Wireless Communication

Overview of Possibilities for Wireless Connections between Computers

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INTRODUCTION

Definition and Main Uses

A wireless network is an infrastructure for communication “through the air”, in other words, no cables are needed to connect from one point to another. These connections can be used for speech, e-mail, surfing on the Web and transmission of audio and video. The most widespread use is mobile telephones. Wireless networks are also used for communication between computers.

This note focuses on ways to set up wireless connections between computers. It gives a basic overview without becoming too technical. It will help to determine whether a wireless network might be a suitable solution. It also is a guide to more resources. Many links are to a document by Mike Jensen. The links used are examples; they are not preferred products.

A Scenario

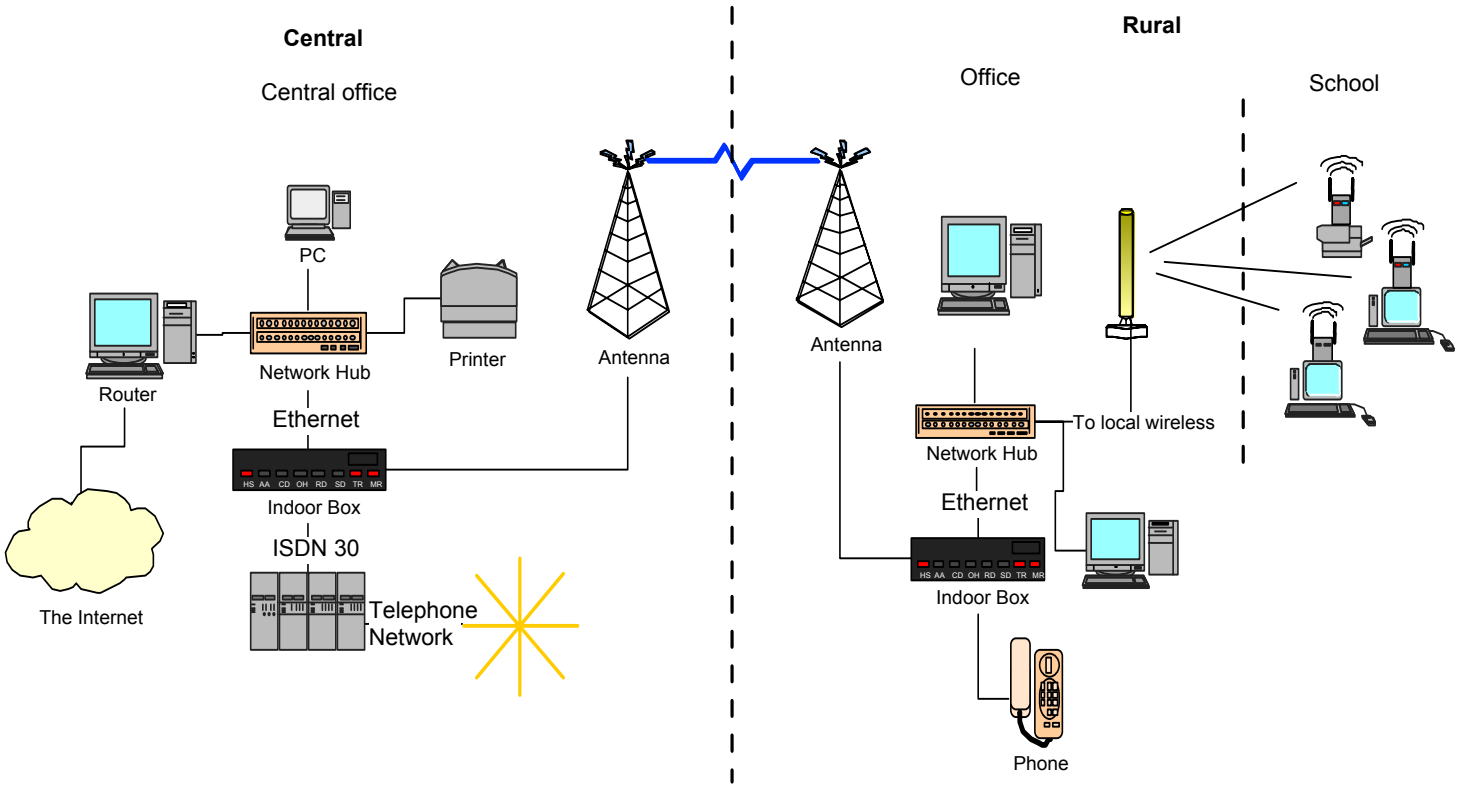
Imagine an office in a city wanting to communicate with a rural village where it has an education project in process. There are no telephone lines and there is no electricity in the rural area. The central office has a local computer network, which is used for e-mail, Web surfing and administrative applications.

