# Performance and comparative analysis of different QOS parameters in ATM networks

[1]J. Padma, [2]Dr.M. Sailaja
[1]Ph.D. Scholar, [2]Professor
JNTUK

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*Abstract* - **The increasing importance of telecommunications for applications leads to requirement for a high bandwidth network such as ATM. Using ATM, it can be flexibly reconfigure the network and re-assign the bandwidth to meet the requirements of all types of services. Hence bandwidth optimization is a critical task for ATM. Bandwidth optimization is required to install a minimum net present cost network that satisfies the customer demand criteria. The design of ATM networks entail optimization of the network. This paper presents particle swarm optimization algorithm (PSO) to optimize the bandwidth allocation and QOS in ATM networks. The algorithm is simulated using NS-2 tool. The performance results are compared with Genetic algorithm.PSO algorithm based control of network has better bandwidth utilization, packet loss and average cell delay and success rate.**

*keywords* - **Particle Swarm Optimization Algorithm, Bandwidth Allocation, Genetic Algorithm, ATM Networks, QoS Performance.**

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## 1. Introduction

Asynchronous transfer mode (ATM) networks are playing major role in the current communication networks panorama for implementing broadband integrated service digital network (B-ISDN).This ATM networks having capability to provide high bandwidth and to handle multiple quality of service requirements can only be realised by effective bandwidth management strategies. The main key factor of ATM network is to provide the flexible and reliable bandwidth allocation. The statistical bandwidth permits the network resources based on demand, maintains traffic isolation and nominal resource allocation. In ATM networks, the bandwidth allocation problem is based on traffic characteristics, service categories and QoS requirements. The different methods are proposed for dynamic bandwidth allocation are generally considered factors are buffer management, cell level control, congestion, assignment in link capacity and dynamic routing. Dynamic bandwidth allocation chooses a way towards the improving the throughput and enhance the QoS performance.

## II. Related work

The increasing complexity of the ATM network design problems requires for advanced optimization techniques. Network design problems where even a single cost function is optimized are optimized [1]. Practically communication network design problems are not time critical. Therefore approaches have been designed to deal with such kind of problems based in meta-heuristics like simulated annealing, tabu search, evolutionary computing, nature inspired algorithms or combination [2][3]. Concerning evolutionary computing in telecommunication network design, a comprehensive study is presented in [4] containing relevant research study references, where network design problems are classified in node location problems, topology design, tree design, routing, restoration, network dimensioning, admission control and frequency assignment/wavelength allocation. The optimization techniques employed are mainly variations of Genetic Algorithms. Additional work on telecommunication network optimization has followed in the last three years. The topological design of communication networks is usually a multi-objective problem involving simultaneous optimization of the cost concerning network deployment as well as various performance criteria (e.g. average delay, throughput) subject to additional constraints (e.g.reliability, bandwidth). These problem specific objectives are often opposing; for example a way to reduce average delay in the network is over provisioning; that is to increase available link capacities which will consequently result in the increase of the total network deployment cost for planning of ATM network there are two key factors are considered. One, the network should meet the end-users needs as far as nature of QoS and cost. Two, for the network operator it ought to be as practical as conceivable to introduce and keep up the network. The second goal has customarily been analyzed as lessening the first introduced expense of the network. Limiting the all out expense is for the most part a matter of finding shortest paths between the ATM nodes, as in introducing another system the greater part of the money is spent on burrowing the link channels. In this paper we will use Particle Swarm Optimization algorithm for the Topological Network Design problem, including bandwidth allocation, average cell delay, packet loss considering shortest path routing. Therefore the objective is to design optimal network which must limit cost of infrastructure, including decisions concerning the locations and sizes of links.

## III. PARTICLE SWARM OPTIMIZATION (PSO) ALGORITHM

Particle Swarm Optimization (PSO) algorithm was an intelligent technology first presented in 1995 by Eberhart and Kennedy, and it was developed under the inspiration of behaviour laws of bird flocks, fish schools and human communities [5].In PSO, a solution can be represented as a particles and the population of the solution is a swarm of particles. Every particle having two main properties such as position and velocity. Each particle is moving towards the new position using velocity. Based on new position. The position of swarm and the position of each particle are updated as per requirement. The velocity of each particle is then adjusted based on the experiences of the particle. The process is repeated until a stopping criterion is reached.

