

1. Effectiveness of Push

Number of Peer issuing query: 1

0/127.0.0.1:13004/127.0.0.1:13001/127.0.0.1:13001/2/file41.txt_0/8/hit/02-28-2017 18-05-10/1 [valid]
0/127.0.0.1:13004/127.0.0.1:13001/127.0.0.1:13001/2/file41.txt_1/8/hit/03-20-2017 20-38-56/1 [valid]
0/127.0.0.1:13003/127.0.0.1:13001/127.0.0.1:13001/2/file31.txt_0/9/hit/02-28-2017 18-05-10/1 [valid]
1/127.0.0.1:13002/127.0.0.1:13001/127.0.0.1:13002/2/file21.txt_0/10/hit/03-20-2017 19-44-39/1 [valid]
1/127.0.0.1:13003/127.0.0.1:13001/127.0.0.1:13001/2/file33.txt_0/9/hit/02-28-2017 18-07-18/1 [valid]
1/127.0.0.1:13004/127.0.0.1:13001/127.0.0.1:13001/2/file41.txt_2/8/hit/03-20-2017 20-41-12/1 [valid]

Number of Peer issuing query: 2

0/127.0.0.1:13006/127.0.0.1:13004/127.0.0.1:13004/5/file61.txt_0/8/hit/02-28-2017 18-05-10/1 [valid]
0/127.0.0.1:13006/127.0.0.1:13004/127.0.0.1:13004/3/file61.txt_1/8/hit/03-20-2017 20-44-16/1 [valid]
0/127.0.0.1:13004/127.0.0.1:13006/127.0.0.1:13006/5/file41.txt_0/9/hit/03-20-2017 20-38-56/1 [valid]
0/127.0.0.1:13004/127.0.0.1:13006/127.0.0.1:13006/5/file41.txt_1/9/hit/03-20-2017 20-39-23/1 [valid]
0/127.0.0.1:13004/127.0.0.1:13006/127.0.0.1:13006/5/file41.txt_2/9/hit/03-20-2017 20-39-55/1 [valid]
0/127.0.0.1:13006/127.0.0.1:13004/127.0.0.1:13004/3/file61.txt_2/8/hit/03-20-2017 20-44-16/1 [valid]
8/127.0.0.1:13005/127.0.0.1:13003/127.0.0.1:13003/4/file51.txt_0/9/hit/03-20-2017 18-29-30/1 [valid]
8/127.0.0.1:13005/127.0.0.1:13003/127.0.0.1:13003/4/file51.txt_1/9/hit/03-20-2017 20-48-30/1 [valid]

Number of Peer issuing query: 3

0/127.0.0.1:13009/127.0.0.1:13001/127.0.0.1:13001/2/file81.txt_0/9/hit/01-28-2017 17-44-27/1 [valid]
0/127.0.0.1:13009/127.0.0.1:13001/127.0.0.1:13001/2/file81.txt_1/9/hit/03-20-2017 20-59-50/1 [valid]
0/127.0.0.1:13009/127.0.0.1:13001/127.0.0.1:13001/2/file81.txt_2/9/hit/03-20-2017 21-00-15/1 [valid]
3/127.0.0.1:13010/127.0.0.1:13002/127.0.0.1:13002/1/file91.txt_0/8/hit/02-28-2017 18-05-10/1 [valid]
3/127.0.0.1:13010/127.0.0.1:13002/127.0.0.1:13002/1/file91.txt_1/8/hit/03-20-2017 21-01-01/1 [valid]
17/127.0.0.1:13010/127.0.0.1:13002/127.0.0.1:13002/9/file92.txt_0/9/hit/02-28-2017 18-05-19/1 [valid]
17/127.0.0.1:13010/127.0.0.1:13002/127.0.0.1:13002/9/file92.txt_1/8/hit/03-20-2017 21-01-30/1 [valid]
126/127.0.0.1:13002/127.0.0.1:13009/127.0.0.1:13009/10/file21.txt_0/9/hit/03-20-2017 19-44-39/1 [valid]
126/127.0.0.1:13002/127.0.0.1:13009/127.0.0.1:13009/10/file21.txt_1/9/hit/03-20-2017 21-02-06/1 [valid]
19/127.0.0.1:13001/127.0.0.1:13010/127.0.0.1:13010/9/file11.txt_0/8/hit/02-28-2017 18-05-10/1 [valid]

