Powering Telstra's Broadband and Multimedia Services

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Introduction

The information super-highway is here, technically at least, fulfilling the predictions of the prophets of the Information Age back in the late 1970s. The convergence of voice, data, and video using broadband network capabilities promises rapid growth in multimedia communications. Multimedia services are likely to grow rapidly as both hardware and software advances are combined with new applications. The range of possible services using a broadband (super-highway) network extends from present day services such as telephone, modem, facsimile, ISDN, radio and PayTV, to new interactive and entertainment services.

Fully integrated services demand broadband network capability and the long-term adoption of optical fibre to replace the copper medium. Such network evolution is part of a fundamental shift of engineering capabilities from the traditional role of telephony services to one of an integrated approach to the content, organisation and carriage of information. In Australia, the telecommunications environment is to be fully deregulated in 1997. Telstra is facing new competitive elements which greatly influence engineering decisions, including powering issues. At present, Australia has a regulated telecommunications carrier duopoly, but in 1997 a much wider, openly competitive environment is planned. Cost, regulatory and customer acceptance issues must be addressed in what is an increasingly competitive environment. In the evolution of fully integrated mulitmedia communications, Telstra's universal service obligations may change. In the future it could be questioned as to whether the ubiquity of cellular radio networks might be grounds to free Telstra from the obligation to provide emergency powering of telephones at each and every customer's premises.

Telstra's Network Evolution

Australia is not immune from world trends, and Telstra's core network is being modernised and simplified to provide a high capacity and highly survivable optical fibre network linking capital cities and metropolitan exchanges. The core network serving metropolitan regions will be fully digital within 3 years, and the Australia network completely digital within 5 years. Already there is 1.5 million km of optical fibre which supports national and international broadband services. By the end of this year (1994) optical fibre will reach to within 600 metres of 60% of Australian homes. Optical fibre and optical fibre/coax hybrid technologies are being deployed in inner, high density areas of Australian cities. Telstra is committed to cabling 150,000 homes by the end of 1994, and to 1.1 million homes - a quarter of the national total - by the end of 1996. This infrastructure serves as an excellent base from which to launch development of fully interactive multimedia services.

Telstra has embarked on a number of field trials to assess broadband and multimedia technologies.[1-3] These trials are designed to provide valuable experience in the provision of services, and examine key issues related to the role of new technologies. Lower population density areas may be economically serviced by using Asymmetrical Digital Subscriber Line (ADSL) technology and existing copper pair phone lines. Telstra Research Laboratories have an ADSL demonstration system under test[1] and it has been shown that a 6MBit/s ADSL service might be used to reach households that are within 3-3.5 km of an exchange. Telstra will establish a pilot ADSL video and multimedia service in mid 1995. The trial, involving approximately 200 homes, will be among the first ADSL market trials in the world. ADSL provision of service requires Telstra powering only at the exchange, with the customer providing local AC power for the set top unit.

Powering issues

Broadband technologies do not in themselves require radical new powering systems. However, network evolution to support the integration of a broadband network and multimedia communications impacts on powering strategies. Historically, Telstra has used traditional centralised DC power systems to power exchange equipment and basic telephony services to customers. With the advent of switchmode rectifier and VRLA battery technology, distributed power architectures are preferred as they provide improved power system availability by reducing points of failure both on the DC and the AC circuits.[4] Distributed power also offers an integrated and modular solution to the diversity of growth. However, distributed power puts a greatly increased number of smaller VRLA batteries into the network and creates new operational maintenance issues which must be addressed.

The growth of new broadband services has accelerated the use of UPS equipment in exchanges to power computing, media storage and video headend facilities. Computing and media storage facilities are likely to be distributed throughout the capital cities, and to a lesser extent the metropolitan areas, co-located in exchanges with existing switch and transmission equipment. The concept of distributed powering and the generic AC powering requirement for computing equipment may lead to distributed UPS powering. Closer examination of the service assurance performance of UPS equipment is seen as a significant issue, especially with respect to improving fault diagnosis using new digital circuit control capabilities. Multimedia communications thus introduces a new prominence for UPS equipment in the exchange environment, requiring modification of traditional exchange experience and practice.

