PROTOTYPING THE PHYSICAL DESIGN

Preparation

- To best prepare for design work, one should (in an ideal world) start long before he even has a particular problem to solve; developing an interest in design and having examples of design ideas you like are part of an ongoing process.
- All one needs to do is develop an interest in the world around you and start paying attention to the wealth of objects and experiences that you encounter.
- This first step will help you work out what you like and what you don't like.
- Over time, you'll start to work out which qualities you particularly appreciate.
- This will end up in observing little things more precisely. For example, one can be attracted to the crisp, sleek lines of your road bike,
- All such observations will help one work out what, for him, makes a good design.
- The more of the world one encounters, the more source material he has to work with.
- As you go, collect details about the items that inspire you.
- One can take photos, jot down things in his notebook, or sketch them out or paste them into an old-school scrapbook or Whatever that works best for him.
- Over time you'll build up an archive of good design that will help you spark your creativity when designing things of your own.
- The other side to a (very) basic design education is an understanding and appreciation of the tools available and the materiality of the processes involved in making things in the physical, rather than the digital, realm.
- Items crafted in the digital world can focus exclusively on appearances and take on any form they like; in the real world, those pesky laws of physics and the limitations of the tools for fabrication come into play.

Sketch, Iterate, Explore

FAQ

1. Explain Sketch, Iterate and Explore process in prototyping.

Sketch

- Sketching enables you to brainstorm, explore multiple ideas, define flows, and communicate with team members all while being quick and cheap.
- Doing a large amount of introductory jobs doesn't mean that you won't do extra research and gathering of possible beginning points when you do eventually sit down with a particular estimate in mind.
- To start with, you're looking for an extensive search across the problem area.
- The motive is to get to clutch with as many aspects of the design as possible, rather than drilling down into one specific possible result.
- Pushing beyond the obvious solutions forces you to look at things differently and increases the likelihood that you'll have a good design among your options.
- Use whatever tools make most sense to help with the idea triggering and investigation
- One can use a whiteboard to jot down thoughts and sketches over a few days—or a notebook to doodle sketches.
- They only need to capture and convey the ideas.

- The more sketching you do, the better they will get.
- Then give it or show it to some of the people who might use the finished item to find out how they interact with it.

Iterative

- Iterative design is a design methodology based on a cyclic process of prototyping, testing, analyzing, and refining a product or process.
- A prototype is a draft version of a product that allows you to explore your ideas and show the intention behind a feature or the overall design concept to users before investing time and money into development.
- Arguably, in the early stages of a design, you can never do too much iterating through ideas and trying out different approaches to solving the problem.
- 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 modeling clay or LEGO or some of the other methods.
- Try out different sizes and see how the changes in dimensions affect the feel or the look of the design.

Explore

- One can even combine the approaches here with the things he learnt for prototyping the software and electronics and lash up a rough-and-ready prototype that he can try out properly.
- Then give it or show it to some of the people who might use the finished item to find out how they interact with it.
- For example, 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 realized that a design echoing the shape of a house better conveyed the core concept of connecting loved ones in their homes.
- The key lesson is to use these techniques to experiment with different possibilities and learn which features of which designs are best.
- This approach allows you to synthesize the results into a coherent final design.

NON DIGITAL METHODS

FAQ

Explain the non-digital methods of prototyping.

- Let's look at some of the more common non digital methods for prototyping:

Modeling clay:

- The most well-known brands are Play-Doh and Plasticine, like PlayDoh, have a tendency to dry out and crack if left exposed to the air.
- Plasticine doesn't suffer from this problem, but as it remains malleable, it isn't ideal for prototypes which are going to be handled.
- Modeling clay is best used for short-term explorations.

Epoxy putty:

- One might have encountered this product as the brand Milliput; it is similar to modeling clay although usually available in fewer colors.
- You could mold it to the desired shape, and in about an hour, it sets solid.

Sugru:

- Sugru is a moldable silicone rubber.
- It is good at sticking to most other substances and gives a soft-touch grippy surface, which makes it a great addition to the designer's toolkit.

Toy construction sets

- You can use LEGO sets.

