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RESEARCH ARTICLE

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Need Based Congestion Control Algorithm for Wireless Sensor Network(WSN)

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ABSTRACT

This paper includes the study of congestion control algorithms which are AIAD (Additive increase additive decrease),AIMD (Additive increase multiplicative decrease), MIMD (Multiplicative increase multiplicative decrease) .To maintain the quality of service a congestion control is the main aim in wsn . In this paper to maintain the' Qos' we develop a Need based congestion control algorithm that is "Need based Additive Increase Multiplicative Decrease " (NBAIMD) congestion control algorithm.

KeyWords— AIAD (Additive increase additive decrease),AIMD (Additive increase multiplicative decrease), MIMD (Multiplicative increase multiplicative decrease),QoS.

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INTRODUCTION

When the sending rates exceed the capacity of the channel then the channel becomes congested and congestion occurred, to improve the quality of service congestion control algorithm is needed'Congestion control algorithms are:

- AIAD (Additive increase additive decrease)
- MIMD(Multiplicative increase multiplicative decrease)
- AIMD(Additive increase multiplicative decrease

First two algorithms are random in nature and unstable,but the behavior of "AIMD" is stable

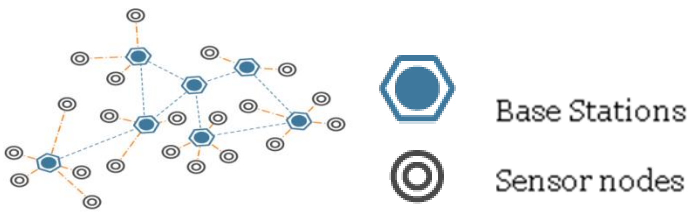

Figure 1. General architecture of WSN.

Figure 1shows the general architecture of WSN where two or more sensor nodes send data to BN.To understand the behavior of "AIMD" let us consider the situation where two sourceswith different data rate say x1 and x2 in (packets/sec) respectively trying to access a single link of capacity c packets/sec. The link provides a feedback to the sources to indicate whether the link access rate (x1+x2) exceeds the capacity or not. if they exceed the capacity that means congestion occurs. The congestion control problem here is to adapt the sending rate of the source to the feedback signal so that link can be fully utilized, the sources adjust their sending rates according to the differential equation

$\dot{x}_i = \alpha I(x1 + x2 \leq c) - \beta x_i I(x1 + x2 \geq c)$ for $i \in \{1, 2\}$ (1)

$\dot{x}_i$ is the time derivative of xi i.e. dx/dt , α and β are the positive constant

MATHEMATICAL MODELLING OF AIMD

The equation (1) says that if the total arrival rate at the link does not exceed the capacity then a source increases its sending rate at a constant rate α (additive increase) and if the link arrival rate exceeds the link capacity, then the sending rate is decreased multiplicatively (as $\dot{x}_i$ is proportional to $-x_i$) with β as the constant of proportionality. Note that the two events x1 + x2≤ c and x1 + x2≥ c are complementary, in the sense that at any instant exactly one of them is true. An assumption implicit in the model is that the network delays are negligible so that the feedback is modeled as instantaneous.To study the behavior of the system, set the variable

$Y= x1-x2$ (2)

From equation we can simply calculate the derivative of the difference of data rates of the two sources as

$\dot{y} = -\beta y I(x1+x2>c)$ (2-a)

So when x1 + x2≤ c, $\dot{y}$= 0, indicating that y does not change with time, and so(x1 −x2) remains a constant. However (1.1) implies that x1 and x2 increase steadilyunder this condition. So when(x1 +x2)≤ c, both x1 and x2 increase steadily at thesame rate while maintaining their difference constant. In the case when (x1+x2) ≥c,equation (2-a) indicates that y evolves to reduce the difference between x1 and x2and as t→∞,(x1 + x2)→ c and y = (x1 − x2) →0. Thus in the steady state, thenetwork attains the equilibrium where the link I fully utilized as (x1 + x2) → c and is equally shared by the two senders as (x1 − x2) → 0

The difference equation obtained from the original differential equation as follows:The original differential equation (1) is

$\dot{x}_i = \alpha I(x1 + x2 \leq c) - \beta x_i I(x1 + x2 \geq c)$ for $i \in \{1, 2\}$

The main step here is to replace the continous derivative by its discrete counter-part

$$dx/dt \approx \frac{\{x(t+\Delta t)-x(t)\}}{\Delta t} \quad (3)$$

In the difference quotient, replace x(t+Δt) by x (k+1), x(t) by x(k) and Δt by δ and then substitute and simplify to get

