Welcome!

- We'll start in a moment :)
- We are NOT recording tonight's event. We may plan to take screenshots for social media.
    - ***If you want to remain anonymous***, change your name & keep video off.
- We'll introduce the hosts and break in-between for Q/A.
- We will make some time for Q&A at the end of the presentation as well.
- You can come prepared with questions. And, feel free to take notes.
- Online event best practices:
    - Don't multitask. Distractions reduce your ability to remember concepts.
    - Mute yourself when you aren't talking.
    - We want the session to be interactive.
    - Feel free to unmute and ask questions in the middle of the presentation.
    - Turn on your video if you feel comfortable.
    - Disclaimer: Speaker doesn't knows everything!

Check out:

- Technical Tracks and Digital Events
- Get updates – join the Digital mailing list
- Give us your feedback – take the Survey

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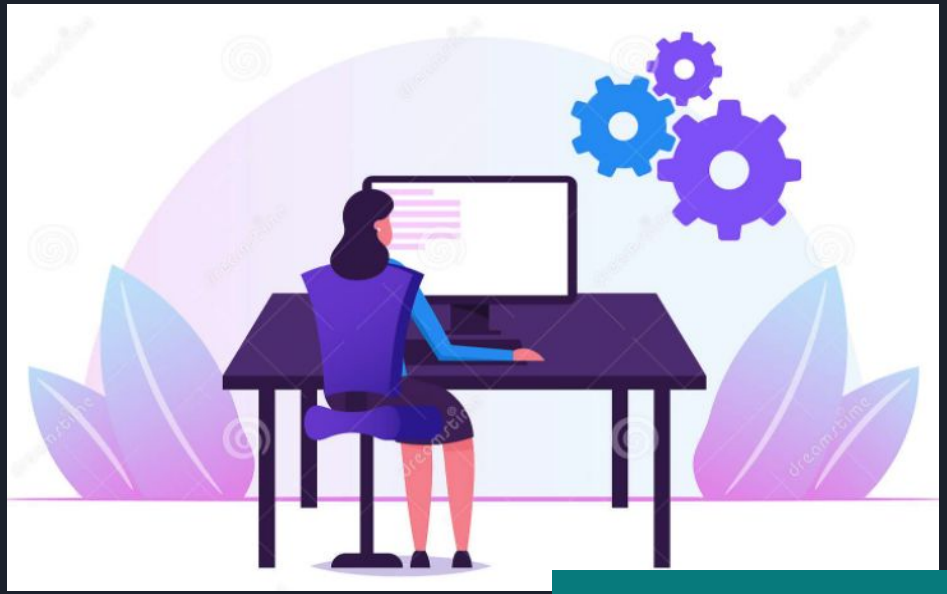

WWCode Digital + **Backend Study Group**

May 5, 2022

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Backend Study Group

- Welcome from WWCode!
- Our mission: Inspiring women to excel in technology careers.
- Our vision: A world where women are representative as technical executives, founders, VCs, board members and software engineers.

