RASPBERRY PI

Raspberry Pi is a small single board computer. By connecting peripherals like Keyboard, mouse, display to the Raspberry Pi, it will act as a mini personal computer.

It is a series of small single board computers (SBCs) developed in the UK by Raspberry Pi Ltd in association with Broadcom. The Raspberry Pi project originally leaned toward the promotion of teaching basic computer science in schools. It is widely used in many areas, such as for weather monitoring, because of its low cost, modularity, and open design. It is typically used by computer and electronic hobbyists, due to its adoption of the HDMI and USB standards.

Raspberry Pi is popularly used for real time Image/Video Processing, IoT based applications and Robotics applications.

Raspberry Pi is slower than laptop or desktop but is still a computer which can provide all the expected features or abilities, at a low power consumption.

Versions of Raspberry pi models

1. **Raspberry Pi 1 Model A**
2. **Raspberry Pi 1 Model A+**
3. **Raspberry Pi 1 Model B**
4. **Raspberry Pi 1 Model B+**
5. **Raspberry Pi 2 Model B**
6. **Raspberry Pi 3 Model B**
7. **Raspberry Pi Zero**

OS for Raspberry Pi

The Raspberry Pi Foundation officially offers the Raspbian OS, a Debian based operating system tailored specifically for Raspberry Pi. Additionally, they provide NOOBS (New Out of the Box Software) for easy installation of various operating systems. While Raspbian is the primary and officially recommended OS, users have the flexibility to explore third-party alternatives such as Ubuntu, Arch Linux, RISC OS, Windows 10 IoT Core, among others.

Raspbian OS, optimized for Raspberry Pi, is freely available. It boasts a user-friendly graphical interface encompassing essential tools for web browsing, Python programming, office applications, and games.

To run these operating systems, a minimum 8 GB SD card is recommended. This serves as the storage medium for the OS and associated files, offering a cost-effective solution for users.

The Raspberry Pi is more than just a computer; it opens access to onchip hardware, particularly the **GPIO (General Purpose Input/Output)** pins. These GPIO pins enable users to develop applications that interact with the physical world. By utilizing GPIO, users can connect and control various devices like LEDs, motors, sensors, providing a hands-on experience in hardware development. These are upward projecting pins in a cluster on one side of the board. The oldest models of the Raspberry Pi had 26 pins, but most have 40 GPIO pins. These pins are sensitive and should be handled carefully. They are essential parts of the Raspberry Pi device as they add to its diverse applications. GPIO pins are used to interact with other electronic circuits. They can read and control the electric signals from other boards or devices based on how the user programs them.

In essence, Raspberry Pi serves as an affordable and versatile platform, offering an array of operating systems to cater to diverse user preferences. Its integration with GPIO pins encourages exploration into the realm of physical computing, making it an ideal choice for both beginners and experienced developers.

Raspberry Pi processor

It has ARM based Broadcom Processor SoC along with on chip GPU (Graphics Processing Unit).

The CPU speed of Raspberry Pi varies from 700 MHz to 1.2 GHz. Also, it has onboard SDRAM that ranges from 256 MB to 1 GB.

Raspberry Pi also provides on chip SPI, I2C, I2S and UART modules.

Breaking down each aspect:

1. ARM based Broadcom Processor SoC:

The Raspberry Pi uses a System on Chip (SoC) design, which means that various essential components are integrated into a single chip. The central processing unit (CPU), memory, and other components are housed in this single chip.

The processor architecture is ARM based, which is a type of Reduced Instruction Set Computing (RISC) architecture commonly used in mobile devices, embedded systems, and increasingly in other computing applications due to its power efficiency.

2. On chip GPU (Graphics Processing Unit):

The GPU is integrated directly onto the same chip as the CPU. It handles graphics related tasks, such as rendering images, videos, and graphical user interfaces (GUIs). This integration is important for multimedia applications and visual output.

3. CPU Speed:

The CPU speed refers to the clock speed of the central processing unit, measured in gigahertz (GHz). It determines how quickly the CPU can execute instructions and process data.

The Raspberry Pi models have varying CPU speeds, ranging from 700 MHz to 1.2 GHz. Higher CPU speeds generally result in better overall performance.

4. Onboard SDRAM (System Dynamic Random Access Memory):

SDRAM is the primary volatile memory used by the Raspberry Pi to store data actively being used by the system and applications.

The onboard SDRAM capacity ranges from 256 MB to 1 GB in different Raspberry Pi models. Sufficient RAM is crucial for running applications smoothly and accommodating multitasking.

