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**Nortel (Canada)**

# NETWORK ACCESS SOLUTIONS USING FIXED WIRELESS ACCESS

## 1 Introduction

Many countries are placing high priority on expanding their telecommunication networks to fulfil fundamental socio-economic goals. In many cases, a first priority has been given to telephone networks in high density urban areas, while rural and remote areas are often underserved.

One of the key network development issues to be addressed by developing countries when improving their telecommunications is that of network access. Rapidity of implementation and obtaining economic solutions are key considerations. Fixed wireless access solutions are gaining increasing acceptance in many parts of the world, particularly for rural and remote locations. A fixed wireless access system operating in a frequency band below 1 GHz is described in outline. A relative cost comparison of wireless and wireline is given.

Recent experience confirms that considerable benefits are achieved in terms of rapid deployment and reduction of costs when fixed wireless access technology is used.

## 2 Rural telecommunication issues

### 2.1 Telephone service penetration

For developing countries, there is a great need to increase service penetration in rural areas. For example, in one Latin American country, only about 30 per cent of the telephone lines are in rural areas. Four cities with 27 per cent of the population account for about 70 per cent of the main lines. Another Latin American country has similar statistics: the capital city has approximately 33 per cent of the population and 63 per cent of the main lines.

## 2.2 Social issues

The absence of adequate telephone service in rural and remote areas may lead to the following social consequences:

- Uneven social service

  The lack of adequate service in low telephone density areas results in lower level of social services when compared to high density areas. Dire consequences may also result in the event of natural disasters and other emergencies.

- Slowing of economic growth

  Another result could be the curtailment of economic growth in large geographic regions where continuous developments in all economic aspects are needed to aid the overall prosperity of the country.

- Universal services objectives

  Lack of fulfilment of universal service in those countries where the provision of equivalent service in all areas is a national objective.

## 2.3 Network access issues

Settlement patterns on the fringes of urban areas tend to be haphazard. Roads are often defined simply by spaces between dwellings which are laid out in a variety of manners. Providing telephone service to these locations with wireline access can be extremely difficult and prohibitively expensive.

Issues facing network planners include:

- Spontaneous demand

  Demand in these areas is often characterized as spontaneous and random. This can present great difficulty to systematic planning.

- Insufficient network infrastructure

  The high cost of capital investment necessary to provide wireline infrastructures restrains operators from providing adequate service in rural and remote areas.

- Long waiting list

  Deployment delay results in long waiting list, unsatisfied demand and loss of potential revenue.

- Low rate of return to telecom operator

  High costs of infrastructure deployment result in low rate of return on investment to the operator. Thus the service may not be commercially viable.

- High subscriber tariff

  Where the service is not subsidized, the subscriber tariff may be too high to allow operators to recover a reasonable level of capital investment.

As a consequence, a vicious circle of the above issues can occur, with no effective solution arising.

# 3 An effective network solution - fixed wireless access

Fixed wireless access offers an effective and low-cost solution to the provision of network access [**Ref. 1**].

Fixed wireless access uses a reliable and high-quality two-way radio link to replace the physical "local-loop" wire that traditionally connects subscribers to the network. The use of digital technology ensures privacy.

For wireline, most of the local loop costs stem from the installation and maintenance of a vast, branching network of copper wires leading from an exchange to individual subscribers' homes. In fact, the last few hundred metres of copper wire leading to the home may account for half of the total cost of the local loop (Figure 1).