Harini Rajendran
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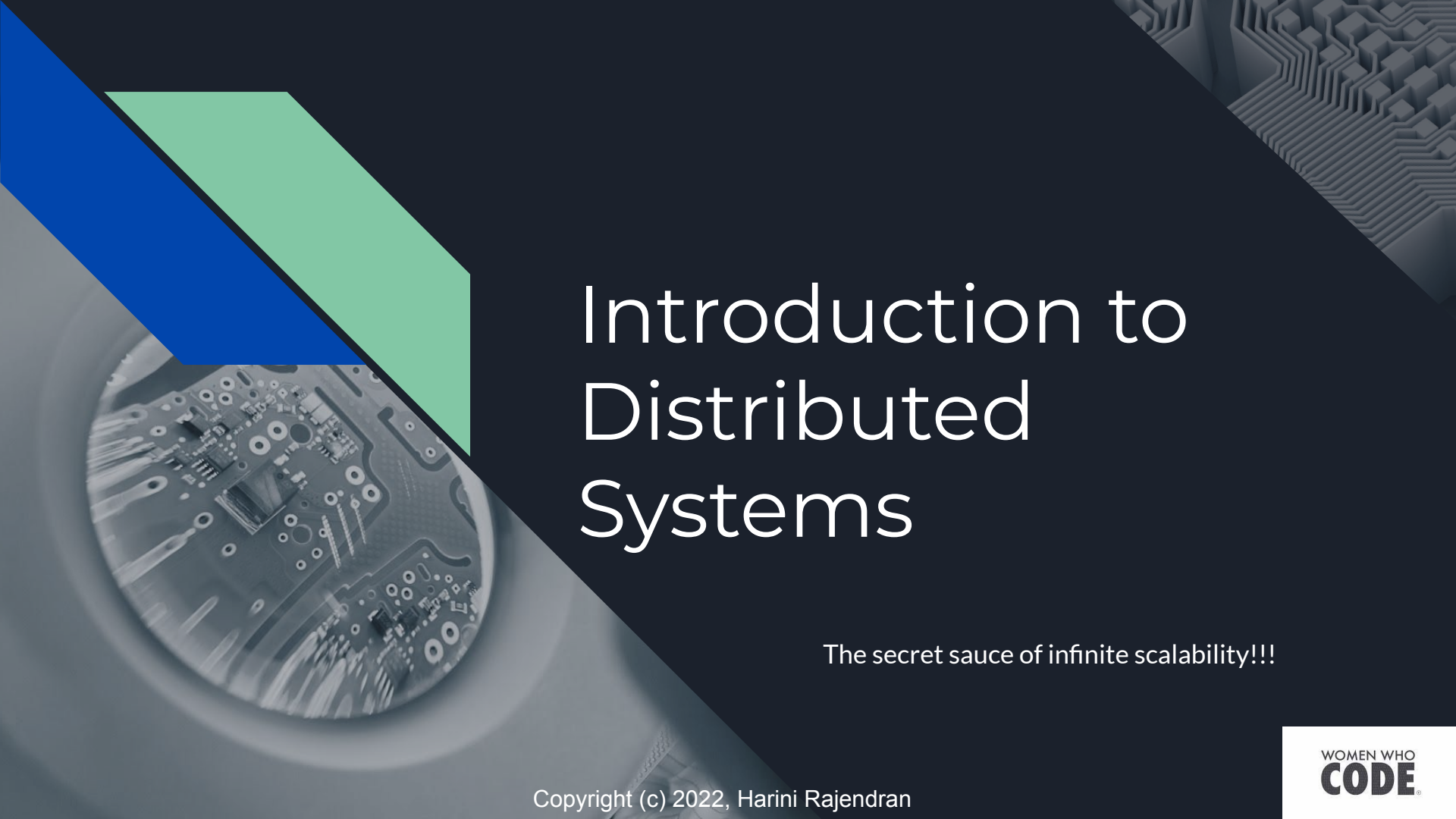

Introduction to Distributed Systems

The secret sauce of infinite scalability!!!

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Agenda

What is Distributed Systems

Why Distributed Systems

Characteristics of Distributed Systems

Challenges of Distributed Systems

Distributed Systems Categories

Q & A

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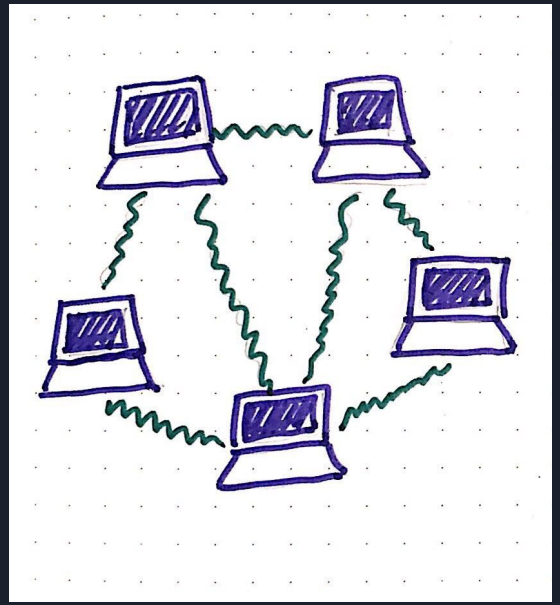
What is Distributed Systems



A group of computers working together but appears as a single computer to the end user.