5. On chip Modules (SPI, I2C, I2S, UART):

SPI (Serial Peripheral Interface): A synchronous serial communication protocol allowing the Raspberry Pi to communicate with external devices like sensors and displays.

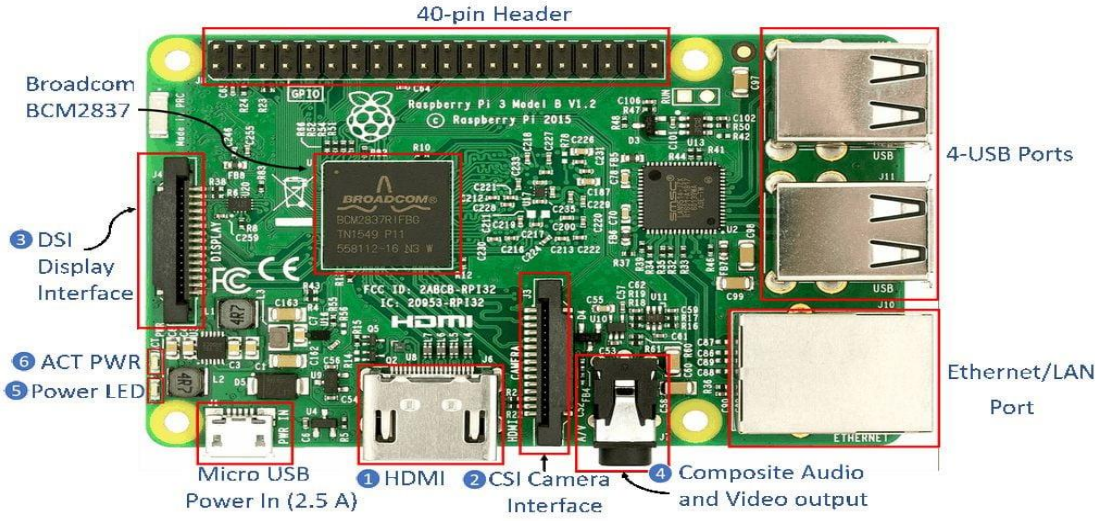
I2C (Inter-Integrated Circuit): A multi-master, multislave serial communication protocol useful for connecting the Raspberry Pi to various sensors and devices.

I2S (Inter-IC Sound): A serial bus interface standard used for high-quality audio transmission between the Raspberry Pi and audio peripherals.

UART (Universal Asynchronous Receiver Transmitter): A serial communication protocol facilitating the transfer of data between the Raspberry Pi and external devices, commonly used for communication with components like GPS modules and Bluetooth adapters.

Raspberry Pi 3 Hardware Details

The On-chip hardware of Raspberry Pi 3 (here) is as shown in below figure,



Some Hardware Components shown above are mention below:

