



COMPARISON OF ENERGY EFFICIENT AODV AND AODV PROTOCOL USING NS2

Vaibhav N Palav¹, Vijaykumar Kawde², Shraddha Kunkunkar³, Preeti Motwani⁴
EXTC Engineering Department, LTCOE NaviMumbai, India

DOI: 10.5281/zenodo.821708

Keywords: AODV, EE-AODV, NS2

Abstract

MANETs consists of many mobile nodes that nodes perform operation like selection of nodes for paths from source to destination. Normally traditional protocols are used for this type of operations. In such traditional protocols packets are routed using store and forward approach. These packets are routed though each intermediate nodes in path from source to destination. Hence routing packets is very costly process. This paper work proposes EE-AODV protocol that uses algorithm which is energy efficient. To run this algorithm NS 2.35 Software is used. This algorithm uses two phase: energy survival phase and energy saving phase. Also it focuses on the shortest path feature and reliability of the network while establishing the connection through intermediate nodes.

Introduction

Mobile ad-hoc networks (MANETs) are collections of mobile nodes dynamically establishing short-lived networks in the absence of fixed infrastructure. Each mobile node is equipped with a wireless transmitter and a receiver with an appropriate antenna. These mobile nodes are connected by wireless links and act as routers for all other mobile nodes in the network. Nodes in mobile ad-hoc networks are free to move and organize themselves in an arbitrary manner [1]. These features make MANETs very practical and easy to deploy in places where existing infrastructure is not capable enough to allow communication, for instance, in disaster zones, or infeasible to deploy locations

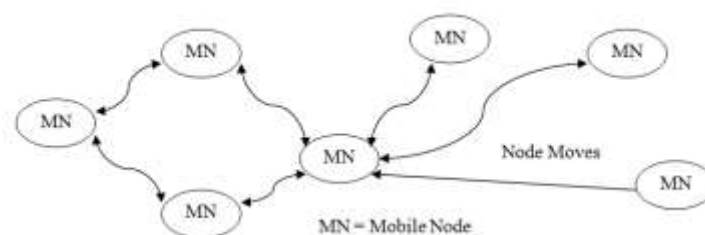


Figure 1. Formation of MANETs Topology [1]

Example for the MANETs Topology is given in Figure 1 .MANETs are the short term temporary spontaneously wireless networks of mobile nodes communicating with each other without the intervention of any fixed infrastructure or central control.

Energy consumption in nodes

From these problems in MANET the most important and ignored issue is Energy consumption of the nodes. Unlike traditional wired networks in which the end hosts are fixed in location, wireless networks include a variety of mobile terminals, such as laptops, cellular phones, personal digital assistants and micro sensors. Mobile/Portable devices are inevitably battery powered, and thus battery lifetime becomes crucial for wireless communications and mobile computing. Battery technology has lagged compared to the advancements in communication and computing technology in the past decade. Now that batteries lifetime cannot be significantly



INTERNATIONAL JOURNAL OF RESEARCH SCIENCE & MANAGEMENT

improved, efforts should be put in to designing energy-efficient software [10]. Since MANET does not have a centralized infrastructure, the routing mechanism has been incorporated in the nodes itself. The dynamic nature of MANETS makes it difficult for the individual node to establish most suitable path from source to destination and for each source to destination, it has to keep track of the established routes in regular interval of time. If any one of the internal nodes dies out of energy while the communication is established then the whole process will be interrupted and again the path has to be chosen for the specified source to destination [10]. So this regular route updating and route maintenance consumes a lot of energy of the battery which is limited. More over the traditional routing protocol of MANET is one of the major causes of high power consumption. Most routing protocols go for the shortest path algorithm that is while selecting a path from as source to any destination; it selects the only path which is having minimum number of intermediate nodes among all possible paths. As the distances between each pair of nodes get increased, the amount of transmission power also gets increased. Therefore whole process is repeated to setup new path. And it is found that the more amount of energy is consumed while transmitting a data rather than receiving a data. Many traditional routing protocols are least concerned with the energy consumption of the nodes and few energy related parameters like energy consumed per packet, energy required per transmission, residual battery power of the node etc. So this paper proposes the basic mechanism of one of the well-known routing protocol; AODV (Ad-hoc On Demand Vector Routing) protocol. We have modified AODV as EE-AODV (Energy Efficient Ad-hoc On Demand Vector Routing).