Cardboard:

- Cardboard is cheap and easy to shape with a craft knife or scissors, and available in all manner of colors and thicknesses.

Foam Core or foam board:

- 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 3 mm or 5 mm thicknesses in a range of sizes.

Extruded polystyrene:

- This product is similar to the expanded polystyrene that is used for packaging but is much denser foam that is better suited to modeling purposes.
- It is often referred to as "blue foam", although it's the density rather than the color which is important.
- The combination of Moore's Law driving down the cost of computing and the expiration of the patents from the early developments in the 1980s has brought such technology within the reach of the economical and small business.

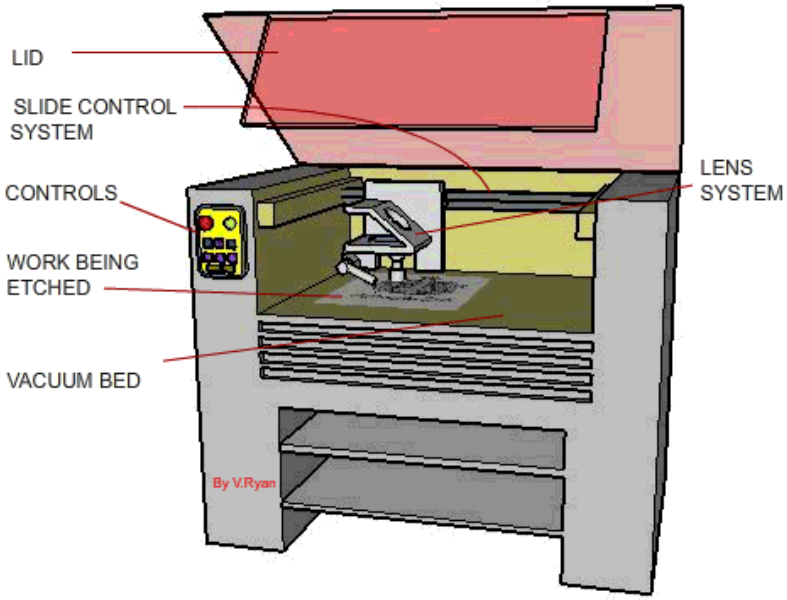
LASER CUTTING

FAQ

1. Write a note on LASER cutting.
2. What are LASER Cutters? Explain the main features to consider while choosing a LASER Cutter.
3. What are the features that need to be considered 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 millimeter depth.



Choosing a Laser Cutter

- 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 cost 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 10mm thick acrylic.
- Moving a few models up in the same range, to one with a 60W laser, would allow us to cut 25mm thick acrylic.

Power(In Watts)	Thickness which it can cut through
40W	10 mm to 15 mm(max)
60W	25 mm to 27mm(max)

Software

- The file formats or software which you need to use to provide your design vary across machines and providers.
- Although some laser-cutting software will let you define an engraving pattern with a bitmap, typically you use some type of vector graphics format.
- Vector formats capture the drawing as a series of lines and curves, which translate much better into instructions for moving the laser cutter than the grid-like representation of a bitmap.

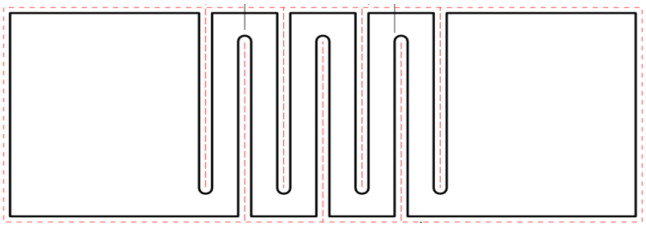
- There's also no loss in fidelity as you resize the image.
- **CorelDRAW** is a common choice for driving the laser cutters themselves, and you can use it to generate the designs too.
- Other popular options are **Adobe Illustrator,** as many designers already have a copy installed and are familiar with driving it, and **Inkscape,** largely because it's an open source alternative and therefore freely available.
- The best choice is the one you're most comfortable working with, or failing that, either the one your laser cutter uses or the one you can afford.
- When creating your design, you use the stroke (or outline) of the shapes and lines rather than the filled area to define where the laser will cut and etch.
- The kerf, the width of the cut made by the laser, is about 0.2mm but isn't something you need to include in the design.
- A thinner stroke width is better, as it will stop the laser cutter from misinterpreting it as two cuts when you need only one.
- Different types of operation—cut versus etch or even different levels of etching—can usually be included in the same design file just by marking them in different colors.
- Whoever is doing your cutting may have a set convention of color scheme for different settings, so you should make sure that you follow this convention if that is the case.