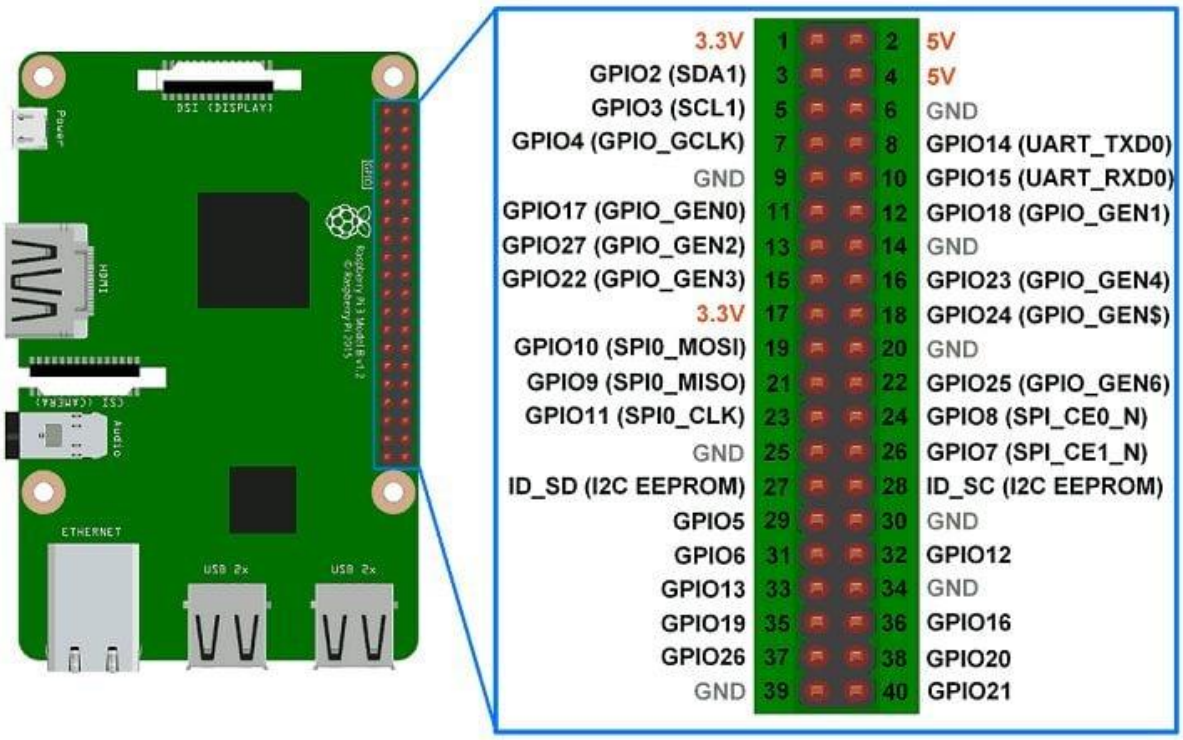
1. **HDMI (High-Definition Multimedia Interface):** It is used for transmitting uncompressed video or digital audio data to the Computer Monitor, Digital TV, etc. Generally, this HDMI port helps to connect Raspberry Pi to the Digital television.
2. **CSI Camera Interface:** CSI (Camera Serial Interface) interface provides a connection in between Broadcom Processor and Pi camera. This interface provides electrical connections between two devices.
3. **DSI Display Interface:** DSI (Display Serial Interface) Display Interface is used for connecting LCD to the Raspberry Pi using 15-pin ribbon cable. DSI provides fast High-resolution display interface specifically used for sending video data directly from GPU to the LCD display.
4. **Composite Video and Audio Output:** The composite Video and Audio output port carries video along with audio signal to the Audio/Video systems.
5. **Power LED:** It is a RED coloured LED which is used for Power indication. This LED will turn ON when Power is connected to the Raspberry Pi. It is connected to 5V directly and will start blinking whenever the supply voltage drops below 4.63V.
6. **ACT PWR:** ACT PWR is Green LED which shows the SD card activity.

RASPBERRY PI GPIO ACCESS

GPIO (General Purpose Input Output) pins can be used as input or output and allows raspberry pi to connect with general purpose I/O devices.

- Raspberry pi 3 model B took out 26 GPIO pins on board.
- Raspberry pi can control many external I/O devices using these GPIO's.
- These pins are a physical interface between the Pi and the outside world.
- We can program these pins according to our needs to interact with external devices. For example, if we want to read the state of a physical switch, we can configure any of the available GPIO pins as input and read the switch status to make decisions. We can also configure any GPIO pin as an output to control LED ON/OFF.
- Raspberry Pi can connect to the Internet using on-board Wi-Fi or Wi-Fi USB adapter. Once the Raspberry Pi is connected to the Internet then we can control devices, which are connected to the Raspberry Pi, remotely.

GPIO Pins of Raspberry Pi 3 are shown in below figure:



Some of the GPIO pins are multiplexed with alternate functions like I2C, SPI, UART etc.

We can use any of the GPIO pins for our application.

Pin Numbering

We should define GPIO pin which we want to use as an output or input. But Raspberry Pi has two ways of defining pin number which are as follows:

- **GPIO Numbering**
- **Physical Numbering**

In **GPIO Numbering**, pin number refers to number on Broadcom SoC (System on Chip). So, we should always consider the pin mapping for using GPIO pin.

While in **Physical Numbering**, pin number refers to the pin of 40-pin P1 header on Raspberry Pi Board. The above physical numbering is simple as we can count pin number on P1 header and assign it as GPIO.

But still we should consider the pin configuration diagram shown above to know which are GPIO pins and which are VCC and GND.

HOW TO USE A RASPBERRY PI?

Getting started with the Raspberry Pi

To get started with your Raspberry Pi, we will need the following:

- a power supply
- boot media (e.g., a microSD card with ample storage and speed)

we can set up your Raspberry Pi as an interactive computer with a desktop, or as a *headless* computer accessible only over the network. To set your Raspberry Pi up headless, we do not need any additional peripherals; we can preconfigure a hostname, user account, network connection, and SSH when you install an operating system. If you want to use your Raspberry Pi directly, we will need the following additional accessories:

- a display
- a cable to connect your Raspberry Pi to your display
- a keyboard
- a mouse

Power Supply

The following table shows the USB-PD power mode required to power various Raspberry Pi models. You can use any high-quality power supply that provides the correct power mode.

