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RTH-RSS Mac: Path loss exponent estimation with received signal strength localisation mechanism in Wireless Sensor Networks

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Abstract: *Nowadays , Wireless Sensor Networks (WSNs) succed in domain of technology trends; new require'sare continuously have more complex challenging, such as the real time location. The MAC layer plays a crucial role in these networks; it controls the communication module and manages the medium sharing. In this work, we integrate the received signal strength path-loss exponent estimation (RSS PLE) based on location technique in Real Time Hybrid MAC (RTHMAC) protocol in goal to minimize the delay phase's and get more life time node's. It combinesalso the advantages of both TDMA and FDMA in order to give a soft real time communication for WSN.*
Keywords: *Duty cycle, RSS, PLE ,FDMA,TDMA, WSN ,Cluster*

I. Introduction

In The localisation of Wireless sensor network its very hard to say the exact position of the sensing field. There is Many proposal ranging methods for localisations in diffrents layers (Time of Arrival(TOA), Time Difference of Arrival(TDOA)…) , in this paper we will focus on the mac layer ,especially we will progressthereal time hybridemacProtocol functioning , Efficiency by integrate the Received Signal Strength(RSS) who is one of the simplest ranging methods,however the RSS can successfully describe the relationship between a distance and the signal strength decrement along with the distance .

we suggest a dynamique self detection RTH-RSS who combine the initialisation and syncronization discovrey phase in order to decrease the energy consumtion node's whatever the environment type.In goal to have the correct location approximativly, we introduce also the path-loss exponent estimation (PLE) node. Therefore the node generates a path-loss model appropriate for a given space.We then determine a node's location based on the RSS path-loss model in the real time.

In WSN the Mac protocol is dividedin two types : the first who give a single hop route (FMAC, FTDMA, VTS, SUPPORTS, CR-SLF, QoSMAC…) it can apply in applications that tolerate some deadline missing, and the second give end to end route thats use a temporal slots/ frequency in goal to reach the final destinationfor exemple the RTHRSS Mac protocol that use also other properties , such as the multi-chanel comunication in order to increase the parallel transmission and reduce the end to end delay exchange packets .

In first part of this work we explain theoretically the Real Time Hybrid RSS- MAC (RTH-RSS MAC) protocol . The RTH- RSS MACis a hybrid protocol based on RSS localisation PLE and multiplexing the Time Division Multiple Access (TDMA) method and the Frequency Division Multiple Access (FDMA) method in purpose to give a hard real time communication and multi-hop WSN . It ensures a deterministic end-to-end delay by avoiding packet conflit and collision. It minimizes the delay communication latency by RSS PLE localisation and assigning time slots in a sequence that allows a continuous data flow from a source node to the sink in one super-frame duration,and make the end-to-end fully available by implementing an acknowledgment/retransmission mechanism. however, it possesses an active/sleep mechanism for efficient energy usage with predefined duty cycle.

In the rest of this paper we present the pratical analysis RTHRSS MAC protocol exchanging packets per cluster nodes using NS2 Simulator.

II. The Theoretical RTH-RSS MAC Protocol :

1. Classical RTH MAC :

The MAC sub-layer plays a specific and important role in WSN and especially for QoS , thats controls the medium access sharing, and all upper layer protocols are depends to that. The classical RTH protocol combines the advantages of the TDMA and FDMA access methods in goal to offer a hard real time communication. however, the RTH-MAC offers the possibility to have multi-relaying in the same time slot in order to avoid the traffic fluctuation problem.

The RTH-MAC functioning is organized in four different phases as illustrated in Fig.1. After nodes initiation, all nodes turn-on their radio transmitter, tilleach node receive a Hello message ,it begins its discovery phase by saving the source address of the message in its neighbor list, and transsmiting a another broadcast Hello message with its proper ID source address. After the assembling of direct neighbor's information, all nodes forward their nearby lists to the base station by hello packets. After that, the base station build a fully tree map that represents the network.

The Slot/channel attribution phase consists of constructing the schedule map , by using this one each node have the appropriate slot time and frequency to communicate , after that the base station will broadcastthe schedule to nodes, and the send data packet phase can begin . However it consume additional time/ energy in intialisation and discovry phase's, for this reason we integrate the RSS PLE technique which replace this two phases , it called IDRSS- PLE (initalisation and discovry RSS PLE).