The rural village has a school with 2 computers. There is a school office for the staff, with 2 more computers and telephone services. The 4 computers are connected to each other through a wireless network. Electricity is provided by solar energy. The distance between the school and its office is 150 meters. The distance between the village and the central office is 150 km.

The challenge is to connect the rural and the central networks, also connecting the rural computers to the Internet. This can be done using a wireless connection. To do this, an extra box is plugged into both networks. This box is used for the wireless communication. The box is connected to a dish on an antenna, which points to the other site. The two dishes need to see each other (line of sight).

But there is a problem. The maximum range for these kinds of connections is 90 Km - placing an antenna halfway solves this problem. The antenna receives the signal from one direction and, after amplification, transmits it to the other site. Now the connection between the two networks is in place. The computers at both sites can work together and the rural site can use the Internet connection of the central site.

The box, which is used for the wireless connection, can also be used for telephony, or for audio and video transmissions. As the picture on the other page shows, the end result is that the sites now can communicate in a quick and efficient way.


Central
Central office
PC
Router
Network Hub
Printer
Ethernet
Indoor Box
ISDN 30
The Internet
Telephone
Network
Antenna
Antenna
Rural
Office
School
Network Hub
To local wireless
Ethernet
Indoor Box
Phone

WIRELESS NETWORKS IN DEVELOPMENT

The use of wireless networks in developing areas is promising. Since ground cables are only economic in high-density environments, a wireless network will be much cheaper when long distances need to be crossed to rural areas. Also in a local community, the use of a WLL (Wireless Local Loop) can be cost-effective. The costs can be earned back by charging for services like telephone and computer use. However, the costs of ownership (http://www.wlana.com/learn/roi.htm) are of course higher than the prices mentioned for equipment.

What can wireless networks be used for? Some of the uses are:

1. Voice services
2. Video/audio services
3. Data services (file sharing etc)
4. E-learning
5. E-trade
6. E-mail
7. Internet browsing
8. Remote signalling
9. Remote control

Using a simple SWOT approach, the strengths of wireless networks are: easy to install, low price, high capacity, no cables to be destroyed, no transmission costs (like leased lines).

Weaknesses include: sensitive equipment, line of sight needed, specialized expertise needed, capacity lower than fibre cables.

On the opportunity side, they can be used in almost any social or economic activity that requires large numbers of people to be involved or connected, especially in rural or remote areas.

Finally, regarding threats, transceivers/antenna's can be stolen or destroyed, they can be affected by sandstorms, heat, and power failure.

Politically, there may also be resistance to wide access to the tools and the information conveyed and the local regulatory framework is critical. Read more in http://www.idrc.ca/acacia/03866/wireless/part2.htm.

WIRELESS COMMUNICATION IN DETAIL

Depending on the application, three major environments can be distinguished:

- A connection among computers in a local network;
- A connection between different points over a longer distance, using a line of sight (LOS);
- A connection between different points using a satellite.

Each is addressed in the following sections.

Connecting Computers

A Local Area Network (LAN) is used for computer connections from a few meters to a few kilometres. The wireless version of these networks (WLAN) is increasingly used in (old) office environments because no wires need to be installed. But also a village or a section in a town could use such a network to connect to a wider network (Wide Area Network- WAN).

