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Efficient Resource Allocation for Relay Nodes Using Overlay Routing

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Abstract: **Overlay routing is a very attractive scheme that allows improving certain properties the routing such as delay or TCP throughput without the need to change the values of current underlay routing. Deploying overlay routing requires the placement and maintenance of the overlay infrastructure. This rises following the optimization problem. Find the minimal set of overlay nodes that the required properties of routing satisfied. In this paper, I study this optimization problem. Showing this is NP-hard and deriving non trivial approximation algorithm for it. I examine the practical aspects of the scheme by evaluating the gain one can get over several real scenarios. The first one is BGP routing and show that , using the up-to-date data reflecting on the current BGP routing policy in the internet, that a relative small number of less than 100 relay server is sufficient to enable the routing over the shortest path from a single source to all autonomous systems, reducing the average path length. Second one is very useful for the TCP performance improvement. And third one is voice-over-IP applications where the small number of overlay nodes can significantly reduce the maximal peer-to-peer delay.**

Keywords: **Resource allocation, overlay network**

I. INTRODUCTION

Overlay routing has been proposed in recent years as an effective way to achieve routing properties without go to long and tedious process standardization, deployment of new routing protocol and without changing standard values of underlay routing. Overlay routing was used to improve TCP performance over the internet, here braking the end-to-end feedback loop into smaller loop. Overlay routing is built on top of the existing layer. It is used to improve reliability, and also reduce latency in BGP routing. Here concentrating on this point and study the minimum number of underbuilding nodes that need to be added to improve routing properties. In this paper improving the routing properties between a single source and a single destination then the problem is not complicated and finding the optimal numbers of nodes become trivial since the potential candidate for the overlay placement is small. When consider one-to-many or many-to-many, then a single a single overlay node may affect the path property of many paths, and choosing the best locations much less trivial. We test our general algorithm in three specific such cases, where we have a large set of source-destination pairs , and to find a minimal set of locations , such that using overlay nodes in these locations allows to create routs such that a certain routing property is satisfied.

II. LITERATURE SURVEY

Overlay routing is used to improve network performance encouraged by many works that studied the effectiveness of varieties of networking architectures and applications. Analyzing the large set of data, Savage et.al. Research the question: How good internet routing from the user’s view considering round-trip time, packet loss rate, and bandwidth? In [7] and [1] TCP performance is strictly affected by RTT. Hence, breaking TCP connection in to low latency sub-connection improves connection performance. In [5], [8], [9] routing paths in the internet are inflate, and real length of routing between clients is longer than minimum hop distance between them.

Overlay routing is used to improve routing and network performance. In [3] routing effectiveness in the internet and the overlay routing s also used to evaluate and study experimental techniques to improve the network over the rea environment. In [2] Resilient overlay network, application layer overlay routing to be used on top of the existing internet routing. This focuses on the overlay infrastructure and it does not consider cost associated with system. In [10], study the relay placement problem, where k relay nodes should be placed in intra-domain network. In [11], introduce routing strategy in which replacement of shortest path routing, that routes traffic to destination and avoid the network congestion under traffic variability.

III. EXISTING SYSTEM

In exiting system, the system is using overlay network only to improve the network performance. It is motivated by the many works that studied that lack of effectiveness of varieties of networking architecture and applications. In existing system analyzed an alternate rooting path with greater quality compared to the default routing path. In present system and later in exiting system studied that TCP performance is strictly affected by round trip time (RTT). Hence breaking TCP connection into low latency sub- connection improves the overall complete connection performance. In exiting system, show that in many cases the routing path in the internet inflated and the real length of routing paths between clients is longer than the minimum hop distance between them. Using overlay routing to improve the routing and also improve the network performance has been studied in several work.

A. Model and Problem Definition:

Given graph G = (V,E) describing a network, let Pu be the set of underlay routing paths and let Po be the set of overlay routing paths. Note that both Pu and Po can be defined explicitly as the set of paths or implicitly, e.g.as the set of shortest path with respect to a weight function W:E=R over the edges .Given pair of vertices s, t £ V, denote by Po^ s ,t the set of overlay path between the s and t. Given instance of the overlay routing resource allocation problem, and non-negative weight function W: V→ R over the vertices, one need to find a set Uopt V such that: 1) Uopt is feasible. And 2) the cost of Uopt is minimal among all feasible sets.

Consider the graph depicted in fig.1 in which the underlay routing scheme is minimum hop count, and the overlaying routing scheme is the shortest path with respect to edge length. In this case, the underlay path between S1 and t1 is (s1, v1, v7, t1), while the overlay path between them should be (s1, v3, v4, v5, v7, t1) or (s1, v2, v1, v4, v5, v7, t1). Similarly the underlay path between s2 and t2 is (s2, v4, v5, v7, v6, v8, v9, t2) while the overlay path between them should be (s2, v5, v7, v6, v8, v9, t2). Deploying the relay nodes on the v4 and v7 implies from s1 and t1 can be routed through underlay paths (s1, v3, v4), (v4, v5, v7) and (v7, t1), while the packets from s2 and t2 can be routed through fallowing underlay paths (s2, v4), (v4, v5, v7), (v7, v6, v8), (v8, v9, t2).Thus, U = {v4, v7} is a feasible solution to corresponding ORRA problem. If the all nodes have equal weight, then one may observe that this is also an optimal solution.

