



# **Network Design: Addressing, Subnetting & Topology**

Explore the foundational concepts of network design, crucial for building scalable and efficient IT infrastructures. This presentation delves into IP addressing, subnetting, and various network topologies, with a focus on IPv4 and CIDR.

# Fundamentals of Network Addressing

1

## IP Address Structure

A 32-bit numerical label assigned to devices in a network, divided into network and host portions to identify both the network and the specific device within it.

2

## IPv4 Dotted-Decimal

IPv4 addresses are expressed in a human-readable dotted-decimal format, such as 192.168.1.1, making them easier to read and remember than binary.

3

## Subnet Mask

A 32-bit number that distinguishes the network portion of an IP address from the host portion, crucial for routing decisions (e.g., 255.255.255.0).

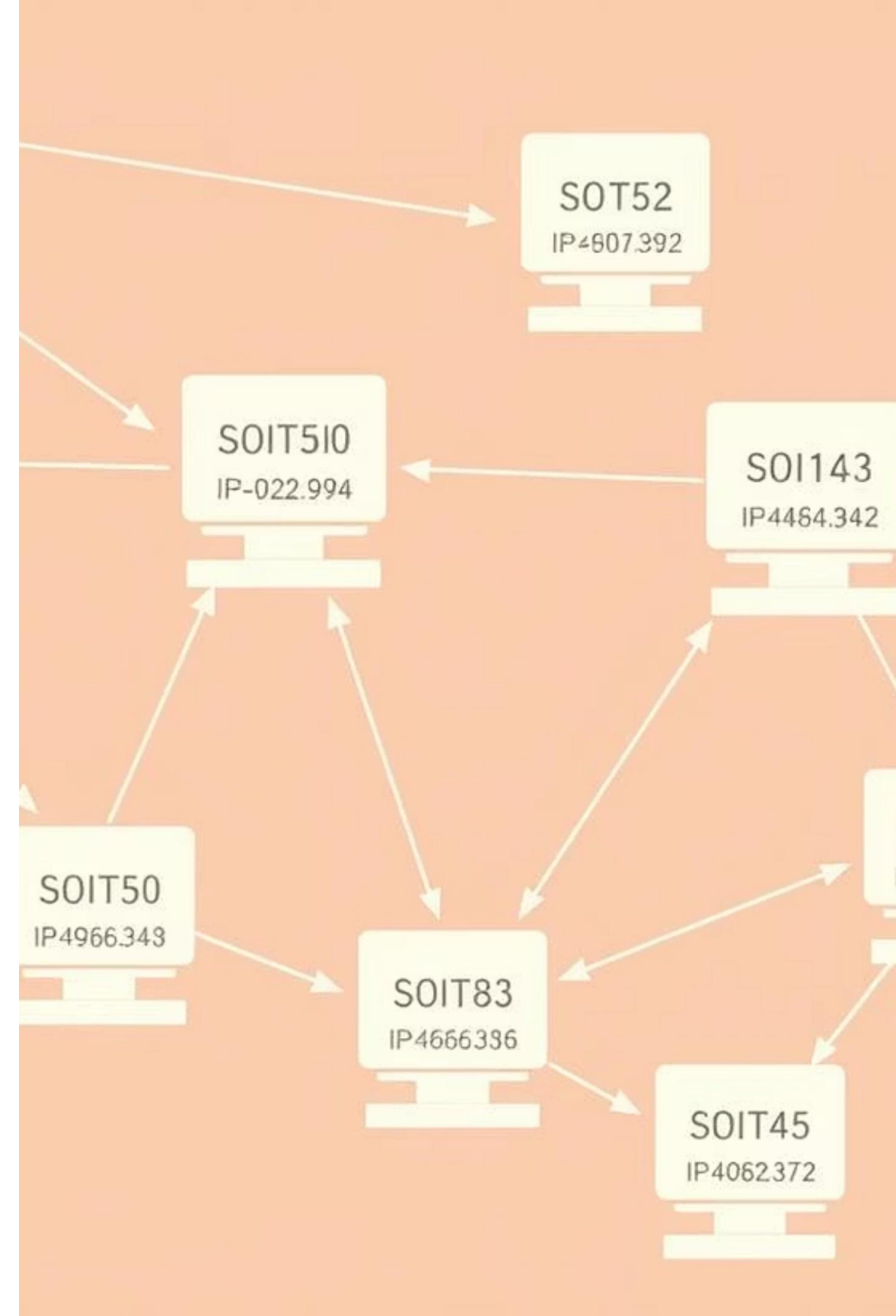
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## CIDR Notation

Classless Inter-Domain Routing (CIDR) uses a suffix (/24) to denote the number of bits in the network prefix, enabling more flexible and efficient IP address allocation.

