SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECT312 – EMBEDDED SYSTEM DESIGN

III YEAR/ VI SEMESTER

UNIT II-DEVICES AND EMERGING BUS STANDARDS

TOPIC – USB

USB

As personal computers and other microprocessor based embedded systems began handling photographic images, audio, video and other bulky data, the traditional communications buses are not enough to carry the data as fast as it is desired.

IBM, Intel, Microsoft, Compaq, Digital Equipment, NEC and Northern Telecom got together and developed USB.

USB

The USB is a medium-speed serial data bus designed to carry relatively large amounts of data over relatively short cables:

up to about **five meters long.** It can support data rates **of up to 12Mb/s** (megabits per second).

The USB is an addressable bus system, with a seven-bit address code so it can support up to 127 different devices or nodes at once (the all zeroes code is not a valid address).

However it can have only one host. The host with its peripherals connected via the USB forms a star network.

On the other hand any device connected to the USB can have a number of other nodes connected to it in daisy-chain fashion,

mini-star sub-network.

Similarly you can have a device which purely functions as a hub for other node devices, with no separate function of its own.

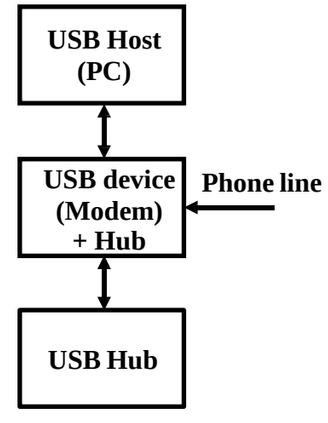
USB

This expansion via hubs is because the USB supports a tiered star topology, as shown in Fig..

Each USB hub acts as a kind of traffic cop for its part of the network, routing data from the host to its correct address and preventing bus contention clashes between devices trying to send data at the same time.

On a USB hub device, the single port used to connect to the host PC either directly or via another hub is known as the upstream port, while the ports used for connecting other devices to the USB are known as the downstream ports.

Fig.1 The USB is a medium speed serial bus used to transfer data between a PC and its peripherals. It uses a tiered star configuration, with expansion via hubs (either separate, or in USB devices).



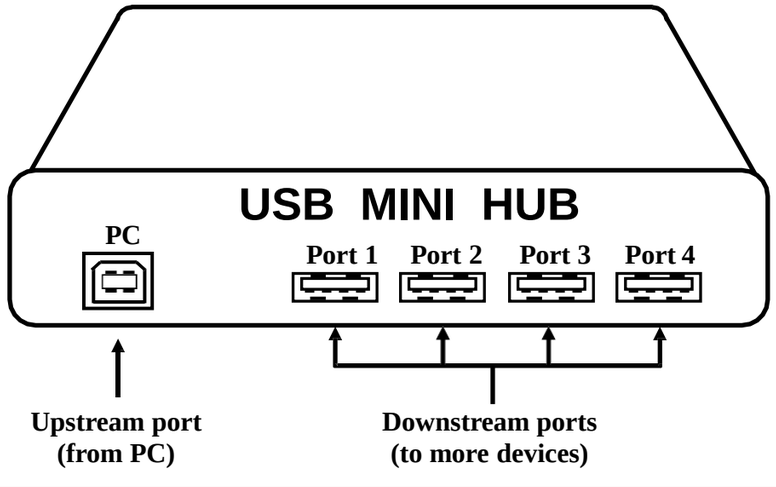
USB

This is illustrated in Fig.2. USB hubs work transparently as far as the host PC and its operating system are concerned.

Most hubs provide either four or seven downstream ports, or less if they already include a USB device of their own.

Another important feature of the USB is that it is designed to allow hot swapping i.e. devices can be plugged into and unplugged from the bus without having to turn the power off and on again, re-boot the PC or even manually start a driver program.

A new device can simply be connected to the USB, and the PC's operating system should recognize it and automatically set up the necessary driver to service it.



USB

Fig.2 The port on a USB device or hub which connects to the PC host (either directly or via another hub) is known as the upstream port, while hub ports which connect to additional USB devices are downstream ports.

•Downstream ports use Type A sockets,

•while upstream ports use Type B sockets.

