Analyze network performance computer science in optimizing packet routing

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ABSTRACT

Network availability , quality of service and reliability are elements necessary for the survival of a network computer science business ; thus , each system and network administrator computer science is supposed to define a good policy in order to be able to provide users with a quality and reliable service ; but nevertheless with the increasing number of objects connected and traffic transported in the network may cause delays if the network optimization policy is not well defined ; reason why this document presents a study carried out on the analysis of network performance in insisting on determining an optimal path for routing packets from transmission to reception in a reliable and fast way.

Keywords: ***Routing, Optimization, Optimal path, Network computer.***

I. INTRODUCTION

Today, the evolution of networks is very intense. new networks emerging, "all optical " solutions *at the heart of networks, "wireless" solutions* to facilitate user access or to install sensors / actors in places difficult access, or finally the Internet of communicating objects. In this evolution, new problems and new scientific questions appear. Some problems concern resource optimization used and improving the performance of tools and techniques. Often those problems optimization lead to patterns using graphics. We search for the optimal solution, approximations that give guarantees for the performance of the algorithms and/ or easy to use heuristics. Problem analysis network optimization is an activity important to the administrator network.

In our approach, identify resource availability issues, optimize band bandwidth and routing tables, then find beneficial solutions is at the center of activities.

Starting from the above, we begin the first part of our study by presenting in the following lines the theory on performance evaluation with the illustration of an example in the case of our study before talking about the optimization of routing in the next section.

II. NETWORK PERFORMANCE EVALUATION COMPUTER SCIENCE

Performance is one of the most important aspects of networking. In fact, it is an important part of practically anything what system. Any administrator network knows how fast everyone blames the network when the performance of any type of device or system network connected leave something to be desired. In effect network performance analysis is realized based on several indicators that we are going to list in order summary below.

A. Network Performance Indicators computer science

Indicators allow to evaluate the functioning of a network computer, among which we can to quote:

- *The transit time (latency)*: between sender and receiver, transmission time on the links + time spent within the elements may be: maximum, average over a time interval, minimum transit.
- *Inter- arrival jitter*: Variation in end -to -end packet transit delay. Perhaps caused by a distortion of the data stream. Real time applications are there sensitive: the signal can be distorted.
- *The band passer-by*: Corresponds to the maximum transfer rate between two terminal points, Limited by the physical infrastructure and by the number of streams sharing the same component of the end -to -end path.

*The loss rate Where reliability***:** When a Where several of these packages do not reach the intended destination, this is called packet loss. For users, packet loss is seen as network disruptions, slow service, or even a loss total network connectivity [1].

B. Network performance evaluation computer science

That the network is young, in full development, that he have hit her full maturity, that he seeks to initiate a new phase in its development Where that he wishes to change to cope with changes in its market, it is essential to assess the performance of its network in the same way as it is essential to analyze the performance of any company. At this difference except that the analysis of the performance of a network is not based on the same key criteria and indicators only one business independent. The goal of one network performance analysis is in effect of identifying the strengths and weaknesses in putting emphasis on the performance indicators cited in point I.1 of our study. In effect Although it exists many ways to perform performance evaluation, the Simple Network Management Protocol (SNMP) is probably the most widely used technology used to measure network performance [2].

C. Tools network performance evaluation

A tool network evaluation _ analysis various aspects of infrastructure computer. He examines the infrastructure network existing of one organization in evaluating devices _ network, network performance and security threats, which contribute all to be defined a network management strategy reliable. Many tools are used in performance analysis in a network computing; thus, we illustrate performance evaluation in putting focus on the latency indicator. Being one of the two components to know to judge a good connection to Internet. It is a measurement of delays And, in general, latency measures the time required for a data packet _ is transmitted from sender to sender and sent back to sender. As a reminder: the speed corresponds to the quantity of data which is transmitted within a given time.

D. Illustration of network performance analysis

We present on this section we evaluate the latency in our network in using the connectivity test with the ping between a machine of our Facebook network and server ; knowing that the transmission time is depending on the bandwidth , we will take two scenarios , the first will be the test in using one only computer connected to the router to see the response time in second place we will do the same test a many times _ peripheral devices are connected to the router and shares the same bandaged passing .

Scenario 1: ping test with a single equipment connected to router

After the test of figure 1 we note the result next, a time one only computer is connected to our router, the average transit time is 130 milliseconds. With a bandaged passer-by of at less than 1 Mb/s. with a such latency it is true what about performance term the network works and we will know determine if this indicator working normally than with the second case in point.

Figure 1. Ping Test Case 1.

Scenario 2: ping test with several equipment connected to the router

Figure 2 presents a result of 303 milliseconds as the average transit time with the same bandaged passer-by; so we can qualify the increase in latency in this term: it is true only with the same bandaged passer-by when it comes to one network equipment _ is fast; but in adding many equipment to the network segment there is a problem of slowness due to the tape that must be shared by all network devices.

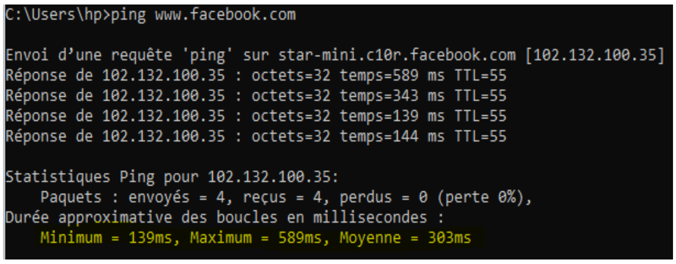


Figure 2. Ping Test Case 2.

We end this part in affirming that he is still it is imperative to audit your network at any time to reassure yourself of its operation , taking into account several aspects ; the case mentioned in this study focuses on the principle of the availability of services and resources in the network because the needs of users are constantly to increase reason why each administrator system and networks is please watch _ the activity of its system , the performance evaluation is one of the necessary steps to be able to detect the flaws in your network .

