



## The Role of an Intranet in a University: The KFUPM Experience

*Dr. Talal H. Maghrabi*

Assistant Professor,

Information and Computer Science Department  
King Fahd University of Petroleum & Minerals, Dhahran

[maghrabi@kfupm.edu.sa](mailto:maghrabi@kfupm.edu.sa)

*Jaweed Yazdani*

Lecturer,

Information and Computer Science Department  
Manager, Academic Computing Services  
Information Technology Center  
King Fahd University of Petroleum & Minerals, Dhahran

[jaweed@kfupm.edu.sa](mailto:jaweed@kfupm.edu.sa)

### ABSTRACT

The rapid expansion of the computing infrastructure in the last two decades has given rise to powerful Intranets. An important consequence of the organized expansion of the computing facilities at KFUPM has been the development of the University Intranet with extensive services encompassing a wide range of technological advances. The main objective in building the KFUPM Intranet was to support University teaching, research, and administrative activities. This paper describes the various stages of building this computing infrastructure and the evolution of the university Intranet in the process.

## 1. INTRODUCTION

As a premier institution in the region, King Fahd University of Petroleum and Minerals (KFUPM) has maintained high standards in computing in both administrative and academic domains. KFUPM was the first university in the region to establish a computer center, in the late 60s, called the Data Processing Center (DPC), which was later, renamed the Information Technology Center (ITC). The Information Technology (IT) infrastructure, that has been planned and implemented in the last three decades, has helped in implementing new technologies in all areas of learning and research.

An important consequence of the organized expansion of the computing facilities has been the development of the University Intranet with extensive services encompassing a wide range of technological advances. The main objective in building the KFUPM Intranet was to support University teaching, research, and administrative activities. Long term planning of the computer resources was taken up to build a network of networks integrating all the computing facilities. Most importantly, we were aiming to build an information infrastructure that would not only lay the physical foundation but would also make these facilities useful to faculty, staff and students. The planning process was done through a series of computer and network projects. Nearly 20 academic buildings were connected to the university backbone while ensuring that every room, whether it is an office, auditorium or a class room, is provided with appropriate computing facilities. This was critical to the success in building the Intranet. Gradual implementation of the Intranet over four years also allowed social technological change that positively affected the level of utilization of resources.

The Internet and its unpredicted rapid growth had changed the way people and organizations conduct their work in all sectors. The most popular Internet application now is the World Wide Web (WWW); which is believed to be the application fueling the rapid growth of the Internet. Applications like file transfer, newsgroup, and email are still very popular. The growth of the Internet has created many technical, business, and social challenges and opportunities. We should focus our efforts on the potential benefits of the Internet.

The first phase to get the potential benefits of the Internet is to build an information infrastructure that is private and internal to the organization. This is what is known as the organization *Intranet*. The Intranet and Internet use the same technology but the first can be view as internal to an organization while the second as global. The importance of having an Intranet is to have a controlled access to the Internet and to protect organizational information resources from outsiders. The second phase to get the potential benefits of the Internet is to connect to it. This connection can be wide-open meaning no censorship or access restriction; other models use firewalls to protect the Intranet from outside threads.

An *Intranet* is basically a network of computers within a corporation or portion of a corporation. The computers are connected to each other by means of the Internet Protocol. This internal network is separated from other networks and computers outside by "firewalls." Firewalls, in effect, act as a moat separating the Intranet from other networks and other computers. The firewall is a means of preventing unauthorized access to the internal network from the outside. The Intranet is a protected neighborhood of computers within the larger city of the Internet. When you allow access to someone else's Intranet, that site becomes an Extranet for your users [1].

Intranets have become an essential corporate information distribution and database tool. Until recently, only large corporations had been able to take advantage of available technologies to develop and maintain Intranets. The introduction of new, easy to use Intranet tools makes this powerful technology accessible to any size organization [2].

The technologies used to implement Intranets include the Network File System (NFS) to share files among heterogeneous computers; Hypertext Markup Language (HTML) authoring tools to create and manage hyperlinked information; Hypertext Transport Protocol (HTTP) servers to publish hyperlinked information; Web browsers to access hyperlinked information; e-mail for interpersonal communications; Network News (NNTP) servers to create threaded discussion groups; Internet Relay Chat (IRC) as the basis of real-time, text-based collaboration; and Portable Electronic Document (PED) technology for Web publishing and e-mail-based collaborative authoring systems [3].

