D.5. Analysis of the Optimized Timeout Duration of FCPP:

In this section, we derive an analytic model to study the relationship between the timeout duration l and the consistency requirement PDC (δ, p), as well as the relationship between l and the traffic overhead. Then we calculate the optimized timeout duration which satisfies the user-specified PDC with minimum traffic overhead. In the analysis, we assume that the data update and the query follow Poisson Process. The number of hops counted in data transmission is used to measure the traffic overhead.

Cost for Time-out Renewal.

When a query comes after the time-out value expires, the caching node first renews the time-out value to l, and then, serves the next l .r (on average) queries. Thus, for every l .r +1 queries, there will be onetime-out renewal. So, we average the cost over the queries and obtain the expected renewal cost per unit time:

2. $\bar{h}$ .N. r / (l.r+1)

Cost for the INV & ACK Process.

Concerning the data updates, for every l .r +1 query on a cache copy, l.r of them occur when the time-out value is valid. The probability of having a valid time-out value is l .r / (l. r + 1). As long as the time-out value is valid, the data source node needs the INV & ACK process upon a data update. Thus, the expected INV & ACK cost per unit time is:

2. $\bar{h}$ ..N. ω. l. r / (l.r+1) According to the discussions above, we obtain the total consistency maintenance cost per unit time:

$$C=2N.\ \bar{h}\ \frac{r+\omega.l.r}{l.r+1}=2r.N.\ \bar{h}\frac{1+\omega.l.}{l.r+1}$$

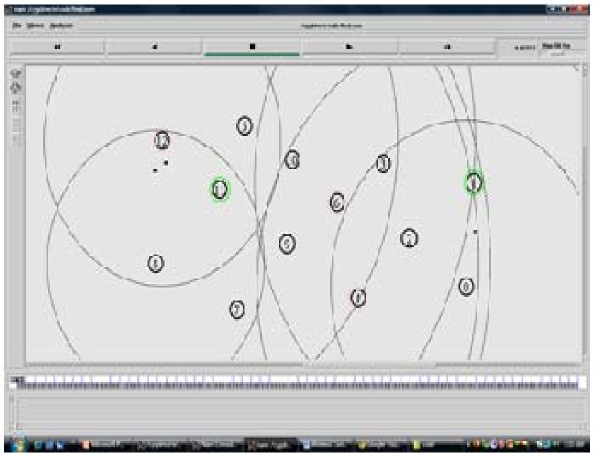
The notations used in the analytical model are listed in Table 1.

Table 1 Notations used in the analytical model

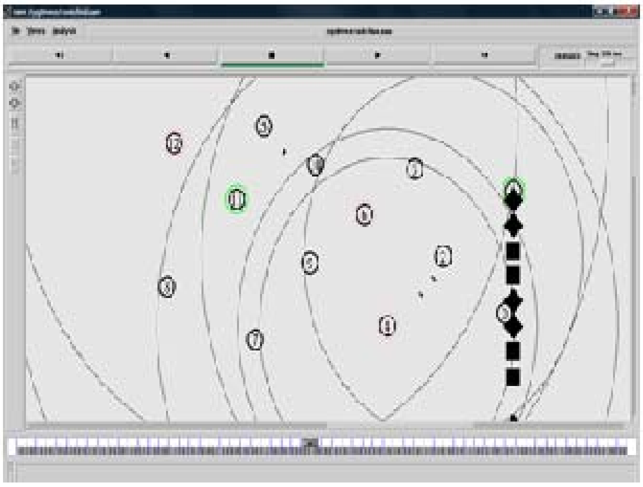
$\bar{h}$	Average path length between data source node and caching node
N	No of caching nodes.
ω	Average data update rate.
l	Time out duration.
r	Average cache query rate

IV .SCREENSHOTS

PROPAGATION IN AD-HOC NETWORK



UDP PACKET LOSS



IV. CONCLUSION

In this paper, we have addressed the problem of how to provide the users with flexibility in specifying their consistency requirements, and how to satisfy the flexible user-specified consistency requirements with minimum overhead. Toward this objective, our contributions can be described as follows: (1) we have proposed a general consistency model PDC, allowing users to flexibly specify their consistency requirements in two orthogonal dimensions; (2) we have developed the FCPP algorithm to maintain cache consistency under the PDC consistency model. FCPP flexibly and efficiently combines push and pull based on timeouts; (3) we have derived an analytical model for FCPP to calculate the optimized timeout duration, so as to provide user-specified PDC with minimum traffic overhead in IMANETs. In our future work, we will study how to enable efficient cooperation among the caching nodes, in order to further reduce the cache maintenance cost. We also plan to study how to satisfy heterogeneous consistency requirements of the users.

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