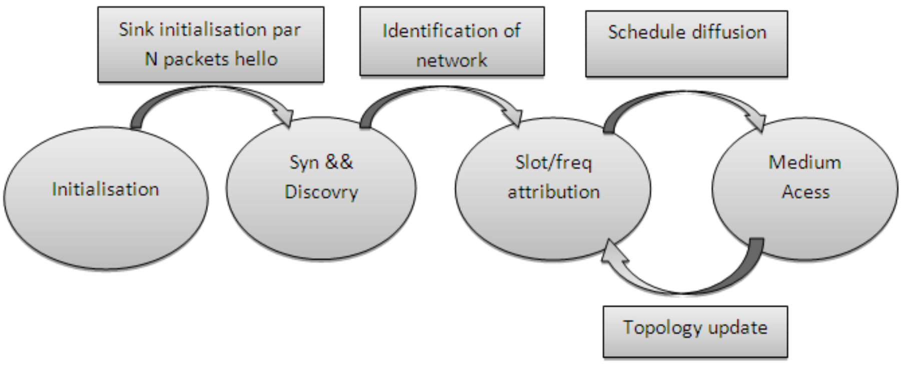
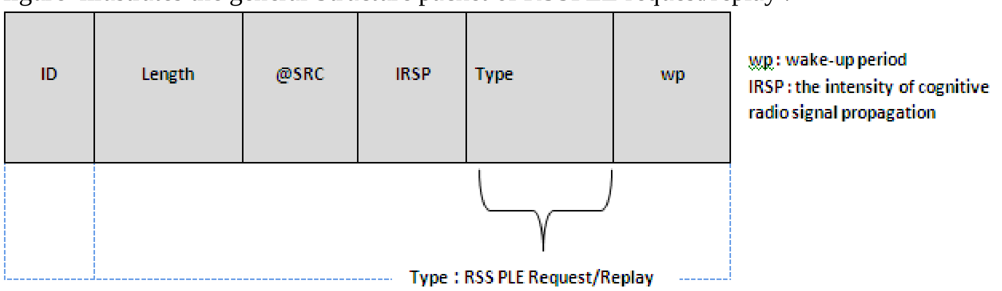


Figure1: Classical RTH-Mac

2. Idrss Ple Phase In Rth Rss -Mac:
2.1) Exchange mechanism of RSS PLE request/replay packets:
As it saidbefore , the classical RTH Mac waste a lot of time and energy node and increase the risk of collision packets in intialisation and discovrey phases , therefore we develop a new protocol RTHRSS- Mac with IDRSS PLE phase localisation as a solution.When a transmitter node (TN) want to relay a data packet ,first it send its RSS PLE request packet to all its neighbors node (Figure 2)and this ones do the same process per cluster by using an algorithm of clustering System density (Algorithm 1) , however all nodes of network receive the request packet of localisation , and every one sent its RSS PLE Replay Packet to the TN , the following figure illustrates the general Structure packet of RSSPLE request/replay :



General structure of RSS PLE Request/Replay in IDRSS PLE phase

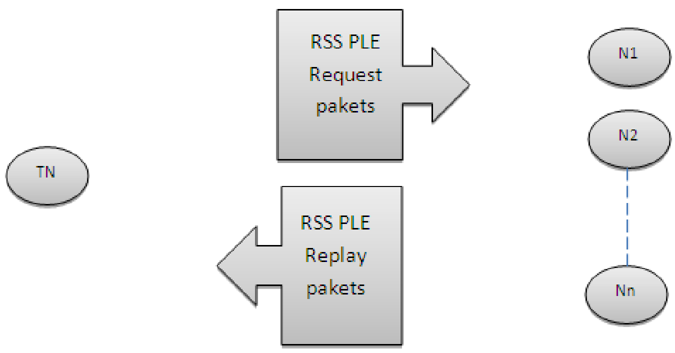


Figure2 Diagram of exchanges request/replay packets RSS PLE per cluster

Algorithm 1 : system of sending request RSS Localisation
Input : **Emetteur node(node requesting localisation) : Qe** **Lists of nodes wsn : L** **Maximumradiusneighborhood: Eps** **Minimumnumber of points inneighborhood-Eps of one point : MinPts** **Set of cluster nodes: SCN** **Output :** **Request pakets Localisation : RPRSS**
For each pi Є L **If dist(pi,Qe) <= Eps ;** **SCN🡐 pi ;** **Pi 🡐pi+1;** **Else pi🡐 pi+1; end ;** **If |SCN (Qe)| >= MinPts ;** **For each pi Є SCN** **Send RPRSS() ; pi🡐pi+1;** **End ;End ;End ;**

2.2)Analysis andgeometrical demonstration of IDRSS PLE phase:

2.2.1) Analysis view :

Every RSSPLE Request/Replay packet of neighbor node must contain the localisation parameter's (x,y) and the speed measure of radio debit which decrease according to the distance, it can be used by the node in order to adjust the intensity of radio and reach the next hop ,we define this two values by resolving the following equations :

$r\ i = (x\text{-}xi)^2 + (y\text{-}yi)^2$ / i : ith beacon node / ri :distance between ith-beacon and node(1)

$Pi = 10\ \alpha \log10\ ri / r0 + P0$, i= 1,2,3…N/ P: intensity of radio cognitif signal propagation (2)

The equation (1) can be resolved such as (xi,yi) parameter's of beacon's node. However in equation 2 , αm is admitted average of α such as αm average of α m-i (E(PLE)={ 1….m} ,m : mth PLE node && F ={ 1…..i} ,i :ith beacon node) , and α m-i can be resolved in (2) , thusr m_i and Pm_i are measurable between the m th PLE node and i ith becon node .