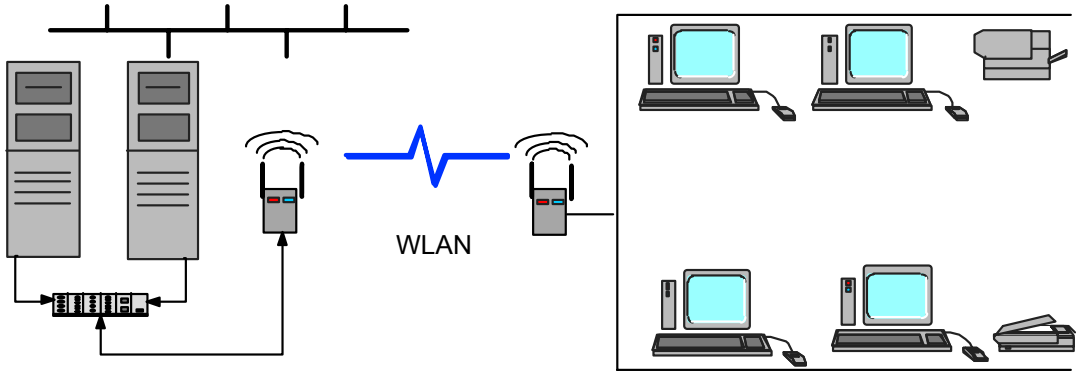
Many manufacturers offer technology at this level. The costs vary from $200 for short distances to $10.000 (or more) per site per 50 Km. Before deciding on equipment, a checklist (http://www.idrc.ca/acacia/03866/wireless/part4.htm) of questions needs to be answered.

The WLAN is mostly used to exchange files, to print, to send e-mail, and to surf the Web. A disadvantage is that the signal can suffer from thick walls and other obstacles. A line of sight is actually needed, although in some cases walls are not a problem. There are many WLAN products on the market and the price/performance ratio in getting better all the time.

A WLAN can be set up for:

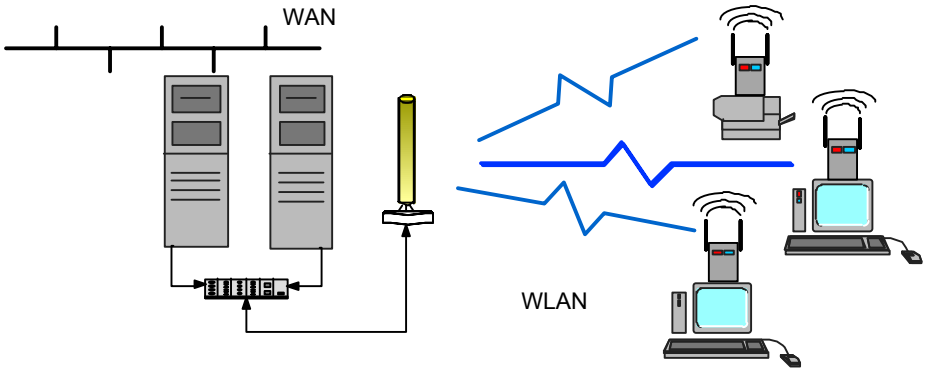
- Administrative processes where several computers are involved**.**
- To give a group of people (or an individual) access to an existing network like a university network.
- To give access to email and Internet browsing. These connections can then be used for e-learning, e-commerce and in general for any application available on the Web.
- The WLAN can also be used for video, audio and voice services.
- Analogue telephone lines can be connected to this network, such as Lucidvoice boxes (http://www.lucidvoice.com/cnt_products_ln-400.html).
- The WLAN is usually connected to another network like the Internet, company networks or a bigger network that is used over longer distances (Wide Area Network- WAN). For this purpose mostly one computer needs to have an Ethernet card to the LAN and another Ethernet card to the WAN or Internet. This computer is called a Bridge or a Router. The Router/Bridge takes care that all traffic is routed well between the two networks. In Windows 2000 this is a standard feature. A specialised router may also be used, such as those of Cisco or 3Com. (http://www.cisco.com/warp/public/44/jump/routers.shtml - http://www.3com.com)

An Example of a WLAN (Local Area Net Work) connected to a fixed WAN (Wide Area Network) with a wireless connection in between the two networks is shown in the picture below. More information can be found at http://www.idrc.ca/acacia/03866/wireless/part2.htm or http://www.wlana.com/learn/educate1.htm#over.



Here, a LAN is connected to another network with a wireless connection. The two transmitters/receivers function as a point-to-point connection, but the distance is limited because WLAN technology is used. There is no need to point antennas toward each other, giving flexibility to place the devices anywhere within the possible range. Another example is the Radiolan Backbone Link (http://www.radiolan.com/specs/spec208.html), which covers 90 meters with 10 Mb for around $1,200.

In the following picture, each station is equipped with a wireless transceiver.



