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MULTI-CONSTRAINED OPTIMAL PATH SELECTION BASED ON APPROXIMATION ALGORITHMS

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Abstract—computing constrained shortest paths is fundamental to some important network functions such as QoS routing, MPLS path selection, ATM circuit routing, and traffic engineering. The problem is to find the cheapest path that satisfies certain constraints. In particular, finding the cheapest delay-constrained path is critical for real-time data flows such as voice/video calls. Because it is NP-complete, much research has been designing heuristic algorithms that solve the -approximation of the problem with an adjustable accuracy. A common approach is to discretize (i.e., scale and round) the link delay or link cost, which transforms the original problem to a simpler one solvable in polynomial time. The efficiency of the algorithms directly relates to the magnitude of the errors introduced during discretization. In this paper, we propose two techniques that reduce the discretization errors, which allow faster algorithms to be designed. Reducing the overhead of computing constrained shortest paths is practically important for the successful design of a high-throughput QoS router, which is limited at both processing power and memory space. Our simulations show that the new algorithms reduce the execution time by an order of magnitude on power-law topologies with 1000 nodes. The reduction in memory space is similar.

1. INTRODUCTION

Constrained Shortest Path First (CSPF) is an extension of shortest path algorithms. The path computed using CSPF is a shortest path fulfilling a set of constraints. It simply means that it runs shortest path algorithm after pruning those links that violate a given set of constraints. A constraint could be minimum bandwidth required per link (also know as bandwidth guaranteed constraint), end-to-end delay, maximum number of link traversed, include/exclude nodes. [1-5]

The randomized discretization cancels out the link errors along a path. The larger the topology, the greater the error reduction. The path delay discretization works on the path delays instead of the individual link delays, which eliminates the problem of error accumulation. Based on these techniques, design fast algorithms to solve the -approximation of the constrained shortest-path problem. We prove the correctness and complexities of the algorithms. [6-10]

2. PROPOSED SYSTEMS

The delay-constrained least-cost routing problem (DCLC) is to find the cheapest feasible paths from s to all nodes in Vs, which is NP-complete [11]. However, if the link delays are all integers and the delay requirement is bounded by an integer λ, the problem can be solved in time $0((m + n\log n)\Lambda)$ by Joksch's dynamic programming algorithm [12] or the extended Dijkstra's algorithm [13-15].

There are two existing discretization approaches.

1. Round to Ceiling
2. Round to Floor

Round to ceiling (RTC): For every link, the delay value is divided by r/λ. If the result is not an integer, it is rounded to the nearest larger integer.

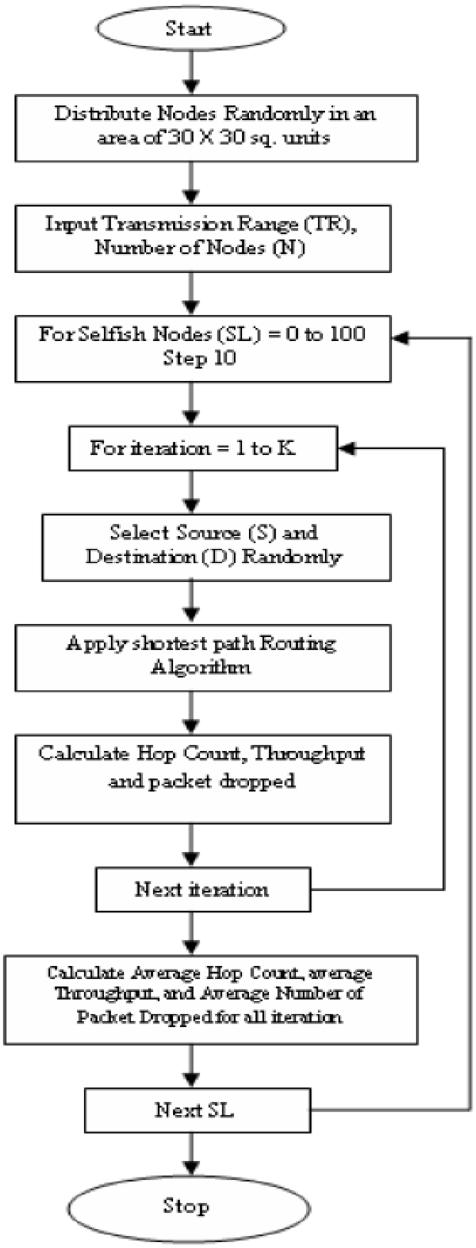

Fig 1 Proposed System

Round to floor (RTF): For every link, the delay value is divided by r/λ. If the result is not an integer, it is rounded to the nearest smaller integer.

