CIS 375
CHAPTER 6

Network Design

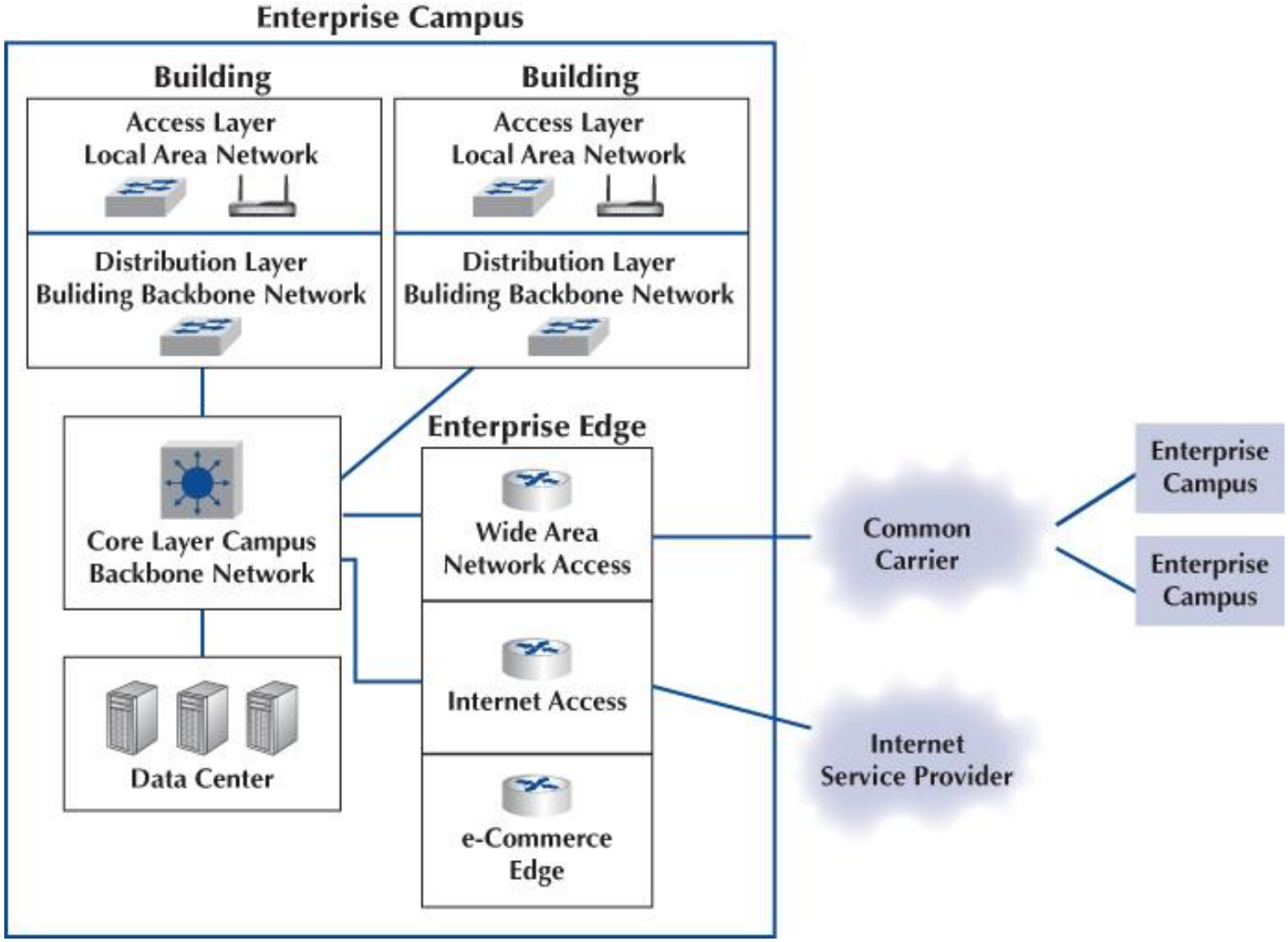
Outline

- Network architecture components
- Traditional network design
  - New network design versus existing network upgrades
- Building-block network design
  1. Needs analysis
  2. Technology design
  3. Cost assessment
- Implications for Cyber Security

