# Peer to peer architecture

### Definition

- Peer to Peer (P2P) Architecture is a way of structuring distributed systems so that they can share a workload or tasks between them.
- In a P2P system, each participating node behaves as both client and server and offers some of its own resources to the system. Each participant has the same functional capabilities and responsibility and there's no dependency on a central entity for administration of the system.
- Vocabulary for components and connectors:
  - Peer: A node in the system is called a peer. Each peer has the same responsibility and capability and holds part of the resources. Every peer involved in the system transmit data to and receive data from other peers at the same time.

#### Topological constraints



(Image source <a href="https://commons.wikimedia.org/wiki/File:P2P-network.svg">https://commons.wikimedia.org/wiki/File:P2P-network.svg</a>)

- Each peer can connect with as many number of other peers in the same network.
- All the peers in the network are visible to all other peers.
- The architecture is decentralized meaning that tasks are delegated to all the peers instead of being handled by a single server.
- Peers are free to join and leave the network at anytime.

# Applicable problems

- Elimination of single points of failure:
  - Since there are multiple peers that act both as clients and servers, applications that need to eliminate single points of failure can use this architecture.
- Applications that require the decentralization of power and resources:
  - Applications like bitcoin where decentralization is the number one priority, P2P architecture is the only choice.
- Systems where low administrative overhead is required:
  - In this system since all the resources are shred, the administrative overhead is also shared.

# Resilience to change

- If software is deployed in a peer to peer model, updating the software becomes very difficult as each and every peer has to individually update their software; which becomes infeasible when a large number of peers are involved in the network.
- In the P2P architecture, when a single node leaving the network, the network will remain available by using the same copy of the data from other peer nodes. At the same time, when a large number of new nodes joining the network, the new nodes are both requiring the content and serving the content at the same time. In this case, the increased demand from the new nodes will be even out by the increased resources those new nodes provide to the network. Therefore, the P2P architecture is resilient to the changes of participants in the network.
- In the P2P architecture, if one single node's data get corrupted it won't be the issue for the entire network. Since, when other nodes realize the content, they are accessing from a specific node is not correct, they can always request the same data from other good copies in the network. Comparing with the traditional server-client architecture which has a single point of failure (the server). P2P, provide high fault tolerance and eliminates the possibility that any single node's fault could affect the entire network. Therefore, P2P has good change resilience when data gets corrupted.

# Negative behaviours

- When a peer needs to find out information but does not know who has it, it might potentially have to go through a lot of other peers causing useless traffic.
- P2P networks are highly susceptible to denial of service attacks as the possibility of implementing a firewall is very low.

# Supported NFPs

- High efficiency
  - P2P distributes the content efficiently, server no longer need to respond to the duplicated request all the time since each client will have a piece of the data themselves and all clients(nodes) could interchange their data without the existence and support from the central server. It provides both bandwidth and storage efficiency.
- Scalability
  - Without the requirement for a powerful central server, P2P network is more scalable than traditional server-client architecture. Since each client's local computing power or network bandwidth are being utilized. When the amount of the request if high, all nodes on the network could even out the spike of the load.
- High availability
  - When a P2P network scales up, each single piece of data is being backed up by multiple nodes on the network. Therefore, there's no single point of failure and the service will always be available without the support from a central server.

### Inhibited NFPs

- Availability
  - If there are no peers on the current network then there is no benefit gained from the network (Same processing power or in the case of a torrent, you cannot get the file). In a client-server architecture, the server is paid for and should be available in most of the time.
- Security and Privacy
  - Anyone connected in the network knows everybody's IP. Thus there is a sense of trust that must exist to all peers in the network. P2P is vulnerable to many types of attacks like poisoning and tracking Attack

#### Comparison with other architectures

- In the event-based architecture, there is no subscription to a generator but to a bus, in the publish and subscribe architecture, subscribers subscribe to a publisher and in the peer to peer architecture, the information is broadcasted to one component at a time.
- In the P2P architecture, trust has to be placed on all the peers in the network, unlike other architectures where trust has to be placed in very few actors.
  - Malicious actors can easily be a part of the network and perform bad actions.
  - If there are enough malicious peers, the network will fail.

#### Credit:

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