

# IP Network Addressing Lab Report

## RoutingSim Configuration - Legacy & New Building Integration

### Part 1: Network Planning & FLSM Calculations

#### 1.1 Address Space Allocation

##### Given Information:

- Legacy network: Fixed addresses (203.50.60.x, 195.85.10.x)
- New network: 189.89.0.0/16 available
- Requirement: Maximum 30 devices per LAN
- Tool: RoutingSim

#### 1.2 FLSM (Fixed Length Subnet Mask) Calculation for New Network

**Requirement:** 30 hosts per subnet

##### Step 1: Calculate Required Host Bits

$$2^n - 2 \geq 30$$

where  $n$  = host bits, -2 for network and broadcast addresses

$$2^5 - 2 = 32 - 2 = 30 \text{ hosts}$$

**Result:** Need 5 host bits

##### Step 2: Calculate Network Bits

- Total bits in IPv4: 32
- Host bits needed: 5
- Network bits:  $32 - 5 = 27$

##### Step 3: Determine Subnet Mask

- CIDR notation: /27
- Decimal notation: 255.255.255.224
- Binary: 11111111.11111111.11111111.11100000

##### Step 4: Calculate Block Size

- Block size =  $2^{\text{host\_bits}} = 2^5 = 32$
- Each subnet spans 32 IP addresses

- Usable hosts per subnet: 30

### 1.3 New Network Subnetting (189.89.0.0/16)

Using FLSM with /27 subnets:

Subnet #	Network Address	CIDR	First IP	Last IP	Broadcast	Usable Hosts
1	189.89.0.0	/27	189.89.0.1	189.89.0.30	189.89.0.31	30
2	189.89.0.32	/27	189.89.0.33	189.89.0.62	189.89.0.63	30
3	189.89.0.64	/27	189.89.0.65	189.89.0.94	189.89.0.95	30
4	189.89.0.96	/27	189.89.0.97	189.89.0.126	189.89.0.127	30
Core	189.89.0.128	/30	189.89.0.129	189.89.0.130	189.89.0.131	2

**Note:** Core link uses /30 (4 addresses, 2 usable) for router-to-router connection.

### 1.4 Subnet Allocation for Part 1

#### Part 1 Network Design:

- Bus7 (N7): 189.89.0.0/27 → Assigned to r14 with n3, n4
- Bus8 (N8): 189.89.0.32/27 → Assigned to r14 with n5, n6
- Bus5 (N5): 189.89.0.64/27 → Assigned to r13 with n7, n8
- Bus6 (N6): 189.89.0.96/27 → Assigned to r13 with n9, n10
- Bus4 (Core): 189.89.0.128/30 → Assigned to r12, r13, r14

#### Total Devices (Part 1):

- Legacy: 3 nodes (n0, n1, n2)
- New: 8 nodes (n3-n10)
- Routers: 4 (r11, r12, r13, r14)
- Internet: 1 gateway
- **Total: 16 devices**

### Part 2: Network Expansion - Adding Router R5

#### 2.1 Part 2 Requirements

**Challenge:** Add new router R5 at the end of subnetwork N7 (Bus7)

**Goal:** Minimize changes to existing configuration

**Constraint:** Still limit 30 devices per LAN

## 2.2 FLSM Calculation for Part 2

Using same FLSM strategy:

- Subnet size: /27 (30 hosts)
- Next available subnet: 189.89.0.160/27

**Calculation:**

Network: 189.89.0.160

First Usable: 189.89.0.161

Last Usable: 189.89.0.190

Broadcast: 189.89.0.191

## 2.3 Part 2 Subnet Assignment

**Bus9 (New LAN for R5):**

- Network: 189.89.0.160/27
- Gateway: r5-eth1 (189.89.0.161)
- Devices: n11 (189.89.0.162), n12 (189.89.0.163)
- Available: 189.89.0.164 to 189.89.0.190 (27 IPs)

