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Telecommunications in Saudi Arabia: A Giant Leap into the New Millennium

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Telecommunications in the Kingdom of Saudi Arabia (KSA) has witnessed recent innovation. In a few years, the underlying infrastructure has been modernized to use new technological tools available today, and support a broad range of user services. In this report we briefly cover this shift, and present the current status of telecommunications in KSA, highlighting some available services. In addition, we present an overview of the digital data network (DDN) infrastructure supporting today's most popular and expanding service, the Internet.

The Origin of Telecommunications in KSA

Telecommunications in KSA goes back to the first years after the unification of the Kingdom, when KSA first joined the Universal Postal Union in 1929. In 1953 the Ministry of Transportation was formed; in 1976 the Ministry of Posts, Telegraphs, and Telephones (PTT) was established. From 1976 to 1998 PTT was the only public sector entity responsible for telecommunications. In 1998 the Saudi Telecommunications Company (STC) was established as a first step toward privatization. STC is now the sole body responsible for the development of telecommunications in KSA.

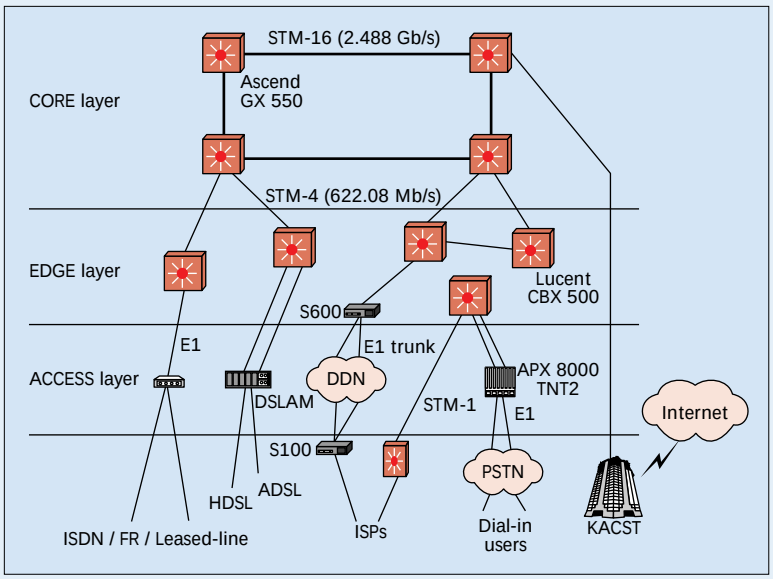

Figure 1. *STC's 3-layer ATM backbone.*

STC's Network Backbone (Design and Infrastructure)

To support the growing demand for telecommunications and data services, an ATM network backbone is deployed. This network consists of three layers: the core, edge, and access layers (Fig. 1). The core layer utilizes four core ATM switches, distributed in different locations throughout KSA and connected in a ring topology via a two-way high-speed fiber link with STM-16 interfaces (2.488 Gb/s). The switches used are the Ascend GX 550, which provides high-speed backbone transport as well as user services at STM-1 (155.52 Mb/s) and STM-4 (622.08 Mb/s) speeds. The edge layer is mainly made up of 38 Lucent CBX 500 switches. Most of these switches are directly connected to the core layer with interfaces reaching up to STM-4 speeds. Finally, the access layer provides a platform for numerous users and user services (e.g., xDSL, ISDN, and frame relay).

Currently, about 90 percent of traffic passing through the ATM network is generated by the Internet; however, in the future most types of traffic, including PSTN traffic, are expected to use the core ATM backbone.

Telecommunications and Services

As of 31 May, 2000, there are 2,858,314 lines in operation in the STC fixed telephone network, with service available in all districts and major cities. Currently, 96.8 percent of these lines are connected to digital exchanges. Various services are available to STC customers, including a wide range of intelligent network services such as caller ID, call waiting, and toll-free service (800). Others include call collect, call forwarding, wakeup call, prepaid phone cards, voice mail, digital directory assistance, and paging (ERMES and POCSAG systems with 745,003 subscriptions). High-speed data communications services, including xDSL and ISDN, are in development.