However, multimedia communications will force the most significant and profound changes to powering in the access network. The increasing use of fibre in the access network generally implies geographical decentralisation of switching or multiplexing equipment away from the exchange and closer to the customer. The need for optical/electrical conversion in the remote equipment necessarily requires duplication of the powering services which were traditionally provided by the telephone central office. Equipment may be located "at the curb" in remote units (RU) or "at the customer's premise" in customer units (CU), introducing different power supply architectures.[5]

In a showcase demonstration[3] of the use of fibre in the access network, broadband services are delivered to 200 homes over the same single fibre passive optical network (PON). The field architecture of the PON trial is shown in Figure 1. Both fibre-to-the-home (customer's premises) and fibre-to-the-curb access networks are used in the trial which is over a 10 km optical distance. Using a high optical split ratio of 32 between the exchange and the customers, telephony, ISDN services and 20 video channels are provided. Each RU, which serves 16 homes, is powered from the local street electricity supply. The CU is powered by the customer's electricity supply. Both the CU and RU consume approximately 100W. The RU is equipped with 8 hours of battery backup; the CU with 4 hours which reflect traditional battery sizing practices. As a continuous requirement, this is costly to provide and forces evaluation of powering architectures and alternative technologies. It must be remembered that the PON trial is to demonstrate the delivery of broadband services to residential customers using available technology. It is axiomatic that service provision costs must be driven much lower before wide scale adoption this type of broadband infrastructure is economically feasible. Nevertheless, power consumption is a important aspect and a savings of even a few watts per customer unit may potentially mean savings of millions of dollars across a network.

The reserve power backup in the PON trial illustrates a critical aspect of powering multimedia communications. Telstra has community obligations to provide at least an emergency Plain Old Telephone Service (POTS).

