



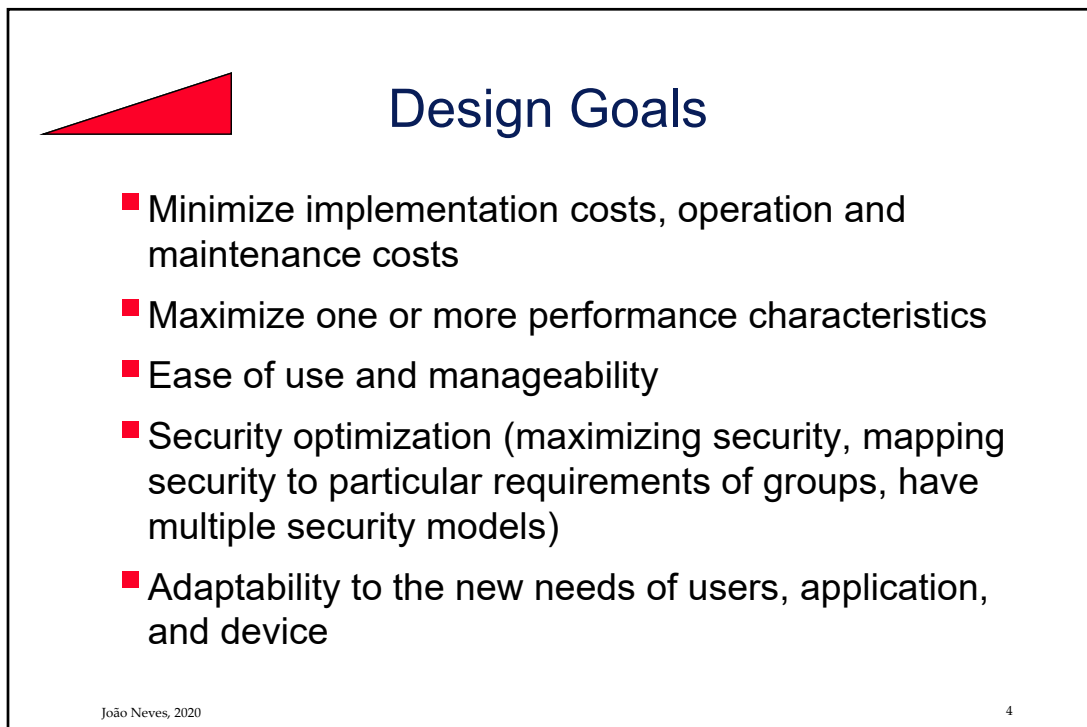
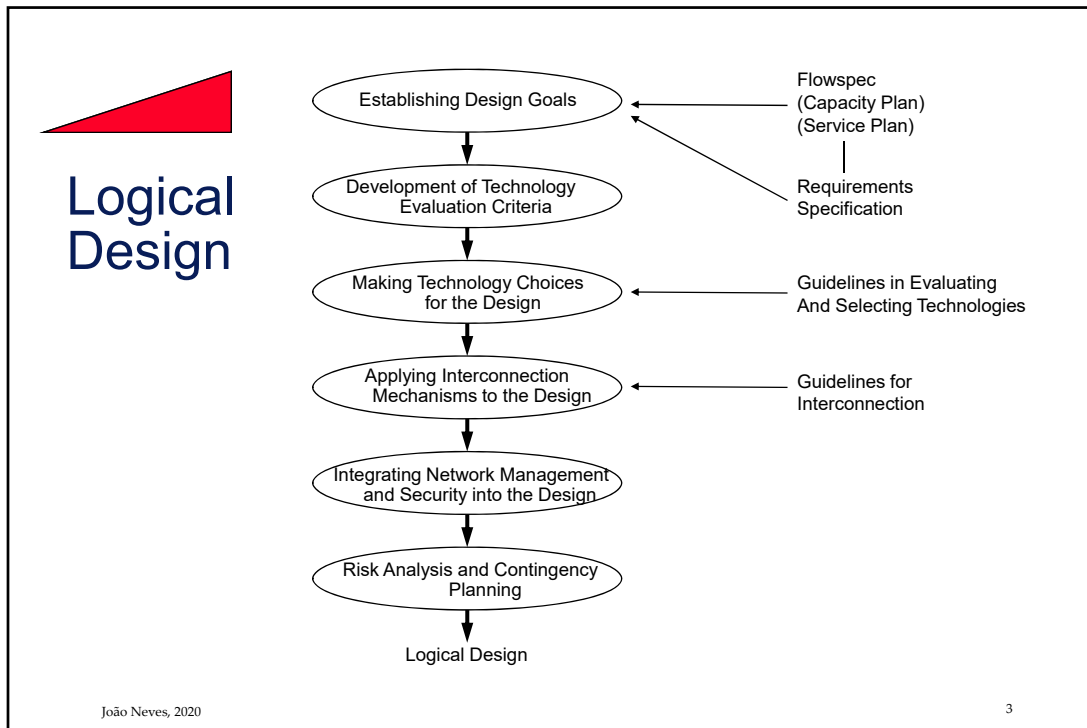
Logical Design

