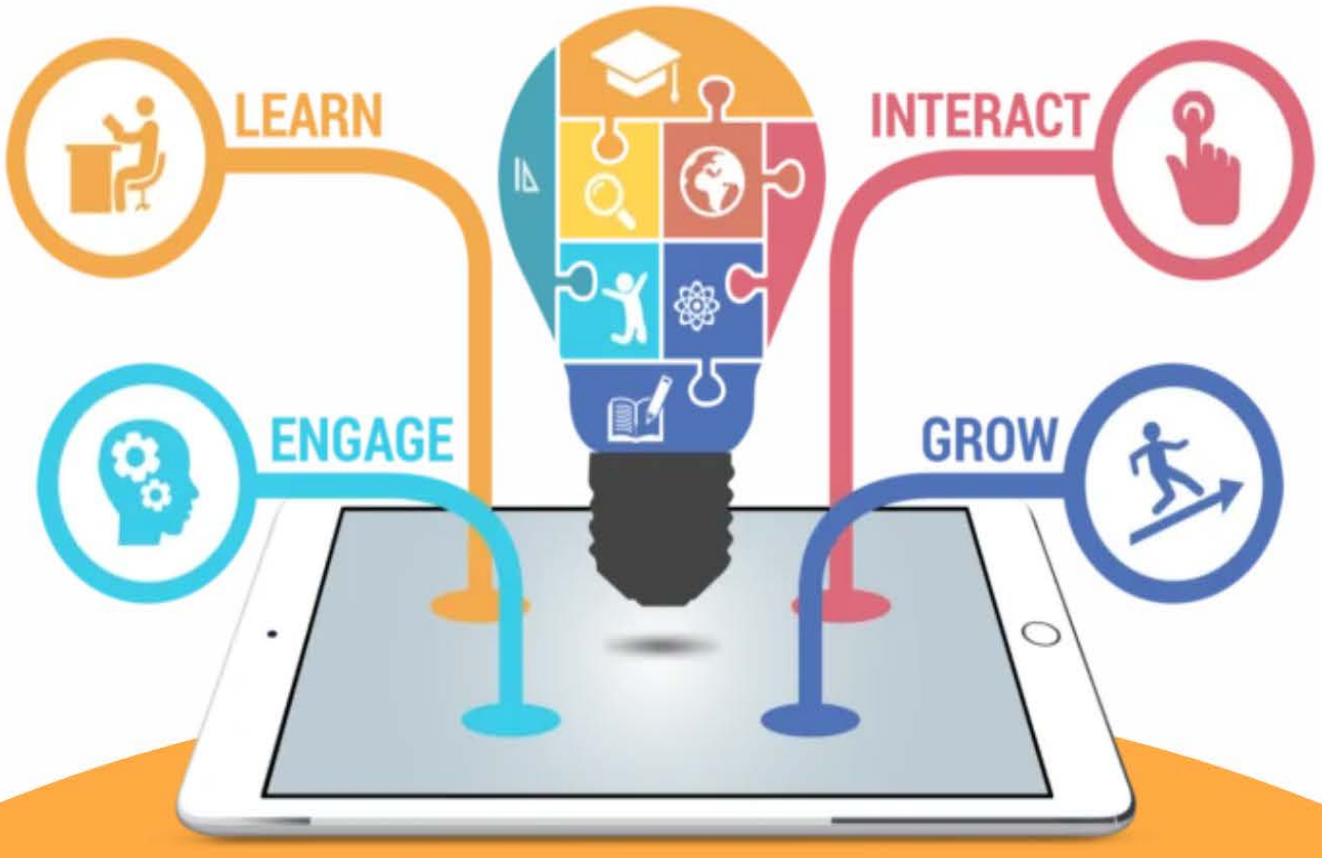
BSC-IT SEM 5

# INTERNET OF THINGS

## QUESTION PAPERS SOLUTION

(NOV 2018, APR 2019, NOV 2019, NOV 2022, APR 2023)

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# UNIT 1

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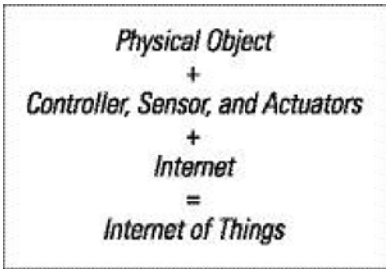
|---|---|
| 1. | Define and explain the Internet of Things. **(NOV 2018)** |
| ANS | ● We used **the *Internet* to send, receive, or communicate information**. And in each case, the gadget that was connected to the Internet wasn't a computer, tablet, or mobile phone but an object, a *Thing*. These **Things are designed for a purpose: the umbrella** has a retractable canopy and a handle to hold it.<br>  <br>*Physical Object*<br>+<br>*Controller, Sensor, and Actuators*<br>+<br>*Internet*<br>=<br>*Internet of Things*<br>● Technology's great drivers have initially been fundamental needs, such as food and water, warmth, safety, and health. Hunting and foraging, fire, building and fortifications, and medicine grow out of these needs. Then, because resources for these things are not always distributed where and when one might like, technological advances progress with enabling and controlling the movement of people, their possessions, livestock, and other resources.<br>● **Information becomes key**, too—hence, the development of language to communicate technology to others. Travellers might pass on messages as well as goods and services, and an oral tradition allows this information to pass through time as well as space.<br>● High-end cars may communicate the location back to a **tracking service for insurance** and **anti-theft purposes**. The wealth of programming and debugging resources available for these platforms has made them attractive to hobbyists and the prototyping market, leading to the proliferation of the microcontrollers For situations in which a fixed network connection isn't readily available, mobile phone connectivity is widespread. |
| 2. | "Any sufficiently advanced technology in indistinguishable from magic". Discuss. **(NOV 2018)**<br>**OR**<br>"Any sufficiently advance technology in indistinguishable from magic." Discuss. **(NOV 2022)** |
| ANS | ● The parallel invention of magic serves largely similar goals. After all, the objects in **folktales and fairy tales** are often wish-fulfilment fantasies to fill the deepest desires Literary and anthropological scholars have long studied fairy tales for the lessons that can be learnt about the basic rules of human narrative and meaning and have analyzed the characters, storylines, and objects found within them.<br>● The ancient storytellers yearning for ***Effortless Mobility*** **invented seven-league boots, flying carpets, and even teleportation.** Through technology, we have invented cars and railways, bicycles, and aeroplanes. The need for *Creative Expression* is fulfilled in stories by the enchanted paintbrushes or magic flutes and harps, while we have always used technology to devise such creative outlets, from **charcoal to paint** to computer graphics, or from **drums to violins and electronic synthesisers**. |
| 3. | Explain calm and ambient technology using example of Live Wire. **(NOV 2018)**<br>**OR** |

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| | Write a note on Calm and Ambient Technology. **(APR 2019)**<br>**OR**<br>What is calm and ambient technology? Explain with example. **(NOV 2022)**<br>**OR**<br>Explain calm and ambient technology using example of Live Wire. **(APR 2023)** |
| ANS | ● Concerned with what happens when **computing power becomes cheap enough** that it can be embedded into all manner of everyday objects. He coined the term *ubiquitous computing*, or *ubicomp* for short.<br>● With its focus on computing power being embedded everywhere, **ubicomp is often also referred to as *ambient computing*.** However, the term "ambient" also has connotations of being merely in the background, not something to which we actively pay attention and in some cases as something which we seek to remove (e.g., ambient noise in a sound recording).<br>● term ***calm technology***—systems which don't vie for attention yet are **ready to provide utility or useful information** when we decide to give them some attention.<br>● The mention of the distinctive sound from the motor when the Live Wire is under heavy load brings up another interesting point. Moving the means of conveying information away from screens and into the real world often adds a new dimension to the notification. On a computer, updating the screen is purely visual, so any additional senses must be engaged explicitly.<br>● Like Live Wire, Bubblino—Adrian's Internet of Things bubble machine which searches Twitter and blows bubbles when it finds new tweets matching a search phrase is a good example in which the side effect of the motor is to generate an audible notification that something is happening. |
| 4. | What is manufactured normalcy field? Explain. **(NOV 2018)**<br>**OR**<br>What is manufactured normalcy field? Explain. **(NOV 2019)** |
| ANS | ● We don't see the present, the world that we live in now, as something that is changing. If we step back for a second, we do *know* that it has changed, although the big advances sneak up on us over time, hidden in plain sight. This is the concept of the *manufactured normalcy field.*<br>● For a technology to be adopted, it has to make its way inside the manufactured normalcy field. As a result, the successful user-experience designer is the one who presents users with an experience which doesn't stretch the boundaries of their particular normalcy field too far, even if the underlying technology being employed is a huge leap ahead of the norm.<br>● For example, the mobile phone was first introduced as a phone that wasn't tethered to a particular location. Now broadly the same technology is used to provide a portable Internet terminal, which can play movies, carry your entire music collection, and (every now and then) make phone calls. |
| 5. | Differentiate between static IP address and Dynamic IP address. **(NOV 2018)**<br>**OR**<br>Differentiate between static and dynamic IP address. **(APR 2023)** |
| ANS | |

| S.NO | Static IP Address | Dynamic IP address |
|---|---|---|
| 1. | It is provided by ISP(Internet Service Provider). | While it is provided by DHCP (Dynamic Host Configuration Protocol). |
| 2. | Static ip address does not change any time, it means if a static ip address is provided then it can't be changed or modified. | While dynamic ip address change any time. |
| 3. | Static ip address is less secure. | While in dynamic ip address, there is low amount of risk than static ip address's risk. |
| 4. | Static ip address is difficult to designate. | While dynamic ip address is easy to designate. |
| 5. | The device designed by static ip address can be trace. | But the device designed by dynamic ip address can't be trace. |
| 6. | Static ip address is more stable than dynamic ip address. | While dynamic ip address is less stable than static ip address. |
| 7. | The cost to maintain the static ip address is higher than dynamic ip address. | While the maintaining cost of dynamic ip address is less than static ip address. |
| 8. | It is used where computational data is less confidential. | While it is used where data is more confidential and needs more security. |

6. Define protocol. Explain the following application layer protocols: HTTP, HTTPS, SMTP, FTP. **(NOV 2018)**
**OR**
Define protocol. Explain the following application layer protocols: **(NOV 2022)**
   a. HTTPS
   b. SMTP
   c. FTP
   d. POP3
   e. IMAP

ANS

- A protocol is a set of rules for communication between computers. It includes rules about how to initiate the conversation and what format the messages should be in. It determines what inputs are understood and what output is transmitted. It also

specifies how the messages are sent and authenticated and how to handle (and maybe correct) errors caused by transmission.

- **HTTP**
  - The Internet is much more than just "the web", but inevitably web services carried over HTTP hold a large part of our attention when looking at the Internet of Things.
  - **the browser is actually sending to the server to do this**. The basic structure of the request would look like this:
    - GET /hello.txt HTTP/1.1
    - Host: book.roomofthings.com
  - **browser sends the following request**
    - GET /hello.txt HTTP/1.1
    - Host: book.roomofthings.com
    - Accept: text/html,application/xhtml+xml,application/
    - xml;q=0.9,*/*;q=0.8
    - Accept-Charset: UTF-8,*;q=0.5
    - Accept-Encoding: gzip,deflate,sdch
    - Accept-Language :en-US,en;q=0.8
    - Cache-Control: max-age=0
    - Connection: keep-alive
    - If-Modified-Since: Tue, 21 Aug 2012 21:41:47 GMT
    - If-None-Match: "8a25e-d-4c7cd7e3d1cc0"
    - User-Agent: Mozilla/5.0 (Macintosh; Intel Mac OS X 10_6_8)
    - AppleWebKit/537.1
    - (KHTML, like Gecko) Chrome/21.0.1180.77 Safari/537.1

**HTTPS**

- The HTTPS protocol is actually just a mix-up of plain old HTTP over the Secure Socket Layer (SSL) protocol. An HTTPS server listens to a different port (usually 443) and on connection sets up a secure, encrypted connection with the client (using some fascinating mathematics and clever tricks such as the "Diffie–Hellman key exchange"). When that's established, both sides just speak HTTP to each other as before.

**SMTP**

- sending email using SMTP, you first need to do the "HELO handshake" where the client introduces itself with a cheery "hello" (SMTP commands are all four letters long, so it actually says "HELO") and receives a response like "250 Hello example. org pleased to meet you!"

**FTP**

- FTP is a standard communication protocol. The FTP shields the user from these differences and transfers data efficiently and reliably. FTP can transfer ASCII, EBCDIC, or image files. The ASCII is the default file share format, in this, each character is encoded by NVT ASCII. In ASCII or EBCDIC the destination must be ready to accept files in this mode.

**POP3**

- POP stands for Post Office Protocol and the latest version is known as POP3 (Post Office Protocol version 3). This is a simple protocol used by User agents for message retrieval from mail servers.
- POP protocol work with Port number 110.
- It uses TCP for establishing connections.
- POP works in dual mode- Delete mode, Keep Mode.