This paper presents the KFUPM Experience in utilizing the Intranet to provide better computing services to the University community. In this work, we describe the phased development of the university computing facilities in terms of the university Intranet. The continuous expansion of the university IT infrastructure is also presented as a prerequisite in offering the Intranet services. We conclude with a look at the future up-gradation and expansion of the university facilities with emphasis on technological advances in the field of academic Intranets.

## **2. BACKGROUND**

King Fahd University of Petroleum and Minerals (KFUPM) is one of the leading universities in the Middle East that was established in 1963. It was the first university in the region to establish a computer center, in the late 60s, called the Data Processing Center (DPC), which was later, renamed the Information Technology Center (ITC). The center was created to provide all computing services needed by KFUPM to support its education, research and Community services

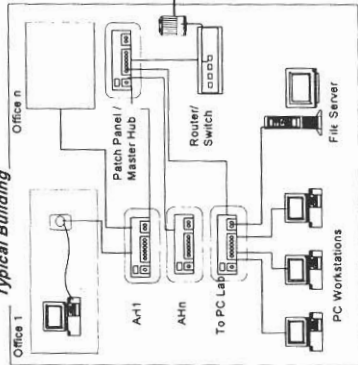
KFUPM has recognized the importance of establishing a networking infrastructure in the early 1990s. Through several projects the University established a fiber-optic backbone connecting all its buildings in addition to internally cabling all rooms, offices, auditoriums, etc and connecting them to the backbone. By the end of year 2001, KFUPM will finish upgrading its backbone from Token-Ring into Gigabit and its local networks to switched fast Ethernet. This will enable the network to support the heavy traffic expected in the next few years. The figure in the next page shows the current KFUPM Infrastructure.

Although Internet was made widely available at KFUPM only at the beginning of 1999, due to reasons beyond the control of the University, KFUPM provided several Intranet services before then. Some of these were E-mail services, Gopher services, Library Access, etc. [4]. In the last few years KFUPM has introduced many new services to its Intranet, in addition to the enhancement of some of the available ones. We will discuss these in more detail in Section 6.

## **3. ROLES AND SERVICES OF INTRANETS IN A UNIVERSITY**

University Computing has taken on a new role with the widespread popularity of the World Wide Web. The WWW is used as a huge public relations tool providing information about the school, its history, degrees granted, courses offered, research program centers, staff directories, and social and cultural aspects of university life. The degree of detail in departmental Web pages is often tied to the need to attract students and researchers, and very elaborate, graphic rich pages serve as recruitment tools. Increasingly, course syllabi and content can be viewed by anyone with access to a browser. [5]

### Typical Building

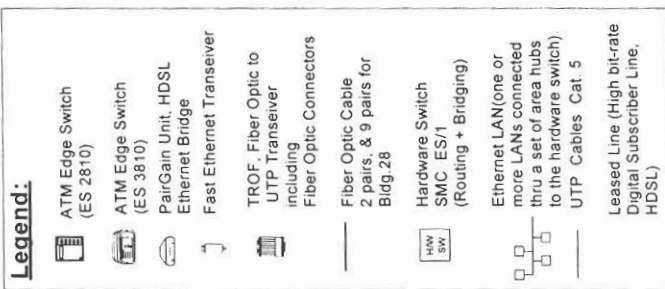


**Note:** All rooms of buildings illustrated are structures cabled thru UTP cables to Patch Panels, Area Hubs and RJ45 Outlets.

### Building Index

- Bldg. 1: Building 1
- Bldg. 2: Building 2
- Bldg. 3: Building 3
- Bldg. 4: Building 4
- Bldg. 5: Building 5
- Bldg. 6: Building 6
- Bldg. 7: Building 7
- Bldg. 8: Library
- Bldg. 9: Dean's Office of Admission & Registration
- Bldg. 14: Information Technology Center
- Bldg. 18: Registrar Institute
- Bldg. 17: Student Affairs
- Bldg. 19: College of Environmental Design
- Bldg. 21: Administration Building
- Bldg. 22: Building 22
- Bldg. 23: Parking Garage
- Bldg. 24: College of Industrial Management
- Bldg. 27: Medical Center
- Bldg. 28: Center for applied physical sciences
- Bldg. 34: Telephone Exchange
- Bldg. 35: KFUPM press
- Bldg. 36: The Stadium
- Bldg. 41: Student Reception
- Bldg. 42: Preparatory Year Complex (Portable 11)
- Bldg. 44: Store Houses & Admin. Services
- Bldg. 45: Car Maint. workshop
- Bldg. 47: Transportation Dept.
- Bldg. 48: Safety & Security Dept.
- Bldg. 50: Project & Main. Dept.