POWER AND DATA

•USB cables consist of two twisted pairs of wires,

•one pair used to carry the **bidirectional serial data**

•other pair for **5V DC power.**

•This makes it **possible for low-powered peripherals** such as a **mouse, joystick or modem** to be powered directly from the USB or strictly from the host (or the nearest hub) upstream, via the USB.

•Most **modern PCs have two USB ports**, and each can provide **up to 500mA** of **5V DC power** for bus powered peripherals Individual peripheral devices (including hubs) can draw a maximum of 100mA from their upstream USB port, so if they require less than this figure for operation they can be bus powered.

USB

If they need more, they have to use their own power supply such as a plug-pack adaptor.

Hubs should be able to supply up to 500mA at 5V from each downstream port, if they are not bus powered.

Serial data is sent along the USB in differential or push-pull mode, with opposite polarities on the two signal lines.

This improves the signal-to-noise ratio (SNR), by doubling the effective signal amplitude and also allowing the cancellation of any common-mode noise induced into the cable.

The data is sent in non-return-to-zero (NRTZ) format, with signal levels of 3.3V peak (i.e., 6V peak differential).

USB

USB cables use two different types of connectors:

1. Type-A plugs for the upstream end,
2. Type B plugs for the downstream end.

Hence the USB ports of PCs are provided with matching Type-A sockets, as are the downstream ports of hubs, while the upstream ports of USB devices (including hubs) have Type B sockets.

Type-A plugs and sockets are flat in shape and have the four connections in line, while Type B plugs and sockets are much squarer in shape and have two connections on either side of the centre spigot (Fig.3).

USB

Data formats (Fig.5)

USB data transfer is essentially in the form of packets of data, sent back and forth between the host and peripheral devices.

However because USB is designed to handle many different types of data, it can use **four different data formats** as appropriate.

1.One of the two main formats is bulk asynchronous mode, which is used for transferring data that is not time critical. The packets can be interleaved on the USB with others being sent to or from other devices.

2.The other main format is isochronous mode, used to transfer data that is time critical such as audio data to digital speakers, or to/from a modem. These packets must not be delayed by those from other devices.

3.The two other data formats are interrupt format, used by devices to request servicing from the PC/host,

4.control format, used by the PC/host to send token packets to control bus operation, and by all devices to send handshake packets to indicate whether the data they have just received was OK (ACK) or had errors (NAK).

USB

Data formats

Some of the data formats are illustrated in Fig.5. Note that all data packets begin with a sync byte (01hex), used to synchronize the PLL (phase-locked loop) in the receiving device's USB controller.

- This is followed by the packet identifier (PID), containing a four-bit nibble (sent in both normal and inverted form) which indicates the type of data and the direction it is going in (i.e., to or from the host).

- Token packets then have the 7-bit address of the destination device and a 4-bit end point field to indicate which of that device's registers it's to be sent to.

USB

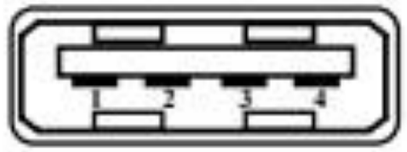
•On the other hand data packets have a data field of up to 1023 bytes of data following the PID field, while **Start of Frame (SOF**) packets have an 11-bit frame identifier instead and handshake packets have no other field.

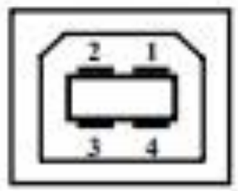
•Most packets end with a **cyclic redundancy check** (CRC) field of either five or 16 bits, for error checking, except handshake packets which rely on the redundancy in the PID field.

•All USB data is sent serially, of course, and least- significant-bit (LSB) first.

•Luckily all of the fine details of USB handshaking and data transfer are looked after by the driver software in the host and the firmware built into the USB controller inside each USB peripheral device and hub

USB





Type A socket (from front)

Pin connections	
Pin No.	**Signal**
1	+ 5V Power
2	- Data
3	+ Data
4	Ground

Fig. 3 Pin connections for the two different types of USB socket, as viewed from the front.

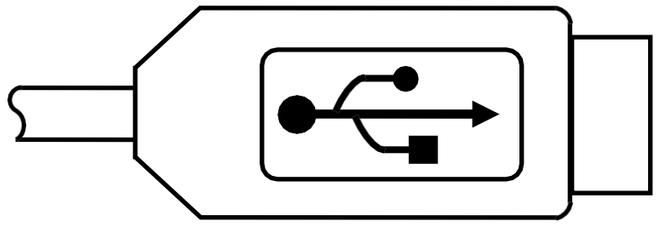


Fig. 4 Most USB plugs have this distinctive marking symbol.

