

# Chapter Three

## **Network Design and Implementation**

**System and Network Administration**

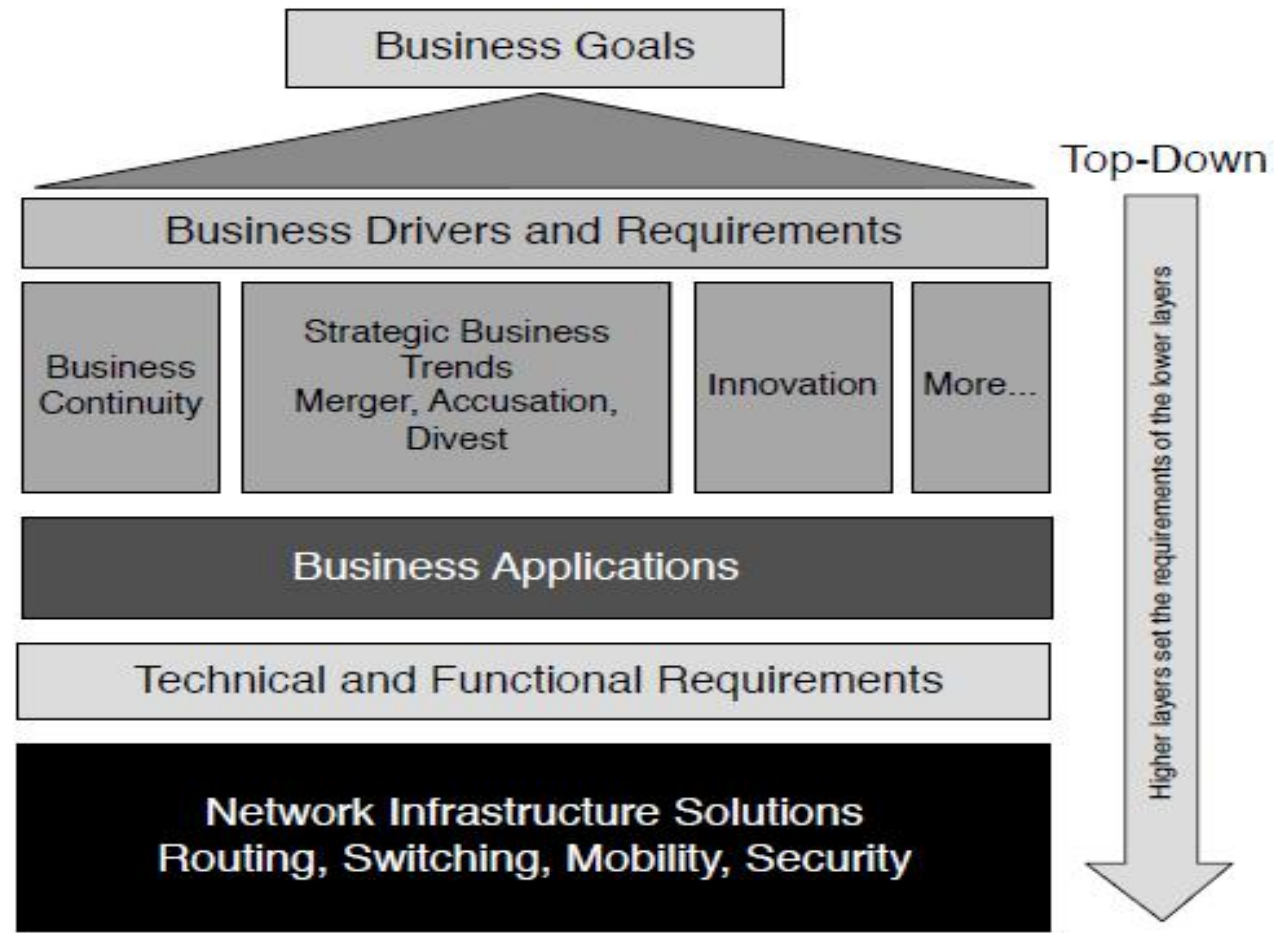
# Network Design Principles

- *Network design* can be defined as the philosophy that drives how various components, protocols, and technologies should be integrated and deployed based on certain approaches and principles to construct a cohesive network infrastructure environment that can facilitate the achievement of tactical or strategic business goals.
- Network design **must be a complete process that matches business needs to the available technology** to deliver a system that will maximize the organization

