Taxonomy of Tele-Technology

by Earle Beattie, Editor

The information below may be of service to readers who would like a ready guide to technicalities in a rapidly developing field, especially with the interfacing of computers and telecommunications. It was drawn from books, e.g. Instant World (DOC); Beyond Babel; journals such as Search, WACC Journal, Public Telecommunications Review; magazines The Futurist, Smithonian; reports (e.g. LaMarsh Report); press releases from the DOC; newspapers and technical dictionaries, sometimes verbatim.

ANALOG (Analogue) SIGNALS, SYSTEMS: Non-digital high information-rate services, offering the most efficient use of the spectrum, but not having the advantage of digital systems in versatility. Telephone circuits, cable-TV, television and radio are systems using the analog code. There is a continuous flow of signals in a form analogous to what goes in at one end and comes out at the other. Analog signals can be transformed into digital signals by Pulse Code Modulation.

BANDWIDTH: Range of frequencies available. The spectrum of a given electromagnetic system is often referred to as its usable bandwidth. Thus broadband, narrowband. TV needs broadband - in which millions of bits of information are sent out every second to make a picture - while telegraph or telephone need only a very narrowband.

BAUDS: Signalling rate of transmission line. Not the capacity, but signalling rate used in the line. If the line condition represents the presence or absence of one "bit", then the signalling rate is the same as the information rate in "bits" per second. If, however, the line is in one or four possible states, then the line condition represents two bits instead of one. Voice by phone has a low information rate and a maximum bit rate whereas TV has a high information rate with a minimum bit rate of 50M per second. In layman terms, the baud for phone (copper wire) is low as copper does not conduct video very well; they require more information or bits. Videophone requires medium baud, Telex low baud.

BROADBAND: Able to combine voice/video/data services. The number of services that can be provided has been limited by the spectrum capability of the system, the usable bandwidth, the electric signals in analog or digital form, or both. But the extraordinary discovery and development in the last years of "Fibre optics" which can replace electricity by light travelling along thin glass fibres offers enormous two-way capacity for voice, picture and data. Trade-offs of service are no longer necessary, technologically speaking, although they may be economically.

CABLE-TV: (also called CATV - Community Antenna TV). A system of bringing TV signals by coaxial cable into the home. The cable is strung on telephone or telegraph poles with a "drop" from these homes and buildings. A monthly fee is charged by the privately-owned cable companies. TV signals (programs) are received by the cable company from distant points by a high antenna (head end) and relayed to subscribers. Programs are also taken from nearby stations or produced in the cable company studios. - Cable-TV has been area selective and one-way - one company is licensed to serve one area of a city or several areas on several separate systems. The signal is analog or digital or capable of both. The baud rate is high. The distances involved in typical CATV systems are relatively short with trunk lines being about 20 miles in length, using some 50 amplifiers. By comparison, telephone service is point selective, requires highly sophisticated switching; the signal is analog and the transmission is two-way. Its baud rate is high.

The synthesis of a cable telecommunication system involves trade-offs between switching, transmission, distribution and terminal facilities. It is necessary to consider the type of signal processing to be used as this determines whether or not electrical signals should be in analog or digital form and how combined (multiplexed) on cable.

First used in England, 1947. In the U.S. a cable system was started in the state of Pennsylvania in 1950 to bring TV programs to a valley town and thus overcome mountain barriers. In Canada, Rediffusion, Inc., an English firm, built a cable system covering 150,000 homes in Montreal in 1952, the year TV began in Montreal and Toronto. Movies and live programs of its own were carried on a second channel. In London, Ontario, Ed Jarmain erected an antenna in his backyard and caught signals broadcast from Buffalo, Erie, Cleveland, Toledo and Detroit which he made available to his neighbours.

COAXIAL CABLE: Consists of copper wire and polyethylene insulation. The wire rests in the centre of the sheath. The sheath and the wire share the same axis - hence coaxial. Around 1962 the first solid aluminium-sheathed coaxial cable was introduced for TV systems as it formed a good water barrier.

Signals can be carried at high speed above ground or underground. Hybrid combinations of multiple pair wires and coaxial cables carry analog and/or digital signals.

Coaxial cable is called broadband communication because the total range of frequencies is broad. It can carry many phone conversations as well as radio and TV signals and data -- all going along together on carrier waves. TV is a broadband glutton - one channel is equal to 600 to 1,200 circuits of telephone. Computers sending data to other computers, take a bandwidth equivalent to about 12 phone circuits. One phone call needs a bandwidth of only 4,000 cycles a second. A pic-
t urephone takes a bandwidth equal to 300 tele-
phone calls by voice only.

**DIODE**: A two-electrode electronic tube or valve
containing an anode and a cathode. Fibre optics
can carry diode-emitting light as well as lasers.

**DIRECT BROADCAST SATELLITE**: Powerful satellites
of the Hermes order will make possible the relay
of signals from earth to satellites to home, es-
pecially as antennas as small as one meter in
diameter are being built for individual home use.

**ELECTROMAGNETIC SPECTRUM**: Electromagnetic radia-
tion is radiant energy resulting from acceleration
of an electron or other charged particle. The
existence of an electromagnetic field or frequency
spectrum was developed mathematically by James
Maxwell, a Scottish physicist, in 1864. He con-
cluded that electricity and magnetic energy travel
in transverse waves. In 1888 Heinrich Hertz, Ger-
man physicist, confirmed Maxwell's electromagnetic
theory and produced electromagnetic waves, showing
that they were long, transverse waves that travel
at the speed of light, can be reflected, refracted
and polarized like light. They are characterized
by wavelength - the distance between one peak
and the next - or by frequency - the number of peaks
that pass a given point in a given time. Frequency
used to be stated in terms of cycles per second,
but now is stated (measured) in hertz, or one
cycle a second. The propagation characteristics
of the spectrum change with the frequency so that
some parts of the spectrum are better suited to
certain purposes than others. At the lower end
the radio waves tend to follow the curvature of
the earth and are useful for reliable long-range
communication through relay stations. In the
medium and high frequency ranges, advantage is
taken of the fact that these waves are reflected
from the ionosphere and so used for long distance,
but less reliable, radio communication and inter-
national broadcasting (short wave).

