NOTE TO THE INSTRUCTORS

These are descriptions of three projects that I have used several times at the university of Pennsylvania and other universities. Abbreviated versions of these projects were also used in 3 day industrial seminars.

The projects follow the outline of the text. The first project concentrates on applications and platform issues, the second is on wireless networks, and the third allows students to pick special topics and make presentations.

I have been using 3 projects and an exam (a little after midterm – around week 10 of the course) model. It seems to work well. All projects are team projects (2 to 3 people per team). You can, of course, reduce these 3 projects to 2 and also customize the project focus based on the student audience. For example, the IT/business courses can have more surveys and analysis of standards, regulations, and wireless industry landscape in project 1 and 3. A more technical and CS type of course may require students to actually build the wireless design aid (project 2).

If you have some interesting projects, please send them to me and I will post them on this site.

Please feel free to contact me (umar@amjadumar.com) for discussion of these projects.

PROJECT 1 (60 points)

PART A: Innovative/Interesting Wireless Applications (10 Points)

Survey the literature to find an innovative/and interesting application of wireless systems. The deliverable is a short report (2-3 pages) that contains the following information:

- What problem is being addressed
- What is interesting/innovative/different about the solution approach
- What is the solution approach, what types of technologies are being used?
- A conceptual diagram of the solution/
- Complete reference

Note: This report should not be "lifted" from a website but should be description, in your own words, of an example. The report has to be exactly in the format shown above.

PART B: WAP Prototype (50 Points)

Download a commercial WAP development platform and install it on your computer. By using the development platform, develop a simple wireless application by using WML. This application should be able to do the following:

a) Show info about 3 "hot spots" for visitors to Philadelphia (create the hotel information in any format you want)

b). Show the U of Pennsylvania SEAS web page (first two page) on a WAP enabled phone. The idea is to display already existing web pages on a WAP phone.

c). Show some other information on the WAP phone (pick one)

Deliverable. : A report describing

a) the overview of WAP prototype with instructions on how to install, run and test it (10 points)
b) how to display hot spots . (15 points)
c) how to display SEAS web site with a discussion of different options and justification of the option you are choosing (20 points)
d) Other info on WAP phone (15 points)

Grades will depend on the depth as well as the breadth of the prototype and also the legance of the solution approach. For example, you can always convert by hand an existing web site HTML page to WML for displaying on WAP. But you should try to find some utilities or other approaches that can help with this conversion process or directly show web pages on WAP.

Project 2 (70 Points) – Wireless Network Design

PART A: Wireless Network Design (30 Points)

XYZCorp was formed in 1985 by a small group of engineers in Chicago to build, repair, and sell electronic devices. The initial business of the company was televisions, radios and calculators. With time, the company included VCRs and PCs into its product lines. In the 1990s, the company entered into business partnerships with numerous suppliers around the globe and acquired a startup company that builds desktops, laptops, "network computers", and personal digital assistants. XYZCorp also formed partnerships with numerous other computer hardware/software vendors and acquired several retail electronic stores that sell and service network products, increasingly in the wireless area. These stores also sell, market and service the XYZCorp products. In the 2000s, the company has started thinking about providing technology solutions, consulting, and training services for mobile and wireless areas. The company management believes in controlled growth, i.e., systematically explore new markets and diversify by using new products and services after careful strategic analysis and evaluation of core competencies.

The company headquarters are in Chicago with branch offices in the US, Europe and Asia. The company has currently about 3000 employees with a great deal of growth expected in the next 5 years. The company operates many regional offices: Southern (HQ: Atlanta), Western (HQ: San Francisco), Eastern (HQ: New York), Midwestern (HQ: Detroit), North Western (HQ: Seattle), European (HQ: Paris), and Asian (HQ: Tokyo). Each region supports between 5 to 10 local offices (some of these offices are stores, the others are marketing, training, consulting and support centers), with an average of 200 staff members per region.

Given the information below about regional offices, corporate headquarters, and wide area network, determine the overall network design for this company (using wireless as much as possible). Your design should include WLANs, WPANs, WLLs, cellular networks, and satellites.

