CONTENTS OF THIS SESSION

Here's what you'll learn in day 1:

1. Introduction to Internet of Things (IoT).

2. IoT Protocol

3. IoT Device and Application

4. Arduino Programming

5. ESP8266 NodeMCU Setup & Program

6. Raspberry Pi overview

7. OS install in Raspberry Pi

8. Wireless Connectivity

9. Remotely Access Raspberry Pi

INSTRUCTOR PROFILE

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Microsoft Certified, Azure IoT Developer Specialty

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Introduction To IoT

What is IoT?

Your things + Sensor

Data Analytics + Insights

Actions + Decision Making

Various Names, One Concept

"M2M"

"Internet of Everything"
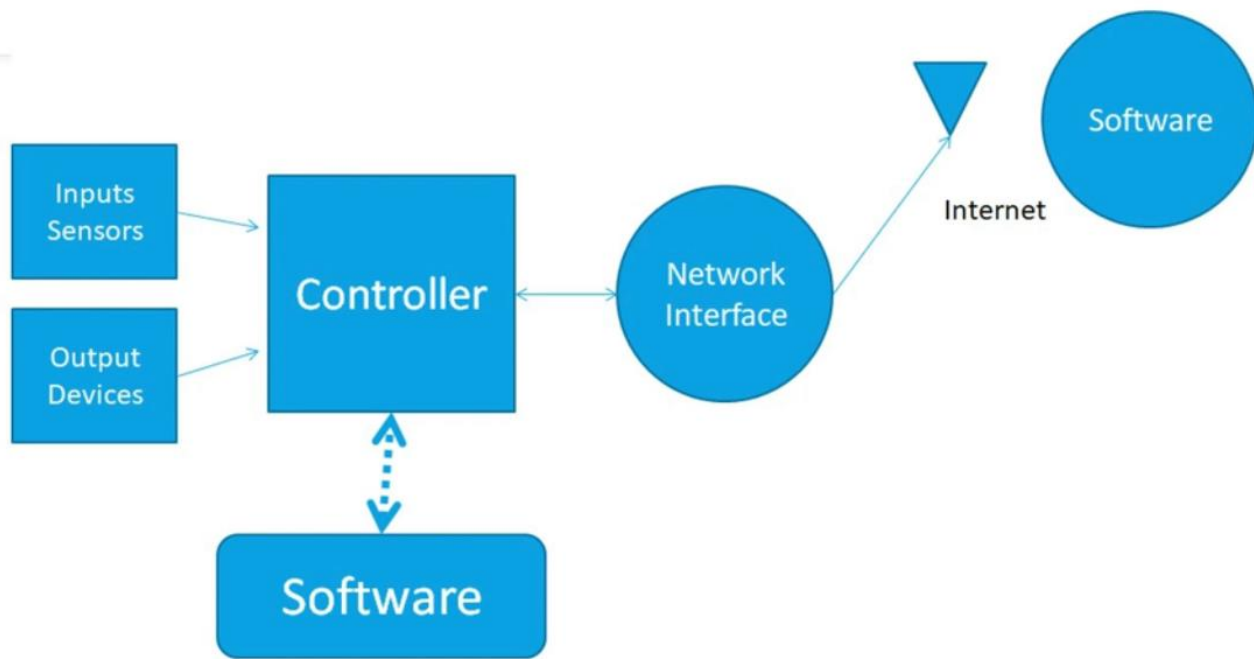
"World Size Web"

Internet of Things

- First coined by British Visionary Kevin Ashton in presentation to Proctor and gamble in 1999

- Though the concept of M2M is quite old dating back to 70's

- What are the "things" in the discussion here?

Things in IOT

IoT will revolutionize the industry

- **Technology**
  - o Robotics – Replacing humans on assembly line
  - o 3D Printing – Manufacturing customized components
  - o Big Data – Collecting performance parameters
  - o Analytics – Understanding collected data

- **Process**
  - o Constant communication – Data exchange between components
  - o Decentralized decision making – Routine decisions
  - o Standardization – Ease of customization
  - o Smart Transport System - Automated transportation of raw material / final products
- **People**
  - o Increased efficiency – Reduction in labor per unit
  - o Skill Development – Up-skilling, Re-skilling, Continuous learning & Mindset change
  - o Only to handle disruptions – Monitoring and corrective actions

Where Is IOT?

Automobile

Construction

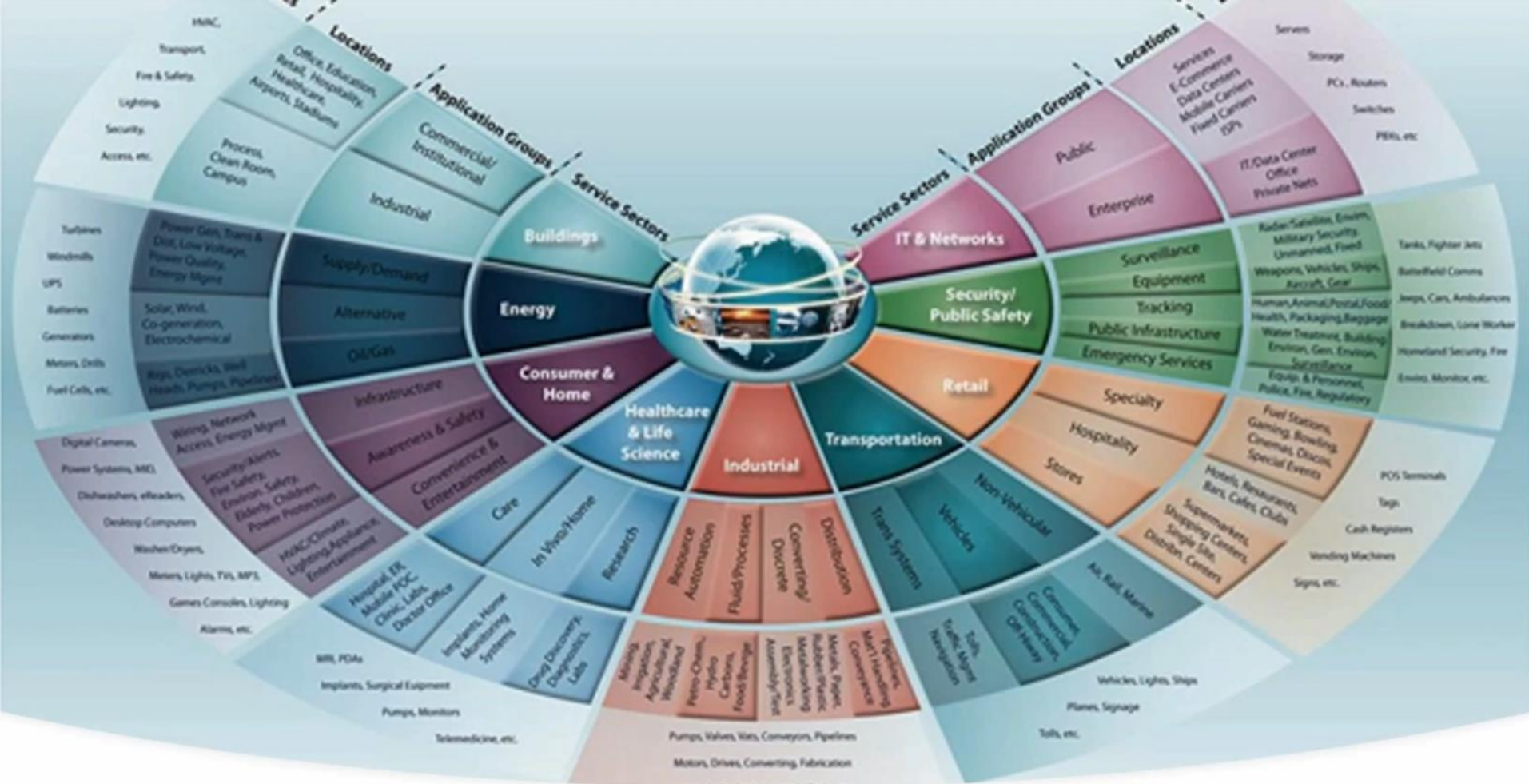Healthcare

Consumer Electronics

Education

Defence

IT

Manufacturing

LoRa (short for **long range**)

