

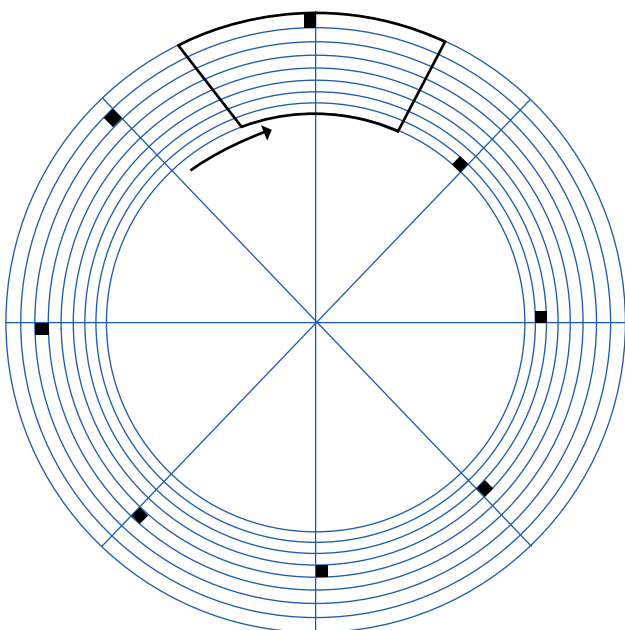


# Television then and now

The ubiquitous television has remained remarkably unchanged since the time it arrived and transformed homes.

**A**ccording to recent figures, 6 million households in Malaysia have TV of some kind, or 95% penetration. There were an estimated 1.43 billion households with analogue or digital TV of all types worldwide as of the end of 2008, which would be almost 100% penetration of the estimated 6.7 billion persons at about that time.

TV is 126 years old and comprises a complex combination of the works of many inventors and engineers in several countries who designed and developed many of its parts over that long period.



 Nipkow disk (Source: Wikipedia)

Until today, TV pictures which we see on our traditional cathode ray tube (CRT) TV screen and more modern plasma and liquid crystal displays (LCDs) still involve the slicing up – or rasterisation - of parts of an image as seen by the camera into multiple parallel lines, the conversion of the light intensity at points in the line into corresponding electrical voltage levels, the transmission of these voltages over wires or as modulated radio frequencies to a receiver which converts the voltages back into varying light intensities and the reproduction of a facsimile of the original image on a display surface.

Early development efforts of TV took two paths. First was the combination of mechanical and electronic principles and second came the all-electronic TV.

## Mechanical TV

Modern TV systems have their roots in the discovery of the photoconductivity of the element selenium by Willoughby Smith in 1873, the invention of a mechanical scanning disk by Paul Gottlieb Nipkow in 1884, the demonstration of televised moving images by John Logie Baird in 1926 and Philo Farnsworth's Image Dissector in 1927.

Mechanical television principles were initially used to transmit a type or line art and in 1881 Sheldford Bidwell demonstrated its use in the transmission of facsimile of still photographs.

Japanese inventor Yasujiro Niwa invented a simple device for phototelegraphic transmission through cable and later through radio. American inventor Charles Francis Jenkins developed mechanical television systems in the 1920s and early 1930s.

In 1923, Jenkins transmitted the first moving silhouette images, and on June 13, 1925 he publicly demonstrated the synchronised transmission of images and sound.

On 26 January, 1926, British inventor John Logie Baird used mechanical TV to transmit a live, moving image with tone gradations (i.e. greyscale), though with only 30 scan lines, its resolution was just enough to produce a recognisable human face, and this was the limitation of mechanical TV systems.

Mechanical TV was used in broadcast TV from 1928 to 1929 and was succeeded by the all-electronic TV era which began around 1926 and never quite went away.

Field-sequential techniques were also used in the Apollo moon missions in the late 1960s and early 1970s to send colour TV signals back to earth, where mechanical equipment at the receiving station converted them into standard TV formats.

## All-electronic

Several experiments into using CRT's in all-electronic TV were undertaken by several inventors very early last century and while several experiments in using CRTs in the receiver had been conducted, the idea of using them in the transmitter was rather novel at the time.

By the late 1920s, several inventors including Kálmán Tihanyi in Hungary, and Philo Farnsworth and Vladimir Zworykin in the United States were already working separately on their versions of all-electronic transmitting tubes.