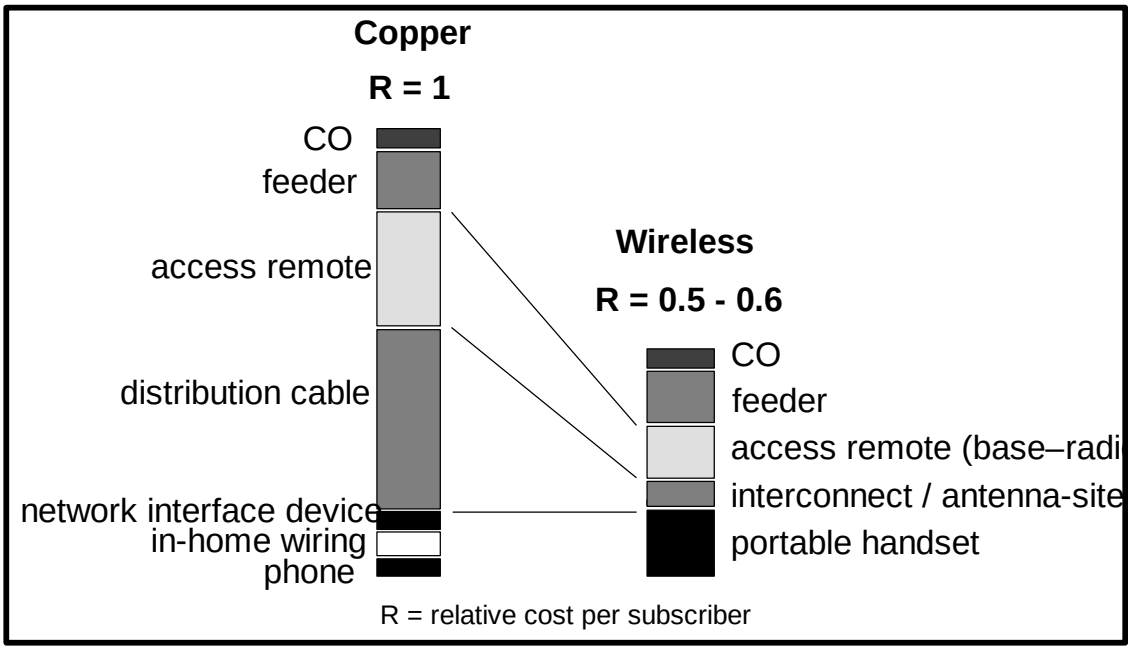


FIGURE 1

**Relative cost per subscriber**

Key advantages for fixed wireless access are:

- Reduced initial capital investment
- Rapid deployment
- Scaleability
- Operating cost savings
- Cost reduction
- Lower subscriber tariff
- Limited mobility.

**Reduced initial capital investment**

Fixed wireless access systems do not require extensive outside plant, ground/aerial cabling, excavation of trenches and other civil works, resulting in substantial reduction in initial capital investment.

**Rapid deployment**

Fixed wireless access systems allow rapid deployment of access capability and immediate generation of subscriber revenues. Once a new household is equipped with a transceiver, it can be connected to the network in minutes, instead of days or weeks. An installation of a transceiver can typically be performed by a subscriber, eliminating the need for operator technician support.

Furthermore, to add new subscribers rapidly, an operator can simply install more radio channels at an existing cell site.

**Scaleability**

Another advantage is that fixed wireless access systems can be implemented on a small scale and quickly expanded to closely respond to the growing subscriber demand, without the large steps of investment needed regardless of service demand for wireline infrastructures (Figure 2).

