Dynamics System Modeling Approach in Node Mobility on Mobile Ad-hoc Network

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Abstract— **Movement of the nodes in a mobile ad-hoc network is affected by distance and strong transmit / receive signal between neighboring nodes to each other, so how the mobility of the nodes in the network connection can maintain connectivity in the line-of-sight is emerging challenges in the dynamics system. In mobile ad-hoc network each connection connectivity is temporary, so the topology changes that appear along with the mobility of the nodes in constructing communication calls will change the position of the transmitter and receiver. This research has been done on modeling the dynamics system approach for each node mobility scenarios were created based on the selected tests and determined. With quantitative methods used involve tools that can observe the data streaming process in real-time, the results obtained demonstrate the system dynamics can serve to test the mobility of the nodes that occur in mobile ad-hoc network is able to maintain a connection connectivity between each neighboring node.**

Keywords: dynamic system, mobile ad-hoc network, modelling, node-mobility

I. INTRODUCTION

The movement of the nodes in the Ad-hoc network initiated when an end-user connectivity requires that new media infrastructure available at the time previously failed to provide the connection is successful; whereby a network service can be accessed if the previous interconnectedness between devices that need each other to build the communication has been intertwined. Compared to wireless networks that are point-to-multipoint, then Ad-hoc network, the infrastructure that is built up and formed is temporary and not permanent. This is what allows the mobility of nodes can be established adjacent to each other continuously throughout each connectivity can be maintained. Thus the nature of the dynamics of the movement of the nodes can be built, and technologies that use this method are called mobile ad-hoc network [1] [2]. When the ad-hoc network, a minimum of two nodes that are interwoven to form a network of relationships in building communication, then the mobile ad-hoc network there are at least three nodes form a network so that communications can be established among them [2][3].

In the mobile ad-hoc network each nodes adjacent to each other has changed the dynamic nature of each position in building communication calls. Dynamic properties can be built by any cause nodes in the network have the capability to act as backwarding / forwarding devices [4]. The mobile ad-hoc networks network itself are in the private network, that's the computer network group that has wide coverage and domain are internal and are limited in building data communications and call [5].

On this research has been carried out a series of simulations that are based on quantitative empirical methods in modeling various node mobility conducted in indoor conditions-building [2] [3] [6]. In mobile ad-hoc network, each nodes adjacent to each other can be changed dynamically by calculating the distance range (line-of-sight, LOS) and transmit/receive signal strong [7]. Line-of-sight is the scope and reach of the transmit / receive signal between sender and receiver are formulated in Fresnell Zone area, and a transmit / receive signal strong is a signal condition value that is sent or received from the sender or the receiver.
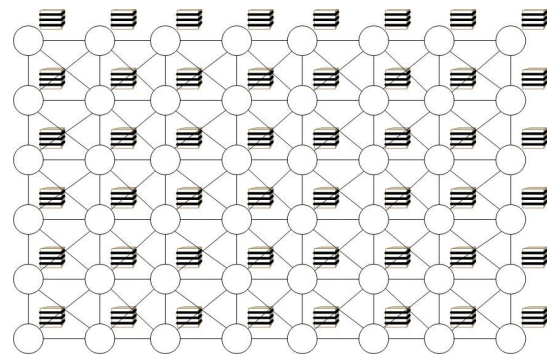

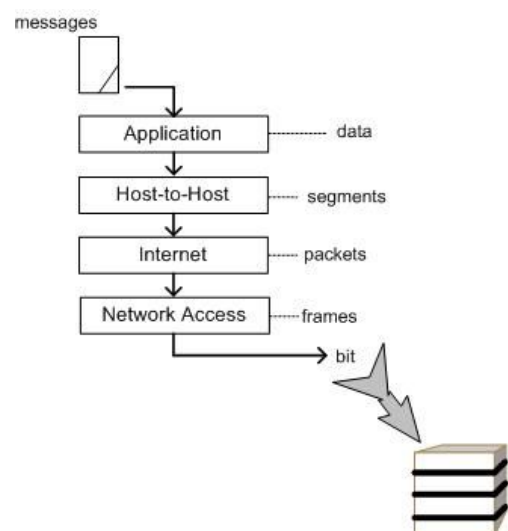Figure 1.   Node mobility on mobile ad-hoc network [2]

Figure 2.   Encapsulation process on layer stack for TCP/IP [2]

II. RELATED WORK

It is tested on the dynamics system of the data communication is a QoS good conditions must be maintained before and after the node mobility occurs. Therefore, the dynamics of the system modeling should be possible QoS parameter values tend to be fixed and unchanging.

