Subnet Design Practice Solutions

Question 1: Medium-Sized Organization Network

Requirements Summary

- 3 departments: HR (50 hosts), IT (110 hosts), Accounts (30 hosts)
- IP block: 170.170.0.0/16
- Support 20% future growth
- Minimize address wastage using VLSM

Step 1: Calculate Host Requirements with Growth

Department	Current Hosts	20% Growth	Required Hosts	Required Addresses
IT	110	22	132	256 (/24)
HR	50	10	60	128 (/25)
Accounts	30	6	36	64 (/26)

Step 2: VLSM Subnetting Scheme

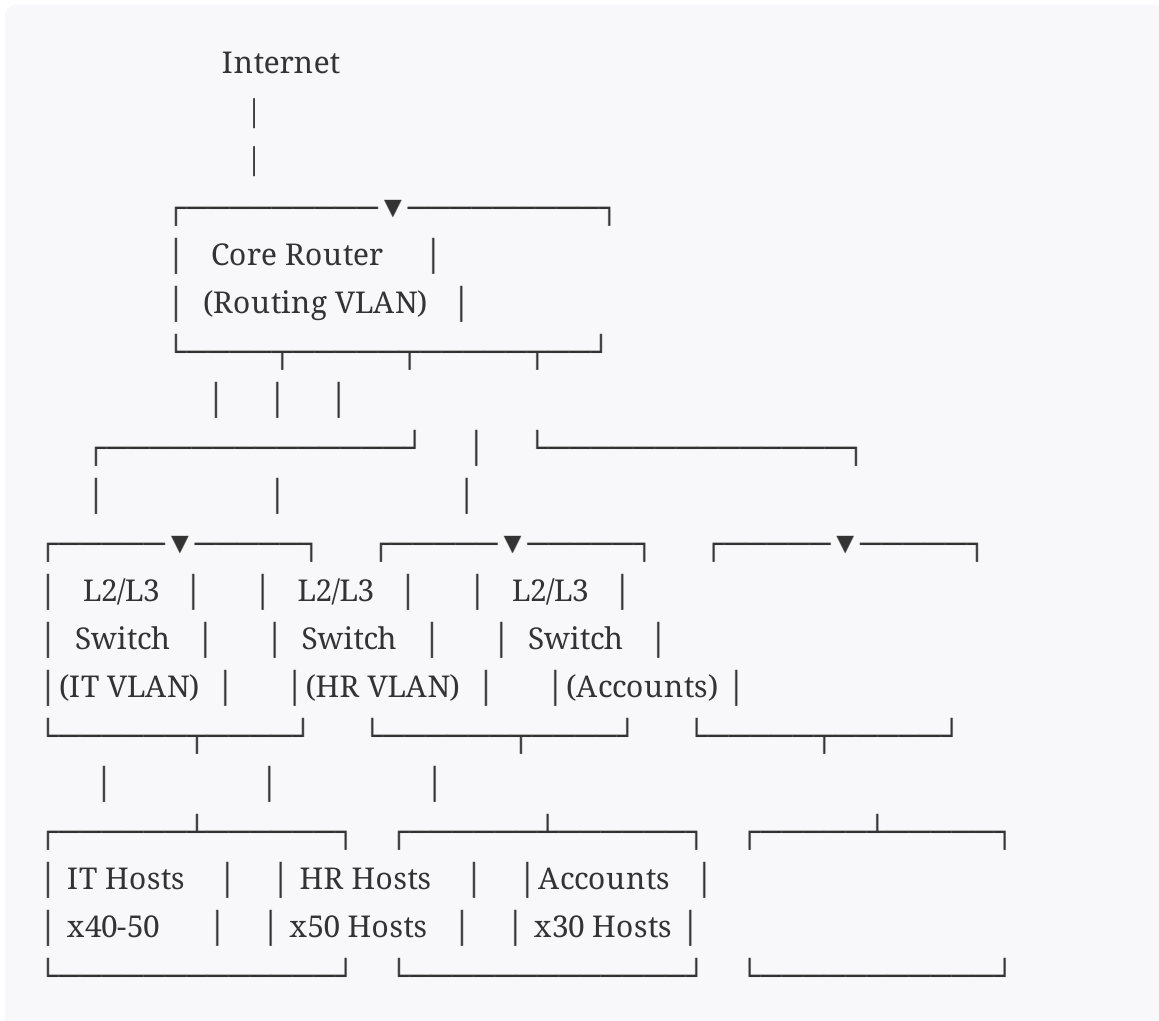| Department	Network Address	Subnet Mask	First Host	Last Host	Broadcast	Hosts
IT	170.170.0.0/24	255.255.255.0	170.170.0.1	170.170.0.254	170.170.0.255	254
HR	170.170.1.0/25	255.255.255.128	170.170.1.1	170.170.1.126	170.170.1.127	126
Accounts	170.170.1.128/26	255.255.255.192	170.170.1.129	170.170.1.190	170.170.1.191	62

