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Energy Efficient Agent Based Intelligent Routing In MANET Integrated With MPLS

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ABSTRACT

Mobile ad hoc networks (MANETs) are infrastructure free networks formed by wireless mobile devices with restricted battery life. Limited battery capacity and dynamic topology of MANETs introduces routing issue as one of highly active research areas. MPLS plays a good role in routing, switching and forwarding using small labels. Intelligent agents have the ability to learn or use knowledge to achieve their goals in routing decisions. The calculation of energy level is important to determine the battery level of every node during active data transmission. The battery level of a wireless node decreased when the node initiated data transmission or when the node forward packets. This paper calculates the energy level of a node before forwarding data packet to the next node for performing energy efficient agent based intelligent routing by integrating with MPLS.

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INTRODUCTION

Mobile Adhoc Network (MANET) is a collection of independent mobile nodes that can communicate to each other via radio waves. MPLS is a new switching mechanism that uses labels (numbers) to forward packets. The mobile hosts are small and light weight and are supplied by limited power resources such as small batteries. Nodes rely on batteries for their energy. This causes vulnerability when attackers may target some node batteries to disconnect them, which may lead to network partition. Some attacks may try to engage the mobile nodes un-necessarily, so that they keep on draining their battery. So the most important design criterion for energy conservation and energy aware agent based intelligent routing in MANET is to integrate with MPLS.

Manet:

Mobile Ad hoc NETwork (MANET) is an infrastructure-less self-configuring network of mobile devices. The increase of cheaper, small and more powerful devices make MANET a fastest growing network. Each device in a MANET is free to move independently in any direction. Each must forward traffic unrelated to its own use, and therefore be a router. In order to maintain connectivity in a mobile ad-hoc network all participating nodes have to perform routing of network traffic. Devices in mobile ad hoc network should be able to detect the presence of other devices and perform necessary set up to facilitate communication and sharing of data and service. The success of communication highly depends on other nodes cooperation. The mobility of nodes needs efficient routing for MANET (Aarti & Dr. S. S. Tyagi, 2013).

A. Factors consuming energy while used in MANET:

1. Control information overhead:

Routing must be done in such a way that it can handle the control messages according to the requirement. Transmission process takes twice power as compared with receiving process, but both operations are still power consuming. The ability to reduce control messages can help in saving the power in mobile devices.

2. Processing overhead:

Complex routing algorithm requires a significant processing cycles which may cause more power consumption in mobile devices. So, the algorithms must be made simple which requires minimum processing.

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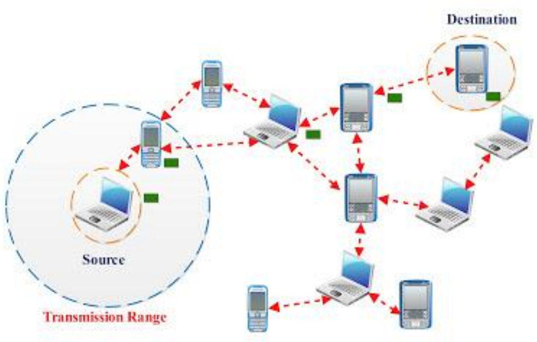

Fig. 1: Packet forwarding from source to destination node in MANET.

Multiple hop routing:

There may be no direct link between source and destination. Routing protocol should be capable of discovering multi hop routes to reach the destination which may consume energy.

Dynamic route maintenance:

Link failure in MANET is common due to dynamic nature. Route maintenance will consume energy.

Loop prevention:

When a routing loop occurs, data packets may transverse the path multiple times until path is fixed or Time to Live (TTL) of the packet approaches zero. Routing loop causes wastage of network resources, so loops may be avoided to preserve energy (Ashraf Abu-Ein, Jihad Nader, 2014).

The network must allow a finite number of nodes to turn off their radio receivers as long time as possible as an idle node can consume the same amount of energy as an active node. Even if the nodes are inactive, the network must take marginally small delay to forward the packets from source to destination as compared to time taken if all the nodes were active (Dr. Annapurna Patil, Saunhita Sapre, 2014).

