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SCEER: Secure cluster based efficient energy routing scheme for wireless sensor networks

S. Gopinath [a], K. Vinoth Kumar [b,*], P. Elayaraja [c], A. Parameswari [b], S. Balakrishnan [d], M. Thiruppathi [d]

[a] Department of ECE, Karpagam Institute of Technology, Coimbatore, Tamil Nadu, India
[b] Department of ECE, SSM Institute of Engineering and Technology, Dindigul, Tamil Nadu, India
[c] Department of ECE, Kongunadu College of Engineering and Technology, Thottiam, Tamil Nadu, India
[d] Department of ECE, Vivekanandha College of Engineering for Women, Namakkal, Tamil Nadu, India

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ABSTRACT

Balancing network integrity and energy efficiency is the one of major tasks in the network. In existing schemes, it is failed to balance both the metrics. In this research work, the Secure cluster based efficient energy routing is adopted to attain the more network lifetime. In first phase of the research, network and routing assumptions are made to initialize the effective packet transmission. In second phase, stability metric is determined for the cluster to maximize the energy efficiency. There are two cluster metrics used for the analysis of network stability. In third phase, the optimal cluster design model is initialized to balance the network integrity and energy efficiency. The proposed scheme is evaluated with network simulation tool in terms of node stability ratio, node reliability ratio, network lifetime, packet delay and energy efficiency.
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1. Introduction

Wireless Sensor Network contains the huge number of nodes that forms a high density networks. A collection of sensor nodes formed together to create network which can be adopted for various applications such as target tracking, malicious detection, smart network routing and so on. Only scarce amount of resources are spent by the nodes in the network. It is difficult to increase the energy of the resources due to unattended nature of sensor network. The least amount of energy is spent in the sensor network for energy management; hence it is required to design the secure energy efficient routing with least energy consumption and more network lifetime.

In this research work, it is decided to create an energy efficient protocol with security. The optimal cluster design model is adopted to balance the network integrity and energy efficiency.

2. Related works

Vinodhini and Gomathy [1] designed a dynamic multi-hop routing protocol for wireless sensor networks to choose the cluster head and to improve the network lifetime. The single hop communication was done to reduce the network traffic. The network lifetime was improved using multi-hop packet transmission. The energy consumption was dramatically using multi-hop communication. Balancing between power consumption and delay was done using the multi-hop routing protocol.

Varun and Gangwar [2] surveyed the energy efficient routing protocols for wireless sensor networks. Sensor nodes consumed more energy for data transmission. The components were switched off for a particular point of period. Various energy efficient techniques were analysed and challenging issues were also identified to reduce the energy drain ratios.

Arivubrakan and Sundari [3] advanced the protocol primarily based totally on multicast routing to enhance the packet transport ratio and bandwidth and to lessen the delay. In the wi-fi community environment, sensor nodes had been deployed. The wide variety of nodes turned into participated in multi-hop communique. The supply node sends facts to sink node primarily based totally on hop distance and multi-hop bandwidth. The replica course

* Corresponding author.
E-mail address: vinodkumaran87@gmail.com (K. Vinoth Kumar).

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requests had been averted by using Request to Send (RTS) and Clear to Send (CTS) packets thru multi-hop transmission paths. The balance of routes turned into progressed and however decreased to collisions.

Huarui Wu et al. [4] advanced an progressed chain primarily based totally clustering hierarchical routing to display the environmental effects. The alerts had been now no longer without delay despatched to the bottom station by means of the cluster head. The chain technique turned into used to conquer the hassle of rapid expiry of nodes. A cluster head may be selected primarily based totally on new parameters to reduce the community lifetime and to enhance the balance. The problems and demanding situations had been solved the usage of this protocol. Manjunath et al [5] proposed the stable multicast scheme for cluster primarily based totally wi-fi sensor networks. The stable multicast communique turned into hooked up among supply node and sink node. The cluster primarily based totally Multicast tree set of rules turned into added for offering stable facts communique. The unmarried hop intermediate nodes had been mixed the usage of multicast primarily based totally vacation spot sequenced distance vector protocol to pick out nearby controllers as a way to cause node screw ups if hyperlink breaks.

