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TELECOMMUNICATION

TITLE: LATIN AMERICAN HEALTHCARE LINK COMMUNICATION TECHNOLOGIES
FOR HEALTHCARE STAFF WORKING IN ISOLATED RURAL AREAS OF
LATIN AMERICA

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SUMMARY OF CONTRIBUTION:

Summary: The objectives of the Latin American Health Link programme are to provide low-cost communication facilities and information access services to medical staff working in rural areas of Latin America not yet served by conventional telephony. The services are based on the exchange of information among colleagues, access to specialists, distance training and access to specialized documentation through what we refer to as "information access facilitators". The technologies, inspired by the experience of the radio amateur community, permit Internet access via radio systems and are based solely on the use of email

1   INTRODUCTION

The major social, political and economic changes that have occurred in western society over the past decade are having an impact on the evolution of traditional healthcare and welfare models. Demographic changes, increasing healthcare costs, the need to improve the quality of welfare, the search for social equity and the opening up of new markets are just some of the factors which make it necessary to develop a new vision of health care, in which there can be no doubt that information and telecommunication technologies play a key role [1].

The situation in the rural and outlying urban areas of some Latin American countries is such that we have no option but to reformulate the technological solutions that the more developed countries have implemented to address the various communication requirements in the healthcare sector. The direct transfer of those solutions to countries lacking in infrastructure and in the process of development does not help to solve the problems. It is only by carefully adapting them to the social, economic and healthcare situation as it exists that the objective of improving the health situation in such rural areas is likely to be achieved [2] [3] [4].

The Bioengineering and Telemedicine Group of the Polytechnical University of Madrid and the NGO *Ingeniería Sin Fronteras* (engineering without borders) have together engaged in research on the

design of communication systems and services suited to the needs of rural healthcare staff in the countries of Latin America. The Latin American Healthcare Link (LAHL) programme is a comprehensive initiative aimed at transferring technological and methodological know-how in the field of access to medical information to counterparts in each of the countries in order that they should be the bodies responsible for providing specific services designed to cover the needs of each country.

2   THE LAHL PROGRAMME

The LAHL programme seeks to contribute to improving healthcare conditions for the rural inhabitants of Latin American countries by improving the working conditions of rural healthcare staff in the areas of communications and access to training, specialized information and medical documentation.

2.1   Objectives of the LAHL programme

The specific objectives of the programme are to:

- improve access to medical information and training for healthcare staff in rural areas;
- enhance the telecommunication infrastructure of healthcare establishments.

2.2   Key elements of the programme

Work under the LAHL programme basically revolves around four key elements, namely:

- services focusing on communication and access to healthcare information;
- services intended for rural healthcare staff in developing countries;
- appropriate low-cost communication technologies;
- development of services in Spanish.

The LAHL programme is introduced on a comprehensive basis in each country as an "LAHL-country" programme, its introduction being divided into four phases, namely:

- identification, constitution and training of the counterparts in each new country;
- study of the communication and access to information requirements of rural healthcare staff;
- implementation of a pilot scheme;
- large-scale introduction of LAHL technology throughout the country.

2.3   Lines of operation

The strategy followed by the LAHL programme in order to achieve the above objectives is based on three main operational strands, namely:

- research into low-cost communication technologies;
- development of information services for healthcare staff in rural areas of Latin America;
- introduction of the LAHL network in countries of Latin America.

3 CURRENT SITUATION WITH RESPECT TO HEALTHCARE ESTABLISHMENTS

Generically speaking, rural healthcare establishments may be grouped into two categories:
Healthcare centres: A higher-level establishment located in a provincial or district capital and served by a telephone line. A healthcare centre is the parent centre for a number of healthcare posts. It is always run by doctors and has the infrastructure and equipment for conducting certain types of diagnostic tests, as well as a laboratory. Some can accept in-patients. It is the point from which the activities of the associated healthcare posts are coordinated (distribution of medical supplies, dispatch and receipt of administrative and epidemiological reports, etc.).

