Dep. de Engenharia Informática

Projecto de redes 2015/2016

Aula 9-12

Objectivos:

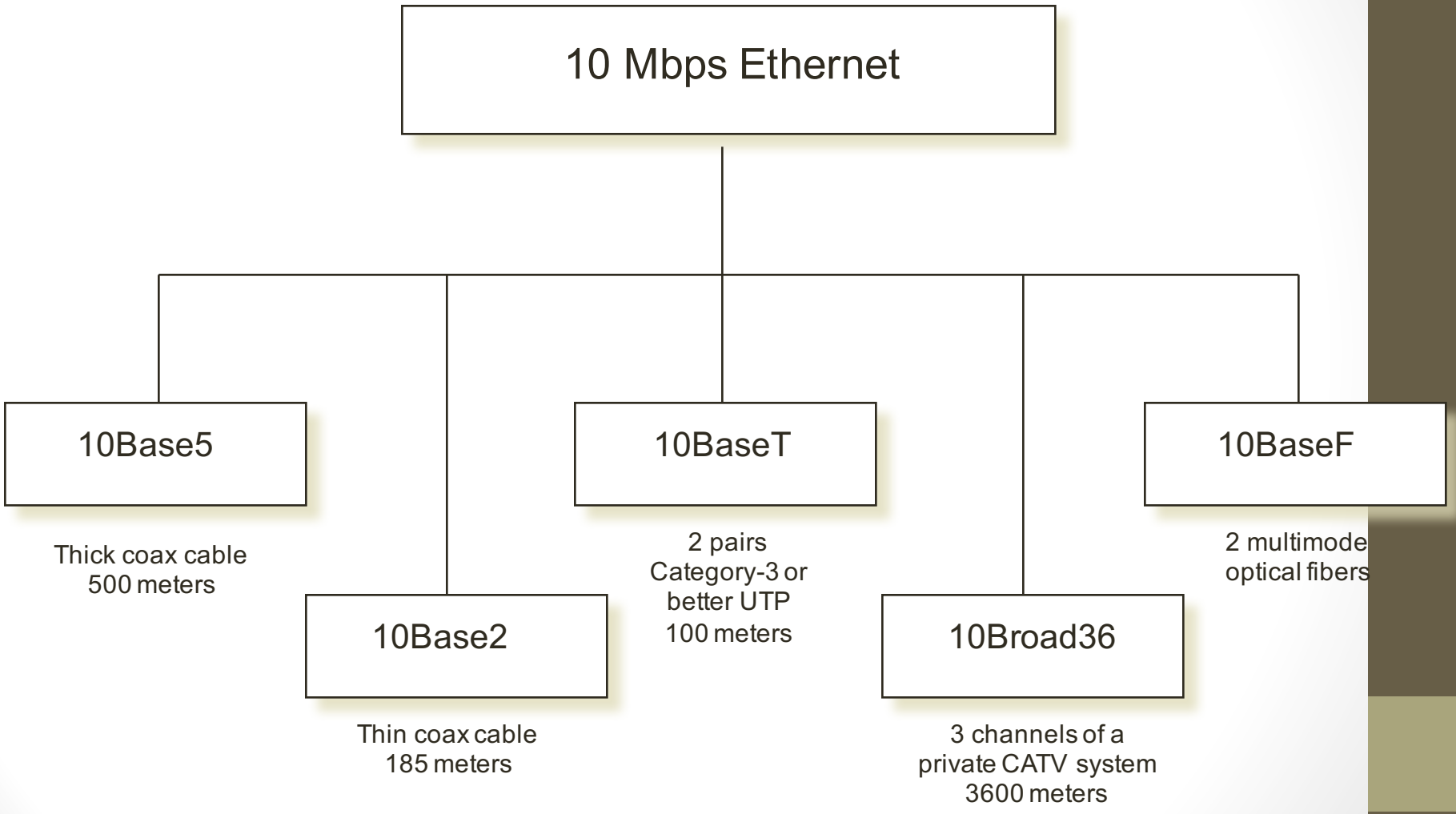
- Considerações acerca dos meios físicos para redes locais de dados.

