

Introduction to Network Design

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Key concepts, steps, and best-practice guidelines for planning and building reliable, scalable networks.

1. What Is Network Design?

Aspect	Description
Definition	The process of planning the architecture, components, and services that enable devices to communicate efficiently and securely.
Goal	Deliver required performance, availability, security, and cost-effectiveness for current and future needs.
Scope	Physical topology, logical topology, hardware selection, addressing scheme, routing & switching, security controls, management, and documentation.

2. Core Design Principles

Principle	Why It Matters	Typical Implementation
Scalability	Network must grow without major redesign.	Hierarchical (core-distribution-access) layers; modular hardware; address pool planning (e.g., IPv6).
Reliability / Redundancy	Minimize downtime.	Dual links, link aggregation, redundant routers/switches, rapid failover protocols (HSRP/VRRP, BGP PIC).
Performance	Meet latency, bandwidth, and QoS requirements.	Proper bandwidth provisioning, traffic engineering, QoS policies, WAN optimization.
Security	Protect data and resources.	Segmentation (VLANs, firewalls), ACLs, encryption, zero-trust principles.
Manageability	Simplify operations and troubleshooting.	Centralized monitoring (SNMP, NetFlow), configuration management, standardized naming.

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Principle	Why It Matters	Typical Implementation
Cost? Effectiveness	Optimize CAPEX and OPEX.	Use commodity hardware where possible, leverage virtualization, adopt cloud services wisely.

3. Design Process – Step by Step

1. Gather Requirements

- Business goals, applications, user count, traffic patterns.
- Performance metrics (latency, jitter, throughput).
- Security & compliance constraints.
- Budget and timeline.

2. Assess Current Environment

- Inventory of devices, cabling, IP scheme.
- Identify bottlenecks, single points of failure.
- Document existing topology.

3. Define Logical Architecture

- **Topology type** – star, mesh, hierarchical, hybrid.
- **Layered model** – Core, Distribution, Access (and sometimes Data Center/Edge).
- **Addressing plan** – IPv4 subnets, IPv6 prefixes, DHCP scopes.
- **VLAN/VRF design** – segmentation strategy.

4. Select Physical Components

- Switches (layer 2 vs layer 3), routers, firewalls, load balancers.
- Cabling (copper, fiber, category, wavelength).
- Wireless APs, controllers (if applicable).
- Consider power (PoE, UPS) and cooling.

5. Design Redundancy & High Availability

- Dual homed links, spanning tree optimizations (RSTP/MSTP), link aggregation (LACP).

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- Redundant routing (HSRP/VRRP, BGP multipath, OSPF/ISIS fast?hello).
- Data?center specific: vPC, VSS, MLAG, active?active firewalls.

6. Plan Security Controls

- Perimeter (firewall, IDS/IPS), internal segmentation (ACLs, micro?segmentation).
- Authentication (802.1X, RADIUS/TACACS+), encryption (IPsec, MACsec, TLS).
- Monitoring & logging (SIEM integration).

7. Define QoS & Traffic Engineering

- Classification (DSCP, CoS), marking, policing, shaping.
- MPLS TE, L3VPN