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| | ● In Delete mode, it deletes the message from the mail server once they are downloaded to the local system.<br>● In Keep mode, it doesn't delete the message from the mail server and also facilitates the users to access the mails later from the mail server.<br>**IMAP**<br>● Internet Message Access Protocol (IMAP) is an application layer protocol that operates as a contract for receiving emails from the mail server. It was designed by Mark Crispin in 1986 as a remote access mailbox protocol, the current version of IMAP is IMAP4. It is used as the most commonly used protocol for retrieving emails. This term is also known as Internet mail access protocol, Interactive mail access protocol, and Interim mail access protocol.<br>● IMAP follows Client-server Architecture and is the most commonly used email protocol. It is a combination of client and server process running on other computers that are connected through a network. This protocol resides over the TCP/IP protocol for communication. Once the communication is set up the server listens on port 143 by default which is non-encrypted. For the secure encrypted communication port, 993 is used. |
| 7. | Explain the components of Internet of Things. **(APR 2019)**<br>**OR**<br>Define Internet of Things and explain its components. **(APR 2023)** |
| ANS | **WEB THINKING FOR CONNECTED DEVICES**<br>● ***robustness principle*** has become so well known that it is commonly referred to as *Postel's Law*. It is good to bear this in mind when designing or building anything which **must interact with other services** particularly when you aren't the one building the other components with which your system interacts.<br><br>**SMALL PIECES, LOOSELY JOINED**<br>● Even if you are building all the components of your service, it makes sense not to couple them too tightly together.<br>● The Internet flourished not because it is neatly controlled from a central location, but because it isn't; it is a collection of services and machines following the maxim of *small pieces, loosely joined*.<br>● Where possible, use existing standards and protocols rather than inventing your own. Any loss of elegance or efficiency of code size or electronics will be outweighed by the availability of standard libraries and skills for people to interact with, and build on, your system.<br><br>**FIRST-CLASS CITIZENS ON THE INTERNET**<br>● An extension of the concept of loose coupling is to strive to make your devices first-class citizens on the Internet. What do we mean by that? Where possible, you should use the same protocols and conventions that the rest of the Internet uses.<br>● In the few cases where the existing protocols don't work, such as in extremely low-powered sensors, a better solution is to work with your peers to amend existing standards or create new open standards which address the issue within the conventional standards groups.<br><br>**GRACEFUL DEGRADATION**<br>● Because the Internet is so welcoming and tolerant of all sorts of devices and services, the endpoints have a massively disparate and diverse range of capabilities. As a result, building services which can be used by all of them is a nearly impossible task. |

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| | • The first is to acknowledge that the wealth of different devices is likely to be a problem and design your system to expect it. If you need to come up with a format for some data being transferred between devices, include a way to differentiate between successive versions of the formats—ideally in such a way that older devices can still mostly read newer formats. This is known as *backwards compatibility*, and although over time it will add some cruft to the format, as certain features will only persist to serve outdated devices, it will greatly extend the life and utility of your users' devices.<br>• The HTML format does this by stating that any client should ignore any tags (the text inside the <>) that it doesn't understand, so newer versions can add new tags without breaking older parsers. The HTTP protocol uses a slightly different technique in which each end specifies the version of the protocol that it supports, and the other end takes care not to use any of the newer features for that particular session.<br>• The other common technique is to use something called *graceful degradation*. This technique involves aiming to provide a fully featured experience if the client is capable of it but then falling back—potentially in a number of levels—to a less feature-rich experience on less capable clients.<br><br>**AFFORDANCES**<br>• As adoption of the Internet of Things gathers pace, more and more of our cities, homes, and environment will become suffused with technology. With these additional behaviours and capabilities will come additional complexity—something that successful designers of connected devices and services will need to counter.<br>• An important start is to keep the existing affordances of the object being enhanced. Users who don't realize that a device has any extra capabilities should still be able to use it as if it hasn't.<br>• Although this principle sounds like common sense, it is often discarded due to costs or difficulties in design.<br>• Don't overload familiar connectors with unfamiliar behaviours. For example, you shouldn't use 3.5mm audio jacks to provide power, although alternative "data-level" uses are probably okay. |
| 8. | Explain the following concepts with respect to IOT: **(APR 2023)**<br>(i) Small pieces loosely joined<br>(ii) Graceful degradation |
| ANS | **SMALL PIECES, LOOSELY JOINED**<br>• Even if you are building all the components of your service, it makes sense not to couple them too tightly together.<br>• The Internet flourished not because it is neatly controlled from a central location, but because it isn't; it is a collection of services and machines following the maxim of *small pieces, loosely joined*.<br>• Where possible, use existing standards and protocols rather than inventing your own. Any loss of elegance or efficiency of code size or electronics will be outweighed by the availability of standard libraries and skills for people to interact with, and build on, your system.<br><br>**GRACEFUL DEGRADATION**<br>• Because the Internet is so welcoming and tolerant of all sorts of devices and services, the endpoints have a massively disparate and diverse range of capabilities. As a result, building services which can be used by all of them is a nearly impossible task. |

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| 9. | Write a note on DNS (Domain Name System). **(APR 2019)**<br>**OR**<br>What is DNS? How does it work? **(NOV 2019)**<br>**OR**<br>Explain the working of Domain Name System (DNS). **(APR 2023)** |
| ANS | • Although computers can easily handle 32-bit numbers, even formatted as dotted quads they are easy for most humans to forget. The Domain Name System (DNS) helps our feeble brains navigate the Internet.<br>o google.com<br>o bbc.co.uk<br>o wiley.com<br>o arduino.cc<br>• Each domain name has a top-level domain (TLD), like .com or.uk, which further subdivides into .co.uk and .gov.uk, and so on.<br>• This top-level domain knows where to find more information about the domains within it; for example, .com knows where to find google.com and wiley.com.<br>• DNS can also point to other services on the Internet—for example:<br>o pop3.google.com — For receiving email from Gmail<br>o smtp.google.com — For sending email to Gmail<br>o ns1.google.com — The address of one of Google's many DNS servers<br>• Configuring DNS is a matter of changing just a few settings. Your registrar (the company that sells you your domain name) often has a control panel to change these settings. You might also run your own authoritative DNS server.<br>• The settings might contain entries like this one for room of things. com:<br>o book A 80.68.93.60 3h |
| 10. | List and explain the roles of people making Internet of Things. **(APR 2023)**<br>**OR**<br>List and explain the roles of people making IOT. **(NOV 2019)** |
| ANS | • We are largely interested in the practice of actually *designing* and *making* Internet connected Things.<br>• There are many crossover points between all the disciplines listed. **Artists** may collaborate with designers on installations or with traditional **craftspeople** on |

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| | printmaking. **Designers** and **engineers** work closely to make industrial products, and **hobbyist "hackers"** (in the sense of tinkerers and amateur engineers), by their nature, are a diverse group encompassing various technical and artistic interests and skills. |
| 11. | Discuss the issue of Privacy in Internet of Things. **(APR 2019)**<br>**OR**<br>"Data available through IOT device belongs to public or company which implement the IOT device". Discuss. **(NOV 2019)** |
| ANS | ● The Internet of Things devices that we own aren't the only ones that should concern us when it comes to **matters of trust**.<br>● With more sensors and devices watching us and reporting data to the Internet, the **privacy of third parties** who cross our sensors' paths (either by accident or design) is an important consideration.<br>● Health care, privacy concerns are an obvious issue, "**Ethics"**. However, even seemingly innocuous applications **can leak personal information**, so you should be alert to the danger and take measures to avoid it.<br>● it is standard practice to **never store passwords as cleartext**. You could also consider applying the standard mechanisms for password encryption, such as the one-way hash, to other pieces of data.<br>● Rather than storing identifying data in the database, if you don't need to return it to its original form (that is, you just need it to be unique and associated with the same group of data), use a one-way **hashed version** of the information instead.<br>● With the number of sensors being deployed, it isn't always clear whose data is being gathered. Consider the case of a camera deployed in an advertising hoarding which can check to see whether people are looking at the different adverts. Does the data belong to the company that installed the camera or to the members of the public who are looking at the adverts?<br>● **in a public space this data is being generated by the public**, so they should at least have **equal rights** to be aware of, and also have access to, that data.<br>● **On private property, you can more easily claim** that the members of the public don't have such a right, but perhaps the **property owner might assert rights** to the data rather than whoever installed the camera. |
| 12. | What is MAC (Media Access Control) address? Explain. **(APR 2019)** |
| ANS | ● As well as an IP address, every network-connected device also has a MAC address, which is like the final address on a physical envelope in our analogy.<br>● It is used to differentiate different machines on the same physical network so that they can exchange packets. This relates to the lowest-level "link layer" of the TCP/IP stack.<br>● Though MAC addresses are globally unique, they don't typically get used outside of one Ethernet network (for example, beyond your home router). So, when an IP message is routed, it hops from node to node, and when it finally reaches a node which knows where the *physical* machine is, that node passes the message to the device associated with that MAC address.<br>● MAC stands for *Media Access Control*. It is a 48-bit number, usually written as six groups of hexadecimal digits, separated by colons—for example: 01:23:45:67:89:ab |
| 13. | Define and explain Ubiquitous Computing (ubicom). **(NOV 2019)**<br>**OR**<br>Define and explain Internet of Things and Ubiquitous Computing. **(NOV 2022)** |

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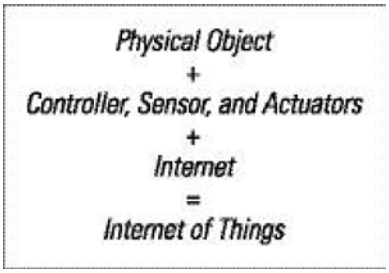
| ANS | • All the cases we used **the *Internet* to send, receive, or communicate information**. And in each case, the gadget that was connected to the Internet wasn't a computer, tablet, or mobile phone but an object, a *Thing*. These **Things are designed for a purpose: the umbrella** has a retractable canopy and a handle to hold it.<br>  <br>*Physical Object*<br>+<br>*Controller, Sensor, and Actuators*<br>+<br>*Internet*<br>=<br>*Internet of Things*<br>• Technology's great drivers have initially been fundamental needs, such as food and water, warmth, safety, and health. Hunting and foraging, fire, building and fortifications, and medicine grow out of these needs. Then, because resources for these things are not always distributed where and when one might like, technological advances progress with enabling and controlling the movement of people, their possessions, livestock, and other resources.<br>• **Information becomes key**, too—hence, the development of language to communicate technology to others. Travellers might pass on messages as well as goods and services, and an oral tradition allows this information to pass through time as well as space.<br>• High-end cars may communicate the location back to a **tracking service for insurance** and **anti-theft purposes**. The wealth of programming and debugging resources available for these platforms has made them attractive to hobbyists and the prototyping market, leading to the proliferation of the microcontrollers For situations in which a fixed network connection isn't readily available, mobile phone connectivity is widespread.<br>• The definition of ubicomp, however, would also include the Glade air fresheners which release scent when they detect movement in the room as part of its domain.<br>• That is to say, such a device is an intelligently programmed computer processor, driven by sensors in the real world, and driving output in the real world, all embedded into an everyday object.<br>• These factors make this ubicomp, and it is only differentiated from the "Internet of Things" by the fact that these days most of the really interesting things done with computing also involve an Internet connection. |
| 14. | Explain the working of IP Protocol. **(APR 2019)** |
| ANS | • The combination of TCP and IP is so ubiquitous that we often refer simply to "TCP/IP" to describe a whole suite or stack of protocols layered on top of each other, each layer building on the capabilities of the one below.<br>• The low-level protocols at the link layer manage the transfer of bits of information across a network link. This could be by an Ethernet cable, by WiFi, or across a telephone network, or even by short-range radio standards such as IEEE 802.15.4 designed to carry data over the Personal Area Network (PAN), that is to say between devices carried by an individual.<br>• The Internet layer then sits on top of these various links and abstracts away the gory details in favour of a simple destination address.<br>• Then TCP, which lives in the transport layer, sits on top of IP and extends it with more sophisticated control of the messages passed. |

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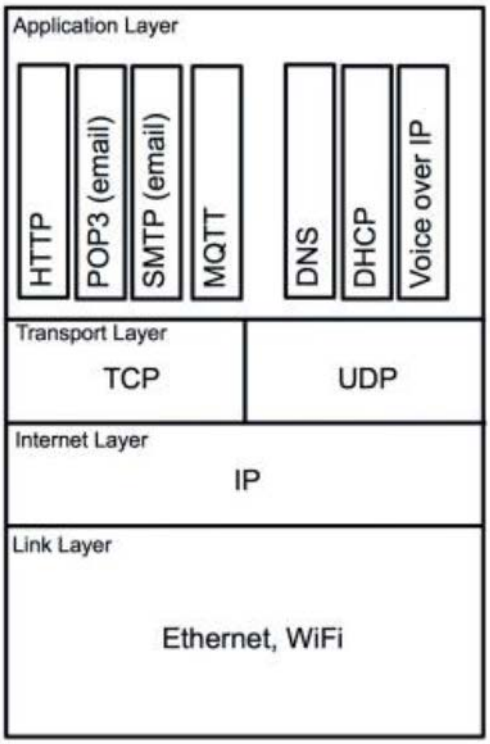
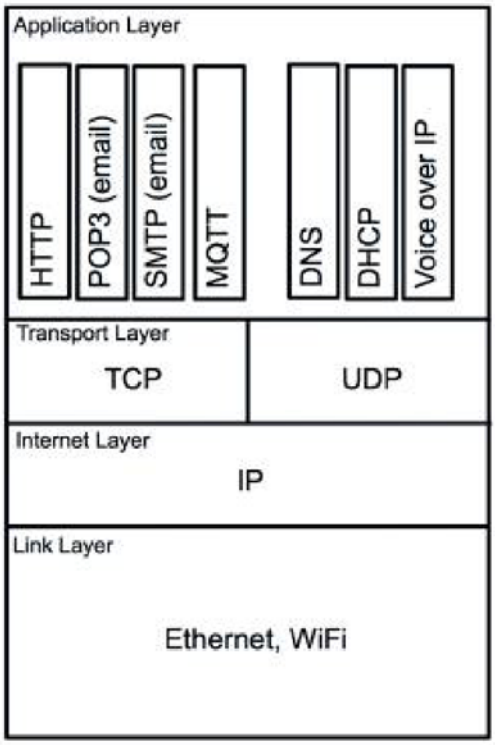
| | • Finally, the application layer contains the protocols that deal with fetching web pages, sending emails, and Internet telephony. Of these, HTTP is the most ubiquitous for the web, and indeed for communication between Internet of Things devices.<br>  <br> |
| 15. | What are TCP and UDP ports? Explain with examples. **(NOV 2019)** |
| ANS | • The simplest transport protocol on the Internet, TCP is built on top of the basic IP protocol and adds sequence numbers, acknowledgements, and retransmissions. This means that a message sent with TCP can be arbitrarily long and give the sender some assurance that it actually arrived at the destination intact.<br>• The lack of overhead, however, makes UDP useful for applications such as streaming data, which can cope with minor errors but doesn't like delays.<br>• Voice over IP (VoIP)—computer-based telephony, such as Skype—is an example of this: missing one packet might cause a tiny glitch in the sound quality, but waiting for several packets to arrive in the right order could make the speech too jittery to be easy to understand. UDP is also the transport for some very important protocols which provide common, low-level functionality, such as DNS and DHCP, which relate to the discovery and resolution of devices on the network.<br>  <br> |
| 16. | Discuss the following IOT device use at Dos Liverpool, **(NOV 2022)** |

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| | i) Central Heating System.<br>ii) Doorbot. |
| ANS | i. Central Heating System<br>● The central heating system has been hooked up to the Internet. YAHMS, as the system is named, consists of a collection of sensors to measure temperature in the office and outside, an actuator to turn the heating on or off, and some server software to manage timer control and provide a web-based interface to the system.<br>● Like many non-Internet connected heating systems, there is a timer-based programme which ensures a basic level of comfort automatically. The temperature sensors have been left as unhoused Arduino boards.<br>● They are managed only by John, whose project it is. However, the cabling to the boiler itself is neatly installed, and the electronics are hidden away. The actual interface that people use every day, however, is well styled with a minimal interface and works equally well on a desktop browser or a smartphone.<br><br>ii. Doorbot<br>● It originally consisted of a networked PC with a flat-screen monitor facing out towards the corridor through a conveniently located window.<br>● The DoorBot works as a kiosk device, showing webcam views of the office, a list of upcoming events (regularly pulled from Google Calendar), and a welcome message to any expected guests.<br>● Currently, its only input device is an RFID reader. Our members can register their RFID cards (Oyster, Walrus, DoES membership card, and so on). Finally, this device is also connected to speakers, so it can play a personalised tune or message when members check in or out.<br>● Developing this device was as simple as running software on a computer ever is: the trickiest cases are things such as turning the screen off and on after office hours and coping with losing or regaining power and network. |
| 17. | "Be conservative in what you do, be liberal in what you accept from others". Explain. **(NOV 2022)** |
| ANS | ● Jon Postel wrote: “Be conservative in what you do, be liberal in what you accept from others”.<br>● ***robustness principle*** has become so well known that it is commonly referred to as *Postel’s Law*. It is good to bear this in mind when designing or building anything which **must interact with other services** particularly when you aren’t the one building the other components with which your system interacts. |

