Iot - Internet of things question with answers

Internet of Things(IoT) (University of Mumbai)

Q1 a) Define and explain the Internet of Things.

Internet of Thing (IoT) is the object which is connected over the internet to send and receive instruction over the internet.

Equation of IOT = Physical Object + Controller,Sensors & Actuators +Internet=Internet of things IOT

Example: Smart Umbrella, WhereDial, etc.

- The Thing is present, physically in the real world, in your home, your work, your car, or worn around your body.
- This means that it can receive inputs from your world and transform those into data which is sent onto the Internet for collection and processing.
- So your chair might collect information about how often you sit on it and for how long.
- The presence of the Thing also means that it can produce outputs into your world with what we call “actuators”.
- Some of these outputs could be triggered by data that has been collected and processed on the Internet.
- So your chair might vibrate to tell you that you have received email. • We could summarize these components in the following simple equation:
- The fact of also being connected to the Internet and having general-purpose computing capabilities doesn’t necessarily have an impact on the form of the object at all.

Q1 a) Explain the components of Internet of Things. (5)

The components of Internet of things are:-

1. Physical Object 2.Sensors. 3.Actuators. 4.Connectivity 5.User Interface

1) Physical Object

- Physical objects embedded with electronics, software, sensors and network connectivity which enables these objects to collect and exchange data and play a remarkable role in many domains including transportation, healthcare, industrial automation, etc.

2) Sensors

- Sensors work to gather minute data from the surrounding environment.
- They are sometimes also known as ‘detectors, as the primary function of sensors is to detect.
- This allows an IoT device to capture relevant data for real-time or post-processing.
- This piece of hardware can measure absolutely anything i.e. smoke, motion and even blood pressure

3) Actuators

- Actuators work opposite to that of sensors.
- While sensors sense; actuators act.
- They receive a signal or a command and on that basis they perform an action.
- They are as crucial as sensors as once the sensors have detected a change in the environment, an actuators is required to make something happen based on trigger.
- E.g. actuator controls the heating and cooling in a smart air conditioner.

4) Connectivity

- The sensors/devices can be connected to cloud through a variety of methods including: cellular, satellite, Wi-Fi, Bluetooth, low-power wide-area networks, or connecting directly to the internet via Ethernet.

5) User Interface

- The user interface is the visible components that is easily accessible and in control of the IoT user.
- This is where a user can control the system and set their preferences.
- The more user-friendly this component of the IoT ecosystem is,easier is a user’s interaction.
- A user may interact with system via the device itself, or can be conducted remotely via Smartphone.

Q1 b) List and Explain the roles of people making IoT.

- People who make Internet of Things are:

1. Artist 2. Designer 3.Craftsperson 4. Hacker 5.Engineer 6.Architect

- People making IoT do not work individually for devices but work together in harmony and mutual understanding to do the task.
- **Artist** works at the forefront of technology innovation and can bring a fresh point of view on technology. They observe how people respond to these experiments in advance. Technologies can provide insights about what people need and will accept, and this can feed into the design and development of those technologies.
- **Engineering challenges** for IoT are developing and managing things, Network and Data/Cloud. Engineers must consider and include the comprehensive characterization of the environment in their designs. Engineers need to create virtual prototypes and simulate them to make sure they will work in the real world. • IoT is all about a new experience, an experience that doesn't exist today. But an experience if designed well can change the way we live tomorrow. That's why designers are going to play a pivotal role in shaping up the future of IoT. For that the designers will also have to change, adapt and broaden their horizon about the way they think about design.
- **Artists** collaborate with designers on time of installation of IoT devices or they collaborate with traditional craftsperson for printmaking while thinking about the idea of IoT device.
- **Designers** and **Engineers** work together and for making the product. In this, the Designer will design the structure of a device by using the idea of Artist and Engineer will implement this design into actual.
- **"Hackers"** by their nature, have various technical and artistic interests and skills. They will include new features into the device or will test the device properly so that the device remains safe.
- The **IoT Architect** leads the way through "the vision, strategy, architecture and shepherding of IoT solutions from inception to deployment." Becoming an IoT Architect requires several strategies:

    1. Data management practices 2. Develop Communication Skills

Q1 c) Explain Calm and Ambient Technology using example of Live Wire.