## KFUPM - ITC Network Topology



**ITC** KFUPM Network Topology  
Ahmed Esnat  
© September 2000

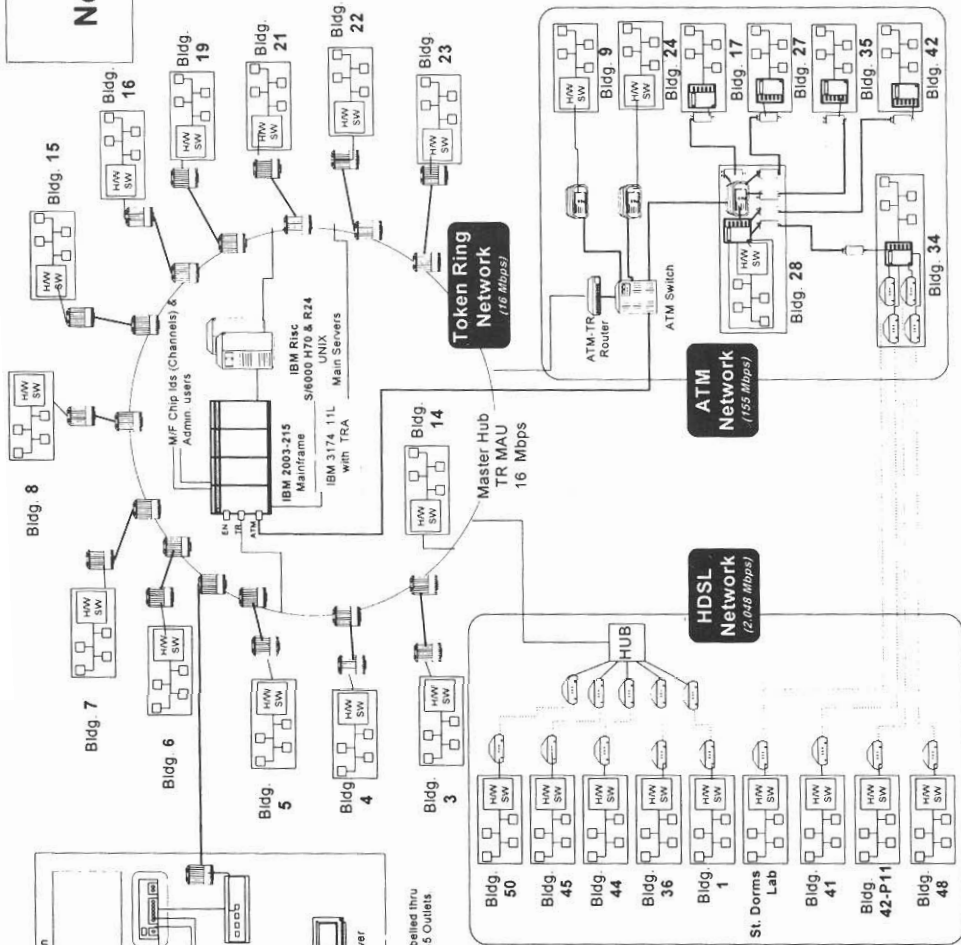


Figure: KFUPM Existing Infrastructure

The university Intranet is therefore a complex and multifaceted creature. It provides administrative, research, academic, and communication support and is a principal means of access to proprietary information for use by the university community. Browser access minimizes the restrictions placed on the university by multiple platforms and allows access to Intranet-based services that were previously restricted by job function. Now, management software can be accessed via the Web, diffusing the ability to use administrative tools into the university population. This has empowered faculty, students, and staff to play a more active role in these operations. Unfortunately, it has also resulted in confusion and fear--confusion over appropriate roles within the university environment and fear of jobs being lost to the mighty tidal wave of technology.

Therefore, the university can utilize its Intranet to facilitate and provide many services to its community (students, faculty and staff), such as:

i. Academic:

These are the services that are needed by faculty and students to support their work. These include software downloading/ execution, On-Line (full or partial) course content delivery, homepage development and publishing and library access.

ii. Administrative:

These are the services that can be provided by the university to its community to support administrative tasks. These include Personnel services, Maintenance and Housing requests, On-Line Access to Student Information Systems (for teaching and advising purposes), and the access and execution of administrative applications such as Payroll, Asset Management, Financial systems, etc.

iii. Communication:

The Intranet will be used for electronic communications, such as e-mail and newsgroups, in addition to a media to publicize and arrange all important events and activities.