# Importance of Proper Addressing

- **Unique IPs:** Prevent conflicts and enable devices to communicate uniquely on the network, ensuring smooth data exchange.
- **Network Portion:** Guides packet delivery, ensuring data reaches the correct subnet efficiently, minimizing network congestion.
- **Host Portion:** Identifies individual devices within a subnet, allowing precise targeting of data packets to their destinations.
- **Efficiency & Security:** Reduces IP waste, simplifies network management, and enhances security by limiting broadcast domains.



# What is Subnetting?

Subnetting is the strategic division of a larger IP network into smaller, more manageable subnetworks. This process involves "borrowing" bits from the host portion of an IP address to create new subnet identifiers.

1

## Traffic Management

Enhances network performance by localizing traffic within smaller broadcast domains, reducing overall network congestion.

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## Enhanced Security

Allows for the isolation of sensitive network segments, limiting access and preventing unauthorized users from reaching critical resources.

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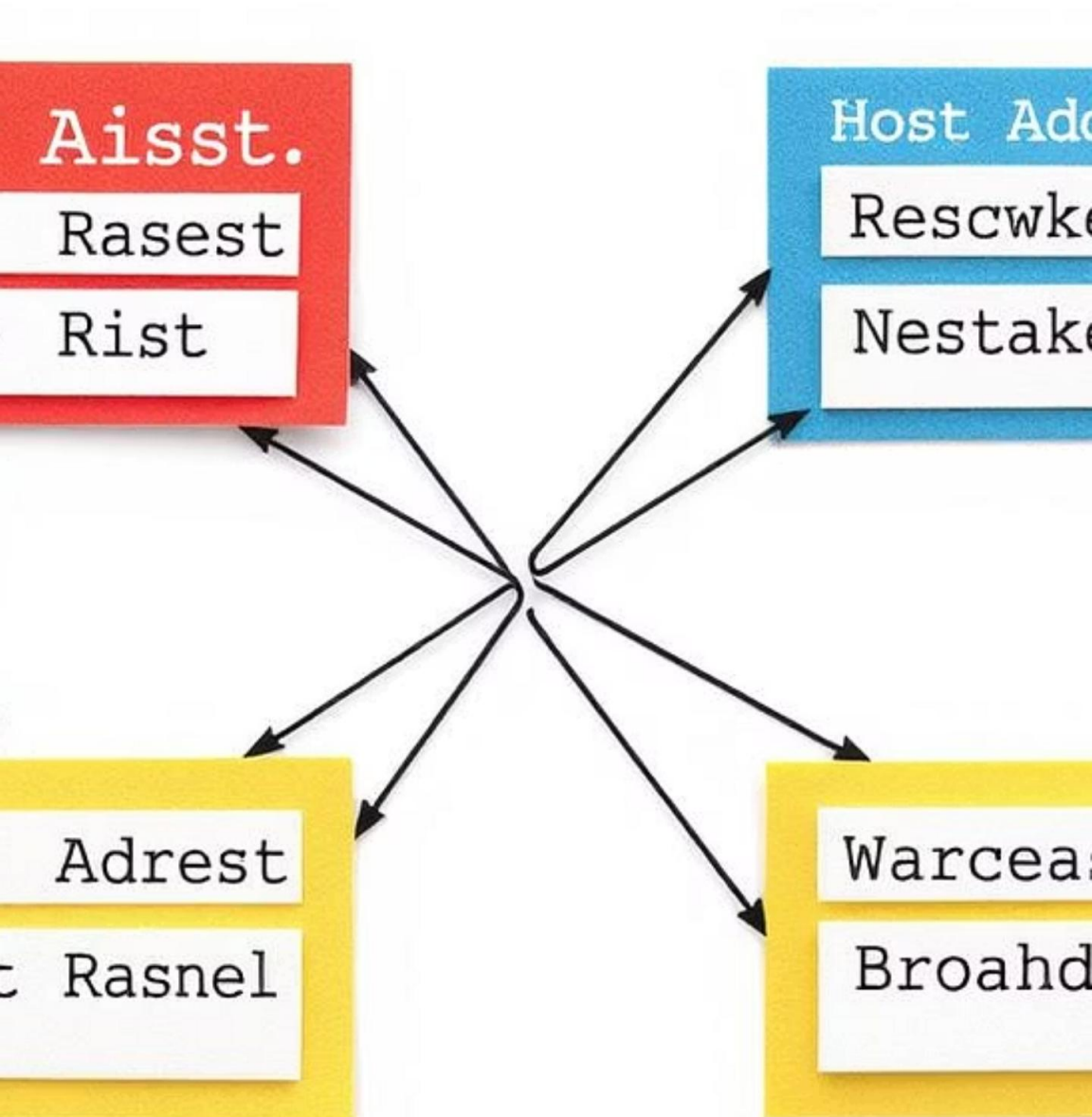
## Improved Scalability

