**Day 1: Progress Report – Blockchain Learning**

Completed 4 lectures covering the following core topics:

* Centralized, decentralized, and distributed systems
* Definition and structure of blockchain
* Hash functions, digests, and Merkle trees
* Miners and smart contracts
* Block structure and transaction data
* Block hashes and their significance
* Permissioned vs. permissionless blockchains
* Challenge–response in consensus mechanisms
* Provenance tracking in data
* IPFS (Inter Planetary File System) and the distributed web

**Day 2: Progress Report – Blockchain Learning**

**Lectures Covered:** Lecture 5 to Lecture 9 (5 lectures)

**Focus:** Cryptographic foundations and Bitcoin fundamentals

**Core Topics Learned:**

**🔐 Cryptographic Foundations**

* Cryptographic Hash Functions  
  • Properties: Collision Resistance, Pre-image Resistance, Avalanche Effect, Puzzle-Friendliness  
  • Introduction to the SHA-256 algorithm\*
* Hash Pointers and Hashchains  
  • Concept of hash pointers as secure references to previous data  
  • Use of hashchains in ensuring data integrity

**🌲 Merkle Trees**

* Structure and purpose in efficient data verification
* Use in blockchain for verifying large transaction sets efficiently

**✍️ Digital Signatures & Public Key Cryptography**

* Purpose of digital signatures in verifying authenticity
* Public and Private Key Mechanism  
  • Public Key (used for encryption)  
  • Private Key (used for decryption)
* RSA Algorithm: Basics of public key encryption\*
* Digital Signing Workflow  
  • Signing with private key, verification with public key  
  • Efficiency via signing the hash (digest) instead of full message

**💰 Cryptocurrency Concepts**

* Introduction to Cryptocurrency secured by hashchains and digital signatures
* **Bitcoin Basics**  
  • Coin creation and supply  
  • Sending payments  
  • Double spending problem and blockchain’s solution  
  • Anonymity in Bitcoin

**📜 Bitcoin Script**

* Introduction to Bitcoin’s scripting language (similar to Forth)\*  
  • Stack-based, uses postfix notation  
  • Common instructions and examples of real-world Bitcoin scripts

**🌐 Bitcoin P2P Network**

* Joining the Bitcoin peer-to-peer network
* Transaction broadcast (flooding mechanism)
* Mining and block generation  
  • Mining puzzle and Proof-of-Work  
  • Block flooding and propagation  
  • Consensus via longest valid chain  
  • Handling latency in block propagation

**Day 3 Progress Report – Blockchain Learning**

Lecture covered: 10 to 13 (4 lectures)

1. Consensus
2. why Consensus
3. example
4. why it can be difficult in certain scenarios
5. Distributed consensus
   1. Faults in distributed systems
      1. Crash fault
      2. Network/portioned fault
      3. Byzantine fault
   2. Properties
      1. Termination
      2. Validity
      3. Integrity
      4. Agreement
6. Synchronous vs Asynchronous system
   1. Asynchronous system
      1. FLP85
   2. Synchronous system
      1. Paxos
      2. Raft
      3. Byzantine fault tolerance (BFT)
7. Correctness of distributed consensus protocol
   1. Safety
   2. Liveliness
8. Consensus in an open system
   1. Traditional distributed consensus protocol
      1. Message passing
      2. Shared memory
9. Consensus in a bitcoin network
10. Consensus algorithm in bitcoin
    1. PoW
       1. Cryptographic hash as PoW
       2. Hashcash PoW
11. Bitcoin Proof of Work
    1. Solving the double spending problem
12. Sybil attack
13. DOS (denial of services) attack
14. Breaking bitcoin PoW
    1. The monopoly problem
    2. PoW power consumption
15. Handling monopoly and power consumption – proof of stake(PoS)
16. PoS (Proof of stake)
    1. Variant of stake
17. PoB (proof of burn)
18. Difference between PoW, PoS and PoB
19. PoET (Proof of elapsed time) {intel}
    1. PoET over trusted environments
20. Mining bitcoins
    1. The life of a miner
    2. Mining difficulty
    3. Setting the difficulty
    4. Hash rate vs difficulty
    5. Mining hardware
    6. Mining pool methods
       1. Pay per share (PPS)
       2. Proportional
       3. Pay per last N share (PPLNS)
       4. Pros and cons