If on the analog communication systems, quality of service expressed in transmit/receive signal strong; hence in digital communication systems is expressed in the parameters: delay (δ), throughput (Γ), jitter (φ), and packet-loss (π).
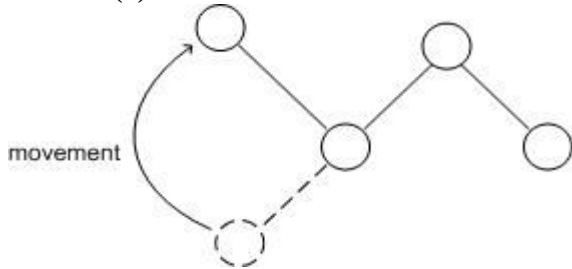

Figure 3.   Node mobility in line-of-sight on mobile ad-hoc network

In mobile ad-hoc network, a position of a node is expressed in two parameters, and based on [8] in the dynamics system there are two major elements that possessed namely vector and function. A vector represented stated direction as node dynamic, and in data communication it's mean a distance and transmission/receipt signal strong; as well as the stated function node movement models are used, wherein the data communication is stated in the position shift is generally expressed in a mathematical model. Tendency of node mobility in mobile ad-hoc networks are more fixed/static when compared to similar networks virtually, namely mobile communications network.

Network models of mobile ad-hoc network which is constructed in this research are shown in Figure 4, which was twice the node mobility scenarios as shown in Figure 5 and 6.
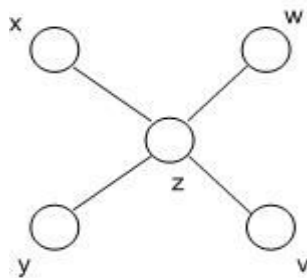

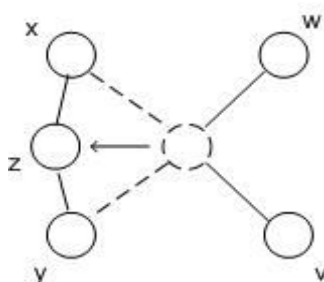Figure 4.   Mobile ad-hoc network model on this research
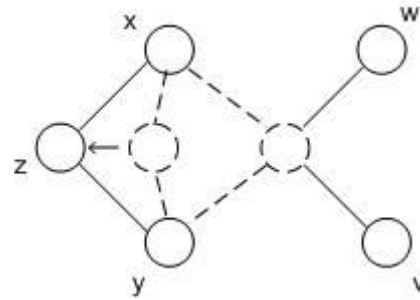

Figure 5.   Node z as mobility node for first

Figure 6.   Node z as mobility node for second

If on the dynamic system has a feedback in order to maintain the value of the connectivity for initial state and after is not affected by dynamics being built, so in data communication the feedback can be represented by the line-of-sight. Classification of line-of-sight consists of an optical line-of-sight, ie, the transmitter and receiver can keep each viewing (face-on-face); and radio line-of-sight, ie, the transmitter and receiver can keep listening to each other [9].

Dynamics system models are generally based on [4] [10] [11] is shown in (1).

$$Ax' + Bx = 0 \qquad (1)$$

Where A and B respectively at the constant changes in the dynamics of inter-state by running on x conditions and its diffrential. Therefore, the dynamics system in order to provide the same quality before and after, then (1) can be translated back into (2).

$$Ax' = -Bx \qquad (2)$$

So if the assumed changes in the inter-state mobility of nodes which occur on the dynamics system while maintaining quality of service in mobile ad-hoc network, (2) can be in the form of new formulated into (3) to (5).

$$\Delta k = \Gamma - \delta - \pi \qquad (3)$$

$$\Delta k' = \Gamma' - \delta' - \pi' \qquad (4)$$

$$\Delta = |\Delta k - \Delta k'| \qquad (5)$$

Then the dynamics system are met if: $0 \leq \Delta < 1$.