2.2.2) Geometrical view :

The following graph describe geometric location calculation (x,y) for node(LN) (Figure 3) by using Sketchup 8designer in 3D . The geometrical solution is :

$X = Xple + X\ ple\_N$ (1)

$Y = Yple + Yple\_N$ (2)

According to (1) and (2) we can find the approximate location of node , the so close PLE node relative to the LN gives usthe advantage of having the Xple and the distance between this one and the nodewhich request the location and the same for the Y value.

After the reception of the localisation values by every node of the wsn , the TNbuild its RSS Localisation graph , thus the attribution slot/freq begins (Figure 4)according to RTH-RSS MAC Functioning .

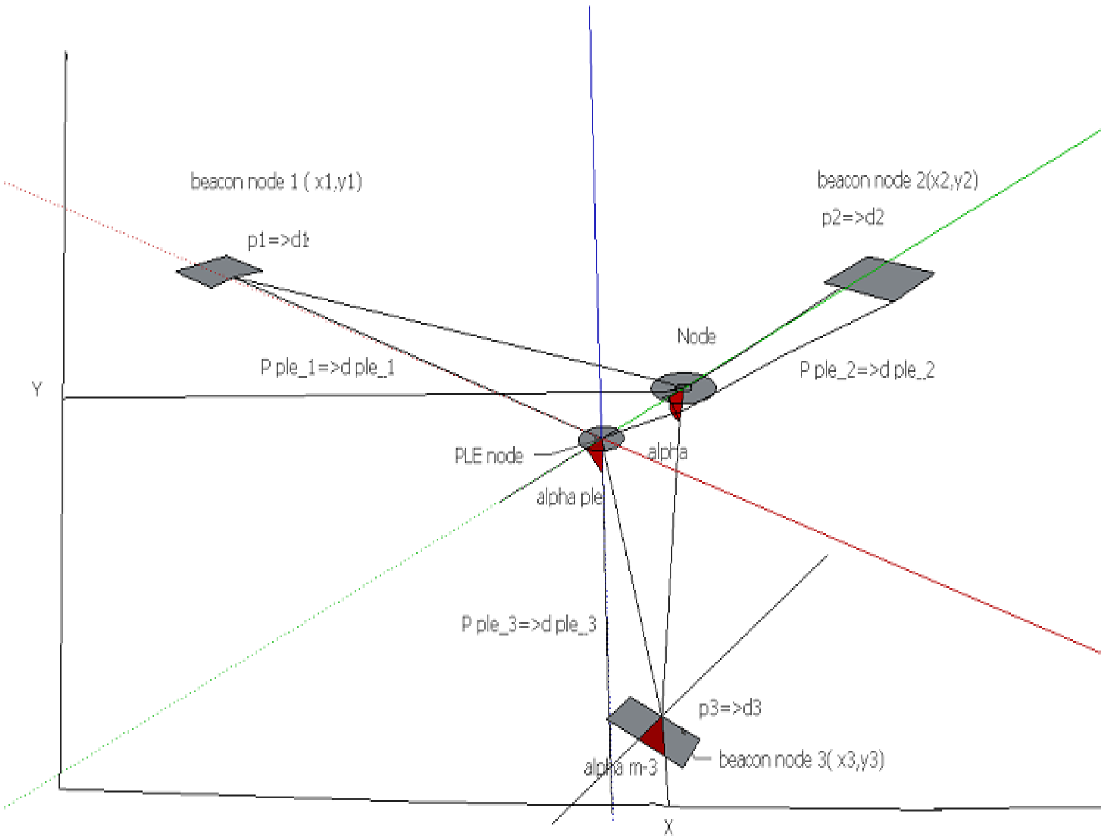


Figure 3: Geometrical diagram of localisation RSS PLE in 3D

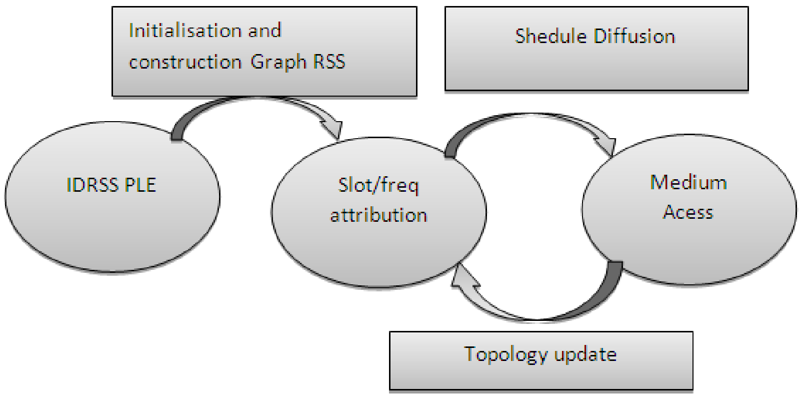


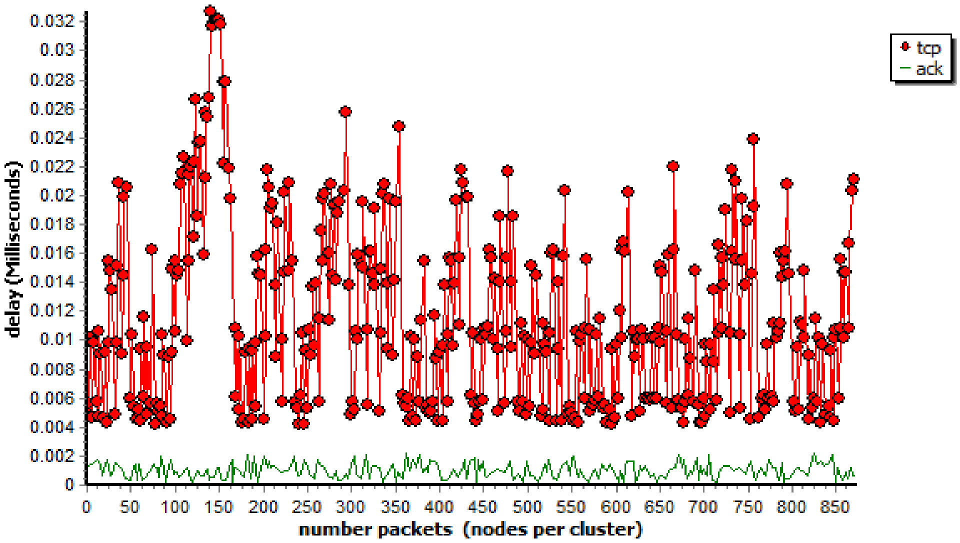
Figure 4: RTH RSS PLE Functioning

III. Experiments:

In this part we present the simulation of exchange Request/ Replay localisation according to the number of sending packets changed dynamically in time by using NS2 Simulator.The following table present the simulation characteristic's :

Table 1: Parameter's of the simulation

Type of event	**Sent delay per cluster**
At node	**Node 0**
Trace level	**Mac**
Y axis Units	**Bytes**
According to	**RFC 1242**
Syn Interval (ms)	**1000**
Troughtput	**Btyes/seconde**
Time Simulation	**13800**



Delay of number Packet request RSSPLE per cluster and replay

IV. Experimental Analyse and disscution:

