

CSC223 NETWORK DESIGN AND MANAGEMENT

Network Design Principles



CONTENTS

- Design goals
- Design choices
- Design approaches
- The design process
- Capacity planning



DESIGN GOALS

Good designs should:

- Deliver services requested by users.
- Deliver acceptable throughput and response times.
- Be within budget and maximise cost efficiencies
- Be reliable.
- Be expandable without major redesign.
- Be manageable by maintenance and support staff
- Be well documented.



FUNDAMENTAL DESIGN GOALS

These requirements translate into four fundamental network design goals:

- ■ **Scalability:** Scalable network designs can grow to include new user groups and remote sites and
- can support new applications without impacting the level of service delivered to existing users.
- ■ **Availability:** A network designed for availability is one that delivers consistent, reliable performance, 24hoursaday, 7 days a week. In addition, the failure of a single link or piece of equipment should not significantly impact network performance.



- **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.
- **Manageability:** No matter how good the initial network design is, the available network staff must be able to manage and support the network. A network that is too complex or difficult to maintain cannot function effectively and efficiently.



WHY MODERN DESIGN

- i. There is rise in technology
- ii. Traditional network boundaries have been removed
- iii. Complexities of network
- iv. Reduce the time to develop and market products

Network design are affected by both business and technology drivers.

- **Business drivers:** return on investment, regulation, competitiveness
- **Technology drivers:** removal of borders, virtualization, growth of application.



THE STEPS REQUIRED TO DESIGN A GOOD NETWORK ARE AS FOLLOWS:

- Step 1. Verify the business goals and technical requirements.
- Step 2. Determine the features and functions required to meet the needs identified in Step 1.
- Step 3. Perform a network-readiness assessment.
- Step 4. Create a solution and site acceptance test plan.
- Step 5. Create a project plan.



DESIGN CHOICES

Factors to consider:

- Balance of distribution
- Level of transparency
- Security
- Connectivity technology



NETWORK DESIGN APPROACHES

- **Top-Down Approach:** a network designer looks at a project starting with the general applications required.
- **Advantages:** Begins with a focus on an organization's specific goals and requirements for network applications and services, while allowing potential future needs to be considered and accounted for.
- **Disadvantages:** Requires thorough initial needs analysis in order to determine specific requirements, and ensure that all possible applications and services have been considered.



- **Bottom- up approach:** tends to start lower in the OSI model, worrying about issues like specific technologies, protocols, network media, and so forth.
- **Advantages:** Generally a faster approach based on past projects and implementations that works within an existing environment.
- **Disadvantages:** The approach may not take all necessary applications and services into consideration, leading to a design that ultimately may not meet the needs of an organization, and may need to be redesigned in the future.