Deliverable

A report, not to exceed 5 pages that proposes an overall wireless network design with clear justification. The overall network design should show the big picture of the Corporate network, with all interconnectivity devices (e.g., routers, gateways), a hardware and communication layout of the chain stores, the calculations to justify the results, and a list of assumptions, if any. Within each site, your proposal should show all the hardware and software needed with the number of LANs, number of servers, etc. on all floors.

Regional Offices Information

Each regional office serves 20 local offices in the region. The regional managers want to use latest technologies and innovative applications in voice, data and images. Each regional office, a two floor 300 feet X 300 feet building, houses around 300 regional employees and supports marketing and customer support services. The following information should be considered while designing this network:

- Each region houses a minicomputer that has regional information and is connected to the "outside world".
- Half of the people are technical support people who work on products in the region. Housed on the first floor, these people use a variety of tools and use the Internet heavily.

- The remainder people in regional office are managers, marketing types, consultants and administrative staff . These folks are "confined" to the second floor and are primarily used to desktop environments.

Corporate Headquarter

The corporate headquarters, a three floor 200 foot X 500 foot building, houses the IT department (first floor), administration and distribution (second floor) and marketing / corporate planning and management offices on the third floor. Each floor will have the office layout as shown in Figure 1. Each person in the office wants a desktop computer for local processing and access to the Internet. Each office room is assumed to be 10 feet x 10 feet and the workstations are assumed to be equally distributed in each area. You are to recommend a layout of the workstations (terminals or microcomputers) for the three floors of the headquarters.

Each room on the first floor should have access to the main computer located on the first floor as shown in Figure 1. While designing the first floor layout, you need to keep the following factors in mind:

- Most work done on the first floor is word processing, accessing mainframe files, software development and technical support (planning, designing, installing and modifying the system hardware/software).
- Each workstation can generate one message per second on the network and the message size can be assumed to be 1000 bytes (10000 bits).

On the second floor, the Administrative Department (payroll, AR/AP, order processing) is considering a LAN. They would like to:

- Allow the PCs to share fast printers
- All PCs should be able to share and exchange information stored in databases in the corporate office.
- All PCa should be able to send/receive information from the mainframe in addition to other branch office PCs.
- Allow some growth so that in the future more devices could be supported on the second floor.

The third floor at present has not specified any requirements. They need occasional access to the mainframe. They will be happy with anything and are "very" open to suggestions and recommendations.

Assume that corporate LAN traffic will increase dramatically in next several years. You can assume that 3000 workstations will be in the building and each workstation will generate one message per second on the network and the message size can be assumed to be 10,000 bytes (100,000 bits).

The company also has a manufacturing building within a mile from the corporate office. This one floor building houses 100 people who specialize in designing, building, and maintaining PCs and also wireless networks.

Wide Area Network

The wireless WAN should be able to handle the estimated traffic. A planning task force has estimated the following daily communication traffic expected to go between the various offices of the corporation:

- 80,000 email messages per day between the corporate office and each business partner office.
- 120,000 email messages per day between the corporate office and each regional office.
- 100,000 email messages per day between each regional office and local office.
- 20,000 file transfers per day from various Internet sites
- 50,000 web surfing requests per day
- 50,000 remote accesses to corporate databases per day from local and regional offices

Assume 10 hour day, 10 bits per byte and 5K bytes per message for email, 1 Meg for file transfers, 200K for web surfing, and 500 K per corporate database access. You should also assume Pareto's principle (i.e., 80% of the traffic is carried in 20% of the time).