In this section, we shall present simulation of the proposed protocol RTHRSS-Mac using the RSS PLE technique , especially the delay according to number of RSSPLE Request packets sending and a acknowledgement (RSSPLE Replay packet) to inform the location node per cluster.Where the number of packet is fewer than 50 packets sent, the average of sending delay take 0,008 ms ,however the sending delay rise till 0,032 ms in proportion with 150 packets sent , after 200 packets sent the delay get a averge time between an interval values [0.004ms , 0.024ms] , the histogramme also display that the delay ack take 0.001ms as an average value whatever the number of packets sent (number of nodes per cluster) .

The simulation show that the cluster outside range [100, 200] nodes take 0.013ms asan average delay of sending, otherwise the request sending packets take a lot of time , thereforethe lifetime of transmitter node which request the localisation become very short .however we explain the fast replay localisation of nodes (ack) because that every one send it RSS PLE Replay directly to the TN without using the next hop in the network. Indeed the implementation of RTHRSS MAC can avoid an over-consumptionof energy , if we have a number node's out of range [100, 200] per cluster.

V. Conclusion:

The RSS PLE is technique which has been proposed as a low-cost, low complexity solution for many WSN protocol Mac .In the existing studies, radio propagation path-loss exponent model can give simplification in many localisation scenarios , and also contribute to save the energy of nodes. Our paper explain an exemple of RTH-RSS Mac Throughtheoretical analysis which presents the algorithme of localisation system.In IDRSS PLE phase, our experiments show that RTH-RSS Mac is able to achieve less energyconsumption,and short replay time of localisation performance.

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