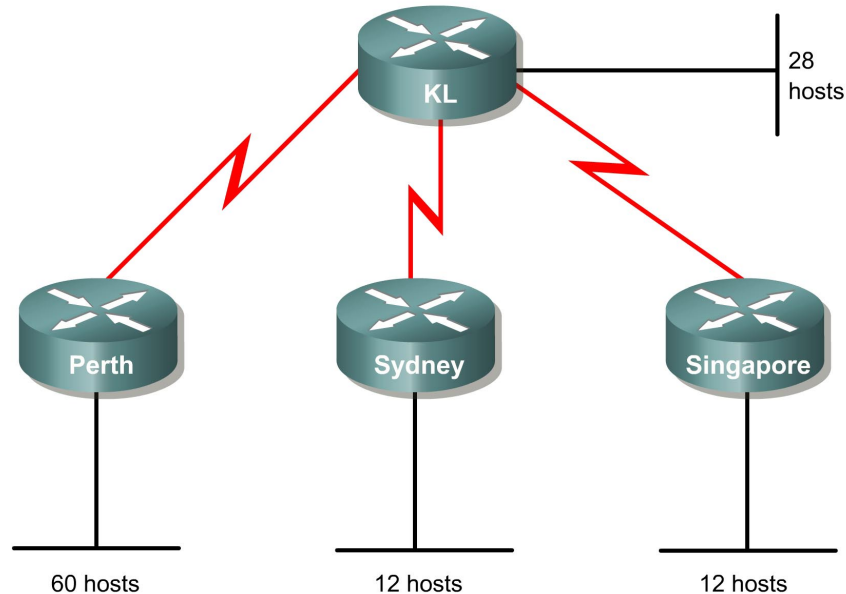## Lab 1.1.4 Calculating VLSM Subnets

Objective

Use variable-length subnet mask (VLSM) to support more efficient use of the assigned IP addresses and to reduce the amount of routing information at the top level.

The solution to this VLSM lab is provided in the steps themselves. Students should take the recommended subnetting in each step and build a diagram of the network, showing routers, LANs and WAN links. Each LAN and WAN link should be labeled with the appropriate subnet address and slash number. A suggested diagram can be found at the end of this lab.

Background/Preparation

A class C address of 192.168.10.0/24 has been allocated.

Perth, Sydney, and Singapore have a WAN connection to Kuala Lumpur.

- Perth requires 60 hosts.

- Kuala Lumpur requires 28 hosts.

- Sydney and Singapore each require 12 hosts.

To calculate VLSM subnets and the respective hosts allocate the largest requirements first from the address range. Requirements levels should be listed from the largest to the smallest.

In this example Perth requires 60 hosts. Use 6 bits since $2^6 - 2 = 62$ usable host addresses. Thus 2 bits will be used from the 4th octet to represent the extended-network-prefix of /26 and the remaining 6 bits will be used for host addresses.

Step 1

The first step in the subnetting process is to divide the allocated address of 192.168.10.0/24 into four equal size address blocks. Since $4 = 2^2$, 2 bits are required to identify each of the 4 subnets.

Next, take subnet #0 (192.168.10.0/26) and identify each of its hosts.

Allocated Address	Sub-networks	62 usable hosts/sub-network (subnet #0)
192.168.10.0/24	192.168.10.0/26	**192.168.10.0/26 (Network Address)**
	192.168.10.64/26	192.168.10.1/26
	192.168.10.128/26	192.168.10.2/26
	192.168.10.192/26	192.168.10.3/26
		thru
		192.168.10.61/26
		192.168.10.62/26
		192.168.10.63/26 (Broadcast Address)

Here is the range for the /26 mask.

Perth	Range of addresses in the last octet
192.168.10.0/26	From 0 to 63, 60 hosts required.
	Hosts 0 and 63 cannot be used because they are the network and broadcast addresses for their subnet.

Step 2

Allocate the next level after all the requirements are met for the higher level or levels.