As an invisible and natural resource the radio
spectrum is capable of infinite renewal and exists
only when it is used. The radio spectrum lies at
the lower end of a continuum of electromagnetic
radiations that extend upwards in frequency from
the longest known radio waves to the shortest cos-
mic rays. Radio (and TV) have added mobility to
message-making and provided millions of people
with easy access to mass entertainment, information
and education. Millions of transmitters around the
world constantly flood our atmosphere with electro-
magnetic radiation, superimposed with voice, music
image and data. Allocating of the spectrum in
Canada and throughout the world has been accom-
plished by dividing it into bands and allotting
them to common types of systems.

Radar, invented in 1924, at first used very long
waves - about 30 feet - until 1939 when a newly
invented oscillator produced powerful and very
short waves (half-inch). This meant an entirely
new portion of the radio spectrum was opened up:
the band of microwaves that lie above the waves of
Ultra High Frequency, waves that could be made
into beams that point accurately at their destina-
tion. A long wave bends around corners, short
waves only travelled in straight lines until the
advent of waveguides and laser light transmission
by fibre optics. Electromagnetic radiation extends
upwards in frequency from the longest known radio
waves to the shortest cosmic rays. On-air tele-
vision consumes 49% of the radio spectrum below
1 GHz.

The possibility of communication by such waves was
demonstrated by Marconi in 1895 with radio tele-
graphy in Morse Code. The transmission of speech,
however, was accomplished in 1900 by Reginald Fes-
senden, a Canadian working in the U.S.A., using
two 50-foot towers on Cobb Island in the Potomac
River, near Washington. It was the world's first
broadcast of a human voice. Speech and music
began with the invention of the diode rectifier
in 1904 and the triode amplifier tube by Lee de
Forest in 1906. That year, Fessenden broadcast to
the crews of freighters in the Caribbean and
Atlantic.

The basic function of a radio transmitter is to
emit from its antenna a magnetic field capable of
inducing a voltage in any receiving antenna within
its area of radiation. This is done in several
stages, beginning with an oscillation circuit which
generates a voltage of radio frequency (called the
carrier wave or carrier frequency). The Oscillator
output is then amplified and combined with the
amplified auto-frequency signal produced initially
at the microphone. **Amplitude Modulation (AM)**
and **Frequency Modulation (FM)** are the two practical
methods of effecting this combination. The final
amplifier delivers the modulated carrier to the
antenna where the energy is radiated as a magnetic
field. Bursts of electric current in the form of
oscillations (up and down movements made in one
second) are fed into an aerial. The faster they
go the more there are (higher frequencies).

The vast telecommunications networks have been built up around systems using electric current flowing through metal conductors, or radio signals propagated through air or through coaxial cable. But ever since the discovery, 100 years ago, that light was but another part of the same electromagnetic spectrum that includes radio emissions, scientists have dreamed of new ways to communicate. A great leap forward came with the discovery of a practical way to use ordinary silicon sand made into glass fibres called fibre optics to transport laser light.

Fibre Optics (also called Optical Fibres): Hair-thin glass fibres made from silicon (sand base) and carrying signals on laser light rather than electricity. The frequency of laser light is about one thousand times that of the high-frequency microwaves with the quantity of information being a function of frequency. (Fibre optics can carry diode emitting light as well as laser light.) It is the newest development in telecommunications transmission and delivery.

The advantages of fibre optics over coaxial cable are wider bandwidths, smaller diameters (one fifth the diameter of a human hair) lower weight, lack of crosstalk, immunity to inductive interference and the ability to deliver many more signals at much lower cost. The early 1980's is seen as a possible implementation date. The silicon fibres in experimental use have used a thin plastic sheath. Ten thousand times more information can be carried through a single fibre than on copper wire or in layman terms 1,000 two-way voice channels plus some 200 or more TV signals.

Thus the phenomenal capacity of fibre optics can bring two-way or retrieval communications, especially when linked to computers, including as now telephone, but extending to videophone, radio and TV programs, videotex units, (Telidon), tele-teaching, teleconferencing, facsimile newspaper delivery, magazine and journal service, electronic mail, polling, debates on political, economic and social issues, library information with book and document printouts, indexes, price comparisons, real estate and housing information, fire and burglary alarms, court reports, index of social services, counselling, employment information, person to doctor to pharmacy to person prescription service, meal planning and menus, medical and ambulance service, health care, appointments, prevention centres, weather reports and disaster warnings, operation of household services such as turning on and off the lights, horticultural and agricultural aids, banking, shopping, games, catalogues, travel information, traffic monitoring, maps, recreation information, encyclopedias and “yellow-page” service, stock market data and innumerable lists. Some of these are already supplied by cable-TV with use of the converter.

The information capacity of a simple light beam is many times that of a radio signal. Line of sight paths have been required in the past for transmission but, recently, satellite relay has decreased the dependency on microwave lower relay.

Experiments in fibre optic use for telephone, radio, TV and data transmission are being conducted at present in Yorkville (Toronto), and Elie, Manitoba.

FREQUENCY: Oscillations of waves or a “signal”, now expressed in Hertz power, formerly described in cycles per second which meant that a given signal emanates as a wave that “vibrates” so many times a second. In Audio the note A to which orchestra tuning has a frequency of 440 Hertz or is also expressed as 440 cycles. A very small change of wave length in the ultra-short wave part of the spectrum results in a huge change in frequency.

