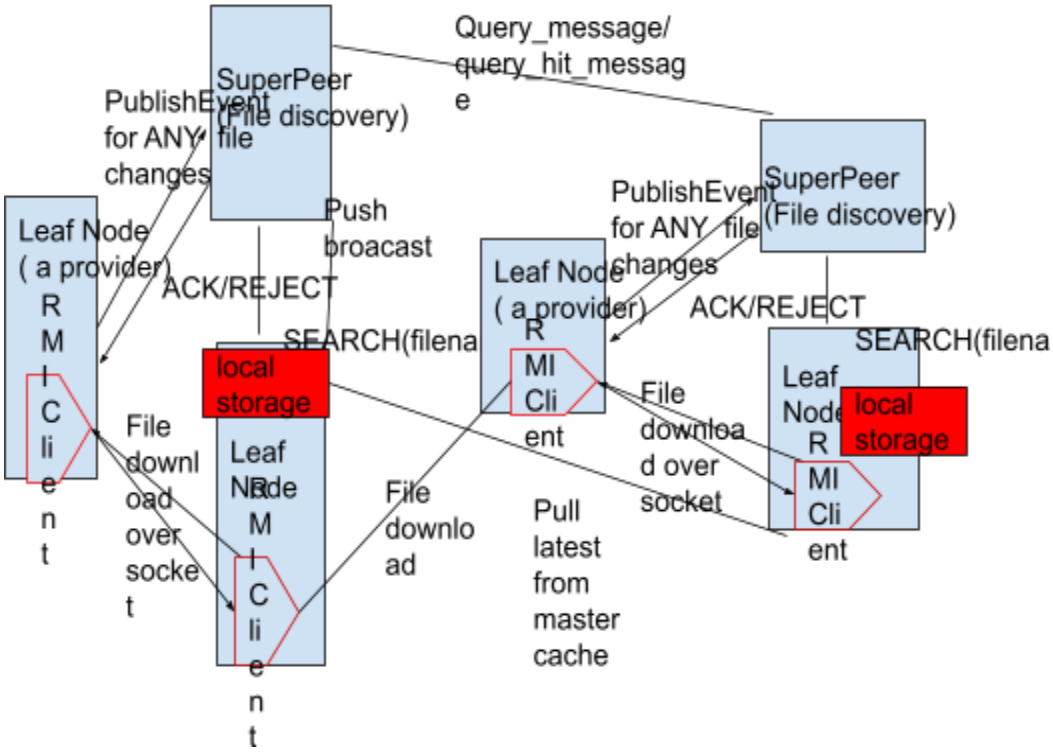
DESIGN DOCUMENT



Fig(a). P2PSystem network topology

OVERVIEW

File Storage on Leaf Node

This programming assignment supports the file caching feature on the leaf node level. The synchronization of this file cache by either using the pull based approach or the push based approach . Further information is provided below on this.

Query messages modifications

The query message is used in PA3 to search for the file just the same as in PA2. The linear topology is used in my results. What has been changed in this assignment is that now the leafnodes will also store a file cache. If the file is stale in their local store, they will query via the super peer to find another leafnode that it can do a direct download from. But how can it know if it is stale or not? It does so by either using the pull method or the push method. In the pull method there is background scheduled thread that is always polling from the master leaf node that this file has originated from when it had first downloaded the file from this leaf node. If it finds the version number to be mismatched it will invalidate its local cache and this also means that if a refresh functionality was available on this leaf node it would notice that its local store doean't have the file so it much fetch the latest copy of this file either from the master node

or any other node that has the highest version number of this file. There can be only one master node for a file and if there are multiple the one with the last modification time is selected to be the master node for this file.

On the other hand, there is also the push based approach, which invalidates the file as soon as the file is modified on the master client. The master client will broadcast an invalidate message across all the super peers and they in turn will broadcast an invalidate message to their respective leaf nodes. This way the file that has been modified will be removed from the local storage of all the leaf nodes.

Looking up the Leaf Node File Cache
Retrieving or refreshing the file have the same implication . If the file is already present in the local storage then no action needs to be taken, however, if it is stale the newest file must be downloaded from any of the valid peer nodes that stores the latest version of this file.

Refreshing the file - pull based
The file is refreshed periodically using a scheduler that runs ever 450 ms until a file is invalid at which time the scheduler is stopped. This is because we only want to keep polling for when the file is valid, as soon it becomes invalid, we invalidate the cache and optionally call RETRIEVE to refresh the file.