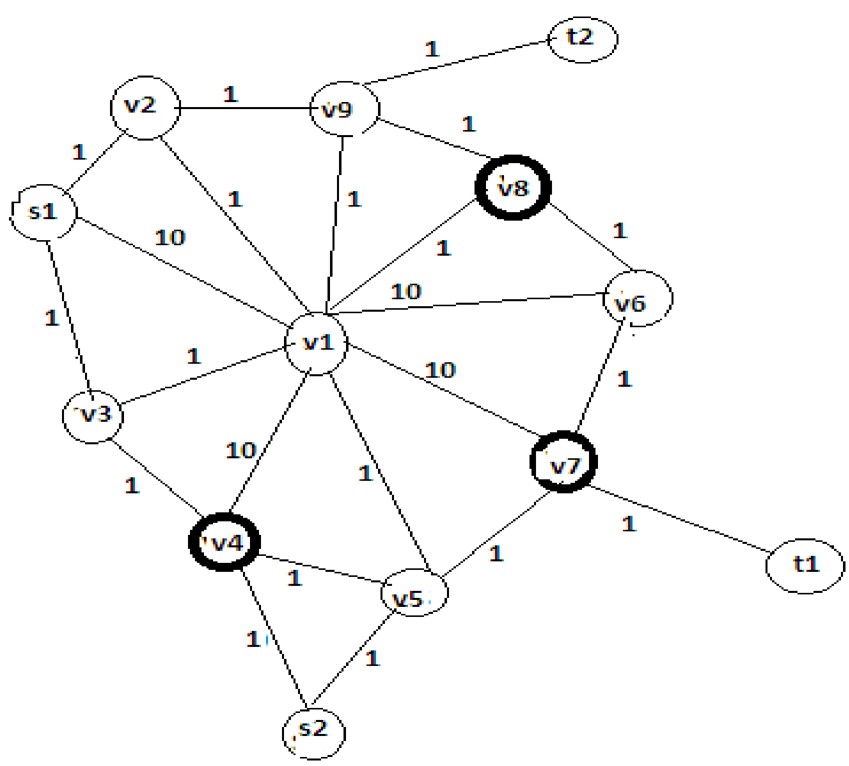


Figure: Overlay routing example

B. On the Complexity of the Orra Problem:

Given a collection of F of subset of S ={1……..n}, Set cover problem of selecting as few as possible subset from F such that their union covers S and maximum K cover problem of selecting k subset from F such that their union has maximum cordiality. Both are NP-hard problem. The k-ORRA problem NP-hard, and it cannot be approximated within the factor O (log (n)) ,where n is the minimum between the number of pairs and the number of vertices. In this also represent the m-approximation algorithm where m is the number of vertices required to separate each pair with respect to the set of overlay path. Set cover problem is given by, U is the universe and a collection of subset Si £ U which covers U and find the minimal size collection covering U. For the set cover evaluation the approximation algorithm by considering the ratio between the number of subset used in the cover output by the algorithm and the number of subset that used by algorithm and the number subset that are used by the optimal solution.

Therom1

1) The k-ORRA problem is NP-hard.

2) The MIN-ORRA problem cannot be approximated within a factor of (1 - £).ln (n) for any £ > 0 unless NP

In set cover problem given a finite set S, a position number k. Set of subset C of S, there is a set of subset C’ C. Such that every element in S appears at least one set of C’,|C’|≤k. Now constructing k-ORRA problem as fallows. For each element in si In set S , match the vertex Vsi, for each element subset cj £ C, match the vertex Vcj.Here adding another vertex vt, where V = {vsi | si £ S} U {vci | ci £ C} U {vt}. For each subset ci £ C and an edge between vci and vsj if and only if sj £ ci and an edge between vci and vt. E= {(vci, vsj) |Sj £ ci, ci £ C} U {(vci, vt | ci £ C)}. The set of underlay path consist of all possible path of length Pu = {(v, u) | (v, u) £ E } and set of overlay path consist of shortest path between the pair of vertices.

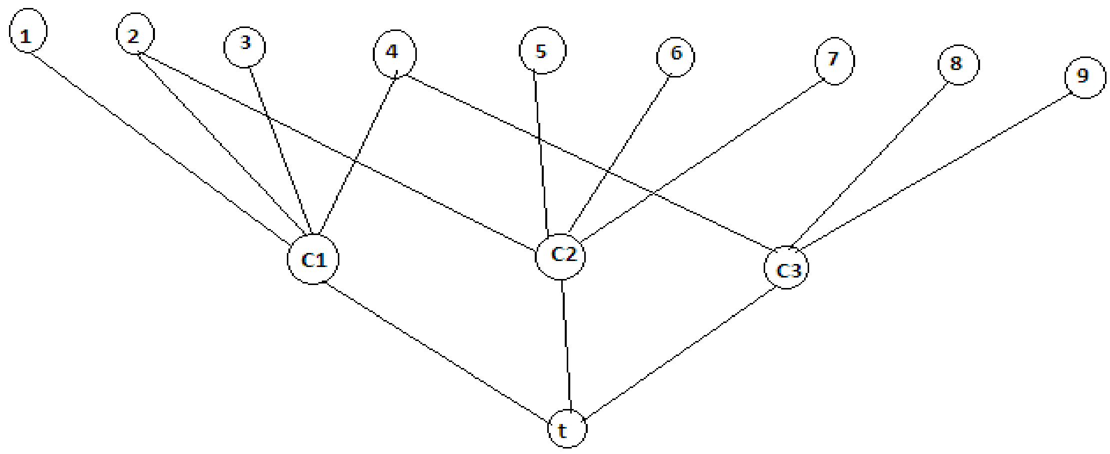


Figure: Set cover-ORRA reduction

From fig.2 shows that

S = {1, 2, 3, 4, 5, 6, 7, 8, 9} and C = {(1, 2, 3, 4), (2, 5, 6, 7), (4, 8, 9)}

Each vertex vsi any shortest path between vsi and vt is of type (vsi, vcj, vt) that is containing two edges. The path (vsi, vcj, vt) exist only if si £ cj. The reduction holds, there is a subset C' C such that |C'|≤ k and C' covers S if and only if there is a solution to the corresponding k-ORRA instance. Given a solution C' = {C1, C2,……… Ck'}, k' ≤ k, to a SC. U = {vc1, vc2, ……vck} is a solution to the corresponding ORRA problem. For each pair (vs, vt) £ Q.si is covered by C', si £ Cj. Since vcj £ U, then vsi can reach t using the concatenation of the following underlay paths (vsi, vcj).Thus U is the feasible solution to th ORRA problem.