- The IoT has its roots in the work done by Mark Weiser at Xerox PARC in the year 1990s. • His work didn't assume that there would be network connectivity but was concerned with what happen when computing power becomes cheap enough that it can be embedded in to all manners of everyday objects.
- He coined the term ubiquitous computing or ubicomp. Ubicomp is ambient technology.
- Calm and Ambient technology means technology which acts in background, not something to which we actively pay attention i.e. Ambient noise in background recording.
- The term Calm technology means system that doesn't seek your attention.

Example: 1) **Live Wire**

- Live wire is one of the first IOT devices,Created by artist Natalie Jeremijenko.
- Live wire also known as Dangling String.
- It is a simple device: an electric motor connected to eight-foot long piece of plastic string.
- The power for motor is provided by the data transmissions on Ethernet network to which it is connected, so it twitches whenever a packet of information is sent across the network.
- Under normal, light network load, the string twitches occasionally.
- If the network is overloaded, the string whirls madly.

Q1 d) What is manufactured normalcy field? Explain. (5)

- Technology blogger Venkatesh Rao came up with a good term to help explain how new technology becomes adopted.
- He posits (suggest something as a basic fact) that 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.
- Rao called this concept the manufactured normalcy (situation in which everythong is normal) field.
- 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.
- 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.
- The way that portable Internet terminals made it into our manufactured normalcy field was through the phone metaphor.
- Introducing technology to people in terms of something they already understand is tried & tested effect:computers started off as glorified typewriters;graphical user interfaces as desktops.

Q1 e) What is DNS? How it works? (5)

- The Domain Name System (DNS) is the phonebook of the internet. Humans access information online through domain names, like nytimes.com or espn.com. Web browsers interact through protocol (IP) addresses. DNS translates domain names to IP addresses so browsers can load Internet resources
- Each device connected to the Internet has a unique IP address which other machines use to find the device. DNS servers eliminate the need for humans to memorize IP addresses such as 192.168.1.1(in IPv4).

  How does DNS work?
- The process of DNS resolution involves converting a hostname (such as www.example.com) into a computer-friendly IP address (such as 192.168.1.1). An IP address is given to each device on the Internet, and that address is necessary to find the appropriate Internet device - like a street address is used to find a particular home. When a user wants to load a webpage, a translation must occur between what a user types into their web browser (example.com) and the machine-friendly address necessary to locate the example.com webpage.
- In order to understand the process behind the DNS resolution, it's important to learn about the different hardware components a DNS query must pass between. For the web browser, the DNS lookup occurs "behind the scenes" and requires no interaction from the user's computer apart from the initial request.
- There are 4 DNS servers involved in loading a webpage:
  1. **DNS precursor**
  2. **Root name server**
  3. **TLD name**
  4. **Authoritative name server**

Q2 a) What is sketching? Explain its role in Prototyping? (5m)

- Sketching enables you to brainstorm, explore multiple ideas, define flows, and communicate with team members all while being quick and cheap.
- Prototyping enables you to get out of the building quicker, talk to users, validate assumptions, ensure expectations are meeting with stakeholders needs, while spending as little time as possible worrying about polish.
- There is a good chance that the first step we will take when working on our prototype will be to jot down some ideas or draw out some design ideas with pen and paper.
- That is an important first step in exploring our idea and one we would like to extend beyond the strict definition to also include sketching in hardware and software.
- What we mean by that is the process of exploring the problem space: iterating through different approaches and ideas to work out what works and what doesn't.
- The focus isn't on the fidelity of the prototype but rather on the ease and speed with which we can try things out.
- For the physical design, that could mean digging out childhood LEGO collection to prototype the mix of cogs and threedimensional forms, or maybe attacking some foam core or cardboard with a craft knife.
- Benefits of Sketching and Prototyping are:
  - Valid assumption
  - Discover problems early
  - Brainstorm Ideas
  - Design more Iterations
  - Conduct early usability testing
  - Cheaper and Faster to implement
  - Shorten the feedback loop
  - Help communication between team

Q2 c) Write note on Sensors and Actuators. (5)

1) Sensors

- Sensors are the way of getting information into your device from the surroundings.
- 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.
- Microphones obviously let you monitor sounds and audio, but piezo elements (used in certain types of microphones) can also be used to respond to vibration.
- Distance-sensing modules, which work by bouncing either an infrared or ultrasonic signal off objects, are readily available and as easy to interface to as a potentiometer.

