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Efficient Routing in Ad- Hoc Wireless Networks using Connected Dominating Set

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Abstract

This research examines wireless networks Ad-hoc where communication between the network components (stations) within the contact area is without wires or a server or Access Point without any infrastructure .

The control of network group contains a decade of electronic devices with the distribution is irregular and variable Topology by selecting (DS) Dominating Set and reduce their number as much as possible by adding laws of more development to reduce the DS, where the study of private networks developed in the evolution of rules binding for bases to a chiave two important hypotheses: Find a DS and reduce their number as much as possible, and the first was the achievement of the main hypotheses which is that the extent of sending all the nodes randomly is distributed equally, and the second hyporesearch is that communication between the nodes is not directed. All nodes in the network are not connected directly but through a third node called the DS. Then came the algorithm by the WU & Li to add the development of the assumptions above .Then the algorithm developed by syndicate Naresh Nanuvala.

In this research , we have proposed a new algorithm that added something new to reduce the number of DS for the previous algorithms.

The simulated is by program in Visual Basic language for a protocol to control the contract for wireless connectivity and less DS and compare the results of the proposed algorithm with the results of the basic rules, WU & Li algorithm and Naresh Nanuvala.

Key words:Wireless network ,Ad-hoc network ,dominating set, graphs

1.Introduction

Ad-hoc is a wireless network temporarily composed of several different devices or uniform and are linked to the devices without an access point or wireless route because the network will be based on direct contact between the card wireless network, is installed on each device for data transfer from one computer to another, in the network and must be as standards-compliant IEEE.

Sometimes called the networks ad-hoc networks (IBSS) Independent Basic Service Set ID is used for the communication between wireless devices in the development of ad-hoc.

Ad-hoc is a term borrowed from the Latin, which means in English created with a specific purpose and meaning "making or to use a special form" .This is similar to the style, sometimes style peer-to-peer where direct contact with each other device is within a decentralized environment accessible to all, as in the Bluetooth technology is easy compared to the configuration patterns infrastructure and the most complex. [1]

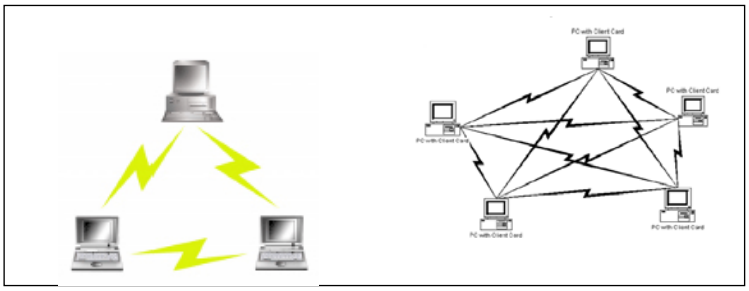

Figure1. Ad-hoc wireless network[1]

2. Network Protocols for Ad-Hoc

For protocols that operate networks Ad-hoc are the same networks operated by the regular use access point which is called infrastructure network which are dependent on the Wi-Fi networks that operate at frequency GHz 2.4 of the standard IEEE 802.11 g / b.

2.1 OLSR

OLSR is an abbreviation for the link-state routing protocol that enhanced Optimized Link State Routing protocol.

Protocol is used OLSR private networks ad-hoc mobile, a protocol proactive pro-active, depends on the tables which is characterized by examining proactive links to modify the routing tables which lead to a lot of complexity and resource consumption processor CPU, but also lead to a better performance. [2]

It uses a technique called multi-point conversion multipoint relaying (MPR) to post messages. Working applications of this protocol are currently among the operating systems to linux, windows, mas OS X, Free BSD and Net BSD.

OLSR protocol is designed primarily to be a protocol and a programmer salary in order to facilitate well-managed, expanded and transferred to other operating systems. Line the current application of the protocol with the document RFC3626 with respect to each of the basic functions and additional resources.

OLSR protocol is currently the most stable and protocols vulnerable to the development of .[3]

2.2 AODV

Protocol Ad-hoc On demand Distance Vector (AODV) routing protocol is designed for private networks ad-hoc mobile phones. This allows dynamic routing protocol multi-point argument multi-hop between the machines.

3. Graph Theory

Networks can be represented by graphs. The mobile nodes are vertices. The communication links are edges. [4]

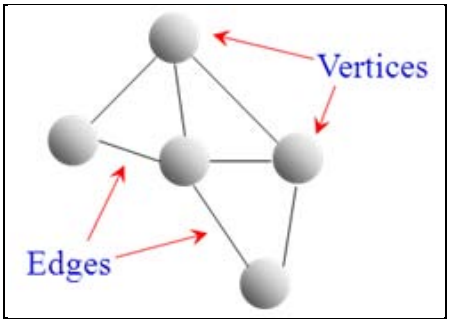

Figure2. Edges & Vertices in graphs[4]

Routing protocols often use shortest path algorithms.

A graph G(V,E) is two sets of object, vertices (or nodes) , set V and edges, set E. A graph is represented with dots or circles (vertices) joined by lines (edges).

The magnitude of graph G is characterized by number of vertices |V| (called the order of G) and number of edges |E| (size of G). [5]

The running time of algorithms is measured in terms of the order and size.

4.Dominating Set

Definition: A subset of the vertices of a graph is a dominating set if every vertex not in the subset is adjacent to at least one vertex in the subset. [6]

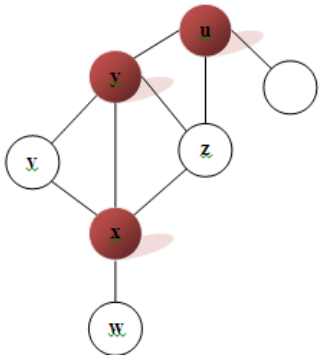

Figure 3. Dominating Set[6]

Wu and Li proposed a simple distributed algorithm that can quickly determine a connected dominating set in a given connected graph.

IDEA: A node is marked as gateway node if two of its neighbors are not directly connected (simple marking rule). [7]

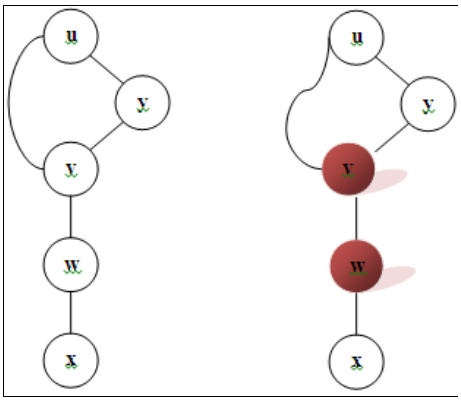

Figure 4. Minimal Dominating Set[7]

Dominating sets are closely related to independent sets: an independent set is also a dominating set if and only if it is a maximal independent set, so any maximal independent set in a graph is necessarily also a minimal dominating set. [8]

5.Evolution of Connectivity Rules

A Dominating Set (DS) is a subset of nodes such that each node is either in DS or has a neighbor in DS. A Connected Dominating Set (CDS) is a connected DS, that is, there is a path between any two nodes in CDS that does not use nodes that are not in CDS. It is favorable to have few nodes in the CDS or DS. This is known as the Minimum Connected Dominating Set (MCDS) problem. [9]

Given an arbitrary undirected graph finding a MCDS or CDS is a NP-hard problem. Various algorithms have been proposed to address this problem. One such approach is dominating-set-based routing theory.