Theorem2 – Local Ratio theorem

Given the approximation of the MIN-ORRA problem and feasible solution U. Let w1 and w2 these are the weight function. Such that W=w1+w2. If U is α-approximate with respect to the weight functions w1 and w2, then U also α-approximate with respect to the weight function W. The algorithm ORRA G=((V,E),W, Pu, Po, U) where, G(V,E) be a graph , w1 and w2 these are the weight functions on V. Where v £ V: w1(v) + w2(v). Let C*,C1*, C2* are the optimum covers of G with respect to the weight function W, w1,w2.It fallows that W(C*)≥ w1(C*) + w2(C2*). Pu be the set of underlay paths and Po be the set of overlay paths. The set of relay nodes in first call is empty.

Proof→ $W(c^*) = \sum W(V) \geq \sum (w1(v) + w2(v))$

$= w1(C^*) + w2(C^*) \geq w1(C^*) + w2(C^*)$

ORRA algorithm

1. ᵾv £ V\U, if w (v) = 0 then U ← {v}

2. If U is a feasible solution returns U.

3. Find a pair (s, t) € Q not covered by U

4. Find a (minimal) overlay vertex cut V' (V' ∩ U = $_\varphi$) with respect to (s, t)

5. Set £ = min v £ V' w (v)

6. Set w1 (v) = { $^\varepsilon$, v £ V'

{ 0, otherwise

7. ᵾv set w2 (v) = W (v) – w2 (v)

8. ORRA (G, w2, Pu, Po, U)

9. ᵾ £ U if U\ {v} is a feasible solution then set U = U \ {v}

10. Returns U

At each iteration, the algorithm takes vertices with weight that equal to zero up to a feasible set is obtained (step 1 and 2). Thus, since at each iteration at least one vertex gets a weight that is equal to zero with respect to w2 (step 5-7), then in the worst case the algorithm ends after |V| iterations and returns back to a feasible set. In step 9 not necessarily vertices are removed from the solution, to reduce cost. This step improve the real performance of algorithm.

C. Proposed Work:

In propose system, the system concentrate to study the minimum number of infrastructure nodes that need to be added in order to maintain important property in the overlay routing. The propose system consist of three modules: AS-level BGP routing, TCP improvement and voice over internet protocol (VOIP).

Advantage of Proposed system

- In proposed system interested in only improving routing properties between single source and single destination, then the problem is not that much complicated.
- Finds the optimal number of nodes becomes less trivial hence the potential candidate for the overlay placement is small and also any assignment would good.

D. System Design:

- ***Service Provider***

In this module, the Service Provider calculates the shortest path to Destination, The shortest-path routing over the Internet BGP-based router. The Service provider browses the required file and uploads their data files to the Specified End User (A, B, C, D) and with their DIP (Destination IP) of End User.

Overlay Router

The Overlay Router is responsible to route the file to the specified destination, the overlay routing scheme is the set of the shortest physical paths simplifies the execution of this system, and finding a minimal path to the destination using overlay routing, one can perform routing via shortest paths, the router is also responsible for Assigning the cost and also can view the cost of nodes with their tags From the node (from), To the node (to) and the cost.