# UNIT 2

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| 1. | Discuss the tradeoffs between cost versus ease of prototyping. **(NOV 2018)**<br>**OR**<br>How can we decide between the cost and ease of prototyping? **(NOV 2022)** |
| ANS | ● Although familiarity with a platform may be attractive in terms of ease of prototyping, it is also worth considering the relationship between the costs (of prototyping and mass producing) of a platform against the development effort that the platform demands. This trade-off is not hard and fast, but it is beneficial if you can choose a prototyping platform in a performance/capabilities bracket similar to a final production solution.<br>o AVR microcontroller chip 210rs cost is less but overhead of work increases<br>o Arduino or similar 1400rs cost is high but reduces work (programming c++)<br>o BeagleBone 2100rs can work on js and node.js and improvement in ram<br>o Raspberry 3800rs standard and works on many languages (python)<br>As always, there is no single “right answer” but a set of trade-offs. Don’t let this put you off starting a prototype, though. There are really no “wrong answers” either for that; the prototype is something that will get you started, and the experience of making it will teach you much more about the final best platform. |
| 2. | What are the challenges when we move from prototype to mass production? Explain. **(NOV 2018)** |
| ANS | ● Chances are that the production techniques that you use for the physical side of your device won’t translate directly to mass production. However, while the technique might change—injection moulding in place of 3D printing, for example—in most cases, it won’t change what is possible.<br>● An aspect that may be of interest is in the way that digital fabrication tools can allow each item to be slightly different, letting you personalise each device in some way. There are challenges in scaling this to production, as you will need to keep producing the changeable parts in quantities of one, but mass personalisation, as the approach is called, means you can offer something unique with the accompanying potential to charge a premium. |
| 3. | Discuss open source versus closed source hardware and software. State their advantages and disadvantages. **(NOV 2018)**<br>**OR**<br>Differentiate between open source and closed source. **(APR 2019)**<br>**OR**<br>What are the disadvantages of Open source? **(APR 2019)**<br>**OR**<br>"Open source has a competitive advantage Discuss. **(NOV 2019)**<br>**OR**<br>Discuss the merits and demerits of mixing open source and close source. **(NOV 2022)**<br>**OR**<br>Discuss open source versus closed source hardware and software. State their advantages and disadvantages. **(APR 2023)** |

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| ANS | ● If you're so minded, you could spend a lifetime arguing about the definitions of "closed" and "open" source, and some people have, in fact, made a career out of it. Broadly, we're looking at two issues:<br>o Your assertion, as the creator, of your Intellectual Property rights<br>o Your users' rights to freely tinker with your creation<br>● As a creative person, you may be torn between your own desire to learn how things work and modify and re-use them and the worry that if other people were to use that right on your own design/invention/software.<br>● tension between the closed and open approaches is rather interesting, especially when applied to a mix of software and hardware, as we find with Internet of Things devices.<br>Advantages of open source:<br>o You may gain positive comments from people who liked it.<br>o It acts as a public showcase of your work, which may affect your reputation and lead to new opportunities.<br>o People who used your work may suggest or implement features or fix bugs.<br>o By generating early interest in your project, you may get support and mindshare of a quality that it would be hard to pay for.<br><br>Disadvantages of open source:<br>o The obvious disadvantage of open source—"but people will steal my idea!"—may, in fact, be less of a problem than you might think. In general, if you talk to people about an idea, it's hard enough to get them to listen because they are waiting to tell you about their great idea (the selfish cads).<br>o If people do use your open source contribution, they will most likely be using it in a way that interests them. The universe of ideas is still, fortunately, very large.<br>o Of course, the right way to handle this process would be to start pushing everything to an open repository immediately and develop in public. This is much more the "open source way". It may take some time to get used to but may work for you.<br>o After you release something as open source, you may still have a perceived duty to maintain and support it, or at least to answer questions about it<br>**WHY CLOSED?**<br>● Asserting Intellectual Property rights is often the default approach, especially for larger companies. If you declared copyright on some source code or a design, someone who wants to market the same project cannot do so by simply reading your instructions and following them. That person would have to instead reverse-engineer the functionality of the hardware and software.<br>● You might also be able to protect distinctive elements of the visual design with trademarks and of the software and hardware with patents.<br>● If you're working on your own or in a small company, you might simply trademark your distinctive brand and rely on copyright to protect everything else. |
| 4. | Explain the following with respect to prototyping embedded devices: Processor Speed, RAM, Networking, USB, Power Consumption and Physical Size and Form Factor. **(NOV 2018)**<br>**OR**<br>Explain the following with respect to prototyping embedded devices: Processor Speed. Networking, Power Consumption and Physical Size and Form Factor. **(APR 2023)**<br>**OR**<br>Explain the following with respect to prototyping embedded devices: Processor Speed, RAM, Networking, Power Consumption and physical size and form factor. **(NOV 2022)**<br>**OR** |

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| | Discuss the factors we should consider when deciding to build Internet of Things device. **(APR 2019)** |
| ANS | o Processor Speed<br>▪ The processor speed, or clock speed, of your processor tells you how fast it can process the individual instructions in the machine code for the program it's running. Naturally, a faster processor speed means that it can execute instructions more quickly.<br>o RAM<br>▪ RAM provides the working memory for the system. If you have more RAM, you may be able to do more things or have more flexibility over your choice of coding algorithm.<br>o Networking<br>▪ How your device connects to the rest of the world is a key consideration for Internet of Things products.<br>▪ Wired Ethernet is often the simplest for the user—generally plug and play—and cheapest, but it requires a physical cable. WiFi is the most widely deployed to provide an existing infrastructure for connections, but it can be more expensive and less optimized for power consumption than some of its competitors.<br>▪ The recent Bluetooth LE protocol (also known as Bluetooth 4.0) has a very low power-consumption profile similar to ZigBee's and could see more rapid adoption due to its inclusion into standard Bluetooth chips included in phones and laptops.<br>o USB<br>▪ If your device can rely on a more powerful computer being nearby, tethering to it via USB can be an easy way to provide both power and networking. Devices such as WiFi dongles often depend on additional software on the host system, such as networking stacks, and so are better suited to the more computer-like option of SoC.<br>o Power Consumption<br>▪ Faster processors are often more power hungry than slower ones. For devices which might be portable or rely on an unconventional power supply (batteries, solar power) depending on where they are installed, power consumption may be an issue.<br>▪ Interfacing with Sensors and Other Circuitry sensors to gather data about its environment; or motors, LEDs, screens, and so on, to provide output.<br>▪ You could connect to the circuitry through some sort of peripheral bus—SPI and I2C being common ones—or through ADC or DAC modules to read or write varying voltages or through generic GPIO pins, which provide digital on/off inputs or outputs.<br>o Physical Size and Form Factor<br>▪ means that we've long passed the point where the limiting factor in the size of a chip is the amount of space required for all the transistors and other components that make up the circuitry on the silicon. Nowadays, the size is governed by the number of connections it needs to make to the surrounding components on the PCB. |
| 5. | How is development done for Arduino? Explain. **(NOV 2018)** |

ANS

- As previously mentioned, the Arduino is optimised for simplicity, and this is evident from he way it is packaged for use. Using a single USB cable, you can not only power the board but also push your code onto it, and (if needed) communicate with it
- **Integrated Development Environment**
  - You usually develop against the Arduino using the integrated development environment (IDE) that the team supply at http://arduino.cc.
  - Most Arduino projects consist of a single file of code, so you can think of the IDE mostly as a simple file editor. The controls that you use the most are those to check the code (by compiling it) or to push code to the board.
- **Pushing Code**
  - Connecting to the board should be relatively straightforward via a USB cable.
- **Operating System**
  - The Arduino doesn't, by default, run an OS as such, only the bootloader, which simplifies the code-pushing process When you switch on the board, it simply runs the code that you have compiled until the
  - board is switched off again (or the code crashes).
  - It is, however, possible to upload an OS to the Arduino, usually a lightweight real-time operating system (RTOS) such as FreeRTOS/DuinOS. The main advantage of one of these operating systems is their built-in support for multitasking.
- **Language**
  - The language usually used for Arduino is a slightly modified dialect of C++ derived from the Wiring platform. It includes some libraries used to read and write data from the I/O pins provided on the Arduino and to do some basic handling for "interrupts" (a way of doing multitasking, at a very low level).
  - **The code needs to provide only two routines:**
    - **setup()**: This routine is run once when the board first boots.
    - **loop()**: This routine is run repeatedly in a tight loop while the Arduino is switched on.

**blinking a single LED**

```
// Pin 13 has an LED connected on most Arduino boards.
// give it a name:
int led = 13;
// the setup routine runs once when you press reset:
void setup() {
// initialize the digital pin as an output.
pinMode(led, OUTPUT);
}
// the loop routine runs over and over again forever:
void loop() {
digitalWrite(led, HIGH); // turn the LED on
delay(1000); // wait for a second
digitalWrite(led, LOW); // turn the LED off
delay(1000); // wait for a second
}
```

- **Debugging**
  - Because C++ is a compiled language, a fair number of errors, such as bad syntax or failure to declare variables, are caught at compilation time.

6. Compare Raspberry Pi and Arduino. **(NOV 2018)**
**OR**
Compare Raspberry Pi and Arduino. **(NOV 2022)**

ANS

| S No. | Arduino | Raspberry Pi |
|---|---|---|
| 1. | In the year 2005, the classrooms of the Interactive Design Institute in Ivrea, Italy, first introduced the Arduino board. | In the year 2012, Eben Upton first introduced the Raspberry Pi device in February. |
| 2. | Control unit of the Arduino is from the Atmega family. | The control unit of Raspberry Pi is from the ARM family. |
| 3. | Arduino is based on a microcontroller. | While Raspberry Pi is based on a microprocessor. |
| 4. | It is designed to control the electrical components connected to the circuit board in a system. | While Raspberry Pi computes data and produces valuable outputs, and controls components in a system based on the outcome of its computation. |
| 5. | Arduino boards have a simple hardware and software structure. | While Raspberry Pi boards have a complex architecture of hardware and software. |
| 6. | CPU architecture: 8 bit. | CPU architecture: 64 bit. |
| 7. | It uses very little RAM, 2 kB. | While Raspberry Pi requires more RAM, 1 GB. |
| 8. | It clocks a processing speed of 16 MHz. | While Raspberry Pi clocks a processing speed of 1.4 GHz. |
| 9. | It is cheaper in cost. | While Raspberry Pi is expensive. |
| 10. | It has a higher I/O current drive strength. | While Raspberry Pi has a lower I/O current drive strength. |
| 11. | It consumes about 200 MW of power. | While it consumes about 700 MW of power. |

7. Write note on Raspberry Pi. **(APR 2019)**

ANS

- The Raspberry Pi, unlike the Arduino, wasn't designed for physical computing at all, but rather, for education. **The vision of Eben Upton**, trustee and cofounder of the Raspberry Pi Foundation, was to build a computer that was small and inexpensive and designed to be programmed and experimented with, like the ones he'd used as a child, rather than to passively consume games on.
- While working at Broadcom, Upton worked on the Broadcom BCM2835 system-on-chip, which featured an exceptionally powerful graphics processing unit (GPU), capable of high-definition video and fast graphics rendering. It also featured a low-power, cheap but serviceable 700 MHz ARM CPU, almost tacked on as an afterthought. Due in large part to its charitable status, even as a small group, the Foundation has been able to deal with large suppliers and push down the costs of the components. The final boards ended up costing around £25 for the more powerful Model B (with built-in Ethernet connection). This is around the same price point as an Arduino, yet the boards are really of entirely different specifications.

| | Arduino Due | Raspberry Pi Model B |
|---|---|---|
| CPU Speed | 84 MHz | 700 MHz ARM11 |
| GPU | None | Broadcom Dual-Core VideoCore IV Media Co-Processor |
| RAM | 96KB | 512MB |
| Storage | 512KB | SD card (4GB +) |
| OS | Bootloader | Various Linux distributions, other operating systems available |
| Connections | 54 GPIO pins<br>12 PWM outputs<br>4 UARTs<br>SPI bus<br>I²C bus<br>USB 16U2 + native host<br>12 analogue inputs (ADC)<br>2 analogue outputs (DAC) | 8 GPIO pins<br>1 PWM output<br>1 UART<br>SPI bus with two chip selects<br>I²C bus<br>2 USB host sockets<br>Ethernet<br>HDMI out<br>Component video and audio out |

- So, the Raspberry Pi is effectively a computer that can run a real, modern operating system, communicate with a keyboard and mouse, talk to the Internet, and drive a TV/monitor with high-resolution graphics.
- Like the Raspberry Pi, the BeagleBone is a computer that mostly runs Linux but is capable of running a variety of other ported operating systems.
- Importantly, for Internet of Things work, both boards come with Ethernet connectivity (assuming the Raspberry Pi Model B) and can take advantage of cheap USB WiFi dongle options if required.

8. How is development done on the Raspberry Pi? Explain. **(APR 2023)**

ANS

- **Operating System**
  - Although many operating systems can run on the Pi, we recommend using a popular Linux distribution, such as

- Raspbian: Released by the Raspbian Pi Foundation, Raspbian is a distro based on Debian. This is the default "official" distribution and is certainly a good choice for general work with a Pi.
- Occidentalis: This is Adafruit's customised Raspbian. Unlike Raspbian, the distribution assumes that you will use it "headless"—not connected to keyboard and monitor—so you can connect to it remotely by default. (Raspbian requires a brief configuration stage first.)
- The main tweaks that interest us are that
  - The sshd (SSH protocol daemon) is enabled by default, so you can connect to the console remotely.
  - The device registers itself using zero-configuration networking (zeroconf) with the name raspberrypi.local, so you don't need to know or guess which IP address it picks up from the network in order to make a connection.