#### **4. BASIC COMPONENTS OF AN INTRANET**

An Intranet is an internal network within an organization that allows highly organized access to up-to-date information stored on computers. Intranets are designed to provide the following functionality through a computer network:

- i. Replace static information sources such as printed documentation, reference manuals, work procedures and policies documents etc. with online computer-based resources;
- ii. Provide a platform for interactive communication including electronic mail, group messaging, creating awareness, gathering and processing feedback, database search, data collection through forms etc.

From the technological standpoint, an Intranet consists of several components including a computer network infrastructure, servers, documents, browsers, and applications.

##### *Network Infrastructure*

A computing network infrastructure is an essential component of an Intranet. It serves as the physical platform for providing the functionality necessary in an Intranet environment. In most computing environments, minimal changes to the existing networks are required for the creation of an Intranet.

### *Servers*

Most of the information on an Intranet is stored on computers running what is usually referred to as a Web server. The server stores documents and responds to user requests to view the documents. The enterprise information in an Intranet is stored on one or more servers throughout the enterprise. Web servers also provide access to information stored on other types of application servers such as database servers, email servers, or a mainframe computer.

### *Documents*

Documents contain the information that is delivered through the Intranet. The default format for these documents is HTML (Hypertext Markup Language). HTML documents are text-files consisting of information and format commands, which control screen formatting and hyperlinks to other documents. HTML documents are normally the major components of any Intranet solution but other document types, including text, audio and video, also form part of the information content.

### *Browsers*

A specially designed application called the browser is used to explore the Intranet and view documents stored on servers. The browsers help locate HTML documents on Web servers, communicate with them, process the HTML format and display the stored documents. Hyperlinks embedded in the documents and search engines provide links to the other documents on the web servers. A browser also renders such multimedia elements as sound, video, and 3D images.

### *Applications*

Enterprise-wide applications designed to solve specific business problems form the core functionality to the Intranet. These applications may either run in traditional forms or through an extension of the functionality of the browser.

## **5 KFUPM INTRANET INFRASTRUCTURE**

### **5.1 University Computing Resources**

The current computing resources available in the ITC consist of the following:

1. A Unix environment consisting of two IBM RS/6000 UNIX servers and a Unix-workstation lab with 20 IBM RS/6000 UNIX workstations. This is the main computing environment for academic users. Software packages available on the Unix server and workstations include language compilers, text formatters, X-windows applications, simulation packages and E-mail services.
2. An IBM Enterprise Server which is the main computing platform for administrative applications, such as Students Information Systems, Material Management Systems, Human Resources Systems, etc. The server utilizes the latest IBM operating system OS/390 with full online and batch processing support. The enterprise server is connected to the University token-ring backbone. More than 350 concurrent TSO users and five CICS partitions are available.
3. Several PC labs with more than 200 PCs and several servers, laser and heavy-duty dot matrix connected in Local Area Networks (LANs) distributed in various buildings. The labs enable their users to use various PC applications such as word processors, spreadsheets, presentation software and specialized software.

4. A large number of peripheral devices, including high-quality printers, plotters, communications controllers for remote dial-up facility and tape drives, are also connected.
5. Several Proxy, Remote Access Services (RAS) and web servers with the necessary Web and firewall software. These servers provide all necessary Internet services.
6. A full-scale Enterprise Network where all University servers, PC labs, workstation labs and office PCs are inter-connected. The network infrastructure consists of a fiber optic Gigabits backbone connecting PC labs in all academic and some administrative buildings. In addition, all offices, classrooms and labs in all University buildings are connected to the Enterprise Network. Advanced switching and routing technology is installed at different locations to enable users to access any computing resource connected to the University Enterprise Network.

## **5.2 University Network Architecture**

### **5.2.1 TCP/IP Network**

The university Intranet is a TCP/IP network that delivers reliable applications in five core areas: directory, mail, file, print and network management. Initially, these services could be accessed using various types of network protocols. In a phased manner, the university network was standardized around the TCP/IP protocols by eliminating the need for other protocols such as IPX and NetBEUI. The network servers/hosts and clients could be running various operating systems and applications as long as they can support TCP/IP.