III. THEORIES OPTIMIZATION OF DATA ROUTING IN THE NETWORK COMPUTER SCIENCE

Network optimization is a technology used to improve network performance in an environment given. He is considered as an important part of effective systems management information. The goal of all network optimization is with the set given constraints; Ensure optimal network design with a low - power structure cost and free data flow. Network optimization should be in measure to ensure a use optimal system resource, improve productivity and enhance efficiency organizational. Network optimization examines individual workstation to server as well as tools and connections associates. The big one's organizations use teams network analysts to optimize networks. Network optimization used often the setting form of traffic, disposal of data redundancy, caching and compression of data, and streamlining of data protocols. Network optimization should be in measure to increase network efficiency without acquiring hardware or software additional Where expensive [3].

From the above, network optimization has many benefits. It can help speed up data transfers, including data transfer in bulk, disaster recovery capabilities, tape cost reduction bandwidth and improved response times for interactive applications such as databases and software applications. It improves also the performance of the application with a better bandaged bandwidth and helps maximize network speed between remote sites.

Network optimization respond also to routing challenges following:

- Congestion, which occurs when too much traffic converges on a router Where a bond that cannot pass it. This local congestion risks then to extend to routers adjacent and therefore to cause a network blockage global. Here we can make the analogy with what is well known in networks roads (traffic jams). A network congested has low overall throughput Where null;
- Bypass _ of elements faulty, of a router or link may stop working. the others routers have to be informed that this itinerary is not available and that other routes have to be offered. Conversely, the use of this way must be recovered when the repair was performed. These adaptations to changes dynamic have to be done enough quickly to be effective and not too quickly to avoid creating instability;
- Don't ask every router to know the topology overall network. The interconnection of networks (public or premises) between them is often the result agreements between several entities: companies, universities, administrations... to build a common communication system. Membership is voluntary and everyone wants stay in control at home, He is not so generally not desirable or acceptable to create a superior entity to administer the network. In order to satisfy this need, it is sought to use routing algorithms that use just the information that they can get from their neighbors immediate. Each administrator of one entity network n / A what to collaborate with network managers neighbors to which he is connected. That nevertheless not just the connection structure network either put in works hierarchically;
- Seek to reach names that do not exist in the network or who are inaccessible. He is necessary for each router having knowledge not of all the names individual existing in the network, but namespaces that can be reached in using a router output port, without prejudging the existence of this name or what the next router will do. For each possible output port, the router knows dynamically Where learn the accessible namespace. Of course, this namespace changes over the life of the network [4].

A. Modeling a network in chart terms

In order to carry out its activity network optimization, it is very important to model first its network. So, in this part of the study, we will try based on some models to explain theories fundamentals on which network optimization computer is based.

B. Flow in networks

One of the most important applications of graph theory is the optimization of flows in the networks. To study this problem, you must first to define this what is a transportation system [3].

A transport network is a quadruple (G, s, t, C) were:

- **G** = (S, A) is a graph simple oriented
- **s:** is an unpredictable vertex called a *source*
- **you:** is a vertex without a successor called *well*
- **C:** A - R+ is a positive evaluation of G called *capacity* for a set of vertices W S:

Incoming arcs W: set of arcs W- = {(x,y) A|x / W and yW}
Arcs outside W: set of arcs W+ = {(x,y) A|x W and y/ W}
if W = {z} is a singleton these sets simply z+ and z- will be noted.

The transport network will serve therefore supporting a *flow. This stream is actually one second Evaluation attached to the chart representing the network.*
Let (G, s, t, C) be a transport network, then a flow on this graph G = (S, A) is a positive evaluation f: A - R+ which verifies:

- Flow does not exceed capacity (x, y) A , 0 f(x, y) C(x, y)
- The law of knots z S { s;t }, X (x,z) z+ f(x,z) = X (z,y) z- f (z,y)

For any vertex z we call:

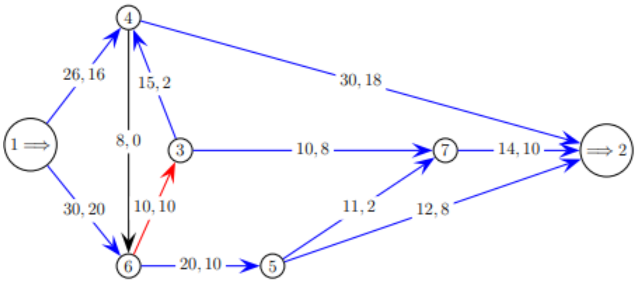
- *Inflow z* : the quantity f -(z) = X (x,z) z- f(x,z)
- *Output of z* : the quantity f +(z) = X (z,y) z+ f(z,y)

And we will say that the flux f on the arc (x, y) is :

- Saturated: if f(x,y) = C(x,y)
- None: if f(x,y) = 0

The most important constraint for a stream is the law of nodes. He was posed by the physicist German Gustav Kirchhoff in 1845, when he established the rules for calculating current intensities in an electric circuit. It expresses simply the preservation of the flow: *incoming flow = outgoing flow*

Example: Representation of a transport network and a flow on a sagittal diagram



Legend: The source is vertex 1 and the sink is vertex 2 and on each arc:

- the first digit indicates the capacity
- the second digit indicates the flow rate

Thus, we will say that the arc (3, 7) has a capacitance C (3, 7) = 10 and a flux f (3, 7) = 8, therefore the flux of the arc (6, 3) is saturated and that of the arc (4, 6) is null for W = {5}; 6}

- W- = {(1, 6); (4, 6)} but does not contain (6, 5)
- W+ = {(6, 3); (5, 7); (5, 2)}

The law of knots is checked at each vertex, for example for 3

- f -(3) = 10 wagons 3 - = {(6, 3)}
- f +(3) = 8 + 2 = 10 because 3 + = {(3, 4); (3, 7)}

From this _ _ demonstration, a network computer science in chart terms _ is defined like a graph related weighted without loop or circuit with a value negative. And he is note by: *= (Ξ,υ,) ωηερε:*

- X is the set of vertices;
- U is all edges;
- is the set of weights.