"LoRa is a long range, low power wireless platform that has become the de facto wireless platform of Internet of Things (IoT)."
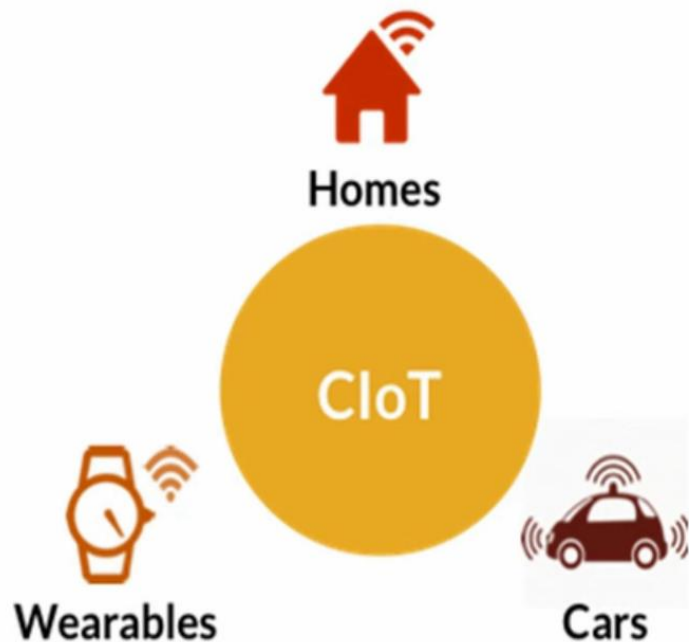
Locations

Application Groups

Service Sectors

Locations

Application Groups

Service Sectors

Buildings

Commercial/Institutional

Industrial

HVAC, Transport, Fire & Safety, Lighting, Security, Access, etc.

Office, Education, Retail, Hospitality, Healthcare, Airports, Stadiums

Process, Clean Room, Campus

Energy

Supply/Demand

Alternative

Oil/Gas

Turbines

Windmills

UPS

Batteries

Generators

Motors, Drills

Fuel Cells, etc.

Power Gen, Trans & Dist, Low Voltage, Power Quality, Energy Mgmt

Solar, Wind, Co-generation, Electrochemical

Rigs, Derricks, Well Heads, Pumps, Pipelines

Consumer & Home

Infrastructure

Awareness & Safety

Convenience & Entertainment

Digital Cameras,

Power Systems, MEL

Dishwashers, eReaders,

Desktop Computers,

Washers/Dryers,

Meters, Lights, TVs, MP3,

Games Consoles, Lighting,

Alarms, etc.

Wiring, Network Access, Energy Mgmt

Security/Alerts, Fire Safety, Environ. Safety, Elderly, Children, Power Protection

HVAC/Climate, Lighting, Appliance, Entertainment

Healthcare & Life Science

Care

In Vivo/Home

Research

Hospital, ER, Mobile POC, Clinic, Labs, Doctor Office

Implants, Home Monitoring Systems

Drug Discovery, Diagnostics, Labs

MRI, PDAs

Implants, Surgical Equipment

Pumps, Monitors

Telemedicine, etc.

Industrial

Resource Automation

Fluid/Processes

Converting/Discrete

Distribution

Mining, Irrigation, Agricultural, Woodland

Petro-Chem, Hydrocarbon, Food/Storage

Metal, Paper, Rubber/Plastic, Metalworking, Electronics Assembly/Test

Pipelines, Matl Handling, Conveyance

Pumps, Valves, Vats, Conveyors, Pipelines

Motors, Drives, Converting, Fabrication

Transportation

Non Vehicular

Vehicles

Trans Systems

Toll, Traffic Mgmt, Navigation

Consumer, Commercial, Construction, Off-Road

Tolls, Matl Mgmt, Marine

Vehicles, Lights, Ships

Planes, Signage

Tolls, etc.

IT & Networks

Public

Enterprise

Services, E-Commerce, Data Centers, Mobile Carriers, Fixed Carriers, ISPs

IT/Data Center, Office, Private Nets

Servers

Storage

PCs, Routers

Switches

PBXs, etc.

Security/Public Safety

Surveillance

Equipment

Tracking

Public Infrastructure

Emergency Services

Radar/Satellites, Environs, Military Security, Unmanned, Fixed, Weapons, Vehicles, Ships, Aircraft, Gear

Human, Animal, Postal, Food Health, Packaging, Baggage

Water Treatment, Building Environ, Gen. Environ, Surveillance

Equip & Personnel, Police, Fire, Regulatory

Tanks, Fighter Jets

Battlefield Comms

Jeeps, Cars, Ambulances

Breakdown, Lone Worker

Homeland Security, Fire

Environ. Monitor, etc.

Retail

Specialty

Hospitality

Stores

Fuel Stations, Gaming, Bowling, Cinemas, Discos, Special Events

Hotels, Restaurants, Bars, Cafes, Clubs

Supermarkets, Shopping Centers, Single Site, Distribtn. Centers

POS Terminals

Tags

Cash Registers

Vending Machines

Signs, etc.

Applications

IOT applications are extensively used in four different areas:

- Consumer

- Industrial

- Commercial

- Infrastructure Spaces
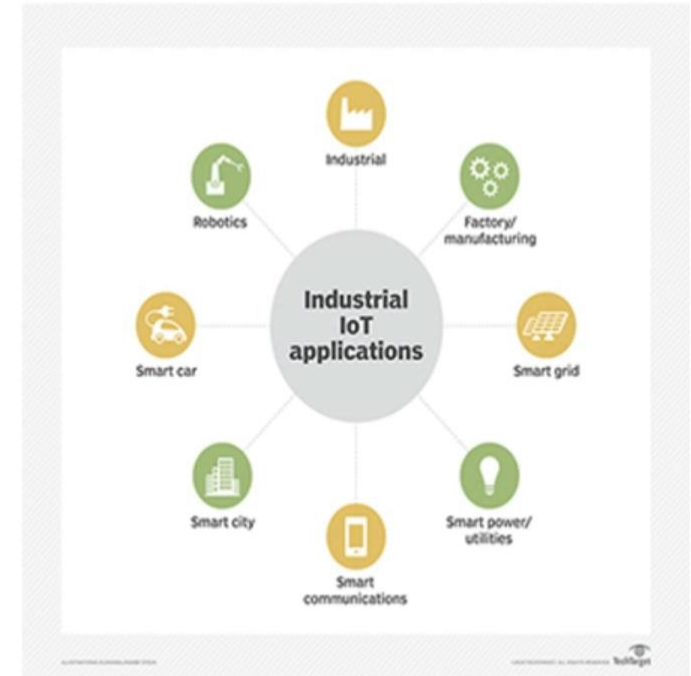
Consumer Applications

- Home Automation

- Wearables

- Connected Cars

Industrial IOT

Called as IIoT

- Monitor Manufacturing
- Remote Maintaince
- Energy Monitoring and Metering
- Predective Maintaince

How Internet of Things (IoT) is transforming the agriculture sector?

