SECURE ROUTING PROTOCOL IN WIRELESS SENSOR NETWORKS: A SURVEY

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Abstract

A wireless sensor network (WSN) is made up of sensor nodes. The sensor node's primary purpose is to monitor physical or environmental variables and transmit them to the sink or base station. Due to the limited power batteries, of sensor nodes network lifespan is very challenging and costly. An energy-efficient routing system for WSN is required to extend the network lifespan. Many of the existing energy-efficient routing protocols in WSN have a high rate of packet loss. As a result, effective data routing in WSN remains a difficult job. Routing in wireless sensor networks is a little more complicated than in conventional wired or wireless networks. Because of the battery-powered nodes, the routing protocols used in other networks cannot be utilized here. Unlike other wireless networks, WSN routing should be the most energy-efficient. This article provides a review of several energy-efficient routing protocols and security methods to enhance the security of nodes in wireless sensor networks, with the goal of designing protocols that use less energy during communication.

Keywords: WSN, Energy-Efficient, Routing Protocol, Security, Data transmission

I. INTRODUCTION

Inexpensive sensors capable of substantial processing and wireless communications are becoming accessible; wireless sensor networks (WSNs) can monitor their external surroundings and transform sensed data into a user-friendly format. These networks have many uses, including the environment, the home, the hospital, and the military. Since the sensors' energy-constrained and restricted computational resources offer significant difficulties for routing protocols and algorithms, the main issue of routing protocols is to preserve the sensors' energies in order to optimize their lifespan in WSN[1,2]. The sensor will be required to gather data to the Sink node in the remote monitoring applications of WSN, Sink node's control information via collaborative interaction among the nodes delivered to the specified regions. According to the communication energy model [3] hierarchical routing methods outperform better routing protocols in terms of flexibility and energy conservation. The cluster-based optimization method and the transmission route of the cluster head are intended for hierarchical routing protocols that must address significant problems and key factors influencing node energy efficient distribution and increasing network lifespan in WSN. Designing a routing protocol that meets many goals like fault tolerance, energy efficiency, and minimal latency, reduced computing overhead, and load balancing, and so on will be difficult since some of these objectives are incompatible. The majority of current routing protocols [2-6] in WSNs are based on the single-path routing approach. The lack of adaptability of such an approach in the face of node, connection, or battery failures may substantially decrease at the network performance and even network lifespan [4].

