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Multicast Optimization Techniques using Best Effort Genetic Algorithms

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***Abstract*—**Multicast Network Technology has pervaded our lives-a few examples of the Networking Techniques and also for the improvement of various routing devices we use. As we know the Multicast Data is a technology offers many applications to the user such as high speed voice, high speed data services, which is presently dominated by the Normal networking and the cable system and digital subscriber line (DSL) technologies. Advantages of Multi cast Broadcast such as over other routing techniques. Usually QoS (Quality of Service) Guarantees are required in most of Multicast applications. The bandwidth-delay constrained optimization and we use a multi objective model and routing approach based on genetic algorithm that optimizes multiple QoS parameters simultaneously. The proposed approach is non-dominated routes and the performance with high efficiency of GA. Its betterment and high optimization has been verified. We have also introduced and correlate the result of multicast GA with the Broadband wireless to minimize the delay in the path.

***Keywords*—**GA (genetic Algorithms), Quality of Service, MOGA, Steiner Tree.

I. INTRODUCTION

A very popular technique “The Multi cast Touting” is a communication service that allows simultaneous transmission of the session, a network must minimizes the session’s resource consumption while meeting the quality of service (QoS) requirements. Multicast transmission of multi media data is a crucial service provided by the network layer ; in fact it allows the operator to spare the huge amount of network resources in any and many circumstances. The main and important problem when implementing multicast service is the design of the multi cast trees , which influences the quality and should take into account the network utilization. First works addressing this problem dealt with a single multicast session and focused on minimizing the transmission cost of the of each single tree [2]. The main goal of developing the mulyi cast routing algorithms is to minimize the communication resources used by the multicast session . This is achieved by minimizing the cost of multicast tree, which is the sum of the costs of the edges in the multi cast tree . The Least cost tree is known a s Steiner tree. Although having solved the Steiner Tree problem [3] effectively , some of them only consider one evaluation metric and can not be extended directly to solve the multicast routing problem with multiple QoS objectives or Constraints are combined to form a scalar single-objective function on and adhoc basis, usually through a linear combination of weighted sum by different requirements. The solution not only of GA recognizes that it can be modified to optimize multiple QoS requirements simultaneously by the Pareto Dominance in genetic operation [4].

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II. MODELING

The first goal is to minimize the cast factor in the multi cast routing methods. Mathematically speaking, an MOP minimizes (or maximizes , Since min {F(x)]= max [-F(X)}) the components of a vector from some universe Ώ. In general,

Minimize.F(x)= (F1(x) ,….,Fp (x)) (1)

Subject to g_i (x) <= 0, i =1,…., m.

An MOP then consists of n variables, m constraints, and p objectives (p >= 2) , of which some objective functions are non linear.

Example: A general MOP includes a set of n decision variables [1], k objectives functions and m restrictions. Objective functions and restrictions are functions of decision variables. This can be expressed as :

Optimize y = f(x) = (f1(x) f2(x)…..,fk(x)).

Subject to e(x)=(e1(x),e2(x),….,em(x)) >= 0,

Where x = (x1, x2, ….,xn) Є X is the decision vector, and y = (y1, y2,…yk) Є Y is the objective vector. Where X denotes the decision space while the objective space is denoted by Y. Depending upon the problem, at hand “optimize” could mean minimize or maximize. The set of restrictions e(x) >= 0 determines the set of objective vectors.

Conventional optimization techniques, such as gradient – based and simplex – based methods are difficult to extend to the multi objective case. The Multi objective genetic algorithms (MOGA) vary from the ordinary GAs about their selection operator. In order to represent an interesting set of the solutions, final solutions are produced by the by MOGAs [3] need to satisfy two conditions. First, they have to be good approximations of Pareto optimal solutions. Secondly, they are distributed on the Pareto front as uniformly as possible. The non dominated individuals from the population are identified to form the current Pareto optimal front. As a MOGA iterates each generation. Non dominated solutions are quickly proceed towards the global optimum, and get saturated at a near optimal set which approximates the Pareto front of an MOP.

III. Problem Formulation

The QoS parameters are simplified in the paper. For example, network cost can be certainly treated as one objective. But we believe it has been partly embodied in the established objectives and can be ignored to simply the model. If other requirements are included, they can be taken as some constraints of the three objectives in our MOGA.

A QoS multicast routing usually involves multiple constraints, such as delay, jitter, bandwidth , cost and packet loss ratio. The Multi cast route satisfies the three major objectives as said above, namely

1) Delay constraints
2) Packet Loss ratio and
3) Bandwidth utilization with one constraint on delay jitter.

Assume for Link L, there is a related packet Loss Ratio P(L), and a delay D(L) which includes queuing , transmission and propagation components. The delay value of the links at a route tree T. The jitter between any three multi cast destinations is the absolute value of the delay difference. D(d) denotes path delay whose destination node among T is d. Usually the three jitter bound requirements means maximum jitter bound in all inter – destination delay variations. The total residual bandwidth for T, is given by ∑ L€T (C (L)- B(L), where C(L) is the capacity of a link L € E and B (L) is the bandwidth utilization U (T) is the fraction of total bandwidth available, which is defined as follows:

$U(T) = (\sum_{L€T} (C (L)- B(L)) / \sum_{L€T} (C (L)$

The total packet loss ratio P (T) among T is calculated as below :

$$P(T) = 1- \prod_{L\in T} (1 - P(L))$$

According to the conditions mentioned, the mathematical model of multi objective optimization is designed by:

Minimize, F = (F1,F2,F3)

$$F1= \prod_{L\in T} D(L)$$

F2= P(T)

F3 = - U(T)

The simultaneous approach of two approaches of objective functions deviates from single object optimization in that the former seldom admits a single solution, but produces a set of alternative solution.