AODV Protocol

AODV performs two basic operations during its whole routing process, route discovery and route maintenance. Every node has its own routing table (Cache table) where paths to all neighboring nodes are saved. If a node wants to send a packets to a destination, then prior to that it has to check its own routing cache whether there is any existing route available to that destination or not. If it finds a route, then it uses it to send the packet to the destination. Otherwise it starts the route discovery process. AODV is modification of DSDV [9] (Dynamic Source distance vector) and DSR (Dynamic Source Routing) protocols. AODV borrows the use of the sequence number from DSDV to supersede stale cached routes and to prevent loops, while the discovery procedure is derived from the one adopted in DSR. The main difference from DSR is that a discovered route is stored locally at nodes rather than included in the packet's header [13].

Main challenges in AODV

Followings are some challenges in AODV Protocol. AODV routing protocols is least concerned with:

- 1) Energy consumption of the nodes
- 2) Energy consumed per packet
- 3) Energy required per transmission
- 4) Remaining Battery power of node

This work proposes a new Energy Efficient-AODV (EE-AODV) protocol which is a modified version of AODV protocol to solve the above listed challenges [15].

Energy efficient aodv protocol (ee-aodv)

The primary objective of EE-AODV is to select the path for the specified source to destination in such a way that all intermediate nodes will have higher level of energy at a given time. That means threshold level is defined for each individual node. And depending on that threshold level AODV protocol selects nodes that satisfy the minimum threshold condition. If any node reaches below the minimum threshold level specified then that node omits itself from path by informing source or the precursor neighbouring nodes to choose a new path to continue communication process. Thus the algorithm has not only the energy saving feature but also has an energy survival So EE-AODV has two main phases, one is EE-AODV Energy Saving Phase and the other one is EE-AODV Energy Survival Phase.

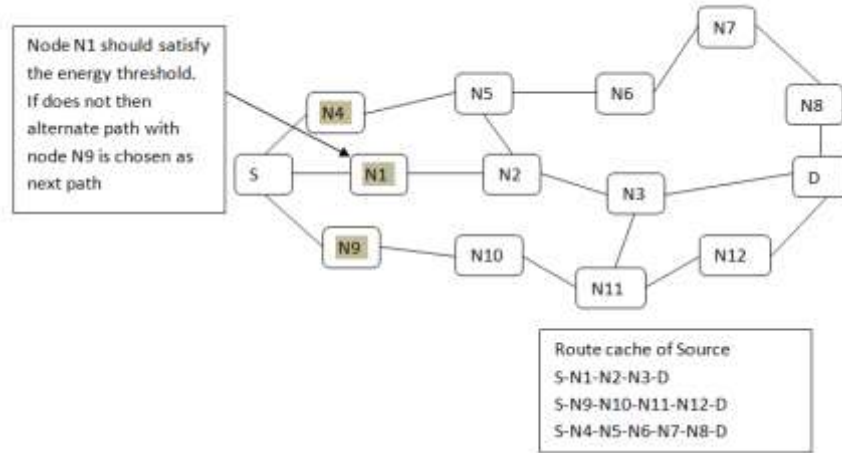


Figure 2. Path selection in EE-AODV Protocol

EE-AODV Energy Saving Phase

The energy saving mechanism comes into action during the route discovery phase when the source node has some packets to transmit to the destination and it wants to have the most energy efficient path among all possible paths. This ensures that the communication will be carried out for a long period of time. Hence the route discovery phase of traditional AODV has been changed from minimum hop count to maximum energy conscious path carrying higher energy intermediate nodes [14]. In the traditional AODV if node receives a RREQ not meant for it or if the receiving node is not the final destination, it holds packet for certain time interval between 0-0.01secs. Normally 0.01sec is considered as a constant broadcast jitter. That means it keeps packets for that time interval and then broadcasts it. But in EE-AODV a dynamic kind of jitter has been introduced by us for control packets like RREQ and RREP. Method of using the different value of jitter depends on remaining residual power of the nodes. The value of jitter has not been disturbed as the range remains between 0- 0.01sec. More the residual power, lesser amount of delay will be imposed on the control packets. If any node is having low energy than the minimum threshold, then it will avoid itself from participation in path selection process & send error message to source node. The delay is inversely proportional to residual battery power of the node. If energy of a node is more than threshold i.e. 1 Joule – delay less than 0.01 sec. Otherwise delay will be max - 0.01 sec , that discussed in following section. In our simulation we have considered our initial energy values to be 90 J and 3 J.