Diagnosis of Diseases

Veriable rate of Feertility

Auto Spreading

Water Stress

Crop yield Analysis

Field Monitoring

Smart Data

Soil Erosion

Wednesday:
Hi: 90°F
Lo: 72°F

Thursday:
Hi: 90
Lo: 72

83°F

So far today:
Hi: 88°F Lo: 71°F
Rain: 0"
Gust: 6mph S

Heat Index: 89°F
Humidity: 72%
Dew Point: 73°F

Technotra
Robotics Ltd
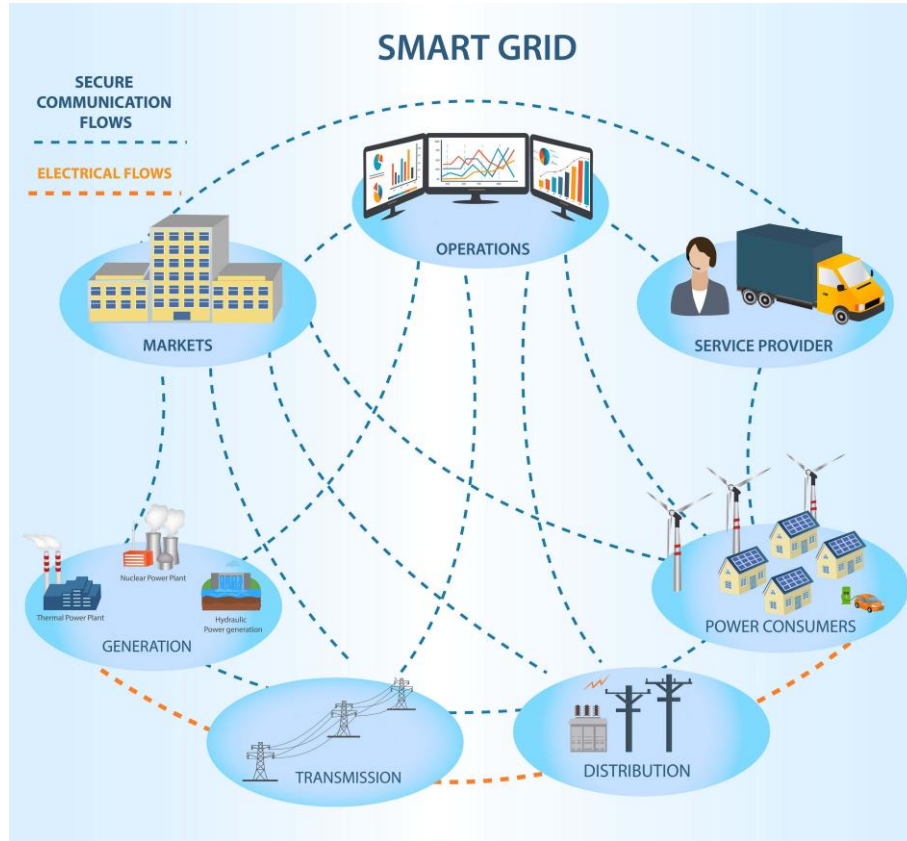
Energy Save

Consumer get real time update

Problem Identify specific location

Total Calculation of Power

Infrastructure IOT

- Smart Waste Management

- Smart Energy Management

- Smart Energy

- Smart Health

- Public safty

- Smart Parking

- Air Pollution Management

IOT
in
Banking
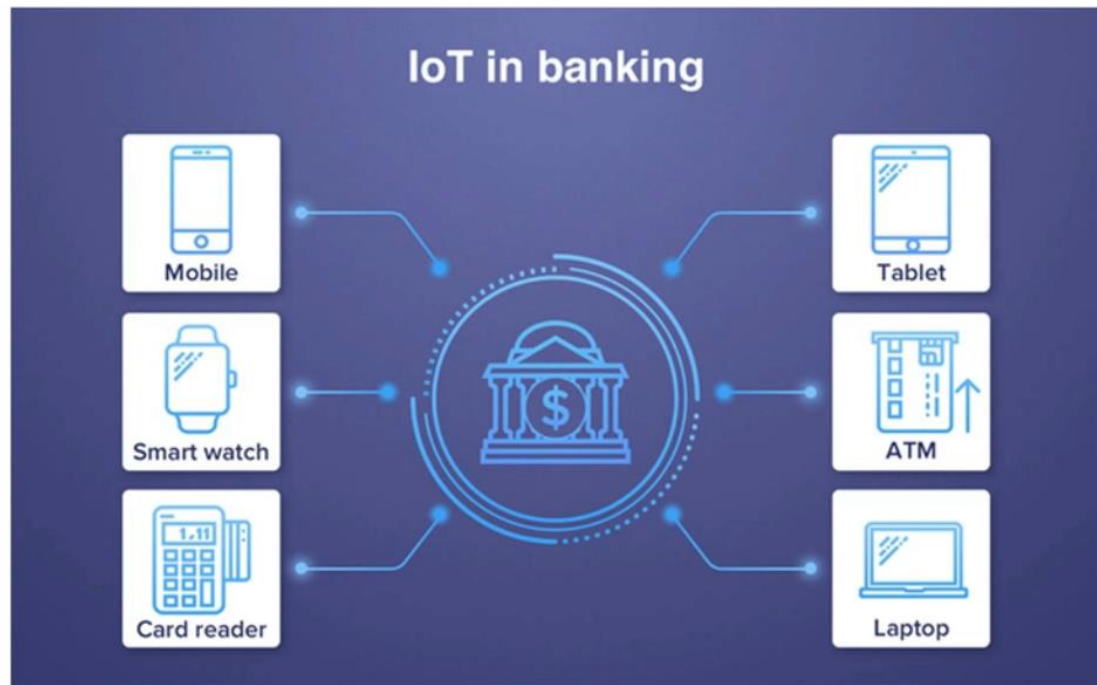
IOT in Telecom

- Data Analytics
- Location services
- Connected cars
- Equipment Monitoring
- Safty Hazards

IOT in Transportion

- Maintaining Vechile health

- Traffic Control

- Public Transit Management

- Geo fencing

IOT
in
Fashion Industry

Child Care

TJ Bot
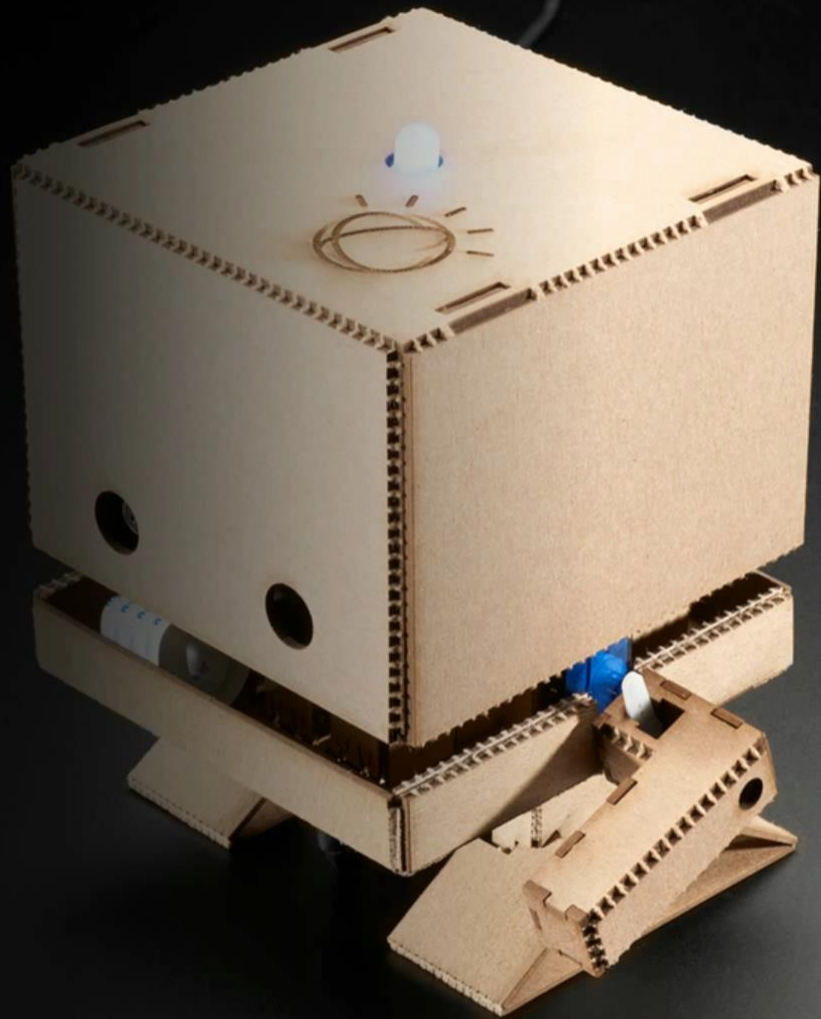
Assistants

- Google Home
- Amazon Echo
- Mycroft AI??