So the design criterion for energy conservation and energy aware intelligent routing in MANET is to integrate with MPLS.

I. MPLS:

In conventional IP forwarding each router make forwarding decision on the basis of IP header information. The router has to analyze the packet and routing table at each hop to make forwarding decisions which cause delay in packet delivery. To overcome this problem, **M**ulti **P**rotocol **L**abel **S**witching (MPLS) was designed. In MPLS forwarding decisions are made on the basis of small short fixed value called as "Labels".

MPLS enhances routing with respect to path and packet forwarding. One of the main difficulties in MANET is the routing problem due to frequently change in topology causing more time in route setup and increasing the delay. MPLS labeling decreases end-to-end delay and minimize the time it takes to setup a route (Sasan Adibi, 2012).

Idea is to integrate MANET with MPLS to improve the energy efficient intelligent routing using agents. This factor is considered in MANET because topology is changed with the movement of mobile nodes resulting in route changes which lead to network partition and energy loss.

Utilizing MPLS in a wireless context provides extraordinary improvement in a faster processing of headers and fast reroute, which improves the end-to-end delay. But it requires an extensive reduction of infrastructure to meet wireless limitations like limited battery and processing power of wireless nodes (Methaq jasam, Dr.salman bin yussof, 2013).

Other benefits from this integration are improvement of QoS parameters like round-trip delays, packet loss, fault tolerant paths and structural management services.

A. Advantages of Mobile-IP using MPLS:

1. Fast Switching:

In IP, the packet header is examined at every node, which increases end-to-end delay. This issue has been dealt with MPLS by assigning labels and switching is performed based on the label information.

2. Small State Maintenance:

Since labels are used, state information maintained will be small.

3. Highly Reliable:

MPLS-enabled routers are often deployed in pairs to create redundant paths.

4. Connection-Oriented QoS:

A connectionless network, such as an IP-based network, cannot provide guaranteed QoS. MPLS-based networks imposes a connection-oriented framework on an IP- based traffic by assigning particular treatment to particular traffic. By this way, guaranteed QoS could be implemented.

II. *Implementation:*

A. *Intelligent agent:*

An intelligent agent is an autonomous entity which observes and acts upon an environment and directs its activity towards achieving goals to make it rational. Intelligent agents may also learn or use knowledge to achieve their goals.

B. *Energy aware agent based intelligent routing:*

Energy consumption is mainly used by transmission and reception of data packets and control packets, including forwarding packets and updating broadcasts. Energy aware agent based intelligent Routing can be done by assigning a weight to each link of the MANET where weight is a function of energy consumed when transmitting a packet on that link as well as the residual energy level. Routing decision can be taken based on this weight parameter or existing protocol can be incorporated with the weight metric for fixing the routing decisions. Route with the smallest weight can be chosen for the packets to be forwarded (Leila Rezaei, 2012).

To find neighbour nodes with enough energy and short distance to the destination, following formula is used

$$w1\left(\frac{energy_i}{max\ \ energy}\right) + w2\left(\frac{max\ \_hopcount}{hopcount_i}\right)$$

where
$energy_i$: Energy of node i
$hopcount_i$: Hop count of node i
max_*energy*: Highest energy level among neighbors of the current node
max_*hopcount:* Maximum hop count
w1: Weight of energy factor
w2: Weight of distance factor
The total energy consumption E to send k bits can be formulated as
$E=P_{on}\times T_{on}+P_{sp}\times T_{sp}+P_{tr}\times T_{tr}+P_{Idle}\times T_{Idle}$
where
P_{on}: power in on mode
P_{sp}: power in sleep mode
P_{tr}: power transient mode
P_{Idle}: power in idle mode
T: represents the time duration that the transceiver stays at each specified condition.

