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Bluetooth 2 - Enhanced Data Rate, EDR

- summary of Bluetooth Enhanced Data Rate, EDR detailing the upgrades to the Bluetooth specification that enables it to attained much higher data rates and improved performance.

Bluetooth tutorial includes:

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Bluetooth EDR or Bluetooth 2 is an upgrade of the original Bluetooth specification. It based on the original Bluetooth standard which is well established as a wireless technology. It has found a very significant number of applications, particularly in areas such as connecting mobile or cell phones to hands-free headsets.

One of the disadvantages of the original version of Bluetooth in some applications was that the data rate was not sufficiently high, especially when compared to other wireless technologies such as 802.11. In November 2004, a new version of Bluetooth, known as Bluetooth 2 was ratified. This not only gives an enhanced data rate but also offers other improvements as well.

Of all the features included in Bluetooth 2, it is the enhanced data rate (EDR), facility that is giving rise to the most comment. In the new specification the maximum data rate is able to reach 3 Mbps, a significant increase on what was available in the previous Bluetooth specifications.

Why is Bluetooth 2 needed?

As proved particularly by the computer industry, there is always a need for increased data rates, and ever increasing capacity. With this in mind and the fact that the previous version of Bluetooth, version 1.2 allowed a maximum data rate of 1 Mbps which reflected in a real throughput of 723 kbps, the next specification should allow many new applications to be run. In turn this will open up the market for Bluetooth even more and allow further application areas to be addressed.

While speed on its own opens up more opportunities, the strategy behind Bluetooth 2 with its enhanced data rate is more deep rooted. When the Bluetooth 2 specification was released there were no applications that were in immediate need of the new enhanced data rate. For example even a high quality stereo audio stream required a maximum of only 345 kbps.

audio, but other applications such as running computer peripherals will increase. The reason becomes clearer when looking at real situations when interference is present. Typically it is found that a good margin is required to allow for re-sends and other data. Under Bluetooth 1.2, high quality stereo audio can be sent on its own within the available bandwidth and with sufficient margin. However when other applications are added there is not sufficient margin to allow for the system to operate satisfactorily. Bluetooth 2 solves this problem and enables sufficient bandwidth for a variety of links to be operated simultaneously, while still allowing for sufficient bandwidth margin within the system.

There are other advantages to running Bluetooth 2. One of the major elements is in terms of power consumption. Although the transmitter and receiver and logic need to be able to handle data at a higher speed which normally requires a higher current consumption, this is more than outweighed by the fact that they need only to remain fully active for about a third of the time. This brings significant advantages in terms of battery life, a feature that is of particular important in many of the Bluetooth applications.

Compatibility is a major requirement when any system is upgraded. The same is true for Bluetooth, and this has been a major requirement and concern when developing the Bluetooth 2 standard. The new standard is completely backward compatible and allows networks to contain a mixture of EDR (enhanced data rate) devices as well as the standard devices. A key element of this is that the new modulation schemes that have been incorporated into Bluetooth 2 are compatible in their nature with the standard rate specification. In this way the new standard will be able to operate with any mixture of devices from whatever standard.

How it works

One of the main reasons why Bluetooth 2 is able to support a much higher data throughput is that it utilises a different modulation scheme for the payload data. However this is implemented in a manner in which compatibility with previous revisions of the Bluetooth standard is still retained.

Bluetooth data is transmitted as packets that are made up from a standard format. This consists of four elements which are: (a) The Access Code which is used by the receiving device to recognise the incoming transmission; (b) The Header which describes the packet type and its length; (c) The Payload which is the data that is required to be carried; and finally (d) The Inter-Packet Guard Band which is required between transmissions to ensure that transmissions from two sources do not collide, and to enable the receiver to re-tune.

In previous versions of the Bluetooth standard, all three elements of the transmission, i.e. Access Code, Header and Payload were transmitted using Gaussian Frequency Shift Keying (GFSK) where the carrier is shifted by +/- 160 kHz indicating a one or a zero, and in this way one bit is encoded per symbol.

The Bluetooth 2.0 specification uses a variety of forms of modulation. GFSK is still used for transmitting the Access Code and Header and in this way compatibility is maintained. However other forms of modulation can be used for the Payload. There are two additional forms of modulation that have been introduced. One of these is mandatory, while the other is optional.

A further small change is the addition of a small guard band between the Header and the payload. In addition to this a short synchronisation word is inserted at the beginning of the payload.

Mandatory modulation format

The first of the new modulation formats which must be included on any Bluetooth 2 device gives a twofold improvement in the data rate and thereby allows a maximum speed of 2 Mbps. This is achieved by using pi/4 differential quaternary phase shift keying (pi/4 DQPSK). This form of modulation is significantly different to the GFSK that was used on previous Bluetooth standards in that the new standard uses a form of phase modulation, whereas the previous ones used on frequency modulation.

Using quaternary phase shift modulation means that there are four possible phase positions for each symbol. Accordingly this means that two bits can be encoded per symbol, and this provides the two fold data increase over the frequency shift keying used for the previous versions of Bluetooth.

Higher speed modulation

used. Eight phase differential phase shift keying (8DPSK) enables eight positions to be defined with 45 degrees between each of them. By using this form of modulation eight positions are possible and three bits can be encoded per symbol. This enables the data rate of 3 Mbps to be achieved.

As the separation between the different phase positions is much smaller than it was with the QPSK used to provide the two fold increase in speed, the noise immunity has been reduced in favour of the increased speed. Accordingly this optional form of modulation is only used when a link is sufficiently robust.

Packet formats

The Bluetooth 2 specification defines ten new packet formats for use with the higher data rate modulation schemes, five each for each of the enhanced data rate schemes. Three of these are for the 1, 3 and 5 slot asynchronous packets used for transferring data. The remaining two are used for 3 and 5 slot extended Synchronous Connection Orientated (eSCO) packets. These use bandwidth that is normally reserved for voice communications.

The new format for these packets does not incorporate FEC. If this is required then the system switches back automatically to the standard rate packets. However many of the links are over a very short range where the signal level is high and the link quality good.

It is necessary for the packet type to be identified so that the receiver can decode them correctly, knowing also the type of modulation being used. An identifier is therefore included in the header which is sent using GFSK. This packet header used for the previous version of Bluetooth only used 4 bits. This gave sufficient capability for the original system. However there was insufficient space for the additional information that needed to be sent for Bluetooth 2.

It was not possible to change the header format because backward compatibility would not be possible. Instead different link modes are defined. When two Bluetooth 2 or EDR devices communicate the messages are used in a slightly different way, indicating the Bluetooth 2 or EDR modes. In this way compatibility is retained while still being able to carry the required information.

Bluetooth 2 / EDR is a significant improvement to Bluetooth and will enable it to retain its position in the market place. Its introduction, as the Bluetooth has become more widely accepted and used will enable it to build on its position within the market place.

By Ian Poole

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