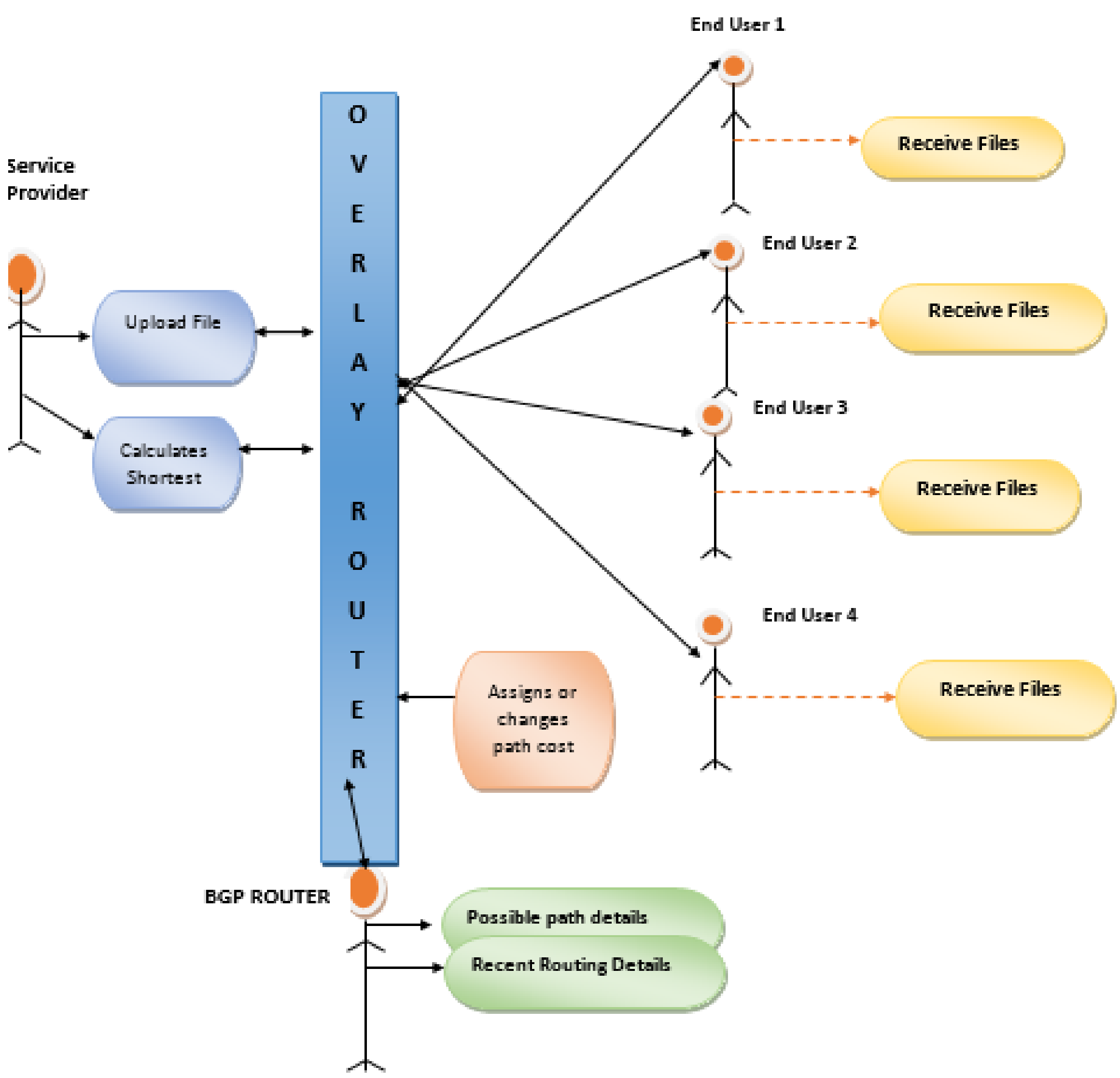


Figure: Block diagram of overlay routing

- ***BGP Router***

The BGP Router is responsible to route the nodes using BGP routing, where the goal is to find a minimal number of relay node locations that can allow shortest-path routing between the source–destination pairs, BGP Router consider a one-to-many destination where we want to improve routing between a single source and many destinations. BGP routing table contains valid paths from its source to the entire set of nodes. BGP is also responsible for storing the possible path to destination, can view the recent routing path to destination with their tags Filename, Recent Path, Destination, DIP, Delay and date and time.

- ***End User(Destination)***

In this module, the End user (Node A, Node B, Node C, Node D) is responsible to receive the file from the Service Provider In the shortest-path routing between the source destination nodes, the system consists of a one-to-many relationship. Where end User receives file from a single source to destination (Node A, Node B, Node C, Node D)

