereum protocol.
  - It is an enterprise-ready, open-source blockchain platform based on Ethereum, designed for processing of pvt. transactions with a permissioned group of known participants.
  - It addresses specific challenges to blockchain adoption and beyond the financial services industry, e.g. privacy, speed, throughput.

- Consensys Quorum - Key features



- What is Consensys Quorum: Platform features



- Consensys Quorum Consensus Algorithm: RAFT
  - Well known consensus algorithm for distributed databases
    Useful for closed membership / consortium settings
  - At the start of the network, a leader is elected, who proposes the blocks and other node validate at the same way
  - A new leader is selected when the current leader goes down or term ends
    Leader election is completely random.

  Pros: Faster block time (20-50 ms), settlement Finality

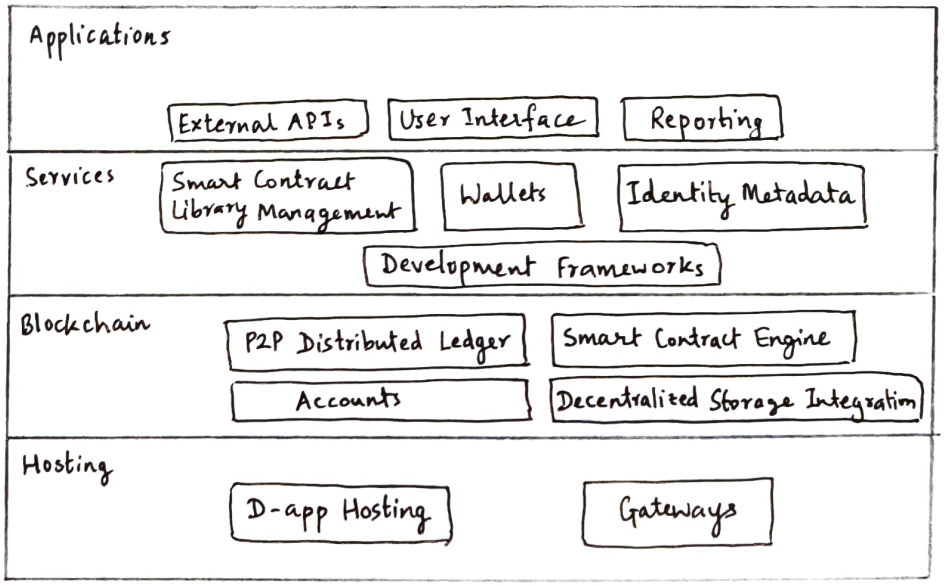
  Cons: No byzantine fault tolerance

- Consensys Quorum Consensus Algorithm: Istanbul BFT
  - In a network of N nodes, the system can withstand F no. of byzantine nodes where
    $N = 3F + 1$
  - The algorithm has 4 phases - Propose, Pre-prepare, prepare and commit.
  - The proposer multicasts the block proposal to the validators, who agree on the block & broadcast their decision to others
  - Each validator waits for $2F + 1$ commits from different validators with the same result before inserting the block into blockchain.

  Pros: Byzantine fault tolerance, settlement finality, high throughput

  Cons: TPS lower than raft algo, more validators can impact throughput

- Blockchain Solution Architecture
  - Illustrative view of solution architecture and layers. To be refined based on the use cases.

