High Availability WAN Implementation with MPLS to Improve Network Connectivity in a Financial Institution

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***Abstract*—This project was developed to offer high availability system to headquarter offices of a financial institution in order to guarantee communication continuity with their branches. The main objectives was to minimize service time due to link failures and to provide redundancy in data links from each branch to the main communication center with the support of two different providers. A secondary objective was to use both links providers simultaneously for symmetrical traffic balance, using them at the same time and by demand. This project was a useful reference guide for both links providers for similar requirements of new clients.**

***Index Terms*—EIGRP, HSRP, MPLS, Routing protocols.**

I. Introduction

THE client is a financial institution with branches across a region, reason why it depends on the telecommunications links among branches with its main communication center. The project pursued to reduce at a minimum level the lost connection to guarantee service provision.

The proposal consisted in connect every main branches by two links with different telecommunications providers with Multiprotocol Label Switching (MPLS) and Enhanced Interior Gateway Routing Protocol (EIGRP) to perform a high availability Wide Area Network (WAN). MPLS was employed for traffic managing in the providers transport network [1][2]. EIGRP was employed for dynamic routing in the client network and for traffic balancing among each branch with the links of the two providers [3][4]. In addition, Hot Standing Routing Protocol (HSRP) was used to configure redundancy in both links and devices at the main communication center [3][5][6].

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II. Client Requirements

The Institution decided to engage links with two providers with the following characteristics:

- Definition of a main communication center, an alternative communication center, and eleven branches (main branches and secondary branches).
- Symmetrical 2 Mbps bandwidth.
- A link must connect the main communication center. In case of failure, a backup option among each branch with an alternative communication center should be available with the same symmetrical bandwidth of 2 Mbps.
- Each branch should have a traffic balance between the two providers symmetrically. This means, bandwidth consumption graphic of one of the providers (main provider) must be identical to the traffic consumption done by the other provider (secondary provider). This will allow up to have a maximum traffic consumption of 4 Mbps from each branch, adding the allowed bandwidth by the providers.
- Configure a dynamic routing protocol to guarantee faster convergence in case of any incident during transmission.
- In each branch, providers should install one last mile connected to an interface of the router deployed.
- Links deployments by providers at a physical level were a task of both Logistic and Planning departments. Deployments run while WAN design is executing.
- Install two independent last miles in the main communication center, connected in a cross way to two concentrator routers (Fig. 1).

III. Main Communication Center

To simplify dynamic routing protocol configuration at the main communication center, two last miles of the main provider connects to two interfaces of a concentrator router (previously configured with a Hot Standby Routing Protocol - HSRP) to achieve high availability of the CPE. The main router connects to the main provider and the standby router connects to the secondary provider (Fig. 2).

IV. Devices Selection

Routers were chosen consulting routing table performance [7], considering also an oversize of the current traffic demands to extend its useful life (Table 1).

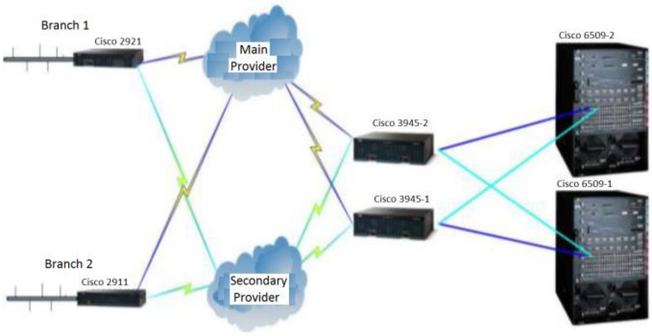

Fig. 1. Topology required at the main communication center.

