

S-38.3192
ITGuru Excercise (2: Building the MPLS-capable
Core Network)

Spring 2006

Original version: Johanna Nieminen and Timo Viipuri (2005)
Modified: Timo-Pekka Heikkinen, Juha Järvinen and Yavor Ivanov (2006)

Task Description

This is the second part of the exercise. In this part, you will have to build an MPLS-capable core network connecting the access networks that you created in the previous part. You may use the blocks available in the MPLS object palette (see Figure 1), or other router objects that can also be made MPLS-enabled.

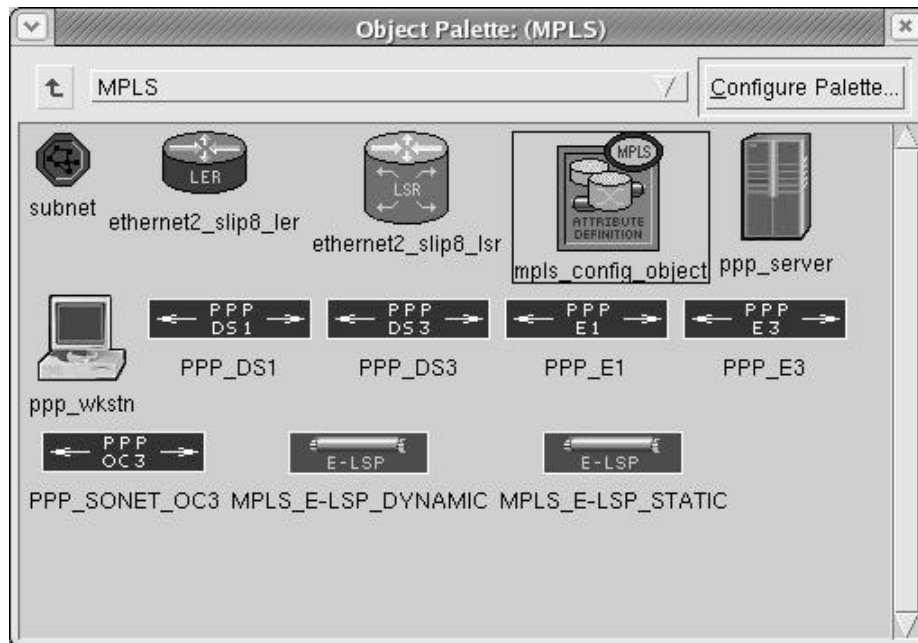


Figure 1 MPLS Object Palette

Before starting the exercise, read briefly through the MPLS Model User Guide from the ITGuru Documentation. Familiarize yourself also with the example MPLS scenarios available in the *p/opnet/11.5A/models/std/example_networks* directory. Especially the MPLS_DiffServ and MPLS_LDP scenarios are useful (you can investigate and run the scenarios from Scenarios->Switch to Scenario).

Creating the Core Network

First, add a sufficient number of Label Switched Routers (LSRs) to the core network. Remember that there should be at least three LSRs between any two subnets. Use appropriate links to connect the routers, for example *PPP_DS1* or *PPP_DS3*. Connect the CE and PE routers with appropriate links (CE here being the gateways in Ethernet sites and DSLAMs in ADSL sites). At this point make sure that every node is properly connected.

Configuring the Core Network

Do the following to configure the core network and to test the network's connectivity:

- Auto-Assign IP-addresses to all interfaces (**Protocols->IP->Addressing->Auto-Assign IP Addresses**)
- Configure OSPF in the core network (**Protocols->IP->Routing->Configure Routing Protocols**)
- Configure OSPF also in the access networks
- Create a traffic flow between two points in the network (try *ip_ping_traffic* demand between two LANs for example)
- Run a simulation and see if traffic goes through the network

You can temporarily use the same routing protocol (instance) that is used in the core to connect the CE-routers to the core so that the core's routes are also present in the CE-routers' routing tables. This way it's easy to test the network without having to configure a separate routing protocol between the CE and PE (which will be done later).

Configuring Label Switched Routers (LSRs)

First, you have to enable MPLS in the LSRs. The easiest way to do this is from the 'Protocols->MPLS->Configure Interface Status'. In the next parts of the exercise you will also have to configure other MPLS parameters as well as routing protocols between the CE and PE. However, do not touch those parameters yet.

Add also an MPLS Configuration Object that defines some general parameters, Forwarding Equivalence Classes (FECs) and Traffic Trunks (use default settings). FECs are used to group packets so that all packets belonging to the group are forwarded in the same way. Traffic Trunks define the traffic profiles and forwarding treatment for the FECs.