Healthcare posts: These come under the healthcare centres and are located in towns without a telephone line and having little in the way of roads. Communication and the exchange of information between such places can normally take hours, if not days. The need for communication in such rural areas is particularly important in the event of an epidemic or natural disaster, for the transmission of healthcare bulletins and for the medical supplies delivery system. Many such posts are run by poorly-trained healthcare technicians who need to be able to communicate with the responsible doctor to obtain advice.

On the basis of the studies carried out into the communication and access to medical information requirements of Ministry of Health personnel, in Peru in December 1997 [5] and Nicaragua in December 1998 [6], by the Bioengineering and Telemedicine Group of the Polytechnical University of Madrid, we can state that: the budget of rural healthcare establishments is such as to exclude costly communication systems; most of the communications are local; many of the healthcare posts, and normally those that are the most remote, are run by healthcare technicians who need to be able to communicate with doctors at the healthcare centre for the purpose of consulting them and receiving advice; the volume of information that a healthcare post needs to transmit to the parent centre is very high and requires that the journey be undertaken more than once a week, during which time the post is left unattended. For the purposes of coordination, training and specialist consultations alone, healthcare staff need on average to attend 51 (Peru) and 77 (Nicaragua) meetings every year away from their establishments. Healthcare employees themselves have expressed the view that attendance of most such meetings could be obviated by the availability of an email system for communication between healthcare staff. They also estimate that the savings made would be sufficient to break even on such a communication system in less than two years.

4 TELEMEDICINE SERVICES FOR RURAL HEALTHCARE STAFF

The services provided over the LAHL network can be divided into four categories, namely:

- distance education;
- electronic conferences or discussion lists covering topics of interest for the rural healthcare sector;
- access to medical documentation in databases and international periodicals;
- medical consultations with specialists.

All of these telemedicine services are provided by means of electronic mail. They will be developed and provided by the national coordination centres that have been set up in each country in which the network has been introduced. The subject areas to be covered in the first instance are: maternal health, child health, infectious diseases and nutrition. The coordination centre staff responsible for locating information are known as "information access facilitators". When healthcare staff send an

email message requesting help or information, it is the facilitators who will seek out the required information in local and international data banks, transmitting the reply to the rural staff by the same means.

5 TECHNOLOGICAL RESEARCH

The basic topology comprises radio and telephone links and access to the Internet. Generically speaking, as can be seen in Figure 8, there are three types of node:

