New Metrics for Data Distribution in Wireless Mesh Networks*

-Sandra Soraya Montesinos Barrios-

Departamento Tecnología Electrónica

E.T.S.I Telecomunicación, Universidad de Málaga

* Trabajo Fin de Grado del Grado en Ingeniería de Sistemas Electrónicos. Julio 2014

Abstract

In this work we study the use of five strategies for selecting the server node: *random*, *Min-Hop*, *ETX*, *fuzzy-1* and *fuzzy-2* (the last two are proposed by us). As simulation environment, we have made use of a regular square network with 8x8 nodes based on Wi-Fi technology. In this network we have analized two escenarios in function of considering or not considering obstacles between nodes. Download time and number of sent bytes have been measured. The results show that the random strategie produces the least performance, that the Min-Hop and ETX criteria work better or worse depending the features of the network, and the fuzzy strategies produce the best efficience due to they adapt to all the situations of the network.

Selection Strategies

Random

The server node is randomly chosen. It does not consider any feature of the network.

Min-Hop

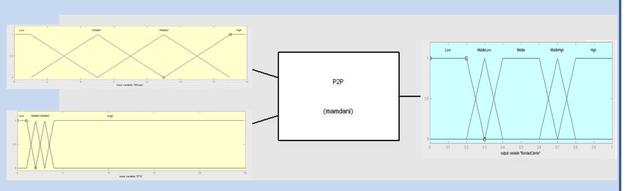
Selects the server node whose path towards the client node has the least number of hops.

ETX

Selects the server node whose path until the client has the lowest average number of retransmissions.

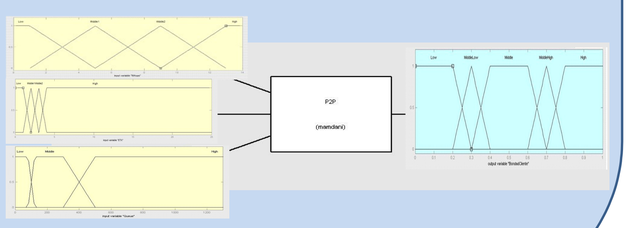
Fuzzy-1

Makes the selection of the server node using a fuzzy inference process taking as inputs the number of hops and the ETX cost in the server-client path.



Fuzzy-2

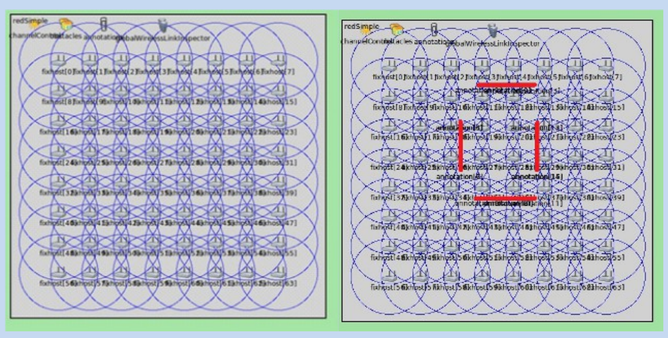
Adds to the fuzzy system of fuzzy-1 strategie the size of the queue of the server node as input.



Scenario

For the study of the selection criteria mentioned above, we have made use of OMNeT++, a tool of simulation of discrete events. We have simulated a network with 64 nodes (8x8) considering two types of scenarios: without obstacles and with obstacles between nodes. For every scenario, we have made simulations considering that a single node containing the information required at the beginning of the test, and considering three possible server nodes initially.

Scenario without obstacles		Scenario with obstacles	
1 initial server node	3 initial server nodes	1 initial sever node	3 initial server nodes



Simulation conditions

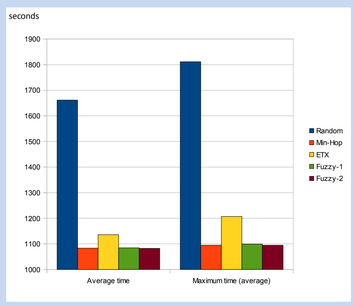
Number of nodes	64 (8x8)
Number of segments to be transmitted	50
Size of the segments	100000 bytes
Maximum packet size	1000 bytes
Number of repetitions with different seeds	10
Obstacles model	Packet loss probability of 50%