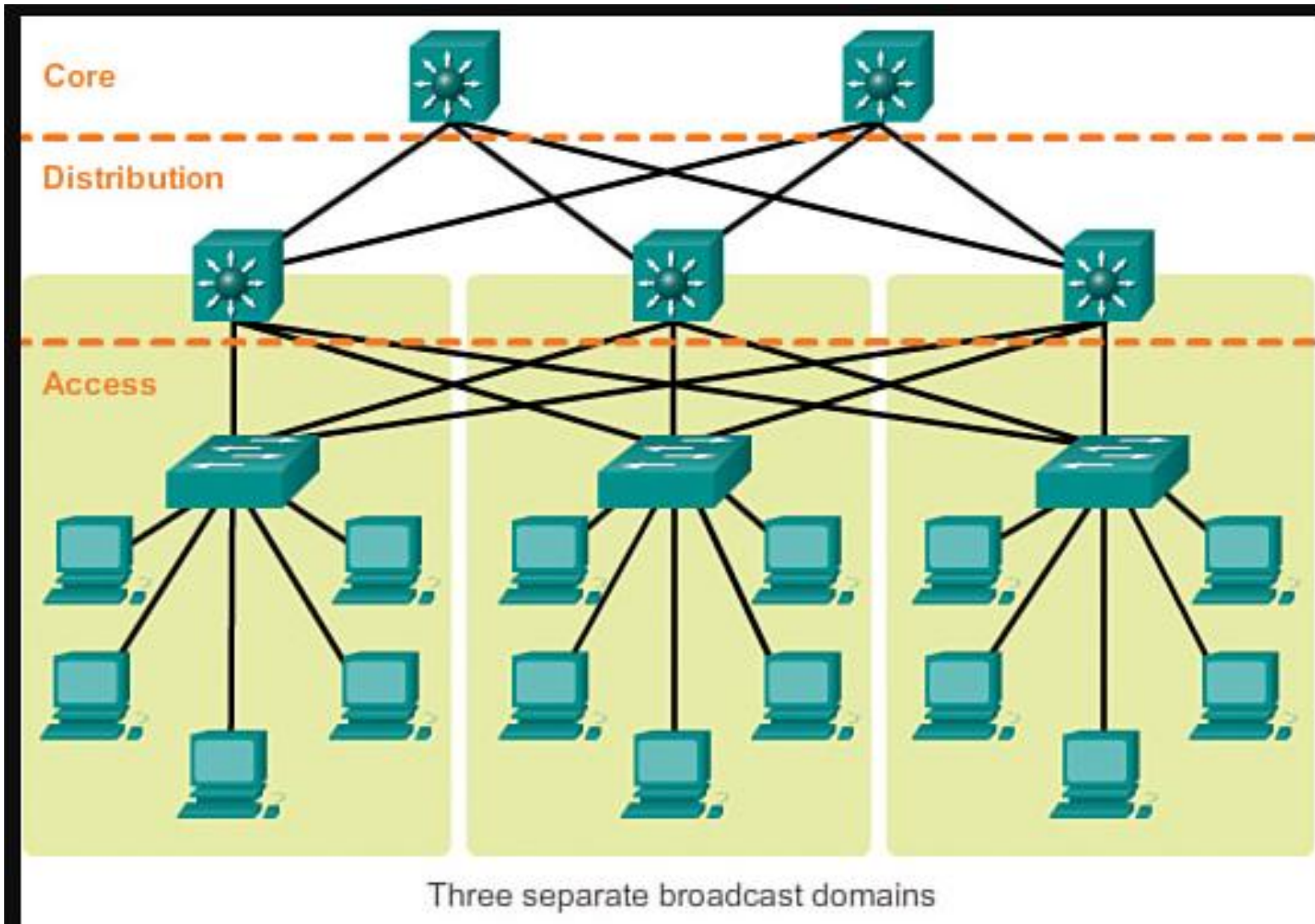


HIERARCHICAL NETWORK DESIGN

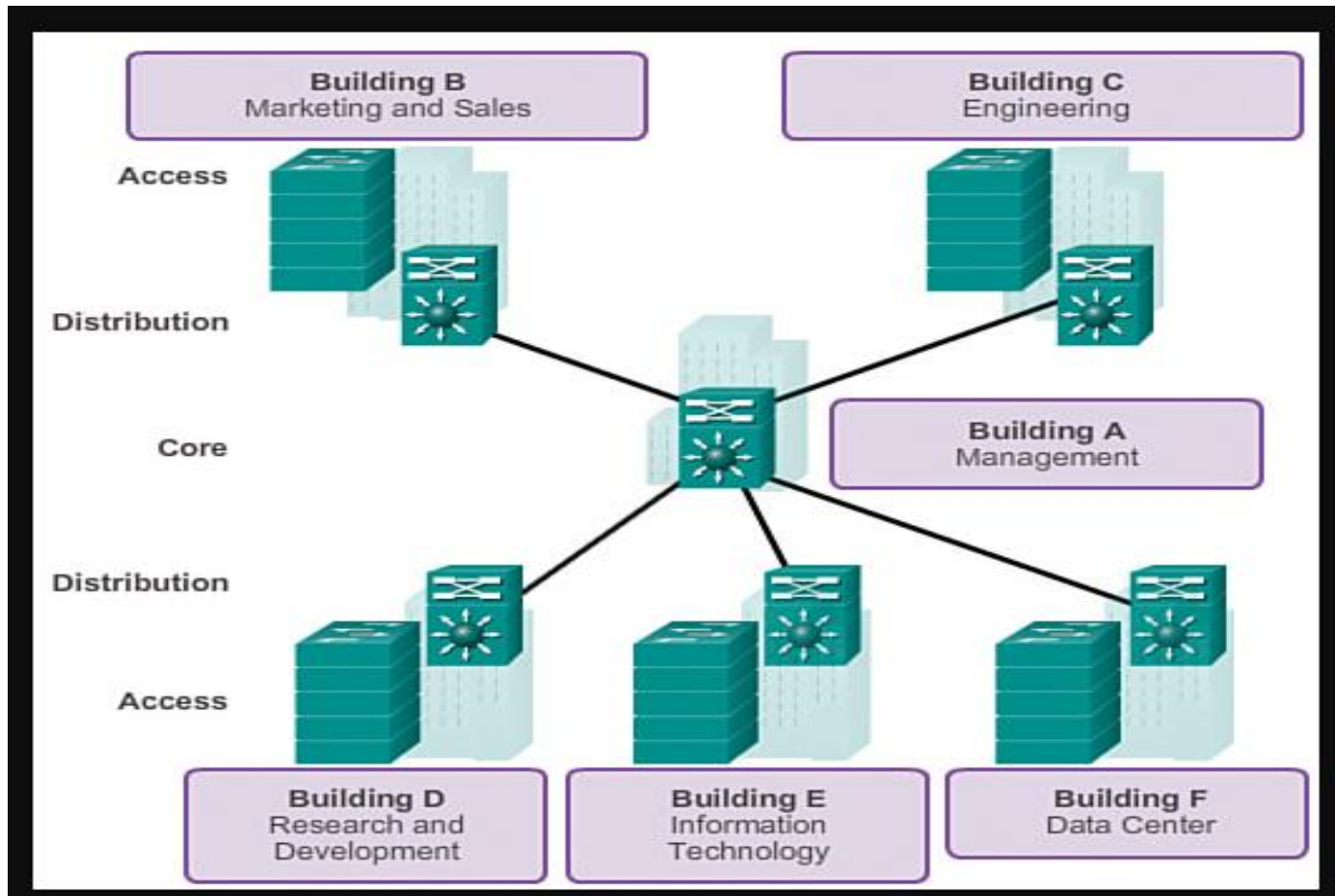
- In networking, a hierarchical design is used to group devices into multiple networks. The networks are
 - organized in a layered approach. The hierarchical design model has three basic layers:
 - **Core layer:** Connects distribution layer devices
 - **Distribution layer:** Interconnects the smaller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