Lingaraj and Prakash [6] proposed the electricity conscious routing protocol to construct the multicast tree. A mild course approach turned into maintained to supply the packets throughout congestion. The strength utilization turned into stored from supply to sink node the usage of multicast tree. It is obligatory to course the packets to hold the strength among intermediate nodes. A multicast message turned into forwarded to lessen the strength intake the usage of electricity conscious routing.

Yang liu et al [7] provided an strength green routing protocol to store the strength i.e. preliminary strength, residual strength and general strength of nodes. A node which turned into near base station will now no longer be allowed to take part withinside the formation of cluster. The strength intake of unmarried hop and multi hop communique modes had been in comparison throughout packet transmission phase. The mode with least strength intake turned into adopted. The communique fee turned into decreased to enhance the community lifetime.

Cevik and Gunagwera [8] provided a directional multicast primarily based totally structure to eat extra strength with dynamic electricity control. This structure turned into framed to eat much less strength the usage of directional antenna. The hop by means of hop fragmentation and strength managed directional transmission had been included to enhance strength usage effectively. The discount of interference turned into done the usage of more than one subsequent hop usage with facts switch load amongst sensor nodes.

Vinoth and Bhavani [9] developed secure energy based routing for attaining link reliability and improving energy efficiency through multi-hop routing. The several parameters were considered to improve the network lifetime i.e. residual energy of node, link stability and distance between nodes. The sink node receives the packets through neighbour nodes. Energy efficient model was introduced to balance the load and transmission energy. The communication between sensor nodes was found to isolate the malicious nodes.

M. Selvi, et.al [10] presented a reliable energy aware routing with threshold factor to improve network lifetime in the presence of misbehaving nodes. The trust score evaluation scheme was introduced to find the malicious nodes and isolate them. The best routes were found using spatial temporal constraints through decision tree algorithm. The solutions for routing issues were found to improve network performance.

S. Gopinath et al. [11] presented each hop network. This defind as E-CDS Essential CDS and UCDS- Unified CDS scheme, this combination of dual hop intermediate junction, reducing the hacks to implement many method to enhancing the performance of a network. Lower distance section is structured based on the CDS method by build a minimum way length in the E-CDS protocol sends only, the capturing of data in thin networks. The mobile nodes can move independently throughout the network, based on the node, the mobility is changed and its output will be increased. Junction network like as steadiness are established. In UCDS, used for improve a minimum efficient result when compared E-CDS with dynamic modification section. The mobile nodes velocity was adjusted with varied state in one transmission. Authority techniques are used to increase the fault clarity. In order to add the best node in the communication path then the overall mobile network environment is made best.

K. Vinoth et al [12] has surveyed about Enhancing the Performance of a MANET mobile node configuration and positioning junction data. The AODV provides some important position for network process improvements. The candidate neighbour node is used to retransmit the request packet to the nearby node by minimizing the overload of the network. The main objective of position monitoring is to create an efficient routing scheme for providing correct information. It is known as transmission storm used for Request packets dropping in usual on-demand communicating scheme. Here the received request packet in routing table is mainly designed as a destination node in the response information. Programmer neighbour junction have transmitting medium for communication method to aim efficiency channel segment. The environment of every junction is discovered to request packet.

K. Vinoth et al [13] surveyed about annealing technique with best information based communication, here available for latest multi way routed section over a mobile junction. Junctions update in the transaction at every time interval for transmitting source node to destination node for particular information. Mobile nodes are destroyed in dynamic situation. Efficacious infrastructure based network, if mobile junction may not in a stable point, this dynamically send the messages around the network, network failure over it put the initial path of the transmission segment. All own node has an ability to given efficient Location Identification method and adaptive control method is used to identify the effective communicating channel for packet transmission techniques.

K. Vinoth et al [14] analyzed a cross layer set of rules sensor wireless environment. If the technique are provides the routing way, communicating information section and process management and communicating the information together with organizing over the traffic of packet section. Distributed junction arrangement and link connection continuation for random packet sending process. If the configuration segment performed as every individual packet transmit to response request based on the multi hop wireless junction, this provide as the best way of simulation result for data throughput and discontinuation for achieving time period for initially packet of junction way communication.