Model	**Recommended Power Supply (Voltage/Current)**	**Raspberry Pi Power Supply**
Raspberry Pi 5	5V/5A, 5V/3A limits peripherals to 600mA	27W USB-C Power Supply
Raspberry Pi 4 Model B	5V/3A	15W USB-C Power Supply
Raspberry Pi 3 (all models)	5V/2.5A	12.5W Micro USB Power Supply

Model	Recommended Power Supply (Voltage/Current)	Raspberry Pi Power Supply
Raspberry Pi 2 (all models)	5V/2.5A	12.5W Micro USB Power Supply
Raspberry Pi 1 (all models)	5V/2.5A	12.5W Micro USB Power Supply
Raspberry Pi Zero (all models)	5V/2.5A	12.5W Micro USB Power Supply

Plug the power supply into the port marked "POWER IN", "PWR IN", or "PWR". Some Raspberry Pi models, such as the Zero series, have output USB ports with the same form factor as the power port. Be sure to use the correct port on the Raspberry Pi!

Boot Media

Raspberry Pi models lack onboard storage, so we must supply it. We can boot our Raspberry Pi from an operating system image installed on any supported media: commonly microSD cards, but also USB storage, network storage, and storage connected via a PCIe HAT. However, only recent Raspberry Pi models support all these media types.

All Raspberry Pi consumer models since the Raspberry Pi 1 Model A+ feature a microSD slot. Our Raspberry Pi automatically boots from the microSD slot when the slot contains a card.

Keyboard and Mouse

We can use any of the USB ports on our Raspberry Pi to connect a wired keyboard or USB Bluetooth receiver.

We can use any of the USB ports on our Raspberry Pi to connect a wired mouse or USB Bluetooth receiver.

Display

If our Raspberry Pi has more than one HDMI ports, plug our primary monitor into the port marked HDMI0.

Raspberry Pi models have the following display connectivity:

Model	**Display outputs**
Raspberry Pi 5	2x micro-HDMI
Raspberry Pi 4 (all models)	2x micro-HDMI, audio and composite out via 3.5mm TRRS jack
Raspberry Pi 3 (all models)	HDMI, audio and composite out via 3.5mm TRRS jack
Raspberry Pi 2 (all models)	HDMI, audio and composite out via 3.5mm TRRS jack
Raspberry Pi 1 Model B+	HDMI, audio and composite out via 3.5mm TRRS jack
Raspberry Pi 1 Model A+	HDMI, RCA connector
Raspberry Pi Zero (all models)	mini-HDMI

Most displays don’t have micro or mini-HDMI ports. However, we can use a micro-HDMI to HDMI cable or mini-HDMI to HDMI cable to connect those ports on our Raspberry Pi to any HDMI display. For displays that don’t support HDMI, consider an adapter that translates display output from HDMI to a port supported by our display.

Audio

All Raspberry Pi models with HDMI, micro-HDMI, or mini HDMI support audio output over HDMI. All Raspberry Pi models support audio over USB. All Raspberry Pi models equipped with Bluetooth support Bluetooth audio. All variants of the Raspberry Pi 1, 2, 3, and 4 include a 3.5mm auxiliary TRRS jack which may require amplification for sufficient output volume.

Networking

The following Raspberry Pi models come with WiFi and Bluetooth connectivity:

- Raspberry Pi 5
- Raspberry Pi 4
- Raspberry Pi 3B+
- Raspberry Pi 3
- Raspberry Pi Zero W
- Rsapberry Pi Zero 2 W

The "Model B" suffix indicates variants with an Ethernet port; "Model A" indicates no Ethernet port. If our model doesn’t have an Ethernet port, we can still connect to a wired internet connection using a USB-to-Ethernet adapter.

Installing an operating system

To use our Raspberry Pi, we'll need an operating system. By default, RaspberryPi is check for an operating system on any SD card inserted in the SD card slot.

Depending on our Raspberry Pi model, we can also boot an operating system from other storage devices, including USB drives, storage connected via a HAT, and network storage.

To install an operating system on a storage device for our Raspberry Pi, we'll need:

a computer we can use to image the storage device into a boot device

a way to plug our storage device into that computer

Most Raspberry Pi users choose microSD cards as their boot device.

We recommend installing an operating system using Raspberry Pi Imager.

Raspberry Pi Imager is a tool that helps we download and write images on macOS, Windows, and Linux. Imager includes many popular operating system images for Raspberry Pi. Imager also supports loading images downloaded directly from Raspberry Pi or third-party vendors such as Ubuntu. We can use Imager to preconfigure credentials and remote access settings for our Raspberry Pi.

