Chapter 4 – Network Design and implementation

Chapter 4:- Network Design and Implementation

Contents:

- ✓ Design principles
- ✓ Requirements
- ✓ Topology option
- ✓ Network design and implementation project management

Introduction

- **Why do we need modern network design?**

✓ Rise of new technologies
✓ Traditional network boundaries have been removed
✓ Complexities of networks
✓ Reduce the time to develop and market products

- **What affect Network Design?**

- Business drivers
  Return on investment, Regulation, Competitiveness

- Technology drivers
  Removal of borders, Virtualization, Growth of applications

Network Design Objective

- Ultimately, our network design must answer some pretty basic questions
  - What stuff do we get for the network?
  - How do we connect it all?
  - How do we have to configure it to work right?
- Traditionally this meant mostly *capacity planning* – having enough bandwidth to keep data moving
  - May be effective, but result in over engineering
- And while some uses of the network will need a lot of bandwidth (multimedia), we may also need to address:
  - Security
    - Considering both internal and external threats
  - Possible wireless connectivity
  - Reliability and/or availability
    - Like speed for a car, how much are you willing to afford?

Design principles

- now summarise some of the key principles that must be followed for successful network design.

✓ Application drives the design requirements

✓ Network design requires experienced personnel

✓ Networks are designed in a lab rather than on paper

✓ Network design usually involves a number of trade-offs

✓ Don't try to mirror the corporate structure

✓ Design every network on its own merits

✓ Vender independent

✓ Design it once or design it a thousand times

✓ Design requires a small capable team

✓ Predictability is the hallmark of a good design

❑ Objective

present a systematic design methodology that meet a customer’s business and technical goals

❑ Network Design Methodology

Step 1. Analyze Customer Requirements
Step 2. Characterize the Existing Network and Sites
Step 3. Design the Network Topology and Solutions

Analyze the Customer Requirements

Step 1. Identify network applications and services.

Step 2. Define the organizational goals.

Step 3. Define the possible organizational constraints.

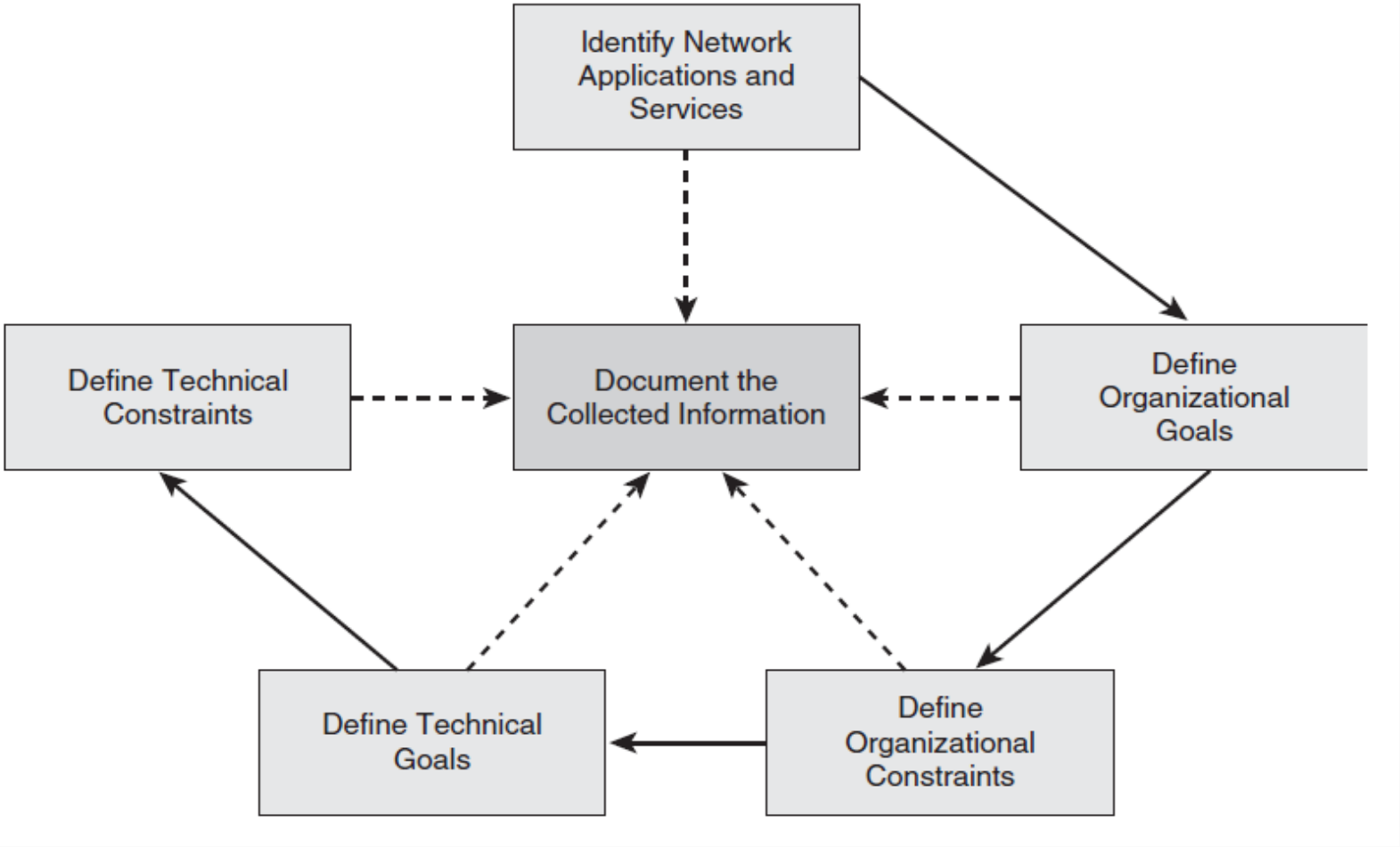
Step 4. Define the technical goals.