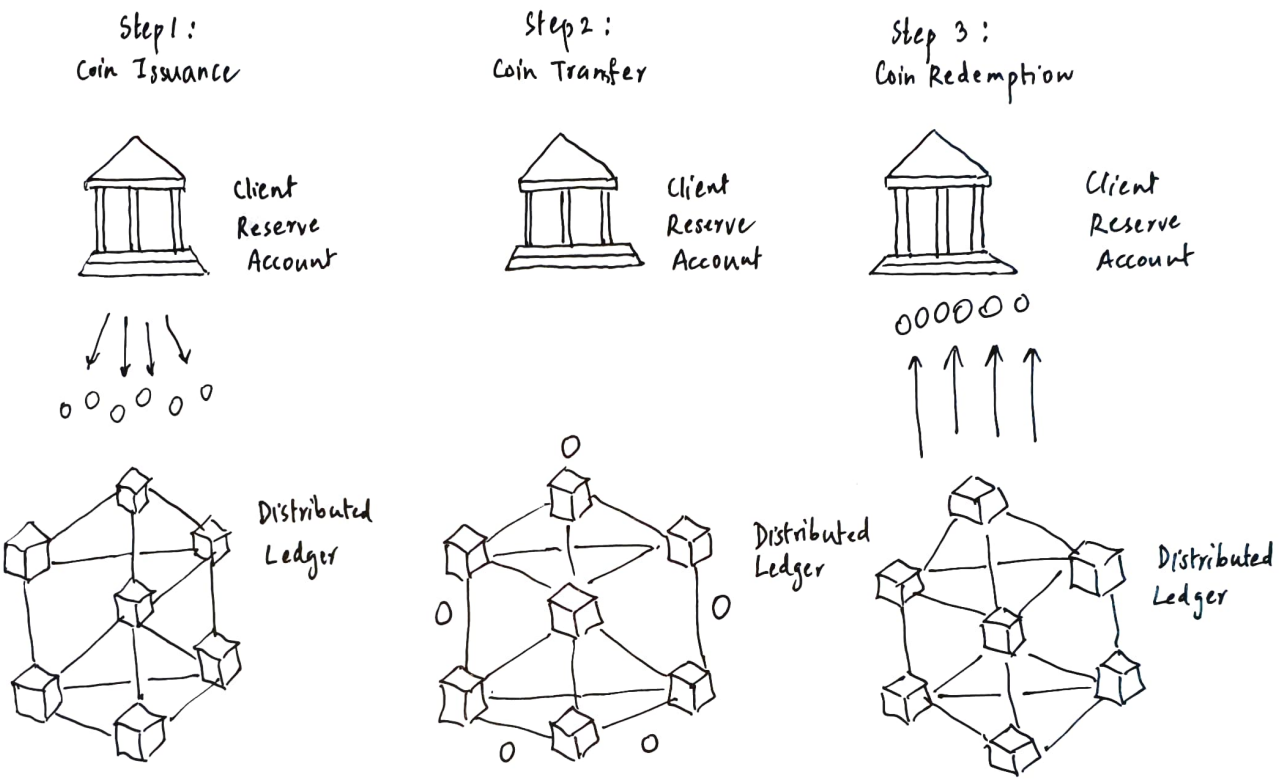


- Central Bank's exploring Blockchain Technology

Project	Phase	Scope	Themes	Platform(s)
Brazil	1. (2017)	• Identify use cases for the central bank using distributed ledger technology (DLT) • Identify a proper DLT platform and build a minimal proof of concept (PoC) • Focused on alternate RTGS system for resiliency purposes	• RTGS • Technology Comparison	• Consensys Quorum • R3 Corda • Blockapps
	2. (2018)	• Information sharing between Brazilian Financial system regulators • Built "Pier" - platform live, on Consensys Quorum	• Information sharing	• Consensys Quorum
Singapore (Project Ubin)	1. (2016)	• Build a POC for domestic payments for interbank obligations on a distributed ledger denominated in balances backed by a central bank. Identify the non-technical implications of deploying DLT for specific RTGS functionalities by putting focus on LSMs.	• RTGS	• Ethereum • Consensys Quorum • R3 Corda • Fabric
	2. (2017)	Understand how RTGS privacy can be ensured on DLT. Compare alternate DLT platforms.	• RTGS • Technology comparison • LSM • privacy	• Consensys Quorum • R3 corda
	3. (2018/9)	Cross-chain interoperability - Consensys Quorum <> Corda	• Interoperability	
South Africa (Project Khoka)	1. (2017/8)	• Build an RTGS system on DLT, with tokens backed by funds held in the central bank. • Investigate privacy solutions while simultaneously having the required throughput • Perform tests in a realistic environment by having each participant run their own node under a variety of deployment models in different locations.	• RTGS • Privacy • Distributed Nodes	• Consensys Quorum

- What is JPM Coin?
  - It is a digital coin designed to facilitate instantaneous payments
  - Created by JPMorgan Chase to represent US dollars held in accounts at JPMorgan Case Bank
  - Will be extended to other major currencies in the future, subject to c ent demand
  - Will be issued on Consensys Quorum and may be subsequently extended to other platforms.