Example:

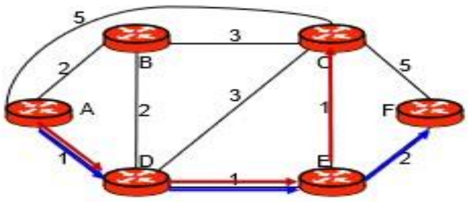


Figure 3. Representation graph of a network.

When arcs can represent transmission cables (Ethernet cables, cables telephone, fiber optics, where vacuum for WIFI), flows are quantities of information, the capacities the maximum flow of a connection (Mb/s), peaks are routers, the source of a machine which transmits information (a mail for example), the sink of the machine which receives this information [14].

C. Finding the path of minimum weight in a network

This search consists in solving the problem of the optimal path in the notion of graphs of the type of search for the path with minimum value or also traditionally called finding the shortest path according to the type of weights considered. The problem is to find the shortest path between [4]:

- given start and end peak;
- a vertex and all the others;
- a starting and ending vertex.

From where the script below:

> Let G = (x, *u*) and =(ξ, u, *C) be a quasi-strongly connected and non- circular (or a non- cyclic transport network related) where:*

$$C = (C_{ij})_{i \le 1, j \le n} \; ; \; n = |X| \; ; \; C_{ij} \ge 0 \, \forall i,j \in X \text{ avec } C_{ij} \equiv M \gg 0, \forall (i,j) \notin U$$

The question of the "path to value creation minimum" *should read as follows:*

$$l_{\mu 0} = \sum_{(i,j) \in \mu 0} C_{ij} \text{ Either minimum.}$$

Many algorithms have summer developed with the aim of facilitating the search for the optimal path in a network. We present especially the most used in packet routing.

D. Shortest Path Algorithm

Suppose only one function f (V): V $\Re^{+}$ allow to evaluate for each channel, V, the cost of passage between two nodes adjacent Where neighbors (the nodes are adjacent since v is a direct channel). This function takes in count the information known on the channel (speed, reservation rate, rate of use real, number of free stamps …). The algorithm must find the shortest path between source A and destination B.

The most obvious solution consists of evaluating:

Cab ine = min [F (C1 ^{ab}), F(C ^{2} ab), …, F(Cnab)] where

F C (*ia b*) = *f*(*Vvi*)
I =1

…V1, … Vp are the p- lanes of the road CiAB .

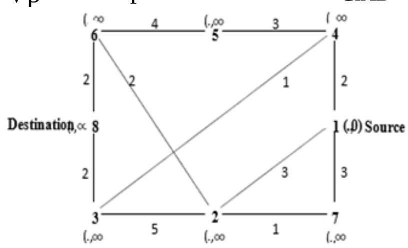


Figure 4. Initial state

This solution is not acceptable because it is too expensive. The minimum path algorithm allows, from any what node in our example, it will be node 1 (see Figure 4.) to find the minimum path between the source node and each destination node. The algorithm must be performed for each possible destination node and every possible source. This algorithm is due to Dijkstra (1959).

The idea of the algorithm is simple: a destination cannot be reached only by one of the roads leading to it. we will so start at the starting point and go to see all the neighbors in calculating the cost of the trip. Then, from each of these points, we will calculate the minimum cost to go to the neighbors immediate (nodes with a direct channel).

For this algorithm, only nodes _ connected to more than two channels have to be included. So, nodes 5, 7 and 8 should vanish by that they do not allow choice of routing. Path 6-4 will then have a cost of 7, path 6-3 will have a cost of 4. Path 1-2 passing through 7 will have a cost of 4: she duplicates the direct channel noted in the figure. We keep those nodes to keep the initial mesh. That allow also to deal with the case of an 8-5 channel which is considered as temporarily broken and therefore cost _ infinity [14].

The algorithm requires nodes _ be renumbered in any what order, except for node of origin, which will be 1, and the destination node, which will be N. To prevent the reader from picking up node numbering again, we have taken as example, in FIG. III.3, 1 as node original and 8 like destination node. Numbering _ will have to be taken back for all other source-destination pair. Each knot is seen assign a label (O, node number predecessor, C1, i cost or distance from the origin which will be denoted $_{Ci}$ for simplicity since the origin is always node 1) which is initialized to (.,0) for the node original and (., 1) for all others knots. The “. » means that the predecessor is not known. The cost infinite suggests that the nodes are not connected. Of course, the cost of staying in place is zero. In the initial state, the cost to go to any other node is unknown.

Destination Source	1	2	3	4	5	6	7	8
1	-	3		2			3	
2	3	-	5			2	1	
3		5	-	1				2
4	2		1	-	3			
5				3	-	4		
6		2			4	-		2
7	3	1					-	
8			2			2		-

Table 1. Cost matrix or distance on the paths connecting two nodes adjacent

Table 1 shows the matrix M of channel costs, derived directly from Figure 4. let's call mij the column input I line j of this matrix; mij is no other than f(v) where "v" is the channel between i and j. The algorithm iterates for each node i looking for distance. He is described below:

Do for i = 1 to N-1 Do for j = 1 to N # calculate cost to go to neighbors via i # If mij exists [$_{Ci} + _{mij} < _{Cj}$ *] then :*
If mid exists [$_{Ci} + _{mij} < _{Cj}$ *] then :*
$_{Cj} = {}_{Ci} + {}_{mij}\ {}_{Oj} = i$
end if
end_do
Do for j=1 to N# check if there was a cost lower ahead _ i from neighbors #
If mNj exists [$_{Cj} + _{mNj} < _{CN}$ *] then :*
CN= Ci+mij Oj =J
end if
End of doing

Figure 5. shows the 8 iterations successive. At the end of the algorithm, the shortest path is marked, as well as its cost. In the figure, the minimum cost to go from 1 to 8 is 5 and you must go through nodes 3 and 4. To find this path, you take the mark at 8 which indicates the predecessor, here 3. At the mark at 3 the predecessor is 4. At the 4 marks, you find 1 as the predecessor. There may be _ several paths of the same cost (in the example, it is the case of the path going from 3 to 7, the cost is 6 passing through 2 or 4 and 1). In this case, the algorithm does not give only one of the two paths according to his order of execution.