# Network Design Principles

- Designing large-scale networks to meet today's dynamic business and IT needs and trends is a complex assignment, whether it is an enterprise or service provider type of network. There are three types network based on size:
  - Small- <200 devices
  - Medium- 200-1000 devices
  - Large- >1000 devices
- There are two common approaches to analyze and design networks:
  - **The top-down design approach:** It simplifies the design process by splitting the design tasks to make it more focused on the design scope and performed in a more controlled manner
  - **The bottom-up approach:** In contrast, the bottom-up approach focuses on selecting network technologies and design models first

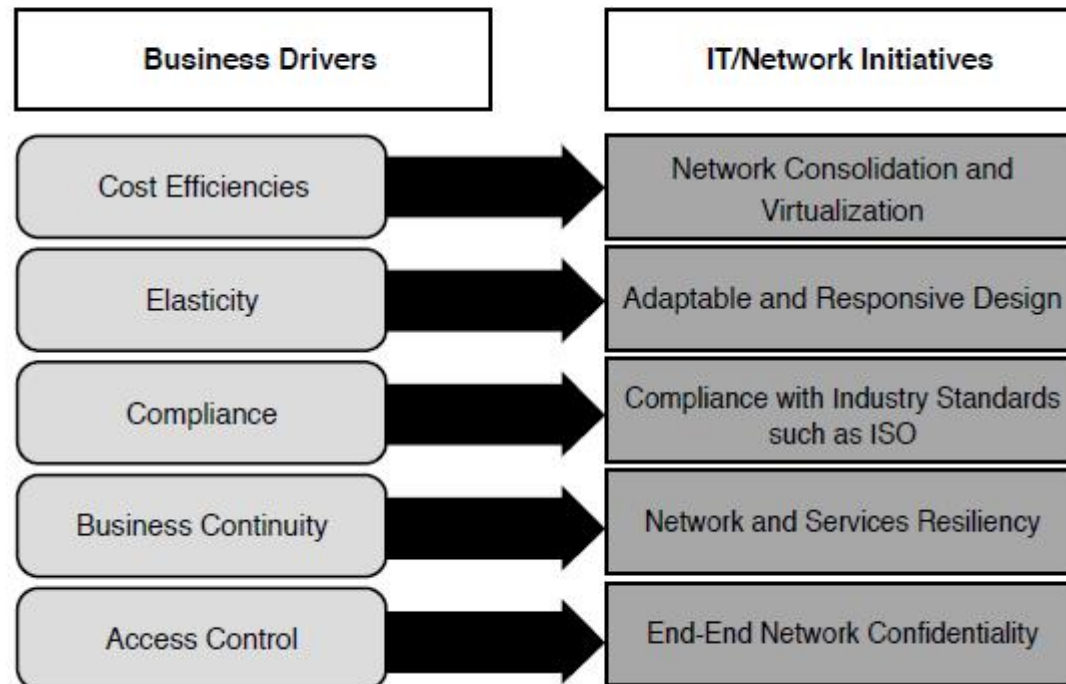
# Network Design Principles



*Business-Driven Technology Solutions*

# Network Design Principles

- To achieve a successful strategic design, there must be additional emphasis on a business driven approach.



*Business Drivers Versus IT Initiatives*

# Network Design Requirements

- This section demonstrates how different types of requirements collectively can lead to the achievement of the desired network design, which ultimately will facilitate achieving business goals.
- The following is a typical classification of the requirements, some of which might be provided directly and some of which can be implied or indicated based on other requirements and goals:

# Network Design Requirements

- **Business goals:**

- Reduce operational cost
- Enhance employees' productivity
- Expand the business (adding more remote sites)

- **Business requirements:**

- Reduce the cost of maintaining multiple networks for voice and data
- Improve employee productivity by enhancing and integrating internal communications through video and mobile devices, without compromising the company's security policy
- Support the business expansion (the rollout of the new remote sites)