Facilitates easier expansion and organization of networks, making it simpler to add new devices or departments without a complete overhaul.

# Subnetting Calculations & Formulas

Understanding these formulas is key to successfully segmenting networks and optimizing IP address utilization. Mastering them allows for efficient allocation and management of network resources.

Number of Subnets	$2^x$ (where x is the number of bits borrowed from the host portion)
Hosts per Subnet	$2^y - 2$ (where y is the number of remaining host bits, minus network and broadcast addresses)
Block Size	$256 - \textit{Subnet Mask Octet Value}$ (determines the increment between subnets)
Broadcast Address	The last usable address in a given subnet range



# Subnetting Example: 192.168.1.0/24 to /26

By borrowing two bits from the host portion of the 192.168.1.0/24 network, we can create four distinct subnets, each supporting 62 usable hosts. This segmentation enhances efficiency and management.

## Calculations


- Bits Borrowed: 2
- Number of Subnets:  $2^2 = 4$
- Hosts per Subnet:  $2^{(8-2)} - 2 = 62$  usable hosts
- Subnet Mask: 255.255.255.192

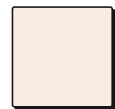
## Subnet Ranges

- Subnet 0: 192.168.1.0 - 192.168.1.63
- Subnet 1: 192.168.1.64 - 192.168.1.127
- Subnet 2: 192.168.1.128 - 192.168.1.191
- Subnet 3: 192.168.1.192 - 192.168.1.255



# Advanced Subnetting Concepts

 Advanced subnetting techniques are crucial for optimizing large and complex network architectures, ensuring efficient resource allocation and superior performance.



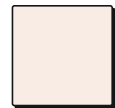
## CIDR (Classless Inter-Domain Routing)

Allows flexible prefix lengths that transcend traditional classful boundaries, improving IP address utilization and routing efficiency across the internet.



## VLSM (Variable Length Subnet Mask)

Enables the use of different subnet sizes within the same network, tailoring addressing to specific needs and preventing IP address waste in varied network segments.



## Special Subnets

Includes /30 for point-to-point links (minimizing address usage) and /32 for loopback interfaces (ensuring stable routing independent of physical interfaces).