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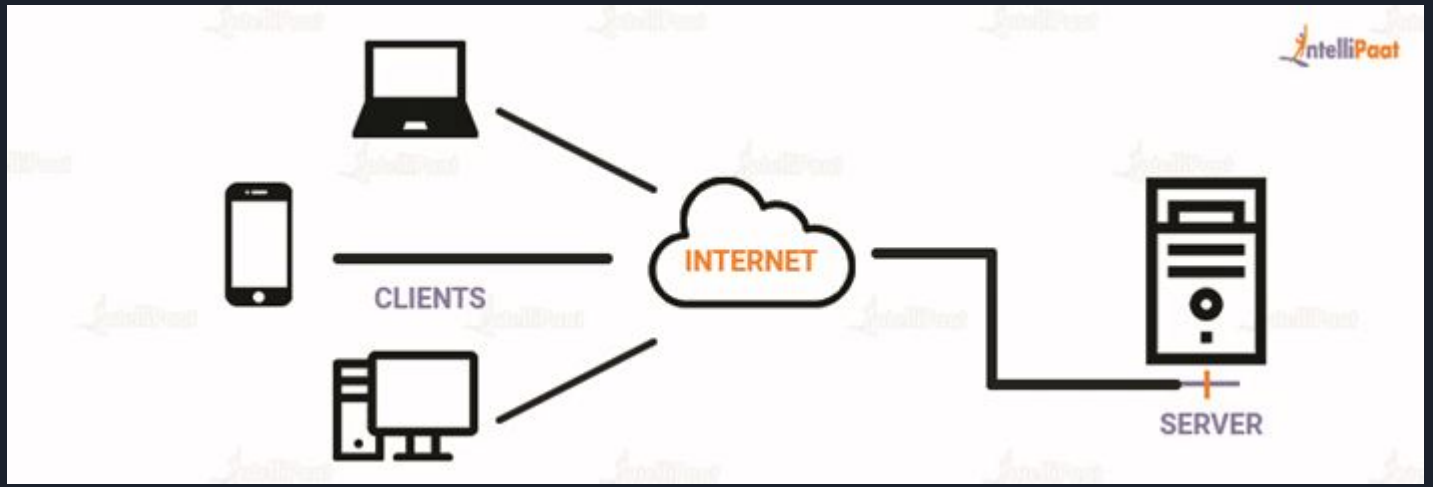
What is Distributed Systems

- Shared state, operate concurrently
- Can fail independently without affecting the whole system's uptime. No Single Point of Failure
- The devices split up the work, coordinating their efforts to complete the job more efficiently than if a single device had been responsible for the task.
- All components are connected by a network for communication with each other

Types of Distributed Systems Architecture

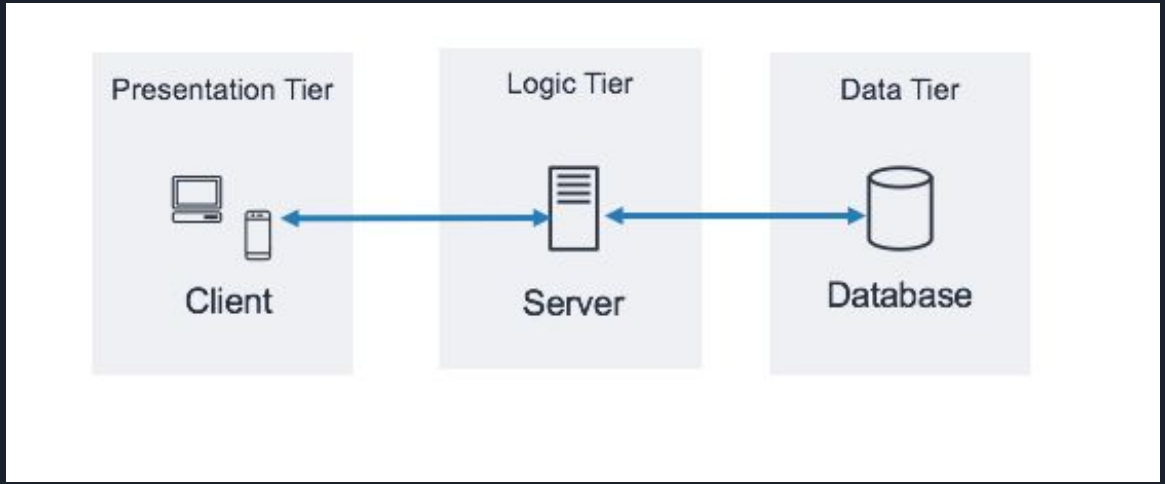
- Client Server
- Multi Tier
- Peer to Peer