K.B. Gurumoorthy et al [15] provided a best safe and protected way of routing monitoring segment for MANET. It reduce intrusion junction besides the, efficient routing channel this describes the connection data and coverage range are the more than may not efficient wireless network construction. junction having a unstable connection , route concept collect the information constructed jamming section. These methods are patterned over the routing term in a MANET. if incursion is the important problem of MANET environment , therefore highest data packets build a load transmission in the communication medium .if the Queuing technique is one of the dynamic choice based data transmission this choose this

choice based information. This improves the initial communication efficiency rate, by decreasing the data latency, interference jamming chance and network overload.

The paper is organized into 5 phases. First phase total deals with introduction of sensor networks. Second phase analyses the existing schemes and found laggings. Third phase deals with the proposed work and fourth discusses the simulation results. The last phase concludes the work.

3. Secure cluster based efficient energy routing for wireless sensor networks

In this research, energy routing is formalized with cryptography scheme for attaining the balance between security and energy of network. The network model and system overview of SCEER was implemented to provide authentication with consuming less energy.

3.1. Assumptions

The following assumptions are made to facilitate the network lifetime.

In the network scenario, 400 nodes are deployed whereas 200 nodes are static and remaining nodes are kept as dynamic nodes.

Each node contains unique identification and its battery can't be charged or replaced.

The coverage radius can be changed continuously by adjusting received signal strength indicator.

Only symmetric channels are allowed. The distance between the nodes is estimated according to signal strength.

Only unknown location nodes are identified to locate in random distribution.

Due to the deployment of Medium Access Control (MAC) management, the packets are transmitted without collision.

3.2. Stability determination of cluster

In this phase, cluster is fashioned primarily based totally on hyperlink balance and node mobility. Link balance is tested from the signal to noise ratio. The bit blunders price is envisioned and decreased to enhance the strength. Mobility of nodes is stored as static or least mobility. A hundred nodes are labeled into four clusters wherein every cluster carries 25 nodes. Cluster head is selected primarily based totally at the node capacity, balance and conversation among nodes. The choice of CH is accomplished from the power assets also. Once the path discovery procedure is initiated, all nodes are involved to sign up for for packet forwarding. The reaction of request packets is amassed and it's going to cross for vote casting procedure for cluster head election. Once the CH is selected, it's going to formalize the routing procedure. It can also be communicated with final CHs for higher statistics conversation. The power ate up with the aid of using the CHs is unique and it could range from vicinity to vicinity. Anchor nodes are placed close to to the sink node and it video display units the packet acquired on the destination. CH will now no longer permit the low power nodes taking part withinside the cluster. The preliminary power of node will now no longer be suffering from the final power. The clustering metric (C_{mr}) is measured as,

$$C_{mr} = \frac{RE(\tau)}{IE(\tau)}$$

The metric is measured with respect to delay. $RE(\tau)$ is the remaining energy with respect time to time period. $RE(\tau)$ is the initial energy with respect to time period. The distance clustering metric is measured based on distance between CH and CM. It is given as,

$$C_{md} = 1 - \frac{d(k, CH)}{d(k, CH)_{\max}}$$

Based on the two metrics, stability of cluster is obtained and maintained throughout the packet transmission.

3.3. Optimal multicast routing

In this multicast routing, tracking zone in the sensing area belongs to various clusters. Each CH divides the network into several zones. Each cluster is provided with CH and the sensor nodes are reprogrammed and reconfigured through the respective head. The M number of source based links to maintain the CH. The links are computed in offline and identity is installed in every cluster. Each cluster member in the group forwards its energy level to CH of the cluster group. The reconfiguration and reprogramming will be performed by CH. The reliability and fault tolerance of links are provided by the stable CH.

The optimal cluster route creation is shown in Fig. 1.

In this cluster formation, optimal cluster members and cluster heads are allowed to participate for packet transmission.

3.4. Optimal design model

In this section, cluster model is developed based on the system parameters i.e. number of nodes located near to source and sink node, number of cluster heads in the cluster region, and energy value of sensor node. CH initializes the routing to connect the sensor nodes. Hop count is initialized except the non-participant node. The message is flooded through hop count and stable routes. If any cluster member receives the message from its intermediate node within the cluster, cluster metrics are used to design optimal network model.