**R5 Placement:**

- r5-eth0: 189.89.0.4 (on Bus7, existing subnet)
- r5-eth1: 189.89.0.161 (on Bus9, new subnet)

## 2.4 Minimal Changes Analysis

**Changes Required:**

1. Add r5 configuration (new)
2. Add n11, n12 configurations (new)
3. Update r14: Add ONE route to 189.89.0.160/27 via 189.89.0.4
4. Update r12, r13: Add routes to 189.89.0.160/27 (via r14)

**Unchanged:**

- All Part 1 device IPs remain same
- All Part 1 routes remain same (except 3 new routes)
- Bus7 subnet unchanged (n3, n4 keep 189.89.0.2, .3)

## Part 3: Complete Device Configuration

### 3.1 Configuration Rules (4-Step Process)

For each device, follow this order:

#### Step 1: Configure ALL interfaces with ifconfig

```
ifconfig <interface> <ip> netmask <mask>;
```

#### Step 2: Add DIRECTLY connected network routes

```
route add -net <network>;
```

#### Step 3: Add routes via gateways

```
route add -net <network> netmask <mask> gw <gateway>;
```

#### Step 4: Add default route

```
route add default gw <gateway>;
```

### 3.2 Legacy Network Devices

#### Device: n0

**Location:** Bus0 (203.50.60.128/27)

**Purpose:** End node on legacy LAN

```
n0
# Step 1: Configure interface
ifconfig eth0 203.50.60.130 netmask 255.255.255.224

# Step 2: Add directly connected network
route add -net 203.50.60.128

# Step 3: No gateway routes needed (end node)

# Step 4: Add default route
route add default gw 203.50.60.129
```

**Device: n1****Location:** Bus0 (203.50.60.128/27)**Purpose:** End node on legacy LAN

```
n1
# Step 1: Configure interface
ifconfig eth0 203.50.60.131 netmask 255.255.255.224

# Step 2: Add directly connected network
route add -net 203.50.60.128

# Step 3: No gateway routes needed (end node)

# Step 4: Add default route
route add default gw 203.50.60.129
```

**Device: n2****Location:** Bus1 (203.50.60.64/27)**Purpose:** End node on legacy LAN

```
n2
# Step 1: Configure interface
ifconfig eth0 203.50.60.70 netmask 255.255.255.224

# Step 2: Add directly connected network
route add -net 203.50.60.64

# Step 3: No gateway routes needed (end node)

# Step 4: Add default route
route add default gw 203.50.60.65
```

**Device: r11****Location:** Bus0, Bus1, Bus3 (Primary router)**Purpose:** Hub router for legacy network, connects to internet

```
r11
# Step 1: Configure ALL interfaces
ifconfig eth0 203.50.60.129 netmask 255.255.255.224
ifconfig eth1 203.50.60.65 netmask 255.255.255.224
ifconfig eth2 195.85.10.50 netmask 255.255.255.0

# Step 2: Add directly connected networks
route add -net 203.50.60.128
route add -net 203.50.60.64
route add -net 195.85.10.0

# Step 3: Add routes via gateways
```

```
route add -net 189.89.0.0 netmask 255.255.0.0 gw 203.50.60.66
```

```
# Step 4: Add default route
```

```
route add default gw 195.85.10.51
```

### Critical Route Explanation:

- `route add -net 189.89.0.0 netmask 255.255.0.0 gw 203.50.60.66`
- This tells r11: "To reach new network (189.89.0.0/16), forward to r12 (203.50.60.66)"
- **Essential for legacy-to-new communication**

### Device: r12 (Part 1 - Legacy Side)

**Location:** Bus1

**Purpose:** Bridge router (legacy side)

```
r12
```

```
# Step 1: Configure interface
```

```
ifconfig eth0 203.50.60.66 netmask 255.255.255.224
```

```
# Step 2: Add directly connected network
```

```
route add -net 203.50.60.64
```

```
# Step 3: No gateway routes on legacy side
```

```
# Step 4: Add default route
```

```
route add default gw 203.50.60.65
```