USB

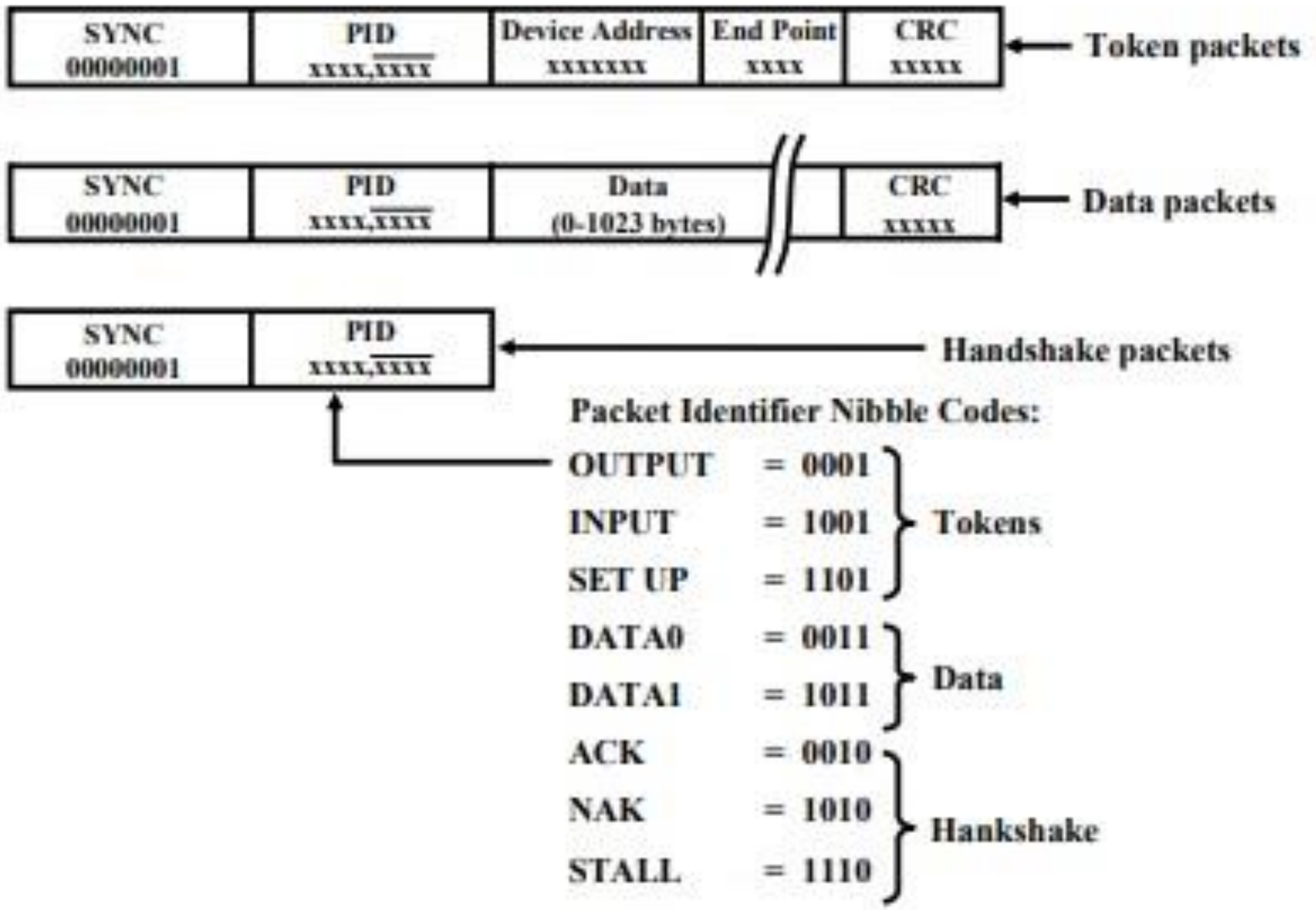


Fig. 5 Examples of the various kinds of USB signaling and data packets.

SUMMARY & THANK YOU