A wireless ad hoc network can be represented as a simple graph G (V, E), where V represents a set of mobile nodes and E represents a set of edges. An edge (u, v) in E indicates that nodes u and v are neighbors, and that u is within ***v*** range of transmission, while v is within ***u*** range. [10]

A dominating set DS is a subset of vertices of a graph G where every vertex that is not in the subset is adjacent to at least one vertex in the dominating set DS subset.

A connected dominating set CDS is a dominating set that induces a connected sub-graph.

The stages of the evolution of the rules of connectivity for private networks to achieve two important rules are:

a) Find a DS.
b) Reduce the number of DS as much as possible.

The following stages of development:

5-1 Basic Rules

a) The dispatch of all nodes distributed randomly similar or equal.
b) Communication between all nodes in the network which has not reached directed , but through a third node called the DS.

5-2 Development of the above algorithm by Wu & Li

a) Any two nodes u, v ∈ dominating sets, If N [v] ⊆ N [u] and id (v) <id (u), change the m (v) to F.
b) Any three nodes u, v, w ∈ dominating sets, u and w are two marked neighbors of v. If N (v) ⊆ N (u) ∪ N (w) and id (v) <id (u) and id (v) <id (w), change the m (v) to F.

Where N [v] ∪ {v} = N [v], it is the closed neighbor set of v. Another condition is that assigns a distinct id, id (v) to each vertex in the dominating set. [11]

5-3 Algorithm of Naresh Nanuvala

An improved algorithm to find a Nintendo DS in wireless networks, as follows:

a) Any two DS works cover a third DS lose sight of the value of the DS-third are less than the values of the DS Monday Nations.

b) There is another option, even if the value of the Union of two of the youngest of the node canceled the final third. [12]

6. Proposed Algorithm

In this research, we have proposed expansion of the previous algorithms with four possibilities, as follows:

a) Any four nodes u, v, w, z ∈ dominating sets, u, w and z are three marked neighbors of v. If N (v) ⊆ N (u) ∪ N (w) ∪ N (z) and id (v) <id (u), id (v) <id (w), and id (v) <id (z), change the m (v) to F.

b) Any four nodes u, v, w, z ∈ dominating sets, u, w and z are three marked neighbors of v. If N (v) ⊆ N (u) ∪ N (w) ∪ N (z) and id (v) < id (u) , id (v) < id (w), and id(v)>id(z), change the m (v) to F.

c) Any four nodes u, v, w, z ∈ dominating sets, u ,w and z are three marked neighbors of v. If N (v) ⊆ N (u) ∪ N (w) ∪ N (z) and id (v) < id (u) , id (v) > id (w), and id(v)>id(z), change the m (v) to F.

d) Any four nodes u, v, w, z ∈ dominating sets, u,w and z are three marked neighbors of v. If N (v) ⊆ N (u) ∪ N (w) ∪ N (z) and id (v) > id (u) , id (v) > id (w), and id(v)>id(z), change the m (v) to F.

7. Simulation of Proposed Algorithm:

In this section, we used Visual Basic as a chosen programming language for applying proposed algorithms. A simulated program built with Database based on access has been written.

In this program we randomized variety numbers of nodes several times. Runs of the program rely on different numbers of nodes according to the area of simulation. By changing the distance between those nodes, we look for closer results to optimum solutions (small number of DS).

The application of these proposals has been simulated one after the other and the stages of the application of complex are interrelated in terms of finding the programming language suitable for simulation and the use of the programming language Visual Basic database with Access, as well as the randomization of the node and the implementation of the randomization for several times and the application of sequential algorithms mentioned above with the difference in the number node and the simulation area for this node in addition to test various change of the distance between those nodes until I got the results closer to the reality of the solution less than a decade the number of the DS.

Select the form of two-dimensional drawing of 9720 × 10680 pixels and commensurate with the width of the screen, has a drawing in this figure the number of nodes each with a number representing the value of the node, or (id) is in the network in real (IP) Suppose figures for the decade of the 1 and after you install the extent of sending a particular d, the algorithm steps were as follows:

1- Reading the number of nodes which represents the number of electronic devices in the ground and the distance between the nodes.
2- Distribution nodes take values of x and y coordinates randomly within the specified two-dimensional shape and the size of each node 15 pixels and black color.
3- Draw lines up between the nodes after calculating the distance (d) between

them and measure the distance dimension according to the law:

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

4- If the distance is within the range of transmission specified any less or equal to d store the value of each node and the node related to the database table in Access.
Then we test the link between the nodes of any integrated each node n1connected to node n2 and the space between them is less or equal to d if yes, goes to Step 6.

5- If they do not get re-link the integrated change the distribution of the node Go to step 2.

6- Apply the basic rule to mark the first decade DS red test .Are there any two nodes not directly related, but through a third If the answer is yes goes to step 8.

7- If there is no third node between two nodes connected it is not DS and will remain black in color.

8- Indicate the third node in red.

9- Rule applies to the first (a) of Wu & Li algorithm to reduce the number of DS and DS pointing the node the new green test If the two DS connecting the same nodes canceled DS-value small (according to sequence id) as in the following example:
Ex: N [2] = {2,5,7,8}
N [5] = {2,5,7,8}
N [2] ⊑ N [5] & id (2) <id (5)
Shall be repealed node 2 and node 5 is the remainder of the DS nodes 7 and 8 .

10- If the answer is yes, al Qaeda second test (b) of the algorithm Wu & Li a node if the three are the DS and the Union, two of which cover the last third are canceled, as in the following example:
Ex: N (v) ⊑ N (u) U N (w)
And id (v) less than all of the values of u, v, if the answer is yes goes to step 12.

11- If the answer is no, keep the node the Red Balloon, and the program stops.

12- Indicate the new node is in green holding the DS.

13- Apply algorithm Naresh Nanuvala and pointing the node the new DS blue test:
(a) If the two are united DS coverage of the third node, despite the fact that one decade, the United less than the third node.
(b) Or that both nodes are less than a third id If the answer is yes goes to step 15

14- If the answer is no, the node remains green, the program stops.

15- Indicate the new node is blue and she is holding the DS .

16- Then apply the new algorithm proposed in the search of the four possibilities one after the other and pointing the node the new pink DS tests the following:
(a) If the DS covered in the first three DS be canceled (if the three largest union of one, each one bigger than the first.
(b) If the Union of three covers and one DS and one of them is lower than the first deleted .
(c) If the Union three DS covers one and two of them, less delete the first.
(d) If the Union of three covers and one DS and all of them, less delete the first.

The Figure 5.-8. illustrates the most important steps of the simulation algorithm is proposed.

