***Gnutella on a Twisted Framework***

CS 114: Peer-to-Peer Networks

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***Foreword***

Gnutella is a decentralized peer-to-peer network that is used to share files. It has five packet types: ping, pong, query, query hit, and push—all of which we have implemented excluding push for reasons later discussed. For our version of a Gnutella client, we decided to use python because it is simple and quick to write code in and has numerous socket handling libraries. Upon further research, we found that the Twisted framework was used to make an earlier version of BitTorrent. Twisted is an event-driven networking framework made in python that greatly simplifies writing network applications. Thus, the Twisted framework was used to create our Gnutella client application because we thought it would be perfect to handle the messages that came in at various times.

***Instructions***

General way to run client (will act as first node in network):

python gnutella.py [directory]

where [directory] is the directory that will act is the node's directory.

Files in the [directory]/files folder will be shared on the network.

A [directory]/output.log file will be created to log interactions the node makes.

If files and directories do not already exist, program will generate them.

To connect to another node in an existing network on start up:

python gnutella.py [directory] -i [ip] -p [port#]

\*\*Note: **please use the same IP for each node** (e.g.: do not connect to a node using "localhost" on some connections and the actual IP on others)

To watch the log file while the node is running, run in another terminal:

tail -c +0 -f [output.log path]

To request a file, after the node is running, enter:

GET [filename];

Downloaded files will be saved to the [directory]/files folder.

***Implementation Description***

1. *Connection specifics and port allocation*

In Twisted, ports can be set to listen or to make a connection with another port. The connections made with our client are all TCP connections. At the start of the Gnutella client, a random, open port is select to listen for incoming connections. Other nodes can connect directly to this listening port—naturally, the listening port can handle multiple connections at a time while watching for new ones. However, when the client is making an outgoing connection, because of the way Twisted connections work, it will select a new, unused port to make the connection instead of using the listening port (but connects to the other client’s listening port). Thus, a single client may be in charge of multiple ports.

Each node is limited to a maximum of 10 connections (this value can be configured). Fortunately, connections are monitored in Twisted and an event handler exists for when any connection is lost. Thus, keep-alive checks with TTL of 1 are unnecessary in this version of Gnutella because when a node dies, its direct neighbors will be alerted through an event. Upon a loss of connection, the client will retry the connection once and if that fails, it may try to connect to a random node with a 50% or 10% depending on how many connections it currently holds. If it has more than 3 connections, it will use the 10% probability. These probabilities and the boundary for the change in probabilities can also be configured in the global values (see *Global configuration values* for more). We hope that these probabilities will produce a more interesting network map than connecting to the first few nodes that join the network or the nodes that have the most shared data.

1. *Protocol*

Unfortunately, bit manipulation is not easy in python because it inherently converts most values to strings—particularly with its various read functions. Thus, for simplicity and readability of code, we decided to transfer messages between nodes as strings instead of bit by bit. However, we kept most of the message formatting the same.

**Node ID assignment**

To ensure that each node’s ID was distinct, we simply used the MAC address of the computer and appended the node’s listening port.

**Message formats**

We retained the most of the general message formats mentioned in the specifications. However, we did not see a need to keep both the TTL and number of hops in the header, so the number of hops was removed. Furthermore, to ensure that each message is parsed correctly, we put a delimiter (‘&’) between each portion of the message. Thus, a Ping message would look as follows: [msgID]&[payload descriptor]&[ttl]&[payload]

**Message IDs**

The client keeps track of how many messages it has sent. The message ID is simply the message number appended to the node ID. However, for each message ID that a node comes across, it stores where the message came from in a dictionary with the message ID as the key. To ensure that the nodes will not run out of memory over a long time, after each 1000 messages, the message number is reset to 0. To differentiate between two different messages with the same message ID, a timestamp of when the message was last seen is added. If a message ID has not appeared for 3 seconds, it is deemed out of use (this timeout is configurable, see *Global configuration values* for more). For different network speeds, processor speeds, and large amounts of traffic, **the message lifetime value may need to be tweaked.**

**Ping**

By default, pings have a TTL of 7 to ensure that the network is not flooded with ping messages that would lead to a flood of pongs.

**Pong**

Pongs follow the message path back to the originator. Each node will save the payload information from the pong. Furthermore, whenever any node receives a pong it will attempt to connect to a peer with the probabilities stated in the *Connection specifics and port allocation* section. Normally, a pong will return the number of files the sender has and the total amount of data it has available. Since our implementation does not use a node’s amount of available data to determine which nodes it should make its neighbors, passing the shared data amounts is unnecessary. Thus, pongs only relay the IP and listening port of the pong-sending node.

**Query**

Queries, like pings, have a TTL of 7 and flood outwards. If the file is not found within 7 hops, the requester request the file again after the network topology has changed or one of the nodes within 7 hops has also requested and successfully retrieved the file. As with pings, this design decision was to minimize network traffic.

**QueryHit**

In addition to its listening port, each node has a port to serve files as an HTTP server would. When a node receives a query and has the requested file, it will send a query hit to the requester. The query hit includes the node’s IP, file serving port, and the requested file name. Upon the first query hit the requester sees, it will send a HTTP GET request to the file serving port of the query hit sender to retrieve the file and save it in the [directory]/files folder.

**Push**

We decided that implementing push to get around firewalls was unnecessary because our implementation should be used within a single network (on the same router or even on the same computer). When our group tried testing through a normal network, we could not find the IP of our actual computers; our router’s public IP was always returned instead. Thus, connections between computers using different routers could not be made because the given IP could not identify the computer behind the router. Thus, firewalls were not an issue under our test cases—which made push unnecessary to implement.

1. *Global configuration values*

As mentioned in the previous sections, there are a few global values that can be changed to configure the node. These values can be found at the top of the gnutella.py file under the “GLOBAL DATA” section. Some of these values may need to be changed based off of network topology, network speeds, amount requests and traffic, etc…

The values are as follows:

* *msgTimeout* – the lifetime of a message ID in seconds. If a message ID has not been seen within the msgTimeout number of seconds, it can be recycled, meaning a node should not ignore a message with that message ID if it has already seen it before.
* *MIN\_CONNS* – when the node has less than this many connections, it will use the UNDER\_PROB (under the min connection barrier) to decide if it should connect to a new node.
* *MAX\_CONNS* – maximum number of connections a node can maintain at any time.
* *UNDER\_PROB* – the probability, in percent, that the node should attempt to connect to another node if the number of connections is under MIN\_CONNS. (e.g.: 50)
* *OVER\_PROB* – the probability, in percent, that the node should attempt to connect to another node if the number of connections is over MIN\_CONNS but under MAX\_CONNS. (e.g.: 10)

***Test Results***

The first testing on the completed client was done with 6 nodes on a single machine to ensure that the general functionalities were correct. General tests for pings, pongs, queries, query hits, and file transfers were tested. Afterwards, we tested thirty nodes on three computers—10 nodes per computer. All three computers were connected to the same router. As we were adding nodes to the network, we simply chose random nodes to connect to. For the most part, the nodes that were alive longer had more connections after all the connections had been completed. This occurrence makes sense because the nodes that lived longer would have seen more pongs than the newer nodes. After disconnecting some nodes, most nodes still held at least 2-3 connections because the client considers reconnecting to another node when one of its connections is lost.

***Challenges Faced and Solutions***

Connections Issues

Picking the right factory

Serving files

Send buffer issues

IP issues