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System Design

→ Network Protocol :-

It is a mechanism or a set of procedures that enables devices to communicate back and forth across the internet.
Two devices must support the same protocol to make communication.

• Three types of network protocols -

(i) **Network Management Protocol -**
These protocols set out policies designed to monitor, manage and maintain a network.
Example - SNMP, FTP, POP3 etc.

(ii) **Network communication protocol -**
A group of protocols used for exchanging the data across a network.
Ex - TCP, UDP, IP, HTTP etc.

(iii) **Network security protocol -**
Protocols that use security measures such as cryptography and encryption to protect data.
Ex. SSL and HTTPS, SFTP.

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1) Transmission Control Protocol (TCP) a.k.a Internet Protocol

- protocol that converts data into packets which is sent between senders and receiver.
- organization use TCP to transfer contents such as files, text, images and emails.
- It guarantees that packet will be delivered accurately and in correct order.

How TCP generate connection?

- The client sends a (SYN) synchronize sequence number to destination server.
- Destination server sends an acknowledgement message known as SYN-ACK.
- origin device receives it & generate ACK message & finalize the connection.

2) User Datagram Protocol (UDP) -

It is also a communication protocol which is designed to send data in form of datagrams from one device to another.

UDP are mostly used than TCP because it offers higher transfer speed.

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It better supports video/audio streaming services, online games which can handle some data loss.

The big difference is that UDP doesn't attempt to establish a connection ~~bet~~ before sending packets to destination which in case will not guarantee the delivery of data to correct device.

3) FTP (File Transfer Protocol) -

It is a network protocol that is used to transfer files from one device to another over an TCP/IP connection.

many organization use FTP because it sends large files or lots of files in one go (∵ it is fast). But it do not give security measure as it transmit all data in plain text.

So, to secure the data organization use FTPS (file transfer protocol secure socket layer) as it provide SSL encryption to the data.

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4) Hypertext Transfer Protocol (HTTP) :-

- communication protocol that enables system to communicate on World Wide web.

- HTTP's request-response cycle to load all necessary text, videos and images on a web page :-
1) Client sends an HTTP request message to server.
2) Web server processes the request message.
3) web server sends a response message which include web page.
4) Then, client receives the message and loads in web browser.

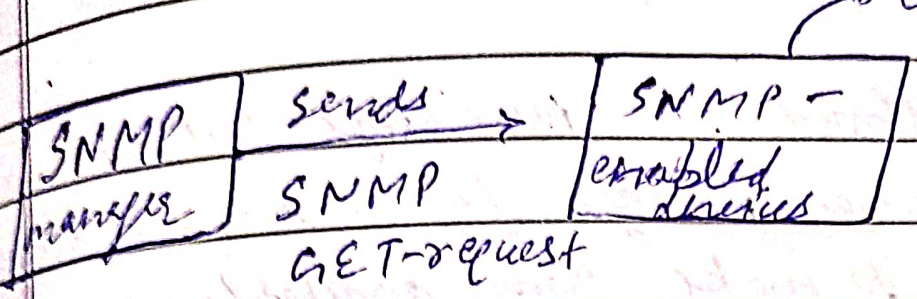
But it is not secure, so to make it secure HTTPS is used which use SSL encryption to encrypt & decrypt the request & response.

5) Simple Network Management Protocol (SNMP) -

- SNMP is an application layer protocol that's used to collect management information from devices such as computers, routers, printers etc.

- SNMP monitors performance and status of devices

throughout a network in real time.



6) Internet Control Message Protocol (ICMP) -

- This network protocol warns devices about connectivity issues and errors.
- It notify devices that forwarded message too long or arrived out of order & send an error message to request to resend the content.
- mainly cyber criminals use the protocol as part of ICMP flood attack.

7) Post Office Protocol (POP) -

- It is a protocol that enables a server to retrieve emails from a remote server & download them to local server or device.

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- Whenever client connects to server, it automatically download new messages to it.

- Email platforms like Microsoft Outlook use POP3 to collect email message from remote server via TCP/IP to make them available offline.

- all emails deleted after download is done from server automatically.

