PROJECT	IEEE P802.16 Broadband Wireless Access Study Group	
TITLE	LMDS Technologies For Broadband Wireless Local Loop Applications	
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DIST	IEEE P802.16 Working Group	
ABSTRACT	In this contribution, we propose a Broadband Wireless Local Loop (B-WLL) system concept based on LMDS millimeter-wave wireless technology. The system utilizes a modified access and backbone architecture to provide users with broadcast communications, bi-directional wideband data exchange, and mixed multiple services.	
NOTICE		

LMDS Technologies For Broadband Wireless Local Loop Applications

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Introduction

The Broadband Wireless Local Loop (B-WLL) can benefit from advances in Local to Multipoint Distribution Services (LMDS) system with large usable bandwidth to support full-duplex, high data rate applications such as high-speed Internet, interactive video, and simultaneously including hundreds of traditional broadcast and digital television channels. However, the conventional LMDS system architecture is not optimized for two-way broadband applications and requires substantial modifications and system parameter optimizations in order to guarantee cost effectiveness, higher service reliability, and increased link availability. Additionally, the current LMDS architecture suffers from complex system designs, difficult installation and alignment situations, high radiation power, excessive losses due to weather, multipath and obstructions [1-3].

In this contribution, we propose a short-range line-of-sight LMDS-like architecture for the broadband access link to serve concentrated users (e.g. tenants in large buildings) in need of wideband and Gbit applications [4,5]. Examples are college campuses, business parks, and multi-story units concentrated in densely populated regions as inner cities and downtown areas. The proposed system differs with conventional LMDS in implementations with many technological and operational advantages. The benefits are in the radio link design, Single channel Gbit bandwidth link, less complex network architecture, system integration, and compatible interface to the existing fiber and satellite core networks**.**

Broadband Wireless Local Loop System Description

The schematic of the proposed B-WLL access architecture is shown in Figure 1. The B-WLL access topology consists of three network segments, a line-of-sight short range passive access point (AP), the hybrid fiber radio (HFR) connection to the backbone network, and the integrated network/service interface segment, The system is a simplified LMDS-like cellular based point-to-multi-point architecture with the following modifications:

⇒ The conventional LMDS standard size cell of 2-5 miles in diameter is converted into a micro/pico size cell of a few tens-to-hundreds meter in radius(e.g. 50-500 m)

⇒ As shown in Figure 1, the "Hub" access is established by direct line of sight "illumination" of large buildings or cluster of small communities utilizing shaped sector antennas at the passive AP.

⇒ Select the antenna radiation pattern to serve multi-tenant buildings in areas such as college campuses, business parks, and multi-story units concentrated in densely populated regions as inner cities and downtown areas. An example is a high-rise where the building faces are illuminated by either rooftop and/or sidewall mounted waterfall type antenna shown in Figure 2 [4]. Typical customer premise antenna could be in a rod or patch form attached to an outside windows. For access scenarios such as campuses and small communities, the signal can be projected from the AP antennas mounted on the street lamp posts, adjacent building, or from the nearby water tower.

⇒ Use the spectrum availability to implement multi-user broadband service links and, if desirable, integrate with the broadcast TV channels for multi-service operations.

⇒ It is further proposed to use the existing embedded fiber to the neighborhood (now available most service areas) for the broadband backbone network integration.

⇒ Relocate the hub radio control and switching facilities to the network control and switching centers for an integrated operation.

The System Architecture Advantages:

Compared to the traditional LMDS system, the proposed direct LOS short range projection topology possesses many technological and operational advantages. These include:

⇒ Increased coverage and user penetration percentage in each individual cell due to densely positioned users in the service area. This relaxes the cell frequency and polarization reuse planning, overlapping cells design, and cell boundary coverage issues. The system cost due to the increase number of hubs are offset by the reduction of system power, design complexity, and planning expense.

⇒ The required AP and customer transmitting power (at mm-wave!) are scaled down (15-dB minimum), due to the relatively short cell diameter. The result is a low power low cost system solution with less complex MMIC hardware design.

⇒ Reduced delay spread permits for higher bit rate channels (e.g. single user link at Gbit rate!) and simplified receiver and equalizer design.

⇒ A major reduction in the system interference (adjacent channel and adjacent cell) constraints and limitations due to the elimination of high power amplifier nonlinearities.

⇒ As a result of operating the amplifier in the linear regime, there is lower adjacent channel interference, and a reduction in the required radio channel spacing is possible that leads to increased system capacity.