Imager supports images packaged in the .img format as well as container formats like .zip.

If we have no other computer to write an image to a boot device, we may be able to install an operating system directly on our Raspberry Pi from the internet.

SET UP THE RASPBERRY PI

After installing an operating system image, connect our storage device to our Raspberry Pi. First, unplug our Raspberry Pi's power supply to ensure that the Raspberry Pi is powered down while we connect peripherals. If we installed the operating system on a microSD card, we can plug it into our Raspberry Pi's card slot now. If we installed the operating system on any other storage device, we can connect it to our Raspberry Pi now.

Then, plug in any other peripherals, such as our mouse, keyboard, and monitor.

Finally, connect the power supply to our Raspberry Pi. We should see the status LED light up when our Pi powers on. If our Pi is connected to a display, we should see the boot screen within minutes.

Quick Guide for the setup

1. Get the Hardware:
   - Raspberry Pi Board: Choose a model that suits your needs (e.g., Raspberry Pi 3, Raspberry Pi 4).
   - MicroSD Card: Minimum 8GB, class 10 recommended.
   - Power Supply: Make sure it provides the right voltage and current for your Raspberry Pi model.
   - HDMI Cable, Keyboard, and Mouse: For initial setup.
2. Download and Install an Operating System:
   - Visit the Raspberry Pi Downloads page.
   - Choose an operating system; Raspbian (now called Raspberry Pi OS) is a good choice for beginners.
   - Download the image and use Etcher to flash it onto the microSD card.
3. Check the slot on the underside of your Raspberry Pi to see whether an SD card is inside. If no SD card is there, then insert an SD card with Raspbian installed (via NOOBS).
4. Find the USB connector end of your mouse's cable, and connect the mouse to a USB port on your Raspberry Pi (it does not matter which port you use). Connect the keyboard int the same way. Make sure your screen is plugged into a wall socket and switched on.
5. Look at the HDMI port(s) on your Raspberry Pi — notice that they have a flat side on top.
6. Use a cable to connect the screen to the Raspberry Pi's HDMI port — use an adapter if necessary.
7. Initial Configuration:
   - Follow the on-screen prompts to set up your Raspberry Pi.
   - Change the default password.
   - Connect to the internet via Wi-Fi or Ethernet.
8. Familiarize yourself with basic terminal commands (ls, cd, mkdir, etc.). Install new software using sudo apt install.
9. Raspberry Pi has GPIO pins for hardware projects. Python is commonly used to interact with GPIO. Install the GPIO library
10. Raspberry Pi supports Python and Scratch. Start with simple Python scripts.

Top 10 Uses of Raspberry Pi

Raspberry Pi has reached an unprecedented level of popularity. Originally created for educational purposes, it has become a go-to solution for tech enthusiasts looking for something to tinker with. This has led to the emergence of several relevant use cases. They are:

1. Constructing a desktop PC

One can use Raspberry Pi to construct a typical desktop personal computer. The hardware includes Raspberry Pi, a micro-SD card with an operating system installed, a constant power source, and an output display device like an old monitor or television. It is also essential to have a USB mouse and keyboard. With all these, the user can work with fully functional devices for a very cheap cost.

2. Enabling media usage

Among the many uses of the Raspberry Pi, it has found profound popularity as a Kodi media player. Kodi software is a free, open-source media player that can be installed from official sites. One must install other add-ons. However, the user must be careful when using Raspberry Pi as a Kodi media center, as it can predispose the unit to security problems. This is easily prevented using a virtual private network (VPN) for data encryption.

3. Controlling IoT robots

Robotics is a vital part of today's technology that promises to strongly influence the future, particularly the Internet of Things (IoT). Raspberry Pi, therefore, is playing a crucial role in the technology of the future. Currently, there are several robot controller Raspberry Pi projects. Anyone can order fully packaged robot parts with DIY instructions and programs from many Pi communities. You can also choose to build your robot from scratch.

Raspberry Pi provides the best core a robot can have. Its miniature, lightweight nature, combined with the unit's low price, makes it simply perfect. The Pi Zero is very popular for robotics because it boasts an even slimmer and more compact size than other Pi models.

4. Acting as a printer server

Raspberry Pi can also be used as a printer server. This is especially important for older printers. Setting this printing server up requires installing CUPS (Common Unix Printing System) file-sharing software. CUPS gives the user access to multiple printer drivers, which should be installed depending on the type of printer.