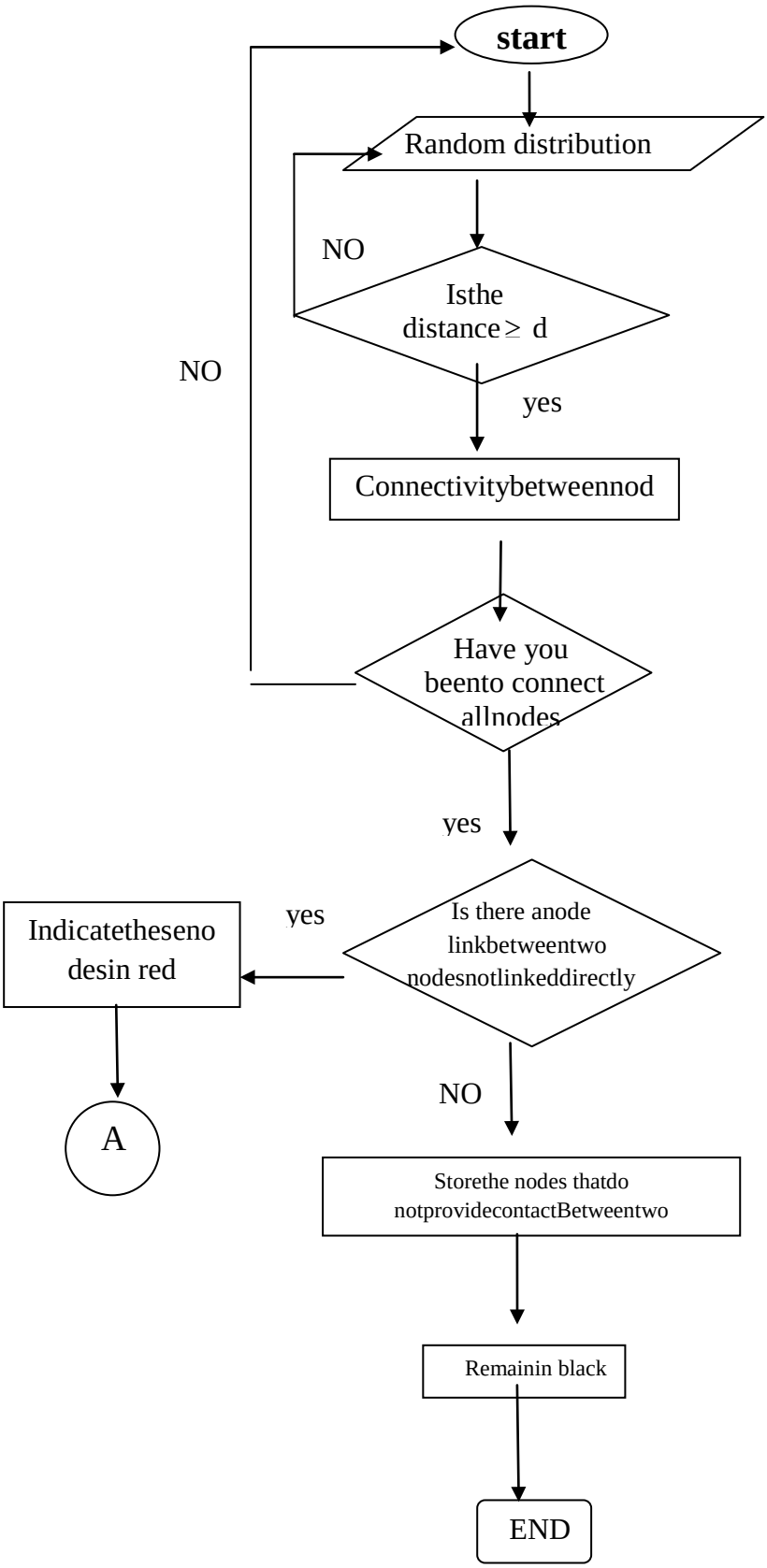

Figure 5. Flowcharttosimulatethe Basic Rule

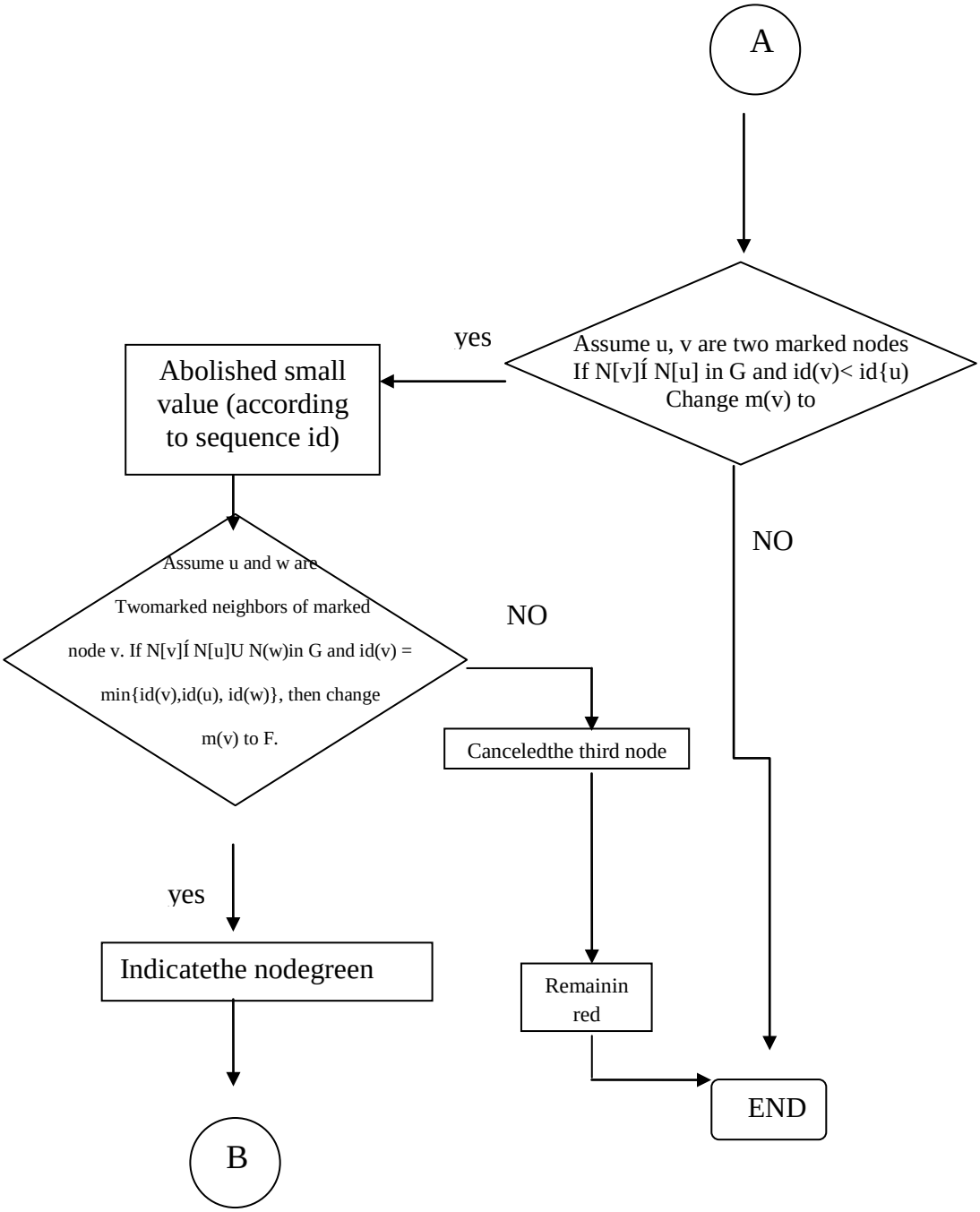

Figure 6.Flowcharttosimulatethe Wu &Li algorithm

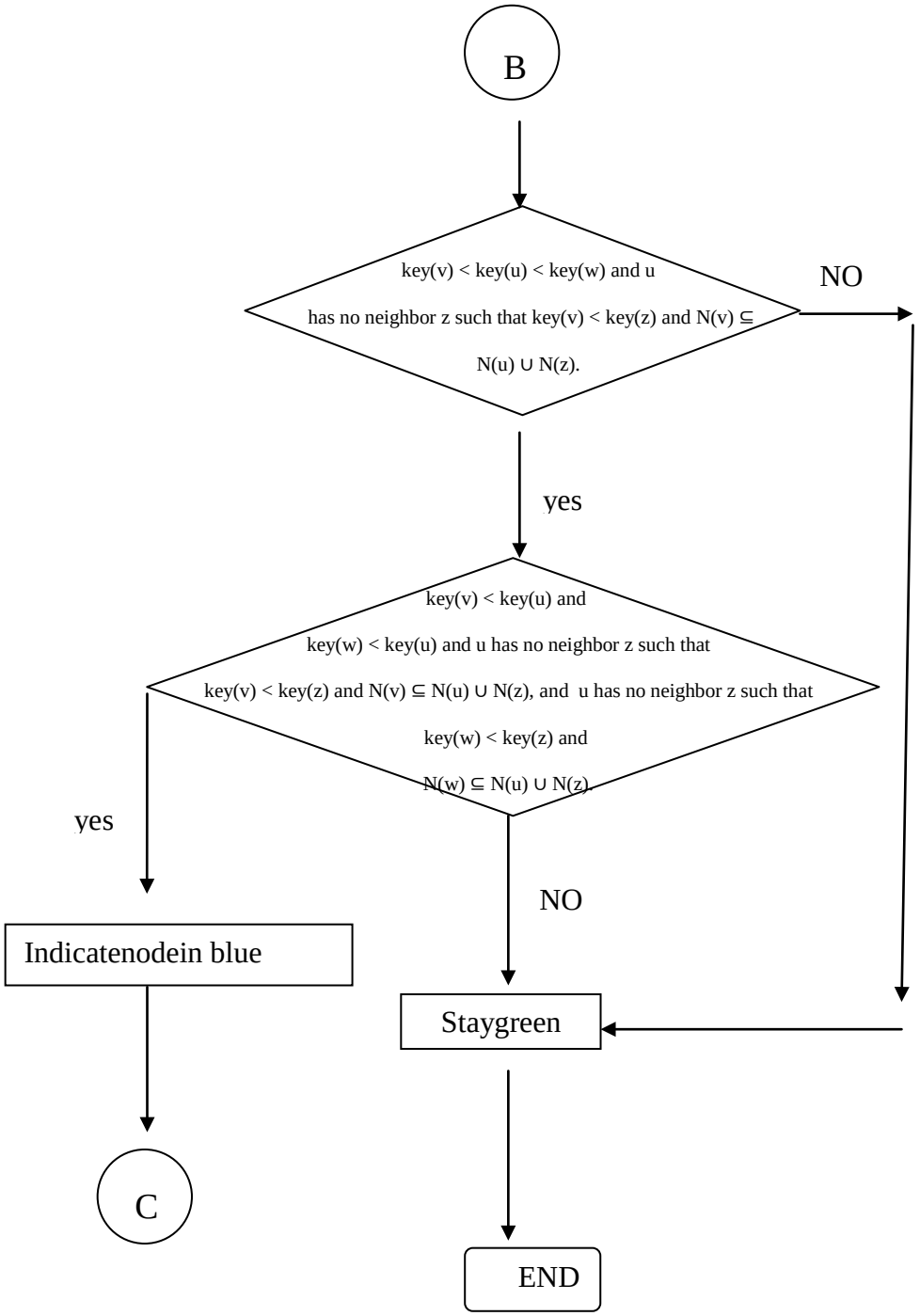

Figure 7.Flowcharttosimulatethe Algorithm of NareshNanuvala

