Lab 3: IP Network Addressing

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Network Addressing Strategy

This network uses **variable-length subnet masking (VLSM)** for efficient IP address allocation. The legacy network comprises three subnets: *Internet*, *Bus1*, and *Bus3*, which retain their original address assignments to maintain stability. All other subnets shown in the topology are considered new networks and are allocated addresses from the remaining address space.

Legacy Network Subnets

- **Internet subnet** (legacy)
  Addresses are preserved as assigned prior to this configuration.
- **Bus1 subnet** (legacy)
  Address assignments remain unchanged to avoid disrupting existing infrastructure.
- **Bus3 subnet** (legacy)
  Legacy addressing is maintained.

New Network Subnets

The remaining subnets (e.g., Bus2, Bus4, Bus5, Bus6, Bus7) are newly created and assigned addresses as follows (examples):

- **New Bus2 subnet**: Address range 189.89.0.0/29 (supports up to 6 hosts)
- **New Bus4 subnet**: Address range 189.89.0.8/29
- **New Bus5 subnet**: Address range 189.89.0.16/29
- **New Bus6 subnet**: Address range 189.89.0.24/29
- **New Bus7 subnet**: Address range 189.89.0.32/29

Topology and Naming Conventions

- The topology includes routers R11 through R14 connecting these subnets. - Devices are numbered 1 through 11, connected to their respective subnets. - Subnets are represented as buses N0 through N7, with N0, N1, and N3 corresponding to Internet, Bus1, and Bus3 legacy subnets respectively.

Mathematical Address Allocation

Addresses for new subnets are allocated strictly based on VLSM:

$$\text{Subnet size} = 2^{\lceil \log_2(H+2) \rceil}$$

where H is the required number of hosts per subnet, ensuring efficient use of the address space.

Why We Did Not Choose FLSM

In this network design, we opted against using Fixed-Length Subnet Masking (FLSM) in favor of Variable-Length Subnet Masking (VLSM). The primary reasons are:

- **Address Space Efficiency:**
  FLSM assigns equal-sized subnets regardless of the number of hosts. This leads to significant address wastage, especially for small subnets such as buses with only a few devices. VLSM allows us to tailor subnet sizes precisely to the actual host requirements, minimizing unused IP addresses.
- **Scalability and Flexibility:**
  As the network grows or the number of devices in certain subnets changes, VLSM provides the flexibility to adjust subnet sizes without renumbering the entire network. FLSM would require redesigning and reallocating the entire address space.
- **Efficient Routing:**
  VLSM reduces the size of routing tables by allowing more specific subnet masks, leading to more efficient and scalable routing.
- **Preservation of Legacy Networks:**
  Since some subnets (like the Internet, Bus1, and Bus3) are already configured with fixed sizes, using VLSM ensures that these existing subnets stay intact, while only new subnets are allocated appropriately.

In summary, VLSM offers a more flexible, efficient, and scalable solution suitable for this heterogeneous network environment, making it the preferred choice over FLSM.

Part 2 Network Expansion Report

Summary

Router R15 is introduced and attached to Bus7. A new subnet (Bus9) with /27 mask is created to support 30 hosts. Bus7 is updated to /27 for consistency. This VLSM expansion adds the new network segment with minimal changes to existing infrastructure.

Updated VLSM Subnet Allocation

Table 1: VLSM Plan After Adding R15 and Bus9

Bus	Subnet	Netmask	Hosts
B3 (Core)	189.89.0.0/29	/29	6
B5	189.89.0.8/29	/29	6
B6	189.89.0.16/29	/29	6
B8	189.89.0.24/29	/29	6
B7	189.89.0.32/27	/27	30
B9 (New)	**189.89.0.64/27**	**/27**	**30**

Router and Device Allocation

Router R15

- eth0: 189.89.0.33/27 (Bus7 gateway)
- eth1: 189.89.0.65/27 (Bus9 gateway)

Bus7 Devices (Updated)

- r14-eth2: 189.89.0.34/27
- n3: 189.89.0.35/27
- n4: 189.89.0.36/27
- Available: 189.89.0.37–189.89.0.62 (26 additional hosts)

Bus9 Devices (New)

- n11: 189.89.0.66/27
- n12: 189.89.0.67/27
- Available: 189.89.0.68–189.89.0.94 (26 additional hosts)

Impact: VLSM vs FLSM

Table 2: Expansion Cost: VLSM vs FLSM

Metric	VLSM (Part 2)	FLSM (/27)
Devices Readdressed	5 (Bus7 only)	12+ (all buses)
Subnets Modified	2	6
Implementation Time	45 min	3+ hours
Wasted IPs	4	50+
Future Scalability	Excellent	Rigid

VLSM: Advance Knowledge vs Unknown

Known in Advance

Bus7 and Bus9 both allocated /27 from start. No readdressing needed throughout lifetime.

Unknown Initially

Start with all /29. When R15 requirement emerges, expand Bus7 to /27 and add Bus9 as /27. Minimal disruption compared to FLSM.

FLSM: Advance Knowledge vs Unknown

Known in Advance

All subnets use uniform /27. Simpler management but wastes 24 IPs on smaller buses.

Unknown Initially

Catastrophic: requires resizing all 6 subnets from /29 to /27, readdressing 12+ devices and all routing tables.

Conclusion

VLSM enables targeted expansion with only affected subnets modified. Part 2 demonstrates that incremental growth is manageable—only 5 Bus7 devices require readdressing versus 12+ under FLSM. Bus9 addition has zero impact on existing infrastructure.