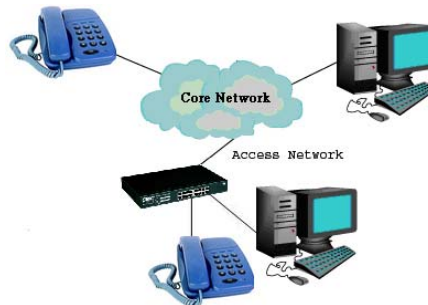## Future Broadband Communication Technologies

Introduction

The telecommunication era started after Sir Alexander Graham Bell invented the telephone in 1876. Since then this field went through many changes with the development of Physics, Electronics and Computer technologies. The present telecommunication goes together with Information Technology and it is called Information and Communication Technology (ICT). The initial requirement was to exchange voice, and the earlier telecommunication networks were designed to fulfill that need. The present requirement is to exchange "Information" such as voice, video and data, which is referred as Multimedia. The telecommunication network is gradually replacing with Internet network and also services are transferring to a common technology called Internet Protocol (IP). Information, including voice exchange through Internet is very economical and simple.

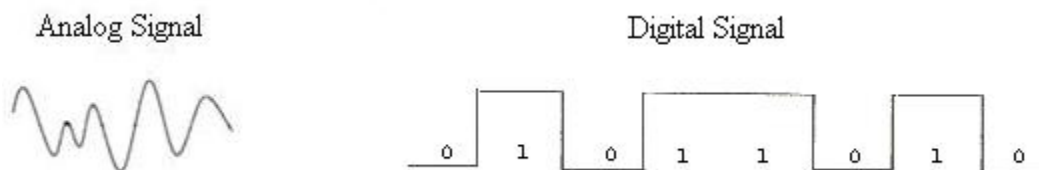Any communication network can be divided into two parts called Access network and Core Network.

The core network is a high bandwidth high-speed network, which is analogous to a road highway network. It provides high-speed broadband connectivity among nodes (similar to telephone exchanges). The Access Network connects subscribers to the Core Network. The connectivity within Core Network or Access Network is made through a transmission media.

There are three types of transmission medias. They are copper, fiber and radio. The radio has a limited bandwidth, copper has a moderate bandwidth and fiber has an enormous bandwidth. Normally the Access Networks are used copper (wired) & radio (wireless) as transmission media and Core Networks mainly fiber is used as the transmission media.

Basic Technology

Voice, video or data is converted to electrical signal for transmission. It can travel as an analog electrical signal or digital electrical signal. The electric voltage variations against time in these two cases are given in the following figures.
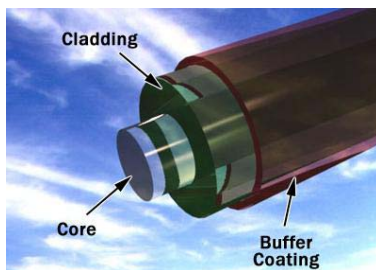
Analog Signal

Digital Signal

0 1 0 1 1 0 1 0

Analog characteristic are mainly measured as a frequency bandwidth and digital is measured as bit rate or bits per second. The voice signal is inherently analog and data signal is inherently digital. The modern telecommunication systems are completely digital. Therefore, analog signals have to be converted to digital signals before transmission. The bandwidth of a typical telephone voice channel is 4 kHz and equivalent digital signal is 64 kb/s. (Kilo – k – 1000, M – Mega – 1 million, G – Giga – 1 billion, T – Tera - 1 Trillion). Nowadays the "bit rate" also refers as "bandwidth".

The present trend is converged networks. All IP based services such as voice, data and video can be sent together. The total bit rate (bandwidth) can be divided among services by using a technology called Quality of Service (QoS). The video and images need broadband. There is no proper definition for the term broadband. Presently, we can say that broadband means at least 512 kb/s. After several years broadband may be at least 1 Gb/s. This is due to the emerging technologies.

In order to provide broadband services to the subscribers, the access network, and core network both should support for broadband.

Fibre Optics

Fibre optic is a revolutionary invention of telecommunication industry. The signal travels through fibre as an optical (light) ray. One fibre can carry about 40 Gb/s information. The latest fibre technology is Dense Wave Length Multiplexing (DWDM) and it can carry about 32 times bandwidth of a normal fibre that is 32 x 40 Gb/s. This is an enormous bandwidth and there will be no bottleneck of bandwidth if fibre is used as the transmission media. Another advantage of fibre is that it can carry signals for even 100km without repeaters.

Fibre Architecture   *Multi Core Fibre*

Present core networks are almost fibre. If a country has a proper fibre core network, the core network transmission cost can be minimized. The traditional way of laying fibre is through the telecommunication ducts. Such ducts are available with only the incumbent telecom operator of a country. There are technologies available to lay fibres along Power Lines, Railway Lines and water Lines. In fact the operator(s) can use such Lines and provide the Core Network infrastructure at a very low cost. Unfortunately Sri Lanka does not use such available resources.