Frequencies may roughly be divided by - High: Toward upper end of electromagnetic field. (Based specifically on radio frequencies in the range of 3 Mhz to 30 Mhz.) Low: between 30 KHz and 300 KHz corresponding to the long wave range.

General Radio Service: Citizen's Band - CB - is a U.S. term, installed in cars and trucks and in some homes, mobile radio (not to be confused with “ham radio”, which has been long in use by amateur operators in private homes) takes up many channels, CR or CB is two-way. The spectrum has already become overcrowded in some cities due to the popularity of mobile radio. In 1979 over 1,000,000 CR and amateur licenses were in force in Canada. Some 50 were for land mobile services -- taxis, police, municipal services, delivery companies, etc., until in some areas (southwestern Ontario) it is at or near the saturation point. They are used by close to 2 million Canadians. Microprocessors may well transform telecommunications and permit significant improvements in mobile radio systems. They increase capacity, make selective signalling more reliable and improve frequency stability and audio quality.

Hertz-Measured Waves: Radio waves are characterized according to their frequency and corresponding wave length. They are expressed in frequency, in cycles per second, or Hertz (called after Heinrich Rudolph Hertz, (1857-94) German Physicist, who confirmed J.C. Maxwell's electromagnetic theory and produced radio waves in the course of experiments to show that, inter alia, they travel at the speed of light). A kilohertz (KHz) is 1,000 cycles per second; a megahertz (MHz) is 1,000 kilohertz; a gigahertz (GHz) 1,000 megahertz and a terahertz (THz) 1,000 gigahertz. Although the radio spectrum ranges up to 3 THz, technological and economic factors limit useful availability to its lower end.

Holography: A Greek word meaning “the whole message” in which laser light and cameras with no lenses create a 3-dimensional image on film or plate. It is like the object itself, life-like, especially a coloured hologram as it seems solid with front, side and back (yet it is only light). A hologram is the record of the pattern produced when two light beams “collide”. The laser is optically divided into two beams, one being aimed at

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the object being holographed which is reflected in all directions, and the other called a "reference" beam reflected from a mirror to the same photographic plate where its wave fronts are superposed on those from the object. The light must be coherent, that is of a single wavelength. Since the two parts of the laser beam arriving at the film or photographic plate have travelled by different paths and are no longer necessarily coherent, they create an interference pattern, but this will not occur if there is vibration. Then the film is developed. This is recorded in the form of points of varying density. "Interference" then is the basis of holography.

The pattern on the film is a record of the waves as they are reflected from the object recorded with the aid of the reference beam. This holograph is later illuminated with coherent light of the same frequency used to form it and a 3-D image of the object is produced known as a wave front reconstruction. Since waves from all part of the object are recorded on all parts of the hologram, any part of the hologram, no matter how small, can be used to reproduce the entire image. Conventional holographs use low power laser light, mostly Helium Neon. Holograms can provide a hundred times greater brightness range than ordinary photographs. Pulsed rather than steady laser light is needed. Photographic holography does not produce an emulation that records a recognizable image but a reflected pattern of light waves radiated from the object. This is the "wave front" which later can be reconstructed by the laser light to present a 3-dimensional image. Unlike conventional photography, the hologram conveys a virtual in-depth image which records information on all aspects of the original. Any one piece of the hologram contains all the information about the original and appears as many tiny images. "If a picture is worth a thousand words, a hologram is worth a thousand pictures."

3-D film challenged filmmakers for some time, emerging in the U.S.A., the USSR and Europe in the 1950's. The 3-D films in movie houses were not really 3-dimensional but an "optical illusion" of a special sort. The concept and initial discovery of holography was introduced in 1947 by Dr. Dennis Gabor and published in 1958. He received a Nobel Prize for this in 1971. Gabor did not have a laser and so used a more rudimentary source of coherent light in the later 40's by means of filters. They were not holograms as we know them today. The first came in 1960 with the invention of the laser at M.I.T. by T.H. Maiman and the first hologram was produced at the University of Michigan. Leth and Upantnieks applied laser light to Gabor's discovery and recorded holograms that produced highly realistic images of 3-D objects.

Shooting Holographic motion pictures with coherent light requires a powerful pulsed laser in three wavelengths (red, green and blue). Colour, motion and 360° viewing have been developed.

Once a holographic film is made the problem of transmission arises which can be done by fibre optics and lasers in combination. Pulse rather than steady laser light is needed here too.

Practical uses have begun and envisioned for the future are uses in advertising such as showing the new fall cars displayed in full size and color on the wall and family pictures with the group in 3-dimensions. Present use is in microcopy and interferometry.

The present TV sets with box-shaped cabinets don't lend themselves to holography. A holographic set would likely be a cylinder powered by a tiny laser. Scenes or people could be viewed from any angle as with ordinary vision.

INFORMATION THEORY: also known as the Mathematical Theory of Communication. This was a construct by Claude Shannon, engineer for Bell Telephone, to define the basic elements of information and the flow, capacity and force of analog signals in the telephone line as well as the "noise" impedance. His binary digital (byte) code made it possible to use pulse-code modulation and eliminated barriers between "different" kinds of communications - voice, video and data - which were to be jumbled together in transmission. Digital code can transfer into analog signals and employ Pulse Code Modulation which allows for the interleaving of several thousands of signals. They are then decoded into the original analog form at the receiving end.

Shannon's Information Theory has been used as a basic design by communication scholars in theorizing on the process of information or communication. The theory embraces every conceivable mode of communication interpersonal, print, electronic - with a sender or senders at one end and the receivers or "destination" at the other. Mechanical and semantic or psychological noise is in between. Feedback, inferred or actual, is postulated. Many view this "communication process" model as "mechanistic" and linear, not representing the phenomenon of communication in a dynamic way. Shannon's work remains a benchmark.