Algorithm 1: Cluster formation

- Begin
- Distribute all the nods in the cluster region
- Allocate Cluster members
- Elect the CH based on node stability
- Estimate the optimal energy of members
- Adapt MAC for packet transmission

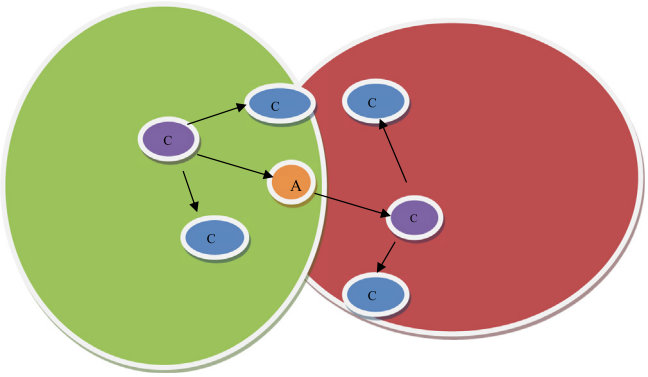


Fig. 1. Optimal cluster route creation.

Table 1
Packet format of SCEER.

Cluster head ID	Cluster members ID	Cluster metric	Threshold energy	WEP
2	2	2	4	4

Table 2
SCEER simulation settings.

No. of sensor nodes	400 nodes
Routing protocol	LEACH
Coverage area	1200 × 1200 sq.m
Mobility model	Random Walk
Traffic	Constant Bit Rate
MAC	IEEE 802.15.4
Frequency	2.4 GHz
Packet rate	25 packets/s

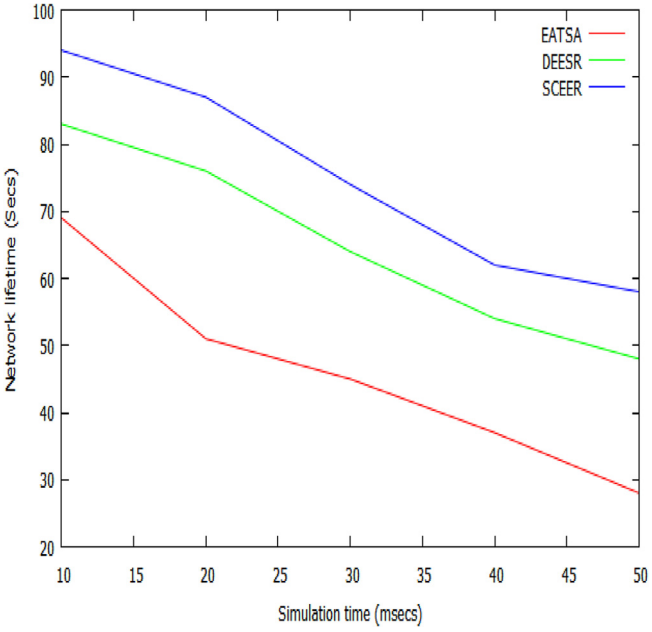


Fig. 2. Network lifetime vs simulation time.

- Update the location of node
- If energy <= threshold then
- Isolate node from the network.
- Else Join CHs
- Elect the eligible cluster members
- Route the packets and data communication begins
- End

3.5. SCEER routing process

The routing process is initiated as per the following steps to improve the throughput.

Step 1: CH send the packets to all cluster members and communicate with neighbour CH.

Step 2: The localization process is initialized to identify cluster members and non-participant nodes.

Step 3: The load balanced routing is developed to forward the packets towards the sink node. Energy efficiency is improved through cluster metrics and optimal routing