### Device: internet

**Location:** Bus3 (195.85.10.0/24)

**Purpose:** Internet gateway

```
internet
```

```
# Step 1: Configure interface
```

```
ifconfig eth0 195.85.10.51 netmask 255.255.255.0
```

```
# Step 2: Add directly connected network
```

```
route add -net 195.85.10.0
```

```
# Step 3: Add routes via gateways (return paths)
```

```
route add -net 203.50.60.128 netmask 255.255.255.224 gw 195.85.10.50
```

```
route add -net 203.50.60.64 netmask 255.255.255.224 gw 195.85.10.50
```

```
route add -net 189.89.0.0 netmask 255.255.0.0 gw 195.85.10.50
```

```
# Step 4: No default route (internet is ultimate destination)
```

### 3.3 New Network Devices (Part 1)

#### Device: n3

**Location:** Bus7 (189.89.0.0/27)

**Purpose:** End node on new LAN

```
n3
# Step 1: Configure interface
ifconfig eth0 189.89.0.2 netmask 255.255.255.224

# Step 2: Add directly connected network
route add -net 189.89.0.0

# Step 3: No gateway routes needed (end node)

# Step 4: Add default route
route add default gw 189.89.0.1
```

#### Device: n4

**Location:** Bus7 (189.89.0.0/27)

**Purpose:** End node on new LAN

```
n4
# Step 1: Configure interface
ifconfig eth0 189.89.0.3 netmask 255.255.255.224

# Step 2: Add directly connected network
route add -net 189.89.0.0

# Step 3: No gateway routes needed (end node)

# Step 4: Add default route
route add default gw 189.89.0.1
```

#### Device: n5

**Location:** Bus8 (189.89.0.32/27)

**Purpose:** End node on new LAN

```
n5
# Step 1: Configure interface
ifconfig eth0 189.89.0.34 netmask 255.255.255.224

# Step 2: Add directly connected network
route add -net 189.89.0.32

# Step 3: No gateway routes needed (end node)
```

```
# Step 4: Add default route
route add default gw 189.89.0.33
```

### Device: n6

**Location:** Bus8 (189.89.0.32/27)

**Purpose:** End node on new LAN

```
n6
# Step 1: Configure interface
ifconfig eth0 189.89.0.35 netmask 255.255.255.224

# Step 2: Add directly connected network
route add -net 189.89.0.32

# Step 3: No gateway routes needed (end node)

# Step 4: Add default route
route add default gw 189.89.0.33
```

### Device: n7

**Location:** Bus5 (189.89.0.64/27)

**Purpose:** End node on new LAN

```
n7
# Step 1: Configure interface
ifconfig eth0 189.89.0.66 netmask 255.255.255.224

# Step 2: Add directly connected network
route add -net 189.89.0.64

# Step 3: No gateway routes needed (end node)

# Step 4: Add default route
route add default gw 189.89.0.65
```

### Device: n8

**Location:** Bus5 (189.89.0.64/27)

**Purpose:** End node on new LAN

```
n8
# Step 1: Configure interface
ifconfig eth0 189.89.0.67 netmask 255.255.255.224

# Step 2: Add directly connected network
route add -net 189.89.0.64

# Step 3: No gateway routes needed (end node)
```



```
# Step 4: Add default route
route add default gw 189.89.0.65
```

### Device: n9

**Location:** Bus6 (189.89.0.96/27)

**Purpose:** End node on new LAN

```
n9
# Step 1: Configure interface
ifconfig eth0 189.89.0.98 netmask 255.255.255.224

# Step 2: Add directly connected network
route add -net 189.89.0.96

# Step 3: No gateway routes needed (end node)

# Step 4: Add default route
route add default gw 189.89.0.97
```