**Comparison to genetic algorithm: Similar** to GA, the PSO algorithm is also begins with group of randomly generated population and utilize fitness values to evaluate the population [6]. This is useful for updating population and searching for optimal solution with random technique. In PSO. Particles update themselves with the internal velocity and a memory also. In PSO only the best particle gives out the information to others. The various steps involved in proposed PSO algorithm is mentioned in figure1.

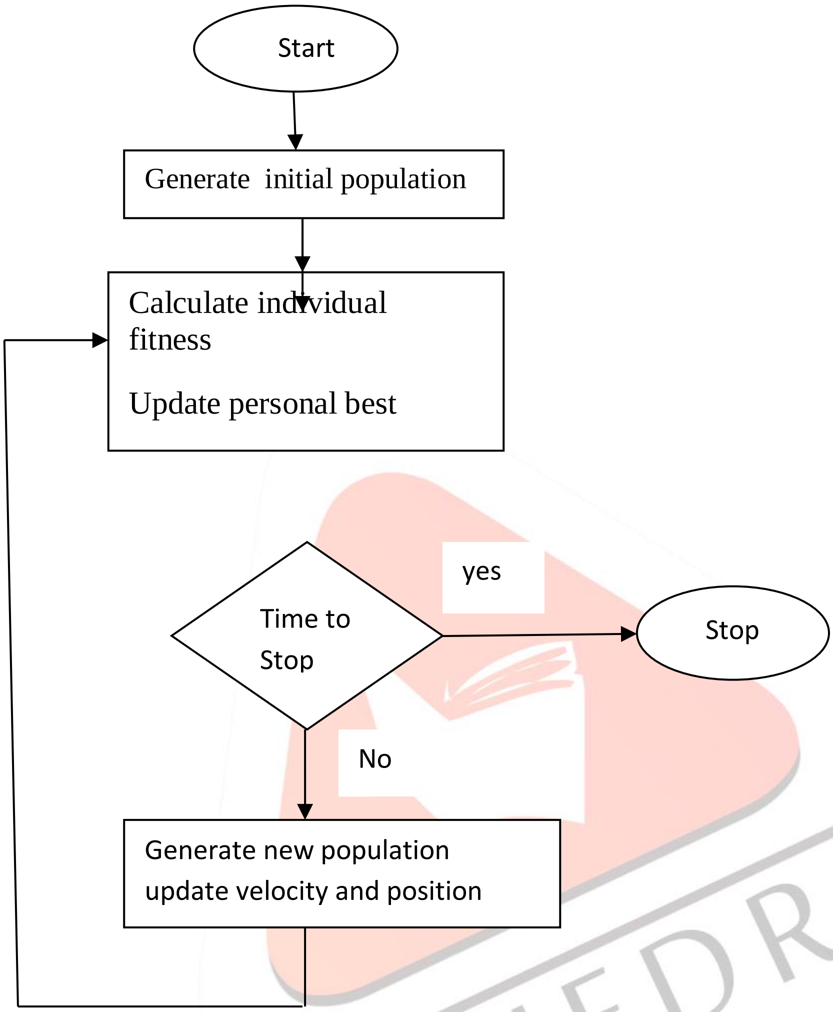


**Figure1 : Proposed PSO algorithm flowchart**

**IV. Network model and constrains**

A network is represented as a directed graph G(V, E) , where V represents the set of routers (nodes) and E represents the set of links (arcs). For any link $e \in E, e = (V_i, V_j), V_i \in V, V_j \in V, i \neq j$ .in this paper, parameters ( delay(e) , bandwidth(e) , cos t(e) ) to represent the best path, p(s,d) is a path which from the source node s (s∈V ) to the target node, T(s,M) is the ATM network , M ⊆ {V −{s}} is node-sets. Have the following relationship:

$$delay(p(s,d) = \sum_{e\in p(s,d)} delay(e) + \sum_{n\in T(s,M)} delay(n) \quad (1)$$

$$band(p(s,d)) = \min(band(e)) \quad (2)$$

$$Pktloss(p(s,d)) = 1 - \prod_{n\in T(s,M)} 1 - \text{pktloss(n)} \quad (3)$$

$$cost(T(s,M) = \sum_{e\in p(s,d)} cost(e) + \sum_{n\in T(s,M)} cost(n) \quad (4)$$

In fact, we choose the node T(s,M) satisfy the following constraints

$$band(p(s,d)) \leq B \text{ where } B \text{ is } MinBandwidth$$

$$delay(p(s,d)) \leq D \text{ where } D \text{ is } Max\ delay$$

$$pktloss(p(s,d)) \leq L \text{ where } L \text{ is } Max\ pktloss$$

and make $cost(T(s,M)$ the smallest.