Client Server Architecture



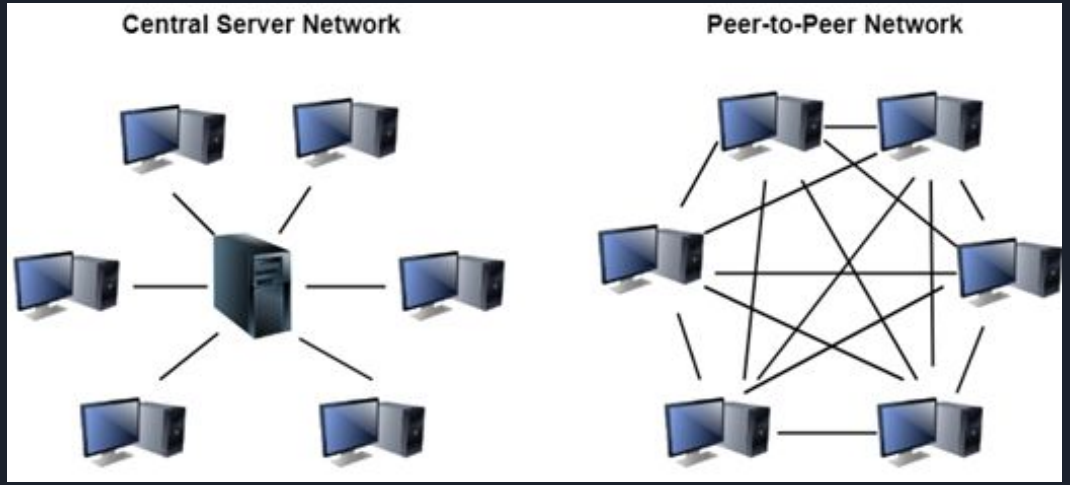
- Many clients (remote processors) request and receive service from a centralized server (host computer).
- Server does all heavy-lifting
- Ex: Printers in library

Multi Tier Architecture



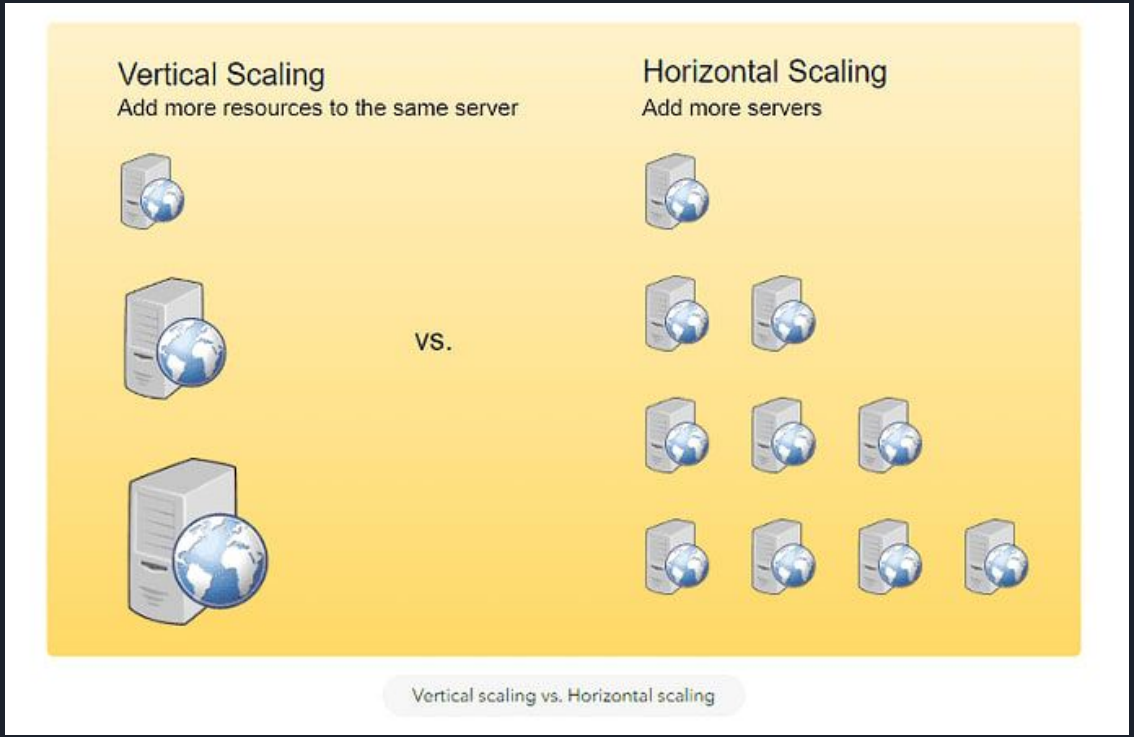
- Presentation Tier -> Application Tier -> Data Tier
- These tiers can be scaled up/down independently
- Each tier can be developed concurrently by different team of programmers in different programming languages

