Optimization Techniques and Application

Routing Optimization In IP Networks

GROUP A2-G18

Submitted to:

Dr. Jayaprakash Kar

Designing and Framework

Abstract

Routing optimization provides network operators with a powerful method for traffic engineering. This enables to distribute traffic flows evenly across available network resources in order to avoid network congestion and quality of service degradation.

Working Model

We will consider our working model as follows:

- Let us take two routers namely A and B from the ISP.
- The bandwidths of A and B are 500 MB/sec and 700 MB/sec respectively.
- We have taken 3 routers C, D , and E which are responsible for supplying the bandwidth coming from A and B to the clients using the internet services.
- We are considering minimum speed requirements of routers C, D , and E to be 200 MB/sec, 300 MB/sec and 250 MB/sec respectively.
- For understanding this, in Fig.1, the values are written on the line joining the routers A and B to C, D and E represents the Time-cost for the transmission of the data packets.
- Let us take the time-delay for the routers of ISP to the client routers be T_{AC}, T_{AD}, T_{AE} , T_{BC}, T_{BD} , and T_{BE}.
- Let us take the bandwidth transferred per second for the router of ISP to the client routers be S_{AC}, S_{AD}, S_{AE} , S_{BC} , S_{BD} and S_{BE}.
- We have a network switch (also called switching hub, bridging hub, officially MAC bridge), which is a computer networking device that connects devices together on a computer network by using packet switching to receive, process, and forward data to the destination device. Being very smart this device has the protocol that will implement the code for optimizing the routing and deliver the packet accordingly. Through the switch, the connections are established ahead.

Formulation 1

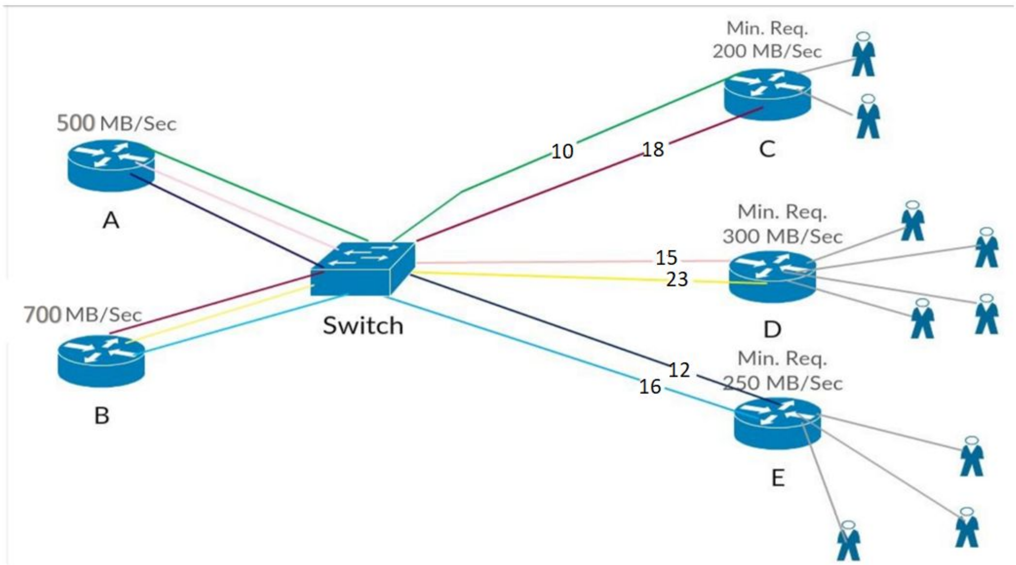

Fig.1 Maximizing the reliability

Now, we will formulate the function which we will have to Maximize in order to increase the reliability so as to optimize the routing.

First of all let's see how the things are planned to work.

Decision Variables

T_{ij} = This represents the time-delay from i to j

{i= A, B}

{j = C, D, E}

Objective Function

Now for optimization of routing, we will try to deliver the packets through the routes with the most reliability keeping in mind the available bandwidth from source and requirement at the destination.

Thus, the objective function will be formulated by summation of the product of the individual route's reliability by time-delay across it.

So, the objective function is: Max { $10T_{AC} + 15T_{AD} + 12T_{AE} + 18T_{BC} + 23T_{BD} + 16T_{BE}$ }

Constraints

- The max reliability through A is 15
    - $T_{AC} + T_{AD} + T_{AE} >= 15$
- The max reliability through B is 16
    - $T_{Bc} + T_{BD} + T_{BE} >= 16$
- Other than this we have another constraint to make sure that time is always taken from A, B to C, D, E and not vice-versa
    - T_{AC} , T_{AD} ,T_{AE} ,T_{BC} ,T_{BD} and $T_{BE} >= 0$
- We will have to set the constraint which will take care of the client's need, i.e., the max time-delay which they can handle.
    - $T_{AC} + T_{BC} <= 11$ (C's Requirement)
    - $T_{AD} + T_{BD} <= 9$ (D's Requirement)
    - $T_{AE} + T_{BE} <= 11$ (E's Requirement)

Algorithm Used

The Algorithm used here is Dual-Simplex method.

Coding 1

PFA the MATLAB File for the Codes.