Formula for delay = $1 / (1 * 100) = 0.01 \text{ sec.}$ (1)

For Initial 90 Joule, Delay = $1 / (90 * 100) = 0.00011 \text{ sec.}$ (2)

For Initial 3 Joule, Delay = $1 / (3 * 100) = 0.033 \text{ sec.}$ (3)

The new path in EE-AODV contains the path with maximum some of total remaining energy of the intermediate nodes which in turn provides a higher possibility of a longer communication without any interruption of link breakage unless the any intermediate node moves out of the range of its neighbor nodes. So with this approach is RREQ packet will reach at the destination which has maximum sum of remaining energy, because delay is inversely proportional to the remaining residual battery power. This phase is used during Route maintenance process. In AODV, link Failure and retransmission of packets which may be caused due to low power is not considered. If packet loss/route loss occurred, congestion or node mobility was considered the reason. This proposed work considers the cause that low energy might be the reason for route breakage. When a node finds its residual energy equal or less than threshold level, it will inform its neighbours that it's no more ready to participate in transmission process. And then it will inform the destination node through alert message generated and insists source to find another path. It will set "Low Energy" field to be 1 in frame format of that particular



INTERNATIONAL JOURNAL OF RESEARCH SCIENCE & MANAGEMENT

packet & this field is to be added with error control message. When neighbour nodes receive this packet, they will simply discard the route containing affected node from its route cache & broadcast an error to source. Source searches for new path in its cache table, else triggers the route discovery process. One major advantage is it saves the node from getting dead completely. It keeps low energy node alive which can be used in some crucial communication in future [14].

Packet Sequence number	Precursor Node ID	Unreachable node ID	Low energy
8 bit	8 bit	8 bit	1 bit

Figure 3. Error Packet Format of EE-AODV

EE-AODV Algorithm

This section shall provide us with the exact flow of the algorithm:

1. Processing of route request by source node.

To find the efficient route, the route request is broadcasted to the medium. The nodes which receive the route request packet compute the delay by using as specified in the previous section and add it to the packet header. If any node does not satisfy the minimum energy threshold set, it will not calculate the delay and neither will it forward the RREQ. So the route request can be processed either by the destination node or intermediate nodes.

2. Processing of the route request by destination node.

The node checks whether the RREQ is first arrived by looking up the sequence number and source id in the cache. If RREQ has arrived previously, the destination node sends a RREP to the initiator of Route Request packet in which it includes the entire source route from initiator to the destination. The destination will send the RREP on the path with the maximum sum of remaining energy. While doing so we may compromise on the shortest path. It will also discard the other RREQ having the same source node or sequence number.

3. Processing of Error Control packets.

While the communication is going on, on the path chosen by the destination node, if any intermediate node goes below or equal to 1 Joule then "Low Energy" field in the AODV is set to 1 and sent to the precursor node. It then broadcasts this packet to all the other nodes with depleted nodes id specified as "Unreachable Node Address". When the neighbor nodes of the affected node receive the error packet, they will remove the path containing the affected node from its route cache and broadcast an error (Route Error) to the source. As soon as the error message received by the source node, it searches the path which is present in its route cache or else it triggers the route discovery phase.

Simulation parameters

For our simulation we considered dense topology with 50 numbers of nodes. We defined multiple sources and destinations as well considered node mobility in order to replicate a real life scenario. Simulation and analysis was done for two values of initial node energy i.e. 90 J and 3 J. 90 J - 100 J is recommended to analyse the QoS of node for better performance. We used 3 J to check when the node going below the threshold condition. Few other parameters used are mentioned in the Table I



INTERNATIONAL JOURNAL OF RESEARCH SCIENCE & MANAGEMENT

Table 1. Simulation Parameter Values

Simulation Parameters	Value
Network Size	500*500 Kms
Number of nodes	50
Traffic Type	CBR
Packet Size	500 bytes
Interface Queue	200
Queue-type	Droptail/ PriQueue
Propagation Model	Two-Ray Ground
Antenna Type	Omni Antenna
Rx power	0.3 W
Tx power	0.6 W

Comparison in Xgraph

For Simulation have consider two cases: First case (Initial Energy = 90J)