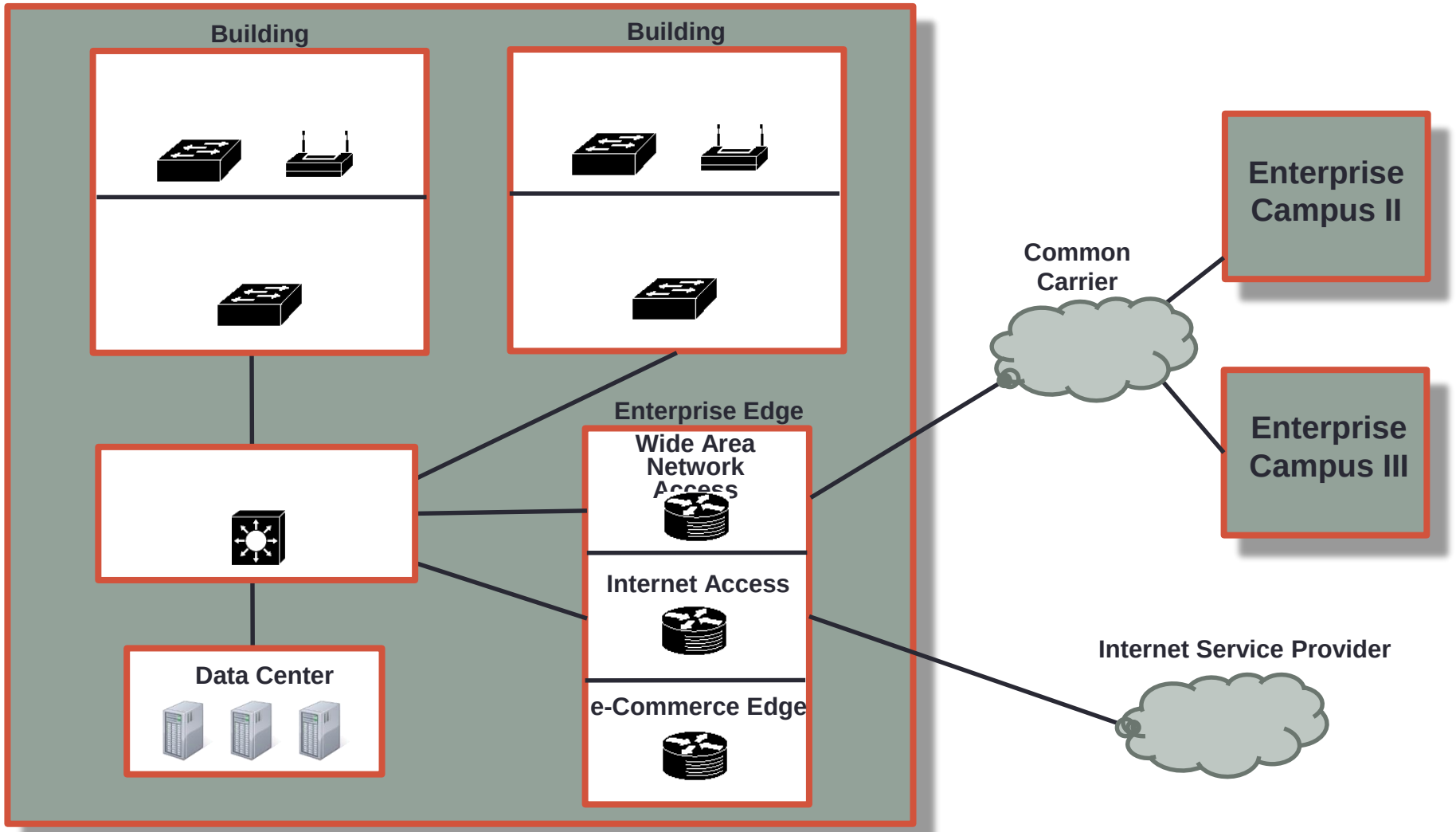
Network Architecture 7 Components

- (1) Local area network (LAN) – Ch. 7
- (2) Building backbone network (or distribution layer) – Ch. 8
- (3) Campus backbone (or core layer) – Ch. 8
- (4) Data center – Ch. 7
- Enterprise edge:
  - (5) Wide area network (WAN) – Ch. 9
  - (6) Internet access – Ch. 10
  - (7) e-commerce edge – Ch. 7 & 11

Network Architecture Components

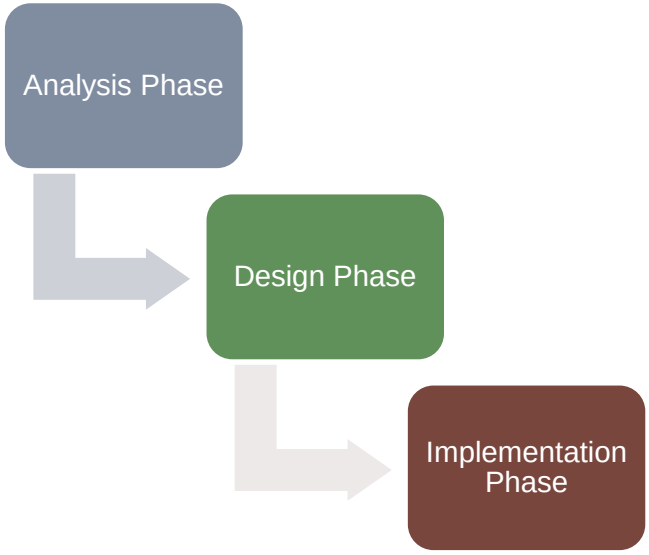


Network Architecture Components



Traditional Network Design

- A structured systems analysis and design process
- Network **analysis phase** includes:
  - Meeting with users to determine the needs and applications
  - Estimating data traffic on each part of the network
- During the network **design phase**, the logical and physical networks are designed and circuits and hardware selected
- **Implementation phase** is the building and implementing of the network