Number Of connected Devices

IOT ANALYTICS — *Insights that empower you to understand IoT markets*

Total number of active device connections worldwide

Number of global active Connections (installed base) in Bn

Year	IoT	Non-IoT	Total
2015	3.8	10.1	13.9
2016	4.7	10.3	15.0
2017	5.9	10.6	16.4
2018	7.0	10.8	17.8
2019	8.3	11.1	19.4
2020	9.9	11.3	21.2
2021	11.6	11.6	23.2
2022	13.5	11.9	25.4
2023	15.8	12.1	27.9
2024	18.5	12.4	30.9
2025	21.5	12.7	34.2

10%

Non-IoT

IoT

Note: Non-IoT includes all mobile phones, tablets, PCs, laptops, and fixed line phones. IoT includes all consumer and B2B devices connected – see IoT break-down for further details

Source: IoT Analytics Research 2018

IoT value add by 2020 - $1.9 Trillion

US$7T IoT Opportunity Globally
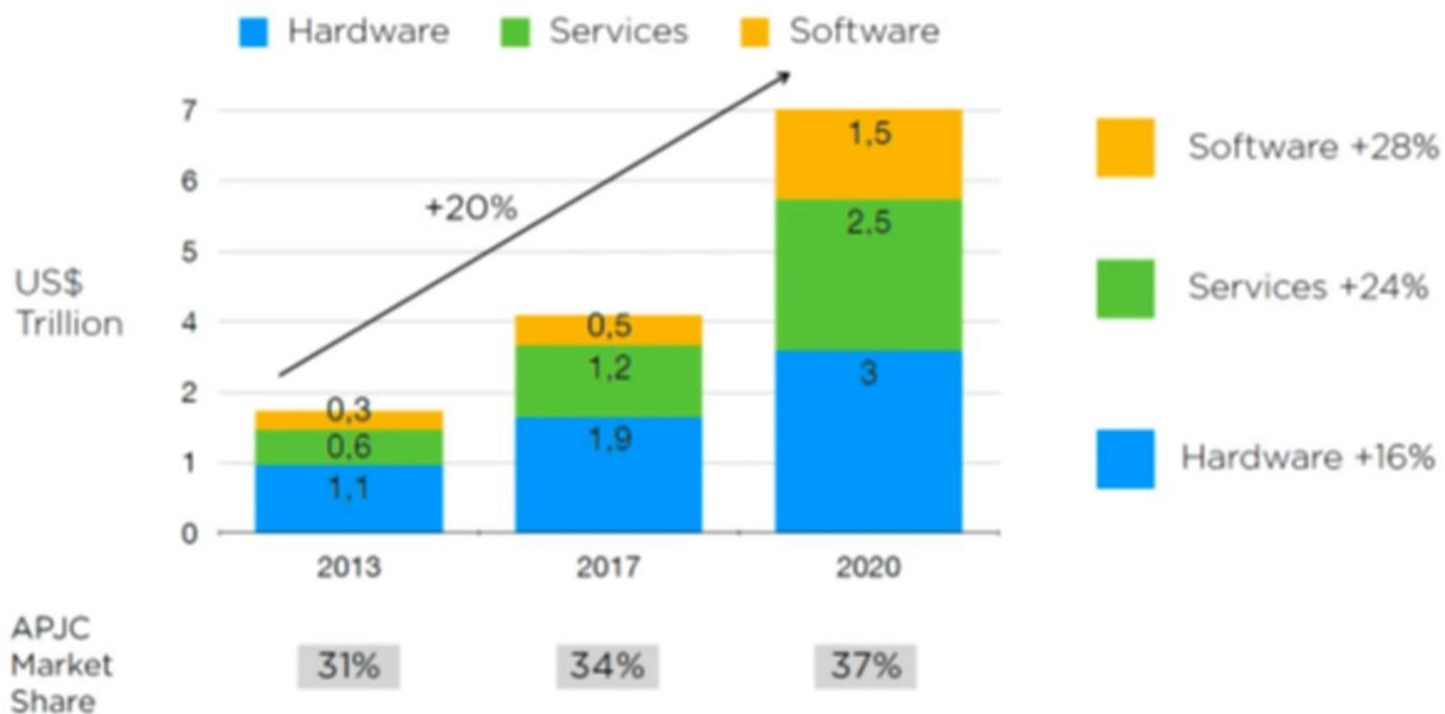
Source: Cisco

Interesting Facts About IOT

k

1. **The global IoT market 2014:** $2.99 trillion ⇒ **2020:** $8.90 trillion

2. **The number of connected devices worldwide 2018:** 23.14 billion ⇒ **2025:** 75.44 billion

3. **Business investment in IoT 2015:** $215 billion ⇒ **2020:** $832 billion

4. **B2B IoT market size2015:** $195 billion ⇒ **2020:** $470 billion

5. **Percentage of enterprises adopting IoT 2017:** 30% ⇒ **2020:** 65%

IoT Device

▶ What is IoT Device?