Hinges and Joints

- Mechanisms you use to construct items with the laser cutter aren't any different from those used in more general woodwork
- A few lesser-known techniques, however, are either easier to achieve with the precision of the laser cutter or have found new popularity after being picked up by this new generation of makers.

Lattice (or Living) Hinges

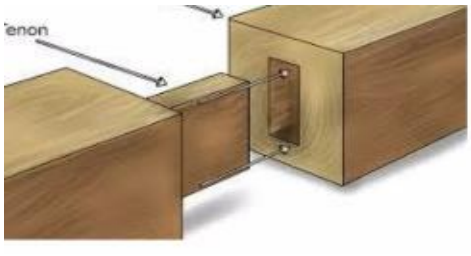
- If you're looking to introduce some curves into your design, one of these hinge patterns,
- A series of closely laid-out cuts, perpendicular to the direction of the curve, allows the material to be bent after it has been cut.
- Varying the number of cuts and their separation affects the resulting flexibility of the hinge.



Integrated Elastic Clips

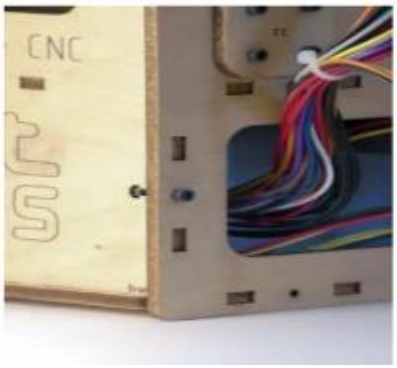
- This jointing technique is used in situations similar to a through mortise-and-tenon joint, when joining two sheets of material at 90 degrees.
- The tenon (tongue) is replaced with two hooks which protrude above and to the side of the mortise, thus holding the mortise sheet tight to the tenon sheet without any need for glue or additional fixings.

- To provide the required flexibility in the tenon to fit it through the mortise during assembly, additional, deeper cuts are made into the tenon side.



Bolted Tenon (or T-Slot) Joints

- An alternative to integrated elastic clips, the bolted tenon joint is a modified version of the standard mortise-and-tenon joint which adds a T- or cross shaped slot to the tenon sheet, with the crossbar of the T or cross being just big enough to hold a nut.
- You can then thread a bolt through a hole in the mortise sheet, down the slot and through the nut.



3D Printing

FAQ

1. Discuss the method of 3D printing.
2. Explain different methods of 3D Printing.

- The 3D printer is also known as an 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 millimeter 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.

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.

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.

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 printhead similar to one in an inkjet printer.

Laminated object manufacturing (LOM):

- This is another method which can produce full-color prints.
- LOM uses traditional paper printing as part of the process

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.
- Both approaches build their models from a vat of liquid polymer resin which is cured by exposure to ultraviolet light.

Software

- No definitive software package is recommended for use when generating your 3D designs.
- If you are already familiar with one 3D design program, see whether it can export files in the correct format for the machine you'll use to print.
- If you are using a printing service, it will advise on which program it prefers you to use or what formats it accepts.
- Or failing that, choose one to suit your budget and that you find easiest to get to grips with.
- Working out how to design items in three dimensions through a two dimensional display isn't trivial, so it's more important than usual to work through the tutorials for the software you choose.
- This gives you the best grounding to manipulate objects, ensuring that the components which make up your design line up correctly to minimize the risk of artifacts in the finished print.
- **Tinkercad (http://tinkercad.com) and Autodesk's 123D Design Online** (http://www.123dapp.com/design) are two options which just run in your web browser.
- So they let you start designing without having to install any additional software.