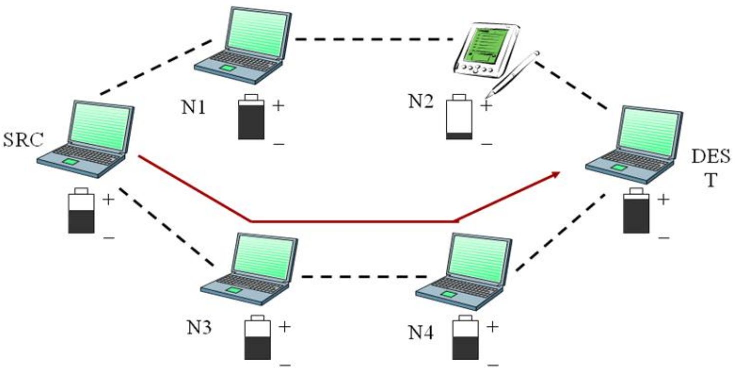

Fig. 2: Energy aware agent based intelligent routing scenario.

To conserve energy, it is better to minimize the amount of energy consumed by all packets traversing from the source node to the destination node (Jin Wang1, 2014).

Transmit Mode (Tx):

Tx = (Pkt-size x 330) / 2 x 106 and PTx = Tx / TTx

Where PTx is transmitting power, Tx is transmitting energy and TTx is time take during packet transmit and Pkt-size is the size of packet in bits.

RX Mode:

RX = (Pkt-size x 230) / 2 x 106 and PRX = RX / TRX

Where PRX is receiving power, RX is receiving energy and TRX is time take during receiving a packet and Pkt-size is the size of packet in bits.

Idle/ Listening Mode:

P_{Idle} = PRX

Where PRX is power consumed in receiving mode and P_{Idle} is power consumed in idle mode.

JADE:

JADE is one of the best modern agent environments. JADE is open-source, it is FIPA compliant and runs on a variety of operating systems including Windows and Linux. Furthermore, it gives very good scalability.

JADE is a middleware that facilitates the development of multi-agent systems. It includes

- A runtime environment where JADE agents can "live" and that must be active on a given host before one or more agents can be executed on that host.
- A library of classes that programmers have to use to develop their agents.

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- A suite of graphical tools that allows administrating and monitoring the activity of running agents.

Containers and platforms:

- Containers:
  - Each running instance of the JADE runtime environment is called a Container as it can contain several agents.
- Platforms:
  - The set of active containers is called a Platform.

A single special Main container must always be active in a platform and all other containers register with it as soon as they start. It follows that the first container to start in a platform must be a main container while all other containers must be "normal" containers and must be told where to find host and port of their main container. If another main container is started somewhere in the network it constitutes a different platform to which new normal containers can possibly register. JADE agents are identified by a unique name and provided they know each other's name, they can communicate transparently regardless of their actual location. Developers don't have to know how the JADE runtime environment works. They just need to start it before executing their agents.

JADE applications are structured quite differently from most programming languages in the fact that JADE programs are not developed by writing code into long files and then compiling all the files together in one go. JADE programs are actually developed using a user interface that allows programmers to visually create classes and define their properties and methods. Instead of locating methods in large files, programmers select the method they would like to edit and only the code for that particular method is displayed. Also instead of compiling all the code of a program at once each method is compiled individually as soon as the method is completed, that is, code can be checked immediately.

All the code for a JADE application is stored in its object-oriented database. This has a number of advantages.

- it allows for multi-user development, as the database maintains concurrency control
- with each piece of the code being a separate object in the database, in a lot of the cases it is possible to recode the system while it is live and online as long as the parts of the system being changed are not in use
- to give programmers what they wanted ie, a seamlessly integrated programming language that would allow developers to just create one application that would go from end-to-end instead of having to write three separate applications for the database server, application server and presentation client and then write the code for them to communicate with each other.

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Screenshots:

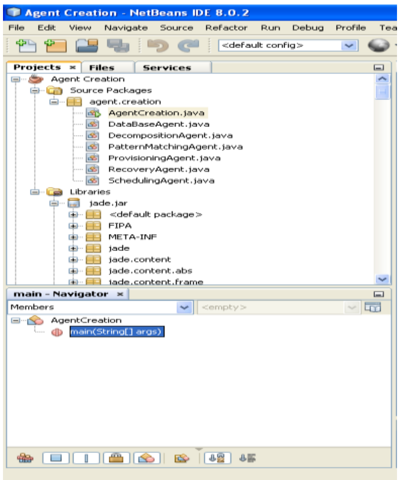

Fig. 3: Screenshot of the Project Creation.

