P2P & DISTRIBUTED SHARED MEMORY

PEER TO PEER COMPUTING AND OVERLAY GRAPHS

Peer to peer (P2P) systems refers to the applications that take advantage of resources like storage, time cycles, content, manpower available at the end systems of the internet. In other words, the peer to peer computing architecture contains nodes that are equal participants in data sharing. All the tasks are equally divided between all the nodes. The nodes interact with each other as required as share resources. This deals with application layer organization of network overlay for flexibility of sharing resources.

The prominent feature of P2P networks is their ability to provide a large combined storage, CPU power, and other resources while imposing a low cost for scalability, andfor entry into and exit from the network.

The ongoing entry and exit of various nodes, as well as dynamic insertion and deletion of objects in P2P network is called **churn.** The impact of churn should be as transparent as possible. There are two types of P2P systems: structured and unstructured.

Differences between structured and unstructured P2P

Unstructured P2P	**Structured P2P**
The construction of overlay network is highly flexible.	The construction of overlay network has lowlevel of flexibility.
The resources are indexed locally.	The resources are distributed remotely andindexed using hash tables.
The messages can be broadcast or randomwalk.	The messages are unicast.
The network puts best effort content location.	The network guarantees the content location.
High overhead.	Comparatively low overhead.
This supports high failure rates.	Supports moderate failure rates.
This is suitable for small scale and highlydynamic applications.	This is suitable for large scale and relativelystable applications.

Overlay network is constructed over another network. For example, connecting internet over telephone lines is an overlay network. The topology of the overlay network is independent from the underlying network.

Characteristics of Peer to Peer Computing

- Peer to peer networks are usually formed by groups computers. These computers all store their data using individual security but also share data with all the other nodes.
- The nodes in peer to peer networks both use resources and provide resources. So, ifthe nodes increase, then the resource sharing capacity of the peer to peer networkincreases.
- The nodes in peer to peer networks act as both clients and servers. Hence, it is difficult to provide adequate security for the nodes. This can lead to denial of service attacks.
- Most modern operating systems such as Windows and Mac OS contain software to implement peer to peer networks.
- Efficient usage of resources.
- Self -organizing nature: because of scalable storage, CPU power and other resources.
- Distributed control: fast and efficient searching for data.
- Symmetric: highly scalable
- Anonymity: efficient management of churns
- Naming mechanism: selection of geographically close server.
- Security, authentication, trust: Redundancy in storage

Advantages of Peer to Peer Computing

- Each computer in the peer to peer network manages itself. The network is quite easy to set up and maintain.
- The server handles all the requests of the clients. This provision is not required in

peer to peer computing and the cost of the server is saved.

- It is easy to scale the peer to peer network and add more nodes. This only increases the data sharing capacity of the system.
- None of the nodes in the peer to peer network are dependent on the others for their functioning. Hence the network is fault tolerant.
- Easy deployment and organization.

Disadvantages of Peer to Peer Computing

- It is difficult to back-up the data as it is stored in different computer systems and there is no central server.
- It is difficult to provide overall security in the peer to peer network as each systemis independent and contains its own data.

Napster P2P system

- The developers of the original Napster launched the service as a peer-to-peer (P2P)file sharing network.
- The software application was easy to use with a free account, and it was specifically designed for sharing digital music files (in the MP3 format) across a Web-connected network.

Napster used a server-mediated, central index architecture organized aroundclusters of servers that store direct indices of the files in the system.

- The central server maintains a table with the:
    i) the client's address (IP) and port, and offered bandwidth
    ii) information about the files that the client can allow to share
- The basic steps of operation to search for content and to determine a node fromwhich to download the content are the following:
    - A client connects to a meta-server that assigns a lightly loaded server fromone of

the close-by clusters of servers to process the client's query.

- The client connects to the assigned server and forwards its query along withits own identity.
- The server responds to the client with information about the usersconnected to it and the files they are sharing.
- On receiving the response from the server, the client chooses one of the users from whom to download a desired file. The address to enable the P2P connection between the client and the selected user is provided by the server to the client.
- The directory serves to provide the mapping from a particular host thatcontains the required content, to the IP address needed to download from it.

Application Layer Overlays

- The fundamental mechanism in P2P networks is data searching.
- This depends on the organization of data and networks.
- The search algorithms for P2P networks tend to be data-centric.
- P2P search uses the P2P overlay, a logical graph among the peers that is used for the object search and object storage and management algorithms.
- Overlays can be thought as a network built over another network.
- Above the P2P overlay is the application layer overlay, where communication between peers is point-to-point once a connection is established.
- The P2P overlay can be structured or unstructured, i.e., no particular graph structure is used.
- Structured overlays use some rigid organizational principles based on the properties of the P2P overlay graph structure, for the object storage algorithms andthe object search algorithms.
- Unstructured overlays use very loose guidelines for object storage. As there

is no definite structure to the overlay graph, the search mechanisms are more ad-hoc, and use some forms of flooding or random walk strategies.