- Autodesk also has a range of 123D apps available to download and install. You can find a desktop version of 123D Design and also of 123D Catch, a clever application which takes an array of photos of an object and automatically converts them into a 3D model.
- This inferred 3D model may then need subsequent refinement—for example, with 123D Design. **SolidWorks (http://www.solidworks.com) and Rhino (http:// www.rhino3d.com) are the industry-standard commercial offerings, and SketchUp** (http://www.sketchup.com), which was owned by Google for a while but in 2012 was sold to Trimble, is popular with hobbyists.
- In the open source camp, the main contenders are **OpenSCAD** (http:// www.openscad.org) , which has a rather unorthodox scripting workflow, and FreeCAD (http://free-cad.sourceforge.net).
- You also can use **Blender** (http://www.blender.org), but it has a steep learning curve and is better suited to 3D animation than computer-aided design.
- When you have your design ready, you need a further piece of software to convert it into a set of instructions which will be fed to the printer
- This is usually known as the slicing algorithm because its most important function is to carve the model into a series of layers and work out how to instruct the printer to build up each layer.
- In most cases the particular slicing software that you use is governed by the specific printer which is building your model, but with the open source designs such as RepRap, you might have a couple of options.
- **Skeinforge** was the first slicing software used by the open source printers, but it has been largely overtaken by the newer and more user-friendly **Slic3r.**
- Both will let you tweak all manner of parameters to fine-tune your 3D prints, specifying options like the temperature to which the plastic should be heated, how densely to fill the solid objects, the speed at which the extruder head should move, etc.
- Getting those settings right (or right enough) can be daunting for the beginner.
- With its configuration wizard, Slic3r does a much better job of guiding you through to a usable starting point.
- Running through some calibration tests will let you tailor the settings to your particular printer and the specific plastic that you're printing.
- It can feel like a bit of a chore to be printing out 20mm cubes when you're itching to set it going with your great design, but taking some time to set things up when the issues are more easily spotted and remedied will pay back in better quality and more successful prints.

Computer Numerically Controlled Milling

FAQ

1. What is CNC Milling? Explain.

- Computer Numerically Controlled (CNC) milling is similar to 3D printing but is a subtractive manufacturing process rather than additive.
- 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.
- Because cutting away material is easier, CNC mills can work with a much greater range of materials than 3D printers can.

- You still need an industrial scale machine to work with hardened steel, but wax, wood, plastic, aluminum, and even mild steel can be readily milled with even desktop mills.
- CNC mills can also be used for more specialized (but useful when prototyping electronic devices) tasks, such as creating custom printed circuit boards (PCB).
- A wide range of CNC mills is available, depending on the features you need and your budget.
- Sizes range from small mills which will fit onto your desktop through to much larger machines with a bed size measured in meters.
- The main component of CNC is number of axis:
  - **2.5 axis:** It can move only in any two directions but one at a time.
  - **3 axis:** It moves in all three directions at the same time.
  - **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.
  - **5 axis:** This machine adds a second rotary axis—normally around the Y—which is known as the B axis.
  - **6 axis:** A third rotary axis—known as the C axis if it rotates around Z—completes the range of movement in this machine.

- CNC milling is split into two types:

CAD

- CAD is Computer-Aided Design.
- CAD software lets you design the models.

CAM

- CAM is Computer-Aided Manufacture.
- CAM software turns that into a suitable tool path.
- A list of coordinates for the CNC machine to follow which will result in the model being revealed from the block of material

REPURPOSE/RECYCLING

FAQ

1. Explain the purpose of recycling /repurposing in prototyping IOT devices.

- Repurposing or recycling in IOT devices is done on an existing product by the team of an hardware team of engineers which can help in following prototypes :
  - Re-built the design
  - Re-building of the launch timeframe and budget in order to make a good amount of profit in the market.
- The interfaces are increased with better connectivity management so that it can power up the monitor's inputs and outputs.
- In short or to conclude, the process of repurposing/recycling in IOT devices is done for the betterment of the system and to build its quality better.
- As with the other elements of building your connected device, a complete continuum exists from buying-in the item or design through to doing-it yourself.