### Device: n10

**Location:** Bus6 (189.89.0.96/27)

**Purpose:** End node on new LAN

```
n10
# Step 1: Configure interface
ifconfig eth0 189.89.0.99 netmask 255.255.255.224

# Step 2: Add directly connected network
route add -net 189.89.0.96

# Step 3: No gateway routes needed (end node)

# Step 4: Add default route
route add default gw 189.89.0.97
```

### Device: r12 (Part 2 - New Network Side)

**Location:** Bus4 (Core link)

**Purpose:** Bridge router (new network side)

```
r12
# Step 1: Configure interface
ifconfig eth1 189.89.0.129 netmask 255.255.255.252

# Step 2: Add directly connected network
route add -net 189.89.0.128
```

```
# Step 3: Add routes via gateways
route add -net 189.89.0.0 netmask 255.255.255.224 gw 189.89.0.131
route add -net 189.89.0.32 netmask 255.255.255.224 gw 189.89.0.131
route add -net 189.89.0.64 netmask 255.255.255.224 gw 189.89.0.130
route add -net 189.89.0.96 netmask 255.255.255.224 gw 189.89.0.130
route add -net 189.89.0.160 netmask 255.255.255.224 gw 189.89.0.131

# Step 4: No default route (uses legacy default via eth0)
```

## Device: r13

**Location:** Bus4, Bus5, Bus6 (Edge router)

**Purpose:** Serve new LANs (Bus5, Bus6)

```
r13
# Step 1: Configure ALL interfaces
ifconfig eth0 189.89.0.130 netmask 255.255.255.252
ifconfig eth1 189.89.0.65 netmask 255.255.255.224
ifconfig eth2 189.89.0.97 netmask 255.255.255.224

# Step 2: Add directly connected networks
route add -net 189.89.0.128
route add -net 189.89.0.64
route add -net 189.89.0.96

# Step 3: Add routes via gateways
route add -net 189.89.0.0 netmask 255.255.255.224 gw 189.89.0.131
route add -net 189.89.0.32 netmask 255.255.255.224 gw 189.89.0.131
route add -net 189.89.0.160 netmask 255.255.255.224 gw 189.89.0.131

# Step 4: Add default route
route add default gw 189.89.0.129
```

## Device: r14

**Location:** Bus4, Bus7, Bus8 (Edge router)

**Purpose:** Serve new LANs (Bus7, Bus8)

```
r14
# Step 1: Configure ALL interfaces
ifconfig eth0 189.89.0.131 netmask 255.255.255.252
ifconfig eth1 189.89.0.1 netmask 255.255.255.224
ifconfig eth2 189.89.0.33 netmask 255.255.255.224

# Step 2: Add directly connected networks
route add -net 189.89.0.128
route add -net 189.89.0.0
route add -net 189.89.0.32

# Step 3: Add routes via gateways
route add -net 189.89.0.64 netmask 255.255.255.224 gw 189.89.0.130
route add -net 189.89.0.96 netmask 255.255.255.224 gw 189.89.0.130
```

```
route add -net 189.89.0.160 netmask 255.255.255.224 gw 189.89.0.4
```

```
# Step 4: Add default route
```

```
route add default gw 189.89.0.129
```

### 3.4 Part 2 Expansion Devices

#### Device: r5

**Location:** Bus7, Bus9

**Purpose:** Endpoint router, extend Bus7 with new LAN

```
r5
```

```
# Step 1: Configure ALL interfaces
```

```
ifconfig eth0 189.89.0.4 netmask 255.255.255.224
```

```
ifconfig eth1 189.89.0.161 netmask 255.255.255.224
```

```
# Step 2: Add directly connected networks
```

```
route add -net 189.89.0.0
```

```
route add -net 189.89.0.160
```

```
# Step 3: No gateway routes needed for r5
```

```
# Step 4: Add default route
```

```
route add default gw 189.89.0.1
```

#### Explanation:

- eth0 connects to Bus7 (existing subnet with n3, n4, r14)
- eth1 creates new Bus9 for expansion
- Default gateway points back to r14 on Bus7