Step 5. Define the possible technical constraints.

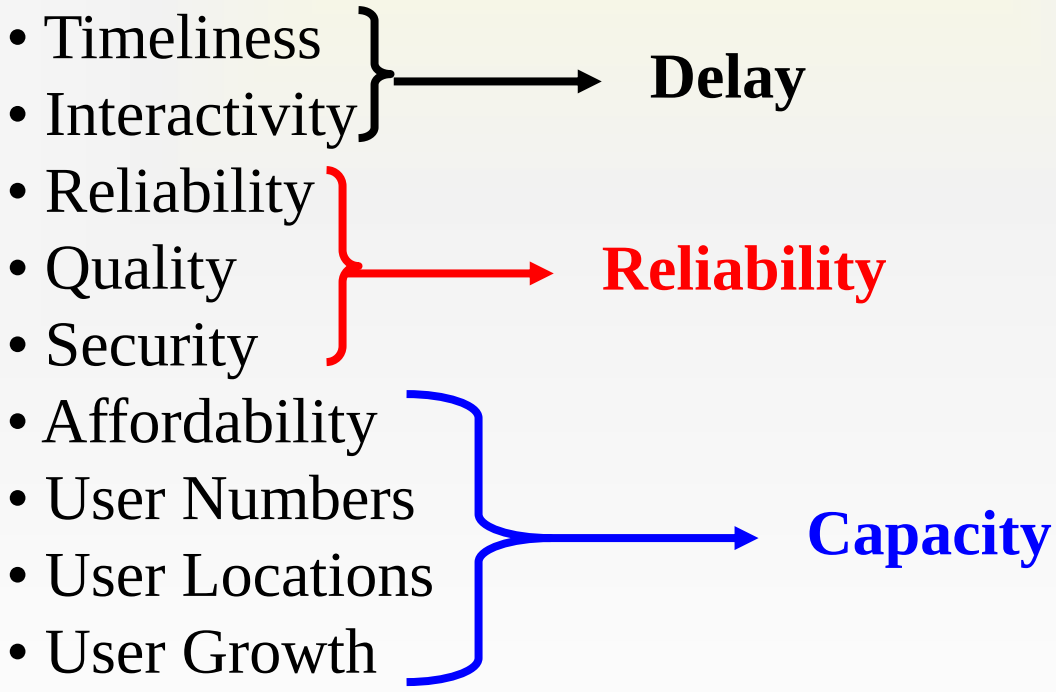
Customer's Requirements
- Understanding the Customer -

- A good network design must recognize the customer's requirements - need to make sure your design meets THEIR needs and not just YOURS!
- The "Customer" may be your own firm, the "who" you are designing the network for
- Need an overview of a customer's requirements
- ***The best designed network will fail miserably without the support of people***