The algorithm constructs a routing graph, or routing tree whose top is origin, shorter paths between source and destination. This tree you allow you to choose the shortest path and eliminate several paths.

Back to the way whose center will process requests. A virtual circuit request is made between 1 and 8.

- The GC executes the shortest path algorithm described above.
- It allocates the path found to the virtual circuit, CV, and modifies the cost on each channel to updating channel and node settings _ _ used.

So after this calculation, it is possible that the new cost values on each channel are _ increased according to a function f ($_{CCV}$). Assume that the cost increase is 1, f'($_{CCV}$) = 1 on each channel composing the CV, on each channel after a CV is established[5].

Thus, the new costs are:

- $m_{1.4 = 3}$
- $m_{4.3} = 2$
- $m_{3.8 = 3}$

We leave it up to the reader to find the next lowest cost path. You will thus see that the optimal path was obtained at the last iteration in the example of Figure 5 is due to luck.

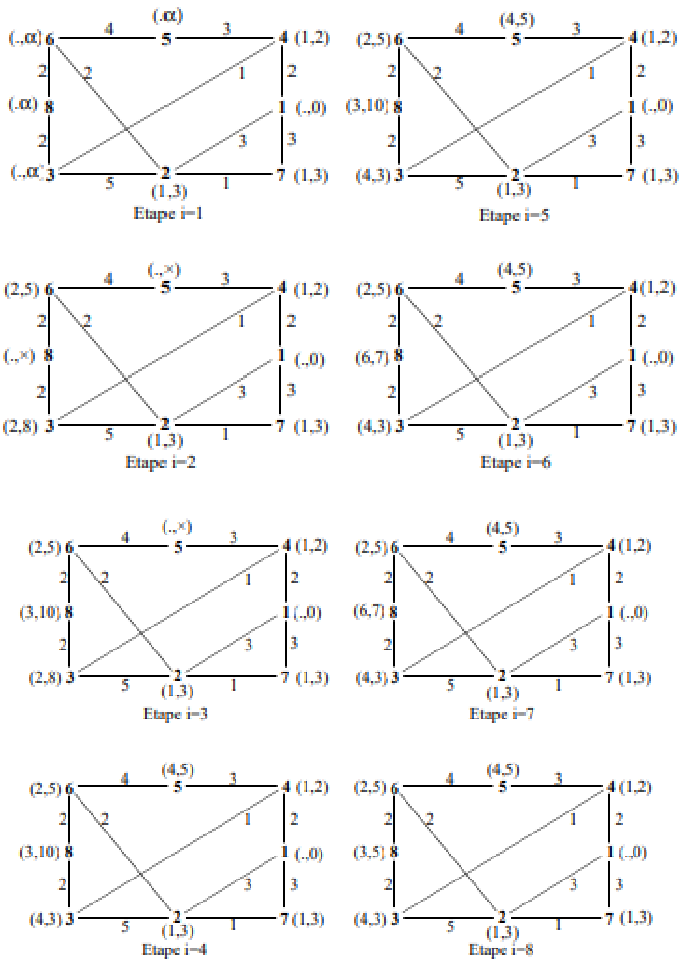


Figure 5. Successive iteration

E. *Dijkstra algorithm*

Optimization of the data transport paths from a sending machine to the recipient is made possible by two techniques, namely: the link state and the remote vector. First, talk about the link state it is important to remember that it is recommended to optimize your line by examining the transport flow in the network in relation to the bandwidth of your line. Then, by choosing the remote vector, it is necessary to instruct the router to play on the search for the optimal path in the network, this choice is possible only with the routing protocols which examine the number of hops to be traveled in the network from the transmission to the reception. The DIJKSTRA algorithm that we present is integrated into the routing protocols and allows each router to calculate all optimal paths in the packet routing process in computer networks. The logic of DIJIKSTRA uses the following elements [6]:

- A graph G = (x, u);
- A starting peak s. each vertex x is associated with the cost of the best-known path called weight(x). The neighbor by which one "arrives" to realize the best-known path is also memorized for each summit;
- All summits;
- ∏ All optimal vertices.

Starting the algorithm

Initializing

Weight(s)← 0

Poids (x) ← +∞

Y Ø

Start

As ≠s

Choose a vertex x ∈ of minimum weight

{x}

For any neighbor y of x ∈϶

If weight(x)+value(x,y) < weight(y)

Then weight(y) ← weight(x)+value(x,y)

Memorize in y that one comes from x

finished

end for all

ending as

Finish

Since the principle of this algorithm is used by network routers to indicate to packets the route to be used from the transmission to the reception, we will present below how this principle becomes an essential element in the optimization of the computer network.

F. *Distance Vector Algorithms*

The *Distance Vector* algorithm, also called the Bellman - Ford algorithm, is an algorithm for which each node exchanges its routing table with its neighbors, in order to update its content, so that it contains the shortest distance to each destination. For this purpose, each router executing this algorithm has in memory a routing table comprising an entry per destination, the content of which comprehends [7]:

- the destination to be reached,
- the cost to reach that destination (expressed as a metric),
- the next neighbor to this destination.