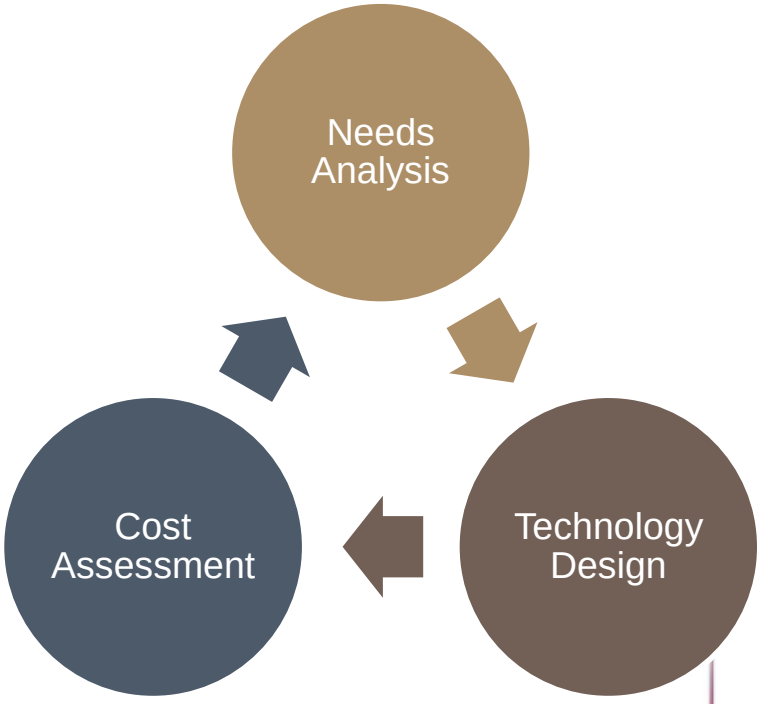


Traditional Network Design

- Pros
  - Useful for static and slowly evolving networks
- Cons
  - Costly
  - Time consuming
  - This approach may not be adequate today due to:
    - Rapid changes in technology
    - Escalating network traffic demands
    - Decrease in hardware costs and increase in staff costs

Building Block Network Design

- Uses a few standard components to simplify design and reduce costs
- Iterative design phases:
  - Needs analysis
    - Understand current and future network needs (users and applications)
  - Technology design
    - Examine available technologies to determine which meet or exceed needs
    - If needs are difficult to estimate, build higher capacity
  - Cost assessment
    - Evaluate financial costs of technology