Peer to Peer Architecture

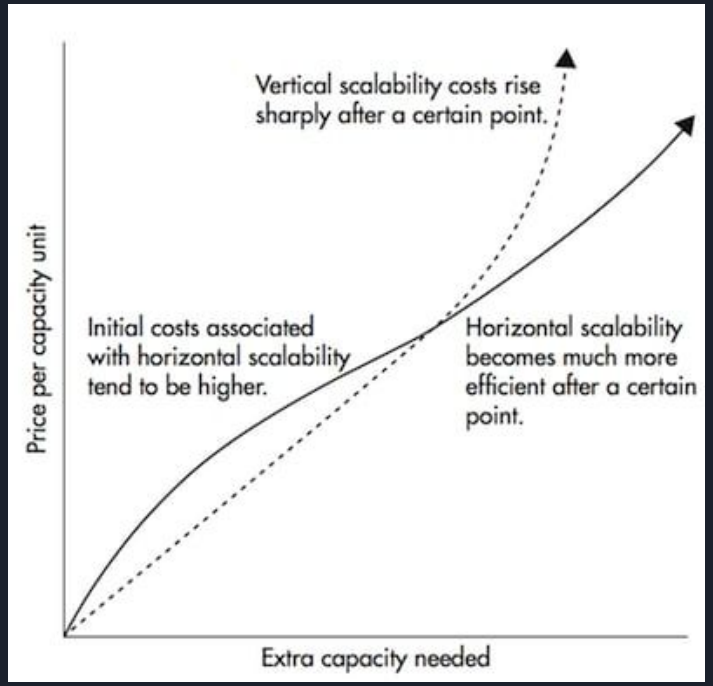


- No centralized or special machine that does the heavy lifting and intelligent work
- All the decision making and responsibilities are split up amongst the machines involved
- Each could take on client or server roles.
- Blockchain is a good example of this.

Why Distributed Systems



Why Distributed Systems



- Enables indefinite scaling(theoretically)
- Cheaper to scale because of commodity hardware
- Computation speed
    - Parallel computation on multiple computers
- No more single point of failure

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Characteristics of Distributed Systems

- Scalability
  - Scalability is the capability of a system, process, or network to grow and manage increased demand.
  - Horizontal and vertical scaling
  - Reasons for scaling: Increased data volume, Increased workload

- Reliability
  - Reliability is the probability a system will not fail in a given period
  - The system will continue to work even when one or more components fail
  - Cheap commodity hardware - Failed nodes can be replaced easily
  - Achieved through redundancy of software components and data

- Availability
  - Availability is when a system remains operational to perform its required function in a specific period
  - Percentage of time a system is operational

Characteristics of Distributed Systems

- Efficiency
  - Latencies (Response time)
  - Throughput (Number of requests handled)
  - Decisions to scale the system up are usually based on these factors

- Serviceability or Manageability
  - Ease of maintenance and operations
  - Speed at which the system can be maintained or repaired
  - High maintenance can result in low availability
  - Ease of diagnosis, sufficient logging, sufficient operational metrics, intelligent monitoring and alerting, etc

Challenges of Distributed Systems

- Increased opportunities for failure
  - In a poorly designed system, a single node crash can bring the whole system down
  - Fault tolerance is not foolproof
- Synchronization between processes
  - No global clock
  - In a complex multi user system (Eg: Online video games), synchronization is a challenge because it is also dependant on public network which carries data
- Scalability and performance are not linear
  - 2x number of nodes doesn't mean 2x performance
  - Designing a distributed system with linear scalability is super complicated and has to take into account load balancing, bandwidth management, redundancy management, etc
- Security is complex
  - A single weak link in one node can expose the whole system to attack

Distributed Systems Categories

- Distributed Datastore
- Distributed Computing
- Distributed File system
- Distributed Messaging
- Distributed Ledger
- Distributed Applications

Distributed Systems Categories

Datastore	Apache Druid, Elasticsearch, Cassandra, DynamoDb
Computing	Hadoop MapReduce, Apache Spark, Apache Storm, Apache Flink, Apache Samza, Kafka streams
File System	HDFS - Hadoop Distributed File System
Messaging	Apache Kafka, Rabbit MQ, Amazon Kinesis
Ledger	Blockchain, Bitcoin
Applications	BitTorrent, Netflix, google.com, Most modern large scale systems