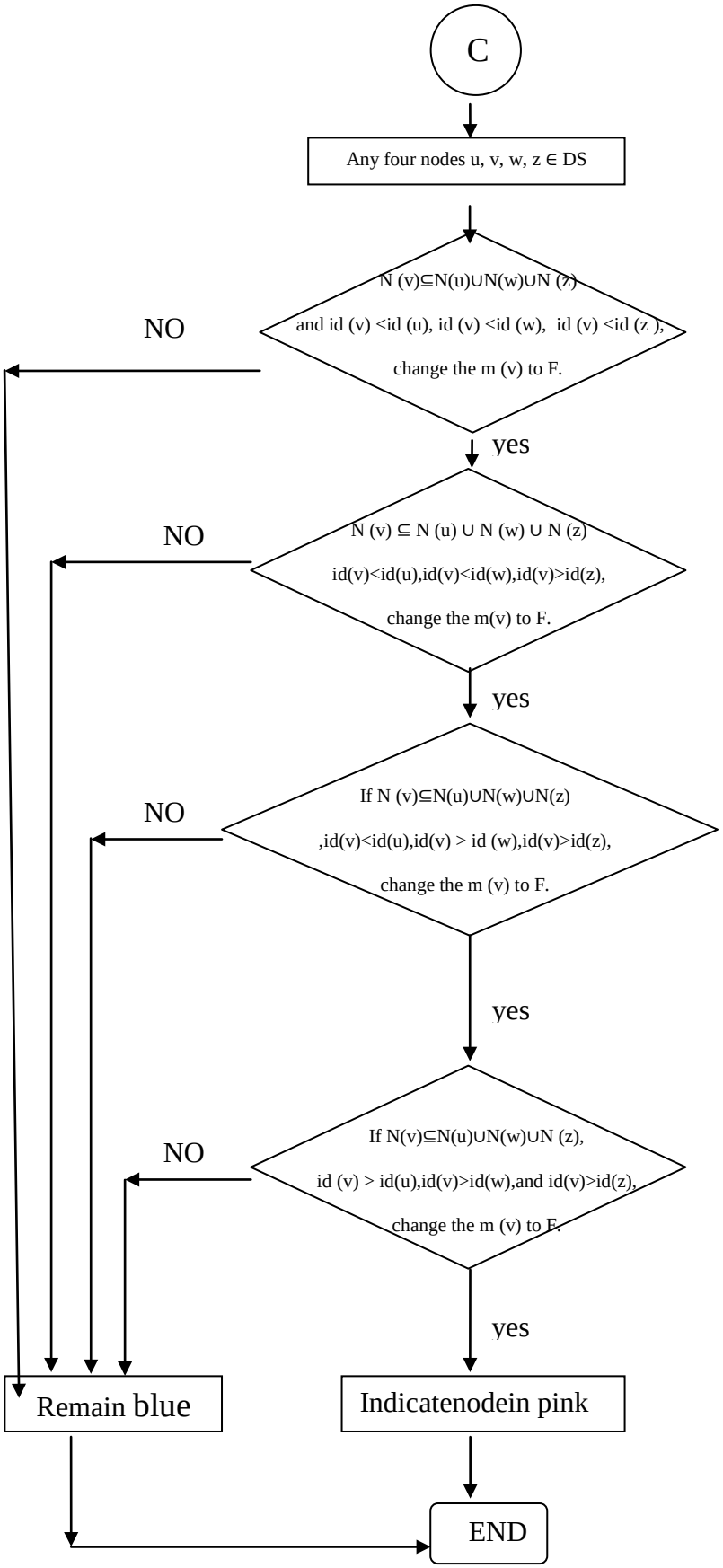

Figure 8.Flowcharttosimulatethe Proposed Algorithm

The following describes the figures of distribution for different numbers of nodes (100,20,50,100,150) and application stages to reduce the number of DS.