**V. Proposed methodology**

Standard PSO uses the concept of groups and fitness, according to the fitness to move to a good area, the individual as particles of no volume in D-dimensional space. Particles in accordance with its own flying experience and peer dynamically adjust its speed. The particle i is expressed as $X_i = (X_{i1}, X_{i2}, \dots X_{id})$ , the speed of particle i is $V_i = (V_{i1}, V_{i2}, \dots XV_{id})$ , i have experienced the best position is called the individual best position $P_i = (P_{i1}, P_{i2}, \dots P_{id})$, the particle swarm search for the optimal position to date is called the global best position $P_g = \left(P_{g1}, P_{g2}, \dots P_{gd}\right)$.For each generation, d - dimensional (1≤ d ≤ D) based on the following equation changes:

$$P_{id}^{k+1} = \begin{cases} P_{id}^{k}\, f\left(X_{id}^{k+1}\right) \geq f * p_{id}^{k}) \\ X_{id}^{k+1} f\left(X_{id}^{k+1}\right) \prec f * p_{id}^{k}) \end{cases} \text{--1}$$

$$V_{id}^{k+1} = \alpha V_{id}^{k} + c_1 * rand() * \left(P_{id}^{k} - X_{id}^{k}\right) + c_2 * rand() * \left(P_{gd}^{k} - X_{id}^{k}\right)\text{---2}$$

$$X_{id}^{k+1} = X_{id}^{k} + V_{id}^{k+1} \text{ ---3}$$

Where k is the iteration number, $\alpha$ is inertia weight, $c_1$ and $c_2$ are the acceleration constants, rand is a random number between −1 and 1. Particles search in a larger space at the beginning, but for the latter part of the particle to the local minimum or global minimum convergence, best p , best g , and i V will tend to the same point, and each particle velocity tends to 0. In order to overcome this phenomenon, the literature presents a good improvement. When $\alpha$ = 0 in equation (2) (3), the particle speed depends only on the particle's current location, history, the best location and the history of particle swarm best position, speed has no memory. In this way, the overall situation in the best position for the particles will remain stationary, while the other particles will tend to best position and global best position. Evolution equation into:

$$X_{id}^{k+1} = X_{id}^{k} + c_1 * rand() * \left(P_{id}^{k} - X_{id}^{k}\right) + c_2 * rand() * \left(P_{gd}^{k} - X_{id}^{k}\right)\text{---4}$$

Compared with the standard PSO algorithm, equation (4) describing make the global search capability weakened, while the local search capacity strengthening. When $X_{jd}^{k} = P_{id}^{k} = P_{gd}^{k}$ , the j particle will stop evolution. In order to improve on the global search capability, we retained the individual best position, re-location of randomly generated particles j in the search space S , and other particles evolved follow equation (4). Then

$$P_{id}^{k} = \begin{cases} P_{id}^{k} & f\left(X_{id}^{k+1}\right) \succ f(p_{id}^{k}) \\ X_{id}^{k+1} & f\left(X_{id}^{k+1}\right) \leq f(p_{id}^{k}) \end{cases}$$

$$P_{gd}^{k} = \min\{f\left(P_{gd}^{k}\right)\} \text{---5}$$

$$P_{gd}^{k} = \min\{f\left(P_{gd}^{k'}\right), f\left(P_{gd}^{k}\right)\}$$

If $P_{gd}^{k}$ = $P_{jd}^{k}$, the particle j in the best historical position, not evolution by equation (4), continue randomly generated the search space S , other particles evolution by equation (4) after $P_{gd}^{k}$ , $P_{jd}^{k}$ update. If $P_{gd}^{k} \neq P_{jd}^{k}$, and $P_{jd}^{k}$ did not update, then all the particles accordingk equation (4)evolution; If $P_{jd}^{k}$ has been updated, thus existence m ≠ j making $X_{md}^{k+1} = P_{md}^{k} = P_{gd}^{k}$ , then the particle m stop evolution, randomly generated the search space S , other particles evolution by equation (4) after $P_{gd}^{k}$ , $P_{id}^{k}$ P update. So at least one particle j to satisfy $X_{jd}^{k+1} = P_{md}^{k} = P_{gd}^{k}$ , enhanced the global search ability.