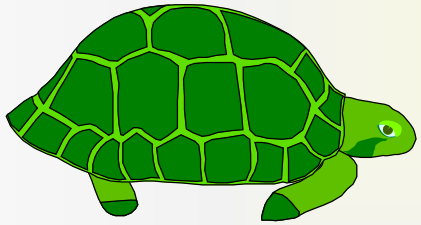
Analyze the Customer Requirements



- **User Requirements → Performance Requirements**

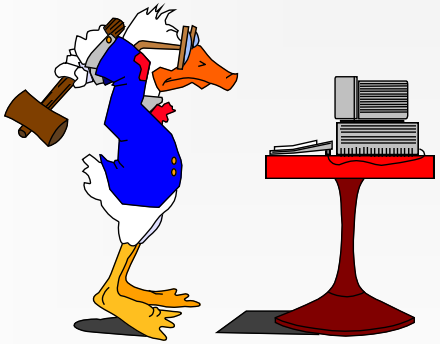


Network Design: Achievable?



Response Time

Cost



Reliability

Business Growth

Characterize the Existing Network and Sites

Step 1. Gather existing documentation and query the organization

Step 2. Perform a network audit

Step 3. Use traffic analysis

- ✓ Identifying Major Traffic Sources and Stores
- ✓ Characterizing Types of Traffic Flow for New Network Applications
- ✓ Characterizing Traffic Behavior
- ✓ Characterizing Quality of Service Requirements

Name of Application	Type of Traffic Flow	Protocols Used by Application	User Communities That Use the Application	Data Stores (Servers, Hosts, and So On)	Approximate Bandwidth Requirement for the Application	QoS Requirements

Types of Network Design

- New network design
- Re-engineering a network design
- Network expansion design

New network design

- Actually starting from scratch
- No legacy networks to accommodate
- Major driver is the budget, no compatibility issues to worry about
- Getting harder to find these situations

Re-engineering a Network Design

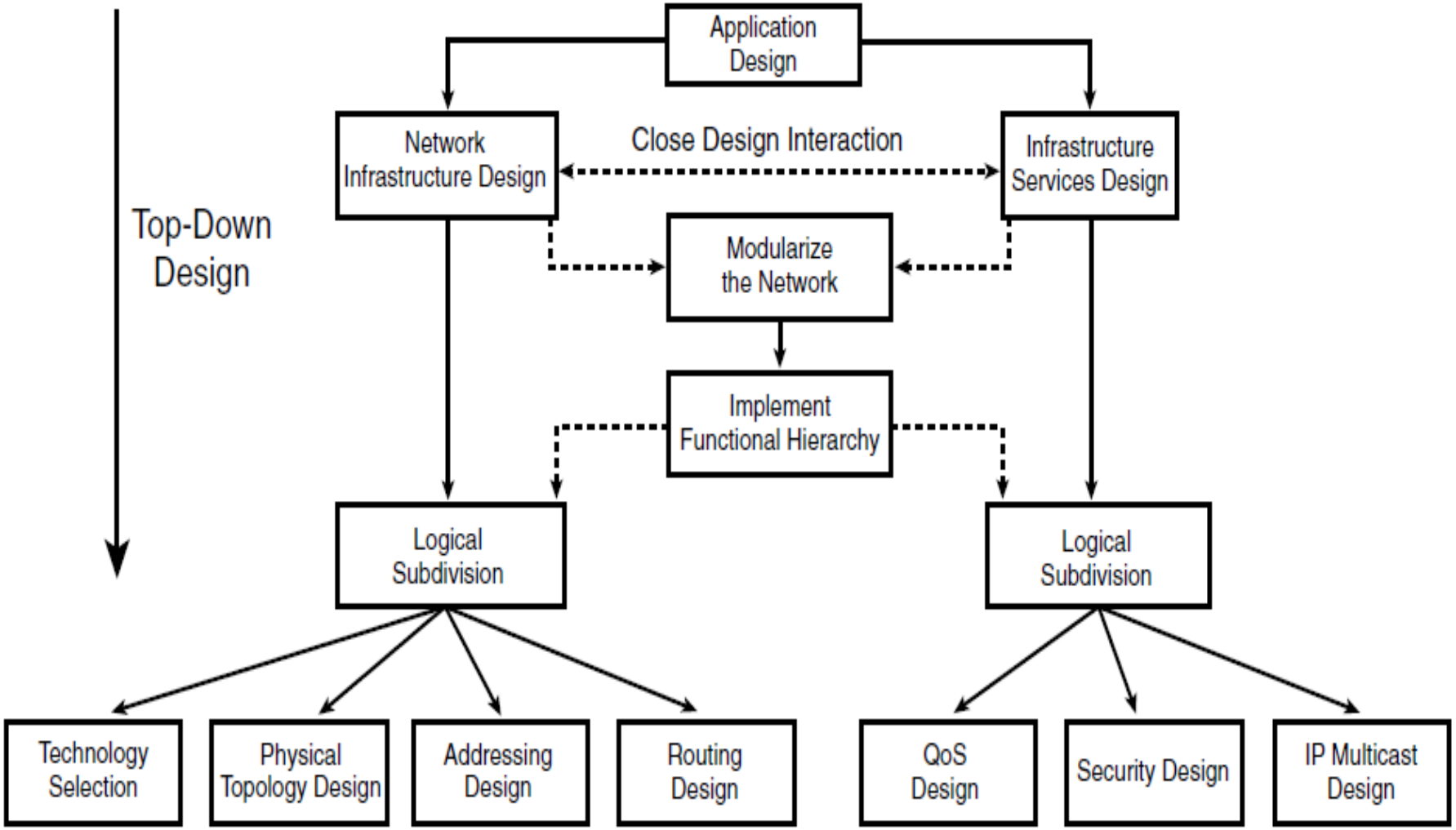
- Modifications to an existing network to compensate for original design problems
- Sometimes required when network users change existing applications or functionality
- More of the type of problems seen today