If anything connected with internet = IoT Device

Cloud Overview

Choice of Cloud Server

1. Custom Design with Major Cloud Providers

Platform as a Service

2. Using existing service Providers optimized for IoT

Software as a Service

SaaS

IoT SaaS product development itself is evolving as a complete new business Area

- Thingworx
- Everythng
- Sensorcloud
- Device Cloud
- ThingSpeak
- Numerex

Adafruit.io

Thinger.io

Cayenne

Platform as a Service

Google Cloud

IBM **Cloud**

aws

Microsoft Azure

IoT Implementation
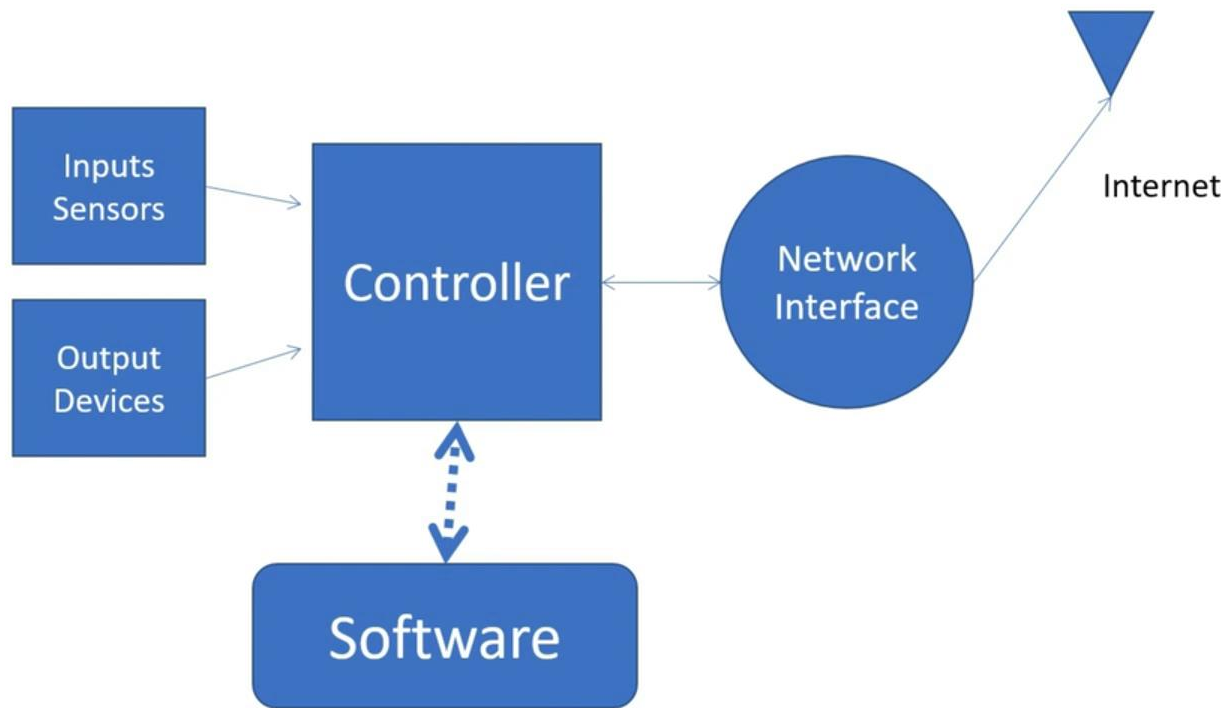
Next Steps

- Connecting to Internet
- Sending data over proper communication channel
- Use of correct protocol
- Visualize data on interent
- Analytics

Connecting to Internet

Direct Connection

LAN

Wifi

Cellular Network

Indirect Connection

Via host device

Bluetooth

Zigbee

Any other RF technology

IoT Communication Requirements

- Every IoT application has its own **unique requirements.**

- Connectivity option that works good for one application may be awful for another

- Your application may:

🔋	Have thousands of remote sensors, so **battery life** is a critical consideration
🖧	Need to send lots of data, like video, so **high-bandwidth** is essential
☁🔒	Need to send important data, so **security** is essential
⏳	Involve life-or-death decisions, so **time** is the primary consideration
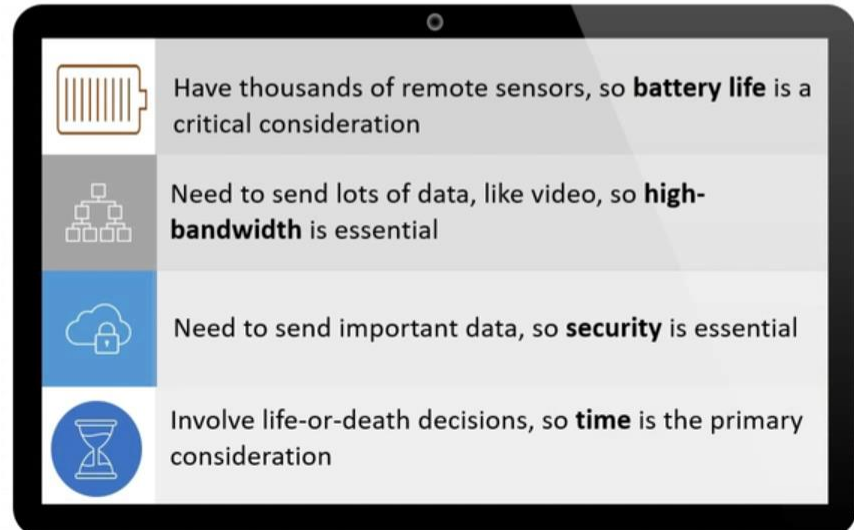
Communication Requirements

- Low Battery life
- High Bandwidth
- Security
- Latency

Applications in remote area

WHEN APPLICATIONS ARE IN REMOTE AREA

E.G. JUNGLE

NO DIRECT INTERNET CONNECTIVITY POSSIBLE

DATA NEEDS TO BE ROUTED

ZIGBEE / RF COMMUNICATIONS CAN BE USED

Raspberry Pi

- With Raspberry Pi, you can directly connect to internet using
  - Wifi
  - Bluetooth

Microcontrollers

- Some microcontrollers come with wifi

- We can have different interface modules with microcontrollers who don't have network connectivity
  - Wifi module
  - Ethernet
  - Cellualar Module

Computer Network Protocols

Technotra Robotics Ltd

HTTP and HTTPS are most common across IoT applications

CoAP (Constrained Application Protocol) is like a lightweight HTTP that is often used in combination with 6LoWPAN over UDP

Messaging protocols like MQTT, AMQP, and XMPP are also frequently used within IoT applications

Let's Introduce with Microcontroller
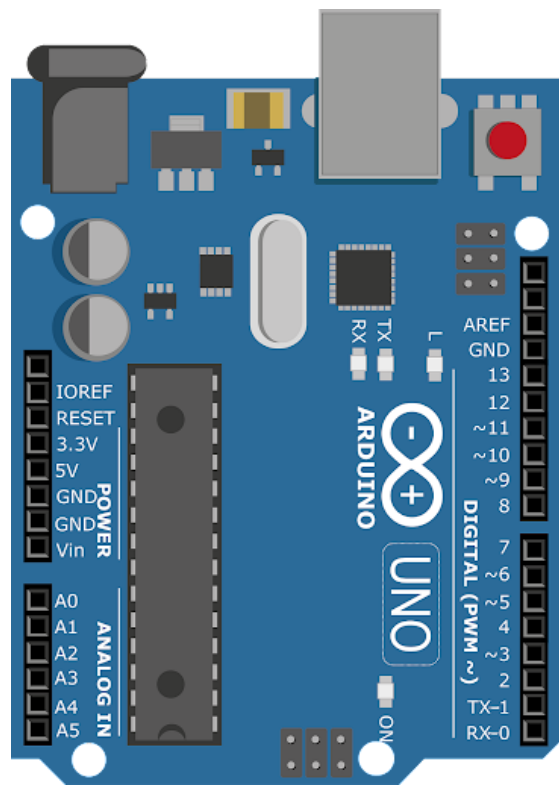
Let's See how to Program Arduino

