TECHNOLOGY MIX FOR THE ISLAND-WIDE TELECOMMUNICATION NETWORK OF THE CEYLON ELECTRICITY BOARD

by

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1.0 Introduction

The increasing trend of deregulation and privatization of public utilities and the increasing participation of private sector in the accelerated industrialization process, an atmosphere is created where the customer satisfaction is the prime focus of any business activity. Customer satisfaction is basically the provision of any business output (goods or services) to the best possible satisfaction of customers. This is vital in a competitive market environment for a sustainable market share.

Power utilities are no exception to this trend although it does not apply fully. To provide a better service at low cost and high quality, it is essential to improve the infrastructure facilities, with the increasing customer base. One of the most vital infrastructure requirement for power utilities is a reliable communication system, for their planning, design, operation, maintenance, administration, accounting etc. Power utilities usually have branches, power plants, grid stations etc., scattered around the country, throughout the population. Hence the requirement for such communication facility is so huge that it would not be economical to obtain this from the Public Switched Telephone Network (PSTN). Especially, the dedicated data communication needs would cost enormously. Further, the PSTN is more prone to failure and blocking, due to large number of users. Thus, the need for a private communication network, tailor made to meet the internal requirements of power utilities, is clear.

The customer base, both domestic and industrial, has been increasing steadily. The National Grid has been constantly expanded with additional power plants and grid stations to meet the demand. These result in the demand for specialized service features on the communication network.

2.0 Historical Background

In the past the communication requirements of power utilities were limited to voice communication, protection signaling, low speed data transmission for SCADA systems etc.

Modern power systems demand for additional features on the communication systems such as high speed data transmission, image transmission etc. So far the Power Line Carrier (PLC) system, were the popular choice of power utilities for their operation and administration. This is because the PLC systems make use of the existing power lines to transmit telephone, telex, SCADA and protection system signals. Once a pair of transceivers with suitable interfacing such as line traps, coupling capacitors etc., were installed on both sides of the power line, a communication link was ready. They did not require huge towers to be erected to launch the signal.

However the operational limitations of PLC systems made them incapable to cater for the communication requirements of modern power systems which are complex and dynamic in nature. Some of them are listed here.

1. limitations arising from the narrow bandwidth available such as;
   (a). low capacity - few channels per link usu ally one or two.
   (b). poor service features - unable to support high speed data transmission, fax etc.
2. The service of PLC system is available only up to grid / power stations. Additional communication systems (VHF / UHF links etc.) are required to extend the PLC communication to administrative offices. On the other hand, the insufficient capacity on the trunks does not allow to provide communications to many.