- Abordagem à metodologia Top-Down network design

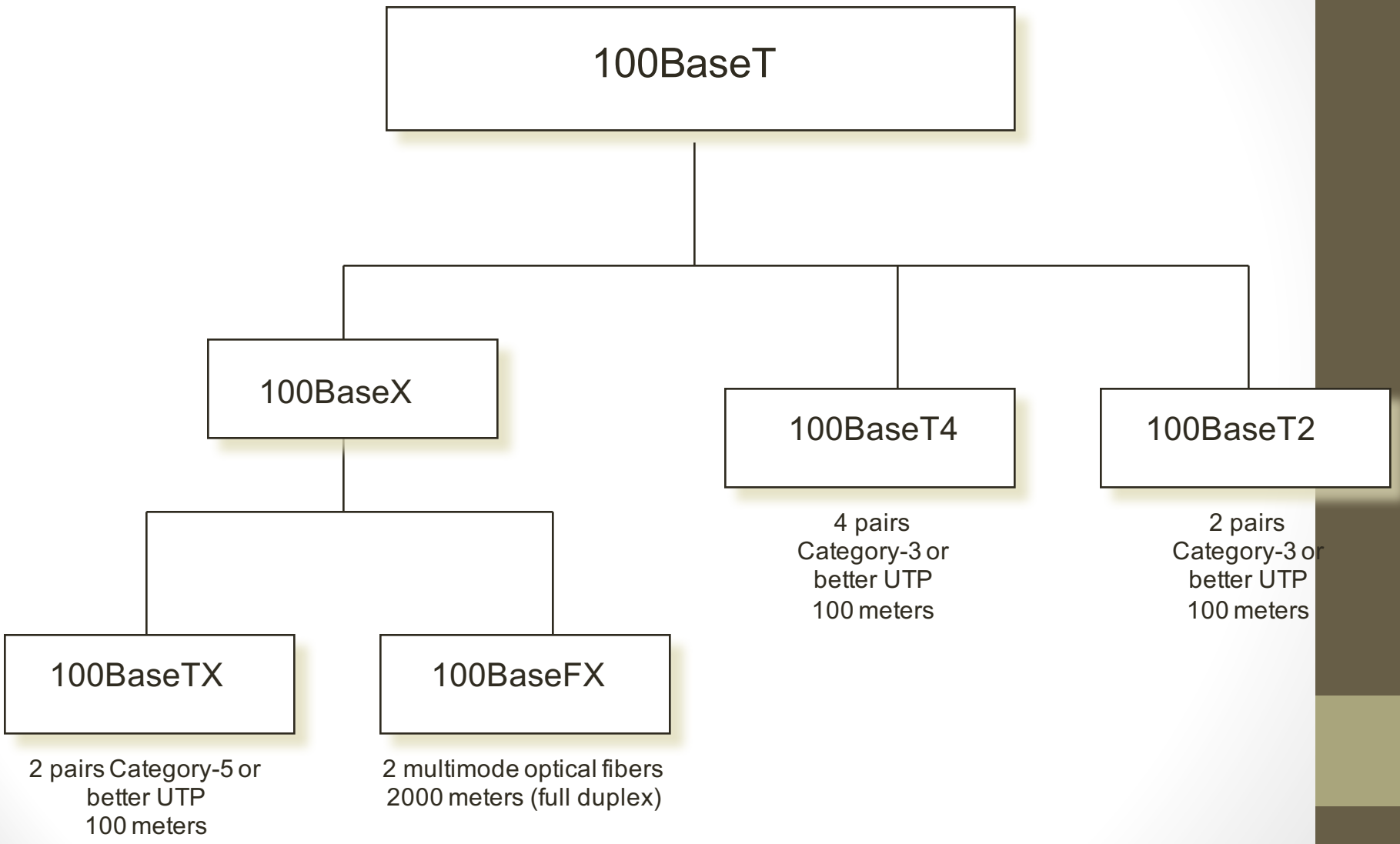
LAN Technologies

- Half-duplex Ethernet (obsolete)
- Full-duplex Ethernet (legacy)
- 10-Mbps Ethernet (obsolete)
- 100-Mbps Ethernet (legacy)
- 1000-Mbps (1-Gbps or Gigabit) Ethernet
- 10-Gbps Ethernet
- Metro Ethernet