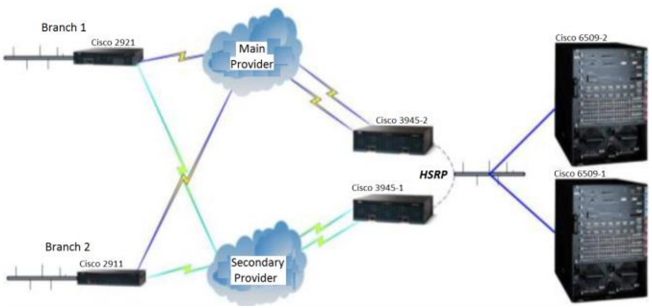

Fig. 2. Topology proposed at the main communication center.

TABLE I
Devices Acquired by the Financial Institution

Device	Quantity	Destiny Location
Router Cisco 3945 SEC	4	2 devices to the the main communication center and 2 devices for the alternative communication center
Router Cisco 2921 SEC	4	4 devices to two main branches
Router Cisco 2911 SEC	20	2 devices for the rest of the branches

Once defined the devices and the routing protocols, the following aspects were considered:

- Every device has three Gigabit interfaces. In each location, Gigabit Ethernet 0/0 connects to the main provider; Gigabit Ethernet 0/1 connects to the secondary provider; and Gigabit Ethernet 0/2 connects to the internal segment of the Institution.
- Definition of IP addressing to avoid overlapping between the providers and the Institution network.
- Both providers use the same EIGRP autonomous system assigned to the Institution (number 65424).
- Providers keep the VRF identity assigned to the Institution. This means, it is not necessary that the VRF of the providers have identical name.

V. Routing Configuration, Main Provider

The MPLS provisioning system of the main provider assigned a VRF, network addressing and VLAN ID for each provider edge router (PE).

A VRF is set and assigns the Router Distinguisher. In addition, import and export destiny routing lists for the VRF set as follows:

ip vrf [*vrf_name*]
rd vrf [*route-distinguisher*]
route-target export [*route- target-ext-community*]
route-target export [*route- target-ext-community*]

VLAN subinterface sets with dot1Q, which corresponds to the VLAN ID assigned in the PE interface connected either to the clients or to the customer edge router (CE). It associates VRF along to the subinterface and assigns IP addressing and subnet mask as follows:

interface [*interface_id*]. [*vlan_id*]
encapsulation dot1Q [*vlan_id*]
ip vrf forwarding [*vrf_name*]
ip address [*ip-address*] [*mask*]
no ip redirects
no ip unreachables
no ip proxy-arp
arp timeout 300

The new VRF sets in the BGP process to propagate the new network assigned in the provider network, as well as it learns the PE networks of this new VRF.

router bgp [*autonomous-system-number*]
address-family ipv4 vrf [*vrf_name*]
no synchronization
redistribute connected
redistribute static
exit-address-family

EIGRP configuration in PE for connection to the CE routers (located in branches) perform by command interfaces in the PE routers at the provider's side, in low impact schedules. The following configuration is set to each PE:

<u>EIGRP activation</u>

router eigrp [*eigrp-autonomous-system-number-isp*]
no auto-summary
!
address-family ipv4 vrf [*vrf_name*]
redistribute bgp [*bgp-autonomous-system-number*] metric 1 1 1 1 1
network [*network-address*] [*wildcard*]
no auto-summary
autonomous-system [*eigrp-autonomous-system-number*]
exit-address-family

<u>MTU configuration</u>

interface [*interface_id*]. [*vlan_id*]

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encapsulation dot1Q [*vlan_id*]
ip vrf forwarding [*vrf_name*]
ip address [*ip-address*] [*mask*]
no ip redirects
no ip unreachables
no ip proxy-arp
ip mtu 1500
arp timeout 300

The following commands set redistribution of learned routes by EIGRP inside BGP, and allowed to every PE of the main provider enabling dynamic routing protocol with every CE located in the branches:

router bgp [*bgp-autonomous-system-number*]
address-family ipv4 vrf [*vrf_name*]
no synchronization
redistribute connected
redistribute static
redistribute eigrp [*eigrp-autonomous-system-number*]
no auto-summary
no synchronization
exit-address-family

VI. Router Installation and Configuration Tests in the Pilot Branch

Once core devices at the providers and last miles in every branch are set, routing devices were configured in the main communication center. Thereafter a router in the pilot branch was installed (Fig. 3).