⇒ The near short-range propagation path is free from “major” multi-path and inter-cell interference and obstructions (buildings, moving objects, and foliage). Consequently, the propagation path loss approaches the square law and increases the system efficiency.

⇒ It is possible to combine on a single infrastructure. The consolidation results in a less complex increased reliability infrastructure with centralized data base and operations.

⇒ Improvement in the system gain margin (10-20 dB) and link availability comes from the short line of sight distance. This removes the signal reception limitation, excessive rain attenuation (7-10 dB), and the system down time experienced in higher power LMDS.

⇒ The passive AP and consolidated processing reduces the operational complexity and provides multiple mixed services on a shared single infrastructure.

Conclusion

We have introduced and described a simplified and yet cost effective high data rate system architecture to be adopted for B-WLL applications.

References

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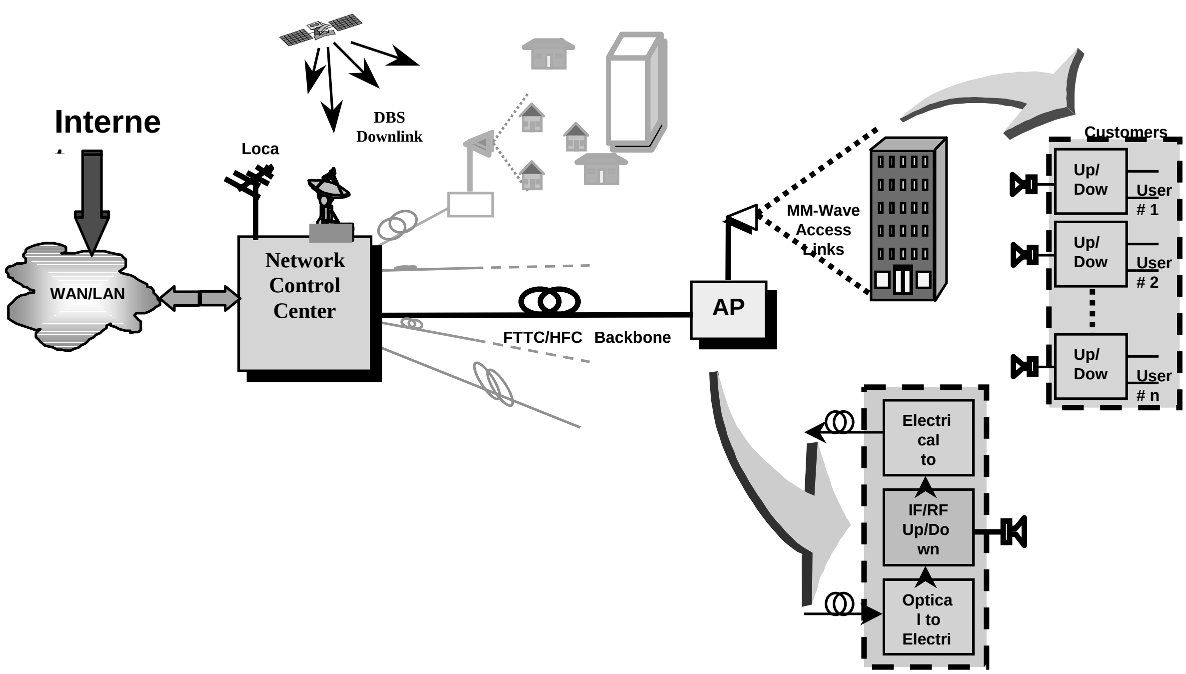

Figure 1. B-WLL Access Senarios and Architecture Based on the LMDS Technologies

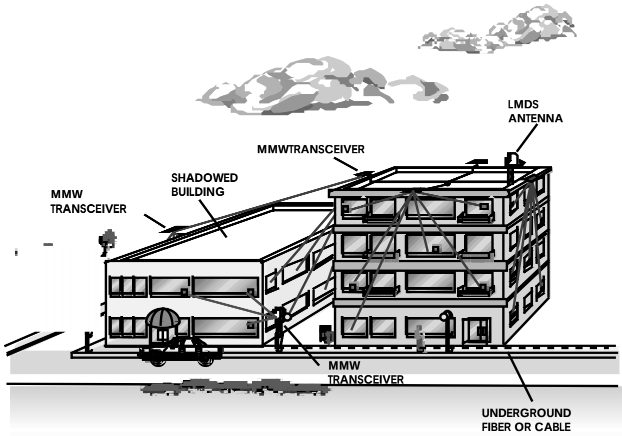

Figure 2. B-WLL Picocell Building Distribution Senarios