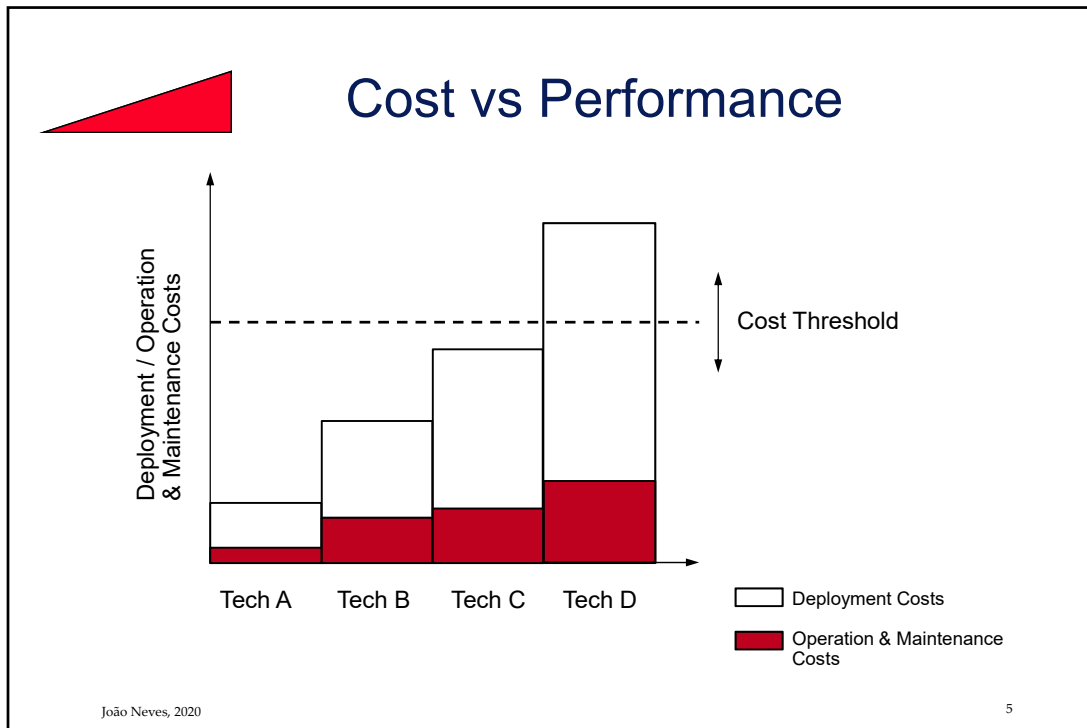
`Joao.Neves@fe.up.pt`



Logical Network Design

- Design a Network Topology
- Design Models for Addressing and Numbering
- Select Switching and Routing Protocols
- Develop Network Security Strategies
- Develop Network Management Strategies