1. Install Arduino IDE
2. Arduino Programming (C++)
3. Input / Output Program

Blink a LED
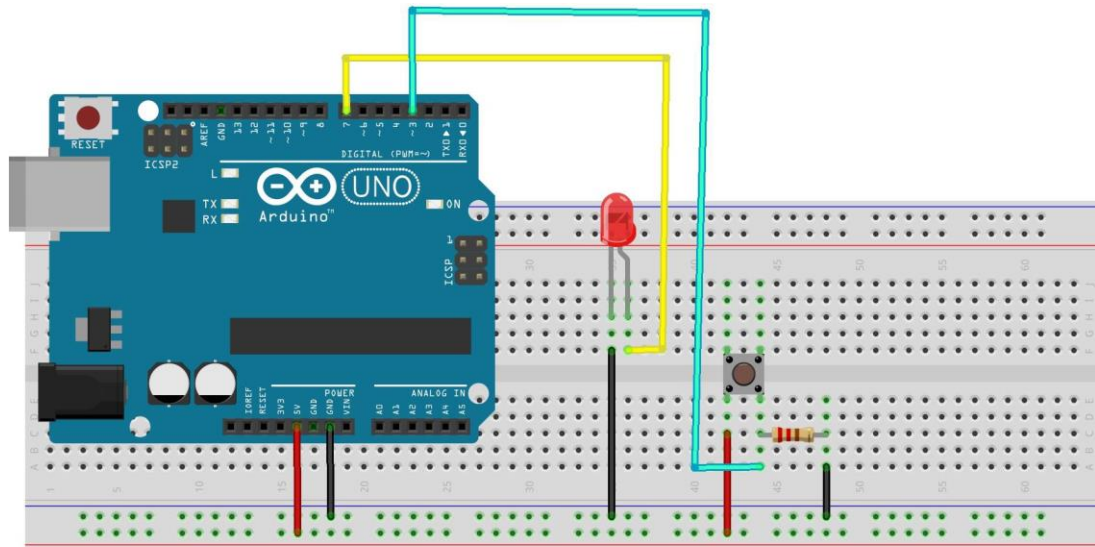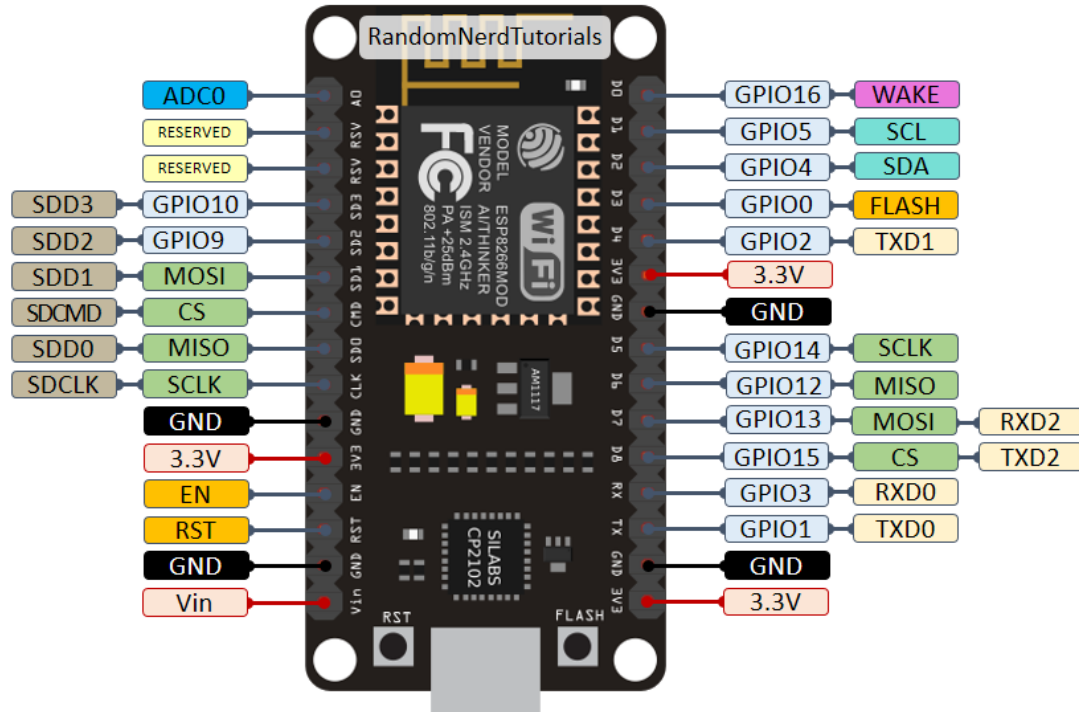
http://arduino.esp8266.com/stable/package_esp8266com_index.json

Micropython in ESP8266

Check the files

```
>>> import uos
>>> uos.listdir()
['boot.py']
```

Install Interpreter

```
>>> from machine import Pin
>>> led = Pin(2,Pin.OUT)
>>> led.value(1)
>>> led.value(0)
>>>
```

By pressing 1 & 2

On board LED on

On board LED on

Micropython.org/download

Blink a LED using not function

```
[ main.py ]
1   from machine import Pin
2   from time import sleep
3   led = Pin(2,Pin.OUT)
4   while True:
5       led.value(not led.value())
6       sleep(0.5)
```

Raspberry Pi Pico Pinout Diagram

Left side (top to bottom):

Pin	GPIO	Functions
1	GP0	UART0 TX, I2C0 SDA, SPI0 RX
2	GP1	UART0 RX, I2C0 SCL, SPI0 CSn
3	GND	
4	GP2	I2C1 SDA, SPI0 SCK
5	GP3	I2C1 SCL, SPI0 TX
6	GP4	UART1 TX, I2C0 SDA, SPI0 RX
7	GP5	UART1 RX, I2C0 SCL, SPI0 CSn
8	GND	
9	GP6	I2C1 SDA, SPI0 SCK
10	GP7	I2C1 SCL, SPI0 TX
11	GP8	UART1 TX, I2C0 SDA, SPI1 RX
12	GP9	UART1 RX, I2C0 SCL, SPI1 CSn
13	GND	
14	GP10	I2C1 SDA, SPI1 SCK
15	GP11	I2C1 SCL, SPI1 TX
16	GP12	UART0 TX, I2C0 SDA, SPI1 RX
17	GP13	UART0 RX, I2C0 SCL, SPI1 CSn
18	GND	
19	GP14	I2C1 SDA, SPI1 SCK
20	GP15	I2C1 SCL, SPI1 TX

Right side (top to bottom):

Pin	GPIO	Functions
40	VBUS	
39	VSYS	
38	GND	
37	3V3_EN	
36	3V3(OUT)	
35	ADC_VREF	
34	GP28	ADC2
33	GND	AGND
32	GP27	ADC1, I2C1 SCL
31	GP26	ADC0, I2C1 SDA
30	RUN	
29	GP22	
28	GND	
27	GP21	I2C0 SCL
26	GP20	I2C0 SDA
25	GP19	SPI0 TX, I2C1 SCL
24	GP18	SPI0 SCK, I2C1 SDA
23	GND	
22	GP17	SPI0 CSn, I2C0 SCL, UART0 RX
21	GP16	SPI0 RX, I2C0 SDA, UART0 TX

LED (GP25)

USB

BOOTSEL

Raspberry Pi Pico © 2020

DEBUG

SWCLK, GND, SWDIO

Install MicroPython

```
help("modules")
Import ous
ous.listdir()

from machine import Pin
Led = Pin(2,Pin.OUT)
led.value(1)
led.value(0)
```

```
from machine import Pin
from time import sleep
led = Pin(2,Pin.OUT)
while True:
    led.value(not led.value())
    sleep(0.5)
```

Raspberry Pi

An Introduction

Contents

Introduction to Raspberry Pi Computer

Raspberry Pi port identification

Installation of Operating system in Raspberry Pi using Noobs

Installing OS in Raspberry pi using Win32 Disk imager

Turning On Raspberry Pi for first time

Raspberry Pi

Although there are a lot of Development Boards that are available in the market at varied prices but **Raspberry Pi** is supposedly the most suited to start learning IoT

What Is Raspberry Pi

- Raspberry Pi is a credit card sized Computer
- Raspberry Pi can run many operating systems using Linux
- Raspberry Pi has Following Interfaces
  - USB
  - HDMI
  - Stereo Audio out
  - GPIO
  - LAN
  - Serial Camera
  - Serial Touch Screen

About Raspberry Pi

Developed in UK by Raspberry Pi Foundation

Promote Programming Education

ARM based Complete Computer

USB, LAN, HDMI, Audio, GPIO

Micro USB Power

SD Card as storage

Very Small Form Factor

What Raspberry Pi is NOT

- Raspberry Pi is not a microcontroller or microprocessor, it's a complete computer
- Raspberry pi is not name of any IC
- Raspberry pi is not the name of any Software
- Raspberry pi is not programming language
- Raspberry pi is simply a COMPUTER in a very small size

Why?

Embedded Systems are getting very demanding these days

High processing requires a descent operating systems like Linux

Boards running linux are very costly

Learning Computer in very cost effective way is need of time

Development of a very cost effective learning and application platform

Primary Objective

Main purpose of building raspberry pi was to enable kids across the globe to learn computer

By providing a Computer to as low as USD 35, raspi is the cheapest computer in world

To teach programming language to kids

To enable hackers and developers develop interesting systems

Raspberry Pi Features

- It is useful for small or home based businesses and is perfect for adaptive technology

- Pi can be coded in Python therefore does not require the user to have extensive programming experience since Python is less complex than other languages

- The product is energy efficient and provides a greener ethical alternative to small businesses

- You are not required to purchase any special licence and therefore you can automate several tasks therefore the product also gives you a lot of room to experiment and turn it into something else that is entirely different

Applications

School, colleges to teach programming

Embedded Systems Application

Computer Vision Applications

POS

Defense products

Many real systems are being built on raspberry pi

Raspberry Pi 3

- CPU: Quad-core 64-bit ARM Cortex A53 BCM2837 clocked at 1.2 GHz.