Results

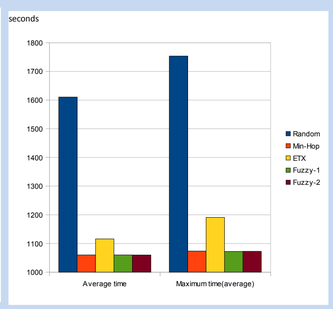
Without obstacles

Average and maximum download time

1 initial server node



3 initial server nodes

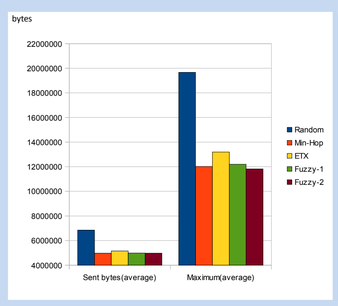


	Random	Min-Hop	ETX	Fuzzy-1	Fuzzy-2
Average time Confidence interval	1661,3 ±4,5	1083,2 ±1,5	1135,9 ±3,7	1084,5 ±1,4	1082,1 ±3
Maximum time Confidence interval	1811 ±9,7	1094,4 ±1,6	1206,6 ±6,9	1099,1 ±2,7	1094,6 ±3,2

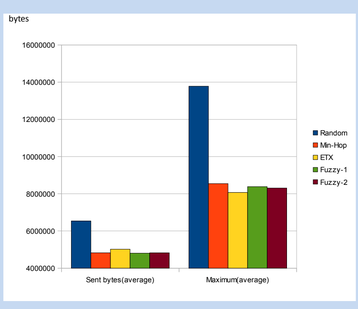
	Random	Min-Hop	ETX	Fuzzy-1	Fuzzy-2
Average time Confidence interval	1610,5 ±8,7	1060 ±0,7	1115,7 ±1,7	1060,1 ±0,7	1059,6 ±0,7
Maximum time Confidence interval	1753,2 ±9,1	1073,7 ±2,2	1191 ±8,9	1072,3 ±2	1072,8 ±1,5

Average and maximum number of sent bytes

1 initial server node



3 initial server nodes



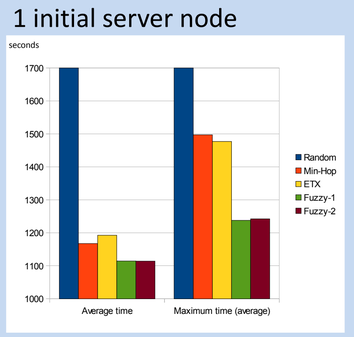
	Random	Min-Hop	ETX	Fuzzy-1	Fuzzy-2
Sent bytes Confidence interval	6843500 ±22390	4978211 ±1382	5157183 ±6062	4979801 ±360	4978495 ±2046
Maximum Confidence interval	19664370 ±503601	12015385 ±414695	13195020 ±905991	12196925 ±392226	11809520 ±383536
Deviation	1824460	1393014	1483207	1429731	1337107

	Random	Min-Hop	ETX	Fuzzy-1	Fuzzy-2
Sent bytes Confidence interval	6533240 ±30534	4822260 ±2117	5020088 ±73742	4809938 ±50670	4821678 ±45452
Maximum Confidence interval	13784690 ±411452	8545927 ±445039	8072461 ±560940	8384627 ±335955	8304671 ±1071756
Deviation	1689705	1294973	1174125	1385484	1316520