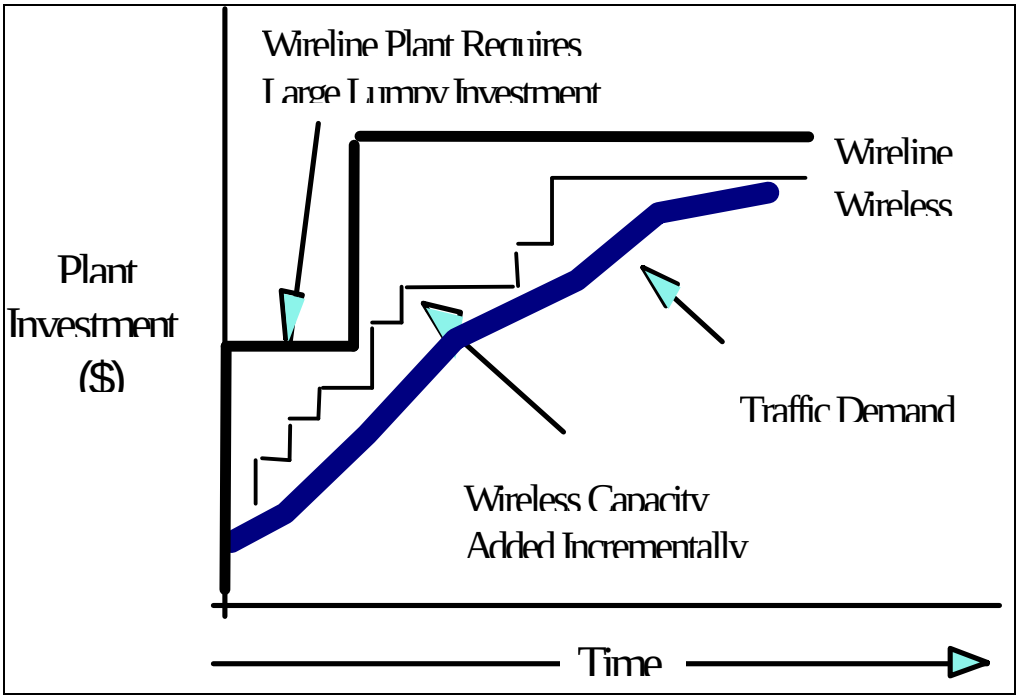


FIGURE 2

**Wireless vs. wireline infrastructure cost [Ref. 1]**

**Operating cost savings**

Relative to wireline, fixed wireless access results in operating cost savings. Less physical protection is required. Replacement costs of copper wires do not occur. Fewer trouble reports occur. It has been shown that operating costs may be reduced by as much as 25 per cent per subscriber per year.

**Cost reduction**

Historically, the cost of electronic equipment has continued to reduce significantly. Hence, for fixed wireless access, where electronics account for the bulk of the overall cost, there is a considerable potential for future cost reduction.

### Lower subscriber tariff

Lower investment and operating costs for fixed wireless access will lead to lower subscriber tariff.

### Limited mobility

Fixed wireless access systems allow a limited range of mobility. The wireless telephone can be located virtually anywhere within a cell coverage area without significantly affecting its performance.

## 4 Radio-frequency spectrum aspects

An essential network planning consideration is the choice of frequency band of operation. Factors to be taken into account include choice of spectrum, coverage area and cost considerations.

### Choice of spectrum

When determining national policies for the use of radio-frequency bands for fixed wireless access, countries should apply some flexibility in their interpretation of frequency allocations in order to balance socio-economic benefits of providing telephone service in rural areas against other services which may share the same bands. Frequency bands which are commonly used for fixed wireless access include 400, 800 and 1 900 MHz [**Ref. 2**].

### Increased coverage

Figure 3 below illustrates relative coverage areas obtained for several frequency bands. Since the free space path attenuation is proportional to frequency, the lower the frequency chosen, the greater the distance that can be covered. Hence for the examples given, a larger coverage area may be obtained at 400 MHz. In practice, a typical cell radius at 400 MHz is approximately 25 kilometres. If a greater distance is required, a higher gain antenna may be employed at the cell site and a directional external antenna used at the subscriber's location to increase the range to over 50 kilometres.

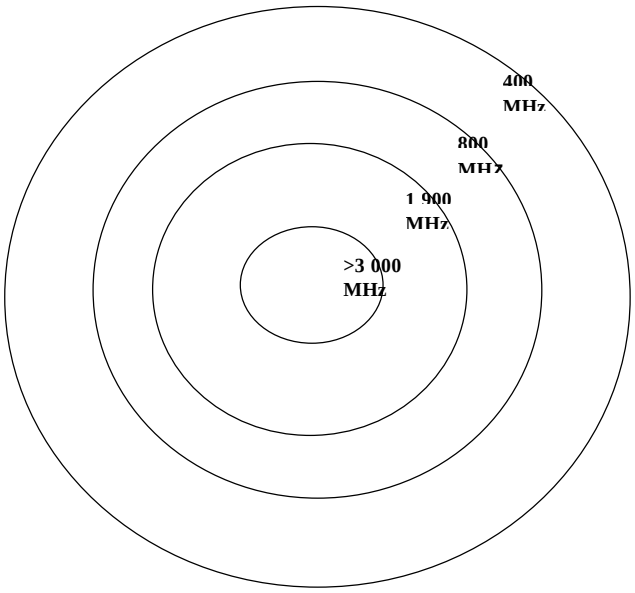


FIGURE 3

**Relative coverage for various frequency bands**

**Reduction in number of cell sites**

The choice of low frequency band of operation has the advantage that less cell sites need to be installed, thus reducing cell site acquisition costs and simplifying network backhaul to the local exchange. This translates into lower cost per subscriber line.