8) Internet message Access Protocol (IMAP)

- It is also used for retrieving emails.
- when a user try to access any email, then, that email will not download or store on computer locally but remains on remote server.
- It helps user to access emails from multiple devices.
- It doesn't automatically delete emails.

9) Simple Mail Transfer Protocol —

- It is a mail delivery protocol that allows a device to sends and dfloy emails to a remote endpoint with a TCP connection.

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- Microsoft Outlook, Gmail, Yahoo Mail use SMTP to send message to remote servers.

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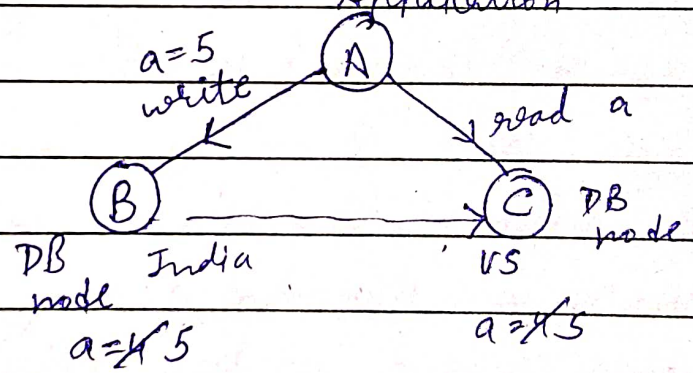
CAP Theorem -

It states that in a distributed data store, it's impossible to simultaneously guarantee all three of following -

1) Consistency (C) :-

Every read receives the most recent write or an error. In other words, all nodes in the system have same data at the same time.



2) Availability (A) :-

Every request receives a response, without the guarantee that it contains the most recent write. The system is always operational and responsive to requests.

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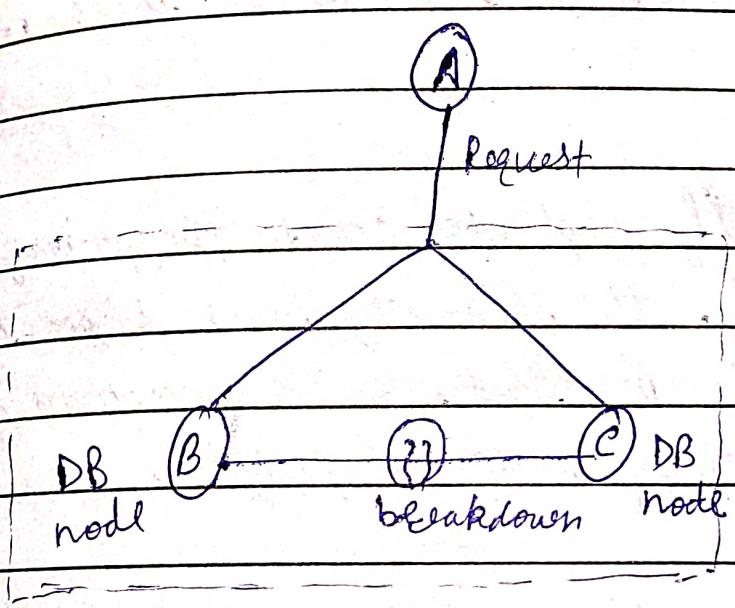
3. Partition Tolerance (P) -

The system continues to operate despite network partition (communication breakdowns) that prevent messages from being sent or received between nodes.



→ CA database (consistency & availability) -

As the name suggests, ~~this~~ this database utilize consistency and availability of data across all connected nodes.
This means system doesn't have partition tolerance which means that a node failure can lead to unavailability of data.

~~Data~~ Database like MySQL, postgreSQL and Oracle priortize CA .. used for services like banks.

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→ Consistency and Partial Tolerance (CP database) –

These database prioritize consistency & partitioned tolerance between all connected nodes. This means that if a partition or node failure occurs, these particular nodes also known as inconsistent nodes will be turned off.

Data is generally replicated across the primary nodes so if they fail, the secondary nodes steps in. But availability isn't priortized, write operations are restricted till primary node is rectified.

CP database are NoSQL databases

→ Availability & Partitioned tolerance (AP) database :–

It prioritize availability during a partion or node failure.

If a node fails, it is still available for use but data from these failed nodes will not be most recent versions.