Here, every station has a separate wireless connection to a central antenna. This is called Multi Point Access or Point to Multi Point. The nominal distance is a few hundred meters depending on different conditions. There are systems that provide longer distances, see http://hydra.carleton.ca/info/wlan.html for an overview of different systems.

Connecting Networks

To connect over a longer distance, mostly a Point-To-Point connection is used. Two antennas (http://www.gabrielnet.com/pr-microwave-fr.htm) focus toward each other and a box connected to the antenna translates the signal to a phone or data infrastructure. These connections use a certain band; this is the frequency over which the signal travels. There are licensed bands (regulations have been made about the use) and unlicensed bands (“free” bands which can be

used if another user is not yet using this band). Equipment for unlicensed bands is mostly one third of the costs of licensed bands - see http://www.idrc.ca/acacia/03866/wireless/part2.htm.

Generally, the lower the frequency, the further the signal travels, but the lower the bandwidth (http://www.idrc.ca/acacia/03866/wireless/part2.htm). Consequently, the higher the frequency, the more data can be transmitted, but the distance gets shorter and a line of sight is needed. High placed antennas are needed to rise above obstacles and to rise above the curve of the earth surface. When longer distances are needed, a repeater station can be used. A repeater consists of two antennas, each focussed on a different site and placed between the two locations. The signals are received and amplified for further transmission in both directions.

An unlicensed wireless point-to-point connection of, for instance 10 Mbs (Mega bits per second), can be used to bridge distances up to 50 Km. This will depend on the terrain and the possibilities to have line of sight. The same line can be used for one or two times ISDN 30. This is a special part of the bandwidth, which is reserved for 30 ISDN connections (called an ISDN 30 line or an E1 line). The costs for this example is per site $10,000 including antenna (2,5 meter wide), tower and a 10baseT Ethernet port and a port for the ISDN 30.

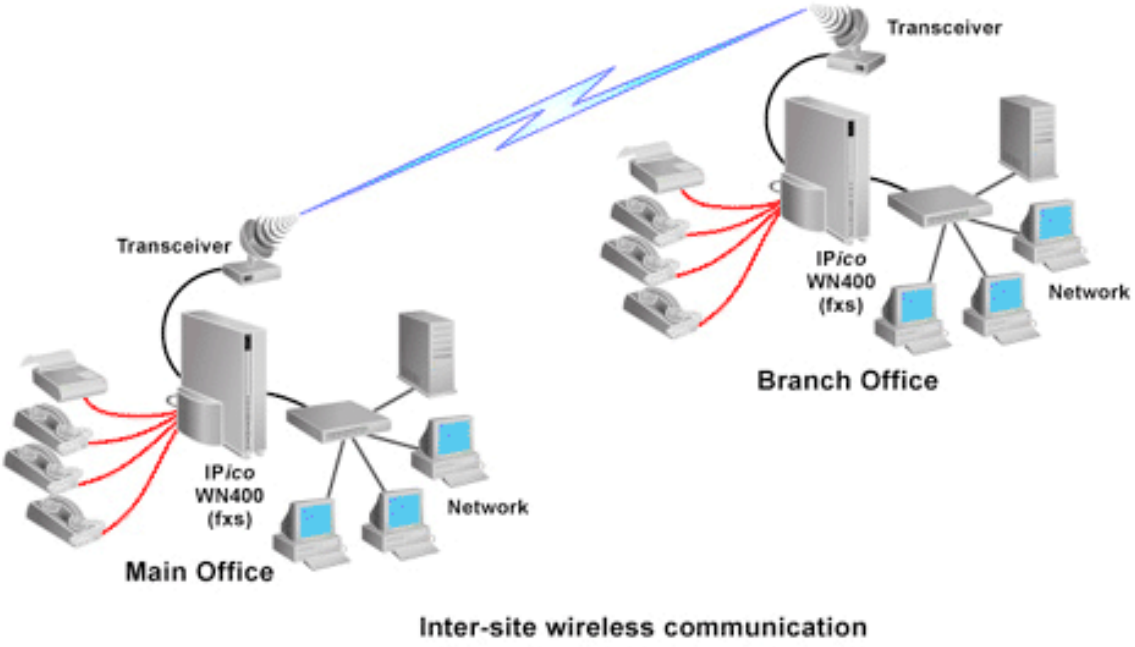
There are also cheaper connections, which will cost less or have less bandwidth. For instance $2000 would bridge a few kilometres (antenna excluded). The costs of a repeater are twice the costs of the equipment for one site. Every repeater will extend the range with an additional 50 Km - if conditions are okay (www.wmux.com).

