

## بناء الشبكة الداخلية: تجربة جامعة الملك فهد للبترول والمعادن

د. طلال مغربي، د. معدوح نجار و جاويد يزداني

قسم علوم الحاسب الآلي و المعلومات، جامعة الملك فهد للبترول و المعادن، الظهران

الملخص : لقد تطورت الشبكة العالمية (الإنترنت) بصورة سريعة حيث ينضم إليها ملايين المستخدمين سنويا. و امتدت التقنيات والخدمات المقدمة في شبكة الإنترنت إلى الشبكات الداخلية للمؤسسات، أو ما يعرف بها "الإنترانت". ولقد أدركت جامعة الملك فهد للبترول والمعادن أهمية الشبكة الداخلية واتخذت خطوات علمية و عملية متقدمة لبناء و تطوير شبكتها الداخلية.

تقدم هذه الورقة تقريرا مبسطا عن تجربة الجامعة في مجال بناء وتطوير الشبكات الداخلية. في البداية تقدم مختصرا عن البنية التحتية للشبكة، يلي ذلك شرح للفوائد التي ستتحقق من بناء الشبكة الداخلية في الجامعة، ثم يتم توضيح وشرح مفصل للخدمات المقدمة على هذه الشبكة. وختاما تسرد الورقة للتوجهات والتطلعات المستقبلية وطرق تطبيقها.

# **Establishing an Intranet: The KFUPM Experience**

**Talal Maghrabi, Mamdouh Najjar and Jaweed Yazdani**

Information and Computer Science department,  
King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia

**ABSTRACT:** The Internet is growing so fast that millions of users are connecting to it annually. The advances in Internet technology and services are now extending to the internal networks of organizations, resulting in what is known as Intranets. King Fahd University of Petroleum and Minerals (KFUPM) has realized the importance of Intranets and is taking steps to establish its own Intranet.

In this paper we report what has been completed to date and what is still ahead. Our networking infrastructure is describe, together with the importance and expected benefits of establishing an Intranet. We also describe the major services that can be provided to our community by our Intranet. The paper ends with a description of our future directions and services in this area and how these can be implemented.

## **1. INTRODUCTION:**

Nowadays, almost everyone who knows about computers and their applications knows about the Internet. However, many people may not know what an Intranet is or the difference between the Internet and an Intranet. While the Internet refers to the huge network of computers span the world, an Intranet is an internal network that connects all the computer resources within an organization.

There is a great similarity between the Internet and an Intranet. Both are large computer networks that use state-of-the-art transport technologies such as fiber optic, routers, Ethernet, etc. Both offer e-mail, information retrieval, bulletin boards and web-search capabilities. However, the major difference between the two is that the Internet is an open system while Intranets are closed. While the Internet can be accessed by any one who has an Internet connection, an Intranet can be accessed only by authorized people who are related to the organization owning it [1,2].

Intranets are growing as fast as the Internet due to the availability of the technology that can be downloaded free of charge. The Transmission Control Protocol/Internet Protocol (TCP/IP) suite and related technologies are driving the growth of the Internet. 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; and Hypertext Transport Protocol (HTTP) servers to publish hyperlinked information. They also include Web browsers to access hyperlinked information; e-mail for interpersonal communications; Network News (NN) 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].

Many organizations and businesses all over the world have established Intranets. These Intranets have helped in reducing the operational cost of these organizations. They also have provided many services and up-to-date information to all the organization's employees [4]. At KFUPM we have realized the importance of building a University-wide Intranet and have started to establish it. We started to build our networking infrastructure in 1993. As we were building the newer phases of the infrastructure we augmented the plan with the latest technologies. Since 1996, we have been evaluating, implementing and providing some of the basic services to our community via our Intranet

In this paper we report what has been completed to date and what is still ahead. We start by describing our networking infrastructure in section 2. In section 3 we describe the importance and expected benefits of establishing an Intranet at KFUPM. In section 4, we describe the major services provided to our community by the Intranet. Finally, in section 5 we describe our future directions and services and how these can be implemented.