$x(k + 1) = x(k) + \alpha \delta I(x1 + x2 \leq c) - \beta \delta x(k) I(x1 + x2 > c)$ (4)

PROPOSED WORK

There are various congestion control algorithms like "Additive increase additive decrease"("AIAD"),"Multiplicative increase multiplicative decrease"("MIMD"), "Additive increase multiplicative decrease"("AIMD") in wsn,but it has the serious drawback of convergence to a point where there is unfair allocation to the multiple sources which causes:

- Un-Optimized use of link capacity
- More dropout of data packets
- Reduce efficiency of the network

To overcome the existing problem of AIMD, the main objective of this paper is to develop an NEED BASED AIMD (NBAIMD) algorithm which detect the congestion like AIMD and is likely to address the limitations of AIMD algorithm and will improve the following parameters:-

- Effective utilization of link capacity among multiple sources

- Reduce the dropouts of data packets
- Increase the efficiency of the network

Need Based AIMD Description:In AIMD nodes adapt their data sending rate only on the basis of their output data rate, in these algorithm there is no role of their input data receiving rate. In [3] node output data rate depends on the nodes input data rate

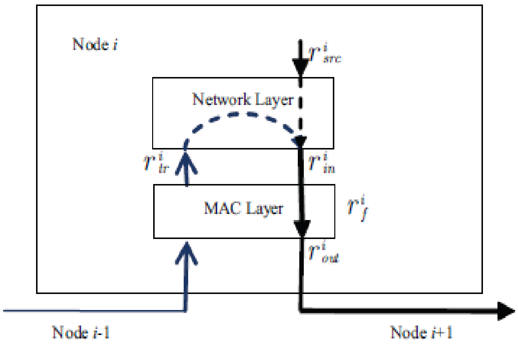

Figure2. The queuing model at a particular sensor node[5] described as:

Let i be the node in wsn . In Mac layer the transit traffic of node i is ritr which is received from its chid node such as i-1. Before forwarding the packet to it's next node i+1 both the transit traffic and source traffic converge at the network layer by the parent node of i. the total input traffic rate of node i at MAC layer is

$$r^i_{in} = r^i_{src} + r^i_{tr} \quad (5)$$

When this total input traffic rate rin greater than packet forwarding rate r^i_f packets could be queued atMAC layer.The packet output rate the node *i* is r^i_{out} which is forwards to its next node *i*+1. If r^i_{in} is smaller than r^i_f, then r^i_{out} is equals to r^i_{in}

If $r^i_{in} < r^i_f$

then, $r^i_{out} = r^i_{in}$

Otherwise, If r^i_{in} is greater than r^i_f,

then r^i_{out} will be close to r^i_f

i.e. If $r^i_{in} > r^i_f$

then, $r^i_{out} \neq r^i_{in}$,

But, r^i_{out} close to r^i_f

Therefore , we can say,

$$r^i_{out} = \min (r^i_{in}, r^i_f) \quad (6)$$

This shows that output data rate of node depends on the input receiving or input forwarding rate of the node. Let the ratio of the output data rate to the input data rate be R

$$R = r^i_{out} / r^i_{in} \quad (7)$$

In eqation 2.4 there is same α and β for both sources and more over they did not consider the input data rate which results in unfair reduction of the rate when congestion is detected for example whichever sources has more current output data rate its reduction in output data rate is also higher than the source which has lesser current output data rate irrespective of their inut data rate. let the two sources have their respective data rate ratio be R_1 and $R_2$and let there are two constants α_1 , α_2 and β_1, β_2.According to the AAIMD the current α and β of the the sources will be

If $R_1 \leq R_2$ then current α and β of the 1st source will be $\alpha = \min(\alpha_1 , \alpha_2)$

$\beta = \max (\beta_1, \beta_2)$

and current α and β of the 2nd source will be

$\alpha = \max(\alpha_1 , \alpha_2)$

$\beta = \min (\beta_1, \beta_2)$

Else

Vice–Versa

PERFORMANCE EVALUATION AND SIMULATION RESULTS

All the simulation are done on MATLAB,simulation results shows that Need Based AIMD (NBAIMD) give improved bandwidth utilization of the link.Figure 3&4 shows the link utilization of AIMD and NBAIMD respectively among two sources over time and NBAIMD clearly shows the effective utilization of the link bandwidth according to the different need of the two sources(users).Figure 5 and 6 shows the comparison of the AIMD and NBAIMD link utilization and bandwidth sharing respectively.