- So, just as you wouldn't think about making your own nuts and bolts from some iron ore, sometimes you should consider reusing more complex mechanisms or components.
- 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.
- If the final design requires processes with massive up-front costs or the skills of a designer that you don't have the funds to hire right now, maybe a product already exists that is near enough to work as a proxy.

GETTING STARTED WITH APIS

FAQ

1. What is an API? What do you mean by mashing up APIs?

- 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 think about your experience of accessing an Internet service, you might follow a number of steps.
- For example, to look at a friend's photo on Flickr, you might do the following:
  - Launch Chrome, Safari, or Internet Explorer.
  - Search for the Flickr website in Google and click on the link.
  - Type in your username and password and click "Login".
  - Look at the page and click on the "Contacts" link.
  - Click on a few more links to page through the list of contacts till you see the one you want.
  - Scroll down the page, looking for the photo you want, and then click on it.

- Although these actions are simple for a human, they involve a lot of looking, thinking, typing, and clicking.
- A computer can't look and think in the same way.
- The tricky and lengthy process of following a sequence of actions and responding to each page is likely to fail the moment that Flickr slightly changes its user interface.
- For example, if Flickr rewards "Login" to "Sign in", or "Contacts" to "Friends", a human being would very likely not even notice, but a typical computer program would completely fail.
- Instead, a computer can very happily call defined commands such as login or get picture #142857.

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 visualize 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.

- Fetching Flickr images that are related to the top headlines retrieved from The Guardian newspaper's API.

SCRAPING

FAQ

1. Explain the term Scraping.

- Screen scraping is the process of collecting screen display data from one application and translating it so that another application can display it.
- This is normally done to capture data from a legacy application in order to display it using a more modern user interface.
- Screen scraping usually refers to a legitimate technique used to translate screen data from one application to another.
- The screen scraping application must usually do both of the following:
  - Capture screen input and pass it on to the legacy application for processing
  - Return data from the application to the user and display it properly on the user's screen
- Following are few examples of Screen Scraping :
  - Adrian has scraped the Ship AIS system to get data about ships on the river, and this information is then tweeted.
  - The Public Whip website is made possible by using a scraper to read the Hansard transcripts of UK government sessions .
  - With this, it can produce both human- and machine-readable feeds.
  - ScraperWiki has an excellent platform for writing scrapers, in a number of dynamic programming languages, which collate data into database tables.
  - Effectively, it provides infrastructure for "Mechanize" scripts that you could run on your own computer or server but allows you to outsource the boring, repetitive parts to ScraperWiki.

LEGALITIES

FAQ

1. What are the legalities associated with scraping?

- Most of the companies have samples of relevant data but they don't have knowledge to make it available as API's.
- Screen-scraping is not useful for websites as it may break the terms and conditions that a website must follow.
- For example the Google won't allow to screen scrap its search bar but will provide an API for the same.
- Even if you don't follow the legal rules the basic terms and conditions that are put by the company like Google should be followed else the company will exclude you from all other services that are provided that would lead to inconvenience.
- Rest of the data is protected with various security techniques like copyright, authenticating users to database rights and many more.
- There are always alternatives for all the information that is available.

- For example you can use Microsoft Outlook rather than using Gmail or you can use OpenStreetMap rather than using Google Maps.
- Some of the laws regarding to it are as follows :
    - DMCA – Violation of the Digital Millenium Copyright Act
    - CFAA – Violation of Computer Fraud and Abuse Act
    - Breach of Contract

WRITING AN API

- Although the process of designing a web application to be used on a browser can mix up the actions that users will accomplish with the flows they will take to navigate through the application, writing the back-end API makes you think much more in terms of the data that you want to process.
- When you know what data you have, what actions can be taken on it, and what data will be returned, the flow of your application becomes simple.
- This is a great opportunity to think about programming without worrying (at first) about the user interface or interactions.
- Although this might sound very different from writing a web application, it is actually an ideal way to start: by separating the business problem from the front end, you decouple the model (core data structure) from the view (HTML/JavaScript) and controller (widgets, form interaction, and so on).
- If you've programmed in one of the popular MVC frameworks (Ruby on Rails, Django, Catalyst, and so on), you already know the advantage of this approach.