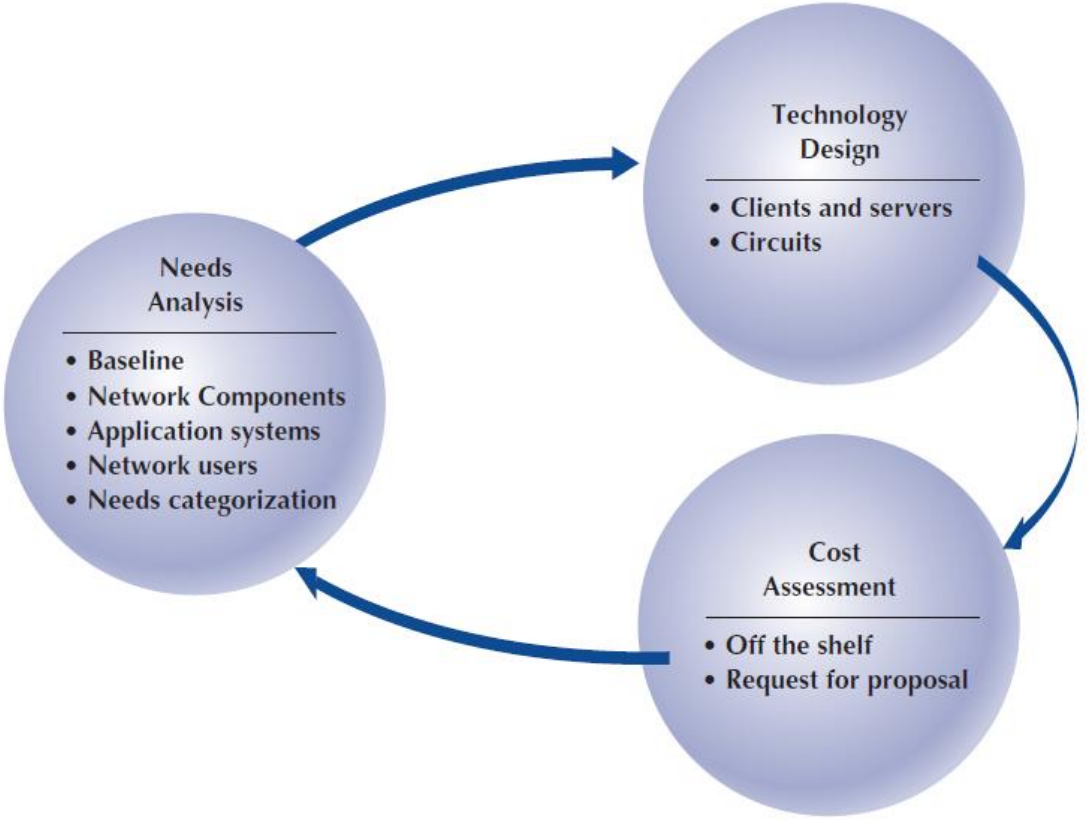


Network Design

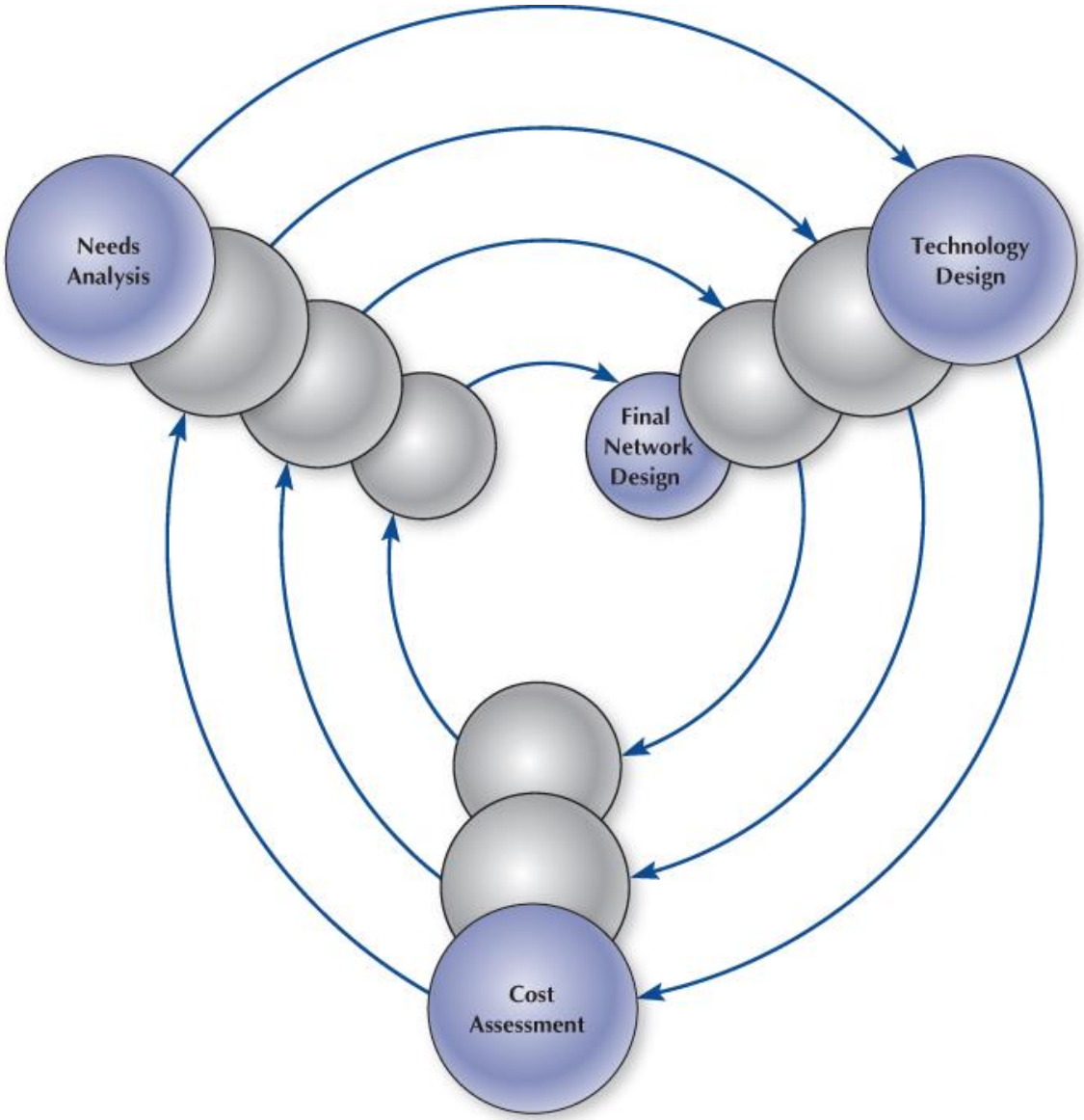
Traditional network design

- Needs analysis
- Precise estimate of amount of data/user
- Circuit need + cost estimate