$$d^f(u,v) = \left\lfloor \frac{d(u,v)}{r}\lambda \right\rfloor$$

The value of λ controls the rounding error (up to) introduced by discretization. With a larger λ, the rounding error accounts for a smaller portion of the link delay. When λ is large enough and thus the discretization error is small enough, we can approximate the DCLC problem by a new problem with integer delays after discretization. The solution to the new problem will serve as the solution of the original problem. However the computation overhead is directly related to λ.

After discretizing the link delays by RTC or RTF, either Joksch's algorithm or the extended Dijkstra's algorithm can solve the -approximation of DCLC, which is to find a path for every node , t ε Vs, such that

$$d(P) \le (1+\varepsilon)r$$
$$c(P) \le c(P_{s,t})$$

Where ε is a small percentage. The delay of the path is allowed to exceed the requirement by a percentage of no more than ε, while the cost should be no more than that of the cheapest feasible path ps, t. Using RTF, the delay scaling algorithm (DSA) proposed by Goel et al. achieves the best time complexity O ((m+nlogn) L/ε among all existing algorithms.

The discretization error of a path P is defined as

$$\Delta^c(P) = \sum_{(u,v)\ \text{on}\ P} \Delta^c(u,v)$$

$$\Delta^f(P) = \sum_{(u,v)\ \text{on}\ P} \Delta^f(u,v)$$

The two proposed scheme is used.

1) Randomized Discretization Algorithm

2) Path Delay Discretization Algorithm

Randomized Discretization:

RTC creates negative rounding errors on links. The error accumulates along a path. The accumulated error is proportional to the path length. The larger the topology, the longer a path, the larger the accumulated error. The same thing is true for RTF, which has positive rounding errors on links. In order to achieve ε-approximation, the accumulated error on a path cannot be too large. To reduce the error on a path, the existing algorithms based on RTC or RTF must reduce the discretization errors on the links by using a large λ value. Given the time complexity 0((m +n log n) λ), the computation time is increased in proportion to λ.

The insight is that if we can reduce the error introduced by discretization without using a larger λ, we can improve the performance of the algorithm. We develop two new techniques. The first one is called randomized discretization. It rounds to ceiling or to floor according to certain probabilities. The idea is for some links to have positive errors and some links to have negative errors.Positive errors and negative errors cancel out one another along a path in such a way that the accumulated error is minimized statistically. We will prove that, when the following discretization approach is used, the mean of the accumulated error on a path P is zero and the standard deviation is bounded by.

$$r\sqrt{l(P)}/2\lambda.$$

Round randomly (RR): For every link (u, v) the delay value is divided by r /λ. If the result is not an integer, it is rounded to the nearest smaller integer or to the nearest larger integer randomly such that the mean error is zero.

The discretized delay of a path P is

$$d^r(P) = \sum_{(u,v)\in P} d^r(u,v)$$

The discretization error of a link (u, v) is

$$\Delta^r(u,v) = d(u,v) - d^r(u,v)\frac{r}{\lambda}$$

The discretization error of a link is path is

$$\Delta^r(P) = \sum_{(u,v)\ \text{on}\ P} \Delta^r(u,v) = d(P) - d^r(P)\frac{r}{\lambda}$$

We design the randomized discretization algorithm (RDA), which is based on Dijkstra's algorithm but considers two additive metrics, delay and cost. It uses RR to discretize the link delays. We will prove that it solves the ε - approximation of DCLC.