# Network Design Requirements

- **Functional requirements:**

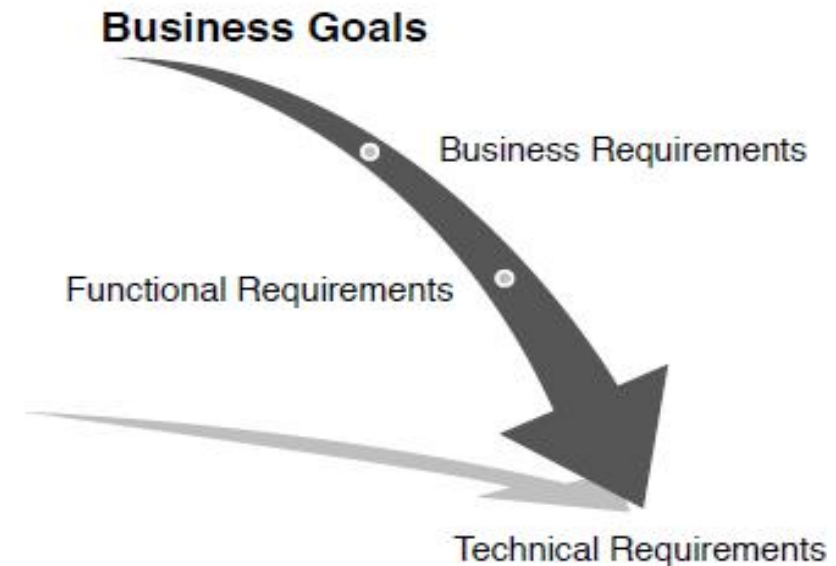
- A unified infrastructure that supports voice, video, data, and wireless
- Ability to provide isolation between the traffic of guests and internal staff (for both wired and wireless) to comply with the standard security policy of the organization
- Capability to support introducing new remote sites to the network without any redesign



# Network Design Requirements

- **Technical requirements:** To achieve the above network's functional requirements considering the ultimate business goals, the design must cater to the following:

- Scalability
- High availability
- Performance
- Manageability
- Security



*Design Requirements Flow*

# Scalability

**Scalability** refers to what is needed today as well as the future

- The ability to grow, for example
  - Cabling is meant to last for 10 years
  - Switches and routers are meant to last for 2 to 5 years, since it is easier to change these
- Get an idea of the needs for next 2 to 5 years

# Scalability

- At least you need to know
  - Number of sites to be added
  - What will be needed at each of these sites
  - How many users will be added
  - Where might servers be located
  - New lines of business
- This is not the current project, but perhaps only things dimly in the future

# Availability

- Availability is the uptime
- A network designed for availability is one that delivers consistent, reliable performance, 24 hours a day, 7 days a week.
- In addition, the failure of a single link or piece of equipment should not significantly impact network performance.

# Performance

- Performance is a key indicator for most projects
- In some cases it is only that “No one complains”
- In most cases it is more definitive
- Common performance measures include
  - Capacity v Throughput
  - Bandwidth Utilization
  - Offered Load ,latency and response

# Performance

- **Capacity** is what the link is capable of
  - Commonly stated as the channel size, such as 1.544 Mbps
- **Throughput** is the measured **quantity of data going through the pipe**
  - Throughput is usually less than capacity, but it could be the same as the capacity, at least in theory
- **Bandwidth Utilization**
  - The percent of total available capacity in use
- **Offered Load**
  - This is the sum of all the data all network devices have ready to send at a particular time

# Security

- Security is a feature that must be designed into the network, not added on after the network is complete.
- Planning the location of security devices, filters, and firewall features is critical to safeguarding network resources.
- Common risks include
  - Use of resources
  - Loss of data
  - Alteration of data
  - Denial of service

# Manageability

- Manageability refers to how easy will it be to monitor the network
- To check for
  - Performance problems
  - Errors
  - Security problems
  - Configuration
  - Accounting
- And network design should be adaptable and affordable