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IV. Multi Cast Routing Approach

GAs have been widely used to solve MOPs, as they are working on a population of solutions of solutions

For a =1 to A do
{ for each Vd €D do // D= Destination set , Vd = Destination,
Vs= Source
Randomly select a path from Vs to Vd as the jth segment of individual I;
}
for gen=1 to maxgen do // loop for all generations
{ Calculate the three sub objectives separately for individuals with the sum of similar individuals :
F1, F2, F3;
Sort the Pareto rank of individuals with their F1, F2, F3;
Calculate the density of individuals with the sum of similar individuals ;
Assign fitness to individuals ;
Perform crossover and mutation operations;
Obtain a new set of strings to produce the next population;
Gen = gen+1;
}
Select non dominated solutions from the maxgen;
For i=1 to M do // M = size of pareto optimal set
{ T= decode(Ii);
// individual Ii € Pareto optimal set, T is multi cast tree constructed from Ii
}

V. Route Selection

At the generation, e.g 100 , the pareto optimal solutions are found and represent the evolutionary result from a run of MOGA . How to select an appropriate solution as a multi cast route depends on the demand of a user. The user may prefer a sub-objective if he is more careful about it.

VI. Performance Evaluation

A. Delay Analysis

The Delay is the time spent until a bandwidth request message successfully transmits.

Delay = Number of retransmission X Frame size[6]To obtain the delay , we need to find the number of retransmission[5]. We derive the number of retransmission as follows:

The probability that one bandwidth request message is uniformly distributed during a frame. The probability that the other bandwidth request messages are not transmitted during that slot is given by.

$P_{another\ slots} = (1-1/F)^{(N-1),}$

So, the probability of successful transmitting a bandwidth request message during a slot (Psuc, 1) is given by:

$P_{suc} = 1/F \times (1- 1/F)^{(N-1)}$,

Since, the frame size is F(slots) , the probability of successfully transmitting a bandwidth request message during a frame (Psuc) is:

$P_{suc} = 1/F \times (1- 1/F)^{(N-1)} \times F$,
$= (1- 1/F)^{(N-1)}$

The probability of unsuccessfully transmitting a particular bandwidth message during a frame is given by:

$P_{col} = 1- (1- 1/F)^{(N-1)}$

Let Psuc (k) be the probability of the successfully transmitting a request message in kth frame.

Using geometric distribution , P suc(k) can be derived as:

$Psuc(k) = (1 - Pcol) X Pcol(k-1)$,

$= (1-1+(1-1/F)^{(N-1)} X (1-(1-1/F)^{(N-1)})^{(k-1)}$,

$=(1-1/F)^{(M-1)} X (1-(1-1/F)^{(M-1)})^{(k-1)}$

The average number of retransmission for a bandwidth request message is:

$E[X=k]= x^{(N-1)}. [1-(1-x^{(N-1)}]^{-2}$,

$= x^{(N-1)}. [1-1+x^{(N-1)}]^{-2}$,

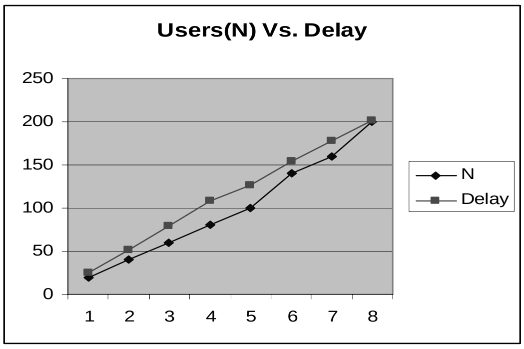
$= x^{(N-1)}. [x^{(N-1)}]^{-2}$,

$=[x^{(N-1)}]^{-1}$,

$=1/x^{(N-1)}$

Now replace x by 1- 1/F, we obtain:

$E[X= K] = 1/(1-1/F)^{N-1}$



B. Optimal size of the Contention Period

Since the throughput and delay are trade-off each other, we define the cost function in order to optimize the size of the contention period using the throughput and delay. Let us denote that the cost function equals θ (N,F), then it can be defined as:

θ (N,F) = Throughput / Delay

Also,

2N-1-F=0 or F-1=0

F-1=0 , implies F=1, i.e., not appropriate for N users

So,

2N – 1 –F=0, implies F = 2N-1

Hence the optimal size of the contention period is 2N-1.

VII. Conclusion and Future Work

We propose a multi objective model and multicast routing approach based on genetic algorithm where and when the population increases, the delay decreases because of the reduction of the average number of the collided request message. As we have tried to minimize the delay constraint .On the other hand, the delay is affected by the size of the contention period more than it is affected by the size of the by the collision probability of the Bandwidth request messages. We have presented an efficient Quality of service scheduling architecture . The main purpose of the architecture is to provide tight QoS guarantees to various applications and to maintain fairness among them while still achieving high bandwidth utilization. For example Our architecture supports diverse QoS requirements of all four kinds of service flows specified in IEEE wireless standards. We analyzed statistically throughput and delay.

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