The decisive solution, the accumulation and storage of electrical charges within the transmitting tube throughout each scanning cycle, was first described by Tihanyi in March 1926, who called his invention the Radioskop in his patent application in Hungary.

The U.S. company RCA acquired the rights to Tihanyi's Radioskop and his earlier design of a receiver tubes even before their patents were approved and in 1931, RCA incorporated aspects of Radioskop technology into its Iconoscope, and the RCA research group headed by Vladimir Zworykin introduced the Iconoscope in 1934.

The Iconoscope contained a plate containing a mosaic of photosensitive granules with an insulating layer which separated them from a shared common plate and when the light from an image was projected onto this plate each granule constituted a tiny capacity which stored an electrical charge proportional to the intensity of the light falling on it.

Earlier in 1922, Philo Farnsworth, a teenage farmboy in Utah, discovered that a CRT could be used to generate an electrical TV signal without the need for mechanical scanning. Farnsworth successfully demonstrated his image dissector in 1927 and this was the first successful demonstration of a fully electronic television system. By 1929, Farnsworth had improved the image clarity of his Image Disector beyond that of mechanical TV systems.

However, the Image Disector was not very efficient since most of the electrons produced did not pass through the aperture, so it required very bright lighting for use as a TV camera and it was eventually superseded by the Iconoscope but Farnsworth still earned some income from the Iconoscope, since it used several of his patents.

In Britain, Isaac Shoenberg employed Zworykin's design to develop Marconi-EMI's own Emitron tube used in cameras designed for the BBC. On 2 November, 1936 a 405 line service was started from studios at London's Alexandra Palace and while it co-existed with Baird's mechanical TV system in adjoining studios, the Emitron was more reliable and visibly superior.

That same year, Tihanyi described the principle of plasma television and designed the first flat-panel receiver, while later in 1941, the United States implemented 525-line television.

The world's first 625-line TV standard was designed in the Soviet Union in 1944 and became a national standard in 1946. The first 625-line broadcast occurred in 1948 in Moscow and the concept of 625 lines per frame was subsequently implemented in the European CCIR standard.

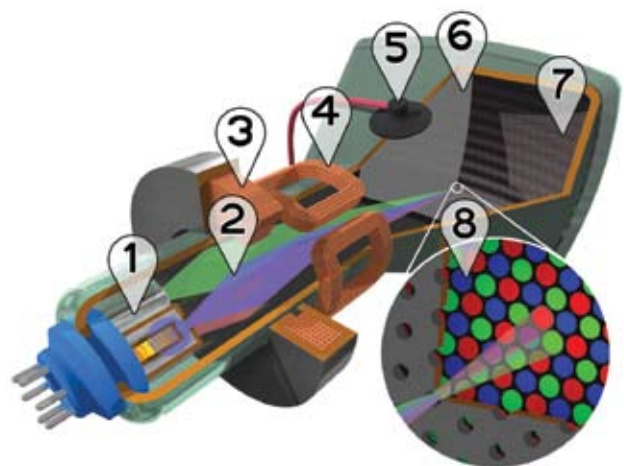
The CCIR (Consultative Committee on International Radio) was founded in 1927 to define international standards for radio communications and was subsequently merged into the International Telecommunication Union Radiocommunication Sector (ITU-R).

Monochrome TV transmissions were launched in Malaysia in December, 1963 by Radio Televisyen Malaysia (RTM), Malaysia's public service broadcaster. It was a PAL-B (Phase Alternating Line version B) system using 625 horizontal scan lines transmitted in VHF Band I.

## Colour TV

A colour TV broadcast can be created from three separate monochrome (black and white) broadcasts, one in red, one in green and one in blue, which when viewed in rapid succession would appear as natural colour by the human eye. This concept had been experimented with almost as soon as black and white televisions had first been built.

Polish inventor Jan Szczepanik patented a colour TV system in 1897. He used a selenium photoelectric cell at the transmitter and an electromagnet controlling an oscillating mirror and a moving prism at the receiver. However, his system had no means of analysing the spectrum of colours



 CRT colour enhanced tube (Source: Wikipedia)



■ A C-Band TV antenna

at the transmitting end, so it could not have worked as he described it.

Baird made the world's first colour broadcast in Britain on 4 February, 1938, sending a mechanically scanned 120-line image from his studios in Crystal Palace to a projection screen at London's Dominion Theatre.