CLOCKODILLO

- Clockodillo is an Internet-connected task timer.
- The user can set a dial to a number of minutes, and the timer ticks down until completed.
- It also sends messages to an API server to let it know that a task has been started, completed, or canceled.
- A number of API interactions deal precisely with those features of the physical device:
    - Start a new timer
    - Change the duration of an existing timer
    - Mark a timer completed
    - Cancel a timer
- Some interactions with a timer data structure are too complicated to be displayed on a device consisting mostly of a dial—for example, anything that might require a display or a keyboard!
- Those could be done through an app on your computer or phone instead.
    - View and edit the timer's name/description and, naturally, the user may want to be able to see historical data:
    - Previous timers, in a list
    - Their name/description
    - Their total time and whether they were canceled.
- For now, assume that each device will send some identifying token, such as a MAC address.
- So the user will somehow identify himself with the server, after which all the preceding actions will relate just to a given user ID.

SECURITY

- How important security is depends a lot on how sensitive the information being passed is and whether it's in anyone's interest to compromise it.
- For example,
  - For a clockodillo, perhaps a boss might want to double-check that employees are using the timer.
  - Or a competitor might want to check the descriptions of tasks to spy what your company is working on.
  - Or a competitor might want to disrupt and discredit the service by entering fake data.
- If the service deals with health or financial information, it may be an even more attractive target.
- Location information is also sensitive; burglars might find it convenient to know when you are out of the house.
- The request has to pass details to identify the user, which is the problem of identity; that is, the application needs to know for which user to create the timer so that the user can retrieve information about it later.
- But the application should also authenticate that request.
- A password is "good enough" authentication for something that isn't hypersensitive.
- You have to consider the risks in sending the identification or authentication data over the Internet
- If the username and password are in "clear text", they can be read by anyone who is packet sniffing.
- The two main cases here are as follows:
- **Someone who is targeting a specific user and has access to that person's wired or (unencrypted) wireless network.**
  - This attacker could read the details and use them (to create fake timers or get information about the user).

- **Someone who has access to one of the intermediate nodes.**
  - This person won't be targeting a specific device but may be looking to see what unencrypted data passes by, to see what will be a tempting target.

- If a software password is compromised, a website can easily provide a way of changing that password.
- But while a computer has a monitor and keyboard to make that task easy, an Internet Connected device may not.
- So you would need a way to configure the device to change its password—for example, a web control panel hosted on the server or on the device itself.
- This solution is trickier (and does require the machine to have local storage to write the new password to).
- One obvious solution to the problem of sending cleartext passwords would be to encrypt the whole request, including the authentication details.
- For a web API, you can simply do this by targeting https:// instead of http://.
- Instead of username/password on HTTPs allowing a MAC address over HTTP for requests 1-4 that will be sent by the timer.

IMPLEMENTING THE API

FAQ

1. Discuss the different standards that must be considered while implementing APIs.

- An API defines the messages that are sent from client to server and from server to client.
- Ultimately, you can send data in whatever format you want, but it is almost always better to use an existing standard because convenient libraries will exist for both client and server to produce and understand the required messages
- Here are a few of the most common standards that you should consider:

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: (Remote Procedure Call)

(Remote Procedure Call is a software communication protocol that one program can use to request a service from a program located in another computer on a network without having to understand the network's details.)

- Access a single web URL like http://timer. roomofthings.com/api/, passing a JSON string such as {‘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.
- Use a REST API because it is popular, well supported, and simple to interact with for a limited microcontroller.
- The design considerations we describe mostly apply for all the standards.

REAL TIME REACTIONS

- To establish an HTTP request requires several round-trips to the server.
- There is the TCP “three-step handshake” consisting of a SYN (synchronize) request from the client, a SYN-ACK from the server to “acknowledge” the request, and finally an ACK from the client.
- Although this process can be near instantaneous, it could also take a noticeable amount of time.
- If you want to perform an action the instant that something happens on your board, you may have to factor in the connection time.
- If the server has to perform an action immediately, that “immediately” could be nearly a minute later, depending on the connection time.

- For example, with the task timer example, you might want to register the exact start time from when the user released the dial, but you would actually register that time plus the time of connection.
- We look at two options here: polling and the so-called “Comet” technologies.