Kuala Lumpur requires 28 hosts. The next available address after 192.168.10.63/26 is 192.168.10.64/26. Note from the above table that this is subnet number 1. Since 28 hosts are required, 5 bits will be needed for the host addresses, $2^5 - 2 = 30$ usable host addresses. Thus 5 bits will be required to represent the hosts and 3 bits will be used to represent the extended-network-prefix of /27. Applying VLSM on address 192.168.10.64/27 gives:

Sub-network #1	Sub-sub-networks	30 usable hosts
		192.168.10.64/27 (Network Address)
192.168.10.64/26	192.168.10.64/27	192.168.10.65/27
	192.168.10.96/27	192.168.10.66/27
		192.168.10.67/26
		thru
		192.168.10.93/27
		192.168.10.94/27
		192.168.10.95/27 (Broadcast Address)

Here is the range for the /27 mask.

Kuala Lumpur	Range of addresses in the last octet
192.168.10.64/27	From 64 to 95, 28 hosts required. Hosts 64 and 95 cannot be used because they are the network and broadcast addresses for their subnet. Thirty usable addresses are available in this range for the hosts.

Step 3

Now Sydney and Singapore require 12 hosts each. The next available address starts from 192.168.10.96/27. Note from Table 2 that this is the next subnet available. Since 12 hosts are required, 4 bits will be needed for the host addresses, 2^4 = 16, 16 – 2 = 14 usable addresses. Thus 4 bits are required to represent the hosts and 4 bits for the extended-network-prefix of /28. Applying VLSM on address 192.168.10.96/27 gives:

Sub-network	Sub-sub-networks	14 usable hosts
192.168.10.96/27	192.168.10.96/28	**192.168.10.96/28 (Network Address)**
	192.168.10.112/28	192.168.10.97/28
		192.168.10.98/28
		192.168.10.99/28
		thru
		192.168.10.109/28
		192.168.10.110/28
		192.168.10.111/28 (Broadcast Address)

Here is the range for the /28 mask.

Sydney	Range of addresses in the last octet
192.168.10.96/28	From 96 to 111, 12 hosts required. Hosts 96 and 111 cannot be used because they are network and broadcast addresses for their subnet. Fourteen useable addresses are available in this range for the hosts.

Step 4

Since Singapore also requires 12 hosts, the next set of host addresses can be derived from the next available subnet (192.168.10.112/28).

Sub-sub-networks	14 usable hosts
192.168.10.96/28	**192.168.10.112/28 (Network Address)**
192.168.10.112/28	192.168.10.113/28
	192.168.10.114/28
	192.168.10.115/28
	Thru
	192.168.10.125/28
	192.168.10.126/28
	192.168.10.127/28 (Broadcast Address)

Here is the range for the /28 mask.