Data flow diagram

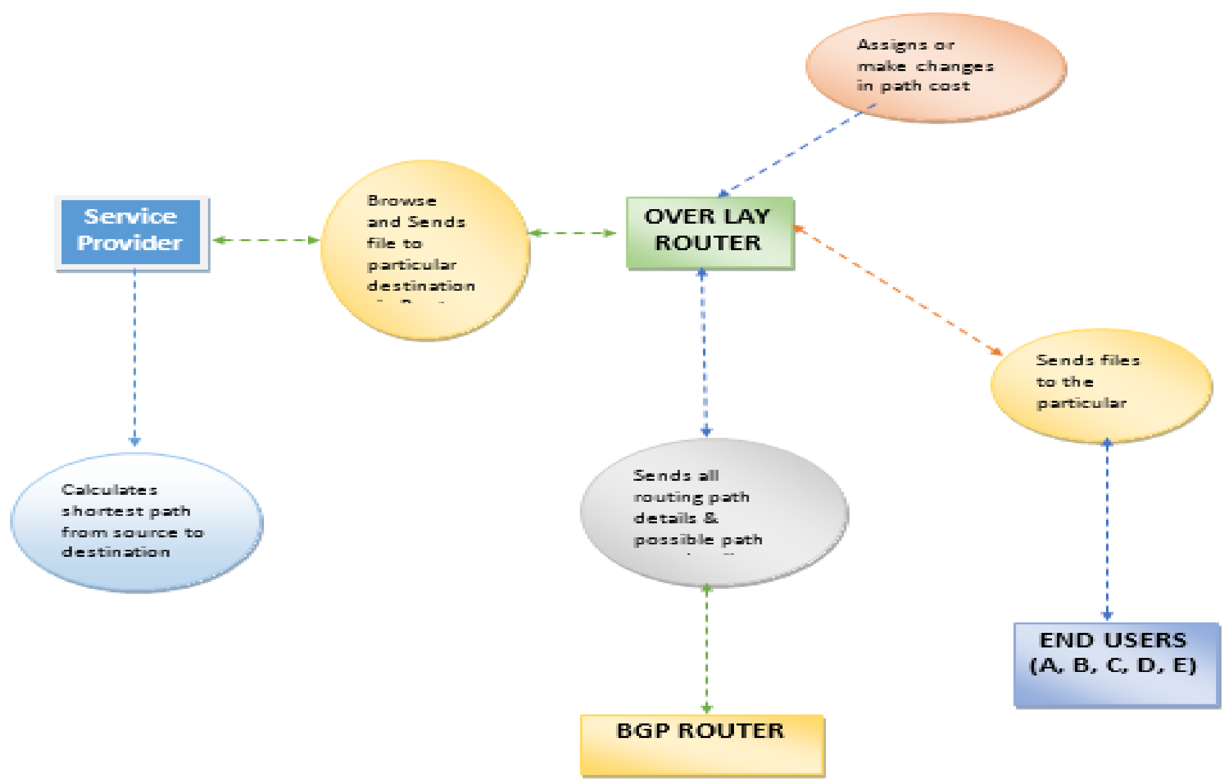


Figure: Data flow diagram of overlay routing

Flow chart

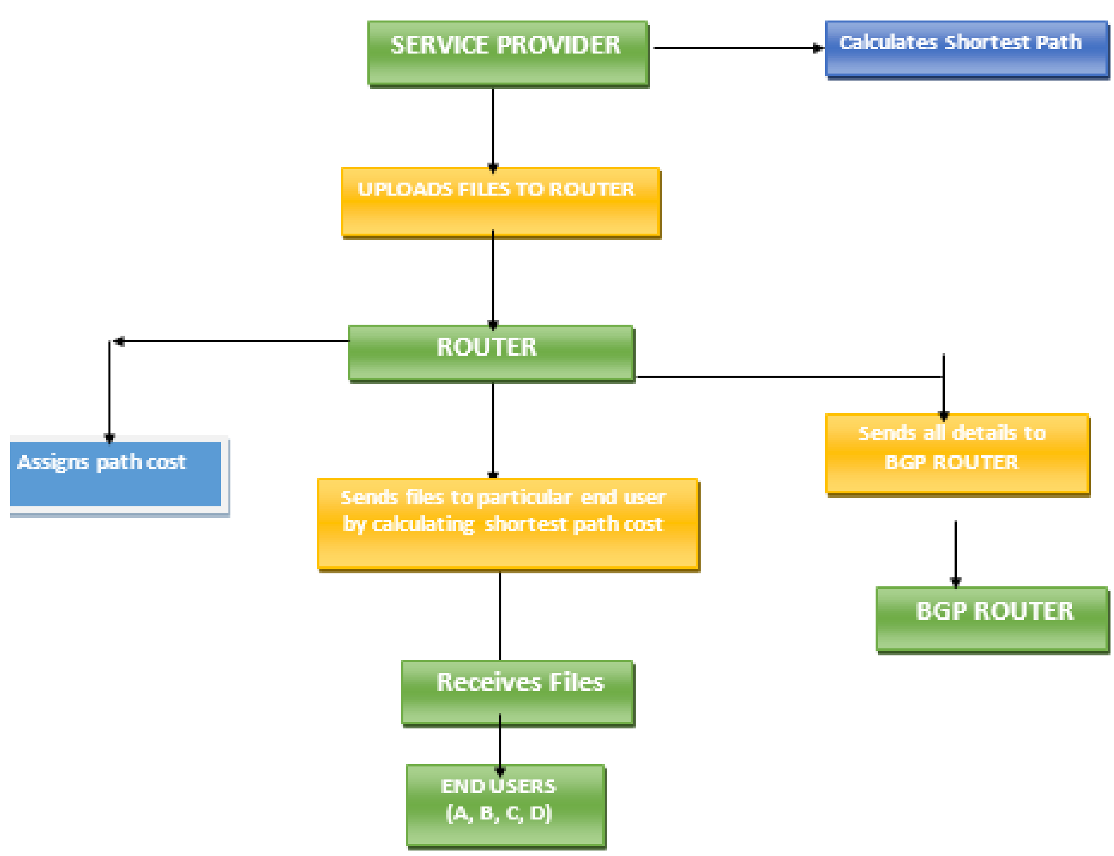


Figure: Flow chart of overlay routing

E. Case Study:

BGP Routing Scheme

BGP is the policy based inter-domain routing protocol and this is used to determine the routing paths between autonomous systems in the internet. In BGP routing protocol each AS system independent business entity, and the BGP routing policy gives back evidence of the commercial relationship between connected AS. A customer provider relationship between Ass anyone AS pays another AS for the internet connection. Means on AS behaves as a customer and another AS behaves as a provider. The peer-peer relationship between Ass is nothing but they have mutual agreement to serve their customer. These business relationship between Ass causes a BGP export policy in which an AS usually does not export its provider and peers rotes to other provider and peers.

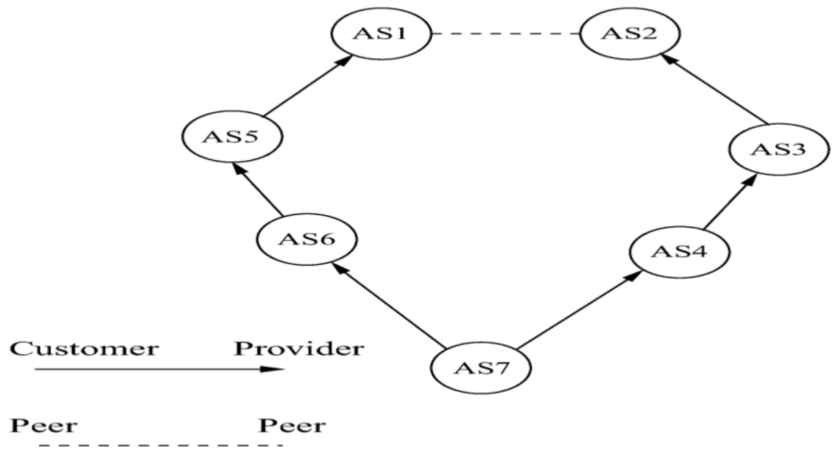


Figure: BGP path inflation

Consider the AS topology graph shown in above figure. In this figure, a vertex represents an AS and an edge represents a peeing connection between ASs the length shorts path between AS6 and AS4 is two by using the path AS6, AS7, AS4 but this is not a valid routing path since it traverses a valley. The length of shorts routing path five by using the path AS6, AS5, AS1, AS2, AS3, AS4. The routing policy is a ground-laying and also important beneficial capability of BGP, and in some other application may require to route the data using the shortest path. Using the overlay routing can perform routing through shortest paths contempt the policy and the relay nodes should be arranged on servers located in certain Ass.

TCP Throughput

Overlay routing is also used to improve TCP performance. TCP protocol responsive to delay and there is statistical relationship between TCP throughput and RTT. Hence it is beneficial to break high latency TCP connections in low latency sub-connections. In above figure shows that they has similar latency, the TCP connection between v and u can be fragmented using the relay node located in w, reducing the maximum RTT of the connection. With respect to the ORRA problem, from the network topology represented as graph G = (V, E) a path p is underlay routing path if it is valid path and the RTT associated with path it does not exceed previously defined RTTmax defining maximum RTT for each sub-connection.