The shadow mask colour television was patented in 1938 by Werner Flechsig in Germany, and was demonstrated at the International radio exhibition Berlin in 1939. Most CRT colour televisions used today are based on this technology.

His solution used three separate electron guns which were aimed at the holes in a metal plate from slightly different angles and when their beams passed through the holes this slight angle caused them to separate again and hit the individual red, green and blue spots a short distance away on the back of the screen to produce different shades and intensities of colour.

The following year, Hungarian engineer Peter Carl Goldmark also introduced a mechanical system while at CBS (Columbia Broadcasting System), which contained an Iconoscope sensor. It was first demonstrated to the FCC (Federal Communications Commission) on 29 August, 1940, and shown to the press on 4 September.

However, three separate colour broadcasts required three times the bandwidth of monochrome transmissions, so the National Television System Committee (NTSC) in the United States introduced a system which encoded the colour information separately from the brightness, which greatly reduced the resolution of the colour information to conserve scarce bandwidth and this was a major technical achievement.

The brightness image in NTSC colour broadcasts was backward compatible with black and white TV sets at slightly lower resolution, while colour TV sets could decode the additional colour information.

However, while colour TV was introduced in the United States in the 1950s, they were very expensive and there were not many programmes in colour. It did not gain wide acceptance until the late 1960s and colour TV sets became standard in the US in the 1970s.

While the NTSC provides the colour TV standard in North America the other two main colour TV standards in use worldwide are PAL and SECAM (Séquentiel Couleur à Mémoire—Sequential Colour with Memory).

NTSC was widely perceived to suffer from hue error problems, especially after the introduction of videotape recorders in the late 1950s, so the Germans unveiled PAL in 1963, which was technically similar to NTSC but incorporated some ideas from SECAM as well.

Eastern Europe used SECAM but has since switched to PAL following the collapse of the Soviet Union, though France and Russia continue to use SECAM.

PAL was originally used in Western Europe. Colour broadcasts in Asia began in Australia (1967), then in Hong Kong (1970), China (1971), New Zealand (1973), Singapore (1974), Thailand (1975), Indonesia (1978) and India (1982). PAL is the most widely used colour TV format today. RTM began colour broadcasts using the PAL-B standard in VHF Band III in 1978.

There are over eight different PAL versions in use in different countries and their common feature is the use of 625 horizontal scan lines and 50 vertical fields per second,



**A Ku-Band TV antenna**

with the exception of PAL-M used in Brazil which uses 525 scan lines and 60 vertical fields per second.

Other variations in PAL are their transmission band (VHF, UHF or both), video bandwidth, sound carrier and channel bandwidth.

Today, the six free-to-air TV stations in Malaysia broadcast in VHF Band I and Band III. The free-to-air TV using PAL-G in UHF Bands IV and V was introduced in 1995.

Seven remaining transmitters still operate over VHF Band I but under SKMM's spectrum re-allocation programme, all transmitters will cease operation in VHF Band I as frequencies in UHF Bands IV and V have been made available for them, while VHF Band I frequencies will be re-farmed for other uses.

## Cable TV

Cable television is believed to have begun as community antenna TV (CATV), whereby TV signals are piped to TV sets in homes within a local community through cable, especially when they are out of reach of terrestrial free-to-air signals, such as in valleys between mountains.

In such places, the TV antenna would be mounted on a mountain or at an elevation where it can receive the signals clearly and the signals are channeled to an amplifier through coaxial cables, from which they are redistributed to antenna sockets in individual apartments also through cable.

CATV is still available, especially in apartment blocks to provide all apartment owners with clear TV reception, especially when their apartment does not face the TV station. It also helps an unsightly mass of TV antennas in front of each apartment.

With these systems, each apartment block has a master antenna mounted on top and pointed towards the TV transmitter and the signal was amplified by a head amplifier and channelled to all apartments through coaxial cable.

The origins of CATV are debatable. One account credits the British company Rediffusion which introduced a limited CATV service called Pipe TV in London shortly after the British Broadcasting Corporation (BBC) began TV transmissions there in 1932 but further development of this service was cut short by World War II.

Rediffusion earlier provided re-broadcast wired radio service to loudspeakers in homes in the U.K., and in British colonies and former colonies. Many older Malaysians will fondly remember Rediffusion's two Gold and Silver services, which ended in the 1990s after Rediffusion obtained an FM licence.