- **Terminal node:** This is the location of the end user, and will normally be an isolated healthcare post. It has only a digital link via radio with the local node (normally its parent healthcare centre). The user works with conventional email programs under Windows 95, with a driver which permits the encapsulation of TCP/IP on AX.25 (link layer protocol for VHF radio). The required hardware is a PC with TNC (radio modem) and radio transceiver. The access rate is 1 200 bps.
- **Local node:** This node is the central point for communications by radio with a number of dependant terminal nodes, managing communications between them without operating costs. The local node is a healthcare centre situated in a locality with a telephone line, which it uses on a periodic basis to communicate with the national node. The server used is a Linux system with mail manager which serves as the gateway between the radio network and the node providing Internet access.
- **National node:** This node is the central point for communications with all of the local nodes, and is also our network's link with the rest of the Internet. The system is an Internet access server, whether commercial or user-owned, in which the accounts of all of the end users are stored.
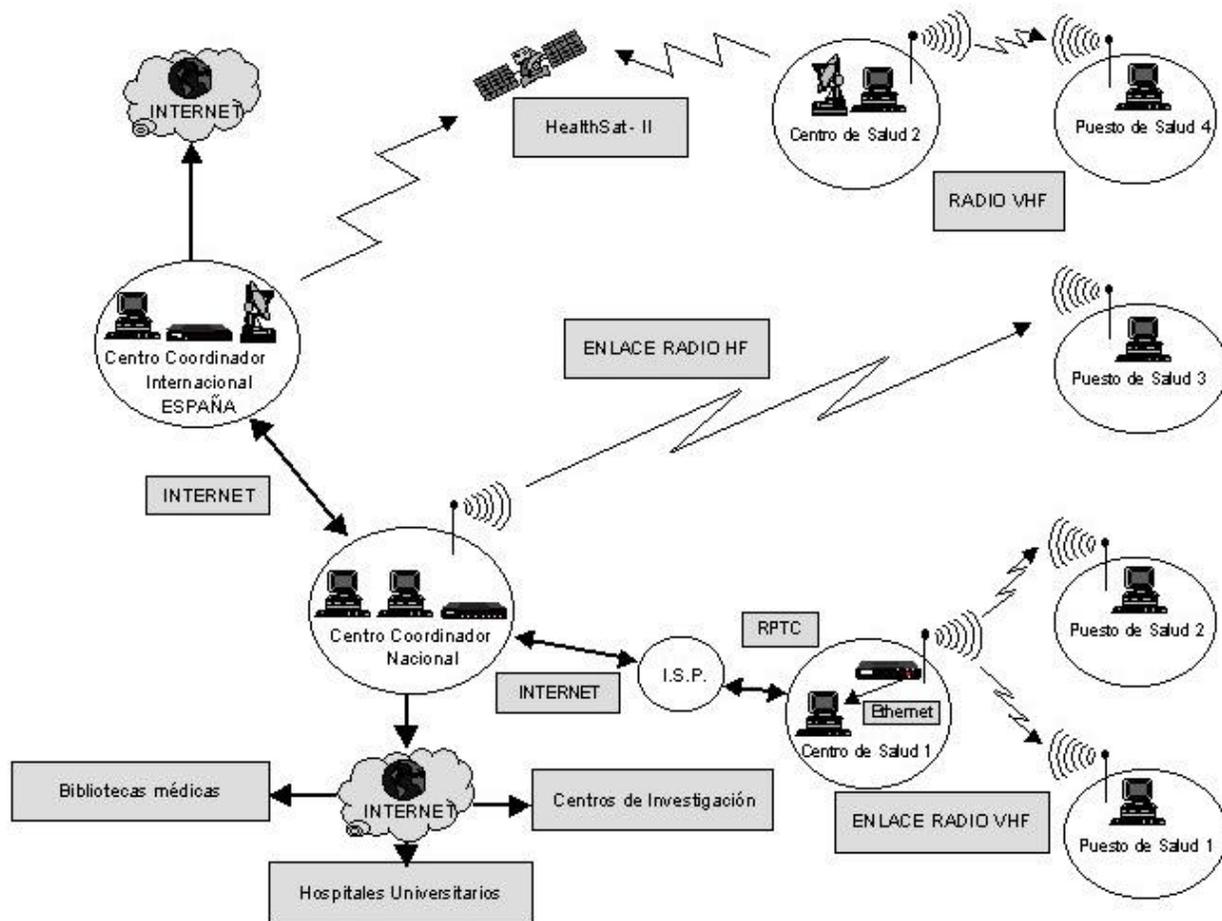
FIGURE
Generic topology of LAHL network

The arrangement shown in the above diagram will operate provided all of the terminal nodes are directly visible from their local node. If any of them are unable to establish a VHF link with the local node, a direct HF link must be established with the national node, with the various advantages and drawbacks this implies. Finally, in the extreme case of a local node which does not have access to a telephone line, messages will be routed via the HealthSat II low-Earth orbit (LEO) satellite to the **international node in Spain**, from where it will be retransmitted via the Internet to its destination.

5.1   Research into technologies

This research focuses on three basic areas of interest:

VHF radio system

Most of the healthcare centres are connected to the telephone network. This is not so in the case of their dependent healthcare posts. For this reason, the bulk of the research effort is concentrated on linking healthcare posts with the nearest telephone, which is normally located in the parent centre. The option which combines low cost with high quality is that of VHF radio (1 200 or 9 600 bps), the drawback being the limited range of the link obtained and the need for direct visibility between antennas.

The client/server communication protocol is TCP/IP, with AX.25 as the link layer. The client has an installed driver (Ethrax25) which encapsulates the TCP frames in AX.25 frames. Ethrax25 is reminiscent of the Windows 95 system which is equipped with an Ethernet driver, but redirects the packets to the serial port where it is connected to the radio modem (TNC) in KISS mode. The server is a Linux system with a recompiled kernel to allow AX.25 connections. The server's send mail function has been modified so as to distribute local messages immediately and to store messages which are not for the machine in an outgoing queue. The telephone connection is established using the PPP protocol with PAP authentication. Once the connection has been established, we instruct the send mail function of our server to release the outgoing queue and request from the provider any messages it has received for our clients. The Linux system checks that both the outgoing and incoming messages have arrived and closes the connection.