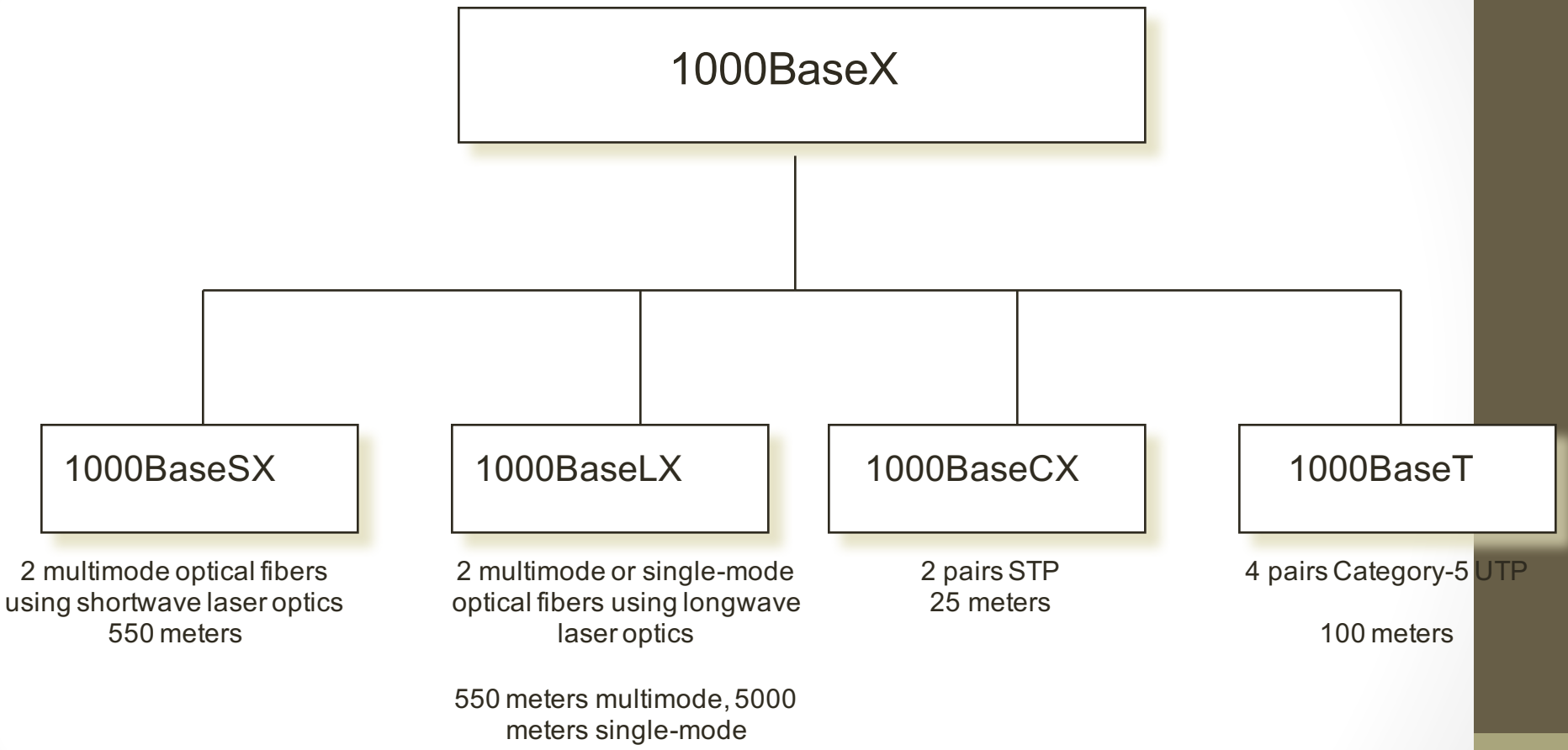
IEEE 802.3 10-Mbps Ethernet



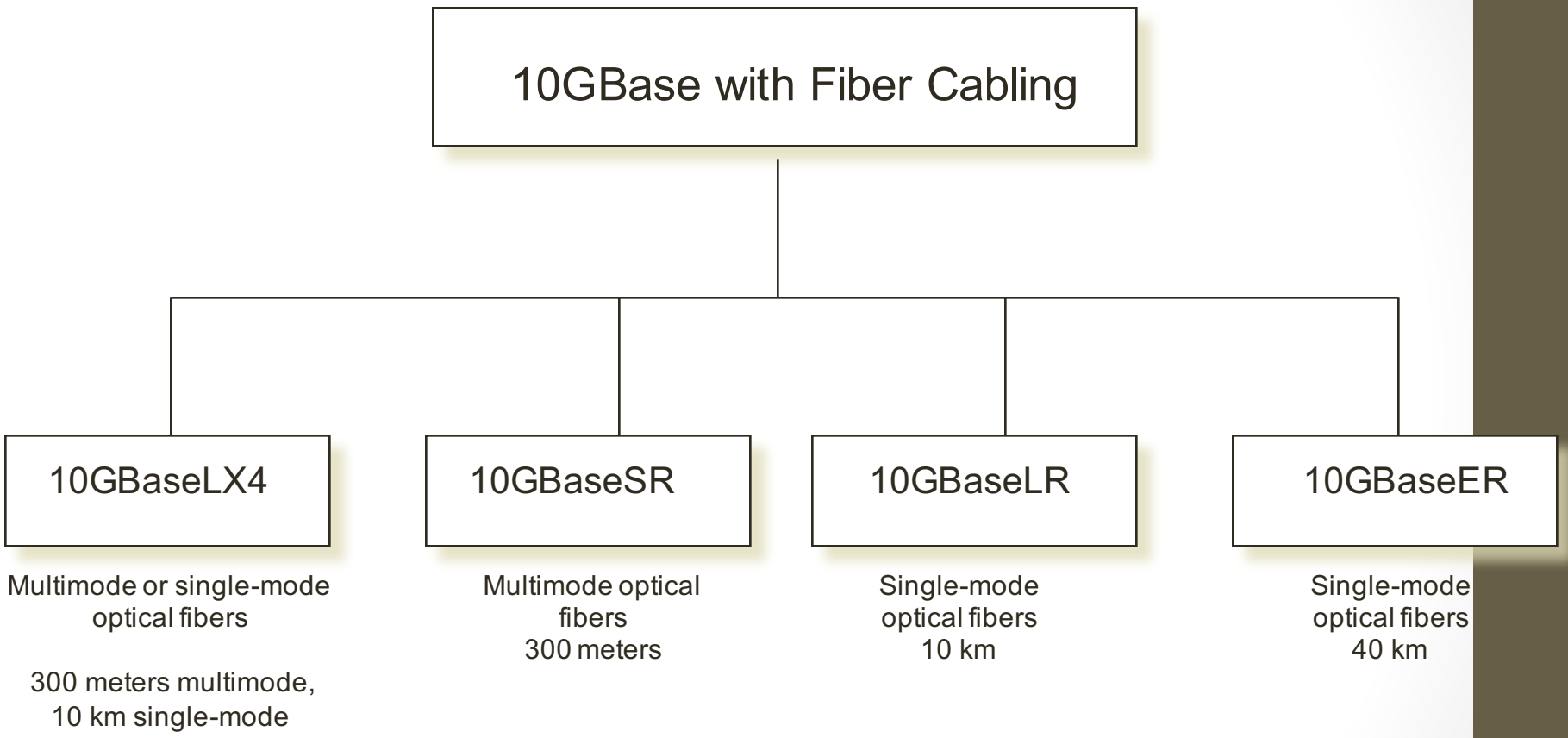
IEEE 802.3 100-Mbps Ethernet



IEEE 802.3 Gigabit Ethernet



IEEE 802.3 10-Gbps Ethernet



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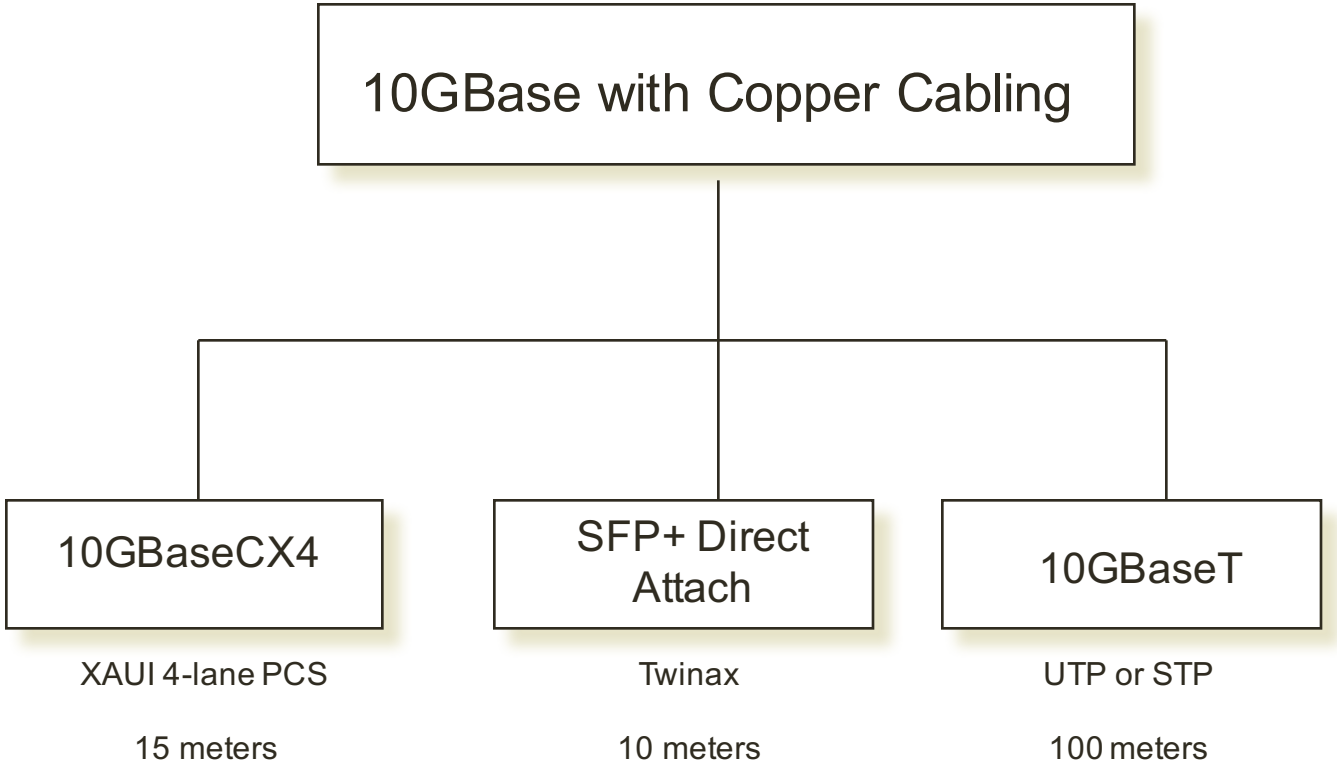