Step 3: Address Allocation Strategy

Why this approach minimizes wastage:

- IT department (largest) gets /24 (256 addresses) - fits 132 required hosts with room for growth
- HR department gets /25 (128 addresses) - fits 60 required hosts efficiently
- Accounts gets /26 (64 addresses) - fits 36 required hosts with minimal waste
- Total usable IPs: 254 + 126 + 62 = 442 addresses from 576 available (/16)

- Utilization efficiency: 76.9% - excellent optimization

Step 4: Network Topology

```
                    Internet
                       |
                       |
             ┌─────────▼─────────┐
             |   Core Router     |
             |  (Routing VLAN)   |
             └─────────────────┘
                 |   |   |
         ┌───────────┘   |   └───────────┐
         |               |               |
     ┌───▼───┐       ┌───▼───┐       ┌───▼───┐
     | L2/L3 |       | L2/L3 |       | L2/L3 |
     | Switch|       | Switch|       | Switch|
     |(IT VLAN)|     |(HR VLAN)|     |(Accounts)|
     └───────┘       └───────┘       └───────┘
         |               |               |
     ┌───┴───┐       ┌───┴───┐       ┌───┴───┐
     |IT Hosts|      | HR Hosts|     |Accounts|
     | x40-50 |      | x50 Hosts|    | x30 Hosts|
     └───────┘       └───────┘       └───────┘
```

Question 2: Company with Four Departments

Requirements Summary

- IP block: 10.10.0.0/17 (32,768 addresses)
- Departments: Admin (40), Sales (25), Engineering (70), Support (15)
- Allow 30% growth in each department
- Use VLSM

Step 1: Calculate Hosts with 30% Growth

Department	Current	+30%	Total Required	Subnet Size	CIDR
Engineering	70	21	91	128	/25
Admin	40	12	52	64	/26
Sales	25	7.5	33	64	/26
Support	15	4.5	20	32	/27

Step 2: VLSM Subnet Allocation

Department	Network Address	Subnet Mask	Usable Range	Broadcast	Gateway
Engineering	10.10.0.0/25	255.255.255.128	10.10.0.1 - 10.10.0.126	10.10.0.127	10.10.0.1
Admin	10.10.0.128/26	255.255.255.192	10.10.0.129 - 10.10.0.190	10.10.0.191	10.10.0.129
Sales	10.10.0.192/26	255.255.255.192	10.10.0.193 - 10.10.0.254	10.10.0.255	10.10.0.193
Support	10.10.1.0/27	255.255.255.224	10.10.1.1 - 10.10.1.30	10.10.1.31	10.10.1.1