There are many fibre optic cables (submarine cables) lay undersea by connecting almost all countries. Therefore, the international backbone cost is drastically decreasing. Hence, the Internet charges can be reduced drastically in the near future.

There are technologies available to use fibre as Access Network transmission media. Fibre to the Home (FTTH) is a technology use to connect the user to the core network by using a fibre. Fibre to the Node (FTTN) is a fibre technology uses a fibre close to a customer premises and the last 500 metres by using Copper. Passive Optical Network (PON) is used to enable a single optical fibre to serve multiple premises, typically 32. Metro Ethernet is another fibre related technology, which can provide very high bandwidth to subscribers. These technologies can provide unbelievable bandwidth to customers in the range of 10 Mb/s, 100 Mb/s, 1 Gb/s and even 10 Gb/s.

Copper

If you have a wired telephone, you have one pair of copper wires from your home to core network. Many people use this pair of copper cable to have a dial-up connection to access the Internet. Its maximum bandwidth is 56 kb/s. It goes through normal telephone network and many disadvantages. Asynchronous Digital subscriber Line (ADSL) is a technology used to access Internet through the same copper wire and it can serve up to5 Mb/s. ADSL2+ is an enhanced technology, which can serve up to 16 Mb/s. The disadvantage of ADSL is it does not properly working for more than 5km and ADSL2+ does not work for more than 500metres. However, combining the fiber and copper technologies those distances can be extended.

Radio

The radio is a technology where installation cost and maintenance cost is very low. The biggest problem it has is the scarcity of frequency spectrum. There are many latest technologies available to use bandwidth effectively and efficiency. OFDM, OFDMA, MIMO are such technologies. Worldwide Interoperability for Microwave Access (WiMAX) is the most popular technology, which aimed at providing wireless data over long distances. It operates up to 30km in non-urban areas and up to 10km in urban areas. The bandwidth can be provided up to several Mb/s. However, the total available bandwidth will be shared among subscribers. It operates in 3.5 GHz, 2.4 GHz and 5.8GHz frequencies. This is a very good technology to a country like Sri Lanka to provide Data connectivity and Internet access at a very low cost. This is the most suitable technology for remote areas where ADSL connections and data leased lines cannot be provided. The WiMAX also can be used as a bandwidth mobile technology.

There are many broadband mobile communication technologies available in the market. The second generation (2G) does not have broadband technologies. The 3G mobile has the EDGE, 1xEVDO, HSDPA, HSUPA technologies which can serve up to several Mb/s. However, the maximum bandwidth depends on the use of external antenna, distance from the tower, ground speed etc. Standards are being prepared for 4G and it will be fully end-to-end IP and it will go even higher than 100 Mb/s.

Other emerging wireless broadband technologies are Mobile Wireless Broadband Access (MWBA) which is based on IEEE 802.20 standard and Local Multiple Distributed Server (LMDS) is based on IEEE 802.1 standard and which operate in extremely high frequencies such as 29 GHz. Operating in such frequencies is an appropriate solution for the present limitation of the frequency spectrum.

Broadband for Scio-economic Development

 Timely available of accurate information is an essential requirement for the socio-economic development of a country. The development goes along with competition and people need a lot of information to decide the best option. With the development of technology people tend to use the available electronic information and requirement of information gradually increases for better decision making. Information technology tremendously contributing to maintain enormous amount of data in electronic data centres. In order to transport such information to the individuals, economical and affordable broadband connectivity should be provided.

All new technologies are abstracted by the IP technology. The IP technology is the most superior communication technology and simplified technology ever found in the market. Hence, the IP technology drives the socio economic development by improving the manageability of the technology, such as QoS, Provisioning, Changing and other features. Therefore, it is geared to have IP applications on the user devices.

The broadband technologies can minimize the gap between urban and rural communities. For instance e-health is an electronic heath care practice which produce Telemedicine, virtual heath care teams, evidence based medicine, electronic media records and many more. Distance education using internet will provide the facility to less privileged school children in rural areas to learn with modern techniques. These are only two applications and almost all applications can use such techniques to improve the standard of service. Another important application is the working from home. According to this concept some jobs can be done from home (virtual office). It can be a solution even for the prevailing transport problem.

Once a proper low cost IT infrastructure (Core Network) and economical Broadband access technologies are implemented in Sri Lanka, all government institutions can have their own networks or a common network for the dissemination of information. This will enable the government servants and public to access the accurate information timely, get the required services and also reduce the paperwork.

The Core Network can be expanded throughout the island by using existing telecommunication network as well as through power lines, railway lines and water lines. Then the core network costs can be minimized.

The Access Network cost can be minimized by implementing wireless broadband technology such as WiMAX.   Very high-speed broadband Access Network can be provided by implementing the technologies such as PON, FTTH, FTTN, Metro Ethernet etc.

The Telecommunication Regulatory Commission (TRC) has a vital role to play in this field. After reducing the core network and access network cost the TRC can insist operators to reduce the Internet Access Charges and Data Connection charges and it will definitely accelerate the socio-economic development and quality of living of all citizens.