This algorithm is implemented in the following protocols: RIP (Routing Information Protocol), BGP (Boarder *Gateway Protocol)*, IGRP (Interior *Gateway Routing Protocol).*

The steps of the algorithm are:

- each router is initialized with its own identifier, the cost of links to each of its neighbors and a zero cost to itself.
- each router periodically broadcasts to each of its neighbors its routing table containing the nodes of the network and the associated cost to reach them.
- when a router receives a new routing table, it calculates its own distance vector by performing the following processes for each entry in the table:
- If the entry is not present in the table, the router adds it to its own table.
- If the cost reported by one of the neighbors added to the cost to reach that neighbor is less than the cost already stored, then the routing table is updated with the new path.
- If the cost reported by another neighbor added to the cost to reach that neighbor is greater than the cost already stored, then the corresponding entry in the routing table remains unchanged, since the shortest path to each destination is selected.

If a router discovers that a link to one of its neighbors is broken, it updates the corresponding entry in its routing table (infinite cost) [15].

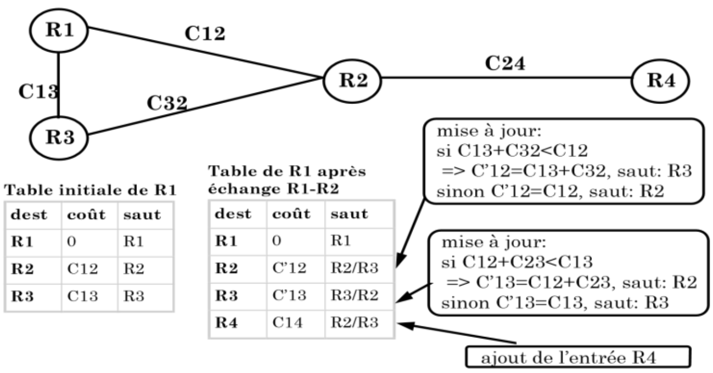


Figure 6. Vector distance on an example topology

The routing tables are exchanged periodically, in order to update for each router the shortest path to each of the destinations. Figure 7. illustrates in part the execution of the *distance vector* algorithm on a simple topology example.

The problem with this method is that a number of iterations must be performed before the algorithm converges (that is, until the content of the routing tables no longer evolves). This can cause loops when the length of a path increases (example: break of a communications link) and result in a significant increase in transmission delay or even packet loss. This problem known as the counting effect is illustrated from the topology shown in Figure 7. This example considers three communication nodes denoted A, B and C connect ed together by unit cost links [9].

Suppose the link between routers B and C is broken. Upon noticing the break of this link, Router B rejects the routing table it has previously received from Router C and recalculates its distance vector. Unfortunately, Router B will not conclude at this time that Router C has become inaccessible; it will establish that its cost to Router C is equal to 3 based on the fact that it is neighbor to Router A (cost of 1 to A) and that Router A has reported to it that it is at a distance (cost) of 2 from Router C. Since the routing table of Router B has changed, Router B will forward the modified routing table to its neighbors still in activity (here Router A). Router A, having received a modified routing table from neighbor B, will recalculate its own table and conclude that C is now at a distance of 4. Both Routers A and B will continue this

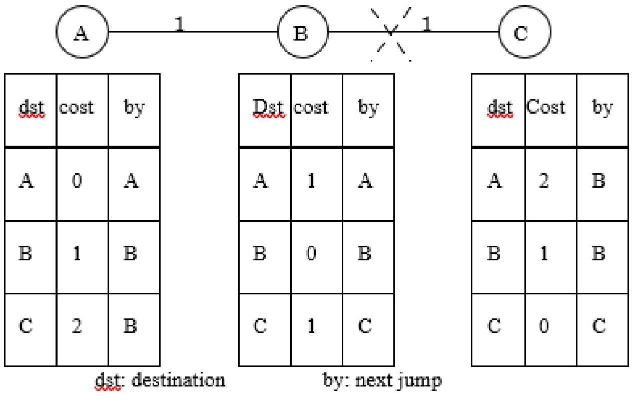


Figure 7. Counting effect sensitive topology

process and increment their distance from Router C until they reach the maximum allowed distance (Routers A and B will finally detect that Destination C has become inaccessible). The formation of a routing loop induced by the counting effect will then considerably slow down the convergence of the algorithm.

The time diagram (see Table 2.) shows the cost updates performed by Routers A and B for Destination C at each iteration of the *algorithm* and highlights the counting effect. The times (T1, T2, etc.) indicated in this table correspond to the update times of routers A and B after the break of the link BC assumed to have occurred at time T0.

Time	**T1**	**T2**	**T3**	**T4**	**T5**
Router A (distance A-C)	2	4	6		
Router B (distance B-C)				3	5

Table 2. Time diagram of the exchanges

It is important for the algorithm to have a low convergence time to detect destinations that have become inaccessible, so mechanisms must be used to avoid the formation of loops in order to ensure consistency between the actual topology of the network and that perceived by the routing algorithm. Several techniques have been implemented to accelerate the convergence of this algorithm [13]:

- the infinite "fixed" cost,
- the cut horizon,

- the coordination protocol for the nodes,
- triggered updates.

IV. Notions of Routing in Computer Networks

Network routing is the process of selecting a path through one or more networks. Routing principles can apply to any type of network, from telephone networks to public transport. In packet-switched networks, such as the Internet, routing selects the paths that IP (Internet Protocol) packets must take to get from their origin to their destination. These Internet routing decisions are made by specialized network devices called routers .

Look at the picture below. For a data packet to go from computer A to computer B, does it have to go through networks 1, 3 and 5 or networks 2 and 4? The packet will take a shorter path through networks 2 and 4, but networks 1, 3, and 5 might be faster to route packets than networks 2 and 4. This is the kind of choice network routers constantly make [8].