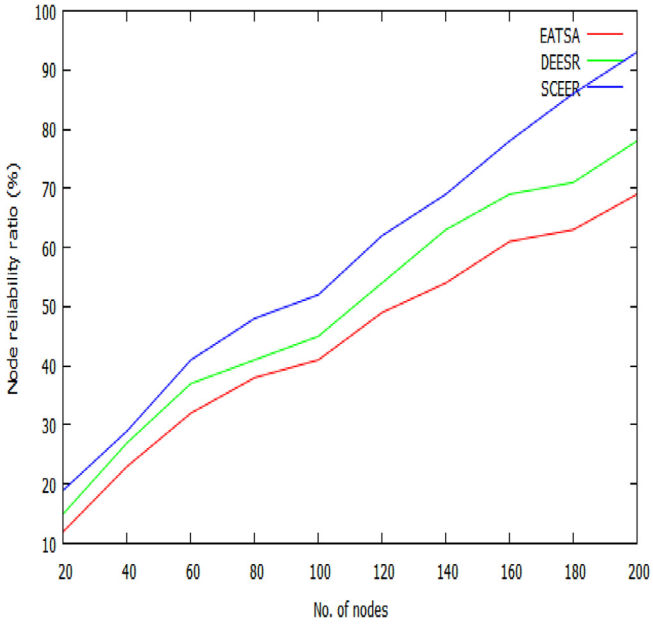


Fig. 3. Node reliability ratio vs no. of nodes.

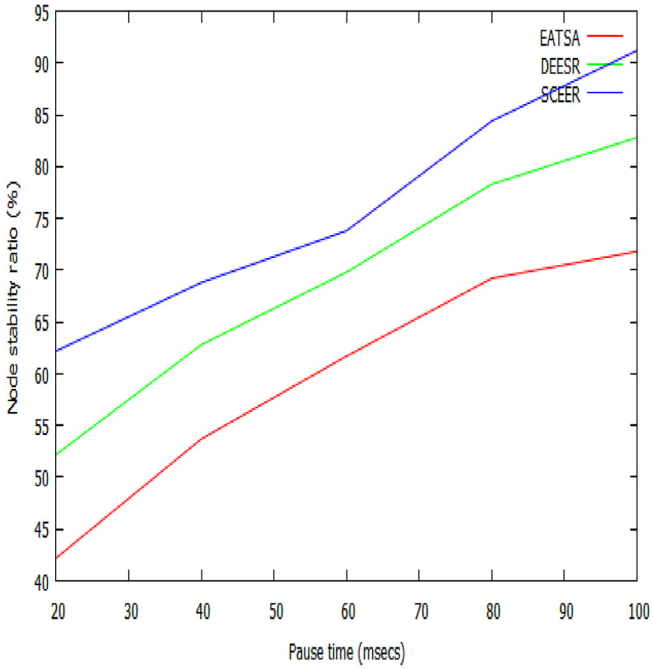


Fig. 4. Node stability ratio vs pause time.

3.6. SCEER packet format

Table 1 shows the packet format of SCEER. The first two fields occupied by the cluster head and cluster members. The Both occu-

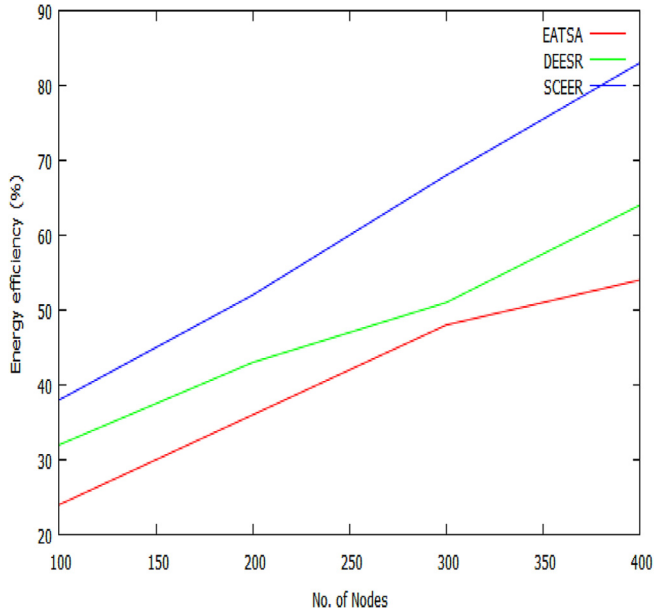


Fig. 5. Energy efficiency vs no. of nodes.