2) Actuators

- Actuators are the outputs for the device which let your device do something to the outside world.
- 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 colours. RGB LEDs have a more complicated setup but allow you to mix the levels of red, green, and blue to make whatever colour of light you want.

Q2 c) Discuss open source versus closed source hardware and software. State their advantages and disadvantages.

Key Points	Open Source	Closed Source
Cost	Free	Cost vary with respect to complexity of software
Service	Poor	Good
Innovation	Innovation is more as the code could be changed	Innovation is less as the R&D is discussed only on discussion forums.
Usability	Less as it is not reviewed by experts	High
Security	Less as the software is not always developed in a controlled environment	High

1) Open Source

✞ **Advantages:**

Open source software is free to use.

- Open source is more secured as the code is accessible to everyone.
- It is not depend on the company and author that originally created it.

✞ **Disadvantages:**

- Open source is not being straight forward to use.
- Services and support are often fails to provide services.
- Many of latest hardware are incompatible on open source.

2) Closed source

✞ **Advantages:**

- It is more secure compare to open source.
- Services and support are also better than open source.
- Usability is the high selling point.

✞ **Disadvantages:**

- Less flexible.
- Customization available for specific user.
- Need to purchase and high cost.

Q2 f) Compare Raspberry Pi and Arduino.

Specification	Arduino Uno	Raspberry Pi
	Arduino design for physical computing	Rpi wasn't design for physical computing
Price	$30	$36
Size	7.6*1.9*6.4	8.6*5.4*1.7
Memory	0.002 MB	512 MB
Clock Speed	16 MHz	700 MHz
OS	Boot loader	Linux OS

Q3 b) What are laser cutters? Explain the main features to consider while choosing a laser cutter.

- Three-dimensional printers can produce more complicated parts, but the simpler design (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.
- Laser cutters range from desktop models to industrial units which can take a full 8' by 4' sheet in one pass.
- 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.
- The computer controls the two-axis positioning mechanism and the power of the laser beam. 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.
- At a sufficiently low power, this feature enables you to etch additional detail into the surface of the piece.
- You can also etch things at different power levels to achieve different depths of etching, but whilst the levels will be visibly different, it isn't precise enough to choose a set fraction of a millimetre depth.

When choosing a laser cutter, you should consider two main features:

- **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. You don't need to think just about the biggest item you might create; a larger bed allows you to buy material in bigger sheets (which is more ost effective), and if you move to small-scale production, it would let you cut multiple units in one pass.
- **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 10mmthick acrylic. Moving a few models up in the same range, to one with a 60W laser, would allow us to cut 25mm thick acrylic.

Q3 e) Explain POLLING and COMET.

1) POLLING

Polling is not a hardware mechanism; it's a protocol in which CPU steadily checks whether the device needs attention.

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.

3) COMET

Comet is an umbrella name for a set of technologies developed to get around the inefficiencies of polling. As with many technologies, many of them were developed before the "brand" of Comet was invented; however, having a name to express the ideas is useful to help discuss and exchange ideas and push the technology forward.

- Long Polling (Unidirectional) The first important development was "long polling", which starts off with the client making a polling request as usual.
- However, unlike a normal poll request, in which the server immediately responds with an answer, even if that answer is "nothing to report", the long poll waits until there is something to say.
- This means that the server must regularly send a keep-alive to the client to prevent the Internet of Things device or web page from concluding that the server has simply timed out.

Q3 c) Explain the different methods used for 3D printing. (5)

- The 3D printer also known as additive method.
- The term additive manufacturing is used because all the various processes which can be used to produce the output start with nothing and add material to build up the resulting model.
- This is in contrast to subtractive manufacturing techniques such as laser cutting and CNC milling, where you start with more material and cut away the parts you don't need.
- Various processes are used for building up the physical model, which affect what materials that printer can use, among other things.
- However, all of them take a three-dimensional computer model as the input.
- The software slices the computer model into many layers, each a fraction of a millimetre thick, and the physical version is built up layer by layer.
- One of the great draws of 3D printing is how it can produce items which wouldn't be possible with traditional techniques.
- For example, because you can print interlocking rings without any joins, you are able to use the metal 3D printers to print entire sheets of chain-mail which come out of the printer already connected together.

