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(SUMMARY)

Title: **Design and Implementation Issues of a Wireless Infrared Ethernet Link**

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Abstract

The design and implementation of a wireless infrared Ethernet link is considered. It is shown that, using commercially available devices, it is technical and economically feasible to implement wireless infrared extensions of Ethernet networks, maintaining the degree of complexity in transceiver electronics at very low level. In particular, it is shown that Manchester coding can still be used in the infrared path without impairing system range and performance. This has implications both in terms of network round trip delay and transceiver costs and power consumption.

A laboratory prototype was developed and implemented using Manchester coding, and achieving a bit error rate of 10^{-10} over a range typical of normal office environments. The utilization of low cost lenses, both for LED's radiation pattern correction and as optical power collecting elements was investigated and shown to provide significant performance improvements.

A companion paper [1], addresses the specific network architecture and topology issues associated with the utilization of wireless infrared links, in combination with cable based Ethernet LANs.

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Introduction

In the past few years, several wireless systems for in-house applications have became commercially available. Audio broadcast systems, wireless telephones, remote control units and cableless Local Area Networks are examples of such systems. The introduction of this concept, offering a wide range of new services, is being studied by several authors [1], trying to collect information and developing a set of methodologies for the correct specification and utilization of these new systems. Among these systems, cableless Local Area Networks (cLANs) seem to have a great impact on the office automated environment, where easy terminal reconfiguration, mobility and the reduction on the number of cables are very important factors.

In the development of cableless LANs, two technologies have been used for the transmission of the information: radio frequency and optical infrared radiation. Both of these technologies have its advantages and drawbacks.

The use of radio frequency, including microwaves, requires the permission of the governmental institutions who regulate the use of the electromagnetic spectrum. In the cases where this is possible, the frequency band allocated for these services is, usually, very narrow (at most 20 MHz). Moreover, the electromagnetic spectrum is already crowded and systems based on radio frequency have to deal with high levels of noise and interference. However, radio frequency provides the best way to implement mobile systems, since no line-of-sight is necessary between emitters and receivers, and

[1] Rui T. Valadas and alli
"Network design aspects of Hibrid (Wireless Infrared / Coaxial) Ethernet LANs"

commercial systems have been developed using spread spectrum techniques to overpass noise and interference.
On the other hand, optical infrared radiation, as it is confined to the room where it is being used, does not requires permission for its use (at least in most countries), provides easy spectrum reallocation and is not affected by other similar systems working in the neighbourhood. The major problem in using optical infrared signals, is that it is not easy to achieve high data rates without a line-of-sight between emitter and receiver.
Then, systems developed until now have data rates up to a few Mbits/seg. When higher speed is required, the use of optical infrared radiation seems to be more favorable, and more complex signal processing techniques have to be used including modulation, line coding and optical filtering.
Another important issue addressed is related to the maximum optical power levels admitted for human eye safety operation of such systems. It is shown that the required power levels are well above the maximum allowed limits.

Reference model and design options

This paper describes the design and development of an infrared link at 10 Mbps as the transmission system for a wireless Ethernet LAN. The physical configuration of the system is presented in figure 1.

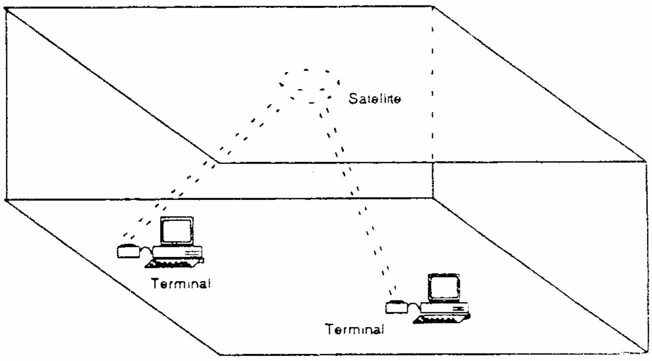

Figure 1. Typical configuration.

Each terminal is connected to the satellite via a bidireccional infrared link at 10 Mbps and the satellite acts like an active reflector, transmitting all the signals emitted by the terminals. The aspects of network architecture and topology are addressed in a companion paper [2].
As the data rate is very high, a line-of-sight between each terminal equipment and the satellite should be provided. Otherwise, an enormous amount of optical power should be used to assure that enough power reaches the receiver through reflections from the walls, ceiling and floor, thus creating a diffuse system [3].
On the implementation of an infrared link at this speed, the selection of the appropriate optoelectronic devices and used techniques should be very careful. LEDs should be powerful, fast and exhibit a convenient radiation pattern. PINs should have large active areas, in order to collect the maximum optical power, keeping the parasitic capacitance as low as possible. Since these devices do not always exist, some optical processing is required. This paper reports the development of an analytical model for the use of low cost lenses, both for LED's radiation pattern correction and as optical power collecting elements. Experimental results are presented that illustrate the improvements achieved using lenses to correct the radiation pattern of LEDs and validate the theoretical model developed for the LED-lens radiation pattern.
The other problem one have to deal with is noise due to background light. Since this is the dominant noise source, in particular at the low frequency band of the spectrum, signal processing techniques should be used in order to reduce the low frequency components of the transmitted signal. In the link reported here, Manchester coding was found to be a simple and efficient solution.
The receiver sensitivity is calculated using a modified version of the Personick model, where noise due to ambient light is considered. The overall link performance and range is calculated, considering optoelectronic devices limitations, and experimental results are presented that validate the theoretical calculations.