LASER: Acronym for Light Amplitude Stimulation Emission Radiation. The higher you go in the radio spectrum, the smaller the waves and the more bandwidth there is. Above microwaves are even shorter waves called millimeter waves and beyond these are the waves of light. The frequency of light is about 1,000 times that the highest-frequency microwave links of today and the quantity of information correspondingly increases. The pursuit of ordinary light as a transmission medium was held back many years by the fact that it tends to be dispersed in the atmosphere by rain, cloud or smoke. A scientific advance came in a few years ago with optical waveguides consisting of hollow glass tubes below ground. Lasers are also developed to produce holography, a form of 3-D photography. They currently have many uses - cloth cutting, reading of videodisc, aircraft shins, power stations, medical operations. Laser technology and development was built on Einstein's
calculations on light behaviour and developed from the Maser.

MASER: A crystal concerned with overcoming "noise", a word used in communications to describe any unwanted interference. Noise in telegraph and telephone, whether by line or radio, can come from a number of sources, e.g. amplifiers or repeaters in a cable. Even the flow of electrons in a wire can cause "noise" and great deal of research goes into designing electronic apparatus that will keep the signal to noise ratio at a satisfactory level. One such instrument is the maser. This is a crystal that can be "pumped up" with microwave energy by an electro magnet in which state it can receive a very weak signal and give out an enormously amplified replica. The maser is very silent in proportion to the amplification it gives and it can be made even more silent by keeping it at a very low temperature (about 268° C.) in a bath of liquid helium. The maser enables a radio telescope to amplify feeble signals from outer space. The weak incoming signals take energy from the crystal atoms of the maser and emerge amplified. The maser is a forerunner of the laser which operates at light frequencies.

MICRO-ELECTRONIC COMPONENTS: Small or very tiny parts of electronic circuits or units used in computers or in the telecommunication processes, ranging from the transistor, integrated circuit and microprocessor to the microcomputer itself. All four came into use over the past three decades. This revolution of faster, cheaper, lighter, more durable and more reliable electronic materials began in 1948 when Bell Labs announced that three of its researchers had invented the TRANSISTOR to replace the vacuum tube as a device capable of amplifying electric current. The transistor was an active semi-conductor with three or more electrodes. The semi-conductor is an electrical conductor whose resistance, unlike that of metals, decreases with rising temperature and the presence of impurities. The transistor has resulted in an explosive development of solid-state technology. By 1958 it was possible to make transistors so tiny that enough could be combined on a small chip of silicon to make a complete circuit. Hundreds of complete circuits could be pressed together in a chip of material the size of a shirt button. The heat problem of the old vacuum tube was solved and current could be reduced to a level that could be handled by a light amplified replica. Consequently, computers could be made much smaller and lighter and as a result it was possible to launch a satellite.

Bell Labs were also responsible for the INTEGRATED CIRCUIT (IC) which was introduced in 1959, another step in the miniaturization process. IC provided a logic network embedded in silicon, ceramic or other material which concentrated the equivalent of several thousand transistors on a single chip only three by four millimeters in size, but all of which made one circuit. At the present time, 20,000 or more miniatured components can easily be put on a chip that sells for $20; the price of the function performed by a transistor dropped 99.3% from 1960 to 1960 and is still declining.

Of great importance was the next step, the MICROPROCESSOR, a general-purpose device. It was developed by Intel Corp., in 1971 for a Japanese manufacturer who wanted it for a small mass-produced calculator. The tiny, powerful, silicon-based semi-conductor resulted. The microprocessor is not a computer, but a computer's logic instrument. Three more sections are needed to make a computer: a memory containing basic instructions, such as how to multiply and divide; a memory to store new instructions and results; and an input/output unit. At first even with the large-scale integration of tens of thousands of individual electronic devices: transistors, diodes, resistors and capacitors on a chip, each section required its own electronic chip or series of chips. Now all four were packed into a minute piece of silicon to help run a TV set, a telephone switching system, teletext machine, an oven or a car. It takes over the function of entire shelves of coils, relays, vacuum tubes and other bulky mechanical gear.

The microprocessor replaced anywhere from ten to two hundred IC chips. It belongs to a class of devices known as large-scale integrated circuits (LSI) and very close to being the ultimate semi-conductor component. A single microprocessor chip can be mass produced and adapted to a multitude of applications.

Add a memory to the microprocessor and you have the MICROCOMPUTER. It performs the control and processing functions of a full-size computer, using microscopic electronic networks that include memories and circuits for input and output of signals. It can handle instructions, decoding, execution, sequencing and control as well as assimilating and generating data. It is slower than the suitcase-sized minicomputer, the next stage above it in today's computer hierarchy, but it can be mass-produced at a fraction of the cost. It is sparking a revolution in telecommunications system design, achieving a new breakthrough in system miniaturization and flexibility.

MICROWAVES: Small radio waves at the upper end of the electromagnetic spectrum, capable of carrying much information. They do not interfere with radio waves low in the spectrum. Techniques developed in the 1940's an essential step in the development of a communications satellites were microwaves which partly released phone networks from their earth carrying imperative of poles. Still, thousands of phone conversation between cities make use of relay towers in line of sight from each other. Satellites were the next step and "direct satellite to home" will complete the development.

MICROWAVE TOWER: Dish-shaped antenna on microwave towers now catch the broadcast radio waves, or telephone signals, strengthen them and pass them on to the ground stations which in turn are linked to homes. They doubtless will be replaced in time by small dish-antennas on the roofs of dwellings, much like the old radio aerials, and
are now being augmented or replaced by communica-
tion satellites which boost and relay signals.