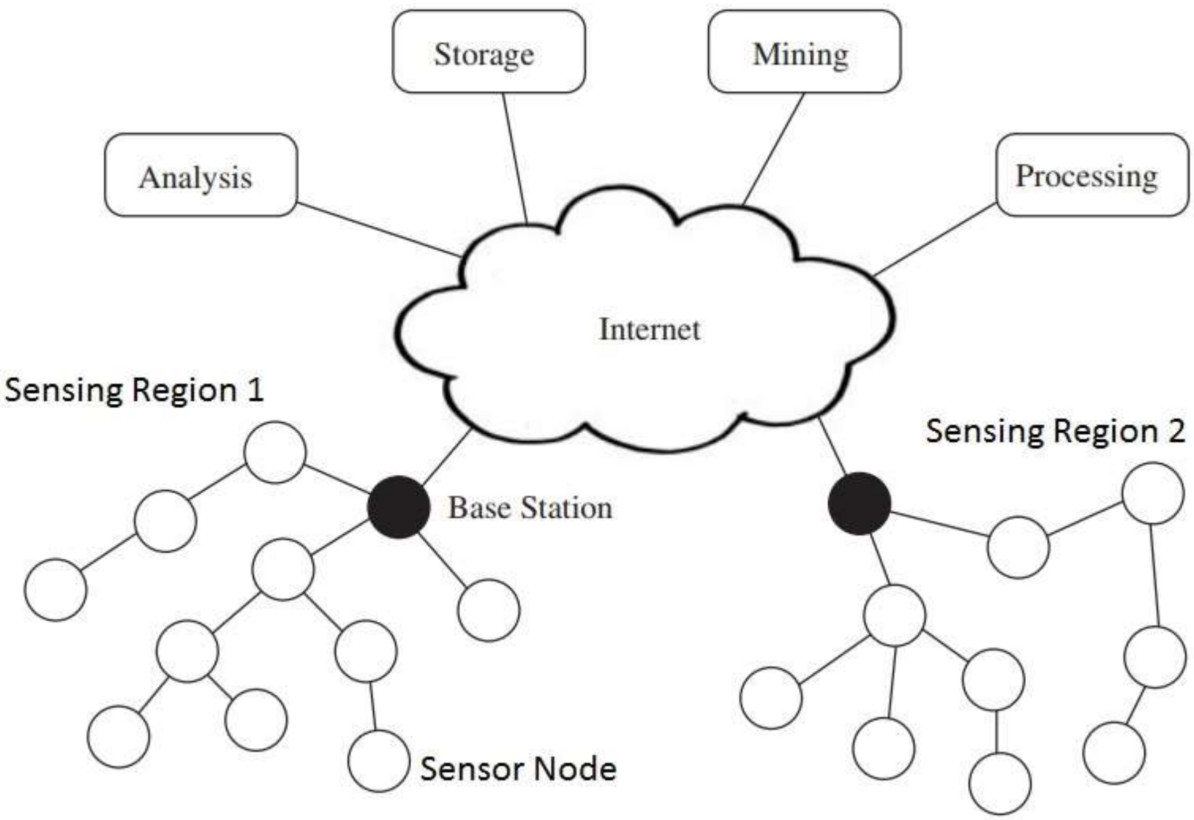

Figure 1: WSN Architecture

The multipath routing method has emerged as a viable solution in wireless sensor and ad hoc networks for overcoming the constraints of single-path routing approaches. There are three kinds of routing protocols in WSN [12]. The first is flat based routing. In this case, all nodes have been given the same functions. The second kind of routing is hierarchical routing, in which each node has a distinct function, and this routing is an excellent method to reduce energy usage. Hierarchical routing is a two-layer routing method in which one layer is used to choose cluster heads and the other layer is used for routing. Location-based routing is a routing method in which each sensor node position is used to route data in the network. Hierarchical routing methods include cluster-based, grid-based, chain-based, area-based, and tree-based routing [5]. Wasteful consumption, on the other hand, may be caused by overhearing, retransmission owing to hostile environment, dealing with duplicate broadcast overhead messages, and idle listening to the media. Clustering [5, 6] and multi-hop transmission methods may be utilized to conserve transmission power. Adjacent sensors may detect the same data, and so data collecting may minimize duplicate data collection. Sensors in the network that are near to each other may be grouped into clusters, and data received from sensors in the same cluster is aggregated and then reported to the base station (BS). Data reporting to the BS can be done through single hop or multi-hop transmission. The general routing procedures of WSN are primarily concerned with reducing latency along the path. It is probable that the shortest route will constantly be busy, and the nodes along the path will be working for an extended period of time. When the harvest energy cannot cover the transmission consumption, the energy of the nodes may decrease, resulting in the network's failure [13]. This article examines various routing protocol reviews, focusing on three factors: transmission quality, energy usage for data transport, and wasted energy. Because the sensor node's energy storage capacity is limited, when the nodes reach their storage capacity, the newly produced energy is squandered. As a result, wasted energy is considered in order to enhance energy usage efficiency. The selected path will vary in different weights are given to the three variables.

In section II, the Literature Review, in section III, the classification of routing protocols are described. Section IV represents the comparative analysis of existing author works, and conclusion is given in section V

II. BACKGROUND STUDY

Ahmed, R. E. [1] It was a difficult task to design a routing system for a wireless sensor network that offers both energy economy and fault tolerance. This article offers a simple, but energy-efficient, fault-tolerant routing protocol that finds two routing routes by modifying the basic DSR protocol and taking into account residual energy levels at intermediary nodes. The protocol's operation was compared to that of conventional DSR, and it was discovered that the protocol has a low overhead in terms of the amount of control messages when compared to the basic DSR.

Huang, W.-W. et al. [2] The authors describe the cluster-head electives' energy strategy; EMHR examines national data, including the reserved energy available in the cluster-head decision on candidates and neighbors, the communication model between the cluster-heads and the Sink nodes, to extend the lifetime of the network and reduce the imbalance of cluster-head energy losses.

Kottath, A. V., & George, A. [5] this study suggested a GERP routing system that could minimize packet loss and decrease network energy design and improve network life. The GERP protocol was a grid-based routing with grid heads for every grid. Each grid head was sleeping or half sleeping while the other nodes are still sleeping.