## 2. BACKGROUND

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 recently renamed the Information Technology Center (ITC). The University's first computer, an IBM 1130 with 8K of memory, was installed as early as 1967. Since then, the computing environment at KFUPM has evolved rapidly. Until the end of 1992, the computing facility at ITC comprised two mainframes in addition to two stand-alone Personal Computer (PC) labs. One of the mainframes, an IBM 3090/150E running MVS/XA, was dedicated to administrative applications such as student information systems, personnel and payroll, material management, the library automation system, and financial resources management systems. The second mainframe, an AMDAHL 5850 running VM/SP5, was dedicated to academic applications. These computing facilities were connected through an SNA network with more than 500 terminals distributed in all buildings, as shown in Figure 1.

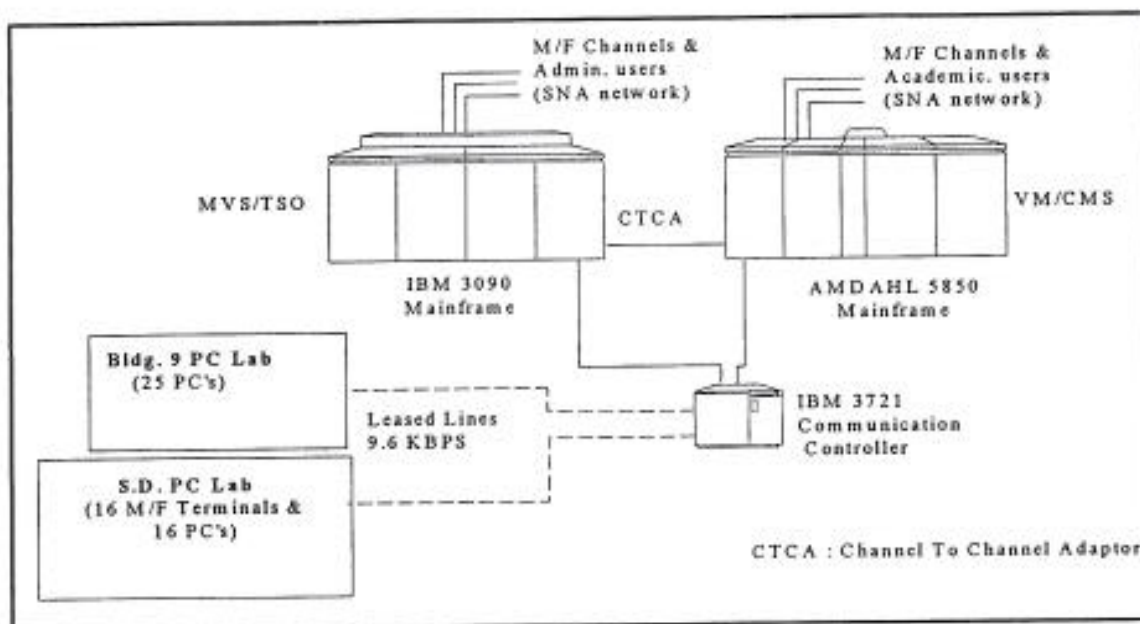


Figure 1: The computing environment at KFUPM in 1992



The University has, in the period 1993-1998, completed, through ITC, several projects resulting in the following major infrastructure changes:

1. The academic mainframe SNA network has been replaced by a token ring (TR) backbone using a fiber-optic cable that runs at a speed of 16 Mbps. This cable has a capacity that substantially exceeds that of the coaxial cables used in the SNA network. It supports the transmission of a hundred megabits per second at distances of up to five kilometers. The TR is capable of routing both IPX/SPX and TCP/IP traffic. The backbone connects virtually all KFUPM buildings to the ITC (Bldg. 14).
2. Academic and administration buildings have been structurally cabled and organized as individual LANs. Each building is equipped with floor-based area hubs connected to a master Ethernet switch. The switch connects each building LAN to the University backbone. This process began in 1994 and was planned for execution in phases. By mid 1998, approximately 90% of the University facilities were on the network, totaling around 2200 connections. Now, every room in most of the buildings is connected to the network. A user with a PC anywhere on campus can communicate and share resources with other users.
3. The academic mainframe (AMDAHL) has been replaced by a Unix server (IBM RS6000). Some terminals were replaced by Unix workstations, while others were replaced by latest technology PCs. This is the main environment for academic users. All software used by academic users can be accessed on the Unix or PC servers located in the ITC building.
4. The administrative mainframe (IBM 3090) will be replaced by an Enterprise server (IBM 2003-215 OS/390) by May 1998. This server will be connected directly to our Intranet through an Ethernet/Token Ring Open System Adapter. This will enable us, in the near future, to provide access to our legacy systems.

Figure 2 shows the current KFUPM enterprise network. This infrastructure paves the way to implement all the Intranet services that will be discussed in section 4. More details about the above projects can be found in [5].

### **3. THE IMPORTANCE AND BENEFITS OF KFUPM INTRANET**

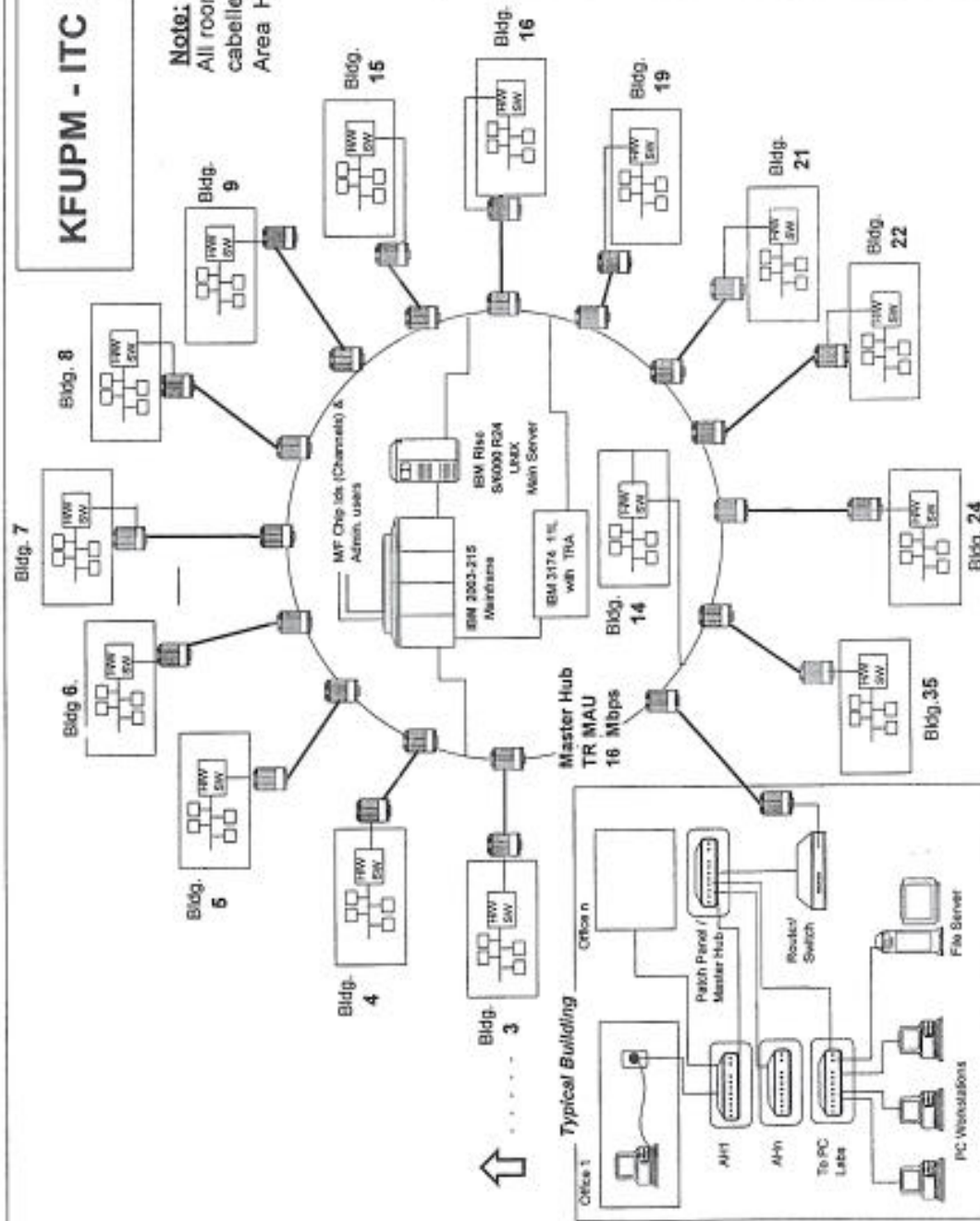
As discussed earlier, establishing an Intranet in an organization provides many advantages for the organization such as providing up-to-date information, e-mail services, homepage access and development, etc. At KFUPM the Intranet will provide benefits for both the academic and administrative.