MULTIPLEXING: Word used in electromagnetic trans-
misson to name an operation whereby various sig-
als can be sent along on the same channel without
interfering with each other: conversation by
phone, pictures, data such as print-outs, radio
and TV signals. There are two types of multi-
plexing - frequency division (side by side con-
stituting one wide band and time division where
the signals are sent sequentially. Time division
means compressing information.)

A hundred conversations are fed into one wire
through a very high speed electronic switch. The
current corresponding to each speaker's voice is
chopped by the switch into bursts (pulses) lasting
a millionth of a second at intervals of one ten-
thousandth of a second. Another switch at the
receiving end sorts out these brief portions of
speech current. Each listener thinks he is hear-
ing an unchanged voice, whereas in fact he is
getting only a series of brief samples. To him
it is as good as the complete message, just as a
series of 24 still pictures thrown onto a screen
in one second appears to be a moving picture.
The mind and perception by the eye, or the mind
and ear in this case makes it so. Another tech-
nique (frequency division multiplexing) rests on
the discovery that human speech consists of a
complex mixture of sounds that vary from a low
frequency of 50 vibrations or cycles per second
to a high of 5,000 cycles per second. But if we
pick up speech sounds on a telephone circuit that
responds to frequencies between 300 and 3,000 and
deliver them to a receiver, the result is perfect-
ly intelligible even though some of the quality
is lost. We can put up with the loss in ordinary
information (conversation) whereas in dramatic
speech (plays) requiring nuances and timing this
loss would detract too much from quality. The
telephone engineer thus is able to compress more
conversations into one line because a narrower
band of frequencies takes up less room in the
transmission system.

NETWORKS (Broadcasting): Term for the linking of
radio (AM and FM) stations and TV stations to
cover areas of a country or the whole nation, at
first by electric wires, then by microwave and
now by satellite. Canada's first Broadcasting Act
was passed by Parliament on May 26, 1932, provided
for a mixed system of powerful central stations
owned and operated by the Canadian Radio Broad-
casting Company (named the Canadian Broadcasting
Corporation in 1936) and local stations to be
owned and operated by private companies. The
pioneer C.N.R. stations and other broadcasting
ventures (e.g. Manitoba government) came into the
network which was to be supported by taxes and
advertising on a limited scale. A second French-
language network was later added to radio and a
Northern Service with Inuit and other dialects.
The international (short-wave) Service (IS) was
put into service shortly after the war. Two TV
networks, French and English, were started in
1952, making 8 major services, owned and operated
by the CBC, including AM and FM radio and TV and IS.

Colour television came to Canada in 1966. A
private network, CTV, began operations in 1961
with 8 stations and has more than doubled in
affiliates since then.

Provincial services TV-networks have been licensed
in Ontario (O.E.C.A.) an educational network and
Quebec. The Alberta government supports coopera-
tive ownership of cable-TV and Saskatchewan has
a cable cooperative. An Ontario-based network,
Global, has expanded to other parts of the country.
Cable-TV is not networked.

PAY-TV: On June 21, 1979, the CRTC invited appli-
cations for a satellite TV system offering at
least nine channels - including one pay-TV channel.
A public hearing may be held in the fall of 1979.
Pierre Camu, CRTC chairman, said the Commission
acted because some 30 pirate operations already
exist in Canada, taking TV signals from the U.S.
(direct reception from U.S.-satellites) Besides a
Pay-TV channel, the Satellite-TV system, Camu
said, is expected to accommodate CBC French and
English network services, CTV, a channel for
parliamentary sittings, the best of provincial
educational network programs, and perhaps a
children's program channel, one for specials, and
one for TVA (French-language independent network).

Pay-TV has been regarded by many entrepreneurs as
a pot of gold at the end of the electronic rainbow,
but postponed for many years by the government
and opposed by the Canadian Broadcasting League
and others as increasing the attachment to U.S.
entertainment fare and its values. A report in
May, 1979, of the special sovereignty committee,
established by the Department of Communications,
recommended that Pay-TV be permitted in the form
of payment by program rather than a flat fee pay-
ment. The CBC and private broadcasters with a
go-slow policy, the cable companies and Bell tele-
phone are all seeking pay-TV licensing. Pay-TV
promises the worst and possibly the best: mass-
appeal shows, pornoviolent films and high-quality
programs.

PRINTOUT: A computer record of data on paper
rolled out automatically from the machine or
turned out manually. Computer "publication" can
be made on the videoscreen, or on paper. By using
a computer attachment to a modified TV set, you
can use a keyboard and bring a printout from your
set. This information from a central computer
storage may be anything from income tax forms to
your daily newspaper.

PULSE CODE MODULATION: A pulse is an electrical
disturbance of short duration. PCM is the process
by which the essential characteristics of a signal
wave (the modulation wave) are impressed on another
wave (the carrier wave).

The digital code make it possible to obtain the
maximum advantage from a discovery of the 30's --
Pulse Code Modulation. In PCM, instead of sending
the full signal made by the voices in a conversa-
tion, only portions are sent. Samples are taken
of the amplitude of the waves made by the voice.
If they are taken often enough - 8,000 times a
second - enough information about the sound is obtained to enable the listener at the other end to hear what sounds like a full voice (like half-tone screen photos for newspapers, dots in black and grey represent a picture and the human imagination fills in the gaps). The advantage of PCM is that samples of other people's conversations can be inserted in the gaps. Use of the digital code which came later broke down barriers between various kinds of signals (print or electronic) and made possible the jumbling of signals.

PUBLIC BROADCASTING SYSTEM: A non-profit, non-advertising U.S. network of some 275 stations, controlled by universities or other institutions. It is financed by congressional contributions and private donors. A good deal of its revenue by donors comes from Southern Ontario and other parts of Canada where the quality programs, many of them made in the United Kingdom (e.g. Civilization, Upstairs-Downstairs), have a following. PBS signals are picked up, as are commercial network programs, from Canada-U.S. border stations. Two and a half million families contributed $50 million in donations last year to keep individual PBS stations alive.