**Day 4 Progress Report – Blockchain Learning**

Lectures: 14 to 17

1. Permissioned model
   1. Use cases
      1. Provenance tracking of assets
2. Smart contracts
   1. Design limitations
      1. Sequential execution
      2. Non-deterministic execution
      3. Execution on all nodes
3. Do we really need to execute contracts at each node?
   1. What if the node that executes the contracts is faulty?
   2. Use state machine replication
4. State machine replication
5. State machine
6. Smart contract state machine – crowd-funding
7. Distributed state machine replication
   1. Place copies of the state machine on multiple independent server
   2. Receive client requests, as an input to the state machine
   3. Propagate the inputs to all the servers
   4. Execute the inputs based on the order decided, individually at each server
   5. Sync the state machines across the servers, to avoid any failure
   6. If output state is produced, inform the clients about the output
8. Permissioned blockchain and state machine replication
9. Why distributed consensus
10. Faults in distributed consensus
    1. Crash fault
    2. Network or partitioned faults
    3. Byzantine faults
       1. Malicious behaviour in nodes
       2. Hardware fault
       3. Software error
11. Consensus for three processes
12. Requirement of a consensus algorithm
    1. Termination
    2. Agreement
    3. Integrity
13. Different consensus algorithms
    1. Crash or network faults
       1. PAXOS
       2. RAFT
    2. Byzantine faults (including crash or network failures)
       1. Byzantine fault tolerance (BFT)
       2. Practical byzantine fault tolerance (PBFT)
14. PAXOS
    1. Types of nodes
       1. Proposer
       2. Acceptor
       3. Learner
    2. Making a proposal:
       1. proposer process
       2. Acceptor’s decision making
       3. Acceptor’s message
    3. Accepting a value:
       1. Proposer’s decision making
       2. Accept message
       3. Notifying learner
    4. Single proposer: No rejection
15. Handling failure:
    1. Proposer failure
    2. Dueling proposers
16. RAFT consensus
17. RAFT
18. Electing the leader:
    1. voting request
    2. Follow node’s decision making
    3. Majority voting
19. Multiple leader candidate:
    1. Current leader failure
    2. Simultaneous request vote
20. Committing entry log
21. Handling failure
22. Byzantine general problem
23. Practical byzantine fault tolerant
    1. Practical byzantine fault tolerant model
       1. Assumptions (asynchronous network, faulty nodes)
       2. 3f+1 nodes req. to tolerate f byzantine faults
    2. Practical byzantine fault tolerant algorithm
       1. Three phase protocol
          * Pre-prepare phase
          * Prepare phase (2f) (excluding its own)
          * Commit phase (2f+1) (including its own)
       2. View change protocol
          * Handle primary failure
          * Ensures progress despite faulty/malicious leader/primary
    3. Correctness
       1. Safety
       2. Liveness
24. Consensus in permissioned model

**Day 5 Progress Report – Blockchain Learning**

Lecture covered (18 -24)