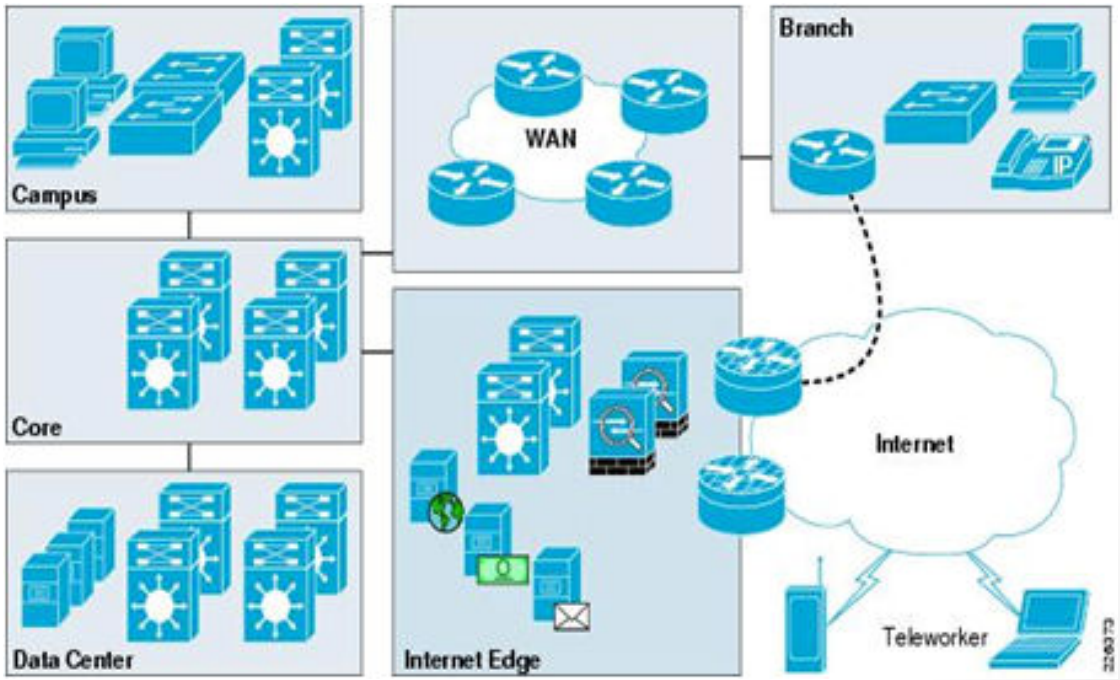


Metro Ethernet

- Service offered by providers and carriers that traditionally had only classic WAN offerings
- The customer can use a standard Ethernet interface to reach a MAN or WAN
- The customer can add bandwidth as needed with a simple configuration change