Apache Cassandra similar to MongoDB is a NoSQL database but it does not have a primary node & keeps all nodes available.

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ACID –

a) Atomicity – Either all operations within a transaction are successfully completed or none of them are.

b) Consistency – Transaction take the database from one consistent State to another consistent state. Starting & ending sum or values must be same

c) Isolation – It ensures that intermediate state of a transaction is not visible to other database transaction until a transaction is committed.

d) Durability – Once a transaction is committed, the changes will be made permanent.

BASE –

(a) Basically Available: BASE prioritize availability over consistency.

It implies that the system will remain operational despite failures & might return a response even data is not consistent.

(b) Soft State – It refers to the idea that data in a distributed

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that
System might be ~~at~~ in an soft state could change over time due to consistency mechanisms.

3) Eventually consistent -

It acknowledges that in a distributed environment, achieving immediate consistency might not always be possible or practical.

* ~~C~~ Databases with MongoDB -

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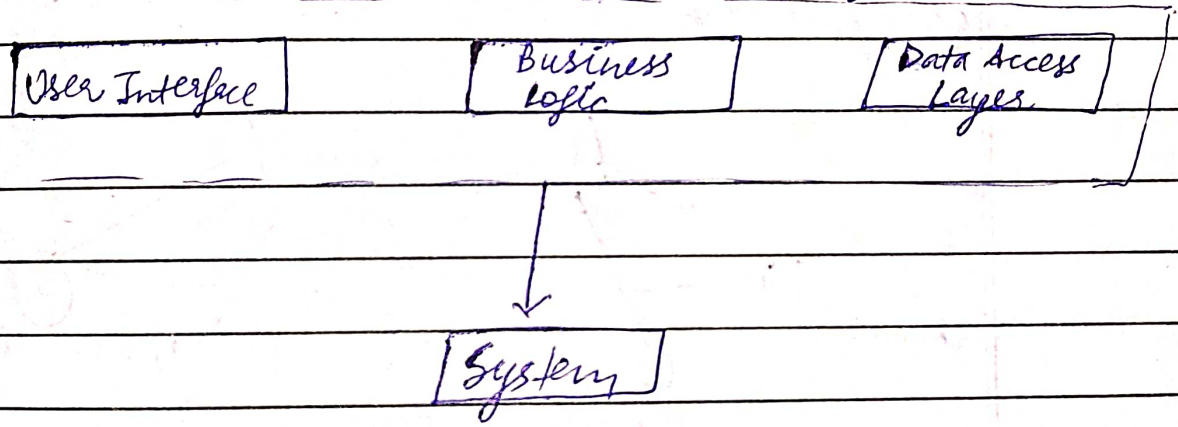
Types of Architecture
- Monolithic
- Microservices

Monolithic -

The monolithic architecture couples and runs all the application's components as a single system.

Any modification made to one part of the application can potentially impact the entire system.



Disadvantages of Monolithic -

- overload IDE
- scaling is very hard
- single bug or single change in code will impact the entire system.
- Difficult to adopt new technology for single functionality