For the academic sector the Intranet will enhance communication methods between departments, faculty and students in all issues related to teaching and research. Specific benefits include the following:

1. The availability of on-line undergraduate and graduate bulletins of the University, allows students and faculty open access to them.
2. The availability of faculty homepages, which include information about their courses and research, will allow straightforward access by students and other faculty members.
3. Enabling searching library resources from any PC connected to the Intranet.

# KFUPM - ITC Network Topology

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



**Legend:**

- TROF, Fiber Optic to UTP Transceiver including Fiber Optic Connectors
- Fiber Optic Cable 2 pairs, & 9 pairs for Bldg.35
- Hardware Switch SMC ES/1 (Routing + Bridging)
- Ethernet LAN(one or more LANs connected thru a set of area hubs to the hardware switch).
- UTP Cables Cat. 5

Figure 2: KFUPM enterprise network in 1998



4. In the near future, the Student Information System will be available for all faculty and students to access. This will allow students to check their academic records and register for their courses on line. It will also enable advisors to monitor the performance of their advisees.

In the administrative sector the Intranet will enhance the process of service delivery by the various departments. For example, the Deanship of Student Affairs can communicate important announcements to students via e-mail or the Deanship homepage. Similarly, the efficiency of service departments, such as maintenance or housing, will be enhanced if all requests are

#### **4. KFUPM INTRANET AND ITS SERVICES**

The University Intranet currently consists of Unix, Windows NT, NetWare and MVS/TSO platforms. The IBM version of Unix, AIX, running on a powerful Unix host computer (IBM RS6000 Model R24) with large memory (256 MB) and disk space (42GB) is the main academic platform. PC Labs and departmental facilities are served through large Intel servers running Windows NT and Novell NetWare operating systems. The MVS/TSO platform is dedicated to administrative applications.

The KFUPM Intranet provides a number of network services to a large base of users. These services are accessible from all types of network clients. The services are managed through the network, using computers that run Web, Email, DNS (Domain Name Server), WINS (Windows Internet Naming Services), DHCP (Dynamic Host Configuration Protocol) and other Intranet applications. A wide range of software applications is also available through the Intranet for installation or access. The highly integrated network provides seamless connectivity between various platforms and services.

The KFUPM Intranet is designed to meet a number of objectives, including:

- communication and exchange of information;
- regular publication of information;
- availability of office, engineering and scientific application systems;
- interoperability between network platforms; and
- remote access facilities.

To achieve these objectives the following services have been provided to faculty and staff from their offices. Students obtain these services via the PC labs around campus.