Types of 3D printing.

1) **Fused filament fabrication (FFF):**
   - Also known as fused deposition modeling (FDM), this is the type of 3D printer you're most likely to see at a maker event.
   - It works by extruding a fine filament of material (usually plastic) from a heated nozzle.
   - The resulting models are quite robust, as they're made from standard plastic. However, the surface can have a visible ridging from the thickness of the filament.
2) **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.
3) **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.
4) **Laminated object manufacturing (LOM):**
   - This is another method which can produce full-colour prints. LOM uses traditional paper printing as part of the process
5) **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.

Q4 a) Explain different types of memory.

ROM (Read-only Memory):

- ROM is non-volatile memory so always retains its data.
- Read-only memory is used to store the hard-coded information of chips and can only be read afterwards.
- It is used to store only the executable program code and any data which is fixed and never changes.
- ROM's are the least flexible memory.
- Creating memory with ROM is the cheapest way.

Flash:

- Flash is a semi-permanent type of memory which provides all the advantages of ROM.
- Flash doesn't need power to store information, so its contents can survive after the circuit being unplugged.
- The reading speed of information is not much different as of speed of RAM or ROM.
- In flash writing process takes few processor cycles, which means it's best to store the program executable data or important data that has been gathered.

RAM (Random-access Memory):

- RAM is also called as read write memory or the main memory or the primary memory.
- RAM is volatile memory as the data loses when power is turned off.
- Random-access memory mostly used for its speed to access the data.
- RAM is used as working memory for the systems, the place where the things are stored while being processed.

Q4 a) Discuss the limitations of memory in embedded devices. How is it managed? Explain. (5)

The rapid development of the Internet of Things has created a number of exciting new opportunities and challenges for designers.

Yet whether an IoT device is brand-new technology specifically designed to be connected, or an upgrade to an existing device to create more capability, there is one consideration that cannot be overlooked: The need for the device to have memory.

Limitation of memory in embedded devices are:

1. **Cost:** Cost is a concern in any project; the more expensive the memory selection, the more expensive the final device.Depending on the market, you need to weigh the cost vs. performance options.
2. **Size:** Most IoT devices are small, and thus the embedded technology must also be small. The amount of space required for memory processing must also be kept to a minimum, as the more silicon wafer space required, the more costs go up.
3. **Power Consumption:** Most IoT devices either run on small batteries or rely on energy harvesting for recharging. For this reason, it's important to consider the power consumption of the memory selection, and choose an option that uses the least amount of power and voltage, both in use and during standby.
4. **Startup time:** Users want excellent device performance, so memory needs to be sufficient to allow for a quick startup. Implementing a code-in-place option, which allows the device to execute code directly without needing to copy operating code from a separate EEPROM chip reduces the time required to boot up, as well as the cost of the chip since there is less need for RAM with substantial on-chip storage.

Q4 c) What are libraries? Explain with examples (5)

- When you are developing software for server or desktop machines you need to also develop array of libraries and framework to make use of software easy.
- In embedded system it becomes bit tricky and becomes better with time as it provides system on chip functionality.
- The other component is micro controller which are resource constrained which pulls mainstream operating system libraries and its code.
- You can use existing code to develop your version but if unnecessary memory allocations are been done by the code it would lead to memory wastage so it's better to start writing your version from scratch keeping the limitation of micro controller in mind instead of simply wasting the memory.
- Following are few commonly used libraries:
  - **IwIP**
    - Also known as LightWeight IP. It is a stack of TCP/IP which runs in condition where there are fewer resources.
    - Requires less memory of about 10KB of RAM and 40KB of ROM/Flash. Arduino Wi-Fi uses such type of library.
  - **Atomthreads**
    - Atomthreads is lightweight real-time scheduler for embedded systems.

    It can be used when the code gets complicated and you want to make more than one task to execute together, scheduler plays an important role here as it switches between the tasks quickly which looks pretty simple as that of multitasking computer.

Q4 d) Define business model .Explain different factors in the definition.