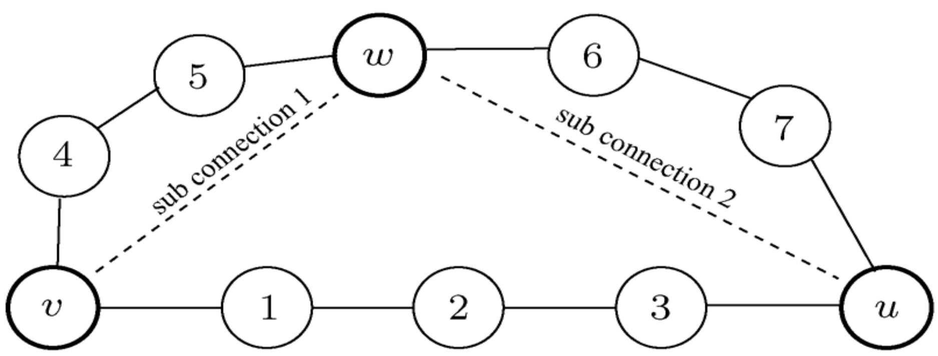
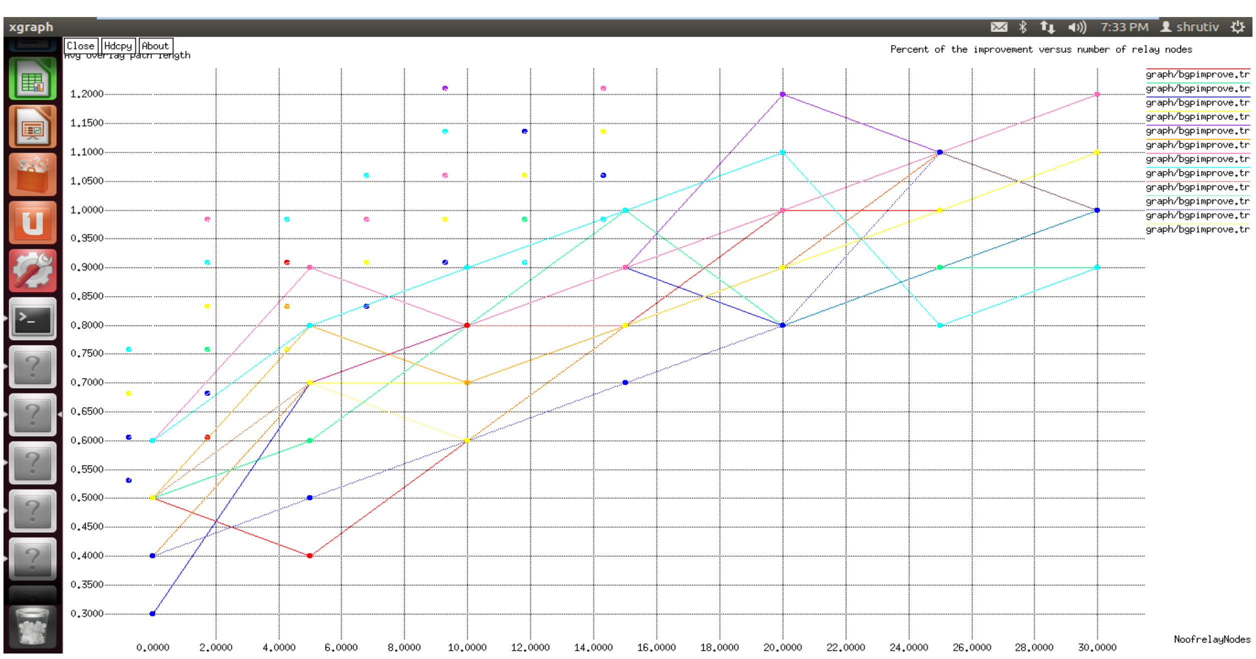


Figure: Breaking a TCP connection into two sub-connection reducing the maximum RTT

F. Performance Analysis:

Performance analysis for % of improvement of average path length against number of relay nodes



Graph: Percentage of improvement verses number of relay nodes

Analysis-In above graph shows that, these colored lines indicates each BGP source of different measurement. As the number of relay nodes increases improves the percentage of average path length.

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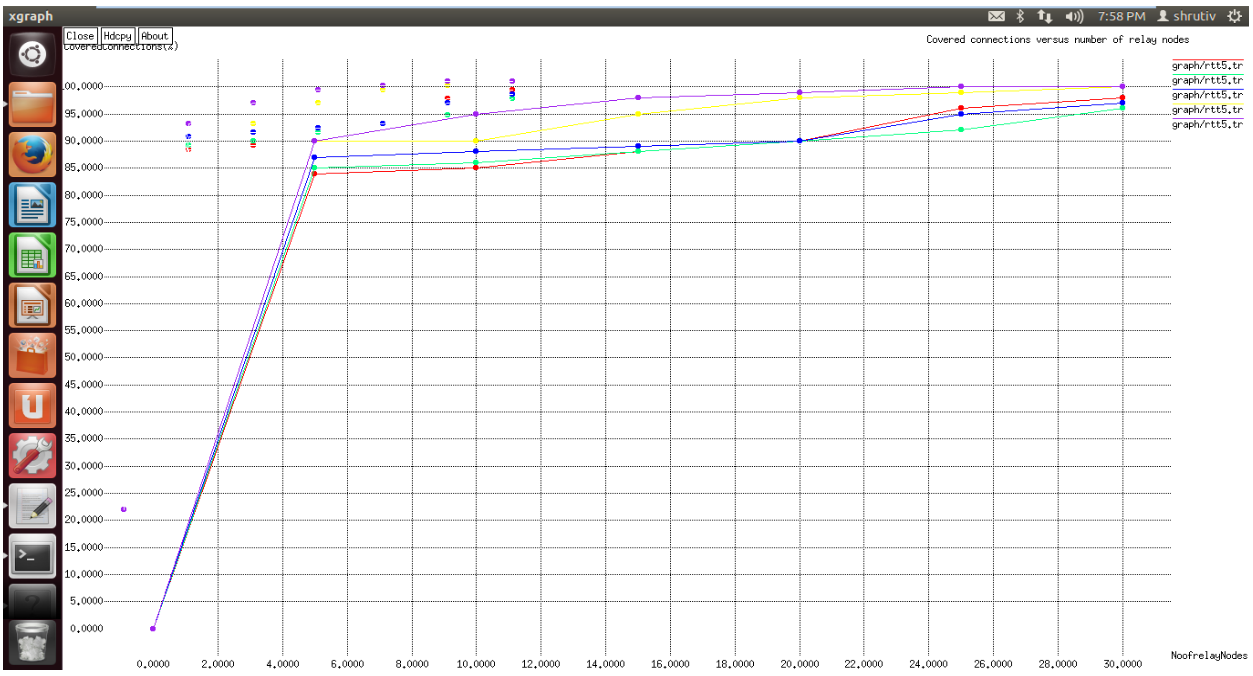
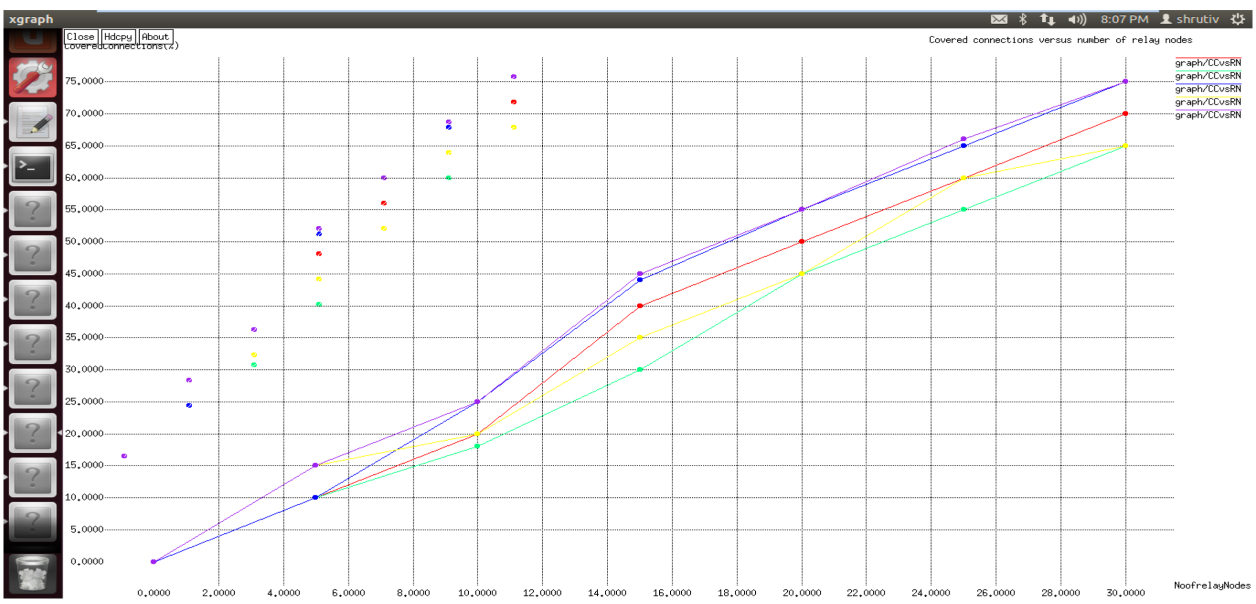
Performance analysis for covered connections verses number of relay nodes, RTT = 3