## 5 Example of a fixed wireless access system

The characteristics of a typical system include:

- a duplex radio channel connecting the subscriber and the cell site;
- a cell site (radio equipment, antenna and associated equipment);
- a radio controller, which manages a number of cell sites, located at a cell site or local exchange.

When a subscriber places a call, the voice signal is transmitted via the radio channel to a pre-assigned cell site, which then transmits the signal via a backhaul link to the local exchange. The call is then routed via the Public Switched Telephone Network to its destination.

An incoming call to a subscriber is first routed via the Public Switched Telephone Network to the local exchange and then to the cell site associated with the subscriber and then by radio channel to the subscriber's telephone.

This section provides an overview of a system and associated subscriber equipment, as shown in Figure 4.

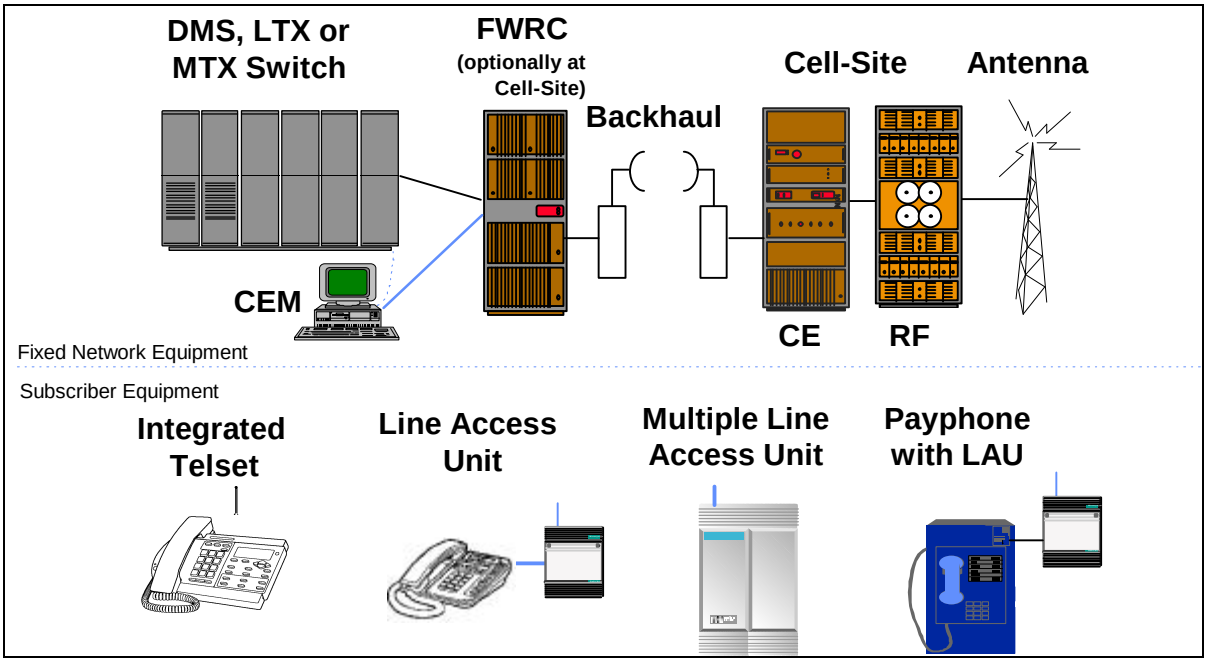


FIGURE 4

**A fixed wireless access system building blocks**

The system consists of four components:

1) Switch

This is the local exchange element which commonly exists in three configurations:

- a mobile telephone exchange (MTX) capable of both mobile and fixed services;
- any local telephone exchange (LTX) with access via a standard line interface;
- a local telephone exchange (DMS) using an alternative interface.