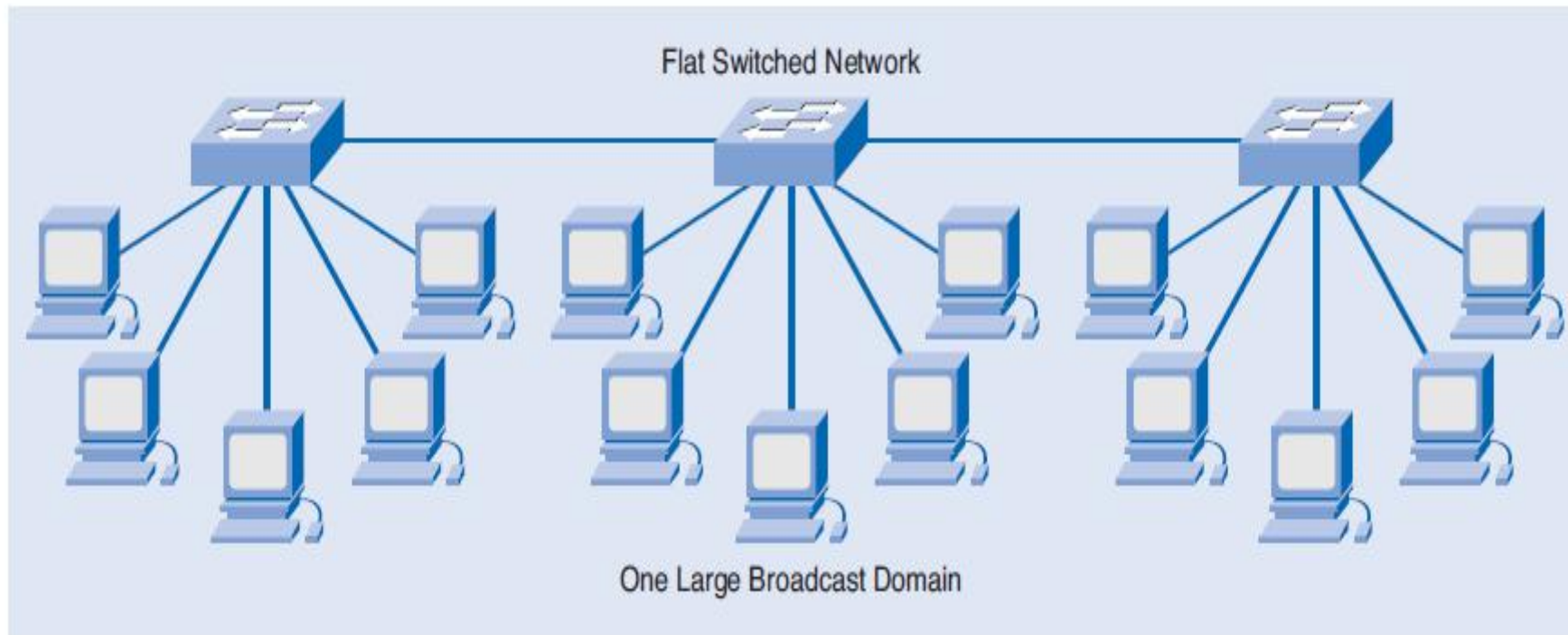


# Designing a Network Topology

- Network design is an art, not a science
- There are no absolutes
- There are no precisely correct formulas
- There are two basic types of network designs:
  - Flat
  - Hierarchical