Network Expansion

- Network designs that expand network capacity
- Technology upgrades
- Adding more users or networked equipment

Design the Network Topology and Solutions

Top-Down Approach



Top-Down Network Design Methodology

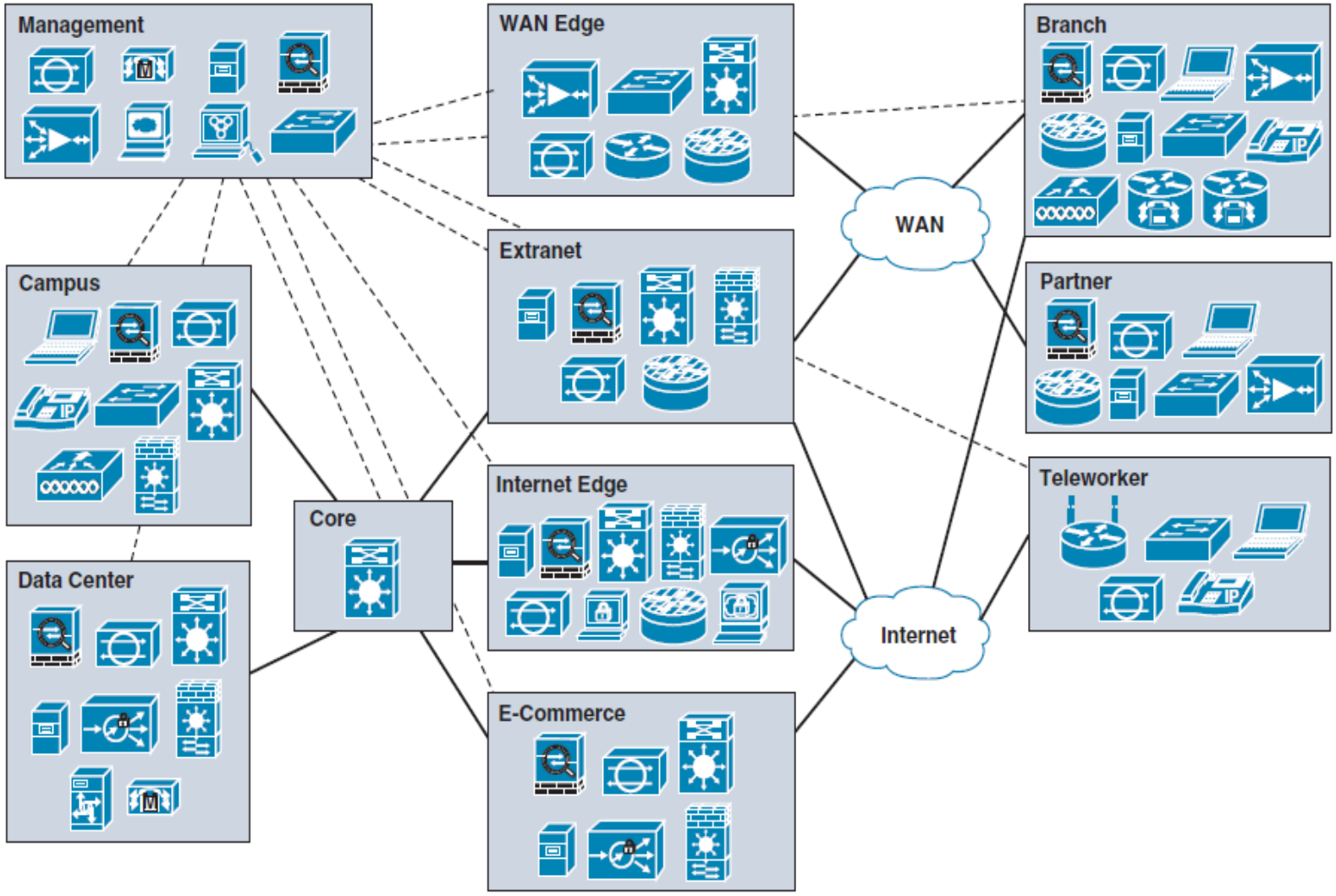
- Network designers often think they understand a customer's applications and requirements.
- However, after the network installation, they may discover that:
  - They did not capture the customer's most important needs
  - Unexpected scalability and performance problems appear as the number of network users increases
- Begins at the upper layers of the OSI reference model before moving to the lower layers
  - Focuses on applications, sessions, and data transport before the selection of routers, switches, and media that operate at the lower layers
- Explores divisional structures to find the people:
  - For whom the network will provide services, and
  - From whom to get valuable information to make the design succeed