POLLING

FAQ

1. What is Polling? Explain in brief.
2. Explain Polling and Comet.

- Polling is not a hardware mechanism; it’s a protocol in which the CPU steadily checks whether the device needs attention.
- 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 might make a call every minute to check whether new data is available for you.
- However, this means that you can’t start to respond until the poll returns.
- So this might mean a delay of (in this example) one minute plus the time to establish the HTTP connection.
- 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 connection.

COMET

FAQ

1. What is Comet? Explain.
2. Explain Polling and 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
- Long polling would be ideal for the case of Where Dial: the dial requests to know when the next change of a user’s location will be. As soon as Where Dial receives the request, it moves the dial and issues a new long poll request.

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.
- From the web server’s point of view, these requests are no different from any other HTTP request, but because the intended recipient is some client-side code, conventions and support libraries (both client- and server-side) have developed to address this method of interaction specifically.
- Many browsers support a multipart / x-mixed replace content type, which allows the server to send subsequent versions of a document via XHR.

HTML WEBSOCKET

FAQ

1. Explain HTML5 Websocket.

- HTML5 web socket is an bidirectional API which is used to directly talk to the TCP layer.
- This web socket was discovered in order to provide some similar type of capabilities like the HTTP layer and thus calling it Web Sockets.
- They work in modern browsers, servers and in other clients too.
- As they are bidirectional in nature they are used in Arduino platforms as it consists of a full UNIX socket handle where the client can freely write down its requests as well as read to the responses also.
- As it was versatile in nature changes to be made in software, modifications , cancellations and sending of the information was made possible via this web socket.

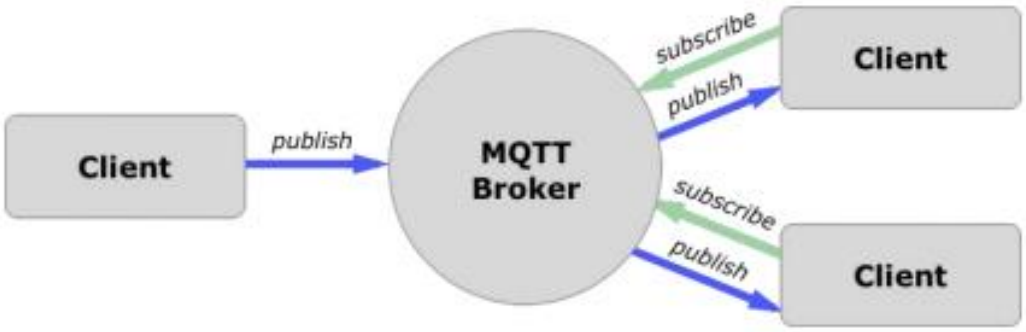
OTHER PROTOCOLS

MQTT

FAQ

1. Write a short note on Message Queuing Telemetry Transport Protocol.

- MQTT is one of the most commonly used protocols in IoT projects.
- It stands for Message Queuing Telemetry Transport.
- In addition, it is designed as a lightweight messaging protocol that uses publish/subscribe operations to exchange data between clients and the server.
- Furthermore, its small size, low power usage, minimized data packets and ease of implementation make the protocol ideal of the "machine-to-machine" or "Internet of Things" world. MQTT server is called a broker and the clients are simply the connected devices.
- When a device (a client) wants to send data to the broker, we call this operation a "publish".
- When a device (a client) wants to receive data from the broker, we call this operation a "subscribe".



- MQTT has unique features you can hardly find in other protocols, like:
- It's a lightweight protocol: So, it's easy to implement in software and fast in data transmission.
- It's based on a messaging technique: Of course, you know how fast your messenger/WhatsApp message delivery is. Likewise, the MQTT protocol.
- Minimized data packets: Hence, low network usage.
- Low power usage: As a result, it saves the connected device's battery.
- It's real time: That's specifically what makes it perfect for IoT applications.