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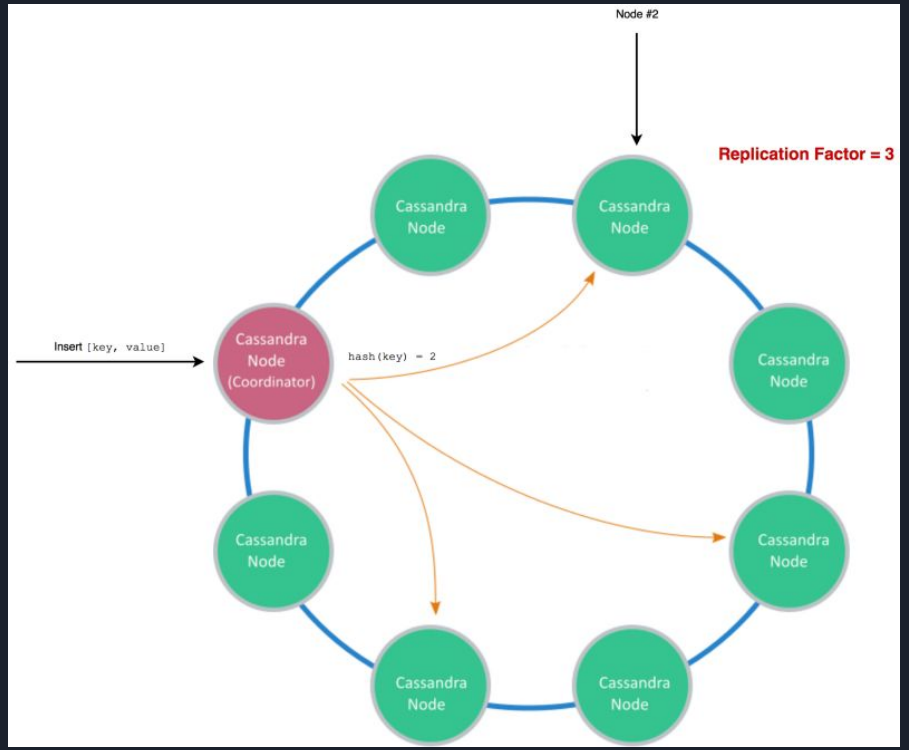
Distributed Datastore

- Most NOSql Databases
- Different types: key value store, graph based datastore, column based datastore, document based datastore

Cassandra

- Key value datastore
- Uses consistent hashing
- Massively scalable and high write throughput



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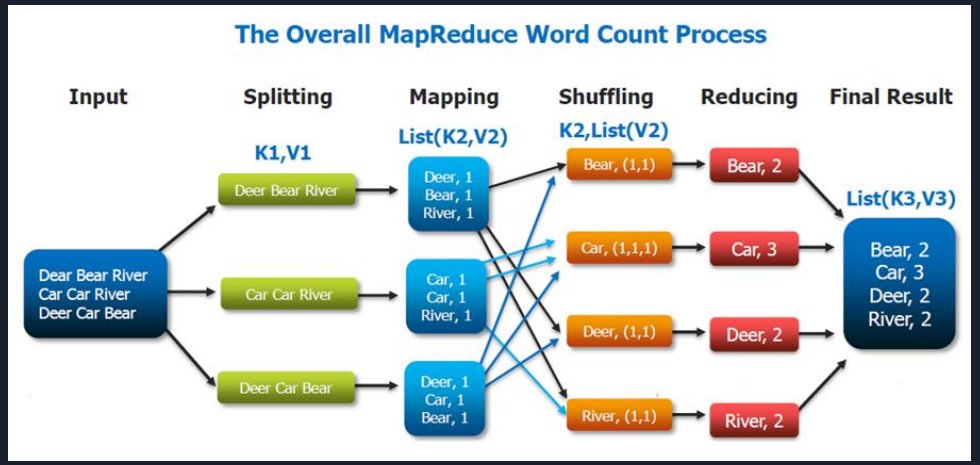
Distributed Computing

- Key to modern scale high volume data processing
- Splitting enormous task across multiple systems which no one computer can handle

MapReduce

- Founded by Google
- Two stages: Map and Reduce
- Each map node works on subset of data
- Intermediate step: Shuffle (Arrange and partition data)
- Final stage: Reduce - Each node works subset of partitions



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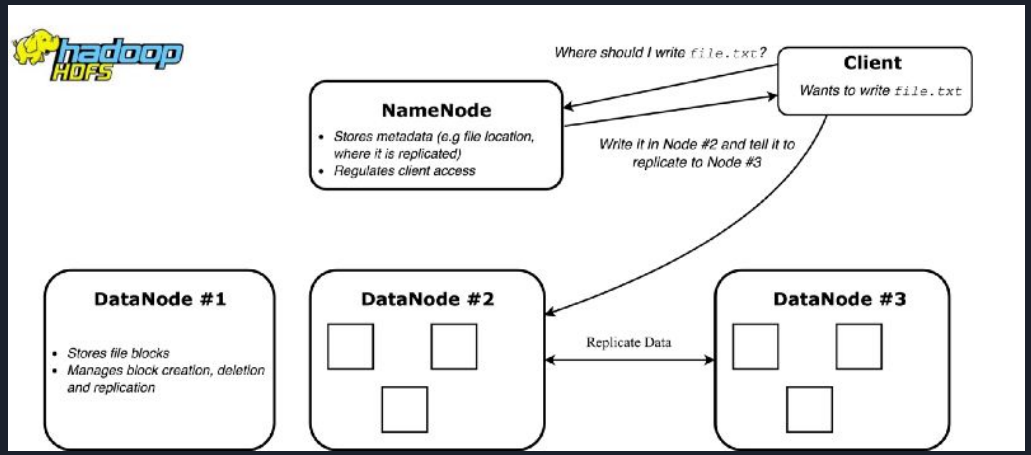
Distributed File System