2) Fixed wireless radio controller

The fixed wireless radio controller (FWRC) provides the operational control functions for the cell site system and interacts with the switch for call control functions. The cell equipment manager (CEM) provides the Operations, Administration and Management (OAM) functions.

3) Cell site equipment

This provides radio equipment including the operational control functions for the cell site system and interacts with the switch for call control functions. The component includes common equipment (CE) used for backhaul, radio-frequency (RF) equipment and an antenna to communicate with subscriber terminals.

4) Subscriber equipment

This may exist in a variety of forms, the most common of which is an integrated telephone set (telset) where the radio, antenna and telephone functions are built into the unit. This integrated set can commonly accommodate other equipments such as facsimile and computer (Figure 5). Another form is where a line access unit is used to provide the subscriber radio functions and is connected to an existing telephone set. Other forms include multiple line access unit for business applications and payphone for public use. The subscriber equipment requires mains power supply and commonly includes battery backup.

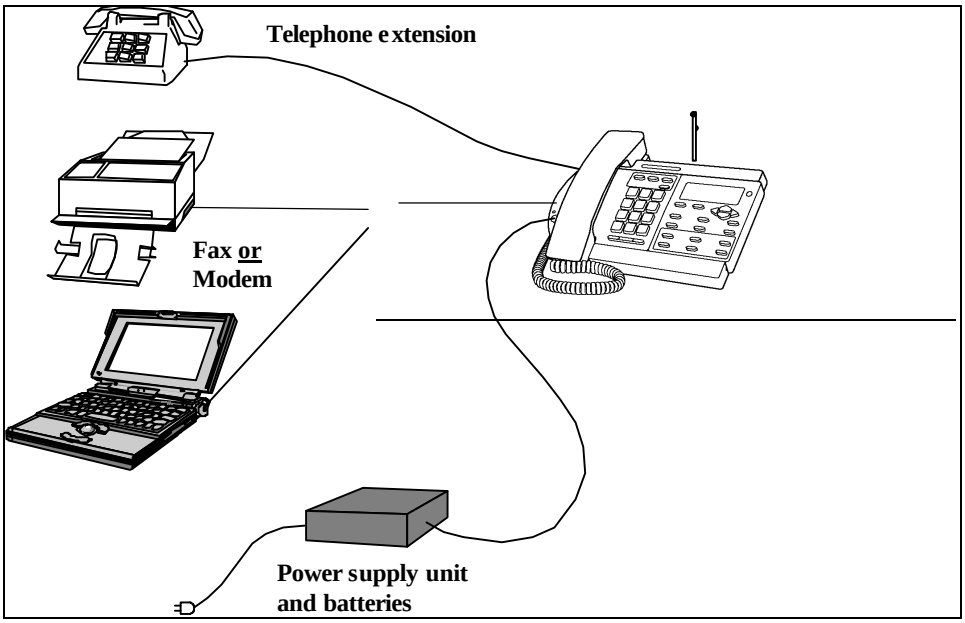


FIGURE 5

**Integrated telephone set with terminal and extensions**

## 6 Recent experience in developing countries

In recent years, Nortel has been working with operators in Africa, Eastern Europe, Middle East, Asia Pacific, Latin America and in Russia to assist them in developing network solutions using fixed wireless access. Many countries are recognizing the fixed wireless access option as a practical solution to providing low-cost access with rapid deployment, especially for low subscriber density areas. For example, the fixed wireless access option has been implemented in Mexico and Vietnam, and is being actively considered by Colombia, Egypt, Guatemala, Kenya as well as many other countries.

With regard to choice of frequency band of operation, Peru has recently allocated spectrum in the 400 MHz region. The systems implemented in Mexico and Vietnam are also operating at 400 MHz. There are several vendors which offer equipment for use in this band.

Our experience confirms the commercial viability of fixed wireless access solutions for both start-up and incumbent operators. Rapidity of service deployment positively responds to customer expectations, enhances customer satisfaction and it stimulates initial revenue generation and results in early business growth for the operator. Capital investment by operators for fixed wireless access is less than that for wireline.

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