These types of wireless networks are mostly used to connect networks with each other over longer distances. If longer distances need to be crossed, a repeater or satellite techniques are used. The choice for a certain technique will depend on costs per bandwidth. These costs will be influenced by terrain, distance, needed bandwidth and other factors (http://www.idrc.ca/acacia/03866/wireless/part4.htm). In developing countries these lines are much quicker and more cheaply installed than traditional wires. A disadvantage is that highly skilled, costly technicians are needed to perform a site review and to set up the equipment.

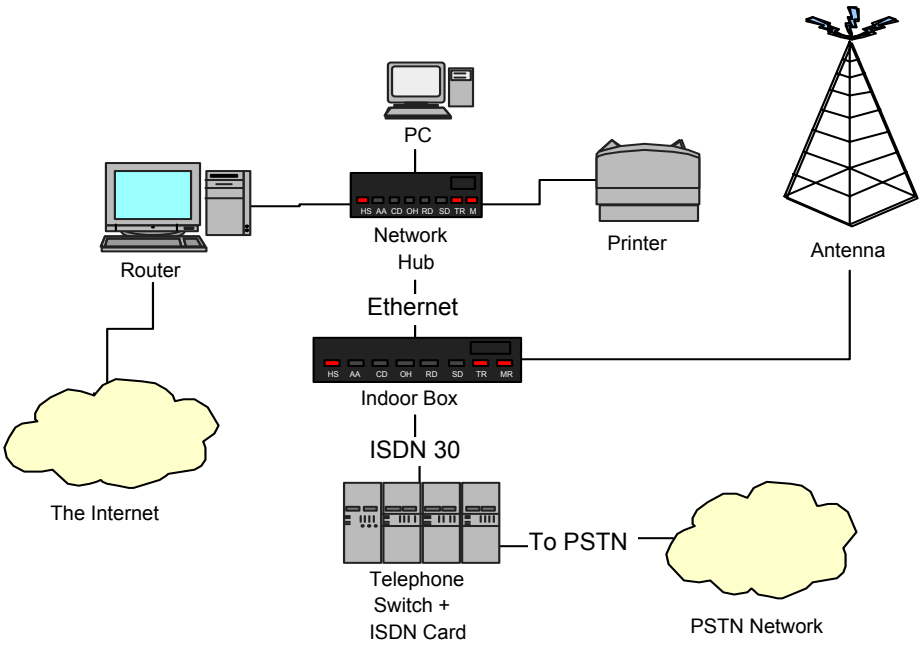
Wireless networks using the 2,4 GHz – 5.8 GHz band (license free) are used for:

- Data transfer. For longer distances (until 50 Km) 2 Mb used to be the minimum but 10 Mb lines are almost the same price today. 100 Mb or more is also possible. The data can consist of file transfer, e-mail, Web surfing etc. Since 10BaseT (a standard for Ethernet) is used, the link will act as a normal 10 or 100 Mb Ethernet line.
- Options for speech. A part of the bandwidth can be used for an ISDN 30 line taking 2 Mb (called an E1 line). Optionally, 2 ISDN 30 can be used. These are good quality lines for general ISDN use. A telephone switch at one site is needed. At the other site a “card” is needed to plug into an existing switch. An example is the Panasonic KX-TD1232 (http://www.prodcat.panasonic.com/shop/templates/square_template.asp?ModelId=2763&show_all=false&product_exists=True&active=1). A hybrid (both digital and analogue phones can be connected) ISDN PABX with E1 card (to connect to Wireless Local Loop) will cost around $5500. Standard 16 phones can be connected. An expansion for 8 phones costs around $400. Analogue phones are available from $25. Also faxes etc can be connected. A digital phone will cost around $175. Standard, 8 outgoing lines are provided but more can be added. The E1 port at the other site of the link needs to be connected to an E1, which can be plugged in the PABX at the other end of the link. Depending on the switch, these cards cost from $2500 until $8000 or more.
- Voice over the Internet (Voice over IP). The disadvantage is mostly the latency of the signal. But in a wireless network, the bandwidth can be allocated for Voice over IP thus giving good quality. Today special boxes are offered for $2,500 that can connect 4 analogue telephone lines over a wireless network. On the other site such a box is also needed where 4 analogue lines are the output. The advantage is that you can start small and easy and expand if needed because more boxes can be added. One line will use 9Kb so a lot of lines can be squeezed into a, for instance, 2 Mb line.