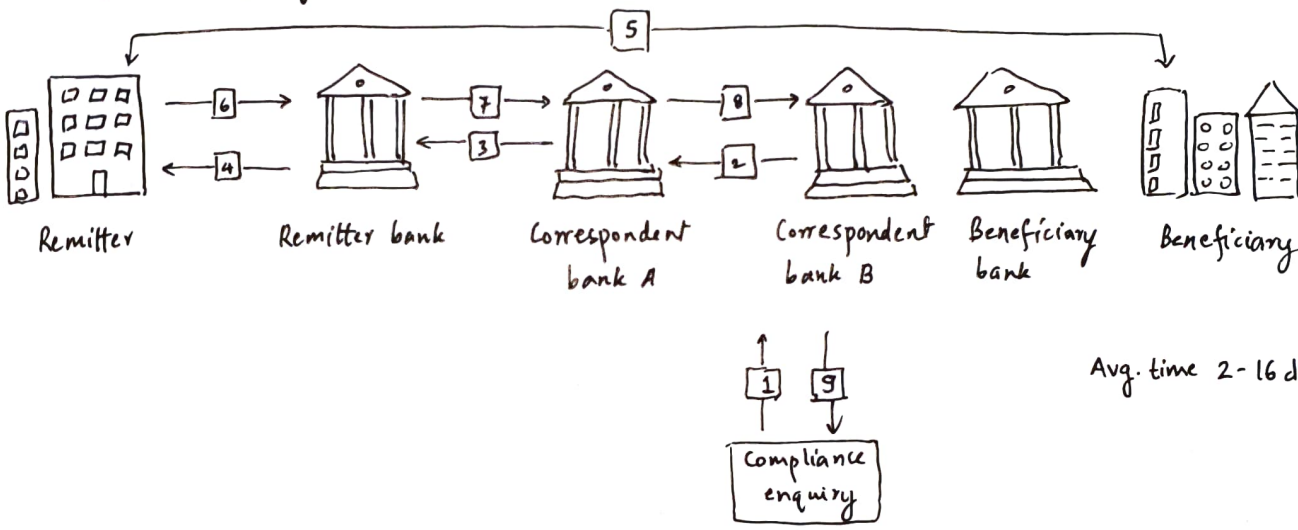
- How JPM Coin Works?



	Cryptocurrencies	Flat-Backed Stablecoins	JPM Coin
Relationship to flat currency	• Value is intrinsic to the coin • Uncollateralized	• Most stablecoins claim to be backed by 1:1 flat reserves held at a bank • Transparency about adequacy of collateral varies by stablecoin	• 1:1 redeemable in fiat currency by clients of JP Morgan Chase Bank account (eg. US $)
Examples	• Bitcoin • Ether • Litecoin	• Libra • Gemini Dollar • USDC • Tether	
Blockchain	• Public - open access	• Public - open access • In case of some stablecoins (eg. USDC) only exchange customers can mint (buy with US $) or redeem (sell for US $) stablecoins but anyone can own/trade	• Permissioned (i.e. enterprise grade secure blockchain solutions built by JPM) • Only institutioned customers passing JP Morgan Chase Bank KYC & onboarded for the JPM coin can transact for JPM coin
Users	• Primarily retail • Limited wholesale investor base	• Retail • Limited wholesale investor base	• Exclusively for institutional customers (eg. Banks, Brokers, dealers and corporates).
Primary Uses	• Investment	• Investment	• Facilitating payment settlement

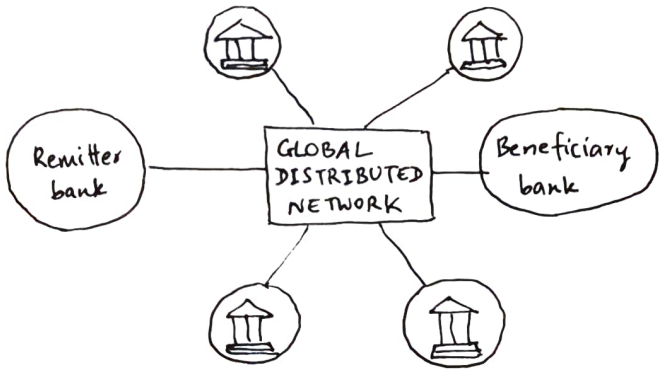
- JPM ONYX Liink - an industry platform for information exchange
  - Create a secure, decentralized, permission-based network to securely exchange information associated with cross-border payments may help enable banks to address today's key pain points, costs and risks by:
    - Reducing payment delays and touch points
    - Facilitation of faster and comprehensive payment tracking
    - Providing real-time sanctions, AML and fraud management tools
    - Maintaining personal information (PI) within a secure network provisioned for validated payments.

- Current Frictions on Cross-Border Payment Processing
  - Today, there are multiple steps to obtain beneficiary-related information when there is a compliance enquiry.



Avg. time 2-16 days

- Liink Aims to Streamline the process of information sharing



- Technology & Infrastructure
- Utility Functions
- Differentiated Product Suites
- Network Adoption
- Liquidity Management
- Peer to Peer Movement
- Streamlined Messaging