$$F(p) = \frac{1}{cost(T(s,M))}\{\partial(delay(p(s,d)) - D)) + (\partial band(p(s,d)) - B)) + (\partial(pktloss(p(s,d)) - L))\}$$

$$\partial(Z) = \begin{cases} 1 & Z \leq 0 \\ r & Z \succ 0 \end{cases}$$

Where $\partial(Z)$the penalty function, r is is the degree of punishment.

**VI. Design steps of PSO**

**Step1:** Initialization, enter the parameters, set the system parameters ( C1 , c2 , the largest number of iterations and the TS parameters), set an empty table.

**Step2:** Under meeting the parameters constraint condition, form the initial particle swarm.

**Step3:** Set the current location of each particle is optimal solution, taking the minimum value of which corresponds to the solution of the current optimal solution, and set it to taken objects, add to table.

**Step4:** Iterative optimization by equation (4) (5), calculate the corresponding fitness value according to equation (6).

**Step5:** For each particle, compare the current fitness value and individual optimal solution, if the current fitness and better, update. Calculated optimal solution of each individual particle, then find the global optimal solution, update the fitness function value.

**Step6:** Compare the two fitness function value, if fitness value of optimal solution which after change less, update the current optimal solution, add to taboo table. Return to Step4. If fitness value of current optimal which solution less, continue.

**Step7:** Determine whether the global convergence or reach the maximum number of iterations; if the termination conditions are met, output; otherwise, repeat Step3.

**VII. Results**

The PSO algorithm is applied to the network model considered. For ATM network designing different qos parameters such as bandwidth allocation, average delay, and packet loss are considered and analyzed using proposed algorithm. Based on those parameters success rate and percentage improvement factor are calculated. The performance analysis of pso algorithm is implemented using ns-2 simulator. The results presented in this section are obtained from simulator on the network considered.ATM is connection oriented; it is requirement to establish a connection in each direction for every node pair. The performance comparison of bandwidth allocation for paths is given in table. Here four possible paths are analysed separately using both algorithms and the amount of bandwidth allocation, delay, path loss and success rate are tabulated. The requested bandwidth is distributed among the paths according to the respective algorithms. In this paper consider model, node '0' is the source and node '17' is destination. For the shortest path the maximum bandwidth allocation is done through PSO algorithm.