Fetching all the possible peers - push based
All the super peers that have ever seen this filename regardless of whether they are currently stale or not will respond with the list of leaf nodes it is aware of. These messages are piggybacked on query messages that will also have an expiration hops of TTL. When the originator of the query is searching for the filename, it will receive files from all the the neighbor super peers it had contacted as well as from super peers that are upto TTL hops away on whether they contain this file. When all the leaf nodes are accumulated and their respective file status , we filter out originator leaf node from the rest.

Fetching all possible peers - pull based

Any valid peer(including master leaf node
can be selected to do the direct download from. If a non-originator peer is selected then the master peer for this file is also stored in its file cache so that it can use this to keep polling validity of the file based on the version number and update its own local file storage to match with the master node.

File Download
The overall design of the project is as above. The RMISuperPeerClient, acts as the client part of the LeafNode server requests for the download of files once it is aware of the file server host and port address and this happens over TCP sockets. This was chosen design to leverage the

multithreaded server and multiple client scenario for file transfers. RMI protocol was used for all interactions between SuperPeers and LeafNode due to its lightweight multithreaded ability.

QUERY MESSAGE

When a query message is sent by the leaf node it first interacts with the super peer it is connected to and checks if the super peer knows any leaf nodes in its own cluster that may have the file associated with the query. If not the message is broadcasted by the super peer to all other super peers connected to it in the Gnutella network and the time to live is decremented by 1. The Query message is also stored in the super peers state so that any future requests on for the same Query message are ignored to break the redundancy because this super peer has already broadcasted to the other super peers in the network. The ' associated array ' cache being used is a least frequently used cache so if some messages are not queried often they may be removed from the cache and the super peer may introduce some message redundancy should these messages get forwarded to it in the future. The cache eviction policy was chosen because less frequently seen messages may be removed from the super peer to save working memory of the system.

QUERY HIT MESSAGE

During Query Process

After having broadcasted the messages to all the super peers in the network a 'serving' super peer checks to see if the filename associated with the query is in its local "coordinator" map. If so , some leaf node connected to this gnutella super peer still has the file and hence a query hit message is sent back to the super peer that had originated in this query message on the 'serving' super peer. Again, the time to live is decremented and forwarded to the originator of the request.

On receipt of Query Hit Message

The originator of the message can be found in the associative array that records the requester of the query message at the 'serving' super node. Again, this the same cache has a least frequently used eviction policy so it may be possible that query hit messages may not be forwarded at all if the message has been evicted from the cache.

Publish File Event

When there changes made to a file such as create or modify then these events are broadcasted to the SuperPeer that will record these changes internaly in a thread safe hashmap that is guarded by synchronized. The hashmap has keys that designate the filename and the values are all the host and ports of peers where this file has been discovered either by creation or modification. On modification, the software is not aware of which version of the file is stale so all the peers that have last registered will contine as values for the coordinator map.

Search

The search for the filename is an exact match search on the filename.

The oldest(in time) peer to have been discovered for this filename at a super peer will be returned as a candidate for other peers to download the files. Peers are not deleted from this map unless they explicitly call deregister.The files will be directly downloadable by the requesting leaf node from the serving leaf node by calling Obtain. This Obtain runs in an asynchronous thread that uses sockets to download the file.

FUTURE WORK

This design works well for a single coordinator but if the coordinator fails the entire system is out of reach . It has a single point of failure which shouldn't be the case in the P2P scenario. The peers should for a distributed hash table rather than a single hash table to make this fault tolerant and also scalable in the set of keys being shared amongst subgroups of peers which would reduce the number of messages that are passed for discovery.

Stateful Load balancing using network bandwidth could be performed on the set of SuperPeer to reduce latency in the scenarios where for a set of peers that have knowledge about a filename could split the load of download requests.

Also, the design could have included leader election to choose an new SuperPeer inside a Gnutella cluster in terms of a failure or have had more than coordinator as a redundancy.

The files could also be sharded in such a way that a certain set of SuperPeers are directly responsible for the file by the filename by applying a hash function an evenly distributing the files. Then the super peers will apply replication using a finite state machine to make sure two Gnutella Clusters sharing the same shards will always be synchronized using a consensus algorithm.

More work can also be done to support timestamping as the files are out of sync on some Gnutella leaf nodes having stale data but sharing the same file server name.