1. Blockchain defined
   1. Problem; difficult to track asset transfers in a business network
   2. Solution; shared, replicated, permissioned ledger
      1. Consensus, provenance, immutability and finality
2. Key concepts and benefits of blockchain for business
   1. Shared ledger
   2. Smart contracts
   3. Security
   4. Consensus
   5. Reduced time
   6. Removes cost
   7. Reduces risk
   8. Enables new business model (IoT integration into supply chain)
3. Degree of centralization
   1. From 100% centralized to 100% decentralized in a gradient manner
4. Permissionless vs permissioned blockchain
   1. Access
   2. Scale
   3. Consensus
   4. Identity
   5. Asset
5. The Linux foundation: Hyperledger project
6. Hyperledger fabric: distributed ledger platform
7. Hyperledger composer: accelerating time to value
8. Actors in a blockchain solution
   1. Regulator
   2. B2B transaction
   3. Membership services
   4. Traditional data resources
   5. Traditional processing platforms
   6. Blockchain network operator
   7. Blockchain developer
   8. Blockchain architect
9. Component in a blockchain solution
   1. Ledger
   2. Smart contract
   3. Peer network
   4. Membership
   5. Events
   6. System management
   7. Wallet
   8. System integration
10. Ledger component
    1. Blockchain
       1. A linked list of blocks (hashchain)
       2. Each block describes a set of transactions
       3. Immutable – blocks can’t be tempered
    2. World state
       1. Stores the most recent state of smart contracts/output of transations
       2. Stored in a traditional database (e.g. key value store)
       3. Data elements can be added, modified, deleted, all recorded as transactions on blockchain
11. Block detail (simplified)
    1. The first block known as genesis block
    2. Block contents (explained)
12. Ledger example: A change of ownership transaction
13. How applications interact with ledger
14. Blockchain events
15. Integrating with existing systems – possibilities
16. Byzantine general problem (was supposed to be cover above but dues to series in playlist, got misplaced)
    1. Three generals problem
       1. Lieutenant faulty
       2. Commander faulty
    2. Four generals problem
       1. Lieutenant faulty
       2. Commander faulty
    3. Byzantine generals model
    4. Lamport-shostak-pease algorithm
17. Hyperledger fabric V1 architecture
    1. External CA, membership services, fabric CA
    2. Client application / SDK (HFC)
    3. Ordering service
    4. Peer
       1. Endorser
       2. Committer
       3. Ledger
       4. Chaincode
       5. Events
    5. Admin etc
    6. Nodes and roles
       1. Committing peer
       2. Endorsing peer
       3. Ordering node
    7. Transaction Flow
       1. Endorse > order > validate
    8. Transaction flow in 7 steps
       1. Propose transaction
       2. Execute proposed transaction
       3. Propose response
       4. Order transaction
       5. Deliver transaction
       6. Validate transaction
       7. Notify transaction
    9. Key benefit of transaction flow
18. Ordering services
    1. Configuration options
       1. SOLO
          1. Single node for development
       2. Kafka: crash fault tolerant consensus (Deprecated)
          1. 3 nodes minimum
          2. Odd numbers of nodes recommended
19. Channels
    1. Single channel network
    2. Multi-channel network
20. Fabric peer
21. Client application
22. Fabric certificate authority
23. Organisations
    1. Each organisation defines:
       1. Membership services provider (MSP) for identities
       2. Admin (s)
       3. Users
       4. Peers
       5. Orderers (optional)
    2. A network can include many organisations representing a consortium
    3. Each organisation has an ID
24. Consortium network
    1. An example consortium network of 3 organisations
       1. Org 1 and 3 run peers
       2. Org 2 provides the ordering services only
25. MSP overview
26. Transport Layer Security (TLS)
27. User Identities
28. Admin identities
29. Peer and orderer identities
30. Channel MSP information
31. New user registration and enrolment
32. Transaction signing
33. Hyperledger fabric network setup
    1. Configure and start ordering service
    2. Configure and start peer node
    3. Install chaincode
    4. Create channels
    5. Join channels
    6. Instantiate chaincode in channel
34. Endorsement policies
    1. Endorsement system chaincode
    2. Validation system chaincode
    3. Endorsement policy syntax
    4. Endorsement policy example

**Day 6 Progress Report – Blockchain Learning**

Lecture (25 to 31)

1. Fabric demo on IBM blockchain cloud

* Covering lecture 25, 27 and 28
* (tried to open the site and perform the demo by myself but I guess the site has removed the functionality as per today’s time)
* I am not sure but I guess there are some changes occurred from the time when lecture took place and today. Which was causing some disturbances while checking out with the things.

1. Hyperledger fabric explainer

* Covering lecture 26
* An informative video of around 2 and half minute for understanding of Hyperledger fabric.