Output on the console

Value of T_{AC}: 4

Value of T_{AD}: 0

Value of T_{AE}: 11

Value of T_{BC}: 7

Value of T_{BD}: 9

Value of T_{BE}: 0

The Optimized Value is: 505.00

Result

- The optimized value of the objective function (f) turns out to be 505.00
- The packets through the routes with the most reliability with available time-delay through A is T_{AC} + T_{AD} + T_{AE} which is equal to 15.
- The packets through the routes with the most reliability with available time-delay through B is T_{BC} + T_{BD} + T_{BE} which is equal to 16.

Formulation 2

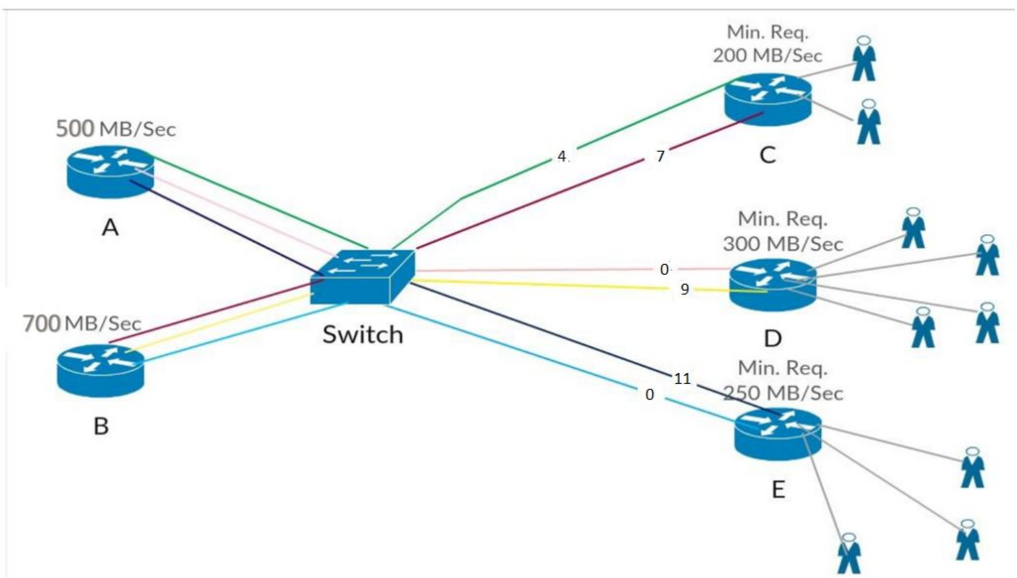

Fig.2 Minimizing time delay

Now we will formulate the function which we will have to Minimize in order to reduce the time-cost in order to optimize the routing.

First of all, let's see how things are planned to work.

Decision Variables

S_{ij} = This represents the transferred bandwidth from i to j

{i= A, B}

{j = C, D, E}

Objective Function

Now for optimization of routing in Fig.2, we will try to deliver the packets through the routes with the least time cost keeping in mind the available bandwidth from source and requirement at the destination.

Thus, the objective function will be formulated by summation of the product of the individual route's time-cost by bandwidth transferred through it.

So, the objective function is: Min { $4S_{AC} + 11S_{AE} + 7S_{BC} + 9S_{BD}$ }

Constraints

- The max bandwidth through A is 500 MB/Sec
  - $S_{AC} + S_{AE} <= 500$
- The max bandwidth through B is 700 MB/Sec
  - $S_{Bc} + S_{BD} <= 700$
- Other than this we have another constraints to maintain the packets to transfer from router A, B to C, D, E and not vice-versa
  - S_{AC}, S_{AD}, S_{AE} , S_{BC} , S_{BD} and $S_{BE} >= 0$
- We will have to set the constraints which will take care of the client's need, i.e., the minimum bandwidth which is required.
  - $S_{AC} + S_{BC} >= 200$ (C's Requirement)

- S_{BD} >= 300 (D's Requirement)
- S_{AE} >= 250 (E's Requirement)

Algorithm Used

The Algorithm used here is Dual-Simplex method.

Coding 2

PFA the MATLAB File for the codes.

Output on the console

Value of S_{AC}:100.00

Value of S_{AE}: 78.00

Value of S_{BC}: 0.00

Value of S_{BD}: 95.00

The Optimized Value is: 2113.00

Result

- The optimized value of the objective function (f) turns out to be 2113.00
- The packets through the routes with the least time cost with available bandwidth through A is S_{AC} + S_{AD} + S_{AE} which is equal to 178.
- The packets through the routes with the least time cost with available bandwidth through B is S_{BC} + S_{BD} + S_{BE} which is equal to 95.

References

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- D. Awduche, J. Malcolm, J. Agogbua, M. O'Dell, and J. McManus,"Requirements for traffic engineering over MPLS,"IETF, RFC 2702,Sep. 1999
- Lecture notes by Dr. Jayaprakash Kar

Contributions

Designing and Framework

Richa Agarwal (17ucs126)

Formulation

1. Princy Garg (17ucs114)
2. Mashu Ajmera (17dcs005)

Coding

1. Jatin Kumar (17ucs186)
2. Mayank Aggarwal (17dcs006)