Building-block network design



Network Design – Cyclical nature



Needs Analysis

- GOAL:
  - A logical network design
- NETWORK ARCHITECTURE COMPONENTS:
  - 7 components
- APPLICATION SYSTEMS
  - Create a baseline
- NETWORK USERS
- CATEGORIZING NETWORK NEEDS
- DELIVERABLES
  - A set of logical network diagrams

Needs Analysis

- Why is the network needed?
  - Performance issues may exist
  - The organization may be standardizing
  - Hardware may need replacement
- What users and applications must be supported?
- Goals differ depending on the network component
  - LAN and BN typically are built with organizational ownership and are often built with excess capacity
  - WANs rely more on leased equipment and circuits are typically designed at or near capacity with organizations leasing additional circuits as required

Needs Analysis

- Baselines
  - Create metrics of current operations to compare design requirements against
  - Baselines may include:
    - Sequence of operations
    - Processing times
    - Work volumes
    - Existing costs
    - Existing user/management needs

Needs Analysis

1. Break down the network into architectural components
   - Evaluate all seven components
   - Often easiest to start with WANs
   - Geographic scope of network

2. Review the existing and expected applications that will use the network
   - Identify hardware and software requirements for these applications
   - Identify protocols used by applications

Needs Analysis

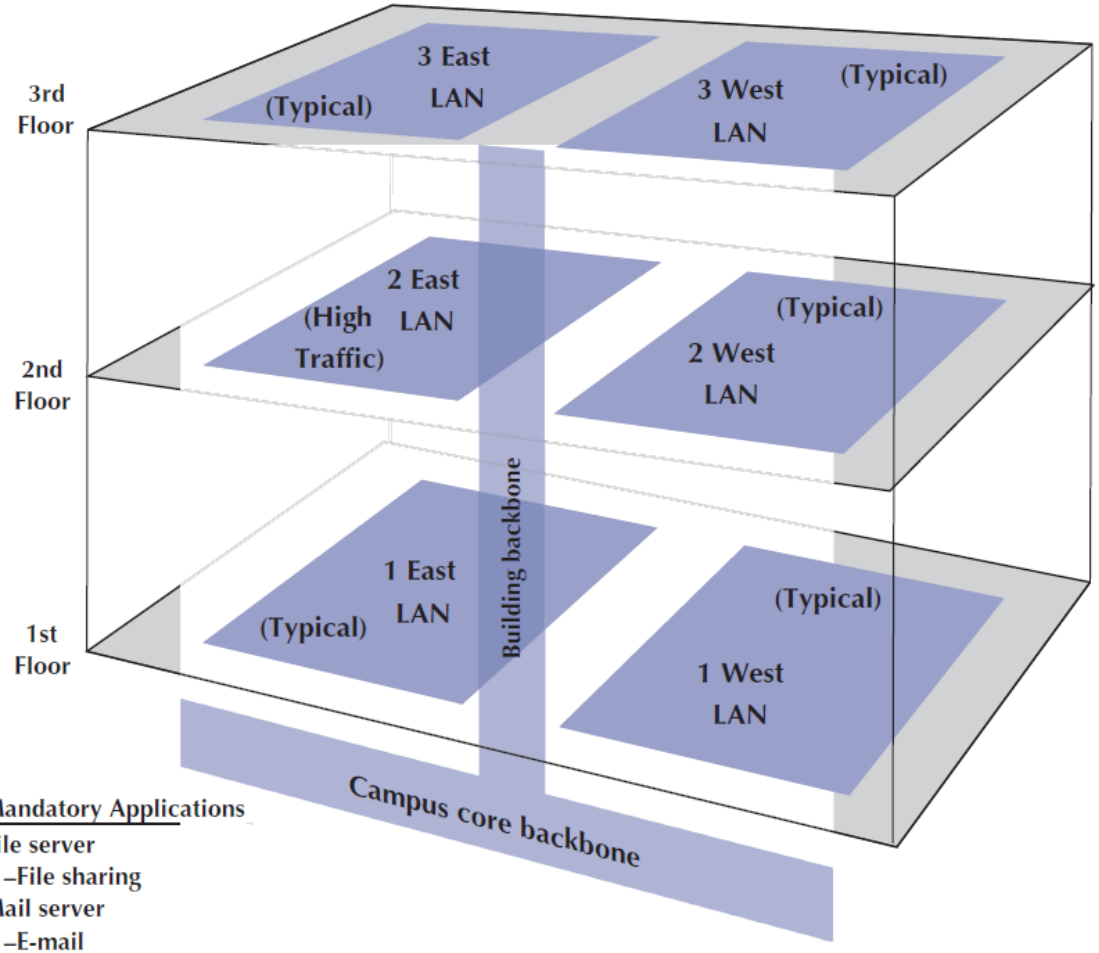
3. Identify and assess network users
   - Some users may have very different needs
   - How many of each type of user?