- Thus, object storage and search strategies are intricately linked to the overlay structure as well as to the data organization mechanism
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DATA INDEXING AND OVERLAYS

Data stored in distributed systems are located through indexing mechanisms. There are three types of indexing:

1. **Centralized:** This indexing entails the use of one or a few central servers to store references or indexes to the data on many peers. The DNS lookup as well as the lookup by some early P2P networks such as Napster used a central directory lookup.

2. **Local:** This indexes to the objects at various peers being scattered across other peers throughout the P2P network. To access the indexes, a structure is used in the P2P overlay to access the indexes. Distributed indexing is the most challenging of

   the indexing schemes, and many novel mechanisms have been proposed, most notably the distributed hash table (DHT). Various DHT schemes differ in the hash mapping, search algorithms, diameter for lookup, search diameter, fault-tolerance, and resilience to churn.

3. **Distributed**: This requires each peer to index only the local data objects and remote objects need to be searched for. This form of indexing is typically used in unstructured overlays in conjunction with flooding search or random walk search.

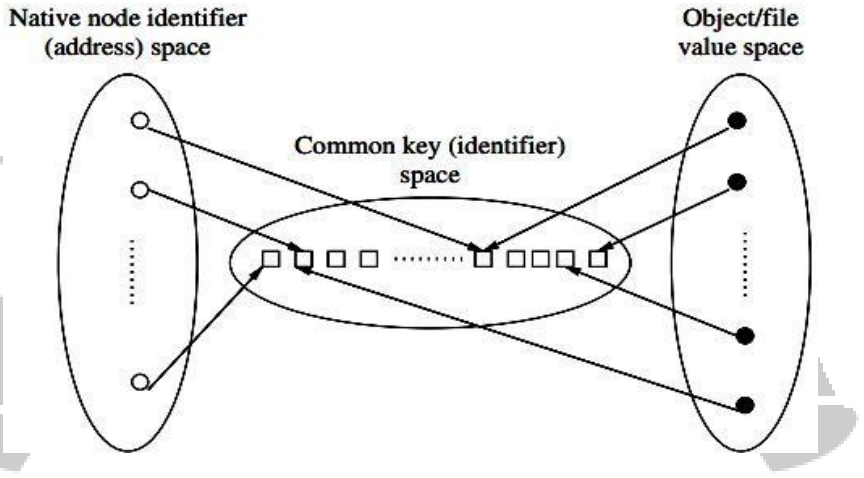

Fig: Mapping between address space and object space

Another criterion for classifying indexing mechanism are based on their semantic structure: semantic indexing and semantic free indexing.

Semantic indexing: A semantic index is human readable. A semantic index

mechanism supports keyword searches, range searches, and approximate searches.

- **Semantic free indexing:** This is not human readable and corresponds to the index obtained by a hash mechanism. These searches are not supported by semantic free index mechanisms.

Distributed IndexingStructured Overlay

The P2P network topology has a definite structure, and the placement of files or data in this network is highly deterministic according to an algorithmic mapping.

- Deterministic mapping allows a very fast and deterministic lookup to satisfy queries for the data. These lookup systems use a hash table for the mapping.
- The hash function maps keys to values, along with the regular structure of the overlay. This facilitates fast search for the location of the file.
- An implicit characteristic of such a deterministic mapping of a file to a location isthat the mapping can be based on a single characteristic of the file.
- The main drawback in this mapping is that arbitrary queries cannot be handled directly.
- Another notable limitation is the overhead occurred due to insertions and deletions of files in distributed environment.

Unstructured overlays

- This P2P network topology does not have any particular controlled structure.
- It do not have any control over where files or data is located.
- Each peer typically indexes only its local data objects, hence, it uses **localindexing.**
- Node joins and departures are easy since, the local overlay is simply adjusted.
- File placement is independent of the topology.
- But searching a file may incur high message overhead and high delays.
- The major advantage is that unstructured overlays support complex queries because

the search criteria can be arbitrary.

- The lack of fixed topology paves way for the formation of new topology.
- **Some of the topologies are:**

Power law random graph (PLRG): This is a random graph where the node degrees followthe power law

Normal random graph: This is a normal random graph where the nodes typically have auniform degree.

Differences between structured and unstructured overlay networks

Structured overlay	**Unstructured overlay**
The networks are constructed over a predetermined topology.	There is no specific topology.
The connections are also predetermined.	Random and dynamic connections can be established.
The insertion and deletion of nodes imposes high overhead over the network performance.	They offer better resilience to network dynamics. Insertion and deletions of nodesis simpler.
This offers faster response time, better performance and lower diameter.	This has comparatively worse performance, node reachability, response time and no guarantee for the diameter.
They are more scalable.	They lack scalability.
They do not support arbitrary searches.	They support arbitrary searches.
Vulnerable to attacks.	Resilience to attacks.
EG: Chord	EG: Gnutella