Quality of service is getting better or a positive value if δ getting smaller, the Γ getting greater, and π is near zero. Therefore the dynamics system in a mobile ad-hoc network must be able to defend the values of quality of service in accordance with the criteria of good.

The series of tests that have been carried out in this research using two scenarios as shown in Figure 5 and 6 earlier, where Wireshark tools used to observe the changes in Γ and δ value, while π assumed negligible.

III. RESULT

After a series of tests based on scenarios that have been determined, then the results are shown in Tables 1 to 6 based on Figure 7 and 8. How to observe the value of Γ used audio-streaming services, and while to observe the value of δ used downloading service.
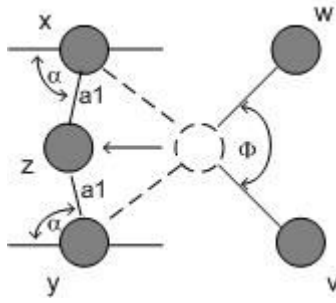
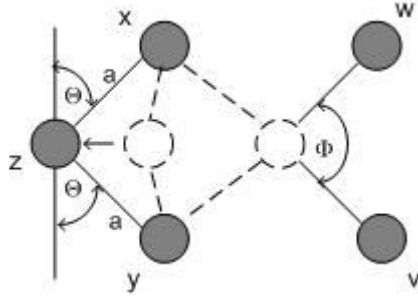Figure 7. Node-z mobility on first scenario with position state

Figure 7.   Node-z mobility onj second scenario with position state

In figure 6 and 7, the node mobility change only applies to node-z, while other nodes remain mutually conditioned neighbors to its original position. The position in a mobile ad-hoc network is in terms of the parameters of the distance and angle between each adjacent node.

TABLE I.   Γ VALUE FOR INITIAL CONDITION

Node-x (KBps)	Node-y (KBps)
86.13	86.09
86.29	86.02
85.92	85.93
85.89	85.82
85.33	85.21
Average: 85.912 KBps	Average: 85.814 KBps

TABLE II.   Γ VALUE FOR FIRST NODE MOBILITY STATE

Node-x (KBps)	Node-y (KBps)
85.7	85.69
85.19	85.12
85.11	85.09
84.69	84.9
84.13	84.12
Average: 84.964 KBps	Average: 84.984 KBps

TABLE III.   Γ VALUE FOR SECOND NODE MOBILITY STATE

Node-x (KBps)	Node-y (KBps)
85.12	84.9
84.63	84.55
83.18	83.12

83.08	82.77
80.11	80.09
Average: 83.224 KBps	Average: 83.086 KBps

TABLE IV.   δ VALUE FOR INITIAL CONDITION

Node-x (second)	Node-y (second)
63.21	63.28
63.3	63.39
63.77	63.62
64.06	64.18
64.49	65.07
Average: 63.766 s	Average: 63.908 s

TABLE V.   δ VALUE FOR FIRST NODE MOBILITY STATE

Node-x (second)	Node-y (second)
63.42	63.42
63.59	63.66
63.9	64.09
64.3	64.35
67.6	67.22
Average: 64.562 s	Average: 64.548 s

TABLE VI.   δ VALUE FOR SECOND NODE MOBILITY STATE

Node-x (second)	Node-y (second)
63.9	63.99
64.09	64.18
65.63	65.62
65.92	65.92
66.09	66.7
Average: 65.126 s	Average: 65.282 s

Then further examination by the dynamics system approach in every states changes for the Γ and δ parameters which is as follows:

On the scenario-1 with Γ parameter is:

(85.912+85.814)/2 = 85.863 *ssd* ; *satu-satuan-dinamika*

On the scenario-1 with δ parameter is:

(63.766+63.908)/2 = 63.837 *ssd* ; *satu-satuan-dinamika*

Counting on Δk parameter is:

85.863 - 63.837 = 22.026

If on the state-0 had Δk = 22.026 and Δk' = 20.419, so a result is: |Δk - Δk'| = 1.607

TABLE VII. DYNAMIC SYSTEM VALUE ON NODE MOBILITY BASED SCENARIOS

	Γ	δ	Δk	$|\Delta k - \Delta k'|$
State-0	85.863	63.837	22.026	0
State-1	84.974	64.555	20.419	1.607
State-2	83.155	65.204	17.951	2.468

Based on the results of testing with quantitative methods have shown that the nodes mobility of in dynamics system modeling showed significant changes to the quality of service parameters. Changes obtained show node mobility on the first movement got 1,607, and while in the 2nd movement gained 2,468.

However, if viewed from the change in the value of each Γ and δ parameter to nodes observed at each node mobility, then the result obtained does not really give a significant change as shown in Figure 8.
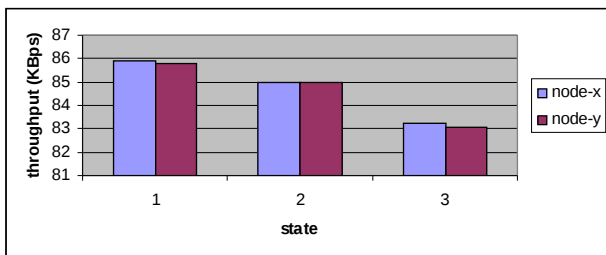

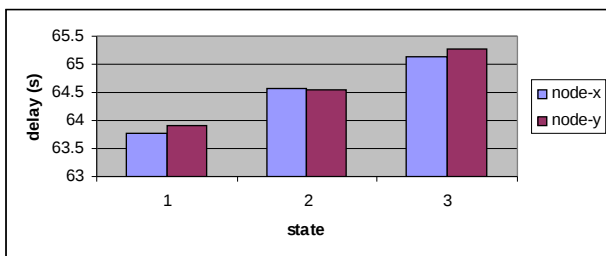Figure 8. Γ and δ value on each node-x and y

Figure 9. δ value on each node-x and y

This situation is in accordance with [6] that the two nodes are observed when the same position relative to the reference node, then the quality of service parameters are measured at each node are relatively equal.

Thus the node mobility that occurs for node-z displacement, although with conditions other nodes are mutually adjacent on observations made at nearby nodes, namely node-x and y represent the dynamics system being modeled exert significant influence on changes in quality of service measurable.

The results of observations made indicate any change in displacement node-z give significant effect on the Γ and δ parameters. Although qualitatively (such as in terms of end-user) shows relative differences can be ignored, but

when viewed from a quantitative approach (such as from the machine) then the result is significant given the change. This is caused by the transmit/receive signal interference on each node is observed by the implications of the node-z movement position.

IV.   CONCLUSION

The node mobility in mobile ad-hoc network is affected by the transmit/received signal strength between the nodes adjacent to each other, so that the switching node tendency to follow the needs and desires of end-users. Data communication can be accomplished if the first connectivity between the nodes that want to build the call has been going and going well.

Dynamics system provides flexibility in terms of value with the criteria of node mobility while maintaining quality of service of any ongoing communication calls. Flexibility in mobile ad-hoc network expressed in node position movement at the area of line-of-sight is formed.

Coverage area of node mobility on line-of-sight can not ignore the changes in the transmit/receive signal on each node. Even if from a qualitative approach does not exert significant influence, but if the node mobility of a quantitative approach is sufficient to give the change in the ratio of Γ and δ parameter measurable.

Based on the test results and calculations indicate node mobility affects the value of the position represented in the distance and angle to the value of the Γ and δ parameter observed for any and inter-state migration is performed. And node mobility have lower tendency quality of service in mobile ad-hoc network. Therefore, the dynamics system has elements of feedback in communication where the data represented in the routing technique. With routing techniques, packet-data will be forwarded to the neighboring nodes that have good support in connectivity.

At a certain state due to changes by node mobility in mobile ad-hoc network, based on the test results, showing inverse ratio between the value of Γ and δ. Where any change Γ give rise to changes impairment δ parameter.

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