The Figures 9. -15. distribution of (100) nodes:

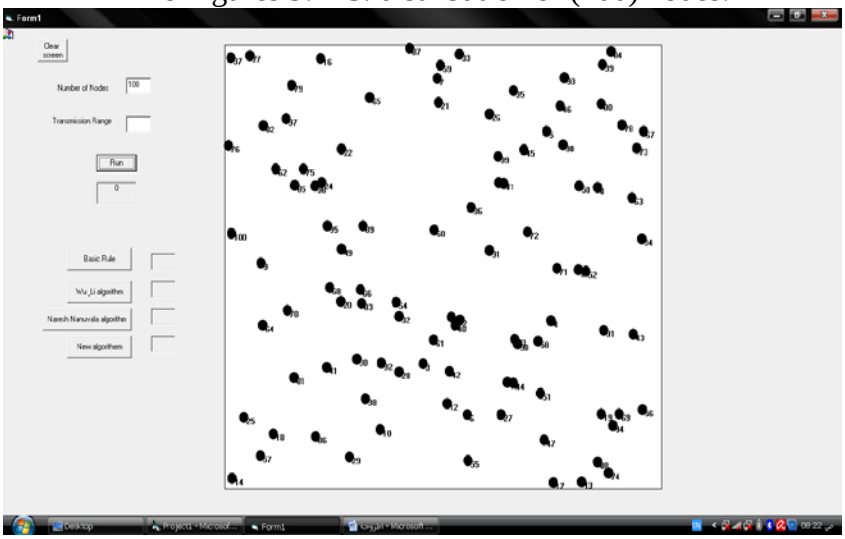

Figure 9. Random distribution of 100 nodes

The figure above is a form of randomization of the node and here 100 nodes have been taken in the two-dimensional space and the dimensions of the drawing 9720 × 10680 pixels and the opportunity to display a simulation of the reality of an area ranging between 100 m to 1 km. The node was given black color and an area of 15 pixels each with a number from 1-100.

In the figure, one of the following forms of implementation is by linking these nodes with each other, Connecting each node with other nodes if the distance between them was less than or equal to d.

We note in Figure (10) that he does not get linked to an integrated, all nodes

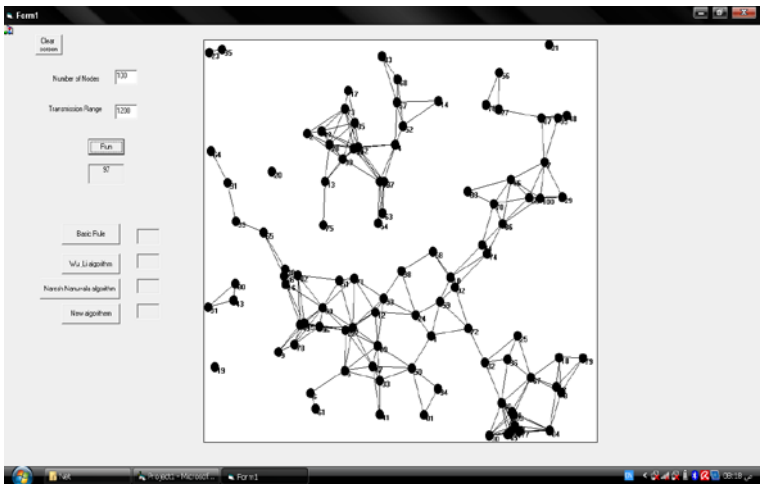

Figure 10. Implementation of the link between the node does not achieve a complete connection

Here,re-implementation several times and it is the distribution of a variable to hold and randomly until we get the link of an integrated network, as in the following format:

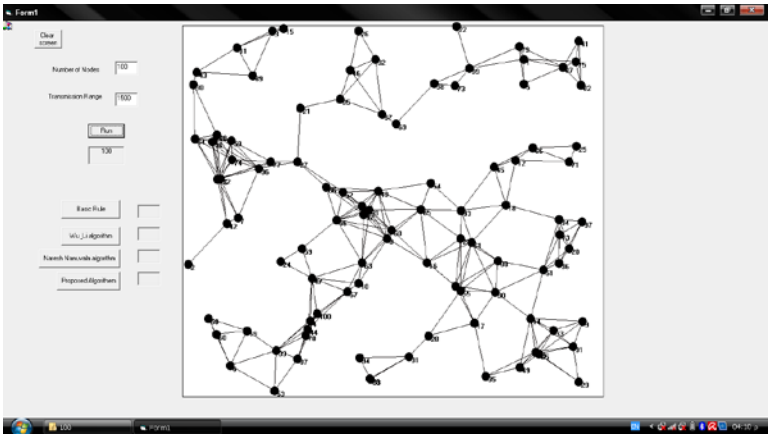

Figure11.linktothe fullnetwork

Basic rules are applied to determine the DS and indicate those nodes in red that are nearly equal to the node in the network and are often node when the parties are not DS and will remain black in color.

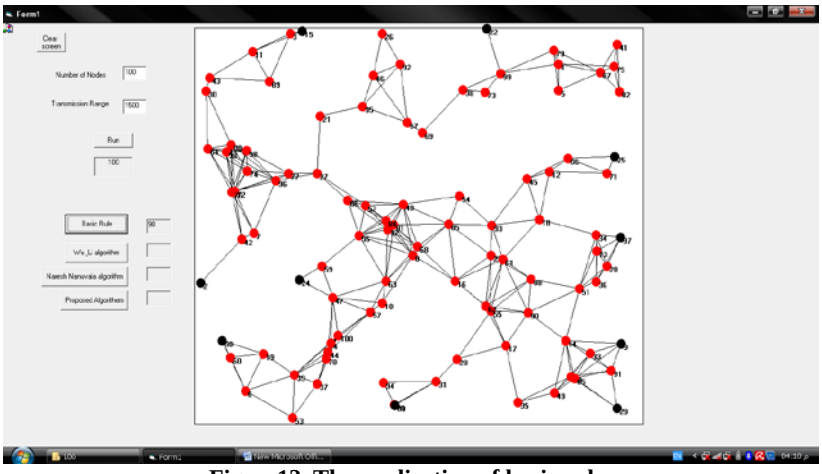

Figure12. The application of basic rules

We applied the Expansion of the rules1 and 2 of Wu & Li's green and discoloration of the node, which represents the DS which is far less than in the past and the other nodes remain unchanged in black or red as in the following format:

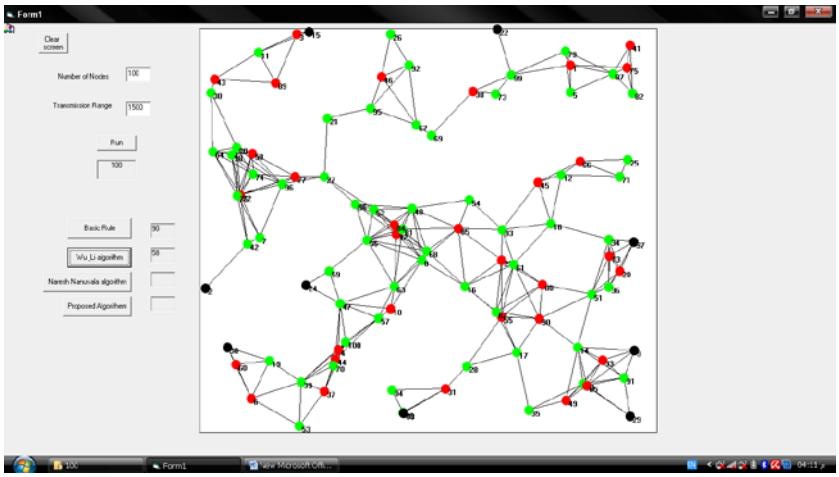

Figure 13. The application of algorithm Wu & Li

Then the algorithm applied to determine Naresh Nanuvala DS blue and we find here an additional decrease in the number of nodes and the DS remains the node which did not cancel any of the DS in black, red and green, as inthe following format:

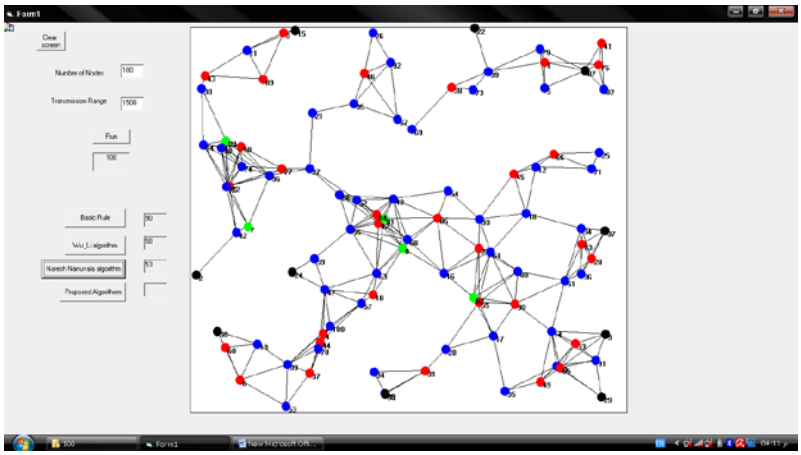

Figure 14. The application of algorithm Naresh Nanuvala

Finally, the application of the proposed new algorithm has won four stages. Certainly, the overlap between node and non-cursor phase is denoted by another. Until we got the results of a decrease in the number of DS, and the results to the left of each form indicate the number of nodes DS after the application of each algorithm P j this example, the number of DS in the implementation of the rule base is equal to 90 At the base of Wu & Li's equal to 58 In algorithm Naresh Nanuvala is equal to 53, in the new proposed algorithm which is equal to 50.

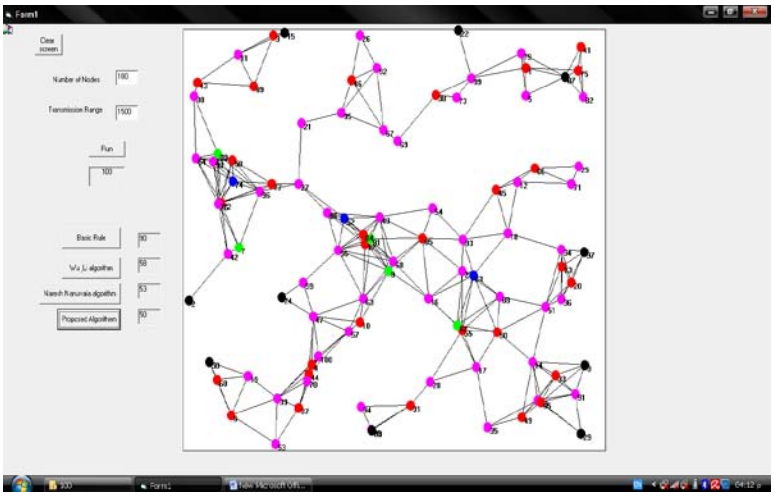

Figure 15. The application of the proposed new algorithm

The Figures (16)-(22) show the distribution of (50) nodes:

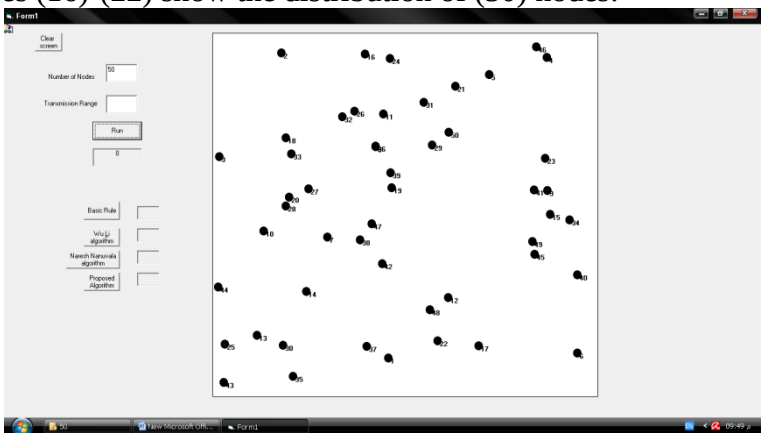

Figure 16. a random distribution of 50 nodes

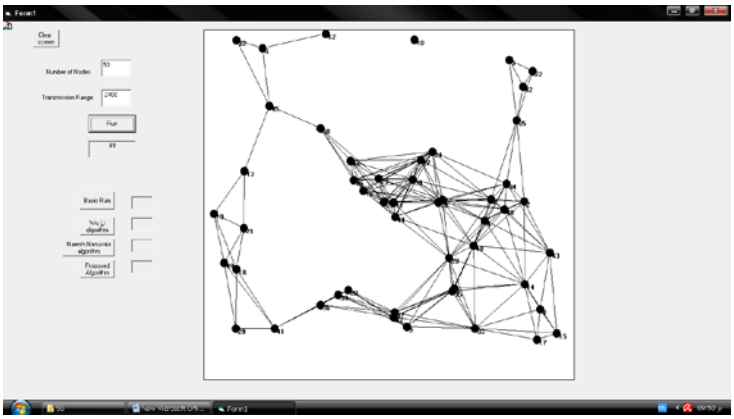

Figure 17. Implementation of the linkbetweenthe nodedoes not achievea completeconnection, including