Mankar, G., & Bodkhe, S. T. [7] WSNs may be preserved by the authors till FND (first node death). Since Sink was a far sensor field, our approach clearly has the best rounds to collect data. In each percentage of death of knots the authors may obtain findings that are node dead in WSNs evenly. The authors compare the topology of death nodes to other protocols involved. A significant role is played by the threshold mechanism. It has progressively prevented the death of the root node, because every node is likely to have roots.

Mao, Y., & Cheng, D. [8] the authors have introduced EERP, energy efficient routing protocol for WSN-based smart mining systems. The authors initially examine the subterranean WSN deployment scenario. The authors then supply the sensor node with an energy consumption model. EERP selects a dominator inside a certain area using a DSA algorithm to create a dominator chain. Simulation findings show EERP can decrease energy usage effectively to enhance the lifespan of the network.

Rong Cui, Zhaowei Qu, & Sixing Yin. [9] The suggested routing protocol takes three variables into account: quality of transport, consumption of energy and waste of energy, and gave the factors varying weights to reflect their importance for the functioning of the network. Then the issue was modeled and the optimal routing solution was developed using the method.

Shwe, H. Y., & Chong, P. H. J. [10] The wireless sensor network was an important instrument to improve energy efficiency in buildings without significantly compromising quality of life. The authors have suggested in this article a protocol based on energy efficient information transmission for smart green buildings.

Sana, M., & Noureddine, L. [11] A Multi-Hop wireless sensor network routing technique has been suggested. Our algorithm has worked with the notion of minimum spanning tree (MST) in the isotropic and anisotropic deployment. Hop counter is a measure used by writers for data transfer from nodes to sinks with minimum hops.

Ya, L. et al. [14] this article proposes to address the issue of the protocol for tree collecting an energy-aware routing protocol based on beaconing. Revised route validation method extends network life and supports efficient downstream transmission and node-to-node transmission via the new beaconing schedule.

III. ENERGY-EFFICIENT ROUTING PROTOCOLS

Routing may often be split into flat-based, Hierarchical, and location dependent upon the network topology in wireless sensor networks. All nodes are normally given equal responsibilities or functionalities in flat-based routing. However, nodes perform various functions across the network under hierarchical routing. Sensor nodes locations are used to route data across the network in location-based routing. If specific system parameters can be adjusted for current network circumstances and available energy levels, a routing protocol will be called adaptable. In addition, such protocols may be categorized as multi-part, query based, negotiation based, QoS-based or protocol-based routing methods. In addition to the aforementioned, it is possible to classify Routing Protocols into three categories: proactive, reactive and hybrid protocols, Based on how the source transfers a establish path to the destination. All routes are calculated in proactive protocols before they are really required, whereas routes are calculated on demand in reactive protocols. A mixture of these two principles is used by hybrid protocols. If the sensor nodes are static, routing protocols based on the table are preferred instead of reactive protocols. In the road finding and setup of reactive treatments, a substantial quantity of energy is used. Another family of protocols is known as cooperative protocols for routing. In cooperation, nodes transmit information to a central node where data may be pooled and subsequently processed; thereby lowering route costs as far as energy consumption is concerned.