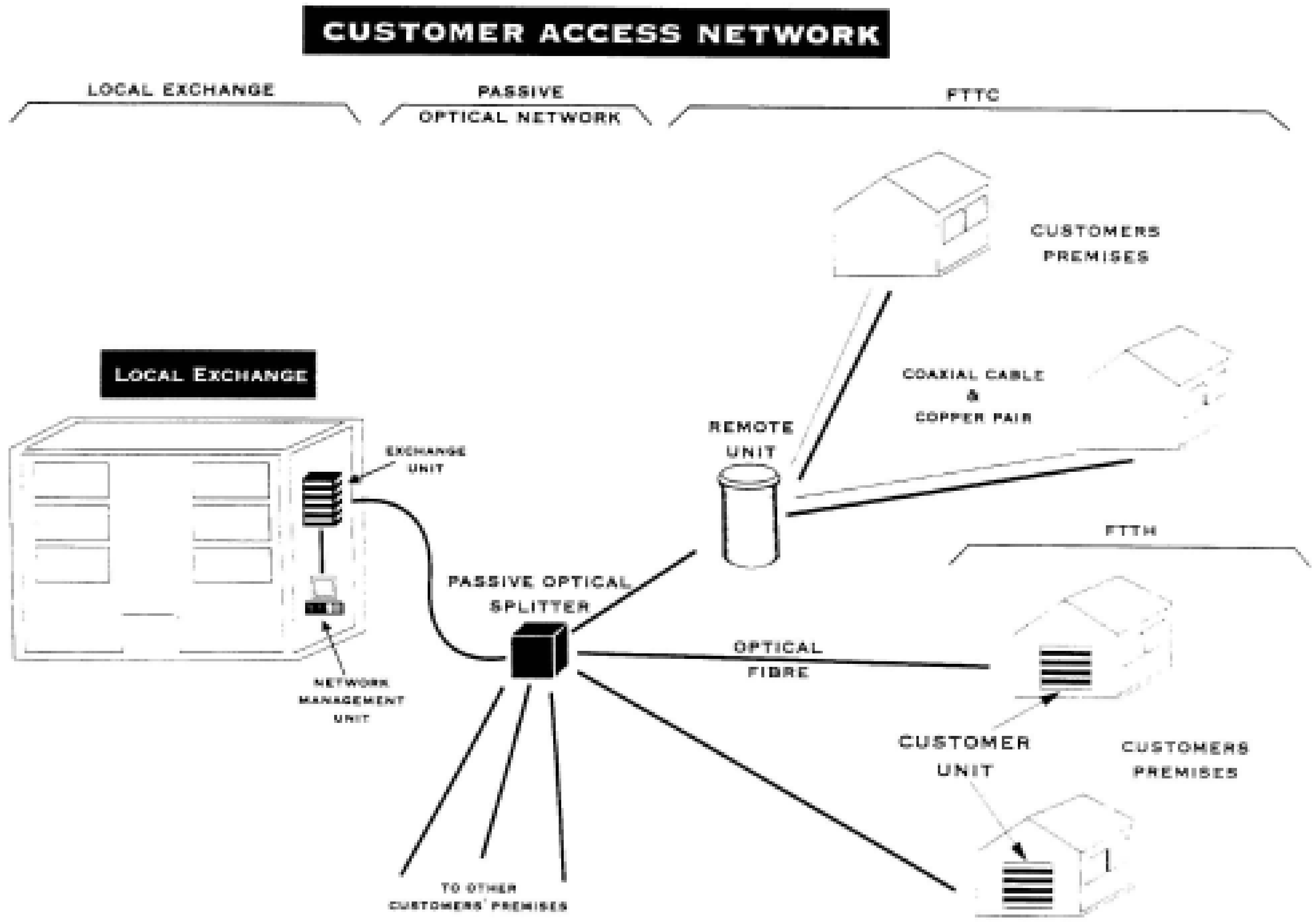

Fig.1: General architecture of one of Telstra's multi-media trials. This one is a passive optical network distributing broadband services to customers' premises from a local telephone exchange via a single optical fibre.

For integrated services, reserve power must be available to supply the basic telephony service in times of AC outage and there is an obvious cost penalty associated with the provision of emergency power.

The reserve power backup used in the PON trial reflects the classical reliability of the telephone network which originates from equipment housed in carefully regulated air-conditioned telephone exchanges. It may not be valid to directly equate such experience to power reserves in a broadband access network. With RUs and CUs, complex electronics is located in widely distributed housings which may experience harsh environmental conditions. In Australia air temperatures in excess of 45°C are not uncommon. Dense packaging of the electronics within the housings results in areas of relatively concentrated heat generation which must be dissipated. Power conversion equipment can be a significant source of the heat energy. Telstra's experience shows the temperature in presently used housings can vary from 40°C to 60°C daily. Reduction of heat using an active cooling system raises system costs and fan-forced air circulation does not always provide significant cooling. Elevated temperatures have an adverse affect on the reliability of electronics. Dry-out of electrolytic capacitors might be expected to threaten the reliability of power conversion equipment.[6] Similarly, the service-life degradation of batteries as a function of operating temperature is well known.[7]

The impact of environmental operating conditions on powering widely distributed optical-electrical interfaces in the access network is not yet fully understood.

Service Assurance Requirements

As increasingly complex equipment is introduced into local exchanges and the access network, a greater emphasis of the role of power related issues in service assurance is expected. The quality and assurance of service are expected to have a major impact in Australia's newly deregulated telecommunications market. Competitive pressures are beginning to focus greater attention on the economic benefits and costs associated with quality, operational and maintenance issues and their related strategies.

Consequently, Telstra is now seeking a systematic response to power delivery issues through Reliability, Availability and Maintenance (RAM) engineering in the local exchange[4] and in the access network.[8] While meeting customer's expectations of service delivery and availability, Telstra's competitive position also requires a demonstrable economic rationale for the implementation of new services and products. The Australian market for communications hardware is relatively small and so the technology choices are limited to some extent by developments in larger, overseas markets. Powering alternatives are linked to equipment selection and powering systems and configurations can have considerable impact on system costs. Thus, one of the major challenges confronting power engineers at Telstra is the provision of systems and solutions that guarantee high levels of end-to-end customer service while minimising life cycle costs and contributing towards acceptable returns on investment.

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