On the other hand, the U.S. Congress and National Cable Television Association recognised John Walson as the founder of cable TV.

The Service Electric Company owned by John and his wife Margaret sold electrical appliances and TV sets in the Mahanoy City, Pennsylvania area in the 1940s but some of their customers were unable to receive good TV reception in that mountainous region, so John installed a master antenna on a pole on top of a mountain, connected it to a booster in his store and retransmitted it to his customers' homes using cable.

Cable TV is like CATV but on a much larger scale, such as city wide or nationwide.

Today, large cable TV operators provide nationwide subscription services mostly in developed countries all over the world.

One great thing about cable TV is the consistency of the signal quality received. Another big advantage is that the cable can also be used to provide non-TV services such as FM radio, broadband Internet and cable telephony services over the remaining bandwidth, which has also enabled cable TV operators to provide competition to incumbent players.

## Satellite TV

Most Malaysians are familiar with satellite TV since MEASAT Broadcast Satellite Systems launched its ASTRO subscription direct-to-home satellite TV service here in 1996. The broadcasts are via its MEASAT satellites using DVB-S (Digital Video Broadcast – Satellite) technology in the 12GHz (Ku Band) and are received through inexpensive parabolic dish antennas and set-top boxes in the homes.

In 1926, the first satellite television signal was relayed from Europe by the Telstar satellite over North America and the first national network of satellite television, called Orbita, was created in Soviet Union in 1967, while the first domestic North American satellite to carry television was Canada's geostationary Anik 1 launched in 1972.

With satellite TV, communications begin with a transmitting antenna located at an uplink facility. These uplink satellite dishes are as large as 9 to 12 metres in diameter for more accurate aiming and greater signal strength at the satellite.

The uplink frequency is in a different frequency band from downlink and is converted in the satellite typically to



#### DVB-H Mobile TV

C-band (4–8 GHz) or Ku-band (12–18 GHz) or both in the downlink to viewers on earth.

A typical satellite has up to 32 Ku-Band transponders and up to 24 C-band transponders, or more for hybrid satellites.

C-band transmission is susceptible to terrestrial interference while Ku-band transmission is affected by rain as water easily absorbs microwaves at this frequency.

The large C-Band receiving antennas are typically a few metres across and can be seen in on the rooftops of houses in countries like Thailand and Taiwan.

Owning a C-Band satellite dish requires an Apparatus Assignment in Malaysia whereas the 60cm KU dish and decoder are available on a Class Assignment. This is done as the programmes relayed to Ku-Band dishes and decoder come from ASTRO, a licenced local broadcaster, whereas C-Band reception comes direct from foreign broadcasters.

### Digital TV

Malaysia already has digital TV services in the form of satellite TV (DVB-S) from ASTRO and digital streaming mobile TV by several operators such as Maxis, DiGi, Celcom which is accessible on suitably enabled cellular phones.

In 2004, the Malaysian Government endorsed and allocated funds for a pilot project of free-to-air digital terrestrial TV broadcasts based on the DVB-Terrestrial (DVB-T) standard. In 2005, SKMM allocated spectrum in the UHF band trial broadcast of digital terrestrial TV in the Klang Valley.

Between September 2006 and March 2007, RTM commenced pilot trials of digital TV broadcasts to 2,000 set-top boxes.

The digital broadcasts from transmitters in Menara KL (KL Tower) and Ulu Kali comprise simultaneous broadcasts of RTM's two FTA analogue TV channels, RTM1, RTM2, and new digital channels Arena and Muzik Aktif daily from 7.00pm to 12.00 midnight during the trials.

Due to positive feedback received during the trials, RTM continued with its digital broadcasts, while using it as an opportunity to test various video and audio codecs. From February 2008, RTM broadcasts at 674 MHz RTM1, RTM2, RTMi, Muzik Aktif, Arena, a demo channel called EPG (electronic programme guide) and Radio Aktif, this last one comprising a simulcast of RTM's seven analogue radio stations in the Klang Valley.

Malaysia plans to phase out all analogue TV transmissions by 31 December, 2015 and go fully digital. SKMM will be allocating the UHF 470–742 megahertz spectrum for digital terrestrial TV towards the end of 2009. The industry has decided on the DVB-T (Digital Video Broadcast – Terrestrial) standard.