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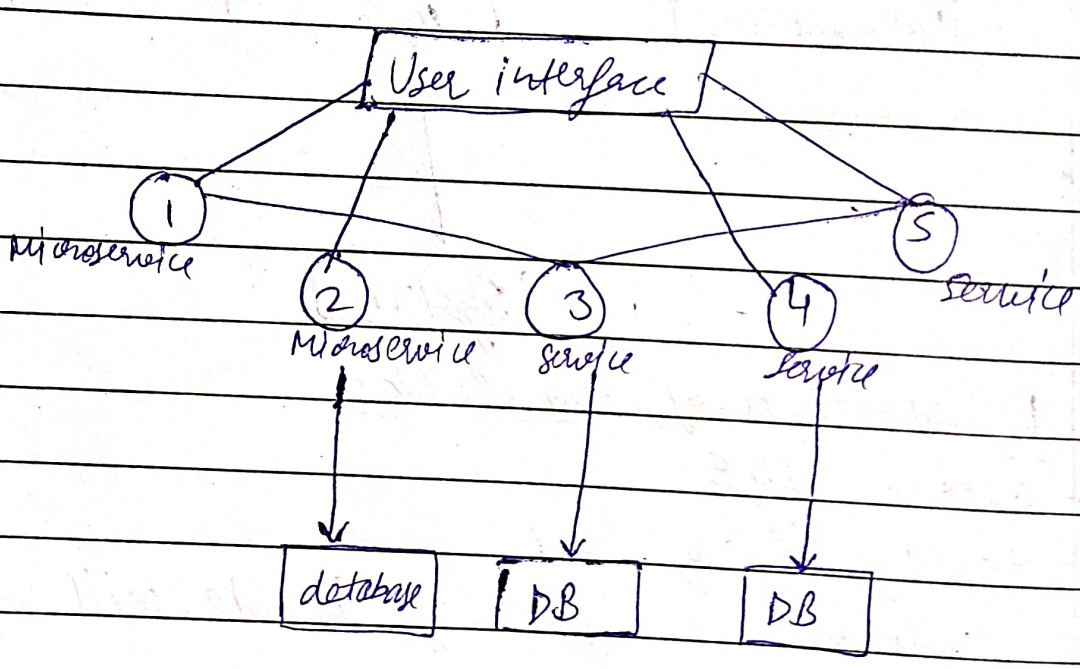
- MicroService

It addresses the limitation of monolithic architecture.

Microservices are small servies ~~with~~ that work together.

In microservices architecture, the application is broken down into small independent servies that communicate with each other using well defined APIs.

Each service is responsible for a specific feature of application.



- Example of a company that uses a microservice architecture is Netflix. As it is a large and complex application that serves millions of users worldwide

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On the other hand, a company that uses a monolithic architecture is Shopify.

Microservice Architecture Patterns –

1) Decomposition Pattern –

This pattern enables splitting the application into a set of loosely coupled services.

There are three types of decomposition approaches –

a) Decomposition by Business Capability –

This approach aims to create microservices aligned with the business needs and can be developed and maintained independently.

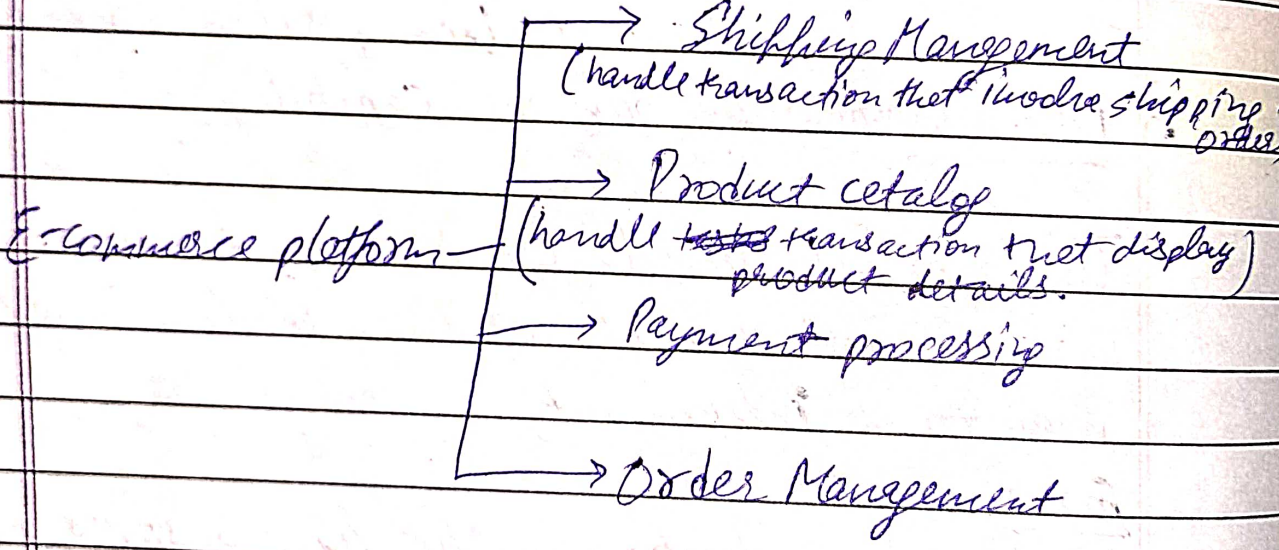
For example –
A banking application might have business capabilities for account management, transaction processing & loan origination.