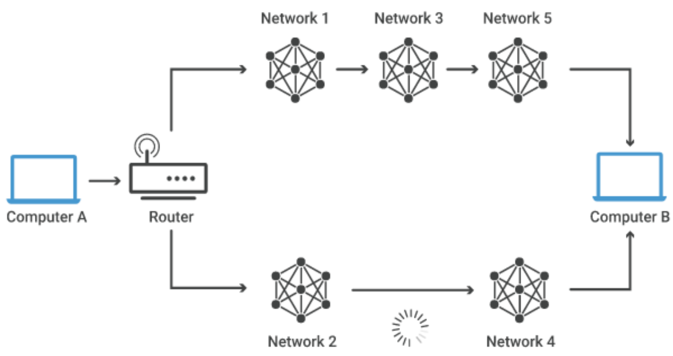


Figure 8. Routing Process

Routers refer to internal routing tables to make routing decisions for packets along network paths. A routing table records the paths that packets must take to reach each destination for which the router is responsible. This is similar to the train schedules that passengers use to decide which train to take. Routing tables are similar, but for network paths rather than trains.
Our study is to optimize the network when sending data from transmission to reception; packet routing becomes an important element that determines this optimization because it is in this process that we must determine the optimal path to save in terms of packet routing time. On this we will present the different types of protocols used at this stage and then opt for a protocol that integrates the algorithm of shorter path as presented above.
In networks, a protocol is a set of standard rules for formatting data so that any connected computer can understand the data. A routing protocol is a protocol used to identify or advertise network paths [12].

Note that there are *external routing protocols,* which are designed to ensure communication between two different networks controlled by two different organizations called autonomous systems, and *internal routing protocols,* intended to ensure communication between the different parts of a network controlled by the same organization (same autonomous system).

In terms of external routing protocols we can quote: The Border Gateway Protocol (BGP) is used to advertise which networks control which IP addresses and which networks connect to each other. (The large networks that make these BGP announcements are called stand-alone systems).

Unlike internal routing protocols that route packets between multiple routers in the same autonomous system; there are two families [13]:

G. *Routing Protocol by Link State:*

The link state protocol falls into the category of internal routing protocols. The best known of these is OSPF (Open Shortest Path First). It was created in the mid-1980s due to the growing inability of another protocol, called RIP (see below), to meet the needs of interests or large and heterogeneous dimensions. Its characteristic is to be in the public domain (open) and based on the DIJIKSTRA algorithm.

H. *Distance vector routing protocol*

This is the protocol most used in TCP/IP. This is a less complex protocol than OSPF. It is based on a protocol called RIP and uses "hop counting" to find the shortest path from one network to another. The “hop count” here means the number of routers through which a packet must pass along the way. (When a packet passes from one network to another, it is referred to as a “jump”) this protocol is also based on a route calculation algorithm called SPF or sometimes Bellman-FORD algorithm, named after its founder.

Other internal routing protocols include Enhanced Interior Gateway Routing Protocol (EIGRP), primarily used with Cisco routers, and Intermediate System to Intermediate System (IS- IS)[8].

From these families of protocols; it should be emphasized that when it is necessary to improve performance by optimizing its network, it is preferable to use either the distance vector protocol or the link state protocol. In the following lines we will present an example of how to configure a network with one of this protocol.

V. Optimal path determination illustration with OSPF protocol

In this section we present the result in two routing scenarios between several system routers _ autonomous, the example taken from a few branches of Equity Bank DRC. First, we will configure the OSPF protocol which incorporates the DIJIKSTRA algorithm for calculating an optimal path for routing packets from transmission to reception. Second, we will the illustration with the example with the routing manual, then compare the two scenarios and draw a conclusion.

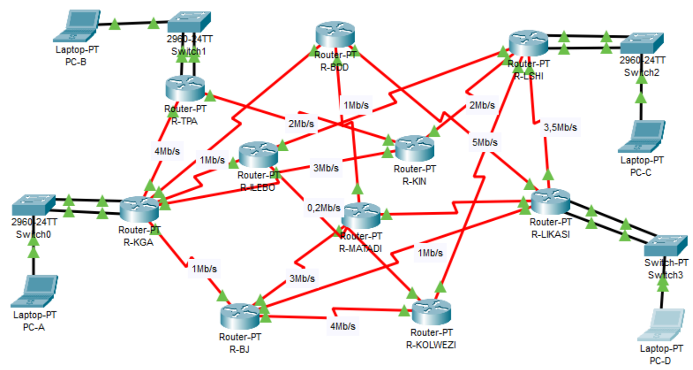
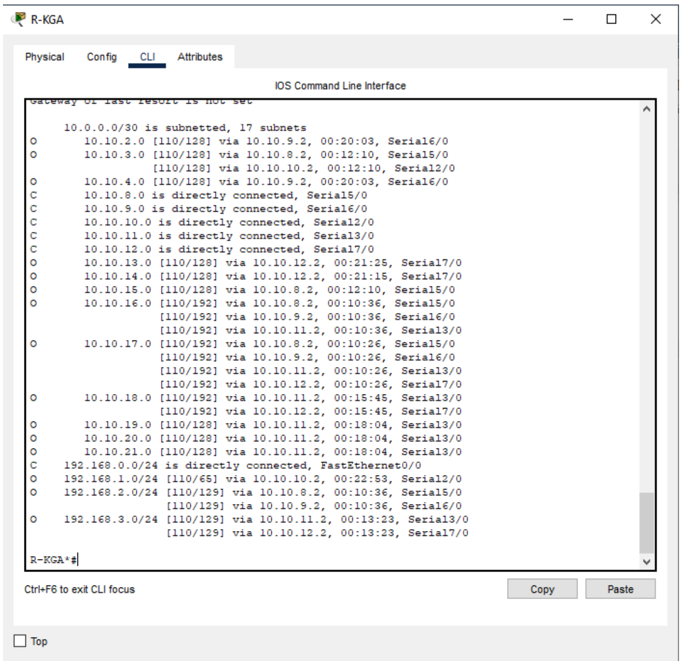


Figure 9. Equity Bank Networks (DRC)

After configuring the OSPF protocol in our autonomous system, we present the routing table of a router in this network and then we will simulate sending packets to trace the route and we will check if the protocol used the shortest path.