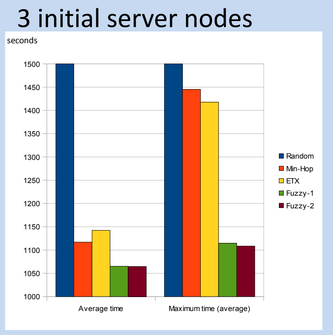
With obstacles

Average and maximum download time

1 initial server node



3 initial server nodes

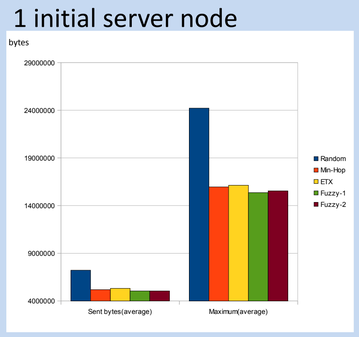


	Random	Min-Hop	ETX	Fuzzy-1	Fuzzy-2
Average time Confidence interval	31096,4 ±57378,8	1167,4 ±15,4	1192,6 ±16,2	1114,4 ±15,6	1113,8 ±15,1
Maximum time Confidence interval	924715,6 ±180722	1497,1 ±47,2	1477,1 ±66,3	1237,6 ±39,1	1242,3 ±45,4

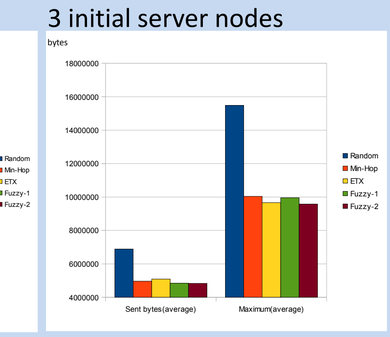
	Random	Min-Hop	ETX	Fuzzy-1	Fuzzy-2
Average time Confidence interval	16870,4 ±29645,1	1117 ±4,2	1142,2 ±6,5	1065,3 ±2,5	1064,7 ±2,7
Maximum time Confidence interval	924676,7 ±180723	1445,1 ±38,1	1417,6 ±51	1114,5 ±10,3	1108,4 ±10,3

Average and maximum number of sent bytes

1 initial server node



3 initial server nodes



	Random	Min Hop	ETX	Fuzzy-1	Fuzzy-2
Sent bytes Confidence interval	7222347 ±81111	5178291 ±30636	5312703 ±35475	5047509 ±28948	5046981 ±29198
Maximum Confidence interval	24218120 ±1603927	15955520 ±2153451	16134370 ±1521654	15357590 ±1429271	15537900 ±1654942
Deviation	2647532	1902134	1891196	1869136	1881155

	Random	Min-Hop	ETX	Fuzzy-1	Fuzzy-2
Sent bytes Confidence interval	6886586 ±90092	4961170 ±12138	5090809 ±21569	4836278 ±7315	4835064 ±7596
Maximum Confidence interval	15482460 ±741724	10043008 ±562659	9665057 ±784757	9957566 ±508690	9577910 ±554613
Deviation	2268840	1612931	1451441	1598274	1535058

Conclusions and future work

In this work we have analysed and compared the performance of five selection strategies: *random*, *Min-Hop*, *ETX*, *fuzzy-1* and *fuzzy-2*.

We have simulated a 64 nodes (8x8) wireless network with obstacles and without obstacles.

Results:

-Fuzzy-1 and fuzzy-2: the best performance, it adapts to all the situations of the network.
-Random: the worst efficience due to it does not consider any parameter of the network.
-Min-Hop and ETX: they work better/worse depending of the features of the network.

Future work

-Investigation about the use of the size of the queue of the server node in the fuzzy system.
-To use the *k-shortest path* algorithm in the first selection of the server node.
-To model obstacles with a probability distribution of the attenuations.

References

-Lissette Valdés, Alfonso Ariza, Sira M. Allende, Rubén Parada, Gonzalo Joya. Study of Alternative Strategies to Selection of Peer in P2P Wireless Mesh Networks, In Advances in Computational Intelligence, Part I; LNCS 7902, pp.124-132, ISBN: 978-3-642-38678-7, DOI 10.1007/978-3-642-38679-4, Springer (2013).

-D. S. J. de Couto, *High-Throughput Routing for Multi-Hop Wireless Networks, Ph.D. Thesis.* Massachusetts Institute of Technology, 2004.

-J. W. a. R. K. Yaling Yang, *Designing Routing Metrics for Mesh Networks,* University of Illinois, Urbana-Champaign, p. 9. http://www.cs.ucdavis.edu/~prasant/WIMESH/p6.pdf.

-F. G. Lagos, Gonzalo Joya. Diseño de controladores difusos. Apuntes de la asignatura Técnicas de Inteligencia Computacional, Málaga, 2013.