4. Categorize network requirements
   - Mandatory
   - Desirable
   - Wish-list

Needs Analysis

- Deliverable: Logical network design

Needs Analysis



Mandatory Applications

File server
–File sharing
Mail server
–E-mail
Web server
–Web applications for internal and external use

Wish-List Applications

–Desktop videoconferencing (2 East and 2 West)

Technology Design

- CLIENTS & SERVERS
- CIRCUITS
  - Capacity planning
  - Circuit loading
  - Bottleneck

Technology Design

- Development of a physical network design (or set of possible designs)
- Design includes clients, servers, circuits, and networking devices (routers, gateways, access points, switches, etc.)
- What new hardware needs to be purchased?
- Can the existing equipment be upgraded?

Technology Design

1. Designing clients and servers
   - Specify of the devices needed in standard units
   - “Typical” users are allocated base-level clients
   - “Advanced” users are allocated advanced clients
   - Servers are similarly allocated based on application needs
   - Definitions of “typical” and “advanced” change as hardware costs fall, and capabilities increase

Technology Design

2. Designing circuits
   - **Capacity planning** is the estimation of circuit size and type required for each network architecture component
   - **Circuit loading** is an assessment of the amount of data transferred across a circuit (currently or in the future)

Technology Design

- Estimating circuit traffic
  - Average traffic vs. peak traffic
  - Designing for peak traffic is ideal
- Estimating message volume
  - Count messages sent in the current network and multiply by the expected growth rate
- Precision may not be the major concern
  - Obtaining precise estimates is difficult and expensive
  - Standard circuit speeds “stair step”
  - Traffic typically increases more than anticipated

Technology Design

- Should network designers plan for excess capacity?
  - Upgrading costs 50-80% more than designing higher capacity time
  - Very few complaints about overcapacity
- Most organizations intentionally overbuild
- The **turnpike effect** occurs when traffic increases faster than forecasts
  - When networks are efficient and fast, users will use them more frequently
  - Most networks designed with excess capacity end up using overcapacity within 3 years

Technology Design

3. Network Design Tools
   - Modeling
     - Users create diagrams of existing or proposed networks
   - Discovery
     - Some tools can automatically create network diagrams by examining existing network
   - Simulation
     - A mathematical technique used to model the behavior of a network under real conditions
     - Simulates applications and users generating traffic and responding to messages
     - May highlight potential problems