- Similar to Distributed Datastores
- Large amount of files are stored across multiple nodes

HDFS

- Namenodes and Datanodes
- Namenode - Has all metadata about cluster
- Namenode acts as coordinator
- Namenode is responsible for data placement
- Datanodes - This is where data resides
- Datanodes are responsible for storing, deletion and replication of data blocks



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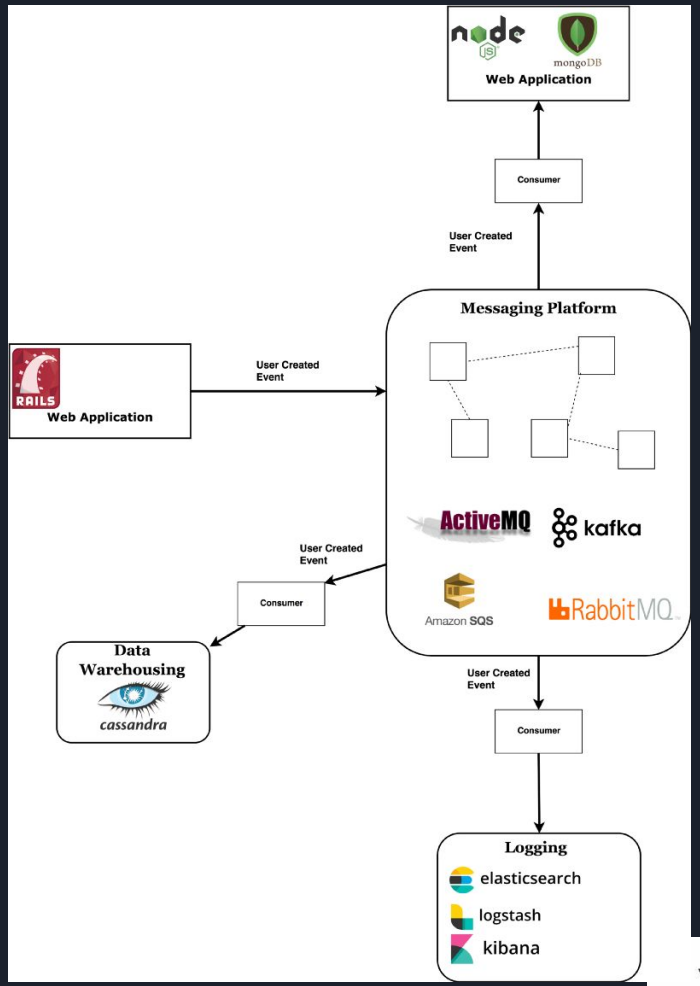
Distributed Messaging

- Distributed message queues
- Used for storage and propagation of enormous number of events in a centralized place
- Decouples application logic from directly talking to other systems

Apache Kafka

- Collection of nodes called brokers
- Producers and Consumers
- Data is organized as topics
- Topics are split into partitions
- [Introduction to Kafka slides]