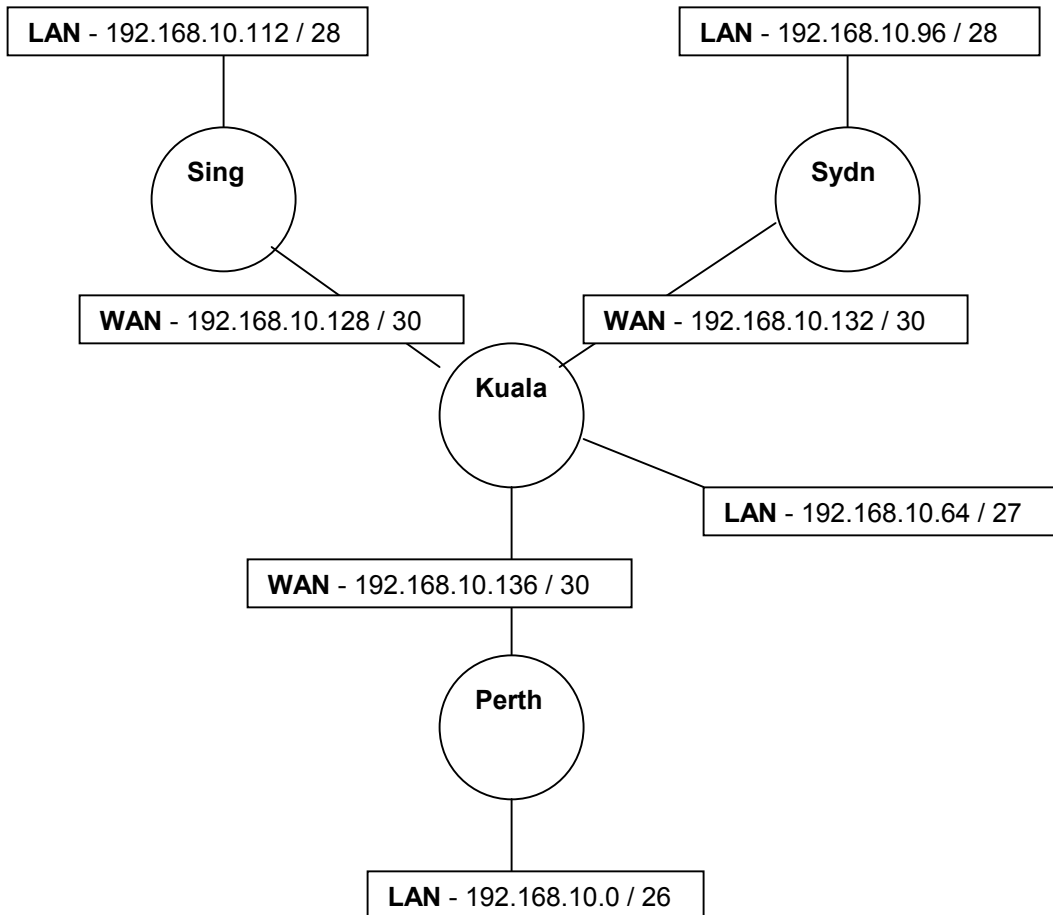| Singapore	Range of addresses in the last octet
192.168.10.112/28	From 112 to 127, 12 hosts required. Hosts 112 and 127 cannot be used because they are network and broadcast addresses for their subnet. Fourteen usable addresses are available in this range for the hosts.

Step 5

Now allocate addresses for the WAN links. Remember that each WAN link will require two IP addresses. The next available subnet is 192.168.10.128/28. Since 2 network addresses are required for each WAN link, 2 bits will be needed for host addresses, $2^2 - 2 = 2$ usable addresses. Thus 2 bits are required to represent the links and 6 bits for the extended-network-prefix of /30. Applying VLSM on 192.168.10.128/28 gives:

Sub-sub-networks	14 usable hosts
192.168.10.128/30	**192.168.10.128/30(Network Address)**
	192.168.10.129/30
	192.168.10.130/30
	192.168.10.131/30 (Broadcast Address)
192.168.10.132/30	**192.168.10.132/30(Network Address)**
	192.168.10.133/30
	192.168.10.134/30
	192.168.10.135/30 (Broadcast Address)
192.168.10.136/30	**192.168.10.136/30 (Network Address)**
	192.168.10.137/30
	192.168.10.138/30
	192.168.10.139/30 (Broadcast Address)

The available addresses for the WAN links can be taken from the available addresses in each of the /30 subnets.

Solution Diagram for VLSM lab

LAN - 192.168.10.112 / 28

LAN - 192.168.10.96 / 28

Sing

Sydn

WAN - 192.168.10.128 / 30

WAN - 192.168.10.132 / 30

Kuala

LAN - 192.168.10.64 / 27

WAN - 192.168.10.136 / 30

Perth

LAN - 192.168.10.0 / 26

This diagram illustrates how the Class C address was subnetted using VLSM. The network address and broadcast address for each subnet are shown in the corners of each box.

0		128 /30 131	136 /30 139	160
		132 /30 135	140 /30 143	
/26		144		
63		159		191

64	96 /28 111	192
	112	
/27	/28	
95	127	255