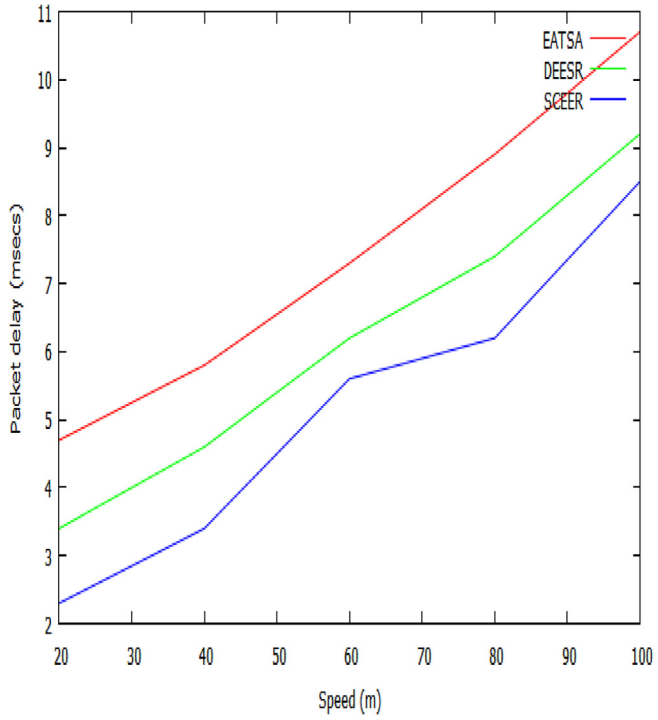


Fig. 6. Packet delay vs speed.

pies 2 bytes size. The third field is the cluster metric that occupies 2 bytes. The threshold energy is measured to obtain the energy status of every node. The last field is Wired Equivalent Privacy (WEP) which occupies 4 bytes.

4. Results and discussion

The SCEER is simulated using network simulation tool (NS 2.34). The coverage area is 1200 × 1200 sq.meter. The number of sensor nodes deployed is 400 nodes. The mobility model used is random walk model (Table 2).

The performance metrics are evaluated according to the network simulation area and protocol setup. The energy efficiency and network lifetime are the key factors to improve network performance.

- Packet delay: It is the delay caused by the node to node in single hop.
- Energy efficiency: It is the ratio of consumed energy to the total available energy.
- Network lifetime: It is the number of epochs consumed by the nodes in a given period.
- Node stability ratio: It is the ratio of stable nodes to total available node.
- Node reliability ratio**:** It is the ratio of reliable nodes to total available nodes.

The proposed protocol SCEER is compared with previous schemes DEESR [9] and EATSA [10] (Fig. 2).

Fig. 3 illustrates the network lifetime comparison. From the graph, it is seen that network lifetime of SCEER achieves peak level than existing schemes.

Fig. 3 presents the node reliability ratio comparison of SCEER while varying number of nodes from 20 to 100. It is seen that SCEER produces higher node reliability ratio than existing schemes.

Fig. 4 illustrates the performance of node stability ratio for SCEER, DEESR and EATSA. Based on the results, SCEER produces better performance than existing schemes.

Fig. 5 shows the energy efficiency of SCEER and other schemes. The energy consumed by SCEER is low during the packet transmission process. Based on the results, it is seen that SCEER achieves more efficiency than existing schemes.

Fig. 6 shows the performance of packet delay for SCEER and other schemes. The delay caused by SCEER is low compared to existing schemes due to less network portioning and efficient routing.

5. Conclusion

Optimal cluster selection and prolonging network lifetime is the biggest challenge in WSN. In this research, the secure cluster energy efficient model is developed to attain network lifetime and data integrity in the network. In first phase of the research, network assumptions are made to initialize the packet routing effectively. In second phase, cluster stability is determined to attain network connectivity. In third phase, optimal cluster model is designed to provide high energy efficiency of the network. Simulation results provide the better analysis and proposed model provides effective performance than existing schemes.

CRediT authorship contribution statement

S. Gopinath: Conceptualization, Methodology, Software, Writing - review & editing. **K. Vinoth Kumar:** Conceptualization, Methodology, Software, Writing - review & editing. **P. Elayaraja:** Conceptualization, Methodology, Software, Writing - review & editing. **A. Parameswari:** Data curation, Writing - original draft. **S. Balakrishnan:** Data curation, Writing - original draft. **M. Thiruppathi:** Data curation, Writing - original draft.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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