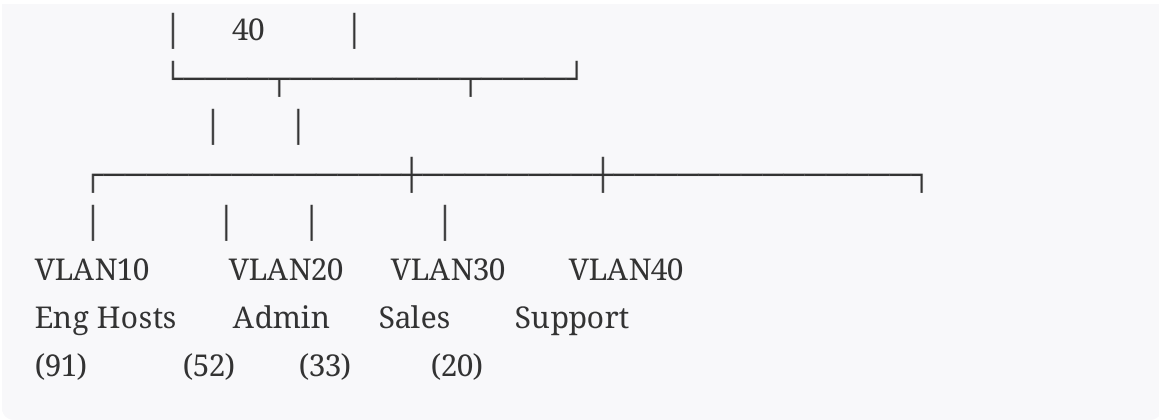## Step 3: VLAN and Topology Configuration

VLAN Configuration:

- VLAN 10: Engineering (Gateway: 10.10.0.1/25)
- VLAN 20: Admin (Gateway: 10.10.0.129/26)
- VLAN 30: Sales (Gateway: 10.10.0.193/26)
- VLAN 40: Support (Gateway: 10.10.1.1/27)

Topology Description:
The network uses a centralized router with VLAN support. Each department connects via a managed switch configured with appropriate VLAN IDs. Inter-VLAN routing occurs at the router, enabling secure communication between departments while maintaining network segmentation.

```
        ┌──────────────────┐
        │  Core Router     │
        │  (VLAN 10,20,30) │
```

```
            |    40     |
          |_____|
            |      |
         |_____|
         |       |    |       |
VLAN10        VLAN20   VLAN30     VLAN40
Eng Hosts      Admin    Sales     Support
(91)        (52)    (33)      (20)
```

Question 3: Branch Office Network

Requirements Summary

- IP block: 192.168.0.0/16
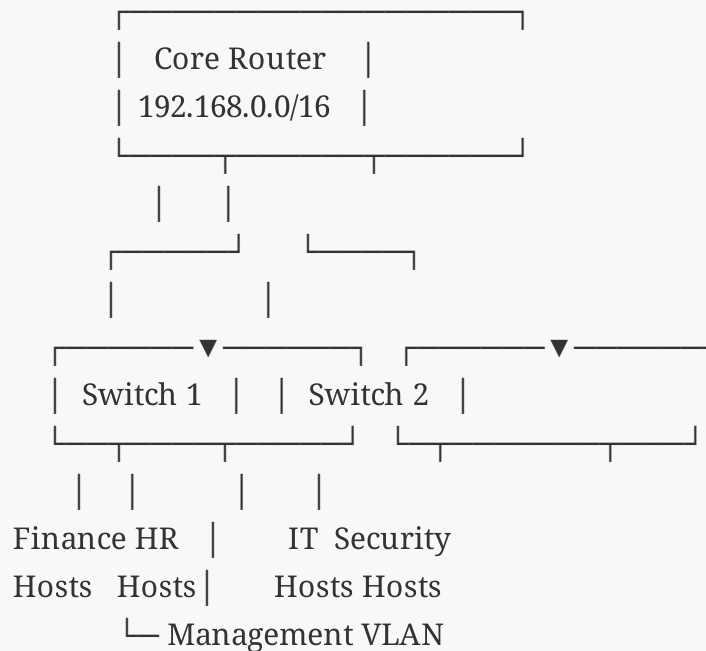- Departments: HR (20), Finance (30), IT (10), Security (5)
- Use VLSM