HIERARCHICAL NETWORK DESIGN



MULTI BUILDING ENTERPRISE NETWORK DESIGN



FLAT NETWORK DESIGN

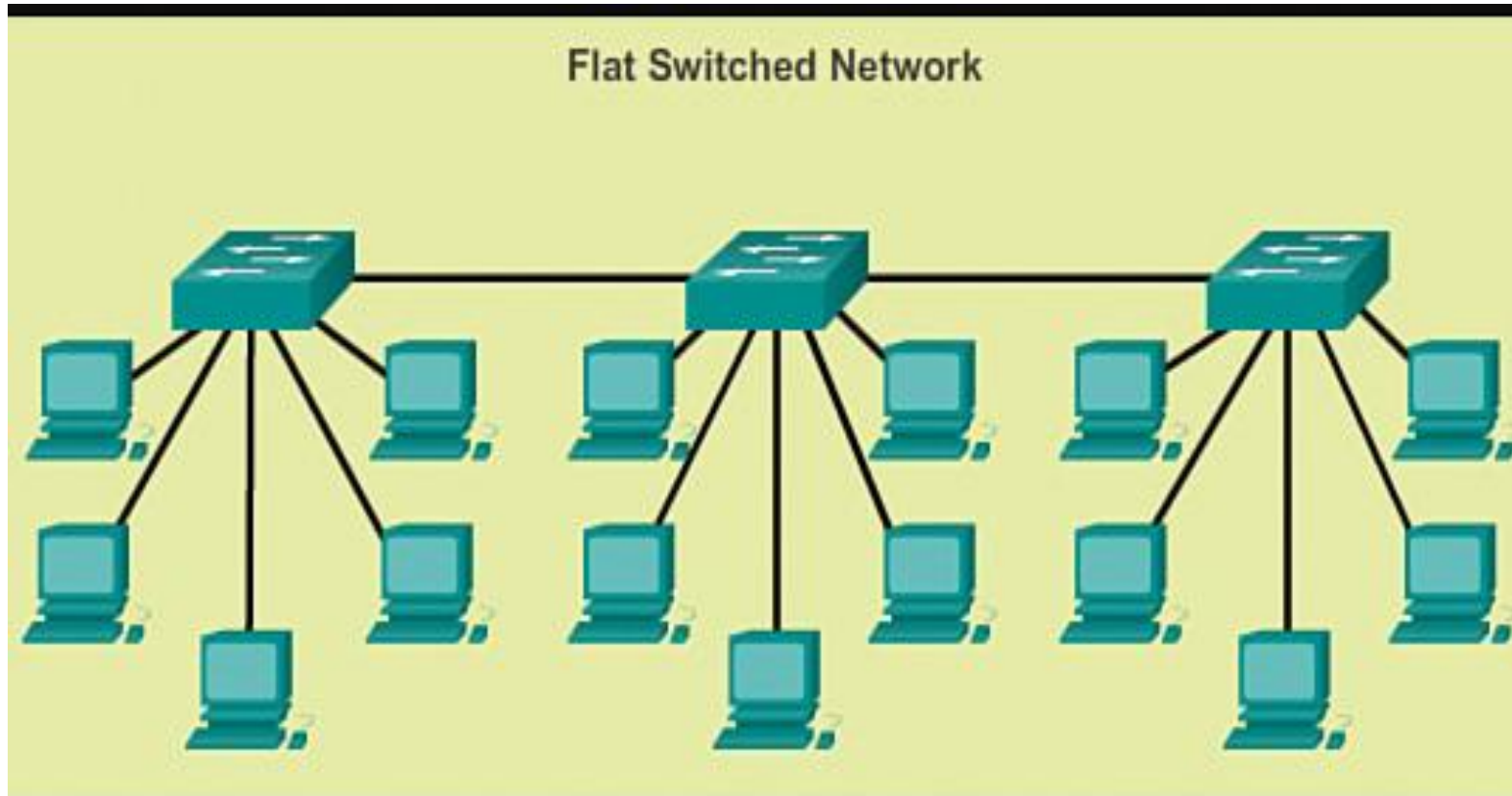
- The topology of a flat network is not segmented or separated into different broadcast areas by using routers
- Layer 2 devices in a flat network provide little opportunity to control broadcasts or to filter undesirable
- To reduce cost, maintenance and administration
- Reduce the number of **routers and switches** on a computer network
- traffic. As more devices and applications are added to a flat network, response times degrade until the network becomes unusable.