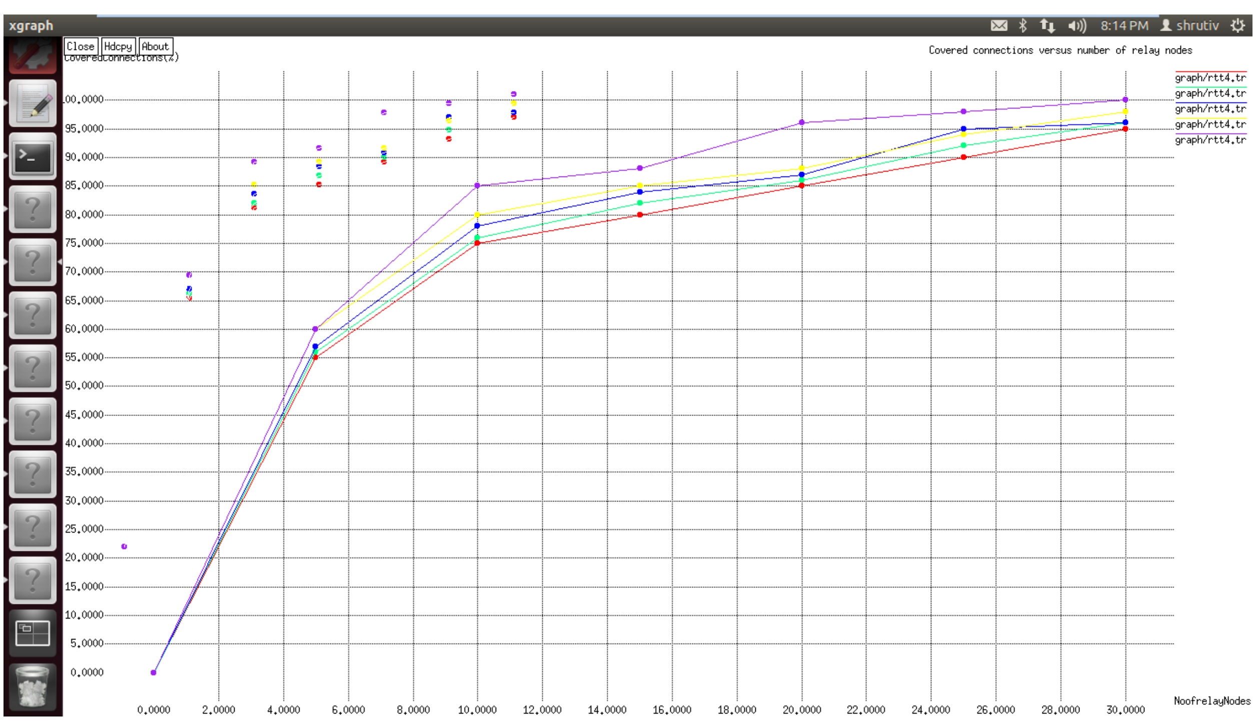
Graph: Covered connection verses number of relay nodes

Performance analysis of covered connection against number of relay nodes, RTT = 4