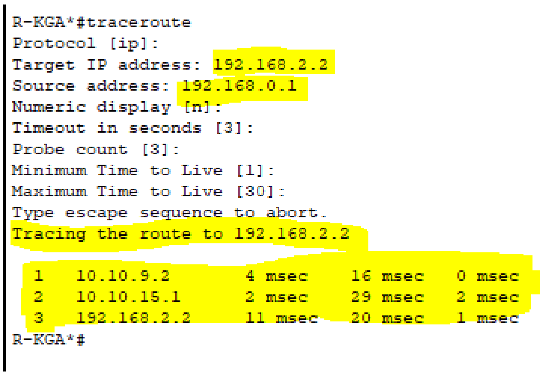


```
R-KGA
Physical   Config   CLI   Attributes
IOS Command Line Interface

     10.0.0.0/30 is subnetted, 17 subnets
O       10.10.2.0 [110/128] via 10.10.9.2, 00:20:03, Serial6/0
O       10.10.3.0 [110/128] via 10.10.8.2, 00:12:10, Serial5/0
                  [110/128] via 10.10.10.2, 00:12:10, Serial2/0
O       10.10.4.0 [110/128] via 10.10.9.2, 00:20:03, Serial6/0
C       10.10.8.0 is directly connected, Serial5/0
C       10.10.9.0 is directly connected, Serial6/0
C       10.10.10.0 is directly connected, Serial2/0
C       10.10.11.0 is directly connected, Serial3/0
C       10.10.12.0 is directly connected, Serial7/0
O       10.10.13.0 [110/128] via 10.10.12.2, 00:21:25, Serial7/0
O       10.10.14.0 [110/128] via 10.10.12.2, 00:21:15, Serial7/0
O       10.10.15.0 [110/128] via 10.10.8.2, 00:12:10, Serial5/0
O       10.10.16.0 [110/192] via 10.10.8.2, 00:10:36, Serial5/0
                   [110/192] via 10.10.9.2, 00:10:36, Serial6/0
                   [110/192] via 10.10.11.2, 00:10:36, Serial3/0
O       10.10.17.0 [110/192] via 10.10.8.2, 00:10:26, Serial5/0
                   [110/192] via 10.10.9.2, 00:10:26, Serial6/0
                   [110/192] via 10.10.11.2, 00:10:26, Serial3/0
                   [110/192] via 10.10.12.2, 00:10:26, Serial7/0
O       10.10.18.0 [110/192] via 10.10.11.2, 00:15:45, Serial3/0
                   [110/192] via 10.10.12.2, 00:15:45, Serial7/0
O       10.10.19.0 [110/128] via 10.10.11.2, 00:18:04, Serial3/0
O       10.10.20.0 [110/128] via 10.10.11.2, 00:18:04, Serial3/0
O       10.10.21.0 [110/128] via 10.10.11.2, 00:18:04, Serial3/0
C    192.168.0.0/24 is directly connected, FastEthernet0/0
O    192.168.1.0/24 [110/65] via 10.10.10.2, 00:22:53, Serial2/0
O    192.168.2.0/24 [110/129] via 10.10.8.2, 00:10:36, Serial5/0
                    [110/129] via 10.10.9.2, 00:10:36, Serial6/0
O    192.168.3.0/24 [110/129] via 10.10.11.2, 00:13:23, Serial3/0
                    [110/129] via 10.10.12.2, 00:13:23, Serial7/0

R-KGA*#
Ctrl+F6 to exit CLI focus   Copy   Paste
Top
```

Figure 10. Routing table R-KGA

A. Scenario routing dynamic with OSPF

We are satisfied with the routing table so our goal was network optimization; Thus, we will test the network, using as source the PC-A of the KGA network which will send the data to the PC-C of the LSHI network to check if normally the configured OSPF protocol will be able to determine the best path based on the aforementioned criteria.



```
R-KGA*#traceroute
Protocol [ip]:
Target IP address: 192.168.2.2
Source address: 192.168.0.1
Numeric display [n]:
Timeout in seconds [3]:
Probe count [3]:
Minimum Time to Live [1]:
Maximum Time to Live [30]:
Type escape sequence to abort.
Tracing the route to 192.168.2.2

  1   10.10.9.2       4 msec    16 msec    0 msec
  2   10.10.15.1      2 msec    29 msec    2 msec
  3   192.168.2.2    11 msec    20 msec    1 msec
R-KGA*#
```

Figure 11. Traceway result

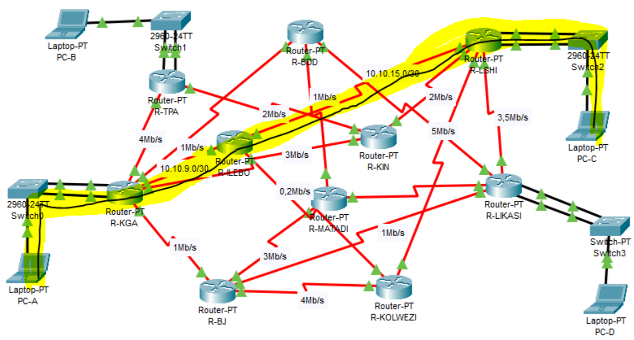
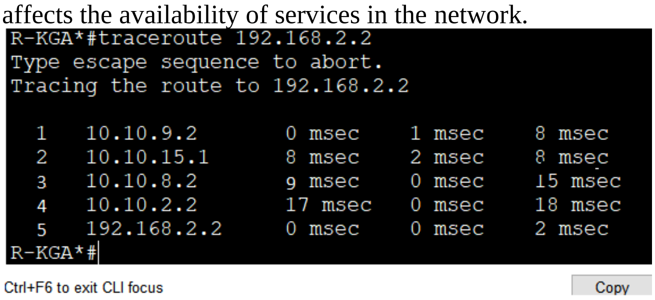


Figure 13. route used from PC-A to PC-B

After checking with the ***traceroute*** command, we find that the protocol has indeed calculated the optimal path for routing packets from PC-A to PC-B by putting emphasis on jump count where the number of routers to traverse.