- Business Model describes the rationale of how organization creates, delivers, capture value in economic, social, cultural or other contexts And the process of business model construct and modify is also called business model innovation.
- The main motive of developing a model for your business is to get a proper idea of what you are trying to do and whether your business is delivering the same what you expected out of it. • Even if you don't follow the formal way of developing the model, the one who thinks about establishing a business as thought in details about things like whether it would be affordable, what business would actually be about and can profit be achieved out of it.

  The business model definition brings together a number of factors:
  - A group of people.
    - People who are going to use the product.
  - The need of those customers.
    - What the customer or the people who are going to be potential user of the product expect out of the product.
  - A thing that your business can do to meet those needs.
    - Strategies and tactics that can be developed to meet these needs.
  - A success criterion such as making a profit.
    - Most of the ideas that looked great and theoretically possible on paper turned out to be practically impossible or high budget. Making all possible combination and trying all possible ideas will help your product to grow and become strong or else it will let you know where your product stands.

Q4 f) What is venture capital? How can one exit? (5)

- Venture capital is finance that investors provide to startup companies and small businesses that are believed to have longterm growth potential. However, it does not always take just a monetary form, it can be provided in the form of technical or managerial expertise.
- Venture capital means risk capital. The risk visualized may be very high, may be so high as to result in loss or very loss so as to result in high gains.
- The main objective of venture capital is not to gain interest but capital gain.
- The venture capital investment is made when a venture capitalist buys shares of such a company and becomes a financial partner in the business.
- The Venture capital typically comes from institutional investors and high net worth individuals and is pooled together by dedicated investment firms.
- It is the money provided by an external investor to finance a new, growing, or troubled business.
- **Advantages of Venture capital investing:**
  - It provides large sum of equity finance
  - Economic growth
  - It is able to bring wealth and expertise to your company
  - It also has wide network of contacts
  - It provides additional funds
- **Disadvantages of venture capital investing:**
  - You must generate the cash needed to make the agreed payments of capital, interest and dividends. This can create great financial pressure.
  - You will have to agree to certain restrictions as part of the deal, such as the amount you are paid and your involvement with other businesses and you will usually need your investors consent to major decisions. **How can one exit?**
- An exit does not mean that you have to leave the company. In fact, in many cases, the exit terms may require that you stay for a maximum of one to three years after acquisition in order

  to ensure continuity and value for the buyer. An exit strategy is a "method by which a venture capitalist or business owner intends to get out of an investment that he or she made". 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, there are only two exits:

  - **You get bought by a bigger a company:**
    - In this case, the buyer buys out the investors that is, the buyer pays the investors value of their percentage equity of their perceived valuation of the worth of the company.
    - Founding members of the company often transfer to the purchasing company, as they constitute one of the company's principal resources.
  - **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 the 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.

Q5 a) Explain in details the process of designing the kits. (5)

- The first step towards selling your idea as a product is to provide it as a kit. Many a time we underestimate the work and start buying it but we will not be able to select the right component and putting together with a step-by-step guide.
- Most kits tend to provide only the electronics and software for a particular application rather than any physical housing. The reason partly comes down to the difficulty, for a cottage kitbuilding industry, of sourcing custom plastic components.
- The main market for such kits is others in the maker community; these makers will perhaps prefer to combine the kit into a project of their own. However, with the growing accessibility of 3D printers and laser-cutters, it is becoming vastly more feasible to provide housing and other physical components even for kits.
- Kits tend to piggyback on existing microcontrollers and often take the form of a standard format plug-on board for example shield in the Arduino ecosystem or a cape on the Beagle Bone.
- It reduces the support overhead for the kit provider; either user will already be familiar with the platform or if not plenty of assistance will be available elsewhere to cover the basics of getting up and running. The kits documentation can then focus on just what is specific in building the project.
- A good starting point for working out your price (how much you will charge consumers) is to take the total cost of the BOM and multiply it by 4 or 5. That calculation gives you a margin to cover that item's portion of the fixed costs and also some profit. It also provides enough margins for resellers to cover their fixed costs and make some profit.
- However, it can also add to the support overhead, because you will need to deal with remotely debugging your customers' issues, which may be down to their poor soldering rather than defects in your work. These problems can all be resolved by moving on a step towards a consumer product and selling fully

Assembled PCBs, populated with all the components.