##### **4.1 Desktop Connectivity**

Whenever a faculty or staff member receives a PC in his office, or for those who have PCs already, a desktop customization process takes place to connect this PC to the Intranet. Using Windows95 (Arabic or English) the right configuration is made to the PC to associate it with the department network, then to the entire network. If the user needs to connect to Unix then the appropriate software is used for text-based access (Telnet) or X-Window access (Exceed). For users who need to have access to the mainframe, a terminal emulation program is installed for their PCs to enable them to access their Legacy application.

After this customization process is completed, the user is trained to use shared resources available all around campus such as printers, scanners and data files. They are also trained to share their resources with others.

It is important to mention here that for the administrative mainframe the SNA network is still available. Many ASCII terminals are distributed around the campus, enabling many users to access and run various mainframe applications.

#### **4.2 E-mail Services**

All faculty members and students are automatically given a user ID on the Unix system, while staff members are given an ID on request. These accounts are the Internet mail addresses for these users. A user with a Unix ID xxx has the e-mail address [xxx@kfupm.edu.sa](mailto:xxx@kfupm.edu.sa). Users can then login to the Unix machine and access their mail. Since many of the mail packages on Unix, such as Pine, are not universally popular, PC mail packages such as Microsoft (MS) Internet mail are installed on the PC. By appropriate customization, the users e-mail messages will be downloaded directly to his PC and then manipulated without accessing Unix. These e-mail addresses are also used for KFUPM internal communication. Various aliases are created, such as EE-faculty and Personnel-dept, to help in passing messages to larger groups of people.

#### **4.3 Web Services**

In the Web all information is organized in the Intranet (Internet) as a set of hypertext documents. A hypertext document contains some information such as text, pictures, etc. that can be expanded by clicking on them. Browsers allow users to move and search between sites, seeking all kinds of information [6]. KFUPM has created a web site that provides updated information on all aspects of the University activities. The Web site combines overall University information with active departmental web sites. This site is designed to promote awareness of all University programs, facilities and resources. Faculty and students are also encouraged to maintain their own home pages. An ITC web-working group coordinates the development and maintenance of the University web site. The group coordinates its activities with all KFUPM departments to keep the site updated.

#### **4.4 Gopher Services**

Gopher is a lookup tool that allows users browse through the Internet/Intranet by selecting resources from menus. Gopher does not require the address of the site that you are looking at. Each user needs a gopher client, which is available in all platforms. The client when run will connect to a gopher server in the site needed. It will allow the user to browse and obtain the required information needed just by choosing the menu [6]. Gopher is an important service for users who do not have browsers or access to the Intranet through modem servers. We have created a gopher for KFUPM that can be accessed from any PC campus wide.

#### **4.5 Library Access**

The library is one of the most important and valuable resources in any university. At KFUPM we are proud to say that 100% of our collection of books are available on-line using the Dobis/Libis library automation system which runs on the mainframe. In the last few years we also had established a network of compact-disk (CD) servers in which CDs of abstract databases and full-text articles are installed. Before our Intranet was established the Dobis/Libis online catalogs could be accessed only through mainframe terminals in the library and other locations. No connectivity was available to the CD servers.

Now, both Dobis/Libis online catalogs and the CD servers in the library can be accessed through our Intranet. From any PC around campus, a user can access both services and can even download the data into his PC or print it on his printer.



#### **4.6 Remote Access**

The University Intranet facilities are accessible from remote locations, e.g. faculty housing, through telephone lines that provide connectivity to all major network platforms. Remote access servers provide direct connection to the network in three different modes: a telnet/X terminal link to the Unix machines, a PPP (Point to Point Protocol) link to the network, and a direct link to the MVS/TSO platform. The remote access link provides users with direct access to the University web site, mail services, and shared resources on servers and workstations.