Graph: Covered connection versus number of relay nodes, RTT = 4

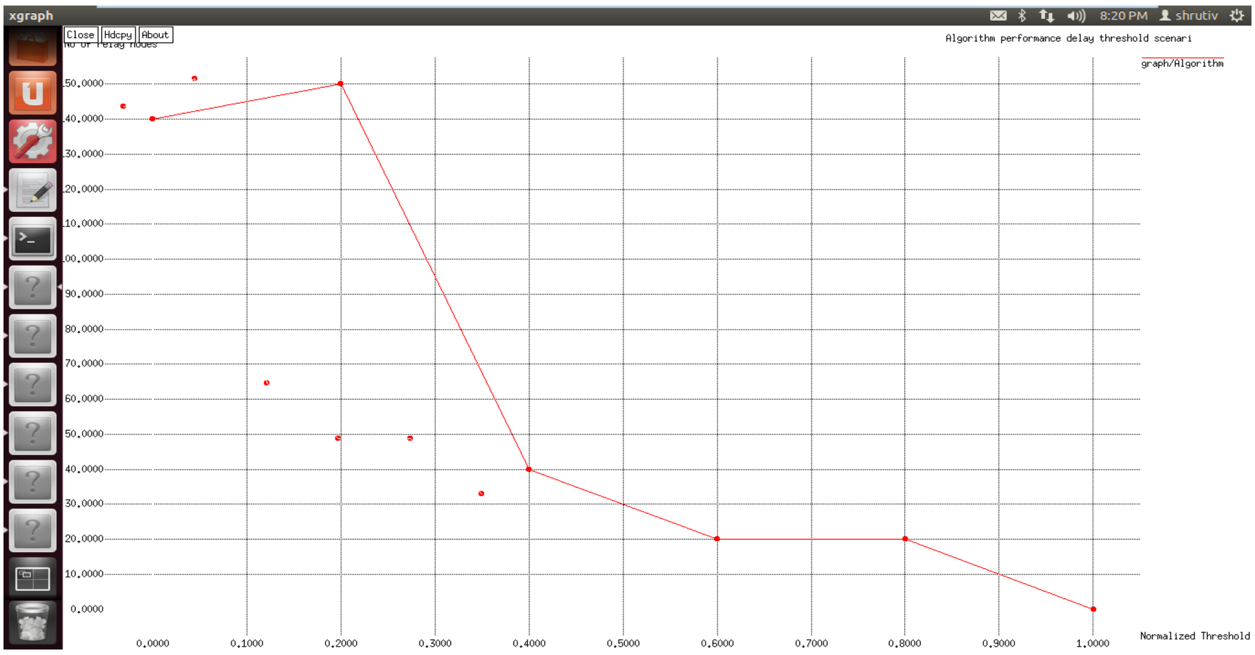
Performance analysis of covered connection against number of relay nodes, RTT = 5



Graph: Covered connection versus number of relay nodes

Analysis-In above three graphs shows that as the number of relay nodes increases improves the percentage of covered connections. As the relay node increases percentage of covered connection also increases. Improves the percentage of covered connection.

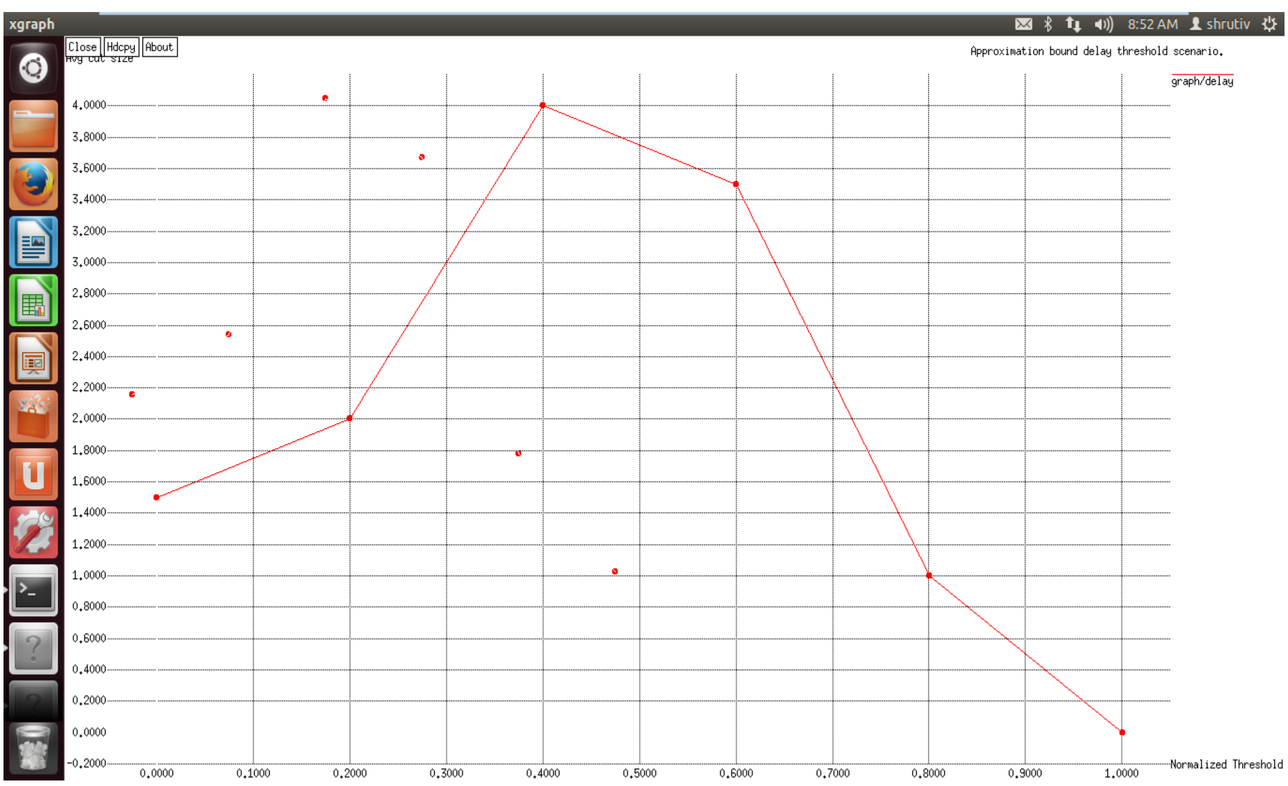
Performance analysis of number of relay nodes against delay threshold



Graph: Number of relay nodes versus delay threshold

Analysis-In above graph shows, When the delay is required to small (threshold 0), a large number of nodes are required. When the requirement is relaxed, the number of relay nodes drops. As the normalized threshold increases, the number of relay node decreases.

Performance analysis of average cut size against normalized threshold



Graph: Average cut size versus normalized threshold

Analysis-In above graph shows, the size of the overlay vertex cut it is a function of the threshold. When the delay threshold increases, the size the overlay vertex cut also increases hence there number of vertices that satisfy delay requirement between the each pair of nodes.

IV. CONCLUSION

In this paper discoursed the fundamental problem developing an approximation algorithm to the problem and considering the specified algorithm for the applications and also suggested a general framework that fits a large set of overlay applications. In this paper, evaluated the performance of the algorithm, and showing that in the algorithm provides close-to-optimal results. BGP routing scheme is used by large content provider to improve the user experience of its customers. The VOIP is used to improve call quality of their customer.

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