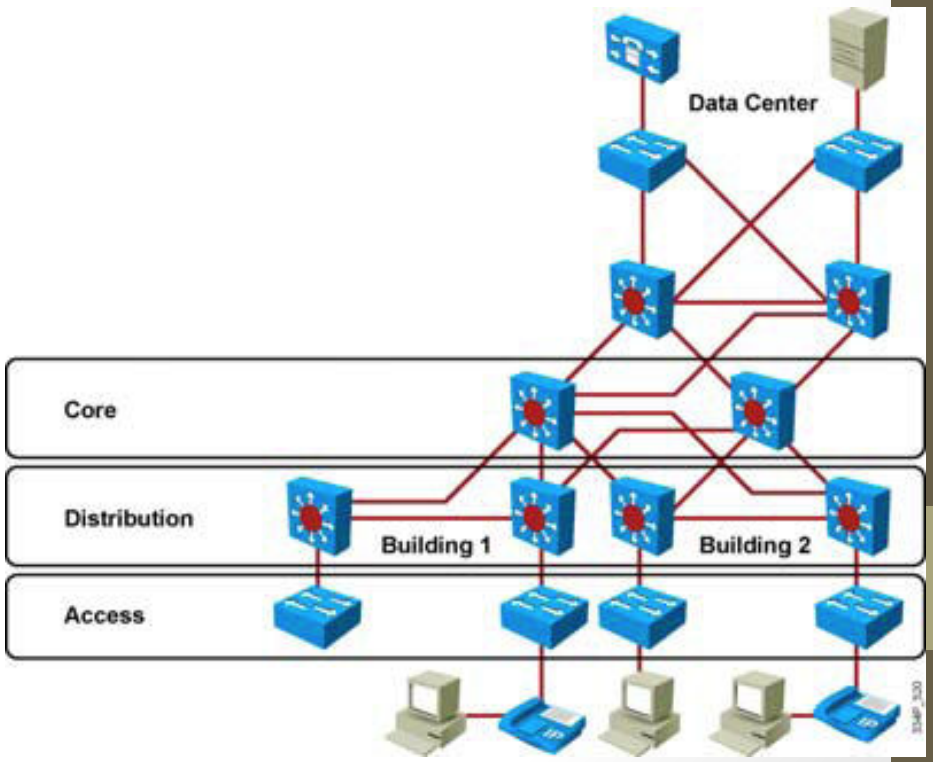
Anatomy of an Enterprise Network

- Core (Backbone)
- Campus
- Data Center
- Branch
- WAN
- Internet Edge



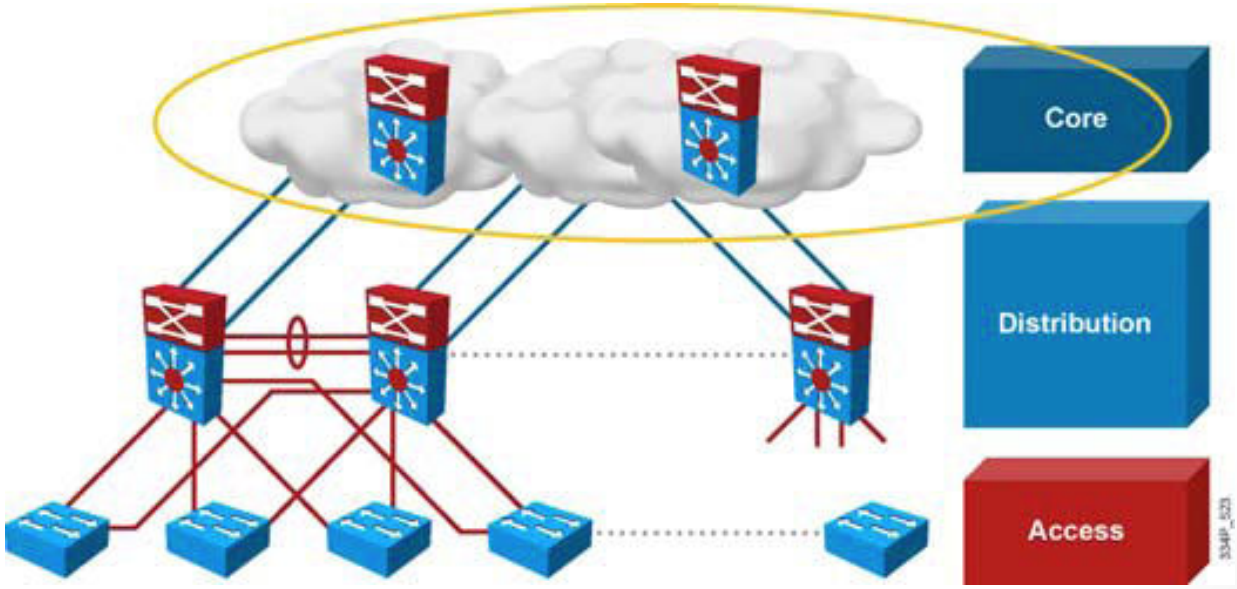
Access, Distribution, and Core Layers

- **Building Core Layer:** high-speed campus backbone designed to switch packets as fast as possible; provides high availability and adapts quickly to changes.
- **Building Distribution Layer:** aggregate wiring closets and use switches to segment workgroups and isolate network problems.
- **Building Access Layer:** grant user access to network devices.