In addition to the fixed telephone network, a wireless GSM network system is available throughout KSA, with access in most cities and on all main highways. Initially, one million lines were supported; however, recent expansion of the GSM system increased this capacity to two million lines. A future expansion is also expected for an additional 500,000 lines, reaching a total of 2.5 million. Currently 1,003,838 of these lines have been allocated.

Table 1 lists basic telecommunication indicators for some Arab states in the region. Details and information regarding the status of telecommunications in KSA can be found at the STC Web site, http://www.stc.com.sa

The Digital Data Network (Design and Infrastructure)

The DDN backbone is made up of three main cluster nodes, located in the cities of Riyadh, Jeddah, and Dammam, connect-

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Telecommunications in Saudi Arabia (continued from page 1)

ed in a ring topology via a high-speed fiber link with STM-1 interfaces and a number of E1 trunks (2 Mb/s) running over an SDH backbone. The DDN network uses Tellabs' MartisDXX system, which provides a broad range of business services, including LAN interconnect, digital leased line, and frame relay. Each cluster node has capacity for up to 256 E1 ports. Basic nodes, with capacity to terminate up to 32 E1 ports, are used to extend the service to remote locations. The number of leased lines currently installed is 34,700. The DDN has the capability to multiplex low- to high-speed data, voice frequency, and trunk interfaces into several outgoing 2 Mb/s streams, providing a wide range of solutions and services to customers.

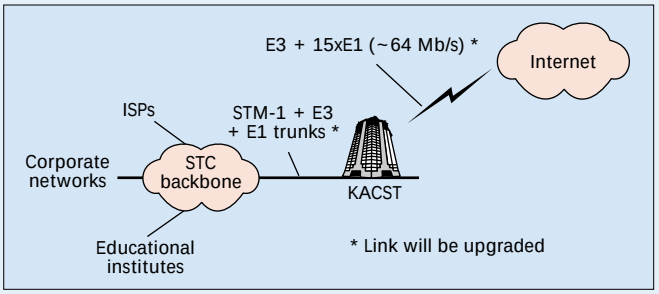

Figure 2. *Internet infrastructure in KSA.*

The Internet in KSA

There has been Internet access in KSA since 1994. In the past, access was restricted to a few research centers and government agencies. In January 1999, Internet access was opened to the public through local ISPs. Today, all public Internet connections in KSA pass through the King Abdulaziz City for Science and Technology (KACST) network. KACST, represented by its Internet Services Unit (ISU), is responsible for provisioning Internet services, and the preparation of regulations and policies that govern use of the Internet.

Currently there are 28 ISPs, and nine educational institutes directly connected to the Internet through KACST. To serve the traffic generated by this number of users (estimated around 200,000), the KACST network is fed, through the STC network, by an STM-1 interface, an E3 interface (34.368 Mb/s), and several E1 trunks (Fig. 2). These links, serving both international and domestic traffic, will be upgraded to a total of four STM-1 links in the future. The uplink capacity, connecting KACST to the Internet, comprises an E3 and 15 E1 links, connected either through an undersea cable or by direct satellite from STC's Deerab satellite station. Expansion of the KACST uplink Internet connection is expected with the addition of an STM-1 link, increasing capacity from the current 64 Mb/s to over 200 Mb/s. By early 2001, two additional STM-1 links will be added for a total of three STM-1 links. In order to reduce downstream Internet traffic volume, several cache-flow machines are also utilized within the KACST network. Details and information regarding the use and status of the Internet in KSA can be found at http://www.isu.net.sa.

Future years are expected to be very important for telecommunications in KSA, and the role it will play in development of the country. As we approach the global market economy, telecommunications will also open new doors for many investors.

By providing the current infrastructure, STC is now enabling Saudi telecommunications to take this giant leap into the new millennium.