Path Delay Discretization:

Each unit of discretized delay represents the amount r/λ of real delay. Due to rounding, each time discretization is performed, a discretization error up to r/λ is introduced between the discretized delay and the real delay. The maximum discretization error of a path is determined by the number of times that discretization is performed on the path. RTF, RTC, and RR perform discretization at the link level. Because discretization is carried out on each link, the maximum error on the path is linear to the path length. In order to achieve ε-approximation, the accumulated error on a path cannot be too large. There are two ways to reduce the error. One is to use a larger, which increases the execution time of an algorithm whose complexity is linear to λ. The other way is to reduce the number of discretizations performed on the path.

Our second technique to control error is to perform discretization on the path level, using the interval partitioning method for combinatorial approximation. For a path P, ideally, discretization is performed once as follows.

$$d'(P) = \left\lfloor \frac{d(P)}{r}\lambda \right\rfloor$$

Because only one discretization is performed, the maximum discretization error on any path is bounded by r/λ, independent of the path length. We design the path discretization algorithm (PDA) based on the above intuition. The algorithm solves the ε–approximation with the same worst-case complexity as RDA. However, its average execution time is better than RDA according to our simulations.

3. PERFORMANCE ANALYSIS

Creation of Nodes

Creation of node to transferring the data from one node to another node in this totally 64 nodes are used in this fig 1

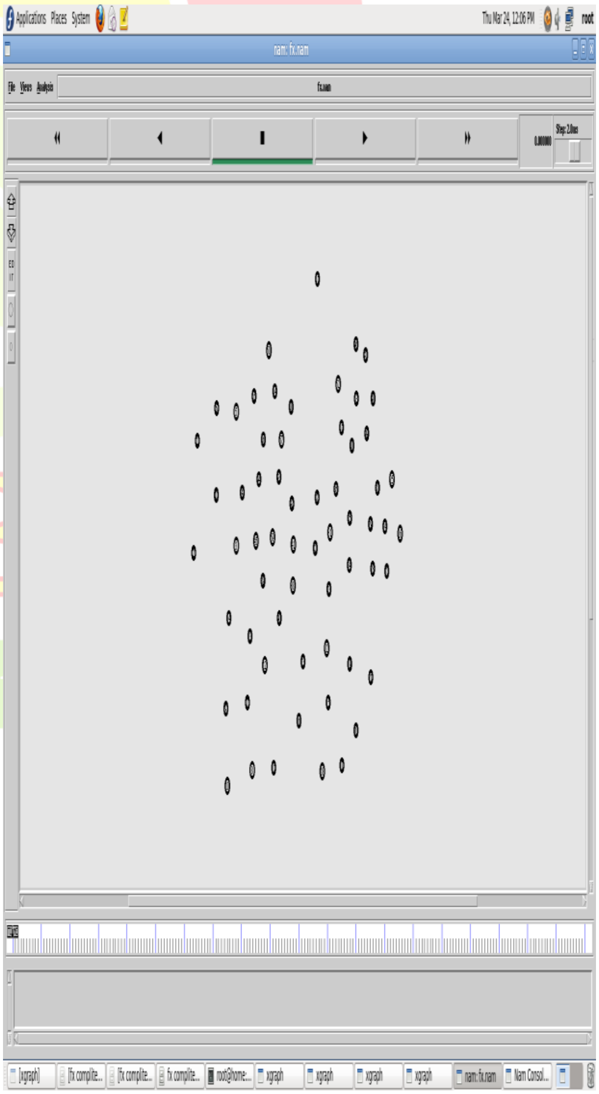

Fig 2 Creation of nodes

Creating the Cluster Head

In this fig 2 the cluster node source node and destination node will be identified according to that the data will be transmitted from source to destination by cluster information cluster node is group controller source and destination is used to communicate between other nodes.