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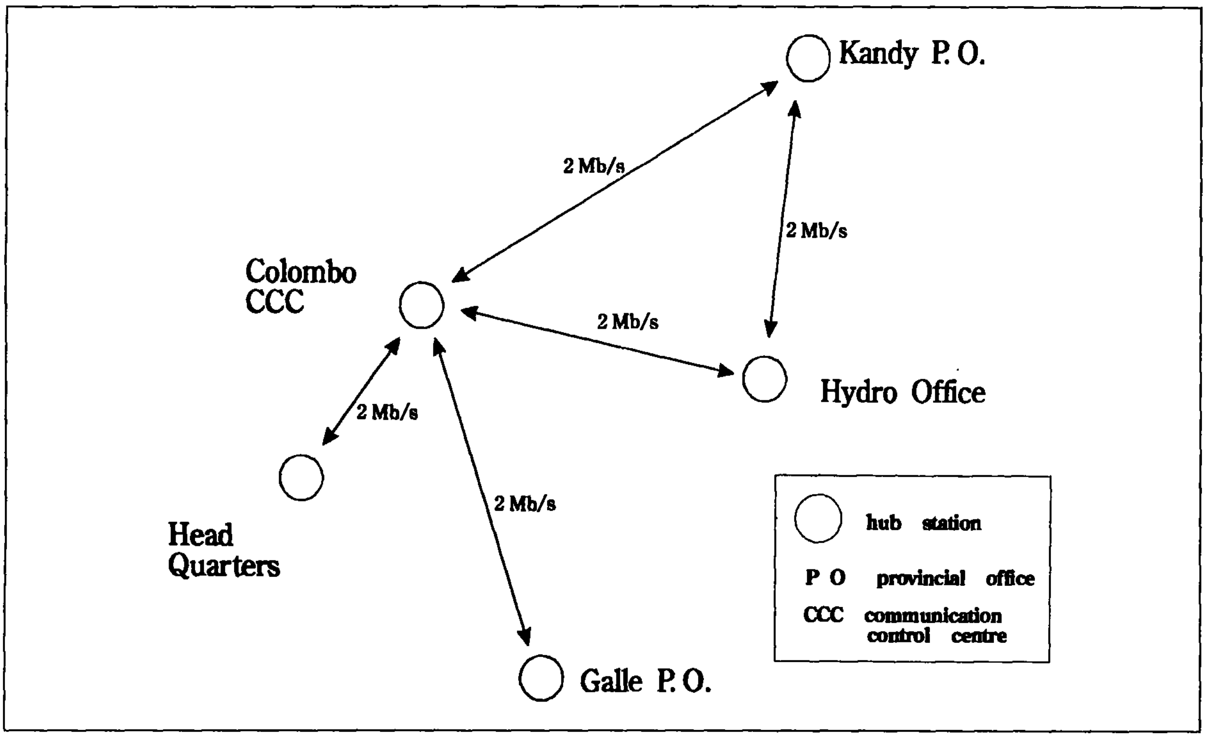


Fig. 1. Microwave Backbone

Due to these limitations PLC systems are loosing popularity. Power utilities are now seeking alternative methods of communications which can cater for the present and future requirements of power systems.

3.0 Present and future requirements

1. Modern power systems demand:

(a) reliable telephone service with sufficient pro tection for their operation and administration. The System Control Center (SCC) has the necessity to continuously communicate with power stations, grid stations, major load centers etc., as well as with the decision makers on the top of the hierarchy of the organization.

2. high speed data transmission in order to;

(a). exchange data between various power / grid stations and the SCC to provide information for monitoring, controlling and decision making. To do this computers employed at these places have to be interconnected through high speed data links.

(b).provide customers with efficient and regular billing system. Area offices and provincial offices, where the electricity metering data are gathered and processed have to beconnected to a computer network which has access to the computer at the billing center, so that a decentralized billing method can be established.

3. a reliable communication medium for modern SCADA systems that require digital data transmission to report on the dynamic changes in state of the power system network.

4. alternative route for the protection signals in addition to that provided by PLC links in order to increase reliability.

The Ceylon Electricity Board (CEB) has taken steps to slowly shift to advanced telecommunication systems. An island-wide digital microwave network has been established, among various CEB premises throughout the country, in order to achieve this target. Considering the remote nature of locations of various CEB branches, offices, power stations grid stations etc., a combined network of high speed digital microwave backbone and a digital radio rural telecommunication system has been chosen.

4.0 The system

4.1. Microwave Backbone

The digital PABX equipment at the hub stations, Colombo Communication Control Center (CCC), Head Quarters, Galle P.O, Hydro office and Kandy P.O have been linked through 2Mb/s digital microwave radio links expandable up to 8Mb/s (fig.01). Wherever necessary repeater stations have been inserted in to the links, to extend the hop distance. The microwave backbone incorporates a supervisory unit which report on the status of the radio equipment in the network.