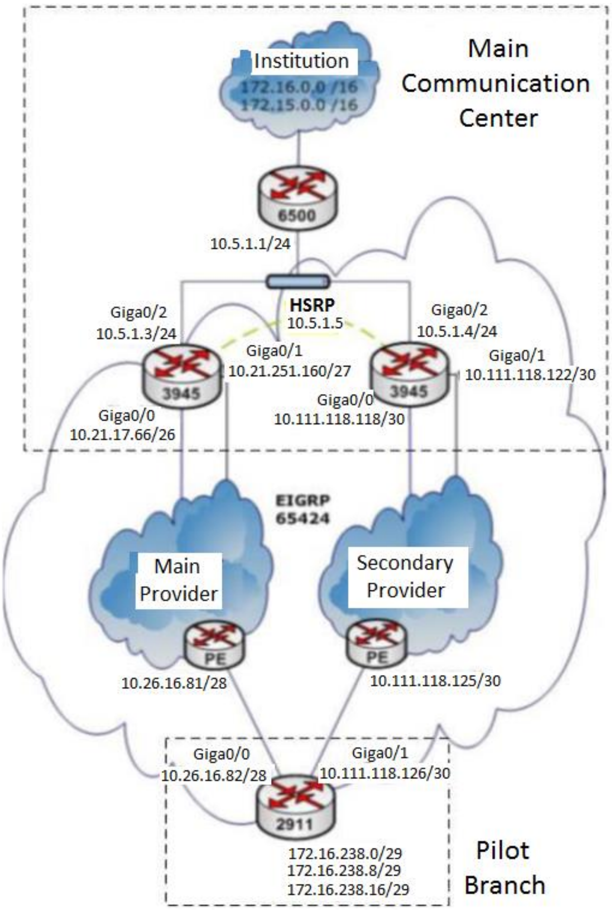

Fig. 3. Topology with pilot branch.

There was traffic generated from the internal network at the pilot branch to the main communication center. Configuration tests were as follows:

- Disconnection of the main provider last mile in the pilot branch for a period, connecting it again. During that period, connectivity was not lost to the main communication center, because traffic conveyed through the secondary provider.
- Disconnection of the secondary provider last mile in the pilot branch for a period, connecting it again. During that period, connectivity was not lost to the main communication center, because traffic conveyed through the main provider.
- Disconnection of the main provider principal link in the main communication center for a period, connecting it again.
- Disconnection of the main provider secondary link in the main communication center for a period, connecting it again.
- Disconnection of the secondary provider principal link in the main communication center for a period, connecting it again.
- Disconnection of the secondary provider secondary link in the main communication center for a period, connecting it again.
- Disconnection of both principal and secondary link of the main provider in the main communication center for a period, connecting it again.
- Disconnection of both principal and secondary link of the secondary provider in the main communication center for a period, connecting it again

With those tests, it was evident that disabling the two links from the main provider connected to the main router at the main communication center (RUIO-COREWAN-01) will cause disconnection from the pilot branch to the main communication center through the secondary provider, so the following change emerged:

- The administrative distance of the secondary router from the main communication center (RUIO-COREWAN-02) changed to a value of 200. This value corresponds to static routes to the main communication center, and is higher than the ones learned (value of 170) by the external EIGRP, learned by EIGRP from RUIO-COREWAN-01.

  RUIO-COREWAN-02
  ip route 172.15.0.0 255.255.0.0 10.5.1.1 200
  ip route 172.16.0.0 255.255.0.0 10.5.1.1 200

- A configuration of static routes in the RUIO-COREWAN-01 to the main communication center, with a *track* to a monitoring network device (in the main provider). In case the two links in the RUIO-COREWAN-01 lose connection with the monitoring device, the *track* erases static routes in its routing table and stops their distribution to RUIO-