5. Replacing web servers

One other practical application of the Raspberry Pi computer is its use as a web server. This simply means configuring the computer to be able to host HTTP websites. It can function as a web server on the internet directly or in a local network such as a home or office. To do this, one must install specific software – the complete LAMP stack comprising Linux, Apache, MySQL, and PHP. After this, one can use the www directory to save HTML files, and the Raspberry Pi can function as a fully functional web server.

See More: Wide Area Network (WAN) vs. Local Area Network (LAN): Key Differences and Similarities

6. Converting into retro gaming machines

Users can also make Raspberry Pi into a gaming console. Without any additional modification, Minecraft comes with the default Pi operating system, Raspbian. Beyond Minecraft, other multiplayer games can also be set up on Raspberry Pi. One can achieve the best gaming experience by using multiple Raspberry Pis with one dedicated as a server.

7. Attaching to surveillance cameras

Businesses, offices, and even homes need surveillance cameras to prevent and apprehend security threats. For some, this can be very expensive, especially for small businesses. However, Raspberry Pi comes in as an excellent alternative. Combining it with a camera module allows anyone to set up their personal surveillance system.

8. Supporting digital signage

Most businesses now use digital signage to achieve a great deal of marketing. Information like the latest product, restaurant menus, adverts, appropriate behavior, maps, etc., can be displayed on large screens or specialized platforms. Raspberry Pi is not left out in this application – the minicomputer is perfect for displaying text and images. It can also display animations but will require more power and data consumption. Overall, using Raspberry Pi for digital signage is a cost-effective process.

9. Conducting network penetration tests

Computer and network security is a big deal for everyone in today's hyperconnected society. Personal and financial information stored on various sites may get into the wrong hands. This has created a massive market for cybersecurity software. But the only way to ensure that you have adequate security is to test it. With Raspberry Pi, you can create an offensive security hacking tool to 'attack' your network. Any breach found is immediately repaired and closed.

10. Providing data to business intelligence dashboards

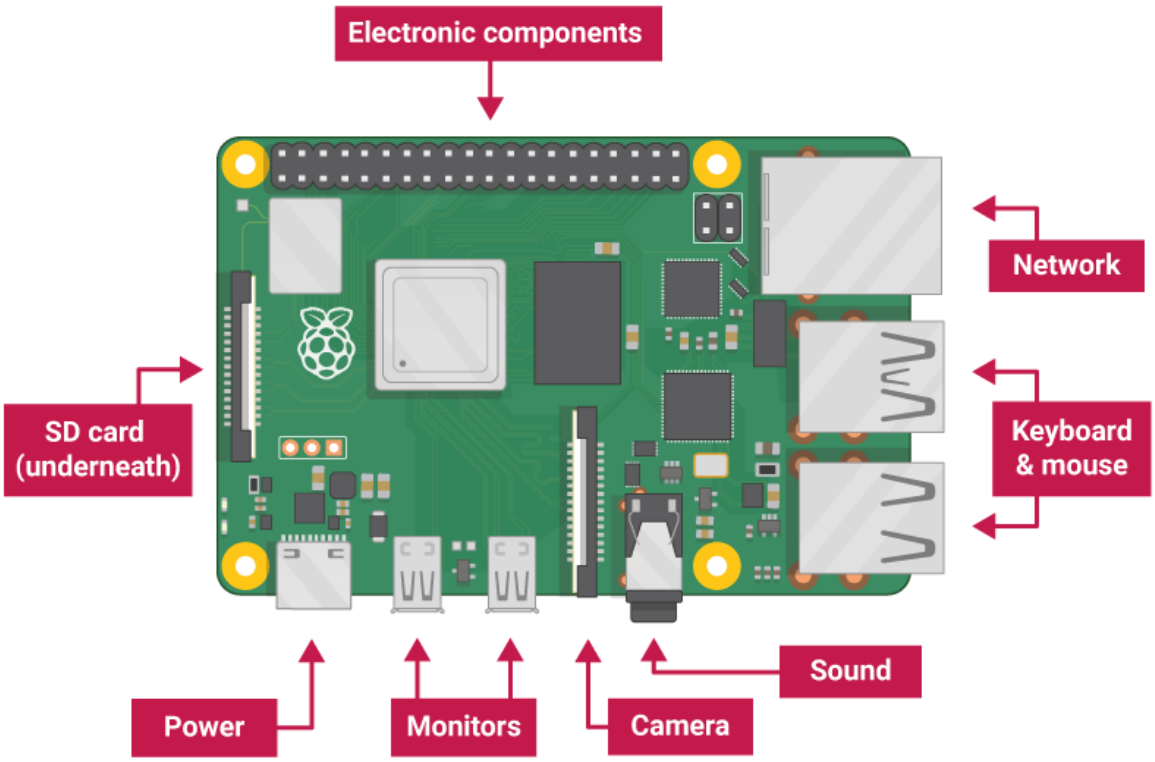
Business intelligence dashboards, in one form or the other, are a vital part of any successful organization. It is a data visualization and analysis tool that displays the status of business metrics and key performance indicators of an organization or team. With Raspberry Pi, any business can display real-time data on a dashboard. The computer helps collect data from multiple sources using business intelligence apps like Power BI.