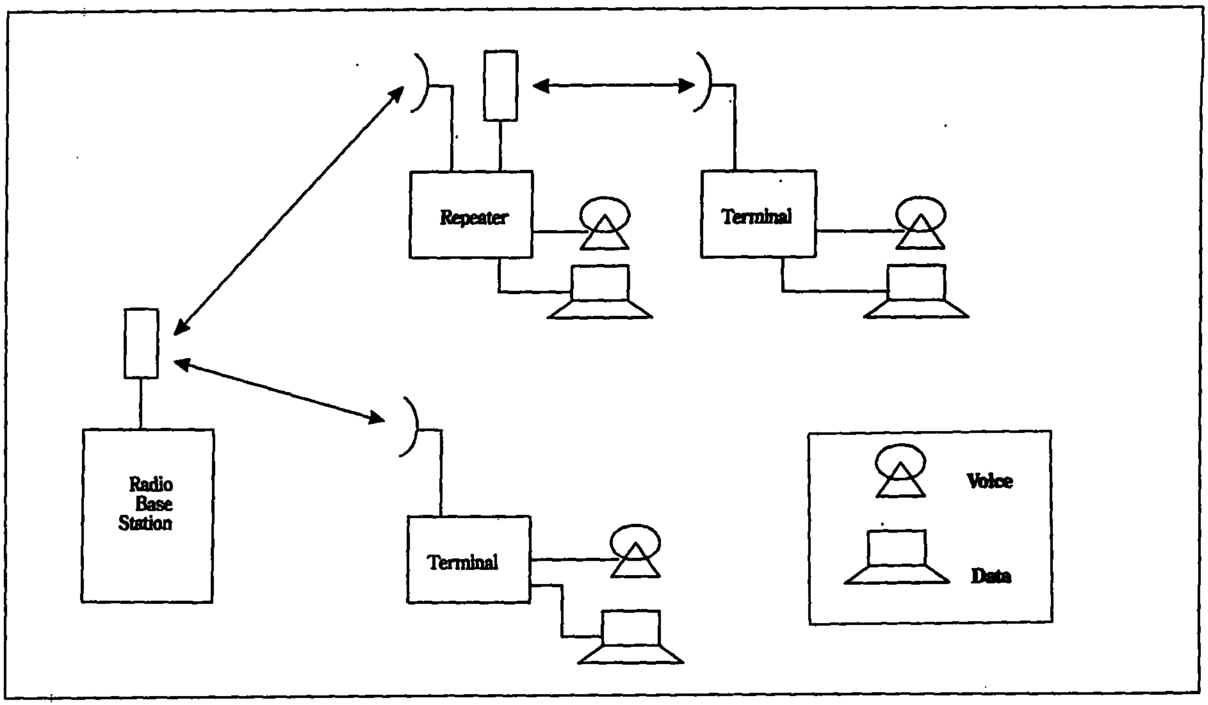


Fig. 2. System Configuration of DRAMASS

4.2. Access Network

Access to the digital PABXs, except to the wired subscribers in the same premises, has been realized through a rural radio telecommunication system called Digital Radio Multiple Access Subscriber System (DRMASS). This is a multiple access subscriber system consisting of Radio Base Stations, Repeater Stations and Terminal Stations (fig.02).

The subscriber lines from PABX are extended to the base station. The base station concentrates the subscriber lines in to 60 time slots in a Time Division Multiplex (TDM) structure. This TDM blocks are transmitted as radio signals on a single frequency by the base station, using an omni-directional antenna, towards the repeater and terminal stations.

The radio link between the base station and terminal stations is established through TDM/TDMA technique. The downward transmission from base station to repeater and terminal stations is by Time Division Multiplex (TDM) technique. On the upward transmission, terminal and repeater stations communicate with the base station through Time Division Multiple Access (TDMA) technique. Here they transmit on a Burst Mode. In the burst mode, each station transmits only during the time slot allocated to it. This is a power saving feature of DRMASS system which allows them to be powered, by even solar panels, wherever the mains supply is not available.

DRMASS uses a Demand Assigned Multiple Access (DAMA) method. In DAMA, time slots are allocated to subscribers on a demand assigned basis. Being multiple access systems each terminal station can support up to 64 subscribers. From the terminal station the subscribers are connected through wired network. The terminal station provides the dial tone, ringing tone etc. to the subscribers as done by standard switches.