Example of Voice over IP boxes for 4 analogue lines
(http://www.lucidvoice.com/cnt_products_ln-400.html)

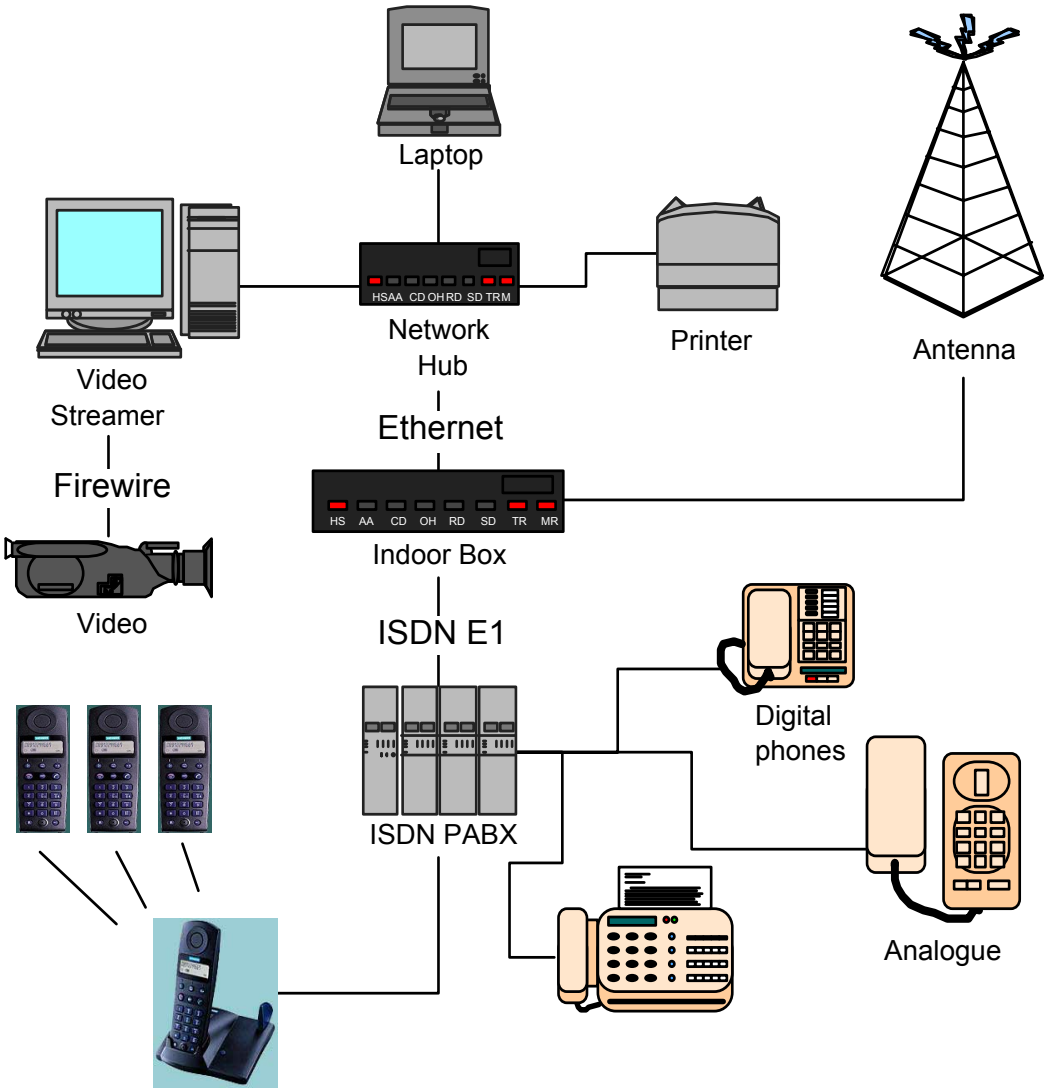


The picture below illustrates how a local network is connected to a fixed WAN (Wide Area Network) with a wireless connection in between the two networks.