Step 1: VLSM Planning

Department	Hosts	Subnet Size	CIDR	Addresses
Finance	30	64	/26	62 usable
HR	20	32	/27	30 usable
IT	10	16	/28	14 usable
Security	5	8	/29	6 usable

Step 2: Subnetting Table

Department	Network	Subnet Mask	Usable Range	Broadcast	Hosts
Finance	192.168.0.0/26	255.255.255.192	192.168.0.1 - 192.168.0.62	192.168.0.63	62
HR	192.168.0.64/27	255.255.255.224	192.168.0.65 - 192.168.0.94	192.168.0.95	30
IT	192.168.0.96/28	255.255.255.240	192.168.0.97 - 192.168.0.110	192.168.0.111	14
Security	192.168.0.112/29	255.255.255.248	192.168.0.113 - 192.168.0.118	192.168.0.119	6

Step 3: Network Topology

```
                    ┌───────────────────┐
                    │   Core Router     │
                    │ 192.168.0.0/16    │
                    └───────────────────┘
                         │     │
                     ┌───┘     └───┐
                     │             │
            ┌────────▼────────┐  ┌────────▼────────┐
            │ Switch 1  │   │ Switch 2  │
            └───────────────┘  └──────────────────┘
              │   │      │   │
              │   │      │   │
          Finance HR   │      IT  Security
          Hosts   Hosts │      Hosts Hosts
                   └── Management VLAN
```

Step 4: Default Gateways and IP Assignment

- Finance: Gateway 192.168.0.1, Range: .1 - .62
- HR: Gateway 192.168.0.65, Range: .65 - .94
- IT: Gateway 192.168.0.97, Range: .97 - .110
- Security: Gateway 192.168.0.113, Range: .113 - .118

Question 4: University Campus Network

Requirements Summary

- IP block: 172.16.0.0/18 (16,384 addresses)
- Science Building (200 hosts), Admin (80), Library (50), Cafeteria (20)
- 25% future scalability
- Use VLSM

Step 1: Calculate with 25% Growth

Building	Current	+25%	Required	Subnet Size	CIDR
Science	200	50	250	256	/24
Admin	80	20	100	128	/25
Library	50	12.5	63	128	/25
Cafeteria	20	5	25	32	/27

Step 2: Subnet Mask and Ranges

Building	Network	Subnet Mask	First Host	Last Host	Broadcast	Total Hosts
Science	172.16.0.0/24	255.255.255.0	172.16.0.1	172.16.0.254	172.16.0.255	254
Admin	172.16.1.0/25	255.255.255.128	172.16.1.1	172.16.1.126	172.16.1.127	126
Library	172.16.1.128/25	255.255.255.128	172.16.1.129	172.16.1.254	172.16.1.255	126
Cafeteria	172.16.2.0/27	255.255.255.224	172.16.2.1	172.16.2.30	172.16.2.31	30

Step 3: Unused Host Calculation

- Total available in /18: 16,384 addresses
- Total allocated: 254 + 126 + 126 + 30 = 536 addresses
- **Unused addresses: 15,848** (96% efficiency - remaining space for future expansion)