SATELLITE (COMMUNICATION): Serves essentially in the role of an extremely high antenna (reaching 22,300 miles about the earth) to occupy a commanding position above terrestrial interferences and receive signals sent from earth stations, amplify and relay them back to earth again. The signals are not received directly as yet but through land stations connected to the telephone, radio or TV networks that will distribute them.

In their first uses, they circled the earth in what was called "low orbits" every few hours. This meant that antennas on the ground had to be capable of tracking a moving body, and communication was lost as the satellite passed over the horizon. Also, they had to be very large and complex. The first satellite to attain synchronous orbit was SYNCOM I in 1963 capable of one TV channel or 50 phone circuits for trans-Atlantic messaging and the first synchronous domestic communication satellite was Canada's ANIK A-1, in 1972. It provided 240 two-way voice circuits for telephone, TV service to remote areas of the country. The Anik satellites were designed and built under Telesat contracts: The "A" series in the first half-decade of the 70's with 10 channel capacity: A-1 in 1972, A-2 in 1973, A-3 in 1975. A joint Canadian-American satellite (not a Telesat product) called "CTS Hermes" was launched in 1973 at the Kennedy Space Centre with the two countries sharing it equally on alternate days. Light-weight solar wings unfurled 24 feet across accordion-like after the satellite left the spacecraft. It had a 2-channel capacity only, although it was powerful in transmission.

TELESTAT Canada continued with a "B" series satellite - one only and its fourth to be launched under the Anik name. 3-1 was a hybrid, working in two frequencies - the 6 and 4 gigahertz bands and the 14 and 12 gigahertz band (dual band transponders). It is capable of providing data and video from tele-mail to remote sensing. Telesat now is working on a series of three new satellites called Anik "C" to improve domestic services in the 14 and 12 GHz band. The launch is scheduled for March, 1981, possible by space shuttle (manned flight, earth orbiting and returnable craft). And coming up is Anik D with two satellites in 1982.

Access to satellites was announced by the Canadian government for broadcasters, cable-TV companies and telecommunication common carriers in February 1979. They were also given the right to own and operate receive-only terminals.

TV-Ontario's "Tele-Academy" will lease capacity for interactive courses to feed local cable stations.

By 1961 an international agreement was signed to form International Telecommunications consortium, INTELSAT, for world-wide service. Canada is a member. The first Intelsat satellite was "Early Bird", launched in 1965. It could carry 240 voice channels or one TV channel. At present 95 member nations belong to INTELSAT and their earth stations are located throughout the world. Last summer the European Space Agency put up the OTS-2. Some 10 satellites serve North America - Telesat Canada's Aniks A-1, A-2, A-3, B-1 and the joint U.S.-Canadian satellite "Hermes". RCA's Satcom I and II, Western Union's Westar I and II, AT&T/ G.T.E.'s Comstar I and II. "Parking space" remains for about 75 satellites, according to one source, and for only 20 according to another.

Canada's first satellites - non-communication - for testing the ionosphere and the atmosphere were Alouette I in 1962 and Alouette II in 1965. Then followed the two Isis satellites in 1969 and 1971. Telesat, a government company, was formed in 1969 with the aim of linking the country's 23 million people across the 10 million square kilometres of their country. In 1973 it issued 6,000,001 shares of which 3 million was retained by the Crown, 3 million bought by participating telephone companies (federal and provincial) and one share held by D.A. Golden, Telesat's first president.

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D.O.C. is also refining plans for a major demonstration of both direct-to-community and direct-to-individual home transmission.

Canadian satellites initiated coverage of the Canadian North by television, one-way coverage of which has been variously received by native peoples.

SAT L E T T I S E S ( C O M M U N I C A T I O N ) I N T E R N A T I O N A L : The first Intelsat satellite was the U.S.A.'s "Early Bird". Subsequently, new and more powerful satellites have been launched and 95 nations now belong to Intelsat. Satellites are also operating over the USSR and China, to mention only a few of the leading ones. In May, 1978, Japan launched the Yuri satellite, the first designed for direct home broadcast. It will be used to provide television reception to the northern islands.

Currently there are 26 communications satellites in operation, not including China and the USSR. These figures do not include military and weather satellites. In 1977 the North American Defence Command counted 902 pieces of hardware in the sky including satellites and debris from the space age.

S I N G A L S : An electric or electronic manifestation conveying information or direction at a distance or to a piece of apparatus such as an amplifier.

S I L I C O N : A non-metallic element of sand, used in making transistors and as a base or bed for transistor circuits. It is the chief constituent of fibre optics. Silicon oxide is the chemical substance used in making semi-conductors.

S I L I C O N C H I P : Large numbers of electric circuits can be built into a tiny wafer called a "chip" capable of performing a complete specific function as part of a sub-system such as the adding machine in a computer. The chip is made from silicon, a constituent of sand. Germanium is also used as both are semi-conductors which will conduct electricity only if certain conditions are created.

S L O W - S C A N : The formation of TV pictures on the telephone line which is made of copper wire. It takes about 8 seconds by present methods to television a scene and transmit the signals to another point. The image is thus scanned slowly. Slow scan experiments are performed by Bill Bartlett, Director of the Direct Media Association, from Port Washington, B.C., an artist. A class in "television as a social force" taught by the writer, was slow-scanned in December 1978, from York University TV studio and transmitted to Victoria, B.C., in an interactive exchange with another class. A long distance phone call video-linked the two groups with use of a regular station TV-camera and a computer called a "robot". A second phone line was used for audio in a tele-conferencing way.