The spectrum holder will have to build a common free-to-air digital terrestrial television broadcast (DTTB) transmission and broadcast infrastructure which all broadcasters can use to transmit their TV programmes and have it ready in time for the switch to digital in 2015.

Luxembourg was the first country to totally switch over to fully digital over-the-air terrestrial broadcasting in 2006,

followed by the Netherlands later that year, by Finland, Andorra, Sweden, Norway and Switzerland in 2007, Belgium (Flanders) and Germany in 2008, and the United States in 2009.

Japan and Canada plan to go fully digital in 2011 and China in 2015. Different parts of the United Kingdom will go fully digital in phases until the whole country is digital in 2010. Major cities in Brazil went digital on 2 December, 2007 and it's estimated that it will take seven years to complete the whole switch over exercise. Brazil opted for ISDB-T to replace its PAL-M analogue system and other Latin American countries including Argentina, Chile and Venezuela have expressed interest in adopting it.

The Japanese ISDB-T (Integrated Services Digital Broadcast – Terrestrial) standard for digital TV and radio broadcast was adopted for commercial transmission in Japan in December 2003 and as of the end of April 2005 it had 10 million subscribers.

China developed its Digital Terrestrial Multimedia Broadcast (DTMB) technology, formerly known as Digital Multimedia Broadcast – Terrestrial/Handheld (DMB – T/H). It employs a single or dual carrier modulation technology called Time Domain Synchronous Orthogonal Frequency Division Multiplexing (TDM-OFDM) capable of transmitting data which can be received with acceptable signal qualities on a HDTV receiver travelling at 200 km/h, such as on a high-speed train. Unlike its European and North American counterparts, DTMB also supports mobile digital TV on handheld devices.

Yet another way to receive digital TV is as an Internet protocol TV (IPTV) transmission over DSL (Digital Subscriber Line) or optical cable. The Internet can also be used to receive digital TV signals, for example by using the many peer-to-peer Internet TV software to watch TV on a computer.

As for drawbacks of digital TV, there is a significant delay when changing channels compared to analogue due to different buffering and preload delays of different viewing devices. Multi-path interference affects digital TV more badly than analogue and affects reception, especially when using simple antennas, such as rabbit ear antennas. What appears as multiple images known as “ghosting” with analogue TV will cause image corruption with digital TV due to inter-symbol interference. It is often worse in wet weather due to increased reflection or re-polarisation of the digital TV signal arriving from multiple paths and in the worst case, the signal is lost completely.

Engineers with the Institute of Electrical and Electronic Engineers (IEEE) recommend the use of outdoor or attic antennas with digital TV, rather than indoor antennas as reflections and other interactions of the signal with objects – including human bodies in the room will increase multipath interference.

One of the key benefits of digital TV is the consistency of the digital picture quality. With an analogue signal, if its shape is distorted during transmission it will produce a degraded image when received, even after amplification

but since a digital signal is a stream of ones and naughts, the receiver can still distinguish between them even if their modulated carrier suffers some distortion within certain limits along the way and can restore the signal to its original form.

Its other benefits include the option to transmit high-definition TV images (HDTV), its use for mobile TV, the carriage of supplementary data services, the enablement of user interactivity, its ability for the system to support more programme channels thanks to the greater spectral efficiency of digital TV over analogue and multi-language capabilities subject to availability of content.

High definition TV (HDTV) can be transmitted over DTT in a 16:9 aspect ratio compared to the familiar 4:3 resolution used in Standard Definition TV (SDTV) and computer monitors. HDTV cannot be transmitted over current analog channels.

Each commercial DTT channel in North America can broadcast at a data rate up to 19 megabits per second but the broadcaster subdivides this bandwidth into several video subchannels of different quality and compression rates. This will allow for the broadcast of several SDTV programmes over one DTT system. At the viewer's end, DTT uses an antenna to receive whatever channels it picks up.

Market research firm Informa Telecoms and Media forecast in the eighth edition of its Global Digital TV report that 343 million of homes with TV or 24% would have digital TV at the end of 2008. North American homes would lead with 90 million homes or 77% penetration at the end of 2008, followed by Western Europe with 63%.

While every region will see a growth over the next five years, the Asia Pacific region will more than double its digital total over that period. By 2013, Asia Pacific will account for 39% of the world's homes with digital TV, followed by North America at 21% and Western Europe 25%. China will be the largest digital TV nation by 2013 with 123 million homes with digital TV by that year. 