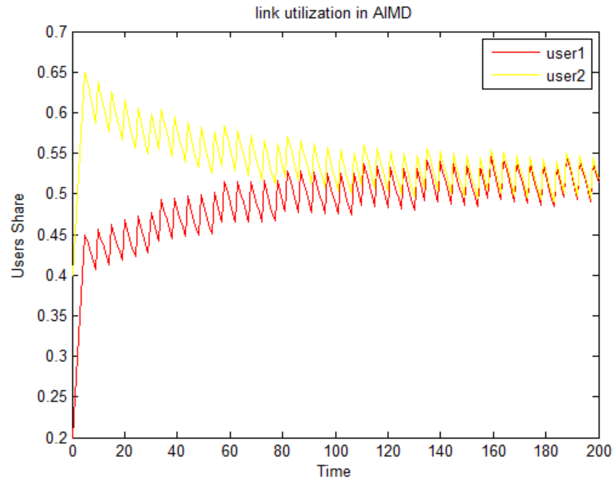

Figure 3 Link utilization in AIMD

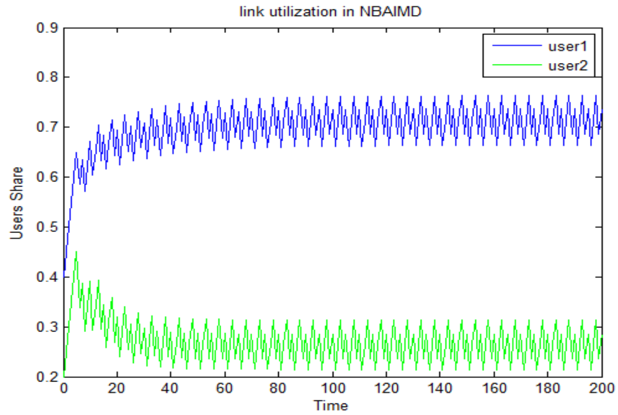

Figure 4 Link utilization in NBAIMD

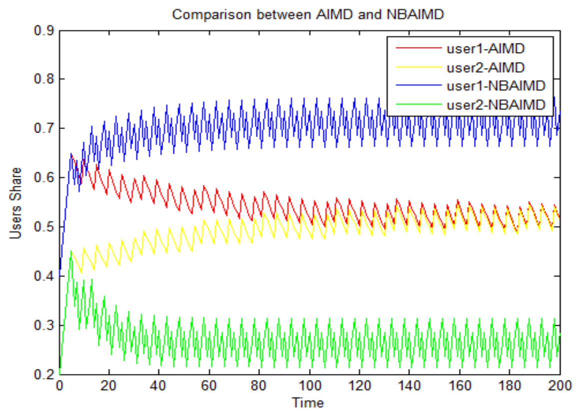

Figure5 Comparison of link utilization of AIMD and NBAIMD.

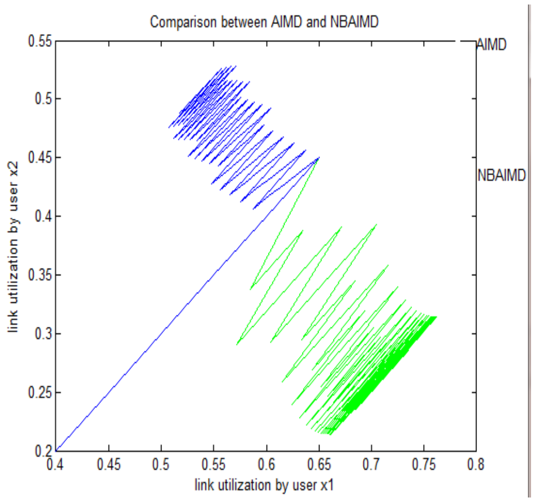

Figure6: Comparison of bandwidth sharing of AIMD and NBAIMD

CONCLUSION

In this paper, Need based Additive Increase Multiplicative decrease(NBAIMD) congestion control algorithm is developed, conventional Additive Increase Multiplicative decrease (AIMD) congestion control algorithm has the drawback of inefficient utilization of the link capacity in case of the multiple sources sharing the same link.It also results in more dropout of data packets during congestion of the link. Proposed NBAIMD algorithm adapts according to the need of the continuous changing data rate of the sources and use the link bandwidth according to the data rates of the sources. Simulation results shows that algorithm converges to a point depending on the input data rate of the sources which results in lesser dropout of the packets and greater utilization of the link capacity.

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