HOP COUNT IN EIGRP METRIC

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ABSTRACT

In a properly designed network, it is expected that multiple routes between any two destinations do exist. If one route becomes unavailable, the traffic flow must continue, without interruptions if possible, through a backup route installed immediately. This paper offers the way to test the influence of RIP protocol and its hop count metric onto EIGRP Protocol, in order to include hop count into EIGRP metric.

One solution to this issue, implemented in the EIGRP routing protocol, is to store in each router its neighbour's routing tables. Then, when a route disappears from the routing table, the router will simply install a new route from the stored information. If a route is not found locally, the router will start time consuming diffusing computations to discover alternative routes.

I. INTRODUCTION

EIGRP stores and maintains backup route, but not for all paths. There are many cases (some of them shown in [1]) when there are existing backup routes, but EIGRP does not store them.

EIGRP's DUAL maintains a topology table separate from the routing table, which includes both the best path to a destination network and any backup paths that DUAL has determined to be loop-free. Loop-free means that the neighbour does not have a route to the destination network that passes through this router.

A route must meet a requirement known as the feasibility condition to be considered as a valid loop-free backup path by DUAL,. Any backup path that meets this condition is guaranteed to be loop-free. Because EIGRP is a distance vector routing protocol, it is possible that there might be loop-free backup paths to a destination network that do not meet the feasibility condition. These paths are therefore not included in the topology table as a valid loop-free backup path by DUAL.

If a route becomes unavailable, DUAL will search its topology table for a valid backup path. If one exists, that route is immediately entered into the routing table. If one does not exist, DUAL performs a network discovery process to see if there happens to be a backup path that did not meet the requirement of the feasibility condition.

There is a new proposed mechanism that improves the convergence by taking into account the hop count that is reported by the neighbouring routers. But, how to test and prove there is an improvement? EIGRP is Cisco proprietary protocol and only operates on Cisco Routers, and cannot be updated.

II. EIGRP METRIC

EIGRP uses the well known *bandwidth* + *delay* metric for route comparison and for detecting routing loops, as default. I will not use the complete composite formula

$$Metric = [K_1 * Bandwidth + (K_2 * Bandwidth)/(256 - Load) + K_3 * Delay] * \\ * [K_5 /(Reliability + K_4)]$$

So, I will use $K_2 = K_4 = K_5 = 0$, that is

$$Metric = [K_1 * bandwidth + K_3 * delay] * 256 \qquad (1)$$

This formula shows the composite metric used by EIGRP. Using the default values for K_1 and K_3, we can simplify this calculation to: the slowest *bandwidth* (or minimum *bandwidth*) plus the cumulative sum of all of the delays to the destination.

In other words, by examining the bandwidth and delay values for all of the outgoing interfaces of the route, we can determine the EIGRP metric. First, determine the link with the slowest bandwidth. That *bandwidth* is used for the (**10,000,000**/*bandwidth*) * **256** portion of the formula. Next, determine the *delay* value for each outgoing interface on the way to the destination. Sum the delay values and divide by 10 (sum of *delay*/10) and then multiply by 256 (* 256). We add the bandwidth and sum of delay values to obtain the EIGRP metric. Note that EIGRP takes the reference bandwidth value of 10,000,000 and divides it by the bandwidth value in kbps. This will result in higher bandwidth values receiving a lower metric and lower bandwidth values receiving a higher metric.

III. IMPLEMENT HOP COUNT INTO EIGRP METRIC

Let's examine the metric coefficients, especially values which depend from K_1 and K_3 in a network where all router interfaces has the same *bandwidth*, and all *delays* are the same, and that value is 256µs. This we can imagine, because EIGRP uses minimum *bandwidth* in the path from the router to the destination, and it is editable value, so we can configure these values.

Now, let's try to implement hop count into EIGRP metric without changing protocol itself.

According (1), and according previously (that is, I will use notation *bandwidth* instead of 10.000.000/min(*bandwidth*)), metric from a particular router to a particular destination network in minimum *n* hops is

$$bandwidth + 10 * n \qquad (2)$$

Just remember that router set the path with a minimum metric as a route to the destination in the routing table. Let's analyze

(2). What do we see here? *Bandwidth* is constant for all paths, and metric depends only from the second part of expression (2), that is 10 * *n*, or more specifically – *n*. We receive that EIGRP metric becomes Hop count metric, which is smallest number of hops from the router to the destination.

IV. BACKUP ROUTES, FEASIBLE SUCCESSOR

The router probably will store many routes in EIGRP topology, but they will have bigger *delay*, and also bigger metric. I must repeat that bandwith is the same for all destination routes, and also minimum *bandwidth* is the same for all paths to the particular destination.

To reach its destination, packet from router must pass next hop router, and decrease the hop count -1. Having (2) as metric for particular destination in *n* hops, one or more neighbour routers will have exactly this minimal *hop count*

$$(n - 1) \tag{3}$$

which is always smaller than *hop count* ***n***. I must note that, for *n* = 0, expression (3) is negative, which is impossible for number of hops. But, that is, the destination network is directly connected to the router, and is already in routing table with metric 0.

EIGRP Metric from this neighbour to the destination is

$$bandwidth + 10 * (n - 1) \tag{4}$$

because sum(*delay*) to the destination is 10 * (*n* - 1). What do we get with (4)? This is the metric from the neighbour router to the destination network. Because that router is configured with EIGRP protocol, the same neighbour router will configure this value as *Feasible Distance* for him to the same destination. Then, with EIGRP protocol, the neighbour router will send this value as *Reported Distance* (minimal) to the first router. With this, neighbour router will become *Feasible Successor* for the first router for the same destination. This is not the only benefit. Every router will receive *Reported Distance* smaller than *Fisible Distance* for every destination. Now, every router will have *Feasible Successor* for every destination, that is, always will store a back up route for every destination.

V. WHAT NOW?

Now, we can examine real network with real parameters for bandwidth and delay, and a copy of that network with above values for the same parameters. What have I done? I included a hop count into EIGRP metric in the copy of original network topology. Every router for every destination (not directly connected, they are already in routing table) will have

- Backup route(s) (if there exists different paths)
- *Feasible Condition* will be always met
- *Feasible Successor*
- *Reported Distance* smaller than *Feasible Distance* to the destination

With this configuration, we can test the network, EIGRP routing, potential existing loops / loop free, having or having not *Feasible Successor* for some destinations, etc.

VI. WHAT NEXT

In routing protocol RIP, maximum distance is 15. That is, every distance greater than 15, is infinity or unreachable.

EIGRP has also limit on the network width. The maximum hop count (network width) is configurable, but cannot be greater than 224.

How we can (try to) apply this measure in EIGRP metric. That is, adding a hop count in the EIGRP metric. I propose as:

$$K_6 * \frac{HC}{MAX - HC} \tag{5}$$

where K_6 is coefficient with the same values as other coefficients in EIGRP metric, that is 0 or 1, *MAX* is maximum hop count in EIGRP autonomous system (which defines unreachable network in EIGRP). Then,

- contribution to metric for directly connected networks will be 0 (preferred network). That is, HC = 0 contributes to metric as 0.
- contribution to metric for unreachable networks will be infinity. That is, HC = MAX contributes division with zero, which is infinity.
- For all other reachable networks will be number between 0 and infinity. That is, smaller hop count, smaller metric, and opposite.

REFERENCES

[1] D. Spasov, M. Gusev, S. Ristov: "*On the Convergence of the EIGRP Routing Protocol*," ICT Innovations 2009, September, 2009.