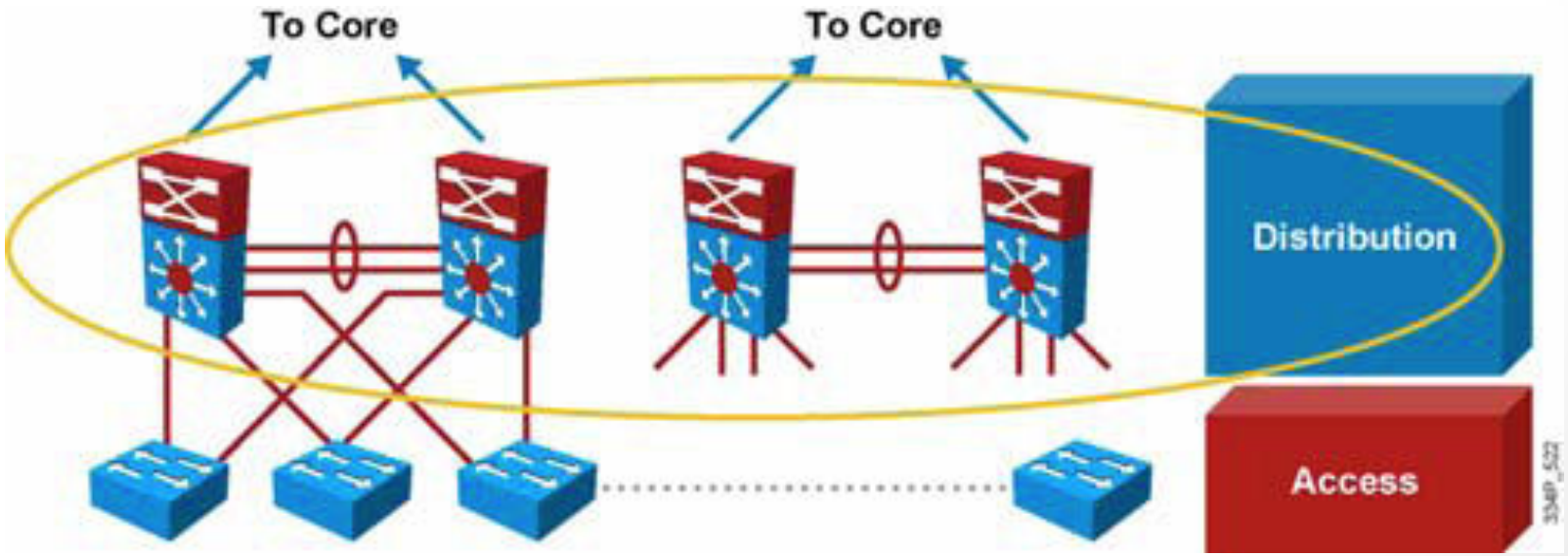
Core Layer

- Aggregates distribution layer switches.
- Implements scalable protocols and technologies and load balancing.
- High-speed layer 3 switching using 10-Gigabit Ethernet.
- Uses redundant L3 links.



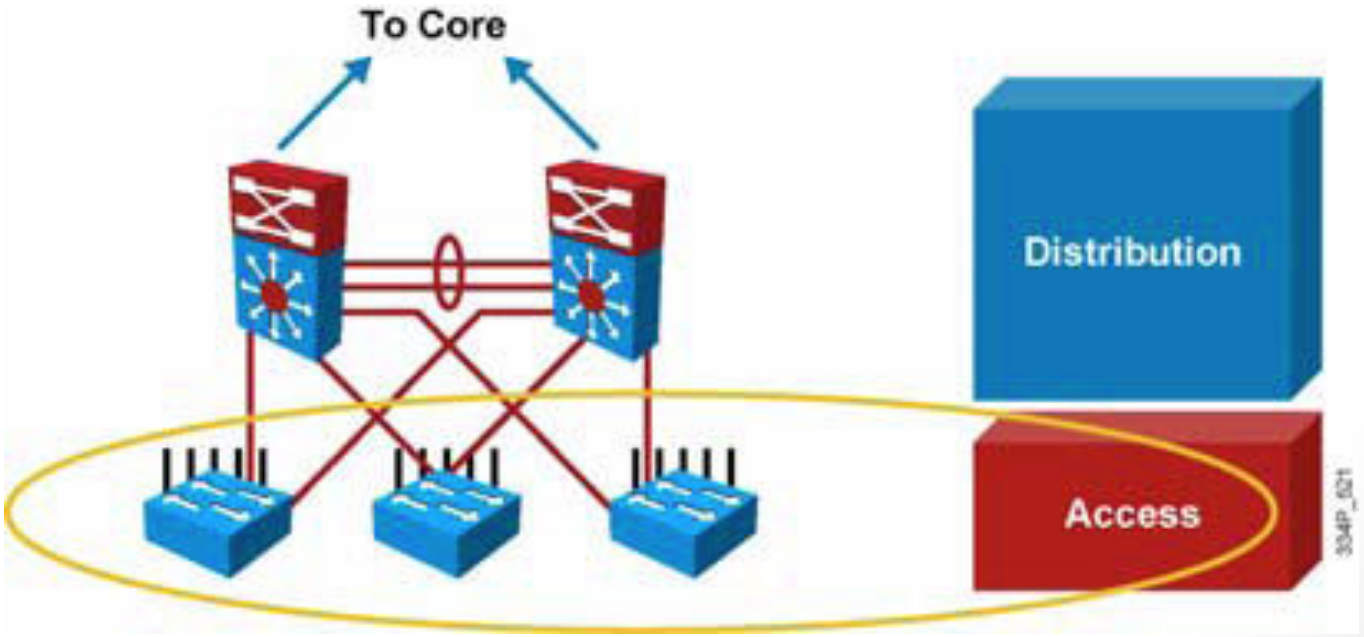
Distribution Layer

- High availability, fast path recovery, load balancing, QoS, and security
- Route summarization and packet manipulation
- Redistribution point between routing domains
- Packet filtering and policy routing to implement policy-based connectivity
- Terminate VLANs
- First hop redundancy protocol (VRRP)



Access Layer

- **High availability** – supported by many hardware and software features, such as redundant power supplies and L2 redundancy protocols.
- **Convergence** – provides inline Power over Ethernet (PoE) to support IP telephony and wireless access points.
- **Security** – includes port security, DHCP snooping, Dynamic ARP inspection, IP source guard.