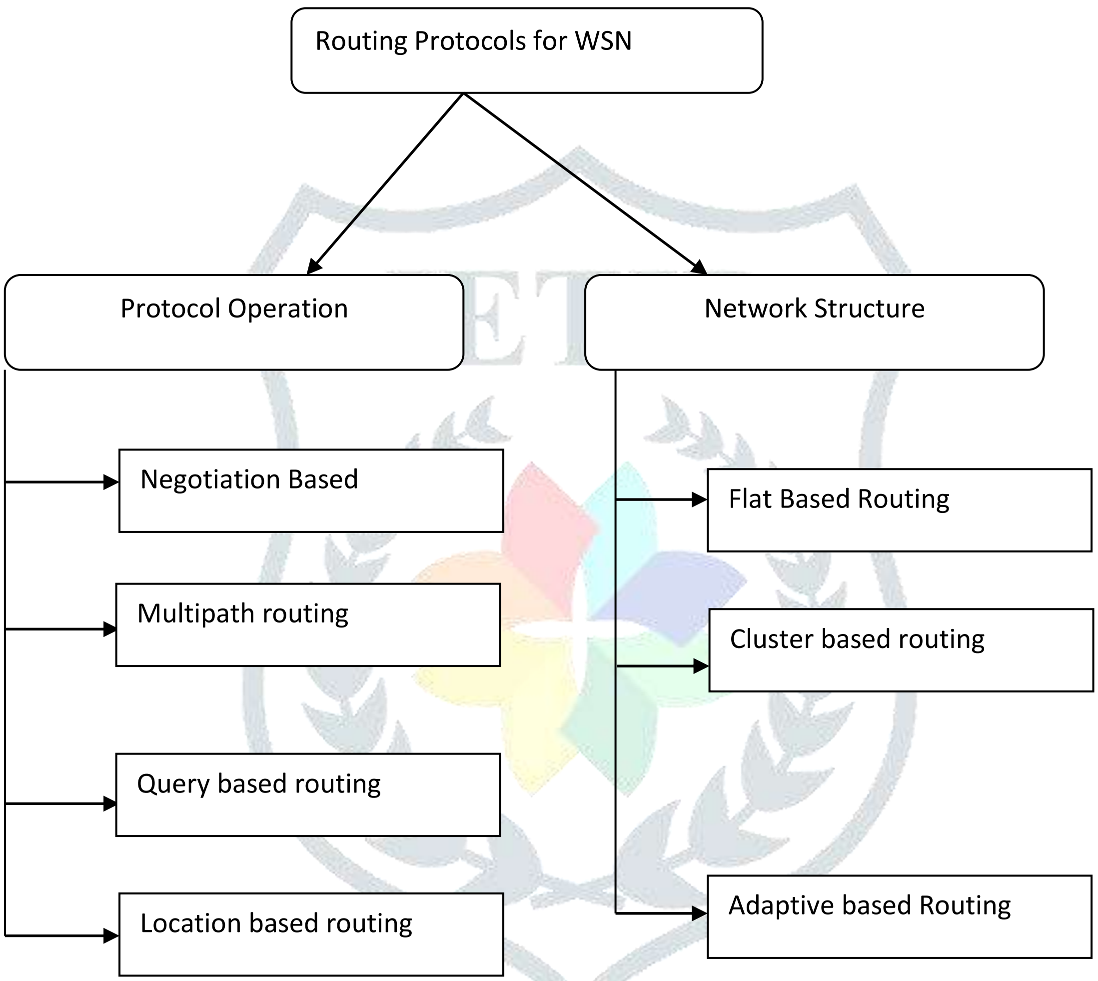

Figure 3.1: Classification of Routing Protocols

The classification of routing protocols is shown in figure 2, and some of the routing protocols are discussed below.

A) LEACH (Low Energy Adaptive Clustering Hierarchy)

An adaptive clustering technique for spreading energy burden across sensor nodes in a network is presented [15]. LEACH employs single-hop routing, in which each sensor node sends data directly to the cluster head or sink. It operates in two stages:

1) In the setup phase, the cluster is structured and the cluster heads are chosen, and each node utilizes each round stochastic method to decide whether it will become a cluster head.

2) The steady-state phase- The data is transmitted to the base station for a longer period of time than the setup phase in order to reduce overhead.

B) PEGASIS (Power-Efficient Gathering in Sensor Information Systems),

A greedy chain protocol [16] that addresses the wireless sensor network data-gathering issue. The primary goal is for each node, to receive from sender and broadcast to its neighbors, and for each node to take turns being the leader for transmission to the base station. This method will spread the energy burden equally across the network's sensor nodes. The nodes are first distributed randomly in the field, and the sensor nodes are organized to create a chain, which may be done by the sensor nodes themselves using a greedy method beginning at some node. Alternatively, the base station may calculate this chain and broadcast it to all of the remaining sensor nodes. To build the chain, all nodes must have global knowledge of the network and then use the greedy method. Because this issue is comparable to the travelling salesman problem, a loop will be built to guarantee that all nodes have near neighbors. The greedy method to chain construction is completed prior to the first round of communication.