**Hyperledger composer (lecture 29, 31) with one optional video (lect. 30)**

1. Hyperledger composer: accelerating time to value
   1. A suite of high-level application abstractions for business network
   2. Emphasis on business centric vocabulary
   3. Reduce risk, and increase understanding and flexibility
2. Features
   1. Model your business networks, test and expose via APIs
   2. Applications invoke transactions to interact with business network
   3. Integrate existing systems of record
3. FULLY OPEN AND PART OF LINUX FOUNDATION HYPERLEDGER {not as per today}
4. Goal for Hyperledger composer
5. Extensive, familiar, open development toolset
   1. Data modelling
   2. Javascript business logic
   3. Web playground
   4. Client libraries
   5. Editor support
      1. Atom
      2. Vscode
   6. CLI utilities
   7. Code generation
   8. Existing systems and data
6. User role in blockchain solution {a single organization may play multi roles
   1. Network service provider
   2. Network service consumer
   3. Business service provider
   4. Business service consumer
   5. End user
7. Key concept for the business service provider
8. Example: vehicle auction developer
9. Business service provider develops three components
   1. Smart contracts
   2. Business logic
   3. Presentation logic
10. Key development concepts
    1. Model files
    2. Access control list
    3. Transaction processor
    4. Business network definition
11. Assets, participants and transactions
12. Access control
13. Event and queries
14. Smart contract development: composer playground
15. General purpose development: visual studio tool
16. Creating the business and end user applications
17. Debugging
18. Network administration
19. Two roles with “admin” responsibilities
    1. Network service consumer
    2. Business service consumer
20. Key concept for administrators
21. Network service consumer packages resources in a BNA file
22. Connection profiles to Hyperledger fabric
23. Participant identity
24. Business network cards
25. System of record integration
26. Exploiting loopback: examples
27. How composer maps to fabric chaincode
28. Hyperledger composer outlook
29. Get started with hyperleger composer

**Day 7 Progress Report – Blockchain Learning**

Lecture: 32 to 37

**Blockchain use cases**

1. Sample use cases by industry
   1. Financial services
   2. Public sector
   3. Retail
   4. Insurance
   5. Supply chain & logistic
2. What makes a good blockchain use case?
   1. A business problem to be solved with efficiency than it’s alternatives
   2. An identifiable business network
   3. A need of trust
3. Understand the business problem
   1. Specific business problem/ challenges
      1. Scope the business challenge up front
   2. It’s current solution
   3. What specific aspects of this business problem will be addressed (assuming the business problem is large)
4. Understanding the participants
   1. Who are the business network participants/ their roles
   2. Who are the specific people within the organization and what are their job roles?
5. Understanding the participants in details (refer to notes)
6. Identities
7. Understanding the assets and transactions
   1. What assets are involved and its associated key info
   2. What transactions are involved and its associated assets
8. Defining transactions
9. Additional point of understanding (refer to notes)
10. Addressing business value
11. Building communities in blockchain networks
    1. Consortium based network
    2. Founder directed network
    3. Community based network

**Payments and secure trading**

1. Cross border payments
2. Stellar protocol and network
3. Ripple protocol and network
4. Permissioned network for payments and settlement
5. Project UBIN: SGD on distributed ledger
   1. Project Ubin phase 1: technical architecture
   2. Project ubin phase 2
   3. Project ubin phase 2 decentralized netting
   4. Project ubin: phase 2 (refer to notes to differentiate between b and d)
6. Blockchain for commercial paper
7. Components, processes in securities trading
8. Securities T+3 trade life cycle
9. Security settlement in low liquidity markets
10. Private equity administration

**Blockchain in finance services: compliance and mortgage**

1. Compliance (KYC, AML)
2. Know your customer (KYC)
3. Shared KYC solution
4. Information sharing
5. Privacy and consent
6. Mortgage processes
7. Example mortgage origination process
8. Syndicated loans

**Blockchain in financial services: financial trade**

1. Overview of international trade
2. Blockchain enabled future state
3. Trade finance elaborated
4. Trade finance: advantages using blockchain
5. We.trade: trade finance network
6. Supply chain financing – as – is
7. Blockchain solution roles/responsibilities