Table 2. EEAODV and AODV comparison for Initial Energy 90J

EEAODV	AODV
<p>1. Nodes consume less energy when simulated with EEAODV. At the end of 10 seconds. Average energy consumed in the network is 13.62 Joules.</p> <p>2. Delay in EEAODV is very less from the start of simulation. This is due to feature of using Jitter inversely proportional to residual energy which is 90 J in our case. As the simulation proceeds delay increases but is very less compared to AODV. At the end of 10 seconds the delay is 12.14 microseconds.</p> <p>3. As the delay is less, packets are transmitted at a faster rate from source to destination in EEAODV as compared to AODV. Hence we get a higher throughput in EEAODV. At the end of 10 seconds we get a throughput of 38.83 Kbps.</p> <p>4. Initially the PDR is less but later it increases and is higher than AODV. At the end of 10 seconds we get a PDR of 0.56.</p>	<p>1. More energy is consumed in the network by the nodes from the start itself when simulated with AODV. At the end of 10 seconds Average energy consumed is 17.21 Joules.</p> <p>2. The initial route discovery process does not take the residual energy of nodes into consideration. Hence it takes more time which further increases the delay in the AODV simulation. Delay decreases but is still high as compared to EEAODV. At the end of 10 seconds delay is 113.11 microseconds.</p> <p>3. As delay is high packet transmission here is slower than EEAODV. Fewer packets reach from source to destination. This gives lesser throughput in AODV. At the end of 10 seconds we get a throughput of 28.26 Kbps.</p> <p>4. For a brief initial period the PDR is higher but it remains almost constant and is less than EEAODV. At the end of 10 seconds we get a PDR of 0.3425.</p>

The Xgraph comparison is categorized in in various key points so 1st is:



INTERNATIONAL JOURNAL OF RESEARCH SCIENCE & MANAGEMENT

1. Energy Consumption in the Network for that we have consider two cases: First case (Initial Energy = 90J)

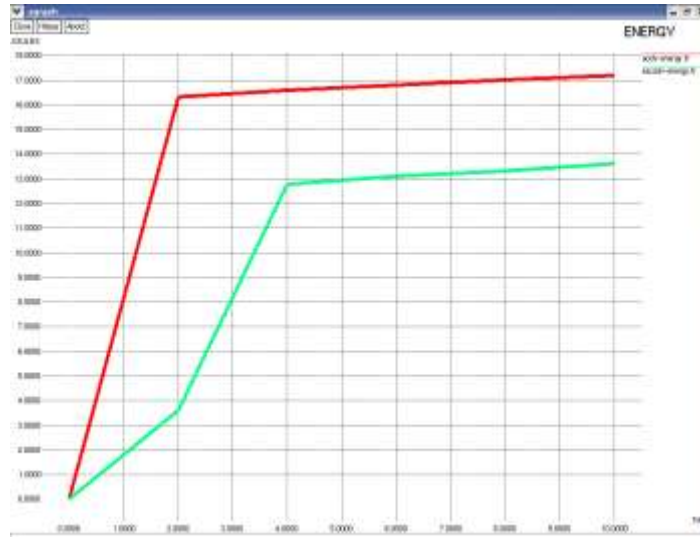


Figure 4. Energy consumption in Network

Hence when simulated for 10 seconds we get a saving of approximately 4 Joules of energy in the network by using EEAODV.

2. End to End Delay

when simulated for 10 seconds we get a delay very less compared to AODV by using EEAODV.

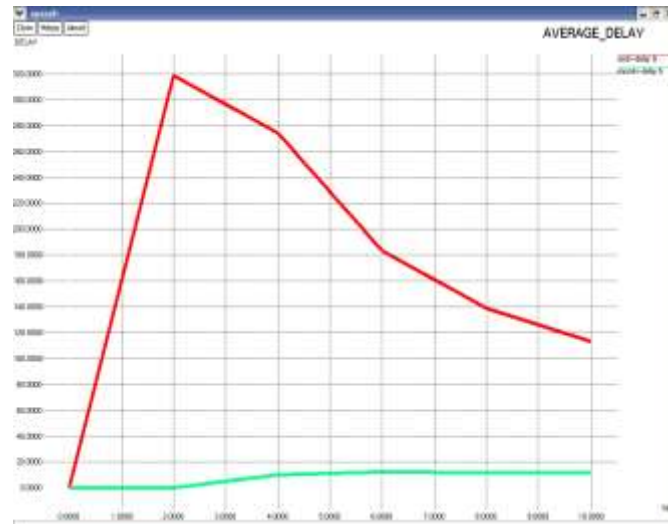


Figure 5. End to End Delay

3. Throughput

when simulated for 10 seconds we get a higher throughput (~ 10 Kbps) in EEAODV than in AODV.