# Designing a Network Topology

In a flat network all connecting devices are on the same level



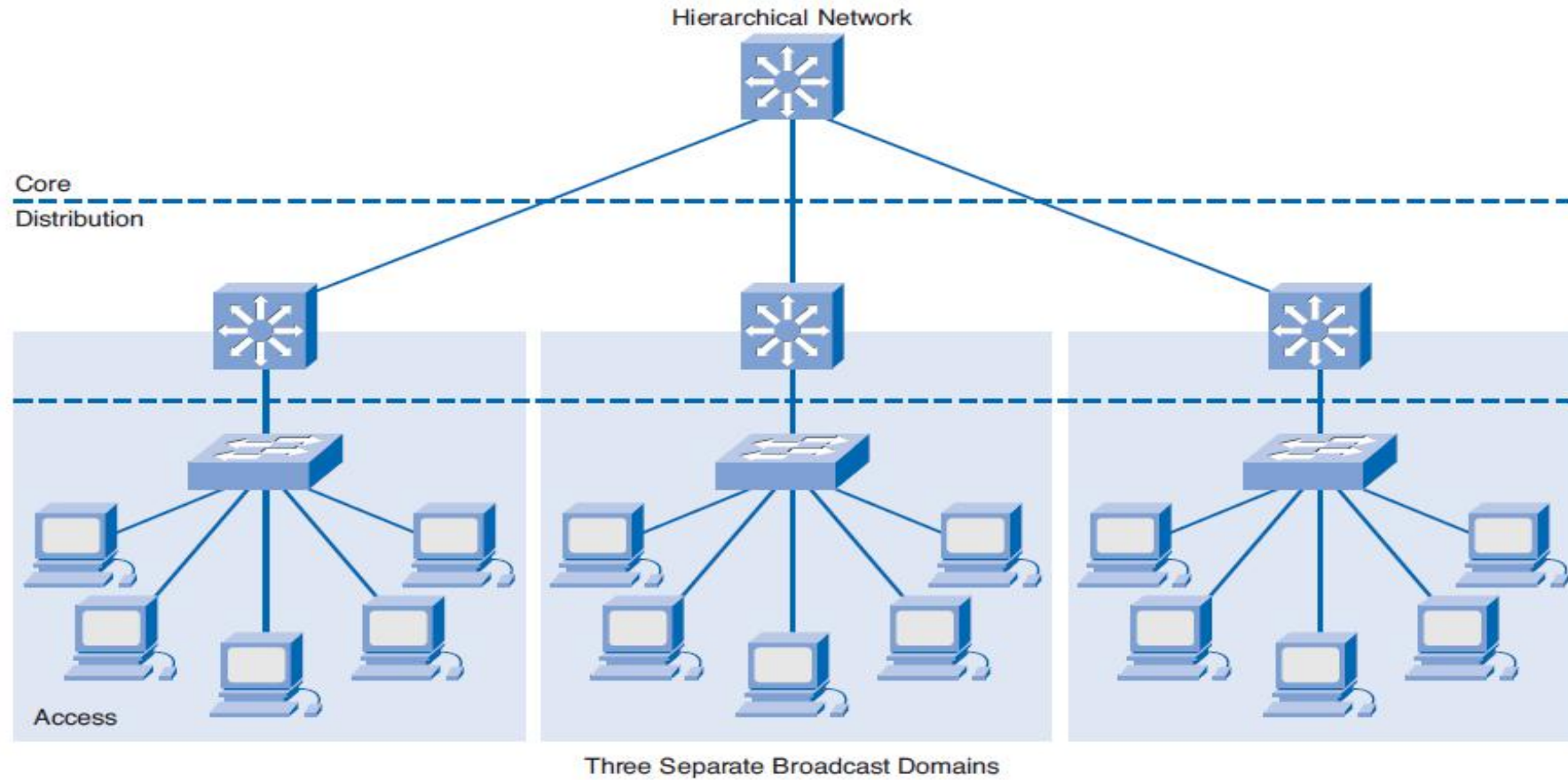
# Flat Network Design

- A flat design is appropriate for a small and static network
- A flat network is a single collision domain or one that is not divided hierarchically
- There is a limit to the number of stations that can be supported in a flat design
- Broadcast domains are divided using
  - Layer 3 Switches
  - Router

# Hierarchical Network Design

- In networking, a hierarchical design is used to group devices into multiple networks.
- The networks are organized in a layered approach.
- The hierarchical design model has three basic layers:
  - **Core layer:** Connects distribution layer devices
  - **Distribution layer:** Interconnects the smaller local networks
  - **Access layer:** Provides connectivity for network hosts and end devices

# Hierarchical Network Design



# What Happens at the Core Layer?

- The core layer is sometimes called the *network backbone*.
- Routers and switches at the core layer provide high-speed connectivity.
- The core layer design enables the efficient, high-speed transfer of data between one section of the network and another.
- The primary design goals at the core layer are as follows:
  - Provide 100% uptime.
  - Maximize throughput.
  - Facilitate network growth.

# What Happens at the Core Layer?

- Technologies used at the core layer include the following:
- Routers or *multilayer switches* that combine routing and switching in the same device
- Redundancy and *load balancing*
- High-speed and aggregate links
- Routing protocols that scale well and converge quickly, such as *Enhanced Interior Gateway Routing Protocol (EIGRP)* and *Open Shortest Path First (OSPF) Protocol*

# What Happens at the Distribution Layer?

- The distribution layer represents a routing boundary between the access layer and the core layer.
- It also serves as a connection point between remote sites and the core layer.
- The distribution layer is built using Layer 3 devices.



# What Happens at the Distribution Layer?

- Routers or multilayer switches, located at the distribution layer, provide many functions critical for meeting the goals of the network design, including the following:
  - Filtering and managing traffic flows
  - Enforcing access control policies
  - Summarizing routes before advertising the routes to the Core
  - Isolating the core from access layer failures or disruptions
  - Routing between access layer VLANs

# What Happens at the Access Layer?

- This level provides local or remote workgroup or user access to the network
- It grants users access to network resources
- Typically this is through a Layer 2 switch
- VLANs may be defined at this layer
- Limit VLANs to a single closet whenever possible