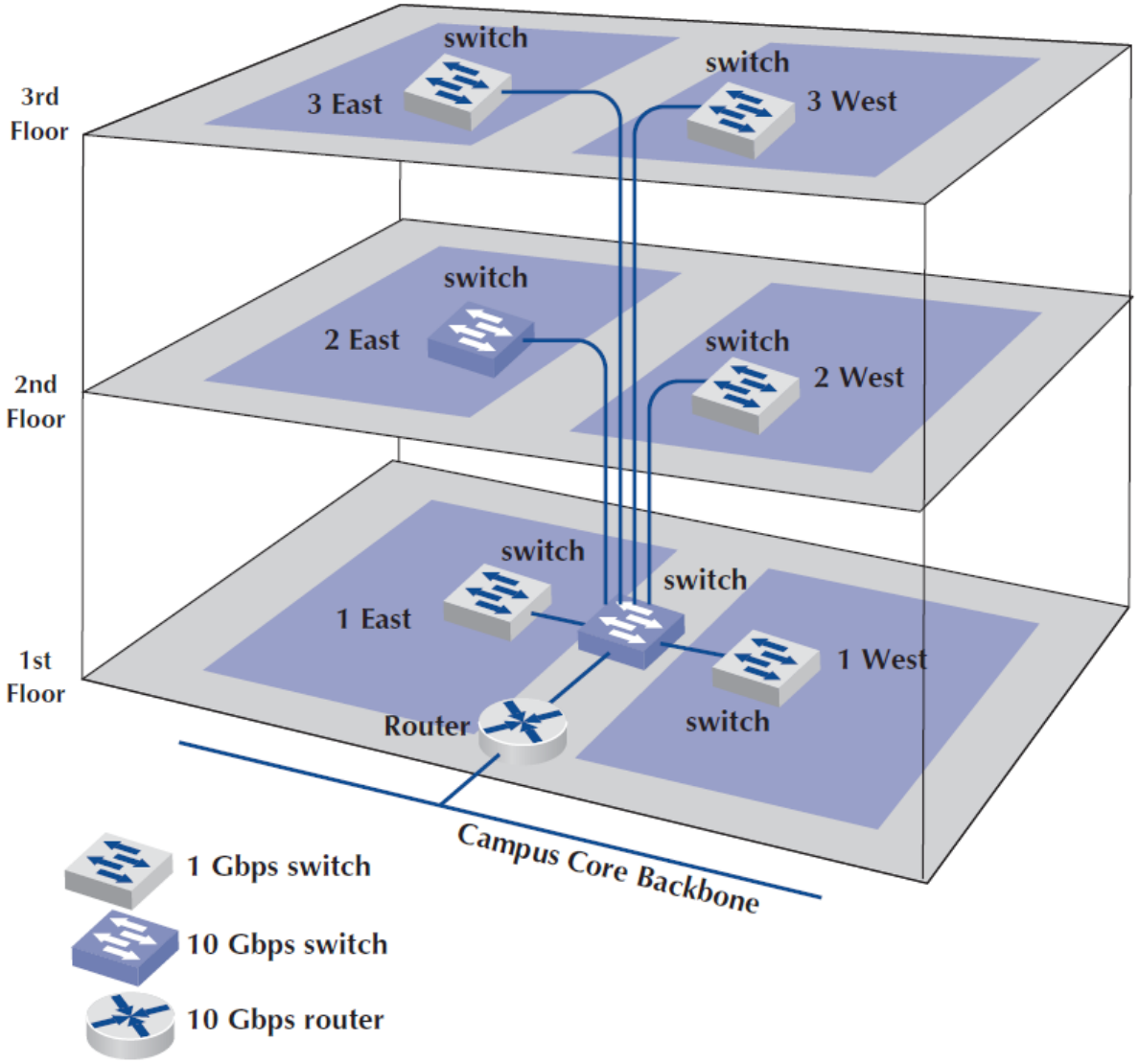
Technology Design

4. Deliverable: One or more physical network designs
   - Multiple designs may be created to highlight tradeoffs between performance and cost
   - Design of circuits and networking devices
   - Designs for new/upgraded clients and servers