	Country	Main telephone lines		Public pay phones		Cellular telephones
		Lines in operation	Lines/100 inhabitants	Connected. to digital exchange (%)	No. of public pay phones	No. of mobile phone subscribers
1	Bahrain	157,619	24.55	100.00	1589	92,063
2	Egypt	3,971,518	6.02	82.00	5046 [1996]	90,786
3	Iraq	675,000	3.10	...	...	–
4	Jordan	510,875	8.34	93.00	3489	70,498
5	KSA	2,878,119	14.26	63.60	42,545	627,321
6	Kuwait	427,288	23.59	94.00	574	250,000
7	Lebanon	620,000	19.43	100.00	...	500,000
8	Oman	219,956	9.23	100.00	3736 [1997]	103,032
9	Qatar	150,508	25.99	100.00	739	65,786
10	Sudan	162,225	0.57	90.00	2850	8,600
11	Syria	1,463,000	9.54	87.00	3186	–
12	UAE	915,223	38.90	100.00	26,050	493,278
13	W.B./Gaza	167,271	5.78	100.00	1255	...
14	Yemen	249,515	1.48	100.00	...	18,000

Source: "Arab States Telecommunication Indicators," ITU, 2000. [indicators as of Dec. 12, 1998].
Available at the ITU Web site : http://www.itu.int/ti/industryoverview/index.htm.
Note: Some values are estimates.

Table 1. *Basic telecommunications indicators in some Arab states.*

EU/ACTS Project Demonstrations at Telecom '99 Focus on Convergence

By Paolo de Sousa, Belgium

The European Union pavilion at Telecom '99 featured some demonstrations from R&D sponsored projects. The "convergence demonstrations" related to two main commercial issues.

The first is the need to provide quality of service (QoS) to IP applications. The explosive growth of the Internet has created a new mass market service. The service is currently still quite homogeneous, however, with a low level of QoS support. A widely deployed "quality Internet" is required to develop the information economy. Several innovative means are proposed to achieve this, all of which imply some convergence of network technologies, transport protocols, or concepts between IP and ATM techniques.

The second issue is liberalization of the telecommunications market, which has created an environment in which many network and service providers compete for the same customers. Tools for encouraging the competition include price, service differentiation, and customer support. Price and service differentiation create new demands for flexible and sophisticated accounting systems, particularly in the areas of tariff management, service customization, and charging. Technical solutions must also be available to enable equipment from different network providers (e.g., in the access and core networks), and subsequently from different vendors, to interoperate.

DIANA demonstrated several options for handling IP traffic with varying QoS requirements, taking into account underlying networks based on both ATM service classes and differentiated services priorities. Some of the methods enhance current schemes (e.g., RSVP over ATM), including aggregation and efficient resource renegotiation, or are combinations of current schemes, such as the heterogeneous RSVP and differentiated services case, as demonstrated in conjunction with ELISA. Other demonstrations from DIANA were premieres of new techniques, such as the Scalable Resource Reservation Protocol (SRP) and Simple Integrated Media Access (SIMA).

SUSIE demonstrated convergence between the technology of the network to provide quality Internet services, and the requirements of business to be able to charge for such premium services.

BTI and SUSIE demonstrated international distance learning using IP-based applications, enhanced with QoS capabilities. BTI included new features of IPv6 and multicasting.