C) PEACH (Power-efficient and adaptive clustering hierarchy)

This Protocol [17] is a wireless sensor network protocol that is both power-efficient and adaptable in its clustering structure. In wireless sensor networks, a node can identify the source and destination of packets broadcast by other nodes by overhearing. PEACH creates clusters based on overheard information without the need for extra packet transmission overhead such as advertising, announcement, joining, and scheduling messages. PEACH is intended to offer adaptive multilevel clustering by operating on probabilistic routing protocols. PEACH is usually more scalable and efficient to different situations as a consequence of the protocol architecture than the current wireless sensor network clustering technologies. PEACH may be utilized on wireless sensor networks that are both location-aware and location-agnostic.

D) TEEN (Threshold sensitive energy-efficient sensor network protocol)

This is the first protocol designed specifically for reactive networks. The cluster-head communicates to its members at every cluster change time in this protocol [18]. As a result, the hard threshold attempts to limit the number of transmissions by enabling nodes to broadcast only when the detected characteristic falls within the range of interest. The soft threshold lowers the number of transmissions even more by removing any communications that would have happened if there was little or no change in the detected characteristic after the hard threshold is reached. TEEN is highly suited for time-critical applications, as well as being very efficient in terms of energy usage and reaction time. It also enables the user to tailor the energy usage and precision to the application.

E) EEABR (Energy Efficient Ant-Based Routing)

[19] Proposed technique based on the Ant Colony Optimization heuristic. Initially, forward ants are delivered to no particular destination node, implying that sensor nodes must interact with one another and that each node's routing tables must include the identity of all sensor nodes in the neighborhood as well as the corresponding levels of pheromone trail. This

may be an issue in large networks since nodes would require a lot of memory to store all the information about their neighbors.

F) SOP (Self-organizing protocol)

To save transmission energy, a proposed protocol [20] incorporates a LEACH cluster design with multi-hop routing. Multi-hop routing is used in several WSNs. This causes a node that wishes to send data to a destination node to look for one or more intermediary nodes. Communication is place across all nodes until the data packets arrive at their destination [10]. In summary, data packets travel many hops between network nodes. The primary benefit of this technique is that it reduces transmission energy usage. However, network latency and data packet delay will rise at the same time.

IV. COMPARATIVE ANALYSIS OF SURVEY

Author Name	Methodology	Limitations
Ahmed, R. E. [1]	An energy efficient, fault-tolerant routing protocol	Resource limitations of the sensor nodes and unreliability of wireless links impose many challenges in designing efficient routing protocols for wireless sensor networks.
Huang, W.-W. et al. [2]	energy-efficient multi-hop hierarchical routing protocol	The energy constrained and limited computing resources of the sensor Node
Karthikeyann, A. et al. [3]	Location aided Routing (LAR)	Data accumulation and collection was limited on excess information, low overhead and least memory storage
Mankar, G., & Bodkhe, S. T. [7]	cluster and tree based protocols	all the sensors must share the limited wireless channel bandwidth in the network
Rong Cui, Zhaowei Qu, & Sixing Yin [9]	Energy harvesting	limited energy storage capacity of sensor nodes

Table 1: Evaluation of various authors' views.

V. CONCLUSION

In this article, we investigated critical routing problems that influence sensor network architecture. Many routing methods, however, have been suggested for wireless sensor networks. In terms of energy efficiency, we examined a number of alternative procedures. The procedures under evaluation demonstrate that their performance in terms of energy efficiency is promising. However, it is not feasible to create a routing system that can solve all WSN design problems while also providing acceptable performance for all wireless sensor network applications.

VI. REFERENCES

[1] Ahmed, R. E. (2015). A fault-tolerant, energy-efficient routing protocol for wireless sensor networks. 2015 International Conference on Information and Communication Technology Research (ICTRC). doi:10.1109/ictrc.2015.7156450

[2] Huang, W.-W., Peng, Y.-L., Wen, J., & Yu, M. (2009). Energy-Efficient Multi-hop Hierarchical Routing Protocol for Wireless Sensor Networks. 2009 International Conference on Networks Security, Wireless Communications and Trusted Computing. doi:10.1109/nswctc.2009.352

[3] Karthikeyann, A., Arunachalam, V. P., Karthik, S., & Dhivya, P. (2018). Energy Efficient Structure Free and Location Based Routing Protocol in WSN. 2018 International Conference on Soft-Computing and Network Security (ICSNS). doi:10.1109/icsns.2018.8573682