- GPU: 400MHz VideoCore IV multimedia.

- 1 GB RAM

- 4 x USB Ports

- On-Board Wifi and Bluetooth

- Video outputs: HDMI, composite video (PAL and NTSC) via 3.5 mm jack.

- Network: 10/100Mbps Ethernet and 802.11n Wireless LAN.

- Bluetooth: 4.1

Pi Versions

Model	A
Model	B
Model	B+
Model	2 B+
Model	3 B+
Pi	Zero
Pi	Zero W
Raspberry	Pi 4 Model B.

Kit Components

- Essential:
  - Raspberry Pi board
  - Prepared Operating System SD Card
  - USB keyboard
  - Display (with HDMI, DVI, or Composite input)
  - Power Supply
- Highly suggested extras :
  - USB mouse
  - Internet connectivity - LAN cable
  - Powered USB Hub
  - Case

Power

5v micro USB connector
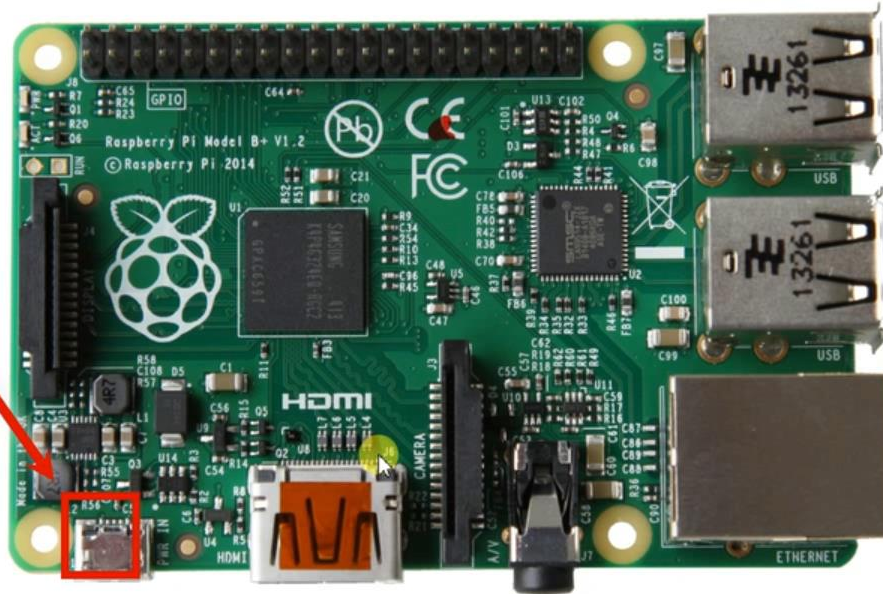
(Similar to the one on a lot of mobile phones!)

Connectivity

GPIO (General Purpose Input & Output)
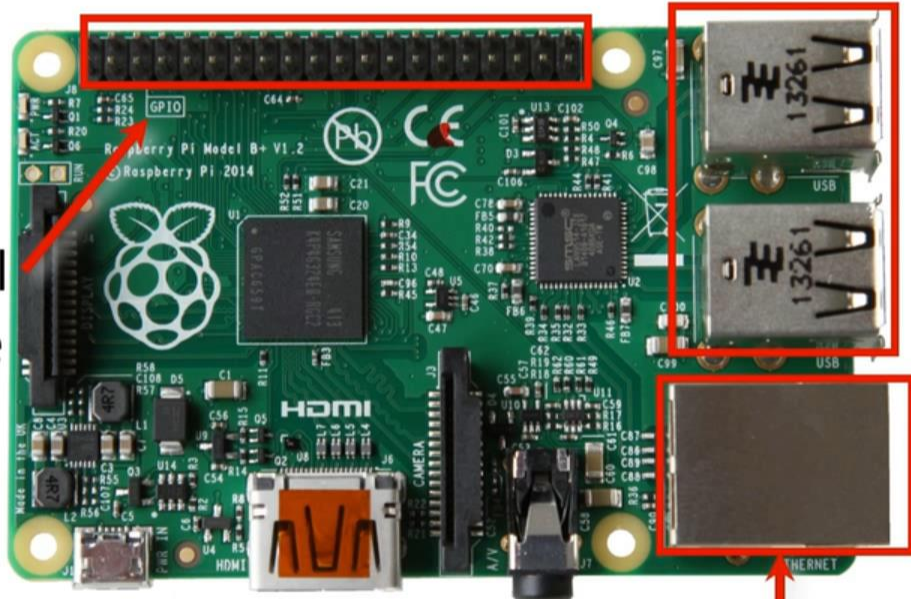
4 x USB 2.0 ports

10/100Mb Ethernet

OS Install In Raspberry Pi

Necessary Software
1.   **Advance IP Scanner**
2.   **Putty**
3.   **Imager**
4.   **VNC Viewer**
5.   **SD Card Formatter**
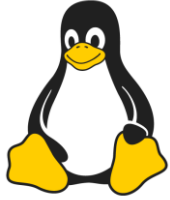
Linux Command
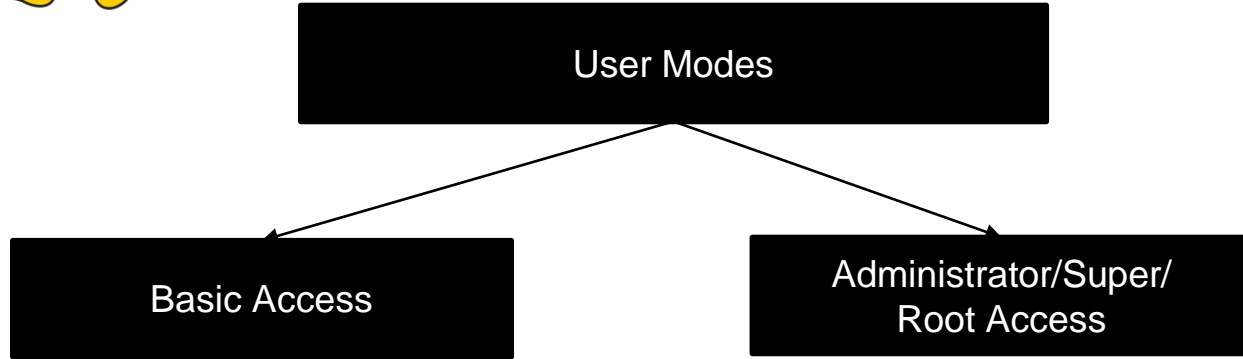
Basic Linux Command

mkdir- make directories

ls- list directory content

cd- change directory

pwd – print name of current working directory

cp – copy files

mv – move files

rm - remove files

find- search for file in directory

history- point recently used commands

su- change user id or become super-user

sudu – super du

Passwd- update a user's authentication tokens(s)

who- show who is logged on

ssh- SSH client (remote login program)