PROS OF THE RASPBERRY PI

1. Vast Peripheral Support

Raspberry Pi comes with 26 GPIO Pins which are very useful indeed for embedded projects and interfacing hardware. These pins are really useful in learning about component interfacing. You can combine multiple digital sensors all together due to the good number of GPIO pins being given. It supports almost all the peripherals supported by Arduino.

It has a lot of accessories available for it in the market. You will find many Raspberry Pi cases with different designs, Raspberry pi HATs, Fans, Heat Sinks, etc... You will find a whole big community and support as well. It is said to be the most popular single-board computer of this era.



1.0 Vast peripheral support

2. Multiple Sensors

As discussed in the above section that it comes with a lot of GPIO Pins, so it is obvious for it to support multiple sensors at once. You can connect various displays, modules, sensors, etc...to it. Unless its not analog.

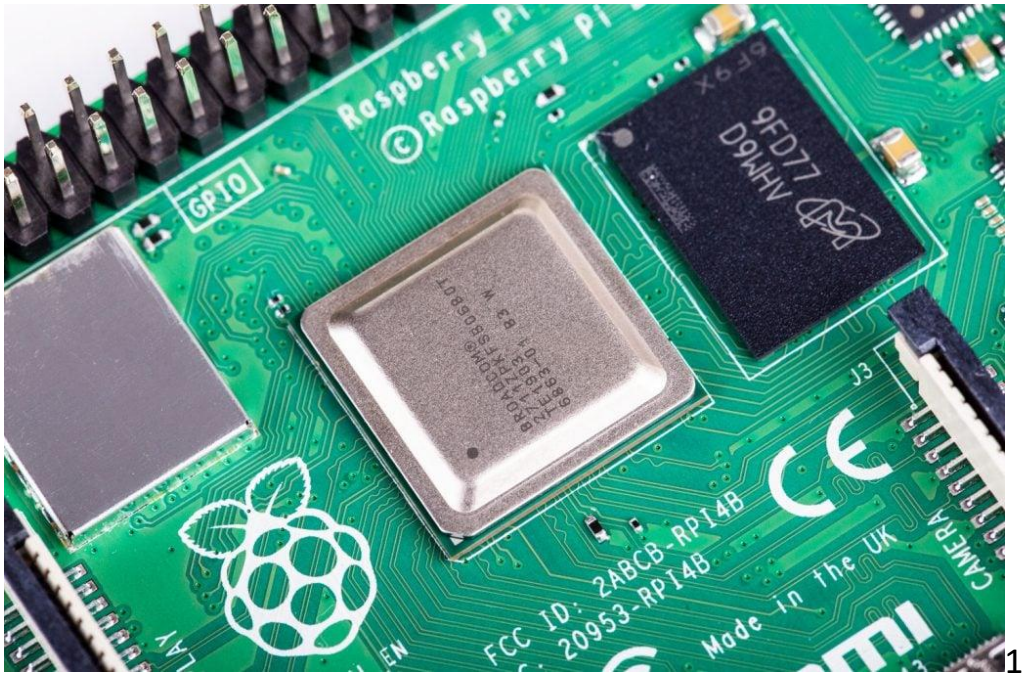
3. Supports all type of Codes

Its one of the best part of this board, if we compare it with Arduino you will know that Arduino only supports C, C++. While this board works as a single board computer. You get a Linux desktop environment in which you can code in almost any language, be it C, C++, C#, Ruby, Java, Python, etc...

This Support for all types of code makes this board famous, one of the main goal of the raspberry pi foundation was to provide cheap computing to people, so that they can learn programming. They have really reached their goal in providing cheap computing to people, so they can learn programming easily.

Moving towards the future, everything is turning digital, so we need more and more programmers. Raspberry Pi is really helping people who cannot spend much for desktop computers.