Main office with Internet access and PSTN access.

This figure shows a typical set-up at the site of the link where for instance the Internet access is available. The antenna will send a signal to another antenna (below). In the centre, the indoor box is shown which connects to the outdoor antenna and to the ISDN and Ethernet network. A network Hub divides the Ethernet network to different client. One of these clients is a computer or box that can be used as a Router to another network like the Internet.



Remote site with ISDN equipment and video

This network is connected to the central office over, for instance a distance of 40 Km and a bandwidth of 10 Mb. In this picture an example is given how to send video (or TV programmes) over the network. The (digital) video can be sent over the network as a file.

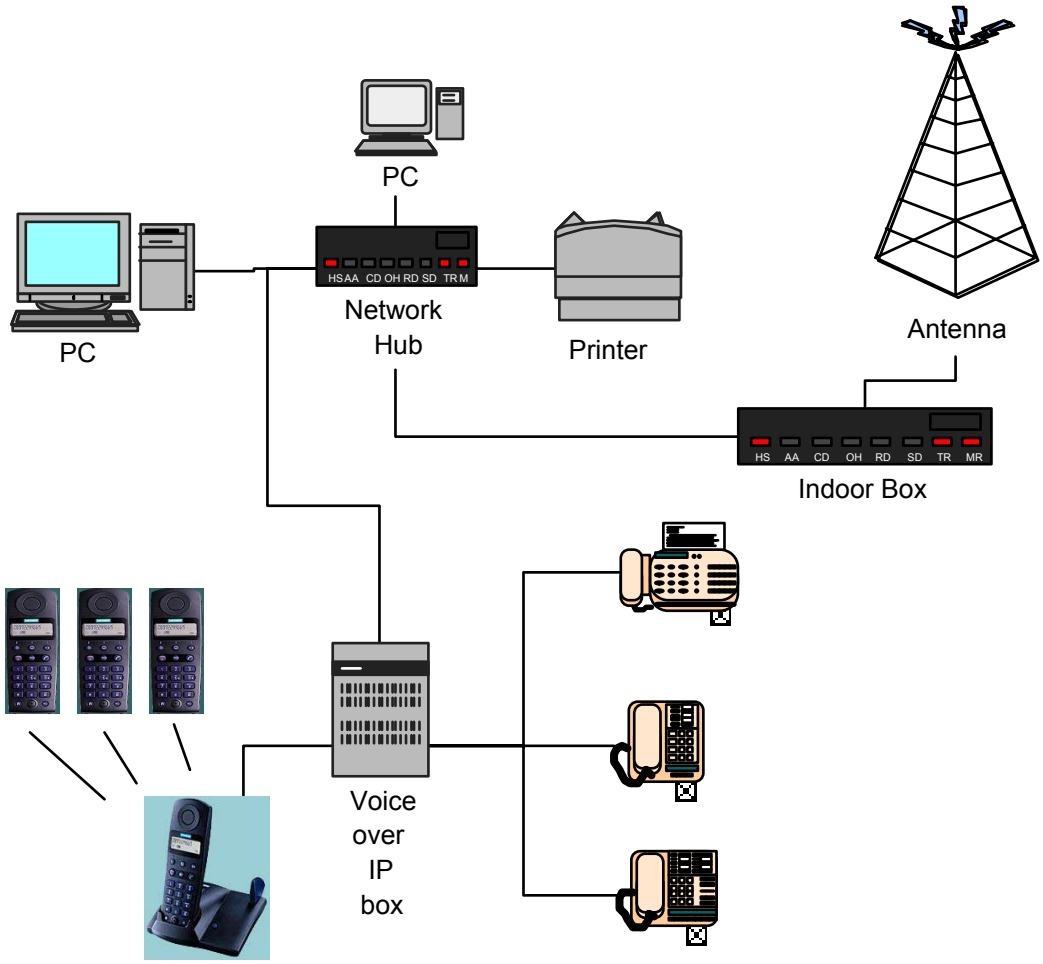
Another technique is to use Video Streaming software to broadcast live over the network (http://www.realnetworks.com/promos/ra8/starterkit.html?src=010509realhome&mcc=rlhmpg). In fact all applications present on the Web these days can be used over this network. One could view such a network as a small version of the Internet (or Intranet/Extranet). Also audio (or radio

programmes) can be sent over the network using either Internet based streaming techniques or other broadcasting techniques (http://www.dalet.com/title_118.html).