Modern design approaches

- **Modular** - easily supports growth and change. Scaling the network is eased by adding new modules in lieu of complete redesigns.
- **Resilient** - proper high-availability (HA) characteristics result in near-100% uptime.
- **Flexible** - change in business is a guarantee for any enterprise. These changes drive campus network requirements to adapt quickly.

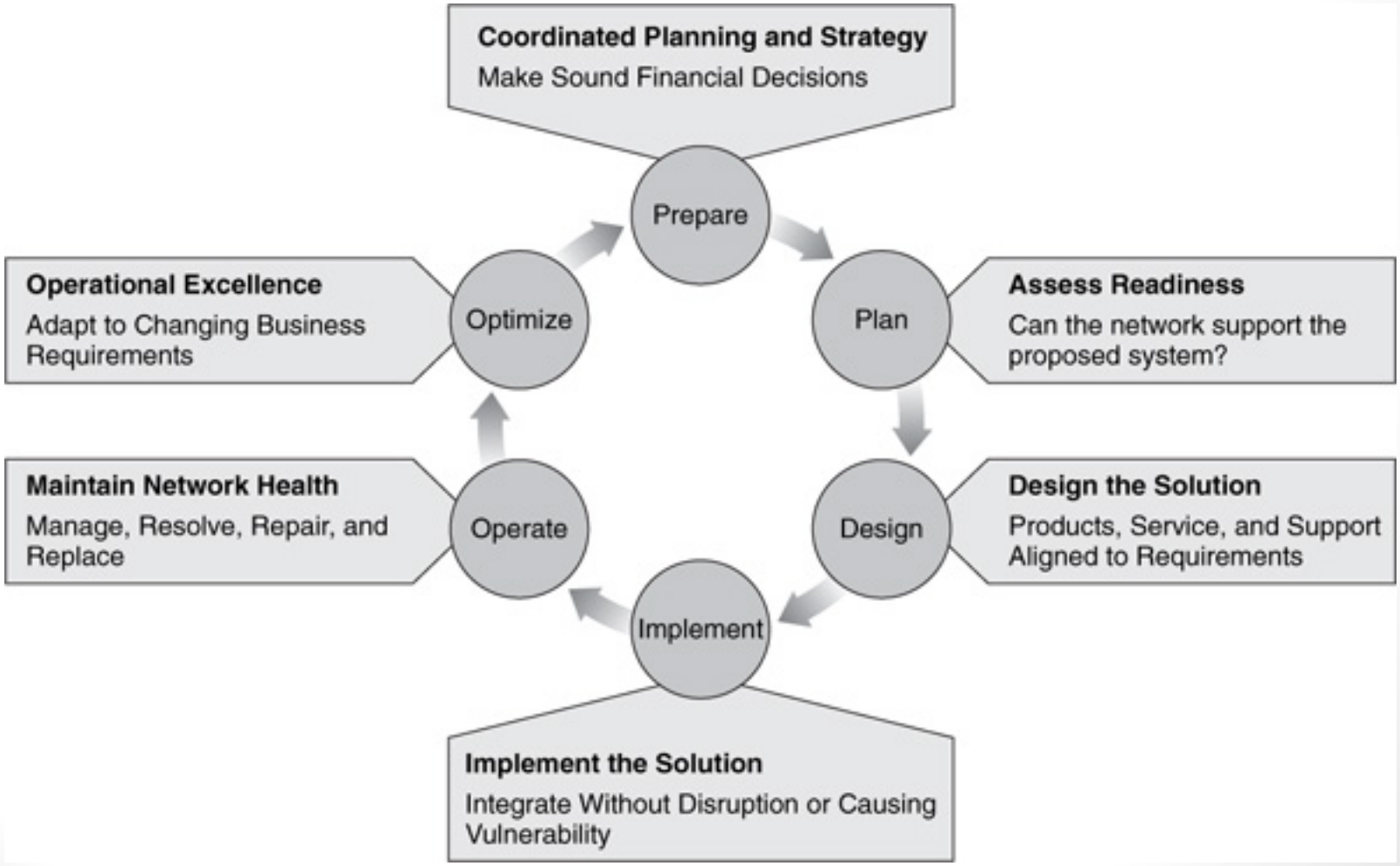
Data traffic characterization

- **Network Management** – BPDU, CDP, SNMP, OSPF, VRRP (for example); low bandwidth
- **IP Telephony** – Signaling traffic and voice traffic; low bandwidth
- **IP Multicast** – IP/TV and market data applications; intensive configuration requirements; very high bandwidth
- **Normal Data** – File and print services, email, Internet browsing, database access, shared network applications; low to medium bandwidth
- **Scavenger Class** – All traffic with protocols or patterns that exceed normal data flows; less than best-effort traffic, such as peer-to-peer traffic (instant messaging, file sharing); medium to high bandwidth

PPDIOO

- Prepare – establish organizational requirements
- Plan – identify initial network requirements
- Design – comprehensive, based on planning outcomes
- Implement – build network according to the design
- Operate – maintain network health
- Optimize – proactive management of network

PPDIOO life cycle



PPDIOO

- Main phases:
  - Phase 1 – Analyze Requirements
  - Phase 2 – Logical Network Design
  - Phase 3 – Physical Network Design
  - Phase 4 – Testing, Optimizing, and Documenting the Network Design

PPDIOO

- Before you start:
  - Analyze business and technical goals first
  - Focus on Layer 7 and above first
    - Determine what applications will run on the network and how those applications behave on a network.