Figure 6. Throughput

4. Packet Delivery Ratio (PDR)

The reason of having the better PDR can be accounted on the survival instinct of the node which informs the destination node to find an alternative route for the same source to the destination before the path gets broken. Hence before the new path is been selected, the data keeps moving through the same path. It reduces the number of retransmission and reduces data loss.



Figure 6. Packet Delivery Ratio

Second case (Initial Energy = 3J):

Table 3. EEAODV and AODV comparison for Initial Energy = 3J

EEAODV	AODV
1. Nodes consume less energy when simulated with EEAODV till they reach the threshold level. After that energy consumption is slightly higher in	1. Energy is consumption is slightly higher in AODV comparatively till the time certain nodes die out. After that it decreases and is less than AODV. At the



INTERNATIONAL JOURNAL OF RESEARCH SCIENCE & MANAGEMENT

<p>EEAODV. At the end of 25 seconds average energy consumed in the network is 2.94 Joules.</p> <p>2. Delay in EEAODV is very less from the start of simulation. At the end of 25 seconds the delay is 13.46 microseconds.</p> <p>3. As the delay is less, packets are transmitted at a faster rate from source to destination in EEAODV as compared to AODV. Hence we get a higher throughput in EEAODV. At the end of 25 seconds we get a throughput of 31.70 Kbps.</p> <p>4. Initially the PDR is same in both cases but later it increases and is higher than AODV. At the end of 25 seconds we get a PDR of 0.79.</p>	<p>end of 25 seconds average energy consumed in the network is 2.83 Joules.</p> <p>2. Delay in AODV is more compared to EEAODV. At the end of 25 seconds the delay is 55.89 microseconds</p> <p>3. As delay is high packet transmission here is slower than EEAODV. Fewer packets reach from source to destination. This gives lesser throughput in AODV. At the end of 10 seconds we get a throughput of 9.91 Kbps.</p> <p>4. For a brief initial period the PDR is almost equal in both cases but further decreases and is less than EEAODV. At the end of 25 seconds we get a PDR of 0.4848.</p>
---	---

1. Energy Consumption in the Network

The slightly higher consumption of energy in EEAODV towards the end can be due to the broadcasting of alert message which is used to indicate other nodes when a node goes below threshold.



Figure 7. Energy consumption in Network

2. End to End Delay

Lesser delay in EEAODV is due to the use of jitter inversely proportional to the residual battery power



Figure 8. End to End delay

3. Throughput

As we started with 3 Joules nodes die quickly and hence we get a lesser throughput. Still it is higher in EEAODV than in AODV.



Figure 9. Throughput

4. Packet Delivery Ratio

Numbers of retransmission of packets are less in EEAODV and therefore we get a better PDR when simulated with EEAODV than with AODV.