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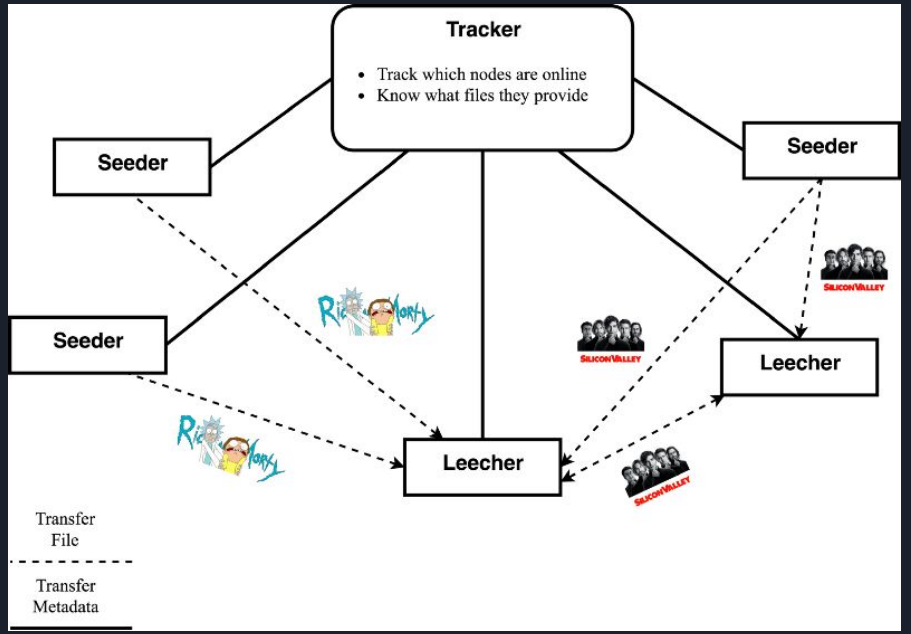
Distributed Application

- Any application whose back end is run across multiple nodes with distributed storage and computation is a distributed application
- Appears as one system to the end user
- Example: Facebook, Netflix, Whatsapp, Instagram, etc



BitTorrent

- Famous for downloading pirated movies :)
- Peer to peer network
- Tracker: Coordinator which coordinates a download/upload
- Seeder: Source of distributed files
- Leecher: Downloaders of the files

Image Credit

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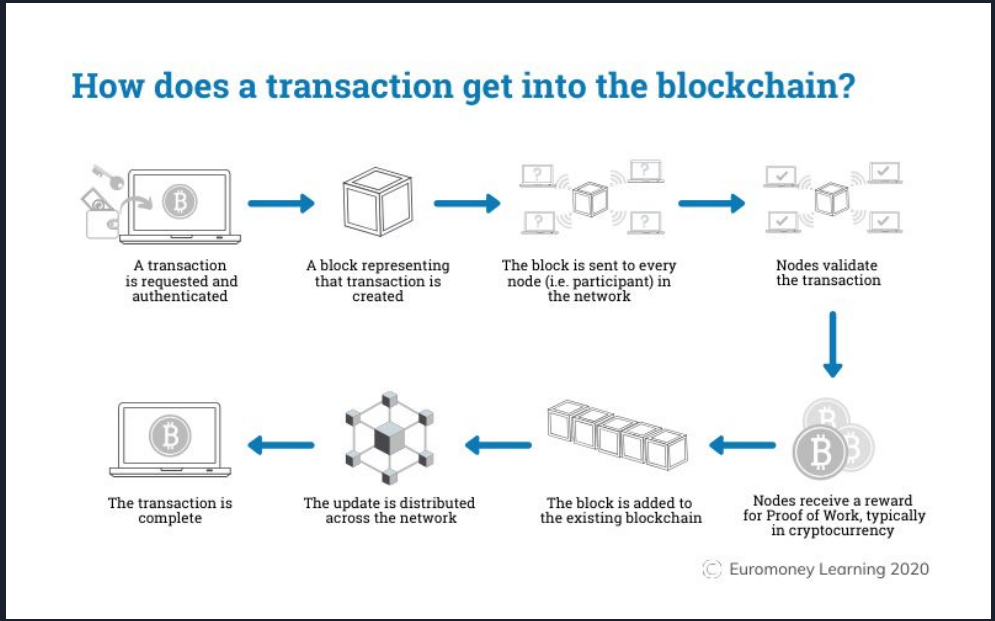
Distributed Ledger

- Peer to peer network
- Immutable, append-only database that is replicated, synchronized and partitioned across all nodes in the distributed network

Blockchain for Bitcoin

- Blockchain is the underlying technology
- Distributed ledger carries ordered list of transactions
- Transactions are grouped and stored in blocks across nodes in the network
- Blocks are computationally expensive to create and tightly linked to each other using cryptography
- Miners create these blocks using extensive CPU



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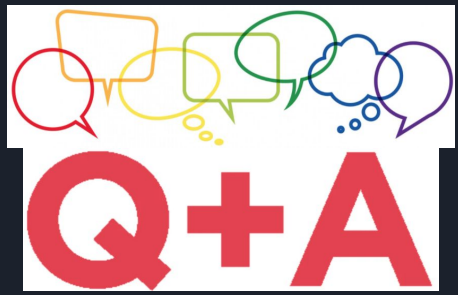

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Backend Study Group:

• Presentations and session recordings found here: WWCode YouTube channel

You can unmute and talk or use the chat.

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