COL 867 -Programming Assignment 1

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Observations:

The follow images are for a single simulation with 5 nodes. The node properties are as follows:

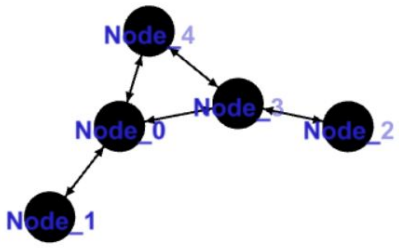

Fig: Network created randomly

Node 0:
- Type : fast
- CPU power : 0.08299088383170923
- Connected to :
- NID: Node_1, PD: 219.3539072997119, BS: 5.0
- NID: Node_3, PD: 76.91187172550423, BS: 5.0
- NID: Node_4, PD: 164.7974345192115, BS: 5.0

Node 1:
- Type : slow
- CPU power : 0.09625908563090695
- Connected to :
- NID: Node_0, PD: 219.3539072997119, BS: 5.0

Node 2:
- Type : fast
- CPU power : 0.09978126903901453
- Connected to :
- NID: Node_3, PD: 380.2242213521799, BS: 5.0

Node 3:
- Type : slow
- CPU power : 0.0767250806767122
- Connected to :
- NID: Node_0, PD: 76.91187172550423, BS: 5.0
- NID: Node_2, PD: 380.2242213521799, BS: 5.0
- NID: Node_4, PD: 130.5836082946892, BS: 5.0

Node 4:
- Type : slow

CPU power : 0.0674755325612142
Connected to :
NID: Node_0, PD: 164.7974345192115, BS: 5.0
NID: Node_3, PD: 130.5836082946892, BS: 5.0

After the simulation the block chain stored in each nodes are as follows:

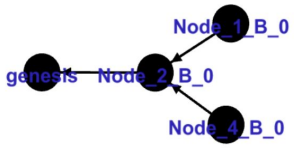

Fig 2: Tree at Node_0

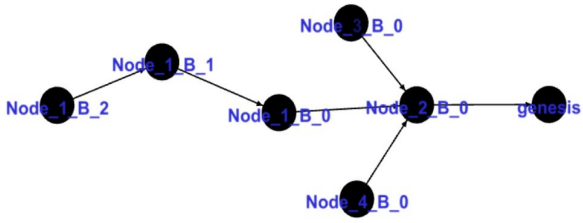

Fig 3: Tree at Node_1

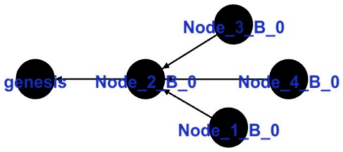

Fig 4: Tree at Node_2

When we tried for larger number of peers in the network the graph came as follows:

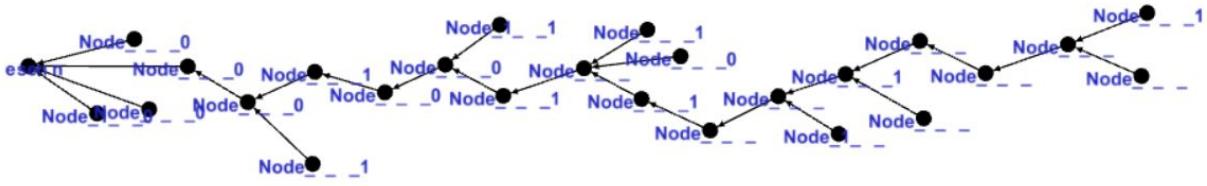

Fig 5: Node tree at Node_9 when number of peers is 10

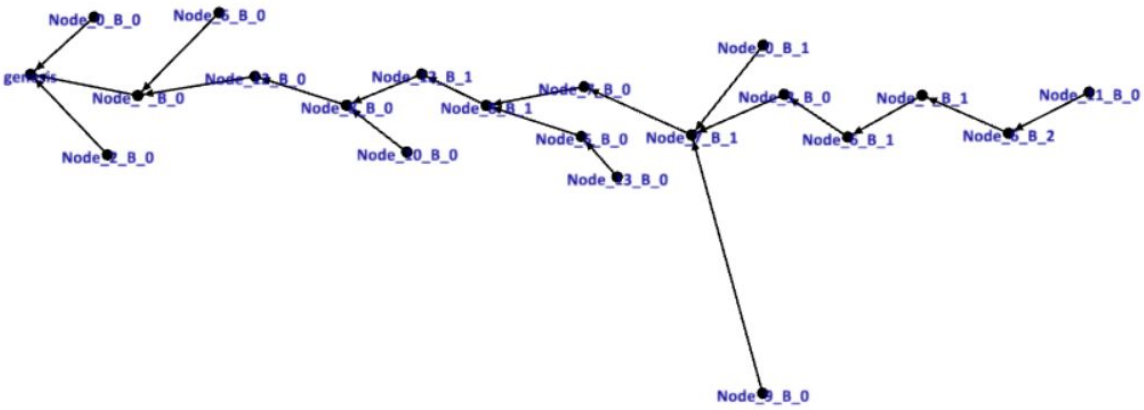

Fig 6: Node tree at Node_0 when number of peers is 15

Conclusions:

- From our experiments, we observe that the average length of the forked and ignored branches is proportional to the number of nodes in the bitcoin P2P network. This can be easily explained based on the block generation frequency which increases with increasing number of nodes.
- We also observe, that with increasing number of slow nodes, the average length of forked parts increases. This is because, though the block generation frequency at nodes is the same, the transmission time of the blocks accross the network increases with more and more slow nodes coming into the picture.
- The interarrival time of the transaction doesn't seem to be affecting the block generation or the forked chain length to a significant extent. We suspect that a very rate of generation of transactions might overload network and thus may cause the routing and forwarding of blocks to slow down, which may eventually cause more forks and of greater average length. But, in not so adverse environments, the correlation between the two seems negligible.
- We observe, that increasing the mean value of arrival times between blocks, reduces number of forks and average fork length to a noticeable extent.
- On a higher level, we can conclude that the parameters that either increase the block generation frequency (in the network or at the nodes) such as the average CPU power, number of nodes etc increase the overall number of forks. Also, parameters increasing network latency in any form such as queuing or link bottleneck speeds also increase forking in the blockchain and thus depleting the blockchain as a whole creating more and more forks.
- Since, the simulations have all fair nodes (no malicious or adversary acting node), the average fork length in all cases always remains small and no forks of more than length 3 have been observed as a part of the simulations. (This can be obviously and easily made greater than 3 by

increasing the number of nodes in the network or/and increasing the connection sparsity - i.e. decreasing network connectivity).

References:

- **https://gephi.org/**
- **http://bitcoin.stackexchange.com/**
- **https://bitcoin.org/bitcoin.pdf**
- **https://en.bitcoin.it**
- **http://bitcoin.stackexchange.com/questions/51656/how-does-a-miner-know-if-a-transaction-has-already-been-included-in-the-block-ch/51657#51657**