Q5 a) What are the different software options for designing PCB? Explain.

1. It is always better to sell the idea as a complete product, many even provide on electronics and software for a particular application rather than a complete product, this approach is somewhat difficult to digest.
2. With so much improvement over 3d printing, it is always better that makers gives the complete ready product. This makes sense because it reduces the support overhead for the kit provider.
3. Only designing the circuit, identifying the electronics components and developing the software will not suffice, you need to also include designing a PCB, documenting the build process, and working out the costs.
4. So now working out what price to charge is to be given a thought So create BOM (Bill of Materials). Now depending on BOM take a decision on how much to charge the consumer. For this, look for similar product prices, check demand of the product and decide the cost.
5. The major issue while giving the kit for assembly to the consumer, will require you to give a support for the same and this is again an overhead.

These problems can all be resolved by moving on a step towards a consumer product and selling fully assembled PCBs, populated with all the components.

Q5 c) Explain common PCB (Printed Circuit Board) making techniques.

If you want only a couple of boards, or you would like to test a couple of boards (a very wise move) before ordering a few hundred or a few thousand, you may decide to make them in-house.

ETCHING BOARDS

- The most common PCB-making technique for home use is to etch the board.
- Some readily available kits provide all you need.
- The first step is to get the PCB design onto the board to be etched.
- This process generally involves printing out the design from your PCB design software onto a stencil.
- If you're using photo-resist board, it will be onto a stencil which masks off the relevant areas when you expose it to UV light.
- 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.
- 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.
- 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.
- The last step is to drill the holes for any mounting points or through-hole components.

MILLING BOARDS

- 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.
- These were first defined by Gerber Systems Corp., hence the name, and are now the industry standard format used to describe PCBs in manufacture.
- To translate your Gerber file into the G-code that your mill needs requires another piece of software.
- Some CNC mills come with that software already provided, or you can use a thirdparty program such as Line Grinder.
- 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.

THIRD-PARTY MANUFACTURING

- If your design has more than two layers, if you want a more professional finish, or if you just don't want to go to the trouble of making the PCBs yourself, many companies can manufacture the boards for you.
- The price for getting the boards made varies based on the complexity and the size of the design but also varies quite a bit from company to company.
- If you need the boards quickly, a local firm is best.
- If you have more time you can give it outside country such as china, it might reduce cost.
- Either way, the Gerber files are what you need to provide to the manufacturer.
- Make sure you export all the relevant layers from your design, meaning each of the copper layers you're using, plus the solder mask, silkscreen and drill files.

Q5 d) Explain privacy with respect to Internet of Things. (5)

The Internet, as a massive open publishing platform, has been a disruptive force as regards the concept of privacy.

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.

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:

- You may not want your data being visible to an abusive ex-spouse.
- You might be at risk of assassination by criminal, terrorist, or state organizations.
- You might belong to a group which is targeted by your state (religion, sexuality, political party, journalists).

More prosaically, you change and your persona changes. Yet your past misdemeanours (drunken photos, political statements) may be used against you in the future.

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.

Even if you stripped out the data, photo-processing technology enables searching of similar photos, which may include these coordinates or other clues.

Similar 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.

This data is incredibly useful to keep track of your progress, and sharing your running maps, speed, heartbeat, and the like with friends may be motivating.

But again, it may be trivial for an attacker to infer where your house is (probably near where you start and finish your run) and get information about the times of day that you are likely to be out of the house.

Q5 f) What is environmental cost of Internet service for IoT device? What is the solution? (5)

- 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.
- It's easier than ever to add up the cost of these emissions: for example, using the ameeConnect API we can find emissions data and carbon costs for the life-cycle, use of different plastics, we might use for 3D printing or injection molding. Calculating the energy costs for manufacture is harder.
- 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. If our product needs to conform to RoHS legislation, then every single component that could be extracted from it must be RoHS compliant.
- Solutions like Instrumenting production lines, home energy usage, transport costs, building energy efficiency, and all other sources of efficiency might seem extreme, but it may be a vital, imperative task. Projects such as a carbon score for every company in the UK will help change attitudes, perhaps simply by gamifying the process of improving one's emissions, but also by having an objective measure that could, in future, be as important to a company's success as its credit score.