Number of Peer issuing query: 4

0/127.0.0.1:13004/127.0.0.1:13001/127.0.0.1:13001/2/file44.txt_0/8/hit/02-28-2017 18-07-24/1 [valid]
0/127.0.0.1:13004/127.0.0.1:13001/127.0.0.1:13001/2/file44.txt_1/8/hit/03-20-2017 21-06-44/1 [valid]
0/127.0.0.1:13004/127.0.0.1:13002/127.0.0.1:13002/3/file44.txt_1/8/hit/03-20-2017 21-06-44/1 [valid]
1/127.0.0.1:13004/127.0.0.1:13003/127.0.0.1:13003/2/file44.txt_2/8/hit/03-20-2017 21-07-21/1 [valid]
2/127.0.0.1:13003/127.0.0.1:13004/127.0.0.1:13003/3/file33.txt_0/10/hit/02-28-2017 18-07-18/1 [valid]
1/127.0.0.1:13003/127.0.0.1:13001/127.0.0.1:13001/2/file33.txt_1/9/hit/03-20-2017 21-07-54/1 [valid]
1/127.0.0.1:13003/127.0.0.1:13003/127.0.0.1:13003/2/file33.txt_1/8/hit/03-20-2017 21-07-54/1 [valid]
2/127.0.0.1:13002/127.0.0.1:13001/127.0.0.1:13002/2/file22.txt_0/10/hit/03-20-2017 20-30-31/1 [valid]
3/127.0.0.1:13002/127.0.0.1:13001/127.0.0.1:13002/2/file22.txt_0/10/hit/03-20-2017 20-30-31/1 [invalid]

32 query hit message out of 33 was valid. (=96.96%)

Result: since whenever the original server broadcasts invalidation message right after the master copy is modified, I should have to download the file again from the original server. As the number of invalidation increases, the load of message was increased since invalidation message is broadcasted throughout the network. However, it was very useful since the client that downloaded specific file doesn't have to request to the origin server or wait response from the origin server.

2. Effectiveness of Pull

TTR Value 10 sec:

```
2/127.0.0.1:13002/127.0.0.1:13003/127.0.0.1:13003/4/file24.txt_2/9/hit/03-20-2017 21-20-10/1 [valid]
1/127.0.0.1:13002/127.0.0.1:13003/127.0.0.1:13003/4/file24.txt_0/9/hit/03-20-2017 21-20-10/1 [valid]
19/127.0.0.1:13002/127.0.0.1:13001/127.0.0.1:13002/2/file24.txt_1/10/hit/03-20-2017 21-22-50/1 [valid]
2/127.0.0.1:13002/127.0.0.1:13004/127.0.0.1:13004/3/file24.txt_1/9/hit/03-20-2017 21-22-50/1 [valid]
25/127.0.0.1:13002/127.0.0.1:13001/127.0.0.1:13002/2/file24.txt_2/10/hit/03-20-2017 21-23-22/1 [valid]
2/127.0.0.1:13002/127.0.0.1:13003/127.0.0.1:13003/4/file24.txt_2/9/hit/03-20-2017 21-23-22/1 [valid]
```

TTR Value 20 sec:

```
3/127.0.0.1:13002/127.0.0.1:13001/127.0.0.1:13002/2/file21.txt_1/10/hit/03-20-2017 21-13-52/1 [valid]
2/127.0.0.1:13002/127.0.0.1:13002/127.0.0.1:13002/1/file21.txt_1/9/hit/03-20-2017 21-13-52/1 [valid]
1/127.0.0.1:13003/127.0.0.1:13003/127.0.0.1:13003/4/file21.txt_1/9/hit/03-20-2017 21-14-00/1 [valid]
7/127.0.0.1:13003/127.0.0.1:13004/127.0.0.1:13003/3/file21.txt_1/10/hit/03-20-2017 21-14-00/1 [valid]
2/127.0.0.1:13003/127.0.0.1:13003/127.0.0.1:13003/4/file21.txt_2/9/hit/03-20-2017 21-15-04/1 [invalid]
2/127.0.0.1:13002/127.0.0.1:13002/127.0.0.1:13002/1/file21.txt_2/9/hit/03-20-2017 21-15-09/1 [valid]
```

12 query hit messages were valid out of 13 query hit messages. (= 92.30%)

Result: as the TTR value increases, the load of network became less. However, the more TTR value is large, the less consistency was achieved. As far as we have to use consistency, it is better to use a small TTR value than a large value to achieve the consistency. The desirable TTR value in my test case was 20 sec. This is because the load of pull request and response was not too much for network and made peers to get less invalid message from other peers.

3. Pros and Cons

Push-Based

Pros: the client side of peers participates in the network doesn't have to interact with other peers and invalidate the file without delay.

Cons: since the invalidation message is broadcasted throughout the network, the burden of invalidation message will be very large and it will be able to cause any other problem.

Pull-Based

Pros: since the consistency is maintained by direct peer to peer, the broadcasting of invalidation is not needed. So, the advantage of pull-based consistency is that we can use network resources efficiently.

Cons: the client side of each peers should allocate more memory to check the TTR and interact with the original server that has master copy. Therefore, the client should consider the performance of it's capability.