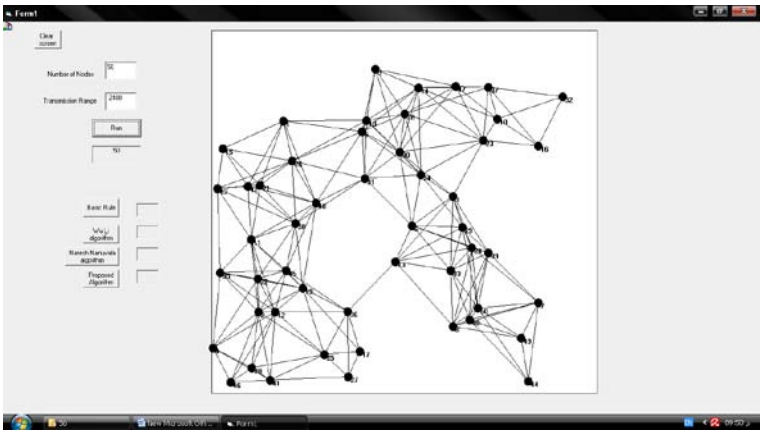

Figure18.linktothe fullnetwork

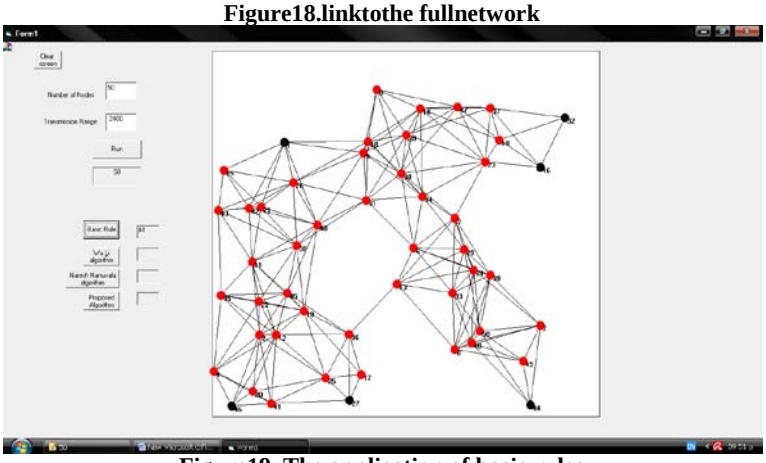

Figure19. The application of basic rules

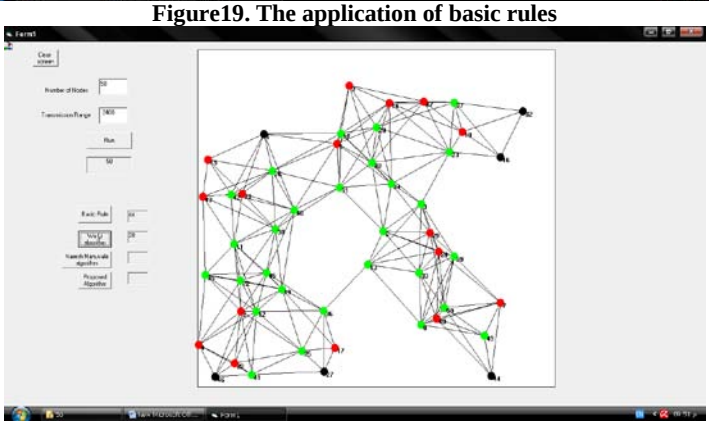

Figure 20. The application of algorithm Wu & Li

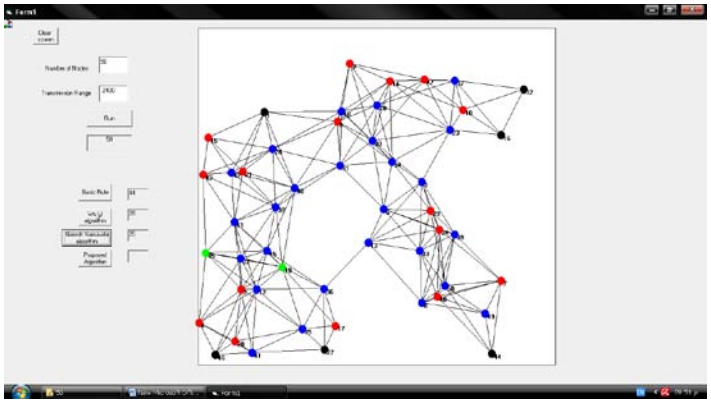

Figure 21. The application of algorithm NareshNanuvala

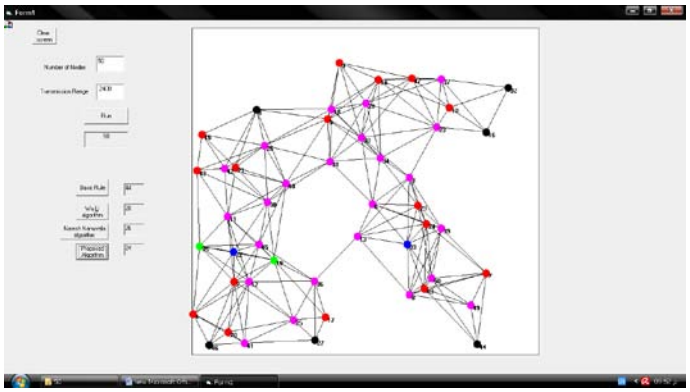

Figure 22. The application of the proposed new algorithm

Table 1. of Average number of dominating set nodes

Number of Nodes	Density	Basic Rule	Wu &Li Algorithm	Naresh Nanuvala	Proposed Algorithm
20	3000	18	11	9	8
30	2500	26	17	14	12
40	2400	35	24	20	18
50	2200	44	28	26	24
60	2000	53	36	33	31
70	1900	62	44	41	39
80	1700	72	47	43	41
90	1600	81	53	49	46
100	1500	90	58	53	50
110	1400	89	57	52	49
150	1200	135	87	80	76

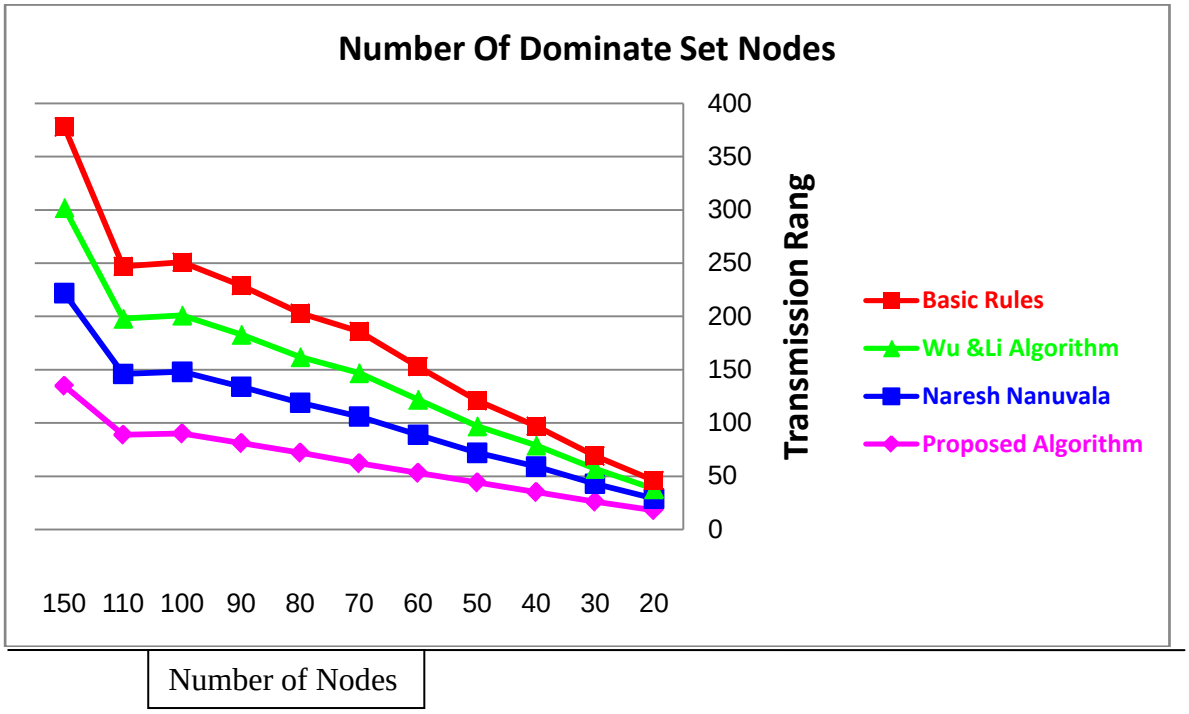

Figure 23.Average number of dominate set nodes relative to varying nodes

8.Discussions and Conclusion

We conducted simulations to reduce the number of DS in the four stages of the proposed algorithm and compared with the previous results of the implementation of algorithms and a simulation program for the four algorithms is the main base and then an

algorithm Wu & Li's algorithm and Naresh Nanuvala Finally, the proposed new algorithm.