Technology Design

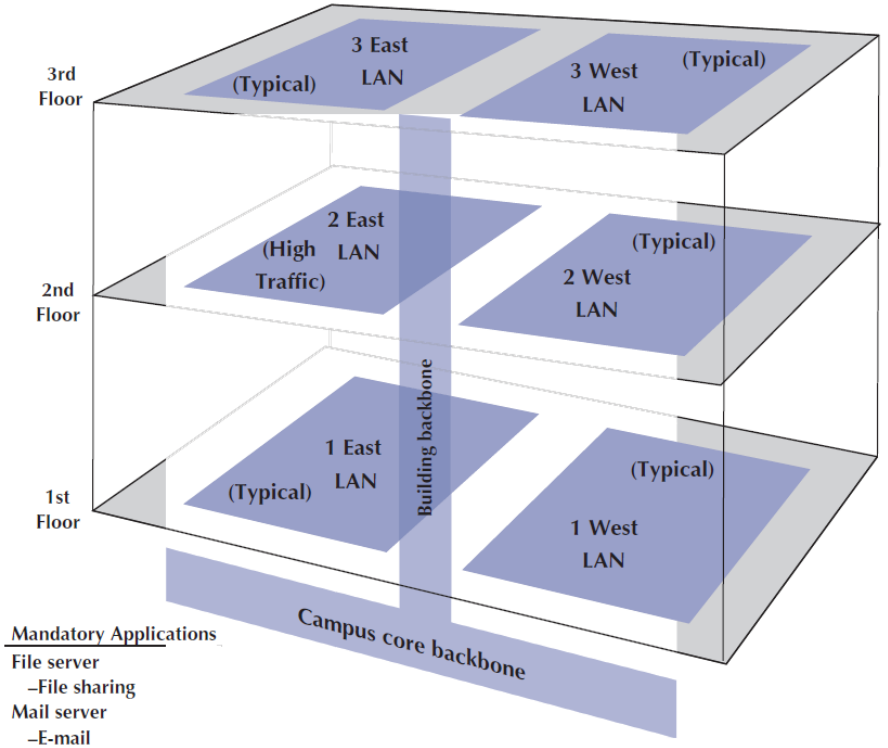
FIGURE 6-5

Physical network design for a single building



Compare Logical Design to Physical Design

Technology Design



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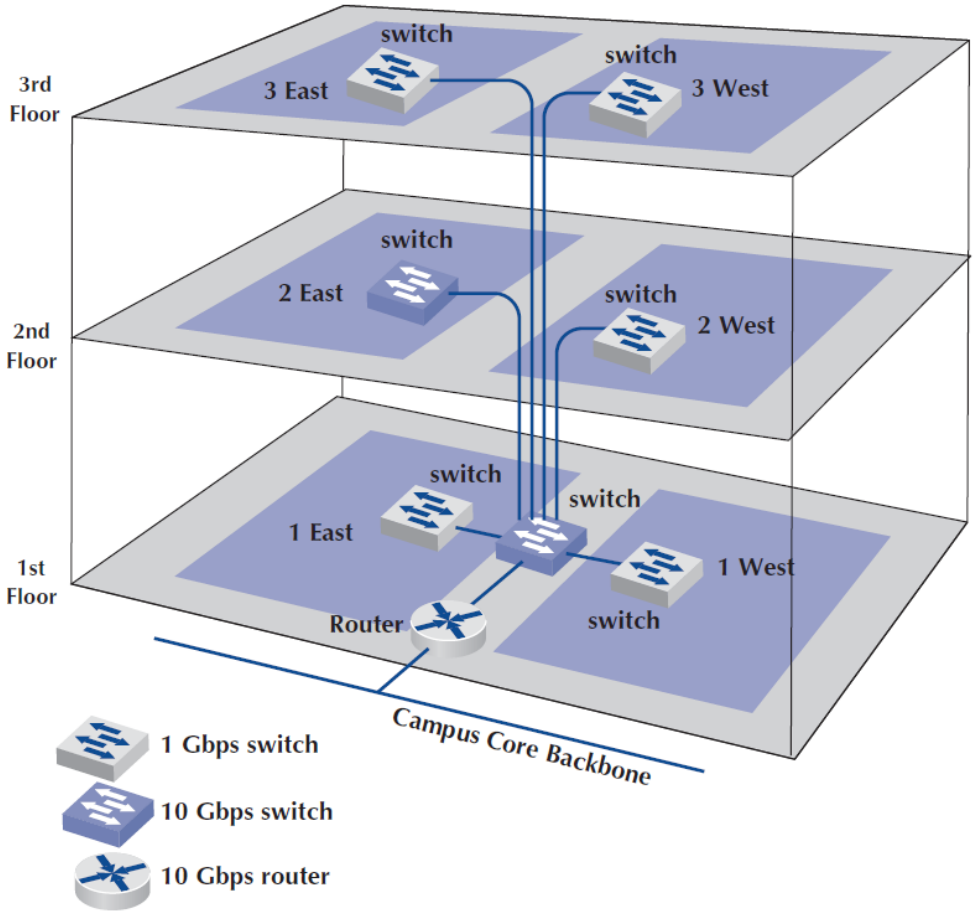

Cost Assessment

- Request for Proposal (RFP)
  - Equipment
  - Software
  - Services

Cost Assessment

- Financial analysis of the various technology design alternatives
- Complex process that requires analysis of many factors:
  - Circuit costs (cabling and installation)
  - Internetworking devices (switches and routers)
  - Hardware costs (clients, servers, power supplies)
  - Software costs (operating systems, application software and middleware)
  - Network management and maintenance costs
  - Operations costs to run the network
  - WAN and Internet circuits

Cost Assessment

- Request for proposal (RFP)
  - Detailed specification of equipment, software, and services desired from vendors
  - Typically used in large network purchases
  - May include timeline and evaluation criteria for proposals
- Allows the organization to evaluate offerings from different vendors
- Multi-vendor proposals
  - May provide better performance
  - May be less expensive
  - May be more difficult to manage

Cost Assessment

- Selling the proposal to management
  - Understand that networks, data centers, and most information technology is viewed as a cost center
  - Make a business case by focusing on organizational needs and strategy
  - The importance of network speed, reliability, and security are easy for non-technical users to understand
  - Avoid focusing on technical details and jargon

Cost Assessment

Cost Assessment

- Deliverables
  - Finalized RFP that is sent to vendors
  - Revised technology design with detailed specifications including exact products and costs
  - Business case for the network design

Implications for Cyber Security

- Network design increasingly relies on standardized technologies and a building-block design
- The cost of hardware, software, and circuits is less expensive in the long-run than human resources to manage network
  - This may make more expensive hardware that is easier to manage a better long-term financial decision
- Secure each architectural component
- Secure the Enterprise Edge
  - This is where most attacks will take place
- Physical Security of the Building
- Do not forget Application Security