reboot- reboot the system

poweroff - power off the system

Use some commands

Ctrl+X=Save

```
pi@raspberrypi:~ $ cd Downloads
pi@raspberrypi:~/Downloads $ ls -l
total 540
-rw-r--r-- 1 pi pi 319513 Oct 25 15:02 appIcon2.png
-rw-r--r-- 1 pi pi 219934 Oct 25 15:17 raspbian-logo.png
drwxr-xr-x 2 pi pi   4096 Oct 27 12:55 temp
-rw-r--r-- 1 pi pi     35 Oct 25 15:29 test.txt
pi@raspberrypi:~/Downloads $
```

```
pi@raspberrypi:~ $ cd Downloads/
pi@raspberrypi:~/Downloads $ mkdir lee_test
pi@raspberrypi:~/Downloads $ ls -l
total 544
-rw-r--r-- 1 pi pi 319513 Oct 25 15:02 appIcon2.png
drwxr-xr-x 2 pi pi   4096 Oct 27 14:14 lee_test
-rw-r--r-- 1 pi pi 219934 Oct 25 15:17 raspbian-logo.png
drwxr-xr-x 2 pi pi   4096 Oct 27 12:55 temp
-rw-r--r-- 1 pi pi     35 Oct 25 15:29 test.txt
pi@raspberrypi:~/Downloads $
```

```
-rw-r--r-- 1 pi pi 319513 Oct 25 15:02 appIcon2.png
drwxr-xr-x 2 pi pi   4096 Oct 27 14:14 lee_test
-rw-r--r-- 1 pi pi 219934 Oct 25 15:17 raspbian-logo.png
drwxr-xr-x 2 pi pi   4096 Oct 27 12:55 temp
pi@raspberrypi:~/Downloads $
```
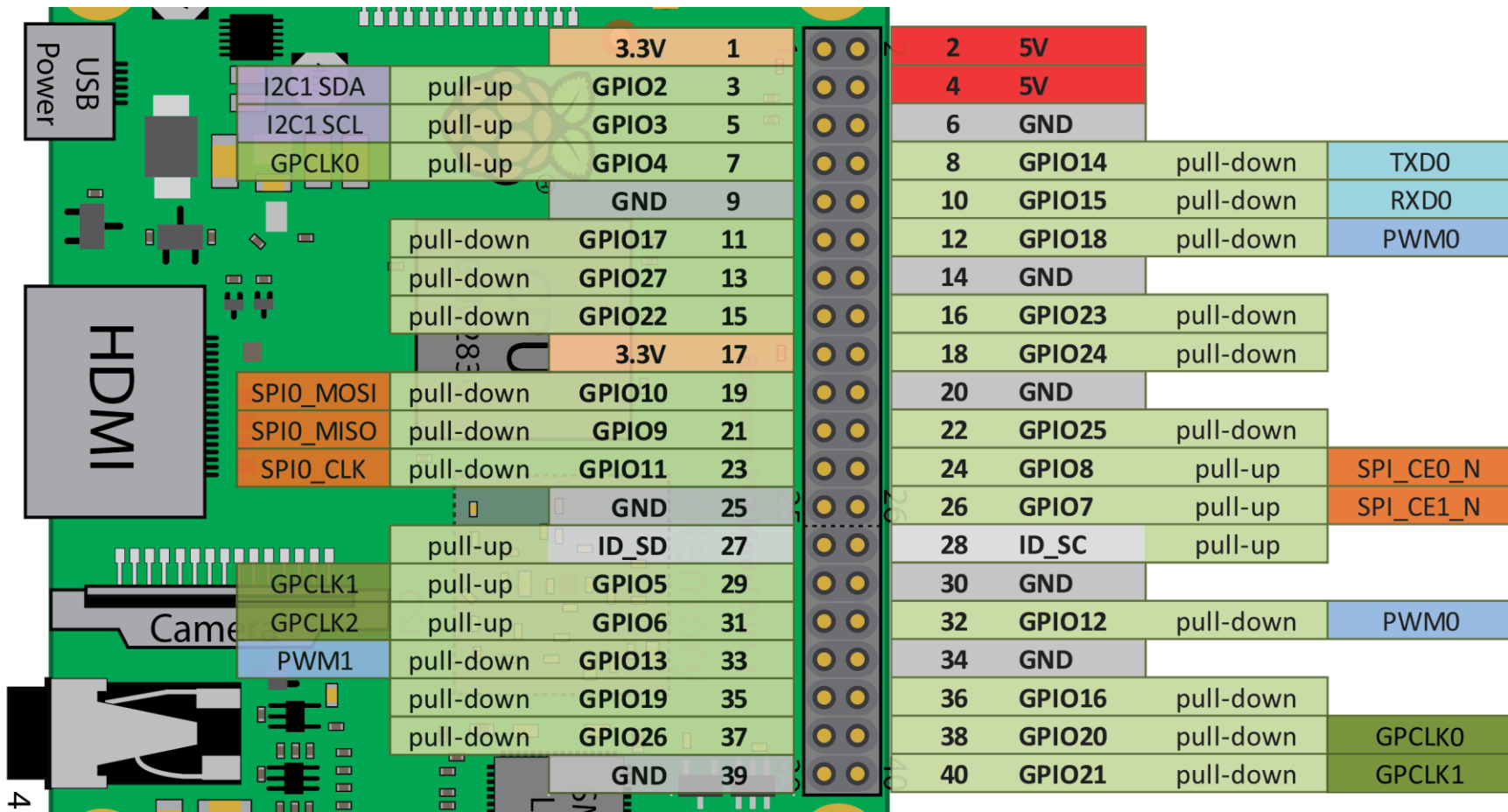
Let's Program in Raspberry Pi

```
print("Hello, World!")

>>> %Run 'Hello World.py'
Hello, World!

print("Loop starting!")
for i in range(10):
print("Loop number", i)
print("Loop finished!")


if userName == "Clark Kent":
print("You are Superman!")
else:
print("You are not Superman!")
```

```
while userName != "Clark Kent":
print("You are not Superman - try again!")
userName = input ("What is your name? ")
print("You are Superman!")
```

Alt function	Pull	Name	Pin	Pin	Name	Pull	Alt function
		3.3V	1	2	5V		
I2C1 SDA	pull-up	GPIO2	3	4	5V		
I2C1 SCL	pull-up	GPIO3	5	6	GND		
GPCLK0	pull-up	GPIO4	7	8	GPIO14	pull-down	TXD0
		GND	9	10	GPIO15	pull-down	RXD0
	pull-down	GPIO17	11	12	GPIO18	pull-down	PWM0
	pull-down	GPIO27	13	14	GND		
	pull-down	GPIO22	15	16	GPIO23	pull-down	
		3.3V	17	18	GPIO24	pull-down	
SPI0_MOSI	pull-down	GPIO10	19	20	GND		
SPI0_MISO	pull-down	GPIO9	21	22	GPIO25	pull-down	
SPI0_CLK	pull-down	GPIO11	23	24	GPIO8	pull-up	SPI_CE0_N
		GND	25	26	GPIO7	pull-up	SPI_CE1_N
	pull-up	ID_SD	27	28	ID_SC	pull-up	
GPCLK1	pull-up	GPIO5	29	30	GND		
GPCLK2	pull-up	GPIO6	31	32	GPIO12	pull-down	PWM0
PWM1	pull-down	GPIO13	33	34	GND		
	pull-down	GPIO19	35	36	GPIO16	pull-down	
	pull-down	GPIO26	37	38	GPIO20	pull-down	GPCLK0
		GND	39	40	GPIO21	pull-down	GPCLK1

USB Power

HDMI

Camera

4

DHT11 Sensor Interface Raspberry Pi

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and **a thermistor to measure the surrounding air, and spits out a digital signal on the data pin** (no analog input pins needed). Its fairly simple to use, but requires careful timing to grab data.

```
1  sudo apt-get install git-core
2  sudo apt-get update
3  git clone https://github.com/adafruit/Adafruit_Python_DHT.git
4  cd Adafruit_Python_DHT
5  sudo apt-get install build-essential python-dev
6  sudo python setup.py install
```

Before writing python code in rasberryPi make sure you have install the firebase on rasberryPi

----

To install firebase and google cloud storage use the following commands step by step in you Command prompt:

$ sudo apt-get update
$ sudo apt-get install python-pip python-dev ipython
$ sudo pip install google-cloud-storage
$ sudo pip install firebase
$ sudo pip install python-firebase

ID	Temperature	Humidity
1	20	18
2	30	40
3	40	50
4	50	60
5	41	25

Thank You