Wherever necessary repeater stations have been included in to the network to extend the coverage of the base station. Repeater stations are of regenerative type; the signal received from upstream is processed, regenerated and re-transmitted on a different frequency towards the downstream repeaters and terminals. Repeater also provides a limited number of subscriber connections.

DRMASS, in addition to the two wire subscribers, also supports for data transmission, with variable speeds ranging from 1.2 Kb/s to 64 Kb/s, on different standard interfaces.

Unlike voice subscribers who are switched, data terminals are connected through hard wired leased lines. Data transmission is available;

(a). Between provincial offices and associated area offices.

(b). Between head office and provincial offices.

(c). Between SCC and power / grid stations.

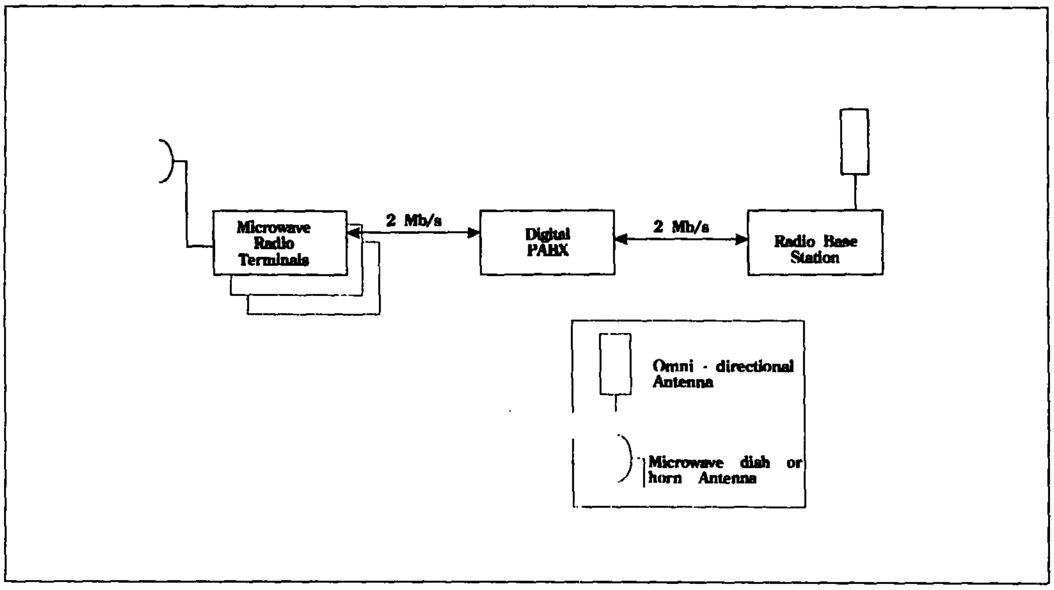
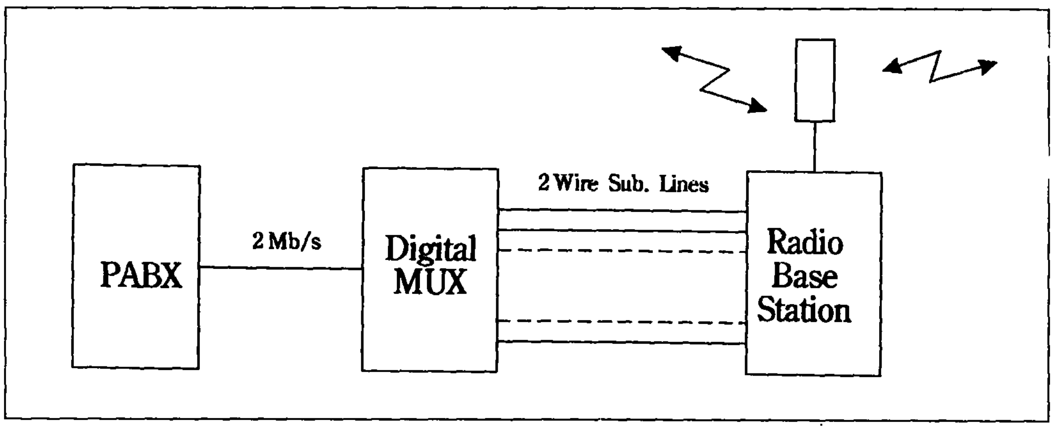