Drawbacks

- **Poor security**
- **No redundancy**
- **Scalability and speed**



FLAT NETWORK DESIGN



One large broadcast domain



STRUCTURED ENGINEERING PRINCIPLES

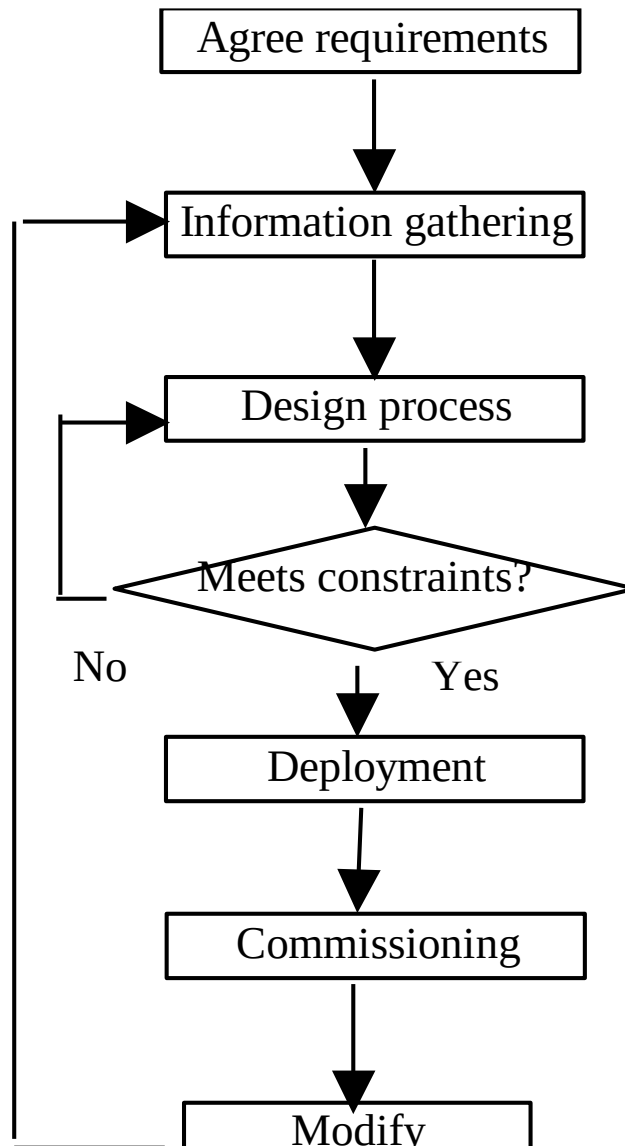
- Regardless of network size or requirements, a critical factor for the successful implementation of any network design is to follow good structured engineering principles. These principles include
- **Hierarchy:** A hierarchical network model is a useful high-level tool for designing a reliable network infrastructure. It breaks the complex problem of network design into smaller and more manageable areas.
- **Modularity:** By separating the various functions that exist on a network into modules, the network is easier to design. Cisco has identified several modules, including the *enterprise campus, services block, data center, and Internet edge*.



- **Resiliency:** The network must remain available for use under both normal and abnormal conditions. Normal conditions include normal or expected traffic flows and traffic patterns, as well as scheduled events such as maintenance windows. Abnormal conditions include hardware or software failures, extreme traffic loads, unusual traffic patterns, denial-of-service (DoS) events, whether intentional or unintentional, and other unplanned events.
- **Flexibility:** The ability to modify portions of the network, add new services, or increase capacity without going through a major forklift upgrade (i.e., replacing major hardware devices).
To meet these fundamental design goals, a network must be built on a hierarchical network architecture that allows for both flexibility and growth.



THE TRADITIONAL DESIGN PROCESS



NETWORK DESIGN STAGES/METHODOLOGY

- Agree and analyse requirements
- Characterize the existing network and sites
- Designing the requirements
 - ❖ Assessing requirements
 - ❖ Information gathering
 - ❖ Site constraints
 - ❖ Planning
 - ❖ Design specification
 - ❖ Implementation



1. AGREE AND ANALYSE REQUIREMENTS

- Engage end users to identify network applications and services.
- Define and translate requirements into:
 - Business goal and constraints
 - Technical goals and constraints
- Phasing the requirements
 - Right level of detail at each design stage



2. CHARACTERIZE THE EXISTING NETWORK AND SITES

- Gather the existing documentation and query organization
- Perform a network audit
- Use traffic analysis
- Identify major traffic sources and stores
 - Characterizing types of traffic flows for network application
 - Characterizing traffic behavior
 - Characterizing quality of service requirement.