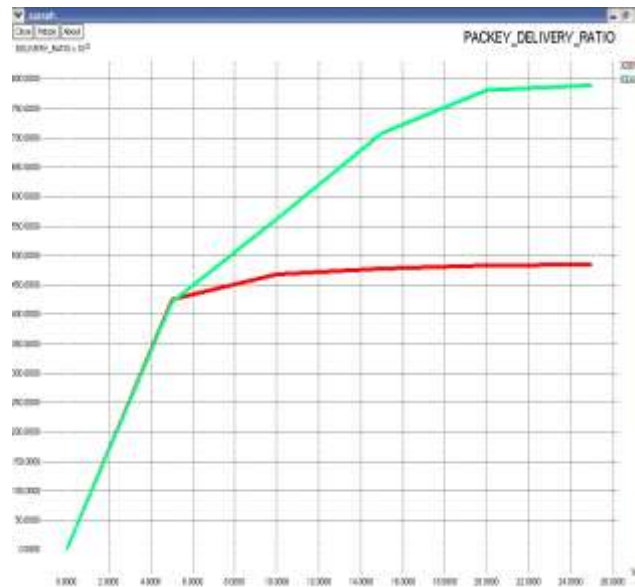


Figure 10. Packet Delivery Ratio

Conclusion

Simulations and analysis of graphs and observations show that in all the performance metrics we get better results for EEAODV simulation than the traditional AODV for both the cases (Initial Node energy 90 and 3 J). As our algorithm introduces dynamic kind of jitter for the route discovery process delay is less in EEAODV than in AODV. Lesser delay resulted in more packets to be transmitted and hence we got a higher throughput when simulated with EEAODV. As in our algorithm we focused on reducing the numbers of retransmissions we achieved a higher Packet Delivery ratio than AODV for our Protocol. Our method has shown that energy consumption is lesser in the individual nodes as well as the average energy consumption in the network is less. We also have a positive result in extending the entire network lifetime. Hence with the addition of the two new phases, to the original AODV routing algorithm, EEAODV turned out to be an energy conscious as well as a better routing protocol.

Future Scope

In MANETs all nodes are mobile nodes. Every time these nodes are in listening mode to receive route request packet. But only few nodes take part in transmission and all other nodes are in listening mode. So these nodes which cannot take part in transmission will also lose some energy as they are actively in receiving mode. If transmission time is more then, these nodes which do not take part in transmission will be running out of battery slowly. To prevent this we can put these nodes in sleep mode to save battery to save battery of node who cannot take part in transmission. If we do this then throughput of network will get increase

Acknowledgements

This work is done for comparison of EE_AODV and AODV to facilitate network design.



INTERNATIONAL JOURNAL OF RESEARCH SCIENCE & MANAGEMENT

References

- [1] Effect of Mobility and Traffic Models on the Energy Consumption in MANET Routing Protocols' by Said EL KAFHALI, Abdelkrim HAQIQ , International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-3, Issue-1, March 2013
- [2] S. Suganya and S. Palaniammal, "A dynamic approach to optimize energy consumption in mobile ad hoc network", European Journal of Scientific Research ISSN 1450-216X Vol. 85 No 2, pp. 225- 232, September, 2012.
- [3] R. Al-Ani, "Simulation and performance analysis evaluation for variant MANET routing protocols", International Journal of Advancements in Computing Technology, Volume 3, Number 1, February 2011.
- [4] A Review of Power Conservation in Wireless Mobile Adhoc Network (MANET) by NeerajTantubay, Dinesh RatanGautam and Mukesh Kumar Dhariwal, IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 4, No 1, July 2011 ISSN (Online): 1694-0814
- [5] Sunil Taneja and Ashwani Kush "A Survey of Routing Protocols in Mobile Ad Hoc Networks", International Journal of Innovation, Management and Technology, Vol. 1, No. 3, August 2010.
- [6] G.Vijaya Kumar, Y.VasudevaReddyr and Dr.M.Nagendra,"Current Research Work on Routing Protocols for MANET: A Literature Survey", (IJCS) International Journal on Computer Science and Engineering 2010
- [7] 'Mobile Ad Hoc Networking: Imperatives and Challenges' by Pravin Ghosekar , GirishKatkar, Dr. PradipGhorpade , IJCA Special Issue on "Mobile Ad-hoc Networks" MANETs, 2010
- [8] Nor SurayatiMohamadUsop, Azizol Abdullah and Ahmad Faisal Amri Abidin, "Performance evaluation of AODV, DSDV & DSR routing protocol in grid environment", IJCSNS International Journal of Computer Science and Network Security, VOL.9 No.7, July 2009.
- [9] K. Arulanandam and B. Parthasarathy," A New Energy Level Efficiency Issues In MANET", IJRIC, E-ISSN: 2076-3336,2009, pp.104- 109,www.ijric.org.
- [10] David B. et al. "DSR: The Dynamic Source Routing Protocol for MultiHop Wireless Ad Hoc Networks", Carnegie Mellon University
- [11] Perkins CEO et al. "Ad-hoc On-Demand Distance Vector Routing, " AMCSA '99i, , Vasu D. Chakravarthy, , Bin Wang, and Zhiqiang Wu, "Spreading Code Design of Adaptive Non-Contiguous SOFDM for Dynamic Spectrum Access" in IEEE JOURNAL OF SELECTED TOPICS IN SIGNAL PROCESSING, VOL. 5, NO. 1, FEBRUARY 2011