- With the Raspberry Pi, however, you've already had to make decisions about the distro and download
- it. Now that distro needs to be unpacked on the SD card, which you purchase separately. You should note that some SD cards don't work well with the Pi; apparently, "Class 10" cards work best.
- the Pi may boot up, if you have enough power to it from the USB.
- $ ssh root@raspberrypi.local
- From Windows, you can use an SSH client such as PuTTY

- **Programming Language**
  - One choice to be made is which programming language and environment you want to use.
  - Here, again, there is some guidance from the Foundation, which suggests Python as a good language for educational programming (and indeed the name "Pi" comes initially from Python).
  - **"blinking lights" example:**

```
import RPi.GPIO as GPIO
from time import sleep
GPIO.setmode(GPIO.BOARD) # set the numbering scheme to be the
# same as on the board
GPIO.setup(8, GPIO.OUT) # set the GPIO pin 8 to output mode
led = False
GPIO.output(8, led) # initiate the LED to off
while 1:
GPIO.output(8, led)
led = not led # toggle the LED status on/off for the next
# iteration
sleep(10) # sleep for one second
```

  - However, when you go beyond this level of complexity, using a more expressive "high-level" language like Python will almost certainly make the following tasks easier:
    - Handling strings of character data
    - Completely avoiding having to handle memory management (and bugs related to it)
    - Making calls to Internet services and parsing the data received
    - Connecting to databases and more complex processing
    - Abstracting common patterns or complex behaviours

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| | ● **Debugging**<br>● While Python's compiler also catches a number of syntax errors and attempts to use undeclared variables, it is also a relatively permissive language (compared to C++) which performs a greater number of calculations at runtime. This means that additional classes of programming errors won't cause failure at compilation but will crash the program when it's running, perhaps days or months later.<br>● you can simply use try... catch... logic so that you can trap errors in your Python code and determine what to do with them. |
| 9. | Write note on Sketching. **(APR 2019)**<br>**OR**<br>What is sketching? Explain its role in prototyping. **(NOV 2019)**<br>**OR**<br>What is the role of sketching in prototyping? Explain. **(APR 2023)** |
| ANS | ● Jot down some ideas or draw out some design ideas with pen and paper. That is an important first step in exploring your idea and one we'd like to extend beyond the strict definition to also include sketching in hardware and software.<br>● For the physical design, that could mean digging out your childhood LEGO collection to prototype the mix of cogs and three-dimensional forms, or maybe attacking some foamcore or cardboard with a craft knife.<br>● From the design constraints problem could be broken into three broad areas:<br>o the graphic design of the printed publication<br>o the physical hardware to easily add items to the shopping list<br>o some server software to tie the rest of the system together |
| 10. | Write note on Sensors and Actuators. **(APR 2019)** |
| ANS | **SENSORS**<br>● Pushbuttons and switches, which are probably the simplest sensors, allow some user input. Potentiometers (both rotary and linear) and rotary encoders enable you to measure movement.<br>● Sensing the environment is another easy option. Light-dependent resistors (LDRs) allow measurement of ambient light levels, thermistors and other temperature sensors allow you to know how warm it is, and sensors to measure humidity or moisture levels are easy to build.<br><br>**ACTUATORS**<br>● One of the simplest and yet most useful actuators is light, because it is easy to create electronically and gives an obvious output. Light-emitting diodes (LEDs) typically come in red and green but also white and other colors. RGB LEDs have a more complicated setup but allow you to mix the levels of red, green, and blue to make whatever color of light you want.<br>● Solenoids can by used to create a single, sharp pushing motion, which could be useful for pushing a ball off a ledge or tapping a surface to make a musical sound.<br>● Stepper motors can be moved in steps, as the name implies. Usually, a fixed number of steps perform a full rotation. |
| 11. | With the help of an example explain the process of Scaling up the electronics. **(NOV 2019)**<br>**OR**<br>With the help of an example explain the process of Scaling up the electronics. **(NOV 2022)** |
| ANS | ● From the perspective of the electronics, the starting point for prototyping is usually a "breadboard". This lets you push-fit components and wires to make up circuits without requiring any soldering and therefore makes experimentation easy. When |

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| | you're happy with how things are wired up, it's common to solder the components onto some protoboard, which may be sufficient to make the circuit more permanent and prevent wires from going astray.<br>● For small production runs, you'll likely use through-hole components, so called because the legs of the component go through holes in the PCB and tend to be soldered by hand.<br>● You will often create your designs as companion boards to an existing microcontroller platform—generally called shields in the Arduino community. This approach lets you bootstrap production without worrying about designing the entire system from scratch. |
| 12. | How can one tap into the community for promoting loT devices? Explain. **(NOV 2019)**<br>**OR**<br>How can we tap into the community for promoting loT devices? Explain. **(APR 2023)** |
| ANS | ● While thinking about which platform you want to build for, having a community to tap into may be vital or at least useful. Again, this is a major reason for our current support of the Arduino platform. If you have a problem with a component or a library, or a question about how to do something (for example, controlling a servo motor with a potentiometer dial), you could simply do a Google search on the words "arduino servo potentiometer" and find a YouTube video, a blog post, or some code.<br>● If you are doing something more obscure or need more detailed technical assistance, finding someone who has already done exactly that thing may be difficult.<br>● if you want confidence that you can hire people with skills in the platform you've chosen.<br>● When you are an inexperienced maker, using a platform in which other people can mentor you is invaluable. If you have a local meeting for makers, such as Maker Night Liverpool, or equivalents in hackspaces around the world, you will very often find someone who is willing to take you through the basics in Arduino or another similar system. |
| 13. | Explain microcontrollers and system-on-chips with respect to embedded computing. **(APR 2023)** |
| ANS | **MICROCONTROLLERS**<br>● Internet of Things devices take advantage of more tightly integrated and miniaturized solutions—from the most basic level of microcontrollers to more powerful system-on-chip (SoC) modules. These systems combine the processor, RAM, and storage onto a single chip, which means they are much more specialized, smaller than their PC equivalents, and also easier to build into a custom design.<br>● These microcontrollers are the engines of countless sensors and automated factory machinery. Unlike the market for desktop computer processors, which is dominated by two manufacturers (Intel and AMD), the microcontroller market consists of many manufacturers. (Atmel, Microchip, NXP, Texas Instruments)<br>● The ubiquitous Arduino platform is based around Atmel's AVR ATmega family of microcontroller chips. The on-board inclusion of an assortment of GPIO pins and ADC circuitry means that microcontrollers are easy to wire up to all manner of sensors, lights, and motors.<br><br>**SYSTEM-ON-CHIPS**<br>● In between the low-end microcontroller and a full-blown PC sits the SoC (for example, the BeagleBone or the Raspberry Pi). Like the microcontroller, these SoCs |

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| | combine a processor and a number of peripherals onto a single chip but usually have more capabilities.<br>● The greater capabilities of SoC mean that they need some sort of operating system to marshal their resources. A wide selection of embedded operating systems, both closed and open source, is available and from both specialized embedded providers and the big OS players, such as Microsoft and Linux. |
| 14. | Explain the transition from prototype to production. **(NOV 2022)** |
| ANS | ● Although ease of prototyping is a major factor, perhaps the biggest obstacle to getting a project started—scaling up to building more than one device, perhaps many thousands of them—brings a whole new set of challenges and questions.<br>● When you scale up, you may well have to think about moving to a different platform, for cost or size reasons.<br>● If you've started with a free-form, powerful programming platform, you may find that porting the code to a more restricted, cheaper, and smaller device will bring many challenges.<br>● if you've used a constrained platform in prototyping, you may find that you have to make choices and limitations in your code. Dynamic memory allocation on the 2K that the Arduino provides may not be especially efficient, so how should that make you think about using strings or complex data structures. |
| 15. | Explain the following loT devices built with Arduino: **(NOV 2019)**<br>i) The Good night lamp,<br>ii) Botanicals<br>iii) Baker treat |
| ANS | i) The Good Night Lamp<br>● Alexandra Deschamps-Sonsino came up with the idea of an Internet-connected table or bedside lamp. A simple, consumer device, this lamp would be paired with another lamp anywhere in the world, allowing it to switch the other lamp on and off, and vice versa. Because light is integrated into our daily routine, seeing when our loved ones turn, for example, their bedside lamp on or off gives us a calm and ambient view onto their lives.<br>● A key challenge in creating a mass-market connected device is finding a convenient way for consumers, some of whom are non-technical, to connect the device to the Internet. Even if the user has WiFi installed, entering authentication details for your home network on a device that has no keyboard or screen presents challenges. As well as looking into options for the best solution for this issue, the Good Night Lamp team are also building a version which connects over the mobile phone networks via GSM or 3G. This option fits in with the team's vision of connecting people via a "physical social network", even if they are not otherwise connected to the Internet.<br><br>ii) Botanicals<br>● Botanicals is a collaboration between technologists and designers that consists of monitoring kits to place in plant pots. The Botanicals kits then contact the owner if the plant's soil gets too dry. The project write-up humourously refers to this as "an effort to promote successful interspecies understanding" and as a way of translating between a plant's communication protocols (the colour and drooping of leaves) to human protocols, such as telephone, email, or Twitter.<br>● The original project used stock Arduino controllers, although the kits available for sale today use the ATmega 168 microcontroller with a custom board, which remains |

Arduino-compatible, and the programming is all done using the Arduino IDE. To match the form factor of the leaf-shaped printed circuit board (PCB), the device uses a WizNet Ethernet chip instead of the larger Arduino Ethernet Shield. Future updates might well support WiFi instead.

iii) BakerTweet

- The BakerTweet device is effectively a physical client for Twitter designed for use in a bakery. A baker may want to let customers know that a certain product has just come out of the ovens—fresh bread, hot muffins, cupcakes laden with icing—yet the environment he would want to tweet from contains hot ovens, flour dust, and sticky dough and batter, all of which would play havoc with the electronics, keyboard, and screen of a computer, tablet, or phone. Staff of design agency Poke in London wanted to know when their local bakery had just produced a fresh batch of their favourite bread and cake, so they designed a proof of concept to make it possible.
- Because BakerTweet communicates using WiFi, bakeries, typically not built to accommodate Ethernet cables, can install it. BakerTweet exposes the functionality of Twitter in a “bakery-proof” box with more robust electronics than a general-purpose computer, and a simplified interface that can be used by fingers covered in flour and dough. It was designed with an Arduino, an Ethernet Shield, and a WiFi adapter. As well as the Arduino simply controlling a third-party service (Twitter), it is also hooked up to a custom service which allows the baker to configure the messages to be sent.

# UNIT 3

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| 1. | Explain the non-digital methods of prototyping. **(NOV 2018)**<br>**OR**<br>Explain the non-digital methods of prototyping. **(APR 2023)** |
| ANS | • One of the key advantages that these techniques have over the newer digital fabrication methods is their immediacy.<br>• Compare that to the speed with which you can reconfigure a model made from clay or from LEGO—and that isn't just down to the hours of practice you put in while you were growing up! Keeping the feedback loop as short as possible between having an idea and trying it out frees you up for more experimentation.<br>• **some of the more common options here**<br>o **Modelling clay**: The most well-known brands are Play-Doh and Plasticine, but you can find a wealth of different versions with slightly different qualities.<br>o **Epoxy putty**: You might have encountered this product as the brand Milliput; it is similar to modelling clay although usually available in fewer colours. It comes in two parts, one of which is a hardener. You mix equal parts together to activate the epoxy.<br>o **Sugru**: Sugru is a mouldable silicone rubber. Like epoxy putty, it can be worked for only a short time before it sets (about 30 minutes, and then about a day to fully cure); but unlike epoxy, once cured, it remains flexible.<br>o **Toy construction sets**: We've already mentioned the ubiquitous LEGO sets, but you might also consider Meccano (or Erector Sets in theUnited States) and plenty of others. If you're lucky, you already have some gathering dust in the attic or that you can borrow from your children. The other interesting feature of these sets is the availability of gears, hinges, and other pieces to let you add some movement to your model.<br>o Cardboard: Cardboard is cheap and easy to shape with a craft knife or scissors, and available in all manner of colours and thicknesses.<br>o **Foamcore or foamboard**: This sheet material is made up of a layer of foam sandwiched by two sheets of card. It's readily available at art supplies shops and comes in 3mm or 5mm thicknesses in a range of sizes. Like cardboard, it is easily cut with a craft knife, although it is more rigid than corrugated cardboard.<br>o **Extruded polystyrene**: This product is similar to the expanded polystyrene that is used for packaging but is a much denser foam that is better suited to modelling purposes. It is often referred to as "blue foam", although it's the density rather than the colour which is important. |
| 2. | What are laser cutters? Explain the main features to consider while choosing a laser cutter. **(NOV 2018)** |

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| | **OR**<br>Write note on LASER Cutting. **(APR 2019)**<br>**OR**<br>Write a short note on laser cutters. **(NOV 2019)**<br>**OR**<br>What are the features that need to be considered while choosing a laser cutter? **(NOV 2022)** |
| ANS | • Three-dimensional printers can produce more complicated parts, but the simpler design process (for many shapes, breaking it into a sequence of two-dimensional planes is easier than designing in three dimensions), greater range of materials which can be cut, and faster speed make the laser cutter a versatile piece of kit.<br>• Most of the laser cutter is given over to the bed; this is a flat area that holds the material to be cut. The bed contains a two-axis mechanism with mirrors and a lens to direct the laser beam to the correct location and focus it onto the material being cut. It is similar to a flatbed plotter but one that burns things rather than drawing on them of the laser beam.<br>• This means that not only can the machine easily cut all manner of intricate patterns, but it can also lower the power of the laser so that it doesn't cut all the way through.<br><br>**CHOOSING A LASER CUTTER**<br>• When choosing a laser cutter, you should consider two main features:<br>  • The size of the bed: This is the place where the sheet of material sits while it's being cut, so a larger bed can cut larger items.<br><br>  • The power of the laser: More powerful lasers can cut through thicker material. For example, the laser cutter at our workplace has a 40W laser, which can cut up to 10mm-thick acrylic. Moving a few models up in the same range, to one with a 60W laser, would allow us to cut 25mmthick acrylic. |
| 3. | Explain the different methods used for 3D printing. **(NOV 2018)**<br>**OR**<br>Discuss the methods of 3D printing. **(APR 2019)**<br>**OR**<br>Explain any three methods of 3D printing. **(APR 2023)** |
| ANS | • **Fused filament fabrication** (FFF): It works by extruding a fine filament of material (usually plastic) from a heated nozzle. The nozzle can be moved horizontally and vertically by the controlling computer, as can the flow of filament through the nozzle.<br>• **Laser sintering:** This process is sometimes called selective laser sintering (SLS), electron beam melting (EBM), or direct metal laser sintering (DMLS). It is used in more industrial machines but can print any material which comes in powdered form and which can be melted by a laser.<br>• **Powder bed:** Like laser sintering, the powder-bed printers start with a raw material in a powder form, but rather than fusing it together with a laser, the binder is more like a glue which is dispensed by a print head similar to one in an inkjet printer. The great advantage of these printers is that when the binder is being applied, it can be mixed with some pigment; therefore, full-colour prints in different colours can be produced in one pass.<br>• **Laminated object manufacturing (LOM):** This is another method which can produce full-colour prints. LOM uses traditional paper printing as part of the process. Because it builds up the model by laminating many individual sheets of paper together, it can print whatever colours are required onto each layer before cutting them to shape and gluing them into place. |

- **Stereolithography and digital light processing**: Stereolithography is possibly the oldest 3D printing technique and has a lot in common with digital light processing, which is enjoying a huge surge in popularity and experimentation at the time of this writing. Both approaches build their models from a vat of liquid polymer resin which is cured by exposure to ultraviolet light.

**4.** Discuss the different standards that must be considered while implementing APIs. **(NOV 2018)**
**OR**
Explain the various standards for implementing an API. **(APR 2023)**

**ANS**

- **Representational State Transfer (REST):** Access a set of web URLs like http://timer.roomofthings.com/timers/ or http:://timer.roomofthings.com/timers/1234 using HTTP methods such as GET and POST, but also PUT and DELETE. The result is often XML or JSON but can often depend on the HTTP content-type negotiation mechanisms.
- **JSON-RPC:** Access a single web URL like http://timer. roomofthings.com/api/, passing a JSON string suchas {'method':'update', 'params': [{'timer-id':1234, 'description':'Writing API chapter for book'}], 'id':12}. The return value would also be in JSON, like {'result':'OK', 'error':null, 'id':12}.
- **XML-RPC:** This standard is just like JSON-RPC but uses XML instead of JSON.
- **Simple Object Access Protocol (SOAP):** This standard uses XML for transport like XML-RPC but provides additional layers of functionality, which may be useful for very complicated systems.