Step 4: Router-on-a-Stick Topology

```
            ┌──────────────────────┐
            │  Router (RoaS)  │
            │   172.16.0.1    │
            └──────────┬───────────┘
               │ Trunk Link (802.1Q)
               │
            ┌────────▼─────────┐
            │ L3 Switch    │
            │ (VLAN Trunk)  │
            └──────────────────┘
              │   │   │
         ┌──────────────────┐  │  ┌──────────────┐
         │         │        │  │  │
         │         │        │
    Science (VLAN10)  Admin (VLAN20)   Library (VLAN30)
      Hosts        Hosts          Hosts
                     │
              Cafeteria (VLAN40)
```
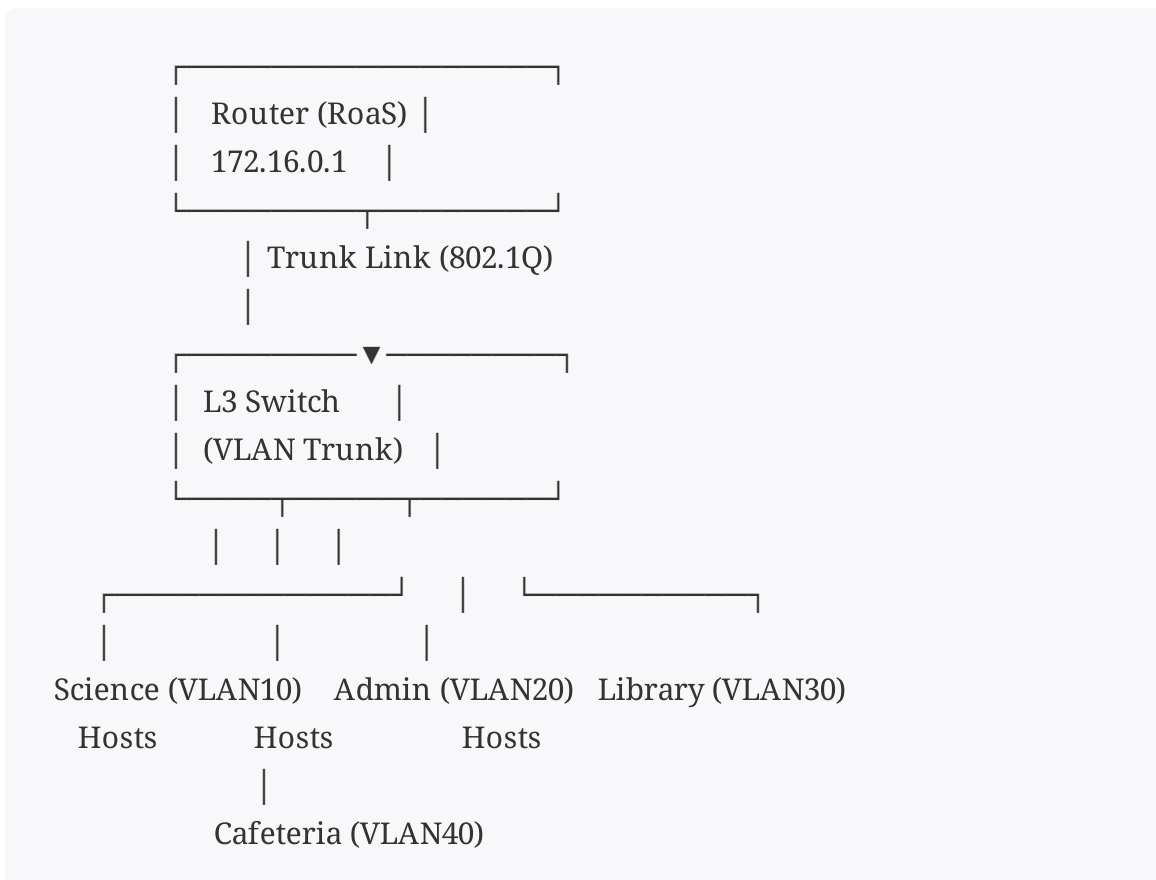
Question 5: Small Company with VLANs

Requirements Summary

- IP block: 192.168.5.0/18 (16,384 addresses)
- IT (60), Accounts (30), HR (20), Guest WiFi (15)
- Separate VLAN for each network
- 20% future growth

Step 1: Host Requirements with 20% Growth

Department	Current	+20%	Required	Subnet	CIDR
IT	60	12	72	128	/25
Accounts	30	6	36	64	/26
HR	20	4	24	32	/27
Guest WiFi	15	3	18	32	/27