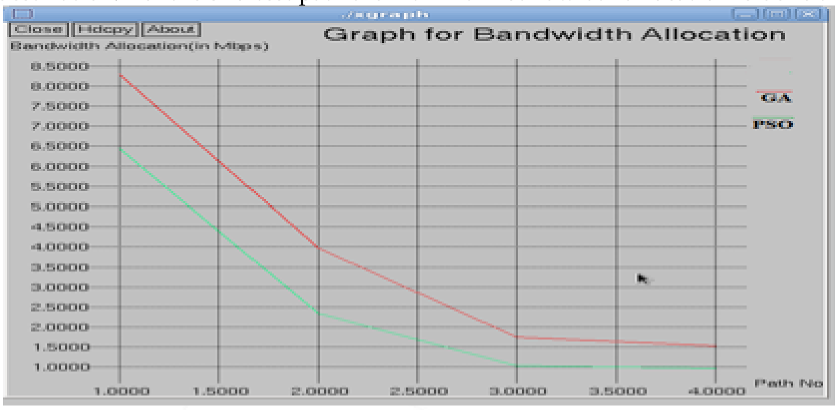


**Figure2: Graph for bandwidth allocation**

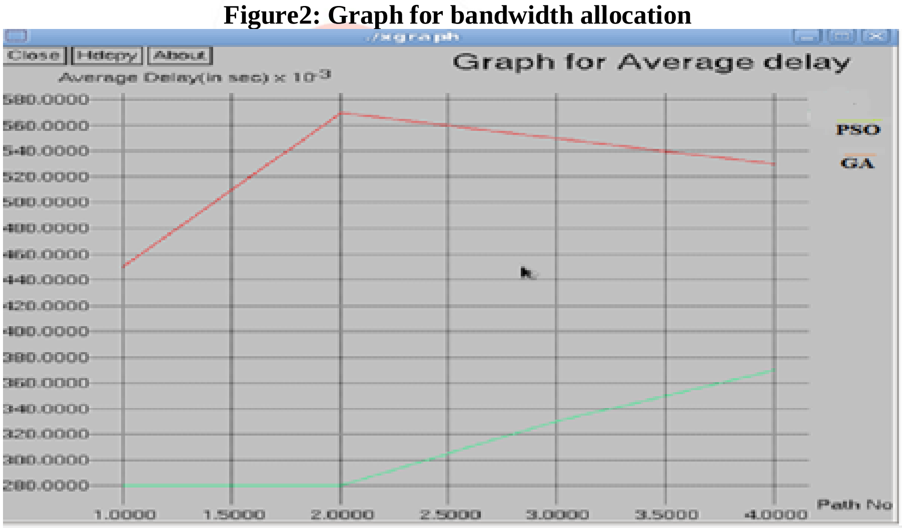


**Figure3: Graph for average delay**

Success rate is computed as the difference between requested bandwidth and allocated bandwidth. The success rate of PSO algorithm is better compared to GA.

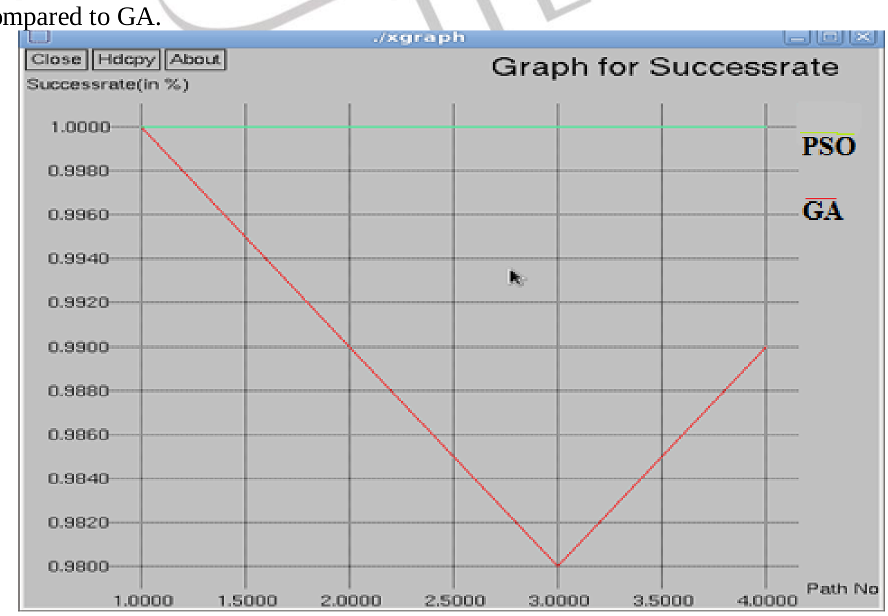


**Figure4: Graph for success rate**

**Table 1: comparative analysis between GA and PSO**

| Path no | Bandwidth Allocation | | Delay | | Success rate | |
|---|---|---|---|---|---|---|
| | GA | PSO | GA | PSO | GA | PSO |
| **Path1** | 8.3 | 6.45 | 0.45 | 0.28 | 1.0 | 1.0 |
| **Path2** | 3.98 | 2.34 | 0.57 | 0.28 | 0.99 | 1.0 |
| **Path3** | 1.76 | 1.04 | 0.55 | 0.33 | 0.98 | 1.0 |
| **Path4** | 1.53 | 0.97 | 0.53 | 0.37 | 0.99 | 1.0 |

**Conclusion**

In this paper discussed different types of parameters such as bandwidth allocation, delay, and success rate are determined using PSO algorithm and also analyzed results with genetic algorithm. This analysis is useful for achieving bandwidth optimization and QOS in ATM networks.

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