- **So the REST API will finally look like this:**

| Resource URL | Method | Auth | Parameters | Outputs |
|---|---|---|---|---|
| 1. /timers | POST | MAC or Cookie | Timer duration | Timer ID |
| 2. /timers/:id/duration | PUT | MAC or Cookie | Timer duration | OK |
| 3. /timers/:id/complete | PUT | MAC or Cookie | | OK |
| 4. /timers/:id | DELETE | MAC or Cookie | | OK |
| 5. /timers/:id/description | PUT | Cookie | Description | OK |
| 6. /timers | GET | Cookie | | List of Timer IDs |
| 7. /timers/:id | GET | Cookie | | Info about Timer |
| 8. /user/device | PUT | Cookie | MAC address | OK |
| 9. /user/device | GET | Cookie | | MAC address |
| 10. /login | POST | User/Pass | User/Pass | Cookie + OK |
| 11. /user | POST | | User/Pass | Cookie + OK |

**5.** Explain POLLING and COMET. **(NOV 2018)**
**OR**
What is Polling? Explain in brief. **(APR 2019)**
**OR**
What'is comet? Explain. **(NOV 2019)**

ANS

**POLLING**

- If you want the device or another client to respond immediately, how do you do that? You don't know when the event you want to respond to will happen, so you can't make the request to coincide with the data becoming available.
- **Consider these two cases:**
  - The WhereDial should start to turn to "Work" the moment that the user has checked into his office.
  - The moment that the task timer starts, the client on the user's computer should respond, offering the opportunity to type a description of the task.
- The traditional way of handling this situation using HTTP API requests was to make requests at regular intervals. This is called **polling.**
- You could make this quicker, polling every 10 seconds, for example. But this would put load on the following:
  - **The server:** If the device takes off, and there are thousands of devices, each of them polling regularly, you will have to scale up to that load.
  - **The client:** This is especially important if, as per the earlier Arduino example, the microcontroller blocks during each connect!

**COMET**

- Comet is an umbrella name for a set of technologies developed to get around the inefficiencies of polling.
- **Long Polling (Unidirectional)**
  - server holds on to the response unless the server has an update, as soon as the server has an update, it sends it and then the client can send another request. Disadvantage is the additional header data that needs to be sent back and forth causing additional overhead.
- **Multipart XMLHttpRequest (MXHR) (Unidirectional)**
  - When building web applications, it is common to use a JavaScript API called XMLHttpRequest to communicate with the web server without requiring a full new page load.
  - Many browsers support a multipart/x-mixed-replace content type, which allows the server to send subsequent versions of a document via XHR.
- **HTML5 WebSockets (Bidirectional)**
  - HTTP protocol used in web services sits atop the TCP protocol. Traditionally, the API used to talk directly to the TCP layer is known as the sockets API. When the web community was looking to provide similar capabilities at the HTTP layer, they called the solution WebSockets.
- **Implementations**
  - On the browser side, it is often possible to abstract the actual transport using a library which chooses which method to connect to the server. For example, it might use WebSockets if available; otherwise, it will fall back to MXHR or long polling.
  - There are also libraries for the microcontroller; however, they tend to support only one scheme. For example, several dedicated WebSockets libraries are available for Arduino.
- **Scaling**
  - An important consideration is that all these Comet techniques require the client to have a long-term connection with the server. For a single client, this is trivial. But if there are many clients, the server has to maintain a connection with each of them. If you run a server with multiple threads or processes, you effectively have an instance of the server for each client. As each thread or process will

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| | consume system resources, such as memory, this doesn't scale to many clients. Instead, you might want to use an asynchronous web server, which looks at each client connection in turn and services it when there is new input or output. |
| 6. | Write a short note on Message Queuing Telemetry Transport Protocol. **(NOV 2018)**<br>**OR**<br>Write note on MQTT Protocol. **(APR 2019)** |
| ANS | • MQTT (http://mqtt.org) is a lightweight messaging protocol, designed specifically for scenarios where network bandwidth is limited or a small code footprint is desired.<br>• Rather than the client/server model of HTTP, MQTT uses a publish/subscribe mechanism for exchanging messages via a message broker. Rather than send messages to a pre-defined set of recipients, senders publish messages to a specific topic on the message broker. Recipients subscribe to whichever topics interest them, and whenever a new message is published on that topic, the message broker delivers it to all interested recipients. This makes it much easier to do one-to-many messaging, and also breaks the tight coupling between the client and server that exists in HTTP.<br>• A sister protocol, MQTT for Sensors (MQTT-S), is also available for extremely constrained platforms or networks where TCP isn't available, allowing MQTT's reach to extend to sensor networks such as ZigBee(*Zigbee* is an IEEE 802.15.4-based specification for a suite of high-level communication protocols used to create personal area networks with small, low-power digital radios) |
| 7. | Explain the following protocols suited to Internet of Things applications: Message Queuing telemetry transport (MQTT), Extensible Messaging & Presence Protocol (XMPP), Constrained Application Protocol (CoAP). **(APR 2023)** |
| ANS | **MQ TELEMETRY TRANSPORT**<br>• MQTT (http://mqtt.org) is a lightweight messaging protocol, designed specifically for scenarios where network bandwidth is limited or a small code footprint is desired.<br>• Rather than the client/server model of HTTP, MQTT uses a publish/subscribe mechanism for exchanging messages via a message broker. Rather than send messages to a pre-defined set of recipients, senders publish messages to a specific topic on the message broker. Recipients subscribe to whichever topics interest them, and whenever a new message is published on that topic, the message broker delivers it to all interested recipients. This makes it much easier to do one-to-many messaging, and also breaks the tight coupling between the client and server that exists in HTTP.<br>• A sister protocol, MQTT for Sensors (MQTT-S), is also available for extremely constrained platforms or networks where TCP isn't available, allowing MQTT's reach to extend to sensor networks such as ZigBee(*Zigbee* is an IEEE 802.15.4-based specification for a suite of high-level communication protocols used to create personal area networks with small, low-power digital radios)<br><br>**EXTENSIBLE MESSAGING AND PRESENCE PROTOCOL**<br>• Extensible Messaging and Presence Protocol, or XMPP (http://xmpp.org). XMPP grew from the Jabber instant messaging system and so has broad support as a general protocol on the Internet.<br><br>**CONSTRAINED APPLICATION PROTOCOL**<br>• The Constrained Application Protocol (CoAP) is designed to solve the same classes of problems as HTTP but, like MQTT-S, for networks without TCP. |

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| | • There are proposals for running CoAP over UDP, SMS mobile phone messaging, and integration with 6LoWPAN. CoAP draws many of its design features from HTTP and has a defined mechanism to proxies to allow mapping from one protocol to the other.<br>• At the time of this writing, the protocol is going through final stages of becoming a defined standard, with the work being coordinated by the Internet Engineering Task Force Constrained RESTful Environments Working Group. |
| 8. | Explain the term Scraping. **(APR 2019)** |
| ANS | • In many cases, companies or institutions have access to fantastic data but don't want to or don't have the resources or knowledge to make them available as an API. While you saw in the Flickr example above that getting a computer to pretend to be a browser and navigate it by looking for UI elements was fragile, that doesn't mean that doing so is impossible. In general, we refer to this, perhaps a little pejoratively, as "screen-scraping".<br>• *Screen scraping* is programming that translates between legacy application programs written to communicate with now generally obsolete inputoutput device. |
| 9. | Explain the following terms with respect to APIs: **(APR 2023)**<br>a. Scraping,<br>b. Mashing up APIs. |
| ANS | **SCRAPING**<br>• In many cases, companies or institutions have access to fantastic data but don't want to or don't have the resources or knowledge to make them available as an API. While you saw in the Flickr example above that getting a computer to pretend to be a browser and navigate it by looking for UI elements was fragile, that doesn't mean that doing so is impossible. In general, we refer to this, perhaps a little pejoratively, as "screen-scraping".<br>• *Screen scraping* is programming that translates between legacy application programs written to communicate with now generally obsolete input output device.<br>**MASHING UP APIS**<br>• Perhaps the data you want is already available on the Internet but in a form that doesn't work for you? The idea of "mashing up" multiple APIs to get a result has taken off and can be used to powerful effect. For example:<br>o Using a mapping API to plot properties to rent or buy—for example, Google Maps to visualise properties to rent via Craigslist, or Foxtons in London showing its properties using Mapumental.<br>o Showing Twitter trends on a global map or in a timeline or a charting API.<br>• Some of the more visible and easy-to-use APIs want to embed your data within them—for example, the Google Maps API. This means that they are ideal to use within a web browser, but you aren't in control of the final product, and there might be limited scope for accessing them from a microcontroller. |
| 10. | Compare Laser Cutting with CNC Milling. **(APR 2023)** |
| ANS | **LASER CUTTING**<br>• Three-dimensional printers can produce more complicated parts, but the simpler design process (for many shapes, breaking it into a sequence of two-dimensional planes is easier than designing in three dimensions), greater range of materials which can be cut, and faster speed make the laser cutter a versatile piece of kit. |

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| | • Most of the laser cutter is given over to the bed; this is a flat area that holds the material to be cut. The bed contains a two-axis mechanism with mirrors and a lens to direct the laser beam to the correct location and focus it onto the material being cut. It is similar to a flatbed plotter but one that burns things rather than drawing on them of the laser beam.<br>• This means that not only can the machine easily cut all manner of intricate patterns, but it can also lower the power of the laser so that it doesn't cut all the way through.<br><br>**CNC MILLING**<br>• Computer Numerically Controlled (CNC) milling is similar to 3D printing but is a subtractive manufacturing process rather than additive. The CNC part just means that a computer controls the movement of the milling head, much like it does the extruder in an FDM 3D printer. However, rather than building up the desired model layer by layer from nothing, it starts with a block of material larger than the finished piece and cuts away the parts which aren't needed—much like a sculptor chips away at a block of stone to reveal the statue, except that milling uses a rotating cutting bit (similar to an electric drill) rather than a chisel.<br>• **Beyond size and accuracy, the other main attribute that varies among CNC mills is the number of axes of movement they have:**<br>o 2.5 axis: Whilst this type has three axes of movement—X, Y, and Z—it can move only any two at one time.<br>o 3 axis: Like the 2.5-axis machine, this machine has a bed which can move in the X and Y axes, and a milling head that can move in the Z. However, it can move all three at the same time (if the machining instructions call for it).<br>o 4 axis: This machine adds a rotary axis to the 3-axis mill to allow the piece being milled to be rotated around an extra axis, usually the X (this is known as the A axis). An indexed axis just allows the piece to be rotated to set points to allow a further milling pass to then be made, for example, to flip it over to mill the underside; and a fully controllable rotating axis allows the rotation to happen as part of the cutting instructions.<br>o 5 axis: This machine adds a second rotary axis—normally around the Y—which is known as the B axis.<br>o 6 axis: A third rotary axis—known as the C axis if it rotates around Z—completes the range of movement in this machine.<br><br>• As with 3D printing, the software you use for CNC milling is split into two types:<br>o CAD (Computer-Aided Design) software lets you design the model.<br>o CAM (Computer-Aided Manufacture) software turns that into a suitable toolpath—a list of co-ordinates for the CNC machine to follow which will result in the model being revealed from the block of material. |
| 11. | What is CNC Milling? Explain. **(APR 2019)**<br>**OR**<br>What is milling? Explain. **(NOV 2019)** |
| ANS | • Computer Numerically Controlled (CNC) milling is similar to 3D printing but is a subtractive manufacturing process rather than additive. The CNC part just means that a computer controls the movement of the milling head, much like it does the extruder in an FDM 3D printer. However, rather than building up the desired model layer by layer from nothing, it starts with a block of material larger than the finished piece and cuts away the parts which aren't needed—much like a sculptor chips away at a block of stone |

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| 12. | Explain the sketch iterate and explore process in prototyping. **(NOV 2019)**<br>**OR**<br>Explain the sketch, iterate and explore process in prototyping. **(NOV 2022)** |
| ANS | ● New digital fabrication tools—such as 3D printers and CNC machines—which let you produce small runs or one-offs that still look professional, we're going to start with a look at some much lower-tech solutions.<br>● You might be tempted to fire up your 3D design package as soon as you sit down to design something. However, your first idea is unlikely to be the best, so you should be optimising for speed of iteration rather than quality of prototype. You could iterate through designs with a 3D printer, but doing so with a pen and paper is much quicker. If the idea warrants it (and maybe even if it doesn't), don't be afraid to take your sketching into three dimensions. Mock up different designs with modelling clay or LEGO or some of the other methods.<br>● the evolution of the design for the Good Night Lamp The original design was a more traditional lamp shape, but in a design workshop, the team batted around a range of ideas with the help of a purely functional prototype. They realised that a design echoing the shape of a house better conveyed the core concept of connecting loved ones in their homes.<br>● After the workshop, the new design was mocked up in laser-cut acrylic and plywood before functional prototypes were made in acrylic and veneered medium-density fibreboard (MDF) with a CNC milling machine.<br>● After living with the redesign for a few weeks, they realised that the prototypes were a little bit large. More mockups followed, this time cut by hand in plywood, to try out different sizes. With the right size chosen, they milled out and assembled a new set of functional prototypes. The revised sizing has proven much better and forms the basis of the design for the first production run. |

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| 13. | What are the legalities associated with scrapping? **(NOV 2019)**<br>**OR**<br>What are the legalities associated with scrapping? **(NOV 2022)** |
| ANS | • Screen-scraping may break the terms and conditions of a website. For example, Google doesn't allow you to screen-scrape its search pages but does provide an API. Even if you don't think about legal sanctions, breaking the terms and conditions for a company like Google might lead to its denying you its other services, which would be at the very least inconvenient.<br>• Alternative sources of information often are available. For example, you could use OpenStreetMap instead of Google Maps. |
| 14. | Explain HTML5 web socket. **(NOV 2019)**<br>**OR**<br>Explain HTML5 web socket. **(NOV 2022)** |
| ANS | • Traditionally, the API used to talk directly to the TCP layer is known as the sockets API. When the web community was looking to provide similar capabilities at the HTTP layer, they called the solution WebSockets.<br>• Although WebSockets are currently a working draft in the HTML5 spec, they seem to have traction in modern browsers, servers, and other clients. WebSockets have the benefit of being bidirectional. You can consider them like a full Unix socket handle that the client can write requests to and read responses from.<br>• This might well be the ideal technology for the task timer. After a socket is established, the timer can simply send information down it about tasks being started, modified, or cancelled, and can read information about changes made in software, too.<br>• Because WebSockets are new and push the HTTP protocol in a slightly unorthodox direction, they are known to have some issues with proxy servers.<br>• This situation should change as the proxies currently broken in this respect are fixed to be aware of WebSockets. This may be an issue with your system's architecture. |
| 15. | Explain the use of repurposing /recycling in prototyping IoT devices. **(NOV 2022)** |
| ANS | • One reason to reuse mechanisms or components would be to piggyback onto someone else's economies of scale. If sections or entire subassemblies that you need are available in an existing product, buying those items can often be cheaper than making them in-house. That's definitely the case for your prototypes but may extend to production runs, too, depending on the volumes you'll be manufacturing.<br>• For example, the bubble machine used in Bubblino is an off-the-shelf unit from a children's game. In the batch production volumes that Bubblino is currently being built, it's cheaper to buy them, even at retail price, than it would be to manufacture the assorted gears, fans, bubble ring, and casing in-house.<br>• Or perhaps you're making just a couple of units or maybe only one. In that scenario the labour involved in working out how to integrate the electronics, graft in newly fabricated parts, or work out how to disassemble the reused item for the bits you need might not matter, as you aren't going to be repeating it many, many times. |
| 16. | What is an API? What do you mean by mashing up API? **(NOV 2022)** |
| ANS | • The most important part of a web service, with regards to an Internet of Things device, is the Application Programming Interface, or API. An API is a way of accessing a service that is targeted at machines rather than people. |

- If you want data from google map you should use api so that you can get a data regarding to what you want.
  - **Request:** api.openweathermap.org/data/2.5/weather?q=London
  - **Respose in json:**
    - {"coord":{"lon":-0.13,"lat":51.51},"weather":[{"id":300,"main":"Drizzle","description":"light intensity drizzle","icon":"09d"}],"base":"stations","main":{"temp":280.32,"pressure":1012,"humidity":81,"temp_min":279.15,"temp_max":281.15},"visibility":10000,"wind":{"speed":4.1,"deg":80},"clouds":{"all":90},"dt":1485789600,"sys":{"type":1,"id":5091,"message":0.0103,"country":"GB","sunrise":1485762037,"sunset":1485794875},"id":2643743,"name":"London","cod":200}

**MASHING UP APIS**

- Perhaps the data you want is already available on the Internet but in a form that doesn't work for you? The idea of "mashing up" multiple APIs to get a result has taken off and can be used to powerful effect. For example:
  - Using a mapping API to plot properties to rent or buy—for example, Google Maps to visualise properties to rent via Craigslist, or Foxtons in London showing its properties using Mapumental.
  - Showing Twitter trends on a global map or in a timeline or a charting API.
    Some of the more visible and easy-to-use APIs want to embed your data within th for example, the Google Maps API. This means that they are ideal to use within a browser, but you aren't in control of the final product, and there might be li scope for accessing them from a microcontroller.