HF radio

In situations involving complicated mountain ranges or large distances between the healthcare post and its parent healthcare centre, the ideal solution is a direct HF link with the capital. This option, which is more costly than VHF radio, has technical limitations in terms of the low transmission rate (200 bauds) obtained.

The client/server communication protocol is Pactor. The client is equipped with mail software which redirects the packets, in ASCII, to the serial port where it is connected to the radio modem (TNC) in Pactor mode. The server is a Linux system connected by serial port to another TNC which receives communications in connected mode from remote users. Messages which are for addresses requiring routing by HF radio are distributed immediately as local messages in the user accounts of the same machine. Messages which are not for the machine are routed via the Ethernet interface to the Internet.

Low-Earth orbit satellites (LEOs)

Only in exceptional cases will the use of LEOs be envisaged to link an isolated healthcare centre (which is itself connected by VHF radio to a number of healthcare posts) with the rest of the LAHL international network. This solution, which provides full duplex transmission at 9 600 bps and access to any isolated point, is at the same time the most costly in terms of infrastructure and operation. The SatelLife organization is the owner of the HealthSat II satellite, which is used solely for the transmission of health-related information to or from developing countries. SatelLife has offered LAHL the use of its satellite for both research work and service development [7].
LEOs travel around the Earth at a distance of 500 to 900 km, at a speed that is sufficiently high to enable them to counteract the Earth's gravity. This means that such satellites are not visible at all times (unlike geostationary satellites). The HealthSat II satellite is visible four times a day, on each occasion for 12 minutes. This drawback is offset by the possibility of communicating by means of conventional dualband radio transceivers with power levels no higher than 50 W, owing to the satellite's proximity to the Earth's surface [8].

Peru

Work in Peru is being carried out under two projects, namely LAHL-Lima and LAHL-Alto Amazonas.

The LAHL-Lima project combines two objectives, namely to establish the centre that will provide services to the LAHL network in Peru (i.e. the coordination centre for Peru) and to bring into operation a laboratory for research on low-cost telecommunication (which will adapt the technological solutions researched in Spain and work on extension of the LAHL network in Peru). The Peruvian counterparts are the Cayetano Heredia University (on the medical side) and the Catholic University of Peru (on the technology side). This project is financed by the Spanish Agency for International Cooperation (AECI).

The LAHL-Alto Amazonas project is a pilot scheme to introduce the LAHL network in 40 rural healthcare establishments in the province of Alto Amazonas, department of Loretto, involving setting-up of the LAHL network infrastructure and testing of the services provided from the coordination centre in Lima.

Nicaragua

Work in Nicaragua is being carried out under a single project known as "LAHL-Nicaragua", which includes the phase of establishing the centre to provide services to the LAHL network in Nicaragua (i.e. the coordination centre), the bringing into operation of a laboratory for research into low-cost telecommunication and the development of a pilot infrastructure in 40 rural healthcare establishments in the department of Chinandega, situated in the north of the country. The counterparts are the Centre for Research and Studies on Health on the medical side, and the National Engineering University on the technology side.

Conclusions

Requirements in the developing and the most developed countries are not the same: neither, therefore, are the solutions. In the case of rural healthcare, the appropriate technologies will be those that permit local communications at very low cost and access to national and international communication networks at a reasonable cost.

The LAHL programme relies on radio-based solutions for places not served by a telephone line. Such solutions permit the exchange of local information without operating costs and make for the very efficient use of national and international communication resources.

Work in this field must always focus on the services provided rather than on the technology used. LAHL always offers technology transfer to the local counterparts, based on training and the exchange of know-how between the various countries in which it is active.

The LAHL programme wishes to operate in other countries having the same or similar needs to those of Peru and Nicaragua, and to this end is seeking sponsors who, through their collaboration, can foster the idea of rural healthcare development through better communication and access to information.

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