[4] Kumar, V. K., & Khunteta, A. (2018). Energy Efficient PEGASIS Routing Protocol for Wireless Sensor Networks. 2018 2nd International Conference on Micro-Electronics and Telecommunication Engineering (ICMETE). doi:10.1109/icmete.2018.00031

[5] Kottath, A. V., & George, A. (2018). GERP: A Grid-based Efficient Routing Protocol for WSN. 2018 International Conference on Circuits and Systems in Digital Enterprise Technology (ICCSDET). doi:10.1109/iccsdet.2018.8821241

[6] Muhamad, W. N. W., Naim, N. F., Hussin, N., Wahab, N., Aziz, N. A., Sarnin, S. S., & Mohamad, R. (2009). Maximizing Network Lifetime with Energy Efficient Routing Protocol for Wireless Sensor Networks. 2009 Fifth International Conference on MEMS NANO, and Smart Systems. doi:10.1109/icmens.2009.35

[7] Mankar, G., & Bodkhe, S. T. (2011). Traffic aware energy efficient routing protocol. 2011 3rd International Conference on Electronics Computer Technology. doi:10.1109/icectech.2011.5942106

[8] Mao, Y., & Cheng, D. (2014). An energy-efficent routing protocol for WSN-based intelligent mining system. 2014 9th International Conference on Computer Science & Education. doi:10.1109/iccse.2014.6926607

[9] Rong Cui, Zhaowei Qu, & Sixing Yin. (2013). Energy-efficient routing protocol for energy harvesting wireless sensor network. 2013 15th IEEE International Conference on

Communication Technology. doi:10.1109/icct.2013.6820427

[10] Shwe, H. Y., & Chong, P. H. J. (2015). WSN-based energy-efficient data communication protocol for smart green building environment. 2015 IEEE International Telecommunications Energy Conference (INTELEC). doi:10.1109/intlec.2015.7572410

[11] Sana, M., & Noureddine, L. (2019). Multi-hop energy-efficient routing protocol based on Minimum Spanning Tree for anisotropic Wireless Sensor Networks. 2019 International Conference on Advanced Systems and Emergent Technologies (IC_ASET). doi:10.1109/aset.2019.8871032

[12] Sreevidya, B., & Rajesh, M. (2017). Enhanced energy optimized cluster based on demand routing protocol for wireless sensor networks. 2017 International Conference on Advances in Computing, Communications and Informatics (ICACCI). doi:10.1109/icacci.2017.8126141

[13] Taneeru, S., & Jain, P. C. (2015). Energy efficient multilayer protocol for wireless sensor networks. 2015 39th National Systems Conference (NSC). doi:10.1109/natsys.2015.7489118

[14] Ya, L., Pengjun, W., Rong, L., Huazhong, Y., & Wei, L. (2014). Reliable energy-aware routing protocol for heterogeneous WSN based on beaconing. 16th International Conference on Advanced Communication Technology. doi:10.1109/icact.2014.6778931

[15] W. R. Heinzelman, A .Chandrakasan, and H. Balakrishnan., "Energy-Efficient Communication Protocol for Wireless Microsensor Networks". IEEE. Published in the Proceedings of the Hawaii International Conference on System Sciences, January 4-7

[16] S. Lindsey and C. S. Raghavendra., "PEGASIS: Power-Efficient GAthering in Sensor Information Systems" 02 WZ IEEE EEFAC p a p #242, Updated Sept 29,2001

[17] S. Yi, J. Heo, Y. Cho, J. Hong., "PEACH: Power-efficient and adaptive clustering hierarchy protocol for wireless sensor networks" ELSEVIER Computer Communications 30 (2007) 2842–2852

[18] A. Manjeshwar and D. P. Agrawal., "TEEN: A Routing Protocol for Enhanced Efficiency in Wireless Sensor Networks" IEEE 2001.

[19] T. Camilo, C. Carreto, J. S. Silva, F. Boavida, "An Energy-Efficient Ant-Based Routing Algorithm for Wireless Sensor Networks", 2006 Springer.

[20] J. Zhao, A. T. Erdogan., "A Novel Self-organizing Hybrid Network Protocol for Wireless Sensor Networks" Proceedings of the First NASA/ESA Conference on Adaptive Hardware and Systems (AHS'06) 0-7695-2614-4/06 2006 IEEE.