# UNIT 4

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| 1. | Discuss the limitations of memory in embedded devices. How is it managed? **(NOV 2019)** |
| ANS | ● When you don't have a lot of memory to play with, you need to be careful as to how you use it. This is especially the case when you have no way to indicate that message to the user. The computer user presented with one too many "low memory" warning dialog boxes will try rebooting, and so will the system administrator who spots the server thrashing its disk as it pages memory out to the hard drive to increase the amount of virtual memory.<br>● On the other hand, an embedded platform with no screen or other indicators will usually continue blindly until it runs out of memory completely—at which point it usually "indicates" this situation to the user by mysteriously ceasing to function. Even while you are developing software for a constrained device, trying to debug these issues can be difficult.<br>● Something that worked perfectly a minute ago now stops inexplicably, and the only difference might be a hard-to-spot extra character of debug logging or, worse still, something subtler such as another couple of iterations through the execution loop. |
| 2. | Explain. What are the concerns regarding performance and battery life while writing code for embedded systems? **(NOV 2019)**<br>**OR**<br>What are the concerns regarding performance and battery life while writing code for embedded systems? **(APR 2023)** |
| ANS | o When it comes to writing code, performance and battery life tend to go hand in hand—what is good for one is usually good for the other. Whether either or both of these are things that you need to optimise depends on your application.<br>o items which run from a battery or which are powered by a solar cell, and those which need to react instantaneously when the user pushes a button, it makes sense to pay some attention to performance or power consumption.<br>o A lot of the biggest power-consumption gains come from the hardware design. In particular, if your device can turn off modules of the system when they're not in use or put the entire processor into a low-power sleep mode when the code is finished or waiting for something to happen, you have already made a quick win. That said, it is still important to optimize the software, too! After all, the quicker the main code finishes running, the sooner the hardware can go to sleep.<br>o One of the easiest ways to make your code more efficient is to move to an event-driven model rather than polling for changes. The reason for this is to allow your device to sit in a low power state for longer and leap into action when required, instead of having to regularly do busywork to check whether things have changed and it has real work to do.<br>o On the hardware side, look to use processor features such as comparators or hardware interrupts to wake up the processor and invoke your processing code only |

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| | when the relevant sensor conditions are met. If your code needs to pause for a given amount of time to allow some effect to occur before continuing, use calls which allow the processor to sleep rather than wait in a busy-loop.<br>o **If you can reduce the amount of data that you're processing, that helps too.**<br>o When it comes to raw performance of your coding algorithm itself, nothing beats profiling to work out where the speed bottlenecks are.<br>o writing if/else constructs to choose between two possible paths of execution, try to place the more likely code into the first branch—the *if* rather than the *else* part<br>o declaring data as constant where it is known never to change can help the compiler to place it into flash memory or ROM,<br>o when you do need to copy data around, the system's memory copying and moving routines (such as memcpy and memmove) usually do a more efficient job than you could, so use them. Where possible, and this is particularly the case on 32-bit processors such as the ARM family, they use processor instructions that copy more than one byte in a single operation, thus considerably speeding up the process. |
| 3. | Write a short note on Libraries for embedded systems. **(NOV 2018)**<br>**OR**<br>What are library? Explain with Example. **(NOV 2019)**<br>**OR**<br>What are the libraries available for embedded systems? Explain. **(APR 2023)** |
| ANS | o These days, when developing software for server or desktop machines, you are accustomed to having a huge array of possible libraries and frameworks available to make your life easier.<br>o **possible libraries that are available**<br>o **lwIP**: lwIP, or LightWeight IP (http://savannah.nongnu.org/projects/lwip/), is a full TCP/IP stack which runs in low-resource conditions. It requires only tens of kilobytes of RAM and around 40KB of ROM/flash. The official Arduino WiFi shield uses a version of this library.<br>o **uIP**: uIP, or micro IP (http://en.wikipedia.org/wiki/UIP_%28micro_IP%29), is a TCP/IP stack targeted at the smallest possible systems. It can even run on systems with only a couple of kilobytes of RAM. It does this by not using any buffers to store incoming packets or outgoing packets which haven't been acknowledged.<br>o **uClibc**: uClibc (http://www.uclibc.org/) is a version of the standard GNU C library (glibc) targeted at embedded Linux systems.<br>o **Atomthreads**: Atomthreads (http://atomthreads.com/) is a lightweight real-time scheduler for embedded systems. You can use it when your code gets complicated enough that you need to have more than one thing happening at the same time<br>o **BusyBox**: Although not really a library, BusyBox (http://www.busybox.net/) is a collection of a host of useful UNIX utilities into a single, small executable and a common and useful package to provide a simple shell environment and commands on your system. |
| 4. | How can we make optimum use of RAM while writing code for embedded devices **(NOV 2022)** |
| ANS | o Now that you've moved everything that you can out of RAM and into flash, all that remains is to work out ways to make better use of the free memory you have. |

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| | o When you have only a few kilobytes or tens of kilobytes of RAM available, it is easier to fill up that memory, causing the device to misbehave or crash. Yet you may want to use as much of the memory as possible to provide more features.<br>o This consideration is important, and it's easier to make the best trade-off between maximising RAM usage and reliability if your memory usage is deterministic—that is, if you know the maximum amount of memory that will be used.<br>o Rather than download the entire page into memory at once, you download it in chunks—filling the buffer each time and then working through that chunk of data before moving on to the next one.<br>o When the system first boots up, it has all RAM available to store things in, but how does it decide what goes where and how to find it later? Two general concepts for arranging memory are used: the stack and the heap. Each has its advantages and disadvantages, and computers (including most embedded systems) tend to make use of both.<br>o **The Stack**<br>▪ What is the stack? It's a special region of your computer's memory that stores temporary variables created by each function (including the main() function). The stack is a "LIFO" (last in, first out) data structure, that is managed and optimized by the CPU quite closely. Every time a function declares a new variable, it is "pushed" onto the stack. Then every time a function exits, all of the variables pushed onto the stack by that function, are freed (that is to say, they are deleted). Once a stack variable is freed, that region of memory becomes available for other stack variables.<br>▪ The advantage of using the stack to store variables, is that memory is managed for you. You don't have to allocate memory by hand, or free it once you don't need it any more. What's more, because the CPU organizes stack memory so efficiently, reading from and writing to stack variables is very fast.<br>o **The Heap**<br>▪ The heap is a region of your computer's memory that is not managed automatically for you, and is not as tightly managed by the CPU. It is a more free-floating region of memory (and is larger). To allocate memory on the heap, you must use malloc() or calloc(), which are built-in C functions. Once you have allocated memory on the heap, you are responsible for using free() to deallocate that memory once you don't need it any more. If you fail to do this, your program will have what is known as a memory leak.<br>▪ Local variables exist only during the function in which they're declared (assuming you don't use modifiers such as static to make them persistent) and so take up space only when they're needed. If you can move more of your variables inside the functions where they're actually used, you can free up more space for use during other parts of the execution path. |
| 5. | What is a business model? Who is the business for? Explain. **(NOV 2018)**<br>**OR**<br>Define business model, Explain business factor in the definition. **(NOV 2019)**<br>**OR**<br>Define business model. Explain different factors in the definition. **(NOV 2022)** |

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| ANS | ● We could define it as a "hypothesis about what customers want, how they want it, and how an enterprise can organize to best meet those needs, get paid for doing so, and make a profit."<br>● **This definition brings together a number of factors:**<br>o A group of people (customers)<br>o The needs of those customers<br>o A thing that your business can do to meet those needs.<br>o Organizational practices that help to achieve this goal—and to be able to carry on doing so, sustainably.<br>o A success criterion, such as making a profit.<br>**A SHORT HISTORY OF BUSINESS MODELS**<br>Gift economies develop where those with the appropriate skills can provide their products or services—hunting, pottery, livestock, grain, childcare—and expect repayment of this obligation not immediately but with a gift of comparable worth later. which the recipient will repay in due course, perhaps when hunting is good, when she happens upon the raw materials for her craft, or even much later in the year at harvest time.<br>**WHO IS THE BUSINESS MODEL FOR?**<br>● Primarily, the reason to model your business is to have some kind of educated hypothesis about whether it might deliver what you want from it.<br>● As a programmer or a maker, you might believe it counterintuitive to think of a piece of paper with nine boxes in it as a "tool", but when you have a well-tested separation of factors to consider, the small amount of structure the canvas provides should help you think about the business and give you ways to brainstorm different ideas:<br>o What if we target the product at students instead of businesses?<br>o What if we outsource our design to an agency?<br>o What if we sell at low volume/high value instead?<br>● The model is also useful if you want to get other people involved. This could be an employee or a business partner…or an investor. In each of these cases, the other parties will want to know that the business has potential, has been thought out, and is likely to survive and perhaps even go places.<br>● Perhaps to a lesser extent, your customers will also be considering whether to invest their time and money in your product. They will ask themselves certain questions about it. Let us look at some of these likely questions, from the wider field of Internet products in general.<br>o **Why should I waste time trying out Yet Another Social Network? I think I'll wait and see whether all my friends join it first.**<br>o **Will my Internet-connected rabbit become an expensive paperweight if you go bust?**<br>o **Your online document collaboration looks great, but is it worth my moving my whole business to it? If you stop trading or change the platform, we may have to redo all the work again.**<br>o **This free service is fantastic, but why don't you let me pay for it, so I can get consistency, receive support, and avoid adverts?** |
| 6. | Explain the following business models: Make Thing Sell Thing, Subscriptions, Customisation. **(NOV 2018)**<br>**OR**<br>Explain the following business models: Make Thing Sell Thing. Subscriptions. Customization. **(APR 2023)** |
| ANS | **MAKE THING, SELL THING** |

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| | ● The simplest category of models, "make a Thing and sell it," is, of course, valid for the Internet of Things.<br>● electrical products sold in shops (physical or online) may be subject to legislation and certification (RoHS, Kitemarks, and so on), which is an additional factor and cost to consider.<br><br>**SUBSCRIPTIONS**<br>● subscription model might be appropriate, allowing you to recoup these costs and possibly make ongoing profit by charging fees for your service. Many products could legitimately use this method, but perhaps the more complex, content-driven services would find it more convincing.<br>● People happily pay subscriptions to music services, corporate groupware, and of course, mobile phones, so perhaps Internet of Things products in these spaces will find subscription more appealing to their consumers.<br>● The so-called freemium model (a portmanteau of "free" and "premium") has always been a way to encourage paying customers while not alienating free ones. In this model, a smaller or larger part of your product is free, while the users are also encouraged to pay a premium to get additional features or remove limits.<br><br>**CUSTOMISATION**<br>● For a mass-produced item, any customisation must be strictly bounded to a defined menu: a selection of different colours for the paintwork, options for fittings such as tyres, the trimmings and upholstery inside, and for features like the onboard computer control and display. Fordian logic dictates that all these components must be optimised for manufacture and fit well together<br>● The new manufacturing techniques, such as laser cutting and 3D printing, should allow great possibilities for customising even the physical devices. |
| 7. | Write a short note on venture capital. **(NOV 2018)**<br>**OR**<br>Explain the term Venture capital. **(APR 2019)**<br>**OR**<br>What is venture capital, how can one exit. **(NOV 2019)** |
| ANS | ● getting funding for a project from an external investor presents its own work and risks. The process of applying for funding takes time, and although much of this time can be justified as thrashing out the business model, it's not directly related to the work you actually want to be doing on the product itself.<br>● Startups often concentrate their fundraising activities into rounds, periods in which they dedicate much of their effort into raising a target amount of money, often for a defined step in their business plan. Before any official funding round comes the informal idea of the friends, family, and fools (FFF) round.<br>● Angels typically disburse sums that are significant for early-stage startups—in the region of tens or possibly hundreds of thousands of pounds.<br>● Though angels take on a lot of risk in investing so early, before companies have proved themselves, they tend to invest in a number of companies to spread the risk.<br>● They usually want equity in your company, a percentage of the value of the company, that will pay back their investment if and when you do well.<br>● The venture capital (VC) round is similar, but instead of your courting individual investors, the investor is a larger group with significant funds, whose sole purpose is to discover and fund new companies with a view to making significant profit. |