EXTENSIBLE MESSAGING AND PRESENCE PROTOCOL

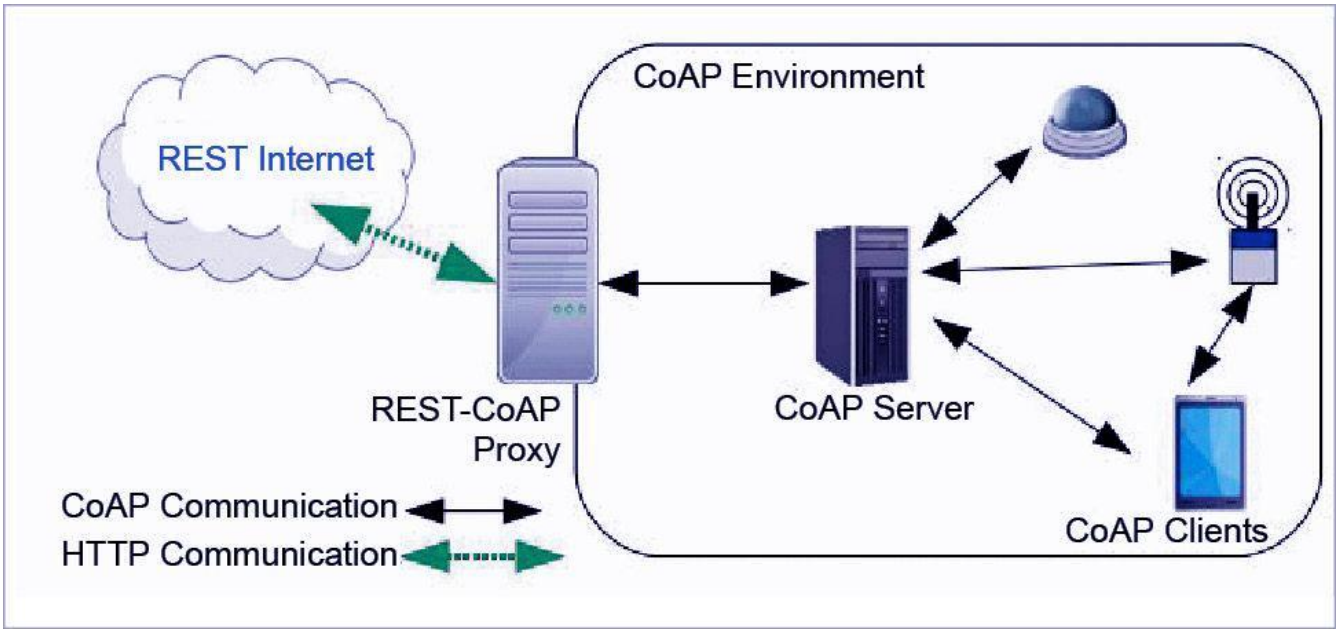
- XMPP is a short form for Extensible Messaging and Presence Protocol.
- It's protocol for streaming XML elements over a network in order to exchange messages and presence information in close to real time.
- This protocol is mostly used by instant messaging applications like WhatsApp.

XMPP means:

- X: It means eXtensible. XMPP is a open source project which can be changed or extended according to the need.
- M: XMPP is designed for sending messages in real time. It has very efficient push mechanism compared to other protocols.
- P: It determines whether you are online/offline/busy. It indicates the state.
- P: XMPP is a protocol, that is, a set of standards that allow systems to communicate with each other.

CONSTRAINED APPLICATION PROTOCOL

- CoAP (Constrained Application Protocol) is a session layer protocol that provides the RESTful (HTTP) interface between HTTP client and server.
- It is designed by the IETF Constrained RESTful Environment (CoRE) working group.
- It is designed to use devices on the same constrained network between devices and general nodes on the Internet.
- CoAP enables low-power sensors to use RESTful services while meeting their low power constraints.
- This protocol is specially built for IoT systems primarily based on HTTP protocols.
- This network is used within the limited network or in a constrained environment.
- The whole architecture of CoAP consists of CoAP client, CoAP server, REST CoAP proxy, and REST internet.



- The data is sent from CoAP clients (such as smartphones, RFID sensors, etc.) to the CoAP server and the same message is routed to REST CoAP proxy.
- The REST CoAP proxy interacts outside the CoAP environment and uploads the data over REST internet.