Step 2: Subnetting Table

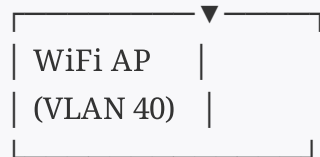| Department	Network	Mask	IP Range	Broadcast	Usable Hosts
IT	192.168.5.0/25	255.255.255.128	192.168.5.1 - 192.168.5.126	192.168.5.127	126
Accounts	192.168.5.128/26	255.255.255.192	192.168.5.129 - 192.168.5.190	192.168.5.191	62
HR	192.168.5.192/27	255.255.255.224	192.168.5.193 - 192.168.5.222	192.168.5.223	30
Guest WiFi	192.168.5.224/27	255.255.255.224	192.168.5.225 - 192.168.5.254	192.168.5.255	30

Step 3: VLAN Implementation

VLAN ID	Department	Network	Gateway	Purpose
VLAN 10	IT	192.168.5.0/25	192.168.5.1	IT Department
VLAN 20	Accounts	192.168.5.128/26	192.168.5.129	Accounts Department
VLAN 30	HR	192.168.5.192/27	192.168.5.193	HR Department
VLAN 40	Guest WiFi	192.168.5.224/27	192.168.5.225	Guest Network (DMZ)

Step 4: Network Topology

```
                    ┌──────────────────────┐
                    │   Core Router    │
                    │ 192.168.5.0/18   │
                    │ (VLAN Support)   │
                    └──────────────────────┘
                            │
                    ┌───────▼───────┐
                    │   Managed    │
                    │   Switch     │
                    │ (VLAN Aware) │
                    └──────────────┘
                      │  │ │
              ┌───────────────┐  │  ┌───────────┐
              │            │            │
          ┌──────▼──────┐    ┌──────▼──────┐    ┌────▼────┐
          │Access  │    │ Access   │   │Access │
          │Switch  │    │ Switch   │   │Switch │
          │(VLAN10) │    │(VLAN20)  │   │(VLAN  │
          └──────────┘    └──────────┘   │ 30)  │
              │       │          │      └───────┘
              │       │      ┌───────────┐
          IT Hosts    Accounts Hosts   HR Hosts
          (72)        (36)         (24)
                                     │
```
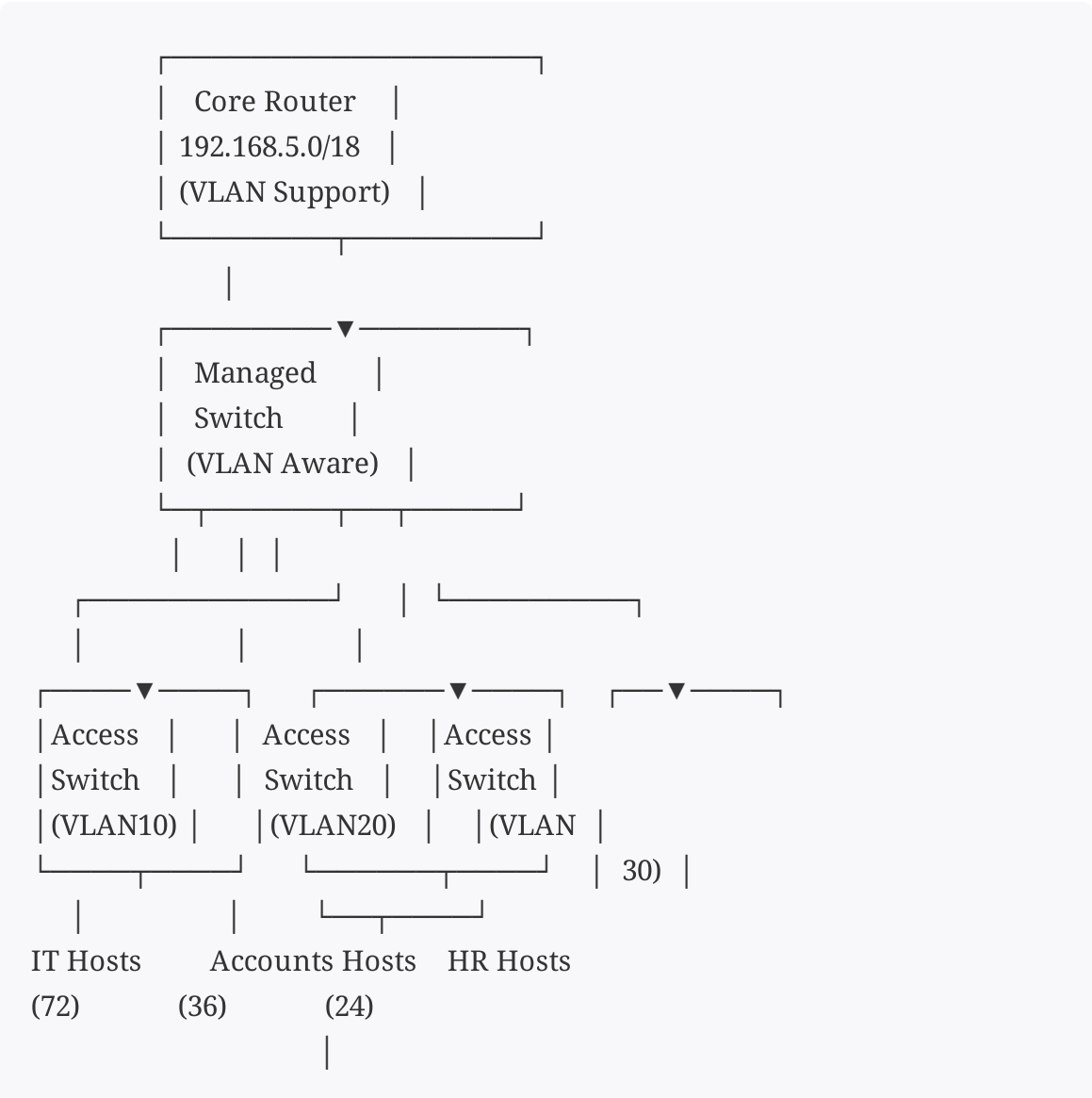
```
          ┌──────▼──────┐
          │ WiFi AP     │
          │ (VLAN 40)   │
          └─────────────┘

          Guest Hosts
          (18)
```