Fig. 3. Hub Station Configuration



Fif. 4. PABX to Bace Station Link

The DRMASS system uses a separate supervisory and control system connected to the base station. This reports on the status of the repeater and terminal stations downstream, to the System Engineer, to monitor the network. It also, to a certain extent, allows to remote control and test repeater and terminal stations. The system status and alarm conditions are displayed by the Video Display Unit.

Another feature of the DRMASS terminals is the Intracall facility. When subscribers within the same terminals are to be connected, after establishing the call, the subscribers are internally connected by the terminal station. Thus the trunk is released for other users. This way, the congestion on the trunk lines can be reduced, increasing the grade of service.

Various antenna configurations are used, dictated by the transmission direction and the type of receiver.

	upstream	**downstream**
Base	————	omni
Rept.	Dish/hor	omni/dish/horn
term.	Dish/horn	————

DRMASS system allows the remotely located Area Offices, Grid stations and Power stations to be easily connected in to a network, in order to share data, provide telephone, telex and fax facilities. It uses a proven cost effective method for rural telecommunication.

The system has 100% compatibility with public telecommunication systems. The system configuration allows for further expansion to provide telecommunication facility to the public. As the system has a very good access to remote rural areas, where the basic telecommunication facility has poor penetration, it is possible to provide them with telephone / data communication to a limited extent. To accomplish this, it is necessary to link the network to the PSTN at suitable hub stations.

This would create the necessary revenue to meet the operating cost of the network. In addition, it would be possible to serve the rural community, by providing one of the vital infrastructure facility required for sustainable development.

5. Conclusion

The major advantages of the microwave network as compared to the PLC comes from the traffic handling capacity and the reach.

PLC, as described earlier, suffers from the poor traffic capacity. Due to the narrow usable bandwidth and the corona noise available in the power lines, usually the PLC systems allow for few trunk channels to be established per transmission line. These channels, being poor in bandwidth and signal to noise ratio, cannot be used for high speed data transmission. On the other hand, microwave systems usually allow reasonably large bandwidth and if properly engineered, good signal to noise ratio. Hence the traffic handling capacity of microwave systems is very high.

The reach of the PLC system is limited up to the grid station. But, microwave radio solutions are so flexible that the service could be reasonably extended to remote rural areas.

PLC systems are used only by power utilities. Hence, due to the limited marketing opportunity for PLC systems, the cost of the PLC terminal equipment and the interface accessories to transmission lines are very high. Microwave radio systems, being compatible with public telecommunication networks, have wide range of applications and usage and therefore, are available at competitive prices. This would serve on not only in the initial cost of the system, but also on the maintenance cost as spares would be available at low cost in the market.

Another possibility of establishing the backbone is to use the optical fibers. Power transmission cables with optical fiber cables placed at the core are now available at competitive prices. Optical yield large bandwidth and hence high traffic handling capacity. This makes the optical fibers more suitable medium for high traffic backbones.

The optical fiber could be incorporated either in to transmission conductors or ground conductors. The ground conductors on the overhead lines would be a cost effective solution for both existing lines and new constructions. Since power lines are usually constructed for high reliability, the resulting optical fiber backbone would also be highly reliable. Since it uses the existing infrastructure, the transmission towers, it would be cost effective for power utilities. Also the nature of the signal transmission, in the form of light waves, provides high immunity against electromagnetic interference and lightening. It would also be possible to lease out the spare capacity for other public telecommunication operators.