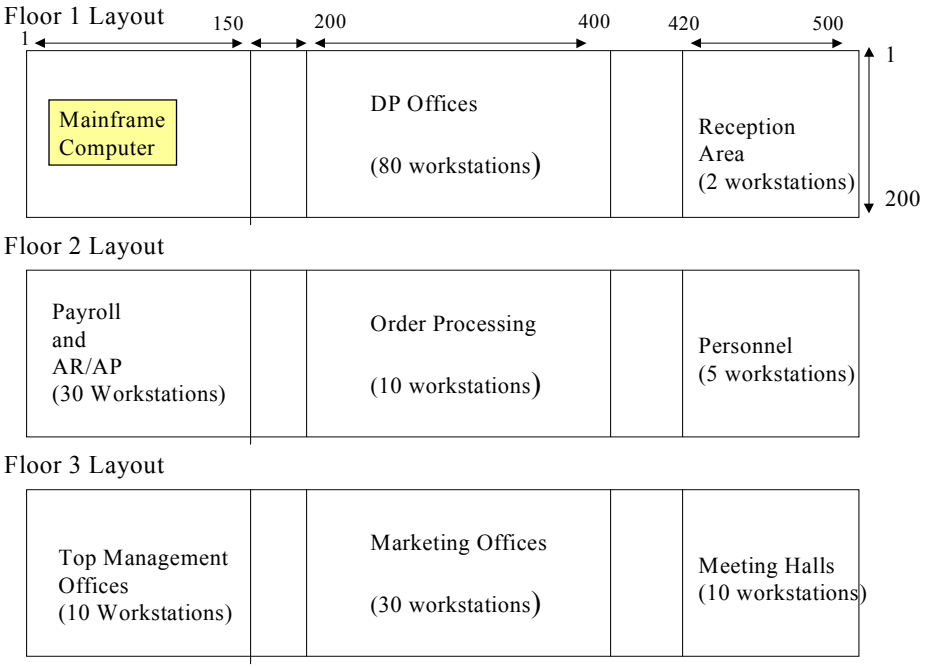

Figure 1: Corporate Office Layout

Part B (40 Points): Wireless Guru

Overview

Generalize the XYZCorp problem stated above into a wireless network advisor ("Wireless Guru") that walks the user through a variety of decisions and suggests plausible solutions with emphasis on wireless. The Wireless Guru is an expert system that suggests a network (preferably wireless) based on a set of factors. The factors may be the company size, type, applications being supported, physical site plan, etc. Potential users of wireless guru are corporate network planners trying to build a mobile corporation. You should assume that the users do not know much about wireless even though knowledgeable about general networking principles. The wireless guru, if designed properly, could also be used by a wireless operator (e.g., T-Mobile), a wireless equipment provider, or a student to learn about various wireless systems.

The Wireless Guru should prompt the users with a few questions (not to exceed 20) and at the end should be able to suggest a solution consisting of:

- The type of wireless technologies to be used and why
- Network segments at different sites. This could be a LAN segment or a wireless cell supported by w-fi, Bluetooth, WLL, or cellular network. You can decide how many users can be handled in each net segment
- Network Interconnectivity Devices (NIDs). These are the routers, access points, gateways, hubs, switches, etc used to interconnect devices. The NIDs may provide connection between users in a net segment, between campuses, and between the internal networks and the outside world (public Internet).
- Approaches to deal with wireless impairments where applicable
- Frequencies in which the different wireless systems should operate
- Actual physical components (e.g., access points) with vendor names

Deliverables

A report describing Wireless Guru design and how to use it. The report should show:

- Overall concept of Wireless Guru (1-2 pages).
- Comparison of Wireless Guru with existing at least 3 expert systems for network design. You will have to search the literature and the web to locate "best" competitors to Wireless Guru (1-2 pages).
- One high level flow chart that describes the overall flow and points to lower level decisions and flowcharts (1 page).
- For each lower level decision, e.g., a wireless LAN design, show the logic that will be used to make final choices (e.g., 802.11, Bluetooth, FSO, UWB, home R/F). This information can be shown as a mixture of rules, flowcharts, decision tables, or any other appropriate tool (choose the most appropriate).

This document (around 10 pages) should be detailed enough so that an actual expert system can be developed from it.

Grade depends on the wireless solutions covered (should cover WPANs to satellites), questions asked (fewer questions are better), and level of details provided for solution (e.g., the vendor products to be used).