Health care platform
- → Patient Management
- → Appointment Management
- → (EMR) Management
- → Billing and Payment Processing
- → Telemedicine.

2) Decomposition by Transaction:-

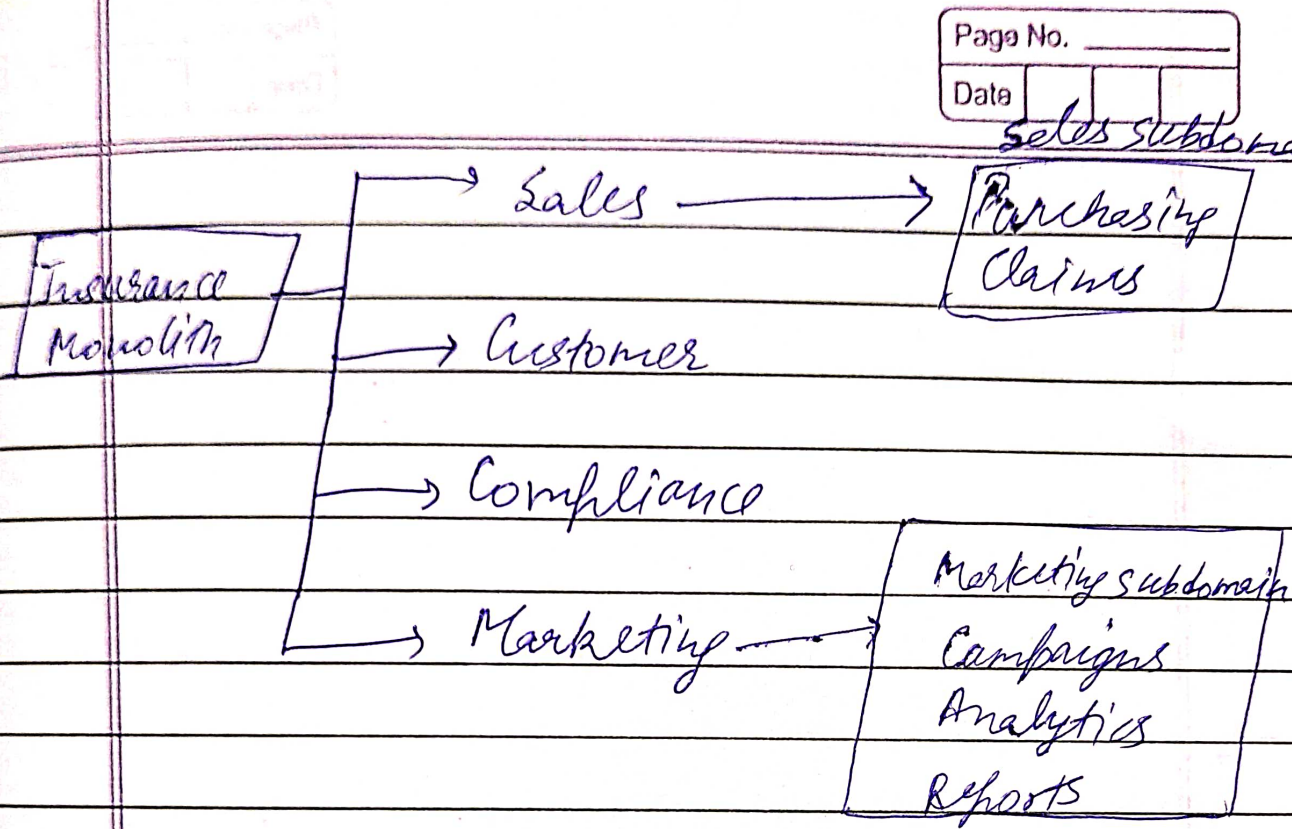
One popular approach to decomposing microservices is through transactions decomposition, where the system is designed such that each particular transaction belongs to a separate microservices.

In this pattern, components that participate in transaction are grouped together as part of same microservices.



3) Decomposition by Subdomain:-

It is a process of breaking down a monolithic system into smaller, independent microservices based on corresponding subdomains defined by Domain-Driven Design (DDD).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