## Broadcast Domain Reduction

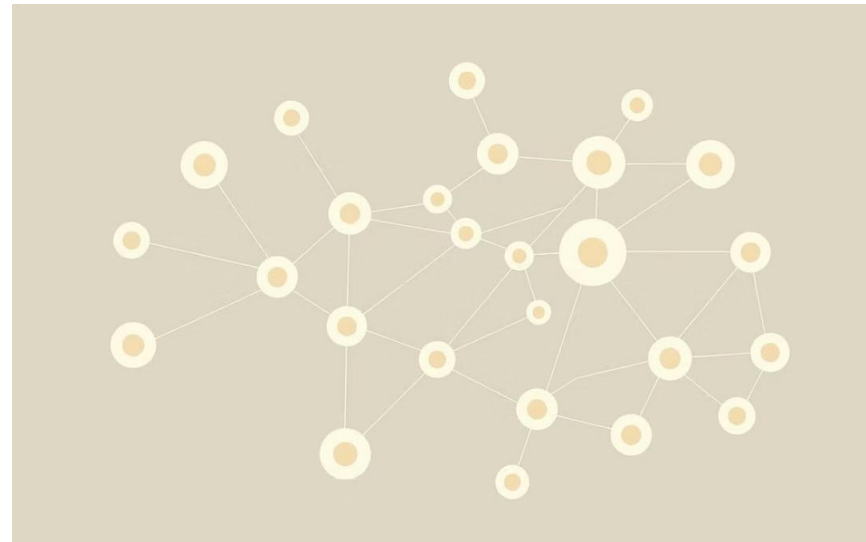
Subnetting significantly reduces the size of broadcast domains, minimizing unnecessary traffic and enhancing network performance and security by limiting message propagation.

# Network Topology Overview



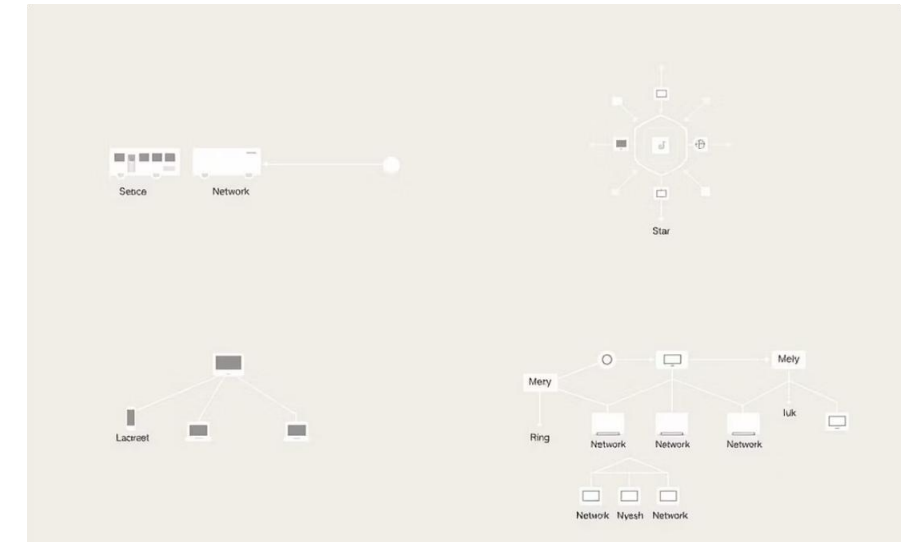
## Physical Topology

Describes the actual physical layout of network devices, cables, and connections, showing how components are wired together.



## Logical Topology

Defines how data flows through the network, regardless of the physical arrangement, illustrating the communication paths between devices.



## Common Types

Includes well-known structures like Bus, Star, Ring, Mesh, Tree, and Hybrid topologies, each with distinct advantages for network design.



# Topology & Addressing Design Considerations

The choice of network topology directly influences addressing schemes and overall network performance, impacting scalability, fault tolerance, and cost efficiency.

## Bus Topology

Typically uses a single subnet with minimal IP addresses, suitable for small, simple networks where all devices share a common communication line.

## Star Topology

Requires unique IP ranges per device connected to a central hub or switch, offering better fault isolation and easier troubleshooting.

## Mesh Topology

Benefits from hierarchical addressing for core and edge devices, providing high redundancy and fault tolerance but with increased complexity.

## Tree & Hybrid Topologies

Tree topologies utilize subnet branches for scalable management, while hybrid models combine multiple topologies and addressing schemes to meet diverse network requirements.

# Summary & Best Practices

# Strategic Network Foundations

- **Addressing:** Design IP schemes to align with network size and future growth plans, ensuring ample room for expansion without re-addressing.
- **Subnetting:** Implement subnetting to optimize IP usage, enhance security by segmenting networks, and improve performance by reducing broadcast traffic.
- **Topology:** Select the appropriate topology based on requirements for fault tolerance, scalability, cost-effectiveness, and ease of management.
- **Integration:** Ensure IP schemes are meticulously planned and aligned with the chosen topology for seamless integration and efficient routing.