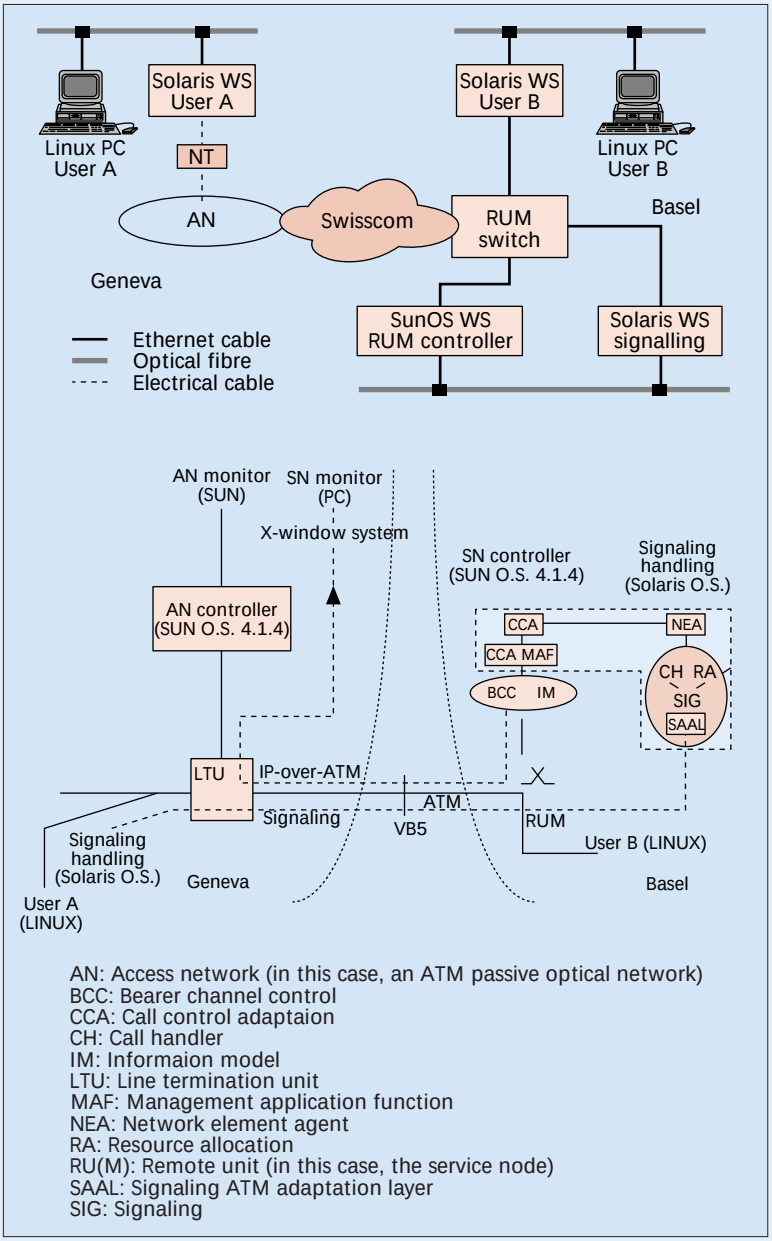

Figure 1. *Details of the EXPERT/VIKING demonstration.*

COIAS introduced a further dimension of convergence, by demonstrating real-time IP-based audio and video communication to aircraft, via satellite. Techniques included IPv6 and differentiated services.

EXPERT/VIKING addressed the fundamental issue of interoperability when connecting equipment from different vendors. The demonstration showed the capability, through adopting open interfaces like VB5, to share usage of the access network among different service providers. In today's liberalized environment, this is increasingly important.

FlowThru demonstrated a solution for the interdomain exchange and resolution of fault alarms and trouble tickets for a multimedia IP service operating over an ATM backbone. This involved interactions with service accounting and SLA management activities, and required the integration of CORBA and CMIP management technologies.

ITUNET presented a practical solution for high-speed data transfer over existing copper pair access networks, through the use of VDSL systems close to the customer and inverse multiplexing. The technique is compatible with different technologies (fiber, fiber rings, G.983 ATM PONs, HFC, wireless, etc).

Many of the convergence demonstrations relied on the TEN-155 pan-European research network for the provision of international managed bandwidth services. The TEN-155 network and its managed bandwidth service are direct results of the QUANTUM project.

Details of the EXPERT/VIKING Demonstration

The VB5 interface is being standardized by ETSI and ITU-

(Continued on page 4)

T in order to ensure that access networks from one vendor can interoperate with core networks (so-called service nodes) from other vendors. The standard therefore defines the messages that cross this interface and the actions these messages should initiate. The demonstration scenario is shown in Fig. 1.

Details of the DIANA Demonstration

DIANA investigates various approaches (RSVP, SRP, and SIMA) to service integration and differentiation in heterogeneous IP and ATM networks. They differ in the nature of the service guarantees offered to the user, in the way a user specifies its demands, and in terms of scalability.