S U P E R S T A T I O N : Superstations, so-called, are beginning to make their appearance in the United States. Atlanta superstation WTCG owned by Ted Turner telecasts to three million homes, in 45 states including Alaska, via satellite. There are three other superstations in the U.S. and the development is looked on as a serious challenge to the existing network. They may be ending the monopoly of the networks. Station CHCH-TV is reported by the Globe and Mail to be interested in the Superstation project. Canadians having rooftop dish antennas with portable earth-stations will be able to receive signals from the super-stations directly, bypassing CRTC Canadian restrictions, to select movies, sport events, dramas, spectacles or other fare by inserting a credit card in a box on the TV set, but with no other attachment to his set. Installation of dish antennas are being tested by the federal Communications Department on 100 homes across Canada - mostly in areas not reached by TV and cable - for receiving signals via ANIK. These are from sources that have paid to use ANIK.

T E L E C O M M U N I C A T I O N : Distance signalling using electric energy. Communication of signals, signs, writing, images or sounds of any kind by line, radio or other systems of electric signalling.

Today, the computer is included in the term telecommunications as the functions it performs have now become integral for systems of signalling at a distance.

The present sophistication of telecommunications - telegraph, telephone, radio, TV, cable, computers - is largely due to the use of computers as functional elements in telecommunications and the marriage of these two technologies. It is convenient to consider the system as consisting of four basic parts: 1. Long haul transmission facilities 2. Switching facilities 3. Local distribution facilities, and 4. Terminal facilities. Consideration should be given to the type of signal processing to be used - analog or digital or how they should be combined (multiplexed) on the systems.

Long Haul - coaxial cable or microwave relays that interconnect various other toll offices (telephone) and stations.

Switching and Local distribution - subscribers or those using the service are connected to local switching offices via pairs of copper wires called loops and these local offices are connected to toll offices in telephony. In the case of cable, from source or headend to signal reception point or cable centre. On-air stations, radio or TV, receive microwave signals and send them on by transmission tower. They also originate signals.

Terminals - Antenna, amplifiers, mixers at the headend of cable TV or radio sets, phone sets or teletype units and computers (when data is being sent by the system).

Of course some cable systems have no switching facilities and use only coaxial cable for local distribution. There are no longhaul facilities interconnecting CATA systems. At present electronic signals travel through the telecommunication system in analog form and frequency division.
multiplexing techniques are used to convert them to digital signals or separate them from digital code.

TELEPHONY: A method of communication in which speech or other sounds are converted into electrical or electromagnetic signals and transmitted by wire or radio to a distant point where they are reconverted into the original sound signal.

TELEMEDICINE: Physicians examining and interviewing remote patients via telecommunication, even directing operations performed by less skilled doctors, medical practitioners, or even laymen.

TELEPRINTER, TELETYPING, TELEX: Data or information machines operated electrically to send and/or print out on a roll of paper, either privately or with the use of a number for all those of the line or to certain individuals, or publicly as in the case of national teletypewriter systems. They are carried on telephone or telegraph lines. The teleprinter and the telex machines have keyboards. Tape is often used and the message run through a "black box" decoder that reads out the tape's punched holes. A teletypewriter is a linotype machine connected to the teletype machine which sets type by phone or telegraph wire from the perforations of the tape. Scores of newspapers can be on the same line setting type at the same time, originating from the news agency.

TELEDON: Department of Communications' name for Videotex, adopted internationally as a public, network-based, "interactive" information retrieval service. It was named Telidon in December, 1978, by the federal Department of Communications and proclaimed as a significant technological advance over other videotex systems. The word is from the Greek "tele", an adverb for "far" or "far away" and "idion" which is one of the form of Greek verb "horao", meaning "I saw" or "I perceived". Telidon is a computer device that attaches to an ordinary TV set or to telephone sets to accommodate to information stored in a computer. The user presses buttons on a keypad and the information will appear on the Telidon screen, ranging from recipes for cooking to hotel room vacancies. It is interactive insofar as one person will be able to converse with another who has a Telidon set. A "billion dollar market" has been visualized for Telidon by the Department of Communications. It is said to have moved at this stage beyond Britain's systems called Viewdata or Prestel and France's Titan (Antiope) with much clearer information. The switches are on a screen and overlay text and color and produce images much faster. Prestel is operational now, however, while Telidon is in the field trial stage. Large scale integration in microprocessing may bring the cost of Videotex modules down within reach of the mass at $200 or $300 market. Any written, graphic or tonal material can be transmitted and a light pen can be used to draw lines on a screen.

TRANS-CANADA TELEPHONE SYSTEM (TCTS): A consortium and technical linking of the 8 major telephone companies across Canada - B.C. Tel, Alberta Government Telephones, Sask. Tel, Manitoba Telephone System, Bell Canada, Maritime Telegraph and Telephone, New Brunswick Telephone and Newfoundland Telephone. In 1975 there were 937 systems in existence. Now 16 principal systems operate for 98% of all the phones, leaving the other 921 small systems to service the other 2%. Bell and its subsidiaries is pre-eminent in Canada. East of Manitoba it controls about 95% of all telephones.

TRANSPOUNDER: The four key elements of a communications satellite are the transponder, the antenna, the attitude control system and the power supply. The transporter is a piece of equipment that receives a broadcast from an earth station and re-transmits the message to earth. It works much the same way as the familiar microwave tower. Each transponder operates on a different channel frequency and is capable of handling either one television channel or numerous voice channels. Some satellites carry as many as 24 transponders. Intelsat I had two transponders each 25 MHz wide and each designed for single carrier access. The transponder receives the up-link signal, translates it to a down-link frequency, amplifies it and sends it back to earth. It is effectively the communications "payload". Intelsat II had one transponder of 130 MHz bandwidth which was suitable for multiple access (for use by more than one ground station). Intelsat III had two 225 MHz transponders. In order to bring intermodulation to an acceptable level, the transponder output amplifier has to be operated well below its maximum power. To better control this, Intelsat IV used channelized transponders with a nominal bandwidth of 40 MHz. A total of 12 transponders can be accommodated within a 500 MHz band.