Top-Down Network Design Process

- It is an iterative process:
  - It is important to first get an overall view of a customer's requirements
  - More detail can be gathered later on protocol behavior, scalability requirements, technology preferences, etc.
- Recognizes that the logical model and the physical design may change as more information is gathered
- A top-down approach lets a network designer get "**the big picture**" first and then spiral downward into detailed technical requirements and specifications

Design a Network Topology

Modular Network Design



Design a Model for Network Layer Addressing and Naming

- Using a Structured Model for Network Layer Addressing
- Using a Hierarchical Model for Assigning Addresses
- Administering Addresses by a Central Authority
- Using Dynamic Addressing for End Systems
- Designing a Model for Naming

Select the Switching and Routing Protocols

Making Decisions

	Critical Goals			Other Goals		
	Adaptability—must adapt to changes in a large internetwork within seconds	Must scale to a large size (hundreds of routers)	Must be an industry standard and compatible with existing equipment	Should not create a lot of traffic	Should run on inexpensive routers	Should be easy to configure and manage
BGP	X*	X	X	8	7	7
OSPF	X	X	X	8	8	8
IS-IS	X	X	X	8	6	6
IGRP	X	X				
EIGRP	X	X				
RIP			X			

*X = Meets critical criteria. 1 = Lowest. 10 = Highest.

Select the Switching and Routing Protocols

❑ **Selecting Switching Protocols**

VLANNIG, VLAN Trunking Protocols (ISL, Dot1q), inter-VLAN Routing, VTP, STP, RSTP, PVST+, CEF

❑ **Selecting Routing Protocols**

✓ Characterizing Routing Protocols

Distance-vector, link-state, or hybrid, Interior or exterior, Classless or classful, Fixed-length or variable-length subnet masks (VLSM), Flat or hierarchical, IPv4 or IPv6