B. Routing scenario manual

With the second routing scenario manual we find that the packages have to follow the path which with the naked eye is a long way from transmission to reception what can have effects detrimental to data transmission time; thus, it befits to underline in spite of the tape bandwidth as we can have, when the road is drawn manually; she may affect latency. This affects the availability of services in the network.



```
R-KGA*#traceroute 192.168.2.2
Type escape sequence to abort.
Tracing the route to 192.168.2.2

  1   10.10.9.2       0 msec    1 msec    8 msec
  2   10.10.15.1      8 msec    2 msec    8 msec
  3   10.10.8.2       9 msec    0 msec   15 msec
  4   10.10.2.2      17 msec    0 msec   18 msec
  5   192.168.2.2     0 msec    0 msec    2 msec
R-KGA*#
Ctrl+F6 to exit CLI focus   Copy
```

Figure 14. Result traceroute routing manual

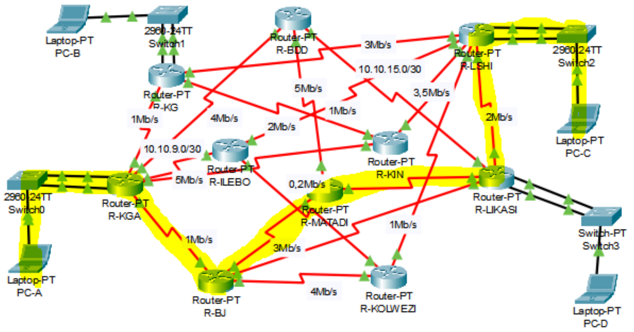


Figure 15. Path traveled by packets from A to B

At the end of the test we have presented in these two scenarios, we can affirm with satisfaction that the optimization of the routing of packets is made possible by choosing a better routing protocol ; and for our cases we recommend to administrators systems and networks computing the routing solution dynamic in configuring in their a system of remote vector protocols to optimize the network and make thus the latter reliable and available; because none company cannot accept slow recording _ neither accepted its agents are private to access the desired resources at any what time. The question of optimization may be solved with several solutions other than the one we have presented in this study.

VI. Conclusion

Communication networks play an increasingly important role in our daily activities, the interruption of the services they provide, or even a significant deterioration in their quality, is becoming less and less acceptable. The availability of services and the reliability of the latter have thus become major issues requiring real methodological advances in several areas. Our contributions in this direction can be divided into two parts: on the one hand, that of performance evaluation and, on the other, that of network optimization. Our work in performance evaluation has presented the elements that slow the availability and reliability of computer network services [16]. Optimization work is essentially devoted to the study of several algorithms and routing protocols used in the routing of data from the source to the destination, then the choice of a protocol judged to be efficient, capable of ensuring optimization by calculating for each packet the shortest path to be taken to reach the destination in order to s ave time-response and thus make the network reliable and its optimal paths. Finally, we illustrated the configuration of such a solution using the Cisco Packet Tracer network simulator.

References

[1] P. Rolin., “*The construction of computer networks”*, 2nd Ed. Hérens , Paris, 2011, p.83

[2] J-B Hountoney, “*static routing, unpublished”*, Dar Es Salaam, 2001, p.29.

[3] L. Saccavini, “*RIP internal routing and OSPF"*, Inria , Paris, 2006, p.3.

[4] J-L. Montagnier., “*Computerized networks through practice”, Eyrolles , Paris, 2008, P.172;*

[5] G. Pujolle ,” The *Networks”*, 2nd Ed. Eyrolles , Paris, 2008, p.85;

[6] G. Pujolle, “*The Networks*”, 4th ed. Eyrolles , Paris, 2016, p. 69-75;

[7] G. Pujolle, “*The Networks*”, 6th ed. Eyrolles , Paris, 2013, p.256-258;

[8] JP. Atelin, “*Networks & Telecoms*”, Ed. Dunod , Paris, 2003; p. 168;

[9] JP.Atelin, “*802.11 Wireless Networks*”, ENI Edition, Brussels, 2018, p.269;

[10] C. Panetto,” Transmission *& networks*”, 2nd edition, Ed. Dunod , Paris, 2009, p.35.

[11] X. Lagrance, “*Mobile radio networks*”, Ed. Hermès sciences, Paris, 2013, p.69-74;

[12] V. Droogenbroeck,“*Principles of analog and digital telecommunications*”; Ed. Hermes Science, Paris, 2015, p.28.

[13] J. Benjamin and T. Julien, "*Client-server architecture*", ed. Dunod 2009, p.99-102;

[14] CCNA 1 Cisco, “*Routing and Switching”*, p.65;

[15] I. Frederick, “*Networks”*, ed. Eyrolle , Paris, 2012, p.425-428.

[16] M. Andrews and L. Zhang, “*The access network design problem. In Proceedings of the 39th Annual IEEE Symposium on Foundations of Computer Science*”, 2008, p.22-24.

[17] WB. Ameur and B. Lia,. *Calculation of routing metrics for the Internet. Annals of Telecommunications*, London, 2010, p.116-118

[18] http://www.unige.ch/dinf/jfl/elem/index.htm

[19] http://reseau.plisson.org/architecture_networks.php