It may be clear that the video/audio streams can also be used to broadcast from a central point to a remote area. Governments could use these techniques to reach areas that could not be reached before with traditional audio and video broadcast.

The ISDN switch connects to the ISDN 30 line. Phone, faxes and other analogue or digital equipment can be connected to the switch.

When using Voice over IP (VOIP), the configuration could look like this:



In this example a voice over IP box with 4 lines is used. A Siemens Gigaset (http://www.siemens.nl/mysiemens/homeandoffice/gigaset3010classic.htm) base station with 4 wireless handsets is connected to one line. A fax and pay phones are connected to the other lines. Also a cheap analogue switch can be connected to one of the VOIP box lines. This box can produce billing reports, encrypts the information, etc. On the other site of the wireless link, a VOIP box is also used with 4 analogue output lines, which can be connected to an analogue switch or other existing lines.

International Connections

Satellite connections are needed when the distance to cross is too long or where there is no fixed place to put a transceiver. Satellite links can range from low bandwidth cellular telephones to high bandwidth dishes that connect a certain area with a data or telephone network. A satellite connection is more expensive in most cases, but can be economic in specific cases.

Some examples are:

- The Iridium satellite network (http://www.iridium.com/) offers telephone (handheld) connection at any location. Data transfer is possible at a speed of 2.4 K. (by the end of 2001, 10K will be available).

- The Inmarsat satellite network (http://www.inmarsat.com) offers telephone connection at any location. A 64K data connection is available, costing around $16.000 for the handset and $7 per minute.

- VSAT techniques are used to communicate with satellites. A dish needs to be pointed at the satellite. Any desired bandwidth can be required. Example: http://www.gilat.com/gilat/. http://www.carrier2carrier.com/

MORE RESOURCES

- The Wireless Toolbox; the “must read” by Mike Jensen: http://www.idrc.ca/acacia/03866/wireless/

- Check out this list for equipment manufacturers and service providers, including local suppliers, etc.: http://www.idrc.ca/acacia/03866/wireless/part6.html

- Also new techniques have been developed since the report of Mike Jensen was written: http://www.oreillynet.com/pub/a/308

- Tutorial on wireless networks: http://iec.org/tutorials/wll/

- Practical guide step by step: http://www.reliefweb.int/library/wtint/toc.html

- Books: http://www.idrc.ca/acacia/03866/wireless/

- ZDNet info: http://www.zdnet.com/enterprise/filters/resources/0,10227,6016597,00.html

- Wirelessnewsfactor: http://www.wirelessnewsfactor.com/perl/section/wlsnetw/

- Telecom research: a portal to wireless: http://www.telecomresearch.com

- To stay updated: http://www.commnow.com/wirelessnow.html

- About transmitters: http://www.transmitter.org

- Radiolan, just one of the many: http://www.radiolan.com

- Telecom glossary 2000: http://www.its.bldrdoc.gov/projects/t1glossary2000/

- Mike Jensen’s glossary: http://www.idrc.ca/acacia/03866/wireless/part7.htm

IICD PROFILE

The International Institute for Communication and Development (IICD) assists developing countries to realise sustainable development by harnessing the potential of information and communication technologies (ICTs). The driving force behind IICD activities is that local 'change agents' themselves identify and develop proposals for realistic ICT applications - local ownership forms the essential basis for sustainable socio-economic development.

Acting as a catalyst, IICD's three-pronged strategy is mainly delivered through a series of integrated Country Programmes.

First, IICD facilitates ICT Roundtable Processes in selected developing countries, where local stakeholders identify and formulate ICT-supported policies and projects based on local needs.

Second, working with training partners in each country, Capacity Development activities are organised to develop the skills and other capacities identified by the local partners.

Third, IICD draws on its global network to provide information and advice to its local partners, also fostering local information exchange networks on the use of ICTs for development. The best practices and lessons learned are documented and disseminated internationally through a Knowledge Sharing programme.

In support of these activities, IICD invests in the development of concrete partnerships with public, private and non profit organisations, thus mobilising knowledge and resources needed by IICD and its local partners.

Country Programmes are currently being implemented in Bolivia, Burkina Faso, Ghana, Jamaica, Mali, Tanzania, Uganda and Zambia.