✓ Routing Protocol Metrics and Loop Prevention

✓ Scalability Constraints for Routing Protocols

Select the Switching and Routing Protocols

Routing Protocol Comparisons

	Distance Vector or Link State	Interior or Exterior	Classful or Classless	Metrics Supported	Scalability	Convergence Time	Resource Consumption	Supports Security? Authenticates Routes?	Ease of Design, Configuration, and Troubleshooting
RIPv1	Distance vector	Interior	Classful	Hop count	15 hops	Can be long (if no load balancing)	Memory: low CPU: low Bandwidth: high	No	Easy
RIPv2	Distance vector	Interior	Classless	Hop count	15 hops	Can be long (if no load balancing)	Memory: low CPU: low Bandwidth: high	Yes	Easy
IGRP	Distance vector	Interior	Classful	Bandwidth, delay, reliability, load	255 hops (default is 100)	Quick (uses triggered updates and poison reverse)	Memory: low CPU: low Bandwidth: high	No	Easy
EIGRP	Advanced distance vector	Interior	Classless	Bandwidth, delay, reliability, load	1000s of routers	Very quick (uses DUAL algorithm)	Memory: moderate CPU: low Bandwidth: low	Yes	Easy
OSPF	Link state	Interior	Classless	Cost (100 million divided by bandwidth on Cisco routers)	A few hundred routers per area, a few hundred areas	Quick (uses LSAs and Hello packets)	Memory: high CPU: high Bandwidth: low	Yes	Moderate
BGP	Path vector	Exterior	Classless	Value of path attributes and other configurable factors	1000s of routers	Quick (uses update and keepalive packets, and withdraws routes)	Memory: high CPU: high Bandwidth: low	Yes	Moderate
IS-IS	Link state	Interior	Classless	Configured path value, plus delay,	Hundreds of routers per area, a few	Quick (uses LSAs)	Memory: high CPU: high Bandwidth: low	Yes	Moderate

Network Security Design

- **Security Strategy**
  - ✓ Identifying Network Assets
  - ✓ Analyzing Security Risks
  - ✓ Analyzing Security Requirements
  - ✓ Developing a Security Plan
  - ✓ Developing a Security Policy
  - ✓ Developing Security Procedures
  - ✓ Maintaining Security

- **Security Mechanisms**

Physical Security, Authentication, Authorization, Accounting (Auditing), Data Encryption, Packet Filters, Firewalls, Intrusion Detection and Prevention Systems

- **Monitoring, Analysis, and Correlation**

Network Management Design

- **Network Management Functional Areas**

- ✓ Fault management
- ✓ Configuration management
- ✓ Accounting management
- ✓ Performance management
- ✓ Security management

- **Network Management Architectures**
- ✓ A managed device
- ✓ An agent
- ✓ A network management system (NMS)

- **Selecting Network Management Tools and Protocols**

Optimize the Network Design

- **Quality Issues in Converged Networks**

✓ Bandwidth capacity
✓ End-to-end delay (both fixed and variable):
✓ Variation of delay (also called jitter)
✓ Packet loss

- **QoS**

The main categories of mechanism
✓ Classification and marking
✓ Congestion management
✓ Congestion avoidance
✓ Policing and shaping
✓ Link efficiency

Select Technologies and Devices

- **Cabling Topologies and Types of Cable for Campus Networks**

✓ Campus- and building-cabling topologies
✓ Cables between buildings
✓ Location of telecommunications closets
✓ Vertical cabling between floors
✓ Horizontal cabling within floors

- **Criteria for Selecting Internetworking Devices**

Number of ports, Processing speed, Amount of memory, Throughput in packets per second, LAN and WAN technologies supported, Media (cabling) supported, Support for redundant power supplies, Support for QoS features,…