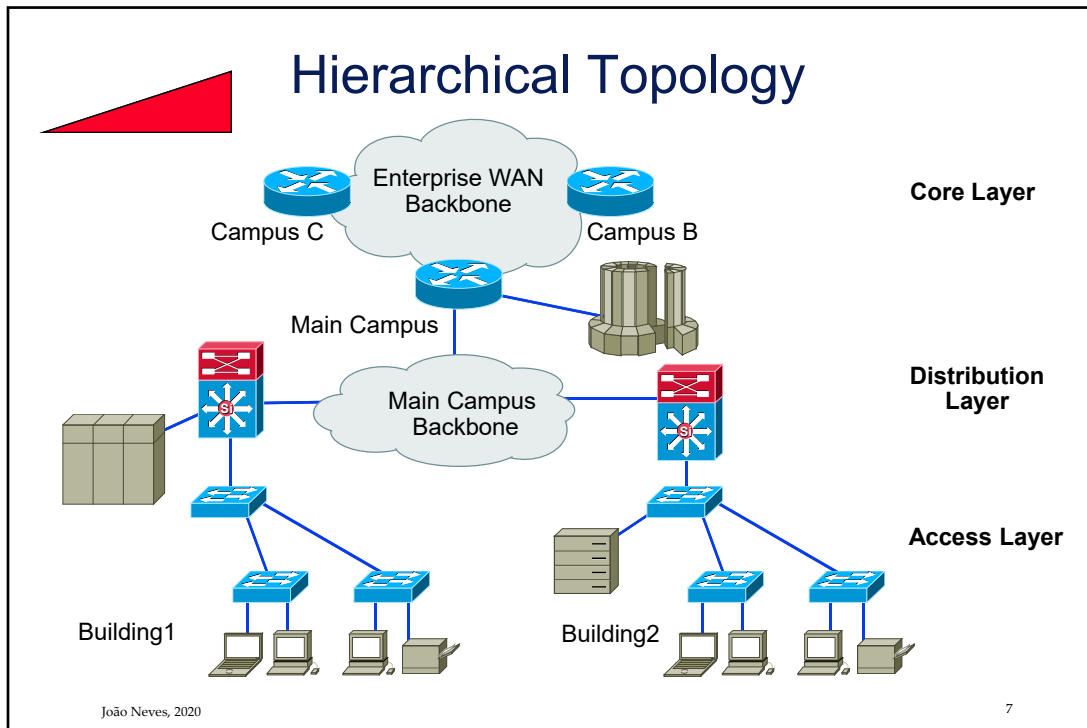


Criteria for Technology Choices

- Maximizing performance leads to the choice of technologies that meet or exceed the desired capacity, delay and reliability:
 - Maximizing data volume requires the availability of high communication capacity
 - Minimizing delays requires resource reservation for specific flows
 - Maximizing reliability requires redundancy

João Neves, 2020

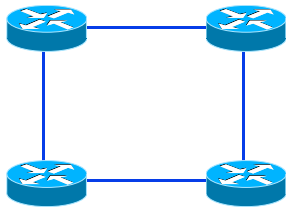
6



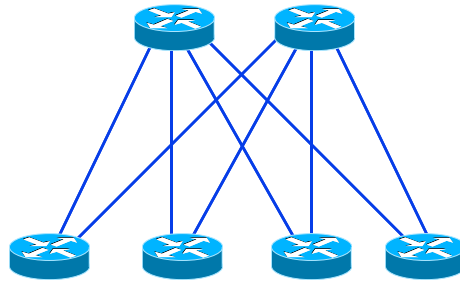
- ## Hierarchical Topology
- The core layer is where are high-end routers, servers and switches, that are optimized for availability and performance;
 - The distribution layer is where specialized servers, routers and switches that implement policies and segment traffic;
 - The access layer that connects users via switches, Wi-Fi, and other devices.
- João Neves, 2020
- 8