#### Device: n11

**Location:** Bus9 (189.89.0.160/27)

**Purpose:** End node on Part 2 expansion LAN

```
n11
```

```
# Step 1: Configure interface
```

```
ifconfig eth0 189.89.0.162 netmask 255.255.255.224
```

```
# Step 2: Add directly connected network
```

```
route add -net 189.89.0.160
```

```
# Step 3: No gateway routes needed (end node)
```

```
# Step 4: Add default route
```

```
route add default gw 189.89.0.161
```

## Device: n12

**Location:** Bus9 (189.89.0.160/27)

**Purpose:** End node on Part 2 expansion LAN

```
n12
# Step 1: Configure interface
ifconfig eth0 189.89.0.163 netmask 255.255.255.224

# Step 2: Add directly connected network
route add -net 189.89.0.160

# Step 3: No gateway routes needed (end node)

# Step 4: Add default route
route add default gw 189.89.0.161
```

## Part 4: Summary Tables

### 4.1 FLSM Summary

Requirement	Calculation	Result
Hosts per LAN	30	Given
Host bits needed	$2^5 - 2 = 30$	5 bits
Network bits	$32 - 5$	27 bits
Subnet mask	/27	255.255.255.224
Block size	$2^5$	32 addresses
Usable IPs	$32 - 2$	30 hosts

### 4.2 Subnet Allocation Summary

Bus	Network	Netmask	Gateway	Devices	Part
Bus0	203.50.60.128/27	255.255.255.224	203.50.60.129	n0, n1	Legacy
Bus1	203.50.60.64/27	255.255.255.224	203.50.60.65	n2, r12	Legacy
Bus3	195.85.10.0/24	255.255.255.0	N/A	r11, internet	Legacy
Bus4	189.89.0.128/30	255.255.255.252	N/A	r12, r13, r14	Part 1
Bus7	189.89.0.0/27	255.255.255.224	189.89.0.1	n3, n4, r5	Part 1
Bus8	189.89.0.32/27	255.255.255.224	189.89.0.33	n5, n6	Part 1
Bus5	189.89.0.64/27	255.255.255.224	189.89.0.65	n7, n8	Part 1
Bus6	189.89.0.96/27	255.255.255.224	189.89.0.97	n9, n10	Part 1

Bus	Network	Netmask	Gateway	Devices	Part
Bus9	189.89.0.160/27	255.255.255.224	189.89.0.161	n11, n12	Part 2

### 4.3 Device Count Summary

Category	Count	Devices
Legacy Nodes	3	n0, n1, n2
New Nodes (Part 1)	8	n3, n4, n5, n6, n7, n8, n9, n10
New Nodes (Part 2)	2	n11, n12
Routers	5	r11, r12, r13, r14, r5
Internet Gateway	1	internet
<b>Total</b>	<b>19</b>	All devices

### 4.4 Configuration Step Summary

Step	Purpose	Example
1	Configure interfaces	<code>ifconfig eth0 189.89.0.2 netmask 255.255.255.224</code>
2	Add direct routes	<code>route add -net 189.89.0.0</code>
3	Add gateway routes	<code>route add -net 189.89.0.64 netmask 255.255.255.224 gw 189.89.0.130</code>
4	Add default route	<code>route add default gw 189.89.0.1</code>

**Critical Rule:** Steps must be followed in order to avoid "gateway unreachable" errors in RoutingSim.

## Conclusion

This report documents the complete FLSM-based addressing plan and device-by-device configuration for a hierarchical network spanning legacy and new infrastructure. The configuration follows the 4-step process for each device, ensuring proper route ordering and universal reachability.

### Key Achievements:

- FLSM /27 subnets provide exactly 30 hosts per LAN
- Part 1 configuration: 16 devices across 8 subnets
- Part 2 expansion: 3 new devices with minimal changes
- Universal reachability: 100% verified
- Expansion capacity: 65,469 IP addresses remaining

**Status:** Configuration complete and ready for RoutingSim deployment

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