Select Technologies and Devices

❑ **Selecting Technologies for Enterprise Networks**

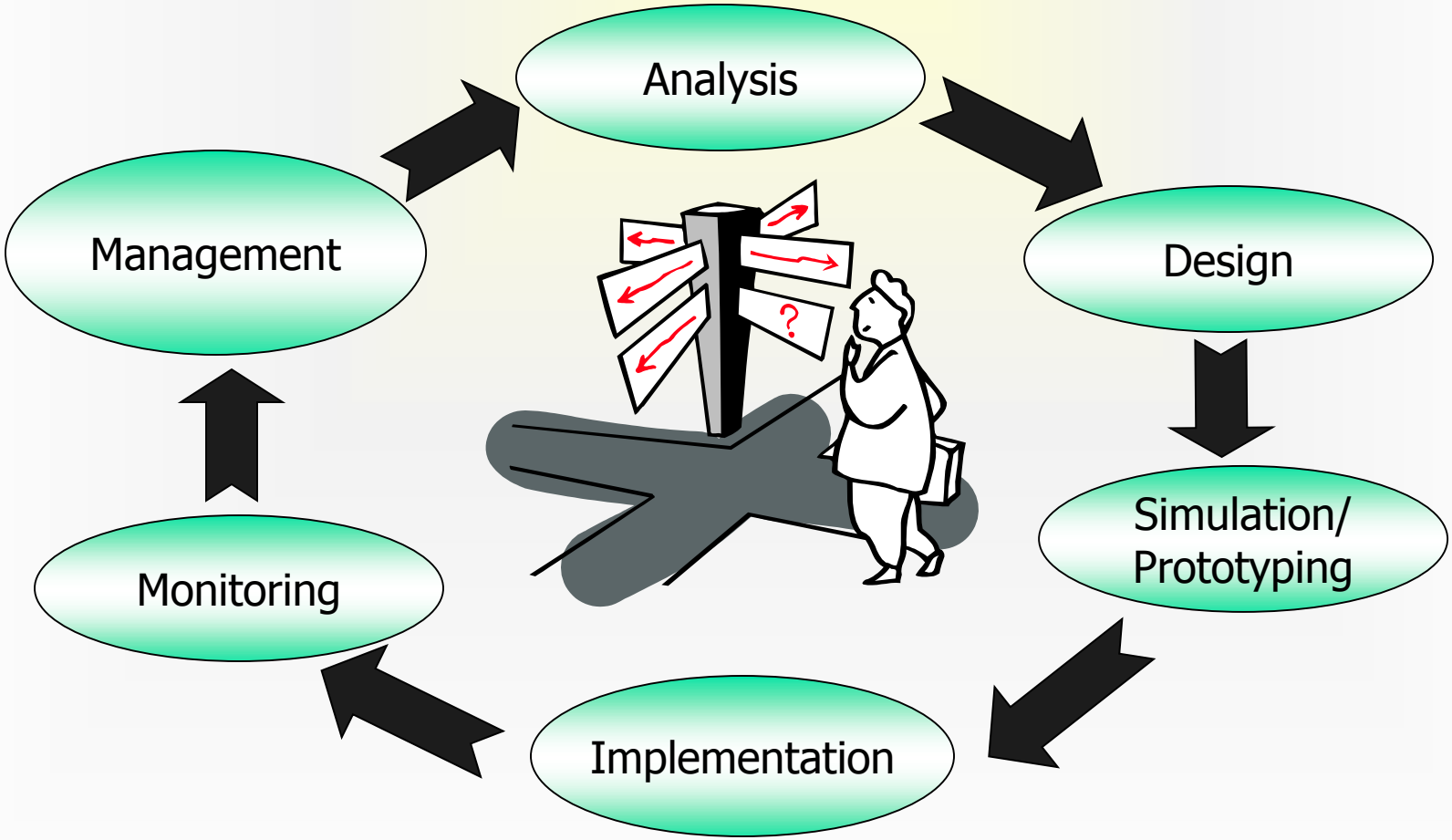
- Remote-access technologies

✓ Point-to-Point Protocol (PPP)
✓ Cable modems
✓ Digital subscriber line (DSL)

- WAN technologies

✓ Leased lines
✓ Synchronous Digital Hierarchy (SDH)
✓ Frame Relay

Network Development Life Cycle



Network Design and Implementation Cycle

- **Analyze requirements:**
  - Interviews with users and technical personnel
  - Understand business and technical goals for a new or enhanced system
  - Characterize the existing network: logical and physical topology, and network performance
  - Analyze current and future network traffic, including traffic flow and load, protocol behavior, and QoS requirements

Network Design and Implementation Cycle

- **Develop the logical design:**
  - Deals with a logical topology for the new or enhanced network
  - Network layer addressing and naming
  - Switching and routing protocols
  - Security planning
  - Network management design
  - Initial investigation into which service providers can meet WAN and remote access requirements

Network Design and Implementation Cycle

- **Develop the physical design:**
  - Specific technologies and products to realize the logical design are selected
  - The investigation into service providers must be completed during this phase
- **Test, optimize, and document the design:**
  - Write and implement a test plan
  - Build a prototype or pilot
  - Optimize the network design
  - Document your work with a network design proposal

Another perspective

- Data collection
  - Traffic
  - Costs
  - Constraints
- Design process
- Performance analysis
- Fine tuning
- *A painstaking iterative process*

Requirements Analysis

- Requirements can come from many aspects of the network system
  - User Requirements
  - Application Requirements
  - Device Requirements
  - Network Requirements
  - Other Requirements

Document the Network Design

- ✓ Executive Summary
- ✓ Project Goal
- ✓ Project Scope
- ✓ Design Requirements
- ✓ Current State of the Network
- ✓ Logical Design
- ✓ Network Layer Addressing and Naming
- ✓ Switching and Routing Protocols
- ✓ Security Design
- ✓ Management Design
- ✓ Quality of service (QOS)
- ✓ Technologies and Devices

Thank you!

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