#### **4.7 Application Support**

The University has implemented a campus-wide software licensing policy with large software houses and popular packages. KFUPM and Microsoft have entered into a licensing agreement for Microsoft products and program updates, which are to be made available to the University every 45 days. Similar arrangements have been made for specialized applications such as SAS on Unix and PC platforms, GTSTRUDL on the Unix platform and Chemshare (Design II) on the PC platform. Installation servers and CD-ROM servers, with access over the network, are available for the direct installation of software. From any PC in the network a user can install the licensed software from the server directly to his PC. In the past, such tasks were done by ITC staff who scheduled visits to requesting users and installed software from CDs.

#### **4.8 University PC Labs**

A strategic policy has been implemented to enhance the use of computers as a tool for further improving educational standards. An additional objective has been to distribute computers across the campus and provide Intranet facilities to faculty and students at all teaching levels and locations. Over 30 PC labs each equipped with 15 to 30 workstations have been set up to accomplish these objectives.

The integration of these labs into the University Intranet provides users, especially students, with full access to the University computing facilities. All Intranet services are available with appropriate authorization for students through the PC labs. However, a few labs are isolated and are scheduled for connection to the University network in the coming network expansion phase.

#### **4.9 Internet Connectivity**

The University network is partially linked to the Internet through a fast E-Mail service. The University web site is also maintained on the Internet. The current unavailability of full Internet connection has led to the installation of a number of services normally accessed through the Internet on the University Intranet. The University Intranet has, therefore, assumed a very powerful role by providing a wide range of network services.

### **5. CONCLUSION AND FUTURE WORK**

The future of the Intranet at KFUPM is the future of its education program. The academic and administrative sectors in the University have set the future requirements of the Intranet; it is a tool to serve their information needs. Past experience in building the infrastructure and initiating the change in information use on campus suggests to us that ITC should be responsible for drafting the blue prints of the future network. International developments in education and the advances in Internet services guide this planning responsibility. However, the future of the Intranet should not be viewed from the technology side only. The pressing question is how the process of change and evolution itself will be managed [7].



As telecommunication technology has made terrestrial distances insignificant and transformed the world into a global village [8] we should be planning to be part of this village and to contribute to its development. Computer infrastructure supports this process of globalization. A 1995 report, "The Changing Nature of the Telecommunications/Information Infrastructure" [9] by the National Research Council and the Computer Science and Telecommunications Board describes the changing nature of the infrastructure in terms of three elements:

- Production of information in film, video, audio, text, or digital format
- Distribution media, including telephony, broadcasting, cable, and computer networks
- Reception technologies, including computers, videocassettes, and satellite dishes

Cooperation among the G-7 nations in the areas of cross-cultural education, training, and electronic libraries gives us an indication of the type of world we will inhabit in the near future. The provision of knowledge in education will be changed dramatically as new technology emerges. The global access to information will change the relationship between people and knowledge [8]. Educational institutions need to work hard to catch this wave or they will be left behind.

In our opinion, the KFUPM Intranet should be upgraded to the latest international standards. In this context it should:

- complete the infrastructure to include sites currently not part of the network, possibly including faculty housing and student dormitories;
- provide all students and faculty with personal computers;
- upgrade the network speed to high-speed communication protocols that provide video and audio to the desktop computer;
- support the use of multimedia in the education process;
- connect to the full services of the Internet;
- allow two-way global access with enhanced security measures; and,
- encourage other national educational institutions to build infrastructures to widen the global access of information.

While the above action list is self-explanatory, some points need more attention. Providing a PC to every student and faculty member is critical. It is a tool for enriching the undergraduate educational programs. It is now recognized to be a productivity tool for students and faculty, as an educational device, and also as a resource area in which educated people would need proficiency in the workplace [10]. Reciprocal global connectivity should be established in a secure way to get the best out of the Internet. Access control policies and requirements need to be developed before firewalls or other means are installed [11].

One should not conclude that Internet services are the goal of our plan. We believe that the Internet is becoming a "commodity" service. Much of our attention must be focused on the use of this global information infrastructure to support the educational process at KFUPM. In the future, today's Internet will be viewed as a primitive precursor of powerful multimedia network technologies [8].

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