3. DESIGNING THE REQUIREMENTS

- Aim for completeness
- Prioritise with a hierarchical system such as
 - [M] - Mandatory
 - [H] – Highly desirable
 - [D] - Desirable
 - [N] - Not



4. ASSESSING REQUIREMENTS

- Consider all aspects
 - E.g. support & maintenance, depreciation, commissioning costs, project management fees, h/w & s/w upgrade costs, b/w/ costs, consultancy charges – **over the lifetime of the network**
- Weighted matrix multipliers
 - $M=100$, $H=10$, $D=1$, $N=0$
 - Produce scores and rank suppliers



5. INFORMATION GATHERING

Need to find details of user behaviour, application use and location information for example:

- User: location, numbers, services used, typical access
- Sites: number, location, constraints on traffic (security, political or cost)
- Servers and services: location, level of distribution
- WAN/backbone predicted link traffic
- Protocol support: bridged, routed or switched – Gateways needed?
- Legacy support: equipment, protocols or services
- Specific availability needs? 24-hour/backup links etc
- Five-year plan – changes to population or business requirements
- Budgetary constraints
- Greenfield or existing site

Information is refined and leads to a requirements database and capacity plan



6. SITE CONSTRAINTS

- Greenfield.
 - Greenfield sites have no legacy constraints but...
 - It is difficult to determine the real network loads and stresses
 - Needs more detail of application use and underlying protocols
 - Could use simulation to predict performance
- Existing site.
 - Limited access
 - Access to live network could be restricted
 - Bottlenecks more obvious
 - Can use traffic/network analysis tools



7. PLANNING

- Uses information on
 - Hosts, users, services, and their internetworking needs
- Iterative process of
 - Conceptual design
 - Analysis
 - Refinement
- Involving
 - Brainstorming, design reviews, modelling tools
- Leading to final draft design



8. DESIGN SPECIFICATION

- Detailed document of the design
 - Acts as a benchmark for design changes
 - Final design choices and changes need justification and documenting
 - Should include change history to aid maintenance
 - Used for the implementation



9. IMPLEMENTATION

- Needs a project plan to include
 - Phased introduction of new technology
 - Educating the users (what to expect)
 - Pilot installation (test for possible problems)
 - Acceptance testing (to prove performance meets requirements)
 - Deployment (provide support on going live and provide fall-back position)



CONNECTIVITY OPTIONS

- Technology choices
 - LANs (Ethernet, Token ring, ATM)
 - MANs (FDDI, SMDS, ATM, SONET/SDH)
 - WANS (Frame relay, ATM, ISDN, X.25, PDCs, Satellite)
 - Wireless (802.11, Bluetooth, GPRS, GSM)
 - Dial-up lines
 - Serial links
 - Digital subscriber line (DSL)
 - Cellular
 - Satellite



CONNECTIVITY OPTION DETERMINANTS

- Packet, cell or circuit switching
- Wired or wireless
- Distance
- Performance
- Bandwidth
- Quality of Service
- Availability



CAPACITY PLANNING - OUTLINE

- Concerned with
 - User response times
 - Application behaviour and performance characteristics
 - Network utilisation
- Needed to
 - Minimise downtime
 - Maximise service to customers
 - Minimise costs of procurement and maintenance
 - Avoid unscheduled maintenance or re-design
 - Avoid costly upgrades and bad publicity



CAPACITY PLANNING - STAGES

- Form a discussion group (involve users etc.)
- Quantify user behaviour
- Quantify Application behaviour
- Baseline existing network
 - Traffic profiles
- Make traffic projections
- Summarize input data for design process
- Assess other data (environmental, location restrictions, deployment constraints etc)



SUMMARY

- Good design
 - Is an iterative process of continuous refinement
 - Is logical and consistent
 - Should deliver acceptable performance and cost metrics (trade-off)
 - Is more than choosing the technology!



END



WITH THANKS