4. Faster Processor



1.1 Fast Processor

Talking about the core. When we compare it with Arduino and other boards, you get a faster processor. Arduino comes with a controller, while here Raspberry Pi comes with a 1.6 GHz Processor in the 4B variant of Raspberry Pi.

Faster processor means good performance. The price to performance of raspberry pi board is really great. I bet you won't get that much performance on any board at that price.

5. Can be Used as a Portable Computer

This is the best part of raspberry pi. Suppose if you attach a display to it, and now it will become a pocket computer. You can do all sorts of task a computer can do. You can check sites, connect to WiFi, do computational tasks.

1.3 As a PC

You can do all sorts of stuff on the raspberry pi which are possible on a Linux distro. You will find many apps and packages that will help you do lots of tasks on the Pi, like photo editing, coding, etc.

Many popular apps like Google Chrome and VLC are also available in Raspbian.

CONS OF RASPBERRY PI

1. Missing eMMC Internal Storage

Since the raspberry pi doesn't have any internal storage it requires a micro SD card to work as an internal storage. We all know that SD cards are not that fast. Even if we compare an class 10 High Speed micro SD card with an eMMC internal storage. It lacks performance, so this increases boot time of the board and read/write speed of the raspberry pi.

1.4 EMMC Internal Storage

Many board manufacturers like Beagle-bone and Asus Tinker board are now using eMMC internal storage for higher speed. They also give an option to expand internal storage with an external SD card. The boot time of such board is very less and super speedy. It think raspberry pi team should give a thought about this one in their next coming board.

2. Graphics Processor Missing

Well graphics process is a very crucial thing, if you're into photo editing, video editing and gaming. Without it your Computer is just a potato. Many of us need a graphics processor so we can do certain tasks. While the raspberry pi doesn't come with a GPU unit. The processor does all the task for it, which is inefficient.

Asus Tinker board comes with a graphics processor. You can play android games on the board while installing android OS easily. You can edit photos and videos faster.

3. Impractical as a Desktop Computer

When we look at the bigger picture of the board here, and think of it as a desktop computer. It misses a lot of stuff. Even if you buy the latest raspberry pi with the 4GB ram. It lacks some performance. It is said to render 4K video at 60 FPS but in actual its a bit less and you will see some stutters in 4K 60 FPS video.

If you open too much tabs, the board will start to slow down a bit. You can't watch online videos on netflix or amazon, you will need to install extra codecs. even after that you will barely be able to stream 2K properly. It needs some improvement and optimization in the software and hardware end both.

4.Overheating

 1.5 Overheating

As the board doesn't come with any heat-sinks pre-applied or any cooling fan. As the raspberry pi 4 comes with a powerful processor and multiple features, it starts to heat up after sometime due to the same board size, the heat dissipation is not proper as expected. If you use it for continuous 6-7 hours without air-conditioning or heat-sink. It will heat up very much above 70 ° C if you are in south Asian region.

5. Not able to run Windows Operating system

Many people will argue about this , that it is able to run windows OS on it. But the fact is , that it is just a community made windows 10 port. Which is not an official release. It will crash a lot and there will be many bugs. Windows operating system is the most user friendly as we know, for gaming its the primary OS. You basically can't play games on Linux systems practically. Many apps are available for windows OS because of the ".exe" format support. We have alternative apps available on Linux , but many popular software developers use the .exe formats.

Reception and Use:

General Adoption:

- Recognized as a "potential BBC Micro 2.0" by technology writer Glyn Moody.

- Awarded T3's Innovation of the Year in 2012 and won the Royal Academy of Engineering MacRobert Award in 2017.

- Used by NASA's Open Source Rover project, showcasing its versatility.

- Raspberry Pi clusters employed for testing supercomputer programs.

Community and Education:

- Strong community support, highlighted by the Raspberry Pi Foundation's learning resources and teacher training courses.

- Community-driven initiatives like The MagPi fanzine and Raspberry Jam events.

- Significant interest from schools, both private and state sectors, with potential sponsorship for less advantaged schools.

Industrial and Commercial Use:

- Utilized in home automation due to its affordability.

- Adoption in industrial automation with devices like ModBerry and commercial products like thin client computer terminals.

- Incorporation in unique products like the Organelle synthesizer and the OTTO digital camera.

Impact During COVID-19:

- Increased demand during the pandemic, with Raspberry Pi Zeros used in ventilators to address healthcare challenges.

Space Projects:

- Astro Pi and Proxima competitions involve Raspberry Pi in space experiments aboard the International Space Station.

- Presence of Astro Pi in the Dragon 2 spacecraft launched by NASA in December 2021.