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| | • Because your investors will want a return, your long-term goal can't just be to make your company successful but to do it in such a way as to pay back the investment. Typically, you have only two exits:<br>o You get bought by a bigger company: In this case, the buyer buys out the investors; that is, the buyer pays the investors the value of their percentage equity of their perceived valuation of the worth of the company.<br>o You do an IPO (initial public offering)—that is, float on the stock market: This involves new shares being issued and sold to the stock market. Although this option "dilutes" the value of the shares already issued, the existing holders are able to then sell their shares on the market too, to get back their investment, or to retain the shares if they believe that the shares will grow in value. |
| 8. | Explain the different types of memories. **(APR 2019)**<br>**OR**<br>Explain different types of memory. **(NOV 2019)**<br>**OR**<br>Explain different types of memory. **(APR 2023)** |
| ANS | • **ROM**<br>o Read-only memory refers to memory where the information stored in the chips is hard-coded at the chips' creation and can only be read afterwards.<br>• **Flash**<br>o Flash is a semi-permanent type of memory which provides all the advantages of ROM—namely, that it can store information without requiring any power, and so its contents can survive the circuit being unplugged—without the disadvantage of being unchangeable forever more.<br>• **RAM**<br>o Random-access memory trades persistence for speed of access. It requires power to retain its contents, but the speed of update is comparable with the time taken to read from it (particularly when compared to flash memory).<br>o Atmel chips used in Arduino—the data (RAM) and program (flash/ROM) memory spaces are separated, which means that they aren't trivially interchangeable. As a result, you may have to do a little additional work to copy the data from flash into RAM when you want to use it.<br>o The Arduino platform, for example, provides an additional macro to let you specify that certain strings should be stored in flash memory rather than RAM. Wrapping the string in F(...) tells the system that this is a "flash" string rather than a "normal" one:<br>▪ Serial.println("This string will be stored in RAM");<br>▪ Serial.println(F("This one will be in flash")); |
| 9. | What is Debugging for Internet of Things device? Explain. **(APR 2019)**<br>**OR**<br>Explain in detail the process of debugging the code for embedded devices. **(NOV 2022)** |
| ANS | • One of the most frustrating parts of writing software is knowing your code has a bug, but it's not at all obvious where that bug is. In embedded systems, this situation can be doubly frustrating because there tend to be fewer ways to inspect what is going on so that you can track down the issue.<br>• embedded Linux usually have support for remote debugging with utilities such as gdb, the GNU debugger. |

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| | ● This utility allows you to attach the debugger from your desktop system to the embedded board, usually over a serial connection but sometimes also over an Ethernet or similar network link.<br>● Another way to get access to desktop-grade debugging tools is to emulate your target platform on the desktop.<br>● If you need on-the-hardware debugging and your platform doesn't allow you to use gdb (or if the serial port is in use for another part of the system), JTAG access might give you the capabilities you need. JTAG is named after the industry group which came up with the standard: the Joint Test Action Group.<br>● JTAG has been extended to provide more advanced debugging features. Of particular interest from a software perspective are those features available when connected to some software on a separate PC called an *in-circuit emulator* (ICE). |
| 10. | Write note on Long tail of Internet. **(APR 2019)**<br>**OR**<br>Write a note on Long tail of the Internet. **(APR 2023)** |
| ANS | ● Tim Berners-Lee's first demonstration of the World Wide Web in 1990, it took only five years for eBay and Amazon to open up shop and emerge another five years later as not only survivors but victors of the dot-com bubble. Both companies changed the way we buy and sell things. Chris Anderson of *Wired* magazine coined and popularized the phrase "long tail" to explain the mechanism behind the shift.<br>● E-books and print-on-demand are also changing the face of publishing with a far wider variety of available material and a knock-on change in the business models of writers and publishers that is still playing out today. |
| 11. | Discuss the business model canvas for Internet of Things. **(APR 2019)**<br>**OR**<br>With the help of a diagram, explain business model canvas. **(NOV 2019)**<br>**OR**<br>With the help of the diagram explain business model canvas. **(NOV 2022)** |
| ANS | ● The canvas is a Creative Commons–licensed single-page planner.<br>● At first sight, it looks as though each box is simply an element in a form and the whole thing could be replaced by a nine-point checklist.<br>o *Revenue Streams*, which is more or less the question of "how are you going to make money?" |

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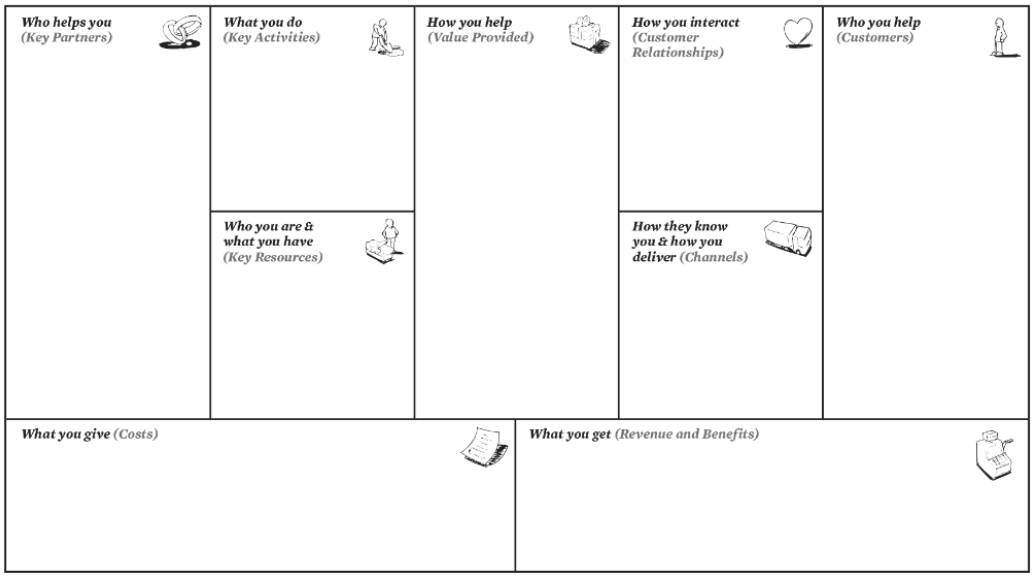
| | o The *Customer Segments* are the people you plan to deliver the product to. That might be other makers and geeks (if you are producing a kit form device), the general public, families, businesses<br>  <br><br>The *Customer Segments* are the people you plan to deliver the product to. That might be other makers and geeks (if you are producing a kit form device), the general public, families, businesses<br>o *Channels* are ways of reaching the customer segments. From advertising and distributing your product, to delivery and after-sales, the channels you choose have to be relevant to your customers.<br>o The *Key Activities* are the things that need to be done. The Thing needs to be manufactured; the code needs to be written. Perhaps you need a platform for it to run on and a design for the website and the physical product.<br>o *Key Resources* include the raw materials that you need to create the product but also the people who will help build it.<br>o *Key Partners*, businesses that are better placed to supply specific skills or resources, because that is their business model, and they are geared up to do it more cheaply or better than you could do yourself.<br>o The *Cost Structure* requires you to put a price on the resources and activities you just defined. |
| 12. | Explain how to achieve customization in Internet of Things devices. **(APR 2019)** |
| ANS | • For a mass-produced item, any customisation must be strictly bounded to a defined menu: a selection of different colours for the paintwork, options for fittings such as tyres, the trimmings and upholstery inside, and for features like the onboard computer control and display. Fordian logic dictates that all these components must be optimised for manufacture and fit well together<br>• The new manufacturing techniques, such as laser cutting and 3D printing, should allow great possibilities for customising even the physical devices. |
| 13. | With the help of examples, compare stack and heap. **(NOV 2019)**<br>**OR** |

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| | With the help of examples compare stack and heap . **(NOV 2022)** |
| ANS | ● **The Stack**<br>o What is the stack? It's a special region of your computer's memory that stores temporary variables created by each function (including the main() function). The stack is a "LIFO" (last in, first out) data structure, that is managed and optimized by the CPU quite closely. Every time a function declares a new variable, it is "pushed" onto the stack. Then every time a function exits, all of the variables pushed onto the stack by that function, are freed (that is to say, they are deleted). Once a stack variable is freed, that region of memory becomes available for other stack variables.<br>o The advantage of using the stack to store variables, is that memory is managed for you. You don't have to allocate memory by hand, or free it once you don't need it any more. What's more, because the CPU organizes stack memory so efficiently, reading from and writing to stack variables is very fast.<br>● **The Heap**<br>o The heap is a region of your computer's memory that is not managed automatically for you, and is not as tightly managed by the CPU. It is a more free-floating region of memory (and is larger). To allocate memory on the heap, you must use malloc() or calloc(), which are built-in C functions. Once you have allocated memory on the heap, you are responsible for using free() to deallocate that memory once you don't need it any more. If you fail to do this, your program will have what is known as a memory leak.<br>o Local variables exist only during the function in which they're declared (assuming you don't use modifiers such as static to make them persistent) and so take up space only when they're needed. If you can move more of your variables inside the functions where they're actually used, you can free up more space for use during other parts of the execution path. |
| 14. | What are the various options available for funding an Internet of Things startup? Explain any two. **(APR 2023)** |
| ANS | ● As important as future costs and revenues are to a well-planned business model, there will most likely be a period when you have only costs and no income. The problem of how to get initial funding is a critical one, and looking at several options to deal with it is worthwhile.<br>● If you have enough personal money to concentrate on your new Internet of Things startup full time without taking on extra work, you can, of course, fund your business yourself.<br>● If the initial stages don't require a huge investment of money, your time will be the main limiting factor. If you can't afford to work full time on your new project, perhaps you can spare a day in the weekend or several evenings after work. You might be able to arrange to work part time on your day job; even an extra afternoon or day might be enough to get things moving. |
| 15. | Explain government funding for IoT projects. **(NOV 2022)** |
| ANS | Governments typically want to promote industry and technological development in their country, and they may provide funds to help achieve particular aims.<br>● **Outputs:** Deliverables (aka outputs) are the metrics that an awarding body may use to tell if you are doing the kind of thing that the body wants to fund. This metric may simply be a test that you are managing the money well or may be related to the goals that the body itself wishes to promote. You might be required to write regular |

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| | reports or pass certain defined milestones on schedule. If your funding is given in stages, the later payments may be conditional on successful delivery of previous outputs. You should be very clear on what needs to be done and how onerous the task is.<br>● **Spending constraints:** Some funding may require you to spend a proportion of the money on, for example, business consultancy or web development, perhaps with the fund facilitator's company or associates. |



## UNIT 5

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| 1. | What are the different software options for designing PCB? Explain. **(NOV 2018)** |
| ANS | ● You have many different choices when looking for some software to help you design your PCB. If you are working with a contract electronics design house, the staff may well use something like Altium Designer<br>● Fritzing (http://fritzing.org) is a free, open-source design package aimed particularly at beginners in PCB design. It deliberately starts with a design screen resembling a breadboard and lets you map out your circuit by copying whatever you have prototyped in real life. It then converts that design to a schematic circuit diagram and lets you arrange components and route the traces on the PCB view.<br>● KiCad (www.kicad-pcb.org) is another open source offering but with a more traditional workflow. It has a more comprehensive library of predefined parts and can be used to design boards with up to 16 layers of copper, compared to the double-sided boards that Fritzing produces. |
| 2. | Explain the steps for manufacturing PCBs. **(NOV 2018)** |

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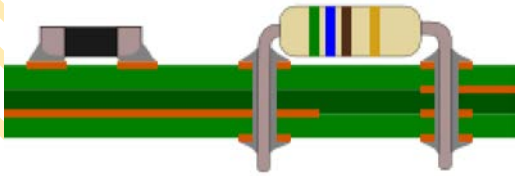
| ANS | • Once we have done with the prototype on breadboard , next step is to prototype on stripboard, still we may have wires connecting components.<br>• Moving beyond stripboard, designing and etching your own custom PCBs gives you more options on how to lay out the circuit and makes it easier to solder up as the only holes in the board will be those for components.<br>• Moving to professionally manufactured boards further simplifies the assembly process because the solder mask will make the soldering a bit easier, and, more importantly, the silkscreen provides outlines of where each component should be placed.<br>• if the routing of connections between components is particularly complex, only a multilayer PCB will let you cross connections; if any of your components are available only in surface-mount packages, a custom PCB will let you place them without resorting to additional breakout boards; and if you've been using an off-the-shelf microcontroller board<br>• The PCB is made up of a number of layers of fibreglass and copper, sandwiched together into the board. The fibreglass provides the main basis for the board but also acts as an insulator between the different layers of copper, and the copper forms the "wires" to connect the components in the circuit together.<br>• if you had a solid plate of copper across the whole board, sections of the copper are etched away—usually chemically, but it is possible to use a CNC mill for simple boards. These remaining copper routes are called tracks or traces and make the required connections between the components.<br>• Single-sided boards have only one layer of copper, usually on the bottom of the board; because they're often for home-made circuits with through-hole components, the components go on the top with their legs poking through the board and soldered on the underside.<br>• Double-sided boards, predictably, have two layers of copper: one on the top and one on the bottom.<br>• When you need to connect traces on two layers together at a point where there isn't a hole for the leg of a component, you use a via.<br>  <br>PCB features (left to right): surface-mount component; through-hole component; via; blind via. |
| 3. | What is the importance of Certification for IoT devices? Explain. **(NOV 2018)**<br>**OR**<br>Explain the need of Certification in IOT devices. **(APR 2023)**<br>**OR**<br>What is the important of certification? Why it is required? **(NOV 2022)** |
| ANS | • One of the less obvious sides of creating an Internet of Things product is the issue of certification.<br>• if you take a closer look at any gadget that's near to hand, you will find a cluster of logos on it somewhere…CE, FCC, UL…. Each of these marks signifies a particular set of regulations and tests that the item has passed: the CE mark for meeting European standards; FCC for US Federal Communications Commission regulations; and UL for independent testing laboratory UL's tests. |

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| | ● Testers check over the materials specifications to ensure you're not using paint containing lead.<br>● Electromagnetic interference is the "electrical noise" generated by the changing electrical currents in circuitry. When generated intentionally, it can be very useful: radio and television broadcasts use the phenomenon to transmit a signal across great distances, as do mobile phone networks and any other radio communication systems such as WiFi and ZigBee.<br>● In Europe, you must also register for the Waste Electrical and Electronic Equipment Directive (WEEE Directive). It doesn't cover any of the technical aspects of products but is aimed instead at reducing the amount of electronic waste that goes to landfills. |
| 4. | Explain privacy with respect to Internet of Things. **(NOV 2018)**<br>**OR**<br>Explain privacy with respect to IOT devices in detail. **(NOV 2022)**<br>**OR**<br>Explain the concept of privacy with respect to Internet of Things. **(APR 2023)** |
| ANS | Everything you write might be visible to anyone online: from minutiae about what you ate for breakfast to blog posts about your work, from articles about your hobbies to Facebook posts about your parties with friends. There is a value in making such data public: the story told on the Internet becomes your persona and defines you in respect of your friends, family, peers, and potential employers.<br><br>A common argument is "if you've got nothing to hide, then you've got nothing to fear." There is some element of truth in this, but it omits certain important details, some of which may not apply to you, but apply to someone:<br>● You may not want your data being visible to an abusive ex-spouse.<br>● You might be at risk of assassination by criminal, terrorist, or state organizations.<br>● You might belong to a group which is targeted by your state (religion, sexuality, political party, journalists).<br><br>Issues exist with sports-tracking data, whether produced by an actual Thing, such as Nike+ or a GPS watch, or a pseudo-Thing, like the RunKeeper app on your smartphone.<br><br>It is very important to note that even aggregate data can "leak" information. If you can see data collected for a street, for example, then comparing a week when a household is away on holiday with a normal week when they are at home might tell you about their usage.<br><br>Even innocuous photos can leak data. With GPS coordinates (produced by many cameras and most smartphones) embedded into the picture's EXIF metadata, an analysis of your Flickr/Twitpic/Instagram feed can easily let an attacker infer where your house, your work, or even your children's school is. |
| 5. | Discuss the five critical requirements for sensor commons project. **(NOV 2018)**<br>**OR**<br>Discuss the five critical requirements for sensor commons project. **(APR 2023)** |
| ANS | ● Fisher's original definition observed five critical requirements for a sensor commons project. It must<br>o **Gain trust:** Trust is largely about the way that an activist project handles itself beyond the seemingly neutral measurements<br>o **Become dispersible:** Becoming dispersible means spreading the sensors throughout the community. |