**TCP/IP** is a set of protocols that allow computers to share computing resources across a network. The TCP (Transmission Control Protocol) breaks messages into packets and reassembles them at the other end. TCP also sends anything that gets lost and ensures packets are sent in the right order. The IP or Internet Protocol is responsible for routing individual packets across the network. An IP packet gets delivered independently since it contains source address and destination addresses. A connection may require the packets to hop through several networks before reaching its destination. IP keeps track of the routes and handles incompatibilities among different transmission media. However, IP alone gives connectionless and unreliable delivery system. It is the TCP that contains the logic necessary to provide a reliable, virtual circuit

### **5.2.2 Network Bandwidth Management**

Since the establishment of the university network, the unending requirement of higher bandwidth for faster access to Intranet and Internet resources, weighed heavily on the list of priorities. In 1994, the local area networks in a number of academic buildings were connected through a fiber-based token-ring network. The network was further expanded to include all administrative and academic buildings using, at various stages, token-ring and ATM networks.

The exponential growth, in terms of users and desktops, ensured that the increase in network bandwidth requirement in shorter time periods was necessary. The introduction of Internet services in 1998 to the whole university community impacted heavily on the need for more bandwidth and more reliable network services. Student and faculty offices were extensively using Internet services in addition to the existing Intranet services. A number of approaches were also introduced in order to ensure efficient use of the bandwidth.

### **5.2.3 Legacy Systems Integration**

A major area of concern in enhancing the university-computing infrastructure was the need to ensure compatibility between the new environment and legacy applications that were developed in the last thirty years. These applications, spread over heterogeneous operating systems and database platforms, had to be accessed from the desktop. Many of these applications were made accessible from PCs through various types of heterogeneous interfaces at the desktop. The tremendous growth in departmental applications, based on local requirements, required interface to university-wide databases. In many such applications, the interfaces were developed and services were provided, by the ITC, to ensure data security and integrity.

The heterogeneous environment produced documents in several formats and a major effort was made to ensure that compatibility is maintained. Various university-wide document formats were made available either through HTML or a portable document formats.

## **6. STANDARD SERVICES ON THE KFUPM INTRANET**

Apart from the interfaces to legacy applications discussed in section 5.2.3, the University Intranet offered standard services to the user community. The gradual introduction of these services over the past several years ensured the effective use of the University Intranet. We list some of the services that are currently available to more than 10000 users across the university:

- User Account Services
  - a. OS390
  - b. Unix
  - c. Windows
  - d. Remote Access
  - e. Email
  - f. Internet
- File and Directory Services
  - a. Control Access to Files and Directories
  - b. Mount a Directory as Windows Share
  - c. Files and Directories through FTP
- Web Publishing Services
  - a. Departmental Web Publishing Services
  - b. Faculty/Student Web Publishing Services
- Email and Messaging Services
  - a. Mail on Unix/Windows Clients
  - b. Mail through the Web
  - c. Mail Aliases
- Online Student Services
  - a. Schedule of Classes
  - b. Faculty Schedules
  - c. Registration Schedules
  - d. Grades
  - e. Academic Record
- Faculty, Student and Staff Search



- Unix Services
  - a. Telnet Terminal Services
  - b. X Terminal and Common Desktop Environment (CDE)
- Online and Backup Storage Services
  - a. Tape Backup
  - b. CD Backup
- Testing Services
  - a. Exam Randomization and Processing
  - b. Faculty and Course/Short Course Evaluation
- Mainframe Terminal Emulation
- Enterprise Applications

## 7. FUTURE SERVICES AND CONCLUSION

The current focus is to further enhance the collaborative computing environment in the university. This entails improvement of the messaging environment, which contributes heavily to collaborative computing. In order to achieve the objectives of further enhancing the University Intranet, a number of initiatives in the following areas have been planned:

- Video streaming;
- Computer-based training;
- Document management; and
- Online storage expansion.

We have presented the thorough and detailed architecture of the KFUPM network and the Intranet services. All academic buildings and the administration building have been internally cabled with every room connected to the university network. Sophisticated networking hardware has been installed to effectively use the network bandwidth. The tremendous expansion of the university infrastructure underlines the need to automate many of the maintenance, operation and support activities. The rapid advances in Intranet and Internet technologies must also be implemented in order to further enhance the University Intranet.

### Acknowledgment

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