Wireless Gigabit Local Area Network

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The exploding number of electronic devices or "appliances" requiring high bandwidth communication will continue to drive the need for higher speed (Gigabit-per-second, Gb/s) networking. We assume that the Next Generation Internet (NGI) will carry high-speed data to and from the home or office. However, a Local Area Network (LAN) within these structures is necessary to continue high-speed data transmission to and from end-use devices, such as cameras, displays, printers, high resolution video, mobile communicators, and novel devices. The enabling technology for this rich set of applications is a wireless Gb/s LAN, (WiGLAN), connected to the NGI.

The WiGLAN offers several research challenges. First, there is a wide range of data rates, quality of service, and need for real time transmission to and from the appliances. For example, voice transmission over the network will not require high data rates but may require low power dissipation for portability. Interactive video transmission requires real time transmission and very high data rates especially as high resolution video and 3D graphics become available. System resources will need to be adaptive in order to support this wide range of appliances. Second, since many of the appliances will require portability, low power design techniques at the circuit, chip architecture and overall system level will be required. Third, this research requires synergy between a variety of disciplines including, communication system design at the physical layer, low power circuit and system design, digital signal processing algorithm and IC design, mixed signal IC design, and RFIC design. It also lends itself to a number of demonstration projects using some of the technology which results from this research. Besides the educational component of the PhD researchers directly involved, this program will generate a number of IC's and algorithms which can be demonstrated by Masters student design projects.

A block diagram of the Wireless Gigabit Local Area Network, WiGLAN, is shown in Figure 20. We envision a network server being the gateway between the NGI and the local area network. Each appliance is attached to the network through a WiGLAN adapter, which is capable of providing a wireless connection to the network. This adapter should be physically small, implying a high degree of integration of the electronic functions required to interface digital data from the appliance to and from the network. The quality of service, QoS, which is a function of data rate and bit error rate, should be scaleable with power dissipation to permit battery operation of many appliances.

The network requirements of high bandwidth efficiency and real time transfer led to our choice of a multi-carrier modulation, such as Orthogonal Frequency Division Multiplexing, (OFDM) using M-Quadrature Amplitude Modulation, (MQAM) signal constellations. We plan to digitize the entire signal bandwidth (150 MHz) available at the 5.8 GHz ISM band and adapt the bit rate (change M) within sub-bands according to the available Signal-to-Noise Ratio (SNR) and interference in the sub-band. A programmable digital signal processor will perform this adaptive modulation.

The adaptive bit rate processor located in the network server will estimate the channel capacity by measuring the SNR and interference within sub-bands across the entire 150 MHz signal band. The channel estimation algorithm is a subject of this research. Depending on the SNR and interference, data modulation will range from simple phase shift keying (PSK) up to 256 level QAM with intermediate levels of QAM, (i.e. 4-QAM, 16-QAM, etc.) allowing for transmission of approximately 1b/Hz for PSK up to 8b/Hz for 256-QAM.

In order to provide the capacity enhancements required to support the target data rates, the system to be developed will make extensive use of multiple-element antenna arrays for both transmission and reception. A key component of the proposed research will therefore be the development of computationally and power efficient space-time coding and space-time processing algorithms that exploit the substantial diversity benefit inherent in the use of such antenna arrays. At the implementation level, multiple-element antenna arrays require a separate receive and transmit channel for each antenna element. To efficiently meet this requirement we propose to build a system of parallel radios divided into three distinct Integrated circuits, namely RF, Mixed signal, and DSP.

The WiGLAN network adapter consists of three functions, digital signal processing for multi-carrier adaptive bit rate QAM, a baseband analog processor performing data conversion and filtering, and an RF transceiver function which interfaces the modulated baseband data to a 5.8 GHz carrier. We will design and characterize integrated circuits to perform these functions.

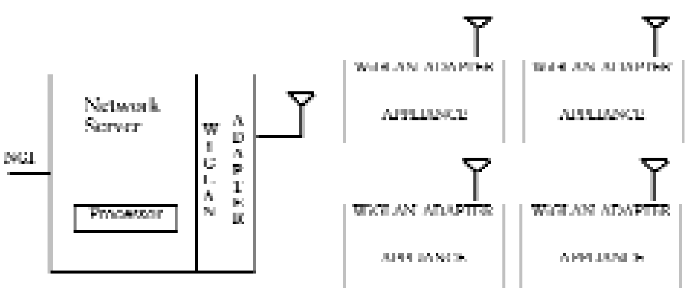

Fig. 20: Wireless Gigabit Local Area Network