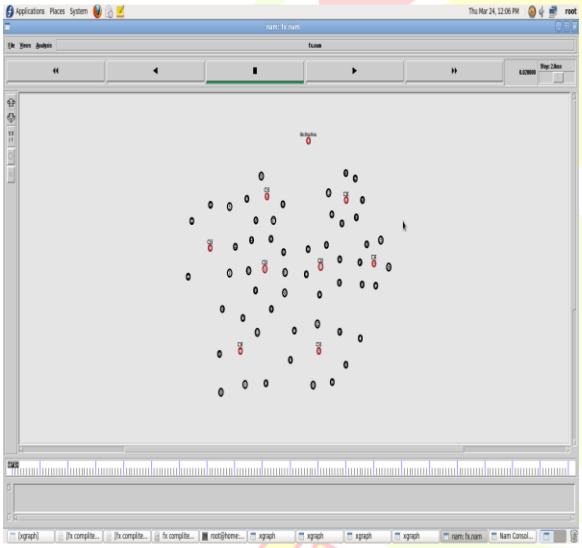

Fig-3 Creating the cluster Head

Collaborative Contact of Nodes

Green and Red color is shown in fig 4 In green color used to know the acknowledgement and red color is used to find the whether the node is active or not.

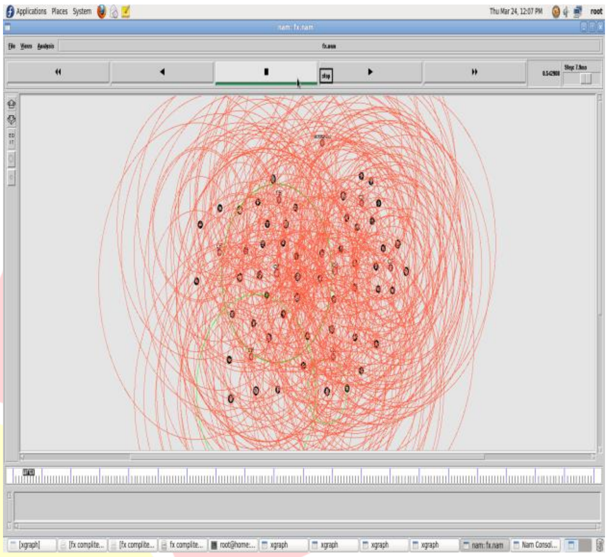

Fig-4 Collaborative Contact of nodes

GRAPHICAL REPRESENTATIONS

Throughput

In the above graph 5.11 shown the difference of throughput and time. The red color line will be indicates the proposed system and green color line will be indicates the existing system.

Table 1 Throughput

S.No	Existing System		Proposed System	
	Time	Energy	Time	Energy
1	0.0000	0.0000	0.0000	0.0000
2	10.0000	0.1800	10.0000	0.5000
3	20.0000	0.6200	20.0000	0.8000
4	30.0000	0.7800	30.0000	1.0000
5	40.0000	0.8100	40.0000	1.2600

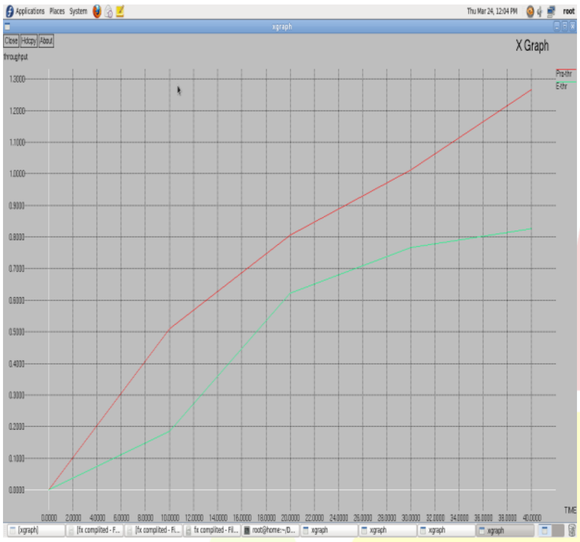

Fig-5 Throughput Graph

4. CONCLUSION

In this paper, we proposed two techniques, randomized discretization and path delay discretization, to design fast algorithms for computing constrained shortest paths. While the previous approaches (RTF and RTC) build up the discretization error along a path, the new techniques either make the link errors to cancel out each other along the path or treat the path delay as a whole for discretization, which results in much smaller errors. The algorithms based on these techniques run much faster than the best existing algorithm that solves the ε-approximation of DCLC

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