Additional Information

As stated previously, the decisions and choices about networks are based on the company size (no. of employees), workload (type of applications being supported), and physical site plan (no. of buildings, locations, etc. The system can proceed with an interview in a variety of ways. A possible flow of the system is:

- First develop a wireless network that is suitable for a small company (30-100 members in a small building). This should include internal network and provide connectivity to the general Internet.
- Now expand this to medium sized companies (200-50 people) that may have multiple sites (the sites may be on one location in a campus environment, in different states, or a mixture). This could be thought of as a collection of small company offices, each with 30-100 employees, that are interconnected through a wireless/wired network.
- Now expand it to larger (1000 to 5000) employees with local, national and international offices. This could be thought of as a collection of small and medium company offices that are interconnected through a wireless/wired network.

For experimentation, try the following scenarios:

- A small furniture manufacturing company (30 people) with 1 secretary, 5 professional staff, 2 designers , 10 manufacturing people, 3 manager types
- A university campus such as Upenn
- An organization such as XYZCorp

At the minimum, you may need the following information from the user in the interview :

- Number of employees and type of business (education, manufacturing, finance,,)
- Number of workgroups -- a logical group such as a department (e.g., marketing department, design group) that does similar work activities. Some of these work groups can be inferred from company type (e.g., manufacturing department for a manufacturing company)
- Number of sites (the geographical locations). A site may consist of one building or several buildings in close proximity (a campus). One or more workgroups may reside on a site.

An enterprise may consist of one or more sites. For example, a small company (30-50 employees) may consist of one site (one building) that may consist of 2-3 workgroups, each workgroup assigned to one network segment. A larger company may consist of several sites where the corporate site is a campus.

You will also have to determine some workload models. Different companies of different types may have different users in different work groups that are located in different parts of the network. These will reflect different workload models. This can be described in terms of following user profiles:

- administrative and secretarial staff – mainly email activity
- professional staff (e.g., HR people, sales/marketing, engineering support): email activity, corporate applications, web surfing
- professional and development staff: email activity, FTPs, web surfing
- managerial staff: : email activity, web surfing
- For each group, you can make several assumptions in terms of traffic (arrival rate, average message size)

Project 3 -- Free for all

(70 Points)

Deliverables due (Last two sessions)

Talks or demos on special topics of your choice. In addition, you will need to write a report (15 to 20 pages) on your project. The talks will be scheduled on the last two days of the course. Each presentation/demo will be roughly 20 minutes presentation by your group on a topic (7 per night, roughly) The talks will be peer evaluated. The topics can include one of the following:

- Extension of Wireless advisor - Add more features to Project 1 advisor and build it into an "industrial strength" system. Now you can use more sophisticated technologies such as expert system shells, Java script, etc. You may want to focus on different aspects (e.g., provider,,). You can also concentrate on one aspect of the system (e.g., cellular networks, satellites, wireless LANs).

♦ Development and demo of wireless applications by using wireless platforms. Here are some examples;

  - Build one application in different platforms (I-mode, WAP, M-.NET, wireless Java) to evaluate the tradeoffs between different platforms
  - Develop a network management application for 802.11 or Bluetooth that shows the number of users on the network, failures, etc.
  - Build an intelligent content converter (converts different contents, VXML, WAP, I-Mode) that goes beyond the current commercially available products
  - Build a simple home networking application by using Bluetooth or 802.11 (e.g., garage door open based on alarm clock).
  - Build a wireless replacement application in 802.11 to compare contrast it with Bluetooth
  - Build an application based on SMS/MMS
  - Build a "unified messaging" application that takes voice messages and converts them to emails and vice versa

♦ Latest research and development in wireless networks, protocols, standards, middleware, and applications. Examples of the topics are:

  - Mobile Web Services (e.g., M-WS, M.NET)
  - Wireless Network Management
  - Wireless sensor networks, ZigBees and 802.15.4
  - Critical analysis of standards bodies in wireless, what do they do, what type of standards are they providing, how do they interrelate with each other, what is the relative popularity/power
  - Research in mobile adhoc networks
  - Research and developments in broadband wireless networks (e.g., UWB, FSO)
  - Recent developments in wireless LANs (e.g., Hiperlan2)
  - 4G and 5G networks
  - Recent developments in error correction

- Recent developments in Satellite technologies
- Developments in wireless development environments (e.g., Wireless Java, J2ME, WAP, I-Mode)
- Intelligent antennas
- Decision models between various wireless optics

Grade: Presentation (35 Points), report (25 Points)