

Ultra-Wideband Systems for Data Communications

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Ultra wideband (UWB, also known as baseband or impulse radio, is a carrier-free radio transmission that uses narrow, extremely low power pulses of radio energy spread across a wide spectrum of frequencies. UWB communications are required to have a -10 dB fractional bandwidth of more than 20% or a -10 dB bandwidth of more than 500 MHz. UWB systems have strong advantages over conventional continuous wave radio transmissions which include high data rates, low probability of multipath fading, highly secure, extremely difficult to intercept, allow for frequency diversity, low power requirements, low cost and a simple design for the wireless transceivers.

UWB has been used in military applications for the past several years for ground-penetrating precision radar applications and secure communications. In the past few years this technology is being developed for commercial applications. With the recent FCC first order and ruling for the use of UWB technology for indoor and outdoor applications, there has been an added impetus to this endeavor. Other UWB applications include collision avoidance radar, tagging/identification, geolocation and data communications in personal area networks (PAN) and local area network (LAN) environments.

We look at UWB technology from a networking perspective for data communications in wireless LANs and PANs and take a closer look at the UWB physical (PHY) layer characteristics and the attributes of Medium Access Layer (MAC) that can be used with a UWB PHY. We compare the UWB with other wireless technologies like 802.11a/b, Bluetooth, HomeRF, Hiperlan I/II and take a look at the standardization effort, the players in the UWB space, the different data communication applications like ad-hoc networking, wireless PAN/LAN, cable replacement and home networking. We also present a brief synopsis of the regulatory effort worldwide with special emphasis on the FCC.

UWB presents a great opportunity for data communications for today's media-rich consumer and home applications that run on battery powered, handheld devices. It can be a potential low-cost, low power and very high data rate solution as a wireless "cable replacement" technology for computer-to-peripherals and digital home networking applications replacing USB, IEEE 1394 or the ordinary serial/parallel cables. A very useful attribute of UWB technology is its ability to perform precision geolocation which can aid in ad-hoc or mesh networking, where the operations of the mobile hosts benefit by knowing the location of the other hosts. UWB promises to be a technology to fill the void left by established technologies like Bluetooth and 802.11a/b. We detail a comparison of UWB with the other wireless technologies in this paper.

There are several future challenges to the wide adoption of UWB for wireless data communications including the infancy of the technology in the commercial arena, lack of reliable channel models, the early stages of standardization effort and lack of low-cost system on chip (SoC) implementations. We will discuss these challenges in more detail.