And I took different numbers of nodes randomly distributed with the difference in distance between them as in the table 1. and in space are limited to Form a two-dimensional, where the dimensions of 9720 × 10680 pixels and this is by the possibility of the screen display standard and was simulated for the preparation of this decade, with the assumption that each node of the sending static and connection of each node with neighboring nodes are only in the case that the distance between them is less than or equal to the transmitter d.

After several times of the implementation and the neglected form separate and which does not achieve a connected network, we have used here the number of the contract ranged between 20-150 knots and a distance relative from 3000 pixels to 1200 pixels, respectively, were the number of times execution a few are large compared to algorithm Naresh Nanuvala where The execution times in the last 500 times. And the viability of the programming language Visual Basic and use the Access database and the potential of the query in this rule to test the stored data, it is the best way to get results, according to architectural possibilities available in the computer hardware used.

Despite the overlap that occurred in the application of four stages of the proposed results to reduce the DS is relatively small given the result is different from what preceded it, the algorithms of the three held in a network of 100 knots, this therefore leads to achieve what we're aiming for this study is the reduction in the number of nodes dominant DS and speed of information transfer.

It was also noted that the change in network topology change any sites of the nodes and the possibility of communication sent over the largest that could lead to a reduction in the number of the DS.

Remain some of the fears and concerns revolve user's thoughts regarding aspects of performance, security and ease of use. As for performance, the number of computers connected to the network any contract affect the performance of the wireless network, increasing the number of nodes means that the waves of the access device, which increases the chance of interference of these waves on one another and reduces the speed of performance. The performance is affected by the distance that separates between the nodes, every time you near the distance I said, the better the performance.

The development of the possibility of wireless networks is linked to more or less in the architectural evolution of networks and devices and component configured for wireless communication in various circumstances, including the change in network topology and the climatic conditions and harsh environmental.

REFERENCES

[1] Karygiannis &Owens , "Wireless Network Security 802.11, Bluetooth and Handheld Devices", Tom Karygiannis , Les Owens , Computer Security Division , Information Technology Laboratory , National Institute of Standards and Technology Gaithersburg , U.S. Department of Commerce , Donald L. Evans, Secretary , Technology Administration , Phillip J. Bond, Under Secretary for Technology , Arden L. Bement, Jr., Director, (2002).

[2] Alzoubi , Wan &Frieder, " New Distributed Algorithm for Connected Dominating Set in Wireless Ad Hoc Networks", Khaled M. Alzoubi , Peng-Jun Wan and OphirFrieder , Department of Computer Science ,Illinois Institute of Technology , Chicago,(2000).

[3] Kuosmanen,"Classification of Ad Hoc Routing Protocols ", PetteriKuosmanen ,

Finnish Defence Forces , Naval Academy , Helsinki, Finland, (2003).
[4] Harju,"Graph Theory ", TeroHarju , Department of Mathematics , University of Turku ,Turku, Finland, (2011).
[5] Ruohonen, "GRAPH THEORY" , KeijoRuohonen , Translation by JanneTamminen, Kung-Chung Lee and Robert Piché,(2008).
[6] Schumacher , "Dominating-set-based Routing in Ad Hoc Networks", Andr´e Schumacher , schumach@rbg.informatik.tu-darmstadt.de, (2003).
[7] Wu, Dai, Gao, and Stojmenovic , " On Calculating Power-Aware Connected Dominating Sets for Efficient Routing in Ad Hoc Wireless Networks" , Jie Wu, Fei Dai, Ming Gao, and Ivan Stojmenovic , Journal of communications and networks , Vol.4, No.1, March , (2002).
[8] "Dominating set" , http://en.wikipedia.org/wiki/Dominating_set ,(2009) .
[9] Sampathkumar , Walikar,"The connected domination number of a graph", E. Sampathkumar , Faculty of education, university of caryounis, El-Beida , Libya and H.B.Walikar,The Mehta Research Institute of Mathematics And Mathematic Physics ,Dilkusha ,New Katra, Allahabad, India,(1979).
[10] Wu & Li, "On calculating connected dominating set for efficient routing in ad hoc wireless networks" , Jie Wu and Hailan Li , Department of Computer Science and Engineering , Florida Atlantic University , Boca Raton ,(1999).
[11] Wu & Li , “A Dominating-Set-Based Routing Scheme in Ad Hoc Wireless Networks” , Jie Wu and Hailan Li ,Department of Computer Science and Engineering , Florida Atlantic University ,Boca Raton, (2001).
[12] Nanuvala, “An Enhanced Algorithm to Find Dominating Set Nodes Iv Ad Hoc Wireless Networks “Naresh Nanuvala , Under the Direction of Yi Pan, A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of ,Master of Science ,in the College of Arts and Science ,Georgia State University,(2006).

تحديد مسارات كفوءة للشبكات اللاسلكية الخاصة باستخدام مجاميع الربط الموجهة

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المستخلص :

يتناول هذا البحث دراسة للشبكات بصورة عامة والشبكات اللاسلكية الخاصة Ad-hoc بصورة خاصة حيث يتم الاتصال بين مكونات الشبكة (المحطات) داخل منطقة الاتصال بدون اسلاك او خادم Server او نقطة وصول Access Point اي بدون أي بنية تحتية .

التحكم في شبكة تحتوي مجموعة عقد والمتمثلة في الاجهزة الالكترونية ذات توزيع غير منتظم ومتغير توبولوجياً وذلك بتحديد Dominating Set (DS) وتقليل عددها قدر الامكان بأضافة قوانين اكثر تطور للتقليل من DS ، حيث تمثلت الدراسة للشبكات الخاصة في مراحل تطور قواعد الربط لتحقيق قاعدتين مهمتين هما: ايجاد DS وتقليل عددها قدر الامكان ، وكان اولها تحقيق الفرضيات الأساسية وهي إن مدى إرسال كل العقد الموزعة عشوائياً متساوٍ ، والفرضية الثانية هي ان الاتصال بين العقد غير موجه وكل عقدتين في الشبكة لم توصل مباشرة الا من خلال عقدة ثالثة تسمى DS. ثم جاءت خوارزمية من قبل WU &Li لاضافة تطوير الاقتراضات المذكورة اعلاه.

ثم الخوارزمية التالية الأكثر تطور من قبل Naresh Nanuvala .

في هذا البحث اقترحنا خوارزمية جديدة تضيف شيئاً جديداً للحد من عدد DS للخوارزميات اعلاه.

وتمت المحاكاة في برنامج بلغة فيجوال بيسك ليمثل بروتوكول للتحكم باتصال العقد لاسلكياً ولأقل DS.

ومقارنة نتائج الخوارزمية الجديدة الناتجة مع نتائج القواعد الاساسية وخوارزمية WU &Li و خوارزمية Naresh Nanuvala

الكلمات المفتاحية :الشبكة اللاسلكية ، الشبكة الخاصة ,مجاميع الربط الموجه ، المخالبياني,