PPDIOO

- Before you start:
  - A focus is placed on:
    - understanding data flow, data types, and processes that access or change the data.
    - the location and needs of user communities that access or change data and processes.
  - Several techniques and models can be used to characterize the existing system, new user requirements, and a structure for the future system.
  - A logical model is developed before the physical model.
  - The logical model represents the basic building blocks, divided by function, and the structure of the system.
  - The physical model represents devices and specific technologies and implementations.

Top-Down Network Design

- Technical Goals
  - Scalability
  - Availability
  - Performance
  - Security
  - Manageability
  - Usability
  - Adaptability
  - Affordability

Top-Down Network Design

- Technical Goals
  - Scalability - refers to the ability to grow
    - Some technologies are more scalable

    Flat network designs, for example, don't scale well
    - Try to figure out about:
      - Number of sites to be added
      - What will be needed at each of these sites
      - How many users will be added
      - How many more servers will be added

Top-Down Network Design

- Technical Goals
- Availability can be expressed as a percent uptime per year, month, week, day, or hour, compared to the total time in that period
  - Different applications may require different levels
  - Redudancy should be added in order to support availability requirements.

Top-Down Network Design

- Technical Goals
- Availability - can also be expressed as a mean time between failure (MTBF) and mean time to repair (MTTR):
  - Availability = MTBF/(MTBF + MTTR)
    - For example:
      - The network should not fail more than once every 4,000 hours (166 days) and it should be fixed within one hour
      - 4,000/4,001 = 99.98% availability

Top-Down Network Design

- Technical Goals
- Network performance:
  - Common performance factors include
    - Bandwidth
    - Throughput
    - Bandwidth utilization
    - Offered load
    - Accuracy
    - Efficiency
    - Delay (latency) and delay variation
    - Response time

Top-Down Network Design

- Technical Goals
- Network performance:
  - Bandwidth Vs. Throughput
    - Different concepts
    - Bandwidth is the data carrying capacity of a circuit
    - Usually specified in bits per second
    - Throughput is the quantity of error free data transmitted per unit of time
    - Measured in bps, Bps, or packets per second (pps)

Top-Down Network Design

- Technical Goals
- Network performance:
  - Factors that Affect Throughput
    - The size of packets
    - Inter-frame gaps between packets
    - Packets-per-second ratings of devices that forward packets
    - Client speed (CPU, memory, and HD access speeds)
    - Server speed (CPU, memory, and HD access speeds)
    - Network design
    - Protocols
    - Distance
    - Errors
    - Time of day, etc., etc., etc.
  - Bandwidth remains constant.

Top-Down Network Design

- Technical Goals
- Network performance:
  - Throughput Vs. Goodput
    - You need to decide what you mean by throughput
    - Are you referring to bytes per second, regardless of whether the bytes are user data bytes or packet header bytes
    - Or are you concerned with application-layer throughput of user bytes, sometimes called “goodput”
    - In that case, you have to consider that bandwidth is being “wasted” by the headers in every packet

Top-Down Network Design

- Technical Goals
- Network performance:
  - Efficiency
    - How much overhead is required to deliver an amount of data?
    - How large can packets be?
    - Larger better for efficiency (and goodput)
    - But too large means too much data is lost if a packet is damaged
    - How many packets can be sent in one bunch without an acknowledgment?

Top-Down Network Design

- Technical Goals
- Network performance:
  - Delay from the User's Point of View
  - Response Time
    - A function of the application and the equipment the application is running on, not just the network
  - Delay from the technical Point of View:
    - Propagation delay
      - A signal travels in a cable at about 2/3 the speed of light in a vacuum
    - Transmission delay (also known as serialization delay)
      - Time to put digital data onto a transmission line
    - Packet-switching delay
    - Queuing delay

Top-Down Network Design

- Technical Goals
- Network performance:
  - Jitter: The amount of time average delay varies
  - Voice, video, and audio are intolerant of delay variation

Top-Down Network Design

- Technical Goals
- Security:
  - Focus on requirements first
  - Identify network assets
    - Including their value and the expected cost associated with losing them due to a security problem:
      - Hardware
        - Software
        - Applications
        - Data
        - Intellectual property
        - Trade secrets
        - Company's reputation
  - Analyze security risks

Top-Down Network Design

- Technical Goals
  - Manageability
    - Performance management
    - Fault management
    - Configuration management
    - Security management
    - Accounting management

Top-Down Network Design

- Technical Goals
  - Usability
    - Usability: the ease of use with which network users can access the network and services
    - Networks should make users' jobs easier
    - Some design decisions will have a negative affect on usability:
      - Strict security, for example

Top-Down Network Design

- Technical Goals
  - Adaptability
    - Avoid incorporating any design elements that would make it hard to implement new technologies in the future
    - Change can come in the form of new protocols, new business practices, new fiscal goals, new legislation
    - A flexible design can adapt to changing traffic patterns and Quality of Service (QoS) requirements

Top-Down Network Design

- Technical Goals
  - Affordability
    - A network should carry the maximum amount of traffic possible for a given financial cost
    - Affordability is especially important in large network designs
    - WANs are expected to cost more, but costs can be reduced with the proper use of technology

Top-Down Network Design

- Network Applications Technical Requirements

Name of Application	Cost of Downtime	Acceptable MTBF	Acceptable MTTR	Throughput Goal	Delay Must be Less Than:	Delay Variation Must be Less Than:

Top-Down Network Design

Tradeoffs

- Scalability 20
- Availability 30
- Network performance 15
- Security 5
- Manageability 5
- Usability 5
- Adaptability 5
- Affordability 15
- Total 100

Top-Down Network Design

- Characterizing the existing Network
  - Where are we?
    - Characterize the existing infrastructure in terms of:
      - Its infrastructure (physical and logical)
      - Addressing and names
      - Wiring and media
      - Architectural and environmental constrains
      - health