Step 5: Configuration Notes

Router Interface Configuration (VLAN Routing):
Interface VLAN 10 - Gateway: 192.168.5.1/25 (IT)
Interface VLAN 20 - Gateway: 192.168.5.129/26 (Accounts)
Interface VLAN 30 - Gateway: 192.168.5.193/27 (HR)
Interface VLAN 40 - Gateway: 192.168.5.225/27 (Guest - isolated with ACLs)

Access Control Policy:

- Guest VLAN isolated from production VLANs (VLAN 10, 20, 30)
- Guest devices can access internet only
- Production VLANs can communicate through router with proper ACLs
- Accounts VLAN restricted from HR and IT (sensitive data)

Summary of VLSM Benefits

1. **Efficient Address Utilization**: Subnets sized appropriately for each network segment
2. **Minimal Wastage**: No oversized subnets allocated to small departments
3. **Scalability**: Built-in growth capacity for future expansion
4. **Simplified Management**: Logical network organization with clear boundaries
5. **Security**: Easy to implement ACLs and firewall rules per VLAN
6. **Performance**: Reduced broadcast domains improve network efficiency

Key VLSM Formula

For any host requirement:

- Add growth percentage: Required Hosts = Current Hosts × (1 + Growth %)
- Find smallest power of 2 ≥ Required Hosts + 2 (network and broadcast)
- CIDR = 32 - $\log_2$(Subnet Size)
- Subnet Mask = 32 - CIDR bits in host portion