Conclusion:

Routing is one of the key issues in MANET because of highly dynamic and adhoc nature of mobile nodes. Especially energy efficient routing is most important because all the nodes are battery powered. Failure of one node may affect the entire network. If a node runs out of energy, the probability of network partitioning will be increased. Since every mobile node has limited power supply, energy depletion is become one of the main threats to the lifetime of the ad hoc network. So, routing in MANET should be in such a way that it will use the remaining battery power in an efficient way to increase the life time of the network. The residual energy of neighbor node is compared with the average energy of the path for routing. MPLS enhances routing with respect to path and packet forwarding. MPLS labeling decreases end-to-end delay and minimize the time it takes to setup a route. Intelligent agents have the ability to learn or use knowledge to achieve their goals. By integrating MANET with MPLS, it is possible to improve the energy efficient intelligent routing using agents. Energy aware agent based intelligent Routing can be done by assigning a weight to each link of the MANET where weight is a function of energy consumed when transmitting a packet on that link as well as the residual energy level.

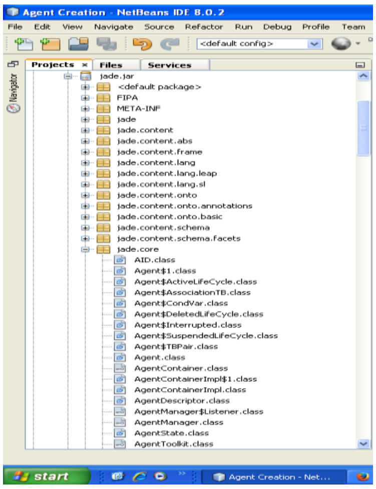

Fig. 4: Screenshot of importing JADE.JAR.

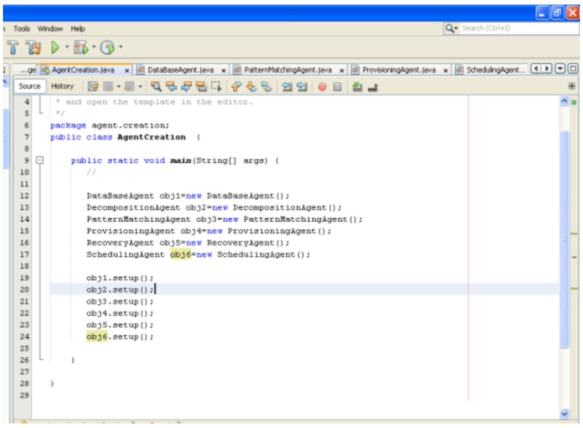

Fig. 5: Screenshot of Agent creation main class.

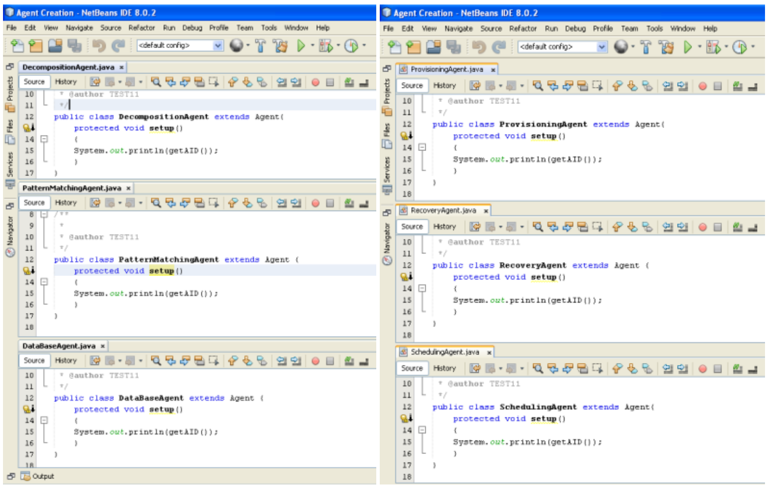

Fig. 6: Screenshot of various agent classes.

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Fig. 7: Screenshot of running of the Main Container.

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