COREWAN-02, learning static routes with an administrative distance of 200.

```
RUIO-COREWAN-01
ip route 172.15.0.0 255.255.0.0 10.5.1.1 track 1
ip route 172.16.0.0 255.255.0.0 10.5.1.1 track 1
¡
ip sla 1
icmp-echo 201.218.38.7
threshold 2
frequency 5
ip sla schedule 1 life forever start-time now
```

Traffic balance achievement was not possible in the pilot branch through its two symmetrical links. GigabitEthernet0/2 assigned a defined metric to incoming traffic (with an access list command). Adding the following commands in EIGRP process allowed matching both routing metrics and administrative distance learned by EIGRP, in order to achieve symmetrical traffic balance:

```
router eigrp 65424
distribute-list route-map METRIC in GigabitEthernet0/2
distribute-list route-map METRIC in GigabitEthernet0/0.113
offset-list 50 in 20000000 GigabitEthernet0/1.115
!
access-list 50 permit any
!
route-map METRIC permit 10
match ip address 50
set metric 2048 100 255 1 1500
```

Once accomplished the requirements, next steps were to install and configure routers in the other branches, including remote technical support. Fig. 4 depicts network topology after configurations.

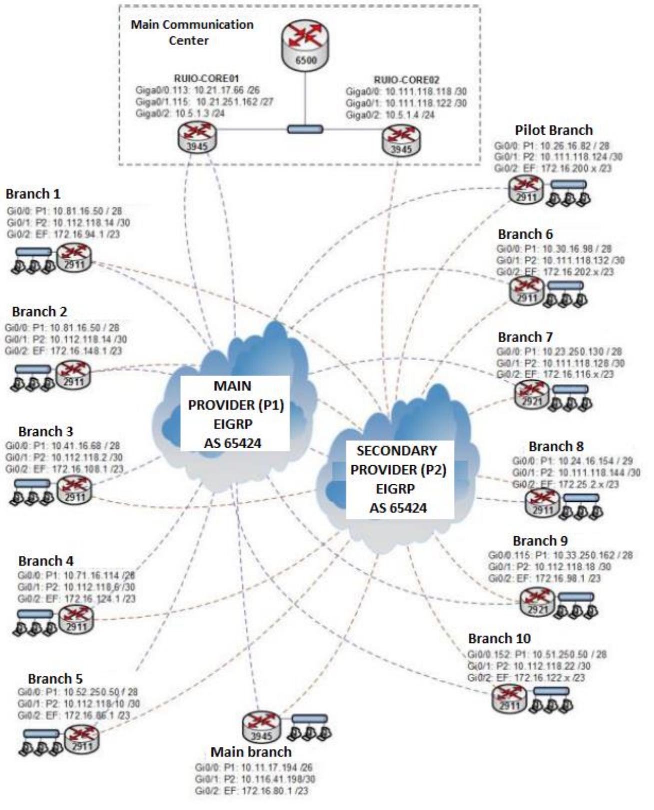

Fig. 4. Topology with all the branches involved.

VII. Alternative Communication Center

The alternative communication center runs when connection shutdowns in the main communication center with both main provider and secondary provider. It has the same segment of the main communication center (172.15.0.0/16 and 172.16.0.0/16).

CE router learns EIGRP routes in normal conditions from both providers' networks with an administrative distance of 170 and with static routes with administrative distance of 200 to main communication center network, but to a router of the internal network of the alternative communication center. Thus, when the router lost connectivity with the segment 172.15.0.0/16 and 172.16.0.0/16, through the main communication center learns static routes with administrative distance of 200 and propagates them to the EIGRP process through both providers' networks in order branches learn automatically a new path to convey information through the alternative communication center.

VIII. Conclusions

It was possible to optimize learning processes in communication links due to an Active-Active configuration, conveying traffic across branches simultaneously through both links in each provider.

MPLS improved routing, as traffic between two branches did not direct towards the main communication center, but directed toward branches through providers networks.

EIGRP over MPLS providers' networks allowed configuring an automatic connection to the alternative communication center when the EIGRP process stops propagation from the main communication center networks and starts learning from the alternative communication center.

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