Configuring Label Switched Paths (LSPs)

In ITGuru it is possible to create either static or dynamic LSPs. In static LSPs the label operations (push, swap or pop) as well as the incoming and outgoing labels have to be configured separately for each router along the LSP. However, ITGuru can configure the label operations automatically as long as you click separately each router in the path when creating the LSP. In dynamic LSPs Label Distribution Protocol (LDP) and Constrained Shortest Path First (CSPF) are used for creating the paths. Only the source and the destination of the path have to be defined. In this part of the exercise you do not yet have to create the LSPs. However, you may test how they work in principle by configuring an LSP between some LSRs and examining the resulting label operations.

Testing the MPLS network (optional)

This part of the exercise is not required but is highly recommended (since the next exercise will be much more difficult and you'll probably not have much extra time).

- Configure Loopback interfaces: **Protocols -> IP -> Interfaces -> Create Loopback interface** (use OSPF, auto-assign IP addresses)
- Create dynamic LSPs (use palette) – could be strict or loose
- Update LSP: **Protocols -> MPLS -> Update LSP details**
- On the ingress LER: **Edit attributes -> MPLS -> MPLS parameters -> Traffic mapping Config ->** (select incoming interface, FEC class and trunk profile, define the primary and/or backup LSP)
- Also on the ingress **Edit attributes -> MPLS -> MPLS parameters -> Traffic assignment mode -> IGP shortcuts**
- On each LSP (if dynamic): **Edit attributes -> Announce IGP shortcuts -> enable**
- Select all results from **Choose Individual DES statistics -> Path statistics -> LSP**
- Create a traffic flow (if you haven't already), simulate and see if the traffic goes through the LSP

Some hints

Since you are using the same scenario in each part of the exercise, remember to save backups once in a while. In this way you will have an older, working version of your project in case you happen to add some objects to the scenario that cause a total crash of ITGuru.

Homework (Preliminary work for Exercise 3)

Since the VPN exercise (Exercise 3) will take a lot of time, you should start designing the VPN at home by doing the following:

In this part your task is to design the main functions of the MPLS BGP VPNs with plain pen and paper. The idea is that you design one MPLS VPN connecting the sites located in Berlin, Lisbon and Rome.

In ITGuru VPN creation is highly automated and it is even possible to build VPNs without knowing almost anything about the underlying technology or routing protocols. However, in real world you have to know exactly how you should configure the devices. Thus, the idea in this part is that before building the VPNs automatically you carefully consider the device and routing protocol configuration.

Answer at least the following questions related to building the VPNs:

- What are the sites that you want to connect with VPNs?
- What are the corresponding Provider Edge (PE) routers?
- Which autonomous system does the core network and the access networks belong to?
- What routing protocols will be used? Hint: In this exercise it is probably wise to run OSPF in the core and in the access networks and BGP in the PEs (iBGP) and between CE and PE (eBGP)

- What interfaces must be configured as OSPF enabled?
- How and where should the routing information be redistributed? (important!)
- What interfaces must be configured as iBGP and what as eBGP?
- What routers must be configured as BGP peers?
- Are you using static routes in some interfaces? Why?
- Where and how should Virtual Routing Functions (VRFs) be configured?
- Where should Label Switched Paths (LSPs) be configured?
- What are FECs and Traffic Trunks and how are they used?

Sketch a picture of your network (access networks may be represented by a simple cloud) and mark the routing domains, BGP peers and LSPs in the picture.

It may be helpful to examine the example MPLS VPN scenarios available in the **'p/opnet/11.5A/models/std/example_networks'** directory. Notice that some configurations in the scenarios are incomplete, for example the Default Network attribute has not been configured in some interfaces where it should be and some static routes may be missing.

The homework should be returned before the beginning of the next exercise session (7th February, 14 o'clock). Return your paper in the box located in G-wing, second floor.

Exercise Sessions

The exercise session for this task will be arranged on 2nd February at 14 o'clock in computer class Maari-A.

Handout Requirements

The exercise should be returned before the beginning of the next exercise session (9th February, 14 o'clock). Send the exercise package as an e-mail attachment to Timo-Pekka Heikkinen ttheikk2@netlab.hut.fi provided that the size of the attachment is reasonable. Remember also to add the names and student numbers of your group's members to the email. You have to pack the files with the command:

```
tar -cf - -C ~ op_models | gzip > 2_core_network.tar.gz
```