Flat Versus Hierarchy



Flat Loop Topology



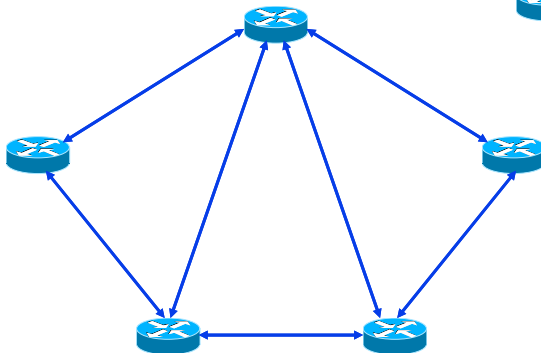
Hierarchical Redundant Topology

João Neves, 2020

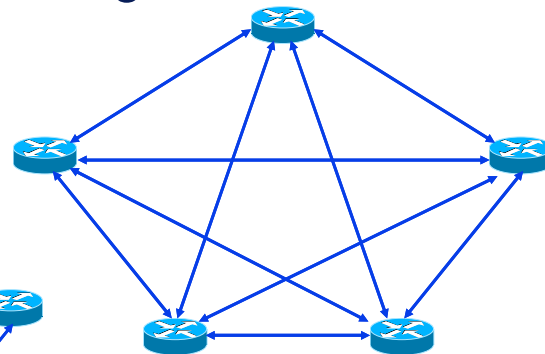
9



Mesh Designs



Partial-Mesh Topology



Full-Mesh Topology

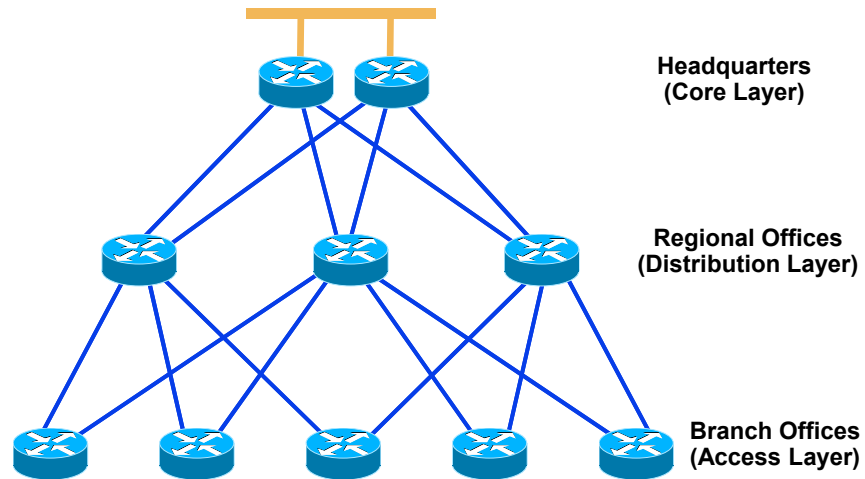
- No. of Links = $\frac{n*(n-1)}{2}$
- Expensive

João Neves, 2020

10



Partial-Mesh Hierarchical



João Neves, 2020

11



External Physical Network Design

- Centralized layout (paths and cables)
- Distributed layout
- Different paths and different physical media
- Redundant paths and cables

João Neves, 2020

12



Internal Physical Network Design

- Distributed cabling and switching:
 - One or more racks per floor
 - Main rack per building
- One single rack per building
- Problem of the maximum length of the cable segments for the horizontal distribution
- Costs associated with the spread of racks by the building
- Need for active switching equipment per rack, resulting in increased costs of acquisition and operation



Cabling Routing problems

Real-world server room nightmares

<http://www.techrepublic.com/photos/real-world-server-room-nightmares/479281>

Gallery: The most nightmarish server rooms out there

<https://www.techrepublic.com/pictures/gallery-the-most-nightmarish-server-rooms-out-there/?ftag=TR&e=10240&bhid=20664553430818404886445572166048>





Maintenance Procedures

- Design proper maintenance and operation procedures



Source: https://www.reddit.com/r/cableporn/comments/8gxs6a/one_of_my_most_frustrating_cable_management/

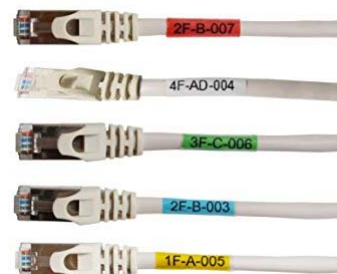
João Neves, 2020

15



Physical and Logical Diagrams

- Make Logical Diagrams
- Make Physical Diagrams (check architectural drawings conformity...)
- Inventory assets and tag all active and passive devices accordingly the logical and physical diagrams



João Neves, 2020

16



Specialized Devices Location

- Choose locations with good environmental support: air conditioning, uninterrupted power supply and space
- Places with physical security (difficult access or conditioned)
- Mark the equipment properly, to be easily identified



Equipment Specifications

Specify some or all of the following for each device:

- Equipment vendor
- Equipment type/class
- Device ID
- Interface types and rates
- Device hardware configuration
- Device OS level/revision
- Any appropriate vendor-specific information
- Routing protocols used