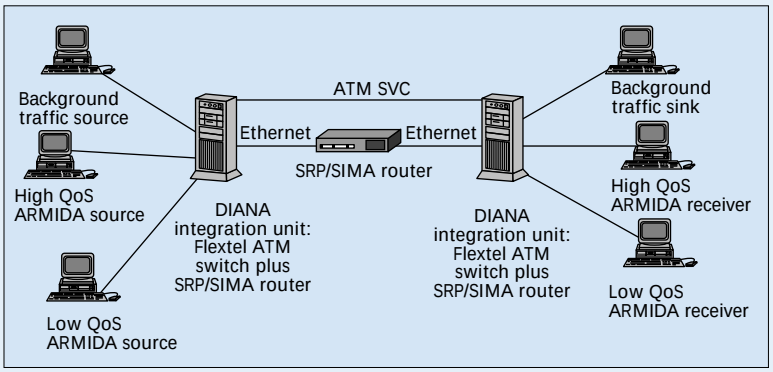

Figure 2. *RSVP, SRP, and SIMA scenario.*

The applications used in the demonstrations were ARMIDA (MPEG audio and video) and CD audio. For the RSVP, SRP, and SIMA scenarios, traffic from the ARMIDA application was separated into two flows which were given a different QoS.

RSVP over ATM

The RSVP-over-ATM solution is relatively close to B-ISDN paradigms. An application explicitly characterizes its traffic profile by means of a leaky-bucket-based traffic descriptor. This information is signaled to the network in advance and results in a stable reservation on a per-flow or per-connection basis. Unfortunately, maintaining per-flow state does not scale with increasing network size. DIANA works around these issues by aggregating flows to a single VC at the ingress to the ATM network. DIANA's threshold-based VC bandwidth renegotiation scheme accounts for dynamic changes of the flow aggregate.

Simple Integrated Media Access

Conversely, the SIMA differentiated services architecture achieves scalability by classifying and marking packets by means of the so-called DS field in the IP header at the ingress to a DS-capable IP network. The goal is to receive a particular per-hop forwarding behavior from DS routers along their path. With this architecture, only relative QoS can be achieved. SIMA is a special implementation of differentiated services aiming to balance resource usage based on a so-called nominal rate specified by the user. Thus, SIMA's control capabilities enable a user to control its resource share at a bottleneck. This control scheme is demonstrated with two reference applications with a different nominal rate sharing resources at a bottleneck with synthetic background traffic.

Scalable Resource Reservation Protocol

Contrary to RSVP over ATM, SRP establishes a QoS path without per-flow state in routers. Senders set a request bit in data packets until the desired reservation level is sent back from the receivers. Similar to RSVP over ATM and contrary to differentiated services, the reservation is absolute and reliable. Senders, routers, and receivers obtain the current reservation level by counting packets with the request or reserved bit set. However, since a network is a system of distributed elements, these elements may have slightly divergent views of the currently reserved resources. Furthermore, a reservation builds up gradually. Hence, SRP is more dynamic than the traditional explicit reservation schemes of, say, B-ISDN.

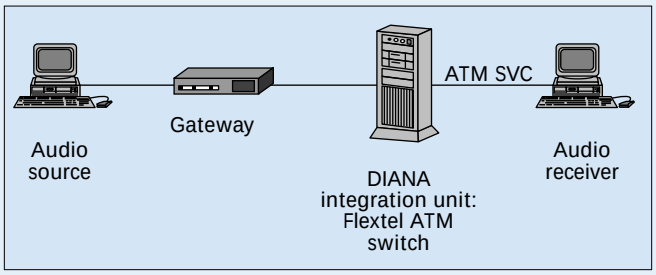

Figure 3. *Peering scenario.*

IP-ATM Peering

As far as the Internet community is concerned, ATM is regarded generally as a link layer offering fast transport, with IP used end to end. Nevertheless, even in this scenario, the integration unit can still solve QoS mapping and, in the case of RTP and RTCP, the multiplexing of sessions into VCs. The alternative for interworking is (as in the IP-ATM peering sce-

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