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| | ○ **Be highly visible:** Being visible involves explaining why the project's sensors are occupying a public space.<br>○ **Be entirely open:** Being open is perhaps what distinguishes the sensor commons from a government project the most.<br>○ **Be upgradable:** Finally, the project should be designed to be upgradable, to enable the network to remain useful as the needs change or hardware gets to the end of its working life. |
| 6. | Write a short note on cautious optimism. **(NOV 2018)**<br>**OR**<br>What is cautious optimism? Explain. **(NOV 2022)** |
| ANS | ● It is true that any technological advance could be co-opted by corporations, repressive governments, or criminals. But (we hope) technology can be used socially, responsibly, and (if necessary) subversively, to mitigate this risk.<br>● Although the Internet of Things can be, and we hope will always be, fun, being aware of the ethical issues around it, and facing them responsibly, will help make it more sustainable and more human too.<br>● When designing the Internet of Things, or perhaps when designing anything, you have to remember two contrasting points:<br>○ Everyone is not you. Though you might not personally care about privacy or flood levels caused by global warming, they may be critical concerns for other people in different situations.<br>○ You are not special. If something matters to you, then perhaps it matters to other people too. |
| 7. | What is Crowdsourcing? Explain. **(APR 2019)** |
| ANS | ● Crowdsourcing is a sourcing model in which individuals or organizations obtain goods and services. These services include ideas and finances, from a large, relatively open and often rapidly-evolving group of internet users; it divides work between participants to achieve a cumulative result. The word crowdsourcing itself is a portmanteau of crowd and outsourcing, and was coined in 2005<br>● In the Internet of Things world, this concept has manifested itself in sensor networks such as Xively. Founder Usman Haque has said that their original intent wasn't simply "making data public" but also letting "the public making data"<br>● Governments and companies simply do not and cannot have a monopoly on all recording of data: there are infinite combinations of data sources.<br>● local activism may be hampered by lack of available data. Coming together to produce such data raises activism from an emotional appeal ("think of the children!") which can be ignored or co-opted by the political elite as expedient, into a reasoned thesis supported by real data<br>● Andrew Fisher, a technologist with interests in big data and ubiquitous computing, has written persuasively about a quiet revolution of the "sensor commons", his term for this collaborative voluntary effort to provide environmental data.<br>● Fisher's original definition observed five critical requirements for a sensor commons project. It must<br>○ **Gain trust:** Trust is largely about the way that an activist project handles itself beyond the seemingly neutral measurements<br>○ **Become dispersible:** Becoming dispersible means spreading the sensors throughout the community.<br>○ **Be highly visible:** Being visible involves explaining why the project's sensors are occupying a public space. |

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| | ○ **Be entirely open:** Being open is perhaps what distinguishes the sensor commons from a government project the most.<br>○ **Be upgradable:** Finally, the project should be designed to be upgradable, to enable the network to remain useful as the needs change or hardware gets to the end of its working life. |
| 8. | Discuss the different environmental issues in Internet of Things. **(APR 2019)**<br>**OR**<br>Explain the environmental concerns about the production and running of the Thing itself. **(APR 2023)**<br>**OR**<br>Discuss the environmental issues associated with IOT devices. **(NOV 2022)** |
| ANS | ● classic environmental concerns about the production and running of the Thing itself.<br><br>**PHYSICAL THING**<br>● Creating the object has a carbon cost, which may come from the raw materials used, the processes used to shape them into the shell, the packing materials, and the energy required to ship them from the manufacturing plant to the customer.<br>● For example, thermal printer paper may contain Bisphenol-A, which has health and environmental concerns. BERG's Internet of Things product, the Little Printer, is sold using only BPA-free paper, but initial reactions to it suggested that using paper at all is an environmental issue.<br>● Of course, a printout the size of a shopping receipt has some carbon cost.<br><br>**ELECTRONICS**<br>● The electronics contained in a Thing have their own environmental cost. Buying PCBs locally or from a foreign manufacturer affects the carbon cost of shipping the completed units. Considering the potential cost savings, even a responsible manufacturer may find it reasonable to offset the extra carbon emissions.<br>● More worryingly, many electronic components rely on "rare earth minerals" (REMs) which have been extracted in China or from other locations worldwide. The mining process must be managed properly; otherwise, slurries formed of mildly radioactive waste minerals will be left behind long after the mines cease production.<br>● Every electronically enhanced Thing that you produce will incur these costs and will also need to be powered to run. |
| 9. | Explain common PCB (Printed Circuit Board) making techniques. **(APR 2019)**<br>**OR**<br>Explain common PCB (Printed Circuit Board) making techniques. **(APR 2023)** |
| ANS | **ETCHING BOARDS**<br>● The most common PCB-making technique for home use is to etch the board.<br>● Your stencil then needs to be transferred to the board. For photo-resist board, you will expose it under a bright lamp for a few minutes; and for the toner-transfer method, you'll use a super-hot iron.<br>● With the board suitably prepared, you can immerse it into the etching solution, where its acidic make-up eats away the exposed copper, leaving the tracks behind.<br>● After all the unnecessary copper has been etched away, and you've removed the board from the etching bath and cleaned off any remaining etchant, your board is almost ready for use.<br>● The last step is to drill the holes for any mounting points or through-hole components. |

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| | **MILLING BOARDS**<br>● In addition to using a CNC mill to drill the holes in your PCB, you can also use it to route out the copper from around the tracks themselves. To do this, you need to export the copper layers from your PCB software as Gerber files.<br>● These were first defined by Gerber Systems Corp., hence the name, and are now the industry standard format used to describe PCBs in manufacture.<br>● The mill effectively cuts a path round the perimeter of each track to isolate it from the rest of the copper. As a result, PCBs which have been milled look a bit different from those which are etched because any large areas of copper that aren't connected to anything are left on the board (to save time milling it away). |
| 10. | Discuss the main goals of Open Internet of Things definition. **(APR 2023)**<br>**OR**<br>Discuss the main goals of Open Internet of Things definition. **(APR 2019)** |
| ANS | ● The Open IoT Assembly 2012 culminated in the drafting of the "Open Internet of Things Definition". An emergent document, created after two days of open discussion, it seeks to define and codify the points of interest around the technology of the Internet of Things and to underscore its potential to "**deliver value, meaning, insight, and fun**".<br>● **We can summarize the main goals of the definition as follows:**<br>o Accessibility of data: As a stated goal, all open data feeds should have an API which is free to use, both monetarily and unrestricted by proprietary technologies with no alternative open source implementation.<br>o Preservation of privacy: The Data Subjects should know what data will be collected about them and be able to decide to consent or not to that data collection.<br>o Accessibility of data: As a stated goal, all open data feeds should have an API which is free to use, both monetarily and unrestricted by proprietary technologies with no alternative open source implementation.<br>o Preservation of privacy: The Data Subjects should know what data will be collected about them and be able to decide to consent or not to that data collection. |
| 11. | Discuss the phase of Testing in manufacturing of Internet of Thing devices. **(APR 2019)** |
| ANS | ● Assembly lines can include automatic optical inspection (AOI). In this process, a high-resolution camera inspects some aspect of the board and its components; for example, it could check that the solder paste is laid properly before the board goes into the pick-and-place machine and compare it to a known good version.<br>● After the boards pass the AOI, the next step is to run them through a functional test. This step is something that you can, and should, be doing even with boards that you've soldered by hand.<br>● You might find that adding a few testing points to the PCB—exposed pads on the PCB connected to useful parts of the circuit—will make the testing process easier, so it's worth considering how the test procedure will run before finishing your PCB design. |
| 12. | Explain the important guidelines to deal with issue of security in Internet of Things. **(APR 2019)** |
| ANS | ● Make sure that your servers are kept up-to-date with the latest security patches, are hardened with the appropriate firewalls, and detect and mitigate against password hacking attempts and rootkit attacks.<br>● User passwords should never be stored in plain text. If your database were ever compromised, an attacker could easily log in as any user. |

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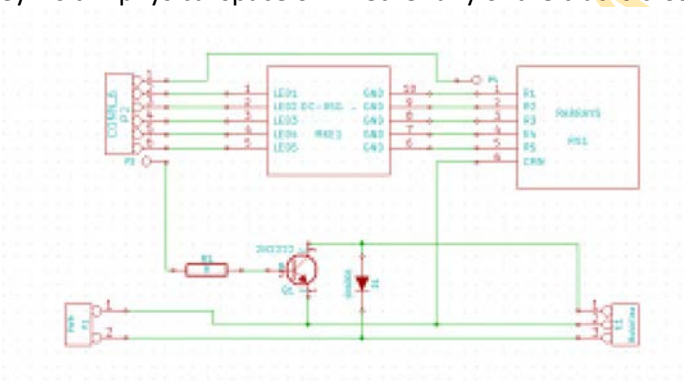
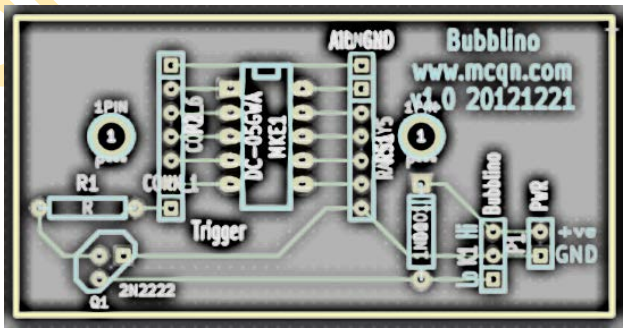
| | ● Risk an SQL injection attack were it to include SQL commands<br>● Aware of cross-site request forgery (CSRF) attacks from other malicious or compromised websites. |
| 13. | Explain in details the process of designing the kits. **(NOV 2019)**<br>**OR**<br>How are printed circuit board are designed? Explain. **(NOV 2022)** |
| ANS | ● Exact program you decide to use to lay out your PCB, your task in creating the design is split between two main views: the schematic and the board.<br><br>**The Schematic**<br>● You usually start the design in the schematic view. It lets you lay out the components logically and make the necessary connections without having to worry about exactly where they'll sit in physical space or whether any of the tracks cross.<br>  <br>**The Board**<br>● It makes sense to keep together groups of components that constitute an area of functionality, such as the power supply, for a more logical layout.<br>● Your PCB software has an auto-route function, which you can use to route all the tracks for you. However, such functions are far from perfect, and in practice, you will find it best to at least lay out the more important tracks first by hand, if not to do all the routing manually.<br>● After all the tracks have been routed, your PCB design is almost finished.<br>  <br>**MANUFACTURING PRINTED CIRCUIT BOARDS** |
| 14. | Write a short note on mass-producing the case and other fixtures. **(NOV 2019)**<br>**OR**<br>Write a short note on mass-producing the case and other fixtures. **(NOV 2022)** |
| ANS | ● A good rule of thumb for keeping down the costs of production is to minimise the amount of time a person has to work on each item. Machines tend to be cheaper than people, and the smaller the proportion of labour is in your costs, the more you'll |

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| | be able to afford to pay a decent wage to the people who are involved in assembling your devices.<br>● most common method of mass production: injection moulding of plastic.<br>● The expensive part of injection moulding is producing the mould in the first place; this is known as tooling up. The moulds are machined out of steel or aluminium and must be carefully designed and polished so that the moulding process works well and the parts come out with the desired surface finish.<br>● for a super-smooth surface, the moulds are finished with a process called electrical discharge machining (EDM), which uses high-voltage sparks to vaporise the surface of the metal and gives a highly polished result.<br>● If you need the thicker walls for strength, an alternative is to use ribs to add rigidity without lots of additional plastic.<br>● One way to reduce the tooling-up costs and also increase the production rate is to mould more than one part at a time. If your parts are small enough, you can replicate many of them on one mould or, as we saw in the model aircraft kit, collect lots of different parts together. |
| 15. | Discuss the issues in scaling up the software for large scale IOT devices. **(NOV 2019)** |
| ANS | ● Producing a physical thing as a prototype or as a manufactured product turns out to be two entirely different propositions. The initial prototype may well be of different size, shape, color, materials, finish, and quality to what ends up on the shelf.<br>● Yet, as with the physical form and electronics of the device, software has to be polished before it can be exposed to the real world. After looking at what is involved in deploying software—both on the embedded device and for any online service you have built—we look at the various factors that require this polish: correctness, maintainability, security, performance, and community. |
| 16. | Discuss the advantage and disadvantages of technology. **(NOV 2019)** |
| ANS | **Advantages**<br>● Is shiny and new<br>● Is progress (with the implication that it is therefore better)<br>● Will save lives and feed the starving<br>● Will (at the least) make us happier, healthier, safer, and better educated<br>● Will free us from drudgery to have more time for leisure<br>● Will create more interesting, rewarding jobs to replace the drudgery it will make obsolete<br><br>**Disadvantages**<br>● Destroys jobs<br>● Is intrusive and will enslave us to technology<br>● Disconnects humanity from ancient traditions<br>● Encourages us to become lazy and unhealthy<br>● Tempts us into thinking we are like gods |
| 17. | "The internet destroys the state", discuss. **(NOV 2019)** |
| ANS | ● The other major possibility that Eaves suggests is that "The Internet Destroys the State". This is also a hard and uncomfortable scenario to imagine. However, toning down this idea a little, we can see a more likely one of "the Internet" fighting back against an attempt by the state or corporations to co-opt it.<br>● When we refer to a technology as "disruptive", we mean that it affects the balance of power. |

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| | ● If one of the fears about the Internet of Things is that it will transfer power away from the citizens, the subjects of technology, to the elite, then perhaps it can also be used to redress that balance.<br>● One extreme example of this would be how surveillance and fears of the Big Brother state (CCTV cameras, remote-controlled helicopter-drones) might be mitigated by "sousveillance".<br>● Here, activists might have compromised public cameras, or perhaps installed additional spy cameras, routed through self-healing networks in people's homes, hidden in public spaces, flying in the airspace, or even crawling the sewers. |
| 18. | What is environmental cost of Internet service for IOT device? What is the solution? **(NOV 2019)** |
| ANS | ● The electronics contained in a Thing have their own environmental cost. Buying PCBs locally or from a foreign manufacturer affects the carbon cost of shipping the completed units. Considering the potential cost savings, even a responsible manufacturer may find it reasonable to offset the extra carbon emissions.<br>● More worryingly, many electronic components rely on "rare earth minerals" (REMs) which have been extracted in China or from other locations worldwide. The mining process must be managed properly; otherwise, slurries formed of mildly radioactive waste minerals will be left behind long after the mines cease production.<br>● Every electronically enhanced Thing that you produce will incur these costs and will also need to be powered to run.<br>● Assuming that you want to go ahead with manufacturing a Thing regardless, we hope that you will be aware of the various possibilities and consider ways to reduce your impact and also consider contributing to offsetting schemes.<br>● From a more optimistic point of view, it's also true that the realisation that the number of Internet-connected devices will be exploding in the coming years is spurring massive research into low-power efficient chips and communications. |