QUESTIONS & ANSWERS ON UWB COMMUNICATIONS

1. What is Ultra-Wideband (UWB) technology?

Ultra-wideband (UWB) is a radio transmission with a spectrum that occupies more than 20 percent of the center frequency, or a minimum of 500 MHz while adhering to certain output power limits. UWB technology offers flexibility, robustness, and good ranging capabilities, making it well suited for applications that need a high data rate over a short transmission range.

2. How far can UWB signal be transmitted?

Because the goal of UWB is to transmit higher bandwidth signals at low power output, the range is not meant to surpass what is called a Wireless Personal Area Network (WPAN), and general maximum distance for transmission is 30 feet or 10 meters.

3. Are there any signal interference of UWB and other wireless technologies?

UWB operates at a low power frequency range of 3.1GHz to 10.6 GHz. This is out of the range of all other wireless technologies (802.11g and 802.11g), and devices such as microwaves ovens and cordless phones that typically operate in the 2.4GHz range.

One of the main goals of UWB is to allow streaming video wirelessly, and in order for that to be successful, it needs its own spectrum to operate and alleviate interference. If WPAN were to use a wireless technology that operated in the 2.4GHz range, there would be limited space to send signals without interference. There are no signal interference challenges with using UWB technology which makes it a premier choice for WPANs.

4. Name and discuss three features of UWB which make attractive for use in consumer applications.

UWB has a number of features which make it attractive for consumer communications applications. In particular, UWB systems

(i) UWB have potentially low complexity and low cost as compared with other wideband technologies. Unlike conventional systems, the UWB transmitter produces a very short time-domain pulse which is able to propagate without the need for an additional RF (radio frequency) mixing stage. The RF mixing stage takes a baseband signal and “injects” a carrier frequency or translates the signal to a frequency which has desirable propagation characteristics. The very wideband nature of the UWB signal means that it spans frequencies commonly used as carrier frequencies. The signal will propagate well without the need for additional up-conversion. The reverse process of down-conversion is also not required in the UWB receiver. Again, this means the omission of a local oscillator in the receiver, and the removal of associated complex delay and phase tracking loops. The very wideband nature of the UWB signal means that it spans frequencies commonly used as carrier frequencies. The signal will propagate well without the need for additional up-conversion. The reverse process of down-conversion is also not required in the UWB receiver. Again, this means the omission of a local oscillator in the receiver, and the removal of associated complex delay and phase tracking loops.

(ii) UWB have a noise-like signal spectrum. Due to the low energy density and the pseudo-random (PR) characteristics of the transmitted signal, the UWB signal is noise-like which makes unintended detection difficult. Whilst there is some debate, it appears that the low-power, noise-like UWB transmissions do not cause significant interference to existing radio systems.

(iii) UWB are resistant to severe multipath and jamming. Because of the large bandwidth of the transmitted signal, very high multipath resolution is achieved. The large bandwidth offers (and also requires) huge frequency diversity, which together with the discontinuous transmission makes the UWB signal resistant to severe multipath propagation and jamming/interference.

(iv) UWB have very good time-domain resolution allowing for location and tracking applications. The very narrow time-domain pulses mean that UWB radios are potentially able to offer timing precision much better than GPS and other radio systems. Together with good material penetration properties, UWB signals offer opportunities for short-range radar applications such as rescue and anti-crime operations, as well as in surveying, and in the mining industry

(Any 3x2 = 6 marks)

5. Which IEEE study group is charged with the responsibility of UWB standards? Briefly explain its terms of reference.

MODEL ANSWER

The IEEE established the 802.15.3a Study Group to define a new physical layer concept for short-range, high-data-rate applications. This alternative physical (ALT PHY) layer is intended to serve the needs of groups wishing to deploy high-data rate applications. With aminimumdatarateof110Mbpsat10m, this study group intends to develop a standard to address such applications as video or multimedia links, or cable replacement. Whilst not specifically intended to be an UWB standards group, the technical requirements lend themselves very much to the use of UWB technology.

The study group has been the focus of significant attention recently as the debate over competing UWB physical layer technologies has raged. The work of the study group also includes analyzing the radio channel model proposal to be used in the UWB system evaluation. The purpose of the study group is to provide a higher-speed physical layer (PHY) candidate for the existing, approved802.15.3 medium access standard. The targeted applications are those which involve imaging and multimedia [14].

The main desired characteristics of the alternative PHY are

(i) coexistence with all existing IEEE 802 physical layer standards;

(ii) target data rate in excess of 100Mbps for consumer applications;

(iii) robust multipath performance;

(iv) location awareness;

(v) use of additional unlicensed spectrum for high-rate WPANs (wireless personal area network).