Places of Strategic Importance

- LAN–MAN and LAN–WAN interfaces
- External interfaces of buildings.
- External interfaces of a campus (this may also be a LAN–MAN or LAN–WAN interface)
- Interfaces between access networks and a LAN backbone
- AS boundaries



Addressing and Naming Design

- Understand IP addressing concepts
 - Variable length net mask
 - CIDR notation
 - Private addressing
- Domain Name System
 - Which Server (ISC-BIND, Knot Resolver, NSD, Unbound, ...)
 - Name space delegation
 - Reverse mapping
- Routing Protocols
 - Interior and exterior routing
 - Which interior protocol
 - Default routing



System Components and Security

- User Security
- Application Security
- Device Security
- Network Security



Security Mechanisms

- Security threat and risk analysis
- Security policies and procedures
- Physical security and awareness
- Protocol and application security
- Encryption
- Network perimeter security
- Remote access security

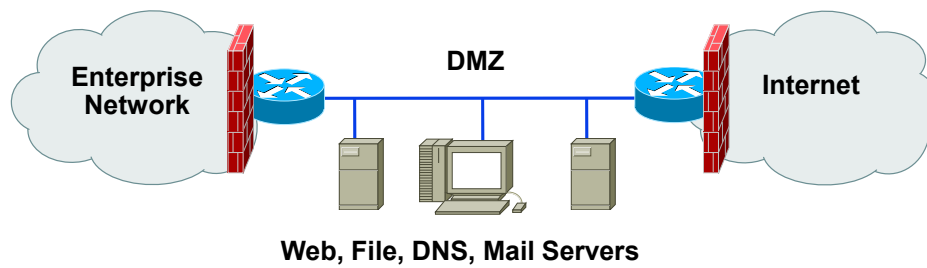


Security Examples

- External Firewall
- Internal Firewall
- Distributed security of workstations
- Perimeter security and Cloud



Security Topologies





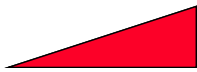
Network Management Mechanisms

- Monitoring and data collection
- Data processing, display, and storage
- Process notifications
- Debugging and diagnosing
- Instrumentation to access, transfer, act upon, and modify data
- Device and service configuration



NM Mechanisms

- FCAPS components
- Instrumentation
- In-band or out-of-band management
- Centralized and distributed management
- Scaling network management traffic
- Checks and balances to verify variables representation
- Managing network management data
- MIB selection



Network Management Configuration

Configuration is setting parameters in a network device for operation and control of that element.

- SSH, *telnet* and command line interface (CLI) access
- Access via HTTP/HTTPS
- Access via common object request broker architecture (CORBA)
- Use of FTP/TFTP to download configuration files
- SNMP *set* commands (security problem using in-band management)



Scaling NM Traffic

Try to estimate of the average data rate for management traffic:

- The number of devices and network devices to be polled
- An average number of interfaces per device
- The number of parameters to be collected
- The frequency of polling (polling interval)



Monitoring Impact...

- Monitor 8 objects on 100 systems
- Readings every 5 seconds
- 800 query operations result in 800 responses
- 64 byte / response or query
- 8 bit / byte
- Total 800 kbit in every 5 sec



Capacity and Delay Requirements

- The amount of management traffic rate should be targeted at 2 % to 5 % of the LAN capacity
- SNMP generally adds less than 2 % of traffic (but can grow uncontrollably if the criterion is relaxed in the number of polling management stations and polled objects)
- As LAN capacity increases, network management traffic may increase in one or more traffic variables
- In a WAN environment, a monitoring probe is recommended for each WAN-LAN interface



Management Data Flows

- *Local storage versus archival*: which management data are necessary to keep stored locally and which data may be archived
- *Selective data copying*: when a management parameter is being used for both event notification and trend analysis, consider copying every N-iteration of that parameter to a separate database
- *Data migration*: when collecting management data for trend analysis, data can be stored locally on the NMS and then downloaded to storage/archiving when traffic is expected to be low
- *Metadata*: additional information about the collected data, such as references to the data types and timestamps of when the data were generated



Additional Reading



McCabe, James D.
Network Analysis, Architecture and Design
3rd Ed., The Morgan Kaufmann Series in Networking
ISBN: 978-0-12370-480-1
eBook ISBN: 978-0-08054-875-3