The antenna concentrates the transmitting power primary in one direction exactly as a reflector on a spotlight focuses the energy of a light bulb. The ATS-6 satellite incorporated a 30-foot antenna.

Attitude control systems are required to keep the satellite's antenna always pointed toward its target on earth. Some satellite are spin-stabilized; they use the gyrostat principle to maintain stability in space. Currently the useful life of a satellite is about seven years and the limit is imposed by the amount of fuel it is able to carry to operate its station-keeping equipment.

TRAPDOOR CODES: Where demands for privacy come into conflict with demands for information on cable-TV (e.g. bills, letters), a "trapdoor code" is used by the individual to ensure privacy - a class of coding and decoding that is said to be unbreakable. The codes are a pair of mathematical functions, an encoder and a decoder, each of which is based on a prime factor of a large number, 200 digits or more. Another method is based on the fact that a microprocessor and memory can now be put on a single chip in such a way that the resulting microcomputer can perform a task without making it possible for anyone to read its memory or get its data or programs out. This will make
it possible to provide software stored in a "read-only" memory (ROM) on such a chip, which can be used but not copied.

**TWO-WAY TELEVISION:** A term now used videotex and telidon for access to a central computer and the read-out of information stored there, whether it is in print or graphics, plus the possibility of introducing lines of a screen with a "light pen". There is as yet no genuine communication between sender and receiver spontaneously in real time.

**VIDEOPHONES:** Electro-mechanical and photo-electric systems which involve a stylus touching a groove like audio records, recording sound and picture. A rigid or floppy disc is used and laser directed onto the track is reflected back along the light track. A new audience and new content besides movies, operas, pornography and various spectacles is expected for this new medium up to 30 minutes of TV programming or the equivalent in data. Not to be confused with a video recorder.

**VIDEO DISPLAY TERMINAL:** A cathode ray tube lighted up with print or graphics and linked to a computer. In some newspaper offices and the Canadian Press news stories are punched on computer keyboard terminals, sent for storage in the computer displayed on the VDT, when requested, then corrected or edited with paragraphs sometimes inserted and additions made. The finally approved story is stored again in the computer and at the required moment is brought out again to be set in "Cold type" (photographically in characters) for printing for an offset press.

**VIDEO HOME COMMUNICATION:** A TV unit and a computer unit in the home, also called a Home Communicator or Console which presupposes a Wired City operation or at least a community computer in which information of all kinds is stored. The user can call up books or documents, TV or radio programs, newspapers and data, including library information or an electronic library printout, by pressing buttons or using a keyboard. "Telidon" is along these lines.

**VIDEOTAPE:** Tape in various-sized diameters that records voice and picture by video camera to be played back on home units or publicly. A videotape camera, recorder and playback unit constituted a virtual revolution in lightweight technology in the 60's as well as production of short and inexpensive movies on tape for home and cinema and for social or activist use. An example was the Challenge for Change series by the National Film Board which pioneered "the Fogo process" starting with social reforms for Fogo Island, Newfoundland using portable Video Tape Recorders as catalysts of action and for bringing people together. VTR St. Jacques was notable.

**VIDEOTEX:** See Telidon

**VISTA:** Bell Canada's experimental electronic information system developed by Bell-Northern. A version of Britain's Viewdata that would use the existing telephone network and link users with a computer and a modified TV set which displays text and graphic information. Bell has 25 terminals in a one-year test in Toronto, Ottawa and Montreal for which 2,000 pages of information have been developed by Telstar Corp. (The Toronto Star's parent corporation), and Southam Inc. and Tele-Direct a Bell subsidiary. Information that can be retrieved by Vista includes current events, travel schedules, income tax advice and shopping guides. The Globe and Mail has also been developing a system for two-way TV by establishing an on-line computer service called Info Globe that contains the entire text of the Globe from November, 1977 to date. The Globe is looking for an inexpensive home terminal. The intent is to turn TV screens into a family newspaper, library, calculator and game board. The Bell-Torstar-Southam trio was the headline in a February issue of the Star. Initially 25 user terminals will be dedicated to the pilot demonstration. Up to 10 different users can be connected simultaneously to the database.

**WAVEGUIDES:** Tubes or sheathing installed below ground to transmit light waves so short they cannot go through the air as they would be soaked up by clouds and cannot be confined in coaxial cable without dispersing. Early laser experiments with glass fibres revealed a fantastic communications capacity with bundles of fibres, no thicker than a human finger. The fibre had a glass core which carried the light waves and a glass cladding with a low reflection index that reflected light back into the core. Fibres when first used had great losses of signal strength (hundreds of decibels per kilometre) and were used only for linking light from a single bulb to various points on an automobile dashboard for a few feet. This loss figure was later brought down to 2 decibels per km. They may open up vast reaches of the spectrum above the microwave. One of the chief problems was the problem of rounding corners as they hit the rides of the tube. A system consisting of metal tubes or dielectric rods or tubes or single wire for transmission of electromagnetic energy by a wave. In essence, a system of material boundaries guiding a wave.

**WIRED CITY, WIRED NATION:** A city or nation with a sophisticated telecommunications system provides a great number of services by wire - copper, coaxial cable and perhaps soon optical fibres - for telephone, radio, television and data of all kinds.

**XWA:** Call letter of the Marconi station in Montreal, forerunner of CFCF, which is said to be North America's first continuously broadcasting station. It was 1919. A counter claim is made by a Pittsburgh station with a starting date of 1920.